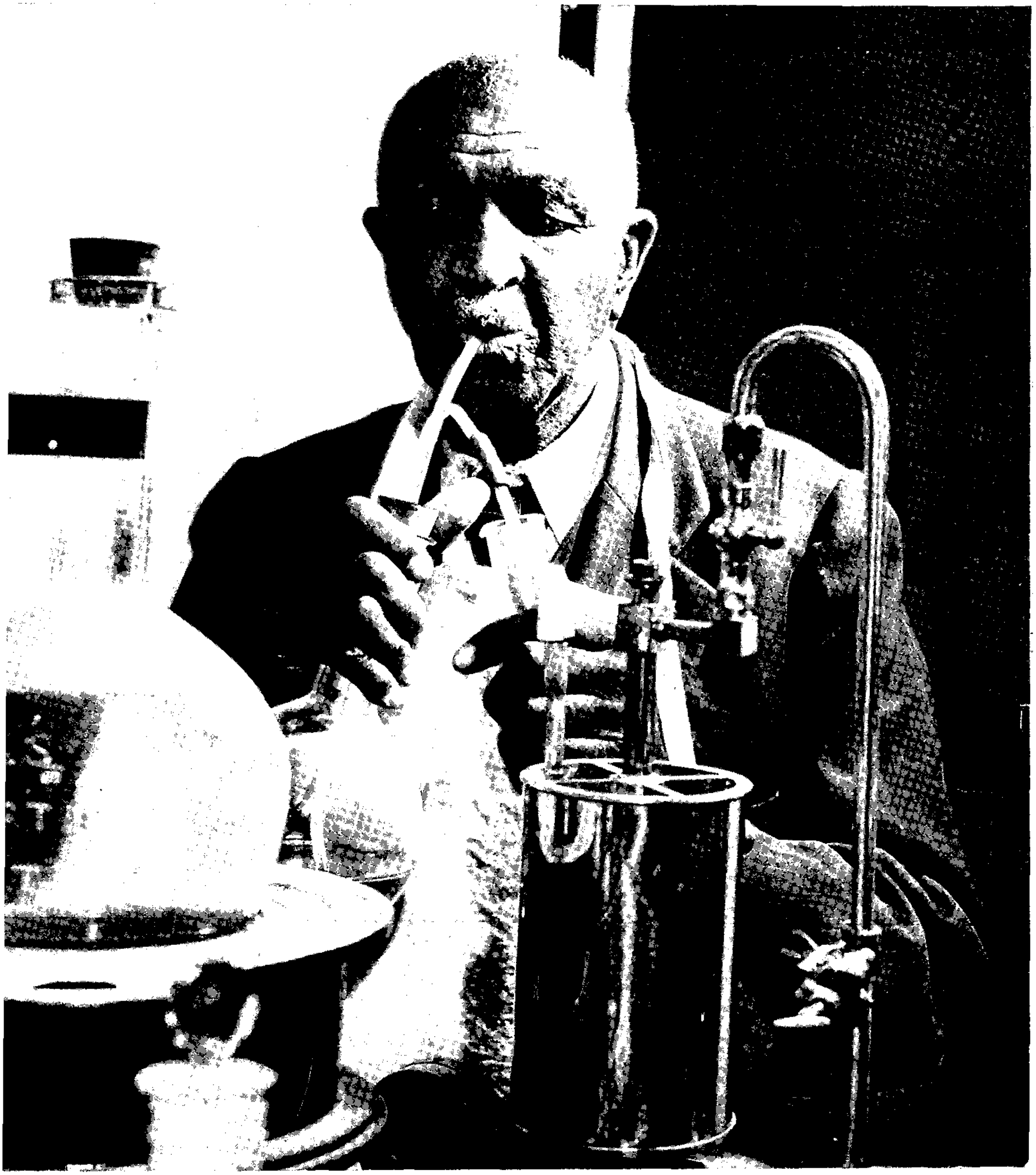
EDIS

Environmental Data and Information Service
September 1978



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Cover: *George Washington Carver in his Tuskegee Laboratory. A pioneering genius in agricultural research and chemistry applications, Carver also took weather observations for 32 years. (See p. 15.)* *USDA Photo*

EDIS is a bimonthly publication designed to inform Environmental Data and Information Service (EDIS) cooperators, colleagues, and contributors of recent developments in EDIS programs and services and in the general field of scientific data and information management. EDIS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, and Center for Environmental Assessment Services. In addition, under agreement with the National Academy of Sciences, EDIS 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.

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EDIS?

On July 16, 1978, the Environmental Data Service officially became the Environmental Data and Information Service. EDS, therefore, is now EDIS.

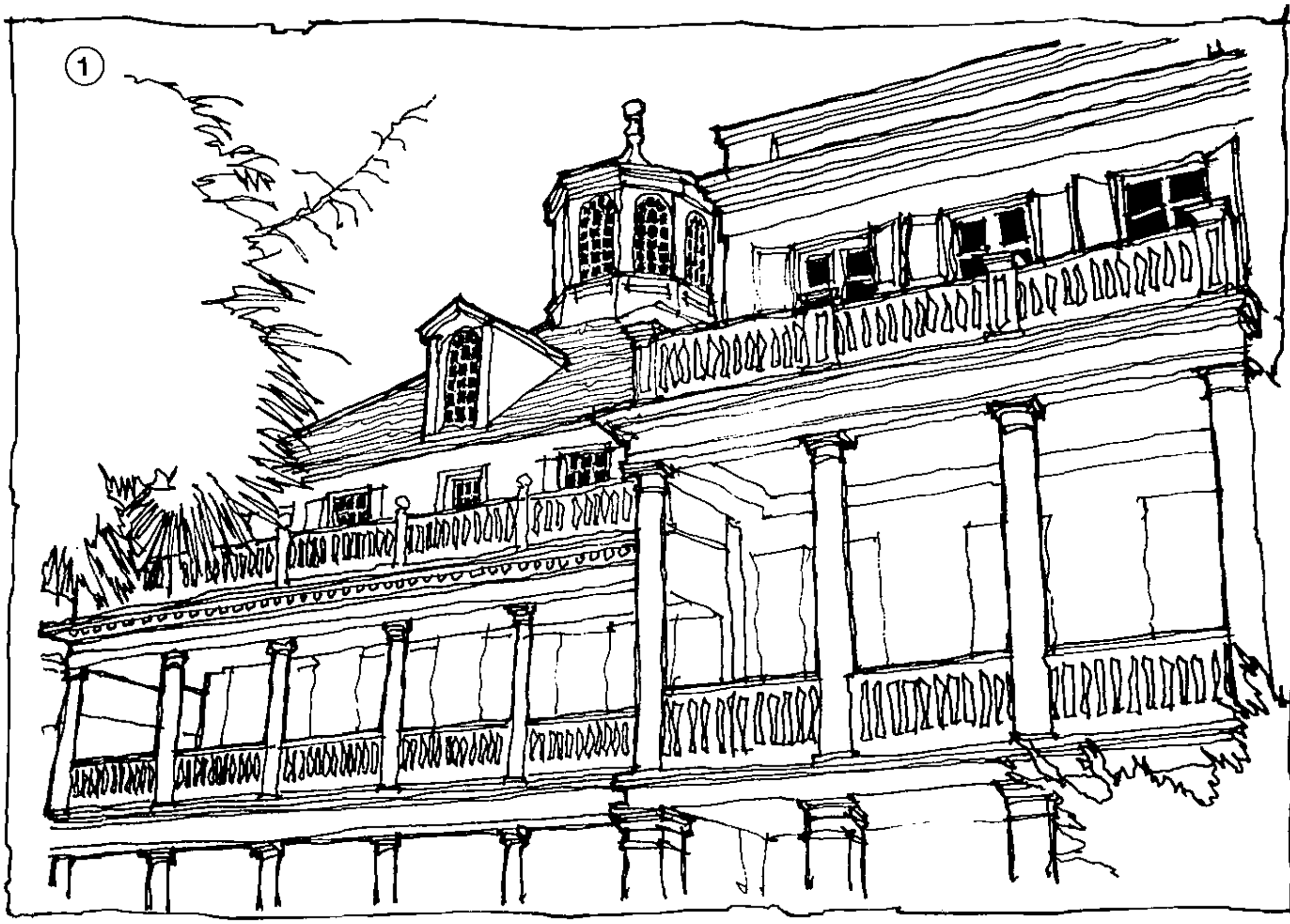
The change was made to more accurately describe our organization and its functions. The Environmental Science Information Center is one of our major components. It provides literature-based scientific and technical information products and services that complement the data products and services provided by our other service centers. Collectively, these centers provide a comprehensive source for both environmental data and information.

The same trend that currently characterizes scientific data management—namely, the evolution from archiving and dissemination to emphasis on applications to solve national problems—also characterizes the scientific and technical information (STI) field. STI is an essential element of EDIS environmental assessments and evaluations related to the energy crisis, environmental pollution, world food problems, climatic anomalies, and many other national and international problems.

In summary, our new name reflects the scope of our service capabilities and commitments.

Thomas S. Austin

Thomas S. Austin, Director
Environmental Data and
Information Service



Climate, Architecture, and Energy Conservation

By Vivian Loftness   American Institute of Architects Research Corporation

"A well designed building is like a carefully trimmed sailboat which makes optimum use of natural forces."

—R. Buckminster Fuller

Can you guess where in the United States the traditional buildings shown on this and the following page are located? (See "Answers," p.8.)

These buildings are in sharp contrast to those being built today, which are almost homogeneous—national, even international in character. All-glass office buildings crowd the skyline in Houston, Chicago, New York, and Los Angeles, while New England colonials can be found in almost any American city.

What did the old regionality reflect? To a certain extent, the local culture, skills, and materials—but most of all, the climate of the region.

In each location, on each site, buildings "feel" the impact of local climate. Low temperatures cause severe heating loads, which winds aggravate and sunshine eases. High temperatures cause severe cooling loads, which sunshine aggravates, but wind, or evaporative cooling, or damping day-night temperature swings, can ease.

The forces of climate continually flow around and through your building, affecting your comfort and determining energy demands for heating and cooling. It is this interrelation between climate, architecture, and energy demand that the American Institute of Architects Research Corporation (AIA/RC) has begun to study in conjunction with EDIS' National Climatic Center (NCC).

In the words of R. Buckminster Fuller, "A well designed building is like a carefully trimmed sailboat which makes optimum use of natural forces."

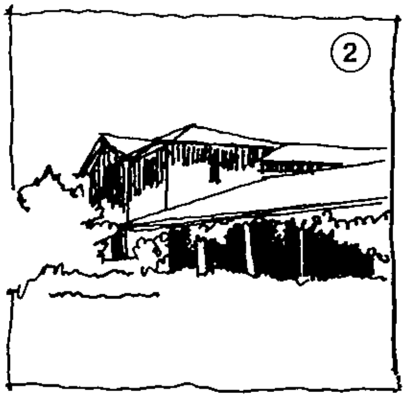
And what does living in a sailboat imply?

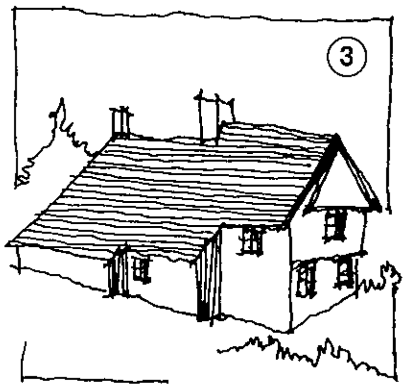
Not that there is no motor, but that when the wind is blowing, the boat can be powered by natural forces. We can design, build, and operate buildings that use the natural heating and cooling forces of nature and rely on "motors" only when those forces are unavailable.

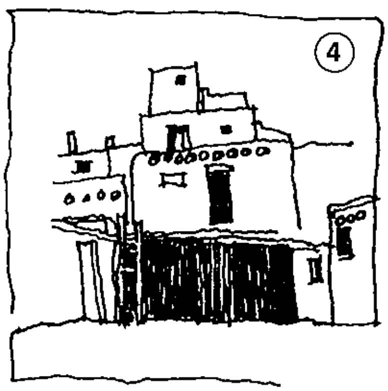
What are those forces?

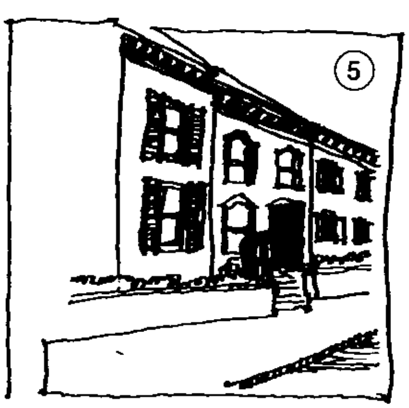
The impact of climate on a building is a function of temperature, humidity, Sun, and wind. Depending on where you live, and on whether heating or cooling is the dominant consideration, different climatic conditions can be liabilities or assets, both to human comfort and to energy consumption.

Climatic liabilities are those aspects of Sun, wind, temperature, and humidity that make seasonal climatic conditions worse. Isolating yourself from these liabilities is the basis of energy conservation by reducing the heating and cooling demand on the building. *Temperature* can be a liability in both hot and cold climates, especially if it is consistently too hot or consistently too cold. *Wind* is a liability in cold climates, because it carries away heat. *Wind* also can be a liability in hot, dry climates, where winds cause humans to dehydrate and consequently overheat. *Moisture* can be a liability when it comes in the form of humidity, and one cannot evaporatively cool (by sweating) in summer. *Sun* is rarely a liability in cold climates, but can be a significant problem in hot climates.









Climatic assets are those aspects of Sun, wind, temperature, and humidity that make seasonal conditions more comfortable. Opening buildings up to the assets of climate is the basis of natural comfort and offers ways to "power" your building with nondepletable resources.

Large diurnal temperature shifts (from daytime heating to nighttime cooling) are found in very dry areas and at high elevations. Such a day-to-night temperature swing can be "flattened" by the use of heavy construction to yield constant temperatures throughout the day.

Wind can be an asset in hot, humid climates, providing natural ventilation and allowing air conditioners to be shut off. The *Sun* can be an asset in cool and cold climates by providing passive heating, allowing heaters to be shut off and heating loads to be reduced. Even *moisture* can be an asset; evaporating water in hot, dry climates cools and humidifies the air—a natural air conditioning system.

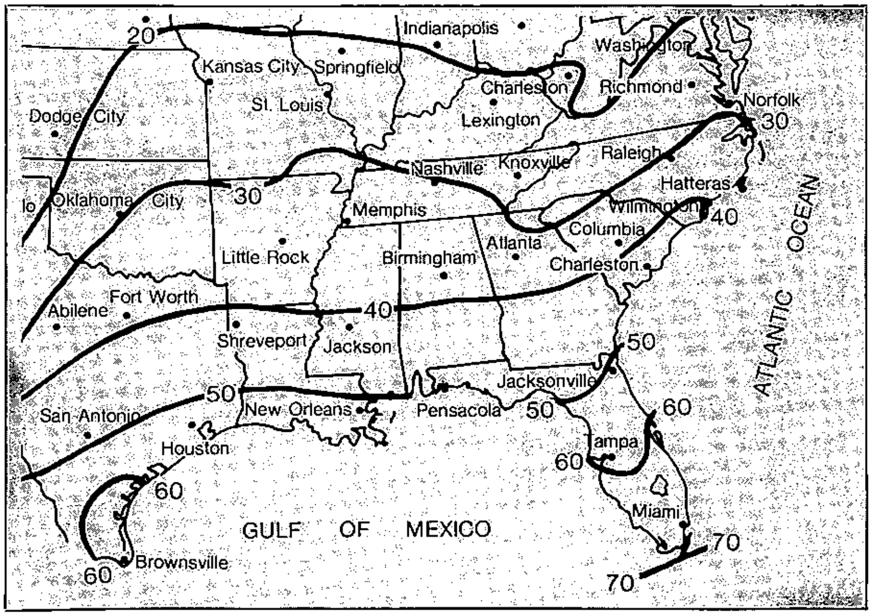
Every climate has its own set of assets and liabilities. Buildings should be designed to reflect a judicious balance between isolating the interior of a building from an "alien" climate and opening the interior of a building to a "friendly" climate.

The varying relative impacts of climatic factors across the country indicate the strong regional character of U.S. climate. The goal of the AIA/RC and NCC climate research project to date has been to characterize the broad climatic differences in this country that will influence design decisions. Regional priorities provide the basis for climatic design and energy conservation in buildings.

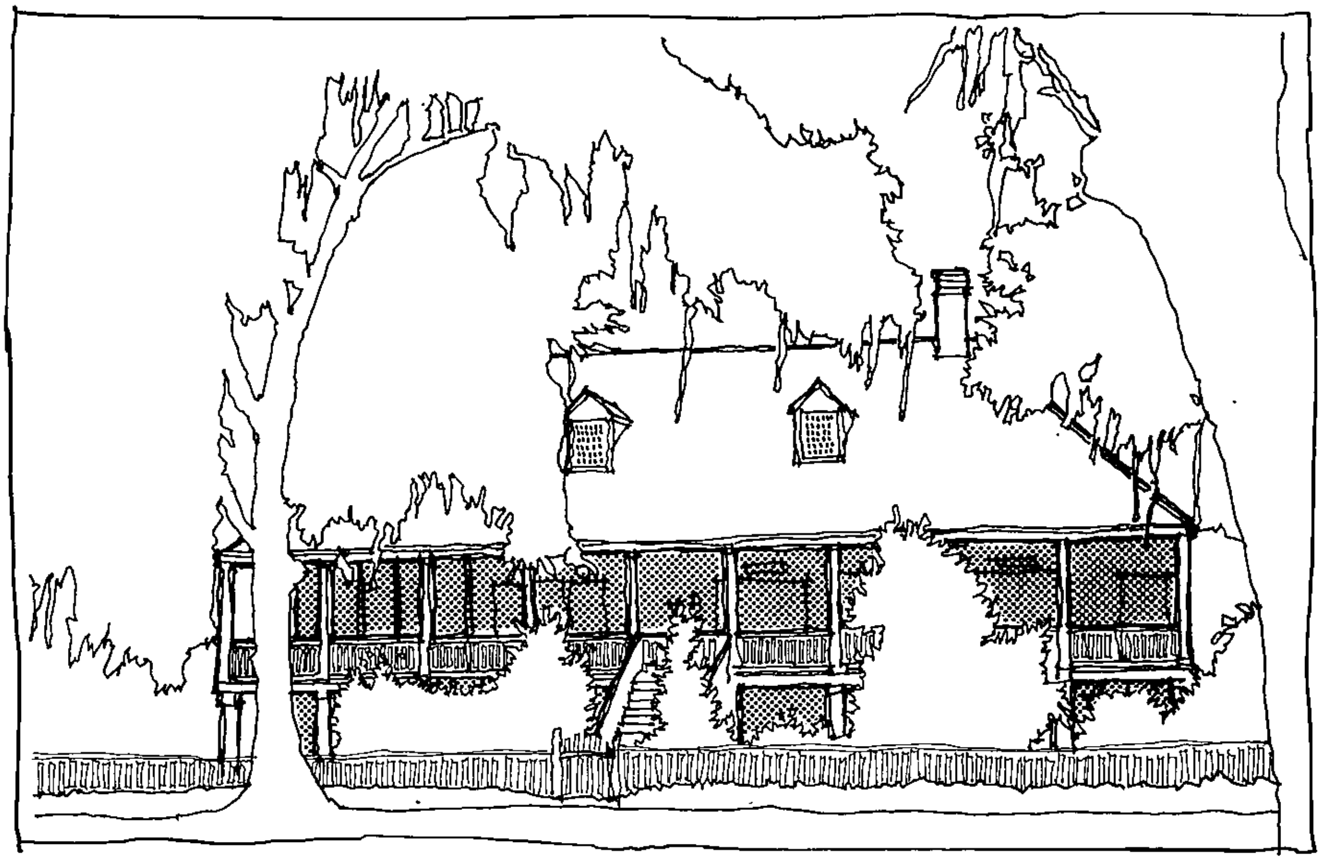
Each of a region's climatic assets and liabilities can be accommodated by simple design changes such as siting, orientation, wall construction and window placement, and even building organization. They also can be accommodated by more sophisticated systems employing Sun, wind, low humidities, even diurnal temperature shifts as power sources. The important point is that buildings should be designed to change as the cycle of the environment changes.

A specific example may best illustrate the principles involved.

The Gulf Coast from southern Florida to Louisiana and Texas is essentially flat and damp, and subject to frequent and heavy rains. Its summers are hot and its winters are sometimes cold. Intense sunshine and high humid-



Above: Annual percent frequency of temperatures and humidities above the comfort zone. Below: Living can be comfortable for much of the year if houses are shaded, screened, and ventilated.

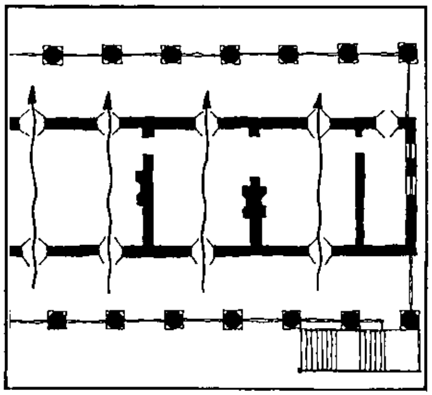


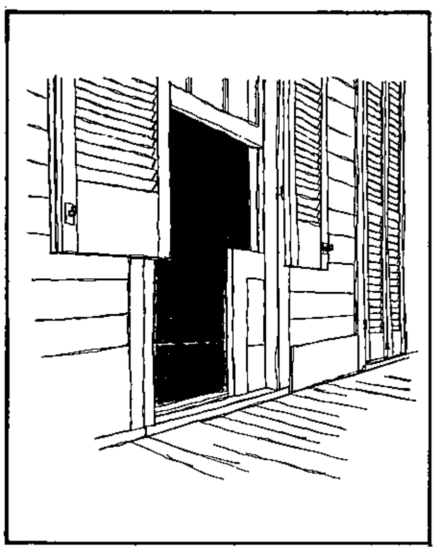
Building Design and Energy Savings

Most buildings in the United States are woefully designed, sited, and constructed in terms of energy conservation. We have been building primarily to satisfy economic or aesthetic criteria, and have compensated for environmentally poor design, siting, and construction by brute-force heating and air conditioning.

About *one third* of all the energy consumed in the United States is used to heat, cool, and operate homes, apartments, offices, and other buildings. It has been estimated that building-associated energy consumption could be cut by up to 40 percent if our buildings were designed, sited, and built by applying climatic data to minimize undesirable environmental effects and to maximize the impact of beneficial environmental elements.

EDIS' National Climatic Center and the American Institute of Architects Research Corporation are cooperating in a pilot project to determine the influence of climate on design criteria for residential housing. The goal is to provide guidance to engineers and architects so that homes can be designed to be responsive to the climate, thus minimizing fossil fuel consumption.





Open, elongated buildings (top), floor-to-ceiling openings, and louvered shutters maximize air flow through the house.

ities complete the range of "alien" conditions. A reliable land and sea breeze, however—southerly during the day and northerly by night—makes this region habitable and sometimes delightfully comfortable. Outdoor living, if shaded, screened, and ventilated, can be comfortable for as much as two-thirds of the year. With this knowledge, derived from considering climatic conditions in relation to human comfort, design priorities and principles can be established for residential building in the area.

Maximizing air movement around and through the house to keep people cool and temperatures down is the first priority, with keeping out the summer Sun a close second. In an area with big day/night temperature differences (especially in spring and fall), using massive building materials to smooth out temperature fluctuations becomes a third priority. Avoiding the creation of additional humidity in this already humid climate is an obvious fourth.

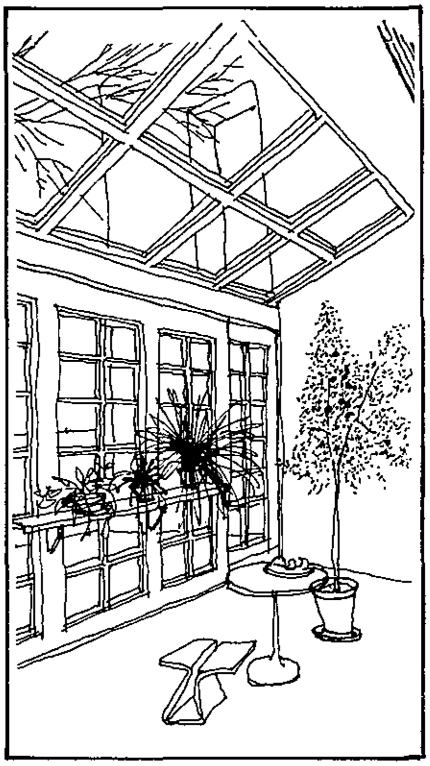
These then, are the four most important guidelines for reducing the cooling requirements in this overheated and humid climate. Winter conditioning also can be reduced with careful design. Letting the sunshine in on winter days can provide most of this climate's heating needs—but first care must be taken to maintain protection from the summer Sun. Preventing winter infiltration of cold air becomes the sixth and last priority, but *not* at the expense of good summer cross ventilation, the first priority.

Perhaps the best place to look for good climatic design is in the architecture indigenous to the area. Buildings constructed pre-air conditioning—and even pre-central heating—had forms, materials, openings, and building plans suited to the assets and liabilities of the climate in which they were set. There are certain traditional features of the early buildings of the Gulf Coast region that successfully combine logic with function to provide some of the most comfortable living spaces in the region.

Galleries, elevated living floors, umbrella roofs, high ceilings, floor-to-ceiling openings and jalousies all represent climate-control features designed to deal with the "friendly" wind and "alien" Sun in the summer. Building sites are large enough to permit ventilation through and around pavilion, open-plan types of houses. The elongated building plan allows easy air movement for cross ventilation, with the addition of wings preferred over compact design. Although windows (often floor-to-ceiling) are extensive, they also are well shaded, with deep verandah overhangs or louvered shutters.

All of these building variations effectively respond to the natural ventilation potential of the region, and are supported by two notions common to Southern living—sleeping porches and screened, hot-weather living spaces. Today, through careful design, we can add to these climatic details to ensure winter comfort, as well as summer comfort.

Controls for reducing air flow around and through the building in winter can be introduced simply by tighter construction for all openings—attic to basement. Zoning the house, so areas can be shut off in winter, will provide a compact and easily heated living area for comfort in cold spells. Solar heating is now appropriate, either by direct heating through south-facing windows or, better yet, through heat storage walls, which can receive the winter Sun but remain shaded from the unwanted summer Sun.



South-facing windows let in sunlight in winter and can be shaded in the summer. (See below.)

With the prevention of winter air infiltration and the acceptance of winter Sun as secondary energy-conservation guidelines, all buildings in this region can be "powered" by sunshine in winter, and by wind and shading in summer.

As you can see, a compact, small-windowed, heavily insulated, unshaded, brick New England colonial is not appropriate to the Gulf Coast.

Today, the architect is not trying to design yachts—even more energy-efficient-yachts—but is trying instead to design sailboats that can be powered and driven by the forces of the natural environment.

Answers: 1. Charleston, S.C.; 2. southern California; 3. the Northeast; 4. the Southwest; 5. northeastern and mid-Atlantic States.

Sunshine and Windows

Solar radiation is the most abundant form of energy available. The total solar energy flux received by the Earth's surface exceeds by a factor of about 5,000 our present, even our foreseeable needs. Unfortunately, solar radiation is also intermittent, and subject to seasonal and geographic variations, as well as to weather conditions such as cloud cover.

Buildings should be designed and sited to take maximum advantage of sunshine. In the United States, the noonday Sun is 45 degrees lower in the sky in midwinter than in midsummer, thus winter sunlight penetrates much deeper into a room or office, while summer sunlight is relatively easy to cut off with roof overhangs, awnings, or other overhead barriers. Also, there is almost a 60-degree difference in the direction of both the rising and setting Sun between summer and winter, adding 120 degrees of arc to the Sun's summer travel. In summer, the Sun rises roughly in the northeast, travels through south, and sets in the northwest. In winter, it rises in the southeast quadrant and sets in the southwest. As a result, the only windows that let in much sunshine in winter are those that face south. In summer, however, the late afternoon sun strikes a west window more squarely than the noonday Sun hits a south window—and at a time when temperatures are the day's highest.

Strictly from an energy conservation viewpoint, the only good window is a south window, and the colder the winters, the more window areas (multiple-layered) should be concentrated on the south side of the building. Conversely, the hotter the summers, the smaller the west windows should be.

Electric Power from Tidal Energy

By Robert L. Civiak
Environmental Science Information Center

The 18-ft tidal range in Eastport (Me.) harbor.

Photos: U.S. Army Corps of Engineers

Realization that the Earth's supply of fossil fuels and other expendable energy sources is limited has focused attention on renewable energy sources. Among these is the energy obtainable from ocean tides.

At several places, tidal oscillations are responsible for sea-level variations of from 15 to 50 ft in just over 12 hours. A dam built across the mouth of a suitable bay would make it possible to control the height of the water level within the bay and to use the twice-daily tidal filling and emptying to generate electricity.

Globally, approximately 3 x 10^6 megawatts (MW) of power are continuously dissipated through the motion of the tides. Because of physical limitations, only 2 percent of the total may ever be harnessed. This amounts to about 5 percent of the present worldwide electric power generation from all sources.

Harnessing tidal power is not a new idea. The tides were used to operate mills as far back as the 11th century. There have been numerous small-scale local uses of tidal energy ever since.

Plans for a large-scale electrical powerplant were proposed as early as 1919, using the Passamaquoddy and Cobscook basins of the larger Bay of Fundy. Located between Maine and New Brunswick, this bay has the world's largest tidal range. The area has been studied frequently since 1919 as a site for a tidal powerplant. In 1935 the U.S. Army Corps of Engineers spent $7 million toward construction of a dam and a powerplant in the region, but dropped the project the following year. Rising energy costs have prompted new studies at a rate of about one every 5 years since then. There is still considerable interest today (Wayne 1977), but no new development projects have been undertaken at the site.

