January 1975

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COVER: *A computer-enhanced, satellite infrared image of the U.S. east coast and adjacent waters. Coldest temperatures appear white, warmest black. The dark, dragonlike pattern dominating the right side of the picture is the warm water of the Gulf Stream snaking north- and northeastward between the colder water over the Continental Shelf and Continental Slope to the west and the open ocean to the east. This remarkable picture reveals fine details of turbulent structure that probably would never be detected by shipboard observations. Copies of this picture, and of those appearing in the lead article, "The View From Space" (beginning on page 4), are available at the cost of reproduction from: Chief, Satellite Data Services Branch, NOAA/Environmental Data Service, World Weather Bldg., Room 606, 5200 Auth Rd., Camp Springs, MD 20023.*

ENVIRONMENTAL DATA SERVICE is designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, Center for Climatic and Environmental Assessment, and National Oceanic and Atmospheric Satellite Data Unit. In addition, under an agreement with the National Academy of Sciences, the National Oceanic and Atmospheric Administration (NOAA) has responsibility for World Data Center-A activities in oceanography, gravity, tsunami, seismology, geomagnetism, meteorology, and nuclear radiation, ionosphere and airglow, cosmic rays, auroras, and solar observations; the Director of EDS coordinates these activities within NOAA.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, July 26, 1973; this approval expires June 30, 1975.

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Change

The new format that begins with this issue reflects the evolution of the mission and services of the Environmental Data Service itself. Although not minimizing the importance of archival and dissemination services, EDS today finds itself increasingly and deeply involved in applying environmental data and information to the understanding and resolution of pressing national and global problems.

During the past year, this magazine has reported EDS contributions to national programs concerned with alleviating the effects of the energy crisis (January 1974) and potential global food shortages (May and July 1974). It also has reviewed the EDS role in international data exchange and in training scientists from developing countries so as to derive maximum benefits from the application of data and information to the problems of other nations, as well as to problems of global concern (March 1974). In May, and again in September, it examined the critical role of environmental data management in all phases of large-scale, interdisciplinary experiments such as the Global Atmospheric Research Program (GARP) Atlantic Tropical Experiment (GATE).

The shift in emphasis in EDS activities may be traced in the growth of its organization and programs. Recently, EDS established a Center for Climatic and Environmental Assessment to provide statistical models and assessments of environmental events that threaten man's social or economic welfare. Earlier, in October 1972, EDS acquired the nucleus of its present Center for Experiment Design and Data Analysis, which played such an important role in the success of the Barbados Oceanographic and Meteorological Experiment, the International Field Year for the Great Lakes and, most recently, GATE.

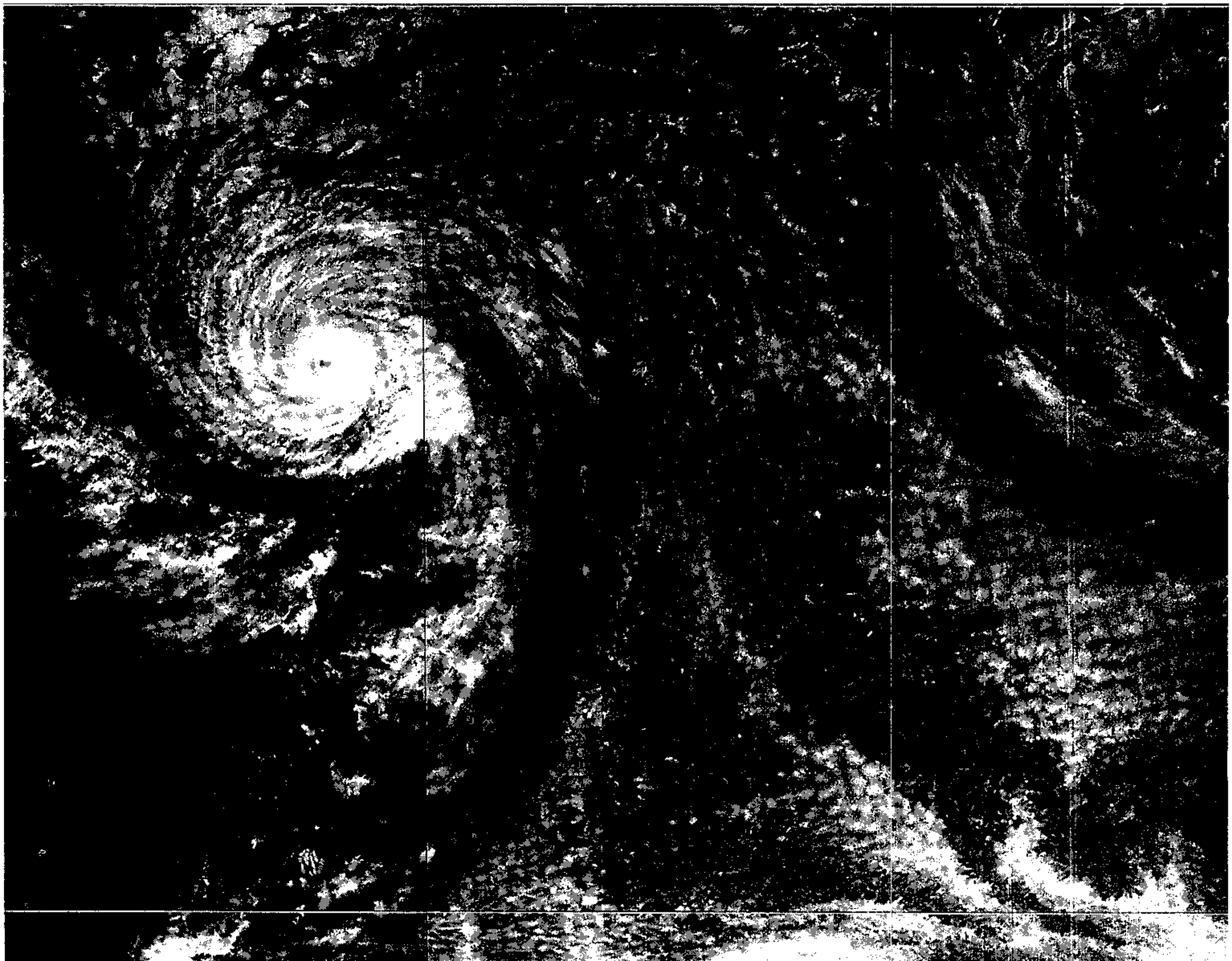
Last October, in recognition of the unique value of satellite data in interpreting and understanding the coupled air/sea system, EDS assumed national responsibility for the dissemination of oceanic and atmospheric satellite data products. More recently, EDS has joined with NASA and the U.S. Dept. of Agriculture in an experiment to determine whether satellite data can improve our capability to make timely and accurate forecasts of global crop production. (See page 16.)

All of these programs and services have been undertaken to meet new national and international environmental data and information needs. At the same time, however, there also has been a rapid growth in the more traditional services and products provided by EDS data and information centers. In calendar year 1971, for example, EDS answered over 32,000 user requests; by 1974, the number was over 75,000 and still growing.

EDS exists to serve user needs, whether new or traditional. Today, under the pressure of increasing demands for environmental baseline data and information against which to measure man's interaction with his environment, the concept and practice of data management, like many traditional concepts and practices, are undergoing revolutionary change. That is as it should be.

John W. Townsend Jr.

John W. Townsend, Jr.
Associate Administrator
National Oceanic and
Atmospheric Administration



The View From Space

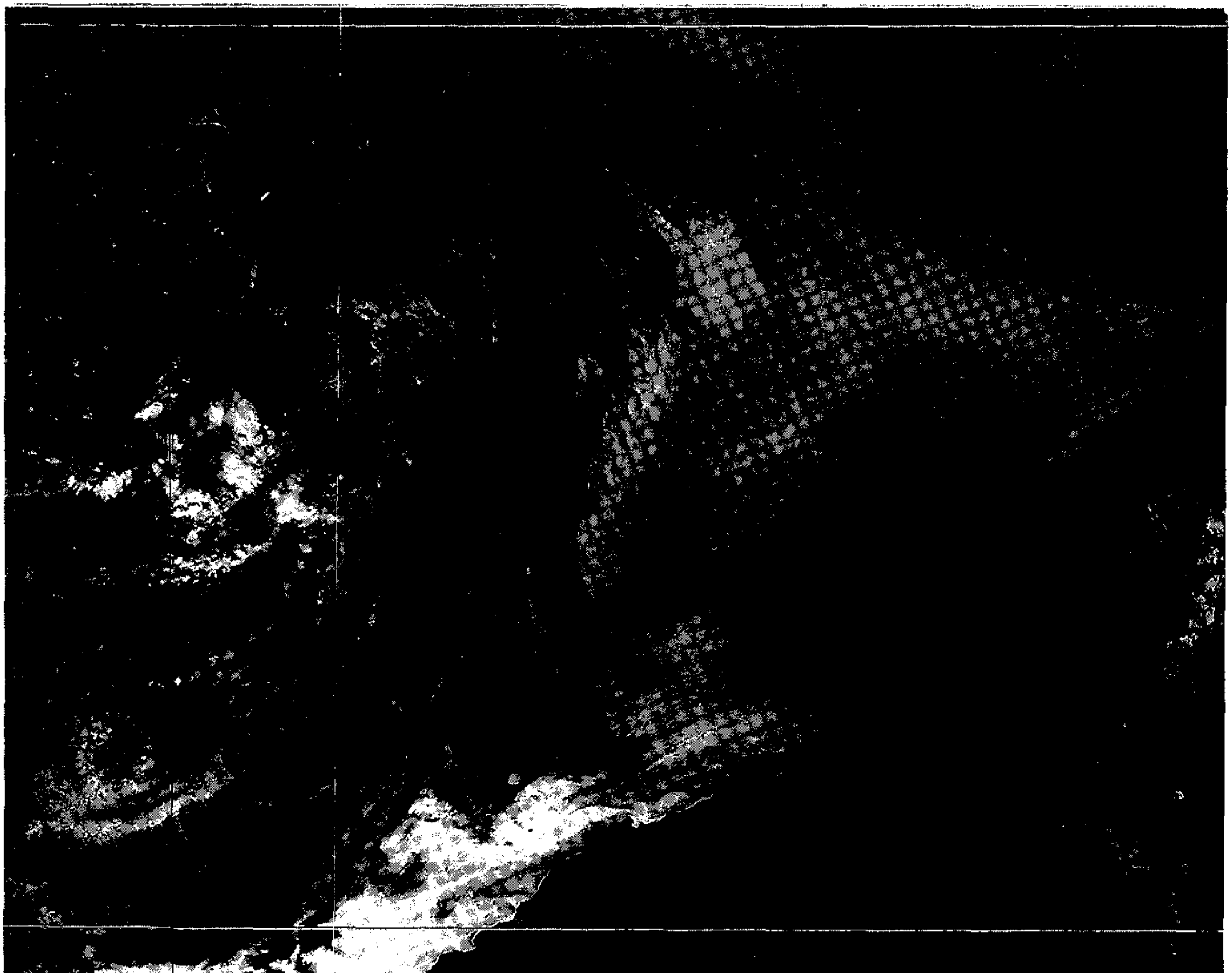
By Patrick Hughes

Just a few short years ago, man knew the Earth and its atmosphere only from the ground, or from the slightly enhanced perspective provided by aircraft. Today, thanks to the satellite, we have "stepped back" far enough to see the real world and its environmental systems.

Satellite data have made perhaps their most valuable contribution in the early detection and tracking of tropical cyclones—the great coiled hurricanes of the Atlantic and eastern Pacific, typhoons of the western Pacific, and cyclones of the Southern Hemisphere. Since the beginning of a national operational satellite service in 1965, probably no tropical storm has gone undetected anywhere in the world.

Besides tropical-cyclone and other storm tracking, the most pervasive application of environmental satellite imagery has been to document the myriad cloud patterns that are the visible manifestations of so many invisible atmospheric processes — wind fields, storm dynamics, the jet stream.

Although meterology has been the primary field of environmental satellite data application to date, it is not the only one. Satellite images, for example, portray the extent and char-



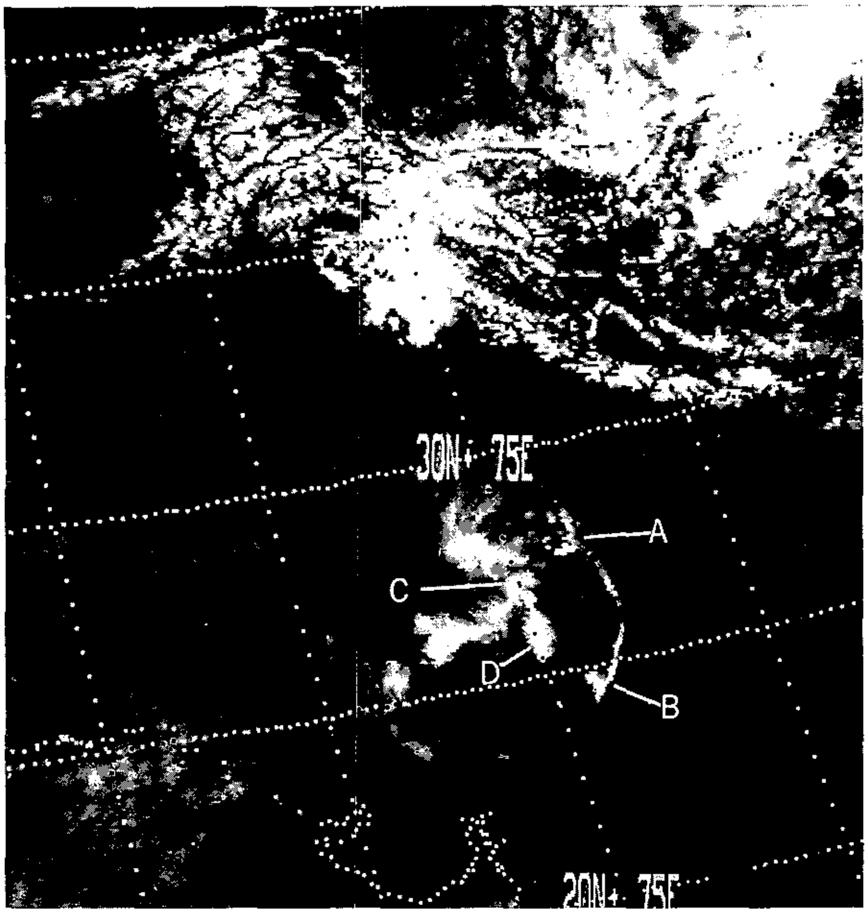
acter of ice fields with a completeness and frequency never before possible. They have brought improvement to the mapping of sea and lake ice, and to the monitoring of the seasonal formation and breakup of polar ice caps.

Unlike the human eye, satellite infrared (IR) sensors can "see" heat—the warms and colds, absorptions and emissions of our planet. They can also see at night, and IR data can be computer-enhanced to greatly increase their value.

For almost a decade-and-a-half, a wealth of data has flowed earthward from polar-orbiting satellites circling the Earth twice a day. Now, a "geostationary" satellite, whose orbit and speed make it hover constantly over the same point on Earth, provides detailed, high-resolution pictures of much of the Western Hemisphere every 30 minutes.

We have only begun to tap the potential of satellite data. At NOAA's National Environmental Satellite Service, for example, a group of scientists spend all their working hours searching satellite imagery for new knowledge, new clues to environmental mechanics, new applications of this privileged view of Earth and environment to the problems of man.

The eastern Pacific (North to the right; U.S. West Coast, lower right) viewed from the polar-orbiting NOAA-3 satellite on August 26, 1974. Swirling cloud masses identify Hurricane Ione (left) and an upper-air low pressure center. More tropical storms and hurricanes are spawned over waters between California and the Panama Canal than in any other part of the world. Most move out to sea, but a few veer northeastward over Baja California and the Mexican mainland. Thanks to satellite surveillance, NOAA is able to issue warnings to the towns and cities in their path.

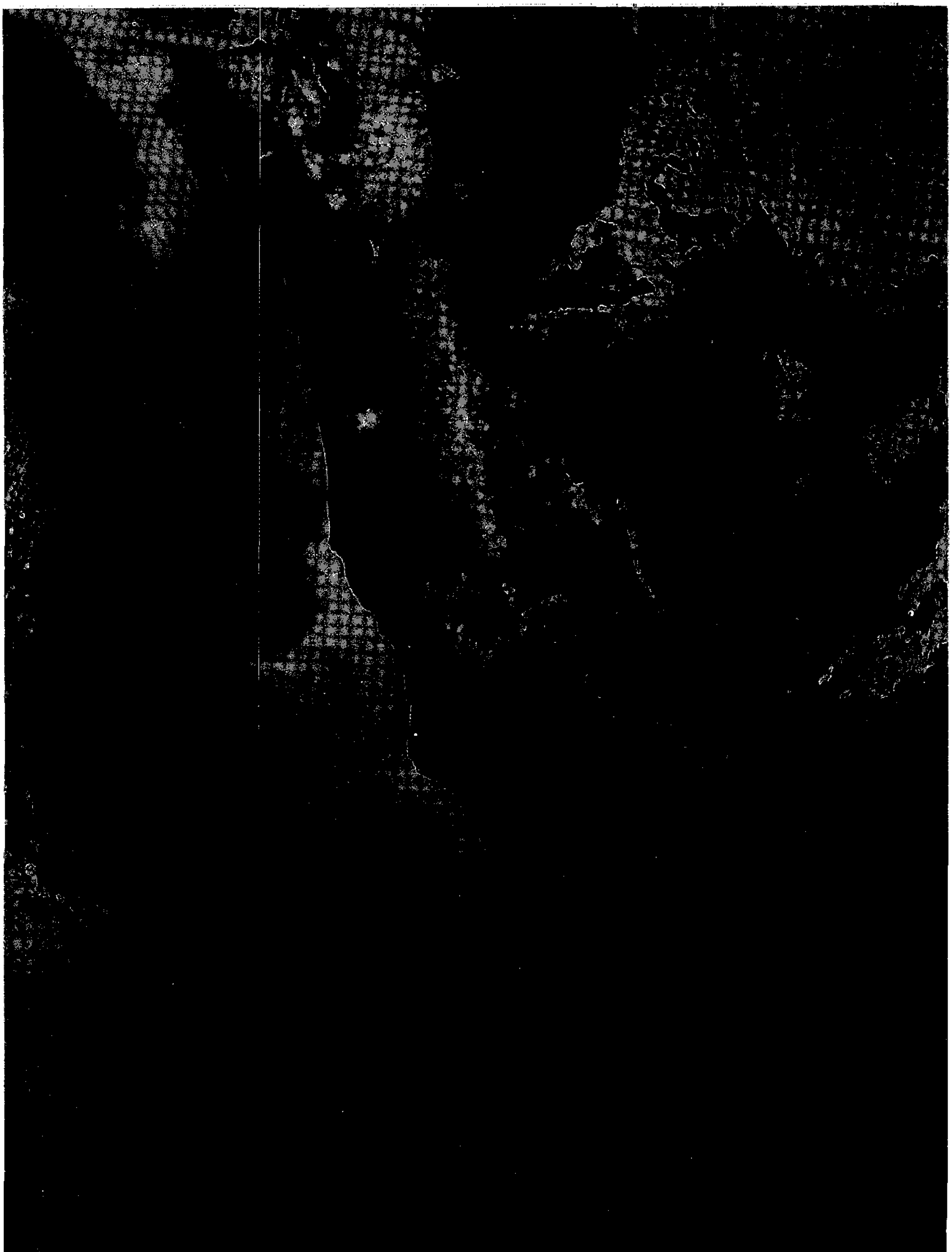


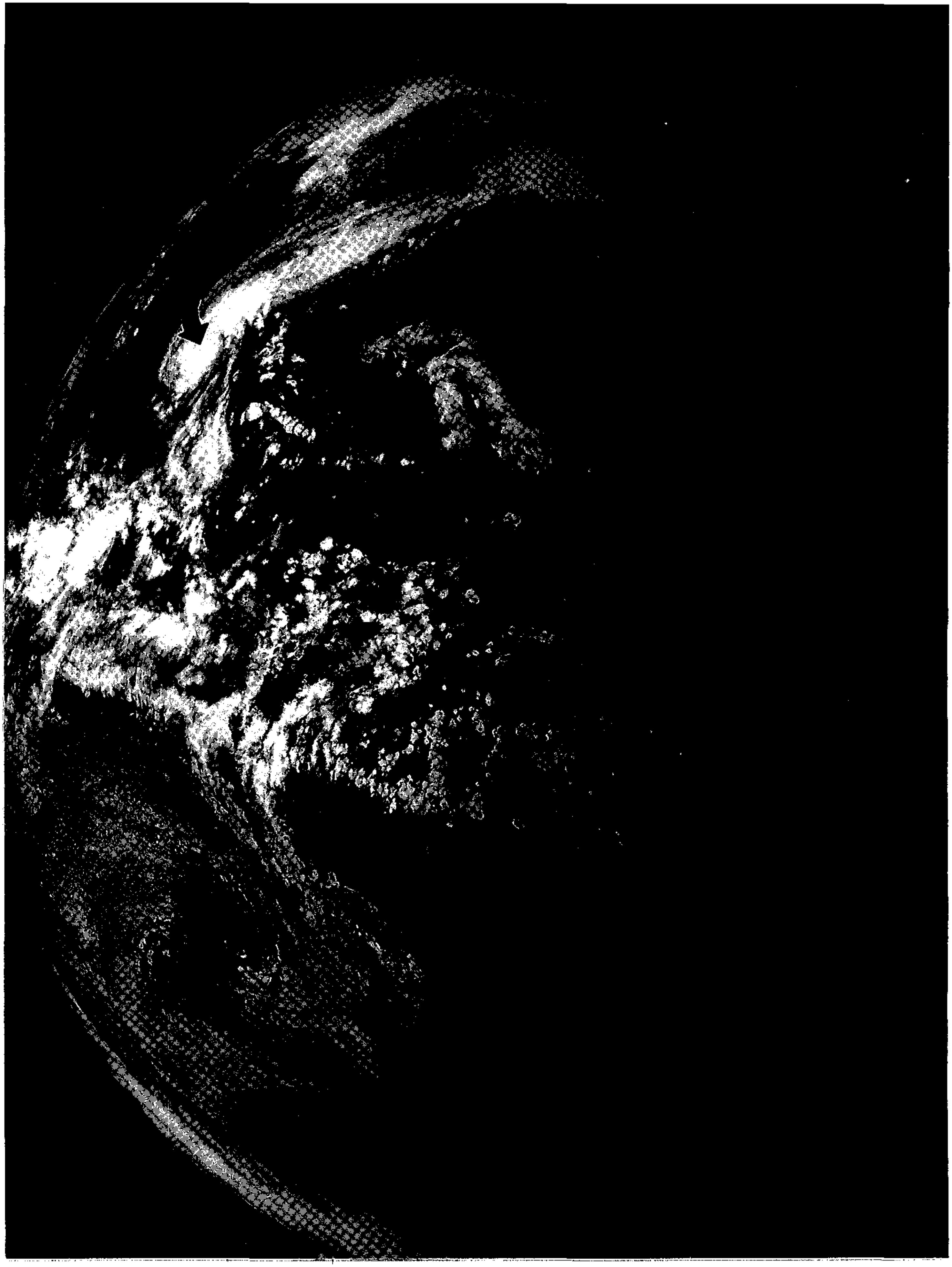
Opposite page: Complex cloud patterns off the west coast of Africa caused by wind eddies downstream from the Canary Islands. Above, left: Thunderstorm structure on the plains of northern India. Arc cloud AB is the leading edge of a low-level, cold air outdraft from thunderstorms along CD. The outrushing air has stirred up clouds of dust visible west and southwest of the arc cloud. Above: A cirrus (ice) cloud shield identifies a jet stream over the eastern United States. Superimposed wind observations show the cloud shield embedded in a strong anticyclonic airflow. Left: Meteorologists studying this satellite cloud picture of December 10, 1973, discovered a telltale trail of smoke (arrow) from a volcanic eruption on Isla Fernandina in the Galapagos. Smithsonian Institution scientists subsequently visited the island and confirmed the eruption.

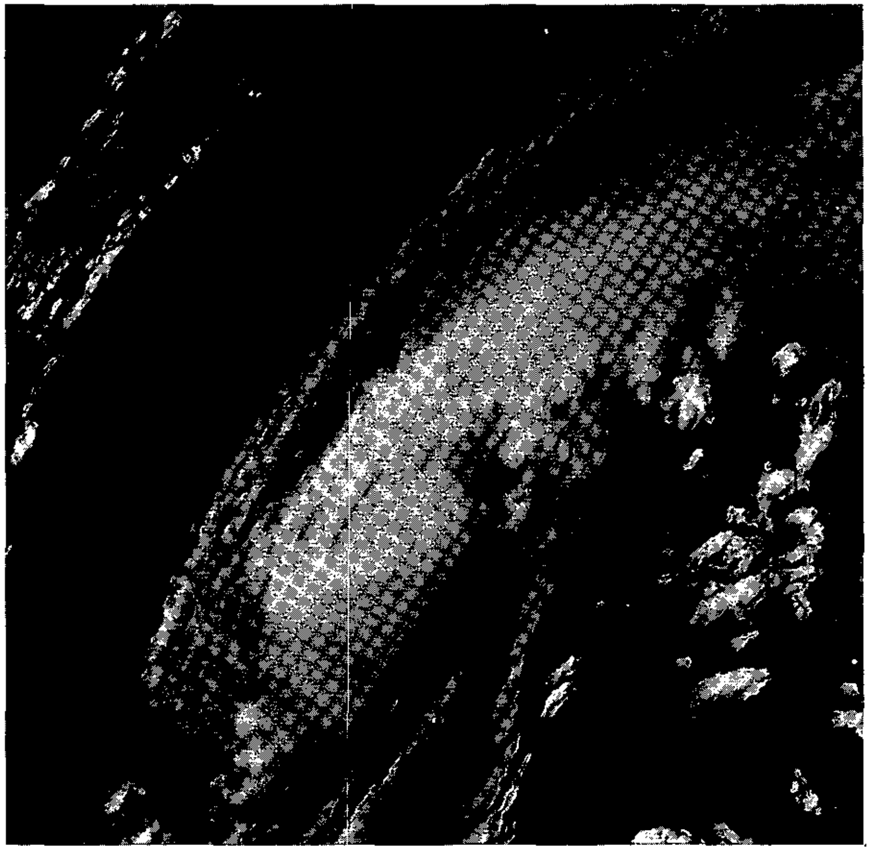
NOAA-2 view of the Ross Ice Shelf in Antarctica, showing open water along the edge of the shelf and ice in the Ross Sea (to the right). Note the 3-dimensional cloud near the top of the picture.

Right: Now you see it, now you don't. Two views of Lake Michigan from NASA's ERTS-1 Satellite, August 21, 1973. Upwelling brings nutrients to the surface and sets off massive, green-colored plankton blooms highly visible in the green-light portion of the visible spectrum (left), but not in the red (right).

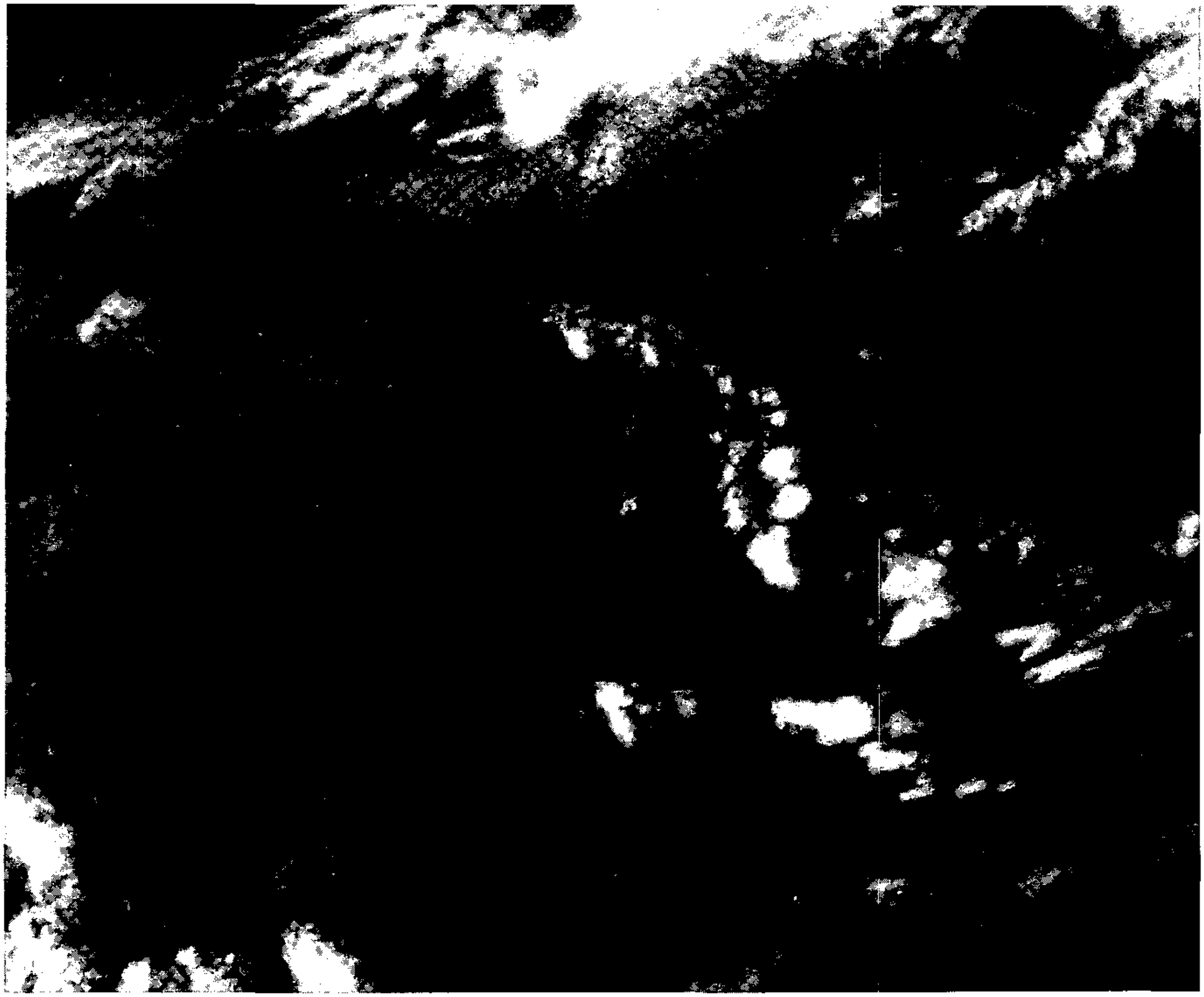
Opposite page: A computer-enhanced, infrared image of the West Coast and adjacent waters during a period of pronounced upwelling on September 11, 1974. Here the turbulent, swirling patterns represent invisible surface and subsurface temperature patterns, rather than visible phenomena such as the plankton in the Lake Michigan pictures.



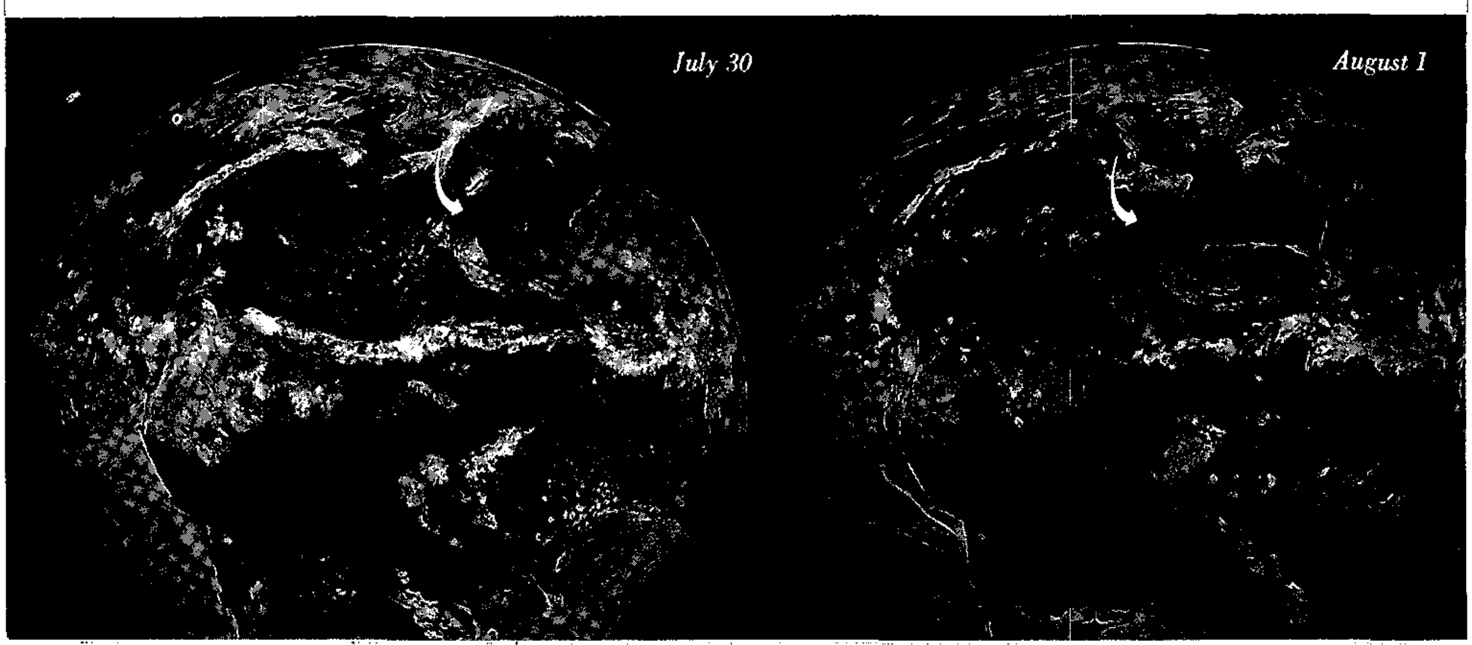


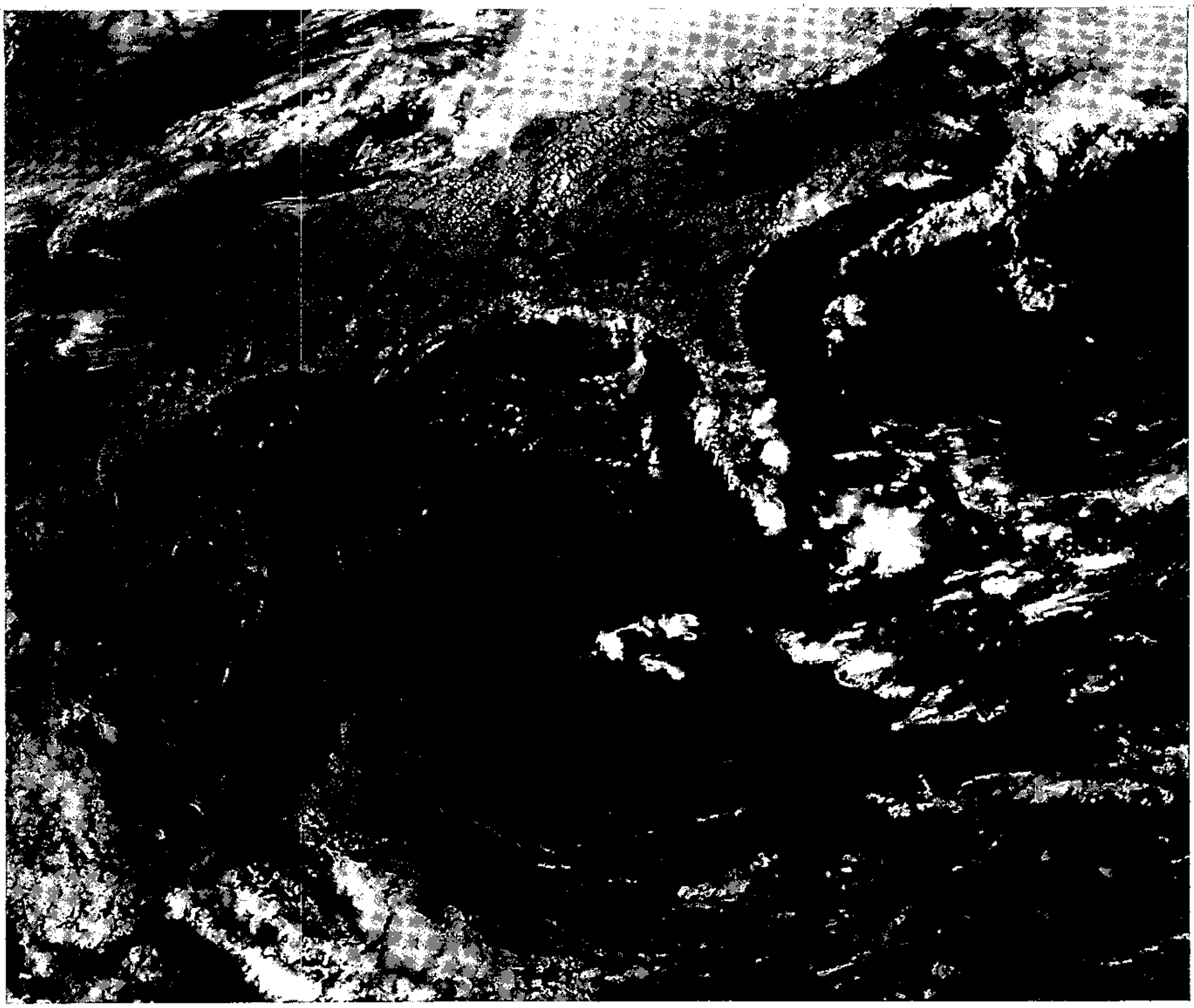


Opposite page: A full-disc, geostationary satellite view of the western Atlantic with night approaching, 4-km (2 mi) resolution, September 7, 1974. South America is in the bottom of the picture, while Hurricane Carmen (arrow) whirls in the Gulf of Mexico. Top left: A higher-resolution (2-km) view of Carmen. Below: A 1-km (½ mi) resolution view. These pictures were taken by NASA's new Synchronous Meteorological Satellite (SMS-1), which is operated by NOAA's National Environmental Satellite Service.

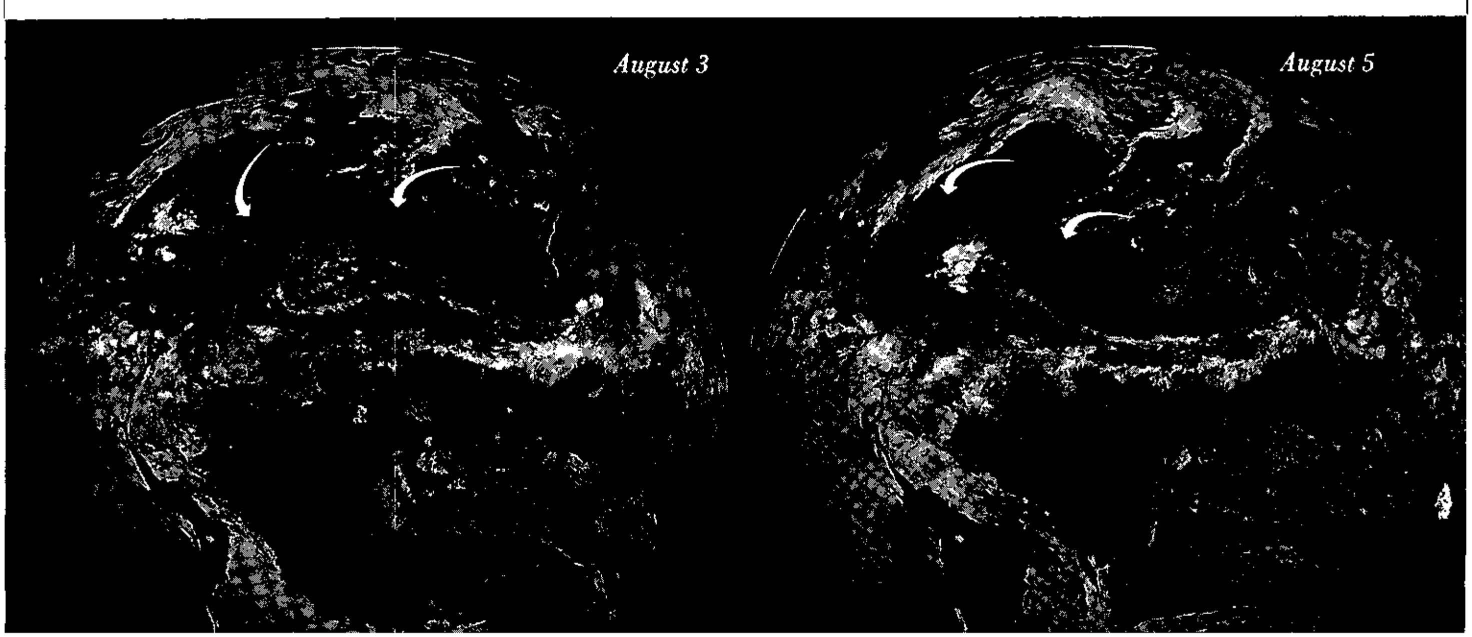


The old and the new. The pictures above demonstrate the difference in resolution between a picture (left) made by NASA's older geostationary Applications Technology Satellite (ATS-3), and a picture (right) made by the SMS-1.





Below: A series of SMS-1 midafternoon pictures documents the trans-Atlantic passage of African dust (arrows) to the Caribbean and southeastern United States from July 30 to August 5, 1974. Such photographs help NOAA scientists study how dust affects the solar energy balance and weather of the tropical Atlantic.



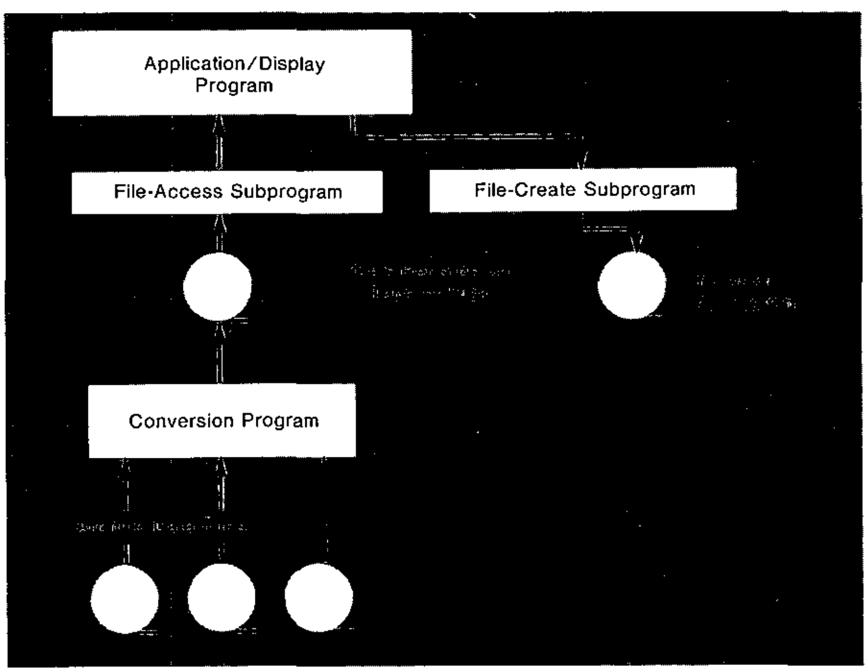
GAS: A File-Independent, Generalized Application System

By Walter Morawski

The introduction of modern data acquisition and collection techniques has resulted in the creation of new, specialized data files. These files, often designed specifically to accommodate inherent instrument peculiarities, present a difficult problem to the would-be user, who is confronted with a multiplicity of formats and file structures.

EDS' National Oceanographic Data Center programers have designed and implemented a Generalized Application System (GAS) to solve or minimize the problem. GAS is based on the premise that, with acknowledged exceptions, most files of oceanographic data consist of identification fields (location, date, etc.), an independent variable (perhaps water depth or time), and one or more dependent variables (e.g., water temperature or dissolved oxygen). A system can be designed to treat these items uniformly. Thus, rather than tailoring display programs to a discrete data file, these basic units are extracted and transmitted to a generalized data-application system from which many products may be derived. This paper describes how such a system operates.

Figure 1. Flow diagram for the GAS system.



A File-Dependent System

Traditional practice has been to tailor a data application display program to the particular data set being studied. Such a program works only with the initial-demand-type file and is therefore file-dependent. A further complication arises when the analyst changes the structure of the file (perhaps he adds another data parameter to the record). Now he must go back and modify all programs in that particular data system. This job is so tedious that it usually never gets finished. Rather than keeping tabs on one system, the analyst now must resolve the permutations of old data records vs. new data records, as well as old and new program versions.

The manpower and machine costs of such a nonintegrated system soon become prohibitive.

A File-Independent System

A particular data application can never be limited totally to one set of input data; the best designed data files and formats will need revisions. Technological advances in data processing (e.g., mass storage, sophisticated display devices) also will impose change. A large portion of these problems can be eliminated by employing a technique called File Independence. As its name implies, a file-independent system of computer programs differs from conventional programing systems by operating at a heirarchical level above the ordinary data file.

At NODC, the link between the data files and the GAS system is a translation or conversion module. (See figure 1.) The main functions of the conversion module are to:

(1) resolve all files to a common location/identification system,

(2) strip out unneeded fields and pass to the application program only the fields designated,

(3) convert all fields to internal machine format for rapid handling and manipulation,

(4) perform basic selection functions such as returning data at regular increments or specified levels, and returning observed or interpolated values.

This conversion module may be either a discrete, "stand alone" program, or a subprogram appended to a file retrieval program.

We now have a system of application programs tailored to an intermediate file created by a program that addresses all discrete data files. A given application can now operate on any of the files in the system and can intermix records from all files. If a new file is to be added to the system, one only has to modify the conversion module, and all programs in the system are free to operate on the new file. We now have "n" number of application programs, rather than a theoretical maximum of "n" times the number of files (the worst possible case). We had to write only one extra program, the conversion module.

This scheme, if carried only this far, has a fatal flaw. If future circumstances make it necessary to redesign the intermediate (GAS) file structure, NODC would have to change every program in the entire system.

This problem is avoided by raising the applications program a heirarchical level above the intermediate file. NODC accomplishes this by providing GAS access routines. Thus, the application programs never address the GAS file directly, rather they call system subprograms that read and write records. These subprograms are written in low-level ASSEMBLER Language, which ensures maximum speed and minimum core size. From figure 1 we see that the ability to change the intermediate file is unlimited, because only three program changes are needed: the conversion module, and the read and write subprograms. Changes of this type are called "transparent," that is the application program and the original archive file are in no way altered.

An added benefit of file access routine utilization is that programs become easier and faster to write. Studies have shown that up to 45 percent of a programer's time can be spent in the reading and writing of data. This time is saved everytime another program is written using a system access routine.

The NODC GAS system is being implemented in stages. Version 1 of the conversion module accessed the files for Nansen casts, mechanical bathythermographs (BT), and expendable bathythermographs (XBT). The first application programs written were inventory-location, map-plotting programs. Later, tabular and graphical summaries of water-column parameters and their monthly variations were added. In less than 1 year, the capabilities of the GAS program have progressed to approximately equal the sum total of the application programs resident in the three systems mentioned above. In addition, all applications can operate on all files, as well as mixtures of files.

GAS is growing in three general directions:

(1) Access to more files. Soon to be added are the continuous salinity-temperature-depth (STD) file, ICES ocean surface reference file, and data from cooperative oceanographic research projects.

(2) More application programs. With most inventory and statistical, summary-type programs completed, more sophisticated analysis, modeling, and quality-control projects are being undertaken.

(3) Expanded capabilities of the conversion module. Several choices of interpolation methods, more specific data-windowing, and more complex, independent parameter relationships will be explored.

Because of the extra processing step necessary in the conversion module, in some cases the simplification at the user end has to be paid for in machine time at the processing end. In most cases to date, however, thanks to the low-level access and conversion methods of GAS, coupled with the application program streamlining now possible, machine time used in the conversion and application processing is in most cases less than the time used in a conventional processing program.

Perhaps the greatest benefit of the GAS system is that the drawing of NODC's many data files into an integrated network will result in improved products and services for NODC data users.

An Earth Resources Technology Satellite (ERTS) mockup during a space chamber test.

Can Satellite Data Improve Crop Forecasts?

In October 1974, the U.S. Department of Agriculture (USDA), National Aeronautics and Space Administration (NASA), and NOAA signed a Memorandum of Understanding to make a joint investigation to determine whether the use of spacecraft data analyzed with the aid of computers can improve the timeliness and accuracy of major crop forecasts. The project, called LACIE (Large Area Crop Inventory Experiment), is one of several large area experiments that NASA will undertake in cooperation with user agencies to test the capabilities of Earth resources survey systems for resource management programs.

At the outset, LACIE will concentrate on wheat growing in North America. The experiment will combine crop acreage measurements obtained from Earth Resources Technology Satellite ERTS-B, scheduled for launch in January 1974, and data and meteorological information from NOAA satellites and from ground stations to relate weather conditions to yield assessment and utlimately to production forecasts. Initially, a particular State or several States will be chosen for detailed evaluation, particularly as to the adequacy of the yield modeling. At the same time, area estimates will be made by a sampling technique covering the entire region. If, during the first year, the program proves successful and useful, it will be extended in the second year to other regions and ultimately to other crops.

The Department of Agriculture will study the utilization of the experimentally derived production estimates in its crop reports. These reports are made public as a routine service to the domestic and international agricultural community.

Data for the sample areas received from ERTS-B will be processed into computer-compatible magnetic tapes at the Goddard Space Flight Center in Greenbelt, Md. The tape reels will be shipped to the Johnson Space Center in Houston, Tex., where a computer-assisted analysis of the North American data will be made to identify crops and to integrate the sample areas into an overall acreage estimate. It is hoped that such information could be assembled a number of times during the growing season. The yield data will also be integrated with the acreage information at Houston, although early experimental work on yield modeling will be done at other places, such as the Environmental Data Service's Center for Climatic and Environmental Assessment (CCEA) at Columbia, Mo.

During the first year of LACIE, computer techniques for classifying growing crops and estimating acreage will be refined, and results checked by visual-image interpretation and field reporting. During the same period, computer models relating weather and climate information to crop yield will be designed and tested. Routine procedures will also be developed to process and analyze the large quantities of data collected during LACIE.

Each of the three agencies will have its own Project Manager responsible for the resources provided by his agency and for guidance of its part of the LACIE implementation; however, to aid in integration, an interagency Executive Steering Group has been established to provide overall management and guidance. The day-to-day management of the experiment itself will take place at Houston under a LACIE Manager selected by NASA.

Although each LACIE task will require integration of efforts of at least two of the three agencies involved, each agency has certain lead responsibilities, including that of the Department of Agriculture in defining output product requirements and in evaluating the utility of output products; NOAA in developing and evaluating yield models and in providing climatological and meteorological data; and NASA in developing the sampling, classification, and mensuration systems, and in acquiring and processing ERTS data. Final evaluations and results of the experiment will be published in scientific and technical literature.

If the experiment proves effective, the new techniques, in combination with current crop estimating methods and historical production data, could benefit both producers and consumers by helping reduce the annual uncertainties affecting the management and marketing of major crops. Faster, earlier, and more accurate forecasts could assist in rational planning for the most effective use of supplies, as well as in emergency food distribution.

New Precipitation-Frequency Atlas

NOAA's National Weather Service is publishing a *Precipitation Frequency Atlas of Western United States.* It consists of eleven volumes covering the States of Montana, Wyoming, Colorado, New Mexico, Idaho, Utah, Nevada, Arizona, Washington, Oregon, and California. One volume is being printed for each State so that users may acquire only the volumes for which they have a need. The work was funded by the Soil Conservation Service (SCS), U.S. Department of Agriculture, under the Watershed Protection and Flood Prevention Act, Public Law 566. SCS will use the atlas in the planning and design of farm ponds and small watershed floodwater-retarding structures, and in various other hydrologic applications. These projects are so numerous and diversified that it would be impossible to make individual studies for each one, thus, generalized studies from which applications for particular locations can be made are most desirable.

SCS is not the only user. Highway departments use precipitation-frequency maps to obtain precipitation values for designing culverts for interstate, Federal, and State highways. The Federal Aviation Administration uses precipitation frequency values to evaluate the design of drainage systems for small private and large international airports in major metropolitan areas. Local communities use the maps to develop design curves for storm drainage systems for housing subdivisions, industrial parks, community facilities, etc.

The atlas shows in much greater detail than its predecessor, *Rainfall Frequency Atlas of the United States* (issued by the Weather Bureau in 1961), the large variations in precipitation frequency regimes over the rugged mountain regions of the West. The basic precipitation frequency data are presented in a series of maps for key return periods of 6- and 24-hours. Utilizing all available data from the western United States, relations have been developed that enable the user to determine values for all durations and return periods from 5 minutes to 24 hours and from 2 to 100 years.

In certain portions of the western United States—the central Rockies, Utah, and Colorado, and the mountainous regions of California—precipitation-frequency values are sometimes influenced by large snowstorms. With the increased data, it now has been possible to isolate the effect of snowfall from rainfall. Thus for the user interested only in immediate runoff, it is possible to determine from the maps or from procedures outlined in the publications the amount of rainfall that would be equaled or exceeded at various probability levels.

User convenience was emphasized in designing the atlas; maps for adjoining States may be placed side by side and joined along their common boundary. The atlas is published in looseleaf form, and all maps are prepared on the same 1:2,000,000 scale.

Each volume of the atlas has been organized into three parts. The first section discusses the historical background, procedures, and methods used in preparing the maps and how to interpret and use them. The second discusses ideas that are applicable only to the particular State considered in that volume. Included in this section are methods (nomograms and equations) useful for estimating precipitation-frequency values for durations other than 6 and 24 hours. The last part of the atlas contains maps for the 6- and 24-hour durations for return periods of 2, 5, 10, 25, 50, and 100 years.

This new atlas is the culmination of many years of investigation. It is based upon all the previous work on precipitation-frequency studies. It utilizes more data and new methods of analysis, and presents in more detail and with greater accuracy the precipitation-frequency regime for western United States. Engineers active in the design of hydrologic structures will be able to use this new standard to develop the best possible design.

The prices for individual volumes of the atlas (NOAA Atlas 2) are:

Vol.	State	Price
I	Montana	$ 8.35
II	Wyoming	8.45
III	Colorado	10.10
IV	New Mexico	8.45
V	Idaho	8.45
VI	Utah	10.10
VII	Nevada	8.45
VIII	Arizona	8.35
IX	Washington	8.45
X	Oregon	8.45
XI	California	10.30

The volumes are available from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

AMS Climatology Conference/Workshop

A Climatology Conference and Workshop sponsored by the American Meteorological Society was held in Asheville, N.C., Oct. 8-11. The central theme was the application of climatic data to global social and economic problems. Conference topics included energy, ecology, air pollution, bioclimatology, forestry, agriculture, general climatological methods, climatic-data user needs, and the outlook for climatology. Scientists from many areas of the United States presented 53 technical papers on a wide variety of activities.

NOAA AMS members chairing sessions or presenting papers were: Thomas S. Austin, James D. McQuigg, Arnold R. Hull, Frank T. Quinlan, Harold L. Crutcher, and J. Murray Mitchell (Environmental Data Service); Douglas R. Greene, Gregory S. Richter, Terrell L. Noffsinger, Daniel L. Smith, L. A. Joos, and M. Bailey (National Weather Service); David S. Johnson (AMS President) and F. W. Nagel (National Environmental Satellite Service). Wilmot Hess, Director of the Environmental Research Laboratories, delivered the banquet address, and Arnold R. Hull, Deputy Director, EDS, chaired the Workshop for State Climatologists.

The Asheville Chapter of AMS and EDS' National Climatic Center were hosts for the AMS meeting.

Continental Shelf Atlas Published

EDS' National Oceanographic Data Center (NODC) has published Key to Oceanographic Records Documentation No. 2: *Temperature, Salinity, Oxygen, and Phosphate in Waters Off United States,* in three volumes—Volume I: Western North Atlantic (Atlantic Coast), Volume II: Gulf of Mexico (Gulf Coast), and Volume III: Eastern North Pacific (Pacific Coast of California, Oregon, and Washington).

The volumes provide a general picture of the variability of the four parameters in oceanic waters on the Continental Shelf and Slope areas of the United States. The data are presented in formats easily usable by nonphysical oceanographers — biologists, engineers, and others responsible for the development, utilization, and management of programs, projects, and surveys relating to the ocean. The data are also useful in studies of marine productivity, pollution, corrosion, fouling, waste-receiving capacity, and oceanic circulation, and in designing instruments and in planning structures.

The data, presented in graphic and tabular computer displays, were compiled from NODC's Oceanographic Station Data File which contains over 25,000 stations (primarily Nansen casts) covering the period 1914-70. Each volume contains computer-derived frequency-distribution histograms (fig. 1), temperature-salinity composites (fig. 2), and vertical numerical arrays and geographic area maps showing surface distribution of stations.

The frequency-distribution histograms depict the seasonal and annual vertical distribution of temperature, salinity, oxygen, and phosphate by preselected ranges of values (class intervals) for specified standard depths. The histograms show values at standard depths to 1,500 meters and are paired with an enlarged plot of the same data for the 0 to 500 meter standard depths. A year-time histogram is also shown to indicate when observations were made.

The temperature-salinity composite plots show simultaneously observed temperature and salinity values taken at the same position and depth. These values are based on all station positions and depths in an area for the period of record.

Vertical array summary tabular printouts give maximum, minimum, and average number of observations, and standard deviation for the given parameter at specified standard depths over a given period of time. These observations are presented in seasonal summaries for standard depths to 300 meters. Annual summaries are given for standard depths beginning at 400 meters and continuing to the deepest level available in each area; the deepest in some areas is 4,000 meters. Station distribution plots (maps) are provided with each seasonal vertical array summary. The maps show the geographic distribution of surface observation points within a specified area for a given season.

About 375 copies of each volume have been sent to Government, State, and educational institutions and 40 to foreign organizations. Copies are for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, and are identified and priced as follows:

Volume I:
Stock No. 0317-00253 $10.40

Volume II:
Stock No. 0317-00254 8.75

Volume III:
Stock No. 0317-00255 15.75

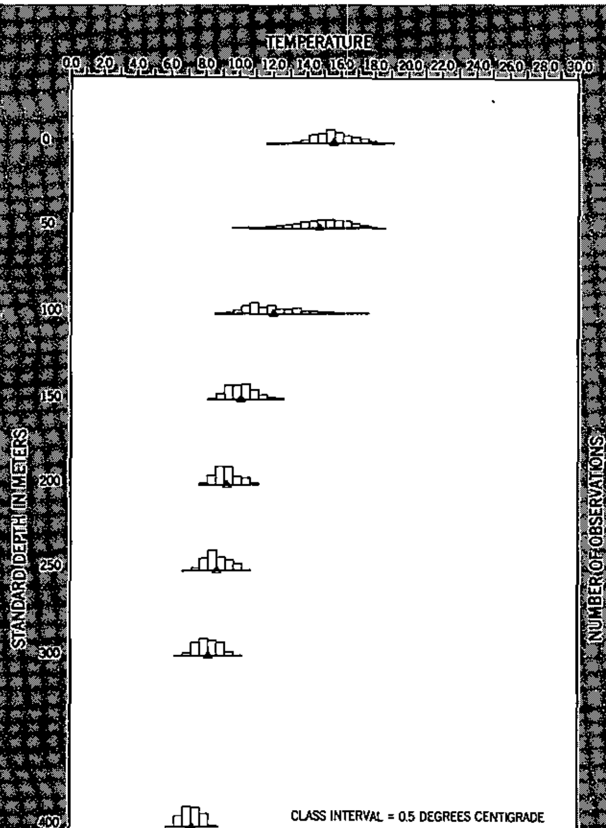


Figure 1. Frequency histogram of water temperature observations at standard depths off Southern California, January through March.

Figure 2. Temperature-salinity composite for Southern California waters, all depths, all months.

Gulf Of Alaska Data Summaries Available

EDS has obtained summaries of some of the data for the Northeastern Gulf of Alaska gathered by the Gulf of Alaska Operator's Committee, a consortium of oil companies. The summaries were presented during hearings held by the President's Council on Environmental Quality (CEQ) in connection with the Outer Continental Shelf Study.

The summaries include information on the chemical analysis of crude oils found in the region, seismology, and the seafloor coring program in the Gulf; data on the physical marine environment of the Gulf; and a general discussion of the birds, marine mammals, commercial fisheries, and the resources of crabs, shrimp, scallops, groundfish, and salmon in the area.

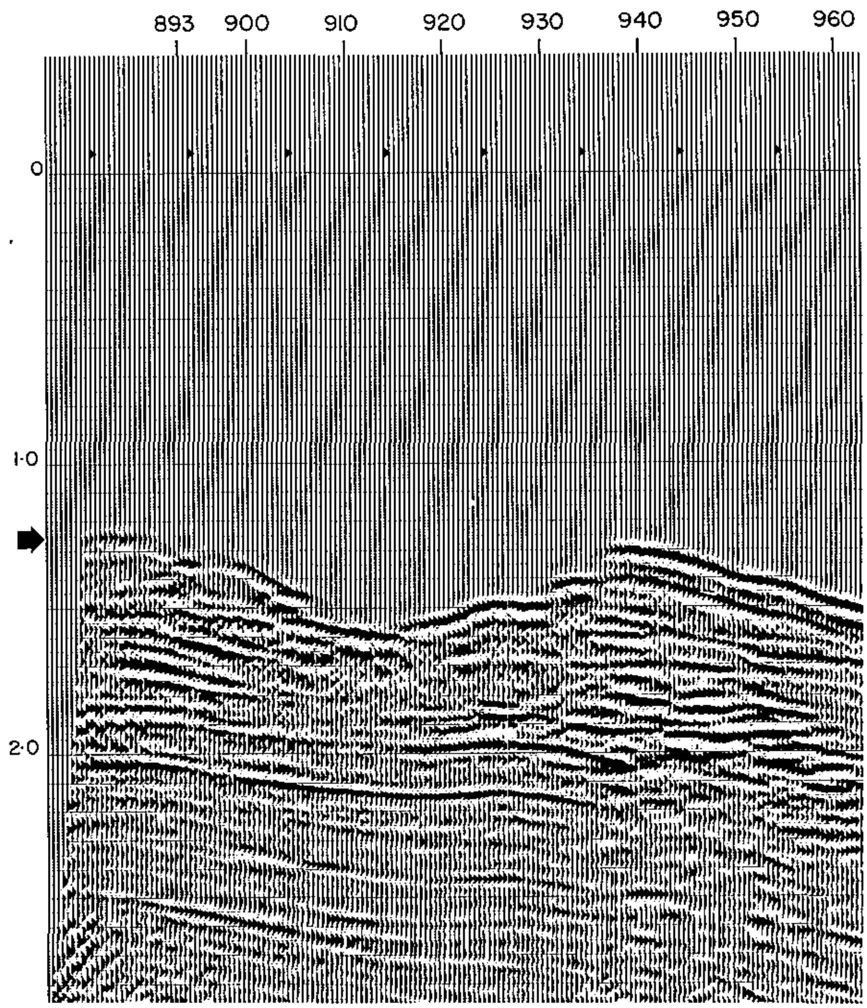
A subject breakdown or copies of the summaries are available from the National Oceanographic Data Center, NOAA/EDS, Washington, D.C. 20235.

Atlantic Oil Lease Site Data

Marine seismic data of interest to those concerned with the discovery and development of U.S. Atlantic Outer Continental Shelf oil deposits are now available from the Marine Geology and Geophysics Branch of the EDS National Geophysical and Solar-Terrestrial Data Center.

The data, derived from commercial lease-site surveys sponsored by the U.S. Geological Survey, consist of multichannel, Common-Depth-Point seismic bottom profiles of high-resolution and clarity for tracklines over the Georges Bank area and in offshore waters of New Jersey and the Delmarva Peninsula. About 700 nautical miles of bottom profiles are contained on 16 3 by 5 ft transparencies. Eight track-line maps at a scale of 1 in = 16,000 ft show air gun shotpoint locations.

The complete data set is available at nominal cost as fullsized Ozalid or sepia transparency copies. Direct inquiries to the Marine Geology and Geophysics Branch, Code DF621, NGSDC, NOAA/EDS, Washington, D.C. 20235. Telephone: (202) 634-7381.



Sample of multichannel seismic reflection data available for Atlantic oil lease sites. This is a corner (reduced) of a 3 by 5 ft mylar transparency. The vertical scale is the two-way travel time in seconds, with "0" representing the water surface. On most transparencies, this scale goes to 10 seconds. The arrow points to the seafloor. Shot points are numbered across the top.

International Report

IDOE Programs Expanded

The National Science Foundation's Office for the International Decade of Ocean Exploration (IDOE) has added two new projects to IDOE programs concerned with environmental forecasting, environmental quality, living resources, seabed assessment, and marine data exchange. The two projects—"Shelf Dynamics" and the "International Southern Ocean Study (ISOS)" involve the study of water movements and thermal unrest, as well as studies focused on dynamic processes in the Southern ocean and their relation to oceanic and atmospheric circulation patterns. The first project is significant because recent observations and theoretical considerations show that the shelf regions are a zone of intense exchange among the nearshore and deep waters of the ocean; a thorough understanding of shelf circulation could lead to important environmental benefits for mankind. The ISOS project includes studies of the large-scale, time-dependent dynamics of the circumpolar current and polar front.

Churgin New WDC-A Oceanography Director

James Churgin has been named Director of World Data Center A (WDC-A), Oceanography, collocated with EDS's National Oceanographic Data Center. WDC-A, Oceanography is part of an international World Data Center system originally established under auspices of the International Council of Scientific Unions to handle the management and exchange of data taken during the International Geophysical Year (1957-58). The system has been continued by international agreement.

Mr. Churgin was instrumental in moving WDC-A, Oceanography from Texas A&M to Washington, D.C., in the early 1960's. More recently, he participated in the International Decade of Ocean Exploration Mid-Ocean Dynamics Experiment (MODE), and is currently involved in planning for the joint U.S.-U.S.S.R. POLYMODE Experiment.

Mr. Churgin has authored and co-authored several NODC publications, including the first *User's Guide to NODC Processing Systems* and *Temperature, Salinity, Oxygen, and Phosphate in Waters Off the United States.* He holds a bachelor's degree from the City College of New York and a master's degree from West Virginia University.

New Rapid Publication Service

A new monthly report has been initiated by the Solar-Terrestrial Data Services Division (STDSD) of EDS' National Geophysical and Solar-Terrestrial Data Center. The *Prompt Monthly Report of Selected Solar-Geophysical Data* contains frequently requested standard solar and geophysical indices. These are the daily Ottawa 10-cm solar flux and the Fredericksburg geomagnetic 3-hourly K and daily A indices, as well as summary information of solar flares of Importance 2 or greater. The 10-cm flux highlights the average daily level of solar activity. The Fredericksburg data are available promptly as an estimate of planetary indices, and indicate the presence or absence of geomagnetic disturbances. The selected solar flares are indicative of any outstanding solar events that occurred during the month.

The report is compiled and distributed as soon as the data for the month are received, usually during the first few days following the end of the reported month. The prompt monthly report is designed to meet the needs of scientists and others who require these rapid and provisional data before the more definitive data appear in the regular monthly issue of the STDSD publication *Solar-Geophysical Data.*

The new report was initiated to replace, in part, the weekly Preliminary Report and Forecast of Solar-Geophysical Data, published until July 1974 by the Space Environment Services Center, Space Environment Laboratory, NOAA, at Boulder. To subscribe to the new publication, check or money order for $10.00 in U.S. currency payable to NOAA, Department of Commerce should be sent to: Solar-Terrestrial Data Services Division/NGSDC, NOAA, Boulder, Colo. 80302.

Atlas Of Solar Flare Flashes During Skylab Published

The World Data Center A for Solar-Terrestrial Physics in Boulder, Colo., has published UAG-36, *An Atlas of Extreme Ultraviolet Flashes of Solar Flares Observed Via Sudden Frequency Deviations During the ATM-SKYLAB Missions.* The atlas is the result of the combined efforts of nine co-authors, R. F. Donnelly, E. L. Berger, and W. M. Retallack of the NOAA Space Environment Laboratory; Lt. J. D. Busman of the NOAA Commissioned Corps; B. Hensen of NASA Marshall Space Flight Center; T. B. Jones of the University of Leicester, UK; G. M. Lerfald of the NOAA Wave Propagation Laboratory; K. Najita of the University of Hawaii; and W. J. Wagner of Sacramento Peak Observatory.

The 10A to 1030A (Angstrom) sudden solar radiation increases of solar flares during the ATM-SKYLAB missions are presented. These extreme-ultraviolet (EUV) increases were observed via sudden frequency deviations (SFDs). SFDs are an ionospheric effect caused by the increase of photoionization in the ionosphere. The SFD measurements were made at Sacramento Peak Observatory; Boulder, Colo.; Leicester, England; Huntsville, Ala.; and Hawaii. EUV bursts are reported for the period April 1, 1973 to February 3, 1974, which includes several 27-day solar rotations before the first manned space mission ATM-SKYLAB. The ATM-SKYLAB missions were periods of low solar activity, when no large SFDs occurred, in comparison with other studies from 1960 to 1970. However, several medium-sized events did occur with quasi-periodic or extensive fine time structure.

This publication should be of particular interest to ATM-SKYLAB principal investigators in determining periods for study during interesting solar occurrences. The SFD data also supplement the excellent ATM-SKYLAB observations, which were taken above the Earth's atmosphere and simultaneously in many wavelengths, by providing high time resolution measurements of the sudden flare emissions originating from source regions in the solar atmosphere. The publication will also be of interest to the general scientific community for correlative studies.

Requests for UAG-36 should be addressed to the National Climatic Center, Federal Building, Asheville, N.C. 28801. Attn.: Publications. Sale price: $.55 per copy.

ASFA/ASFIS Editorial Board Meets In Russia

The editorial board charged with implementing the United Nations' Aquatic Sciences and Fisheries Abstracts/Information System (ASFA/ASFIS), met in Moscow, Oct. 24-25. The board comprises systems parners from England, France, Germany, the United States, and the Soviet Union. Erodgan Akyuz, a representative from UNESCO's Food and Agricultural Organization (FAO), chaired the sessions.

ASFA is part of an international information system coordinated by the FAO. The original plan for ASFA/ASFIS called for a worldwide information system through which references to conventional and nonconventional literature would be available as hard copy (ASFA) and through an automated international system (ASFIS) for retrospective searches. The ASFA phase has been available for several years, and it appears that, after several delays, input information is closer to standardization and automation. The AFSIS phase is expected to become a reality when magnetic tapes containing information from the 1975 input of all systems becomes available. This is expected to take place by mid-1976. When that occurs, the National Oceanic and Atmospheric Administration will add this international information file to its growing list of Oceanic and Atmospheric Scientific Information System (OASIS) services.

During the sessions, decisions were made concerning content and style of indexes, amendments to the subject thesaurus, style and content of corporate entries, and assessment of patent literature for a 6-month trial period. In addition to providing references with abstracts and descriptive terms for all NOAA and NOAA-sponsored nonconventional publications, the agency, through its representatives on the Board—Drs. Joseph Caponio and Elaine Collins of the Environmental Data Service—has agreed to provide automated reference lists for corporate entries and taxonomic terms.

Seismicity Map Centered On Peking

A unique, computer-drawn seismicity map showing the location of earthquakes around the World in an azimuthal equidistant projection centered on Peking, China was prepared by the EDS National Geophysical and Solar-Terrestrial Data Center (NGSDC) for the United States Seismological Delegation's visit to the People's Republic of China in October 1974. The plot shows all located earthquakes of magnitude 4.5 and larger from 1963 through 1973, and the plasticlike geography peculiar to this projection. The projection allows for the direct measurement of the distance from Peking to an epicenter, seimic belt, or geographic point. The Delegation was also supplied with a set of microfilm copies of seismograms from stations of the worldwide standardized seismograph network for the destructive Chinese earthquake of May 10, 1974.

In April and May 1974, a Delegation of 10 People's Republic of China seismologists toured United States facilities, including NGSDC.

World seismicity as seen from Peking (arrow).

Changes in Ionosphere Data Dissemination

The method of worldwide data distribution on the "climatology" of the ionosphere has been changed by EDS' National Geophysical and Solar-Terrestrial Data Center. Due to economic considerations, the monthly diurnal values of ionospheric characteristics for 140 worldwide ionospheric stations will no longer be published in monthly booklet form, but rather data for individual stations will be available separately from the center. The periodical publication *Ionospheric Data*, which was started thirty years ago in September 1944, was at least temporarily suspended as of September 1974. The data which would have been published for the remaining issues of 1974 will be compiled in the same format on microfiche so that yearly data collections can be complete through 1973—the data had been published with a one-year time lag.

These data are widely used in applications and research concerning radio communications, where long-distance transmissions are reflected from the ionospheric layers over the curve of the Earth. The state of the ionosphere at the point of reflection determines what radio frequencies can be used for telecommunications. The electron density of the inonosphere varies widely with time of day, season, and the 11-year solar activity cycle, as well as with geographical position. The data formerly published in *Ionospheric Data* are also used extensively in studies of the physical processes which result in these complex variations.

The data which comprise *Ionospheric Data* will continue to be available through World Data Center A for Solar-Terrestrial Physics, collocated with NGSDC. These data will also be available from the other World Data Centers located in Moscow, England, and Tokyo. Users are invited to use the services or the World Data Centers to meet their needs for ionospheric data for specific stations.

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The new logo of UNESCO's Intergovernmental Oceanographic Commisison.

March 1975

EDS

Environmental Data Service

March 1975

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Cover: *A boy and a beach. NOAA's Coastal Zone Management Program (see lead article) seeks a balance between economic development and the preservation of the natural environment, including recreational areas.*

ENVIRONMENTAL DATA SERVICE is designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, Center for Climatic and Environmental Assessment, and National Oceanic and Atmospheric Satellite Data Unit. In addition, under an agreement with the National Academy of Sciences, the National Oceanic and Atmospheric Administration (NOAA) has responsibility for World Data Center-A activities in oceanography, gravity, tsunami, seismology, geomagnetism, meteorology, and nuclear radiation, ionosphere and airglow, cosmic rays, auroras, and solar observations; the Director of EDS coordinates these activities within NOAA.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, July 26, 1973; this approval expires June 30, 1975.

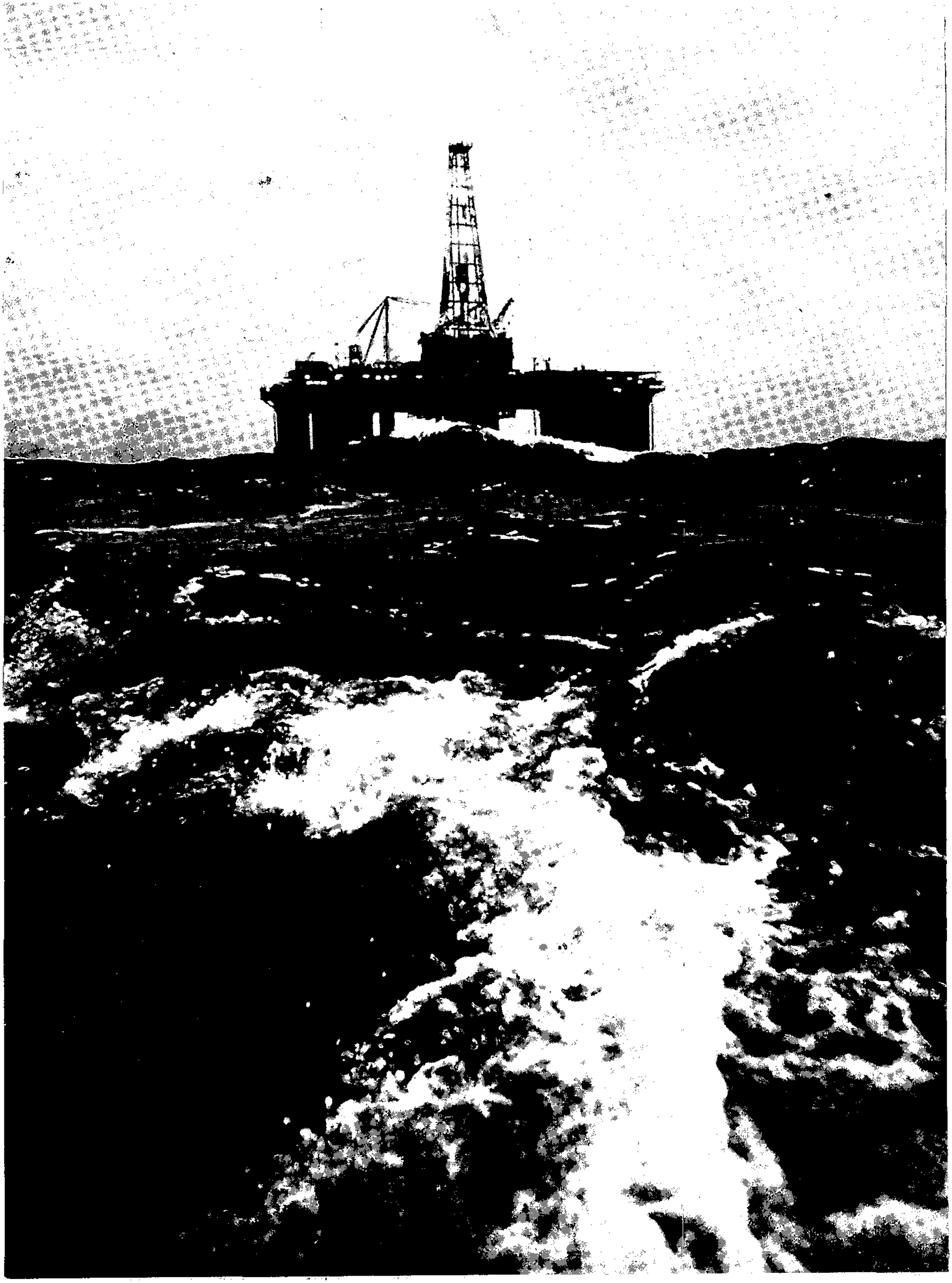
The Nation and the Sea— A New Awareness

By Robert M. White
Administrator, National Oceanic and Atmospheric Administration

The following is a slightly edited version of a report on the state of U.S. oceanic programs and policies originally published in the January 1974 issue of Sea Power, *under the title: "From the Coastal Zone to the Deepest Depths."*

NATIONAL POLICIES reflect national concern. Nowhere is this currently more apparent than in the increasing attention being given to marine programs by the Administration and the Congress. This attention reflects the growing national awareness that oceanic resources promise at least partial solutions to some of the most pressing social and economic problems facing the nation and the world.

Man has reached a critical juncture in his relationship with his environment. His supply of both food and raw materials is threatened, and the threat will hang over him for a long time to come. Viewed against such needs, the fossil fuels, living resources, and minerals in and under the sea will play an increasingly large role in national efforts to cope with the problems facing mankind, now and in the future. Oceanic resources, however, must be developed with minimum harm to the marine environment.



High-Level Recognition

The need for a balanced approach is recognized at the highest levels of government, and has given new impetus to development of marine policies and programs designed to provide an effective national framework for both progress and conservation.

Recognizing the growing importance of the oceans, Congress in 1966 enacted legislation to establish the National Council on Marine Resources and Engineering Development and the Commission on Marine Sciences, Engineering, and Resources (known as the Stratton Commission).

Largely as a result of the Stratton Commission's report (published in 1969), the National Oceanic and Atmospheric Administration (NOAA) was established (in 1970) to provide a Federal focus for many civilian aspects of the nation's ocean activities. The following year, the National Advisory Committee on Oceans and Atmosphere was formed and the Federal Council for Science and Technology established the Interagency Committee on Marine Science and Engineering to succeed the National Council. Those steps represented a systematic evolution in the institutions for dealing with ocean policy considerations to meet national needs. Recent events, however, have led to further action by Congress and the Executive Branch to strengthen and guide marine development.

The National Ocean Policy Study (NOPS) of the Senate was initiated in February 1974. Participants include the members of the Senate Committee on Commerce, representatives of other Senate committees responsible for ocean affairs, and other Senators who are members at large. To date, NOPS has focused on two areas: the impact of oil and gas exploration and drilling activities on the coastal zone environment, and Federal involvement in ocean affairs. In addition, NOPS has sponsored studies on ocean data and instrumentation, and on the economic value of ocean resources. Many other aspects of ocean affairs will also receive attention. The end result of the studies will be new legislation designed to improve the conduct of ocean science and the use of marine resources.

Offshore exploration and drilling hold the greatest potential for increasing national oil and gas supplies. Exxon Photo

The Office of Technology Assessment (OTA), established as an advisory body to Congress early last year, is also studying the impact of offshore energy operations on coastal areas, including the effects of offshore oil drilling, and the construction of offshore nuclear plants and anchorages for supertankers. The areas chosen for study are off New Jersey and Delaware. OTA seeks to determine the direct and secondary impacts of multiple offshore activities on coastal States, and will compare them with the effects of alternative development plans. These efforts will be complemented by policy attention at the cabinet level in the Executive Branch.

Recent Legislation

The evolution of national ocean policies and programs has been strongly influenced by recent legislation enacted to meet emerging national needs — specifically: the National Environmental Policy Act of 1969; the Federal Water Pollution Control Act Amendment of 1972; the Coastal Zone Management Act of 1972; the Marine Protection, Research and Sanctuaries Act of 1972 (ocean dumping); the Marine Mammal Protection Act of 1972; the Ports and Waterways Safety Act of 1972; the Endangered Species Act of 1973; the Special Energy Research and Development Appropriation Act of 1974; and the Solar Energy Research, Development, and Demonstration Act of 1974.

Major thrust of the current national marine program concern development of marine energy and food resources, environmental protection and the preservation of endangered species, management of coastal zones, and cooperation with other nations in other areas of mutual interest and concern. The same program areas will continue to receive priority attention for years to come.

Energy

The Outer Continental Shelf (OCS) continues to offer the greatest national potential for new oil and gas development, and the Federal Government is, therefore, accelerating a leasing schedule for marine lands. To hasten development of new OCS leases, Congress has directed reactivation of three NOAA oceanographic vessels that had been out of service for several years because of spending curtailments. The NOAA ships will be used in joint programs of the U.S. Geological Survey, Bureau of Land Management, and NOAA to gather baseline data needed to make critical environmental assessments in the OCS leasing program.

Providing docking facilities for supertankers is another way in which marine facilities are used to increase supplies of oil and natural gas. No existing U.S. port receiving crude petroleum shipments can accommodate the superships, and it appears that few, if any, can economically be deepened.

In December 1971, the U.S. Army Corps of Engineers began studying potential U.S. sites for three types of deepwater facilities — monobuoy arrays, mooring platforms, and artificial islands, all connected to shore-based storage tanks by submarine pipelines. In addition, the Maritime Administration has supported a detailed study of potential sites for artificial islands along the Atlantic and Gulf coasts.

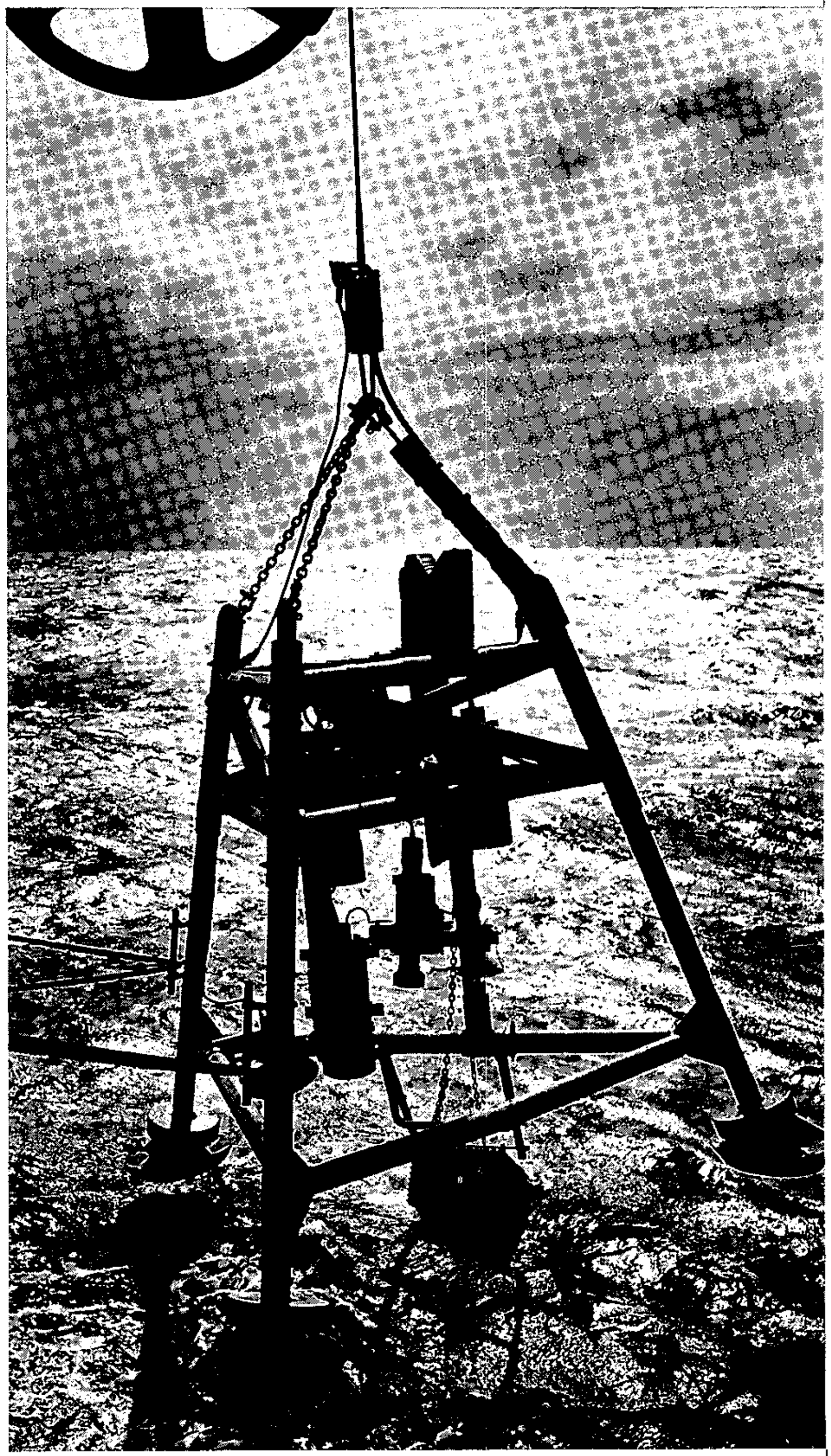
In 1972, NOAA's Environmental Data Service published two special supertanker studies. The first, "*Environmental Guide for Seven U.S. Ports and Harbor Approaches*," was prepared for the President's Council on Environmental Quality and examined coastal locations from Maine to Texas. Later, when the Gulf Coast area was chosen for initial development, the Army Corps of Engineers asked for a more detailed study of the potential sites selected. That request led to the "*Environmental Guide for the U.S. Gulf Coast.*"

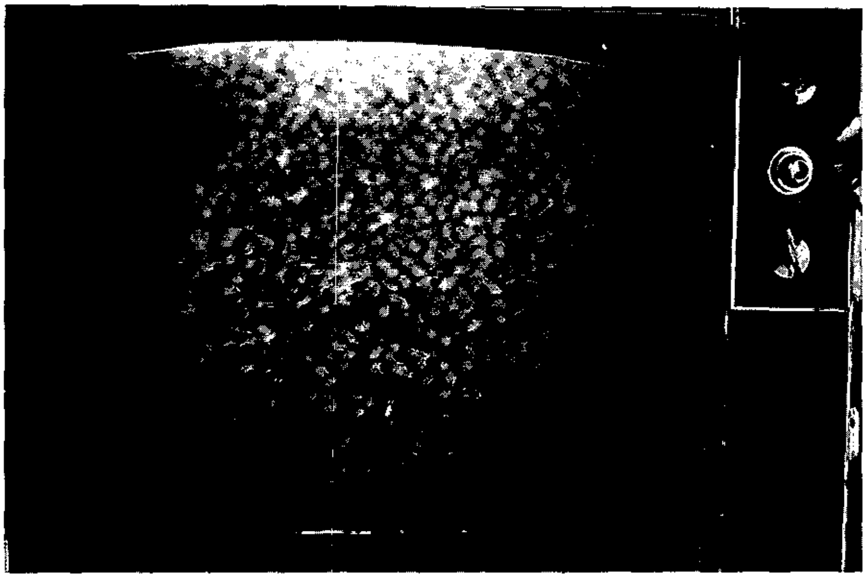
At present, monobuoy mooring appears to be the most promising type of facility. It reduces the risk of collision or grounding and permits unloading of larger tankers (thus reducing the number of transfer operations and possible spills). Oil industry groups are currently in advanced stages of planning for monobuoy facilities along the Gulf Coast and elsewhere.

Increasing petroleum supplies is essential. But, in the final analysis, the world's petroleum resources are finite and eventually new energy sources will be needed.

National energy requirements are expected to triple in the next 25 years, and the use of electricity to meet those growing needs is expected to increase even more rapidly. Conservation of energy resources by all users obviously becomes an urgent national need. Nuclear power, which now produces about 7 percent of the country's electricity, is expected to provide 50 percent of U.S. needs 25 years from now. As with oil and gas development, the most promising sites for nuclear powerplant construction are offshore.

The Atomic Energy Commission, in cooperation with the President's Council on Environmental Quality, NOAA, the Department of the Interior, and other agencies, is conducting comprehensive studies to provide the environmental baseline data and information needed to construct





Television technique for deep-sea mining. A TV camera and tripod (left) are towed a few feet above the ocean bottom (tripod also carries high intensity lights and a sample basket to recover small quantities of manganese nodules for analysis).

TV monitor shows a picture received from a depth of approximately 18,000 feet. A wire dredge basket (above) is used to recover nodules after television survey.

Photos by B. J. Nixon
Deepsea Ventures, Inc.

offshore nuclear facilities and to prevent damage to the ocean environment. The studies include assessments of potential damage resulting from hurricanes, storm surges, and other natural phenomena, during both construction and operation. They also examine the effect that such installations might have on other uses of the coastal zone.

The Ocean Thermal Energy Conversion Program, initiated by the National Science Foundation, is evaluating the technical and economic feasibility of ocean-based and near-shore powerplants capable of converting ocean heat into electric power. Developments in that area could offer new energy sources in the decades ahead.

Food

Recent world food problems have led to greater appreciation of the role the coupled ocean/atmosphere system plays in global grain production. In 1974, severe food shortages caused widespread hunger in parts of Africa and India. Those shortages can be traced to climatic fluctuations that many scientists believe are associated with changes in the world's oceans, and give more urgency to development of global ocean monitoring programs.

Congress recently approved funding for SEASAT, NASA's ocean satellite, which should enormously enhance ocean-monitoring capabilities. SEASAT will be able to measure ocean topography, wave spectra, sea-surface temperatures, and ice conditions, as well as wind speeds and directions and atmospheric water vapor content. And it will collect all such data concurrently, routinely, and on a global basis.

Although the ocean, by influencing weather and climate, has an indirect effect on world grain supplies, improved management and use of fishery resources are more directly related. Fishery conservation and management traditionally have suffered from a lack of adequate biological data. A new program, MARMAP (Marine Resource Monitoring and Prediction Program), now provides far more data to those charged with fishery conservation than they have ever had before. MARMAP data are currently being used as a basis for fishery management by the International Commission for the Northwest Atlantic Fisheries and other international fisheries commissions.

Minerals, Monitoring, and Mammals

The United States is almost totally dependent on imports for manganese, nickel, and cobalt, yet extensive areas of the ocean floor are overlain with manganese nodules rich in those minerals. The technology for nodule recovery and processing is being developed to permit commercial operations by the end of the decade. To prevent possible environmental damage by deep sea mining activities, NOAA has initiated a Deep Ocean Mining Environmental Studies (DOMES) project, which will provide the information needed to develop environmental impact statements and to monitor environmental effects of prototype equipment tests.

Under the Marine Protection, Research, and Sanctuaries Act of 1972, the Department of Commerce is responsible for researching and monitoring programs concerned with the effects of ocean pollution and other man-induced changes on the marine environment. Those programs, developed and carried out by NOAA, are designed to provide the information needed by the Environmental Protection Agency to improve regulation and control of ocean dumping and pollution discharge. In March 1974, NOAA made its first report to Congress on Federal research concerning the effects of pollutants on the marine environment.

Marine Ecosystems Analysis (MESA) program efforts are concentrated in regional projects to develop information on the biological, physical, and chemical processes of selected

The effects (top) of ocean pollution and the protection of seals and other marine mammals are both concerns of national programs to preserve the quality of the marine environment.

coastal areas, to improve the ability to assess and predict the impact of man's activities. The New York Bight, first area selected for study, is one of the most complex and heavily used U.S. coastal areas. The MESA New York Bight Project is an integrated study involving NOAA and other Federal and State agencies, as well as industry and a number of universities.

Several agencies of the Department of the Interior also have developed programs concerned with preserving the quality of the marine environment. Among them are the Bureau of Land Management's Outer Continental Shelf environmental program, and the U.S. Geological Survey's "streamgaging" program, which provides data needed for pollution control in estuaries, bays, and nearshore areas.

The National Science Foundation's Research Applied to National Needs program supports regional studies of coastal zone pollutants. In one such project, a four-institution consortium in the Chesapeake Bay area is studying domestic waste problems to develop criteria for sewage effluent loading in Chesapeake Bay.

In 1973, the Environmental Protection Agency issued new regulations to govern ocean dumping of all wastes except dredge spoil, which is regulated by the Army Corps of Engineers. The Corps is currently engaged in a major program to develop techniques for determining and reducing the polluting effects of dredge materials.

In addition to pollution control, environmental protection encompasses the preservation of threatened species. Under the authority of the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973, NOAA and the Department of the Interior are supporting regulatory and scientific programs for the conservation of whales, seals, and other marine mammals, as well as endangered species of fish, waterfowl, and other wildlife.

Coastal Zone and Sea Grant

As indicated by recent and pending legislation, the United States is becoming increasingly concerned about the impact of development upon coastal areas. Vulnerable nursery and spawning grounds in coastal wetlands as well as the basic economic and labor patterns of coastal communities could be affected. To deal with the problem, the Coastal Zone Management Act of 1972 established the Coastal Zone Management Program, administered by NOAA, to provide a balance between economic development and the preservation of environmental quality in the coastal zone. The program is broad in scope and involves consideration of ecological, cultural, historical, and aesthetic values—as well as the requirements for economic development. The Federal Government provides guidance and support; state governments are responsible for coastal zone management.

By the end of 1974, 31 of 34 coastal states and territories, including the Great Lakes states, had been funded for development of coastal zone management programs. The Coastal Zone Management Program, together with the Sea Grant Program, provides the mechanisms needed for comprehensive planning and management of coastal zones.

The Sea Grant Program was established in 1966. It has a three-pronged mission involving (1) applied research, (2) education and training, and (3) providing of advisory and extension services across the whole range of ocean problems. Nearly 50 U.S. institutions now have Sea Grant programs, and some 600 important projects in mariculture, marine resource recovery, coastal zone management and protection, and other areas have been initiated or completed. Sea Grant advisory services have also developed rapidly, and currently about 200 agents work in 22 States. Last year the Secretary of Commerce designated the University of California as the seventh Sea Grant college. The other six are: Texas A&M, Oregon State University, and the Universities of Rhode Island, Washington, Hawaii, and Wisconsin.

Samples of marine life collected in the New York Bight area.

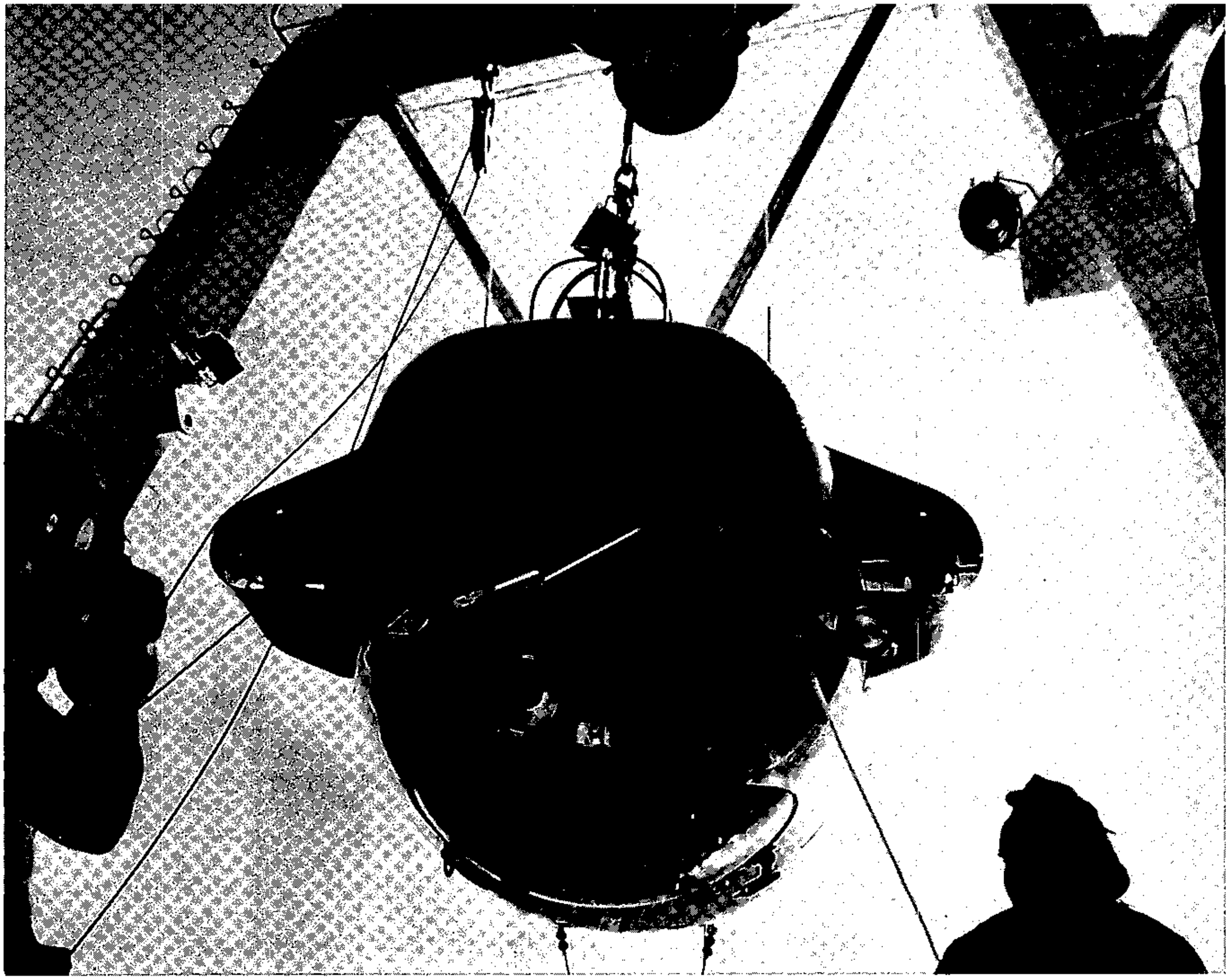


Photo: CNEXO

The CYANA, one of two French submersibles used in the recent French-American exploration of the Mid-Atlantic Ridge.

International Developments

The United States firmly supports a comprehensive, broad-based treaty on the Law of the Sea and will continue to work toward a satisfactory international agreement on the oceans at the next session of the Third United Nations Law of the Sea Conference, to be held in Geneva in the spring. Such agreement should permit development of deep-sea marine mineral resources beyond the jurisdiction of any nation, with appropriate environmental safeguards, and should guarantee freedom of access for private companies, under reasonable conditions, coupled with security of tenure.

The United States also supports establishment of a 200-mile economic zone wherein coastal nations would have sovereign rights to develop seabed mineral resources (subject to certain international responsibilities, including environmental protection and the right to regulate offshore installations affecting their economic interests). Coastal nations would also have exclusive rights to manage living marine resources, subject to certain obligations. Special treatment would be given to anadromous species, such as salmon, and to highly migratory species, such as tuna.

Besides the Law of the Sea Conference, the United States has been an active participant in the work of UNESCO's Intergovernmental Oceanographic Commission and in a number of major, multinational oceanographic field experiments. For example, the recently completed Atlantic Tropical Experiment of the Global Atmospheric Research Program (GATE), a joint program of the World Meterological Organization and the International Council of Scientific Unions, was an enormously successful 3-month air/sea study in the South Atlantic off Africa, and involving 40 vessels from 15 nations.

Project FAMOUS (French-American Mid-Ocean Underseas Study) is another exciting and productive cooperative international effort. Project FAMOUS field investigations, completed last summer, were conducted along the Mid-Atlantic Ridge some 300 miles southwest of the Azores. The investigations, which required 3 years of intensive planning and preparation, involved the ALVIN, a United States research submersible, and the ARCHIMEDES and CYANA, two French submersibles. In some 50 dives—to depths of 3,000 meters—it was possible for the first time to obtain evidence by direct human observation to confirm and advance contemporary concepts of plate tectonics and sea-floor spreading. The observations provided new scientific insights on continental drift, earthquakes, geothermal energy, and evolution of minerals deep within the Earth.

In June 1973, the United States and USSR signed an agreement calling for bilateral cooperation in exploration of the global sea. A joint committee was established and, at its first meeting in February 1974, agreed on cooperative projects in six areas of ocean investigation: air/sea interaction; planetary-scale ocean currents and other aspects of ocean dynamics; geochemistry and marine chemistry of the world ocean; geological and geophysical investigations; biological productivity; and the intercalibration and standardization of oceanographic instrumentation and methodology.

Problems and Prospects

There are, of course, serious obstacles that must be overcome in successfully meeting U.S. national needs for ocean services and resources. One of the most challenging involves the fisheries situation.

Mankind is rapidly reaching the point where the capacity of the world's fishing fleets will exceed the capacity of the oceans to sustain the fish stocks on which all depend. Several important species found off the coast of the United States have already been seriously depleted. To date, international efforts to develop satisfactory conservation measures have failed.

International Law of the Sea conferences may well provide a new opportunity to conserve such vital ocean resources. The proposed extension of national economic jurisdiction to a 200-mile zone would give the United States exclusive management authority over its own zone's living resources, many of which are now fished by foreign fleets.

In addition, NOAA, in cooperation with the Department of the Interior, State governments, and recreational and commercial fisheries organizations, is currently preparing a national fisheries plan. The plan will include contingency arrangements for fishery management in cooperative efforts of the States, regional groups, and the Federal Government.

Another serious problem facing the United States involves maintaining an oceanographic fleet adequate to provide the information needed to map and chart the oceans, survey their resources, assess and ameliorate environmental hazards, and conduct the basic research upon which future advances will be built. Ship support as a percentage of total program budgets is declining. Part of the decline can be compensated for by the use of other platforms, such as buoys and satellites, but eventually it will be necessary to make the investment required to continue needed ship operations and to replace vessels that are worn out.

Budget constraints of the last several years caused the retirement of 10 old ships without replacement. In addition, four NOAA ships, all less than 10 years old, were temporarily out of service last year. The pinch on ship-operating funds also is being aggravated by escalating fuel and maintenance costs. Like the rest of the nation, ship operating agencies will have to watch dollars closely and spend them where they are most needed.

Ships, satellites, aircraft, and buoys provide the most economical and efficient means of gathering much of the data needed about ocean features and processes. The national capability for ocean exploration is deficient, however, so long as it does not have adequate submersible and habitat facilities for manned undersea exploration.

In the 1960s, a great variety of submersibles and undersea habitats was built, but most were engineering experiments and are now "on the shelf." At present, the Navy is the only Federal agency owning a submersible, and NOAA, through its Manned Undersea Science and Technology Office, has assumed the task of coordinating civilian undersea operations. NOAA's efforts to help preserve the technology needed for underseas oceanographic exploration, but the United States well may face a future shortage of undersea platforms. It is to be hoped that NOAA, the Navy, and the National Science Foundation will be able to provide joint support for at least modest efforts to maintain the U.S. manned underseas capability.

Despite the problems which lie ahead, the U.S. marine program today is both healthy and growing. Ocean resources are no longer considered minor supplements to land resources but, rather, because of the rich potential of the sea, are viewed as part of the solution to some of the most serious national and international problems. The new national awareness which has developed will shape and structure marine programs for a long time to come. Priorities will have to be reassessed to serve the greatest national needs, and intensive interagency cooperation will be required to ensure maximum value for available resources.

The future promises discipline and hard choices, but also an increasingly important role for marine programs in the economic life of the nation.

Marine Engineering Data and Information Exchange*

By Richard M. Morse
Environmental Data Service

Foster H. Middleton
University of Rhode Island

Introduction

In September 1972, the Marine Board of the National Academy of Engineering (NAE) established a panel to consider whether the ocean engineering community's needs for data and information are being met by existing service systems. This paper summarizes the Panel's report and examines some of its considerations.

Considerable effort was spent trying to determine if: the larger national data centers are meeting the needs of ocean engineers; ocean engineers are taking advantage of the data and information (technical reports) already available to them through these centers; a completely new engineering data base or center is needed.

To help answer these questions, a questionnaire was prepared and circulated to members of the marine engineering community. The response to this sample survey confirmed the Panel consensus, i.e., the ocean engineering professional community, particularly the small firm or individual engineer, is amazingly uninformed on available data and information services. Some respondees knew of and used one or two of the major bases available, but such was not the usual case.

The data needs of the ocean engineer differ from those of the ocean scientist. An engineer preparing to erect a structure, bury a cable, or install a large pipeline needs a family of very specific environmental measurements at the particular point of concern. A marine scientist, on the other hand, concerned with physical environment processes, usually needs only a relatively limited number or period of more general observations.

In light of these differing needs, the panel considered the desirability of a new national engineering data center. Review of a large number of existing marine data and information bases, however, led to the conclusion that an additional base was not practical nor was it really needed. Instead, it seemed that the procedures and practices of several of the larger existing data bases and centers might have changes that would gradually improve the status of ocean engineering data services.

To accomplish these changes, it is necessary for the engineering community to understand how a particular ocean parameter becomes a routinely accessioned part of an ocean data base. Even in such major centers as the National Oceanographic Data Center, a user need must be identified in terms of requests for or submission of particular kinds of data. Once the user need is recognized and can be weighed against priorities for other user services, the center can make it a regular practice to archive the types of data needed.

Report Contents

The Panel report has an appendix listing the ocean engineering subdisciplines considered in the study. Items in the list were changed many times during the life of the Panel, and there is still nothing "absolute" about the listing. The Panel, however, was reasonably content that the list is as useful as any that has been printed. In total, there are some 90 subitems listed, grouped into 13 larger groups. These larger groups are given in table 1 and indicate the scope of the subject matter reviewed by the Panel.

A second major item in the report was a "first-cut" summary of what the Panel believed were the 14 large data or information centers of greatest relevance to ocean engineering. This grouping is also arbitrary, in that it was not practical to include all of the many other relevant centers. It was a surprise to most Panel members to learn that more than 2,000 centers contain information useful and available to marine users. Some of these data and information bases are university or industrial archives, or files associated with military laboratories. In many instances, the information centers are highly specialized and their holdings would not interest the practicing ocean engineer. Considerable discussion took place about which major centers to look at, and the Panel would defend their selections principally on the basis of convenience.

The center names in table 2 are reasonably descriptive of their activities. Clearly, none of these centers was established with ocean engineers in mind, yet all contain some information of interest to certain ocean engineers. It is also fair to say that all 14 of the centers are flexible, in that their products and services could be more relevant to the needs of ocean engineers if these needs were known.

A commonality of these activities is that computers are used. Also, all the centers are willing to consider the needs of their user communities. With this in mind, it appears that the establishment of yet another center for the ocean engineers has little merit. Although an ocean engineer may have to become familiar with several dif-

* Condensed from a paper presented to the Ninth Annual Conference of the Marine Technology Society, September 23-25, 1974.

Table 1—Ocean Engineering Subject Groups

Minerals—Mining
Coastal Processes
Platforms
Living Marine Resources
Environmental Data
Communication & Telemetering
Swimming—Diving
Natural Gas & Oil
Waste Disposal
Marine Recreation
Surveying
Sea Floor Engineering
Ports, Harbors, and Channels

Table 2—Data/Information Bases

Defense Documentation Center (DDC)
National Technical Information Service (NTIS)
Smithsonian Science Information Exchange (SSIE)
Defense Metal Information Center (DMIC)
Maritime Research Information Service (MRIS)
Water Resources Scientific Information Center (WRSIC)
Environmental Science Information Center (ESIC)
National Referral Center for Science and Technology, Library of Congress
Solid Waste Information Retrieval Systems (SWIRS)
National Oceanographic Instrumentation Center (NOIC)
National Climatic Center (NCC)
National Oceanographic Data Center (NODC)
Storage and Retrieval of Water Quality Data (STORET)
National Geophysical and Solar-Terrestrial Data Center (NGSDC)

Table 3—Data Base Descriptors

Center Name
Address
Center Character (Federal, referral service, etc.)
Sponsor
Staff (size, type)
Facilities (computers, etc.)
Mission and Scope
Relationship to Other Systems (access to others)
Size (no. of volumes, file of data, etc.)
Growth Rate (rate of acquiring new data)
Cataloging (what form?)
Indexing (accession number, author, etc.)
Abstracting (monthly abstract service?)
Data Base Review
Monographs (special publication)
Basic Service (primary type of information)
Qualified Users (who is eligible for services?)
Special Publications
User Access (how?)
Response From (tabulation, Xerox copy, etc.)
Inquiry Activity (how many per month?)
Ocean Engineering Relevance (how appropriate?)
Users (who is usual customer?)

ferent centers to get the information he needs, this did not appear to the Panel to be an unreasonable approach.

At the present time, one of the earliest positive steps that could be taken would be to acquaint the entire ocean engineering community with what information is available, where it is held, how it can be obtained, and how much it will cost.

It is not obvious exactly which holdings of a given data or information center will be of direct interest to the ocean engineer. The panel studied the holdings of the 14 centers and summarized their findings in a comparative format. Table 3 lists the keywords or descriptors upon which the review was based. The Panel has no illusions about the optimum character of the bases selected, or the basis on which they were compared. Both are subject to change. For additional details of the review, the panel report itself should be consulted.

The Panel hoped to produce a list of subjects followed by ratings of relevance for each of the data and information centers. We were unable to do so, but hope that it will be possible in the future.

Summary and Recommendations

At present, there is no formal mechanism for stimulating existing data centers to meet the needs of the engineer. There is not even a reasonable set of standards for ocean engineering data, or any standard language on the subject. Moreover, the relatively young academic community of ocean engineering has done little to tell the new ocean engineer what existing data and information are available. The Panel thinks this situation should be changed, and that the many established graduate programs in ocean engineering would be significantly improved by the inclusion of the essential ingredients of the Panel's report. Certainly, any graduate course in "Ocean Engineering Data Processing" should include a substantial presentation of this kind.

The student engineer should be advised as to:

- what data bases exist
- what they contain
- how to go about accessing this information
- how much it will cost
- how long will it take
- what form the output will be in
- whether or not he is eligible to apply for the data (applicable only with restricted use files)

This body of information must be developed in cooperation with the key centers. At the same time, the centers need an organized input, a voice, from the ocean engineering community. The Panel does not believe that either company proprietary restrictions or military security classifications cause serious problems in the exchange of engineering data and information. Rather, there simply is no group or agency in the ocean engineering community sufficiently concerned with data and information needs.

The panel recommended that a good remedial approach would be to establish a liaison office for ocean engineering data and information. This could be done on a trial basis for 2 years, to measure its effectiveness. The Panel recommended that the Liaison Office for Ocean Engineering (with a small staff) be established in EDS. This would be an excellent location for the trial office, because EDS has already established a dialog with ocean engineers, operates three marine data centers plus an information center, and has a clearly identified lead role in national and international data management and exchange.

The liaison office for ocean engineering would consider all of the problems mentioned in the foregoing discussion. It would also establish and maintain communication with the ocean engineering community, disseminate available information, and identify information needed but not available. Much of this would be accomplished with the aid and cooperation of the professional engineering societies.

Conclusion

The general consensus of the Panel was that although their initial report contained a significant amount of arbitrary material, it nonetheless appeared to be a worthwhile pioneer effort. The proposed liaison office could serve as a focal point for possible new developments in several ways. Being within EDS, the liaison office staff should be able to develop the capability to respond quickly to questions from the ocean engineering community. For the first time, the engineer would have a place to start his search for marine information. He also would have a means of reporting needs that were unsatisfied.

The liaison office would pick up where the Panel left off, i.e., it would review the lists of ocean engineering subjects, add new data bases, and amend the Data Base Descriptor list (table 3) to improve its usefulness. Similarly, the liaison office would work toward making available to the ocean engineering academic institutions the best possible data and information. These institutions would, in turn, be leaders in disseminating up-to-date information as to just what kind of data is available to the ocean engineer and how he can get them.

POLYMODE

By James Churgin
Director, World Data Center A,
Oceanography

For the past year, United States and Soviet scientists have been developing POLYMODE, a large-scale midocean dynamics experiment based on the previous POLYGON (U.S.S.R.) and MODE-I (U.S. and U.K.) programs, which documented the presence and scale of midocean eddies and tentatively explored their nature and importance.

POLYMODE is the next necessary step in the development of a physically correct ocean model. Such a model would provide a basis for oceanological forecasts and could be coupled with an atmospheric model for climatological studies and prediction of long-range weather and climate fluctuations.

The main scientific objectives of POLYMODE are:

(1) To conduct a kinematic and descriptive study of the midocean eddy field, including eddy-eddy interactions, on significantly longer time and larger space scales than previously studied;

(2) To determine local dynamic balances in a typical midocean region;

(3) To determine the contributions to the eddy transports of momentum, heat, and energy and their meridional distribution, as well as the interaction of eddies with the mean circulation;

(4) To explore the mechanisms of production, transformation, and dissipation of eddy energy;

(5) To develop and test numerical models of the oceanic mesoscale and general circulations, including (explicitly and implicitly) mesoscale eddies, for the purposes for forecasting, process investigation, and coupling to atmospheric models.

A year of intensive POLYMODE field experiments is scheduled tentatively for 1977. A draft plan for the proposed POLYMODE field program consists of three major components:

(1) Current and temperature measurements from moored stations.

(2) Density surveys from ships and other platforms (e.g. inserted echo sounders).

(3) Observations with SOFAR (sound fixing and ranging) floats.

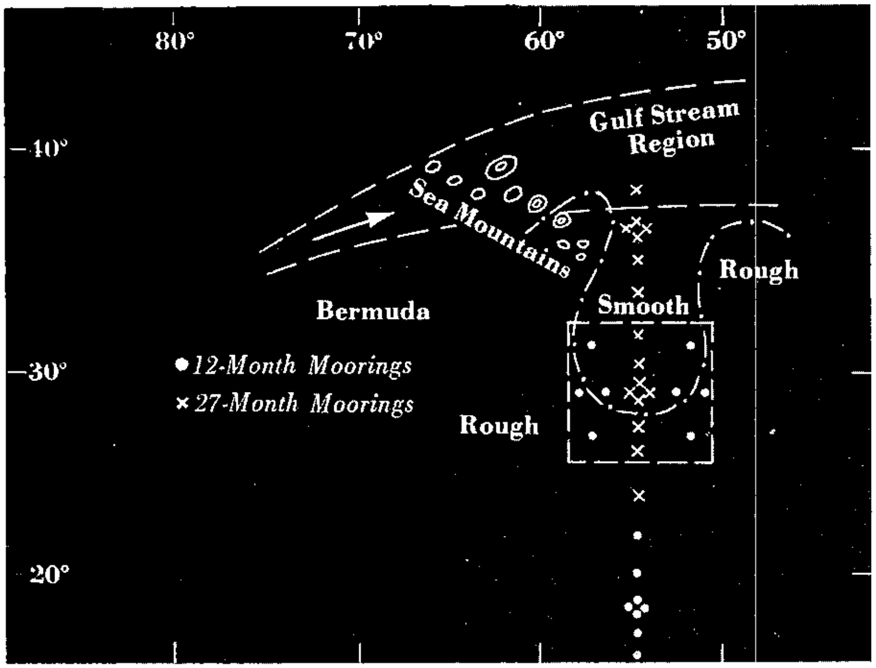
At least 32 moorings hosting more than 200 current or current/temperature instruments will be deployed by the two countries for periods of 1 to 2 years. In addition, 160 SOFAR floats with a 2-year lifetime are to be deployed by the United States. SOFAR floats at 600- and 2,000-meter levels will be used to obtain quasi-synoptic eddy data, particularly in the central square. (See figure 1.) A total of nearly 4 ship years will be required for the combined mooring and shipboard programs.

By sharing ships, instruments, equipment, and techniques, it will be possible to extend POLYMODE capabilities well beyond those possible with the resources of a single country. Resources to be pooled through agreements developed by joint working groups include ships; moorings and mooring components; scientific instruments; port, communications, and data processing facilities; and a joint POLYMODE operations control center.

Many of the shared activities will be developed experimentally, well before their use during POLYMODE field operations. Joint work on moorings deployment, shipboard programs, and communications should be tested this year during one or more pilot experiments.

POLYMODE is being conducted under the U.S./U.S.S.R. Agreement on Cooperation in Studies of the World Ocean. Participation by other nations who share the common scientific objectives will be arranged with the consent of the Joint Organizing Committee.

Data obtained during POLYMODE will be made fully and expeditiously available to all participating scientists. Finalized data also will be made available to other users through the World Data Center (WDC) system, under ground rules to be established by a U.S./U.S.S.R. data management subcommittee.



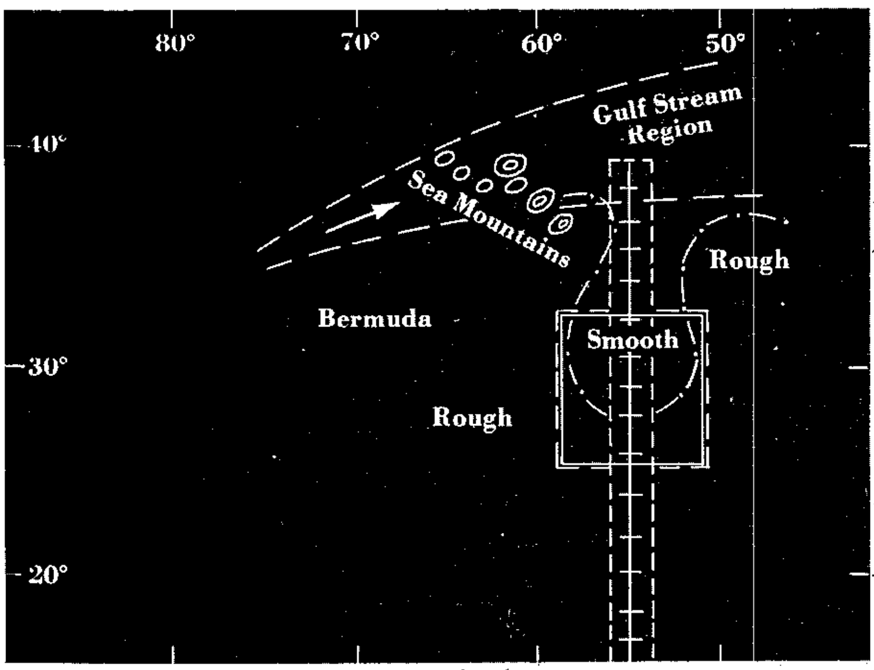


Figure 1 (top) shows the proposed POLYMODE mooring pattern, figure 2, the density survey pattern (the dashed lines enclose the mooring pattern of figure 1, the solid lines indicate the density survey stations and central area). The u-shaped contour in both figures delineates areas of rough and smooth bottom topography.

National Report

Climate Assessment Center Operational

The staff of CCEA's Model Development Division. Standing: Sharon LeDuc, Marla Lockard, Richard Katz, Paula Rosenkoetter, Joan Darkow, Gardner Von Holt, Norten Strommen (Deputy Director), Cathy McFate, Dolores Knipp, and Rita Terry. Sitting: Marguerite Johnson and James McQuigg (Director). Two staff members, Rita Fobian and Jeanne Beare, are not shown.

NOAA's Center for Climatic and Environmental Assessment (CCEA) became an operational EDS unit on November 15, 1974. Organizationally, CCEA consists of a Director's office and two major subelements: the Model Development Division and the Climatic Assessment Division. Dr. James D. McQuigg, the Center Director, and the Model Development Division are located in the Federal Building in Columbia, Mo., to provide an interface with a variety of discipline specialists on the staff of the nearby University of Missouri. The Assessment Division is located in EDS headquarters in Washington, D.C., to ease interactions with other government agencies.

CCEA's primary mission is to provide consultant services to Federal agencies concerned with the effect of the environment on socioeconomic programs and policies. (See page 8, May 1974 *Environmental Data Service;* also, page 3, July 1974 and page 16, January 1975.) Its specific objectives are to develop a global climate monitoring system, model the environmental impact on food, establish a climate warning system, and serve as a focal point for information on climatic effects.

The Model Division will initially develop crop/weather models by assembling large data sets containing historical information on crop yields and weather. This will be followed by the testing of various statistical regression models. The goal is to produce models that can use meterological data which are received daily, weekly, or monthly.

The Assessment Division will evaluate ongoing crop conditions by monitoring the world weather picture and ancillary aspects of plant growth. Yields will be estimated from the developed statistical models relating crop yield to local meterological conditions.

Crops to be analyzed will be selected on the basis of their importance to nutrition and trade. Foremost on the list are wheat, corn, and rice. Other choices include soybeans —because of their high protein content—millet, and sorghum. The countries to be studied are those that export grains and those most vulnerable to food shortages. The availability of historical crop and weather data is a secondary factor in the selection process.

At the present time, work is centered on North American regions, because they have production and meteorological data readily available. If this work proves successful, studies will be extended globally on an area-by-area basis.

To accomplish its mission, CCEA pursues an interdisciplinary approach. Professionals on the staff are social and geophysical scientists with broad bases in environmental disciplines. Services of personnel from the National Weather Service and National Marine Fisheries Service also will be available. Where practical, supplemental economic engineering research support will be obtained by contracts with universities and industry.

New Jersey Inshore Data Released

The Public Service Electric and Gas Company of New Jersey has released to NOAA environmental data collected in the inshore waters of New Jersey north of Atlantic City (centered at latitude 39° 28′ N and longitude 74° 15′ W).

The data, deposited in EDS, were collected as part of a site survey for a proposed nuclear generating station by several research groups under contract to the Public Service Company. Data sets consists of 6 biological reports, 2 geological/geophysical reports, 3 water quality (chemistry) reports, 13 physical oceanographic reports (currents, waves, tides, hydrography), 98 analog seismic reflection profiles, and digitized depth, temperature, salinity, and current observations.

The reports contain detailed information on:

1. Ecological studies: life histories and migrations of some important fishes, distribution of eggs and larvae of fishes, results of seine and trawl collections, sport and commercial fisheries, invertebrates (including shellfish), other marine and estuarine organisms, organisms associated with artificial reefs, problems and consequences of effects of powerplants on marine ecology.
2. Physical properties of water masses: daily wave statistics, joint distribution of significant wave heights, wave-rider data analyses, normalized wave energy spectra from wave-rider records, and a summary of wave records.
3. Currents: currents vs. direction, histograms, plots, profiles, computer printouts of current speed vs. direction, surface and subsurface drogue tracks, and dye dispersion.
4. Tides: summary and analyses of tide recordings.
5. Hydrography: seasonal and daily variations in water temperature as a function of depth, and depth-temperature-salinity profile summaries.
6. Geology/Geophysics: bathymetry, seismic reflection profiling and sediment analysis.

The data, in scientific report and analog form, are available from EDS on loan or microfilm copy. Automated data are available as magnetic tape copy or machine listing. Write: National Oceanographic Data Center, Environmental Data Service, National Oceanic and Atmospheric Administration, 3300 Whitehaven St. N.W., Washington, D.C. 20235, or phone: (202) 634-7441.

San Fernando Earthquake Documented

The first and third volumes of *San Fernando, California, Earthquake of February 9, 1971,* has been published by NOAA's Environmental Research Laboratories. The three-volume set documents the engineering and scientific aspects of the moderately strong San Fernando earthquake and its effects in the metropolitan Los Angeles area. It brings together the findings of postearthquake field investigations and studies by Federal and State agencies, local government activities, public and private institutions, engineering firms, and numerous professional organizations.

Volume I describes how the earthquake affected both building structures and the soils and foundations as these relate to buildings. It is bound in two parts: Part A. Introduction and Buildings; and Part B. Buildings, Soils and Foundations. Other topics treated at length include the State role in seismic safety, development of California earthquake codes and practices, damage repair techniques, earthquake damage and related statistics, and nonstructural damage.

Volume II considers the earthquake's effects on utilities and transportation, as well as its sociological aspects. Utilities are divided into energy and communication systems and water and sewerage systems. Individual and organizational impacts treated in detail include human reactions and response to law enforcement, medical emergency, disaster aid, mental health aspects, the role of the media, traffic control, real property, voting behavior, and community perspectives.

Volume III contains papers in classical seismology, surface and subsurface geology, vertical and horizontal geodesy, strong-motion seismology, and geomagnetism.

Engineers, scientists, legislators, administrators, planners, and public safety and welfare officials will find these volumes a helpful reference in preparing for emergencies that accompany natural disasters.

Volume II is scheduled for release in early 1975. All three volumes will be for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Each volume should be ordered by its respective stock and catalog numbers.

Volume	Stock Number	Price
I (Parts A & B)	0317-0087	$21.60
II	0317-0088	9.85
III	0317-0089	11.90

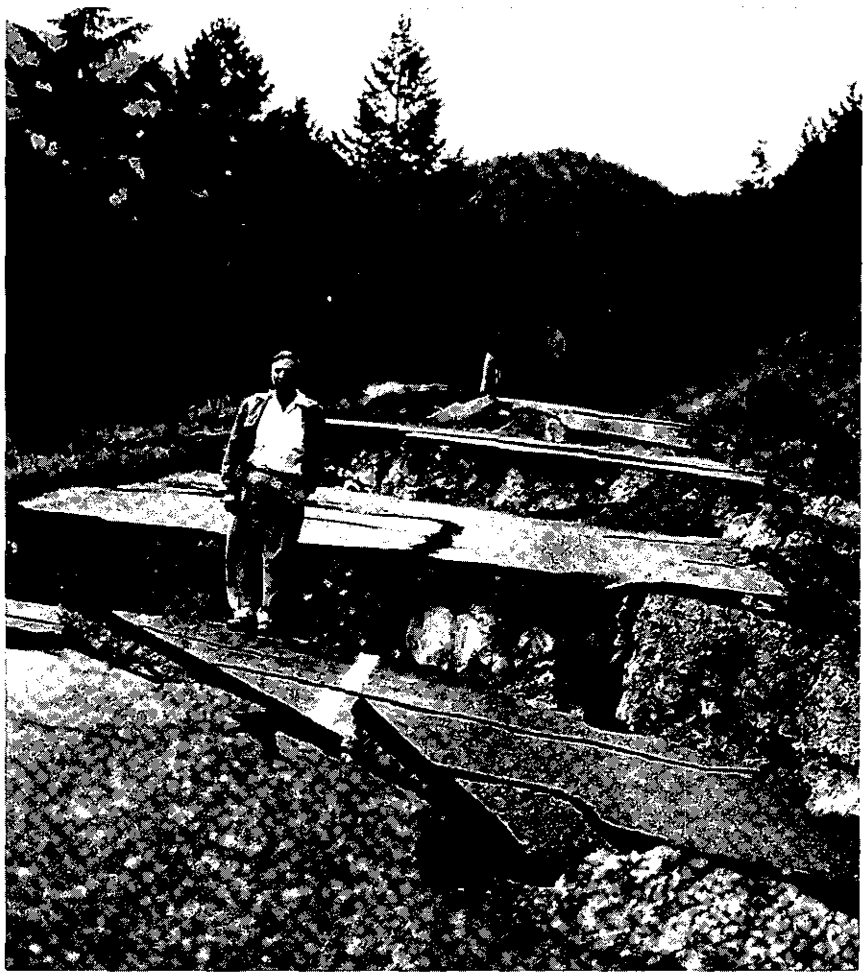
Earthquake Photo Catalog Published

A *Catalog of Earthquake Photographs* has been published by the National Geophysical and Solar-Terrestrial Data Center. It represents an initial effort to collect photographs and maps from many sources and make them generally available to the public.

The catalog lists about 300 photographs and 200 maps on the subject of earthquakes, and also contains descriptions and samples of the picture collection. Many of the photographs show earthquake-damaged buildings, bridges, dams, and other manmade structures; several show spectacular landslides, rifts, and ground cracks caused by destructive shocks. The maps depict intensity distribution of important earthquakes and the seismicity of geographical areas throughout the world. Both photographs and maps are available as black and white prints or 35-mm transparencies, and some may be obtained in color.

Photographs of earthquake damage preserve a record of effects that otherwise might be lost in clean-up and repair operations. For engineers, they provide specific details of construction effects that cannot be reduced easily to a written report.

The 42-page illustrated catalog is available from the National Geophysical and Solar-Terrestrial Data Center, NOAA/EDS, Boulder, CO. 80302.



Top picture: Chilean earthquake on December 20, 1967 caused the collapse of this bedroom's cinder block walls. (Photo: E. Kausel, University of Chile.) Right: Hebgen Lake, Montana earthquake of August 18, 1959 made a flight of stairs out of State Highway 287.

User's Guide to Solar-Terrestrial Physics Data

Solar-Terrestrial Physics Services and Publications is now available from the National Geophysical and Solar-Terrestrial Data Center (NGSDC). It lists the data for all disciplines and subdisciplines held by NGSDC, their costs and related products and services, and instructions on how and where to obtain them. Seven major data categories are described, plus an eighth category comprising miscellaneous data on environmental influences.

The 16-page guide should help research scientists, as well as users concerned with the Sun's effects on man and his activities. These include the direct and indirect solar effects on shortwave radio communications, navigation, use of satellites for communications and navigation, man and instruments in space, electrical power transmission, geomagnetic prospecting, gas pipeline monitoring, possibly weather, and human and animal behavior.

Copies of the new publication are available on request from the National Geophysical and Solar-Terrestrial Data Center, NOAA/EDS, Boulder, Colo. 80302.

Satellite Electron Data Available

Data for precipitating electrons as observed by the satellites of the U.S. Air Force Defense Meteorological Satellite Program are now available from the National Geophysical and Solar-Terrestrial Data Center (NGSDC) in Boulder, Colo. These data on the conditions in the high ionosphere and magnetosphere are expected to be of greatest value when used in conjunction with concurrent auroral optical imagery from the same satellites.

The electron data are in counts per second with a 1-second sampling interval, and are organized by time with geographic and corrected geomagnetic coordinates. The data now available are for 6.3 keV electrons and cover the period August 27, 1973 to March 11, 1974.

The data are made available by the USAF Air Weather Service. They are from a system of two (nominally) satellites, in dawn-dusk and noon-midnight orbits, sun-synchronous, with 99-degree inclination. The satellite altitudes are 815 to 850 km and orbital periods are about 102 minutes.

Future data acquisitions from newer satellites in this series will be from improved instrumentation, providing finer time resolution and a broader range of electron energies (from about 50 keV to 20 keV in two bands). Plans are being explored to archive these data on magnetic tape, and NGSDC is working with the NASA National Space Science Data Center (NSSDC) on how best to process them to service future user requests.

Seismogram Package Reduces User Costs

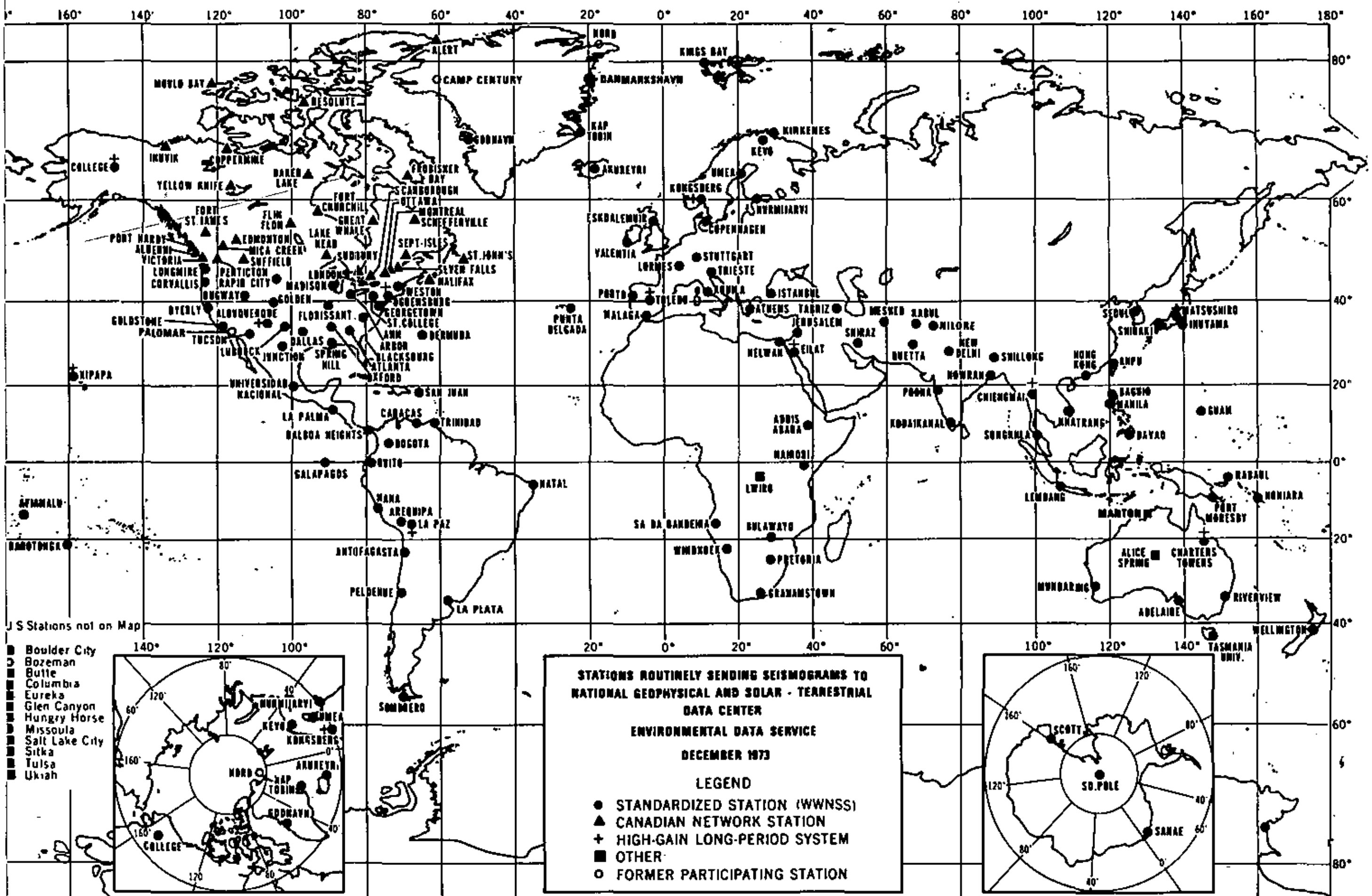
A new seismogram data package is being offered to users by EDS' National Geophysical and Solar-Terrestrial Data Center on a trial basis. Microfilms of seismograms for the global Worldwide Standard Seismograph Network (WWSSN) and other networks (up to 150 or more stations), for selected days during 1974 when large earthquakes occurred, are being offered at rates less than half the cost of more expensive, individually prepared data sets. The new service may be attractive to users who do not have access to the full network files and are mainly concerned with large-magnitude events.

Seismograms for earthquakes of magnitude 6.5 and greater will be available in the package. During the last 5 years, earthquakes of magnitude 6.5 and larger averaged about 40 per year. The basic collection will be the 115-station WWSSN. Also available will be seismograms from the 10-station, high-gain, long-period net and the 30-station Canadian seismic network. For earthquakes larger than magnitude 7.5 (and some others of special interest), seismograms can be provided from other stations that participate in international exchange through World Data Centers. Each station usually has six seismograms (three long-period and three short-period components).

Several types of microfilm are available—70-mm rolls or chips (with or without jackets) and 35-mm rolls. (The resolution of 35-mm microfilm is significantly less than that of 70-mm, but is sufficient for most purposes.)

The first copies of WWSSN seismograms for 1974 will be mailed as soon as records from a minimum of 40 stations have been processed for the event and a second shipment sent when about 40 more are available. Usually, records for about 100 stations are available within a reasonable time.

Similar data packages will be prepared for years before 1974, if demand is sufficient.



Prices per event for this special service are as follows:

	WWSSN	HGLP	Canadian	Other
35-mm roll	$60	$6	$18	*
70-mm roll	65	6.50	—	*
70-mm chip	70	7	—	*
70-mm chip (in jackets)	85	8.50	—	*

* Price furnished on request; depends on number of stations available.

Orders and requests for additional information should be directed to:

National Geophysical & Solar Terrestrial Data Center (D62)
EDS/NOAA
Boulder, CO. 80302.

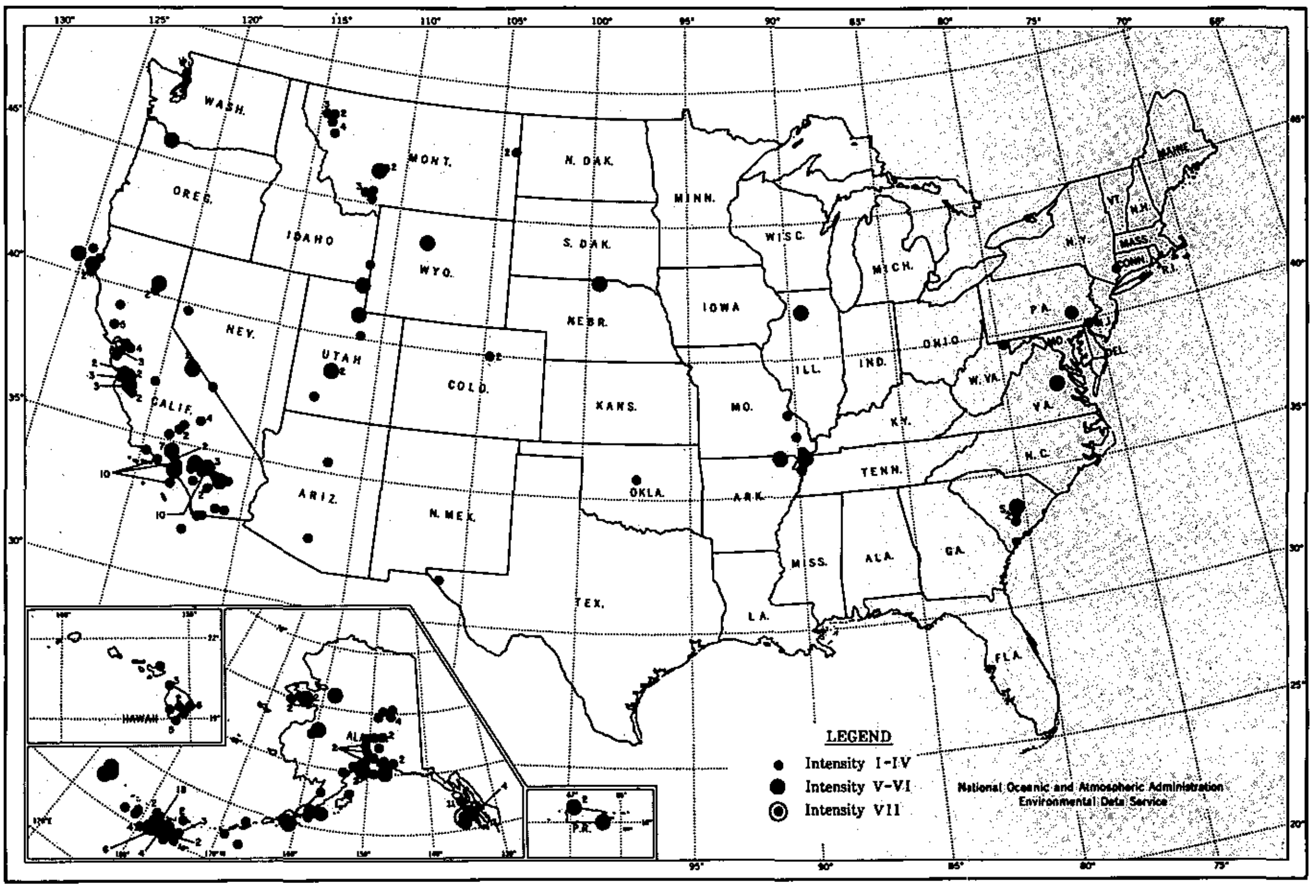
1972 Annual Earthquake Summary

'United States Earthquakes, 1972,' was published recently by EDS' National Geophysical and Solar-Terrestrial Data Center. The publication summarizes earthquake activity in the United States and nearby territories for the calendar year 1972. It includes descriptions of all earthquakes reported by residents of the United States, Puerto Rico, Virgin Islands, and the Panama Canal Zone. The descriptions include date of occurrence, time, location, magnitude, felt area, and damage details when available. Several maps complement the earthquake data, including intensity maps for moderate earthquakes in four States.

The report lists all instrumentally located earthquakes and related phenomena in the United States. It also presents sections on geodetic work of seismological interest; tidal disturbances of seismic origin; and fluctuations in well-water levels, with corresponding earthquakes and principal earthquakes of the world for 1972—including a list of earthquakes recorded and records obtained from the NOAA strong-motion network (now operated by the U.S. Geological Survey).

The 128-page report (Stock No. 0317-00216, Sales Price $2.30) is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, or from local GPO bookstores located in Birmingham, Ala.; Los Angeles and San Francisco, Calif.; Denver, Colo.; Washington, D.C.; Atlanta, Ga.; Chicago, Ill.; Boston, Mass.; Detroit, Mich.; Kansas City, Mo.; New York, N.Y.; Canton, Ohio; Philadelphia, Pa.; Dallas, Tex.; and Seattle, Wash.

Below: Earthquakes that were felt or caused damage in the United States during 1972.



International Report

IOC Committee on International Oceanographic Data Exchange To Meet in Rome

The Intergovernmental Oceanographic Commission Working Committee on International Oceanographic Data Exchange (IOC WC IODE) will hold its VIIIth Session at the Food and Agriculture headquarters in Rome, Italy, May 12-16, 1975. As part of a general restructuring of the IOC, the former Working Group on IODE, which held its last (VIIth) meeting in New York in July 1973, has now been upgraded to a Working Committee and its terms of reference broadened to include not only data but also the international exchange of and referral to information resulting from marine programs.

Among the main topics to be considered at the VIIIth session are: strengthening and modernizing arrangements for international oceanographic data exchange in conjunction with national, regional, and World Data Center systems; formulation of standard formats for data exchange, with special emphasis on the needs of major new interdisciplinary programs; and the management of oceanographic information and collaboration with respect to on-going information services, such as FAO's Aquatic Sciences and Fisheries Information (ASFIS) and the United Nations Environment Programme's International Referral System.

Other agenda items of particular importance include standards for the documentation and exchange of marine pollution data, exchange of satellite data, and further development of archiving schemes for data and data products resulting from IGOSS.

The Sessions of the Working Committee, one of the oldest continuing bodies of the IOC, are convened about every 18 months; the United States has been an active member since the group's inception in 1961 and has chaired the Committee since its IVth Session in 1968.

Electrojet Magnetic Indices Published for 1966

Auroral Electrojet Magnetic Activity Indices AE (10) for 1966—Report UAG-37 has been issued by World Data Center A for Solar-Terrestrial Physics at Boulder, Colo. The report is the fifth 1-year compilation published by the Center. AE has been usefully employed as a correlative index in studies of substorm morphology, the behavior of communication satellites, radio propagation, radio scintilation, and the coupling between the interplanetary magnetic field and the Earth's magnetosphere. Report UAG-37 is available at $0.75 a copy from the National Climatic Center, Federal Building, Asheville, N.C. 28801, Attn: Publications.

Vol.	Stock/Catalog Nos.	Price
I	0317-0087/C55.2:Sa 5	$21.60
II	0317-0088/C55.2:Sa 5	9.85
III	0317-0089/C55.2:Sa 5	11.90

The Intergovernmental Oceanographic Commission Working Committee on International Oceanographic Data Exchange (IOC WC IODE) will hold its VIIIth Session at the United Nations Food and Agriculture Organization's headquarters in Rome, Italy, May 12-16, 1975. As part of a general restructuring of the IOC, the former Working Group on IODE, which held its last (VIIth) meeting in New York in July 1973, has now been upgraded to a Working Committee and its terms of reference broadened to include not only data but also the international exchange of and referral to information resulting from marine programs.

Peruvian and Caribbean Earthquake Seismograms

On October 3, 1974, an earthquake of Richter magnitude 7.6 shook the central coastal area of Peru from Lima to Chincha, killing 78 people, injuring 2,414 others, and causing heavy damage. In Lima, the streets were littered with debris and flooded by water from broken mains and sewer lines. Within a few days, teams of engineers and scientists arrived to study this major seismic event and to evaluate its effects.

A second major earthquake (magnitude 7.5) occurred in the Leeward Islands in the Caribbean on October 8, 1974, injuring four people and causing moderate damage on the Islands of Antigua, Barbuda, and St. Kitts.

Seismograms for these two major earthquakes are being collected from several hundred cooperating seismic observatories around the world and filmed by the EDS National Geophysical and Solar-Terrestrial Data Center for international dissemination through the World Data Center system. They will be used by scientists to study focal mechanisms, magnitudes, epicenters, and other parameters.

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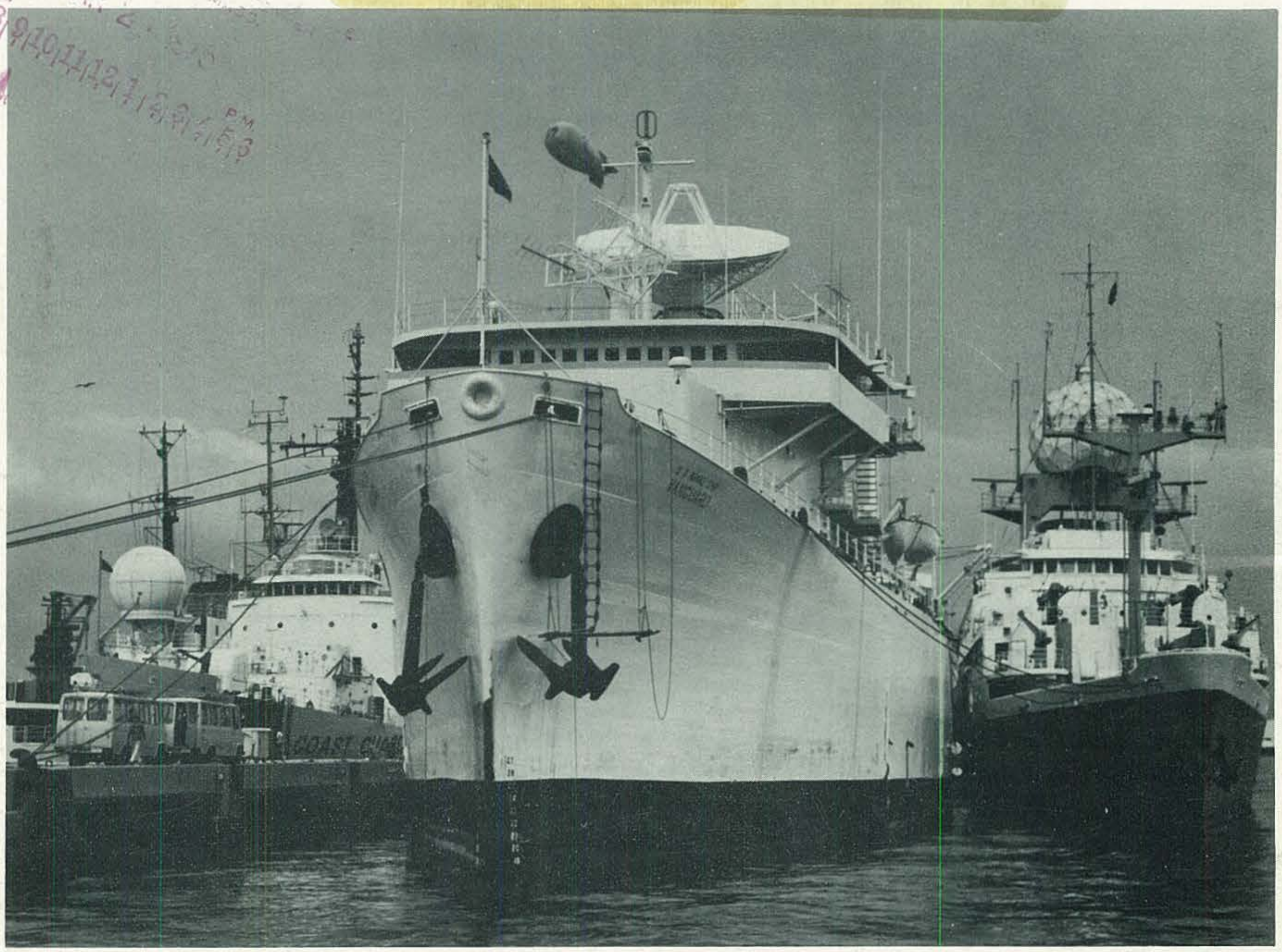

Photo: Josh Holland

Four of the 40 vessels which participated in the recent international Atlantic Tropical Experiment of the Global Atmospheric Research Program. (See "International Developments" in the lead article.) The radar dome on the left side of the picture belongs to NOAA's OCEANOGRAPHER. The Coast Guard cutter next in line is the DALLAS, whose tethered balloon is seen over the satellite tracking ship VANGUARD. The ship on the right is the Canadian research vessel QUADRA.

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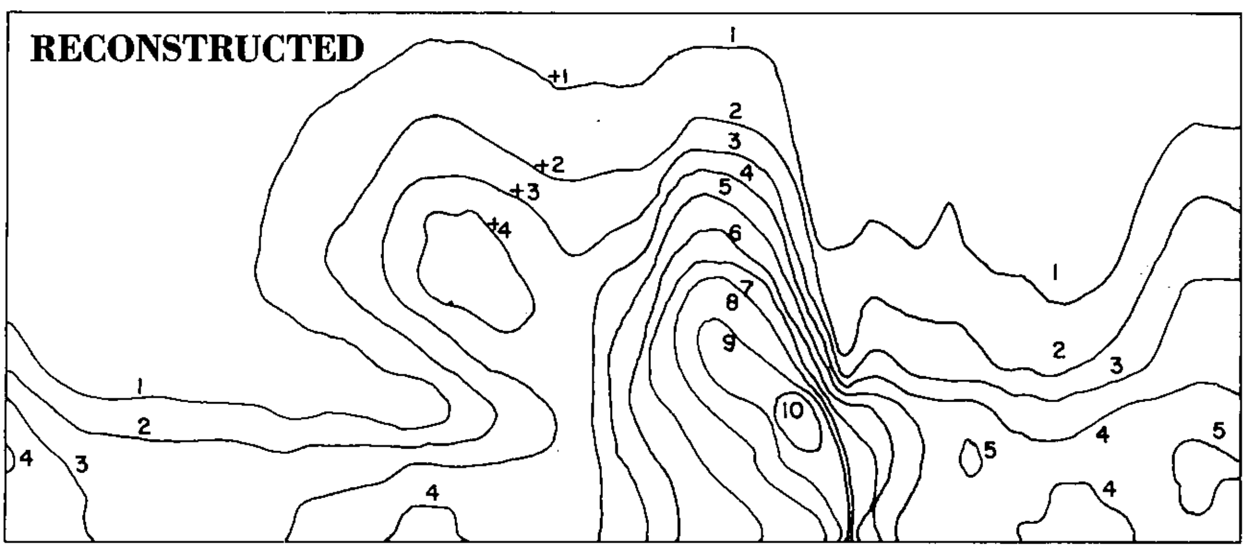

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Cover: *Specific humidity time-height analyses for a Canadian upper-air sounding station during the International Field Year for the Great Lakes (IFYGL). The original analysis (top) was made with all (more than 7,500) data-point observations; the reconstructed section, a product of a new data analysis and compaction method developed by EDS scientists, is based on about 250 data points—a reduction factor of more than 30 to 1. The reconstructed analysis is also a "smoothed" data field, with much of the "noise" present in the original observations eliminated. A detailed description of the analysis technique and its benefits begins on page 3.*

ENVIRONMENTAL DATA SERVICE is designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, Center for Climatic and Environmental Assessment, and National Oceanic and Atmospheric Satellite Data Unit. In addition, under an agreement with the National Academy of Sciences, the National Oceanic and Atmospheric Administration (NOAA) has responsibility for World Data Center-A activities in oceanography, gravity, tsunami, seismology, geomagnetism, meteorology, and nuclear radiation, ionosphere and airglow, cosmic rays, auroras, and solar observations; the Director of EDS coordinates these activities within NOAA.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, July 26, 1973; this approval expires June 30, 1975.

Validation, Compaction, and Analysis of Large Environmental Data Sets

By John Jalickee
Jerry Sullivan
Richard Rozett

EDS scientists have developed a technique which, among other benefits, allows them to compact a data set of 184,000 values into an equivalent data set of fewer than 6,000 values, while retaining 90 to 98 percent of the variability of the original data fields. Moreover, much of the remaining variability appears to be sensor noise.

Introduction

Large-scale environmental field experiments such as the Barbados Oceanographic and Meteorological Experiment (BOMEX), the International Field Year for the Great Lakes (IFYGL), and the GARP (Global Atmospheric Research Program) Atlantic Tropical Experiment (GATE) produce huge data sets and attendant large-scale problems in data validation, analysis, and synthesis. New and more sophisticated techniques are needed to extend and complement traditional methods when working with such large data sets.

The failure of conventional smoothing techniques to adequately remove noise from an IFYGL rawinsonde (atmospheric sounding) wind data set and still retain meaningful, though highly variable, natural fluctuations led the authors and other scientists of EDS' Center for Experiment Design and Data Analysis (CEDDA) to try a new method, called the asymptotic singular decomposition method, or ASD for short. The resulting computer program eliminated the noise and retained the essential data. It also greatly reduced the size of the original data base and, through intermediate graphics, provided a quick and efficient method of error detection, while isolating physical relationships and characteristic patterns.

The ASD Method

The idea behind this data decomposition technique is to extract meaningful information in the form of characteristic patterns. As an example, consider a meteorologist studying daily maximum temperature data for the east coast. Station by station, he observes that, in general, it is warmer in summer than in winter: from this he abstracts a typical seasonal variation. On the other hand, studying station-to-station variations, he notes that temperatures are generally colder in the north than in the south at almost any time of year. With these two characteristic variations (space and time) he can qualitatively explain the main features of the entire data set. And by retention of a relatively few significant temperature values he could quantitatively describe perhaps 90 percent of the east coast maximum temperature field.

The ASD data decomposition method adapted by CEDDA formalizes this process and provides a technique to calculate characteristic patterns for small and large data sets. Using the ASD method, dominant patterns within the data are easily extracted in an objective, repeatable fashion. In many respects, the science of ASD is much akin to the art of the caricaturist: the major features of the subject are quickly shown with a few sure, deft strokes.

CEDDA scientists have used ASD to reduce the quantity of data needed for a sufficient representation of a physical situation; often the equivalent data set is an order of magnitude smaller than the original one. Data generated by the method also are used in calculations that require relatively noise-free data; random noise is smoothed out, while real discontinuities or sharp changes are relatively unchanged. An unexpected bonus of the method is its error-detection capabilities; keeping with the caricaturist analogy, distorted (erroneous) features stand out sharply. Physical relationships within the data, often buried by the volume of numbers, are also highlighted by the method.

The ASD method is related to other statistical techniques such as principal component analysis, Lorenz's[1] empirical orthogonal functions in meteorology, and the factor analysis method of psychologists, political scientists, and sociologists; however, ASD has the advantages of simplicity and accuracy. A factor analysis computer program might fill over a thousand punched cards, while ASD would use a hundred. And ASD is almost immune to computer roundoff error, an important consideration when large data sets are involved.

			Nov. 3				Time (GMT)				Nov. 4	
Pressure (P*) in Mbars	18	21	00	03	06	09	12	15	18	21	00	03
	-23.0	-23.9	-26.1	-25.2	-26.4	-29.7	-31.5	-29.0	-25.5	-25.8	-25.9	-26.1
	-22.0	-22.9	-24.6	-23.8	-25.0	-28.7	-32.7	-29.4	-24.4	-24.0	-24.3	-24.7
	-20.9	-21.9	-23.1	-22.6	-23.7	-27.0	-33.7	-30.1	-24.1	-22.5	-22.9	-23.3
	-19.9	-20.9	-21.6	-21.8	-22.8	-26.0	-32.5	-29.2	-23.6	-21.2	-21.1	-21.8
	-19.0	-20.0	-20.3	-20.6	-22.5	-25.1	-31.3	-28.2	-23.0	-20.0	-19.7	-20.4
	-17.9	-19.0	-18.9	-19.3	-21.4	-24.1	-30.0	-30.4	-22.4	-18.7	-18.4	-19.4
	-16.8	-17.9	-17.5	-18.0	-20.6	-23.3	-29.0	-29.0	-21.4	-18.2	-17.3	-19.3
	-15.7	-16.6	-16.3	-17.0	-19.3	-22.6	-27.9	-27.5	-20.1	-16.9	-16.4	-17.9
	-14.4	-15.2	-14.9	-16.2	-18.2	-21.9	-26.8	-26.4	-19.2	-16.2	-16.1	-16.6
500	-13.2	-14.0	-13.8	-15.6	-17.2	-20.5	-25.9	-25.1	-18.1	-15.5	-15.0	-15.7
	-12.0	-12.6	-13.0	-14.7	-15.9	-18.7	-25.7	-24.2	-17.0	-14.8	-14.5	-14.7
	-10.8	-11.4	-11.8	-13.4	-14.8	-18.2	-25.5	-23.5	-16.1	-13.9	-13.7	-14.0
	-9.8	-10.2	-10.7	-12.0	-13.6	-17.4	-24.4	-22.6	-15.2	-13.0	-12.8	-13.2
	-8.9	-9.3	-9.9	-10.5	-12.6	-16.4	-22.8	-21.6	-14.5	-11.7	-11.8	-12.3
	-8.3	-8.8	-9.2	-9.6	-11.4	-15.6	-21.7	-20.5	-13.3	-11.0	-11.0	-11.7
	-7.7	-8.3	-8.5	-9.7	-10.7	-15.0	-20.8	-19.6	-12.4	-10.3	-10.1	-10.4
	-7.1	-7.7	-7.6	-8.0	-9.4	-14.7	-20.0	-18.4	-11.7	-9.5	-9.3	-9.4
	-6.5	-7.0	-7.1	-7.7	-8.4	-14.0	-19.3	-17.5	-10.8	-8.4	-8.2	-8.4
	-5.8	-6.4	-6.2	-6.6	-7.3	-13.4	-18.2	-16.8	-10.1	-7.6	-6.9	-7.5
400	-5.0	-5.7	-5.3	-5.4	-6.3	-13.0	-17.3	-15.6	-8.9	-6.6	-6.1	-6.7
	-4.5	-5.2	-5.0	-4.3	-5.6	-12.0	-16.8	-15.0	-8.3	-5.4	-5.5	-6.2
	-4.0	-4.9	-4.2	-3.1	-4.7	-11.0	-16.5	-14.6	-8.4	-4.6	-5.2	-5.2
	-3.5	-4.4	-3.4	-2.5	-3.9	-10.3	-15.9	-13.8	-7.9	-4.4	-4.7	-4.8
	-2.7	-3.5	-3.5	-1.9	-3.4	-9.3	-14.9	-13.3	-7.2	-4.0	-4.0	-4.2
	-2.0	-2.8	-2.9	-1.0	-3.4	-8.7	-14.3	-12.7	-6.6	-3.7	-3.2	-3.6
	-1.5	-2.3	-1.8	-.6	-4.4	-8.3	-13.9	-11.8	-6.0	-3.1	-2.7	-2.8
	-.6	-1.3	-.7	.1	-5.3	-9.6	-12.8	-11.3	-6.1	-2.3	-2.4	-4.3
	.0	-.3	.5	.1	-5.7	-9.6	-12.0	-10.4	-5.6	-2.0	-1.9	-4.9
	1.0	.8	1.3	.8	-5.3	-9.1	-11.0	-9.8	-5.5	-1.9	-2.3	-4.9
300	1.8	1.6	1.9	1.3	-4.6	-8.8	-10.5	-9.2	-4.9	-1.7	-1.5	-4.7
	2.7	2.8	3.0	1.5	-3.9	-8.4	-10.6	-9.0	-4.1	-1.1	-1.2	-4.4
	3.1	3.5	4.2	.9	-3.7	-7.9	-9.3	-8.3	-4.0	-.4	-1.1	-3.9
	3.8	4.2	5.2	1.8	-2.8	-8.2	-8.6	-7.3	-3.6	.0	-.8	-3.9
	4.5	4.7	6.1	2.9	-2.0	-7.3	-8.0	-6.5	-2.9	-.6	-1.0	-3.8
	4.9	5.1	7.1	3.4	-1.6	-7.3	-7.4	-6.2	-2.1	-2.1	-1.6	-4.1
	5.4	5.5	8.2	4.5	-.9	-7.0	-6.7	-5.4	-2.3	-3.5	-1.9	-4.7
	6.0	6.2	9.2	5.0	-.8	-5.6	-6.0	-4.5	-2.0	-4.0	-2.0	-4.1
	6.7	7.0	10.1	5.4	-.3	-3.7	-5.5	-4.0	-2.5	-3.8	-2.3	-3.8
	7.0	7.2	10.7	5.7	.2	-2.8	-4.9	-3.6	-2.1	-3.6	-2.5	-4.7
200	7.7	8.0	11.1	6.5	.9	-2.0	-4.0	-3.0	-2.0	-3.7	-3.2	-4.8
	8.2	8.5	10.9	6.9	1.7	-.7	-3.1	-2.6	-2.7	-4.5	-4.1	-6.3
	8.5	9.0	10.7	7.6	2.4	-.5	-2.5	-1.8	-2.3	-4.1	-4.8	-5.6
	8.9	9.4	10.0	7.9	3.2	.9	-1.6	-1.2	-1.8	-3.4	-4.5	-5.2
	9.2	9.9	10.2	8.7	4.1	1.9	-.6	-.5	-2.3	-2.7	-4.4	-4.5
	9.6	10.4	10.3	9.2	4.8	2.6	.1	.3	-2.5	-2.2	-3.7	-4.5
	9.8	10.9	10.7	9.7	5.6	3.5	1.0	.6	-2.1	-1.7	-3.2	-3.6
	9.8	11.4	11.0	9.8	6.2	4.4	1.6	1.4	-1.3	-.9	-2.6	-3.0
	9.8	11.7	11.6	10.4	7.1	5.2	2.0	1.9	-.3	-.3	-2.0	-2.2
	9.3	12.0	12.3	11.0	7.9	6.1	2.5	2.6	.1	.3	-1.5	-1.6
100	9.4	12.3	12.9	11.7	8.7	7.1	3.2	3.2	.8	.8	-1.3	-.8
	9.6	12.6	13.3	12.4	9.7	8.5	4.0	3.3	1.6	1.3	-1.2	-.1
	9.9	13.0	13.9	13.0	10.5	8.7	4.7	4.3	2.5	1.9	-.8	.4
	10.1	12.9	14.5	13.5	11.1	9.9	5.6	5.1	3.3	2.0	-.2	.9
	9.8	12.6	14.9	13.3	11.3	10.1	6.2	5.6	4.2	1.7	.3	.5
	9.5	12.1	15.0	12.8	11.7	10.6	7.3	5.9	5.0	2.3	1.1	-.0
	9.4	11.6	13.4	12.7	12.1	11.1	8.2	6.7	5.8	3.1	2.1	.5
	9.5	11.4	13.2	13.2	12.6	11.7	8.9	7.4	6.7	3.9	2.9	1.0
	9.4	11.3	13.5	13.5	13.2	12.1	9.9	8.5	7.5	4.7	3.6	1.7
	9.6	11.0	13.6	13.3	13.3	12.1	10.6	9.1	8.4	5.5	4.3	2.6
0	9.8	10.8	12.0	12.1	12.0	11.7	10.3	9.8	9.4	8.0	5.2	3.7

Figure 1. Upper-air temperature data for Stony Point, New York.

Data Compaction

Data from IFYGL for 1972-73 provide some vivid illustrations of the benefits of ASD applications. To demonstrate the data-compacting capabilities of the ASD method (plus the method itself), consider 12 successive IFYGL rawinsonde launches from station Stony Pt., N.Y., for the period 1800 GMT Nov. 2, 1972, to 0300 Nov. 4, 1972 (fig. 1). Temperature values are given for each 10-mbar pressure level, so that up to the 590-mbar level we have $12 \times 60 = 720$ values. (The pressure variable used in all figures is P*, the difference between surface pressure and observed pressure, i.e., $P^* = P_{surface} - P$.) The particular time period was chosen because a sharp upper-air trough was passing over Lake Ontario, producing the characteristic temperature variations represented by the solid lines in figure 2.

The object of ASD application in this instance is to replace the 12 columns of 60 numbers with 1 column of 60 numbers and 1 row of 12 numbers, as in figure 3. In the latter illustration, the column represents the pressure dependence of the temperature soundings, while the row represents the time variation. To obtain the 350-mbar temperature for 0000 GMT on November 3, one would multiply the 36th number from the bottom of the column by the 3d number of the row (as shown in fig. 3), or,

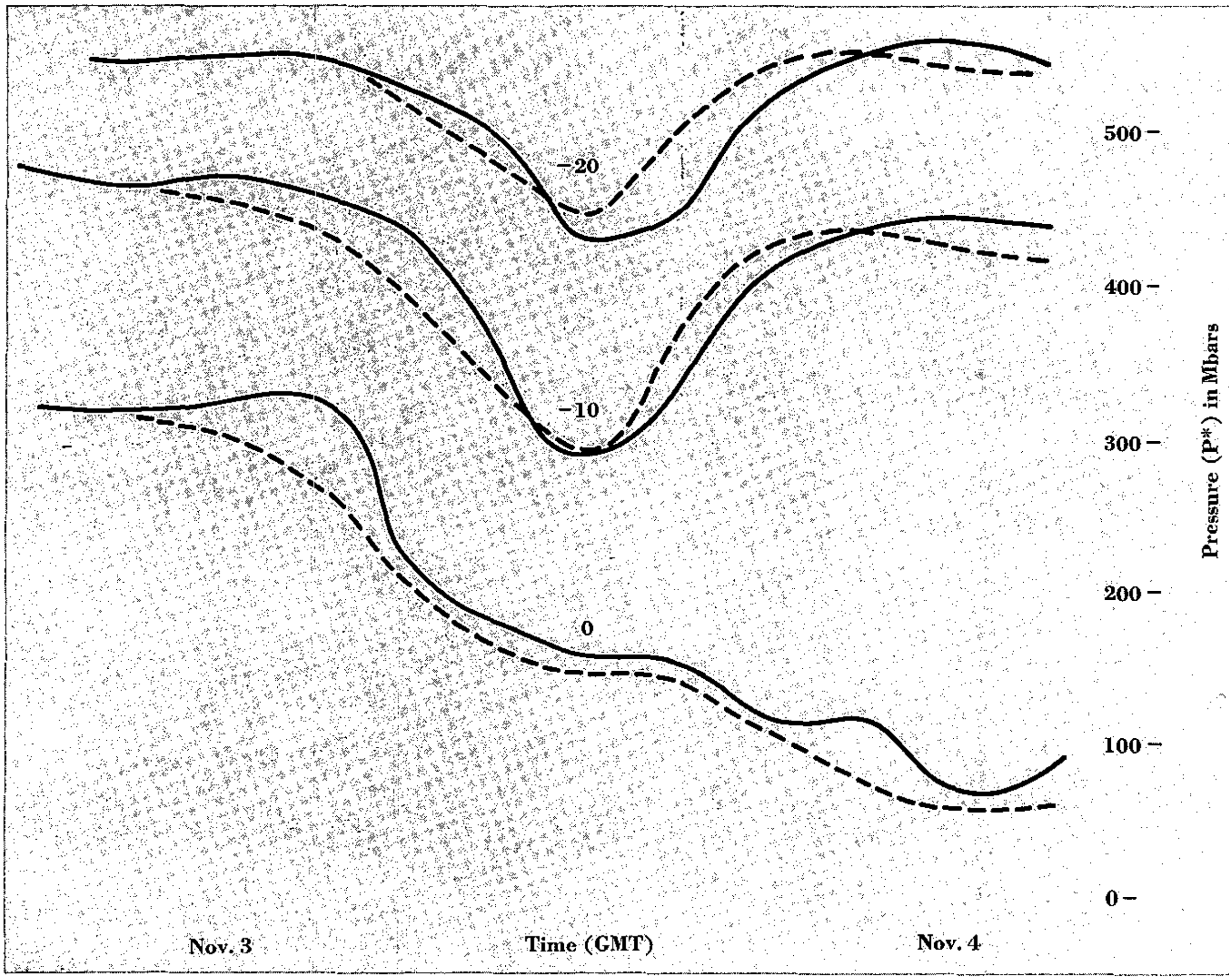


Figure 2. Time-height temperature analyses for Stony Point. The solid lines are based on the original data set, the dashed lines on a reconstituted data set.

to get the 150-mbar temperature at 1800 GMT on November 3, multiply the 16th column number from the bottom by the 9th number in the row.

Where did the column and row come from? Any column and row of numbers can be multiplied together to generate a temperature field. The best choice is one that minimizes the sum of squared differences between the generated field and the original field. In practice, the ASD computer program begins with a trial column and row, then generates successive values until there is no further minimization of differences between the two temperature fields.

In the example at hand, the original 720 numbers have been replaced by $60 + 12 = 72$ numbers, a 10-fold reduction. The new field generated by the row and column explains approximately 90 percent of the variation about the mean of the original field. The ASD method now may be used again to describe the residuals of the original field minus the first generated field, producing another row and column. Usually, about 98 percent of the original temperature field variation is covered by three rows and columns. The broken lines in figure 2 show a reconstituted temperature field using three rows and columns.

Overall, CEDDA scientists were able to compact 60 levels of temperature, humidity, and wind values from 768 IFYGL upper-air soundings (6 stations, 128 launches each), a total of 184,000 values, into an equivalent data set containing fewer than 6,000 values. From 90 to 98 percent of the characteristics of the original fields are retained, and much of the unexpected variability appears to be sensor noise.

Error Checking

Figure 4 illustrates ASD's error-detection capability. Obviously, the sounding for station 2 differs greatly from the soundings for the other five stations. Figure 5 shows the time components corresponding to the pressure component of figure 4. Once again, a strong anomaly (circled values) shows up. The six soundings indicated were checked and did prove to be erroneous. Thus, a 10-second scan of these two ASD graphs isolated an error that previously had escaped detection.

Physical Relationships

Three station pairings stand out clearly in the lower levels of the soundings shown in figure 6. These station pairs—1-2, 3-6, and 4-5—are geographically related. Stations 4-5 are on the western end of Lake Ontario, 3-6 on the middle shoreline, and 1-2 on the eastern end. Figure 7, a plot of the corresponding time component, shows that the effect is most pronounced for launches number 20 through 27. A detailed check of the soundings from all stations for this period revealed a large east-west wind velocity gradient which varied from 2 m/s in the west to 6 m/s in the middle to 14 m/s in the east.

Other Uses

With ASD, new data can be compared quickly with older data obtained by the same measuring system. Drastic differences in the ASD plots will suggest instrument drift and/or mistaken assumptions about experimental background conditions. The same approach can be used where different types of instruments are supposedly measuring the same physical phenomenon. This type of application allows CEDDA scientists to study the very large data sets associated with ecosystems and often, through simultaneous analysis of many different kinds of variables, uncover hidden interactions.

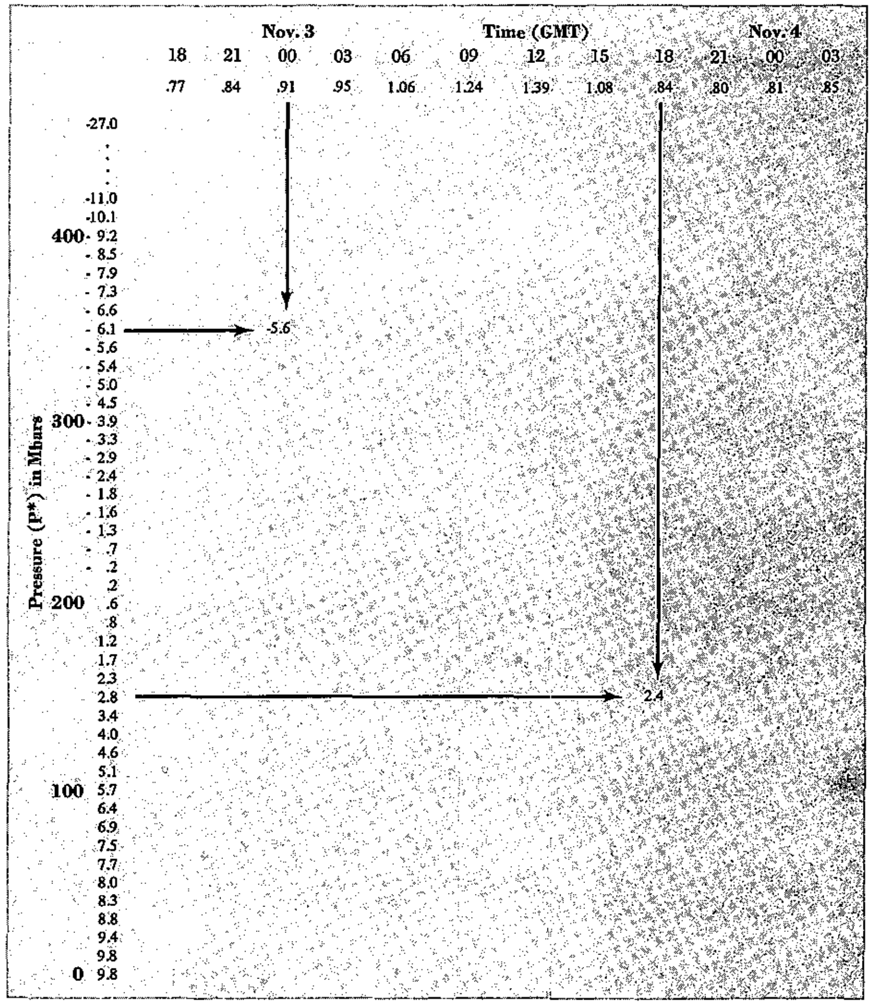


Figure 3. An illustration of the ASD data compaction technique. The single column of 60 numbers and single row of 12 numbers replace the 12 columns of data appearing in figure 1, yet retain approximately 90% of the details of the original data set.

Modeling and Experiment Design

CEDDA scientists are pursuing other potential applications of the ASD method, including its use in modeling and experiment design. The characteristic patterns obtained provide important clues as to the physical realities underlying the data. We hope that the pattern-detection capabilities of the ASD method may lead to an empirical, data-oriented form of system modeling.

Another promising path leads towards the economical design of field experiments and data collection systems, based on characteristic patterns derived from preliminary survey data. Much redundant data and information are often collected in large-scale field experiments. If the redundancies could be eliminated, all subsequent data collection, processing, analyses, archival, and dissemination activities would be greatly simplified and more cost-effective. The ASD method, by highlighting significant patterns of preliminary survey data sets, could suggest which data contribute most to the definition of the patterns, and which are dispensable.

Reference

[1] Lorenz, E. H., *Empirical Orthogonal Functions and Statistical Weather Prediction*, MIT Department of Meteorology, Science Report No. 1, 1956.

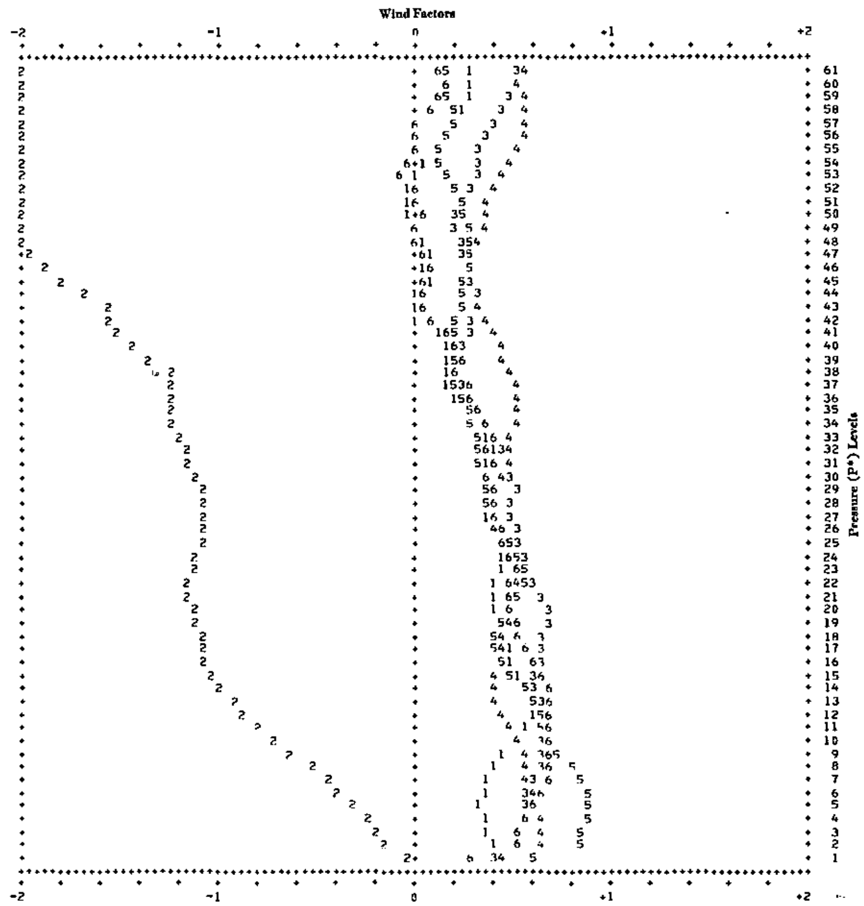


Figure 4. Composite printout of U-components of the wind for 48 upper-air soundings taken at each of six IFYGL observation stations.

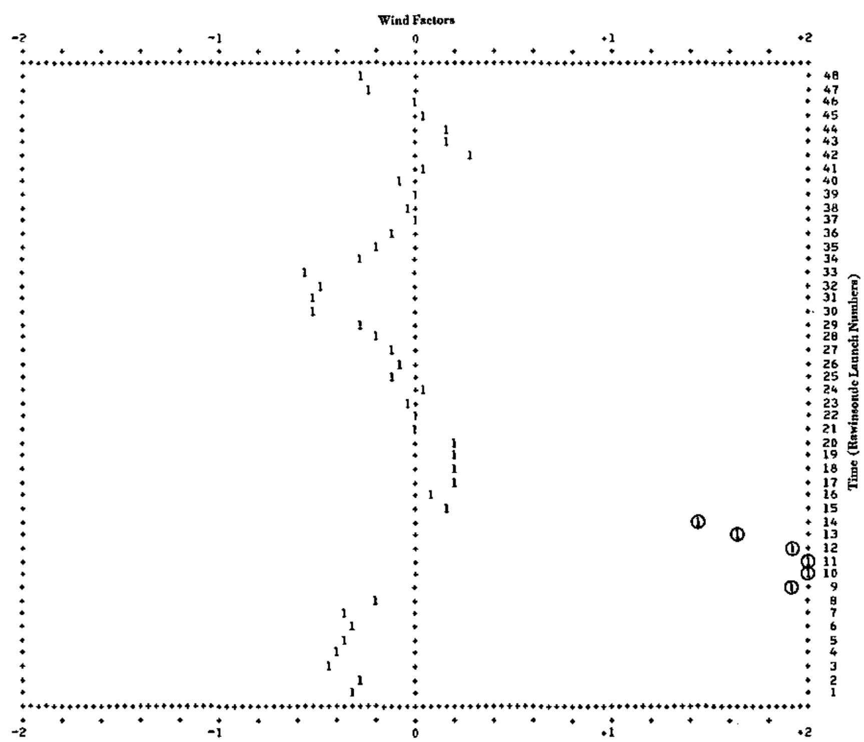


Figure 5. Time analysis of data from figure 4 isolates six anomalous soundings (circled).

Figure 6. Composite of V-components of the wind for 48 upper-air soundings taken at each of six IFYGL observation stations.

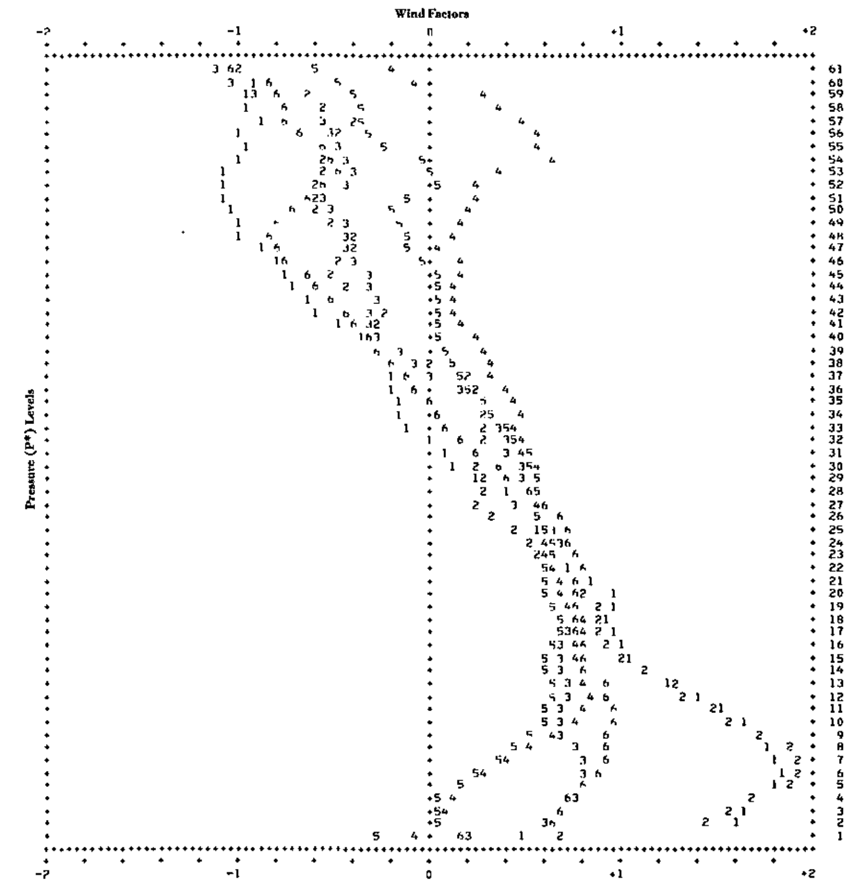
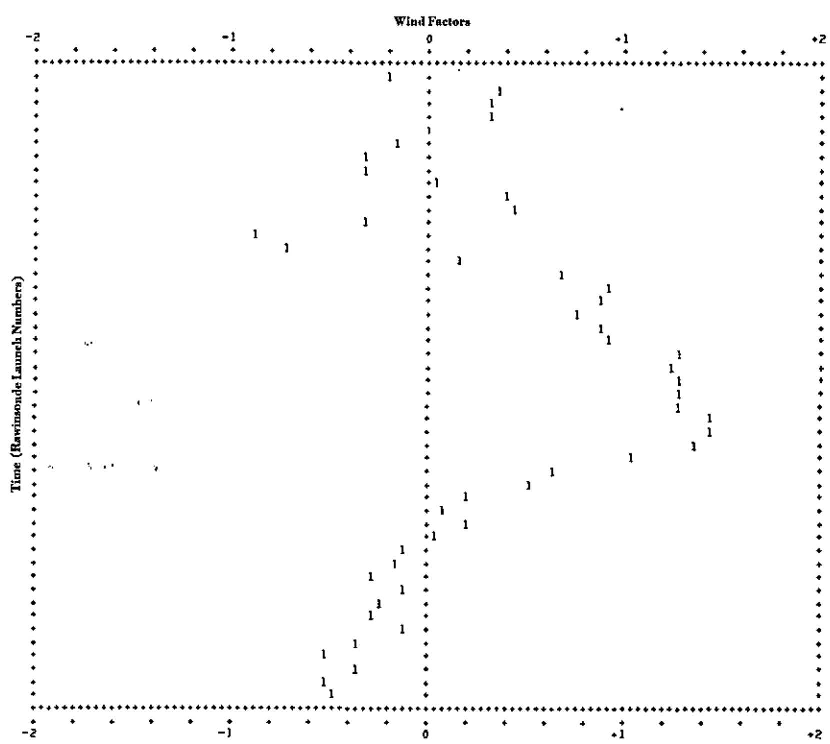


Figure 7. Time analysis of data from figure 6 indicates that the pairing pattern is most pronounced in soundings 20-27.



About the Article and the Authors

JACK JALICKEE was thumbing through a scientific journal in the spring of 1973 when he came across an article on the mathematical theorem of singular decomposition. It was evident that the theorem was adaptable to the analysis of the large data sets the EDS Center for Experiment Design and Data Analysis (CEDDA) was working with. This was the origin of the ASD (Asymptotic Singular Decomposition) method.

CEDDA analysis of atmospheric data from the International Field Year for the Great Lakes (IFYGL) began in the autumn of 1974. Problems arose almost immediately. Divergence calculations derived from upper air winds did not make physical sense. (The calculation is a very sensitive one, involving small differences of large numbers which contain noise.) The data themselves appeared reasonable and consistent with observed weather conditions, which were highly variable. Traditional analysis techniques could not resolve the problem; ASD did.

A native of Washington, D.C., Jack Jalickee worked his way through Catholic University (in D.C.), receiving a B.A. in 1962, and a Doctor's degree in 1966, both in Physics. Subsequently, he worked as a research associate and teacher at Northwestern University in Evanston, Illinois. A Presidential Internship appointment brought him to EDS/CEDDA in 1972.

JERRY SULLIVAN was the man having problems with IFYGL data divergence calculations. His inhouse paper on the subsequent resolution of those problems through ASD applications provided the nucleus of the current article.

Jerry received a Bachelor's degree in Physics from Holy Cross College, Worcester, Mass., and his Doctor's Degree from Catholic University. He joined EDS/CEDDA in the fall of 1970.


Jack Jalickee


Dick Rozett


Jerry Sullivan

Fr. RICHARD ROZETT, S.J., is on a year's sabbatical from Fordham University in New York. His previous work and interest in the application of statistical techniques to large data sets led Fr. Rozett to come to CEDDA, where he heads up its MESA (Marine Ecosystem Analysis) Project. Since September 1974, he has been working with Jack Jalickee in collecting, devising, and developing ASD and similar techniques to analyze ecosystems data sets.

Ecosystems data sets are very large, complex, and highly redundant. They include physical measurements such as temperature, depth, pressure, and the particle size of sand; chemical measures of oil, lead, phosphate, acidity, salinity, nitrate, and carbonate concentrations—not to mention garbage and sewer sludge; and biological measurements such as the number of barnacles per square meter, or the percent of flounder with fin rot. ASD and similar techniques make it possible to massage the original data into a simpler, concentrated, and more meaningful data set.

Dick Rozett earned a B.S. degree in chemistry from Spring Hill College in Spring Hill, Alabama, a M.S. degree from St. Louis University, then studied chemical physics at Johns Hopkins in Baltimore, Md., where he received his Ph.D. in 1967.

Ordained a priest in 1962, Fr. Rozett was an Assistant Professor of Chemistry at Fordham from 1967 to 1972, when he was made an Associate Professor. He is the author of more than 30 scientific papers on chemistry and the statistical analysis of large data sets, and has participated in international scientific conferences in Leningrad, Lisbon, Kifissia (Greece), and Kyoto.

The Role of Interactive Computer Systems in Data Processing at CEDDA

By Gerald Barton and David Saxton

Introduction

The Environmental Data Service's Center for Experiment Design and Data Analysis (CEDDA) processes enormous volumes of interdisciplinary environmental data collected in major field research programs and projects, such as the recent GARP (Global Atmospheric Research Program) Atlantic Tropical Experiment (GATE). As an example, CEDDA received 1,700 miles of magnetic tape data from the four U.S. ships (*Researcher*, *Oceanographer*, *Dallas*, and *Gillis*) in GATE's primary array.

CEDDA's goal is rapid processing to provide the data to the scientific community as soon as possible after the completion of a field experiment. One necessary step is editing the data to remove invalid readings. CEDDA's current turnaround time for interactive editing of a data file is 1 to 3 weeks. It is hoped that a new interactive computer system CEDDA is currently assembling will cut this time to ½ hour or less.

Data Collection

During field experiments, environmental data are recorded continuously by instruments on ships, towers, buoys, balloons, and other platforms at sample rates from 10/second to 4/second. A wide variety of specially calibrated sensors measure such variables as temperature, dewpoint, pressure, wind, radiation, salinity, and rainfall. The outputs are processed and stored on multitrack magnetic tapes. One track is used exclusively for time so that the exact Julian date, hour, minute, second, and 1/10 second for each sample are known.

To augment this high-resolution taped data, each major sensor subsystem output is supplemented by logs, stripcharts, and optical marked cards that record calibration checks, sensor changes (with all serial numbers), and special events, such as the beginning or end of an instrument cast.

The completeness of the data sets and their security are matters of prime concern. At the end of a phase of a field experiment, or at other convenient intervals, all tapes, logs, cards, etc., are shipped to CEDDA using the safest methods available. During GATE, CEDDA had a data manager on each of the 4 U.S. ships in the primary (B-scale) array and also at the GATE Operations Control Center to ensure the completeness and security of the transfer process.

Current Processing System

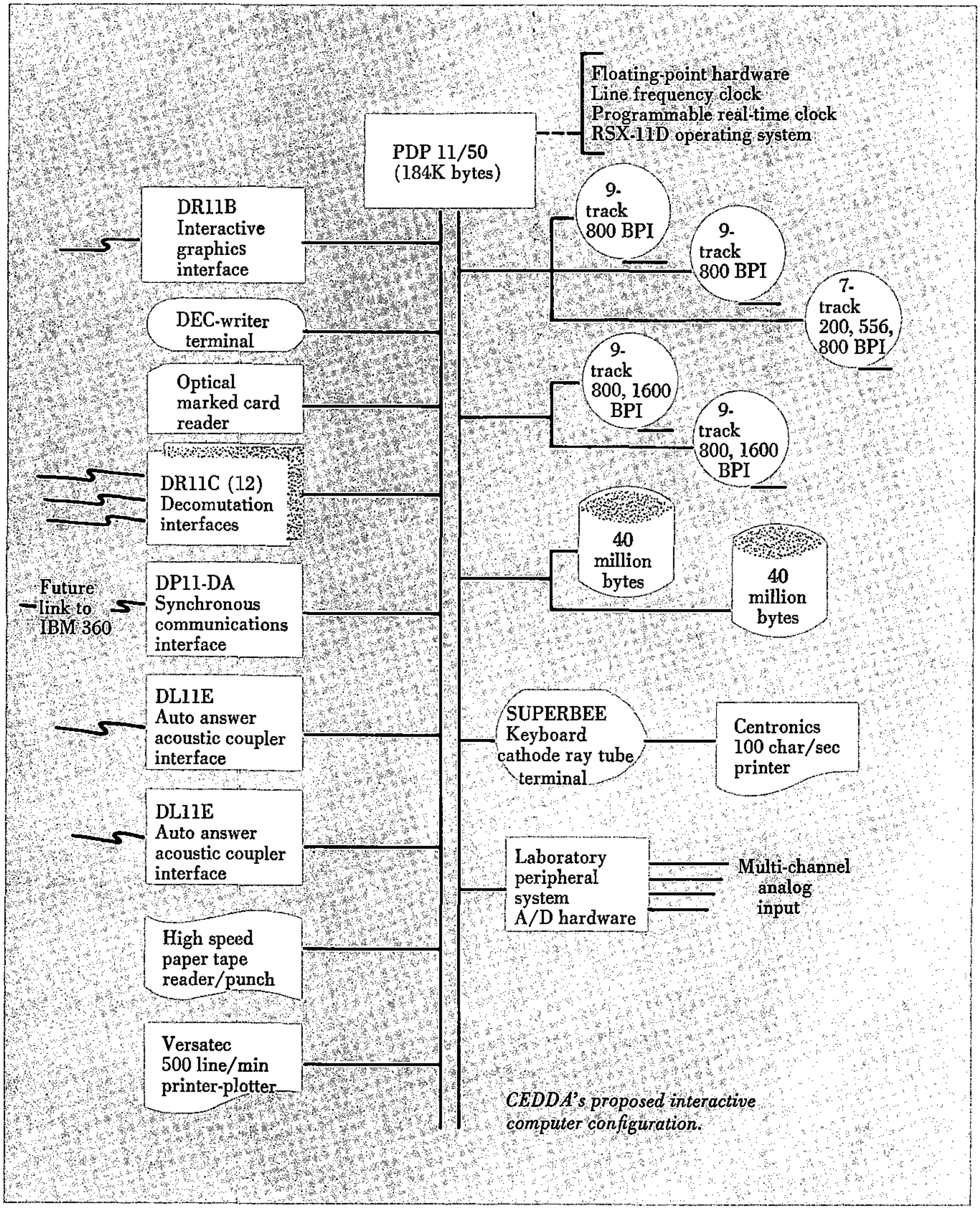
At CEDDA, the incoming analog data tapes are first checked for recording quality and completeness. Next, a minicomputer converts the analog data to digital form, producing a digital tape. Playback time is 32 times faster than field recording speed, so an 8-hour field tape is transcribed in about 15 minutes. During the minicomputer processing, an additional computer time word is added to each sample to control subsequent data processing programs and to preclude the loss of any sensor data due to malfunction or noise in the field time system.

Processing next proceeds to one of NOAA's larger computer systems, where data sets are organized by component systems used on the data collection platform, e.g., Oceanographic Data Set or Rawinsonde Data Set. Graphical display of the data as time-series plots and graphs, and frequency distribution plots, is required for the analysis of these data sets.

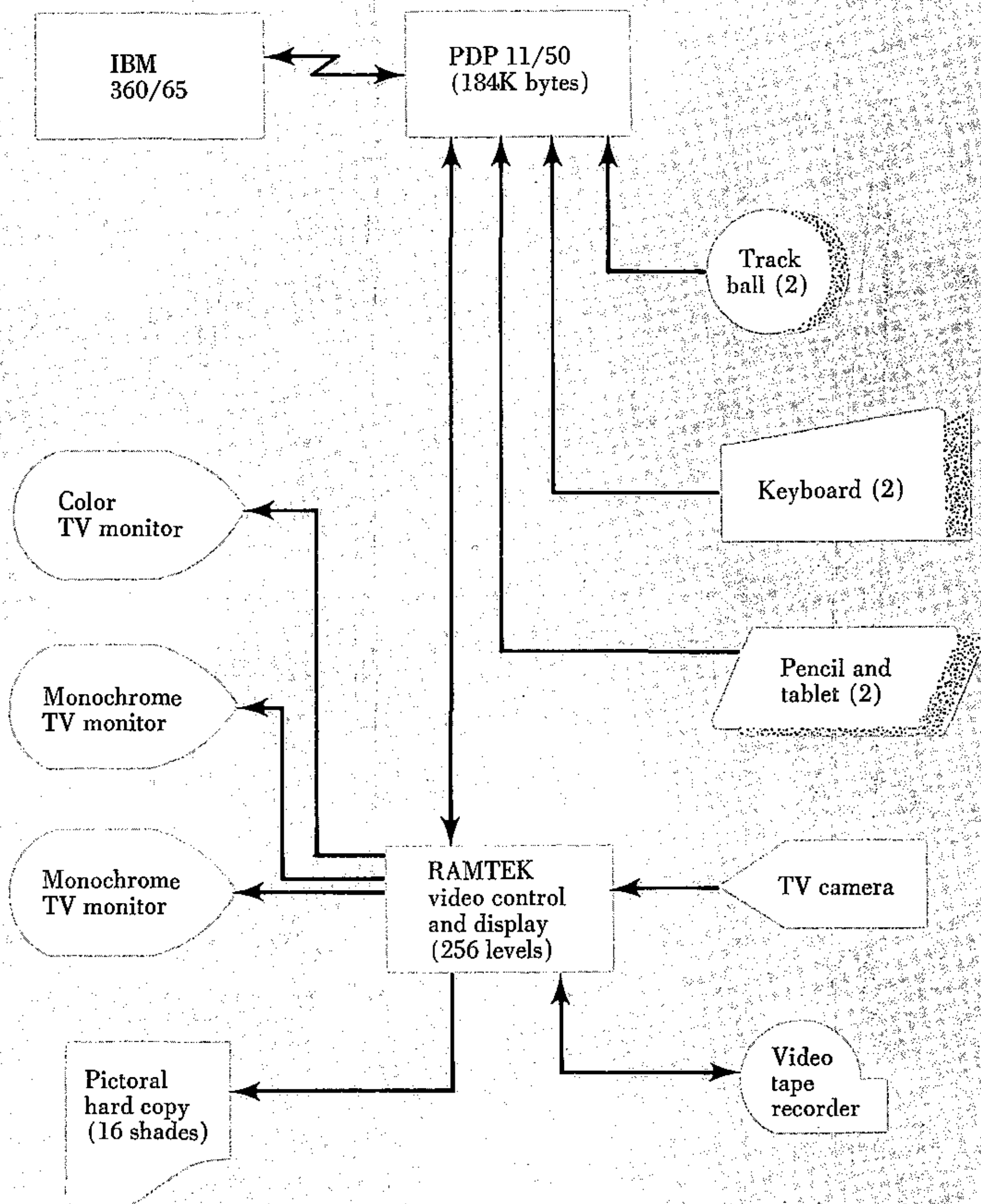
The editing features of the current computer processing system can be thought of as an interactive graphics system, with the time required for interaction varying up to a week or more. For optical mark cards, reaction is rapid since all event cards may be listed in chronological order and cards may be inserted, deleted, or corrected using a list-edit program in the minicomputer. However, for high-resolution meteorological or oceanographic data which must be transformed to engineering units and properly scaled, display for editorial review is currently limited to a microfilm graphics subsystem located in nearby Suitland, Md. For these data sets the time required for interaction includes the transport of data tapes, generation of microfilm graphics in a batch mode at the remote site, transport of microfilm on the return loop, review using microfilm readers, testing of automated corrections when required, and the recycling to display

New Processing System

CEDDA is currently assembling the hardware and software necessary to implement an interactive computer system that will allow the data editing and updating functions to be performed in a single processing step (real time). The main components of the system will remain a Digital Equipment Corporation (DEC) PDP-11/50 minicomputer and an IBM 360/65. It will be possible to access data on the IBM 360/65 through the PDP-11 or through terminals. The



CEDDA's proposed interactive computer configuration.



CEDDA's proposed interactive graphics subsystem configuration.

PDP-11 will have a graphics subsystem that will take less than 30 minutes to perform the functions of the current microfilm subprogram.

The major features and components of the interaction system are:

(1) Access to the IBM 360/65 time-sharing facilities via keyboard cathode ray tube (KCRT) terminal, ASR-33 teletype terminal, or PDP-11/50 minicomputer.

(2) Input terminals to the PDP-11/50, including an LA-30 DEC writer terminal, a KCRT, and two dial-in terminal interfaces for use with remote terminals.

(3) A graphics subsystem for the PDP-11/50.

(4) DEC's (RSX)-11D real time, priority-driven, multidisking executive system for the PDP-11/50.

With these features, a user can access the 360 to perform mathematical computations or generate data sets. He can look at the data and analyze them in real time on the interactive graphics subsystem. When he finds errors, he can immediately correct the data, and display them again on the graphics system to validate the corrections. He can then archive the updated data set for future use.

Interactive Graphics Capabilities

The interactive graphics subsystem, designed and assembled by Operating Systems Incorporated of Tarzana, California, consists of a RAMTEK graphics display system interfaced with CEDDA's PDP-11/50 computer by an appropriate switching network. Features of the full system (only part of which is required for the data editing job) include two black and white TV monitors, one color TV monitor, two data entry keyboards, two pencil and tablet systems, two track ball cursor controls, a television tape recorder with microphone input, a TV camera with zoom lens, an analog to digital convertor, eight planes of memory that allow up to 256 shades of gray or color and a cross-print switching network that allows mixing control of inputs and outputs.

A simple use of an interactive graphics system is the editing of raw data displayed as a time-series analysis or plot. For example, a single parameter, such as temperature, is plotted at its highest resolution in a time sequence covering several hours or days. Visual inspection of the data may reveal large errors where the sensor or telemetry system failed. To correct these larger errors, a window edit program might be tested with all "good" values of the parameter constrained to fit between the upper and lower limits of the window. Diurnal and other trends might be superimposed on the data plot. The limits and trends can be displayed with the raw data to show which data points should be edited out.

A slightly more sophisticated version of this time-series plot would compute running means over minutes or hours and show which of the high-resolution points will fall outside two or three standard deviations. Complex curves using higher order polynominals can be fitted to time-series data, both before and after various editing passes, to eliminate, insofar as possible, "noise" from the data. Various filters and smoothing functions also can be tested and evaluated before going into an Automatic Data Processing (ADP) production mode.

In general, CEDDA's new interactive graphics system will make it possible to display two or more curves simultaneously, using color, intensity, or blinking characteristics to distinguish, for example, between a standard and trial edit scheme or between different parameters. It will provide the capability to produce hard-copy documentation of both the trial programs as they progress during a test and the data sets used.

A more demanding requirement of an interactive graphics system is the ability to display and operate on digitized field data. An example of this type of data is a digitized radar picture. Under the control of an interactive graphics system, the analyst should be able to select and display a radar picture, to rotate and rescale it to a standard grid size, to enhance the digitized increments by contours or false color transfers, to overlay and compare it with the previous picture, and to display only those points from the two pictures whose change exceeds some threshold value. Similarly, the analyst should be able to display the overlap portion of digitized radar pictures from two locations and to scale and normalize these independently so that compatibility is established on common echo systems.

A further refinement is the addition of a TV-type scanner so that analog material can be rapidly digitized at high resolution and then handled with all the capabilities of the interactive graphics system. For example, a satellite visual range photograph could be scanned and digitized and then displayed with a radar picture covering the same area. Specific rainfall rates from surface observations could be overlayed on the same display so that some integration of areal rainfall amounts would be immediately available.

An interactive graphics system provides the ability to overlay data from different platforms or different systems. For example, the temperature and vertical velocity from sensors at several levels on a tethered balloon system could be compared by an analyst for coherence and lags as convective plumes are sampled. Dropsondes (atmospheric soundings) from aircraft could be graphically superimposed on simultaneous radiosonde soundings from ships. Spectra taken by instrumented aircraft during ship flybys can be compared with high-resolution data recorded on board each ship.

CEDDA plans to have the new interactive computer system in operation by late 1975. By that time, implementation of the graphics subsystem should include the work done in the current COM cycle. Future CEDDA applications of the graphics system will include programs that allow display of radar or satellite pictures in multicolors or up to 256 shades of gray using the tape-recording features of the graphics system. It should be possible to construct time-motion pictures of changing weather features. Also envisioned is the capability to display slices through 3-D models of weather systems. CEDDA currently has analysis programs that allow an analyst to change parameters in a weather model. The real time operation of the graphical display should allow the scientists to experiment with parameters that he may never have had the opportunity to look at previously.

It can be seen from the above examples that an interactive graphics system has broad applicability, extending from program design and test through all stages of data reduction and processing to scientific data analysis. In addition, interactive graphics provides programmers and analysts with the ability to see the data move through programs from recorded voltages on multiple channel tapes until they become validated meteorological or oceanographic data suitable for permanent archival and dissemination to the user community.

Gerry Barton

Dave Saxton

The Authors

GERALD BARTON, Chief of CEDDA's Computer Systems Branch, has a B.S. degree in Geophysics from Pennsylvania State University and an M.A. in Geological Science from the University of Texas. Before coming to CEDDA, he worked for ten years with the U.S. Naval Oceanographic Office as a geophysicist. His early association with the Oceanographic Office included gravity survey cruises in the USS Archerfish, a research submarine, in the Western Pacific and off the east and west coasts of the United States. From 1967 through January of 1974, when he joined CEDDA, Gerry spent most of his time working in computer programming, systems design, and the processing of gravity and geodetic data—to determine, among other things, the deflection of the vertical, or "which way is up."

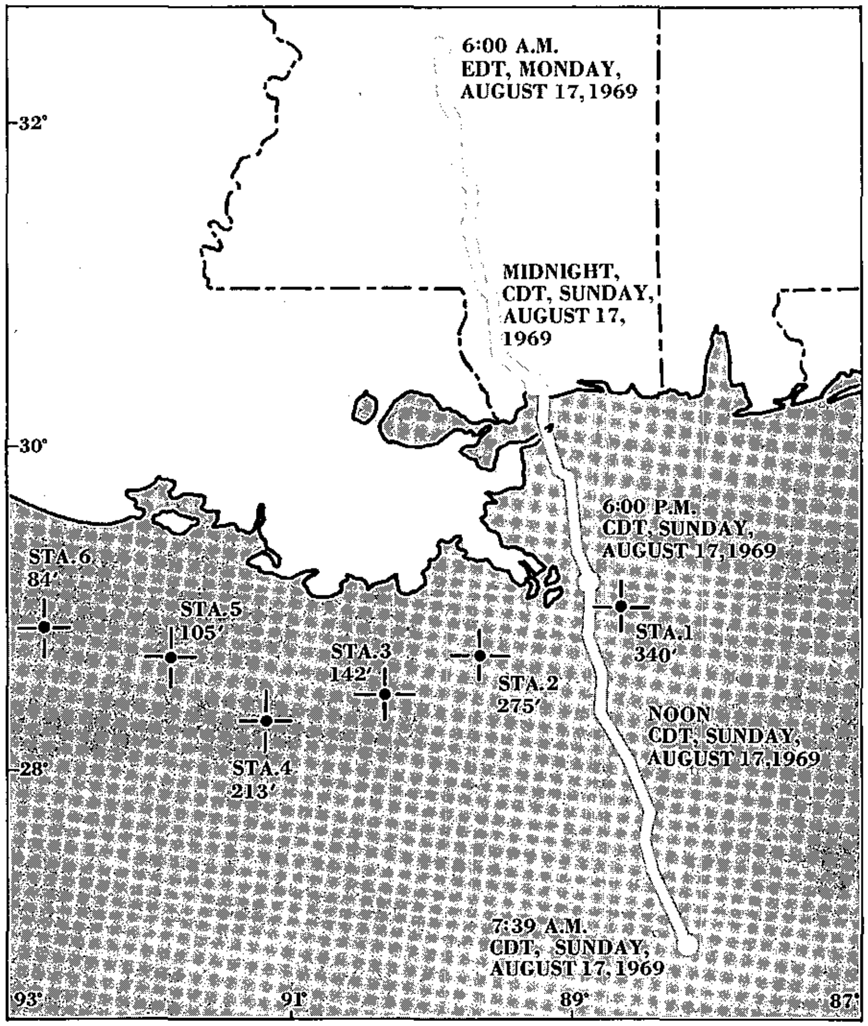
DAVID SAXTON joined CEDDA as Chief of the Operations Division in April 1974, following a 30-year career in the Air Weather Service which took him to England, France, Germany, and Japan. Dave has a B.S. degree from the University of Michigan and an M.S. from the University of Chicago. During World War II, he served as an Air Force weather forecaster in Europe. After the war and a year of civilian/student life, he was recalled to active duty and assigned to the joint Weather Bureau/Army/Navy Weather Central in Washington, D.C. Subsequently, he was posted to the Tokyo Weather Central, then to the USAF Weather Central in Suitland, Md., later moving with that organization to Offutt AFB, Nebraska. In 1961 he was assigned as Chief of the Strategic Air Command Weather Support Center in High Wycombe, England. Four years later he was assigned to Air Weather Service Hqs., Scott AFB, Illinois, as Chief of AWS' Computer Techniques Division. In 1967, Dave returned to Offutt, now the Air Force's Global Weather Central, as Chief, Development Division, and later Chief of Operations. In 1971 he went to Hickman AFB, Hawaii, as Chief of Operations Division, Headquarters, First Weather Wing. Retiring from the military in March 1974 (with the Legion of Merit), he joined CEDDA the following month.

National Report

Unique Storm and Hurricane Data Donated to EDS

Shell Oil Company, Houston, Tex., acting on behalf of eight petroleum firms, has given EDS oceanographic and meteorological data on major storms and hurricanes striking the Gulf of Mexico over a 31-month period. The data were collected at a cost exceeding $1 million dollars in a cooperative petroleum industry effort called the Oceanographic Data Gathering Program. Participants in the study, headed by Shell, included Chevron Oil Field Research Company, Exxon Production Research Company, Amoco Production Company, Gulf Oil Company, Texaco Incorporated, Mobil Research and Development Corporation, and CAGC (Continental Oil Company, Atlantic Richfield Oil Company, Getty Oil Company, and Cities Service Oil Company).

Data on wave height, wind speed and direction, and barometric pressure were taken at six offshore drilling and production platforms spaced along 260 miles of the Louisiana coastline. The data comprise 252 analog magnetic tapes covering a 31-month period and are available to users through NOAA's Environmental Data Service (EDS). Data tapes are available for a winter storm of February 1969; Hurricane Camille, August 1969; Tropical Depression, September-October 1969; Hurricane Laurie, October 1969; Hurricane Celia, August 1970; and tropical storm Felice, September 1970. A limited number of printed reports are also available for some of the storms, including Hurricane Camille, on a first-come, first-served basis. When these are gone, microfilm copies will be provided at cost.



Hurricane Camille's track and the Oceanographic Data Gathering Program's six instrumented offshore oil rigs.

Hurricane Camille was one of the most severe and destructive storms ever to strike the Gulf of Mexico. Maximum wave heights of 72 feet were recorded as the eye of the hurricane passed within 15 miles of one measurement station during the study. The data on Camille are one of the most comprehensive sets of oceanographic and meteorological information available for such an extreme weather event and should prove invaluable for basic research and offshore engineering applications.

Shell has provided a listing of all tapes, giving the completeness of data recorded per sensor. A literary summary of tapes containing storm and hurricane periods is also available, providing a readable account of pre and poststorm events. Written summaries for specific time periods of other tapes will also be provided.

The cost of providing duplicate tapes will be about $136 per tape. Each tape will be accompanied by available calibration and other information necessary to interpret the data. In addition, a compressed time-scale strip chart is available for each tape for an additional $10.

For further information, write: NOAA/EDS, National Oceanographic Data Center, Washington, D.C. 20235.

Ocean Data Resources Report Available

Ocean Data Resources, a directory of marine data management activities in the United States prepared by EDS' National Oceanographic Data Center (NODC) has been published by the United States Senate.

The report lists the locations, principal contacts, and facilities concerned with ocean data. While the report initially focused on Federal agency activities, State and regional activities, academic institutions, and industry have also been included to relate Federal ocean data activities to the overall national ocean data effort.

The report addresses itself primarily to data management activities; it does not include organizations involved in the actual acquisition of ocean data through research and survey. Appendixes include addresses of referral services and a bibliography of directories of marine science activities.

NODC compiled the report at the request of the Interagency Committee on Marine Science and Engineering (ICMSE), Federal Council for Science and Technology. The assistance of ICMSE in identifying holders and users of ocean data was requested by Senator Ernest F. Hollings, Chairman of the National Ocean Policy Study.

Copies of *Ocean Data Resources,* a U.S. Senate Publication, will be available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 for $0.85.

NOAA Buoy Data Available

NOAA's National Data Buoy Office (NDBO) has sent some 42,000 observations from 17 different buoys to EDS' National Oceanographic Data Center (NODC) in compliance with a cooperative agreement between the two organizations. Under the terms of the agreement made in August 1971, NDBO makes monthly shipments of buoy data to NODC.

The data now available to users from NODC are from 3 buoys off the Atlantic coast, 3 off the Alaska coast, and 11 in the Gulf of Mexico. The buoys are collecting meteorological data such as air temperature, dewpoint, wind speed and direction, barometric pressure, and precipitation rate, as well as global radiation in infrared and visual, and also oceanographic data such as wave height, wave period, pressure, temperature, current speed and direction, and conductivity.

NODC can select data from the file by buoy name and date of observation. The selected data can then be printed or copied onto magnetic tape for the requester. For additional information write: NODC, 3300 Whitehaven St., NW, Wash., D.C. 20235.

NDBO is now computing wave spectra (distribution of wave heights with respect to frequency) for a buoy off Alaska (EBO3) and another off Virginia (EBO1). These spectral data are being computed for 50 band widths from 0.0 HZ to 0.5 HZ and will be available from NODC in the near future.

Summary of NOAA Buoy Data at NODC

Buoy name	*Location*	*Inclusive dates*	*Approximate number of 3-hourly observations**	*Area*
EBO1	36°N 73°W	10/72- 4/73 9/73- 3/74	5,250	Atlantic
EBO2	27°N 88°W	3/73- 9/73	1,250	Gulf
EBO2	47°N 130°W	6/74- 9/74	609	Alaska
EBO3	56°N 148°W	10/72- 3/73 11/73- 6/74	4,700	Alaska
EB10	27°N 88°W	10/72- 7/74	7,200	Gulf
EB12	30°N 89°W	6/73-11/74	4,150	Gulf
EB13	32°N 75°W	12/73-11/74	2,700	Atlantic
EB31	27°N 86°W	3/73- 5/73	272	Gulf
EB32	27°N 88°W	1/73- 6/73	230	Gulf
EB32	27°N 84°W	9/74-11/74	320	Gulf
EB33	58°N 141°W	10/74-11/74	300	Alaska
EB36	26°N 84°W	3/73- 4/73	60	Gulf
EB52	26°N 83°W	2/73- 4/73	227	Gulf
EB53	29°N 88°W	3/73	61	Gulf
EB61	26°N 84°W	2/73- 5/73 9/74-11/74	266	Gulf
EB62	29°N 85°W	11/74	92	Gulf
XERB-1	36°N 75°W	2/70- 6/72	14,300	Atlantic

* Some observations may be missing because of data recovery problems or data quality uncertainty.

Hodge New U.S. IFYGL Data Manager

At the February 1975 meeting of the Canadian-United States Joint Management Team for the International Field Year for the Great Lakes (IFYGL), it was announced that William T. Hodge of EDS' National Climatic Center (NCC) would be the new U.S. IFYGL Data Manager, replacing David Drury of the EDS Center for Experiment Design and Data Analysis (CEDDA). In this role, Hodge will answer all requests for IFYGL data from U.S. investigators. The changeover marks a significant milestone in the orderly progression of IFYGL data from collection, through processing for participants, to archiving for dissemination to other users.

William Hodge

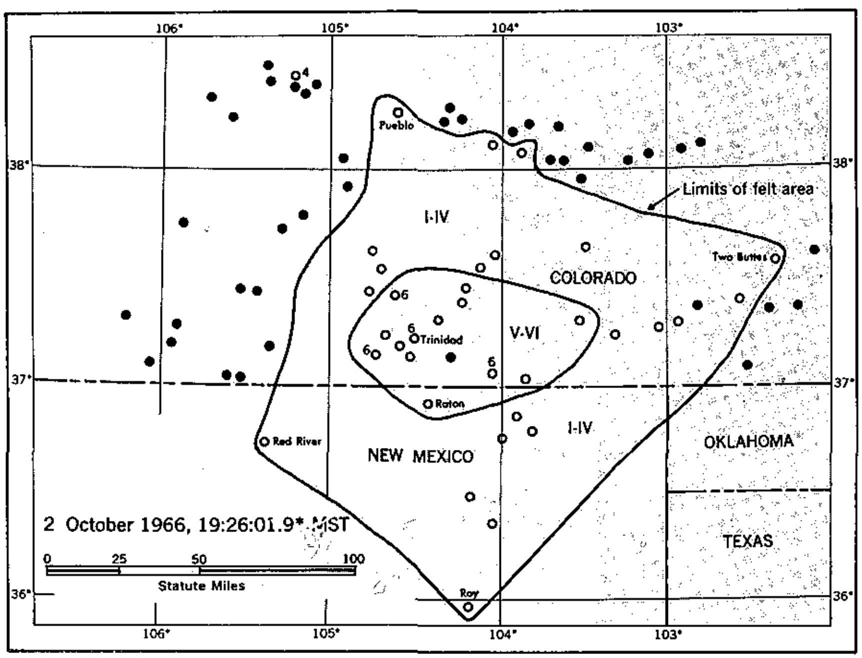
From the Field Year in 1972-73 to April 1975, CEDDA had primary responsibility for processing and initial analysis of three major U.S. IFYGL systems—Rawinsonde System, Ship System, and the Physical Data Collection System. CEDDA was also responsible for U.S. IFYGL data management activities for this period. These include tracing the data from the other major U.S. projects (Radar, Aircraft, and Satellite), coordinating the data flow to and from the members of the five IFYGL Panels (Atmospheric Boundary Layer, Chemistry-Biology, Energy Balance, Terestrial Water Balances, and Water Movement) and coordinating data exchange with the Canadian Centre for Inland Waters (CCIW).

In early 1974, EDS designated NCC the final U.S. archive for IFYGL data. CEDDA has now turned over to NCC all IFYGL data for the permanent archive. The CEDDA/NCC interaction for IFYGL data will serve as a prototype for the data flow cycles of other large-scale field experiments.

New U.S. Earthquakes Intensity File

Seismologists at EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) in Boulder, Colo., have compiled a new earthquake intensity data file containing computerized descriptions of U.S. earthquakes in several formats. The file is used to answer data requests from structural engineers, who need to know the effects of past earthquakes to determine design requirements for earthquake-resistant structures; seismologists, who analyze local or regional earthquakes to determine earthquake risks; and private citizens, who are concerned about living in earthquake-prone areas.

The file contains data on about 1,500 U.S. earthquakes that have occurred since 1928. This includes over 80,000 intensity* observations, usually 1 per community, that describe these tremors. A printout of the file can provide the following information about each earthquake: 1) Date and time of occurrence, 2) geographic location, 3) magnitude, 4) maximum intensity, 5) depth of focus, 6) cities



A "felt-area" analysis of a 1966 Colorado earthquake. Open circles indicate that the earthquake was felt, filled-in circles that it was not felt. Roman numerals represent intensity ranges.

* Intensity (on a scale of 1 to 12) defines the effects of an earthquake on people, ground or soil, and manmade objects at a particular place.

(with geographic coordinates) at which the earthquake was observed, 7) intensity at each city, and 8) distance of each city from the earthquake center.

In a matter of seconds NGSDC now can retrieve:

1. A listing of all damaging U.S. earthquakes (for any period after 1928) of a specified intensity range that were "felt" or caused damage at a particular city or in any geographic area. As an example, a West Coast engineer can request a list of earthquakes in the Seattle, Wash., area with intensity 5 and above for the period 1970-74.

2. A listing of all earthquakes of a specified range of intensities that were "felt" within a particular radius of any city. For example, a private citizen may want to know what earthquakes have caused damage within a 50-mile radius of Bristol, Va., since 1928.

NGSDC seismologists will continue to update and expand the earthquake intensity file. In the future, it will include all U.S. earthquake data from earliest history. (The first reported earthquake that caused damage in the United States occurred in the St. Lawrence Valley area in 1638. A written history of earthquakes for other areas of the country is available from the mid-1700's.)

NGSDC can provide a printout from the intensity file for $20 per location or area. Inquiries should be addressed to:

National Geophysical and Solar-Terrestrial Data Center
EDS/NOAA Boulder, CO. 80302
Phone: (303) 499-1000, ext. 6472
FTS Phone: (303) 499-6472

ERDA Marine Data Dissemination Guidelines

Coincident with its recent transfer to the newly established Energy Research and Development Agency (ERDA), the Division of Biomedical and Environmental Research (DBER) of the former Atomic Energy Commission issued new guidelines for the submission of marine environmental data and samples collected by ERDA/DBER contractors to national centers for dissemination to other users. This is the seventh such statement issued by a Federal agency since the Interagency Committee on Marine Science and Engineering's policy statement (see page 19, August 1972 issue of *EDS*) encouraging cooperation among Government agencies to ensure availability of marine environmental data and samples to secondary users, that is, users other than those for whom the data were originally collected.

DBER has designated the following national centers to receive its data: the National Oceanographic Data Center (NODC), the National Geophysical and Solar-Terrestrial Data Center (NGSDC), and the National Climatic Center (NCC)—all components of EDS—as well as the Smithsonian Oceanographic Sorting Center (SOSC), a part of the Smithsonian Institution. NODC will be the lead center for data inventories, data information, and for chemical, physical, and biological oceanographic data; NGSDC for geological geophysical oceanographic data; NCC for meteorological data; and SOSC for collections of marine biological specimens.

Prior to the final commitment of DBER support to any project, representatives from the appropriate national centers will contact the principal investigators of potential DBER programs expected to generate oceanographic or meteorological data. Based on the preliminary discussions, the parties will agree on the documentation required for each type of data to ensure meaningful interpretation by others, and the methods and formats whereby the data and ancillary information will be transmitted to the appropriate data repositories.

ENDEX/OASIS Training Courses

EDS personnel recently held a series of 17 ENDEX/OASIS training courses in 10 cities. ENDEX and OASIS are EDS computerized referral service systems for environmental data and information sources. (See "The Environmental Data Connection," May 1974 issue of *EDS*.) ENDEX provides reference to historical environmental data files, OASIS to technical literature concerning the environmental sciences and marine resources.

About 370 people attended the first day of the training sessions which consisted of an overview and computer-terminal demonstration of the systems. About half of the attendees participated in an additional 1½ days of "hands-on" terminal practice in using the ENDEX/OASIS systems.

No additional training sessions are currently scheduled, but groups desiring to attend such a course should contact either James Stear of EDS' Environmental Science Information Center, telephone (202) 634-7334 or Christopher Noe of EDS' National Oceanographic Data Center, telephone (202) 634-7298. Demonstrations can be arranged in EDS offices in Washington, D.C., Woods Hole, Mass., Miami, Fla., La Jolla, Calif., or Seattle, Wash.

Ocean Dumping Survey Data

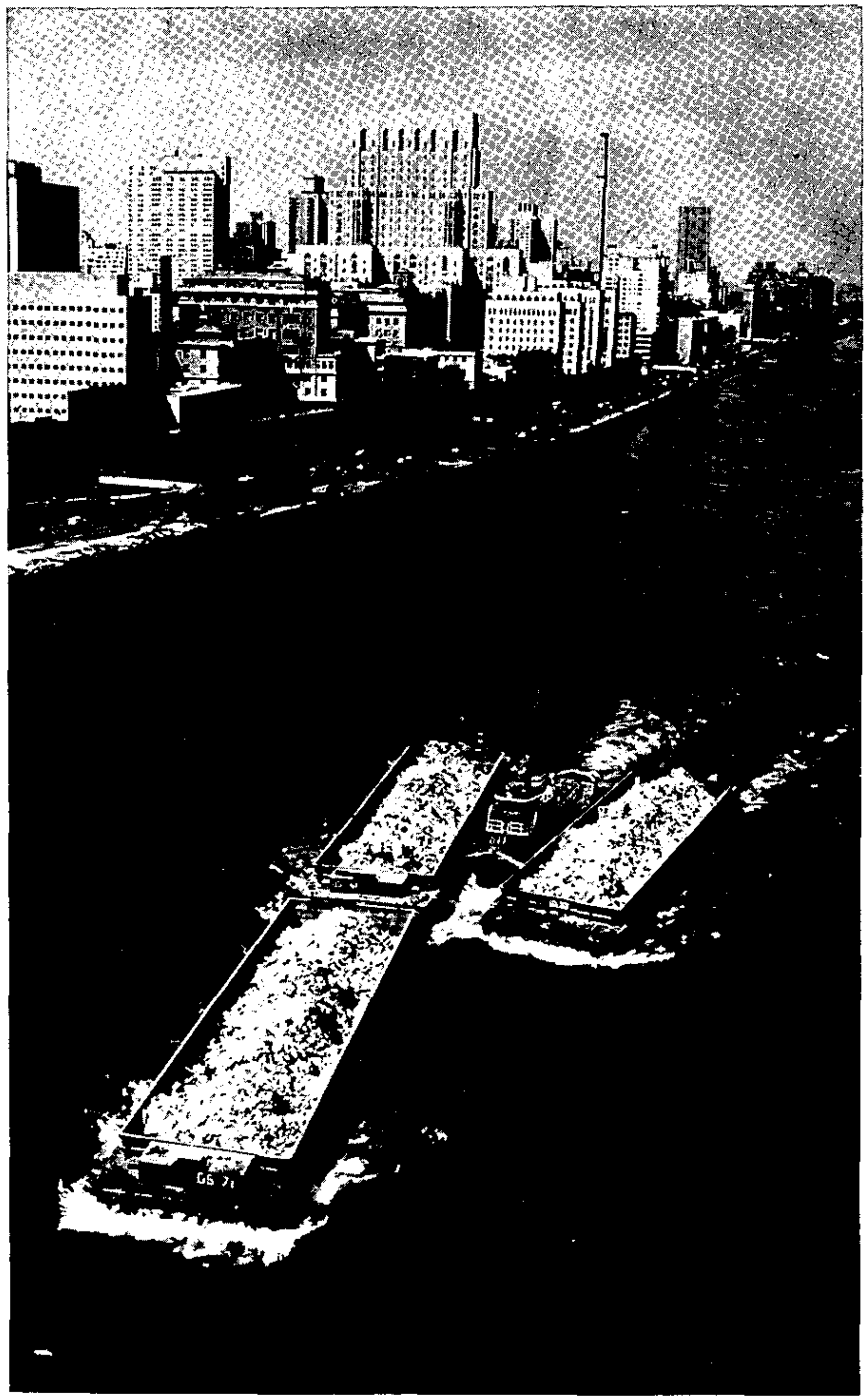
Oceanographic station data (temperature, salinity, oxygen, nutrients, etc.) collected from Deepwater Dump #227, located 106 miles offshore of the entrance to New York Harbor, are now available from EDS' National Oceanographic Data Center.

The Deepwater Dump survey was carried out under the direction of NOAA's Office of Marine Resources Ocean Dumping Program as a baseline investigation in May 1974. The two-ship operation sought to acquire sufficient data to assess the environmental impact of present dumping practices, provide a data base against which future effects could be gaged and determine the possible long-term effects of the dumping. The investigation also tried to assess the adequacy of present dumping techniques and provide information for a decision on whether dumping at the site should be continued. Reports of the principal investigators are now being analyzed for NOAA by the Woods Hole Oceanographic Institution.

NOAA made this survey under the responsibilities assigned it by the Marine Protection, Research and Sanctuaries Act of 1972. Among other changes, this act made NOAA responsible for research and monitoring of the effects of dumping and other man-induced changes to ocean ecosystems, and for coordinating programs to devise alternatives to present dumping practices.

The oceanographic station data from the Deepwater Dump survey can be obtained from the National Oceanographic Data Center, NOAA, 3300 Whitehaven St., NW., Washington, D.C. 20235.

Copies of scientific reports on ocean-dumping surveys will be available as they are published from EDS' Environmental Science Information Center, NOAA, 3300 Whitehaven St., NW., Washington, D.C. 20235.



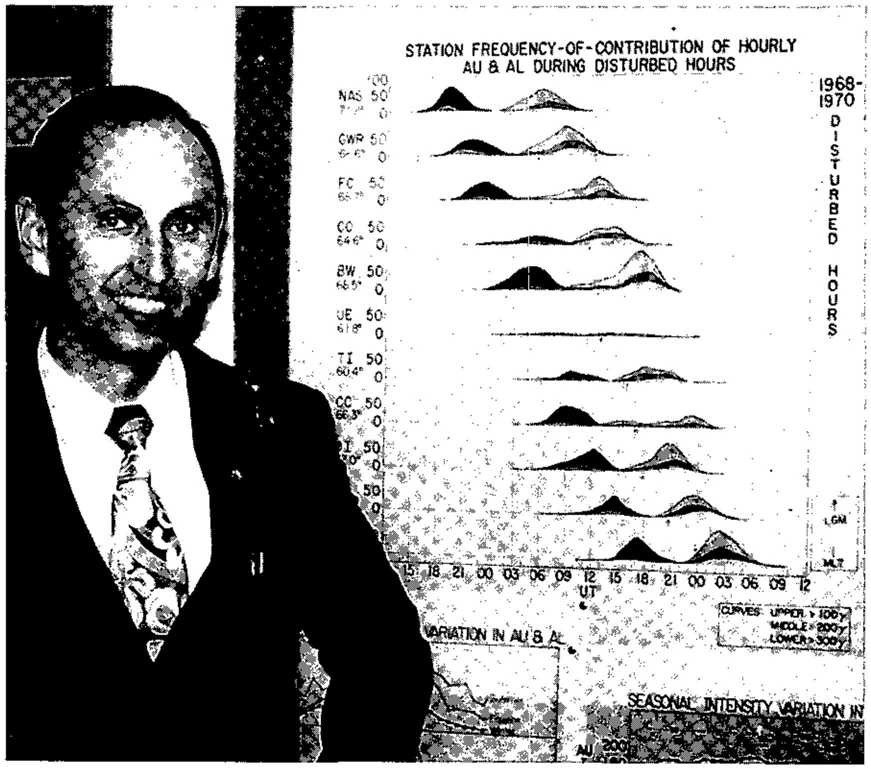
A tug tows part of the 26,000 tons of solid waste that New York City produces daily down the East River toward the open sea.
EPA-DOCUMERICA—Gary Miller.

International Report

Remote Area Russian Magnetograms Acquired

EDS' National Geophysical and Solar-Terrestrial Data Center has received a new data set from WDC-B for Solar-Terrestrial Physics in Moscow, U.S.S.R. It is the first microfilm reel of magnetograms from five new stations located in a remote area of Russia along the 145° geomagnetic meridian. The magnetograms were recorded from November 1973 to February 1974, using Bobrov-type magnetometer systems. The 100-ft. reel of 35-mm microfilm is now being copied for addition to the WDC-A for Solar Terrestrial Physics/National Geophysical & Solar Terrestrial Physics archives for distribution to users. Copies will be available from WDC-A for Solar Terrestrial Physics, NOAA, Boulder, Colo. 80302. Additional magnetograms are expected continuing through during the International Magnetospheric Study beginning in 1976.

The 5-station chain was established and is operated by A. Zaitsev, who visited NGSDC in 1974. At that time he discussed methods for making these magnetograms available through the WDC's and suggested a program of cooperative data analysis between himself and NGSDC. Zaitsev hopes to resolve the spatial and temporal variations of auroral zone ionospheric currents by comparing the Auroral Electrojet indices (AE) (see page 21) and Data Acquisition and Processing Program (DAPP) satellite auroral images in NGSDC's archives with the detailed record of surface magnetic variations from his North-South chain of stations, and with data on energetic particles in the outer atmosphere from the Interkosmos series of U.S.S.R. satellites.



Dr. A. N. Zaitsev during his 1974 visit. The graphics relate to Auroral Electrojet indices prepared at NGSDC.

International Visitors to NGSDC

In its dual role of national and world data (WDC-A) repository, the National Geophysical and Solar-Terrestrial Data Center attracts many international visitors. While attending the joint meeting of the American Astronomical Society (Solar Physics Branch) and the American Meteorological Society in Boulder and Denver January 20-23, 1975, a number of foreign scientists stopped in to renew professional contacts, browse through center archives, use center facilities to finish research papers, and to discuss future data-gathering programs.

Y. F. Ivanov, Deputy Director, Applied Geophysics Institute, headed a group of four visiting Russian scientists who attended the AAS/AMS meetings and also took part in discussions with the staffs of the National Center for Atmospheric Research (NCAR) and the National Oceanic and Atmospheric Administration (NOAA), EDS' parent agency. The Russians were interested particularly in the collection and rapid distribution of ionospheric, geomagnetic, and meteorological data and in research into solar/weather and climate interactions.

One of the Russian meteorologists, G. G. Gromova, was especially interested in viewing American TV "weathermen," and visited a Denver studio to observe the preparation of National Weather Service materials for an evening weather program telecast. Gromova is responsible for preparing Russian weather forecasts and presenting them on all the TV channels broadcasting from Moscow.

Her colleague, V. S. Loginov, discussed the Auroral Electrojet (AE) magnetic activity indices derived at NGSDC (see page below), which he hopes to correlate with variations in meteorological measurements.

Ivanov, V. V. Miknevich, and Gromova presented scientific papers on solar/meteorological interactions at the Joint AAS/AMS session chaired by Alan Shapley, Director, NGSDC.

In addition to the week of meetings, there was a full postconference schedule of US-USSR planning sessions, tours of the different Boulder laboratories, and many social and informative activities for the visitors.

Non-Russian scientists visiting NGSDC after the meetings included C. I. Meng (University of California at Berkeley), C. G. Park and L. Svalgaard (Stanford University), J. W. King (Appleton Laboratories, United Kingdom), and W. Becker (Max Planck Institute, Lindau, German Federal Republic). King represented the Special Committee on Solar Terrestrial Physics of the International Council on Scientific Unions as a special consultant at the US-USSR working group discussions and in planning with NGSDC for the sharing and distribution of data resulting from the International Magnetospheric Study scheduled to begin in 1976. (See page 12, March 1974 issue of *EDS*.)

Russian visitors Drs. Loginov, Miknevich, and Gromova (left to right) during their January visit.

New Master Station List for Solar-Terrestrial Physics

A new list of the 1,066 stations or observatories active in one or more of the disciplines of solar-terrestrial physics was recently published. The report, "Master Station List for Solar-Terrestrial Physics Data at WDC-A for Solar-Terrestrial Physics," UAG-38, lists stations which participated in data exchange at some time since the beginning of the 1957-58 International Geophysical Year (IGY). Also included are those stations which were in operation prior to IGY whose data are held at WDC-A and those stations proposed for the International Magnetospheric Study (IMS), 1976-78.

The list is arranged alphabetically by station name, by geomagnetic latitude from north to south, and by discipline in an order appropriate to the discipline. For example, for solar phenomena the order is by east longitude, since it is important to know the probability of 24-hour coverage of the sun in the solar disciplines.

In the alphabetical listing of each station are given geographic coordinates, geomagnetic coordinates, conjugate geomagnetic locations, L-shell value, invariant latitude value, computed geocentric magnetic dip, and opening and closing dates. For stations with programs in cosmic rays, the cutoff rigidities and station altitudes are also presented.

This Master Station List will be used in conjunction with the separate catalogs to be issued for Solar-Terrestrial Physics disciplines or subdisciplines. The catalogs are planned to replace the users catalog covering all disciplines issued in 1973 as WDC-A Report UAG-30.

The Master Station List report can be obtained for $1.60 from National Climatic Center, Federal Building, Asheville, N.C. 28801.

Serial Publication of Auroral Electrojet Magnetic Activity Indices

In February 1975, World Data Center A for Solar-Terrestrial Physics issued Report UAG-39, the sixth in a series of publications presenting Auroral Electrojet Magnetic Activity Indices, based on either 10 stations, AE(10), or 11 stations, AE(11). Each issue contains hourly indices and graphs of 2.5-minute values for 1 year, as well as information on stations providing the values. Report UAG-39, prepared by Joe Haskell Allen, Carl C. Abston, and Leslie D. Morris of the National Geophysical and Solar-Terrestrial Data Center, provides AE(11) for 1971.

The six reports issued to date cover the years 1966-71, and compilation of the indices for 1972 is nearing completion. Each of the annual reports is available for 75 cents from the National Climatic Center, Federal Building, Asheville, N.C. 28801, Attn: Publications.

IGOSS Data Manual Published

The Intergovernmental Oceanographic Commission (IOC) of UNESCO recently published and distributed the *Manual of IGOSS Data Archiving and Exchange,* Manuals and Guides for Oceanographic Services, Vol. 1, UNESCO, 1974. IGOSS (Integrated Global Ocean Station System) is an evolving cooperative services program for the unrestricted international exchange of ocean data, information, and services.

The manual is concerned primarily with the archiving and exchange of oceanographic data collected under IGOSS and reported in or related to the United Nations World Meteorological Organization's (WMO) code forms of bathythermograph and temperature/salinity/current (TESAC) data. The authors discuss the impact of the rapid growth in the telecommunications dissemination of oceanographic data on archiving and exchange procedures and centers; describe the basic elements of the IGOSS data archiving and exchange scheme and the flow of data within the system (with special emphasis on the needs of secondary users), as well as most of the obligatory procedures and data forms; and provide the latest information on the identities and functions of service centers concerned with various aspects of IGOSS data archiving and exchange.

The manual was prepared by the IOC Working Committee on International Oceanographic Data Exchange (IODE) on behalf of the IOC Working Committee and the WMO Executive Committee Panel on Meteorological Aspects of Ocean Affairs. The IODE Committee was assisted by data management experts from WMO and from the International Council for the Exploration of the Sea.

An IODE ad-hoc Group on IGOSS Data Archiving and Exchange will provide continuing review of the manual, associated logs, and instructions in close collaboration with the IOC Working Committee for IGOSS and the Joint IOC/WMO Planning Group for IGOSS, and will issue amendments or additions as needed.

Copies of the English language version of the manual, which is the first of several manuals dealing with various aspects of IGOSS, may be obtained from the U.S. National Oceanographic Data Center, NOAA, 3300 Whitehaven St., NW., Washington, D.C. 20235.

CICAR Bibliographies Offered

The National Oceanographic Data Center (NODC) has available for free distribution a limited number of copies of the Cooperative Investigation of the Caribbean and Adjacent Regions (CICAR) Bibliography. The work was published in three volumes: *Volume I, Marine Climatology, Marine Meteorology,* and *Physical Oceanography,* published in 1969; Volume II, *Marine Biology,* published in 1972; and Volume III, *Marine Geology and Geophysics,* also published in 1972. Requests will be filled as long as the supply lasts and should be addressed to:

Technical Records Branch (D764)
National Oceanographic Data Center
National Oceanographic and Atmospheric Administration
Washington, D.C. 20235

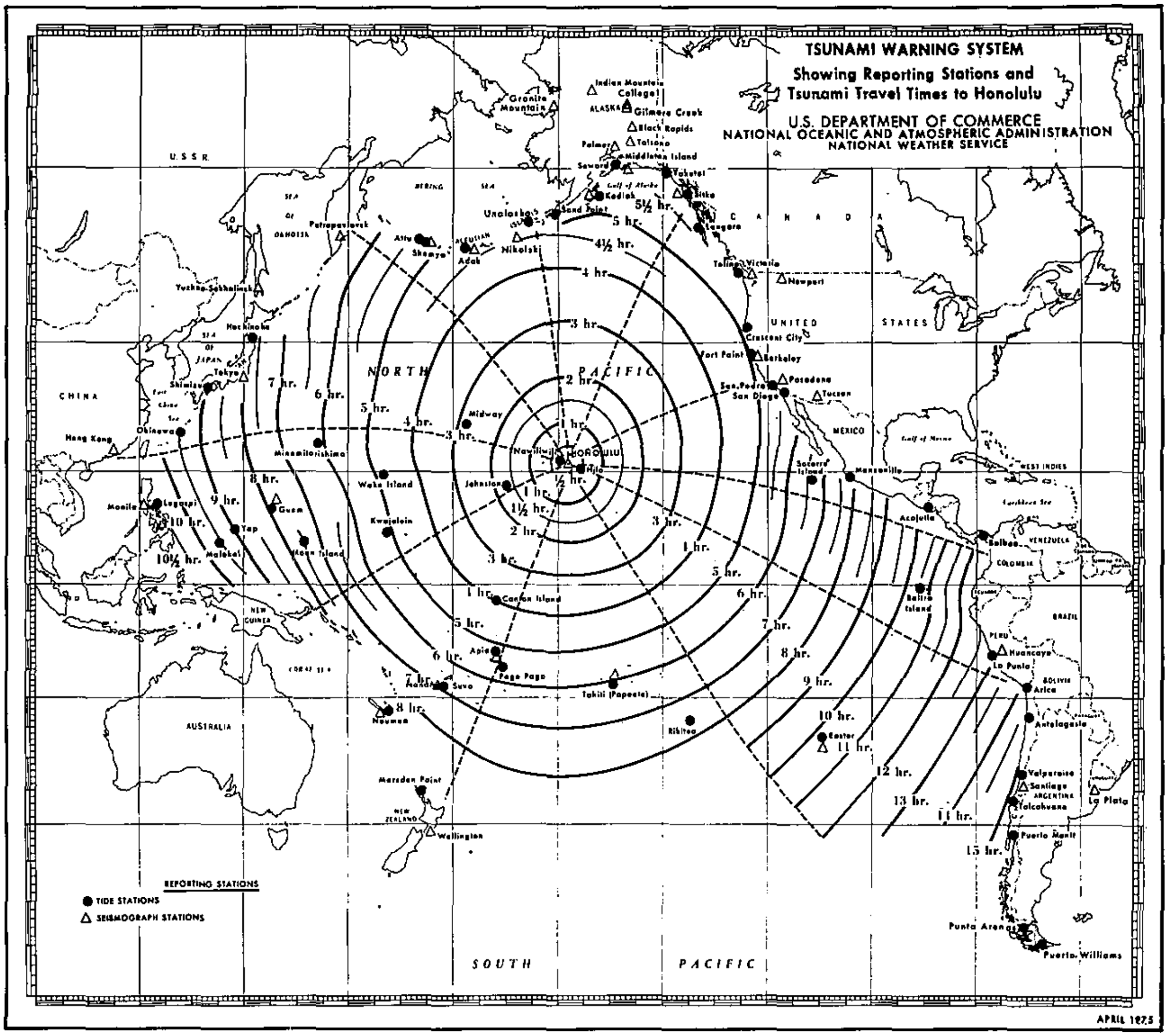
WDC-A for Tsunamis Relocated

World Data Center A for Tsunamis recently moved from Honolulu, Hawaii to Boulder, Colo., to be closer to facilities and staffs of the other WDC-A solid earth geophysics activities. Advantages of the move include, in particular, the availability of digitizing and microfilming facilities and the services of full-time data managers.

Tsunamis (or seismic sea waves) are waves generated by great earthquakes near the continental margins and are a leading cause of death and destruction in coastal areas. For exexample, in 1960, a magnitude 8.5 earthquake in Chile spawned a tsunami that was responsible for a large part of the 2,000 deaths and $550 million in property damage experienced locally. The tsunami, traveling at speeds of about 600 miles per hour in the open ocean, then hit other shores around the Pacific, causing 61 deaths and $75 million damage in Hilo, Hawaii; 32 deaths in the Philippines; and 22½ hours after the earthquake, 138 deaths and $50 million damage in Japan.

In the open ocean, tsunamis are virtually invisible, with amplitudes of only a foot or so and wavelengths of about 100 miles. As they reach shallow water, however, the wavelengths shorten and the heights increase—in extreme cases, to more than 100 feet.

NOAA operates a Tsunami Warning System in Honolulu. When the Honolulu seismograph shows that a large earthquake has occurred, warning system personnel quickly locate the earthquake and alert the nearest tide stations to the possibility of a tsunami wave. If a definite wave is detected, a tsunami watch—or, if



warranted—a tsunami warning—is issued to coastal areas and foreign countries are advised of the situation. It is not yet possible to predict the wave height or even if a tsunami will occur, so unnecessary precautions and evacuations sometimes result.

Scientists at NOAA's Environmental Research Laboratories in Boulder and elsewhere are engaged in tsunami research that depends heavily on seismograms that record seismic vibrations and mareograms (tide gage records) that record the height of water waves. The new *Guide to International Data Exchange Through the World Data Center* (P. 18, May 1974 issue of *EDS*) has lowered the criteria for mareograms qualifying for international exchange to records showing "perceptible" tsunami heights. This will increase the data base available through the WDC for research. NOAA hopes that study of data for these much smaller events collected at WDC-A and other WDC's will shorten the time needed to develop technology to predict tsunami heights at all points around the Pacific Basin.