Work began on the world's first commercial tidal powerplant, on the Rance Estuary near St. Malo, France, in 1959. Power was produced in 1966. The plant has a modest peak power of 240 MW. The only other operating tidal powerplant of which much is known is a small (400 KW) experimental plant on the Kislaya Inlet in the Soviet Union.

Much has been learned from the operation of these two plants, prompting governments and private groups to study the possibilities of harnessing tidal power in many other locations worldwide.

President Roosevelt is briefed on a Passamaquoddy Bay tidal powerplant model. Campobello Island, his summer retreat, is included in the model.
U.S. Army Corps of Engineers

Since 1958, the Peoples Republic of China has built dozens of small (100 KW or less) tidal powerplants (Wayne 1977). Little is known outside China about these plants.

The simplest type of tidal powerplant involves a single basin. Water is allowed to enter a bay through open sluices, which are closed off at high tide. After the tide has receded, the water is released through turbines, generating electricity. This method generates all the available power during only a small part of the tidal cycle. Furthermore, the timing is dictated largely by the tidal cycle and does not coincide with daily variations in demand for power. This makes integration into a practical power system difficult.

The situation can be improved somewhat if electric power generation occurs both while the basin is filling and emptying. However, there is still no power available during those substantial periods when the water level difference between the basin and the ocean is too small. The time of occurrence of these periods can be controlled somewhat if the turbines are designed so that they also can be operated as pumps. Using energy from other sources to pump water up through small level changes can result in a net gain in energy, if that water is later used to generate power when the level difference between the basin and the ocean is large. This is the system in use at the Rance powerplant; however, the design and construction of turbines that can generate and pump in both directions is costly.

Further improvements in the time of power production and in the net power produced can be realized by using more than one basin, as well as by introducing multiple sluices and turbines. Many designs and operating cycles are possible, depending on the topography of the site chosen. Each design has unique qualities that must be evaluated if a cost/benefit analysis is to be performed.

Though generally less severe than those associated with fossil fuel or nuclear power generation, environmental effects of tidal power development projects also must be considered. One fundamental concern is the effect of a dam on the very tides it is built to harness. In some bays, large tides are partly a resonance phenomenon dependent upon the length and depth of the bay and the period of tidal variations. The large-scale topography of the region also has a significant effect on the size of the tidal range. Considerable study involving mathematical modeling of tides has been directed to predicting the effects of structures on tides.

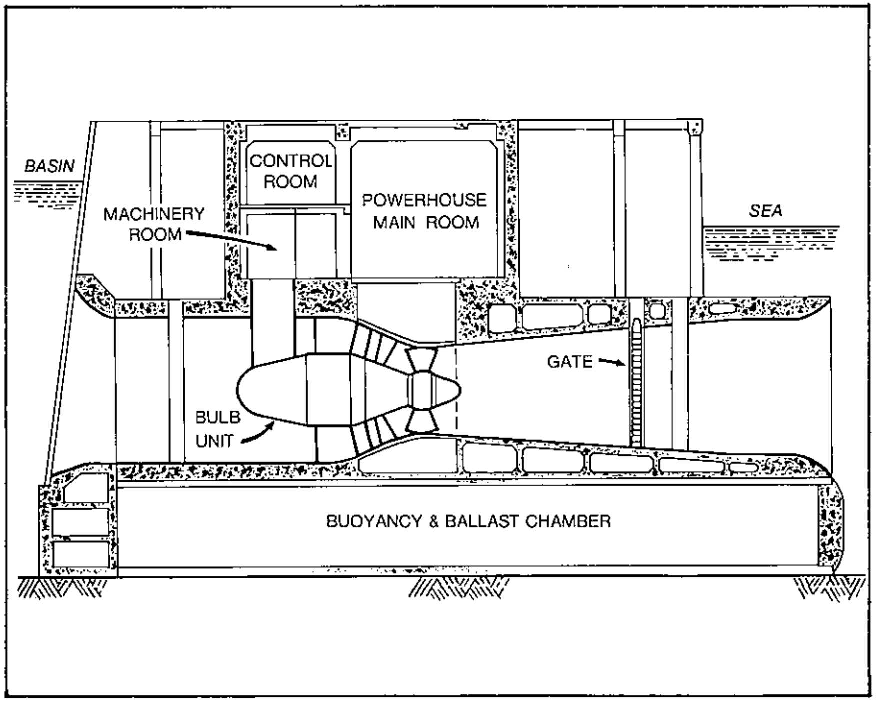
Another environmental concern is the impact of changes in the shore boundary and of reduced tidal variations that result from controlling the tides. These could have substantial short-term effects on marine species and human construction in the coastal zone. Sediment transport in the basin also would be affected by the reduced tidal currents. This could have a positive or negative effect on shipping channels and harbors, depending upon the characteristics of the particular site.

It is believed that most fish species would be able to migrate through the sluices and relatively slow-moving turbines of a tidal powerplant. However, there might be a migration problem for some species in some locations. The dam would be somewhat of an impediment to navigation, as ships would have to pass through locks, but the areas considered as tidal plant sites do not have enough traffic at present for this to be a major problem. Other environmental effects that need to be considered are: reduced vertical mixing within the basin; changed current patterns—which could lead to changes in coastal erosion processes; reduced salinity; and increased concentration of pollutants already present, owing to reduced mixing of the waters of the estuary with the open ocean.

In spite of the success of the Rance power project, in operation for more than 10 years, development of tidal power has been slow. One of the difficulties is that very large initial capital costs and expected long operating lifetimes of tidal powerplants make cost comparisons with other power sources difficult and strongly dependent upon assumed interest rates.

A recently completed tidal power study for the U.S. Department of Energy (Wayne, 1977) focuses on development at sites in Passamaquoddy Bay in Maine and in Cook Inlet, Alaska. The report's conventional cost/benefit analysis indicates that tidal power is still too expensive compared to other energy sources. However, an accompanying life-cycle cost analysis covering a 50-year period and including reasonably expected increases in fuel costs indicates that development of tidal power at Passamaquoddy is "an extremely attractive prospect" and should proceed. The report concludes that life-cycle cost analysis is the proper method by which to evaluate a long-term project, such as a tidal powerplant.

No tidal powerplants are now under construction anywhere in the world. Serious consideration, however, is being given to a host of sites, and construction is scheduled to begin soon on at least one.



A typical modular unit powerplant (Wayne 1977). A major tidal power facility would require a large number of such units.

The pending tidal power project furthest along involves Inchon Bay in South Korea. Construction is to begin there soon on a 400 MW plant, which is scheduled for completion in 1985. In addition, the Canadian government is studying several sites in the Bay of Fundy and the Hudson Bay region, and the Soviet Union is considering development of at least two sites, including a plan for a massive 20,000-MW tidal powerplant in Penzhina Bay on the Sea of Okhotsk, north of Japan. There also is strong pressure in Britian for tidal power development of the Severn Estuary. Other sites are being considered in France, Australia, Argentina, and India.

This is the second of a series of Current Issue Outlines developed by the Library and Information Services Division of EDIS' Environmental Science Information Center. The outlines provide objective background material on current topics of high general interest. This issue outline is available as a separate publication from: User Services Branch, LISD, Environmental Science Information Center, WSC#4, 6009 Executive Boulevard, Rockville, MD. 20852. The original report contains an extensive bibliography that has been omitted here.

Reference

Wayne, W.W., Jr., 1977. Tidal power study for the U.S. Energy Research and Development Administration *Final Report,* Stone and Webster Engineering Corp., Boston, Mass., 2v. Available from NTIS as DGE/2293-3 (Vol. 1 & 2).

Weather and Mortality

By William Hodge National Climatic Center

Should we be more concerned about the weather? Statistically, our chances of encountering a tornado or hurricane are small. Our houses and offices shelter us from the elements, and furnaces and air conditioners control the environment around us. Seemingly, we can ignore the weather.

Or can we?

As the changing air masses move by overhead, are there influences that reach us, even through our protective walls? Our bodies instinctively make adjustments to changing conditions. Healthy people seem to have no trouble adapting to the ordinary changes. For the weak or sick, however, it can be a different story.

Temperature is obviously a critical factor for humans, since the body must maintain an almost unchanging core temperature. In this, the body seems to have been engineered for a semitropic climate, where a balance can be readily maintained. The body mechanisms for maintaining a stable inner temperature cannot work continually against large temperature differences.

In past centuries, as people moved into harsher and colder climates, clothing was improved to provide the insulating protective layer of air so necessary in maintaining a stable temperature next to the body. Further protection was provided by buildings, which today are heated or cooled by the expenditure of large amounts of energy.

Normal, healthy people maintain rather stable deep-body temperatures from infancy to old age. The efficiency of the thermoregulatory system is more remarkable in view of the weight and size increase—some twenty times—from birth to adulthood.

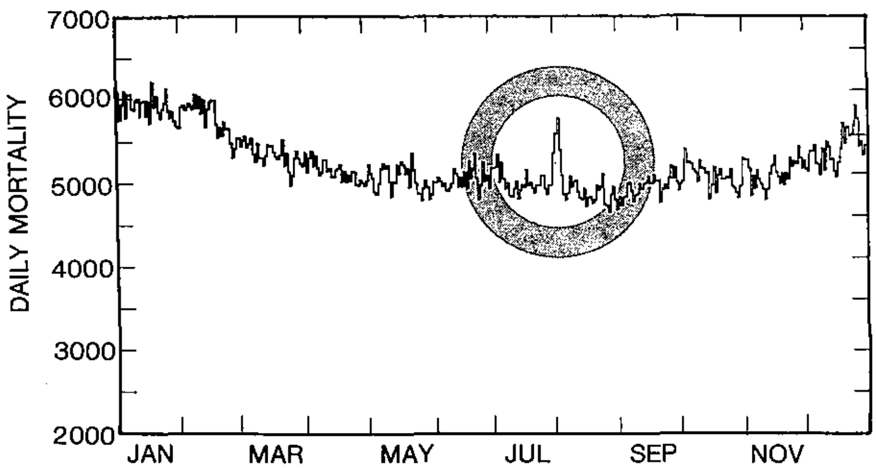


Figure 1. Daily deaths in the United States, 1975. The unusual upsurge in early August coincided with a heat wave in the Northeast.

The adjustments our bodies must make to their surroundings are delicate. We are familiar with the extreme cases of imbalance: high temperatures and radiation lead to heatstroke; prolonged chilling leads to freezing or frostbite. But what about less extreme cases?

Older people cannot adjust as readily to large temperature changes. One factor in the aging process is the failure of sweat glands. Sweating and the resulting cooling by evaporation is a vital protective mechanism of the body during heat stress. High temperatures, which present no problem to young and healthy people, may be deadly to an older person who cannot sweat.

In the normal person, blood vessels near the skin surface enlarge or constrict with temperature changes. Other organs respond in varying degree to pressure changes, radiation, and the inhalation of allergens or other air-carried substances.

One way to assess the impact of weather changes on humans is to examine patterns of mortality. Do more deaths occur as certain types of weather systems move by? If so, can we learn enough to lengthen the life-span of people who might otherwise die prematurely?

Just as some diseases are seasonal, there is an annual trend in mortality statistics. Figure 1 shows deaths in the United States for each day in 1975. From a peak in January, there is a decline to early summer. Then there are irregular variations until the year's low is reached in late summer. Mortality increases again toward the end of the year. The same general pattern occurs every year, though the features may shift a bit. Sometimes the peak is in February.

Some of the day-to-day changes are near-random. Disasters, motor vehicle deaths, and homicides all are included in the statistics. These, however, represent a relatively small part of the whole. Motor vehicles were involved in a daily average of 126 deaths; their day-to-day variation was small compared to the overall mortality.

A weekly cycle also occurs in the data, with the highest mortality occurring on Saturday.

Seasonal patterns of diseases are shown in figure 2, to compare with the annual mortality cycle. These 1973 data are on a relative scale, with 100 equaling the average of all months. Thus, the high index values of respiratory diseases, which include pneumonia and influenza, indicate a very great variation from winter to summer.

Infectious and circulatory system diseases show significant, but smaller seasonal patterns. The flat pattern for neoplasms shows that mortality from cancer occurs regularly throughout the year, with little month-to-month change.

Returning to figure 1, a singular event is obvious in the data for the first four days of August. From a level of 4,934 on July 31, mortality rose to 5,733 on August 3. The excess deaths for the 4-day period appear to be in the 1,500 to 2,000 range. The most obvious reason for the increased deaths is the heat wave that afflicted the Northeastern United States at the time. Much of the U.S. population is concentrated in the East and Northeast. Weather systems affecting those regions are thus reflected to a proportionally greater extent in national statistics.

An enlarged view of the "spike" on the mortality curve is shown in figure 3. Maximum daily temperatures for Philadelphia are superimposed. A high-pressure regime settled over the East from the Great Lakes to the Atlantic during the period. For several consecutive days, the midsummer Sun raised temperatures higher each day. Winds were too light to offer relief or bring in cooler air until the system finally drifted away.

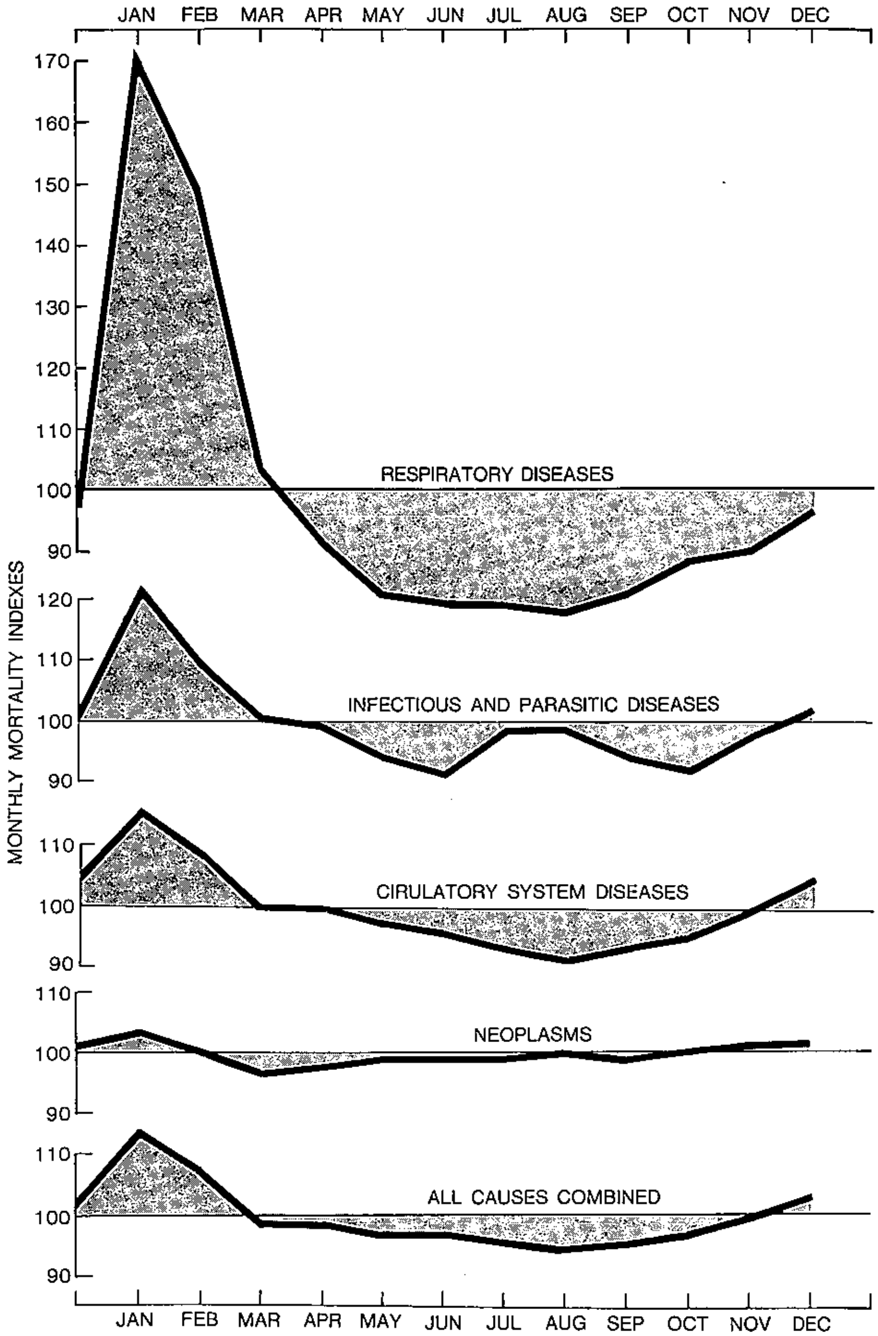


Figure 2. Seasonal patterns of disease-related deaths, 1973.

Strangely, this catastrophe of some 1,500 deaths has been taken largely as a matter-of-course. Were these deaths necessary? What were the circumstances?

Research shows that the elderly

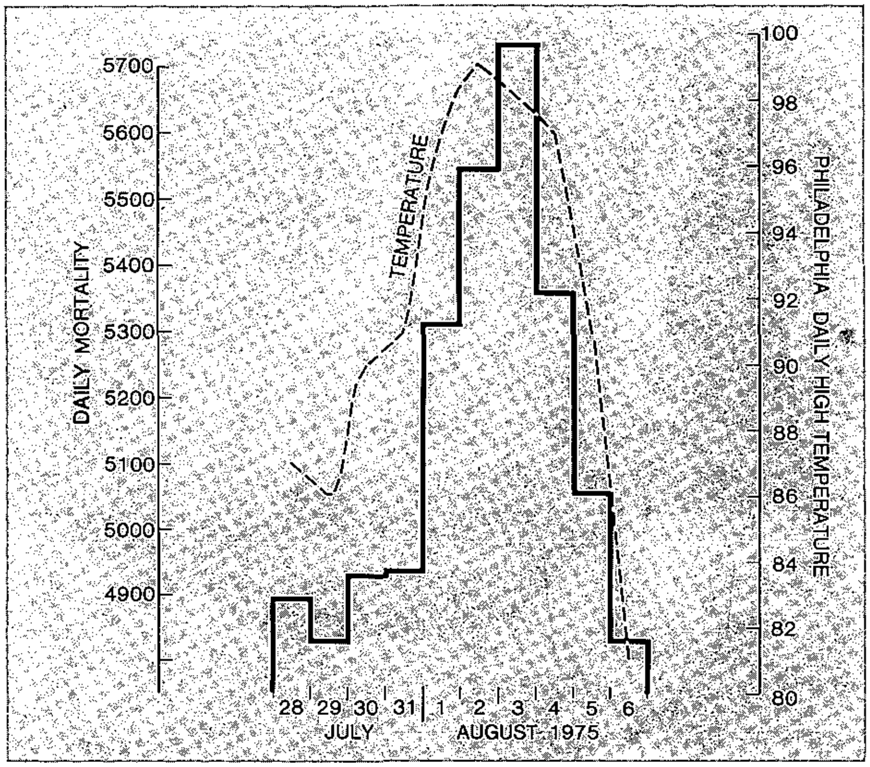


Figure 3. Closeup of the "spike" circled in figure 1, with maximum daily temperatures for Philadelphia superimposed.

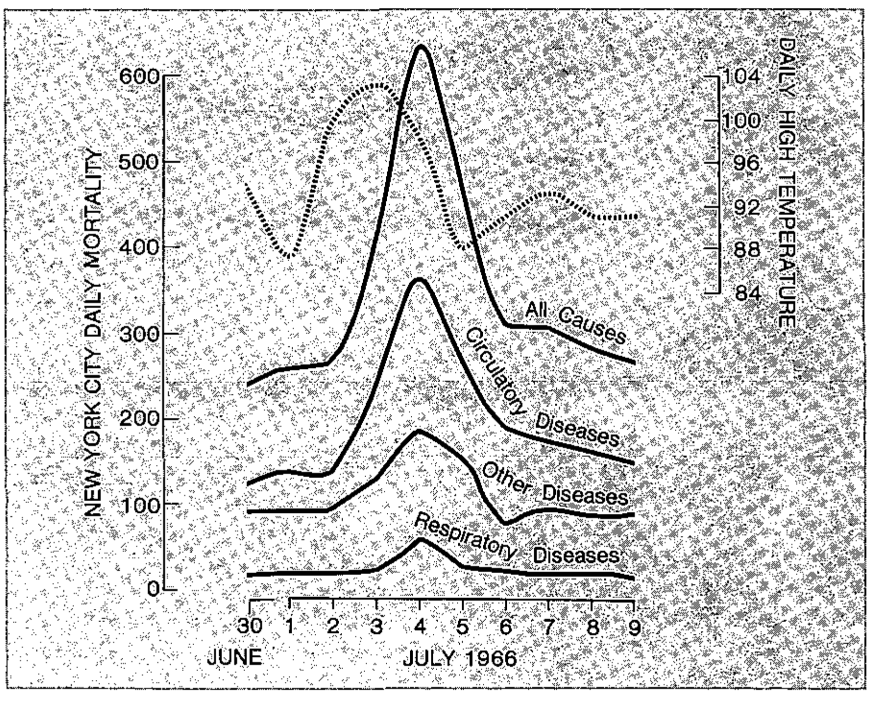


Figure 4. Mortality and temperature curves during a New York City heat wave.

and infants are the most susceptible to cold and heat stress. One theory of such catastrophies states that, in a polulation as large as that of the United States, there is always a group of seriously ill people. Heat waves, it is surmised, hasten terminal cases. Other victims, however, might survive for appreciable periods except for such weather extremes.

The 1975 event was not an isolated one. Figure 4 is drawn from data obtained from Lawrence Truppi, a NOAA meteorologist working with the Environmental Protection Agency's National EnvironmentalResearchCenter. It shows that during a New York City heat wave in 1966, deaths attributed to a variety of causes rose markedly.

Statistics from individual cities and states must be examined to learn more about these incidents. National figures are too all-inclusive. The mix of weather events occurring across the country at any one time tends to cancel out some statistics. Work is continuing toward more localized analyses.

The implications of research into climate and weather stress are great. Dr. F.P. Ellis of the London School of Hygiene and Tropical Medicine has studied mortality during New York City heat waves over a number of years. He concludes that many of us are not as well acclimatized to summer heat as were our ancestors. Buildings are no longer constructed for cross-ventilation through large doors and windows. (See article beginning on p.4.) Much of our reliance is on air conditioning; should it fail due to power generating or energy problems, a serious emergency could result.

The cases presented above concern heat stress. Cold waves have their own patterns of mortality. Some symptoms of illness have been linked to other weather events. We need to increase our knowledge in each of these areas.

Tuskegee Institute.

George Washington Carver, Weather Observer

By Patrick Hughes

Almost every day for more than 32 years, George Washington Carver recorded weather observations as an unpaid, volunteer weather observer. Unlike thousands of other citizen observers before and since, however, Carver seems to have been relatively uninterested in weather itself. Where the remarks of other observers dwell on the power and beauty of the elements, his deal almost exclusively with their effects on agriculture, the central concern of his amazing career.

Carver took daily observations from November 1899 through January 1932, except for June and July, 1900—when Isaiah T. Hardeman signed as observer and apparently recorded the observations—and possibly during February 1917, for which there is no record.

Although he occasionally commented on severe weather during the early years, most of Carver's comments concern the impact of Sun, rain, drought, and storm on the farm and garden of Tuskegee Institute. His very first entry (November 1899) in the remarks column is: "Light frost on the third and fourth both killed tender vegetation."

In March 1902, Carver did report that

> "on the night of 15 the wind was very heavy. Blew the iron flagpole down and completely dismantled it. No flags can be displayed until another is put up."

Earlier, on May 28, 1900, he also recorded a total eclipse of the Sun. He did not, however, comment on a local earthquake that occurred on October 18, 1916.

For most of the rest of his 32+ years of record, Carver's remarks deal almost exclusively with the health and progress of the crops to which he devoted his life. The only significant variation in the records through all those years occur in his handwriting and signature, which exhibit considerable diversity.

George Washington Carver was one of several thousand citizen weather observers scattered throughout the country. At the end of each month, they sent their observations to the climate and crop service of the Weather Bureau, then part of the U.S. Department of Agriculture. Collectively, these records document and define the climate of the United States. Some 12,000 unpaid observers continue this work today.

The records of all these cooperative weather observers are collected in the Environmental Data and Information Service's National Climatic Center in Asheville, N.C. George Washington Carver's records recently were microfilmed and the originals sent to the rare book room of EDIS' central library facility in Rockville, Md. (just outside Washington, D.C.), where they are available to qualified researchers.

Great Lakes Coastal Information Center

A regional coastal information center was established in June 1978, in Ann Arbor, Mich., at the offices of the Great Lakes Basin Commission and the Michigan Sea Grant Program.

Funds for the center, in the form of a $50,000 grant, come jointly from three agencies of NOAA: the Office of Sea Grant, Office of Coastal Zone Management, and the Environmental Data and Information Service. An additional $25,000 has been pledged by the University of Michigan.

Similar Centers are operating in the Pacific Northwest and the Northeast. (See *EDS*, January 1978.) Six more regional centers are planned.

The centers provide state and local agency personnel, coastal planners, legislators, environmentalists, and the general public with information and guidance on coastal area subjects, including laws and zoning regulations, scientific data, and sources of publications.

Nancy Huang of the Great Lakes coastal information center.

A unique aspect of the Great Lakes center will be the regular exchange of information with Canadian federal and provincial governments. Canadian representatives participate in Great Lakes programs and activities, and the Canadian government is officially represented on the Great Lakes Basin Commission.

To contact the Great Lakes Center, call (313) 668-2300 or write Box 999, Ann Arbor, MI 48106.

CEDDA + CCEA = CEAS

The Environmental Data and Information Service has combined the Center for Experiment Design and Data Analysis (CEDDA) and the Center for Climatic and Environmental Assessment (CCEA) into a single new Center for Environmental Assessment Services (CEAS).

CEAS will provide assistance to managers of critical national resources by assessing the impacts of climatic variations on food, transportation, and energy resources, and of offshore energy developments on marine environments and resources.

CEDDA was formed in 1971 to reduce, process, and validate data from large international field experiments. Its scientists and system analysts subsequently participated in BOMEX, the Barbados Oceanographic and Meteorological Experiment; IFYGL, the International Field Year for the Great Lakes; and GATE, the GARP (Global Atmospheric Research Program) Atlantic Tropical Experiment.

CEDDA also has been providing data management, interpretation, analysis, and products for projects dealing with air-sea interactions, boundary layer processes, the monitoring and prediction of pollutant transport and fate in the oceans, and the synthesis of atmospheric/oceanic baseline and engineering data. Current activities include the design and implementation of a prototype baseline monitoring program for assessing the ecological impacts of proposed brine discharge in the Gulf of Mexico as part of the National Strategic Petroleum Reserve Program.

CCEA was established to assess the impact of climate variability on social and economic systems. It has made significant strides in accomplishing this mission, particularly in providing preharvest wheat-yield estimates for the United States, Canada, Australia, India, Brazil, and the U.S.S.R. to the Large Area Crop Inventory Experiment (LACIE), a joint investigation by the U.S. Dept. of Agriculture, the Dept. of Commerce, and the National Aeronautics and Space Administration.

In addition, CCEA has been publishing weekly global weather/crop assessment reports, while special weekly assessments of the effects of weather on local crops have been provided to the U.S. Department of State AID Program for parts of Africa and the Caribbean. Projections of natural gas demand for multi-State regions of the conterminous United States on a monthly and seasonal basis also have been made.

The consolidation of CCEA and CEDDA into a single center gives organizational recognition to the considerable collaboration and sharing of functions that has already occurred. The merger will allow optimum integration of the interdisciplinary expertise and experience developed in each Center.

Coastal Information Workshop

On June 22-23, 1978, the University of Rhode Island's Center for Ocean Management Studies held a Workshop on Information Systems for Coastal Zone Management. Under EDIS sponsorship, the meeting convened at the University's W. Alton Jones Campus in West Greenwich, with about 30 invited experts participating.

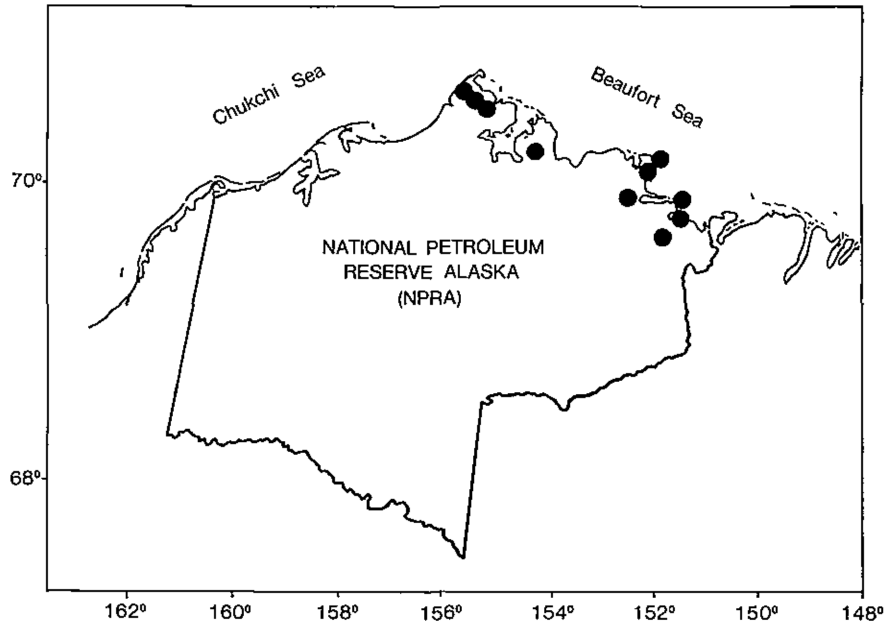
The workshop was held to discuss the present and future roles of coastal zone information systems in coastal resources management. EDIS was primarily interested in the experts' advice on the design of the Regional Coastal Information Center network. (See January 1978 issue of *EDS*.) These NOAA-sponsored centers make available interdisciplinary coastal information to regional users, local planners, State agencies and legislators, environmentalists, and private citizens. Three centers are operating and six more are planned.

Workshop participants were asked to:

1. Determine what effects, if any, coastal zone information systems have in management decisions and policy making. Also, to what extent do (or should) information systems promote interagency/interdisciplinary cooperation?
2. Suggest how information systems might be designed (or how existing systems could be modified) to help States meet their goals for coastal zone management, legally, technically, and economically.
3. Look more closely at perceived data needs and procedures for determining what those needs are. Consider ways to acquire data, and the amounts and quality of data that would maximize the effectiveness of particular systems.
4. Discuss the role of computers in coastal zone information systems—in theory and reality.

The workshop also provided the basis for continued monitoring of information systems as they relate to and support coastal zone management programs. It emphasized a continued exchange between system developers, information/data contributors, and users.

Alaska National Petroleum Reserve Data



Location of wells on the Alaskan North Slope.

The EDIS National Geophysical and Solar-Terrestrial Data Center (NGSDC) has accepted responsibility for disseminating data collected in the National Petroleum Reserve Alaska (NPRA). The data were collected by the U.S. Navy, and have been made available to NGSDC for distribution by the U.S. Geological Survey, which took over management of the Reserve in June 1977.

Between 1955 and 1977, the Navy Department drilled a series of wells to explore the promising energy potential of an area on the Alaskan North Slope near Barrow. Presently, data from 17 of the 26 wells to be drilled by 1980 are available from NGSDC. The data consist of well log measurements of a variety of parameters. Additional data, including gravity and seismic measurements, will be available from NGSDC in the near future. Requests for information concerning these data should be addressed to: National Geophysical and Solar-Terrestrial Data Center, Code D621, NOAA/EDIS, Boulder, CO 80303.

Moisture-Drought Indices Workshop

EDIS hosted a Moisture-Drought Indices Workshop in Washington, D.C., June 28-29, 1978. The Workshop was chaired by Norton D. Strommen, Chief, Climatic Impact Assessment Division of EDIS' Center for Environmental Assessment Services. Strommen outlined the primary objectives of the meeting: to review the adequacy of current soil moisture-drought indices to meet users needs. and to make recommendations on areas that need additional work.

All segments of the agricultural community were represented at the meeting. Presentations on their soil moisture and drought index models (covering the methods in current use) were made by: Wayne Palmer (NOAA, retired), the Palmer Drought Index (PDI) and the Crop Moisture Index (CMI); Dr. Wolfgang Baier (Agriculture Canada), Versatile Soil Moisture Budget (VSMB), developed in collaboration with Dr. George Robertson; Dr. Robert Shaw (Professor of Agronomy, Iowa State University), soil moisture model for use in the deep soils of Iowa; Dr. Robert Dale (Professor of Agricultural Climatology, Purdue University), modification of the Iowa work for application to the perched water table condition in Indiana; Dr. Edward Kanemasu (Professor of Agronomy, Kansas State University), soil moisture measurement using satellite data; Malcolm Reid (EDIS), cumulative precipitation program to identify global moisture-deficient regions.

The conclusions and recommendations reached by participants of the Workshop were:

1. The PDI and CMI should continue to be published for the purpose of maintaining continuity.
2. No single index can meet the needs of all users.
3. Efforts need to be made to improve the reliability of the flow of daily precipitation data through the World Meteorological Communication System.
4. Efforts should continue to develop more use of satellite systems in estimating solar radiation and precipitation amounts around the Globe.
5. The use of modern communication technology should be pursued for the distribution of the contents of the *Weekly Weather and Crop Bulletin* and other assessment information.

OCSEAP Data Catalog

The *NODC Catalog of OCSEAP Data, Part 1—Distribution of Digital Data Received for the Alaska Outer Continental Shelf Environmental Assessment Program* was updated recently by EDIS' National Oceanographic Data Center. Part 2 of the catalog, *Inventory of Digital Data by Lease Area for the Alaska Outer Continental Shelf Environmental Assessment Program* is a new publication.

Both parts describe 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. EDIS is responsible for developing the OCSEAP data base.

Part 1 of the catalog consists of a series of computer plots showing the types of data and their locations for all OCSEAP data held by EDIS. Part 2 provides information on principal investigators, survey dates, platforms, and the number of stations or observations within designed limits surrounding each lease area. This information is sorted by data types similar to those presented in the plots of Part 1.

For copies of the catalog write to: National Oceanographic Data Center, Oceanographic Services Division, 2001 Wisconsin Ave. NW, Washington, DC 20235. Telephone: (202) 634-7500.

Marine Geological Data Workshop

Within the past several years, a large number of major marine programs and studies have been initiated, resulting in a virtual explosion of marine geological data collections. Programs such as the International Decade for Ocean Exploration (IDOE), a number of Marine Ecosystem Analysis (MESA) programs, and various Outer-Continental Shelf (OCS) studies are gathering large volumes of increasingly complex and variable data.

The EDIS National Geophysical and Solar-Terrestrial Data Center (NGSDC), through its role as a national center or through agreements with several funding organizations, is now involved in the proper management of these data. Because of the importance of securing the data and the requirements to make the data available in usable form to others, most Federal and academic organizations also have designated one or more data specialists to act as data managers.

Recognizing the need to establish a dialog with the designated individuals, NGSDC proposed to the National Science Foundation that a workshop be held to bring them together to discuss the impact of the quantum increase in geological data collection.

There were 34 participants from 27 Federal and academic organizations (including industrial representation) at the data workshop held in Boulder, Colo., May 22-24. The gathering brought together a broad representation of expertise in all phases of data management.

Three New Marine Geophysical Data Sets

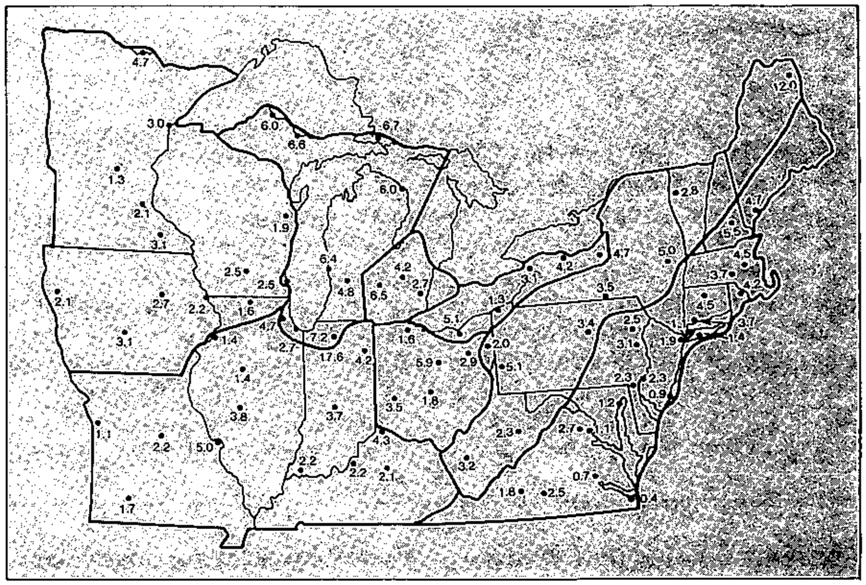
EDIS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) recently received three major data sets from the U.S. Naval Oceanographic Office (NAVOCEANO). The first set consists of over 350 microfilm rolls of marine geophysical data gathered under contract to NAVOCEANO by Texas Instruments, Inc., and Alpine Geophysical Associates, Inc., during the 1960's in the Marine Geophysical Surveys (MGS) Program. The original records have been destroyed, and this set of microfilm is the only complete collection of these data known to exist.

The second data set consists of the original paper analog records of high-energy seismic profiling information gathered by ships such as the *USNS Kane, Bent* and *Wilkes* operating under the technical guidance of NAVOCEANO from 1968 through 1977. Microfilm copies of these records will be made available to the public for the first time in the fall of 1978.

The third set of data consists of twenty magnetic tapes of digital underway geophysical information consisting of navigation, bathymetric and magnetic data from approximately 100 oceanographic cruises (more than 200 port-to-port operations).

For further information concerning these data write to: National Geophysical and Solar-Terrestrial Data Center, Code D621, NOAA/EDIS, Boulder, CO 80303.

Snowload Workshop



Maximum water equivalent (in) of snowfall during the winter of 1977/1978. Preliminary models developed by EDIS based on snow-depth and precipitation observations generally estimated these values quite well.

A Design Value Snowload Estimation Workshop was held July 6-7, 1978, at the Climatic Impact Assessment Division (CIAD) of EDIS' Center for Environmental Assessment Services (CEAS) in Columbia, Mo. Extreme snowloads the past two winters have focused attention on snowload estimation and design problems.

Those participating in the workshop included representatives of: CIAD/CEAS, EDIS' National Climatic Center (NCC), the University of Missouri-Columbia, the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), the National Bureau of Standards, and the Nuclear Regulatory Commission.

The workshop had two objectives: 1) to review procedures for estimating snowloads from related meterorological data; and 2) to discuss statistical analysis of the results of estimation efforts. Previous standards for estimating snowloads were based on only 10 years of meteorological data. It is now possible to base standards on 1950-78 data.

CIAD representatives presented results of joint CIAD/NCC snowload modeling efforts undertaken in a project for the Nuclear Regulatory Commission. CRREL participants presented results of their snowload modeling efforts, both on the ground and on roofs.

Areas of possible joint effort on snowload estimations were explored. It was agreed that the determination of extreme snowload statistics from basic meteorological data and the conversion of ground loads to roof loads require a coordinated effort involving multidisciplinary research.

Discussions were held on common experiences in data management policies, data formats, user requirements, the roles of regional and national data centers, and related topics. In addition, a committee was established to explore the feasibility of constructing a standard exchange format for all marine geological data.

Climatic Summaries for 1,063 U.S. Sites

The National Climatic Center (NCC) recently published *Climatography of the U.S. No. 20,* which includes climatic summaries for 1,063 substations in all States and Puerto Rico. Substations provide abridged weather reports, which are supplementary to the more complete observations provided by the basic network of National Weather Service stations.

The four-page data summary for each location contains a Means and Extremes Table; sequential tables for monthly and annual mean maximum, mean minimum, and average temperature, as well as total precipitation and total snowfall; monthly normals (1941-70) of temperature, precipitation, and heating and cooling degree days; and probability statistics for monthly precipitation, spring and fall freeze dates, and freeze-free periods for five temperature thresholds.

The summaries were prepared for stations with a complete record for 1951-70 and are based upon the period 1951 through the latest complete year of record available at the time of preparation. Additional information concerning this series can be obtained from the Information Services Division, National Climatic Center, Asheville, NC 28801. Telephone: (704) 258-2850, Ext. 683 or FTS 672-0683.

Weather Observations Summary, Alaska Coastal Marine Area

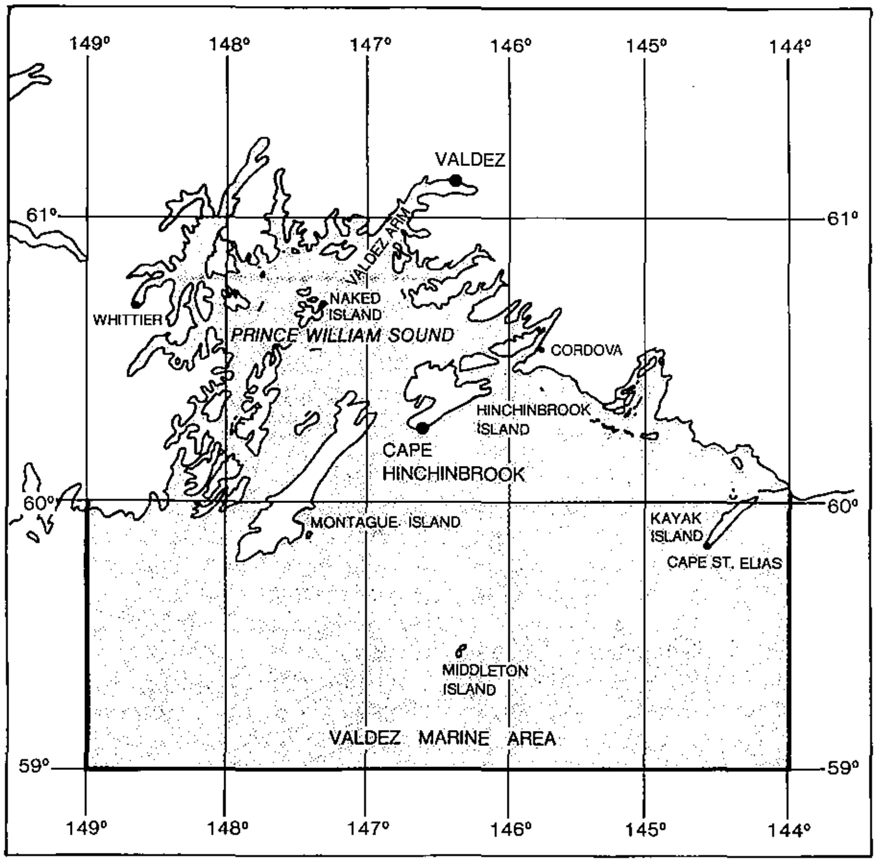
The EDIS National Climatic Center (NCC) recently published *Summary of Synoptic Meteorological Observations (SSMO), Alaska Coastal Marine Area.* It contains monthly and annual statistical tables of descriptive climatology for the coastal marine area, 59°N to the Alaska coast and 144° to 149°W, and for two coastal stations, Valdez and Cape Hinchinbrook.

The SSMO was prepared for and supported by two programs, the Bureau of Land Management's Outer Continental Shelf Environmental Assessment Program (OCSEAP) and the Marine Pilot Program of EDIS' National Oceanographic Data Center.

The publication serves as an environmental aid to petroleum development on the Alaskan outer continental shelf and to merchant ships traversing the coastal waters enroute to and from Valdez port, the oil terminal for the pipeline from Alaska's north slope.

The SSMO tables are based on hourly weather observations taken at Valdez and Cape Hinchinbrook over the 10-year period 1967-1977 and 1964-1974, respectively, and on observations taken aboard vessels of varying registry within the marine area over the period 1929-77. Statistics detail means, extremes, and percent frequency of occurrences for: wind, visibility, present weather, sea-level pressure, air and sea temperatures, clouds, and waves.

Copies of the 158-page publication are available from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161. A limited number of copies are available for $4.00 per copy at NCC, Federal Building, Asheville, NC 28801.



Area covered by weather summaries.

Current Issue Bibliographies

The Library and Information Services Division (LISD) of EDIS' Environmental Science Information Center recently published five new packaged online searches of high-interest topics. The new titles are *Ozone,* 78-1; *Marine Mining,* 78-2; *Tsunamis,* 78-4; and *Oceanic Bibliographies,* 78-5. Packaged search 78-3, *Weather Modification,* is an updated version of an earlier search.

Oceanic Bibliographies is a new departure for LISD. Rather than providing references on a single topic, this search lists all bibliographies cited in *Oceanic Abstracts* from 1964 to the present. It is indexed in depth, and bibliographies on specific subjects can be readily identified.

Earlier topics available include *The Coastal Zone, Marine Corrosion,* and *Oil Spills—Cleaning Up.* Custom packaged searches to meet individual requirements also are executed in response to user requests. For further information, write: LISD, D822, NOAA, WSC #4, 6009 Executive Boulevard, Rockville, MD 20852 or call (301) 443-8330.

International Report

A Global Oceanographic Data Center

An intensive global atmospheric and oceanographic experiment is scheduled for the period December 1, 1978 to December 1, 1979. This Global Weather Experiment (GWE) is part of the Global Atmospheric Research Program (GARP), a joint effort by the International Council of Scientific Unions (ICSU) and the World Meteorological Organization (WMO).

GARP has two major objectives that may be summarized briefly as: (1) extending the range, scope, and accuracy of weather forecasts, and (2) understanding the physical basis of climate and climate fluctuations.

The Intergovernmental Oceanographic Commission (IOC) of UNESCO recognized the Global Weather Experiment period as a unique time and opportunity to increase oceanographic research observations, so that combined oceanographic-atmospheric data would be available for current and future research. More than 120 nations are contributing to GWE; this concentrated observational effort is not likely to recur within the next 5 to 10 years, if ever. Therefore, it is extremely important that as much as possible of the high-quality data collected during the experiment be assembled, merged, and validated for future use.

The Global Weather Experiment Project Office has made provision to collect, quality control, and archive data collected on a real-time or near-real-time basis. However, the complex nature of and methods required to obtain subsurface oceanographic data inhibit rapid collection, quality control, and dissemination. To provide management for these data, the United States offered to have EDIS establish a Responsible National Oceanographic Data Center (RNODC) with two goals: (1) to design and implement a global inventory of all data of any type concerning the marine environment collected during the period of the GWE, and (2) to construct a uniform global oceanographic data base for the period, using selected oceanographic parameters. The data set to be produced is necessary for research on the physical cause of climatic variations and for the development of numerical models of the coupled atmosphere/ocean general circulations.

A planning meeting on Data Management for Oceanography during the Global Weather Experiment, cosponsored by the IOC and the WMO, was hosted by EDIS in Washington, D.C., February 14-17, 1978. The purpose of the meeting was to obtain comments and recommendations from representatives of the oceanographic research community on EDIS' proposal to assemble, merge, and validate the global set of oceanographic data collected during the GWE and to create the global ocean data inventory.

The RNODC will be a joint effort of two EDIS Centers: the National Oceanographic Data Center and the new EDIS Center for Environmental Assessment Services. (See story on page 17.)

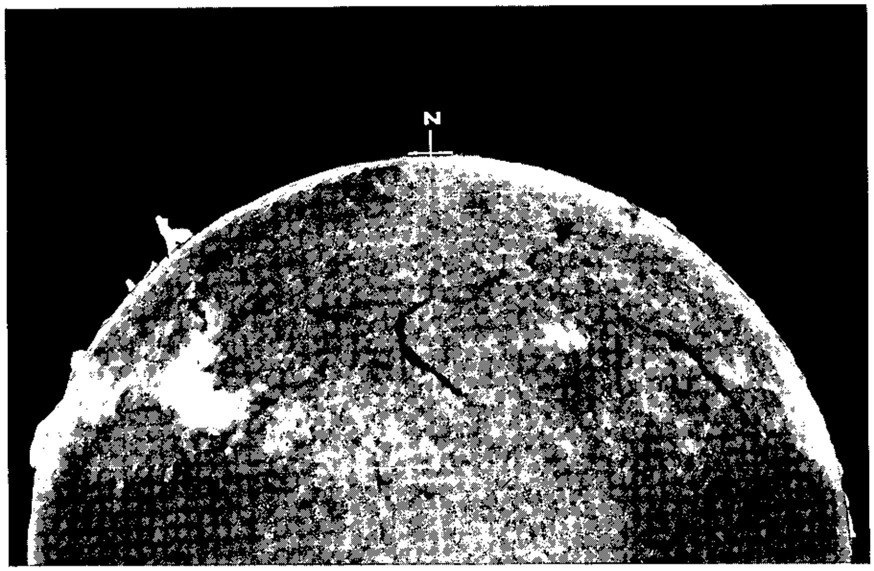
The unified global ocean data inventory will provide a directory to all marine observations of any type collected during the global experiment year. The inventory will contain information on type of data, instrumentation, investigator, project identification, geographic and temporal extent of the data, density of sampling, and residence of the data. Some information as to the degree of data reduction and processing and validation also will be available in the inventory records.

Any user with computer terminal access will be able to use the inventory at any time. Updated inventories will be published at 6-month intervals beginning in June 1979. These will be available to all users.

To establish the uniform global oceanographic data base, the RNODC will accept from participating nations all data collected during the year of the global experiment by specific type—including bathythermograph, Nansen/Niskin bottle casts, STD/CTD (salinity-temperature-depth/conductivity-temperature-depth) casts, current-meter data records, phosphate, silicate, oxygen, and sea-level data—and will create from these data a single global data base of uniform format and known quality for use by the oceanographic community, in particular, ocean modelers and climate researchers.

The resulting global data set will be deposited in the World Data Centers A and B for Oceanography for dissemination to interested scientists. WDC-A, Oceanography, is operated by NODC in Washington, D.C., and WDC-B, Oceanography, is in Moscow.

First Significant Solar Flares Since 1976



Solar flares of April 28, 1978.

Between April 24 and May 8, 1978, solar rotation carried a large and magnetically complex sunspot group across the solar disk—one that flared four times at intensities sufficient to affect significantly the Earth's dayside and polar ionospheres and the planet's magnetic field. Indeed, one of the largest flares ever observed (importance 3B) occurred at 1304 UT on April 28. This series of flares represented the first energetic outburst since the sunspot cycle passed through its minimum in June 1976.

Strong bursts of soft X-rays, of centimeter- and meter-wavelength radio waves, and of high-energy protons erupted from positions east of the central meridian of solar longitude. In addition, a clear and classic correspondence emerged between the four flares and partial blackouts of polar HF communication links, large variations in the magnitude and direction of the Earth's magnetic field, and vivid auroral displays.

These characteristics helped convince researchers in solar-terrestrial physics that the 2 weeks of significant activity should be declared a special period of study, that is, a "Retrospective World Interval." Consequently, scientists worldwide have been directed by the Monitoring of Sun-Earth Environment Steering Committee of the International Council of Scientific Unions' Special Committee on Solar-Terrestrial Physics to examine intensively the April 24 to May 10 period.

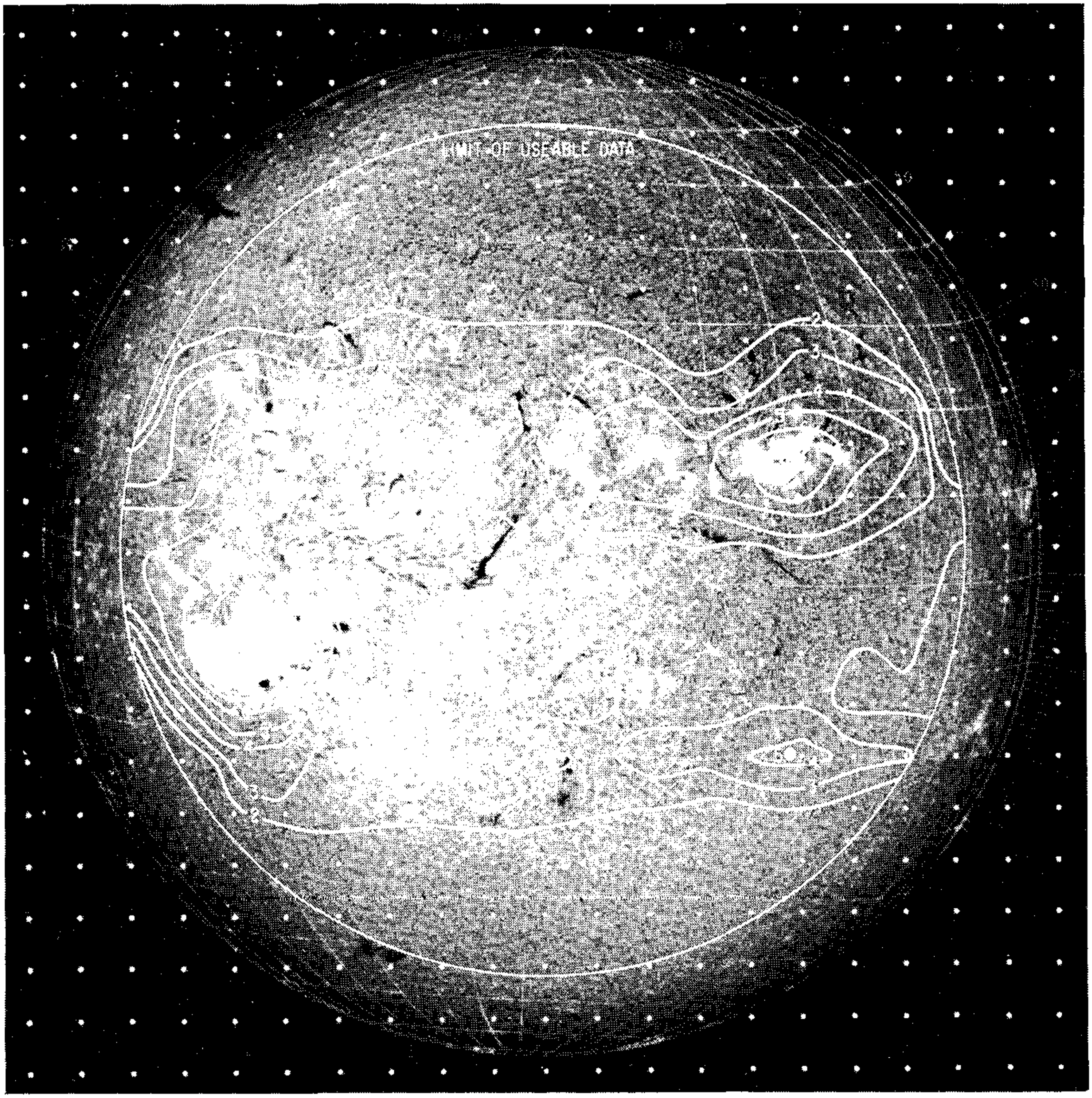
At the same time, the Steering Committee has encouraged each investigator team to submit upon request a brief summary of their observations to World Data Center A for Solar-Terrestrial Physics in Boulder, Colo., for publication in a UAG report. The completed document, when distributed to participants about 12 months after the fact, will serve as a case study as well as a catalog of available observations.

Similar data compilations have been prepared for the periods of high or unusual solar-geophysical activity that occurred in 1968, 1971, 1972, and 1976. For information regarding these earlier UAG reports or the planned volume on the April-May 1978 activity, contact World Data Center A for Solar-Terrestrial Physics, NOAA, D63, Boulder, CO 80303.

Synoptic Radio Maps of the Sun

World Data Center A for Solar-Terrestrial Physics (WDC-A for STP) Report UAG-66, *Synoptic Radio Maps of the Sun at 3.3 mm, 1970-1973,* by Earle B. Mayfield and Fred I. Shimabukuro of the Aerospace Corporation, El Segundo, Calif., was published in May. It is available through EDIS' National Geophysical and Solar-Terrestrial Data Center, NOAA, Boulder, CO 80303, for 75 cents. This report completes the series of 3.3 mm maps for the years 1967-73; the data for 1967-69 were published by WDC-A for STP as Report UAG-32 by Mayfield, White, and Shimabukuro in 1974.

The observations used to produce the maps were made with the Aerospace Corporation's millimeter radio telescope. Maps of the whole solar disk at 3.3-mm wavelength (90 GHz) were produced routinely on a near daily basis from 1967 through 1973. These daily maps have been converted into 27-day synoptic charts to study correlations of the enhanced millimeter emission from well-defined, stable features such



Radio temperature contours superimposed on concurrent solar photograph. Contours are labeled in percent enhancement relative to the temperature of undisturbed regions denoted by hatched contours.

as the photospheric magnetic fields, faculae, and centers of activity. The synoptic charts present contours of the solar radio emission at levels of 4, 6, 8%, etc. Enhancement above the quiet value is given, with the peak enhancement position indicated by a closed circle with its value.

If the 3.3 mm 4% contour levels are compared with the Zurich photoheliographic charts, a close correlation with the area of white light faculae is evident. Active regions based on the 4% enhancement level can last from less than a solar rotation to five or six rotations.

Space Data at NGSDC

The EDIS National Geophysical and Solar-Terrestrial Data Center (NGSDC) in Boulder, Colo., and its associated branches of World Data Center-A are actively involved in disseminating data from several of the Nation's satellite and space-probe systems. They share with WDC-A for Rockets and Satellites at NASA some of the responsibilities for servicing satellite data that pertain to solar-terrestrial physics disciplines. To a large extent, the Boulder facility accomplishes its task through publication of summary data. Currently, data from 23 experiments are being published on time lags ranging from 1 to 6 months. These data appear in the regular monthly publication, *Solar-Geophysical Data.*

Other satellite and space-probe observations are published by NGSDC in its special data compilations called *UAG Reports.* Several volumes in this series have been devoted entirely or largely to summary satellite data. *Report UAG-58,* for example, *ATS 6 Radio Beacon Electron Content Measurements at Boulder, July 1974-May 1975,* compiled by R. B. Fritz of NOAA's Space Environment Laboratory, presents hourly values of total electron content and plasmaspheric or residual electron content. Moreover, in those UAG volumes related to specific solar-geophysical events, authors frequently contribute observations from such vehicles as the polar-orbiting satellite METEOR and the Sun-orbiting space probes HELIOS 1 and 2.

Not all satellite and space-probe data received are published, and NGSDC relies on fliers and catalog mailings to announce the availability of additional data to potential users. At present, NGSDC holds data from 16 additional experiments. For these experiments, data acquisition by the center varies from 1 week to 2 years following observation.

The International Magnetospheric Study (IMS), which began on January 1, 1976, will continue in its observational phase through 1979. In response to inquiries by many IMS participants, WDC-A for Solar-Terrestrial Physics (STP) established a Central Information Exchange Office to collect and distribute information for coordinating experiments during this intense study period. The exchange office contacts more than 1,700 IMS participants and other interested persons in 57 countries via a newsletter that it publishes for the Special Committee on Solar-Terrestrial Physics of the International Council of Scientific Unions. This bulletin contains timely information about completed programs and future experiments.

WDC-A for STP also supports many IMS projects through its usual roles of archiving and distributing data from various worldwide networks of monitoring stations. In addition, and as rapidly as the required observations become available, the Data Center computes and distributes AE(s) indices—a ground-based, quantitative measure of auroral zone magnetic activity used collaterally with satellite observations.