Tsunami warning system network and travel times to Honolulu.

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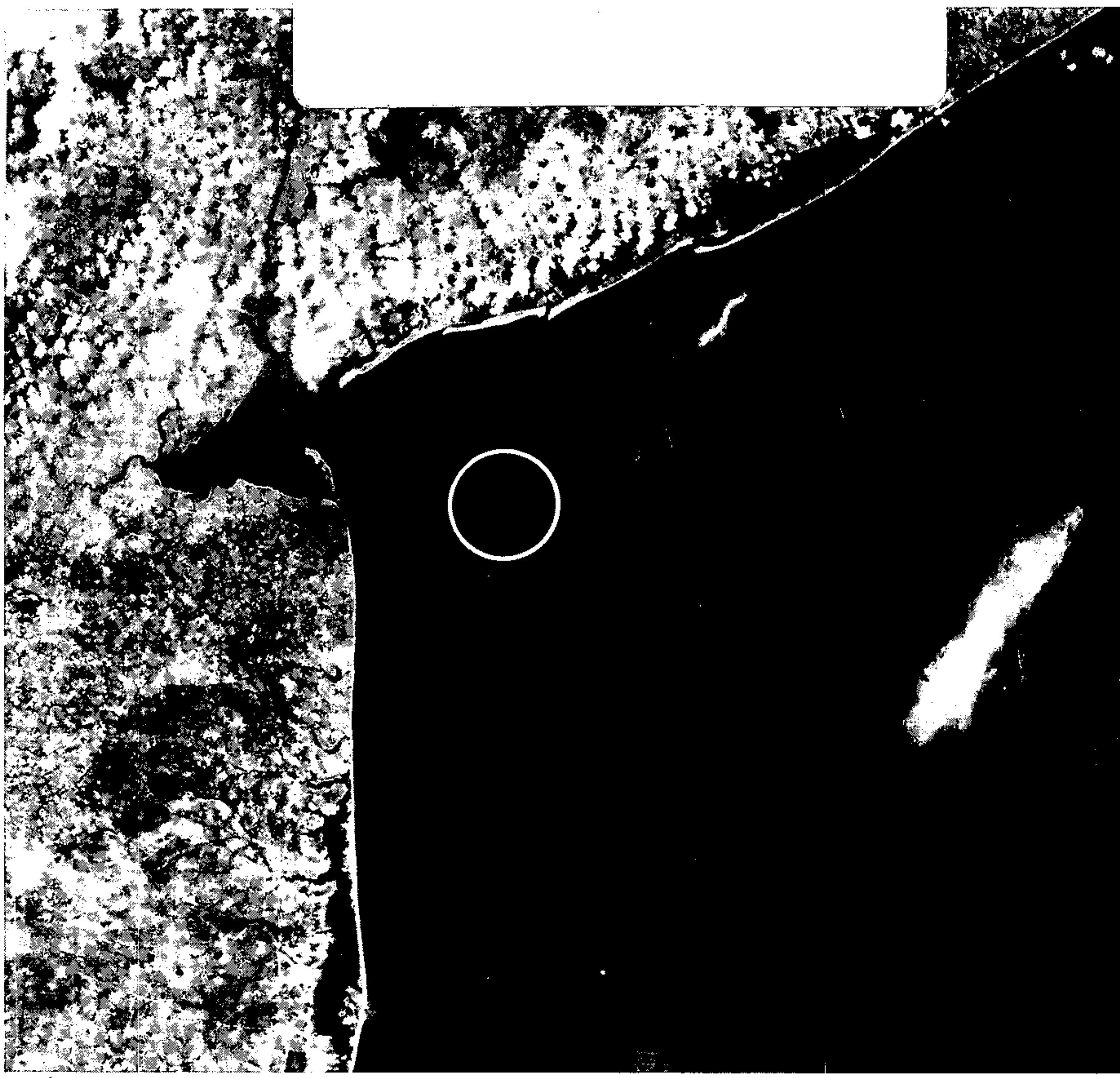

Satellite photo shows an S-shape pattern (circle) resulting from the dumping of sewage sludge outside New York Harbor. (See story on page 19.)

NASA Photo

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

EDS

Environmental
Data Service
July 1975

July 1975

EDS

Environmental Data Service

Cover: *Pollution of tidal marshes critical to wildlife survival is but one of many potential problems facing coastal zone developers. A description of NOAA's coastal zone management program and the data needs of coastal zone managers begins on page 3. EPA–DOCUMERICA Hope Alexander*

ENVIRONMENTAL DATA SERVICE is designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, Center for Climatic and Environmental Assessment, and National Oceanic and Atmospheric Satellite Data Unit. In addition, under an agreement with the National Academy of Sciences, the National Oceanic and Atmospheric Administration (NOAA) has responsibility for World Data Center-A activities in oceanography, gravity, tsunami, seismology, geomagnetism, meteorology, and nuclear radiation, ionosphere and airglow, cosmic rays, auroras, and solar observations; the Director of EDS coordinates these activities within NOAA.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, July 26, 1975; this approval expires June 30, 1976.

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Data Needs For Coastal Zone Management*

by Robert W. Knecht
Assistant Administrator for
Coastal Zone Management, NOAA

Abstract

Coastal Zone Management, to cope with impacts from Outer Continental Shelf (OCS) oil and gas development, needs data of the following types:

OCS Exploration Phase—environmental data for areas proposed for leasing: seismic information, descriptions of the marine ecosystem and unique resources within the area, basic information for the general area on weather, waves, and tides, for example.

OCS Development Phase—comprehensive inventories of the extent of discovered resources, baseline data on tract areas to provide a reference for long-term monitoring, sea floor information needed for pipeline location, and specific information on the size and prospective location of needed onshore support facilities, both industrial and in the public sector.

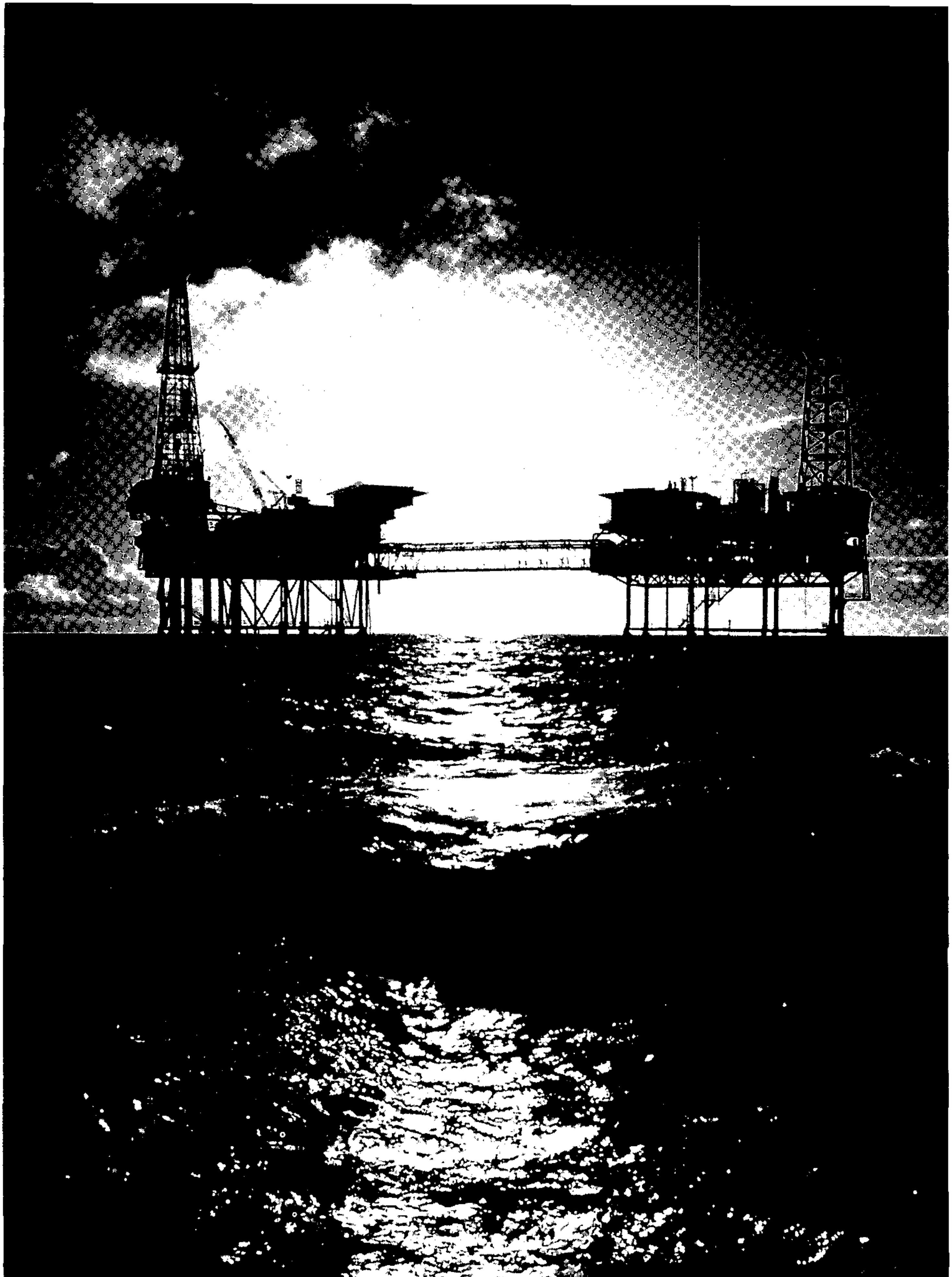
Impact Compensation—information about the net costs of offshore production, such as the costs of required public facilities in excess of added tax revenues, additional pollution burdens, additional planning and regulatory expenses, and costs for land acquisition for recreational purposes to balance industrial land commitments.

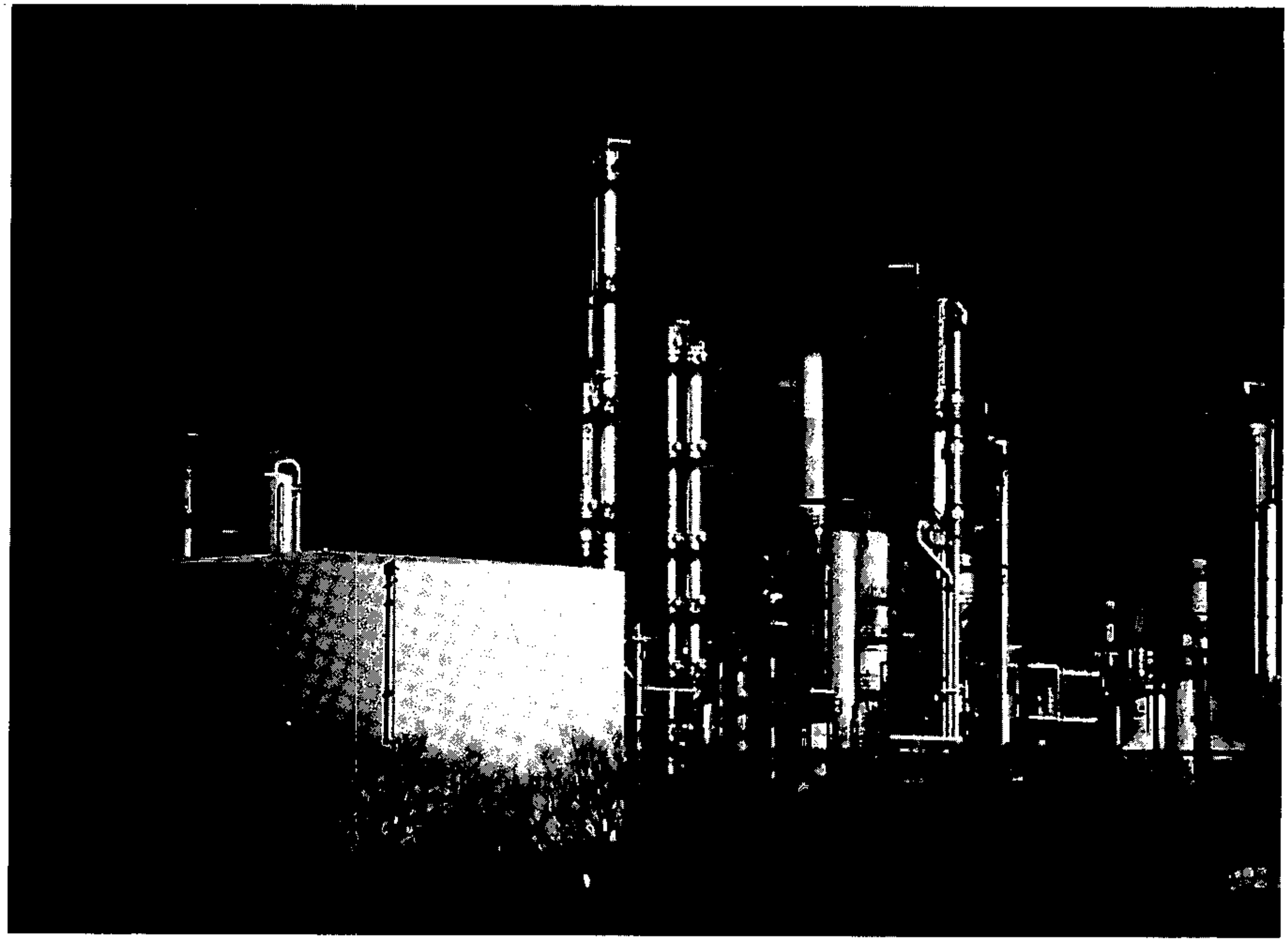
Coastal Zone Management—information of a basic nature about the population in the coastal areas, their needs and desires; an inventory of present coastal resources; analysis of the natural carrying capacity of coastal areas; an examination of the socio-economic structure in coastal areas to which OCS operations might be added; projections of future demands on coastal resources; and analysis of existing governmental regulatory mechanisms affecting the coastal zone.

Coastal Zone Management

Before discussing the data and information needs of the coastal zone management effort as offshore tech-

*Presented at the Offshore Technology Conference, Houston, Tex., May 8, 1975





Above: East Coast natural gas refinery.

Left: Drilling for oil off the Louisiana coast.

EXXON photo

nological developments are integrated into State programs, it may be useful to review what the coastal zone program is about.

The Coastal Zone Management Act became law in October 1972. The first Federal funds for implementation were available in December 1973, and the initial Federal grants to designated State coastal zone agencies were made in March of last year. Currently, all 30 of the eligible States are voluntarily participating, as are 3 of the 4 eligible territories. Participation means the States have to fund one-third of the program cost.

The aim of the coastal zone program is fairly straightforward. It is to encourage and support—not dictate or require—preparation and implementation of comprehensive plans for use of coastal areas in the States, providing for a balance between economic considerations and environmental constraints. There is no penalty if a State chooses not to participate.

The Federal role is restricted to guiding and overseeing the adequacy of the processes States use to develop their individual approaches. There is no "second guessing" on the specific land and water use choices States, together with local government units, arrive at.

The coastal zone act provides that Federal agencies must conduct their activities in a manner consistent with approved State coastal zone management programs. We feel this "Federal consistency" provision is probably the single most important feature of the program and gives the States an important lever in their dealings with Washington, D.C.

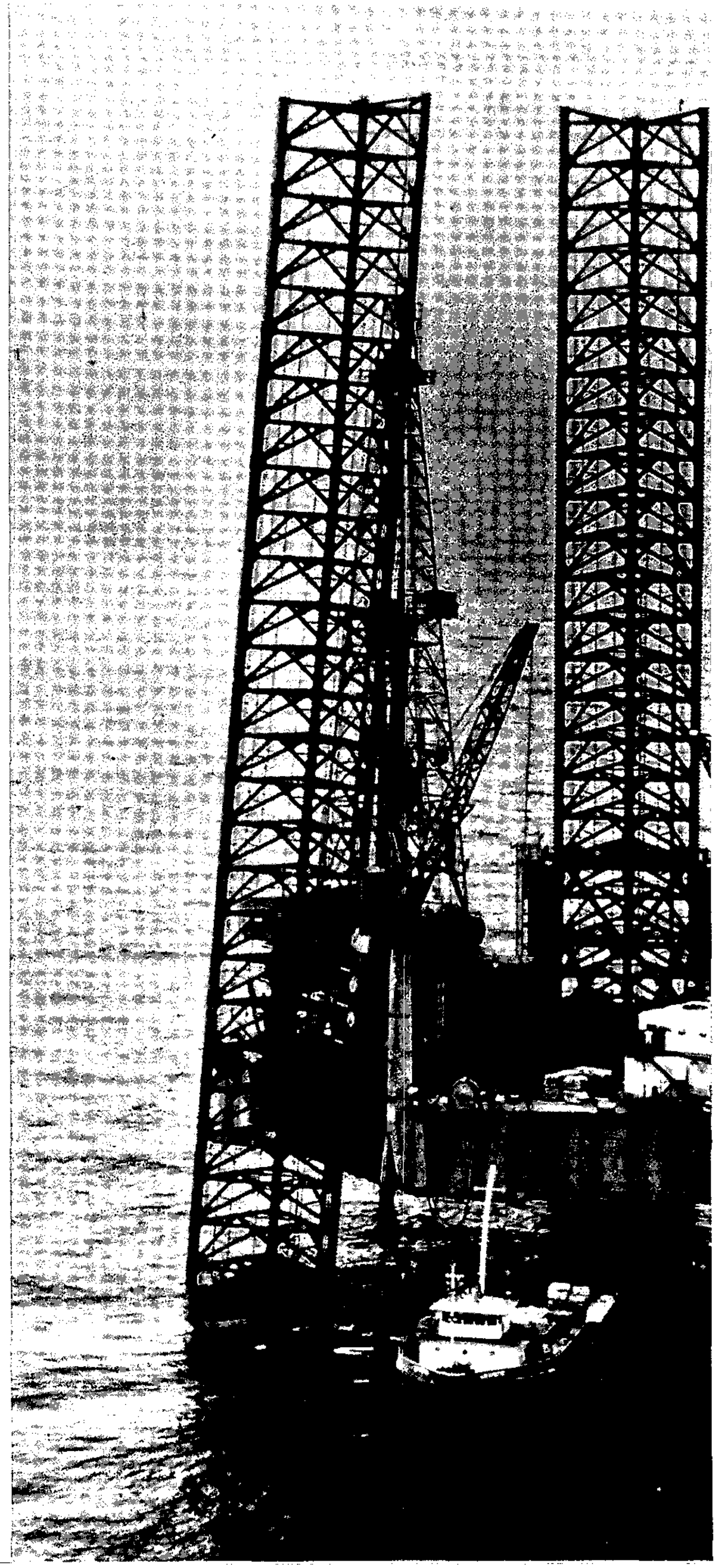
The basic approach of the program is to allow the States up to 3 years to prepare their coastal programs for submittal for approval at the Federal level. Approval means the States qualify for matching grants to operate the coastal programs. All States are due to complete program development by September 1977. We are now discussing adding a 2-year implementation phase to the program in 1978 and 1979.

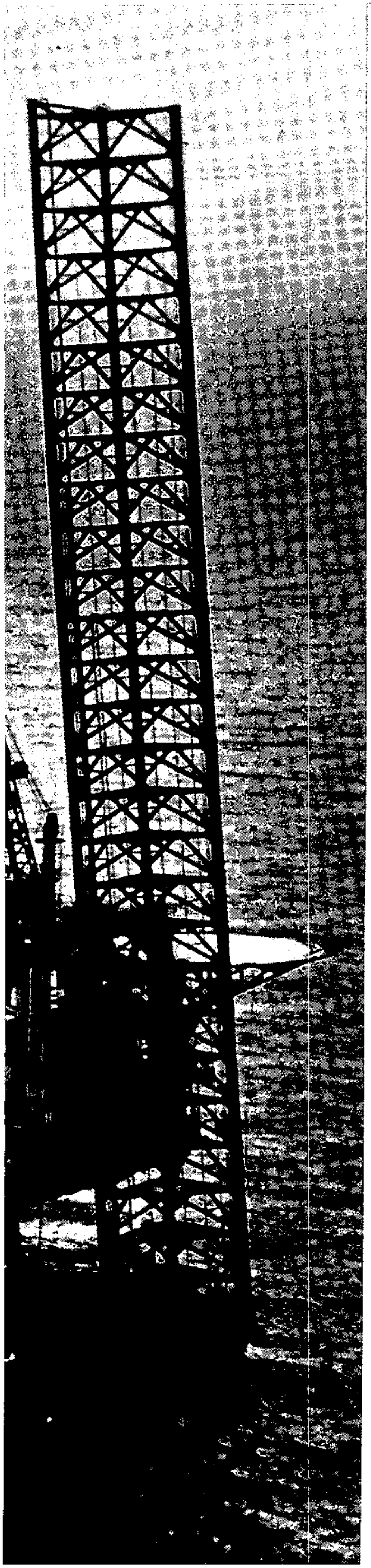
The first two completed programs, from the State of Washington and the midcoast region of Maine, are now under review. It is possible one or both will be approved before June.

Legislation now under consideration in Congress may modify and add to the dimension of the program, but none of the amendments would change the basic approach outlined above. Perhaps the most important change under discussion from the standpoint of the offshore community is a proposed coastal State impact fund, intended to help States and local communities prepare for, assess, and ameliorate where necessary the impact of offshore oil and gas operations.

One of the objectives of this proposed new fund relates directly to the topic of this paper. The fund would be used to make accurate assessments of the actual net gain or loss experienced, or likely to be experienced, by local communities in the coastal zone as the result of providing support for offshore operations. Where it can be shown that in the long run the tax revenues generated will not cover the increased costs to local and State governments brought about by the presence of the offshore industry, the suggestion is that compensation from OCS revenues be provided.

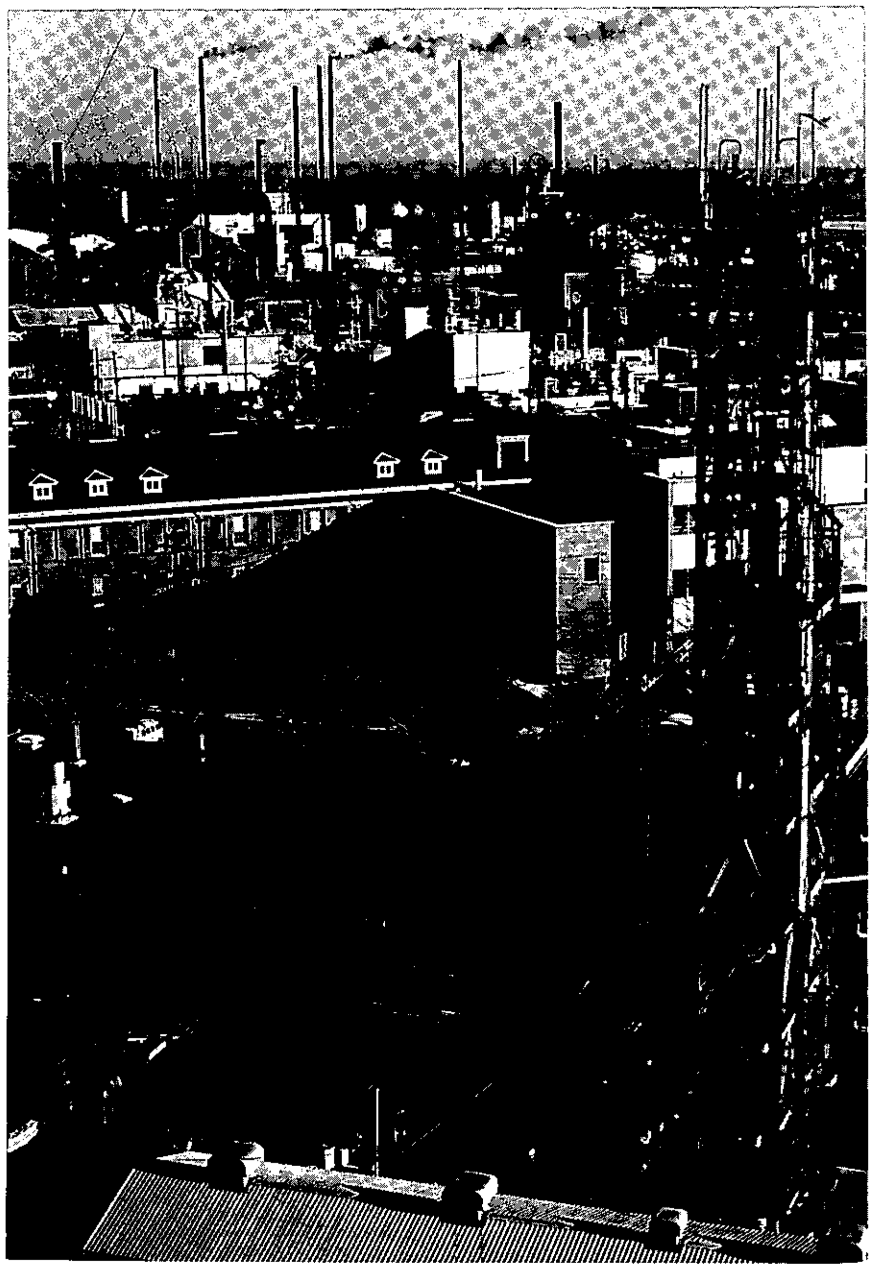
Clearly, for this proposal to work, it will be necessary to have accurate assessments of the net economic im-





Left: Lowering the legs of a mobile oil exploration platform.
Mobil Oil Corporation

Below: East Coast industrial complex.



pacts, analyses that can be readily accepted by local, State, and Federal officials, and the industry involved.

I want to stress this economic impact assessment for energy-related facilities both because it is a possible key to coming developments in the coastal zone management program, and because it is a particular kind of data need unique to the coastal zone effort.

States and local communities to be affected by offshore operations such as oil and gas drilling, or deepwater port construction, are expressing a new emphasis on socioeconomic factors. Previously, the major emphasis had been on such environmental concerns as the likely impacts of accidental oil spills. Though this concern continues, a shift of emphasis is beginning to occur. Thanks to advances made in oil spill prevention and cleanup technology by the industry, the chief concerns in areas which have had no previous experience with offshore operations are how rapid the buildup will be, the effects on wage scales and housing, how extensive the public facility and service requirements will be, and whether present lifestyles in rural areas will be disrupted.

It should be clear from this description of the coastal zone program that more than data gathering and information assembling is involved. Successful preparation of a comprehensive coastal management program takes a major effort to synthesize information in usable form for those responsible for State and local decisions about coastal uses.

Data Needs

It is a major challenge to the States to first assemble the full range of available data, discovering thereby the gaps, and then to translate this material for use by decision-makers.

What makes this process complicated is that persons charged with choosing among alternative uses for coastal areas cannot look at isolated factors. The coastal zone is a complex natural system of interaction between land and water, and between fresh and saline waters. We are just beginning to understand the nature of the interrelations. It is only in relatively recent years, for instance, that the richness of the estuarine areas has been grasped.

There are as many different approaches to meeting data needs for coastal zone management as there are State programs. An outline of just one approach will give some suggestions of the type of work going on.

A management information system suggested for Long Island[1] has these four objectives:

- to describe the existing condition of the environment in time and space,
- to predict the influence of causal factors upon the condition of the environment in time and space,
- to assess the effect of environmental conditions on marine-related activities, and
- to select from alternatives those combinations of activities and conditions which best meet the mix of State goals and needs.

Five general functions were ascribed to the proposed system:

- to identify and describe what is involved in the problems put forth for analysis
- to identify data and relations that will form the basis of the analysis
- to provide the data for analysis in a usable fashion
- to synthesize and analyze the data to provide information, and
- to present the resulting information in a manner consistent with the needs of the decision-maker.

The particular issues raised by offshore development have to be translated into broad data-gathering efforts such as this.

Coastal zone program managers look at offshore petroleum development in distinct phases in terms of the data needed. First is the exploration phase, to determine if oil and gas exist in commercial quantities. Work on a comprehensive environmental assessment of the marine ecosystem, plus distinctive shore features in the area in question precedes this drilling.

Additionally, information is needed on the seismic history of the area to be drilled. For administration of safety regulations, which State officials would share with Federal authorities, data on waves, tide conditions, and weather patterns also are essential.

You can gage the dimension of these baseline studies from the fact that the Department of the Interior's Bureau of Land Management has before it a proposal for a $22 million environmental study off the coasts of Alaska. The work, to be directed by NOAA's Environmental Research Laboratories, would involve 11 ships, airplanes, and helicopters and would assess a wide range of environmental factors in the Gulf of Alaska and the Bering and Beaufort Seas, which are all scheduled for future lease sales.

The second phase is field development, which requires from the coastal zone program developer a detailed description of the resource discovered and the plans for production. Most essential at this stage is information about onshore facility requirements. Where will a pipeline come ashore? Will storage tanks be needed? Is additional refinery capacity required? Will platform construction facilities be needed? How large an impact will supply needs have on area harbors?

What will employment levels and wage scales be? From answers to these and other questions, State and local officials can assess the secondary impacts—housing needs, new service establishments, related industrial development, and public facility needs. Acquisition of this type of data is high on the list of current State concerns and is, in fact, one of the major requests for OCS reforms adopted by the National Governors Conference in February of this year.

At this stage there is also a need for sea floor information to determine the safest location of pipelines from platforms to shore.

A third element of information needed in coastal zone management to deal with offshore development is, as mentioned before, the data to assess accurately the net costs to State and local governments of producing new or additional public services and facilities. It is fair to state that there is no disposition in the Congress to pump impact aid into States that are not making a good faith effort to raise revenues. That is to say, if some States choose not to tax the business and industry that offshore production brings with it, the Congress is not likely to approve filling this revenue gap from the national treasury. Accurate information on the real net impact of offshore operations is obviously critical.

The final information element has also been discussed previously — the importance of thorough socioeconomic understanding of areas to be impacted by as dynamic an industry as the offshore petroleum business. State and local governments are mindful that offshore fields have a finite life of 20 to 30 years, and that there is the danger of an unplanned "boom-bust" cycle. Most communities are anxious to avoid this. They want to have time and the information they need to make careful preparations to accomodate the needs of offshore petroleum, and to be ready to phase it out gradually without community disruption when the fields are drained.

What we are seeing, in short, is a major expansion of the information needs of State and local governments as they attempt to carry out the objectives of the coastal zone management program which they have, to date, enthusiastically accepted.

Reference

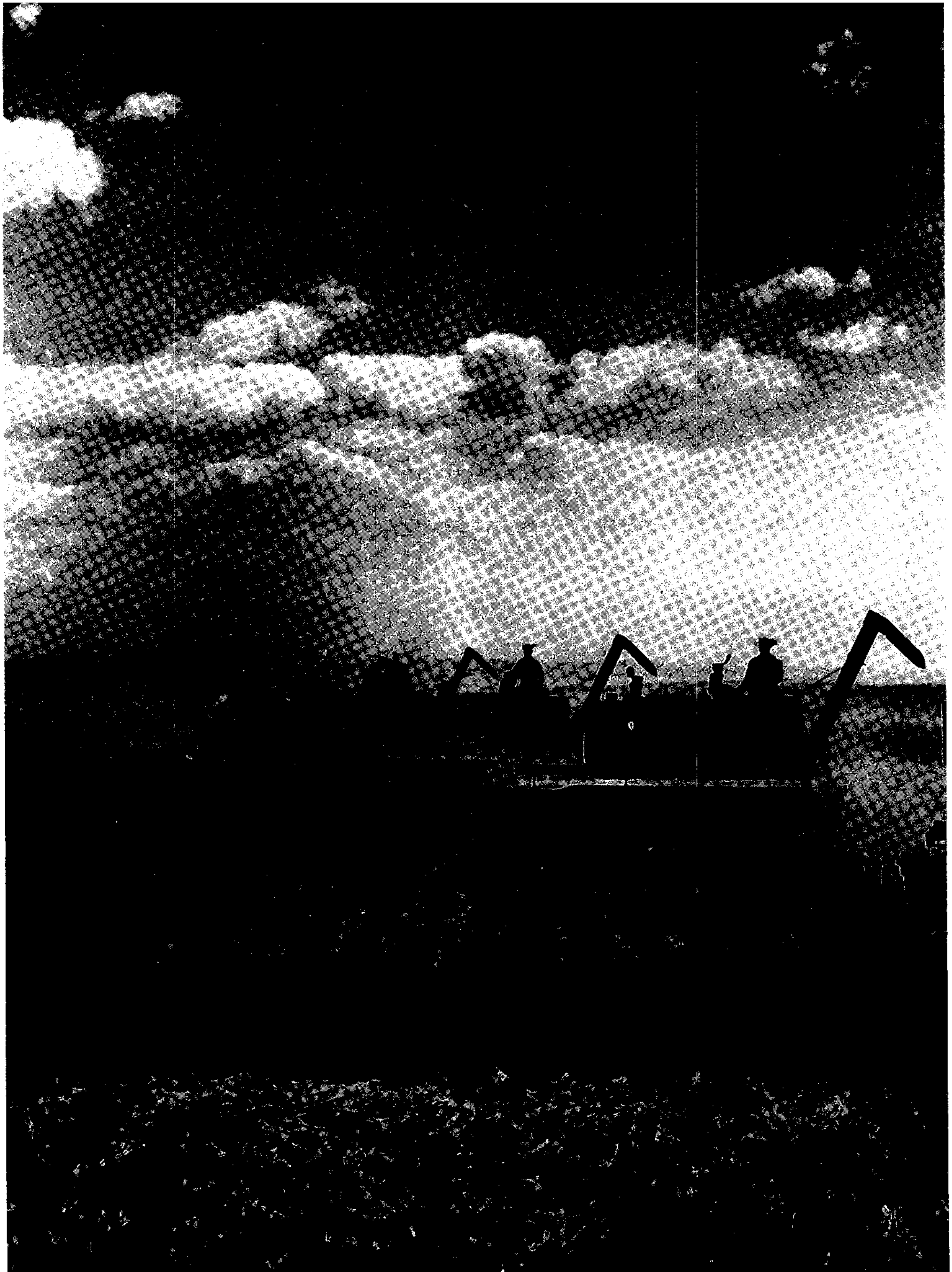
1. "Coastal Zone Management System: A Combination of Tools," Robert Ellis, "Tools for Coastal Zone Management," MTS Conference, 1972.

About the Author

ROBERT W. KNECHT is Assistant Administrator for Coastal Zone Management in the National Oceanic and Atmospheric Administration (NOAA). He is responsible for implementing the Coastal Zone Management Act of 1972, a landmark statute to reconcile increasing and often conflicting demands upon America's seashores.

Mr. Knecht began his government career in 1948 with the National Bureau of Standards. Since then he has held a series of successively more responsible positions leading up to his present assignment. Before assuming his present duties in November 1972, Mr. Knecht was Deputy Director of NOAA's Environmental Research Laboratories in Boulder, Colo.

Mr. Knecht is a former Mayor and Vice-Mayor of Boulder and the author of 35 technical papers on solar-terrestrial relations, atmospheric and space physics, and coastal zone and land use management. He has a Bachelor of Science degree from Union College, Schenectady, N.Y., and a Master of Marine Affairs degree from the University of Rhode Island. From 1959 to 1960, he was a Fellow at Cambridge University (England) and at the University of Rhode Island in 1971.



Technology Considerations in Wheat Yield Modeling for the Great Plains

by Richard W. Katz, Norton D. Strommen, and Sharon K. LeDuc

Technology has been given credit for the rapid increase of wheat yields in the Great Plains area during the past 25 years. Yet, despite continuing technological applications, wheat yields in some areas of the Great Plains appear to have leveled off since about 1960. The implications of such a development must be carefully evaluated in developing models to generate future wheat-yield estimates if reasonably accurate results are to be expected.

Thompson (1969), in his attempt to evaluate the effects of technology on wheat yields in the Great Plains, assumes a breakpoint in 1945; from 1945 to the late 1960's the technology trend is assumed to be linear (or curvilinear). He concludes that two factors account for most of the variability in observed yields since 1945. These are technology, assumed to be continuing as a positive contribution to yield, and weather, assumed to be responsible for the variability of yields around the central tendency of the technology trend.

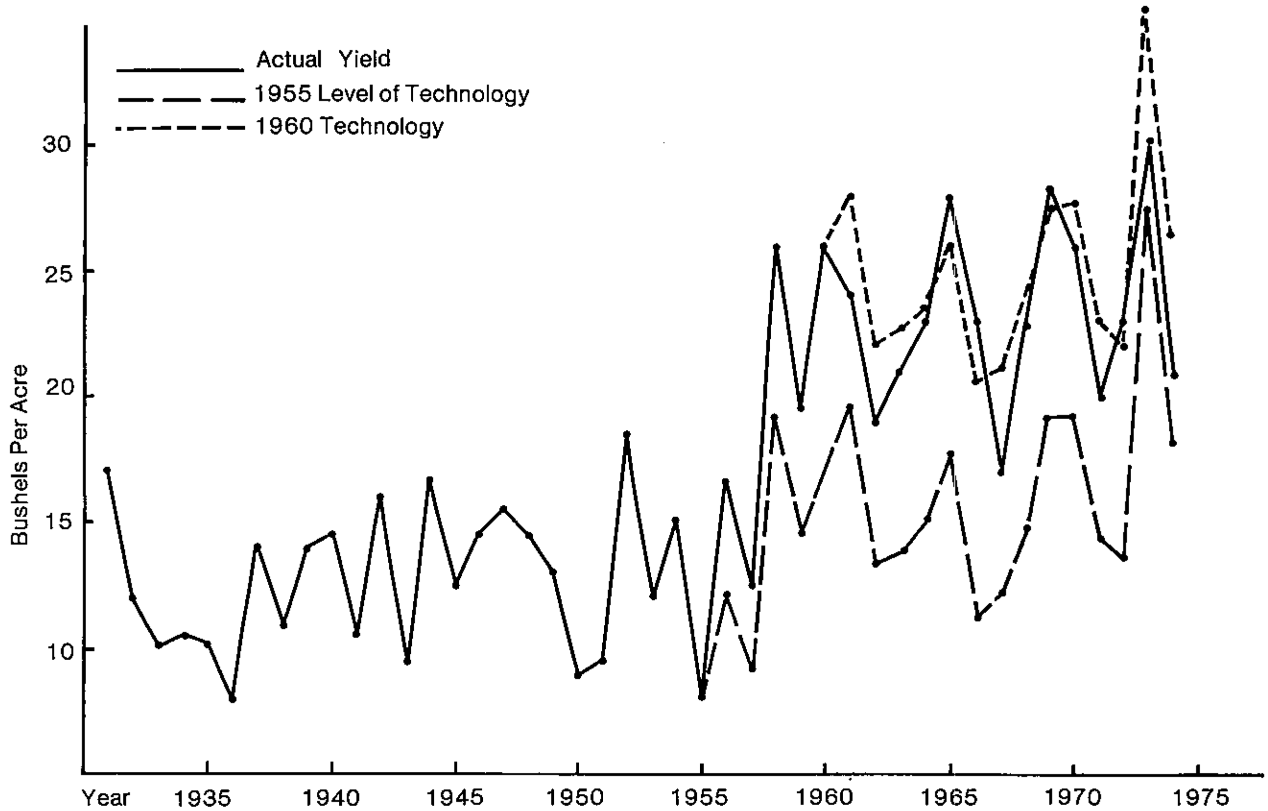


Figure 1: Oklahoma Wheat Yields.

Technology involves the application of a wide variety of farm practices, including tillage, fertilizer application, pesticide application, and the variety of wheat planted. In theory, these practices provide the best possible response to favorable weather and, hopefully, no significant reduction in yield results when unfavorable weather occurs.

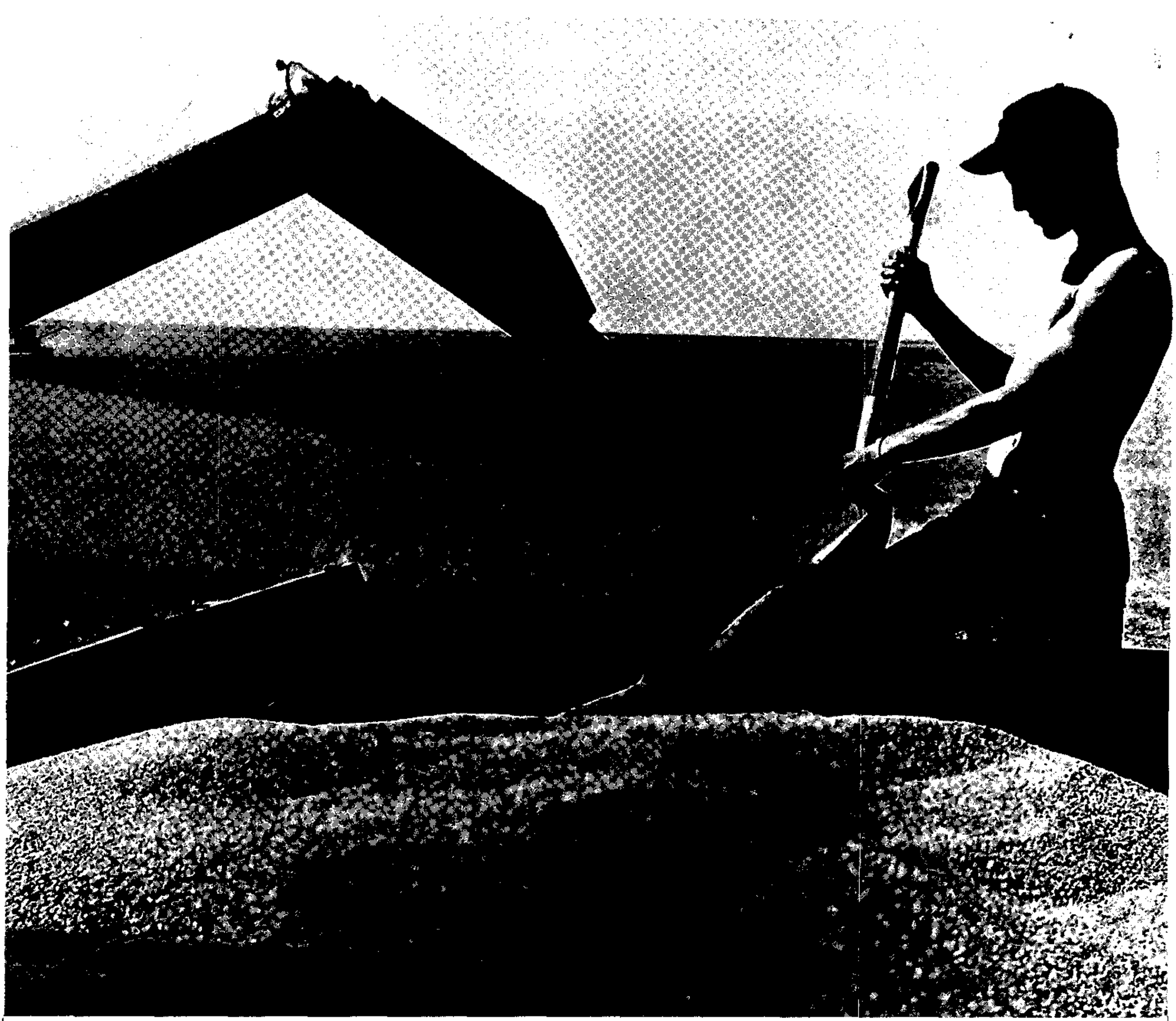
For some areas of the Great Plains, the technology trend is readily apparent from cursory examination of yield data figures compiled by the Statistical Research Service (SRS) of the U.S. Department of Agriculture (USDA). However, for other areas this trend is not so clearcut. In fact, in the case of Oklahoma wheat yields, it appears that the response to technology has been concentrated into a period of 5 years from 1955 to 1960 (fig. 1). In other years, the high variability in yields appears to reflect more strongly the influence of weather rather than technology. This is a reasonable response for an area close to the southern climatic boundary suitable for wheat.

To further examine possible technological trend changes in Oklahoma, a technique has been devised to simulate wheat yields if the level of technology had been held constant (McQuigg and Thompson, 1973). The simulated yields are generated using an agrometeorological model developed from yield and climatic data.

The coefficients of the agrometeorological model were estimated using yield and climatic data for the 1931-55 time period. A single linear time trend is assumed for the period, and simulated yields for subsequent years are generated by holding the trend line constant at its 1955 value and evaluating the model using the observed climatic data for 1956-74. The resulting simulated estimates are then compared with the actual wheat yields reported by SRS. The patterns are essentially the same except that the simulated wheat yields are generally 5 to 10 bushels per acre lower than the actual yields (fig. 1).

The observed yield increases are attributed primarily to technology introduced in Oklahoma from 1955 to 1960. What were the factors most instrumental in this significant increase?

The first factor was the new wheat varieties introduced during the 1950's. Sample surveys conducted at 5-year intervals by the USDA's SRS



show that in 1954 two major wheat varieties, Triumph and Wichita, accounted for 40.5 percent and 19.0 percent of the total seeded acreage, and were the only varieties accountable for at least 10 percent of the planted wheat acreage. By 1964, the improved Triumph group had increased to 64.9 percent of the planted acreage with Wichita and Kaw accounting for 14.4 percent and 11.3 percent, respectively.

The second factor was a substantial increase in the rate of fertilizer application. The number of pounds of nitrogen applied per acre of wheat receiving fertilizer, for example, increased steadily throughout this period (Thompson, 1969, fig. 3).

Even though varietal changes have continued, and fertilizer use continued to increase through the 1960's, wheat yields have not shown the continued response exhibited in the 1950's. No explanation is readily apparent for this change in the yield trend.

Simulated wheat yields have also been generated for the period 1961-74, assuming the 1960 level of technology. (In this case, a piecewise linear trend was assumed, with separate linear trends for 1931-55 and 1955-60.) These yield estimates closely follow the actual yields of the USDA's SRS (fig. 1), thus indicating no significant technology-associated increase in yields since 1960.

If the impact of technology has actually leveled off, this will have important repercussions on future crop yield modelling efforts. For example, yield-trend projections for 1975 range from 24.0 bushels per acre, if yields are assumed to have leveled off after 1960, to 27.5 bushels per acre, if it is assumed that yields have continued to increase at a constant rate since 1955.

The question of why technological impact appears to be leveling off in Oklahoma since 1960 is complicated. Some reasons have been provided by the USDA (1975, p. 9). Recent efforts to increase wheat production have involved cultivating marginal lands. Problems of getting the desired fertilizer at reasonable cost have resulted in stabilized or lower application rates. To complicate the problem further, the changing weather pattern has been less than favorable for optimal wheat yields.

Whatever the reasons, an accurate assessment of the technology trend is essential to modeling efforts if accurate crop yield estimates are to be made.

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About the Authors

RICHARD W. KATZ is working on the development of CCEA statistical models to evaluate the impact of the current year's weather on the progress of the world's wheat crop. This information is important in determining, as early as possible, the potential for food grain yields on a global basis so as to minimize the impact of unfavorable climate in any one region of the world. Rick has completed the wheat yield/climate models for the Great Plains in the United States and is currently working on the development of foreign wheat yield/climate models.

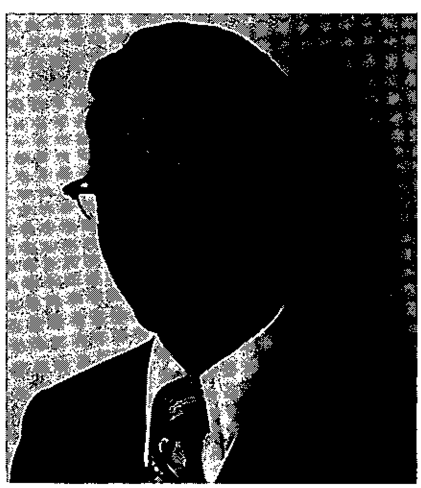
Rick completed his Ph.D. in Statistics in 1974 at Penn State University prior to starting his work with CCEA in September 1974.

NORTON D. STROMMEN is responsible for CCEA liaison with and support to the joint NOAA/NASA/USDA Large Area Crop Inventory Experiment project. (See page 16, January 1975 *EDS.*) Norton, a Navy veteran, also worked as a consulting meteorologist before joining the National Weather Service in 1960. He subsequently served as State Climatologist for South Carolina and for Michigan, and at the National Severe Storm Center, Kansas City, Missouri, prior to joining CCEA in October 1974.

Norton, who recently completed his Ph.D. in Climatology at Michigan State University, East Lansing, Mich., is the author and coauthor of many journal articles.

SHARON K. LEDUC is also working on the development of statistical models to evaluate the impact of large-scale climatic fluctuations. Sharon has worked with Dr. James D. McQuigg, Director of CCEA, for about seven years, first as a student and then as a statistician. She is currently developing the wheat yield/climate models for Canada and has completed initial work on models for flax, sorghum, and corn yields. Sharon is the coauthor of a number of articles on the impact of climatic change on crop yield.

Sharon completed her Ph.D. in Statistics at the University of Missouri-Columbia in 1971.



National Report

EDS Establishes Deepwater Ports Project Office

A Deepwater Ports Project Office has been established in the Environmental Data Service to meet requirements placed upon NOAA by the Deepwater Port (DWP.) Act of 1974, which establishes procedures for the location, construction, and operation of deepwater ports off the coasts of the United States. Dr. Dail W. Brown will head the new office.

Dail Brown

The DWP Act invests licensing authority in the Secretary of Transportation, while the Administrator of NOAA is called upon to provide essential support. To meet NOAA's obligation, EDS' Project Office will review, evaluate, and prepare recommendations for the Administrator on DWP license applications, related environmental impact statements, and adjacent coastal State status.

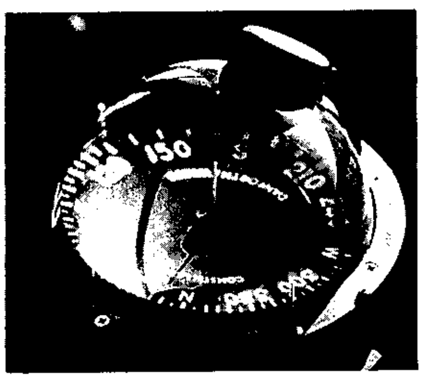
The Act specifies that, upon petition of a State, the Secretary of Transportation shall ask the NOAA Administrator whether that State is likely to be impacted by a DWP oil spill to an extent equal to or greater than the impact on the State connected to the DWP by pipeline. The determination must be made within 45 days after a petition is received from a State.

Procedures developed to evaluate the potential impact of DWP oil spills on adjacent coastal states will also be used in developing NOAA's recommendations on license applications and environmental impact statements. However, in addition to oil spill, other possible environmental impacts, including those that might result from the presence of physical structures, dredging of wetlands, and secondary development will also be considered.

NOAA's DWP review activities will be fully documented and made available for public examination.

Data For Devil's Triangle

As the result of recent publicity about the area, EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) has received many requests for information about magnetic anomalies in the Bermuda (or "Devil's") Triangle. The Triangle is an area of the Atlantic Ocean bounded by Bermuda, the southern tip of Florida, and a point somewhere east of Puerto Rico; it is believed by some to be a diasaster-prone area for navigation.



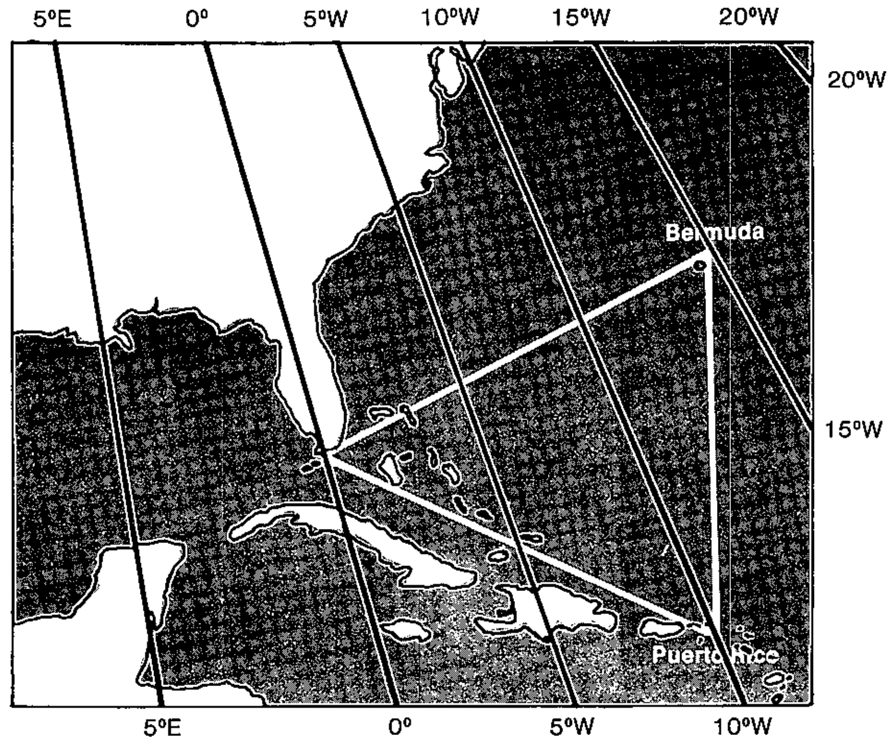
The evidence is a series of shipwrecks (some dating back to the time of Colombus) and missing aircraft. One cause suggested for these events is unusual fluctuations of the magnetic compass. It has been stated incorrectly that the Triangle is one of only two places where magnetic compasses point to true north, to the navigator's confusion.

Actually, the compass needle does not point to anything in particular, but rather alines itself with the direction of magnetic north, the direction of the horizontal component of the Earth's magnetic field. The angle between the directions of magnetic north and true north is called the magnetic declination. In places where the magnetic declination is zero, these two directions coincide and the compass needle may be said to "point true north." This is the situation anywhere along the agonic line, or line of zero declination, as shown on an isogonic chart.

In the recent past, the agonic line was further to the east and clearly in the area of the Triangle, but at the present time it lies just west of the Triangle, parallel to the Florida Peninsula. However, chart values are only approximate, and it is quite possible that one might find "anomalous" points near the western end of the Triangle where the declination is zero. This would not confuse a navigator, however, since he routinely corrects a magnetic compass reading in terms of true north by taking into account the magnetic declination. The fact that this value happened to be zero in a particular area would present no problem.

A more significant question is whether there are any places in the Triangle where the declination might be appreciably different from the values indicated on isogonic or navigation charts. NOAA receives navigators' reports of "anomalous" observations that deviate significantly from chart values. There are several such reports for this area, but neither the number of reports nor the magnitude of the reported anomalies is unusual. There are many reports of larger anomalies in other areas. It is remotely possible that there are points in the Triangle that have larger anomalies that have not been observed and reported, but with all the sea and air traffic that traverses the region, this seems unlikely. As far as NOAA's records are concerned, the Bermuda Triangle would seem to be relatively stable, magnetically speaking.

Whether the Bermuda Triangle is unusually dangerous for navigation may be open to question, but NGSDC does believe that, if there is particular danger, it must derive from some cause other than the Earth's magnetic field and the magnetic compass.



Magnetic declination in the Bermuda Triangle area.

IFYGL Data Processing Completed

The EDS Center for Experiment Design and Data Analysis (CEDDA) has finished processing data for both the IFYGL (International Field Year for the Great Lakes) Ships System and Physical Data Collection System and turned them over to the permanent archive for IFYGL data. (Data for the Rawinsonde System, the third major IFYGL data collection system, were processed earlier. See page 8, November 1973 EDS for details.) IFYGL was a joint Canada-United States program that surveyed the meteorology and limnology of Lake Ontario in 1972-73.

IFYGL Ships System data were collected by NOAA's *Researcher* and the Cape Fear Technical Institute's *Advance II*. Parameters measured include windspeed and direction, barometric pressure, air temperature, dewpoint, long and short wave radiation, surface and water column temperatures, and chlorophyl content. The parameters were sampled several times per second. Edited data from 27 cruises for each ship were processed. Magnetic tapes of one-second average data (.1 second subsurface data), bathythermograph (XBT) on-station data, decibar average of subsurface data, and 6-minute totals for radiation and 6-minute averages for other data have been archived. In addition, microfilm time-series displays of the radiation data and 6-minute and 1-second average data were generated for the archive.

The Physical Data Collection System network included 10 remote automatic buoys and 4 remote towers on the U.S. portion of Lake Ontario, as well as six automatic land stations. The parameters recorded were air temperature, barometric pressure, dewpoint, pan evaporation, long and short wave radiation (incident and reflected), precipitation, wind and current speed and direction, and water temperatures from the lake's surface to bottom. Instantaneous observations were made of these parameters at 6-minute intervals throughout the field year. Real-time recorded data, backup data recorded at the field center in Rochester, New York, and on-board magnetic tapes were merged and edited to form the final archivable data set. Tapes of the edited 6-minute data and hourly averages, as well as microfilm time-series display of the 6-minute observations were generated for the archive.

Auxiliary data for both systems, including event logs, station histories, and calibration records also have been forwarded to the U.S. permanent archive for IFYGL data, located at the EDS National Climatic Center, Federal Building, Asheville, N.C. 28801.

Climatological Publications Series Available on Microfiche

The EDS National Climatic Center (NCC) has launched a long-term project to develop a microfiche file of selected climatological publication series. The project offers substantial savings in both cost and shelf space for users interested in acquiring the publications or replacing current hard copy files.

All series will be filmed from the initial publication date through 1973. To date, the following series have been filmed: *Storm Data, Monthly Climatic Data for the World, Climatological Data,* and *Climatological Data, National Summary.* NCC is currently filming *Local Climatological Data* publications, which it expects to finish by the end of the year.

Series scheduled for later microfilming include: *Hourly Precipitation Data, Hydrologic Bulletins, Weekly Weather and Crop Bulletin, Northern Hemisphere Data Tabulations, Climates of the States, Daily River Stages, Summary of Hourly Observations, Mariner's Weather Log, Monthly Normals of Temperature, Heating Degree Days and Cooling Degree Days, Climatic Summary of the United States,* and *World Weather Records,* among others.

When the program is finished, about 1¼ million pages of climatological data will be available on microfiche, at a reduction factor or space savings of about 70 to 1. In addition, since many back issues of the publications are out of print, obtaining microfiche copies is considerably cheaper than obtaining reproduced paper copies. A diazo copy microfiche costs 60 cents, a silver positive copy 80 cents. Each microfiche contains about 58 pages of climatological data; the cost for paper copies of 58 pages from out-of-print issues is about $15.

Costs can be reduced even further by placing a *standing order* for microfiche copies of publications series not yet filmed. In this way, copies can be made at the same time the original microfiche is produced, with considerable savings in personnel time and effort. The cost of such a diazo copy microfiche is only 30 cents, a silver positive copy, 50 cents.

All prices listed above are subject to change. To order any microfiche series or for further information on the subject, including payment procedures, write to National Climatic Center, Federal Building, Asheville, N.C. 28801. NCC's telephone numbers are 704-258-2850, ext. 620 (commercial) and 704-254-0620 (FTS).

Great Lakes Climatological Summaries Published

A four-volume series entitled *Summary of Synoptic Meteorological Observations for Great Lakes Areas* has been published by EDS' National Climatic Center, Asheville, N.C. The four volumes are: Volume 1—Lake Ontario and Lake Erie, Volume 2—Lake Huron and Georgian Bay, Volume 3—Lake Michigan, and Volume 4—Lake Superior. The Lakes are divided into 13 major areas. Each volume contains 19 tables for each area by month, and 21 tables in an annual summary.

The elements summarized are weather occurrence, wind direction and speed, cloud amount, ceiling height, visibility, precipitation, dry-bulb temperature, relative humidity, air-sea temperature difference, sea height and period, sea surface temperature, and sea-level pressure.

The surface marine observations summarized were taken aboard cooperating Great Lakes vessels in cooperation with the Great Lakes carriers' Association, the National Weather Service, and the Atmospheric Environment Service of Canada. A limited number of copies of the publications are available from the National Climatic Center, Federal Bldg., Asheville, N.C. 28801. Attn: Publications.

Idaho-Utah Border Earthquake Latest in a Series

The magnitude 6.3 earthquake that shook southern Idaho near the Utah border on March 27, 1975, was the largest shock in the continental United States since the February 9, 1971, San Fernando, Calif., earthquake. The EDS publication *Earthquake History of the United States* and other historical data on file at the National Geophysical and Solar-Terrestrial Data Center's Earthquake Information office in Boulder, Colo., indicate that 11 earthquakes strong enough to cause damage or be felt widely have been recorded in the area since 1880.

A damaging shock on March 12, 1934, was centered about 64 kilometers (40 miles) southwest of the recent earthquake, near the town of Kosmo, Utah. Measured at magnitude 6.6, the 1934 tremor resulted in little damage in the sparsely populated area. Damage reports were similar to those received for the March 27th earthquake, with fallen chimneys and cracked walls (intensity VIII) the most common type of damage experienced. The total area affected was about 442,000 square kilometers (170,000 square miles).

A strong aftershock (magnitude 6.0) occurred 3 hours after the initial shock; another aftershock (magnitude 5.5), on May 6, caused additional damage in northern Utah and southern Idaho.

On August 30, 1962, damage in excess of $1 million was reported from a magnitude 5.7 shock about 80 kilometers (50 miles) east of the 1934 event and 64 kilometers (40 miles) southeast of the March 27 earthquake. The town of Richmond, Utah, suffered the greatest damage. The shock was felt over and area of approximately 169,000 square kilometers (65,000 square miles). Building damage in the epicenter region consisted mostly of cracked and distorted walls and fallen chimneys.

Other earthquakes, intensity V (Modified Mercalli scale) or greater, occurred in the area in 1880, 1913, 1914, 1924, 1960, 1966, 1972, and 1973. These were part of a long north-south band of moderately strong earthquakes extending from western Montana to central Arizona. In the Idaho-Utah border area, past earthquakes have been associated with the Wasatch fault, the East Cache Valley fault, and the Hansel Valley fault.

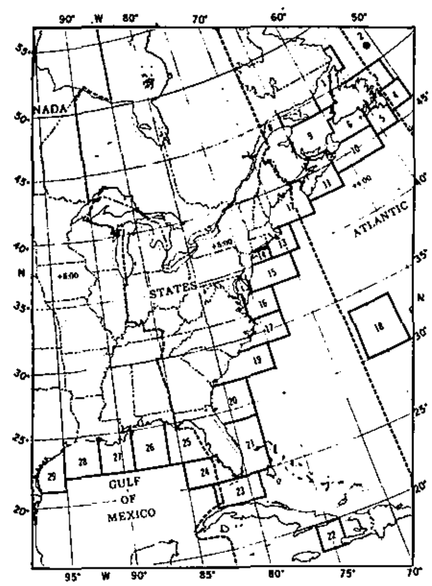
The NGSDC Solid Earth Data Services Division disseminates historical seismic data for both technical and general users; they prepare earthquake histories of local and regional areas, answer public inquiries concerning historical earthquakes, publish historical compilations and annual earthquake summaries, and make available seismograms and strong-motion accelerograph data in a variety of formats.

U.S. Atlantic and Gulf Coast Meteorological Summaries Updated

The EDS National Climatic Center in Asheville, N.C., has updated and revised its *Summary of Synoptic Meteorological Observations* (SSMO) publication series for the U.S. Atlantic and Gulf Coasts. This series is funded by the U.S. Naval Weather Service Command. The revised version is based upon all marine meteorological observations available through 1971.

Ten new marine areas have been added to the 19 covered in the original edition. Several of the original areas have been modified to exclude sheltered areas and/or to increase geographical coverage. The content of the data tables is essentially the same, but reformatting and reductions have made it possible for the revised material for the 29 areas to be covered in only four volumes; the original 19 areas were presented in six volumes.

Copies of the revised and updated series may be obtained from the National Technical Information Service (NTIS), Springfield, Va. 22151.



Marine areas covered in revised SSMO summaries.

New Marine Geophysical Data Catalog

The Marine Geophysical Data Catalog, 1975, Key to Geophysical Records Documentation No. 4, was published recently by EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC). It lists data available from NGSDC, including bathymetric, magnetic, gravity, seismic, and navigation data. The catalog also indicates types of records and data formats; identifies specific projects, cruises, or surveys; and depicts geographical distribution of the data by area index charts. This 1975 catalog supersedes the marine geophysical data catalog published June 1972.

The new catalog incorporates the material contained in the 1972 version and describes an additional 58 marine geophysical data sets (bathymetry, magnetics, gravity, and seismic reflection profiles) that have been obtained by NGSDC since the old catalog was issued. The 1975 edition also provides information on the availability of other complementary data and information, including maps and publications.

Requests for the catalog should be directed to the Marine Geology and Geophysics Branch, National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo. 80302.

International Report

IOC Working Committee On International Ocean Data Exchange Meets

The VIIIth Session of the Intergovernmental Oceanographic Commission Working Committee on International Oceanographic Data Exchange (IOC WC IODE) met in FAO headquarters in Rome, Italy, May 12-16. The 50 participants represented 24 IOC member countries and 8 observer and scientific advisory groups.

Thomas Winterfeld of EDS, Dr. Paul Lefcourt of the Environmental Protection Agency, and Dr. Pern Niiler of Oregon State University represented the United States. EDS' James Churgin, Director of World Data Center A for Oceanography attended as an observer, while Richard Morse and Dr. Joseph Caponio of EDS represented the IOC Secretariat on interdisciplinary data management and FAO's Aquatic Sciences and Fisheries Information Service (ASFIS), respectively.

Among the main topics considered at the VIIIth Session were: strengthening and modernizing arrangements for international oceanographic data exchange in conjunction with national, regional, and World Data Center systems; formulating standard formats for data exchange, with special emphasis on the needs of new major interdisciplinary programs; and the management of oceanographic information and collaboration with on-going information services, such as FAO's ASFIS and the United Nations Environment Programme's International Referral System.

Other agenda items of particular importance included: standards for the documentation and exchange of marine pollution data; exchange of satellite and geological and geophysical data; and further development of archiving schemes for data and data products resulting from the Integrated Global Ocean Station System (IGOSS).

Agreements were reached on all substantive agenda items and a number of major decisions embodied in some 17 adopted recommendations. Some of the more important accomplishments included:

a) finalization of plans to implement the so-called "Responsible" National Oceanographic Data Center (NODC) scheme whereby better-developed NODC's would, on behalf of the World Data Center System, voluntarily assist the other NODC's and Declared National Agencies to standardize and automate oceanographic data holdings and provide user services. Implementation will be accomplished under the guidance of a group of experts chosen by the IOC.

b) continuation of the Declared National Programs and National Oceanographic Programs concepts, which have been a long standing and effective form of international cooperation in data exchange;

c) adoption, on an experimental basis, of the interdisciplinary data format developed for GATE—Global Atmospheric Research Program (GARP) Atlantic Tropical Experiment—as a standard IOC format for international exchange of oceanographic data; and

d) establishment of mechanisms for information management, including close collaboration with FAO's ASFIS project, and through an ad hoc group, continuous monitoring of the international oceanographic communities' requirements for access to, and exchange of, marine environmental and related information and information referral services.

The meetings concluded with an address by the outgoing chairman, Dr. Thomas Austin, Director of EDS, outlining the challenges new broad interdisciplinary programs such as the upcoming First GARP Global Experiment will pose to the committee in future years, and with the statutory election of new officers. Mr. Georges Peluchon, Director of France's Bureau of National des Donnes Oceanographiques of the Centre Oceanologique de Bretagne was chosen the new Chairman of the committee and Thomas Winterfeld of EDS' National Oceanographic Data Center Vice Chairman. The IXth meeting of the committee is scheduled for UNESCO headquarters, Paris, in the spring of 1977.

The VIII Session of the IOC Working Committee on International Oceanographic Data Exchange. Head table, left to right: Richard Morse; Dr. José Alvarez (Argentina), Vice Chairman; Thomas Austin, Chairman; Al Tolkachev (USSR), IOC Secretariat; Dr. Joseph Caponio, Rapporteur; and Henry Jones (Canada), Assistant Rapporteur.

Gate Data Catalog Published

World Data Center A, Meteorology, collocated with the EDS National Climatic Center in Asheville, N.C., has published and distributed the *GATE Data Catalogue, which* describes the data sets and products now available from the Global Atmospheric Research Program's (GARP) Atlantic Tropical Experiment (GATE). The catalogue has been distributed worldwide to more than 300 scientists who participated in the GATE Program.

The catalogue lists the 16 major GATE data sets completed by April 1, 1975. These include preliminary sets prepared during the experiment, data from several participating ships, and much of the data collected by satellites. The lists are organized into four major sections:

(1) Information products prepared during the experiment.
(2) Nationally processed and validated data.
(3) Internationally processed and validated data.
(4) National raw data holdings.

The catalogue is in looseleaf form and will be updated periodically. The first update will be prepared this summer and will include new data products received at the Asheville archives through July 1, 1975. The final GATE data set will be the largest collection of oceanographic and meteorological data ever compiled for a particular region of the world.

Copies of the GATE data catalog may be obtained by writing:

Grady McKay
World Data Center-A, Meteorology
Federal Building
Asheville, N.C., 28801

The World Data Center system is serving as an archive and data distribution system for all GATE data. Participating countries forward completed data sets to World Data Centers in the United States (WDC-A) and the Soviet Union (WDC-B) for permanent retention. The WDC system will archive all GATE data except national raw data collections, which will be kept by the national organizations responsible for their processing.

U.S. GATE raw data holdings are archived and disseminated by the EDS National Climatic Center. As of May 1, this collection included over 8,000 reels of digital magnetic tape and 10,000 satellite photographs.

WDC-A Oceanography Receives Millionth Marine Observation

World Data Center A (WDC-A), Oceanography received and cataloged data for its millionth marine scientific observation during the latter half of 1974. The actual total of 1,002,611 observations (comprising the Center's international marine data base) contains data for 449,168 oceanographic serial stations, 162,745 bathythermograph observations, 72,929 biological observations, 13,444 geological observations, 4,448 geophysical observations, and 299,877 surface and subsurface current measurements.

All data held by the Center are described in the *Catalogue of Data* and the semiannual Change Notices to the *Catalogue*. The *Catalogue* is available to qualified requesters in the international scientific community.

In 1957 the International Council of Scientific Unions (ICSU) established the WDC system to assemble and make globally available data collected by the varied and widespread observational programs of the International Geophysical Year (IGY). The resulting network of data centers has been continued on a permanent basis by international agreement. Most of the data held by WDC-A, Oceanography are contemporary data collected since the beginning of the IGY in 1957.

Worldwide Data for Three Big Earthquakes

World Data Center A (WDC-A) for Seismology, Boulder, Colo., now has available seismograms from a large number of stations throughout the world for three large or destructive 1974 earthquakes. These earthquakes occurred in the People's Republic of China (May 10, magnitude 6.8), northern Peru (October 3, magnitude 7.6), and the Leeward Islands (October 8, magnitude 7.5).

Under the provisions of the *Guide to International Data Exchange through the World Data Centres, Seismology*, Section 6 (ii), seismograms have been collected and copied from a worldwide network of participating stations. Records are on hand for at least one of these earthquakes from 153 stations in 48 countries, including 42 received from WDC-B in USSR and many from the worldwide standardized seismograph and the Canadian networks. Most of the stations have sent records for three long- and three short-period components.

To make these records quickly available for current research studies, WDC-A is prepared to provide immediate copies of the records for these earthquakes and to send to subscribers additional records in batches of about 40 stations' seismograms each as they become available.

The seismograms for these earthquakes are available on 35-mm microfilm for $100 for the set for each earthquake. There probably will be 175 or more stations represented in the collection by the end of 1975, but a first shipment of the more than 70 stations on hand will be made on receipt of an order. Most of the seismograms are also available on 70-mm microfilm. The prices are $110 (70-mm roll), $120 (70-mm chips), and $135 (70-mm chips in jackets).

The Guide provides that each WDC-A subcenter, to the extent possible, provide each contributor with a body of data equivalent to that contributed. Initially, WDC-A will consider this body to be a set of network data for one earthquake per year and will provide it on request to each contributor of seismograms without charge under this exchange provision.

POLYMODE Data and Information Exchange

At a meeting in Moscow the week of March 24, representatives of the United States and Soviet Union negotiated data exchange arrangements for the planned POLYMODE experiment. During 1977, POLYMODE will investigate the dynamics of mesoscale motions in the ocean, their energy source, and their role in general ocean circulation in an area east of Bermuda. American and Russian scientists jointly planned and organized and will conduct the POLYMODE experiment, under the direction of the Joint US—USSR POLYMODE Organizing Committee established by the Agreement on Cooperation in Studies of the World Ocean between the governments of the United States and Soviet Union.

At the March meeting, members of the Joint Organizing Committee agreed to establish the Field Program Coordination Center to collect, integrate, and disseminate data and information. The center will be linked to participating laboratories in both countries, to all POLYMODE ships, and with tracking, numerical analysis, and forecasting centers. Selected data will come into the center on at least a daily basis from POLYMODE ships. The data will be summarized and disseminated to national laboratories and the ships. If feasible, the Coordination Center will be located at Woods Hole Oceanographic Institution, Woods Hole, Mass., and will begin operation in 1976 and continue through February 1978.

Working Group members from both nations also agreed to complete the international cruise data inventory forms (Report of Observations/Samples Collected by Oceanographic Programs) and to forward these to the Coordination Center. The Coordination Center will prepare a detailed inventory of all data collected during the POLYMODE field program.

Complete sets of raw or reduced data on magnetic tape will be exchanged between POLYMODE scientists as soon as such data are available in usable form. Exchange of final data will take place, if possible, 6 months after the end of the field experiment. All data shipments will be accompanied by Data Documentation Forms currently used by the U.S. National Oceanographic Data Center. The forms describe when, where, and by whom the data were collected; the instruments and techniques used to collect and analyze them; and the format in which they are recorded.

H-Alpha Synoptic Charts

World Data Center A (WDC-A) for Solar-Terrestrial Physics, Boulder, Colo., has issued two new special publications, Reports UAG-40 and UAG-41. These are entitled, respectively, *H-Alpha Synoptic Charts of Solar Activity for the Period of SKYLAB Observations, May 1973-March 1974,* by Patrick S. McIntosh, NOAA Environmental Research Laboratories; and *H-Alpha Synoptic Charts of Solar Activity During the First Year of Solar Cycle 20, October 1964-August 1965,* by Patrick S. McIntosh and Jerome T. Nolte, American Science and Engineering, Cambridge, Mass.

Report UAG-40 is one of the reference data packages to be used in association with the study of the detailed SKYLAB observations. Report UAG-41 provides data of the first 11 months of the current solar cycle. This cycle is now approaching sunspot minimum (anticipated in late 1975 or early 1976), and these data should be especially useful to compare with observations made during the initial months of the next cycle.

These UAG-reports provide charts of the slowly varying, large-scale features of chromospheric solar activity. They are based on once-daily, standard H-alpha observations that have been interpreted in terms of large-scale magnetic field regions. The data are shown on charts covering one solar rotation. The charts represent the solar globe from latitude 70°N to 70°S. Similar but preliminary charts have been published regularly in NGSDC's monthly "Solar-Geophysical Data" since June 1973.

Reports UAG-40 and UAG-41 are available from the National Climatic Center, Federal Building, Asheville, N.C. 28801. Their prices are 56 and 48 cents, respectively.

New Film of Aurora Classifications Available

A 45-minute, 16-mm black and white film that depicts various auroral forms at the rate at which they were observed (when the film is projected at 20 frames per second) was recently acquired by World Data Center A for Solar-Terrestrial Physics in Boulder, Colorado. Normally, aurora films are speeded up a dozen or more times when projected because of the insensitivity of film or detector to the weak light level of the aurora.

The pictures were originally recorded on video tape from April to October 1971 at Syowa Base, Antarctica. Dr. Takasi Oguti of the Geophysics Research Laboratory of the University of Tokyo developed the TV system used, which is 1,000 times more sensitive than ordinary photographic systems. Even subvisual aurora are recorded. The system is most sensitive to violet light (4,200 A°), and thus the recorded auroral images are mainly due to radiation from the negative band of nitrogen ions (N_2+). The field of view is about 60° of the sky across the diagonal of the screen.

Dr. Oguti divides auroras into two categories: continuous or intermittent (on-off switching). The patterns are further classified into six distinct types: sheet, diffuse arc, smoke, striation, patch, or surface. The deformations of the auroras are classified as elementary or combination. Elementary deformations are divided into seven groups: splitting or disruption modes, fractional rotation modes, disruption and reconnection modes, drift and propagation modes, meandering or folding modes, on-off switching modes, or fading out modes. Further subclassifications were made.

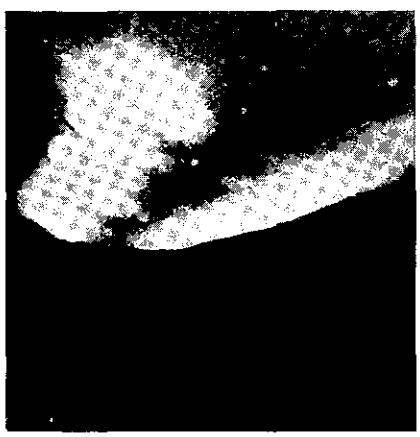
Combination deformations are classified into seven types: S-pattern formation, S-pattern deformation, flame-pattern formation, rotation mode variations, drift propagation mode variations, on-off switching mode variations and others.

The movie gives examples of all of these classes, identifying each scene by date, universal time to the second, and the direction in which the TV system was oriented.

Dr. Oguti indicates that there was precise correlation in time of VLF hiss (very-low-frequency radio noise) with foldover structures and of magnetic pulsations with on-off switching striations and patches. Rapid brightenings and motions of a poleward expanding front during auroral breakup were coincident with spikelike enhancements of VLF hiss emissions.

The film may be borrowed from World Data Center A for Solar-Terrestrial Physics, NOAA/EDS, Boulder, Colo. 80302.

Fleeting auroral forms. Viewing of sequential film frames is necessary to determine the genesis and classifications of various types of aurora.



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Wheat yield modeling (p. 11).

Coastal zone data needs (p. 3).

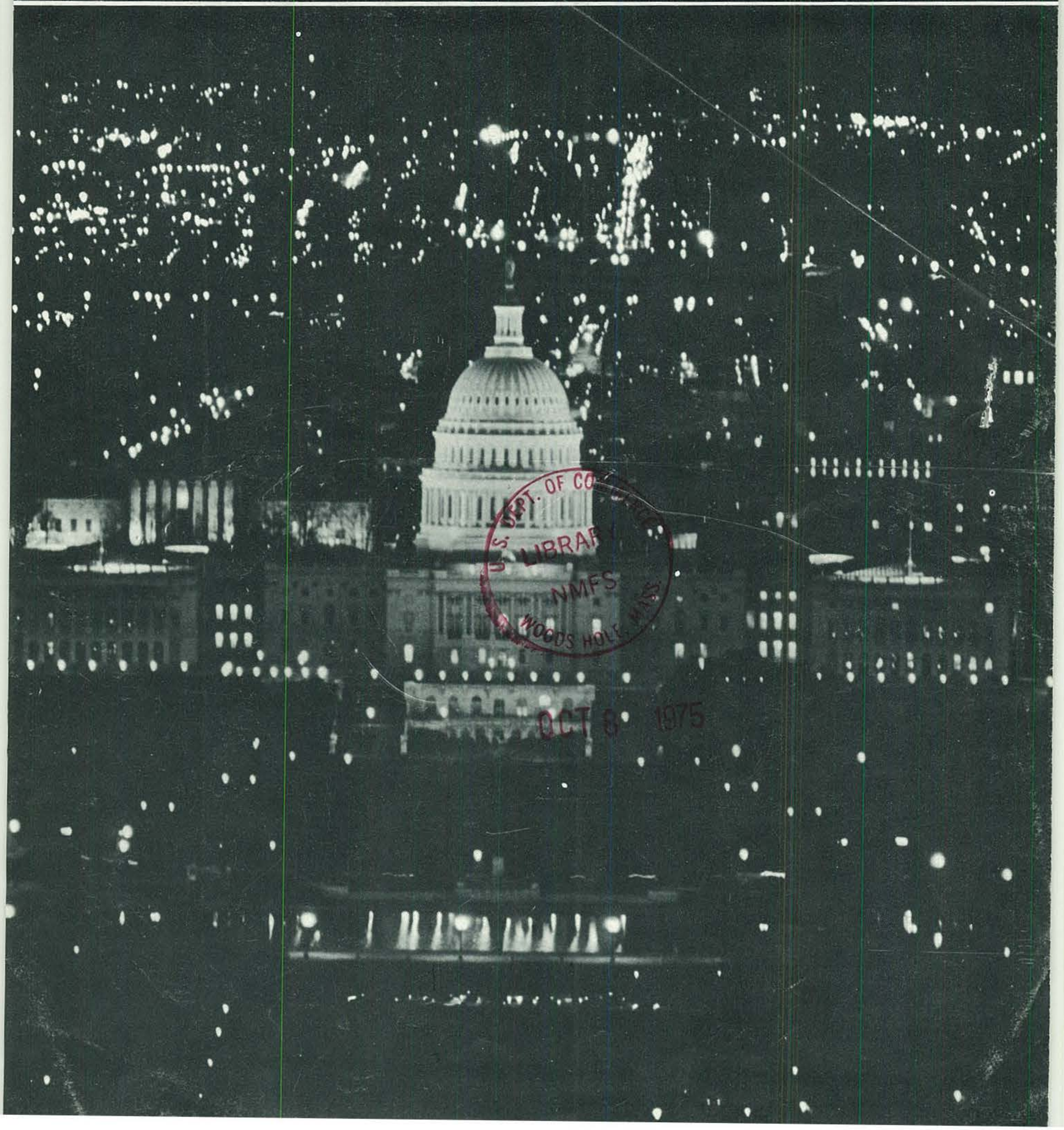
International oceanographic data exchange (p. 20).

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

New aurora film (p. 23).

EDS

Environmental
Data Service
September 1975



September 1975

EDS

Environmental Data Service

***COVER:** The Nation's Capital will be a prime attraction during the Bicentennial. EDS is preparing a series of regional weather guides for travellers who will be touring the country next year. The text and tables of the guide for the Mid-Atlantic region, which includes Washington, D.C., and most of the major battle sites of the Revolution, are reproduced beginning on page 17.*

ENVIRONMENTAL DATA SERVICE is designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, Center for Climatic and Environmental Assessment, and National Oceanic and Atmospheric Satellite Data Unit. In addition, under an agreement with the National Academy of Sciences, the National Oceanic and Atmospheric Administration (NOAA) has responsibility for World Data Center-A activities in oceanography, gravity, tsunami, seismology, geomagnetism, meteorology, and nuclear radiation, ionosphere and airglow, cosmic rays, auroras, and solar observations; the Director of EDS coordinates these activities within NOAA.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 16, 1975; this approval expires June 30, 1978.

NASA used rhesus monkeys and chimpanzees in its research. Here "Ham," one of the chimps, reaches for a reward after a successful 420-mile spaceride in a Mercury capsule.

Comparability and Availability of Marine Environmental Data*

By Robert Ochinero, Director
National Oceanographic Data Center

During the early days of spaceflight research preceding manned flight, it was common to see news pictures of monkeys in space suits. The pictures usually showed a monkey strapped into a space couch with numerous electronic leads coming from sensors implanted in the monkey to record physiological reactions to space travel.

In a sense, the monkey in space is part of an ecosystem being remotely monitored to determine the monkey's response to various stimuli. The project researchers had the tasks of integrating multidisciplinary data, synthesizing and evaluating these data, and ultimately producing reports and conclusions on how the stimuli affected the monkey's well-being.

Marine environmental assessments concerned with major social and economic problems such as energy and food shortages have much in common

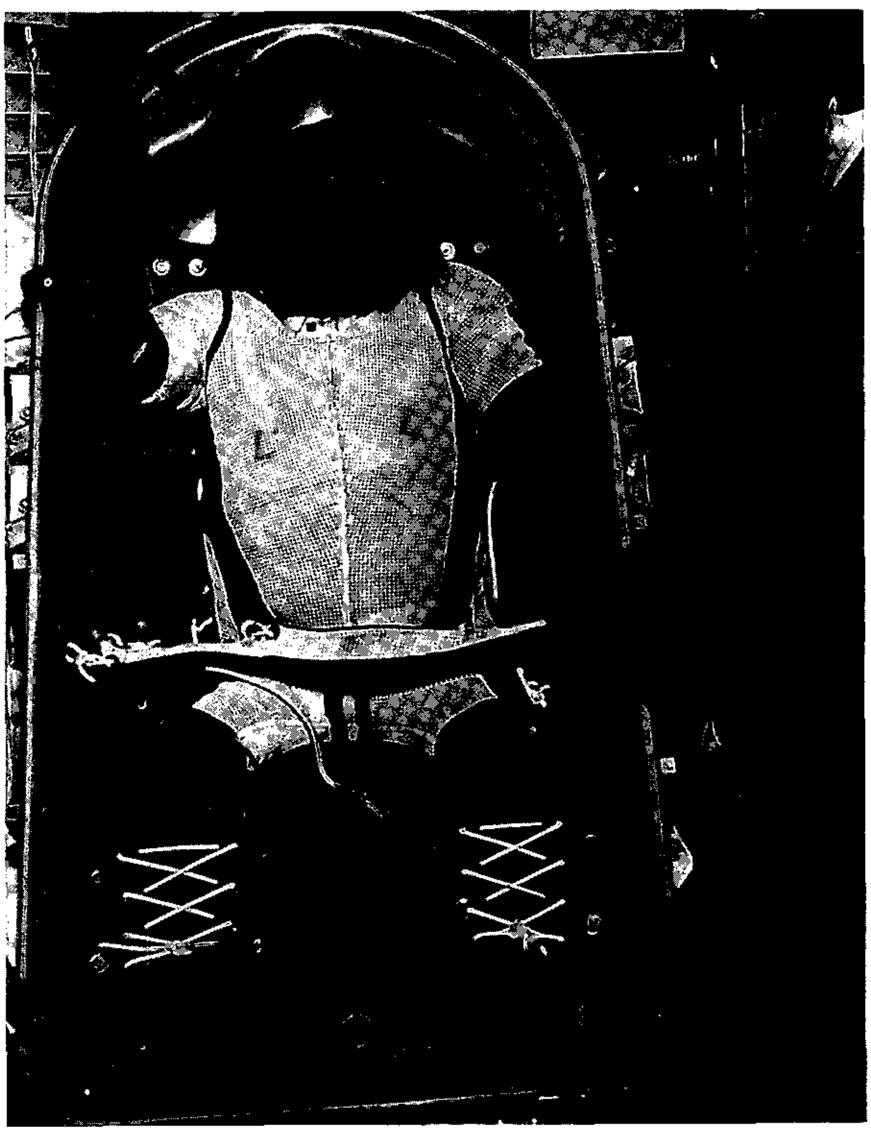
* *Adapted from a presentation made at the Offshore Technology Conference, Houston, Tex., May 8, 1975.*

with space monkeys. The scientists involved, for example, are concerned with ecosystems and their responses to stimuli, both natural and manmade. Monitoring is an important aspect of the task (but remote monitoring is used for convenience rather than by necessity). Also, marine assessments involve the integration of multidisciplinary data for synthesis and evaluation and ultimately the production of reports and conclusions on how a proposed project will affect the ecosystems involved.

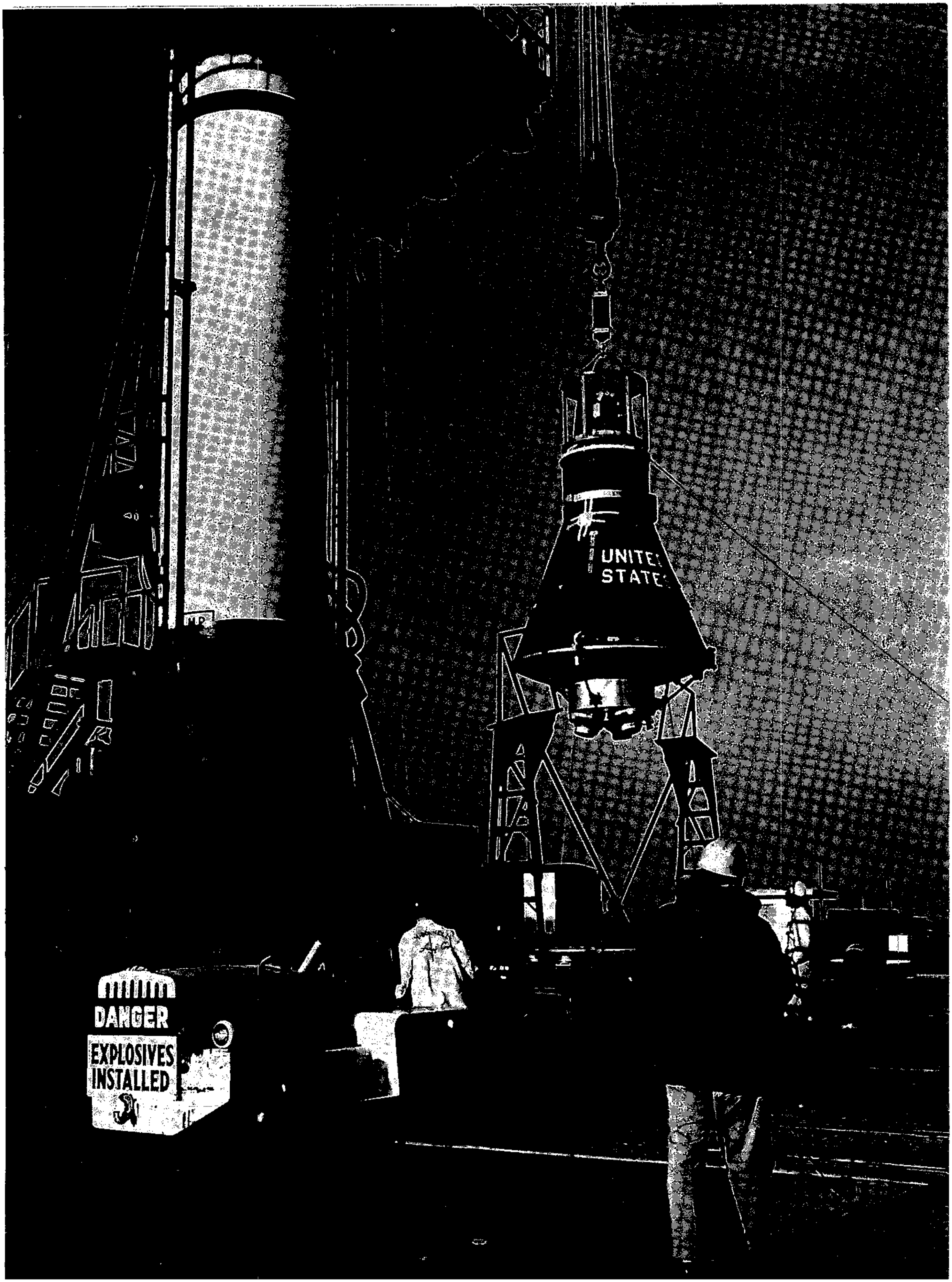
From a data management viewpoint, the monkey is part of a relatively small ecosystem. The number of persons involved in the design of the experiment, the collection of data, and their subsequent analysis also were relatively small. Most importantly, all the data were collected at the time of the experiment. Moreover, "normal" monkey standards are available for such things as blood pressure, respiration rate, reaction times, and a host of other physiological "norms." What is more, if these are not already known or documented, they can be obtained by experiment or observation prior to the launch. Admittedly, there are uncertainties in the role the brain plays in body control and regulation, and reflex actions can complicate the picture, but space monkey research led to an impressive set of baseline or benchmark data against which to compare stimuli responses before, during, and after space flight.

Unfortunately, marine environmental assessment problems are much more complex. The multidisciplinary nature and scope of the problem requires numerous participants to assure that all facets (physical, chemical, biological, geological, etc.) of an ecosystem are covered to the necessary level of detail. Also, although closer at hand than outer space and traversed since the days of early man, the marine environment is by far a more hostile and destructive environment than space. The coastal zone/outer continental shelf region, for example, may be characterized by large fluctuations in tidal action (in both tide height and tidal current strength), rate of sediment transport, riverine and estuarine discharges, beach stability, erosion, productivity, etc. Also, there are very few (if any) marine ecosystems with sufficient site-specific data and information to describe the "normal" environment. Indeed, for most ecosystems there are not sufficient baseline data for a general description, let alone detailed analyses in various disciplines. More importantly, the existing data and information usually come from many and varied sources involving different methods of collection and analysis methods.

Varying techniques of data collection and analysis make it more difficult to integrate and synthesize the data and information into meaningful conclusions and reports. For example, decisions must be made concerning data anomalies. Do the anomalies



A chimp in a spacecouch (left) being readied for flight in a Mercury capsule (right) to test environmental and recovery systems.


UNITED
STATES
DANGER
EXPLOSIVES
INSTALLED

Unlike space, the marine environment is one of changing moods; tranquil beauty can yield to hurricane fury.

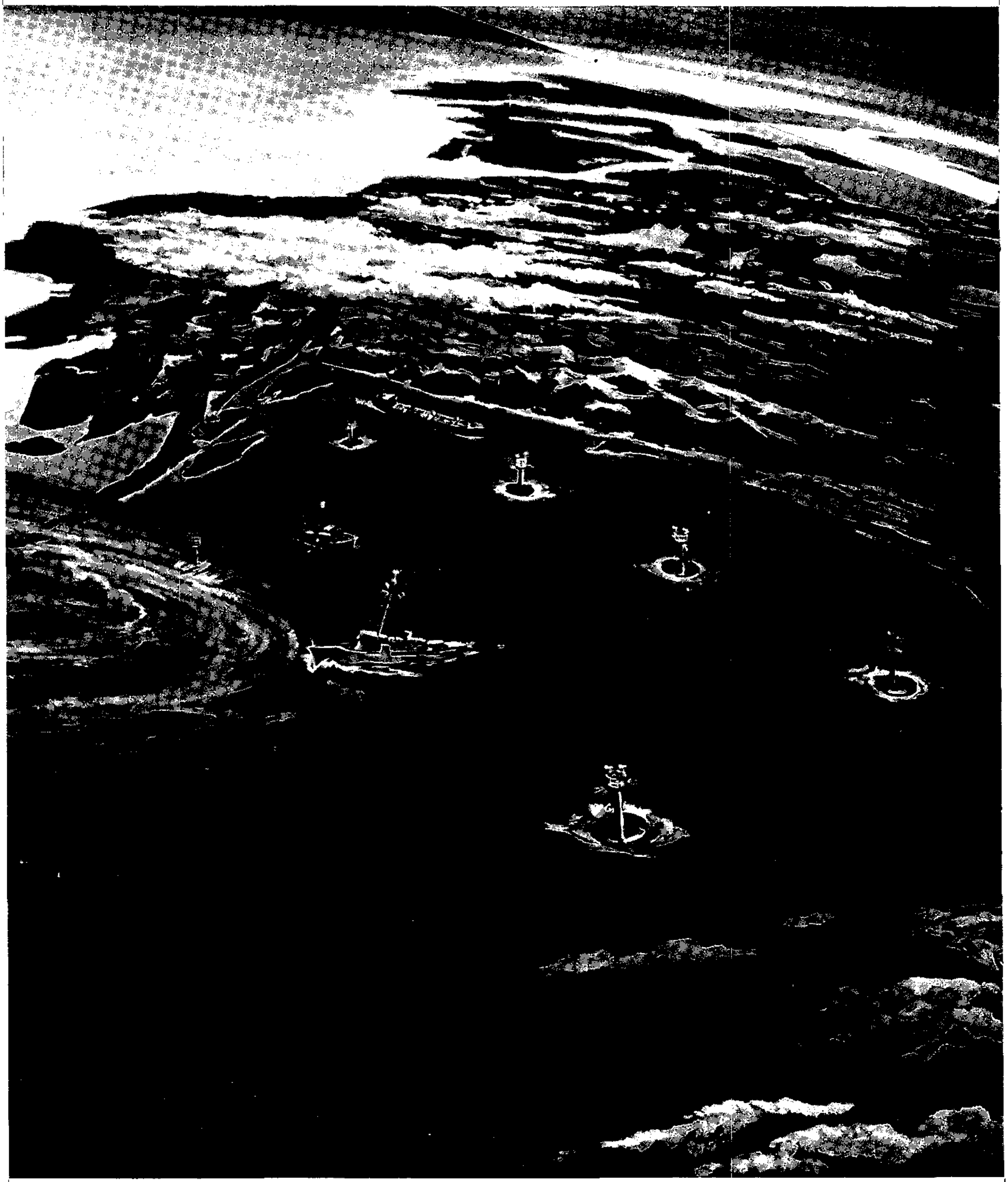
really represent environmental fluctuations, or do they reflect the use of different methodologies (or aberrant sensors)? In other words, how can we be sure that the numeric value 5 from source A means the same thing as the numeric value 5 from source B? This question is true for both historical (baseline or benchmark) and contemporary (or project-generated) data.

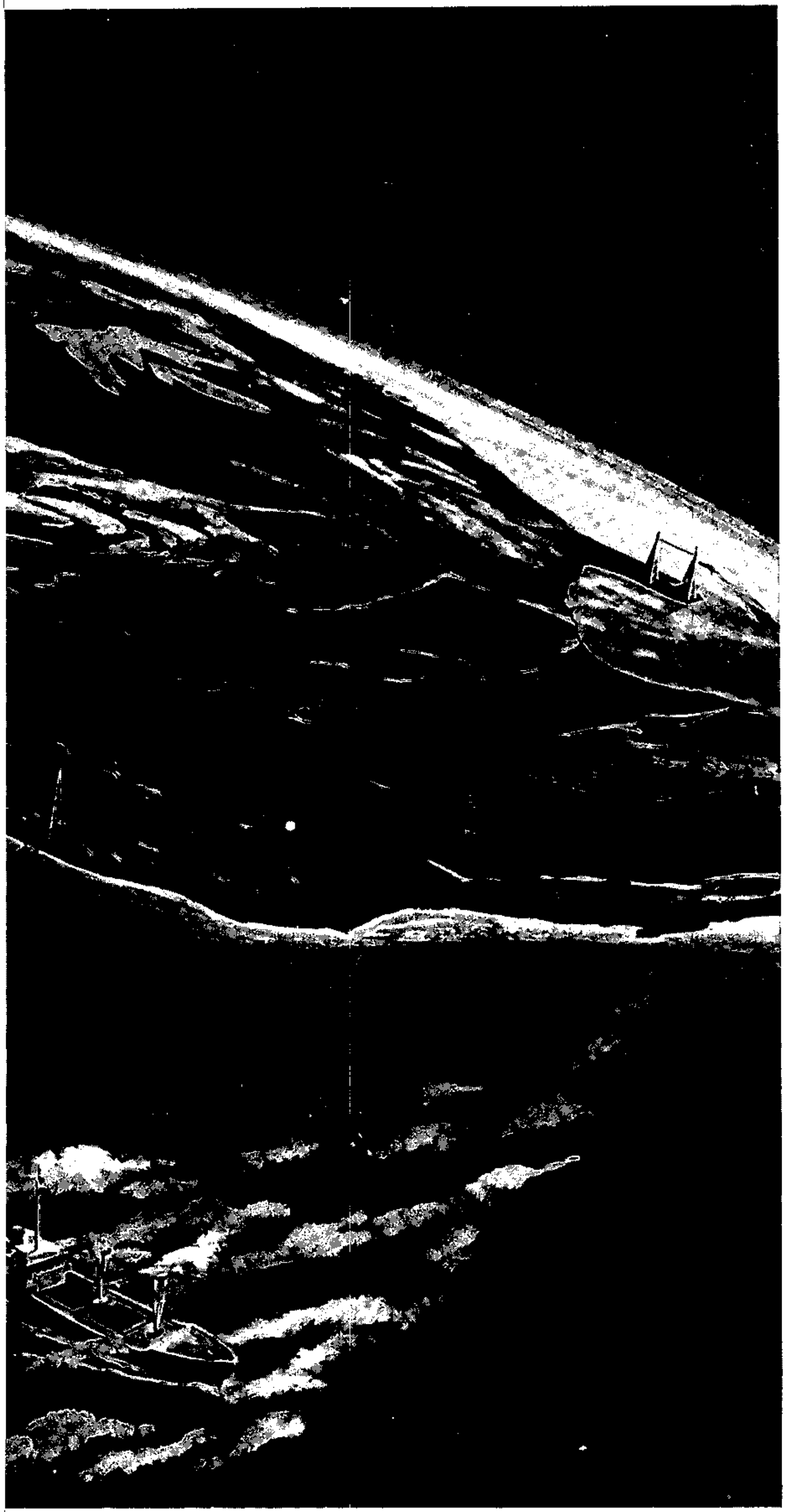
The multidisciplinary nature and scope of marine environmental assessment projects, as well as the large number of data gatherers involved, make it imperative to make every effort to achieve data comparability. How do we do this? The heart of comparability is documentation. Documentation means providing descriptions of (1) data collection methods, including such things as platform type, method of observation, instrument type and model, and method and frequency of calibration; (2) analytical methods, including such things as laboratory techniques, reagents, and standards—such as bovine liver and tuna tissue tests for trace metals; the National Oceanographic Instrumentation Center/National Bureau of Standards methods for measuring dissolved oxygen; (3) assumptions made; and (4) units.

For those who do not already have a standard format for recording this information, EDS has developed a Data Documentation Form (with supplements) that is relatively easy to use.

The obvious question a data collector might ask is, "Why should I bother to complete the form? I know what data I have and how they were collected." The prime reason for complete documentation is that it permits the merging of data of comparable quality from numerous sources. In this way, a comprehensive set of dependable baseline data eventually can be compiled and made available to all future investigators, including contributing collectors.

Interdisciplinary marine environ-





mental data collected by many Federal agencies, private sources, and other nations are made available to the general user community through three Environmental Data Service (EDS) data centers. These are the National Oceanographic Data Center, the National Geophysical and Solar-Terrestrial Data Center, and the National Climatic Center.

The National Oceanographic Data Center (NODC) is the largest repository of unclassified oceanographic data in the world. Global data available include mechanical and expendable bathythermograph data, oceanographic station data for surface and serial depths, continuously recorded salinity-temperature-depth data, surface current information, biological data, and papers on marine biology.

NODC services and products include data processing, data reproduction (in computer printout, punched card, magnetic tape, and other forms), preparation and analyses of statistical summaries, evaluation of data records to meet specific user requirements, library search referral, general marine sciences information, and preparation of publications including data processing manuals, catalogs of holdings, data reports, and atlases. The *User's Guide to NODC's Data Services* is available on request.

The data holdings of the Marine Geology and Geophysics unit of the National Geophysical and Solar-Terrestrial Data Center consist largely of bathymetric, gravimetric, magnetic, and seismic data collected at sea by Federal agencies, universities and research centers, and some foreign organizations. NGSDC also processes and disseminates marine geophysical data obtained from International Decade of Ocean Exploration programs.

A planned NOAA buoy array designed to fill data gaps in a marine area that spawns much of the weather affecting the United States. The buoys will radio atmospheric and oceanic data to Coast Guard stations for relay to the National Weather Service.

NGSDC data are available in reports and publications; on microfilm, punched cards, or magnetic tape; in summaries and tables; and as maps, charts, and graphs. Marine geological records include cores, samples, and heat-flow and sediment data.

The National Climatic Center (NCC) is the largest climatological data center in the world and the custodian of all U.S. historical weather records and of much foreign meteorological data. Most marine observations are collected through the National Weather Service's cooperative ship and Ocean Station Vessel programs and the World Meteorological Organization (WMO) international marine exchange program. A limited number of observations come from lightships, anchored automatic buoys, coastal stations, and lighthouses.

There are about 40,000,000 marine observations on file at NCC. With Navy support, these observations have been placed in a common format (Tape Data File 11), so they may be recalled for synoptic and historical studies.

In addition, NCC provides selected weather maps and charts, derived and summary data tabulations, and data from special collections such as those for the Barbados Oceanographic and Meteorological Experiment (BOMEX), the International Field Year of the Great Lakes (IFYGL), and the Global Atmospheric Research Program (GARP) Atlantic Tropical Experiment (GATE), among others.

Copies of original records or groups of records, magnetic tapes, computer-prepared microfilm analyses or graphics, and manually prepared tabulations and analyses are available to users. NCC data are also summarized in many publications series and atlases.

NCC's Satellite Data Services Branch distributes historical marine satellite imagery and digitized data in magnetic tape form. (The November issue of *EDS* will carry an article describing the operations, products, and services of the satellite unit in detail.)

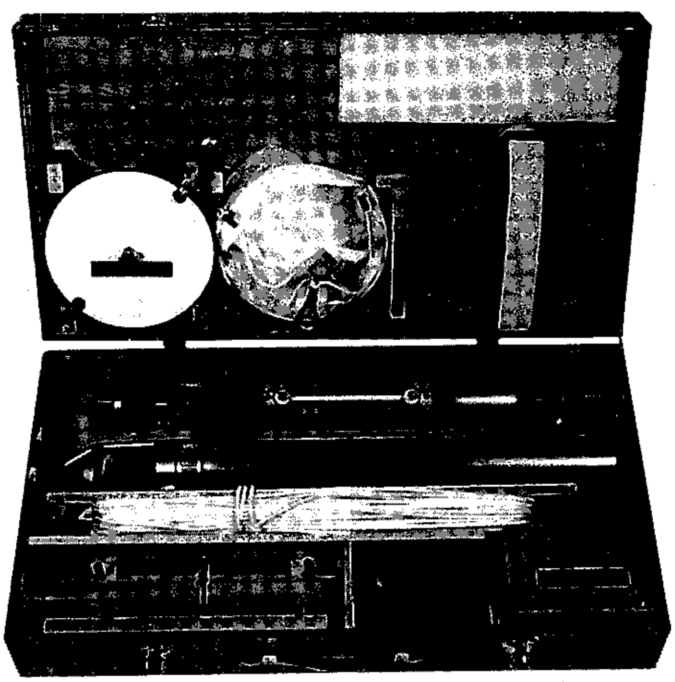
In addition to its other data services, EDS provides referral to marine environmental data not contained in its files. The EDS referral system is called ENDEX (Environmental Data Index). A complementary, literature-based referral service is called OASIS (Oceanic and Atmospheric Scientific Information System).

ENDEX/OASIS provide referral to available environmental data and information files of NOAA, other Federal agencies, State and local governments, universities, research institutes, and private industry. At present, ENDEX references just under 3,500 environmental data files. These pertain largely to the eastern United States and Great Lakes areas. Further file description efforts are underway in Alaska, California, New England, and the Pacific Northwest. On the literature side, OASIS references literally millions of technical articles.

ENDEX contains computer-searchable descriptions of interdisciplinary files of environmental data on many levels. Specifically, ENDEX has three major components:

- Descriptions of data collection efforts.
- Descriptions of data files.
- Detailed inventories of large, commonly used files.

Descriptions of field data collection efforts consist of first- and second-level inventories. The Report of Observations/Samples Collected by Oceanographic Programs (ROSCOP) is the first-level inventory used for marine data. ROSCOP has been approved by the Intergovernmental Oceanographic Commission (IOC) and currently is used by the more than 75 IOC member states. In the United States, ROSCOP replaced the National Marine Data Inventory (NAMDI) that has been used previously. The ROSCOP inventory system is maintained by World Data Center-A, Oceanography, collocated with the National Oceanographic Data Center.



A commercial kit designed for student use in sampling and measuring common marine elements.
Wildlife Supply Co.

Second-level marine inventories provide more precise inventory information on the geographic distribution of data and samples than ROSCOP. Examples of second-level inventories include:

- International Geological/Geophysical Cruise Inventory (IGGCI). Like ROSCOP, IGGCI is IOC-approved, used internationally, and maintained by World Data Center A, Oceanography.
- Results of Marine Biological Investigations (ROMBI). ROMBI's usage is urged by the IOC. In the United States, the system will be maintained by NODC. ROMBI forms will be available for distribution later this year.
- NODC Index of Instrument-measured Subsurface Current Observations (NIMSCO). This inventory currently is used only in the United States and is maintained by NODC.

The second component of ENDEX, comprising descriptions of existing environmental data files, is called the Environmental Data Base Directory (EDBD). EDBD file descriptions list the types of parameters and volumes of data available, the methods used to measure them, when and where the data were collected, the sensors and platforms used, data formats, restrictions on data availability, publications in which the data may be found, whom to contact for further information, and the estimated cost of obtaining the data.

At the present time, the only operational detailed inventory of large, commonly used data files—the third component of ENDEX — is the Parameter Inventory Display System (PIDS) maintained by NODC. The PIDS inventory includes the NODC Mechanical Bathythermograph File, the Expendable and Aircraft Expendable Bathythermograph File, and the Station Data File.

On the literature side, OASIS offers access to major meteorological and oceanic bibliographic files not available in computer-searchable form anywhere else in the United States.

In the final analysis, the comparability and availability of marine environmental data depend on the marine community. Data comparability is related directly to the reliability of the data collection systems and instruments used, their durability, and the degree of repeatability of measurement. Consider, for example, the large number of do-it-yourself marine observation kits currently being marketed. I am concerned not with the number of kits, but rather, with the numbers that these kits will turn out. How comparable will their data be? How are the instruments calibrated, how frequently and by what method? Documentation providing answers to these and other questions must accompany the data if they are to be made available to other potential users.

Members of the oceanographic community are both originators and users of marine data. As originators, only they can provide the documentation which is the key to data availability. As data users, their feedback on the "goodness" of the data, data products, and services received from EDS is an important factor in helping us provide quality data services and products.

Our Nation's current concern with pollution and the related demand for reliable baseline or benchmark data dramatically highlights the value of such comprehensive, multidiscipline data files. Personally, I would like to see just as much effort made to conserve marine environmental data as to conserve the marine environment.

For further information on EDS marine environmental data services write or call:

National Oceanographic Data Center, NOAA
Washington, D.C. 20235
Tel: (202) 632-7500

National Geophysical and Solar-Terrestrial Data Center, NOAA
Boulder, Colo. 80302
Tel: (303) 499-1000, Ext. 6521

National Climatic Center
Asheville, N.C. 28801, NOAA
Tel: (704) 258-2850, Ext. 683

About the Author

ROBERT V. OCHINERO has been Director of the EDS National Oceanographic Data Center since October 1971. He was acting director from October 1970 to October 1971 and Director of the NODC Operations Division from September 1961 to October 1970.

Mr. Ochinero began his Government career in May 1951 with the U.S. Naval Oceanographic Office, where he was head of the Tides and Currents Section, Physical Properties Section, and Physical Properties Division. He was also the Oceanographic Office's Harbor Defense Atlas Coordinator. He attended Hofstra University in Hempstead, N.Y. receiving a BA in Biology and Chemistry and an MA in Biology.

Implicit Climate Forecasts

By James McQuigg

Introduction

This paper concerns an important but relatively unexamined aspect of the dual problem of climate change and climate forecasting, namely: the implicit evaluation of both past and future climate by policy-level decision-makers whose major attention is devoted to economic, technical, or political considerations, and who pay only peripheral attention (or none at all) to the effects of climate.

Consider agriculture. Most of the scientific/technical progress made in agriculture in all of history has occurred in the last two decades. It is quite natural, then, that many projections of future output of modern agricultural systems are based on an extension of yield trends observed through these last two decades.

In some important grain-producing regions, however, crop season weather during much of the last decade or two has been unusually favorable. Thus, a projection into the future of yield trends for this period is an implict forecast of unusually favorable climate.

Examples

(1) Using a weather crop-yield model developed by Thompson[1], and holding "technology" fixed at 1973 levels, scientists at the Center for Climatic and Environmental Assessment (CCEA) have generated a simulated corn-yield series over a 73-year period for the major corn belt States of the United States. Figure 1 shows the empirical frequency distributions of these simulated yields for the periods 1901-55 and 1956-73. Projection into the next decade of the trend line of corn yields based on the 1956-73 sample would result in about a 3 to 4 percent overestimate of yields, if the climate of the future decade should turn out to resemble that of the 1901-55 period, rather than the climate of the unusually favorable period 1956-73.

(2) Using a sample of monthly pre-

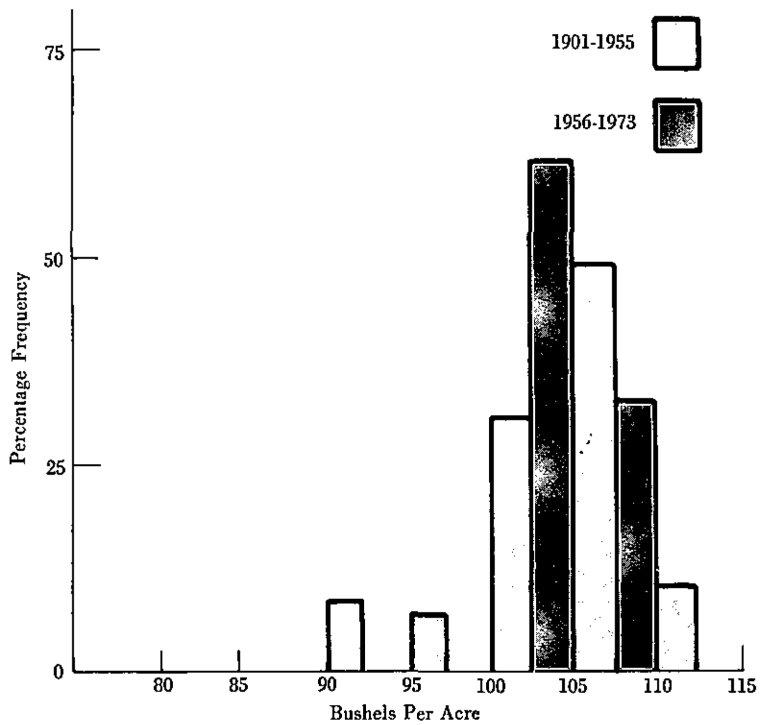


Figure 1. Distribution of simulated corn yields in major U.S. corn belt states (1973 technology).

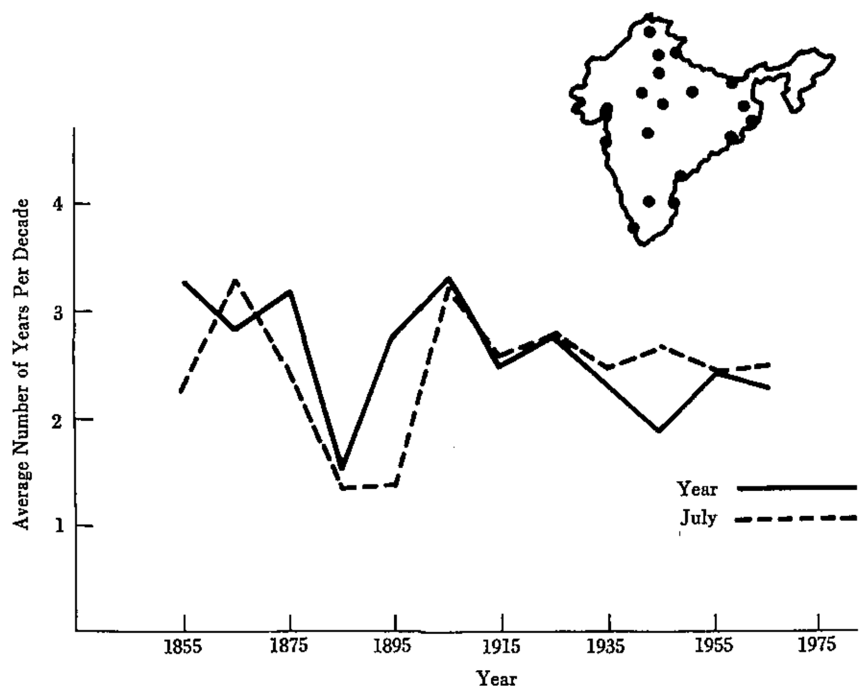


Figure 2. Decadal average values for stations in India for years with precipitation in the "lowest-in-four" category.

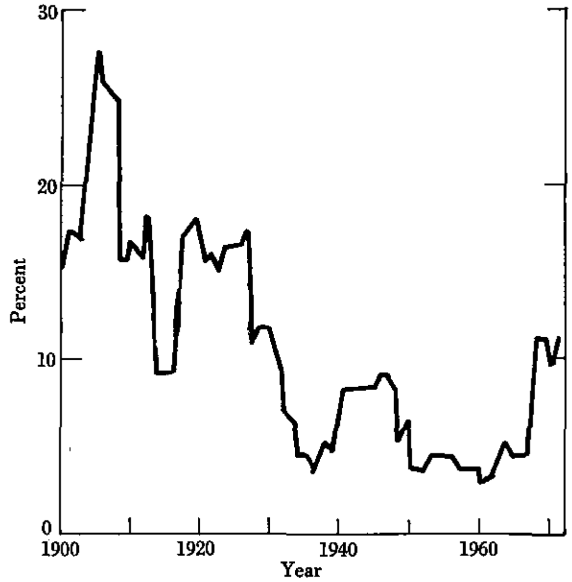


Figure 3. Trends in the percentage of weather stations in northwestern India reporting less than half of normal annual rainfall in a given year. (After Bryson[2].)

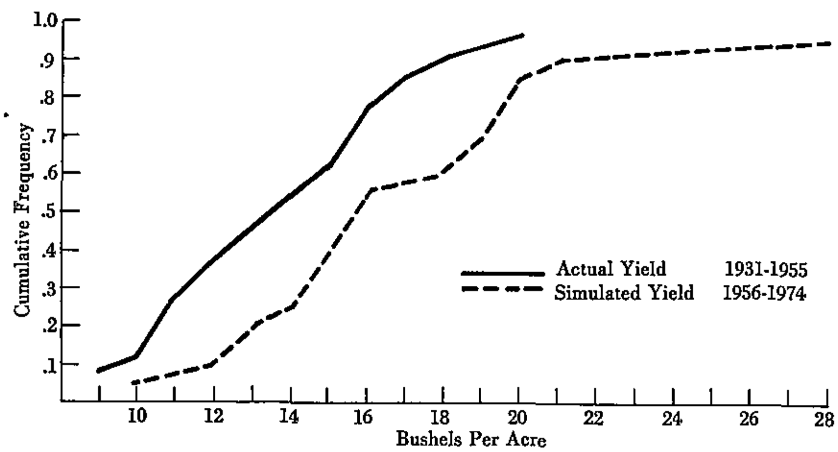


Figure 4. Comparison of Oklahoma wheat season weather.

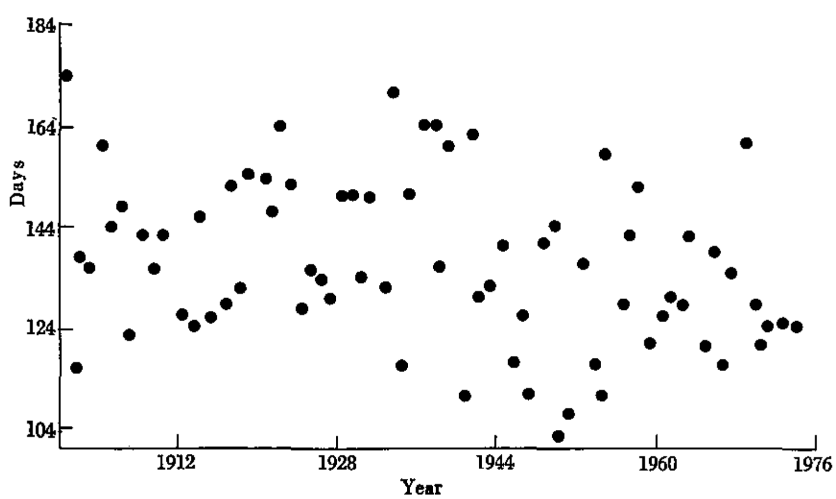


Figure 5. Length of growing season, Broken Bow, Nebraska.

In recent decades global weather patterns generally were favorable for abundant crop production, a climatic anomaly not likely to continue indefinitely.

cipitation data from locations in India for which long-term records were available (stations indicated in the inset map, fig. 2), decadal averages were computed for the number of years that stations reported precipitation equal to or less than a value set at the 25th percentile for each particular station. In other words, these were the driest "1 in 4" years.

The decadal averages shown in figure 2 are for annual total precipitation and for July precipitation (monsoon maximum). The important feature to be noted is the comparatively low incidence of very dry years from the early 1930's through the early 1960's.

An agricultural production system that evolved during that time would have interacted with generally favorable climate. A projection of the results of this interaction into the decade of the 70's would have been an implicit forecast of the climate of the 70's that was overly optimistic. Bryson[2] came to the same conclusion after analyzing long-term precipitation records (fig. 3) in a slightly different manner.

(3) CCEA scientists have developed a weather/wheat-yield model for Oklahoma using sample data only for years prior to 1956 (1931-55). Observed weather data for 1956-73 were then applied to this model, while technology was held at the 1955 level. The simulated results (fig. 4) indicate that the 1956-73 period was one of generally favorable weather. Again, a projection of the simulated sample of wheat yields into the future would be an implicit forecast of a future climate more favorable than the climate of the years from 1931 to 1955.

(4) There have been frequent statements in the press in the last few years concerning changes in the length of the growing season. If one defines the growing season as the period between the last date in spring and the first date in fall with temperatures as cold as 0°Centigrade, and if a sample of growing-season-length data is accumulated from analysis of long-term daily weather data for a sample station in the North Central United States, the plot of the data looks like figure 5. The plot shows the considerable degree of variability in the growing season statistic, and illustrates the need to avoid the implicit climate forecast contained in the assumption that experience with specific seed varieties over a period of 5 to 10 years is directly applicable to the next 5 to 10 years.

Conclusions

Managers and policy-makers will, of course, continue to project non-meteorological system outputs into the future, which means that in some important instances they will be making implicit climate forecasts. While it may be some time before meteorologists develop strong climatic forecasting capabilities, climatologists today do have the capability to detect meteorological bias in an implicit climatic forecast, and to provide highly useful assessments to correct such a bias.

References

1. Thompson, L. M., "Weather and Technology in the Production of Corn in the U.S. Corn Belt," *Agronomy Journal*, 61 (May-June 1969): 453-6.
2. Bryson, Reid A., "The Lessons of Climatic History," unpublished manuscript, Institute of Environmental Studies, U. of Wisc., Madison, August 1974.

About the Author

JAMES D. McQUIGG is Director of the EDS Center for Climatic and Environmental Assessment. The Center was established in late 1974 to model and assess climate, climatic change, and other natural environmental phenomena and to evaluate their probable impact on man's social and economic activities.

Born at Schaller, Iowa, McQuigg attended Cornell College, Mt. Vernon, Iowa, where he received his bachelor's degree in 1941. He earned his master's degree (agricultural economics) at the University of Chicago in 1942, and his doctorate (atmospheric sciences) at the University of Missouri in 1964.

McQuigg joined the U.S. Weather Bureau in 1946, following a 3-year tour of duty as a weather officer with the U.S. Army Air Corps. In 1953, he was appointed State Climatologist for Missouri and a research associate at the University of Missouri. When the State Climatologist program was terminated, he remained at the University as an EDS research meteorologist.

Working with University experts in the fields of engineering, economics, agriculture, human health, and statistical methods, Dr. McQuigg pioneered in computer simulation of the environment to translate climatic data into economically useful parameters. These parameters have been used to produce estimates of the economic effects of weather modification and to define the meteorological component of electrical energy production and distribution problems. Subsequently, McQuigg has been successful in matching comparatively short (a few years) periods of economic, operational, and meteorological data to develop quantified decision models covering much longer periods of time for applications in road construction, electric power distribution, and crop production operations.

McQuigg has made many significant contributions to scientific literature and serves on several national and local advisory committees and panels. He is a consultant to the World Meteorological Organization (WMO) Executive Committee Panel of Experts on Meteorology and Economic and Social Development, and the author of a major portion of the WMO publication, *Applications of Meteorology to Economic Development.* He has also lectured on meteorology and economics in several European countries under North Atlantic Treaty Organization (NATO) sponsorship.

National Report

Weather Guides for Bicentennial Travelers

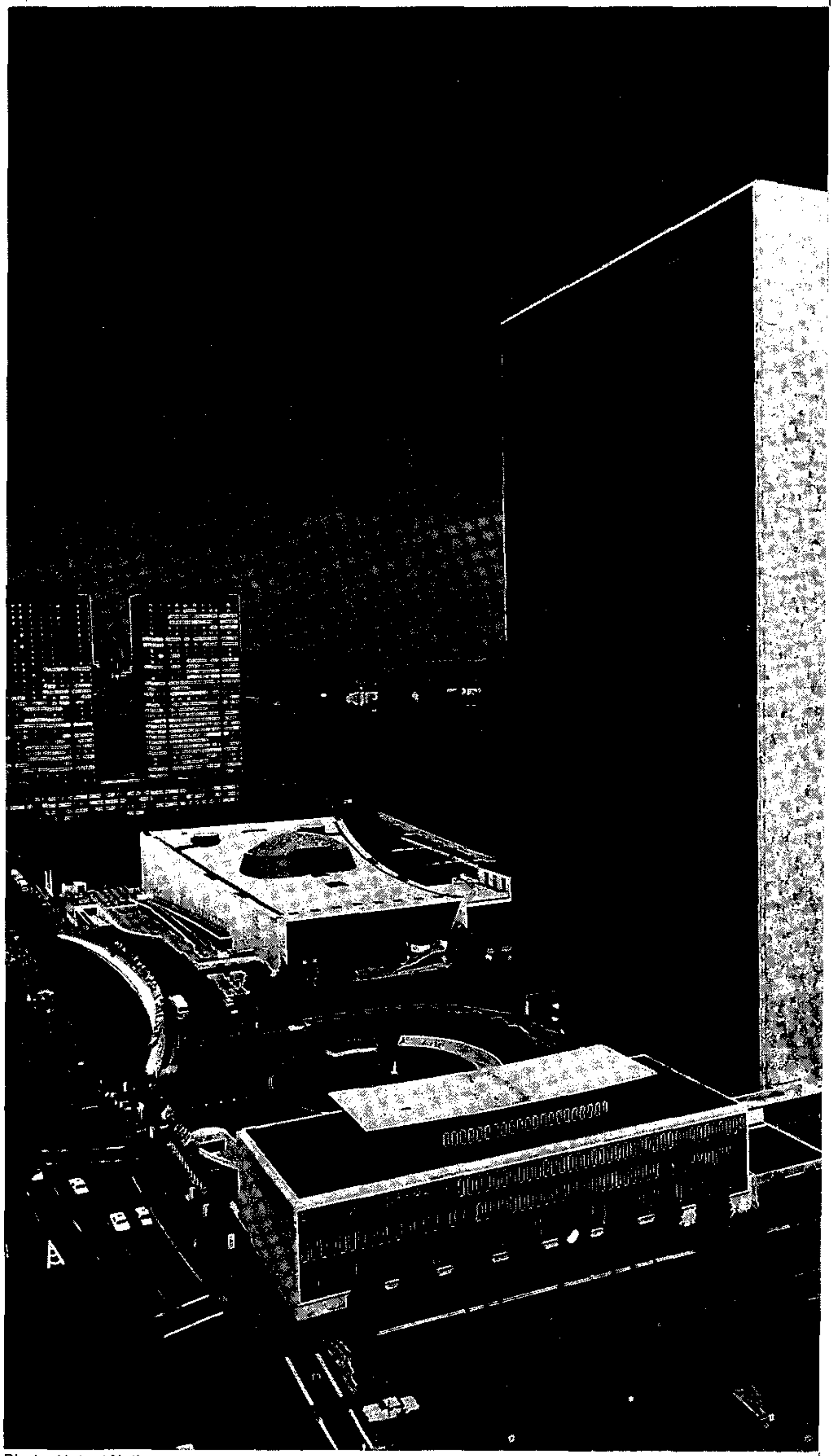
EDS is preparing a set of *Bicentennial Guides to Climates of the United States* for visitors, both foreign and domestic, who will be touring various parts of the country in 1976.

There are individual guides for the South Central, Northeastern, Midwestern, Mid-Atlantic (see below), Southern Mountain, Southeastern, North Central, Rocky Mountain, Northwestern, and Southwestern regions and for the Hawaiian Islands. Each Guide describes the region's climatic character and gives monthly temperature and precipitation data for about six representative cities in the area.

The Bicentennial Guides should be available by the end of the year. An announcement and ordering instructions will appear in a future issue of *EDS*.

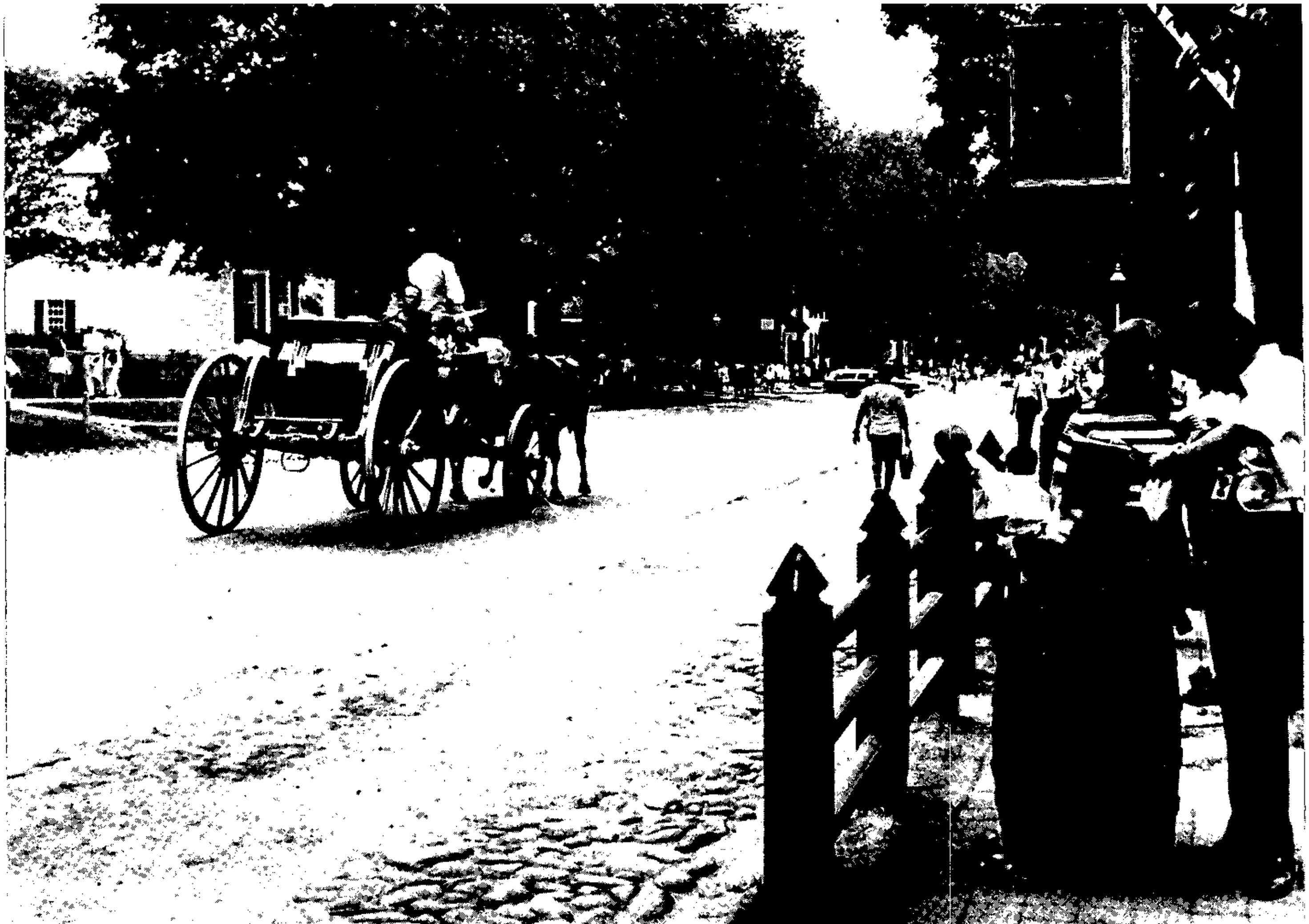
THE CLIMATE OF THE MID-ATLANTIC REGION OF THE UNITED STATES
(Virginia, Delaware, Maryland, Pennsylvania, New Jersey, and New York)

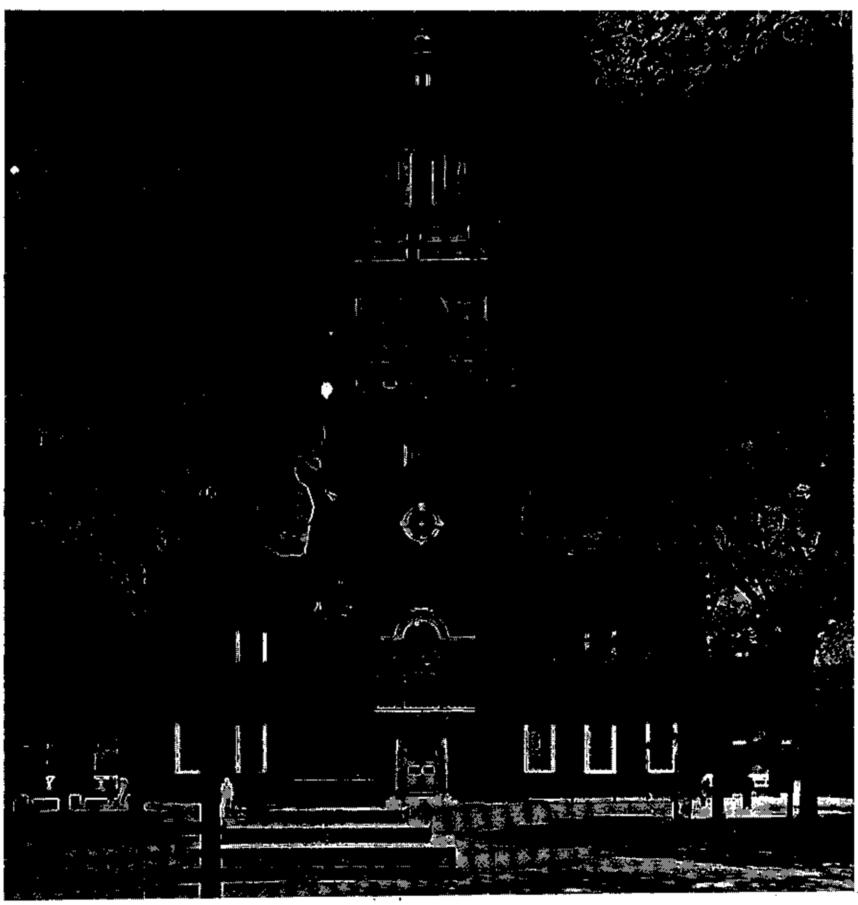
This region, with its huge urban centers and myriad truck and dairy farms, contains within its boundaries six of the Original Thirteen Colonies and almost all the major battle sites of the War for Independence. Stretching westward from the shores of the Atlantic Ocean and the coastal lowlands through the weathered remains



United Nations headquarters in New York City, one of 6 cities for which detailed weather data are summarized in the EDS Bicentennial guide for the Mid-Atlantic region.

Photo: United Nations





Colonial Williamsburg, Va., (above) and Independence Hall, Philadelphia, Pa., will be key attractions for Bicentennial visitors to the Mid-Atlantic region.

of the once mighty Appalachian Mountains to the St. Lawrence Valley and Great Lakes, the mid-Atlantic region offers a relatively mild range in climate. Frequent bracing changes in the weather elements result from the interplay between warm humid air from the Gulf of Mexico and the cool, dry, invigorating air pressing southward from Canada.

Summers over the lower elevations are characterized by warm, humid weather with afternoon showers and an occasional thunderstorm. These sultry conditions are modified along the sandy shorelines and numerous bathing beaches by refreshing daytime onshore breezes. Higher elevations enjoy a dry cool climate ideal for outdoor living.

Spring and fall stand out as perhaps the most pleasant of the seasons. The decided change from chilly winter to benign spring, which normally occurs in late April or early May, is accompanied throughout this region by an exotic, multicolored explosion of flowering plants and trees. Another natural display during the normally cool, dry October consists of a profusion of rich fall colors that are particularly striking in the hardwood forests east of the Appalachian ridge line.

Growing periods vary considerably as one would expect in an area of this size. The average length of the growing season in coastal Virginia is about 200 days, while in upper New York State and in Pennsylvania the growing season is just over 100 days.

Although this region is densely populated and intensely farmed, vast areas are reserved for outdoor recreation. These include the Adirondack and Catskill Forest Preserves in New York State, the Shenandoah National Park in Virginia, and a number of seashore reserves. The cool, dry, refreshing summer weather that prevails over the higher elevations entices the camper, the hiker, and the boating enthusiast.

The many colonial, Revolutionary War, and Civil War sites located in or around the major cities, particularly New York, Philadelphia, and Washington, D.C., can be seen to advantage year-round, while such National parks and monuments as Williamsburg, Yorktown, Gettysburg, and Shiloh are best visited during the spring, summer, and early fall.

In summary, the mid-Atlantic region offers travellers both a panorama of early American history and particularly pleasant spring and fall climates.

Philadelphia, Pennsylvania

Month	Daily Maximum	Daily Minimum	Highest	Lowest	Normal Total Precipitation	Average Snowfall
JAN	40.1	24.4	69	−5	2.81	5.4
FEB	42.2	25.5	69	−4	2.62	6.0
MAR	51.2	32.5	80	9	3.69	3.9
APR	63.5	42.3	92	24	3.29	0.3
MAY	74.1	52.3	96	28	3.35	T
JUN	83.0	61.6	100	44	3.70	0.0
JUL	86.8	66.7	104	51	4.09	0.0
AUG	84.8	64.7	99	45	4.11	0.0
SEP	78.4	57.8	97	35	3.03	0.0
OCT	67.9	46.9	88	25	2.53	T
NOV	55.5	36.9	80	17	3.39	0.7
DEC	43.2	27.2	71	3	3.32	4.4

Buffalo, New York

Month	Daily Maximum	Daily Minimum	Highest	Lowest	Normal Total Precipitation	Average Snowfall
JAN	29.8	17.6	61	−11	2.90	22.0
FEB	31.0	17.7	60	−20	2.55	18.2
MAR	39.0	25.2	78	−4	2.85	12.1
APR	53.3	36.4	83	13	3.15	2.7
MAY	64.3	45.9	88	29	2.97	0.1
JUN	75.1	56.3	94	36	2.23	0.0
JUL	79.5	60.7	94	46	2.93	0.0
AUG	77.6	59.1	93	38	3.53	0.0
SEP	70.8	52.3	90	32	3.25	T
OCT	60.2	42.7	82	20	3.01	0.3
NOV	46.1	33.5	80	9	3.74	12.5
DEC	33.6	22.2	66	−4	3.00	20.3

Pittsburgh, Pennsylvania

Month	Daily Maximum	Daily Minimum	Highest	Lowest	Normal Total Precipitation	Average Snowfall
JAN	35.3	20.8	68	−18	2.79	10.4
FEB	37.3	21.3	66	−9	2.35	11.0
MAR	47.2	29.0	80	−1	3.60	10.1
APR	60.9	39.4	87	15	3.40	1.6
MAY	70.8	48.7	91	26	3.63	0.2
JUN	79.5	57.7	96	34	3.48	0.0
JUL	82.5	61.3	98	42	3.84	0.0
AUG	80.9	59.4	95	40	3.15	0.0
SEP	74.9	52.7	95	31	2.52	0.0
OCT	63.9	42.4	87	16	2.52	0.3
NOV	49.3	33.3	82	8	2.47	4.1
DEC	37.3	23.6	72	−5	2.48	8.5

Washington D.C.

Month	Daily Maximum	Daily Minimum	Highest	Lowest	Normal Total Precipitation	Average Snowfall
JAN	43.5	27.7	71	3	2.62	4.7
FEB	46.0	28.6	77	4	2.45	5.1
MAR	55.0	35.2	86	16	3.33	2.6
APR	67.1	45.7	90	27	2.86	T
MAY	76.6	55.7	97	36	3.68	T
JUN	84.6	64.6	100	47	3.48	0.0
JUL	88.2	69.1	101	56	4.12	0.0
AUG	86.6	67.6	99	51	4.67	0.0
SEP	80.2	61.0	96	39	3.08	0.0
OCT	69.8	49.7	91	29	2.66	T
NOV	57.2	38.8	85	20	2.90	0.7
DEC	45.2	29.5	74	10	3.04	4.2

New York, New York

Month	Daily Maximum	Daily Minimum	Highest	Lowest	Normal Total Precipitation	Average Snowfall
JAN	38.0	24.8	64	0	2.69	6.6
FEB	39.1	25.2	65	−2	3.05	8.2
MAR	46.5	32.1	72	7	3.77	4.5
APR	58.1	41.7	87	26	3.59	0.3
MAY	68.4	51.1	99	34	3.54	T
JUN	78.0	60.9	99	45	2.98	0.0
JUL	83.2	66.9	104	55	4.04	0.0
AUG	81.7	65.4	98	46	4.30	0.0
SEP	75.4	58.6	94	40	3.31	0.0
OCT	65.8	48.7	84	25	2.76	T
NOV	53.7	39.3	73	20	3.90	0.2
DEC	41.3	28.4	68	5	3.60	4.8

Richmond, Virginia

Month	Daily Maximum	Daily Minimum	Highest	Lowest	Normal Total Precipitation	Average Snowfall
JAN	47.4	27.6	80	−12	2.86	5.4
FEB	49.9	28.8	83	−10	3.01	3.5
MAR	58.2	35.5	93	11	3.38	3.1
APR	70.3	45.2	96	26	2.77	0.1
MAY	78.4	54.5	100	31	3.42	0.0
JUN	85.4	62.9	104	40	3.52	0.0
JUL	88.2	67.5	104	51	5.63	0.0
AUG	86.6	65.9	102	46	5.06	0.0
SEP	80.9	59.0	103	37	3.58	0.0
OCT	71.2	47.4	99	21	2.94	T
NOV	60.6	37.3	86	10	3.20	0.5
DEC	49.1	28.8	80	−1	3.22	2.3

Temperatures are in degrees F; precipitation amounts are in inches. Periods of record are variable. Source: *Annual Local Climatological Data*, National Climatic Center, Asheville, N.C. 28801.

NGSDC Units Move to Boulder

Two former field units of EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) recently moved to Boulder, Colo., to consolidate all NGSDC activities in one location.

The Marine Geology and Geophysics Branch, formerly in Washington, D.C., acts as a national clearinghouse for data collected under various programs by U.S. marine institutions and government agencies. The data include bathymetric, magnetic, gravimetric, and seismic observations, and bottom sample information.

The high-precision scientific microfilming facility, formerly located in Asheville, N.C., uses panoramic cameras of special design to copy records of earthquakes. Observatories around the world send some 300,000 seismograms each year to be copied and then cataloged in the national archive in Boulder, which contains almost four million seismograms. The facility annually distributes several million seismogram copies to research scientists. The 115-station Worldwide Standard Seismograph Network and other stations participating in international data exchange through the World Data Center System are principal seismogram sources.

Daily U.S. Cloud Cover Depicted

A U.S. Cloud Cover Depiction package is prepared daily by NOAA's National Environmental Satellite Service (NESS). It consists of a daily 1700 GMT Synchronous Meteorological Satellite (SMS-1) cloud cover photograph, a brief narrative description of the cloud cover and weather over the continental United States, and an 8½ by 11 inch copy of the 1500 GMT surface weather analysis prepared by the National Meteorological Center.

This program began in January 1966, using cloud cover photographs generated from satellite mosaics made from pictures acquired from an Automatic Picture Transmission (APT) satellite. To improve the product, pictures from the geostationary Applications Technology Satellite (ATS) replaced the APT images in May 1971. ATS pictures continued to be used until December 1974, when they in turn were replaced by images obtained from the more sophisticated Synchronous Meteorological Satellite, which has an improved picture resolution made possible by spin-scan radiometers flown on the SMS spacecraft.

NESS provides the cloud cover photograph and narrative description to various U.S. wire services for further dissemination to news media. Copies of the U.S. cloud cover photographs are available at the cost of reproduction from:

Satellite Data Services Branch
National Climatic Center
Room 606, World Weather Building
Washington, D.C. 20233

The daily narrative descriptions and surface weather analysis are not routinely archived by the Satellite Data Services Branch.

NODC XBT Files Expanded

Under an interagency exchange agreement, the Navy's Fleet Numberical Weather Central, Monterey, Calif., recently forwarded to the EDS National Oceanographic Data Center about 125,000 digitized XBT's on magnetic tape. These data increase the NODC XBT archives by 60%; the total is about 300,000 observations worldwide. Some previous NODC voids in global coverage will now be filled, and this should result in better, more accurate data products, such as analysis of thermoclines and mixed-layers and summaries of vertical temperature gradients.

Cooperative Station Data Summaries

The National Climatic Center has begun publishing a series of climatological data summaries for about 1,000 National Weather Service cooperative climatological observing stations. The format is similar to that used in the earlier issues of the publication series, *Climatological Substation Summaries* (Climatography of the United States, No. 20), except that the new summaries will not contain a narrative description of the local climate.

Stations included in the new program were drawn from a group for which 1941-70 normal values were calculated. The summaries are based on digitized data available beginning in 1951 and include: (1) a table of monthly and annual means and extremes of temperature and precipitation; (2) sequential tables of average monthly maximum, minimum, and average temperatures; (3) sequential tables of monthly total precipitation and snowfall; (4) probability statistics for spring and fall freezes and the length of the growing season for five temperature thresholds; (5) probability statistics for monthly total precipitation; and (6) monthly and annual normals for mean temperature, total precipitation, total heating degree days, and total cooling degree days.

Summaries are being produced first for those States with the fewest summaries available. As of June 30, summaries had been published for 200 stations in 10 States (Alabama, Arizona, Connecticut, Colorado, Illinois, Iowa, Kansas, Louisiana, and Mississippi). Projected completion date for the remaining States is June 30, 1979.

Summaries for the 10 states are available from the National Climatic Center, Federal Building, Asheville, N.C. 28801, at $0.15 per station copy.

Climatic Data and Wastewater Management

The National Climatic Center (NCC) recently completed a report for the Environmental Protection Agency (EPA) entitled, *Climatic Data for Use in Design of Soils Treatment Systems.* Now being printed by EPA, the report provides information about climatic influences on water storage requirements, availability of pertinent climatic data, and suggested methods for using climatic data to determine water storage needs. It will be distributed to planners, designers, and operators of wastewater management systems that serve the dual purposes of water treatment (for recycling) and irrigation.

In compiling the report, NCC developed a computer program to analyze basic daily climatic data in a form that can be used to estimate wastewater storage requirements. The program classifies each day in the winter season as "favorable" or "unfavorable" for discharge of water from storage. The climatic threshold criteria (temperature, precipitation, and snow depth) are flexible and can be adjusted to take into account other limiting factors peculiar to the geographic area of the planned wastewater management site.

Ocean Buoy Data Summaries

Monthly marine meteorological data from U.S. ocean buoys are now being published in the Environmental Data Service's bimonthly periodical, *Mariners Weather Log,* beginning with the January 1975 issue. Two months' data are summarized in each issue for each buoy reporting a significant amount of data. The November 1974 issue had a summary of prior data available from various buoys.

The data are collected, processed, and summarized by the EDS National Climatic Center, Asheville, N.C. The published summaries include: buoy identification and location; means and extremes of air temperature, dew-point temperature, sea temperature, and air-sea temperature difference, and pressure, with hour and day of occurrence, number of observations, and number of days with observations; frequencies and means and extremes of wind direction versus speed (knots), including the hour, day, and direction of the maximum wind, plus the total number of observations; and the number of days and observations with precipitation. Percentage frequencies of wave heights and percent of observations with potential superstructure icing conditions are included where appropriate.

The *Mariners Weather Log* is available to persons or agencies with marine interests from: Environmental Data Service, D762, Washington, D.C. 20235. The data may be obtained from the National Climatic Center, Federal Building, Asheville, N.C. 28801.

Wind-Energy Data Assessment Study

The National Climatic Center (NCC) has published the report, *Initial Wind Energy Data Assessment Study.* The publication presents the conclusions and recommendations of the National Science Foundation-sponsored data assessment meeting held at NCC in Asheville, N.C. in July 1974. Topics discussed at the meeting included data availability, vertical and horizontal extrapolation techniques, turbulences and gust effects, and problems involved in the design and siting of wind turbine equipment. The report also includes the results of a survey of applicable data and data summaries that are available at NCC.

Copies of the publication may be obtained from the National Climatic Center, Federal Building, Asheville, NC 28801, or the National Science Foundation, Division of Advanced Technological Applications - RANN, Solar Energy Program, Washington, D.C. 20550.

Antarctic Climatic Data Published

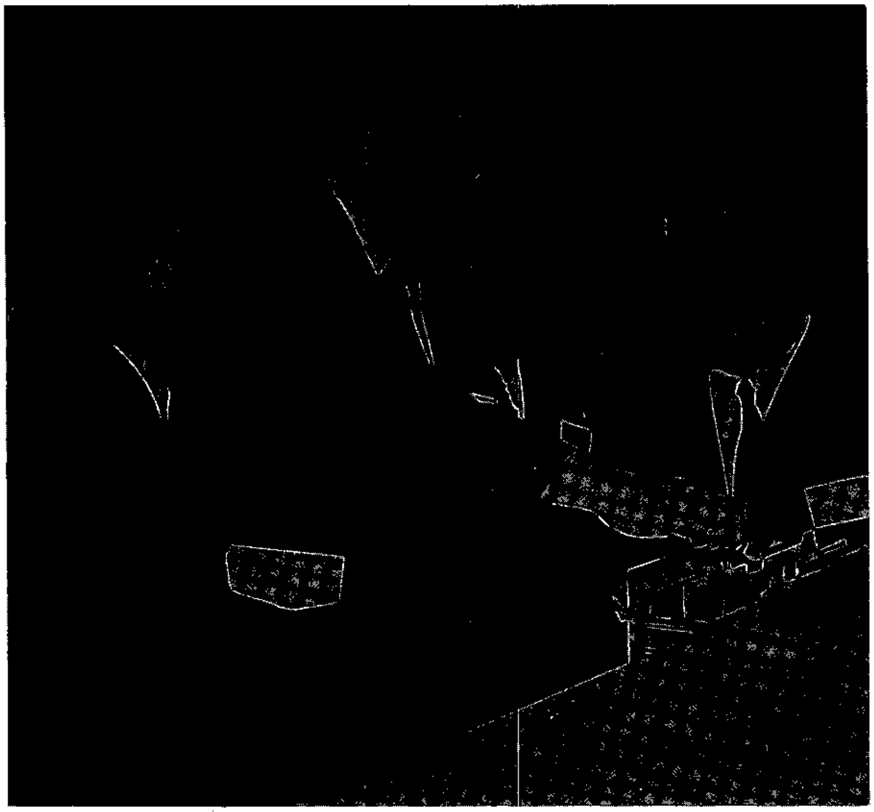
NCC recently published the report, *Climatological Data for Amundsen-Scott, Antarctica,* January 1973 through December 1973. This issue, number 13 in the series, summarizes both surface and upper air meteorological observations. It also contains a chronological listing of the recorded observational data (height, temperature, relative humidity, and wind direction and speed) for each standard level for each upper air observation taken during 1973. Copies of this publication may be obtained from the National Climatic Center, Federal Building, Asheville, NC 28801.

International Report

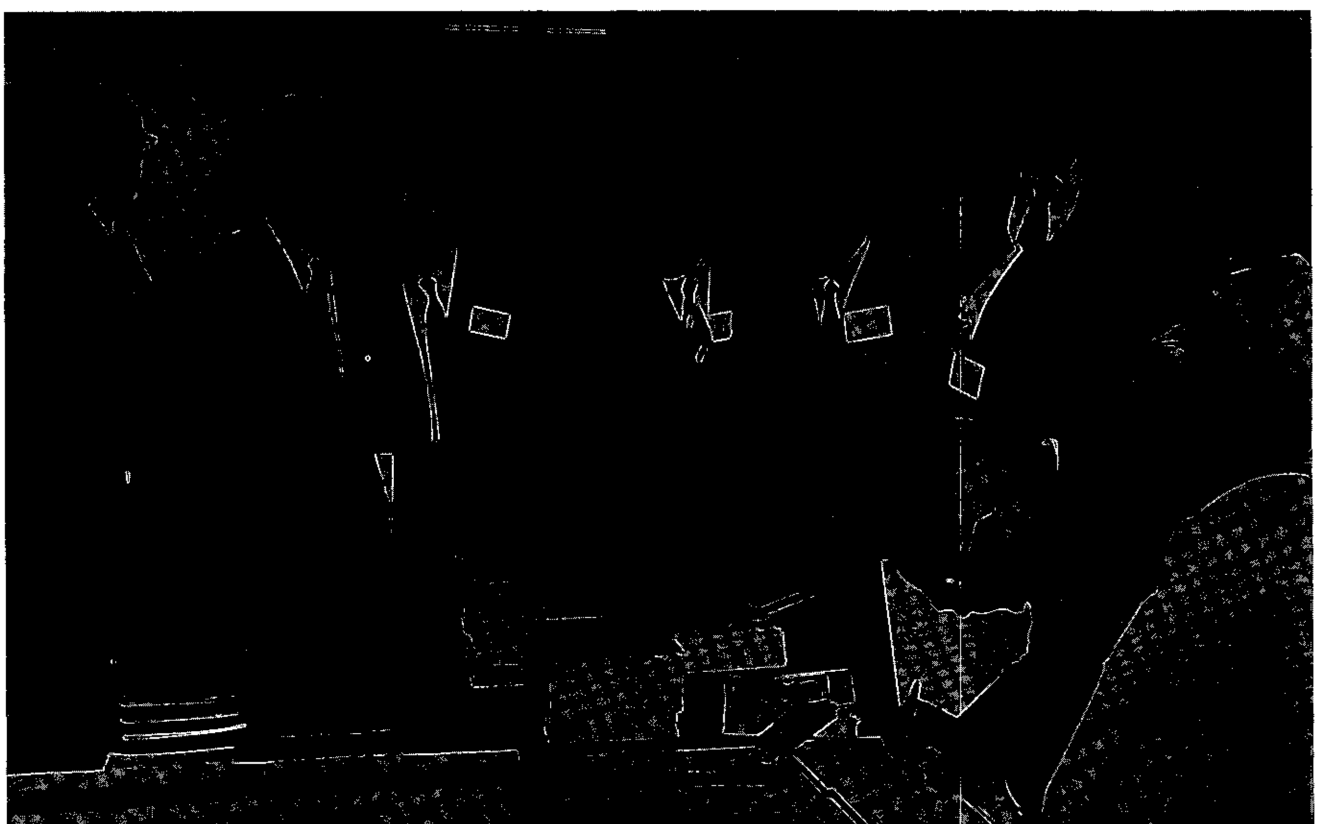
Chinese Seismological Data and Reports

As a result of a visit to the National Geophysical and Solar-Terrestrial Data Center (NGSDC) by a delegation of scientists from the People's Republic of China in May 1974, and a reciprocal visit to scientific institutions in China (PRC) by a U.S. scientific delegation in October 1974, several sets of seismological data have been made available to NGSDC for copying and distribution to the scientific community.

One of the most interesting items is the *Catalog of Chinese Earthquakes* (in two parts), which gives detailed descriptions of strong Chinese earthquakes from 1177 B.C. to 1949 A.D. Very little descriptive material on strong earthquakes centered in China has been available in recent years.



Below: Seismologists from the People's Republic of China sign the guest book during their visit to NGSDC. Above: Jim Lander, Deputy Director of NGSDC, shows Professor Ku Kung-Hsu, head of the delegation, samples of 3 million microfilmed seismograms from the Worldwide Standard Seismograph Network.



The Catalog is now available from NGSDC on microfilm and microfiche. Until a translation can be prepared, the numerical data in the document will be helpful to users even though they may not read Chinese.

Some of the other new data include seismograph station bulletins with earthquake arrival times and epicenters for various years, and seismograms from several different stations for two China earthquakes in 1971. In addition, NGSDC regularly receives the *Monthly Earthquake Observation Report for Peking Stations* and the annual *Chinese Seismological Station Report.* In exchange, NGSDC supplies copies of annual *United States Earthquakes* publications and has provided microfilm copies of seismograms for two important recent earthquakes in China.

NGSDC offers the above materials to the scientific community on microfilm and microfiche at cost of copying. Address inquiries to:
National Geophysical and Solar-
Terrestrial Data Center
EDS/NOAA
Boulder, CO 80302

U.S./Canadian Environmental Information Workshops

On May 28, 29, and 30, the Environmental Data Service sponsored a number of international environmental information workshops with Environment Canada and the Environmental Protection Agency. The meetings were held at the U.S. Department of Commerce Building in Washington, D.C.

Environment Canada, of the Department of the Environment, is NOAA's Canadian counterpart. EPA's personnel participated primarily as observers and to share the results of previous U.S./Canadian workshops.

The objectives of the workshops were to become better acquainted with the persons in each agency responsible for specialized environmental data and information and library resources, and to learn more about the resources themselves, so as to develop guidelines and procedures for more effective cooperation and exchange.

The workshops involved overviews of the primary functions of EDS and Environment Canada, as well as working group sessions in the fields of public information, library and documentation services, and specialized information and data services. The final wrapup conference concluded that the current limited data and information exchange between NOAA and Environment Canada should be better documented and a formal program of selective data and information exchange developed. Definitive guidelines and administrative procedures for data and information exchange will be developed at subsequent meetings.

New Solar-Terrestrial Physics Publications

In April 1975, World Data Center A for Solar-Terrestrial Physics (STP) issued Report UAG-42, *Observations of Jupiter's Sporadic Radio Emission in the Range 7.6-80 MHz, 10 December 1972 through 21 March 1975* ($1.15). This continues a series of similar reports by James W. Warwick, George A. Dulk, and Anthony C. Riddle of the University of Colorado that presented data for 1960 through December 1971.

Catalog of Observation Times of Ground-Based Skylab Coordinated Solar Observing Programs ($3.00), compiled by Helen E. Coffey of WDC-A for STP, was published as Report UAG-43 in May. The catalog was compiled from daily forms supplied by participating observatories, and from program descriptions received from ground-based experimenters. The publication identifies the type and duration of observations, as well as data formats and availability.

UAG-44 *Synoptic Maps of Solar 9.1 cm Microwave Emission from June 1962 to August 1973* ($2.55), by Werner Graf and Ronald Bracewell of Stanford University, was also published in May. The microwave emission was mapped almost daily by the Stanford spectroheliograph. These spectroheliograph records have been reduced to a homogeneous format and are available as numerical printouts, contour diagrams, movies, punched cards, and 9-track magnetic tape. UAG-44, a visual guide to the content of the records, presents monthly synoptic maps formed by assembling meridian data. In addition, the course of developments over the 11-year interval is illustrated by a microwave butterfly diagram and by 12 annual average microwave maps.

Interplanetary Magnetic Field Data 1963-1974, UAG-46 ($2.95), compiled by Joseph King of NASA, was published by WDC-A for STP in June 1975. The report consists of listings and plots of cislunar hourly average IMF parameters for the period November 27, 1963, to May 17, 1974, as well as a discussion of the mutual consistency of the IMF data used. The magnetic tape from which the plots and listings were generated is available from NASA's National Space Science Data Center, Goddard Space Flight Center, Code 601, Greenbelt, MD 20771.

All of the publications described above are available at the cost indicated from the National Climatic Center, Federal Building, Asheville, NC 28801, Attn: Publications.

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Environmental Data Service
Washington, D.C. 20235

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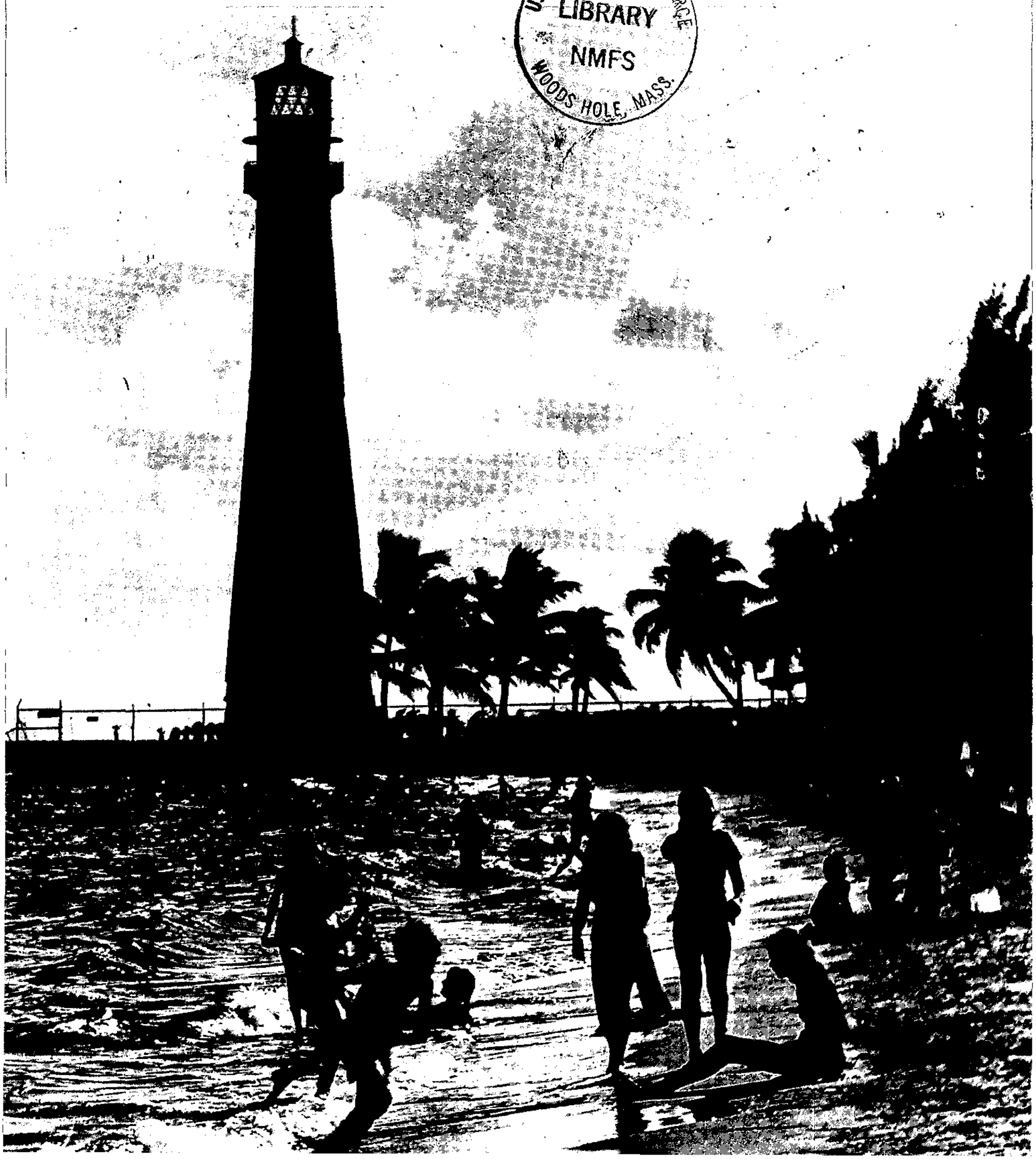
IN THIS ISSUE: Chimps in space (p3), climatic assessment (p12), and Bicentennial weather guides (p17).

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

EDS

Environmental Data Service

November 1975



EDS

Environmental
Data Service
November 1975

COVER: The critical role of data management in national and international efforts to assess, monitor, and preserve for future generations the quality of man's environment is examined in the lead article.

ENVIRONMENTAL DATA SERVICE is designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, Center for Climatic and Environmental Assessment, and National Oceanic and Atmospheric Satellite Data Unit. In addition, under an agreement with the National Academy of Sciences, the National Oceanic and Atmospheric Administration (NOAA) has responsibility for World Data Center-A activities in oceanography, gravity, tsunami, seismology, geomagnetism, meteorology, and nuclear radiation, ionosphere and airglow, cosmic rays, auroras, and solar observations; the Director of EDS coordinates these activities within NOAA.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 16, 1975; this approval expires June 30, 1978.

U.S. DEPARTMENT OF COMMERCE
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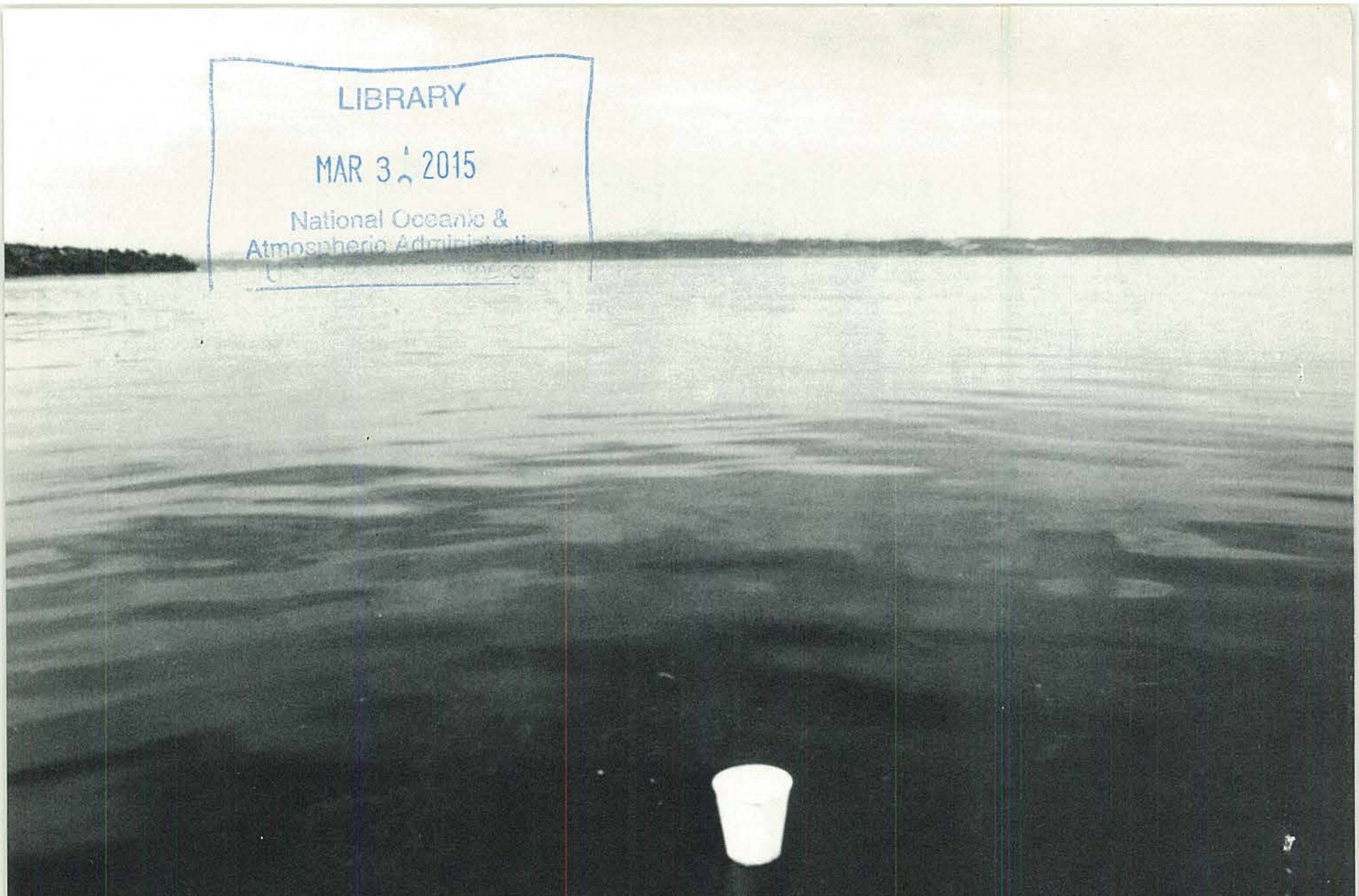


Data Management: Key to Environmental Quality Assessment

By Thomas S. Austin
Director, Environmental Data Service

The following is a condensed version of a paper presented at the International Conference on Environmental Sensing and Assessment, Las Vegas, Nev., September 14-19, 1975.

INTRODUCTION

In recognition of the critical need to know more about the oceans, the 1970's have been dedicated an International Decade of Ocean Exploration (IDOE).

The IDOE is, in part, designed to provide the data base needed to assess and predict man-induced and natural modifications of the marine environment, to identify harmful or irreversible effects of waste disposal at sea, and to study the impact of man's activities on marine life forms.

When IDOE got underway it quickly became obvious not enough historical baseline data were available to formulate a rational research study of marine pollution, one of the major areas of concern and study. Baseline data were needed to establish quantitatively the current levels of pollution and to identify ocean areas of current or potential pollution. The workshop on "Man's Impact on the Global Environment," which met in Williamstown, Mass., in the summer of 1970, concluded that no large-scale monitoring of oceanic pollution or related research program should be started until supplementary baseline data acquisition projects had been completed.

Baseline environmental data provide an essential benchmark record

Photo: EPA-Documerica Doug Wilson

Taking water samples in the New York Bight area as part of NOAA's Marine Ecosystems Analysis (MESA) Program.

against which to calculate the subsequent impact of man upon his natural environment. Accurate assessments require accurate baseline and monitoring data.

Data flow is another critical aspect of environmental assessment efforts. It must be tailored to meet project needs.

In summary, data quality and data flow must be central concerns of an environmental assessment system. The plan, design, and operation of the system must be built on baseline data. These obvious points are often overlooked or underemphasized in environmental assessment activities.

THE DATA CYCLE

The National Science Foundation, which funds the U.S. portion of IDOE, adopted a strong data management policy to ensure that data collected in U.S. IDOE programs would be systematically and adequately documented, cataloged, archived, and disseminated to all users. The NSF Office for IDOE designated NOAA's Environmental Data Service (EDS) as lead agency for data management and final national repository for data resulting from all U.S. IDOE programs.

Environmental data collected by scientists are used to evaluate the present state of the environment, to test the validity of scientific hypotheses and models, and to produce data products such as maps and charts. Environmental conditions defined by the data can be extrapolated in time and space to provide warnings and forecasts of environmental events. Finally, the data are used by other scientists, engineers, program managers, planners, businessmen, and private citizens to solve particular environmental problems.

Users not involved in collecting the data or in their primary application are called "secondary" users. In practice, however, the scientist collecting the data is also a secondary user, in that he uses baseline data collected by other scientists to plan his own collection efforts and to establish criteria against which to calibrate his instruments and compare his observations.

LARGE-SCALE, INTERDISCIPLINARY PROJECTS

The environmental sciences have moved into an era of very large, interdisciplinary projects and programs. The recently completed GARP (Global Atmospheric Research Program) Atlantic Tropical Experiment (GATE) is an excellent example of the trend.

GATE was carried out over a 20-million square mile area of tropical land and sea. It involved some 4,000 scientists, ship and aircraft crews, and technicians from 65 nations. Instruments aboard 40 ships, 65 buoys, 13 research aircraft, and 6 types of satellites recorded phenomena from the top of the atmosphere to nearly 5,000 feet below the surface of the sea. In addition, nearly 1,000 land stations provided surface weather reports, while a network of stations took upper air soundings twice daily. U.S. observation platforms alone produced some 14,000 magnetic tape reels of raw data.

GATE data management planning began more than 2 years before field operations, so the data would be available in their most useful forms to scientists and other users, including designers of larger follow-on-programs such as the First GARP Global Experiment (FGGE), scheduled for 1977-78. (FGGE will involve the majority of the nations of the world in an attempt to gather environmental observations on a global basis to test our theories of climate.)

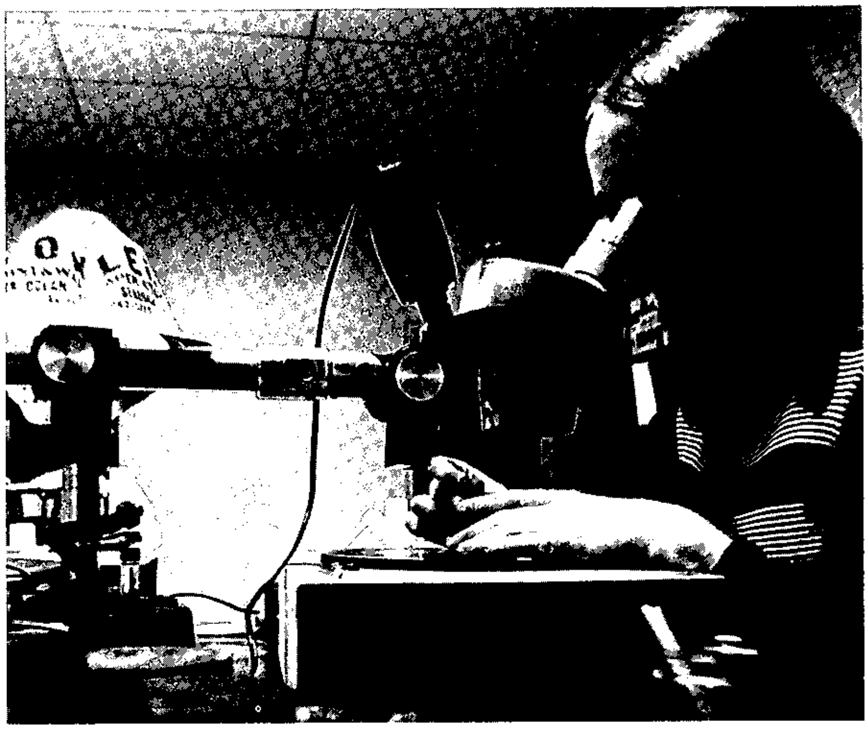
APPLICATION TO ENVIRONMENTAL QUALITY ASSESSMENT

GATE was the latest in a series of large-scale, interdisciplinary environmental efforts. Because of the central data management role EDS scientists played in the Barbados Oceanographic and Meteorological Experiment, the International Field Year for the Great Lakes, and GATE, EDS has gained unique experience and expertise transferable to the design of other large-scale, interdisciplinary field experiments, including environmental assessments.

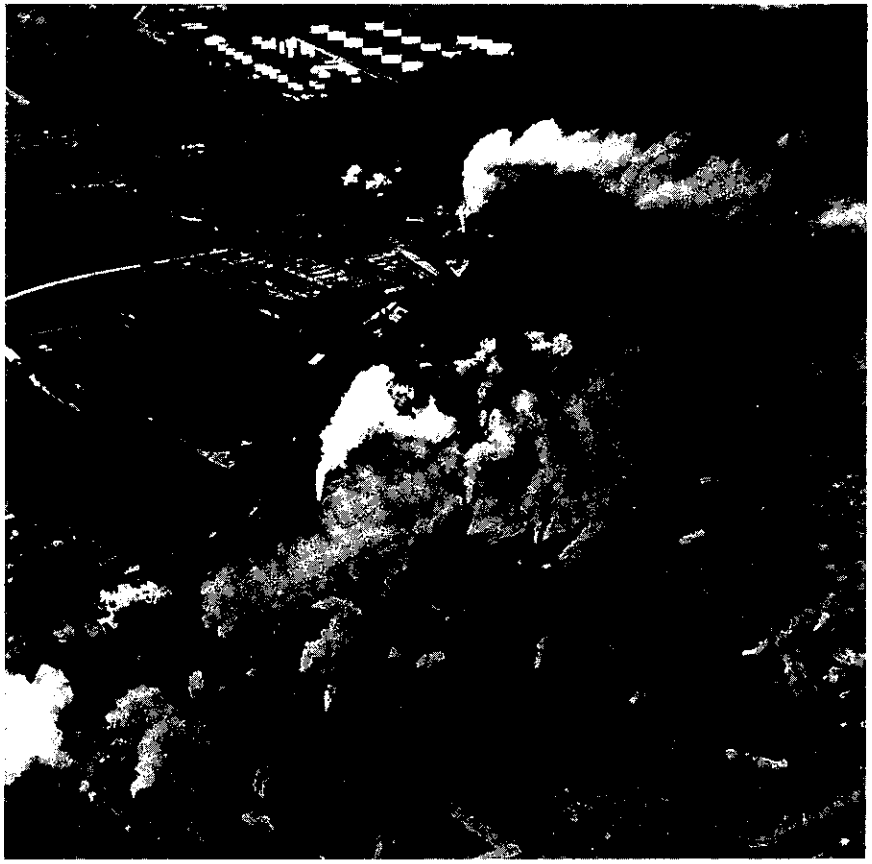
This expertise and experience have been applied to NOAA's Marine Ecosystems Analysis (MESA) New York Bight Project, a study of ocean dumping and of total ecosystem processes. In scope, this is one of the most comprehensive environmental studies of a major coastal area yet undertaken.

A New York Bight Data and Informatiton Management Plan was developed by NOAA's Environmental Research Laboratories in collaboration with EDS and other NOAA components to assure the smooth flow of data and data products from field collection to users. The plan outlines relationships among participants and defines data management standards and responsibilities. It is concerned with adequate data quality control measures, processing procedures, documentation, data flow milestones, and efficient storage and dissemination practices.

Under the plan, the Director of the EDS Center for Experiment Design and Data Analysis (CEDDA) has been designated MESA Data Consultant, and CEDDA is the lead EDS center for data management, planning, and experiment design. Other EDS centers organize, archive, and disseminate environmental data, information, and



Classifying biological samples collected during the MESA New York Bight Project.



Industrial air pollution.

literature derived from the MESA New York Bight Project to other users once project objectives have been met.

To the extent practicable, the New York Bight Data and Information Management Plan is applicable to other MESA projects, including the study of waste disposal practices in Washington State's Puget Sound.

The same data management principles have been incorporated into *The Environmental Quality Monitoring Report,*[1] a proposed NOAA program plan for environmental monitoring on the U.S. Outer Continental Shelf. The report was prepared in light of the rapid development of the Bureau of Land Management's Outer Continental Shelf Environmental Studies Program established to minimize disturbance of the marine environment during development of the OCS oil and gas resources.

Initial phases of the Environmental Studies Program will assemble present knowledge of the environment in OCS leasing areas and establish baseline descriptions. Subsequent special studies and monitoring activities will augment understanding of cause-and-effect relationships and document changes in the environment, whether man-induced, or naturally caused.

The proposed NOAA plan for OCS monitoring stresses the need for a data management system continuing the standards and procedures of baseline data and studies—a total system concept. Data quality assurance is central to the entire concept. The program recommended includes standard sampling protocols, laboratory quality control, standard reference materials, sensor and instrument calibration, and data management standards.

Specifically the data management system must:

- Provide timely feedback to field operations to identify sensor and data-flow problems.
- Provide status information to project management to locate problems affecting project schedules.
- Ensure security of basic and intermediate data forms, including backup copies of all essential data.
- Oversee timely delivery of data products and related documentation to project users and to appropriate national centers for dissemination to secondary users.
- Provide a liaison mechanism for scientific review and feedback to project analysts.

INTERNATIONAL ASSESSMENT EFFORTS

GIPME

The Global Investigation of Pollution of the Marine Environment is an international cooperative program of scientific research sponsored by the Intergovernmental Oceanographic Commission of UNESCO. GIPME is an umbrella concept designed to achieve intergovernmental coordination of marine pollution programs and activities. It considers pollution studies in a regional and global context, since marine pollution is a regional-and global-scale problem.

GIPME's objective is to provide a sound scientific basis for the assess-

ment and regulation of pollution, including sensibly planned and implemented monitoring programs. To encourage an early start and sensible orientation of monitoring activities, high priority has been assigned to the conduct of baseline studies. A fundamental requirement of coordinated baseline studies is intercalibration, which we hope will lead to common standards and practices.

The management and international exchange of data and information generated by baseline and other assessment projects are important concerns of the GIPME Comprehensive Plan. Because of intergovernmental exchange obligations, GIPME should greatly increase access to data and information resulting from marine pollution studies. This should be particularly beneficial to nations now unable to mount their own studies and programs.

GEMS/Earthwatch

The Global Environmental Monitoring System is part of Earthwatch, an assessment program of the United Nations Environment Program (UNEP). The primary purpose of Earthwatch is to assess the impact of pollutants upon the human environment and of the environment upon man. GEMS will provide the basic data sets for the assessments.

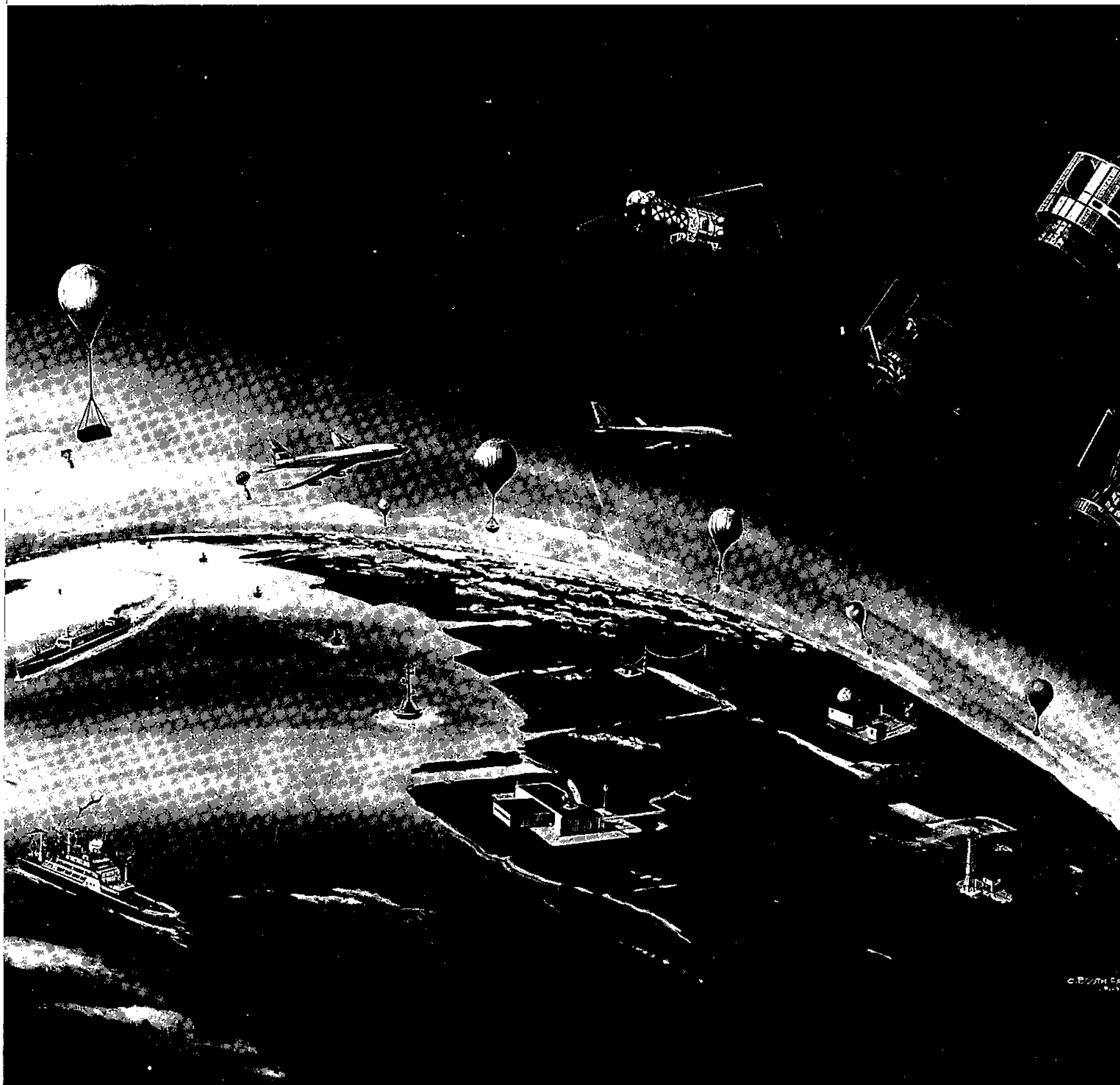
GEMS is a worldwide linkage of national and regional environmental monitoring networks and systems. Like GIPME, it will bring many opportunities for intergovernmental cooperation. As R.E. Munn[2] writes in the Action Plan for Phase 1 of GEMS:

> "Environmental assessment will . . . require reliable data, thus the greatest importance must be placed on quality control and the absolute necessity for intergovernmental agreement on sampling and analytical procedures for monitoring each pollutant and indicator."

Another major concern of GEMS is the proper management of data and information to ensure their current and future availability to all concerned with environmental assessment. This involves the development of referral and exchange mechanisms so that both developed and developing nations can determine what data and information are already available, where they are located, and how to gain access to them. Such systems prevent the unnecessary duplication of expensive data collection efforts.

Representatives of 130 nations attended the United Nations Conference on the Human Environment held in Stockholm, Sweden from June 5 to 16, 1972. The conference was called to attack common threats to the environment such as pollution.

Photo: United Nations



Artists' concept of observation systems proposed for gathering environmental data on a worldwide basis during the Global Atmospheric Research Program experiment scheduled for 1977-78.

INTERNATIONAL REFERRAL AND EXCHANGE

International Referral System (IRS)

IRS was born of a resolution adopted at the United Nations Conference on the Human Environment in Stockholm, June 1972. At the direction of the Governing Council, it is being developed "with special consideration for timely and appropriate access by the developing countries, free of charge . . ."

IRS is essentially a computerized directory of referral sources and is viewed as the first step in facilitating the exchange of information about local, regional, and international environmental activities. It connects users and sources by responding to user queries. The user is given a listing of names and addresses of selected sources of information most likely to satisfy his needs.

In addition to source listings, IRS is able to draw directly upon the United Nations Environment Program (UNEP) library for information gathered by UNEP activities. IRS also stores relevant information from sources which are not themselves prepared or able to provide user service, but will provide information directly to UNEP.

Governments have been asked to solicit details on information holdings and services from their national agencies for input into IRS.

IMAR/MEDI

IMAR is an abbreviated acronym for an IOC Joint Task Team on Interdisciplinary and Interorganizational Data and Information Management And Referral (IMAR).

IMAR was established to improve the exchange of marine pollution data and information. It is composed of representatives from the International Council for the Exploration of the Sea, Intergovernmental Oceanographic Commission, International Hydrographic Organization, Intergovernmental Maritime Consultative Organization, International Atomic Energy Agency, World Health Organization, World Meteorological Organization, and the United Nations Environment Program. A Food and Agriculture Organization representative has observer status.

In mid-1973, the Joint Task Team formulated a two-pronged approach to their task: (1) compilation and publication of an international, multilingual brochure describing the data and information service capabilities of agency-sponsored marine data and information centers, and (2) a detailed, technical referral catalog for each center described. The brochure was published in May 1975 and describes the capabilities of 55 centers around the world. The technical catalog, still under development, will be used by the centers to improve their referral service capabilities and is a major contribution to the development of an effective international Marine Environmental Data and Information (MEDI) referral system.

A subcomponent of IRS, MEDI provides a more detailed description of marine environmental data holdings.

ASFA/ASFIS

On the literature side, as a result of the Stockholm Conference, IOC is working with the Food and Agricultural Organization to expand FAO's existing Aquatic Sciences and Fisheries Abstracts service into a broader marine science referral service. The plan calls for a worldwide information system that would continue to provide marine science abstracts through ASFA, as well as references to conventional and nonconventional literature and sources through ASFA/ASFIS (Aquatic Sciences and Fisheries Information System). The information would be provided in hard copy, microfilm, and magnetic tape forms for both manual and computer use. The ASFA/ASFIS system is expected to become operational during the next year or two.

Satellite Remote Sensing

Rapidly developing satellite technology promises to play an ever more important role in environmental monitoring and assessment. Satellites provide regional and global coverage that would be prohibitively expensive, if not impossible to obtain by any other method. Moreover, since a satellite passes or hovers over the same spot day after day, year after year, comparative data can easily be obtained to develop baseline profiles and for followup monitoring studies.

NASA's NIMBUS G, a polar-orbiting research satellite, is scheduled for launch in 1978. One of its missions will be the detection, identification, mapping, and measurement of worldwide air and ocean pollution. Observations will be used to establish baseline conditions, so that long-term trends can be determined.

Satellite technology adds a new dimension to environmental assessment data management, namely high-data-rate recording. A single Synchronous Meteorological Satellite (geostationary), for example, collects 37 billion data bits per day. This is the equivalent of 200 reels of magnetic tape. Fortunately, computer technology is also advancing, and a system capable of storing the same data on one reel of recording media is already available.

REFERENCES

1. *The Environmental Quality Monitoring Report.* National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D.C. In press.

2. Munn, R.E., "Global Environmental Monitoring System (GEMS) Action Plan for Phase I," *SCOPE Report 3*, The Scientific Committee on Problems of the Environment, International Council for Scientific Unions, Toronto, Canada, 1973, 130 pp.

Early American Weathermen*

By Patrick Hughes

The following is the first of a series of Bicentennial articles based largely on the historical records of the Environmental Data Service.

The American Revolution interrupted John Jeffries' weather journal.

During the winter of 1775-76, General George Washington laid siege to Boston. The British Army evacuated the city in March and Dr. Jeffries, a Loyalist, went with them.

John Jeffries was a Boston physician who recorded two series of notes on that city's weather between 1774 and 1816. He made daily entries from December 15, 1774, through March 4, 1776, then resumed his weather observations upon his return to Boston in 1790. The second series is an intermittent record of daily observations from May 27, 1790, through September 19, 1816, prefaced by a summary of the winter of 1790.

Long before there was a U.S. weather service, and before the first American weather observer network was established by the Army's Medical Department in 1814, citizen scientists and students of nature were recording the climate of our country. These included such giants of American history as Benjamin Franklin, Thomas Jefferson, and George Washington, as well as hundreds of other less famous Americans. Collectively, their records constitute our principal source of information concerning the weather and climate of the United States from colonial days through the War of 1812.

John Jeffries was extraordinary, even in an age of exceptionally gifted men. After the evacuation of Boston, he served as a surgeon with the British Army in America. Then, when Cornwallis surrendered, he left to live in England, where he soon became interested in levitation or aerostation—the brand-new art of operating a manned balloon.

Jeffries flew with the French aeronaut, Francois Blanchard. Together, they made the first scientific measurement of the free air over Lon-

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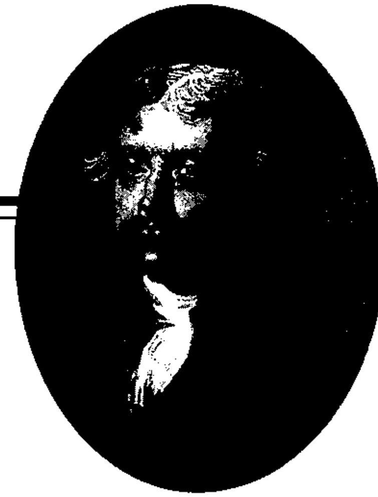
Originally published in ESSA, April 1970

Dr. John Jeffries, physician, weather scientist, and balloonist.

Photo: National Library of Medicine





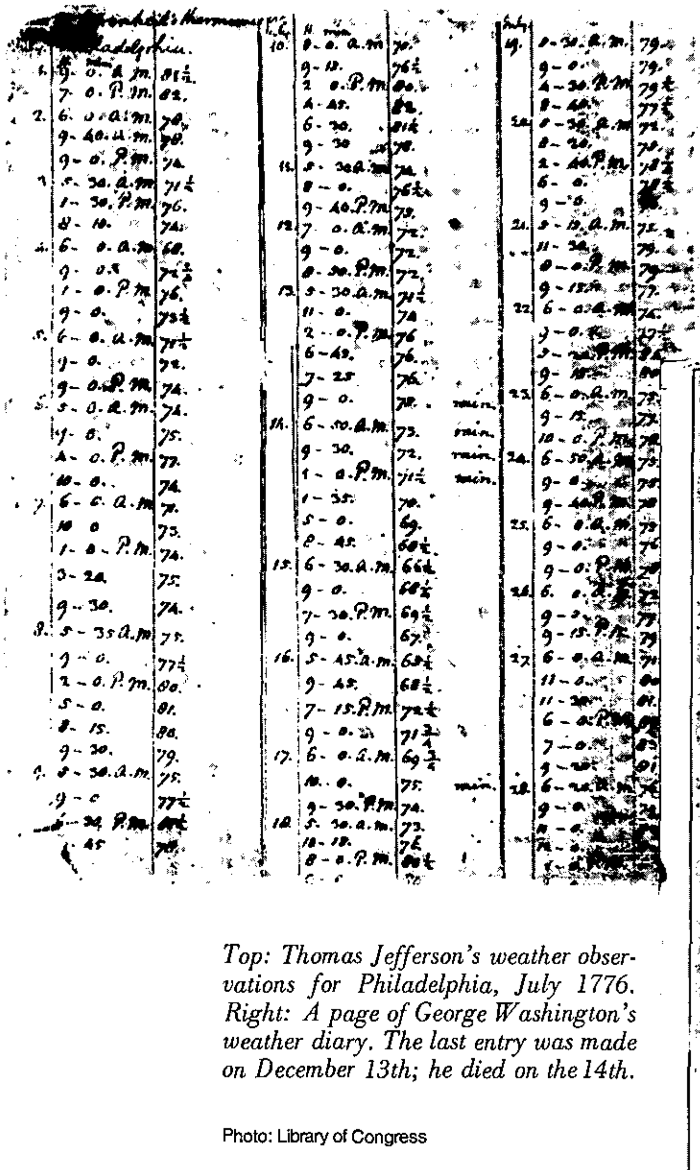
Weathermen Science and The Founding Fathers

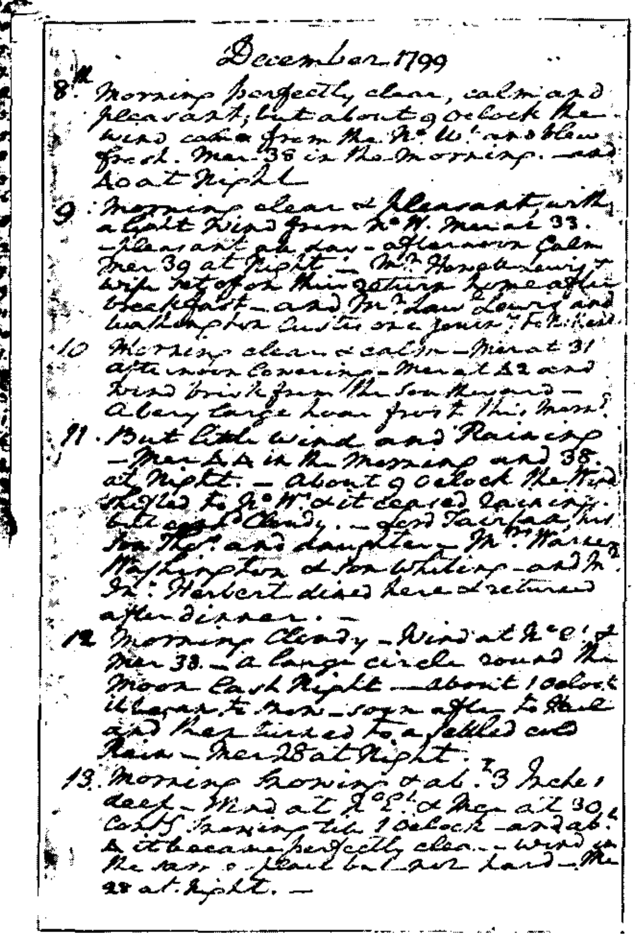
Benjamin Franklin and Thomas Jefferson loom almost as large in the history of American weather science as they do in the history of our country, and the last entry in George Washington's weather diary was made the day before he died.

When a "nor'easter" hit Philadelphia in September 1743, obscuring an expected eclipse of the Moon, Benjamin Franklin learned that the eclipse was seen by his brother in Boston (because the storm reached Boston later than Philadelphia) and rightfully concluded that the storm had moved from the southwest despite the northeast winds. This important concept was years ahead of Franklin's time; it wasn't until a century later that it was generally recognized that storms are approximately circular wind systems that move from place to place.

Thomas Jefferson studied the Nation's climate, collecting weather records from as far west as the Mississippi River. He bought his first thermometer while writing the Declaration of Independence and his first barometer a few days after the document was signed. Jefferson made regular weather observations at Monticello from 1772-78, and for much of the last 2 of these years he and the president of William and Mary College in Williamsburg took the first known simultaneous weather observations in America.

Like George Washington, Jefferson took weather observations well into his final illness. The last entry in his "Weather Memorandum Book" was made on June 29, 1826, six days before his death.





December 1799

8th. Morning perfectly clear, calm and pleasant, but about 9 o'clock the wind came from the No. Wt. and blew fresh. Mer. 38 in the morning and 40 at Night.

9. Morning clear & pleasant, with a light wind from No. Wt. Mer. at 33. Pleasant all day—afternoon calm. Mer. 39 at night. Mr. Howell Lewis & wife set off on their return home after breakfast—and Mr. Lawe. Lewis and Washington Custis on a journey to New Kent.

10. Morning clear & calm—Mer. at 31. Afternoon lowering—Mer. at 42 and wind brisk from the Southward. A very large hoar frost this morng.

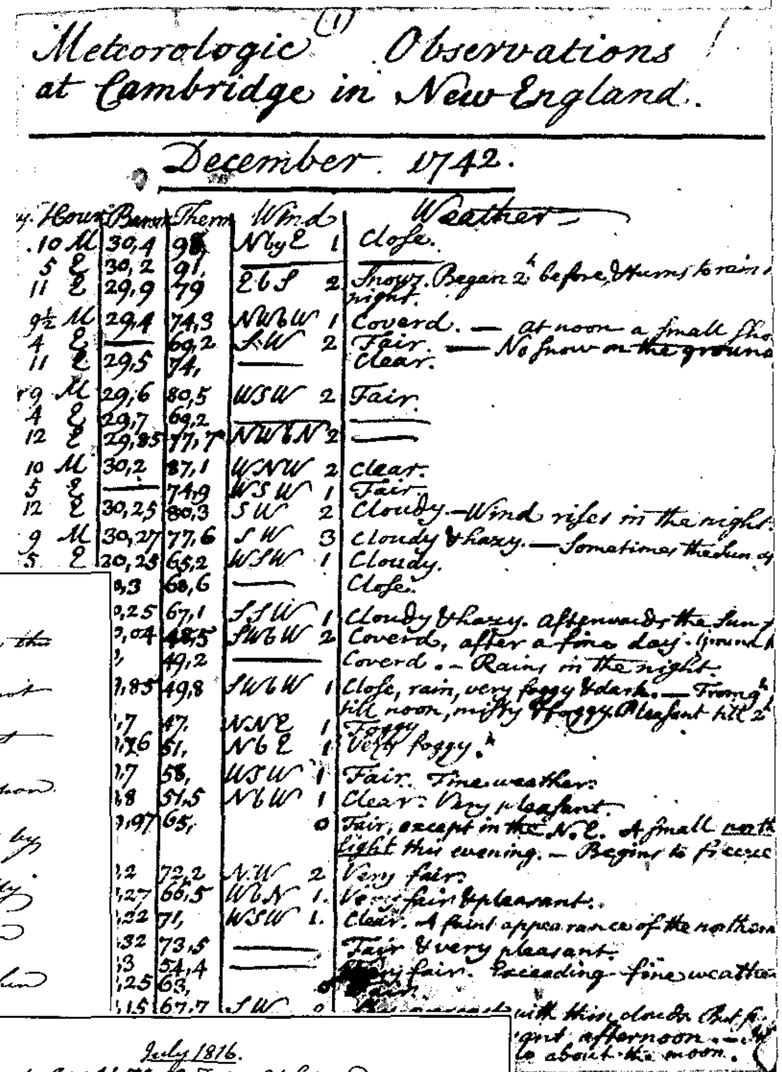
11. But little wind and raining—Mer. 44 in the morning and 38 at night. About 9 o'clock the Wind shifted to No. Wt. & it ceased raining but contd. Cloudy. Lord Fairfax, his Son Thos. and daughter—Mrs. Warner Washington & Son Whiting—and Mr. Jno. Herbert dined here & returned after dinner.

12. Morning Cloudy—Wind at No. Et. & Mer. 33. A large circle round the Moon last Night. About 1 o'clock it began to snow—soon after to Hail and then turned to a settled cold Rain. Mer. 28 at Night.

13. Morning Snowing & abt. 3 Inches deep. Wind at No. Et. & Mer. at 30. Contg. Snowing till 1 o'clock and abt. 4 it became perfectly clear. Wind in the same place but not hard. Mer. 28 at Night.

Top: Thomas Jefferson's weather observations for Philadelphia, July 1776. Right: A page of George Washington's weather diary. The last entry was made on December 13th; he died on the 14th.

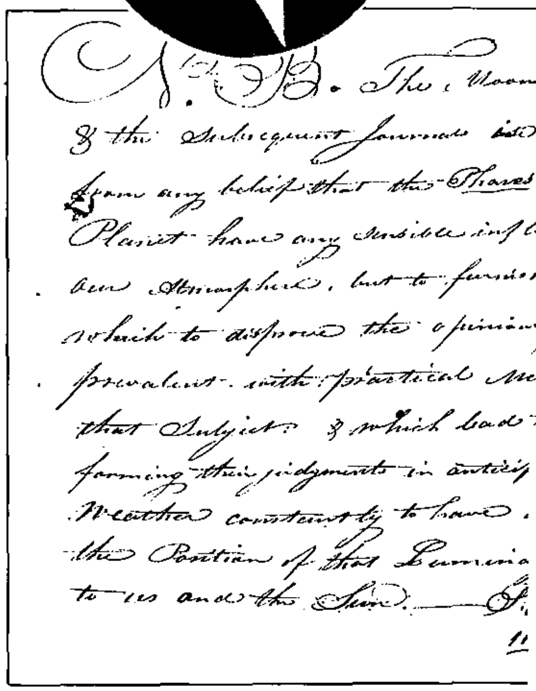
Photo: Library of Congress



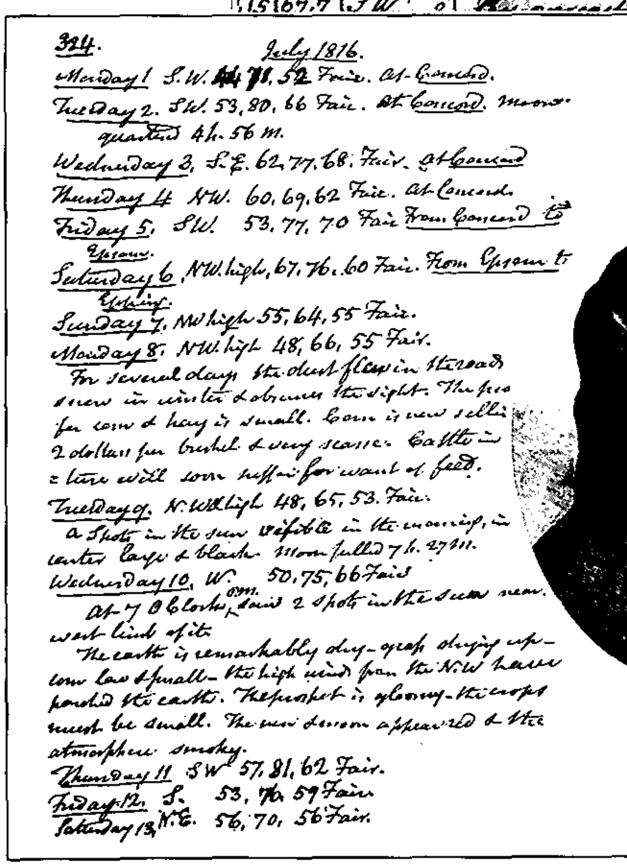
Meteorologic (1) Observations at Cambridge in New-England.

December 1742.

Hour		Baro	Therm	Wind		Weather
10	M	30,4	98	N by E	1	Close.
5	E	30,2	91,			
11	E	29,9	79	E b S	2	Snowy. Began 2h before, & turns to rain in the night.
9½	M	29,4	74,3	NW b W	1	Coverd. — at noon a small sho[wer]
4	E		69,2	S W	2	Fair. — No snow on the ground
11	E	29,5	74,			Clear.
9	M	29,6	80,5	W S W	2	Fair.
4	E	29,7	69,2			
12	E	29,85	77,7	NW b N	2	
10	M	30,2	87,1	W N W	2	Clear.
5	E		74,9	W S W	1	Fair.
12	E	30,25	80,3	S W	2	Cloudy. — Wind rises in the night.
9	M	30,27	77,6	S W	3	Cloudy & hazy. — Sometimes the sun [illegible]
5	E	30,25	65,2	W S W	1	Cloudy.
		[illegible],3	68,6			Close.
		[illegible],25	67,1	S S W	1	Cloudy & hazy. afterwards the Sun [illegible]
		[illegible],04	48,5	S W b W	2	Coverd, after a fine day. [illegible]
			49,2			Coverd. — Rains in the night.
		[illegible],85	49,8	S W b W	1	Close, rain, very foggy & dark. — From [illegible] till noon, misty & foggy. Pleasant till 2h
		[illegible],7	47,	N N E	1	Foggy.
		[illegible],76	51,	N b E	1	Very foggy.
		[illegible],7	58,	W S W	1	Fair. Fine weather.
		[illegible],8	51,5	N b W	1	Clear: Very pleasant.
		[illegible],97	65,		0	Fair, except in the N.E. A small north light this evening. — Begins to freeze
		[illegible],2	72,2	N.W.	2	Very fair.
		[illegible],27	66,5	W b N	1.	Very fair & pleasant.
		[illegible],22	71,	W S W	1.	Clear. A faint appearance of the northern [illegible]
		[illegible],32	73,5			Fair & very pleasant.
		[illegible],3	54,4			Very fair. Exceeding fine weather.
		[illegible],25	63,			Fair.
		[illegible],15	67,7	S W	0	[illegible] with thin clouds [illegible] [illegible] afternoon. [illegible] to about the moon.



N.B. The Moons age in this & the subsequent Journals is noted, not from any belief that the Phases of that Planet have any sensible influence upon our Atmosphere, but to furnish data by which to disprove the opinion generally prevalent with practical Men upon that Subject & which lead them when forming their judgments in antici[illegible] Weather constantly to have [illegible] the Position of that Lumina[illegible] to us and the Sun. — S. [illegible]



324. July 1816.

Monday 1 S.W. 44 71. 52 Fair. At Concord.
Tuesday 2. SW. 53, 80, 66 Fair. At Concord. Moon quarter 4h. 56 m.
Wednesday 3, S.E. 62, 77. 68. Fair. At Concord
Thursday 4 NW. 60, 69, 62 Fair. At Concord.
Friday 5, SW. 53, 77, 70 Fair From Concord to Epsom.
Saturday 6 NW. high, 67, 76. 60 Fair. From Epsom to Epping.
Sunday 7. NW high 55, 64, 55 Fair.
Monday 8. NW. high 48, 66, 55 Fair.
For several days the dust flew in the road [illegible] in winter & obscured the sight. The [illegible] for corn & hay is small. Corn is now selling 2 dollars per bushel & very scarce. Cattle [illegible] will soon suffer for want of feed.
Tuesday 9. N.W. high 48, 65, 53. Fair.
A Spot in the sun visible in the morning, in center large & black. Moon full 7 h. 27 m.
Wednesday 10. W. 50, 75, 66 Fair
At 7 O Clock a.m. saw 2 spots in the sun near west limb of it.
The earth is remarkably dry — grass drying up — corn low & small — the high wind from the N.W. have parched the earth. The prospect is gloomy — the crops must be small. The new [illegible] appeared & the atmosphere smoky.
Thursday 11 SW 57, 81, 62 Fair.
Friday 12. S. 53, 76, 59 Fair
Saturday 13 N.E. 56, 70, 56 Fair.

Upper right: The first page of John Winthrop's weather diary. Above: Samuel Rodman Jr. and a note from his weather journal. Opposite: William Plumer and his notes on Concord, N.H. weather for July 1816.

don on November 30, 1784. The crowd watching included the Prince of Wales and the Duchess of Devonshire, among other notables. The oars (see cover) the men attached to the balloon to steer it must have been as much of an oddity as the flight itself.

On this ascent, the balloonists measured pressure, temperature, humidity, electrical potential, and the chemical constituents of the air to a height of 6,560 feet. The values they obtained agree closely with those of today's observations.

Jeffries and Blanchard also were the first men to make an international voyage by air, crossing the English Channel from Dover to the forest of Guines, France, on January 7, 1785. Celebrated as heroes (a monument was erected in their honor near Calais), they reached Paris on January 11, where Jeffries dined with Benjamin Franklin, the American Ambassador to France and himself a pioneer weather scientist.

Jeffries returned to Boston in 1789, where he gave the first public lecture in New England on anatomy and, in 1790, resumed his weather diary.

John Winthrop was another early American weather observer active during the Revolution. A descendant of the first Governor of Massachusetts, Winthrop was a personal friend and adviser of George Washington and Benjamin Franklin and one of the Colonies' leading scientists and scholars.

In 1738, when only 24, Winthrop was elected professor of mathematics and natural philosophy at Harvard. He was America's first astronomer, as well as a physicist and mathematician. He established the first laboratory of experimental physics in America in 1746, and in 1751 introduced "the elements of fluxions"—now known as differential and integral calculus—into the Harvard curriculum.

Winthrop, a patron of Benjamin Franklin's lightning experiments, was also a student of atmospheric phenomena. He kept a daily record of the weather at Harvard from December 1742 until his death on May 3, 1779, during the fourth year of the Revolution.

In 1959, Harvard University's Blue Hill Observatory donated its collection of original 18th and early 19th century weather diaries and journals to the National Weather Records Center (now the EDS National Climatic Center) in Asheville, N.C. These journals include John Jeffries' observations and come largely from the New England area. One of the more interesting was kept by William Plumer of New Hampshire.

Plumer, a teenager when the Revolution began, was born at Newburyport, Massachusetts, on June 25, 1759, and moved to a farm in Epping, New Hampshire, in 1768. He served in the New Hampshire legislature intermittently between 1785 and 1800, and was Speaker of the House in 1791 and 1797. During this period, he drafted major revisions to the state's constitution, creating the form of government under which New Hampshire still operates.

From 1802 to 1807, Plumer served in the United States Senate, then declined to stand for reelection, preferring instead to return to the New Hampshire legislature. After serving as president of the State Senate in 1810 and 1811, he was elected governor the following year. During the War of 1812, Plumer was the only New England governor who actively supported the national government. A candidate for governor in the three succeeding years, he was defeated by narrow margins in bitter campaigns. When peace came, however, he was reelected and served from 1816 to 1819.

William Plumer recorded daily weather conditions during most of the period 1796 through 1823. His observations were made at his home in Epping, in Washington, D.C., while he was a U.S. Senator, and at Concord, during his years as governor.

Following his retirement from public life, Plumer began a writing career, and is credited with more than 1,900 articles and sketches of American biography. He died in his childhood home in Epping on December 22, 1850 at the age of 91.

Like Plumer, Samuel Rodman, Jr., took weather observations during the War of 1812. A leading merchant and manufacturer of New Bedford, Mass., Rodman was also a member of the Society of Friends, an anti-slavery advocate, and a leader in local charities. He began a daily weather journal in New Bedford in 1812, when he was 20, and continued it until his death in 1876, when his son Thomas took over his meteorological observations.

In 1889 Adolphus W. Greeley, Chief of the Signal Corps' weather service, wrote to Thomas Rodman that for continuity and homogeneity, his father's rainfall record was "the most remarkable record in this country, and perhaps in the world." Later, in thanking Rodman for a copy of an unbroken record of mean temperature kept at New Bedford from 1813 to 1890 by both father and son, Greeley praised it as affording "an opportunity seldom presented for the study of the variations of our climate . . . ."

Today there is growing concern over the impact of these climatic variations on national and world food production. (See "Climatic Variability and the World Food Situation, p3, July 1974 *EDS*.) As indicated by Mr. Greeley, the scientific evaluation of such fluctuations depends upon the period of reliable record; the longer the record, the more meaningful the measurement of variations. In this regard, the weather journals of private citizens dating to the colonial period add significantly to our knowledge of the climate of our country in earlier days.

The original Rodman, Jeffries, and Plumer records are archived at the Environmental Data Service's National Climatic Center. A microfilm copy of the Winthrop record was provided by the Harvard University Library. Altogether, there are approximately 300 18th and early 19th century weather journals and diaries on file at the Center; most are the original manuscripts, the rest, microfilm copies.

EDS Satellite Data Services

By Lawrence Berry

The Satellite Data Services Branch (SDSB) of the EDS National Climatic Center provides environmental and earth resources satellite data to other users once the original collection purposes (i.e., weather forecasting) have been satisfied. The branch also provides photographs collected during NASA's SKYLAB missions.

SDSB is collocated with the operations center of NOAA's National Environmental Satellite Service (NESS). NESS manages the national operational environmental satellite program. Collocation expedites SDSB acquisition of environmental satellite data. It also allows SDSB personnel to monitor the latest applications of satellite data, to note outstanding environmental events which may interest subsequent users, and to ensure that original imagery negatives and magnetic data tapes reach the branch in good condition and as economically as possible.

Data Holdings

(1) ENVIRONMENTAL DATA. SDSB files contain data from the early TIROS (Television InfraRed Observational Satellite) series of experimental spacecraft flown in the '60's; much of the imagery gathered by spacecraft of the NASA experimental NIMBUS series; full-earth disc photographs from NASA's Applications Technology Satellites (ATS) I and III, geostationary research spacecraft; tens of thousands of images from the original ESSA and Current NOAA series of Improved TIROS Operational Satellites; and both full-disc and sectorized images from the Synchonous Meteorological Satellites (SMS) 1 and 2, the current operational geostationary spacecraft. In addition to visible light imagery, infrared data are available from the NIMBUS, NOAA, and SMS satellites.

Each day, SDSB receives about 239 negatives from the polar-orbiting NOAA spacecraft, more than 235 SMS-1 and 2 negatives, and several special negatives and movie film loops.

Data from many of the satellites also are available in digital form on magnetic tape. Copies of the tapes are used by investigators who need quantitative data that have suffered little or no degradation. Since each photographic step tends to degrade data, the tapes represent an important source of quality information readily adaptable for use in computer programs.

(2) EARTH RESOURCES DATA. Multispectral imagery derived from data collected by NASA's Earth Resources Technology Satellites (ERTS), currently LANDSAT-1 and 2, are also part of the branch's holdings. The 1/3-mile resolution imagery from these experimental, polar-orbiting satellites are in great demand by investigators throughout the worldwide scientific community and constitute one of the branch's most active holdings.

(3) SKYLAB PHOTOGRAPHS. Branch files also include the excellent photographs (both color and black-and-white) taken during the three SKYLAB missions (May-June, 1973, July-September, 1973, and November 1973-February 1974). The pictures provide authentic colors and excellent resolution and are being requested more frequently as their availability becomes more widely known.

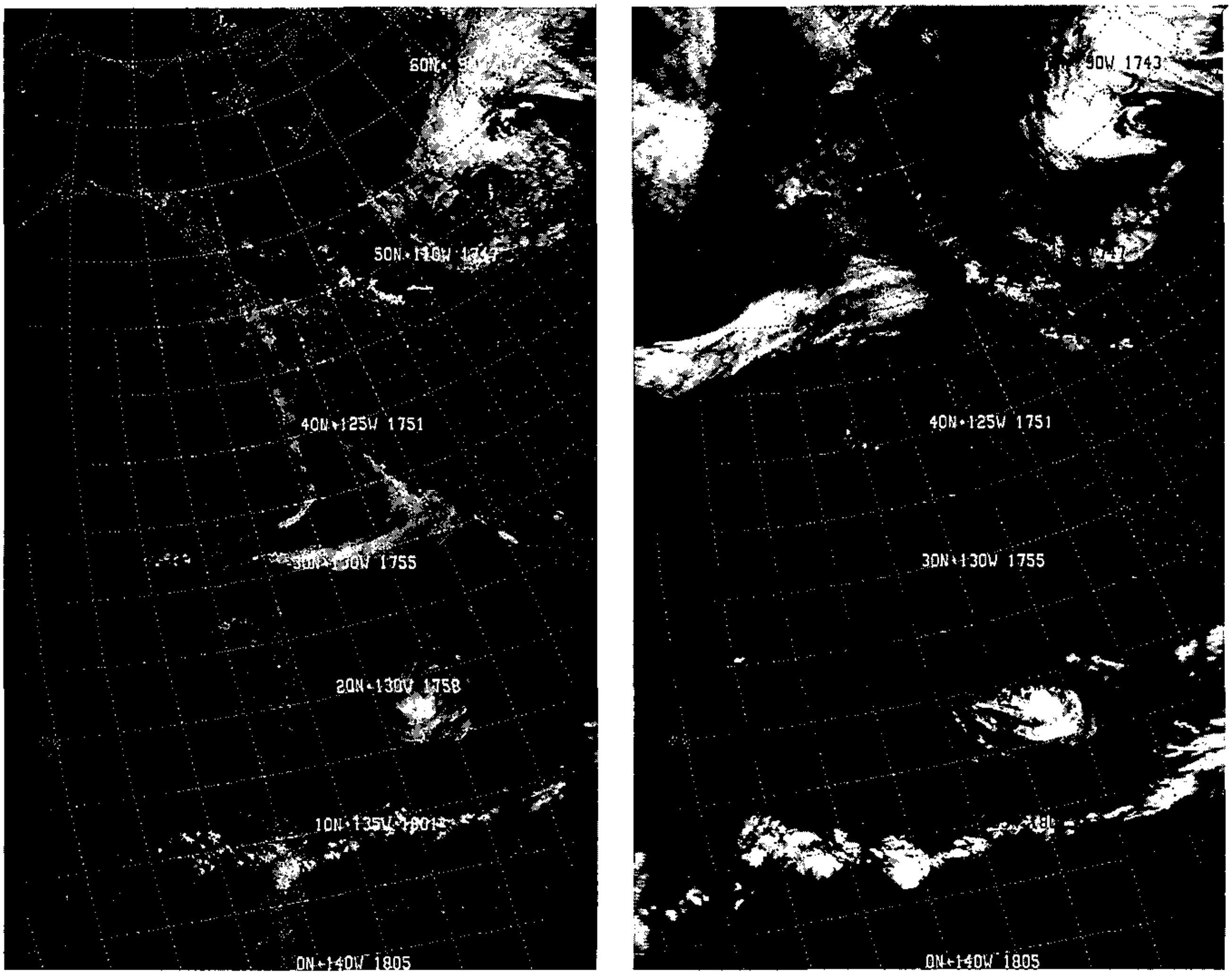
Data Users

Satellite Data Services Branch users come from all walks of life. Scientists place orders for data with significant retrospective (climatological) application potential in the areas of meteorology, coastal management, oceanography, deep-water port planning and management, hydrology, and agriculture. Lawyers preparing weather-related court cases seek satellite data to bolster or substantiate other evidence; authors, editors, and publishers use the satellite imagery to illustrate publications; numerous Government agencies require satellite documentation of current conditions of atmospheric, land, and water areas on a national and international scale; the general public order satellite views of their hometown or State; and students and educational institutions at all levels seek satellite data and information for classroom and research use.

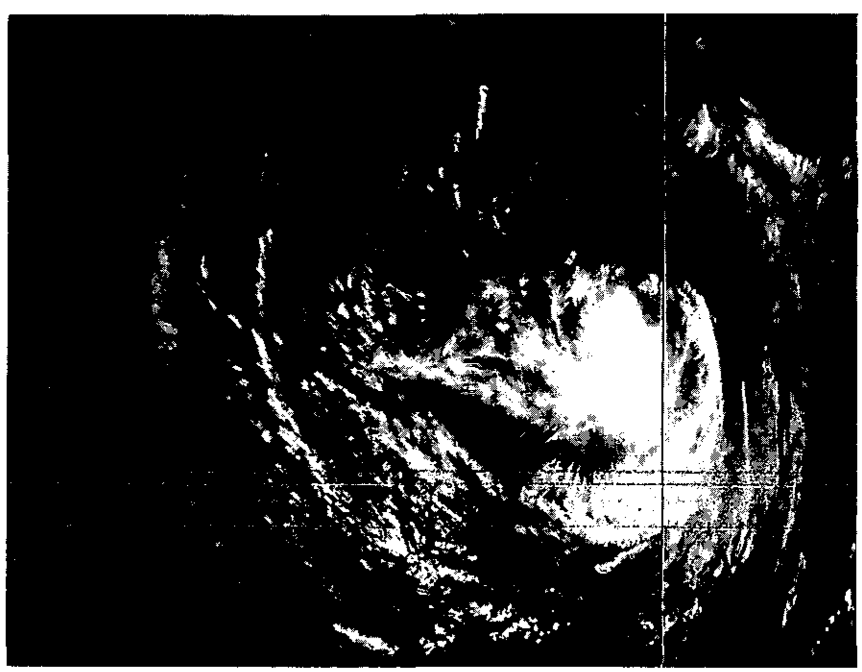
A large proportion of user requests come from foreign countries. Since most other nations do not yet have their own environmental satellites, they meet their data needs from the archives of the United States and the USSR. Data are available to foreign users at cost on the same basis as for U.S. users.

User Services, Products, and Prices

Potential users can obtain the data they need, or more information on the types of data available, by calling the



Above: NOAA-4 imagery of Hurricane Elsa off Southern California in the visible (left) and infrared spectrums, 4-mile resolution, August 25, 1975. Right, close-up of Hurricane Elsa, infrared imagery, ½-mile resolution.



Satellite Data Services Branch (301-763-8111) or by writing to:

Satellite Data Services Branch
World Weather Building, Room 606
Washington, D.C. 20233

In addition, several satellite data catalogs are available for reference.

CATALOGS. The National Environmental Satellite Service has published a *Catalog of Operational Satellite Products* which summarizes various photographic and digital data products that can be provided. The catalog is available in limited quantities from SDSB. Also available is a brief explanation of user charges for the products described and information concerning the method of payment.

The Environmental Data Service publishes *Key to Meteorological Records Documentation No. 5.4 (Environmental Satellite Imagery)*, a monthly issue describing data available from the NOAA series of operational polar-orbiting satellites. The catalog includes black and white photographs (5 inches in diameter) of daily imagery mosaics (visible and infrared) for both Northern and Southern Hemispheres, and is sold by the National Technical Information Service, U.S. Department of Commerce, Sills Building, 5285 Port Royal Road, Springfield, Va. 22151.

Earth Resources Technology Satellite (ERTS/LANDSAT) and SKYLAB pictorial data are also cataloged. The *SKYLAB Earth Resources Data Catalog* is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The ERTS/LANDSAT catalog is separated into standard (images over the contiguous U.S., Alaska, and Hawaii) and nonstandard (images of all remaining global coverage) listings, and is updated both monthly and annually. An inventory of LANDSAT imagery on 16mm microfilm is also available as a supplement to the catalogs.

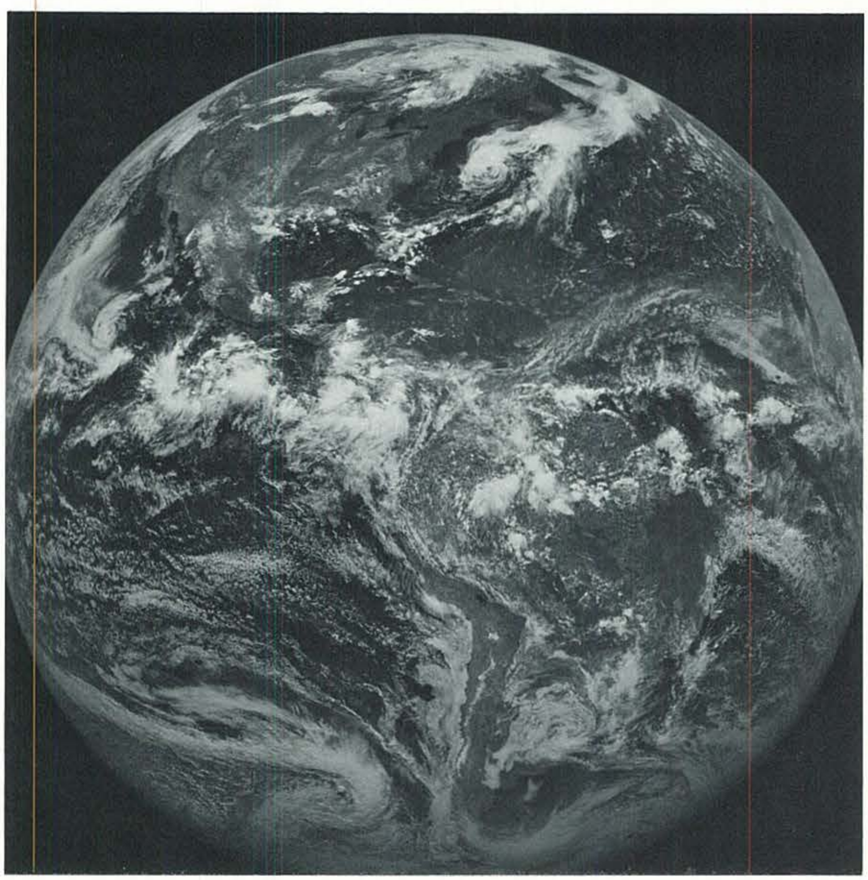
Catalogs are available to official LANDSAT investigators and approved agencies through the Image Processing Facility (IPF) of the Goddard Space Flight Center. Copies of the standard catalog and microfilm may be purchased by the public from the EROS* Data Center, Sioux Falls, S. Dak., 57198. Additional information concerning the catalogs or microfilm may be obtained by writing or telephoning:

Support Services
NASA/Goddard Space Flight Center
Code 563
Greenbelt, Md. 20771
301-782-5406

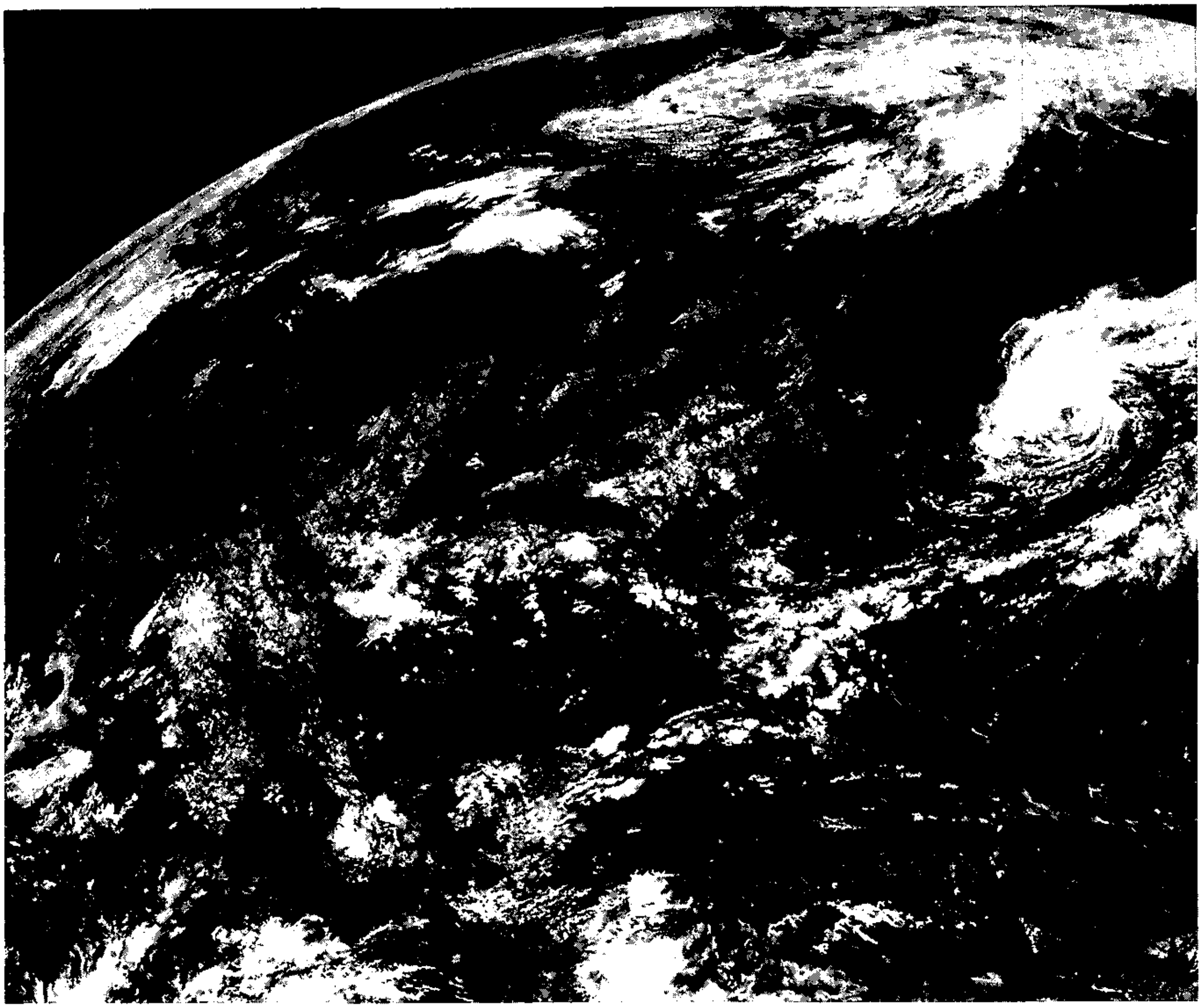
BROWSE FILES. To increase public access to LANDSAT and SKYLAB imagery, NOAA and the Department of the Interior have established 39 browse files throughout the United States, located mainly in larger cities. Current addresses and telephone numbers can be obtained from the Satellite Data Services Branch.

The NOAA Browse Files provide

Full-disc, visible imagery from the SMS-1 geostationary satellite showing North and South America (2-mile resolution). Note Hurricane Amy off the U.S. East Coast.

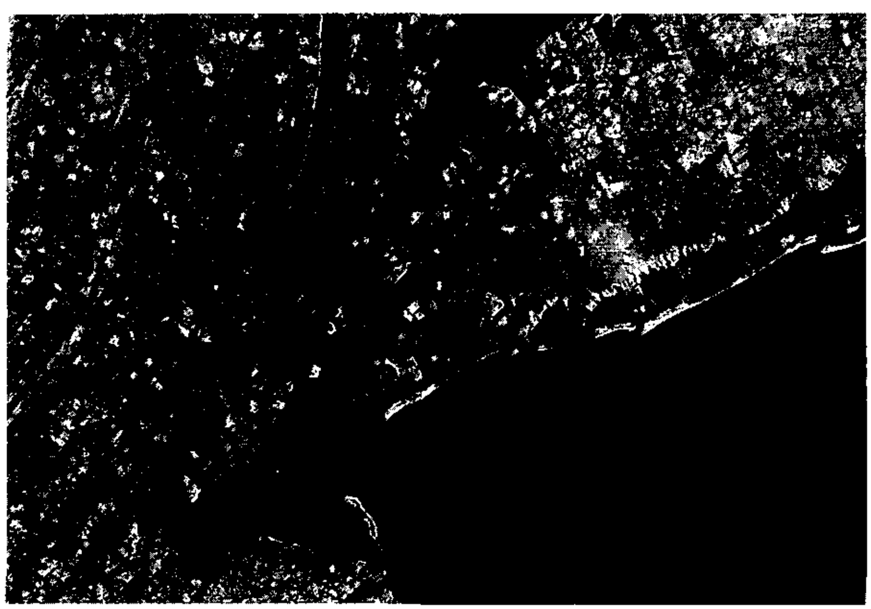


* *Earth Resources Observation System*



A closer look (1-mile resolution) at the United States and Hurricane Amy. (One-half-mile resolution imagery is also available, in both visible and infrared spectrums.)

LANDSAT photo of New York City area, 1/3-mile resolution.

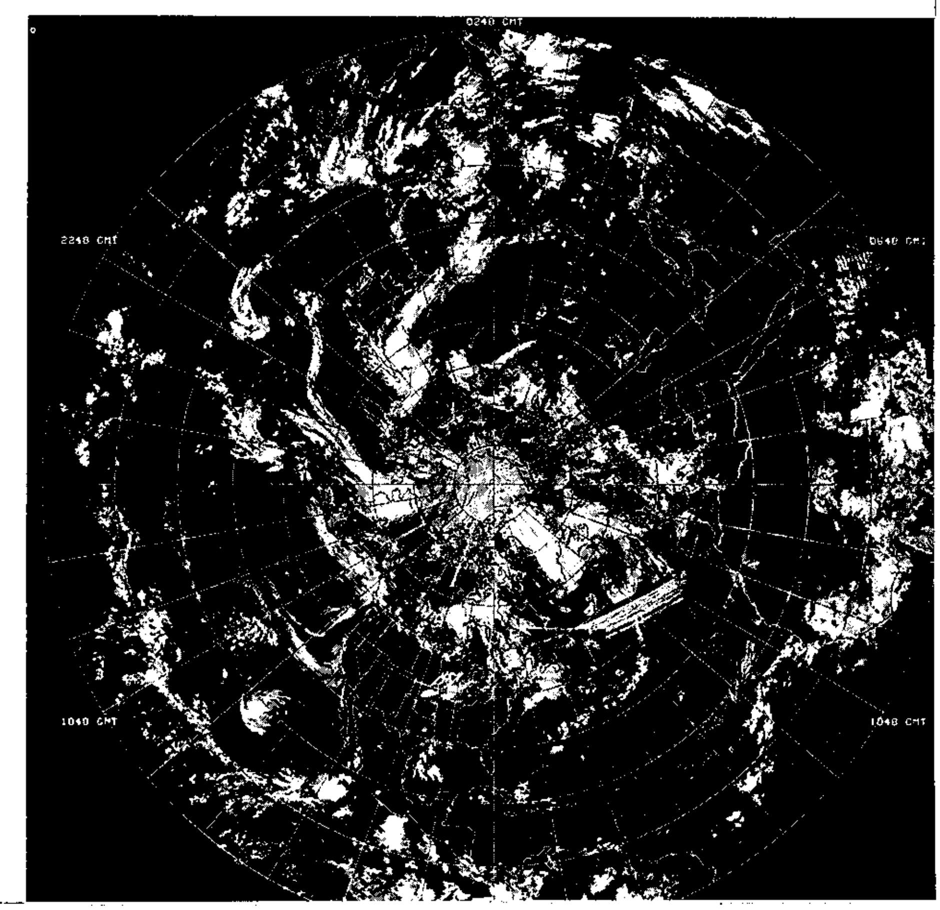


16mm microfilm (and reader) imagery of one channel of the LANDSAT Multispectral Scanner (MSS), standard catalogs identifying each film frame, a data user handbook providing additional LANDSAT System information, a list of available data products and prices, and detailed ordering procedures. The 16mm display films are updated frequently.

A computer terminal will soon be installed that will link SDSB to the NASA/LANDSAT data base in Huntsville, Ala. This will allow quick search and response to user questions concerning LANDSAT data availability.

DATA FORMATS AND PRICES. Many satellite data users request photoprints; others seek negatives, transparencies, slides, and, in many instances, movie loops of changing weather patterns. To meet these demands, SDSB offers data in several standard formats. This allows fixed user costs to be determined for each data type. The bulk of user requests, for example, are for black and white prints of visible and/or infrared imagery. These prints (on matte paper) currently are furnished in a 10″ x 10″ size for $2.50 each. Prices of other for-

SKYLAB photograph of the San Francisco area, June 5, 1973. Note low stratus cloud shield just offshore caused by coastal upwelling of cold water.



Computer-generated composite of NOAA-4 visible imagery for the Northern Hemisphere at approximately 9 a.m. local time, August 25, 1975. (Note Hurricane Elsa off Southern California, as shown in the NOAA-4 strip chart on page 17.) This computer presentation is featured in the **Environmental Satellite Imagery** *Catalog published monthly by EDS, which contains daily visible (daytime) and infrared (nighttime) composites for both Northern and Southern Hemispheres.*

mats vary with their production costs. (See listing.) Prices are reviewed and, if necessary, adjusted at least once annually, generally at the beginning of each fiscal year.

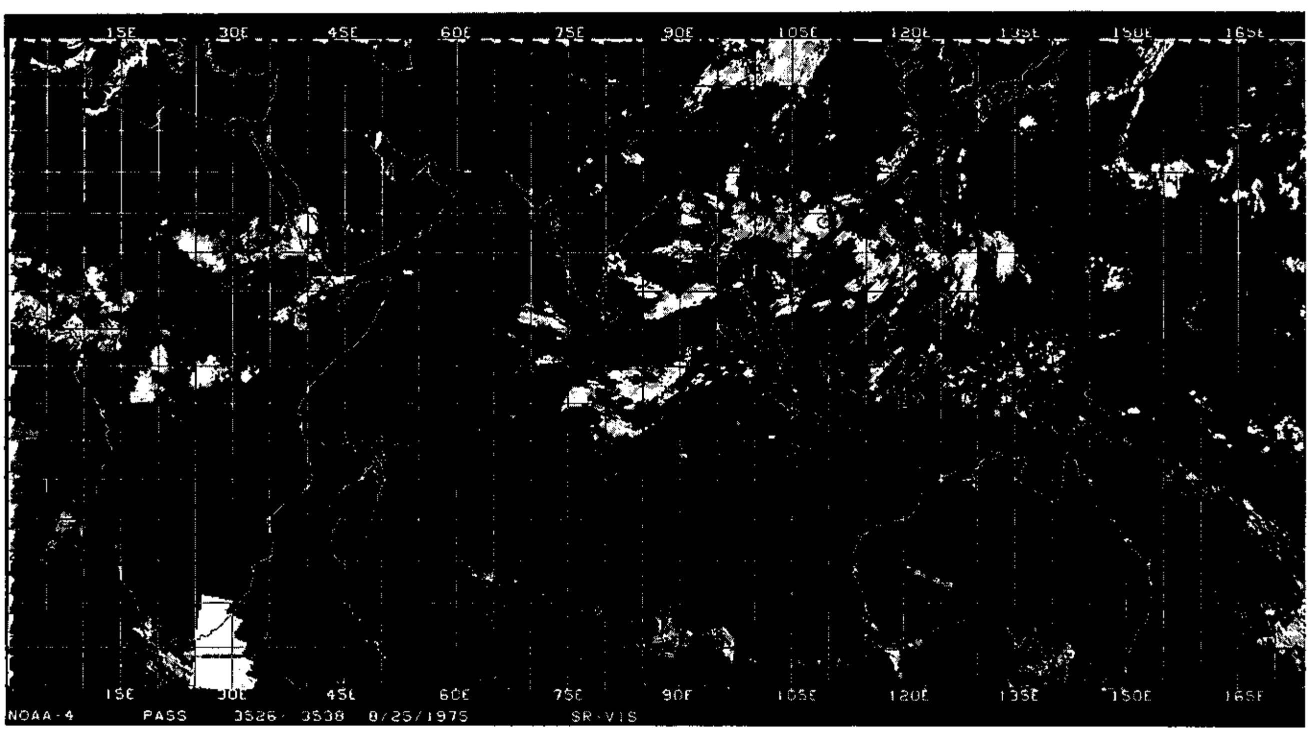
ORDERING DATA. When ordering environmental satellite data, the requester should furnish as much of the following information as possible:

- Satellite from which data are requested.
- Date and time of data requested.
- Type of data needed (visible or infrared).
- Data format desired (print, transparency, 35mm film, etc.).
- Use that will be made of the data (to be sure you get what you need).
- Task number to be charged (Federal agency).
- Name of person or organization to be billed (if non-Federal).
- Address where data are to be sent (plus telephone number).
- Other information which might help SDSB personnel identify and locate the correct data from the archives.

LANDSAT and SKYLAB data should be ordered, when possible, by using order blanks available at the Browse Files. Such data, however, can also be ordered by letter request to the Satellite Data Services Branch. LANDSAT data must be requested by ID/ORBIT number (from the catalogs) or by geographical coordinates, date, and time. The requester should also indicate the multispectral scanner (MSS) channel desired or, if unknown, state the use to be made of the imagery to help SDSB personnel select the most advantageous channel. SKYLAB pictures desired can be identified from the catalog or 16mm film rolls available at the Browse Files.

Future Data Products and Services

SDSB data archives are expected to expand at a fast pace during the next few years with the advent of advanced satellites such as the TIROS-N series and such projects as the First GARP Global Experiment. Mass storage devices and systems will be introduced to condense these and current SDSB data archives into manageable files allowing quick access and retrieval. In this way, the Satellite Data Services Branch will be able to continue providing efficient service to an increasing number of satellite data users.



Because of the lower-latitude distortion inherent in the polar stereographic projections used to construct the hemisphere composites, mercator-projection strip charts for middle and lower latitudes are also generated. These are used by research meteorologists (among others) studying hurricanes and tropical meteorology.

National Report

Whistlers

The EDS National Geophysical and Solar-Terrestrial Data Center in Boulder, Colo., has acquired a "whistler" data set. "Whistlers" are very low frequency radio signals that originate both in lightning flashes and in natural emissions. These signals propogate from one hemisphere to another in magnetic-field-alined ducts of electron density in the Earth's magnetosphere. They can be recorded on magnetic tape which, when played back, converts the radio signals to an audible frequency, producing a quasi-musical sound; hence, the name "whistlers." Whistler data are used by scientists to study the origins of these emissions and their paths, as well as electron density distributions far from the Earth's surface.

Whistlers were first reported in 1919. In 1953, L.R.O. Storey theorized that whistlers were strong evidence of the presence of ionized gas in the atmosphere to a distance of a few earth radii. This theory has been confirmed by satellite observations.

The whistler data held at NGSDC come from investigations conducted at numerous sites in the Western Hemisphere and in Antarctica. R.M. Gallet of NOAA collected the data during the period 1956-65. The data set consists of audio magnetic tape that can be studied by ear or examined visually when played through a spectrum analyzer.

Copies of the tapes are available at the cost of reproduction. Address requests to: Raymond O. Conkright, National Geophysical and Solar-Terrestrial Data Center, NOAA, Boulder, CO 80302, U.S.A. Telephone 303-499-1000, extension 6467.

Seismic Reflection Data for the Continental Margin

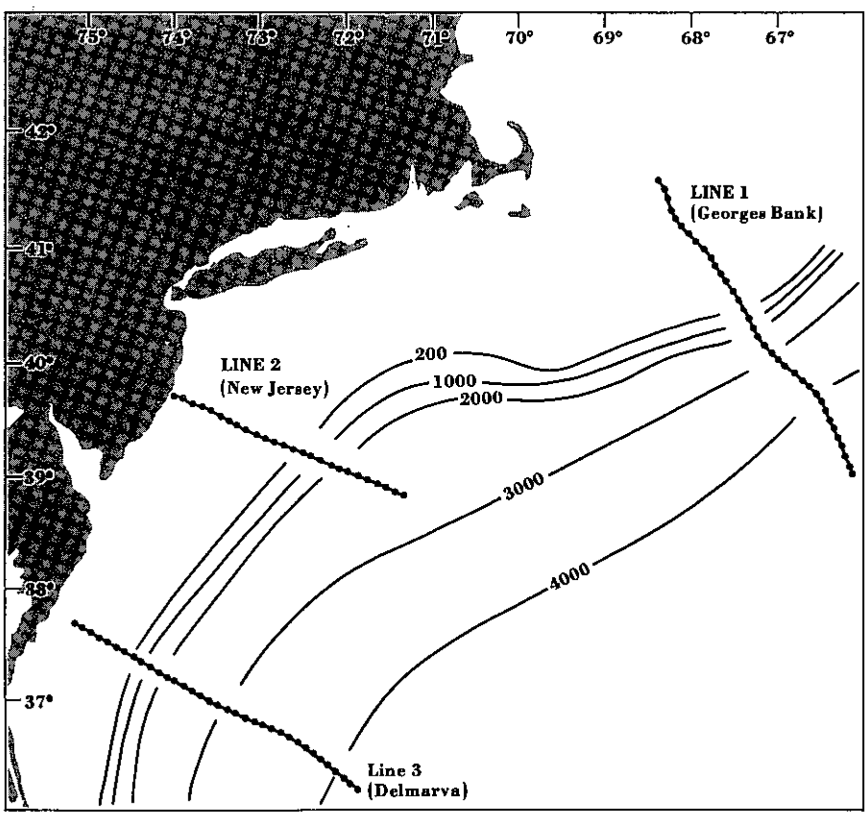
The EDS National Geophysical and Solar-Terrestrial Data Center is now making available magnetic tapes of data collected during the first three of a series of survey lines to be run by the U.S. Geological Survey on the U.S. Continental Shelf, Slope, and Rise.