CICAR Data Guide

As its final contribution to the Cooperative Investigations of the Caribbean and Adjacent Regions (CICAR), EDIS' National Oceanographic Data Center (NODC), recently published the *Guide to CICAR Data.*

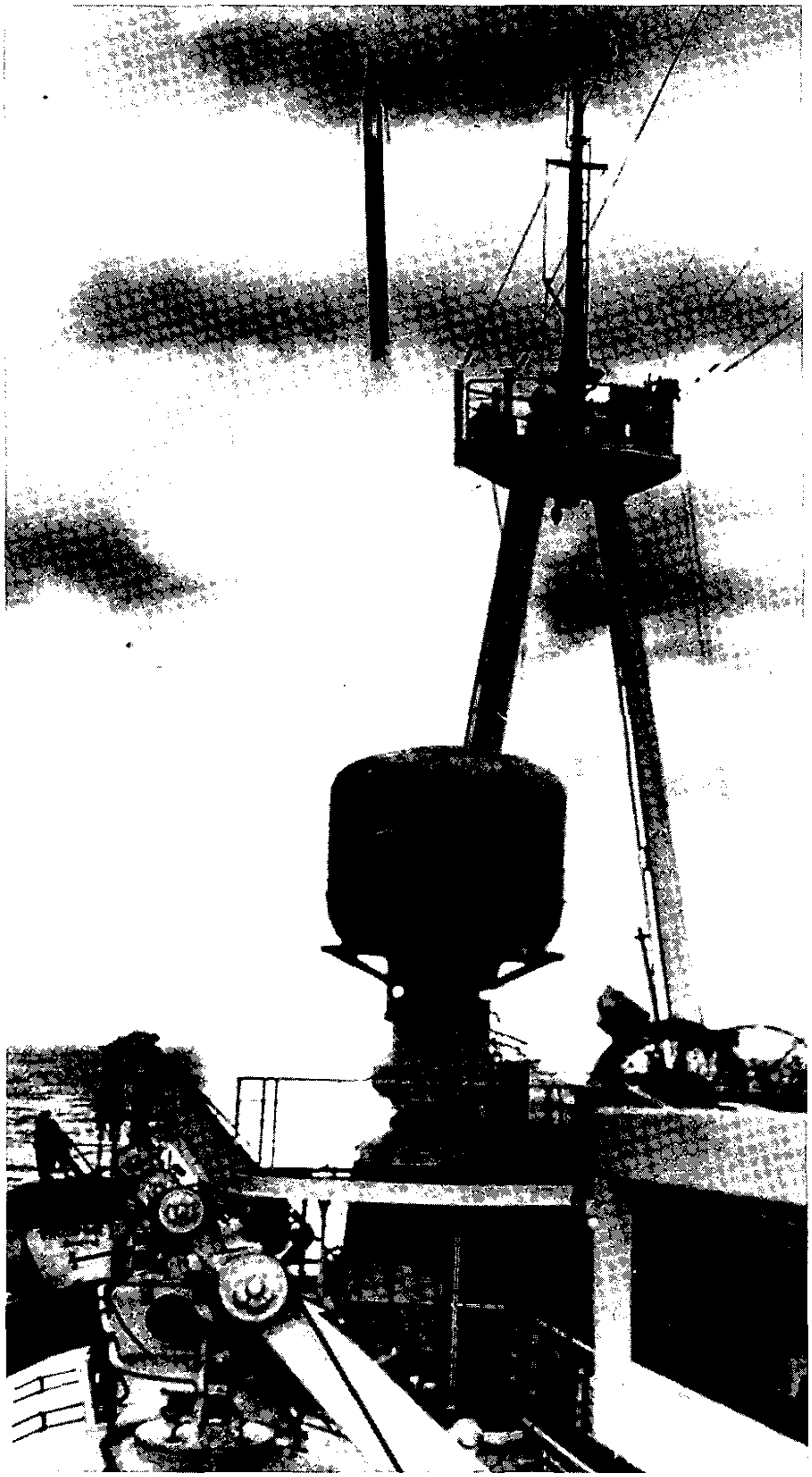
CICAR was a multination program conducted from 1970 to 1975 and managed by an International Coordination Group under the aegis of the Intergovernmental Oceanographic Commission. Objectives of the program were to seek better understanding of air/sea interaction; circulation into, out of, and within the Caribbean and the Gulf of Mexico; marine chemistry and related biological processes; and the water-sediment interface.

NODC acted as the Regional Data Center for CICAR and was responsible for processing standard (physical/chemical) oceanographic data. The Mexican Oceanic Sorting Center (CPOM) was responsible for sorting of biological samples.

The Guide contains an inventory of data collected during CICAR that were reported to and/or submitted to NODC. It shows which data were taken by each of the participating countries and the total received each year. It also inventories the data collected by each of the participating ships, comparing the amount of data reported with the amount of data received by NODC.

In addition, the Guide contains plots showing the data collection locations and the number of observations received by NODC for each 1° rectangle of the CICAR area. It also presents the number of mechanical bathythermograph observations by 1° rectangle archived at NODC prior to CICAR.

The Guide also has plots showing the annual average, maximum, and minimum values, as well as the total number of observations for temperature, salinity, and density (sigma-t) based on all fully processed station/STD/CTD data from the CICAR area and available at NODC. These data are compiled by 2° rectangles for the depths 0, 50, 100, 200, 300, 500, 700, 1000, 1200, 1500, 2000, and 3000 meters.



U.S.-U.S.S.R. Particle Intercalibration Project

The EDIS National Geophysical and Solar-Terrestrial Data Center's two-man staff at the Ionosphere Station at NASA's Wallops Flight Center played a key supporting role in a recent Joint American-Soviet Particle Inter-Calibration (JASPIC) Project, during which eight rockets carrying various types of instruments were launched. Two Nike Apaches and one Nike Tomahawk were launched from Wallops Island, Va., while five Soviet MR12 rockets were launched from the Russian research ship *Professor Vize,* located off Virginia's coast from June 2 through June 25, 1978.

The primary objective of JASPIC was to compare U.S. and U.S.S.R. experimental techniques that have been used to deduce the absolute value of energetic electron and proton fluxes that may be responsible for ionization of the lower region of the midlatitude ionosphere at night.

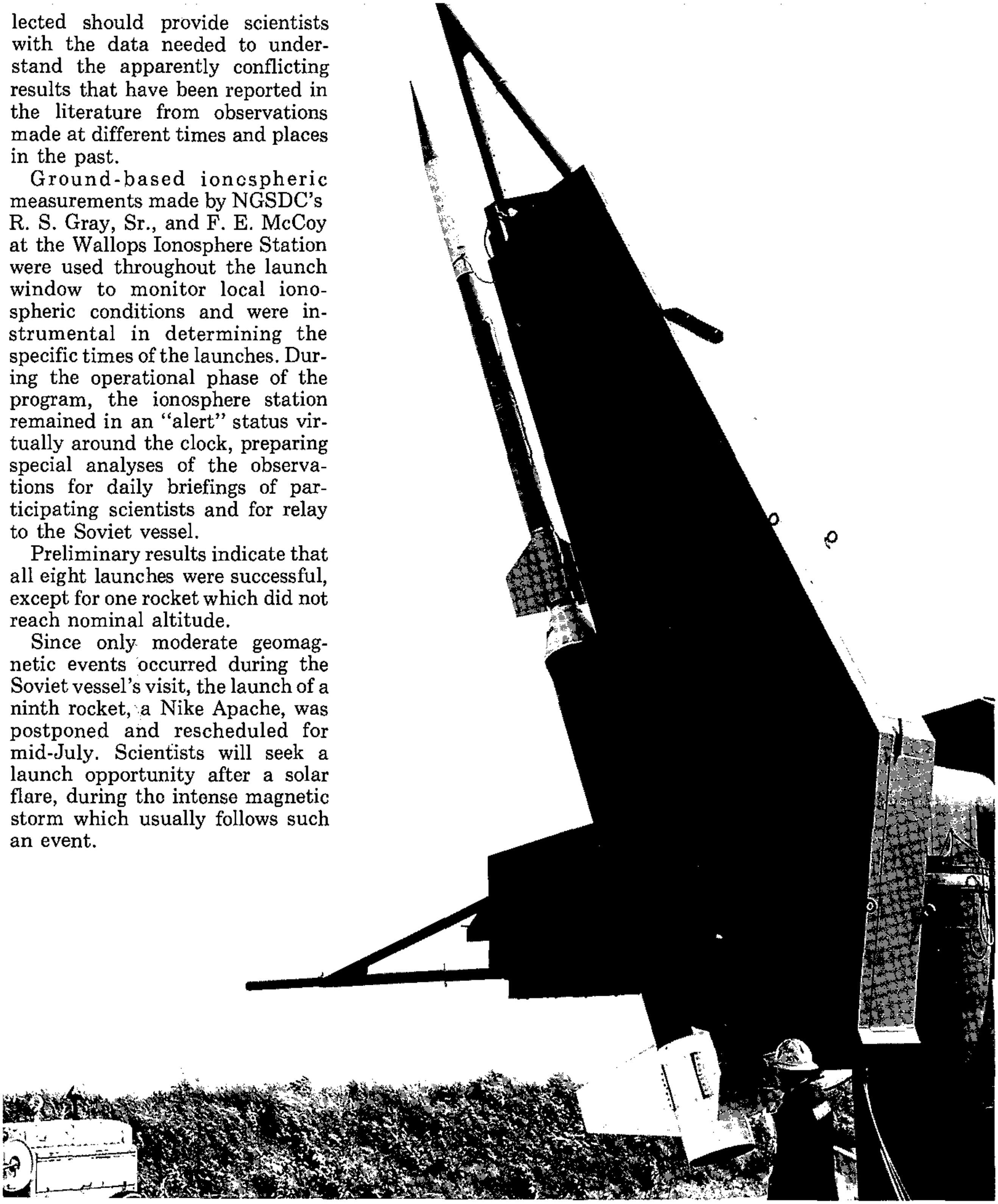
The near-simultaneous rocket launches were complemented by a coordinated program of supporting ground-based, airborne, and satellite measurements. The data col-

Left: An MR-12 solid-fuel rocket is launched from the Soviet ship Professor Vize off the Virginia coast. Right: Preparing a Nike Apache rocket for launch from Wallops Flight Center. NASA photo lected should provide scientists with the data needed to understand the apparently conflicting results that have been reported in the literature from observations made at different times and places in the past.

Ground-based ionospheric measurements made by NGSDC's R. S. Gray, Sr., and F. E. McCoy at the Wallops Ionosphere Station were used throughout the launch window to monitor local ionospheric conditions and were instrumental in determining the specific times of the launches. During the operational phase of the program, the ionosphere station remained in an "alert" status virtually around the clock, preparing special analyses of the observations for daily briefings of participating scientists and for relay to the Soviet vessel.

Preliminary results indicate that all eight launches were successful, except for one rocket which did not reach nominal altitude.

Since only moderate geomagnetic events occurred during the Soviet vessel's visit, the launch of a ninth rocket, a Nike Apache, was postponed and rescheduled for mid-July. Scientists will seek a launch opportunity after a solar flare, during the intense magnetic storm which usually follows such an event.



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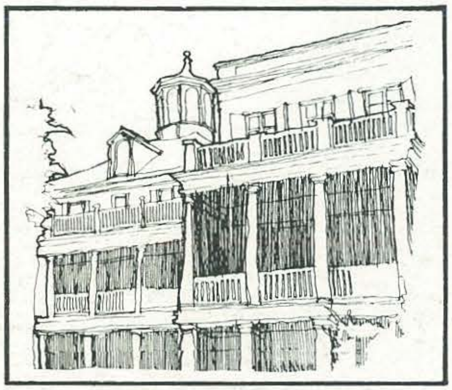
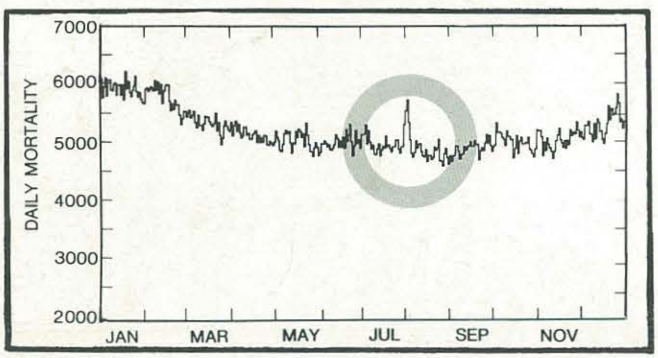
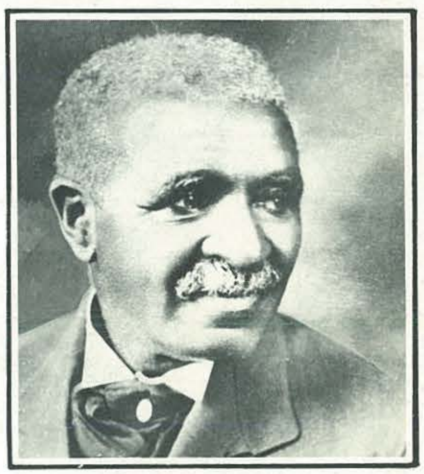


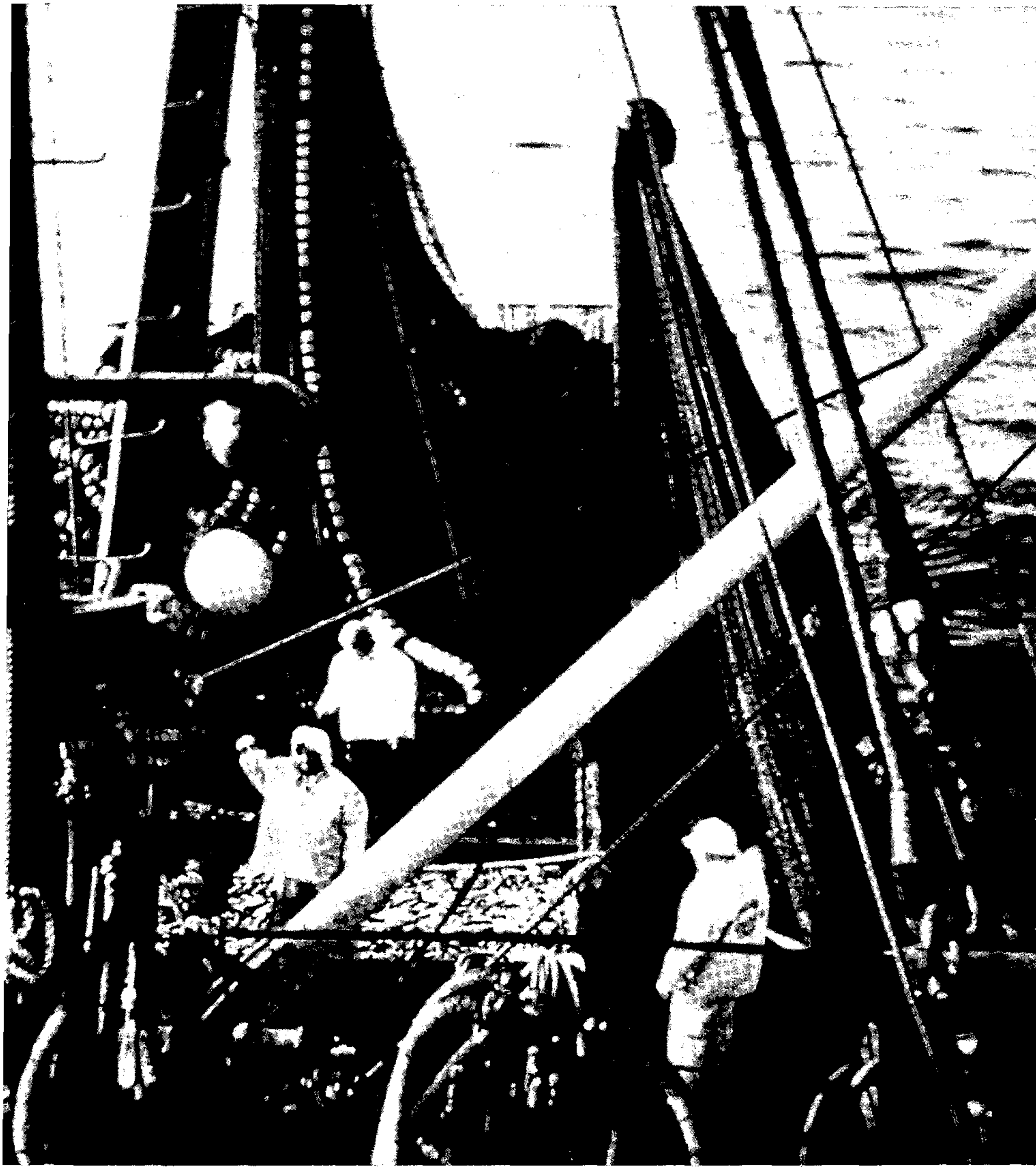




In this issue: *Climate and architecture (p.4); electricity from tides (p.9); weather and mortality (p.12); and George Washington Carver, weather observer (p.15).*

EDIS

Environmental Data and
Information Service
November 1978



EDIS

Environmental Data and Information Service
November 1978

Cover: *The relationship between weather and climate and the quality, abundance, and distribution of fish stocks is explored in an article that begins on p. 14.*
Photo: C. P. Idyll

EDIS is a bimonthly publication designed to inform Environmental Data and Information Service (EDIS) cooperators, colleagues, and contributors of recent developments in EDIS programs and services and in the general field of scientific data and information management. EDIS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, and Center for Environmental Assessment Services. In addition, under agreement with the National Academy of Sciences, EDIS operates World Data Centers-A for Oceanography, Meterology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology (Snow and Ice).

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, EDIS, Page Building 2, Room 533, 3300 Whitehaven St. N.W., Washington, DC 20235.

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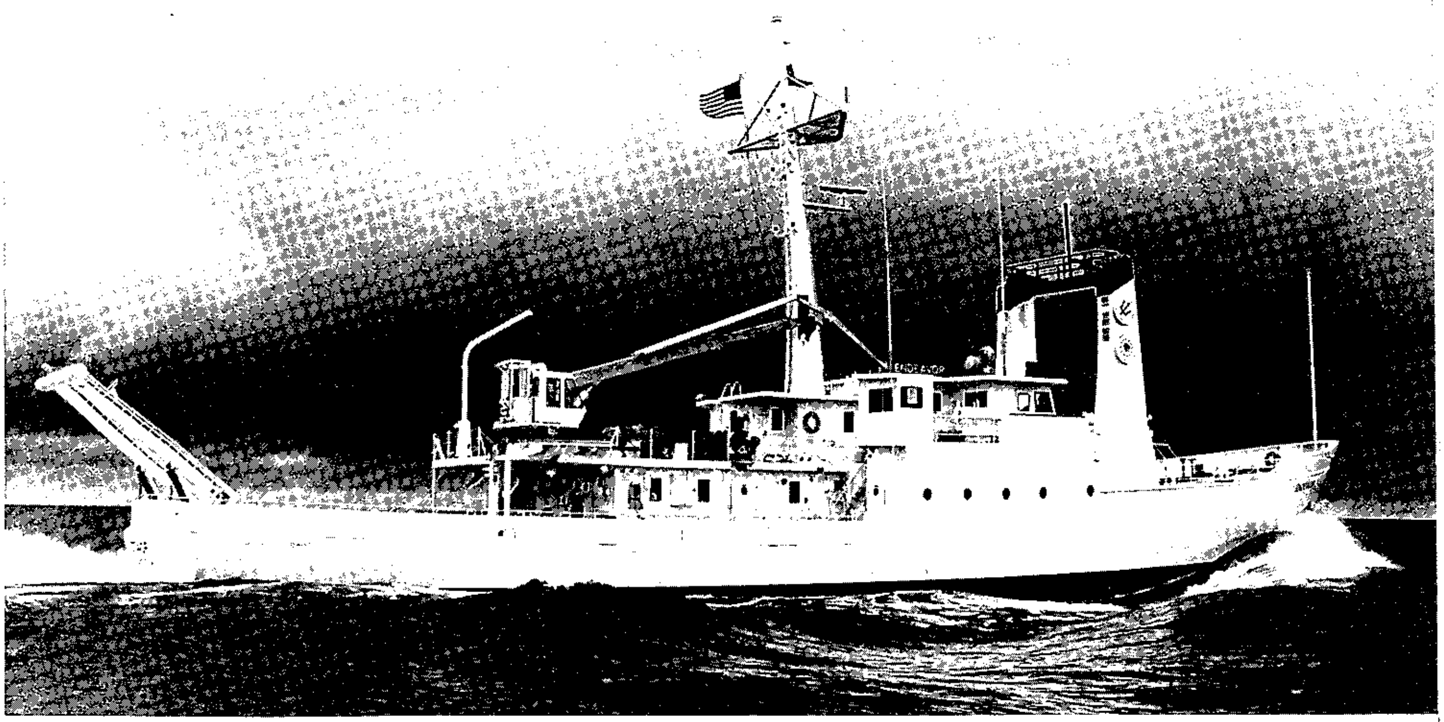
Oceanographic Data Systems*

By Thomas S. Austin



RV Endeavor. *Photo: University of Rhode Island.*

The decade of the 70's has brought us Big Ocean Science, resulting in multidisciplinary, multiship, and multinational programs. Without computers we never could digest the unprecedented quantities of data produced by such programs. With computers, we may never understand the data collected.

As the conference program summarizes the problems:

> "We are now facing a period of contradictions. Some oceanographers feel the need to escalate the size and power of the seagoing computer . . . whereas others feel the need to minimize computing power at sea and to accomplish more sophisticated processing on shore by taking advantage of standard telecommunication techniques. We notice an increasing trend toward scientists in one institution using ships of another institution. We see problems arising in the logistic support of these ventures because of the nonstandardization of computers, instruments, and programs."

There also are other, related, issues involved. These include the implications of satellite technology, as well as consideration of the needs of the whole data user spectrum.

Computer Systems

As Gus Tollios notes in his abstract:

> "We have emerged from a period where the use of seagoing computers in oceanographic research was restricted because of limitations of cost and technology."

Computer power is getting cheaper every year. The state-of-the-art in minicomputers and microprocessors is developing rapidly, and ever smaller, more powerful, and

**Keynote Address, Second Working Conference on Oceanographic Data Systems, Woods Hole Oceanographic Institution, September 26-28, 1978.*

cheaper computers are available for shipboard use.

With these developments, large-scale, ship-to-shore data communication may not be economically competitive in the near future, even if practical. Moreover, from my own viewpoint, quality control problems are a major concern. If our data centers have to accept transmitted, rather than analog data, with the inherent potential for noise and garbling, we may lower the value of the data bases for all retrospective users.

My own agency's experience during GATE—The GARP (Global Atmospheric Research Program) Atlantic Tropical Experiment—shows that a minicomputer at sea can be invaluable. GATE was carried out over 200 million square miles of tropical land and ocean. It involved more than 5,000 scientists, technicians, and ship and aircraft crews from 65 nations. Instruments aboard 41 ships, 65 buoys, 12 research aircraft, and 5 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 EDIS Center for Experiment Design and Data Analysis (now Center for Environmental Assessment Services) was the National Processing Center for data acquired by U.S. ships in the primary (B-scale) GATE array, and also coordinated the data gathering and processing operations of all U.S. participants. Minicomputers on four U.S. ships were used to edit data, calculate low-resolution averages, plot data, and produce computer-derived variables and budgets. They also were used to compute transfer equations and to isolate problems in the system.

These shipboard computers were not used to change any of the raw, incoming data, but only for at-sea evaluation of the data collected. Final data reduction, data processing, and data editing were accomplished on large-scale, shore-based computer systems.

There are strong arguments for using a minicomputer (or microprocessor) at sea to evaluate collected data. A scientist who is able to look carefully at the data is more apt to collect good data and—perhaps even more important—provide good support information, such as written logs of acquisition events. The computer also enables the scientist to examine complex relationships. Budgets which don't balance, for example, may mean a component is not being properly sampled. Harmonic analysis may help to pinpoint a source of background noise or aliasing which requires a change in the sampling rate. This kind of interaction never can be completely replaced by later analysis at the base station.

At the same time, however, the final edit and evaluation for permanent archiving cannot be performed as thoroughly at sea as at a home base. Big machines enable the analyst to look at the entire data base and to use complex interaction computations that would be too large for the minicomputer to handle.

In short, there is a place for each type of computer in the data gathering and archiving system. If one machine is extended to eliminate the other, some flexibility will be lost, with a likely concomitant loss of high-quality data.

I note with interest that Martha McClure of the University of Rhode Island will describe a data acquisition system that will allow a scientist to leave the *RV Endeavor* with data from the ship's instruments that are immediately usable in a mainland computer. This is the kind of thinking that can solve a lot of problems for all of us.

Standards

At its very first meeting in Paris, in October 1961, the Intergovernmental Oceanographic Commission noted that:

> "Recent investigations have shown that some oceanographic data collections made by different countries in the same area and at nearly the same time have unexplained discrepancies . . . we have scientists from different countries doing essentially the same job obtaining different results. In some instances the discrepancies are considerable, and it is not possible to explain why. One principal reason may be the lack of standard techniques and differences in standards and intercalibration of instruments."

Lest you think there has been marked improvement since, allow me to cite a more recent example, provided by W.M. Nicholson, of NOAA's National Ocean Survey.

During an IFYGL (International Field Year for the Great Lakes, 1972-73) experiment, Canadian and U.S. data buoys were moored side-by-side to compare readouts. Average current velocity differences of 2.5 cm/s, or 35 percent of reading, were noted for July and August 1972 at one location in Lake Ontario. Because of the lack of field standards, it was impossible to determine which system was the more accurate.

In standardization, we must consider not only the sensor and its calibration (and intercalibration), but also formats, processing techniques, data applications, and so on—in short, the total data collection and use system.

There are, for example, few standard data formats. A scientist working on a ship of an organization or country other than his own cannot easily use the ship's computer to get information from its data system, let alone specifications and calibration data for the sensors deployed.

And standardized formats are not enough. A computer can spit out many numbers in a standard format, but do the numbers and the original measurements mean the same thing? The algorithms, formulas, and compression and computer techniques used all affect the meaning of the numbers. As we try to decipher the real meaning of environmental measurements, the variability of computer techniques employed to process them presents a formidable complication.

Regarding hardware standardization, I am inclined to agree with R.L.K. Tripe's statement describing data acquisition and processing by the Canadian Hydrographic Service:

> "Experience to date has shown that data formats, storage media and software standardization play a more important role than hardware standardization."

Satellites

As Victor Delnore notes in his abstract, a major shift toward satellite oceanography has occurred since the 1975 Working Conference. The current SEASAT program, for example, will have significant impact on plans for future oceanographic data collection and processing programs.

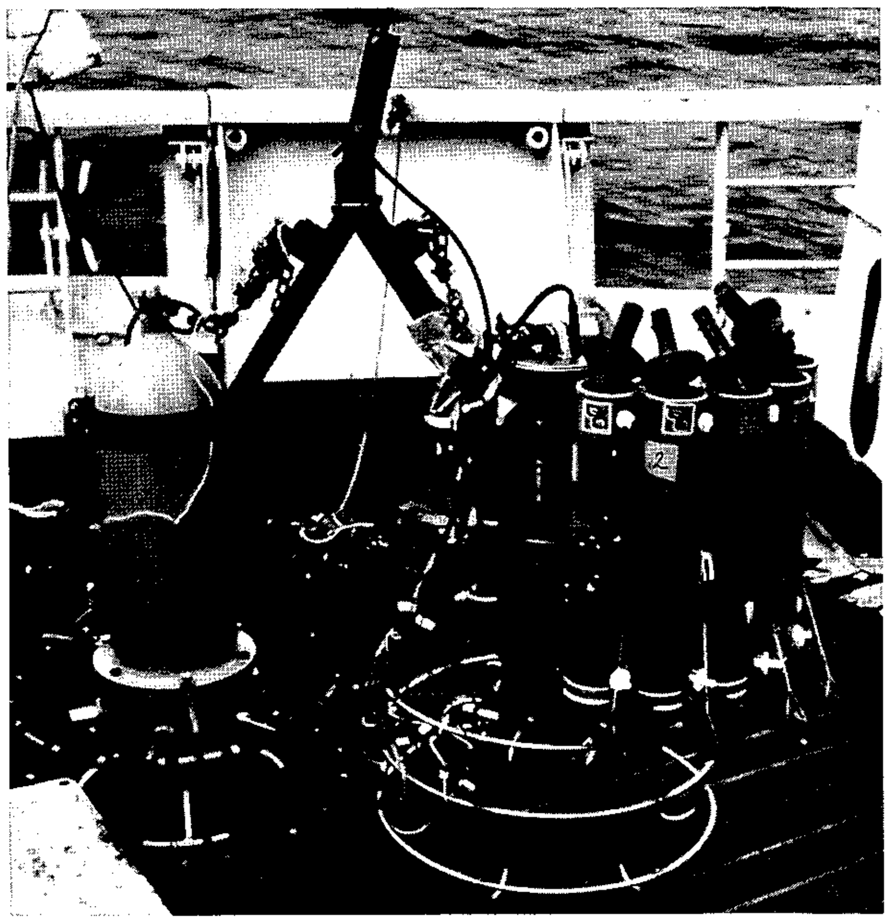
SEASAT, launched by the National Aeronautics and Space Administration on June 26 of this year, introduced a new era in data sampling techniques to obtain synoptic ocean information. Such information thus far is available only in limited quantities, because engineering verification and validation of the five sensors carried have occupied the first several months.

The sensors are: (1) a radar altimeter for precise measurement of the displacement from the satellite to the ocean surface; (2) a radar scatterometer for measurement of surface wind velocity; (3) a synthetic aperture radar for high resolution (25 m) imaging of ocean and ice features; (4) a 5-frequency microwave radiometer for measurement of surface water temperature, wind speed, sea ice, and water liquid and vapor in the atmosphere; and (5) a visible and infrared radiometer for general low resolution (7 km) feature identification.

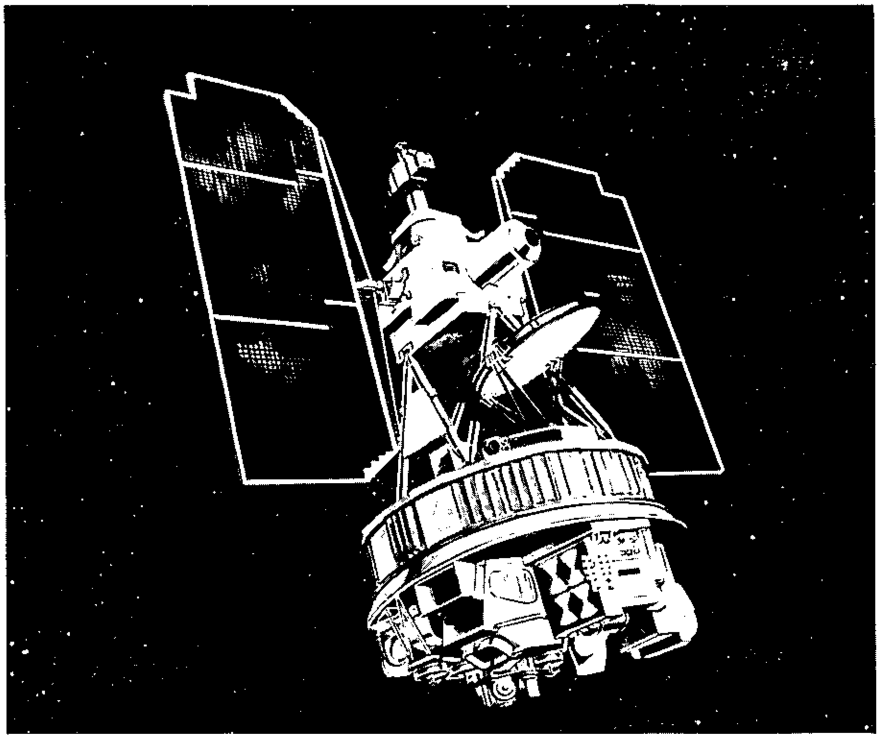
The first three sensors are active, that is, they transmit their own microwave energy to be reflected and returned to a satellite detector. The last two are passive and depend on emissions or reflections of natural energy.

The radar altimeter measures the displacement from satellite to surface with a precision of 10 cm. This will permit an improved measure of the Earth's geoid, assist in the definition of ocean circulation and currents, and, by special processing of the returned signal, will measure (at nadir only) significant wave height and windspeed.

All sensors, except the altimeter, are scanning instruments.



Soviet (left) and U.S. conductivity—temperature—depth instruments during intercomparison experiments on the **RV Akademik Vernadsky** *during joint U.S.-U.S.S.R. Mid-Ocean Dynamics Experiment in the fall of 1976.* *Photo: R. Millard*



Artist's concept of Nimbus-G, an environmental research satellite that carries a sensor to measure ocean color.
NASA Photo

Swathwidths are as small as 100 km for the imaging radar and up to 2,000 km for the visible and infrared radiometer. The imaging radar pictures ocean features including waves (both period and direction), sea and lake ice and icebergs, ocean current boundaries, wave-wave interactions, and wind-wave interaction effects. The three radar sensors are near all-weather instruments and measure features of the ocean surface through clouds, storms, and darkness.

NIMBUS-G, scheduled for launch next month by NASA, carries a microwave radiometer identical to the one on SEASAT and, more importantly, the first space sensor designed specifically to measure ocean color. This instrument, the Coastal Zone Color Scanner, with five visible and near-visible channels and a sixth thermal infrared channel, will be used in discriminating between surface water masses (including currents and upwelling features), the measurement of chlorophyll and sediment conditions, and in detecting possible effects of oceanic pollution.

The merging of data from NIMBUS-G and SEASAT will serve to demonstrate the validity of satellite techniques for oceanography. The next step will be to determine if the benefits warrant the development of a prototype operational oceanographic satellite system. I recently attended a number of meetings concerning the establishment of just such a system. This is something we all must work into our thinking about future oceanographic data systems.

While satellites will contribute much to our future, they cannot give us the subsurface data we need. And even the surface data collected by satellite will require the concurrent collection of baseline data for calibration and reference.

Users

The ocean is now recognized as a major resource for energy and mineral development, food, pollution disposal, etc. This has resulted in an increasing and increasingly active community of secondary ocean data users who are not scientists, let alone research scientists. Often, they are engineers, managers, economists, lawyers, and many others who need the fruits of ocean research in a form directly applicable to their own work.

As Warren Wooster has stated:

> "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."

This consideration applies to ocean data systems as much as to other facets of ocean research and exploration. We are not collecting data solely for our own use. The needs of retrospective users must be considered in all our deliberations.

With these points in mind, then, I would like to leave you with the charge so reasonably stated in the conference program:

> ". . . we have accumulated a great deal of experience and by now ought to be in a position to recommend directions which we as a community would like to see taken to standardize and consolidate our efforts."

Thank you.

SOFAR Floats Track Deep Ocean Currents

By T. Rossby
University of Rhode Island

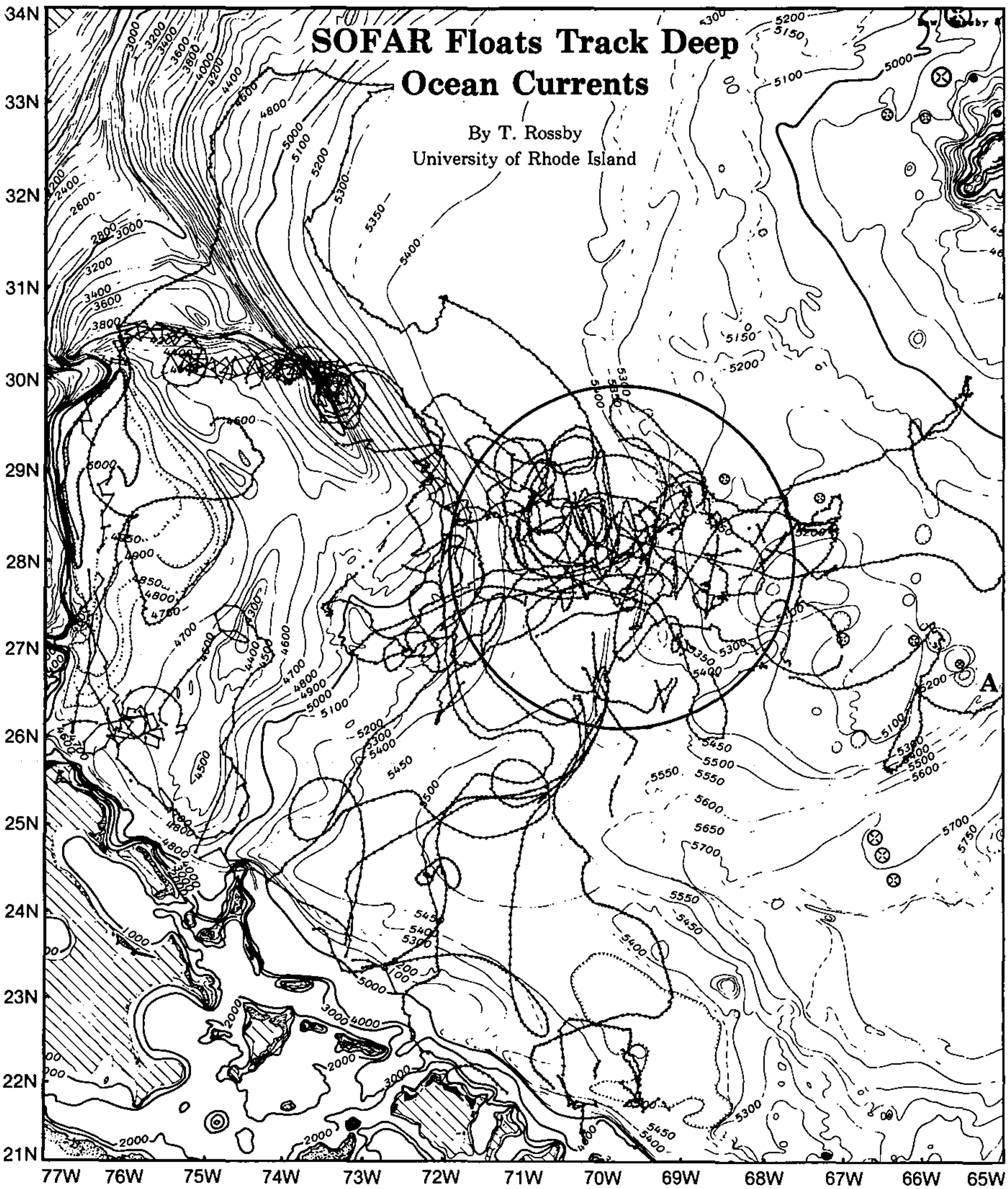


Fig. 1. The "spaghetti" chart. All floats were launched within the area circled.

Enlarged sections of fig. 1 show trajectories characteristic of various ocean areas.

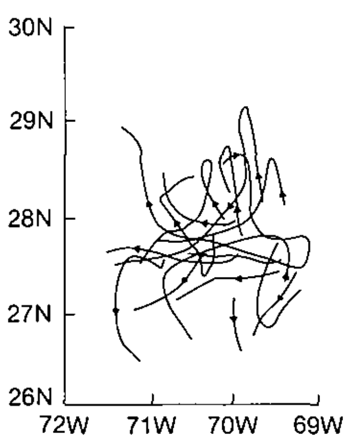


Fig. 2

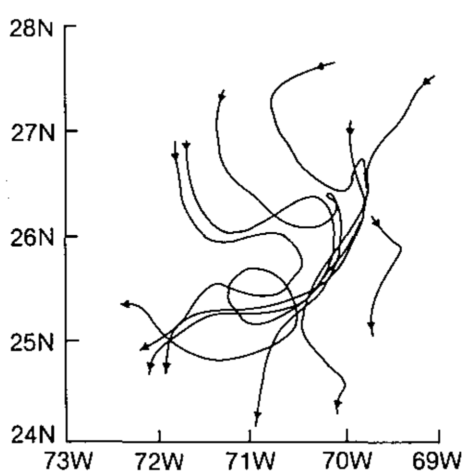


Fig. 3

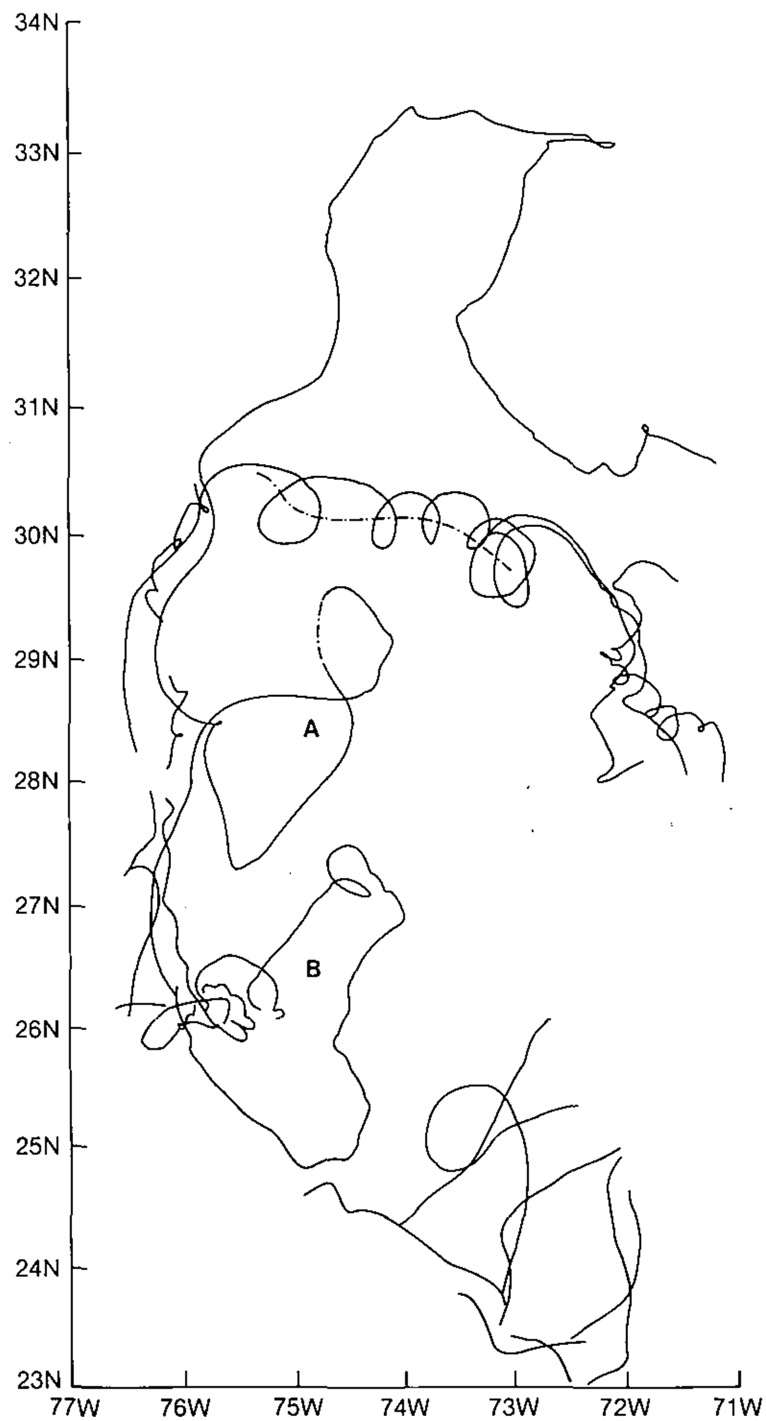


Fig. 4

Knowledge of the ocean circulation and how it is maintained is one of the prime concerns of the physical oceanographer, who seeks to develop a systematic description of the ocean's different water masses and their movement throughout the basins. Classically, the most effective way of doing this has been to compute the currents of the upper ocean from observations of temperature and salinity, which together govern the density and hence the pressure distribution. However, the more persuasive pictures of large-scale circulation lean heavily upon the spatial distribution of the physical properties of sea water, especially salinity, oxygen, and silicate content. With continued improvement in analysis techniques, inclusion of other chemical constituents, such as radioactive tracers, have underscored the importance of chemical signatures in water mass identification, movement, and mixing. Thus, the classical view and method of portraying the circulation is essentially a Lagrangian description; fluid motion is determined from the trajectories of labelled particles as they move through space.

In recent years an observational technique has been developed to make such measurements directly. Submerged, drifting, neutrally buoyant floats are used to transmit a low-frequency acoustical pulse at precisely timed intervals. From the time of arrival of these signals at a minimum of two receivers, the float position can be determined. What makes this possible over great distances is the existence of a remarkable feature of the ocean known as the deep sound channel or SOFAR (Sound Fixing and Ranging) channel. This is an acoustic waveguide which owes its existence to the fact that the speed of sound is a function of pressure and temperature (and salinity to a lesser extent). As one leaves the warm surface waters of a subtropical ocean, the speed of sound decreases with increased depth. Below the main thermocline, where the vertical gradients of temperature become small, the effect of pressure becomes dominant and the sound velocity increases with greater depth. In the western North Atlantic the depth of the sound channel axis is about 1,200 meters. At this depth, a few watts of sound at 250 Hz can be detected at distances in excess of 1,500 km.

In 1973, 20 floats were constructed for use in a large, cooperative study of ocean currents known as MODE (Mid-Ocean Dynamics Experiment) (Rossby, Voorhis, and Webb, 1975). During the intensive phase of this experiment, the floats were deployed at 1,500 meters depth and kept in a tight cluster in order to construct a series of synoptic charts of the currents at this depth and their evolution with time. After the experiment, the floats were allowed to disperse and explore the variability of ocean currents on large scales. While there is little question that the wayward character of the currents made planning for float placement difficult, in the end the floats have rewarded us with a rich sample of different processes as they wandered about the ocean between Bermuda and the Blake and Bahama Escarpments.

The most compact statement of all the data that has been collected we call the spaghetti diagram (fig. 1). The trajectories of all floats have been superimposed without regard to time onto this one chart. All floats, except for the one labeled "A," which was about 1,000 meters deep, were ballasted for 1,500 meters depth and launched inside the circle centered at 28°N, 69°40'W.

From the chart, one can see the speed and direction of movement of each float (the dots are spaced one day apart), and what areas have been traversed. Typical speeds are 3-5 cm/s and the inertial drift of the cluster is 1 cm/s to the west-southwest. Actually, the root-mean-square (rms) speeds vary significantly from one region to another. South of 27°N and west of 70°W, the rms speeds are 5-10 cm/s, and along the Blake Escarpment speeds in excess of 40 cm/s have been observed. Curiously, the dispersion is only to the south and west; not a single instrument broke off to the north or east.

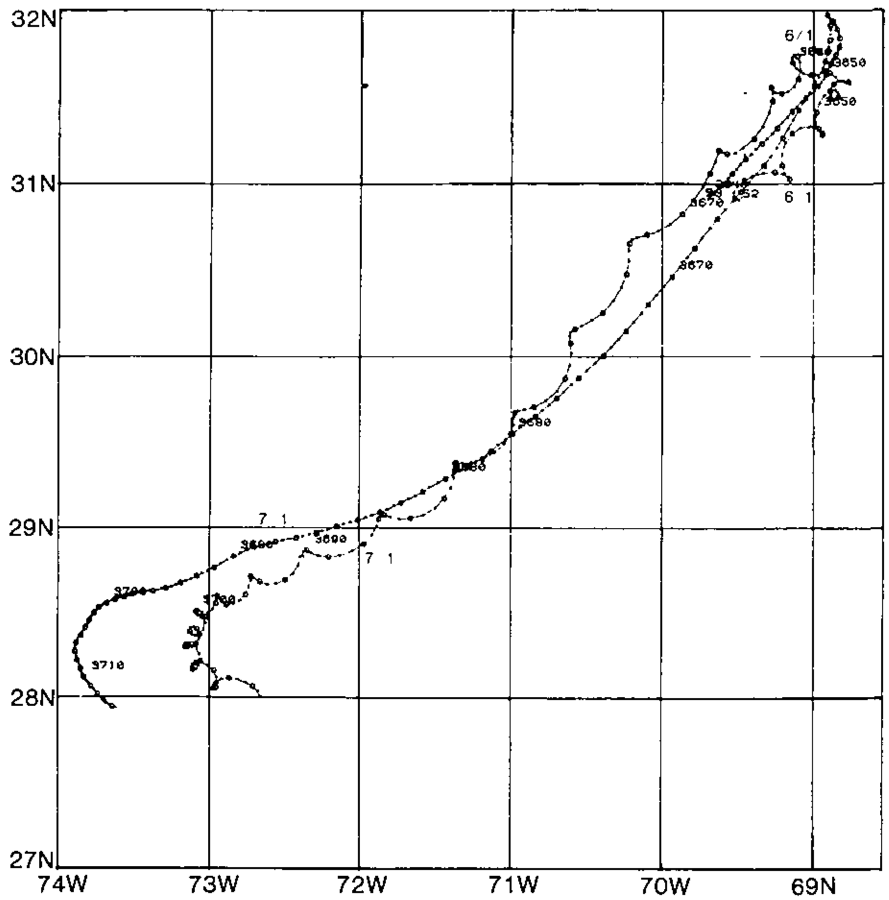
As one examines the spaghetti diagram more closely, one discovers a spatial organization that appears to be unique for each area. Just south of 28°N the trajectories are predominantly east-west zonal, whereas to the north and south there is more meridional motion. These are highlighted in fig. 2. Farther south, around 25°-26°N, there is another rather conspicuous example of spatial structure. In fig. 3, there are seven trajectories that go through this region from north to south along qualitatively very similar paths, but at different times. These two figures help to illustrate why it is so important to examine "raw" data before it is subject to statistical summaries which may destroy valuable spatial or "phase" information.

Fig. 4 shows a set of trajectories that are conspicuously coupled to bottom topography. While the tracks along the escarpments are self-evident, the two orbiting floats along the Blake-Bahama Outer Ridge and the loops A and B are particularly telling.

Taken together these figures suggest a strong spatial organization to the currents. The horizontal scales of coherence are small, certainly less than 100 km. At the same time, it is obvious from the crossing of trajectories locally in space that the currents must be highly variable in time.

A full discussion of this would take too much space, but it can be mentioned that there is strong evidence for propagating planetary

Fig. 5. These two float trajectories indicate the presence of a very small eddy.



waves with a period of 55 days, at least near 28°N, 70°W (Freeland, Rhines and Rossby, 1975). We believe that these, together with the strong spatial organization mentioned above, suggest that the mesoscale currents throughout this region are governed substantially by their proximity to the lateral boundaries of the ocean basin. According to theory, planetary waves, upon reflection at a western wall, become much shorter, with a corresponding increase in kinetic energy per unit wavelength. Although their energy flux is to the east, their phase velocity is still to the west. The complex patterns we observe in the spaghetti diagram presumably result from the complicated shape of the escarpments. From data we have collected in the last two years (not included in the spaghetti diagram), we find dramatic changes in the currents as one moves farther east away from the influence of the continental margins. The two month period "disappears," and a much weaker zonal oscillation with an approximate 1/2 year period emerges. The floats at about 25°N, 62°W reveal, after two years' drifting, no significant mean flow, i.e., much less than 1 cm/s at their operating depth, 2,000 meters.

Earlier work with SOFAR floats was all done at levels in or near the sound channel to insure maximum detectability. In the past two years we have done much exploratory work with floats in the main thermocline. As a measure of the variety of phenomena we are studying, I would like to mention the discovery of an extraordinarily small, yet energetic eddy that was found in the main thermocline. The trajectories of two floats, both near 700 meters depth, are shown in fig. 5. One of these undergoes very characteristic anticyclonic (clockwise) oscillations as it is advected by a larger scale flow. The orbital velocity is about 15-20 cm/s with a diameter of approximately 10-15 kilometers. Another float which was very close by for part of the time shows no evidence of orbital motion and appears, thus, to be strong testimony to the discreteness of this "mini-eddy." Further support for this comes from the preliminary hydrographic analysis, which indicates that the core of this eddy may have come from the region of upwelling off the west coast of North Africa. We hope to publish a more complete report on this in the near future.

The data shown in the spaghetti diagram are available from EDIS' National Oceanographic Data Center. Copies of a poster sized spaghetti diagram, as well as a detailed data report, are available from the author. The addresses are: (1) National Oceanographic Data Center, Environmental Data and Information Service, 3300 Whitehaven Street, NW, Washington, DC 20035, and (2) Dr. Thomas Rossby, Graduate School of Oceanography, University of Rhode Island, Kingston, Rhode Island 02881.

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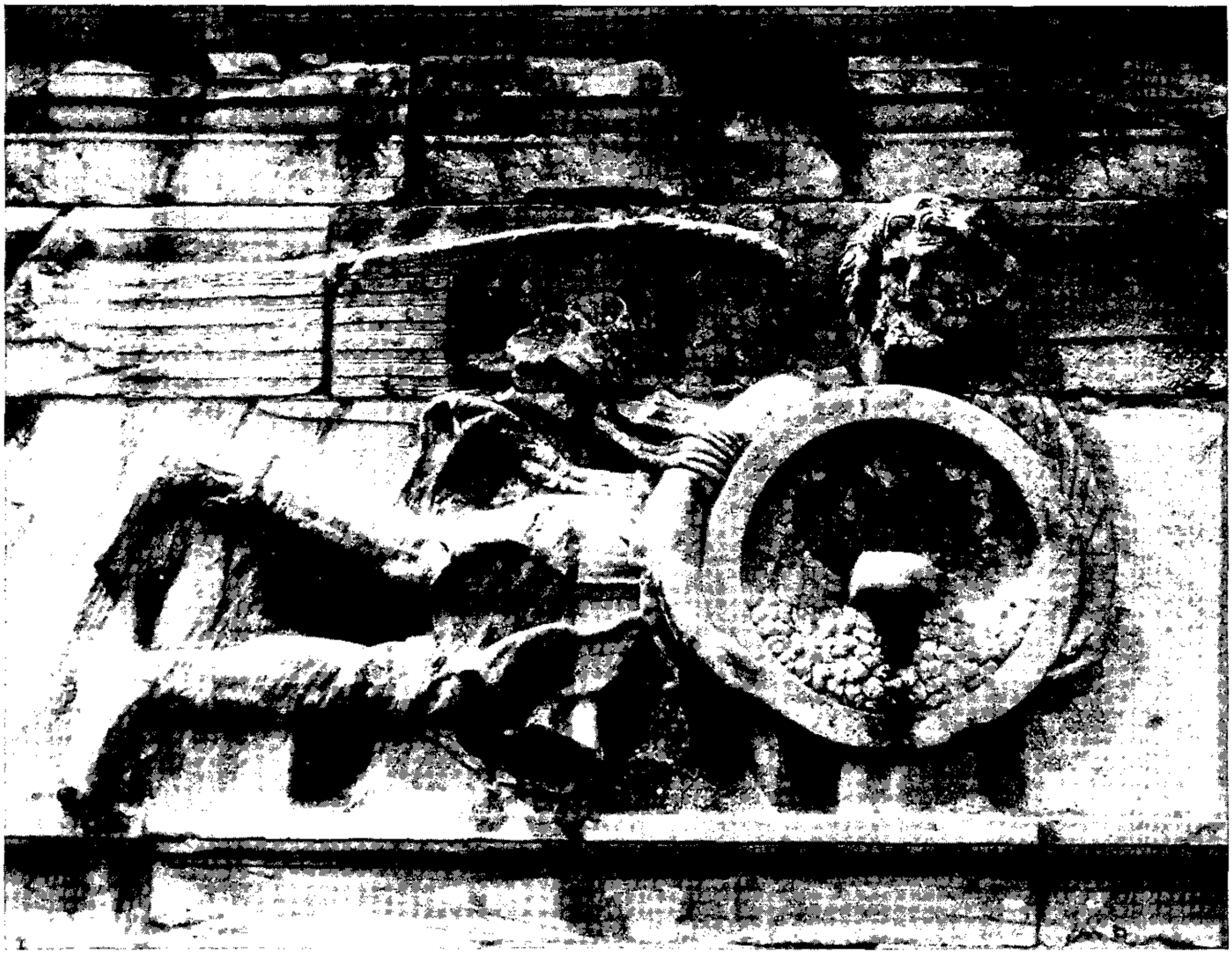


The Mythology of Meteorology

By Patrick Hughes

Kaikias, the ancient Greek personification of the northeast wind from the "Tower of the Winds" in Athens. His shield is half full of hail-stones, which he is getting ready to dump on the countryside.

Photo: Ralph Kresge

Worrying about weather is one of man's oldest preoccupations. He has always tried to understand it, to influence it, and to predict it.

Modern meteorology, the science of weather, was born only a few hundred years ago. Until the invention of the thermometer and the barometer, accurate measurement of the basic elements of weather was impossible.

For thousands and thousands of years, observation, superstition, pseudo-science, and imagination were the principal wellsprings of weather knowledge, generating a cumulative mythology of meteorology, the prehistory of the modern science.

The witch doctor of some primitive clan may well have been the first to rely on ritual and incantation to bring rain or still the storm. Indeed, in our own Southwest today, rain dancers continue to beseech ancient gods even as airplanes seed the clouds overhead with silver iodide.

Clay tablets in the British Museum tell us that the ancient Babylonians associated haloes, clouds, winds, storms, and thunder with the positions and motions of heavenly bodies. The priestly profession of astro-meteorology they developed, however, was more interested in omens than in weather forecasts. This is il-

Hippocrates related weather and climate to human health and comfort and to the outbreak of epidemics.

National Library of Medicine

lustrated by the ancient adage of Asaridu, a Babylonian priest:

> "When it thunders in the day of the moon's disappearance, the crops will prosper and the market will be steady."

Such predictions can be traced from Babylonia through the Middle Ages.

The early Greeks related weather (and all natural phenomena) to their gods. The rainbow was the many-hued robe of Iris; earthquakes were caused by the restless movement of Typhon in his underground prison; and lightning was a manifestation of the anger of Zeus, father of the gods, whose sign was the thunderbolt. In many lands, there was a special stone or statue worshipped for its magic power over weather.

About 750 B.C., the Greek poet Hesiod, ignoring the gods, published some sound weather rules based on observation. The Greeks began making regular weather observations about the fifth century before Christ. During the same century, Hippocrates, the father of medicine wrote of the effects of hot and cold winds on human health and comfort and related the outbreak of epidemics to seasonal weather changes. A little later Aristophanes, in his play, *Clouds*, questioned whether Zeus really made it thunder, or whether the noise was caused by clouds "banging together."

It was a Greek philosopher and astronomer, Anaximander of Ionia, who gave us the first recorded scientific definition of wind—"a flowing of air"—a definition still difficult to improve.

Some 200 years later, probably between 347 and 335 B.C., Aristotle published *Meteorologica*, a monumental milestone in the history of weather science. In *Meteorologica*, Aristotle collected most of the previous writings on astronomy and meteorology and attempted to explain all natural phenomena. He included the work of Hippocrates, Democritus, Anaxagoras, Anaximenes, and Empedocles, espousing one grand, relatively simple theory embracing shooting stars, the aurora borealis, comets, haloes, rainbows, the Milky Way, rain, clouds, mist, dew, frost, snow, hail, winds, rivers, seas, thunder, lightning, earthquakes, typhoons, fire winds, and thunderbolts. Since his work was based on the then-accepted theory that everything in the universe is composed of only four basic elements (earth, air, fire, and water), Aristotle eventually was proven wrong in most of his conclusions; yet *Meteorologica* was the weather bible of men of science for almost 2,000 years.

Even in Aristotle's Greece, the man in the street wasn't much interested in scientific explanations of the weather; he just wanted to know if it was going to rain the next day. To satisfy this popular demand, Tyrantus, a disciple of

Galileo Galilei is credited with inventing a simple thermometer about 1593.

Aristotle, writing under the pen name of Theophrastus, published the *Book of Signs*, a long collection of rules for weather forecasting based on a mixture of "science" and folklore.

About 270 B.C. another Greek, the poet Aratus, wove these rules into popular verse and proverbs, many of which survive to our own day. A familiar example is the following verse form of one of Theophrastus' rules:

> "Red sky in the morning
> Sailor take warning;
> Red sky at night
> Sailor's delight."

A slightly different version of this proverb was later used by Christ when the Pharisees and Sadducees asked for a sign from heaven:

> "When it is evening you say, 'The weather will be fair, for the sky is red.' And in the morning you say, 'it will be stormy today, for the sky is red and lowering.' You known how to read the face of the sky, but cannot read the signs of the times." (St. Matthew, 16:2-3)

From the earliest days, farmers and sailors have been credited with the ability to predict the weather by watching the sky, and people have associated weather changes with their bodily aches and the behavior of birds and animals. This cumulative store of ancient observation and imagination, often colored by superstition, was the basis for Theophrastus' and Aratus' work. Since many short-term weather proverbs and signs are based on observation, they have considerable validity, though usually only for the locale where they originated.