The tapes contain demultiplexed digital data for multichannel common-depth-point (CDP) seismic reflection measurements which cover 578 nautical miles of the Atlantic continental margin. The three survey lines trend generally northwest-southeast. Line 1 extends across Georges Bank off the New England coast, line 2 extends outward from the New Jersey coast, and line 3 extends off the Delmarva Peninsula. There are 78 tapes for survey line 1, 52 for line 2, and 82 for line 3—a total of 212 tapes. The 800 bpi, 9-track tapes are in SEG-Y (Society of Exploration Geophysicists) format and are available for $60.00 per tape. Analog data available for the same three survey lines are described on page 20 of the January 1975 issue of *EDS*.

Over the next several years, the USGS will record multichannel, common-depth-point (CDP) seismic reflection profiles in the U.S. Atlantic, Pacific, and Alaska coastal areas to gain a better understanding of the general geologic framework of the Continental Shelf, Slope, and Rise and its relationship to onshore Geology, as well as to assess the petroleum potential of the Continental Margin.

Additional data sets will be announced as they become available. For further information contact:

National Geophysical and Solar-Terrestrial Data Center, Code D62
EDS/NOAA
Boulder, CO 80302
Phone (303) 499-1000 ext. 6521



Three U.S. Geological Survey track lines for which digital seismic reflection data are now available. (Depths in meters.)

U.S. IFYGL Archive Almost Complete

The U.S. archive for the International Field Year for the Great Lakes (IFYGL) is now about 90% complete. IFYGL was a joint, Canada-United States program that surveyed the meteorology and limnology of Lake Ontario in 1972-73. The biology, chemistry, hydrology, limnology, and meteorology data collected are available on magnetic tape, microfilm, and microfiche from the National Climatic Center, Asheville, North Carolina.

Although IFYGL concentrated on Lake Ontario, the data collected also are contributing to a better understanding of other inland freshwater bodies. Investigators are continuing their analyses, and their completed reports will be added to the archive.

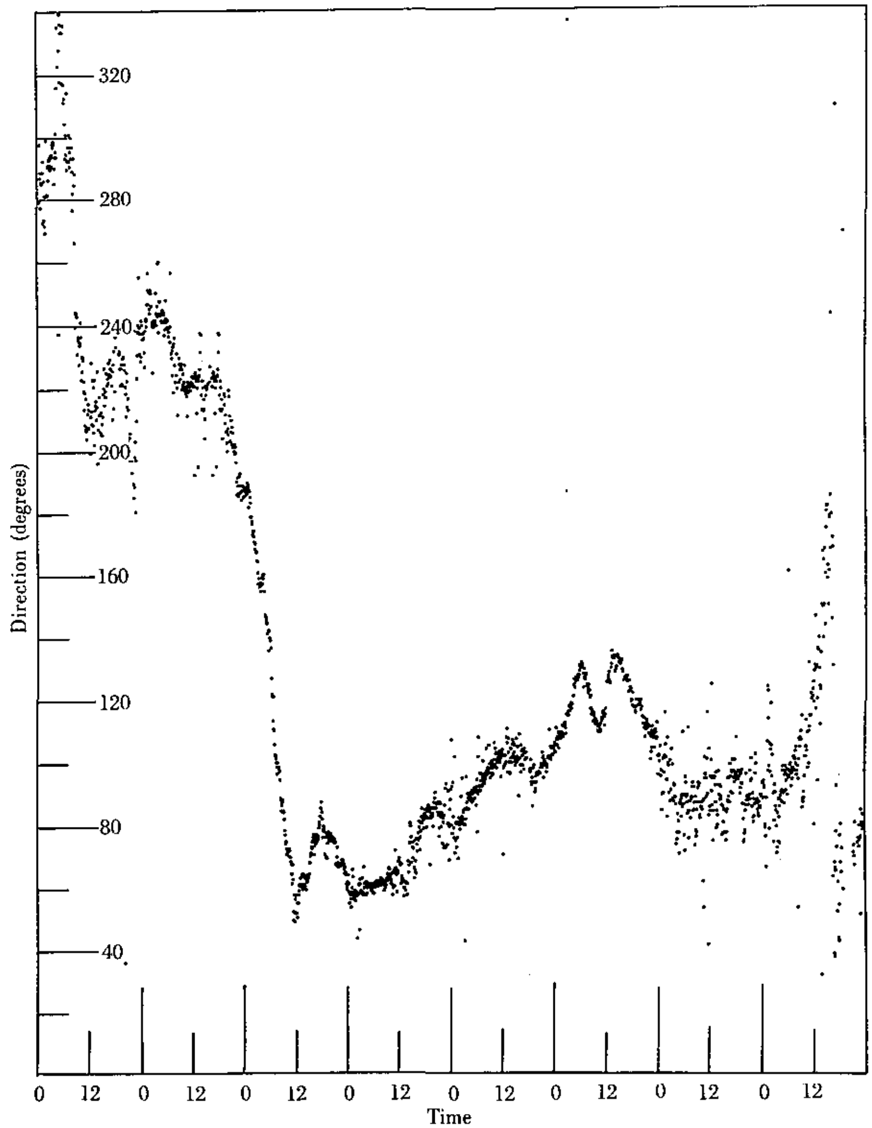
Data available include observations made by two research vessels, NOAA's *Researcher* and the Cape Fear Technical Institute's *Advance II*. These data consist of measurements of windspeed and direction, barometric pressure, air temperature, dewpoint, long- and short-wave radiation, surface and water column temperatures, and water chlorophyl content. Available are magnetic tapes of 1-second average data (0.1 second subsurface data), bathythermograph (XBT) onstation data, subsurface data averages by pressure levels, and 6-minute totals for radiation and 6-minute averages for other data. In addition, microfilm time-series displays of radiation data and 6-minute and 1-second average data are in the archive.

Also included are data collected by 10 remote automatic buoys and 4 remote towers on the U.S. portion of Lake Ontario, as well as 6 automatic land stations. These consist of measurements of air temperature, barometric pressure, dewpoint, pan evaporation, long- and short-wave radiation (incident and reflected), precipitation, wind and current speed and direction, and water temperatures from the lake's surface to bottom. The archive has tapes of edited 6-minute data and hourly averages, as well as microfilm time-series displays of the 6-minute observations.

Auxiliary data accompanying the ship and physical data just described include event logs, station histories, and calibration records.

Also in the archive are data collected by three United States and three Canadian rawinsonde stations. These include measurements of wind speed and direction, as well as temperature, humidity, and pressure. The data are available from the archive on magnetic tape, and the soundings are available as plots on 35mm microfilm.

Several types of user indexes and data descriptions have been prepared for scientists interested in using the data. Assistance can be obtained from W.T. Hodge, D5xl, U.S. IFYGL Data Manager, National Climatic Center, Federal Building, Asheville, NC 28801. (Telephone: 704-258-2850, extension 754.)



Bottom current direction, IFYGL buoy station 16, Lake Ontario, May 30 to June 7, 1972.

New Bibliographic Data Bases Available Online

The Oceanic Index and Meteorological and Geoastrophysical Abstracts data bases, as well as a special file on aquaculture are now available to users for online interactive searching as part of the EDS Oceanic and Atmospheric Scientific Information System (OASIS). The data bases can be accessed through any teletype-compatible terminal over direct-dial, low cost telephone lines.

Oceanic Index is an automated, online version of the bimonthly publication, *Oceanic Abstracts.* Coverage is from 1964 to the present and consists of approximately 76,500 citations. The data base contains citations to published literature relating to the oceans and freshwater-saltwater interface in the subject areas of accoustics, biology, fisheries, geology, meteorology, oceanography, optics, and pollution.

Meteorological and Geoastrophysical Abstracts is the automated, on-line version of the monthly journal of the same name. Present coverage of the online data base is for 1972-74. The years 1975 and 1970-71 will be added during the next 3-6 months. The data base includes articles on astrophysics, hydrology, meteorology, and physical oceanography.

The aquaculture file contains information on subject index terms including common names of organisms, and cultured organisms by genus and species, as well as complete bibliographic references. Most of the 2,100 items in the file were published since 1970. New references will be added via a grant from the Office of Sea Grant to the Virginia Institute of Marine Sciences.

For further information on using these files contact the Systems Branch, Environmental Science Information Center on 202-634-7335. Other files available for online searching include: Biological Abstracts; Engineering Index Compendex; Government Reports Announcements; Information Service in Physics, Computers and Control, and Electrotechnology; National Agricultural Library (CAIN); and Scisearch.

The Boulder Interference Committee

In April, a group of scientists, engineers, and administrators met at the Federal Communications Commission offices in Washington, D.C., to review policies and methods designed to protect a radio quiet zone at the Table Mountain Field Site, a 1,500 acre area north of Boulder, Colo., used for radio and electromagnetic research by the Department of Commerce laboratories in that city.

The meeting, convened by the FCC was attended by representatives of several FCC bureaus, the DOC Radio Frequency Management Officer and members of his staff, three Boulder Laboratories staff members, and Ed Schiffmacher of the EDS National Geophysical and Solar-Terrestrial Data Center, who represented the Boulder Laboratories Interference Committee, of which he is long-time chairman. The committee consists of the Boulder Laboratories Radio Frequency Management Officer as "exofficio" member and representatives from each technical division and laboratory of the agencies and organizations comprising the Department of Commerce Boulder Laboratories: the National Bureau of Standards, the Office of Telecommunications, and NOAA's Environmental Data Service and Environmental Research Laboratories.

Since its establishment in the mid-1950's the Interference Committee's mission has been to help integrate new experimental programs into the Boulder Laboratory environment with minimum interference to or from ongoing work, and to resolve problems related to radio interference brought to its attention by researchers in the laboratories or at their field sites.

Members of the Boulder Interference Committee check analog chart showing electromagnetic wave leakage of a microwave oven. Left to right: C. Hornback, R.L. Peevler, W. Jessen, E. Yuzwiak, H.E. Taggart, and E. Schiffmacher.

The Table Mountain Field Site, used jointly by all the Boulder DOC laboratories, has been devoted to radio research and data collection programs which require state-of-the-art, ultrasensitive receiving equipment, and hence are especially vulnerable to interference. Both State legislation and Federal Communications Commission regulations have been enacted to provide mechanisms for protection against interference of various kinds, principally electromagnetic.

FCC rules require that broadcast license applicants whose proposed operations would result in new strong radio signals exceeding defined criteria at the Table Mountain Field Site, based either on the applicant's calculations or Boulder Laboratories predictions, should coordinate their activities with the Boulder Laboratories Radio Frequency Management Office during the planning stages to provide assurance that no harmful interference will result. The April FCC-DOC meeting produced recommendations which, if approved, will clarify for license applicants the methods by which suitable, field-strength predictions can be made and more clearly define the circumstances requiring prior coordination with the Boulder Laboratories. Further joint DOC-FCC studies were also recommended to define mutually acceptable locations and methods for making reference field-strength measurements at the Table Mountain site to confirm compliance with the regulations.

Typical of research programs at the Table Mountain Field Site are those which involve reception of telemetry signals from NOAA and NASA satellites, and analysis of transmissions from the Radio Beacon Experiment on NASA's Applications Technology Satellite, ATS-6. These activities are part of a program to monitor the environment in the vicinity of the satellites and gain information on magnetospheric—ionospheric interactions. The data derived from these exceedingly weak radio signals eventually become part of the EDS NGSDC archives.

New research programs or experimental setups within the Boulder Laboratories themselves frequently create interference to existing projects, or are themselves disturbed by ongoing activities. When this happens, the Interference Committee tracks down the interference mechanism and suggests equipment changes or adjustments to eliminate the interference. The committee also makes recommendations to management on such questions as the degree of special filtering required in the power system for a new computer facility. Without such filtering, the computer and research activities in nearby laboratories would suffer disastrous mutual interference, crippling to both.

Ed Schiffmacher

Airport Climatology Report

The National Climatic Center has compiled and printed the report, *Ceiling-Visibility Climatological Study and Systems Enhancement Factors.* The report was funded by the Systems Requirement Division of the Federal Aviation Administration (FAA) and contains climatological data needed to make decisions on facilities and equipment investment for 271 airports.

Ceiling and visibility data for periods of record of 5 to 15 years (depending upon the availability of hourly data in a digital media) were used to prepare the report. FAA selected the stations on the basis of the annual number of instrument approaches made at the airports. (An instrument approach to an airport is one made on an Instrument Flight Rules flight plan, when the visibility is less than 3 miles and/or the ceiling is at, or below, the minimum initial approach altitude.)

The report provides monthly relative frequencies of six different ceiling and visibility categories for each of the 271 airports. In addition, tables show the annual relative frequency of these categories for the hour groups 0700-1300, 1400-2100, and 2200-0600. The systems enhancement factors included are estimates of the percentage of time that various instrument systems are used by aircraft on instrument approaches. A station index lists the cities concerned in alphabetical order (by State), with the airport name, latitude, longitude, and elevation.

Copies of this 153-page publication are available from the National Technical Information Service, Springfield, VA 22151. Price: paper copy $5.75; microfilm $2.25.

International Report

IDOE Progress Report No. 4 Available

The fourth of a series of progress reports on the International Decade of Ocean Exploration (IDOE) has been published by the Environmental Data Service under a National Science Foundation (NSF) contract. IDOE is a long-term, international cooperative program to enhance utilization of the ocean and its resources.

The report, prepared for the NSF Office for IDOE, covers the period April 1974 to April 1975 and provides information, data inventories, and lists of scientific papers. The text is ordered by program subject areas established for IDOE: Environmental Quality, Environmental Forecasting, Seabed Assessment, and Living Resources. An appendix contains a summary of Reports of Observations/Samples Collected by Oceanographic Programs.

In addition to publishing the progress report, EDS is also under contract to NSF to manage the scientific data collected during IDOE. EDS either has the data, information, and papers described in the progress report, or knows where they may be obtained.

Requests for copies of the report, or for IDOE data, should be addressed to the National Oceanographic Data Center, National Oceanic and Atmospheric Administration, Rockville, MD 20852.

Solar-Terrestrial Physics and Meteorology

In the introduction of a recent review paper, "Solar Activity and the Weather," John Wilcox quotes an author writing in 1898:

> "That there is a causal connection between the observed variations in the forces of the Sun, the terrestrial magnetic field, and the meteorological elements has been the conclusion of every research into this subject for the past 50 years."

This assertion by F.H. Bigelow in U.S. Department of Agriculture *Weather Bureau Bulletin No. 21* was accompanied by a reference to the "large" bibliography on the subject covering a century of published work and including among its authors some of the foremost scientists of the age. Considering the additional 1,000 or more papers published on this subject in the intervening 75 years, Wilcox asks "Exactly what has been accomplished (since then)?"

Wilcox concludes his introduction with a statement that any appreciable influence of solar activity on weather is not commonly accepted, available information on solar variations is neither generally nor systematically used in weather forecasting, and the literature on the subject is disjointed, seemingly published by authors working in isolation rather than building on work done by their predecessors and unaware of similar efforts by their contemporaries.

Solar-Terrestrial Physics and Meteorology: A Working Document, tries to answer some of these questions, to provide a unifying impetus to further research in the field, and to contribute to improved communications among interested scientists.

This new publication of the EDS National Geophysical and Solar-Terrestrial Data Center contains a selected international bibliography of more than 800 entries, a first-author listing that provides a key to the divisions of the bibliography, an address list of currently active scientists who have published papers or books in this field in the years 1970-75, a selected list of nine sets of key dates or data that have been used in landmark studies in the field or that are currently in use, and reprints of two recent review papers (including the one by Wilcox), to provide a contemporary survey of the subject of solar-terrestrial physics and meteorological interactions.

This compilation was prepared by A.H. Shapley, Director of the EDS National Geophysical and Solar-Terrestrial Data Center, and H.W. Kroehl and J.H. Allen of NGSDC's Data Studies Division. It was published by the Special Committee for Solar-Terrestrial Physics of the International Council of Scientific Unions.

The availability of data from new instruments such as satellite monitors of the solar wind and the resurgence of scientific interest evident from the list of papers published from 1970 to 1975 suggest that now is the time to encourage a general scientific appraisal or reappraisal of the field.

J.H. Allen

Frost Damages Brazilian Coffee Crop

A disastrous frost—the worst in over a century—damaged at least 70 percent of the more than two billion coffee trees in southern Brazil in July of this year. The frost was not the usual, so-called "white frost" that affects only the leaves of the coffee trees. It was what local people call a "black frost," one that freezes the slender trunks and turns the sap black.

With the coffee crop already partially harvested, 1975 production was only moderately affected by the frost. Unless a substantial number of the damaged trees can be saved, however, 1976 and 1977 crop losses are expected to be severe, since it will take several years for replacement seedlings to produce a crop.

The EDS Center for Climatic and Environmental Assessment monitors climatic fluctuations such as the Brazilian freeze that impact upon world food supplies. (See p17, March 1975 *EDS.*)

The region in Brazil considered suitable for coffee growing extends from the State of Ceara in the north to that of Santa Catharina in the south. The most concentrated areas, however, lie between 18-24° south latitude, between the coast and the Reo Parana River. This includes the States of Parana, Sao Paulo, Rio de Janeiro, Espirito Santo, and the southern part of Minas Geris.

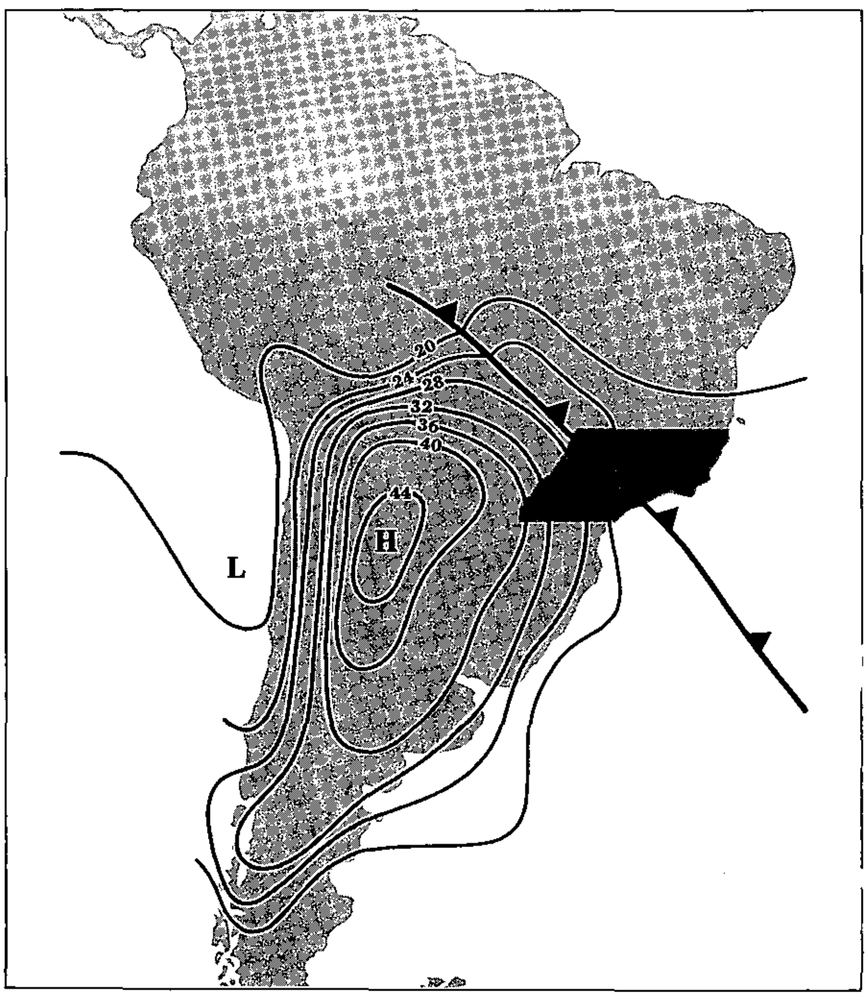
Much of Brazil's coffee-growing land is at a latitude where frost may occur, resulting in considerable current-year crop loss and in damage to the tender coffee tree branches necessary for the crops of the next few succeeding years. In little more than a century, Brazilian coffee growers have suffered serious frost losses at least 7 times: 1870, 1886, 1902, 1942, 1962, and 1975.

Severe frost damage this year occurred during the period from July 16-18. A high pressure, polar airmass centered near 30° S and 85° W at 0000 GMT, July 12 (120000Z) moved slowly southeastward during the next few days and gradually intensified. As it approached the Andes Mountains, the airmass split into two centers. One center moved southward, while the other moved northward along the eastern edge of the mountains, intensified, and became quasi-stationary just west and south of Brazil's coffee-producing areas from the 16th through the 18th. The polar air-mass moved eastward out over the Atlantic Ocean by 200000Z

The polar airmass brought below-freezing temperatures to the coffee-growing region of Brazil. At 151200Z, temperatures ranged from 11 to 18 degrees Centigrade (52 to 64 degrees Farenheit). The next day at the same time, temperatures were mostly 1-2° C below freezing (30-28° F). In many lowland areas, daily minimum temperatures plunged to 15-20° C below freezing (5° F to -4° F). These cold temperatures persisted for 3 days.

The track of this polar airmass was quite unusual. Generally, strong high pressure systems move easterly or northeasterly across the Andes Mountains at this time of year, staying well south of Brazil. Alternatively, only part of the cold air passes over the mountains, resulting in a small, weak secondary high pressure system over the land area, while the major part of the cold airmass remains over the ocean off the Chiliean coast, where it is gradually modified and eventually disappears.

Augustine Y.M. Yao



Weather analysis for 1200 July 17 (Greenwich time) shows polar air mass centered southwest of Brazil's coffee-growing region.

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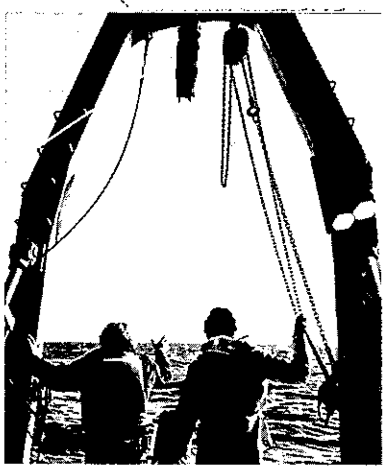
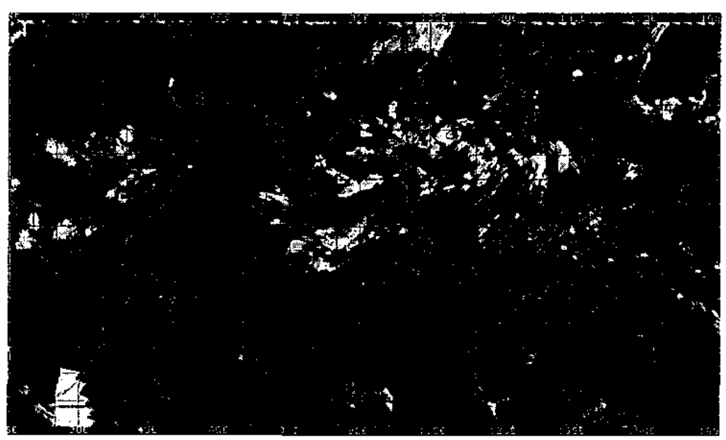


IN THIS ISSUE: Environmental pollution (p3), early American weathermen (p10), satellite data services (p16) and the Boulder Interference Committee (p23).



AMERICAN REVOLUTION BICENTENNIAL 1776-1976

EDS

Environmental
Data Service
January 1976

EDS

Environmental Data Service
January 1976

COVER: *During the Blizzard of '88 (story begins on page 14) snow drifts piled up to the second floor level on many New York City streets. The two gentlemen in the background are standing next to the top of a lamp post.*

Photo: Library of Congress

ENVIRONMENTAL DATA SERVICE is designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, Center for Climatic and Environmental Assessment, and a Deepwater Ports Project Office. In addition, under agreement with the National Academy of Sciences, the National Oceanic and Atmospheric Administration (NOAA) has responsibility for World Data Center-A activities in oceanography, gravity, tsunami, seismology, geomagnetism, meteorology, and nuclear radiation, ionosphere and airglow, cosmic rays, auroras, and solar observations; the Director of EDS coordinates these activities within NOAA.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 16, 1975; this approval expires June 30, 1978.

U.S. DEPARTMENT OF COMMERCE
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Degree-Day Data Help States Cope With Natural Gas Shortages

By Edwin Weigel
National Weather Service

The National Weather Service and the Environmental Data Service are providing a new, weekly data service to State energy offices (excluding Alaska and Hawaii) to help State officials cope with expected natural gas shortages this winter. Specifically, the service helps States to determine where they stand in heating fuel usage and to project the weather effects on heating-fuel needs.

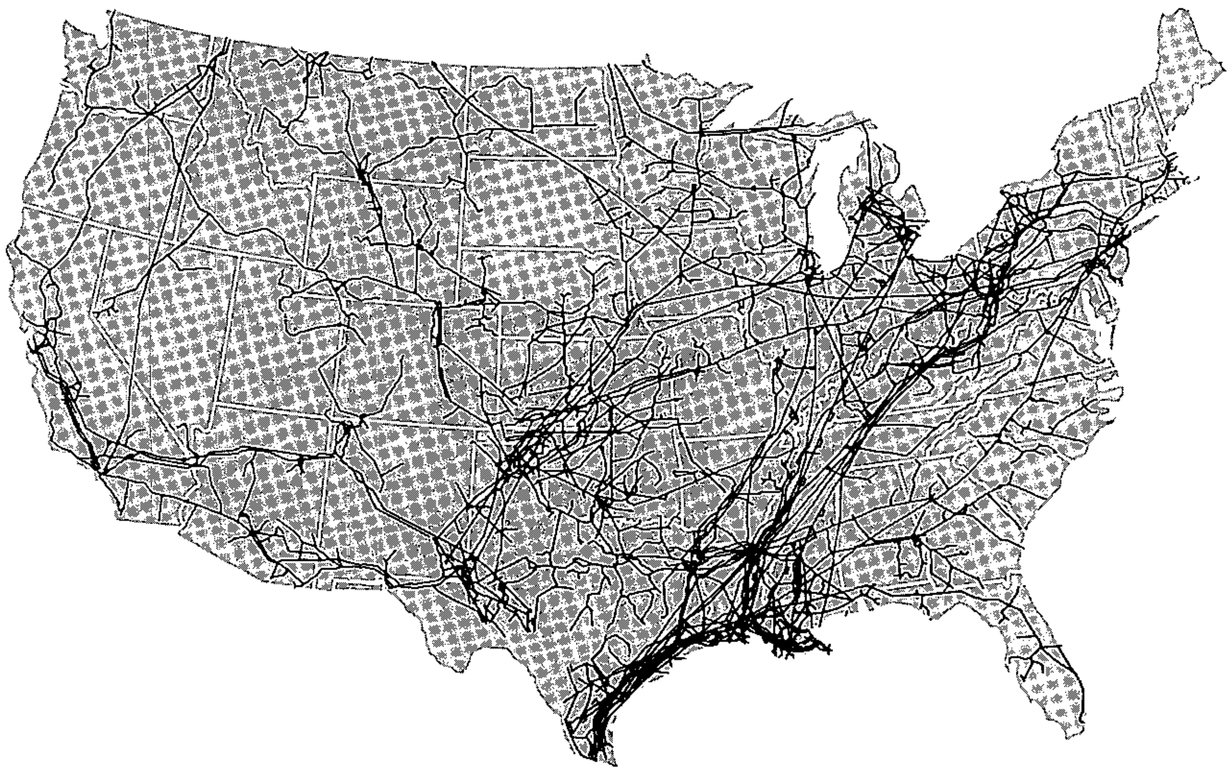
The new service began December 1975. Each week during the heating season, National Weather Service field offices provide degree-day data to State energy advisers who are then able to anticipate natural-gas shortages on a week-to-week basis and to initiate conservation measures, where necessary, until warmer weather returns. The data provide warnings sufficiently in advance to make distribution adjustments possible with a minimum of hardship.

The Environmental Data Service supplies each State with a base graph showing the normal 30-year curve of accumulated cold weather in the State throughout the heating season, plus curves on either side showing extremes of cold or warm weather that have occurred an average of once every 10 years in that State. Each Wednesday, the National Weather Service provides observed and forecast weather information to be compared with those curves.

In all instances, the information provided is weighted by population so that, for example, cold-weather reports from a large city, where heating needs will be great, will weigh more heavily in the statistics than equally cold weather in a sparsely populated region of the State.

In order to use the new service, State officials had to become familiar with a concept called the "heating degree day," developed many years ago by heating engineers to provide a useful measure of the way cold weather of a given severity and duration affects consumption of heating fuel, in the absence of actual measurements of fuel use.

The heating degree day is based on a temperature of 65 degrees F., agreed upon as the dividing line between where furnace heat ordinarily is required to provide a comfortable indoor temperature, and where it is not. When the average temperature for a



given day (which is obtained by adding together the low and the high and dividing by two) is 1 degree below 65, it counts as 1 degree day, and so on, down the thermometer scale. Successive daily totals of degree days are added together to produce the cumulative totals of degree days for a week, or a month or a season.

The degree-day concept assumes that the same amount of heating fuel is needed for any combination of cold and duration that add to the same number of heating degree days. For example, 10 days at 64 degrees, 5 days at 63 degrees, 2 days at 60 degrees, and 1 day at 55 degrees all equal 10 heating degree days. Presumably each combination would call for the same amount of heating fuel. Over the years, the analogy has been found close enough to be useful in estimating customers' heating fuel needs following a period of cold weather.

Both Environmental Data Service graphs, showing normal and extreme accumulations of heating degree days during the season, and Weather Service observations and forecasts are population weighted.

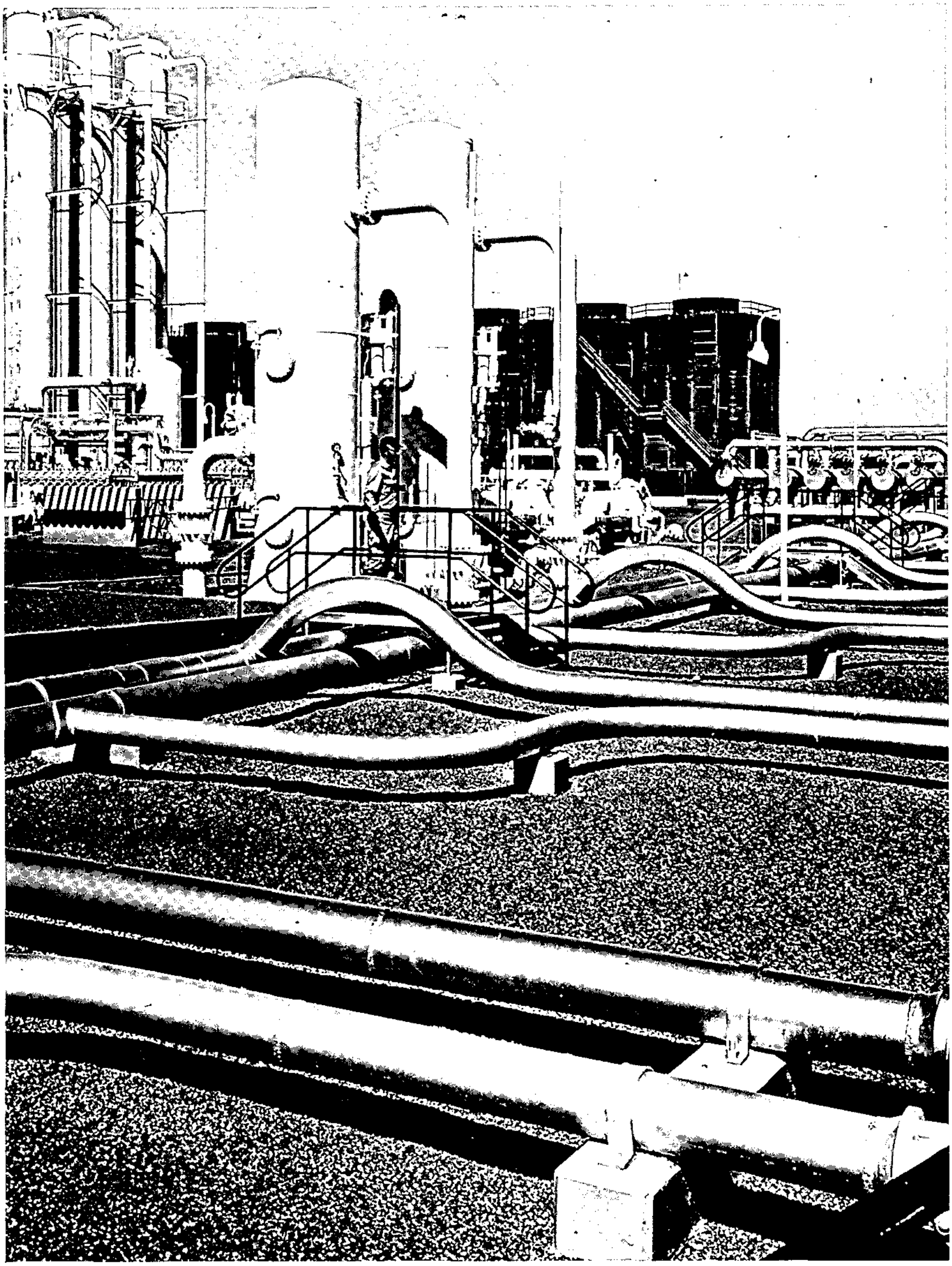
The base graphs against which current and projected degree days are plotted were provided by EDS' Center for Climatic and Environmental Assessment (CCEA). With these graphs, it is a simple matter for State energy advisers to apply current and projected National Weather Service data to determine their States' position on heating-fuel usage and needs.

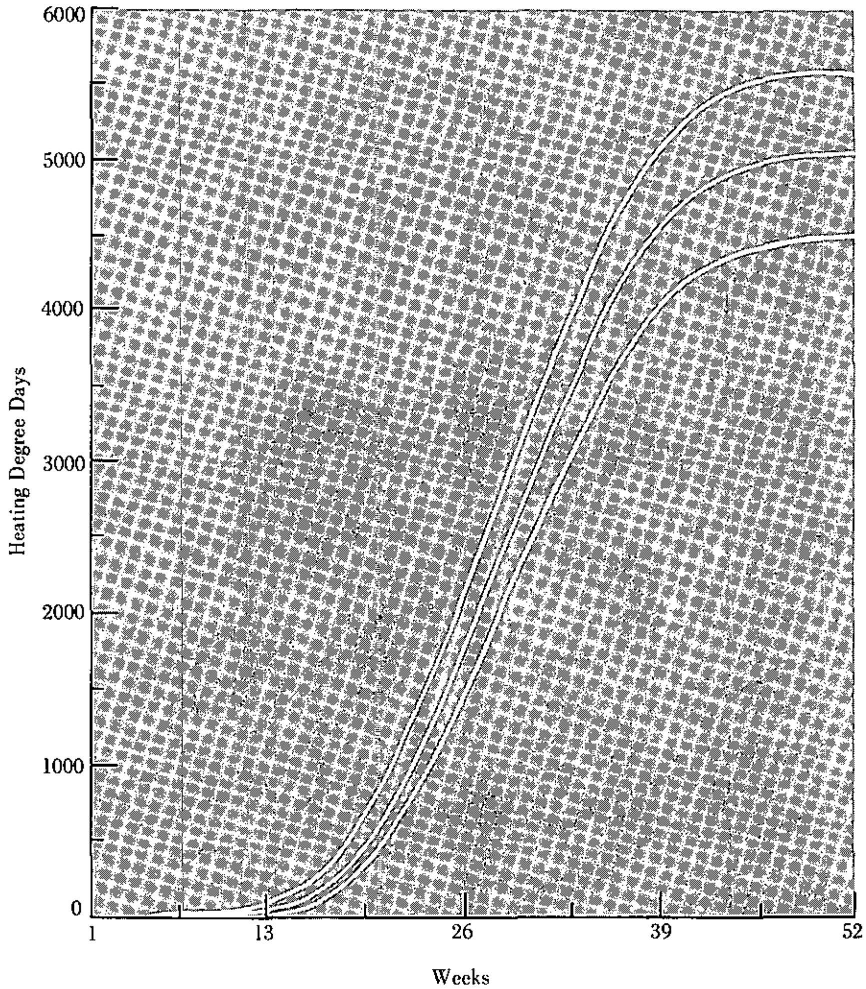
Weekly Statewide degree-day statistics are provided by the National Weather Service's Long Range Prediction Group. Each Wednesday morning, the Weather Service's National Meteorological Center distributes population-weighted State degree-day summaries and forecasts by teletype. These tabulate nine values for each State. The first three values are the State's degree-day total for the week ending the previous Sunday, the normal total for the week of the year, and the last year's total for that week. The second three values are the cumulative total of degree days since July 1, 1975, the 30-year norm for the coorespon-ding period, and last year's total for that period. The last three values are the prediction of total degree days for the week to end the following Sunday, the normal for that week of the year, and last year's total for that week. (Two of the days are observed data and five are forecasts.)

The forecast portion of this service is being provided for the first time in response to needs generated by the predicted natural-gas shortage.

Above and right: Almost 1-million miles of pipeline carry natural gas from U.S. gas fields to users.

Photo: Colorado Interstate Corporation





The average annual accumulated heating degree day total for Missouri is shown in the center curve. Upper and lower curves show the extremes of cold or warm weather.

In addition to the fuel-planning graphs for 48 States, CCEA is preparing mathematical models for Missouri and North Carolina by which population-weighted degree days can be linked specifically to demand for natural gas, excluding other fuels. The models are based on a merger of degree-day statistics with actual records of natural-gas use provided by industry.

By this means, it is expected that the severity of the pending natural-gas shortage can be quantified much more precisely for those States, making better decisions for allocation possible. Under current plans, residential users of natural gas will be the last to be affected, although home users of natural gas may be urged to cut back on their use so that factories and commercial buildings will not be cut off completely.

Once Missouri and North Carolina pilot models become operational, it is expected that other States will want to develop the same capability for translating degree-day data into quantified natural-gas demand. CCEA is prepared to help each State energy team gather the necessary historical information to construct a mathematical model tailored to their natural-gas consumption and distribution system.

Each State's model will be different. Once developed, however, it will be a simple matter each week for the State to assess its position.

According to the Federal Energy Administration, the 21 States expected to experience some degree of natural-gas shortage this heating season are:

Arizona	Nevada
California	New Jersey
Delaware	New York
Florida	North Carolina
Georgia	Ohio
Indiana	Pennsylvania
Iowa	South Carolina
Kansas	Tennessee
Kentucky	Virginia
Maryland/D.C.	West Virginia.
Missouri	

Assessing the Impact of Environmental Fluctuations on Food and Natural Resources

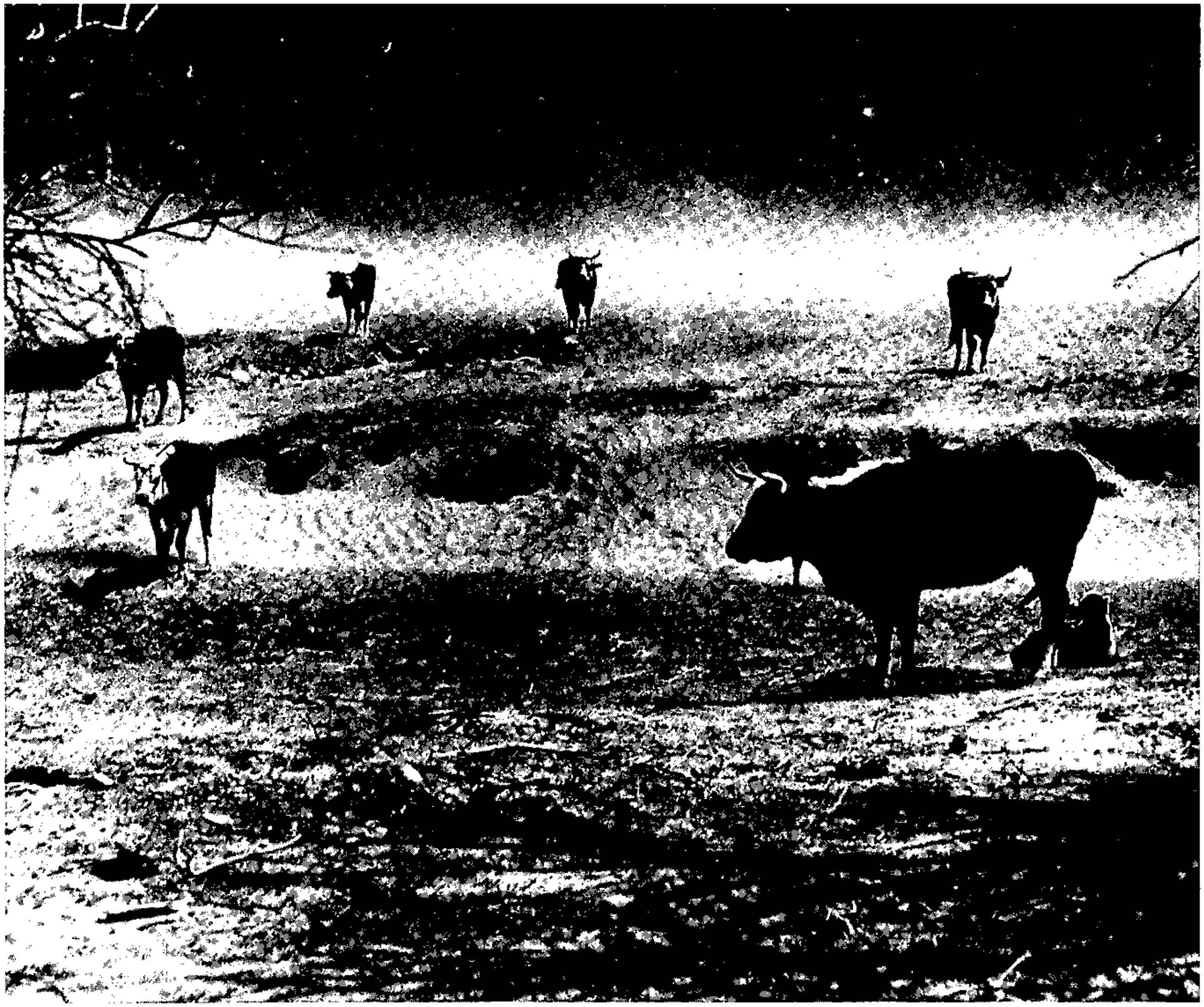
Life moves to the rhythms of seasons; the sowings and harvests, follow the advance and retreat of the Sun. But there are longer/period rhythms too. Our economic systems, our crops, our fisheries, our use of scarce resources—these all are tied to climatic and other environmental fluctuations that count their cadences in years, decades, and generations.

In a world grown crowded, marginally fed, and petroleum-dependent—even in a technologically sophisticated one—the penalties for miscalculating the impact of large-scale weather phenomena on our life styles and resources every year grow a little harsher. The environmental fluctuations alone are difficult to predict, for they involve processes shaped very slowly by successive, often minuscule variations in the physical world.

Slow adjustments in the deep ocean may gradually force climatic fluctuations, shifting global rain patterns, making temperate winters more

This years good U.S. grain harvest was affected by unusually favorable weather.

Photo: U.S. Department of Agriculture



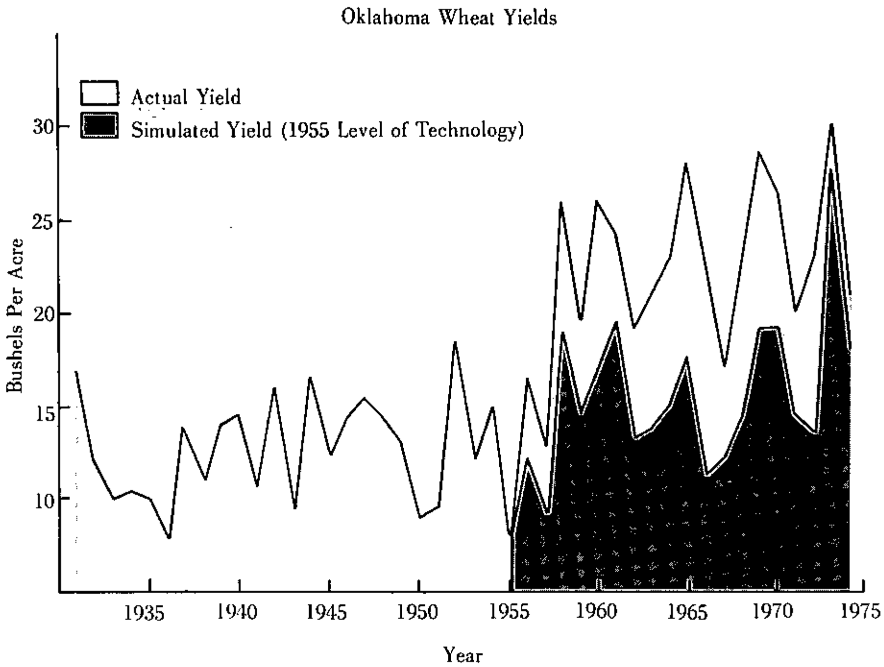
severe, and changing the distributions of species in the sea. An atmosphere burdened with volcanic dust may turn the world colder, and alter the tempos of human agriculture. Human activities may add or deplete crucial atmospheric constituents, causing unpredictable variations in the radiation we receive from the Sun.

The National Oceanic and Atmospheric Administration is applying the combined skills of environmental scientists, computer specialists, and data managers to study these problems and solve them to the degree they can be solved by modern science and technology. A major part of this effort is concentrated in the Department of Commerce Center for Climatic and Environmental Assessment, one of six major service centers of NOAA's Environmental Data Service.

The Center for Climatic and Environmental Assessment (CCEA) is an organizational response to two scientific questions. First, how do we extend our present abilities for observing and predicting short-term weather events to predicting longer-term environmental fluctuations of climate? And second, how do we put knowledge gained to work in ways that are meaningful in terms of crop production estimates, resources management, energy utilization, and the like?

CCEA's response to the problem of climatic variability prediction is to develop mathematical simulations—models—of certain key elements and relationships, so that scientists can, by

Top and above: Drought affects the entire food chain—plants, animals, and eventually humans.



Recent favorable weather for Oklahoma wheat yields is revealed by this comparison of actual yield (light tone) to yield simulated from 1955-74. Technology is held fixed at the 1955 level. Recent yield averages higher than those prior to 1955.

varying the quantities in the model, determine the consequences of various changes within those relationships. This part of the CCEA effort is carried out by its Model Development Division, located with CCEA headquarters in Columbia, adjacent to the University of Missouri.

The specific objectives here are to develop models capable of simulating the environmental component of some environmentally sensitive areas of study. These models will quantify the climate-associated fluctuations and the socioeconomic consequences of those fluctuations.

First generation crop-weather models have been developed by this group using large historical data sets, linking crop yields and weather. Other models are to be developed to simulate distribution and demand for conventionally produced energy, production and yield of coastal and oceanic fisheries, and energy potentially available from the Sun, tides, winds, and geothermal sources.

The solution to the second problem—how to apply knowledge gained from the models—requires a kind of socioenvironmental climatology capable of assessing large-scale climatological fluctuations in terms of their impact on national and international resources. The Climatic Assessment Division of CCEA in Washington, D.C., is concerned with monitoring world weather and its effects on plant growth. Work is underway to assess large-scale climatic changes and their impact on energy demand in the United States, global grain production, and fish production in coastal waters and the open ocean.

From these efforts come special studies and consultant services and a family of new products, including:

- yearly warning through timely crop-climate assessments,
- periodic crop yield estimates,
- global weather briefings linking climate and socioeconomic systems, and
- assessments of risks of damage to national resources by climatic variation.

One CCEA area of special effort is the Large Area Crop Inventory Experiment (LACIE), a joint program of NOAA, NASA, and the Department of Agriculture. This program is intended to improve the timeliness and accuracy of major crop assessments by combining current and historical weather crop information with data from surface sources and satellites.

The CCEA role in LACIE is to provide processed climatological and meteorological data and to develop and refine statistical models that relate climatic variations to their impact on crop yields. NASA is acquiring and interpreting satellite data to determine cultivated acreage and stage of crop development, and USDA is using this information to improve its periodic crop production estimates.

The CCEA approach is interdisciplinary. Professionals on the staff are social and geophysical scientists with broad experience in enivronmental and computer disciplines. Other experts are available to CCEA from within NOAA—for example, from the National Weather Service and National Marine Fisheries Service—and interagency cooperative agreements provide consultants from other federal agencies. Supplemental economic and engineering research support is available to CCEA through contracts with universities and private industry.

Visitors are welcome at the Center for Climatic and Environmental Assessment. CCEA headquarters and the Model Development Division are located in the Federal Building, Room 116, 600 East Cherry Street, Columbia, Mo. 65201 (telephone: 313-442-2271, extension 3261). The Climatic Assessment Division is at 2001 Wisconsin Avenue, Washington, D.C. 20235 (telephone: 202-634-1196). The LACIE Section is at Johnson Space Center, NASA, Houston, Tx. 77058 (telephone: 713-483-3057).

Oil Imports and Deepwater Ports

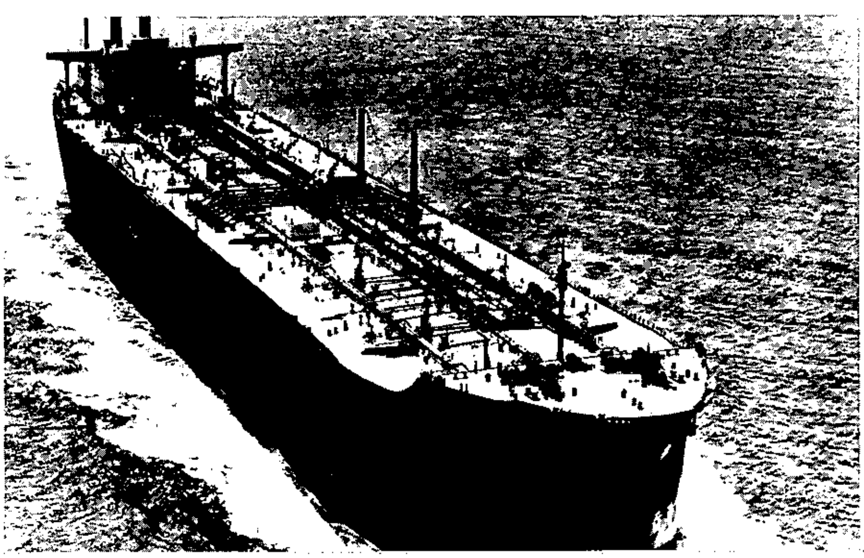
By Dail Brown
Director, Deepwater Ports Project Office

One way the U.S. can reduce the cost of its petroleum imports is to take advantage of the economies of supertankers. Known also as very large crude carriers (VLCC) and ultra large crude carriers (ULCC), these superships range from 200,000 to 400,000 deadweight tons (dwt). Clearly, it is cheaper to ship oil in supertankers. For example, the cost of transporting crude oil from the Persian Gulf to the North Atlantic coast using a 70,000 dwt ship is about $9.00 per ton. This compares to an estimated $5.35 per ton cost using a 326,000 dwt ship.

Most international oil now moves in supertankers. Unfortunately, United States ports cannot accommodate ships with deep drafts. Only two American ports now have the capacity to handle moderately large tankers; Los Angeles—100,000 dwt and Beaumont, Tex.—80,000 dwt. All other ports can handle ships in the 30 to 55,000 dwt range or smaller.

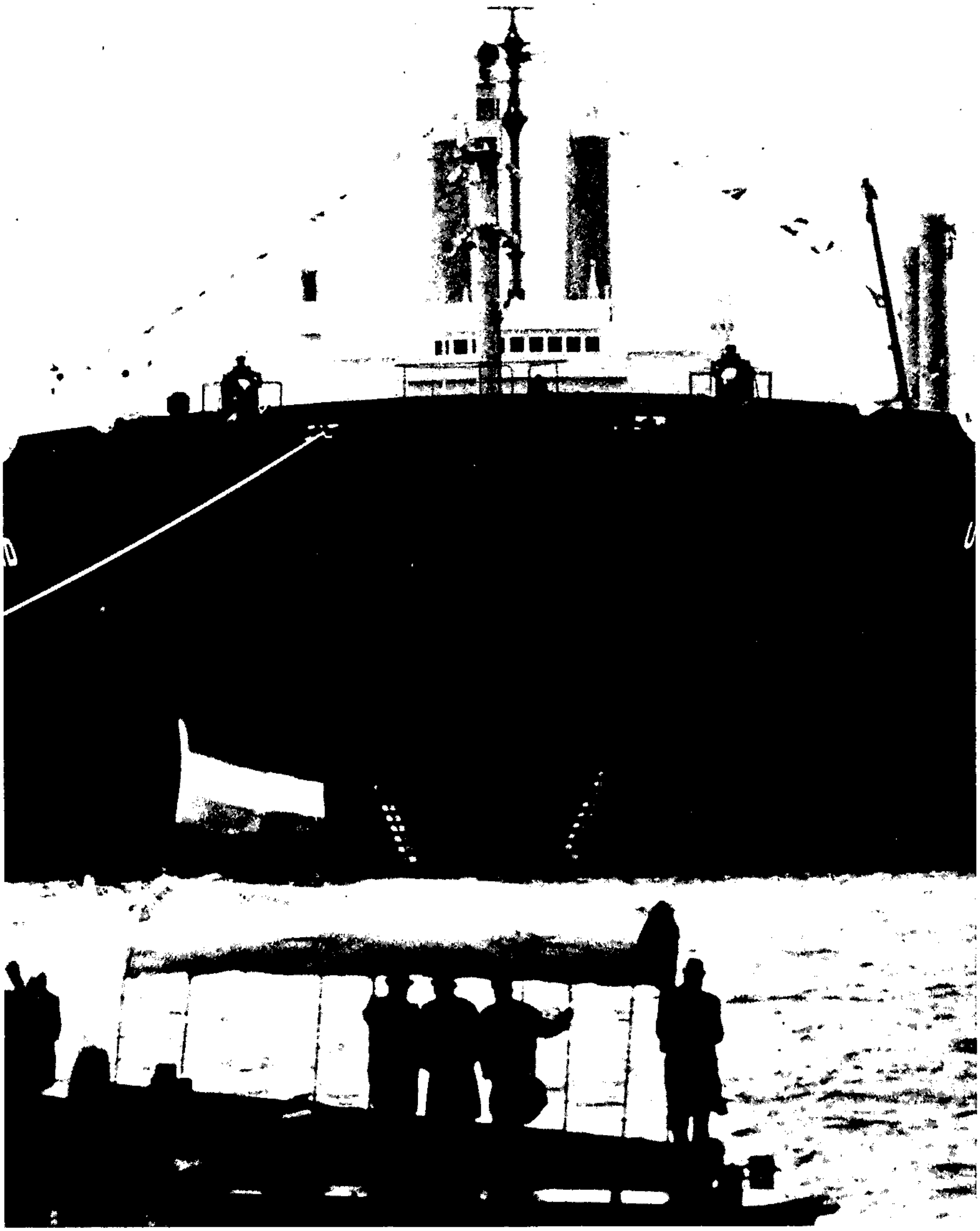
There are several approaches to developing the capability of handling supertankers: The dredging of existing ports, the construction of deepwater ports, and the lightering of oil to shore by small vessels. Perhaps the most feasible approach from both an economic and environmental point of view is the use of a single point mooring (SPM). A SPM is a large buoylike structure that can be anchored in waters of about 100 feet outside 3-mile State territorial limits, and to which a supertanker can moor. Oil is transported by hoses from ship to SPM and from the SPM by pipeline to a pumping platform, from which it is pumped to a tank farm.

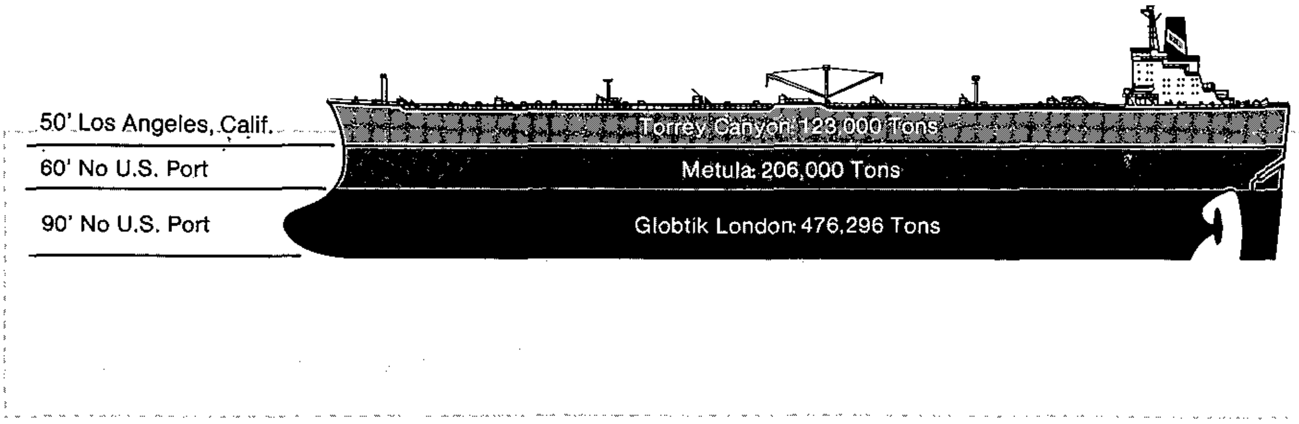
To protect the environment of coastal areas that would be affected by deepwater ports, the Congress enacted



Left: The supertanker Universe Ireland, *displacing 326,000 tons and measuring 1,135 feet in length, provides economical transportation for crude oil. Right: Laden with oil, the* Universe Ireland *conceals most of its 80-foot draft.*

Photos: Gulf Oil





Above: Since no U.S. port can accomodate a ship with a draft greater than 50 feet, offshore terminals, like the monobuoy (right), will be used to unload supertankers.

the Deepwater Port Act in 1974.

The Act provides for the proper siting, construction, and operation of deepwater ports and for the full consideration of environmental and socioeconomic values in the coastal regions affected. It gives authority for the licensing and regulation of deepwater ports in Federal waters to the Department of Transportation. Operationally, this responsibility will be carried out by the United States Coast Guard. The Act also calls for the establishment of detailed regulations, guidelines for environmental analysis, and environmental review criteria. A unique aspect of the Deepwater Port Act is the involvement of States in the vicinity of a proposed deepwater port in the licensing process.

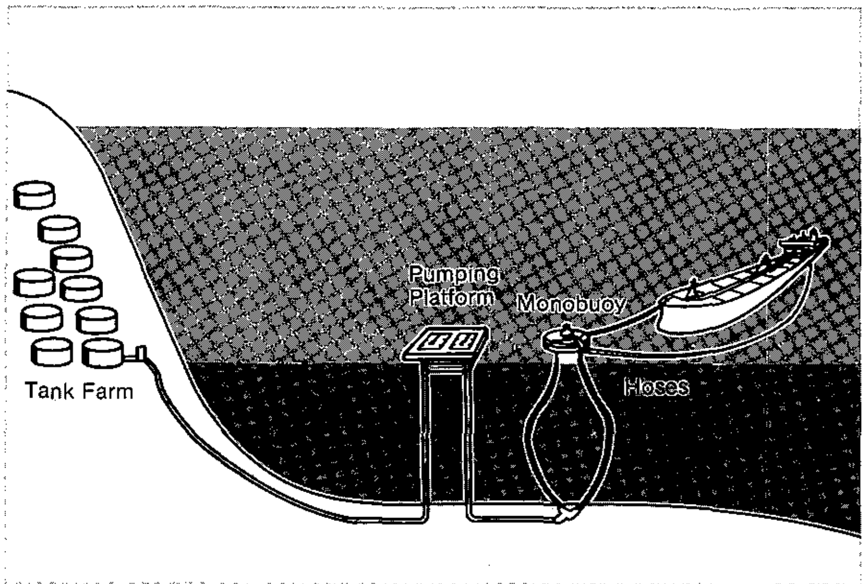
The National Oceanic and Atmospheric Administration (NOAA) will play a significant role in the development and licensing of deepwater ports. To date, NOAA has worked closely with the U.S. Coast Guard in developing licensing regulations governing the design, siting, construction, and operation of deepwater ports, which include extensive guidelines on the environmental analyses required of an applicant to assess the impact of a proposed facility. NOAA has also played an important role in the preparation of environmental review criteria for evaluating the environmental efficacy of a proposed DWP.

The Act assigns the following operational responsibilities to NOAA:

- The review of and comment on deepwater port environmental impact statements.
- The analysis of deepwater port applications and preparation of recommendations on the environmental efficacy of the proposed port.
- The preparation of recommendations on whether a State qualifies as an adjacent coastal State.

The Deepwater Ports Project Office (DPPO) was established in NOAA's Environmental data Service to carry out these operational responsibilities. The most important task of DPPO is, of course, to ensure that deepwater ports are developed in a manner that preserves and protects the environment in coastal marine areas. As applications for a DWP are received by the Coast Guard, the Deepwater Ports Project Office will undertake an intensive assessment of, among other things, (1) the impact of DWP structures and operations on other uses of the involved area, (2) the effects of oil spills and other pollutants on living resources and ecosystems, and (3) the modifications to wetlands by pipeline corridors, tank farms, and refineries.

One of the more challenging responsibilities is the recommendation on adjacent coastal State status. A State designated as an adjacent coastal State has veto power over the proposed deepwater port and reaps certain economic benefits. A State that can qualify as an adjacent-coastal State has veto power over the proposed deepwater port and reaps certain economic benefits. A State can qualify as an adjacent coastal State if: (1) it is connected to the deepwater port by a pipeline, or (2) it is within 15 miles of the proposed deepwater port. A State may also qualify as an adjacent coastal State if it is determined that such a State will be affected by a potential oil spill from the deepwater port to an extent equal to or greater than the risk



posed to a pipeline State. In this latter case, the Secretary of Transportation must seek the recommendation of the Administrator of NOAA in determining whether a State will be so affected.

The DPPO is developing analytic procedures to evaluate the risk of damage from oil spills to coastal States in the vicinity of proposed deepwater ports. The general analytic approach to be used includes the following:

- Oil spill trajectories will be computed using climatological records of winds and currents, and representative oil spill scenarios. These trajectories will be used to compute risk exposure maps for the coastal areas.
- Resources in the coastal environment, such as recreational facilities and commercial fisheries, will be identified and their ecological and economic value determined. In addition, vulnerability to oil of different concentrations will be estimated.
- Based on the risk of exposure to oil of varying concentrations and the presence of different resources, economic and ecological impacts for various sectors of the coastal environment will be determined.
- The relative impacts to a State requesting adjacent coastal State status and the pipeline State will be evaluated.

The EDS Deepwater Ports Project Office provides a NOAA focal point for drawing upon the broad base of NOAA expertise and for preparing, in a timely way, comprehensive assessments and recommendations. These efforts in environmental impact analysis will help ensure that deepwater port development is undertaken in the most environmentally acceptable manner.

About The Author

Dail Brown, head of the EDS Deepwater Ports Project Office, previously worked in the NOAA Office of the Associate Administrator for Marine Resources and the Office of the Associate Administrator for Environmental Monitoring and Prediction. Before joining NOAA, he was an Oceanographer for the Smithsonian Institution. Brown received his Ph.D. Degree in Oceanography (Ecology) from the University of California at Santa Barbara.

The Blizzard of '88*

By Patrick Hughes

This is the second of a series of Bicentennial articles on the American weather experience. The series is based largely on the historical weather records of the National Climatic Center and on contemporary accounts.

"The snow fell fast and was caught by the wild winds and hurled everywhere . . . (it) came with such force into the eyes of the pedestrian as to blind him; melting . . . (it) would remain frozen fast to the eye, so that it was his constant work to protect his sight. The snow would follow the breath . . . into the lungs and . . . fill them with water, nearly choking him, if not quite doing the work of strangulation."

This is an eyewitness account of the blizzard of 1888 which affected one quarter of the country's population and isolated a dozen of its largest cities. It literally buried hundreds of towns and villages from Maine to Maryland.

The blizzard cut off and immobilized Washington, D.C., Philadelphia, New York City, and Boston. Snowfall averaged 40 to 50 inches over southeastern New York State and southern New England, with drifts to 30 and 40 feet. In Middletown, New York, snowdrifts were reported to have covered houses three stories high. The townspeople had to tunnel through the snow like miners, shoring up the passageways with timber. For 2 days, frequent gale-force to near-hurricane winds accompanied below-freezing temperatures which ranged from near zero to the low twenties over much of the area.

Men, women, and children died in city streets, in country fields, and on ice-choked ships and boats. Over 400 died, 200 in New York City alone. Thousands more suffered everything from exhaustion to amputation of frostbitten limbs. Some wandered blindly into snowbanks and died quietly. Others became hysterical, shouting and cursing the wind, pounding the snow in tearful frustration.

The great storm buried trains all over the Northeast, marooning

Veterans of the storm pose next to huge mounds of snow.

All photos: Library of Congress

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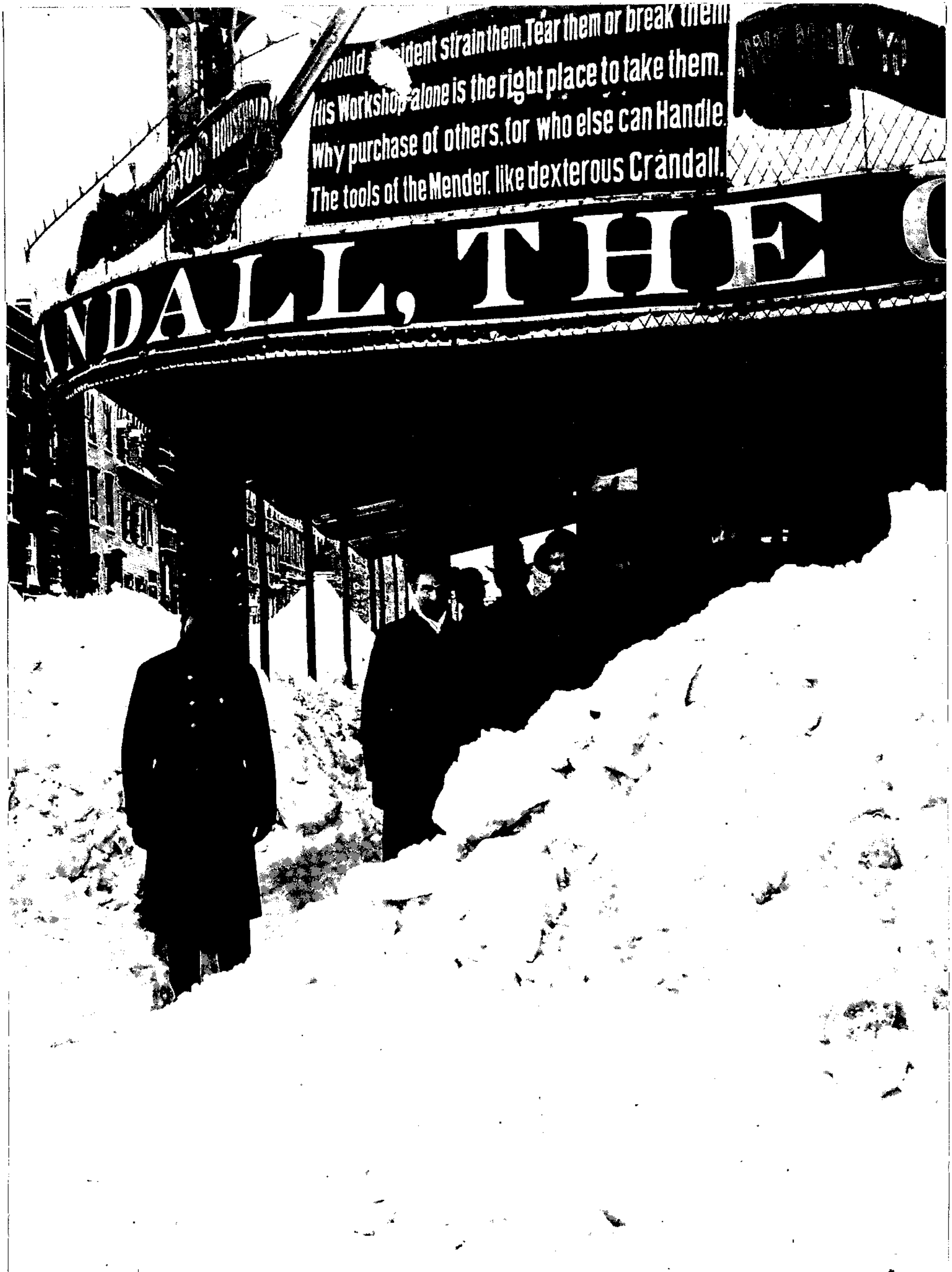
*Reprinted from *NOAA*


His Workshop alone is the right place to take them.
Why purchase of others, for who else can Handle,
The tools of the Mender, like dexterous Crandall.
NDALL, THE

Left: The snow continued all day, accompanied by northwest winds of nearly 50 miles per hour. Right: The wind swept sidewalks nearly clear on one side of the street and piled snowdrifts on the other.

passengers for days and in some cases a week or more. Water froze solid in the washrooms, and there was usually little or no food. Card tables and seats were chopped up and burned in small stoves, but the drafty cars were still unbearably cold. Many left the trains to search for food or shelter; some perished.

The blizzard was a marine disaster from Chesapeake Bay through New England. Some 200 vessels were sunk, grounded, or wrecked and abandoned. At least 100 seamen died in the storm they called the "Great White Hurricane." Of 40 vessels in Philadelphia's harbor, only 13 escaped destruction or disabling damage, and at least 30 crew members perished.

In urban areas throughout the Northeast, telegraph, electric light, and telephone wires broke under the weight of wind, ice, and snow, and poles snapped and toppled. Railroad and steamship stations were jammed with stranded travelers. Overnight, the most populous section of the United States was transformed into an arctic wasteland where nothing moved, an alien world of wind and white.

Although the blizzard blanketed an area from Maine through Maryland and from Buffalo to Pittsburgh, it was in New York City that the great storm became a legend.

Saturday, March 10, 1888, was a warm and sunny day in New York. Grass was growing, trees budding, and men talking of the upcoming baseball season.

It began to rain Sunday afternoon. By evening, the temperature had dropped, the wind was rising, and New York City's streets were coated with ice. The rain turned to snow just after midnight on Monday, March 12. The snow continued all day, accompanied by northwest winds that reached nearly 50 miles per hour and temperatures that dropped to near 10 degrees.

Most New Yorkers first became aware of the storm when they tried to go to work Monday morning. It was a period of economic depression, and no one was likely to stay home if he could make it to work. They started out by the thousands, but relatively few reached their destinations.

The wind had swept sidewalks clean on the south side of many streets, while snowdrifts 15 to 20 feet deep covered brownstone stoops on the north side and sometimes reached the

second floor. The wind was cutting, the snow blinding. And the storm worsened between 7 and 9 a.m., when most working people were out on the streets.

Men were blown off their feet and forced to crawl on their hands and knees past exposed areas. Pedestrians were sprayed with flying glass from shattered windows, and occasionally felled by falling chimneys or flying signs. Cheeks cracked in the stinging wind, and frostbitten noses swelled.

According to the *New York Times*, "the wind seemed to have a rotary motion as well as a terrible, direct propelling force. . . slinging the snow into doorways and packing it up against the doors . . . sifting it through window frames . . . piling it up in high drifts at street corners . . . twirling it into hard mounds around elevated railroad stations . . . as most New Yorkers had never seen before. For the first time in their lives they knew what a western blizzard was."

Horsedrawn streetcars were abandoned all over the city, and the steam-driven elevated railway trains were soon stalled. Hundreds of people jammed wind-whipped platforms waiting for trains that never came. Wealthier New Yorkers offered fabulous sums to cab and carriage and even wagon drivers to take them a few blocks or a few miles. Prices ranged as high as $40, but in most cases the conveyance bogged down and both passenger and driver were stranded. Sometimes the horse was rescued, sometimes abandoned.

Those who did manage to reach work generally found no one else there or nothing to do. They had to turn around and try to struggle home again or find a place to stay in the city.

Out on the streets, policemen were administering first aid to hundreds of people and rescuing drunks from certain death in snowdrifts. As the storm worsened, many had sought shelter in nearby saloons, which did a record business. While the loss of life was small, serious accidents were numerous, and many people were victims of exposure and overexertion.

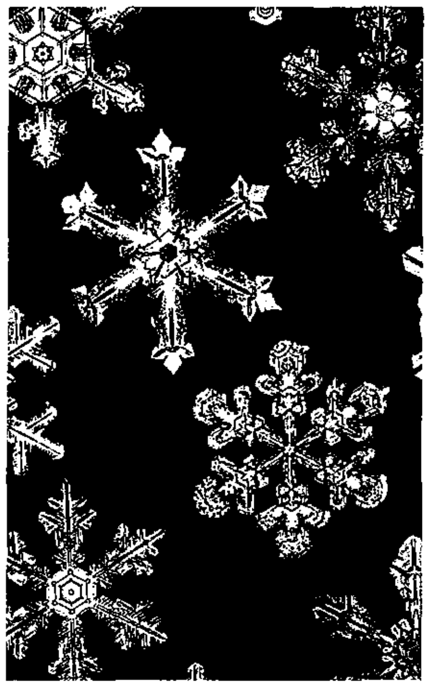
In Brooklyn, more than 20 letter carriers were found unconscious in snowdrifts, and a great number of poor families had to be carried from icy, unheated hovels to the nearest police stations which, by noon, were filled to overflowing.

Near City Hall, a policeman found four girls lying unconscious on the sidewalk. He dragged each of them across the street by their wrists to shelter in a nearby hotel.

Hotels, bars, private homes, and

Snowbound in New Jersey

The following is the personal account of a gentleman caught by the storm during a Sunday visit to friends in Jersey City Heights, and of his attempt to return to New York City on "Blizzard Monday."



It never for a moment occurred to me to regard this storm as a thing to prevent me from getting to New York. I thought, of course, that owing to the high winds and the isolated condition of the house that there was more snow there than anywhere else, and that as soon as I got out into the regular streets it would be all right. The Jackson Avenue station of the New Jersey Central was only five or six blocks from the house, and I anticipated not the slightest trouble in getting there. . . . I bade my friends a fond adieu and started for town. It was still snowing and blowing . . ., and not a print had been made in the snow about the house. . . .

A great bank of snow, piled up against the shrubbery lining the sidewalk confronted me, but I could see a comparatively clear valley on the other side and I took a running jump to clear it. . . . (The) top of my hat was the first part of my person to strike the snow, and my head and neck and the greater portion of my fall overcoat followed it into the freezing hole it made. This wasn't pleasant, but with melted snow going down my trousers leg into my boots, I got out to the gate and into the "street," and was then able to discover the real snow.

It was everywhere. Great piles of it rose up like gigantic arctic graves . . . in all directions. Every way that I turned I was confronted with these awful mounds. I took my bearings and steered for the Jackson Avenue station. Every step I took I went in to my knees in the snow and every other step I fell over on my face and tried to see how much of the stuff I could swallow. The wind was at my back and its accompanying snowflakes cut the back of my head and my ears like a million icy lashes. . . .

I . . . plowed my way, jumping, falling, and crawling over the drifts, some of which were nine or ten feet high, and regaining my wind in spots where the snow had been driven away, and after an hour and ten minutes I got at the end of my six blocks. There were trains there, two of them, but they were stuck as fast as if somebody had suddenly dumped hogsheads of mucilage about them. There were passengers in them, too, half-frozen and wholly disgusted, some of them women. . . . There had been one train run through in the morning, but that was all. . . .

I gave up the idea of going to New York. . . . My trip back to the house was simply awful. The wind was straight in my face and beat so in my eyes that I couldn't see a rod before me. My mustache was frozen stiff, and over my eyebrows were cakes of frozen snow. My gloves were of kid, and by the time I had gotten halfway back I thought my hands would break off at the wrists. I stumbled along, falling down at almost every step, burying myself in the snow when I fell, struggling frantically up only to sink deep down again. Then I began to feel like a crazy man. Every time I fell down, I shouted and cursed and beat the snow with my fists. I was out there alone, and I knew it, and if I should get down some time and not be able to get up I knew that I might just as well say my prayers. Then it got dark. The wind howled and tore along, hurling the icy flakes in my face, and the very snow on the ground seemed to rise up and fling itself upon me.

In one of my crazy efforts to forge ahead, I caught just a glimpse of the welcome gate posts, and then I laid down on my back and "hollered." I felt as if I couldn't move a limb if $40,000,000 was held above me. Somebody heard my cries, and just as I was going off comfortably to sleep my friend came plowing out through the snow, and he and his man dragged me into the house.

—*New York Times, March 16, 1888*

public buildings were jammed with people looking for shelter. Some eventually spent the night in jail on cots provided by the police, while a number of wealthy businessmen and bankers found themselves sharing quarters with skid row inhabitants; not a few had their pockets picked.

With trains, steamers, horsecars, and ferries halted, the city's only link to the outside world was the Brooklyn Bridge. Foolhardy pedestrians dragged themselves across hand over hand, clinging blindly to the railings as the biting wind cut them to the bone and blew their hats into the East River. The police eventually closed the bridge, for fear of someone being blown off or dying of exposure.

By nightfall New York City was an eerie, abandoned arctic landscape. Not a streetlight was on, and the streets were deserted. People stranded in the city knew nothing of those at home, and wives and children could only guess the fate of father or husband. Exaggerated rumors of deaths and disasters were everywhere, as the storm continued unabated.

Three hundred people spent Monday night in Grand Central Station and were still there Tuesday night. More than two dozen trains were stranded enroute to the city, with 10 stalled in northern Manhattan alone.

The Albany Express was snowbound for 48 hours at Hastings-on-Hudson, north of the city. The passengers were so impressed by nature's interruption of their daily lives that they formed an association called "The Snow Birds," and resolved to meet annually on March 12 to commemorate the event.

Charles Palmer, who worked on Broadway, left Stonington, Conn., at 12:30 Monday, and 2 hours later he and 180 other passengers were stuck in an 18-foot drift. They stayed there for 2 days, except when compelled by hunger to send a foraging party to a nearby farmhouse. One of the volunteers was badly frostbitten and was thought to have suffered "permanent injury."

Among the passengers was a Mrs. Parker with a nurse and two small children. When her brother learned of her situation, he hired a tugboat and reached Sable Point, about 5½ miles from the train at about 10 a.m. Wednesday morning. It took him and his rescue party 4 more hours to plow through the snow to the train. Besides the four ladies and the babies on board, Mr. Palmer and one other gentleman were rescued. The other 170-odd souls were still stranded on Thursday and, according to Palmer, might be there much longer, as the railroad had made no efforts to send out a rescue party.

Back in the city, residents began clearing the sidewalks early Tuesday morning, after the snow tapered off to a light fall. The snow had packed down hard, and axes and picks were needed to break it up.

Most New Yorkers left for work Tuesday morning before the snow shovelers began working, burrowing through or climbing over drifts as big as a 60-ton locomotive. Broken windows, wrecked signs, torn awnings, and snowbound cars and wagons greeted them everywhere.

Sleighs, skis, and snowshoes became common sights on Fifth Avenue, Broadway, and other main thoroughfares, and the city looked more like Moscow than New York. One woman commented that it was strange to see sleighs sliding over snowbanks at the level of second-story windows.

There was suffering in New York's East Side slums, where thousands of immigrants were crowded into the city's shabbiest tenements. Food was scarce, and coal ran out; there was no milk for babies. Except for milk and dairy products, there was no real food shortage. Supplies were scarce only because they couldn't be delivered. East Side inhabitants lived from day to day, buying their coal by the pailful, their flour by the pound, their butter by the half pound, and their tea by the quarter pound. The stores they dealt with kept small stocks, which they replenished once a week. Monday was their usual purchasing day, after the weekend trade had cleaned them out. The blizzard made it impossible for the wholesale houses to deliver.

Many store owners raised prices. Coal went from 10 cents to 20 cents a pail and, according the the *Times*, "Eggs sold at 40 cents, wretched butter at 60 cents, the poorest beefsteak—called steak only by the most barefaced mendacity—for 30 cents a pound."

Paradoxically, the blizzard proved a financial blessing to the city's poor. Any man or boy able to lift a shovel could make at least double the normal laborer's wages. Street car companies, street cleaning agencies, and many private organizations were giving work to all comers at $2 or more a day. The biggest bonanza of all was shoveling snow for private homeowners and shopkeepers. Many men made as much as $10 dollars a day, and all were paid well above scale. The shoveling was still going on by Friday the 16th, and the end was not in sight.

It required thousands of men to clear the principal streets of snow, and most of the laborers were recruited from the East Side. Facing removal of an estimated 20 million cubic feet of snow, Superintendent Green of the Street Cleaning Department remarked that the city was fortunate the storm came in March, rather than December or January, when a freeze would have caused indefinite paralysis.

Ferries began making occasional runs to New Jersey Tuesday morning, and elevated trains started running sporadically a few hours later. Many people were injured during the day from falls on the wind-exposed, glazed pavements, and by midafternoon, the police had shot some 20 horses that had broken legs.

On Thursday, March 15, with bright sunshine and rising temperatures, a thaw set in. Soon ponds, puddles, and small lakes appeared, and many basements were flooded. The situation was particularly bad in Brooklyn, built on a series of hills and valleys and vulnerable to serious flooding.

People who had been snowbound in the suburbs or country towns began to arrive in the city by midweek, and with each train came tales of higher snowdrifts. The highest reported was a 52-foot drift in the neighborhood of Gravesend, reported by a John McKane. Great damage was reported at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Rockaway Beach, where new buildings under construction for the electric light company, part of a hotel, and numerous small buildings had been blown down.

Many casualties were discovered during the days following the storm. The body of a boy about 12 years old was found in the snow at Cypress and Fulton Avenues, East New York. Although not identified, it was thought to be that of a newsboy who had left the Howard House in Canarsie on Monday and not been heard from since.

An Irish coachman who had driven his carriage all day "Blizzard Monday" had died just after reaching home, and the little son of Baker Provst, who had started out on his daily delivery rounds on Monday, was missing and presumed dead.

An unknown man was dug out of a drift on Fulton street and died at the City Hospital without regaining consciousness.

Henry Henrihan, of Raritan Township in nearby New Jersey, left Milltown Monday morning to go home. He was "somewhat intoxicated" at the time and had not been heard from since. When the neighbors went to his home to tell Mrs. Henrihan, they found her dead in bed, a victim of cold and hunger, and her children half-starved and frozen.

Samuel Randall, an 80-year-old Long Island farmer, when out to the barn to feed his horse and cattle on Monday night and lost his way coming back to the house. Two elderly women who had been nursing his sick wife went out in search of him and, after a half-hour found him nearly frozen to death. They tried to carry him into the house, but failed and had to leave him to save their own lives. No other help could be found before morning, when he was discovered dead.

The storm played havoc with New York's fleet of pilot boats and other shipping. Ice had to be cut constantly from the riggings; meanwhile, heavy waves sent spray over the vessels from one end to the other, and the ice formed again with incredible speed. The sails became so stiff they broke like glass. Many crews were forced to take to the ships' yawls and were caught by the gale winds. The lucky ones were carried up on the shore. One of the yawls, a 600-pounder, was blown over and over nearly 150 feet up on the beach.

The *Niagara*, arriving from Havana, reported that Sunday night her deck had been covered with knee-deep snow. At noon on Monday, a high wave carried away 40 feet of her railing on both sides, swept away ventilators, smashed cabin windows and stove in doors. The Captain called it the heaviest storm he had ever experienced. Captain Murray of the steamship *Alaska* said the wind "blew a hurricane," and estimated its velocity at 70 miles per hour.

Some 30 funeral processions bound for Calvary Cemetery on Long Island on Monday had stalled in snowdrifts; bodies had to be taken into nearby houses overnight. Several horses and carriages were completely covered with snow, and drivers and mourners narrowly escaped death. In one instance, a party of four had to be dug out and carried unconscious to a nearby hotel.

Two days later, an undertaker started for the New Catholic Cemetery on West Side Avenue to bury Martin King. At Bolton and Montgomery streets the snowdrifts were impassable. The undertaker produced two hand sleds, lashed the coffin to them, and pulled it to the cemetery leaving the mourners to manage the passage as best they could.

On Wednesday, with the streets still buried under snowdrifts and temperatures still frigid, Adolph Osborne, a wealthy lawyer, applied to the court for a dispossess notice to evict Mary McMahon, a widow, from a tenement he owned.

"I don't dispossess anybody today," said Justice Kenna, to the cheers of the crowd of loungers in the courtroom, who had already begun to heckle Osborne.

"But I want this woman put out," said the lawyer.

"Well you can't get it done through me."

"But I want my rent," said Osborne.

"I can't help that. You will just have to wait."

Osborne left the court, "followed by the taunts of the crowd."

The Blizzard of '88 was not the most violent storm ever to visit the Northeast. Maximum wind velocities recorded ranged from 48 miles per hour at New York City to 60 miles per hour at Atlantic City, and 70 miles per hour at Block Island. The winds accompanied a severe cold wave of unusual duration and an almost unprecedented snowfall. It was this combination that so indelibly imprinted itself upon the memory of those who experienced it. As a result, the storm became a legendary event, and many parents named babies born during its visit "Snowflake," "Snowdrift," "Snowdrop," "Storm," "Tempest," and even "Blizzard" to commemorate the event.

Other veterans formed clubs to meet annually on March 12, the anniversary of the storm. One of these, "The Blizzard Men of 1888," was still meeting in New York City as late as 1941, to award a silver cup for the most interesting personal account of the storm.

The Blizzard of '88 impressed the Government, as well as the people. The Nation's Capital was completely cut off from the rest of the country for almost 24 hours. Said a United States Senator: "We cannot control the elements . . . we can protect our communications . . . wires now running overhead must be placed underground in urban areas and thus shielded from the caprices of nature. Not only are the overhead wires unsafe and unsightly . . . they are a damned menace to the security of the United States of America."

Within a few years, city telegraph and telephone wires did go underground.

New York City streets remained clogged with snow for days after the storm. Thousands of men worked to remove an estimated 20 million cubic feet of snow.

National Report

Data From Alaskan Areas With Oil Potential

The Geological Survey of Canada's Marine Geology and Geophysics Group has forwarded to EDS National Geophysical and Solar-Terrestrial Data Center a collection of marine geophysical data from relatively unexplored Alaska areas that may have potential petroleum reserves. The data collected in the Gulf of Alaska and Bering Sea consist of about 71,000 bathymetric and magnetic data points, representing almost 50,000 km of trackline.

This is the third in a series of data sets that have been forwarded to NGSDC by the Canadian Geological Survey. Previous data shipments contained marine seismic profiles collected on the Canadian Pacific continental shelf and digitized marine geophysical data collected during a joint U.S. Geological Survey-Canadian Geological Survey expedition in the Strait of Juan de Fuca.

Copies of these data sets are available from the National Geophysical and Solar-Terrestrial Data Center, National Oceanic and Atmospheric Administration, Boulder, CO 80302. Telephone 303-499-1000 ext. 6338.

Pollution-related Data Files Descriptions

The EDS Environmental Data Index (ENDEX) now contains descriptions of over 200 files of pollution-related data for U.S. coastal areas. The descriptions characterize the types of records held by various Federal, State, and local government agencies, industry, and universities.

The Data Files contain the following parameters, measured in air, water, land, or sediment: Hydrocarbons—total, aliphatic, aromatic, and chlorinated hydrocarbons, oil slick occurrence, and oils; Pesticides—2-4-D, 2-4-5-T, thion compounds, aldrin, carbaryl, chlordane, DDT,DDE, DDA, DDD, toxaphene, dieldrin, endrin, heptachlor, lindane, methoxychlor, and mirex; Heavy Metals—cadmium, copper, cobalt, chromium, lead, mercury, nickel, and zinc; Miscellaneous—PCB's, biochemical oxygen demand, and chemical oxygen demand.

Additional information on these and other ENDEX file descriptions along with costs can be obtained from the Oceanographic Services Branch, National Oceanographic Data Center, EDS/NOAA, Washington, DC 20235; telephone (202) 634-7500. Specify geographic areas, type of pollutant (e.g. aliphatic hydrocarbon, 2-4-D, lead), time periods, methods of analysis, and/or data storage media.

New Liaison Officer for Alaska

Mike Crane, of EDS' National Oceanographic Data Center, is the new EDS representative in Alaska. He will help scientific, industrial, and local governmental researchers involved in outer continental shelf projects to obtain data needed from EDS and acquire new data from them to add to the EDS data banks.

Prior to joining EDS, Crane was with the Ocean Survey Department of the U.S. Naval Oceanographic Office for 3 years, where he participated in acoustic surveys from ships and aircraft.

His address is (in care of): Arctic Environmental Information and Data Center (AEIDC), 708 A Street, Anchorage, AL 99501. Tel: 907-279-4523.

Marine Climatic Atlas of the World

The publication, *U.S. Navy Marine Climatic Atlas of the World, Volume I, North Atlantic Ocean (Revised 1974)*, is now in print. This volume updates and revises Volume I of the *U.S. Navy Marine Climatic Atlas of the World, 1955* (NAV AIR 50 1C-528) with nearly 20 additional years of meteorological data. It has two parts under the same cover: Part I, Meteorology, prepared by the EDS National Climatic Center (NCC); and Part II, Oceanography, supplied by the U.S. Navy Oceanographic Office. The volume, funded and published by the Naval Weather Service Command, is the first of eight volumes of the *Marine Climatic Atlas of the World* that the Navy will revise and update.

Part I, Meteorology, contains monthly charts and supplementary graphical presentations for surface elements: wind, waves, temperature (air and sea), humidity, precipitation, visibility, cloud cover and height, and atmospheric pressure. Part I also includes monthly presentations of tropical cyclone roses for each 5° quadrangle, extratropical cyclone roses for each 10° quadrangle, and monthly charts showing mean storm tracks and areas of cyclogenesis.

Part II, Oceanography, contains charts for types of tides, cotidal lines, typical tide curves, tide ranges, ocean surface currents, and sea and glacier ice.

Some of the meteorological data presentations have been changed from the 1955 Atlas: wave statistics have been added, and there are no upper air charts included, since several comprehensive volumes of upper air data have been published elsewhere in recent years.

The nearly 400-page volume is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price $23.90.

Incoherent Scatter Radar Data

Through recent exchanges, EDS National Geophysical and Solar-Terrestrial Data Center has acquired files of incoherent scatter radar data collected worldwide from 1963 to present. These ionospheric observations are not typically made routinely, but rather during preselected time periods, or as needed, because radar installations that can make these observations are expensive to operate and can be used for many kinds of research.

For most observations, NGSDC has acquired the signal-to-noise and autocorrelation function values converted to profiles of electron density (Ne), electron temperature (Te), and ion temperature (Ti) versus height above the station. For various reasons, data are normally obtained only between heights of about 200 and 700 kilometers.

The incoherent scatter data are available as graphical representations or tabulations on paper, or in digital form on magnetic tape.

Inquiries may be addressed to Raymond O. Conkright, National Oceanic and Atmospheric Administration, National Geophysical and Solar-Terrestrial Data Center, Environmental Data Service, Boulder, CO 80302. Telephone 303-499-1000, ext. 6444.

This 60-foot-diameter parabolic antenna on Table Mountain—6 miles north of Boulder, Colo.—is used to acquire incoherent scatter radar data.

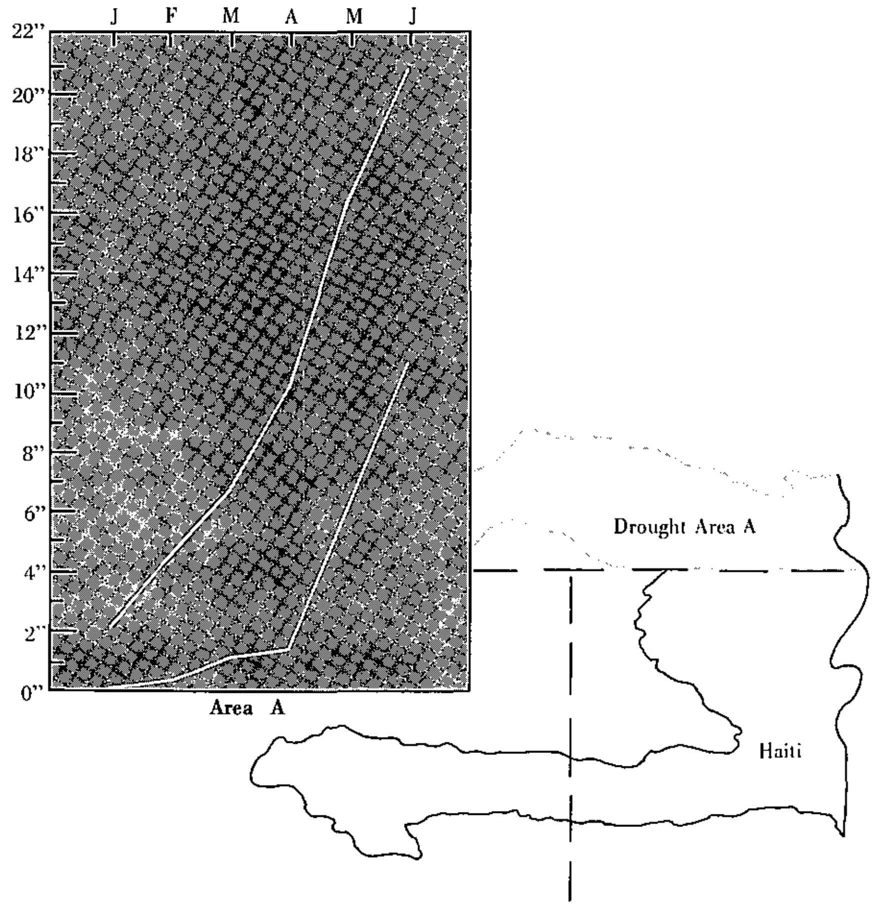
International Report

Haitian Drought Studies

EDS' Center for Climatic and Environmental Assessment has prepared a five-volume report on the recent Haitian drought for the Office of Foreign Disaster Relief Coordination, Agency for International Development (AID), U.S. Department of State. The report documents the sparse rainfall and subsequent drought that occurred in Haiti during the first half of 1975.

Accepted and innovative climatological methods were used to establish, for the 6-month period of study, that most locations in Haiti received about 50% or less of normal rainfall. The period from the beginning of January through the first half of May was particularly dry; thereafter, rainfall was near normal in northern Haiti, but below normal in the rest of Haiti. The study provides a quantitative tool for relating the drought to Haiti's agricultural production and need for foreign assistance.

In compiling the report, CCEA provided climatological frequency distribution data and analyzed deviations from average precipitation through statistical analyses of historical data. CCEA also related satellite photos with surface synoptic weather charts for each day of the 6-month period to define and evaluate the extent and intensity of the Haitian drought.



Area most severely affected by Haitian drought is shaded. The mean precipitation (upper curve) is plotted against the estimated precipitation (lower curve).

World Atmospheric Turbidity and Precipitation Chemistry Data for 1973

Atmospheric Turbidity and Precipitation Chemistry data for the World, 1973, has been published by the EDS National Climatic Center. The publication, sponsored by the World Meteorological Organization (WMO), was produced by NOAA and the Environmental Protection Agency (EPA). It contains available daily atmospheric turbidity data and monthly precipitation chemistry data for 15 separate chemical constituents. Before 1972, the precipitaiton chemistry data were published separately.

Data were submitted by WMO Regional and Baseline Air Monitoring networks and other worldwide cooperative stations. EPA processed the precipitation chemistry data. NCC processed the atmospheric turbidity data and printed and distributed the publication.

The publication is available from the National Climatic Center, Federal Building, Asheville, NC 28801 for $5.10 per issue domestic, and $7.55 foreign.

International Geophysical Calendar for 1976

The International Geophysical Calendar for 1976 has been prepared in cooperation with the world scientific community and distributed by EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC). The calendar is issued annually to coordinate solar and geophysical observations and data exchange. The calendar was compiled from information on coordinated observing programs involving scientists from different disciplines, institutions, and countries. For example, since the half-dozen giant ionospheric radars around the world can operate only a few days a month, it is necessary to coordinate their schedules so that they operate on the same days.

This calendar continues the series begun for the International Geophysical Year (1957-58). Its annual preparation is now the responsibility of a small, interdisciplinary organization called the International Ursigram and World Days Service (IUWDS), which adheres to the Federation of Astronomical and Geophysical Services of the International Council of Scientific Unions. J. Virginia Lincoln of NGSDC is the IUWDS Secretary for World Days.

A single day each month is designated a "Priority Regular World Day." There also are three consecutive Regular World Days each month, always on a Tuesday, a Wednesday, and a Thursday near the middle of the month. Various standard invervals of 1 to 2 weeks also are chosen to meet the needs of one project or another. Where possible, several projects are scheduled for the same interval so interdisciplinary comparisons can be made.

Copies of the 1976 Calendar may be obtained from J. Virginia Lincoln, World Data Center A for Solar-Terrestrial Physics, NOAA, Boulder, CO 80302.

International Geophysical Calendar for 1976

(See other side for information on the use of this Calendar)

JANUARY

S	M	T	W	T	F	S
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JANUARY 1977

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23	24	25	26	27	28	29
30	31					

- (17) Regular World Day (RWD)
- (18) Priority Regular World Day (PRWD)
- ◇21 Quarterly World Day (QWD) also a PRWD and RWD
- 2 Regular Geophysical Day (RGD)
- [29] Day of Solar Eclipse
- 28* Dark Moon Geophysical Day (DMGD)
- 5 6 World Geophysical Interval (WGI)
- [5 Day with unusual meteor shower activity, Northern Hemisphere
- 27] Day with unusual meteor shower activity, Southern Hemisphere
- 20 21 Airglow and Aurora Period

NOTES:

1. In 1976 the Antarctic and Southern Hemisphere Aeronomy Year (ASHAY) will have special periods of observations: Mar. 21-Apr. 3; June 17-30; Sept. 15-29; Dec. 8-23. Contact is S. Radicella, Observatorio Astronomico "Felix Aguilar", U.N.S.J., San Juan, Argentina.
2. N-MAC (noon-midnight auroral correlations) periods are: Oct. 29-Nov. 13, 1975; Nov. 26-Dec. 10, 1975; Dec. 24, 1975-Jan. 7, 1976; Jan. 20-Feb. 4, 1976; Nov. 16-Dec. 1, 1976; Dec. 15-Dec. 29, 1976; Jan. 12-Jan. 26, 1977.

OPERATIONAL EDITION, October 1975

Magnetic Pulsation Data

World Data Center A for Solar-Terrestrial Physics (WDC-A for STP), operated by the Environmental Data Service' National Geophysical and Solar-Terrestrial data Center in Boulder, Colo. has acquired magnetic pulsation (micropulsation) data from Dr. Wallace H. Campbell, who guided the data collection program while with NOAA's Environmental Research Laboratories. These data were collected at several stations in the Western Hemisphere and Antarctica from 1963 to the present.

Pulsation data have been used in studies of magnetospheric phenomena, such as particle injection, field line mapping, and substorms, and ionospheric phenomena, such as current systems, auroral activity, and absorption. Solar activity controls pulsations, but differently for various ranges of pulsation.

Most of these data are on FM audiofrequency magnetic tape. North-south pulsations are also recorded on paper strip charts as a record of amplitude vs. time. Specialized equipment are required to analyze the magnetic tape records, depending on the type of output desired—frequency-time, amplitude-time, or amplitude-frequency. Since such equipment is not generally available, investigators are invited to use the facilities at WDC-A. Write: World data Center A for Solar-Terrestrial Physics, NOAA, Boulder, CO 80302, or call 303-499-1000 ext. 6467.

Seismograms for Large Earthquakes

Recent changes in the International Council of Scientific Unions' *Guide to International Data Exchange in Seismology* call for participating observatories to routinely submit seismograms to the World Data centers (WDC) for days when earthquakes of magnitude 7.5 or larger occur. During the 18 months since the provision was adopted, six earthquakes have qualified. They occurred in China, Peru, the Leeward Islands, the Aleutian Islands, Chile, and the Atlantic Ocean. To date, 284 stations throughout the world have submitted 620 seismograms to WDC-A for Solid-Earth Geophysics; over 100 of these were received from 48 stations of the U.S.S.R. network.

Scientists can obtain copies of these seismograms, and of seismograms from the 120-station network of the World Wide Standard Seismograph Network (WWSSN), on 35-mm and 70-mm microfilm from WDC-A for Solid-Earth Geophysics, NOAA, Boulder, CO 80302. Tel: (303) 499-1000, ext. 6215.

The Guide now also asks that stations willing to lend seismograms to requesting scientists or a World Data Center for days when earthquakes above magnitude 6 were recorded make themselves known. So far, over 110 stations have volunteered to participate.

International Conference on Environmental Sensing and Assessment Meets

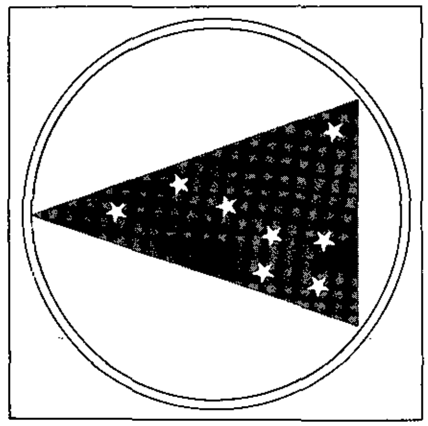
An International Conference on Environmental Sensing and Assessment (ICESA) was held in Las Vegas, Nev., September 14-19, 1975. The Conference combined the International Symposiúm on Environmental Monitoring and the Third Joint Conference on Sensing of Environmental Pollutants into a single, integrated program. The Symposium was cosponsored by the World Health Organization (WHO), the Environmental Protection Agency (EPA), and the University of Nevada. The World Meteorological Organization (WMO) participated in the Symposium at the invitation of WHO. The Third Joint Conference was cosponsored by various U.S. Federal agencies and professional societies.

ICESA was organized into 2 plenary sessions and 38 technical sessions. More than 200 papers were presented. The technical sessions were attended by about 1,000 participants representing about 40 nations.

The technical sessions addressed: (1) pollutants of concern—measurements, trends, and impacts; (2) systems for monitoring and assessment—both basic approaches and specialized systems; and (3) the interaction of human activities and environmental quality.

Pollutants discussed included heavy metals, halogenated organics, particulates, pesticides, inorganics, sulfates, carbon monoxide, and organics. Sessions on monitoring systems covered ground water, marine areas, remote sensing, personal exposure, ambient conditions, and the stratosphere. Human activity areas included agriculture, transportation, industrial processes, energy extraction, and waste disposal.

ICES Meets in Canada



The 63rd Statutory Meeting of the International Council for the Exploration of the Sea (ICES) was held in Montreal, Canada, September 28 to October 8, 1975, the first ICES meeting in the Western Hemisphere. ICES coordinates the marine research activities of its member governments and encourages international cooperation in the exploration of the sea. Two members of EDS attended sessions of the Hydrography Committee and its Working Groups: Thomas Winterfeld, U.S. member of the committee, and James Churgin, observer for WDC-A, Oceanography.

Discussion within the Hydrography Committee focused on the potential of remotely sensed data for both physical and fisheries oceanography applications. A number of United States and Canadian papers were given on that subject, including the report of the special study group on remote sensing compiled by W. Glidden of NOAA's National Marine Fisheries Service. The Committee members decided to continue the study group, which is chaired by the United States, to prepare updated reports for future meetings.

Data management problems were discussed, as they have been at many previous sessions. Members agreed that both standard data inventories and formats must be developed for the exchange of marine pollution data. The Service Hydrographique of ICES, with the advice of the Hydrography Committee's Working Group on Marine Data Management, will design such an inventory format. The Committee also decided to test UNESCO's Intergovernmental Oceanographic Commission's new General Data Format 2 by encoding continuous recording data, especially currents, obtained by cooperative studies in the North Sea.

A joint meeting of the Hydrography and Fisheries Improvement Committees was held to discuss data observing techniques and coordination of pollution monitoring programs, a topic which is of interest to both committees and some of their working groups.

At the closing of the session of the Hydrography Committee, the members of Canada and the United States asked whether the titles, structure, and mission of the Committee working groups adequately represent the problems and geographic coverage of concern to the Hydrography Committee. For example, although ICES has always been interested in the entire North Atlantic Ocean and adjacent seas, as a result of its pioneering role in coordinating pollution monitoring programs and of the entry of Canada and the United States into the organization, its concern with the western Atlantic has intensified in the past few years. The Committee formed an Ad Hoc Group chaired by Canada to consider this question.

Copies of the more than 400 papers presented in the 13 standing committees of ICES at the 63d meeting will be kept on file by EDS' Environmental Science Information Center.

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National Oceanic and Atmospheric Administration
Environmental Data Service
Washington, D.C. 20235

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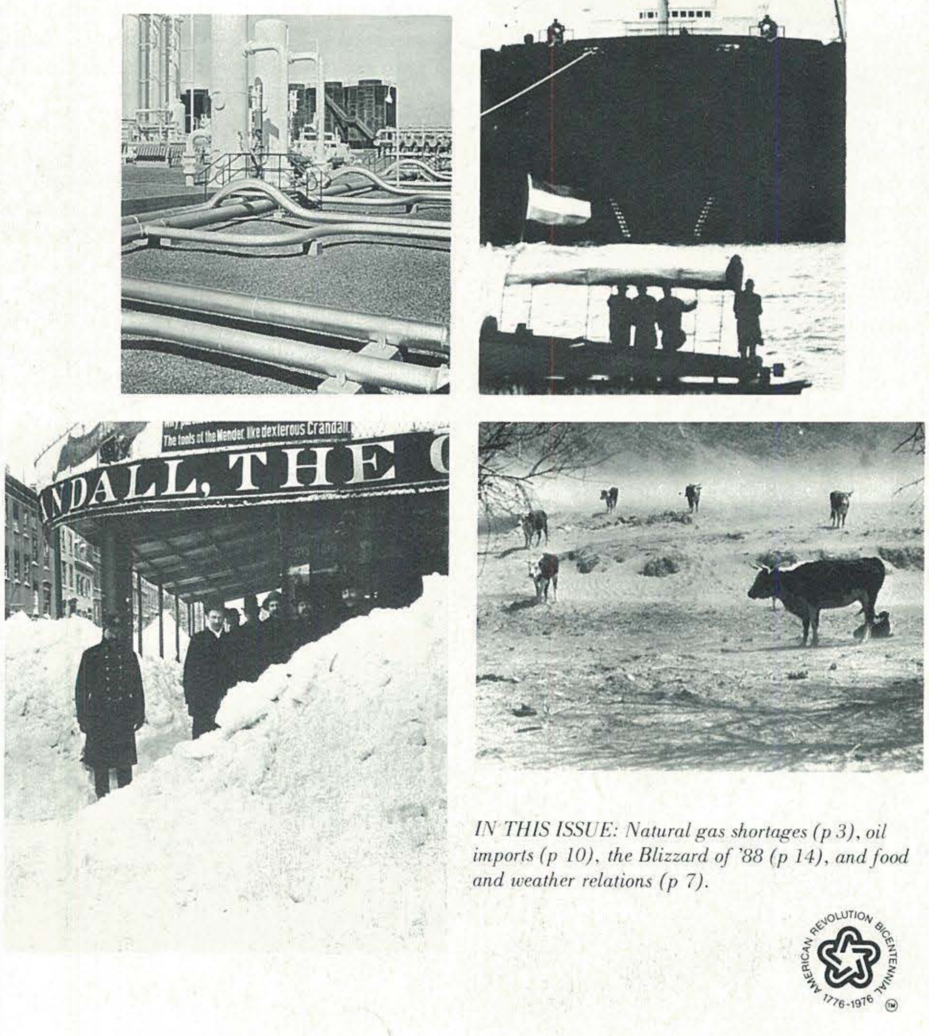


IN THIS ISSUE: Natural gas shortages (p 3), oil imports (p 10), the Blizzard of '88 (p 14), and food and weather relations (p 7).

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

EDS

Environmental
Data Service
March 1976

EDS

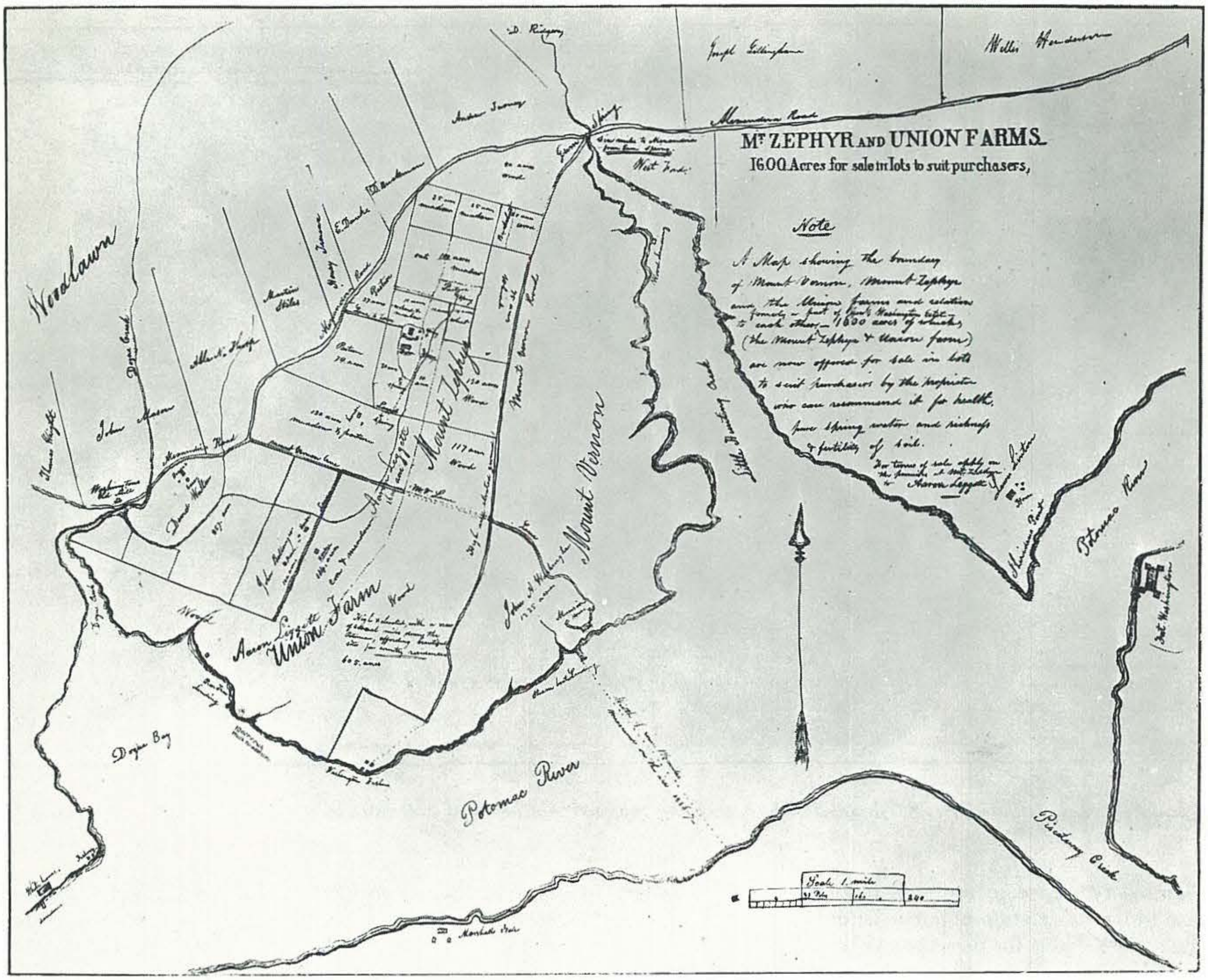
Environmental
Data Service
March 1976

COVER: Grain yields depend heavily on weather. The use of weather data to project global grain production is examined in an article beginning on page 7.

Photo: Howard M. Lambert

ENVIRONMENTAL DATA SERVICE is designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, Center for Climatic and Environmental Assessment, and a Deepwater Ports Project Office. In addition, under agreement with the National Academy of Sciences, EDS operates World Data Centers-A for Oceanography, Meterology (and Nuclear Radiation), Solid-Earth Geophysics, and Solar-Terrestrial Physics.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 16, 1975; this approval expires June 30, 1978.



Subdivision survey of George Washington's original estate drawn in 1855. Despite intervening changes (see graph on page 5), compass bearings were about the same as when George Washington surveyed the land sometime around 1760.

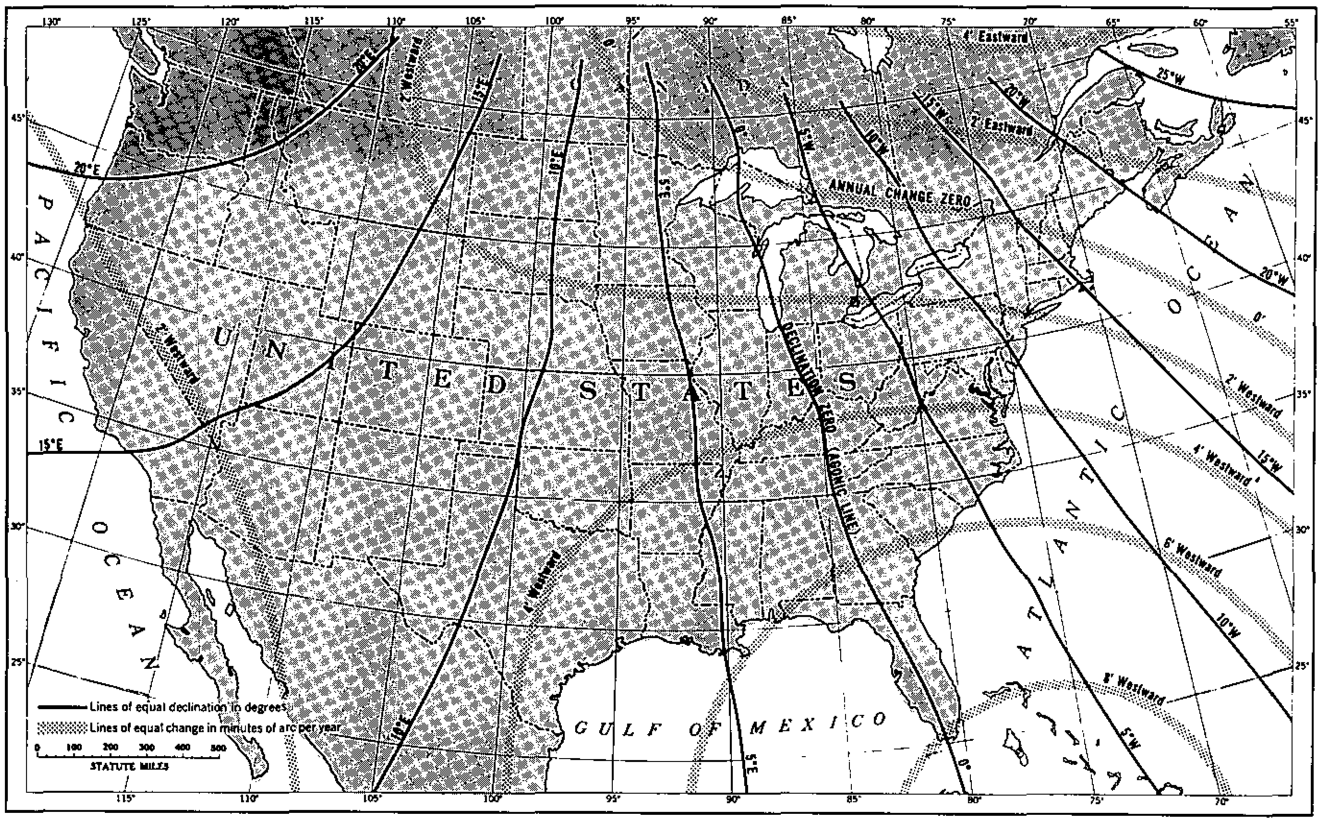
Photo: Mount Vernon Ladies' Association

Helping The Surveyor Get His Bearings

by Kendall Svendsen
National Geophysical and Solar–Terrestrial Data Center

When the land in the United States was originally divided into tracts, the deeds described the boundaries in terms of magnetic bearings. In the eastern half of the country, for instance, some state boundaries, many of the rectangular tracts defining public lands opened to settlement, and most private property lines were originally surveyed by magnetic compass. When boundary lines are disputed or property changes ownership, such tracts must be resurveyed. But the earth's magnetic field is constantly changing, altering magnetic bearings. For example, if the magnetic bearing of a north-south property line that George Washington surveyed at Mt. Vernon 200 years ago was resurveyed by magnetic compass today, the magnetic bearing of the new line would be displaced 7 degrees to the west of the original line.

Because of this problem, many states have legislated against the use of the magnetic compass and of magnetic bearings in describing property lines. The Bureau of Land Management has



Simplified version of 1970 U.S. Magnetic Chart showing magnetic declination and rates of annual change.

required reference to the true meridian in the description of public lands since 1894. Thus, for new surveys for land subdivision, the surveyor describes the boundary lines in terms of true bearings, derived by reference to geodetic markers or by observations of the sun or stars.

Early surveyors were probably aware that the direction of magnetic north would change through the years, but at the time the magnetic compass was the only practical instrument available for use. It was not until the presidency of Thomas Jefferson that the U.S. Coast Survey was established to collect magnetic data. Even then, the making of magnetic observations and the collection and analysis of results remained sporadic for many years. It was only in the last half of the 19th Century that the surveyors' need for systematic observations and analysis of changes in magnetic directions was recognized. As a result, the Coast Survey began to repeat measurements at several locations and established magnetic observatories, where the changes in the magnetic field were continuously recorded to gain more detailed information on their behavior. In addition, the Survey established a system of field survey points at county seats throughout the nation. Thus, a surveyor could compare his compass readings with these true values and determine the necessary correction.

Today, current values of magnetic declination (the difference between true north and magnetic north) are depicted on isogonic charts published by the U.S. Geological Survey, or stored in a computer by the EDS National Geophysical and Solar-Terrestrial Data Center (NGSDC). Until 1960, tables of changes in magnetic bearings (secular changes) were published. Now, these data too are stored in a computer, and a printout can be tailored to meet the needs of the requester. Values for intersecting magnetic lines for an entire area, state, or region also can be furnished. Many NGSDC requests concern court actions, for which a certified copy of the data can be furnished.

As might be expected, reliability of the data stored decreases with age. Some information was provided by early explorers, but secular change information for a particular area is generally available only from the time the area was settled. For New England, for example, NGSDC has good data for the period since 1750, less reliable data for years prior to that time. For the Far West, data are generally available only since 1850. Accuracy of secular

NGSDC Geomagnetic Products and Services

Copies of primary data and of data products are available to users on an exchange basis or at the cost of copying. Contributors of data to NGSDC and its associated World Data Centers are entitled to an equivalent amount of data without charge. The costs of copying are listed in various NGSDC catalogs or will be provided on request.

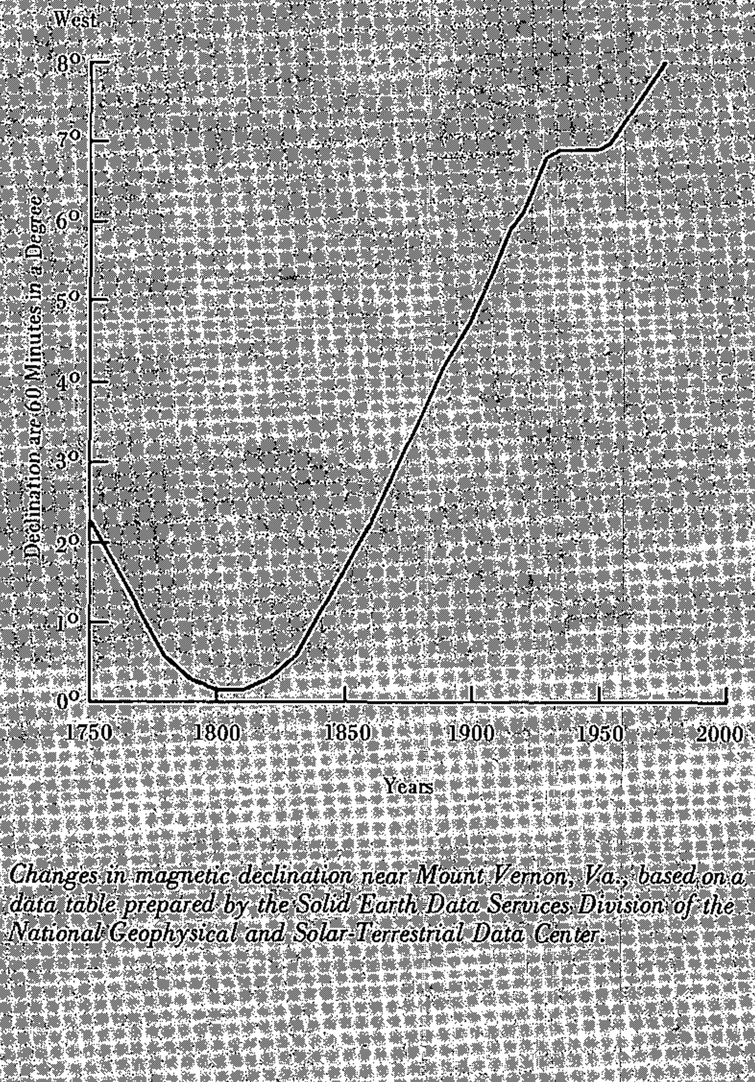
The following are available from the center:

• Magnetic survey data tables of selected observed values or long-term changes in magnetic declination or other components, tape copies of all or part of the file, information on magnetic anomalies.

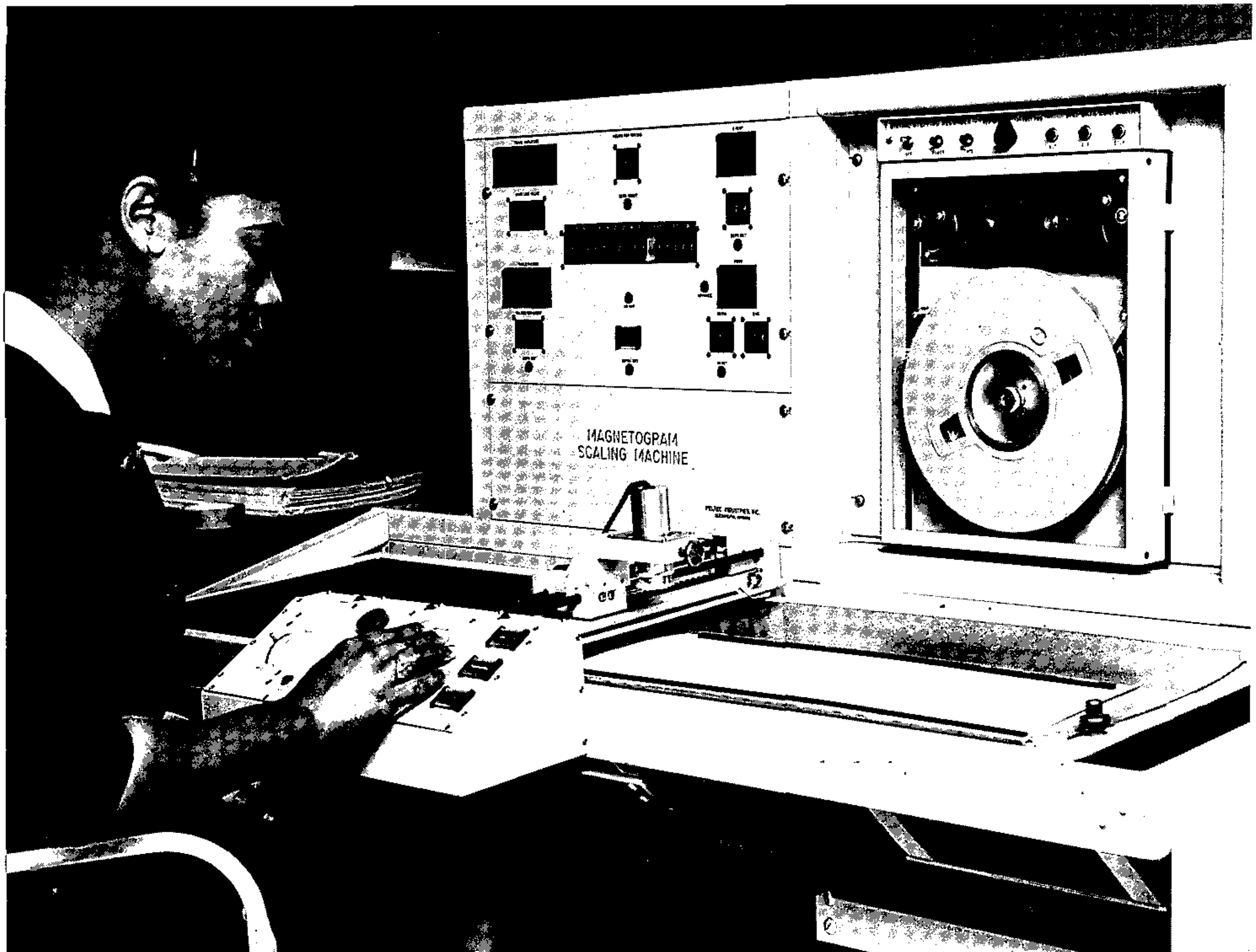
• Secular-change data tables showing long-term changes in declination and other components.

• Publications: U.S. Magnetic Charts (isogonic charts of the United States show lines of equal magnetic declination and rates of annual change, published every 5 years; magnetic charts for magnetic dip, horizontal intensity, vertical intensity, and total intensity, published every 10 years). These charts are produced jointly with the USGS.

• U.S. Magnetic Tables (published every 10 years) show magnetic values for each station occupied in the United States during the preceding 10 year period. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.



Changes in magnetic declination near Mount Vernon, Va., based on a data table prepared by the Solid Earth Data Services Division of the National Geophysical and Solar-Terrestrial Data Center.



Records of magnetic field changes are converted to digital data by a magnetogram-scaling machine and stored on magnetic tape.

change data is extremely important. An error of 12 minutes of arc in a line 91 meters (300 feet) long results in an offset of 3.3 meters (1 ft) for the corner. Where ownership of a strip of expensive land is at stake, a small error could make a big difference.

When a surveyor wants to know the location of the nearest meridian line to check his compass, NGSDC furnishes instructions for locating the station, along with true bearings of prominent objects and the present estimated value of magnetic declination for the station. The surveyor may also be furnished data on changes in the magnetic field for the period of his observations, compiled by reference to data for the nearest observatory.

NGSDC has received many unusual and interesting requests. One person was attempting to locate encampments of the Lewis and Clark expedition by use of their recorded magnetic readings. Another was looking for a road in use at the time of the Revolutionary War. And still another had a copy of a pirate's map and was looking for buried treasure. Recently, there have been many inquiries about magnetic variations in the Bermuda Triangle.

Many other types of requests for magnetic data come to NGSDC. Some ask for explanations of magnetic phenomena or for data to use in studying the correlation between magnetic phenomena and other geophysical phenomena. Space scientists need geomagnetic coordinates and conjugate points. Data have even been furnished to study the navigational ability of homing pigeons.

Whatever your need for geomagnetic data, chances are that NGSDC can meet it. Write: National Geophysical and Solar-Terrestrial Data Center, NOAA, Boulder, CO 80302. Tel.: 303-499-1000, extension 6521.

Effective Use of Weather Information in Projections of Global Grain Production

By James D. McQuigg, Director
Center for Climatic and Environmental Assessment

The following is a slightly edited version of a presentation made to the Seminar on Population, Food and Agricultural Development, Rome, Italy, December 1 to 5, 1975, organized by the International Association of Agricultural Economists in collaboration with the Food and Agriculture Organization (FAO) of the United Nations and the United Nations Fund for Population Activities.

Abstract

Projections of future grain yields are necessary for planning and operating a global system of grain distribution. Such projections have traditionally included an assumption of "normal" weather. Three major problems resulting from this assumption will be discussed, followed by a suggested approach toward a more suitable method for estimating climate-induced variability of future grain yields.

Introduction

If the crop-season weather of the world would remain within some comparitively narrow range suited to the requirements of the crops of each particular region, there still would be many difficult problems with food production and distribution. Unfortunately, crop-season weather patterns of most regions of the world exhibit a significant degree of variability from year to year, affecting food production on both a local and global scale. More effective use of the excellent body of both historical and real time meteorological information available on a global scale, together with the application of increasing knowledge concerning interactions between the atmosphere and grain production systems is necessary, if the global system for grain distribution is to remain viable.

Large-ScaleTrends in Grain Yields, Area Harvested, and Production

World total grain yield values over a long period of years are shown in figure 1. An envelope containing the plotted points would show a general upward trend in yields. Much of the variability within this envelope can be associated with large-scale meteorological anomalies, with the range of yield variability equal to about 1.5 quintals (330 pounds) per hectare (2.47 acrés).

In the past decade and a half, yields have tended to increase about 2.4 percent per year, except that yields in the two most recent years show a large downward departure from the general trend. Over the same decade and a half, the total area harvested has tended to increase about 0.3 percent per year (figure 2), while total production has increased about 2.7 percent per year (figure 3).

The study of the patterns of past behavior of yields, harvested area, and grain production is very interesting and highly instructive, but it is more important to be able to project these patterns into the future. There are crop years (such as 1974 for the U.S. corn crop) where large, weather-induced anomalies of grain yield can be detected about midway through the summer months and an effective "early warning" issued prior to harvest. A combination of the knowledge and skills of economists, agronomists, demographers, and climatologists is necessary if reasonably precise projections of grain yields are to be made.

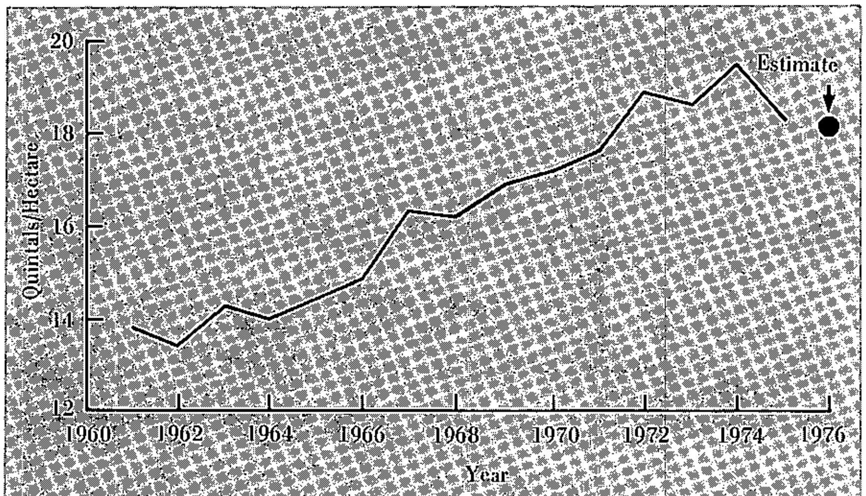


Figure 1: World total grain (wheat, rye, barley, oats, corn, and sorghum) yields. (Excludes People's Republic of China and parts of Eastern Europe). Source: Foreign Agricultural Service, USDA, 1975.

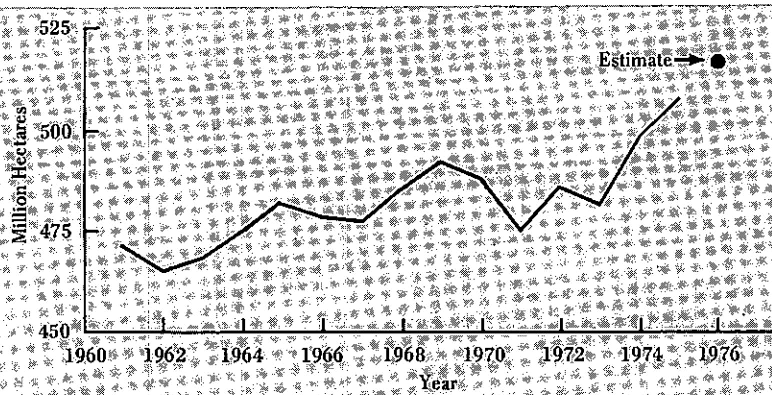


Figure 2: World total area harvested. Same as figure 1.

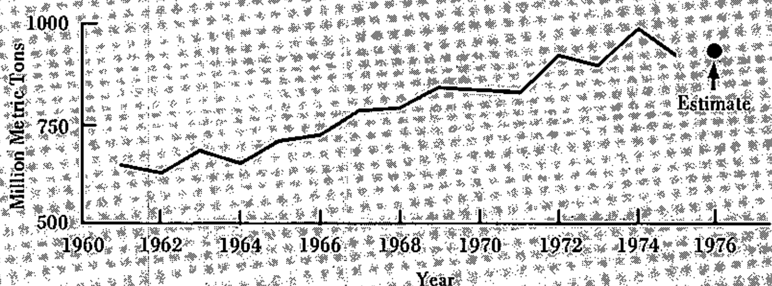


Figure 3: World total grain production. Same as figure 1.

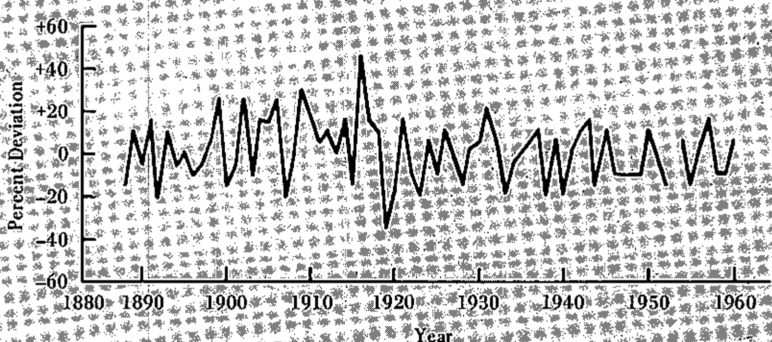


Figure 4: Deviations of annual total precipitation from the long-term mean. Port-Au-Prince/Bowen Field, Haiti.

Table 1. Corn Weather Seasons in Iowa Between 1931 and 1975 with "Normal" Weather Percentile Rank

Year	June Temperature	July Precipitation	July Temperature
1939	64	42	69
1942	41	80	41
1943	65	75	57
1966	40	43	76

Food Production Projections

Most projections of grain yield of production that are published include a statement such as the following:

". . . Assuming normal weather, United States wheat output is likely to be 13 - 24 percent larger than in 1974 and coarse grains 24 - 39 percent larger . . . ." (FAO, 1975) or, "Projections of future food production levels including those in this study, generally rest on the assumption that 'normal' weather can be expected to prevail. But policies and programs should allow for the strong possibility that weather conditions could either be less favorable or more favorable than normal. This underscores the need for flexible food policies to adapt to changes in conditions and to provide a margin of security against sudden or unexpected changes." (Economic Research Service, U.S.D.A., 1974).

There are three major difficulties in the assumption of "normal weather" for future yield (or production) of grain.

First, it is extremely difficult to find even a small sample of crop seasons in which precipitation and temperature values are within a reasonably narrow range of "normal." To illustrate this further, we examined a 44-year (1931-74) series of temperature and precipitation data for Iowa. Using Thompson's (1969) weather/crop yield model, it was determined that the search for a "normal" corn weather season in Iowa should be limited to consideration of only June temperature and July temperature and precipitation. The result is that in the entire 44 year series of Iowa weather data, there is not one season in which all three weather variables were within 10 percent of the 44-year mean. The best subset of years we could find that were close to "normal" are those shown in table 1.

A similar problem was encountered in a search for a sample of "normal" weather years in Kansas, a major wheat producing state. In this search, a 44-year (1931-74) series of temperature and precipitation data was available for each of the nine crop districts in the state. The weather/wheat yield model developed for this state leads us to believe that the year-to-year variability of March, May, and June precipitation and the March and May temperatures were associated with a substantial portion of the year-to-year variability in Kansas wheat yields. Even when a "normal" value of each of these five weather events is defined as values lying between the 30th and 80th percentile, there was not one year in the entire 44 year sample when each of the crop districts had a "normal" crop season in Kansas.

One should not assume that weather during other months of the crop season for corn (or for wheat) are not important. For example, April temperature and precipitation do affect the newly emerging wheat crop in Kansas. However, the regression coefficients in the weather/yield regression model for that month are quite small compared to those listed above.

In tropical climates, the annual total precipitation is a reasonable variable to use for illustrative purposes. Again, it is difficult to find a sample of years with close to normal rainfall. The range of variability of precipitation from year to year is quite large, as illustrated by figure 4.

The second difficulty is that in many major grain-producing regions, "normal weather" is associated with higher-than-average yields. Large meteorological anomalies on either side of "normal" tend to depress yields. This is consistent with the fact that the response of yield to weather is best expressed in nonlinear form, producing results similar to those of Thompson (figures 5, 6, and 7).

Assuming 1973 levels of technology, models for corn, soybeans, and wheat were applied to a long series of weather data. The empirical distributions of the resulting simulated yield are shown in figures 8, 9, and 10. In each case (wheat, corn,

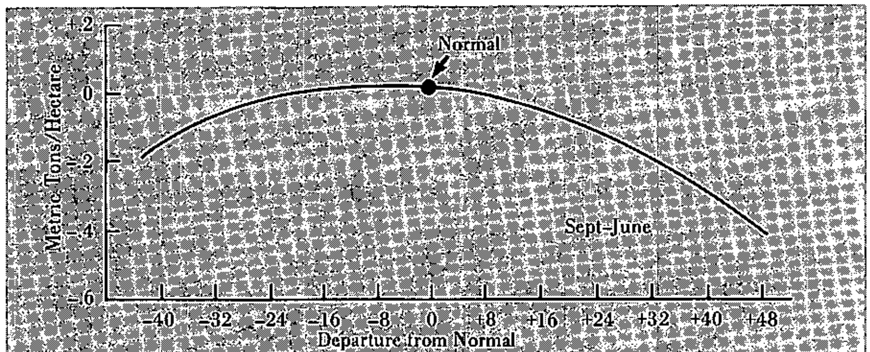


Figure 5: Influence of September-to-June precipitation (cm) variability on corn yield. Thompson (1969).

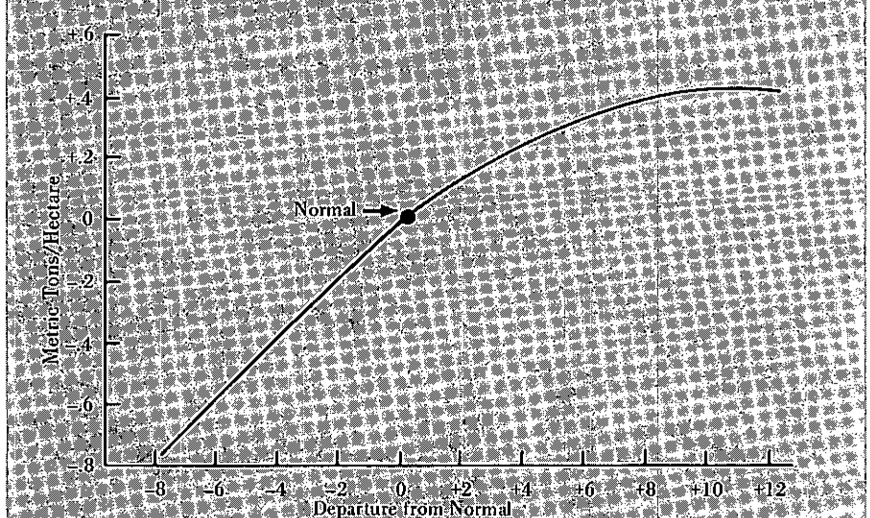


Figure 6: Influence of July rainfall (cm) variability on corn yield. Thompson (1969).

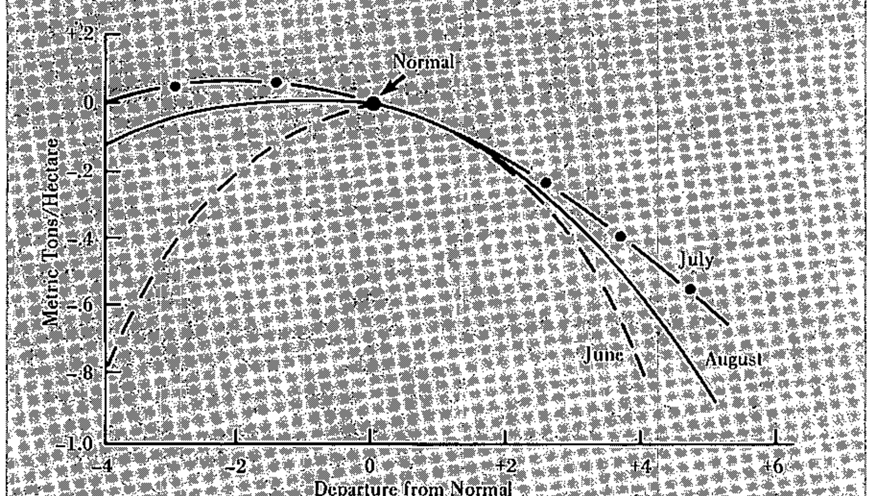


Figure 7: Influence of summer temperature (°C) variability on corn yield. Thompson (1969).

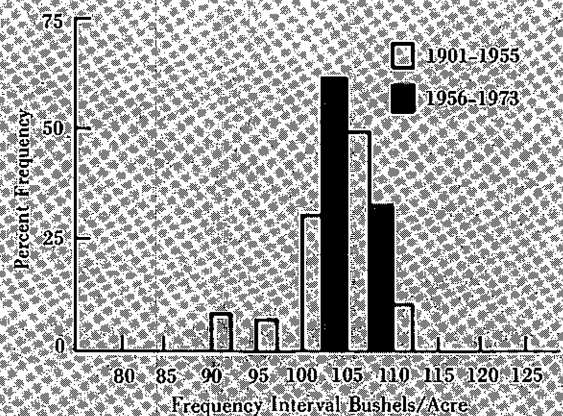


Figure 8: Distribution of simulated corn yields, 1973 technology. (Weighted average for Ill., Ind., Iowa, Mo., and Ohio).

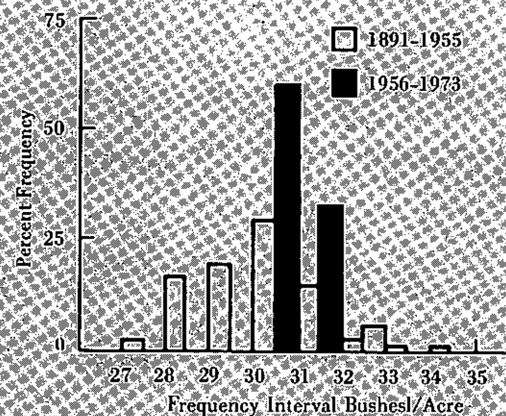


Figure 10: Distribution of simulated soybean yields, 1973 technology. (Weighted average for Ill., Ind., Iowa, Mo., and Ohio).

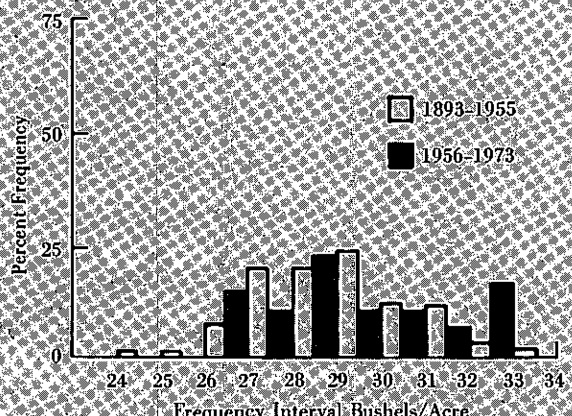


Figure 9: Distribution of simulated wheat yields, 1973 technology. (Weighted average for Kans., N. Dak., Nebr., Olka., and S. Dak.).

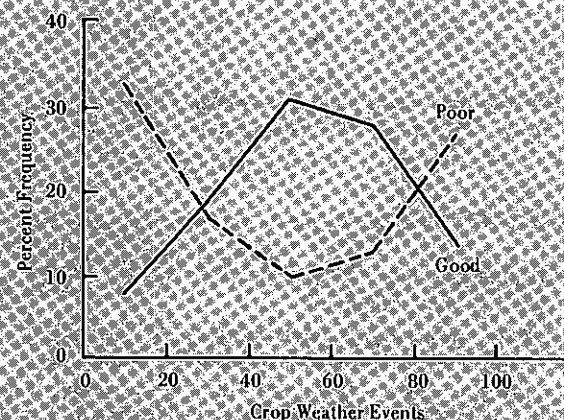


Figure 11: Iowa Corn: Empirical frequency distribution of weather associated with above- and below-trend yields.

and soybeans), "normal weather" yields are higher than the sample mean yield.

If one objects to the results of the simulation model described above, consider the following analysis of a series of actual yields.

Ten years were selected from the series when yields were at or above the trend line value, and ten were selected for years when yields were far below the trend line. The actual observed weather was tabulated for both ten year samples. Figures 11 and 12 show the empirical frequency distributions of weather associated with above-trend yields and with definitely below-trend yields.

In the case of Iowa corn yields, the weather variables associated with most of the yield variance about trend are clustered near the median for the "favorable" sample of good yield years (figure 11). For the poor yield years, the weather variables tend to be more out on the tails of the distribution. A similar, but less dramatic, pattern is observed in the case of Kansas wheat (figure 12).

The third and most important, difficulty is that projections of grain yields into future years which are based on statistical analysis of a historical series of yield data covering the period from the mid or late 1950s into the early 1970s may be more optimistic than they should be. Most of the chemical, mechanical, genetic, and managerial improvements associated with the trend toward higher grain yields have been adopted during the past two

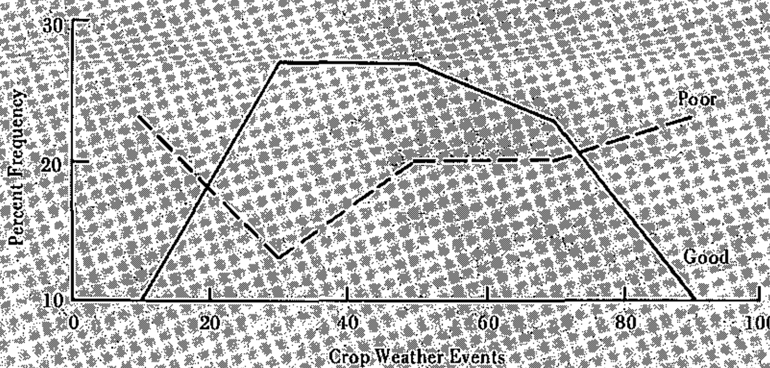


Figure 12: Kansas Wheat: Empirical frequency distribution of weather associated with above- and below-trend yields.

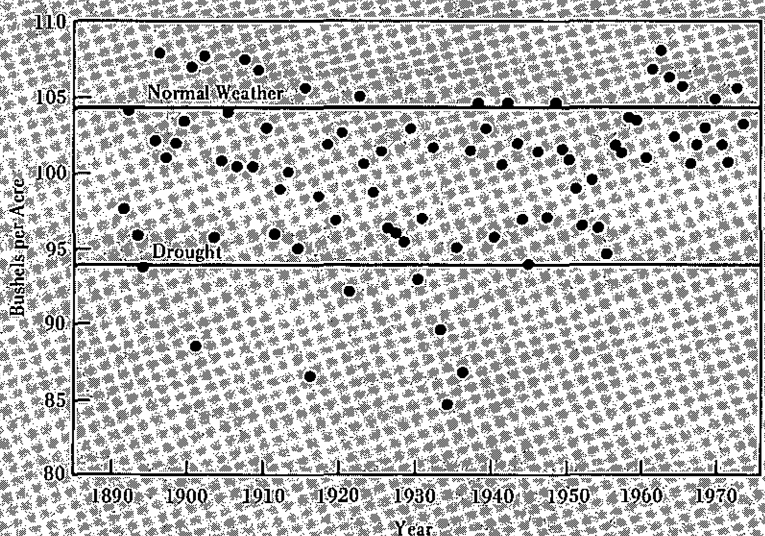


Figure 13: Simulated 5-State (Ill., Ind., Iowa, Mo., and Ohio) Weighted-Average Corn Yields, 1973 technology and harvested acreage.

decades. It would seem reasonable to use the experience gained in this most recent period as the basis for future projections. But one or two decades is not a sufficient sample of crop-season weather, because it does not permit computation of a reasonably precise estimate of year-to-year variability.

As examples, consider again the results of the analysis of corn yield/weather relationships. The simulated corn yields shown in figure 13 were computed by applying Thompson's model to a long series of weather records from the five Corn Belt states of the United States. The period 1955 to 1973 in the Corn Belt featured a large crop-season weather anomaly, when compared to any other sample period of similar length chosen at random from the period 1890 - 1954. Not only is the sample average yield for 1955-73 higher than the sample average for the preceding period of years, but the range of variability from year to year is significantly smaller than in a similar length sample were drawn from the 1890 - 1954 period.

The conclusion we have drawn from this example (and from others which are not included for lack of space) is that projections of future yields which are based on extrapolations of the trend of yield over the most recent one or two decades are likely to result in forecasts of future yields which are likely to be overoptimistic. Further, if the projection of future yields includes an estimation of weather-induced variability about a future expected yield, this estimate, too, can be in serious error, because it is not based on a sufficiently long series of crop season weather data.

Final Remarks

Professional societies involved both in meteorology and agricultural economics should strongly recommend that the phrase "assuming normal weather" not be used in statements concerning future grain yields or production.

There is an excellent body of historical yield and weather data from many regions of the world, together with a growing body of knowledgeof weather/grain yield interactions. Statements concerning future yield trends can be more usefully made in terms of estimates of future variability of yields based on an adequate sample of climatic data. If this is done, policy and programs vital to the world economy and population can be based on more realistic knowledge than has been the case in the past.

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View From A Civil-War Cornfield*

Edited By William T. Hodge
National Climatic Center

The Notes of Joseph T. Caldwell

☆ ☆ ☆

The volunteer citizen weather observer is an American institution. In earlier days such observers often commented on more than the elements.

One such commentator was Joseph T. Caldwell, a farmer in the village of Athens (pronounced with a long "a") Missouri, who, from 1863 to 1866 made three daily observations of temperature, clouds, precipitation, and wind as one of a network of volunteer weather observers established by the Smithsonian Institution. Beginning in January 1864, Caldwell began adding lengthy notes to his observations, comments which today provide a vivid glimpse of life and weather in Missouri during the Civil War.

Caldwell's observations exist only on microfilm in the National Archives. The extraction of the following text was complicated by unusual handwriting, lack of punctuation, and quaint spelling. Where necessary to clarify meaning, punctuation has been added and spelling corrected.

Notes from the observer

Athens, Clark County, Missouri, Latitute 41° 31', Longitude 14° 45' (west of Washington, D.C.) Observer: Joseph T. Caldwell

January 1864. This month of January, 1864 is the coldest weather that has been experienced for a number of years. From the 23rd day of December to the 23rd day of January, the ground has been coverel of 17 inches and has drifted to the height of the fences. Many roads that run south in course are full and (so) impassable that the community has to shovel out the snow that they could pass. The general depths of the drifts, six feet . . . . The beech and small timber was bent to the ground and a quantity of timber broken . . . . I will say that the tenth part of the timber will die on account of the snow-storm. The cattle . . . those that had sheds they lost none, but when they had to stay in the storm, ¼ have died. The cattle that has not been put in the enclosures, many of them stampeded to the timber and died before they could be found. Sheep that had sheds or houses done well, but where they had to stem the storm, ¼ have died, caught in the drifts and perished. Hogs that had good sheds would pile up and I would say that ½ of them were dead in that situation, but those that had to stand the storm, ¾ of them have died. The prairie chickens, they have ½ of them died; the quails have many of them died. Half the rabbits, many of them have been found dead for want of food. There has been many persons froze to death and many frosted badly. This winter will be a lesson long . . . remembered by all persons, that they must have their wood and coal ready for winter use, and not wait till winter to get it. They must have sheds for their stock and their feed at the barns (so) they can feed handy. There has been stock enough lost . . . this winter to have built every farmer sheds . . . . I will say that the farmers and all other branches of business have become careless in the last two years . . . . Their minds have been on the war, which I hope will wind up in the course of this year . . . .

May 1864. In regard to this part of the country and affairs, there are ⅔ of the

**This is the third in a series of Bicentennial articles on the American weather experience.*

CASUAL PHENOMENA.

Note observations of the following:

THUNDER STORMS—Time of occurrence and direction of motion. TORNADOES—Time of occurrence, width and direction of path, effects produced, and whether attended by electricity or hail. LIGHTNING AT A DISTANCE—Time of occurrence, direction from observer, whether zigzag, forked, or diffuse. Objects struck by lightning, as trees, buildings, &c. HAIL STORMS—Time of occurrence, direction and width of path, size and quantity of stones, and amount of injury. AURORA BOREALIS—Time of appearance and disappearance; time of the formation of arch, beams, and corona, and whether there is a dark cloud below the arch. Direction and time of occurrence of METEORS, SHOOTING STARS, SOLAR and LUNAR HALOS, PARHELIA and PARASELENÆ. Time of early and late FROSTS, particularly first and last. DEPTH OF GROUND FROZEN, in feet and inches; disappearance of frost from the ground. Time of closing and opening of RIVERS, LAKES, CANALS, and STREAMS, and their extreme rise and fall. TEMPERATURE of wells and springs at least once each season. EARTHQUAKES—Time of occurrence, direction of impulse, number of shocks, and effects produced.

This Month of Janury 1864 is the coldest weather that has bin experienced for a number of years from the 23 day of December to the 23 day of Janury the ground has bin covered with snow to the extent on a level of 17 inches and has drifted to the highth of the fences many Rods that Run South in lanes are full and impassable that the community had to shovel out the snow that they could pass. the general debth of the drifts six feet we have had as deap snows before but not sow cold and not drifted sow bad the timber was loaded down with snow the Brush and small timber was bent to the ground and quantity of timber broken of more especially the Pin Oaks and Black Jacks which had ther leaves on I will say that the tenth part of the timber will died on account of the snow storms The Cattle when the Storme commenced those that had sheads they lost none but when the had to stay in the storme one 1/4 have died the cattle that had not bin put in the Enclosing many of them stampeded to the timber and died befor they could be found

Sheep that had sheads or houses done well but where they had to stand the storme one 1/2 have died caught in the drifts and perished Hogs that had good sheads would pile up and I will say that 1/2 of them are dead in that situation but those that had to stand the storme 3/4 have died The Prairie Chickens there have one 1/2 of them have died the quails have many of them died & the Rabbit many of them have bin found dead all for the want of food There has bin many persons froze to death and many frosted badly. This winter will be a lesson long to be remembered by all persons that they must have there Wood & Cole Ready for winter use and not wait til winter to get it they must have sheads for there stocke and there feed at the Barnes sow that they can feed handy there has bin stocke enough lost in this vicinity this winter to of built evry farmer sheads, that there stocke would look well if they had provided with them we would of not lost any Feed is scarce and high but the People with economy may get threw but they have had something to learn them that a few leasure spent would be a fortune to them. I will say that the farmers and all other Branches of Business have become careless in the last 2 years in this part of the Country there minds have bin on the War, which I hope will wind up in the cores of this year then the minds will return to the farmes the Mecanicks in this State is different from that of Iowa or Ill. we have had the two Army to destroy and men had become dishartened they would put in one half they could of the Iowa & Ill the farmer tryed to have gone up the dry season the Lemmon died to amount to any proves a failure on the see we would like for you to Remember

Isaac Austin

Above: Joseph Caldwell's comments in his own hand. Right: Union Army headquarters during the battle of Athens, Mo., August 5, 1861.

men in the Army . . . ¼ of them are in the Rebel Army or left the state. This leaves the country with many widows who are dependent on the husband's wages for support. Provisions is very high and has caused great economy, and has started many to industry, not only in the homes but many in the cornfields, thinking, while the husband is defending the government, she can raise enough to support a family. Home manufacturing is becoming common at every house.

I do not think there will he half the farms put in cultivation. Many are trying to put their farms in grass and gone into raising sheep. I think that there will be thousands shipped here to stock the county and, in doing, in a few years more, we will have one of the first wool states in the Union . . . . Before, our state was fenced in too much, cattle, mules and hogs was profitable, but the range is gone. The land is wore out to some extent and people are in the Army and manuring land is almost stopped here.

June 1864. On the night of the 1st of June, we had frost enough to bite the vines, and kill some of the hickory leaves, and turn the corn yellow . . . . Rye, wheat, oats and barley will make a fine crop, and busy commencing harvesting and hands scarce and commanding $2.00 per day, but the prices will justify the wages well. There will not be wheat enough for consumption, but there will be a fine surplus of rye and oats. Potatoes, onions and all other vegetables bid fair to make fine crop. Navy beans, and unless rain comes soon, they will not do well . . . . As for the season to put in crops, it has been fine and easy to attend to. There has been ¼ of the labors performed by women . . . . Taking all in consideration, there will be ⅔ as much as was raised in 1862 . . . the Spirit of Agriculture never was greater. And Domestic Manufacture—some five years ago there was not one wheel to every 20 families in this county. Now there is 9 out of 10 have them, and are putting them to use as in the days of '76. Who can make the finest piece of linen or the finest piece of janes. Economy is the conversation of the fireside, and a speedy end of this war; unconditional surrender to the Stars and Stripes . . . .

July 1864 . . . has been a fine month for closing out harvest and the most of it is in the stacks and barns and all . . . is fine, and a better prospect for corn never has been had than at this time . . . . There has been more work done to the land than I ever saw before. We have been blessed with rain, but the rains are sectional. We have some excitement here . . . on account of some bushwhackers but all quiet now . . . .

February 1865. In the Mississippi River, the ice moved out clear past Keokuk, Iowa. The evening of the 20th February, ice 14 inches thick. The Des Moines River, the ice broke up the 22nd February. The ice on mill ponds, 18 inches. This has been the greatest weather for putting ice up that has been for years. Ice very clear and sound, and large amounts put up here . . . .

26th, 27th, some rain but our water courses have not risen only some seven feet which is less than usual. The frost on the ground in the prairies froze 18 inches; in the timber, froze 10 inches. The deepest freezing we have had for 4 years. Navigation of the Mississippi River resumed to Keokuk, Iowa. First Steamboat, KATE KERNEY, landed. Belonged to the Keokuk and St. Louis Packet Company.

March 1865 . . . . For the first time in 20 years, on the 9th, the thermometer was 1 degree below zero.

On the 10th, in the morning, the thermometer was down to 4 degrees; 2:00 p.m., 10 degrees; 9:00 p.m., 15 degrees with an east wind which was uncommon to be so cold in this climate. On the 13th, heavy sleet, so as to break many limbs of timber such as willow . . . .

On the 18th, the wind south 45 in the morning. At 2:00 p.m., southwest 60 miles. At 9:00 p.m., 25 southwest. Some buildings unroofed. Great destruction with fencing and timber. The heaviest wind for six years.

October 1865 . . . . The first frost, 16th, not too much damage. The 19th, eclipse of the sun 7:00 a.m. to 9:00 a.m. Appearance of the atmosphere, clear and visible to the eye. Snow the 24th, the first for the season. 1/16 of an inch. Ice, the first of the season, ¼".

March 1866. [Ed. note: Apparently Caldwell was ill; his weather entries are shakily written and the comments appear to have been written by his wife or daughter.]

Fickle March fairly outdid herself this year and more than sustained her fabled fickle reputation. 2nd, Des Moines River broke up. Ice gorged. Water overflowed everything higher than was ever known before. Great destruction of property. 13th, snow. 14th, snow all disappeared. 15th, snow in morning, all off before night. 17th, snow. 18th, rain accompanied by heavy thunder. 19th, misty rain and heavy hail, large as quails egg. 20th, foggy. 22nd, smoky, rain. 24th, snow. 27th, raining, sleet and snow. 30th, smoky. If the above is not a "bundle of contradictions," we will be indebted a new "Easter" to some correspondent that will oblige us with one.

April 1866 . . . . Fruit of all kinds, except peaches, showing a favorable prospect. Peaches failed to put in an appearance this spring owing to the excessive cold of the winter. Fall wheat on the prairie is generally killed. Other cereal OK. Farmers have made good progress in spring work. Providence interposing between us and frost, we may reasonably expect bountiful crops of every description.

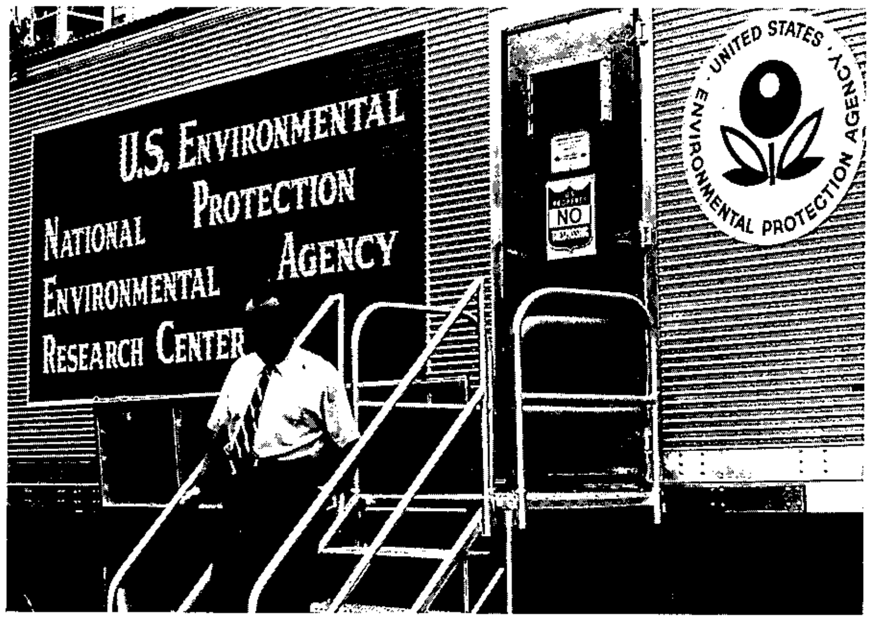
Joseph Caldwell's observations ended in July 1866; the tradition of citizen weather observers did not. Today, thousands of Americans still take weather observations for the National Weather Service without compensation, or for only token payment. Their instruments may be more modern, but their spirit is still that of Joseph Caldwell.

EPA's Aerometric and Emissions Reporting System

By James H. Southerland
Environmental Protection Agency

The Aerometric and Emissions Reporting system (AEROS) is the Environmental Protection Agency's computerized air pollution data system. The name AEROS is an umbrella term for several major and minor air data systems and their related subsystems.

In order to gather and store legally required data, the National Air Data Branch of the Office of Air and Waste Management, Office of Air Quality Planning and Standards, Monitoring and Data Analysis Division, originally established two basic computerized data storage systems known as National Emissions Data System (NEDS) and Storage and Retrieval of Aerometric Data (SAROAD). In 1973 and 1974, however, it became apparent that these systems would have to be expanded. A decision was made to merge the two systems into a larger, unified system having analysis capabilities, uniform procedures and expanded storage capability. Thus, the Aerometric and Emissions Reporting System (AEROS) came into being.



EPA National Air Data Branch headquarters, Research Triangle Park, N. C.

AEROS includes both NEDS and SAROAD and numerous other subsystems, as well as the routine data management procedures required. Some of these systems are in final development and will provide information to users in the immediate future.

Function

The Aerometric and Emissions Reporting System (AEROS) is a comprehensive computer-based system established by the National Air Data Branch to collect, store and analyze air pollution data. The data are collected by the various state and local agencies and reported to EPA. These data are then stored and analyzed in AEROS. The most notable feature of AEROS is that it is a reporting system. The primary function of AEROS is to provide concise and standardized reports on various aspects of air pollution.

Several of the AEROS subsystems are capable of functioning as independent data systems. The following information shows the relationships between the various AEROS subsystems and the information available from each.

Organization

The complete AEROS complex can best be understood by considering its two basic segments: (1) the AEROS Data System collects, stores and reports air pollution data to be put into the system; (2) the AEROS Analysis System draws data from the Data System and uses them to answer questions regarding the nature and causes of air pollution, predictions of future problems, legal action which should be taken and related problems.

By coordinating these two systems, the Environmental Protection Agency is able to obtain answers to many questions regarding air pollution problems and needs from one comprehensive system. The make-up and coordination of these two portions of AEROS as well as the interaction between the various agencies and their respective responsibilities in maintaining AEROS are described in the following sections.

Harry Schaeffer, EPA Documerica

Interagency Responsibilities and Cooperation

State and Local Agencies

Point Source Inventories	Collect Data
	Perform Laboratory Validation
Area Source Inventories	Perform Engineering Analysis
Air Quality Data	Update/Upgrade Current Data
	Convert to Machine Readable Media
	Submit Data to Regional Offices
	Check Data
	Resolve Errors

EPA Regional Offices

- Coordinate Data Receipt with States
- Maintain Logs and Audit Trails
- Data Processing and Submission
- Technical/ Engineering Support to States
- Technical/ Engineering Validation
- Error Resolution/ Correction
- Data Review And Forwarding to States

National Air Data Branch

- Control and Maintain NEDS/SAROAD Data Bases
- Validate Data Quality
- Prepare and Enter Area Source Data
- Technical/Engineering Support to Regional Offices
- Develop and Document Procedures
- General Data List And Reports
- Develop Emission Factors and Other Engineering Data and Files

Output for User

- Reports
- Retrieval
- Analysis
- Publications
- Models
- Studies

AEROS DATA SYSTEMS

NEDS (National Emissions Data System)

• Stores and reports source and emissions related data for: particulates, oxides of nitrogen and sulfur, carbon monoxide, and hydrocarbons
• Describes 78,000 point sources
• Reports data for 3,200 area sources
• Reports information to AEROS via emission inventory questionnaires, State Implementation Plan background data, and Semiannual Reports

SAROAD (Storage and Retrieval of Aerometric Data)

• Stores and reports information gathered by ambient air monitoring networks across the country
• Provides information on pollutant levels, weather information, and sites
• Collects information for AEROS from over 4,000 active monitoring sites across the nation, plus historical data for an additional 5,000 sites. Some 60 million observations are now in the system

SOTDAT (Source Test Data System)—new system

• Stores data collected from extensive tests conducted at pollution sources
• Provides retention of data supplementary to that stored in NEDS data base
• Provides source test data for development of emission estimation factors

EHIS (Emission History Information System)—new system
• Determines and reports pollution emission estimates for the U.S. for previous years
• Provides data for development or evaluation of national air pollution control strategies
• Provides basic prediction data for detecting future problems

SIPS (State Implementation Plan System)—new system
• Stores text of state regulations which pertain to limitation of air pollutant emissions
• Stores federally promulgated regulations when implemented

FPC-67 (Federal Power Commission Form No. 67)—new system
• Stores and selectively outputs descriptive and operation data from power plants over 25 megawatt capacity as reported yearly to the Federal Power Commission
• Facilities complete and comprehensive overview of power generating facilities and associated air pollution problems

HATREMS (Hazardous and Trace Emissions System)—under development
• Stores data collected regarding emissions of air pollutants that are not included in NEDS: emissions other than particulates, sulfur oxides, nitrogen, oxides, carbon monoxide, or hydrocarbons

EDS (Energy Data System)—under development
• Gathers and reports energy related data, such as fuel usage, from the other data bases in the AEROS system

AEROS ANALYSIS SYSTEMS

REPS (Regional Emissions Projection System)—new system
• Predicts emissions from geographical area or source to the year 2000
• Identifies probable future problems
• Provides mechanism for manipulation to allow prediction of the effect of changing conditions (e.g., less strict regulations)

SIEFA (Source Inventory and Emission Factor Analysis)—new system
• Computes estimated errors in emissions data due to inaccuracies in data collection and estimation procedures
• Provides mechanism for determination of areas where data improvement is required

WSAP (Weighted Sensitivity Analysis Program)—new system
• Computes the tolerable error in emissions data

QAMIS (Quality Assurance Monitoring Information System)—new system
• Stores data on the procedures, equipment, personnel, and other related information about data acquiring agencies
• Provides mechanism for monitoring and analysis of data gathering techniques

AEROS COMPATIBLE SYSTEMS

CDHS (Comprehensive Data Handling System)
• Provides software systems for state/local control agencies to use on their computers in performing their daily operations and to ease their job in meeting EPA reporting requirements; updates and enhancements are provided by NADB
• Allows state and local agencies to better monitor and manage their air pollution data management problems

The CDHS System consists of the following:

AQDHS (Air Quality Data Handling Subsystem)
• Creates and maintains an air quality data base
• Prepares a data set for submission to EPA to automatically satisfy agency quarterly reporting requirements

EIS/P&R (Emission Inventory Subsystem/Permit and Registration)
• Creates and maintains a data base describing sources of pollution, levels of pollution, and descriptive data related to permits or registrations
• Supports the agency functions of inspections, complaints, legal compliance, and source surveillance
• Prepares a data set for submission to EPA to automatically satisfy agency semiannual reporting requirements

EMS (Enforcement Management Subsystem)
• Provides a data base for use by state and local agencies to control enforcement activities
• Prepares reports, including standardized letters which can be mailed directly to sources

PREMOD (Pre-Modeling Data Output)—under development
• Makes air pollution data compatible with mathematical modeling computer programs
• Provides mechanism for data output for determination and prediction of ambient air quality for a specific area from source data

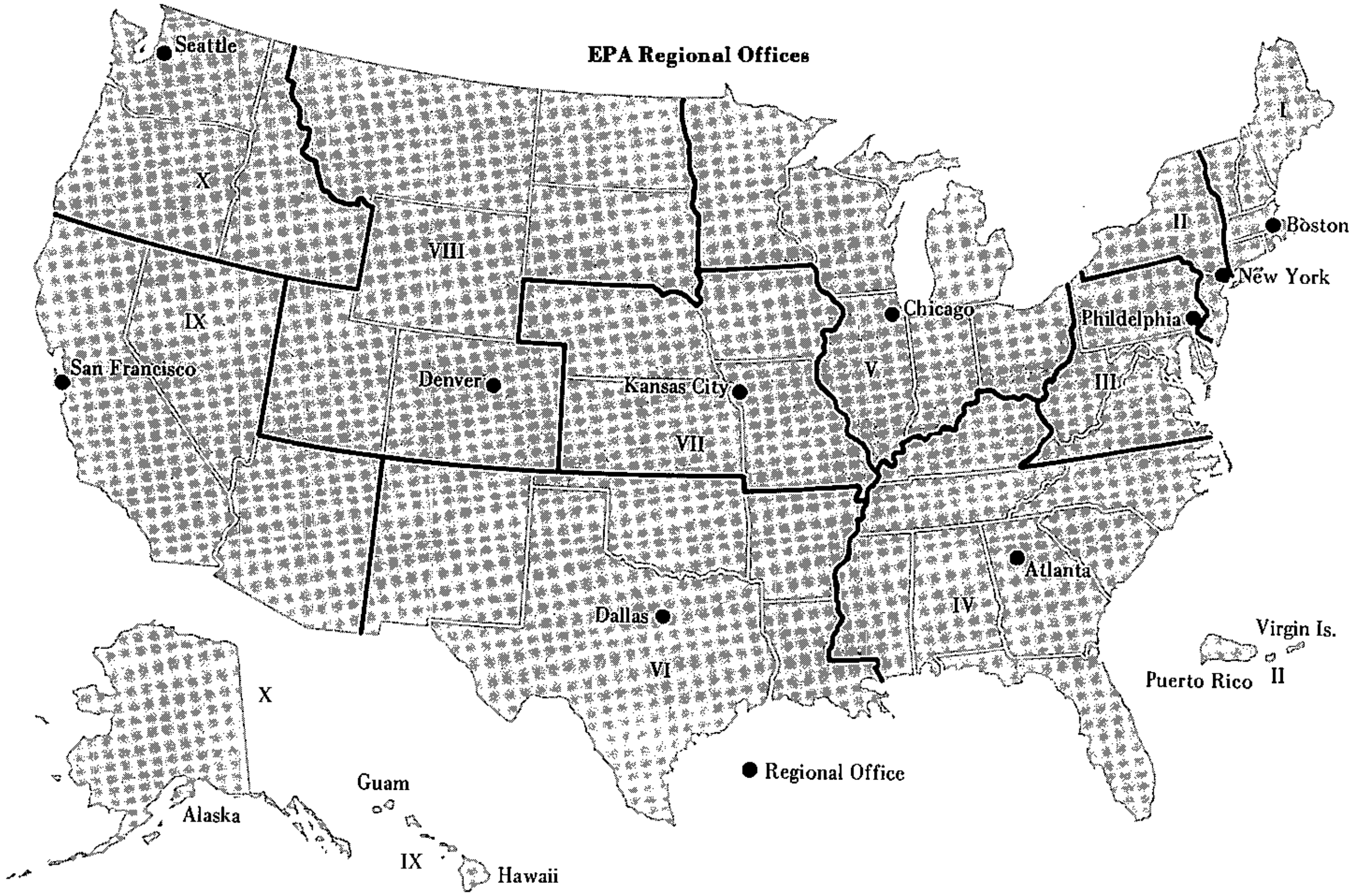
CAASE (Computer Assisted Area Source Emissions)
• Proportions county, area-source data into smaller areas based on population and similar factors to show pollution levels within grids
• Provides mechanism for usage of NEDS area source data in mathematical air quality models

USERS

The EPA air data systems are used primarily by government agencies, although the private sector is becoming more aware of the advantages in utilizing a common data base. It is expected that private sector use of the EPA air data systems will increase in the future.

Information from these systems can be accessed through standardized publications or by custom data retrieval requests. Publications available include:

Air Quality Data Statistics (Annual/Quarterly)
Compilation of Air Pollutant Emission Factors
Directory of Active Air Quality Monitoring Sites (Annual)
Emission Factors for Trace Substances
National Emissions Report (Annual)
AEROS Manual Series — Now in



Aeros Contacts

Regional Office		Regional Office	
I	John F. Kennedy Bldg. Boston, MA 02203 (617) 223-4448 or 240 Highland Ave. Needham Heights, MA 02194 (617) 223-7266	V	230 S. Dearborn Federal Building Chicago, IL 60604 (312) 353-1447
		VI	1600 Patterson Street Dallas, TX 75201 (214) 749-1176
II	26 Federal Plaza New York, NY 10007 (212) 264-9578	VII	1735 Baltimore Avenue Kansas City, MO 64108 (816) 374-3791
III	Curtis Building 6th & Walnut Streets Philadelphia, PA 19106 (215) 597-9860	VIII	1860 Lincoln Street Denver, CO 80203 (303) 837-4261
		IX	100 California St. San Francisco, CA 94111 (415) 556-2270
IV	1421 Peachtree St. N.E. Atlanta, GA 30309 (404) 526-2864	X	1200 6th Avenue (M/S 413) Seattle, WA 98101 (206) 442-1580

draft form only, not available for general distribution at this time.

AEROS Overview, Vol. I - OAQPS No. 1.2-038

AEROS User's Manual, Vol. II - OAQPS No. 1.2-039

AEROS Summary & Retrieval Manual, Vol. III - OAQPS No. 1.2-040

AEROS Manual of Codes, Vol. V - OAQPS No. 1.2-042

Copies of these publications are available from the Air Pollution Technical Information Center, Environmental Protection Agency, Research Triangle Park, NC 27711, or from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22151.

For all other information please contact the AEROS Representative at your regional EPA office, or the Requests and Information Section, NADB, Research Triangle Park, NC 27711.

New Surface Current Data Available

By Wellington Waters
National Oceanographic Data Center

Introduction

The EDS National Oceanographic Data Center (NODC) has developed a storage and retrieval system called SCUDS (Surface Current Data System) for a new file of ocean surface current data acquired from the U.S. Naval Oceanographic Office. The file contains over 4 million set-and-drift observations made by seamen of the Netherlands, Japan, Great Britain, France, and the United States. They are supplemented by several thousand Geomagnetic Electrokinetograph (an instrument which measures currents) observations, mostly of Japanese origin. The new file replaces and basically includes the nearly 3.2 million U.S. and Netherlands observations which in the past constituted NODC's surface current data file.

The file spans the period from the early 1850s through 1974. Observations for the 19th century were collected primarily by the Netherlands; those of the 1960s through 1974 (about 64,000 records) are primarily from U.S. collections.

Although it is commonly known that the ship's drift technique of observing surface currents leaves much to be desired, it is also generally agreed that this technique is the best source of supporting observations for analytic studies of vast ocean current systems. The usefullness of this current observation technique is further illustrated by the plans for an international ships drift observational and data exchange program presently being developed by the World Meteorological Organization.

General Data Quality

The quality of the SCUDS data file is considered high for this type of derived value. The data have been carefully screened for duplication; observations taken under adverse conditions (e.g. high winds and waves, time between observation greater than 12 hours, etc.) have been eliminated, when warranted. Doubtful shipboard computations of set and drift and erroneous locations (mostly positions reported as on land) also have been eliminated. The accepted data are considered most useful when used collectively such as in summaries where a number of observations show trends.

A unique feature of SCUDS is that a rather detailed, factual narrative concerning the various observational, data processing, and editing techniques employed by the several source countries is available. NODC plans to release copies of this documentation along with data output products from SCUDS.

Data Organization and Record Description

The basic SCUDS file is organized geographically following NODC's modified Canadian Consecutive Ten-Degree (COTED) square system which divides the world into squares for each 10 degrees of latitude and longitude. The file is further broken down into 1-degree squares within the 10-degree squares and arranged by months and by years for each month.

Most SCUDS records in the file contain the identity of its 10°, 5°, 2°, 1°, ¼°, and 1/10° square; the month; day and year; current direction (based on a 36 point compass), speed (to tenths of knots); and a data source (country) code. Some records do not contain year or ¼° and 1/10° square identification.

General Observation Technique

Current set (direction) and drift (speed) are determined from the difference between the dead reckoning (DR) position and the actual position, determined by any type of navigational fix after a period of steering towards the DR position. The drift is determined along a straight line track and includes all factors which cause differences in the DR and fix positions. When a fix is obtained, the current set (direction) is from the DR position "TO" the fix. The drift (speed) is equal to the distance in nautical miles between the DR and fix positions divided by the number of hours since the last fix. For successive observations, the navigational fix of one observation becomes the starting point of the next observation.

Since the influence of currents may vary along a ship's track, the MEAN POSITION of the track is assigned as the geographic location of the current observation. An example of a current computation is shown in Figure 1.

Data Products

The basic outputs of the system are selected records and data summaries. These products are retrievable for a variety of geographic areas and time periods.

Summaries are available in a long

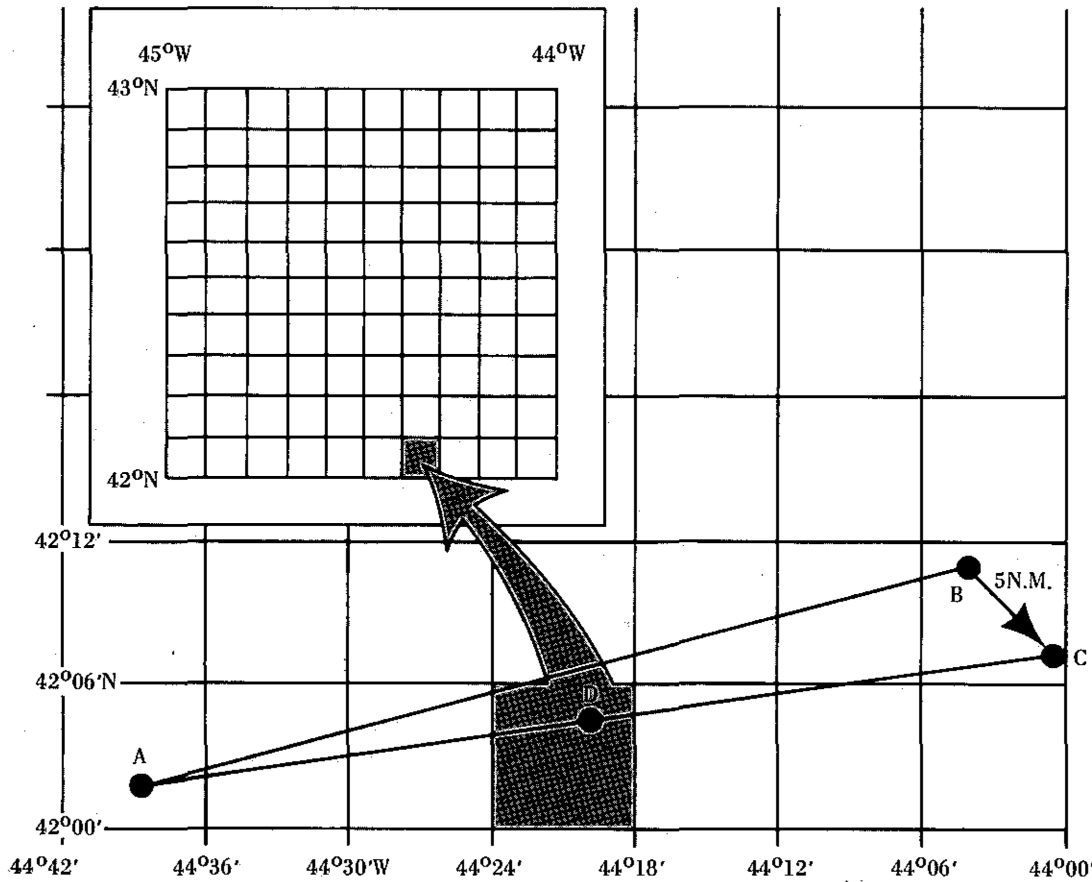


Figure 1. Example of a surface current (ship's drift) observation.
AB Course steered, 075° (true).
AC Course made good, 082° (true). Time =2.8 hr.
BC Current set 138° (true). Speed = 1.8 kn.
D Geographic location of current observation (midpoint of AC).

and short format. The long format provides area and time (monthly, or period) identity, basic statistical computations (area resultant direction and speed, north and east components, etc.), and a matrix of current speed and direction classes. Percent of observations for each direction and speed class, mean speed, maximum speed (per direction), and standard deviation are also computed.

The short summary format omits the matrix of direction and speed classes, but contains the area and month identity, the average northern and eastern current vector components for the area, the resultant direction and speed, total observations for the area, and number of calms.

Data are available on standard magnetic tape formats and as printout listings. Requests for SCUDS data or related inquiries should be addressed to:

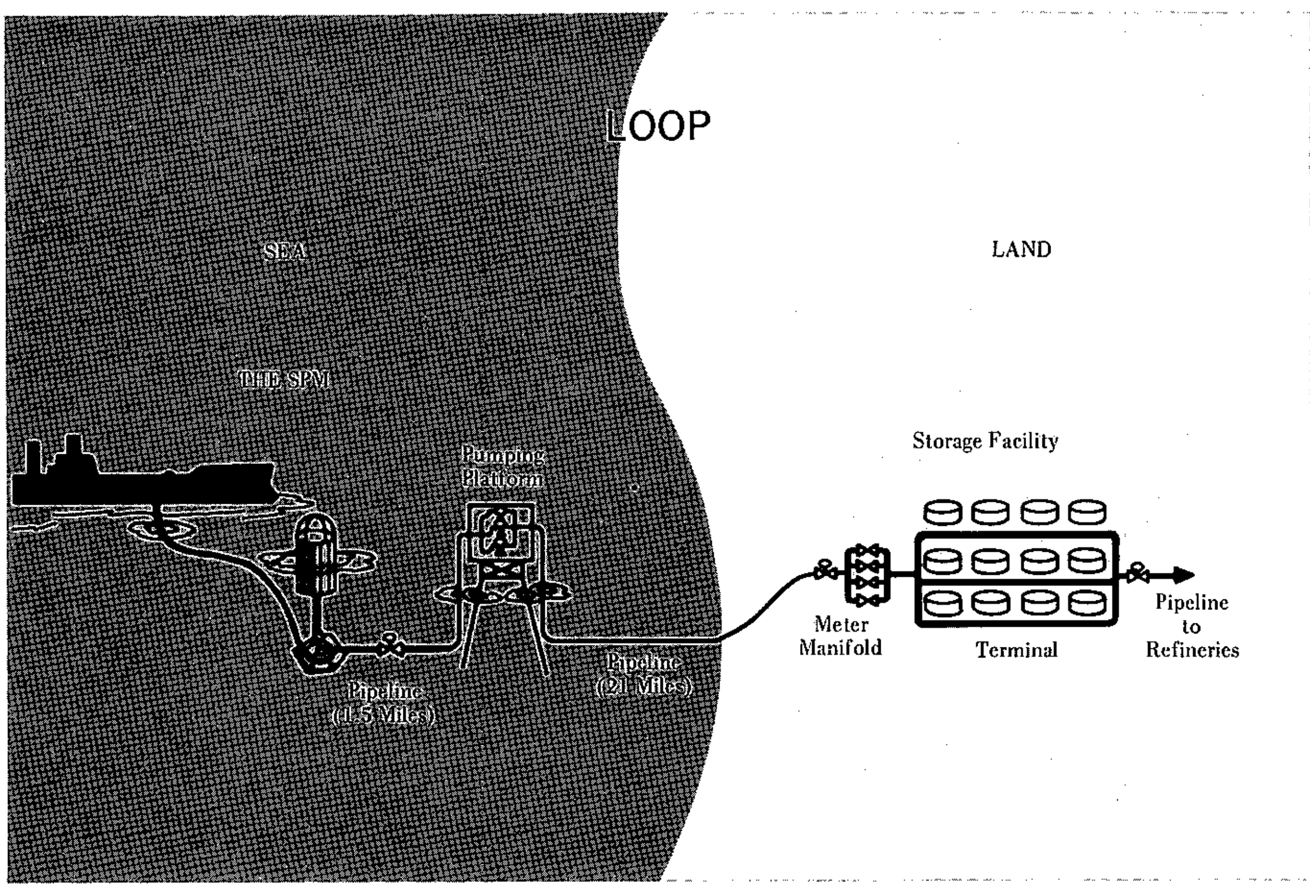
Data Services Division
National Oceanographic Data Center
National Oceanic and Atmospheric Administration
Washington, DC 20235
Tel.: 202-634-7500

National Report

First Deepwater Port Applications Received

On December 31, 1975, both Louisiana Offshore Oil Port (LOOP) Inc. and SEADOCK, Inc. submitted applications to the Secretary of the Department of Transportation for licenses to own, construct, and operate deepwater ports capable of handling very large Crude Carriers of up to 500,000 dead weight tonnage in size. LOOP intends to build a facility with a capacity of 3.5 million barrels per day 30 kilometers (18 miles) offshore to the southwest of the Mississippi River Delta, while SEADOCK is planning a facility with a capacity of 2.5 million bbl/d 43 km (26 mi) offshore to the south of Freeport, Texas. Each installation will consist of an offshore marine terminal, single point moorings (buoys), and associated submarine pipelines for transporting the oil to shore. LOOP will utilize a leached-out salt dome for storing oil, while SEADOCK will employ a conventional tank farm.

Both the LOOP and SEADOCK applications have undergone the required 21 day review period for completeness prior to their official announcement in the *Federal Register* on January 26, 1976. To meet NOAA's obligations under the Deepwater Port (DWP) Act of 1974, the EDS Deepwater Ports Project Office has reviewed, evaluated, and prepared recommendations for the NOAA Administrator on the license applications. Related environmental impact statements, and adjacent coastal State status are also being investigated by DPPO. A full-length article ("Oil Imports and Deepwater Ports") on this subject appeared in the January 1976 issue of *EDS*.



New ENDEX Services

The EDS Environmental Data Index (ENDEX) provides rapid, automated referral to multidiscipline environmental data files of NOAA, other Federal agencies, state and local governments, universities, research institutes, and private industry. (See *EDS*, May 1974.) ENDEX now offers three new services to users: an ocean bottom photo index, Great Lakes data files descriptions, and several data file distribution plots.

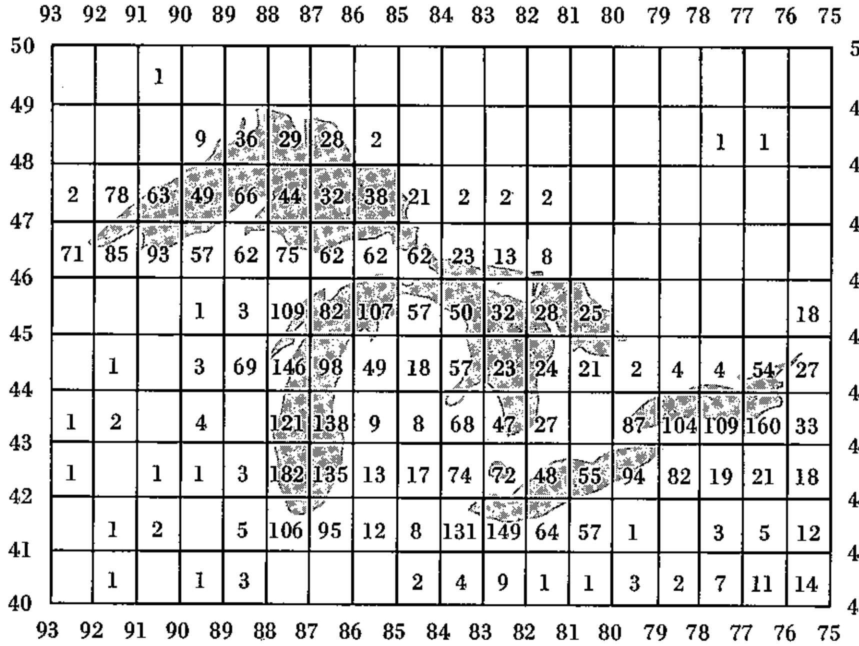
• The ocean bottom photo index contains references to over 250,000 photographs covering the world ocean. For each camera lowering, ENDEX tells an inquirer the address of the holder of the negatives, type of camera and film used, number of photos taken, location, date, ship name, and cruise and station number. Also available for many lowerings is the percent of sea floor covered by manganese nodules, water depth, and whether core, grab, or dredge samples, or current measurements were taken concurrently with the photographs. The file may be searched by any of these terms.

EDS does not have any of the 250,000 photographs in its possession, but can tell a requester where they may be obtained. Arrangements for obtaining the photos must be made by the requester.

• The Great Lakes data files descriptions contain references to over 1,000 data files. It covers descriptions of environmental data on pollution, solar flares, meteorology, wildlife, aquatic biology, pesticides, and hydrology. The description list each parameter measured, time periods, geographic area of data collection, data storage media (punched cards, data sheets, etc.), person to contact, and costs for obtaining these data.

• Data file distribution plots showing the geographical coverage of ENDEX data files also are available. One plot shows the distribution of data worldwide and indicates the number of data files available by 10-degree square. Other plots for any geographic area can be made to show counts by 10-degree or 1-degree square areas. Plots can also be made showing only those files that contain user-specified parameters.

Requests for any of the above services should be made to the Data Index Branch, D782, National Oceanographic Data Center, Washington, DC 20235. Tel.: 202-634-7298- A firm estimate of the cost of ENDEX services (usually no cost to $30) is provided to the user before a chargeable search is made.



Number of data files described for the Great Lakes and surrounding area by 1-degree square as of 12/25/75.

NGSDC Services and Publications

The EDS National Geophysical and Solar-Terrestrial Data Center (NGSDC) has published a 22-page booklet entitled "Solar-Terrestrial Physics Services and Publications." The booklet describes the regular services provided by NGSDC with respect to solar and interplanetary phenomena, ionospheric phenomena, flare-associated events, geomagnetic variations, aurora, cosmic rays and airglow, as well as a general price list for these services. The remainder of the booklet describes special services and NGSDC's regular and special publications series.

Copies of the publication are available on request from the National Geophysical and Solar-Terrestrial Data Center, NOAA/EDS, Boulder CO 80302.

Hurricane Edith Reports Available

The May 1975, issue of EDS reported the availability of storm and hurricane data reports donated to the EDS National Oceanographic Data Center by the Shell Oil Company. One report, relating to Hurricane Edith of September 16, 1971, was not made available at that time.

A limited number of copies of this report are now available for free distribution on a first-come, first-served basis. When these are gone, microfilm copies will be available at cost. The microfilm copies also include the six earlier reports covering the winter storm of February 1969; Hurricane Camille, August 1969; Tropical Depression, September-October, 1969; Hurricane Laurie, October 1969; Hurricane Celia, August 1970; and tropical storm Felice, September 1970.

For further information, write NOAA/EDS, National Oceanographic Data Center, Washington, DC 20235.

Data Summaries for 337 Cooperative Climatological Stations

The EDS National Climatic Center has completed printing climatological data summaries for 143 National Weather Service cooperative climatological observing stations in the states of Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, South Carolina, Tennessee, Vermont, and West Virginia. This is the second group of 10 states completed. (Summaries for 194 stations in the states of Alabama, Arizona, Arkansas, Connecticut, Colorado, Illinois, Iowa, Kansas, Louisiana, and Mississippi were printed in July 1975.)

Stations included in this special summary program are drawn from the group for which 1941 to 1970 normal values were calculated. The summaries are based upon digitized data available beginning in 1951 and include: (1) a table of monthly and annual means and extremes of temperature and precipitation; (2) sequential tables of monthly average maximum, average minimum, and average temperatures; (3) sequential tables of monthly total precipitation and snowfall; (4) probability statistics for spring and fall freezes and length of growing season for five temperature threshholds; (5) probability statistics for monthly total precipitaiton; and (6) monthly and annual normals for mean temperature, total precipitation, total heating degree days, and total cooling degree days.

Summaries for the 337 stations in these 20 states are available from the National Climatic Center, Federal Building, Asheville, NC 28801 at $0.15 per station copy.

New Navy Marine Meteorological Publications

The EDS National Climatic Center (NCC) has completed the preparation and printing of two U.S. Naval Weather Service Command publications.

A Study of Fog and Stratus for Selected Cold Regions (85 pages) was prepared from the analysis of surface marine and coastal land station meteorological data for the Alaskan Coastal Region (Bering Sea and North Pacific Ocean), North Atlantic Region (Iceland and Greenland coastal areas), and the Antarctic Region (Ross Sea). The publication contains monthly charts showing percent frequencies of (1) all fog occurrences, (2) fog occurring with visibilities less than one-half mile, and (3) fog and stratus occurring with air temperatures between 5° celcius (40° Farenheit) and -30°C (-22°F) for the Alaskan Coastal Region and the North Atlantic Region. Also included are monthly cumulative distributions depicting the occurrence of fog and stratus versus air temperature from 5°C (40°F) to -30°C (-22°F) for selected marine areas and land stations within each Region.

Climatic Resume of the Mediterranean Sea (NAVAIR 50-1C-64) is a 315-page atlas-type publication covering the Mediterranean and Black Seas. It is based on meteorological records from ship reports archived at NCC and sea surface current data processed by the EDS National Oceanographic Data Center. Data for one-degree quadrangles are summarized monthly and include visibility, ceiling height, wind, waves, and sea surface currents. Supplemental presentations for ceiling-visibility, wind speed, surface air temperature, sea surface temperature, and wave height are also included.

A limited number of these publications are available from the National Climatic Center, Federal Bldg., Asheville, NC 28801.

International Report

BOMEX Atlas Series Completed

The *BOMEX Rawinsonde Atlas,* the last of the atlas publications dealing with the Barbados Oceanographic and Meteorological Experiment, has been published. Based on data collected during the first three BOMEX observation periods (May to June 1969), it contains time cross sections of specific humidity, potential temperature, u and v wind components and windspeed and direction; temperature profiles; and pseudoadiabatic charts.

The *BOMEX Period III Atlas of Low-Level Atmospheric Data* and the *BOMEX Period III Radar-Satellite Atlas* were also published in 1975. The former consists of day-to-day time series displays of data obtained in late June and early July 1969 from the boom instrumentation on the BOMEX ships and from the specially designed Boundary Layer Instrument Package (BLIP). The latter, covering the same time period, shows time-matched radar and satellite products: (1) composites of data from the radar on the island of Barbados, one of the ship radars, and the radar aboard one of the aircraft; and (2) satellite photographs and maps consisting of ATS III cloud photographs and Nimbus 3 high-resolution and medium-resolution infrared radiometer minimum cloud top maps.

Earlier BOMEX atlas publications are the *BOMEX Synoptic Weather Atlas, BOMEX Period III Upper Ocean Soundings, BOMEX Atlas of Satellite Cloud Photographs, BOMEX Period III High-Level Cloud Photography Atlas,* and *BOMEX Field Observations and Basic Data Inventory,* the last of which gives a detailed description of the field operations, the instrumentation used, and the close to 100 individual investigations that were part of BOMEX.

For availability of copies of these publications, write to Center for Experiment Design and Data Analysis, Environmental Data Service, National Oceanic and Atmospheric Administration, Washington, DC 20235.

New WDC-A Data Publications

World Data Center-A for Solar-Terrestrial Physics, collocated with EDS' National Geophysical and Solar Terrestrial Data Center, has issued four new reports in its Upper-Atmosphere Geophysics (UAG) series. The series is available from the National Climatic Center, Federal Bldg., Asheville, NC 28801, Attn: Publications. Subscription price $25.20 a year; $17.30 additional for foreign mailing. The single issue price for each of the following publications is given after the title.

The *Catalog of Standard Geomagnetic Variation Data, UAG-49* ($1.85) consolidates, for the first time, all the geomagnetic variation data from standard and rapid-run measurements at the Center. These now include data collected prior to the International Geophysical Year (1957-58). The earliest data set is for Batavia, Indonesia, 1867.

The geomagnetic variation data are held in the form of microfilm, magnetic tape, yearbooks, and bulletins. They are in a variety of formats including magnetograms (normal, storm, and rapid-run), hourly values, 2.5 minute values, and various derived indices for individual observatories as well as for selected groupings of observatories. Data from over 350 observatories are referenced in the catalog, as well as a list of these observatories along with their geographic and geomagnetic coordinates. The observatories known to be in operation in 1974 are shown on a foldout map. These include some for which there are no data yet available in WDC-A archives.

The main body of the catalog displays the years and months for which the center holds tables of hourly values, hourly or 2.5 minute values, magnetic tape, magnetograms, and K-indices for each observatory. A section on sample data formats is also included, as is a listing of derived geomagnetic indices, both for individual and groups of observatories. Also provided are information on principal magnetic storms, and a listing of available sets of magnetograms reduced to common scales for selected disturbed intervals.

High Latitude Supplement to the URSI Handbook on Ionogram Interpretation and Reduction, UAG-50 ($4.00). This publication, authored by W.R. Piggott of the British Antarctic Survey, presents collections of actual ionograms and their interpretation from 23 high-latitude stations. This is in contrast to the Handbook (UAG-23), which only presented line drawings of ionograms together with their interpretation.

The ionograms selected for the Supplement cover the many phenomena that occur regularly at high latitudes, but which are difficult to interpret. (Many of the phenomena shown also occur at lower latitudes.)

The Supplement will be of particular interest to both beginning and experienced scalers of high-latitude ionograms. A large number of different types of ionosonde displays are shown for both typical and difficult-to-scale situations. The Supplement also discusses abnormal F-layer structures of special interest to International Magnetosphere Study (IMS) scientists, such as ridges and troughs associated with the auroral oval. The Supplement is part of the effort to standardize the scaling of ionograms during the IMS observing period 1976 to 1978.

The Appendix of the Supplement contains a collection of all known corrections and additions to the Handbook (Report UAG-23), printed for easy insertion into the earlier Report.

Synoptic Maps of Solar Coronal Hole Boundaries Derived from He II 304 A Spectroheliograms from the Manned Skylab Missions, Report UAG-51 ($0.54) by J.D. Bohlin and D.M. Rubenstein of the U.S. Naval Research Laboratory (NRL), Washington, D.C., is the fourth UAG Report which specifically covers the Skylab period, and the first to be compiled from data actually recorded on Skylab, rather than from corroborating ground-based data.

Solar coronal holes are very quiet areas on the sun where the magnetic field lines, instead of reconnecting on the solar surface, extend out into space. This subject is a field of intense research at present. Three Skylab Workshops are being held during 1975-76 to delve into this specific phenomenon.

The boundaries of the coronal holes on the solar surface were derived from He II 304-Angstrom spectroheliograms obtained during the manned mission periods with the NRL slitless extreme ultraviolet spectrograph experiment on board Skylab. The boundaries are plotted for each solar rotation (according to the Carrington rotation scheme begun in 1853) as synoptic charts in both the standard rectangular and polar-view projections. The polar-view projections emphasize that during this period the major areas occupied by coronal holes were in the polar caps. The charts can be used in the study of the Skylab and other space and ground-based data taken during the manned mission periods.

Report UAG-52, *Experimental Comprehensive Solar Flare Indices for Certain Flares, 1970-1974* ($0.60), was compiled by Helen W. Dodson and E. Ruth Hedeman of the McMath-Hulbert Observatory in Michigan. It updates an earlier report by the same authors (UAG-14, July 1971), which covered the period 1955 to 1969.

The experimental Comprehensive Flare Index (CFI), is based on the following criteria: (1) the amount of the ionizing effect of the solar flare in the Earth's atmosphere as indicated by sudden ionospheric disturbances (SID), (2) the flare's brightness and area estimate (known as "importance") when observed at ground-base solar observatories in the wavelength of hydrogen-alpha, (3) the amount of radio-frequency radiation given off at centimeter and meter wavelengths by the flare as monitored by the various solar radio observatories on the Earth's surface, and (4) the type of dynamic radio spectrum of the flare.

Also included in the UAG Report is information on the peak X-ray flux in the 1 to 8-Angstrom band observed by the SOLRAD satellite during the flare. This direct type of ionizing measurement could replace the SID importance in future derivations of CFI without a serious break in homogeneity of the indices.

"Major" flares are considered to be those which were well above average in at least one of the criteria given above. A table is given of these "Major" flares with their time of occurrence, duration, position on the sun, and CFI components. Also, in the Appendix to the Report, there is a table of "Lesser Events"—flares which have interesting characteristics, but which do not satisfy the criteria for "Major" flares. Distributions of the "Major" flares are given by CFI and by UT time of the flare for the two periods 1965 to 1969 and 1970 to 1974. A similar pair of histograms was prepared for the "Lesser" flares. If events with CFI greater than 10 are considered outstanding, there were 41 such cases in 1965 to 1969 and 59 in 1970 to 1974 for the "Major" flares and none in 1970 to 1974 for the "Lesser" flares.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Environmental Data Service
Washington, DC 20235

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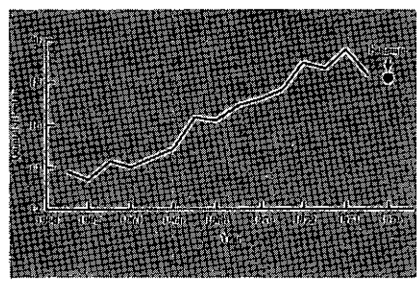
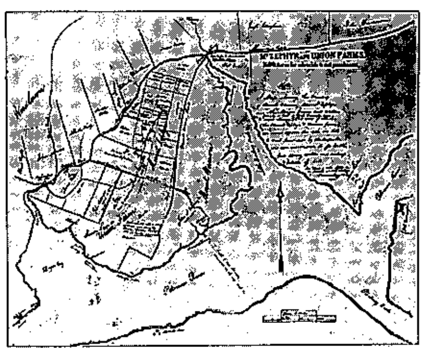
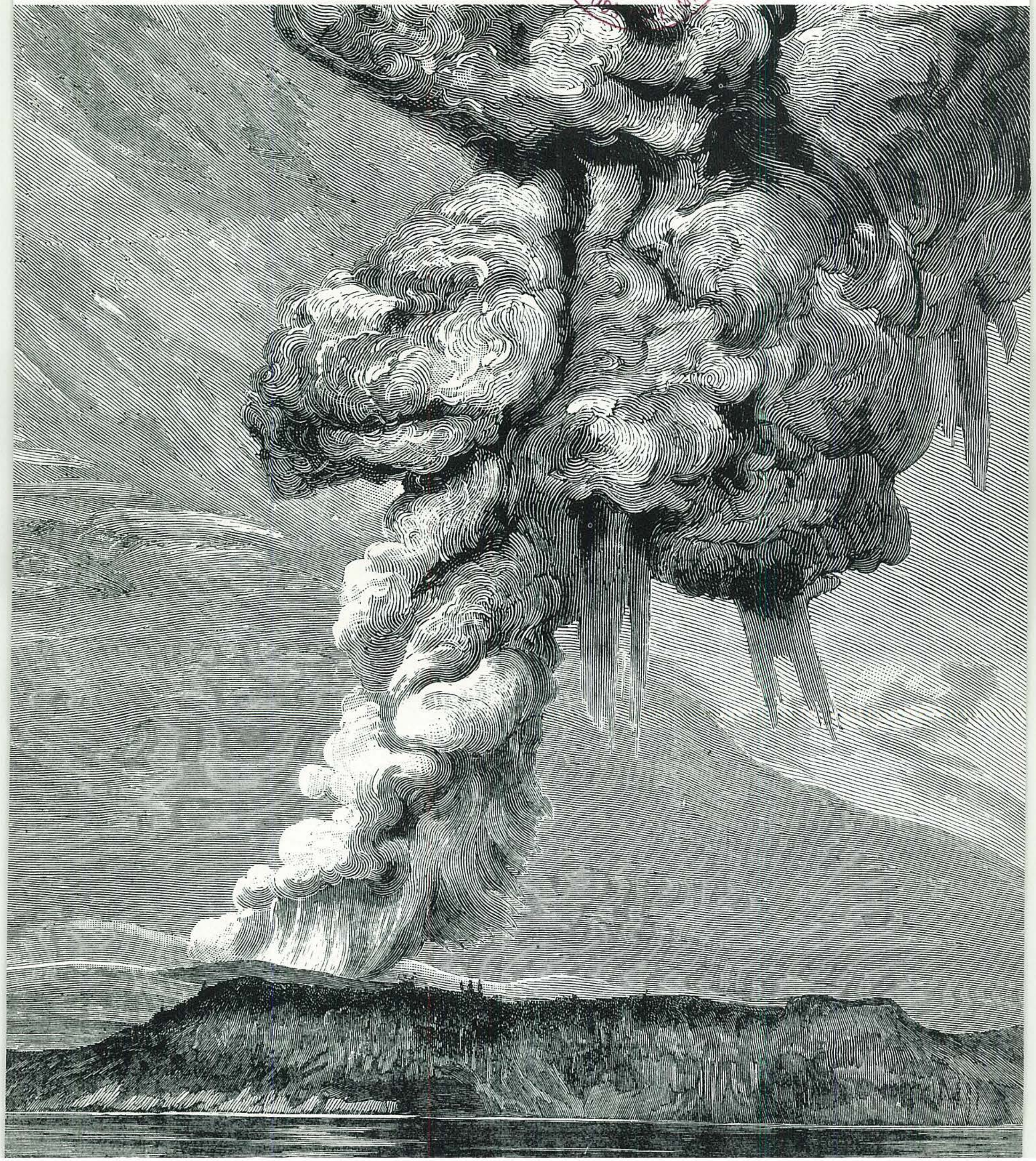




IN THIS ISSUE: Air pollution data systems (p.16), weather and grain projections (p.7), correcting magnetic compass bearings (p.3), and a view from a Civil-War cornfield (p.12).

EDS

Environmental
Data Service
May 1976



EDS

Environmental Data Service
May 1976

COVER: The eruption of Krakatoa, August 1883. The explosion, heard 3,000 miles away, threw vast amounts of dust into the atmosphere, where it stayed for as long as 3 years. (See article beginning on page 14.)
Photo: Mansell Collection

ENVIRONMENTAL DATA SERVICE is designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, Center for Climatic and Environmental Assessment, and a Deepwater Ports Project Office. In addition, under agreement with the National Academy of Sciences, EDS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, and Solar-Terrestrial Physics.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 16, 1975; this approval expires June 30, 1978.

U.S. DEPARTMENT OF COMMERCE
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National Oceanic and Atmospheric Administration
Robert M. White, Administrator

Environmental Data Service
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Meeting National Needs for Environmental Data and Information

I. National Needs

The number of users requesting data and information products or services from NOAA's Environmental Data Service (EDS) grew from about 32,000 in 1971 to about 80,000 in 1975. At the same time, EDS has become increasingly involved in the application of its data and information files and expertise to the solution of urgent national and global environment-related problems.

Energy Applications

A special NOAA data study[1] completed in September 1973 defined the extent to which national demand for heating fuels in the coming winter would depend upon the weather. The study was a key guide in formulating the national heating oil allocation program subsequently established by the U.S. Department of the Interior.

Over the last few years, NOAA's Environmental Data Service has provided baseline environmental data and information products, studies, and expertise to national efforts in the planning, site selection, design, construction, and safe operation of supertanker terminals, nuclear powerplants, offshore oil and gas facilities, and the Alaska pipeline.

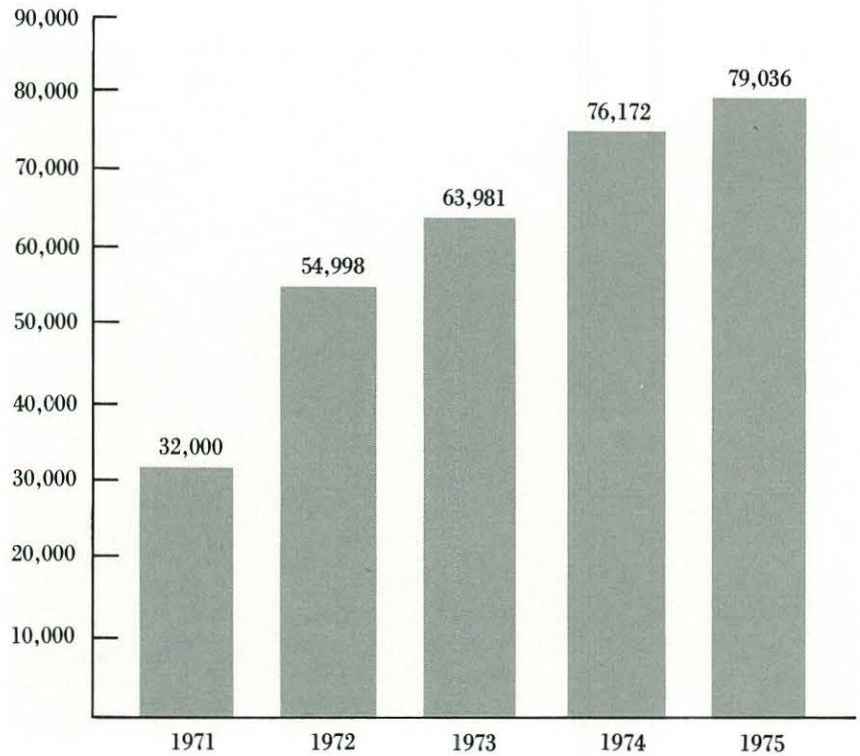
An EDS research team has developed computer simulation models which translate historical temperature data into probability projections of potential power failures due to overload during hot weather. These estimates contribute significantly to the formulation of effective planning, design, and operating strategies for large, interconnected electric power systems serving major urban areas.

NOAA "degree-day" data statistics — a measure of heating fuel and electric power demand — are used by suppliers to gage fuel needs and ensure adequate supplies. A National Weather Service/EDS degree-day service makes it possible for State energy officials to estimate cumulative, weekly, Statewide totals of natural gas usage in the current heating season as compared to normal and extreme seasons, as well as probable gas consumption in the coming week. In addition, degree-day monitoring statistics are supplied monthly to the Energy Resource Development Administration and the Federal Energy Administration.

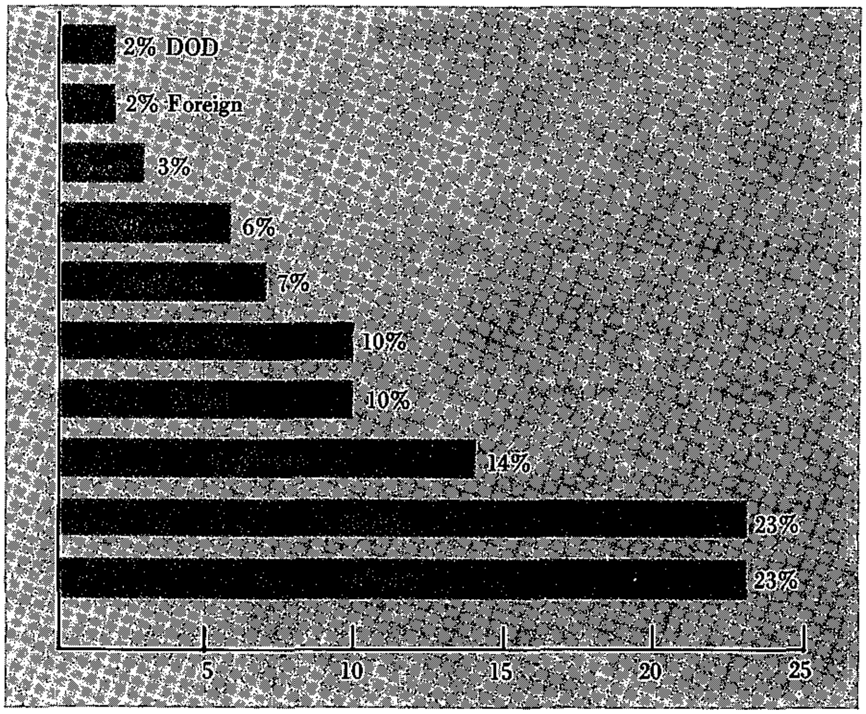
Finally, EDS and NOAA's Air Resources Laboratory, funded by the National Science Foundation, are working to rehabilitate existing solar data to produce an isolation climatology of the United States in a form most useful for solar energy applications.

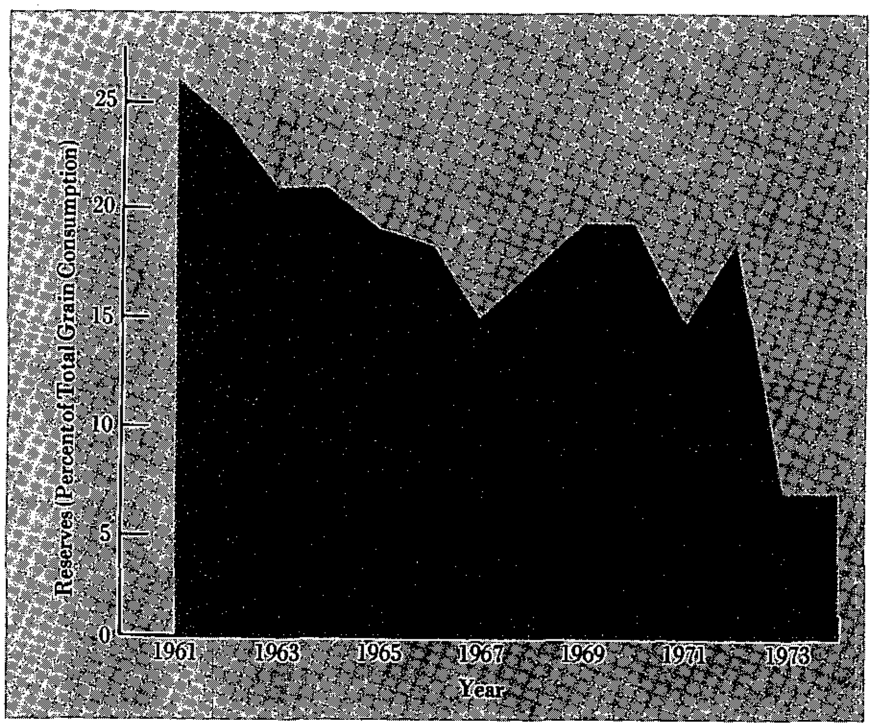
World Food Supplies

Since 1972, world grain reserves have fallen to a level about equal to the difference (8 to 10 percent of total consumption) between production in highly favorable weather and production in unfavorable weather situations. Moreover, climatic odds



EDS user requests more than doubled over a 5-year period.





Top, user catagories at the National Climatic Center, EDS' largest data center. Above, world grain reserves as a percentage of total consumption.[2]

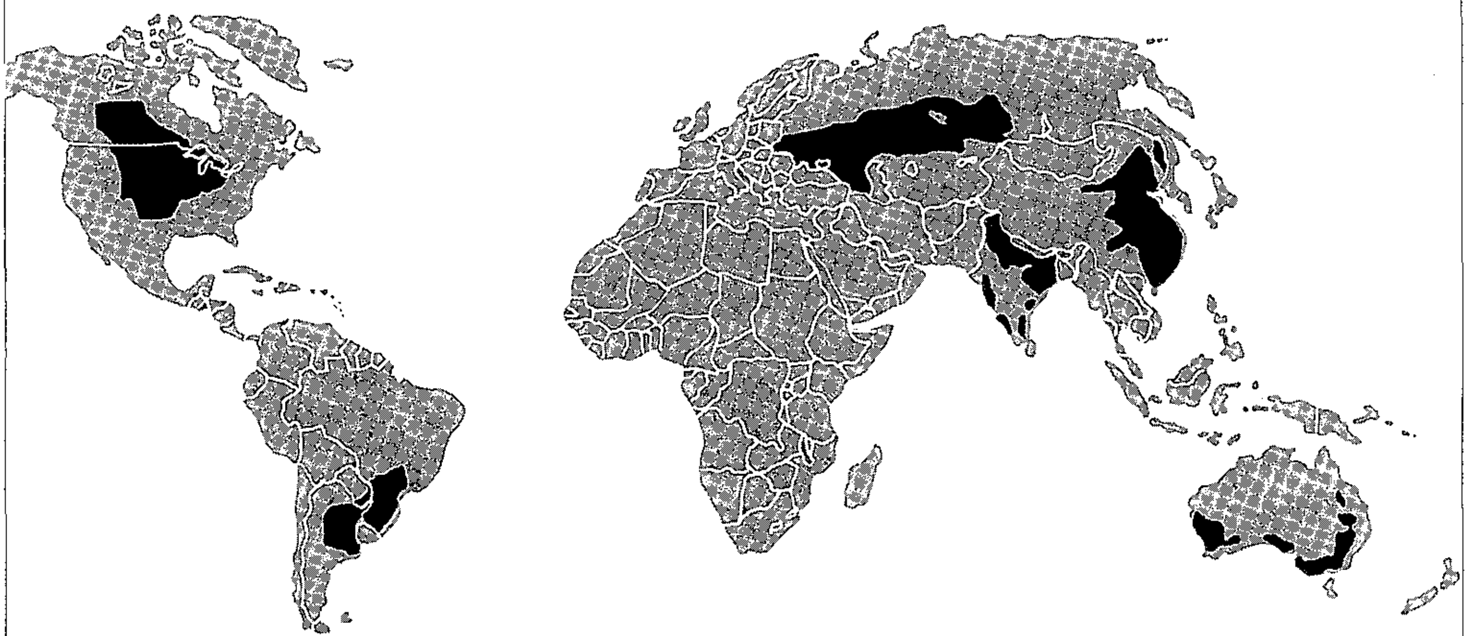
suggest that unfavorable conditions may be more likely in coming decades. Our chances of coping with or improving this precarious situation depend in part on our ability to use environmental data and information to anticipate, plan for, and adapt to climatic variability.

EDS data-based assessment studies are used by the State Department and other Government agencies to examine the potential effects of drought and other climatic fluctuations on national and global food supplies. In addition, EDS has joined the National Aeronautics and Space Administration and the U.S. Department of Agriculture in a Large Area Crop Inventory Experiment to determine whether satellite crop-monitoring and meteorological observations can be used with environmental data products to make timely and accurate estimates of future crop production.

Marine Environmental Quality Assessments

EDS provides multidisciplinary environmental data and information products and services to user and regulatory agencies concerned with pollution and its impact upon the marine environment and with developing and managing the coastal zone. EDS works with such Federal agencies as the Bureau of Land Management, Environmental Protection Agency, and NOAA's own Office of Coastal Zone Management, as well as with State and local agencies to determine environmental data and information needs and to provide products and services tailored to meet these needs.

EDS data management expertise has been applied to NOAA's Marine Ecosystems Analysis (MESA) New York Bight Project, a study of ocean dumping and total ecosystem processes. A New York Bight Data and Information Management Plan was developed by NOAA's Environmental Research Laboratories in collaboration with EDS to ensure that data and data products flow smoothly from field collection to users. The plan is also applicable to other MESA projects, in-



Major wheat-producing regions of the world.

cluding the study of the impacts of waste water and oil on the ecology of Washington State's Puget Sound.

To meet NOAA's obligations under the Deepwater Ports (DWP) Act of 1974, EDS evaluates and prepares recommendations for the Administrator regarding DWP license applications, related environmental impact statements, and the status of adjacent coastal states.

Finally, the National Science Foundation, which funds the U.S. portion of the International Decade of Ocean Exploration program, has designated EDS the lead agency for data management and final national repository for data resulting from all U.S. IDOE programs. IDOE is designed to provide the data base needed to assess and predict man-induced and natural modifications of the marine environment, to identify harmful or irreversible effects of waste disposal at sea, and to study the impact of man's activities on marine life forms. The NSF Office for IDOE adopted a strong data management policy to ensure that data collected in U.S. IDOE programs would be systematically and adequately documented, cataloged, stored, and disseminated nationally and internationally to all potential users.

Environmental Impact Statements

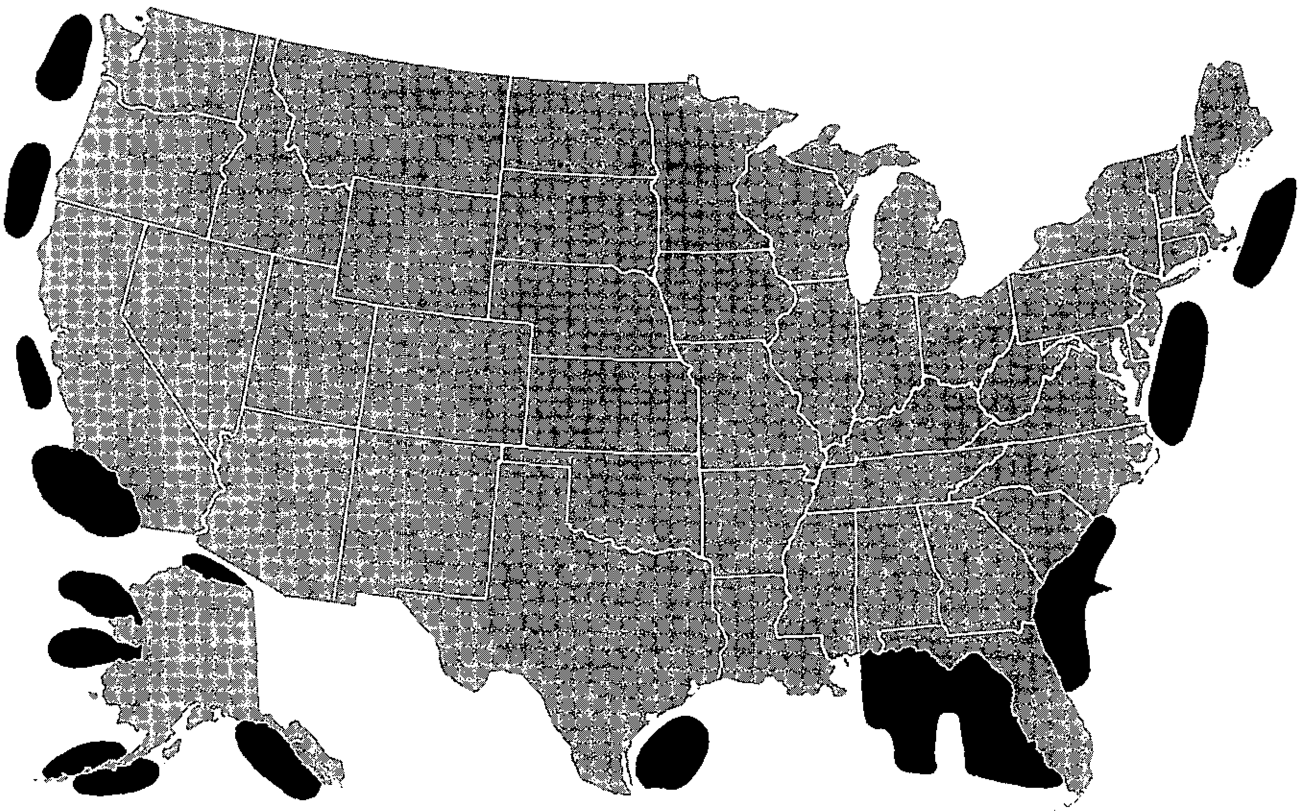
EDS provides multidiscipline environmental data and information products and services to local, State, and Federal agencies and their agents for use in preparing Environmental Reports (local, State) and Environmental Impact Statements (Federal) required by the National Environmental Policy Act of 1969 for proposed programs that may impact the environment. In addition, EDS scientists review draft Environmental Impact Statements and, where needed, suggest and provide additional data and/or information to the authors.

Large-Scale Interdisciplinary Field Projects

The environmental sciences have entered an era of very large, interdisciplinary, and usually international field experiments. The knowledge and understanding gained through such studies are essential to the solution of national and global environment-related problems. The recently completed GARP (Global Atmospheric Research Program) Atlantic Tropical Experiment (GATE), undertaken to study the coupling of ocean and atmosphere, is an excellent example of such a study.

GATE was carried out over 20 million square miles of tropical land and sea. It involved some 4,000 scientists, ship and aircraft crews, and technicians from 65 nations. Instruments aboard 40 ships, 65 buoys, 13 research aircraft, and 6 types of satellites recorded phenomena from the top of the atmosphere to nearly 5,000 feet below the surface of the sea. In addition, some 250 land stations recorded surface observations 8 times a day, while approximately 100 stations took upper air soundings twice daily.

The EDS Center for Experiment Design and Data Analysis is the National Processing Center for data acquired by U.S. ships in the primary GATE array, and also coordinated the data gathering and processing operations of all U.S. participants. U.S. GATE data holdings are stored



Current areas of oil and gas exploration on the Continental Shelf.

and disseminated by EDS' National Climatic Center.

EDS GATE data management planning began more than 2 years before field operations, so the data would be available in their most useful forms to scientists and other users, including designers of larger, follow-on programs such as the First GARP Global Experiment (FGGE), scheduled for 1977-78. FGGE will involve all the nations of the world in an attempt to gather environmental observations on a global basis to improve the accuracy of long-range weather forecasts. Even modest advances will have enormous impact on the national economy.

GATE was but the latest in a series of large-scale, interdisciplinary efforts to attack large-scale environmental problems. EDS scientists also played a central data management role in the Barbados Oceanographic and Meteorological Experiment (1969) and the International Field Year for the Great Lakes (1972-73).

II. Current EDS Capabilities and Deficiencies

Mission

The Environmental Data Service (EDS) acquires, processes, stores, analyzes, and disseminates worldwide environmental data and information for use by commerce, industry, the scientific and engineering community, the general public, and Federal, State, and local governments. It also provides professional data management support for large-scale field experiments; assesses the probable impact of environmental fluctuations on life-support and other environmentally sensitive systems for responsible Federal agencies; and manages or provides functional guidance for NOAA's scientific and technical editing, publishing, and library activities.

Service System

To carry out its mission, EDS operates a number of specialized centers, a Deepwater Ports Project Office, and a comprehensive data and information referral system. In addition, it operates relevant World Data Center (Appendix A) facilities and participates in international data and information exchange programs.

The *National Climatic Center* (NCC) is the custodian of U.S. weather records and the largest climatic data center in the world. It also disseminates environmental and earth resources satellite data, as well as photographs taken during NASA's SKYLAB missions. NCC houses World Data Center-A, Meteorology and Nuclear Radiation.

The *National Oceanographic Data Center* (NODC) houses the world's largest collection of oceanographic data and provides facilities for World Data Center-A, Oceanography.

The *National Geophysical and Solar-Terrestrial Data Center* (NGSDC) disseminates solid earth and marine geophysical data, as well as ionospheric, solar, and other space environment data. It provides facilities for World Data Center-A, Solid-Earth Geophysics and Solar Terrestrial Physics.

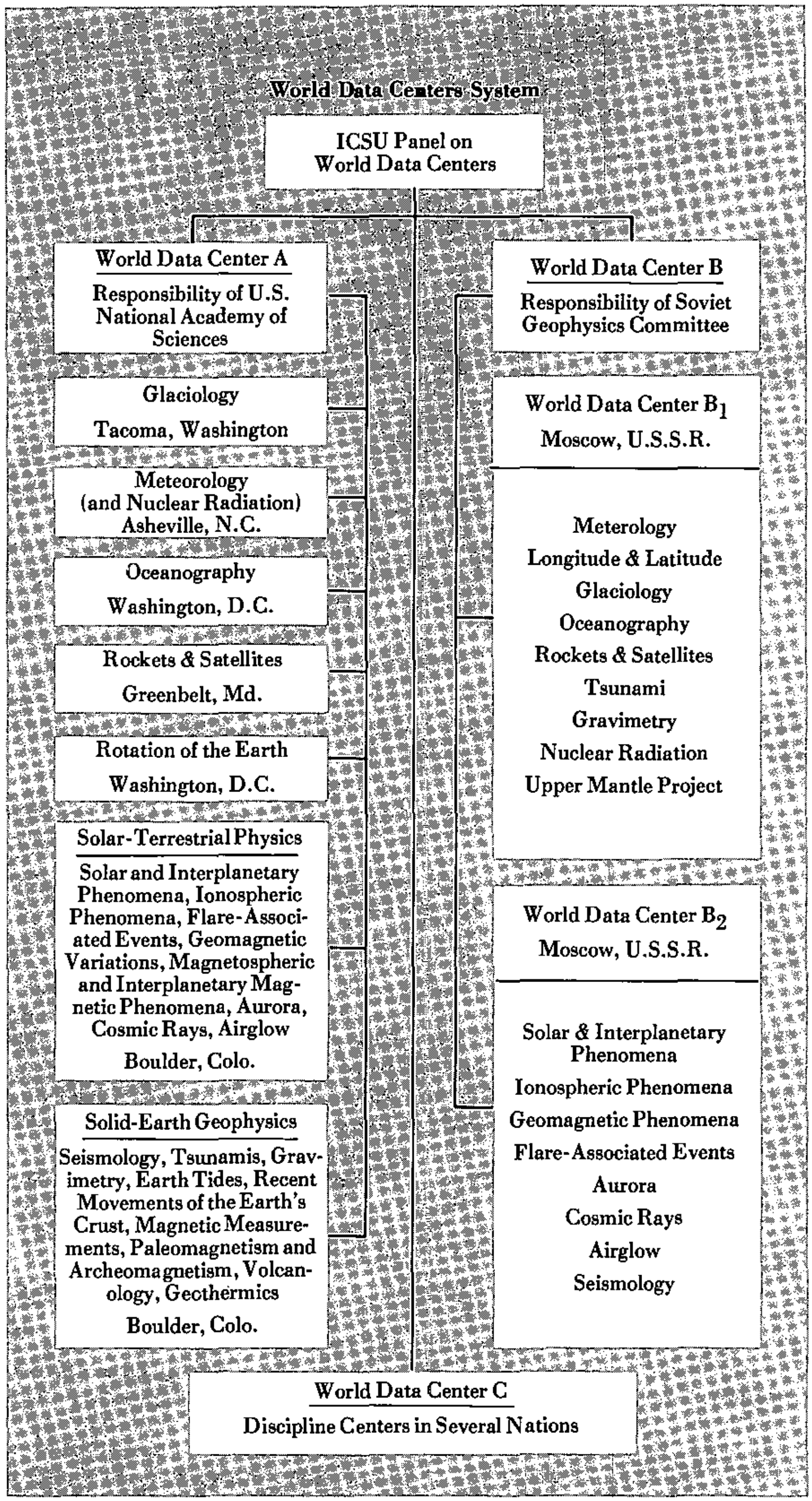
The *Environmental Science Information Center* (ESIC) disseminates environmental scientific and technical literature and information and manages or provides functional guidance for NOAA editing, publishing, and library programs.

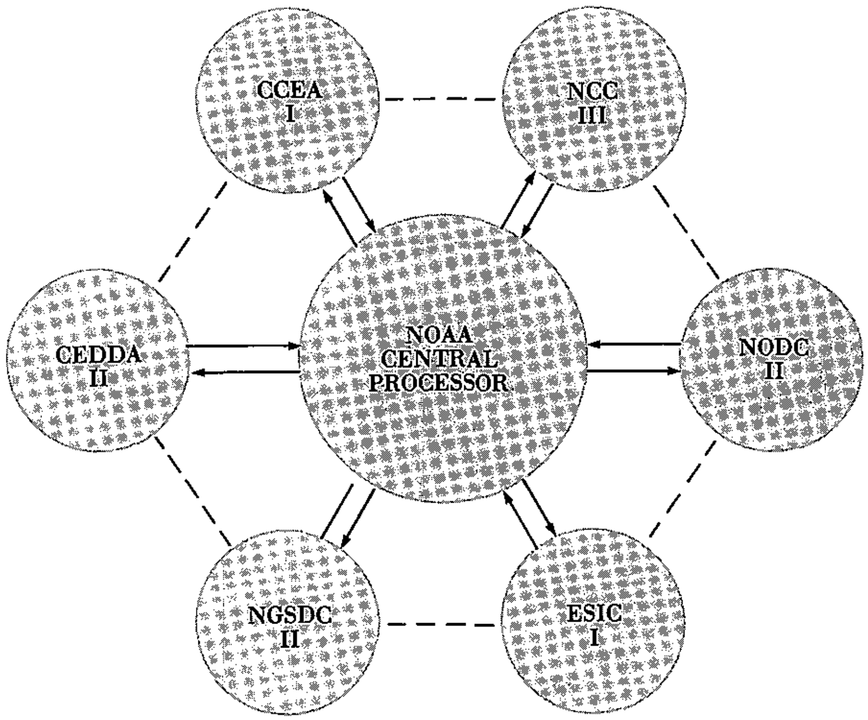
The *Center for Experiment Design and Data Analysis* (CEDDA) provides experiment design, data management, and scientific analysis support to large-scale environmental field research projects, to ensure that data needs are met for both project scientists and subsequent users.

The *Center for Climatic and Environmental Assessment* (CCEA) provides consultant assessment services and products to Federal agencies concerned with the impact of the environment on national social and economic programs and policies.

The *Deepwater Ports Project Office* reviews, evaluates, and prepares NOAA recommendations on deepwater port license applications, related environmental impact statements, and adjacent coastal State status for the Secretary of Transportation, who is the licensing authority.

The *Environmental Data Index* (ENDEX) provides rapid, automated referral to multi-discipline environmental data files of NOAA, other Federal agencies, state and local governments, universities, research





EDS' proposed distributed data processing system. I - Terminal, II - Small to medium scale mini-computer, III - Large scale processor.

institutes, and private industry. A complementary, literature-based system, *Oceanic and Atmospheric Scientific Information System* (OASIS) provides a parallel subject-author-abstract referral service.

EDS acquires foreign and global environmental data and scientific literature through bilateral and international exchange programs. The World Data Center System, for example, provides data collected by various nations and by large-scale, international research efforts such as GATE, IDOE, and Earthwatch (a United Nations effort to assess the impact of pollution on the human environment). These programs provide massive amounts of multidiscipline data and information to U.S. national programs and other users at a small fraction of the cost of mounting national collection efforts.

Reimbursable Services and Capabilities

EDS provides a wide range of multidiscipline data and information products, services, and management support to Government agencies and other users on a cost-reimbursable basis. In addition to baseline data and environmental assessments related to energy, food, and pollution, EDS provides:

- staff support in planning data management systems.
- planning, design, and evaluation of sampling and observation programs.
- monitoring and coordination of field data management activities.
- processing, analog-to-digital conversion, quality checking, statistical summarization, error analysis, and scientific analysis of environmental data.
- data management systems that ensure timely and adequate flow of project data to national repositories for dissemination to national and international user communities.

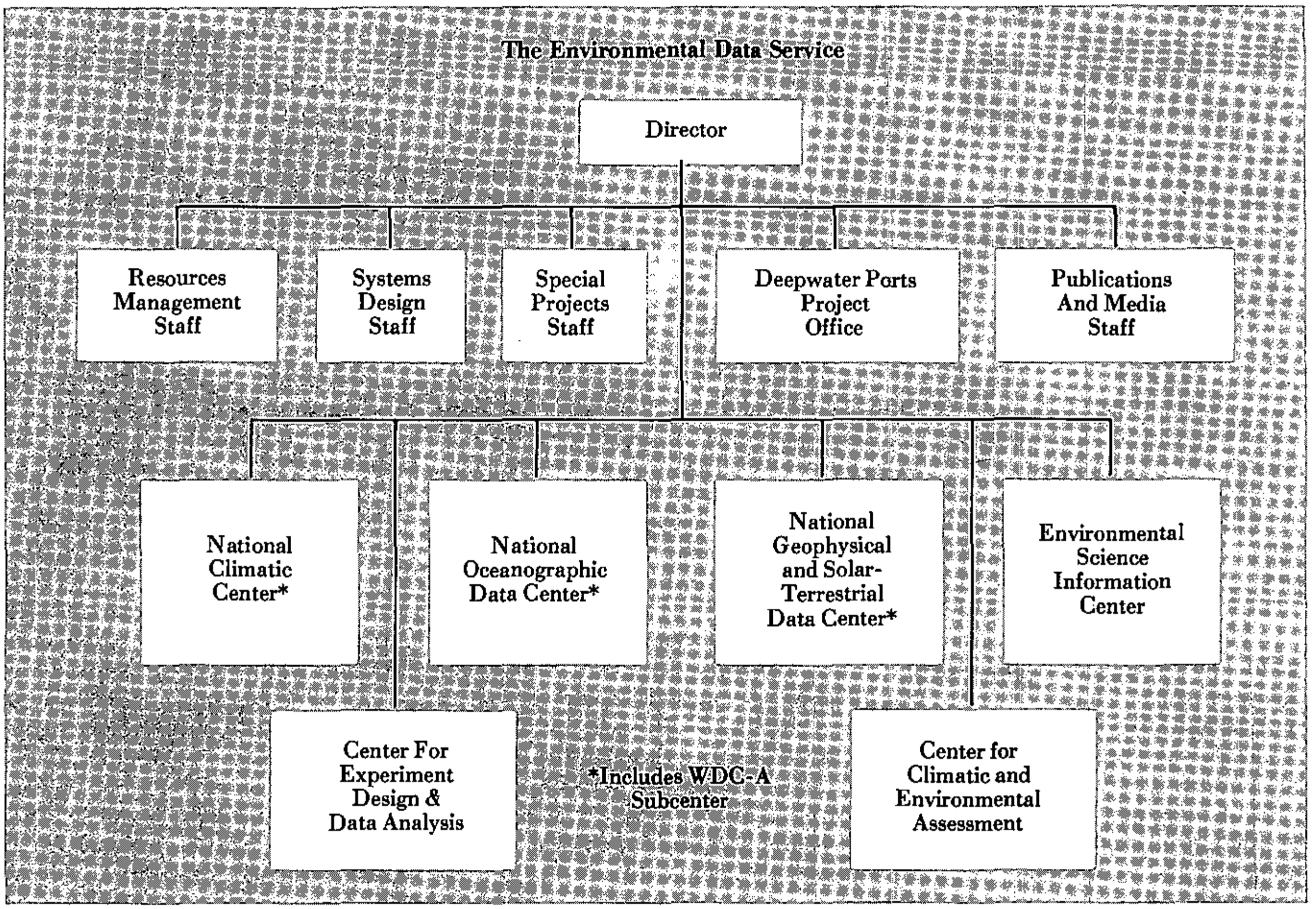
EDS also furnishes data tabulations, summaries, analyses, atlases, special studies, and other data and information products to the Department of Agriculture, Energy Research and Development Administration, Environmental Protection Agency, Federal Aviation Agency, Federal Energy Administration, National Aeronautics and Space Administration, Nuclear Regulatory Commission, U.S. Air Force and Navy, U.S. Geological Survey, other NOAA offices, and many other users, both government and private, on a reimbursable basis. In addition, public sales of EDS data and information products and publications are rising rapidly. Overall, EDS reimbursable services total about $2 million annually.

III. Long-Range Goals

Despite these its accomplishments, EDS faces a rapidly widening gap between national demands for environmental data and information and EDS response capability. Current and planned environmental data collection systems and programs, for example, require massive deployment of both conventional and high-data-rate collection sensors whose combined output would inundate current EDS data storage and retrieval systems. Acquisition of high-density, mass-storage systems capability will make it possible to handle these data volumes, yet provide efficient user access to data subsets, In addition, increasing demand for multi- and interdisciplinary environmental data and information makes it mandatory that EDS change its ADP system orientation from the current collection of individual applications files to that of a common, integrated environmental data base.

To meet growing national needs and correct service system deficiencies, EDS plans to:

- develop or expand its capabilities to assess the impacts of environmental variations on energy, food, and pollu-



tion problems, programs, and activities. Data and information resulting from these activities will be developed for or made available to the Government agents and agencies responsible for policy, planning, and decision-making in these areas.

• Provide data and information products and support services to national and international efforts to advance understanding of environmental processes. In support of this goal, EDS will participate in the planned U.S. Climate Program,[3] projects of the Global Atmospheric Research Program, the International Magnetospheric Study (see page 22), and NOAA climate diagnostic efforts.

• Upgrade service systems to meet national needs and changing user demands. EDS plans to establish a National Oceanic and Atmospheric Satellite Data Center, replace its discipline-oriented file management systems with a single data base administration system, adopt distributed data processing techniques, acquire mass-storage system capability, develop an automated library service network, and institute an EDS-wide microforms program. EDS also will enlarge the service files of its comprehensive referral system and acquire selected data files of national importance for which no adequate dissemination services now exist. In addition, it plans to develop a medical climatology data base to meet the needs of health and regulatory agencies.

In addition to the above goals and objectives, EDS will continue to provide multidiscipline environmental data and information products, planning, management, and support services to Government agencies and other users on a reimbursable basis.

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NOAA: A National Focus for Marine Environmental Data and Information*

By Thomas S. Austin,
Director, Environmental Data Service

I have been asked to respond to the Committee's recent recommendation that:

"The Department of Commerce should sponsor a program to compile, place in more useful form, and disseminate relevant data and information on outer continental shelf development and the coastal environment which is already held by Federal agencies, states, academic institutions, and others. In addition, standards should be developed and promulgated for such items as environmental data collection equipment and their operation and maintenance, data collection methods (e.g., collection frequency and duration, sampling grids, and times of day), sample/data analyses and preservation, and reporting."

Let me begin by saying that NOAA's Environmental Data Service (EDS) already provides a national mechanism by which interdisciplinary marine environmental data and information collected by many agencies, private sources, and other nations are made available to the general user community—including marine users—once the initial collection purposes have been served. These data include physical, chemical, geological, geophysical, and biological data or their inventories. For convenience, I will refer to these as "natural science" data.

While it is true that a large number of Federal agencies have mission-oriented marine environmental data and information programs, EDS is specifically charged with acquiring, processing, and disseminating such data and information to the general user community.

To carry out its mission, EDS operates three national data centers—the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center—as well as an Environmental Science Information Center, a Center for Experiment Design and Data Analysis, a Center for Climatic and Environmental Assessment, a Deepwater Ports Project Office, relevant World Data Centers A, and a comprehensive data and information referral system. (See pages 6 to 8 for a detailed description of the EDS service system.)

In 1972, the Interagency Committee on Marine Science and Engineering (ICMSE) issued a statement of Interagency Policy for Marine Data and Information Management that encourages cooperation among Federal agencies to ensure that marine environmental data and samples are made available to the general user community because such data and samples ". . . constitute a valuable national resource, the proper management of which is the responsibility of the Federal Government."

Specifically, the policy statement urges ICMSE member agencies to work with the EDS and the Smithsonian Institution to establish bilateral agreements whereby marine environmental data (or inventories) and specimens are properly managed for timely dissemination to the user community. NOAA currently is party to formal and informal interagency data management agreements with the Oceanographer of the Navy, Coast Guard, National Science Foundation, Bureau of Land Management, U.S. Geological Survey, Fish and Wildlife Service, Energy Research and Development Administration, and Defense Mapping Agency, among others.

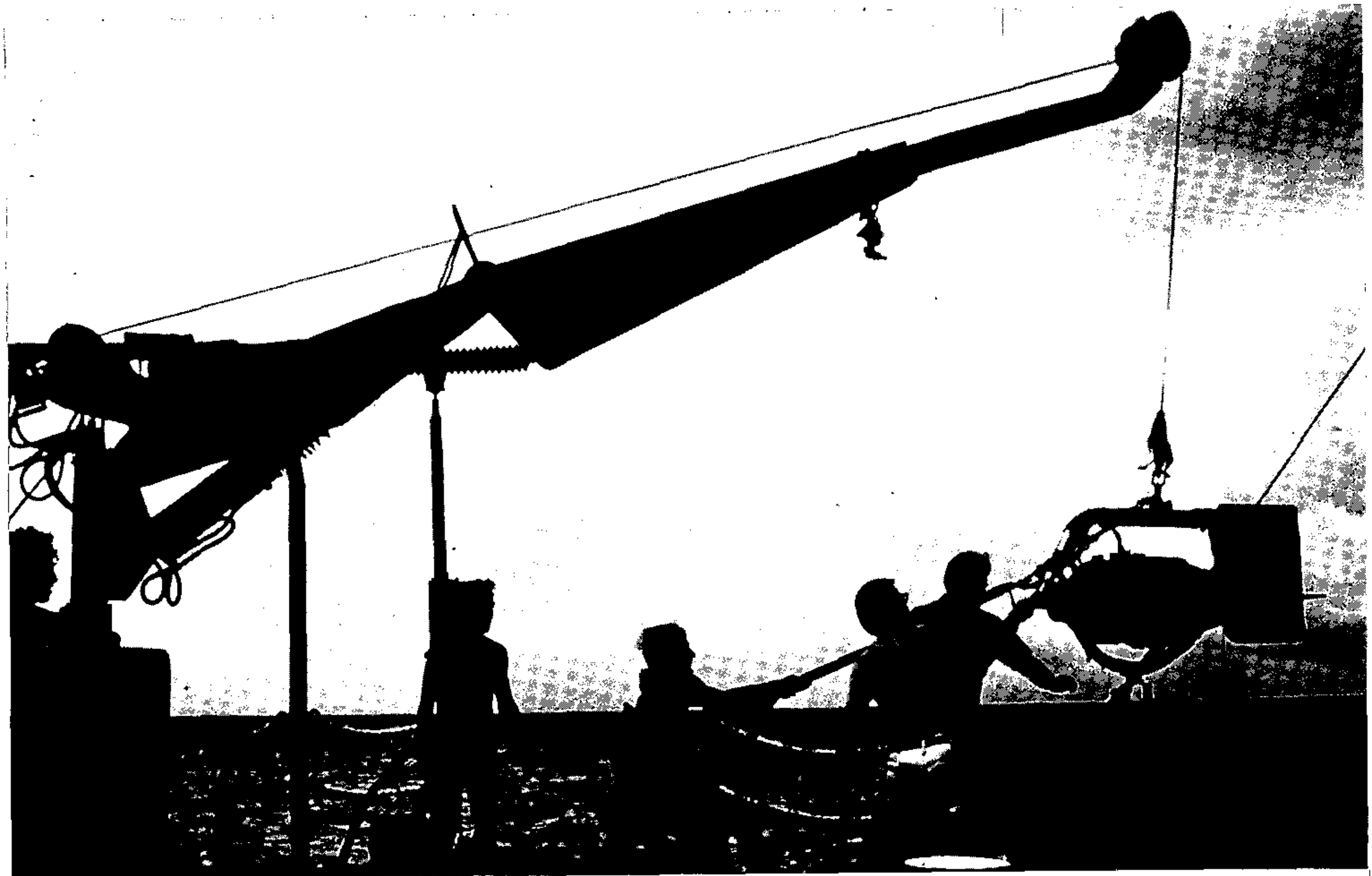
In addition to data it acquires and disseminates itself, EDS also provides referral to available marine data holdings of other agencies and organizations through its Environmental Data Index (ENDEX) inventories. ENDEXing efforts have concentrated on data files concerning U.S. coastal areas and the Great Lakes.

Last year, in response to a request from the National Ocean Policy Study of the U.S. Senate to ICMSE, EDS' National Oceanographic Data Center (NODC) prepared a directory, Ocean Data Resources,[1] which lists Federal agencies, State and regional facilities, academic institutions, and industrial marine-oriented companies that acquire, process, disseminate, and use ocean data.

On the information side, EDS provides a computerized information referral service—Oceanic and Atmospheric Scientific Information System (OASIS)—for technical literature and for research in the environmental sciences (atmosphere, solid Earth and marine) and coastal resources. OASIS currently accesses 35 national information bases, including the Department's National Technical Information System, Oceanic Abstracts, and Pollution Abstracts. Subjects include, among others: climatology, coastal zone management, environmental-related engineering, geodesy, hydrography, hydrology, marine biology, marine geology, meteorology, and oceanography.

NOAA is currently developing a multidisciplinary data base for the Outer Continental Shelf (OCS) pro-

Presented to the U.S. Department of Commerce Marine Petroleum and Minerals Advisory Committee, New Orleans, La., Feb. 25, 1976.



Above, a seismic energy source gun used in geology studies.

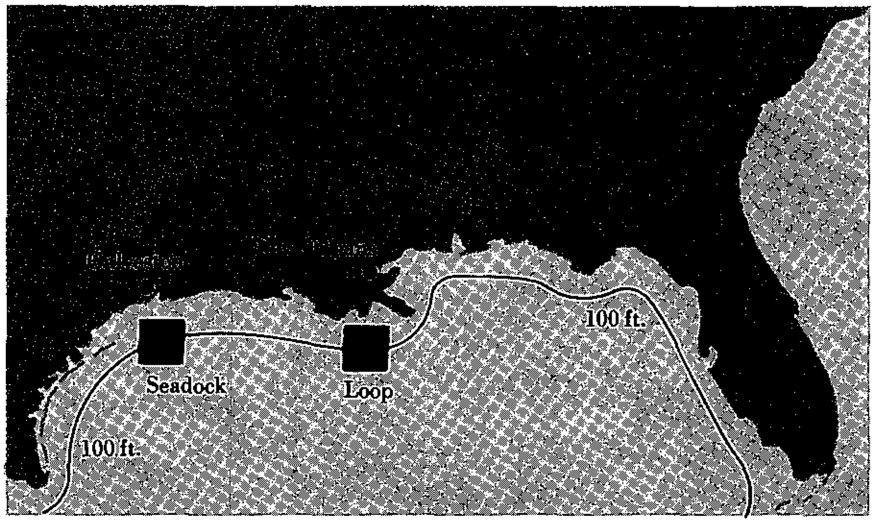
jects and is the repository for all data generated by BLM's Outer Continental Shelf Environmental Studies Program. In addition, we will be receiving marine data collected by EPA Energy Research and Development Programs.

EDS also disseminates results, data, and information from research programs of other Federal agencies, such as the International Decade of Ocean Exploration (National Science Foundation), and Deep Ocean Mining Environmental Studies (NOAA's Environmental Research Laboratories).

In addition to providing marine data, information, and referral services, NOAA has been called upon to apply its unique data and information resources and expertise to help in the solution of national problems such as the energy crisis. These national efforts are concentrated in the coastal zone, where planning, site selection, design, construction, and operation of facilities depend heavily upon interdisciplinary, environmental baseline data. Such data studies also are needed to predict and assess the impact on the environment of such things as oil spills.

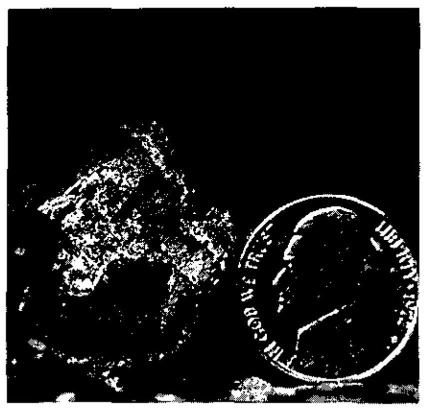
Specifically, EDS has contributed, among others:

- A detailed description of the climatology of the route between Valdez and U.S. West Coast ports for the Department of the Interior's final *Alaska Pipeline Environmental Impact Statement.*[2]
- *Environmental Guide for Seven U.S. Ports and Harbor Approaches,*[3] compiled for the President's Council on Environmental Quality (CEQ), to aid in selecting suitable supertanker terminal sites at selected Gulf and East Coast ports.
- *Environmental Guide for the U.S. Gulf Coast.*[4] Detailed environmental profiles for seven potential Gulf Coast Deepwater Port sites, prepared by the U.S. Army Corps of Engineers.
- CEQ *Outer Continental Shelf Study for Gas and Oil Exploration off Atlantic Coast and Gulf of Alaska.*[5] EDS provided detailed statistics on probabilities of severe storms, ice, tsunamis, and earthquakes.
- *CEQ Floating Nuclear Power Plant Study.* With input from NOAA's National Marine Fisheries Service and the Department of the Interior, EDS prepared a comprehensive description of the environments (marine geology and geophysics, physical and chemical oceanography, meteorology, seismology, and living resources), of the U.S. Atlantic, Gulf, and Pacific coasts, and the Great Lakes, as well as more detailed environmental descriptions for four selected Atlantic coast areas. The descriptions include detailed analyses of meteorological threats and earthquake and tsunami hazards for the four Atlantic coast areas.



Above, proposed Louisiana Offshore Oil Port (LOOP) and SEADOCK deepwater ports located southwest of the Mississippi River and south of Freeport, Texas, respectively.

Right, metallic ions and colloidal particles in sea water precipitate out, forming manganese nodules which cover large areas of the ocean floor.



• *Mid-Atlantic Bight Study of Historical Physical Oceanographic/Meteorological Data.* The EDS Center for Experiment Design and Data Analysis (CEDDA), funded by BLM, currently is compiling historical meteorological and physical oceanographic data needed to characterize the Mid-Atlantic region between the coast and the 200-m isobath, 36°N and 41°N, and to provide input to trajectory prediction models in conjunction with offshore oil and gas developments.

CEDDA also will make recommendations for additional physical oceanographic and meteorological field measurements to remedy data deficiencies. In addition, it will formulate recommendations for the design and strategy of future observsational sampling programs to provide an improved basis for evaluating the impact of oil and gas operations on the environment of the Mid-Atlantic shelf.

CEDDA's experiment design capabilities led me to the second part of the Committee's recommendation #3, namely, data quality and standardization. In this regard, EDS helps project managers develop data-management plans that detail the specific responsibilities of data collectors, processors, and managers, as well as those of the EDS national dissemination centers. Such plans are in effect or are being established for BLM baseline environmental studies for OCS lease areas, the MESA New York Bight study, environmental assessment surveys of Northern Puget Sound and the Western Gulf of Mexico, the DOMES Project, and NOAA's Ocean Dumping Program. In all these programs, EDS works closely with Project Managers and Principal Investigators to establish and standardize details of data collection, formatting, and submission to EDS centers for public dissemination.

In the DOMES Project, for example, an ERL Project Data Manager formulates operational procedures for data acquisition, instrument calibration, standard formats, quality control, data flow, and the protection of proprietary data acquired from industry. A central DOMES data archive is being established in EDS. Data output will be tailored to meet the specific needs of project researchers, as well as the general needs of industry, government, and the general public.

EDS recently established a Deepwater Ports Project Office to meet requirements placed upon NOAA by the Deepwater Port (DWP) Act of 1974, which establishes procedures for the location, construction, and operation of deepwater ports off the coasts of the United States. EDS' Project Office reviews, evaluates, and prepares recommendations for the Administrator on DWP license applications, related environmental impact statements, and adjacent coastal State status.

To do its job, the Project Office needs data and information which EDS and NOAA do not now have easy access to—namely, social, economic, and demographic data. Many other marine users also need such data and information. To implement fully the first part of recommendation #3, these data and data references should be added to the natural science data and information provided by EDS. The National Advisory Committee on the Oceans and Atmosphere (NACOA) recently suggested a mechanism to accomplish this, a suggestion which NOAA is now implementing.

In its Fourth Annual Report (June 30, 1975)[6] NACOA recommended that:

"The Office of Coastal Zone Management of the National Oceanic and Atmospheric Administration (NOAA) expand its informational services to fulfill the function of a Federal coastal informational coordinating center and to assure effective intercommunication with State centers and Federal and other sources."

OCZM's Coastal Zone Information Center currently provides many of the services called for in the NACOA recommendation, though admittedly in a limited, informal manner. By drawing on the resources of NOAA's Office of Sea Grant and other agencies, OCZM is moving in the direction of providing the needed Commerce focus for social, economic, and demographic data and information referral. Formalization of an agreement between the various Department of Commerce elements concerned to add this service capability to current EDS and OCZM services will greatly enhance the accessibility of existing DOC data and information resources and will provide the single Federal focus for environmental data and information pertaining to the Coastal Zone and OCS areas recommended by your committee.

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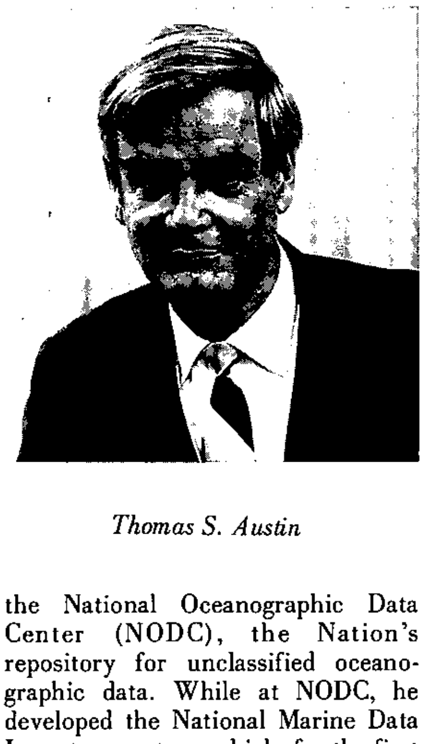
About the Author

Thomas S. Austin, Director of the Environmental Data Service is an international authority on marine science affairs and the management of scientific data and information.

During World War II, Austin was an oceanographer with the Woods Hole Oceanographic Institution, and in 1946-47 participated in the Bikini Atoll atomic tests. After working from 1946 to 1952 at the Naval Oceanographic Office, he joined the Bureau of Commercial Fisheries—now NOAA's National Marine Fisheries Service—where he worked for the next 15 years, serving as assistant director and then director of various laboratories.



Thomas S. Austin

While working for BCF in 1963, Austin planned and coordinated the first international survey sponsored by the Intergovernmental Oceanographic Commission (IOC) of UNESCO—the International Cooperative Investigations of the Tropical Atlantic—demonstrating that large areas of the ocean can be studied successfully through international cooperation.

In 1967, Austin became Director of the National Oceanographic Data Center (NODC), the Nation's repository for unclassified oceanographic data. While at NODC, he developed the National Marine Data Inventory system, which, for the first time, provided information to the scientific community on the collection and availability of U.S. marine environmental data well in advance of their actual submission to NODC or other repositories.

In 1971, Austin was appointed Director of the Environmental Data Service. He has since made extensive organizational and program changes to improve the quality of user services and products, increased automation to reduce user costs and provide faster service, strengthened EDS' capability to provide multidiscipline data and information, and developed ENDEX/-OASIS, a prototype national referral system for world-wide environmental data, information, and literature. More recently, he established an EDS Center for Climatic and Environmental Assessment and a Deepwater Ports Project Office to meet national needs in these areas.

A native of Olean, N.Y., Austin holds a bachelor's degree in biology and masters' degrees in zoology and limnology. In 1965, he received an honorary doctorate from Grove City College, Grove City, Pa., his Alma Mater. In 1975, he was awarded the Department of Commerce Gold Medal for unique achievements and outstanding accomplishments in marine science affairs and management of scientific data and information over a public service career spanning more than 28 years.

The Year Without A Summer

By Patrick Hughes

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This past summer and fall have been so cold and miserable that I have from despair kept no account of the weather.
—Adino Brackett, 1816

The year 1816 is legendary in the annals of weather. It has been called "the year without a summer," "poverty year," and "eighteen hundred and froze-to-death."

From May through September, an unprecedented series of cold spells chilled the northeastern United States and adjoining Canadian provinces, causing a backward spring, a cold summer, and an early fall. There was heavy snow in June and frost even in July and August. All across the Northeast, farmers' crops were repeatedly killed by the cold, raising the specter of widespread famine.

The amazing weather of 1816 is well documented in the diaries and memoirs of those who endured it. Benjamin Harrison, a farmer in Bennington, Vt., termed it "the most gloomy and extraordinary weather ever seen." Chauncey Jerome of Plymouth, Conn., writing in 1860, recalled:

I well remember the 7th of June . . . dressed throughout with thick woolen clothes and an overcoat on. My hands got so cold that I was obliged to lay down my tools and put on a pair of mittens . . . On the 10 of June, my wife brought in some clothes that had been spread on the ground the night before, which were frozen stiff as in winter. On the 4th of July I saw several men pitching quoits in the middle of the day with thick overcoats on, and the sun shining bright at the time.

Since relatively few settlers had yet crossed the Mississippi, most of our weather observations for 1816 come from the eastern United States, particularly the Northeast, where there was a tradition of weather watching. The best observations available were made at Williamstown, in the northwestern corner of Massachusetts.

April and May 1816 were both cold months over the Northeast, with frost retarding spring planting. Flowers were late in blooming and many fruit trees did not blossom until the end of May—only to have their budding leaves and blossoms killed by a hard frost which also destroyed corn and some other plants.

Warm weather finally came to all parts of the Northeast during the first few days of June. Farmers forgot the frosts of May and began replanting their crops. But even as they labored, a cold front was approaching that would bring disaster.

Following the frontal passage, temperatures tumbled dramatically under the onslaught of Arctic air. At noon on June 5, the temperature at Williamstown was 83 degrees. By 7 a.m. on the 6th, it had dropped to 45 degrees—the highest temperature recorded for the day. All across central New England, early morning temperatures were the highest recorded for the day.

From June 6 to 9, severe frost occurred every night from Canada to Virginia. Ice was reported near Philadelphia, and "every green herb was killed, and vegetables of every description very much injured." In northern Vermont, the ice was an inch thick on standing water while elsewhere in the state "icicles were to be seen a foot long . . . corn and other vegetables were killed to the ground, and upon the high lands the leaves of the trees withered and fell off."

People shivered, dug out their

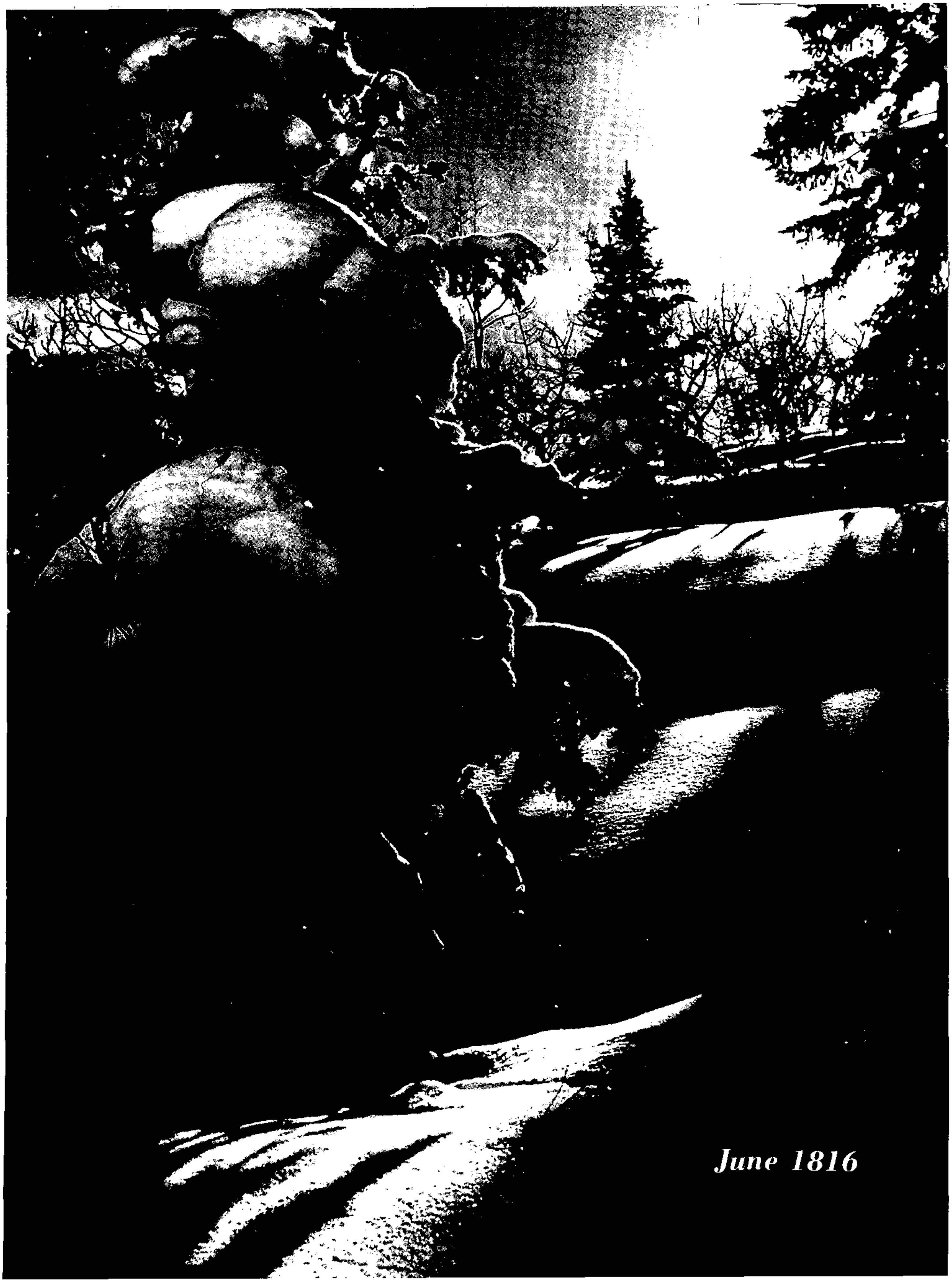

June 1816

Photo: U.S. Geological Survey

winter clothing, and built roaring fires. Farmers watched helplessly as their budding fields and gardens blackened, and in northern towns newly shorn sheep, though sheltered, perished. Thousands of birds also froze to death, as did millions of the yellow cucumber bug.

The culmination of this remarkable cold wave came early on the 11th of June. At Williamstown the observer noted, "Heavy frost—vegetables killed—at 5 o'clock temperature 30.5 degrees." Overall, frost killed almost all the corn in New England, the main food staple, as well as most garden vegetables.

There were two snowfalls. The first, on the 6th, brought relatively light snow to the highlands of western and northern New York State and most of Vermont, New Hampshire, and Maine. The second occurred during the night of June 7-8, following the passage of a second cold front. It brought moderate to heavy snow to northern New England, with lighter snow and snow flurries extending eastward to the coast and southward through northern Massachusetts and New York State's Catskill Mountains.

The following account appeared in the Danville, Vermont, *NORTH STAR:*

Melancholy Weather . . . On the night of the 7th and morning of the 8th a kind of sleet or exceeding cold snow fell, attended by high wind, and measured in places where it drifted 18 to 20 inches in depth. Saturday morning [8th] the

William Humphreys, a Weather Bureau scientist, documented the relationship between volcanic eruptions and low temperatures around the world. According to his theory, volcanic dust in the atmosphere partially shields the earth from the sun's rays, but permits heat to escape, thus lowering the temperature.

weather was more severe than it generally is during the . . . winter. It was indeed a gloomy and tedious period.

In Canada, Montreal had snow squalls on both the 6th and 8th of June, while 12 inches of snow accumulated near Quebec City from the 6th to the 10th, with some drifts "reaching to the axle trees of carriages."

This first summer cold spell was followed by 4 weeks of relatively good weather. Farmers again replanted, and crops were growing well when, at the end of the first week in July, a new cold outbreak came. Although not as severe as the one in June, it killed corn, beans, cucumbers, and squash in northern New England, and soon had local farmers talking about the threat of a general famine.

Once again, the remainder of the month was more seasonable, though there was another cool spell around the 18th. The hardier grains such as wheat and rye, however, came along well, and by August farmers were joking about their earlier "famine fever."

On August 20, another cold wave arrived, tumbling temperatures in New Hampshire some 30 degrees. During the next 2 days, frost was reported as far east as Portland, Maine, and as far south as East Windsor, Conn. Travelers between Albany, New York, and Boston reported most of the corn in low-lying areas destroyed.

A more severe frost came at the end of August. In Keene, N.H., it put an end to the hopes of many corn growers, and whole fields had to be cut up for fodder.

The first week of September was relatively warm, but around the 11th and 12th a cold outbreak again visited the Northeast with hard frost reported in northern and central New England. It was the widespread and killing frost of September 27, however, which irrevocably closed out this dismal growing season and destroyed all hopes of even a small corn harvest in northern New England.

A Concord, N.H., paper reported: "Indian corn on which a large portion of the poor depend is cut off. It is believed that through New England scarcely a tenth part of the usual crop . . . will be gathered." In Montreal it was said that ". . . many parishes in Quebec must inevitably be in a state of famine before winter sets in." During the severe winter of 1816-17 which followed, the threat of starvation or semistarvation became reality for many.

The first general migration from New England to the Middle West occurred the following year. Although there were other factors involved, it is interesting to note that the three northern States of Vermont, New Hampshire, and Maine, which bore the brunt of the cold weather, suffered the greatest exodus.

In summary, the chief weather abnormalities of 1816 were the series of totally unexpected cold spells that occurred continuously through the late spring, summer, and early fall—and, of course, the June snow.

New England temperatures averaged 3 to 6 degrees below normal in June and July, and 2 to 3 degrees below in August, May also had been below normal, as was the following September. It had been just as cold (or even colder) in each of these months in other years, but never consecutively. More significant, however, is the fact that, in 1816, the low temperatures occurred in a region where even a few degrees' difference in the minimum temperature can mean a severe frost.

Although the New England farmer considered it a local tragedy, the abnormal weather was widespread throughout the Northern Hemisphere. In England it was almost as cold as in the United States, and 1816 was a famine year there, as it was in France and Germany.

Actually, 1816 was just one of a famous series of cold years. From 1812 to 1817 it was cold over the whole world. In the United States, the depression of summer temperatures was the most remarkable on record.

According to William Humphreys, a Weather Bureau scientist writing almost a century later, the cold years were caused largely by volcanic dust in the Earth's atmosphere. Such dust partially shields the Earth from the Sun's rays, but permits heat to escape from the Earth, thus lowering the temperature.

Three major volcanic eruptions took place between 1812 and 1817. Soufriere on St. Vincent Island erupted in 1812; Mayon in the Philippines in 1814; and Tambora on the island of Sumbawa in Indonesia in 1815. The worst was Tambora, a 13,000-foot volcano that belched flame and ashes from April 7 to 12, 1815, and rained stone fragments on surrounding villages.

It has been estimated that Tambora's titanic explosion blew from 37 to 100 cubic miles of dust, ashes, and cinders into the atmosphere, generating a globe-girdling veil of volcanic dust.

The idea that volcanic dust suspended in the atmosphere might lower the Earth's temperature has been around for a long time. Like many other scientific firsts, it can be traced to Benjamin Franklin, although the thought may not have been original with him. In 1913, William Humphreys published a now classic paper documenting the correlation between historic volcanic eruptions and worldwide temperature depressions.

According to Humphreys, volcanic dust is some 30 times more effective in keeping the Sun's radiation out than in keeping the Earth's in. And once blown into the atmosphere—more specifically, the stratosphere—it may take years for the dust to settle out (the finest particles from Krakatoa's eruption in 1883, for example, took 2½ to 3 years to reach the ground). During this period, the average temperature of the whole world may drop a degree or two, while local losses can be considerably greater.

The chief effect, however, as in 1816, seems to be the dramatic depression of minimum temperatures during the summer.

A weak sunspot maximum also preceded the cold summer of 1816. During May and June, these blemishes on the face of the Sun grew large

The Cold Season

Extracts from History of Madison County, New-York, by Mrs. L.M. Hammond, Pub. 1872.

"Town of De Ruyter, Madison Co. N.Y.

"In 1816 came the 'cold season'. There was a frost in every month. The crops were cut off, and the meagre harvest of grain was nowhere near sufficient for the needs of the people. The whole of the newly settled interior of New-York was also suffering from the same cause. The inhabitants saw famine approaching. (The alarm and depression so wrought upon the feelings of the community, that a religious revival ensued.) What little grain there was that could be purchased at all, was held at remarkable prices, and this scant supply soon failed. Jonathan Bentley at one time paid two dollars for a bushel of corn, which, when ground, proved so poor that it was unfit for use; throwing it to his swine, they too refused the vile food. Every resource for sustenance was carefully husbanded; even forest berries and roots were preserved. The spring of 1817 developed the worst phases of want. In various sections of the county, families were brought to the very verge of starvation! One relates that he was obliged to dig up the potatoes he had planted, to furnish one meal a day to his famishing family; another states that his father's family lived for months without bread, save what was obtained in small crusts for his sick mother, and that milk was their chief sustenance. When the planting season arrived there was no seed grain in De Ruyter; so the inhabitants combined and sent Jeremiah Gage to Onondaga County to canvass for wheat and corn. He was absent several days and the people, all alive to the importance of his mission, grew discouraged, fearing there was none to be found. At length he was seen approaching along the road where the head of the Reservoir now is, his wagon loaded, his hankerchief fastened to a pole and hoisted, fluttering in the breeze, a signal of joy and plenty. A crowd quickly gathered; there was great rejoicing and tears stood in strong men's eyes. Each family repaired to Gage's house to receive their quota of grain, and every household that day was glad."

enough to be seen with the naked eye, and people squinted at them through smoked glass.

In Humphreys' day, sunspots were thought to reduce the amount of solar radiation emitted and, during a period of maximum occurrence, to depress the Earth's average temperature by as much as a half degree. As a result, sunspots also were blamed for the trials of the New England farmer in 1816. Humphreys showed, however, that whatever the historic correlation between the Earth's average temperature and the occurrence of sunspot maximums, the most pronounced dips in the world temperature curve were, without exception, associated with violent volcanic eruptions that exploded great quantities of dust into the stratosphere.

An example is the famous cold year of 1785, which followed the frightful eruptions of Mount Asama in Japan and Skaptar Jokull in Iceland. These produced a widely observed "dry fog," the phenomenon that led Benjamin Franklin to suspect a relationship between cold weather and volcanic eruptions.

Volcanic dust is believed to have played a role—and perhaps a major one—in the great climatic changes of past ages. Even relatively small variations in the Earth's annual mean temperature can cause widespread changes in Arctic ice packs and world sea levels, in desert boundaries, and in the geographic limits of plant, animal, and human life. According to Humphreys, volcanic dust blown into the stratosphere once a year or even once every 2 years, would continuously maintain temperatures low enough to "cover the earth with a mantle of snow so extensive as to be self-perpetuating . . . and thereby initiate at least a cool period, or, under the most favorable conditions, even an ice age."

The New England farmer of 1816, of course, knew nothing of such theories; he knew only that something had gone wrong with the weather. And when that dreadful summer was followed by a winter so severe that the mercury froze in the thermometers, he must surely have thought the change was permanent.

National Report

NOAA National Aquaculture Information System

The National Aquaculture Information System (NAIS) is a joint EDS/Office of Sea Grant Project which provides computer-assisted access to a broad range of information on the growing of marine, brackish, and freshwater organisms. It is one of the newest files in EDS' Oceanic and Atmospheric Scientific Information System (OASIS) and was developed to answer the need for a centralized aquaculture information source in the United States.

NAIS can be queried via any OASIS terminal (see listing) or by writing to the Environmental Science Information Center, D826, EDS/NOAA, 3300 Whitehaven Street N.W., Washington, DC 20235. Non-NOAA users pay $10.00 for most inquiries.

Most of the NAIS references were published since 1970, but older material important to aquaculture is being added. The file now has about 2,300 entries. Each contains complete bibliographic information as well as subject index terms, common names of biota involved, and genus and species of any organism cultured. Any part of this information base can be searched via computer, according to the needs of the user.

Collection of material began in 1973, when the Office of Sea Grant sponsored a small pilot project in which 384 articles were indexed at the Virginia Institute of Marine Science (VIMS) and sent to EDS. After a brief interruption, 1 full year of work was funded in which 1,500 references were added to the system. A computerized file of information on the economics of aquaculture was also included.

As NAIS developed, it became obvious that input from experts in all aspects of aquaculture was necessary to ensure inclusion of the most useful information. Visits to various researchers and commercial firms began in September 1975 and are continuing. During these visits, actual documents or references are obtained or borrowed, and advice is solicited as to what sorts of information should be included. Much important information not in normal circulation has been added as a result.

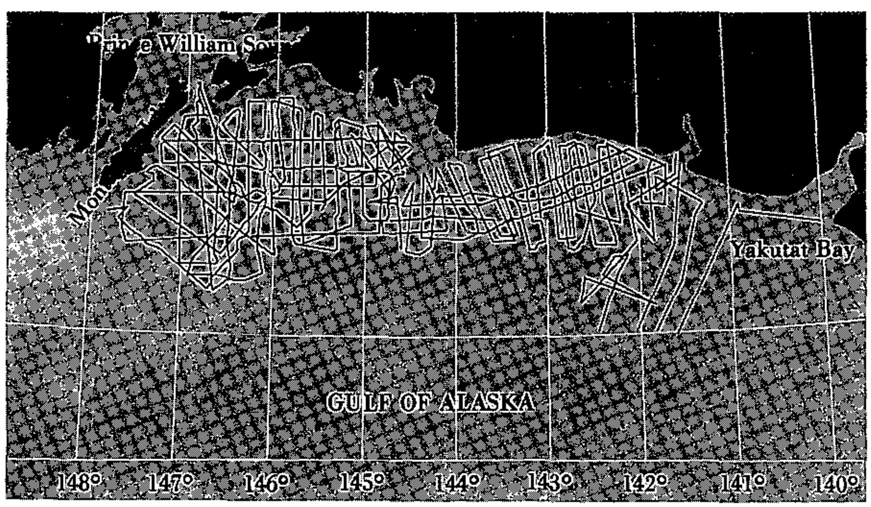
In addition to the computer-searchable file, a microfiche copy of each document is made when permission to copy has been obtained from the publisher. These microfiche copies are also available to users.

Gulf of Alaska Seismic Data

The U.S. Geological Survey is making available to the public continuous seismic reflection profile data collected in the Gulf of Alaska. USGS collected the data in its Northeast Gulf of Alaska Program to appraise natural resources and environmental hazards before sales of oil and gas leases.

The first data set now available from the EDS National Geophysical and Solar-Terrestrial Data Center contains 6,500 kilometers of seismic profiles collected in collaboration with the University of Washington during September and October 1974. These data, recorded at both high and intermediate frequencies, were taken on the Alaska Outer Continental Shelf from Yakutat Bay to Montague Island.

Copies of the original profiles on 35-mm microfilm together with ozalid copies of ship track lines can be obtained from the National Geophysical and Solar-Terrestrial Data Center, Code D621, NOAA, Boulder, CO 80302. Telephone (303) 400-1000 ext. 6542.



USGS seismic reflection data available from Environmental Data Service.

New ENDEX/OASIS Users Guide

A new Users Guide to ENDEX and OASIS is now available. ENDEX (Environmental Data Index) and OASIS (Oceanic and Atmospheric Scientific Information System) provide rapid, computerized referral to available environmental data files and to published literature in the environmental sciences and marine coastal resources, respectively. The new guide describes available data bases including: dates of coverage, type of information, access methods, file size, and search charges. Sample outputs and a subject index to the data bases are also provided.

Copies of the new users guide are available from the Environmental Science Information Center, D8, 3300 Whitehaven Street NW., Washington, DC 20235 (202-634-7336).

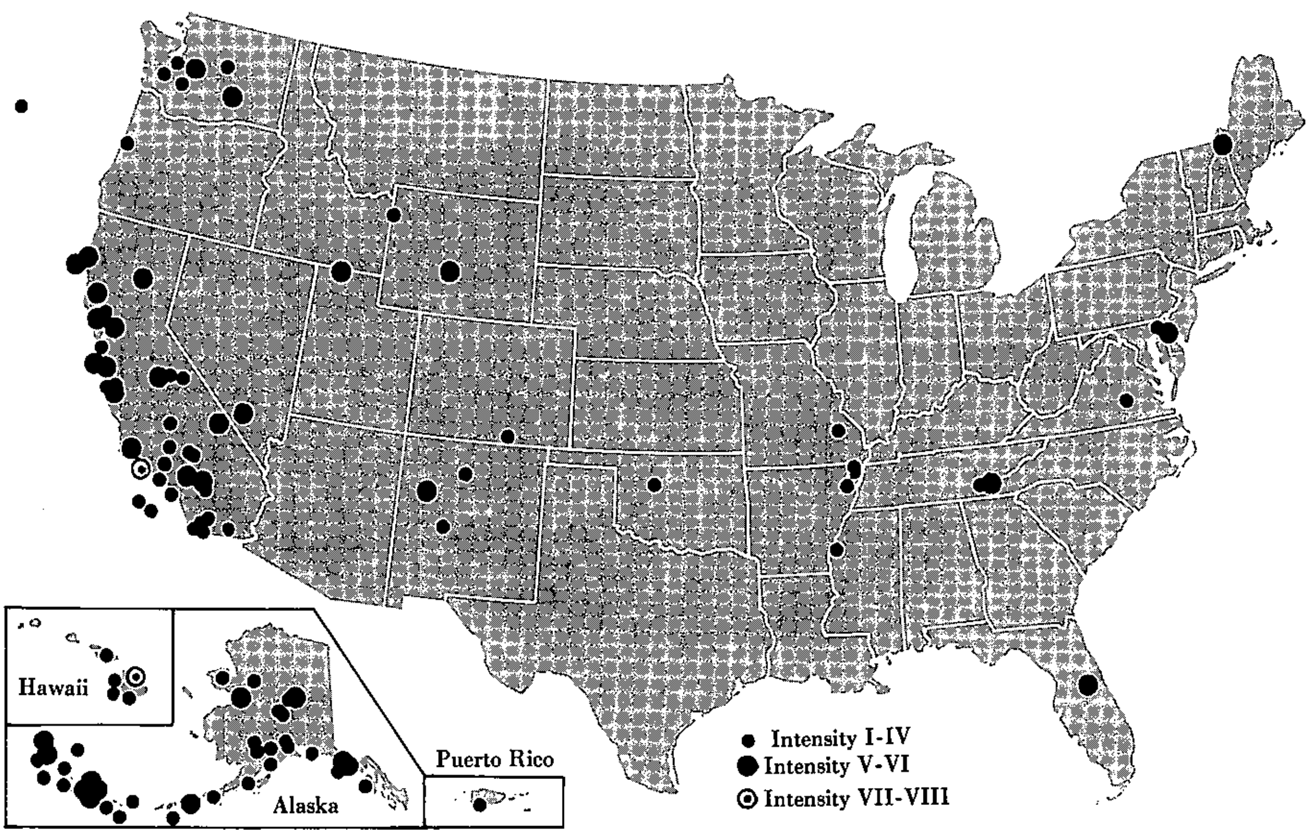
U.S. Earthquakes - 1973

United States Earthquakes - 1973 has been published jointly by the U.S. Geological Survey and the EDS National Geophysical and Solar-Terrestrial Data Center. The report describes all earthquakes felt in the United States and nearby territories during the year.

Earthquakes are listed chronologically in 11 regions: Northeastern Region, Eastern Region, Central Region, Western Mountain Region, California and Western Nevada, Washington and Oregon, Alaska, Hawaii, Panama Canal Zone, Puerto Rico, and the Virgin Islands. A cross-reference of State and town names is also provided. In addition, the report includes sections on horizontal and vertical control surveys for crustal movement studies, tsunamis, well-water fluctuations, and strong-motion seismograph data.

Copies of the report are for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price: $1.85.

Earthquakes that were felt or caused damage in the United States during 1973.



Interagency Union List of Serials

The EDS Environmental Science Information Center, the Commerce Department's Office of Patents and Trademarks, and the Environmental Protection Agency recently published a joint *Union List of Serials*. A total of 57 participating libraries listed their serials holdings.

A serial is defined as a publication issued in successive parts, bearing numerical or chronological designations and intended to be continued indefinitely. Not only periodicals, but numbered reports, yearbooks, memoirs, proceedings, bulletins, and transactions are included.

The new list references 11,715 titles and 20,767 holdings. It will facilitate the sharing of literature-based information resources within NOAA and among collaborating libraries. Nineteen NOAA libraries, thirty-two EPA libraries, and six Office of Patents and Trademarks libraries participated in this joint project, which may represent the first interagency listing of serials holdings in the Federal library community.

Meteorological Station Data Available on Microfiche

The EDS National Climatic Center (NCC) has started a long-term project to develop a microfiche file of meteorological station data. The project offers substantial savings in both cost and storage space for users interested in acquiring the records.

All surface weather observations from national Weather Service First Order Stations (currently 292) from July 1972 to date are already on microfiche. Records from January 1965 to June 1972 are now being microfilmed, with records for Alabama, Alaska, Arizona, and Arkansas completed. The remaining states will be filmed in alphabetical order, and should be completed by January 1977. Next to be filmed are surface weather observations from all American military weather stations throughout the world (currently 256) and then probably the records of climatological observations from cooperative observers (currently 8,072) from January 1965 to date.

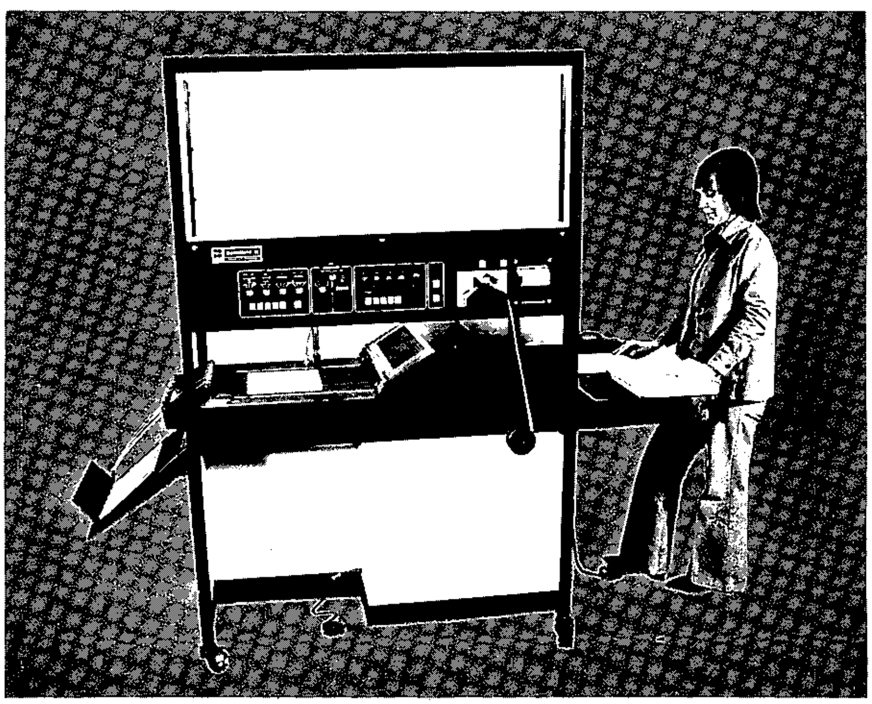
Even though a microfiche camera that can film 2,500 documents per hour is being used in the project, it will take many years to copy the 100 million pages of meteorological records housed at NCC.

Microfiche copies of station data are available in the Committee on Scientific and Technical Information (COSATI) format of 98 frames per 4" x 6" diazo microfiche card. Each card contains 1 month of record for one station and sells for $0.60. Minimum order is $5.00.

User cost can be reduced ever further by placing a standing order for microfiche copies of records not yet filmed. In this way, copies can be made at the same time the original microfiche is produced, with savings in personnel time and effort. The cost of such microfiche copy is 50 cents.

Prices listed above are subject to change. To order any microfiche copy or for further information on the subject, including payment procedures, write to National Climatic Center, Federal Building, Asheville, NC 28801. NCC's telephone numbers are 704-258-2850, ext. 683 (commercial) and 8-672-0683 (FTS).

NCC microfiche camera films 2,500 documents per hour.



International Report

IMS Central Information Office

A Temporary International Magnetospheric Study (IMS) Central Information Exchange Office has been established at World Data Center-A (WDC-A) for Solar-Terrestrial Physics. The Office gathers information about IMS investigations and distributes it to scientists and administrators around the world through the monthly *IMS Newsletter*.

The IMS, scheduled from January 1976 through 1979, is an international program to study the structure, time change, and physical processes of the outermost parts of the Earth's atmosphere, with emphasis on simultaneous measurements by groups of satellites. It includes complementary experiments and monitoring by rocket, balloon, aircraft, and ground-based sensors.

IMS is organized under the International Council of Scientific Unions (ICSU), and the more than 800 voluntary participants represent 41 countries. The program is planned by an IMS Steering Committee under the ICSU Special Committee on Solar-Terrestrial Physics. There are two key coordinating mechanisms: The Satellite Situation Center at World Data Center-A for Rockets and Satellites, NASA which keeps track of the orbital location of the 5 or more dedicated IMS Satellites and the more than 30 other satellites useful to IMS objectives, and the Information Exchange Office, established by the Steering Committee, which issues a monthly newsletter that disseminates updated plans for the more than 1,500 ground-based balloon and rocket experiments.

The *IMS Newsletter* began circulation to 1,700 recipients in January 1976. Each issue contains information about programs scheduled for the next 3 months and includes data on accomplished launches and descriptions of the experiments carried out. Notes and general news are included for each of the 3 months and for the IMS program.

Special IMS periods are detailed in the program plans. These periods are identified by the Satellite Situation Center using orbital information about a number of U.S. satellites in high-altitude, elliptical orbits. When two or more of these satellites are to pass within a few hours of each other through some special region of the magnetosphere or across a critical magnetospheric boundary, the period is marked for consideration as a special IMS data-gathering interval. The IMS Steering Committee selected 18 such intervals for 1976. A 6-month calendar groups IMS investigations by region of the world and by time.

Additional information about the IMS and the *IMS Newsletter* can be obtained from J.H. Allen, Head, TIMSCIE Office, WDC-A for STP, D64, NOAA, Boulder, CO 80302. Telephone: (303) 499-1000, ext 6501.

International Earthquake Epicenter Data

The National Geophysical and Solar-Terrestrial Data Center has received data for 7,390 earthquake epicenters from the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and from S.T. Algermissen of the U.S. Geological Survey for inclusion in NGSDC's earthquake data file. The epicenters are those of historical earthquakes for the years 2100 BC to 1970 AD that occurred in parts of Southeast Europe, Northeast Africa, and Western Asia — an area bounded lat. 21° and 49° N. and long. 2° and 43° E.

Algermissen used the epicenter data collection to establish the probability of earthquakes in six eastern European countries. UNESCO published the data following a survey of the seismicity of the Balkan Region.

Strong-Motion Seismograms for Southwest Pacific

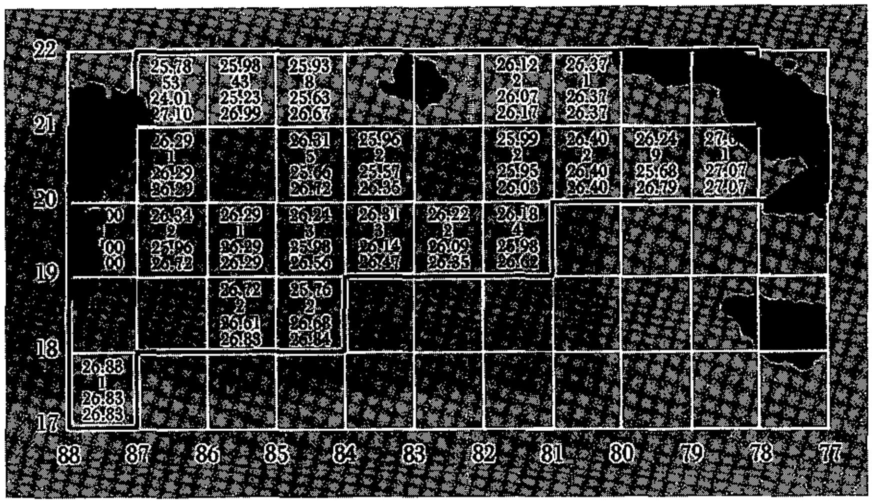
The Bureau of Mineral Resources, Geology and Geophysics of Canberra, Australia has forwarded 48 uncorrected and corrected digital strong-motion seismograms for the Southwest Pacific Ocean to the World Data Center-A for Solid Earth Geophysics in Boulder, Colo. The seismograms are for 41 different earthquakes that occurred in an area bounded by lat. 3° to 10° S. and long. 144° to 156° E. The earthquakes triggering these recordings ranged in magnitude from 5 to 6.5 on the Richter Scale and produced intensity effects in categories 3 to 7 in the area affected. This is the first data set received from a foreign source under a program to exchange seismic data pertinent to engineering applications.

New Oceanographic Atlas Published

A new publication, *Distribution of Temperature, Salinity, Oxygen, and Phosphate in Waters Off Eastern Central America and Northern South America, Volume IV*, prepared by the EDS National Oceanographic Data Center, will soon be ready for distribution. This is the fourth of a series of NODC atlases depicting oceanographic conditions of coastal regions and was prepared in response to requests by member nations of CICAR (Cooperative Investigations of the Caribbean and Adjacent Regions).

The atlas summarizes existing environmental data and provides charts and tables showing the temporal and spatial distributions of temperature, salinity, oxygen, and phosphate. The data are divided into six ocean areas extending from the Yucatan Channel to south of the Amazon River, and add to these in Key to Oceanographic Records Documentation No. 2, *Temperature, Salinity, Oxygen, and Phosphate in Waters off the United States, Volume II, Gulf of Mexico, March 1975.*

Data summaries for the six areas are presented as computer-produced graphics. These include: temperature-salinity composites, surface summaries (fig. 1), station distribution plots (fig. 2), vertical array summaries, and frequency distribution histograms. The data used were compiled from the National Oceanographic Data Center's Oceanographic Station Data File, which contains data taken primarily by Nansen casts over a period of 58 years (1914-72).



Surface temperature (°C) values plotted for January-March in 1-degree quadrangles. From top to bottom, the values indicate: Average temperature, number of observations, and minimum and maximum temperatures. Area is south of Cuba.

The publication should be useful to physical oceanographers, biologists, engineers, and others responsible for the development, utilization, and management of ocean resources, and for planning and managing programs, projects, and surveys that relate to the ocean. The data are also valuable in studies of marine productivity, pollution, oceanic circulation, and for designing instruments and planning structures.

Copies of *Volume I (Western North Atlantic), Volume II (Gulf of Mexico),* and *Volume III (Eastern North Pacific)* of the series also are available from the Data Services Division, National Oceanographic Data Center, Washington, DC 20235.

Acronym Guide for International Marine Science

Annotated Acronyms and Abbreviations of Marine Science Related International Organizations and Programs, originally issued in 1969, was recently revised by EDS' National Oceanographic Data Center. The new edition varies from the 1969 compilation by its arrangement. Descriptive entries are grouped into three sections: (1) organizations; (2) programs, projects, and expeditions; and (3) miscellaneous terms. The descriptions often incorporate two or more organizations, projects, or terms, in order to show pertinent relationships. Two indexes are provided: one lists acronyms and abbreviations in alphabetical order; the other lists full titles in alphabetical order. To make the listing as complete as possible, a few marine science-related international organizations, programs, or other terms have been included, even though they do not have acronyms or abbreviations.

Since organizational changes occur frequently in international marine science activities, comments, corrections, and additions are welcome and may be mailed to the National Oceanographic Data Center, Technical Records Branch (D764), Washington, DC 20235.

A limited number of copies are available free from the Center.

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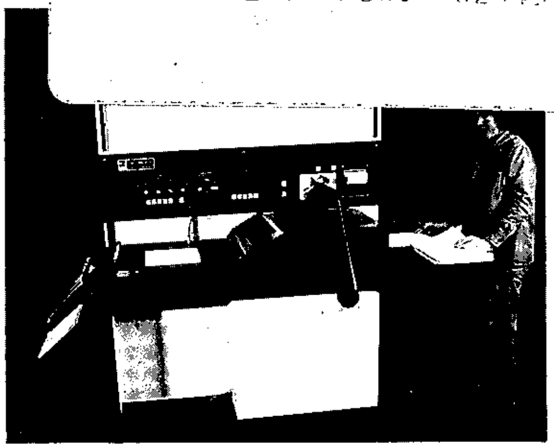

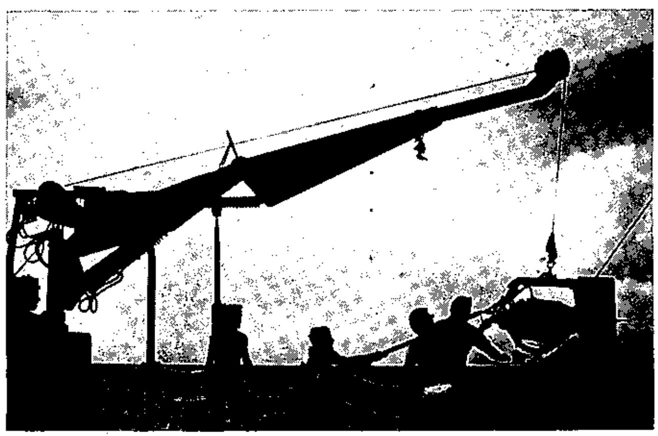

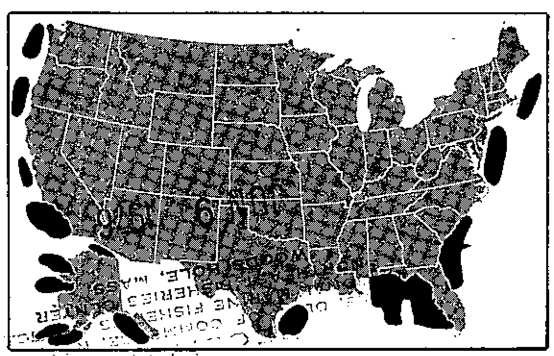

IN THIS ISSUE: Microfilming meteorological station data (p.21), the year without a summer (p. 14), a national focus for marine data (p. 10), environmental data needs for oil and gas exploration on the Continental Shelf (p. 3).

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

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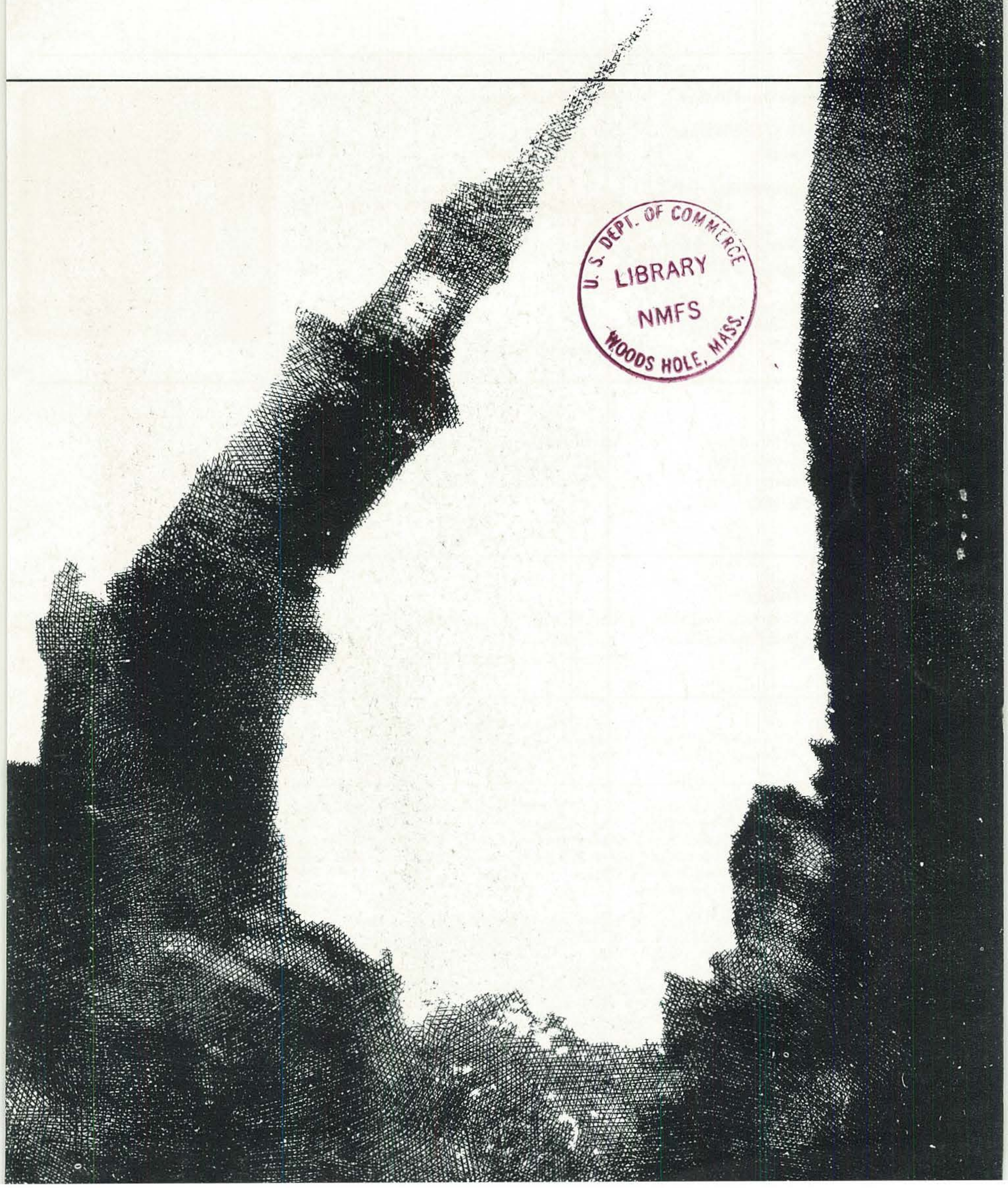
July 1976



EDS

Environmental Data Service July 1976

COVER:
The steeple of Boston's historic Old North Church is toppled by hurricane Carol (1954). The steeple was built in 1806 to replace the original, also toppled by a hurricane (1804). (See article beginning on page 3.) Artwork derived from photo by Wide World Photo Service.

ENVIRONMENTAL DATA SERVICE is designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, Center for Climatic and Environmental Assessment, and a Deepwater Ports Project Office. In addition, under agreement with the National Academy of Sciences, EDS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, and Solar-Terrestrial Physics.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 16, 1975; this approval expires June 30, 1978.

U.S. DEPARTMENT OF COMMERCE
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National Oceanic and Atmospheric Administration
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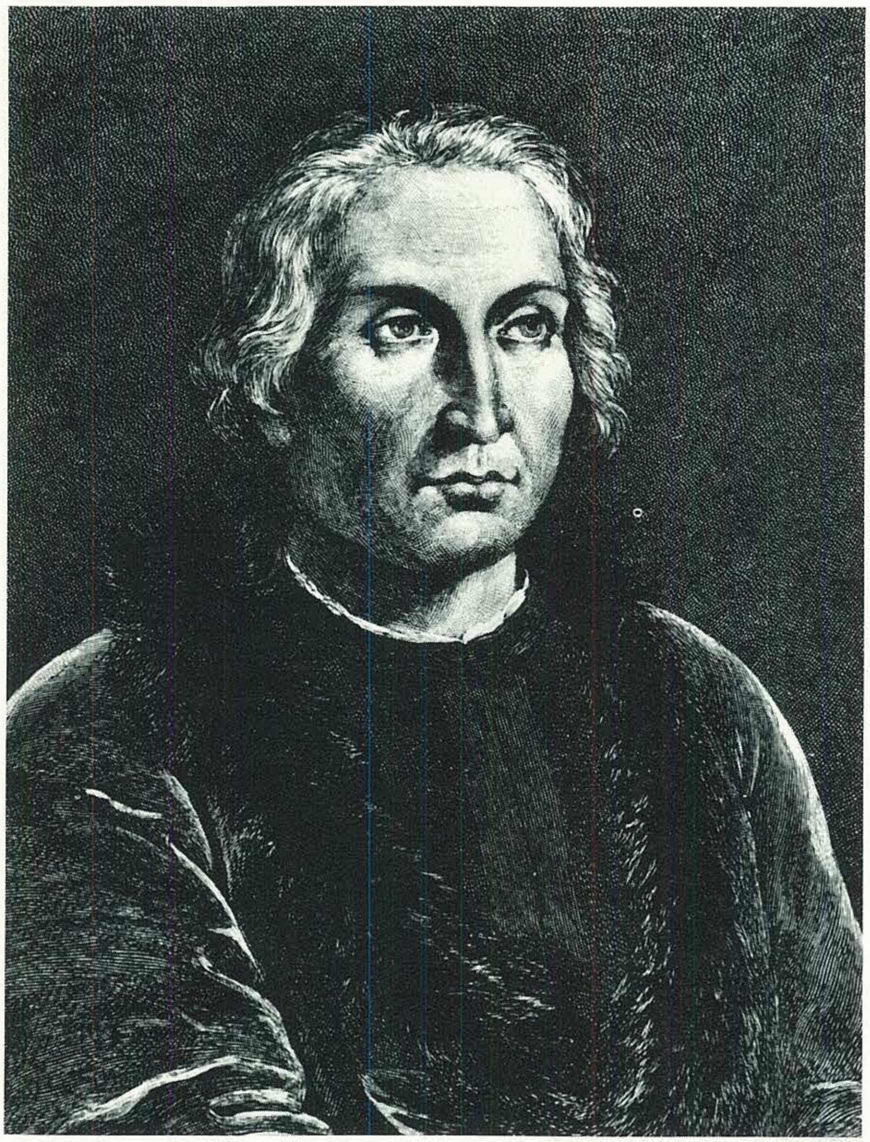
Hurricanes Haunt Our History*

By Patrick Hughes

American weather has helped shape our national culture, character, folklore, and conversation. The following is the fourth in a series of Bicentennial articles on the American weather experience.

Christopher Columbus was intimately acquainted with hurricanes.



From the very beginning, hurricanes have played an awesome role in the American panorama. They have touched the lives of Americans great and small and, at times, changed the course of our destiny—as well as the shape of our coastline. There also have been hurricanes whose effects were felt on the shores of the Old World, as well as the New.

Christopher Columbus was intimately acquianted with hurricanes. Arriving off Hispaniola on his fourth and final voyage in the summer of 1502, the aging Admiral, now fallen from favor, read the signs of an approaching storm. He requested the shelter of Santo Domingo harbor, but was refused. Instead, ignoring Columbus' warning, some 30 vessels, many loaded with gold and slaves, sailed proudly out of the harbor for Spain. Francisco de Bobadilla, Columbus' mortal enemy, sailed on the flagship.

Twenty ships and over 500 men, including de Bobadilla, were never seen again. Only one vessel reached Spain—a small, leaky ship grudgingly assigned to carry back to Spain the proceeds from the sale of Columbus' few remaining Island properties, his guarantee of an independent old age.

Columbus himself, a weatherwise seaman, rode out of the hurricane safely at anchor in an island cove. Meanwhile, Santo Domingo was smashed flat—for the first of many times.

It is fortunate indeed that Columbus did not encounter a hurricane on his first voyage, out on the open sea. His three tiny caravels might well have

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perished, delaying the discovery of the New World and changing the course of our history.

In August 1508, Ponce de Leon encountered two hurricanes. The first drove his ship onto the rocks in the port of Yuna, Hispaniola; 13 days later, a second cyclone beached the same vessel on the southwest coast of Puerto Rico. Hernando Cortes, whose discovery of treasure focused the covetous gaze of Europe on the newly discovered lands to the west, lost the first vessel he sent to Mexico in a severe hurricane in October 1525. Captain Juan de Avalos (a relative of Cortes), two Franciscan friars, and some 70 seamen were drowned.

Soon annual treasure fleets were carrying the richs of the virgin continent back to the war-depleted coffers of Spain. Each year the fleet assembled in Havana, scheduled to sail for Spain in March. Each year fiestas, banquets, and religious ceremonies stretched the departure date to August, and even to September, at the height of the hurricane season. Many ships sailed from havana; often only a handful reached Spain. It is said that a ship was sunk for every lonely mile of the unexplored Florida coast.

In July 1609, a small fleet of ships crowded with settlers for the Virginia colonies was overwhelmed by a hurricane. One sank immediately; the others were scattered. All but one of the surviving vessels managed to limp into Jamestown. The *Sea Adventure*, flagship of the fleet, was given up for lost. Ten months later, however, her passengers and crew arrived at Jamestown in a small boat built from the wreckage of the flagship. They had foundered on the rocks of Bermuda.

The voyagers had found Bermuda a natural paradise. An account of their adventure was published in London in 1612, intriguing an English playwright. His interest in the tale led William Shakespeare to write his beautiful play, "The Tempest"—one of the happiest endings a hurricane story ever had.

Throughout the long colonial period of American history, the predominantly low-lying coastal settlements were repeatedly raked by hurricanes. The terrible storms struck without warning, unroofing, flooding, and washing away homes; destroying crops; tearing up great trees by their roots; sinking ships or stranding them in village streets, forests, and cornfields. The cyclones often killed settlers, sailors, and travelers by the hundreds, occasionally, by the thousands. They blew down great forest areas and made travel impossible for months, isolating stricken survivors, who often faced the threat of famine in the coming winter.

On the night of August 13, 1766, the tiny village of Trois-Islets, on the Island of Martinique in the French West Indies, was crushed by a hurricane. Joseph-Gaspard Tascher, a wealthy planter, was wiped out by the storm, his family poverty stricken. Later one of his daughters, Marie Josephine Rose, returned to France to seek her fortune. There she caught the fancy of an ambitious young army officer,. whom she married.

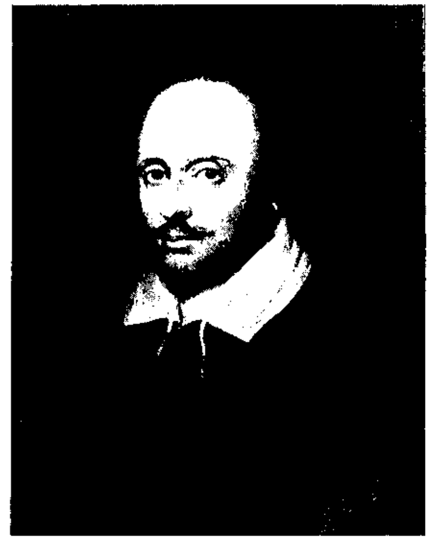
If it hadn't been for that hurricane, Marie might well have spent her days on Martinique, a belle of island society. Instead she became the Empress Josephine of France when her husband, Napoleon Bonaparte, rose to power. A hurricane in the New World was felt in the Old—as they are to this day.

It was a hurricane that brought Alexander Hamilton into the pages of American history. His description, in a letter to his father, of a terrible storm that ravaged the island of St. Croix in the West Indies on August 30 and September 1, 1772, so impressed local planters that they took up a collection to send Hamilton to America for an education. He was there in 1774, a student at King's College (now Columbia University) in New York when the first rumblings of revolution were heard.

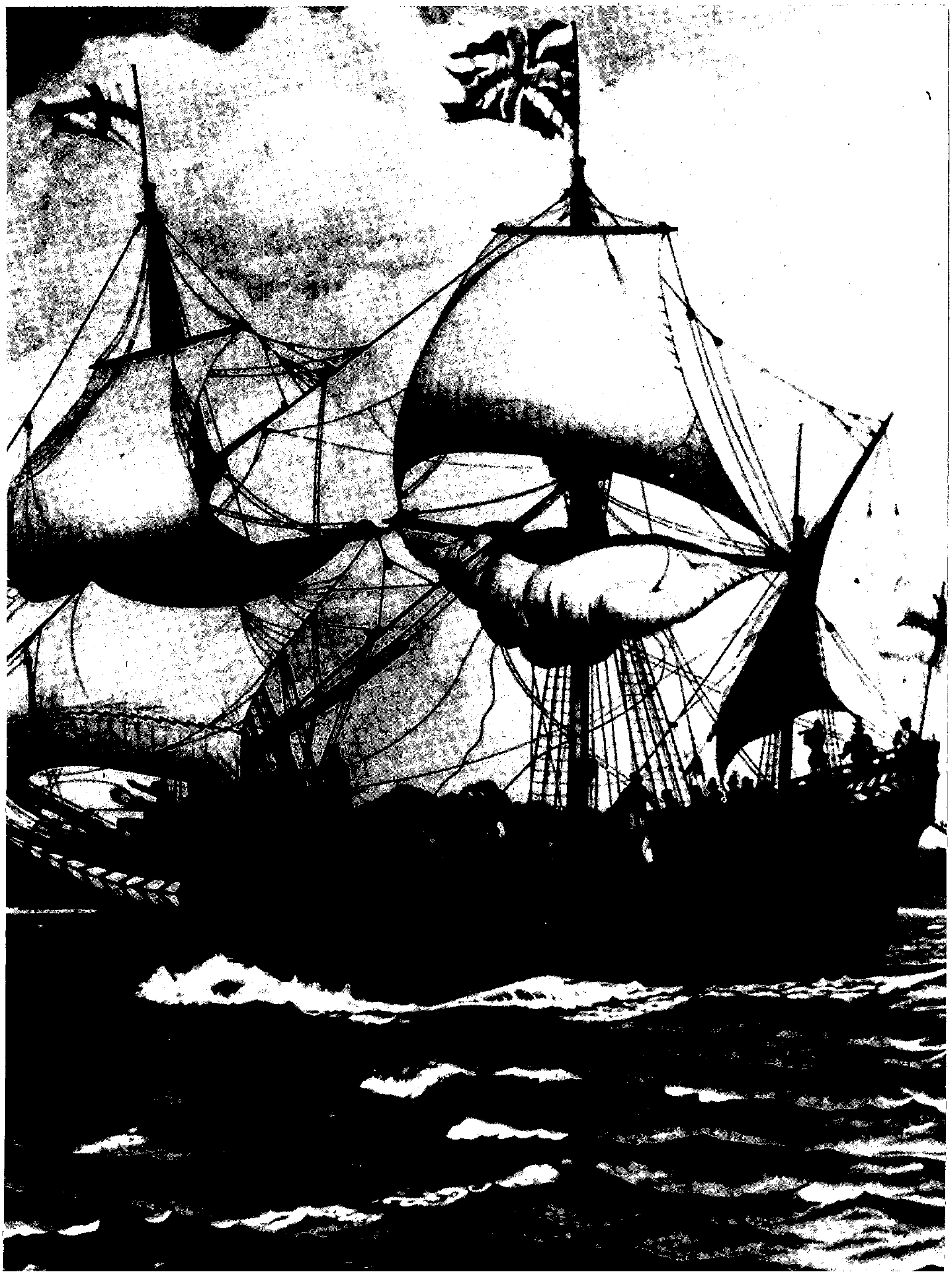
On August 1778, a hurricane mauled and separated warships of British and French fleets maneuvering for battle south of Newport, R.I. Two years later, a British fleet east of Daytona Beach, Fla., was savaged by an early October hurricane, then, a few days later, struck by a second storm near Bermuda. Meanwhile, the first cyclone scattered and badly damaged a second British fleet off the Virginia Capes, then roared northward to strike yet another British squadron off Rhode Island. It has been said that the final British surrender at Yorktown in October 1781 was at least partly due to the British Navy's reluctance to engage the French fleet blockading General Cornwallis during the dangerous fall hurricane season.

In September 1815, just months after the War of 1812 ended, the worst hurricane since 1635 roared through New England at 50 miles per hour and left a path of destruction from the south shore of Long Island, N.Y., northward through New Hampshire.

One of the most notorious hurricanes of the 19th Century demolished a fledgling American settlement on Galveston Island in the newly proclaimed Republic of Texas in



William Shakespeare's play, "The Tempest," was based on the adventure of Virginia colonists shipwrecked on Bermuda by a hurricane.



early October 1837. According to an eyewitness, ". . . every house, camp, sod house, and inhabited structure was swept away, except the Old Mexican customhouse. . . ." Only one of 30 vessels in Galveston Harbor held to its mooring; the rest were driven aground or blown out to sea. "Men, women, and children were seen floating upon boards, logs, and small boats, for days and nights, in every part of the island. Miraculously, only one life was lost." Unfortunately, the hurricane was far from finished.

Eight days later, the brand new paddle-wheel steamer, *Home,* was beached and demolished just south of Cape Hatteras, N.C., by the same storm. There were only two life preservers on the ship. Forty of her 130 passengers struggled ashore to safety; the rest, mostly women and children, were drowned. Because of this disaster, Congress passed a law requiring all American vessels to carry a life preserver for each passenger—a law that has since saved many Americans from a watery grave.

On October 29, 1861, the Federal "Expedition," the largest fleet of American warships and transports yet assembled, sailed south from Chesapeake Bay to attack Confederate coastal installations. As the fleet rounded the Carolina Capes on November 2, it was staggered by a hurricane that sank two vessels and scattered the rest. The fleet managed to regroup, however, and, on November 7, captured Port Royal Sound, S.C.

When the *Maine* was sunk in Havana harbor in 1898, the United States declared war on Spain. The hurricane season was fast approaching. Fearful for the safety of American naval units soon to be operating in hurricane waters, Willis L. Moore, Chief of the Weather Bureau, went to see President McKinley to urge the establishment of hurricane warning stations in the West Indies. Impressed by Moore's arguments, McKinley declared that he was more afraid of a hurricane than he was of the Spanish Navy. He ordered Moore to organize the warning system immediately.

A battle fleet left Spain steaming westward. Concern spread along the east coast of the United States. Observation posts were hurriedly built at key points . . . emergency plans made—all for nothing. The Spanish fleet was trapped in the harbor at Santiago, Cuba, and destroyed. The war ended. Not a single hurricane had appeared . . . no American ships or men had been lost . . . as they might have been. The hurricanes came late that year, or they might have played a role in the drama that marked the end of the Spanish power in the New World—as they had at its beginning, four centuries before.

Those coastal lookout stations, built for a Spanish attack that never came, were abandoned by the Navy. A little later they were taken over by the Weather Bureau as hurricane observation posts. Upon inventory, the installation at Carolina Beach, N.C., was found to lack a most desirable piece of equipment—its privy had disappeared. Intensive investigation disclosed that a local citizen, admiring its quality, had appropriated it for his nearby property. There was such a fuss made that the outhouse was reluctantly returned . . . only to be completely demolished in the hurricane surf of October 2, 1898, immortalizing to this day the "Privy Hurricane."

With the exception of a handful of pioneers, it is only in comparatively recent times that man has probed the nature and habits of hurricanes. We know more about these colossal storms today, from our vantage point in time and knowledge, than our forefathers ever knew . . . even as the hurricane winds howled around them and they fought for their lives.

Hurricanes are born at sea, over the warm waters near the Equator. Like people, no two identical hurricanes have ever been seen.

The average hurricane lives about 9 days, but some have been tracked for 4 and even 5 weeks. Centuries before European explorers and settlers were

After a hurricane ruined her father, Marie Josephine Tascher went to France to seek her fortune and later became the Empress Josephine.

President McKinley feared for the safety of American naval units operating in hurricane waters during the Spanish-American War.

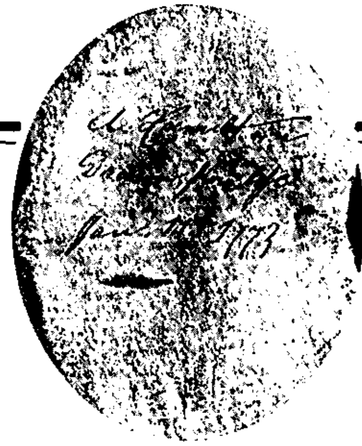
Col. Duckworth was the first man to fly into the eye of a hurricane.

exposed to their devastation, native Americans trembled helplessly before the brutal force of their semingly infinite winds. The word hurricane itself is thought to be derived from the Carib Indian's word for evil spirit.

Hurricanes were first mentioned in the logs of Christopher Columbus, their earliest European student. After Columbus, the next major contribution to man's knowledge of the hurricane was made by Benjamin Franklin.

On November 2, 1743, a "Noreaster," actually the outer fringes of a hurricane raging offshore, hit Philadelphia, obscuring an expected eclipse of the Moon. Franklin, learning that the eclipse was seen at Boston (because the storm reached there later than Philadelphia) realized that the "noreaster" had moved from the southwest—despite surface winds from the opposite direction.

Six years later, Franklin verified his theory by tracking the progress of another hurricane from North Carolina through New England. This independent motion of a storm was a novel and important concept. As



Alexander Hamilton (Age 15) Describes A Hurricane

"Good God! what horror and destruction! It is impossible for me to describe it or for you to form any idea of it. It seemed as if a total dissolution of nature was taking place. The roaring of the sea and wind, fiery meteors flying about in the air, the prodigious flare of almost perpetual lightning, the crash of falling houses, and the earpiercing shrieks of the distressed were sufficient to strike astonishment into Angels. A great part of the buildings throughout the island are levelled to the ground; almost all the rest very much shattered, several persons killed and numbers utterly ruined—whole families roaming about the streets, unknowing where to find a place of shelter—the sick exposed to the keeness of water and air, without a bed to lie upon, or a dry covering to their bodies, and our harbors entirely bare. In a word, misery, in its most hideous shapes, spread over the whole face of the country."

Excerpt from a letter to his father written on St. Croix Island in the West Indes, September 6, 1772, following a hurricane.

usual, Franklin was years ahead of his time. It wasn't until the middle of the nineteenth century that it was realized that all storms are actually circular wind systems, moving from one place to another.

In 1831, William Redfield, a Yankee student of the hurricane, showed that these giant storms were "rotary," with the winds blowing from all directions around a slowly moving center. He also traced long curved hurricane tracks from the West Indies to the east coast of the United Sates mainland. Later, Henry Piddington, an Englishman sent to study the devastating tropical storms of India, coined the term "cyclone" (from a Greek word meaning "the coils of a snake") to describe all rotary storm.

Perhaps the man who contributed the most to our present-day knowledge of hurricanes was Benito Vines, a Jesuit priest, and the director of the College of Belen in havana from 1870 until his death in 1893. During those years, Father Vines devoted all his time to the study of the hurricane, so that the Cuban people might be spared the needless tragedy a few hours' warning could prevent.

Father Vines early established a hurricane alarm system throughout Cuba, including a "pony express" between the most isolated villages. He received telegraph warnings flashed by cable from nearby islands, as well as reports from the ships reaching their ports. He organized hundreds of volunteer observers all around the long Cuban coastline. This far-flung network enabled Father Vines to track and to study hurricanes with a degree of thoroughness unknown until this day.

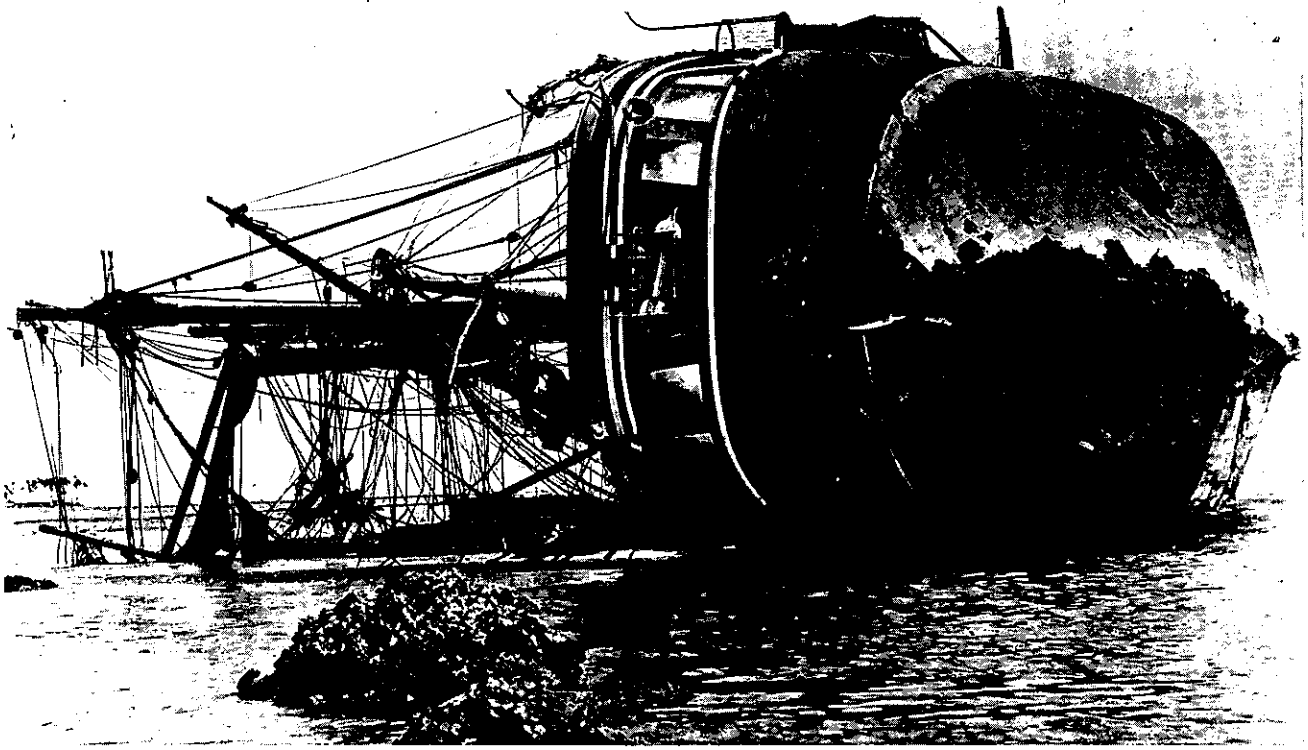
Although his discovery of the forecast value of those icy cloud fingers which reach across the sky ahead of the storm's body is considered his greatest achievement, there were many others, all confirmed by later investigators, who marvelled at what he accomplished. From Father Vines' point of view, the most important thing was that his forecasts saved countless lives and untold misery; for the first time, his people had a chance.

In 1870, a U.S. national weather service was founded as a branch of the Army Signal Service. The first hurricane ever seen on a weather map appeared on the Signal Service map of September 28, 1874, located over the coastal waters between Savannah, Ga., and Jacksonville, Fla.

In 1891, the U.S. Weather Bureau was organized, taking over the duties of the Signal Corps. In 1902 Marconi invented the wireless, and, at last, hurricane warnings were no longer dependent on telegraph wires or on cables stretched across the ocean's floor. Now instantaneous reports from far-off islands or lonely ships could give early warning . . . the modern age of hurricane warnings had begun.

Colonel Joseph P. Duckworth, a pioneer in instrument flight, together with Lieutenant Ralph O'Hair as navigator, made the first intentional aircraft penetration of a hurricane in 1943. Duckworth fought a light, single-engined plane through the maelstrom of wind and water that was a Galveston-bound hurricane into the very eye itself, that eerie canyon of clouds and stillness hidden deep in the heart of every hurricane.

For his courage and initiative,



Colonel Duckworth received the Air Medal. His flight opened the door to a whole new era in hurricane tracking and forecasting. Today, reconnaisance aircraft fly many missions during every hurricane season, tracking and analyzing storms still days away from the nearest land station. This vital, but now routine service, owes its existence to Duckworth's faith in his ability to fly safely in any kind of weather.

More recently, new tools have been given the hurricane forecaster. Among these are radar and the weather satellite. Nowadays, few hurricanes roar in unheralded on helpless people. They are kept under constant surveillance from the moment of their discovery, often far out at sea. Except for the crew of some unlucky ship, the people of some isolated island, there is time to prepare . . . to get out of the way. Today, it is not hurricane forecasting, but hurricane control that is more often the topic of conversation.

It used to be popularly suggested that battleships could shell a hurricane and destroy it. More recently, atomic and hydrogen bombs have been discussed. What is not realized is the enormous energy involved in these storms. In 24 hours, the average hurricane releases the energy equivalent of 500,000 atom bombs of the Nagasaki type. Hydrogen bombs are far more powerful than atomic bombs, but even they fall far short of the energy released by such a storm. Yet a hurricane operates at only about 3 percent efficiency in releasing its energy.

Even if it were possible, the destruction of hurricanes might create more problems than it would solve. The hurricane may be essential in preserving the heat balance of the atmosphere. If it is, and man interferes, no one can predict the consequences.

Hurricanes definitely have their place in the scheme of things. Down through the centuries they have helped shape the very environment in which we live. As we have seen, they have frequented our history, and at times have changed its course. There was even a hurricane that kept the United States out of war.

In 1888 Prince Bismarck, the Chancellor of Germany, tried to establish a German protectorate in Samoa. German naval vessels, while shelling a native village, destroyed some American property, and German sailors ripped down and burned an American flag. U.S. warships sped to Samoa. On March 16, 1889, as the ships of the two nations faced each other in the harbor of Apia, a savage hurricane overwhelmed them. The ships were either sunk, or wrecked and driven aground. The seamen of both nations struggled to survive . . . and to help one another. The island's natives came to the rescue of both. Even so, about 150 sailors drowned. It was a high price to pay, but the hurricane brought peace. In a time of mutual disaster, grievances were forgotten and differences soon resolved in the Treaty of Berlin of 1889.

The hurricane had prevented war. A worthy addition indeed to that long line of hurricanes that have whirled through the lives of the American People from the very beginning.

The German Man-of-War Adler, *wrecked by a hurricane that kept the United States out of war.*

First Meeting of US/USSR Data Exchange Experts

By Leon LaPorte

The first meeting of the U.S./U.S.S.R. Experts on Data Exchange was held March 29 to April 2, 1976, at EDS Headquarters in Washington, D.C. The group is one of several formed under the U.S./U.S.S.R. Joint Committee on Cooperation in World Ocean Studies, established to implement joint projects under a June 19, 1973, Nixon-Brezhnev Agreement.

At its first meeting held February 25-27, 1974, in Washington, D.C., the Joint Committee approved specific cooperative projects for implementation under the six areas named in the Agreement:

- Large-scale ocean-atmosphere interaction,
- Ocean currents and dynamics,
- Geochemistry and marine chemistry,
- Geology and geophysics,
- Biological productivity and biochemistry,
- Instrumentation calibration and standardization.

Participants at the Committee's first meeting also agreed to develop arrangements for the exchange of data and information resulting from these cooperative projects. They further agreed to develop bilateral mechanisms and technical specifications for data exchange between the national oceanographic data centers of the two countries, to facilitate the eventual broader exchange of data through the World Data Center System.

The recent meeting of US/USSR Experts on Data Exchange was called to help develop the arrangements and specifications. At the meeting, the U.S./U.S.S.R.experts agreed upon general principles and procedures for the exchange of data and information and made recommendations for approval by the Joint Committee on Cooperation in World Ocean Studies during its forthcoming third session (Fall 1976).

The participants recommended that:

- All data resulting from programs unde the Nixon-Brezhnev Agreement that have been preliminarily analyzed are subject to exchange.
- The exchange also includes results of statistical summaries and other derived data and information produced in institutes and laboratories using agreed methods.
- The exchange of data shall be accomplished free of charge to the receiving national center.
- Immediately upon completion of a project or portion thereof—such as a ship's cruisse or leg of a cruise—a First-Level Inventory of all observations and samples obtained should be prepared by the Chief Scientists and transmitted to and subsequently exchanged between the respective national oceanographic data centers. For most data, UNESCO's Intergovernmental Oceanographic Commission ROSCOP (Report of Observations/Samples Collected by Oceanographic Programs) inventory form should serve as a suitable First-Level Inventory form, especially if augmented by additioanl project information such as was specified for the Global Atmospheric Research Program Atlantic Tropical Experiment (GATE).
- A more detailed Second-level Inventory, i.e., an inventory which describes the methods used to obtain and analyze the data and/or samples, should be prepared for all data that are either (a) not well suited for centralized archiving and exchange, or which (b) must undergo time-consuming processing before they can be exchanged. Such data, to the extent practicable, should be preserved by the holding activity and made available on request (by copying, summarizing, or other means) to scientists working on projects of potential interest to both nations under the Agreement.
- All fully processed data, data summaries, data products, and information derived from such data, which are obtained from programs under the Agreement, should be submitted to the appropriate central repositories within each country (e.g., for oceanographic data, the national oceanographic data centers) and be promptly exchanged by providing complete copies to the designated counterpart centers in the US and USSR. Subsequently, the data will be also exchanged through the World Data Centers.
- It is recognized that, in some instances, certain experimental, ancillary, highly specialized, or unprocessable data may be collected and that such data may not warrant preser-

Top: The Soviet delegation was headed by Dr. Vadimir I. Alekseyev of the U.S.S.R. Council of Ministers, State Committee for Science and Technology.

Top right: The meeting was hosted and cochaired by Robert V. Ochinero, Director of EDS' National Oceanographic Data Center.

Participants in the meeting of U.S./U.S.S.R. Experts on Data Exchange (from left): D. E. Gershanovich, V. A. Burkov, P. Afansenko, V. I. Lamanov, A. S. Barinov, A. P. Metalnikov, V. I. Alekseyev, R. V. Ochinero, T. S. Austin, J. K. Barnes, T. Winterfeld, J. Churgin, and P. J. Grim. (R. R. Freeman not shown.)


CCEA
CCEA

Top: Dr. D. E. Gershanovich (left) of the U.S.S.R. prepared the Russian-language version of the participants recommendations.

P. Afanasenko (left) from the U.S. State Department did the translating.

vation or detailed inventorying and thus would be exempt from the exchange arrangements. However, all scientific papers or reports, based on or dealing with such observations, should be exchanged.

- Specific technical details of the exchange arrangements, such as frequency of transmission, data formats, and technical carriers, tailored to meet the requirements of individual programs under the agreement, will need to be developed and agreed upon by groups of experts with in the projects. In arriving at such details, these groups of experts should consider existing data exchange mechanisms and agreements already established by both nations, such as those for GATE, which should serve as a model. Procedures established by such existing approved guides to data exchange, such as the IOC *Manual on International Oceanographic Data Exchange,* should be used wherever applicable and practical.

- It is recommended that the basic technical carrier for the exchange of data be 12.7 mm (½ inch) magnetic tape, 9-track, with a density of 800 bits per inch in the agreed upon formats. For oceanographic data, nonreturn to zero (NRZ) impulse (digital) coded recordings can be used in the EBCDIC data information code using the GATE format. The preferred format is a fixed length, 800-byte record. Also acceptable are information carriers of other types, such as tables, charts, microfilms.

- Basically, the exchange of data should be carried out no later than 1 year after the completion of a project, or any independent phase (e.g., leg, cruise) of this project. In those cases where it is necessary to spend more time in processing the data from certain projects under the Agreement, the dates of the exchange will be determined by the responsible project leaders. When data are exchanged, they should be accompanied by descriptions of the methods used in their collection, analysis, and reduction; the archival format; and the results of intercalibration of instruments.

- All officially published scientific papers, reports, analyses, etc., that are the direct fruits of the programs under the Agreement should be freely exchanged between collaborating scientists and made available to governmental activities and scientists in both nations through the mechanism of routine exchange of such material between the respective national centers designated for data exchange.

The W.F. Thompson Memorial Library

By Mollie Endicott

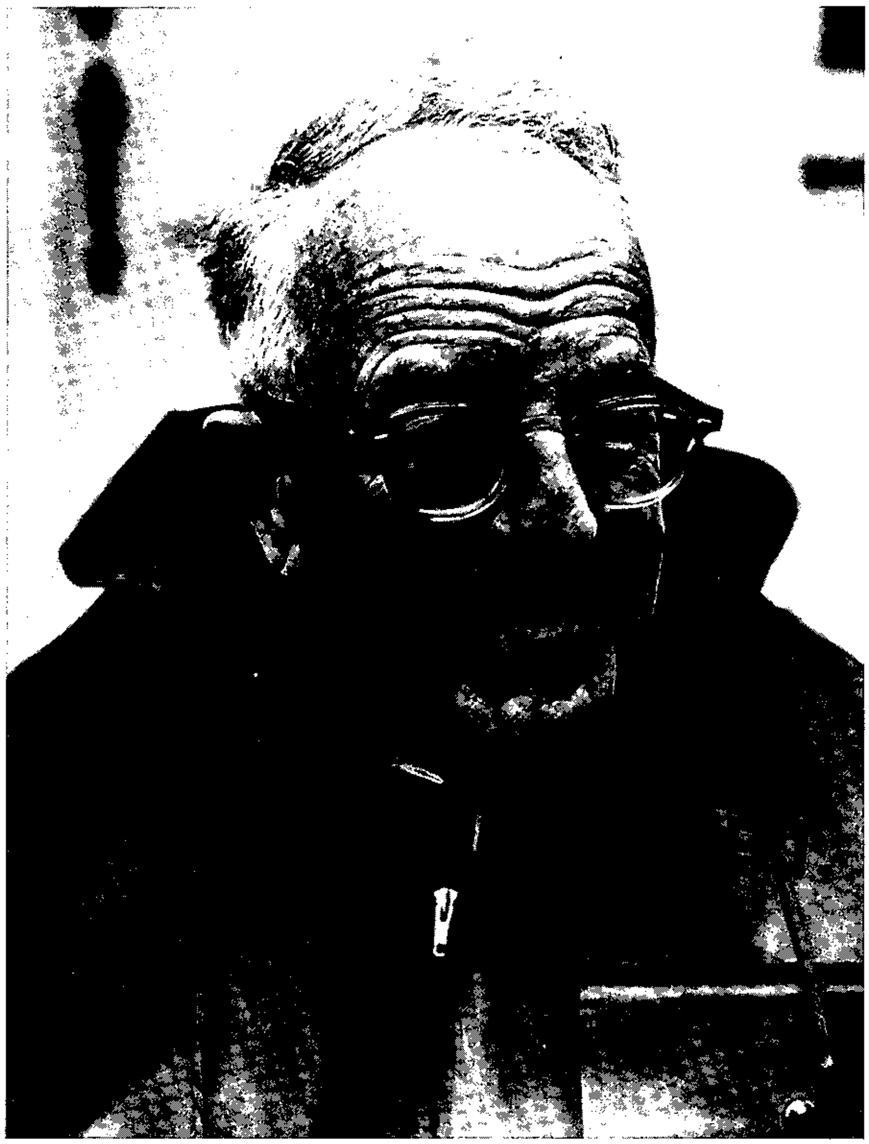
This library was dedicated on July 7, 1971, at the National Marine Fisheries Service's (NMFS) Northwest Fisheries Center Facility in Kodiak, Alaska, as a memorial to W.F. Thompson's career in fisheries research.

Thompson was a student of David Starr Jordan, the eminent ichthyologist and president of Stanford Unviersity. When Thompson attended Stanford, it was a world center for fisheries research.

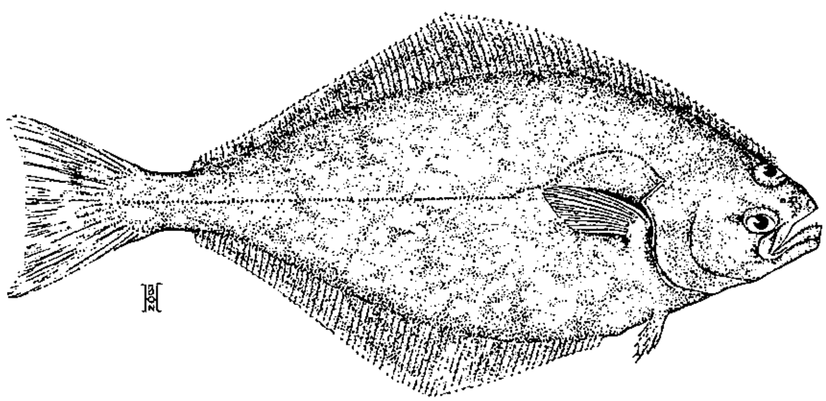
After he graduated in 1911, he began working with the California Department of Fish and Game during the summer and continued his graduate studies during the winter. During the period 1912-16, he investigated the British Columbia shellfish resources and the halibut and herring fisheries. His pioneer studies of the halibut fishery provided the basis for the management programs that soon made him famous.

In 1917, he established the fishery research program of the California Fish and Game Commission. Later, in 1924, he was asked to organize and direct investigations for the International Fisheries Commission. As a result of the Commission's research, the regulations that were established for halibut provided a model for fisheries management.

In 1937, Thompson became Director of the International Pacific Salmon Fisheries Commission, which carried on the investigations that led to the management and improvement of the sockeye salmon run of the Fraser River, B.C. While director of these international commissions, he took an active interest in the School of Fisheries at the University of Washington and was acting head of the school for many years. In 1943, he became the Director of the school.



William F. Thompson, a leader in fisheries research, 1888 to 1965.



Top: NOAA's National Marine Fisheries Service Facility in Kodiak, Alaska houses the Thompson library.

Above: Thompson studied the habits of the Pacific halibut and developed one of the earliest models for its fishery.

During 1947, Thompson returned to research, organizing and directing the Fisheries Research Institute at the University of Washington. Although he retired at the age of 70 in 1958, he remained active as a fisheries consultant and counselor until his death in 1965. He left behind a large group of colleagues and former students who remember him with great respect and fondness.

W. F. Thompson's personal library was purchased from his estate and combined with two other NMFS libraries, the Exploratory Fishing and Gear Research Base collection in Juneau and the Ketchikan Technology Laboratory Library. Many early periodicals and publications, including autographed first editions of rare Alaska historical volumes, are included in this collection.

Today, the Thompson Memorial Library contains 2,800 bound volumes, receives 70 current periodical subscriptions, and has access to a large number of research publications. There also are files of NOAA research vessels' cruise results, which form the basis of the NMFS Kodiak Facility's ongoing studies of shrimp, crab, bottomfish, and mollusks. The library has a complete collection of International Halibut Commission documents from its inception in the 1920's as well as documents, proceedings, bulletins, and special publications of the International North Pacific Fisheries Commission. In addition, there are extensive pictorial files of cruise sequences, gear in action, and individual portraits of the animals studied. Photographs taken abroad foreign vessels by U.S. observers are also included in the files. In addition, many journals dating back to 1940 provide good coverage of the food sciences, chemistry, and biochemistry fields.

The library is a rich source of fishery information and at present is being inventoried to establish future needs. With the advent of extended Federal Fisheries jurisdiction and the development of Alaska offshore oil, the demands for research reports and scientific documents may increase. In the meantime, the library supplies fishermen and processors with various information. In addition, the University of Alaska at Kodiak has increased public awareness and usage of the Library as a convenient source of information.

The library's address is:

Kodiak Laboratory, NWFC
P.O. Box 1638
Kodiak, AL 99615

Research Data Users Workshop

The EDS National Climatic Center (NCC) in Asheville, N.C., hosted an EDS/National Science Foundation (NSF) cosponsored workshop for research users of climatological data on April 27 and 28. The Workshop followed a survey of data users in the national research community.

The purpose of the Workshop was:

• To acquaint research data users with current and planned data processing techniques and service capabilities in EDS, NOAA's National Environmental Satellite Service (NESS), and the National Center for Atmospheric Research (NCAR), and

• To seek information from the research community about their current and anticipated data and service needs which could be used by EDS to plan future development of data base and service capability at NCC.

Workshop participants included representatives from the University of Alaska, California State College at Northridge, Colorado State University, Florida State University, the Massachusetts Institute of Technology, the University of Minnesota, the University of Oklahoma, Oregon State University, Texas A&M University, and the University of Wisconsin; consulting meteorologists; the Environmetnal Research Technology Corporation and the Rand Corporation; NCAR, NSF, the Energy Research and Development Administration, the U.S. Navy, the National Oceanic and Atmospheric Administration (NOAA), and NOAA's Environmental Research Laboratories, NESS, National Weather Service, and EDS.

The Workshop resulted in the enumeration of a number of specific recommendations, including the establishment of a Scientific Advisory Panel for NCC. A formal Workshop Summary, now being prepared, will detail the recommendations that were developed.

Right: R. Greenfield of the National Science Foundation addresses the workshop.

Two discussion groups were formed to prepare recommendations on future NCC services: one on local and regional scale data sets (above) moderated by A. Eddy, University of Oklahoma, the other on hemispheric and global scale data sets (right), moderated by D. Johnson, University of Wisconsin.

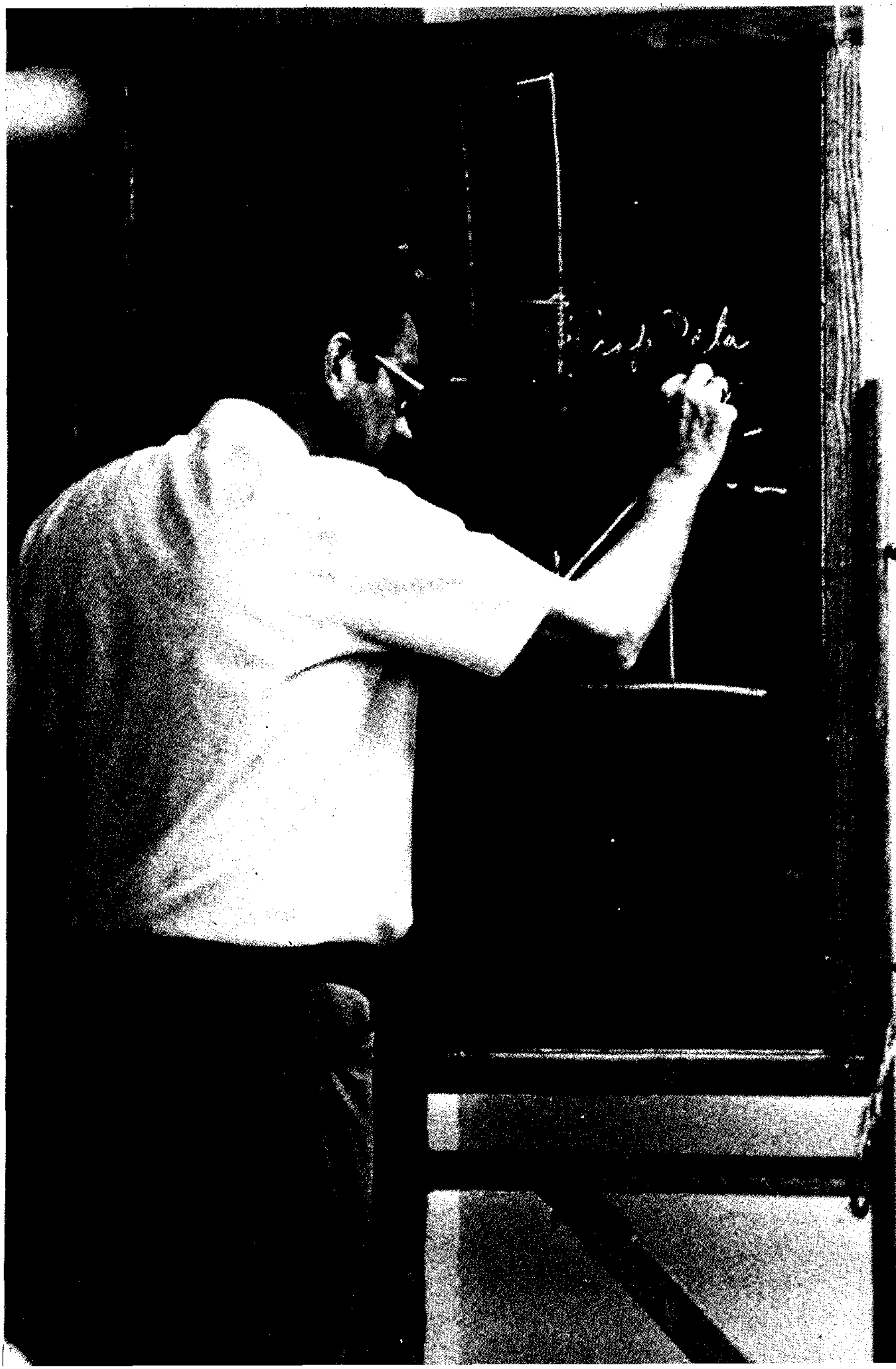
Climate and Fisheries Workshop

A joint National Marine Fisheries Service (NMFS) Environmental Data Service Workshop was held at the EDS Center for climatic and Environmental Assessment (CCEA) Headquarters, Columbia, Mo., April 26-29, 1976. The purpose of the workshop was to explore areas of potential mutual interest, identify specific projects where a joint effort might be beneficial, and assess joint operational capability areas.

In addition to NMFS and EDS representatives, participants included representatives of the National Oceanic and Atmospheric Administration (NOAA) and NOAA's National Weather Service, National Environmental Satellite Service, and Environmental Research Laboratories, as well as the Scripps Institution of Oceanography and Oregon State University.

Workshop discussions centererd on two major subject areas: (1) cooperative modeling efforts focusing on the impact of large-scale climatic variation on global protein potential and selected regional fisheries, and (2) potential use of CCEA climate assessments by NMFS. During the workshop, a general awareness developed that the atmospheric forcing that triggers such events as El Ninos was also evident simultaneously in other anomalous fisheries events, highlighting the global, rather than local impact of atmospheric impulses.

Top: Dr. H. Austin, Dr. M. Laurs, and J. Johnson of NMFS consider a presentation linking climatic variations and anomalous fisheries events.
Right: Dr. K. Sherman, M. Ingham, and M. Laurs of NMFS prepare to participate in a working group session.
Opposite: Dr. J. McQuigg, CCEA Director, diagrams climatic effects on grain production..



Modeling the Impact of Climatic Variability To Estimate Grain Yields*

By James McQuigg, Director
Center for Climatic and Environmental Assessment

Abstract

There are two basic approaches to modeling the impact of meteorological variability on crop yields. The physiological approach is an attempt to describe in detail how meteorological variability affects biological/physical processes that occur within a typical plant or plant canopy. The statistical approach is an attempt to use a sample of yield data from an area (an experimental plot, a crop district, State, or province) and a sample of weather data from the same area to produce estimates of model coefficients by some sort of regression technique.

Physiological Approach

Another name for this approach is *causal.* Ideally, a model of this type should be based on detailed knowledge of the biological/physical processes that take place (hour-by-hour, or day-by-day) within the plant and within the immediate atmospheric/soil environment of the plant. This knowledge, expressed in quantitative form, is the model. Such a model is very useful for a variety of purposes, serving as a scientific tool for (1) studying the impact of climate change, (2) deliberate genetic "engineering" leading to better adaptation of a crop to a given range of climatic conditions, (3) estimating crop yields, or (4) estimating the phenological progress of a crop, given knowledge of weather conditions.

While it is surely true that investigators in a number of disciplines have developed an impressive body of

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**A slightly edited version of a paper presented o a Symposium on Modelling: Climate - Plants - Soil. April, 1976. Sponsored by the Department of Land Resource Science, University of Guelph, Guelph, Canada.*

detailed, quantified knowledge of the many complex processes that occur within plants and within the immediate environment of plants, I am not aware that a model exists which is based directly and only on such biological/physical knowledge.

Many of the models of this type that have appeared in the literature are consistent with one or more causal mechanisms within the crop and within the immediate environment of the crop, but coefficients in the models are often the result of regression/correlation analysis of samples from greenhouses or experimental plots. The reader not already familiar with the physiological approach is referred to the papers by Haun (1973), Runge (1968), and DeWit et al. (1971).

The major advantage of this approach is that it is based on knowledge of causal relationships. The major disadvantages are:

- The knowledge of causal relationships between weather events and biological/physical processes within the plant or the plant canopy is incomplete.
- Detailed measurements needed to estimate the coefficients in a physiological model are limited to comparatively small sample plots and to comparatively short sampling periods. The problem of extending the results of physiological modeling for specific locations to aggregated estimates of crop progress or final yield over commercially important large regions has not been completely solved.

Statistical Approach

Another name for this approach is *correlative.* In this case, the investigator usually has access to a series of yield estimates from an area (which may be as small as a research plot or as large as a whole country), and a sample of weather data from the same area. Using some sort of regression technique applied to the yield and weather data, model coefficients are estimated.

At its worst, the regression work proceeds as a "cut and try" effort to look at almost all possible specifications of the weather variables that could be included in the model. At its best, the specification of the form of the model is made in a manner consistent with the most complete knowledge of biological and physical processes.

The chief advantage of the statistical approach is mainly that it is feasible. It is usually possible to find sample weather and yield data from a desired geographical region, and it is not very difficult to gain access to a regression routine that requires only minimal programing efforts. Some of the disadvantages of the statistical approach are:

- The investigator nearly always has to use historical yield and weather data collected for some other purpose.
- If the sample yield and weather data have been collected from a carefully documented research plot, they can be regarded as precise measurements. If these data are large production areas (the equivalent of a U.S. county or larger) they are nearly always estimates rather than measurements, and thus they are subject to sampling error (which gets larger as the sample area gets smaller).
- Multicollinearity of the "independent" weather variables in the model results in subtle, but serious problems in testing hypotheses on the regression coefficients, and in applying the model in a predictive mode. This is a fancy way of saying that there are not very many "independent" meteorological variables.
- A most troublesome problem involves specifying the impact of technological change for the historical sample of yield data and of projecting this trend into the future. If this is not handled properly, the portion of the model related to meteorologically induced variability will be weakened. (This problem also exists in causal models.)

The reader not familiar with the statistical approach is referred to papers by Thompson (1969a, 1969b, 1970) and by Changnon and Neill (1968).

Technology Trend Function in Statistical Crop-Yield Models

Figure 1 shows a wheat-yield data series for Oklahoma. This is typical of yield data series for other regions and other crops during this time period. Most of these data series show a comparatively flat trend for the first few decades, with a substantial trend toward higher values in the most recent two or three decades. We can make a plausible list of the mechanisms (which we lump together under the term "technology") which have caused the recent increases. These would include better seed, more fertilizer, insecticides and herbicides, substitution of mechanical energy for animal and human energy, better machinery, and better management. A rational weather/crop yield model should theoretically include these factors as specified variables; most models do not. Instead, they use "time" or "year" as a surrogate variable.

In figure 2, a piece-wise time trend

Example of the Application of a Statistical Model

The model is for wheat in Kansas, 1975.

Climatic Data: Climatological division values of precipitation and temperature are weighted to obtain State values using weights based on 1973 wheat-harvested acreage.

Climatic Division	Weight
Northwest	0.1129
North Central	0.1088
Northeast	0.0232
West Central	0.1229
Central	0.1486
East Central	0.0268
Southwest	0.1838
South Central	0.2289
Southeast	0.0442

Potential evapotranspiration (P.E.T.) is estimated by Thornthwaite's method, using the State monthly average temperatures as the climatic inputs. Average monthly daylength is for latitude 38°N.

May degree days above base 90°F are obtained by averaging the values for the following stations: Ashland, Columbus, Hays, Horton, McPherson, Medicine Lodge, Tribune, and Winfield.

Normals for the climatic variables are based on the 1931-74 time period.

Variable	Normal
August to February Precipitation	10.271 in
March Precipitation - P.E.T.	0.796 in
May Precipitation	3.540 in
June Precipitation	3.809 in

Wheat Model: The data base is 1931-74. Normals are based on the entire time period. Yield data is measured in bushels per acre harvested. Coding of variables is given in table 1. Truncated models are shown in table 2.

Truncated Yield Forecasts for 1975:

February Truncation: $\hat{Y} = 10.471 + 0.268(25) + 0.741(21) + 0.521(AFP - 10.271)$

June Truncation: $\hat{Y} = 13.347 + 0.225(25) = 0.759(21) + 0.284(AFP = 10.271) + 1.591(MPP - 0.796) - 0.139(MPP - 0.796)^2 - 0.299(MP - 3.540)^2 - 2.453(MDD) - 0.133(JP - 3.809) - 0.119(JP - 3.809)^2$

$\hat{Y}$ = Yield estimate in bushels per harvested acre,
AFP = August to February precipitation (in),
MPP = March precipitation-P.E.T. (in),
MP = May precipitation (in),
MDD = May degree days above 90°F (= *1 if degrees days* > *8.5*, = 0 otherwise),
JP = June precipitation (in).

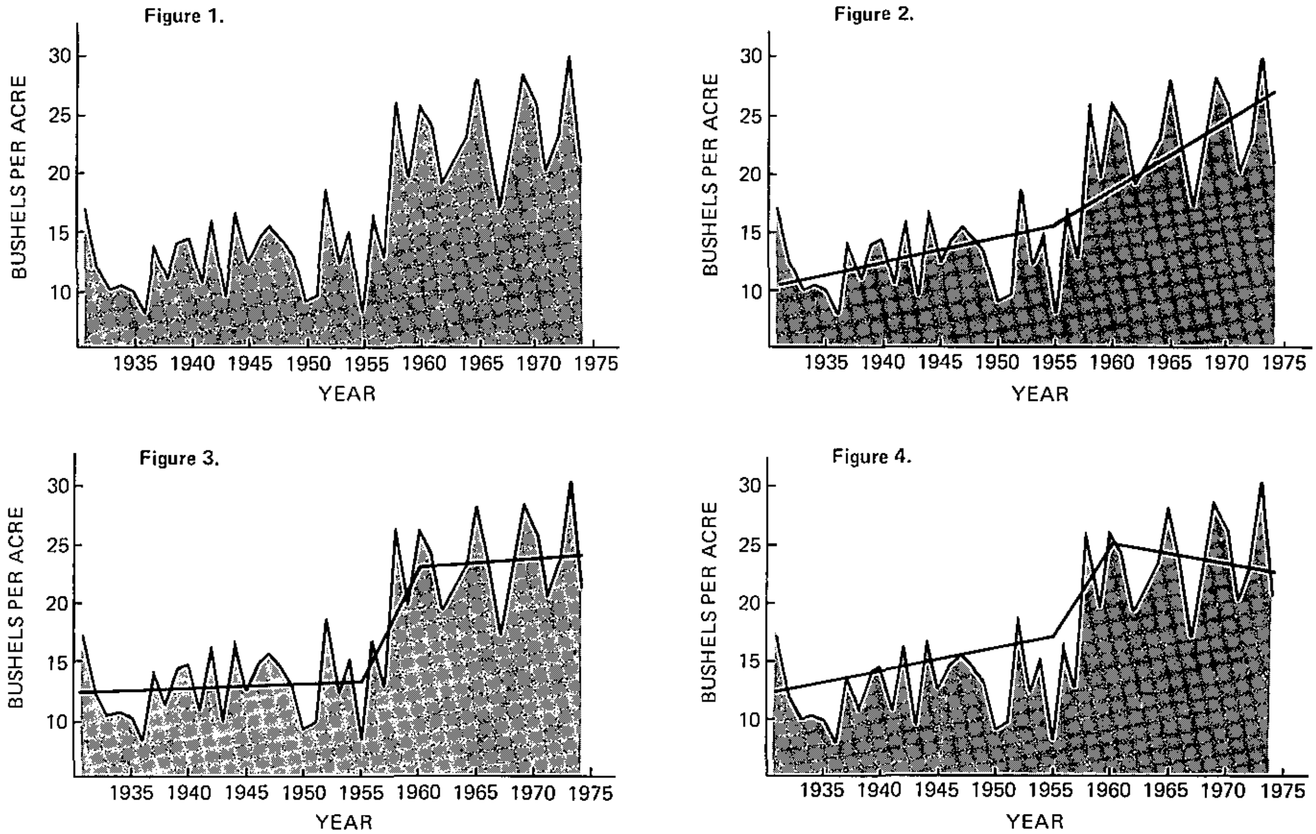
Table 1 Kansas State Wheat Model

Variable	Coding
Constant	=1
Linear trend, 1931-55	1931=1, 1932=2, ..., 1955=25, 1956=25, ..., 1974=25
Linear trend, 1955-74	1931=1, 1932=1, ..., 1955=1, 1956=2, ..., 1974=20
August to February precipitation (in)	Departure from normal
March precipitation-P.E.T. (in)	Departure from normal Squared departure from normal
May precipitation (in)	Squared departure from normal
May degree days above 90°F	=1 if degree days > 8.5 =0 otherwise
June precipitation (in)	Departure from normal Squared departure from normal

Table 2 Truncated Models for Kansas Winter Wheat

Variable		Time of truncation				
		Trend	February	March	May	June
Constant		10.383	10.471	11.407	13.263	13.347
Linear trend, 1931-55		0.250	0.268	0.213	0.208	0.225
Linear trend, 1955-74		0.819	0.741	0.811	0.775	0.759
Aug-Feb precip. (in)	DFN	—	0.521	0.343	0.293	0.284
Mar precip. -P.E.T. (in)	DFN	—	—	1.875	1.487	1.591
	SDFN	—	—	-0.170	-0.120	-0.139
May precip. (in)	SDFN	—	—	—	-0.369	-0.299
May degree days above 90°F		—	—	—	-2.424	-2.453
Jun precip. (in)	DFN	—	—	—	—	-0.133
	SDFN	—	—	—	—	-0.119
Standard error (bu/acre)		3.68	3.48	2.90	2.53	2.48
R^2		0.77	0.80	0.86	0.90	0.91

Standard deviation of yields = 7.42 bu/acre
DFN = Departure from normal
SDFN = Squared departure from normal



Time-trend analyses of an Oklahoma wheat-yield data series.

line has been fitted to the yield series, with a break in the trend line at 1955. This year coincides with the time of introduction of new wheat varieties and the use of increased amounts of chemical fertilizer. But in an equally plausible model (fig. 3), the investigator thought it reasonable that the piece-wise time trend line be fitted to the data with discontinuities at years 1955 and 1960. And in figure 4, the trend line coefficients and the meteorolotical coefficients were estimated concurrently. This model is of the form

$$Y - Y = f(\text{year}) + g(\text{weather})$$

where Y and Y are yield estimates and g (weather) is evaluated as a nonlinear function of deviations from mean weather values. We are using this latter specification of the technology trend function in operational work in progress at our center in Columbia, Missouri.

Which of these specifications of the yield trend function is the right one? We think the last one presented (fig. 4) is the most reasonable, largely because there have been significant shifts in land use. Much more work needs to be done on this important component of yield variability.

Acquisition of Weather Data for Statistical Crop Yield Models

The current system of collecting surface weather data developed mainly in response to the needs of aviation and those of synoptic meteorologists. Anyone wishing to use these data as inputs to models for assessing the impact of weather events on grain yields is faced with sampling problems in time and space. More frequent observations and/or a larger number of stations might indeed offer the possibility of more precise estimates of meteorological impacts, but this has to be weighed against the substantial increase in costs that would be involved.

At the Center for Climatic and Environmental Assessment, data are obtained from first order stations of the National Weather Service and from cooperative climatological stations. These stations issue monthly reports summarizing their daily observations, and these monthly data are used in the crop yield models. The yield estimates prepared by CCEA compare favorably with the excellent estimates of the U.S. Department of Agriculture (fig. 5 and 6).

Choice Of a Model

It has not been my intention to go into great detail concerning the particular biological, physical, or statistical properties of a large number of particular models that have

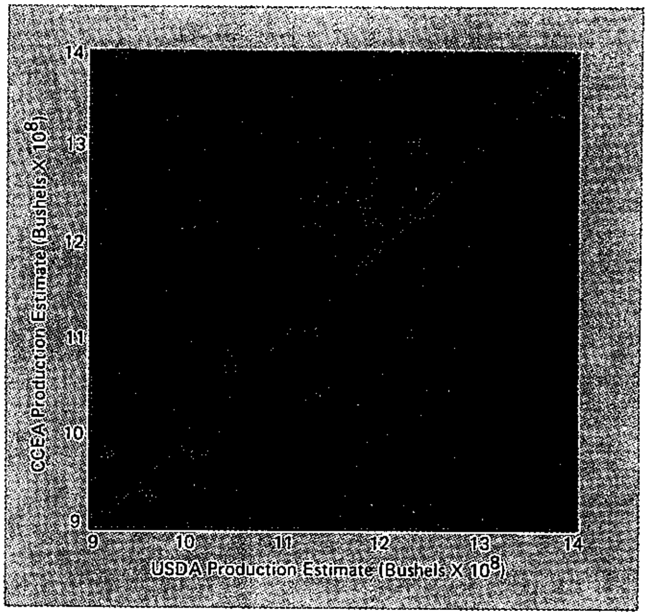


Fig. 5 USDA and CCEA Wheat Production Estimates (1965-75).

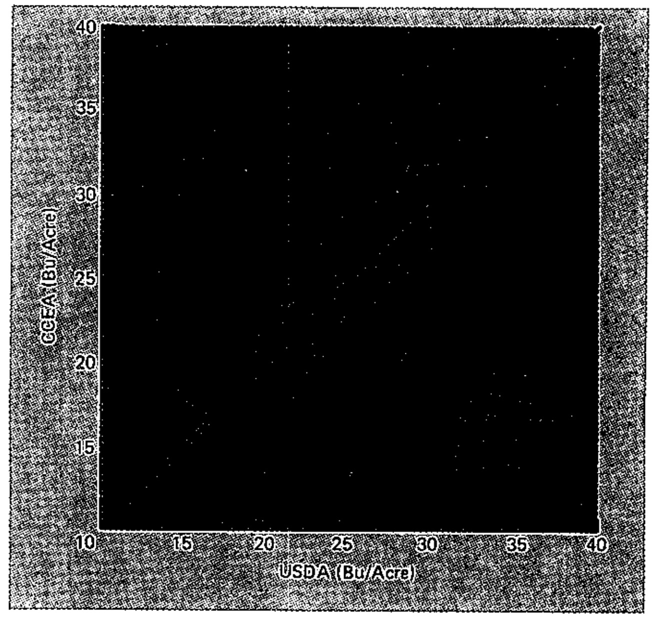


Fig. 6 USDA Wheat Field Estimate vs. CCEA Estimate (1965-75).

appeared in literature. In addition to a proper amount of concern for these matters, the choice of a model should be made on the basis of the answer to the question, "For what purpose(s) will the model be used?".

• The model may serve as an investigative tool, leading to better understanding of the complex interactions of the crop with the atmosphere.

• The model may serve as an operational tool, to be used to translate the flow of meteorological data through the worldwide communications system (supported by a large number of national weather services) into estimates of grain yields, as the crop season progresses. The complex system of distributing food grain on a global basis is becoming more sensitive to large scale meteorological anomalies, rather than less. Application of well-conceived, feasible crop yield/weather models to the management of national and international food grain programs is a comparatively recent phenomenon.

Technical and scientific considerations in the choice of a particular approach to weather/crop yield modeling are important. It is my opinion that we now have completely adequate theoretical and practical knowledge to support the process of choosing a modeling approach that will best serve the purposes(s) we have in mind.

Conclusion

We are now at the juncture where the most difficult remaining problem is to find an effective way to communicate the results of applied crop/weather model applications to the decision-makers in government, industry, and international bodies in a credible, useful form. The opportunity for discussion and communication that this meeting offers is a rare opportunity to improve our ability to find ways to use our modeling capabilities more effectively.

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National Report

Bicentennial Climatic Guides

As part of its contribution to the Nation's Bicentennial, EDS has published 4-page color brochures describing the climates of 11 regions of the United States. The regions are Northeastern, Mid-Atlantic, Southern Mountain, Southeastern, North Central, South Central, Mid-Western, Rocky Mountain, Northwestern, Southwestern, and Hawaii. (The text of the Mid-Atlantic Region guide appeared in the September 1975 issue of *EDS*.)

Each regional guide contains an outline map of the included states and a climatic data table for a number of representative cities. Topographic and climatic descriptions, as well as visitors information, are also included. A capsule story on weather science and the Founding Fathers is featured on the back page.

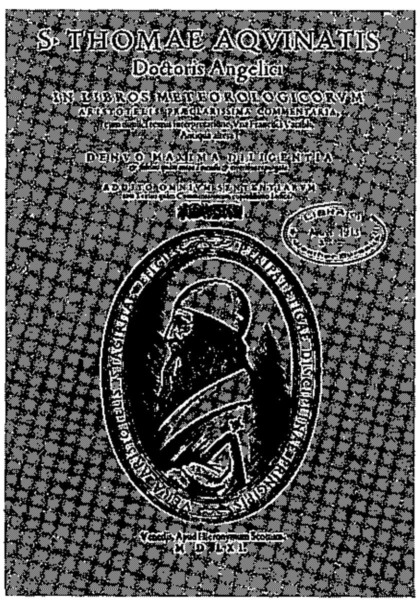
Copies of the brochures have been sent to State travel, tourism, and visitor's offices around the country. The guides can be obtained from the Environmental Data Service (Code Dx2), 3300 Whitehaven Street, N.W., Washington, D.C. 20235. Telephone: (202) 634-7306.

NOAA's Rare Book Collection

The Library and Information Services Division of EDS' Environmental Science Information Center (ESIC) is the proud possessor of about 600 books that are rare or have unusual historical value. About half of the books were handed down from the U.S. Weather Bureau collection begun in the 1880's by Prof. Cleveland Abbe, the father of the U.S. weather forecasting service.

Over the past 2 years, ESIC has begun restoration of some of the oldest and most valuable works, two of which date back to before 1500 (1485 and 1494). Twenty-four others were published between 1500 and 1599. More recent works (1665-1800) include volumes by Boyle, Bacon, marriotte, Mairan, and Franklin. One of the most interesting books contains the text of and commentaries on Aristotle's *Meteorologica* by St. Thomas Aquinas, published in Venice in 1561.

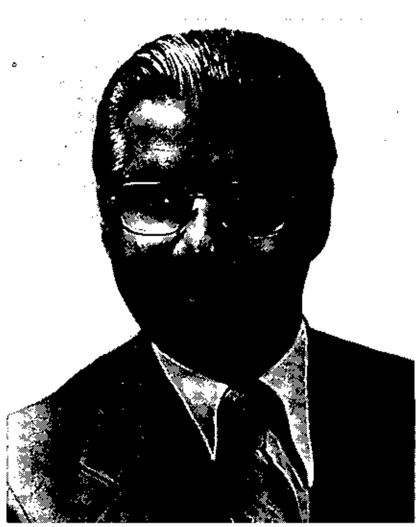
Eight rare books have already been restored, and an additional 20 volumes are scheduled for this year. A list of the titles in the collection is being prepared and will be published in a future issue of *EDS*.



Title page from St. Thomas Aquinas' commentaries on Aristotle's Meteorologica.

Coordination of Federal Library and Information Center Activities

Dr. Joseph Caponio, Director of EDS' Environmental Science Information Center, has been appointed chairman of the Federal Library Committee's Special Technical Group. The Group's mission is to work toward integration of Federal libraries and other information centers to reduce duplication of effort and to improve the efficiency of the total Federal information system. The study is based on recommendations of the General Accounting Office.

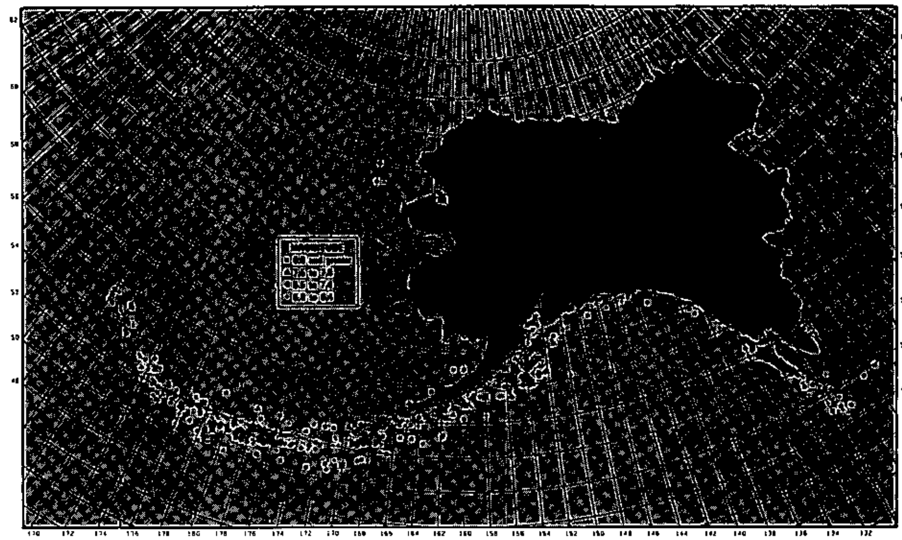


Alaska Earthquake Summary

In support of the Bureau of Land Management/NOAA Outer Continental Shelf Environmental Assessment Program (OCSEAP) for Alaska, the EDS National Geophysical and Solar-Terrestrial Data Center (NGSDC) has published *A Historical Summary of Earthquake Epicenters in and Near Alaska*. OCSEAP is a multiyear environmental assessment of the Northeast Gulf of Alaska and Bering, Chuckchi and Beaufort Seas related to petroleum development on the Alaska Continental Shelf.

Included in the new report are plots and tables summarizing about 10,000 earthquakes which occurred between 1786 and 1974. The data are presented in a manner that will permit researchers, engineers, and environmentalists to independently assess the earthquake risk for any specific locality in Alaska.

Copies of the report are available from the National Geophysical and Solar-Terrestrial Data Center, NOAA, Boulder, CO 80302.



Major Alaska earthquakes (1899-1974).

Alaska Tsunami Catalog First in New Publication Series

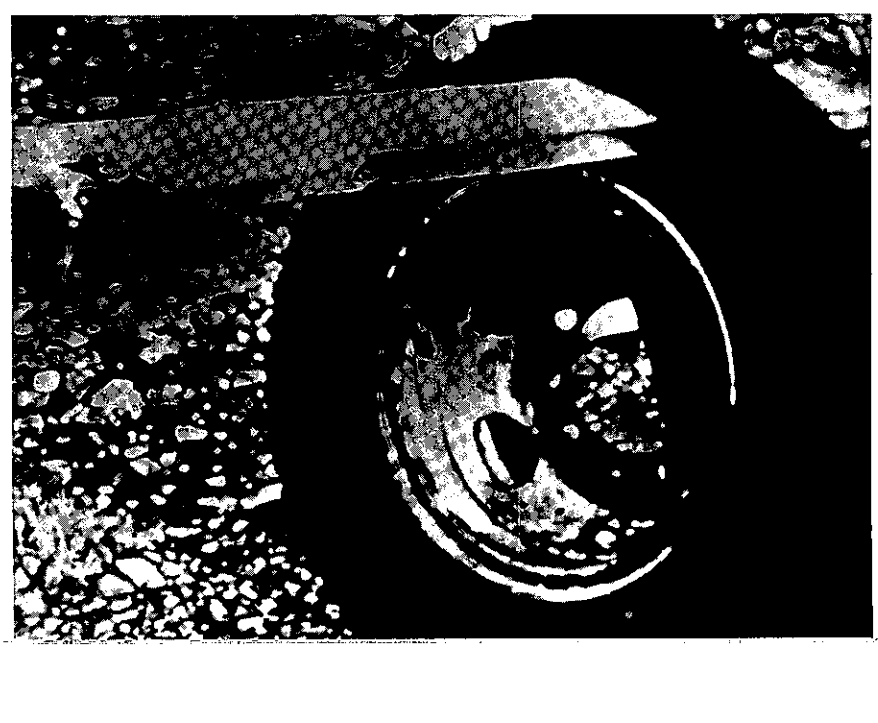
WDC-A for Solid Earth Geophysics has issued *Catalog of Tsunamis in Alaska*, SE-1, the first publication in its new Solid Earth (SE) Report series. The catalog is an update of a 1969 document with the same title, issued by the WDC-A subcenter for tsunami data when it was operated by the Coast and Geodetic Survey in Honolulu, Hawaii. In 1974, this subcenter became a part of WDC-A for Solid Earth Geophysics, which is operated by NGSDC in parallel with the corresponding national services.

The original publication, which contained data on tsunamis for the period July 22, 1788 through 1966, has been updated through 1974. The update includes information on 12 Pacific tsunamis which have been reported since 1967, with pertinent additions to the references, a few editorial changes, and some corrections to the original manuscript. A map showing location of areas experiencing tsunamis and charts of tsunami traveltime to Adak and Sitka have been added to the new catalog to facilitate the use of the data.

Future issues of the new Solid Earth publication series will be published at irregular intervals to make available data sets for which there is potential widespread interest. They will include subjects such as strong-motion accelerograms, network seismograms, tsunamis in Hawaii, and geodynamics progress reports.

Copies of *Catalog of Tsunamis in Alaska* may be obtained from WDC-A for Solid Earth Geophysics, National Geophysical and Solar-Terrestrial Data Center, NOAA/EDS, Boulder, CO. 80302

Board driven through a tire by a tsunami.



International Report

First Global Heat Flow Map Available

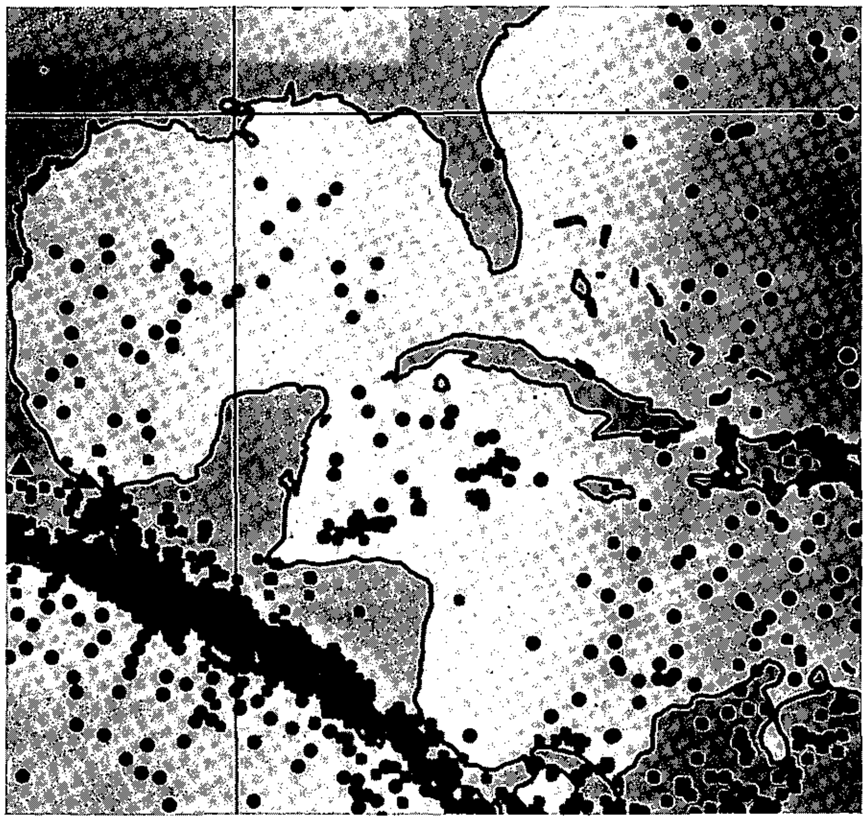
A World Heat Flow Map—the first of its kind showing the amount of heat flowing outward from the Earth's interior—has been prepared by the World Data Center-A for Solid Earth Geophysics, operated by EDS' National Geophysical and Solar-Terrestrial Data Center in Boulder, CO, as a contribution to the International Geodynamics Project. Heat flow values on the map are indicated by one of five colors (the number of measurements is about 5,500 for the entire globe). The map represents work carried out on land and sea by scientists from many nations during the last several decades.

In addition to heat flow data, the map also shows two other types of data closely related to heat flow: the locations of active volcanoes and earthquake epicenters. The epicenters delineate lithospheric plate boundaries which mark places where two plates interact with each other (midocean ridges, fracture zones, trenches, areas of mountain building). The volcanoes for the most part occur at places where one plate underthrusts another plate close to oceanic trenches (e.g., the Aleutians, volcanoes of South America), where new crust is being formed (midocean ridges), and where intraplate islands (e.g., Hawaii) exist. The map also shows a general correlation between high heat flow and locations where geothermal energy is being produced or is likely to be produced.

The map measures 56½ by 35½ inches (scale approximately 1 to 30 million). The projection used is Mercator; the upper and lower latitude limits are 75N and 70S, respectively.

Copies of the map may be ordered from the Distribution Division (Code C44), National Ocean Survey, Riverdale, MD 20840 for $2.50 each. Checks should be made payable to NOS/Department of Commerce. Specify whether the map should be rolled or folded. Foreign remittance should be made either by international money order or check payable on a U.S. bank.

The heat flow data shown on the map are available in digital format on magnetic tape or on punched cards from World Data Center-A. Each measurement has the following: Identification code, latitude, longitude, temperature gradient, thermal conductivity, and heat flow value. In addition, each heat flow measurement is referenced to the publication in which it first appeared. This reference list is also available on magnetic tape or on cards. For further information, contact World Data Center-A for Solid Earth Geophysics, Environmental Data Service/NOAA, Boulder, CO 80302.



A small section of the global heat flow map. Circles show heat flow ranges (in color), triangles denote active volcanoes, and squares mark earthquake epicenters.

New Solar-Terrestrial Physics Data Publications

Four new publications in the *UAG Report* series have been published by World Data Center-A for Solar-Terrestrial Physics (WDC-A for STP) collocated with EDS' National Geophysical and Solar-Terrestrial Data Center. The series is available from the National Climatic Center, Federal Building, Asheville, NC 28801, Attn: Publications, at an annual subscription cost of $25.20 (plus $17.30 for foreign mailing).

• UAGp53, *Description and Catalog of Ionospheric F-Region Data, Jicamarca Radar Observatory (November 1966-April 1969)*, by W. L. Clark, J. P. McClure and T. E. VanZandt. This report describes the equatorial F-region data reduced from the Jicamarca Radar Observatory (JRO) incoherent scatter observations and provides a catalog listing of the times of these observations. JRO is the only incoherent scatter observatory near the magnetic Equator. Its location is 2°N magnetic dip, geographic coordinates S11.95, E283.13. The F-region data include the electron concentration (Ne), and the electron and ion temperatures (Te and Ti) profiled against height in the ionosphere. The effective height range for temperatures is about 250 to 600 km. Although some data are presented for lower and greater heights, they should be treated cautiously since the analysis method assumes the F layer consists only of pure ionized oxygen (0+).

The data containing all Ne, Te, and Ti results are available as both graphical and numerical profiles on paper, and also on magnetic tape. Because incoherent scatter systems are difficult and costly to operate, continuous or synoptic observations were not made. The catalog presents time intervals during which observations were made, along with the number of profiles acquired in each interval.

• UAG-54, *Catalog of Ionosphere Vertical Sounding Data.* This publication is the second in a series of catalogs planned by WDC-A for STP to cover in considerable detail the data disciplines in Solar-Terrestrial Physics. UAG-54 covers the data for ionospheric vertical soundings, including details for all the data held at the Center, as well as information on data held elsewhere. Unlike previous catalogs which began with data for the International Geophysical Year, 1957-58, this catalog contains all data held by WDC-A for STP since the beginning of systematic multifrequency soundings; the earliest data set is for 1930.

Data are included for 310 stations throughout hte world that were operated more or less systematically for at least a few months. They are listed both alphabetically and by geomagnetic latitude. Station locations and other details are provided.

The data holdings for each station are listed by type or format of data. The types are ionograms (the basic vertical incidence ionospheric record), frequency vs. time plots (f-plots), one sheet per day of tables of all scaled hourly characteristics, tables of daily hourly values and medians by characteristic, data in computer format, and hourly composite N(h) profile data. The listing is by year and month, with symbols indicating completeness of the monthly holdings and other information.

Other sections of the catalog present the ionospheric characteristics sealed from the data of each station, and provide explanations of the various data formats. A separate section catalogs the special data holdings including the availablility of individual electron density vs. height profiles, reduced form ionograms. Final sections provide dates dates of Special Observational Intervals for which more data are exchanged or reduced, and addresses of the many sources of the cataloged data.

• UAG-56, *Iso-intensity Contours of Ground Magnetic H Perturbations for the December 16-18, 1971 Magnetic Storm*, by Y. Kamide. This report presents a summary of graphical data derived from records fo selected Northern Hemisphere magnetic observatories for the dramatic magnetic storm of December 16, 1971. To enable study of the progressive development of this event in terms of ground magnetic signatures, consecutive iso-intensity contours of H component deviations from quiet time patterns at middle and low latitudes were prepared. Quiet-time patterns of magnetic variations were determined for 52 observatories between 0# and 60°N geomagnetic latitude. Two and a half days of magnetic variations at these locations were digitized every 5 minutes and, after subtraction of the usual undisturbed values for each location, perturbation values were interpolated for each 30 seconds. Contour plots were prepared on microfilm by the computer to produce a movie by which one can observe the smooth changes from moment to moment during the storm's progression. Graphs of Auroral Electroject indices AU and AL and the lower latitude Dst indices were plotted on each frame showing the pattern of index variation for the entire 2½ days. A timing bar moves across these plots to indicate the moment for which the associated contours present the global H perturbation. The report provides excerpts from the movie film by reproducing the frames for each 10 minutes of the event.

Copies of the film may be obtained from Data Studies Division, National Geophysical and Solar-Terrestrial Data Center, NOAA, Boulder, CO 80302, U.S.A.

• UAG-55, *Equivalent Ionospheric Current Representations by a New Method Illustrated for 8-9 November 1969 Magnetic Disturbance*, by Y. Kamide, H. W. Kroehl, M. Kanamitsu, J. H. Allen, and S. I. Afasofu. This report describes in detail a new method for the calculation of equipotential contours that represent equivalent ionospheric currents which produce magnetic disturbances known as "storms" or "substorms". To illustrate results possible by applying this technique, a computer-produced movie film was prepared from records of 82 Northern Hemisphere magnetic observatories. H and D magnetogram traces for November 8-9, 1969, were digitized each 2½ minutes, and quiet-time patterns for each location were subtracted to leave only the perturbations. After extensive computer processing, the result was a global plot of equipotential contours from which the deviations could have arisen. Each frame also displays the Au and AL index variations for the entire period. Frames from the movie are reproduced in the report, alongside global plots of the vector magnetic perturbations at each observatory. Conditions for each 10 minutes are shown, and discussion is provided to point out the information contained in selected images.

This is the first time such a substorm interval has been studied in this detail with such fine time resolution. The report should be useful for those interested in studying this event or in using the technique described here to study other intervals. Copies of the movie film are available from the Data Studies Division of the National Geophysical and Solar-Terrestrial Data Center, NOAA, Boulder, CO 80302, U.S.A.

New WDC-A Oceanography Publications

EDS' World Data Center A (WDC-A), Oceanography, recently completed four publications of interest to the global oceanographic community. Addresses on WDC-A's international mailing list have already been sent the following:

• *Introduction to World Data Center A, Oceanography,* is a pamphlet describing the World Data Center (WDC) system and the functions and services provided by WDC-A, Oceanography.

• *Semiannual Report of Oceanographic Data Exchange through 30 June 1975,* which summarizes the oceanographic data exchange activities of WDC-A, Oceanography, and includes tabulations of data received during the first half of 1975, as well as a compilation of all data received before 1975.

• *Change Notice No. 15* to the *Catalogue of Data,* which describes in loose-leaf format all data received by WDC-A, Oceanography during the period July 1 to December 31, 1974.

• *Supplement No. 8* to the *Catalogue of Accessioned Publications, 1975,* which lists all publications received by WDC-A, Oceanography, during the period July 1, 1974 to June 30, 1975, and, in addition, contains both a keyword and author index.

Members of the global oceanographic community who are not on WDC-A's international mailing list can obtain copies of these publications by writing:

World Data Center A,
Oceanography
National Oceanic and Atmospheric Administration
Washington, D.C. 20235
U.S.A.

Churgin Chairman of MEDI

James Churgin, Director of EDS' World Data Center A, Oceanography, was elected Chairman of UNESCO's Intergovernmental Oceanographic Commission's (IOC) newly established Group of Experts on the Marine Environmental Data and Information (MEDI) System. MEDI is a referral system to marine data held by organizations around the world.

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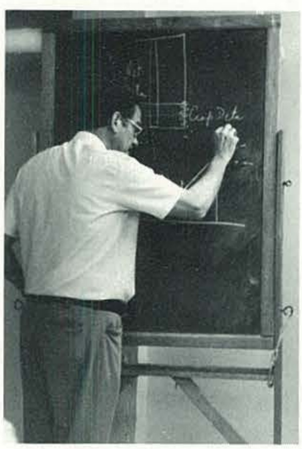
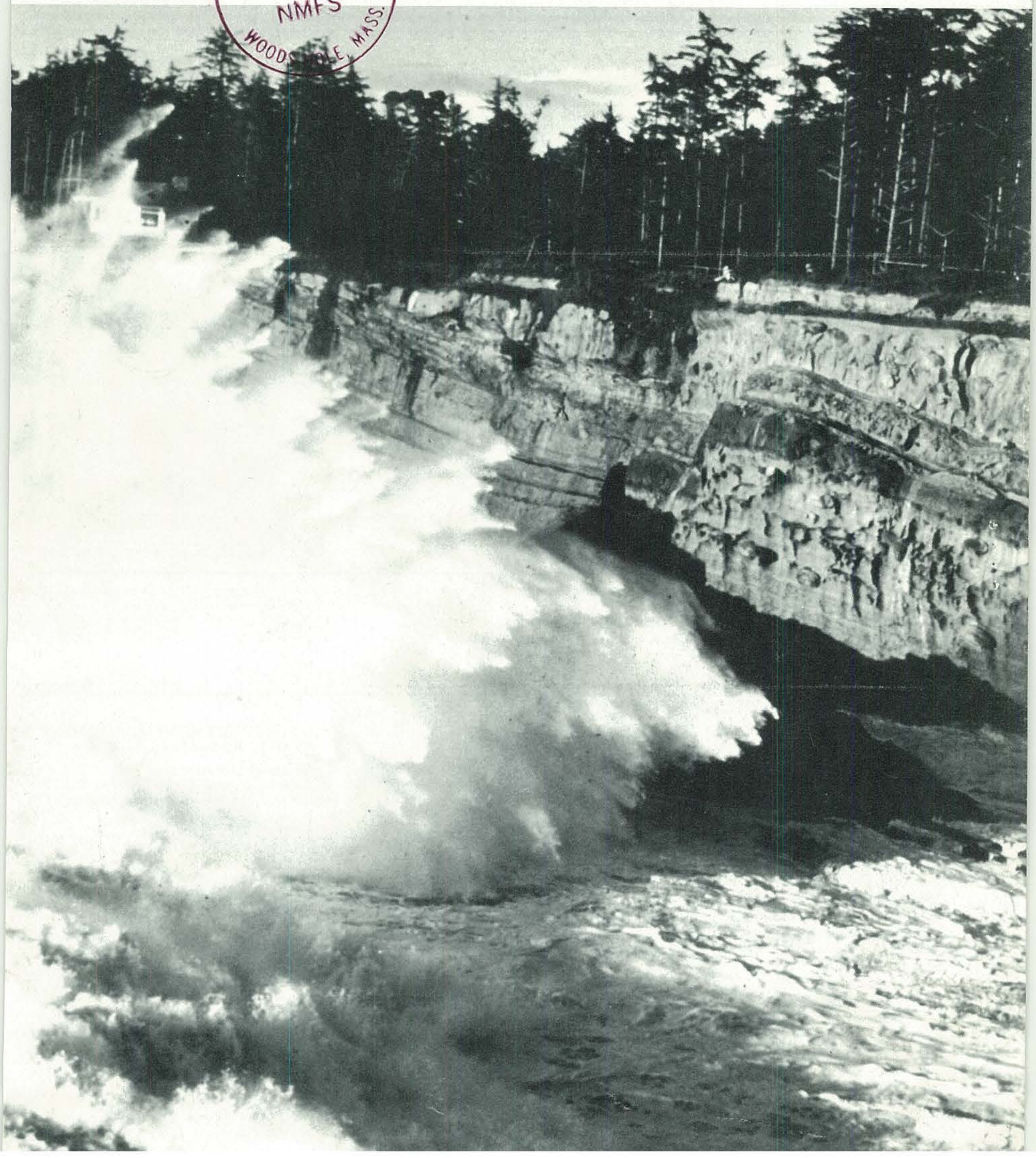


Hurricanes and history (p. 3), Climate and fisheries workshop (p. 16), W.F. Thompson Memorial Library (p. 13), U.S./U.S.S.R. Data Exchange Experts meet (p. 10).

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

EDS

Environmental
Data Service
September 1976



EDS

Environmental
Data Service
September 1976

COVER: Wave data were used by one company to evaluate potential beach erosion. *See SSMO, page 14.*

ENVIRONMENTAL DATA SERVICE is designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, Center for Climatic and Environmental Assessment, and a Deepwater Ports Project Office. In addition, under agreement with the National Academy of Sciences, EDS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, and Solar-Terrestrial Physics.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 16, 1975; this approval expires June 30, 1978.

U.S. DEPARTMENT OF COMMERCE
Elliot L. Richardson, Secretary

National Oceanic and Atmospheric Administration
Robert M. White, Administrator

Environmental Data Service
Thomas S. Austin, Director

Editor: Patrick Hughes
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A Slick Trail To Follow

by Leon LaPorte

On Thursday, May 20, 1976, at 9:15 a.m., a Miami radio news broadcast reported ". . . an oil slick, 42 miles long, offshore between Marathon and Islamorada" in the Florida Keys.

Judson Owen of Miami immediately called his friend, Elaine Chan of EDS' Deepwater Ports Project Office in Washington, D.C., a member of the newly formed NOAA/Coast Guard Oil Spill Trajectory Experiment Planning Team that investigates such spills to gather scientific data needed to verify trajectory models. The models are being developed to assess the potential impact of oil spills from ships, offshore oil fields, and deepwater ports.

On learning of the spill in the Florida Keys, Chan consulted with another Team member, James Mattson of EDS' Center for Experiment Design and Data Analysis. They decided that this large spill could be the first opportunity for the Team to go into action.

Chan quickly called LCDR Richard Kulack of the Coast Guard's 7th District in Miami for more details and learned that the oil was first sighted 30 miles offshore of the Middle Keys on Monday, May 17. By Tuesday morning, it was 15 miles off Grassy Key and by Wednesday, 10 miles offshore. On Thursday morning, what was left of the oil spill had separated into two 10-mile-long patches of light sheen, one 15 miles southwest of Key Largo, the other 10 to 12 miles off Key Biscayne.

At 12:30 p.m., Chan learned from Clem Bowman of Coral Reef Flying Services on Key Largo that a large slick was visible off Little Conch Reef, 10 miles south of Tavernier, surrounding a small patch of black oil less than 600 feet in diameter. Since the oil was only about 1 mile off the reef line, it was ap-

A Coast Guard plane spots a 42-mile long oil slick off the Florida Keys.

Coast Guard photo.

The wings of Chan, chartered to spot oil and drop drift cards.

Chan deploys a Richardson surface current probe.

parent that it would be driven ashore within several tidal cycles. But there was still time for scientific investigation.

Chan and Mattson spent the next few hours on the telephone trying to make the necessary preparations for the operation. At 2 p.m., Chan left Washington on a commercial flight that would get her to Miami by 5 p.m. Mattson stayed behind to continue the phone calls.

Within 20 minutes of her arrival in Miami, Chan and Tom Jones of the University of Miami were airborne in a chartered airplane, and in another 25 minutes they were over the northernmost slicks sighted that day—inshore from Carysfort Reef. Flying at 1,000 feet in a search pattern along the reef line, they proceeded as far southwest as Alligator Reef, sighting no additional oil.

Plastic cards, provided by Joe Richard of the University of Miami, were used to trace the drift of the ocean currents. They were dropped at Molasses Reef; because oil had been reported in the area of Little Conch Reef 6 hours earlier, another card drop was made 10 miles east of Islamorada. A third drop was made at Alligator Reef. Then they turned the airplane to begin the return run (between the reef line and the shore) at lower altitudes (200 to 500 feet).

Adverse weather, including thunderstorms, may have prevented sighting of some of the oil, but oil was seen again at 6:25 p.m., between The Elbow and French Reef, about 3 miles from shore, and again at 6:50 p.m. between Carysfort Reef and The Elbow, 190° from the Key Biscayne VHF Omnidirectional radio range station, 3 to 4 miles offshore. The slicks were distinct and black, and about 600 feet long by 50 feet wide. They were headed inshore on the wind, oriented in stringers on a heading of 250° to 260° true north. The Islamorada Coast Guard Station reported easterly winds of 10 knots at 4 p.m. and ENE at 10

p.m. on Thursday, correlating well with the observed slick heading.

Drift cards were released into the area of the slicks observed at both 6:25 p.m. and 6:50 p.m., after which the plane returned to Tamiami Airport.

Jim Mattson arrived in Miami Thursday night.

Capt. Ed Little of the Florida Marine Patrol offered a boat and Randy Willich to work with Chan and Mattson on Friday in an effort to deploy Richardson surface current probes. The probes release green dye masses which can be photographed from the air. At 9:30 a.m. on Friday, using another airplane from Coral Reef Flying Services, Chan, Mattson, Willich, and Clem Bowman found 6- to 8-foot diameter patches of oil surrounded by sheen halos in the area of the northernmost oil sighting of the previous evening. The patches were 5 to 6 inches thick in the center and about 1 inch thick at the edges. A typical patch or pancake contained between 1½ to 3 barrels of oil. The edges were continually feathering, or spewing off tar balls 1 to 5 inches in diameter.

The pancakes were difficult to see from the air; even from a boat, they were visible only at close range. A search of the reef line down to Little Conch Reef, revealed no more oil, but 250 drift cards were released at Little Conch Reef, a drop which turned out to be fortuitous, as the cards were later picked up with the oil that had not been seen from the air. Several cards were covered with oil.

Near noon, Willich took Chan and Mattson out in the boat to make slick velocity, wind, and surface current measurements. The plane, piloted by Clem Bowman, directed them to the pancakes and carried a photographer, James Bohnsack of Miami.

As they were heading out, another private pilot reported sighting a patch of oil ". . . 30 feet in diameter near Marker 33," at the edge of Hawk Channel. This information was relayed to Willich by the radio-telephone-radio patch the Marine Patrol had set

up between the plane and the boat. The airplane proceeded to this new location and found four pancakes, each about 6 to 8 feet in diameter. Chan and Mattson later compared the infrared spectra of a sample of oil taken from one of the pancakes with the oil sample taken by the Coast Guard on Wednesday. The two were identical, confirming that the oil which formed the "42-mile" slick on Wednesday was the same as that present in small patches on Friday, No. 6 fuel oil.

Three Richardson current probes were deployed—one each south and north of a pancake, and one right through the oil patch—at about 11:55 a.m. Friday. From oblique aerial photos taken from about 1,200 feet, and using the boat for scale, the scientists computed the surface current speed. From the aerial photos showing the dye patches released by the current probes and the patch of oil, they computed the amount by which the speed of the oil exceeded the surface current (differential velocity).

(Top) Plastic cards released by Mattson drift with the surface current.

(Left) Mattson holds tar lump taken from the water.

Also, by anchoring the boat in the path of one of the patches of oil, Chan and Mattson were able to directly measure the velocity of the oil by stationing observers on the bow and stern of the boat, using a common reference point on the horizon, and timing the passage of the leading edge of the oil past the boat. The patches of oil, pushed along by tidal and wind-driven currents, as well as the wind, moved at 3.5 ±0.3% of the wind speed. Mattson and Chan also came up with values of 2.3 ± 0.3% of the wind speed for the surface current and 1.3 to 1.4 ± 0.2% of the wind speed for the differential velocity of the oil.

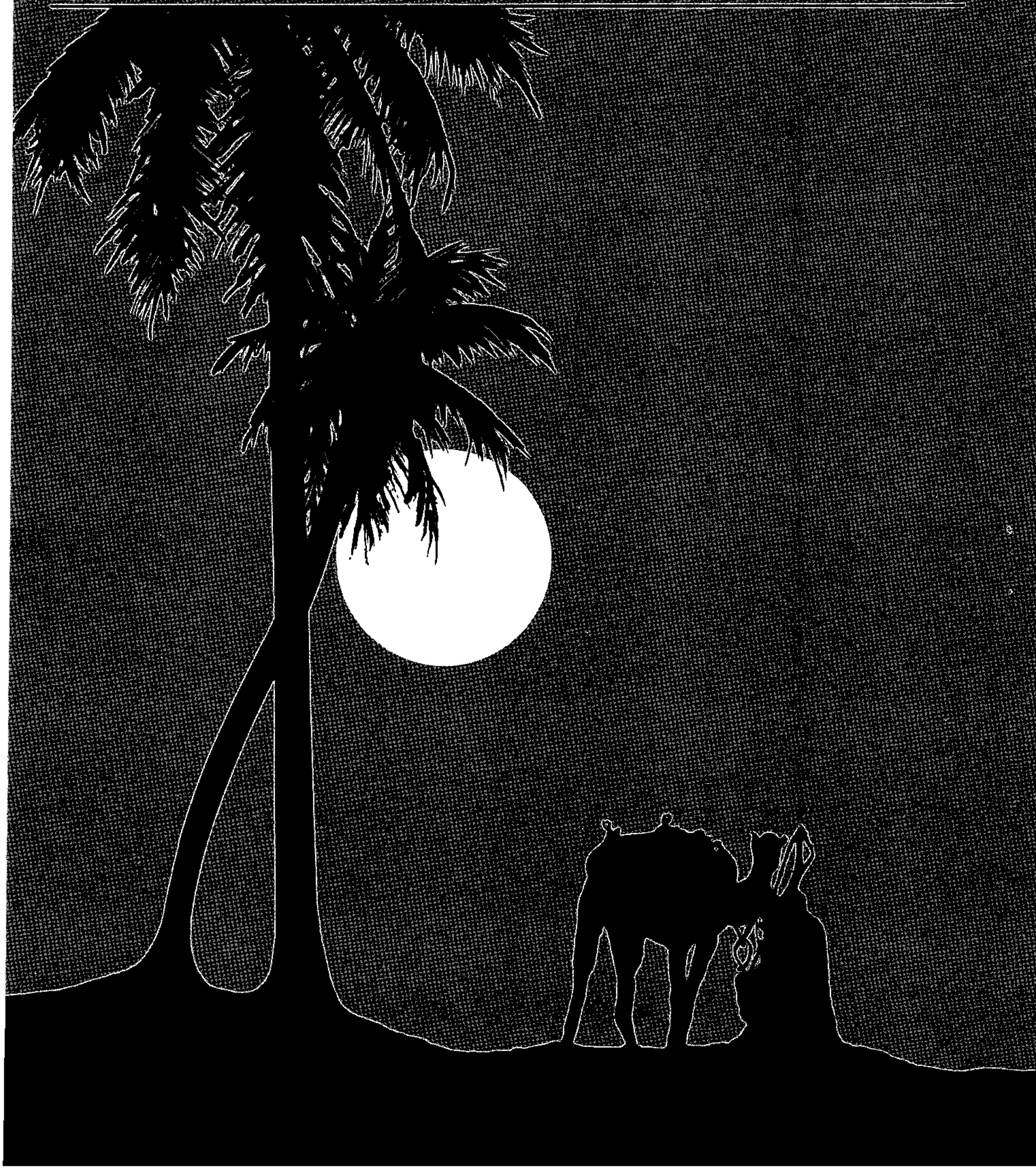
Of the 1,050 drift cards released, 50 from the Alligator Reef drop site have been returned from Lower Matacumbe Key, 47 by a single individual. Also, 57 cards from the Little Conch Reef drop site have been returned from a single, mile-long stretch of beach near Islamorada, again, all but one coming in from one individual. The latter group of cards came ashore on a heavily oiled stretch of beach.

On Saturday morning, 7 students and employees of the University of Miami joined Chan and Mattson to investigate the oil damage to the mangrove swamps. Joe Burns of John Pennekamp Coral Reef State Park loaned two boats to the group. Chan's boat investigated the mangroves near Whitmore Bight, while Mattson's boat searched between Point Mary and Point Elizabeth. Both found large amounts of oil and tar.

The data gathered by Chan and Mattson will be used as input to several oil trajectory models including those developed by NOAA, the Coast Guard, the Environmental Protection Agency, and the University of Southern California. The experience gained in solving the logistic and investigative problems of tracking the spill have gone into a proposed Operation Plan that will help the NOAA/Coast Guard Team to better follow the trails of other slicks.

OASIS: A View From The Desert

By May Laughrun



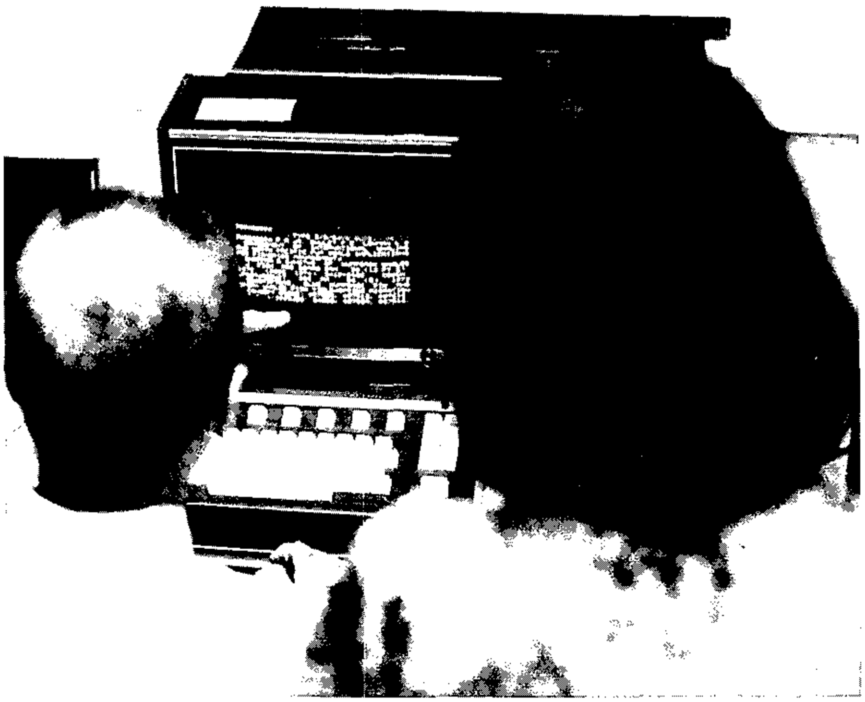
For the user, OASIS can be a particularly apt acronym. It stands for Oceanic and Atmospheric Scientific Information System, which in providing answers to user questions, can indeed seem "a fertile spot in the midst of a desert."

Steve Douglas, for example, is an Electronics Engineer with the Office of Systems Engineering of NOAA's National Environmental Satellite Service. Douglas has used OASIS twice, the first time to obtain published material on computers, which, he said, "would have taken me at least 2 weeks to dig out." The second time he was faced with scarcity of information on a computer language called ATLAS that had been proposed for use. "I could find no references anywhere," he said "but the keyword ATLAS fed into OASIS produced two very valuable references."

For 2 years, the Environmental Science Information Center (ESIC) of NOAA's Environmental Data Service (EDS) has been offering automated literature searches through OASIS to both NOAA and non-NOAA users. Operated by ESIC's Library and Information Services Division (LISD), OASIS has grown into a network that allows computerized access to some 11 million references to published scientific and technical information. There no longer is any need to spend hours or days manually going through large numbers of publications or subject-and-author indexes for the information covered in OASIS. The 35 data bases that make up OASIS can be searched for any subject in the atmospheric, marine, and Earth sciences in as little as 10 to 15 minutes.

The user experiences that follow illustrate the broad spectrum of questions and problems to which OASIS provides answers.

Malin Bonnett is a Marine Biologist with the National Marine Fisheries Service in Auke Bay, Alaska. No onsite terminal is available at that distant post, but the NOAA librarian at the laboratory alerted all personnel about OASIS as soon as it became operational and transmits all requests



to LISD in Washington for mail replies.

Bonnett has used the system three times: the first time, for a routine bibliographic search; the second, to find out what has been written on marine invertebrates. But it was the third time that the results she obtained were particularly rewarding. Having found out that little work has been done on how petroleum hydrocarbons affect marine colonizing organisms, Bonnett is now preparing a research proposal on the subject. "Will you be using OASIS again?" we asked. "Definitely," was the answer.

Gary Carter is a Research Meteorologist at the Techniques Development Laboratory of the National Weather Service. Attending a conference in Albany, N.Y., he found out about OASIS through a casual conversation with the wife of another NOAA employee attending the conference. Returning home, he went to the LISD library at the World Weather Building in Camp Springs, Md., where the librarian, by on-line searching, compiled a wealth of data on surface winds, wind gusts, and low-level wind shear. "We have," said Carter, "for 3 years had a system for transmitting forecasts on surface winds—direction and speed—to approximately 230 weather stations across the country, to be used as guidance for public and aviation forecasts. With the information gathered through OASIS, we now are trying to extend the forecasting system to include gustiness and low-level wind shear."

John Ernst, a Meteorologist in the Field Services Division with the National Environmental Satellite Ser-

(Far Left) George Kahler of EDS helps Laura Matsuda of NOAA's Office of Sea Grant search for references to salmon diseases. (Top) Kahler explains a listing that might meet her request. (Left) Matsuda requests a printout of several abstracts.

vice (NESS), reports he has used OASIS several times, working with the librarian at the World Weather Building, and has been "very gratified." Most recently, he made a search for published information on dust as seen in satellite cloud imagery. He explained that dust is important, because it serves as a shield against the heat from the Sun that spawns thunderstorms and hurricanes. This information is now included in the bulletins that NESS transmits worldwide every 6 hours.

The National Marine Fisheries Service (NMFS) is the major OASIS user. Particularly enthusiastic is John J. Ryan, Supervisory Research Food Technologist at the NMFS Northeast Utilization Research Center in Gloucester, Mass. He tells us that a terminal borrowed from the NMFS regional office has been in constant use for several months earlier this year—until it had to be returned. Among the many searches made, he singled out two of particular significance. For a new research project on electrophoresis—a chemical means of species identification—OASIS provided invaluable background information on past work in the field. Another search was made on the influence of the use of nitrites in fishery products, with equal success.

For a further evaluation of OASIS, Ryan referred us to a bimonthly report distributed to all Center personnel.

It said, in part: "An effective search can be completed in as little as five or ten minutes. Individual researches at this Center have been able to conduct their own searches with a minimum of training and thus keep up-to-date on their research projects. We hope to acquire our own terminal shortly to enable research personnel to utilize the system more effectively."

The Environmental Research Laboratories rank second among NOAA users of OASIS. Two such users are Edmund Brown and Alfred Bedard, both with the Wave Propagation Laboratory in Boulder, Colo. Brown is finishing up a review paper on atmospheric acoustics. "Although," he notes, "all of us who are specialists in the field of atmospheric acoustics—some 90 or so—know each other, I wanted to be sure that my paper would include everything." And he is now confident, having gained a few additional references through OASIS, that his paper will, indeed, cover the state-of-the-art.

Alfred Bedard is engaged in a high-priority project funded by the Federal Aviation Administration. For this project, sensors are being deployed at various airports to detect the atmospheric analog of a turbidity current, the cold air outflow at the base of a thunderstorm. "Such a current," said Bedard, "presents an extreme aircraft hazard, and in our research we turned to OASIS, through which we found a number of obscure, and extremely useful, references."

Capt. Charles Burroughs, NOAA Corps, is a marine specialist in the Deepwater Ports Project Office of NOAA's Enrironmental Data Service. About a year and a half ago, Capt. Burroughs, then Chief of Operations, Pacific Marine Center, National Ocean Survey, learned about OASIS from James R. Stear, Chief of the Systems Branch in ESIC's Library and Information Services Division.

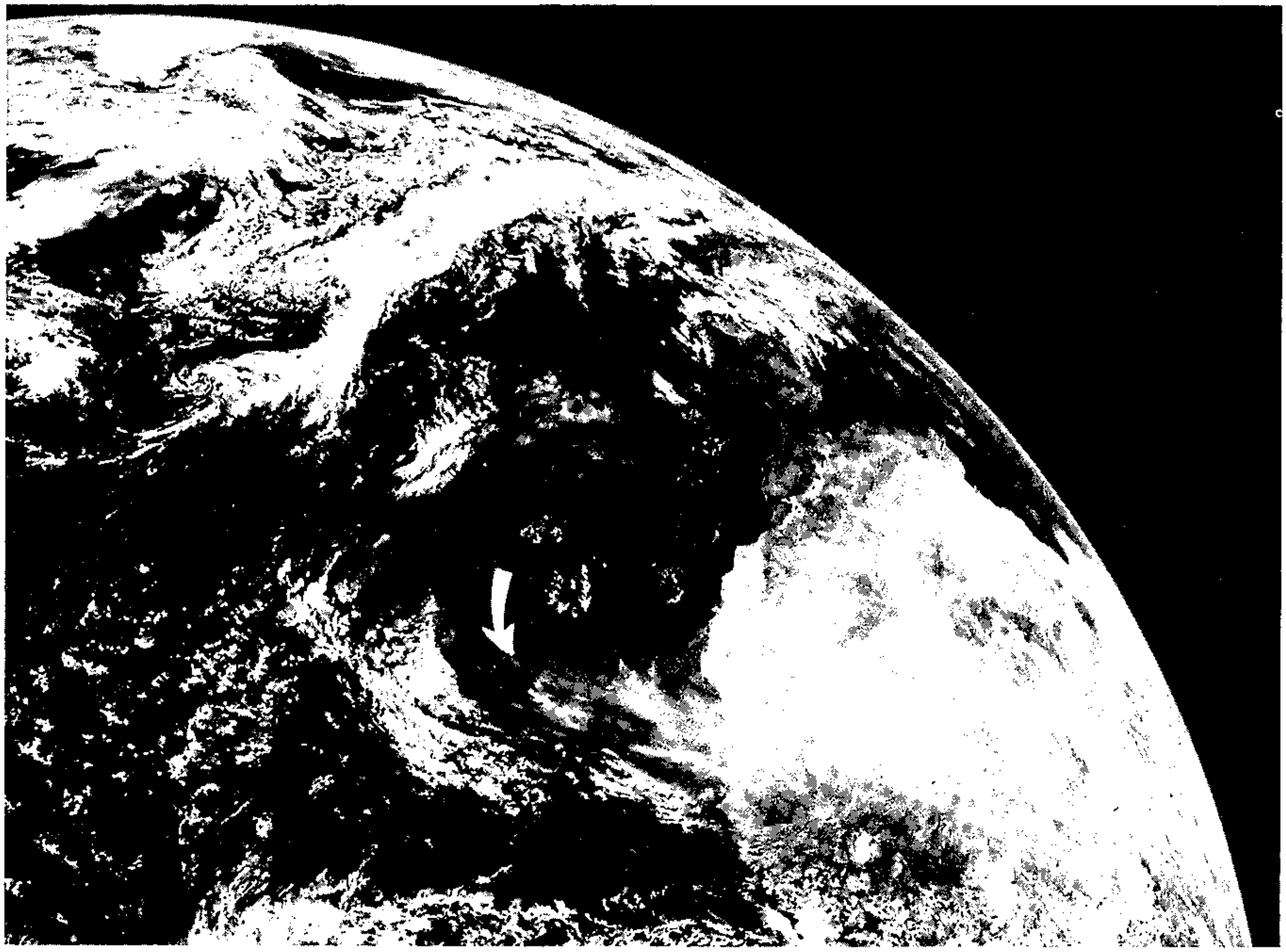
"At the Center," Burroughs said, "we were responsible for providing ship support for the Outer Continental Shelf Environmental Assessment Program (OCSEAP) managed by NOAA's Environmental Research Laboratories, and we needed historical environmental information. Stear opened his attache case, which contained a terminal, picked up the phone, and in a few minutes searched the OASIS files with excellent results. I was really impressed."

Since joining the Deepwater Ports Project Office (DPPO), Capt. Burroughs, working with personnel of the Systems Branch, LISD, has used the system several times. The mission of DPPO is to evaluate, in terms of environmental factors, proposed construction of complex offshore terminals for handling very large crude oil carriers. (NOAA serves primarily as an advisory agency in this regard; the Secretary of Transportation has the final decision-making responsibility.) As an example, Burroughs cited a recent analysis of how a proposed deepwater port off the coast of Louisiana would threaten the adjacent Florida coastline if tankers in transit were to spill oil.

"To study the problem," he said, "we needed information on the various routes of tankers carrying oil from Saudi Arabia." He turned to OASIS and before long was able to put his hands on *Law of the Sea - Particular Aspects Affecting* the *Petroleum Industry*, a publication issued by the National Petroleum Council that contained, among other valuable information, a map showing worldwide tanker routes.

NOAA users requests to OASIS totaled 945 during the first quarter of 1976 alone—a fivefold increase over the same quarter of the previous year. Of these queries, 651 came from the NOAA major line components, distributed as follows: National Marine Fisheries Service, 304; Environmental Research Laboratories, 167; Environmental Data Service, 136; National Environmental Satellite Service, 18; National Weather Service, 14; and National Ocean Survey, 12. Other NOAA users made 43 requests. Although these figures might seem to indicate that meteorologists had a relative lack of interest in the system, atmospheric research is a large part of the activities at ERL, the second largest OASIS user.

Use of OASIS, on a fee-basis, by non-NOAA users—academic institutions, industrial organizations, other government agencies, and the public—also has grown, and totaled 251 requests during the period January through March 1976. As part of OASIS, ESIC last year sponsored the automation of *Oceanic Abstracts*, *Meteorological and Geophysical Abstracts* for on-line retrieval through



John Ernst used OASIS to find information on dust storms, such as this one (arrow) off North Africa.

contract with the Lockheed Corporation, without restricting access to these OASIS data bases to NOAA users. According to latest reports, these two data bases have been used directly through Lockheed by more non-NOAA than NOAA users. Among them have been institutions in Mexico, Canada, and France, the last gaining on-line access to the system via satellite.

A complementary system to OASIS is ENDEX, the Environmental Data Index, a computerized referral system to data files held within and outside NOAA. Currently, this expanding system for locating "who has data on what" covers some 5,500 environmental data files pertaining largely to the coastal zone of the United States and the Great Lakes area. Plots of these data, by geographic area or by specific parameters, are available or can be prepared on request. Requests for information concerning ENDEX should be directed to the Data Index Branch, D782, National Oceanographic Data Center, EDS, NOAA, Washington, D.C. 20235. Tel: 202-634-7298; FTS 634-7298.

Both OASIS and ENDEX are fully described in *User's Guide to ENDEX-/OASIS*, issued in January 1976 and available from the Environmental Science Information Center, D826, EDS, NOAA, Washington, D.C. 20235. Tel: 202-634-7334; FTS 634-7334.

Data Bases Available Through OASIS

Abstracted Business Information (INFORM)

Air Pollution Abstracts (APA)

Aquaculture (CULTURE)

Automatic Subject Citation Alert (ASCA)

Bibliography and Index of Geology (GEOREF)

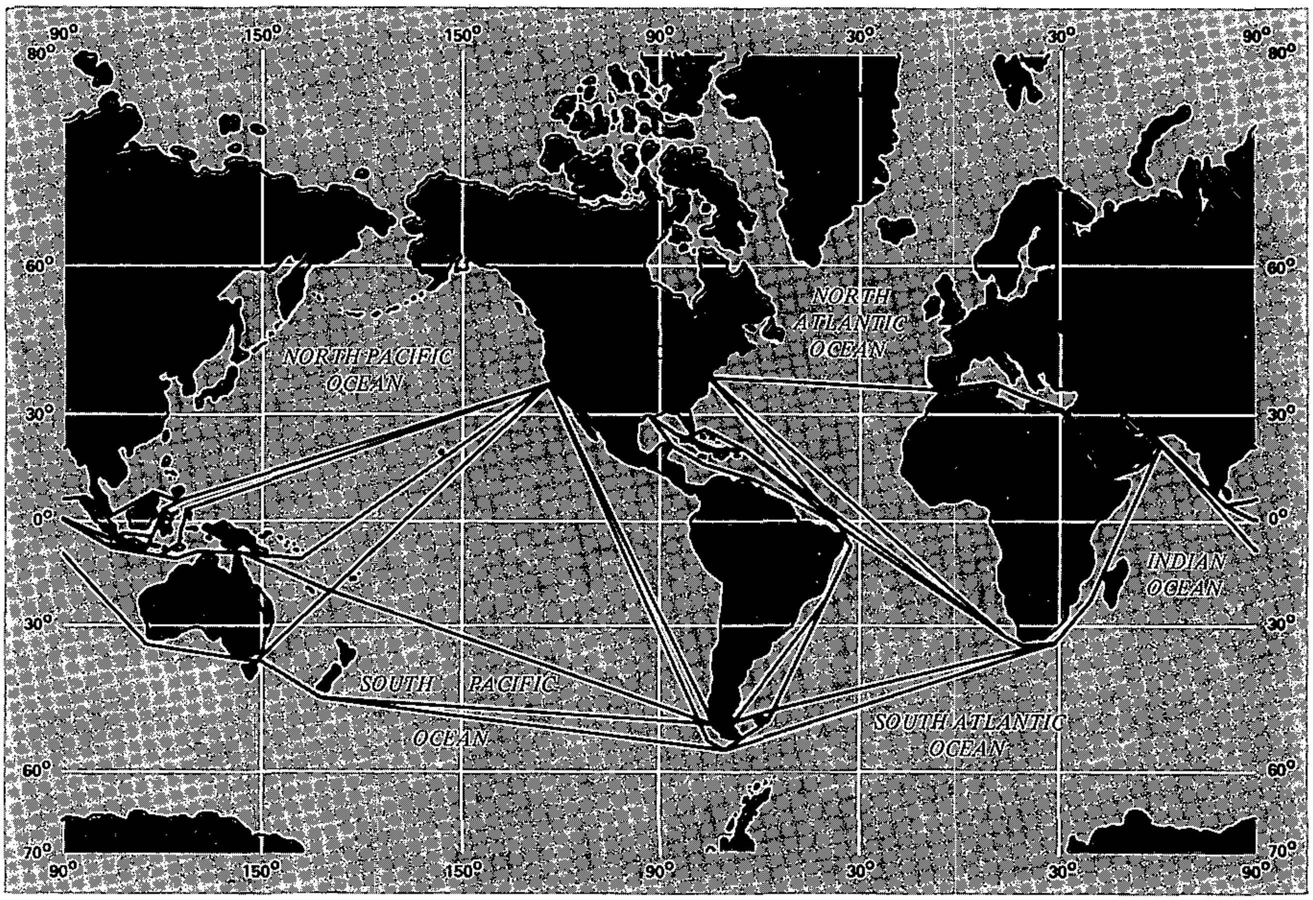
Bibliography of North American Geology (GEOL)

Biological Abstracts (BA)

Biological Information Retrieval System (BIRS)

Bioresearch Index (BRI)

Chemical Abstracts Condensates (CAC)



OASIS helped Burroughs find this map of worldwide tanker routes (top). (Below) Burroughs identifies the major sea route to a proposed supertanker deepwater terminal, the Louisiana Offshore Oil Port off New Orleans.

Chemical Titles (CT)
Congressional Information Service (CIS)
Defense Documentation Center Data Base (DDC)
Educational Resources Information Center (ERIC)
Dissertation Abstracts
Energy (ENER)
Engineering Index Compendex (EI)
The Fish and Wildlife Reference Service (FWRS)
Food Science and Technology Abstracts (FSTA)
Geophysical Abstracts (GPA)
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Information Service in Physics, Electrotechnology, Computers and Control (INSPEC)
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Meteorological and Geoastrophysical Abstracts (MGA)
NASA Information Bank (NASA)
National Agricultural Library (CAIN)
Nuclear Science Abstracts (NSA)
Ocean Abstracts (OA)
Petroleum Abstracts (TULSA)
POLLUTION
Science Citation Index (SCISEARCH)
Selected Water Resources Abstracts (SWRA)
Smithsonian Science Information Exchange (SSIE)

Contact-Points for General On-Line Access

Environmental Data Service (E/O)*
NODC Liaison Office
8604 La Jolla Shores Drive
P.O. Box 271
La Jolla, California 92037
Tel: Commercial (714) 453-2820, x204
FTS 893-6204

Library Services (E/O)
Environmental Research Laboratories
1209 Radio Bldg.
Boulder, Colorado 80302
Tel: Commercial (303) 499-1000, x3271
FTS 323-3271

National Oceanographic Data Center (E/O)
Data Services Division
Page Bldg. 1, Room 404
2001 Wisconsin Ave., N.W.
Washington, D.C. 20235
Tel: Commercial (202) 634-7500
FTS 634-7500

Marine and Earth Sciences Library (E/O)
Fisheries Branch
Page Bldg. 2, Room 194
3300 Whitehaven St., N.W.
Washington, D.C. 20235
Tel: Commercial (202) 634-7346
FTS 634-7346

NOAA Miami Library (O)
Atlantic Oceanographic and Meteorological Laboratories
15 Rickenbacker Causeway
Miami, Florida 33149
Tel: Commercial (305) 361-3361, x 330
FTS 350-1330

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FTS 350-1111

Atmospheric Sciences Library (O)
Gramax Bldg., Room 816
8060 13th St.
Silver Spring, Maryland 20910
Tel: Commercial (301) 427-7800
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Marine and Earth Sciences Library (E/O)
Washington Science Center, Bldg. 1, Room 108
6001 Executive Blvd.
Rockville, Maryland 20852
Tel: Commercial (301) 443-8022
FTS 443-8022

Camp Springs Information Service Center (O)
7th Floor, World Weather Building
Auth Road
Camp Springs, Maryland 20233
Tel: Commercial (301) 763-8266
FTS 763-8266

Suitland Information Service Center (O)
Federal Office Building 4, Room 3216
Suitland, Maryland 20233
Tel: Commercial (301) 763-7432
FTS 763-7432

Library (O)
Northeast Fisheries Center
Woods Hole, Massachusetts 02543
Tel: Commercial (617) 548-5123, x60

NODC Liaison Office (E/O)
Woods Hole Oceanographic Institution
Room 317A, Clark Laboratory
Woods Hole, Massachusetts 02543
Tel: Commercial (617) 548-1400, x546
FTS 840-7279

Library (O)
Great Lakes Environmental Research Laboratory
2300 Washtenaw Avenue
Ann Arbor, Michigan 48104
Tel: Commercial (313) 769-7263
FTS 374-5263

Library (O)
Sandy Hook Laboratory
Mid-Atlantic Coastal Fisheries Center
P.O. Box 428
Highlands, New Jersey 07732
Tel: Commercial (201) 872-0200, x30

National Climatic Center (E/O)
User Services Branch
Federal Building
Asheville, North Carolina 28801
Tel: Commercial (704) 258-2850, x680
FTS 672-0680

NODC Liaison Office (E/O)
Pacific Marine Environmental Laboratory
3711 15th N.E.
Seattle, Washington 98105
Tel: Commercial (206) 442-0199
FTS 399-0199

*E = ENDEX on-line access
O = OASIS on-line access

The All-Purpose SSMO

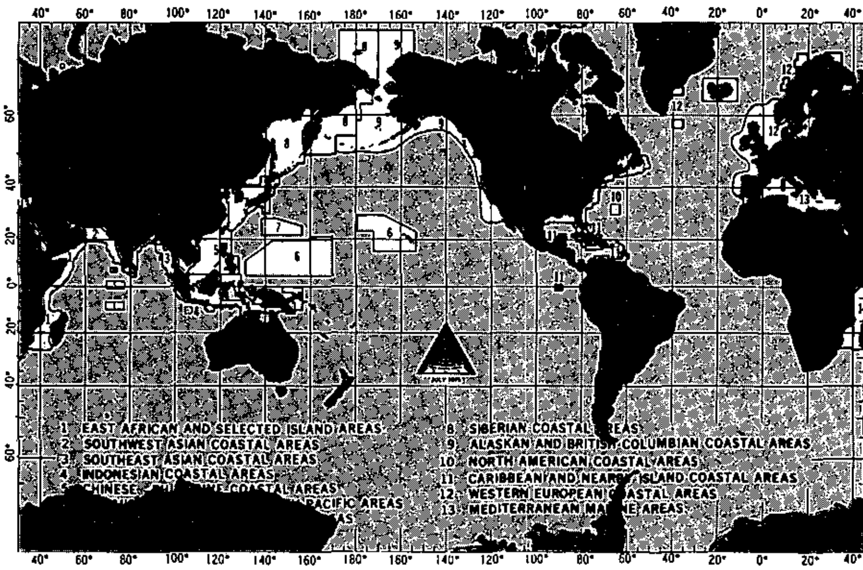
By Dick DeAngelis

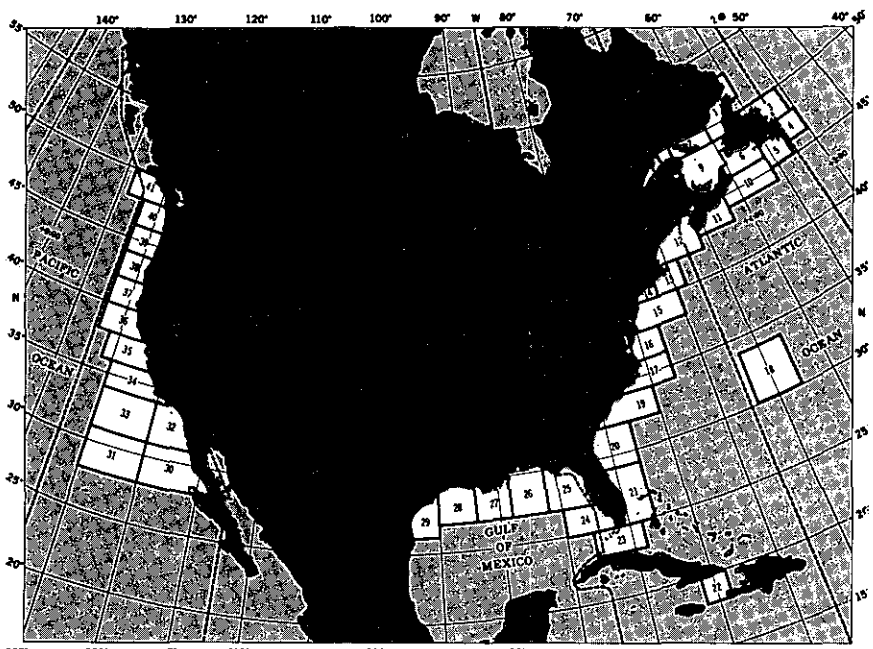
Coastal waters no longer are the sole province of fishermen, weekend boaters, and seamen. Offshore gas and oil drilling rigs are found worldwide. Deepwater ports for supertankers are a reality. Mineral harvesting of the continental shelf is at hand. Offshore nuclear powerplants lie in the near future, while desalinization plants are increasing. Historical marine data are a necessity to assess how all these offshore activities affect the environment and how the environment affects them.

One of the few available sources of long-term environmental data for the coastal zone is the *Summaries of Synoptic Meteorological Observations* (SSMO).

These summaries are produced by a joint effort of the Naval Weather Service's Detachment at Asheville, N.C., and EDS' National Climatic Center (NCC). They are based on marine surface observations dating back to the mid-19th century and cover a good portion of the world's coastal zones. They contain monthly and annual tables of wind, wave, weather, visibility, relative humidity, cloud, air and sea temperatures, and various combinations of these parameters.

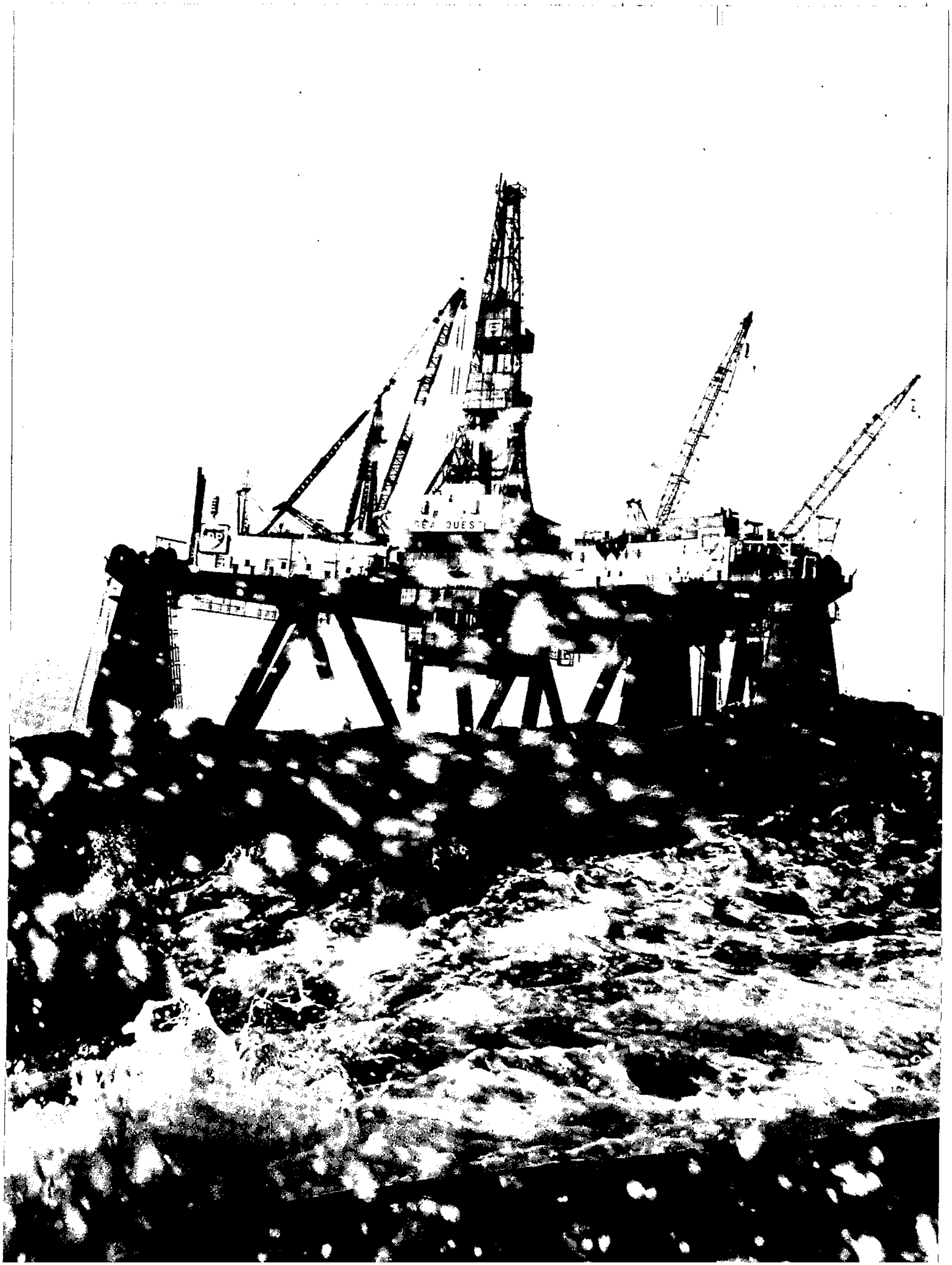
SSMO's are used by ocean engineers, naval architects, oil companies, universities, and government agencies, among others. The ocean engineering firm of Tetra Tech Inc., for example, uses SSMO data to design coastal structures and to help evaluate potential beach erosion and silting. They even have NCC run off special data products to meet their needs. For instance, they had NCC adjust some deepwater wave data for nearshore use, then compared the results with coastal wave observations. The preliminary correlations were satisfactory, and the adjustment technique

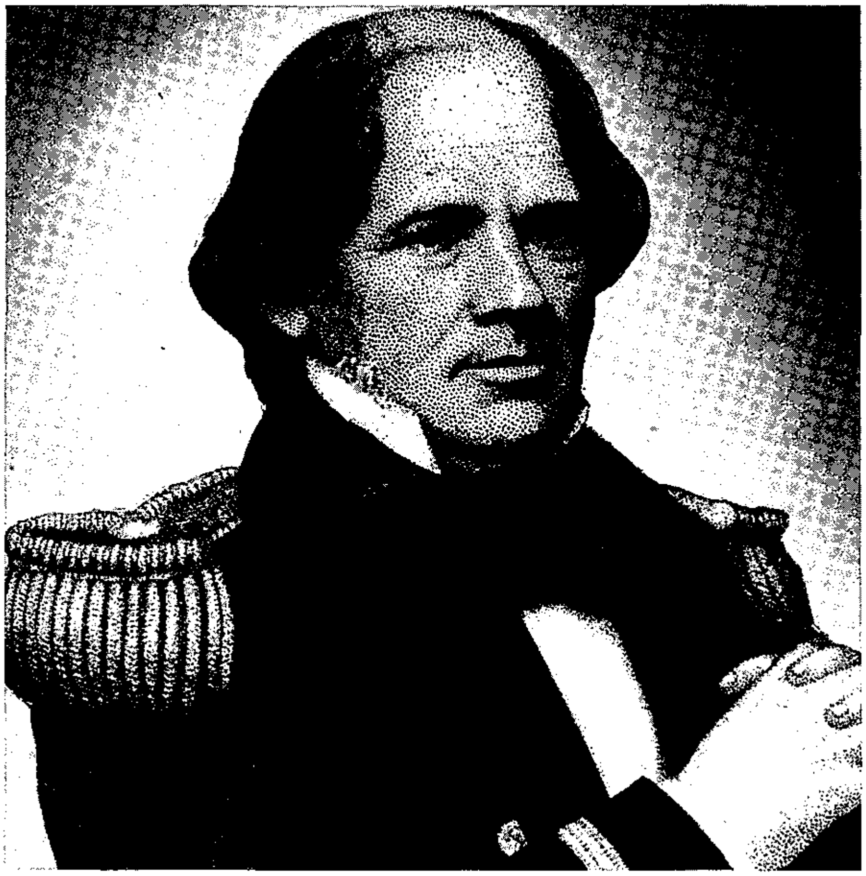




Top: Aerial coverage for each of the 13 sets of SSMOs. Above: Marine areas included in the 6-volume North American Coastal Areas *set. Right: Wind and wave data are used to asses environmental effects on offshore structures such as this one in the North Sea.*

British Petroleum photo.


SEA QUEST



Matthew Fontaine Maury established a prototype international marine data exchange system.

could have important applications in areas where no coastal wave observations are available.

The Division for Marine Technology of Det Norske Veritas in Oslo, Norway, recently inquired about weather summaries to aid them in developing design codes and evaluating the safety of offshore drilling structures. They were pleased to hear that SSMO data were available, particularly for the North Sea. (Naval architects also use SSMO wave data to establish design codes for coastal platforms such as oil rigs.)

Major oil companies, like AMOCO and Getty, are using SSMO's to evaluate weather conditions at potential offshore drilling sites. The data are valuable in estimating the potential downtime of a rig, a critical economic consideration in such rough weather areas as the North Sea.

Off the Gulf Coast of the United States, Louisiana State University scientists use SSMO data to evaluate energy potential from wind and Sun.

Sanders Associates Inc. was looking for a site off New England where they could test a shipboard antiship-missile defense system. Environmental conditions had to be such that there was a good chance of 10- to 20-knot winds and 2- to 6-foot seas. With the SSMO's as a guide, a time and site were selected. Within the test period the conditions were right and the tests went off without a hitch.

SSMO's played an important role in the development of one of the first major environmental impact statements, which involved the Trans-Alaska pipeline. Since then, they have been used by government agencies to prepare many environmental impact statements—and by environmentalists to evaluate the government's evaluation.

EDS itself uses SSMO's as a base for its climatological input to the Defense Mapping Agency's *Planning Guides* and the National Ocean Survey's *Coast Pilots.*

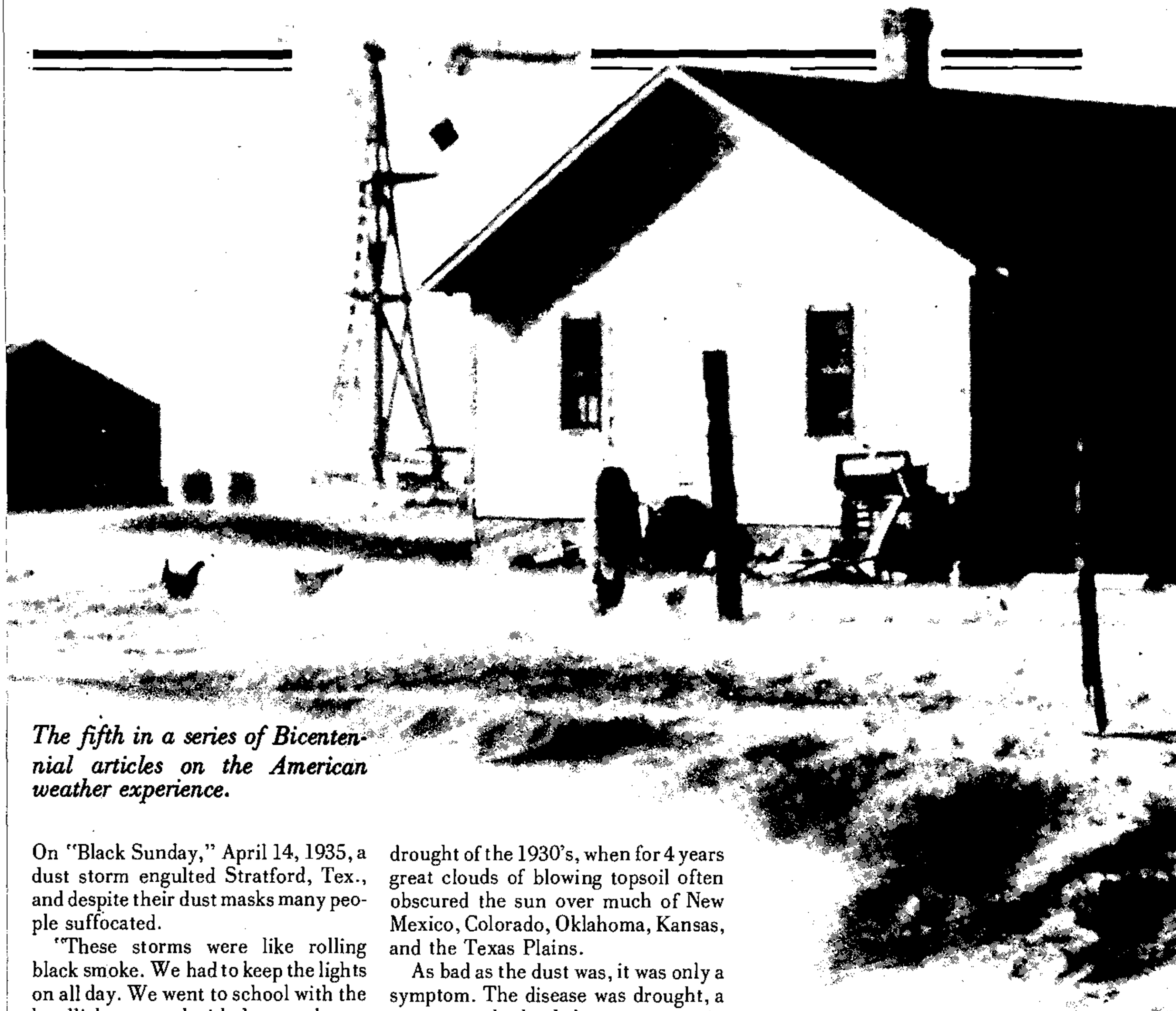
The data family that comprise the SSMO's contains more than 40 million marine surface observations. The data are filed on magnetic tape by 10-degree Marsden Square, year, and month. These observations are culled from ships' logs, weather reporting forms, automatic observing buoys formats, and ship weather radio messages. They also come from foreign meteorological services in the form of punched cards and magnetic tape. The latter international exchange dates back to the days of Matthew Fontaine Maury—the father of marine climatology.

After a stagecoach accident cut short his Navy sea career, Maury was made Superintendent of the Depot of Charts and Instruments. He noticed that his depot was a warehouse for ship's logbooks and, after reading a few, soon realized they were an untapped source of practical knowledge of winds and ocean currents. Five years later he issued his first *Wind and Current Chart of the North Atlantic.* He devised a special logbook for recording weather observations and offered his valuable chart to any mariner who would take observations. The idea caught on, and Maury soon was able to establish an international data exchange system among the world's maritime nations.

SSMO's are available for the cost of reproduction as paper copy or on microfiche. For information on how to order the Summary of Synoptic Meteorological Observations and what specific areas are contained in which volumes, contact the Marine Climatological Services Branch, D762, Page Building 1, Room 400, Washington, D.C. 20235. Telephone: (202) 634-7394.

The Land Killer: Drought

By Patrick Hughes



The fifth in a series of Bicentennial articles on the American weather experience.

On "Black Sunday," April 14, 1935, a dust storm engulted Stratford, Tex., and despite their dust masks many people suffocated.

"These storms were like rolling black smoke. We had to keep the lights on all day. We went to school with the headlights on and with dust masks on. I saw a woman who thought the world was coming to an end. She dropped down on her knees in the middle of Main Street in Amarillo and prayed out loud: 'Dear Lord! Please give them another chance.' "

This was the eyewitness account of a Texas schoolboy during the dust bowl drought of the 1930's, when for 4 years great clouds of blowing topsoil often obscured the sun over much of New Mexico, Colorado, Oklahoma, Kansas, and the Texas Plains.

As bad as the dust was, it was only a symptom. The disease was drought, a cancer on the land that returns again and again to haunt the farmer and cattleman and to remind the city dweller of his ultimate dependence on nature.

The drought of the 1930's, which coincided with the economic disaster of the Depression, has indelibly imprinted on American minds the image

The drought and high winds of the 1930's showed that the semi-arid lands of the West could not be farmed by the same methods used in the more humid East.

of dust-streaked Texas and Oklahoma farm families abandoning their parched, dusty land for the green promise of California. Much of this notoriety is a direct result of the terrible dust storms of 1935-37, when unusually strong winds joined with the drought to produce a natural disaster. Other droughts have been as bad, but usually less spectacular. Farming methods then in use were such that if the weather was dry and windy, the soil would just blow away. And it did.

For some parts of the country, the drought of the 1950's was worse. In Texas, it was the worst on record. Most of Texas' quarter of a million square miles did not have what old timers call "a public rain" for 5 or 6 years.

The drought seems to have begun along the Rio Grande River in 1950; by the fall of 1956, western farmers were praying for rain. Relentlessly, one of the worst droughts in our recorded weather history spread across America's heartland. Acre after acre, mile after mile of parched, barren land stretched from horizon to horizon.

Dr. Edmund Schulman of the University of Arizona's Laboratory of Tree Ring Research, studying the concentric rings of thousands of trees (where wet years are recorded as wide rings and dry years are narrow rings), concluded that it was the worst drought to afflict the American Southwest in 700 years.

Major rivers could be jumped on foot, and the bottom of giant reservoirs lay naked and cracked. Irrigation canals—the life blood of farms in arid western States—ran dry. In a few places, dust storms actually created small, mobile deserts, with sand dunes moving forward in wavelike ripples with every breeze.

In 5 years the drought took $2,700,000,000 from the pockets of Texas farmers and ranchers alone. Stockmen in Arizona, New Mexico, Oklahoma, Kansas, Colorado, and Nevada had to sell or butcher even their breeding stock, while dairy farmers of Kansas and Missouri, unable to find feed or water, were forced to liquidate herds they had spent their lives building.

In Kansas, two-thirds of the State's 115,000 farmers had to find off-farm jobs, while in Oklahoma, farm families were moving off the land at the rate of 4,000 per day by 1957. In Texas, exranchers were pumping gas or working at the general store or roadside hamburger joint. Many of these men were working off their own land for the first time in their lives. The young men, in particular, moved to the cities.

Despite the scope and duration of this drought, the total misery of the dust bowl days was missing. With the national economy booming, jobs were available in nearby towns and factories, and most farmers and ranchers could ride out the hard times. And advances in farming practices such as irrigation, deep plowing, and the use of cover crops made it possible in many areas to save the soil from the wind. Even the dust storms were relatively few and far between, while the government's soil-bank payments, liberalized credit, subsidization of stock-feeds, and other measures helped the drought-stricken farmer and rancher get by.

The situation even generated a kind of grim humor, such as the Texas story: "Well, the wind blew the ranch plumb into Old Mexico, but we ain't lost everything. We get to keep the mortgage."

The Northeast's worst drought in 160 years began in the early 1960's. It brought unemployment to loggers, government disaster aid to dairy farmers, irrigation to tobacco fields, a private rainmaker to Fitchburg, Mass., and severe or critical water shortages to scores of cities and towns in the most thickly populated section of the United States.

New Yorkers or visitors could get a glass of water in a restaurant or hotel only if they asked for it. It was forbidden to water lawns or wash cars, and steel harnesses were installed on fire hydrants to prevent street bathing, a longtime summer sport for city children.

Real concern over this prolonged period (1961-67) of predominantly dry weather arose in October 1963, about the warmest and dryest October of record over most of the United States east of the Continental Divide. Forest fires were numerous, and continuing drought in the Great Lakes region caused an alarming drop in lake levels. A few wells and springs in the Northeast failed in 1963, but many went dry in 1964. Early in 1965, the reservoirs for the City of New York were down to 25 percent of capacity.

After mid-1965, the heart of the drought area shifted southward to the Potomac River Basin. By the summer of 1966, residents of the Nation's Capital were facing the grim possibility of water rationing.

The unusual thing about the Northeast drought was its duration. Past weather records suggest that a drought lasting 5 years or more in this area would occur on the average only once in several centuries.

Drought returned to the Southwest in the fall of 1969 and visited southern Florida the following year. Abnormally dry weather set in over southern California and parts of Arizona in late 1969, spread across New Mexico and west-central Texas by mid-1970, and over central and south Texas in the fall of 1970.

In February 1971, high winds coated northern Texas and parts of Oklahoma with a think layer of dust. In March, dust generated by winds gusting up to 43 miles per hour obliterated the sun over parts of Texas for 9 hours. Three days later another dust storm, lasting for 17 hours, blanketed West Texas in a choking, blinding shroud of dust. By April, many parts of Texas had had no appreciable rain for many months, over 2 million acres had been damaged by wind erosion, and huge tumbleweeds were drifting across baked, barren land.

In Texas, Oklahoma, New Mexico,

In the 1930's rolling black clouds of dust often engulfed large areas of the country's midsection.

and Arizona cracked soil and dry lake beds characterized the countryside. By June, cattle and sheep were weak and thin. Many starved to death. Ranchers sold out and went to look for jobs in the city. Some farmers went bankrupt, and others borrowed to the hilt. Most of the 200,000 bats that live in the Carlsbad Caverns of New Mexico fled their caves, where there was no food or water. They could be seen in thick flocks in the town of Carlsbad and along the Pecos River hunting water insects. Even gravediggers complained, because the dry ground was so hard to dig.

Meanwhile, south Florida from Orlando to Key Largo was suffering its worst water shortage in more than 200 years. Abnormally dry weather began in mid-1970. By the spring of 1971, the drought, augmented by the ever-increasing water demands of a growing population, reached disaster proportions. Haze and smoke from thousands of Everglades grass fires were shrouding the sky. The fires, coupled with the lack of water, drove thousands of animals and fish from their natural homes.

The Everglades swamplands, normally covered with shallow water, were so dry that in some places the soil itself—peat formed from centuries of decaying vegetation—was burning. Such fires are almost impossible to stop until they burn down to rock or sand. If enough of the soil burns, the Everglades could become a desert.

Drought has been a scourge of man since he first appeared on this planet. Unlike a hurricaine or flood, drought

The dust bowl drought of the 1930's blew away the soil and dotted the nation's heartland with barren, deserted farms.

creeps up on you. Initially, everyone welcomes the long spell of fine weather, but appreciation gradually turns to apprehension as water supplies decrease, and eventually to despair as crops wither, streams are reduced to a trickle, and little islands begin to appear in reservoirs. No one knows why drought came, if or where it spread nor how long it will stay.

In the simplest terms, a drought is a prolonged and abnormal water deficiency. Severe or extreme drought conditions can result in near zero crop yields, serious livestock feed shortages, lack of water for cities and industries, greatly increased fire hazards, and a general disruption of the local or regional economy. If a large-scale drought is severe enough and lasts long enough, it can seriously damage the Nation's whole economic structure.

From time to time droughts of similar severity occur in two or more areas with vastly different climates—New Jersey, for example, as compared to eastern Oregon. Each area is affected in it own way. Extreme drought in New Jersey usually means low water tables, deficient streamflow, depleted reservoirs and, now and than, serious shortages in soil moisture. In eastern Oregon, on the other hand, extreme drought produces dry ranges, critical fire hazards, and a shortage of water for irrigation and livestock use. The many and varied effects of a prolonged drought depend on the peculiar climatic conditions and established economies of the areas affected.

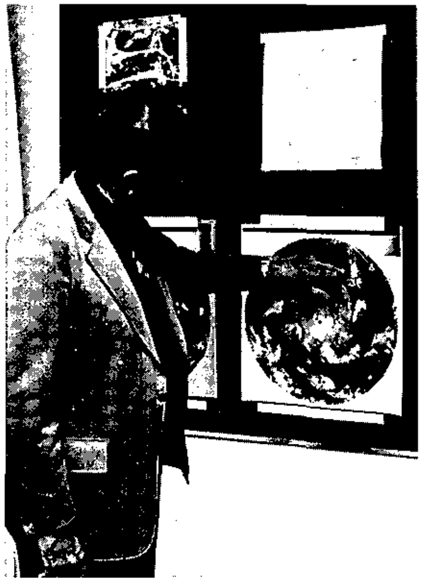
The terrible experiences in the Great Plains in the 1930's when, at one time or another, serious drought afflicted the entire midsection of the country from Canada to Mexico, and from the Great Lakes to the Sierras, brought home to farmers the climatic truth that the semi-arid lands of the West could not be farmed by the same methods used on the farmlands in the more humid eastern portions of the country. Since then, a number of techniques have been developed to promote maximum absorption of the moisture and minimum loss of topsoil due to dryness and high winds. These include new farm machinery that covers the soil surface with wind-resistant clods, terrace farming, and "trashy" or stubble mulch farming, which leaves the remains of previous crops exposed to stabilize the soil and promote better absorption of rainwater. Improved farm technology, however, is no substitute for a good rain.

From 1948 to 1962 drought accounted for 39 percent of all indemnities paid to farmers by the Federal Crop Insurance Corporation. The next largest weather category—floods—accounted for only 14 percent of the total losses. With each succeeding year a drought takes an increasing toll of capital and resources and leaves more and more farmers and ranchers—and those with whom they do business—with nothing except debts.

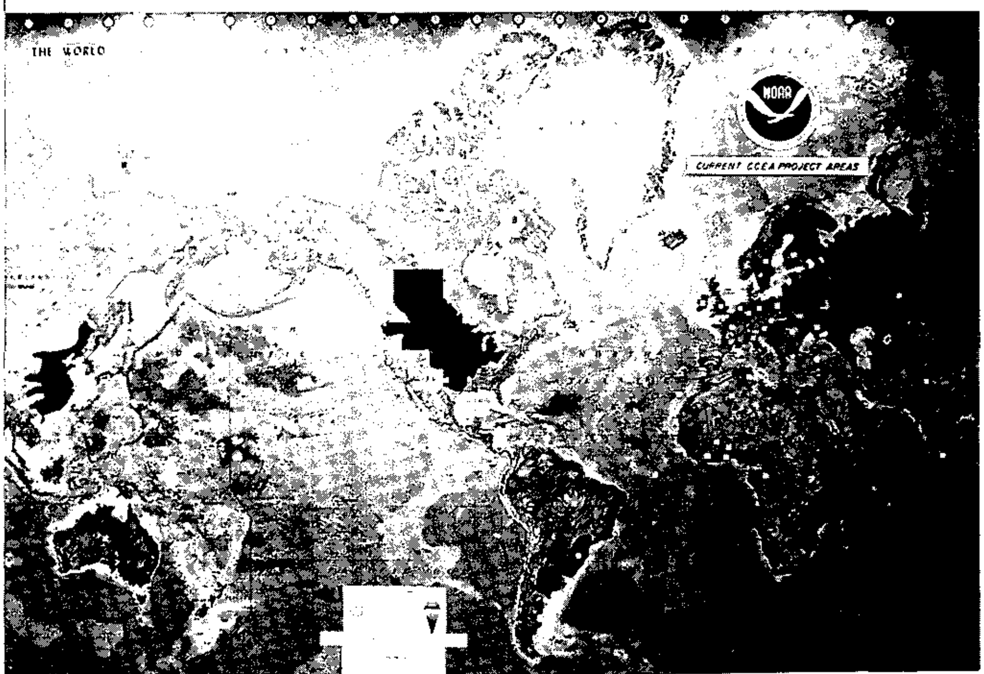
An Oklahoma farmer raises a fence to keep it from being buried by drifting sand.

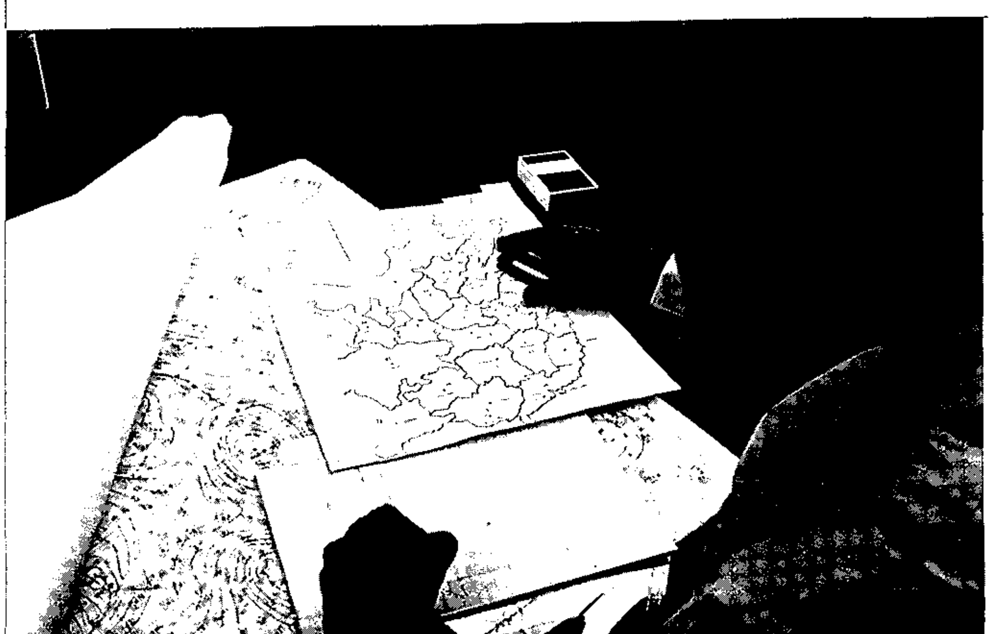
During the drought of the 1950's President Eisenhower—remembering the drought that helped plunge his own father into debt—summed up the personal impact of drought on hundreds of thousands of rural Americans in these words: "Of the many natural forces that wage war on farmers and ranchers, the most demoralizing is a prolonged drought. In its grip the individual farmer is well-nigh helpless."

Droughts are prolonged weather anomalies, and conditions have always returned to normal sooner or later,



Today, EDS' Center for Climatic and Environmental Assessment analyzes grain growing regions of the world (map) and climatic trends to assess the effect of drought and other weather anomalies on crop production.





thus the outlook is always favorable for the end of a drought. Often the problem is surviving until nature is ready to resume more moderate ways.

The dynamics of drought are not very well understood, certainly not to the degree where we can predict its occurence, duration, or intensity. Meteorologists usually explain a specific drought in terms of abnormal atmospheric circulation cutting off precipitation in the affected area. This explanation, however, says nothing about the fundamental forces which produce the unusual circulation pattern. Solar cycles, the relative temperature difference between ocean and continent, volcanic eruptions (which eject large amounts of dust into the air and thus may alter the Earth's radiation balance), and changes in the gaseous composition of the atmosphere have all been blamed. The actual cause of drought may include any or all of these, and possibly other factors as well.

Meteorologists generally discount the idea that manmade effects are responsible for droughts. While urbanization and pollution can definately influence climate, most weathermen think that these artificial factors are too weak to affect the great upper-air circulatory wind patterns that flow around the globe.

According to past performance, a major drought seems to occur in the Great Plains and American Southwest about every 20 years. (The drought in the East in the early 1930's and again in the 1960's were separate phenomena, and not part of this pattern.) These quasi-periodical occurrences of drought are not regular enough to predict, but rather show up in after-the-fact analyses. This apparent relative regularity may be misleading; the 100 years or so of weather records available is too brief a period to definitively establish long-term climactic trends. Drought predictions based on past history currently present about the same problems as predicting the behavior of the stock market from past performance. Both are highly speculative ventures.

U.S. GATE Data Processing Completed

By David Saxton

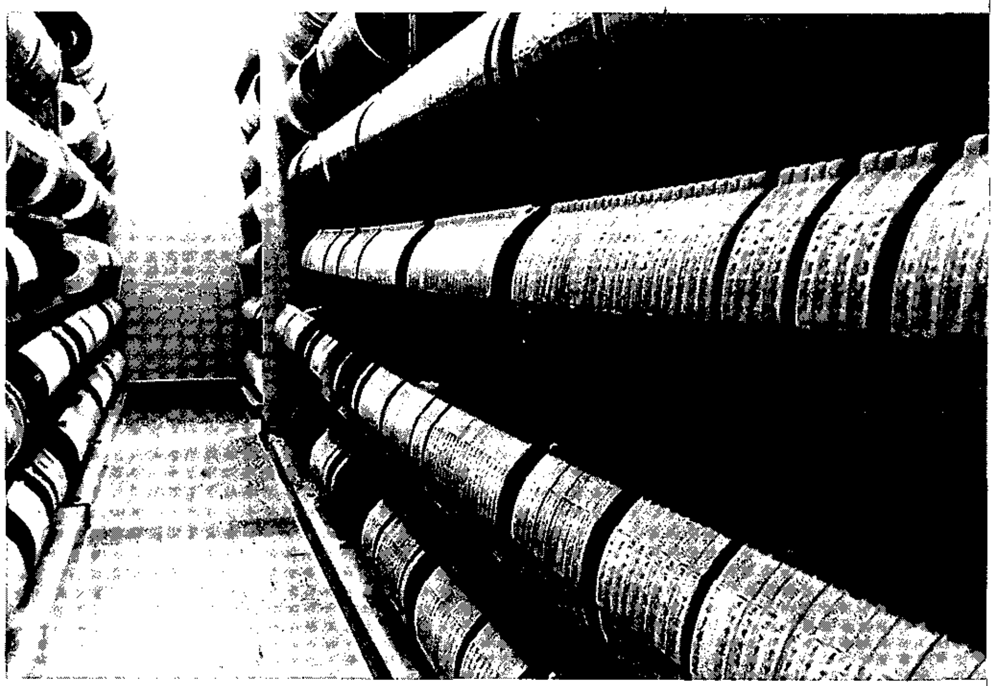
EDS' Center for Experiment Design and Data Analysis (CEDDA) has completed the processing and validation of data collected by U.S. ships in the central array during the Global Atmospheric Research Program Atlantic Tropical Experiment (GATE).

GATE was a pioneering investigation of the role of the Tropics in global weather. During the field phase of data collection, which ran from June to October 1974, 66 Nations used 38 ships, 65 buoys, 13 aircraft, and 6 satellites to study a 200 million square mile area centered in the Atlantic Ocean off the coast of Dakar, Senegal. The central array of ships included the *Researcher, Gilliss, Dallas, Oceanographer,* and *Vanguard* from the United States; they collected high-resolution data and sent them to CEDDA.

By late fall 1974, CEDDA had received 2,000 magnetic tapes, 38,000 optical marked cards, 12,000 strip charts, and 40 boxes of logs and forms containing the data collected at sea. Data processing and validation were completed by July 1976.

The data processed by CEDDA have been archived on 250 magnetic tapes at World Data Center-A (WDC-A), Meteorology, Asheville, N.C. The data sets include digital radar data, tethered balloon meteorological data, upper air rawinsonde data, high-resolution surface meteorological data, and expendable bathythermograph and salinity-temperature-depth oceanographic data.

A complete description of these data sets (and other internationally archived data sets) and instructions for ordering them are in the WDC-A GATE catalog. Copies of this catalog are available from the World Data Center-A, Meteorology, GATE Archive, National Climatic Center, Asheville, N.C. 28801.



Experts Review Techniques for Predicting Oil Slick Behavior

The Ralph Parsons Laboratory of the Massachusetts Institute of Technology held a workshop of experts on June 3-4, 1976, to review a draft of a report they are preparing for EDS' Deepwater Ports Project Office.

Basic Techniques for Predicting the Behavior of Surface Oil Slicks is being prepared under a grant through NOAA's Office of Sea Grant. It documents state-of-the-art capabilities in oil trajectory modeling.

At the workshop, MIT obtained a critical outside review and evaluation of the draft from participating experts. These included representatives from Woods Hold Oceanographic Institute; U.S. Coast Guard; Texas A&M University; Shell Development Company and Texaco, Inc., both representing the American Petroleum Institute; and NOAA.

A wide range of report topics were discussed: modeling of coastal wind fields; spreading of oil slicks by wind-waves and ocean currents; the experimental basis for a fixed "drift-factor" relating wind speed and surface wind-driven currents; oil slick transformations; and the dissolution, subsurface transport, evaporation, and emulsification of oil.

MIT will use the workshop inputs to produce their final report scheduled for release in November 1976.

EDS Supports Energy Research

EDS is providing data management support for NOAA energy-related research and development studies funded by the Environmental Protection Agency. These studies include assessments of the environment of Northern Puget Sound and the Strait of Juan de Fuca, related areas.

EDS is providing the following services:

- Developing and standardizing data formats for marine and estuarine environmental information.
- Participating in the development of an effective data management system. This effort involves identifying minimal requirements for submitting multi-disciplinary data to EDS' national data centers to ensure efficient archiving of data, compatibility of submission formats with retrieval requirements, adequate quality control, and complete and accurate documentation.
- Identifying gaps in files of marine and estuarine environmental data.
- Establishing design criteria and developing an operational plan for baseline surveys, including intercalibration and standardization of sampling and analytical techniques, survey area criteria, priorities, and schedules.
- Updating a bibliography on the marine environment of Northern Puget Sound.

In addition to the above, EDS will update a bibliography on the Northwestern Gulf of Mexico, where NOAA is describing the ecosystem in a producing oil field and determining ecosystem changes from that of an undistributed area.

Energy Resource Related Marine Data

EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) can now provide users a variety of new, multiagency data sets that depict the marine geophysical environment on the continental shelves.

U.S. Geological Survey data available through NGSDC consist of multichannel common depth point seismic and sound velocity profiles, collected between Maine and Virginia and in Cook Inlet, Alaska. Complementing these are about 1,800 nautical miles of single-channel seismic data collected by the University of Rhode Island during two cruises off the coast of New Jersey, and about 4,000 nautical miles of similar data collected by the University of Washington and the U.S. Geological Survey in the Gulf of Alaska.

U.S. Naval Oceanographic Office data available consist of digital gravity data from the western offshore areas of the United States, Gulf of Mexico, and waters near Iceland. About 117,000 gravity observations comprise the West Coast data coverage, 150,000 on the Gulf Coast, and 38,000 from Iceland water.

More information about these and other available energy-relevant data can be obtained by contacting the:

National Geophysical and Solar-Terrestrial Data Center
Code: D621
NOAA/EDS
Boulder, CO 80302

Telephone: (303) 499-1000, Ext. 6338

Climatic Studies of Coastal Zone

EDS National Climatic Center (NCC) has recently published two publications: *Climatic Study of the Near Coastal Zone, East Coast of the United States* and *Climatic Study of the Near Coastal Zone, West Coast of the United States.* NCC compiled and printed the studies for the Director, Naval Oceanography and Meteorology.

The East Coast study covers the marine area from latitude 30°N to latitude 45°N and east from the shore to longitude 68°W; the West Coast study covers the marine area from latitude 34°N to latitude 49°N and west from the shore to longitude 130°W. Data are presented in charts for each calendar month in three ways: isopleth analysis, tables by 1-degree squares, and graphs by 1-degree squares. The elements covered are: ceiling, visibility, combinations of ceiling and visibility, surface wind speed and wind roses, air and sea temperatures, wave heights, and surface currents.

NCC has a limited number of these 133 page publications for distribution to requestors. The publications will also be available from the National Technical Information Service, Springfield, VA 22151.

Climate and Health Workshop

A Climate and Health Workshop was held on June 8 and 9 at Research Triangle Park, N.C., to encourage the use of climatic data by the health community and to explore areas of further study relating climatology to health needs and problems.

The workshop was sponsored by EDS' National Climatic Center (NCC), the National Institute of Environmental Health Sciences, National Institutes of Health, and the Environmental Protection Agency (EPA). Organized by a Steering group headed by Thomas D. Potter, Director, NCC, the workshop was attended by representatives of NOAA, Department of Health, Education and Welfare, National Science Foundation, Bureau of the Census, EPA, the Veterans Administration, Harvard University, Columbia University and the University of North Carolina.

Among the many topics discussed were: the current incompatibility between climatological and health data bases; application of climatic data to the study of specific diseases; separation of climatic variables from pollution levels; the effect of rate of change in climatic conditions as related to health, including indoor versus outdoor climate; and possible need for additional data to establish valid relationships in the areas of both climatology and health.

Preliminary recommendations being considered include:

- Make professionals and the public more aware of climate-health relationships by informing the health community of available climatic information and establishing a mini-information center.
- Assess needs for climate and health data by contacting various agencies and other interested groups and, as needed, convert current data bases to compatible formats.
- Evaluate the relationship of airport weather data to urban localities and of heat-island phenomenon to human health.
- Develop more systematic ways of relating temperature and temperature-humidity data to health problems.
- Use dosimeters to measure the exposure of individuals to climate.
- Relate climatic data to cardiovascular, musculoskeletal, respiratory, neurological, psychiatric, asthmatic, and allergenic diseases.
- Survey current work on correlating climate and health research.

Proceedings of the workshop will be published and will contain a summary of the discussions, final recommendations, and a bibliography of past studies on climate-health relationships.

Participants in the Climate and Health Workshop. (Front, from left) J. Jordan, National Science Foundation; I. Goldstein, Columbia University; J. Shuman, EDS; M. Laughrun, EDS; T. Potter, EDS; E. Rogot, Health, Education and Welfare; P. Leaverton, HEW; M. Hogan, HEW; W. Riggan, Environmental Protection Agency; M. Buchwald, EDS; (second row, from left) C. Keplinger, Veterans' Administration; B. Brown, HEW; R. Lehman, NOAA; J. B. Van Bruggen, EPA; C. Shy, University of North Carolina; M. Garland, Census Bureau; W. Hodge, EDS; L. Truppi, NOAA; (back row, from left) R. Horton, EPA; B. Ferris, Jr., Harvard Medical School; R. Kopec, University of North Carolina.

F-Lacuna Phenomenon Studied

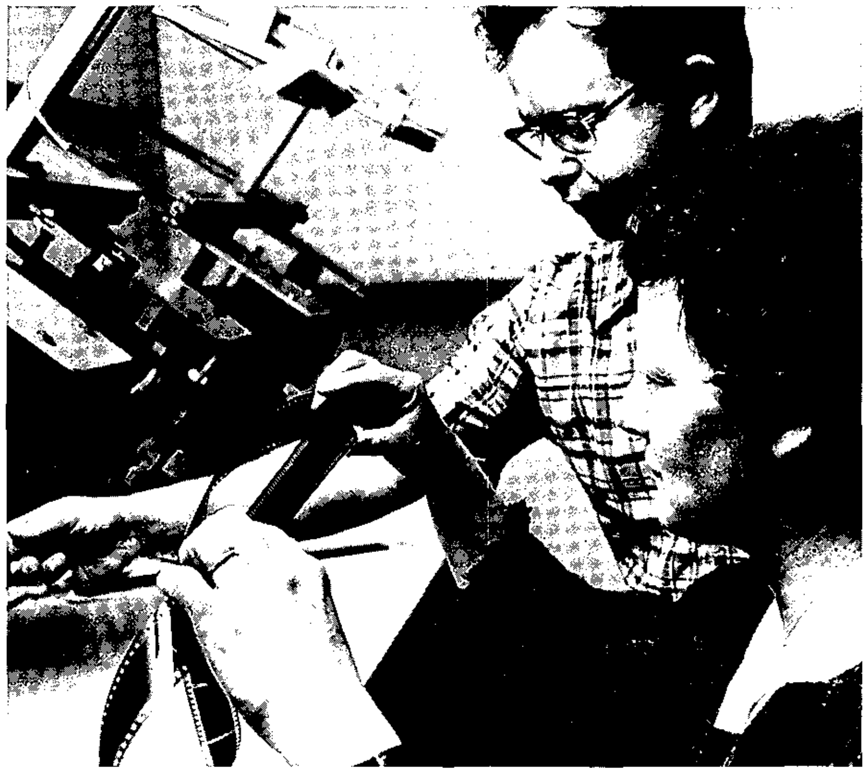
Two French scientists recently visited EDS' World Data Center-A for Solar-Terrestrial Physics in Boulder, Colo., to make the first worldwide study of the occurrence of the F-Lacuna phenomenon. This is a phenomenon in which unstable conditions in the electron and ion concentration in the Earth's ionosphere produce scattering or deformation of a vertically transmitted radio signal. The result is that the radio signal reflected back to the ground from the ionosphere may be severely weakened or sometimes lost completely.

To study this phenomenon, Suzanne Cartron and Michel Sylvain of the French Laboratoire de Geophysique Externe spent 1 month studying 120,000 ionograms at WDC-A. The ionograms are records of time delays of ionosonde signals received by vertical reflection from the ionosphere over a range of frequencies. The time delay data can be interpreted in terms of the heights of reflection in the ionosphere.

Results of the study are expected to give information on:

- The geographical extent of occurrence.
- The degree of disturbance within the perturbed zone at a given time, which is needed to correlate with data from the International Satellites for Ionospheric Studies satellites, which transmit radio signals down onto the top-side of the ionosphere.
- The variations observed with invariant latitude (which describes the geomagnetic field); the dip angle (the inclination of the geomagnetic field from the horizontal); and other pertinent parameters.

In particular, the French scientists hope to confirm or invalidate published interpretations.



French scientists, Suzanne Carton and Michel Sylvain, examine WDC-A ionograms for data on the F-Lacuna phenomenon.

Earthquake Epicenters Tetrahedron Kit

EDS' National Geophysical and Solar-Terrestrial Data Center has available a do-it-yourself earthquake epicenter tetrahedron kit.

The kit consists of a map of the world with earthquakes of magnitudes of 4.5 or greater plotted in red. The data for this plot came from NGSDC's earthquake data file and include the years 1963-74. The plot is 1 of 39 map projections available from NGSDC that are used to show world or regional geophysical data.

To make the tetrahedron, you simply cut on the figure provided, make six folds, and add a little glue or tape.

For a copy of the tetrahedron kit write: Solid Earth Data Services Division, NGSDC, EDS, NOAA, Boulder, CO 80302. Telephone (303) 499-1000, Ext. 6477.

Computer Programs in Marine Science

EDS' National Oceanographic Data Center (NODC) has released a new publication *Computer Programs in Marine Science.* The booklet, based on the 1970 NODC publication *Computer Programs in Oceanography*, has four chapters—Fisheries, Engineering, Coastal and Estuarine Processes, Pollution— not available in the older publication.

The publication has abstracts of over 700 programs supplied by 80 organizations from 10 countries. A General Index, allowing the reader to search by parameter, method, author, etc., is supplemented by indexes to institution, language, and hardware.

Most of the programs listed in the publication are available from the originators or from other sources identified in the publication. The author's address and phone number are generally given.

The publication is available from NODC on an exchange basis or may be purchased for $3.50 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Stock number 003-017-00379-5.

Marine Life Code for World Ocean

EDS' National Oceanographic Data Center has let a contract through the NOAA Office of Sea Grant to expand a coding scheme for taxonomic names that the Virginia Institute of Marine Sciences originally developed for Chesapeake Bay. The University of Alaska, Fairbanks, Institute of Marine Science will enlarge the scheme to include organisms from the world ocean.

The large number of oil exploration activities on the outer continental shelf has stimulated national need for such a code, and several international groups have also shown concern.

When completed on October 1976, the code will be hierarchial from phylum to species or class to species, depending on the group under study. Provision is also being made to add subspecies of birds and mammals. Copies of the code will be made available to those interested.

Marine Science Newsletter Bibliography Updated

An updated version of *Marine Science Newsletters, an Annotated Bibliography*, has been published by EDS' National Oceanographic Data Center.

The new issue describes 146 international newsletters and is divided into two parts. Part I lists the newsletters alphabetically. Each citation includes title, name and address of publisher, frequency of publication, price, and content description. Many of the publications listed are available free of charge to qualified users.

Part II of the Bibliography has an index to publishers by type (academic, business, Federal) and an alphabetical list of publishers, both indexed to the appropriate newsletters.

Free copies of the Bibliography can be obtained from the Technical Records Branch (D764), National Oceanographic Data Center, NOAA, Washington, D.C. 20235. Tel: (202) 634-7301.

Two New Data Services Brochures Available

EDS' National Geophysical and Solar-Terrestrial Data Center has published two new brochures to inform scientists and the general public of the services and publications now available in the fields of seismology and marine geology and geophysics.

Earthquake Data Services and Publications describes regular services (for example, copies of seismograms, earthquake photographs, or searches of Earthquake Data File) and special services (for example, custom epicenter plots) available through NGSDC. Each service is summarized, and the cost and availability of data and information provided. The brochure also lists earthquake and related publications available from several Federal Government sources.

Marine Geological and Geophysical Data Services and Publications summarizes regular data services and special data sets relating to the marine environment. The special data sets described include multichannel common-depth-point data, heat-flow data, and digital hydrographic survey data, among others. Prices for each service are included. Also described are geophysical maps and publications available.

Both of these brochures may be obtained free of charge from the National Geophysical and Solar-Terrestrial Data Center, NOAA/EDS, Code D62, Boulder, CO 80302.

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National Oceanic and Atmospheric Administration
Environmental Data Service
Washington, D.C. 20235

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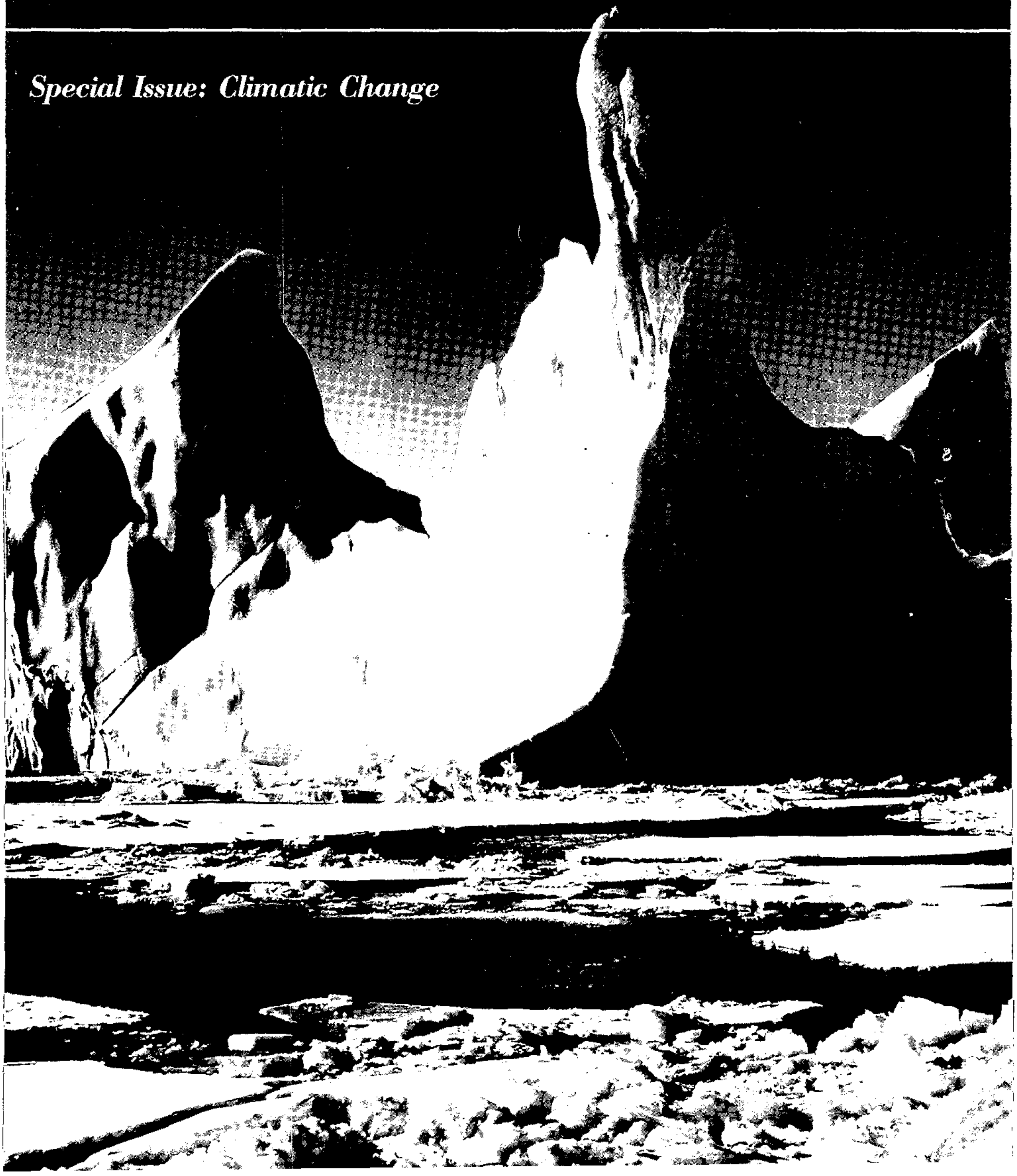
EDS

Environmental
Data Service
November 1976

Special Issue: Climatic Change



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COVER: Icebergs and sea ice in the Arctic. The advance and retreat of polar ice reflects climatic fluctuations.

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World Meteorological Organization Statement on Climatic Change

In spite of man's remarkable advances in technology, his economic and social welfare are still highly dependent on climate. Food production especially is significantly affected by variations in climate as evidenced by the decrease in world grain reserves over recent years. This dependence is becoming of even greater importance in the face of the demands of an increasing world population. But it is not only the demand for food which illustrates man's dependence on climate; floods, droughts and extremes of temperature seriously disrupt urban communities, interfere with agriculture, industry and commerce, and hamper economic and social development.

Evidence of conditions of the Earth's climate in past decades, centuries, millennia and geological epochs, has been deduced from a wide variety of direct and indirect sources. This evidence clearly reveals that climate exhibits variations on all scales of time. Since the climate has been so continuously variable due to natural causes in the past, it must be assumed that it will continue to vary in the future. However, long-term trends in global climate are masked by shorter-term fluctuations and by regional changes; exceptionally wet or warm conditions in one region are often accompanied by unusually dry or cool conditions in another.

The recent occurrence in certain regions of climatic extremes persisting for a few weeks, months or even years, such as excessive rain, droughts and high or low temperatures, have led to speculation that a major climatic change is occuring on a global scale, which could involve a transition to one or another of the vastly different climates of past ages. While such a global change could occur from natural causes, the trend towards such a change is likely to be gradual, and would be almost imperceptible. This is because the fluctuations over shorter periods of time are likely to be so much larger as to obscure these long-term trends. It is these shorter-term climates changes, which may be due to natural or man-made causes, that now require urgent attention and further studies.

The natural shorter-term variability of climate is becoming of increasing importance as the result of growing pressures on limited natural resources. It is this variability which has been highlighted by the disastrous droughts and weather extremes in many parts of the world which have caused so much human suffering and have adversely affected economic development. It is the changes due to variability to which governments could respond if sufficient advance warning could be given.

The possible change of climate resulting from man's activities is at least of equal concern. Burning of oil and coal increases the amount of carbon dioxide in the atmosphere and this could produce a long-term warming, and as a consequence, large-scale changes in rainfall distribution. The release of chemicals (for example chlorofluoromethanes) and the increase in the dust content in the atmosphere as a result of man's activities, if not checked, might also alter the climate. Direct thermal emmissions from urban and industrial areas have already affected climate on a local scale and could have wider effects if these emissions were to increase. However, with the present state of knowledge of the atmosphere it is not possible to give an accurate assessment of the magnitude of such changes.

Being aware of the importance and urgency of these problems, meteorologists and other scientists have taken steps to improve the quality and accessibility of data relating to past behaviour of the atmosphere, the oceans and other relevant environment factors; they are seeking to improve the monitoring of current climatic developments and of environmental changes to assess the impact of natural processes and of man's activities; they are endeavouring to intensify research aimed at a better understanding of climatic processes and the impact of climatic variability on the natural environment and on human activities.

In view of the increasing inportance of the inherent shorter-term variability of climate to many human activities greater use should be made of existing knowledge of this variability in planning for economic and social development; for example an assessment of the probability of occurence of rainfall within given ranges can provide an assessment of the viability of proposed agricultural or hydrological projects. If the results of further research by meteorologists and other scientists reveal that man's activities could produce changes in climate having serious consequences for mankind, political and economic decision makers would be faced by additional problems, as described in paragraph 5. Further research in climatic change is therefore of the greatest importance.

What Can We Say About Future Trends in our Climate?*

By J. Murray Mitchell, Jr.

Not so many years ago, climatic change was perceived as a problem having mainly to do with the ice ages of the remote past. Present-day climate wasn't supposed to be changing. When some kind of data came to light that hinted it was changing—perhaps a long meteorological record with a trend in it—one's first reaction was that something was wrong with the data. (And, not infrequently, there was.) Failing that, evidence of climatic change was rationalized on the basis that something was wrong with our definition of climate. (After all, wasn't the virtue of the very concept of climate its immunity from participation in the sampling variability of atmospheric state, and wasn't all sampling variability just random variability in the first place?)

Nowadays, as we all know, climatic change connotes something entirely different. Climate is described as dynamic, not static. There are no hang-ups any longer about the climate being incapable of change in a single human generation or less. The present-day "trend" of our climate, whatever that term might mean exactly, finds itself the topic of animated discussion in our daily newspapers, in high government circles, and in scientific forums.

**This is a slightly edited version of an article which appeared in* Atmospheric Quality and Climatic Change, *Richard J. Kopec, Editor, Papers of the Second Carolina Geographical Symposium, March 21, 1975, University of North Carolina at Chapel Hill, Department of Geography, Studies in Geography No. 9.*

Scientists are divided on whether the climate is getting colder or warmer, but all agree it will be different in the future.

Why this extraordinary change in perspective on the subject of climate? Is the climate itself doing something differently now that it was never known to do before—something which requires a redefinition? Not really. True, the climate is now seen as inherently variable, whereas it was not seen that way before. But the climate is not suddenly becoming variable in a way that it had never been variable before. As to why climatic change has burst into public consciousness as a matter of vital concern for the future, we can point to the following circumstances:

- Newer and more detailed reconstructions of past climates (1) indicate that climate has tended to be variable on all scales of time, as if climate is continually "hunting" around an equilibrium that it never fully achieves. This, in turn, implies that future climate will be more likely to differ (in some way) from present climate, than it will to stay the same.
- Man's activities are suspected of being capable in various ways to bring about inadvertent changes of climate, either now or in the relatively near future. The nature and extent of such human influences on climate are not yet clear (2).
- There is observational evidence that the world's climate has been cooling slightly in the past 30 years, and in some respects may have become more variable as well (3).
- World society seems to have become increasingly vulnerable to even small and transient deviations of atmospheric conditions from their long-term expectancies.

These circumstances are enough for both science and society to sit up and take careful notice. But it is my reading of the situation that public concerns about climatic change, and its relevance to the future, have been conditioned not so much by these circumstances per se as by alarming projections of impending climatic disaster of one kind or another. These projections are alleged by their respective authors to follow more or less directly from the facts of climatic change as we—or at least they—see them. Yet, there is nothing approaching peer consensus that any such projections are entirely reasonable and proper.

The untenability of the situation is illustrated by a series of recent events. A BBC produced television special aired two winters ago left the impression that we may be headed for a rapid cooling of global climate, in what was described as a "snow blitz" (4). Shortly thereafter, a new book appeared that warns of the inevitability of a kind of heat death of the earth if man persists much longer in feeding his ever growing appetite for energy from conventional fossil and nuclear sources (5). More recently, a pointed warning on this same theme, which addresses itself to the warming effect of carbon dioxide growth in the atmosphere, was published in *Science* (6). Meanwhile, the cooling trend of the past 30 years is still cited in some quarters as confirmation of approaching calamity, as if this modern-day cooling signals the start of a new ice age and is destined to continue without interruption in one direction.