The Romans accepted Aristotle's ideas and passed them on. Virgil, borrowing freely from Theophrastus, published some weather forecasting rules in his *Georgics*, establishing the tradition of including weather "signs" in handbooks or almanacs for farmers. Meanwhile, Roman chroniclers recorded significant weather events in their histories of the empire, particularly phenomena requiring sacrifices to the gods.

As the Asiatic conquests of Alexander the Great had brought knowledge of monsoons to the Greeks, so the conquests and colonies of the Romans brought to their attention the difference between continental and maritime climates. In the same way, the Great Age of Exploration at the end of the 15th Century, including the voyages of Columbus, were to reveal to Europeans weather phenomena and climates they had never seen before.

After the breakup of the Roman Empire, weather "science" generally remained stagnant or deteriorated. During this period, feudal astrologers had the thankless, sometimes fatal, job of forecasting the weather for military campaigns. If the forecast and the campaign ended in disaster, the astrologer's life might well be forfeit.

Meteorologica was rediscovered in the 12th century and again became the bible of weather science, a role it enjoyed until the age of instrumentation in the 16th and 17th Centuries. Despite the fact that hundreds of Europeans were making and recording regular weather observations, some on a daily basis, Aristotle's work and the folklore of the Greeks were generally adopted by the people of the late Middle Ages, who added some folklore of their own, often based on pious imagination.

From the mid-thirteenth century almost until modern times, it was generally believed wrong to question the causes of weather and evil to investigate its processes. Indeed, a 17th century English law (only recently rescinded) specified death by burning as the punishment for weather forecasting.

Hopi Indians do a snake dance to bring rain.

Weather, Climate, and Fish Stocks

By Sydney Schultz

Aerial photo of spawning sockeye salmon in Bristol Bay, Alaska.

The relationship between weather and climatic factors and agricultural production has been studied extensively; when the weather is poor or changes unexpectedly, annual crop yields are likely to be reduced. Long-term weather patterns, or climate, also influence crop yields and planting decisions. Less well documented to date, although equally vital to a nation's economic well-being, is the relationship between weather and climatic changes—as manifested in fluctuations in the ocean environment (circulation patterns and water temperature, for example)—and the quality, abundance, and distribution of fish crops.

Oceanographers and meteorologists are studying ocean-climate interaction, monitoring and assessing climate data, and constructing models of fish production under various climatic conditions. These activities assist in fishery management decisionmaking and in the establishment of fish catch quotas to prevent overfishing and ensure adequate fish yields in the future. The capability for predicting catch size has large-scale economic and political implications.

Other factors influence fish yields—for example, pollution and overfishing—but weather and climatic factors may have a more direct impact on fish size, abundance, and distribution, and currently are being studied extensively. Spawning behavior, survival potential for eggs and larvae, migration routes, and available food supply may be determined by climate-related factors.

Marine organisms of all types—from plankton to mammals—are affected by climate. Fish species involved include food and sport fish, fish caught for fish meal manufacture (for use as a food supplement and as fertilizer), and fish that are part of the food chain for other fish species. Specific effects on fish populations depend on a species' feeding, breeding, and migrating habits.

Some weather and climate characteristics and their ocean manifestations of interest to fishery researchers include atmospheric flow patterns, windspeed and direction, air temperature and pressure, solar radiation, cloud cover, storm surges, ice, ocean currents, ocean oxygen content, sea-surface temperature anomalies, and microorganism blooms.

Some climatic conditions influence fish populations directly: the colder the seawater, for example, the slower the rate of seaward migration of young sockeye salmon, the slower they grow, and the fewer the number that return to spawn. Other factors have indirect effects: unusually warm water (and other meteorological anomalies) in the New York Bight in February-March 1976 depressed the oxygen supply, causing massive fish and shellfish kills.

Research on Climate and Fish Stocks

Studies of the waters of the English Channel have revealed cyclical patterns of warming and cooling related to the warming and cooling of the Arctic. North Sea circulation patterns are affected, and thus water circulation, temperature, and pressure through the English Channel, an area of particular interest to the fisheries off Plymouth. Russell (1971) suggests that these ocean movements help determine the availability of nutrient salts and plankton, conditions that result in shifts in fish species such as herring, cod, ling, haddock, and pilchard.

Southward (1975) documents temperature and solar cycles of 11 years' duration in this area that can be linked with corresponding fluctuations in fish catch. Warm water temperatures are associated with an abundance of warm water species (such as hake and red mullet) and a decrease in cold water species (such as cod, haddock, and mackerel). This situation concerns fisheries management because warm water species are considered to be of less commercial value than cold water species. When the seawater temperature cycle is in the cooling phase, more productive catches can be anticipated.

A sizable decrease in the abundance of winter flounder in Narragansett Bay and Rhode Island Sound from 1968 to 1972 was largely explainable by an analysis of average seawater temperatures during the 30-month periods required for the flounder to reach catchable size (Jeffries and Johnson, 1974).

Cushing (1976) also suggests ocean temperature cycles, notably a warming trend in the North Atlantic for the period 1920 to 1945 and a cooling trend since 1945, accompanied by changes in wind strength, wind direction, and solar radiation. The warming trend is associated with the rise of the cod fishery off the west coast of Greenland; the cooling trend is associated with its subsequent collapse. Cushing speculates that sea temperature and ocean currents, sustained by atmospheric changes, combined to restrict the passage of the young cod from the spawning ground off southwest Iceland to the Greenland fisheries.

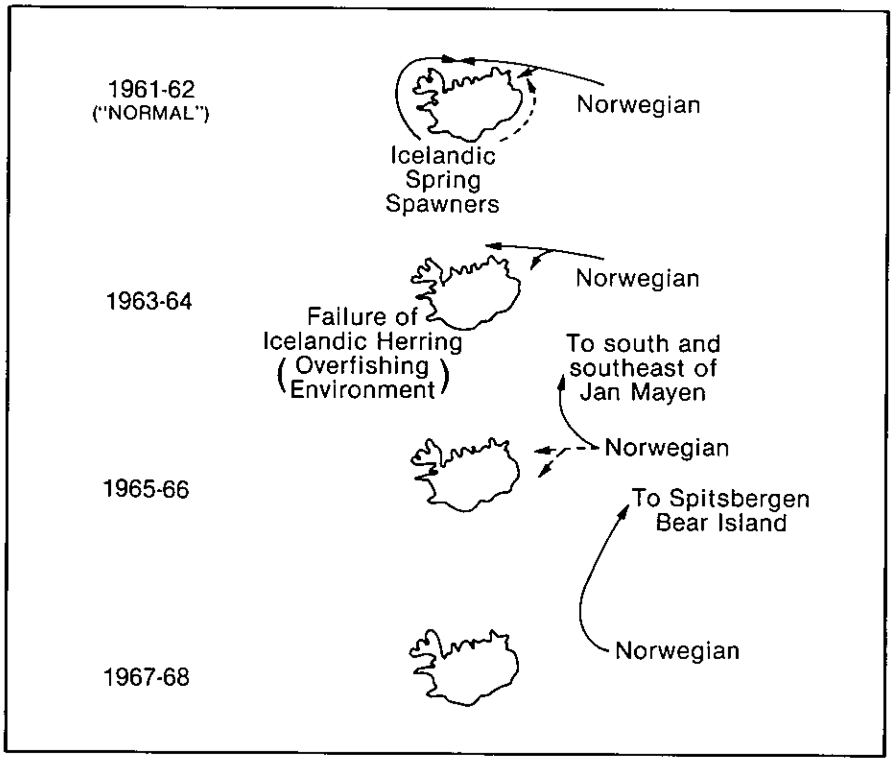
The collapse of the Icelandic herring industry in the late 1960's, disastrous to that island's economy, has been partially attributed to changes in the ocean climate (causing northern ice to drift unusually far southeastward) that forced the alteration of the fish migration routes (Johnson, 1976).

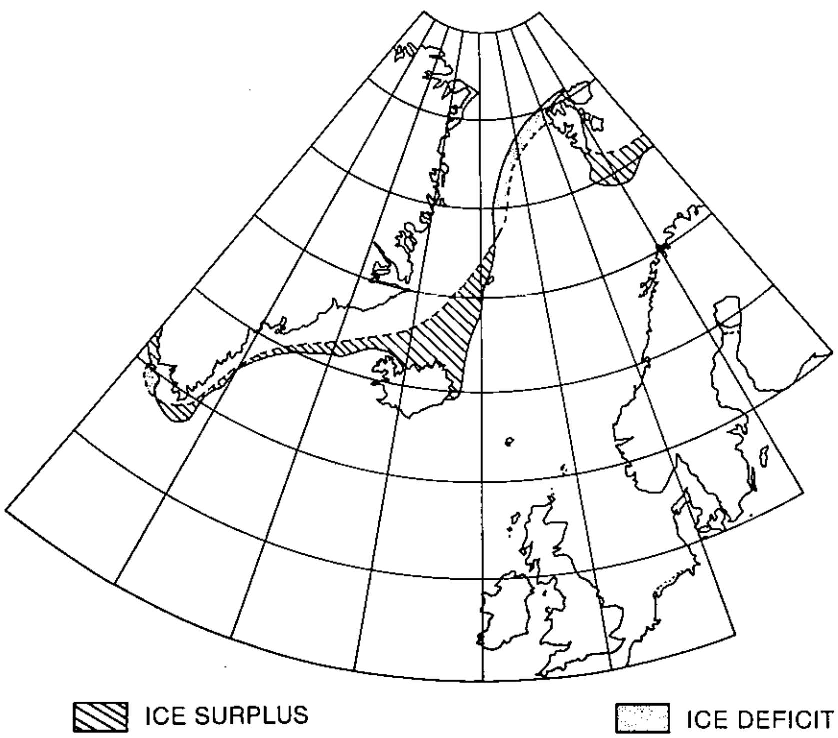
Some species, such as herring, are affected by climatic factors in other ways. These fish spawn at the same time each year, whereas production of plankton, the vital food for the newly hatched fish, may vary by several weeks depending on wind strength and direction and amount of solar radiation. If insufficient food is available, the species will become less abundant that season (Cushing, 1976).

The El Niño phenomenon, the appearance of unusually warm water off the Peruvian coast, often accompanied by heavy rains, has a negative effect on the fisheries of the Peru Current off the western South America coast. The movement of the warm water toward the coast is associated with the relaxation of the southeast trade winds and the temporary weakening of the upwelling of the current. The normally cold water supports a large fish population, but the suppression of the upwelling from deep water allows the anomalously warm, tropical, oxygen-poor water, which cannot support plankton, to dominate. The plankton provide necessary nutrients for many species, notably the Peruvian anchovy, which is valued for the production of fish meal (Caviedes, 1975). Migration routes and abundance of certain species of tuna also are affected by the warm water.

The 1972 El Niño reduced the total fish catch to 30 percent of the 1970 volume, and the economic effects were so potentially critical that the Peruvian fishing industry was nationalized and, in 1978, suspended indefinitely to allow stocks to recover. Sea surface temperatures during the 1972 El Nino were as much as 10°F warmer than for a corresponding month in 1973, a non-El Niño year (Johnson, 1976).

Another El Niño developed in 1976, and its characteristic sea surface temperature patterns were easily distinguishable from those





Top: Changes in the migration routes of herring that led to the collapse of the Icelandic fishery have been partially blamed on changes in ice cover (above) in the North Atlantic.

of cold or non-El Niño years (Miller, 1977).

Quinn (1976) suggests that monitoring factors such as sea level atmospheric pressure may lead to a method that could be used to predict climate-related changes such as the El Niño, thus forecasting favorable and unfavorable periods for tropical Pacific fisheries.

Cold temperatures in the Bering Sea keep some species of flatfish (for example, yellowfin sole, rock sole, and flathead sole) from feeding off the richly concentrated benthos in the northern regions (benthos are organisms that live at the bottom of the sea and provide food for fish). In years when climatic factors cause the waters to warm, more of this food becomes available to these commercially valuable fish (Alton, 1974). The impact of the icepack in this area on fish resources is currently being studied (McLain, 1976a).

Seawater temperatures also determine the available stock of sockeye salmon (Straty, 1974). Warmer temperatures in parts of Bristol Bay and the Bering Sea keep the migration routes of the young fish in coastal waters. Temperature governs the amount of energy required for swimming and feeding, thus influencing the rate of migration seaward. Seawater temperature also determines the amount of growth achieved before the salmon face winter in the North Pacific Ocean. Colder temperatures slow migration and growth and decrease catches, probably because of predation on these smaller-than-average spawners. Similarly, the halibut catch is inhibited by unusually cold waters.

Low salmon catches in the early 1970s were attributed to 1971 and 1972 sea-surface temperatures that were colder than had been reported for at least twenty years (Johnson, 1976).

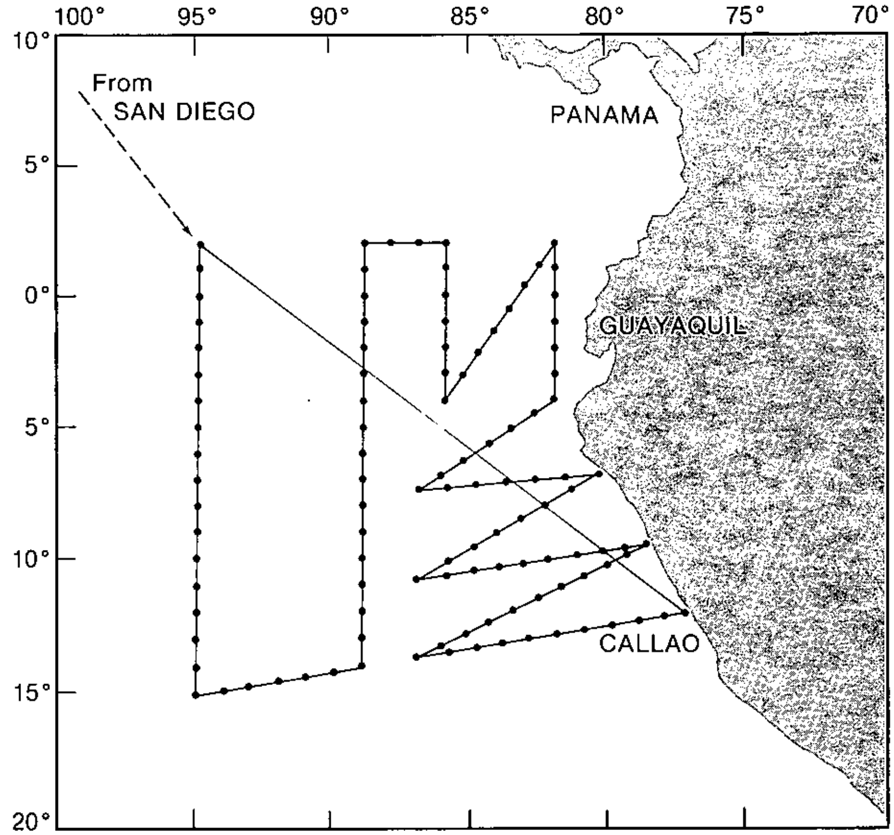
McLain (1976b) reports various warming and cooling trends in water temperature off the east and west coasts of the United States, and he relates these data to changes in distribution and abundance of several fish species.

Unusually early warming of the atmosphere in February and March of 1976 led to early and excessive runoff of fresh snowmelt into the waters of the New York Bight. The warm freshwater formed a layer over the ocean water. A lack of spring storms suppressed mixing, and normal respiration by bottom-dwelling species depleted the oxygen in the bottom waters off New Jersey. This condition is held responsible for excessive kills of surf clams, red hake, lobsters, crabs, cunner, and ocean pout. The extreme temperatures also interrupted spawning, decreased the survival rate of eggs and larvae, and disrupted the fish food chain (Armstrong, 1976; Cook, 1976; Diaz, 1976).

Eastern seaboard and Gulf coast fisheries are of particular concern to scientists because the young of major food and fertilizer species (such as shrimp and menhaden) live in bays and estuaries. These areas are subject to considerable climate variation, especially in winter, because of atmospheric patterns that affect temperature, rainfall, and the consequent runoff.

Menhaden, spawned off Cape Hatteras, depend on wind-driven water to carry the larvae inshore to estuaries. Unsatisfactory atmospheric and oceanic movements result in low fish yields (Nelson, 1976).

The eastern seaboard shrimp fishery seems to have better yields when the preceding winter has been relatively mild and the water remains warmer. Winter weather conditions in this area have been related to air-sea interaction over the equatorial Pacific and the development of troughs and ridges over the North Pacific and North America. Strong troughs bring colder air masses over the eastern seaboard; ridges tend to block northern storms and admit more tropical air masses, allowing water temperatures to remain warmer and encouraging greater shellfish yields (Johnson, 1976).



Cruise tracks of an El Niño Watch undertaken from February to April 1975 in anticipation of an expected El Niño event.

Current Activities

Several NOAA agencies are active in fishery oceanography and meteorology. The Environmental Data and Information Service (EDIS) provides oceanographic and meteorological climate data and information to fisheries. The National Marine Fisheries Service (NMFS) collects and analyzes oceanic data, as part of its MARMAP program (Marine Resources Monitoring, Assessment, and Prediction), to predict changes in fish stocks. The NOAA Climate Program provides for continuing support of efforts to assess and quantify the impact of climate fluctuations on fish yields to help determine fishery allocation and management decisions.

The Pacific Environmental Group of the NMFS and the U.S. Navy's Fleet Numerical Weather Central at Monterey, Calif., provide environmental data such as water temperature for fisheries research, and study long-term, large-scale fluctuations in marine populations. The NMFS and the Inter-American Tropical Tuna Commission in La Jolla, Calif., also provide input for fisheries research and for improving means of establishing fish catch quotas.

Although there is much still to be learned about the relationship between climate and fish stocks, scientists have succeeded in constructing productivity models for major crops such as shrimp, tuna, anchovies, herring, sardines, and menhaden. The NMFS and the EDIS held a workshop on climate and fisheries in April 1976 at the Center for Climatic and Environmental Assessment in Columbia, Mo., which served to focus attention on the use of climate-fishery models as well as the collection of oceanographic, meteorological, and biological data from the world's fisheries.

This is the third in a series of Current Issue Outlines developed by the Library and Information Services Division of EDIS' Environmental Science Information Center. The outlines provide objective background material on current topics of high general interest. This issue outline is available as a separate publication from: User Services Branch, D822, LISD, Environmental Science Information Center, NOAA, WSC#4, 6009 Executive Boulevard, Rockville, MD 20852. The monograph contains additional bibliographic material that has been omitted here.

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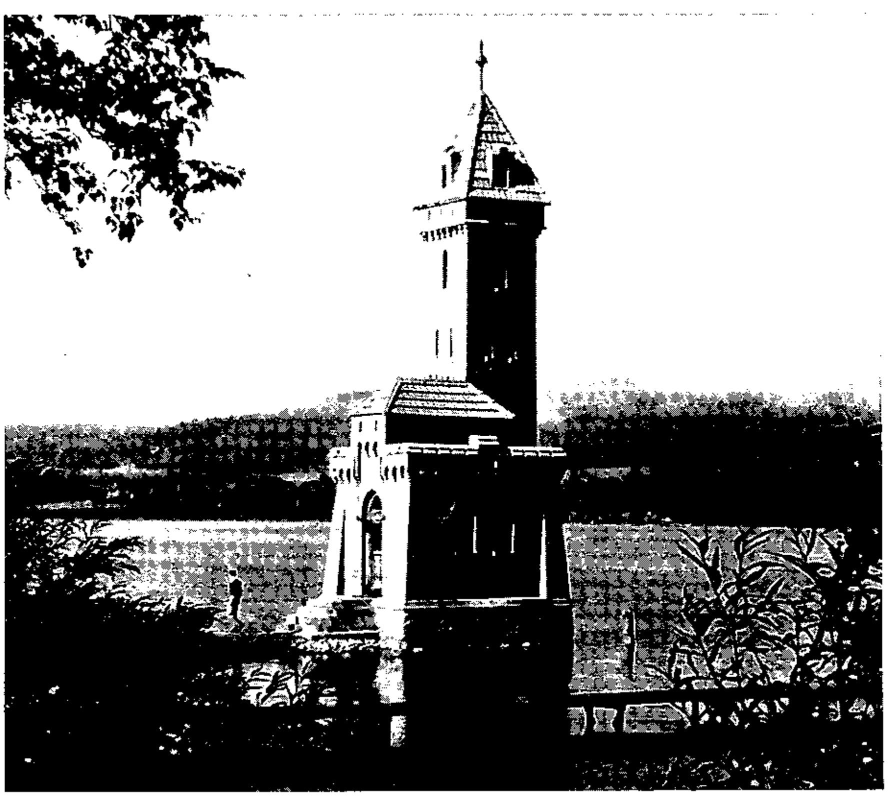
Cooling Degree Days and Power Consumption

In July 1978, the Climatic Impact Assessment Division of EDIS' Center for Environmental Assessment Services initiated an analysis of cooling degree days and a summary of temperature-related power consumption. Analyses are made weekly and monthly during the cooling season (see below) and are reported in the Center's weekly *Environmental/Resource Assessment and Information* publication.

The analysis and reports use population-weighted cooling degree day data and the 30- and 90-day outlooks of the National Weather Service's Climate Analysis Center. The reports analyze cooling degree days compiled in the period from May through September 30, since this period includes the primary cooling season for most parts of the country.

The weekly reports compare accumulated cooling degree days for each of the 48 conterminous states to the normal accumulation and the accumulation in the previous season. In addition to this information, the monthly reports incorporate projections of cooling degree days based on the 30- and 90-day temperature outlooks. The state cooling degree day values also are incorporated into regional and national population weighted values.

In mid-September, analysis indicated that most of the population of the United States was experiencing more cooling degree days than normal. However, except for the West South Central and Pacific regions, these totals were less than last year's. Some of the highest totals relative to normal had occurred in Arizona, Nevada, New Mexico, Louisiana, Oklahoma, Texas, Florida, Maryland, Maine, New Hampshire, and Vermont. Although this would indicate an increase in electricity demand for cooling, it did not appear that any critical power shortage situations had occurred.



Nineteenth Century Weather Records

The National Climatic Center (NCC) has distributed two prototype publications to members of the climate research community for evaluation and comment. The booklets are *Index of Historical Surface Weather Records—New York* and *A Long Record of Weather Observations at Cooperstown, New York (1854-1977).*

The publications are part of NCC's efforts to catalog recorded meteorological data during the 1800's and to synthesize available station documentation into a single reference source. The Center also will create a unique digital

Kingfisher Tower on Otsego Lake, the famed "Glimmerglass" of James Fenimore Cooper's Leatherstocking Tales.
New York State Dept. of Commerce

data file of long-term climatological data for stations selected on the basis of the availability of adequate documentation as to location, instrument exposure, and observing practices.

NCC intends to publish a data inventory for each state and to do a number of individual station summaries. The state inventories will be converted to digitized information files for computer information retrieval.

The index of New York records publication brings together station histories and other types of documentation from various published and unpublished sources on file at NCC. Stations were selected on the basis of the existence of recorded meteorological data over a period of at least 5 complete years (not necessarily continuous) during the 1800's. Exceptions were made if the record began after 1895, but was uninterrupted to the present time. A total of 160 stations was selected.

The following information is given for each location: station name and index number, geographic coordinates, period of record, ground elevation, types of instruments in use, location of the original records, hours at which the daily temperature observations were taken, known sources of published data, and any additional remarks that may aid the user in the interpretation of the data.

The Cooperstown publication presents a serially complete set of mean monthly temperature and total monthly precipitation values from January 1854 to December 1977. Included in this climatological summary is a unique record of the closing by ice and subsequent reopening of nearby Otsego Lake.

In addition, summaries are presented of monthly average maximum and minimum temperatures (1890-1977), highest and lowest monthly temperatures (1890-1977), first day in fall and last day in spring with a temperature of 32°F or lower, monthly and seasonal snowfall totals, and 3-month seasonal temperature means. Also presented are time-series graphs of the seasonal and annual mean temperatures, total annual precipitation, and a normalized index of the ice cover duration at Otsego Lake compared to November-March average temperatures.

30,000 Hawaiian Earthquake Locations Added to File

The U.S. Geological Survey's Hawaiian Volcano Observatory recently transferred data on 30,000 earthquake locations on and near the island of Hawaii to EDIS' National Geophysical and Solar-Terrestrial Data Center (NGSDC). NGSDC is now reformatting and merging these into its Earthquake Data File.

The NGSDC file identifies more than 150,000 earthquake locations obtained from many cooperating worldwide seismological institutions and agencies. In addition to the Hawaiian Observatory collection, it contains important government catalogs from the United States, Russia, China, and Japan, and from universities in California and New York. Each record contains the earthquake's location, date and time, depth, and magnitude, and maximum intensity. A recently developed data base management system provides for rapid retrieval and updating of the file.

Additional information concerning the data may be obtained from NOAA/EDIS/NGSDC, Code D622, Boulder, CO 80303. Telephone: (303) 499-1000, Ext. 6591 or 6471, FTS 323-6471 or 323-6591.

New Temperature and Precipitation Data Publications

The National Climatic Center (NCC) has released two new publications containing state, regional, and national temperature and precipitation data for the period January 1931-December 1977. These monthly and annual series are derived by areal weighting of the monthly temperature and precipitation data for climatic divisions. Each state is divided into divisions (up to 10) which represent, to the degree possible, homogeneous climatic regions.

The two publications are part of NCC's continuing effort to document and describe the nation's climate. Specific goals are to provide data to expand knowledge of climatic variability processes; to assess the effect of climatic variability on human affairs; and to evaluate man's impact and influence on climate. The two publications are titled *State, Regional, and National Monthly and Annual Temperatures, Weighted by Area (Jan. 1931-Dec. 1977)* and *State, Regional, and National Monthly and Annual Total Precipitation, Weighted by Area (Jan. 1931-Dec. 1977).*

A limited number of copies is available from the National Climatic Center, Federal Building, Asheville, NC 28801.

South Atlantic Marine Climatic Atlas Revised

The publication *U.S. Navy Marine Climatic Atlas of the World, Volume IV, South Atlantic Ocean (Revised 1978).* NAVAIR 50-1C-531, is now available. Published by the Director, Naval Oceanography and Meteorology, it updates and revises NAVAIR 50-1C-531, published in 1958. The new issue was compiled from a data base nearly twice the size of that used in the 1958 volume. It has two parts under the same cover: Part I, Meteorology, was compiled by EDIS' National Climatic Center; Part II, Oceanography, was compiled by the U.S. Naval Oceanographic Office.

Part I contains monthly charts and supplementary graphics for the surface elements: temperature (air and sea), humidity, precipitation, visibility, wind, waves, cloud cover and height, and atmospheric pressure. Part II, Oceanography, contains charts for tides, ocean currents, and ice conditions.

Some of the meteorological data presentations have been changed from the 1958 Atlas: wave statistics have been added, and there are no upper air charts included, because several comprehensive volumes of upper air data have been published in recent years.

The 325-page volume is for sale by the Superintendent of Documents, Government Printing Office, Washington, DC 20402. GPO stock number is 008-042-00069-1. Price $16.25.

Airport Climatological Summaries Published

EDIS' National Climatic Center has completed 80 of its proposed 175 *Airport Climatological Summaries* for major U.S. airports. These 18-page summaries are based on the 10 years of record 1965-1974 and serve principally as aids to aviation.

Each publication contains a capsule summary of aviation weather for the station; means and extremes data; tables of monthly and annual values of average maximum, average minimum, and average temperature; total precipitation; total snowfall; and total heating and cooling degree days; and monthly and annual percent frequency of observations for five selected ceiling-visibility categories.

The publications also contain tables of monthly and annual percent frequencies of observations for various weather elements, such as ceiling, visibility, and weather type by wind direction; and wind direction versus windspeed for both all-weather and instrument flight conditions. In addition, the monthly and annual frequencies for 10 selected weather types, 8 windspeed classes, 7 temperature ranges, and 6 visibility categories are shown for each of the eight 3-hourly observations. The history of the station location and instrument exposures also are included.