The mass media have been having a lot of fun with this situation. Whenever there is a cold wave they seek out a proponent of the-ice-age-is-coming school and put his theories on page one. Whenever there is a heat wave, they turn to his opposite number in the greenhouse warming school and put his comments on page one. To the man in the street, it all means that mankind is going to either freeze or fry. To the more discriminating layman, however, it simply creates something of a credibility gap for science that draws attention away from the more pressing problems of climatic variability and its myriad impacts on society that we would like to —and need to—understand better.

In this paper, my aim is to call attention to some of the facts of life concerning climate and climatic variability that we have to consider when trying to peer into the future beyond tomorrow's weather forecast. In doing so, I can be somewhat reassuring, but not altogether so, that our long-range climate problems will be ordinary and manageable, rather than extraordinary and unmanageable.

To begin with, it is useful to ask some questions as a way of reminding ourselves of the dimensions of the problem of climate prediction.

If man were not around to interfere with nature, what would nature throw at us in the way of future climatic developments? This question is not as straightforward as it may sound because it may very well be that nature herself does not know the answer. The evolution of natural climate may not be a deterministic process in times, and if nature could somehow be interrogated as to what it plans to look like 100 years from now she might have to answer in the form of a set of probabilities of various possible outcomes.

To the extent that nature herself knows the answer to the foregoing question, to what further extent is it within man's technological grasp to wring that answer from her? Science tends to be optimistc in this regard, but it cannot fully justify such optimism on the basis of known facts about climate system behavior. It's simply a matter of faith in the scientific method that it suffices to extract all secrets from nature.

A question of a rather different sort must also be asked here: What are man's intentions with regard to the future? Irrespective of future climatic developments, man will presumably have choices of many kinds toward the betterment of his lot on the earth. We don't know what man's preferred ways of life will be in another 100 years, but whatever they are will have great impact on future trends of industrial growth and energy use. By now it should be clear that we would be foolish to continue in the nonsense of the 1960's and early 1970's— that the future can be gauged by extrapolation of the quasi-exponential growth of the past. It is not an exponential world we are living in any longer. But without fear of contradiction we can say that man will very likely be more numerous, more active, and more prolific in his use of energy a hundred years from now than he is today. To that extent, man will bring himself ever closer to the day when the climatic impacts of his activities will vie with natural climatic forcing mechanisms in determining the course of future climate. It follows that in order to predict climate very far into the future decades and centuries, it would be necessary to predict future trends in many aspects of the overall human condition! And, as if that weren't challenging enough, we must recognize that the human condition a hundred years from now will likely depend on what man learns in the meantime as to the environmental implications of proceeding along different and optional lines of societal progress. Among the environmental implications he will need to consider, of course, are his impacts on the climate. Thus, what man will do in the future, and what the climate will do in the future are not going to be independent of one another.

A final question to be asked is this: If it turns out that certain avenues of future societal progress would lead to serious and possible irreversible changes of climate, as a result of inadvertent side effects on the environment, would man realize this in time to avert possible calamity? Again, we can be optimistic, and trust in the scientific method to gain for us the understanding of the climate needed to answer this question. Yet, the behavior of the climate system is highly complex. Many years of vigorous research undoubtedly will be required to illuminate that behavior adequately. Meanwhile, the world is changing. The atmosphere is becoming richer in carbon dioxide by a fraction of a per cent every year. Energy use is growing inexorably, albeit at a slower rate than before the Arab oil embargo. And we are becoming aware of new pollution problems, for example, those related to ozone destruction by nitrogen oxides and chlorofluorocarbons ("freons"), which may extend to potentially serious and slow-to-heal impacts on climate. With all this in mind, we may not have all the time we need to identify unacceptable societal options before we innocently start down the road to one of them.

At the present time, there are no definitive answers to any of the questions I have posed here. Until we have those answers—and it is by no means clear when we can expect to have them—meaningful projections of the future trend of our climate will remain beyond the grasp of science. We can speculate on the risk of another ice age, or on the risk of overheating the earth by our overuse of fossil or nuclear energy. But we will not be able to quantify those risks to the extent that society requires, if society is to plan for the future on a more rational basis than simply catering to fears of the unknown.

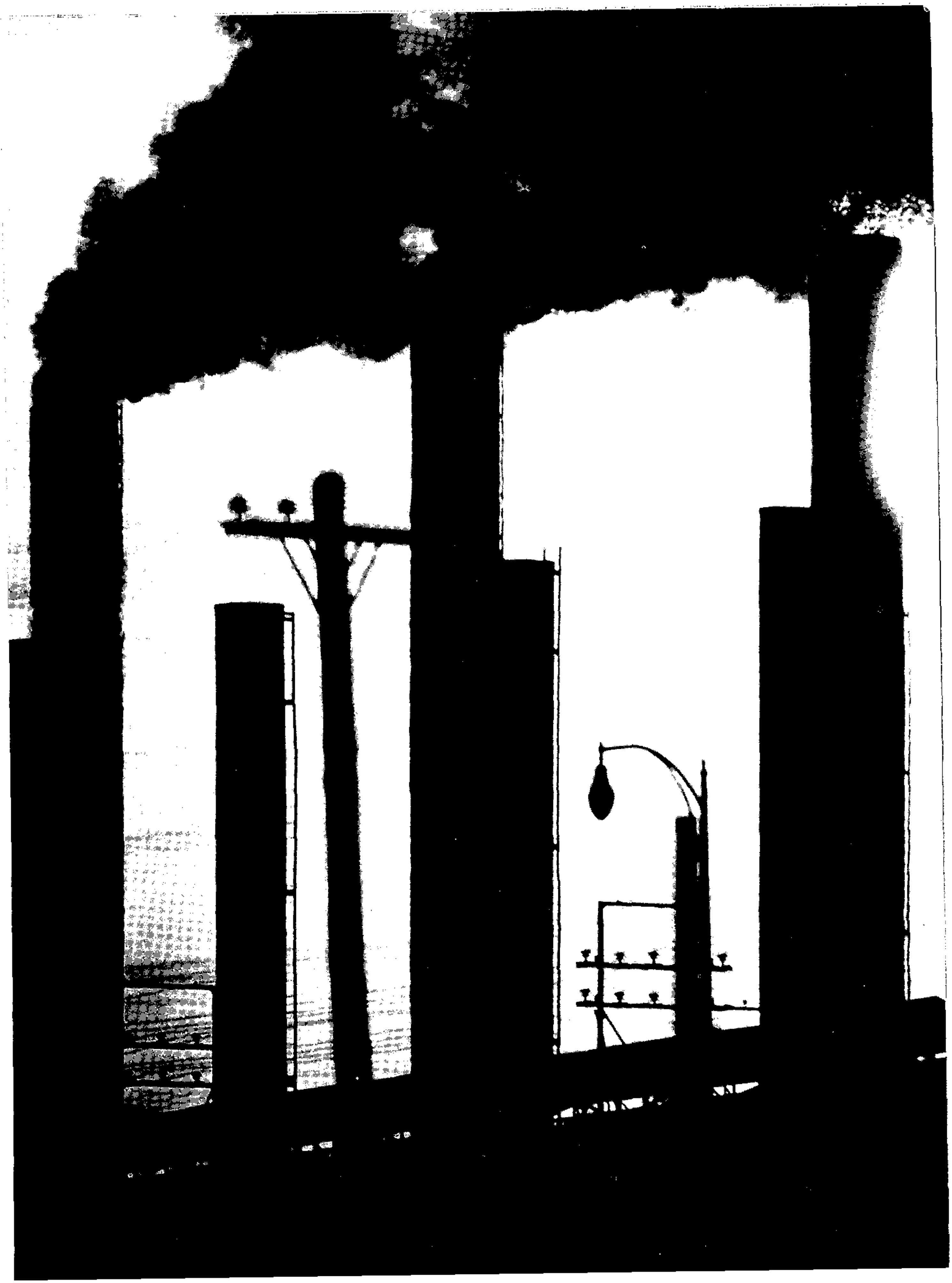
If the future tendency of our climate is in doubt, and if mankind depends on information about future climate to plan its affairs wisely, we climatologists should take a good look at ourselves to see how well we are responding to the challenge that is ours, to assess the future of our climate realistically, reponsibly, and objectively. When I attempt to do this, I find plenty of room to be embarrassed by things we climatologists have been doing wrong, but also plenty of room to be satisfied by things we are striving hard to do right. Permit me to mention what I perceive as the wrongs and rights, respectively.

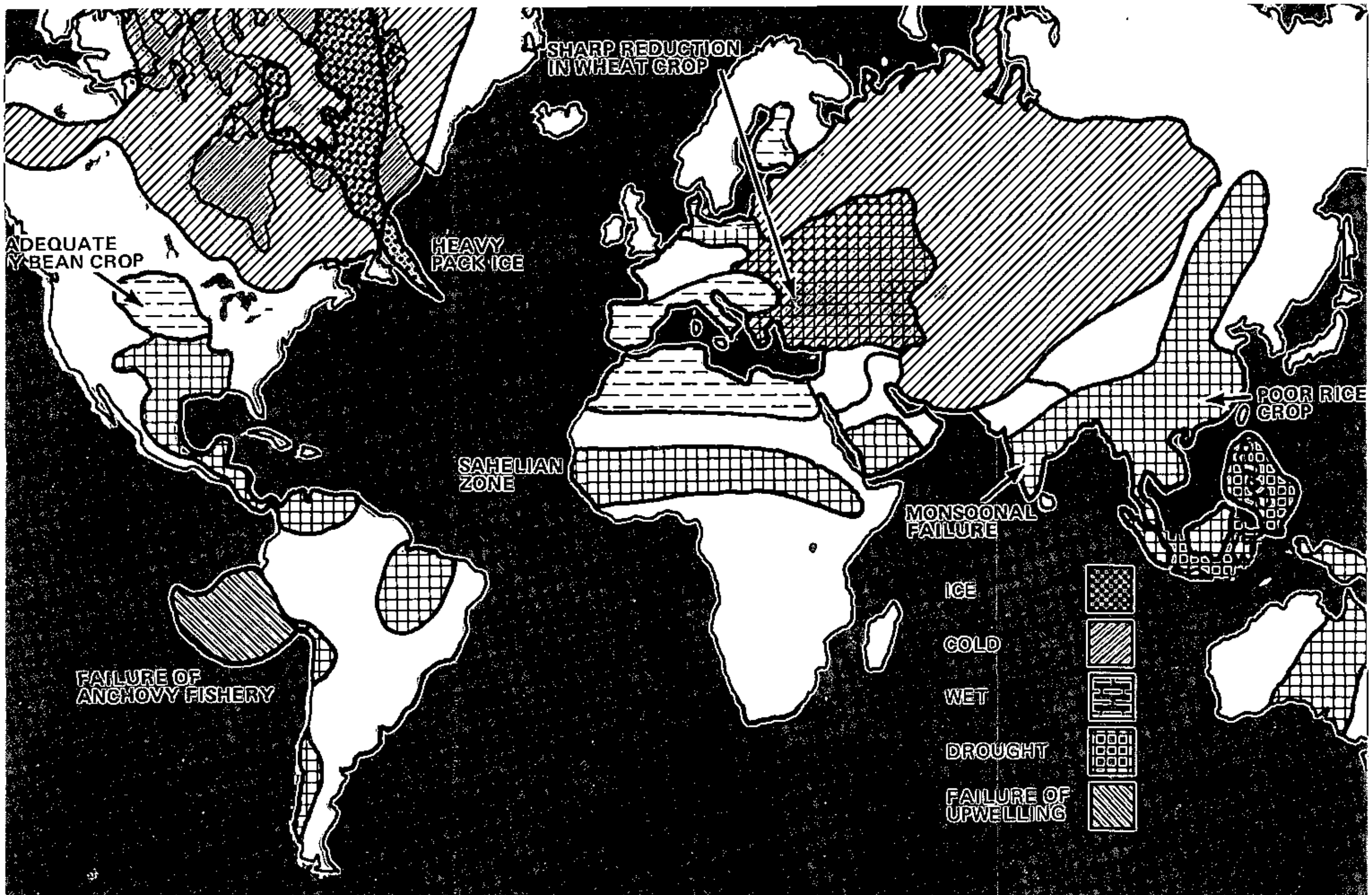
Among the wrongs are the myopic ways we have been looking at the statistics of past climates. We have tended to extrapolate too much from our limited past experience as to the facts of climatic variability. We have looked at a thirty-year cooling trend in northern hemispheric average temperature and spoken of it in items that the climate of our hemisphere *is* cooling at the present time. (At least one new study (7) suggests the cooling may already have bottomed out, if not actually reversed.) We have looked at a five-year record of density-weighted mean hemispheric temperature (8), and a five-year record of the extent of ice and snow cover in the Arctic (9), and finding trends in both we have occasionally spoken of both as evidence of approaching disaster, as if these trends deserved to be extrapolated to eternity. (Newer data in both cases have shown these "trends" for what they were: temporary excursions of climate that have since reversed themselves.) Similarily, the devastating recent drought in the Sahel zone of Africa was suggested at the time to be an irreversible effect of global atmospheric pollution. Pollution continues but the drought is gone.

We have tended to focus on developing climate disturbances as "the problem" of climate, as we did at the time of the Sahelian drought. We have seemed to forget, in our preoccupation with the crisis of the moment, that all climate-bred disasters are essentially only chance realizations of a much broader class of climatic variability which is the more meaningful object of our concerns. (I would venture to say that the world will experience innumerable climatic crises of other kinds, and in other parts of the world, before it is time for the Sahel to be ravaged by another, similar drought a few decades hence.)

Another wrong is the one-dimensional way we have been prone to explain climatic disturbances and climatic changes. We have tended to pick out one, or a few, simplistic causative mechanisms to account for the facts of past climatic change, and to rely on these as a guide to future climatic developments. In truth, there are undoubtedly many causative mechanisms—some internal and some external to the climate system—that govern climatic variability and change. No mechanism can be realistically dealt with in isolation of the others. All must be considered together in a suitable general physical framework

Carbon dioxide in the atmosphere impedes cooling of the earth at night and tends to warm the climate.





Climatic anomalies like those in 1972 have often lead to projections of impending climatic disaster.

before we can claim to understand much of anything about climatic changes.

Since we do not yet have a good grasp of all causative mechanisms, and we are not yet certain what constitutes a suitably general physical framework to encompass those mechanisms, it is rather absurd for us to speak of having "explained" the changes of global-average temperature in the past century (for example) as the result of increasing atmospheric pollution, or of changing solar activity. Where interesting statistical relationships appear to exist, as between climatic variations and such plausible forcing phenomena as volcanic eruptions, carbon dioxide trends, or sunspot numbers, these should by all means be reported as possible clues to climatic behavior. Hypotheses to account for climatic change, based on such relationships, should be advanced. But let them be recognized for what they are: statistical relationships and hypotheses. And let them be recognized also for what they clearly are not: self-sufficient explanations of climate behavior and reliable bases for climate predictions.

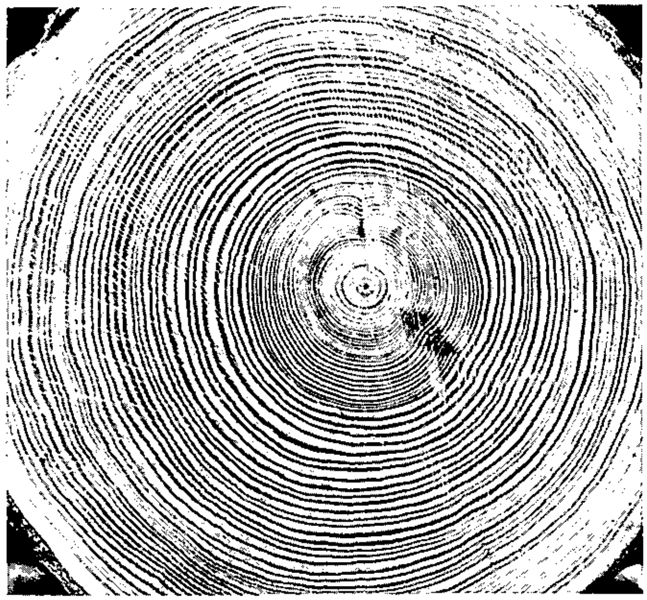
Among the things we are doing right, I would cite the following. First, we are discovering the value of extending our climatic records into the past as far as we can, in as much detail as the many exciting new advances in the multidisciplinary field of quantitative paleoclimatology allow. Where meteorological records and human recordings begin to fail us, going back a century or so, we are expending considerable effort to reconstruct the chronology of climate in earlier centuries and millennia by means of a variety of "proxy" indicators such as tree-rings, varved sediment analyses, pollen profiles, stable-isotope variations in ice cores, and the like. All this is having the effect of extending the range of our experience as to climate behavior and climate variability. This, in turn, permits us to put recent climatic experiences into very much better historical perspective. One-of-a-kind climatic developments evident in our modern meteorological records are increasingly seen to have many historical precedents. More realistic bounds on climatic behavior can be set, with the result that the probabilities of extreme climatic events in modern-day climate can be assessed far more realistically, and more confidently, than before. Causative factors in climatic change can be assessed more reliably as well.

We are finding modern technological tools equal to the task of developing comprehensive numerical models of climate behavior. We are turning to climate modeling as a powerful stratagem for bringing into consideration all of the factors that together are likely to account for climatic variability and change. The exciting thing here is not what has already been accomplished, which is considerable, but the promise of what seems possible to accomplish in the future with respect to the quantitative understanding and prediction of climate.

We are exploring the theory of climate predictability from first principles of the behavior of complex fluid-dynamical systems. In this way we hope to clarify the limits of predictability, and to focus research on those aspects of atmospheric behavior which would appear to be predictable for relatively long periods into the future.

We are dramatically broadening our capacity to monitor our terrestrial and extraterrestrial environment, through remote sensing technology and a variety of new satellite observing systems, to track all manner of environmental variation that may affect the state of the climate system or give rise to climatic variability.

All of these promising developments will eventually come together to provide a sound basis for assessing our future climate. That day cannot come soon enough. For the present, we must settle for vague, qualitative judgments as to what the future is most likely to bring. The world is not unlikely to be preparing itself for the breakdown of the interglacial warmth of the past 8,000 years, and to begin the transition into a colder, more glacial regime. The onset of that transition is an unknown number of centuries or millennia away; conceivably it has happened already. We may assume that any such transition, whether past or future, would proceed so slowly as to be barely perceptible in a human lifetime and well disguised amid the more rapid fluctuations of climate, of an irregular and transient character, that seem always to be with us. Meanwhile, man is beginning to have appreciable impacts on the climate, mostly (it appears now) in the direction of warming. These impacts are likely to grow in importance in future decades and centuries. The resulting picture of future climatic developments is contradictory and very unclear. Let us get on, as soon as we can, with the mammoth research task that is plainly required to clarify that picture.



Climate in earlier times can be reconstructed from tree rings. The width of a ring is determined by the temperature and/or moisture conditions during the year of its formation.

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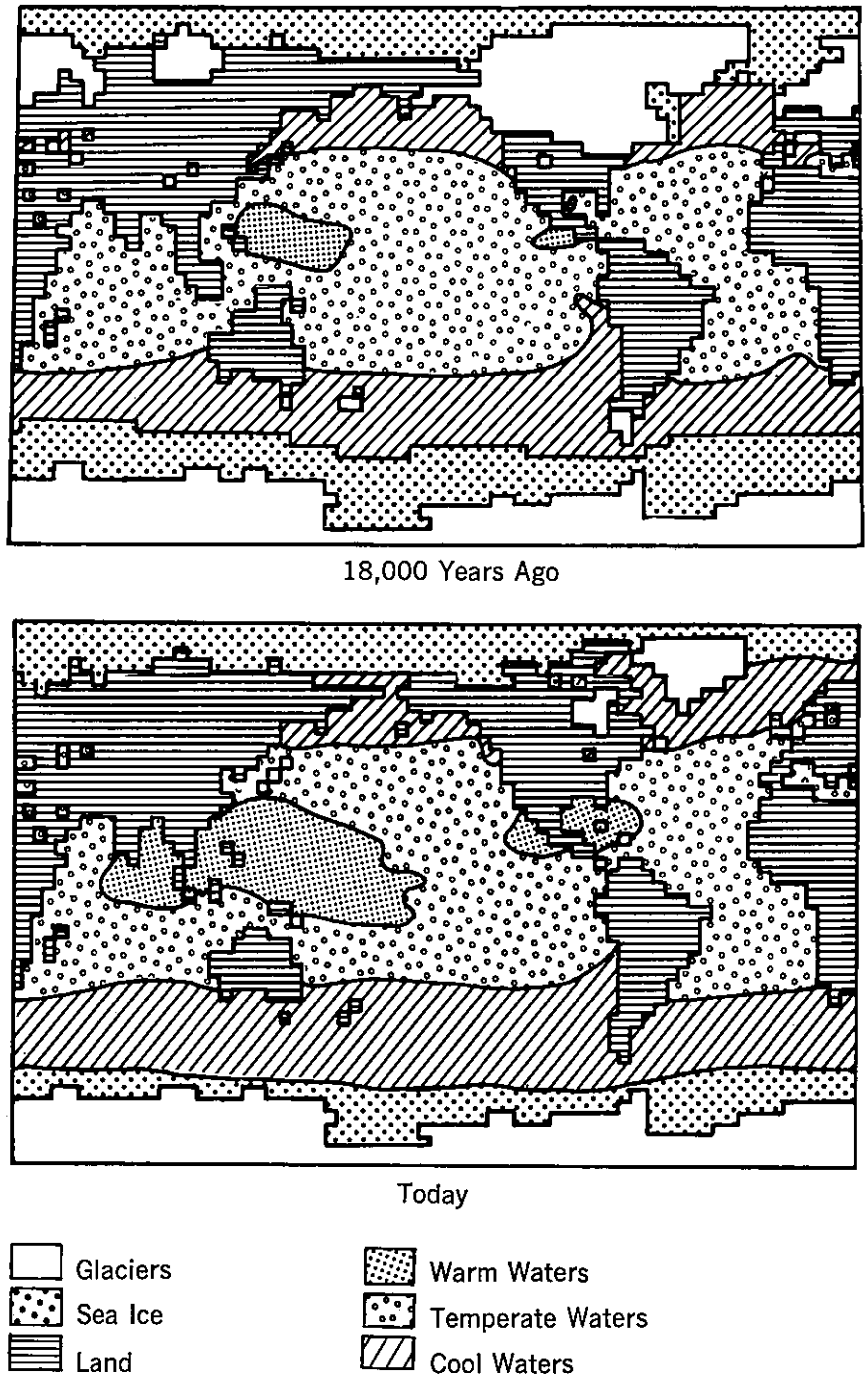
The Facts About Climatic Change

A Technical Report by the WMO Executive Committee Panel of Experts on Climatic Change, June 1976

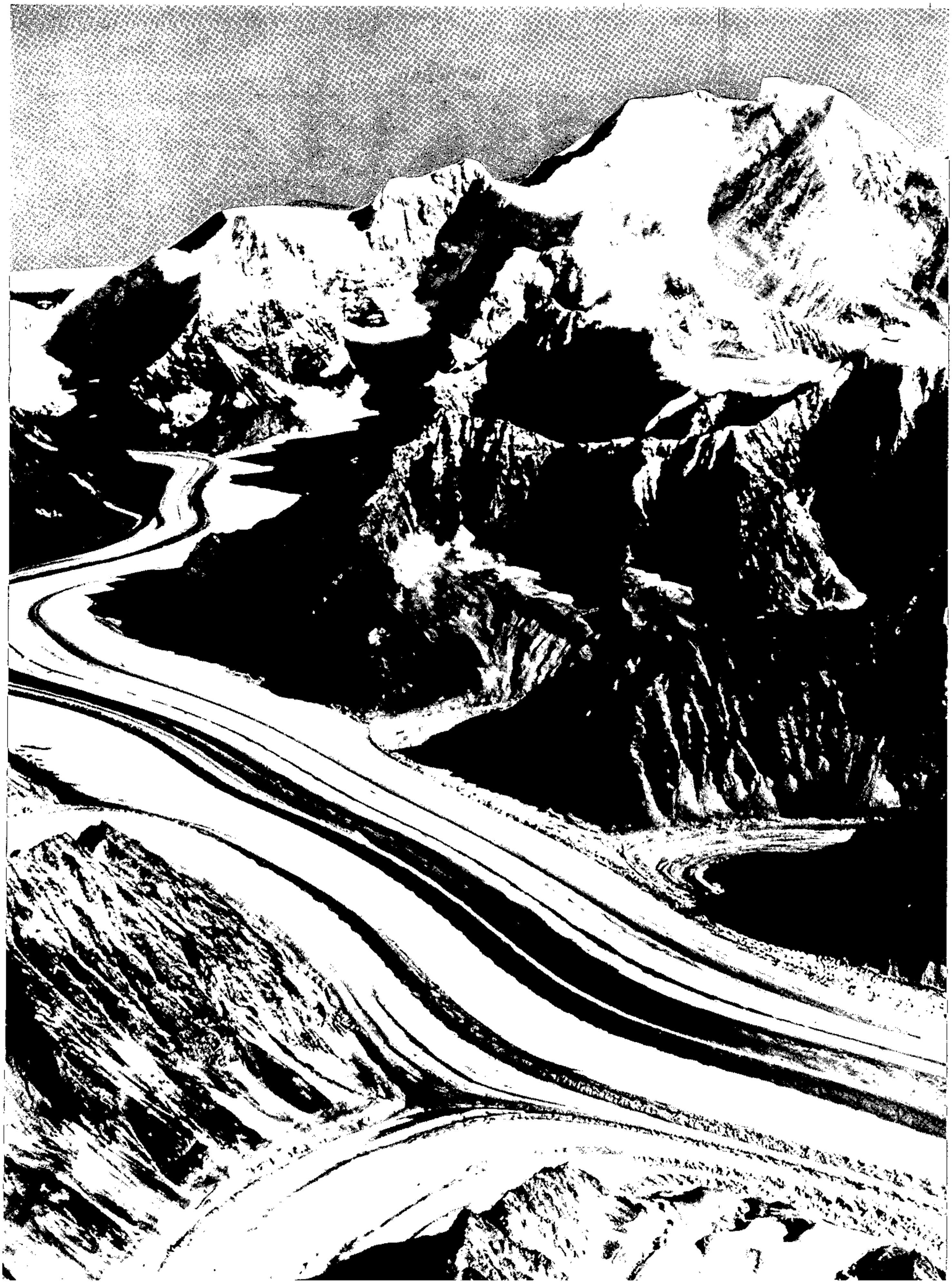
Past climates

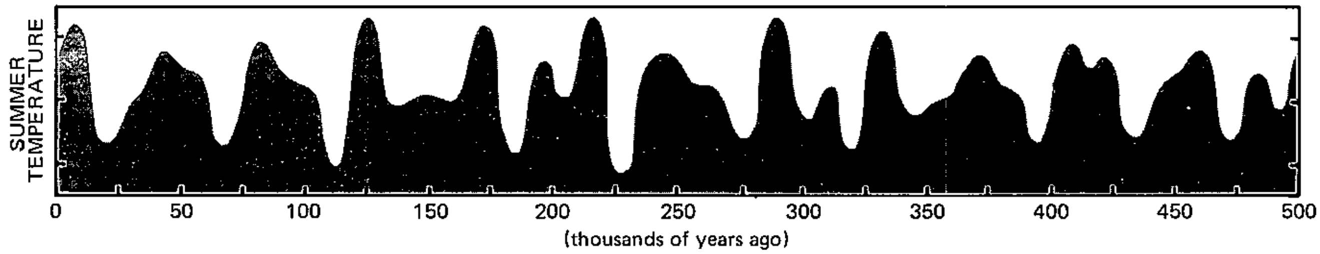
During the past two million years or so, there has been a long sequence of alternations between glacial and interglacial epochs of climate, in which the glacial epochs have tended to recur at approximately 100,000 year intervals. For the past 8,000 years or so, the Earth has been in a comparatively warm interglacial phase of this ice-age sequence, with less ice (most of it in the Greenland and Antarctic ice sheets) than at any time in the past 100,000 years or so. Mid-latitude temperatures are today 5 to 8° warmer, and sea levels 80 to 100 meters higher, than those typical of extreme glacial stages, such as the Würm (or Wisconsin) glacial maximum about 18,000 years ago.

Since recovery of the Earth from the last glacial stage, about 8,000 to 10,000 years ago, global climate has been found from a variety of paleoclimatic indicators to have fluctuated within much narrower limits. In part the post-glacial climate changes have involved expansions and retreats of polar ice and mountain glaciations, at intervals of approximately 2,000 to 3,000 years, in what is described as a "neo-glacial cycle". The "Little Ice Age", a period of temperatures 1 or



Above: Comparison of world surface features 18,000 years ago and today. Right: One of the glaciers around today, the Yentna glacier in South-Central Alaska.





Summer temperatures have varied from cool to warm over the past 500,000 years. The cycle repeats itself about every 21,000 years.

2° C lower than today and stormy conditions in the North Atlantic, lasting from about 1550 to 1850 A.D., was a member of the neo-glacial cycle.

Since the time of the Little Ice Age, the world has generally warmed about 1° C, but the rate of warming has been irregular and it is not certain whether the Little Ice Age has yet run its full course. This warning was especially pronounced during the first half of the 20th century, with temperatures rising most rapidly (several degrees (C) in 50 years) in the Atlantic sector of the Arctic. Meteorological data provide evidence that the wind belts and storm tracks of the northern hemisphere contracted somewhat towards the Arctic at that time, akin to the poleward shift of the climate belts from winter to summer. Events in the southern hemisphere are less clearly documented.

The climate trends characteristic of the first half of the 20th century appear, generally speaking, to have reversed direction since then, at least in the northern hemisphere. Temperatures have fallen especially in the Arctic and the Atlantic Sub-Arctic (by several degrees (C) in some areas) where the extent of sea ice has again been increasing. The atmospheric circulation of the northern hemisphere appears to have reverted to a pattern resembling that of the latter 19th century, with a tendency towards greater variability of weather conditions in many areas. These changes may have begun to falter, if not actually to reverse yet again, in the last few years.

Recent years also witnessed severe drought, as in the Sahelian zone of Africa, shifts in the monsoon belt of the tropics, and other extreme events elsewhere in the world. To what extent such developments are related to one another, as manifestation of a globally coherent and systematic fluctuation of climate, is not clear. In any case they illustrate the sometimes considerable variability that is characteristic of climate on the time scales of months, years, and decades.

Physical causes of climate fluctuations

Present understanding of the causes of climate fluctuations is rudimentary. A great many physical mechanisms have been proposed. The difficulty has been to verify which of these mechanisms are the valid ones, and to assess to what extent each contributes to the totality of the observed fluctuations. The development of sufficiently realistic numerical models of the overall climate system, not yet achieved, is considered a necessary (though not a necessarily sufficient) strategem for reliable assessment of the causes of climatic fluctuations. It has to be recognized that the relative importance of these causes differ with the time scale being considered.

The climate system refers, collectively, to the atmosphere, the oceans, the snow and ice masses, the land surfaces, and the vegetation, whose many complex physical and chemical linkages play major roles in establishing the pattern of global climate.

Climatic fluctuations and variability may arise in part from sources within the climate system. Many potential mechanisms exist to produce internal variability of the system, on a wide range of time scales. These follow directly from the highly non-linear interactions (so called feedbacks) occurring between the different parts of the climatic system, together with the widely disparate reaction times of the different parts.

Climatic fluctuations may also arise in part from influences originating outside the climatic system. Well-known examples are possible variations of the radiant energy output of the sun (the actual extent of such variations is unclear), variations of the quantity of particles in the upper atmosphere originating from volcanic eruptions, and the accumulation of carbon dioxide in the atmosphere from fossil fuel combustion.

One illustration of the kind of interaction that probably contributes significant variability to the climatic system is that between snow cover, reflection of solar radiation, and air temperature. If a small decrease of temperature occurs which favours the development of a snow cover, the greater reflection of solar radiation from the snow will locally reduce solar heating of the Earth's surface and atmosphere. The reduced heating will then lower air temperature still further, preserving the snow and perhaps favouring additional snowfall over a wider area. A similar, but opposite, chain of events is involved if the starting point is a small increase of temperature. The end effect is both to amplify small climatic disturbances, and to prolong them.

No one mechanism of climatic fluctuation, however, can be realistically considered in isolation of other mechanisms that may exist. All must be considered together in a suitably general physical framework before it is possible to claim very meaningful understanding of climatic fluctuations. We do not yet have an adequate conception of all the mechanisms that may be involved, and we are not yet certain what would constitute a suitably general physical framework to encompass those mechanisms. These shortcomings indicate something of the problem faced in developing numerical models of the climatic system that have any reasonable expectation of reproducing the essential behaviour of the system.

Effects of man's activities on climate

Many scientists have suggested that man's activities may be responsible in various ways for changes of climate occurring now or in the future. On a local scale, as in urban areas, human effects on climate are a demonstrable reality. The relative warmth of large cities, known as the "urban heat island effect", is a well documented example of such local effects. On larger geographical scales, human effects are generally thought to be small, at the present time, in relation to the magnitude of natural climate variability. They are, nevertheless, to be recognized as of potentially great importance in alternating the natural evolution of large-scale climate over the next century or two.

A build-up of carbon dioxide in the global atmosphere, already clearly evident in observations around the world and which thus far amounts to at least ten per cent since the latter part of the 19th century, is reliably traceable to the combustion of fossil fuels. If most known reserves of such fuels are consumed in the next century or two, as now anticipated they may be, atmospheric carbon dioxide concertrations would be likely to increase several fold above present levels. The best information now available indicates that such a large carbon dioxide increase would result in a very significant warming of global climate, by several degrees (C) and that, because of the slow pace of removal mechanisms, this warming would persist for many centuries after the fossil fuel reserves have been very depleted. Further climatic effects, as yet difficult to foresee in specific detail, would also be likely.

The heat released to the environment by the generation and use of energy, whether fossil or nuclear, may also produce a significant warming, although this would be unlikely to be a cause for concern unless or until the societal demand for energy increases by a factor of ten or more, which could take place within the next century.

Further effects of man, for example those attributable to increasing pollution of the atmosphere by particulate materials, and alterations of the upper atmosphere through the effect of contamination by nitrogen oxides or chlorine compounds (such as chlorofluoromethanes), are yet of relatively uncertain importance to future climate. These matters deserve further investigation.

Other than on local scale, there is no unequivocal observational evidence that human influences of any kind have yet been the origin of unusual climatic behaviour anywhere in the world. This is not altogether surprising in view of the high natural variability of climate which makes detection of human impacts difficult. Nevertheless there is no justification on these grounds for complacency about the potentially serious effects that man's activities could have in the future.

Assessment of climatic developments in the next 100-200 years

In recent years, rapid developments toward a quantitative theory of climate have been realized through a combination of mathematical models of climate and observational studies of the physical processes that are believed to govern the overall behaviour of the atmosphere and oceans. These developments have led to fairly realistic model simulations of the atmosphere part of the climate system. However, they are recognized as being not yet adequate to investigate many important aspects of climatic variability, including the predictability of climate.

At this time, very little can be said about the ultimate limits of predictability of future states of the climatic systems. The possibility should be recognized that future developments of global climate may not be inherently predictable in sufficient detail, and over sufficiently extended ranges of time, to satisfy many of the needs of society for such information.

To the extent that climatic variability arises from mechanisms internal to the climatic system, the prediction of climatic variations is thought to depend upon the development of mathematical models of the climatic system that extend well beyond the present generation of climate models in geophysical scope and complexity. In no other manner does it appear likely that all the physical factors that together account for climatic variability can be brought together into a suitably general physical framework for purposes of climatic prediction.

To the further extent that climatic variability arises from changes that affect the climatic system from the outside, such as possible changes of solar radiation or human influences, the successful prediction of climate will also depend upon the predictability of the changes themselves.

Until further progress in climate research is able to establish the possibilities for climate prediction through physical reasoning, the assessment of future climate developments must be based upon statistical inferences having a relatively low level of information content. Such inferences are confined largely to assessments of the probability of various alternative developments which are suggested as possible either by past experience or by insights into future impacts of man's activities.

Knowledge of past climates suggests that the interglacial warmth of the past 8,000 years or so will eventually change to a colder, more glacial regime. The onset of that change may be a number of millennia or centuries away; conceivably it may already have begun. It seems likely that this transition will be sufficiently gradual so that in the next 100 to 200 years it would be almost imperceptible amid the ubiquitous variability of climate. There is however a very small yet finite probability that a much more rapid cooling of climate will occur in the same time period.

It must be recognized that such assessments would be invalid if, as now considered probable, the addition of carbon dioxide to the atmosphere, and other effects of human activities during the next 200 years, contribute to a general warming of global climate. This would probably result in a considerable reduction of the floating sea-ice in the Arctic regions. It is pertinent to note that when the sea-ice retreated during the so called climatic optimum, about 5,000 years ago, there were important shifts of climatic belts in lower latitudes. The general warming could conceivably culminate in the total disappearance of the Arctic sea-ice, an extreme situation believed to be without precedent in the past million years.

Effects of climate variability on the environment and man's activities

The biosphere and many human activities such as land use, agriculture, energy consumption, etc., are sensitive to weather and climate, the degree of sensitivity varying in different climatic zones of the globe. This sensitivity is growing in importance in many parts of the world as population pressure and demands are rapidly increasing.

Present ecosystems and many of the complex, interdependent systems developed by modern man are fairly well adapted to the climatic conditions that prevailed in the past, and are therefore quite sensitive to changes in climate. For example, the present systems used for food and fibre production are predicated on average climatic conditions and even a modest change in climate would have serious social and economic repercussions. A cooling of the Earth by as little as 1°C could result in a shorter growing season and a shift of the boundary of major wheat production regions, and decrease fish catch and timber production in middle and higher latitudes; in lower latitudes, however, such a change could be beneficial. Similarly, warmer global temperature could result in improved production in some latitudes and reduced yield in others.

Various studies have also shown that even in the absence of a climatic shift, these systems could be significantly affected by the occurrence of climatic variability greater than experienced in the past. Therefore in planning future weather-sensitive activities due allowance should be made for a reasonable range of climatic variability.

Information about past climate must therefore be used with caution and a methodology developed for the appropriate use of such information in deducing possible changes in climate variability.

As long as it is not possible to predict climate variability and trends, the methodology to be applied in planning of human activities such as land-use, agriculture and energy demands must be developed on the basis of past climate and reasonable assumptions. The first step in the development of the planning methodology would be to establish the sensitivity of a certain activity to stable weather and climate conditions on the basis of suitable models developed from past climate, data and including the various parameters involved. The next step would include the further application of the models to draw conclusions about the impact of climate variability. Application of the models will have to be carried out for different time scales of anticipated variations. For instance, it would seem reasonable to determine the impact on food production in different parts of the world on the basis of reasonable assumptions in seasonal and inter-annual variability of the most important climatic parameters. On a long-term basis a similar determination should be attempted for reasonable trends in important parameters over periods of one to three decades.

It is important to emphasize that information regarding the impact of climate variability on human activities is essential for application in the decision making process. The methodology to be developed for this purpose therefore should aim at making it possible to present ultimately the impact of climate variability in terms of production figures, costs or other similar measures which can be used directly by the economists, planners and politicians.

Future action

On the base of existing knowledge, *monitoring* of the natural and anthropogenic processes causing climatic variability is of vital importance, especially for the early assessment of possible risks. Such monitoring is now in preparation within the GEMS Global Environmental Monitoring System Programme of the United Nations. Among the parameters to be monitored, the following should be mentioned:

- Carbon dioxide;
- Nature and transmissivity of aerosol particles of volcanic origin in the stratosphere especially in polar regions;
- Amount of trace gases (e.g. nitrogen oxide, sulphur dioxide, chlorofluorocarbons) and low-tropospheric aerosols;
- Extent and albedo of snow and ice at the surface;
- Changes in surface albedo over both land and sea especially with

respect to land use patterns, vegetation changes, pollution and biological productivity of the oceans.

Special stress must be given to the need to monitor possible small changes of the extraterrestrial solar rediation, mainly in the visible and near ultraviolet range.

Research is specially needed for a better understanding of the interactive processes within the climatic system (such as the interactions between radiation, clouds and aerosols; between sea-ice, ocean and atmosphere; between sea-surface temperature anomalies, fluxes of latent and sensible heat and atmospheric and oceanic currents and the exchange of carbon dioxide between the atmosphere, oceans and biosphere) for the development of suitable parameterization techniques in numerical models.

The development of explicit three-dimensional, time-dependent coupled atmosphere—ocean—ice models, as the basis for climatic prediction, should be given especially high priority. Simpler models with parameterized dynamics in the atmosphere and/or the oceans are likewise important, especially for testing the possible impact of man-made processes.

Research is also needed for a better adaptation of man's activities to climatic variability and change. This is especially true regarding the need for increasing agricultural production and regarding the impact of energy use on local, regional and global climatic conditions.

As a basis for testing the degree of reality of numerical climate models, as well as for statistical-synoptic research, more quantifiable "proxy" data capable of illuminating the history of climate before the beginning of instrumental observations are needed. Among those are tree-ring data, pollen data from peat or lake-bottom cores, annually layered ice and sediment cores, weather diaries, cereal prices, etc. Existing instrumental time-series should be evaluated, checked for homogeneity and collected in data banks; high priority should be given to observations made before the founding of weather services. Such data should include not only temperatures, but also wind direction frequencies and rainfall amount and frequency, (preferably averaged for climatically homogeneous areas of the order of 10^4 to 10^5 km^2). Priority should also be given to the collection of time series of marine meteorological and oceanographic data in areas not exceeding 10^5 km^2, together with sea-ice data, and the dates of freezing and thawing of rivers and lakes.

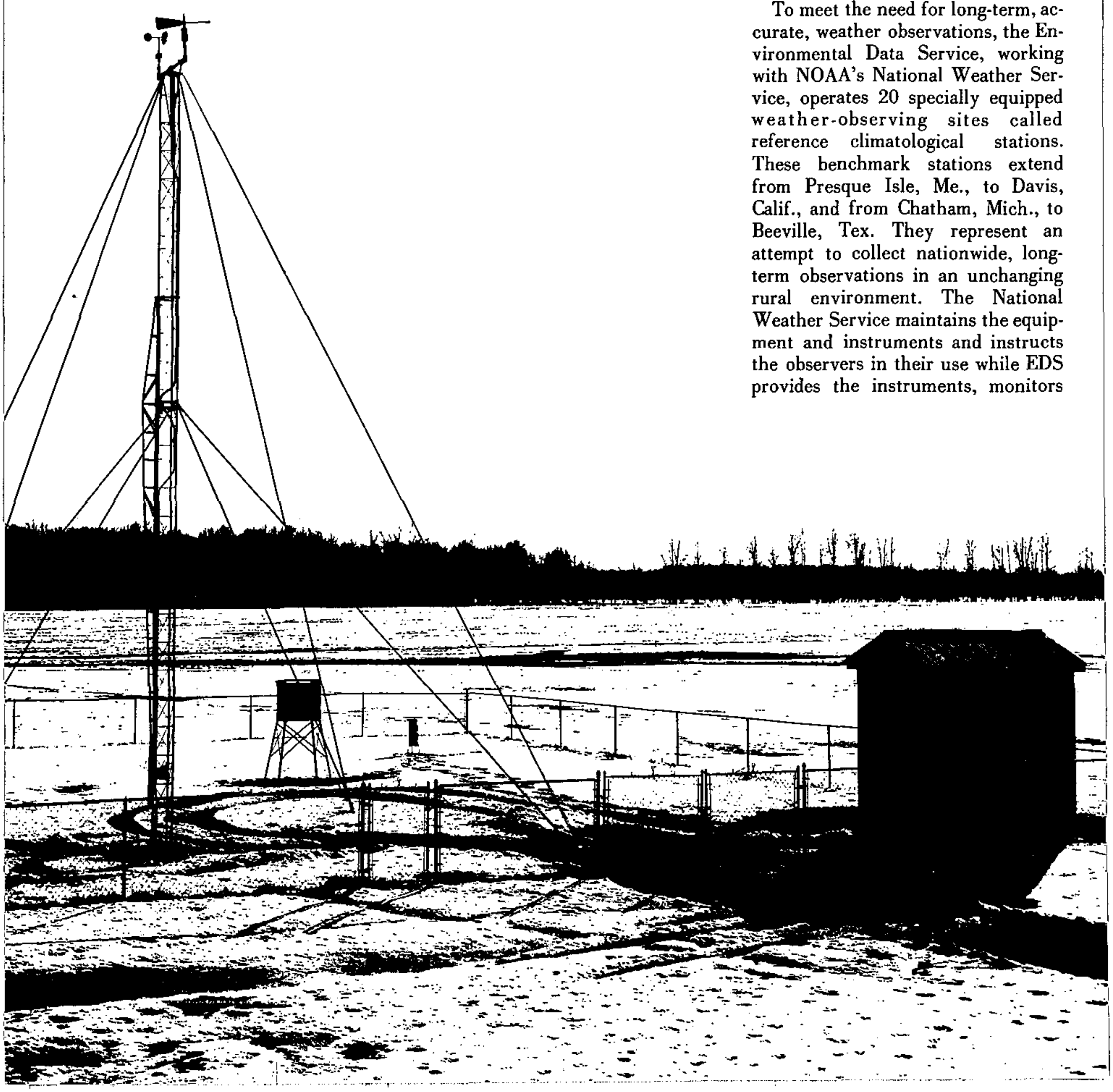
More research data such as that from ocean sediment cores (above) is needed to develop a history of past climate.

Monitoring Climatic Change

By Douglas LeComte

Scientists may disagree about whether the world's climate is getting warmer or colder, but they do agree that there is a need for accurate baseline observational data to monitor climatic change.

To meet the need for long-term, accurate, weather observations, the Environmental Data Service, working with NOAA's National Weather Service, operates 20 specially equipped weather-observing sites called reference climatological stations. These benchmark stations extend from Presque Isle, Me., to Davis, Calif., and from Chatham, Mich., to Beeville, Tex. They represent an attempt to collect nationwide, long-term observations in an unchanging rural environment. The National Weather Service maintains the equipment and instruments and instructs the observers in their use while EDS provides the instruments, monitors

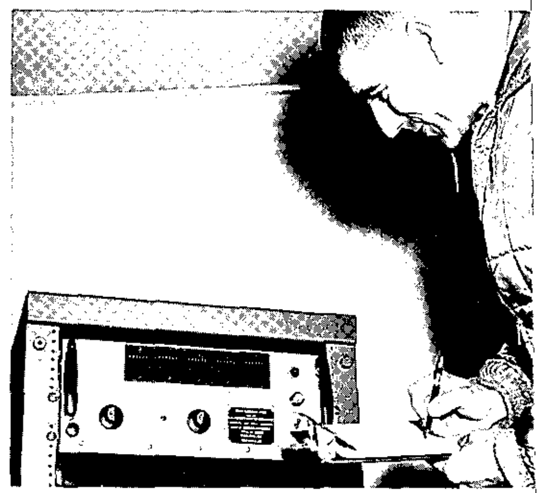


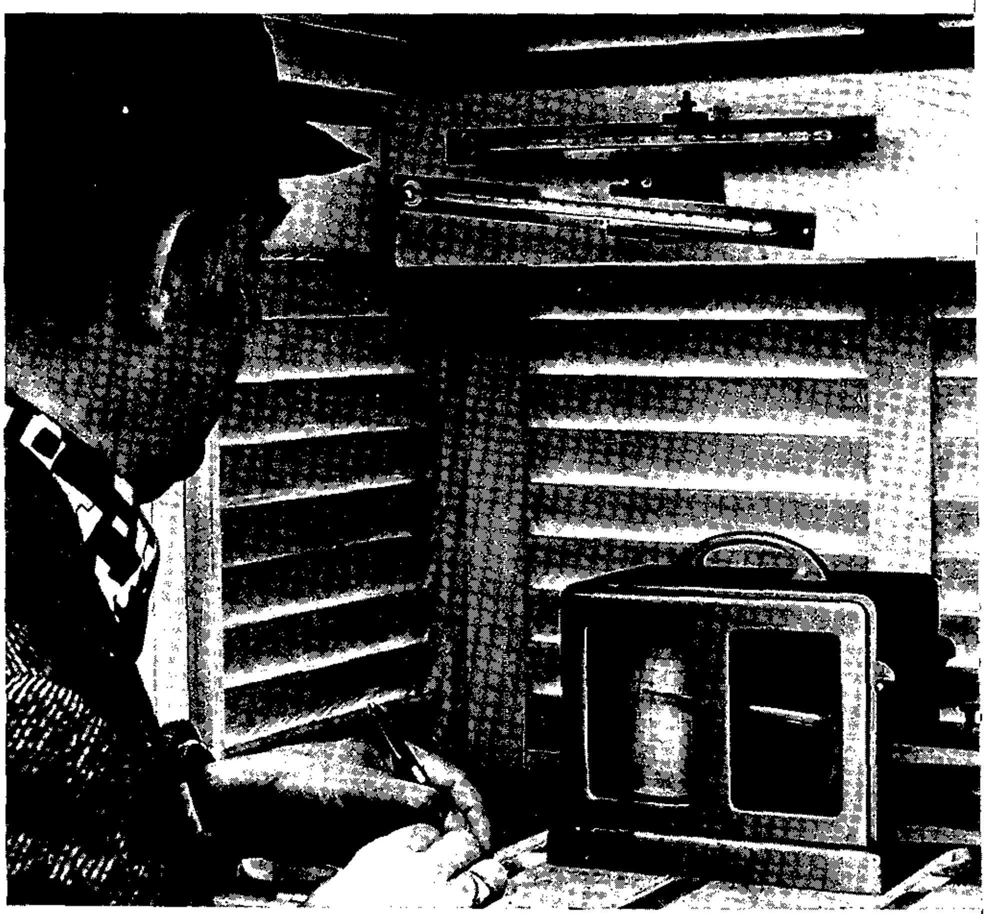
the program, and publishes the collected data.

Why is such a program needed? Because, although the big city weather station may have an impressive number of years of observation records, the ability of these records to indicate climatic fluctuations is seriously impaired by changes in the local environment. These changes may be due to relocation of the instruments for new construction, tree growth near the station, or even inadvertent man-made weather changes caused by urbanization and industrialization. Such local effects bias observations made to monitor climate. Moving the observing instruments from a courthouse lawn to a city building roof, then to an airport terminal roof, and finally to a runway location — which could be the life history of many city weather station instruments — will not provide the homogeneous data needed to monitor climate.

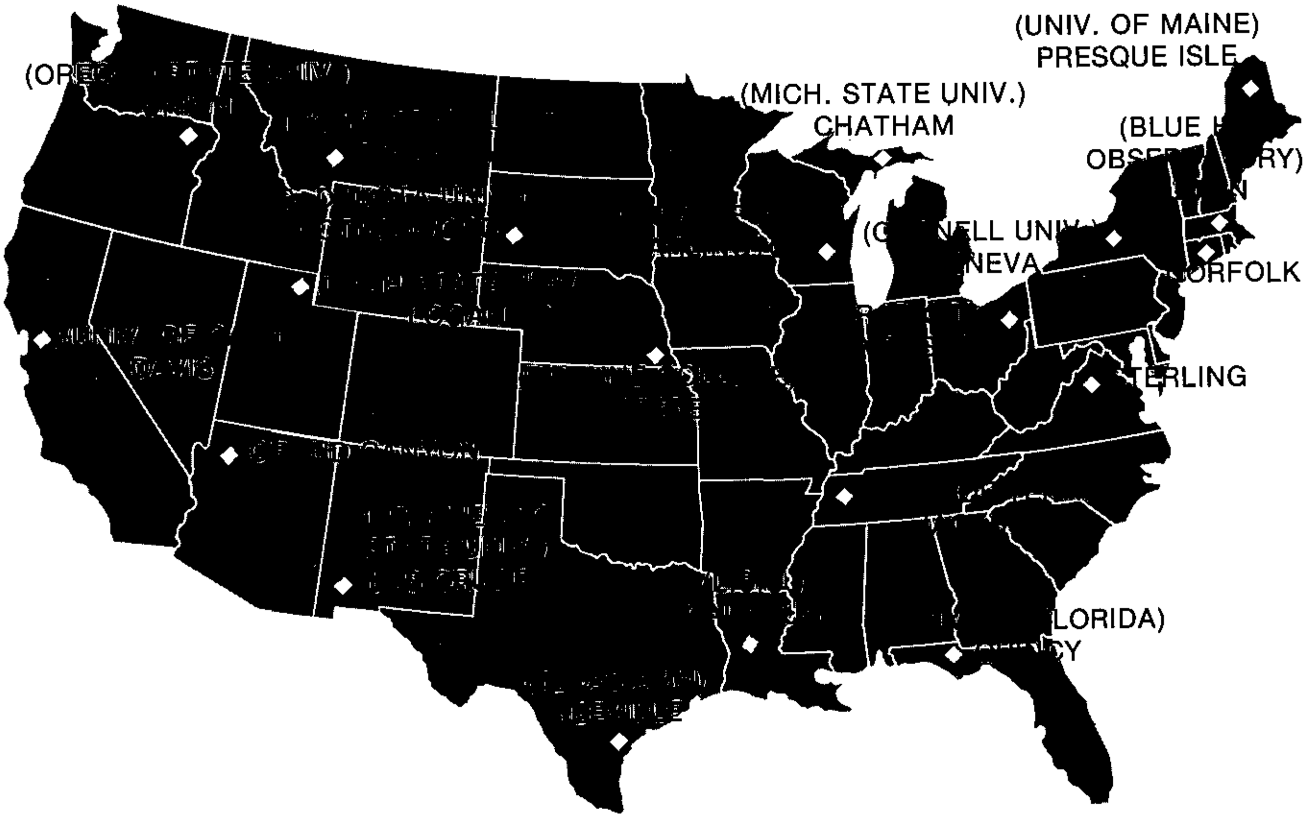
To avoid these problems, EDS' reference climatological stations are located only in areas where no changes in the surroundings are foreseen. Furthermore, since many years of continuous and accurate observations are essential to this program, the stations must be located where reliable people will always be available to take such observations.

Because EDS has found that these requirements are usually best met at the agricultural experiment stations run by state universities, this is where most of the benchmark stations are located. The majority of university weather stations are located in fields away from buildings or trees, so instru-





Opposite: Reference climatological station. Top left: Testing prototype annemometer. Top right: Wind accumulator designed for the reference climatological stations. Right: Thermometers and hygrothermograph.



Reference climatological station network.

ment exposure is good. Since the surrounding land is used for crops or pasture, use of the land is not likely to change significantly. Also, the weather observations at these stations go back many years; some universities have weather records dating back to the 19th Century.

The weather observations are likely to continue as long as the university exists, so future prospects for weather records are reasonably secure. Another advantage is that there are usually people available to take the observations. Observers include students, professors, farmers, and secretaries.

The wind-measuring instrumentation at the reference stations has a conventional, rotating, 3-cup, anemometer and a windvane, but the recording unit was designed specially for this program. The instrument, a wind accumulator, measures mileage instead of speed — like an automobile equipped with an odometer and no speedometer. Unlike a standard odometer, however, the movement of the wind spinning the 3-cup anemometer is broken down into directional components.

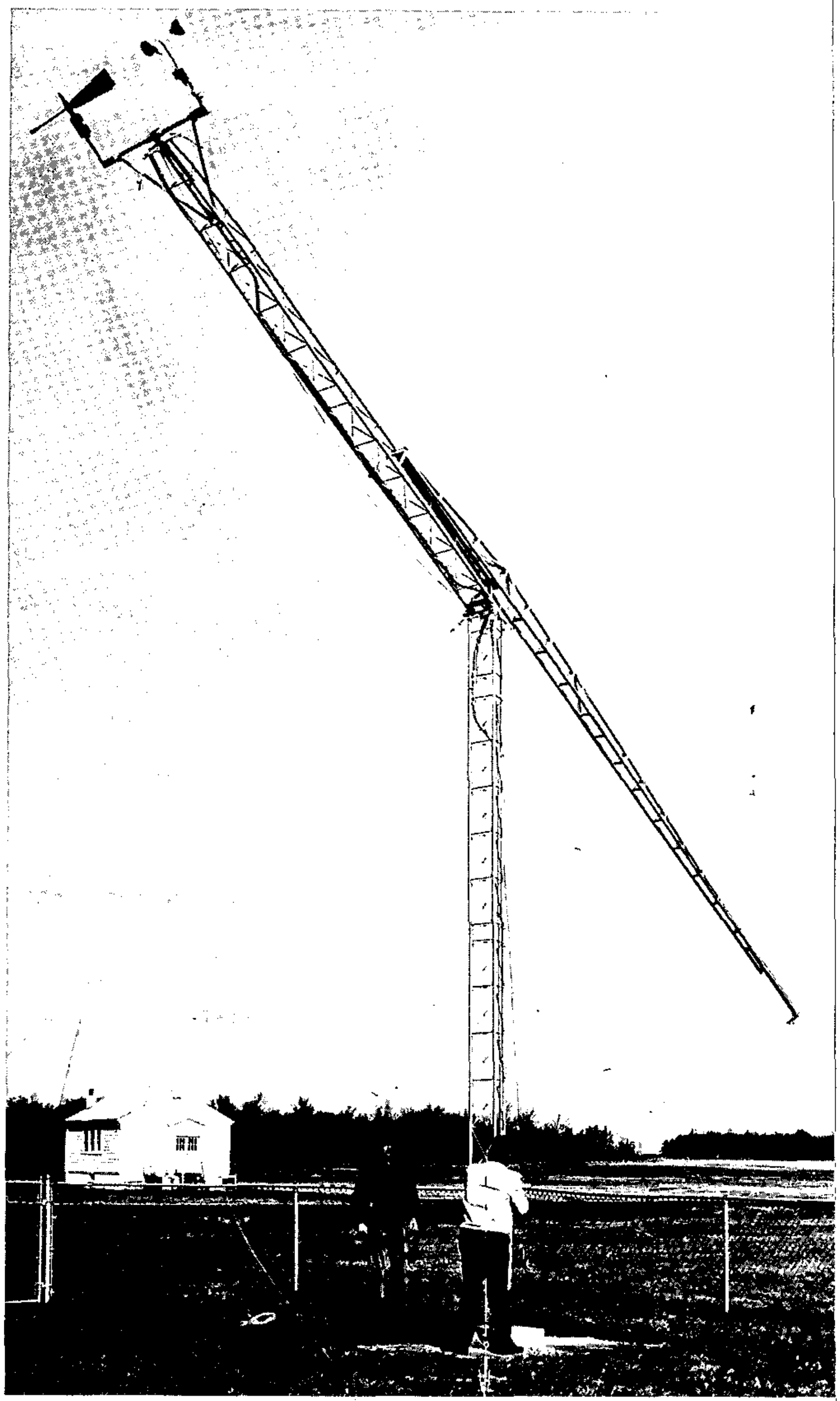
At observation time the observer checks four readout counters and writes down the west, east, south, and north wind components measured in fiftieths of a nautical mile. A fifth counter displays the total wind passage in fifths of a nautical mile. With these data, the contribution each directional component makes to the total wind can be computed, and average wind speed for the day, month — or any other desired period — can be derived.

The system's anemometer and windvane are perched upon a 10-meter tilting tower which "bends at the waist" for easy maintenance. The instruments are usually connected via underground cable to a recording unit in a nearby shed. A battery backup power supply is installed so that the equipment will continue operating if the electricity goes out. In spite of these precautions, Mother Nature still creates problems. Wind accumulators in Bozeman, Montana, for instance, have twice been destroyed by lightning strikes. And each winter, many days of data are lost at the Norfolk, Conn., station, where ice storms stop the anemometer cups from rotating.

Temperatures and rainfall observations are also made with conventional instruments. Located in the thermometer shelter are a liquid-in-glass, maximum-minimum thermometer as well as a hygrothermograph. For measuring rainfall, a standard 8-inch rain gage and a recording, weighing rain gage are used. Many stations have additional equipment such as evaporation pans and soil temperature thermometers, but for now the basic elements recorded at reference stations are wind, air temperature, and rainfall.

The emphasis is on simple and accurate equipment. J. Murray Mitchell, Jr., EDS's Senior Research Climatiologist and the man responsible for the observational procedures of the network, is concerned with the problem of obtaining adequate instrumentation. "There seems to be a preoccupation with costly, complicated, electronic equipment with elaborate, minute-by-minute, computation capabilities," comments Mitchell. "As a result, there is an expertise gap that we have had to bridge, starting almost from scratch, to design simple equipment with a very good performance as regards mean time between failures."

Unfortunately, the design of such equipment is difficult. Durability problems encountered with the wind accumulator attest to this. Also, there is no way to guarantee unchanging surroundings for the weather instruments. Land uses do change and sometimes the instruments must be moved. Despite these problems, the program is a step in the right direction towards the operation of an observation network that can help scientists monitor climatic change and that could even help ultimately to forecast such change.



The head of the tilting tower comes down for maintenance of anemometer and wind vane.

The Weather on Inauguration Day*

By Patrick Hughes

It has been reported that Harry Truman, upon receiving the official invitation to his second inauguration, wrote across it in reply, "Weather permitting, I hope to be present—HST." If so, Truman, a student both of humor and history, paid Presidential tribute to one of the most durable of American traditions—bad weather on Inauguration Day. It is a tradition that deserves respect.

The first American President to die in office was a victim of Inauguration Day weather, and his own contempt for its consequences.

At 68, William Henry Harrison was the oldest man ever to become President, and the last President born (1773) before the American Revolution. His Inauguration Day in 1841 was cold, blustery, and overcast—so chilling that building owners along Pennsylvania Avenue reportedly charged $500 for window space to watch the parade (for $1 you could take a quick look.)

Ignoring the biting wind, the old soldier refused the offer of a closed carriage. Instead, without hat or overcoat, he rode a magnificent white charger in the 2-hour procession from the White House to the Capitol, where his inaugural address took an additional 1 hour and 40 minutes. Later, he returned to the White House on horseback in another slow-moving parade. That night, after attending three inaugural balls, again lightly dressed, the hero of Tippecanoe returned exhausted to the Executive Mansion, where he suffered a "chill." The weather continued raw and bitter in the weeks that followed and Harrison persisted in ignoring it, wearing neither hat nor coat, while the chill became a lingering cold. One morning he went out in a downpour and got soaked to the skin, then returned to the drafty White House where he worked all day in his wet clothes. His cold deepened into pneumonia, and Harrison slipped into a coma. He died on April 4, 1841, a victim of his militant disdain for the elements.

A dripping, smiling President Roosevelt and First Lady drive back to the White House in an open car on a very wet Inauguration Day. Photo: Washington Star-News.

Abraham Lincoln may not have developed pneumonia from the weather that almost wrecked his second inauguration in 1865, but a lot of other people probably did. It had been raining in the East for 2 days. Washington was so deep in yellow mud that a story was going around that Army engineers had tried to lay a pontoon bridge between the Capitol and the White House, but had been forced to abandon the project because the "bottom" was too soft to hold the anchors of the workboats.

Despite the downpour, a crowd of drenched men, women and children waited patiently in front of the Capitol and cheered when Lincoln came out, just moments after the rain finally ended. Dark clouds were still scudding across the sky as Lincoln began his inaugural address, but soon sunlight broke through and lit the face of the Capitol behind him.

"The worst weather on the face of the earth," said one eyewitness Congressman of the snowstorm that nearly buried the inauguration of William Howard Taft in 1909.

Heavy snow began the day before and continued through the night, driven by a stinging, whistling wind. Branches and telegraph and telephone lines snapped under the weight of the wet, clinging snow, while the wind toppled trees and poles. Pedestrians were quickly driven indoors and carriages and streetcars stalled as a thick white mantle submerged the deserted streets of the Nation's Capitol.

Six thousands shovelers struggled vainly through the night and forenoon to clear the areas in front of the White House and Capitol, and the route between. As noon approached, the storm still howled on unabated. People stood huddled in doorways or peered out at the arctic landscape through snow-streaked windows. Postponing his decision until the last moment, Taft finally decided to take his oath of office in the Senate Chamber, rather than on the outdoor platform erected in front of the Capitol. Ironically, the snow stopped just a few minutes later and despite the icy, piercing wind, people began lining Pennsylvania Avenue for the inaugural parade.

Some 20,000 marchers sloshed past the snow-covered stands flanking the parade route. The wind howled through their ranks, playing particular havoc with the high-hatted representatives of various political clubs, while decorations and bunting whipped about in wind-torn shreds or sagged sadly under heavy burdens of snow. All in all, it was the worst Inauguration Day weather in the nation's history. Quipped President Taft to a reporter friend: "I always knew it would be a cold day when I got to be President."

A startlingly similar storm paralyzed the Capital City on the eve of John Fitzgerald Kennedy's inauguration in 1961. It left 8 inches of snow and caused the most crippling traffic jam in the city's history. Hundreds of motorists were marooned; thousands of automobiles, abandoned. Because of the storm, the President-elect had to cancel his dinner plans and, in struggling to keep other commitments, is reported to have had only 4 hours' sleep.

Heavy snow began falling in the afternoon, and by evening streets and roads were impassable. Thousands of motorists were stranded in the storm. Police switchboards were swamped with calls from people trying to find wives, husbands, and children who had not come home. Many of the missing were still sitting in their stalled cars trying to keep warm, where they would remain for hours before help reached them. Others simply abandoned their cars wherever they stalled, and set off on foot through the blinding storm.

The snow ended by sunrise, but it was bitterly cold, and a biting wind was to blow all day. Snowplows and sanders had worked throughout the

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**This is the sixth and final article in a Bicentennial series on the American weather experience. The series has been collected into a book,* American Weather Stories, *described on page 30.*

night, and the inaugural parade route was in reasonably good shape. By noon, when the ceremonies began, the temperature was a chill 22 degrees, and a biting 19 mile-per-hour northwest wind cut through the thickest clothing.

Some 20,000 shivering spectators sat huddled between snowbanks at the Capitol Plaza to witness the swearing-in. Later, despite the icy blasts, an estimated 1 million people watched the inaugural parade, which included 30,000 marchers, a PT boat, and the 8 surviving members of the crew Kennedy had commanded in World War II. As twilight came, the cold deepened and people began drifting away. By the time the last marcher had passed, the President, his brother Robert, and Robert's wife, Ethel, were almost alone on the reviewing stand.

Obviously, there is more than a little historical support for Truman's respect for Inauguration Day weather. Of the 47 quadrennial ceremonies held to date, 19 were plagued by substantial rain or snow, bitter cold, or chilling winds. Despite this rather dismal record, however, the odds are high that the weather for future inaugurations will be more pleasant.

The reason? The 20th Amendment which, beginning in 1937, changed the date for Presidential inaugurations from March 4 to January 20. Weatherwise, the change means considerably less chance of rain or snow, though it favors lower temperatures. Bearing this out, of the 9 inaugurations held since 1937, only one—that of John F. Kennedy—was marred by significant precipitation. On the other hand, one out of every three inaugurations held on March 4 was notable for its wet and miserable weather.

Weatherwise, the change to January 20 seems to have been a fortunate one, and more than 100 years of weather records for that date are equally encouraging.

Even though the coldest time of the year in Washington comes during late January and early February, temperatures on January 20 are usually not severe. The normal high temperature for the day is 44 degrees, the low, 29 degrees. The highest temperature on record is 71 degrees, in 1951; the lowest, 8 degrees, in 1940. If it does rain or snow in Washington, D.C., on January 20, the odds are that it will do little more than wet the pavement.

Average weather conditions for noon, when the President-elected is usually sworn in, would be a temperature of about 37 degrees, a wind of 10 miles-per-hour or less, and partly cloudy skies. Chances of precipitation during the swearing-in ceremony itself are about 1 in 6 and of snow, about 1 in 13.

Of course, it will rain or snow on occasion, and January temperatures and winds will often make standing outdoors for several hours a chilling experience.

Whatever the odds, history seems to suggest that the weather often ignores climatic expectations on Inauguration Day. This impression is reinforced when you consider that the weather was beautiful for the first seven inaugurations—all held indoors (although George Washington took his first oath of office on the balcony of Federal Hall in New York City)—but turned sour soon after the ceremonies were moved outdoors.

Tradition has it that the First Congress chose March 4 as Inauguration Day out of respect for the Sabbath, because it is the date that quadrennially falls least frequently on Sunday.

All but the first three inaugurations took place in Washington. The first was held in New York City in 1789, the second and third in Philadelphia, in 1793 and 1797, respectively, before the Nation's Capital was moved to the new Federal City in 1800. The first outdoor inauguration was James Monroe's held in Washington on March 4, 1817. Almost as if to lull participants into a false sense of security, the weather was warm and sunny, with not a cloud in the sky.

Bad weather struck the very next inauguration, Monroe's second, in 1821. For the first time, Inauguration Day fell on a Sunday and the ceremonies were postponed until Monday the 5th. According to the *Daily National Intelligencer,* a "good deal" of rain and snow fell during the night. John Quincy Adams, a student of weather (as were George Washington, Benjamin Franklin, and Thomas Jefferson before him), recorded rain for Sunday and snow for Monday.

Whatever the elemental sequence, precipitation continued through Inauguration Day, forcing Monroe to change his plans for an outdoor ceremony, and to take his oath of office in the House Chamber, where an "immense crowd" of subdued spectators in soggy clothing thronged the Galley to witness the swearing-in.

Although the amount of precipitation that fell is not recorded, the noon temperature is—a chilly 28 degrees. The observation was taken by John Quincy Adams, who was to suceed Monroe as President. On Adams' own Inauguration Day, in 1825, it rained—the weather observation again being recorded by Adams. Once again, the ceremonies had to be held indoors.

In 1845, just 4 years after President Harrison's fatal exposure to the elements, James Knox Polk took his oath of office in the pouring rain. A sea of umbrellas was all that could be seen from the temporary platform where the President-elect insisted on being sworn in. On the Mall below him, thousands of spectators stood ankle-deep in mud as the roar of the rain on their umbrellas drowned out Polk's inaugural address.

The parade back to the White House was a shambles. Floats had been reduced to soppy paper-and-cloth monstrosities and, as Polk's carriage moved up Pennsylvania Avenue in the downpour, the President saw mostly the backs of spectators splashing to shelter.

Franklin Pierce was inaugurated President of the United States on March 4, 1853; it snowed most of the day. Heavy snow greeted the

Clearing some of the nearly 10 inches of snow off Pennsylvania Avenue in front of the White House before Taft's inauguration.

President-elect when he awoke in the morning and continued until 11:30 a.m., when it seemed the sun might come out. President Pierce had just finished his oath of office and was beginning his inaugural speech when the snow began again, scattering many of the onlookers. Cancelling plans for a parade back to the White House, Pierce dropped ex-President Millard Fillmore and his wife off at the Willard Hotel, then continued on to the Executive Mansion.

Abigail Fillmore, wife of the outgoing President, had caught a cold as she sat on the exposed platform during the swearing-in ceremony, a cold that soon deepened into pneumonia. She died at the end of the month.

Ulysses S. Grant was the victim of a meteorological doubleheader. It rained on the morning of his first inauguration in 1869, and 4 years later he took office on the coldest Inauguration Day on record.

When cannon fire announced the dawn on March 4, 1873, the temperature was just 4 degrees above zero; by noon, it had risen only to 16 degrees. Throughout the day, icy winds gusting up to 40 miles an hour buffeted the city, knifing through the heaviest clothing and chilling to the bone all who ventured outdoors.

Despite the wind and cold, large crowds filled the streets. Heavy clothing and earmuffs were the uniform of the day, except for West Point cadets and Annapolis midshipmen, who were to parade without overcoats. When president Grant delivered his inaugural address, the wind made his words inaudible, even to those on the platform with him. Meanwhile, a number of lightly dressed cadets and midshipmen, who had been standing on the windswept Mall for more than an hour and a half, lost consciousness and collapsed; several were reported "frozen."

It was almost as cold at the inaugural ball that night, held in a $40,000 temporary building erected on Judiciary Square. The contractor had neglected to install heating equipment. It was so cold that the guests danced in their overcoats and heavy wraps, and when the President left just after midnight, so did everyone else.

James Garfield's Inauguration Day took place on March 4, 1881. It snowed all the night before, and by midnight deep drifts were everywhere. The next morning, streets were impassable, except for Pennsylvania Avenue between the Capitol and White House. where workmen had spent the night shoveling snow from the street onto the sidewalk as fast as it fell. The snow finally ended about midmorning. Most of the decorations were ruined, and snow-covered bleacher seats originally priced at $5 now sold for 50 cents. There were few takers. As Garfield delivered his inaugural address, a chill wind whistled through still-naked tree limbs and the temperature hovered just 1 degree above freezing.

In 1889, Benjamin Harrison, despite his grandfather's fatal exposure 48 years earlier, insisted on taking his oath of office and delivering his inaugural address in the pouring rain, then stood outside reviewing the parade until dark. (The evening before Harrison had taken his usual long daily walk, also in the rain.)

March 4 fell on a Monday, and it had been raining hard all weekend. When the dripping Presidential procession arrived at the East Portico of the Capitol for the ceremonies, however, some 20,000 spectators stood waiting on the Capitol Plaza, their massed umbrellas buffeted by wind and rain.

Harrison took his oath of office under an umbrella, his words drowned out by the downpour. Despite his inaudibility, the President stood in the rain and delivered a very long, rambling inaugural address. When he finished, only a few thousand spectators remained; even his wife and daughter had gone indoors.

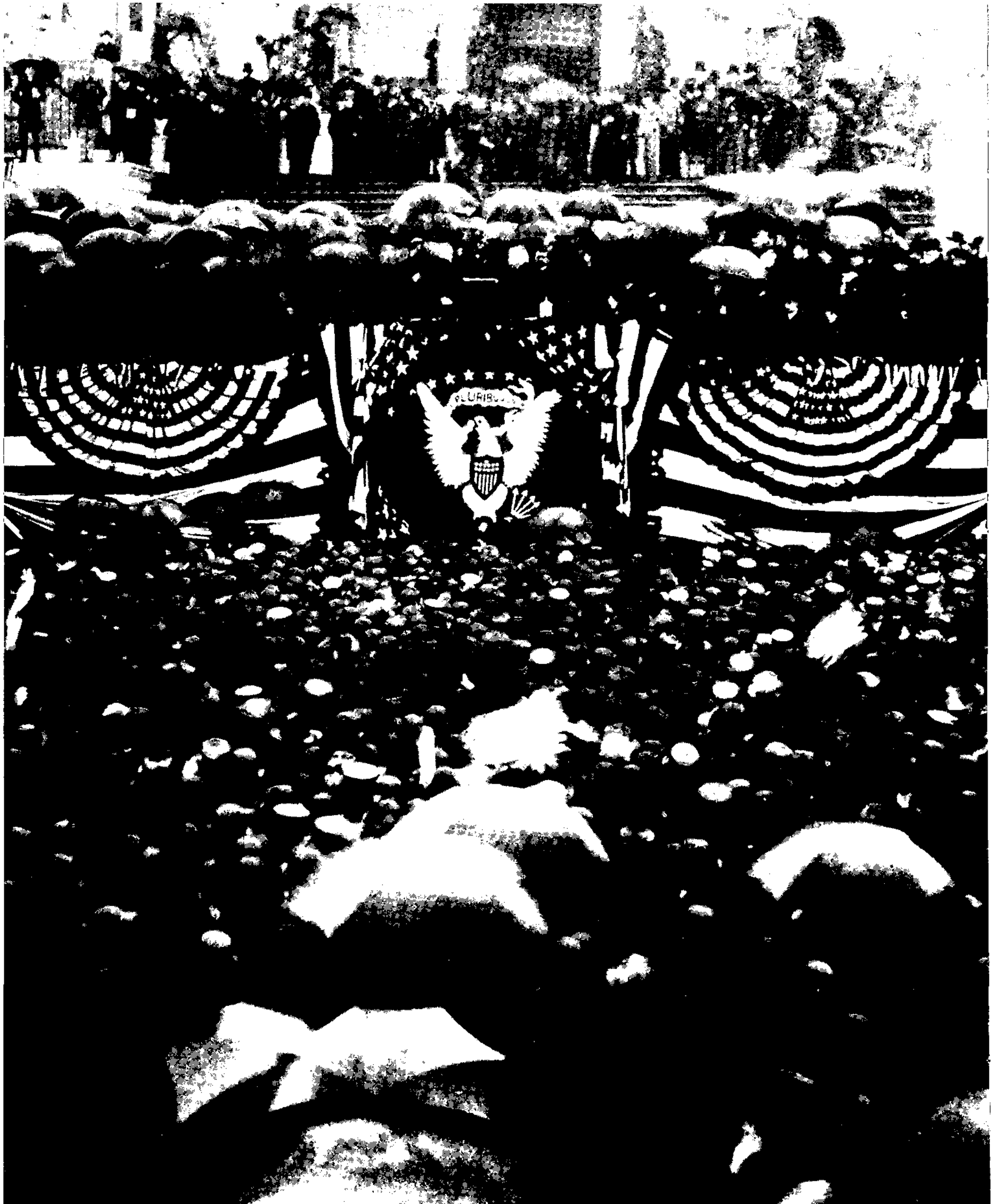
Still undaunted, Harrison went to the White House reviewing stand to watch the inaugural parade. By dark, the surrounding stands were deserted, except for a few solitary figures huddled under shiny black umbrellas. Harrison still stood there ignoring the pouring rain, as if settling a personal score with the elements. As a precaution, however, he wore a special leather shirt under his outer clothing.

Four years later, Grover Cleveland (who also preceded Harrison as President) started his second term in a snowstorm. Rain began falling the previous evening, but by early morning had changed to snow. By midmorning, when Cleveland left for the Capitol, the snow had tapered off, but a biting northwest wind was whistling through the city and the temperature was in the low 20's. Pennsylvania Avenue was almost deserted, and Cleveland's mustache reportedly glistened with tiny icicles as the President-elect rode to the Capitol for ceremonies.

Some 10,000 shivering people were huddled around the inaugural platform when the President-elect arrived; according to a contemporary account, many kept warm with "jokes and flasks." The snow stopped about one o'clock, but the wind whipped in icy blasts, cracking the robes of the Supreme Court justices like rifle reports. Cleveland clutched his high hat tightly in his left hand and began his inaugural address. The wind caught his words and carried them to the crowd. High winds continued throughout the day, and a fireworks display scheduled for the evening had to be cancelled.

Bad weather also cancelled the fireworks display planned for William McKinley's second inauguration in 1901. Rain began during the swearing-in and continued through most of the afternoon. The crowd that witnessed

Top : President Roosevelt and President-elect Taft drive to the Capitol through a howling snowstorm.
Bottom : President Taft and his wife return to the White House after his swearing-in at the Capitol. The snow had tapered off, leaving a street scene more suggestive of Moscow than Washington.



the inaugural oath was described as the smallest in many years; only a handful of people sat scattered among the 7,000 seats facing the temporary platform erected on the East Portico of the Capitol.

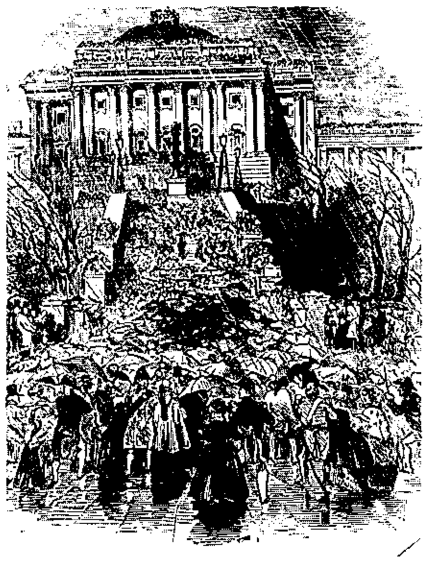
In 1929, Herbert Hoover was sworn in, delivered his inaugural address, and then marched in intermittent rain that began just before he took his oath of office and continued throughout the day. The weather did little to dampen the spirits of the crowds which jammed Pennsylvania Avenue, making it impossible for anyone to run for cover during the downpours. Most of the spectators endured the drenching good-naturedly; many, with water running down their faces and coat collars, laughed at the soaking.

Just before the swearing-in, it began to rain very hard, but with an estimated 100,000 people thronging the Capitol grounds and nearby streets, Hoover went ahead with the outdoor ceremonies. The new President was drenched by the time he completed his inauaural address, his face beaded with water and his suit wringing wet. Nevertheless, he returned to the White House and, an hour or so later, was back outdoors reviewing the parade of 20,000 as it passed in the downpour.

Thirty-two years later, on another Inauguration Day, a snowstorm prevented former President Hoover's plane from landing in Washington, and he had to miss the swearing-in of John F. Kennedy.

These are some—though by no means all—of the weather woes that have plagued past inaugurations and Presidents. With the exception of Kennedy's in 1961, each of the inaugurations described took place on the old date, March 4, rather than

Left: Despite his grandfather's fatal experience 48 years earlier, Benjamin Harrison takes his oath of office and delivers his inaugural address in the pouring rain.



A canopy of umbrellas covers the Capitol steps leading to the temporary platform on which James K. Polk took his oath of office in 1845.

January 20 when, statistically speaking, the chances favor fair weather.

Unfortunately, you can lose even when the climatic odds are with you. The very first inauguration held on January 20— that of Franklin Delano Roosevelt in 1937—was almost washed out by one of the heaviest rains in the event's history.

Two hundred thousand visitors came to Washington for the inauguration, though several thousand never got further than Union Station. It was a cold, miserable day. The temperature hovered just above freezing, while wind-blown rain fell in soaking, slanting sheets. Thousands of soggy spectators stood for hours in the downpour under a canopy of largely ineffective umbrellas. As he rode from the White House to the Capitol for the swearing-in ceremonies, Roosevelt repeatedly leaned out the window of his limousine to wave to umbrellaed knots of people clustered like black mushrooms along Pennsylvania Avenue.

Undaunted by the cold, driving rain, thousands more had massed in front of the Capitol to witness the inaugural oath. Under the umbrellas, overcoats and raincoats predominated, but, despite the deluge, some spectators wore formal attire. On the inaugural platform itself, attendants dumped puddles of water from chairs as Cabinet members and Supreme Court justices waded down a waterlogged red carpet to their wet seats. Icy torrents blowing in under the roof bathed Congressmen, government officials, and quests alike as Eleanor Roosevelt raced back and forth, bringing blankets for family and friends.

The head of the Inaugural Committee tried to talk Roosevelt into taking his oath indoors but he refused, replying "If they can take it, I can take it," and led Vice President-elect John Nance Garner out to the inaugural stand. The shivering, soggy crowd burst into cheers as Roosevelt was sworn in at 12:39 p.m., his right hand resting on the cellophane-wrapped old Dutch Bible of Claes Martenzen van Roosevelt. All during his inaugural address, the rain beat steadily on the President's face, and several times he had to pause to wipe the water off.

Roosevelt insisted on an open car for the return ride to the White House. The thoroughly soaked President and First Lady rode the mile to the Executive Mansion laughing and waving to the crowds, which responded in kind. Later, Roosevelt spent another hour and a half watching the inugural parade splash by from a specially constructed reviewing stand, an $11,000 model of Andrew Jackson's home, the Heritage; he even had the bulletproof windows removed, the better to be seen and rained on.

Said harried Senator George William Norris of Nebraska, whose amendment had changed the inauguration date to January 20: "They're trying to blame this on me. You can't charge this up to me until after March 4, when you see what kind of day that is."

It was, of course, a beautiful day—sunny, with a high temperature of 67 degrees, unusually warm for that date.

EDS Women Go to Sea

This past summer, Meda Moore, a geophysicist with the National Geophysical and Solar-Terrestrial Data Center, participated in an eastern equatorial Pacific cruise to get first-hand experience in the collection of geological and geophysical data. Dedee Solow, a biological oceanographer with the National Oceanographic Data Center, participated in a New York area coastal cruise to help develop data recording forms for future dumpsite cruises.

Dedee Solow.

Meda Moore.

Meda Moore made her cruise aboard the Scripps Institution Research Vessel *Melville.* The purpose of the cruise was to study sediment dynamics and heat flow in an eastern equatorial Pacific region. The cruise began at Balboa, Panama, on July 15, 1976 and ended in Hawaii on August 15.

Studies performed included: monitoring the shear strength of sediments in place on the bottom, measuring heat flow, obtaining free fall cores, and collecting biological samples. Almost all stations included collection of both box and piston cores. Most of the work on the cores was to be done ashore. However, the sediments were dated by paleontological studies aboard ship, and simple tests were made to determine the kinds of material contained.

In the box cores, half of each core was stored in a cylindrical plastic tube to be taken back to the laboratory. The other half was opened and hosed down to wash away the loose sediments, thus exposing such things as worm burrows. Slices were taken off the edge of the core and it was washed again. Each step was photographed to show the progression of the burrows. One green worm was brought up alive from the depth of about 2.5 miles.

The piston core sediments were not tested on board, except for the insertion of a heat source every so many feet. Heat was applied and the temperature curve recorded for 6 minutes.

Moore said that the "most valuable part of the cruise in my estimation, was watching the way the chief scientists used the various records being collected to determine where the next station would be taken, and to have him explain the records to me. We crossed the Clarion Fracture Zone and he explained the correlations between all the different types of records and explained the findings in the cores (which turned out just as he had predicted)."

Deedee Solow participated in a Deepwater Dumpsite 106 project shakedown cruise investigating the impact of chemical waste on marine organisms.

The Dumpsite, located 106 miles east-southeast of New York City, is the joint responsibility of the Environmental Protection Agency, U.S. Coast Guard, and NOAA. EPA issues dumping permits, the Coast Guard monitors the dumping, and NOAA determines the environmental impact of the dumping.

The cruise, jointly sponsored by the Woods Hole Oceanographic Institution and NOAA, was from July 31 to August 13, 1976 aboard the WHOI research vessel *Knorr.*

A test dump was made of chemical insecticides dyed with rhodamine. The ship attempted to follow a drogue buoy, released at the time of the dump, to try to correlate the movement of the water mass with the waste dispersal. Water samples were collected at 5-minute intervals both at the surface and at 5 meters depth for salinity, chlorophyll, metals, and nutrients analyses to determine changes to the environment of the plankton.

Solow did much of the onboard data management by keeping the records on sample location, time, date, depth, type, and values and completing the required NOAA cruise inventory form. She discussed, with principal and other investigators, the design of data recording forms. Following the scientists' specifications, NODC is now developing forms to record the parameters measured during future dumpsite cruises.

Hurricane Eloise Marine Data Package

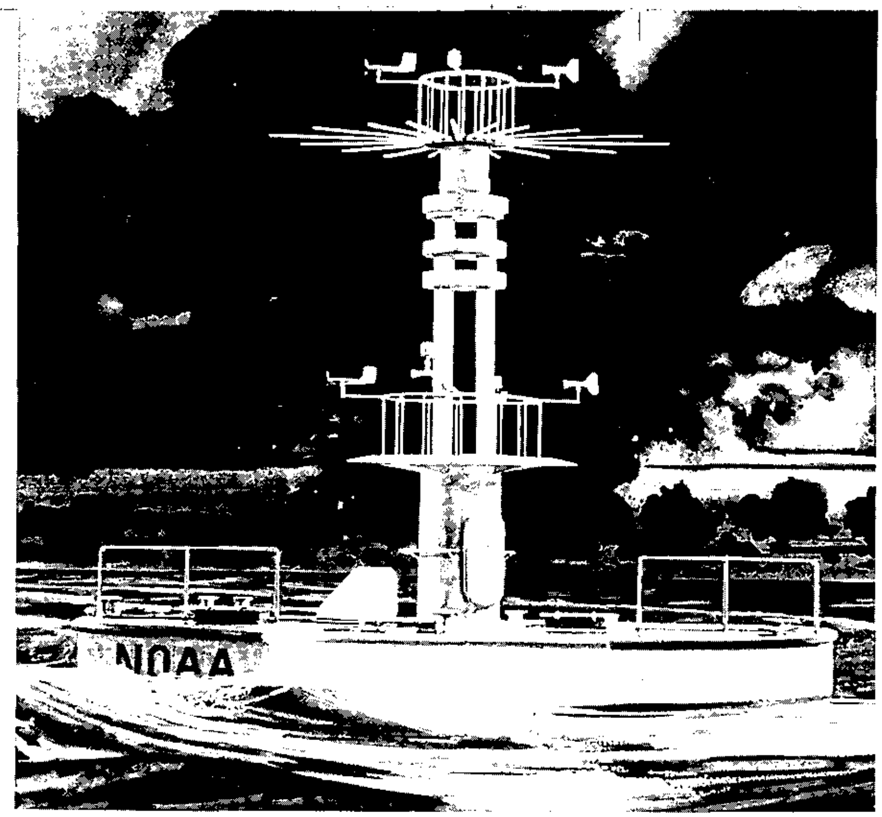
On September 22 and 23, 1975, hurricane Eloise passed over two environmental data collecting buoys in the north-central Gulf of Mexico, providing a unique record of the storm.

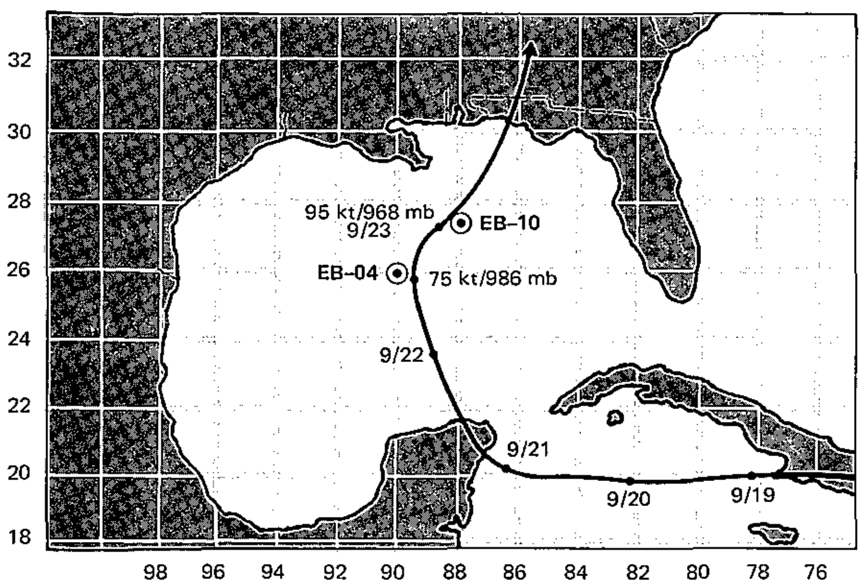
Eloise, accompanied by 110-knot winds and 16-foot storm tides, slammed ashore over the Florida Panhandle, leaving $100 million worth of damage in her wake. The bouys, (EB-04 and EB-10), operated by the NOAA Data Buoy Office (NDBO), provided hourly readings and monitored the deepening storm's vital signs just 12 hours prior to landfall. In addition, observations before and after the storm's passage allowed a measurement of the environment's response to the hurricane.

Recognizing the value of the data buoy observations to researchers, NOAA has prepared a package containing both the buoy and supporting data for the marine portion of hurricane Eloise's life. The joint efforts of NOAA's Environmental Data Service, National Weather Service, National Environmental Satellite Service, National Ocean Survey, and Environmental Research Laboratories, as well as those of the U.S. Army Corps of Engineers, has produced an extensive environmental data package.

Though it varies for some parameters, the basic observational period extends from September 15, when Eloise entered the Caribbean Sea, through September 28, five days after landfall. Most data is on magnetic tape, but microfiche and microfilm were used where appropriate.

The heart of the Eloise data package is the EB-04 and EB-10 data, which are available on magnetic tape and in an NDBO data report. The data include such surface and subsurface parameters as winds, waves, current, air and sea temperatures, along with other meteorological and oceanographic measurements. Supporting data include surface and subsurface observations (expendable bathythermograph) from cooperating merchant ships. Surface and upper-air weather charts and land station records also have been collected. Film and digital information are available from satellite and radars. Detailed aircraft reconnaissance observations at





Top: The type of environmental buoy that collected data in Hurricane Eloise.

Above: Storm track of Hurricane Eloise.

10-second intervals also are available. Sea state photographs, radar film, and aircraft expendable bathythermograph records are included. Tropical cyclone advisories and bulletins are in the package, which also includes coastal flooding information in the form of storm-surge data from tidal stations and high-water mark measurements along the coast.

The data were assembled by the Environmental Data Service's National Oceanographic Data Center, and National Climatic Center, and NCC's Satellite Data Services Branch. Requests for data or information on the package should be directed to the Environmental Data Service, National Oceanographic Data Center, Code D762, Washington, D.C. 20235; telephone 202-634-7394.

Alaskan Coastal Zone Climatic Atlases Due Next Fall

EDS' National Climatic Center (NCC), Asheville, N.C., in cooperation with the University of Alaska's Arctic Environmental Information and Data Center (AEIDC), is compiling a set of comprehensive climatic atlases for the Alaskan Coastal Zone. The atlases, which will be published in the fall of 1977, will cover each of three marine areas in the Alaskan Coastal Zone (50° — 75°N, 130° — 180°W): Gulf of Alaska, Bering Seas, and Chukchi-Beaufort

This data publication effort is in support of the NOAA Alaskan Outer Continental Shelf Environmental Assessment Program (OCSEAP) being carried out for the Department of Interior's Bureau of Land Management (BLM). The atlases will describe the climatology of the areas and present data analyses of surface marine and atmospheric parameters, permitting an assessment of the risks involved in the construction and operation of energy related structures in these waters.

The climatological analyses of the Alaskan waters will be based on 600,000 surface marine observations and on two million 3-hourly surface observations for 49 selected coastal stations contained in NCC's digital data base. As marine data are typically sparse in the near coastal zone — an area of sharp gradients and complex climate — data from land stations are being included to develop the best possible climatological picture of the near-coastal waters. Environmental records and publications held by the NCC and the AEIDC will be used to provide supplemental information.

The climatic data in each atlas are to be represented monthly by isopleth maps and by statistical graphs and tables. Elements to be included are : clouds, visibility, fog, precipitation, air and sea temperatures, waves, winds, sea-level pressure, and extratropical cyclones. Each atlas will be about 11" x 11" in size and contain 480 pages, of which 228 will be 3-color maps, each map page having an opposing page of graphs for selected marine areas and coastal stations. The remaining pages will consist of statistical tables and a descriptive narrative.

Interagency Library Newsletter

The first issue of a bimonthly *Environmental and Natural Resources Newsletter* is scheduled for publication in January 1977. A joint effort of NOAA, the Environmental Protection Agency, and the Department of the Interior, the newsletter is designed to fill a need for communication among the library and information units within the three agencies.

The new newsletter will supersede current individual agency newsletters. One of the main objectives of the new publication will be to keep the numerous field units of the participating agencies across the country informed of developments within the Federal library and information science community. Production costs will be shared, and editorial responsibilities will be rotated on an annual basis. William E. Hardy, of EDS' Environmental Science Information Center, will serve as the first editor, with Barbara Bauman of the Department of the Interior and Sharon Schatz of EPA providing coordination for their agencies.

American Weather Stories

NOAA recently published *American Weather Stoties* as part of its Bicentennial observance. Prepared by the Environmental Data Service, this popularly written book traces the American weather experience from the hurricanes that threatened Columbus to the peculiar run of bad weather that has plagued American presidents on their inaugurations days (see article beginning on page 20); from Americans who recorded the weather and climate of the Revolutionary and Civil War eras to those who suffered through the "year without a summer," the Blizzard of '88, and the dust-bowl droughts of the 1930's.

A large number of historical photographs and illustrations accompany the text, including a complete almanac/gallery of American presidents and the weather elements they encountered on Inauguration Day.

American Weather Stories is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402. Price $2.10. Order No. 003-018-00070-9.

International Report

Marine Climatological Summaries Published

The EDS National Climatic Center (NCC) has published *Cooperative Marine Climatological Summaries* Volumes 9 and 10 (1969 and 1970) for the U.S. area of responsibility under a World Meteorological Organization (WMO) data publication program. The U.S. zone of responsibility extends from longitude 50°W to longitude 170°W and from latitude 50°S to the North Pole.

The 400 page volume contains monthly summaries for 57 representative marine areas and 3 Ocean Weather Stations. The elements summarized are: dry-bulb temperature, dew-point temperature difference, visibility, weather, wind direction and speed, atmospheric pressure, cloud cover, and waves.

Copies of these summaries can be purchased from the National Climatic Center, Federal Building, Asheville, NC 28801. The price for each volume is $7.45 for domestic and $12.00 for foreign orders. A microfiche copy of each of these two volumes can be provided for $2.80.

Ignorosphere Measurements Manual

EDS' World Data Center A (WDC-A) for Solar-Terrestrial Physics, Boulder, Colo., has issued Report UAG-57, *Manual on Ionospheric Absorption Measurements,* edited by K. Rawer, Fraunhofer-Gesellschaft, Institut fur Physikalische Weltraumforschung, Freiburg, Federal Republic of Germany.

Report UAG-57 completes a project that was in progress for many years. Absorption measurements have long been recognized as a powerful tool in applied radio propagation work and are, in geophysics, one of the few synoptic ground-based techniques which can shed light on what is sometimes called the "ignorosphere," the region of the atmosphere not accessible to ionosondes, satellites, or other global measurement techniques. Measurements of ionospheric absorption have not, however, been as widely employed as they might have been — and where they have been used it has often been with considerable difficulty — because of the lack of a suitable manual for the guidance of workers in the field. Brief instruction manuals were produced for the International Geophysical Year and the International Years of the Quiet Sun, but these were not attempts at a comphehensive treatment of the subject.

The new manual is in two parts. The first deals with general information and contains chapters on propagation influences, theory, and fading. The second part describes the different methods of measurement: pulse reflection, cosmic noise absorption, oblique incidence field strength observations on frequencies above 2 MHz, oblique incidence field strength observations on frequencies in and below the MF broadcasting band, the partial reflection method, and satelite measurements of absorption.

The manual is being issued in this special WDC-A data report series to stimulate systematic ionospheric absorption observations in more parts of the world. Copies of Report UAG-57 are available from the National Climatic Center, Federal Building, Asheville, NC 28801, Attn: Publications. Price $4.27. Checks and money orders should be made payable to the Department of Commerce, NOAA.

WDC-A Oceanography Receives Record Number of ROSCOP Forms

For the 1-year period July 1, 1975—June 30, 1976, World Data Center A (WDC-A), Oceanography received more than 1,500 Report of Observations/Samples Collected by Oceanographic Programs (ROSCOP) forms from scientists of the international oceanographic community. This total is approximately three times greater than the number received for any previous 1-year period and is greater than the total number of ROSCOP's received during the years 1971—74.

ROSCOP is an international marine data inventory system maintained by WDC-A with the assistance of EDS' National Oceanographic Data Center. ROSCOP forms provide WDC-A, Oceanography with a means for determining the availability of internationally exchangeable data in advance of the actual receipt and cataloging of the data. These inventories are also useful in providing a user referral service to data not exchanged through the WDC system.

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Environmental Data Service
Washington, D.C. 20235

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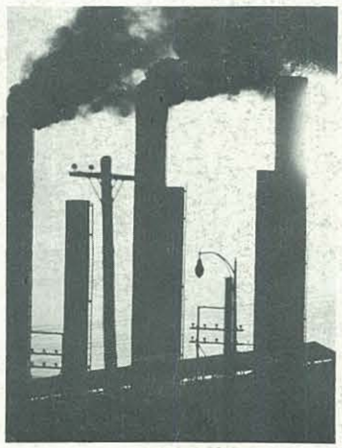

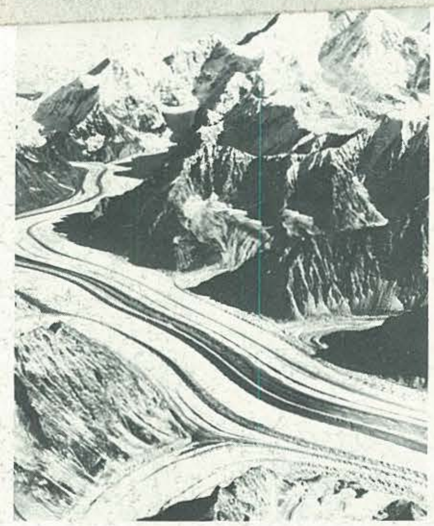

IN THIS ISSUE: Future climate trends (p. 4), facts about climatic change (p.10), a climatic monitoring system (p.16), and the weather on Inauguration Day (p.20).

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

EDS

Environmental
Data Service
January 1977

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COVER: *Whiteout in the Alaskan Arctic. The article beginning on page 4 describes Federal efforts to assess potential environmental effects of oil and gas development in the Alaska continental shelf region.*

Joseph C. LaBelle

ENVIRONMENTAL DATA SERVICE is designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, and Center for Climatic and Environmental Assessment. In addition, under agreement with the National Academy of Sciences, EDS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 16, 1975; this approval expires June 30, 1978.

U.S. DEPARTMENT OF COMMERCE
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Robert M. White, Administrator

Environmental Data Service
Thomas S. Austin, Director

Editor: Patrick Hughes

Associate Editors: Leon La Porte
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Ocean Data Services

The energy crisis, potential global food shortages, marine pollution, deepsea mining potential, and recent large-scale environmental research programs have focused world attention on the ocean and generated a pressing need for greatly expanded ocean data services. NOAA's Environmental Data Service (EDS) is the national focal point for most oceanic data services and continually adjusts its programs to meet changing national needs. This special marine issue describes some current EDS ocean data and information services.

The National Oceanographic Data Center and several other EDS service centers are providing data management support services to energy-related marine environmental assessment programs for the Alaskan outer continental shelf and Puget Sound. The policies and procedures being followed are consistent with those developed by EDS and the Bureau of Land Management for the rest of the country's offshore areas. Moveover, the data bases for all areas are intercomparable.

The EDS Center for Experiment Design and Data Analysis has developed an automated mathematical technique for the analysis of large data sets. CEDDA recently adapted the procedure to classify oceanographic data into representative subsets, thereby simplifying the task of understanding and describing the marine environment and its variations in time and space.

The EDS National Climatic Center is helping to fill in gaps in our knowledge of the climate over the world ocean. NCC is working with the Netherlands, Federal

Republic of Germany, and the United Kingdom in a World Meteorological Organization effort to produce reliable monthly summaries of sea-surface temperature and wind data for each year back to 1861, when most countries had adopted standard data-collection methods.

Efforts to collect subsurface ocean current measurements have accelerated over the last decade or two, particularly in U.S. coastal waters and the Carribean Sea. A significant number of the observations were taken near the ocean bottom, and many are very deep measurements. The EDS National Oceanographic Data Center has indexed these data and is now offering computerized subsurface current data and information referral services.

Meanwhile, EDS' National Geophysical and Solar-Terrestrial Data Center has begun disseminating the first part of a 40-million record data set containing nearshore digital bathymetric, bottom characteristic, and hydrographic data for U.S. coastal areas. The data are a byproduct of NOAA's National Ocean Survey program to automate production of their nautical charts, another step in improving NOAA's ocean services

EDS itself is examining Federally funded marine science and engineering programs in the Atlantic coastal region between Cape Hatteras and Maine to see if an adequate body of scientific data and information is available on which to base management decisions concerning the Atlantic coastal margin.

In the marine information area, the EDS Environmental Science Information Center (ESIC) is also the U.S. participant in the Aquatic Sciences and Fisheries Information System. ASFIS is a cooperative international mechanism designed to cope with the current worldwide flood of marine scientific and technical information, an output beyond the capabilities of any single nation to manage.

Finally, EDS has published the fifth progress report for the International Decade of Ocean Exploration, a cooperative program to improve the use of the ocean and its resources for the benefit of man. IDOE areas of investigation are: environmental quality, environmental forecasting, seabed assessment, and living resources. As IDOE data manager, EDS can provide the data, or reference to the data, described in the reports.

David H. Wallace

David H. Wallace
NOAA Associate Administrator for
Marine Resources

Energy-Related Marine Data Management in the Pacific Northwest

By Patrick Hughes

Underlying the waters of two oceans and three seas, the Alaskan continental shelf is burdened by thick winter ice in the north and frequently swept by strong winds and high seas in the south. Because of its vast size and formidable natural environment, it is the least studied of all the Nation's frontier oil and gas exploration areas.

Besides potential oil and natural gas deposits, the Alaskan continental shelf is rich in marine life and vistas of breathtaking natural beauty. Federal law requires environmental studies in offshore areas where energy-related development is proposed; if the studies show development will mean unacceptable environmental or ecological risks, leases for the areas will not be issued.

More than 200 scientific investigators currently are collecting environmental data in the Alaskan Outer Continental Shelf Environmental Assessment Program, run by NOAA's Environmental Research Laboratories and funded by the Department of the Interior's Bureau of Land Management. OCSEAP investigations include determining the effects of petroleum development on marine mammals and birds; fishes; invertebrates; aquatic microorganisms; sea ice; and the chemistry and geology of the Gulf of Alaska and Bering, Chukchi, and Beaufort Seas. Supporting studies are being conducted in physical oceanography and meteorology.

Environmental baselines will be established in each region. As used in this program, a baseline is a measure of some quantity of interest, such as the number of bird nests per kilometer of beach or the amount of petroleum hydrocarbons found in a sample of the water column or sediment of a given area.

Above: Scientists sample the salinity of ice on the Beaufort Sea.
Fisheries and Wildlife

Right: Oil Platform in Cook Inlet flaring waste gas.
Bureau of the Census

Monitoring surveys will be conducted at least annually after completion of the initial baseline survey. In addition, a continuing study program will be conducted in each lease area following a sale, because of the need for regulation, environmental protection, and assessment in advance of successive sales in the same lease area.

A comprehensive, reliable data management system is critical to the success of OCSEAP. Data management policies and procedures are consistent with those developed by EDS and the Bureau of Land Management for continental shelf exploration areas off the Atlantic, Gulf, and Pacific coasts of the "lower 48."

Overall OCSEAP data management is the responsibility of Dr. Rudy Engelmann, the ERL program manager. Wayne Fischer of EDS is program data manager, while ERL project data managers Mauri Pelto and Francesca Cava are responsible for data flow from investigators. Mike Crane, Dean Dale, and Jim Audet of EDS provide data management expertise and support services to OCSEAP principal investigators. Mike is the EDS Liaison Officer in Anchorage, Dean Dale in Seattle, Washington. Jim Audet is the OCSEAP Data Coordinator at the

EDS National Oceanographic Data Center (NODC) in Washington, D.C., where the OCSEAP data base is located.

Specifically, the EDS OCSEAP team:

• provides technical assistance to program participants on data management requirements;

• develops formats for OCSEAP data, using specifications recommended by the ERL project office and scientific experts from each data discipline;

• specifies standard media that will be most compatible with EDS (national) storage/retrieval systems;

• is developing a digital data base of all processed data;

• maintains a data-tracking and information system;

• is preparing a catalog of available program data and data products;

• is organizing and maintaining a file of certain non-digital data (such as analog records, data reports, maps, charts, and photos);

• maintains a catalog of all analog, photo, and other non-digital information collected as part of OCSEAP field efforts;

• provides data processing services to OCSEAP investigators;

• services OCSEAP user requests for data;

• provides data dissemination services for non-OCSEAP users.

The roles of the Anchorage, Seattle, and Washington, D.C. EDS team members in carrying out these OCSEAP responsibilities are varied. Mike Crane has an office in the Arctic Environmental Information and Data Center, a University of Alaska activity in Anchorage. He works closely with OCSEAP investigators (principally in Alaska) to develop data formats to meet both OCSEAP requirements and EDS data base compatibility requirements. In addition, he helps individual investigators and their data managers digitize and process their data. Mike also developed the initial design for the OCSEAP data tracking system, then worked with ERL and NODC personnel on its final form and implementation.

Dean Dale is located in ERL's Pacific Marine Environmental Laboratory on the University of Washington campus in Seattle, the home port for NOAA vessels taking part in the Alaskan OCSEAP, and a base of operations for many OCSEAP investigators. Like Mike, Dean works with OCSEAP investigators to develop suitable data forms and formats.

Jim Audet works at NODC and provides the same type of services to OCSEAP investigators as Mike and Dean. He also coordinates the development and maintenance of the OCSEAP digital data bank within NODC, assists in updating and distributing products of the data tracking system, and is involved with the development of an OCSEAP data catalog.

EDS is now receiving and processing OCSEAP data collected since 1974. Digital data and data reports from the fields of physical oceanography, marine biology and chemistry, ice, and meteorology have been received at NODC, while EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) has received geological and geophysical data from several cruises. Practically all digital data sets are being submitted on magnetic tape in formats designed by the EDS OCSEAP team (including NGSDC personnel), working with ERL representatives and individual principal investigators.

By mid-November, major OCSEAP data accessions included STD (salinity-temperature-depth) and CTD (conductivity, temperature, depth) measure-

Below: Scientists tag a seal pup. Right: This ice pressure ridge west of Barrow (June 1974) is the boundary between landfast and pack ice.

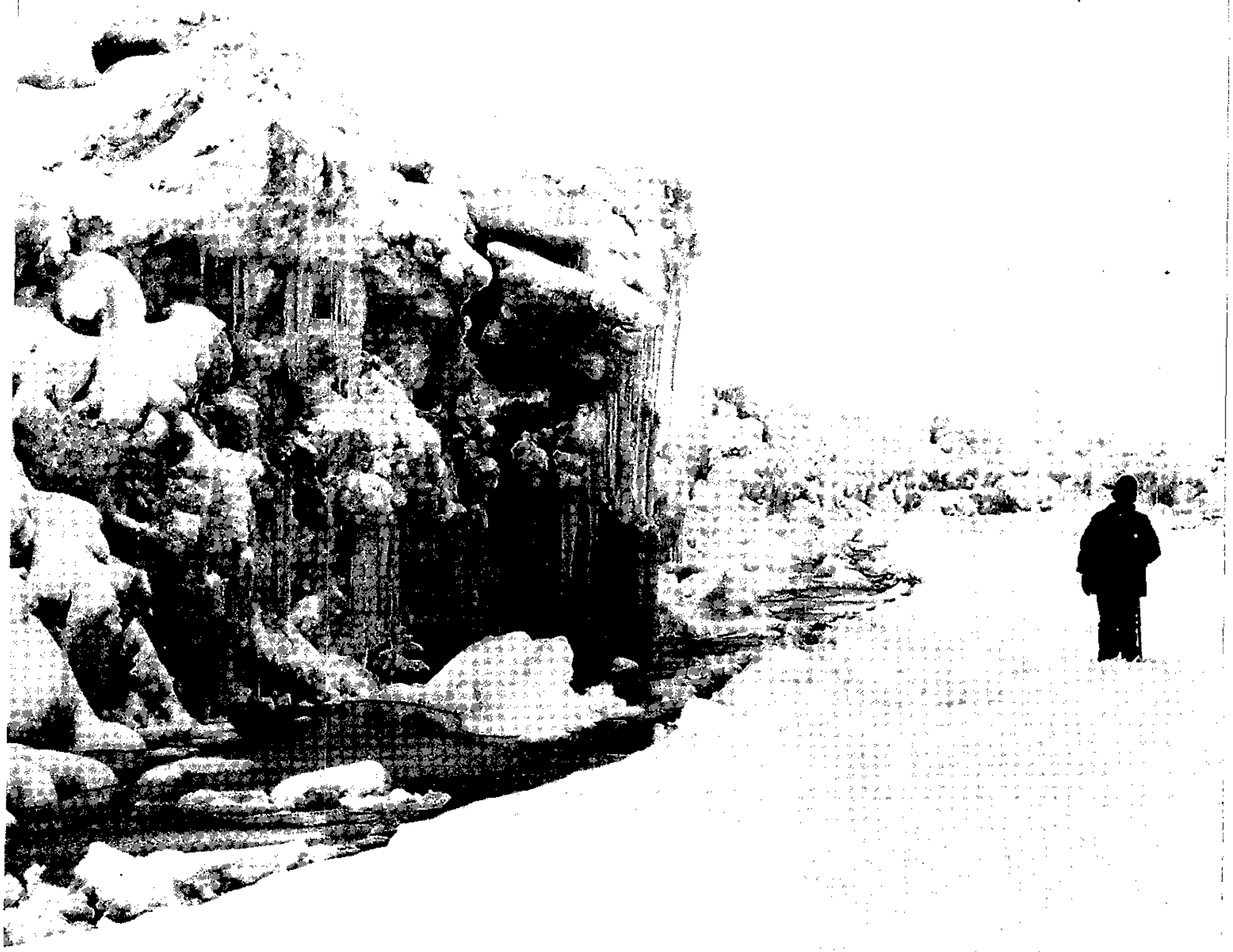
C.D. Evans, AEIDC

ments and current meter data for the Gulf of Alaska and the Bering and Beaufort Seas; intertidal observations made in the Gulf of Alaska and Beaufort Seas; primary productivity, phytoplankton, and zooplankton collections from the Gulf of Alaska and Bering Sea; benthic organism and fish resource studies of the Beaufort and Bering Seas and the Gulf of Alaska; mammal sightings made in the Bering, Beaufort, and Chukchi Seas and Norton Sound; mammal specimen data from Gulf of Alaska and Beaufort Sea studies; marine bird observations made on the Pribilof Islands; and geological data for the Gulf of Alaska.

OCSEAP data flow begins with the submission of most digital data to the ERL project office in Juneau, where the data are reviewed for contract fulfillment, adequate documentation, and proper identification. The data then are forwarded either to Jim Audet in Washington for inclusion in the data base, or to Mike Crane in Anchorage.

Magnetic tape data forwarded to Anchorage are checked by Mike for documentation information, type and completeness of data, and for correct data formats. He also converts punched-card data (submitted in some cases to satisfy an investigator's contract) to magnetic tape for NODC processing.

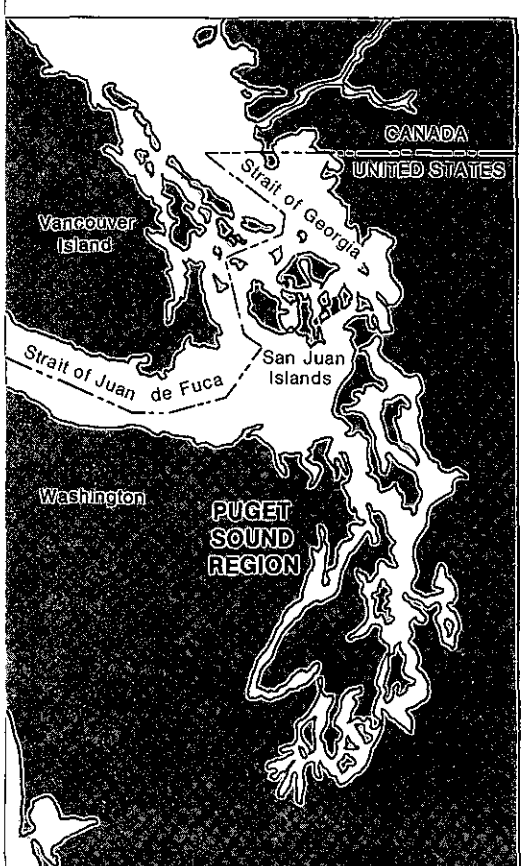
The automated data-tracking system at NODC provides up-to-date information to the OCSEAP Program and Project Offices (Juneau and Fairbanks), to the Bureau of Land Management, and to other users. It describes planned data collections as well as data received, processed, and available



for each OCSEAP task, identified as a research unit. The 1975-76 effort, for example, involved over 150 separate research units.

Although the data-tracking system has been designed primarily for digital data sets, the status of other types of data such as analog records, photos, or data reports can be included. The tracking system will provide the framework for a data catalog that will be an inventory and description of the many types of data collected by OCSEAP investigators.

By November, over 150 data sets and almost 160 data reports had been received at NODC. The data sets are now in various stages of processing, or already are available to provide inventories, tabular and graphic products, and comparisons of interdisciplinary data. In addition, a subset of existing NODC data for the Alaska continental shelf area—including Nansen casts and STD's, MBT's, and XBT's (temperature-depth), and surface current data—has been made available to investigators to combine with OCSEAP data sets. EDS' NGSDC and National Climatic Center (NCC) also have provided data and data products for the Alaska shelf areas to various OCSEAP investigators. In addition, NCC, in cooperation with the Arctic Environmental Information and Data Center, is compiling a set of comprehensive climatic atlases for the Alaskan Coastal Zone to be published in the fall of 1977.



Unlike Mike Crane, Dean Dale spends only about one-quarter of his time on OCSEAP. Much of the remainder is spent on the NOAA Puget Sound Energy-Related Research Project, funded by the Environmental Protection Agency, and the NOAA MESA (Marine Ecosystems Analysis) Puget Sound Project.

Like OCSEAP, the Puget Sound Energy-Related Project is concerned with potential environmental and ecological consequences of intensified petroleum activities. Puget Sound, the Strait of Juan de Fuca, and the Strait of Georgia form an inland sea surrounded by a population center of 3.5 million people. The natural beauty of the area is perhaps unsurpassed in the country, while the mild climate of the region permits outdoor recreational activities thoughout the year. Shipping, forestry, farming, and heavy industry also share this spectacular environment, and two major petroleum refineries are located in northern Puget Sound.

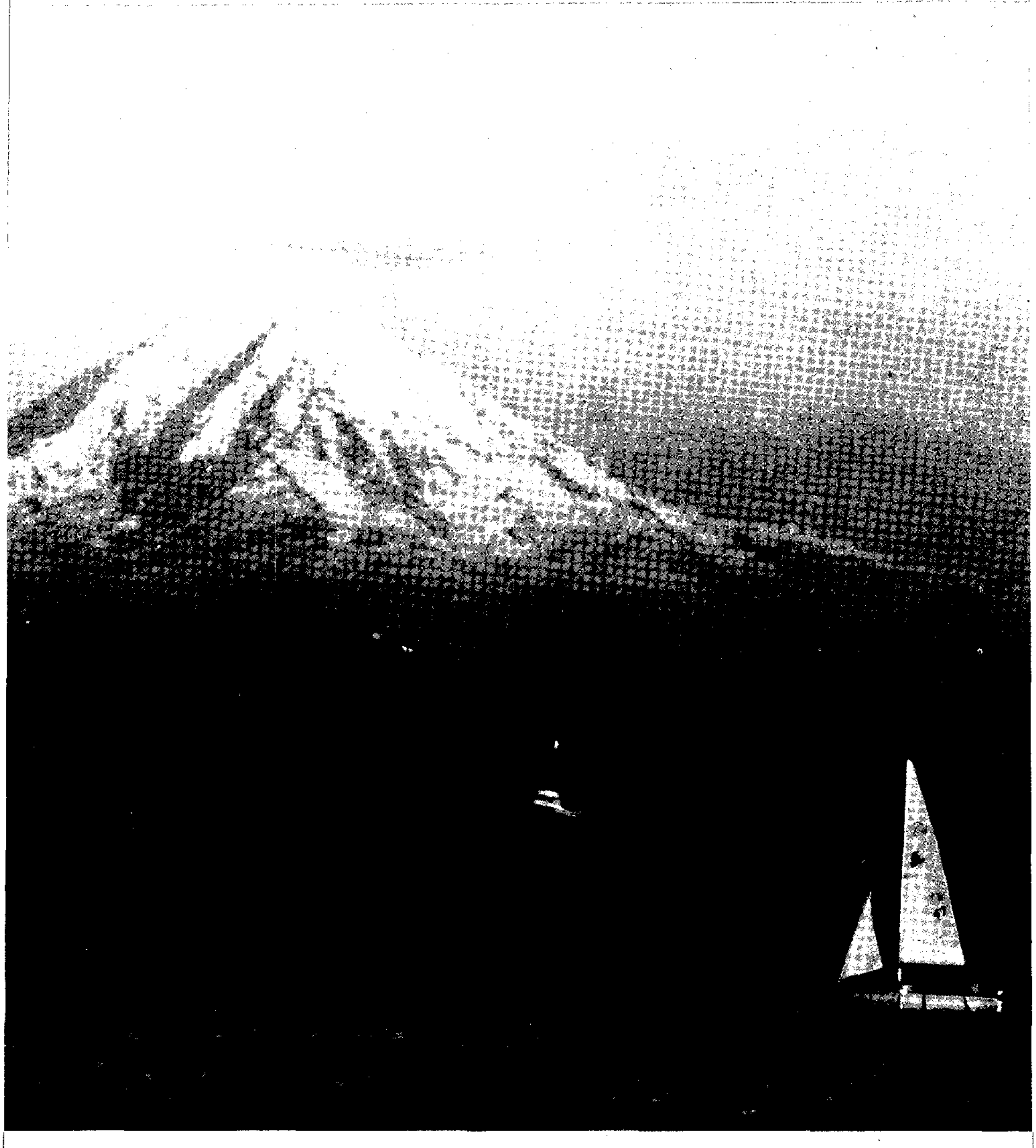
The great number and variety of activities within the Puget Sound area place heavy demands upon its environmental resources. Because of widespread publicity about the construction of the Trans-Alaskan pipeline and the subsequent designation of Puget Sound as a southern terminal for Alaskan crude oil, the potential danger posed to the environment by petroleum-related activities has become the most prominent issue among resource-use conflicts.

A study commissioned by the State legislature estimates that Puget Sound refinery capacity could double by 1980, and that tanker transport of crude oil could increase as much as 10 times by the turn of the century. To prepare for such a potential intensification of petroleum refining and shipping major marine resource management decisions must be made by the petroleum industry and by various levels of the Federal and State governments. As in Alaska, these decisions require detailed knowledge of the marine environment and ecosystem, largely lacking at present. With money provided by the Environmental Protection Agency, NOAA has initiated the Puget Sound Energy-Related Research Project as a high-priority effort to collect and assess this knowledge.

As with OCSEAP, management responsibility for the Puget Sound Energy-Related Research Project has been assigned to the Environmental Research Laboratories in Boulder, Colo., and is administered through the ERL MESA Program Office. Project implementation is the responsibility of the MESA Puget Sound Project Office in Seattle, Washington, headed by Dr. Howard Harris. This office also administers a MESA Puget Sound project to study the effects of wastewater disposal. The project

Left: The Puget Sound region.

Right: Sailing on the Sound.



Mike Crane

Mike Crane and his wife, Susan, are outdoor enthusiasts who love living in Alaska. Mike is a pilot and flies his own light plane—sometimes the only way to get from here to there in our biggest, most untamed State.

According to Dave Hickok, Director of the Alaskan Environmental Information and Data Center, "Mike is very well liked all over the State. He is candid, and tells it like it is—a necessity here in Alaska."

Mike began his professional career with the Acoustics Branch of the U.S. Naval Oceanographic Office in June 1969. There he collected, processed, and analyzed environmental data for antisubmarine and undersea warfare applications. Field duties included the collection and processing of data aboard oceanographic survey ships and navy aircraft. While at sea, he also supervised other oceanographers in the calibration, maintenance, and operation of acoustic data instrumentation. Back at the office, Mike's duties included data processing and analysis and managing the ambient noise and volume reverberation data file.

Mike earned a bachelor's degree in physics in 1969 and a masters in oceanography in 1974, both from the College of William and Mary in Williamsburg, Va.

Dean Dale

Dean Dale, a bachelor, once made his living making model airplanes (for wind tunnel testing). Like Mike Crane, he is an ardent outdoorsman and camper. For several years, Dean has been building his own 36-foot, ferrocement-hull sailing vessel.

Before joining EDS, Dean worked for the Navy's Fleet Numerical Weather Central in Monterey, Calif., where he reorganized FNWC's Expendable Bathythermograph processing, quality control, storage, and retrieval system. In addition, he had operational and development responsibility for Northern Hemisphere surface current analyses,

was begun during the summer of 1975, and its output should directly benefit portions of the petroleum-related studies.

With the help of Dean Dale and other EDS personnel, a joint data management plan has been developed for both the energy-related and wastewater projects, to assure that an adequate, data base is available for resource planning and coastal management. Baseline studies and specialized investigations are being carried out by some 20 principal investigators under contract to the project office. It is the specific responsibility of each principal investigator to be sure that his contract with the project office includes adequate funding to satisfy all data management requirements.

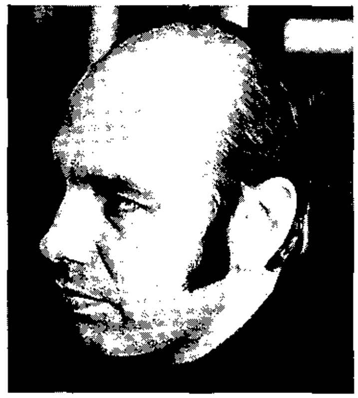
Again, as with OCSEAP, EDS is responsible for a wide range of data services. Specifically, EDS:

- provides a project coordinator, Jim Ridlon, to work with other participants,
- provides data management expertise to project participants,
- organizes and archives all data submitted into a project data base
- maintains data flow records and publishes inventory reports, and
- serves as the primary distribution point for the data collected, filling requests for data and data products from both project and other users.

In addition, NODC has funded the University of Washington to provide an Environmental Data Base Directory for all of British Columbia, Washington, and Oregon. The Directory will index oceanographic and limnological, as numerical search and rescue drift computations, the search and rescue data base, shallow water wave refraction prediction models, and a surface current model to be used by the U.S. Coast Guard's International Ice Patrol Units in predicting iceberg movement. Dean also helped in the development of a new ocean climatology data bank for FNWC.

While serving on the Aircraft Carrier *Kitty Hawk* in 1966, Dean was awarded the Secretary of the Navy Commendation Medal. According to the citation, he "contributed significantly toward the creation of an extensive automated target photo file, a current target status file, and several tactical order of battle files. The subject files were used extensively by Commander, Task Force SEVENTY-SEVEN and exclusively by Commander Task Group SEVENTY-SEVEN POINT SIX in a combat environment in Southeast Asian waters. These files served as a basis for many decisions which directly contributed to the overall success of Task Force SEVENTY-SEVEN and Task Group SEVENTY-SEVEN POINT SIX in the South China Sea."

Dean earned a bachelor's degree in oceanography from the University of Washington in 1970.



Jim Audet

Jim Audet is a member of the American Canal Society; he also designs games. Currently, he is working on a game series based on historic American trails and waterways. The first in the series is called the "Chesapeake and Ohio Canal."

Like Mike and Dean, Jim and his wife, Mary Ellen, are weekend campers. Jim also coaches soccer teams for a number of local boys' clubs.

Before joining EDS in 1975, Jim was a staff oceanographer with the Acoustic Environment Support Detachment of the Office of Naval Research, where, according to a commendation, he played "an extremely important role in developing the capability of the Propagation Model Prediction Group." Jim was responsible for analyzing and evaluating environmental factors affecting sound propagation, plan-ning and developing environmental studies, and recommendations regarding data base quality, adequacy, and priorities. He also acted as consultant to the head of the detachment on effects of the environment on antisubmarine warfare operations.

From 1961 to 1972, Jim worked for the U.S. Naval Oceanographic Office on various projects involving underwater acoustics, tide and current studies, and the distribution of artificial radiosotopes in the oceans. The latter work included evaluating the effects of underwater detonation of nuclear weapons.

Jim received his bachelor's degree in physical sciences from Lycoming College, Williamsport, Pa., in 1960, and a master's degree in environmental systems management from American University, Washington, D.C., in 1975.

well as geological, geophysical, and meteorological data and information held within the boundaries of the province and states. Similarly, the University of Alaska is describing over 600 Alaskan data files.

On the literature side, the EDS Environmental Science Information Center is directing the update of the *Bibliography of Literature on the Puget Sound Marine Environment,* published in 1971 by the University of Washington. The update, expected to at least double the size of the original, is being done by the University of Washington through the Sea Grant Program with funds provided by the Puget Sound Energy-Related Research Project. Publication is expected in March 1977.

Mike Crane and Dean Dale are but two of five EDS Liaison Officers stationed at marine centers around the country. Dale's role in Seattle represents a transition between that of Mike Crane in Alaska and the other three L.O.'s—George Heimerdinger, at Woods Hole Oceanographic Institution in Woods Hole, Mass.; Nelson Ross, at NOAA's Southwest Regional Fisheries Center in La Jolla, Calif.; and John Sylvester, at NOAA's Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla. Dean spends much of his time servicing NOAA programs and projects (like Mike Crane) and also providing EDS environmental data and information products and services to hundreds of users a year—the traditional role of the other three Liaison Officers. These latter L.O.'s and the services they provide will be the subject of an article in a future issue of *EDS.*

An Objective Method of Classifying Oceanographic Data

By Douglas Hamilton, National Oceanographic Data Center, and
John Jalickee, Center for Experiment Design and Data Analysis

"Which of these things is not like the others?" This is one type of question posed in scientific analysis of complex data sets. Sometimes a more difficult question to answer is "which of these things are similar to one another?" Both questions are important in efforts to describe and understand the ocean environment.

The May 1975 issue of *EDS* introduced an automated mathematical technique for analysis of large data sets, called Asymptotic Singular Decomposition (ASD). New applications have been found since that article was published. In this article we will show how ASD is used to answer the above questions in analyzing oceanographic data.

As man makes greater demands of the ocean, particularly the coastal zone, many problems arise that require an accurate description of the ocean environment. As an example, consider the problem of predicting the effect of a proposed coastal powerplant on marine life near the proposed site. Part of the problem might be to predict changes in water temperature and salinity and how those changes would affect various species. Before that problem could be tackled, however, we would need a description of the water temperatures and salinities that exist before the power plant is built. This is only one of the many types of problems that lead to the specific task of describing the environment, a task which will now be considered in relation to ASD.

To describe temperature and salinity in a region of interest, many measurements must be analyzed and compared. Measurements of temperature and salinity are usually made at several depths at one location and one time. Such measurements are referred to collectively as a station, and they may be plotted as depth profiles of temperature and salinity, or as a profile of temperature vs. salinity (fig. 1). If temperature and salinity values were constant at all water depths, in all locations in the region, during all times, the task of describing the environment would be simple. We could state the values, and they would be good indicators of temperature and salinity at all depths, in all locations and at all times. Of course, they are not constant, but change with depth and location, and with time at any depth and location.

Even though oceanic conditions are not constant in time and space, it is often possible to find data subsets in which temperature and

Below: Temperature and salinity profiles. Right: Which of these profiles is not like the others?

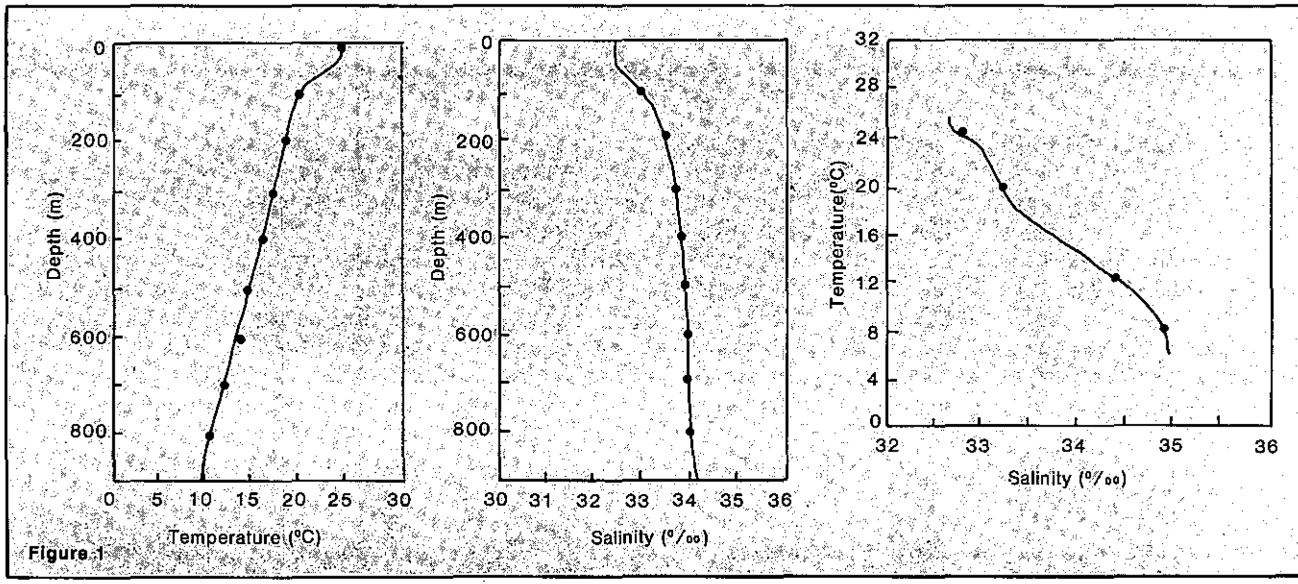


Figure 1

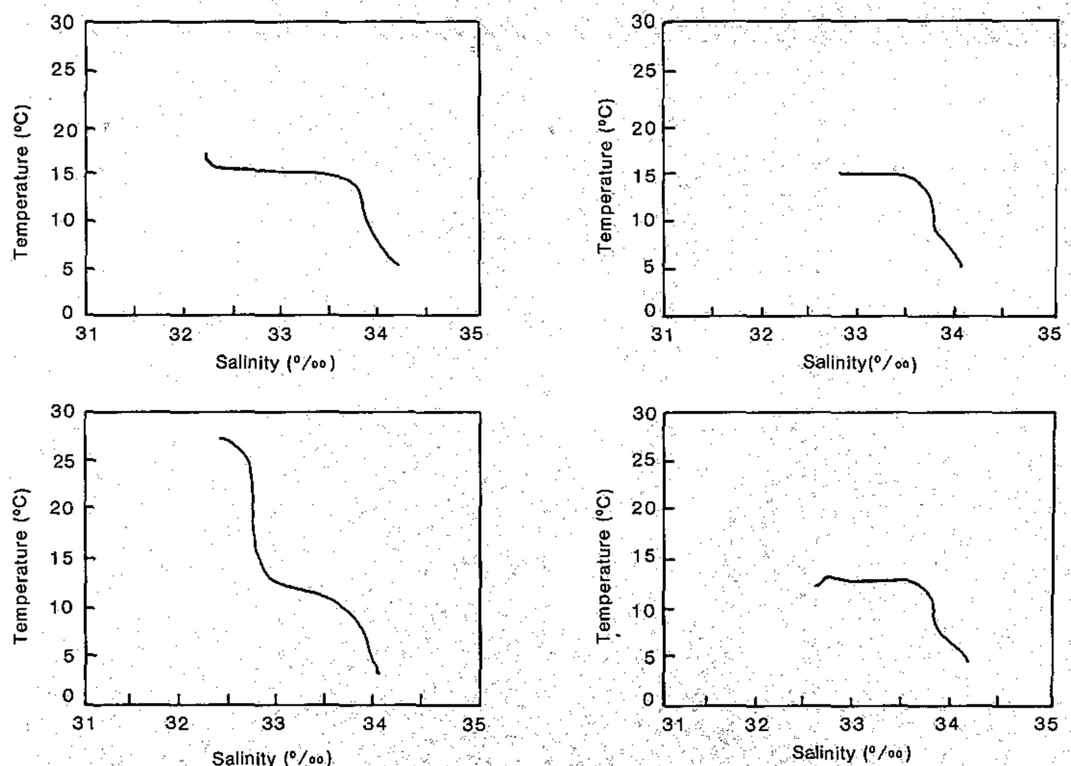


Figure 2

salinity profiles from different stations show striking similarities over a certain time period or in some geographic subarea. If we can identify such subsets, the task of understanding and describing the environment is greatly simplified. To find times or subareas with homogeneous traits, each temperature-salinity profile must be compared with all other profiles to answer the two questions . . . "which of these things is not like the others?" and "which of these things are similar to one another?" (fig. 2). This can be done manually by having someone look at each profile to subjectively classify the profiles into groups; but the task can be formidable if there are several hundred stations and several homogeneous groups.

As an automated alternative, ASD is particularly well suited for this task, because it is able to extract dominant patterns from a data set. For our application the patterns of interest are the shapes of profiles of temperature and salinity. To illustrate the power of ASD in this type of problem, 95 stations off the Oregon coast (fig. 3) were analyzed by ASD. Each station included temperature and salinity measurements between the surface and a depth of 900 meters. A composite plot of all temperature-salinity values (fig. 4) illustrates the diversity of profile shapes.

In the process of extracting predominant patterns from the data, the ASD method compares each profile to every other profile in a computerized, mathematical procedure. In a sense, it strips away the insignificant bits of information to reveal those features which form the underlying framework. This is not meant to imply that the minor bits of information have no meaning. Once the major features are understood, minor variations will stand out and can be more easily examined. The information provided by ASD is a series of a few important profile shapes and, for each profile shape, a set of 95 numbers which contain the unique relationship between each of the original 95 stations and the profile shape. The profile shapes will be called shape functions, and the numbers relating them to each station will be called coefficients.

The shape functions and coefficients are used in classifying stations into homogeneous groups.

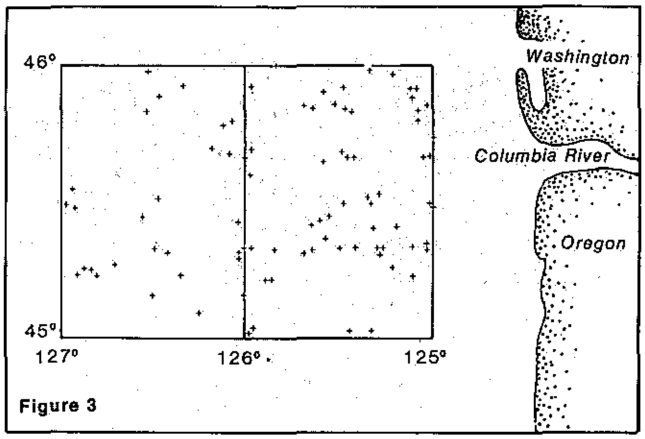


Figure 3

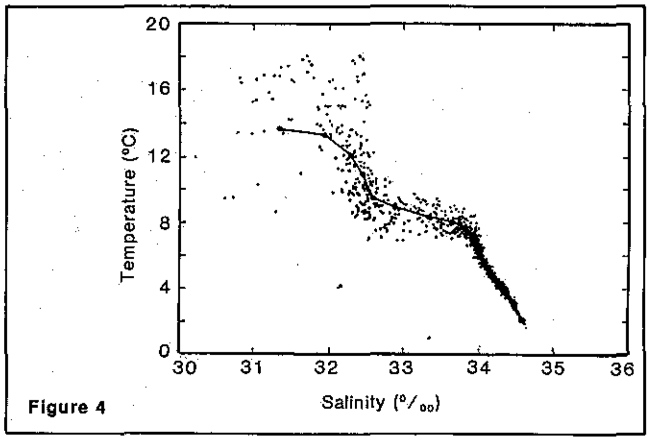


Figure 4

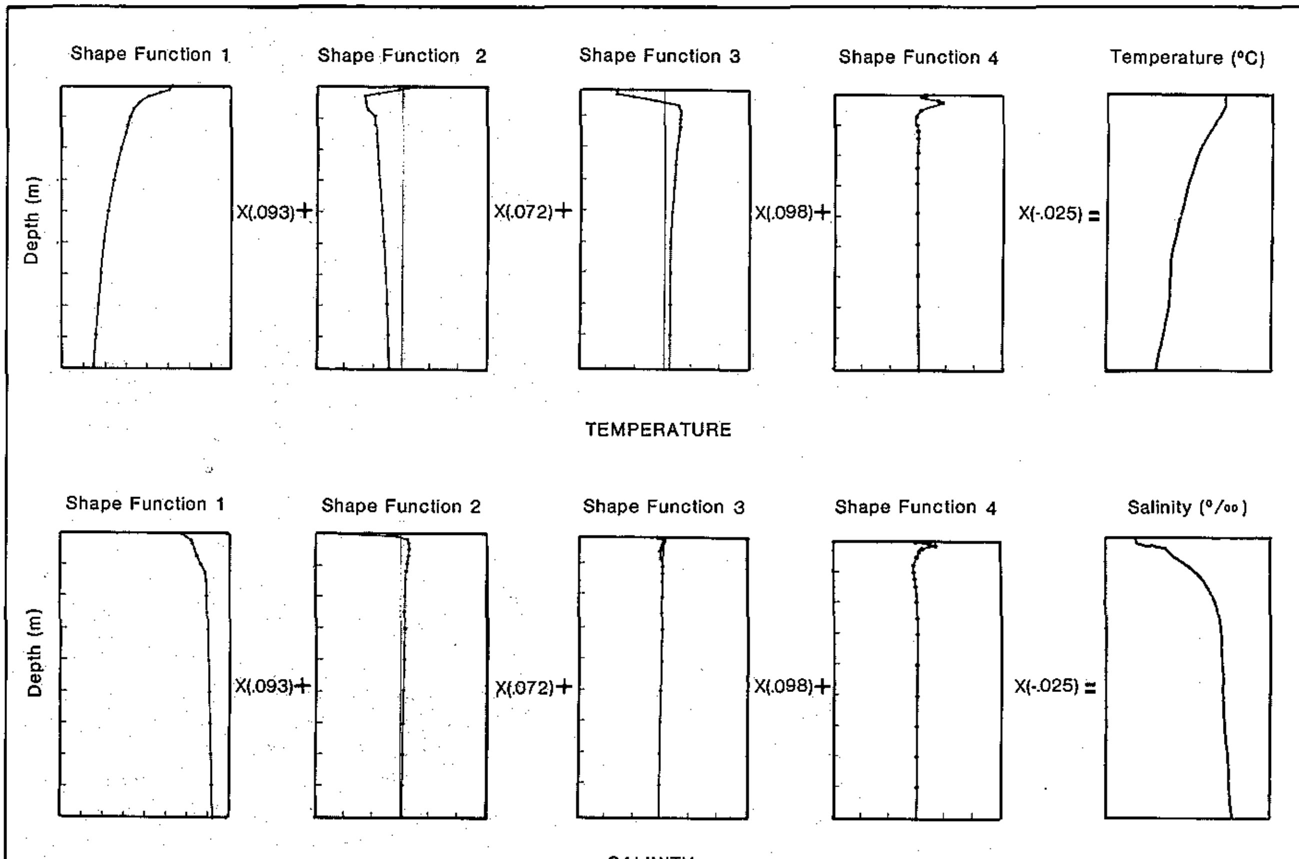


Figure 4

Top left: The 95 stations used in the analysis below. Top right: Composite plot of temperature-salinity values for the stations. Above: Dominant patterns are represented by shape functions. Unique coefficients link shape functions to each original station. If each shape function is multiplied by the coefficient for one of the stations, and the resulting modified shape functions are added, we get an approximation of the original station profile. Near right: Station coefficients for the second shape function show the inflow of fresh water from the Columbia River during June and July. Far right: Coefficients of the third shape function show the seasonal heating and cooling cycle in the surface layer.

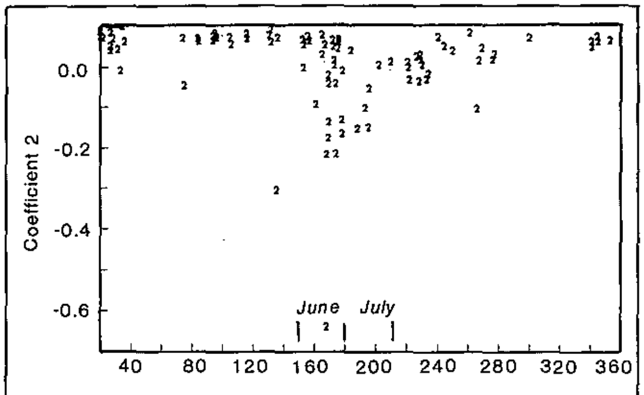


Figure 5

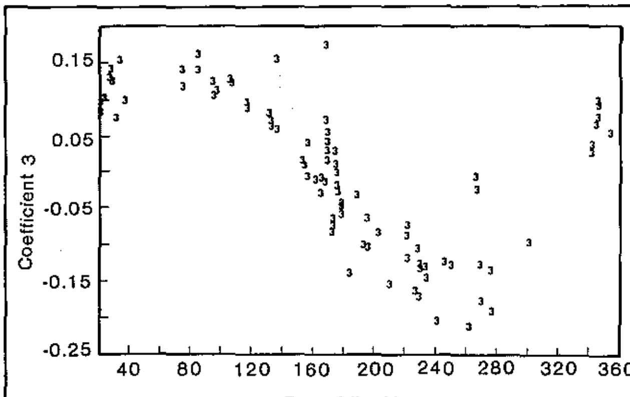


Figure 6

However, they also provide information about (1) important characteristics of the environment and (2) important relationships of temperature and salinity to time and location. The first shape function, which is the most important in describing the data, provides an estimate of average temperature and salinity profiles of all the data. This can be seen in figure 4, in which the first shape function is superimposed on all data used in the analysis. While the first function shows average conditions, subsequent functions show the most important variations of actual data from the first function.

In this analysis, the second shape function has large negative values for salinity at the surface. This reflects the fact that several stations in the data set were taken at a time and location in which fresh (low-salinity) water from the Columbia River existed at the surface. Examination of the 95 station coefficients related to the second shape function reveals a sharp peak in the values during June and July (fig. 5). Columbia River outflow is normally at a maximum during June and July.

In the third shape function, there are large negative temperature values in the upper layer of water, and only slight changes in salinity. A plot of coefficients related to this function (fig. 6) shows an annual cycle related to the seasons. This function and its coefficients show the effect of normal seasonal heating and cooling of water at the surface.

We turn now to the original problem, which is to find groups of data profiles with similar traits. Because the shape functions represent all stations, information about the unique shape of each data profile is contained in coefficients related to that station. Stations that have similar temperature and salinity profiles will also have similar coefficients, and those with dissimilar profiles will have different coefficients. It is this property of coefficients that makes an objective classification possible.

In determining homogeneous groups within the data set, ASD is used to rearrange the shape functions and station coefficients to form a new set of functions and coefficients. Each new shape function represents profiles of average temperature and salinity for one of the groups, and the new station coefficients indicate the degree of relationship of a station to each of the groups.

Classification by ASD of the 95 stations off the coast of Oregon produced four groups, each unique with similar traits. To illustrate the effectiveness of the grouping, fig. 7 shows the temperature and salinity characteristics of each of the four groups, and the distributions of the stations in space and time. The first two groups reflect normal winter and summer characteristics. Notice that the major difference between these two classes lies in surface layer temperatures. According to the station locations, conditions represented by each group can be expected in any location during the months indicated by the time plot.

Groups 3 and 4 show the influence of the Columbia River on this region. Extremely low surface salinity, occurring mostly in June and near the Columbia River, is the identifying characteristic of the third group.

With time, as this thin surface layer of freshwater spreads outward and is mixed downward, a somewhat deeper layer of moderately low salinity water is produced. This is shown in the stations of group four, which are distributed over a wider geographic area and a longer time period than the stations of group three.

The application of ASD to our set of temperature and salinity values has answered the questions stated at the beginning of the article. In addition, those answers have helped us understand the environment and its variations in time and space. This understanding can be used as a starting point in the search for answers to other, perhaps more significant, questions.

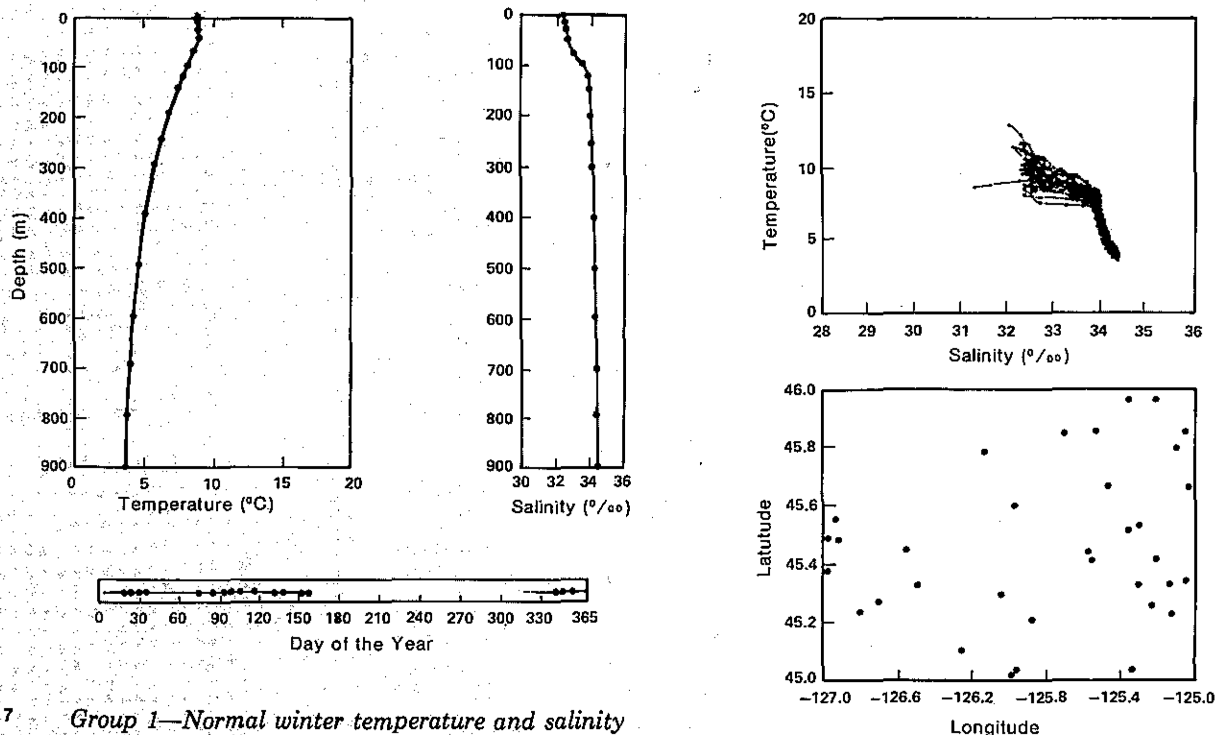


Figure 7 *Group 1—Normal winter temperature and salinity distributions.*

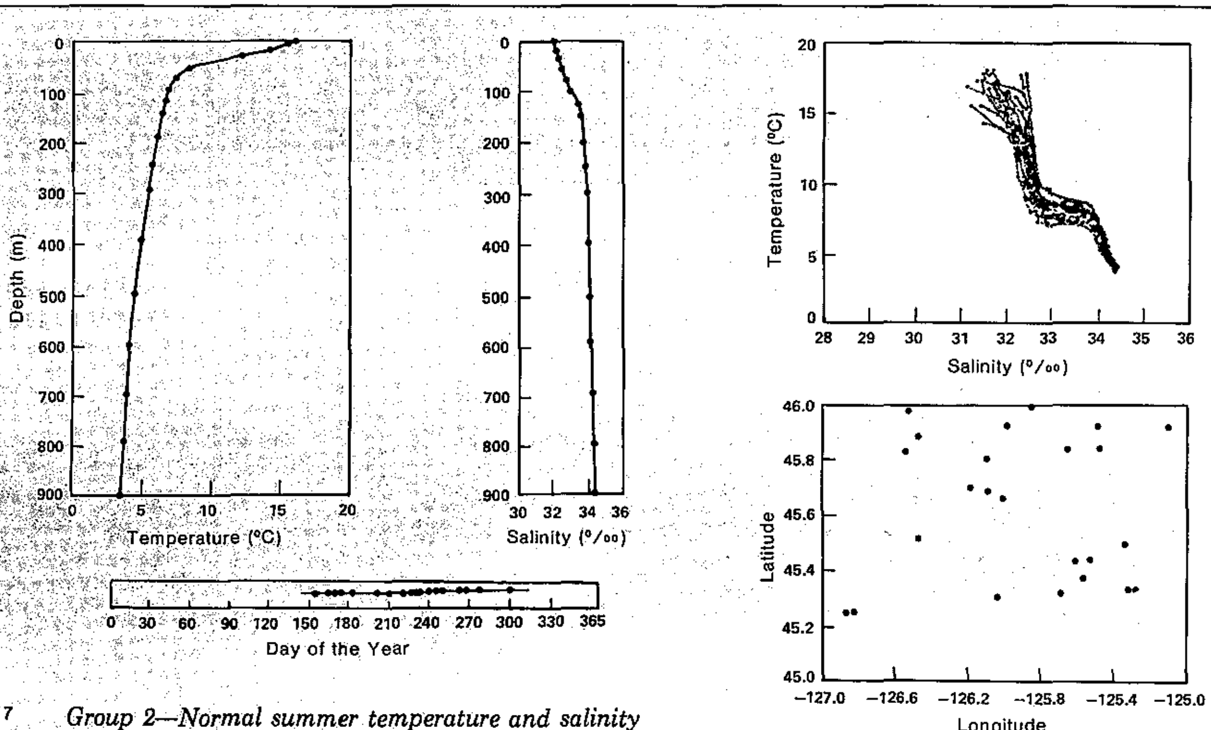


Figure 7 *Group 2—Normal summer temperature and salinity distribution.*

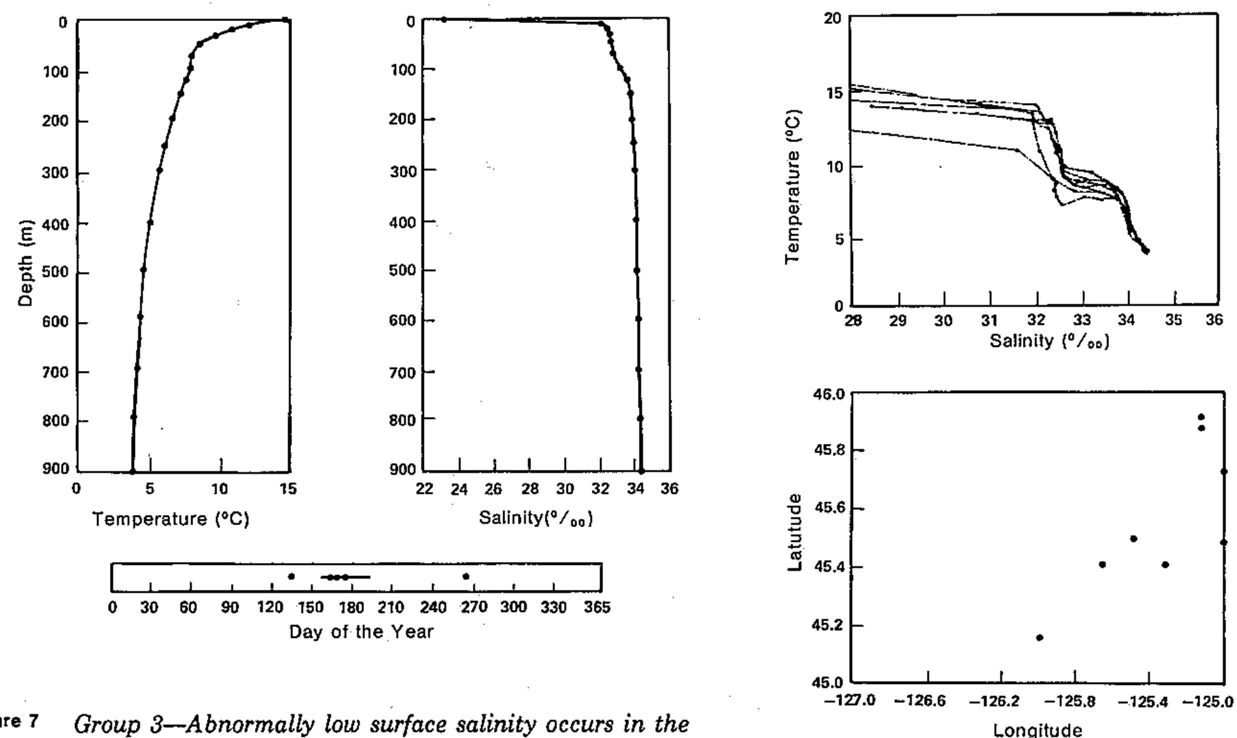


Figure 7 *Group 3—Abnormally low surface salinity occurs in the eastern part of the region during June.*

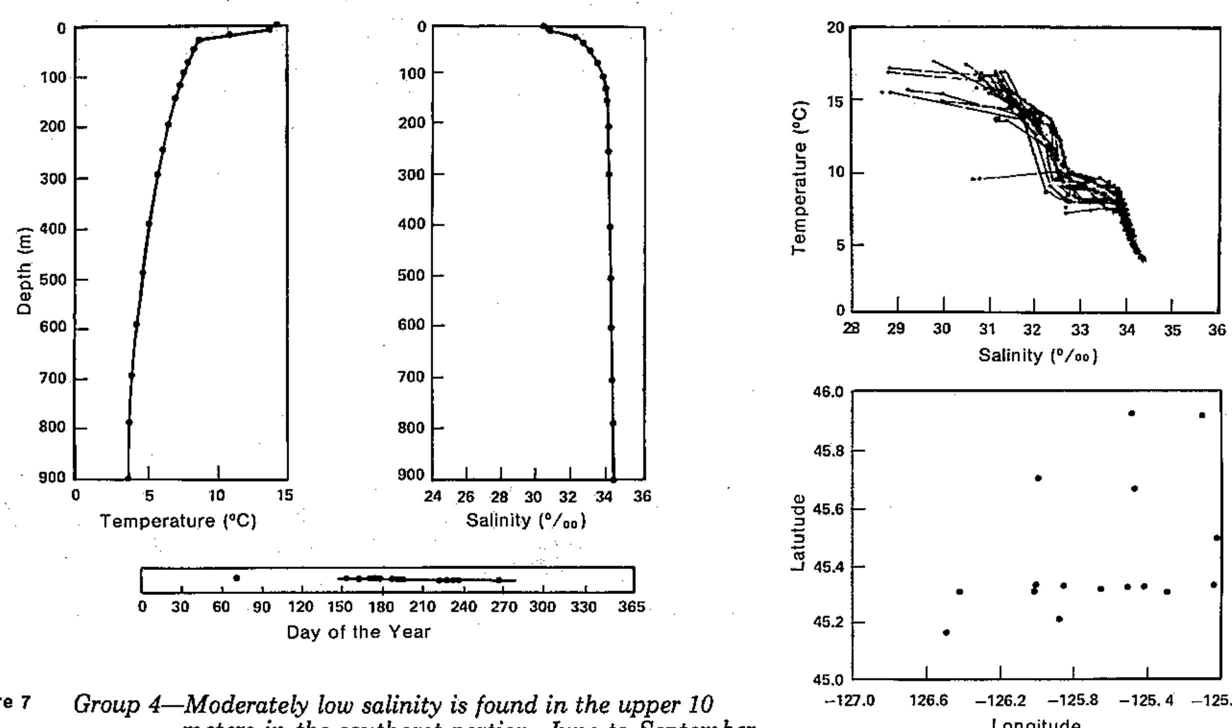
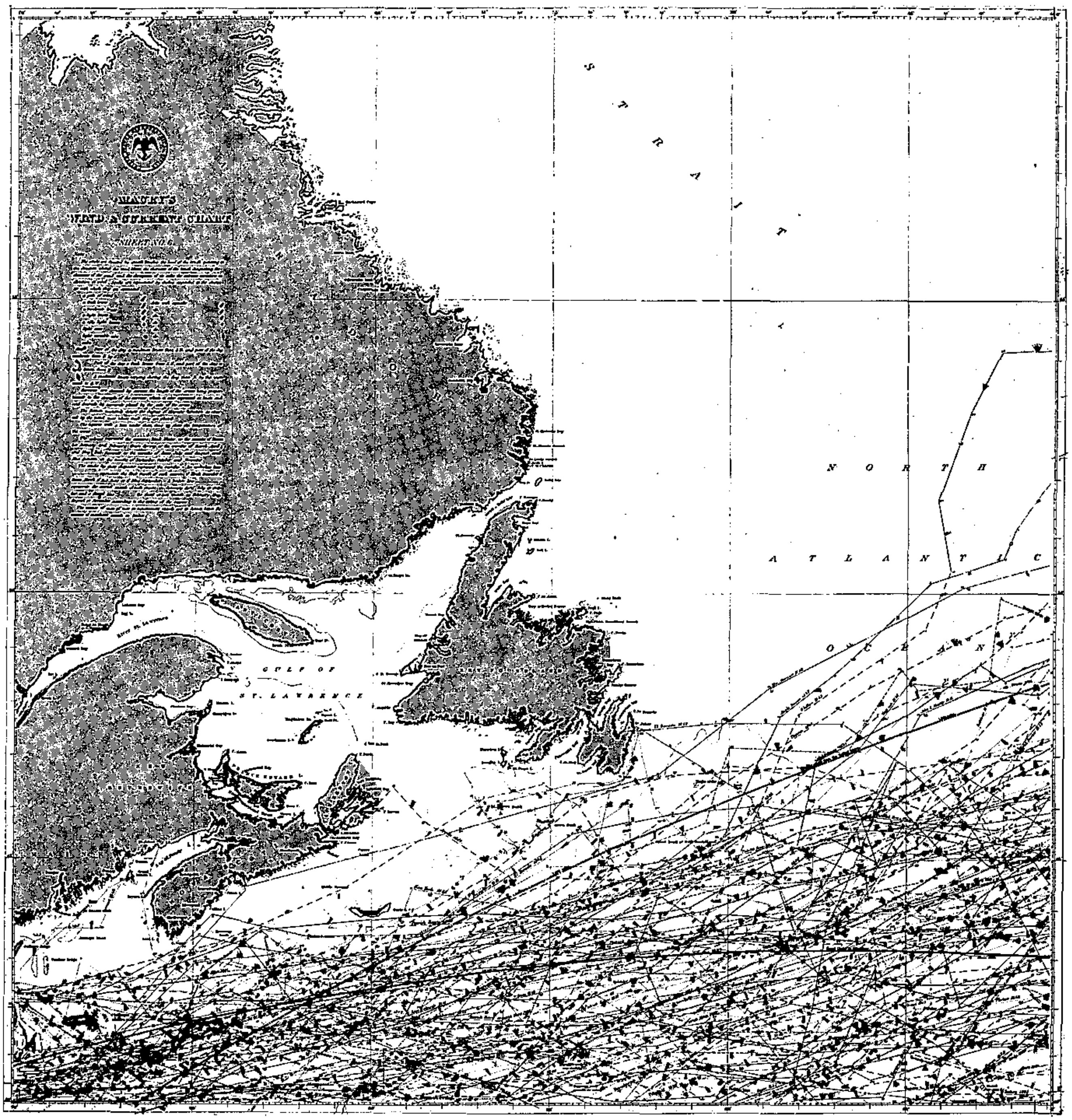


Figure 7 *Group 4—Moderately low salinity is found in the upper 10 meters in the southeast portion, June to September.*

Marine Climatology Since 1860

By Robert Quayle
National Climatic Center



The EDS National Climatic Center, with financial support from the National Science Foundation's Office for the International Decade of Ocean Exploration, is helping fill some gaps in our knowledge of the climate over the world's oceans for the past 115 years. The effort is called the Historical Sea-Surface Temperature Data Project. Some of the questions that it may help to answer are:

- What has been the overall oceanic climate variability since 1860?
- How are climatic trends in one part of the world related to trends in other parts of world?
- Is there a balancing effect, so that climatic extremes in one area tend to be offset by opposite extremes in another area?

Stated briefly, the goal of the project is to produce monthly summaries of sea-surface temperature, surface air temperature, and wind for each year during the period since 1860 for all ocean areas of the world. The period 1861-1960 will be studied first.

The areas of responsibility accepted by countries cooperating in this World Meteorological Organization (WMO)-sanctioned effort are:

- Pacific Ocean—the United States (Publication goal: early 1977).
- Indian Ocean and Mediterranean Sea—The Netherlands (Publication goal: late 1977).
- Atlantic Ocean—Federal Republic of Germany (Publication goal: 1978).

The United Kingdom is cooperating in the project by providing data, but is not responsible for producing summaries of any ocean area. Data will be available in three forms:

- The published summaries.
- Magnetic tapes of the published summaries (about one tape per ocean).
- Magnetic tapes of the basic observational data.

The basic WMO project guidelines established rather rigid international rules for the project. Namely, the period was to be 1861 (possibly earlier, if data coverage warranted) to 1960; only bucket sea-surface temperatures were to be summarized; modified Beaufort wind equivalents were to be used (WMO, 1970a and -b); and only well-documented data sources of relatively high quality were to be included.

After publication of the basic WMO summaries, the National Climatic Center and the EDS Center for Experiment Design and Data Analysis plan further cooperative efforts, including:

- Augmenting the basic data with additional sources (including data since 1960).
- Evaluation of nonbucket sources and refined (interactive-graphics) quality control of all data.
- Objective analysis of the expanded and extended data base.
- Investigation of the relationships of large-scale patterns of temperature and wind over the Pacific and of weather over North America.

Project Background

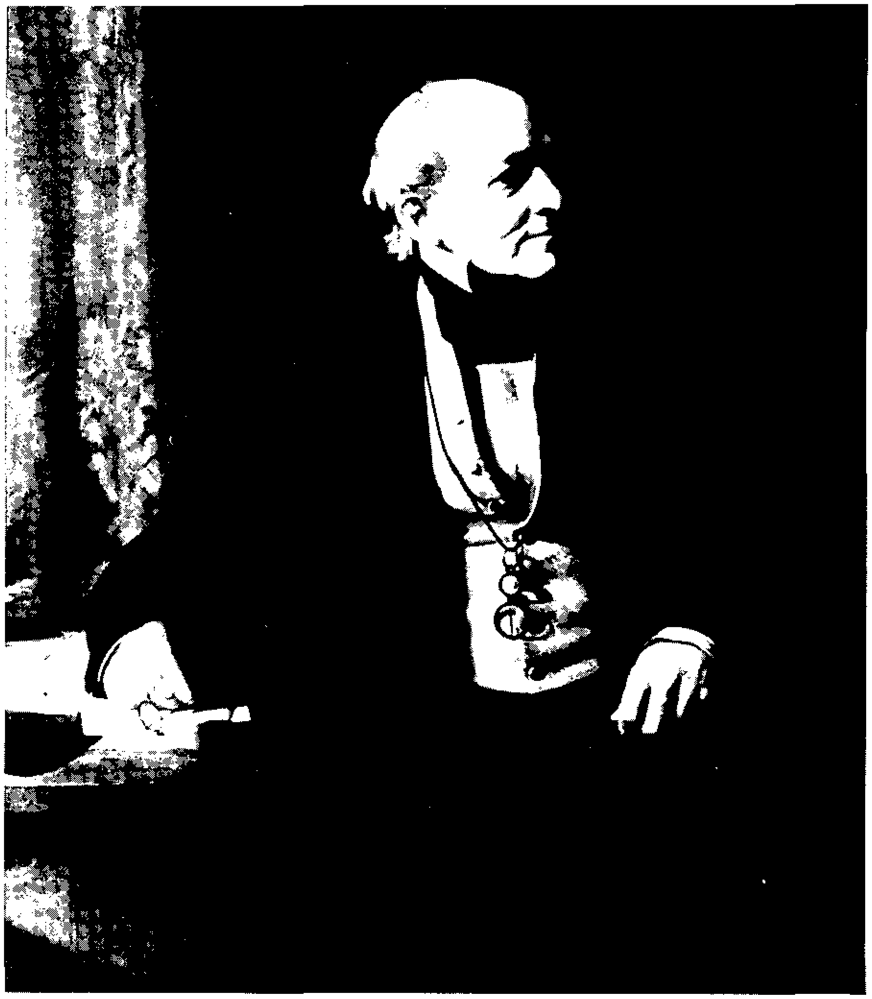
Mariners, because of their sensitivity to wind and weather, were perhaps the first to systematically record weather observations. Sea-surface temperature was among the earliest weather entry in ships' logs. Near the end of the 18th Century, under the leadership of Benjamin Franklin, sea-surface temperature was used as an aid to navigation, particularly in and near the Gulf Stream (Canfield, 1957). Systematic codification of environmental data was instituted in December 1838 by the British Navy, after a period of over 30 years development by Rear-Admiral Sir Francis Beaufort.

Shortly after the introduction of Beaufort's codes in England, U.S. Naval Officer Matthew Fontaine Maury was named Superintendent of the Depot of Charts and Instruments, which was also, coincidentally, the United States repository of all ships' logs. In a flash of insight that provides the stimulus for a quantum-jump in so many human endeavors, he saw in the vast accumulation of disused weather logs a priceless record of a part of our planet's geophysical history. From a practical standpoint, he envisioned summarization of these data into simple charts that would be beneficial to mariners in transit or planning a voyage.

In 1847 Maury issued the first "Wind and Current Chart of the North Atlantic." This was the forerunner of today's Pilot Chart Series and of all forms of comprehensive marine climatic atlases. Maury's charts were an immediate success, significantly shortening the time required for oceanic crossings. They also attracted the interests of meteorologists and climatologists, who used them to broaden their understanding of the ocean's surface environment. Maury also introduced the summary log concept and the idea of giving volunteer marine observers useful climatic information in exchange for their cooperation.

Maury's next major initiative was directed toward obtaining international agreement among maritime nations on "An uniform system of meteorological observations at sea." Largely because of his efforts, an international meeting was convened in August 1853 in Brussels, Belgium. Ten

Left: A section of Maury's "Wind and Current Chart." (Circa 1848)
Defense Mapping Agency.



Sir Francis Beaufort (1774-1857). British National Maritime Museum

leading maritime nations were represented at this meeting—the earliest significant international meteorological/oceanographic scientific conference of such scope. Other maritime nations, understanding the importance of such cooperation, soon joined in, and the conference was a success. Today's World Meteorological Organization can trace its beginnings back to that 1853 meeting. It was 1872 before a similar meeting was held to deal with observations from land stations. Clearly, the maritime community pioneered the concept of an international system of weather observations.

Indeed, the year 1854 ushered in a new era in marine data processing . . . an international era. By 1860 most countries were operating under standard procedures, thus the selection of that year as approximately the first year of the Historical Sea-Surface Temperature Data Project. Cooperators are free to go back further in time if possible—to 1854 if they wish—providing data coverage is adequate.

Some other significant milestones are worth noting. In 1886 Herman Hollerith, an Englishman working for the U.S. Bureau of the Census, introduced the first practical system of electrical tabulating. Just 10 years later the U.S. Navy Hydrographic Office—a direct descendent of Maury's "Depot"—began using Hollerith punched cards for tabulating marine weather data. This was the first recorded use of "automation" in the field of meteorology (Bates, 1956). This fact was apparently missed in a 1945 bibliography of early uses of punched cards in meteorology, which attributed the earliest efforts to the European community in 1921 (George, 1945; Bates, 1956). By 1924 international exchange of Hollerith cards had become a reality, initial efforts having been made by England, Belgium, and Norway (*The Marine Observer*, 1924). A young U.S. Naval Officer, Lt. F. W. Reichelderfer, later to become Chief of the U.S. Weather Bureau, was involved with arrangements for similar exchanges with the United States at about the same time.

Thus, by the mid-1920's all the necessary groundwork was laid: An internationally consistent set of observing practices, electrical computing procedures, and an internationally accepted method of exchange—the Hollerith card. Now all that was required was time—time for data to accumulate and technology to advance. In 1967, a young Dutch marine climatologist, George Verploegh, following ideas expressed earlier by C. H. B. Priestly, published his *Report of the Consultant on the Historical Sea-Surface Temperature Data Project* for WMO. Predating the recent popular interest in climatic change, the report set forth the basic principles that were to guide the international group of experts which met in Geneva in 1970. This meeting, and a subsequent session in early 1975, established the project as described here.

Unfortunately, 1967-70 was a period of technological transition from international acceptance of punched-cards to dominance of magnetic tape as a medium of storage, retrieval, and exchange. The project probably would have been completed by now (but far less efficiently) had the punched-card concept of the 1967 Report been adopted. By 1970, however, it was obvious that all major environmental data services were converting to magnetic tape, so it was decided to await conversion of data from cards to tape on an international basis.

All participants were invited to back-punch as much historical data as possible for the project, but there were problems. The urgency for completion of the project was in conflict with long-term European plans to back-punch data. The United States, having been a minor maritime power during a good part of the period, had relatively little historical data to add as compared to the United Kingdom, Germany, and The Netherlands. To complicate matters further, punching is expensive and the early 70's, it must be remembered, were not "boom years." A decision was reached. The European cooperators would back-punch what they could, and the United States would contribute punched data (partly Japanese) off-the-shelf. In return for a lessened punching effort, the United States agreed to publish the entire series of data summaries from the "summary tapes" to be produced by the United States, Germany and The Netherlands.

It is estimated that about 25 million marine observations will be used in the formal WMO project. While this is an impressive amount of data, a similar amount probably resides in various national archives, yet to be put in digital form. The results of this project and related work may indicate that further studies should be planned to make use of this vast, untapped store of knowledge.

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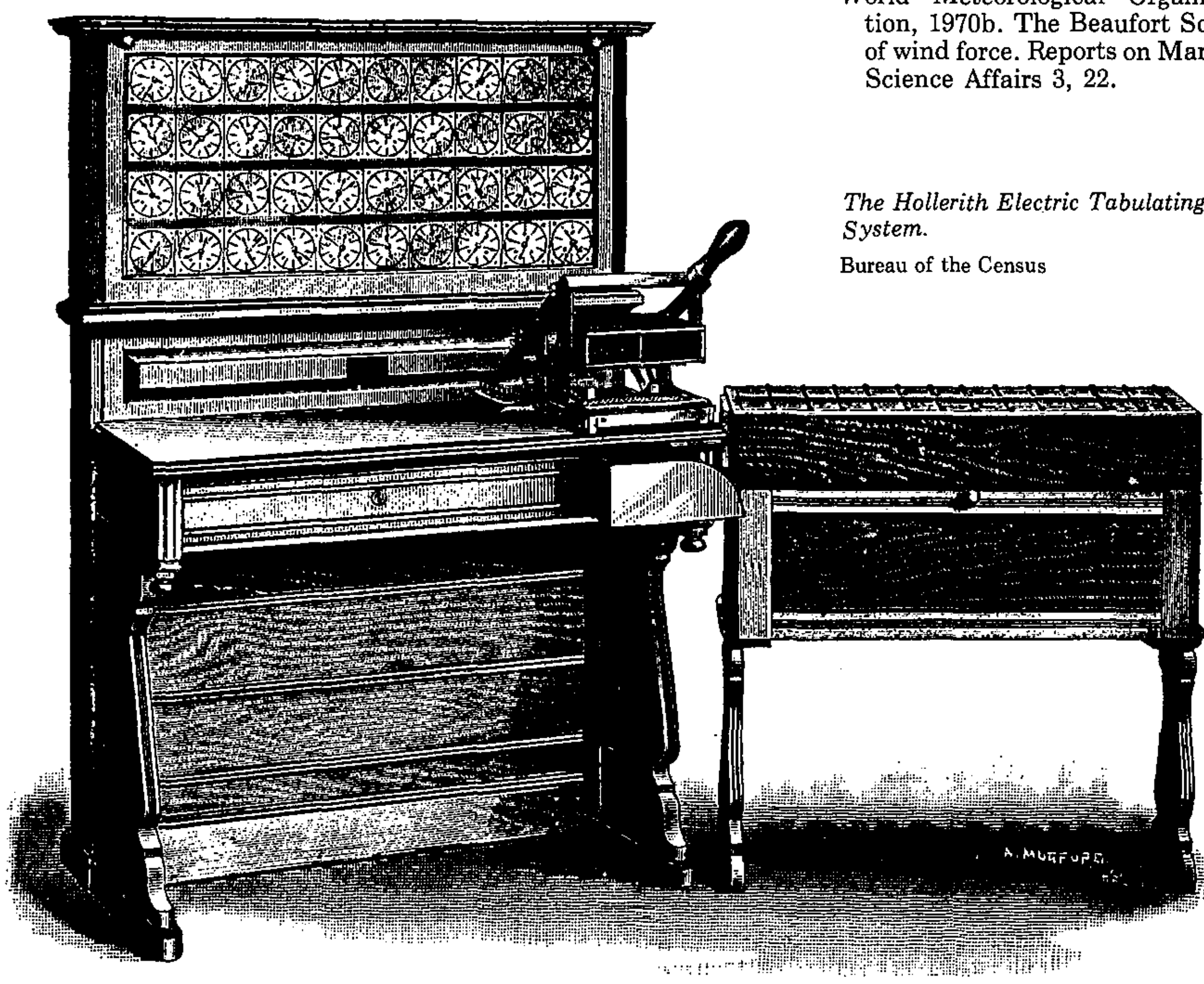


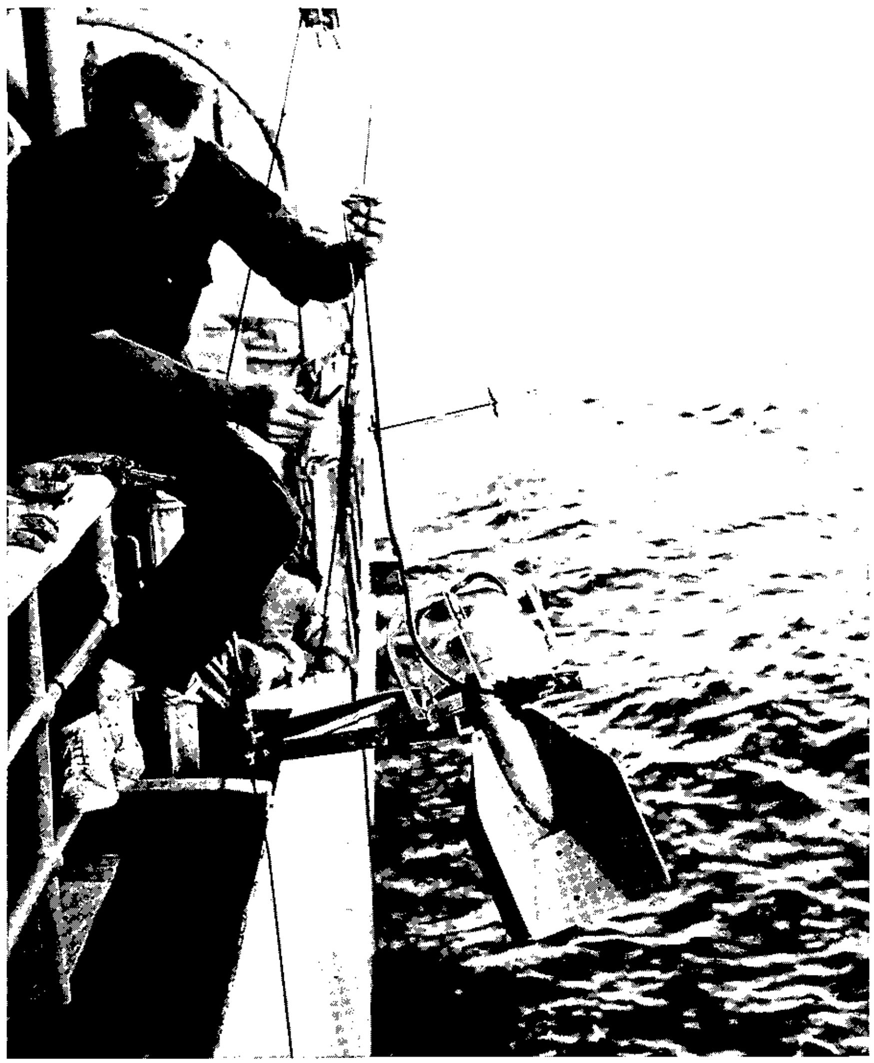
The Hollerith Electric Tabulating System.

Bureau of the Census

Subsurface Current Data and Information Referral Services

By Wellington Waters, National Oceanographic Data Center

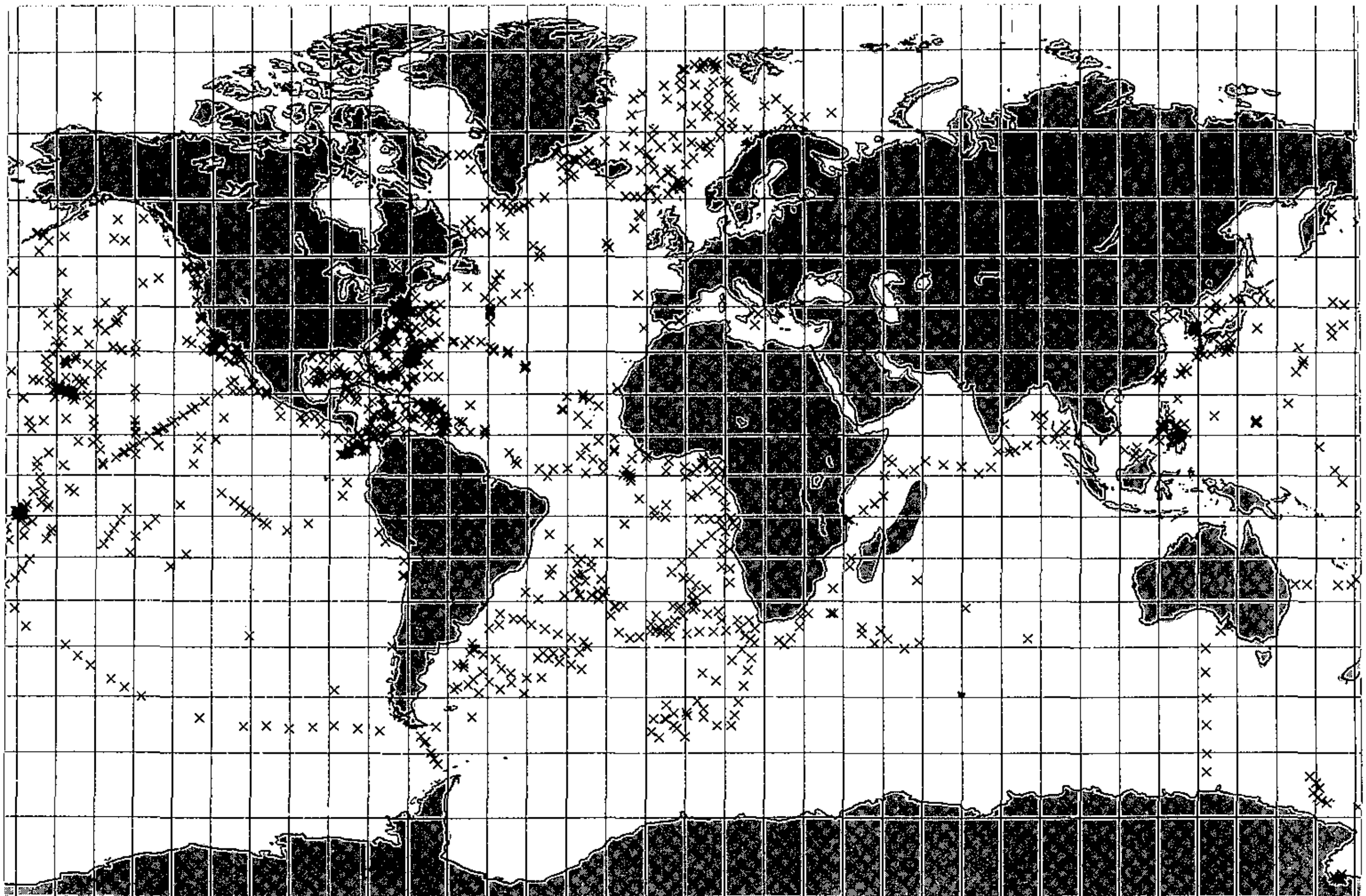
Over the past two decades or so, various national and international institutions have been developing and perfecting a growing family of ocean current measuring devices. These current meters generally can be classified as either Eulerian (stationary) or Lagrangian (moving with the current). During this period, significant files of subsurface current speed and direction data have been collected worldwide by national institutions, with the heaviest concentration of observations made near the U.S. east and west coasts and in the Gulf of Mexico and the Caribbean Sea.



Several years ago, two NOAA components, the National Oceanographic Data Center (NODC) and the National Oceanographic Instrumentation Center jointly sponsored a workshop on subsurface current measurements. The workshop, held at NODC, was attended by representatives from Woods Hole Oceanographic Institution, NOAA's National Ocean Survey, Scrips Institution of Oceanography, Nova University, the U.S. Naval Oceanographic Office, and the U.S. Coast Guard Oceanographic Unit. One of the recommendations of the workshop was that NODC should develop an index of subsurface current measurements and act as a referral center for these data.

In response to this recommendation, NODC developed the *NODC Index Form For Instrument-Measured Subsurface Current Observations (NIMSCO)*. This form served as the basis for collecting inventory information on subsurface current observation from the U.S. institutions. Subsequently, instead of completing NIMSCO forms for each current meter record, some institutions provided NODC with computer-compatible outputs of their inventories of current meter collections which were converted to NODC's NIMSCO computerized storage and retrieval system.

Over the past three years, as part of its Environmental Data Index (ENDEX), NODC has built a computerized file of over 2,000 individual current meter records. These records range in duration from a few hours up to several months. A significant number of



Left: NOAA scientists deploy a current meter.

Above: Geographic locations of subsurface current meter observations indexed by NODC.

the observations were taken at or near the ocean bottom; many are very deep measurements. Other measurements, of course, were made at the same mooring, but at different depths.

Some of the indexed current meter observations are obtainable from NODC in computer-compatible form. Others are available from the data-collecting institutions themselves. NIMSCO records contain the information needed to contact the data collectors, and the index can be searched and information retrieved on the collecting institution, cruise period, platform type, project, instrument and model number, usable record period, 10° and subsquares, processing status, data location, and observation depth.

The major user products of the NIMSCO file are listings of records and geographic plots by areas (10°, 5°, 2°, and 1° squares) of the number of collections and the collection locations. Requests for these products should be addressed to:

The Director, Data Services Division
National Oceanographic Data Center
Environmental Data Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Washington, DC 20235

Those wishing to include inventories of their subsurface current meter data (historical and future collections) in the NODC NIMSCO file should contact:

Chief, Data Index Branch
National Oceanographic Data Center
Environmental Data Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Washington, DC 20235

In addition to developing NIMSCO, NODC in 1974 published a *Bibliography on Subsurface Ocean Currents.* This product includes references to and abstracts of over 4,000 articles, reports, and papers published worldwide through 1972. These are indexed by subject, author, and geography. Microfiche copies of this bibliography or portions thereof are available from NODC. Hard copies are available from the Department of Commerce's National Technical Information Service, 5285 Port Royal Road, Springfield. VA 22161.

Aquatic Sciences and Fisheries Information System: An International Cooperative Exchange Mechanism

The increasing importance of marine and freshwater resources to the economic growth of nations has led to an ever-increasing flood of scientific and technical information. No single nation or government has sufficient scientific and technical personnel or funds to examine all aspects of the global marine and freshwater environments. Only an integrated system of information exchange coordinated by an international body can provide the needed scope and expertise.

The needs of nations for the international exchange of environmental information has been recognized by the International Conference on the Human Environment, held in Stockholm in 1972, and by international bodies such as the Scientific Committee on Oceanic Research (SCOR), Intergovernmental Oceanographic Commission (IOC), Food and Agriculture Organization (FAO), and United Nations Environment Program (UNEP). This recognition led to the formation of the international Aquatic Sciences and Fisheries Information System (ASFIS) to serve the science and technology of marine and freshwater environments.

ASFIS came into being as the result of resolutions of FAO and IOC. FAO called for a collaborative program to integrate and develop an international computer-oriented information system at the second session of the IOC Executive Council in Paris, May 1973. Action subsequently was taken to establish ASFIS under a resolution of the 8th Session of the General Assembly of IOC. This resolution led first to a meeting of experts in Rome, in November 1974, and a second meeting, the First Session of the Joint FAO/IOC Panel of Experts on ASFIS in New York, September 1975, to formulate policy and guidance for the development of ASFIS products and services.

Input Centers

Today, ASFIS input centers in six countries identify, select, index, and input to the system literature from 4,500 serial journal titles, reports, books, monographs, and pamphlets.

The following bodies are currently (late 1976) cooperating with FAO and IOC in the development of the ASFIS system. The special contribution of each is indicated.

- All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Moscow, U.S.S.R., undertakes scanning, selecting, indexing, and abstracting Russian and other Cyrillic language ASFIS-related literature.
- Federal Research Institute for Fisheries, Hamburg, Federal Republic of Germany, undertakes scanning, selecting, indexing, and abstracting ASFIS-related literature published in the German language as well as International Council for the Exploration of the Seas (ICES) papers.
- National Center for Exploitation of the Oceans (CNEXO), National Bureau of Oceanic Data (NBDO), Brest, France, undertakes scanning, selecting, indexing, and abstracting ASFIS-related literature published in France.
- Department of the Environment, Fisheries and Marine Service, Ottawa, Canada, undertakes scanning, selecting, indexing, and abstracting all ASFIS-related literature originating in Canada.
- Information Retrieval, Limited, London, United Kingdom, undertakes scanning, selecting, indexing, and abstracting all ASFIS-related articles from serial journal titles not covered by other input centers, and under contract from FAO, compiling and publishing, as printed products, monthly issues of *Aquatic Sciences and Fisheries Abstracts* (ASFA) and its related indexes.
- National Oceanic and Atmospheric Administration (NOAA), Washington, D.C., United States: undertakes scanning, selecting, indexing, and abstracting report literature originating in the United States.
- National Environment Research Council (NERC), London, through Marine Biological Association of the United Kingdom, Plymouth, United Kingdom undertakes scanning, selecting, indexing, and abstracting marine pollution and other ASFIS-related serial literature.
- The ASFIS Coordinating Centre in FAO headquarters (Rome) is responsible for collecting, organizing, and processing the bibliographic data and abstracts received from these input centers, and for making the total base available to those who need the information.

Output: ASFIS Products and Services

Marine Science Contents Tables

A free monthly pamphlet that reproduces the tables of contents of the world's leading marine science journals. In addition, important future marine science meetings are listed, giving the meeting date, place, sponsoring body, and title. Over 3,000 copies of the pamphlet are circulated without charge to marine scientists around the world.

Aquatic Sciences and Fisheries Abstract

ASFA is a monthly journal with an annual cumulative index. Monthly issues contain about 1,200 abstracts classified under a subject grid comprising 32 chapter headings and 132 subheadings. Abstracts relevant to more than one subheading are referenced. Journal issues also contain book notices; notices of the availability of translations; and monthly geographic, taxonomic, and author indexes. The annual index is divided into three parts: subject, taxonomic, and geographic; in each the entry is cross-referenced to taxonomic, geographic, or subject information.

The literature scanned in the compilation of ASFA includes journals from over 20 countries, reports, unpublished documents, books, monographs, and translations. Mean lag time between appearance of an article and appearance of its ASFA abstract is 20 weeks for nonconventional literature.

ASFA Related Tape Services

Starting with January 1, 1975, ASFA indexes have been generated from computer input prepared at the FAO Coordinating Centre. An experimental semiannual index for the first half of 1975 was produced for the FAO by the Institut fur Dokumentationswesen in Germany utilizing the facilities of the Zentralstelle fur maschinelle Dokumentation. In the United States, EDS has sponsored the availability of this test data base to the public through the Dialog on-line information retrieval service operated by the Lockheed Corporation in Palo Alto, California. ASFA thus joins *Oceanic Abstracts* and *Meteorological and Geoastrophysical Abstracts* in being available through Lockheed as a part of EDS' Oceanic and Atmospheric Scientific Information System (OASIS). Users of Dialog will find that ASFA is available as File 44. Others who wish searches of ASFA may direct their requests to any EDS center that services OASIS requests. ASFA is also available in Canada on the Q/L Systems under the sponsorship of Environment Canada. An experimental semiannual index for the second half of 1975 was produced by the Canadian Department of the Environment.

In addition to these two indexes, computer tapes in International Standards Organization format for bibliographic data in machine-readable form have been prepared for experimental purposes. Centers interested in using any of these indexes experimentally should apply to FAO.

Tapes carrying bibliographic and indexing data for the 1976 and 1977 ASFA input will be available in late 1977. Starting in January 1978, the entire ASFA data base (bibliographic captions, abstracts, and index entries) will be available in tape format.

ASFIS World List of Periodicals in Marine and Freshwater Science

The Fisheries Department of the FAO compiles a listing of bibliographic details of serial publications. This list of 1,200 key titles was published as a preliminary edition in 1976, giving each journal title, its abbreviated title as used in ASFA, publisher, place of publication, commencement date, frequency, language of text, and language of summaries. A new supplementary list of 600 additional and amended titles will be published in 1977, and regular updates will be prepared.

ASFIS Register of Experts and Institutions

A directory of experts and institutions in the science and technology of marine and freshwater environments has been compiled by querying individuals in 100 countries. Seven hundred institutions have been identified, and 12,000 experts and their fields of expertise have been listed. The information is computer-stored and is continuously being updated. The Register will be published in 1977.

How to Obtain ASFIS products:

Marine Science Contents Tables.
Free.

ASFIS World List of Periodicals in Marine and Freshwater Sciences.
Free.

ASFIS Register of Experts and Institutions. Free.

Should be ordered from:

Research Information Unit
Fishery Resources and
Environment Division, FAO
Via delle Terme di Caracalla
00100 Rome, Italy

Aquatic Sciences and Fisheries Abstracts + associated index.
$250.00 U.S.

Should be ordered from:

(North and South America)
Information Retrieval, Inc.
1911 Jefferson Davis Highway
Arlington, Virginia 22202, U.S.

(Rest of the World)
Information Retrieval Limited
1 Falconberg Court
London W1V 5 FG, England, U.K.

Questions or comments should be directed to the above addresses or to national input centers.

ASFA Editorial Board Meets

The Aquatic Sciences and Fisheries Abstracts (ASFA) Editorial Board met October 18-21, 1976, at the FAO Fisheries Building in Rome, Italy. ASFA is an international information journal and data base for the science and technology of marine and freshwater environments. ASFA is a module of the Aquatic Sciences and Fisheries Information System (ASFIS) described on page 24 .

During the October meeting, Robert R. Freeman, Deputy Director of EDS' Environmental Science Information Center, conducted a demonstration computer search of the ASFA data base for Dr. Hiroshi Kasahara, Director of the FAO Fishery Resources and Environment Division, and members of his staff. A computer terminal at FAO was connected by telephone to Paris, where a ground station for a satellite data communications network called TYMNET is located. The connection from Paris was via TYMNET to the Lockheed Dialog system in Palo Alto, California, which contains an automated test file of ASFA information for the first 6 months of 1975. The demonstration illustrated the capability of remote searching of a central computer system a great distance from a terminal.

Plans were laid at the meeting for improvements to ASFA. By 1978, the automated file will be updated regularly. Also, ASFA intends to increase the number of abstracts included from the current 14,000 to 20,000-25,000 per year. Future issues of the ASFA journal will be divided into two separate volumes, each with a specific emphasis. Volume 1 will cover marine and aquatic biology, biological oceanography and limnology, marine and freshwater ecology, and living marine and freshwater resources. Volume 2 will cover physical, chemical, and geological oceanography and limnology; marine geophysics; applied oceanology; ocean engineering; and non-living marine resources. Each volume may be purchased separately.

Northeast U.S. Marine Program Study

EDS has undertaken a study of Federally funded marine science and engineering programs in the Atlantic coastal region between Cape Hatteras and Maine. The study was initiated last summer by the Interagency Committee on Marine Science and Engineering (ICMSE). Lead responsibility was assigned to EDS.

The goal of the study is to assure the adequacy of the body of technical and scientific information available as a base for management decisions about the Atlantic coastal margin. The study will (1) identify all Federally supported marine science and engineering programs in the study area for fiscal years 1977 and 1978, (2) identify information gaps and program overlaps, and (3) recommend program modifications necessary to obtain specific types of scientific and engineering knowledge needed for decision making. The study also will provide a means of coordinating research efforts among various Federal agencies.

Last August, questionnaires were sent to ICMSE member agencies to solicit information on their marine programs. ICMSE member agencies involved include the Departments of Health, Education, and Welfare; Commerce; Defense; Interior; and Transportation; as well as the Energy Research Development Administration; Environmental Protection Agency; and the Smithsonian Institution. The information received is currently being analyzed by the EDS Case Study Staff of the Center for Experiment Design and Data Analysis' Marine Assessment Division, whose members are working in close cooperation with representatives of the ICMSE member agencies.

Interagency workshops at the Woods Hole Oceanographic Institution in January 1977 will review the draft report resulting from the project. A final report will be completed by spring 1977.

Two Computerized Earthquake Catalogs Available

Under a contract awarded by EDS' National Geophysical and Solar-Terrestrial Data Center, the University of California at Berkeley has prepared a computerized catalog of earthquakes. The catalog contains 5,600 seismic shocks recorded in California and adjacent areas from 1769 to 1927.

Under the NGSDC contract, Professor Bruce Bolt of UC and his students revised the Townley-Allen catalog, first published in the *Bulletin of the Seismological Society*, Volume 29, 1939. They used criteria based on modern understanding of earthquakes, tectonic structure, published field observations, and damage reports. The Townley-Allen catalog lists epicentral intensity on the Rossi-Forel scale. The catalog prepared by Professor Bolt uses field observations or an accepted conversion formula to list intensity on the Modified Mercalli Scale. The revised catalog and a FORTRAN program to list it are available from NGSDC on magnetic tape for $60.

The other computerized catalog contains all earthquakes recorded in China from 1177 B.C. to 1900 A.D. W. H. K. Lee of the U.S. Geological Survey used original sources in the Chinese language and translated the data and verified dates, epicenters, magnitudes, epicentral intensities, and provinces where the earthquakes occurred. The catalog, listing 566 earthquake events, is available from NGSDC either on punched cards or magnetic tape. Lee plans to complete the catalog through 1974 by the latter part of 1977.

For additional information on either computerized catalog contact NGSDC, D62, National Oceanic and Atmospheric Administration, Boulder, CO 80302.

Great Lakes Study Data System Described

IFYGL Physical Data Collection System: Description of Archived Data has been published by EDS' Center for Experiment Design and Data Analysis. The report concerns the International Field Year for the Great Lakes (IFYGL)— a joint United States/Canadian research program during April 1, 1972, to March 31, 1973.

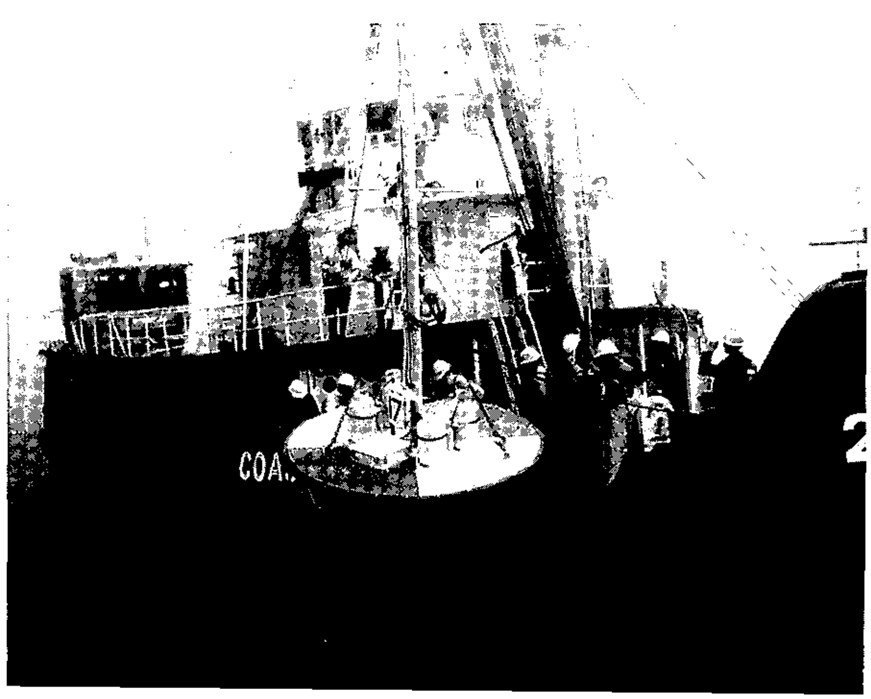
During IFYGL, a Physical Data Collection System (PDCS) was established to support the program's primary objective—to study the physical processes related to Lake Ontario and its basin. The system consisted of deepwater buoys, moored towers, and land stations and was designed to measure the meteorological and limnological qualities of Lake Ontario. Following the field data acquisition stage, a CEDDA team designed data reduction procedures to guide NOAA's Lake Survey Center initial processing of PDCS data, and completed final processing and validation of the data.

This new report describes in detail PDCS characteristics, calibration procedures, and techniques used in processing the data, as well as factors affecting the data's quality and quantity. A chronology of events, station inventory, internal calibration values, sensor calibration correction values, and station position corrections are given in separate appendices. The report also has archive formats and a catalog of acquisition numbers required to obtain the data from the IFYGL.

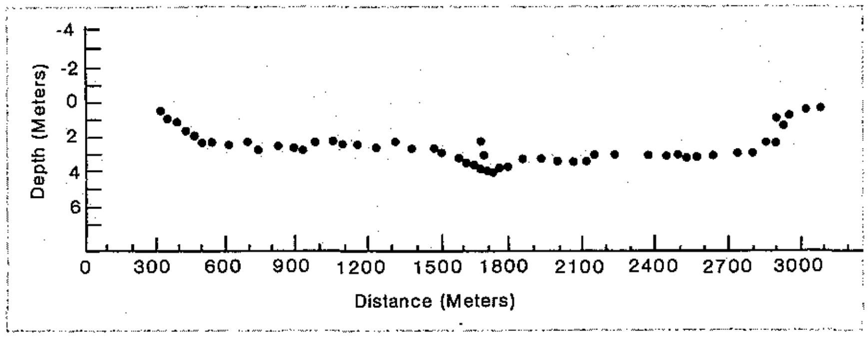
Copies of the PDCS report or requests for IFYGL data should be addressed to:

IFYGL Data Manager, Room 17
National Climatic Center
National Oceanic and Atmospheric Administration
Federal Building
Asheville, NC 28801

Lowering a buoy into Lake Ontario during IFYGL.



Bathymetric and Associated Data for U.S. Coastal Regions



Bottom profile across Bay River, N.C.

In June 1976, the EDS National Geophysical and Solar-Terrestrial Data Center (NGSDC) received from NOAA's National Ocean Survey (NOS) the first portion of a 40-million record data set containing nearshore digital bathymetric, bottom characteristic, and danger-to-navigation (i.e., hydrographic) data. These data are being made available to the public through NGSDC as a byproduct of an NOS program to automate their production of nautical charts.

The initial phase of the NOS automation program includes the digitization of data from 2,800 hydrographic survey sheets dating from 1930 to 1965 and ranging in survey scale from 1:2,500 to 1:40,000. A typical survey sheet contains about 10,000 soundings.Generally the sounding line spacing is 100 meters (330 ft.) in depths less than 11 fathoms, ranging to 800 meters (2,640 ft.) at depths of 30 to 50 fathoms.

The second phase includes digitization of data from an additional 400 survey sheets for the same time period, but covering survey scales of 1:40,000 to 1:200,000. Data taken since 1965 are collected in digital form, and NGSDC will add them to the data base as they are received.

Within several years, NGSDC will be managing a data base containing data from all coastal surveys taken since 1930 and updated continuously as new information is received from NOS. Ending in 1977, NGSDC will publish the first in a series of six catalogs. The catalogs will describe the data, indicating distribution and density by area index charts. The first catalog will describe the data available in the area from Passamaquoddy Bay, Maine, to Silver Bay,N.J.

A hydrographic survey performed by NOS (previously the Coast and Geodetic Survey) satisfies the following requirements:

- An area has been systematically covered with accurately located depth measurements sufficient to insure that all dangers to navigation have been found.
- All underwater relief features have been determined, including channels, shoals, banks, and reefs, and the least depth determined on all dangers to navigation.
- The position of all fixed and floating aids to navigation has been accurately determined.
- Contemporary tide observations have been made from which soundings may be reduced to plane of reference.
- Bottom samples have been obtained with sufficient frequency to reveal the general characteristics of the submerged land.
- Other miscellaneous operations have been completed, such as locating and describing landmarks to be charted, accumulating data to be published in the U.S. Coast Pilots, and measuring magnetic variation.

About 98% of the data that have been digitized and placed on magnetic tape are soundings (depths) collected by continous record fathometers. The rest of the data concern bottom characteristics and dangers to navigation. Bottom characteristics data consist of a one-to four-word description (e.g., soft gray mud, hard, coarse sand) of the bottom at the sample site. Clam-shell-snapper sampler devices collect this information to aid mariners determine suitable anchoring conditions and also help them locate their position at sea. Danger to navigation data can include information on rocks, pilings, wrecks, oil platforms, etc.

All data records on magnetic tape contain the registry number of the survey sheet from which they were extracted, the date of the survey, the latitude and longitude to the nearest 0.01 second, and a code identifying the precise type of information (i.e., sounding, bottom characteristic, danger to navigation).

In addition to digital data on magnetic tape, various plotter products can be constructed by NGSDC. Plots can be made depicting soundings on a variety of map projections at any desired scale. Plots showing varied depth ranges color coded or in symbol can be drawn. Bottom profiles can also be plotted. Data which have been programed by computer to conform to a uniform grid can be made available both on magnetic tape and as computer plots.

International Report

World Data Center-A For Glaciology Transferred

In October, U.S. responsibility for operation of the World Data Center-A for Glaciology was transferred from the U.S. Geological Survey, Tacoma, Wash., to EDS National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo. The move brings the glaciology center together with the WDC-A's for Solid Earth Geophysics and Solar-Terrestrial Physics, operated by NGSDC. The WDC Glaciology activity is being operated for NGSDC by the University of Colorado's Institute of Arctic and Alpine Research (INSTAAR). The Glaciology Center has data on the properties, processes, morphology, and effects of snow cover, glacier fluctuations, avalanches, polar ice masses, sea ice, permafrost, and paleoglaciology.

Glaciological Notes published by WDC-A for Glaciology will be replaced by *Glaciological Data*, a new series that will be distributed without charge to the scientific community. Inquiries should be sent to World Data Center-A for Glaciology, Institute of Arctic and Alpine Research, University of Colorado, Boulder, CO 80309, USA.

IDOE Progress Report No. 5 Published

The fifth of a series of progress reports on the International Decade of Ocean Exploration (IDOE) has been published by the Environmental Data Service under a National Science Foundation (NSF) contract. IDOE is a long-term, international, cooperative program to improve the use of the ocean and its resources for the benefit of mankind.

The report, prepared for the NSF Office for IDOE, covers the period April 1975 to April 1976 and provides information, data inventories, and lists of scientific papers. The text is arranged according to established program subject areas for IDOE: Environmental Quality, Environmental Forecasting, Seabed Assessment, and Living Resources. An appendix contains a summary of Reports of Observations/Samples Collected by Oceanographic Programs.

In addition to publishing the progress report, EDS is also under contract to NSF to manage the scientific data collected during IDOE. EDS either has the data or papers described in the progress report, or knows where they may be obtained.

Requests for copies of the report, or for IDOE data, should be addressed to the National Oceanographic Data Center, National Oceanic and Atmospheric Administration, Washington, DC 20235.

Setting instrument floats in Drake Passage during IDOE.

New North Pacific Atlas

The U.S. Naval Oceanographic Office recently released the Atlas of *North Pacific Ocean Monthly Mean Temperature and Mean Salinities of the Surface Layer.* The atlas was prepared by Margaret K. Robinson of the Scripps Institution of Oceanography, assisted by Roger A. Bauer, a computer specialist with Compass Systems, Inc.

The temperature charts in the atlas are based primarily on bathythermograph data collected from 1942 to 1969. They result from an extremely detailed data quality check and thorough statistical analysis. The salinity charts are based on hydrocast data from the 1969 files of EDS' National Oceanographic Data Center. The area covered by the charts extends from 5°S to 65°N and from 100°E to 75°W.

The atlas will be particularly useful to oceanographers and marine biologists who undertake studies in the North Pacific requiring knowledge of water temperatures in the upper 400 feet. Underwater acousticians may also find these data useful in conducting near-surface sound propagation studies.

The atlas contains monthly mean sea temperatures at the surface and four subsurface levels at 100-ft (30.5-m) intervals to 400-ft (122-m). The choice of the 100-ft depth interval continued the analysis standard set by earlier studies of subsurface temperature distribution in the Pacific Ocean based on BT data. These depths are clearly marked on BT grids making depth interpolation unnecessary and minimizing reading errors. The four 100-ft intervals are required to describe accurately the basic subsurface temperature structure. Mean salinities are also presented at the five levels.

The atlas also includes charts derived from monthly means consisting of topographies of the top of the thermocline, monthly temperature differences between the surface and 400 ft, annual means and ranges for each of the five levels, and annual cycle curves for selected locations demonstrating surface and subsurface seasonal temperature variations.

A matching data distribution chart is provided for each monthly and annual temperature chart at all levels and for the surface salinity charts only, since the salinity data distribution for all levels is essentially the same, exclusive of shallow areas.

The monthly temperature and salinity data in this atlas are a portion of the Bauer-Robinson Numerical Atlas available on magnetic tape. The charts were traced from computer-generated contour charts from the Numerical Atlas. Data in the Numerical Atlas contain temperature and salinity values at the surface, subsurface 100-ft levels, and at all NODC hydrocast depth levels from 30 to 5,000 meters.

Additional information about the new published atlas may be obtained from the U.S. Naval Oceanographic Office, Washington, DC 20373. Telephone: 301-545-6700.

Volume II, *Marine Climatic Atlas of the World,* Revised

The publication *U.S. Navy Marine Climatic Atlas of the World, Volume III, Indian Ocean (Revised 1976),* NAVAIR 50-1C-530, is now in print. This volume, funded and published by the Naval Weather Service Command, updates and revises Volume III of the *U.S. Navy Marine Climatic Atlas of the World, 1957* (NAVAIR 50-1C-530) with nearly 20 additional years of meteorological data. It has two parts under the same cover: Part I, Meteorology, was compiled by the EDS National Climatic Center (NCC); Part II, Oceanography, was compiled by the U.S. Naval Oceanographic Office. This is the second volume to be revised in the Marine Climatic Atlas of the World series.

Part I, Meteorology, contains monthly charts and supplementary graphical presentations for the surface elements: wind, waves, temperature (air and sea), humidity, precipitation, visibility, cloud cover and height, and atmospheric pressure. Part I also includes monthly presentations of tropical cyclone roses by 5° quadrangles. Part II, Oceanography, contains charts for tides, ocean currents, and ice conditions.

Many of the meteorological data presentations have been changed from the 1957 Atlas: wave statistics have been added, and there are no upper air charts included, since several comprehensive volumes of upper air data have been published in recent years.

This 350 page volume is for sale by the Superintendent of Documents, Government Printing Office, Washington, DC 20402. The GPO stock number is 008-042-00066-7. Price: Domestic mailing, $21.00; Foreign: $26.25.

International Geophysical Calendar for 1977

The international Geophysical Calendar for 1977 has been prepared in cooperation with the world scientific community and distributed by EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC). The calendar is issued annually to coordinate solar and geophysical observations and data exchange. It is compiled from information on coordinated observing programs involving scientists from different disciplines, institutions, and countries.

This calendar continues the series begun for the International Geophysical Year (1957-58). Its annual preparation is the responsibility of a small, interdisciplinary organization called the International Ursigram and World Days Service (IUWDS), which adheres to the Federation of Astronomical and Geophysical Services of the International Council of Scientific Unions. J. Virginia Lincoln of NGSDC is the IUWDS Secretary for World Days.

A single day each month is designated a "Priority Regular World Day." There also are three consecutive Regular World Days each month, always on a Tuesday, a Wednesday, and a Thursday near the middle of the month. Various standard intervals of 1 to 2 weeks also are chosen to meet the needs of one project or another. Where possible, several projects are scheduled for the same intervals so interdisciplinary comparisons can be made.

Copies of the 1977 Calendar may be obtained from J. Virginia Lincoln, World Data Center A for Solar-Terrestrial Physics, NOAA. Boulder, CO 80302.

JANUARY

S	M	T	W	T	F	S
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30	31					

FEBRUARY

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27	28					

MARCH

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27	28	29	30	31		

APRIL

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MAY

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JUNE

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26	27	28	29	30		

JULY

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[31]						

AUGUST

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21	22	23	24	25	26	27
28	29	30	31			

SEPTEMBER

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18	19	20	21	22	23	24
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OCTOBER

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JANUARY 1978

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(18) Regular World Day (RWD)

(19) Priority Regular World Day (PRWD)

◇16 Quarterly World Day (QWD) also a PRWD and RWD

2 Regular Geophysical Day (RGD)

[18] Day of Solar Eclipse

19* Dark Moon Geophysical Day (DMGD)

9 10 World Geophysical Interval (WGI)

[3 Day with unusual meteor shower activity, Northern Hemisphere

5] Day with unusual meteor shower activity, Southern Hemisphere

16 17 Airglow and Aurora Period

1. N-MAC (noon-midnight auroral correlations) periods are: Jan. 12-26, Mar. 10-24, Nov. 5-19 and Dec. 4-18, 1977.
2. IAGA/URSI Working Group on Passive Electromagnetic Probing of the Magnetosphere international campaign June 21-July 20, 1977.
3. Special Satellite Periods identified by Satellite Situation Center: Jan. 3, 0700—Jan. 5, 1000; Jan. 27, 0300—Jan. 28, 2300; Feb. 3, 1000—Feb. 4, 0800; Mar. 5, 1200—Mar. 7, 1800; Apr. 13, 0000 — Apr. 15, 0000; Jun. 25, 2000—Jun. 28, 0600; Jul. 10, 1800—Jul. 11, 0800; Aug. 3, 2000—Aug. 5, 1800; Aug. 13, 0000—Aug. 14, 1200; Aug. 28, 1700—Aug. 29, 0900; Oct. 13, 1900—Oct. 16, 0600; Oct. 16, 0400—Oct. 18, 1200; Oct 26, 1100—Oct. 27, 0100; Nov. 21, 0300—Nov. 23, 0600; Nov. 24, 2000—Nov. 26, 0600; Nov. 27, 1400—Nov. 30, 0500; Dec. 13, 1800—Dec. 15, 2300; Dec. 23, 0300—Dec. 23, 1800; Dec. 27, 1900—Dec. 30, 0600.

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see other side

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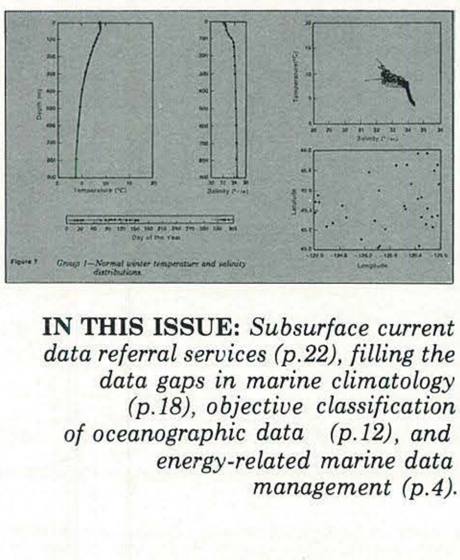

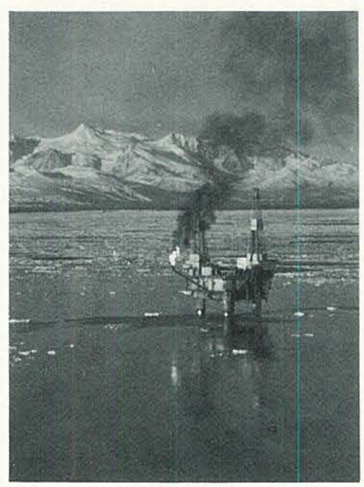

IN THIS ISSUE: *Subsurface current data referral services (p.22), filling the data gaps in marine climatology (p.18), objective classification of oceanographic data (p.12), and energy-related marine data management (p.4).*

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Cover: *The earthquake of April 18, 1906 topples the statue of Naturalist Louis Agassiz from its niche at Stanford University, Palo Alto, Calif.* *(See page 26 for information on obtaining earthquake photos.)*

Photo: W. C. Mendenhall, USGS

ENVIRONMENTAL DATA SERVICE is designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, and Center for Climatic and Environmental Assessment. In addition, under agreement with the National Academy of Sciences, EDS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 16, 1975; this approval expires June 30, 1978.

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Carbon Dioxide and Future Climate

By J. Murray Mitchell, Jr.

Hundreds of millions of years ago, the tropical forests of the carboniferous period withdrew carbon dioxide from the atmosphere, which nature slowly replaced. When we burn coal or a petroleum derivative produced by the decay of such flora, we suddenly release that carbon dioxide into the atmosphere at a rate much faster than natural forces can remove it.

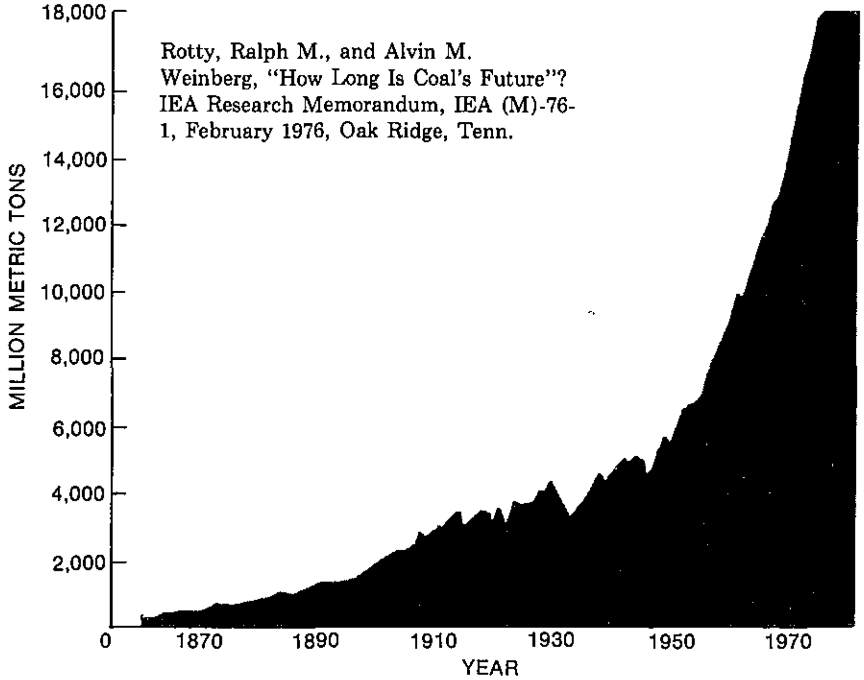
Photo: Field Museum of Natural History

In recent years, books and newspaper stories have conditioned us to expect colder weather in the future. In geological perspective the case for cooling is strong. The modern-day world is perched atop an interglacial period, a relatively warm interlude—lasting perhaps 10,000 years—between much longer intervals of cold and snow. If this interglacial respite lasts no longer than a dozen earlier ones in the past million years, as recorded in deep-sea sediments, we may reasonably suppose that the world is about due to begin a slide into the next ice age.

Considering the much more recent past, climatologists point out that the world has been in the throes of a general cooling trend during the last 30 or 40 years. Because this modern-day cooling trend has sometimes been misinterpreted as an early sign of the approach of an ice age (it is really only one of many irregular ups and downs of climate that mankind has witnessed through history), it has reenforced the popular notion that our future is likely to be a cold one. (In point of fact, this cooling trend has been faltering in very recent years, and may already have started to reverse itself.)

I agree with those climatologists who say that another ice age is inevitable. I strongly disagree, however, with those who suggest that the arrival of the next ice age is imminent, and who speak of this as the proper concern of modern civilization in planning for the next few decades or centuries.

Should nature be left to her own devices, without interference from man, I feel confident in predicting that future climate would alternately warm and cool many times before shifting with any real authority toward the next ice age. It would be these alternate warmings and coolings, together with more of the same ubiquitous, year-to-year variability of climate that has always been with us, that would be the appropriate object of our concerns about climate in the foreseeable future.



Rotty, Ralph M., and Alvin M. Weinberg, "How Long Is Coal's Future"? IEA Research Memorandum, IEA (M)-76-1, February 1976, Oak Ridge, Tenn.

Because of man's presence on the Earth, however, what will actually happen in future decades and centuries may well follow a different scenario; imperceptibly different at first, but importantly so later on. It seems likely that industrial man already has started to have an impact on global climate, although this is difficult to prove by direct observation, because the impact is not easily recognizable amid the large natural variability of climate. If man continues his ever-growing consumption of energy, however, and in the process adds further pollution to the global atmosphere, it may not be very many years or decades before his impact will break through the "noise level" of natural climatic variability and become clearly recognizable.

My purpose in this article is to take a closer look at man's potential for upsetting the balance of climate, with particular reference to the problem of carbon dioxide. Specifically, what is the problem? How certain are we that the problem is real? How serious might the situation become, and in what period of time? To what lengths should society be prepared to go to avert the problem—if indeed it can be averted?

We are not yet in a position to answer all of these questions with the kind of confidence we would like. Yet, our knowledge is sufficient to give tentative answers, and also to indicate what we must do to come up with more confident answers in the reasonably near future.

When speaking in general of man's impact on climate, we are concerned with not one, but many kinds of impact. There are the potentially significant climatic effects that may follow from massive alteration of the Earth's surface through agriculture, irrigation, forest cutting, and urbanization. There are further climatic effects that may follow from our ubiquitous discharges of heat, smoke, dust, and various gaseous wastes—carbon dioxide, sulfur dioxide, chlorofluoromethanes ("Freons"), and nitrogen oxides—into the atmosphere.

It is not likely that any one of these activities has played an im-

Left: The addition of CO_2 to the atmosphere since 1860.

Above: Cutting snow off a building whose roof is caving in at South Pole Station, Antarctica, where atmospheric CO_2 is monitored.

portant role in climate fluctuations up to now. Suggestions, for example, that man's releases of dust and smoke into the atmosphere have been responsible for the cooling trend since World War II may have seemed credible a few years ago, but now our understanding of atmospheric particles, and of their optical properties (which determine their net influence on climate), has developed to the point where we are no longer persuaded that particles introduced by man have an important cooling effect. In fact, in virtually all instances, the effects of man's activities on climate are now recognized as contributing to warming, not to cooling. Such is clearly the case with carbon dioxide, chlorofluoromethanes, nitrogen oxides, and heat (the end product of all energy used by man).

If the net climatic effect of man's activities is likely to be in the direction of warming, as I have indicated, then the fact that the Earth has actually been cooling in recent decades strongly implies that nature—not man—is still firmly in the driver's seat where global-scale climatic change is concerned.

Having said that man is unlikely to have impacted significantly on global-scale climate to date, I hasten to add that this is no grounds for complacency about the future. Man has amply demonstrated that he is a socially and technologically progressive being. In the decades and centuries ahead, he is likely to increase in numbers and advance his standards of living. He will put heightened pressures on his natural resources, expand his reliance on energy, exploit new territory for agriculture, and manage his environment in many new ways. In some of these activities, he will undoubtedly impact global climate more intensively, and more extensively, than now. In other respects, however, his concern for his environment will perhaps reduce the stress on climate: already he seems willing to limit his use of chlorofluorocarbons, and to check the volume of many of the more obnoxious forms of pollution that he is pouring into the air and water.

One pollutant, however, will not be easily controlled. I refer to carbon dioxide. This gas is a product of combustion of all hydrocarbon fuels, including coal, oil, gasoline, natural gas, wood, peat, methane, propane, and a wide variety of lesser fuels. It is perhaps ironic that when we speak of controlling pollution emitted by such substances, we are to a large extent speaking of ways of converting more obnoxious intermediate combustion products (such as carbon monoxide and other toxic hydrocarbons) to their completely oxidized equivalent, carbon dioxide. In other words, when we talk of limiting pollution we are speaking of increasing the emission of carbon dioxide!

When we burn wood for warmth or energy, we are not really adding new carbon dioxide to the atmosphere. We are simply replacing carbon dioxide that was withdrawn from the air by photosynthesis when the tree composed of the wood was growing in the forest, a relatively short time ago. Much the same is true when we burn peat or organic methane.

On the other hand, when we burn coal or a petroleum derivative, the carbon dioxide released had been withdrawn from the atmosphere millions of years ago. In all the years since, the carbon dioxide used in the growth of the coal- or petroleum-producing flora had ample opportunity to be replaced through very slow natural regulatory processes, such as the oxidation of exposed sedimentary rocks. Now we suddenly release that carbon dioxide back to the atmosphere, at a rate enormously faster than the rate at which other natural regulatory processes—such as the rain of calcareous-shelled marine organisms into the ocean depths—can remove it from the atmosphere again.

Fuels that are withdrawn from geological formations (and contain carbon fixed from atmospheric carbon dioxide in the distant geological past) are categorically referred to as fossil fuels. The overwhelmingly greater part of all the energy produced in the world today is derived from the combustion of fossil fuels. At the present time, nearly 20 billion tons of carbon dioxide are released in this way to the atmosphere each year. This amounts annually to about 0.7 percent of the total carbon dioxide already in the atmophere. Since at least 1950, the release rate of carbon dioxide to the atmosphere has been growing by an average of 4.3 percent per year (significantly less rapidly, however, since the oil embargo of 1973). In all, this represents a truly enormous source of "new" carbon dioxide to the atmosphere.

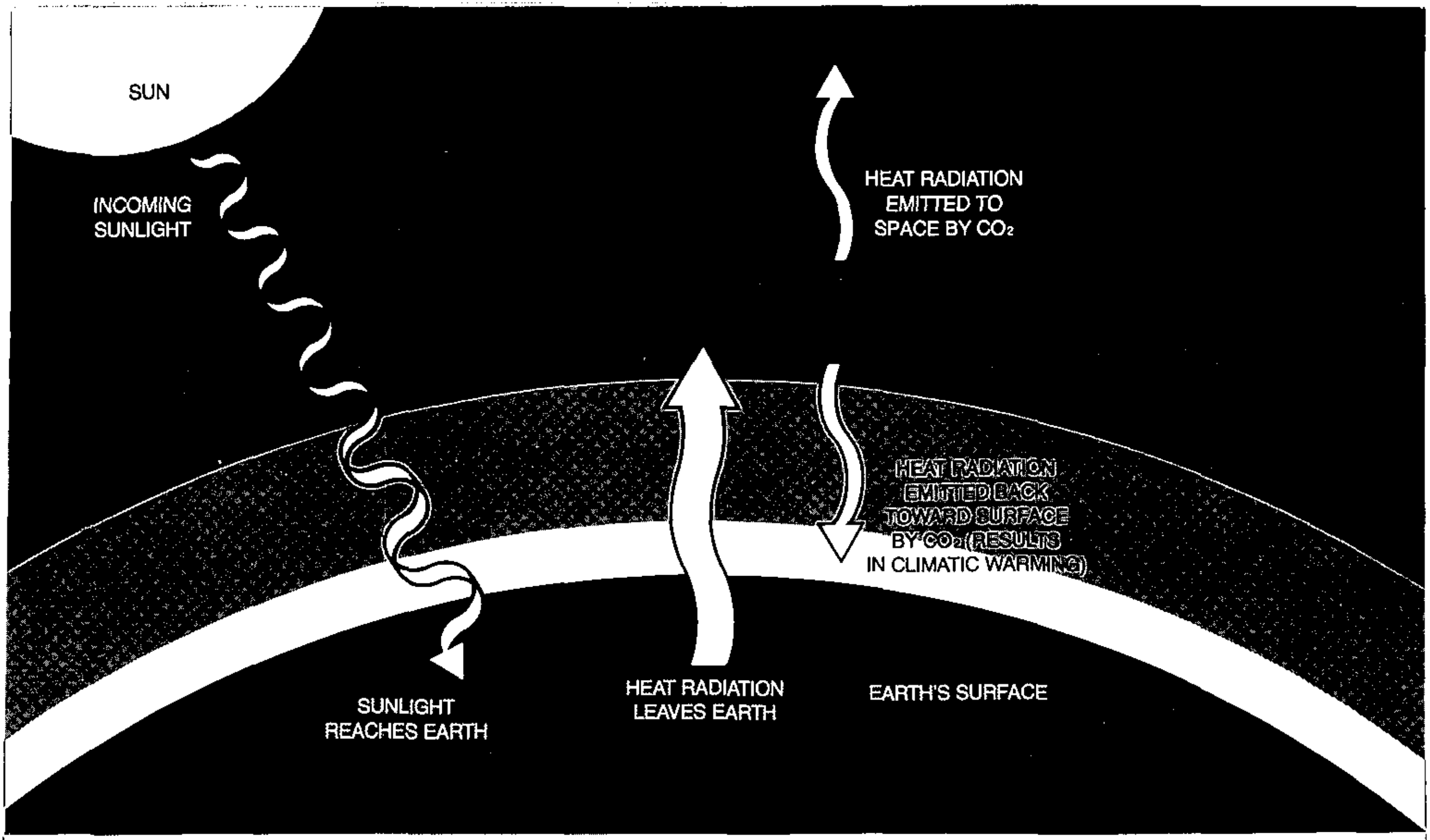
To date, all the "new" carbon dioxide released to the atmosphere by fossil fuel combustion since the dawn of the Industrial Revolution comes to more than 20 percent of the total already in the atmosphere. Reliable estimates of the amount in the atmosphere, and its changes from year to year, are available since 1958 (the International Geophysical Year) from monitoring stations at Mauna Loa (Hawaii), the South Pole Station (Antarctica), and elsewhere. These estimates clearly reflect an accumulation of the gas in the global atmosphere during the past 18 years. The observed rate of accumulation, however, is consistent with what we know is entering the atmosphere from fossil sources only if between 50 to 60 percent of the fossil input has remained in the atmosphere. The remaining 40 to 50 percent has somehow been leaking away from the atmosphere into other carbon reservoirs. Since we know that geological processes of removal from the atmosphere are much too slow to have accounted for the missing percentage, it is highly likely that it has been accumulating either in the oceans or in terrestrial vegetation.

Careful modeling of the terrestrial carbon cycle, in which the attempt has been made to consider all the chemical and biological transactions that govern the partitioning of "new" carbon between the various carbon reservoirs on the Earth, confirms that most of the missing carbon dioxide is likely to have been accumulating in the mixed (near-surface) layers of the oceans. It remains to be seen if a substantial fraction also has found its way into vegetation or some other reservoir such as soil humus. Such possibilities are extremely difficult to verify without undertaking much more careful worldwide assays of the mass of vegetation and other biota than have been feasible to date. Some scientists have suggested that through forest cutting and other human activities the total mass of carbon in vegetation may have been decreasing over the years, rather than increasing, as required to account for a part of the missing atmospheric carbon dioxide. If that turns out to be true, then we must look to the oceans as an even more effective "sink" for carbon dioxide than we have surmised.

The situation at the present time can be summarized briefly as follows. The atmosphere is becoming richer in carbon dioxide by a few tenths of 1 percent each year. Altogether, the atmosphere is now holding an estimated 13 percent more carbon dioxide than it held a century ago. The source of this added carbon dioxide has been reliably traced to the burning of fossil fuels. Were it not for the absorption of some of the added carbon dioxide by the oceans (plus an unknown, but probably smaller intake by terrestrial vegetation, the atmospheric increase would be roughly double what has been observed.

As long as man continues to rely on fossil fuels to meet the bulk of his energy requirements, the atmosphere buildup of carbon dioxide will continue. Here we arrive at the doorstep of the carbon dioxide "problem." In consideration of the vast and assessable fossil fuel reserves (mostly coal) known to still be in the ground, as contrasted with the increasingly obvious economic and technological deffiaculties of developing new energy sources (such as breeder nuclear power) that meet acceptable standards of safety and economy, how reasonable is it to suppose that man will wean himself from reliance on fossil fuels before his reserves become very depleted—perhaps 100 or 200 years from now? My guess is that, not withstanding higher energy costs and the glamour of exotic energy technology such as the harnessing of solar radiation, man will continue to find fossil fuels an attractive source of energy for a very long time to come.

Suppose that no new inhibiting factor comes into the picture, to discourage man from proceeding to consume the bulk of his known fossil fuel resources in the next few centuries. In that event, the combustion of all known fossil fuel reserves in the world would pour into the atmosphere a total amount of "new"carbon dioxide equal to somewhere between 5 and 14 times the total amount of carbon dioxide now present. Of that enormous quantity entering the atmosphere, the oceans would be unlikely to withdraw as much as the fraction (perhaps 40 percent) they are believed to have withdrawn of the much smaller increase up to the present time. Terrestrial vegetation might be able to take up a substantial share of it, but only temporarily. This means that the increase of carbon dioxide



The "greenhouse" effect of CO_2. Even in present concentrations, atmospheric carbon dioxide is capable of absorbing and of re-emitting back to the Earth a significant part of the terrestrial heat radiation that would otherwise pass through the atmosphere into space.

in the atmosphere would aggregate to a major fraction of the total input—something in excess of 3 times the present atmospheric amount and conceivably as much as 10 times the present amount.

The ultimate carbon dioxide increase, reached after nearly all fossile fuel reserves are consumed, would not depend to an important degree on the rate at which the reserves are used up, unless that would take longer than the few hundred years anticipated. Once the atmospheric levels reached these high values, however, they would decline only very slowly thereafter; after a thousand years, more than half of the excess carbon dioxide would still remain in the atmosphere. Whatever the consequences of the carbon dioxide buildup, including the consequences to our climate, they would endure for thousands of years after fossil fuels had been consumed!

If the levels of carbon dioxide in the atmosphere did increase by a factor of 3 to 10 in the next few centuries, what of it? This would cause no physiological discomfort to humans. It might even stimulate faster growth of forest and food crops, as suggested by experiments with carbon dioxide-enriched air in greenhouses.

The problem becomes clear when we consider the likely effect of so large a carbon dioxide increase on global climate. Carbon dioxide, in present-day atmospheric concentrations, is capable of absorbing and re-emitting a significant part of the heat radiation passing upward through the atmosphere from the Earth. This outgoing terrestrial radiation balances the incoming solar radiation, to maintain the temperature of our planet near its accustomed "equilibrium" level.

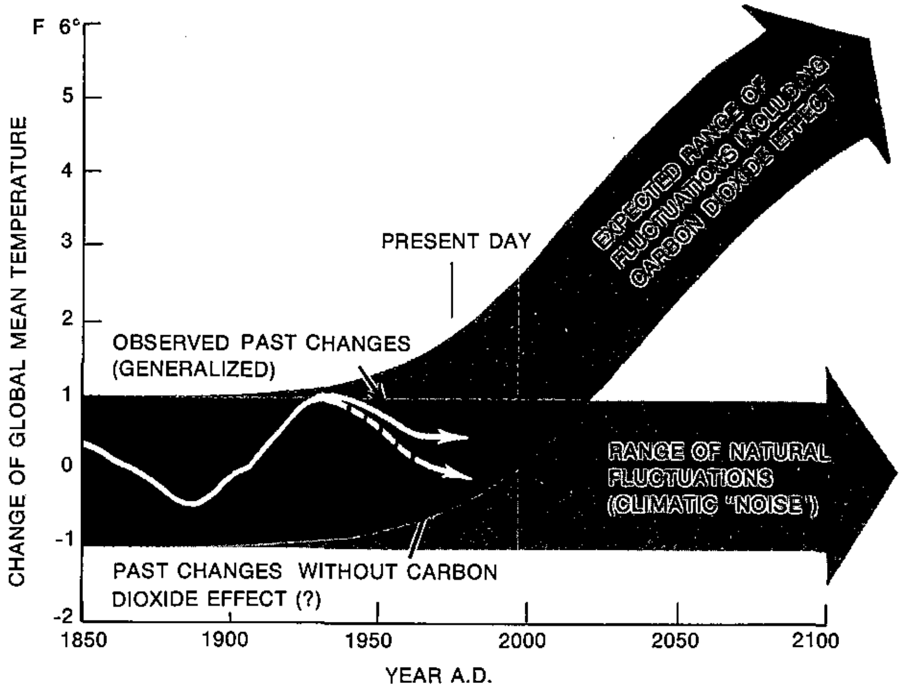
Numerical models have been constructed in recent years in which the effects of carbon dioxide on atmospheric radiation fluxes have been simulated with a rather high degree of realism. Some of these models are in other respects highly simplified ones that omit many of the detailed atmospheric processes that determine climate. Others are much more sophisticated, and include many although by no means all of these processes. All the models are very much alike, however, in what they tell us to expect concerning the average temperature if the amount of carbon dioxide in the atmosphere should change.

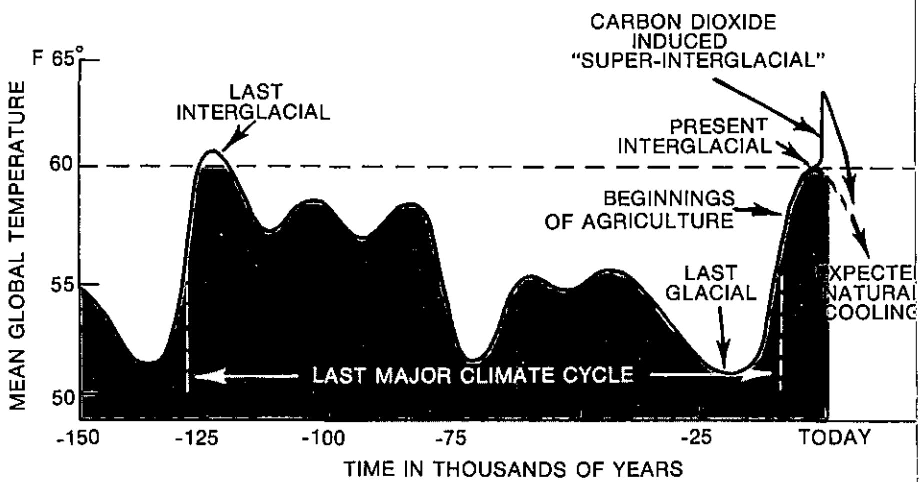
The implications of these climate modeling experiments can be summarized as follows:

• The amount of carbon dioxide now in the atmosphere maintains the average temperature of the Earth (and the lower atmosphere) at levels about 10°C (18°F) higher than those we would experience if the atmosphere contained no carbon dioxide.

- A doubling of the amount of carbon dioxide in the atmosphere, relative to its present amount, would increase the average annual temperature of the Earth by about 2.4 to 2.9°C (4.3 to 5.2°F), depending on which model is used to derive the estimated temperature change.
- The dependence of temperature on the change of carbon dioxide follows an approximately logarithmic relationship, such that a fourfold increase of carbon dioxide would result in a doubled of temperature increase.
- Based on one climate model in which the hydrologic cycle is modeled in detail along with other aspects of climate behavior, a doubling of carbon dioxide has been calculated to result in about a 7-percent increase in global average precipitation. Most of this increase would be concentrated in the higher latitudes.
- A general retreat of snow and sea-ice cover, by perhaps as much as 10 degrees of latitude, would result in the Arctic regions. The extent of such changes in the Antarctic, however, has not yet been determined.
- Generally speaking, the effect of a doubling of carbon dioxide on surface temperatures would be two or three times greater in the polar regions than the average temperature change for the world as a whole.

It cannot be asserted that a real doubling of carbon dioxide in the real world would have the same effects on real climate as a simulated doubling of carbon dioxide in climate models have on "model climate." This caveat is in order because no climate model is altogether realistic in its description of the real climatic system, and because some of the physical processes that operate in the real climatic system cannot yet be





Top: How the accumulation of atmospheric carbon dioxide might affect global mean temperature. Increasing CO_2 levels may not have an easily detectable effect until near the end of the century; thereafter, however, the warming effect may be dramatic and will continue until the end of the fossil-fuel era.

Above: The effect of increasing CO_2 on global mean temperature, viewed in the perspective of the glacial-interglacial cycles of the past 150,000 years. By analogy with the last interglacial period, we might expect a cooling toward a new ice age in the next several thousand years. The warming effect of carbon dioxide, however, may interpose a "super-interglacial," with global mean temperatures in the next few centuries reaching levels several degrees higher than those experienced at any time in the last million years. The next ice age would have to wait until this warming had run its course, more than a thousand years from now.

simulated at all in climate models.

For example, no climate model on which the above conclusions are based is capable of developing its own cloud systems in a realistic way: most models must be instructed before hand where the clouds are assumed to exist, and the clouds remain there unchanged throughout the computer experiment using the model. We should be wary of this, because if the cloudiness were to change in the real world along with a carbon dioxide change, then the role of clouds in affecting the temperature of the Earth might significantly alter the net temperature effect of the carbon dioxide change as inferred from models that assume fixed cloudiness.

Very recently, some preliminary model experiments have been attempted at NOAA's Geophysical Fluid Dynamics Laboratory, in Princeton, N.J., in which the model is allowed to adjust cloudiness along with other weather variables as the calculation proceeds. Early indications are that allowance for cloudiness changes does not greatly alter the results of experiments using models with fixed cloudiness.

Altogether, our experience with climate models suggests that their use in evaluating the magnitude of temperature changes associated with changes of atmospheric carbon dioxide leads to results that are likely to approximate reality fairly closely. Models may be overestimating the temperature and other climatic effects of carbon dioxide changes by as much as a factor of two. On the other hand, it is equally likely that they may be underestimating the effects by a factor of two. In balance, I would share the view of most of my colleagues that the model results to date deserve to be taken as an unprejudiced, and a credibly realistic approximation to reality. Until better climate models are developed, and better ones are already on the drawing boards, we have no better insight into the nature and magnitude of the impact of carbon dioxide changes on world climate. Alternatives to our reliance on climate models do not really exist, unless we prefer the alternative of "wait and see."

Putting together the different parts of the story of climate and carbon dioxide as I have briefly summarized them here, what picture emerges as to our future climate? If mankind does indeed rely for very long on fossil fuels to meet its energy needs, the consequences to climate are likely to become noticeable by the end of this century, but not become a serious problem until well into the next century. On the longer, geological time scale, the picture that emerges is rather startling. In words of Dr. Wallace Broecker of the Lamont-Doherty Geological Observatory, one of the world's foremost authorities on the carbon dioxide issue, comsumption of the bulk of the world's known fossil fuel reserves would plunge our planet into what he describes a "super-interglacial," the likes of which the world has not experienced in the last million years.

Admittedly, we are talking here of possibilities, not certainties. The climatic consequences of massive fossil fuel comsumption may be less severe than we have assessed them (but they might also be more severe). Mankind eventually may discover a new energy source that will obviate the need to raid our fossil reserves so extensively. Or perhaps technology could develop a cosmetic, such as the introduction of an artificial dust cloud surrounding the Earth to screen incoming sunlight. This would tend to offset the warming effect of the added carbon dioxide.

All of this may strike you as a problem too far removed from the present day to merit our concern. I would, however, like to close with a few additional thoughts. Suppose we elect to ignore the problem of carbon dioxide until it is staring us in the face—perhaps in another 20 years—in the form of a clear signal that a global warming trend has begun that is unmistakeably attributable to the further accumulation of carbon dioxide in the atmosphere. If we delay until then to take action to phase over our principal energy sources from fossils fuels to other kinds of fuels, on an orderly rather than a crash basis, the transition will be likely to take another 40 or 50 years to complete. That puts us at least a half-century into the future before we will have managed to shut off the problem at its source. By then, much of the damage will already have been done!

To make matters worse, the effects of carbon dioxide would endure for thousands of years after we have abandoned our fossil fuel economy, because it would take thousands of years for the atmosphere to rid itself of any excess carbon dioxide. A thousand years of unusually warm climate would be likely to result in substantial melting of the Greenland and Antarctic ice caps, raising sea levels around the world enough to submerge many of our coastal population centers and much productive farm land.

The alternative is clear. Ours is the generation that must come to grips with the carbon dioxide problem and mount a vigorous research effort to allow us to understand all of its ramifications for the future. Ours is the generation that may have to act, and act courageously, to phase out our accustomed reliance on fossile fuels before we have all the knowledge that we would like to have to feel that such action is absolutely necessary. If we harbor any sense of responsibility toward preserving spaceship Earth, and toward the welfare of our progeny, we can scarcely afford to leave the carbon dioxide problem to the next generation.

Building a National Strategic Petroleum Reserve

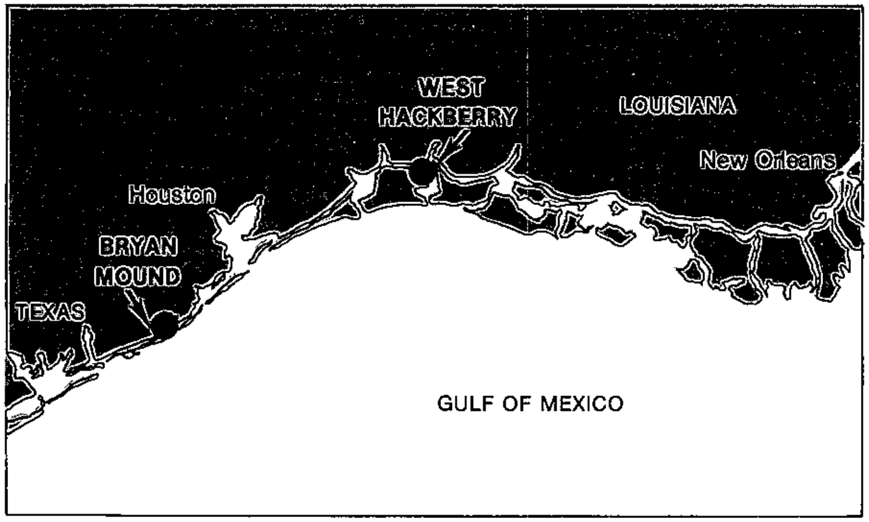
By Dail Brown
Center for Experiment Design and Data Analysis

The Marine Assessment Division of EDS' Center for Experiment Design and Data Analysis is helping the Federal Energy Administration (FEA) in a program to establish a national Strategic Petroleum Reserve.

As a result of the oil embargo of 1973-74, Congress enacted the Energy Policy and Conservation Act of 1975. Among other provisions, the Act calls for establishment of a Strategic Petroleum Reserve as a contingency supply against future embargoes. One hundred and fifty million barrels of crude oil must be stored by the end of 1978 and 500 million barrels by the end of 1982—the latter is enough to offset a 45 percent loss in imports for a 6-month period.

FEA was assigned responsibility for establishing the reserves. Among the storage options studied, the most attractive from an economic and environmental standpoint is storage in solution-mined salt dome cavities near existing petroleum distribution facilities along the Gulf of Mexico coast. Large quantities of brine will be produced in the creation and operation of these salt dome cavities, and the environmental impact of disposal of the brine into the sea must be evaluated.

Considerable storage space is currently available along the Gulf coast in existing salt dome cavities created for the production of brine as chemical feedstock and for industrial short-term, small-scale storage of petroleum products and crude oil. (Salt dome cavities are also used for crude oil storage in France and West Germany.) Among the possible early storage sites only two existing domes, Bryan Mound and West Hackberry (see map), are close enough to the coast to consider brine disposals into the Gulf.



Above: Location of two salt dome cavities being considered as early storage sites for crude oil reserves.

Right: A common sight during the 1973-74 oil embargo.

Both domes have full cavities of brine containing about 300 parts per thousand (ppt) dissolved solids. Normal seawater in the area is about 30 ppt. The brine in the dome must be disposed of as it is replaced by the initial oil fill, a process resulting in a continuous flow over a period of 15 to 18 months.

Once the caverns are filled with oil, no further brine disposal will be required until after a drawdown cycle, when the cavern will be refilled with oil. Drawdown is accomplished by displacing the stored oil with raw water.

The oil withdrawn from the Reserve will be replaced as soon as oil is available for that purpose. Refilling the caverns with oil (under pressure) will displace water which will have become nearly saturated brine. Refill and the associated continuous brine disposal will require 12 to 24 months. It is not feasible to retain, in brine ponds, the large amount of brine created by this process. Engineering design of the caverns assumes five fill/withdrawal cycles over a minimum of 25 years.

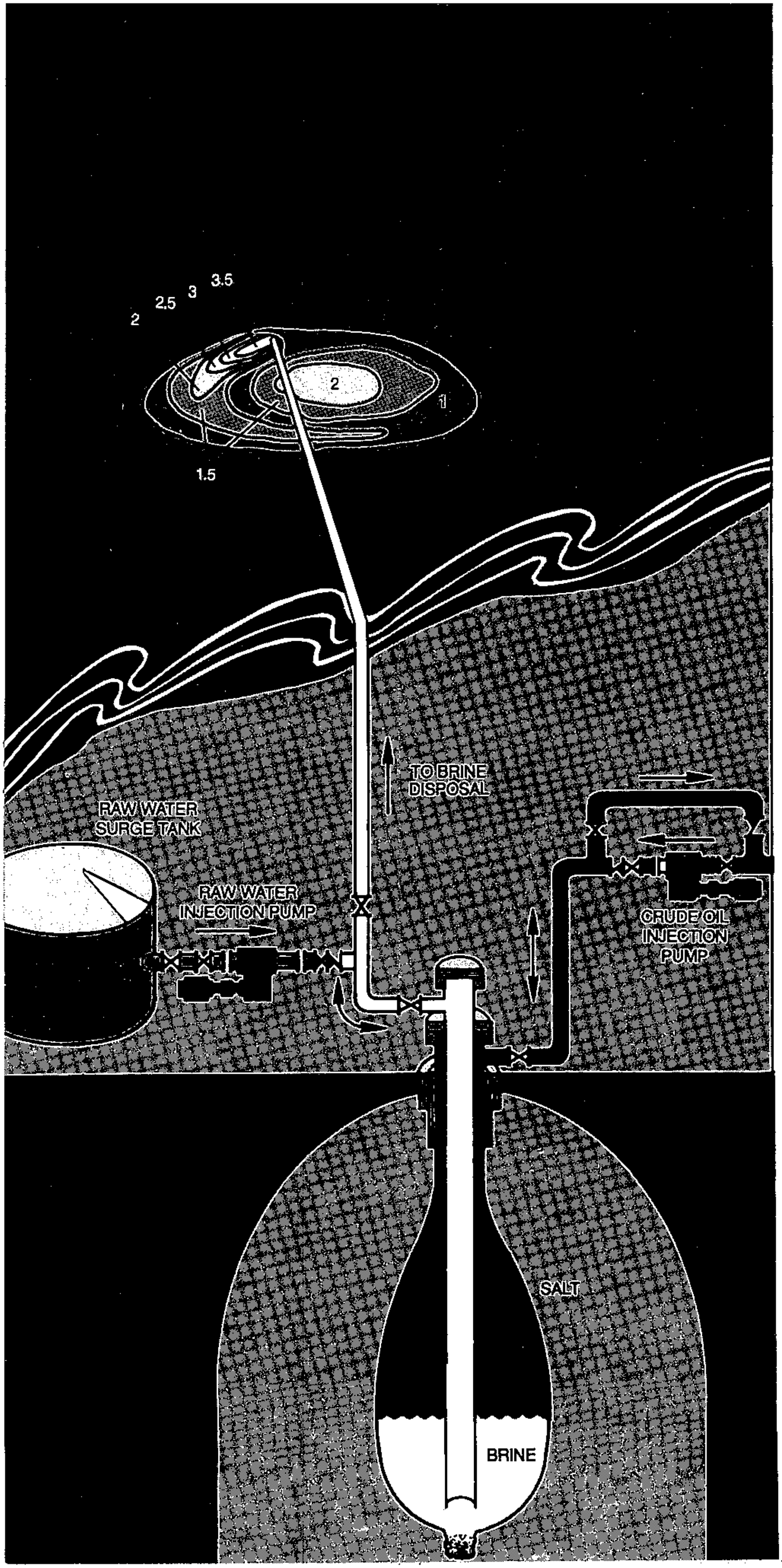
Other possible sites to implement the full program by 1982 include virgin salt domes that must be leached to created storage space. In addition, the storage capacity of Bryan Mound and West Hackberrry salt domes may be expanded by leaching. The required leaching will necessitate large supplies of water and brine disposal systems. Either freshwater or seawater can be used

for leaching as there is relatively little difference in efficiency between them. Leaching one barrel of space requires slightly more than 6 barrels of freshwater or about 7 barrels of seawater. Therefore, leaching a new site may require the disposal of as much as 1,400 million barrels (MMB) of saturated brine over a period of 36 to 44 months.

Estimates of total salt mass added to the marine environment for each disposal mode range from a minimum of 2.5 to 3.1 million short tons for the initial fill of existing space at Bryan Mound, to a maximum of about 76 million short tons for leaching a new 200 MMB facility. CEDDA's Marine Assessment Divison is assisting FEA in the Strategic Petroleum Reserve Program by evaluating the potential impact of brine discharges into the Gulf Mexico from salt dome cavities. Specifically, for each proposed site CEDDA scientists are:

- Summarizing existing data and information on bathymetry, oceanography, meteorology, and biology.
- Refining and applying state-of-the- art diffusion models to simulate brine dilution and transport.
- Assessing physical impacts of the brine discharge on the surrounding environment for different diffusion rates and patterns.
- Developing a monitoring plan to evaluate actual impacts and verify model predictions.

A thorough compilation and evaluation of existing environmental data and information is essential for further model analyses and impact assessments. They also provide a baseline for future monitoring. Of particular concern are expected wind patterns that will promote mixing, and unusual



bathymetric features that may trap the dense brine. Studies already undertaken for oil and gas exploration and deepwater port construction in the Gulf of Mexico (see *EDS*, March 1976, page 23) will provide key inputs to the data base.

FEA has developed a mathematical model to simulate the dilution and transport of brine. It is now operational on EDS computers. Assessments are being made for each prospective offshore location of the resulting brine plume under different environmental conditions and diffuser locations and configurations. To assist in the modeling analyses, a grant has been provided through NOAA's Sea Grant Program to the Ralph Parsons Laboratory, Massachusetttitute of Technology, to provide an independent assessment of brine disposal using existing MIT models.

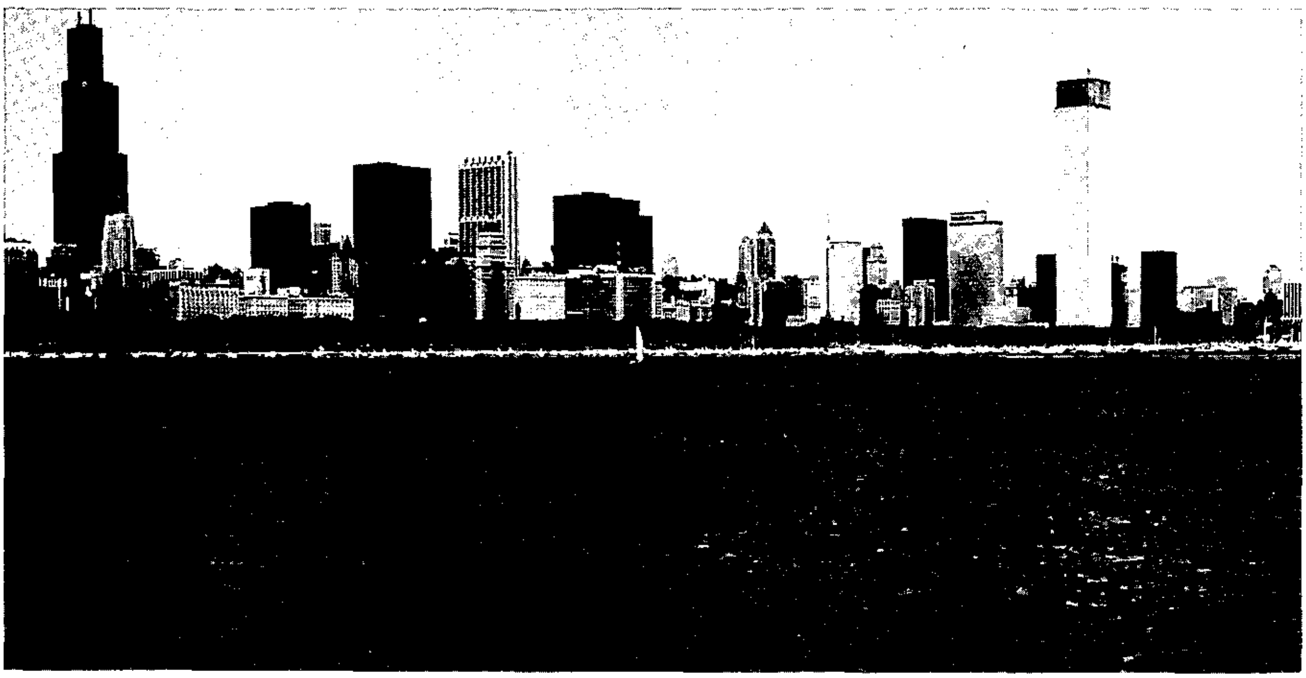
FEA will decide what constitutes an acceptable level of impact after it receives information from EDS and others. EDS will provide a suite of impact scenarios based upon model outputs that will assist FEA in selecting the optimum approach to brine disposal.

Should the decision be made to proceed with the leaching of salt domes and disposal of brine in the Gulf of Mexico, and approved by the Environmental Protection Agency, there may be a requirement imposed to monitor the actual impact of such an action. As a contingency, FEA has asked NOAA to prepare a monitoring program for each area of consideration.

Left: Typical salt cavern storage of crude oil, raw water displacement. The rock salt is nonporous and, under the weight of overlying and surrounding rock, has a compression strength comparable to concrete.
Top: MIT brine dispersion model for Bryan Mound. The numbers show the increase in salinity (parts per thousand) above the normal concentration.

Endexing the Environment

By Robert Gelfeld and Michael McCann
National Oceanic and Atmospheric Administration



The Chicago skyline from Lake Michigan. City planners used ENDEX in developing a plan for management of the Lake's coastal zone within the city's jurisdiction.

Photo: Kee T. Chang, Chicago Association of Commerce and Industry

The Department of Development and Planning of the City of Chicago is working on a plan for management of the lake Michigan coastal zone within the city's jurisdiction. To begin this effort, city planners needed to identify existing collections of environmental data concerning the lake.

Specifically, the Department needed answers to two questions: What data have been collected? and who has them? To find the answers, Chicago's planners consulted EDS' Environmental Data Index (ENDEX).

ENDEX is a computer-oriented referral service that identifies and describes collections and sources of environmental data. ENDEX is an inventory; it contains no raw data. Rather, it provides information on the types of measurements made, where they were made, projects associated with the collection efforts, and, most importantly, the names and addresses of individuals and institutions holding the data.

ENDEX provided Chicago's planners with descriptions of 260 data files dealing with southern Lake Michigan.

AMAX Exploration Inc., a Colorado-based company with worldwide mining interests, recently undertook a feasibility study on manganese nodule mining in the Pacific Ocean. AMAX turned to ENDEX to identify data available on the subject. ENDEX's Bottom Photograph Camera Station file provided the needed information.

The Camera Station file is an inventory of photographs of the sea floor. Included are the geographic location, date the pictures were taken, type of camera (stereo, TV, movie), type of film (color or black and white), number of useable negatives, and the name of the institution holding the photos. Additional information, included whenever possible, is water depth and distinguishable features (animals, plants, rocks, evidence of currents, and nodules). In all, the file describes over 7,500 geographic locations pictured in over 200,000 photographs.

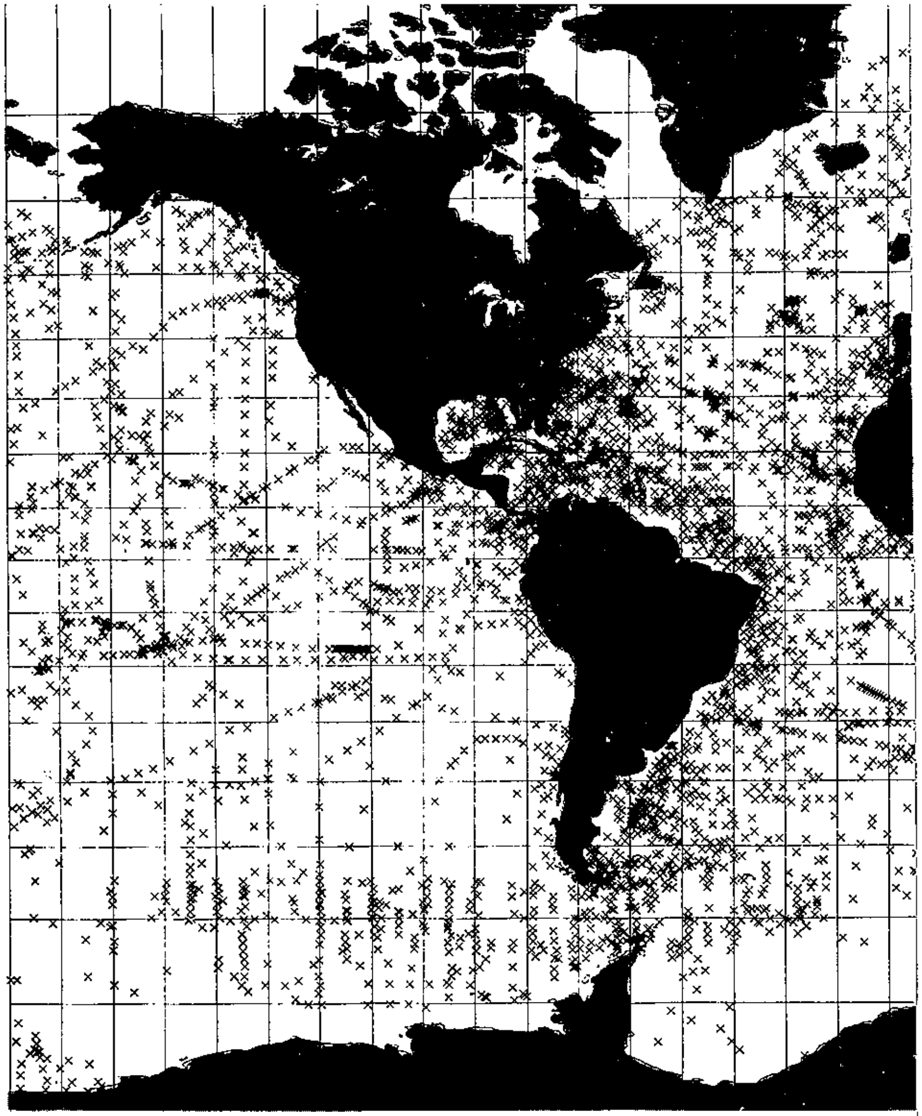
The Photo file contained 309 records of location in the Pacific Ocean where photographs of manganese nodules have been described. AMAX used the ENDEX computer printout to contact photograph holders and acquire the pictures.

ENDEX is structured to meet all types of users' needs. Input information is strictly controlled to ensure quality. Control features include (1) a dictionary of environmental parameter names/spheres/methods; (2) thesauri for media, platforms, projects, and institutions; and (3) an algorithm to store data latitude and longitude references in 10-degree to 1-minute (or 1-mile) grids.

ENDEX describes many types of environmental data files—pollution, meteorology, biology, chemistry, oceanography, geology, and solar-terrestrial physics—hence a uniform, easily readable output is essential for system efficiency and universal user comprehension. An ENDEX data file description lists the types of parameters and volumes of data available, the methods used to measure them, when and where the data were collected, the sensors and platforms used, data formats, restrictions on data availability, publications in which the data may be found, whom to contact for further information, and the estimated cost of obtaining the data.

In developing ENDEX, EDS has sought out, documented, and automated selected files of environmental data or arranged for access to such files when already automated. Holders of environmental data files include Federal, State, or local governments; colleges and universities; private companies; and private individuals.

The ENDEX task team began their work by ENDEXing data files for the areas of study for three national marine projects: the International Field Year for the Great Lakes study of Lake Ontario, the MESA (marine ecosystems analysis) study of the New York Bight area, and a U.S. Army Corps of Engineers' study of Chesapeake Bay. Although all three were marine studies, the data collections ENDEXed include all types of environmental data.

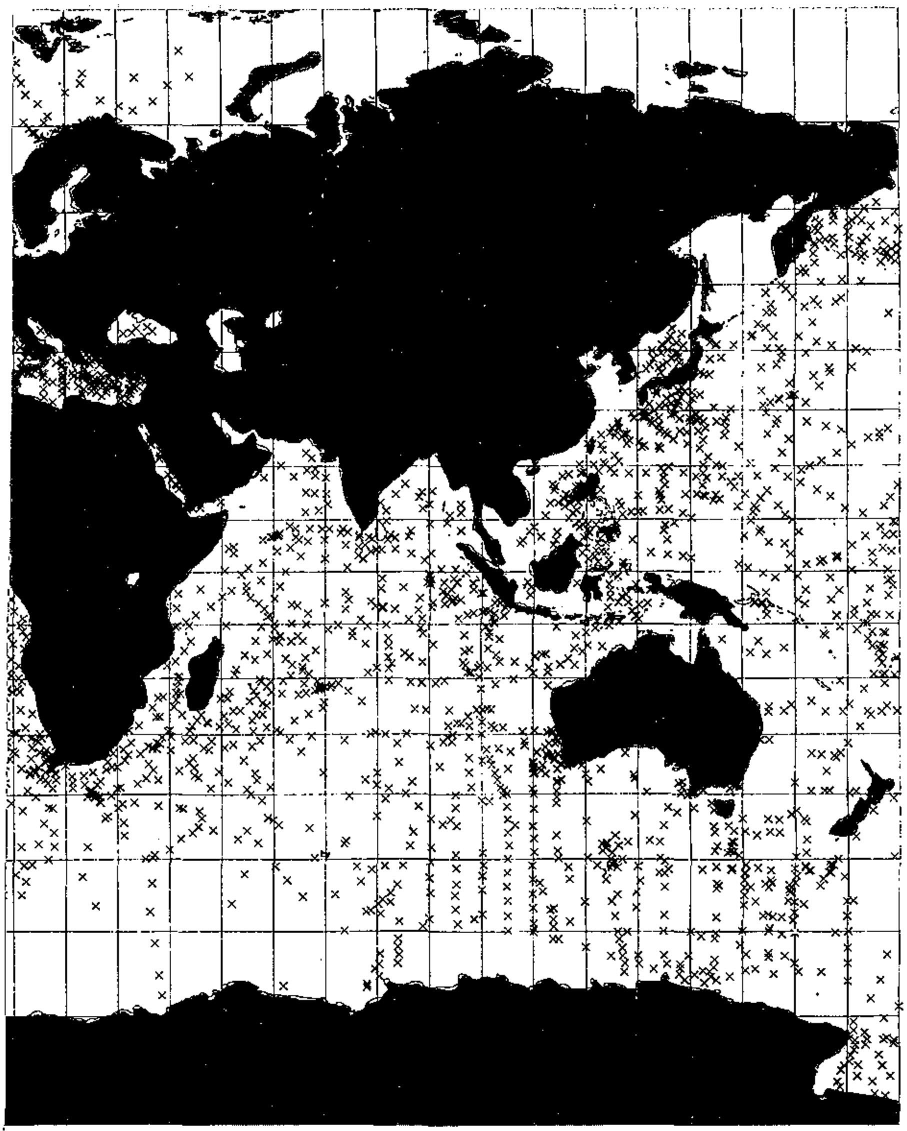


ENDEX Camera Station Inventory.

The data files were ENDEXed by personnel of local institutions under contract to EDS. Through telephone calls, letters, and personal interviews, these institutions were able to describe most of the existing environmental data files available in their areas.

The ENDEX task team coordinated the contractor interviews, then processed the file description for entry into and retrieval from ENDEX. As of January 1977, about 1,500 data files had been described for the Great Lakes region, about 400 for the New York Bight, and approximately 1,600 for Chesapeake Bay.

The remaining East Coast States are now undergoing the same process as the three original areas. In addition, in conjunction with the Bureau of Land Management/NOAA Outer Continental Shelf Environmental Assessment Program (OCSEAP) (see January 1977 *EDS*, page 4),



ENDEX contractors have described over 800 environmental data files in Alaska, as well as 855 files in the States of Washington and Oregon, and parts of California. EDS and the National Marine Fisheries Service have begun a cooperative effort to describe environ-mental data files available in the Gulf Coast States, and the remaining U.S. coastal zone States also are scheduled for ENDEXing.

ENDEX file descriptions are sent back to the original investigator after 2 years for additions, corrections, or deletions. In addition, new files that were not described in the original canvassing are referred to the EDS task team, who create new file descriptions. As of January 1977, over 8,0-00 files descriptions have been entered into ENDEX.

EDS recently added several new components to ENDEX. One of these is the Earthquake Data File (QUAKE). It contains descriptions of about 120,000 earthquakes from the year 1638 to the present. The descriptions include date, origin time, location, focal depth, magnitude, and intensity (when available). The data themselves are maintained by the Seismology Branch of EDS' National Geophysical Solar-Terrestrial Data Center in Boulder, Colo.

The two other new components of ENDEX are marine oriented. One is the NODC Index for Instrument-measured Subsurface Current Observation (NIMSCO). (See January 1977 *EDS*, page 22.) This inventory is indexed by instrument type and model; sampling location, depth, date; and institution holding the current data.

The third new component is an international marine reporting system developed by UNESCO's Intergovernmental Oceanographic Commission—the Report of Observations/Samples Collected by Oceanographic Programs (ROSCOP)— in support of international environmental data exchange. ROSCOP provides timely inventories of data and samples recently collected, but not yet archived.

ENDEX services are available to everyone. The cost varies according to the complexity of the request. A good rule of thumb is that the user is charged 30¢ for each record selected and printed out. The ENDEX system is described in depth in the *User's Guide to ENDEX/OASIS*, available free of charge. Both user's guides and answers to queries may be obtained by writing or calling the Data Index Branch, D782, NOAA/EDS, Washington, DC 20235. Telephone: 202-634-7298.

A recent ENDEX query came from a young couple in New England. They were interested in buying a small farm next to a lake, and wanted data on local climate, animal inhabitants, and pollution. EDS personnel found two ENDEX references that provided the data they wanted. One was a seasonal data study of the area by a college professor made in the late 1960's. The other was a State survey of air and water pollution levels for the area. Together, the two gave an excellent environmental picture. Based on these ENDEX references, the couple bought their farm.

Weather Proverbs*

By R. E. Spencer

The trouble with weather proverbs is not so much that they're all wrong, but that they're not all right for all times in all places. Some of the ones we hear in New England originated thousands of years ago in northern Africa near the Mediterranean Sea where they could be heard and repeated and at last recorded by the writers of the Old Testament. And many a farmer in the Middle West, depending on a sure-fire weather saying his grandfather brought from Germany or Sweden, has found it useless in the United States.

But distances far shorter than either of these are enough to ruin some weather proverbs-for instance, those that predict rain from the direction of the wind. When the wind blows up the side of a mountain it is cooled and loses its moisture in the form of rain; so that a west wind blowing up the west side of a mountain would produce the same result, a fall of rain, as an east wind blowing up the east side of the same mountain. What this adds up to is that a distance just great enough to hold a good-sized mountain might also be great enough to ruin a proverb about west (or east) winds bringing rain; and people living in Denver should be cautious about wind-and-rain signs that work well for their neighbors over the mountains in Grand Junction, and vice versa. Here are a few, by authors of obvious standing, that were no doubt written in different places:

"Fair weather cometh out of the north."-Job

"The north wind bringeth forth rain."-Proverbs

"Take care not to sow in a north wind or to graft and innoculate when the wind is in the south."-Pliny

"The north wind is best for sowing of seed, the south for grafting."-Worledge, 1669

Another point worth noticing about the importance of locality is that on our Pacific Coast the moisture-bearing wind blow in from the west and southwest, while in the East they come from over the Gulf of Mexico and the Atlantic. The two following, then, should not be considered too seriously in the East:

"A western wind carrieth water in his hand";
"When the east wind Toucheth it, it shall wither,"

On the other hand the one following would have few takers on the west slopes of the Cascade Mountains and Sierras, where rain and snow are very frequent companions of west and southwest winds,-

"When the wind is in the west
The weather is always the best."

Also, the south wind, about which it is said

"The south wind warms the aged" and "The south wind is the father of the poor,"

is about the wettest, stormiest, and generally least pleasant of winds in our states bordering the Gulf of Mexico. The proverb writers, including Shakespeare himself, are noticeably consistent in pointing this out—

"The southern wind doth play the trumpet to his purposes, and by his hollow whistling in the leaves foretells a tempest and blustering sky."

"If feet swell, the change will be to the south, and the same thing is a sign of a hurricane."

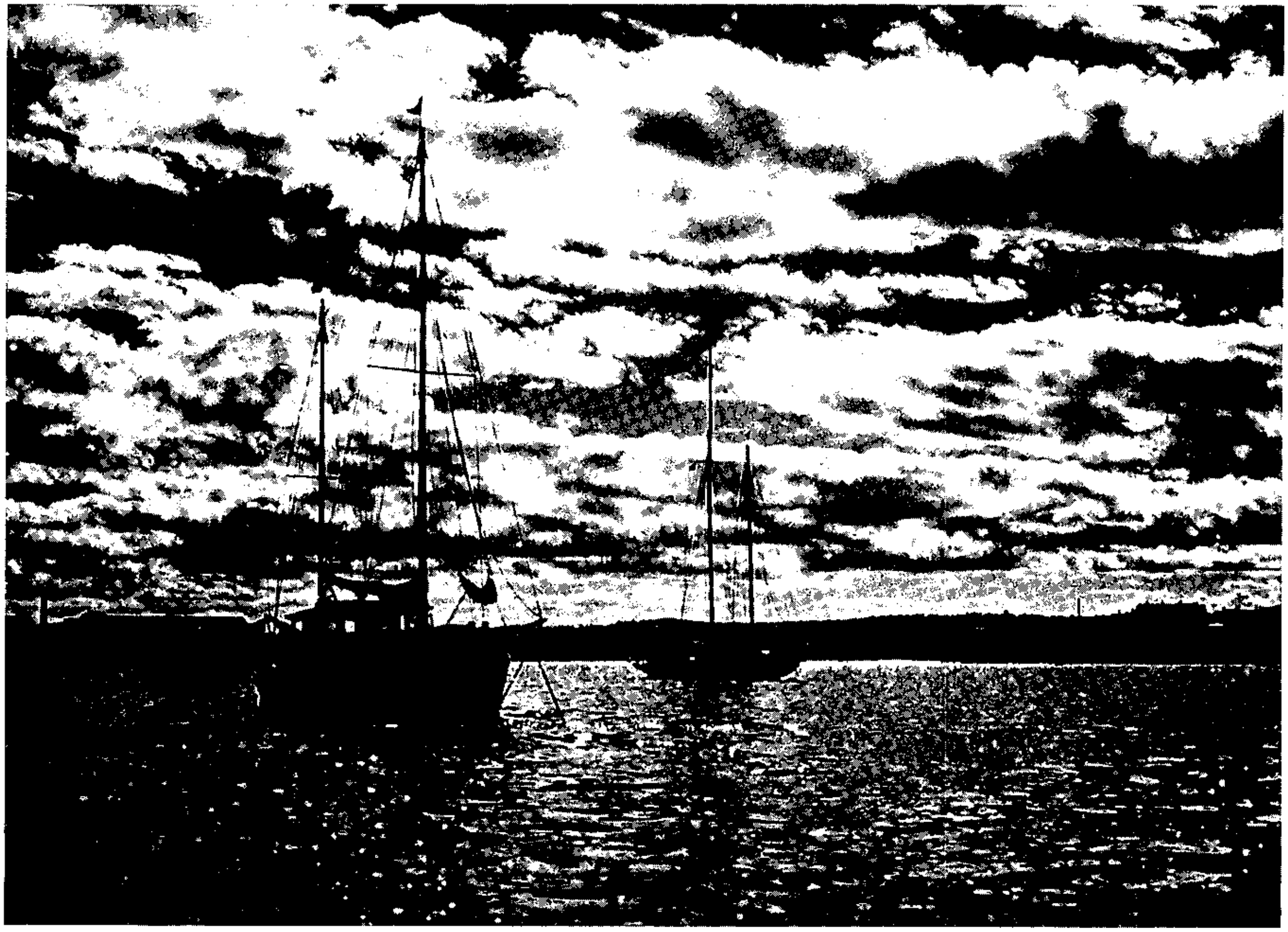
"When the wind's in the south
the rain's in its mouth."

Anybody who has ever looked at a collection of these sayings must have been impressed by their variety. They are extremely ancient—about as old as language itself; they illustrate as well as anything could illustrate the importance of weather in human affairs; they demonstrate very clearly man's hopeful opinion that experience is a good teacher; their literary merit ranges from excellent to unspeakable; and their range of subject includes practically everything from apple trees to zymology. Also, like politics, which we are told make strange bedfellows, they produce some very striking relationships—wolves and crops, sky colors with foul results, holy days and unholy weather; and rain is foretold by the behavior of cats and dogs and cattle, red hair and ropes, spiders and smoke, crickets, frogs, birds, mice, flies, rheumatism, etc., etc., etc. Squirrel stores and the thickness of their fur make prophesies of hard

The groundhog sees his shadow.

Photo: Lambert Studios, Inc.

*Reprinted from the *Weekly Weather and Crop Bulletin*, December 27, 1954.



winters. The drought or wetness of summers is predicted by the weather in March; what happens on Christmas foretells what will happen on Easter; light or heavy fogs in October foretell light or heavy snows in the coming winter; and one proverb says "If the spring is cold and wet, then the Autumn will be hot and dry," another, "A wet fall indicates a cold and early winter," and still another (this one from Holland), "A cow year is a sad year and a bull year a glad year."

A few other, good, bad, and indifferent, showing this variety of subject:

"When the wind is in the south
It blows the bait in the fishes' mouth"

"One swallow does not make a summer"

"If the weather is fine, put on your cloak,
If it is wet, do as you please"

"A bad year comes in swimming"

"The first Sunday after Easter settles the weather for the whole summer"

"A windy May makes a fair year."

"When birds and badgers are fat in October, expect a cold winter."

"Wet May, dry July
Mud in May, grain in August"

"One would rather see a wolf in February than a peasant in his shirtsleeves."

". . . Red sky at night, sailor's delight." The red sky is caused by the setting sun lighting the spread-out remains of daytime fair weather clouds. It is a pretty sight and usually a sign of good weather.

"February rain is only good to fill ditches."

"February rain is as good as manure."

"A warm Christmas, a cold Easter,
A green Christmas, a white Easter."

"The circle of the moon never filled a pond; the circle of the sun wets a shepherd."

"Moonlight nights have the hardest frosts."

"A red morn, that ever yet betokened
Wreck to the seaman, tempest to the field,
Sorrow to shepherds, woe unto the birds,
Gust and foul flaws to herdmen and to herds."

"Do business with men when the wind is in the northwest."

One of the best known of the rain prophesies is the one about the wet 40 days that supposedly follow a rainy St. Swithen's Day (July 15); and the ground-hog-day story gets into practically every newpaper in the country during the first week in February. Since neither of these old standbys has any basis in fact so far as weather is concerned, their persistent popularity, like that of countless others, must be explained by something else—possibly that nearly everybody on earth, now and for many thousands of years, has wanted to know what the weather is going to be tomorrow, next week, next month, a year from now, and so on. Farmers want to know this and so do sailors because such a large part of their actions and fortunes depend on weather, but it also affects the work of a great variety of other outdoor operators—salesman, washerwomen, grain-speculators, baseball and amusement park managers, brides planning outdoor weddings, fishermen with their eyes on a holiday, military leaders planning field actions, and any number of others, from advertisers to zoo keepers.

Another partial explanation of why these sayings are repeated so often is that the repeaters like to speak their wishes or gloomy states of mind, regardless of whether they make logical weather predictions; another, because we love the prestige that comes with prophecy, most of us can't resist the temptation to spout a jingle when it fits the conversation (and even, very often, when it doesn't) like these:

"Fish bite the least
With wind in the east"

"Winter's thunder
Bodes summer hunger"

"Two full moons in a calendar month bring on a flood"

"A red sun has water in his eye"

Another explanation, also taking account of human vanity and the natural desire to simplify, is that we enjoy the praise of being helpful and the glamor of interpreting mysteries. Here are a few likely examples (if delivered to the right audiences):

"New moon on its back indicates wind; standing on its points indicates rain in summer and snow in winter."

"Mackerel clouds in the sky
Expect more wet than dry."

"When smoke in clear weather rises vertically, the weather will remain clear."

"When oak trees bend in January good crops may be expected."

But the best explanation for the persistence, the invention, and the very wide distribution of these sayings is simply that a great many of them make good sense. For example, the one quoted above about the peasant in his shirtsleeves in February means simply that a warm February will advance the growth of vegetation so far that a subsequent hard frost will destroy it—which nobody wants, especially a farmer who depends on his crops. Here are three other with the same message—

"A late spring never deceives."

"Better to be bitten by a snake than to feel the sun in March."

"A wet March makes a sad harvest."

And "A year of snow is a year of plenty,"
is just a pleasant way of pointing out that a snowy winter provides enough soil moisture to assure good crops.

The familiar halo of the sun or moon is caused by the refraction of their light by ice-crystals in the cirrus clouds, which frequently appear when lowered air pressure and high clouds are present and rain is approaching. Thus, proverbs saying the ring around the sun (or moon) is a sign of rain, such as this one—
"The moon with a circle brings water in her beak" are frequently right.

Several of the many signs men see in the behavior of animals and insects are worth note too. For example,

"A bee was never caught in a shower."

"Expect stormy weather when ants travel in lines, and fair weather when they scatter."

"When flies congregate in swarms, rain follows soon."

"Pigeons return home unusually early before rain."

The following rather inclusive one, giving several results of low air pressure of high humidity (which often precede rain) should prove, if we wait long enough, that not all weather signs are wrong —

"Lamp wicks crackle, candles burn dim, soot falls down, smoke descends, walls and pavements are damp, and disagreeable odors arise from ditches and gutters before rain."

And finally this one, of dubious meteorological value, requires no comment—

"Dirty days hath September,
April, June and November;
From January up to May
The rain it raineth every day.
All the rest have thirty-one,
Without a blessed gleam of sun;
And if any of them had two-and-thirty
They'd be just as wet and twice as dirty."

Argo Merchant Oil Spill Report

NOAA has published a preliminary report of onsite research activities conducted in connection with the *Argo Merchant* oil spill off Nantucket Island, Mass., on Dec. 15, 1976, one of the largest oil spills in U.S. history.

The report was prepared by members of the Joint NOAA/U.S. Coast Guard Spilled Oil Research (SOR) teams (see *EDS*, September 1976, page 3), some of whom were on the scene only hours after the grounding. SOR teams are specially trained and equipped to respond rapidly to oil spills at sea.

The SOR teams are made up of scientists from EDS and NOAA's Environmental Research Laboratories (ERL), the U.S. Coast Guard, and the Alaska Department of Environmental Conservation and are part of NOAA's Outer Continental Shelf Environmental Assessment Program (see *EDS*, January 1977, page 4), funded by the Bureau of Land Management. The program is managed by ERL and was established to provide the environmental data needed by the Department of the Interior to assess the ecological consequences of offshore oil and gas exploration and development on the outer continental shelf of Alaska. The Nantucket spill is the first major cold water spill the teams have had a chance to examine.

The teams were established to improve predictive modeling techniques for all types of spills. Four quick-response teams were formed—one each in Washington, D.C., Seattle, Wash., and Juneau and Fairbanks, Alaska. SOR scientists collect spill information to refine existing models and isolate key parameters most in need of study. Major areas of interest include determining more accurately the speed with which oil moves over surface water, how quickly oil slicks break up, how oil enters the water column and, eventually, the sediments.

Many factors interact to determine what happens to spilled oil—its original hydrocarbon composition, air and water temperatures, wind, waves and currents, and the load of sediments and microscopic organisms suspended in the water. Because of these factors, it is not feasible to fully simulate oil spills either in the laboratory or by using less obnoxious simulant materials on the ocean surface. Computer models developed to simulate the movement, dispersion and degradation of the oil require quantitative expressions for these processes. One of the few ways of obtaining the information under realistic conditions is to study "spills of opportunity," such as the Nantucket event.

This preliminary technical report is intended to provide the scientific community with brief preliminary summary of the physical, chemical, and biological studies initiated by numerous Federal, State, and private individuals and institutions during the two-week period immediately following the grounding of the *Argo Merchant*. This information is needed to support the planning of follow-on research programs to document the short- and long-term ecological effects of the oil spill. Once the data described in this report have been analyzed and interpreted, a final technical report is planned to summarize the findings and conclusions of the many scientists who were involved in the investigations undertaken during the first six weeks following the spill. Also under consideration is a workshop where the participating investigators can present their results.

Copies of the preliminary report are available from:
Services Branch, D825
Environmental Science
Information Center
6009 Executive Blvd.
Rockville, MD 20852

Oil-soaked Navy frogmen rest between dives.

Comparing the Climates of U.S. Cities

The EDS National Climatic Center has developed a new publication to meet the needs of editors of almanacs and other users interested in comparative weather statistics. *Comparative Climatic Data* matches values of climatological elements for about 300 National Weather Service stations in the 50 States, as well as for San Juan, P.R.; Swan Island, Honduras; and 12 Pacific islands. The stations listed include 79 of the 90 major urban areas that reported populations greater than 150,000 in the 1970 census; data are also presented for weather stations within 30 miles of the other 11 major urban areas.

The data are arranged by climate elements, so that monthly and annual values can be compared for different locations in a single table. The tables include:

Observed Data

Temperature, highest of record, degrees F
Temperature, lowest of record, degrees F
Mean number of dates with minimum temperature 32 degrees F or less
Mean number of days with precipitation 0.01 inch or more
Snowfall (including ice pellets), average total in inches
Wind, average speed (mph)
Wind, maximum speed (mph)
Sunshine, average percentage of possible
Cloudiness, mean number of days: clear, partly cloudy, cloudy
Average relative humidity, morning and afternoon

Climatological Normals

Normal daily maximum temperature, degrees F
Normal daily minimum temperature, degrees F
Normal daily mean temperature, degrees F
Normal heating degree days (July-June)
Normal cooling degree days (January-December)
Normal precipitation, inches

The observed data tables will be updated annually. Climatological "normals" (50-year averages) are recomputed at 10-year intervals to include the latest 30-year period (1941-70 is the period used to compute current normals).

For further information concerning the publication, write to:
Director
National Climatic Center
Federal Building
Asheville, NC 28801

Telephone inquires are welcome at 704-258-2850, Ext. 683 (FTS 672-0683).

Alaska Earthquakes Analyzed

A new publication, *An Analysis of Earthquake Intensities and Recurrence Rates in and Near Alaska* (NGSDC TM-3), has been issued by the EDS National Geophysical and Solar-Terrestrial Data Center. This volume complements a publication prepared last year, *A Historical Summary of Earthquake Epicenters in and Near Alaska* (NGSDC TM-1). Both publications were prepared in support of the NOAA/Bureau of Land Management Outer Continental Shelf Environmental Assessment program (see *EDS*, January 1977, page 4) related to petroleum development.

The new publication summarizes earthquake intensities reported in the Alaska region since 1786. A comparison is made between magnitude and intensities and a relationship established. Recurrence rates for earthquakes of various magnitudes and intensities for numerous regions also are provided.

Copies of either publication may be obtained from:

Solid Earth Data Services Division, D62
National Geophysical and Solar-Terrestrial Data Center
EDS/NOAA
Boulder, Co 80302

Prepackaged Marine Literature Searches Available

International Policies, Agreements, Law, Regulations, and Cooperation Relating to the Oceans (No. 76-1); and *Manganese Nodules (No. 76-2)* are the first of a planned series of computer-produced prepackaged literature searches available from EDS' Environmental Science Information Center. No. 76-1 contains about 280 citations, and No. 76-2 cites 175 references.

Subject areas planned for future prepackaged searches include climate and health, the coastal zone, heavy metals, marine minerals, ocean dumping, ocean mining, and weather modification. Oceanic-related searches cover the period from 1964 to the present; meteorological-related searches from 1972.

These prepackaged searches are available without charge. Requests should be made to Document Dissemination, Library and Information Services Division, WSC-4, 6009 Executive Blvd., Rockville, MD 20852, or by telephone: (301) 443-8334.

Weatherizing the Homes of Low-Income Americans

The Federal Energy Administration (FEA) is using climatic data products prepared by EDS' National Climatic Center (NCC) in its formula to allocate Federal funds to the States to insulate over 1 million homes of low-income persons.

The Energy and Conservation Production Act of 1976 provides that FEA shall make grants to the States to weatherize the homes of low-income Americans. It authorizes the allocation of $55 million in fiscal year '77, $65 million in FY '78, and $80 million in FY '79. The objectives of the program are to conserve energy and to help those who suffer the most from higher energy costs and are least able to afford the cost of insulating their homes, particularly the elderly and the handicapped.

A proposed FEA formula based on the climate, number of low-income people, and cost of insulating thermally inefficient low-income homes will be used to determine the amount of money to be allocated to each state. At least 90 percent of the money must be spent on weatherization materials such as caulking, ceiling insulation, storm windows, and weatherstripping.

The climate data used in the formula are heating and cooling degree days, measures of temperature as it relates to energy demand for spacing heating and air conditioning, respectively. To date, NCC has provided FEA with population-weighted average annual heating and cooling degree day totals for all States (and the District of Columbia) except Alaska, during the 30-year (normal) period 1941-70. Normal temperatures were used because year-to-year variation in annual heating and cooling degree days can be extreme in some States.

Heating degree-days are based on the fact that most buildings require no heat to maintain an inside temperature of at least 70°F when the daily mean temperature is 65°F (18.3°C) or higher. If the average of a day's high and low temperature extremes is above 65°F, the degree-days for that day are taken to be zero; otherwise, they are equal to the difference between the average and 65°F. A large number of degree-days implies cold temperatures.

Cooling degree days are computed by subtracting 65°F from the daily mean temperature during hot weather. As temperatures increases, more cooling degree days accumulate, meaning more energy is required to maintain indoor temperatures at a comfortable level.

NCC's data should be representative of thermal conditions near every U.S. population center. The input data are the monthly average temperatures compiled from thousands of cooperative climatological station reports sent to the Center each month, and available for each of the approximately 350 State climatological divisions into which the nation has been divided.

Climate and Health Workshop Report

Climate and Health Workshop: Summary and Recommendations was recently published to report on interagency meetings held at Research Triangle Park, N.C., June 8-9, 1976. The workshop was organized by EDS and jointly sponsored with the Department of Health, Education and Welfare's National Institute of Environmental Health Sciences, the Environmental Protection Agency, and the Energy Research and Development Administration. Representatives of other Federal agencies and of several universities also participated.

The report includes descriptions of several data bases useful in human biometeorology work, as well as a 19-page selected bibliography on climate and health. Copies may be obtained from the National Climatic Center, Federal Building, Asheville, NC 28801 as long as the limited supply lasts.

Heat waves, cold snaps, and sudden changes in atmospheric pressure can trigger cardiovascular distress.
Photo: Herb Austin

Digital Satellite Data Now Available

The Satellite Data Services Branch of EDS' National Climate Center now can provide copies of magnetic tapes containing (1) Visible and Infrared Spin Scan Radiometer (VISSR) data from two geostationary satellites (GOES-1 and SMS-2) and (2) Very High Resolution Radiometer (VHRR) data from the NOAA series of polar-orbiting satellites.

The VISSR provides observations of the Earth in the infrared spectrum (10.5 to 12.6 m) and in the visible spectrum (0.55 to 0.75 m). Scans are made as the satellite spins. North-south traverses of the Earth are accomplished by a step action of the scanning optics.

One visible and five infrared full-disk images of the Earth (both at 4-mile resolution) are available on a separate tape for each geostationary satellite for each day. However, such things as storms or equipment breakdowns may reduce the volume of data collected on a given day. Each image covers a sector of about 89° of latitude by 90° of longitude, from latitude 39°S to 50°N, and centered at 75°W for GOES 1 and 135°W for SMS-2. Daily data beginning July 26, 1976, are normally available at the following times (times may differ ± ½ to ± 1 hour):

West Satellite (SMS-2)	East Satellite (GOES-1)
0915Z (Infrared)	0930Z (Infrared)
0945Z (Infrared)	1000Z (Infrared)
1515Z (Infrared)	1600Z (Infrared)
2145Z (Infrared)	1600Z (Visible)
2145Z (Visible)	2130Z (Infrared)
	2200Z (Infrared)

Requesters can determine scan line and sample number for a given latitude and longitude through use of a Benchmark file on the tape. (Archive tapes written before August 9, 1976 cannot be Earth-located, because of an error in the Benchmark record.)

In addition to the Benchmark file on the tape, the user can get Earth-location software that will determine scan line and sample number for a given latitude and longitude. The software is designed for the NOAA/NESS 360/195 computer. The user must convert the software to his own system.

The VHRR (polar-orbiting satellite) data are collected by a scanner that has both visible and infrared channels with 1-km resolution. The image swaths extend 50 to 60 degrees of latitude along the orbital track. About 8 minutes (1/15th of a complete orbital track) of coverage in other parts of the world also may be programed for storage aboard the satellite on some, but not all, orbital passes each day. All infrared frames from an individual orbit are placed on one computer compatible tape and the visible frames on a separate tape.

All NOAA series polar-orbiting satellite tapes, beginnig with those for January 1, 1977, are sent to Satellite Data Services Branch. The tapes will be held 90 days after the date of data collection. After 90 days the tapes will be erased. During the period that the tapes are maintained at SDSB, requesters will be provided copies of the tapes at cost of reproduction.

Requests for copies of any of these tapes should be addressed to Satellite Data Services Branch, World Weather Building, Room 606, Washington, DC 20233; Telephone (301) 763-8111. Cost of reproduction of the tapes varies: for 1 to 9 tapes the cost is $60; for 10 to 49, the cost is $45 per tape; and for 50 or more, the cost is $35 per tape.

Orders for tape-to-tape copying can generally be filled within 10 days. Costs of other services, such as preparation of printouts, vary with the complexity of the request. Documentation will be furnished with all tapes. Standing orders for copying certain specified scenes periodically will be accepted.

High-Resolution STD Data

For the first time, EDS' National Oceanographic Data Center (NODC) can provide salinity-temperature-depth (STD) data in high-resolution format. This format provides data on observations vertically spaced 1 to 5 meters apart. The data were acquired from the U.S. Naval Oceanographic Office, Scripps Institution of Oceanography, and University of Washington.

The data, originally processed by the collectors, were reformatted at NODC. Accompanying the data is documentation describing instrument calibration, acquisitions method, and original processing techniques. The documentation allows users to decide the value of the data with respect to their own needs. For these data, NODC also has computed values for sound velocity, dynamic depth anomaly, salinity from conductivity, and depth from pressure.

Copies of the data may be obtained on magnetic tape from Oceanographic Services Branch, National Oceanographic Data Center, NOAA Washington, DC 20235.

Originator of STD data who wish to process their data into NODC's high-resolution format may receive detailed instructions from the above address.

International Report

World Seismicity and Volcanic Activity Map

A new map—"World Seismicity and Volcanic Activity in the Year 1975" (copy enclosed)—has been published by the National Geophysical and Solar-Terrestrial Data Center (NGSDC). The three-color map shows the location of earthquakes and volcanic eruptions reported respectively by the U.S. Geological Survey's National Earthquake Information Service and the Center for Short-Lived Phenomena.

Of the 5,431 earthquake epicenter reports around the world, 1 was in the magnitude range 8.0 to 8.4, 14 were magnitude 7.0 to 7.9, 107 were magnitude 6.0 to 6.9, and 5,309 were less than magnitude 6.0. There were 12 volcanic eruptions reported.

Since 1974, the Hammer Equal-Area map projection has been used to plot world seismicity. The Hammer projection clearly delineates the circum-Pacific seismic zone, the Earth's most seismically active region. Most of the deep-focus (300- to 700-km depth) earthquakes and volcanic eruptions occur in or near this ocean basin. Also clearly defined is the Mid-Atlantic Ridge, an undersea mountain range that stretches from Spitsbergen to south of Africa. Most of the earthquakes in the region are of shallow depth (0- to 70-km depth).

The Alpide belt, which branches westward from near Burma, across India, the Near East, and through the Mediterranean, continues to be the area were thousands are killed annually by earthquakes. This is due as much to the poor construction of buildings in the region as to the magnitude of the earthquakes. As an example, the worst disaster in the world during 1975 occurred in this belt in Lice, Turkey, on September 6, killing more than 2,000 people and injuring about 3,400 others. The magnitude 6.7 shock also demolished 5,275 houses, damaged another 6,850, and caused property losses estimated at $17 million.

On February 4, 1975, a major earthquake (magnitude 7.4) struck Liaoning Province, China. The tremor caused extensive damage in the Yingkou-Haicheng area; however, the casualty total was greatly reduced by public warnings issued before the main shock. The prediction of this major earthquake was based on an intensive program involving numerous professional and amateur observations made over an area suspected of building up stress over a 2-year period.

Several other earthquakes caused major damage at scattered points around the world. In Kashmir, near the border with Tibet, 47 people were killed, about 40 injured, and 2,500 were left homeless from a magnitude 6.8 earthquake on January 19.

About 17 deaths were reported during 1975 from earthquakes in Burma, Chile, Hawaii, Iran, Java, the Philippines, and Venezuela. A magnitude 7.2 shock on November 29 caused 2 deaths, 50 injuries, and about $4 million damage on Hawaii Island. This was the strongest earthquake there in more than a century. A damaging tsunami followed the shock; wave heights reached about 7.5 meters (25 feet) along the southeast coast.

Other damaging earthquake activity in the United States during 1975 occurred in Idaho and California. The Pocatello Valley, Idaho, area was strongly shaken on March 27 by a magnitude 6.3 shock. About $1 million damage in Idaho and Utah resulted from this tremor, the largest in the continental United States since the destructive San Fernando earthquake of February 1971.

On August 1, a magnitude 6.0 earthquake caused damage estimated at $6 million in Oroville, Calif. Twelve persons were treated for minor injuries at local hospitals. The shock was felt over an area of about 120,000 square kilometers.

The map itself is based on seismic data from the NGSDC Earthquake Data File, a computerized data bank that contains epicenters for about 125,000 worldwide earthquakes for the period 1897-1975. The file also contains noninstrumental data for historical United States earthquakes since 1638.

A data printout of a search of the file can be provided for $15. The search can be made for any geographic area, for any specified time period, for any magnitude range, and for other parameters covered by the file (tsunami, intensity, etc.). The complete file may be purchased on magnetic tape 7- or 9-track mode, and in densities of 556, 800, or 1,600 BPI for $60 per tape. The file is available on 16-mm microfilm for $20.

For further information on the availability of the map, or of other seismic data, contact:

National Geophysical and Solar-Terrestrial Data Center, D62
EDS/NOAA
Boulder, CO 80302

Very Long Period Seismic Data Available

The First data for a new, very-long-period seismic data base have been received by WDC-A for Solid Earth Geophysics. The data were recorded for periods up to 60 cycles/hour, a range which includes Earth tides, free oscillations of the Earth and long period surface waves produced by earthquakes. This is a range which, until now, has not been studied much, because of instrumental difficulties and problems with digitizing analog records.

The new data base is expected to aid in studies in gravity physics, Earth and ocean tides, theoretical studies of the Earth's interior (density, elasticity, stratification, etc.), free oscillation of the Earth (when large earthquakes occur the whole Earth "rings" with natural frequencies which tell much about the Earth's properties), regional properties of the Earth's mantle, and the nature of the mechanisms that cause earthquakes.

The data come from the International Deployment of Accelerometers (IDA) Program of the University of California, San Diego, sponsored by the Cecil and Ida Green and National Science Foundations. The data were collected by a worldwide network of digital recording La Coste-Romberg gravimeters. At present the network consists of stations at Canberra, Australia; Sutherland, South Africa; Pinon Flats, California; Halifax, Canada; and Nana, Peru. The network will be expanded to a maximum of 20 stations evenly distributed over the globe.

Digital data will be supplied to World Data Center-A monthly about 1 year after it is collected. The data are available from the Center on magnetic tape, punched cards, and plots. For additional details write:

WDC-A for Solid Earth Geophysics
NOAA/EDS/D6
Boulder, Co. 80302.

Sunspot Relative Numbers On Magnetic Tape

In response to many requests for such data in computerized form, the World Data Center A for Solar-Terrestrial Physics at Boulder, Colo., announces the availability of a magnetic tape containing data on relative numbers of sunspots. The data set is based upon *Sunspot Activity in the Years 1610-1960* by Professor M. Walsmeier, Director of the Swiss Federal Observatory at Zurich, and his more recent data compilations. The master tape contains five subsets: epochs of maxima and minima of sunspot activity for the years 1610 through 1975; yearly means of sunspot relative numbers for 1700 through 1975; monthly means of sunspot relative numbers for 1749 through 1975; smoothed monthly means of sunspot relative numbers for 1749 through 1975; and daily sunspot relative numbers for 1818 through 1975.

A copy of the complete tape or of individual subsets may be obtained from the World Data Center A for Solar-Terrestrial Physics, Code D63, NOAA/EDS, Boulder, CO 80302. Telephone: (303) 499-1000, Ext. 6467.

World Atmospheric Turbidity and Precipitation Chemistry Data for 1974

Atmospheric Turbidity and Precipitation Chemistry Data for the World, 1974 was recently released by EDS's National Climatic Center (NCC). This serial publication contains atmospheric turbidity data for stations in 19 countries and precipitation chemistry data for 15 pollutants collected at 34 stations in 11 countries. The 1974 issue also includes atmospheric turbidity and precipitation chemistry data for years that have not been published previously.

The World Meteorological Organization (WMO) sponsors the publication which is prepared jointly by NOAA and the Environmental Protection Agency (EPA). Data are submitted by stations in the WMO Networks for the Monitoring of Background Air Pollution and by other worldwide cooperative stations. EPA processes the precipitation chemistry data and supplies them to NCC. NCC processes the atmospheric turbidity data and prints and distributes the publication.

Requests for the publication should be sent to the National Climatic Center, Federal Building, Asheville, NC 28801. The cost is $5.10 per issue domestic and $7.55 for foreign.

Updated Catalog of Earthquake Photos

The EDS National Geophysical and Solar-Terrestrial Data Center has published *Catalog of Earthquake Photographs* (Key to Geophysical Records Documentation No. 7), an update and revision of a publication of the same title (KGRD No. 3), dated November 1974. The new catalog contains descriptions and examples of 750 photographs for 65 U.S. and foreign earthquakes. This more than doubles the content of the first edition, which had 300 photograph descriptions for 32 damaging tremors.

Photographs of earthquake damage are a unique data form. They provide a record of effects that otherwise would be lost in the cleanup and repair operations that usually follow within a day or two of the earthquake. For the engineer, they provide details of construction and special effects that cannot easily be reduced to a

Earthquake damage in Ingelwood, Calif., June 21, 1920.

Photo: California Division of Mines and Geology

written report. For others, they are graphic evidence of the tragic aftermath of destructive earthquakes.

NGSDC receives numerous requests for photographs of earthquake damage from magazine editors, earth scientists, and from educational institutions and others compiling text books and preparing visual displays. Until 1974, NGSDC answered these requests from scattered photo files that had never been cataloged and which contained, at most, 100 photographs from 15 or so earthquakes. Most photographs lay uncataloged in the files of various government and seismological organizations and in private collections.

Because of the increase in demand for this information, and because of the need to have it available form one source, NGSDC in early 1974 began collecting all types of earthquake photos for its new Earthquake Photograph Library. The library includes views of toppled buildings, collapsed bridges and dams, spectacular landslides and ground cracks, and tsunami waves and resulting inundation.

Each organization and individual contacted for contributions to the photo library was eager to assist in the project and many others offered their collections after reading about the undertaking in the *Bulletin of the Seismological Society of America* and other journals. The largest contributors were NOAA (Photography Section), U.S. Geological Survey, and the University of California at Berkeley, who jointly contributed about 75% of the collection. Other contributors included the California Division of Water Resources (Sacramento), California Division of Mines and Geology (Sacramento), University of Chile (Santiago), Geological Society of India (New Delhi), and Japan Meterological Agency (Tokyo). In all, 63 different government and private sources gave photos to the collection. Because of the assistance of these agencies, the first catalog was published in November 1974.

The updated catalog contains information on damaging earthquakes in the U.S. and foreign areas dating from December 1811 (the 1811 earthquake photos were not actually taken until 1905) to September 1975. It includes the date, location, description, and credit for each photo and 65 examples from the collection. The photos are listed chronologically by date of occurrence, but are cross-referenced in the index in four categories: 1) earthquake damage; 2) aerial views; 3) human interest; and 4) damage (all types) by location. Category 1 is broken down into 10 more detailed subjects to guide the user to his area of interest.

NGSDC would appreciate donations of photographs to its Earthquake Photograph Library. Those interested in obtaining a copy of the catalog or in contributing to the library should contact:

Jerry L. Coffman
National Geophysical and Solar-Terrestrial Data Center
EDS/NOAA, Code D62
Boulder, CO 80302
Phone (303) 499-1000, ext. 6472
(FTS 323-6472)

Auroral Electrojet Indices for 1974 Published

World Data Center A for Solar-Terrestrial Physics has published Report UAG-59, *Auroral Electrojet Magnetic Activity Indices AE(11) for 1974*, by Joe Haskell Allen, Carl C. Abston, and Leslie D. Morris. This report is the ninth in a series of these indices prepared by EDS' National Geophysical and Solar-Terrestrial Data Center beginning with data for 1966.

The indices are one of the most used ground-based parameters for the study of the magnetosphere. They are prepared from magnetrograms from a selected group of auroral zone magnetic observations.

The report contains daily graphs of AE and related auroral electrojet functions, plotted at 2.5-minute intervals. Hourly tables of values are also provided, as is a listing of observatories providing input data.

The data for the 2.5-minute indices are also available on computer listings or digital magnetic tapes. Microfilm copies of the graphs can also be obtained from World Data Center A for Solar-Terrestrial Physics, NOAA, Boulder, CO 80302 U.S.A.

The UAG Report itself is available to U.S. subscribers for $2.16 (price varies for foreign mailing). Make check or money order payable to the Department of Commerce, NOAA, and send to the National Climatic Center, Federal Building, Asheville, NC 28801, Attention: Publications.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Environmental Data Service
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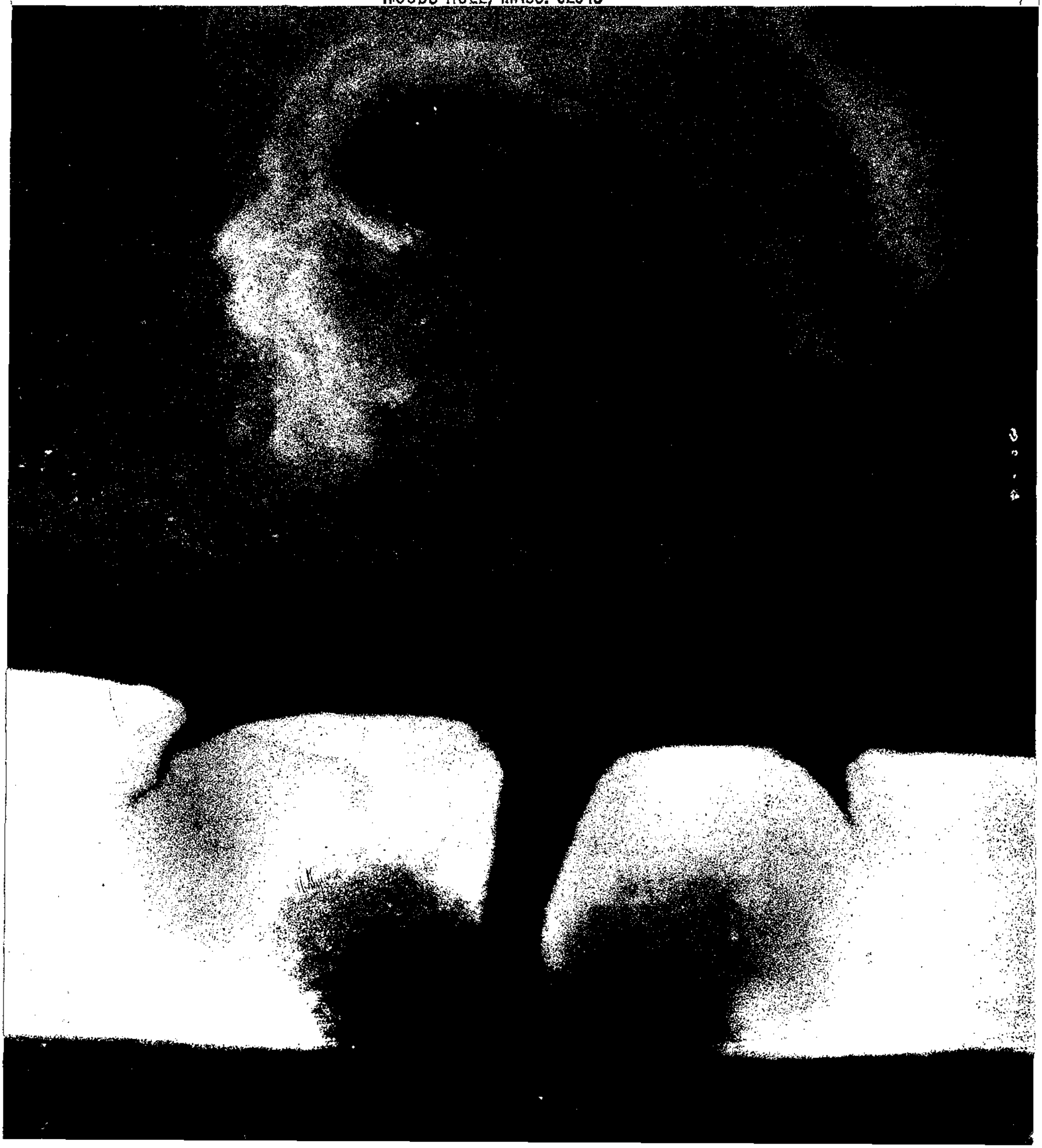
IN THIS ISSUE: CO_2 and future climate (p.3), The groundhog sees his shadow (p.16), Nantucket oil spill report (p.20), and building a national petroleum reserve (p.10).

EDS

Environmental Data Service
May 1977



EDS

Environmental
Data Service
May 1977

Cover: *The first known photograph of a tornado, taken near Howard, South Dakota, August 28, 1884. For a much closer look at these terrible storms see "Inside a Texas Tornado," beginning on page 16.*

EDS is a bimonthly publication designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, and Center for Climatic and Environmental Assessment. In addition, under agreement with the National Academy of Sciences, EDS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 16, 1975; this approval expires June 30, 1978.

U.S. DEPARTMENT OF COMMERCE
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National Oceanic and Atmospheric Administration
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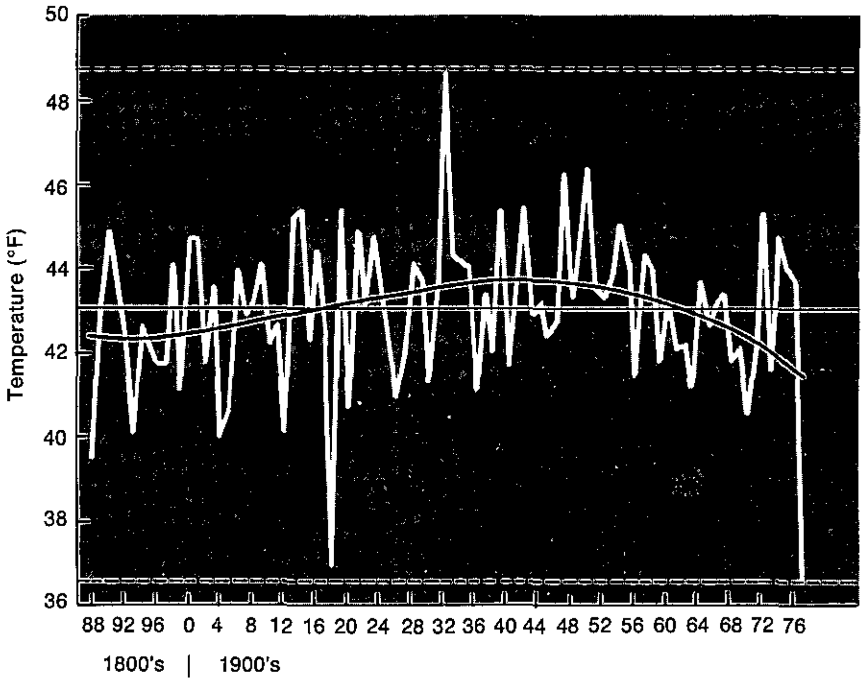
An Old-Fashioned Winter

By Robert Quayle
National Climatic Center



October through January mean temperatures for the eastern and plains States.

Severe cold caused much suffering and inconvenience because of the lack of fuel. Many important industries either partially or wholly suspended operations. Transportation was often badly crippled and at times completely paralyzed.

Temperatures as low or lower have doubtless existed in the past, but no known record appears of their continuation over such a long period. Heavy ice formed on most of the important northern rivers, and on the Ohio the conditions were reported as the worst in its history. On the middle Mississippi River the amount of ice at points was the greatest ever known.

The weather conditions west of the Rocky Mountains were almost the reverse of those to the east. In the Sierras of California, the deficiency of the snow cover was the greatest ever known, and the possibilities of the failure of the usual water supply became alarming.

What a winter! If most of the points made above seem only too familiar to even the most casual observer of this past cold season, consider this: They were plagiarized—in toto—with no change in meaning—from issues of the 1918 *Monthly Weather Review.* Even the term "An Old Fashioned Winter" was used in 1918 by the famed meteorologist C. F. Brooks in describing the ferocious 1917-18 winter. Why old fashioned? Because Brooks was recalling the bitter winters of the colonial and early republican periods. During the past winter of 1976-77, however, large areas of the country broke the records set in 1917-18, and, indeed, many others that happened to have been lying around.

For the period of widely recorded quantitative temperature data (the mid to late 1800's onward), this 1976-77 cold season appears to have been practically unprecedented. How was this deduction reached? First, a method had to be established for making extended cold spells over wide areas intercomparable from year to year over many years. Existing digital records on file at the National Climatic Center formed the basis of the study. One of the major historical collections used was a large data set including monthly average temperature for many stations throughout the world. This set was produced a few years ago by joint cooperation among NCC, the Harvard College Observatory, and the National Center for Atmospheric Research. From this, and smaller collections, a network of about 50 stations was selected from the "Lower 48" States. The major selection criteria were:

Long-term, relatively high-quality records.

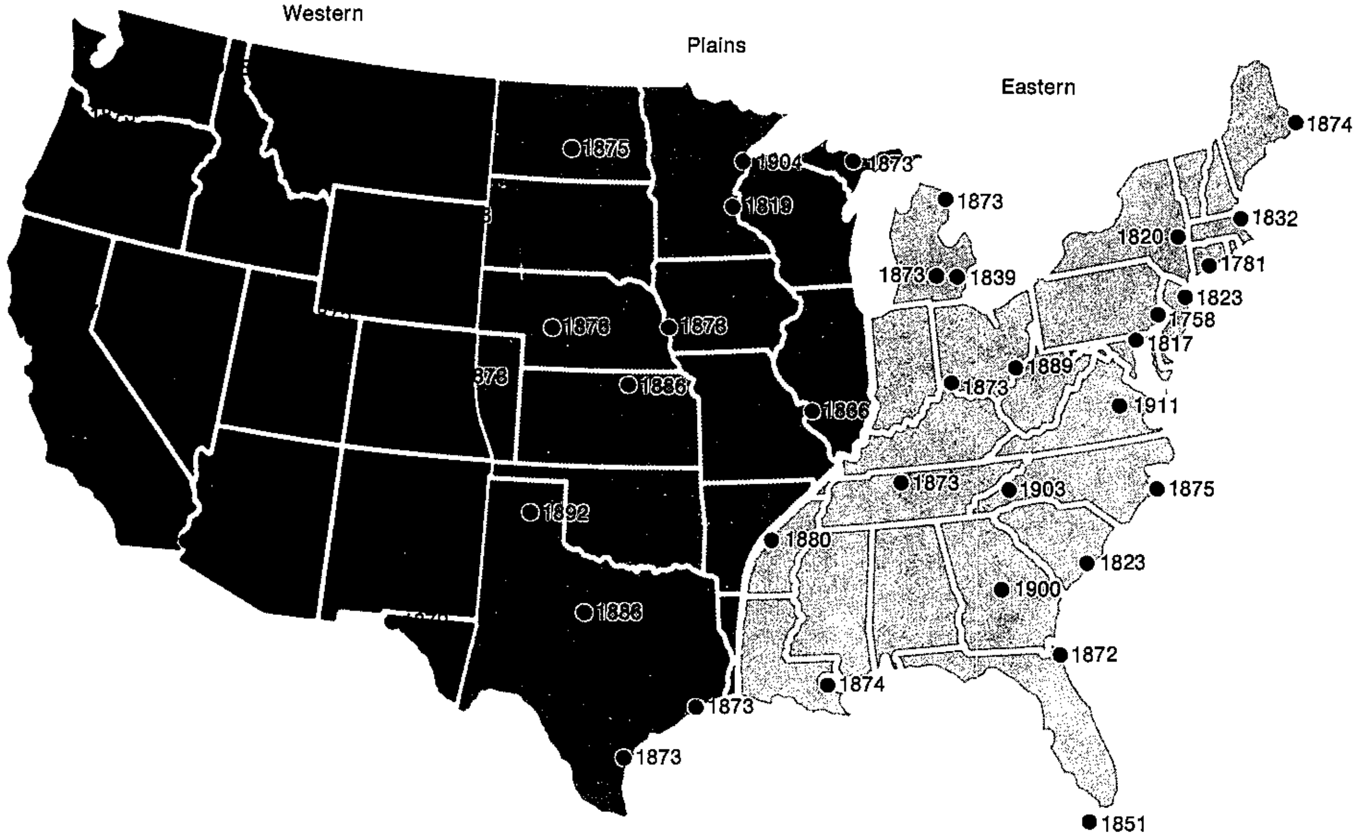
A geographically and climatically representative scattering, with individual stations being familiar to a wide spectrum of people.

Currently operating stations, whose records would be readily available at the end of each month.

The resulting station files were processed individually and then combined into broad geographic subregions called eastern, plains, and western networks. Network averages (or "indices") were compiled with no weighting, though there is a slight geographic bias toward areas of higher population density. The key was not so much to develop locally representative index values, but rather to develop relatively pure, easily reproducible grid indices that would be generally representative over broad geographic regions of significant population.

Comparisons with areally weighted State averages and population weighted regional averages

The winter of 1976-77 in Adams, New York.



The long-term station network used by the National Climatic Center to compare past winters.

(both of which are generally available only from the 1930's onward) showed that the network indices detected significant, widespread climatic variations well, while damping out smaller station-to-station fluctuations. To analyze the entire heating season on a continuing basis through the winter, statistics for October through January, October through February, and October through March were prepared for many years. In this way, only exceptional events in temporal and spatial extent appeared as significant anomalies.

At press time the March 1977 statistics were not yet in, but it appears that the recent October through January and to a less dramatic extent, October through February have been the coldest since 1887 for the nation-wide network as a whole and for the combined average of the plains States and the east. An "average" March, or one even slightly warmer, will keep this winter in league with the worst. For the east alone, the data show this season to be slightly warmer than 1917-18, but very close. Also of considerable interest are back-to-back cold seasons in the east in 1903-04 and 1904-05, though they were not as intense and widespread as the past season.

To go even further back in time, aggregate analyses of some very long term data were undertaken for New Haven, Conn.; New York, N.Y.; Philadelphia, Pa.; Baltimore, Md.; Charleston, S.C.; St. Louis, Mo.; Minneapolis, Minn.; and Portsmouth, Ohio. The results were quite striking. This season's October through January seasonal averages were generally on a par with the two or three coldest since the early 1800's—often the coldest. At Philadelphia, where interrupted records exist back to 1758 and continuous records have been kept since 1790, this October through January season beat them all (as did January alone). October through February cold at Philadelphia was second only to 1836-37. New Haven, with records back to 1781, had several years colder than this, showing New England fared relatively well this past season.

Climate and Shelter

By H. E. Landsberg, Professor Emeritus
University of Maryland

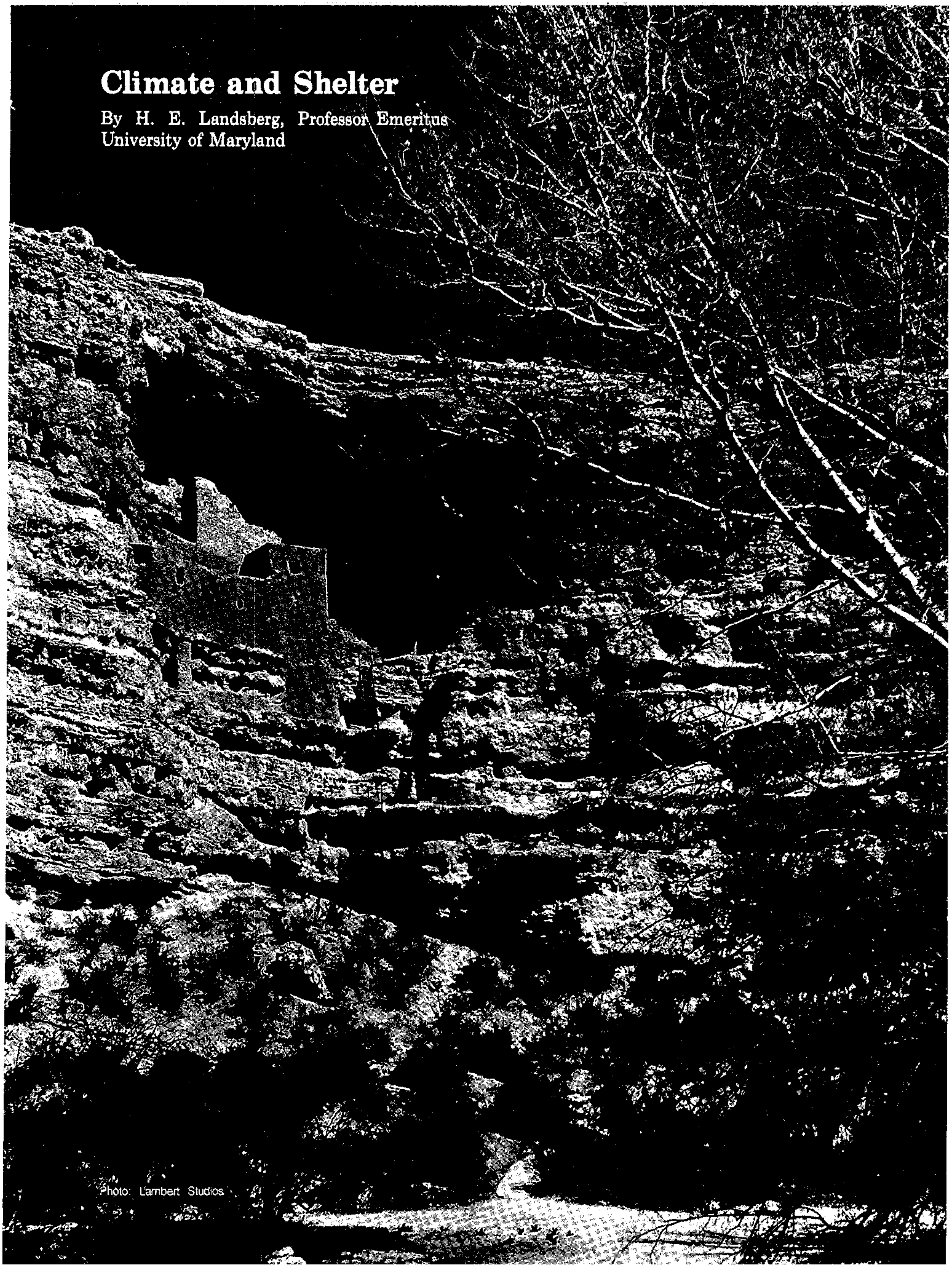


Photo: Lambert Studios

There is little doubt that the first human effort to cope with climate was to seek shelter. In the most primitive stages, mankind used caves, rock overhangs, and lean-tos. Tents of one kind of another also had an early origin. Later logs and fieldstones were used to build shelters. Early civilizations also used adobe and, in cold regions, molded snow.

Recent centuries have seen the evolution of many building techniques and a continuous succession of new materials and procedures: from wood to metals, bricks to glass and plastics, open hearths to electric heating, hand-held fans to air conditioning. The end of this evolution is not in sight. New architecture, new building designs, and new technology are continuously being introduced.

Why does the atmospheric environment play such a decisive role in these developments? Basically, because of the physiological and psychological make-up of human beings. We can survive by our internal regulatory processes alone only within narrow limits of heat flux to and from the environment. These conditions exist only in a few tropical areas the year around. Any seasonal or permanent departure from these conditions requires some external regulatory intervention. Shelter in the form of houses and buildings is an essential part of the human answer to harsh climates that otherwise would not permit permanent settlement.

What then are the essential functions of these structures vis-a-vis the wide variety of climates and the individual weather conditions which combine to constitute these climates? Probably, one has to give safety the first priority. Buildings and houses have to stand the onslaught of fierce winds in many regions, especially along those coasts where hurricanes occur and in areas where tornadoes are frequent. Wind-driven storm surges must also be considered.

Next is protection from precipitation, and in this connection extreme snow loads have to be incorporated into structural design calculations. Protection from electrical discharges in thunderstorms cannot be overlooked either.

Nearly all other functions of houses and buildings as shelters are related to human comfort and efficiency. These two factors are completely interwined. An uncomfortable human being—whether too cold or too hot—cannot function and work efficiently. I will, therefore, from now on refer only to comfort. Admittedly, there are somewhat different ranges of comfort conditions for people according to age groups and occupations. But these differences, except for certain factors, are not very large and are usually met by various design devices which permit regulation over the ranges necessary for the particular structure.

Comfort at the cold end of the scale is essentially a function of temperature and wind. Hence, all buildings in cold climates must permit production of some artificial heat, or at least prevent loss of metabolic heat to the atmosphere outside. The prevention of wind penetration is also an important design factor. At the warm end of the comfort sensation many more factors combine, but both temperatures and wind (perhaps better termed ventilation) again play an important role. Added to these are humidity and radiative energy flux.

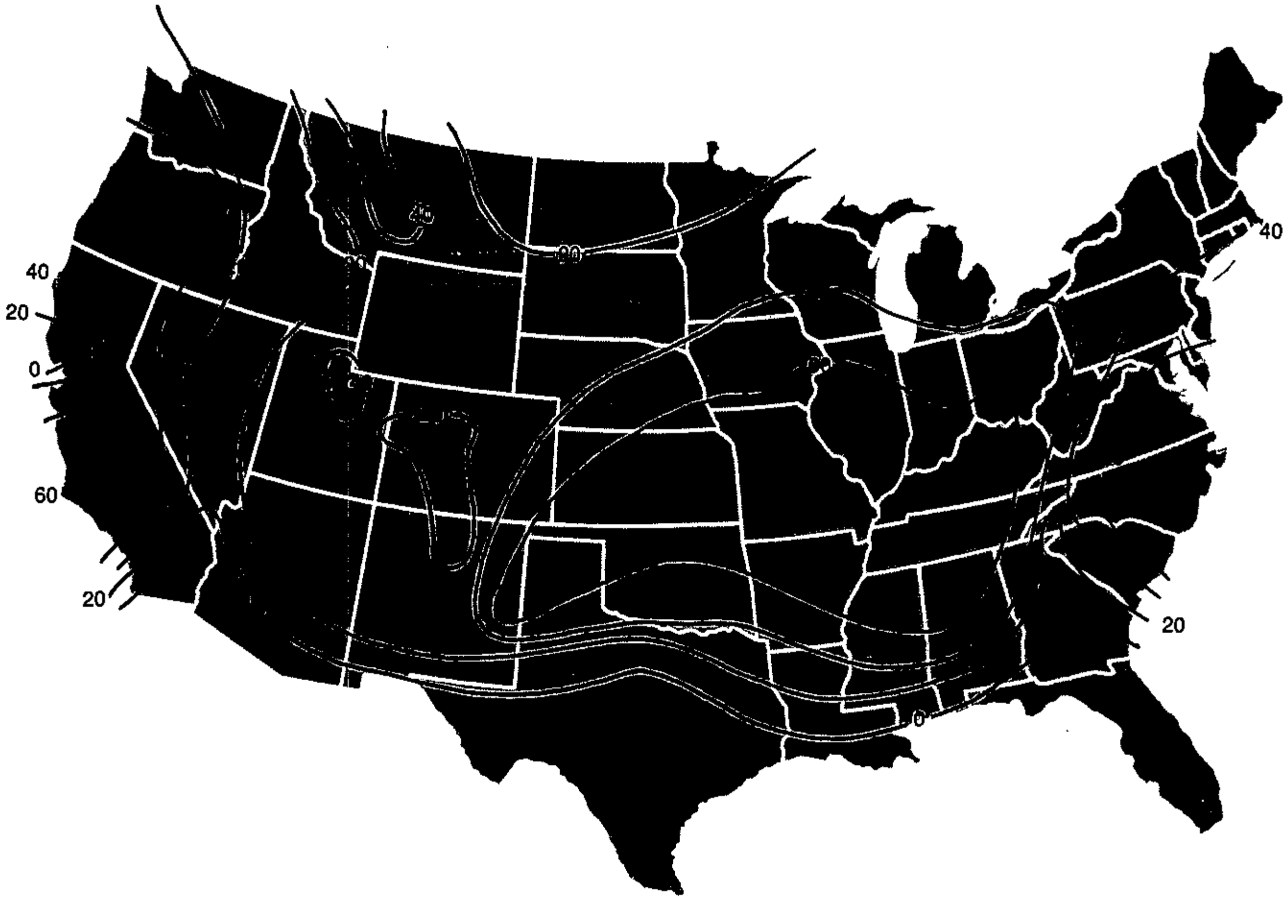
Relatively little attention has been paid to air pollution. This is certainly a facet deserving far more attention than heretofore. It concerns both the production of pollutants by devices in the structure, such as heating plants, and penetration of pollutants from outdoors into the structure. Acute dangers are inherent in the use of certain building material, such as asbestos.

Finally, in an era where energy conservation is a primary consideration, one cannot overlook the energy needs of variously designed structures, be it for heating or air conditioning, or both, in areas with wide seasonal swings of weather. This requires compromises and optimizations which are not always easy to achieve. Compromises will also be needed in many instances with esthetic and traditional considerations. These may involve architectural decisions for buildings in historical settings or for particular functions. But even in such cases there is still a need for minimizing any adverse impact of the atmospheric environment.

In context of the needs for heating and cooling, one should not overlook the possible use of atmospheric energy sources, such as solar radiation and wind momentum. These are now coming into use for individual houses or small settlement complexes. Their design and exposure must be based on very intimate knowledge of local climatic conditions.

Clearly, the preceeding outline of what weather elements affect the safety of and comfort in human structures presents the world's meteorological services with an enormous task and challenge. Certainly the classical concept of climatological data and analysis is hopelessly inadequate to yield the desired information. Everything that has been stated above indicates that mean values (or so-called "normals") are essentially useless for the questions that the meteorologist has to answer for planning housing and other buildings.

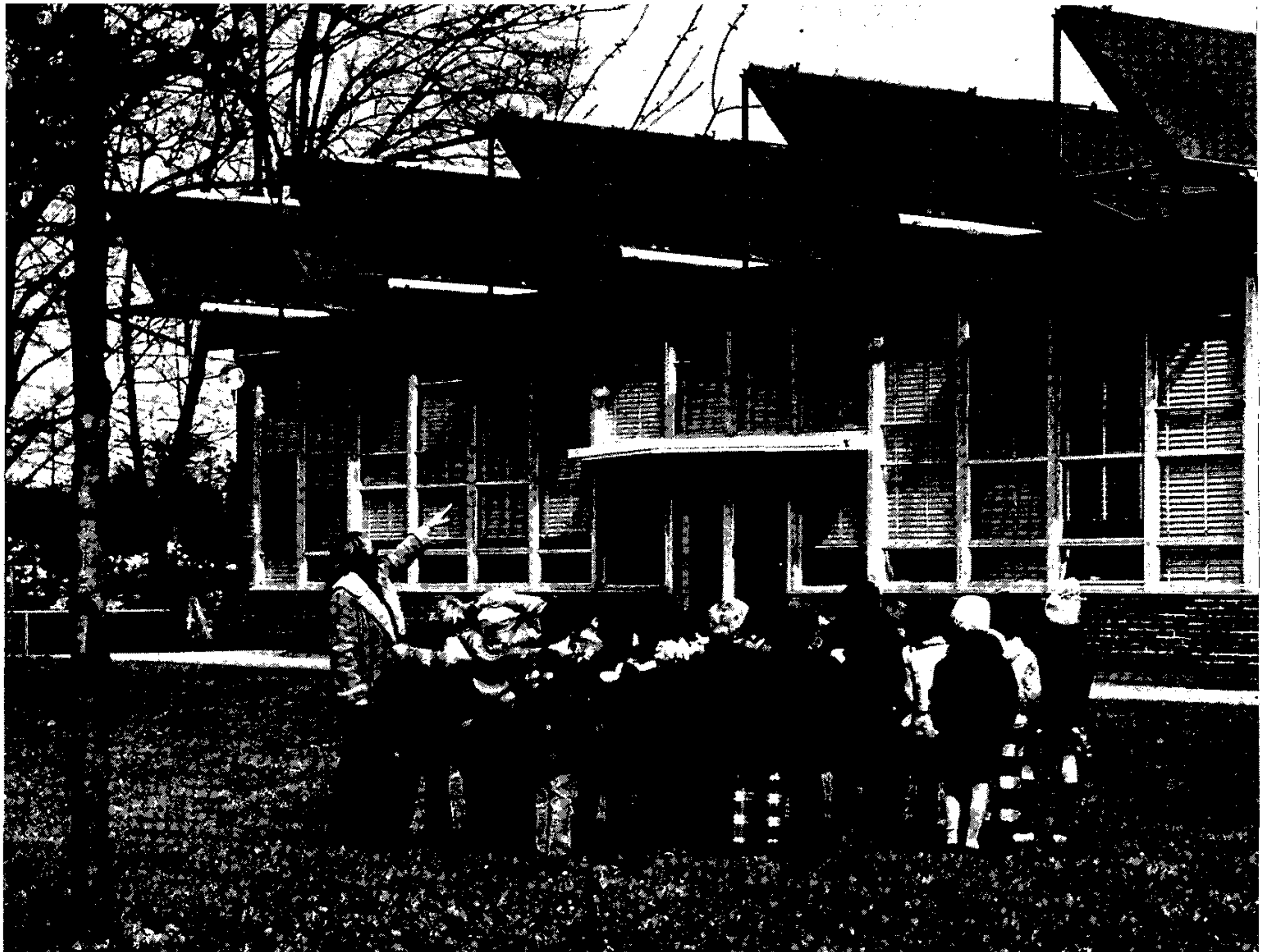
Therefore, we must address ourselves to the twin questions: What data are needed by the designers and architect and where can such data be found? Whereas,



Potential energy savings (percent), subsurface versus surface construction. (Robert Goetz, Jr., 1975 University of Maryland M.S. thesis.)

in consultations with the engineers, we can find reasonably suitable answers to the first question, it will often be very difficult to find a satisfactory answer to the second question. The reason for this is twofold. In the first instance, we may have an adequate data store, but one that has never been compiled in the format necessary for a building job. In the second instance, there may be ample meteorological observations, even compiled or readily compilable from machine-processable records, but they refer to localities miles from the prospective building site. In this case, the meteorologist is confronted with the task of interpreting his available data over a distance. This can require formidable transformations governed by meso-and micrometeorological factors. For some purposes, where safety or similar considerations dictate great care, such as construction of a nuclear power plant, one may have no other choice than to gather the information needed by establishing special stations at prospective building sites. The job of relating even a relatively short data series to an existing longer one is far less demanding than direct interpretation of a longer series for a distant site.

Assuming that an adequate source of observations exists, meteorologists will find that design criteria require statistical analyses of the material. For a number of purposes an estimated extreme value for a projected life time of the building is needed, for example, the highest wind gust likely to occur once in 50 years. A number of extreme value distributions exist and, with a suitable data base, a good estimate of rare events can be made. For other purposes, such as heating and cooling plants, design for even an annual extreme event is wasteful; the thermal inertia of buildings can generally cope with the extremes, or auxiliary devices can be mobilized for such events. In such cases, a 2-3% probability value of annual occurrence of such extremes may yield a quite satisfactory design value. Here



A teacher explains the experimental solar heating system installed at Timonium Elementary School, Baltimore County, Md.

again, analysis of the appropriate statistical distribution function is needed. For exacting jobs, hourly values may be required.

The design problems certainly go far beyond the information usually obtained for synoptic meteorological purposes at airport stations. In design for housing, there is much need for solar radiation data. Sunshine duration, although not useless, is generally inadequate. Radiation intensities on horizontal surfaces (global radiation) are better, but may have to be translated into values on vertical surfaces (walls, windows) or slanted surfaces (roofs), and into various directions (time of day) by seasons. This is really essential information for calculating supplemental heat that may be available in winter or that should be excluded in summer. Properly used, such data should help in orientation of buildings, design of windows and shading devices, and calculations of heating and cooling loads. Neglect of this factor alone has resulted in uncoolable buildings in many places and overdesign of heating equipment.

Very often the important piece of meteorological information is the duration of a given condition. Let us cite here, as an example, the duration of heavy rainfall with a given wind direction. Such conditions, common in hurricanes or monsoon rains, may lead to wall penetration by rainwater. In some regions this requires special wall construction. Similar duration problems are, of course, also encountered in atmospheric energy exploitation and may require frequency distributions of sunless time intervals or duration of calm intervals.

In urban areas, with a large

percentage of ground covered by impermeable material, storm sewers are often so inadequately designed that they can barely carry the water from ordinary precipitation rates of a few tens of millimeters per hours, and are usually completely incapable of handling cloud burst or hurricane rainfalls. Meteorological data can materially aid in better designs for drainage systems.

The proper placement of water and sewage lines is of great importance for the general design of commercial, industrial, or housing districts. Depending on the climatic regions, these have to be placed at depths below the penetration of freezing temperatures. Soil temperatures are measured only at a few places, but they can be approximately calculated from air temperatures and physical soil constants.

Similar considerations will become increasingly important for underground construction. Although this building mode was in the past restricted to special purposes, there is good reason to believe that it will become more common. The principal consideration, of course, aside from protection against hazards such as tornadoes, is the developing world energy shortage. There is evidence that in areas where winters are cold and summers hot, requiring both air conditioning and heating during the course of the year, placing structures underground can potentially result in substantial energy savings. Meteorologists and engineers will have to develop new climate/construction concepts for this purpose.

For buildings above ground in many climatic regions, much attention has to be paid to fenestration. The size of windows and their exposure govern both illumination and ventilation. Windows are also the reason for much heat loss in winter and for the trapping of solar radiation. In hot climates, placement of windows for cross ventilation is an important task and makes detailed analyses of wind speed and direction combinations by hours of the day and by seasons essential. Where daylight illumination is desired, similar analyses of sunshine and cloudiness information is needed.

A factor that is often overlooked in the building trade is the interaction of the climate, landscaping, and structures. Often trees and shrubbery are arranged more for the esthetic aspect than for the climatic protection they can afford a building. Deciduous shade trees properly placed can reduce the impact of solar radiation on roofs and walls during warm seasons, but not interfere with welcome winter sunshine. Similarly, hedges planted upwind from a house, in the direction of the coldest winds can reduce fuel needs. These and similar plantings along driveways and roads can reduce snow drifting. Greenery, especially in housing developments, can also contribute greatly to reducing rainfall runoff.

Hurricane Camille demolished this home in Biloxi, Miss.

Of course, one cannot look at the interaction of atmospheric paramenters with single houses or structures alone. Building complexes act differently than single buildings. Tall structures affect air flow and may cause turbulence at surface level. Pollutants may be wafted by channeling to sites where they can damage health and property. Interpretation of meteorological conditions in such complex settings is just beginning to emerge from research studies, and meteorologists will have to incorporate the findings into their consulting practice to meet the needs of architects, engineers, and the general public.

Introduction to a proposed World Meteorological Organization technical note, "Building Applications of Climatological Data."

NOAA-YES-MAYBE: Global Crop-Yield Modeling and Assessments

By Norton Strommen, Director
Center for Climatic and Environmental Assessment

This article reviews NOAA's efforts in operational crop-yield modeling and assessments on a global scale, highlighting yield-estimate model performance for the 1976 growing season.

The models were developed by the EDS Center for Climatic and Environmental Assessment (CCEA) as part of NOAA's contribution to a three-agency cooperative effort called the Large Area Crop Inventory Experiment, or LACIE. NASA, through the use of LANDSAT remote-sensed data, provides information on crop acreage. Using the products of the NASA and NOAA efforts, the U.S. Department of Agriculture develops estimates of wheat production.

Within the LACIE project, the CCEA operational models for 1976 are formally known as the CCEA I-type. Informally, they are better known as the first-generation NOAA-YES-MAYBE models by the Columbia, Mo., staff who developed and exercise them to generate estimates of wheat yields for LACIE. YES stands for the Yield Estimation Subsystem of LACIE, and MAYBE stands for Model Assessment of Yields by Extrapolation. The latter, however, does not accurately represent the full capability of the CCEA I-type models. These estimates are not simple extrapolations of trends, but rather reflect the level of an established technology trend, plus a response of the crop to weather, which is identified as a deviation around the trend. In oversimplified terms, the yield estimate equation is in the form of: Y = f(trend) + f(weather).

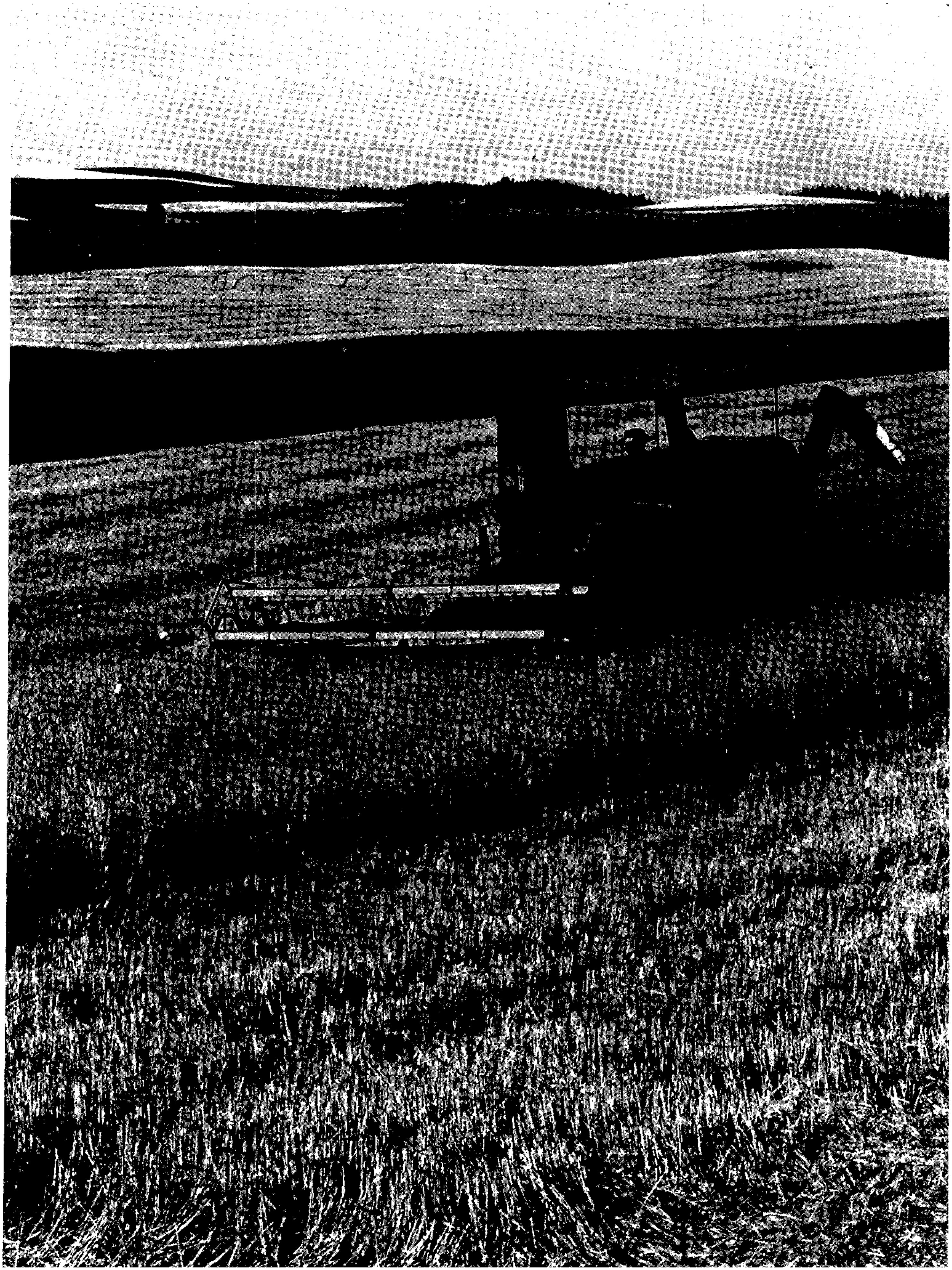
CCEA I-type model yield estimates for the 1976 crop season are shown in figures 1 and 2. Figure 1 shows the CCEA operational yield estimates for the combined 5-State winter wheat area of Colorado, Kansas, Nebraska, Oklahoma, and Texas. These are compared with the USDA Statistical Reporting Service's (SRS) estimates for the same regions. The CCEA models began operation in March and continued to produce updated estimates each month through the final estimate in August.

SRS produces its estimates through systematic sampling of selected fields. The sampling data are summarized into successive aggregations of county, crop-reporting-district, and State estimates for input to the national estimates. Their initial field estimate of yield is made when the crop is sufficiently advanced so that they can go out and sample its condition in the field with regard to stand, and later, as the fruit sets and matures, to estimate the potential yield.

The initial yields produced by the CCEA yield models in March were very close to the yield estimations for the 5-States area provided by the SRS in May. With deterioration of the weather, the trend for potentially lower yields shown by the yield models in May was reflected in the sampling of the crop conditions by SRS in their June survey. Similarly, when the yield models showed an improvement in the potential of the crop in June, this pattern was reflected in the July SRS sampling techniques. This suggests that the models are able to reflect trends due to both deteriorating weather and improving weather conditions about 1 month in advance of the results gained from the field surveys with the progession of the crop season.

A similar trend is shown in figure 2, which evaluates the 1976 USSR winter wheat crop. The initial CCEA estimate was made in April and an updated estimate provided each succeeding month through August. The general trend of the estimates is compared with that provided routinely by the Foreign Agriculture Service (FAS). The trends in these curves are very similar, and the final estimate provided through the CCEA I-type models is very close to the final estimate provided by FAS. The primary difference is that the changing potential reflected by the CCEA estimates was shown 3 to 4 months earlier than reflected in the conventional FAS estimation program. Thus, by early June, the CCEA models provided a good indication of the USSR yield estimates, while it was early October before conventional FAS estimates reached about the same conclusion.

An additional highlight of this figure is an estimate provided by a second modeling approach at CCEA. This effort, supported by the Charles F. Kettering Foundation Grant (through the University of Missouri), produces yield estimates based only on monthly



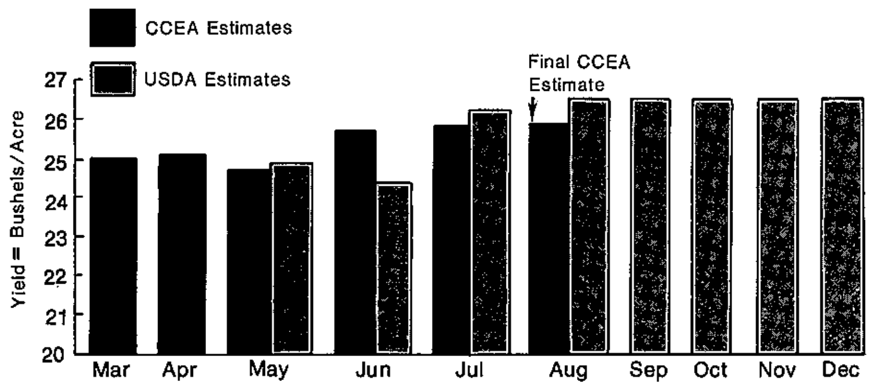


Figure 1. 1976 winter wheat yield estimates for the U.S. (5 States).

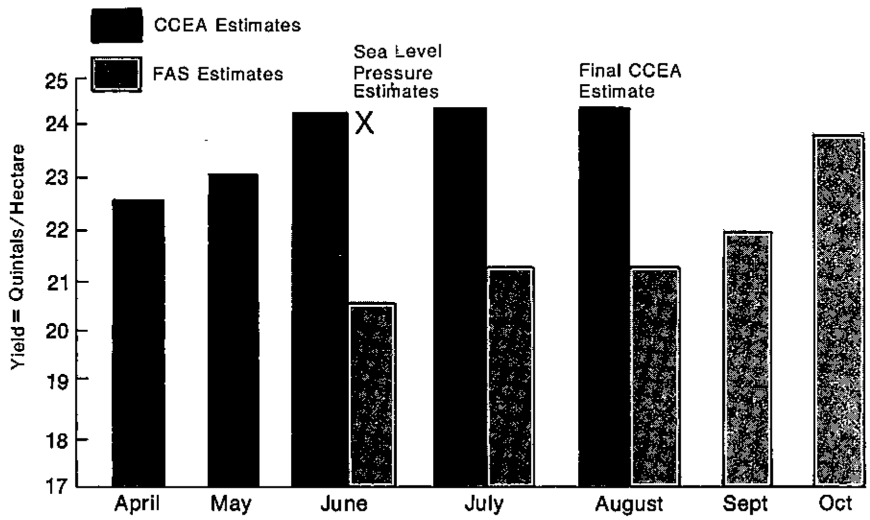


Figure 2. 1976 winter wheat yield estimates for the U.S.S.R.

sea-level pressure data as input to the yield model. The approach is designed primarily to produce estimates for large areas or combinations of States. These models were operationally tested for the first time in 1976. The result provided by this alternate approach is indicated in figure 2 by a large X, which represents the June estimate of potential wheat yields from the USSR winter wheat region. This estimate was very close to the aggregate estimate produced by the CCEA I-type yield models.

The advantage of working directly from the sea-level pressure data is that this approach minimizes data handling problems inherent in the more elaborate systems now being used and/or in the development state. The greatest disadvantage is that it does not reflect the larger variations in local yields needed for research work.

The basic constraints in the development of the CCEA I-type model were time and data. The first step taken was to evaluate the historical data bases available and the current data flow of meteorological information to ensure that the needed information to drive the models would be available, once they had been developed.

Conceptually, it would have been ideal to have developed a model which provided a response to daily weather events that very closely simulated the response of the plant as it progressed through its various biological states. Unfortunately, for most areas of the globe, neither the phenological data base needed to develop such models nor the meteorological data base needed to support their operation could be readily assembled.

For the approach selected, the agronomic data that are available are generally limited to the final yield estimations for a growing season, and the historic meteorological data base is limited in most areas to monthly mean temperatures and total precipitation. Fortunately, in many areas these data bases were found to be compatible. Thus, very little manipulation of the historic data bases was required to begin development of the yield models.

Current meteorological data to support an operational program are available from the flow of observations on the World Meteorological Organization's Global Telecommunications System. These data provide daily information on temperature and precipitation for most regions of the globe. At the end of the month, a summary of monthly mean temperature and total precipitation information is provided as a part of the *climat* message. This allows summarized daily data to be incorporated with the more reliable *climat* data available once a month. These combined data are adequate to provide estimates of monthly temperature and total precipitation for relatively large crop regions. In the United States these estimates can be completed for regions the size of crop reporting districts, which in most States are the same as the climatic divisions. For foreign regions, these estimates are provided readily for areas the size of Oblasts or combinations of Oblasts in Russia and/or other appropriate sized areas for other countries.

The models may also be exercised using as input climatological probabilities of temperature and precipitation based on 30-day forecasts. The change in crop potential can then be projected into the future by using the best available weather forecast.

In summary, the strengths of the approach used in the development of the CCEA I-type operational model are (1) compatible agronomic and meteorological historic data bases for regions of sufficiently small size to provide a near homogeneous response to the observed weather parameters, (2) a flow of meteorological data on a current basis that will adequately support the timely operation of these models, with estimates being systematically quantified and reproducible for evaluation and study at a later time, (3) supplemental data are not needed beyond the input of the current meteorological information, thus eliminating the need to wait for the accumulation of large amounts of ancillary information to support the operational aspects of producing yield estimates over relatively large areas.

There are, of course, also some disadvantages. Perhaps the primary one is that only monthly data are used as input to the models; thus, episodal type weather events—say large departures from normal in weather for short periods that might damage crops—may not be adequately reflected in the yield estimates, because the events are not of sufficient duration to be reflected in the monthly mean temperature and total precipitation data.

The second weakness occurs when the weather departs sufficiently from its normal time of occurrence so that the fixed calendar data are not representative of the crop states. This happened in 1974 with the spring wheat crop for the northern Great Plains, when planting was delayed 3 to 4 weeks. The yield models using a fixed calendar period in this area have a term for antecedent moisture for the period September through March. In 1974, however, the crop did not go into the ground until early May, nearly a month late; thus, the antecedent moisture really should have included the moisture which fell from September through April.

A third disadvantage is that when the biological stages of the plant's development are strongly skewed from the normal data, yield potential changes caused by stress of limited moisture supplies will not be adequately assessed. Similarly, heat stress during these critical biological stages of plant development may not be evaluated accurately.

These problems will be addressed by CCEA in the development of more advanced yield estimating models.

Drought-damaged crops in Dalhart, Texas

Inside a Texas Tornado*

By Roy S. Hall, Captain, U.S. Army, Retired

That warm morning of May 3, 1943, my wife and I were sitting in our back yard making small talk, when suddenly she pointed upward and said, "Look how still those leaves are."

I was startled. The wind was blowing from the south at about 25 miles an hour, and there could be no reason in such a remark. But when I looked up at the big hackberry tree I saw what she meant. The wind was so steady and dead-level in its pressure that leaves and small branches were pushed before it and held almost motionless, with scarely a tremor.

"I'm going in," my wife said. "That solid pressure scares me."

After a bit I went in to have a short rest on my cot. I was barely stretched out when a hard clap of thunder brought my feet to the floor with a slam. The ominous silence which follows close thunder got on my nerves, and I walked through the house to the west lawn to have a look at the weather.

Since noon, thunderstorms had been developing to the west and southwest, muttering and grumbling, miles away, but as the three small clouds that showed prospects of rain were 15 miles off, and drifting north on the air current, I had given them no more thought. The temperature was in the middle 80's, and the air was very humid.

When I stepped off the front porch one of those little thunderheads almost hit me in the pit of the stomach. It wasn't little any more, but spanned the western sky, black as ink, less than three miles away. And right across its nearer rim, low, very low, a mile-long scud-cloud was sliding along. It was moving swiftly eastward, and the whole cloud had done something I had never heard of before. It had made a right-angle turn in the sky and was cutting across the wind current which definitely had not slackened. I went to the porch and yelled for my wife.

Back on the lawn I did not know she had come out, till she spoke and scared me. "You sounded urgent, so I hurried the children out. . .Oh!" She had seen the storm for the first time. "What a terrible cloud!" I looked around and saw our four children standing on the porch. She said nothing further for the moment, but I felt her hand touch my arm in a muted question.

The squall, which was now about two miles away, was coming directly toward us, and the scud-cloud, stretched across its front between 400 and 500 feet above the earth, was revolving as if it were being pushed in reverse along the ground. Behind the scud-cloud a curtain of dark, green rain was falling in a solid, opaque wall.

The south wind was veering. In a matter of a few seconds it had changed, and was blowing, undimished, from the southeast toward the cloud. Lightning, the most fearful I have ever seen, and wide as a house, flashed with some regularity between the scud-cloud and the ground.

In the comparative stillness following the terrific thunder crashes I could hear a sustained hollow roaring, like a distant freight train. Feeling my wife's eyes on my face. I said, "Sounds like heavy hail." But it wasn't hail. She knew it wasn't, and I did too. While the sound was somewhat similar, there was a vast difference. You can't feel the sound of hail vibrating the air against your ear drums, nor pulsating it against your face. This was a new sound, one we had never heard before.

The low, deadly looking scud-cloud was right on us now, and I could see no sign of a tornado funnel this side of the greenish rain. But it was there, and my wife knew it was there. I told her to go in and take the children. We had no storm cellar, but, had there been a tornado showing, we could have gotten into the car and run out of its path. Now, we had to take a chance on it missing us. It was behind the rain, without question; I had seen them that way.

In another minute the low cloud passed close overhead, and the dusk of early evening enveloped us. I turned to go in, and as I went up the porch steps hailstones the size of tennis balls began falling on the house and in the yard. These made my heart sink, for they almost invariably fall in the forefront of a tornado. They came down sparsely, one on about each square yard, but they made a most hideous bang and clatter, and I knew some of them were going all the way through our shingled roof. We all went into the west bedroom.

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*Reprinted from *Weatherwise*, June 1951. The tornado struck the community of McKinney, Texas, where Captain Hall devoted much of his time to meteorology as a hobby. This is a unique instance of a trained weather observer looking into the vortex of a tornado.

Lightning was striking all around the house now, adding its horror to the fast-rising din. As my wife snapped on the overhead light, a gust of wind and rain hit the west wall of the room with a crash. My wife was pointing to the west wall. "The wall's blown in!" She had to scream to make herself heard. I could see that it had slipped inward six inches or more at the ceiling, and was vibrating under the wind pressure. Drops of water were hitting my face across the room. I tried to assure her. "That gust always comes ahead of a rainsquall," I shouted.

But there was no abatement in the deafening hubbub outside. I know it was growing in intensity by the second, and realized that a tornado was right on us. I yelled in my wife's ear:

"Everybody in the back room: Get under the bed!"

Under a foolish impulse I jumped to the south window for a last look outside before following the family. As I did so the overhead light went off (3:04 p.m., as shown later by our electric clock). Between the flashes of lightning it was as dark as midnight, but by shielding my eyes I could see somewhat. I saw that my neighbor's house across the vacant lot was standing, but trees and shrubbery out that way were flattened almost to the ground. From the course the planks, sheet-iron, and other debris took as they flailed over the lot, I saw that the wind was from due west. It was a grim perspective, but out of it all I gathered a bit of hope.

The wind was from the west! It should have been from the south. While a tornado, as a whole, moves generally eastward, the funnel itself rotates counterclockwise, and the west wind indicated that we were in the southern edge of the twister. It, apparently, was passing just north of us. And too, the vivid lightning and rending crashes were passing on and there was now a decided lull in the screeching roar outside.

And then very suddenly, when I was in the middle of the room, there was no noise of any kind. It had ceased exactly as if hands had been placed over my ears, cutting off all sound, except for the extraordinary hard pulse beats in my ears and head, a sensation I had never experienced before in my life. But I could still feel the house tremble and shake under the impact of the wind. A little confused, I started over to look out the north door, when I saw it was growing lighter in the room.

The light, though, was so unnatural in appearance that I held the thought for a moment that the house was on fire. The illumination had a peculiar bluish tinge, but I could see plainly. I saw the window curtains lying flat against the ceiling, and saw loose papers and magazines packed in a big wad over the front door. Others were circling about the room, some on the floor and others off it. I came out of my bewilderment enough to make a break for the back of the house.

But I never made it. There came a tremendous jar, the floor slid viciously under my feet, and I was almost thrown down. My hat, which I had not removed, was yanked off my head, and all around objects flashed upward. I sensed that the roof of the house was gone.

As I gained footing another jarring wham caught me, and I found myself on my back over in the fireplace, and the west wall of the room right down on top of me. The "whams" were just that. Instead of being blown inward with a rending crash of timbers, as one would expect of a cyclonic wind, the side of the room came in as if driven by one mighty blow of a gigantic sledge hammer. One moment the wall stood. The next it had been demolished. The destruction had been so instantaneous that I retained no memory of its progess. I was standing, and then I was down, 10 feet away. What happened between, I failed to grasp or to sense.

By a quirk of fate I was not seriously injured, and as soon as I had my senses about me I clawed up through the wreckage, and crawled around and through the hole where the east door had been. I could tell by the bluish-white light that the roof and ceiling of this room were gone also. I almost ran over my four-year-old daughter, who was coming to see about me. Grabbing her up I was instantly thrown down on my side by a quick side-shift of the floor. I placed her face down, and leaned above her as a protection against flying debris and falling walls.

I knew the house had been lifted from its foundation, and feared it was being carried through air. Sitting, facing southward, I saw the wall of the room bulge outward and go down. I saw it go, and felt the shock, but still there was no sound. Somehow, I could not collect my senses enough to crawl to the small, stout back room, six feet away, and sat waiting for another of those pile-driver blasts to sweep the rest of the house away.

After a moment or so of this, I became conscious that I was looking at my neighbor's house, standing unharmed 100 feet to the south. Beyond I could see others, apparently intact. But above all this, I sensed a vast relief when I saw that we were still on the ground. The house had been jammed back against trees on the east and south and had stopped, partly off its foundation.

The period of relief I experienced, however, was a very short one. Sixty feet south of our house something had billowed down from above,and stood fairly motionless, save a slow up-and-down pulsation. It presented a curved face, with the *concave* part toward me, with a bottom rim that was almost level, and was not moving either toward or away from our house. I was too dumbfounded for a second, even to try to fathom its nature, and then it burst on my rather befuddled brain with a paralyzing shock. It was the lower end of the tornado! I was looking at its inside, and we were, at the moment, within the torando itself!

The bottom of the rim was about 20 feet off the ground, and had doubtless a few moments before destroyed our house as it passed. The interior of the funnel was hollow: the rim itself appearing to be not over 10 feet in thickness and, owing possibly to the light within the funnel, appeared perfectly opaque. Its inside was so slick and even that it resembled the interior of a glazed standpipe. The rim had another motion which I was, for a moment, too dazzled to grasp. Presently I did. The whole thing was rotating, shooting past from right to left with incredible velocity.

I lay back on my left elbow, to afford the baby better protection, and looked up. It is possible that in that upward glance my stricken eyes beheld something few have ever seen before and lived to tell about. I was looking far up the interior of a great tornado funnel! It extended upward for over a thousand feet, and was swaying gently, and bending slowly toward the southeast. Down at the bottom, judging from the circle in front of me, the funnel was about 150 yards across. Higher up it was larger, and seemed to be partly filled with a bright cloud, which shimmered like a fluorescent light. This brilliant cloud was in the middle of the funnel, not touching the sides, as I recall having seen the walls extending on up outside the cloud.

Up there too, where I could observe both the front and back of the funnel, the terrific whirling could be plainly seen. As the upper portion of the huge pipe swayed over, another phenomenon took place. It looked as if the whole column were composed of rings or layers, and when a higher ring moved on toward the southeast, the ring immediately below slipped over to get back under it. This rippling motion continued on down toward the lower tip.

If there was any debris in the wall of the funnel it was whirling so fast I could not see it. And if there was a vacuum inside the funnel, as is commonly believed, I was not aware of it. I do not recall having any difficulty in breathing, nor did I see any debris rushing up under the rim of the tornado, as there surely would have been had there been a vacuum. I am positive that the shell of the twister was not composed of wreckage, dirt or other debris. Air, it must have been, thrown out into a hollow tube by centrifugal force. But if this is true, why was there no vacuum, and why was the wall opaque?

When the wave-like motion reached the lower tip, the far edge of the funnel was forced downward and jerked toward the southeast. This edge, in passing, touched the roof of my neighbor's house and flicked the building away like a flash of light. Where, an instant before, had stood a recently constructed home, now remained one small room with no roof. The house, as a whole, did not resist the tornado for the fractional part of a second. When the funnel touched it, the building dissolved, the various parts shooting off to the left like sparks from an emery wheel.

During pistol practice in the army, when the light was favorable, I have seen bullets from a .45 pistol flash from gun to target. The bullets had a known velocity of 825 feet a second. The white planks from the house moved at a speed equal to, if not greater than, those of the bullets, which would establish the velocity of the tornado's rotation close to 600 miles an hour. This, I believe, is conservative. My own conviction is that the funnel was spinning faster than the speed of sound, accounting, in some way beyond my knowledge, for the total lack of noise within it.

The very instant the rim of the funnel passed beyond the wreck of the house,long vaporous-appearing streamers, pale blue in color, extended out and upward toward the southeast from each corner of the remaining room. They appeared to be about 20 feet long and six inches wide, and after hanging perfectly stationary for a long moment, were suddenly gone.

The peculiar bluish light was now fading, and was gone abruptly. Instantly it was again dark as night. With the darkness my hearing began to come back. I could hear the excited voices of my family in the small back room, six feet away, and the crunching jars of heavy objects falling around the house. The tornado had passed. The rear edge was doubtless high off the ground and went over without doing any damage. Quickly, real daylight commenced to spread in the wake of the storm, and how good it did look! And how astonishing! I had come to believe, in those few long minutes, that the tornado had struck in the nighttime. It was now about 3:06 p.m.

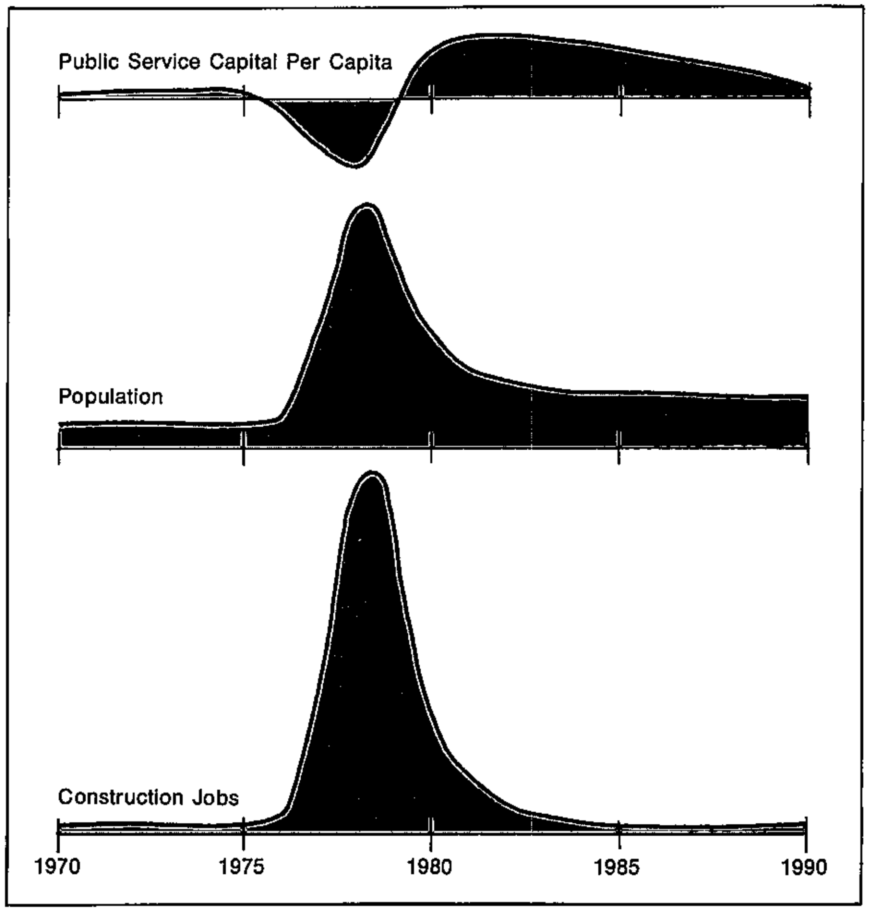
Luck was with us that day. The only injuries sustained by the family were a severe gash in my boy's arm and a scalp wound on my own head. The rest of the district did not fare so well. The tornado cut a swath through the southern part of the city, killing and wounding upward of a hundred people, and doing property damage of over five million dollars.

Forecasting Social and Economic Impacts of Coastal Energy Development

EDS'Center for Experiment Design and Data Analysis (CEDDA) soon will have operational a highly sophisticated, dynamic, economic forecasting model capable of simulating the onshore economic effects from a variety of offshore marine resource development activities. The initial application of the Assessment of Coastal Energy Development (ASCEND) models will be to make a series of forecasts for the Office of Coastal Zone Management's (OCZM) Coastal Energy Impact Program (CEIP).

CEIP was created to ease the impact of energy development activities (both new and expanded) in the coastal zone through grants, loans, and bond quarantees to qualified State and local governments based upon changes in employment and population. The ASCEND model will help the CEIP staff forecast just how large these changes will be in communities that qualify for impact assistance. The figures for population and employment will form the basis for calculating the amount of impact assistance allocated to each State.

ASCEND also can be used to evaluate local needs for such assistance on the basis of the effects upon public revenues and public expenditures created by changes in population and employment. Thus, ASCEND can help form the basis for constructing a repayment schedule for communities to follow in meeting their loans and bond obligations. Upon completion of this phase of development, CEDDA plans additional modifications of the ASCEND model over the next several months. These will include expanding several of the submodels to develop the capability to simulate impacts from such diverse coastal marine activities as deep-sea nodule mining, alternative forms of oil and gas transportation, and electrical energy generation.



The impact of a new 1500 Megawatt powerplant on a local community as shown by the ASCEND model.

Additional information and documentation on ASCEND can be obtained by contacting: NOAA/EDS, Center for Experiment Design and Data Analysis, Marine Assessment Division, D23, Washington, DC 20235. Telephone: (202) 634-7379.

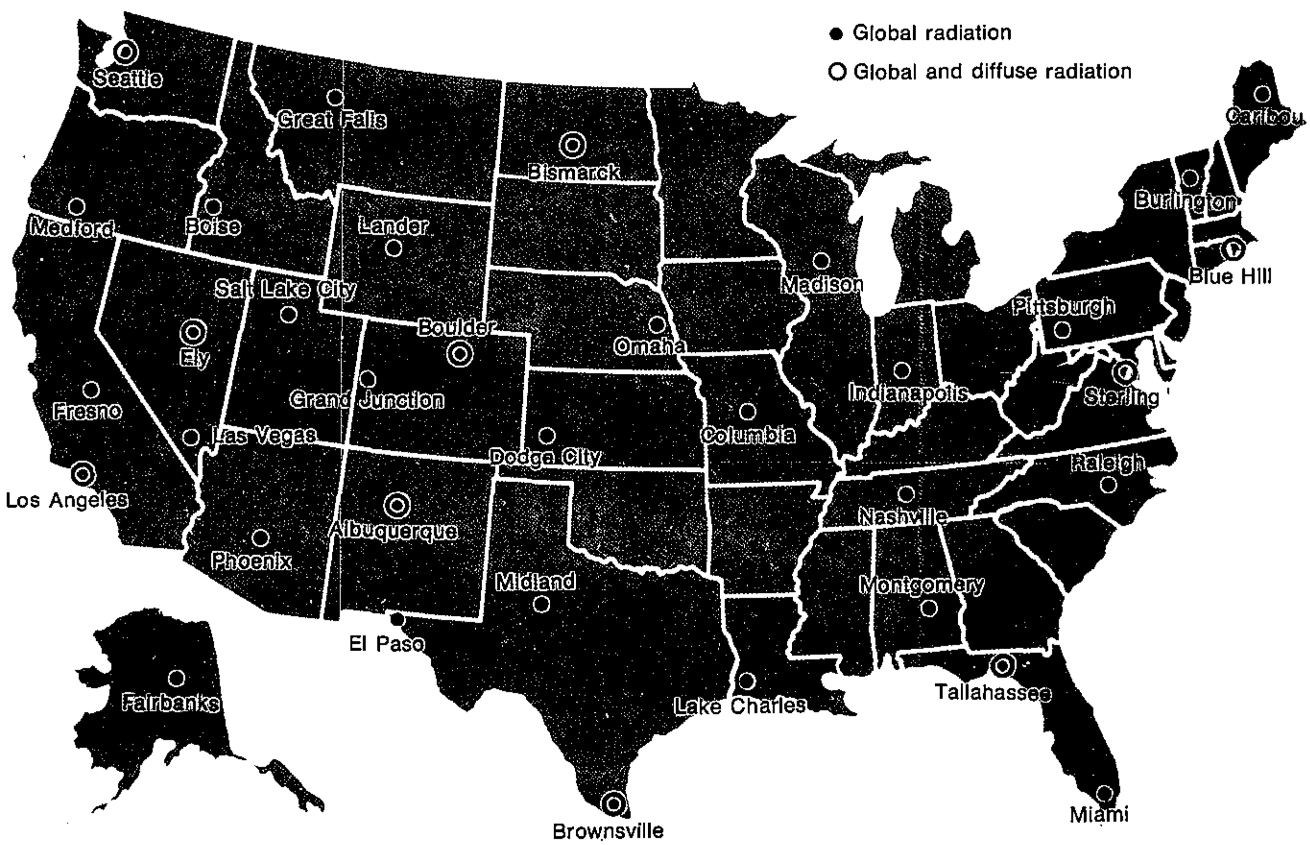
Solar Radiation Network Started

A nationwide solar radiation network to help develop the technology of solar energy was started January 1, 1977 by NOAA in cooperation with the Energy Research and Development Administration's (ERDA) Division of Solar Energy.

By May 1977, solar radiation measurements will be taken at 35 stations of NOAA's National Weather Service to provide data needed by prospective solar energy users. The measurements will give scientists and engineers information on how much solar energy is available at each site, on the average, for use in home heating or cooling, agricultural drying, heating water, generating electricity, and many other applications.

The network will help solar-energy users determine the best size of solar-energy collectors, energy-storage capacity, and auxiliary-energy sources that will be needed. Accomplishing this for home heating and cooling—an application that may be expected on a large scale in the not too distant future—will by itself more than offset the cost of the network.

Solar-radiation information is useful for more than solar-energy technology. Hydrologists use it to



The National Weather Service's new solar radiation station network.

estimate evaporation from the soil, lakes, and reserviors; agriculture scientists to help estimate crop growth; architects to design houses with desired exposure to the sun; and air-pollution experts to estimate production of photochemical smog during periods of air stagnation.

Solar radiation is not the only weather information needed in solar-energy technology. Other data such as temperature and wind must be known to determine local energy needs and to design solar collectors for home heating and cooling plants of optimum size. EDS' National Climatic Center in Asheville, N.C., combines conventional weather data with solar data onto a single magnetic tape called SOLMET, for archiving and distribution to the public. Such tapes for each of the 35 stations will be available at nominal cost to all users. In the future, SOLMET data may also be available from other NOAA and non-NOAA stations measuring solar radiation.

Traditionally, the instrument used to monitor solar radiation has been the pyranometer, which measures the amount of radiation falling on a horizontal surface. In the new network, a new and improved pyranometer will be used that can measure extremely accurately. All of the pyranometers in the new network have been carefully calibrated against the international standard of the World Meteorological Organization by NOAA's Air Resources Laboratories, Boulder, Colo. The instruments will be periodically recalibrated.

Data acquisition and recording equipment for the network was purchased by ERDA with funds from the National Science Foundation. Part of this equipment integrates the amount of solar energy received at a pyranometer once each minute and stores the data on a cassette tape. Another component permits immediate, visual inspections of radiation measurements taken at 10-minute and hourly intervals. These are printed on a strip of paper. Instantaneous measurements of radiation intensity are available on a second visual display. All of the data are processed and quality controlled by NOAA's Air Resources Laboratories.

The new network includes 10 special stations at which diffuse or scattered solar radiation also is to be monitored. This provides an indirect means of computing the direct solar beam—important in applications where solar radiation is to be focused on a small area to produce high temperatures.

At these stations, a strip of metal shades one of two pyranometers from the direct solar beam, allowing the collection of only that part of the Sun's radiation that is scattered by the atmosphere. By subtracting the diffuse solar radiation from the amount of radiation measured by an unshaded pyranometer, one can deduce the direct solar beam. In addition to its value for focused-energy applications, measurement of the direct solar beam is useful for calculating the amount of solar energy falling on inclined surfaces. Later, all 35 stations in the network will be supplied by ERDA with a pyrheliometer, an instrument to measure the direct solar beam.

EDS Sponsors Brine Disposal Workshop

A workshop on the Impact of Brine Disposal on the Marine Environment was held recently in Houston, Tex. It was organized by the Texas A&M University Sea Grant Program and sponsored by the Marine Assessment Divison of EDS' Center for Experiment Design and Data Analysis, under an interagency agreement with the Federal Energy Administration.

The purpose of the workshop was to assess impacts that may result from the disposal of brine from salt dome storage cavities as part of the Strategic Petroleum Reserve. (See March *EDS*, page 10.) The meetings focused on the offshore area around the Bryan Mound Salt Dome off Freeport, Tex., and addressed three questions:

What are the critical biological concerns relative to osmotic stress, trace inorganics, and hydrocarbons;

What studies may be required to establish impact standards; and

What are appropriate criteria for a monitoring program?

Participating organizations representing the Federal government, State agencies, private industry, and the university community were: Environmental Protection Agency, Federal Energy Administration, U.S. Geological Survey, NOAA, Moody College, Texas A&M University, Massachusetts Institute of Technology, Louisiana State University, Texas Parks and Wildlife, and Energy Resources, Inc.

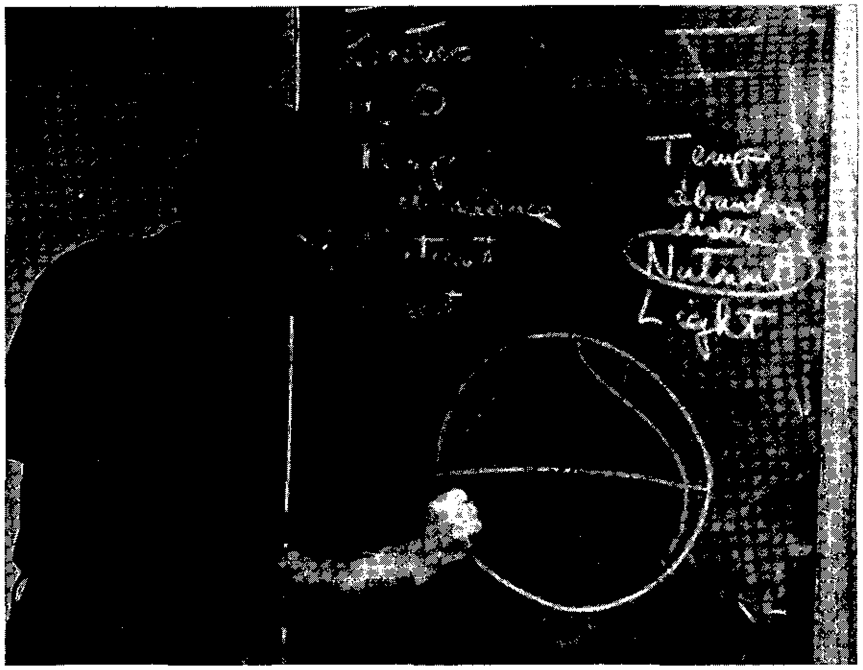
Texas A&M is preparing a report summarizing the conclusions and recommendations of the workshop.

Proceedings of Climate and Fisheries Workshop

Proceedings of the NMFS/EDS Workshop on Climate and Fisheries—April 26-29, 1976 is now available from the EDS Environmental Science Information Center. This publication summarizes the discussions at the workshop (see July 1976 *EDS*, p. 16) held at EDS' Center for Climatic and Environmental Assessment in Columbia, Mo., to explore areas of potential mutual interest, identify projects where a joint effort might be beneficial, and assess areas of joint capability.

Some of the papers presented at the workshop describe efforts currently underway to model ocean-atmospheric circulation and interaction, others describe the state of the art in biological modeling. It became apparent during the discussions that we are moving toward more sophisticated models relating air-sea interactions to fishery yields.

Copies of the publication are available from Environmental Science Information Center, Library and Information Services Branch, D82, WSC-4, Rockville, MD 20852.



Dr. Herbert Curl discusses the global distribution of marine food chain constituents.

Deep Ocean Mining Data Base

EDS' National Geophysical and Solar-Terrestrial Data Center is currently assembling a marine resources environmental data base. Two ongoing Federally supported programs now provide the bulk of the data base—NOAA's Deep Ocean Mining Environmental Study (DOMES) and the International Decade of Ocean Exploration (IDOE) Manganese Nodule Program funded by the National Science Foundation.

The DOMES project is concerned with the environmental aspects of anticipated marine mining of manganese nodules. Scientists are studying three sites in the east-central Pacific before these nodules are mined commercially.

NGSDC currently has bottom and box core photographs, in addition to vane shear data collected from three cruises to three DOMES sites. The Hawaii Institute of Geophysics collected bottom photographs at eight locations near Site A (8°27′N, 150°47′W). These are available on eight reels of 35-mm film.

The NOAA Ship *Oceanographer* collected bottom samples for the same location and completed two cruises to all three sites. NGSDC has bottom photographs for Site A on three reels of 35-mm film at five stations, as well as 59 color transparencies (35-mm) of 29 box cores. Bottom photographs from five stations at Site B (11°42′N, 138°24′W) are contained on three reels of film with 44 color transparencies of 30 box cores; and data from Site C (15°00′N, 126° 00′W) consist of nine reels of film from 10 stations and 64 color transparencies of 48 box cores.

NGSDC has about 500 bottom photographs on each reel of 35-mm film, and each reel sells for $20. Duplicates of color transparencies are $1 each with a 25 percent discount available for orders in excess of 40. The complete set (22 reels and 167 transparencies) sells for $565.

Vane shear measurements are available in tabulated form for most box cores. Paper copies are available for $20.

The distribution and chemistry of marine manganese nodules are under investigation in the IDOE program. NGSDC can provide data from about 1,500 samples collected at 800 locations. The data comprise five digital files which include source, location, sampling method, and depth; nodule type and weight percentages for selected elements; and two files containing bibliographic references to the data. A magnetic tape copy of all five files on a single tape sells for $60. A printout of the same data can be obtained for $50.

For further information, or to request copies of the data, contact NGSDC, Code D621, NOAA/EDS, Boulder, CO 80302. Telephone: (303) 499-1000, Ext. 6338.

Marine Geophysical Data For North Atlantic Oil and Gas Lease Tracts

The U.S. Geological Survey (USGS) has provided EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) with high-resolution marine geophysical data for 206 selected tracts in the Georges Bank region of the North Atlantic continental shelf for dissemination to the public. The surveyed tracts are those identified in the Bureau of Land Management's news release, "North Atlantic OCS Tract Selection Announced for Proposed Oil and Gas Lease Sale No. 42," dated January 2, 1976.

Offshore Navigation, Inc. (ONI), under contract to the USGS Conservation Division, acquired and interpreted these nonproprietary data between May and August 1976, using echo sounder, subbottom profiles, sparker, and side-scan sonar. This new data set provides valuable geophysical information on shallow geological structure, sedimentary environment, and other features that might indicate hazards to exploration and aid in the development of possible oil and gas resources of the selected tracts.

The data collection consists of raw data and documentation, interpretative maps, and ONI's final technical report. Maps include: bathymetry, thickness of unconsolidated sediments, structure, hazard, and final navigation charts. The final technical report (available as microfiche) fully describes all survey and navigational equipment, auxiliary data from other sources, methods of using equipment and survey, processing data, and results of the survey.

Inquiries concerning these new data should be addressed to the National Geophysical and Solar-Terrestrial Data Center, Code D621, Boulder, CO 80302. Telephone: (303) 499-1000, ext. 6542, or 6338; FTS 323-6542 or 323-6338.

Marine Climatology Atlas For the New York Bight

The Sea Grant Institute, State University of New York, has published New York Bight Atlas Monograph #7, *Marine Climatology*, for one of the world's most intensively used coastal areas. The authors of the atlas are Bernhard Lettau of the National Science Foundation's Division of Polar Programs and William A. Brower, Jr. and Robert G. Quayle of EDS' National Climatic Center.

The marine climate of the Bight is presented in two ways: first, selected data illustrate the seasonal variation of meteorological parameters; second, isopleth maps and statistical graphs give a detailed climatic profile. The interactive processes among land, sea, and air are interpreted for their influence on the meteorological variables and their production of the distinctive marine climate.

The data summaries consist of monthly averages of temperature, temperature anomalies, heating degree-days, relative humidity, precipitation, wind, fog, and haze over the eastern, central, and southern portions of the Bight. The climate-forming processes active over the Bight include the effect of the heat reservoir on the sea surface, the sea breeze, and the effect of coastal geography on storms.

The National Climatic Center processed and analyzed data from 130,000 surface marine observations, 500,000 observations for six coastal land stations, and 50,000 observations at two light stations for the general period 1949 to 1974. These data provide the best possible climatological picture of the Bight's data-sparse, near-coastal zone, an area of sharp gradients and complex climates.

Copies of the publication may be obtained from: New York Sea Grant Institute, State University of New York, 99 Washington Avenue, Albany, NY 12246. Price: $4.00. Telephone (518) 474-5787.

Geomagnetism Data Products and Services

EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) has just issued *Geomagnetism (solid-earth) Data Services and Publications*. This 14-page booklet lists and describes NGSDC's various data files and available data products and services related to the Earth's main magnetic field and its core-related, long-term variations. These publications and services are of interest to surveyors, exploration geophysicists, mariners, aviators, geophysical research scientists, and others.

The booklet tells how to obtain, for example, tables of secular change in the mangetic declination, descriptions of locations where a magnetic compass may be calibrated, magnetic charts for navigation, and tables of computer-models of magnetic elements for removal of the smoothed field. Specific files or subjects covered include land survey data, magnetic observatory data, airborne survey data, marine survey data, secular change data, magnetic station descriptions, magnetic charts, and mathematical models of the main magnetic field.

A copy of the booklet may be obtained without charge on request to NGSDC, EDS/NOAA, Boulder, CO 80302. Phone: (303) 499-1000, ext. 6478, or FTS 323-6478. (For information on the shorter term variation data from magnetic observatories and other related geophysical phenomena, please request a companion booklet, *Solar-Terrestrial Physics Services and Publications*.)

Airport Climatological Summaries Published

EDS' National Climatic Center recently published an *Airport Climatological Summary* for each of 20 major airports. Data for an additional 150 major airports will be summarized during the next 2½ years. These 18-page summaries are based upon 10 years of records from 1965 through 1974 and are intended mainly as aids to aviation.

Summaries now are available for the following airports: Atlanta, Ga. (Hartsfield Atlanta Intl.); Boston, Mass. (Gen. Logan Intl.); Buffalo, N.Y. (Greater Buffalo Intl.); Chicago, Ill. (O'Hare Intl.); Cleveland, Ohio (Cleveland Hopkins Intl.); Columbus, Ohio (Port Columbus Intl.); Detroit, Mich. (Metropolitan); Indianapolis, Ind. (Weir Cook Municipal); Los Angeles, Calif. (Intl.); Minneapolis-St. Paul, Minn. (Intl.); New York, N.Y. (La Guardia and John F. Kennedy Intl.); Philadelphia, Pa. (Intl.); Pittsburgh, Pa. (Greater Pittsburgh Intl.); Portland, Oreg. (Intl.); San Diego, Calif. (Lindbergh Field); San Francisco, Calif. (Intl.); Seattle, Wash. (Seattle-Tacoma); St. Louis, Mo. (Intl); and Washington, D.C. (Washington National).

These publications contain a capsule summary of aviation weather for the station; means and extremes data; tables for each of the 10-year periods of monthly and annual values of average temperature (maximum, minimum, and mean), total precipitation, snowfall, and heating and cooling degree-days; and monthly and annual percent frequency of observation for five selected ceiling-visibility categories. The publications also have tables of monthly and annual percent-frequency of observation for various weather elements such as ceiling, visibility, and weather type by wind direction; wind direction versus wind speed for both all weather and instrument flight conditions; and 3 hourly weather conditions (00 GMT, 03GMT, ...21GMT). The history of the station location and instrument exposures is also shown.

Additional information on these summaries can be obtained from the National Climatic Center, Federal Building, Asheville, NC 28801. Telephone: 704-258-2850, ext. 683. Copies can be purchased for 50 cents each.

Climate and Health Reprint Available

EDS has reprinted a special section, "Climate and Health," which appeared in the October *NOAA* Magazine. The articles in the reprint document the pervading influence of weather and climate on our health. They also explore the need to tie together the efforts of the medical and atmospheric science communities to work toward improving the quality of life.

Articles in the reprint are:

"Climate and Government: A Fresh Look"

"Weather, Climate and You"

"Climate To Order"

"Dear Asheville/ Asheville Answers"

"Sickness From the Sky?

"Climate and Bill Hodge"

"Ambulance Weather"

Copies of the reprint may be obtained from: Environmental Data Service, Publications and Media Staff, Dx2, Washington, DC 20235. Telephone: (202) 634-7305.

Worldwide Ocean Sediment Core Descriptions

EDS' National Geophysical and Solar-Terrestrial Data Center has 6,859 descriptions of ocean sediment cores collected worldwide by Columbia University's Lamont-Doherty Geological Observatory.

Each core is described in detail. Mineralogy, paleontology, and sediment type were determined microscopically; carbonate and coarse fraction percentages were roughly estimated. Also included for each core are collection latitude, longitude, corrected water depth, core length, and other descriptive data.

Paper copies of the core descriptions may be retrieved selectively according to any combination of search criteria (i.e., geographic area, water depth, ship, cruise number, or date of collection). Charge for this service is $15 per search, plus 15 cents per page in excess of 150 pages. The descriptions are also available on 35-mm microfilm at $15 per reel or $100 for the entire set of seven reels.

An inventory summary listing based on any combination of search criteria described above is also available, but it does not include the descriptive information. Inventory summary listings are generally provided free, except for requests for extensive inventory searches involving different combinations of criteria or large geographic areas. Costs for this service will be $15 per search. A printout or magnetic tape copy of the entire core description inventory may be obtained for $60.

Direct inquiries to: NGSDC/NOAA/EDS, D621, Boulder, CO 80302. Telephone (303) 499-1000, ext. 6338.

Chemical Analyses of Igneous Rocks

EDS' National Geophysical and Solar-Terrestrial Data Center in Boulder, Colo., has acquired PETROS, a major historical data bank of chemical analyses of igneous rocks compiled by Eastern Washington State College. As of September 1976, the collection included 25,000 major-element chemical analyses of igneous rocks collected worldwide and was divided into 178 groups representing geographic areas or petrologic provinces. Also included were 419 calculations of average rock compositions for selected areas.

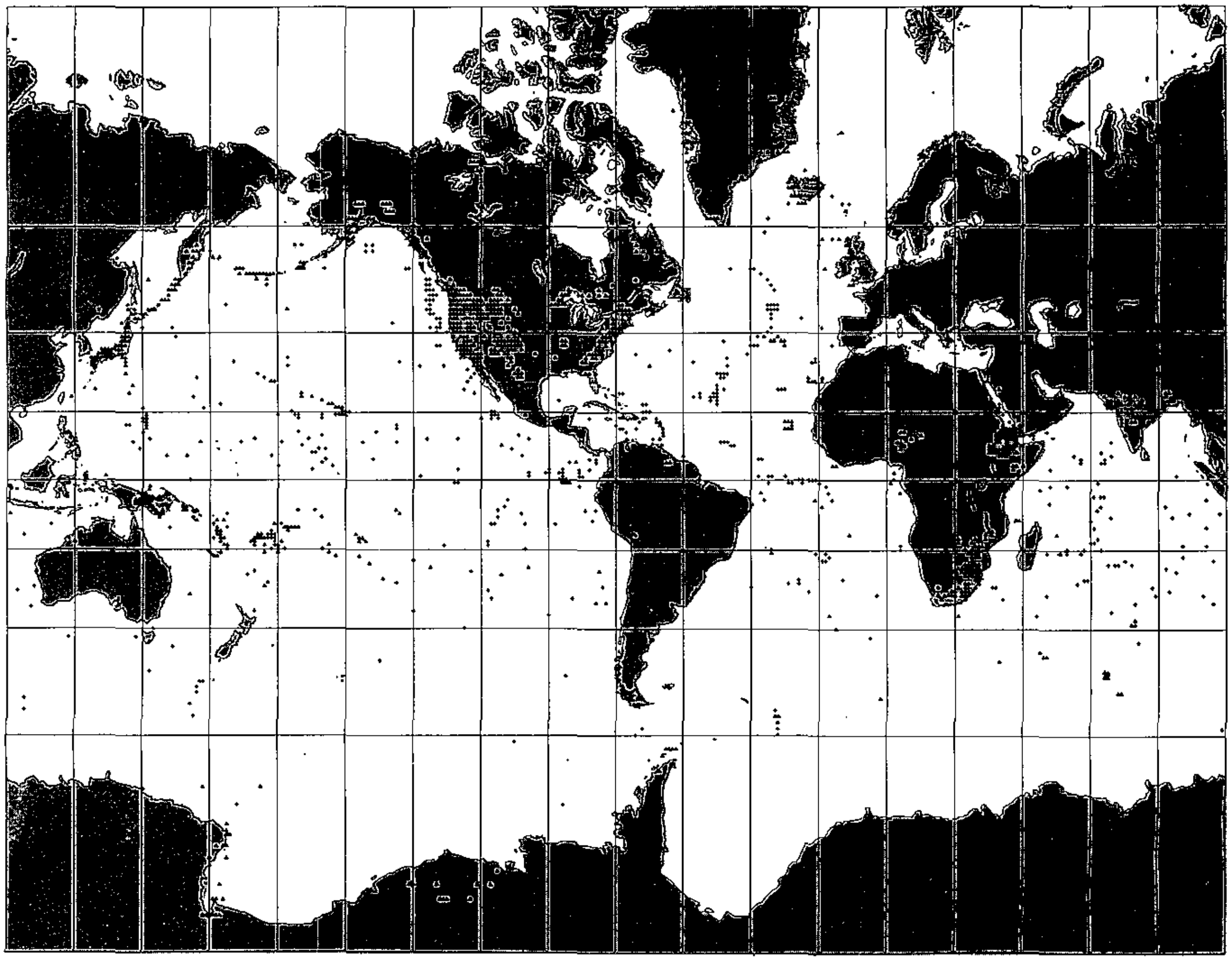
In addition to percentages of major elements, including at least nine major oxides, the data file provides: reference (author, date); geographic or petrologic province; latitude and longitude to the nearest degree; rock name; geologic age by era, period, or epoch; types of igneous rock body in which the sample occurs; author's analysis number; and other analytical information.

A second file describes the organization of the data bank and lists sample identification formats and codes, bibliographies giving the sources of analyses for each major group, and operating instructions for the data bank.

Sources of data for PETROS include published works and these will be updated periodically as new data are published.

The PETROS data bank is available on 7- or 9-track coded magnetic tape, at any compatible density, with a record length of 80 characters. Specify blocked (5,120 characters or less) or unblocked. The documentation file (MARTHA) is provided in print form and also appears in text form on the tape following the PETROS file. Price: $60 payable to "Commerce/NOAA/NGSDC."

For additional information contact NGSDC, D62, National Oceanic and Atmospheric Administration, Boulder, CO. Telephone: (303) 499-1000, Ext. 6338.



PETROS sample locations. Each symbol may represent more than one sample.

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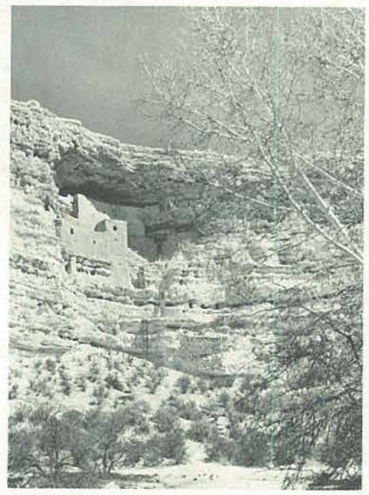
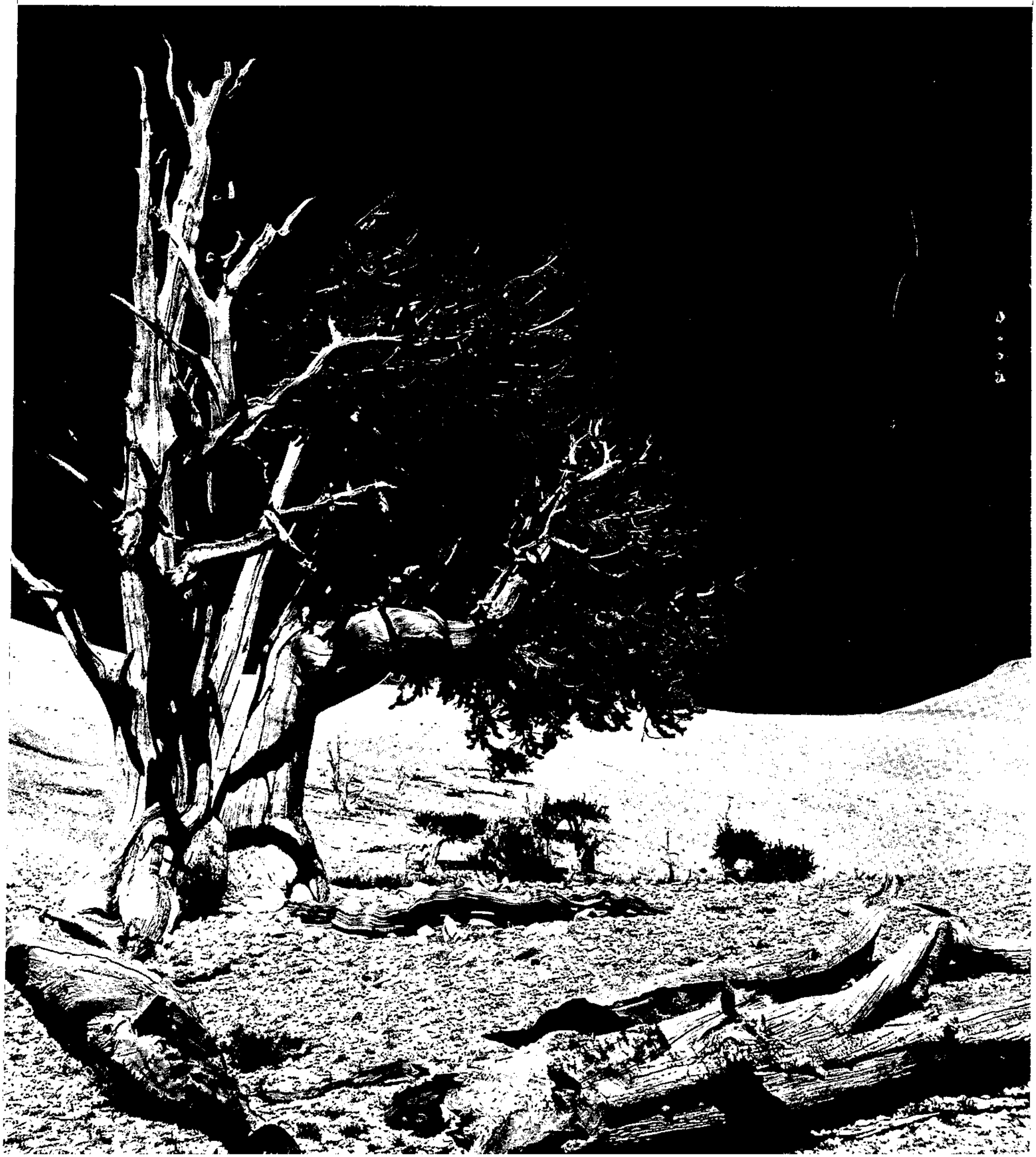


In this issue: *An old-fashioned winter (p. 3), climate and shelter (p. 7), global crop-yield assessments (p. 12), and inside a Texas Tornado (p. 16).*

EDS

Environmental
Data Service
July 1977



EDS

Environmental
Data Service
July 1977

Cover: *Bristlecone pine (Pinus longaeva). Such old, stressed trees provide the best tree-ring records of seasonal variations in past climate (see story, opposite page), because growth is highly limited by climatic factors.*

EDS is a bimonthly publication designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, and Center for Climatic and Environmental Assessment. In addition, under agreement with the National Academy of Sciences, EDS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 16, 1975; this approval expires June 30, 1978.

U.S. DEPARTMENT OF COMMERCE
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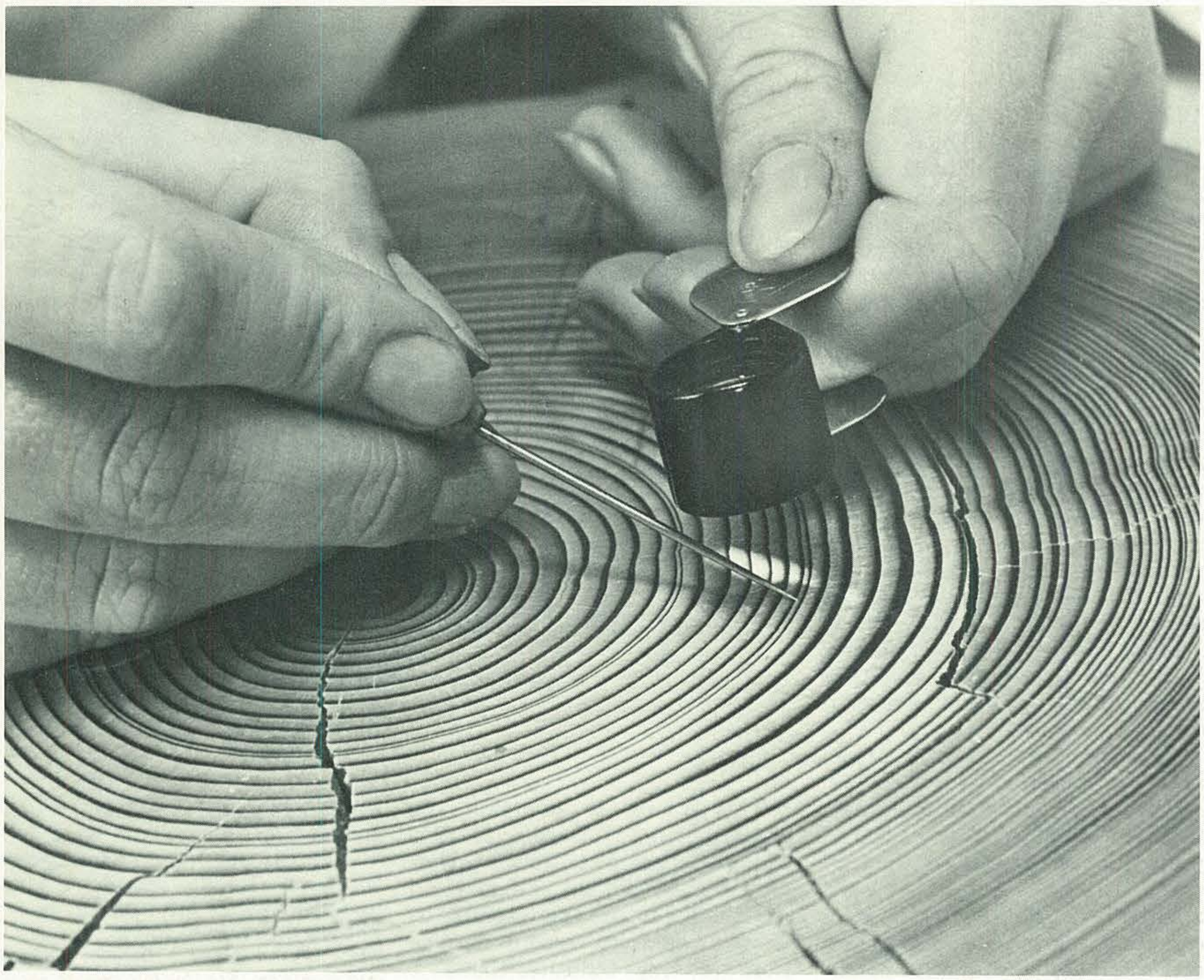
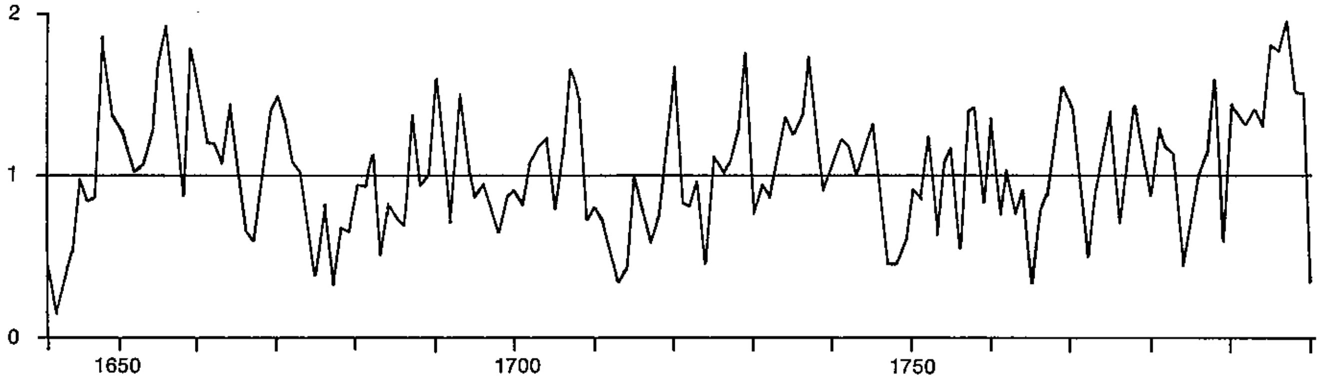
Tree Rings: A Record of Climate Past

By Harold C. Fritts
Laboratory of Tree-Ring Research
University of Arizona



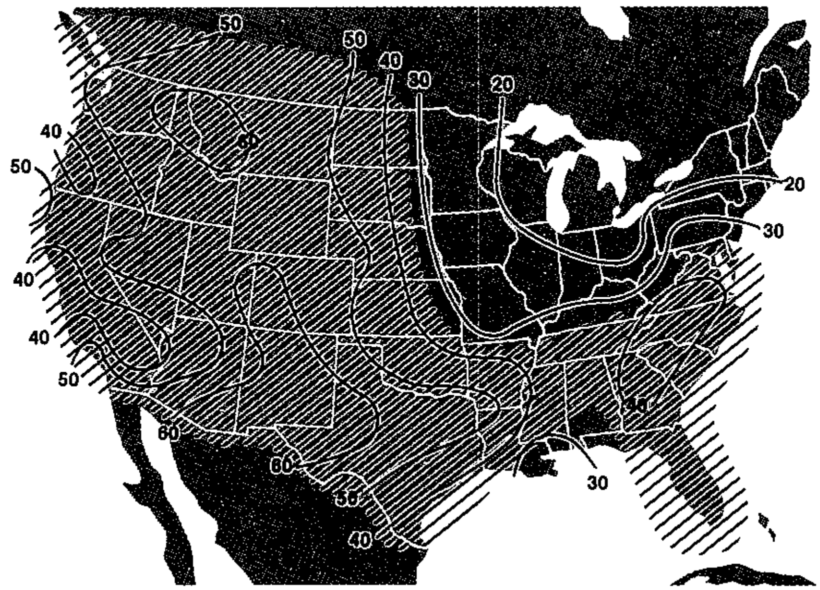
A cross section from the stem of a stress-site tree is examined for particular patterns of wide and narrow rings that allow it to be cross-dated with other specimens in the area and with trees on nearby sites. The dated ring widths are then measured and processed to extract any information they contain on climatic variations. Note that the widest rings are in the center, and that ring width diminishes with increasing tree age.

Photo: Bob Broder



The winter of 1976-77 was perceived by most Americans as remarkably abnormal, with severe cold in the East, drought in the West, and mild temperatures as far north as southern Alaska. In fact, the experiences of this past winter seem so unusual that it is hard to believe that the same conditions are likely to occur again in the near future. Yet, research with tree rings at the University of Arizona indicates that particular ring-width patterns in trees throughout western North America are associated with climatic anomalies like the 1976-1977 winter. Examination of the continuous 363-year tree growth record dating from A. D. 1601 to 1963 for 65 selected sites in western North America reveals that the same growth patterns occurred often in the past.

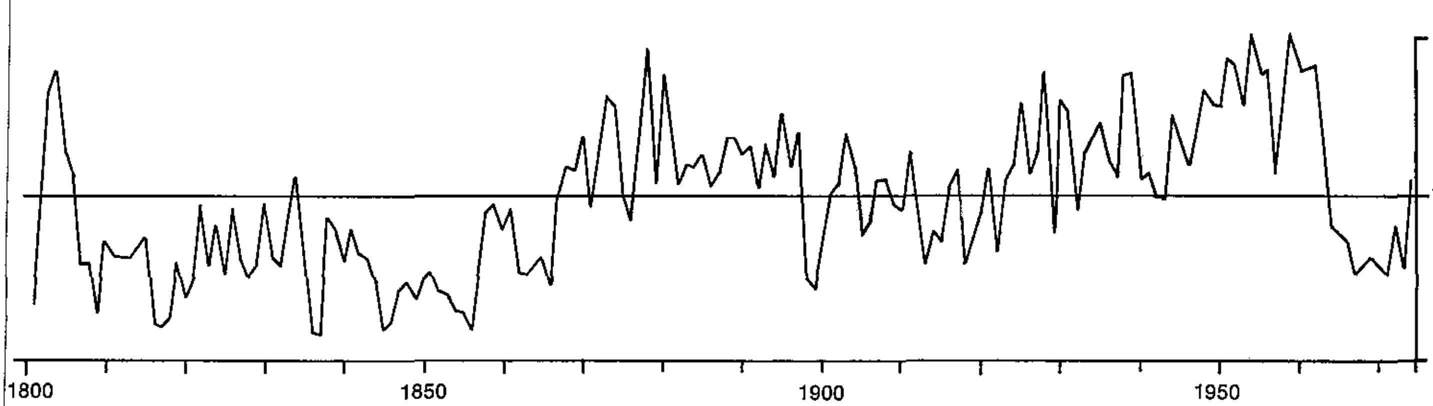
Tree rings support some of the ideas espoused by Hubert H. Lamb (1966) and Reid A. Bryson that the climate of the first 60 years in the Twentieth Century was unusually mild and remarkably different both from conditions of the past three centuries and perhaps from the conditions to which we could be returning for the remainder of the Twentieth Century. In this perspective, the winters for the interval 1900-1960 were, on the average, milder in the North and East and wetter and cooler in the West than those of the prior three centuries.

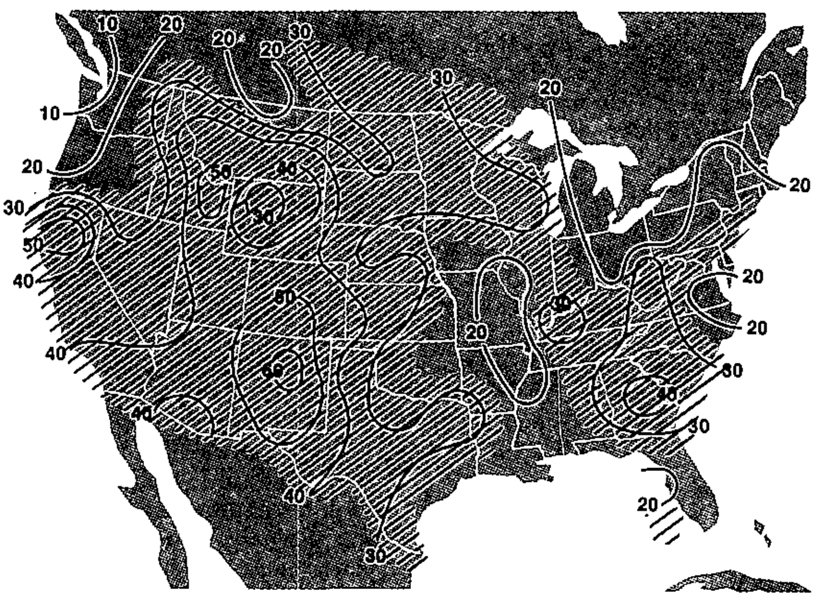


SPRING TEMPERATURE

This is not to say that the climate of all years prior to 1900 was as extreme as this winter's climate, nor that the climate of all years in the future will resemble it. Rather, the past record derived from tree rings indicates that 47% of the winters were distinctly colder than the Twentieth Century normal in the East and Northeast, while only 26% were distinctly warmer, and that perhaps we should expect and plan for a similar percentage of cold winters in the future.

Across the top: Ring-width chronologies derived from 18 larch (Larix laricina) from Fort Chimo along the tree line in northeast Canada provide a long record of area temperature variations. The low growth rate during the last 11 years is associated with cool springs and summers. Similar low growth rates in the first half of the 19th century indicate similar cool climate, while high growth rates for other periods indicate warmer temperatures.



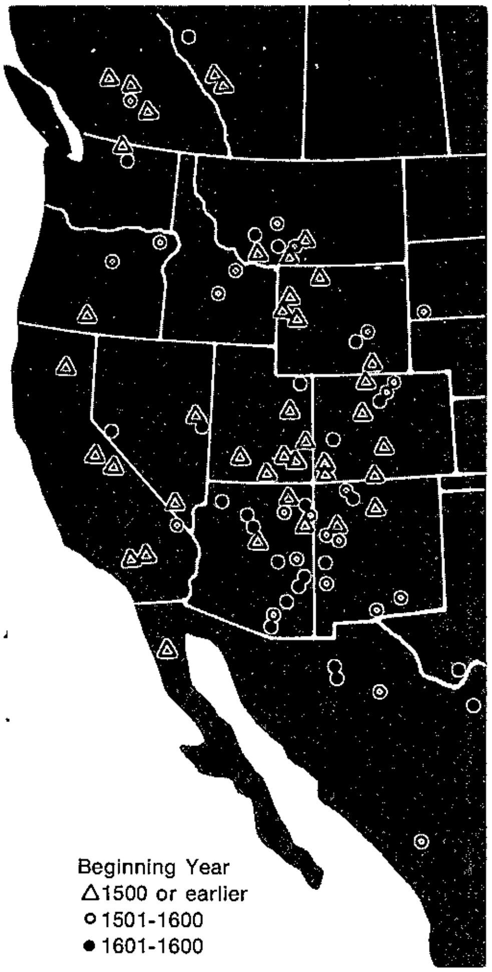


SPRING PRECIPITATION

Above and opposite page: Percentage agreement between observed and reconstructed average spring temperature and precipitation for the period 1901-1962 (0=no relationship; 100=perfect agreement). The reconstructed values were derived from 65 selected tree-ring chronologies (page 6) from western North America. The shaded areas show where the agreement exceeds chance and thus appears significant.

The evidence for this statement consists of past reconstructions of climatic variables for three centuries derived from computer analyses of the annual growth rings from nearly 1,000 coniferous trees. The widths of the rings, which are sampled by coring the trunks of living trees or by studying cross sections from fallen trees, provide a measure of climatic factors as they have varied over all four seasons of the year and as they have limited growth-controlling processes within the tree. By sampling and averaging ring widths from many trees on a particular site, the variations among different trees are minimized, and the limiting conditions of the macroclimate common to all trees are enhanced in what is referred to as the ring-width chronology.

The various growth responses for chronologies of different evergreen species, sites, and geographic areas throughout the mountains and plateaus of western North America and the Arctic provide a variety of information on the yearly variations in past environments which, in turn, are highly correlated with the corresponding regional anomalies of patterns of climatic variables. Since the trees often respond to several climatic factors over a number of seasons, only a portion of the climatic information in a particular set of ring widths is utilized in a particular reconstruction of a climatic variable. Computers are used to factor out the pertinent information. The tree-ring data for each year are correlated with corresponding measurements of climate to calibrate the varying growth patterns. A scale is obtained (called a transfer function) which is analogous to the markings on a thermometer or rain gage. This scale is used to convert the ring-width measurements into estimates of corresponding temperature or precipitation for



The locations of tree-ring chronologies selected for reconstructing past climatic variations. The triangles and open circles represent the 65 chronologies used in this report.

the years when the rings were formed.

Often very complex transfer functions are obtained. These functions are applied to ring-width variations from as many as 65 tree sites to calculate seasonal estimates of temperature or precipitation at as many as 78 weather stations throughout North America, or seasonal estimates of surface pressure at 96 grid points representing nearly one half of the Northern Hemisphere.

The general field of tree-ring analysis for purposes of dating or studying past events is called dendrochronology. Dendroclimatology is a subfield in which tree-ring information is used to estimate past climate.

There are a variety of techniques required to convert the ring-width data to information useful for climatic reconstruction. The techniques are necessary because three primary biological and physical phenomena distort the climatic record to a certain extent.

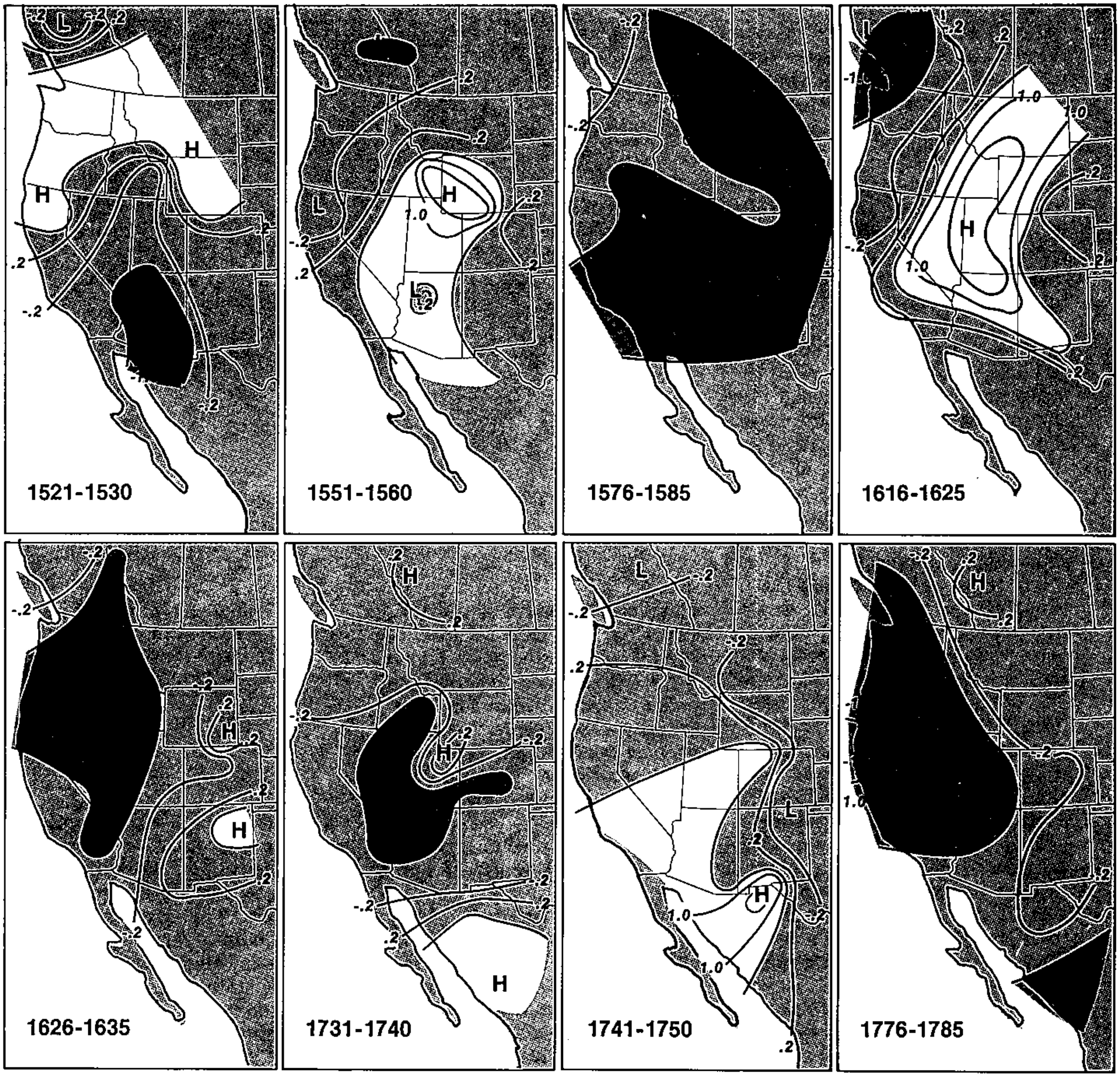
(1) *Trees differ in the amount of climatic information retained in the ring-width variations.* Tree-ring experts, or dendrochronologists, select trees from stressed sites where some climatic factor has been critical to growth-controlling processes. If factors other than climate (such as fire, human interference, disease, etc.) have been most limiting to the growth processes in the sampled trees, there will be little or no agreement in ring-width variations from one tree to the next attributable to climate, and no amount of analysis will yield climatic information.

Most of the trees studied today grow either in arid sites, where low moisture and high temperatures are often limiting, or at high altitudes or high latitudes, where low temperature is the most critical condition. Climatic factors such as sunshine, wind, carbon dioxide, and relative humidity also affect ring width.

However, because of advances in objective, quantitative procedures, modern dendroclimatology is being successfully extended to the less stressful forest habitats of eastern North America and Europe. In such cases, larger numbers of trees are sampled and more rings analyzed, or characteristics other than ring widths are measured by means of x-ray photographs and optical density scanning of the exposed film. The maximum wood density, for example, is an excellent indicator of July and August temperature, because it arises from cells which are growing in the summer, while total ring width is an indicator of the climate over the entire year because annual net photosynthesis largely controls the food reserves that in turn govern the rate of cell division, the length of the growing period, and the total number of cells which form the ring.

(2) *Certain trees may fail to produce an annual ring or, on occasion, may form more than one growth layer per year.* Such problems are identified and corrected by using a procedure referred to as cross-dating. The pattern of wide and narrow rings is observed on one specimen and compared to another. If there are no problem growth layers in either specimen and if climatic factors have been limiting, the sequence of wide and narrow rings has a one-to-one correspondence between the two specimens. When a ring is absent or double for a particular year on one sample but not on the other, the patterns can be matched for the time period either preceding or following the problem ring, but not both. When correct dating is established for the absence or doubling, the correspondence is apparent both before and after the problem ring.

The cause of the difficulty often can be identified by more careful examination of the ring structure or by examining rings of other trees for the same years. Typically, it may take 2 to 3 weeks of fulltime effort for an expert to examine all specimens from a site, to identify and resolve all of the problems, and to assign the correct year to each growth layer. If the cross-dating is performed carefully, the probability of a ring being assigned to the wrong year is so remote as to be essentially nonexistent, and the



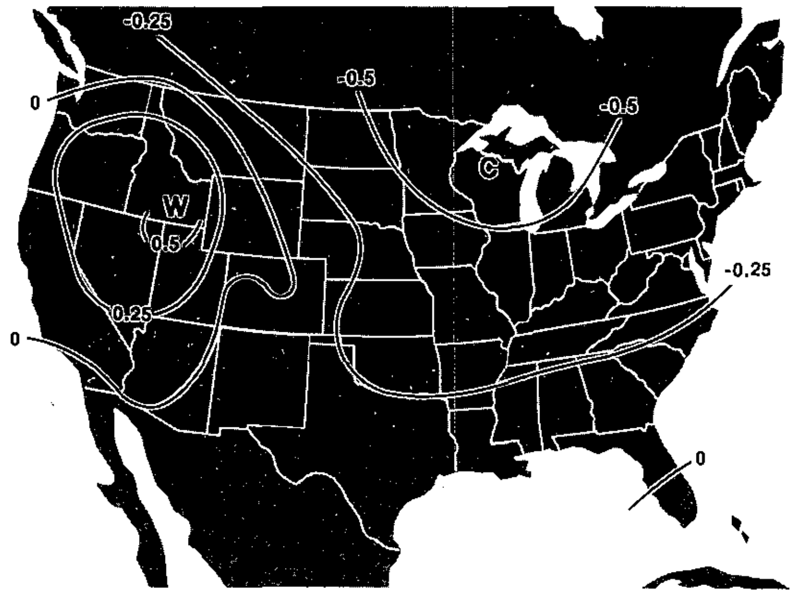
Another way to derive past climatic conditions is to identify areas of anomalously wide rings (white areas) or narrow rings (dark areas) in the past and to infer corresponding climatic conditions that are likely to have occurred. Since the trees are on semi-arid sites, areas of wide rings are inferred to have been moist and cool, while areas of narrow rings are inferred to have been dry and warm for the years indicated.

date of every ring can be considered a certainty. The specimens are then measured by a technician or x-rayed for density determination, depending upon the type of analysis involved.

(3) *Trees grow more rapidly in youth than in old age.* This results in a gradual reduction in ring width with increasing tree age. The measured ring-width data are fed into a computer, a regression line or curve is fitted to the decline in width associated with increasing tree age, and the value along the curve for each year is divided into the corresponding ring width to obtain a ring-width index. The indices for each year from all trees sampled on a particular site are averaged together to obtain a yearly value of what is referred to as the ring-width chronology.

The index values now are free of the declining growth rates due to increasing tree age, but if there is a very gradual trend in climate over the life span of the tree, the trend also will be removed by the indexing procedure. Usually, the trees are several hundred years old, so there is a risk of losing only changes in climate lasting several centuries. Most changes in climate lasting from 1 year to one or two centuries are preserved in the derived ring-width chronology. The averaged indices for each year from all trees sampled on a site are then utilized in the calibration analysis.

In addition to studying past climate, tree-ring analyses also are used to date archaeological ruins, forest fires, mud flows, glacial advances, and even the panels used for a Rembrandt painting. The pattern in wide and narrow rings of an undated piece of wood is matched with a chronology that is ultimately tied to living trees in the same area. If the piece of wood dates back to an earlier time period than the chronology used to date it, the specimen can be used



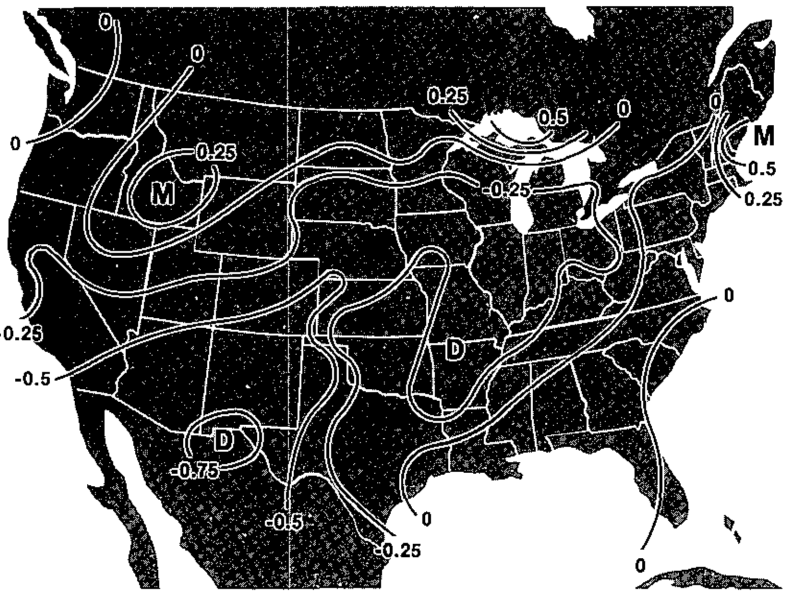
1601-1900 WINTER TEMPERATURE

Mean reconstructed winter temperature and precipitation anomalies for the previous three centuries, expressed as departures (in standard deviation units) from the 1901-65 means. These analyses indicate

to extend the length of the dating chronology. In this manner, the chronology from the 4,000-year-old living bristlecone pines was extended back in time for an additional 4,000 years, using old pieces of wood found on the ground in the same area. This provided a chronology of favorable and unfavorable growing seasons and precisely dated wood for a period of more than 8,000 years (Ferguson, 1968).

Tree-ring information can be used in a variety of applications other than those already described. Hydrologic parameters such as streamflow, lake levels, and sea surface temperatures are correlated with the varying ring widths, because these parameters are affected by the same climate factors that limit tree growth (Stockton and Jacoby, 1976). Isotopes of carbon, hydrogen, and oxygen in the wood dated by tree rings can be measured to obtain estimates of past fluctuations of these substances. Analysis of amino acids in dated tree rings may provide information on past temperatures, while pollutants incorporated in the wood or anomalies in ring structure serve as records of past environmental conditions. Tree-ring variance in exposed habitats may even provide valuable information in the search for sites suitable for wind power generation.

Tree-ring analysis has been attempted on all continents of the world except Anarctica. V. C. LaMarche of the Laboratory of Tree-Ring Research has been pioneering in chronology development in Argentina, Chile, New Zealand, and Australia. He also sampled in South Africa with less success, but European scientists report suitable materials can be found in the Atlas Mountains of Morocco in North Africa.



1601-1900 WINTER PRECIPITATION

winters were colder (C) throughout much of the north and east-central United States, warmer (W) in the West, and drier (D) over large parts of the interior and Far West than during the 20th century to date.

Many dendrochronologists are active throughout Europe (Eckstein, 1972) and the U.S.S.R. (Bitvinskas, 1974), and work has started in the People's Republic of China. Two international meetings are scheduled in England for the summer of 1977. A meeting on Dendrochronology in Northern Europe is to be held at Greenwich in July, while a symposium on tree-ring work and climatic reconstruction is to be a part of the Tenth Crongress of the International Union for Quarternary Research to be held at Birmingham in August.

Dendrochronologists have organized an International Tree-Ring Data Bank under the guidance of an international committee. It is administered by the committee chairman and the Data Bank Manager at the University of Arizona's Laboratory of Tree-Ring Research. The Environmental Data Service (EDS) and the National Science Foundation (NSF) are supporting both this Data Bank and a larger collection of tree-ring chronologies referred to as the Laboratory of Tree-Ring Research Data Base, also housed at the Laboratory. Together, these two data bases approach a total listing of more than 1,100 chronologies, each representing an average of 10 or more trees, two measured radii per tree, and 200 to 300 rings per radius.

EDS and its predecessor, the Office of Climatology of the U.S. Weather Bureau, supported some very basic developmental work in dendroclimatology during the past 15 years. Maps of early tree-ring variations throughout western North America were drawn and published under the auspices of one grant (Fritts, 1965), and the discovery of new techniques to calibrate the transfer function can be traced to this early support of tree ring work (Fritts *et al.*, 1971).

To what extent can tree-ring analysis contribute to our understanding of past climate? Many of my thoughts on this subject are summarized in a book recently published by Academic Press (Fritts 1976). Briefly, the unique possibilities offered by tree rings are:

- Annual growth layers are precisely dated, making possible a year-to-year analysis of past environmental conditions affecting growth. Few, if any, other proxies of past climate can offer such resolution.
- The record from a living tree is continuous and relatively stable, because the same growth response and genetic potential is maintained over the life span of the tree. Many other proxies represent discontinuous records or include changing populations of many species through time.
- Usable ring data are readily available and easily sampled from large areas throughout the temperate regions of the world.
- Calibration can be obtained between ring-width indices and present-day measurements of climate, making it possible to reconstruct or estimate the values of corresponding past climatic variables as far back as dated tree ring information is available in quantity.

Because of these attributes, tree rings will allow us to extend our climatological record into the past in many regions, as in the example cited at the beginning of this article. Charles W. Stockton, a hydrologist at the Laboratory of Tree-Ring Research, has extended the record of streamflow from the Colorado River backwards in time by means of similar tree-ring analysis. In addition, C. W. Ferguson, also at the Laboratory, is working with geochemists who have used his precisely dated bristlecone pine materials to recalibrate the radiocarbon time scale for more than 8,000 years.

My own group includes three meteorologists: Terence J. Blasing, G. Robert Lofgren, and Donald W. Stevens. We have worked on a number of techniques for studying recent climatic variations and for characterizing similar variations in the past, as reconstructed from tree rings. One technique includes a statistical routine for classifying surface pressure anomalies into a small number of meaningful types (Blasing, 1975; Blasing and Fritts, 1976). Others involve studies of sea surface temperatures, 700-mb heights, the Krick-Elliot weather types, Dzerdzeevskii's elementary circulation mechanisms, and surface pressure anomalies.

All of these studies are focused on one primary objective: to reconstruct past climatic conditions—including temperature, precipitation, and pressure—for stations throughout North America and the North Pacific. So far we have processed more than 250 different calibrations for the above three variables for each of the 4 seasons. At present, we are carefully comparing our reconstructions and verifying them against independent climatic data not used for calibration. We have completed a large part of the analysis work and are now selecting the best results, which we hope to summarize in a first attempt at characterizing the year-to-year climatic variations for the last four to five centuries.

While much work remains to be done before our task is completed, we believe that within ½ year we will have a 375-year record of past climate for the North American continent sufficiently detailed and precise to begin to examine different climatic hypotheses. We hope to relate these data to the long period records available for Europe and to the rich source of historical data from China to develop a meaningful picture of the fluctuations in climate throughout the temperate Northern Hemisphere. With the additions of LaMarche's collections and his work in the Southern Hemisphere, we may eventually be able to deal with variations throughout most temperate regions of the world.

While we have made a very important begining, much work still lies ahead. The data collections, though numbering more than 1,000 for western North America, are still grossly inadequate and nonrepresentative of eastern North America and of all other continents. In addition, methods of analysis are not completely standardized among North American and European workers, and scientists in different countries have just begun to collaborate actively with one another and to organize international bodies where mutual problems and differences may be discussed openly.

However, dendrochronologists have laid a solid foundation and practice the rigor and objectivity demanded of a science. We will be working with our meteorological colleagues in the climatological phases of our investigations. We already are applying our long climatic reconstructions to the problem of estimating future probabilities of climatic variability, and we hope to help with the problem of forecasting future climate.

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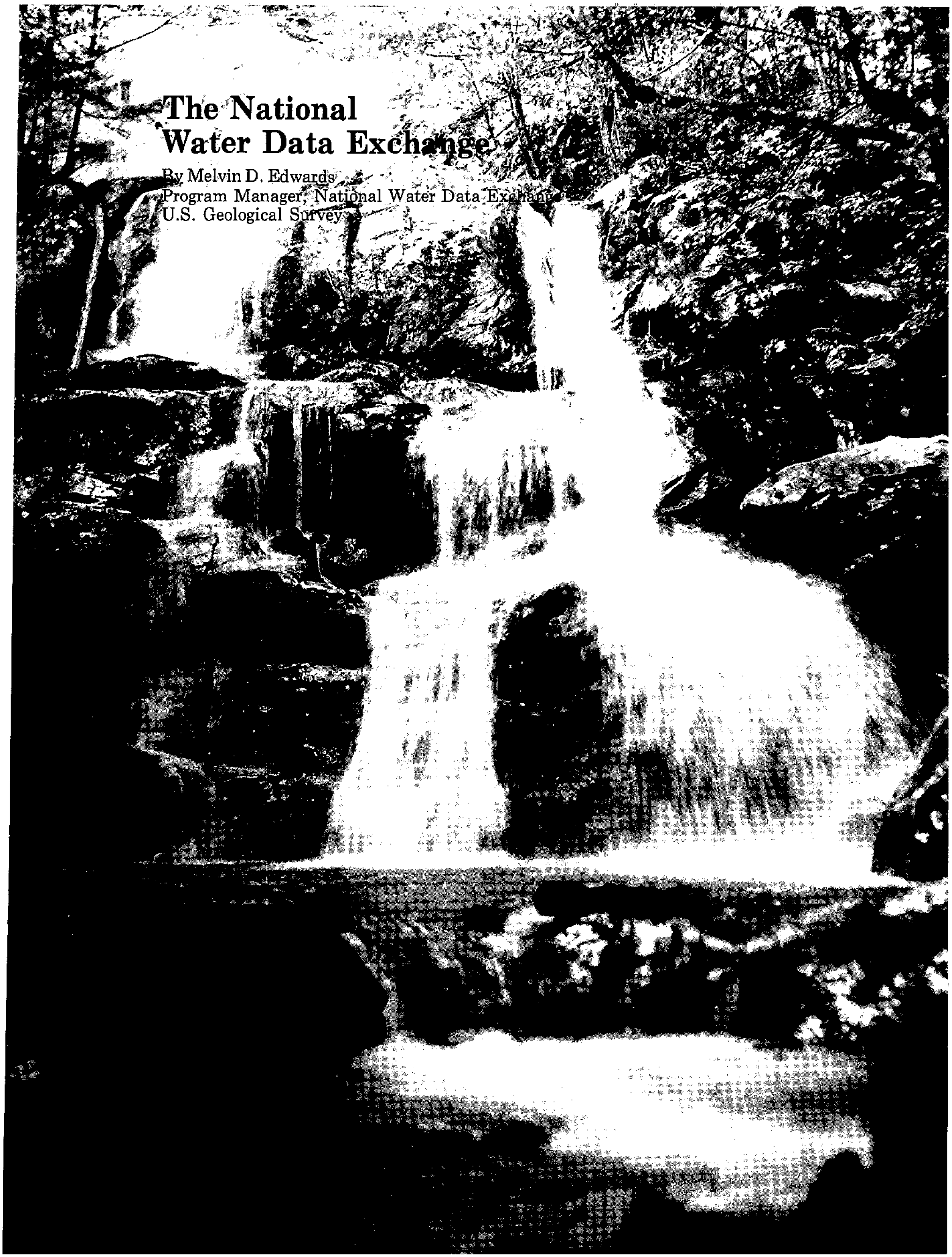
The National Water Data Exchange

By Melvin D. Edwards
Program Manager, National Water Data Exchange
U.S. Geological Survey



Introduction

Existing water data are becoming more important in the appraisal and management of available water resources, pollution surveillance and studies, monitoring of water quality criteria and standards, and the development of energy resources. The National Water Data Exchange (NAWDEX) has been established to help users locate and acquire needed water data. NAWDEX is not a large depository of water data; rather, its objective is to tell the user what data are available, where these data may be obtained, in what form the data are available, and some of the major characteristics of the data.

Organization

NAWDEX has been organized using guidelines and design characteristics developed by the Federal Intergency Water Data Handling Work Group. This Group is comprised of representatives of 13 Federal agencies and is a task group of the Federal Interagency Advisory Committee on Water Data, established under the auspices of the U.S. Geological Survey's Office of Water Data Coordination. The implementation of NAWDEX also has been endorsed by the non-Federal Advisory Committee on Water Data for Public Use.

NAWDEX Program Office: The U.S. Geological Survey has lead-role responsibility for NAWDEX. In this capacity, it has established the NAWDEX Program Office at its National Center in Reston, Va. This office provides the central management for NAWDEX. It also has the responsibility for coordinating all operational activities within the program. This includes serving as liaison between NAWDEX members and users of the system.

Local Assistance Centers: The service capabilities of NAWDEX are supported by a nationwide network of Local Assistance Centers established in the offices of NAWDEX members to provide local and convenient access to NAWDEX and its services. This network initially consists of 51 Centers located in 45 States and Puerto Rico. A complete list of these Centers and their locations may be obtained from the Program Office. Most Centers are equiped with computer terminals, thereby providing an extensive telecommunication network for access to the computerized directory and indexes being developed for the NAWDEX program. As NAWDEX membership increases, additional centers will be added in large population areas and areas of high user interest to provide improved access to NAWDEX and its services.

NAWDEX Members: Organizations that become participating members of NAWDEX form its base units. Current membership includes representation from the Federal, State, academic, and private sectors of the water-data community. Participating members work together as a confederation to provide ready and convenient access to their water data.

NAWDEX Services

A variety of services are provided by NAWDEX. The major ones are:

Identification of Sources of Water Data: The NAWDEX Program Office maintains a *Water Sources Directory*. This directory identifies organizations that collect water data, locations within these organizations from which water data may be obtained, the geographic areas in which water data are collected by these organizations, the types of water data collected, alternate sources for acquiring the organization's data, and the media in which the data are available.

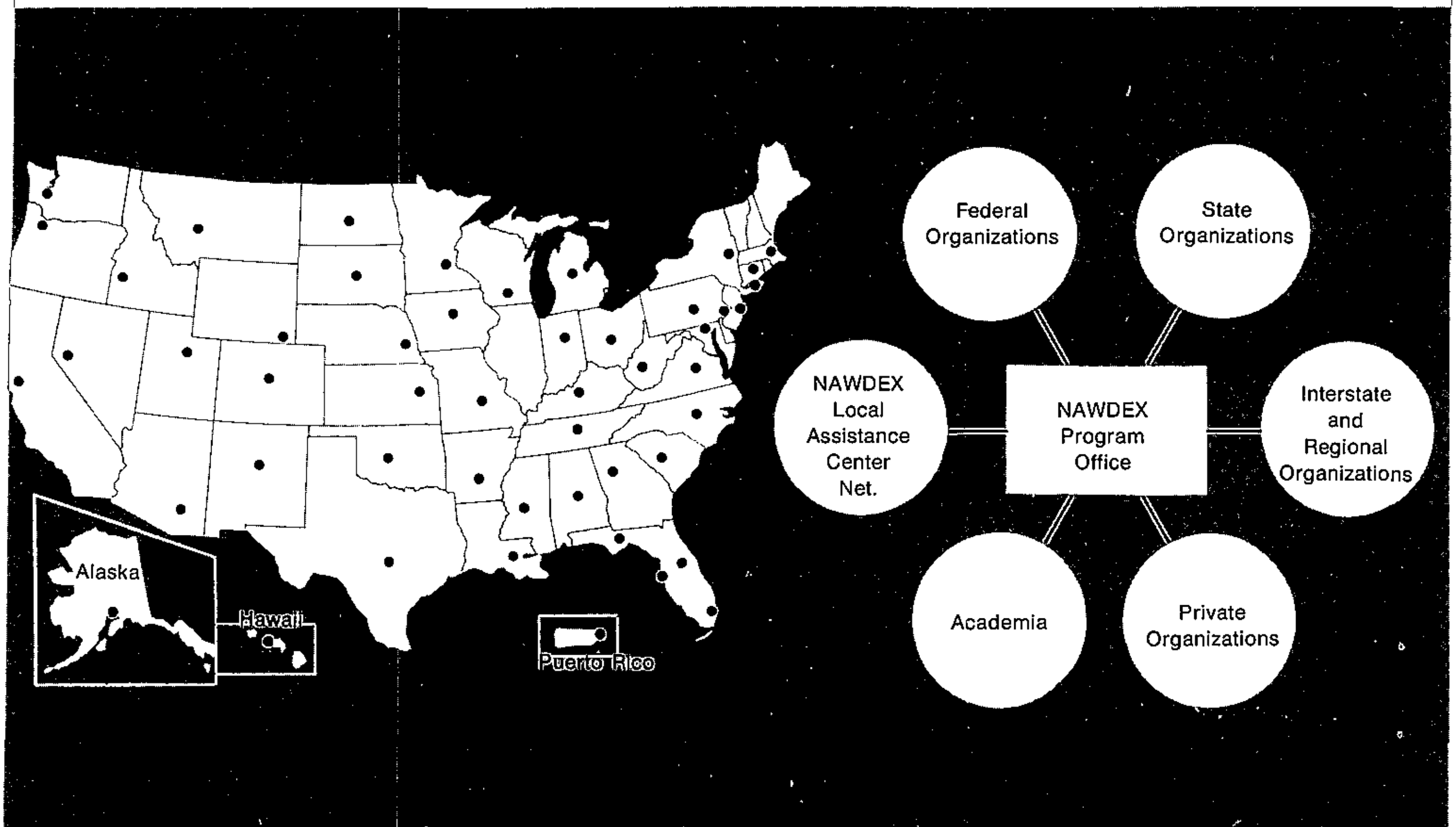
Nationwide Indexing of Water Data: A computerized *Master Water Data Index* is also maintained. This index identifies individual sites for which water data are available, the locations of the sites, the organizations collecting the data, the hydrologic disciplines represented by the data, the periods of record, water data parameters, the frequency of measurement of the parameters, and the media in which the data are available. More than 61,000 water data sites are currently being indexed from information contributed by 19 Federal organizations and more than 300 non-Federal organizations. The contents of the index will grow significantly as the NAWDEX membership increases.

Data Search Assistance: Through its *Water Data Sources Directory*, its *Master Water Data Index*, and indexes and other reference sources made available by its participating members, NAWDEX assists users in locating data of special interest. These data include water data in computerized and in both published and unpublished forms. The user is then referred to the organization(s) having the needed data. NAWDEX thus serves as a central point of contact for locating water data that may be held by several different organizations. Data search assistance may be obtained from the NAWDEX Program Office or from any of the Local Assistance Centers.

NAWDEX Membership

Membership in NAWDEX is voluntary and open to any water-oriented organization that wishes to take an active role in NAWDEX activities. There are no fees or dues associated with membership.

Conditions for becoming a NAWDEX member are quite flexible. However, a signed Memorandum of Understanding is required



The map shows the distribution of NAWDEX Local Assistance Centers. These Centers and the NAWDEX Program Office, which serves as liaison between NAWDEX members and the user community, provide data-search assistance, request-referral services, access to major water data bases, data source identification, and a nationwide index of water data.

between the NAWDEX Program Office and the member organization. While the terms of this document may be negotiated, it generally requires that the member consent to being listed as a source of water data; provide sufficient input to NAWDEX to allow water data held by the member to be indexed; respond to requests for water data; and participate, to the extent possible, in the development and utilization of standardized techniques and methodologies for the handling of water data.

Charges For Services

Users requesting data or services through NAWDEX may be required to pay charges assessed at the option of the member organization supplying the data or service. In general, charges will apply to those requests that require extensive computer usage or manpower for response. In all cases, the charge will not exceed the actual cost incurred in providing the service or product. Generally, users will not be charged for data search assistance by a NAWDEX office.

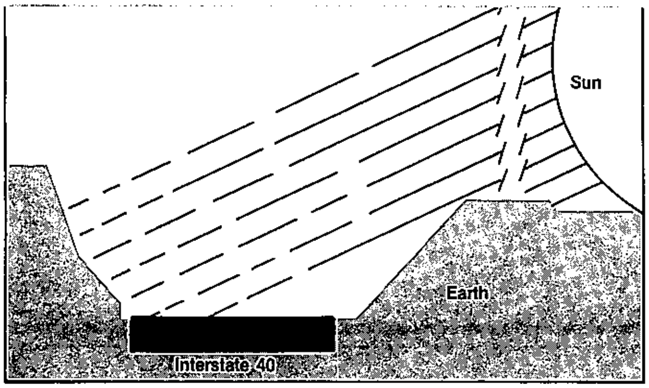
Requests for services or additional information related to the NAWDEX program may be directed to:

National Water Data Exchange
U.S. Geological Survey
421 National Center
Reston, VA 22092

Telephone (703) 860-6031,
(FTS) 928-6031.

Let The Sunshine In

By Harold Crutcher
National Climatic Center



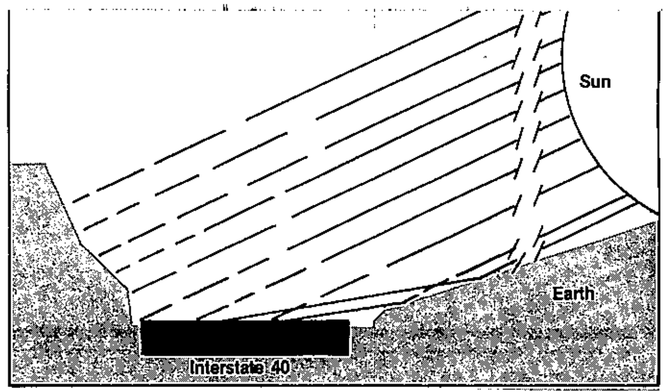


Figure 1. The Problem: The south bank, rising more than 25 degrees, prevents some of the sun's rays from reaching the highway.

Figure 2. The Solution: When the south bank is cut below 25 degrees, solar radiation reaches the road. If cut low enough, additional radiation is obtained by reflection from the bank.

"From Murphy to Manteo" is a familiar expression in North Carolina. The State's borders extend from the coast at Manteo to near Murphy in the west, a distance of over 500 miles. The land rises gently from the coastal area through flat coastal plains to rolling foothills. Rising more sharply, it becomes the southern portion of the Blue Ridge (the Eastern Continental Divide) and thence extends westward to the Great Smoky Mountains and on to Murphy.

Because of this topographical diversity, North Carolina has many climates. On the southern flank of the Blue Ridge bordering South Carolina and thence westward toward Georgia lies the well-known "Thermal Belt." The sun's rays fall almost perpendicularly against this escarpment in the wintertime, keeping it warm, while the northern flank in Tennessee and Virginia remains rather cool. Moist air from the Gulf of Mexico and the Atlantic is forced upwards by south, southeast, and southwest winds, and precipitation is relatively high just north of the escarpment and low some distance further north. In fact, the highest and lowest average precipitation east of the Rockies is found along the escarpment and 50 miles north of the escarpment, respectively.

The North Carolina Department of Transportation faces formidable highway construction tasks, especially in the mountains. Topography, rainfall, drainage, snow, ice, and falling rocks are just a few of the problems.

Some years ago the old, snaky highway leading from the east near Raleigh over the Eastern Continental Divide to Asheville, thence branching westward to Chattanooga, northwestward to Knoxville and north to Bristol, was replaced by a much better, safer highway, Interstate 40 (I-40).

The I-40 link between Old Fort and Ridgecrest now is being relocated to further improve safety and to make for more economical driving. Taking its cue from the example of the Thermal Belt, the State's Department of Transportation decided to try to alleviate the problem created by icing conditions during the winter in the highway cuts made in the mountains. Some of the cuts were deep, and even during the summer, with the sun high in the sky, the southern walls shaded part of the highway. Particularly hazardous conditions occurred with heavy snow or freezing rain. The time and cost of keeping the highway clear at such times is considerable.

To get help with the problem, John Mills of the North Carolina State Highway System visited the National Climatic Center in Asheville, N.C. There he posed the question: "For the shortest day in the year, say December 21, how much would the southern part of the ridges, left standing when the cuts were made, have to be cut down to permit the sunshine to fall on the highway between ten in the morning and two in the afternoon?"

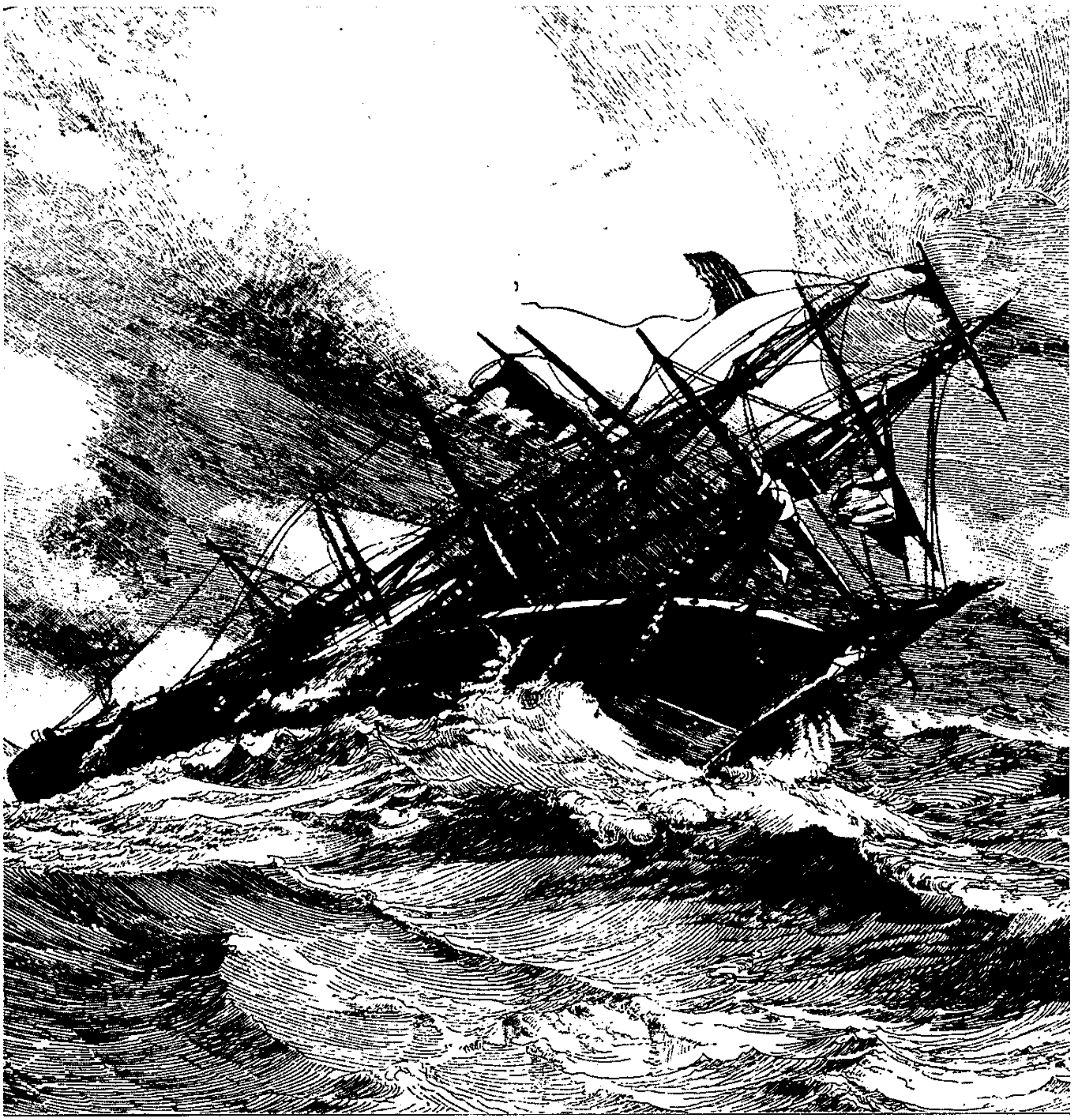
Figure 1 roughly diagrams the problem. The answer to Mill's question is to cut the south bank down so that its highest part is not more than 25 degrees above the highway. Additional help could be obtained from reflected light if the bank were graded even lower. Landscaping with low growing forage, shrub, or bushes would keep out unwanted, tall-growing trees.

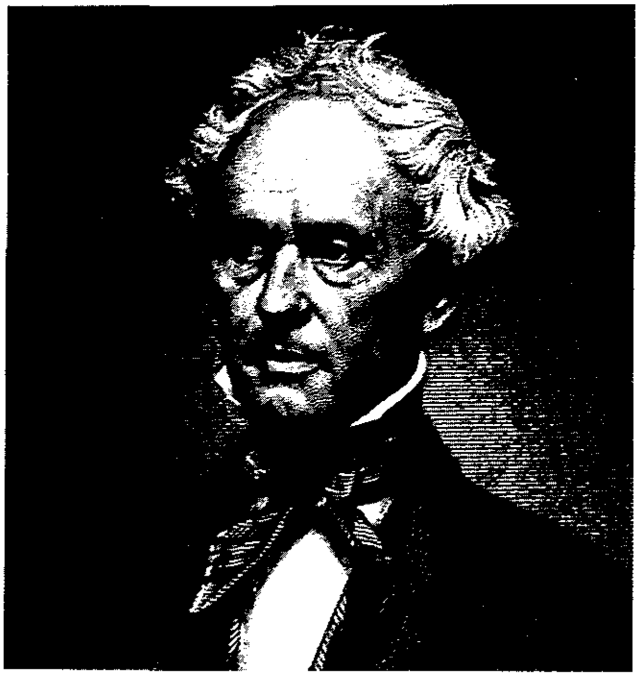
Figure 2 represents the suggested solution. Once adopted, (there being no clouds or fog) the sun should shine on the eastern part of the link near Old Fort from 9:30 a.m. to 2:30 p.m. and on the western part near Ridgecrest from 10:30 a.m. to 3:30 p.m., EST.

There will be a few places where solid rock will not permit cutting down the south bank, except at exorbitant cost. But for the rest of the route, this environmental adaption should result in a safer, sunnier drive.

Early Tropical Cyclone Chroniclers

By Dick DeAngelis
National Oceanographic Data Center





William Redfield

The foundations of tropical cyclone climatology were laid by a small band of dedicated, amateur weather men who began the orderly collection of data and unselfishly shared both their data and findings with fellow enthusiasts.

While the rotary nature of tropical cyclones had been common knowledge among seamen and geographers since the 17th century, and early insights into this characteristic were provided by Franklin, Langford, and Dampier, it was not until 1801 that a record of a number of these circular systems appeared, prepared by James Capper.

A well educated Englishman, Capper attained the rank of Colonel in the Hon. East India Company, holding for some time the post of comptroller-general of the army and fortification accounts on the cost of Coromandel. Based on firsthand experience he published, at the age of 58, *Observations on the Winds and Monsoons, Illustrated with a Chart and Accompanied with Notes Geographical and Meteorological.* This famous book contains accounts of several cyclones that afflicted India from 1746 through 1779.

Despite Capper's efforts, it was not until William Redfield's works began to appear in 1831 that tropical cyclones stirred scientific curiosity. After a decade of patient analysis of every shred of available evidence, Redfield was able to construct North Atlantic tropical cyclone tracks, and an 1846 article contained tracks of all known tropical cyclones affecting the coast of the United States from 1804-42.

Redfield was a self-educated, practical man whose early interest in the sea and its storms came from his father, a seaman, who died when William was just 13. His interest in hurricanes was heightened by the "Great September Gale of 1821," which ravaged the east coast of the United States. Young Redfield, then a storekeeper in Cromwell, Conn., made a trip across the State right after the hurricane struck. He had noticed that trees in the vicinity of his home had fallen toward the northwest, and he was surprised to find that in the western part of the State the trees had fallen toward the southeast. Contrary to the prevailing scientific consensus, he decided that the storm had a rotary wind system.

Redfield's theory inspired William Reid of the British Royal Engineers, who was stationed at Barbados to reconstruct government buildings that had been destroyed by an 1831 hurricane. Reid devoted himself to verifying Redfield's views by gathering and analyzing ship's logs and other weather observations. The two men corresponded frequently and exchanged ideas, which prompted Reid to publish several important works. So Redfield, a layman, converted a British engineer to a tropical meteorologist.

Reid, in addition to being a Major General, also became governor of Bermuda and later of the Windward West India Islands. In both posts he was credited with vastly improving the life of the natives and developing the agricultural resources of these areas. Earlier in his career he had served under Wellington, in Spain, during the Peninsula War. During that period he was wounded in battle on two different occasions and won numerous decorations. Later one of his five daughters married Sir Neville Chamberlain.

An account of the relationship enjoyed by Redfield and Reid was expressed by Commodore Perry in an account of his Japan Expedition: ". . . and there can be nothing more beautiful, as illustrative of the character of these two men, than the fact, well known to myself, that not withstanding their discoveries, in different parts of the world, neither claimed the slightest merit over the other, but each strove to give his co-worker in research the need of superior success in the great object of their joint labors; and thus without ever meeting, a strong friendship was formed between them, growing out of congenial aspirations for an honorable fame, and mutual admiration of the generous and enlightened views exhibited by each other; and this enobling feeling was kept alive to the last by friendly correspondence."

Redfield expanded his climatological interests to the eastern and western North Pacific, while Reid's attention was drawn to storms of the North and South Indian Ocean. Reid's analyses included a number of charts of the structure and paths of these Indian Ocean storms during the 1830's. Just as important, he appointed weather buff Henry Piddington as curator of the Calcutta Museum and later president of the Marine Court of Inquiry.

Piddington's interest in tropical cyclones stemmed from an incident that occurred when he commanded a ship in the mercantile marine for the East India and China trade. During an encounter with an Indian Ocean "cyclone," a term he later coined, his ship was dismantled. It was saved from sinking only by a fortunate veering of the wind.

Piddington retired from the sea after his first appointment in 1830. Inspired by writings of Reid, he began in 1839 a series of memoirs on the storms of the Indian Seas. Receiving semi-official recognition from the Indian government, he was able to publish a formal notice inviting observations on any hurricane, gale, or other storm of more violence than usual: "A scientific gentleman in Calcutta has obligingly undertaken to combine all reports that may be so received into a synopsis for exhibition of the results, and such reports marked 'Storm Report' can be sent post free to the secretary of the government." The practice of volunteer observers submitting such storm reports to government meteorological services is still followed worldwide today.

Piddington accumulated a wealth of material which he turned into a local handbook on the "law of storms" in the India and China Seas. In 1848 he expanded this pamphlet into *A Sailor's Hornbook for the Law of Storms.* His writing style was conversational and the book contained a great deal of information on tracks and behavior of tropical cyclones. It was a great success, ran through six editions, and was the recognized text on the subject for more than 30 years.

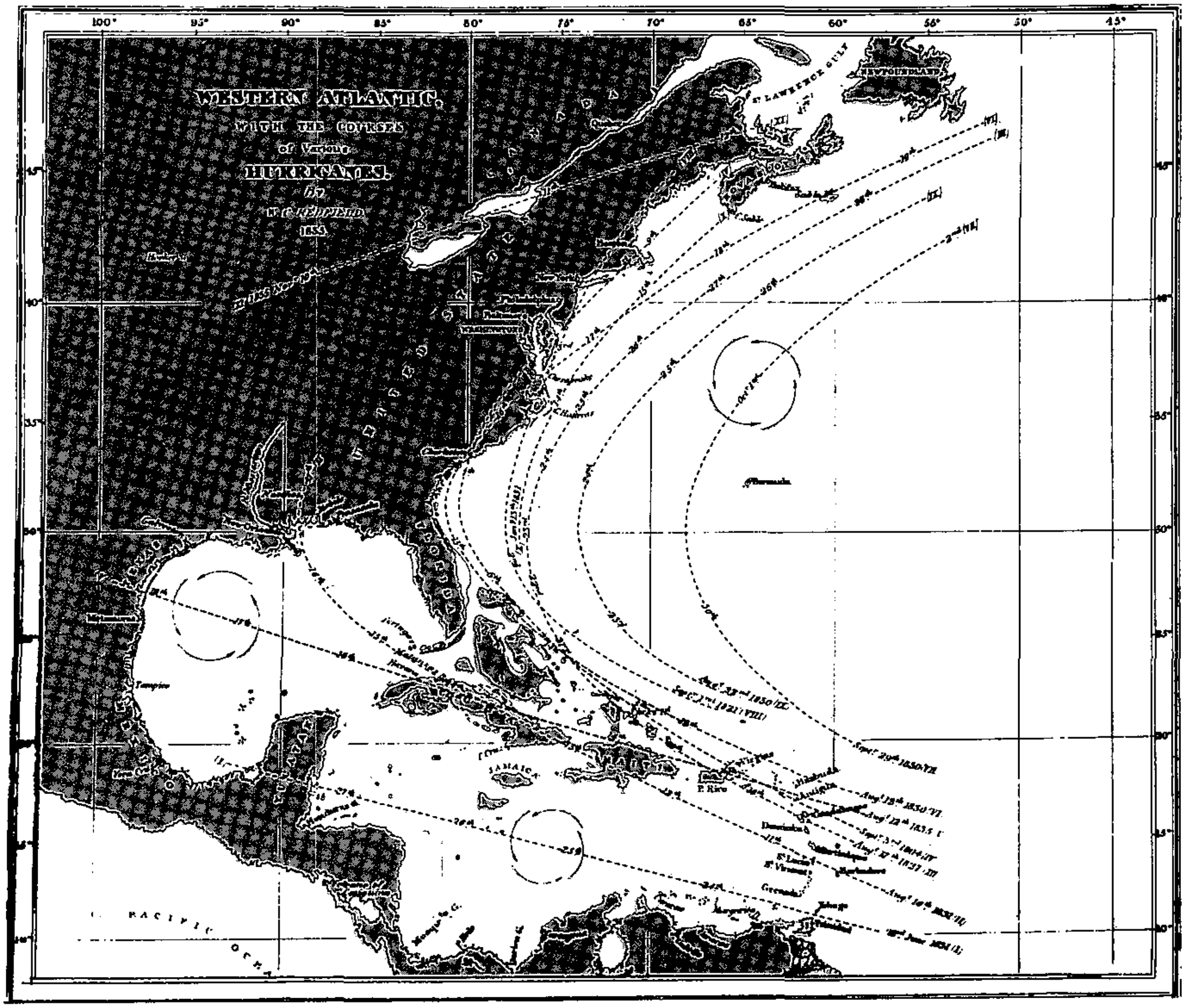
Sir William Reid's writings also inspired another Englishman, Dr. Alexander Thom, an army surgeon stationed on the island of Mauritius in the South Indian Ocean. Thom's interest was further heightened by the hurricane-damaged ships he saw in Port Louis. His excellent analysis of the Rodriguez Hurricane of April 1843 was due in large measure to the fact that fourteen or fifteen vessels were caught in the storm for several days. Thom obtained copies of their logs and interviewed their captains. From this infomation he retraced the hurricane's path and analyzed its characteristics. Accounts of the storm and many others in this ocean were published in his classic *Inquiry into the Nature and Course of Storms*, published in 1845.

Redfield and Reid were also an inspiration to yet another budding tropical cyclone climatologist—Andres Poey y Aguirre of Havana, who undertook a massive listing of all North Atlantic tropical cyclones since 1493. He even visited Redfield, who allowed Poey access to all his notes, including his unpublished Record Book of Storms. Poey's first list, including an extensive bibliography, was published in 1855. His sources also included Professor Alexander Keith Johnston of Edinburgh, who listed 127 hurricanes in his Physical Atlas, and the tables of Sir Robert H. Schomburgk, who recorded a similar number for the period from 1494 to 1846. Pioneers also began to appear in other tropical regions.

In 1877 Henry F. Blanford, in *The Journal of Asiatic Society of Bengal*, published a catalog of 112 recorded cyclones in the Bay of Bengal for the period October 1737 through November 1876. A similar catalog was prepared for the Arabian Sea by F. Chambers and contained details for 70 cyclones for the period May 1648 through July 1881. William Dallas and John Eliot also contributed their skills a few years later. Dallas extended Chambers' chronicle through 1889 and included a brief history of each storm. Eliot, who published several accounts of Bay of Bengal cyclones, brought all of his work together in his *Handbook of Cyclonic Storms in the Bay of Bengal for use of sailors*.

Thomas Dobson was an early tropical cyclone pioneer in the South Pacific-Australia region. He published accounts of 24 storms in 1853. This was improved upon by Edward Knipping some 40 years later. Knipping's article included tracks and frequencies since 1789.

By the beginning of the Twentieth Century, record-keeping chores were being taken over by the meteorological services of the countries most affected by these storms. While the collections became more orderly and complete, it is important not to forget the early unselfish efforts of these "amateur" climatologists.



An early hurricane track chart published by William Redfield.

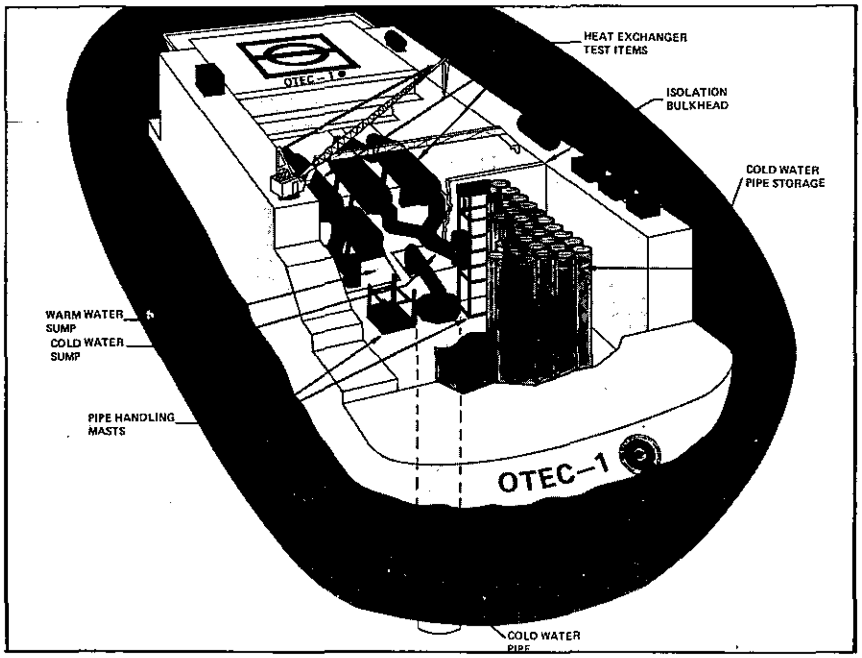
National Report

Ocean Thermal Energy Conversion

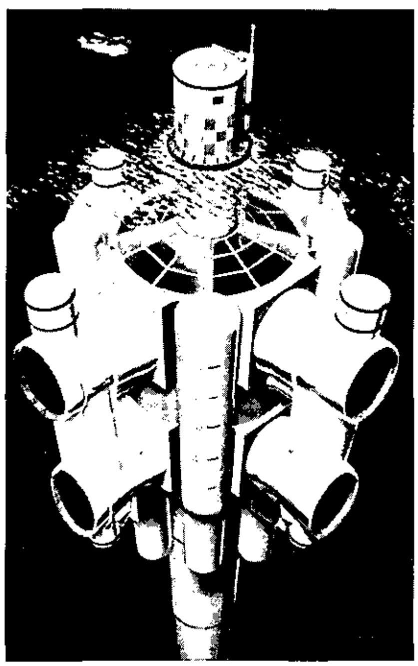
The concept of ocean thermal energy conversion (OTEC) has moved from the research phase under the National Science Foundation to the engineering phase under the Energy Research and Development Administration (ERDA). By mid-1979, ERDA plans to have a 1-megawatt test facility in operation using the converted Hughes Mining Barge as the platform. A 5-megawatt test facility is planned by 1981. If these tests indicate that OTEC is commercially feasible, a modular plant of 25-100 megawatts will be tested during the period 1983-1984.

Siting of these energy facilities will depend on the identification of a sufficiently large and persistent thermal difference between surface and subsurface waters. The effect of the surface and subsurface environments on the platforms, the effect of biofouling and corrosion on the heat exchangers and other components, along with a host of other engineering concerns will have to be considered.

The assessment phase of the OTEC program involves a number of tasks which require or will generate environmental data. In anticipation of this, ERDA has requested that EDS establish a test data base for OTEC, identify areas requiring additional observations, provide data and data products to ERDA contactors, and prepare a proposal for an operational OTEC data service.



OTEC-I, the converted Hughes Mining Barge as a 1-megawatt test facility.



Lockheed's concept of a possible commercial OTEC facility. Each port would provide more than 50 megawatts of electrical power.

First Regional Coastal Information Center Established

The New England Regional Coastal Information Center, located at the University of Rhode Island's Pell Library adjacent to Narragansett Bay, has gotten its start with a $50,000 grant from NOAA's Office of Sea Grant. Also cooperating in the project are NOAA's Office of Coastal Zone Management and EDS. An additional $25,000 has been pledged by the University of Rhode Island.

The New England center is the first of a network of regional coastal information centers that will eventually include eight others located near the Great Lakes and along the Atlantic, Pacific, and Gulf coasts.

The new center will provide to New England users information on coastal area subjects, including laws and zoning regulations, scientific data, and publications sources. In addition, it will act as a referral service, exchanging information and publications (on the subjects of coastal resource planning and management) among State and local governmental agencies, citizen groups, special interest groups, and the general public.

Satellite Data Users Workshop

The National Environmental Satellite Service (NESS) and EDS sponsored an Environmental Satellite Data Users Workshop on March 15-16, 1977, at the World Weather Building, Camp Springs, Md. The Workshop was organized to furnish NESS/EDS with a realistic insight into current and future needs of the satellite data user community and to get their reaction to satellite data archive proposals for the 1978-80 time period, when the amounts of data available for archival will reach staggering proportions. Over 40 representatives of the private, academic, and governmental scientific user communities attended.

Major topics discussed were:

- Satellite data currently archived.
- Future satellite data availability (TIROS-N, GOES, SEASAT, NIMBUS-G).
- User data requirements.

Many helpful suggestions and recommendations were obtained during the Workshop, and more are expected following discussions between attendees and their colleagues. This user input will greatly assist NESS/EDS in formulating their final archival plans for the late 1970's.

Coastal Zone Bibliography Available

"The Coastal Zone—Packaged Literature Search 76-3" is the third in a series of computer-generated bibliographies produced by EDS' Environmental Science Information Center. It contains more than 500 references covering the coastal zone and its management.

Available free, the bibliography may be ordered from: the Library and Informaton Services Division, User Services Branch, D822, WSC-4, 6009 Executive Blvd., Rockville, MD 20852 or by calling (301) 443-8330.

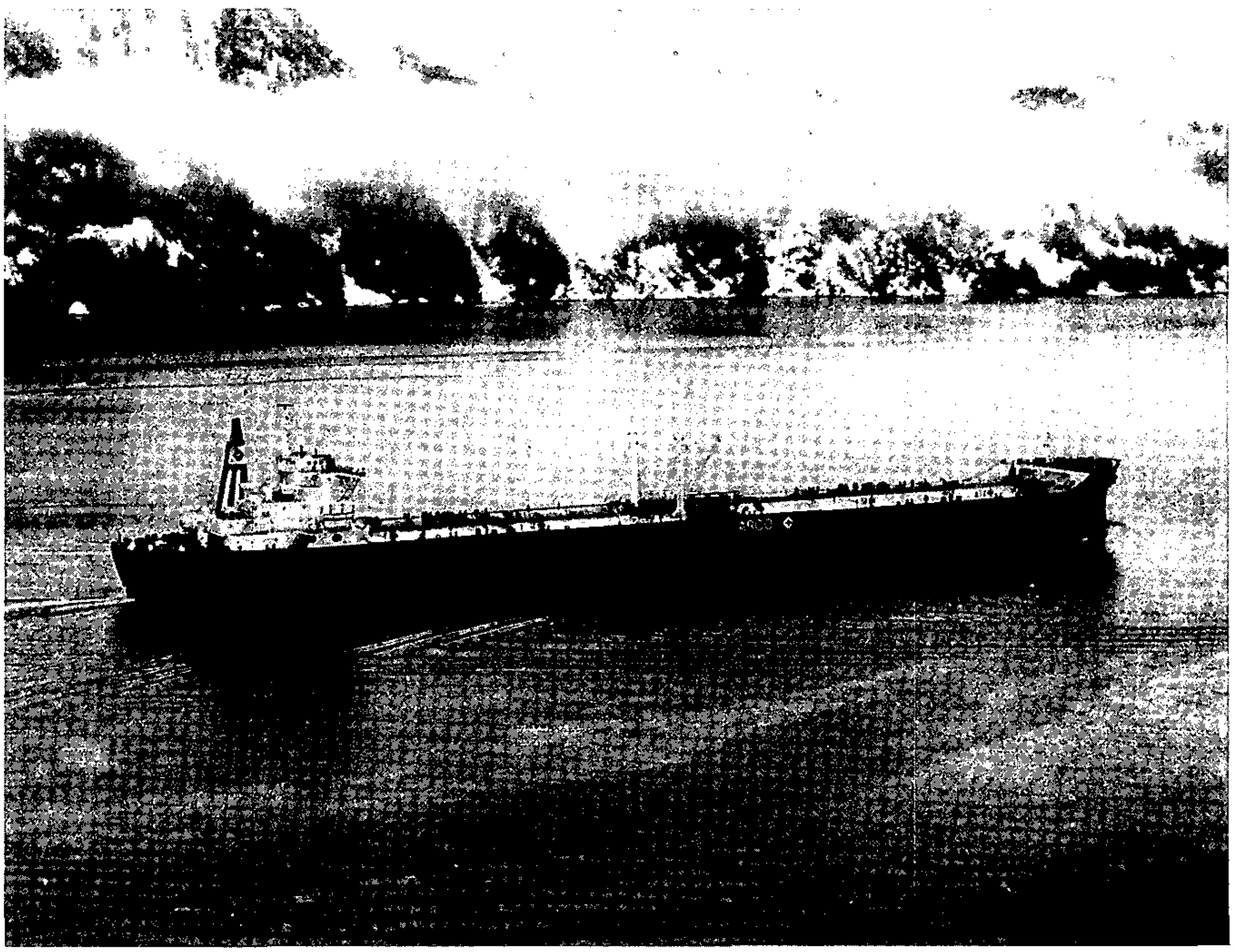
Packaged Literature Search 76-1, "International Policies, Agreements, Law, Regulations, and Cooperation Relating to the Oceans," and 76-2, "Manganese Nodules," also are available free in this series (prepared by Robert Walter). Searches are currently being prepared on oil spills, ocean mining, and weather modification.

Specialized bibliographies also are prepared on request to meet invidual needs. Literature searches of more than 40 different data bases are available through the Oceanic and Atmospheric Scientific Information System (OASIS). The cost to non-NOAA users is determined by the type of search provided and the number and character of the data files searched.

Data For Gulf of Alaska Tanker Trials

Tankers carrying oil over the marine leg of the Trans-Alaskan Pipeline system will have to navigate the often environmentally hostile Gulf of Alaska waters near the terminal at Valdez. The various hazards involved must be evaluated in operations planning for the tanker traffic, to reduce chances of accidents.

In response to a request from a Data Gathering Workshop held in Juneau in January, EDS' National Climatic Center provided the Coast Guard's Vessel Traffic Services at Valdez with detailed local environmental profiles for tanker trials conducted by the *ARCO Fairbanks* in April. These profiles included summaries of wind, waves, visibility, and icing potentials for selected land stations and adjacent waters in the Valdez area. Oil from the Alaska pipeline is expected to begin flowing this month.



The ARCO Fairbanks makes a trial run through the passage to Valdez.

Photo: U.S. Coast Guard

Third Meeting of the US/USSR Joint Committee on Cooperation in World Ocean Studies

The US/USSR Joint Committee on Cooperation in World Ocean Studies held their third meeting in Washington, D.C., April 14-15, 1977. The Joint Committee was formed in accordance with an agreement between the governments of the U.S. and the U.S.S.R. signed in Washington on June 19, 1973.

The agreement covers:

- Large-scale ocean atmosphere interaction, which includes laboratory studies, oceanic experiments, and mathematical modeling of the ocean atmosphere system.
- Ocean currents of planetary scale, as well as other questions of ocean dynamics.
- Geological, geophysical, and geochemical investigations of the floor of the world ocean, including deepsea drilling for scientific purposes.
- Intercalibration and standardization of oceanographic instrumentation and methods.
- Biological productivity of the world ocean, as well as biochemistry of the functioning of individual organisms and whole biological communities in the world ocean..

From the first meeting of the Joint Committee, it was agreed that the data resulting from these program areas be formally exchanged between the Soviet and United States national oceanographic data centers and ultimately provided to the World Data Center (WDC) system for further international exchange. General principles and procedures for the exchange of these oceanographic data and information were developed by a joint US/USSR Group of Experts on Data Exchange during a March 29-April 2, 1976 meeting in Washington. These principles and procedures, as well as the recommendation to continue the Group, received formal approval during the recent third meeting.

During the period April 1977-June 1978, the Group of Experts on Data Exchange plans to:

- Review existing plans for the exchange of data and information within projects under the Agreement and provide guidance where needed.
- Identify centers within each country responsible for nation-to-nation exchange.
- Review existing and proposed international standards for the exchange of data on magnetic tape and amend these, as necessary, for the nation-to-nation exchange of project data.
- Review and amend existing standards for exchange of data on forms not suitable for magnetic tape.
- Initiate development of procedures for the timely exchange of information (including publications) produced by projects under the agreement.
- Conduct a join meeting of the Group of Experts in the U.S.S.R. during late 1977 or early 1978.

Global Marine Life Code

As promised in the September 1976 EDS, copies of a digital marine life code for the world ocean are now available from EDS' National Oceanographic Data Center. The national need for such a code to handle marine organisms in data bases has arisen from the increasing number of scientific investigations of the coastal and outer continental shelf environments related to energy development.

The code, developed for NODC by George Mueller and the Marine Sorting Center of the University of Alaska at Fairbanks, is an expanded version of a coding scheme developed by the Virginia Institute of Marine Science to handle organisms in the Chesapeake Bay. The code is hierarchical from phylum to species, but the taxonomic levels used vary between groups.

Copies of the code can be obtained from:

Elaine Collins
National Oceanographic Data Center
NOAA
Washington, DC 20235

Telephone: (202) 634-7215

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National Oceanic and Atmospheric Administration
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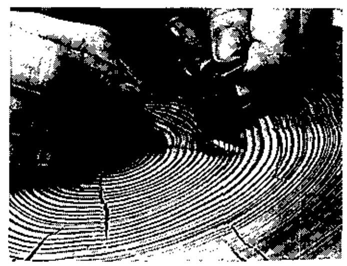
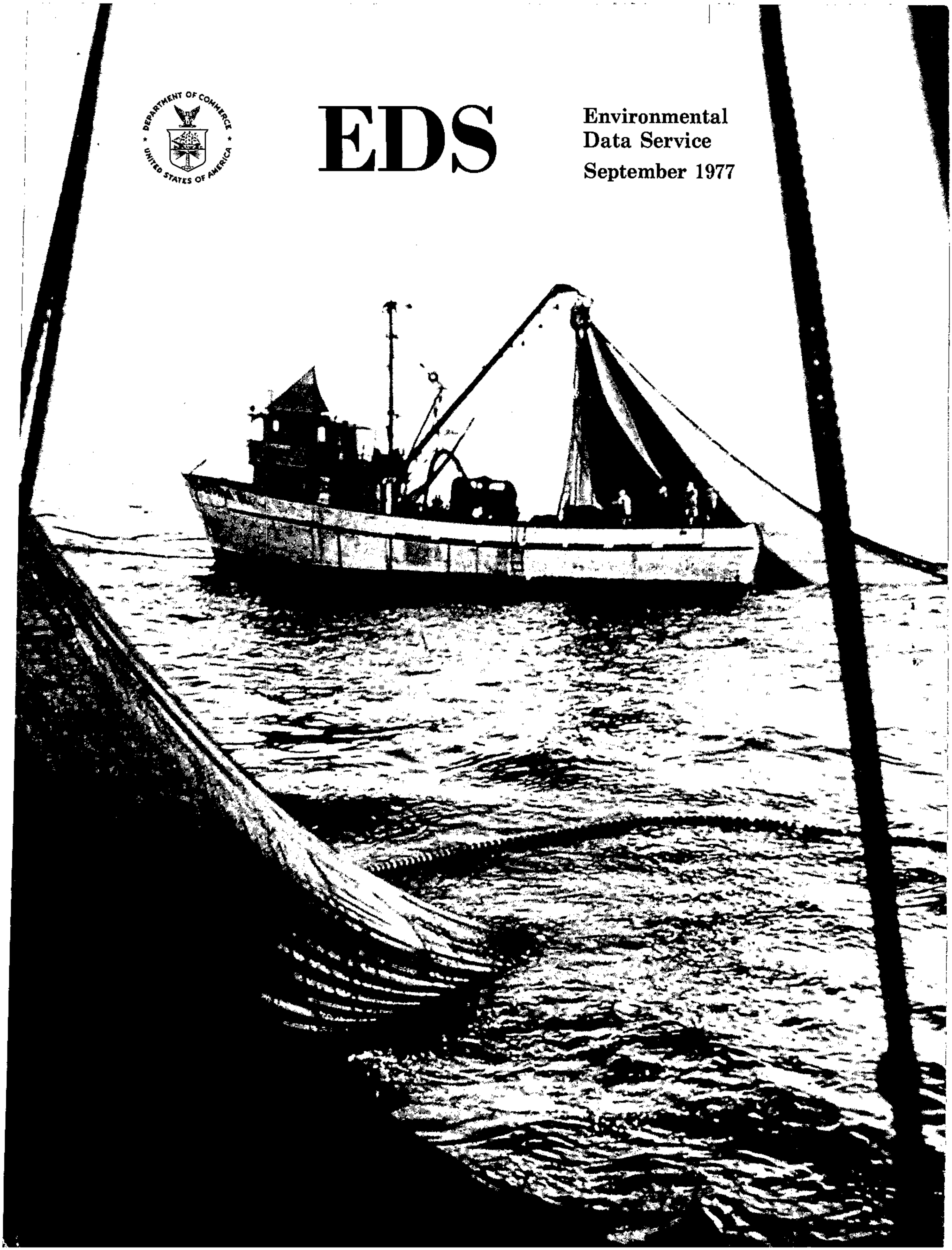


In this issue: The National Water Data Exchange (p.11), tree rings as a record of past climate (p.3), early students of tropical cyclones (p.16), and sunshine and highway construction (p.14).

EDS

Environmental
Data Service
September 1977



EDS

Environmental Data Service
September 1977

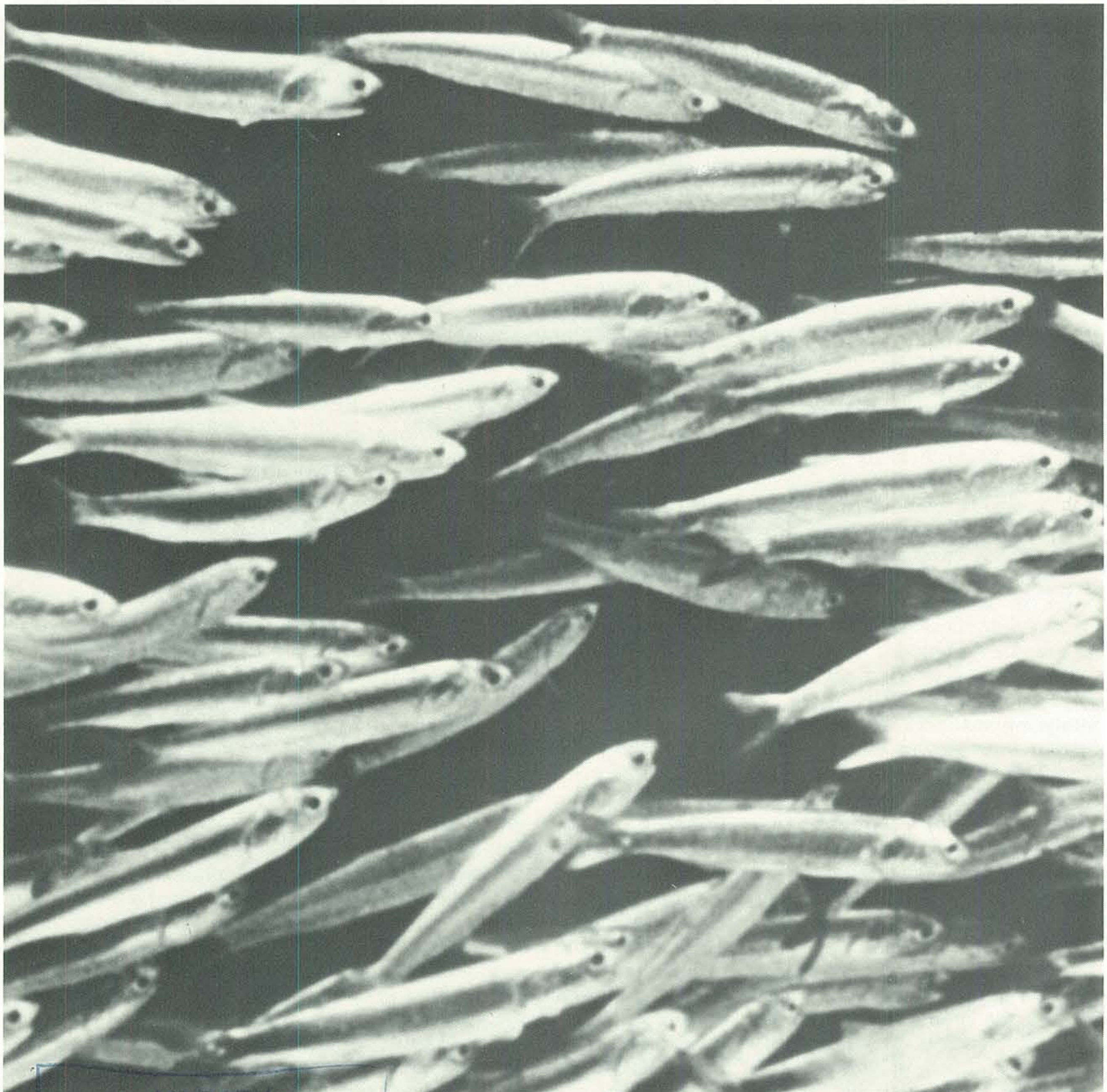
Cover: *Anchovy fishing off the coast of Peru. The article beginning on the opposite page examines the effects of climatic changes on commercial fisheries.*
Photo: C. P. Idyll

EDS is a bimonthly publication designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, and Center for Climatic and Environmental Assessment. In addition, under agreement with the National Academy of Sciences, EDS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 16, 1975; this approval expires June 30, 1978.