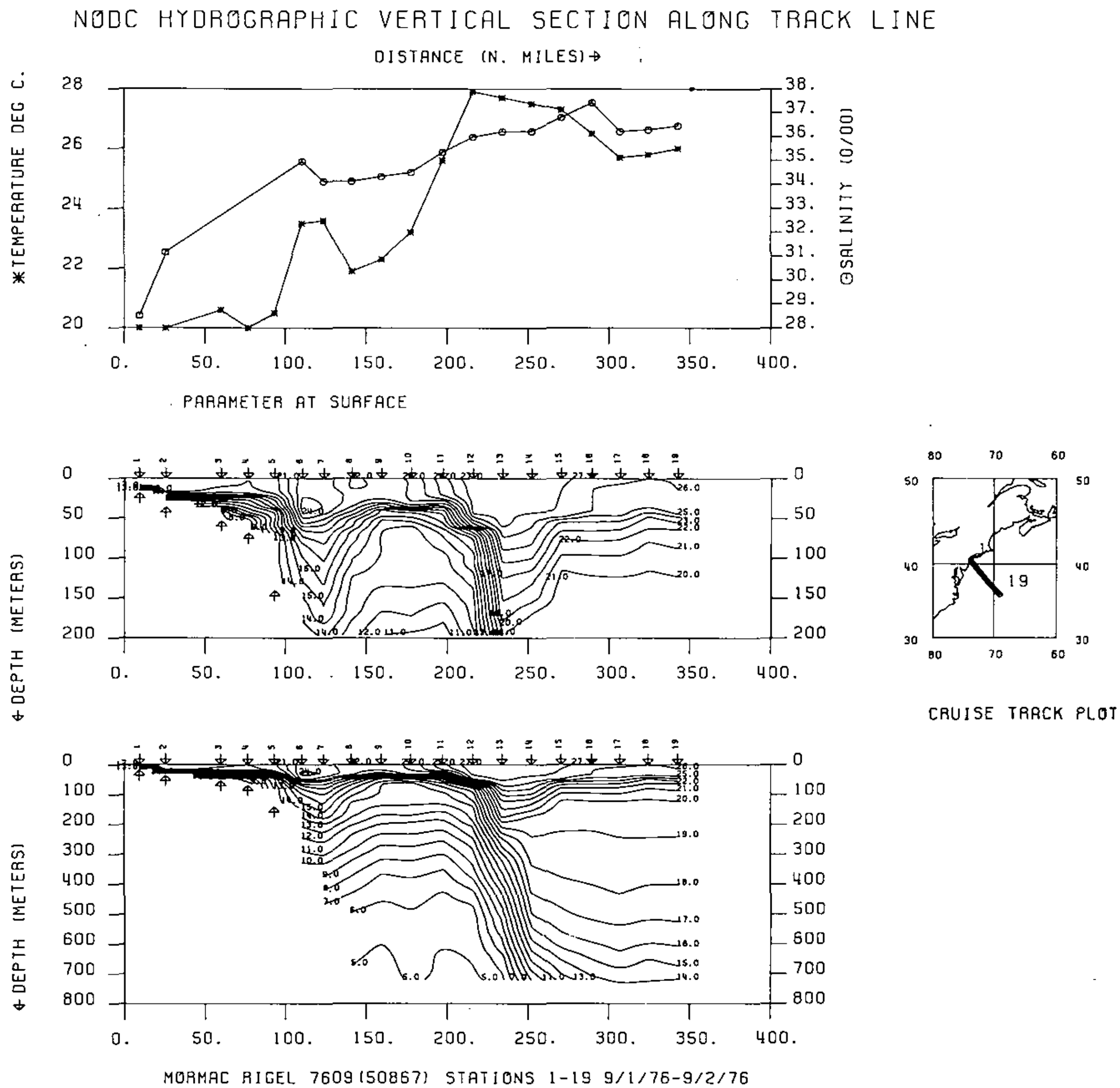
Copies of the published summaries are priced at $0.50 per station. Request for information or orders for copies of these publications should be addressed to: Director, National Climatic Center, Federal Building, Asheville, NC 28801 or telephone (704) 258-2850, Ext. 683.

XBT Inventory Published for U.S. Atlantic and Gulf Coasts

EDIS' National Oceanographic Data Center (NODC) has published an inventory of expendable bathythermograph (XBT) observations taken in U.S. Atlantic and Gulf coastal waters under the Ship of Opportunity Program. The program, conducted to support the National Marine Fisheries Service's Marine Resources Monitoring, Assessment, and Prediction Program, seeks to identify and describe seasonal and year-to-year variations of temperature and circulation in major currents of the tropical Atlantic, Caribbean Sea, Gulf of Mexico, and western North Atlantic, using merchant ships to collect oceanographic data.

The inventory contains monthly plots of observations taken in 1976 for which NODC has processed data. In addition, each ship transect is identified on the plots and correlated with a chronological listing giving cruise dates, location by longitude and latitude, and depth scale. Data for the transects are available from NODC in a variety of forms. The transect plot graph—a popular form—encompasses a station location plot, plot of surface temperature and salinity, and two vertical section temperture plots for selected ocean depth ranges. (See next page.)

Copies of the publication, *NODC Inventory of XBT Data in U.S. Atlantic and Gulf Coastal Waters,* can be obtained from: National Oceanographic Data Center (D761), Environmental Data and Information Service, NOAA, Washington, DC 20235.



Climates of the States Revised

The National Climatic Center has completed revision and printing of Climatography of the U.S. No. 60, *Climates of the States* for each of the 50 states and for Puerto Rico and the U.S. Virgin Islands. The revised publication contains a narrative description of the general climate of the state or area; a Normals, Means, and Extremes Table for each National Weather Service (NWS) First Order Station in the state; and a Means and Extremes Table for those substations in the state that are included in another publication series, *Climatography of the U.S.* No. 20 (see September EDIS, p20). This latter series provide climatic summaries for 1,063 NWS cooperative climatological observing stations in all 50 states and Puerto Rico.

Copies of *Climates of the States* are priced at $0.50 each. Address requests for copies to: Director, National Climatic Center, Federal Building, Asheville, NC 28801 or telephone (704) 258-2850, Ext. 683.

SAM'S CLUB

"SAM'S CLUB" (System of Automatic Message Switching for Communicating Lucidly with Brevity) is a computer conference experiment designed to improve communication between individuals in several countries involved in planning, managing, and operating the international Aquatic Sciences and Fisheries Information System (ASFIS). The experiment, sponsored by the U.S. Environmental Data and Information Service, is part of a series of computer conferences planned to test the benefits of this new mode of communication.

As a geographically decentralized organization, ASFIS continually faces communication problems when a printed record is necessary. Written communication between international contacts is slow and normally requires more than a week for a simple exchange of letters and even longer for more complicated transactions. Moreover, time differences pose another problem. Since satellite data transmission links between North America and Europe are already in place, it is now practicable to communicate with individuals and organizations outside the U.S. Soon, group or two-way communication between Washington, New York, Ottawa, London, Paris, Hamburg, and Rome to support ASFIS international activities may become routine.

To support ASFIS coordinating bodies such as the Panel of Experts and the Aquatic Science and Fisheries Abstracts Advisory Board requires extensive communication of detailed lists, instructions, and advice. Some of this material must be sent to all Centers; other portions may be applicable to only one or two Centers. The computer conference system makes it possible to exchange this material and to receive comments and responses more rapidly.

The new system is accessible to ASFIS participants from most places in North America and Western Europe via simple computer terminals. It makes use of the United States commercial data transmission networks called Telenet and Cyphernet. Users in some European locations must make arrangements through their domestic post-telephone-telegraph authorities to gain access to these U.S. Networks. In addition, SAM's CLUB uses a computer conference program (CONFER) designed by the Environmental Data and Information Service.

Computer conferences serve as a means to present new information and to confront and resolve differences of opinion between ASFIS participants. Furthermore, in certain situations, a freer and more reflective information exchange ensues if the pressures of personalities and time are removed. One major advantage over telephone communication is the availability of a printed record, and, in some instances, the cost is lower. The message can also be stored and forwarded to the recipient when called for, even days later. This is a distinct advantage over existing teletype systems.

The concept of computer conferences was originally developed to speed communication in crisis situations such as natural disasters. Conferees may exchange messages via text in unstructured note form, conduct seminars or meetings, develop jointly authored reports, and elicit information in questionnaire style. Participants may have preassigned roles such as critic, reviewer, editor, expert, and so on.

Using computer conferences to develop jointly authored reports represents a major breakthrough in text-editing. This involves combining standard text-editing procedures with message transmission to permit several individuals to participate from different locations. Each maintains his own copy while making comments and suggestions concerning the text of others.

As of September 1978, SAM'S CLUB was being used actively for ASFIS-related communication between the following agencies:

- NOAA/EDIS, Washington, D.C. and Rockville, Md.
- Department of Fisheries and Environment, Water Resources Document Reference Centre, Ottawa, Canada
- Intergovernmental Oceanographic Commission of UNESCO, Paris, France
- Marine Biological Association of the U.K., Plymouth, England
- Centro de Informacion Científica y Humanística, Universidad Nacional Autonoma de Mexico, México City

Expansion to other European and United Nations participants in ASFIS is expected soon.

New Master Marine Data Set for the Pacific

A new, comprehensive (16 million observations) marine data set for the Pacific Basin, suitable for studying long-term climatic variations and large-scale sea-air interactions, has been assembled by EDIS' National Climatic Center (NCC). The objective in creating this data set was to bring together all readily usable shipboard observations of wind, air temperature and sea-surface temperature in compact form on a single set of magnetic tapes.

These data date back to 1854, and include the Pacific bucket temperature data recently assembled by NCC as part of the Historical Sea Surface Temperature Data Project as well as ship-intake water temperature observations.

The identification of duplicate observations was among the more difficult problems encountered. These problems were compounded because of the different identification and coding methods in use by the various data sources. Other aspects of quality assurance were handled through programs that checked for internal consistency and climatic limits. In addition, data were arranged into frequency and cumulative relative frequency distributions by 1°C or 1 knot class intervals by 10° latitude-longitude area and were reviewed for anomalies and errors. Errors that were detected were eliminated and the entire data set placed on 34 reels of magnetic tape (9 ch, 800 bpi).

For further information, write: Director, National Climatic Center, Asheville, NC 28801 or call (704) 258-2850, Ext. 203.

Egyptian Oceanographic Data Center

EDIS' National Oceanographic Data Center (NODC) is cooperating with the Egyptian Government in developing a National Oceanographic Data Center at Alexandria. Potential NODC support involves technical assistance in purchasing computer equipment and assistance in training Center personnel. When fully developed, the Center will process and analyze oceanographic and fisheries data and support studies of pollution transport rates along the coast, erosion and deposition processes in the Nile Delta area, and the rapidly developing United Nations Environment Program's marine pollution studies in the Mediterranean.

NODC representatives visited the Egyptian facility in September 1978 to begin negotiations for procurement of equipment and to make final plans for a training program in the United States. The Egyptian data center will be developed according to guidelines issued by UNESCO's Intergovernmental Oceanographic Commission for establishing Responsible National Oceanographic Data Centers.

International Exchange of Volcano Data

The International Association of Volcanology and Chemistry of the Earth's Interior has adopted a first *Guide for the International Data Exchange through the World Data Centers for Volcanology.* The World Data Centers were established for the International Geophysical Year in 1957-1958 to facilitate the exchange of data worldwide and have served this function for many geophysical disciplines since then.

The new guide for volcanology is the first to formally specify the data to be exchanged internationally in this field. It calls for the WDC's to archive copies of physical and chemical data from many compilers worldwide and to distribute these to requesters, particularly when multidiscipline geophysical data are needed. The WDC's will use these data themselves in a number of publications and data products, such as a world map of active volcanoes.

World Data Center-A for Solid Earth Geophysics, which is operated by EDIS' National Geophysical and Solar-Terrestrial Data Center in Boulder, Colo., will serve as the Volcanology Data Center within the United States.

US/USSR Joint Seismic Experiment

As part of the U.S./U.S.S.R. Agreement on Environmental Protection, a joint seismic experiment for tsunami research has been implemented to exchange long period seismographs and the records from these instruments. Three long-period Soviet seismometers were installed adjacent to U.S. equipment in a tunnel at Kipapa, Hawaii on January 19, 1978, to run for about one year. U.S. equipment has been installed at Yuzhvo Sakhalinsk, U.S.S.R.

Seismograms from these instruments are microfilmed at World Data Center-A in Boulder and copies sent to the principal investigators in the U.S. and U.S.S.R. and to WDC-B in Moscow. This experiment will help improve the comparability of U.S. and Soviet data and provide researchers in both countries with better data sets.

Three Earthquakes Qualify for International Data Exchange

A rare earthquake near Bermuda on March 24, 1978, a major earthquake off the coast of Japan on June 12, 1978, and a disastrous earthquake in Iran on September 16, 1978 have been declared eligible for the International Data Exchange program. This program, conducted in accordance with principles set forth by the International Council of Scientific Unions, provides for the exchange of seismograms of large magnitude events. Since the program's inception in 1974, 25 earthquakes have qualified.

World Data Center A for Solid Earth Geophysics, collocated with and operated by EDIS' National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo., to date has received more than 30,000 records from 300 seismological 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 scientific community worldwide.

The magnitude 6.0 Bermuda earthquake of March 24, 1978 is interesting to scientists because of its unusual location, centered about 300 km southwest of Bermuda. The shock was strongly felt on the island, and additional felt reports were received from a number of places along the east coast of the United States.

The earthquake which occurred near the east coast of Honshu, Japan was centered beneath the Pacific Ocean about 130 km off Sendai. This tremor, measured at magnitude 7.5, caused extensive damage at Sendai and other towns

Women and children evacuated from Sendai City, Japan, following a major earthquake on June 12, 1978.

Wide World Photos

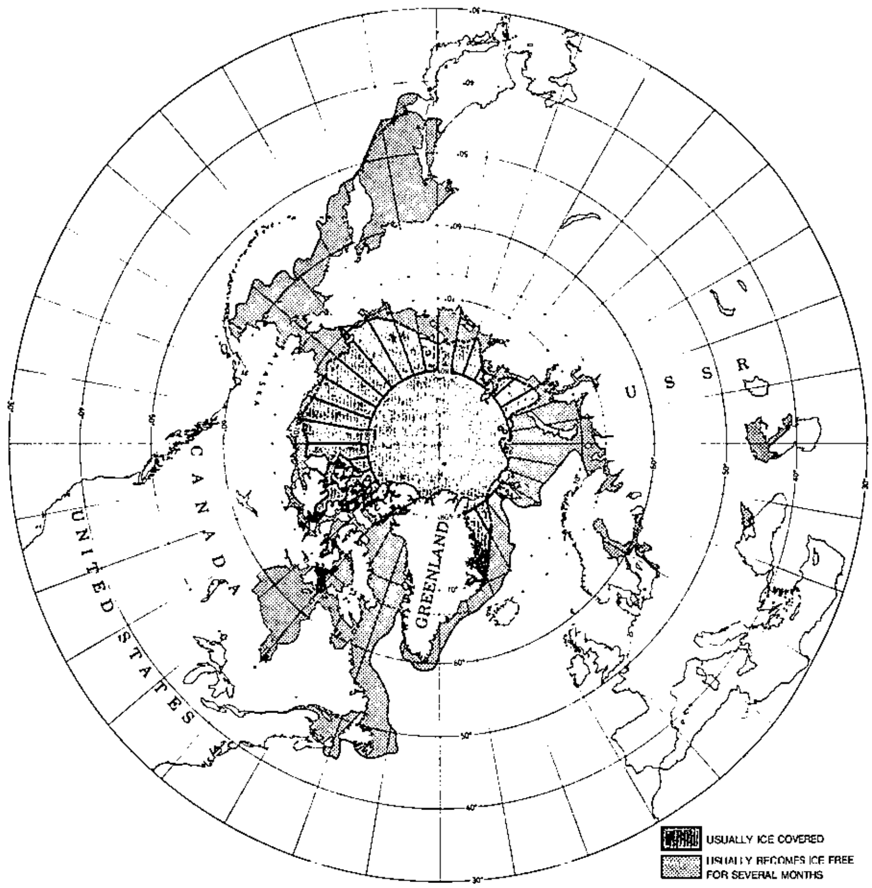
in Miyagi Prefecture. Twenty seven deaths and about 700 injuries resulted from the earthquake. Broken windows were reported in Tokyo, 350 km from Sendai. A minor tsunami (seismic seawave) followed the earthquake.

The devastating earthquake that hit a broad area of eastern Iran killed an estimated 25,000 persons. The cities of Tabas and Ferdows were virtually destroyed by the magnitude 7.7 shock; in addition, more than 100 villages suffered major damage.

Arctic Sea Ice Publication

World Data Center-A for Glaciology (Snow and Ice) has published a two volume compilation of articles and references entitled *Arctic Sea Ice.* The report, GD-2, is the second in a series of topical reports on the various disciplines in glaciology. It contains seven contributed articles on current activities and survey papers, as well as a selected and classified bibliography of more than 2,300 items.

WDC-A Glaciology is operated by the University of Colorado's Institute of Arctic and Alpine Research under contract to EDIS. Communications concerning the publication should be addressed to: Marilyn Shartran, World Data Center-A for Glaciology (Snow and Ice), Institute of Arctic and Alpine Research, Boulder, CO 80309.



Mean maximum and mean minimum limits of sea ice in the Northern Hemisphere (Whittman and Schule, 1966).

Ionospheric Observations Handbook Revised

The World Data Center A for Solar-Terrestrial Physics has published a revised edition of Chapters 1-4 of the Unions Radio-Scientifique Internationale's *Handbook of Ionogram Interpretation and Reduction (November 1972).* The chapters were revised to further refine and standardize routine procedures at the 150 or more individual ionospheric stations forming the worldwide ionospheric network.

Most sections of the Handbook consist of detailed instruction for technicians who use special high frequency radios to measure heights and other characteristics of ionospheric layers, typically 100 to 400 km high. The introduction, however, and subsections at the beginning of each section also explain the general principles involved. These, together with historical notes, are designed to document the evolution of established practices.

Before and during the International Geophysical Year (1957-58), the main users of ionospheric data were largely the groups who collected them. Today, the number of noncollector scientists using the data far exceeds the collectors. These scientists need data from different stations in standard comparable form. The handbook is designed to assist that purpose. Copies are available from EDIS' National Climatic Center, Federal Bldg., Asheville, NC 28801 at $2.14 a copy.

International Geophysical Calendar for 1979

In cooperation with the world scientific community, the International Geophysical Calendar for 1979 has been prepared by EDIS' National Geophysical and Solar-Terrestrial Data Center (NGSDC). The calendar is issued annually to coordinate solar and geophysical observations and data exchange.

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 is a permanent scientific service of the International Union of Radio Science (URSI), with participation by the International Astronomical Union and the International Union of Geodesy and Geophysics. The IUWDS coordinates the international aspects of the world days program and of rapid data interchange. 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 1979 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 80303.

JANUARY

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JANUARY 1980

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27	28	29	30	31		

16 Regular World Day (RWD)

17 Priority Regular World Day (PRWD)

14 Quarterly World Day (QWD) also a PRWD and RWD

10 Regular Geophysical Day (RGD)

26 Day of Solar Eclipse

24* Dark Moon Geophysical Day (DMGD)

5 6 World Geophysical Interval (WGI)

25 26 Airglow and Aurora Period

3, 28 Day with unusual meteor shower activity, Northern, [,or Southern,], Hemisphere

NOTES:

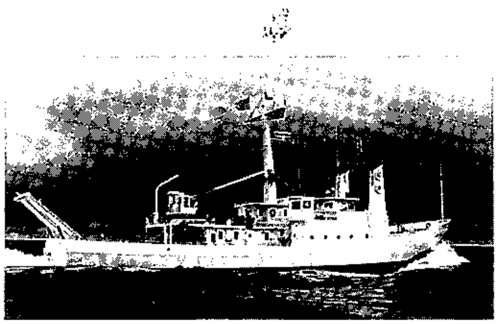
1. N-MAC (noon-midnight auroral correlations) periods are: Jan. 21-Feb. 3, Feb. 19-Mar. 4, Mar. 19-Apr. 1, Sep. 16-Oct. 2, Oct. 15-30, Nov. 13-28, 1979.
2. IAGA/URSI Working Group on Passive Electromagnetic Probing of the Magnetosphere international campaign Jun. 18-Jul. 15, 1979.
3. Special observing periods for FGGE are Jan. 5-Mar. 5 and May 1-Jun. 30, 1979.
4. STIP Interval VI rehearsal for SMY, Apr. 15-May 15, 1979.
5. STIP Interval VII (Spacecraft Parade) Aug.-Sep. 1979.
6. Flare Buildup Study test interval May-Jun. 1979.

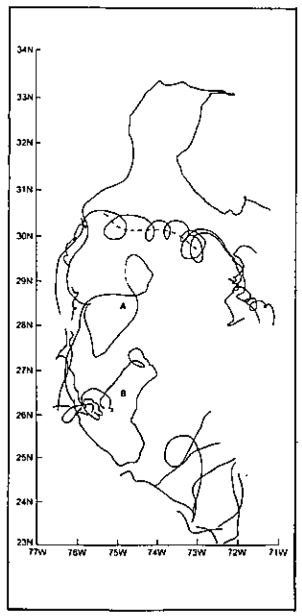
OPERATIONAL EDITION, August 1978.

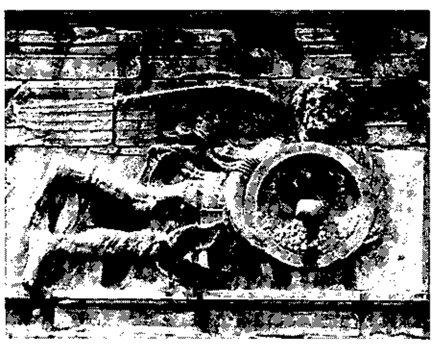
U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Environmental Data and Information Service
Washington, D.C. 20235

OFFICIAL BUSINESS
Penalty for Private Use, $300

Postage and Fees Paid
U.S. Department of Commerce
COM-210
Controlled Circulation Rate



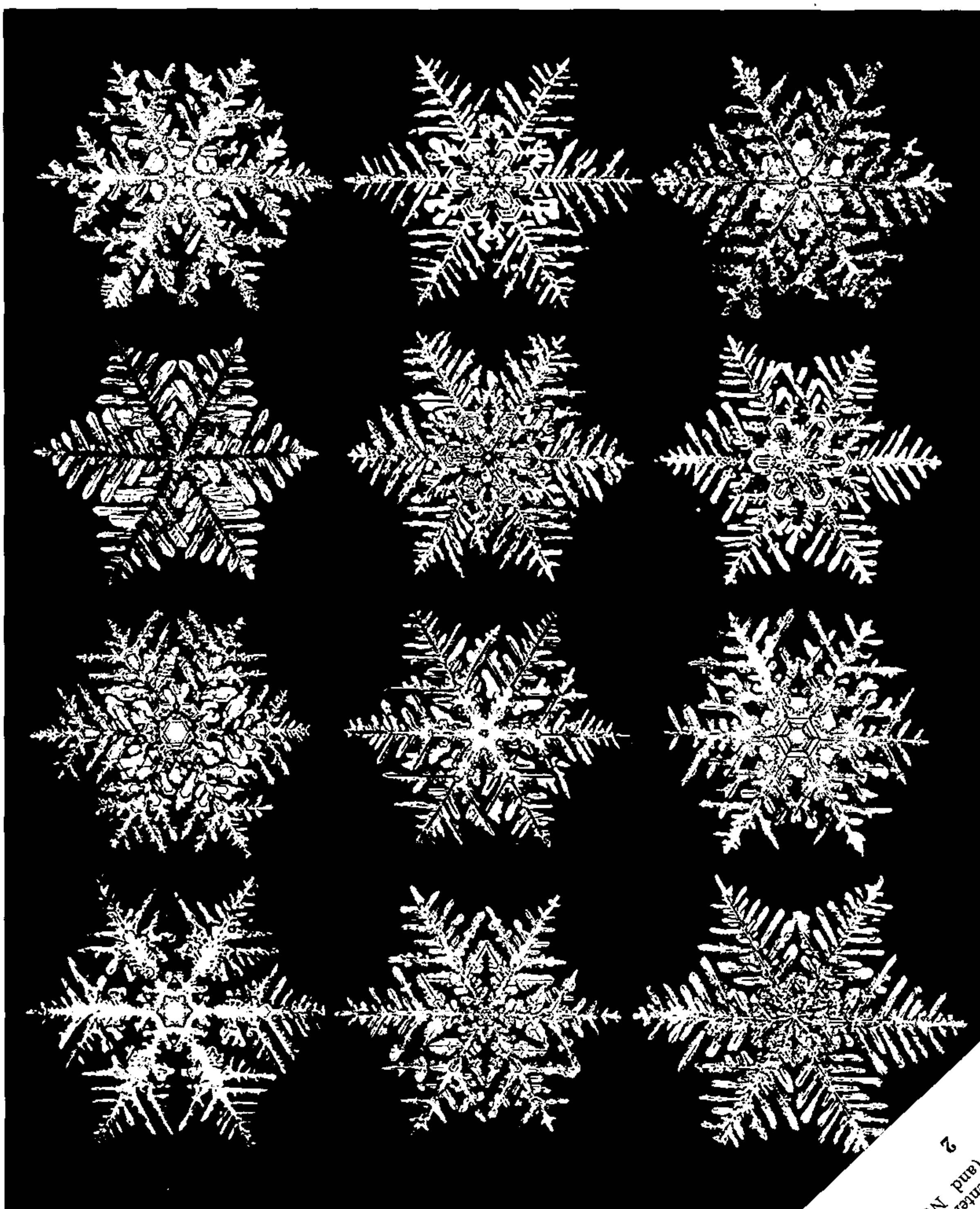




In this issue: *Oceanographic data systems (p. 3); tracking deep ocean currents (p. 7); the mythology of meteorology (p. 11); and weather, climate, and fish stocks (p. 14).*

EDIS

Environmental Data and
Information Service
January 1979



EDIS

Environmental Data and Information Service
January 1979

Cover: *Snow crystals. The past two winters rudely reminded us of our vulnerability to climatic vagaries. Their impact on our national life and economy provided part of the impetus for the National Climate Program Act, examined in the following editorial and in the article that begins on p.4.*

Photo: Wilson Bentley, Vermont Historical Society

EDIS is a bimonthly publication designed to inform Environmental Data and Information Service (EDIS) cooperators, colleagues, and contributors of recent developments in EDIS programs and services and in the general field of scientific data and information management. EDIS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, and Center for Environmental Assessment Services. In addition, under ...ment with the National Academy of ...EDIS operates World Data ...eanography, Meteorology ...tion), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology (Snow and Ice).

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, EDIS, Page Building 2, Room 533, 3300 Whitehaven St. N.W., Washington, DC 20235.

The National Climate Program Act: A Congressional View

The National Climate Program Act passed by Congress and signed into law by the President will make an important contribution to our Nation's well-being. The program and its goals received widespread support as Congress developed this legislation over the past two years. There is an urgent need for the mandated increases in climate research, monitoring, prediction, and information dissemination, if we are to more effectively anticipate and respond to the impacts of climate change.

Climate change directly and indirectly affects all segments of society. Therefore, the broadest possible initiatives are called for, with the coordinated involvement of numerous government agencies, the research community, and the private sector. In this time of budgetary pressures, it is crucial that we stress the potential large economic benefits this program can provide by helping to reduce climate-related losses in agriculture, energy, transportation, and water planning.

The climate act legislation does not spell out a specific program, but rather initiates a *process* for evolving a workable program, with planning input from both users and producers of climate information. The climate program is a prototype of a class of programs that can succeed only if involved organizations are able to transcend classic patterns of bureaucratic rivalry and inhibited information flow. The whole point of making climate the focus of a national program is to emphasize that it is a subject which cannot be confined in ordinary organizational boundaries and that it must be considered a critical element of strategic planning in almost all areas of human endeavor.

The Secretary of Commerce and the National Climate Program Office have an important and challenging responsibility. They must carry out their leadership roles in such a way that other Federal agencies, as well as State and local governments and private interests, perceive the climate program not as a Department of Commerce effort, but as a national partnership that uses the best talents and capabilities of all participants in both planning and execution.

Climate change presents an epic challenge to the technical community. Knowledge of climate change will probably imply the need for short-term sacrifices in the economic or political realm. Without an unwavering consensus and data of great credibility, the scientific sector will not be able to convince the rest of society of the need for these sacrifices. Imagine the difficulty of persuading a State's agricultural industry to refrain from expanding a high profit crop with the argument that recent favorable climatic conditions are very unlikely to persist. The difficulty must be multiplied many times to approximate the world technical-political ramifications associated with facing the implications of a possible man-caused CO_2 buildup and "greenhouse" effect.

The global nature of climate and its impacts make expanded international scientific cooperation in this area not merely desirable, but essential. Countries the world over are becoming increasingly conscious of how closely global agriculture and energy systems are intertwined, and how vulnerable they are to climate perturbations. Projects such as the current Global Atmospheric Research Program (GARP) demonstrate the necessity and value of multinational efforts. The National Climate Program should be geared to vigorously pursue the excellent opportunities for interaction with the World Climate Program and other cooperative international climate ventures.

Congress will be watching with great expectations as the climate program takes shape, and will be enthusiastically participating in its implementation through intensive oversight activities. We will be working with all concerned parties to help ensure that the National Climate Program is a successful example of a new kind of cooperation that will serve as a model for future programs requiring equally broad-based support.

George E. Brown Jr.

George E. Brown, Jr.
Chairman, House Subcommittee on the Environment and the Atmosphere

The National Climate Program Act: A Special Challenge

By Edward S. Epstein, Director
National Climate Program Office

This time last year.
Newsday, *Long Island*

The National Climate Program Act, which President Carter signed on September 17, 1978, has three rather distinct aspects of particular significance.

First, the Act is a statement of policy, making it clear that the United States believes that the Nation and the world will be better off when we learn to "understand and respond to natural and man-induced climate processes and their implications." The Congress and the President now have said, "Let's get on with the job."

The second significant aspect of the legislation is the emphasis placed on the various "elements" which will comprise the climate program. The list is a broad one, and although it does include research to increase our understanding of climate processes, the emphasis is clearly on providing more and better climate information, on identifying and quantifying the impact of climate and climate fluctuations, and on delivering climate information and services to users.

The third aspect of the legislation of particular interest is the manner in which the program is to be administered. The National Climate Program must involve not only a large number of Federal agencies, but also State governments, as well as a large gamut of users of climate information. At the same time, however, a National Climate Program Office is given specific responsibility for leadership of the program. How the program office exercises leadership responsibilities while keeping the program pluralistic is a special challenge presented by the legislation.

Program Elements

The Act defines nine "elements." The last of these is a 5-year plan (to be updated at least every 2 years) which will be promulgated by the President. The plan is important to the Congress, because it will provide a firm basis for their oversight of the program, clear evidence of coordination, and specifics on agency roles and funding requirements. The Congress has decreed a very short timetable for writing the plan. A preliminary version is to be delivered to Congress by March 1979. The remaining elements define the substance of the program.

The first element concerns "assessments of the effects of climate on the natural environment," and on a host of activities of social and economic importance. These assessments are to be conducted by the "Federal agencies having national programs in food, fiber, raw materials, energy, transportation," and so on, and "may include recommendations for action." Thus, the first thing the climate program must be concerned with is the effects of climate, determining what they are and suggesting ways to cope with them. This particular element also requires that every Federal agency that has a mission in an area that can be affected by climate (Are there any exceptions?) is to participate in the program. The Congress recognizes that to be credible and useful, assessments will have to be generated by those whose policies may be affected.

Element number two is "basic and applied research to improve the understanding of climate processes, natural and man-induced, and (of) the social, economic and political implications of climate change." It is worth noting that the Congress recognizes that there is much to be learned about climate processes, but that they place on an equal footing the need to learn about the implications of climate change; most previous discussions of what a climate program should entail have stressed the former and said almost nothing about the latter. Congress is asking for a balanced approach.