Use of Marine Meteorological Observations in Fishery Research and Management

By James H. Johnson, Regional Fisheries Attache, Japan and
Gunter R. Seckel, Chief, Pacific Environmental Group
National Marine Fisheries Service



Resource Category	Potential Increase (millions of tons) 1985	2000
Conventional species	8	14
Unconventional species (krill, squid, etc.)	5	35
Waste elimination (equivalents)	2	15
Total	15	64

Table 1. Opportunities for increased fish and shellfish production, 1985 and 2000 (Alverson, 1975)

Introduction

During the last 20 years there has been a phenomenal growth in world fisheries. Catches (marine and freshwater) rose from 27.6 million metric tons in 1954 to a peak of 70.2 million metric tons in 1971. The collapse of the Peruvian anchoveta fishery caused the subsequent decline to about 65 million metric tons in 1972. The anchoveta catch declined from a peak of 12 million to 2 million metric tons in 1973. This decline was probably caused by a combination of over-fishing and adverse environmental conditions, specifically, the occurrence of El Niño, a weather-related ocean change that visits the coast of Peru at irregular intervals.

Despite the leveling off of the total catch since 1970, there remains opportunity for significant further increases in the supply of protein from the sea. In summarizing the various possibilities, Alverson (1975) estimates that production from the ocean alone could rise from 55 million metric tons in 1973 to about 119 million by the year 2000, an increase of 64 million tons (table 1).

In a world desperately in need of protein, the possibility for increasing marine production cannot be ignored. However, this possibility will be realized only by better management of fishable stocks. Clearly, the collapse of the Peruvian anchoveta fishery points out the need for more efficient fishery management and increased research to better understand the effects of environmental changes on living marine resources.

Despite the large amount of environmental data collected over the past several years in fishery research programs, the most useful information is the marine surface meteorological observations and their historical record. There is no other marine data set that is global in nature and covers such a long period of time. These attributes are precisely what is needed in many kinds of environment-related fishery research.

Relationships established between environmental changes and fish stocks usually are empirical, and the cause-and-effect relationships may not be well understood. Thus, it is possible that the decline in a fishery is due primarily to fishing efforts too heavy for the fish stock to sustain, and the apparent relation to environmental change is only coincidental. The emerging consensus appears to be, however, that declines in many exploited fish stocks are caused by a combination of adverse environmental conditions and heavy fishing pressure. In the following examples we illustrate relationships between changes in some fisheries and environmental indices. The indices were derived from marine surface meteorological observations.

Salmon

A climatic shift occurred in the Bering Sea in the early 1970's which has had a drastic effect on the Alaska salmon fishery and significant effects on other fisheries. The 1973 and 1974 commercial salmon harvests were among the lowest since inception of the salmon fishery in the late 1800's. The low catches are attributed to the effect of the unusually cold years of 1971 and 1972 in the Bering Sea. Ocean sea surface temperatures near the Aleutian Islands in these years were the coldest for at least twenty years. In the winter of 1970-71, Aleutian land stations reported all-time low temperature readings.

The onset in the decline of sea and air temperatures appeared to coincide with an unusual southward penetration of the Arctic ice pack (Kukla and Kukla 1974). Using marine surface meteorological data, McLain and Favorite (1975) related the cold sea temperatures to large changes in North Pacific atmospheric circulation. These changes, producing northerly winds over the eastern Bering Sea, probably displaced the ice pack southward. Severe environmental stresses may have affected salmon survival in all phases of its life history, i.e., in lakes, streams, and the ocean. The severe conditions in the first two habitats appear to have been the cause of most mortality.

Atlantic Menhaden

The Atlantic menhaden at one time constituted the largest U.S. fishery. Recent studies concerning the size of yearly broods in this fishery suggest that annual variations in the surface water drift during the egg and larval stages may have been the predominant cause of variations in year-class size.

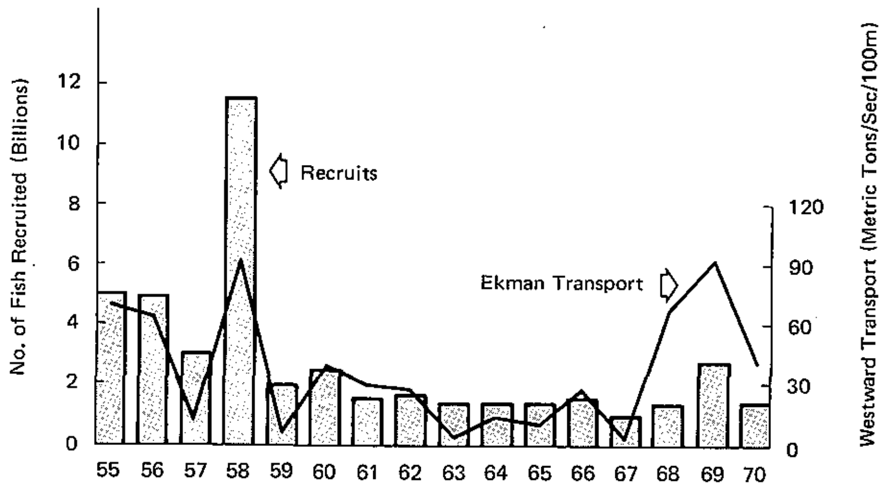


Fig. 1

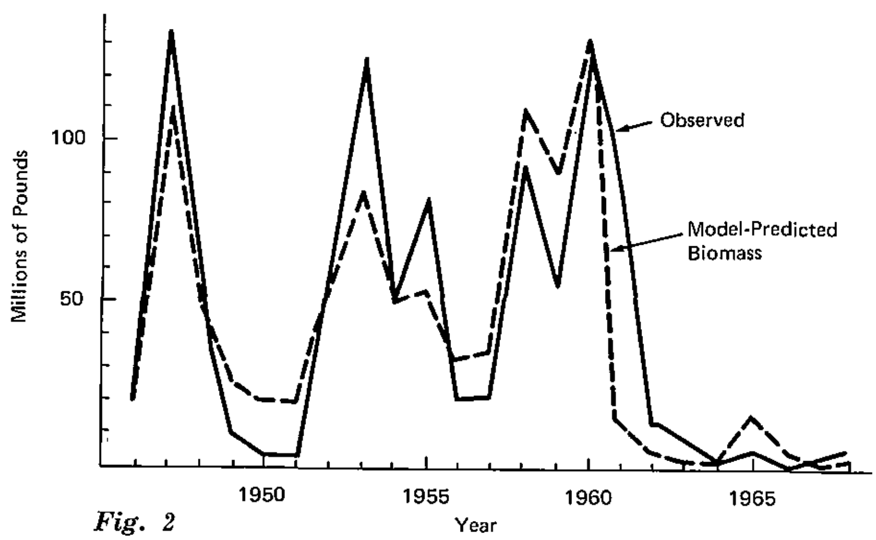


Fig. 2

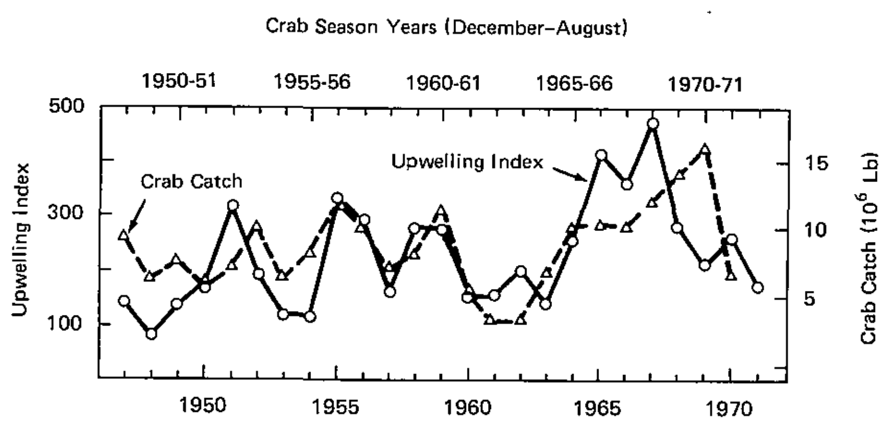


Fig. 3

The composition of the Atlantic menhaden stock obtained yearly since 1955 shows a range in number recruited into the fishery of from 11.5 billion in 1958 to 0.9 billion in 1967. Although some variation in recruitment can be attributed to fluctuation in the size of the spawning stock, Nelson, Ingham, and Schaaf (1976) found that much of this wide range in year-class size was related to an index of surface water drift. Marine surface meteorological observations (wind and atmospheric pressure) were used to calculate an index of surface water drift, commonly called Ekman drift or transport (Bakun, 1973). Figure 1 illustrates the relationship between the magnitude of the westward or onshore drift and the year-class size. The relationship is interpreted to mean that westward surface wind drift favors drift of eggs and larvae from the ocean spawning grounds to the estuarine environment which favors menhaden survival.

Pacific Mackerel

The California fishery for Pacific mackerel is another example of environmental variation during the egg and larval stages affecting the success of the fishery. Fluctuations in year-class size were large before the demise of this fishery in the late 1960's (fig. 2). Parrish (1976) showed that most of the variation

Fig. 1. Atlantic menhaden recruits at age one and east-to-west Ekman transport. (Nelson, Ingham, and Schaaf, 1976.)

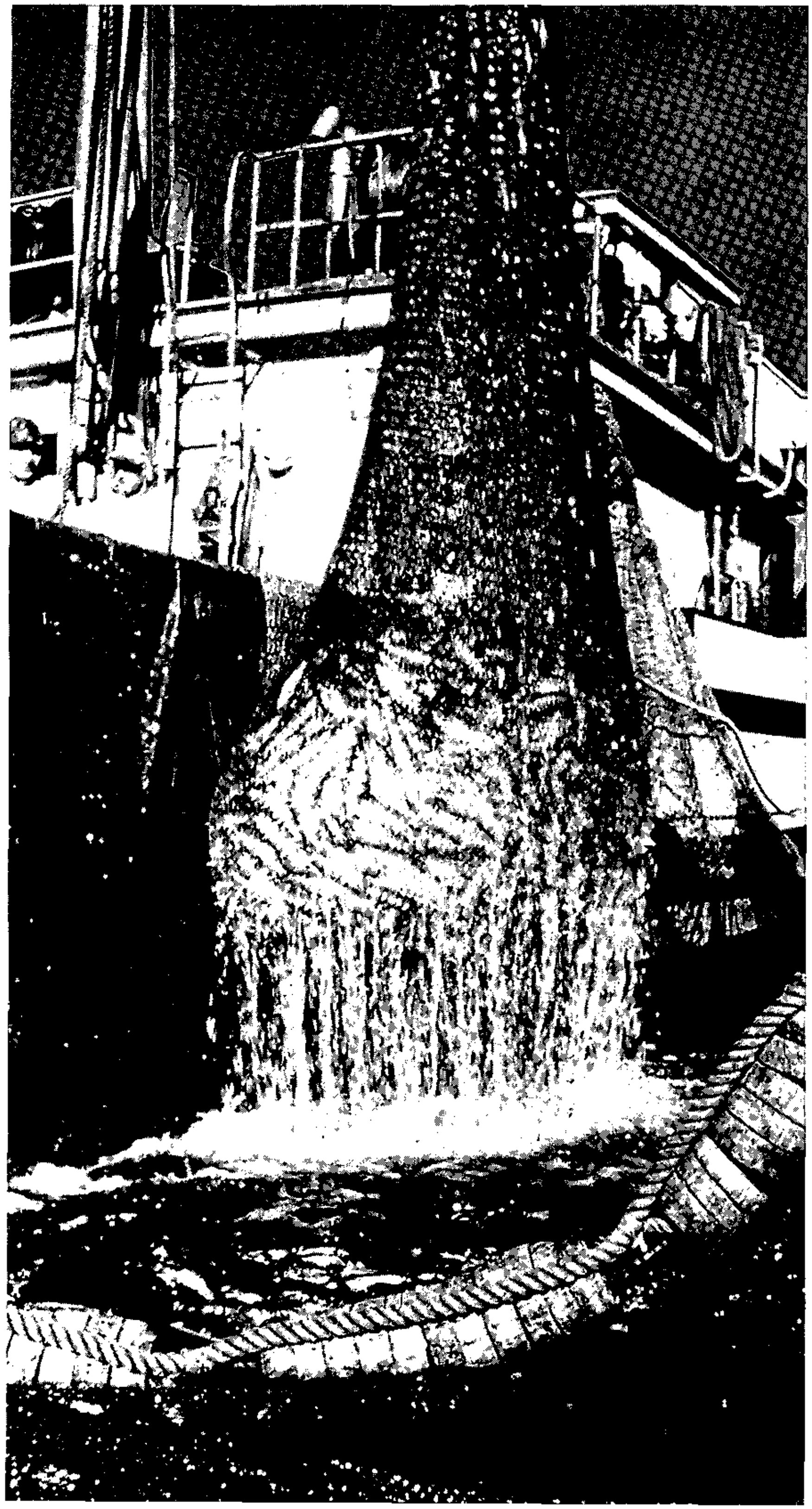
Fig. 2. Year-class size in the California stock of Pacific mackeral. (Parrish, 1976.)

Fig. 3. Upwelling index values versus crab catch in Oregon. Catch lags upwelling by 1.5 years (Peterson, 1973).

in year-class size and, thus, the size of the later fishable population, was related to fluctuations of upwelling and surface water convergence in the spawning grounds of the mackerel. In addition to the observed year-class size, figure 2 also shows the predicted year-class size in a simulation model using these environmental indices. Several years of unfavorable environmental conditions occurring during a period of increased fishing pressure caused the demise of the fishery. Population simulations suggest that the fishery would have partially recovered in the early 1970's if the effect of the environmental conditions had been recognized in time to reduce the fishing pressure before the collapse occurred. Again, indices of upwelling and surface water convergence were calculated from marine surface wind and atmospheric pressure observations (Bakun and Nelson, 1975).

Dungeness Crab
An empirical relationship between the success of the valuable crab fishery off the U.S. west coast and intensity of upwelling has been indicated by Peterson (1973) and Botsford and Wickham (1975). The upwelling index again is that calculated by Bakun (1973) from marine surface observations. The relationship for the period 1948 to 1975 is shown in figure 3, with the crab catch lagging the upwelling index by 1.5 years. The relationship is holding for recent years not shown in the figure. There was anomalously intense upwelling off Northern California in 1974, 1975, and 1976, accompanied by rising crab landings. The 1974-75 landings increased by a factor of more than four, and the 1975-76 landings increased by a factor of more than thirty over the low landings of the 1973-74 season.

Currents and Fish Distributions
Another type of environment-



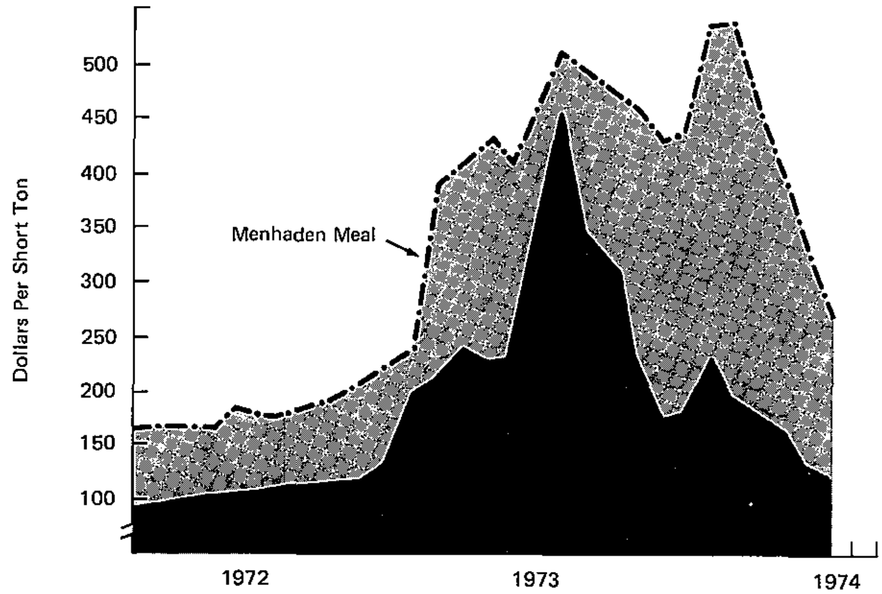


Fig. 4. Changes in monthly prices of menhaden and soybean meal.

fishery relationship concerns ocean currents. Currents can determine the migration paths of fish, as well as concentrate or disperse fish, and so affect their availability to the fisherman. For example, skipjack tuna that are found off Baja California appear one to two years later in the Hawaiian fishery. Seckel (1972) modeled the effect of baroclinic flow and surface wind drift on floating objects that had been distributed meridionally at longitude 120°W. After about two years, these objects were distributed zonally near Hawaii. Marine surface observations were used to calculate the wind-driven surface flow. The work of Meyers (1975) indicated that, in time, it may be possible to use surface observations to estimate the seasonal variability in the baroclinic flow of the Pacific North Equatorial Current. This means that the effect of currents on fish migration can be simulated by using marine surface observations.

El Niño and Air/Sea Interactions

The El Niño off the west coast of South America is a short-term climatic anomaly that has a large effect on the anchoveta fishery. This effect has been widely discussed. Here we would like to point to its tremendous impact on fish meal and soybean meal prices in the United States, which quadrupled shortly after the onset of the 1972 El Niño (fig. 4).

Differences between El Niño and non-El Niño years are reflected in large variations in sea surface temperatures not only along the South American coast in the area of the anchoveta fishery, but over vast areas of the equatorial Pacific. For example, the sea surface temperature in the eastern equatorial Pacific in November 1972, an El Niño year, was up to 5°C (10°F) warmer than in November 1973, a non-El Niño year (fig. 5). These large differences also are reflected in changes in the atmospheric circulation.

Bjerknes (1969) described anomalous conditions in the equatorial Pacific during El Niño years. He related high heat supply in the equatorial Pacific during these years with intensification of the Hadley circulation, increased flux of angular momentum, and intensified mid-latitude westerly and trade winds. He indicated that these teleconnections affect the weather over the North American continent and believed that regular monitoring of the sea surface temperature in the tropical Pacific is indispensable in long-range forecasting for North America. Namias (1972 and other studies) also stressed the importance of the oceans in long-range weather prediction.

Quinn (1972) examined air-sea interactions in the equatorial Pacific and the associated trough and ridge development over the North Pacific and the continental United States. The type of atmospheric circulation that prevails over the eastern part of the United States appears to affect the eastern seaboard shrimp fishery. Williams (1969) has shown that a good fishery tends to follow warm winters along the eastern seaboard and a poor fishery tends to follow cold winters. Johnson and McLain (1975), examining the type of circulation related to warm and cold years, have used marine surface observations to describe the anomalously warm February of 1949 and the anomalously cold February of 1958 along the eastern seaboard (fig. 6). They also identified the types of atmospheric circulation that tend to typify these extreme conditions (fig. 7).

During warm winters, as in 1949, ridge development at the 700 mb level tends to block storms of northern origin. Consequently, air masses of tropical character predominate and water temperatures are warmer. During cold winters, as in 1958, trough development over the eastern United States at the 700-mb level tends to bring cold continental air masses over the southeastern seaboard. Consequently, increased heat loss through evaporation and conduction of sensible heat results in colder water temperature. Thus it

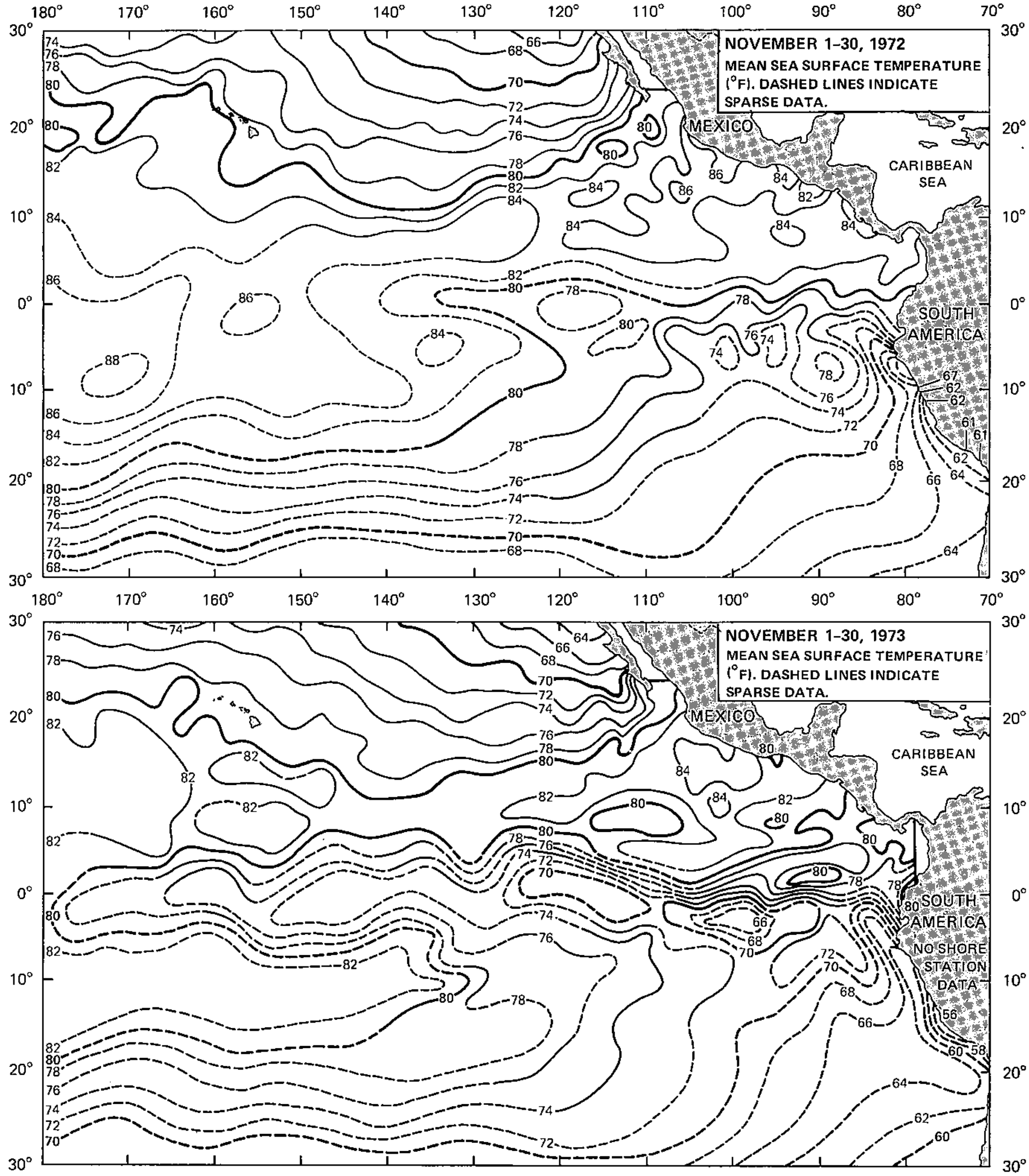


Fig. 5. *Mean sea-surface temperatures, eastern tropical Pacific, November 1972 and 1973. (U.S. National Marine Fisheries Service, 1972, 1973.)*

appears that ridge development in the upper air circulation is more favorable to the shrimp fishery than is development of a trough.

Conclusion

The rising demand for fishery products makes fishery management an increasingly important function. In the past, environmental considerations were not a part of management models. Our illustrations show that this omission can lead to management errors. For example, had the relationship between the Pacific mackerel and the environment been known earlier, correct management procedures could have prevented collapse of the fishery.

An important part of fishery management is prediction of year-class strength. A large year-class, for example, may lead to a large increase in fishing effort, which continues after the year-class has been harvested, leading to over-capitalization and over fishing in subsequent years of reduced stock size. A large year-class, followed by several poor year classes, is potentially disastrous to fish stocks and to the fishing industry. The prediction of environmental changes and their effect on year-class strength, therefore, is a major goal of our research.

In our examples we have tried to point out that relating changes in fisheries with variations in environmental conditions depends upon the availability of long-term marine environmental data series. The only source for such series are the historical files of marine meteorological observations.

Once a fishery-environment relation has been established, current marine meteorological observations become the basis for predictions of fish abundance. Clearly, the World Meteorological Organization's foresight in sponsoring the archival of a vast amount of marine meteorological data and in continuing a strong

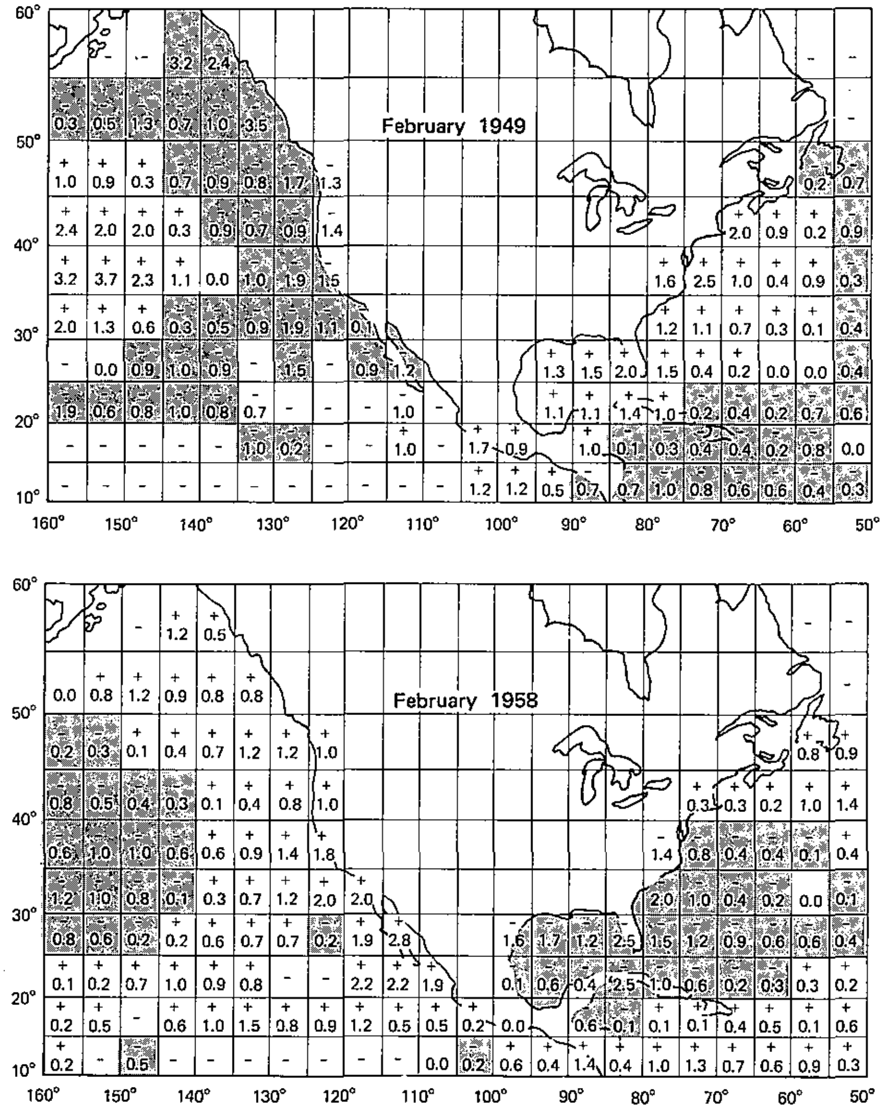
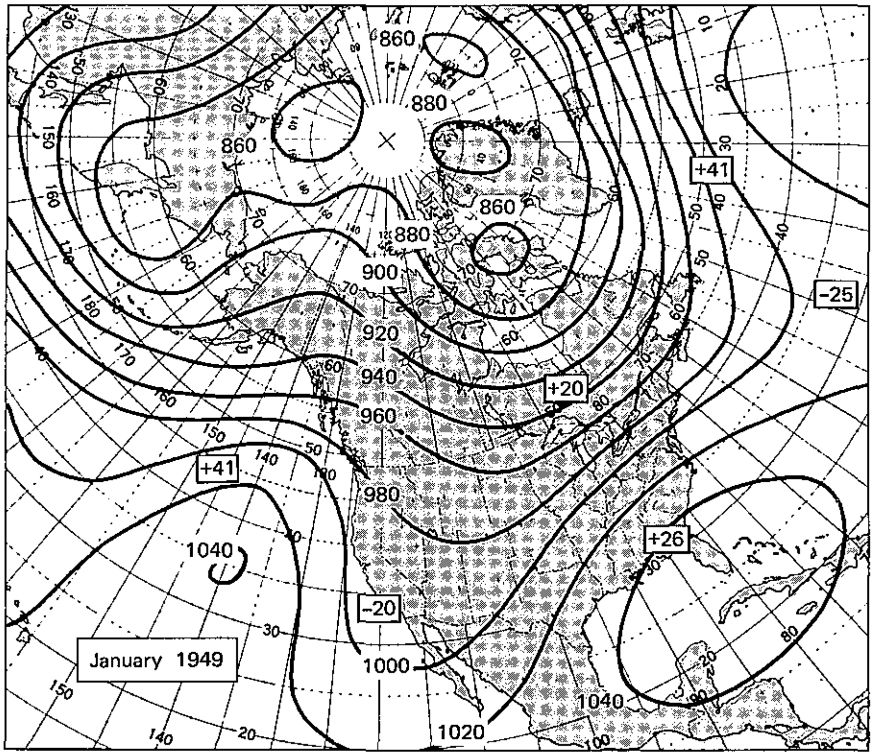
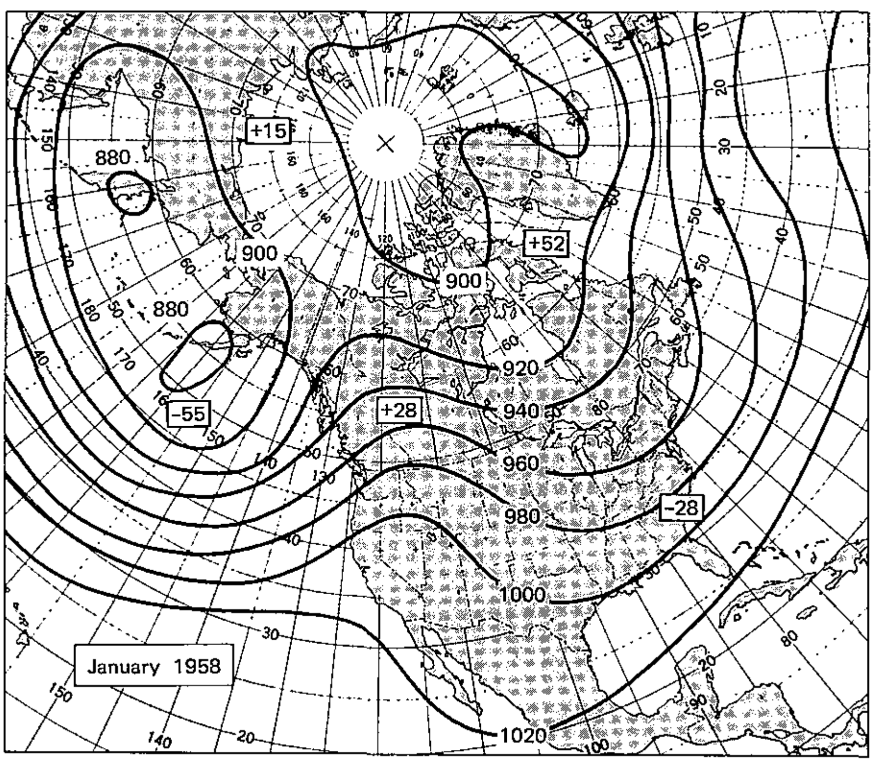


Fig. 6. (Above.) Sea-surface temperature anomalies (°C). Shaded areas are colder than the 20-yr (1948-67) mean. (Johnson and McLain, 1975.)

Fig. 7. (Opposite page.) 700-mb heights and departures from normal (in boxes) in tens of feet. (Johnson and McLain, 1975.)





marine program will have a significant impact on our ability to manage fishery resources and to help feed the hungry of the world.

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Peruvian fishing boats tied up in port during the El Niño of 1972.

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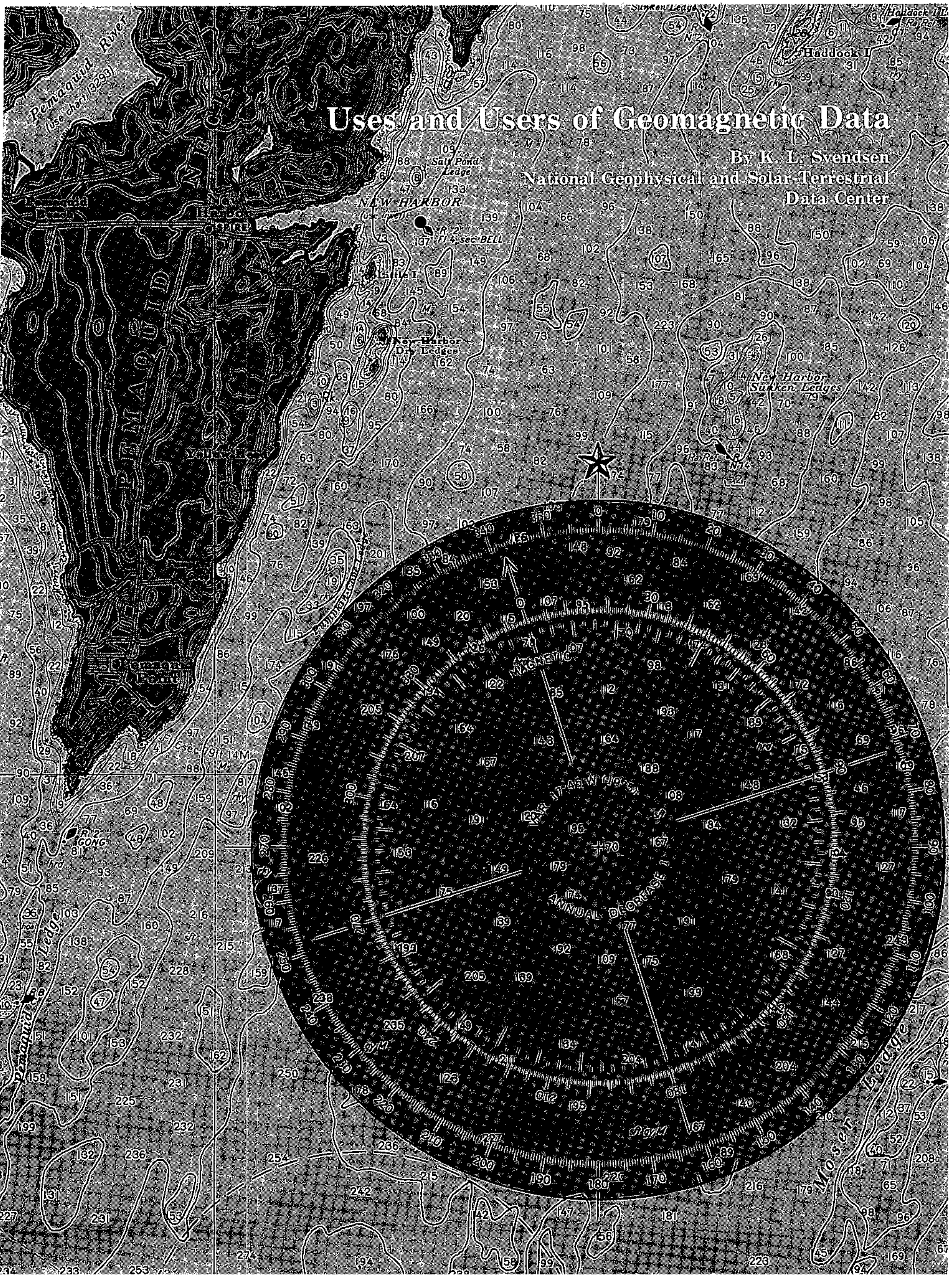
* Presented at the World Meteorological Organization's Technical Conference on the Applications of Marine Meteorology to the High Seas and Coastal Zone Development, 22-26 Nov. 1976, Geneva, Switzerland.

Uses and Users of Geomagnetic Data

By K. L. Svendsen
National Geophysical and Solar-Terrestrial
Data Center



The EDS National Geophysical and Solar-Terrestrial Data Center (NGSDC) in Boulder, Colorado is the central Federal depository for geophysical data acquired in national programs, including geomagnetic data. Following reformatting, quality control, and other required processing, NGSDC makes these data available to users in convenient form.

World Data Centers A (United States) for Solid Earth Geophysics and Solar-Terrestrial Physics are collocated with NGSDC. Having the national and international data services together is a convenient arrangement that permits sharing of facilities and personnel. Other World Data Centers for geomagnetism are located in Denmark, Japan, and the USSR. Identical core collections of data are maintained, with each center providing the other copies of data it alone receives. The multiple center system was designed to facilitate distribution of data to users throughout the world.

In the following discussion, I have not attempted to survey all the uses and users of geomagnetic data. Rather, the statistics apply to NGSDC products and services, with particular attention paid to U.S. data.

Table 1 shows the number of requests for geomagnetic data received by NGSDC during 1976, as well as the types of data requested. The largest customer was NOAA's National Ocean Survey (NOS). The magnetic declination data furnished NOS appear on their nautical and aeronautical charts and are essential for navigation by magnetic compass. Despite more modern navigation methods, every ship and plane still must have a magnetic compass. It is the only method of navigation for most

Data Products and Services Requested	Number of Requests
Compass Roses and Disturbance Notes for NOS Marine Charts	1,180
Publications of AE Indices	882
Observatory Records for Research	421
Data From Field Survey File	149
General Information	126
Observatory Records for Field Corrections	103
Disturbance Data for NOS Aeronautical Charts	54
Mathematical Models	23
Observatory Annual Means	7
Total	2,945

Table 1. Requests for NGSDC geomagnetic data, 1976

Data Types	Number of Requests	Quantity of Data
Magnetograms		
Normal	191	10,955 Station-Months
Rapid-Run	28	298 Station-Months
Hourly Values		
(Film, Paper)	36	3,508 Station-Months
Digital Tapes		
Hourly Values	13	10,958 Station-Months
Other (2.5-min.)	7	429 Station-Months
AE Indices		
Yearbooks	1,071	882 Books
Tapes	21	1,085 Months
Other Indices	83	11,747 Months
Annual Means	7	NA
Miscellaneous		
(Selected Effects, etc.)	9	68 Station-Months

Table 2. Observatory data distributed by NGSDC, 1976

Data Products and Services Requested	Number of Requests
Magnetic Grids	60
File Searches for Disturbance Information	57
Mathematical Models	23
File Searches for Values of Magnetic Elements	20
Magnetic Station Descriptions	10

Table 3. Field survey data distributed by NGSDC, 1976

Uses	Number of Requests
Research (Including AE)	1,264
Navigation (Air, Marine)	1,249
Surveying	166
Education, Public Service	132
Unknown	87
Exploration, Mining	37
Energy, Environment	10

Table 4. Uses of NGSDC geomagnetic data, 1976

User Categories	Number of Requests
NOAA (Mostly Charting)	1,328
Foreign	564
Academia	402
General Public	231
Other Federal Government	230
Industry	167
State and Local Government	23

Table 5. Users of NGSDC geomagnetic data, 1976

small ships and planes, and serves as a backup where other systems are used.

We have no way of knowing how many users of NOS charts use the magnetic information, but we do know that over two million charts are sold by NOS each year. Considering the entire Government's output, probably 50 million charts are distributed each year, all containing magnetic information.

Considering most of the other items in the table, we know that a piece of data or a publication sent to a customer often is used by more persons than the recipient. In a survey made to determine the uses of one type of publication, for example, we found that, on the average, each one distributed had as many as five users.

Another indication of the value of geomagnetic data is their use in national and international programs. The present network of U.S. observatories operated by the Geological Survey, for example, is vital to the multimillion-dollar International Magnetospheric Study (IMS), 1976-79. More than 40 countries are participating and are establishing some 75 new (albeit temporary) observatories. Another indicator is the proposed multimillion-dollar project for production of a National Magnetic Anomaly Map, to help locate new sources of minerals and petroleum. This project will need all the geomagnetic data it can get.

What kinds of geomagnetic data are useful? There are two general classes of data, observatory and field survey. Observatory data may be broken into subgroups, as shown in table 2, where we also have attempted to quantify the interest in each. (Annual means are part of the general data file and are distributed automatically with other data sets, so their use cannot be measured; subjectively, we feel it is considerable.)

As the table indicates, the popular data format from the individual observatory is the daily magnetogram. Because most orders for magnetograms are for records of the last two years, we are always urging observatories to get their microfilmed records to us promptly. We have standing orders for copies of magnetograms as soon as available. Some are for one observatory only; some are for as many as 11 observatories. Though most of our collection starts with the International Geophysical Year (1957-58), we have some magnetograms dating back to 1901, and we do get occasional requests for the older records. Most of our orders, however, are for copies of magnetograms recorded in the last ten years.

About 35% of the copies furnished to users are for U.S. observatories. Since the ten U.S. stations constitute only about 5% of the worldwide network, this is testimony to the particular usefulness of U.S. data. The average annual number of requests for each observatory is about 35; the average order is for about 125 magnetograms. For U.S. stations we estimate the average number of requests for each magnetogram is about 100; if we consider only the more popular stations, the number is about 150. These figures are based on actual orders; they do not take into account the fact that purchased copies are often passed around for use by others. Moreover, some copies are distributed by the observatories before the originals get to NGSDC, and copies also are distributed by foreign data centers. It is entirely possible that the number of users of some individual magnetograms, particularly at times of interesting magnetic events, may run into the many hundreds.

Impressive as this may be, it still does not tell the whole story. Some uses of the data are very important, but are difficult to quantify. One of these is our internal use of the magnetograms from College and Barrow. These two observatories are part of an auroral zone network of 11 select stations that the World Data Center uses in compilation of the auroral electrojet (AE) indices. These indices are important for the interpretation of other geophysical phenomena, and there are hundreds of investigators worldwide who impatiently await the derivation of these indices each year. Other internationally sponsored indices are derived utilizing data from Fredericksburg, Honolulu, San Juan, Sitka, and Tuscon.

Another important use is that made by NOAA's Space Environment Laboratory and the U.S. Air Force's Global Weather Central. These laboratories derive daily predictions of magnetic activity (useful in short wave communications), electrical power transmission, air navigation over the poles, and satellite communications. The data that go into these predictions include the magnetic activity from Boulder, College, and Fredericksburg.

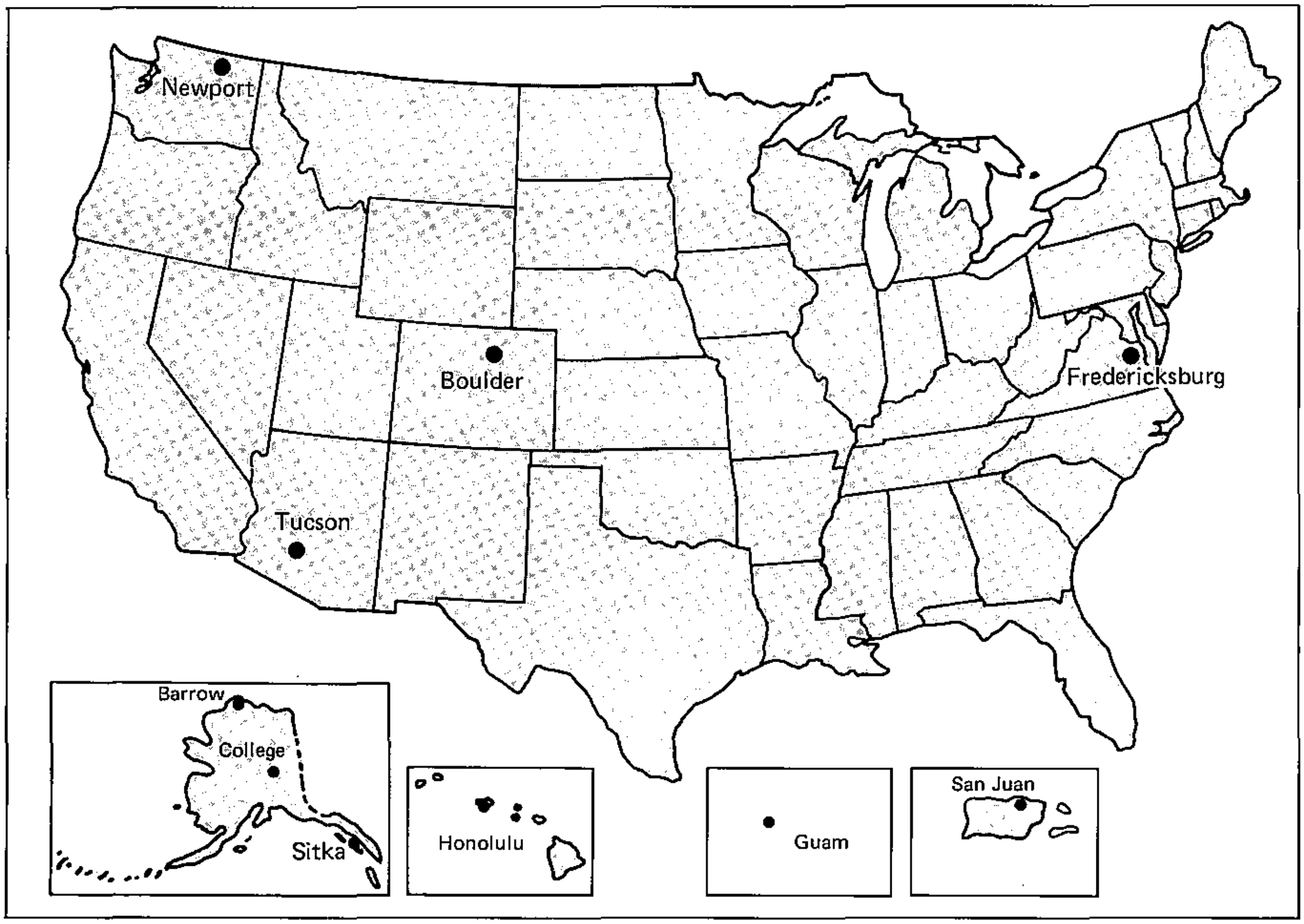
Table 3 shows an accounting for field survey data. Here we are not usually concerned with individual pieces of data such as those of observatories. Rather, magnetic values observed by field parties are added to the large, general survey file, after which some analysis is performed. Derived values are then extracted from the analyzed data set.

What are the uses of geomagnetic data? Many of our customers, particularly those in the research area, do not tell us what they want the data for, so for many requests we have had to guess the type of use from the name of the organization. We have adopted some broad categories, shown in table 4. There are, of course, other known uses, such as communications, which do not happen to show in this set of requests. (NGSDC also receives hundreds of requests for *marine* geomagnetic data for exploration purposes. Marine data have not been considered in this study.)

Who are the users? For simplicity we have grouped them as shown in table 5. As the figures show, we have a large number of foreign customers. This includes users in other parts of the Americas who would naturally turn to the collocated World Data Center.

What do the above statistics mean? They mean that various segments of our society need the magnetic data generated by USGS and other agencies and archived and maintained by NGSDC. We already have mentioned charting needs, which is a matter of safety of air and marine navigation. We have not mentioned military needs, but we have been told many times by military authorities that up-to-date information on the behavior of the magnetic field is essential to their activities.

The statistcs mean that magnetic data are needed for relocation of property corners and boundaries in areas where the original surveys were made using magnetic compasses. To meet this need, we must maintain historical summaries of magnetic data and keep them up-to-date. Often there are disputes over property boundaries, and the data furnished are used in court. We provide certified copies of data for these purposes.



U.S. magnetic observatories

They mean that the mathematical field models and the observatory monitors are important to the geophysical exploration community. For proper interpretation of magnetic survey profiles, the main magnetic field must be removed, and this depends upon a smoothed model developed from the file of observations. Moreover, the importance of knowledge of the secular change in the model has recently been demonstrated by users of the International Geomagnetic Reference Field (IGRF), an internationally agreed, highly smoothed, mathematical model of the Earth's magnetic field. This knowledge comes from observatory and repeat survey results.

They mean that the geophysical research community is heavily dependent upon the records in NGSDC (and the World Data Center). Scientists working in space programs and, in particular, the current International Magnetospheric Study, are primary users. The various geophysical disciplines are interdependent and it is essential that records of the changes in the geomagnetic field be monitored to supply one of the parameters. Because many studies require long term, continuous recordings from one location, data from an old observatory such as Sitka (which began operation in 1902) are of special value.

As accustomed as we are to big orders for magnetograms and digital records, we can still be impressed. Recently, we filled one order from Italy for 17,000 station-months (or 172 magnetic tapes) of digital values. It came too late to be included in this 1976 count of data requests.

Using Interactive Graphics to Edit Scientific Data

By Calvin E. Anderson and Raymond Crayton
Center for Experiment Design and Data Analysis

Introduction

In a general sense, data editing consists basically of reviewing data to detect suspicious values. One of the capabilities now available to the scientific community for data editing is a collection of electronics equipment called interactive graphics (IAG). This equipment provides nearly instantaneous display of data points on a color cathode ray tube (CRT) and special means for changing these data values rapidly by manual, real-time entry. Recently, programmers at the EDS Center for Experiment Design and Data Analysis (CEDDA) used this technology to develop a technique for automatically editing scientific data.

One of the greatest advantages of this approach is that data changes are made by a few simple keyboard commands. This eliminates the need for coding, punching cards, generating new data tapes, developing microfilm, etc. Of paramount importance is the fact that by this method a much higher quality data set than usual can be made available to the research community.

The IAG equipment was used to edit high resolution meteorological data collected during the Global Atmospheric Research Program's (GARP) Atlantic Tropical Experiment (GATE) during the summer of 1974 off the West coast of Africa near Dakar, Senegal. The various data subsystems involved collected millions of unprocessed scientific observations on magnetic tape, plus supplementary logs, strip charts, optical mark sense cards, and calibration data. Data from the main ship array, which was manned by U.S. ships, were shipped to the CEDDA, the National Processing Center for GATE Ship Systems, for conversion to scientific units, editing, and validating prior to archival in World Data Center-A.

Two surface data sets are of interest here. One is the data set acquired by sensors mounted on a boom about 10 m above the ocean and about 10 m in front of each ship's bow. Data from continuously recording wind sensors mounted near the top of the ships' mast also were included in this set. These data initially were recorded at a sample rate of two per second. From these high resolution samples, CEDDA computed data sets of 4-second and longer period averages. The other data set of interest is the GATE World Meteorological Organization (WMO) hourly surface (marine) observations that were manually recorded by shipboard personnel on the bridge of each vessel.

Data Editing

There are at least two philosophies of data editing. One stresses that the original data should never be modified and that erroneous or suspicious values should be indicated by a quality code number. The second stresses that edited data should be error free and, to provide continuity, erroneous or missing data should be replaced by reasonable estimates. To accomodate both philosophies, two data sets are made available to data users by CEDDA's IAG system; one, a copy of the original data, plus quality code numbers; and two, a copy of edited data and quality code numbers.

Boom 4-second data from the main GATE array were edited by the traditional manual techniques. Near the completion of this task however, CEDDA was given the job of editing the bridge hourly surface observations, and other data sets, from these ships. CEDDA scientists decided to use its newly developed IAG editing system to accomplish this new task. Thus, hourly 10-minute averages were computed from the edited boom 4-second data already available and compared with the bridge observations as a means of quality control and validation.

There are two modes for reviewing data with the IAG system. One is to review one block (picture) at a time, whereby up to three days of hourly data (73 points) can be displayed. The second mode is to "scroll" the data, whereby data points continuously move across the color CRT screen at a rate of 107 increments (one screen width) of time per 15 seconds. Scrolling is usually employed when the data are determined to be of high quality, thus requiring few interruptions for corrections.

To complete the editing process, one must be able to change questionable or obviously erroneous values and also provide values for missing data. This can be accomplished in CEDDA's IAG system by the use of an interrupt device that inserts new values into a given data set. With this device, point values can be replaced by linearly interpolated values, assigned values, or inserted values from other data sets.

Examples

Selected data editing cases are presented in figures 1 and 2 to demonstrate some of the main features of the IAG edit program and some of the problems encountered by the analyst while editing data.

Figure 1 shows bridge and boom hourly IAG sea level pressure plots for the NOAA ship *Researcher.* These values are typical of a tropical data set in that they display a strong semidiurnal pressure oscillation and small perturbations with periods of a few hours. In editing a data set, small perturbations are hard to distinguish from errors unless a comparison data set can be examined. One such case appears on July 7, where both bridge and boom data support a slight pressure drop at 2200 GMT. Also in this figure, a questionable data point (July 6 at 1200 GMT) has been replaced by a linearly interpolated value.

There are some problems that cannot be readily corrected by any editing technique. One of these is heating of the ship's deck by solar radiation. This phenomenon is well demonstrated in figure 2 by the IAG plot of bridge and boom hourly dry-bulb temperatures from NOAA's ship *Researcher.* The shaded areas show that each day the bridge temperatures exceeded the boom temperatures by about 2°C during the daylight hours. These bridge values were thus considered suspect and quality coded accordingly.

Conclusions

CEDDA's technique for automatic data editing shows that the technology and methodology exist to improve on the tedious, time consuming, error prone, and extra step activities required to manually edit data. For example, manual editing steps that require several

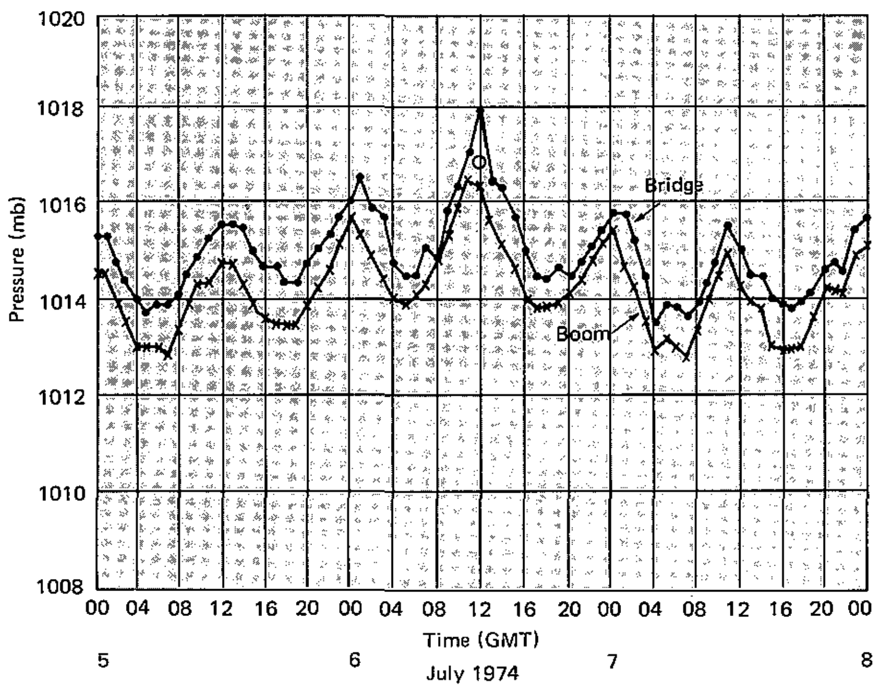


Fig. 1. (Top.) IAG plot of atmospheric station pressure values from the NOAA Ship Researcher. *Open circle on Bridge curve (July 6, 1200) GMT indicates a linearly interpolated point.*

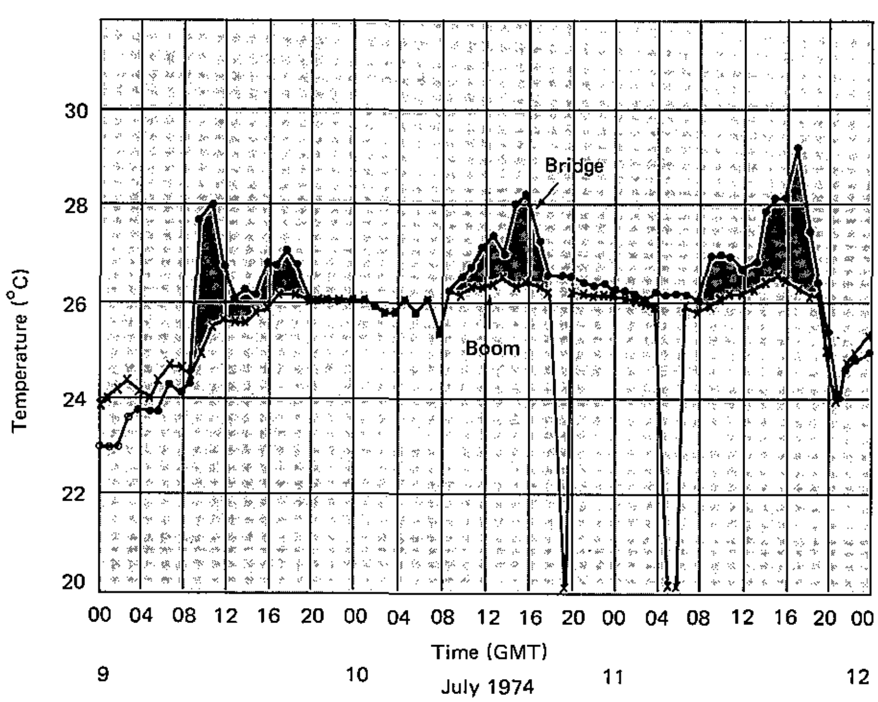


Fig. 2. (Left.) IAG plots of surface dry-bulb temperature values from the Researcher. *Shaded areas indicate periods of excessive shipboard heating due to solar radiation.*

hours to select times, code and punch changes, and prepare for a computer run are replaced by a procedure requiring only a few seconds to position a cursor and press a button. From a manpower point of view, several technicians are replaced by one analyst.

In terms of computer products, dozens of boxes of computer listings and hundreds of reels of microfilm are replaced by almost instantaneous displays, as needed, on a color CRT screen. Also, hundreds of intermediate stage magnetic tapes are replaced by a disc pack. Generally speaking, this IAG approach makes data editing more humanly tolerable, more accurate, faster, and less costly.

An added advantage of the IAG data editing technique is its potential as an analysis and research tool. For example, by displaying the pertinent combination of parameters, one can almost recreate squalls and other meteorological phenomena and study them nearly as they occurred. In many cases the capability to make comparisons provides reasons to accept rapidly changing values or other features one is not accustomed to seeing. While editing the bridge data, for example, the analyst frequently found that enough information was available to observe, discuss, and question the physical processes that may have occurred.

Above: Author Ray Crayton displays fig. 1 on CEDDA's IAG screen.

Acknowledgements
The development of the design, specifications, and techniques for CEDDA's IAG editing program was a joint effort by the authors and P. Sabol under the guidance of W. Seguin. Applications software design and programming were performed by the co-author, R. Crayton. K. Kidwell assisted in preparing the illustrations and assisted in editing the data. W. Seguin's encouragement to write this article and his helpful suggestions are greatly appreciated.

Visit by Soviet Scientists Should Improve International Data Exchange

By A. H. Shapley, Director
National Geophysical and Solar-Terrestrial Data Center

In May and June, after several years of planning, five scientists representing Academia Nauk (The Soviet Academy of Sciences) spent 4 weeks in the United States visiting and working at the several components of World Data Center A and associated U.S. national science centers. This visit was a significant step forward in efforts to improve the effectiveness of international data exchange in the environmental sciences.

The Soviet scientists represented World Data Center B; two were full time staff workers. This was not the first meeting between representatives or staff of these World Data Centers, established during the International Geophysical Year (IGY) 1957-1958. Almost all such previous meetings, however, were brief visits of opportunity—when scientists involved in data management, or data center staff, were passing through on other business. Such short visits have helped resolve specific questions and have provided opportunities to obtain an overview of facilities, but the 1977 working visit allowed enough time for discussion of many details with the people actually doing the

Above: Russian visitors Kharin, and Tiupkin (left) and Kotliakov (far right) in a working session with U.S. scientists in Boulder. Right: Visitors Dreyer and Powsner (left and center) relax during a coffee break.

The World Data Center System

The general mechanisms for data exchange through the World Data Center (WDC) system were laid down for the International Geophysical Year (IGY) Program, 1957-58, and continue virtually unchanged today.

The individual WDC's were designated by the International Council of Scientific Unions (ICSU), acting on offers from national bodies (Academies). For reasons of safety of the data collections and the convenience of data contributors and users, three duplicate WDC's in different parts of the world were designated for most disciplines, with at least two for all disciplines. The WDC's, though operated with national funds, agree to follow ICSU principles and guidelines.

WDC-A centers are located in the United States, WDC-B centers are in the USSR, and WDC-C centers for various disciplines are in different countries—Belgium, Czechoslovakia, Denmark, France, Germany, India, Italy, Japan, Sweden, Switzerland, and the United Kingdom.

The type and quantity of data and, in many cases, the formats, are detailed in data exchange recommendations compiled by ICSU scientific organizations (unions, associations, committees) and relevant intergovernmental bodies; the recommendations are collected in a publication, *Guide of International Data Exchange Through World Data Centers,* issued by the ICSU Panel on WDC's.

The ICSU *Guide* calls for data to be sent by the observer either to all of the WDC's for that discipline or to only one of them; in the latter case, the WDC receiving the data is to send copies to the others or at least make it available upon request. In this way the core data collection is available at all relevant WDC's; all the rest of the data are available on request through any of the WDC's. In general, data contributors are entitled to an equivalent amount of data without cost; other data are to be made available at no more than the copying cost. Participation in the WDC system is fully voluntary, but the cooperation of the scientific community has been remarkable.

In the United States, WDC-A centers have been collocated with corresponding national centers. This positioning simplifies carrying out another recommendation in the ICSU *Guide*; namely, that WDC's will undertake to obtain for requesters data not specifically included in the WDC archives. WDC-B and WDC-C centers also respond to such requests.

WDC-B services about 10,000 requests per year, and the WDC-A level of activity is about the same. Some of the WDC-C centers are proportionately active, but many concentrate on subsets of data for particular disciplines and on data processing or summarization.

The number of user requests is not necessarily the most meaningful measure of the value of the WDC system of centralized sources for international data. What if one had to write to the 35 solar flare patrol stations around the world every time one wanted data on a particular flare? Or to 150 ionospheric sounding stations to know what the electron density of the F2 layer was at 1300 UT on a given day? Or to 100 oceanographic laboratories to find out if they had cruise data near the Galapagos Islands?

work and in-depth observation of techniques and procedures.

The leader of the WDC-B delegation was Vladimir Kotliakov, a distinguished Russian glaciologist, who is a Corresponding Member of the USSR Academy of Sciences. He was assisted by Dr. Artyom Powsner, Secretary of the Soviet Geophysical Committee, which oversees the activities of World Data Center B and operates WDC-B2, which deals with solar-terrestrial and most solid earth data. The other component of the center, WDC-B1, is operated by the hydrometeorological department and covers meteorology, oceanography, and related disciplines, including glaciology, Dr. Kotliakov's speciality. The other visiting scientists were Dr. Zh. Kharin, Deputy Director of WDC-B2; Dr. Ye. Tiupkin, who is head of the WDC-B2 mathematical and computer group; and Dr. Natalia Dreyer, a hydrologist experienced in data matters.

The visit was made in response to a 1972 recommendation of the International Council of Scientific Unions (ICSU) Panel on World Data Centers that was endorsed by ICSU itself. The recommendation was followed by an exchange of letters between the Presidents of the

U.S. and USSR Academies of Science and by the inclusion of the visit in the formal exchange plans of the two Academies. U.S. arrangements were the responsibility of Dr. P. J. Hart, Secretary of the Geophysical Research Board of the National Academy of Sciences and Director of WDC-A.

The WDC-A component centers which the Russian delegation visited are located in or near three cities—Washington, D.C.; Asheville, N.C.; and Boulder, Colo. WDC-A subcenters for Oceanography, Rockets and Satellites, and Rotation of the Earth are in the Washington area; the WDC-A subcenter for Meteorology and Nuclear Radiation (atmospheric) is in Asheville. Boulder is the location of the WDC-A subcenters for Solar-Terrestrial Physics, Solid Earth Geophysics, and Glaciology. The Boulder and Asheville centers, as well as WDC-Oceanography, are operated by NOAA's Environmental Data Service. (The University of Colorado operates WDC-A Glaciology under contract to EDS.) Drs. Kotliakov and Dreyer also visited the key glaciological activity of the U.S. Geological Survey in Takoma, Wash., the former site of WDC-A Glaciology, to work on an international data compilation project concerning snow and ice.

The three main themes for the visit were to: (1) share experience on detailed procedures for data acquisition, processing, archiving, and dissemination; (2) agree on formats and other particulars to enhance the exchange of data, particularly in machine readable form; (3) share information on and experience with equipment used in all aspects of the data service function. A great deal of progress was made in all three areas, and several pages of agreements were put into the record.

Of special interest were the very detailed discussions and written understandings regarding machine-readable data. This bodes well for the future, as data from modern sensors, especially from the newer, international data-intensive programs, such as the International Magnetospheric Study, flow into the WDC's in great quantity. Problems of compatibility of data from different computers have always existed. Incompatibility causes problems even when data are exchanged among centers and institutions in the United States, but difficulties are amplified when centers try to cooperate internationally. The USSR computer at WDC-B2 is not compatible with U.S. computers, but WDC-B2 has limited time access to another computer in Moscow which, in general, is compatible. Shortly before the visit of the WDC-B scientists, each center had successfully read pilot tapes from the other, so the discussions during the visit were conducted with this background of mutual experience.

The timing of the exchange visit was influenced by plans to relocate and re-equip WDC-B at a central location in Moscow, including, it is hoped, acquisition of a computer compatible with those in the United States. To the extent possible, there also will be an attempt to achieve compatibility in copying, microform, and other data handling equipment. The WDC-B scientists now have seen the equipment used or available in the U.S. and have had opportunities to use many pieces themselves. In the long run, this experience will reduce the reformatting effort required for data exchanged between the centers and improve services to users in the many countries served by WDC-A and WDC-B.

One of the fruits of the WDC-A/B exchange visit was the sharing of experiences and plans to communicate on data exchange matters with the various specialized international scientific committees that influence observing programs. One thing the two groups realized was that there is a need to constantly renew information about the WDC mechanism for scientific leaders in the various disciplines and countries, particularly developing countries. The older scientists, many of them veterans of the IGY, are quite familiar with the WDC's, but the turnover of potential users and contributors is perhaps 5% per year. Since it has been almost 5 years since the last mass mailing of the *ICSU Guide to International Data Exchange Through World Data Centers*, almost a quarter of the present scientific community may not have heard directly about the WDC system. A number of ways the WDC's themselves could help in renewing such information for the user community were discussed.

It was generally agreed that this should be only the first working visit of this kind. A reciprocal visit of WDC-A workers to WDC-B should be made at an appropriate time in the planned evolution of WDC-B activity. It was also agreed that there is a need for more specialized working visits on data-related activities and that visits of opportunity would continue to be encouraged, involving not only WDC-A and B, but also the various WDC-C centers, located in various countries.

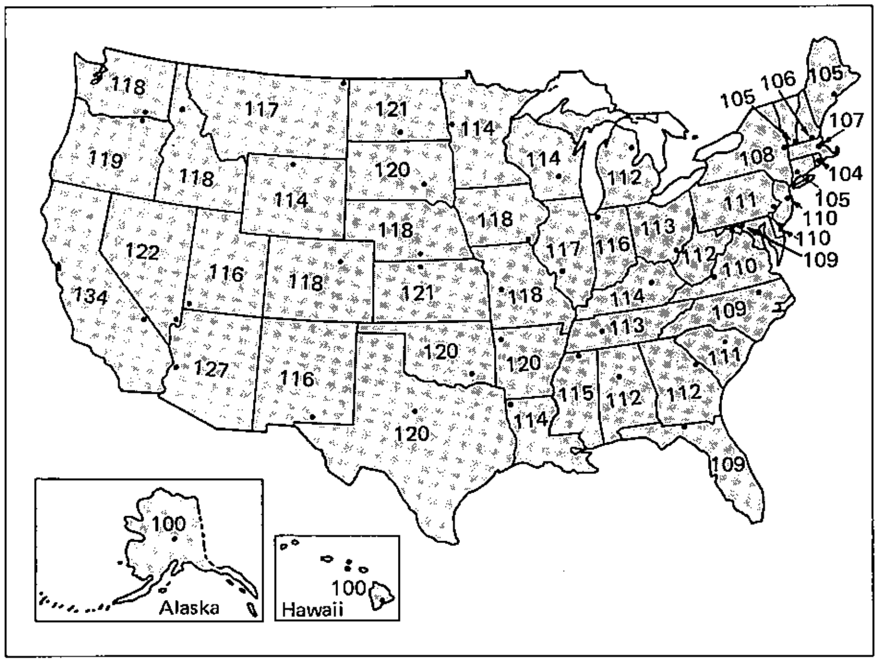
At the concluding session in Boulder, which included several of the members of the U.S. National Academy advisory committee concerned with the WDC's, it generally was agreed that the visit had inaugurated a new era in cooperation in the data service activities of the two countries. This cooperation will benefit the entire community of WDC users.

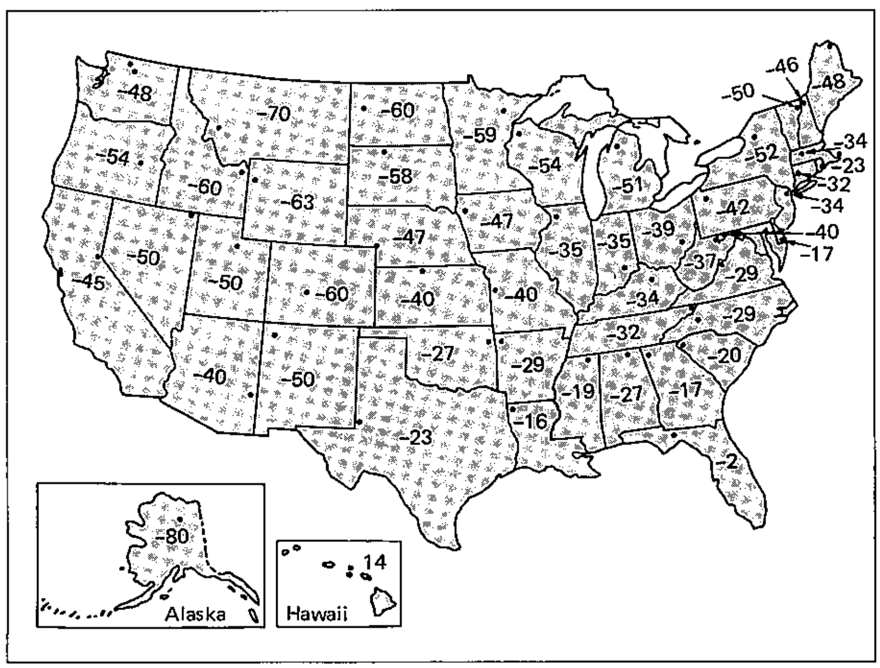
U.S. Temperature Extremes Summary

The highest temperature ever officially observed in the United States was 134° Fahrenheit at Greenland Ranch, Calif. The lowest, -79.8°F, was observed at Prospect Creek Camp in the mountains of northern Alaska. These highest and lowest temperature statistics and those for the remaining 49 states are listed in the recently revised publication, *Temperature Extremes in the United States.*

Published by EDS' National Climatic Center, the booklet contains updated tables listing by State the extreme temperatures, date they occurred, and station name and elevation. The recorded temperature extremes depend on several factors: elevation, latitude, condition of the earth's surface, local effects of terrain, density of observational network, and length of observational record.

Greenland Ranch station is 178 feet below sea level and recorded the 134°F on July 10, 1913. The station is located in Death Valley, which has the hottest summers in the Western Hemisphere, and is the only known place in the United





The highest (top map) and the lowest temperatures of record by state, through March 1977. The all-time U.S. high temperature was recorded in Death Valley (top, opposite page).

States where nighttime temperatures sometimes remain above 100°F.

Prospect Creek station is at 1,100 feet and recorded the -79.8°F on January 23, 1971. The lowest temperature ever recorded in the conterminous 48 States, -69.7°F, was observed at Rogers Pass in Lewis and Clark County, Mont., on January 20, 1954.

The booklet also lists some rapid temperature changes associated with hot downslope winds. For example, the temperature rose 49°F in 2 minutes at Spearfish, S. Dak. on January 22, 1943. The change was from -4°F at 7:30 a.m. to 45°F at 7:32 a.m.

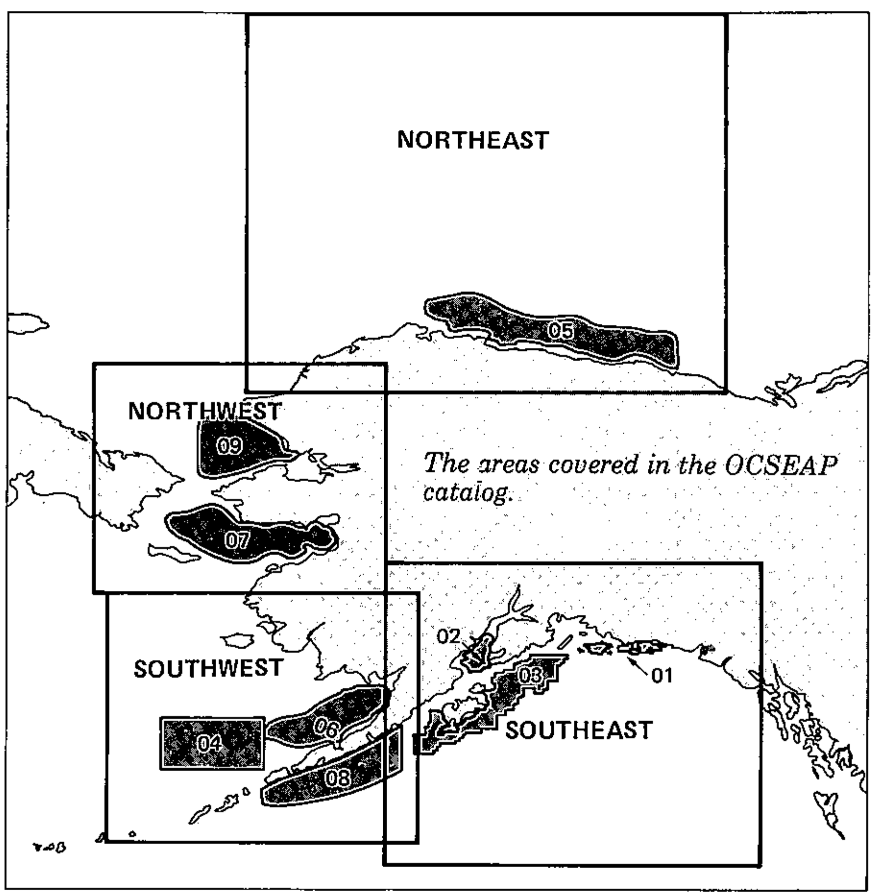
Two maps show the highest and lowest temperature and location for each State.

Copies of the booklet are available from National Climatic Center, Federal Building, Asheville, NC 28801.

OCSEAP Data Catalog

The *NODC Catalog of OCSEAP Data, Part I—Distribution of Data Received by File Type* is availale from EDS' National Oceanographic Data Center. The catalog lists the collection sites and types of data gathered for the Bureau of Land Management's (BLM) Outer Continental Shelf Environmental Assessment Program (OCSEAP) for Alaska. OCSEAP is a study of the environment of offshore areas where energy-related development is proposed to determine if development will pose unacceptable environmental or ecological risks. EDS is responsible for developing the OCSEAP data base.

In the catalog, the Alaskan shelf is displayed in four adjacent



The areas covered in the OCSEAP catalog.

charts. Each individual chart contains the lease areas defined by the Bureau of Land Management and the data collection site for a specific data type (e.g., zooplankton data, wind data, fish resource assessments, salinity/temperature/depth measurements, or current observations, etc.). Altogether, there are four charts for each of the 36 data types plotted at a combined total of 25,000 locations.

The data themselves are also available on magnetic tape or as printouts. These list latitude, longitude, ship, cruise number, date, and measurements.

Additions to the OCSEAP data catalog are planned: Part II—tables of station locations, collection dates, and data originators; Part III—descriptions of subtypes within each data type and copies of recording formats; and Part IV—samples of data summaries and other products prepared from the OCSEAP data.

A limited number of copies of the catalog and additional information are available from National Oceanographic Data Center, EDS, NOAA, 2001 Wisconsin Ave., N.W., Washington, D.C. 20235. Telephone: (202) 634-7298.

Brine Disposal Reports

The Marine Assessment Division of EDS' Center for Experiment Design and Data Analysis completed its third report on environmental analysis of brine disposal areas for creation of a national strategic petroleum reserve. The report titled, *Analysis of Brine Disposal in the Gulf of Mexico, 3. Capline Sector,* was prepared for the Federal Energy Administration (FEA) under an interagency agreement between FEA and NOAA.

Previous reports, *1. Bryan Mound* (near Freeport, Texas) and *2. West Hackberry, Louisiana,* also considered the environmental consequences of discharging large amounts of brine into the Gulf of Mexico as part of leaching activities that will create sub-surface caverns for oil storage. Discharge into these shallow coastal waters is one alternative under consideration for disposal of the brine. All three reports will assist FEA in fully examining the potential environmental impact of this disposal alternative.

Major portions of the third report include:

- An extensive summary of physiographic, meteorological, and oceanograhic conditions in the study region;
- A comprehensive review of ecological conditions in the study region;
- An analysis of the dispersion of brine discharged at several locations under various environmental conditions;
- General design criteria for a brine diffuser; and
- Potential impact of brine due to osmotic stress.

The report also includes sections on the brine dispersal model of the Massachusetts Institute of Technology (MIT) and sections on ecological factors prepared by Texas A&M University.

A limited number of copies of the reports are available from Marine Assessment Division, CEDDA, EDS, NOAA, 3300 Whitehaven St., N.W., Washington, D.C. 20235. Telephone: (202) 634-7381

Data Summaries for Cooperative Climatological Stations

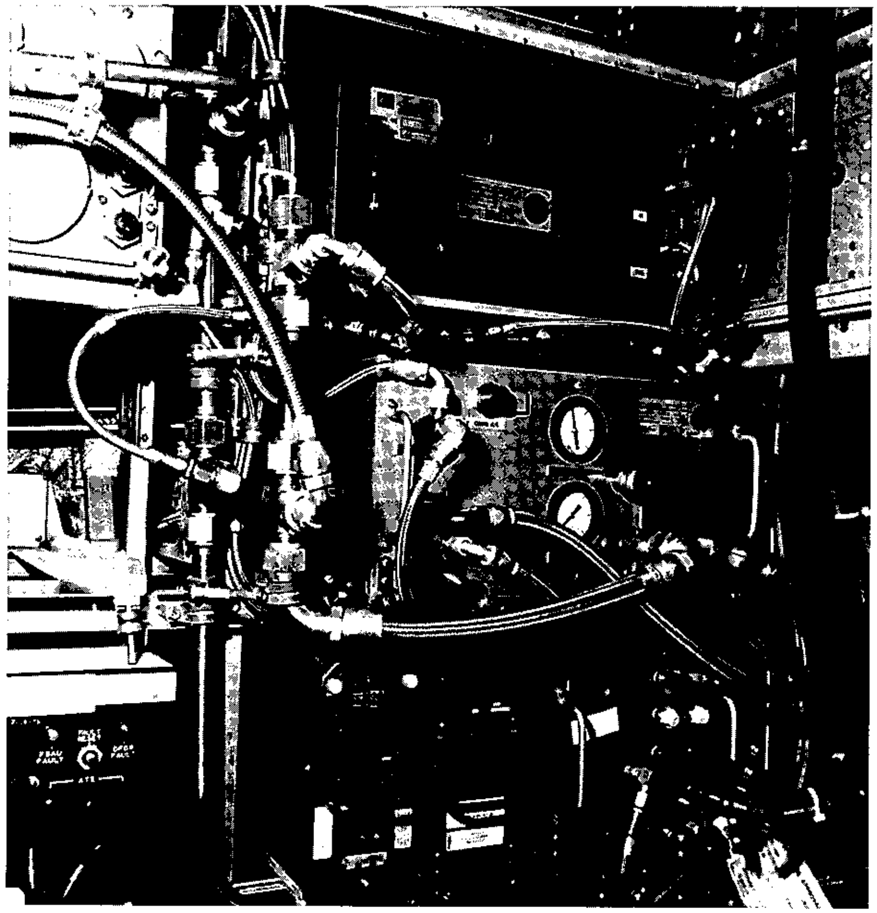
The EDS National Climatic Center has completed 220 new climatological data summaries for NOAA National Weather Service cooperative climatological observing stations. The new summaries are for stations in California, Delaware, Kentucky, Maryland, Missouri, Montana, Oklahoma, Pennsylvania, Utah and Wisconsin. This completes a total of 557 data summaries for cooperative climatological observing stations in 41 States. Summaries for stations in Alaska, Georgia, Hawaii, Michigan, Nevada, Ohio, Texas, Virginia and Washington remain to be processed.

Stations included in this special summary program are drawn from a group for which 1941 to 1970 average climatological values have been calculated. The summaries include: (1) a table of monthly and annual means and extremes of temperature and precipitation; (2) sequential tables of monthly average maximum, average minimum, and average temperature; (3) sequential tables of monthly total precipitation and snowfall; (4) probability statistics for spring and fall freezes and length of growing season for five temperature thresholds; (5) probability statistics for monthly total precipitation; and (6) monthly and annual normals for mean temperature, total precipitation, total heating degree days, and total cooling degree days.

Summaries for each of the 557 stations are available from the National Climatic Center, Federal Building, Asheville, NC 28801 at $0.15 per copy. For additional information, call (704) 258-2850, ext. 319.

International Report

Global Atmosphere Sampling Data Available



Atmospheric trace constituent data measured under NASA's Global Atmospheric Sampling Program (GASP) are now available on magnetic tapes from EDS' National Climatic Center. Measurements of ozone, water vapor, clouds, and trichlorofluoromethane are made by automated air sampling systems on board several commercial B-747 aircraft in routine airline service. The data are acquired in the upper troposphere and lower stratosphere to provide baseline information that NASA will use to assess the potential adverse effects of aircraft exhaust emissions on the natural atmosphere.

A United Airlines B-747 is collecting data over the contiguous United States and between the

Below: 747 participating in the sampling program. Right: GASP equipment inside aircraft.

West Coast and Hawaii. Two Pan American World Airways B-747's provide global coverage with around-the-world flights in the Northern Hemisphere, transatlantic flights to Europe, transpacific flights to the Orient, intercontinental flights to Central and South America, and occasionally transpacific flights to Australia. A Qantas airliner gives more frequent coverage in the Southern Hemisphere on transcontinental Australia flights and on flights from Australia to the South Pacific and Europe.

For each flight, data acquisition begins when the plane climbs above 6 km altitude and terminates on descent below 6 km. Ozone measurements are made using a continuous ultraviolet absorption ozone photometer. Water vapor is measured with an aluminium oxide dew-frost point hygrometer. A light-scattering particle counter detects clouds. Concentrations of trichlorofluoromethane (F-11) are obtained by subsequent laboratory analysis of whole air "grab" samples. These bottle exposures are programmed to occur every third calendar day at altitudes greater than 9.3 km. Tropopause pressure fields obtained from NOAA's National Meteorological Center analyses as well as flight data accompany the measurements.

The magnetic tapes are available from NCC by arrangement with James D. Holdeman of NASA's Lewis Research Center in Cleveland, Ohio. Five tapes are on file, covering 604 flights between March 1975 and June 1976. For additional information contact the NCC Computer Products Branch on (704) 258-2850, ext. 203, or write National Climatic Center, Federal Building, Asheville, NC 28801.

ICITA Atlas Volume II Published

Chemical and Biological Oceanography, Volume II of the International Cooperative Investigation of the Tropical Atlantic (ICITA) Atlas, was recently published by the United Nations Educational, Scientific and Cultural Organization (UNESCO). Volume I, *Physical Oceanography*, was published in 1973.

Both volumes were edited by Academician A. G. Kolesnikov, Marine Hydrophysical Institute, Ukrainian Academy of Sciences, Ukranian SSR. L.R.A. Capurro, formerly with the Argentine Hydrographic Office, was Assistant Editor of Volume II. Thomas S. Austin, EDS Director, was Chairman of the Atlas Editorial Committee and the International Coordinator for ICITA.

Publication of Volume II climaxes several years of analysis by West Germany, the United States, and the U.S.S.R. of data collected by eight nations in ICITA, the 1963 multination survey of the Tropical Atlantic. During ICITA, 18 ships from Argentina, Brazil, Nigeria, Republic of Congo, Republic of Ivory Coast, Spain, United States, and U.S.S.R. took observations along north-south profiles from Africa to South America.

Volume II contains charts of oxygen, phosphate-phosphorus, pH, silicate-silicon, nitrite-nitrogen, protein, detritus, and particulate matter. Zooplankton taxa counts and displacement volumes are also included. The chemical charts were prepared by the U.S.S.R., the microbiomass charts by West Germany, and the zooplankton taxa counts and displacement volumes by the United States.

Both volumes of the Atlas are available through Unipub, P.O. Box 433, Murray Hill Station, New York, NY 10016, U.S.A., or through UNESCO Centers in 100 other countries.

Satellite Geophysical Data

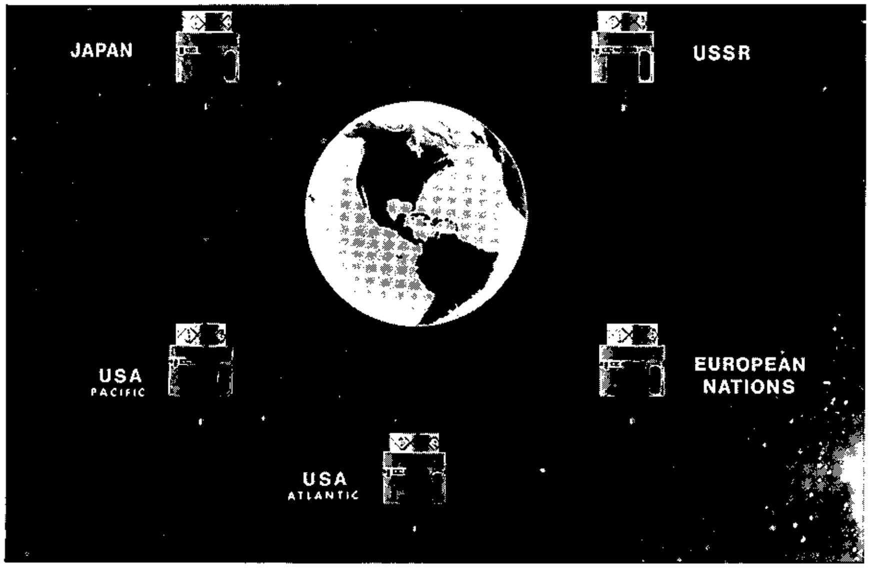
EDS' World Data Center A for Solar-Terrestrial Physics now has available energetic particle and solar X-ray data as well as magnetic field measurements collected by the SMS/GOES satellites operated by NOAA's National Environmental Satellite Service. Data from these geostationary satellites are prepared by the Space Environment Laboratory of NOAA's Environmental Research Laboratories at the rate of one magnetic tape of data a month for each data type since July 1974. The data are also available on microfilm, one 100-ft. reel a month for each data type.

The particle data are recorded on magnetic tape in counts per second every 3 seconds in multiplex from 14 channels in the megaelectronvolt energy ranges 0.8-4.0, 4.0-6.0, 6.0-10.0, 18-38, 40-500, 84-150, 150-500, 4.0-10, 10-16, 18-56, 71-150, 167-245, 340-392, and ≥ 2.0. The microfilm data are presented as 2-minute averages per day for up to 14 channels per day.

The solar X-rays data are 3-second samples in Watts/m^2 for the two energy ranges 0.5-4 Å and 1-8 Å. The microfilm data are recorded similarly one frame per hour.

The magnetic field data are 5-minute averages for each of the three components: parallel to the satellite axis, normal to the satellite axis, and between the satellite and earth in the outward direction in a right-handed system. The microfilm data have three-components per frame, 3-second averages per hour, and 2-minute averages per day.

These data may be ordered from the World Data Center A for Solar-Terrestrial Physics, EDS, NOAA, Boulder CO 80302. Check should be made payable to Department of Commerce, NOAA/NGSDC. The magnetic tape copies cost $50 each, plus cost of tape for tape-to-tape copies. The microfilm copies are $8.40 a month for each data type. Call (303) 499-1000, ext. 6413, for further information.



The two U.S. SMS GOES spacecraft and the 3 geosynchronous satellites launched or planned by other nations will provide continuous coverage of all but the far polar regions of Earth.

Marine Climatic Data Summaries

EDS' National Climatic Center has available a limited supply of a 27-page booklet entitled, *Index of Surface Marine Climatic Data Products.* The booklet contains samples of marine data summaries that can be prepared by NCC for any ocean area with a sufficient number of observations.

Some of the summaries included are: Summary of Synoptic Meteorological Observations (SSMO), pilot chart tabulations, buoy summaries, and historical sea-surface temperature tables; bimonthly ocean station vessel and marine climatology summaries; and marine data arrays.

NCC can also provide copies of a map series showing geographic distribution of available observations (number per 1° square). These maps were prepared by the Naval Weather Service Detachment, Asheville, N.C. and distributed by direction of the Director, Naval Oceanography and Meteorology (formerly Commander, Naval Weather Service Command).

Copies of the publication and information on preparation of summaries may be obtained from the National Climatic Center, Federal Building, Asheville, NC 28801. Telephone: (704) 258-2850, ext. 765.

Do-It-Yourself Earthquake "Globe"

The EDS National Geophysical and Solar-Terrestrial Data Center has prepared an icosahedron (20 sides) "globe" showing the distribution of earthquake epicenters of magnitude 4.5 and greater for the years 1963-74. This four color representation of the Earth is printed on heavy paper and can be folded to construct a useful desk device or ceiling hanging. It has been received favorably by individual scientists and the national meetings of the Seismological Society of America and the American Geophysical Union.

Cartographers have used polyhedrons to represent the globe for hundreds of years. In the 1940's Irving Fischer designed a 20-sided globe made of equilateral triangles, and exhibited it at the Metropolitan Museum of Art in New York. In the particular projection he used, all great circles are straight lines on the facets. John Ward, a computer specialist at NGSDC programed Fischer's construction, including also the code to plot geophysical data.

For further information on the ichosahedron globe, contact: Solid Earth Data Services Division, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO 80302. Telephone: 303-499-1000, Ext. 6591.

Increasing WDC-A's Geomagnetic Data Base

EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC), which operates the collocated World Data Center-A for Solar-Terrestrial Physics (WDC-A for STP), has collected geomagnetic data since the beginning of the International Geophysical Year (July 1957-December 1958). These data consist primarily of analog records (magnetograms), mean hourly values, 2.5 minute values, and various types of activity indices. NGSDC has the largest collection of these data in the world. Although the bulk of the collection begins with the IGY, a large amount (over 100 years) of earlier data, primarily publications of mean hourly values, also are available.

Since the beginning of the IGY, there have been about 300 magnetic observatories in operation throughout the world. A large number of these, however, were temporary stations, established just for the IGY. Data have been received at WDC-A for STP from about 200 of the 300 observatories, on schedules ranging from a few months to a few years after the recording period.

At the present time, there are nearly 200 observatories in operation, and data are received regularly from about 125 of them. Little or no data are received from the others, except upon special request. Since many of the latter are located in regions of the world where there are few observatories, their data are particularly valuable. In this category are most of the observatories in South America, Africa, the Middle East, and Southern Asia.

Lack of funds or copying facilities have been the main reasons for their not sending copies of their data to one of the World Data Centers. Very few observatory operators have been willing to send their actual magnetograms for copying, because of the possibility of loss of irreplaceable originals.

In an effort to solve this problem, WDC-A for STP offered to send a representative to visit the observatories not sending data in. He would make microfilm copies of the magnetograms and tables of hourly values. The International Association of Geomagnetism and Aeronomy gave its blessing to this proposal at its XVIth General Assembly in Grenoble, France (August 24-September 6, 1975).

NGSDC purchased a portable microfilmer (Model RP-1) to copy these data. The camera uses 16-millimeter film and has a reduction ratio of 20 to 1. If desired, two original negatives can be prepared simultaneously. The camera is a rotary-type which can accept any record up to 12 inches (30.5 cm) wide and any length. The two types of magnetograms to be copied are RUSKA (52cm x 20cm) and LA COUR (40 cm x 30 cm). There is one record for each 24-hour period. With this camera, one station-year's records can be filmed in about one hour, and 2-1/2 years' records fit on one 100-foot roll of microfilm.

During the interval January 31-March 4, 1976, William Paulishak of NGSDC visited institutions which operate magnetic observatories at the following locations in Mexico and South America:

Teoloyucan, Mexico
Fuquene, Colombia
Huancayo, Peru
Arequipa, Peru
La Paz, Bolivia
La Quiaca, Argentina
Pilar, Argentina
Orcadas Del Sur, Argentina
Trelew, Argentina
Las Acadias, Argentina
Vassouras, Brazil
Tatuoca, Brazil

On this trip about 100 observatory-years of data were copied. This is approximately equal to the total amount of data NGSDC received from the same observatories prior to Paulishak's visit. Based on the cost of the trip, the price of each magnetogram copy made was approximately $0.10.

For the future, arrangements have been made to have the original records from one of the observatories sent via U.S. Embassy channels to NGSDC for filming. In other cases, provisions were made to supply microfilm where the station has a copy camera, but has been unable to obtain proper film. (Arrangements also were made to supply paper to a few observatories where it was essential for continuous operation of the magnetometer.)

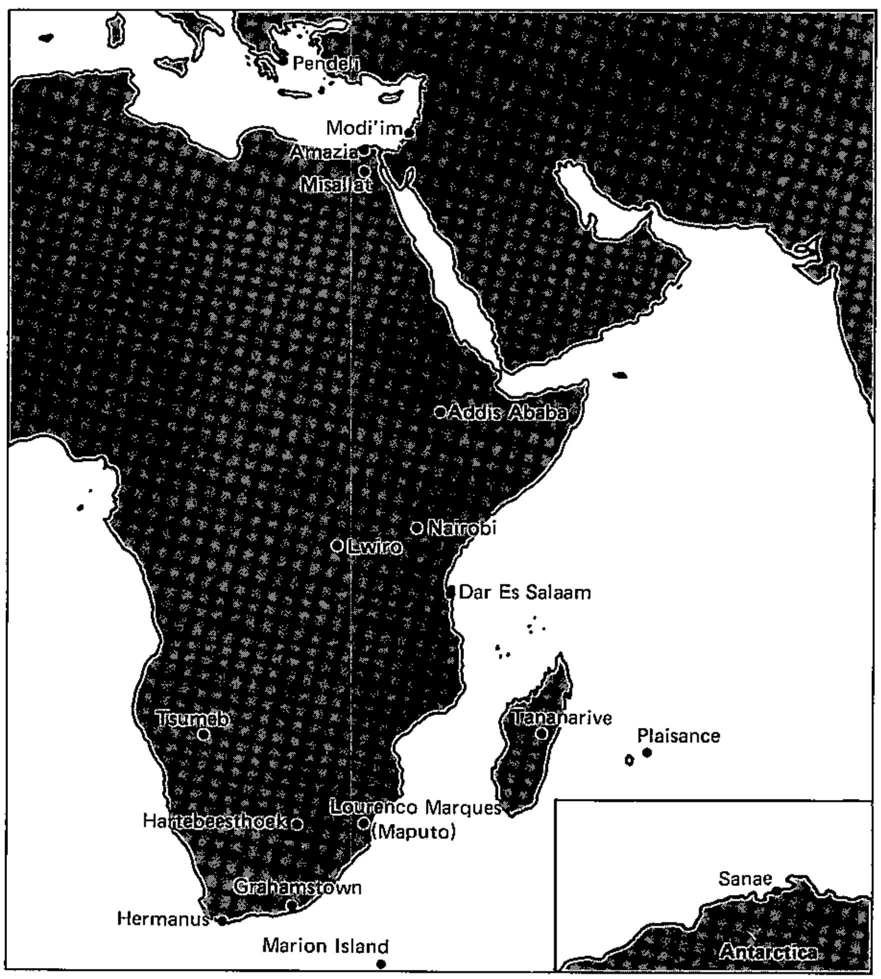
A second trip was made during the period January 7-February 17, 1977. Institutions operating magnetic observatories at the following locations were visited:

Hermanus, South Africa
Grahamstown, South Africa
Hartebeesthoek, South Africa
Marion Island, South Atlantic
Sanae, Antarctica
Dar Es Salaam, Tanzania
Nairobi, Kenya
Lwiro, Zaire
Addis Ababa, Ethiopia
Missallat, Egypt
Tsumeb, S.W. Africa
Maputo, Mozambique
Plaisance, Mauritius
Tananarive, Malagasy
Pendeli, Greece
Modi'im, Israel
Amazia, Israel

Approximately 65 observatory-years of data were copied on this trip. The cost of copying these data was thus about $0.25 per magnetogram. As with the first trip, the amount of data copied was approximately equal to the amount that had been received since the IGY from those locations. Also, as with the earlier trip, arrangements were made to supply paper and microfilm to those in need. Special arrangements were made to have the data from a few observatories sent to NGSDC for microfilming.

The cooperation and assistance provided by the operators of the observatories visited on both trips was excellent.

Copies of the data gathered on these trips can be obtained from World Data Center-A for Solar-Terrestrial Physics, EDS, NOAA, Boulder, CO 80302. Telephone: (303) 499-1000, ext. 6467.



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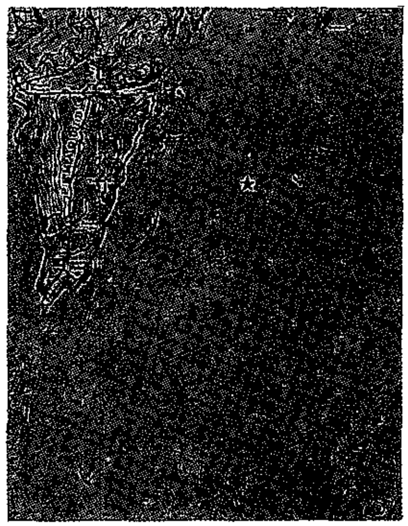

In this issue: Russian visitors (p.21), geomagnetic data uses and users (p.13), climatic change and fisheries (p.3), and editing with computer graphics (p.18).

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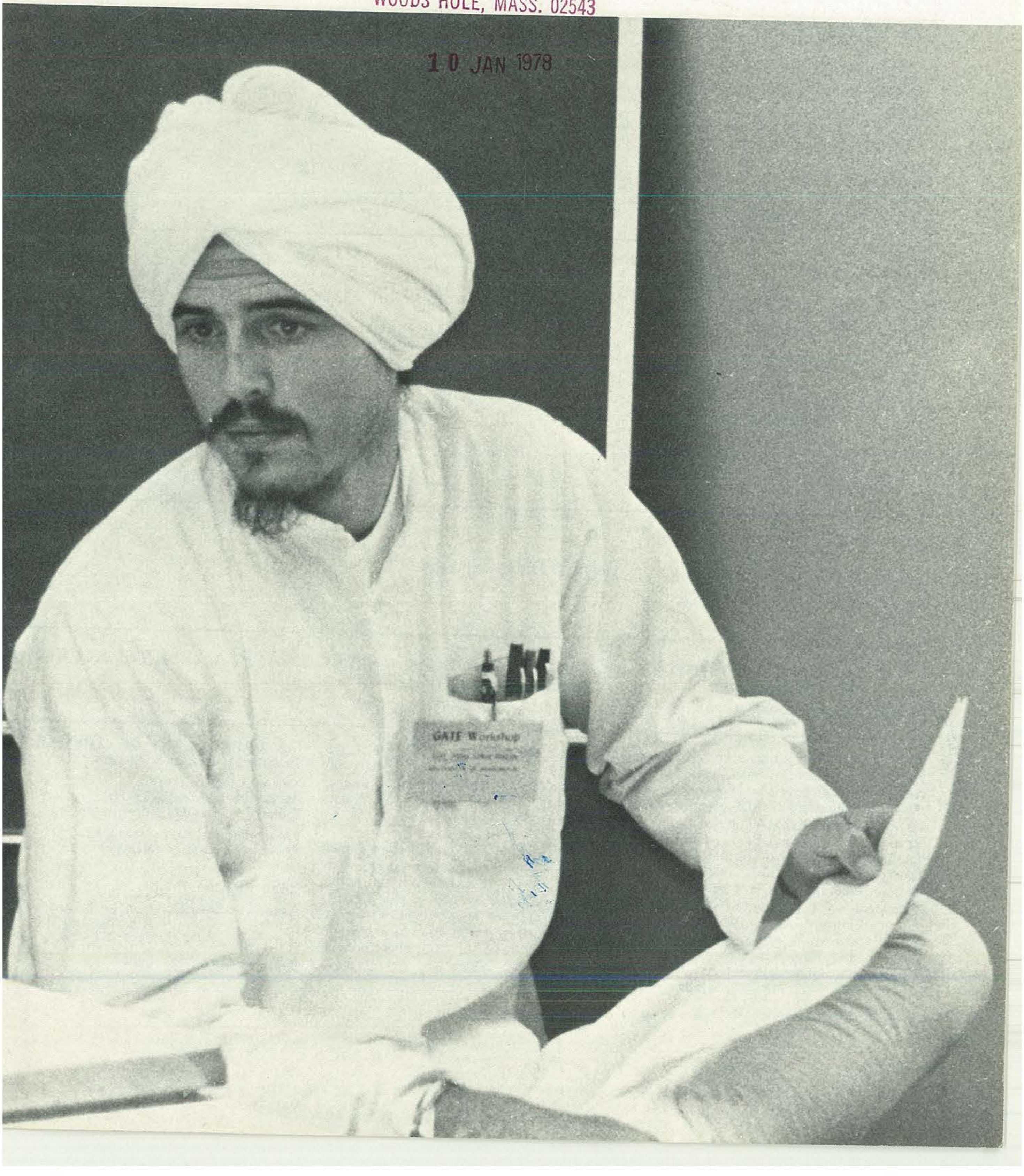

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Environmental Data Service
November 1977

Cover: *Siri Jodha S. Khalsa of the University of Washington participated in a 3-week workshop (p. 25) held to evaluate the scientific results of GATE, The Global Atmospheric Research Program (GARP) Atlantic Tropical Experiment.*

Photo: Ginger Wadleigh, NCAR

EDS is a bimonthly publication designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, and Center for Climatic and Environmental Assessment. In addition, under agreement with the National Academy of Sciences, EDS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 16, 1975; this approval expires June 30, 1978.

U.S. DEPARTMENT OF COMMERCE
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Challenges In Meeting Public Needs For Science Information*

By Thomas S. Austin
Director, Environmental Data Service

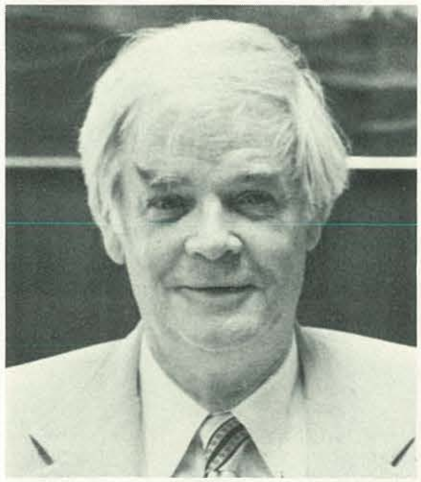
Abstract

Many of the problems facing those working in the scientific and technical information (STI) field today may be traced to the fact that in the last few decades the emphasis of STI application has been shifting from the advancement of science to the solution of socio-technical problems and the formulation of public policy. Concurrently, the STI user audience has expanded beyond the scientist to include the engineer, public policy maker, attorney, regional planner, businessman, citizen's group, and individual taxpayer. Many of these users need different types of information services and products than those required by the scientist. The STI establishment is not meeting these new needs. This paper examines the current situation, its evolution, and its implications with respect to STI concepts, roles, responsibilities, structures, practices, and relationships, both public and private.

Introduction

In 1974, a National Science Foundation contractor asked more than 200 Federal executives for the source of their science information. The answer? Mostly from the newspaper. Almost none came from the science information establishment, Federal or private.

If this is the case with Government executives with direct access and even management control over scientific and technical information systems, one may ask where



Thomas S. Austin

state legislators and regulators, regional planners, attorneys, business executives, citizen's groups, and the average taxpayer get most of their science information? Are we meeting their needs for scientific and technical information (STI)? I think, in most cases, the answer is "no."

Allow me to cite another example, originally presented by Dr. George Anderla (1974) of the Sorbonne. Dr. Anderla's example is ENDS (European Nuclear Documentation Service) in Luxemburg, at the time the largest automated information system in Europe and the third largest in the world.

ENDS computerized files then contained nearly 1.5 million articles on nuclear energy. Some 45 to 50 people worked on file maintenance and user searchers. Supported by the common market, the service was free. Despite this tremendous resource commitment, there were, on the average, only 3 users a day.

Dr. Anderla concluded: ". . . the system does not provide the information the users want or need because we know the users' requirements only superficially," and ". . . this kind of situation cannot go on very long, because no government or intergovernmental agency will allow millions of dollars to be spent for such limited use and for such a restricted number of users."

These two examples highlight three key problems in STI today:

- The user audience is expanding—at a rapid rate—beyond the scientist and the engineer. Today, the audience also includes public policy makers at the national, state, and local levels; attorneys; regional planners; businessmen; citizen's groups; and individual taxpayers. Increased public concern over environmental, ecological, energy, and other issues with a scientific base is noticeably shifting the application emphasis for STI from the advancement of scientific knowledge

*Presented at the 28th Alaska Science Conference sponsored by the American Association for the Advancement of Science—Alaska Division, Anchorage, Alaska, September 22-24, 1977.

Vincent E. Giuliano

to using that knowledge to solve national and global socio-technical problems and to choose among potential alternative futures.

- These new users need information in different forms than those traditionally provided the scientist and engineer. Increasingly, the product must be understandable to the layman.

- The current STI establishment is not meeting user needs. Users often go elsewhere to get the information they need while elaborate, computerized STI systems go virtually unused.

Changing Users And Uses

Dr. Vincent Giuliano (1977), who is directing an analysis of Federal STI policies under an NSF grant, suggests viewing the changes cited above in the context of three eras:

- Era I represents the traditional, discipline-oriented system which evolved to transfer scientific knowledge from scientist to scientist. It dates back to the 19th Century.

- Era II represents the emergence of "big science and technology." It began with the development of the atom bomb in World War II and reached its peak in NASA's space programs in the 1960's. The STI systems involved were, and to a significant degree still are, mission-oriented creations of the Federal Government, with a strong emphasis on engineering and applications. The information transfer is primarily from scientist to engineer or engineer to engineer.

- Era III, which began in the 1960's and has grown in the 1970's, is concerned with public policy formulation, planning, and management. The issues include quality of life, preserving the environment, managing natural resources, etc. The users are policy analysts, social scientists, lawyers, law makers, and a wide spectrum of interest groups.

These three STI environments coexist in the Federal Government today.

The Era III infrastructure is still evolving. Meanwhile, Era I and Era II concepts continue to dominate the planning and design of STI systems. According to Giuliano, most "complaints" and "issues" in recent STI studies are the result of Era III pressures for modernization and revision of Era I and Era II systems.

Implications And Current Issues

Era III users and applications frequently require assessment and interpretation of STI as it relates to specific problems. This results in greater emphasis on packaging information to meet user needs, which cut across traditional disciplines, missions, programs, and agencies. These new functions require more precise identification of user needs. To achieve this, user feedback links have to be established and existing dissemination systems supplemented by market-oriented techniques. In short, modification of existing and development of new STI systems must consider contemporary user requirements.

The same evolution is occurring in the field of data management. Originally established to provide traditional archiving and dissemination services, the Environmental Data Service, as an example, is today increasingly involved in analyzing and applying its data (and information) to help those seeking solutions to national and global environment-related problems. These include problems such as potential global food shortages, the energy crisis, environmental pollution, climatic anomalies (like last winter's Alaskan heat wave), the wise development of the coastal zone, and even the ill effects of weather and climate on human health.

Technology and the Marketplace

In still another area of evolution, we are experiencing a dramatic change in the way information is processed and disseminated. Today, a computer can fit in the palm of your hand—minicomputers are in. This opens the way to distributed data processing and network information services, with terminals in offices and, eventually perhaps, in homes. Meanwhile, commercial distributors of repackaged Government-originated information have staked a claim to a share in a traditionally public market. These changes raise important questions concerning ownership, control, and conditions of access to STI.

Current Concepts, Roles, and Responsibilities

Activities of the public and private STI sectors often conflict. The Federal Government, for example, tends to think of STI as a national resource to be applied to current and potential social problems. The private information broker, on the other hand, sees STI—whether Government or privately produced—as a commodity to be marketed. He feels that the Federal Government should rely upon the private sector to provide STI user services, except where the costs are prohibitive, or where security problems make private services impractical. Government practitioners, however, argue that STI resulting from Government-sponsored research has already been paid for by tax dollars and that the user taxpayer should not have to pay for it twice.

Clarification of concepts, roles, and responsibilities also is needed in intra- and intergovernmental relationships. Federal STI systems are characterized by pluralism rather than coordination. Interagency coordination is needed to make Federal STI systems more effective and coherent, and to prevent agencies from competing with each other. Federal-state-local interfaces also would benefit from the coordination and clarification of relative roles and degree of involvement in STI activities.

The Cost of STI

In both the public and private sectors, overhead and STI system capital investment costs increasingly are being passed on to the user. Retrieval costs also are charged to the user. It can be very expensive for a private citizen or citizen group to acquire information from a large or specialized STI system. Suggestions have been made to set special telephone and postal rates for STI users, but they remain only suggestions.

In the Federal sector, it has been suggested that resource allocation priorities be realigned to increase funding for information dissemination. Specifically, this would involve setting aside for STI dissemination a portion of the funds allocated for each generation (R&D) effort.

There also have been suggestions for Federal aid to professional societies, students, and public interest groups seeking STI. Finally, it has been suggested that the Government adopt a uniform pricing policy to replace the spectrum of policies followed by individual agencies.

STI Access

Locating STI is a problem for many potential users, particularly Era III users. There are many STI sources, as even a casual survey of catalogs, directories, indexes, and indexes of indexes will quickly show. A centralized referral system for Federal STI has been advocated. Such a system or center would direct the user to the appropriate source for the specific STI needed. Here I modestly mention EDS' Oceanic and Atmospheric Science Information Service (OASIS) and its data companion, ENDEX (Environmental Data Index), examples of such referral services provided by NOAA. OASIS is particularly interesting in this regard, since it accesses existing commercial information systems, rather than duplicating their files and services.

Current Federal Policies

The National Science, Engineering, and Technology Policy and Priorities Act of 1976 (PL94-282) calls for "effective management of scientific and technological information" in developing and maintaining a solid base for U.S. science and technology. It charges the Federal Government—

"To promote prompt, effective, reliable, and systematic transfer of scientific and technological information by such appropriate methods as programs conducted by nongovernmental organizations, including industrial groups and technical societies."

In addition, it is recognized as a

Federal responsibility "not only to coordinate and unify its own science and technology information systems, but to facilitate the close coupling of institutional scientific research with commercial application of the useful findings of science."

One of the major goals of the Act is "to incorporate scientific and technological knowledge in the national decision-making process." To accomplish this, it encourages strong cooperative relationships between the Federal Government, state and local governments, and the private sector to further shared decision-making, funding, and program planning and execution in science and technology.

President Carter (1977) has since made it his administration's policy to promote wider public participation in Government decision-making, better coordination of the delivery of Government services, and a greater degree of local and state involvement in matters affecting each.

Currently, Federal STI information policy responsibility is spread throughout the Government. As examples, the Department of Commerce's Office of Telecommunications Policy is concerned with the ownership of computer communications media; the Freedom of Information Committee in the Department of Justice addresses access to information; Domestic Council committees have addressed information content, particularly the privacy issue; the Office of Management and Budget addresses the source of information through R&D funding and organizational recommendations; and the National Commission on New Technological Uses of Copyrighted Works was established to review ownership of information within the context of new information technologies. Finally, of course, there are the Federal STI agencies and organizations themselves, each with its own policies and mechanisms.

Summary And Conclusion

To sum up briefly, we must broaden the base of both Federal and private STI activities by recognizing and meeting the needs of Era III users and developing feedback mechanisms to give them a voice in STI policy considerations. This will, of course, require modification and modernization of some Era I and Era II concepts, systems, and system components. Secondly, the public and private STI establishments must develop a framework and forums for joint planning and interaction.

Meanwhile, there is one area in which considerable progress is being made in adapting the Federal STI system to meet the needs of Era III users—regionalization, bringing STI services closer to the user.

A current and particularly pertinent example of this trend is the National Oceanic and Atmospheric Administration's establishment of a network of Regional Coastal Information Centers to meet the needs of and interact with users concerned with the coastal zone—including state, county, and local officials, citizen groups, trade associations, and local businessmen. The RCIC's are designed to improve the referral, delivery, and feedback system for existing marine and coastal information, rather than to establish new files or systems.

To date, two RCIC's have been established. The first, serving New England users, is located at the University of Rhode Island. The second, serving the Pacific Northwest, has two service centers, one at Oregon State University in Corvallis, the other at the University of Washington in Seattle. Seven more RCIC's are planned, including one in Alaska.

In concluding, allow me to quote from the conference announcement:

"Now is the time to examine the informational needs of educators, scientists, government planners, resource and community developers, legislators, and citizens, to survey the existing collections and systems, and to seek innovative means of improving information exchange . . . ."

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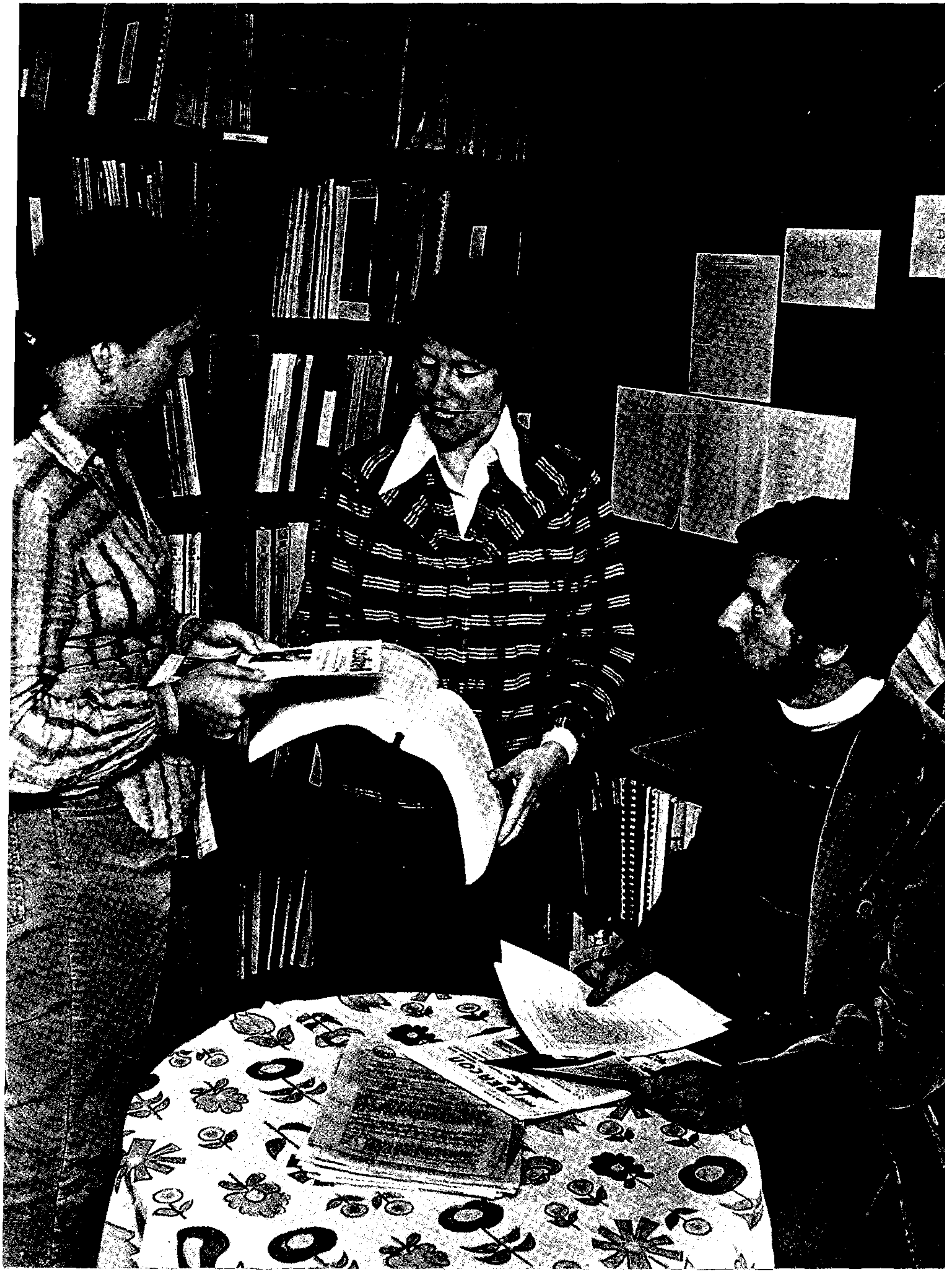
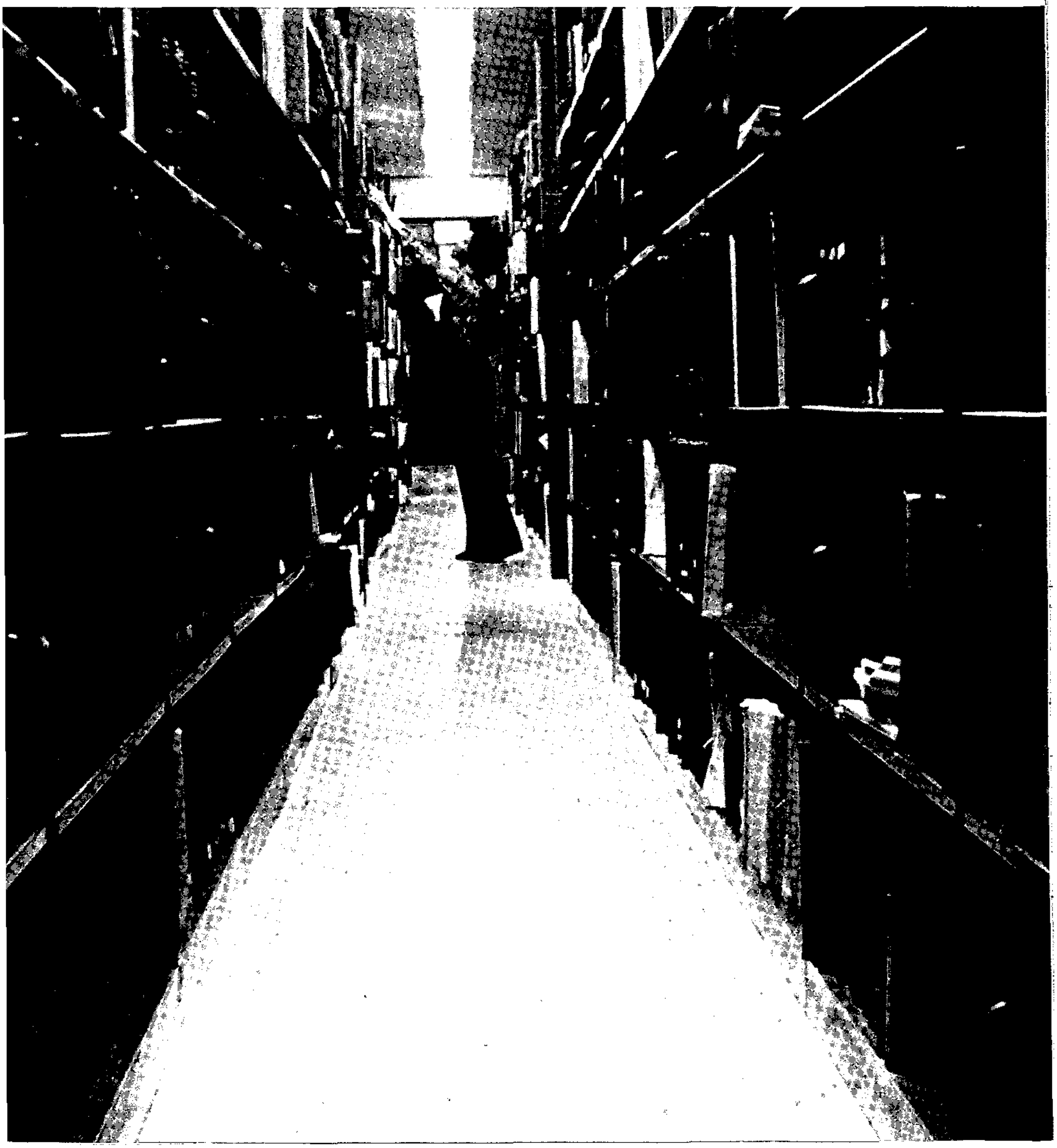
Jane Miner, Candy Dunn, and Christopher Benetti of the Northeast regional coastal information center. The center, housed in the University of Rhode Island's Division of Marine Resources Library, is operated by the University for the New England Marine Advisory Service.



NOAA's Marine Library and Information Services

By Elizabeth J. Yeates
Environmental Science Information Center



The National Oceanic and Atmospheric Administration serves as a national and international focus for the development, conservation, and effective utilization of ocean resources. Its acronym, NOAA, homonymous with the Biblical survivor of a water-covered world, is particularly apt. The pervasive presence of the ocean, covering over 70 percent of the Earth's surface, is a constant factor throughout man's existence.

The ocean presents many facets to be studied and explored. It can be viewed as a cradle of weather and of life, as a global reservoir of water and of energy, as a complex pollution problem to be solved, as a home of nutritive and mineral resources, and as a setting for the man-involving web of life.

NOAA looks at the ocean in all its many aspects. Since its creation in 1970 from existing environmental science, oceanographic, and marine fisheries organizations, NOAA has been in the forefront of oceanic, atmospheric, and marine biological research and the development of related technologies.

NOAA's mission is basically one of continuing exploration and development in an attempt to expand man's understanding of the marine environment, its resources, and life forms. It takes place in offices and laboratories, in data analysis and computer centers, aboard research and survey ships at sea, and in submarines and diving apparatus under the sea. It encompasses a multitude of approaches:

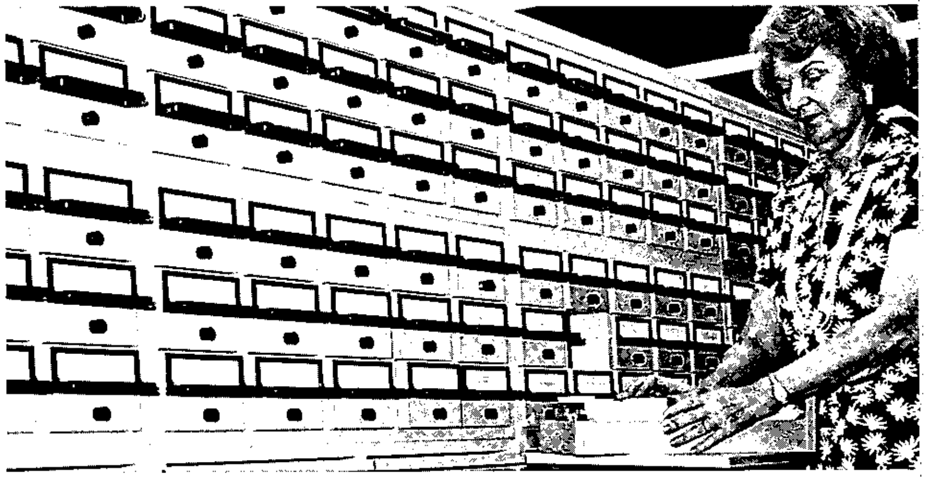
- Physical and geophysical research into the marine environment, with studies of currents, waves, plate tectonics, and continental drift;
- Monitoring the impact of man on the marine environment, with investigations of ocean dumping, pollution, over-fishing, deep-ocean mining, and offshore drilling;
- Development of plans to assure wise use of the coastal zone in accordance with legislative mandate;
- Meteorological research and the design of attendant instrumentation and techniques to provide more accurate prediction of the marine environment;
- The mapping and charting of ocean depths, shorelines, and other navigational features;
- International cooperative environmental studies to advance mankind's understanding of the atmosphere and ocean;
- Programs to comprehend, develop, use, and conserve the living resources of the oceans and to foster a viable fishing industry;
- Conservation efforts in connection with the Marine Mammals Protection Act and the Endangered Species Act.
- The advancement of new technologies such as computers, satellites, and ocean instrumentation to provide the means to gain an adequate comprehension of the marine environment.

Much of this work, which is carried out at many locations throughout the country, is interrelated and is linked to the work of investigators outside of NOAA. For example, individuals and institutions receiving support from NOAA's Sea Grant Program often share in projects, as do many State, regional, and multinational research organizations.

Because of the multiplicity of approaches, widely distributed work sites, increasing emphasis on regulatory as well as research responsibilities, and the commitment to serve not only NOAA employees but all who share NOAA's interests, providing library and information services in support of NOAA's oceanic programs presents quite a challenge. The focus for library and information activities within NOAA is the Library and Information Services Division (LISD) of EDS' Environmental Science Information Center (ESIC). To meet ever-increasing demands for all types of information relating to the oceans (and atmosphere), LISD has recently undergone a major reorganization. This restructuring enables LISD to provide a total response to information needs which arise both within and outside of NOAA. To create this ability, several aspects of information activity that are usually conceived of as outside the traditional library scope were placed in a new setting as part of a total library/information system.

To the requester it does not matter whether his or her information is satisfied by traditional library services, by recourse to technical report literature, by a computerized search of a data base, or by an expert in the field of interest. With this concept in mind, LISD has espoused the goal of providing a one-stop service to satisfy all types of information inquiries. To accomplish this, two previously separate information activities—the secondary distribution of NOAA publications (in response to information requests) and the searching of computerized literature, research, and data-referral files—were brought into the library framework and integrated with existing reference and referral services.

The resulting service composite provides a single phone number (301-443-8330) that users can call to get complete reference service. Manned during work hours by information professionals, this integrated service is expected to provide users with information that best meets their specific needs through combined access to NOAA-published documents, online data bases, the NOAA library collection, and staff specialists throughout the organization.



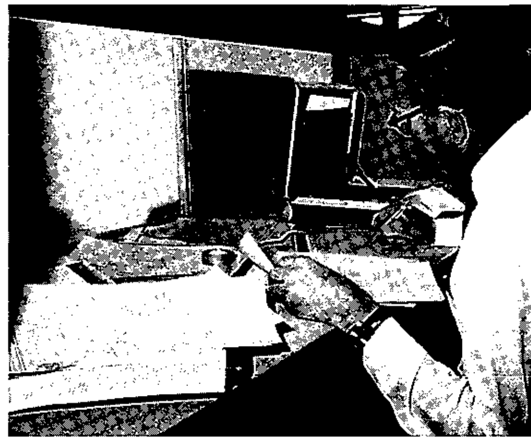
From a functional standpoint, what we have done is to unify a variety of information output functions. It is on this fundamental division of library operations into input and output functions that the new organizational structure of LISD is based. On the input side is the Information Resources Development Branch which makes available for use a broad spectrum of material in a variety of formats. On the output side is the User Services Branch which serves as the interface between information resources and the user.

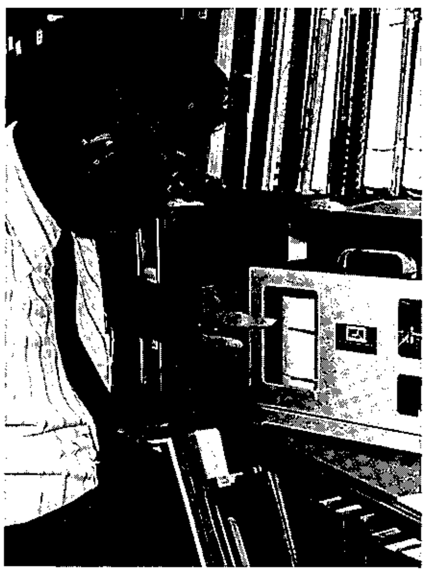
To provide quick, convenient access to library materials and information sources, the User Services Branch comprises several centers, located to serve identifiable concentrations of NOAA personnel in the Washington, D.C., area and in Miami, Fla. Each center has an area of specialization, dictated by its primary user population; however, each center can immediately tap into the total resources of LISD to round out its local capability.

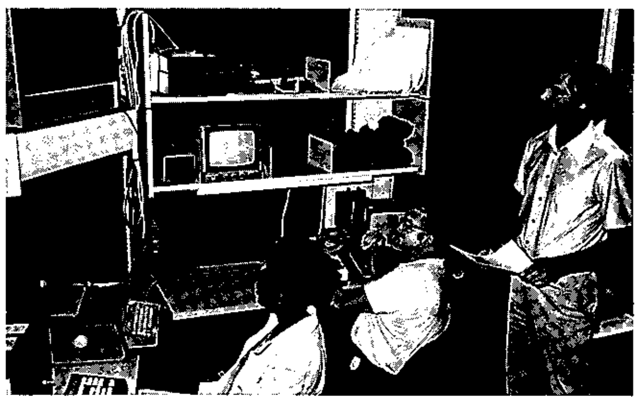
In addition to these facilities which it administers directly, LISD coordinates and provides technical supervision to the activities of more than 30 other NOAA library and information units. These units remain part of the organizations which were originally brought together to form NOAA, and are still administered by their parent organizations. For example, the National Marine Fisheries Service, originally the Bureau of Commercial Fisheries, has a library in each of its 19 laboratories. Some of these field libraries are very small and may be staffed by only one person, not necessarily a trained librarian. To assure as far as possible that all NOAA personnel have the benefit of effective library/information service, LISD provides technical assistance and advice to these libraries.

Other programs within NOAA also provide certain information and library services. A particularly pertinent example is the Coastal Zone Management Information Center. The Center provides information services for its staff, state coastal programs, and all other intested parties, and also acts as a clearinghouse for its coastal and marine planning and management materials.

EDS' National Oceanographic







Photos: Bob Williams and John Roseborough

Data Center, National Climatic Center, National Geophysical and Solar-Terrestrial Data Center, and field liaison offices are other important sources of NOAA ocean information services. Involved primarily with data accession, dissemination, and referral, they also offer computerized literature searches.

Our approach at LISD to providing information is to create a specialized package in response to user requests. Our librarians and information specialists review and analyze requests, taking into account the particular requirements of the individual requester. In creating a customized package tailored to the specific user and request, we call upon a complete range of information resources. Not only are what might be called traditional library resources available in the form of an extensive scientific and technical collection, but we can also, if appropriate, incorporate the documented results of research reflected in NOAA technical reports and other NOAA publications. Computer searches of data bases of published literature or ongoing research may be used to meet particular information needs, requiring the determination and selection of the most relevant files for the purpose in question. It may be that the best way to meet a demand is to secure information from or refer the request to a NOAA laboratory or scientist with special expertise in the area under consideration or call upon another Government agency for assistance. By selectively using, either individually or in combination, these four information resources—library collection, NOAA report literature, referrals, and computer searches—LISD is able to respond in a highly personalized way to a wide variety of oceanic informtion requests.

As part of its effort to provide a total response to information inquiries, LISD is working to develop a capability that will allow it to give further specialized assistance such as information retrieval and analysis or literature research. To this end, and because of the specialized nature of our collection and clientele, we require that our librarians and information specialists have a scientific or technical background.

Our own research collection, on which we rely extensively, consists of about 700,000 volumes maintained by LISD and available to the entire NOAA staff regardless of where they are located. About 20,000 items from this main collection are circulated each year. The collection covers the many aspects of the ocean and ocean resources in which NOAA has a research or regulatory interest. Particular emphasis is on oceanography, hydrography, geodesy, physical geography, mathematics, cartography, ocean engineering, naval science, climatology, meteorology, marine biology, fish culture, marine ecology, and related subjects. LISD also has the records of the earliest U.S. surveys and studies of tides and currents—a unique collection which dates from 1816. Of particular interest to researchers are early studies of the Gulf Stream. A reference use to which our historical and rare book collection is frequently put is establishing the coastline as it was originally charted.

Adding to the accessibility of the more recent collection is our first book catalog, just published, which is available through the field libraries. Plans for a computer-output-microfilm catalog which will allow for frequent updating are underway. This is the first step in totally automating access to the LISD collection. Creation of a serials sub-set is an important component of this plan. It will provide online access to holdings of journals and periodicals, which are perhaps our most highly utilized information resource.

Currently, a monthly accessions list provides updates on additions to the LISD collection. This product is a spinoff of our input to the Ohio College Library Center (OCLC) system.

One of the responsibilities we have assumed is making available through OCLC cataloging information on NOAA technical reports and other NOAA publications. This is in addition to our efforts to provide access to the material itself through the Department of Commerce's National Technical Information Service (NTIS). LISD arranges for the abstracting and indexing of NOAA reports for incorporation in the NTIS Government Reports Announcements, in both hard copy and online data base. Cataloging data for OCLC is frequently available several weeks before NTIS cites the same report, providing the fastest way to identify significant material being produced by NOAA. In response to information requests, LISD distributes about 40,000 NOAA and NOAA-sponsored reports a year.

The Library and Information Services Division is involved in networking and resource-sharing with other libraries, both Federal and non-Federal. LISD lends over 3,600 items a year to other libraries—including 1,200 to other Government, 700 to academia, 1,000 to industry, and 700 to the public. A cooperative effort in which we are presently engaged is an update of a union list of serials with input from NOAA and a number of other Federal libraries.

A feasibility study for a minicomputer is currently being carried out, and with its acceptance we will be able to move more forcefully into networking operations. We feel the minicomputer rather than a mainframe is the best choice for our planned computerized system. It will permit the needed degree of flexibility and control, while providing us at a reasonable cost with the ability to interface directly with other systems such as OCLC. The creation of a NOAA-wide library network would not only benefit the non-LISD NOAA libraries by providing them with access to the main collection and various support services, but also all other libraries who share our interests.

In addition to providing information and sharing resources, LISD also is involved in maintaining the commercial availability of three online data bases that deal directly with NOAA's areas of interest. The three data bases we support, in varying ways and to various degrees, are Oceanic Abstracts, Meteorological and Geoastrophysical Abstracts, and Aquatic Sciences and Fisheries Abstracts.

The library and Information Services Division has, as mentioned, the capability of providing literature searches. It makes this service available free to all NOAA personnel and on a cost-recovery basis to others. LISD not only conducts searches itself but provides direct access to online systems to the non-LISD NOAA libraries, other NOAA information facilities, and individual researchers. More than 3,000 searches/yr are performed.

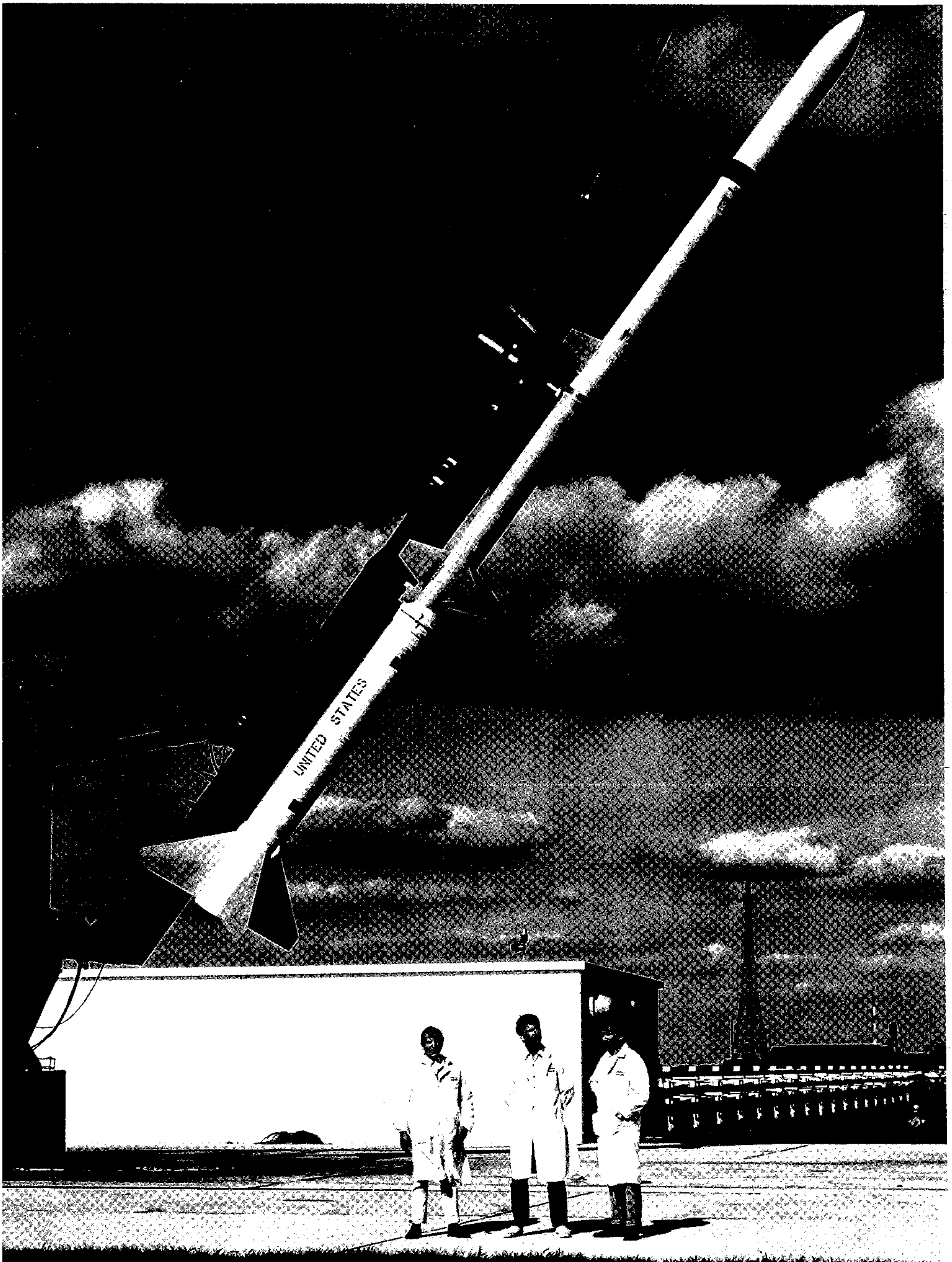
In addition, LISD offers free Selective Dissemination of Information services to the NOAA staff. Many researchers in universities and industry also make use of these services. In an effort to make this type of information more widely available, LISD has recently gone a step beyond and published several computer-produced bibliographies in areas of particular current interest. These bibliographies, which are available free, have dealt with ocean law, managanese nodules, and coastal zone management. Work is currently in progress on a bibliography on oil spill clean-up—a problem with which NOAA is much involved.

The Metrocket

By Edward E. Edstrom
National Climatic Center

Above: A PWN-11a meteorological rocket is loaded into a launcher at the Guiana Space Center, Kourou, French Guiana. The rockets are loaded in an air-conditioned shelter to prevent deterioration in the tropical environment.
Photo: Bruce Kennedy, U.S. Army

Overleaf: A ***Javelin*** *metrocket ready for launch at NASA's Wallops Island (Va.) station. Before the development of rockets designed specifically for meteorological use, existing military rockets were used.*


UNITED STATES

Many vehicles have carried instruments aloft to probe the atmosphere. They include kites, manned balloons, aircraft, free balloons, rockets and, most recently, satellites. All have made their particular contribution to our knowledge of the atmosphere.

The meteorological rocket (metrocket) began as a giant. In 1946 meteorological sensors were substituted for the 2,000 pound warheads on about 100 captured German V-2 rockets to obtain atmospheric measurements at altitudes much higher than could be reached by balloon-borne instruments. Research and development efforts over the years since have led to the current small and relatively inexpensive metrocket, which is used by the 30 stations in the worldwide Cooperative Meteorological Rocketsonde Network to reach altitudes of 20 to 90 km in a semi-synoptic observation program begun in 1960. As with the V-2 rockets, instrument packages are parachuted back to Earth.

Early metrocket observations proved wrong some then-popular theoretical assumptions about stratospheric circulation and its effect on the troposphere. The discovery of marked variability in the vertical profiles of all meteorological parameters, for example, proved the stratosphere was not, as theoretically assumed, a quiescent layer exhibiting smooth vertical parameter profiles with no rapid fluctuations. Also proven wrong was the assumption that the influence of the stratospheric circulation upon the tropospheric layer was negligible. Proof of this came when it was found that "explosive warming events" begin at altitudes of 40 to 45 km, propagate downward into the lower stratosphere, and do indeed alter the tropospheric layer.

From these early investigations it became obvious that before supersonic aircraft, satellite, manned spacecraft, and space shuttle operations could be successfully attempted, it was necessary to increase our knowledge of the interactions between the stratosphere and the troposphere by direct measurement. The metrocket provided the vehicle.

The metrocket has been an important data source in determining wind and thermodynamic stresses which manned and unmanned spacecraft must be designed to withstand during launch and reentry operations. These same data now are being used in the design, test, and operational phases of the Space Shuttle Program. In addition, they undoubtedly will be important in determining design and loading factors for vehicles used in the establishment and operation of the proposed orbiting space station.

Normally, the metrocket is used to obtain temperature and wind data, but it also has been used to gather information in fields other than meteorology, such as astronomy, geophysics, astrophysics, atmospheric optics, sound propagation, geomagnetics, and ionospheric physics. The versatility of the metrocket as an instrument platform is due partly to its adaptability to a wide variety of sensors. It has been used to measure atmospheric constituents such as: atomic oxygen (O), oxygen (O_2), ozone (O_3), atomic nitrogen (N), nitrogen (N_2), nitric oxide (NO), nitrogen dioxide (NO_2), nitrous oxide (N_2O), carbon monoxide (CO), methane (CH_4), ammonia (NH_3), hydrogen (H_2), carbon dioxide (CO_2), and others.

Routine rocketsonde ozone measurements now are being made to determine the effects of aerosols and supersonic aircraft on the ozone layer. Considerable controversy exists as to whether aerosols are detrimental to the earth's ozone layer, which shields us from destructive ultraviolet radiation from the sun. In addition, metrocket measurements of CO_2 are being used to study the effects on our atmosphere of man's increased use of fossil fuels.

A V-2 metrocket provided the first panoramic cloud pictures. These early pictures were the inspiration for the development of meteorological satellites, which now provide pictures of global cloud coverage. Today, metrocket data are used to calibrate remote-sensing instruments carried on meteorological satellites and are vital to the improvement of satellite instrumentation and data reduction processes.

Metrocket data also are being used for synoptic and climatological studies of the stratosphere and to determine the cause of stratospheric warming events and the equatorial quasi-biennial cycle, and how the interactions of the stratosphere and troposphere affect day-to-day weather. Metrocket data are needed in the preparation of range reference atmospheres for rocket and missile launches, the U.S. Standard Atmosphere, and also in the development of a 4-D (time) Global Reference Atmosphere for aerospace operations, as well as for the development and testing of theoretical atmospheric models. The Department of Defense also uses metrocket data in the design and operation of our National Defense System, while aircraft manufacturers use them in designing improved aerospace vehicles.

EDS' National Climatic Center in Asheville, N.C., currently archives about 26,000 metrocket observations in a publication library file covering the years 1960 through 1976. A magnetic tape file of about 15,000 observations taken during the years 1969 through 1975 is also available. Observations prior to 1969 are expected to be added to the magnetic tape file in the future. An average of 2,000 observations is added each year to the metrocket data files.

Earthquake Intensity

By Jerry Coffman
National Geophysical and Solar-Terrestrial Data Center

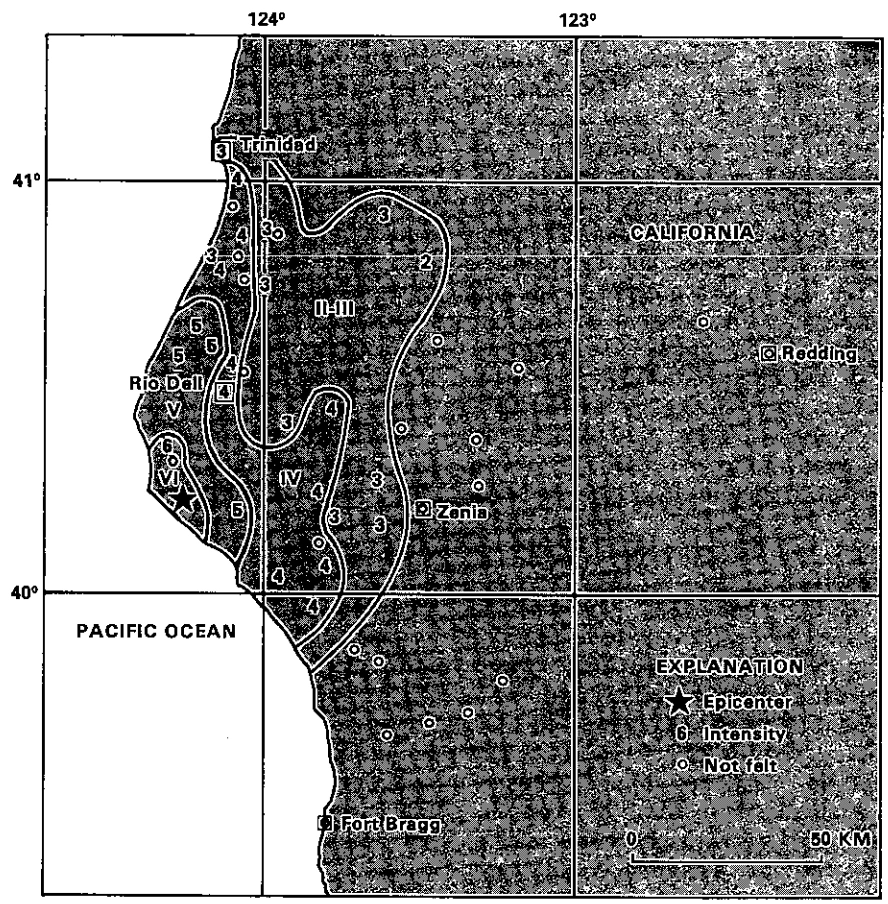
When an earthquake occurs in or near a populated area, seismologists want to know if it collapsed houses, caused landslides, tumbled chimneys, or cracked buildings. Was it noticed by all residents in the area or felt by only a few? In other words, what was the *intensity* of the earthquake?

Intensity is an indication of an earthquake's apparent severity at a specified location. It is determined: (1) by analyzing earthquake questionnaires distributed to people in the area; (2) by interviewing persons who experienced the tremor; and/or (3) by conducting damage surveys. Through all of these exercises the regional effects of an earthquake can be systematically described.

For seismologists and engineers, intensity is an effective shorthand for describing earthquake effects. Since 1928 all intensities derived for U.S. earthquakes have been published in the annual *United States Earthquakes* publication series. The publication is issued jointly by the NOAA/National Geophysical and Solar-Terrestrial Data Center and the U.S. Geological Survey.

Earthquake intensity data have been collected in the United States for about 50 years. They have become increasingly important to the insurance actuary, city planner, and scientist in estimating earthquake risk.

Although a large body of traditional applications and uses exist, and a great deal of study has gone into the attempt to relate intensity to acceleration of gravity and other physical parameters, until recently little had been done to systematize the intensity assignments or to evaluate the large volume of intensity data available for applicability and internal consistency. Public safety and, more recently, the need for the assessment of environmental impact have required those involved in the planning and construction of major facilities such as dams, nuclear powerplants, and high-rise buildings to allocate an appreciable portion of the cost of construction to this preliminary work.



Above: Analysis of earthquake effects in northern California, Jan. 11, 1975.

Right: Earthflow caused streetcar tracks to buckle (MM intensity X) on Howard Street during the great San Francisco earthquake, April 18, 1906.

Photo: G. K. Gilbert, USGS

Modified Mercalli Intensity Scales Of 1931

(ABRIDGED)

I. Not felt except by a very few under specially favorable circumstances.

II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing of truck. Duration estimated.

IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably.

V. Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.

VI. Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.

VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motorcars.

VIII. Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. persons driving motorcars disturbed.

IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from riverbanks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.

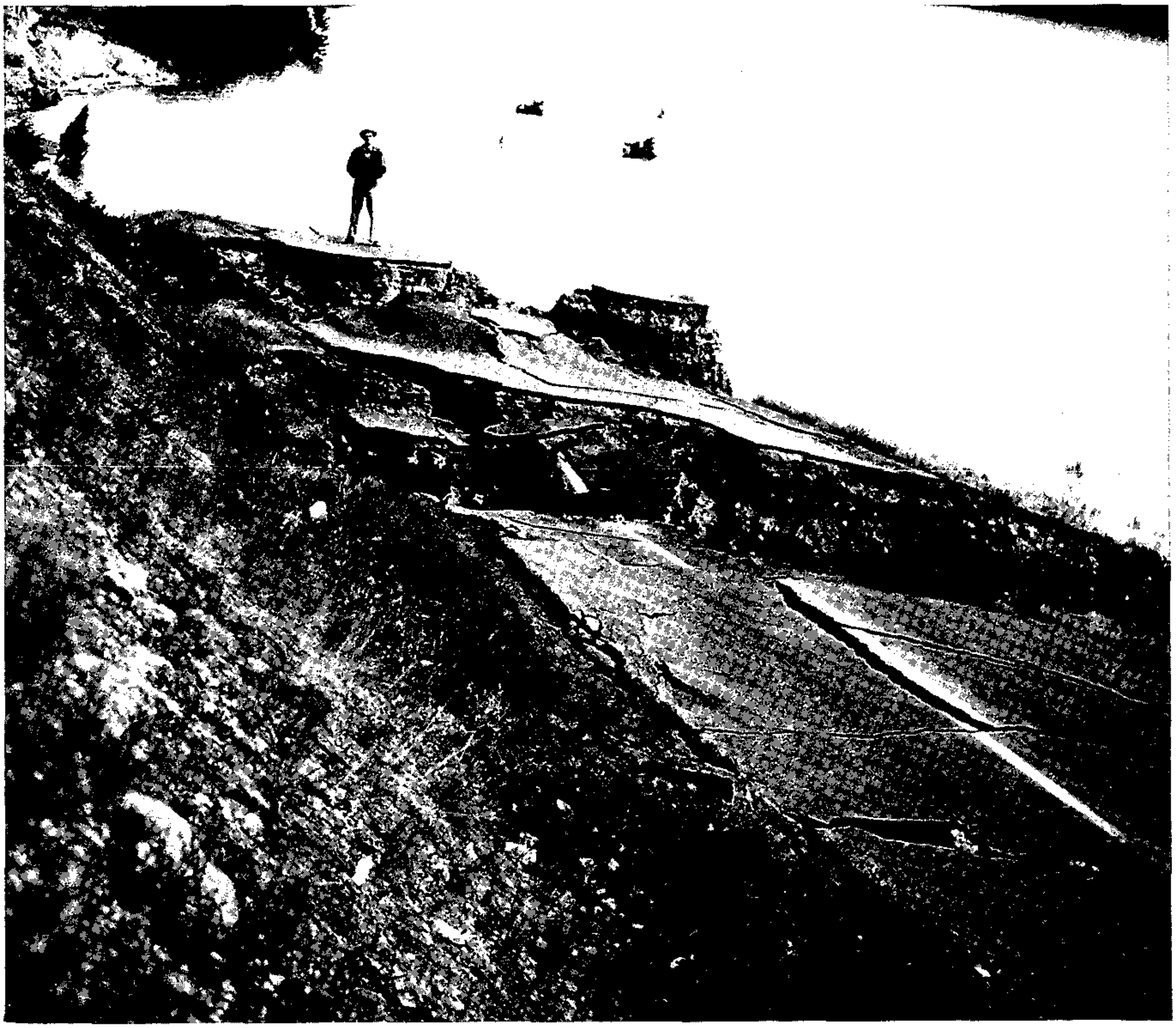
XI. Few, if any (masonry), structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into air.

The analysis of the seismic risk of a particular area can cost hundreds of thousands of dollars, but will reveal to the seismologist the highest intensity that would be likely to occur in that area.

When the science of seisomology was in its infancy, earthquake effects were grouped at various levels of intensity of a logical progression of adjectives: felt by few, several, many, all; damage slight, moderate, severe. Data were few and were drawn from a few well-document earthquakes. The intensity scaled as they were conceived classified earthquake effects in descriptive terms, primarily providing a history of seismic activity. They also were designed to provide a guide for future investigators of earthquakes.

Historically, earthquake intensity scales date from the mid-18th Century. The first widely recognized system was developed in 1883 by M. S. de Rossi of Italy and F. A. Forel of Switzerland. Known as the Rossi-Forel Scale, it was used almost exclusively until the adoption of the Modified Mercalli or MM Scale. G. Mercalli expanded and improved the 10-step Rossi-Forel Scale in 1902. In 1904 A. Cancani published a version that included levels of acceleration. These works were later consolidated and revised by A. Sieberg, and finally the latter work was revised and modified by H. O. Wood and Frank Neumann in 1931. This is the MM Intensity



Scale, which has been used as a standard in the United States since that time. The MM Scale grades observed effects into 12 classes ranging from felt only under special circumstances, to total damage (see MM Scale on p. 18).

It is doubtful that the originators of the MM Scale foresaw the importance intensity would attain or the stringent uses to which it would be put in modern society. Because intensity is the seismic parameter related most directly to the human condition and to economics, and because of the plethora of this type in comparison to instrumental earthquake data, a continuing effort is being made to relate intensity to acceleration gravity, energy density, and other quantities that can be treated mathematically. While a cursory reading of the MM Scale demonstrates that these subjective data cannot yield the exact results required for a direct comparison to these quantities, the data remain one of the major tools for gaging earthquake severity and for determining the level of seismic activity that might be expected in a given area.

The end of the road (MM intensity X). State Highway 287 disappears into Lake Hebgen, Montana, following an earthquake on Aug. 18, 1959.

New Weather Modification Biblography

A new computer-produced bibliography, *Weather Modification—Packaged Literature Search 77-1,* has been published by the Library and Information Services Division of EDS' Environmental Science Information Center. The fourth in a series of packaged searches on high-interest topics, it contains almost 1,000 references to technical literature dealing with topics such as cloud seeding, fog dissipation, lightning suppression, snow augmentation, and other aspects of weather modification and control.

Available free, the bibliography may be ordered from: the Library and Information Services Division, User Services Branch, Attn: R. R. Walter, D822, WSC-4, 6009 Executive Blvd., Rockville, Md., 20852, or by calling (301) 443-8330.

Weather Modification includes abstracts for many citations. It was produced from the Meteorological and Geoastrophysical Abstracts data base, which is automated with EDS support.

Work is currently underway on searches dealing with oil spills and heavy metals. Suggestions for other topics are welcome.

Bibliographies also are prepared on request to meet individual needs. Data bases dealing with ongoing research as well as those dealing with published literature are available.

Cutting Construction Costs for Nuclear Powerplants

To minimize construction costs in siting nuclear reactors, the Tennessee Valley Authority has given EDS' National Climatic Center two contracts to extract and analyze wind data.

The first contract is to extract daily maximum 30-minute and hourly wind speeds from each of eight directions (N, NE, SE, E, S, SW, W, and NW) for Knoxville, Tenn., for the period June-September 1948-74. Frequency tabulations of the daily maximum wind speeds (both 30-min and hourly) will be prepared for each month and season. In addition, monthly and seasonal extreme value analyses will be performed to derive selected probability estimates for each direction and each quadrant.

Comparisons will be made of frequency distributions for Knoxville for 1948-74 with the frequency distributions for Phipps Bend, a proposed nuclear reactor site, for a shorter period, 1973-75. The results will enable TVA design engineers to derive more realistic probability estimates of extreme 30-min and hourly wind speeds.

The results of a study of northerly directions only (NW, N and NE) provided TVA with the data necessary to show that analysis of extreme wind speeds for a critical direction, as opposed to analysis of extreme wind speeds for all directions, provided probability estimates which were significantly lower than those used in previously determined design standards and therefore reduced construction costs of the nuclear power plant being built by Phipps Bend.

The remainder of the first contract (nearing completion) will compare the remaining five directions (E, SE, S, SW, and W) for Knoxville with those of Phipps Bend. Comparisons also will be made of extreme value analyses for each direction for 30-min and hourly values with standard extreme value analysis, where the extreme wind speeds are derived from all directions.

The second contract is to extract daily maximum 30-min and hourly wind speeds for three additional stations within Tennessee—Chattanooga, Nashville, and Memphis. Extreme value analyses will be performed and regions of homogeneity will be examined.

The results of these studies will provide design engineers with more realistic probability estimates of extreme wind speeds for critical directions. These estimates may be used to significantly reduce construction costs for other nuclear power plants within the Tennessee Valley.

CDP Seismic Reflection Data for Alaska Coastal Areas

EDS' National Geophysical and Solar-Terrestrial Data Center has acquired from the U.S. Geological Survey over 3,400 n mi of multichannel common depth point (CDP) seismic reflection data for coastal areas of the Gulf of Alaska and the southeast Bering Sea. These data are of particular interest to groups involved in exploration and research on the Alaska continental shelves.

The CDP lines for the Gulf of Alaska were gathered from June through August 1975 aboard the *M/V Cecil H. Green.* The amplitude recovery sections, which contain either 24- or 48-fold recovery, were produced at a scale of 2 1/2 in/s and 20 traces per inch. The data are available in the following formats:

- Sections and location maps—sepia or blackline.
- Velocity profiles and observer logs—35-mm microfilm.
- Technical report, shot-point locations—microfiche.

CDP lines for the Bering Sea of Alaska were obtained by the Research Vessel *Lee* in September 1975. These sections are being distributed in the form of sepia or blackline copies. While all of the data were processed using standard automated gain control techniques, approximately 1/4 of the sections also include amplitude recovery. The shot point data are on microfiche.

For further information and costs contact: National Geophysical and Solar-Terrestrial Data Center, NOAA/EDS, Code D621, Boulder, CO 80302. Tel.: 303-499-1000, ext. 6542 or 6338; FTS 323-6542 or 323-6338.

Areas for which CDP seismic reflection data are available.

Catalog of Digital Bathymetric Data for Northeast U.S. Coastal Regions

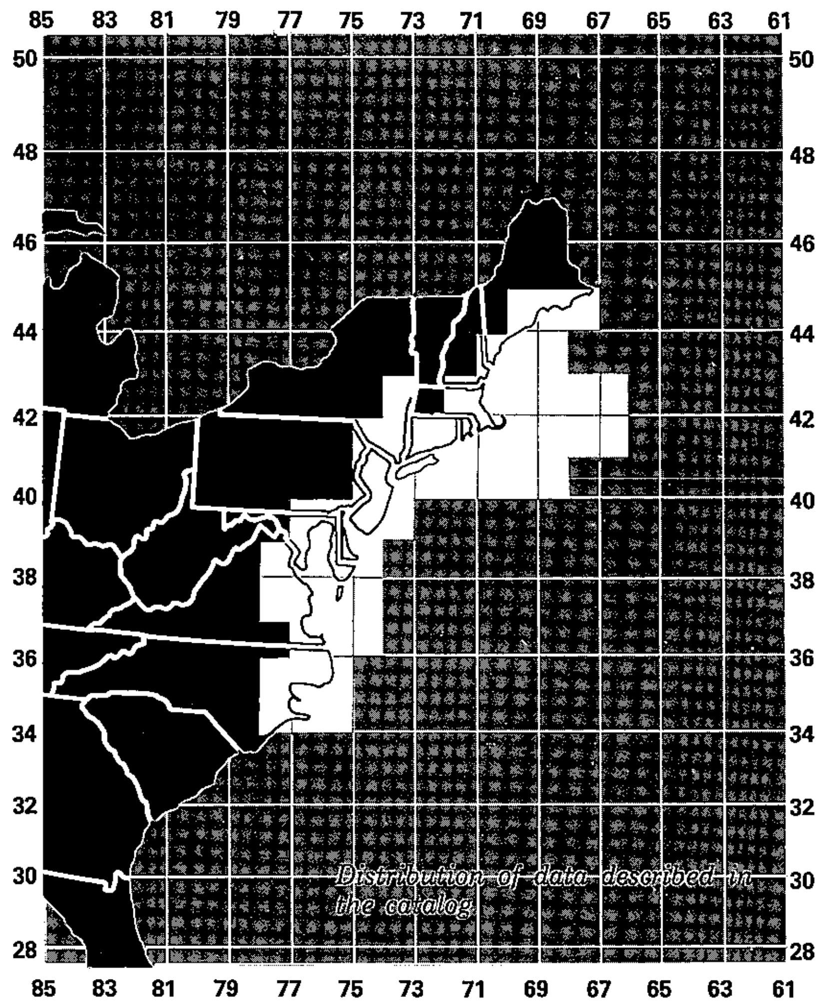
EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) has issued *Catalog of Digital Bathymetric Data for the United States Coastal Regions* for 34°-45° North Latitude, Atlantic Coast. This is the first in a series of catalogs that describe digital bathymetric and associated data available from NGSDC. The catalog includes a brief history and description of the data, describes data products, gives ordering instructions and prices, and depicts geographical data distribution and density on area index charts. The data result from a National Ocean Survey (NOS) program to digitize hydrographic data from more than 3,200 hydrographic surveys as part of a project to automate the nautical chart production process. Soundings, bottom characteristics and danger to navigation data from all coastal waters of the United States including Alaska, Hawaii, Puerto Rico, and the Great Lakes are included in this project.

These data have been extracted from surveys made between 1930 and 1965. Data from surveys conducted after 1965 will become available during the next several years. All data has been coded directly from hydrographic survey smooth sheets, which constitute the official permanent record of a hydrographic survey.

Approximately 98 percent of the hydrographic survey data available from NGSDC are soundings; the remainder concern bottom characteristics and dangers to navigation (e.g., coarse yellow sand, hard, mud, wreck, piling, rock, etc.). All data records contain the registry number of the survey from which they were extracted, the year and month of the survey, the latitude and longitude to the nearest 0.01 second, and a cartographic code identifying the precise type of information (i.e., sounding in feet, sounding in fathoms, bottom characteristics, dangers to navigation, etc.).

Various plotter products also are available, in addition to data on magnetic tape. These include; plots of soundings, bottom characteristics, dangers to navigation, bottom profile plots, and various statistical plots.

Copies of the catalog may be obtained from the National Geophysical and Solar-Terrestrial Data Center, Code D621, NOAA/EDS, Boulder, CO 80302. Tel.: 303-499-1000, Ext. 6338. FTS 323-6338.



Projections of Natural Gas Demand

The Environmental Data Service's Center for Climatic and Environmental Assessment (CCEA) is now providing projections of natural gas demand for multi-state divisions of the conterminous United States on a monthly and seasonal basis.

The seasonal estimates are based on the National Weather Service's (NWS) long-range seasonal outlook for average temperature. The outlook indicates areas of the country that are expected to have temperatures above, below, or approximately normal.

To relate these temperature outlooks to potential demand for natural gas, the expected numbers of heating degree days (a temperature-related measure of fuel demand) for the States in each division are derived, based on the climate of the State and the NWS temperature outlook (Lehman 1977).* These State heating degree day values are then weighted according to the number of the residential natural gas heating customers in each component State. The customer-weighted divisional heating degree day values are input to linear equations whose estimated coefficients relate the values to natural gas consumption. The equations themselves were derived by fitting historical divisional degree days to the American Gas Association's quarterly reports on natural gas consumption in each division.

CCEA's initial projection of

natural gas demand for the current heating season was made on August 31 for the period September through November. It was based on the NWS Long-Range Prediction Group's *Outlook for Fall Average Temperature.* Consistently lower demand was projected in the central and eastern divisions as compared to the level of demand during the same period in 1976, during record-breaking cold weather. In the United States overall, the estimate was that natural gas consumption would be about 84 percent of consumption during the same period last year. If this projection proves accurate, natural gas supplies should be more abundant than last year as we head into the mid-winter period of peak demand, December through February.

In addition to producing seasonal forecasts for the winter and spring on December 1 and March 1, respectively, CCEA also will provide monthly projections of natural gas demand on the first of every month, starting on October 1. The projections will include: (1) estimates of natural gas consumption to date, based on accumulated heating-degree days obtained from the NWS *Population Weighted State Degree Day Summary and Forecast,* (2) a projection of natural gas demand, based on the NWS *Average Monthly Weather Outlook,* employing the methodology previously described, and (3) an estimate of natural gas demand over the balance of the heating season (i.e., through May), based on the normal climate of each division.

The CCEA seasonal and monthly estimates are provided to the U.S. Department of Energy and other Federal agencies involved in energy use and planning studies. It is anticipated that these analyses will make possible a better assessment of natural gas use and demand throughout the winter on both a regional and national level.

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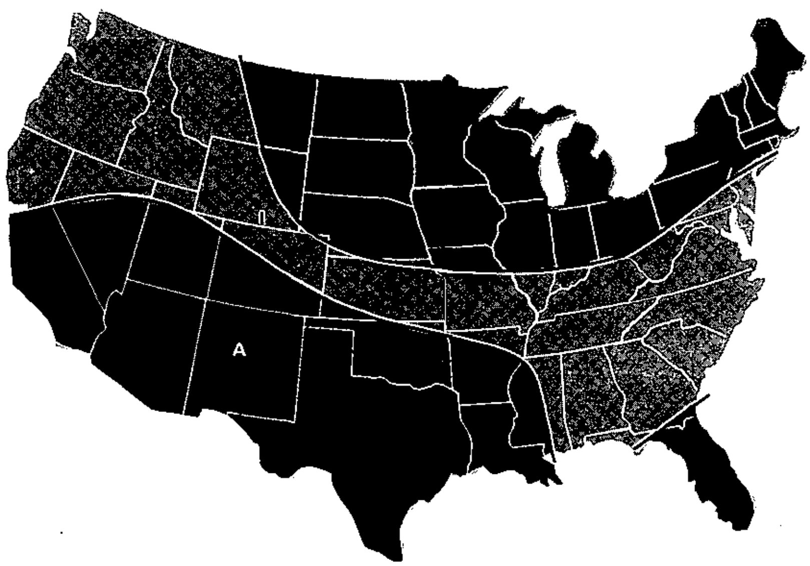
*Lehman, Richard L., and James Sebenius. *Month and Season Ahead Natural Gas Consumption Forecasts: Optimal Use of National Weather Service Data* (Working Paper), May 24, 1977.

The National Weather Service's outlook for fall average temperatures was used to produce EDS' first seasonal projection of natural gas demand.



A Above Normal, 60% chance of occurrence
B Below Normal, 60% chance of occurrence
I Indeterminate, 50% chance of Above Normal 50% chance of Below Normal

NOAA Products and Services in Puget Sound Area

In mid-August, a 38-page pamphlet, *NOAA Products and Services, Puget Sound,* was issued for public distribution in the Seattle area. The booklet was prepared jointly by personnel of EDS' Environmental Science Information Center (ESIC) and NOAA's Marine Ecosystems Analysis Program Office in Seattle and lists NOAA marine and atmospheric products and services available in the Puget Sound region.

The volume is divided into five sections, which correspond roughly to the NOAA components offering the services. After each entry, there are access numbers which represent (1) the principal source for the product or service and (2) a local source where the product (or related information) can be obtained, including current prices. These numbers are keyed to an appendix where complete mailing and telephone information is listed.

In Section I, nautical publications, charts, maps, photographs, and surveys are enumerated and described. Services relating to weather, climate, and forecasts are listed in Section II.

Fishery services are detailed in Section III, including education and information programs, inspection assistance, publications available, and financial aid programs for the regional fishing industry.

In Section IV, data and information services are described. These include general background on data referral services, as well as sources of oceanographic, meteorological, and geophysical data and satellite data. The materials on hand and operating hours of the three NOAA libraries open to the public in the region are outlined. In addition, borrowing privileges regarding the NOAA movie library are explained.

NOAA research activities and related services are spelled out in Section V.

Primary distribution of the catalog will be made from the MESA office in Seattle. Requests should be directed to MESA Puget Sound Project, NOAA/ERL, 7600 Sand Point Way, N.E., Seattle, Washington 98115. Telephone: 206-442-5590; FTS 399-5590. A limited number of copies are available in the Washington, D.C. area. The address is ESIC, User Services Branch (D822), WSC #4, Rockville, Maryland 20852. Telephone: 301-443-8330; FTS 443-8330.

Climate and Housing Design

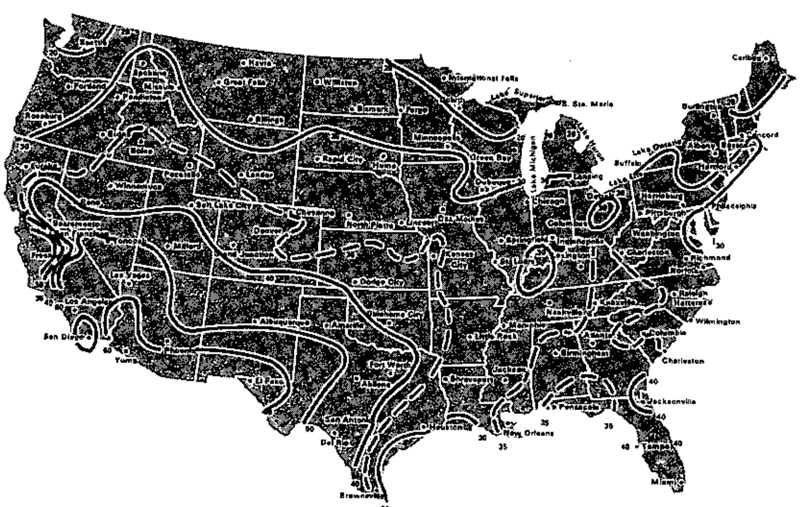
The American Institute of Architects Research Corporation and EDS' National Climatic Center are collaborating in a pilot project to determine the influence of climate on design criteria for residential housing. Initial project objectives are to (1) define design regions in the United States based upon climatic variables influencing human comfort and (2) determine specific climate responsive/energy conserving techniques.

Different climates require different approaches to housing design. In the Gulf Coast region, for example, wind impact on comfort is sustantial since, during a significant number of hours, temperatures are slightly above the comfort level. Opportunity for wind cooling is very favorable. House design for maximum use of wind includes elongated building plans that allow cross ventilation through each individual room. The designer also may consider building outside stairways leading to balconies, thereby giving each living space a front and back exposure.

In the Northern Plains, on the other hand, the winters are very cold and the summers hot. A person would want to shield himself from this climate's harsh effects. This can be accomplished in two ways. First, he can go underground until an almost constant temperature of 55°F is attained. (Dampness will not be a problem because of the region's low relative humidity.) Secondly, he can build a very tight, well-insulated house with relatively few windows which are small and shuttered.

The joint AIARC/NCC pilot project is using summarized climatic data for 130 localities in the contiguous United States to develop techniques that will identify regional influences on building design. The next phase will use actual hourly data from a much denser network of stations, permitting solution to the comfort design problem on a station-by-station basis, as well as finer tuning to local climatic variables.

Annual percent of time people would be comfortable without artifical heating or cooling if their homes were designed to take advantage of the local climate.



GATE Research Evaluation

A comprehensive 3-week workshop was held July 24 to August 12 to provide a forum for reporting and evaluating the U.S. research effort in the Global Atmospheric Research Program (GARP) Atlantic Tropical Experiment (GATE) of 1974. GATE was a pioneering investigation of the role of the tropics in global weather.

Although many GATE scientists had not completed their research, a number of important contributions to understanding of the tropical ocean and atmosphere were presented at the workshop. GATE has documented the great variability of convective activity in the Intertropical Convergence Zone (ITCZ) and its relation to large-scale synoptic events. Convection was found to occur primarily in the form of meso-scale clusters, which typically last a day or less. These convective entities, including squall lines, showed large temporal and spatial variability. Preliminary indications are that radiation has a more profound influence on the temporal variations of mature storms than was generally believed. The research also indicates that low-level convergence in the eastern Atlantic is stronger than that found in previous studies of the western tropical Atlantic and Pacific.

Several scientists reported on the progress of atmospheric budget studies, which attempt to account for all the gains and losses of, for example, water inside a large atmospheric volume; more specifically, the magnitudes and vertical and temporal distribution of water transport, evaporation, and condensation are sought. Initial comparisons of precipitation estimates obtained as residuals from the budget analyses to those derived directly from the GATE digital radar data show excellent agreement between the two independent methods, which sug-

Joost Businger of the University of Washington discussing energy transfer coefficients for the boundary layer between tropical ocean and atmosphere.
Photo: Ginger Wadleigh, NCAR

Ernst Augstein, University of Hamburg, raises a question during a GATE panel discussion. Also shown: NOAA's Feodor Ostapoff (left) and Steve Cox of Colorado State University.

Photo: Ginger Wadleigh, NCAR

gests that the quality of the data used for both procedures is quite good. Results from the budget analyses will improve physical understanding of the tropics and our ability to predict the state of the tropical atmosphere. An additional payoff will come from using GATE radar rainfall estimates as "ground truth" for evaluating the accuracy of satellite methods for estimating rainfall over tropical oceans.

An extensive set of observations are now available for studies of atmospheric processes below cloud base. Comparisons of the vertical energy transports for fair weather as well as foul measured by ships, aircraft, and tethered balloon sensors indicate very good agreement. Virtually all of the quantities necessary to initiate and test boundary layer models are available. Validation of such models, which account for the interaction of the atmosphere with the underlying sea surface, was one of the principal goals of the field experiment.

One of the surprising results was the percentage of the time the moist air below cloud base is replaced by air from above cloud base, which is typically much drier. Meteorological records from the acoustic sounder aboard the NOAA ship *Oceanographer* as well as other observations indicate the subcloud layer was significantly affected by such downflows 30 percent of the time in the center of the major GATE ship array. This may have important consequences for the atmosphere's ability to sustain active cumulus convection, which requires a supply of moist air derived from the subcloud layer.

Much of the oceanographic research has just begun. Preliminary analysis shows that tropical weather systems whose lifetimes are less than a few days do not force an oceangraphic response that is discernible above the background noise in the data. It appears that significant changes in the sea surface temperatures are on a time scale of several days to weeks. The implications are that advection by the mean currents and upwelling due to divergence of the mean currents play central roles in determining sea surface temperatures, which in turn may influence atmospheric motions.

Over 120 scientists participated in the workshop, including a few from Canada, France, Germany, the Soviet Union, and United Kingdom. Seven EDS scientists from the Center for Experiment Design and Data Analysis participated as part of CEDDA's continuing role in GATE research.

The scientific results of the Workshop are being published in a final report scheduled for fall 1977. This document will contain a synthesis of the U.S. GATE research to date and will be available from the GATE Project Office, NOAA, Rockville, MD 20852. The final results will be published in journals and in technical reports. A bibliography of ongoing GATE research will be published periodically by the GARP Activities Office of the World Meteorology Organization in Geneva, Switzerland. These reports also will be available through the GATE Project Office. Additonal information of this type will occasionally be included in the *GATE Information Bulletin* published by the National Center for Atmospheric Research, Boulder, CO 80302.

Geomagnetic Data for January 1976

The World Data Center-A for Solar-Terrestrial Physics (WDC-A STP) in Boulder, Colo., has published Report UAG-60, *Geomagnetic Data for January 1976 (AE (7) Indices and Stacked Magnetograms).* This publication, authored by J. H. Allen, C. A. Abston, and L. D. Morris of EDS' National Geohpysical and Solar-Terrestrial Data Center, presents one of the most used types of ground-based data, i.e., analog records of geomagnetic variations.

The report consists of tables, graphs, and statistics from the preliminary derivation of Auroral Electrojet (AE) indices based upon these records. Similar monthly data reports will be made available on an increasingly timely basis for the entire IMS (International Magnetospheric Study) observing period, January 1976-December 1979.

The seven observatories supplying data for this report are Barrow, Alaska; Fort Churchill, Canada; Narssarssuaq, Greenland; Leirvogur, Iceland; Abisko, Sweden; Dixon Island and Tixie Bay, U.S.S.R. These were chosen from among a list of 12 observatories whose records are now routinely used by WDC-A STP in the derivation of AE magnetic activity indices. Reasons for their selection were: (1) records from these sites are most promptly available, (2) the sites are about evenly spaced in longitude, and (3) each location has demonstrated its importance in the prior derivation of AE indices. As digital data processing from other observatories becomes more routine, the network can be expanded, and data from College, Alaska, and Great Whale River and Yellowknife, Canada can be included to improve the station distribution for these prompt indices.

Of the seven stations, only Fort Churchill and Barrow are presently supplying digital variations recorded onsite for this publication. Both observatories use fluxgate instruments supplemented by proton precession magnetometers and generate more or less routine absolute observations. Each component's amplitude is recorded every 10s at Fort Churchill and every 20s at Barrow on magnetic tape, and analog chart records are prepared as back up data. These high-time-resolution digital data are processed at central facilities responsible for each observatory. Obvious errors (usually spikes) are corrected and 1-min average values are computed. These preliminary data are sent on tape to WDC-A STP where they are plotted and checked for stability of quiet-time levels (baseline drift), presence of noise, and day-to-day continuity. As necessary, remaining spikes are removed, and "temporary" baselines are adopted to compensate for data problems that would affect derivation of AE indices.

All the other observatories record magnetic variations photographically. Their magnetograms are copied on 35-mm microfilm for transfer to WDC-A STP together with calibration information. Here they are reproduced as almost original size magnetograms and digitized at 1-min intervals using semiautomatic scaling equipment. Resulting digital tapes of component amplitudes relative to baselines are passed through the same plotting and other quality control processes as the original digital data described above.

Reports UAG-62 and 63 containing similar geomagnetic data and indices for February and March 1977 are now in press. All these reports are available from the National Geophysical and Solar-Terrestrial Data Center, NOAA, Boulder, CO 80302. Price $1.07 each.

Seismic Data Catalogs

Three new publications of interest to seismologists and other earth scientists were recently released by EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) and the collocated World Data Center-A for Solid Earth Geophysics.

The first, KGRD No. 9, *Catalog of Seismogram Archives,* describes in detail the seismograms and related services available from NGSDC. Of particular interest to researchers are the summaries of various seismograph station networks, archival lists, and special services offered. Prices, formats, and ordering information are included.

World Data Center-A for Solid-Earth Geophysics has issued Report SE-6, *Catalog of Seismograms and Strong-Motion Records.* It lists WDC-A holdings of seismograms and strong-motion records, provides price lists, and describes formats in which the records are available. The guidelines for collecting these data also are summarized.

WDC-A has also published Report SE-7, *Directory of Seismograph Stations,* which lists the technical characteristics of almost 300 seismograph stations that participate in the International Data Exchange program through the World Data Centers. The Directory is an important and useful tool for researchers, as it represents the first major attempt by any organization to compile such information since 1953.

These catalogs are available from National Geophysical and Solar-Terrestrial Data Center (D62) NOAA/EDS, Boulder, CO 80302.

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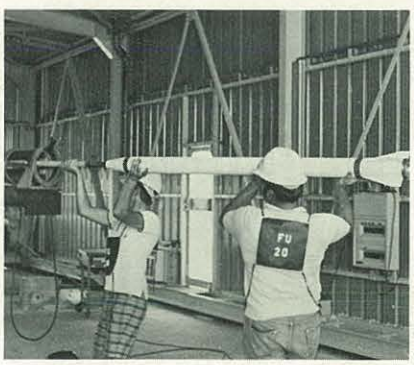
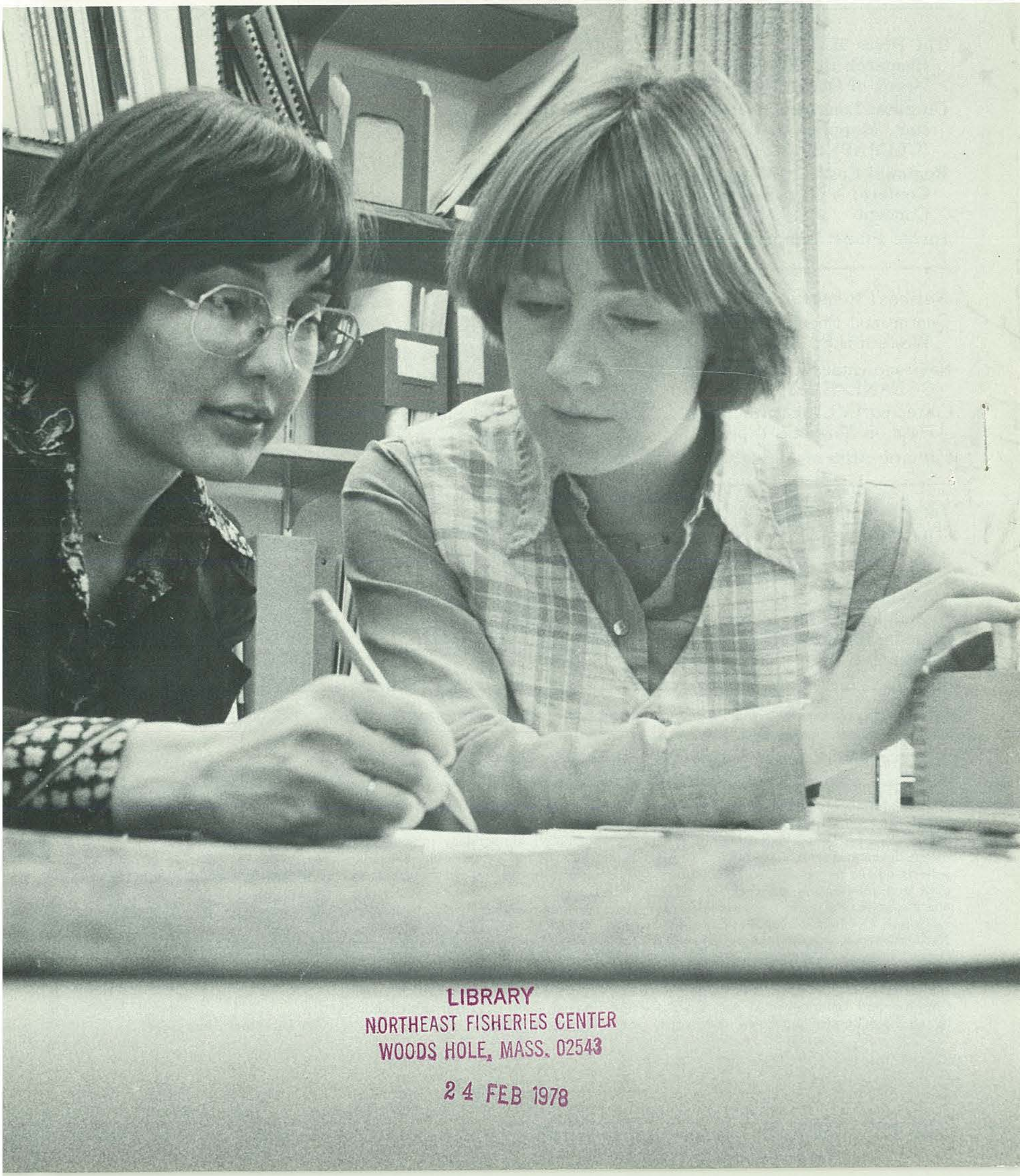


In this issue: *Meeting public needs for science information (p. 3), NOAA marine libary and information services (p. 8), meteorological rockets (p. 13), and earthquake effects (p. 16).*

EDS

Environmental
Data Service
January 1978



EDS

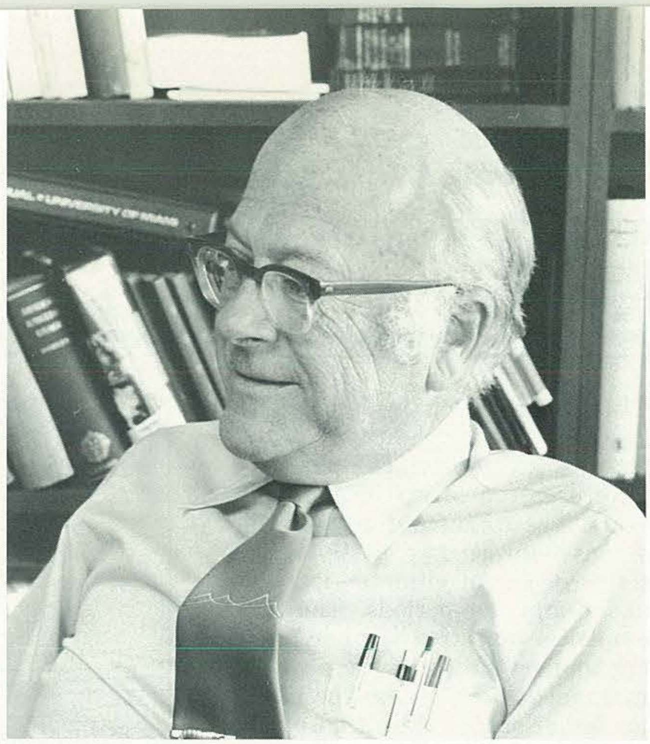
Environmental Data Service
January 1978

Cover: *Saskia Schott (left) and K. Allisan Black answer user requests at the new Pacific Northwest regional coastal information service center (see p. 8) at the University of Washington in Seattle.*

EDS is a bimonthly publication designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, and Center for Climatic and Environmental Assessment. In addition, under agreement with the National Academy of Sciences, EDS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 16, 1975; this approval expires June 30, 1978.

The Roles of Basic and Applied Research In Meeting The Needs of Ocean Users



In considering the development of a program of large-scale ocean research and exploration in the 1980's, the question must be addressed of its relevance to solving societal problems such as food, energy, and mineral resources, protection of the marine environment, and the forecasting of weather and climate.

The nature of the interaction between fundamental and applied research was noted by Lee DuBridge at the California Institute of Technology commencement exercise in June 1977: "Applied research—aimed at meeting the urgent needs of our society—is important. But we shall not succeed if we fail to produce the fundamental knowledge on which future applications depend, just as we shall not succeed if we don't seek to make that knowledge applicable to human needs."

The extent to which large-scale oceanographic investigations of the 1980's should be expected to lead to near-term applications and the possible use of criteria for selecting projects of high potential for application, were discussed by a workshop on post-IDOE (International Decade of Ocean Exploration, 1970-1980: see p. 19) planning on 27-29 June 1977. Although participants considered that the scientific quality of the proposed research should be the prime criterion for support, they agreed that potential application of project results to long-term societal problems was also of great importance. As the report states, "Eventually, the investment of public funds will be justified by the gain in understanding of ocean phenomena and processes and by the application of this knowledge to the beneficial use of the ocean and its resources."

Additional insight into the question can be gained from some 65 letters received during the late spring and early summer, largely in response to an inquiry from the Marine Board of the National Academy of Engineering, and dealing with the practical utility of IDOE results and the needs of a variety of users for information on the ocean and its resources. These users represent a cross-section of government agencies and ocean-based industry. There are a number of conclusions that can be drawn from their responses:

- The results of IDOE investigations, with few exceptions, have not yet been applied, except within the field of marine research itself.

- Reasons for this lack of application may include: the long-term and fundamental nature of IDOE projects, a mismatch between IDOE projects and applied needs, or the lack of a suitable mechanism for the transfer of research results.

- In most cases, it is too early to expect direct application. Some respondents argue that IDOE projects should have been selected and designed to produce shorter term payoffs, but most accepted the more fundamental nature of the research.

- Some research needs expressed by various user groups, e.g., those needs involving routine monitoring of oceanic conditions, should more appropriately be met by government agencies or by industry than by academic institutions. But the scientific basis and methodology for such programs may be developed in the process of academic research.

- Government agencies and other user groups differ in their experience in working with academic institutions and in their appreciation of the proper role for academic research vis-a-vis that of government or industry. The experienced users with large-scale and long-term programs of ocean use (e.g., the Navy and some NOAA elements) are most likely to articulate needs that match the interests and capabilities of academic laboratories.

- The transfer of research results to application would be facilitated by greater user involvement in the development and selection of projects, and in relevant advisory and review panels.

- In the long run, information and understanding of value to user groups are more likely to be developed by academic institutions if they arise through research on concepts and processes rather than through narrow, application-oriented research.

Warren S. Wooster

Warren S. Wooster
Chairman, Steering Committee
for Post-IDOE Planning
National Research Council

Climate: Long-Range Investigation, Mapping and Prediction (CLIMAP) Study*

By John Imbrie
Brown University

CLIMAP research is designed to describe and explain the major changes in global climate that have occurred in the past million years. These changes involve transitions between two partly stable states of global climate—ice ages and temperate periods. The fundamental objective is to improve our understanding of the physical mechanisms that cause these major variations in the atmosphere, ocean, and ice sheets. Because these changes have simpler geographic patterns and occur more slowly than climatic changes taking place on a year-to-year or decade-to-decade scale, they are in many ways easier to understand than the higher frequency events.

CLIMAP's central strategy is to view the geological record of the ice-age cycle as a huge, natural experiment to gain new climatic insights. These insights will help improve our ability to understand and forecast the economically important variations in climate that occur on human time scales.

A unique aspect of the CLIMAP study is that analyses of deep-sea sediments are used as the primary source of data. Deep-sea sediments are particularly useful as indicators of past climatic conditions for a variety of reasons. 1) They are not geographically restricted, and their global extent adds to their value as climatic indicators because the interchange between the ocean and the atmosphere plays a dominant role in climatic variations. 2) Deep-sea sediments accumulate at a relatively constant and continuous rate that is uninterrupted for perhaps hundreds of thousands of years. 3) The chemical, physical, and biological characteristics leave a permanent record of many aspects of the ocean, including the temperature and circulation pattern of the surface waters, the chemical nature of the bottom waters, and the extent of sea ice. In addition, isotopic studies of marine sediments make it possible to calculate historical changes in the volume of terrestrial ice sheets.

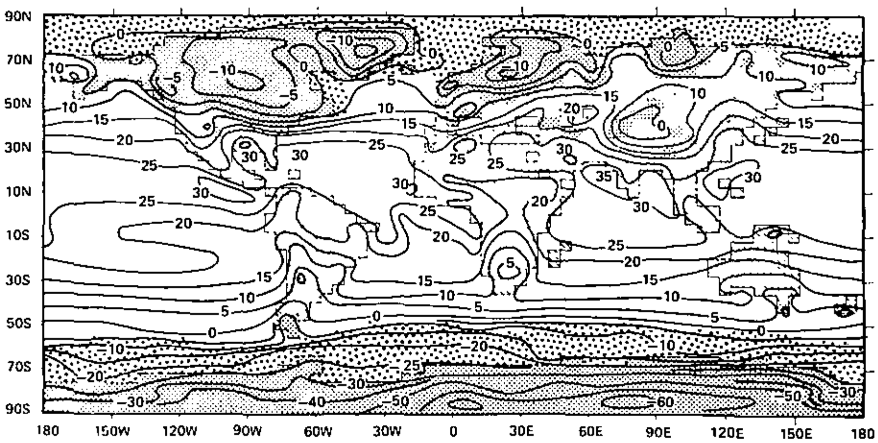


Figure 1

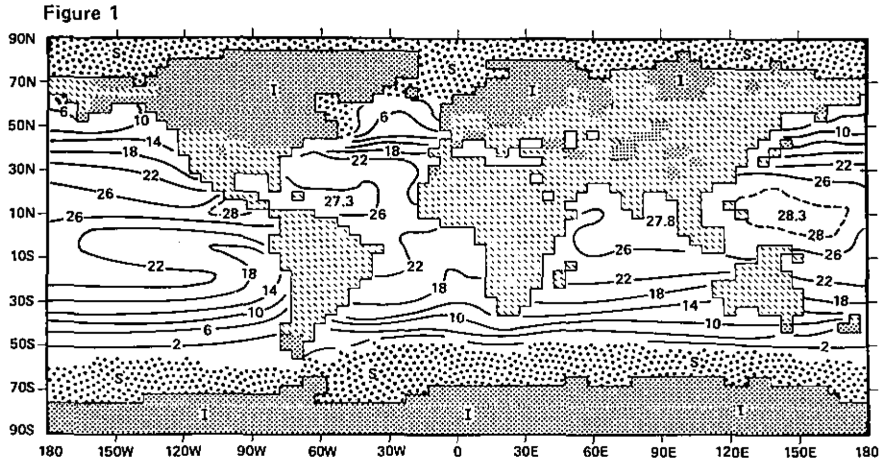


Figure 2

Top: Simulated surface air temperatures (°C) for ice age August. Above: Ice age surface boundary conditions for August. Sea-surface temperatures are in degrees Celsius. On both charts, large dots denote sea ice, small dots ice sheets.

* **International Decade of Ocean Exploration Progress Report, Vol. 6.** See page 19.

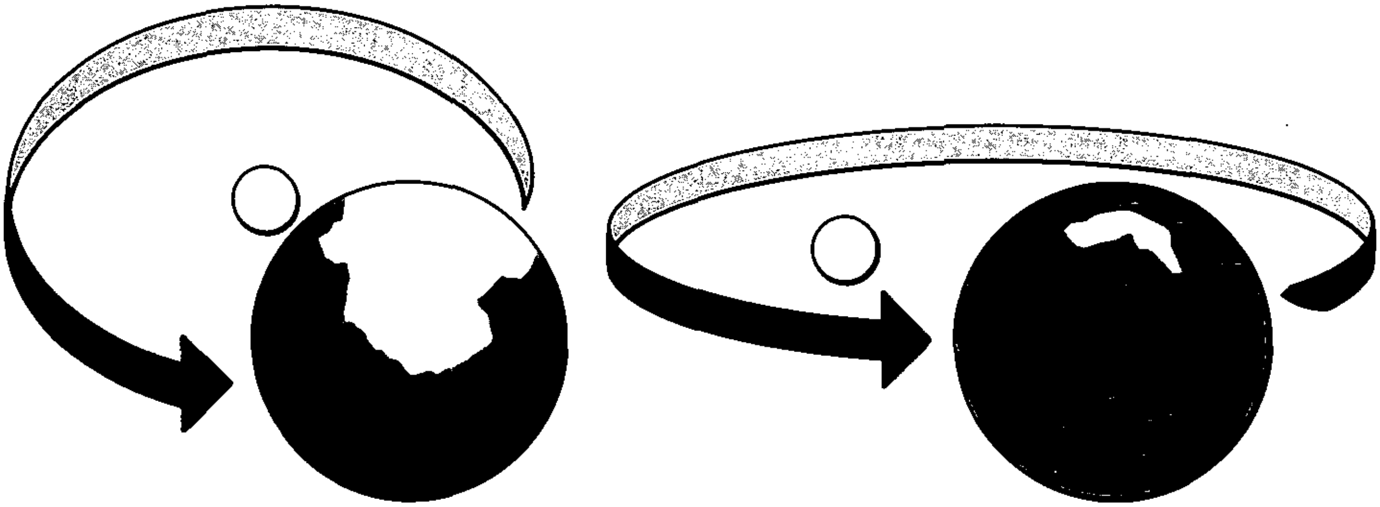


Figure 3

The ice sheet advances when the Earth's orbit is circular, retreats when it is elliptical.

Each sediment core is thus a multipurpose recorder monitoring past climatic changes.

Modeling of Ice Age Climate. One recent advance in CLIMAP research is the publication of a numerical model of the global atmosphere at the maximum extent of the last ice age, 18,000 years ago (fig. 1). This work is part of a larger program directed to reconstruct the geographic pattern of selected past climatic states—and to learn from these reconstructions how winds and the ocean currents balance the Earth's radiation budgets during climatic regimes quite different from that of today.

The results shown in figure 1 were obtained by CLIMAP corresponding member W. L. Gates as follows:

CLIMAP paleo-oceanographers first assembled synoptic records of the Earth's surface 18,000 years ago (fig. 2). These records include the extent and elevation of the ice sheets, the extent of sea ice, the temperature of the sea surface, and the albedo (reflectivity) of the land surface. This information is assembled and used as the set of boundary conditions for running a numerical model of the atmosphere. The surface air temperatures (fig. 1) and other properties of the ice age atmosphere are then calculated by the model. When averaged globally, and compared to temperatures calculated for the climate today, the mean air temperature decrease during the ice age was only 5° C. This result is one of the most important CLIMAP contributions to date. For the first time, we have an accurate estimate of the magnitude of the largest climatic change to occur during the past million years. Thus, we have a basis for judging the impact of any change in future climate that might occur either naturally or as the result of man's activities.

Solar Control of Climate. Another important advance in recent CLIMAP research is the publication of evidence that changes in the geometry of the Earth's orbit are a major cause of the ice ages. This theory, which was developed originally a century ago and has come to be known as the Milankovich theory, assumes that ice ages are caused by changes in the seasonal and latitudinal distribution of solar energy that must result when the geometry of the Earth's solar orbit changes.

Three periodic variations in the orbit occur as a result of changes in the position of planets in the solar system—variations in the eccentricity of the orbit, with an average period of about 100,000 years; in the tilt of the Earth's axis with a period of about 41,000 years; and a 22,000-year cycle in the position of the orbital path at which a given season occurs. According to a modified version of the Milankovich theory, each of these periodicities should be found in climatic records—if, in fact, the orbital changes are the fundamental cause of the ice ages. CLIMAP researchers assembled long climatic records from two deep-sea cores from the southern Indian Ocean, and discovered climatic periodicities so close to those predicted that the Milankovich theory is confirmed as the primary cause of the ice age cycle. The effect of the longest cycle is shown schematically in figure 3.

CLIMAP Data

CLIMAP Data are available as follows:

Paleontological and geochemical data are available for the 635 core locations indicated in figure 4. Paleontological data include counts of 51 species of diatoms, 44 species of planktonic foraminifera, 21 species of radiolaria, and 68 species of coccoliths. Geochemical data include percentages of opal, quartz, carbonate, and organic carbon. Percentages of opal and quartz were determined by X-ray diffraction and carbon analyses were performed on a "Leco" Induction Furnace. A breakdown of the available data appears below:

Data Type	No. of Cores	No. of Analyses
Chemistry	219	1,757
Coccoliths	96	886
Diatoms	43	43
Foraminifera	290	960
Radiolaria	173	624

In addition, each data record contains the following information:

- Ship-cruise-core number
- Latitude, longitude, and water depth
- Core type, length, and sample depth within a core.

The CLIMAP data set is available on 7- or 9-track coded magnetic tape, at any compatible density, with a logical record length of 80 characters, blocked (5120 characters or less) or unblocked. Documentation and format of the data are provided in print form and also appear in text form at the beginning of the tape.

Queries should be addressed to:

IDOE Project Leader (J. B. Grant)
Marine Geology and Geophysics Branch
National Geophysical and Solar-Terrestrial Data Center
National Oceanic and Atmospheric Administration
Boulder, CO 80302
Tel: (303) 499-1000, ext. 6339

Other Accomplishments. Other CLIMAP accomplishments during the report period include:

- An interactive system of computer programs called the CLIMAP Update System has been designed to store paleo-oceanographic data. Over 11,000 carbonate, 4,000 isotope, and 140 radioisotope analyses will soon be added to the CLIMAP data file presently archived with EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) in Boulder, Colo.
- A volume of 17 scientific papers published in 1976 reflects the multidisciplinary efforts of the CLIMAP project. (Geographical Society of America Memoir 145, edited by R. M. Cline and J. D. Hays, *Investigation of Late Quaternary Paleo-oceanography and Paleoclimatology,* x + 446 pages, 245 figures, 66 tables, 26 appendices on three 98-frame microfiche for use on 24x readers.)
- Studies of the movement of the North Atlantic Polar Front during the last major climatic cycle (127,000 to 12,000 years ago) indicate that at times the rate of movement can average in excess of 1 kilometer/year over several thousand years. Thus, a major change in climate from a full-glacial state to an average interglacial configuration can occur in less than 3,000 years.
- Polar studies in both hemispheres have shown that significant portions of ice age sheets were grounded below sea level. Compared to ice sheets on land, these marine ice sheets are relatively unstable. During the last ice age, the Antarctic ice sheet was considerably expanded from its present condition, mostly in the West Antarctic. Since then, the marine ice sheet there has receded slowly. During the last interglacial interval, about 125,000 years ago, this portion of the Antarctic ice sheet collapsed completely.
- CLIMAP's synoptic reconstruction of the surface of the ice age world, 18,000 years ago, has been significantly improved by increasing the number and accuracy of the control points. In addition, reconstruction for average August and February conditions has been completed.

Future Activities. Future CLIMAP research plans include:

- Numerical simulation of the ice age atmosphere by several general circulation models. Plans call for simulation experiments to be made by: W. L. Gates, Oregon State University; the Geophysical Fluid Dynamics Laboratory, Princeton; The National Center for Atmospheric Research, Boulder, Colorado; the Institute of Oceanology, Moscow; and members of the IDOE NORPAX (North Pacific Experiment) project.
- Detailed investigations of the dynamics of climate change im-

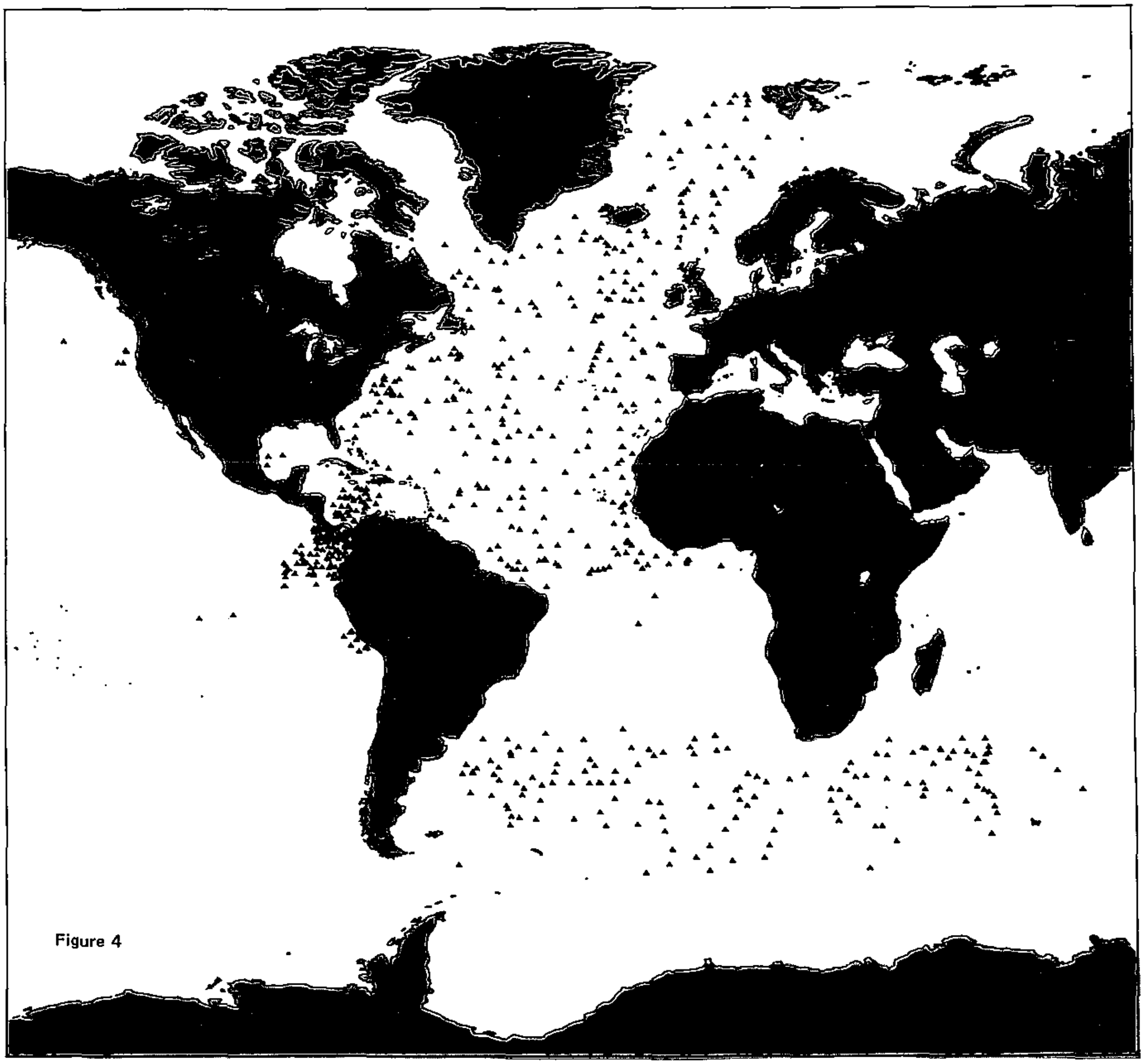


Figure 4

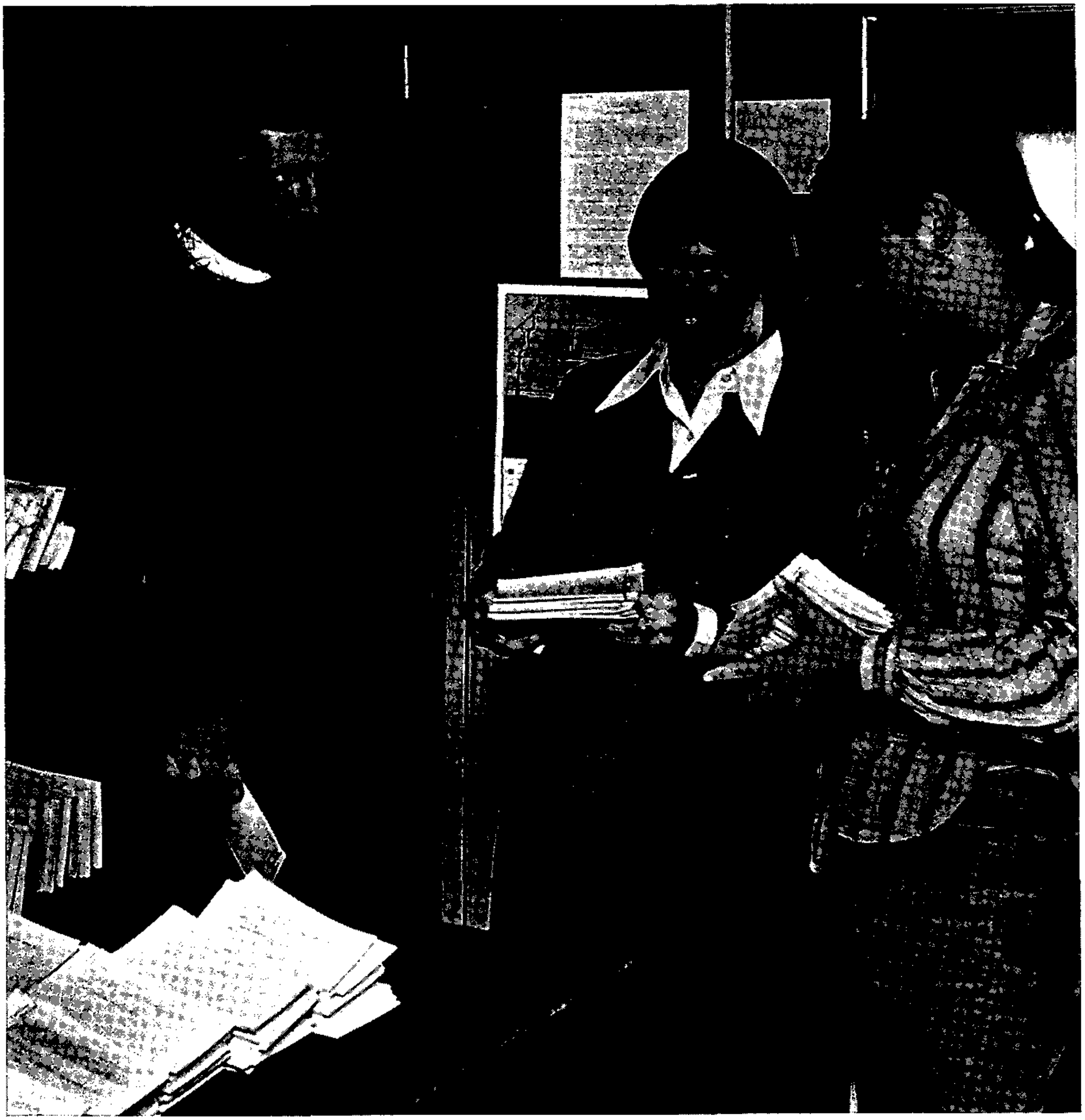
mediately before, during, and after the last interglacial period before the present (circa 125,000 years ago).

• Investigations of the frequencies of climatic changes as recorded in long deep-sea cores selected from all major oceans. Of particular interest in these studies will be a study of the timing of the response of various parts of the climate system during major regime changes: surface waters of the ocean, deep waters of the ocean, atmosphere, and ice sheets. In particular, it is important to find out what part of the global climate system responds first to changes in orbital geometry. This information will give valuable clues to the mechanism (now unknown) by which orbital variations influence climate.

CLIMAP core locations. Deep-sea sediments are the primary data source for the study.

Regional Coastal Information Centers: A New Service Concept

By Donald McGuire
National Oceanographic Data Center



The Jamestown Taxpayers Association, Inc., of Jamestown, R.I., wondered whether their community's drinking water supply would be adequate to meet the demand of proposed housing developments. Rhode Island's Coastal Resources Center needed a variety of energy consumption statistics for Rhode Island and New England for research it was carrying out for the Rhode Island Coastal Resources Council, the agency in charge of the state's Coastal Zone Management Plan. A summer research aide with the Environmental Defense Fund in Washington, D.C., was trying to determine the relationship between wetland development and local tax structures. The principal planner of Cape May County, N.J., wanted to know what research had been done on the use of dredged materials in rebuilding eroded beaches.

All these people needed information related to the coastal zone. All went to the same place to get that information—the newly established (April 1977) Regional Coastal Information Center of the New England Marine Advisory Service. The center, located in the Division of Marine Resources on the Bay Campus of the University of Rhode Island in Narragansett was established specifically to provide coastal and marine information and data for the New England States and New York.

The Jamestown Taxpayers Association was sent copies of pertinent pages of a 1971 study, *Public Water Systems of Rhode Island* and was referred to the town's Water and Sewer Commission and the State Water Resources Board.

Christopher Benetti, Candy Dunn, and Jane. Miner review a master list of information sources being developed by Coastal Information, the Northeast RCIC.

Statistics for the Coastal Resources Center were compiled from phone conversations and correspondence with the Bureau of Mines in Washington, D.C., the Rhode Island Department of Economic Development, the Massachusetts Institute of Technology, the New England Energy Policy Council, and the University of Rhode Island's Government Publications Repository.

The researcher with the Environmental Defense Fund in Washington got materials on loan from the National Sea Grant Publications Depository at the University, the names and telephone numbers of Marine Advisory Service personnel in each coastal state, and was referred to the National Coastal Zone Information Center in Washington, part of NOAA's Office of Coastal Zone Management, and to local information sources in her region.

The Cape May planner was referred to the U.S. Army Corps of Engineers District Office for New Jersey and their Coastal Engineering Research Center near Washington, and was given a list of 10 publications and a list of experts working in the area of beach nourishment and stabilization. The information specialist at the Center also arranged for the publications to be obtained on inter-library loan by the Cape May County Library.

Other inquiries during the Center's first month of operation came from a governor's advisor concerned about nuclear powerplants and their social and economic effects; the New England Aquarium which was holding a meeting on coastal zone issues for Massachusetts marine educators and needed samples and ordering information on readily available and inexpensive coastal zone related documents; a local town planner who wanted to know how the Coastal Resources Council reviews town project proposals; and a scientist preparing an environmental impact statement for a local utility company.

The Regional Coastal Information Center (RCIC) concept is a new NOAA approach to making coastal and marine information and data locally available to those who need it. There is a growing constituency for such services, particularly as more and more of the management of coastal resources is being undertaken by state and local governments.

The development of the RCIC concept parallels a concept put forward by Dr. Vincent Giuliano in a National Science Foundation-sponsored study of Federal scientific and technical information policies. (See *EDS*, Nov. 1977, p. 4.) Guiliano points out that there have been three "eras" in the development of scientific and technical information dissemination systems. The first is the traditional, discipline-oriented system evolved in the 19th Century for the transfer of knowledge from scientist to scientist. The second resulted from the emergence of "big science" and technology in World War II and reached maturity with the space program in the 1960's. Here the systems are mission-oriented, and information transfer is from scientist to engineer or engineer to engineer. The third era, which began in the 1960's and is still evolving, is concerned with public policy formulation, planning, and management. Issues include quality of life, environment, natural resources, and related matters. Here information transfer involves physical scientists and engineers, but also policy analysts, social scientists, lawyers, legislators, and a wide variety of public and private interest groups. These new users need information in different forms and combinations than those provided by traditional information services.

The NOAA concept of a network

of Regional Coastal Information Centers addresses the need for a mechanism capable of providing a service interface between the broadening user community and traditional technical information dissemination systems.

The basic RCIC program is built on four general goals:

- To increase the *awareness* of local planners, managers, legislators, decision-makers, and researchers of the existence of information resources of potential value to them.

- To enhance the *accessibility* of environmental, social, and economic information, thereby making it easier and less costly to obtain.

- To provide a source of *availability* of information of substantial potential value for which no suitable means of dissemination otherwise exists.

- To improve the *assessment* of information and its application to practical problems by acting as a middleman between those who need analytical services and those who can provide them.

Many users lack the knowledge or resources to search out available data and information. Working on a regional basis, the RCIC can identify resources that relate to the coastal and marine environment of the region, whether resources are academic, private, industrial, or governmental and whether held locally, regionally, or nationally. Users are able to request materials or referral to resources within the region and throughout the country.

An RCIC places special emphasis on incorporating the needs of actual and potential users into the design of their services and the development of their information resources. To be certain that these services are accessible to all potential users, an RCIC undertakes broad-based efforts to publicize its existence and services within the region.

Initially, the emphasis of the RCIC program is to serve existing State coastal zone management programs and Sea Grant program constituencies. As its capabilities expand, an RCIC is expected to serve as large a user community as possible, including the general public, universities, institutions, and Federal and State agencies. At the Federal level alone, seven agencies currently are involved in coastal zone management activities.

Universities perform the majority of the Nation's basic research. They are both a large and active user community and a source of information, data, and expertise. Many university libraries are equipped to support traditional (scientific and engineering) users, but few are prepared to support multidisciplinary environmental resource planning and management efforts, or to answer the varied concerns of the general public.

Private industry is directly impacted by Federal and State environmental, resource management, and regulatory activities in the coastal zone. To comply with regulations and adjust to environmental constraints, industry needs information on such things as climate, baseline environmental conditions, air and water quality standards, land use regulations, permit procedures, new technologies, and management techniques.

Public interest groups require greater access to information as the emphasis on public participation in coastal zone management decisions and in the development of Federal policy grows. An RCIC provides this access.

The RCIC program is sponsored jointly by three NOAA components: the Marine Advisory Service, Environmental Data Service, and Office of Coastal Zone Management. The NOAA Marine Advisory Service (NMAS) promotes and disseminates information on the use and development of marine and Great Lakes resources to industry, Government, educational institutions, and the general public. The RCIC's are an integral part of NMAS. They have been piggybacked on existing Marine Advisory Service resources and communications networks, thus reducing costs and speeding implementation, while strengthening the NMAS program. The full range of Sea Grant programs—the core of NMAS—also strengthens and is strengthened by the RCIC concept.

The Environmental Data Service has a variety of RCIC responsibilities. Among them is the provision and upkeep of the Oceanic and Atmospheric Scientific Information System (OASIS) and the Environmental Data Index (ENDEX). These two computerized referral services, the first bibliographic and the second an index to data sources, provide a valuable adjunct to other information services and are particularly useful in broadening regional information bases. In addition, the RCIC's will be provided computer terminals for accessibility, OASIS and ENDEX training, and the resources of EDS' national environmental data and informaton files. The RCIC's also can count on cooperation and support by the five EDS Field Liaison Officers stationed in coastal locations around the country.

The Office of Coastal Zone Management's National Coastal Zone Information Center was established in Washington, D.C. in 1973 to respond to State and national coastal planning and information needs generated by the Coastal Zone Management

Program. The Center is expected to refer many of its inquiries to the RCIC's, and will back them up with its 11,000 cataloged books and documents, more than 500 newsletters and periodicals, and numerous files and services in such subject areas as legislation, land use, the outer continental shelf, and energy-facility siting.

State and local coastal planning staffs are expected not only to be users, but also suppliers of data and information. They may provide data generated by the development of their plans to the RCIC 's, which will act as regional repositories for such materials and will provide copies to users.

The major subject areas RCIC's handle are: coastal and marine resources, land use and facility siting, energy, urban and regional planning, and legal, socioeconomic, and environmental information. The coverage of these subject areas is comprehensive enough to include material relevant to the analysis of land use, facility siting, and energy allocation issues of direct concern to onshore planners as well.

Timeliness is a critical concern, and special emphasis is placed upon "current awareness" types of services. The Centers are acting initially in a clearinghouse or referral mode, but eventually will broaden their activities to include data acquisition and dissemination.

At present, two RCIC's are operational: Coastal Information, the Northeast RCIC, and the Pacific Northwest RCIC, a part of the Washington and Oregon State Marine Advisory Service Program, established in September, 1977. The latter has two service components: one at Oregon State University in Corvallis, the other at the University of Washington in Seattle.

Eventually there will be nine RCIC's, covering all U.S. coastal zone regions, including Alaska and Hawaii. The specific service configuration of each RCIC will be developed over the first 3 years of its existence. As the RCIC grows to maturity, it typically will provide the following services:

- Selective dissemination of information service for targeted user groups such as State coastal managers and Sea Grant Institutions.
- Literature searches using a variety of resources, including OASIS.
- State-of-the-art compilations in critical subject areas or on new issues.
- Regionally focused data files for local use.
- Lists of newly published materials and resources, both regional and national.
- Newsletters and information brochures.
- Regional depository and distribution services for State generated coastal zone management materials and Sea Grant and NOAA publications.

The RCIC's also will develop their own networking mechanisms for the sharing of information resources between different regions, as well as tying into national and Federal sources of materials and services.

As a part of its development, each Center will involve users closely in the development and introduction of new products and services. User feedback and evaluation mechanisms will identify gaps in the information base and help determine the potential market for various service resources, as well as which user needs are the most critical. Overall progress of the RCIC program will be evaluated in part by analyzing user responses and by monitoring the development and success of a fuller range of user services.

At the Pacific Northwest RCIC, coastal and marine management and planning information and documents are associated with the Coastal Resources Program of the University of Washington. While the main university library can handle journals and books well, it is less effective with other forms of information, such as environmental impact statements, Federal and State reports and documents, draft reports, and so on. This is the kind of material the Coastal Resources Program collection concentrates on.

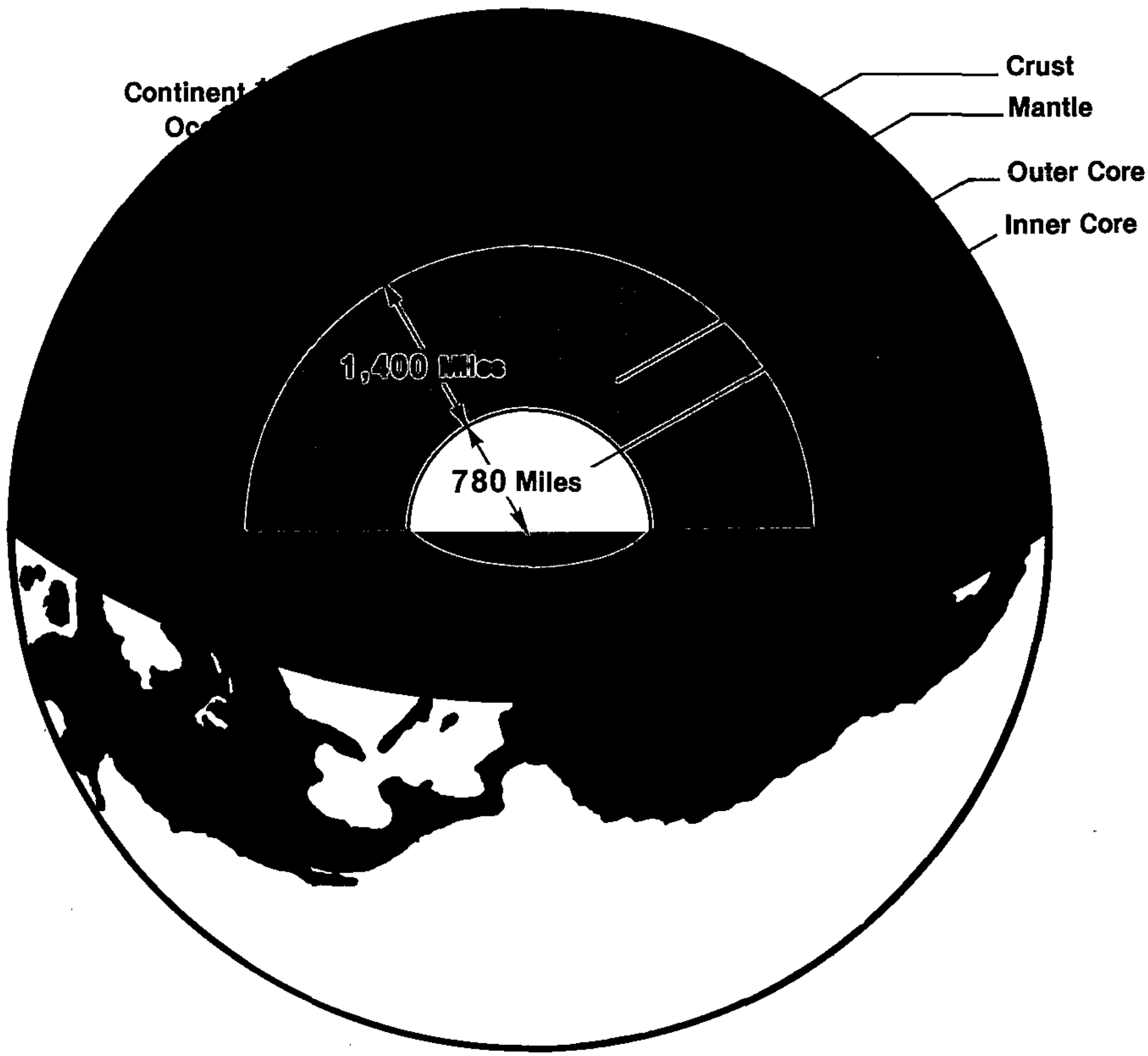
A professor teaching a course in regional planning at the University had his students prepare a regional plan for the San Juan Islands in Puget Sound. Steered by one of his students to the Coastal Resources Collection, he declared it to be the finest and most complete collection on coastal planning and management he had ever seen. Without this collection effort, the constituent documents would have been scattered over the campus—in the engineering, fisheries oceanography, law, and urban planning libraries.

A similarly comprehensive collection, covering technical and scientific information on the Pacific Northwest coastal and marine areas and established by the Oregon Estuarine Research Council, forms the other half of the Pacific Northwest RCIC, located at Oregon State University in Corvallis. For Washington State users, it is much easier to have the RCIC obtain research information from Oregon than to try to obtain it themselves.

And that is the basic principle of the RCIC system—find all the information resources pertinent to the region and provide the best information available to the user, no matter where the user lives or where the resource may be located. With the first two RCIC's, the concept is working well.

Inside Planet Earth*

By Jerry Coffman
National Geophysical and Solar-Terrestrial Data Center



Over a century ago, Jules Verne's *Journey to the Centre of the Earth* described the adventures of three men as they descended to the center of the Earth through the vent of an Icelandic volcano. Their journey took them into a vast grotto in the center of the Earth, replete with prehistoric monsters and giant men, from which they escaped back to the Earth's surface by way of an elevator-like ascent through the crater of Stromboli, a volcanic island near Sicily.

We now know that pressures due to the weight of the rocklike material above will squeeze together the tiniest crack just a few tens of miles below the Earth's surface. There can be no caves to lead the way to the center of the Earth. As one descends into the Earth, the temperature increases at the rate of 12 degrees Fahrenheit per mile, an effect observed in the deepest mines. The temperature apparently levels off at about 3,500 degrees Fahrenheit, a temperature that would melt the material in the Earth's interior, even if it were steel, were it not for the great confining pressures. The pressure at the center of the Earth reaches 3.5 million times the pressure on the Earth's surface.

Then how do we know the Earth has a crust, mantle, and outer and inner core, and the probable thickness of each to them? Fortunately, Nature has provided another mode of "seeing," however indirectly, into the dark, hot, interior regions of the Earth. Man looks through the "eye" of an earthquake.

Details of Earth's interior began to emerge in the late 19th Century, with the development of sensitive instruments (seismographs) capable of recording weak waves emanating from distant earthquakes. These waves pass through the Earth's interior, speeding up or slowing down as they pass through different zones of material. They are bent (refracted) or bounced (reflected) in varying degrees as they pass into different layers. Thus, a careful study of the recorded waves reveals much about the nature of the material they penetrated.

Specific and identifiable wiggles on the seismogram record are associated with two major types of waves or phases. The *P* wave got its name from the fact that it has the highest velocity of all waves types and arrives at a recording station first; hence *P* is primary. The *S* phase, observed somewhat later, is secondary. These are the familiar "fingerprints" of an earthquake. They tell the seismologist not only about the magnitude of an earthquake and its distance from the recording station, but also about the physical makeup of the material between the station and the location of the earthquake.

The *P* and *S* waves are two different types of vibrations that travel through the body (or interior) of the Earth. Hence, *P* and *S* waves are known as body waves. Other waves with velocities even slower than the body waves travel around the outer surface of the Earth and are called surface waves. Although they do not penetrate as deep as body waves, they are used to learn the secrets of the crust and upper mantle.

Shortly after the first earthquakes were recorded, they were being used to study the interior of the Earth.

First, the depth of the Earth's crust was discovered by A. Mohorovicic, quite accidently, when studying a Yugoslav earthquake in 1909. He became perplexed by the burst of speed by *P* waves after the first 100 miles traveled from the center of the shock. He reasoned that they must have met a change in material (an interface or discontinuity) that caused their speed to increase after penetrating about 20 miles into the Earth. Thus, the thickness of the crust of our planet was determined, at least in that area; its lower boundary became known as the Mohorovicic discontinuity (or Moho for short), where the crust ends and the mantle begins.

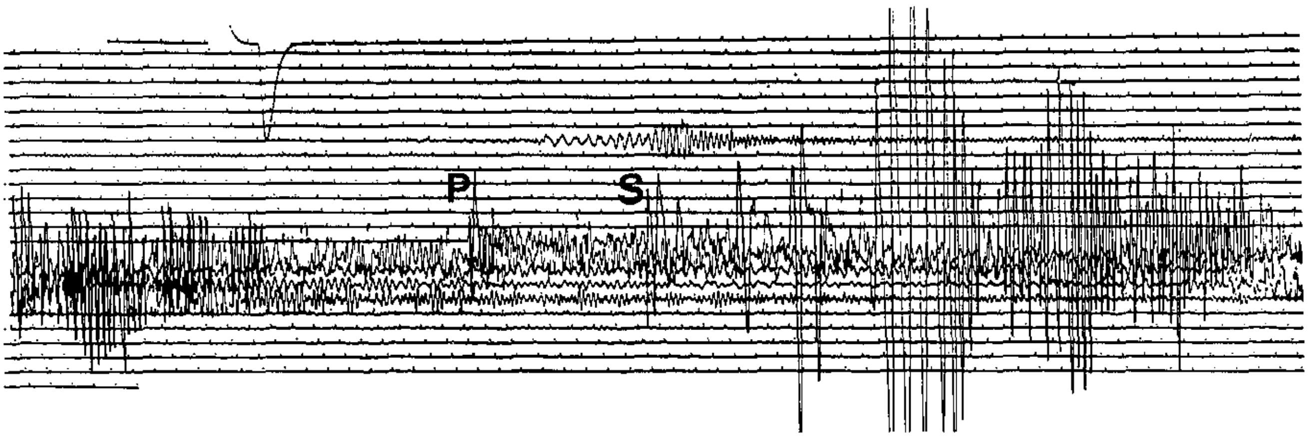
Using other techniques, it was determined that the crust under oceans is some 5 to 10 miles thick, and where further crustal measurements were made under continents, the average depth has been found to agree with Mohorovicic's calculation, about 22 miles.

Surface waves are really misnamed. They are guided by a surface, but also penetrate into the surrounding layers. In fact, the longer the period (crest-to-crest time observed at a given spot) of the wave, the deeper its penetration into the crust and mantle and the faster it travels. This leads to the casual observation that the longest-period portions of the surface wave train arrive first, with progressively shorter periods arriving later. Observing the amount of this dispersion gives an average velocity profile of the crust and upper mantle along the path. This has led to the conclusion, mentioned earlier, that the crust is thinner under the oceans than under continents.

R.D. Oldham began studying seismograms recorded at great distances from earthquakes. As the waves arrived later than expected, he predicted in 1906 that the Earth had a core of lower-velocity material, and that this would cause a shadow zone in which *P* phase signals would not be recorded.

In 1913, Beno Gutenberg in Germany discovered the waves reflected from the core, and ac-

*Slightly edited version of an article that appeared in the **Earthquake Information Bulletin** under the title "Earth's Most Inaccessible Region."



Seismogram of Tonga Islands earthquake of 10/11/75 recorded at Mundaring, Australia. The primary wave (P) reaches the station first; the secondary wave (S) arrives later.

curately located the core boundary at 2,900 kilometers below the surface, a little less than halfway to the center. The predicted shadow zone was found in which *P* and *S* data are absent or feeble beyond 103 degrees to 142 degrees.*

Waves passing through the core are denoted by the letter *K*. Thus, a wave leaving the earthquake source as a *P* wave, passing through the core and emerging on the other side as a *P* wave, is designated *PKP*. Similar waves beginning and ending as an *S* phase are designated *SKS*. The *K* leg of the traveltime, while slower than the *P* leg, is too fast to be an *S*-type wave. It is a *P*-type phase traversing a liquid. Thus, it was discovered that the core is liquid. Refined work by Drs. James Taggart and Eric R. Engdahl in 1968, using waves from nuclear explosions, improved knowledge about velocities in the mantle, and high-speed computers found the core at a depth of 2,894 $\pm$ 2 kilometers, in striking agreement with the pioneer work done by Gutenberg more than half a century earlier.

Dr. Inge Lehmann, a Danish seismologist studying the waves passing through the core, postulated an inner core, which other investigators decided was probably solid, at 5,000 kilometers below the surface. Direct evidence was not available until 1970, when Engdahl, Flinn, and Romney,**using data from large arrays of seismometers in Montana and other sites in the United States, observed waves reflected from the inner core surface. At the Montana array, signals from 525 seismometers arrayed over an area up to 10,000 square miles are simultaneously recorded. They can be filtered to separate the tiniest signal from the background noise. Using signals detected by these huge arrays, the inner core reflections were recorded, giving the first direct evidence of the existence of the Earth's inner core. It was found at a depth of 5,145 km.

Great earthquakes provide another means of determining the Earth's internal structure. A great earthquake acts like a hammer blow, setting the Earth "ringing" and "twisting." The periods of vibration of the whole Earth range from about 1 minute to nearly 1 hour for different modes. Seismologists can test their ideas about the Earth's interior against this "music of the spheres." Would an Earth with a given distribution of density and other physical properties ring with the observed tones? Calculations will show which distributions are possible.

Seismologists working in many countries over the decades have pieced together a dramatic picture of the Earth's remote interior. They have given us a picture of an Earth with a solid center, surrounded by a zone 2,260 kilometers thick of molten, nickle-iron outer core, molten from the heat at the creation of the Earth and from the compressive heating of the solid mantle above. They have done this by deciphering the meaning in the puzzle called a seismogram, wiggle by wiggle.

The picture is far from complete, but we do have more facts than did the generation that had only the fantasy of Jules Verne for a guide.

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*A degree of distance is a measure often used by seismologists and is equivalent to 111 kilometers or 69 miles; a distance of 180 degrees is half-way around the Earth.

**"Inner Core Reflections," presented by Eric R. Engdahl at the Seismological Society of America meeting at Hayward, Calif., March 26-28, 1970.

Geothermal Energy Map for Western U.S.

The first detailed map of geothermal energy sources in the western United States (excluding Alaska and Hawaii) has been prepared by EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) to demonstrate the potential importance of heat from the Earth's interior in meeting future energy needs of the United States.

The map shows geothermal areas now producing, or with known potential to produce, electrical power from steam-driven turbines. Also shown are areas where hot water from the Earth is being used for such purposes as heating buildings, agriculture, and various manufacturing activities, or where there is known potential for such uses.

There are more than 100 locales in the western United States—from the Rocky Mountains to the Pacific—classified as "Known Geothermal Resources Areas," several of which already supply usable energy.

One geothermal field near Santa Rosa, Calif., known as "The Geysers," produces more than 500 megawatts of electrical power, enough to meet the needs of a city of 500,000 population, while in both Klamath Falls, Oreg., and Boise, Idaho, a number of private homes and public buildings are heated by geothermal energy.

Other areas of known geothermal resources are near Reno, Nev.; Brawley, Calif.; Alvord, Oreg.; Raft River, Idaho; Milford, Utah; Los Alamos, N.M.; and Alamosa, Colo.

In addition to the known and potential geothermal areas, the 46 by 35-inch multicolor map shows other types of geological and geophysical data closely associated with geothermal resources, such as heat flow, earthquake epicenters, major faults, and volcanoes and volcanic cones.

NGSDC produced the map in cooperation with the Energy Research and Development Administration—now part of the Department of Energy—and the United States Geological Survey. Copies are available, folded or rolled in a mailing tube, for $2.50 from NOAA/National Ocean Survey, Distribution Division (C44), Riverdale, MD 20840. Make check or money order payable to "Commerce/NOS."

Environmental Site Reports for OCEANLAB Project

The National Oceanographic Data Center (NODC) is the EDS lead center in providing historical environmental data for areas of prospective OCEANLAB deployment. The OCEANLAB Project, operating under NOAA's Office of Ocean Engineering and the Manned Undersea Science and Technology Office, will employ an autonomous submersible with diver capability, combined with a minisub carried piggy-back. Operating characteristics include a 30-day independent operating period, a 1,000-nautical mile surface range, a 50-100-nautical mile submerged range, a 17-man capacity, a 2,000-foot depth capability, and the latest in navigational, communications, and life support equipment.

In preparation for upcoming operations (1981-1982), NODC is compiling a variety of physical data into *Environmental Site Reports.* Other EDS centers contributing to these reports are the National Climatic Center and the National Geophysical and Solar-Terrestrial Data Center. The reports are structured to enable OCEANLAB operations personnel to visualize the environmental background of a proposed deployment area and to prepare for the range of possible operating conditions which may be encountered at a specific site. They also point up deficiencies in information availability and the necessity for additional data gathering. *Environmental Site Reports* physical data include climatic summaries, water movement conditions, water column description, seismic profiling, earthquake activity, core analysis, bottom photo information, sediment data, navigational charts, and other measurements of importance.

Prior to the OCEANLAB deployment, the reports will be used in support of operations involving the submersible *Alvin,* belonging to the Office of Naval Research. As requirements for the OCEANLAB system are more firmly established, data products and display methods will be refined to meet specific needs.

Corrected U.S. Solar Radiation Data on Magnetic Tape

SOLMET is a new, common magnetic tape format designed to provide, in a single FORTRAN-compatible tape, quality controlled and serially complete hourly solar radiation and collateral meteorological data available for selected stations at EDS' National Climatic Center (NCC) in Asheville, N.C. The format is a metric conversion, in the International System of Units (SI), of all parameters currently available for hourly solar radiation and hourly surface meteorological observations. SOLMET was designed to provide solar energy data users with easy access to all appropriate historical meteorological data that are normally available in digitized form and to archive the data from a new National Weather Service (NWS) network and cooperators.

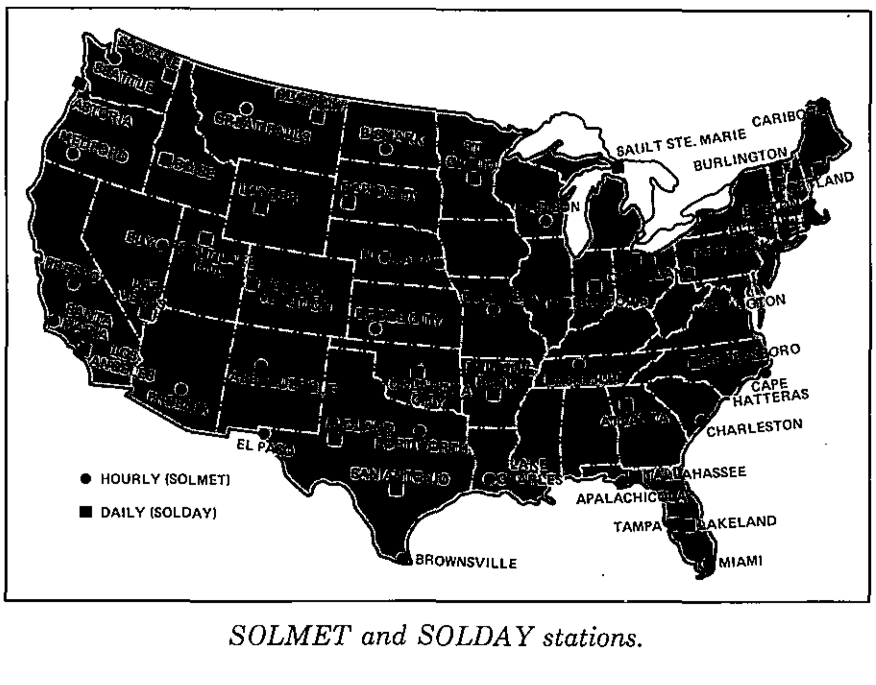
Solar radiation data have been collected at NWS locations in the United States for many years. These data include both hourly values and daily totals for the period beginning about July 1952. The data collected through 1976 contain some serious errors resulting from calibration and instrumental problems. They also were referenced to two different international scales (Smithsonian scale of 1913 and the International scale of 1956). With the recent increased interest in solar radiation data and the installation of new instrumentation at NWS observational sites in January 1977, it became apparent that these historical data must be rehabilitated and made available on magnetic tape in a common format that allows for inclusion of all available meteorological parameters and with all known procedural and instrumental errors removed.

Salient features of the new SOLMET format are:

- It provides total incoming radiation data corrected for all known scale, instrument, and calibration problems, as well as a data set corrected via a standard year irradiance model.
- It provides time information, so users can access the data in true solar time and/or local standard time; the time of the collateral meteorological data is also indicated. Provision is made to convert data recorded in local standard time to solar time.
- It allows for additional solar radiation parameters (such as direct, tilted, normal incidence, diffuse, net) that will be available in the future. Allowance is also made for additional measurements in supplemental fields; e.g., ultraviolet, spectral, etc.
- It codes missing observations and those that are estimated via models; e.g., sunshine and cloud regression models.

Volume I of the SOLMET Users Manual, *Hourly Solar Radiation-Surface Meteorological Observations,* which describes the tape format and characteristics in detail, may be secured without charge by writing: Director, National Climatic Center, Federal Building, Asheville, NC 28801, or by calling (704) 258-2850, extension 203 (FTS 672-0203). Volume II of the Users Manual is being prepared to describe the data correction processes and the regression models used to serially complete the global radiation data.

Data for selected stations for which there is an historical collection of daily total solar radiation data are now being processed into another new format, called SOLDAY. The SOLDAY file is being developed using procedures similar to those used for SOLMET. The SOLDAY file will be serially complete; it will contain collateral meteorological data, such as maximum and minimum temperatures, type of weather and minutes of sunshine; and it will be used to archive future data.



SOLMET and SOLDAY stations.

Climatic Atlas of Alaska's Outer Continental Shelf

EDS' National Climatic Center (NCC) and the University of Alaska's Arctic Environmental Information and Data Center (AEIDC), have jointly compiled the *Climatic Atlas of the Outer Continental Shelf Waters and Coastal Regions of Alaska.* The atlas has three volumes: I. The Gulf of Alaska, II. The Bering Sea, and III. the Chukchi and Beaufort Seas covering the area from 50°-75°N, 130°-180°W. It was published in support of NOAA's Outer Continental Shelf Environmental Assessment Program for Alaska, being carried out for the Department of the Interior's Bureau of Land Management.

Each volume describes the climatology of the area and presents data analyses of surface marine and atmospheric parameters which will aid in assessing the risks involved in the construction and operation of energy-related structures in these Alaskan coastal waters. The climate data in each volume are presented in monthly isopleth maps and statistical graphs and tables. Elements included are: clouds, visibility, fog, precipitation, air and sea temperatures, waves, winds, sea-level pressure, and extratropical cyclones. The climatological analyses are based on 600,000 surface marine observations and on two million 3-hourly surface observations for 49 selected coastal stations contained in NCC's digital data base.

As marine data are typically sparse in the near coastal zone—an area of sharp gradients and complex climate—data from land stations were included to develop the best possible climatological picture. Environmental records and publications held by NCC and AEIDC provided supplemental information.

Each volume is 11½" x 11½" and contains 409 to 433 pages. Volumes I and II each contain 228 pages of three-color maps. Each map has an opposing page of graphs for selected marine and coastal stations. For those parameters that apply only to marine areas, such as sea-surface temperatures and wave data, the maps and graphs are on the same page. Volume III has fewer maps, since sea ice makes marine data sparse during winter months. The remaining pages for each volume consist of sections on selected topics such as storm surges, sea ice, weather extremes, tides, bathymetry, and ocean currents.

The atlas is available from the Arctic Environmental Information and Data Center, University of Alaska, 707 A Street, Anchorage, AK 99501 for $5.00 per volume ($15.00 for all three), plus postage and handling.

Solar-Terrestrial Physics and Meteorology: Working Document II

The recent drought in the High Plains came on the heels of a minimum in a 22-year cycle of solar activity. This is the fourth consecutive time such a sequence has occurred, and scientific interest is again rising in the relationship between solar-terrestrial physics and meteorology.

Working Document II is the culmination of a 2-year effort by the staff of EDS' National Geophysical and Solar-Terrestrial Data Center. It includes a comprehensive bibliography (correcting and extending that of *Working Document I,* published in July 1975), a section listing the interests of the approximately 300 scientists who responded to the publication of *Working Document I,* selected key dates and data, and a report on solar-terrestrial physics and meteorology prepared by a working group of the International Council of Scientific Unions' Special Committee for Solar-Terrestrial Physics. The Secretary-General of the World Meteorological Organization provided the foreword to the document. A. H. Shapley and J. M. Mitchell of EDS are members of the Working Group.

Requests for *Solar-Terrestrial Physics and Meteorology: Working Document II* should be sent to A. H. Shapley, NOAA/EDS/NGSDC, D64, Boulder, CO 80302.

Indexes of Original Surface Weather Records

The National Climatic Center (NCC) has compiled and published an *Index of Original Surface Weather Records (Hourly, Synoptic and Autographic),* for each of the 50 States, the Pacific Islands, and Puerto Rico and U.S. Virgin Islands combined. The set of 52 indexes lists the hourly aviation, synoptic, supplementary airways, and similar observations available in manuscript form at NCC for each station in each State or geographical area through 1976. Records for years prior to 1900 that are held by the National Archives and Records Service and information about cooperative climatological daily records are not included.

The indexes are presented in four formats: Alphabetical By Station, By Year, By Elevation, and

By Latitude. The Alphabetical listing indicates the frequency of hourly observations for each month and year of record, in addition to the availability of autographic records, radar logs, synoptic observations, and meteorological summary forms. The By-Year index is a rearrangement of the Alphabetical By Station listing to identify the network of stations for which records are available in any particular year. The By-Elevation and By-Latitude listings are designed to help researchers select records available for desired elevations and latitudes.

Copies of the indexes are available from NCC for fifty cents per State or geographic area. Requests for copies should be addressed to: Director, National Climatic Center, Federal Building, Asheville, NC 28801. Or call 704-258-2850, Ext. 683.

Rhode Island Vacation Guide

Rhode Island's Vacation Climate is the first issue in a new series of resort brochures developed by EDS and NOAA's Sea Grant Marine Advisory Service. It a joint product of EDS' National Oceanographic Data Center and the Marine Advisory Service at the University of Rhode Island.

The brochure's weather section discusses the likelihood of sunshine, swimming weather, and weather problems you might run into in the "Ocean State." There is a special feature on sailing weather which includes information on winds, seas, and visibilities. There also are boating safety tips and weather forecast information.

For the fisherman, there is a section on both salt and fresh water fish found in State waters. The types of fish are listed, as well as information on their season, how to catch them, and limit and licensing requirements.

Other outdoor activities such as swimming, camping, and sightseeing also are covered. For example, each year national surfing championships are held at either Newport or Narragansett. Newport also is an authentic colonial city, with many of its restored buildings open to the public, as are some of its famous, turn-of-the century mansions. The pamphlet contains a map of the State and a list of other helpful publications available from both State and Federal sources.

EDS plans to publish several of these cooperative environmental brochures each year for coastal resort areas. Each will be tailored to the particular resort. A brochure for the Outer Banks of North Carolina is currently in work.

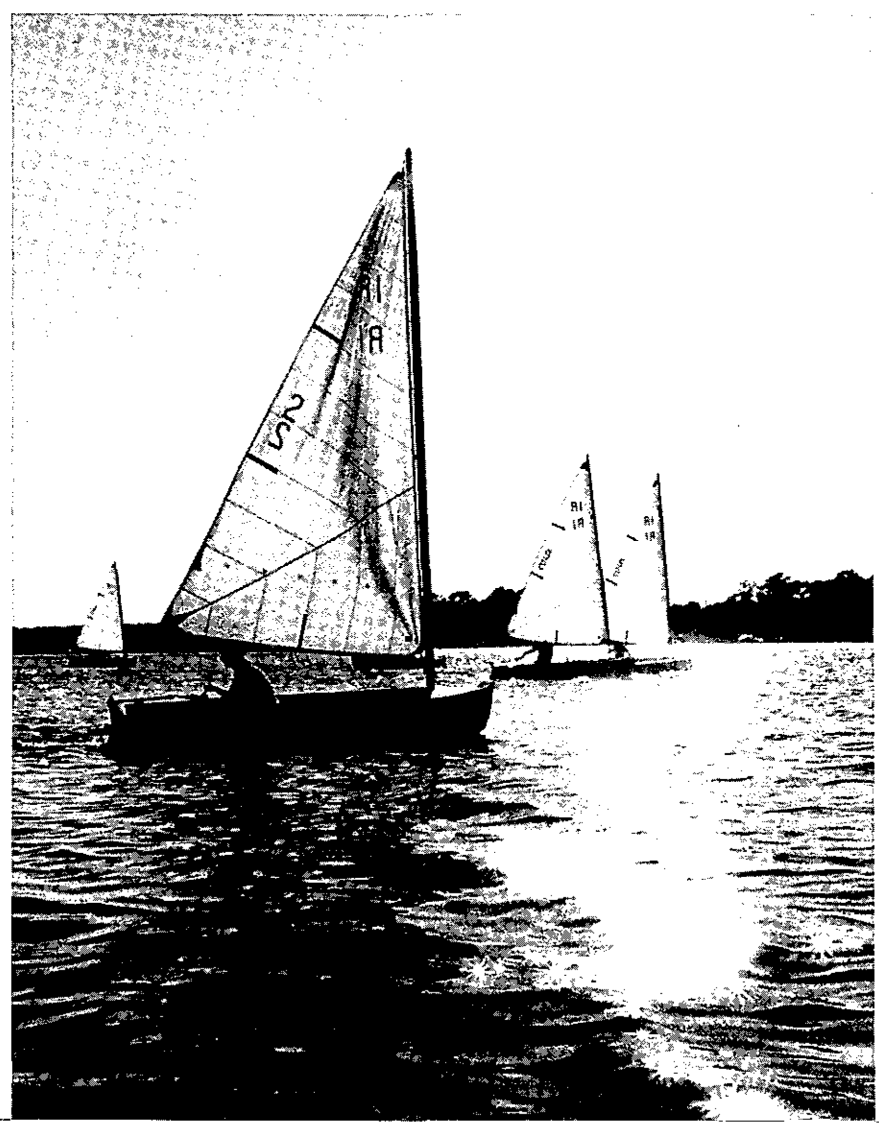
Rhode Island's Vacation Climate may be ordered from:

Environmental Data Service, D762
Room 400, Page Building I
Washington, DC 20235

or

URI Marine Advisory Service
Pubications Office
Davis Hall, URI
Kingston, RI 02881

Rhode Island's Vacation Climate *includes a special section on sailing weather.*



International Report

IDOE Progress Report No. 6

The sixth in a series of reports on the progress of the 1970-1980 International Decade of Ocean Exploration (IDOE) has been published by the Environmental Data Service under a National Science Foundation (NSF) contract. IDOE is a multination cooperative program to improve the use of the ocean and its resources.

The report, prepared for the NSF Office for IDOE, covers the period April 1976 to April 1977. The text, data inventories, and bibliographies are arranged according to IDOE program subject areas: Environmental Quality, Environmental Forecasting, Seabed Assessment, and Living Resources.

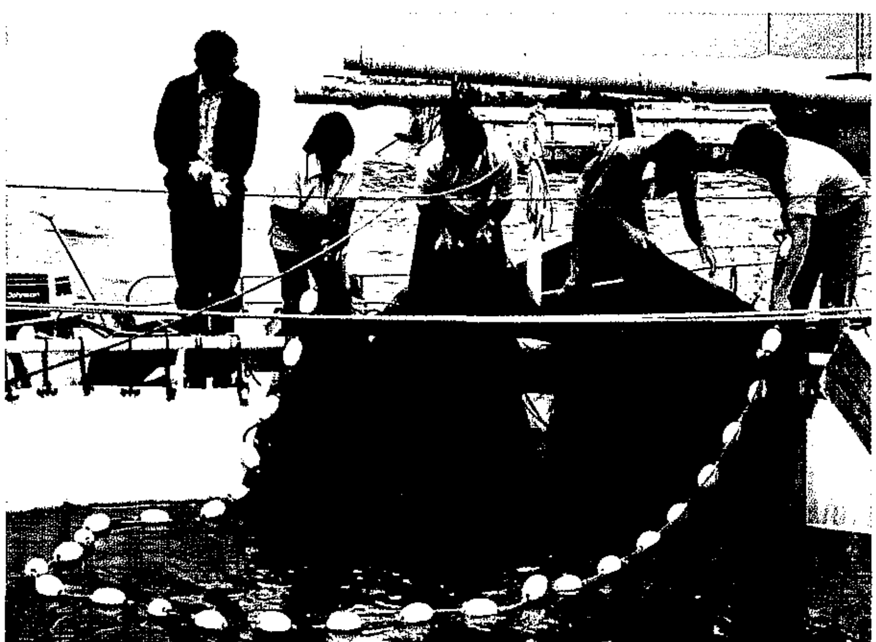
During the reporting period, scientists in the North Pacific Experiment (NORPAX) continued their efforts to link large areas of unusually warm or cold sea-surface waters in the North Pacific to U.S. seasonal weather patterns. One aspect of these studies involved efforts by Jerome Namias of Scripps Institution of Oceanography to forecast such patterns 3 months in advance. In spring 1976, he correctly predicted the warm, dry weather in the North Central States and the cool, wet weather in the Pacific Northwest that occurred the following summer. These forecasts suggest that the oceans play a pivotal role in shaping seasonal weather patterns, and that the ability to predict these patterns will depend on the extent to which researchers can refine their understanding of air-sea interactions.

On a much longer-term basis, scientists in the Climate, Long-range Investigation, Mapping, and Prediction (CLIMAP) Study (see p. 4) used fossils captured in deep-sea sediment cores to describe the main features of the global environment 18,000 years ago. Drawing on this data, they found that changes in the distribution of solar radiation caused by relatively small changes in the path of the Earth's orbit, tilt, and wobble are the fundamental causes of the waxing and waning of ice ages during the last 500,000 years. Ignoring the possible effect of man-made influences, the data indicate a coming, extensive glaciation period for the Northern Hemisphere over the next few thousand years.

Also in early 1977, scientists supported by the Seabed Assessment program used the submersible *Alvin* to dive over 3,000 m below the surface of the Pacific Ocean to explore and sample eruptions of superheated, metal-rich water from the sea floor. They worked in a portion of the Galapagos Rift 350 kilometers northeast of the Galapagos Islands and 800 kilometers west of Ecuador. The area is on a spreading center or boundary between two sections or plates of the Earth's crust. Molten materials flow up from the Earth's interior through the cracks between the plates, forming new crust and forcing additional sea-floor spreading—and sometimes earthquakes. Data from the dives promise to shed some light on the way in which metal-rich, deep-sea sediments are formed, the chemical history of seawater, and the transfer of heat from the Earth's interior into the oceans.

A major effort is underway to design a program to succeed the IDOE, which ends in 1980. During the spring of 1977, the University of Rhode Island's Center for Ocean Management Studies sponsored five workshops to consolidate ideas for the post-1980 program. Each workshop involved about 20 specialists in physical, chemical,

One IDOE experiment involves trapping water and pelagic marine communities in large plastic bags and assessing the effects of selected pollutants on the communities.



biological, and geological oceanography. In addition, letters inviting ideas were sent to other specialists in these disciplines and to professional journals.

The National Academies of Science and Engineering sponsored a follow-on workshop in September 1977 to synthesize the ideas from the earlier workshops and from the replies to the letters into a framework for an oceanographic research program for the 1980's. The results of these efforts will be described in next year's *Progress Report.* In the meantime, one of the major issues involved is examined on p. 3 of this magazine.

In addition to publishing the progress reports, EDS is under contract to NSF to manage scientific data collected during IDOE. EDS either has the data and papers described in the reports, or knows where they can be obtained.

Requests for copies of the reports, or for IDOE data, should be addressed to the National Oceanographic Data Center, National Oceanic and Atmospheric Administration, 3300 Whitehaven St., NW, Washington, DC 20235.

ASFA Splits to Expand Oceanography and Earth Sciences Coverage

Beginning this month, *Aquatic Science and Fisheries Abstracts* (ASFA) will be published in two complementary parts, *Part I: Biological Sciences and Living Resources* and *Part 2: Ocean Technology, Policy and Non-Living Resources.* Since its conception in 1971, ASFA had concentrated mainly on living resources, ecology, and biology. Part 2 represents a considerable extension and enlargement of the oceanographic and Earth sciences coverage previously included, as well as an increased emphasis on ocean policy.

The Food and Agriculture Organization (FAO) of the United Nations and the Intergovernmental Oceanographic Commission (IOC), coordinators of the ASFA project, formed the Aquatic Sciences Information System of which ASFA is now a module. It became obvious that a system of this kind would be of limited value if incomplete in its scope, and on the recommendation of FAO, IOC,and other international bodies, work commenced to close the gaps, concentrating particularly on the increasingly important fields of ocean technology, geophysics, oceanography, and marine policy.

The international editorial teams of ASFA, in consultation with the editorial board and the Institute of Oceanographic Sciences in the United Kingdom, have extended their coverage to include the important physical and chemical fields more thoroughly. The expertise of editorial teams in 8 countries (Italy, France, Germany, United Kingdom, Soviet Union, United States, Canada, and Portugal) is now being drawn upon to monitor serial literature, books, conference proceedings, and the more elusive reports and nonconventional data relevant to oceanography.

Topics covered in Part 2 include policy and legislation, coastal zone management, descriptive and dynamic oceanography and limnology, geochemistry, geology, geophysics, technology and engineering (including vessels, offshore structures, diving, support services, coastal engineering etc.) resources and commerce (including minerals, oil, desalination, and marine energy), and pollution.

Part 1 will include abstracts on biological topics, environmental factors, and living resources (with particular reference to fisheries) included in the previous ASFA, but again with the scope considerably improved and extended. It is hoped that both parts, taken together, will provide worldwide coverage on all aspects of marine and freshwater environments.

Both parts of ASFA will be fully indexed on a monthly and annually cumulative basis, using rotated subject, taxonomic, and geographic terms. Since January 1, 1975, ASFA monthly indexes have been generated from computer input. An experimental, semiannual index for the first half of 1975 was produced for FAO by the Institut fur Dokumentationswesen in Germany. Centers interested in using any of these indexes experimentally should apply to the FAO Fishery Information, Data, and Statistics Service. An experimental computer tape in International Standards Organization Format for bibliographic data in machine-readable form also has been prepared for the period January to June 1975. In the United States, this text data base is available to the public (as File 44) through the DIALOG online information retrievel service operated by the Lockheed Corporation in Palo Alto, Calif. Searches of the ASFA data base are also available through EDS' Oceanic and Atmospheric Scientific Information System (OASIS). For further information, contact Jim Stear, D82, Environmental Science Information Center, 6009 Executive Blvd., Rockville, MD 20852. Tel.: (301) 443-8287.

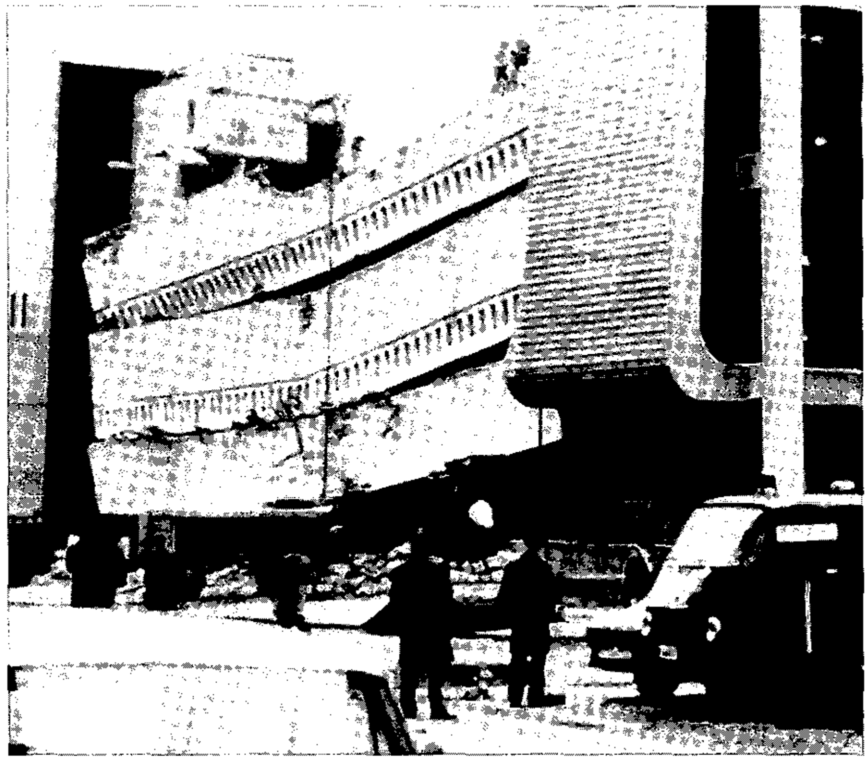
Beginning with the January 1978 issue of ASFA, the entire input data base (bibliographic captions, abstract, and index entries) will be available in tape format. Tapes of bibliographic data for the latter half of 1975, 1976, and 1977 ASFA input will be available late in 1978.

Rumanian Earthquake Qualifies for International Data Exchange

The Rumanian earthquake of March 4, 1977 has been declared eligible for the International Data Exchange program. The program, described in the guide to *International Data Exchange through the World Data Centres,* provides for the exchange of seismograms of large-magnitude events.

Since the program's inception in 1974, 20 earthquakes have qualified for the exchange. World Data Center A for Solid Earth Geophysics, collocated with and operated by EDS' National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo., to date has received over 20,000 records from 300 seismic observatories worldwide. Copies of all records received by WDC-A have been shared with WDC-B in Moscow and also have been made available to the worldwide scientific community.

The Rumanian earthquake of March 4, 1977 was one of the largest earthquakes to have occurred in Europe in recent decades. Its magnitude of 7.2 on the Richter scale was last exceeded by a magnitude 7.4 event that occurred in the same location in 1940. The March 4 earthquake was located approximately 150 kilometers north-northeast of Bucharest and caused extensive damage and casualties. Rumania reported 1,500 killed and 10,500 injured. Twenty people were killed and 165 injured in Bulgaria. Yugoslavia also reported some injuries, and Moscow reported damage in the Soviet Republic of Moldavia. The earthquake was widely felt from Rome to Moscow and from Turkey to Finland.



Bucharest Computer Center after the earthquake.

Photo: C. Rojahn, U.S. Geological Survey

New Glaciological Data Publication

A new publication series, *Glaciological Data,* is available from World Data Center A for Glaciology. It supersedes *Glaciological Notes,* an accession bulletin.

Each issue of the new series—which will appear 3 to 4 times per year—comprises a systematic bibliography on a selected theme. The bibliography is based on available published bibliographies, holdings in the WDC-A, and available computer-retrievel systems. It is anticipated that a cycle covering the major topics in glaciology (avalanches, arctic sea ice, ground ice, glaciers, ice sheets, snow cover, antarctic sea ice, freshwater ice, etc.) will span approximately 2 years. Subsequent issues will provide an updating and expansion of these lists. Issues on other themes or issues providing regional coverage of snow and ice studies may be published from time to time. In addition to the bibliography, short contributions relating to the collection, organization, and retrievel of data on the subject covered are included.

The first issue (on avalanches) was published in July 1977. It contains discusses of avalanche terminology and of procedures and problems in avalanche data collection; descriptions of avalanche research in Switzerland, United States (Colorado), the USSR, and

Iceland; and book reviews. The bibliography of nonRussian literature consists of over 600 citations and covers the period 1950-1977. A supplement containing the Russian citations will be published at a later date.

Glaciological Data is available free from:
Marilyn J. Shartran
Editor, *Glaciological Data*
World Data Center-A, Glaciology
Institute of Arctic and Alpine Research
University of Colorado
Boulder, CO 80309
Telephone: (303) 492-5171, FTS 323-4311

Collected Data Reports For STIP Interval II, 20 March - 5 May 1976

The request for this special study came from the Study of Traveling Interplanetary Phenomena (STIP) Project of SCOSTEP, the Special Committee for Solar-Terrestrial Physics of the National Academy of Sciences. STIP Interval II was a period of concentrated and coordinated study of traveling interplanetary phenomena. The dates for the STIP Interval were selected several months in advance, primarily because the configuration of several space probes at that time would afford a unique opportunity to study various traveling interplanetary phenomena, should the sun cooperate. The sun did cooperate, and the period 20 March-5 May 1976 was very active for a solar minimum period.

The report consists of 67 individual data contributions from scientists in many countries. In addition to a summary of the 20 March-5 May 1976 events, there are five papers on solar optical data, 17 on solar radio data, 10 on space observations, 11 on cosmic rays, nine on the ionosphere, 11 on geomagnetism, and three on airglow and aurora.

This report, UAG-61, is available for $2.95 from the World Data Center A for Solar-Terrestrial Physics, NOAA, Boulder, CO 80302.

Solar flare of April 30, 1976. Recorded at Ottawa River Solar Observatory, Ottawa, Canada.

International Geophysical Calendar for 1978

The International Geophysical Calendar for 1978 has been prepared in cooperation with the world scientific community and distributed by EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC). The calendar is issued annually to coordinate solar and geophysical observations and data exchange. It is compiled from information on coordinated observing programs involving scientists from different disciplines, institutions, and countries.

The calendar continues the series begun for the International Geophysical Year (1957-58). Its annual preparation is the responsibility of a small, interdisciplinary organization called the International Ursigram and World Days Service (IUWDS), which adheres to the Federation of Astronomical and Geophysical Services of the International Council of Scientific Unions. J. Virginia Lincoln of NGSDC is the IUWDS Secretary for World Days.

A single day each month is designated a Priority Regular World Day. There also are 3 consecutive Regular World Days each month, always on a Tuesday, a Wednesday, and a Thursday near the middle of the month. Various standard intervals of 1 to 2 weeks also are chosen to meet the needs of various projects. Where possible, several projects are scheduled for the same intervals, so interdisciplinary comparisons can be made.

Copies of the 1978 Calendar and additional information on scientific programs and data exchange may be obtained from J. Virginia Lincoln, World Data Center A for Solar-Terrestrial Physics, NOAA, Boulder, CO 80302.

JANUARY

S	M	T	W	T	F	S
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DECEMBER

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31						

JANUARY 1979

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14	15	16	17	18	19	20
21	22	23	24*	25*	26	27
28	29	30	31			

(17) Regular World Day (RWD)

(18) Priority Regular World Day (PRWD)

◇8 Quarterly World Day (QWD) also a PRWD and RWD

3 Regular Geophysical Day (RGD)

[7] Day of Solar Eclipse

10* Dark Moon Geophysical Day (DMGD)

6 7 World Geophysical Interval (WGI)

6 7 Airglow and Aurora Period

[3,4] Day with unusual meteor shower activity, Northern, [,or Southern,], Hemisphere

NOTES:

1. N-MAC (noon-midnight auroral correlations) periods are: Jan.2-16, Jan.30-Feb.13, Feb.27-Mar.13, Sep.27-Oct.11, Oct.26-Nov.9, Nov.24-Dec.8, 1978.
2. IAGA/URSI Working Group on Passive Electromagnetic Probing of the Magnetosphere international campaign Jun. 21-Jul. 20, 1978.
3. Build-up year FGGE continues to December 1, 1978 when operational year begins.
4. All radio meteor and incoherent scatter facilities will be operating continuously June 1-14 inclusive under the URSI/IAGA Cooperative Tidal Observations Program CTOP. Details from Dr. R. G. Roper, Georgia Tech, Atlanta, GA 30332, U.S.A.

OPERATIONAL EDITION, September 1977

see other side

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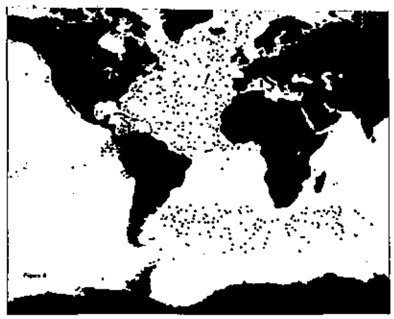
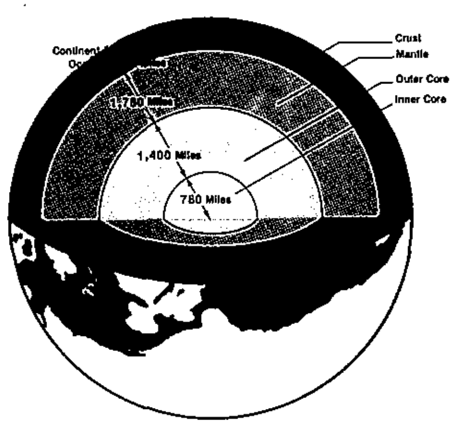
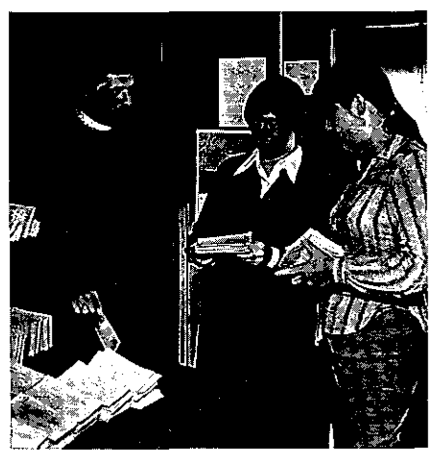






In this issue: *Studying and mapping the ice age cycle (p. 4), what earthquakes tell us about the internal structure of planet Earth (p. 12), new regional coastal information service centers (p. 8).*

EDS

Environmental
Data Service
March 1978

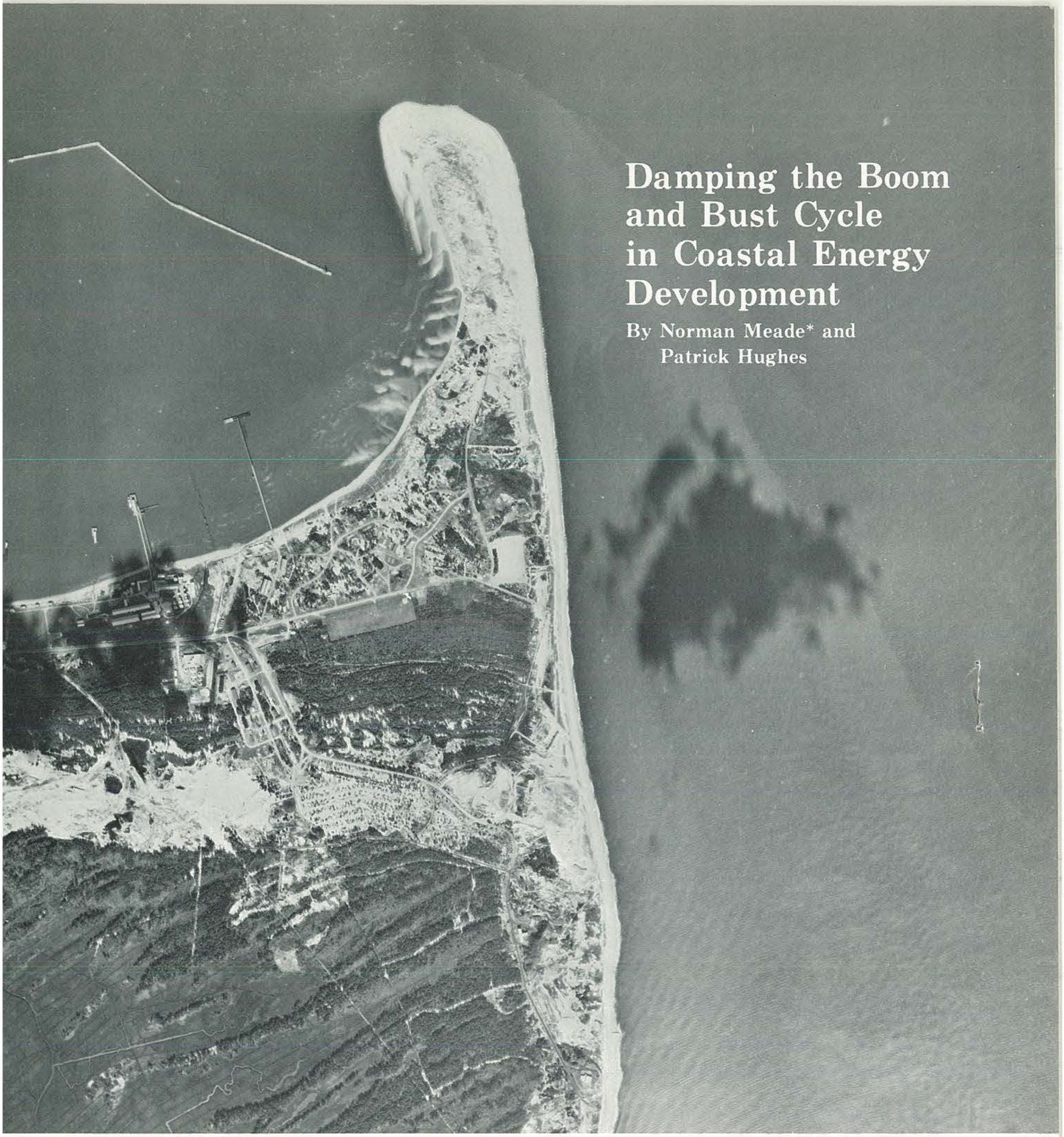
EDS

Environmental Data Service
March 1978

COVER: *Coastal energy development will change the lives of people living in nearby small communities. The lead article describes an economic model that predicts the social and economic impacts of such development and determines the possible need for impact assistance to lessen adverse affects.*

EDS is a bimonthly publication designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, and Center for Climatic and Environmental Assessment. In addition, under agreement with the National Academy of Sciences, EDS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 16, 1975; this approval expires June 30, 1978.

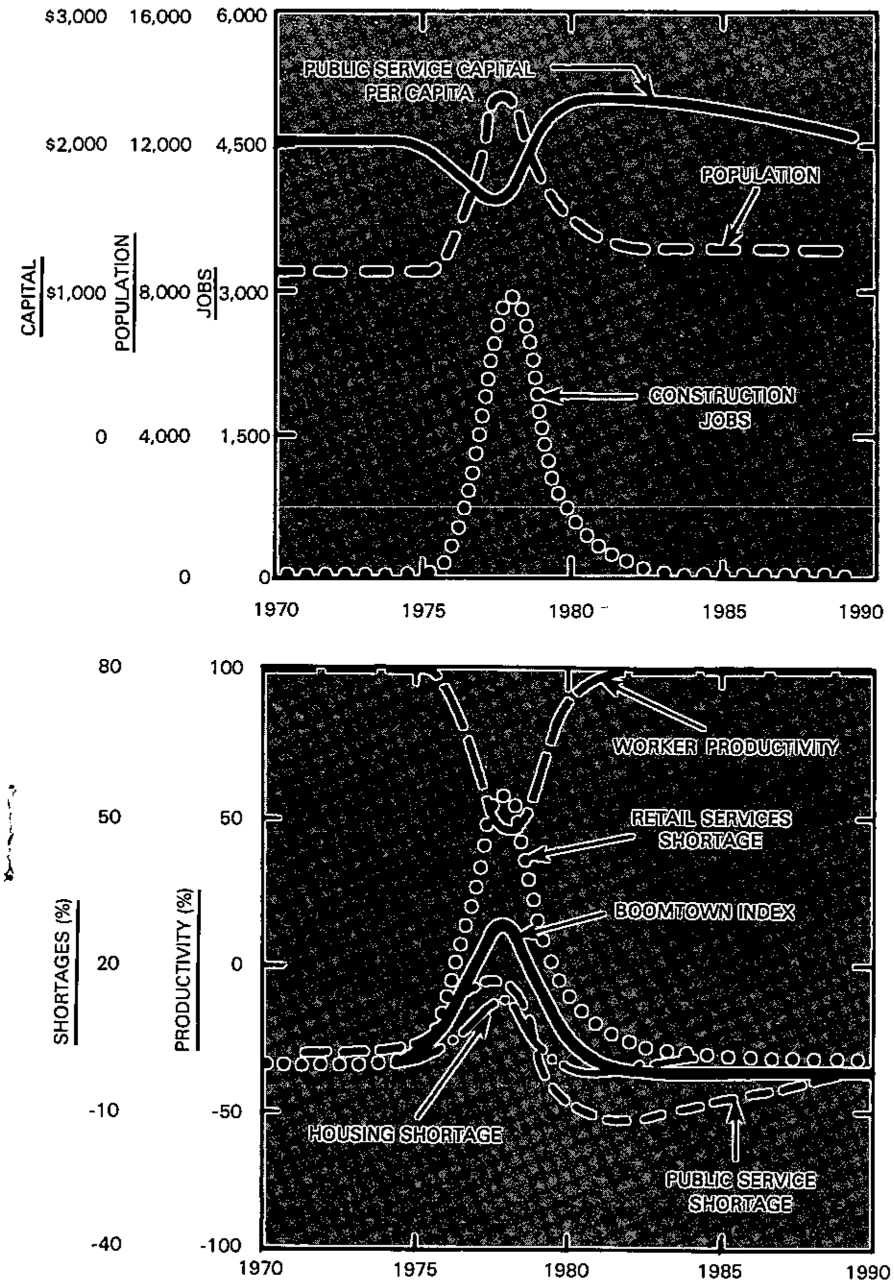


Damping the Boom and Bust Cycle in Coastal Energy Development

By Norman Meade* and Patrick Hughes

What happens to a small coastal community when a deepwater port is built nearby? Construction could bring several thousand workers into a town of less than 1,000 people. It could mean housing shortages, inadequate police and fire protection, and over-

*Office of Ocean Management, NOAA



Top: Impact of construction of a 1,500 megawatt power plant as simulated by ASCEND. Above: The Boomtown Index (see p. 7).

crowded schools and roads. There would be increased demand for restaurants and retail stores.

If the community raises property taxes to finance the new facilities and services it must provide, it may well find itself overbuilt, overstaffed, overserviced, and overtaxed when most of the workers and their families leave after construction is completed.

This boom-and-bust cycle is typical of the impact that construction of major energy facilities has had on small communities in the West. This body of experience was used by the Marine Assessment Division of EDS' Center for Experiment Design and Data Analysis to develop an economic model which would: (1) predict social and economic impacts on local coastal communities resulting from new or expanded energy and marine resource development, and (2) determine the possible need for impact assistance to help mitigate adverse effects.

The basic economic model developed is called "ASCEND," for Assessment of Coastal Energy Development. Actually, ASCEND is a family of models (submodels), including an outer continental shelf oil and gas development model, a deepwater port model, a liquid natural gas terminal model, and a power plant model. ASCEND can be used for such a wide range of applications because the important variables to be measured are similar in all submodels, and because of the unique methodology—systems dynamics—employed to construct the model.

Real World Modeling

Systems dynamics first gained prominence in the early 1960's with the publication of *Industrial Dynamics*, by J. W. Forrester, its creator and long-time advocate. Systems dynamics provides a framework in which to view the internal operation of a system in a coherent and orderly manner and to forecast changes in that system over time. The system one would be looking at in an ASCEND model would be the actual structure of local communities.

Systems dynamics models move forward in discrete time intervals. All systems are viewed in terms of levels and rates. A level represents the state of some part of the system—for example, the total population or the number of school children. A rate defines the amount by which a level will change during any defined time interval. Thus, population growth would be a rate affecting the population level.

The idea of a closed boundary within which all meaningful interaction is assumed to occur is of basic importance in systems dynamics. Feedback loops are another essential element. Such loops contain chains of alternate levels and rates, combined to capture complex interrelationships between relevant variables.

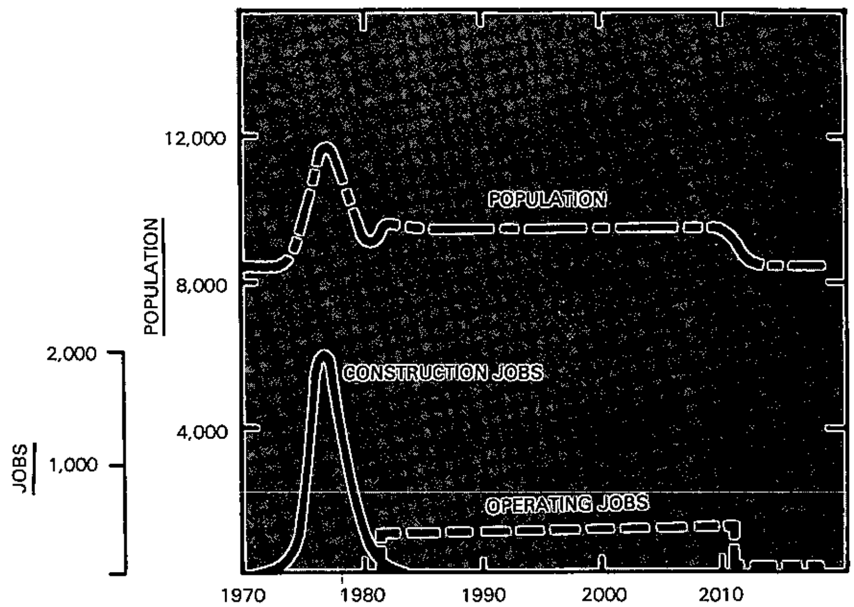
The systems dynamic technique is particularly useful in modeling complex social problems. It often can compensate for limited objective data by drawing on the opin-ions of experts and on the modeler's intuitions. According to Forrester, systems dynamics models belong to the same class of systems as the real world.

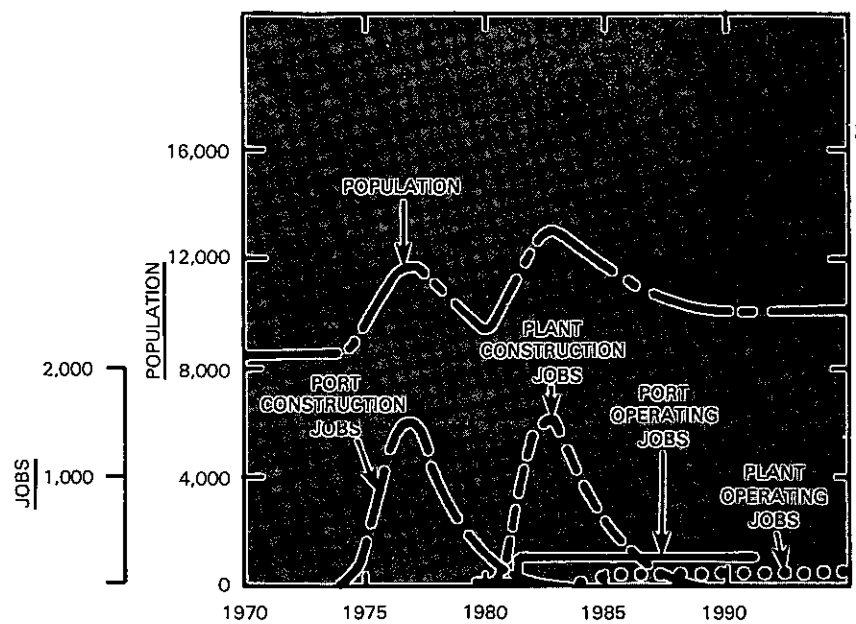
Using Real-World Models

Models such as those in the ASCEND family can be used in various ways. In "unconditional forecasting," a model predicts the circumstances that policy makers are likely to face, such as unemployment rates, tax income, and public expenditure levels. These predictions do not tell modelers how to prepare for the future, but they do give some idea of the problems that will be emerging.

A "conditional forecast" is contingent on the actions that a policymaker takes, i.e., adopting or rejecting a particular program. It suggests how the consequences of various actions may differ, but does not indicate whether one set of consequences is more desirable than another.

Models also help identify the most efficient option (least cost or highest profit) in putting a policy





Top: Population projection for construction of a deepwater port. Above: Population changes associated with successive construction of a deepwater port and an electric power plant.

into practice. In addition, they are used to formulate and examine various goals and to call attention to inconsistencies in them.

Modeling is also very useful in stimulating the inventiveness and refining the perceptions of decision makers. Simulation gaming, one of the components of the ASCEND models, is designed specifically for these purposes. Simulation gaming tests ideas and reveals how variables interact, given certain changes in some key factors (conditional forecasting). It is a way of understanding the system or community. In some cases one can, after a time, predict how the model will react without actually having to exercise it.

Anatomy of an ASCEND Model

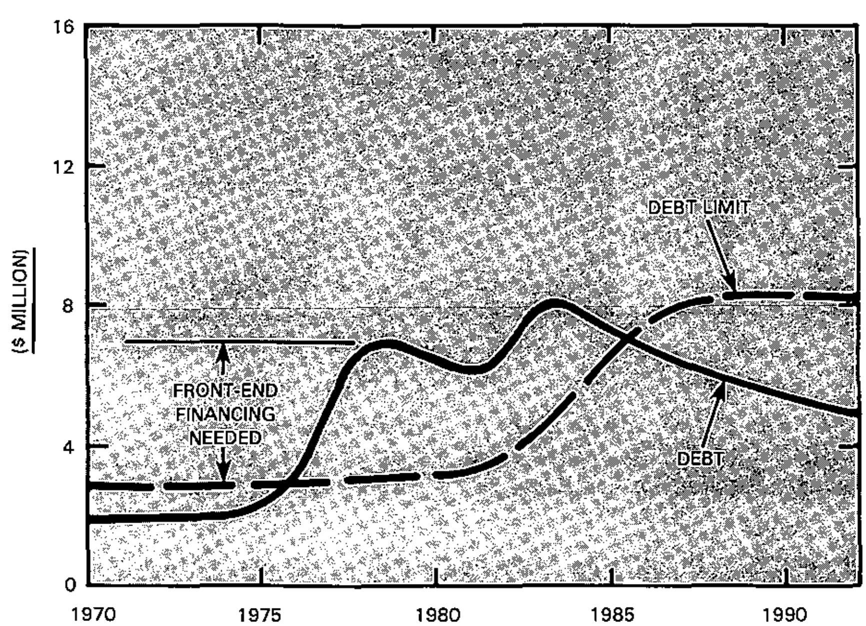
Structurally, ASCEND models are organized into five sectors: (1) the major economic activity, (2) housing, (3) retail sales and services, (4) public services and facilities, and (5) migration or population. All five contain built-in assumptions.

In the major economic activity sector, the first assumption is that the number of construction workers involved depends on the size of the facility to be constructed and on the productivity of the workers. Second, worker productivity may decline if the town experiences adverse growth conditions and the quality of life declines. Third, the construction initiated is an external input to the model; the modeler specifies how big the operation will be, how many workers will be needed, and how long construction will last. The fourth assumption concerns timing the arrival of the peak construction work force and the duration of its stay. Construction of a deepwater port, for example, typically could be expected to take five years and peak during the second and third years. The number of workers who remain as permanent employees to operate the facility is typically much smaller than the construction work force—often just a small fraction (5 to 10 percent) of the construction work force.

The major assumptions in the housing sector are: (1) home construction depends on housing need and the stock of dwelling units existing before the boom in population growth; (2) housing needs depend on the number and size of families and their preference for either permanent or temporary housing; (3) a shortage of permanent housing leads to an increase in the number of mobile homes and other temporary housing; (4) both permanent and temporary homes contribute to the amount of property tax collected in the community; and (5) housing construction may decline if contractors have to compete with the construction project for scarce labor. If labor costs rise, home builders will tend to reduce the amount of construction and will have to raise prices, which will decrease home sales.

Assumptions of the retail and service sector include: (1) Retail and service capital investment depends on the demand for retail service facilities and the pre-existing stock of such facilities as grocery stores, barbershops, etc. (2) The need for the retail and service facilities depends on a variety of factors, including total personal income in the community, the distance to the next nearest town, the fraction of income that workers spend on retail products and services, the cost of retail facilities and services, and the products and services that are sold; (3) Retail investors are reluctant to invest in facilities that may be unneeded after the construction population leaves town, and (4) Retail investors are reluctant to locate in a town experiencing adverse growth conditions, such as inflated construction costs and rising rents and labor costs.

Assumptions in the public services and facilities sector are: (1) Public construction depends on the need for public facilities, the pre-existing stock of facilities, and the ability of the locality to finance new construction; (2) The need for public facilities depends on the size of the population and the public services the community provides per capita; and (3) The model includes all facilities available in the community, whether they are provided by the



Front-end financing needed to cushion the local impact of construction of a deepwater port and power plant (see previous graph).

state or county government, or by the government of the community being impacted.

There are five assumptions for the municipal financing sector. (1) State and local property and sales taxes and transfer payments (revenue sharing, etc.) to the community are the two major sources of local revenue. The State and Federal transfers are calculated on the number of individuals living in the community, while property tax payments depend on the assessed value of local property and the property tax rate. Sales tax revenues depend on the effective tax rate and the level of retail sales. (2) The property tax rate is set to ensure that the locality receives sufficient revenue to pay its operating costs and debt obligations, and to contribute a percentage of the cost of construction and provision of new public facilities and services. (3) Additional funds needed would come from any number of Federal programs, or from loans and bond issues underwritten by the community, which would have to be paid back later. Localities unable to obtain sufficient debt financing will have to restrict construction of new public facilities and services; (4) Localities whose outstanding debt is close to their legally allowed limit will be unable to issue the full amount of new debt and will have to cut back on construction goals, unless outside help is available. (5) The value of bonds a community can sell to raise money for capital construction is determined by the bond limit set by the State, residential and commercial property, and the taxable portion of the completed facility.

There are five assumptions in the migration sector: (1) The number of individuals migrating to the locality depends on the number of jobs available and the fraction of jobs taken by local residents; (2) Jobs in other than the new facility sector are assumed to be constant in the initial stages of the model run. Later, this assumption is relaxed, and there is job growth in other industries and services that might emerge in the community as a result of the initial growth-inducing activity; (3) Jobs in the retail sales and services sector and the public sector depend upon the capital invested in those sectors; (4) Population depends on the number of families and the average number of individuals per family, and (5) The average size of permanent families is constant. The average size of construction families may decline if the town experiences adverse living conditions, because some workers who ordinarily would otherwise bring their families into the community may decide to either leave them home or settle them somewhere else in a better living situation, and perhaps commute to be with them on weekends.

Other qualities are built into an ASCEND model. One is an index of adverse community living conditions, a "boomtown" index. This index is weighted by the shortage of permanent housing, retail service facilities, and public services, as well as the amount of temporary housing available. The index gives some idea of whether the town is becoming a more or less desirable place to live. As the quality of life in the community decreases, worker productivity also drops.

By varying one or more of the above assumptions, the modeler can determine the potential impact of remedial actions to counter or ameliorate the boom-and-bust cycle. For example, by spreading out the construction timetable so that the population does not increase as suddenly and is not as high for any given year, the extent of boom town conditions is lessened. Consequently, because of improved living conditions, worker productivity does not decline as badly as it does with the shorter construction schedule. However, a longer construction interval means higher costs in providing some of the facilities and services needed, which can lead to a revenue shortage because the community cannot tax the new facility until it goes into operation.

When front-end financing is made available, ASCEND again shows reduction in the severity of economic impact, resulting in a more livable community and thus higher worker productivity. Necessary public and retail facilities and services are available earlier. The housing shortage is not as great, because contractors see that there is advanced planning and are more willing to build more houses sooner. Also, because the town is more stable, the retail sector is more willing to invest in more services, thereby not forcing so many to shop outside the town.

Deepwater Ports and Policy Options

Currently, ASCEND models are being applied in two major areas. One concerns deepwater port construction, the other analyzes policy options under various Federal assistance programs.

The deepwater port project involves exercising an ASCEND model to look at the effects on local communities of proposed deepwater port development off the State of Delaware. One potential site is inside Delaware Bay, with another in the Atlantic Ocean off Delaware's southern coast. The model will be specified with data from local communities potentially vulnerable to impacts from the construction and operation of a deepwater port at each site.

In some cases, towns are quite small along the Delaware coast. Deepwater port development could bring several thousand construction workers into a small community that is to be used as a staging area for offshore pipelaying and platform construction, as well as onshore pipelaying, pumping station, and storage activities. This could put considerable strain on a small town, resulting in overcrowded schools, housing shortages, inadequate police and fire protection, and excess demand on roads and sewerage treatment facilities. These impacts would require increased capital investment, and without appropriate taxing authority and new revenues coming into the community in a timely fashion, investment might lag well behind demand for increased public services and facilities. A similar situation would arise in the provision of retail services.

There are other concerns. The community will want to know if the deepwater ports will generate more jobs for local people, or if most of the workers will be brought in from outside.

There is also the question of industrial growth. If the deepwater port provides crude petroleum stocks in an area where they previously had not been available, petrochemical companies might wish to move into the area to take advantage of the petroleum supplies. This, of course, would create more jobs—and more pressures on the local communities to provide public facilities and services. They also would be faced with new zoning, housing regulation, and land-use decisions.

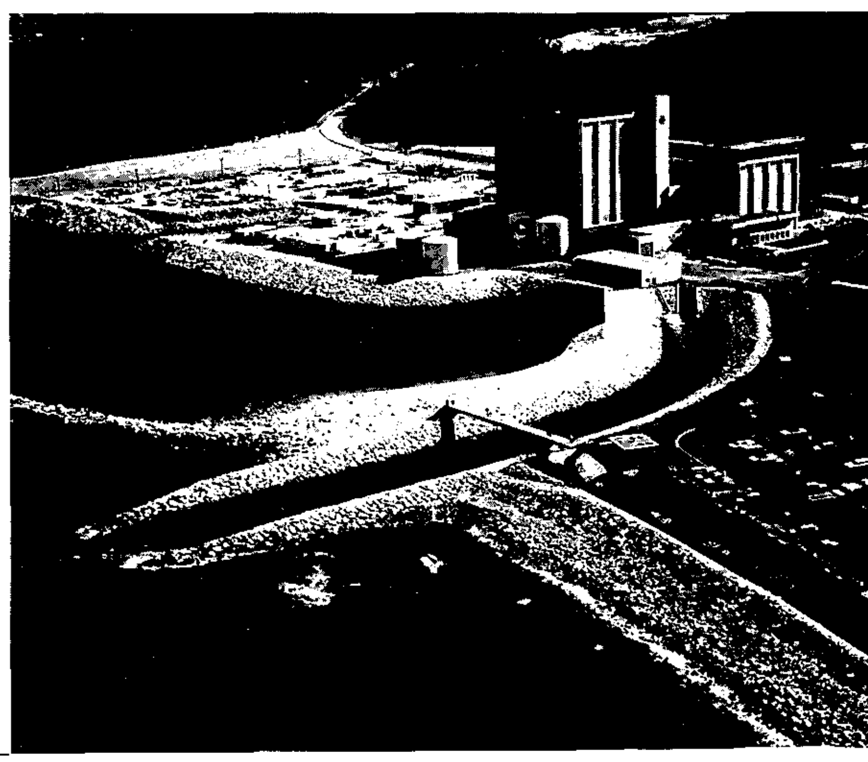
ASCEND analyzes all of these potential impacts. It projects tax revenues, tax expenditures, per capita income changes, and demand for new housing—and whether the demand will be for public housing, temporary housing, or permanent housing. It can forecast new spending on the part of the new population, as well as what new levels of economic activity, if any, can be expected in the area.

The analysis of policy options for Federal assistance programs runs along parallel lines, but it is not limited to a single type of industrial or energy facility such as a deepwater port. Front-end financing can be made available to help with the capital investment needed to meet demands for housing and public services via bond guarantees and outright grants. The crucial questions that must be answered are just how much money is needed and when. Needs can be overestimated or help come too late. A community might receive too much funding, invest in too many public facilities and services, and then not have the population increase necessary to pay for them. The commnity then might have to default on some of the guarantees or loans, requiring the Federal government to absorb most of the losses. Similarly, the community may not receive assistance in time to plan and build the additional infrastructure needed to prevent degradation in the quality of community life.

Conversely, the community might experience more growth than predicted, and find not enough public infrastructure had been created. The community would then be undersupplied with facilities and services.

Obviously, it is important that the estimate of Federal assistance needed be as accurate as possible. One logical way to ensure this is to trace the detailed series of interactions involved. This is what ASCEND does.

For more information on the structure of the ASCEND model and the results of the applications cited, please write or call: Norman Meade, Office of Ocean Management, 3300 Whitehaven St., N.W., Wash., D.C. 20235. Tel: (202) 254-7413.



Pilgrim Station nuclear power plant, Plymouth, Mass.
Photo: Boston Edison

Proxy Data: Nature's Records of Past Climates

By J. Christopher Bernabo*

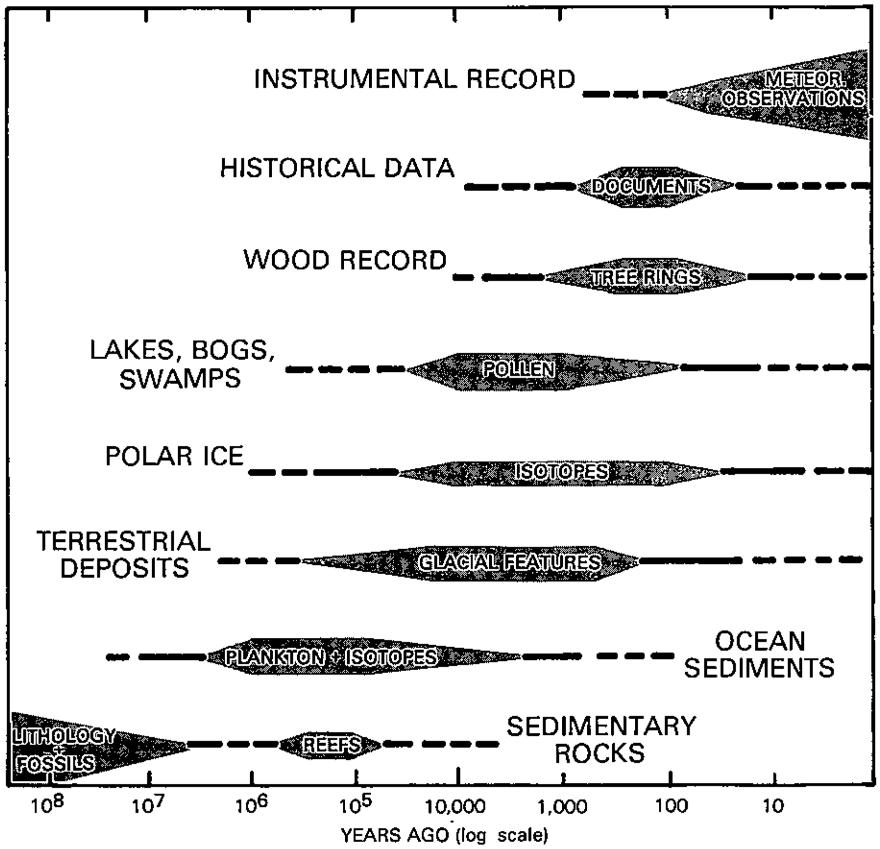
Glaciers, sedimentary rock, lakes, and trees all provide records of climatic variations.

*National Research Council Resident Research Associate with NOAA/EDS

In the 1920's the Colorado River Pact was drawn up to allocate water among user states, using data on river flow during the preceding few decades to estimate the likely future flow. The 1930's drought made it painfully obvious that the estimates were overly optimistic, because they were based on too short a period to be representative of the long-term average. In fact, paleoclimatic studies now indicate that 1900 to 1920 was the wettest interval in that region since 1700 A.D. (1).

The more we know about the climates of the past, the more intelligently we can plan for the inevitable climatic changes of the future. Variations in tree-ring widths, changes in the pollen or marine plankton content of sediment cores, isotopic fluctuations in polar ice, the movements of alpine glaciers, and many other natural phenomena related to climate provide evidence of past conditions. These indirect or "proxy" paleoclimatic records provide information on the behavior of all three major components of the climate system: the atmosphere, the oceans, and the cryosphere (ice caps).

There are four major objectives in studying past climates (2): Defining the frequency, patterns, and magnitudes of climatic fluctuations; studying processes and causes of climatic change; supplying empirical data for use with mathematical models of climate,



SOURCES	INDICATORS
Instrumental Record	Meteorological data from ground and space sensors.
Historical Data	Documentary material: chronicles, diaries, farm records, government papers, ship logs, etc.
Wood Record	Tree-ring widths; variations in the isotopic composition, density, and chemistry of wood.
Lake, Bog, and Swamp Sediments	Fossil pollen and other plant remains; fossil lake-dwelling organisms; variations in sediment composition, isotopes, and varve thicknesses.
Polar Ice Accumulations	Changes in the isotopic composition, melt-layer thicknesses, and other properties.
Terrestrial Deposits	Glacial, alluvial, and soil features; ancient lake shorelines, cave deposits, and archeological records.
Ocean Sediments	Fossil plankton and their isotopic composition; sediments mineralogy, rock debris and dust accumulations.
Sedimentary Rocks	Ancient glacial deposits, fossils, and mineralogy; sea-level terraces (reefs).

Figure 1 (top). Time spans of proxy data sources. The thickness of each box reflects the relative contribution of that source during different time periods in the past. The major paleoclimatic indicators each source contains also are shown. Table 1 (right) has a more complete listing.

and increasing knowledge about the impact of climate on biological, geological, and societal systems.

Records of Past Climates

Data on climatic change can be obtained from meteorological, historical, biological, and geological sources. Instrumental observations are used to study directly the fluctuations of climate in recent decades. The period of time covered by instrumental data is, unfortunately, too brief to contain the full spectrum of climatic variability. Furthermore, meteorological records do not always constitute a sufficient acturial basis for long-range planning, because the conditions of recent decades are not typical of the last few centuries.

Historical information serves as an important secondary source of climatic data extending back beyond the instrumental period. Past climatic conditions are inferred from documentary material such as annals, chronicles, diaries, government papers, farm accounts, and ship logs. Historical climatologists have been able to distill meaningful and quantitative reconstructions of past

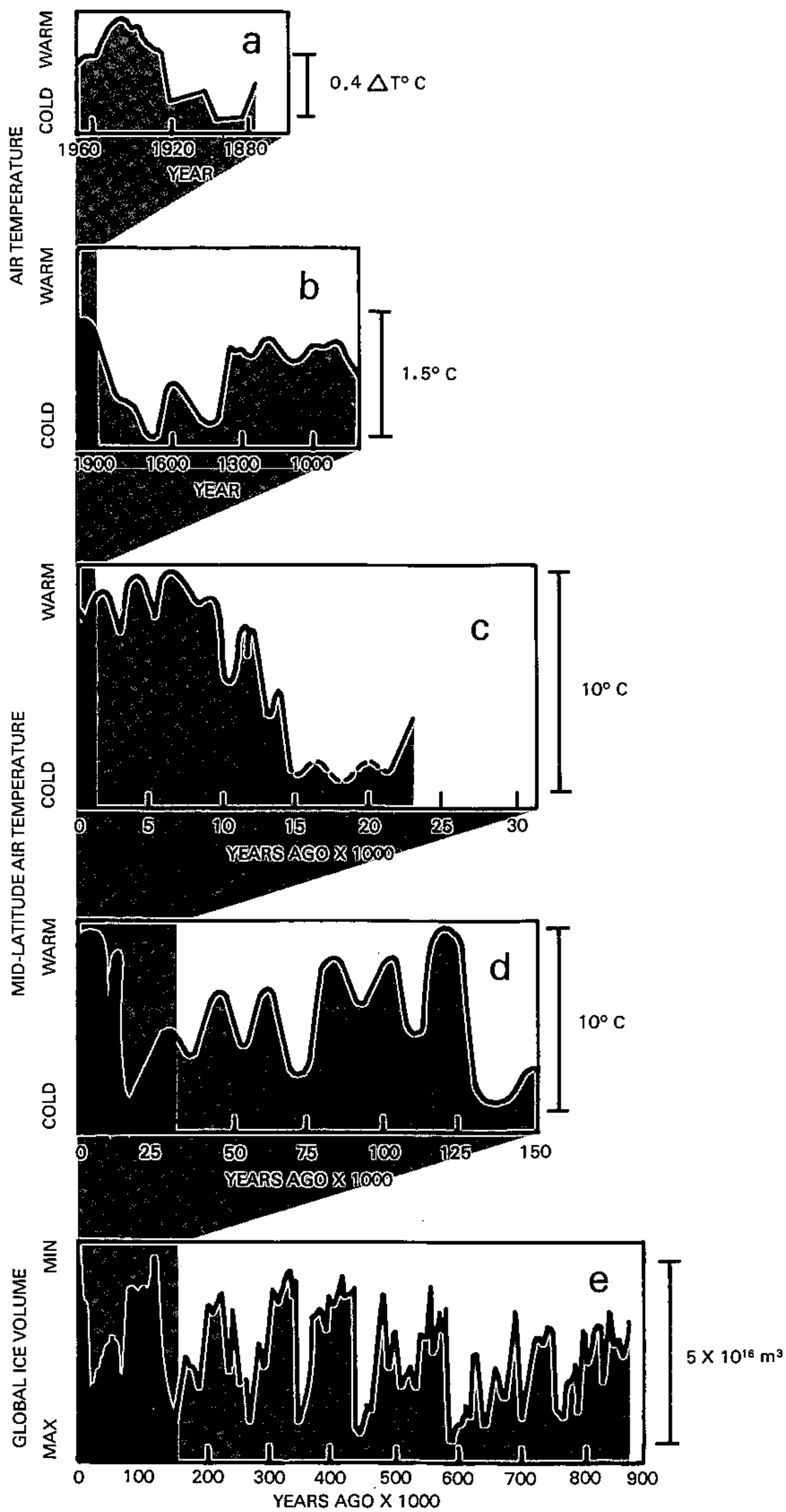


Figure 2. General trends in global climate for various time scales ranging from decades to hundreds of millennia. Climatic change reconstructions are based primarily on records from (a) instrumental data; (b) historical information; (c) pollen data and alpine glaciers; (d) marine plankton and sea-level terraces; and (e) isotopic fluctuations in deep-sea sediments. (After: National Academy of Sciences (1975); Understanding Climatic Change, a Program for Action: *p. 130.)*

climates from diverse written sources (3). The historical record is particularly complete for the last 1,000 years in Europe, but is less adequate in other regions and over longer periods.

Proxy information from biological and geological sources extends our knowledge of climate far beyond the temporal and spatial limitations of both instrumental and historical sources. Proxy data come from various paleoclimatic "sensors" that record the climatic responses of some natural system in a datable form.

Characteristics of Proxy Data

Proxy data are discussed in terms of the *sources* and the *indicators* of past conditions. Each proxy source is a natural archive that has preserved the record of various paleoclimatic indicators. The indicators are the measurable variables that have acted as sensors of climatic change. For instance, ocean sediments contain indicators of past water temperature, such as fossil plankton.

Figure 1 illustrates the major sources of paleoclimatic data and shows their relative importance over different time intervals. The primary indicators of climatic change contained in these sources also are listed (table 1). Each source of paleoclimatic information is limited not only by the time span it records, but also by the temporal resolution and geographical coverage it provides.

All proxy sources require some means of time control to determine the age of the paleoclimatic data. The two most common approaches to absolute dating are: 1) counting annual bandings in sources where they exist, and 2) using radiometric dating techniques (such as carbon-14), that depend on "atomic clocks" marking time by the decay of unstable isotopes. Chronologies for undated sources are sometimes established by correlating them with dated sequences, as in the application of the paleomagnetic time-scale to deep-sea sediments. The degree of temporal resolution a paleoclimatic data set provides is related to the degree of uncertainty associated with dating the source. Uncertainties in determining the age of proxy data generally become larger as earlier time periods are considered.

Each paleoclimatic indicator contained in proxy data sources has its own characteristics. These sensors differ as to which aspects of climate they respond to, their degree of climatic sensitivity, and the time it takes them to react to a given change. Studying various paleoclimatic indicators not only enlarges our knowledge of climatic change, but also increases our understanding of the impact of climate on other natural systems.

Sources of Proxy Data

Paleoclimatic studies reveal that global climate has been perpetually changing, with no true equilibrium state evident (4). Figure 2 shows the general features of climatic variability over time periods ranging from decades to hundreds of thousands of years. To document and understand all scales of climatic variability, a number of different paleoclimatic data sources must be examined. Each source of proxy data is, in effect, tuned to monitor certain frequencies of change. Overlaps between the time intervals covered by the various sources allows collaborating and checking of the climatic inferences derived from the individual sources.

The Wood Record

The wood record provides information on the climate of past years, decades, and centuries. Tree rings result from seasonal changes in growth, and variations between annual rings reflect longer-term fluctuations in physiological conditions. Tree rings thus provide a means of dating the wood record, as well as obtaining information on past environmental changes. The isotopic composition of tree-rings also provides a record of long-term variations in atmospheric CO_2 concentrations. The majority of the currently available data used for dendroclimatic studies comes from western North America, but efforts are being made to greatly expand the geographical coverage (5).

Variations in tree-ring widths are primarily a function of climatic change at locations where weather is a dominant factor limiting growth. Trees on a dry site, for instance, are particularly sensitive to precipitation changes and record drought occurrences as narrow rings. Because growth in individual trees is affected by many variables other than climate, computer techniques are used to separate the paleoclimatic message from non-climatic "noise."

The precise time control and the rapid climatic response of tree-ring data enable reconstruction of conditions for individual years in the past. The wood record illustrates high-frequency climatic variations and furnishes valuable information about climatic change. For example, tree-ring data in the western United States (1) show that during the last few hundred years droughts have tended to recur approximately every 20 to 22 years and are systematically related to sunspot cycles (6).

Lakes, Bogs, and Swamps

The sedimentary records of lakes, bogs, and swamps provide much of our knowledge about climatic trends since the beginning of the present interglacial period about 10,000 years ago (fig. 2c). Accumulating sedimentary material and fossils supply information on climatically induced changes in biological, physical, and chemical

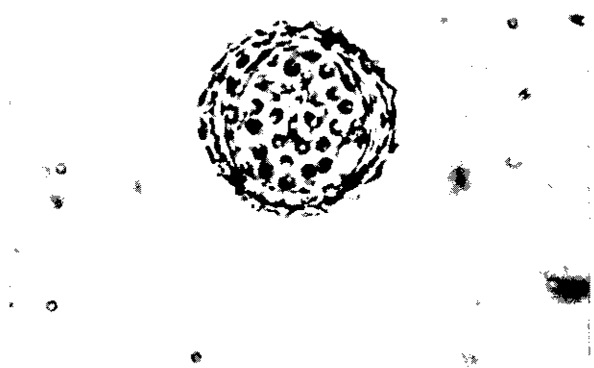
Pollen: an Ideal Fossil

Pollen grains and spores are encased in an exceptionally durable substance that is resistant to most forms of chemical breakdown. Delicately sculptured spores have remained preserved in ancient rocks for hundreds of millions of years.

Pollen and spores are dispersed by wind, water, and insects, and then are deposited in sedimentary environments ranging from lakes and bogs to soils and oceans. Hundreds of thousands of these tiny fossils accumulate in each teaspoonful of lake sediments, providing a statistical sampling of existing plant communities.

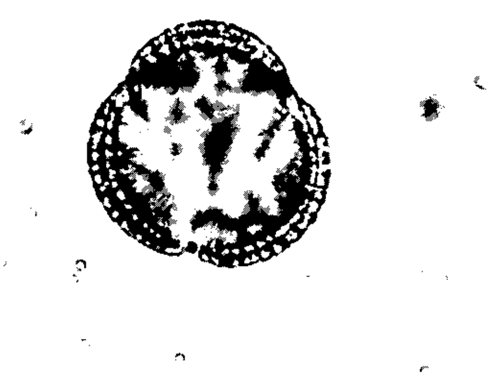
Because of its natural resistance to breakdown, highly corrosive chemicals are used to extract the pollen from sediments obtained from depositional basins. Hot acids dissolve and destroy most of the mineral and organic material, leaving a residue rich in pollen. This residue is examined under the microscope to identify and count the different pollen types. The resulting data give a "snapshot" of the vegetation that existed during the time the sediments were deposited. Pollen studies reveal changes in the vegetation that have resulted from environmental factors such as variations in climate and from man's shifting land-use patterns.

Pine.



Ragweed.

Basswood.



Sagebrush.

systems. Lakes and related depository basins occur primarily in the formerly glaciated portion of the temperate regions. These deposits are most often dated using carbon-14 analysis, which yields a temporal resolution of about ± 5 percent of the true age. In some lakes, the cycle of seasonal productivity results in annual sedimentary laminations called varves, which provide temporal resolution equivalent to tree rings.

Pollen grains are a major paleoclimatic indicator contained in lake sediments. These microscopic plant fossils furnish a census of the local and regional vegetation at the time they were deposited. As climate varies it causes changes in the composition of the vegetation, and these changes are recorded by the accumulating pollen. Pollen data therefore document the ecological responses of plant communities to climatic fluctuations, whereas tree-ring data reflect the more rapid physiological responses of individual organisms. Although plant distributions are largely a function of climate, other ecological and biogeographical factors must be considered when using pollen as a paleoclimatic sensor.

Pollen-based climatic reconstructions can help us evaluate the potential consequences of climatic warming, such as one induced by man's release of CO_2 from combustion and deforestation. A period of higher global temperatures about 7,000 years ago provides a possible analog for studying the regional patterns of change that might accompany a future warming. In addition, the pollen record reveals man's impact on the vegetation and can be used to document the history of terrestrial biomass reductions that may have contributed to atmospheric CO_2.

Ocean Sediments

Paleo-oceanographic studies elucidate changes in ocean circulation and their role in climatic variations. Sediments from the world's ocean basins contain a continuous history of the major glacial-interglacial oscillations of the last few millions years (fig. 2e). Such marine proxy data supply information about an enormous span of time, but offer temporal resolution only to within several thousand years. Deep-sea sediments primarily record the lower-frequency climatic changes and represent the most widely found paleoclimatic data source.

The remains of tiny organisms accumulating in the deep sea serve as indicators of changing water-mass properties. Variations in the distribution of fossils such as foraminifera, diatoms, and radiolaria are used to reconstruct past sea-surface temperatures and salinities, as well as to trace the previous positions of currents and upwelling zones. The former extent of sea ice is indicated by the distribution of rock particles that have melted out of icebergs, while dust that has settled to the ocean floor reveals the intensity and direction of winds once blowing across the continents.

The deep-sea record is a key source of information about the frequency, magnitude, and causes of the ice ages. Fluctuations in the oxygen-isotope ratios of marine fossils record the waxing and waning of ice ages, because growing ice sheets enrich the oceans in oxygen-18, while deglaciation removes it from sea water. The ocean's record of changing global ice volume has been used to demonstrate that cyclic geometric variations in the Earth's orbit have acted as a pacemaker for the periodic ice ages (7).

Other Sources

Polar ice, terrestrial deposits, and sedimentary rocks are other major sources of paleoclimatic data. Variations in the seasonal melt-layers and the isotopic composition of ice accumulated in polar regions are chronicles of temperature changes in high latitudes. Core samples of ice caps provide paleoclimatic time series that span more than 100,000 years and show the details of change during more recent millennia.

Terrestrial deposits such as glacial sediments and soil sequences also contribute evidence about climatic events. These sources supply information about many time periods, but generally represent isolated periods and discontinuous records. Glacial deposits show the extent of ice sheets whose margins and relief are first-order boundary conditions affecting atmospheric circulation. Changes in the size of alpine glaciers indicate that cold intervals, like the Little Ice Age (from about 1450 to 1850 A.D.) have repeatedly occurred during the last 8,000 years (8).

Sedimentary rocks provide the oldest record of the Earth's climatic history. The ancient geologic record suggests that glaciations are rare, and that even the poles have been relatively ice-free for perhaps 95 percent of the Earth's history. The last epoch of glacial-interglacial cycles like those of the present probably occurred about 300 million years ago. From this perspective, it is apparent that we live in a period of extreme climatic variability.

Mapping Past Climates

Maps showing the past distributions of meteorological variables, such as temperature and precipitation, furnish climatologists with an ideal basis for studying the patterns and dynamics of climatic change. Three sources of proxy data—the wood record, ocean sediments, and lake and bog deposits—each offer the geographic coverage, sampling density, and continuous records required to produce synoptic maps. Computers are used to develop transfer functions, which transform proxy data, including tree-ring widths (9), marine plankton (10), and pollen data (11) into quantitative estimates of past conditions. The transfer functions calibrate the paleoclimatic sensors, and are based on the empirical relationships between modern biological and meteorological variables.

CLIMAP (12) constructed maps of global sea-surface temperatures during the last ice age (18,000 years ago) by applying transfer functions to deep-sea data. Tree-ring data from western North America also have been used to produce anomaly maps of temperature, precipitation, and pressure patterns during past centuries (9), (5). Pollen data from eastern North America supply a basis for paleoclimatic maps illustrating the climatic trends during the last 10,000 years (13), and varved lake sediments allow quantitative study of the detailed patterns of climatic change during the last few millennia (14).

Quantitative reconstructions of past conditions provide a valuable link between paleoclimatic research and computer models that numerically simulate climate. Synoptic paleoclimatic studies contribute empirical data needed to experiment with and test the theoretical models. The combined efforts of paleoclimatic research and computer modeling yield a better understanding of the global climate system and its behavior. This understanding is essential if we are to plan for adequate water, food, and fuel supplies to ride out future climatic changes.

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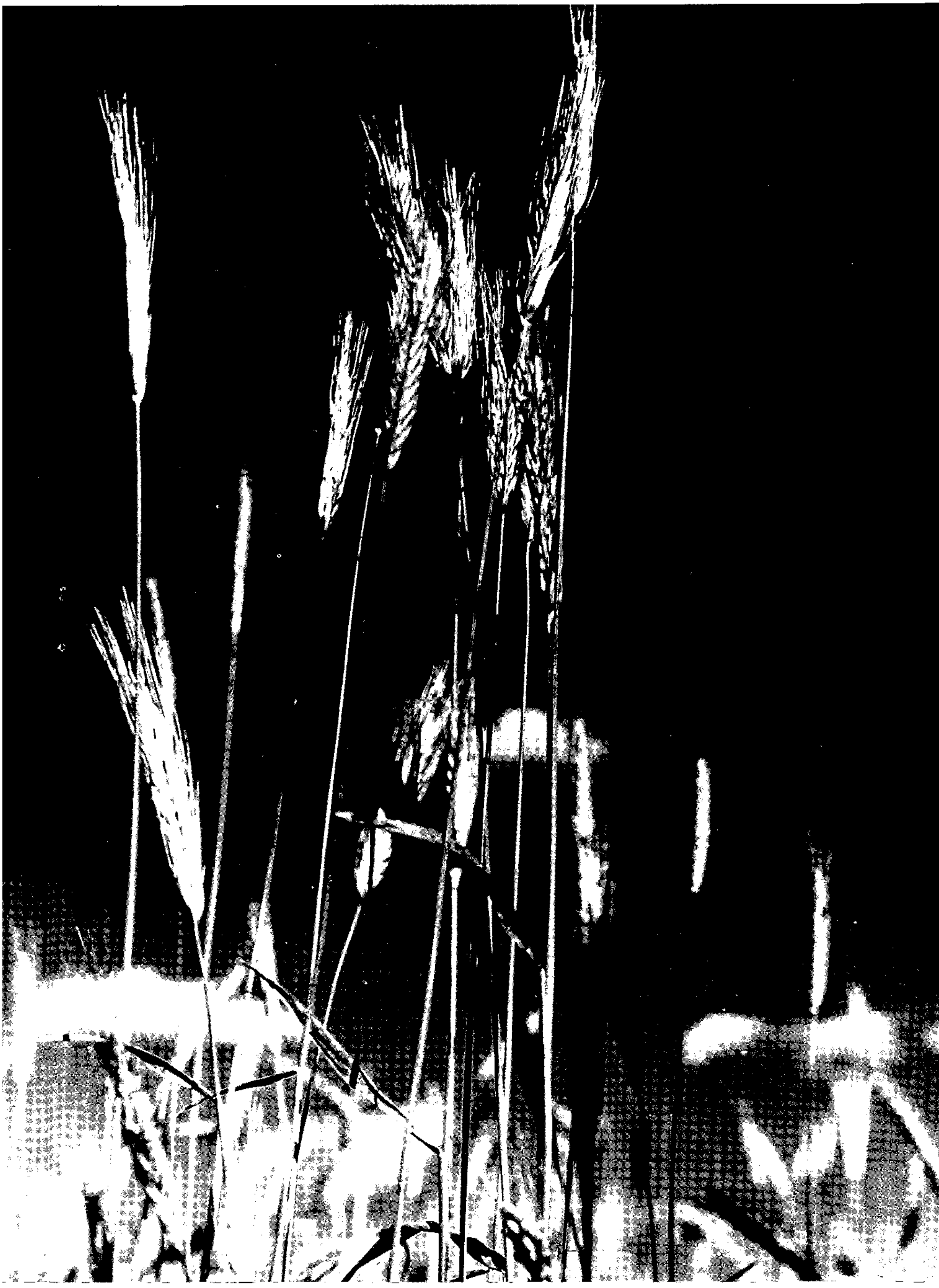


Impact of Climate Variability on Global Grain Yields

By Norton Strommen, Clarence Sakamoto, and Sharon LeDuc
Center for Climatic and Environmental Assessment

Introduction

Variability in global grain yields is a function of climate variability. An understanding of the implications of this relationship is important in formulating national policies for grain production and grain reserves.

This study provides probabilities of positive or negative grain yield departures of more than 10 percent. A 10 percent threshold value was chosen for several reasons. In recent years, global grain reserves declined to near 10 percent of total annual consumption (though they have since risen). Also, yield reductions of more than 10 percent correlate well with major drought years in the world's leading grain-producing countries, including the United States and U.S.S.R. It should be noted, however, that when larger departures are used for threshold values—say 15 percent—some of the respective probabilities in the accompanying tables change markedly. The United States, for example, seldom has departures this large; in the U.S.S.R. they are relatively frequent.

The probabilities are based on crop yield, rather than crop production, because yield is more responsive to weather and climate changes. Production data can be altered by acreage changes, thereby masking the influence of weather changes.

Normal yield is defined as the trend-line yield. This assumes that yield has increased with time because of technological advances, and that variations about this technology trend are caused primarily by weather variability.

Wheat Yield Probabilities for the United States and U.S.S.R. ***(tables 1a and 1b)***

The probabilities of yield departures being more than 10 percent below normal is considerably greater in the U.S.S.R. (34 percent versus 20 percent) over the longer period, but for the years from 1950 to 1975 the probabilities were 23 percent for the U.S.S.R. versus 19 percent for the United States. The authors believe that the difference in the Russian probabilities for the two periods reflects: (1) recent expansion of the (spring) wheat crop into the New Lands, and (2) a run of poor-yields in the 1920's. Weatherwise, the Russian spring and winter wheat areas are out of phase; when one has a poor year, the other usually has a good year, thereby damping the magnitude of fluctuations. The probability of any given year having yield departures greater than 10 percent above normal is more than twice as great in the U.S.S.R. as in the United States.

Data for both periods of record suggest that the role of weather in determining yield variability is substantially greater in the U.S.S.R. than in the United States. Both data series also suggest that the weather has been less variable in the last 25 years, but that increases in crop failures in

Period	> +10% Successive Years			< -10% Successive Years		
	1	2	3	1	2	3
1867-1976	14	4	2	20	6	3
1950-1975	8	0	0	19	8	0

Period	> +10% Successive Years			< -10% Successive Years		
	1	2	3	1	2	3
1886-1930 and 1950-1975	30	13	7	34	13	7
1950-1975	25	12	8	23	0	0

Tables 1a and 1b. Probabilities of positive and negative departures-from-trend wheat yields for the United States (top) and the U.S.S.R. (above).

the 1970's may signal a return to an era of greater variability such as prior to the mid-1950's.

The pattern for 2 or 3 consecutive years of yields more than 10 percent below normal is similar. For 2 successive poor years, the long-term probability drops to 13 percent for the U.S.S.R., while for 3 successive poor years the probability is only 7 percent (table 1a). In the United States, the probabilities are 6 percent and 3 percent for 2 and 3 years, respectively (table 1b). Again, the more recent 25 years show a dramatic improvement in the U.S.S.R. data as compared with the longer period of record.

Simultaneous Wheat Yield Probabilities for the United States, Russia, and Canada

The probabilities of experiencing simultaneous yield departures greater than 10 percent in any given year are analyzed by three periods (table 2). When comparing the United States and the U.S.S.R. for a longer data period, the probability of a simultaneous negative departure is about 10 to 15 percent. When only the 1950 to 1975 period is used, this value drops to less than 5 percent. Again, this reduction can be attributed to the opening of the New Lands region to increase spring wheat acreage, which usually offsets poor yields observed in the U.S.S.R.'s winter wheat regions. The study found no cases where 2 or more consecutive years of simultaneous unfavorable yields were observed in both the U.S.S.R. and the United States.

For the U.S.S.R., the United States, and Canada, the probability (table 2b) of simultaneous unfavorable yields ranges from 4 to 7 percent, depending on the number of years of data considered. When the United States, U.S.S.R., Canada, Australia, Argentina, and India all are considered, the probability of a simultaneous poor year drops to zero. (In 1919, however, the United States, U.S.S.R., Canada, and Australia had yield decreases of at least 10 percent, but Argentina had a 10-percent yield increase.)

Period	> +10% Successive Years 1	2	3	< -10% Successive Years 1	2	3
1886-1930; 1950-1975	7	1	0	11	0	0
1911-1930; 1950-1975	7	0	0	15	0	0
1950-1975	8	0	0	4	0	0

Period	> +10% Successive Years 1	2	3	< -10% Successive Years 1	2	3
1867-1975	2	1	0	5	0	0
1911-1930; 1950-1975	7	0	0	7	0	0
1950-1975	4	0	0	4	0	0

Tables 2a and 2b. Probabilities of simultaneous positive and negative departures-from-trend wheat yields for the United States and U.S.S.R. (top) and for the United States, U.S.S.R., and Canada (above).

Country	> +5%	> +10%	<-5%	< -10%
China				
2 Years	0	0	8	4
3 Years	0	0	4	0
India				
2 Years	19	4	4	4
3 Years	8	0	0	0

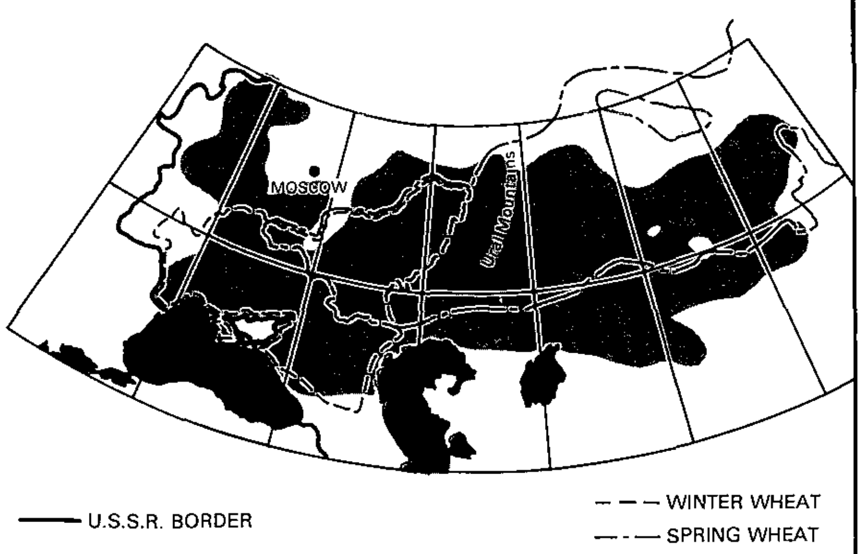
Table 3. Probabilities of consecutive departures-from-trend rice yields for China and India.

Rice Yield Probabilities for China and India

Rice data for China and India were analyzed in terms of yield variations greater than 5 percent and 10 percent (table 3). The 5-percent

Country	> +10%		< -10%	
	Successive Years		Successive Years	
	1	2	1	2
Argentina	25.9	6.5	23.4	8.5
Australia	28.5	9.4	20.8	4.7
Brazil	16.5	6.6	13.9	1.3
Canada	26.4	6.7	26.4	6.7
China	7.7	1.3	10.3	6.7
India	15.5	4.6	13.7	4.6
Japan	14.1	4.1	14.1	4.1
U.S.A.	15.8	5.0	15.5	4.6
U.S.S.R.	29.2	12.3	25.7	5.1

Table 4. Probabilities of departures-from-trend for major crops (generally corn, rice, soybeans, and wheat). Data generally for 1950-1975, except a longer period for wheat.



Approximate extent of U.S.S.R. drought in 1975.

level was included because departures greater than 10 percent had such low probabilities. The probabilities of rice yields more than 5 percent above normal for 2 consecutive years in India is 19 percent, and 8 percent for 3 consecutive years. China did not experience 2 consecutive years of good yields during the period of record. The probability of rice yields greater than 5 percent below normal is 8 percent for China and 4 percent in India for 2 consecutive years, and 4 percent for China and near zero for India for 3 consecutive years. Further analysis shows that the probability of China and India experiencing favorable yields simultaneously is 12 percent. For poor yields, it is less than 4 percent.

All Grain Yield Probabilities for Major Agricultural Nations

When data for all grains—corn, rice, soybeans, and wheat (table 4)—were considered for the major agricultural nations of the world, two patterns emerged. First the probability of positive or negative yield departures greater than 10 percent of normal generally increases as one moves into the mid and higher latitudes; and second, labor-intensive agricultural areas have the smallest probabilities of getting such departures.

Strategic Petroleum Reserve Baseline Study

The Marine Assessment Division of EDS' Center for Experiment Design and Data Analysis is coordinator for a prototype baseline study of oceanographic and ecological conditions off Bryan Mound near Freeport, Texas. Bryan Mound has been selected as one of the initial sites for crude oil storage of the National Strategic Petroleum Reserve.

The Reserve was established by Congress to provide a contingency supply against future oil embargoes. The Federal Energy Administration, now part of the Department of Energy, was assigned responsibility for establishing the reserve and has requested the Environmental Data Service's Marine Assessment Division (MAD) to assist them in evaluating the potential impact of discharging brine into the Gulf of Mexico from salt domes as crude oil is pumped in.(See EDS, March 1977.)

MAD already has analyzed historical environmental data for the area, and is now analyzing newly collected measurements of physical oceanographic properties and water and sediment quality, as well as assessments of the indigenous benthal and nekton communities. These new data will be used as part of a baseline against which monitoring data can be compared, should the decision be made to dispose of brine in the Gulf of Mexico.

Most of the data are being collected for MAD by personnel of the Civil Engineering Department of Texas A&M University, funded by NOAA's Office of Sea Grant. The University has established a field station at Freeport, which includes the research vessel EXCELLENCE, a leased pier facility adjacent to the Intracoastal Waterway, and an office for use by the principal investigators.

Scientists from Texas A&M's Biology Department and NOAA's National Marine Fisheries Service at the Port Aransas Laboratory have conducted bio assay tests, including tolerance studies of several life stages for a number of species that are common to the proposed disposal site and are vital to its food web.

Additional data are being collected by the NOAA Data Buoy Office using an instrumented offshore oil platform, which has a satellite telemetering instrument package to sense wind speed and direction. This system is being upgraded to yield additional oceanic parameters including bottom current, bottom temperature, sea surface temperature, air temperature, and barometric pressure.

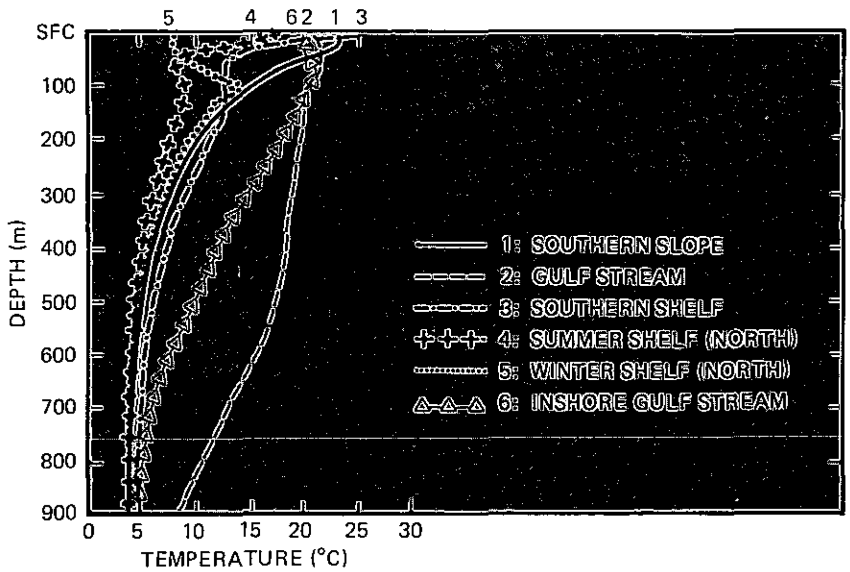
Environmental Study of Mid-Atlantic Oil Lease Areas

EDS' Center for Experiment Design and Data Analysis has prepared an environmental study of Federal oil lease areas off the Mid-Atlantic Coast for the Department of the Interior's Bureau of Land Management (BLM). The report, *Summarization and Interpretation of Historical Physical Oceanographic and Meteorological Information for the Mid-Atlantic Region,* will be used by BLM to establish baselines for the physical charactistics of the marine and coastal environment and to help predict the impact of exploration for and development of petroleum and natural gas deposits. The region covered by the publication extends from 38°N to 41°N and from the coast to the 2,000-m. isobath.

The report summarizes historical meteorological and oceanographic data for the region. The surface-wind field, which plays an important role in determining the movement of spilled oil and other pollutants, is discussed in detail. Seasonal means and variability of surface winds are illustrated, and a method is described by which coastal-station wind data can be adjusted to approximate conditions over adjoining ocean areas. Wind trajectory patterns are calculated, and visibility restrictions and the potential super-structure icing are discussed.

A major part of the report deals with the physical characteristics of water masses in the Mid-Atlantic region, whose structure and variability are particularly relevant to the dispersion and advection of pollutants. Because diffusion, mixing, and advection are seldom measured directly, the potential for these processes is inferred from analysis of such variables as water temperature, salinity, and density. The vertical density, which depends on temperature and salinity and which determines the rate of vertical mixing and momentum exchange from the surface, is considered in detail. In addition to analyzing the surface and subsurface water temperature and salinity, the report includes data on dissolved oxygen and nutrient concentrations which are needed in evaluating potential degradation rates of ocean pollutants.

Circulation features analyzed include the mean surface current field and its variability, which act directly to advect and disperse pollutants; subsurface currents and their tidal constituents; and subtidal flow, which produce large water-mass transports. From these circulation features and from the water-mass characteristics, some



Water mass classification based on STD data.

inferences concerning vertical mixing are drawn. Ocean waves are discussed, including estimates of return periods of extreme wave heights in the region.

The final section of the report evaluates the reliability of and deficiencies in the data used, and includes recommendations for the designs of future field programs to fill gaps in the data needed for adequate environmental assessment.

Copies of the report are available from the Center for Experiment Design and Data Analysis, EDS, NOAA, Washington, DC 20235.

New Environmental Data Source Directory

Sponsored jointly by the National Science Foundation (NSF) and the National Oceanic and Atmospheric Administration (NOAA), *Federal Environmental Data: A Directory of Selected Sources* was compiled to assist individuals and organizations outside the Federal Government. Major environmental data bases maintained by U.S. Government agencies are described. Several systems, information centers, and programs that are themselves repositories of a large number of data bases also have been included.

Data bases operated by five Federal agencies are featured: the Department of Agriculture, Commerce, the Interior and Energy, and the Environmental Protection Agency. In addition, a few data sources from the Department of the Army, the National Library of Medicine, and the Council on Environmental Quality are described.

Listings in the Directory represent organized collections of scientific and technical data and bibliographic and directory information searchable by predefined terms. Each entry contains the following information: source name, source agency, objective, general description, size, update frequency, time reference, cost, user turnaround time, product, and person to contact.

A sample of the spectrum of environmental topics covered includes agricultural chemistry, crop improvement, plant genetics, ecology, marine biology, oceanography, meteorology, climatology, nuclear energy, public utilities, pollution, and environmental science.

A limited number of copies of the Directory are available from Dr. Louis Cima, OSIS Program, NSF, 1900 Pennsylvania Ave. Wash., DC 20550, Tel: 202-632-5800. Additional copies will be available in the spring through the National Technical Information Service, Springfield, VA 22161.

Probabilities of Flying Conditions for Space Shuttle Flights

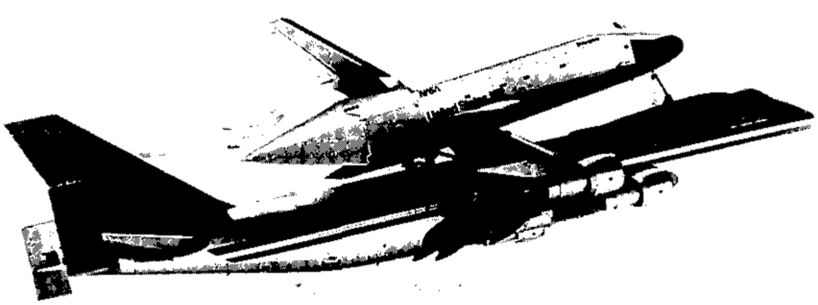
The National Climatic Center (NCC) has prepared a climatological study for the National Aeronautics and Space Administration's George C. Marshall Space Flight Center. *Probabilities of Good, Marginal, and Poor Flying Conditions for Space Shuttle Ferry Flights* provides probabilities for flying weather conditions for "piggy backing" the Space Shuttle Orbiter from Edwards Air Force Base, Calif. to Kennedy Space Center, Fla., and from Edwards to Marshall Space Flight Center, Huntsville, Ala.

During the past 6 months, the Space Shuttle has been flight tested at the Dryden Flight Research Center at Edwards. This spring it will be ferried piggyback atop a Boeing 747 to the Marshall Space Flight Center for vibration testing. The orbiter will be ferried to Edwards in August, and 3 months later will be carried to Kennedy in preparation for the March 1979 launch.

Weather conditions will determine the precise time schedule for the ferry flights. Unfavorable weather enroute could cause unscheduled landings or diversions. Favorable terminal weather is desirable for safe transfer of the orbiter from the 747 jumbo jet.

The study contains figures and tables that summarize the flying weather conditions. The figures show the percent frequency of occurrence of up to four successive days of good, marginal, or poor flying weather over the route from Edwards to Kennedy. The tables show monthly frequencies and probabilities of up to four successive days of good, marginal, or poor weather over all or portions of the Edwards to Kennedy and Edwards to Huntsville routes.

Copies of the report can be obtained from the National Technical Information Service, Springfield, VA 22161.



Space Shuttle Orbiter, "ENTERPRISE" *during first captive test flight over Edwards Airforce Base, Calif.*

OASIS User Services Double

Use of EDS' Oceanic and Atmospheric Scientific Information System (OASIS) increased dramatically last year. In 1977 more than 5,000 searches were provided in response to information requests from NOAA personnel, other Government investigators, academic researchers, industry, foreign requesters, and the general public. This is almost double the 1976 total and 5 times the number of searches performed in 1975, OASIS' first full year of operation. Over half of last year's requests came from non-NOAA users.

OASIS provides automated searches of the tecnical literature and of research in the environmental sciences and marine and coastal resources. It accesses both NOAA and non-NOAA data bases.

One reason for the recent increase in OASIS requests is user interest in prepackaged searches. Produced by the Library and Information Services Division (LISD) of EDS' Environmental Science Information Center, which manages the OASIS program, these bibliographies meet the need for information on high-interest topics. LISD recently published three new bibliographies. Two of these, *Oil Spill—Cleaning Up* and *Marine Corrosion,* are new. The third, *The Coastal Zone,* is an updated version of an earlier publication.

OASIS, however, is designed primarily and used most extensively to meet demands for information tailored to individual user requirements. Searches can go back several years (in some 10 or more) to provide a comprehensive bibliography on a user subject. If desired, periodic updates (usually monthly) can be routinely provided. Last year LISD used OASIS to provide requesters with information on the effectiveness of hurricane warning systems, the fate of oil spilled at sea, the legal aspects of aquaculture, the role of carbon dioxide in climatic change, and the hazards of ocean dumping of nuclear wastes, to name but a few topics.

OASIS files cover subject areas such as meteorlogy, oceanography, aquatic sciences, biology, chemistry, physics, and engineering. In addition, a large number of interdisciplinary, problem-oriented files are included; these deal with such subjects as pollution, environment, and energy. Other files cover particular types of material, including government documents, Environmental Impact Statements, Congressional publications, news articles, and ongoing research efforts. LISD will select and search the best combination of files available for each request. Searchers are provided free to NOAA personnel and on a cost-recovery basis to other users. Although the price varies for data bases, the average cost is about $50.

Further information on OASIS services is available from the EDS Library and Information Services Division, D822, National Oceanic and Atmospheric Administration, WSC-4, 6009 Executive Blvd., Rockville, MD 20852, or by calling 301-443-8358.

Precipitation Probabilities for Wastewater Management Systems

The National Climatic Center (NCC) recently completed a study for the Environmental Protection Agency (EPA) to provide information on the amount of precipitation at 93 locations in the United States during three time periods: April-September, October-March, and January-December (annual).

The planning, design, and operation of land-based wastewater management systems can depend on the amount of precipitation during the operating season, especially where soils with low permeability limit the hydraulic load for irrigation-type systems. Operating-season precipitation is most important in areas where its ratio to evapotranspiration is high, and where soils limit the hydraulic load to low values.

NCC processed 30 to 40 years of monthly precipatation totals to provide tables showing the likelihood of precipitation exceeding or failing to reach selected amounts. EPA published the tables under the title, *Annual and Seasonal Precipitation Probabilities,* EPA-600-2/77-182, coauthored by R. E. Thomas (EPA) and D. M. Whiting (NCC). Copies may be obtained through the National Technical Information Service, Springfield, VA 22161.

Pacific Ocean Climatic Atlas Revised

U.S. Navy Marine Climatic Atlas of the World, Volume II, North Pacific Ocean (Revised 1977). NAVAIR 50-IC-529, is now in print. Published by the Director of Naval Oceanography and Meteorolgy, it updates and revises the atlas published in 1956.

The new issue contains nearly 20 additional years of meteorological data. Part I, Meteorology, was compiled by the EDS National Climatic Center (NCC); Part II, Oceanography, was compiled by the U.S. Naval Oceanographic Office. It is the third volume to be revised and updated in the series.

The Meteorology segment contains monthly charts and supplementary graphical presentations of surface elements: temperature (air and sea), humidity, precipitation, visibility, wind, waves, cloud cover and height, and atmosphere pressure. It also includes monthly presentations of tropical cyclone compass roses by 5-degree quadrangles. The oceanography section contains charts for tides, ocean currents, and ice conditions.

Some of the meteorological data presentation in the 1956 Atlas have been changed in the new issue: wave statistics have been added, and no upper air charts are included, because several comprehensive volumes of upper air data have been published in recent years.

The 388-page volume is for sale by the Superintendent of Douments, Government Printing Office, Washington, DC 20402. GPO stock number is 008-042-00068-3; price is $27.50.

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In this issue: *Damping the boom and bust cycle in coastal energy development (p.3); the impact of climate fluctuations on global grain yields (p.17); and nature's records of past climates (p.9).*

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May 1978

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Cover: *The Margerie Glacier, St. Elias Mts., Alaska. The dark bands of moraine material (earth and stones) were deposited by avalanches. A picture story illustrating types and traits of North American glaciers begins on page 4.*

EDS is a bimonthly publication designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, and Center for Climatic and Environmental Assessment. In addition, under agreement with the National Academy of Sciences, EDS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 16, 1975; this approval expires June 30, 1978.

U.S. DEPARTMENT OF COMMERCE
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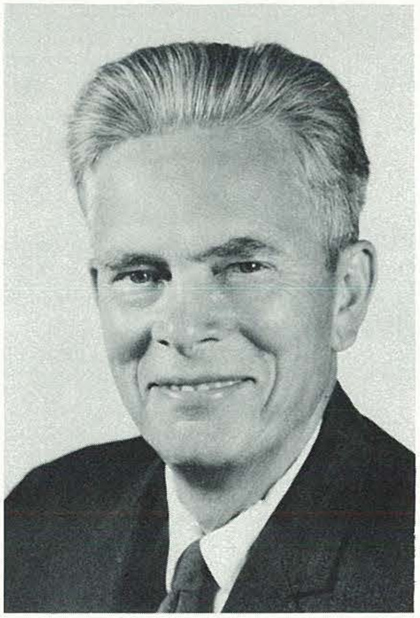
Natural Hazards Data Needs

There is a growing trend to consider as one problem the various natural hazards to people and their property. Individually, locales may be more or less vulnerable to earthquakes, floods, hurricanes, severe storms, or other extreme events, but no locale is safe from all natural hazards. Approximately 600 lives and $5 billion in property are lost annually in the United States to such events. And these figures could be exceeded by a single major disaster.

Urbanization is rapidly concentrating more lives and property in coastal areas, flood plains, and other potentially hazardous but often desirable locations. Moreover, modern communities are a complex combination of supply, communication, and transportation systems and services vulnerable to disaster.

Many who need natural hazards data are concerned with the overall risk, not the hazard agent. Such users include land-use planners; engineers designing large-scale projects such as nuclear power plants, dams, and other major structures; insurance companies, property owners, and Federal, State, and local relief agencies. The data and data products they need are now either scattered



among organizations or, in some cases, not available at all.

In general, existing natural hazards data bases were developed for applications other than risk and hazard assessment. The data are hard for a prospective user to find, and harder still to meld into an accurate risk analysis. When the data needed are not accessible, we pay the price of overdesign, since prudence dictates high safety standards when faced with uncertainty. We will pay a much higher price when future disasters test our land-use and emergency response plans and find them wanting because of inadequate design data.

At this writing, EDS is planning a Workshop on Natural Hazards Data Resources cosponsored by the U.S. Geological Survey and the National Science Foundation. The Workshop is being organized by the University of Colorado's Natural Hazards Research and Applications Information Center. It will bring together scientists and administrators from nearly a dozen Federal agencies, as well as academic researchers and users from industry, insurance, and environmental activities, and State and local governments. One result of the Workshop will be a clear recognition of the extent to which existing data services are or are not adequate to meet national needs. Another will be a series of practical suggestions as to ways of improving both the data and their availability.

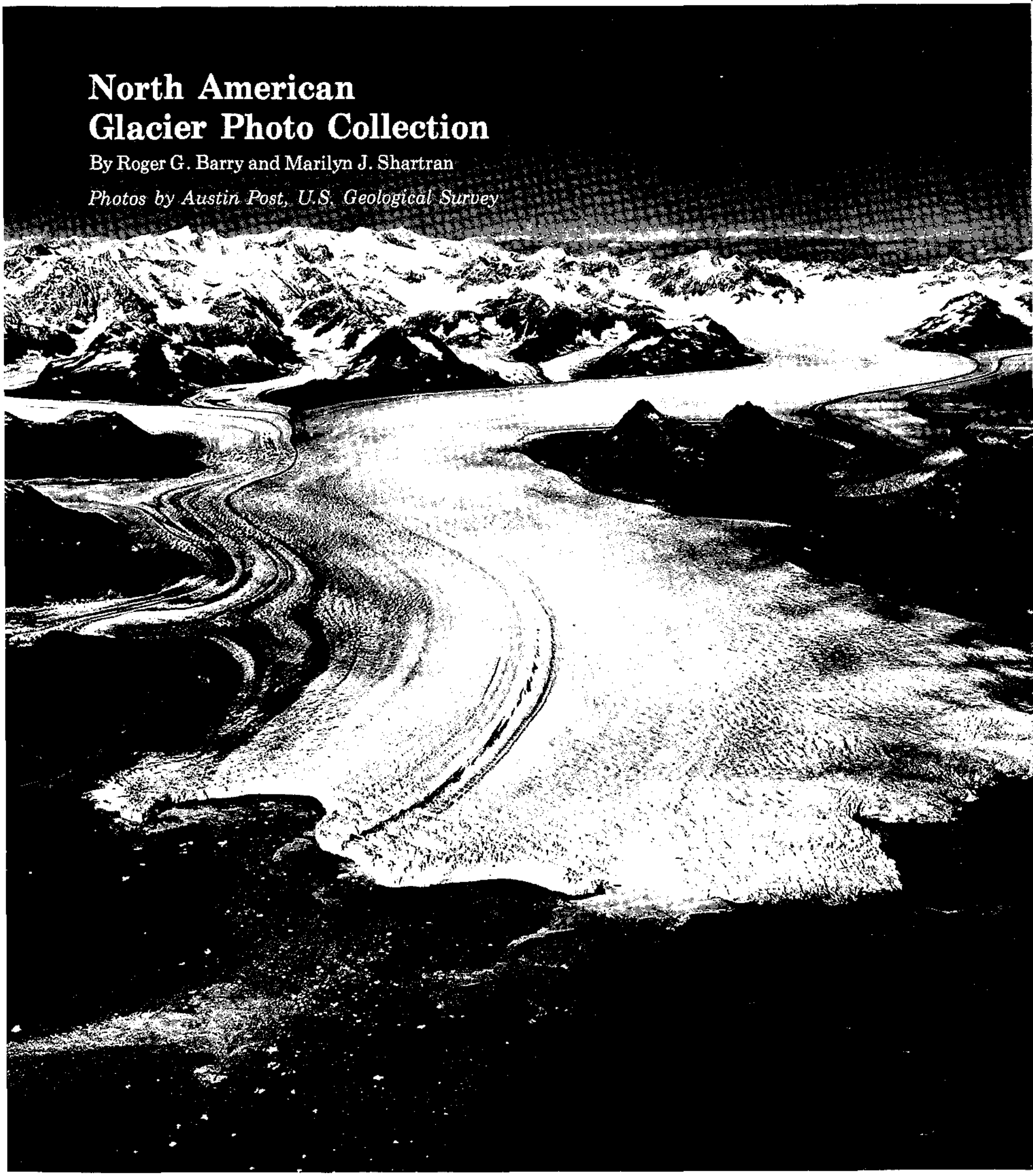
Gilbert F White

Gilbert F. White, Director
Natural Hazards Research and
Applications Information Center
University of Colorado

North American Glacier Photo Collection

By Roger G. Barry and Marilyn J. Shartran

Photos by Austin Post, U.S. Geological Survey



Left: The terminus of the Columbia glacier near Valdez, Alaska. This is the only calving (see p.9) glacier in North America that has not undergone drastic retreat in recent centuries. The Johns Hopkins Glacier (above), Glacier Bay, Alaska, a favorite tourist attraction, has retreated about 100 km since the first observation was recorded.

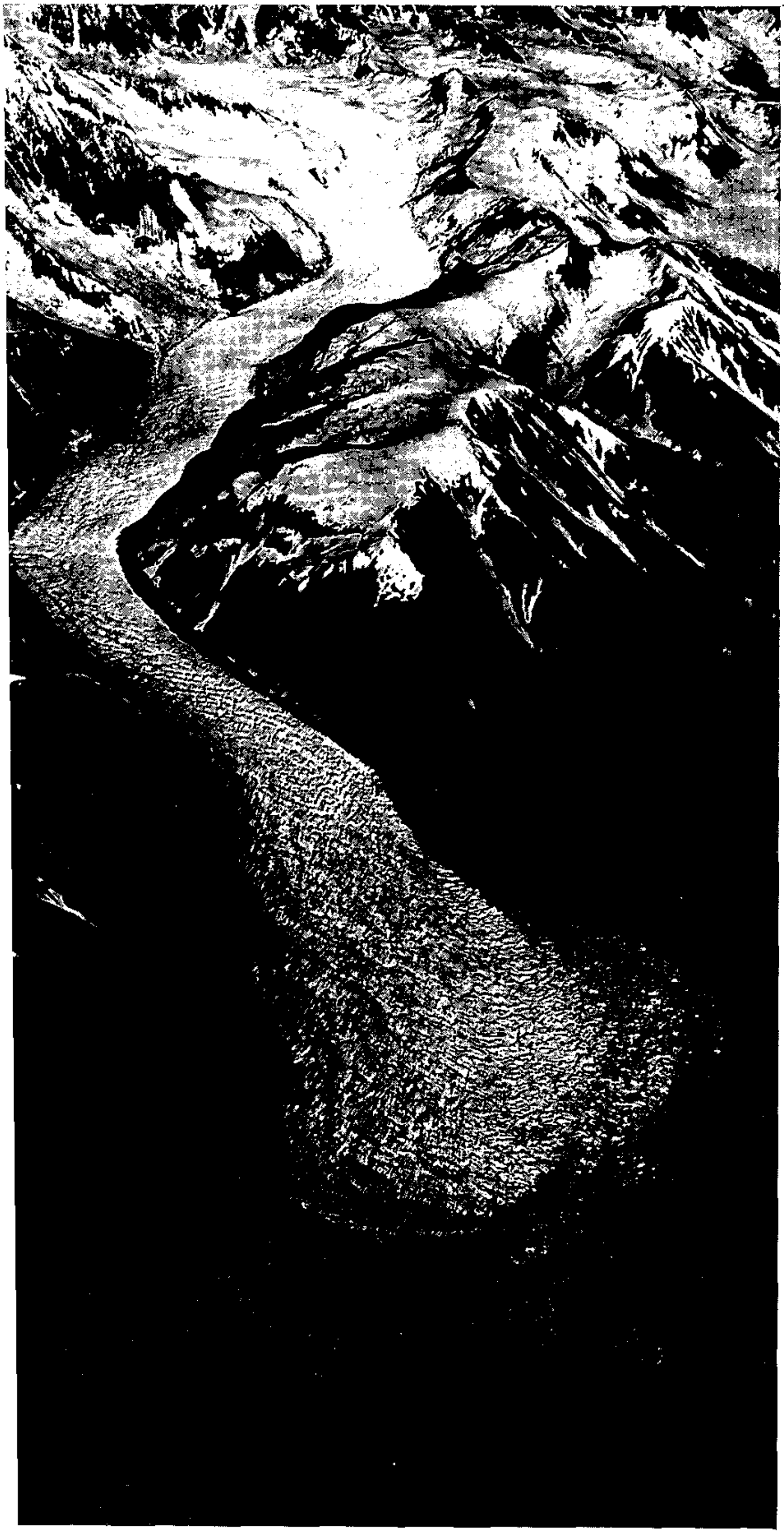
A collection of aerial photographs of North American glaciers is a major holding of World Data Center-A for Glaciology (Snow and Ice) in Boulder, Colo. The pictures were taken by Austin Post of the U.S. Geological Survey's (USGS) Project Office for Glaciology in Tacoma, Washington. With the transfer of the center from USGS to NOAA/EDS in October 1976, it was agreed that microfilm copies of the original 9-in roll film photographs would be made for deposit in the relocated WDC in Boulder. Many of the rolls have not yet been identified, and a major effort is now underway in Boulder with Post's guidance to complete the task for the approximately 100,000 frames.

An identification system has

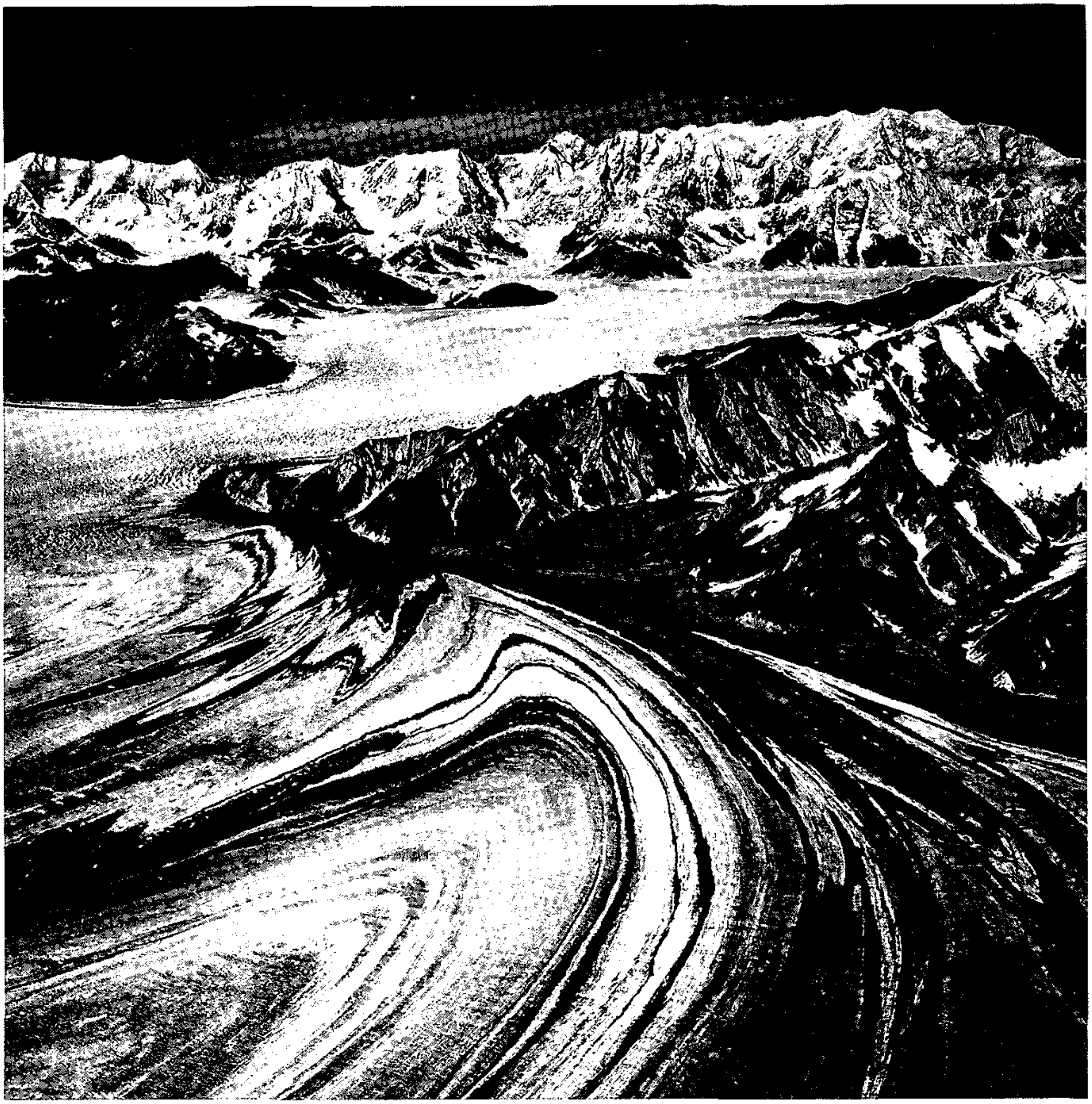
been developed which will provide material for a computer-based information storage and retrieval system. The identification system includes: camera type, focal length, film size and number, format (negative, transparency, microfilm, etc.), date and hour of exposure, camera angle, photo quality, percent of cloud cover, location (country, State, mountain range, map), IHD (International Hydrological Decade) number, glacier name, and glacier feature (terminus, firn line, moraine, etc.).

The photos in the collection date from 1960, when Post, then with the University of Washington, began taking glacier pictures for a National Science Foundation-sponsored project to record annual snowline and glacier fluctuations in the Western United States and Alaska. Since 1964, the work has continued under the USGS in Tacoma, with emphasis on the study of glacier dynamics, calving glaciers, and surging glaciers. This 18-year record is a valuable archive and of great interest to glaciologists and scientists interested in climatic change, since glacier movements represent an integrated response to recent climatic fluctuations.

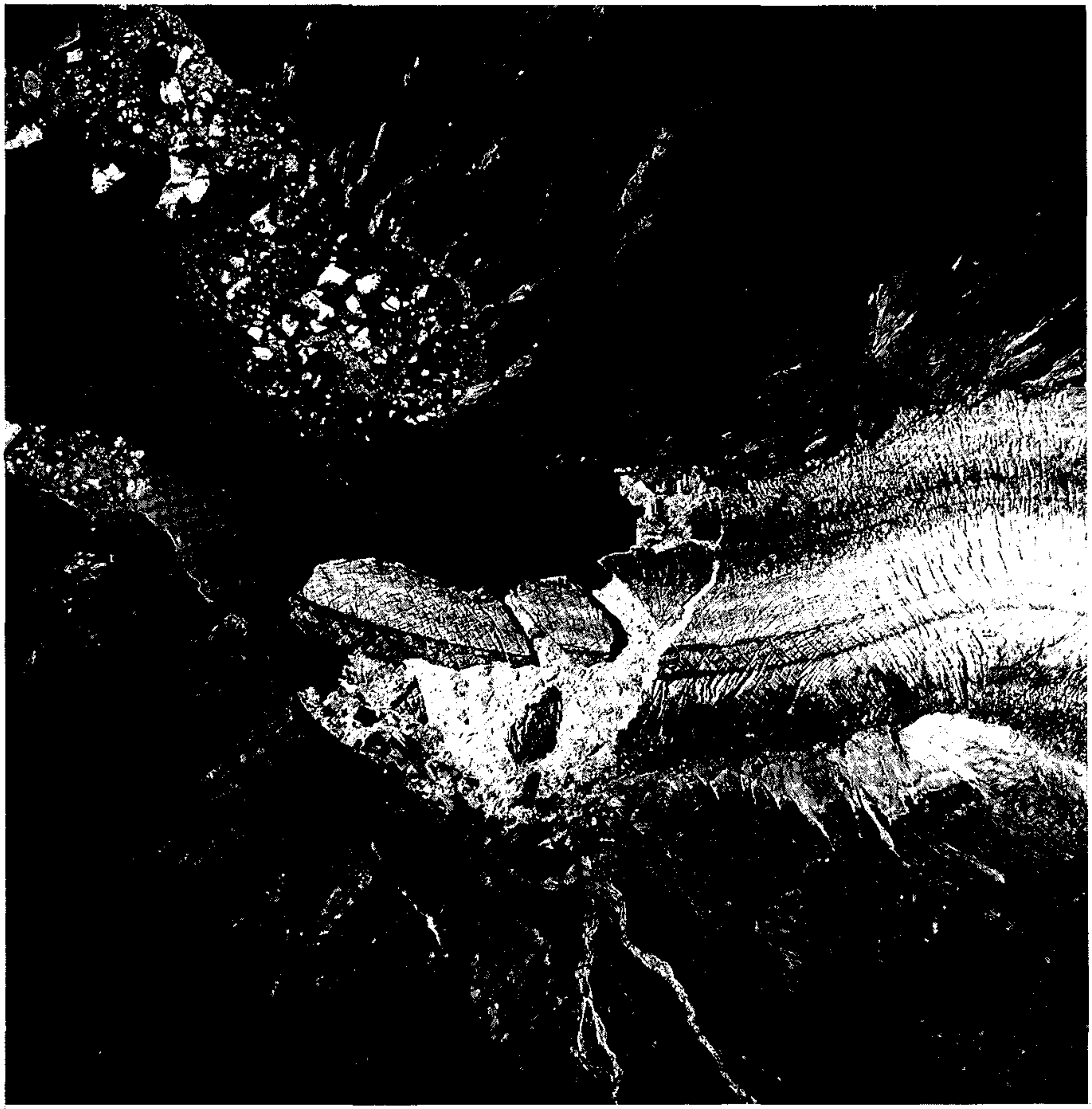
Since the collection has not yet been fully transferred to WDC-A for Glaciology, photos currently are available from: U.S. Geological Survey, 1201 Pacific Ave., Suite 850, Tacoma, WA 98402. Tel.: (206) 593-6502; FTS 390-6502.



While general retreat relating to warming since the "Little Ice Age" (about 1550 to 1850 A.D.) has characterized most glaciers, a few undergo irregular rapid advances or surges unrelated to climatic conditions. Such unstable behavior, still not fully understood, is illustrated by the Variegated Glacier, St. Elias Mts., Alaska. The picture on the opposite page was taken August 29, 1964; the one to the left, August 22, 1965. During this time, the glacier moved forward about 6,000 m.



Alaska's Malaspina Glacier illustrates unusual folding of the moraines, another phenomenon not totally understood by glaciologists.



The Shakes Glacier, near Petersburg, Alaska calving into a freshwater lake.

Early Drought Detection in the Tropics

By Douglas LeComte

A youngster at the child-feeding center in Boucan Patriot, Haiti in August 1975, during a severe drought.
Photo: John Metelsky, U.S. AID

In a number of tropical countries, food crop production has failed to keep pace with population increases. In some cases, per capita production has fallen substantially over the last 10 to 15 years.

A recent EDS survey of 11 nations in the Caribbean Basin examined their relative success in increasing food production. The survey compared per capita food crop production in 1976 with average per captia production for 1961-65. Production changes ranged from a 45% improvement in Guatemala to a 30% decline in Trinidad. Honduras, Haiti, and Jamaica also showed significant drops in per capita production.

While various reasons can be given for the declines, a major factor appears to be anomalous weather, particularly drought. Hurricanes caused the sharpest and most immediate declines (Honduras, 1974 and 1975), but long-term droughts have figured prominently in prolonged and extensive losses which occurred in Haiti, Jamaica, and Trinidad. The problem has been particularly acute in Haiti, where unusually dry weather has caused serious food shortages during the last few years, especially in remote northern areas.

The suffering which frequently follows drought in tropical countries can be alleviated if help arrives in time. To get food and medical supplies to a disaster area when needed, however, requires some lead time. If developing droughts can be detected and monitored before food shortages result, disaster relief operations become more efficient and malnutrition and famine can be reduced or averted.

EDS' Center for Climatic and Environmental Assessment (CCEA) is working with the Office of U.S. Foreign Disaster Assistance to monitor rainfall in the Caribbean Basin and in central Africa to keep it apprised of potential and developing drought situations. CCEA is also investigating climatic fluctuations and their effects on agricultural products in the Caribbean and the African Sahel regions.

The Office of Foreign Disaster Assistance is part of the State Department's Agency for International Development (AID). It was created in 1964 to coordinate U.S. Government response to foreign disasters. The international preparedness objectives of the Office include the monitoring of potential and incipient disasters throughout the world and the development of new ways to determine the probability of disasters. These objectives tie in with the work CCEA is doing in crop-yield modeling and crop weather analysis, so the two organizations have been working together to develop ways to assess drought severity in various developing tropical nations.

Country	**(1)**	**(2)**
Guatemala	+45	1
Costa Rica	+33	2
Nicaraqua	+10	3
Venezuela	+ 9	2
Mexico	+ 5	3
Panama	+ 4	2
Dominican Republic	+ 3	2
Honduras	- 15	4
Haiti	- 17	5
Jamaica	- 29	7
Trinidad	- 30	6

(1) Changes in *per capita* food crop production, comparing 1976 with the 1961-65 average.

(2) Climate and weather events that caused significant reductions in food crop production, 1966-76.

CCEA's association with AID began in 1975, when CCEA was asked to study the drought which had afflicted Haiti early that year. Since rainfall data were sparse, CCEA evaluated the severity of the dry spell by using rainfall estimation techniques based on NOAA satellite photographs. The study showed that the winter and spring of 1975 were unusually dry in Haiti, though historical weather records revealed that the rainfall deficiencies were not without precedent.

In 1976, CCEA began weekly rainfall assessments for Africa. The reports, still being issued regularly, discuss the rainfall situation in over a dozen countries stretching across the middle of the African continent, including the Sahel region and those countries to the south and east of it. CCEA's Assessment Division analysts use rainfall reports supplemented by analyses of surface, upper air, satellite, and climatic data to produce rainfall summaries for these countries.

In some cases, very few rainfall measurements are received, and estimates must be made using the best data available. A technique has been developed by the Assessment Division whereby weekly rainfall amounts can be estimated for a country by combining available surface rainfall observations and climatic data. Using rainfall frequencies and long-term average rainfall amounts, a graphical determination can be made of a country's weekly rainfall, even if not a single rainfall measurement is available.

By keeping track of weekly and seasonal accumulated rainfall amounts and comparing these figures with long-term averages, CCEA is helping AID determine which countries have developed serious rainfall deficiencies and may, as a result, need disaster assistance in the future because of failed crops.

In late 1977, CCEA embarked on an ambitious study of drought and food problems in the Caribbean Basin. In the first phase of the project, CCEA is providing AID with near-real-time weekly assessments of weather conditions in the Caribbean and adjacent areas of Central and South America. Weekly and accumulated rainfall in over a dozen countries are monitored, so that deteriorating moisture conditions can be detected early. If CCEA finds that unfavorable conditions are developing that could have a serious effect on crops, AID can advise the government of the affected countries to take appropriate early action to minimize potential adverse impacts and to plan to move food stocks from surplus to deficient regions.

Heavy reliance is placed on satellite estimates of rainfall to supplement the sparse rainfall reports which come from the region. The extent and type of rain-producing cloudiness shown on SMS GOES (geostationary) satellite imagery are used to estimate daily rainfall amounts by region. Haiti, on which particular emphasis is being placed because of current food problems, is divided into six regions for this purpose. It is hoped that this division will enable CCEA to detect relatively small-scale droughts. Regional moisture shortages, especially in the northern areas, can have devastating affects on the availability of food in Haiti.

The weekly assessments reveal areas where major rainfall anomalies are developing; phase two of the project is designed to objectively relate weather conditions to agriculture. CCEA's Model Development Division in Columbia, Mo., is gathering available meteorological and agricultural data in an attempt to relate these variables and enable CCEA to assess the impact of drought on future crop potential.

Besides developing crop/weather relationships CCEA, phase two researchers will try to determine if a climatic change has begun in the Caribbean region. Surface and upper air data will be examined for evidence of any change to a drier or a more variable climate. Tradewind inversion heights and divergence fields will be analyzed to see

if the tropical atmosphere has become less favorable for convection.

The climate change investigation will also focus on Haiti, where several devastating droughts have occurred during the last few years. CCEA will try to determine if a local, man-made climate change could have contributed to the recent rainfall deficits. It has been hypothesized that wood-clearing operations could have altered the thermal reflectivity of the ground enough to have affected moisture and temperatures in the lower troposhere. The resulting change in stability could possibly inhibit local convection, a major source of rainfall at this latitude.

Sorting out the natural versus the manmade contribution to climate change—if a climate change can be documented—will be a difficult task, but this kind of knowledge relates closely to the future ability of Haiti to feed its people.

CCEA currently is developing a data base of long-term climate and

Left: Women wait to receive U.S. sorghum in Gorom Gorom in Upper Volta during the severe drought that persisted in the Sahel area of West Africa from 1967-1973. Above: Shifting desert sands engulf trees in Mauritania.

Photos: Agency for International Development

CARE project supervisor Isseini Mahonet checks grain level at a "silo" near Sjeria, Chad in February 1977.
Photo: Emmett George

crop information. Adequate surface weather data are essential to analyze surface climate and develop traditional climate/crop yield models based on temperature and precipitation. Surface data for Haiti have not been published in recent years, so EDS personnel will be visiting Haiti and other Caribbean countries to seek the data needed for the project.

Meanwhile, CCEA's Assessment Division continues to provide AID weekly reports of rainfall in both Africa and the Caribbean. The sparseness of timely and accurate rainfall reports remains the major obstacle to accurately depicting the extent and intensity of drought in the tropics. CCEA believes, however, that by using satellite estimates and other indirect methods of rainfall determination—and rainfall reports where available—moisture deficits which lead to severe food shortages can be identified before crisis situations develop.

Acknowledgement

The author would like to express his appreciation to Paul F. Krumpe, Science and Technology Office, Office of U.S. Foreign Disaster Assistance, for providing information used in writing this article.

Weather Records and Litigation

By Mortimer Buchwald and Keith Butson
National Climatic Center

During the New Orleans Mardi Gras in 1970, a man was killed when a parade float overturned in a severe thunderstorm. His family sued the parade's sponsors, claiming they were negligent in permitting the float to be exposed to high winds. The sponsors claimed the accident was an "Act of God." NOAA's National Climatic Center (NCC) provided certified wind records from nearby weather stations, as well as a history of high winds in the New Orleans area to both sides in the dispute.

On January 18 of this year the roof of the Hartford, Conn., Civic Center collapsed during a blizzard. Within a week, an attorney called NCC for snowfall data. NCC provided daily snowfall amounts and daily snow depth measurements for the Hartford area for January 1977 and January 1978.

A New York Admiralty Law Firm, representing a marine insurance company that had insured a freighter that was lost in the North Pacific, contacted NCC for local weather data for the time of the ship's last known position. NCC supplied certified copies of surface and upper air weather maps and of marine surface weather observations for several days bracketing the date of the last report received from the ship. It also supplied satellite photographs of the area for similar dates. In addition, the law firm was referred to the American Meteorological Society to obtain the services of a meteorological consultant who could interpret the weather materials at Coast Guard hearings and in court if necessary.

Hardly a day passes that EDS' National Climatic Center in Asheville, N.C., does not receive inquiries from attorneys, insurance adjusters, Government officials, and private citizens concerning legal matters in which weather may have been a critical factor. During 1977, NCC answered more than 63,000 inquiries for weather data or information, and more than 5,000 of these came from attorneys. In addition, nearly 2,900 more came from the insurance industry, most concerning claims.

Frequently, attorneys, insurance adjusters, and other requesters require records certified as true copies of the originals on file at NCC. Certified copies generally are admissible in court as evidence, without additional testimony concerning their authenticity. In 1977, nearly 3,500 responses to weather data and information requests included certified copies of records. All regularly published NCC data bulletins include a statement signed by the Director certifying that the published data were compiled from records on file at or received by NCC.

Official weather observations are taken at about 12,000 stations operated by the National Weather Service (NWS) and its cooperators throughout the country. Most stations record daily precipitation amounts and many also record daily high and low temperatures. Some are equipped with recording precipitation gages which provide a continuous record of precipitation, so that hourly amounts and actual times of precipitation can be determined.

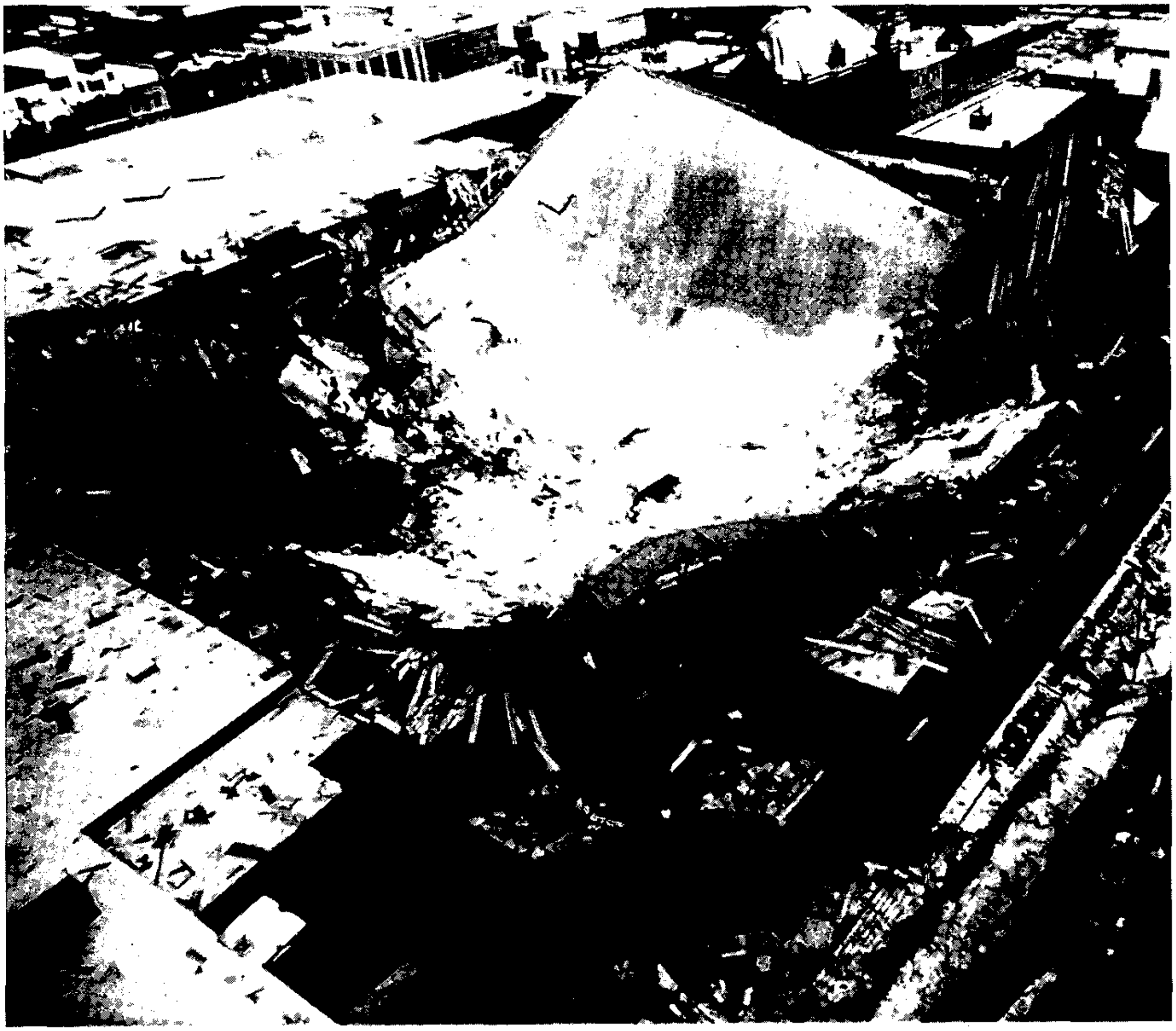
At the approximately 300 NWS offices, more detailed data—such as wind, temperature, humidity, type of weather, atmospheric pressure, visibility, and clouds—are recorded at hourly intervals 24 hours a day. Similar data are recorded at airports served by Federal Aviation Administration, military, and airline weather observers.

Selected NWS stations are equipped with weather radar, and most radar stations photograph the radarscope periodically to record the geographical distribution and heights of precipitation around the station.

All of these original records are filed at NCC; much of the information contained in the records is published in the monthly and annual issues of a variety of weather data bulletins. Some of the bulletins are prepared for individual states or combinations of states; others are issued for individual weather stations.

In addition to the weather records, NCC also maintains accounts of major storms, files of analyzed weather maps, observations from aircraft, summaries of weather conditions, and foreign weather data publications. All of these materials are available to requesters and can be certified as true copies if required. User charges depend upon the search time and the type and number of copies required.

Requesters frequently require weather data for places or times for which no official observation record exists, or they need information about the effect of weather conditions on roads, crops, or



animals. Answers to such questions require analysis and interpretation, and NOAA meteorologists are precluded from rendering opinions in legal matters in which the U.S. Government is not a participant. When such testimony is needed, the requester is advised to seek the services of a private consulting meteorologist. (Names and addresses of private consulting meteorologists may be obtained from the American Meteorological Society, 45 Beacon Street, Boston, MA 02108.)

Requests to NCC concern both civil and criminal cases. Homeowners living near a road construction site in North Carolina claimed that recent flooding in their residential area was due to changes in natural drainage caused by the construction. They maintained that similar or heavier rains prior to the constrution activity did not cause flooding. The attorney retained by the homeowners was provided certified copies of perti-

Above: On January 18, the roof of the Hartford, Conn., Civic Center collapsed following a storm, apparently from the weight of accumulated snow. Just hours earlier, over 4,700 fans had watched a college basketball doubleheader.

AP Laser Photo

Right: A collision on the Mississippi River in heavy fog. The fog also hindered rescue operations.

Photo: U.S. Coast Guard

nent rainfall records for the area for possible use in supporting his clients' contention.

A commodities speculator bought cotton futures for acreage in Mississippi. Cotton prices rose dramatically between the purchase date and harvest. However, crop yield was reported to be low, because excessive rainfall ruined the crop. NCC provided the speculator with measured and normal rainfall amounts for the area and time interval to use in determining if rainfall could have ruined the crop.

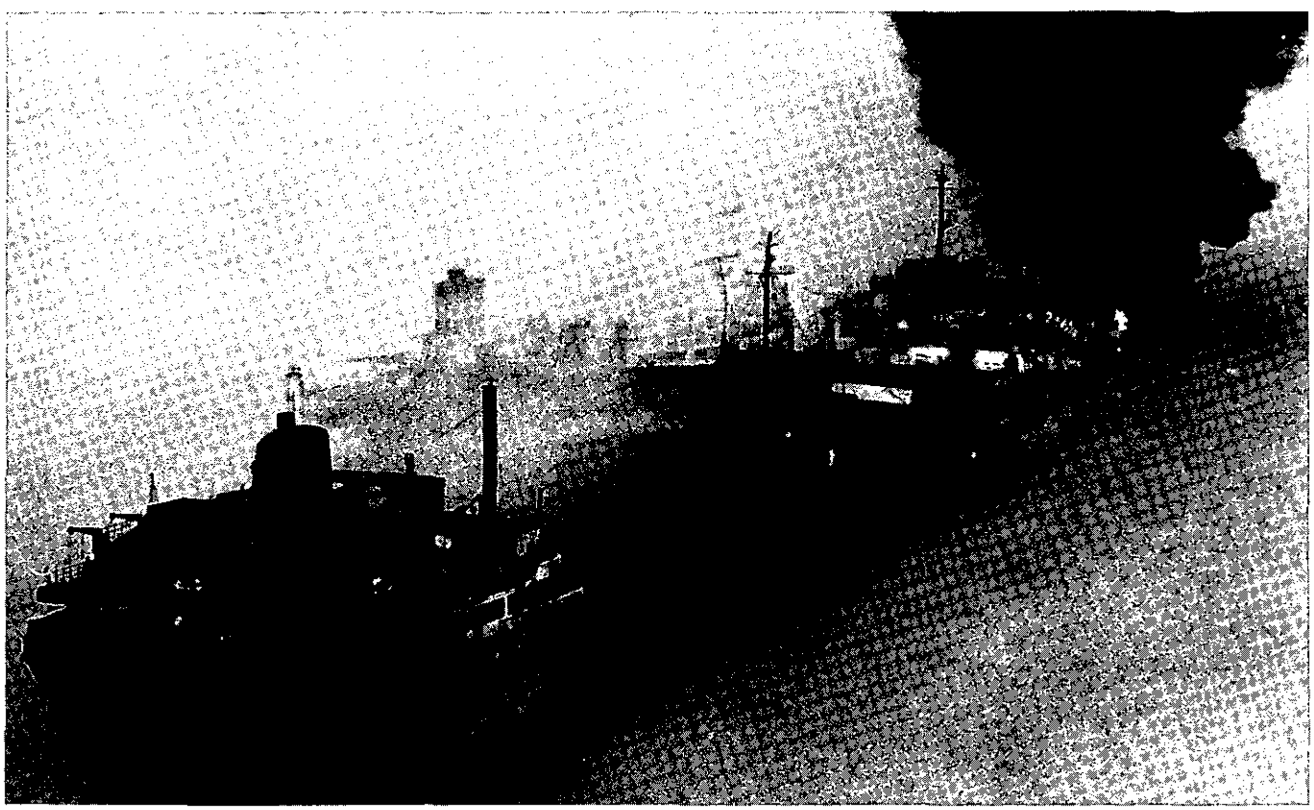
A farmer in Alabama contended that chemicals used by a crop-dusting firm employed by his neighbor were blown onto his land and damaged his crops. He was furnished hourly observations of wind speed and direction from nearby weather stations to support his contention that Environmental Protection Agency crop-dusting regulations were not followed.

In December 1977 an attorney seeking wind data for Libya pertinent to litigation in which he was involved was supplied certified copies of wind summaries for several locations.

And then there are the requests related to criminal cases. When a shrimp boat ran aground in the Florida Keys, investigators found the vessel loaded with marijuana. The operators claimed their boat had been hijacked, and that the transportation of the marijuana had been conducted by their captors, who had since fled; they contended the boat was beached when the hijackers attempted to unload their cargo. NCC supplied hourly surface weather observations for Miami and Key West to the prosecuting attorney, who wanted to determine if weather conditions could have caused the grounding, rather than hijackers.

Finally, in a classic story, a man charged with the armed robbery of a New York City restaurant in February 1973 claimed that he was attending a family barbecue in southeastern North Carolina on the day in question. His family corroborated his testimony that the day was sunny and very warm. The prosecutor, however, introduced as evidence the NCC publication *Storm Data*, which described what is now known as the "Great Southeastern Snowstorm." It occurred in the barbecue area on the day of the robbery, and was the worst snowstorm to hit the area in its history. Snowfall amounts ranging from 7 to 16 inches were recorded, with drifts piling up to two to six feet.

The defendant was convicted, and the weather testimony of his relatives was presented to the grand jury for possible perjury indictments.



CERTIFIED WEATHER RECORDS

Copies of materials that do not have a preprinted certification will be certified by NCC upon request. There are three types of certifications:

(1) *Individual Certification.* Copies of records and photographs can be individually certified as true copies of originals on file at NCC. Publications can be individually certified as official publications. This type of certification consists of the appropriate statement stamped on each document and signed by the certifying officer. A charge of $1 is made for each signature.

(2) *Attached Certification Statement.* A certificate without seal can be provided as a cover to multiple records. This consists of an appropriate statement signed by the Certifying Officer and affixed to manageable collections (usually not more than 40 pages) of assembled documents. There is a charge of $3 per group of records.

(3) *Authenticated Certification Under the Seal of the U.S. Department of Commerce.* This two-part certificate (certification and authentication) can be furnished when required. Different types of records are certified and authenticated as separate groups as in (2) above, without additional charge. For individual certifications plus authentication, the total charge is $3 per certificate.

Some entries on original weather records may be in code form—digits or symbols—not known to non-meteorologists. Qualified NCC employees will prepare a plain language description of the records and codes if necessary and have it certified. Requests for certified weather records should be addressed to: National Climatic Center, Federal Building Asheville, NC 28801.

In addition to the above, the Marine Climatological Services Branch (D762) of the National Oceanographic Data Center, Washington, D.C. 20235, provides certified copies of the *Mariners Weather Log* for Admiralty cases and supplies certified weather maps for the most recent 3-month period. (After 3 months the charts are available from the National Climatic Center.) The *Log*, published bimonthly, contains detailed narrative descriptions of North Atlantic and North Pacific weather.

Astronomical Data

The National Climatic Center does not provide certified data about sunrise, sunset, moonrise, moonset, moonphase, or the beginning and ending of darkness. The U.S. Naval Observatory has prepared sunrise and sunset tables for many locations, and copies of these tables are available for National Weather Service offices and stations. Upon request, the Nautical Almanac Office, U.S. Naval Observatory, Massachusetts Avenue and 34th Street, N.W., Washington, D.C. 20390, will prepare a certification statement for a specified location and date concerning sunrise, sunset, moonrise and moonset times, as well as the phase of the moon.

Weather Forecasts and Warnings

Copies of weather forecasts and warnings issued by the National Weather Service are not available from NCC. Requests for *certified* copies of forecasts and warnings should be made to the appropriate National Weather Service Regional Headquarters at the addresses given below. The accompanying map shows the geographic boundaries of the six NWS regions.

Texts of forecasts and warnings are retained for a maximum of 5 years. Requests that require one or more of the following types of forecast materials should be made to the National Weather Service, NOAA, Gramax Building, 8060 13th Street, Silver Spring, MD 20910.

- Authenticated certification under the Seal of the U.S. Department of Commerce.
- Forecast data overlapping NWS regional boundaries.
- Prognostic weather maps.

Addresses of National Weather Service Regional Headquarters

National Weather Service Eastern Region
585 Stewart Avenue
Garden City, NY 11530

National Weather Service Southern Region
819 Taylor Street, Room 10E09
Fort Worth, TX 76102

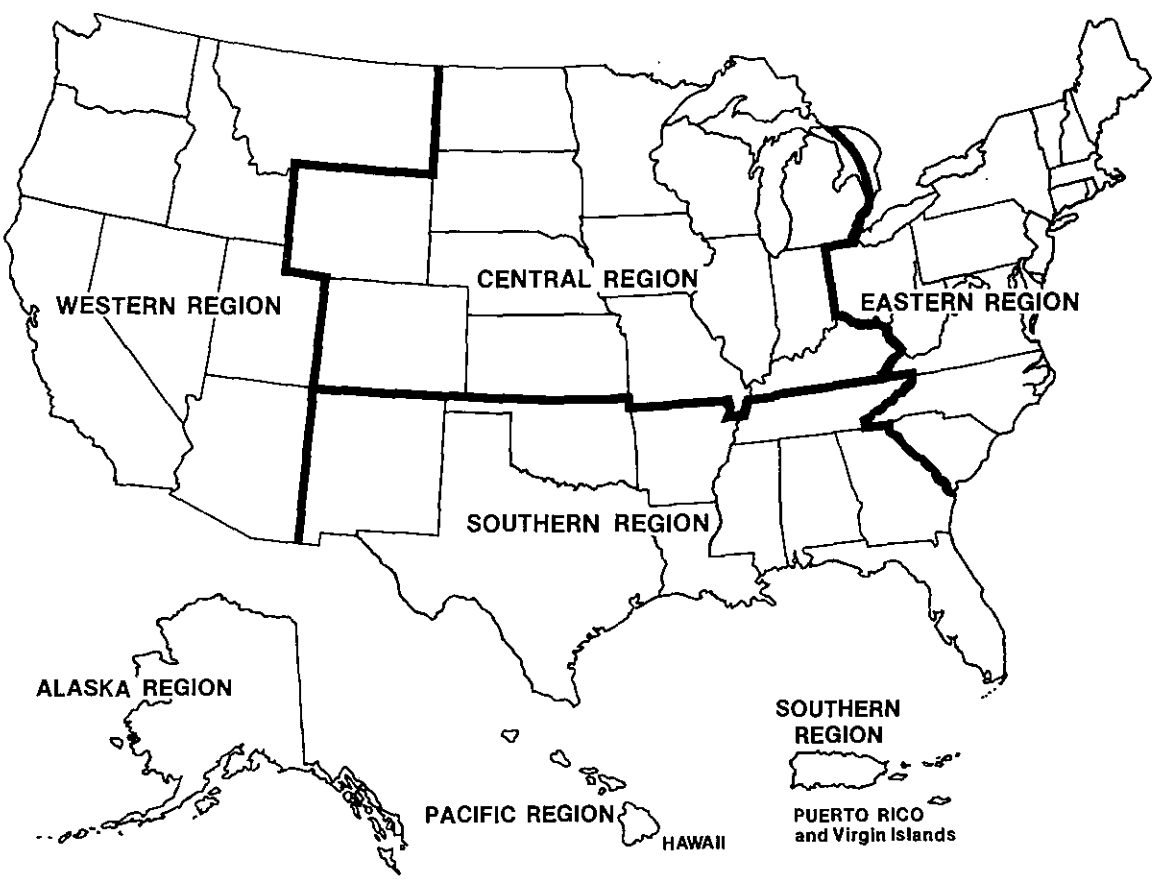
National Weather Service Central Region
601 East 12th Street, Room 1836
Kansas City, MO 64106

National Weather Service Western Region
Box 11188, Federal Building
Salt Lake City, UT 84147

National Weather Service Alaska Region
632 6th Avenue
Anchorage, AK 99501

National Weather Service Pacific Region
P.O. Box 3650
Honolulu, HI 96811

Geographic Boundaries of National Weather Service Regions



Winter of '78 the Coldest?

Average temperatures east of the Rockies appear to have hit a new low during the past December through February period. The winter of '77 was bad enough—with January '77 still standing as the coldest single month since formal records-keeping began in the late 1800's—but for the season as a whole, this winter's temperatures probably were worse than last winter's, and the combined

Bonnie Alexandre of Boston tries to protect her car from the snowplows during the winter of '78.

average for two cold winters back-to-back will almost certainly set a new low, vying with the winters of 1904-1905 for the record.

These preliminary conclusions are based upon a sampling of reports from several dozen National Weather Service stations scattered around the country. EDS' National Climatic Center in Asheville, N.C. made the survey and NCC will have final results when data from some 10,000 stations have been mailed in and processed in a few months.

Depite some similarities, much of this past winter's weather resulted from somewhat different circumstances than last year, as evidenced by the record drought in the Far West last winter and the record floods this season. Both winters exhibited high pressure in the West and low pressure in the East combining to pump cold arctic air deep into the U.S. heartland, but this year's high pressure area was farther north and east over Canada, leaving California open and exposed to Pacific storms. The jet streams were more intense, farther south, and less convoluted this year, with storm after storm hammering away at the United States. Instead of a steady cold flow, like last year, this year's storms alternated at intervals of about 5 days, bringing snowy bursts of cold air with them every time. Both winters were similar in that the Far West was warmer than normal.

Around the country 1978 established new record cold winter average temperatures at such widely scattered places as Galveston, Tex.; St. Louis, Mo.; Cincinnnati, Ohio; Nashville, Tenn.; and Concordia, Kan.; to name just a few. Ties or runners-up were recorded in Jacksonville, Fla.; Asheville, N.C.; Macon, Ga.; Chicago, Ill.; Parkersburg, W. Va.; and North Platte, Nebraska. All these stations have weather records dating back into the late 19th Century.

State Maps of Low-Temperature Geothermal Energy Resources

A series of geothermal energy resource maps for 12 or more Western States is being prepared for the U.S. Department of Energy (DOE) by the EDS National Geophysical and Solar-Terrestrial Data Center (NGSDC). The purpose of the maps is to promote the use of geothermal energy as an alternate energy resource and to identify areas likely to yield such resources. These maps will emphasize the occurrence of relatively low temperature resources which can be used in direct, non-electric heat applications.

The States participating in this effort include: Alaska, Hawaii, Washington, Oregon, California, Idaho, Montana, Nevada, Colorado, Utah, Arizona, and New Mexico. Many organizations will be involved directly or indirectly in the production of the maps. These include the Department of Energy, the U.S. Geological Survey, numerous State agencies (in some cases, organizations affiliated with State agencies), the University of Utah Research Institute (UURI), the Los Alamos Scientific Laboratories, and other organizations such as university groups.

It is anticipated that some private firms also will participate, possibly in the compilation of certain types of data. UURI will play a key role by contacting various State officials to obtain geothermal data compiled as part of a DOE/State program and by arranging for the data to be sent to both the USGS GEOTHERM file in Menlo Park, Calif., and to NGSDC for the production of the maps.

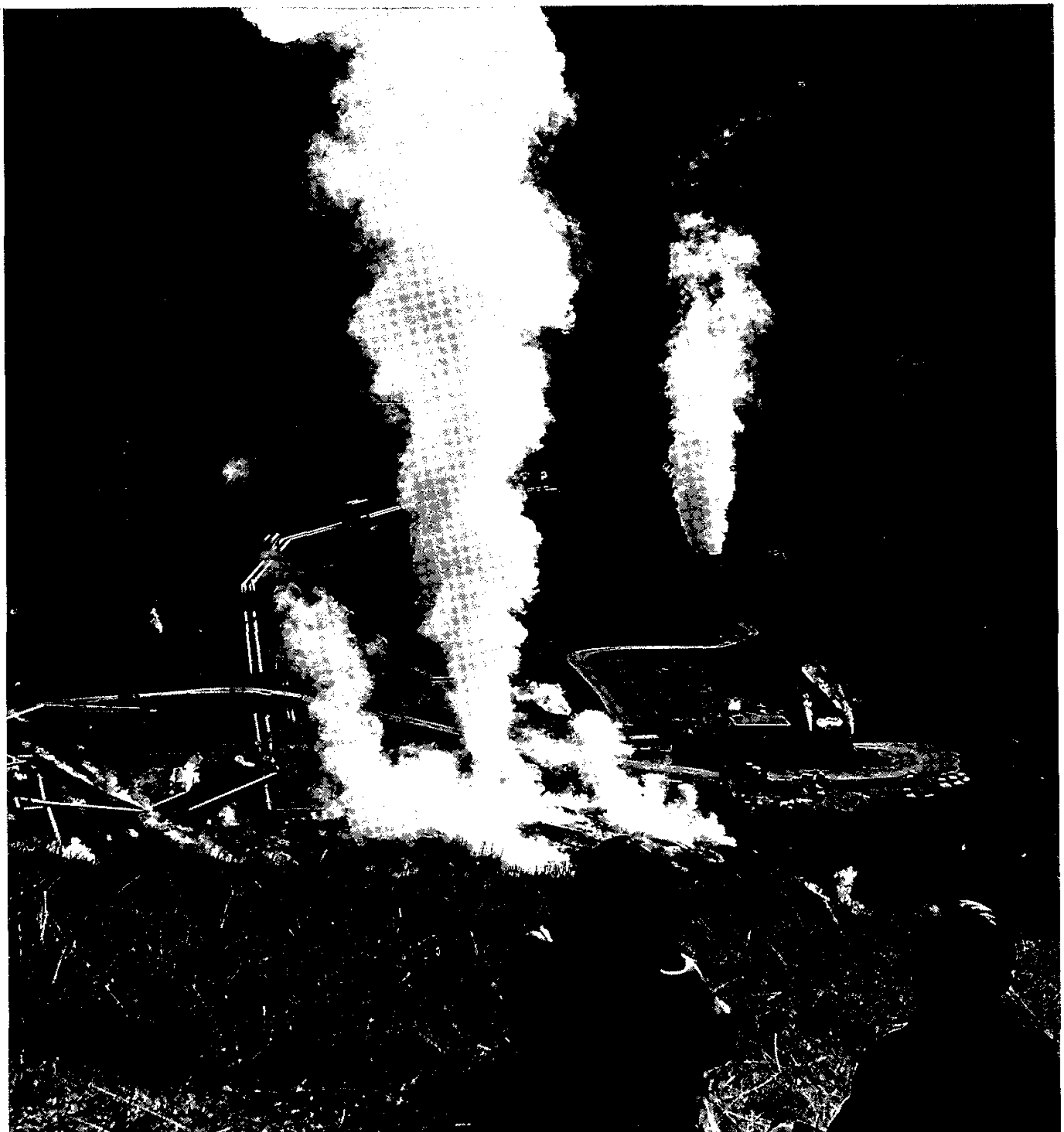
The maps will be identical in scale and projection to existing U.S. Geological Survey State maps (scale 1:500,000 on a Lambert conformal conic projection), except for Alaska and Hawaii which probably will be treated differently.

"Scientific" and "Planning" Maps

Because of the great amount of geothermal and related data it is desirable to show on the maps, it tentatively has been decided to produce two maps for each State. One will be designed to appeal to scientific and exploration personnel; the other will be intended for the use of planners and non-specialists. Both maps, however, will have certain "core" data presented in the same manner.

Although the types of data to be shown on the maps have not been finalized, and it is likely that there will be slight differences from State to State, preliminary decisions have been made. The "core" data to be shown on both maps are:

- Thermal spring and well temperatures
- Thermal spring and well geothermometer data
- Cities/towns
- Rivers and streams
- Township/range data
- Water bodies
- Known geothermal resource areas
- Interpretations of resources.



Where temperatures are high enough, as in this field in Sonoma County, Calif., underground steam can be used to generate electricity.
Pacific Gas and Electric Co.

The "scientific" maps will include the above core data, plus the following:

- Heat flow data
- Earthquakes/microearthquakes
- Distribution of hot spring deposits
- Other geologic deposits, such as mercury
- Lava flow data (rhyolitic and non-rhyolitic)
- Lava flow ages
- Volcanic cones and volcanoes
- Faults and lineaments
- Physiographic/structural province outlines.

The "planning" map will include the core data listed above, plus the following:

- Mean annual temperatures
- Spot elevations
- Highways
- Indications of areas presently using geothermal energy
- Power transmission lines
- Oil and gas lines
- Power generating stations
- Land ownership
- Water quality.

One of the most important of the above data types is the "interpretations of resources." These will indicate where the likelihood of finding geothermal resources (steam and thermal water) is greatest. The interpretations will be made by geothermal experts in each State.

Most of the geothermal data will be provided to NGSDC from the USGS GEOTHERM ile. The data from this file come, for the most part, from compilations by State agencies or organizations working closely with State agencies, but also from USGS scientists and other contributors. Additional geothermal data for the maps will come from university workers and UURI; much of the non-geothermal data will be compiled by UURI and NGSDC.

Map Schedule

The first maps will be produced for Idaho. It is anticipated that these will be printed in late 1978 and will be followed within several months by the Arizona maps. The experience gained in the production of maps for these two States should allow map sets for other States to be completed at a rate of about five per year (ten maps per year). Most of the maps will show essentially the same type of data in the same manner. However, it is likely that the method or type of data presentation for a few maps will be slightly different, because of unique situations in some States.

One of the most important aspects of this endeavor is to ensure that the maps for each State are widely advertised and circulated, especially at the local level. An effort will be made to ensure that all potential users of geothermal energy within a given State know of the existence of the maps and how to obtain them. It is anticipated that they will be sold to the general public for a nominal fee.

This report was prepared by Paul J. Grim, EDS; Clayton R. Nichols, U.S. Department of Energy; Phillip M. Wright and George W. Berry, University of Utah Research Institute; and James Swanson, U.S. Geological Survey.

Climate and Health Brochure

A brochure describing climate data available for health applications is available from EDS' National Climatic Center. The booklet, *Climate and Weather Data for Physicians and Health Researchers*, describes the types, formats, collection frequency, and area coverage of data for health applications and lists several helpful publications. The data and publications are useful in finding alternate locations for patients who find their present environment too stressful and in correlating case histories or medical statistics with environmental conditions.

Copies of the brochure are available from the National Climatic Center, NOAA, EDS, Federal Building, Asheville, NC 28801.

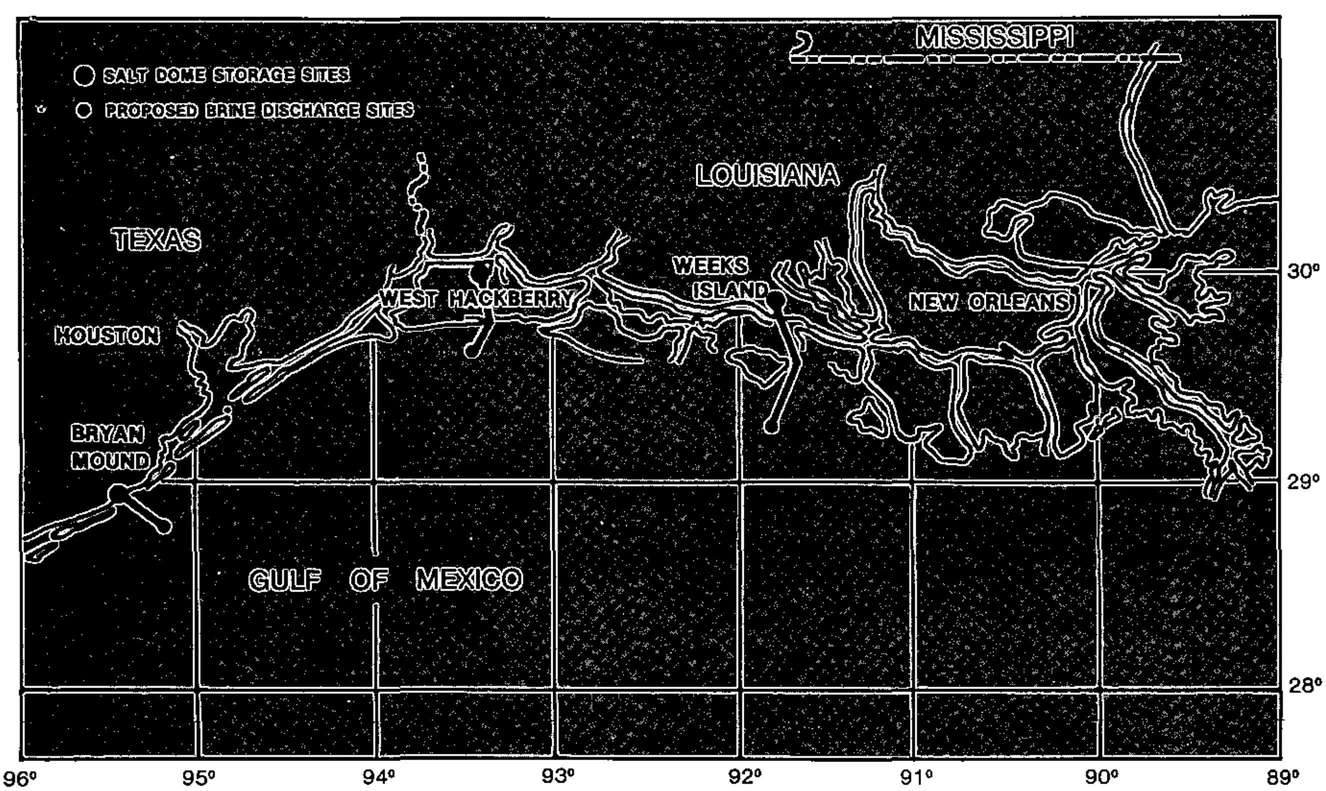
Interagency Energy Studies

Two new major tasks have been undertaken by the Marine Assessment Division (MAD) of EDS' Center for Experiment Design and Data Analysis under interagency agreements.

The first task is an expansion of MAD's study of brine disposal in the Gulf of Mexico for the Department of Energy. The brine would result from leaching of salt domes to be used for oil storage under the Strategic Petroleum Reserve program. MAD now is responsible for obtaining the necessary environmental and biological data and conducting analyses with computer models to evaluate the environmental impact of proposed brine disposal at two new sites off the Louisiana coast. MAD already has underway a similar study of the proposed Bryan Mound disposal site off the Texas coast.

Other NOAA elements participating in the expanded study are the Office of Marine Surveys and Maps of the National Ocean Survey, the Galveston Laboratory of the National Marine Fisheries Service and the NOAA Data Buoy Office of the Office of Ocean Engineering. The Ralph M. Parsons Laboratory of the Massachusetts Institute of Technology will continue to support MAD in brine plume modeling. Meanwhile, Texas A&M University, along with MIT and the NMFS Galveston Laboratory, are continuing work on the Bryan Mound studies (see *EDS,* March 1978, p. 20).

The second new task is a synthesis of available historical oceanographic and meteorological data for the George's Bank area, undertaken for the Bureau of Land Management (BLM) of the Department of the Interior. This study of the Outer Continental Shelf oil and gas lease area off the New England coast will follow the general approach used in the *Summarization and Interpretation of Historical Physical Oceanographic and Meteorological Information for the Mid-Atlantic Region* completed earlier for BLM, and will be closely coordinated with field studies also being conducted in the area under BLM sponsorship. (See *EDS,* March 1978, p. 20.)



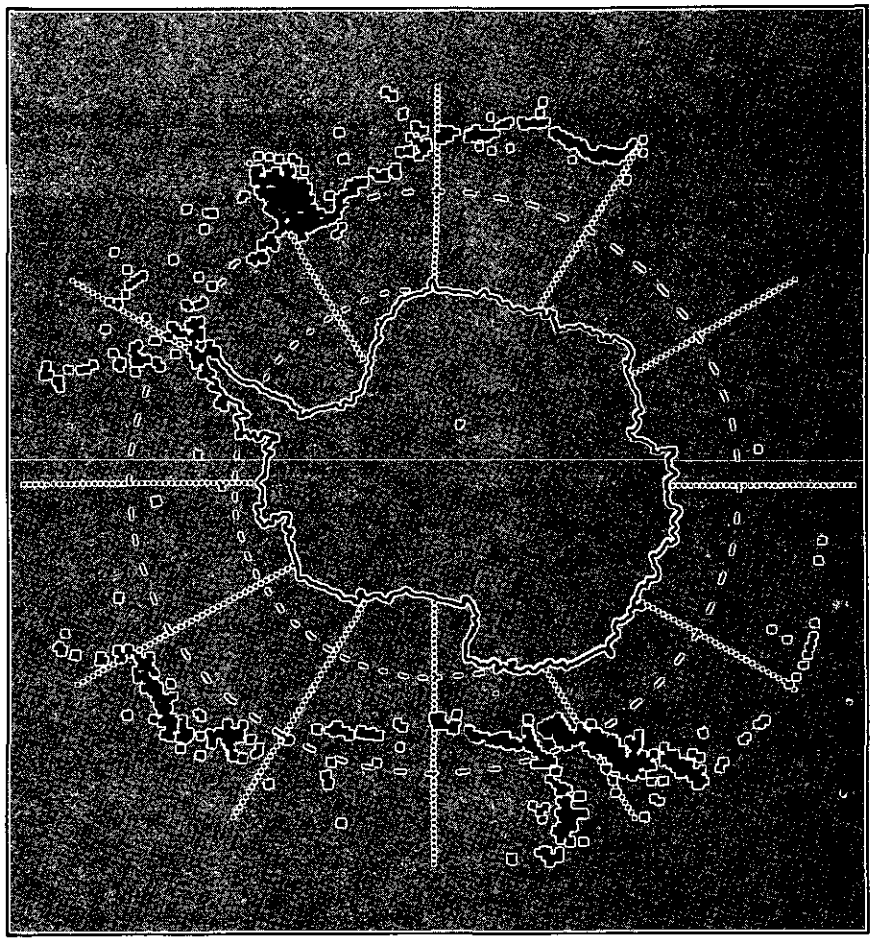
Salt dome locations and proposed brine discharge sites.

Antarctic Data Inventory

EDS is introducing a new series of publications titled: *Key to Environmental Data Inventories.* Each issue will contain an index of multidisciplinary data held by EDS for a specific geographic region.

The first publication in the series will inventory EDS data available for the Antarctic region, and will cover the area from 50 degrees south latitude to the pole. This includes the entire circumpolar current, the Antarctic convergence zone, and the limit of pack ice. Major files of environmental data for this area include oceanographic station data (separated into the winter and summer seasons), land- and sea-based meteorological data, airborne and vessel magnetic profiles, and geological core information. The publication is expected to be available in the early summer.

Subsequent issues are expected to be released quarterly and cover the following areas: the Arctic, Tropical Oceans (4 reports), and the Mediterranean.



Location of approximately 2,000 earthquake epicenter reports in the files of EDS' National Geophysical and Solar-Terrestrial Data Center.

Geophysical Data for Georgia Embayment

EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) has available data from high-resolution marine geophysical surveys of parts of the U.S. Outer Continental Shelf and Slope in the Georgia Embayment east of South Carolina and Georgia (lease sale no. 43). The surveys (October 1976 through March 1977) and preliminary interpretations of data were performed by Digicon (areas south of 31°) and BBN-Geomarine Services (areas north of 31°) under contract to the U.S. Geological Survey.

The project provided basic reconnaissance data regarding water depth and bottom topography, bottom sediment distribution and thickness, shallow geologic structure, and potential safety and pollution hazards or constraints to offshore drilling and construction.

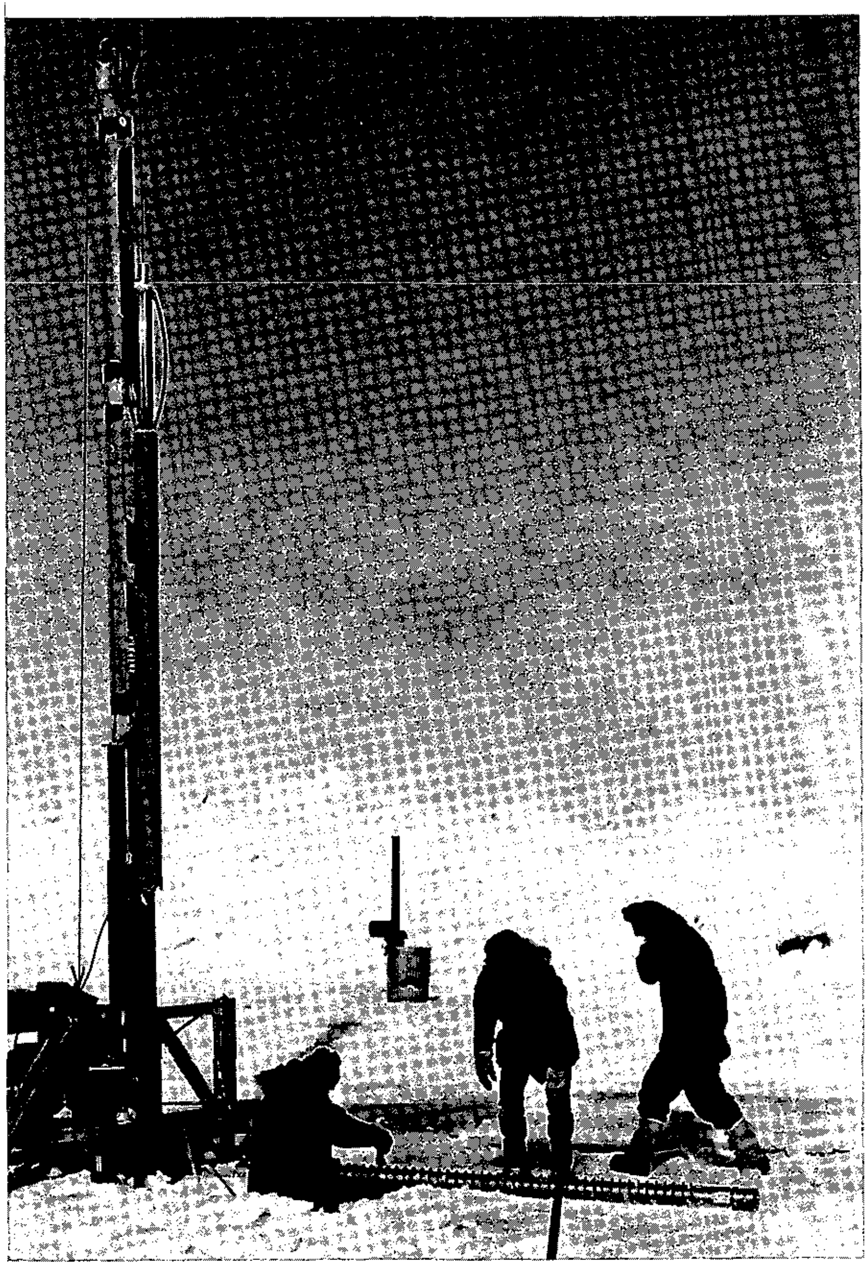
Additional information concerning the data may be obtained from National Geophysical and Solar-Terrestrial Data Center, NOAA/EDS/NGSDC, Code D621, Boulder, CO 80302. Telephone: (303) 499-1000, Ext. 6542 or 6338; FTS 323-6542 or 323-6338.

North American Ice Core Inventory

The World Data Center-A: Glaciology (Snow and Ice) in Boulder, Colo., recently began a survey and data inventory of North American ice coring products. Ice core records are a major source of paleoclimatic information for long-term studies of climatic change and trace chemical variations. The survey will provide an inventory of existing core storage locations, curator agencies, core samples available for destructive analysis, and completed microparticle, trace chemical, and oxygen isotope analyses.

The WDC-A: Glaciology study is designed to combine and supplement existing core inventories and bibliographies and to make this information available to interested members of the scientific community. Documentation and a bibliography of published core analyses will be added to the EDS ENDEX (Environmental Data Index) computer information retrieval system.

In the first phase of the study, the Center will collate existing inventories from the major North American curator agencies, the State University of New York at Buffalo, and the Polar Continental Shelf Project at Ottawa. Encoding of relevant core data will begin in late 1978. Future plans include surveys of Antarctic core data and coordination of data inventories with European, Soviet, Japanese, and Australian sources.



This drill takes ice cores from depths of 500 feet or more.
National Science Foundation

Delegates to the MAPMOPP Meeting. Across the table, left to right, R. Lissovsky and E. Sobtchenko of the Odessa branch of the U.S.S.R. State Oceanographical Institute, and I. Zrajevskij, representing the World Meteorological Organization.

MAPMOPP Experts Meet

The Second Session of the Joint Intergovernmental Oceanographic Commission (IOC)/World Meteorological Organization (WMO) Subgroup of Experts on the Integrated Global Ocean Station System (IGOSS) Marine Pollution (Petroleum) Monitoring Pilot Project (MAPMOPP) was held in February in Washington, D.C. EDS' National Oceanography Data Center hosted the session on behalf of the IOC.

Canada, France, the Federal Republic of Germany, Japan, Malta, Sweden, Thailand, the United Kingdom, the United States, and the USSR were represented, as well as IOC, WMO, and the United Nations Environment Program. Participants evaluated the Pilot Project's progress in terms of the significance of submitted data, data products, and future activities.

The group concluded that: (1) procedures in the *Manual for Monitoring of Oil and Petroleum Hydrocarbons in Marine Waters and Beaches* require minor revision, (2) aircraft techniques used in remote sensing are suitable, but present satellite technology is inadequate, (3) a concentration of oil pollutants exists along the main shipping lanes, while there is little oil pollution north of the Gulf Stream and equatorial area in the Atlantic Ocean away from coastal shipping lanes, and (4) the anticyclonic gyre in the Sargasso Sea is prone to oil accumulation.

The members recommended that: (1) visual observation of oil slick pollutants and reports on petroleum residues (tar balls) be made on an operational basis, (2) a study by selected consultants be made to determine the usefulness of dissolved/dispersed hydrocarbons and beach tar data, and (3) the total exchange of data between the two MAPMOPP Responsible National Oceanographic Data Centers (Japan and the United States) continue to be ensured.

The conclusions and recommendations will be presented to the Joint Working Committee for IGOSS scheduled to meet in Paris in September.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Environmental Data Service
Washington, D.C. 20235

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WOODS HOLE, MA
02543

In this issue: *North American glacier photos (p.4); drought in the tropics (p.10); and weather records and litigation (p.15).*

EDS

Environmental
Data Service
July 1978

EDS

Environmental
Data Service
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Cover: *The idea of towing icebergs from the Antarctic to arid coastal areas seems to be coming of age. A typical iceberg could satisfy the collective thirst of 10 million urban users for 1 year. A review of the pros and cons begins on page 3. (Artwork suggested by a Harold Larsen cartoon.)*

EDS is a bimonthly publication designed to inform Environmental Data Service (EDS) cooperators, colleagues, and contributors of recent developments in EDS programs and services and in the general field of scientific data and information management. EDS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, Center for Experiment Design and Data Analysis, and Center for Climatic and Environmental Assessment. In addition, under agreement with the National Academy of Sciences, EDS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this publication approved by the Office of Management and Budget, June 5, 1978; this approval expires June 30, 1980.

To cancel delivery of this publication in the event you no longer need to receive it, or to change the delivery address if you are moving but still need to receive it, please notify us by writing: Editor, EDS, Page Building 2, Room 533, 3300 Whitehaven St. NW., Washington, DC 20235.

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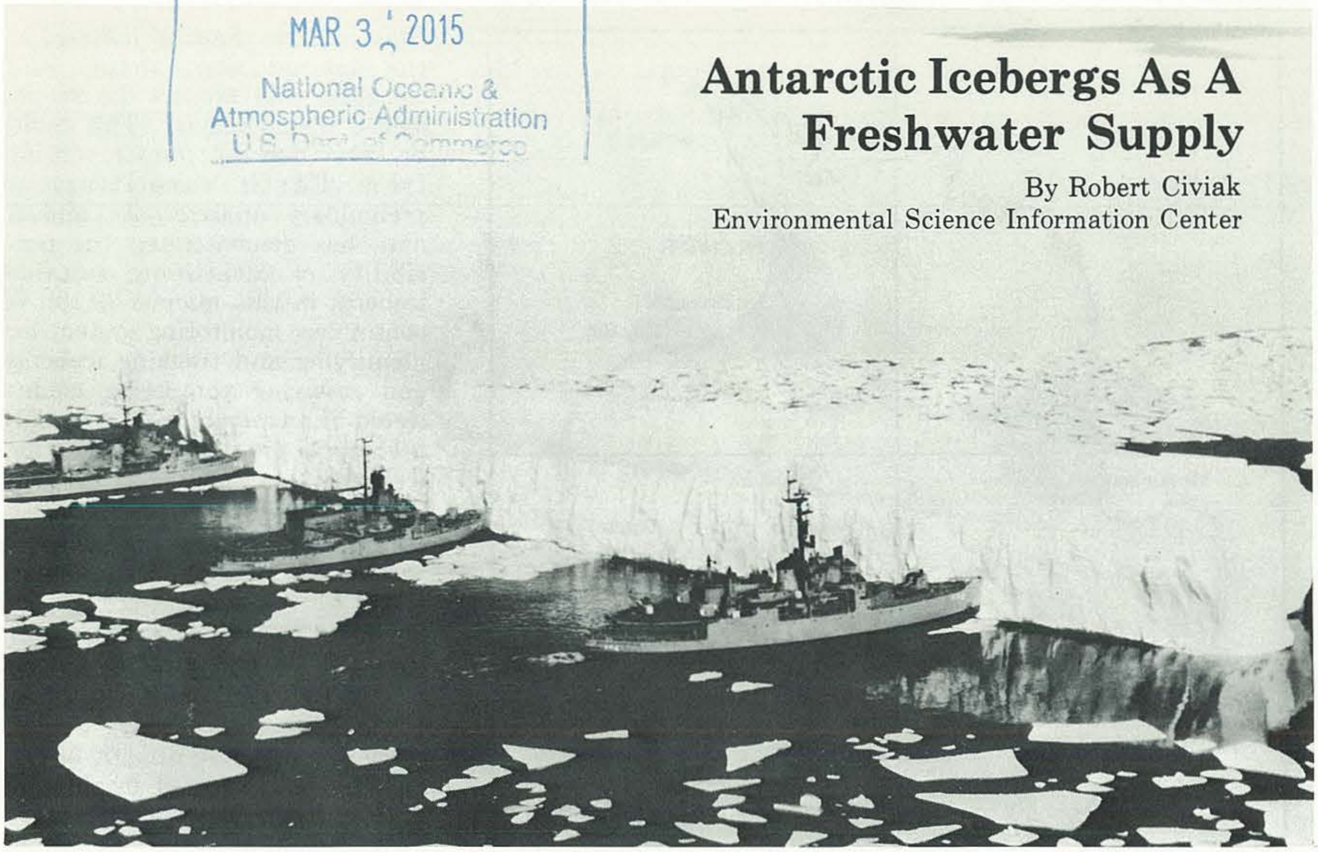
Antarctic Icebergs As A Freshwater Supply

By Robert Civiak
Environmental Science Information Center



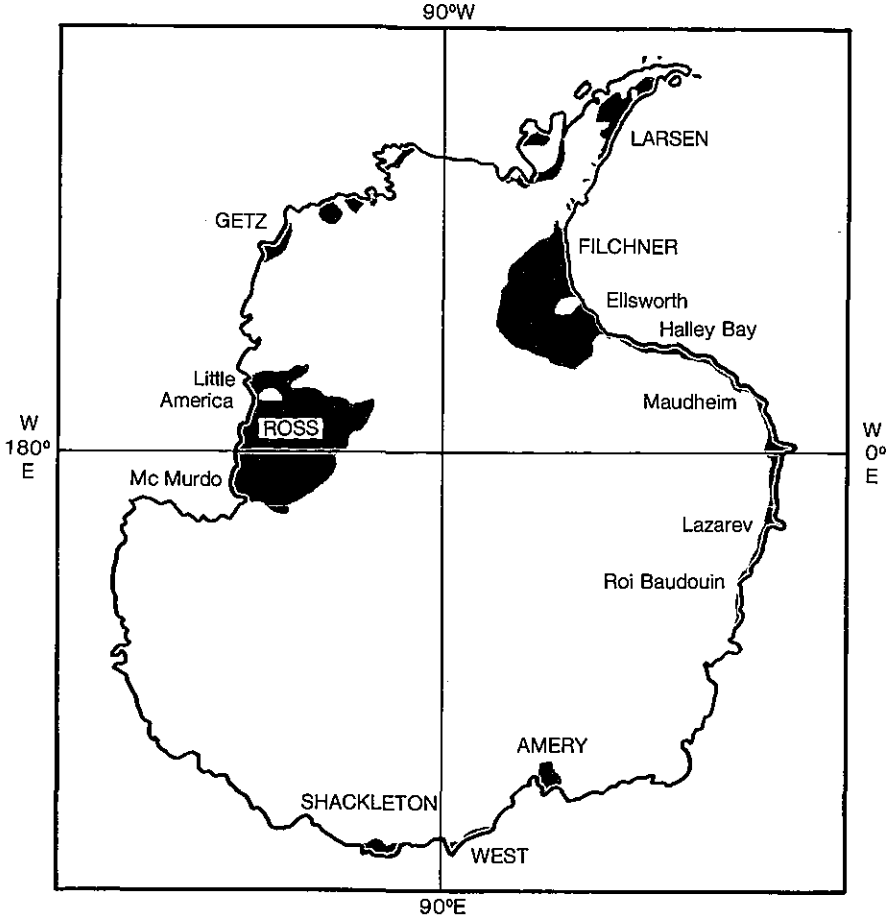
Navy icebreakers push a large tabular iceberg—the type considered most suitable for towing—out of the shipping lanes in McMurdo Sound, Antarctica.

Photo: National Science Foundation

Fresh water for urban, industrial, and agricultural use is an increasingly precious resource worldwide. Over three-quarters of the Earth's supply of fresh water is locked up in polar ice. Recent estimates have indicated that this water can be made available for use for from 20 to 50 percent of the cost of desalination of seawater. This involves locating and transporting huge icebergs from the Antarctic and mooring them offshore near arid lands. A single iceberg could supply 1 million acre-feet of water. This is enough to satisfy 10 million urban users or irrigate 600 square miles of land for 1 year, and would be worth a minimum of $20 million.

Though possible with existing technology, the handling of fragile, melting masses on the order of 100 million tons (200 times the largest supertankers) presents substantial problems. Other important considerations are the environmental effects and legal responsibilities attendant to transporting icebergs and locating them offshore.

Towing icebergs is not a new idea. Weeks and Campbell (17) refer to the towing and sailing of Antartic icebergs as far north as Peru before 1900. John Isaacs of the Scripps Institution of Oceanography calculated that iceberg water was a feasible solution to California's water problem in 1951, but did not publish this work. His calculations were publicized by Burt in 1965 (5), but the idea still did not catch on. In the early 1970's, two independent groups undertook studies of the feasibility of using icebergs as freshwater sources. One group (Hult and Ostrander) at the Rand Corporation, worked under a National Science Foundation contract. The other (Weeks and Campbell), represented the U.S. Army Cold Regions Research and Engineering Laboratory and the U.S. Geological Survey. Both groups published their findings in 1973. The plans of the two groups differ substantially, in that Weeks and Campbell discussed towing "naked" icebergs to Australia and western South America, while Hult and Ostrander focused on the more difficult problem of transporting protected "trains" of



Shaded areas show major Antarctic ice shelves.
Cold Regions Research and Engineering Laboratory

icebergs to California. Both studies concluded that water could be supplied from icebergs at prices that compared favorably to existing sources.

Large ice shelves have formed in the Antarctic by the compaction of snow accumulated during thousands of years of snowfalls. A steady state situation has been reached; the entire ice shelf flows northward, while icebergs break off the edge of the shelf, which is maintained at about the same location year to year. The annual yield of icebergs, which now just drift north and melt in the warmer oceans, is about equal to the total amount of water used in the United States.

The major effort in iceberg use has been directed toward these tabular Antarctic icebergs, because they will be more stable during towing than the irregularly shaped icebergs originating in the Arctic. The Antarctic climate should not be affected by the harvesting of icebergs, as only a small part of the annual yield of icebergs will be removed. Moreover, the Antarctic climate is controlled primarily by sea ice, which annually freezes and thaws over an area thousands of times larger than the area of the icebergs and amounts to more than 10 times the total mass.

The first step in iceberg utilization is to locate suitable icebergs. This involves finding icebergs of the desired size, shape, and thickness that are not too deeply locked within sea ice. This could be done best by remote sensing from Earth satellites. A preliminary analysis of Landsat data has demonstrated the possibility of identifying suitable icebergs in this manner (9,10). A continuous monitoring system for identifying and tracking icebergs and resolving competing claims would be an integral part of a comprehensive program for harvesting icebergs.

Several methods have been proposed for propelling the icebergs. Weeks and Campbell considered large conventional tugboats or nuclear-powered supertugs near the size of the aircraft carrier *Enterprise.* Hult and Ostrander envisaged electrically driven propellers mounted directly on the icebergs and powered by floating nuclear powerplants. Others have suggested using the temperature difference between the ice and the seawater or the salinity gradient to power the icebergs. In all cases, the speed of transport would have to be low (probably less than 1 mile per hour), as the drag forces become too great at higher speeds. A yearly delivery cycle would be most economical, with icebergs secured in March, when the sea ice is at a minimum.

The optimum size of the towed iceberg depends on the final destination, the power available for propulsion, and the insulation used to retard melting. However, it seems that the lowest cost (per volume of ice delivered) could be achieved with icebergs roughly on the order of 4 by 1 kilometers and 250 meters thick. There have been proposals to link severl icebergs together in trains, or to shape the front of the iceberg to reduce drag. Neither of these ideas is now believed practicable.

For a relatively short trip, i.e., to the Chilean or Australian desert regions, it may not be necessary to insulate the icebergs, but to reach Southern California or the Middle East with anything more than an empty towline, the iceberg would have to be protected from melting. Most of the melting of an unprotected iceberg is due to convection. This could be greatly reduced by covering the bottom and sides of the iceberg with a plastic sheet. The insulation would be provided by the several centimeters of water trapped between the iceberg and the covering. Foam insulation also has been proposed.

Upon arriving at their final destination, the icebergs would be moored offshore. Present opinion diverges over how the water would be made available for use. Early suggestions of surrounding the

This LANDSAT picture shows one of the largest icebergs ever recorded aground near the tip of Antarctica's Palmer Peninsula (top of map, page 4) on January 31, 1977. Nearly the size of Rhode Island, it contains enough water to last Washington, D.C. for 5,000 to 7,000 years or California for up to 1,000 years.

iceberg with "skirts" and pumping off the convectively melted fresh water as it rose to the top of the salt water, have been challenged because of uncertainties in the amount of mixing between fresh and salt water that would take place. Use of waste heat from off-shore powerplants would not melt enough ice to produce sufficient quantities of water to be economical; however, the cooling of the waste heat would be a useful byproduct of the icebergs. Enough direct solar energy to melt the ice would be available only at low latitudes, and then only if the icebergs were sliced into smaller pieces. Slicing of the icebergs would be necessary in the Middle East in any event, as the Red Sea is not deep enough to accommodate the draft of the large icebergs considered.

Some of the questions needing more complete answers before a regular program of iceberg towing can be established include:

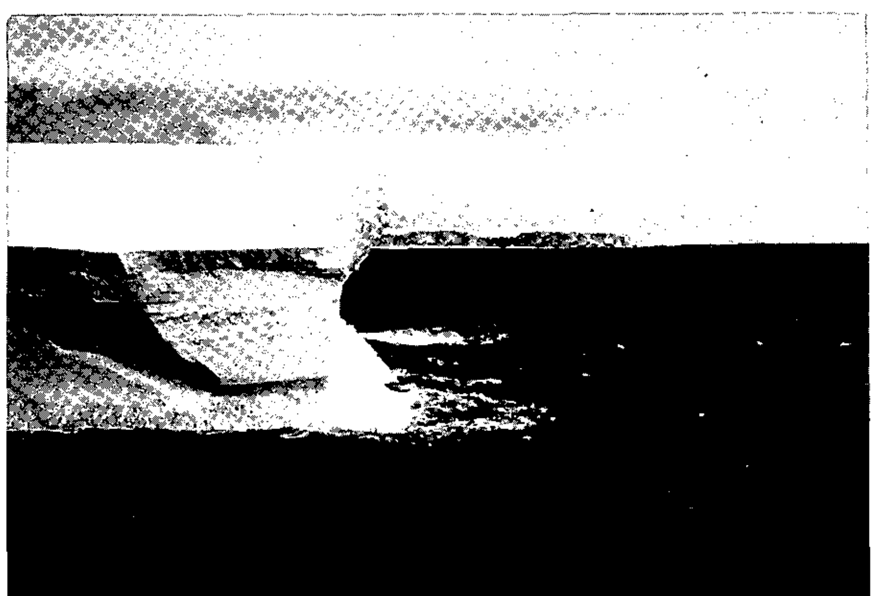
(1) What is the international legal status of Antartic resources? The 1959 Antarctic Treaty passed over the problem of resource use as too intractable at that time.
(2) Where are the most accessible icebergs? The answer requires monitoring the growth and retraction of sea ice and the calving (breaking off) of icebergs from the main ice shelves for several seasons. Little has been done since Hult and Ostrander's early study (9, 10).
(3) What is the best way to harness an iceberg?
(4) What is the most cost-effective propulsion technique?
(5) What will be the effect of rough seas on the integrity of the towed icebergs? Can icebergs with faults be identified during selection? Little is known "about the glaciology" of icebergs.
(6) What will be the environmental effects during transit? Will marine life be significantly affected or shipping channels interfered with?
(7) What is the best way to insulate an iceberg? Will the insulation survive in rough seas?
(8) What will be the local climatic effects at the final site? Warm moist air will likely be condensed as fog. Will this be acceptable in the immediate vicinity of the iceberg? How large an area will be affected?
(9) What will be the effect on local marine flora and fauna? Could migratory patterns be affected?
(10) What is the best way to melt the ice and ultimately integrate it into existing water distribution systems? Marine scientists interested in iceberg use have consistently passed over this problem as beyond their expertise, but it must be attacked by a realistic program.

Considerable interest in iceberg use has been generated recently by Prince Mohamed Al Faisal, a past head of Saudi Arabia's Saline Water Conversion Program. In early 1977, the Saudi government commissioned the French firm, Centre d'Informatique Commercial & Economique & de Recherche Operationnelle (CICERO), to make cost estimates for delivery of iceberg water to Jidda Saudi Arabia. CICERO concluded that a small experimental iceberg (80,000 acre feet) could deliver water for $650/acre-foot. This compares favorably with a planned desalination plant which would supply the Saudis with water at a cost of $1,000/acre-foot. Officials, however, were still skeptical and withdrew their support from CICERO, which filed for bankruptcy in October 1977.

Al Faisal since has formed a private corporation, Iceberg Transport International (ITI), to continue studying the problem. ITI, jointly with the U.S. National Science Foundation and other organizations, sponsored a major conference held in Ames, Iowa, October 2-6, 1977 (14). This first International Conference on Iceberg Utilization, brought together over 200 participants from 18 countries. Papers were presented on all significant problems that must be tackled. The concensus was that it is an immensely difficult project that, nevertheless, may well be feasible.

The Australian government is supporting iceberg use studies under the direction of Peter Schwerdtfeger, of the Institute for Atmospheric and Marine Sciences at Flinders University, Adelaide, South Australia. This group hopes to be able to charter a ship to tow a small iceberg to Australia. A group

Side view of a tabular iceberg in Antarctica's Weddell Sea.
Photo: Stephen Ackley



from the University of Newfoundland has been testing lasso-type tows of small icebergs which threaten offshore drilling operations in the North Atlantic.

Several U.S. groups participated in the conference at Ames. The most active, currently, is at the Naval Postgraduate School, Monterey, Calif. They have submitted proposals for further study of towing icebergs. A resolution has been passed by one house of the California State legislature asking the U.S. Congress to support experimental towing of icebergs; however, as yet there is no concerted American effort in that direction.

This is the first of a series of Current Issue Outlines being developed by the Library and Information Services Division of EDS' Environmental Science Information Center. The outlines are part of a new program to provide objective background material on current topics of high general interest. This issue outline will be available as a separate publication (Icebergs for Use As Fresh Water) *from: User Services Branch, LISD, Environmental Science Information Center, WSC #4, 6009 Executive Boulevard, Rockville, Maryland 20852. The concluding bibliography has been condensed to those papers directly addressing the subject; the original contains additional general references and information sources.*

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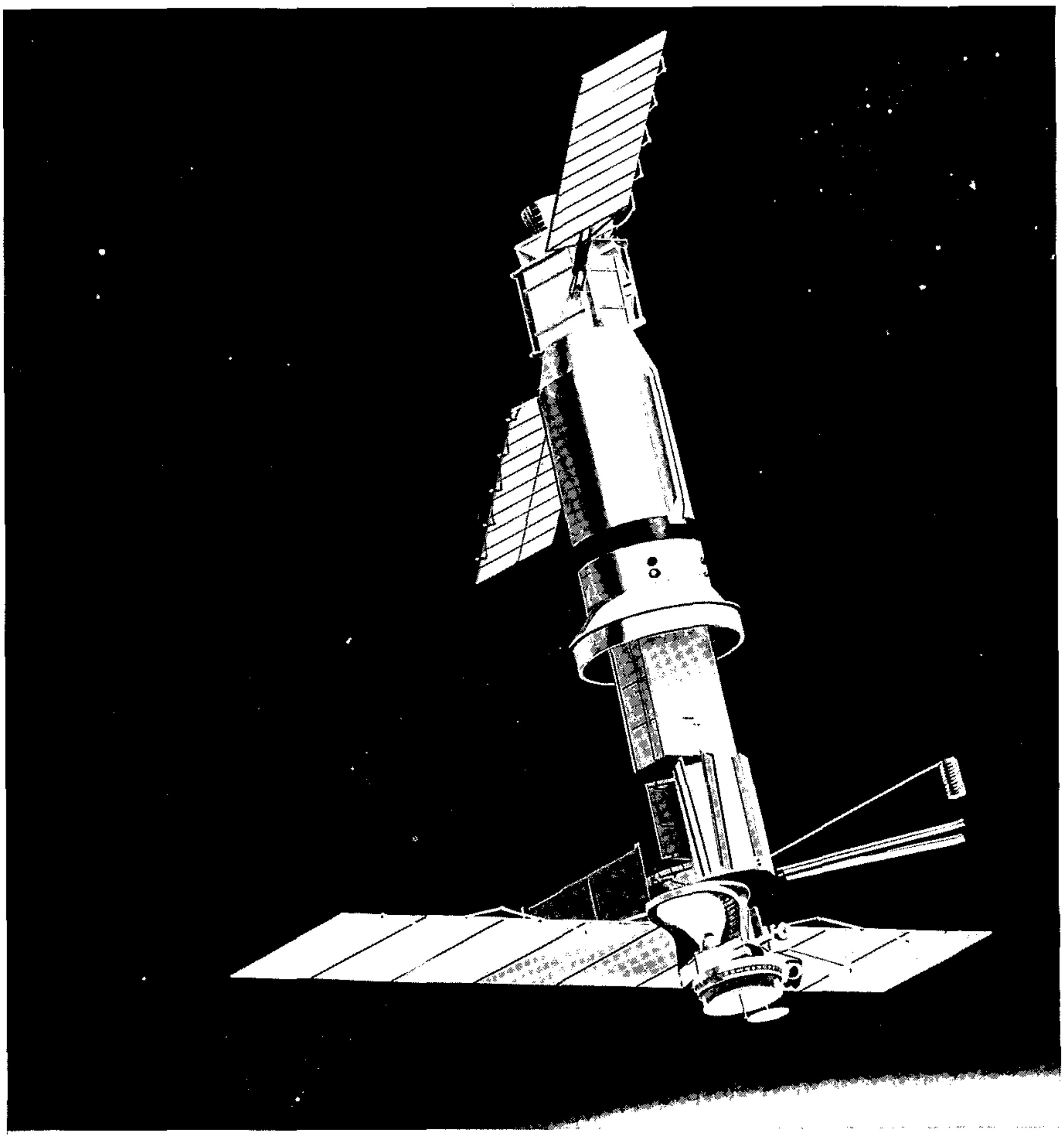
A Better Look at the Ocean

By Doris Stewart



Artist's concept of Seasat. *NASA Photo*

Beginning this year and into the 1980's, satellite technology will be able to focus on marine problems, thanks to the National Aeronautics and Space Administration's (NASA) newest research satellite, Seasat, scheduled for a late June launch from the Air Force's Western Test Range. The Satellite Data Services Branch of EDS' National Climatic Center has established a Data Archival and Distribution System to support the Seasat program.

The Seasat Program is a joint venture of NASA, the Department of Defense, and the National Oceanic and Atmospheric Administration (NOAA). Seasat is considered a first step toward achieving improved global coverage of major oceanic, climatic, coastal, and ice conditions.

Seasat objectives are to measure global ocean dynamics and physical characteristics, to provide useful data for user applications, to demonstrate key features of an operational system, and to help determine the economic and social benefits of products and services to user organizations.

Specific NOAA goals are to establish environmental measurements and acquisition techniques that are efficient and economical, to determine the geoid to the accuracy needed to serve as a reference for sea-surface topography, to improve understanding of the oceans' complex dynamic behavior and sea-air interface, and to contribute to major ongoing international, national, and NOAA programs.

The launch of Seasat is scheduled to coincide with several major national and international oceanographic and atmospheric programs. The Global Atmospheric Research Program and the International Decade of Ocean Exploration have scheduled a considerable number of ocean-atmosphere experiments during the 1978-80 time period. Most of these investigations have large-area-coverage data requirements that Seasat can partially fulfill. Additionally, the Bureau of Land Management and NOAA have agreed jointly to develop study plans for a program of environmental data acquisition and analyses for the Alaska Outer Continental Shelf areas. In general, the Seasat vehicle will provide sea-surface topography; wave height, length, and direction measurements; and fine-detail coastal and ice processes data on a limited-swath, non-global basis. Sea-surface winds and temperatures will be measured globally on a 36-hour, full-coverage repeat cycle.

Some Seasat data will be distributed on a real-time, operational basis by the Navy's Fleet Numerical Weather Center for its own use, to NOAA's National Meteorological Center, and to certain selected users approved by NASA. These data will not be archived. EDS' Satellite Data Services Branch will archive, duplicate, and distribute Seasat data on a non-real-time basis to NOAA experimenters and the marine community at large, both nationally and internationally. These data will consist of both magnetic tapes and imagery, which will be processed by the Jet Propulsion Laboratory.

Seasat raw data will first be acquired by the appropriate ground station and relayed to NASA's Goddard Space Flight Center (GSFC). In turn, GSFC will forward a copy of raw and telemetry data to the Jet Propulsion Laboratory where a set of Master Sensor Data Records will be assembled and transformed into Interim Geophysical Data Records. The Records will then be archived by the Satellite Data Services Branch within 10 days after acquisition from the satellite. However, only limited data sets will be available during the first year of the mission, since only about 20 percent of the total global data acquired will be processed.

Imagery data will be available in a variety of formats (contact prints, negative or positive transparency, etc.). Digital data will be provided on 9-track, 800 or 1,600 BPI computer-compatible tapes (CCT). It is estimated that for the period from June 1978 through September 1979, the EDS Satellite Branch will have copied portions of some 6,000 input CCTs onto some 3,000 output tapes. In addition, about 10,000 nine-by-nine inch black and white prints of satellite imagery will have been reproduced for NOAA experimenters.

NOAA has funded 36 Seasat experiments. Research experiments are included in broad categories such as coastal zone/lakes, open ocean, geodesy, polar studies, and hydrography. Based on current knowledge of data needs and Seasat capabilities, demonstration programs will be undertaken in meteorology, oceanography, living marine resources, and geodesy.

These scientific experiments will be made by various NOAA personnel from the Pacific Marine Environmental Laboratory, National Ocean Survey, National Environmental Satellite Service, EDS Center for Experiment Design and Data Analysis, National Weather Service, National Marine Fisheries Service, Environmental Research Laboratories' Atlantic Oceanographic and Meteorological Laboratories, and NOAA headquarters.

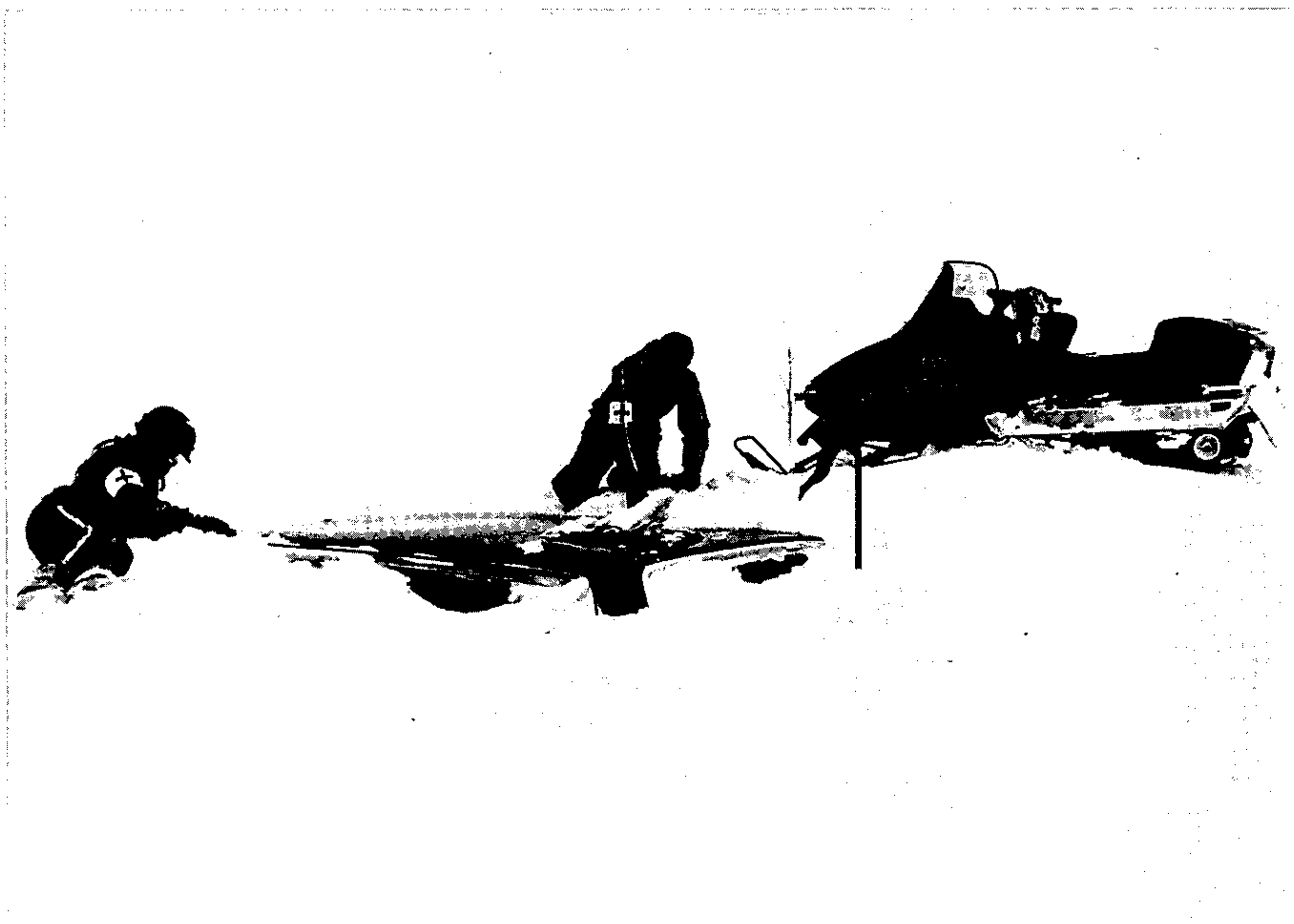
If Seasat performs as planned, data will be available (particularly for the data-sparse marine areas) to improve and upgrade NOAA services and products. Benefits can accrue to NOAA in the form of an improved data collection system and to NOAA users in the form of more accurate and reliable ocean data and information.

Polar sea ice images produced by an airborne synthetic aperture radar similar to the one to be carried by Seasat. The picture on the left was taken on August 18, 1975, the one on the right on August 22, 1975.

C. Elachi,
Jet Propulsion Laboratory

Weather Profile of 1977

By Dick Whiting
National Climatic Center



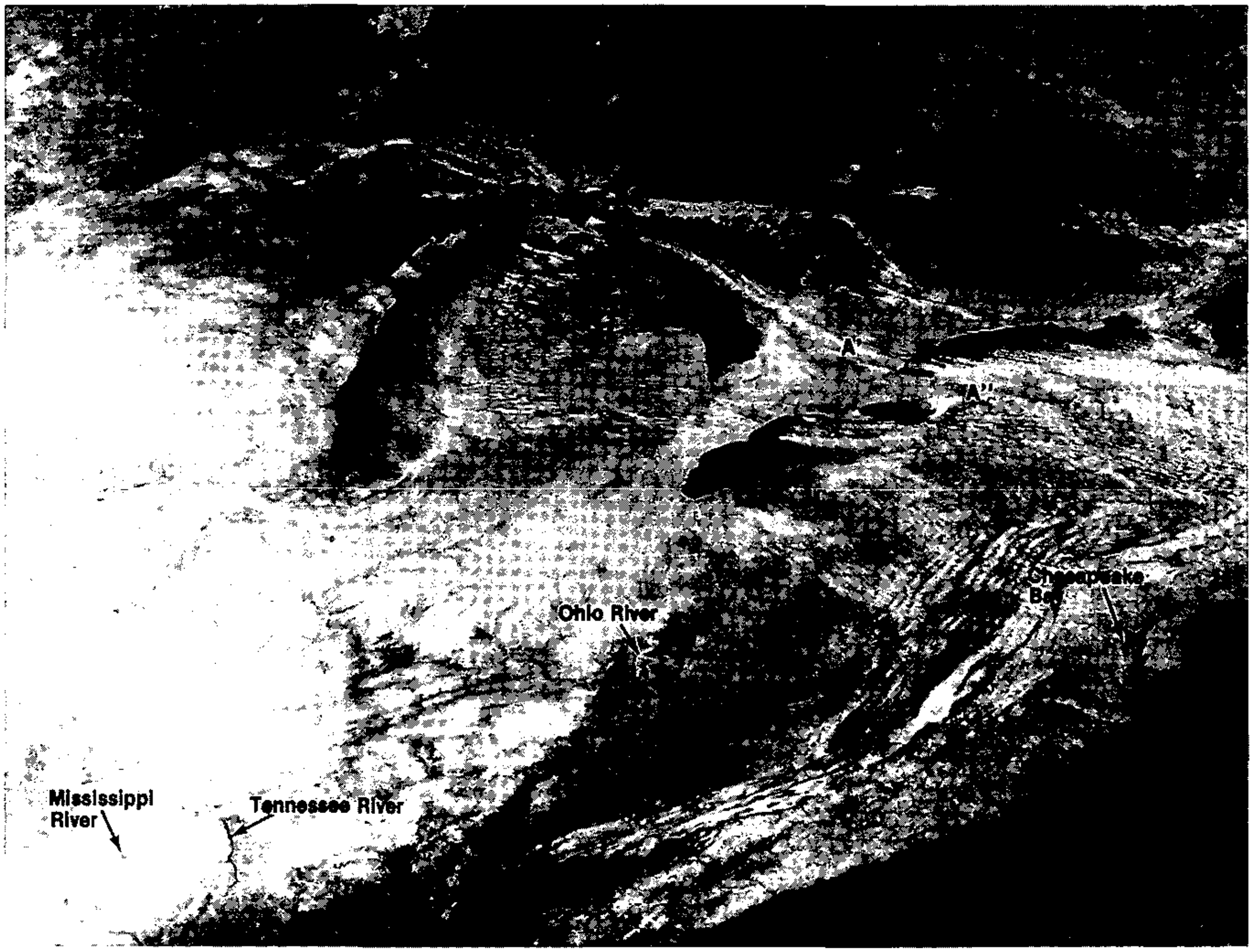
Red Cross volunteers search for people trapped in their cars by a record February snowfall that paralyzed Buffalo, N.Y.
American Red Cross Photo by Smith

This is the first in a series of annual reviews of significant weather in the United States. Subsequent summaries will appear in March issues.

Storms

Buffalo, N.Y. had its most severe blizzard on record the last days of January 1977. Snowfalls of 174 cm (69 in) during the month had already exceeded many previous years totals, and high winds piled drifts over 9 m (30 ft) high. Visibility dropped to zero as a cold front moved across western New York State on the 28th. Thousands of motorists abandoned their vehicles to take any available shelter. Winds gusted to 111 km/h (76 mph), and snowdrifts blocked roads for over a week. Earth-moving equipment was used to remove drifts too high for conventional equipment. Four-wheel drive vehicles and snowmobiles provided the only reliable transportation. Losses in excess of $250 million were estimated, while 29 people lost their lives in storm-related incidents. Cold temperatures, coupled with a heating gas shortage , caused the closing of many factories, schools, and public and commercial establishments. Total winter snowfall (October-April) at Buffalo was a record 508 cm (200 in), or 187 cm (74 in) more than the previous high.

Tornado activity during the year took the lives of 43 people. Of the



852 tornadoes reported, 7 swept through Alabama on April 4, killing 23 people and doing extensive damage to Birmingham's business district.

A severe outbreak of Arctic air swept into Florida on January 10, bringing intense cold and snow as far south as Homestead. Stations in southern Florida reported the first snow ever, and an all-time low temperature of -2.8°C (27 °F) was recorded. Below-freezing temperatures continued for up to 14 hours, and an unusually heavy frost accompanied the low temperatures. Severe losses were reported in citrus, vegetable, commercial flower, sugar cane, and tropical fish industries. Overall losses to the Florida economy were estimated at $2 billion.

Temperature

January temperatures set records across much of the eastern United States. It was the coldest January on record for most of the Ohio Valley, with readings 11° C (20°F) below normal. In Detroit, Mich., it was the first January on record in which the temperature failed to rise above 32° F. Indianapolis, Ind., and Buffalo, N.Y., also recorded month-long below freezing temperatures. In the meantime, persistent strong southerly winds flowing over the Gulf of Alaska gave Anchorage and Nome their warmest Januaries on record.

The effects of a record cold winter are seen in this January 11 satellite picture. Ice clogs the Mississippi River, ice and snow cover the Ohio River, and ice is beginning to close the Great Lakes. There is also ice in the upper Chesapeake Bay. The Tennessee River is open, however, because of its depth and width at this point. A long, snow-producing cloud plume can be seen at A-A'-A".

Spring came early to much of the eastern United States, and March brought temperatures 6°C (8° to 10°F) above normal to many stations in the Midwest. March also brought winds over 161 km/h (100 mph) to Pueblo, Colo.; a 24-hour snowfall of 61 cm (24 in) at Valentine, Nebr.; and a snowfall of 101 cm (40 in) in the Black Hills of South Dakota, with temperatures down to -18°C (0°F). Chicago, Ill., reported 9 consecutive days above 32.2°C (90°F) in May. In July, heat records were set at Wilmington, N.C., 37.8°C (100°F); Richmond, Va., 41.1°C (106°F); and Pierre, S.Dak., 42.2°C (108°F), among others. Red Bluff, Calif., reported 45°C (113°F), while the temperature at Blue Canyon, Calif. at an elevation of 1,610 m (5,284 ft), rose to 33.9°C (93°F). A cold Canadian anticyclone moved into North Dakota and Minnesota in mid-August, dropping temperatures to -2.2°C (28°F) at Cloquet, Minn., and -4.4°C (24°F) at Thornhult, Minn. Subzero (C) readings were recorded in late November from Montana and Wyoming to the Central Plains, as an early season cold wave moved across the Nation. In North Dakota, average temperatures were as much as 13°C (23°F) below normal.

Drought

Drought conditions remained serious in the eastern Great Plains, the northern Corn Belt, and the Pacific and Intermountain regions during 1977. Parts of the Sierra Nevada mountains have not had a winter with so little snow since snow surveying began in 1906. Streamflow in many of the rivers in this area was the lowest ever recorded.

Though parts of the West received above normal rainfall in May and June, the excess was small and did not improve the overall situation caused by two consecutive dry seasons. July and August showed no improvement, with conditions in the drought areas remaining hot and dry. Widespread rains fell in late August over several long suffering agricultural sections of the Central and Southern Plains. Rain also came to Washington and Oregon in August, but little fell in Northern California until mid-September. Extreme drought continued through October in parts of Washington, Oregon, and California. Welcome precipitation, heavy at times, covered the parched areas during the last week of November as a hopeful sign for the beginning of the "wet" season in California. The drought-related loss to farming was estimated to be $1.8 million, and thousands of trees valued at $30 million died in national forests in California and Alaska. Many stations in the State of California experienced the most severe drought of the century during 1976-77.

Rain and Floods

Heavy rains from two cyclonic systems fell in the tri-state area of Kentucky, West Virginia, and Virginia in early April. Amounts of 76 mm (3 in) fell in the valleys, with higher readings on the mountain slopes. The Cumberland River at Williamsburg, Kent., reached a stage of 11.3 m (37 ft), or 0.6 m (2 ft) above the previous record established in 1886. Property losses were heavy.

Later in the month, a 3-day rainfall of 362 mm (over 14 in) flooded the lowlands around Franklin, La., while rains in east Texas sent the Colorado River in the Austin-Bay City area into the highest flood stage since 1940.

The rare passage of an occluded front on July 2 dropped a record 8.9 mm (0.35 in) on San Francisco International Airport. This is the largest amount ever measured in the entire month of July during the 127 years of record. The previous record 5.8 mm (0.23 in) was set in 1886. Thus, a record wet month went into the books during the worst drought in California history.

The name Johnstown has been synonymous with the word flood ever since the great disaster on May 31, 1889 which wiped out a large part of the Pennsylvania industrial city and caused the deaths of more than 2,000 people. Another flood situation in March 1936 resulted in the construction of dikes and channels to make Johnstown floodproof. Its residents thought it was floodproof until it began to rain on the evening of July 19, 1977. In the seven hours from 9 pm on the 19th to 4 am on the 20th, a rain gage at the Public Safety Building registered 215.9 mm (8.5 in). The Conemaugh River once again rose in a mighty flood that swept through residential, business, and industrial section of the city of 42,000 people. At least 76 were drowned, and damage exceeded $100 million. Weather observers in the vicinity reported as much as 304.8 mm (12 in) of rain for the storm total.

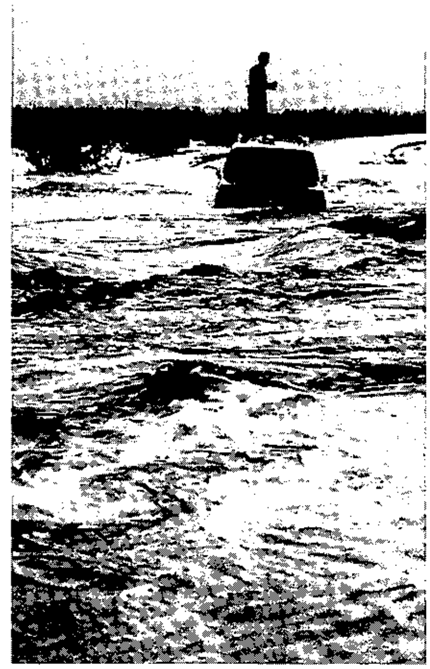
The surface weather map showed no surface front that could have produced the continuous heavy showers, but the upper air charts revealed a trough of low pressure aloft. A very moist and very warm tropical air mass occupied the area for several days, and the upper trough apparently triggered the deluge.

August brought all-time record rainfalls to southern California as Tropical Storm Doreen moved into the area. San Diego has had only two Augusts (1861 and 1873) with more than 25.4 mm (1.00 in) total rainfall since 1850. This year a total of 54.1 mm (2.13 in) was measured in just 2 days! In Los Angeles, measurable rain fell during every hour for 28 hours for a 2-day total of 62.8 mm (2.47 in). The previous record for August, set in 1889, was only 15.5 mm (0.61 in).

On September 12-13, very heavy thunderstorms occurred in the Kansas City, Mo., area that resulted in serious flooding, death, and destruction in the vicinity of Brush Creek and the Country Club Plaza Shopping District. Total rainfall for the 2 days ranged up to 406 mm (16 in), and 25 people lost their lives. Hundreds of homes were destroyed and hundreds of thousands of acres of farmland were flooded, leaving an estimated 3,500 families homeless.

Hurricane Heather brought record rains to Southern Arizona from October 6-11, 1977. The storm developed south of the Baja Peninsula around the first of the month. It moved northward for four days and then curved eastward under the influence of the westerly flow aloft. The combination of moist air, a trough aloft moving in from the Pacific, and a frontal system moving across the State on the 7th brought rainfall amounts that equaled or exceeded total rainfall for an average year.

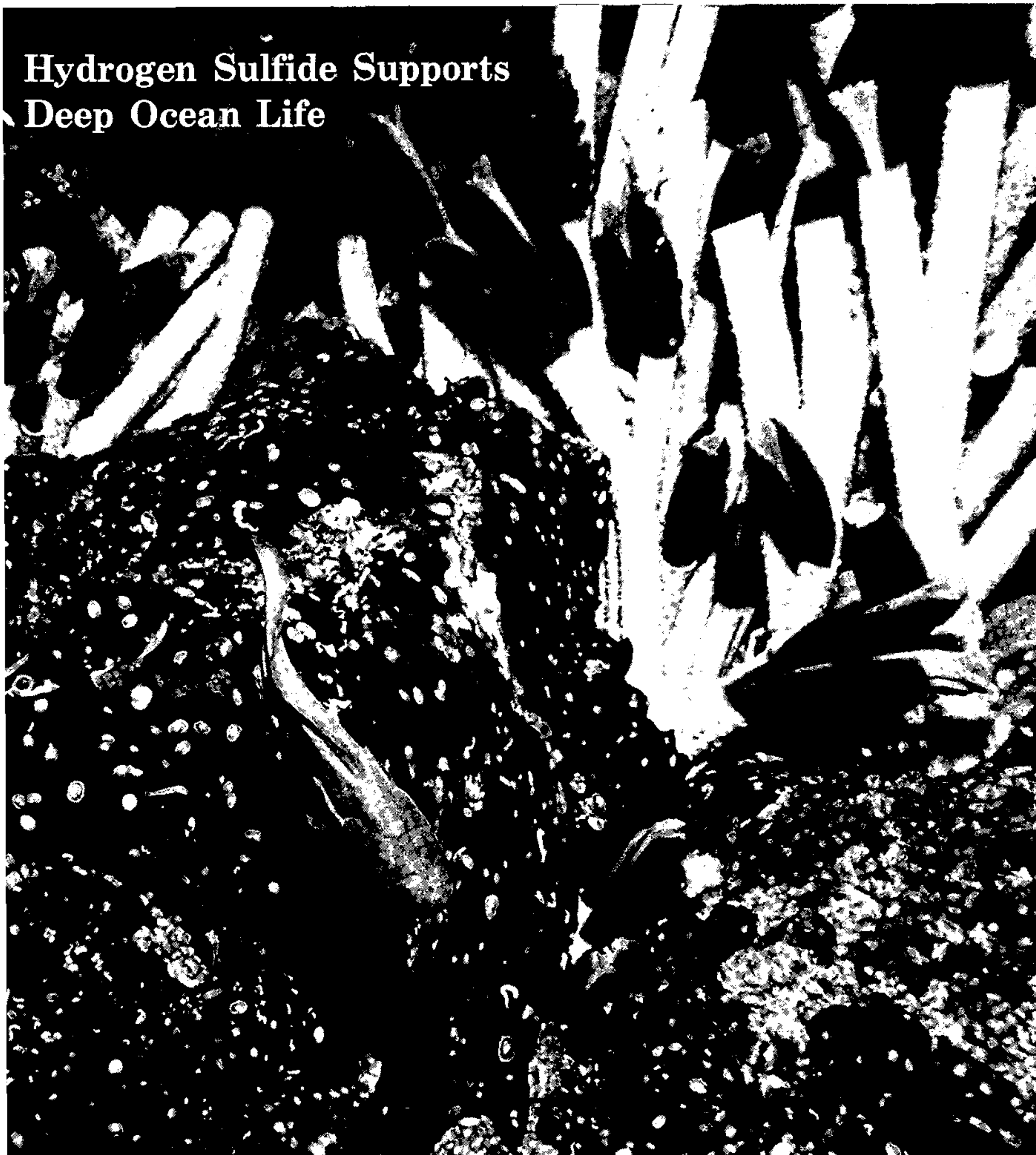
Heavy and prolonged rains in the southeastern United States in early November resulted in tragedy. An earthen dam gave way at Toccoa, Ga., sending a wall of water through a valley where 38 students at a small college lost their lives. Flash floods also claimed five lives in western North Carolina as heavy rains spread northeastward. Up to 203 mm (8.00 in) were reported for the 24-hour period; however, much of the rain fell during a 3- to 4-hour period.



A San Diego, Calif., Sheriff's deputy is stranded atop his patrol vehicle during a flash flood.
Photo: John Ruddley

The results of a November flash flood in Toccoa, Georgia. *Photo: Glenn Schwartz*

Hydrogen Sulfide Supports Deep Ocean Life



The stalk-like creatures are tubeworms. Tubeworms usually are much smaller than these, which are 14 to 18 in (36-46 cm) long. Limpets, crabs, seaworms, and an unknown variety of fish also are seen in the photograph. The photo was taken by Dr. John Edmond of MIT from the submersible Alvin *at about 9,000 ft (2,800 m).*

Photo: Woods Hole Oceanographic Institution

The scientists call them "Clambakes." They are animal communities made up of fields of dandelionlike organisms (possibly soft coral or crinoids), clams up to 10 inches across, and about 10 other species clustered around hot water vents and apparently thriving 2,500 to 2,700 meters (about 9,000 feet) below the ocean's surface. How do they survive? At these depths, the seascape is usually devoid of such clusters of large organisms, owing to the lack of light for plant photosynthesis and near-freezing temperatures.

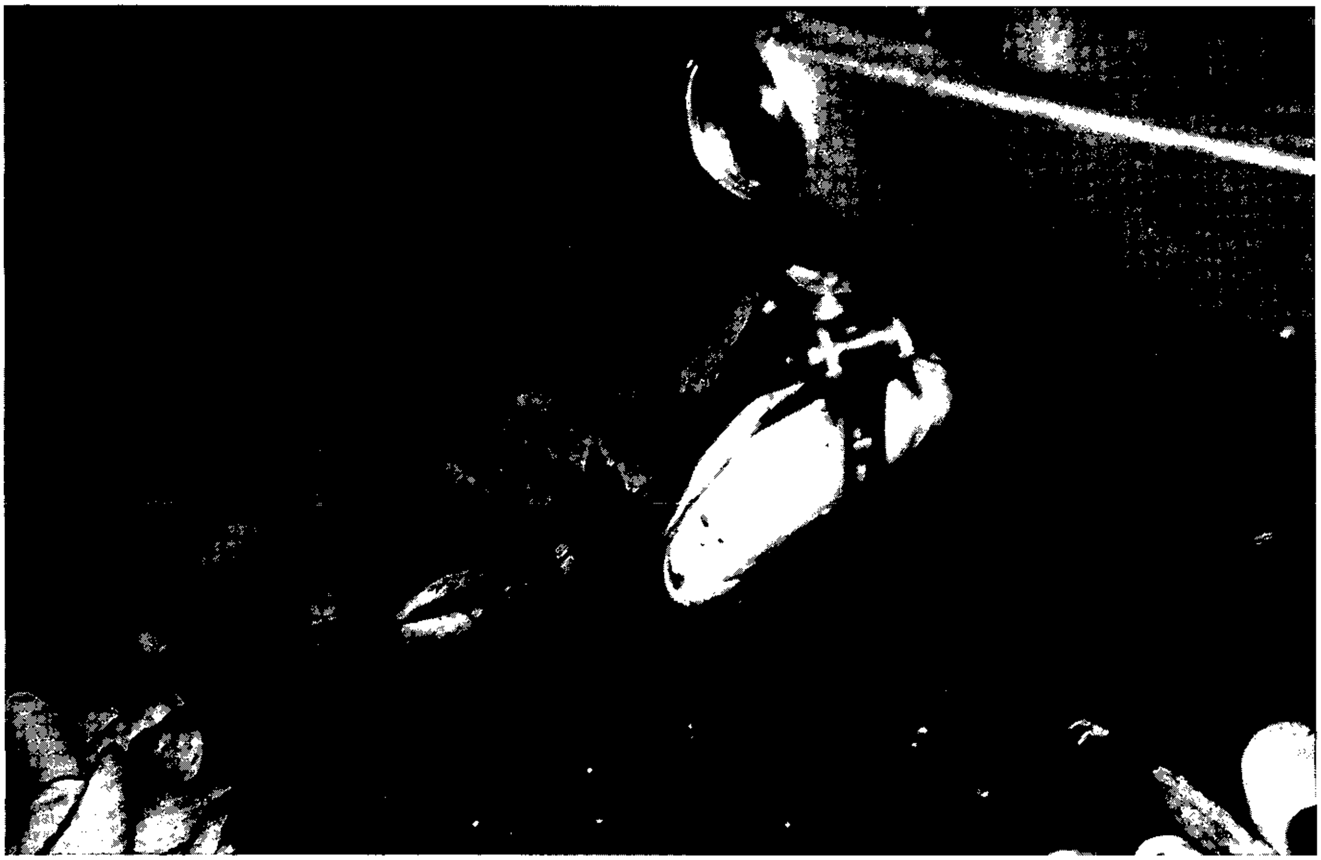
Scientists from the Woods Hole Oceanographic Institution and other collaborators made this unexpected find during a diving expedition on the Galapagos Rift in the Pacific in March 1978. The National Science Foundation's International Decade of Ocean Exploration (IDOE) program sponsored the project. IDOE is a long-term, international, cooperative program to improve the use of the ocean and its resources. EDS manages the scientific data for IDOE under contract with NSF and publishes an annual progress report. These periodic summaries provide the scientific community and other interested persons with descriptions, data inventories, and lists of scientific reports derived from IDOE projects.

Dr. Holger W. Jannasch, a marine microbiologist at Woods Hole, suggests that the abundant life observed near underwater springs at the site is only marginally related to the increased temperature, but rather lies in a well-known microbiological phenomenon that occurs wherever the water has a high hydrogen sulfide content. Although this phenomenon is well known in shallow water, this is the first known occurrence in the deep sea. The source of biological activity in the deep sea is usually assumed to be organic matter that reaches the sea floor through sedimentation from surface waters.

This crab—about 6 in (15 cm) across—seaworms, and dead clams were photographed by Dr. Robert Ballard of Woods Hole.

Photo: Woods Hole Oceanographic Institution

At the Galapagos vents, the source of energy for the growth of organisms apparently emerges from the submarine springs in the form of hydrogen sulfide. This reduced inorganic sulfur compound can be used by a certain group of bacteria as an electron donor, i.e., a source of energy used to turn carbon dioxide into organic



Alvin's *mechanical arm picks up a large clam from the area called "Clambake 1." The clam is about 12 in (30 cm) long.*

Photo: Woods Hole Oceanographic Institution

carbon. This is comparable to the process green plants use with the aid of light rather than reduced sulfur. The growth of sulfide-oxidizing bacteria produces the ideal food for filtering organisms, which may include large clams or smaller organisms on which clams feed. With this food chain, the amount of life found around these springs will be more or less directly related to the amount of hydrogen sulfide contained in the emerging water. The rates at which these biological transformations occur will also determine how much biomass is produced, and how much temperature and pressure affect the rate.

Jannasch's theory on life-sustaining hydrogen sulfide is more than adequately supported by oceanographers who recently completed their third major expedition over the past 4 years. Their mission is to investigate spreading centers where huge tectonic plates on which the continents ride move and grow, thus producing volcanic activity that causes gaps in the Earth's interior.

As these tectonic plates move over the globe, new volcanic material wells up from the Earth's interior to fill gaps between them. Observations by scientists inside the 23-foot submersible *Alvin* and from photographs made by a camera sledge towed by Woods Hole's vessel *Knorr* matched those made on the Mid-Atlantic Ridge in 1974 and in the Cayman Trough near Cuba early in 1976. The Galapagos work presents the first observations of active hot water vents emerging from holes about the size of a cereal bowl in pillow lava.

According to Dr. Richard Von Herzen of Woods Hole, "The highest elevation in the Galapagos is about 200 meters (630 ft) while on the Mid-Atlantic Ridge, we found mountains up to 2 kilometers (about 1¼ miles) high. That rougher terrain probably allows free interchange of warm water circulating through the subsurface rock with the bottom seawater. The more even terrain of the Galapagos Rift may also make it easier to find the warm water vents." Positive identification of all biological masses found at the Galapagos Rift will be determined through water sample analyses.

National Report

New Earthquake Intensity Evaluation Published

A new publication, *Reevaluation of the Modified Mercalli Intensity Scale for Earthquakes Using Distance as a Determinant* (NOAA technical Memorandum EDS NGSDC-4) by R. J. Brazee, has been published by EDS' National Geophysical and Solar-Terrestrial Data Center in Boulder. The work was sponsored by the U.S. Nuclear Regulatory agency. This is the first evaluation of the 1931 Modified Mercalli Intensity Scale that is based on detailed analyses of the mass of intensity data collected by Federal agencies over nearly half a century (1928-74). The data base consists of 400,000 earthquake intensity reports.

Earthquake intensities—numerical values assigned to effects of earthquakes on man, the works of man, and the natural environment—have several advantages over instrumental measurements (magnitude). Intensity depends on population density and structures (buildings, dams) to measure earthquake severity. Thus a large portion of the globe is adequately covered with "sensors" whose response can be compared and, to a degree, evaluated in meaningful units. Because instrumental measurements (magnitude) of earthquakes are available for less than 80 years, they provide only a short time span on which to base historical seismicity or to estimate future activity. The investigator, using intensity as a parameter, can extend this base in populated areas several-fold, with a reasonable degree of accuracy.

This study examined phrases in the 1931 Intensity Scale that describe reported effects, such as "felt by man," "frightened all," "damage severe," and others, in terms of attenuation with distance. This allowed elements of similar attenuation with distance to be grouped together in the new scale, minimizing overlapping and misassignments. The grammar of the scale has been made consistent, and each element is described as unambiguously as possible.

The new scale, if adopted, will facilitate the objective assignment of intensities by analysts or computers. It also should reduce scatter in the assigned values. With minor revisions in the upper intensity ranges, this scale could serve as the new standard for earthquakes in the United States and elsewhere.

Copies of the publication are available from the National Geophysical and Solar-Terrestrial Data Center, NOAA/EDS, Boulder, CO 80302.

Natural Hazards Data Workshop

A workshop was held at the University of Colorado in Boulder, Colo., on April 13-15, 1978, to examine the adequacy of data services for natural hazards applications. Forty participants from Federal, State, and local governments, insurance and engineering companies and associations, disaster relief agencies, and academia attended. One of the recommendations of the workshop was the completion of an inventory of natural hazard data sources in the Federal Government. A draft inventory of over 100 data files was prepared by Robert Alexander of the U.S. Geological Survey and James F. Lander of EDS' National Geophysical and Solar-Terrestrial Data Center.

Researchers present were distressed particularly by the aggregation of data into various summaries (such as by county and building type) not suited to their needs, as well as the numerous data location schemes (latitude and longitude, zip code, various map grids). It was recommended that Federal agencies that collect and disseminate pertinent data improve their coordination so that relatively small changes in internal processing and data storing techniques can improve their usefulness. The Federal Disaster Assistance Administration is to convene regularly an interagency coordinating group for this purpose.

A third major recommendation was for the development of a computer simulation model that would contain a demographic data base onto which the predicted geographical effects could be superimposed. This would provide estimates of the potential impact of an earthquake or hurricane of any given location and severity.

Climate and Natural Gas Consumption

The late cold weather this year surprised many people, but on January 31, 1978, EDS forewarned that natural gas consumption in the United States by residential and commercial customers would reach approximately the same level as during the heating season of 1976-1977, a record cold season.

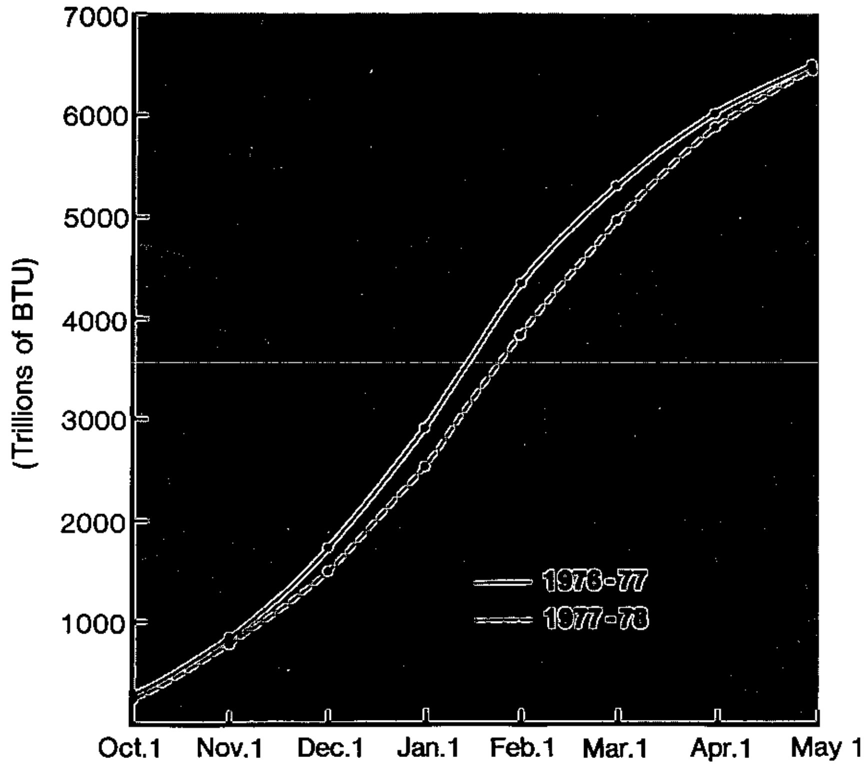
The "Summary and Outlook for Natural Gas Demand" prepared monthly by EDS' Center for Climatic and Environmental Assessment is based on relationships between U.S. natural gas consumption and heating degree days (an index of cold weather). It uses current heating-degree-day data, the National Weather Service's 30- and 90-day Long Range Outlooks for average temperatures, and climatology to track and project natural gas consumption from September through May. Results are routinely supplied to officials in the U.S. Departments of Commerce and Energy and as requested by state energy agencies and by industry.

The past winter differed from the previous one in many respects, but one of the most inportant was the early cold of the previous winter as contrasted to the late cold this year. Thus, on January 31, 1978 EDS estimated that residential and commercial customers had consumed only 88 percent of the amount of natural gas they had consumed from September through January the previous winter; however, the outlook for colder-than-normal temperatures over most of the United States east of the Rockies indicated that for the coming months natural gas consumption would be up about 13 percent, so consumption for the whole heating season, September through May, would likely reach 97 percent of the amount consumed the previous season, with consumption in the north central states equaling or exceeding consumption in the previous season.

Estimates made at the end of April based on observed heating degree day data indicated that natural gas consumption had reached a level of 99 percent of last season's consumption.

Last winter's cold weather did not have the same effect on natural gas supplies as did the previous winter's early and intense cold temperatures. Last winter's cold weather was later and spread out more evenly and did not overtax the pipeline supply system or prematurely exhaust local storage capacity. The primary impact was on some electric utilities that were counting on surplus natural gas to be available for electricity generation to supplement coal-fired generating capacity idled by the prolonged coal strike.

The past heating season was the first in which the EDS climate/energy consumption program was operated in its present form, and testing and evaluation are still underway. Initial results, however, indicate that the program should provide valuable and timely information on natural gas consumption that will benefit policy and planning in government and industry.



Estimated natural gas consumption in the United States, September 1 to April 30.

Pollen Reveals Climate's Past

Natural records in the form of fossilized pollen are revealing the first detailed picture of changing climatic conditions in the central Great Lakes region over the past 2,500 years.

Studying fossil pollen contained in lake sediments, J. Christopher Bernabo, National Research Council resident research associate with NOAA's Environmental Data Service, has determined that recent decades are the warmest in the upper Midwest since 1200 AD. But long-term trends in the same area show annual rain – and snowfall have increased 50 percent since 600 BC.

Bernabo says his initial research in Michigan shows that the past 30 years in this region have been warmer than any similar period since about 775 years ago, when it was roughly as warm but drier than today. Further study indicates a cold "Little Ice Age" period occurred from about 1450 to 1850, with temperatures about 2°F cooler than the current 30-year mean.

Snowfall in the past three decades has been below the long-term trend line, but still 10 percent greater than the 2,000 year average.

Bernabo's studies of past climate trends are possible because the climatically induced changes in forests are recorded by fluctuations in the types of pollen that accumulate in muds on lake bottoms. Computer techniques are used to transform the pollen data from the natural sedimentary archives into estimates of past climatic conditions.

U.S. Gravity Data

EDS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) now has available a file of gravity data for the conterminous United States. These data were furnished by the Department of Defense's Gravity Library located at the Defense Mapping Agency, Aerospace Center, St. Louis, Mo. The file contains observed gravity, free-air anomaly, and Bouguer anomaly data for about 375,000 gravity stations. Supplemental data include: latitude and longitude, elevation, standard deviation for the free-air and Bouguer anomalies, and documentation reference numbers. The entire file and data for specific geographic areas are available in magnetic tape and computer printout formats. For further information address inquiries to: National Geophysical and Solar-Terrestrial Data Center, NOAA/EDS, Code D621, Boulder, CO 30302, or call David Clark (303) 499-1000, ext. 6541 (FTS 323-6541) or Allen Hittelman (303) 499-1000, ext. 6542 (FTS 323-6542).

Marine gravity data from both continental shelf and deep ocean areas also are available from NGSDC.

Climate Change to the Year 2000

The results of the first phase of a climate change study sponsored by the National Defense University, the Department of Agriculture, and the National Oceanic and Atmospheric Administration were recently published. *Climate Change to the Year 2000* presents the findings of a survey of expert climatologists on the subject of climate change and variability.

The study shows that there is a wide divergence of opinion among the experts about future change in climate, but concludes that the likelihood of catastrophic change by the year 2000 is minimal. According to the survey, the most likely event will be a climate resembling that of the past 30 years, but with a tendency toward slight global warming. Succeeding phases of the project will investigate the effect of various climate change scenarios on world crop production and on U.S. domestic and foreign policies.

For copies of the 109-page publication, contact: Library and Information Services Division, D822, EDS/NOAA, WSC-4, 6009 Executive Blvd., Rockville, MD 20852, or call 301-443-8334.

Codfish over Georges Bank. *Photo: Bell Telephone Laboratory*

Climate / Fisheries Workshop

Scientists from the National Marine Fisheries Service and the Environmental Data Service joined other participants at the University of Rhode Island's Center for Ocean Management Studies in the Climate/Fisheries Workshop, March 29-31, to discuss the application of climatology and oceanography to fisheries problems.

The participants noted that progress is likely to be made in this area because of three recent developments: (1) greatly increased data collection programs for the oceans and fisheries, (2) increased computational power in these disciplines, and (3) a marine community willing to devote significant resources to such ventures.

Conference participants suggested the establishment of a multidisciplinary team to review the problem of climate and fisheries, and the examination of critical point or catastrophic events to develop predictive capabilities.

To be successful, climate and fisheries studies require: (a) a sound time-series base of environmental data; (b) an understanding of the species' life histories and interspecies relationships; and (c) a sound time-series base of fisheries data. It was thought that the following species have accumulated reasonable data bases from which progress can be made: Pacific anchovy, albacore tuna, Atlantic menhaden and herring, and cod and haddock on Georges Bank.

Dr. John Knauss, University of Rhode Island Provost for Marine Affairs, chaired the workshop. Background papers developed for the conference by the Steering Committee will be made a part of the proceedings scheduled for publication in June.

International Report

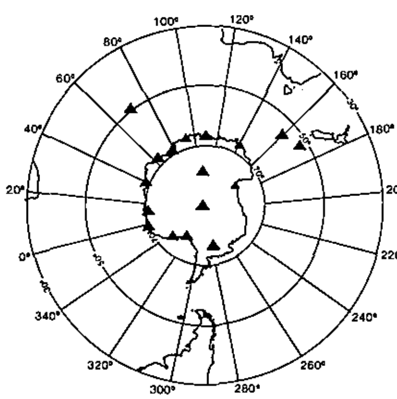
Directory of Solar-Terrestial Physics Monitoring Stations

World Data Center A for Solar-Terrestrial Physics in Boulder, Colo., in cooperation with the Air Force Geophysics Laboratory, has compiled MONSEE (Monitoring of the Sun-Earth Environment) Special Publication No. 1. This compilation, *Directory of Solar-Terrestrial Physics Monitoring Stations,* contains a current list of continuously monitoring ground-based observing stations, with information about each station's program. In addition to location coordinates and alternate names, details are included about instrumentation at each site, observing schedules, data formats, whether the data collected are available at any of the World Data Centers (WDC), and addresses to write to for information about the station and the data.

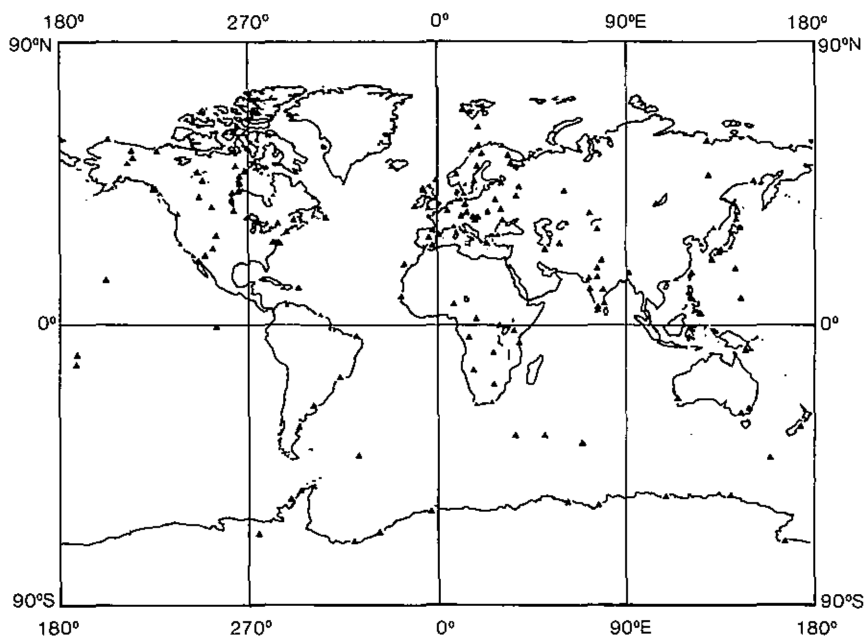
Because all the data are computerized and processed through a computer data mangement language, it is relatively easy to update or add to the file. WDC-A for Solar-Terrestrial Physics invites continuously monitoring solar-terrestrial physics stations that are not included in the directory to forward information for their station to the address below for inclusion in the next update.

MONSEE is a program under the auspices of the Special Committee on Solar-Terrestrial Physics of the International Council of Scientific Unions. MONSEE Special Publication No. 1 is an effort to encourage and advertise the existence of routine, high-quality data observational programs worldwide. These programs are essential for viable solar-terrestrial physics programs.

Copies of the directory are available at no charge from WDC-A for Solar-Terrestrial Physics, NOAA, D63, Boulder, CO 80302 U.S.A.



South Pole MONSEE Stations. The station in the center is at the geographic pole; the one above it, at the geomagnetic pole.



Global distribution of MONSEE Geomagnetic observatories (standard and rapid run measurements).

PRC Marine Scientists Visit EDS

On April 28, EDS was visited by a delegation of marine scientists from the Peoples' Republic of China (PRC). Their visit to the United States was hosted by the Committee on Scholarly Communication with the PRC, which is sponsored by the American Council of Learned Societies, the National Academy of Sciences, and the Social Science Research Council. The Chinese Society of Oceanography organized the visiting delegation.

During the visit to EDS, the group was briefed on current marine data activities and those planned for the future. The PRC delegation toured the National Oceanographic Data Center (NODC) and were introduced to the operations of the NODC as well as the international exchange of oceanographic data through the World Data Center System. They were shown computer operations, the use of interactive graphic terminals for retrieval of inventory information and analysis of oceanographic data, the use of alphanumeric terminals for retrieval of bibliographic information, and the use of automatic data plotters.

Bob Ochinero, Director of the National Oceanographic Data Center and Jim Churgin, Director of World Data Center-A, Oceanography, welcome LoYü-ju, Deputy Director of the National Bureau of Oceanography, People's Republic of China.

The Chinese delegation was lead by LoYü-ju, Deputy Director, National Bureau of Oceanography, and represented expertise in physical oceanography, marine chemistry, marine geology, marine biology, and ocean engineering. The Group was in the United States for 1 month. Their itinerary included visits to several other NOAA facilities, including the Geophysical Fluid Dynamics Laboratory and Atlantic Oceanographic and Meteorological Laboratories, as well as NOAA research vessels, various universities and research institutions, and marine instrumentation manufacturing facilities. A U.S. delegation of marine scientists will be visiting the PRC later this year.

Global Seismic Data Base Workshop

In recognition of the growing need for data on past occurrences of earthquakes worldwide, UNESCO recently sponsored a meeting of experts organized by the International Association of Seismology and Physics of the Earth's Interior and held in Paris on March 20-23. The meeting defined the elements that should be included in the data base when possible. These include location, focal mechanism, magnitude, intensity and intensity maps, surface faulting, tsunamis, casualties, and references. Such a data base would support scientific, engineering, and commercial (insurance) users, particularly in cases where a long-term data base is needed.

A simple compilation of existing sources with a critical evaluation of probable accuracy was considered as a first phase, with a continuing second phase to improve on the compiled history. In many countries, efforts are being made to compile definitive histories over periods of hundreds or thousands of years (China) from original sources and ground observations. The problem with earlier reports is complicated by calendar changes, and place-name changes.

The workshop recommended that the International Seismological Center in Newbury, England, be considered the focus for this effort if additional funding could be found and that the World Data Center-A for Solid Earth Geophysics in Boulder, Colo., continue its effort to compile its file. WDC-A has a computer-searchable file containing information on nearly 150,000 earthquakes from nearly 25 sources.

Scientists from Czechoslovakia, France, Germany, Japan, Peoples' Republic of China, United Kingdom, and the United States participated in the meeting.

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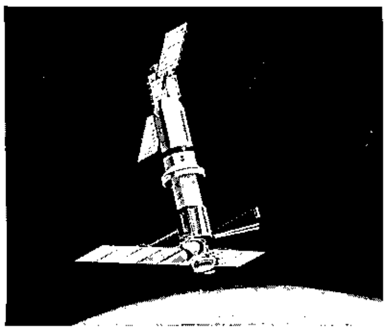

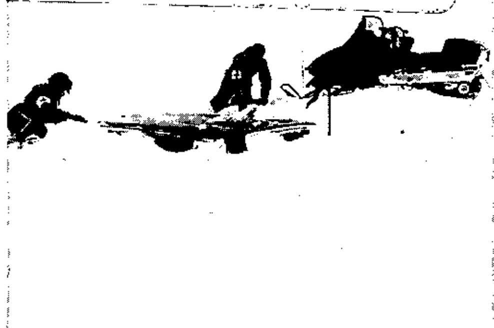

In this issue: *Seasat data services (p.9); the weather of '77 (p.11); unexpected life in the deep ocean (p.15); and Antarctic icebergs as a freshwater supply (p.3).*