The third and the eighth elements must be considered together. Number 3 involves "methods for improving climate forecasts on a monthly, seasonal, yearly, and longer basis" (Note the implicit definition of climate), while number 8 requires the establishment of "experimental climate forecast centers." Forecasting is important, and the inadequacies of present capabilities are recognized; but we should not, the law states, let our efforts be stymied by lack of assurance of success. Further, we should seek out innovative scientists and novel approaches, and not rely on a single source for progress in this very difficult area.

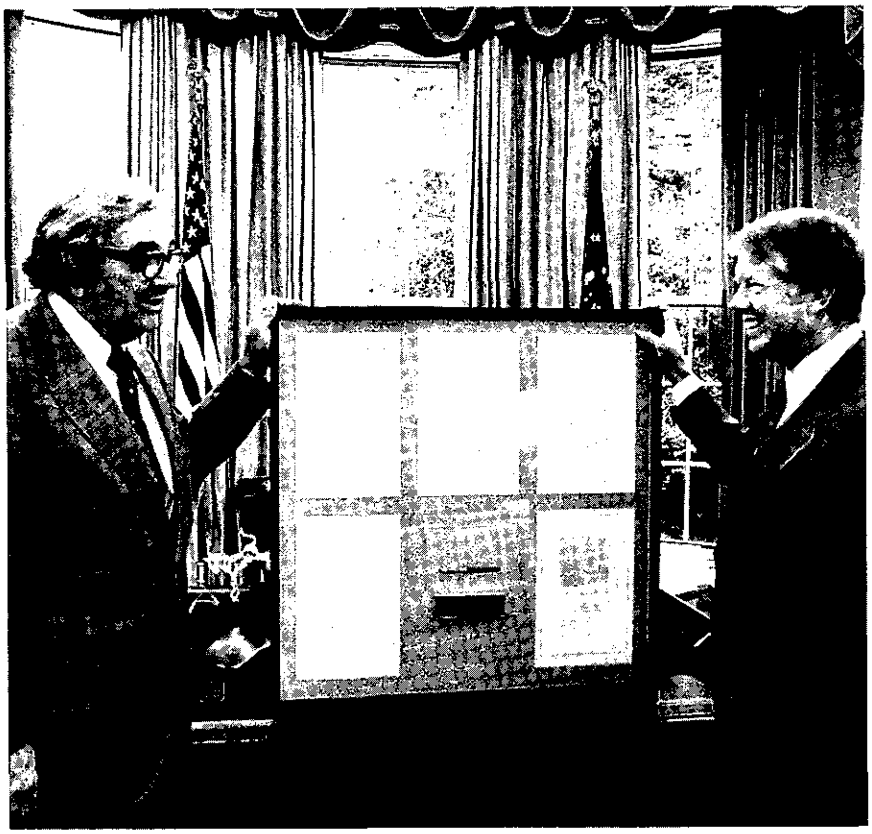
Elements four and five deal with global data collection and data management. Again, the emphasis is on end products: "reliable, useful, and readily available information," and "active dissemination of . . . information and assessments." There also is an added caveat that there be "consultation with current and potential users." The message is very clear. The purposes of the program are to provide information, to assure that there are means to determine what information is most needed, and to stimulate its wide application.

The sixth element declares that we should act to increase "international cooperation in climate research, monitoring, analysis, and data dissemination." The United States has much to gain from strong international cooperative efforts in acquiring global climate data, information, and knowledge—and also much to contribute. The Congress is urging the strengthening of already successful cooperative international activities such as the World Meteorological Organization's World Weather Watch, and the joint effort of WMO and the International Council of Scientific Unions in the Global Atmospheric Research Program. Indeed, planning for a World Climate Program is well underway, and a World Climate Conference will be held in Geneva in February.

The remaining element of the Program concerns "mechanisms for intergovernmental climate-related studies and services." These are spelled out in great detail in Section 6 of the act. Climate services must not be thought of as wholly a Federal activity. State governments, universities, the private sector and others concerned with applied research and advisory services all must be involved. These channels eventually may become the most important mechanisms by which climate services are generated and delivered, and by which feedback on the directions the Program should take are brought to the attention of those doing the planning.

Program Management

The Act imposes two somewhat opposing thrusts on the management and direction of the National Climate Program. First, it requires the Secretary of Commerce to establish a National Climate Program Office to "be the lead en-



President Carter and Congressman George Brown with a memento of the signing of the National Climate Program Act of 1978.

tity responsible for administering the Program." At the same time, the language and the history of the act make it very clear that this is to be a multiagency program, and that the function of the Office must be to encourage, not stifle, broad participation in the program. That this may prove to be a difficult task has not been lost on the Congress.

In the Conference Report which accompanied the Bill, the conferees noted that "the national climate program is a prototype of the class of programs which can only succeed if involved organizations are able to transcend the classic patterns of bureaucratic rivalry and inhibited information flow. The entire point of making climate the focus of a national program is to emphasize that it is a subject which cannot be confined in ordinary organizational boundaries, and that it must be considered as a critical element of strategic planning in almost all areas of human endeavor."

The report continues, "[the Secretary of Commerce and the Office] . . . must carry out their leadership responsibility in such a way that the other Federal agencies, as well as State and local governments and private interests, perceive the climate program not as a Department of Commerce effort, but as a national partnership, utilizing the best talents and capabilities of all participants in both planning and execution."

Thus the Climate Program is something of an experiment in management of multidiscipline, multiagency activities. The plan for making the program work, therefore, is worthy of considerable attention.

First of all, the National Climate Program Office, which has been established in NOAA, will be staffed by professional people from several different agencies and from non-Federal sources as well. Already, several Federal agencies (the National Aeronautics and Space Administration, U.S. Department of Agriculture, and National Bureau of Standards) have provided personnel for the Office. Additionally we are being assisted by a State Climatologist (from Colorado State University) and a scientist from the National Center for Atmospheric Research. This type of staffing will help us achieve a program with a national character.

The function of the Office will be actively to seek advice and input as to what climate efforts are needed and opportune. We will solicit and welcome advice from all sources—Federal and State agen-

NATIONAL CLIMATE PROGRAM ACT
ELEMENTS

(1) Assessments.

(2) Basic and Applied Research.

(3) Methods for Improving Climate Forecasts.

(4) Global Data Collection.

(5) Management and Dissemination of Data, Information, and Assessments.

(6) International Cooperation.

(7) Intergovernmental Studies and Services.

(8) Experimental Climate Forecast Centers.

(9) 5-Year Plan.

National Climate Program Office staff members. **Standing** *(left-to-right): Edward Epstein, NOAA; Thomas McKee, Colorado State University; Stanley Ruttenberg, National Center for Atmospheric Research; Dudley McConnell, NASA; Alan Hecht, National Science Foundation; Douglas Sargeant, NOAA; and Harry Moses, Department of Energy.* **Seated***: Thomas Waltz and James Almazan, NOAA; Howard Hill, Department of Agriculture; Harry Rook, National Bureau of Standards; and William Sprigg, NOAA.*

cies, individuals, the National Academy of Sciences, industry, professional societies, our own statutory Advisory Committee—and try to turn that advice into a coherent and effective plan of action. The plan will outline specific program objectives, strategies, resources, and importantly, who will be responsible for implementing each part of the program. The agencies to whom the tasks are assigned—not the program office—will have responsibility for seeking funds for these programs and for managing their day-to-day activities.

An interagency committee made up of policy officers of the various Federal agencies concerned is being established. This body will provide general policy direction to the Office and thereby to the program, and will approve the plans and reports prepared by the Office in response to the legislation. In giving their approval, for example, to the 5-year plan, these officials will be committing themselves and their agencies to try to live up to the expectations of the plan. Each agency will be encouraged to be an enthusiastic participant, carrying out programs that are traditionally a part of its mission, but which have special national and global significance because of their relevance to the climate program and to the efforts of all the other participants.

If this sounds like an unlikely scheme to observers of the Federal bureaucracy, my response is that it can be done if we put our minds, muscles, and good wills to work on it. If there are others who think developing a smooth, effective cooperative program among a dozen Federal agencies, State governments, and the academic and industrial cummunities is not too great a challenge, I ask them to support our efforts to do so. We have made a commitment to implement the National Climate Program Act, to make the system work, and to try to make our world of ever-varying climate a more hospitable one for people everywhere.

Independent Peer Evaluation of the Large Area Crop Inventory Experiment

Introduction

From November 1974 through November 1, 1978, the U.S. Department of Agriculture, NASA, and EDIS/NOAA cooperated in a Large Area Crop Inventory Experiment. LACIE was undertaken to determine if satellite crop monitoring and meteorological observations could be used with climate/crop-yield models to make timely and accurate estimates of future crop production in the major wheat-producing countries of the world.

LACIE was an attempt to exploit agriculture-related information available from the Landsat Earth-observing satellite and the global meteorological observational network, supplemented by meteorological satellite observations. Information requirements were determined by the U.S. Department of Agriculture (USDA). NASA adapted Landsat remote-sensing technology to crop identification and area estimation. NOAA/EDIS provided current crop assessments and crop-yield predictions based on crop/weather relationships. Final crop production estimations were calculated as the product of wheat area and wheat yield within a crop region.

LACIE made extensive use of independent peer review during its lifetime. These appraisals were made by experts from Government, industry, and academia. The following section is excerpted from a final evaluation (1) presented at the LACIE Symposium held at NASA's Lyndon B. Johnson Space Center, Houston, Tex., in October 1978.

LACIE Results

The LACIE results to date clearly demonstrate that present remote-sensing capabilities can be combined with or substituted for conventional methods of collecting information in order to improve foreign crop production estimates. However, experiment results are not uniform throughout the growing season or from region to region. In certain regions, the LACIE results indicate that technology improvements are needed. It is important to recognize these differences and to assess experiment results in these various phases rather than simultaneously in their entirety.

Primarily because of such factors as field size and climatological conditions which influence management practices and alternatives, LACIE achieved its best results in estimating wheat production in the U.S.S.R. Information on wheat production in the U.S.S.R. from traditional sources has been and remains poor, particularly from the point of view of timeliness. At the same time, the U.S.S.R. is periodically a large purchaser of U.S. grain with significant impact on domestic as well as international prices. This, then, can only lead to the conclusion that LACIE results provide much needed information not now available from other sources. In the U.S.S.R., LACIE is of practical and immediate value.

Because of small fields, strip farming, and difficulties of separating "confusion crops," experiment results are not as impressive for the spring wheat regions of the United States and Canada. New technology such as improved satellite resolution may be required to solve these problems.

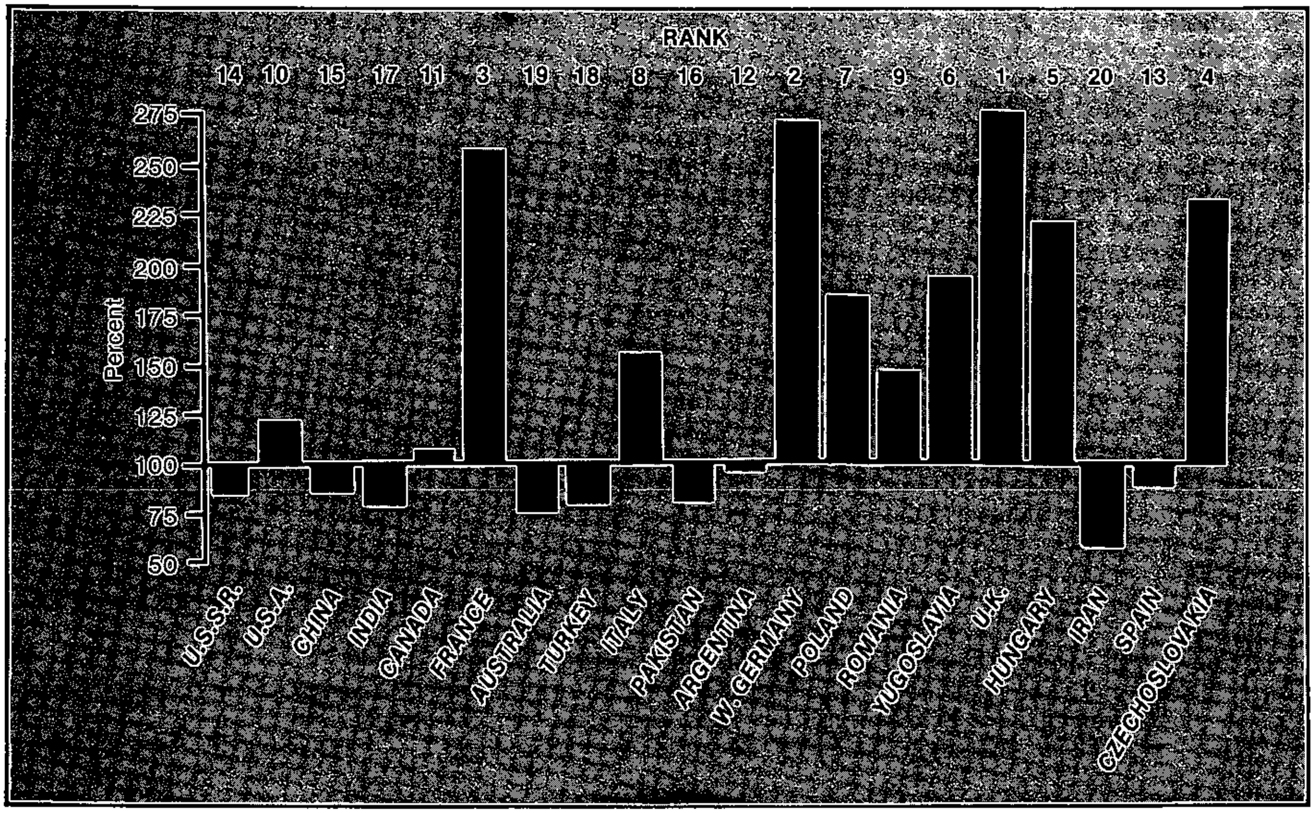
Although the original list of LACIE countries included China, India, Australia, Brazil, and Argentina, no production estimates were generated for these countries. Given the magnitude of the task and the available resources, we view the original goal of providing production estimates for all these countries as having been too ambitious. However, LACIE did conduct exploratory investigations within these countries. Although these investigations indicated that the LACIE approach would be generally applicable in these countries, additional investigations of the kind conducted in the United States, Canada, and the U.S.S.R. will be required to establish the degree of applicability.

In addition to the accuracy of commodity forecasts, another important consideration is timeliness. The LACIE data system and operations were experimental and thus not optimized for timeliness. The LACIE system required on the average 45 to 60 days between Landsat acquisition and completion of analysis of a segment. However, much of this time resulted from weekend or overnight hold time or time during which data lay on a desk awaiting analysis. Without such delays, it appears quite feasible to design an operational system that can complete analysis of the Landsat data within approximately 2 weeks of acquisition.

Regarding the question of the transferability of the LACIE technology from wheat to other crops (corn, soybeans, rice, or forage), the technical approaches developed in LACIE should be generally applicable; however, considerable additional research and development may be required to adapt this technology to the characteristics of each crop. To assess more fully the utility of remote-sensing technology for the multiple crop application, additional experimental efforts will need to be made.

Yield models, which are used in conjunction with acreage estimates to arrive at production estimates, are an important component in the LACIE experiments. Given the overall performance in the U.S.S.R., a reasonable evaluation would be that yield models for that region of the world produce better information than is available currently. Such models are therefore useful, although replacement with more advanced models that account for wider ranges of weather variation must definitely be considered. Because the current stage of model development would have to be assessed as being marginally adequate for the United States and Canada, it is believed that a major effort should be put forth to develop models which do a more adequate job of yield estimation. It is recommended that such models have a good theoretical, physical, and physiological basis rather than relying exclusively on linear statistical regression, which produces models that are limited in their response to extreme conditions. It is realized that the less sophisticated models will probably be required for some time in many countries because of the limited availability of meteorological and historical data. However, techniques that permit the use of satel-

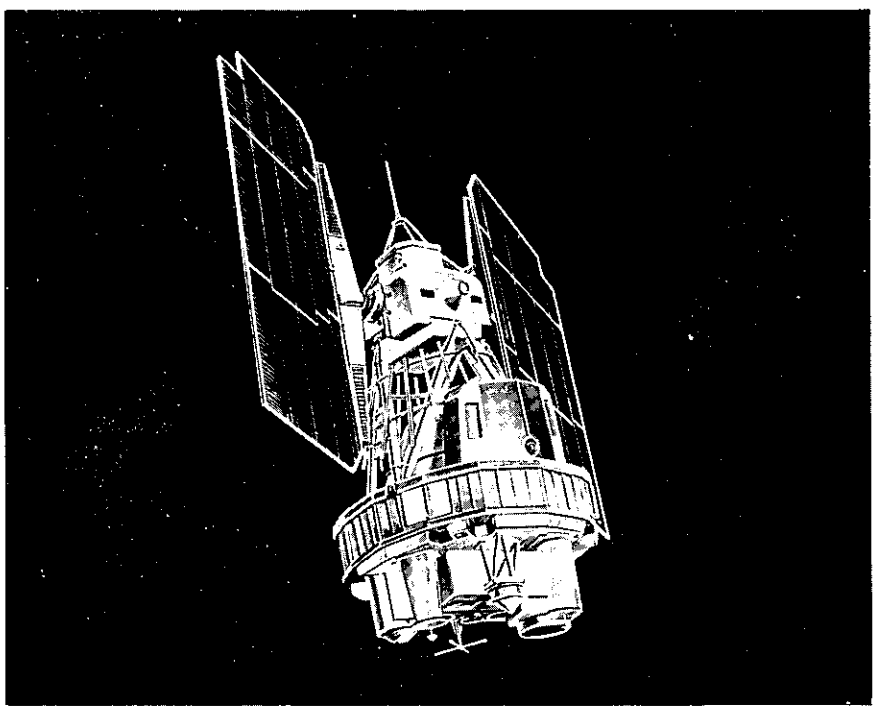
Indian women harvesting a crop of high-yield wheat.
FAO photo by Peyton Johnson



Relative percentages of world wheat yield, 1973-77. (The world average yield of 24.74 bushels/acre equals 100 percent.)

lites to provide additional meteorological data—such as solar radiation, surface temperature, precipitation, or snow cover—should be further developed. With such techniques, environmental satellites should play an increasingly important role in providing such meteorological data at finer spatial intervals and in areas where access to such data is otherwise restricted.

The primary benefit of improved yield models will most likely be improved near- and at-harvest estimates of yield. Up to a month or so before harvest, the major source of yield forecast uncertainty will be uncertainty in the weather through harvest. In this period of uncertain yield, the component of production which can be known with the greatest certainty is the growing area of the crop. While the LACIE estimates of acreage are accurate



The LANDSAT satellite.

An example of a general wheat-yield model. Variables include temperature and moisture departures from normal.

$$\hat{Y} = \alpha + \beta_1 T + \beta_2\left(\frac{Z_i \cdot W_i}{\sum_{i=1}^{n} W_i}\right) + \beta_3\left(\frac{Z_i \cdot W_i}{\sum_{i=1}^{n} W_i}\right)^2 + \sum_{j=1}^{m} \gamma_j D_j + \sum_{j=1}^{m} \delta_j D_j^2 + \sum_{j=1}^{k} \eta_j P_j + \epsilon$$

from midseason on, they are biased low early in the season, before the crop is completely detectable in the Landsat data. It is believed that the LACIE early-season acreage estimates could be greatly improved by using statistical bias reduction techniques such as multiyear ratio estimation. An additional issue that must be resolved is the difficulty in using Landsat data to distinguish wheat from other small grains, primarily spring barley and winter rye.

Results of attempts to evaluate the economic importance of LACIE technology seems to us to be of limited usefulness to date. This limitation stems primarily from the inability to develop good estimates of the value of improved commodity forecast information. In addition, it appears to us that the economic evaluations that were conducted did not reflect an in-depth understanding of the current LACIE methodology and results or the potential results of an improved future technology.

Concerning the transfer of LACIE technology to the USDA, the LACIE technology components are being transferred partially or in full to the department's Application Test System; however, in response to recently shifting USDA priorities, LACIE technology is being used by the Applications Test System primarily to detect and assess unusual crop conditions abroad rather than to make the quantitative commodity production forecasts evaluated by LACIE. While the Applications Test System has demonstrated it can produce a complete and timely assessment for a restricted foreign region, it will be difficult to determine the accuracy of these assessments in regions with a lack of confirming data. There has as yet been no feedback from the Foreign Agricultural Service, the intended major client of the Applications Test System. Thus, while the time is proper to review LACIE accomplishments, a review of the Applications Test System at this time is perhaps premature.

Despite the obvious room for additional research and improvement, the Large Area Crop Inventory Experiment must be considered a success. Our assessment of the experiment results leads us to the conclusion that for global wheat regions such as the U.S.S.R., the LACIE technology can be made operational and that for regions where the technology requires improvement (such as regions having small fields), funding for further research and development should be continued.

The Review Process

The review involved approximately 45 discipline and technical specialists organized into 7 review teams. Each team conducted detailed reviews in specialized areas. The above material is from a paper (1) prepared by the Plenary Team, whose members are listed below.

D. Paarlberg, Purdue University—General Chairman

R. Balwin, Cargill, Inc.—Member at Large

L. Eisgruber, Oregon State University—Cochairman, Experiment Results Team

B. Scherr, Data Resources, Inc.—Cochairman, Experiment Results Team

H. O. Hartley, Texas A&M University—Chairman, Experiment Design Team

D. Ingram, IBM—Cochairman, System Implementation and Operations Team

J. Quirein, Schlumberger—Cochairman, System Implementation and Operations Team

D. Goodenough, Canadian Center for Remote Sensing—Chairman, Data Processing Systems Design Team

G. Nagy, University of Nebraska, Lincoln—Chairman, USDA Applications Text System Team

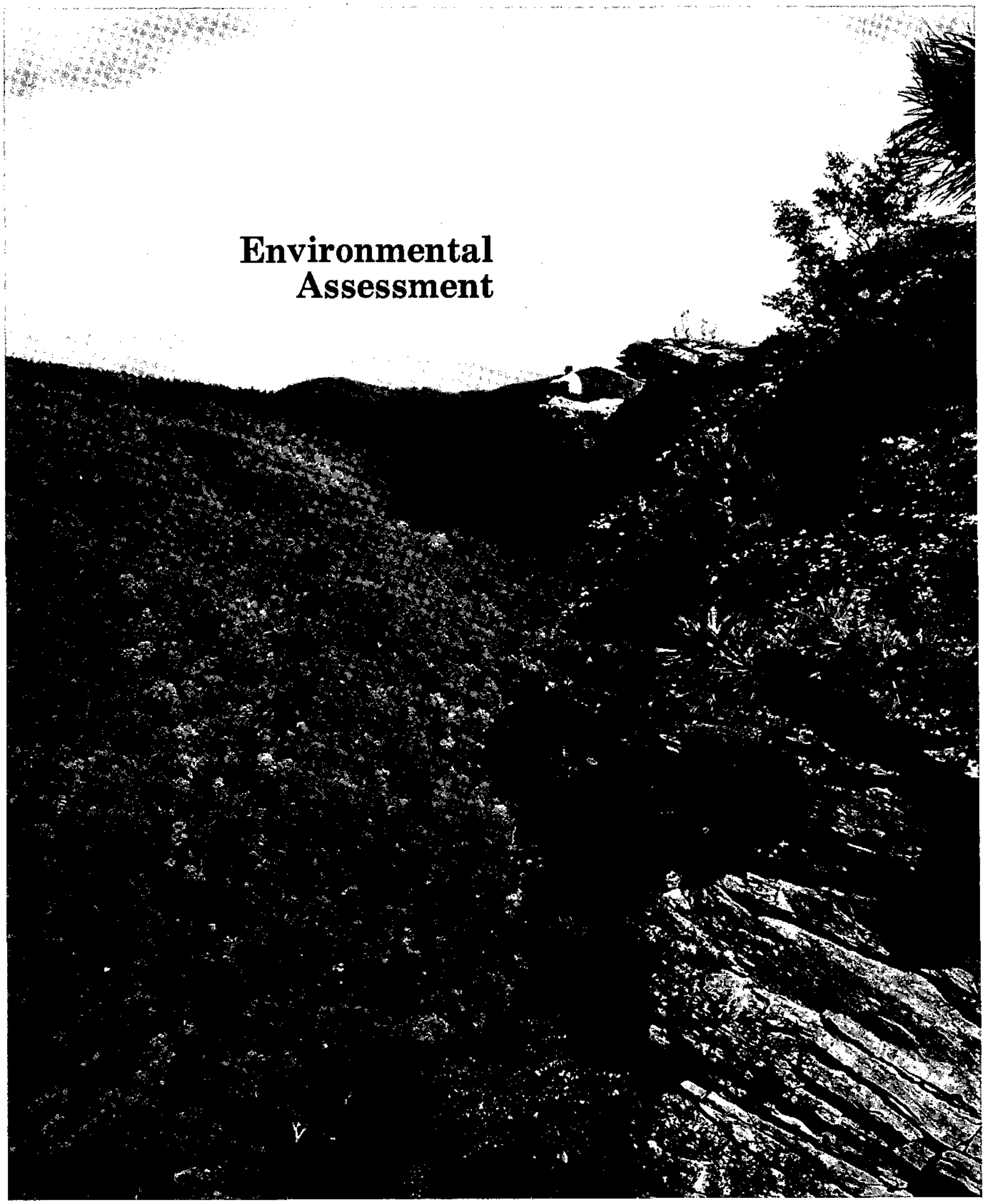
R. Holmes, General Motors Institute—Cochairman, Supporting Research Team

R. Shay, Oregon State University—Cochairman, Supporting Research Team

Reference:

(1) "An Independent Evaluation by the Plenary Review Team." *Independent Peer Evaluation of the Large Area Crop Inventory Experiment*. National Aeronautics and Space Administration, NASA JCS-14550. October 1978.

Environmental Assessment



The solutions to many environment-related problems facing the Nation today depend on data. Multidisciplinary scientific data can be applied to help resolve problems such as potential global food shortages, the energy crisis, environmental pollution, and climatic anomalies. NOAA's Environmental Data and Information Service (EDIS) assists national decision-makers in solving such problems by providing data analyses, applications, assessments, and interpretations to meet their particular requirements. Many of these services are provided by the EDIS Center for Environmental Assessment Services (CEAS). The following are examples of CEAS projects and services.

World Food Supplies

Between 1972 and 1976, world grain reserves fell to a level close to the difference between production in years with good weather and years when the weather is bad. Although reserves since have risen substantially, historical climatic data suggest that climate may be more variable and unfavorable weather more likely in coming decades than in the recent past.

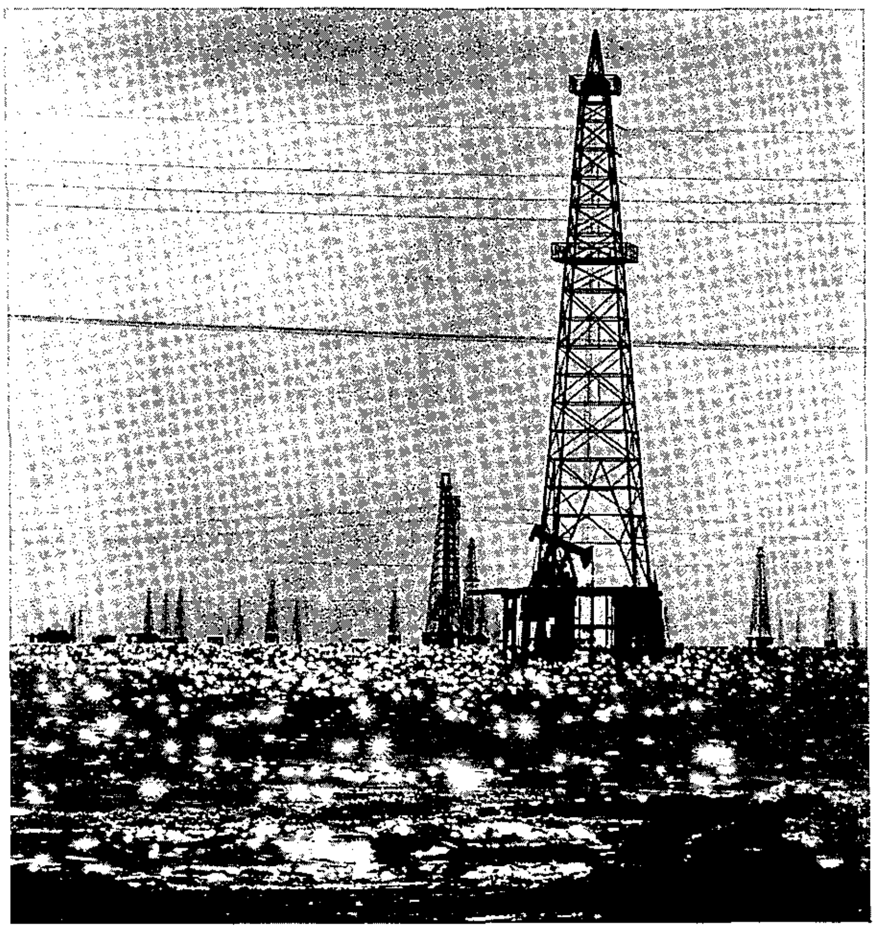
CEAS prepares data-based studies and weekly assessments of potential effects of climatic fluctuations on national and global grain production. These reports are used by the U.S. Departments of Agriculture, State, and other Federal agencies, as well as by foreign governments and international organizations, to help minimize the effects of grain production failures in any region of the world. In addition, EDIS/-NOAA, the National Aeronautics and Space Administration, and the Department of Agriculture cooperated in the Large Area Crop Inventory Experiment (LACIE) (see article beginning on p 8) that used satellite crop monitoring, meteorological observations, and EDIS data-based computer models to make estimates of future crop production in the major wheat-producing regions of the world.

The abundance, distribution, and availability of many marine food sources also are related to climatic variations. Cooperative efforts to model these relationships are underway between CEAS and NOAA's National Marine Fisheries Service.

The Energy Crisis

Efficient and effective planning, site selection, design, construction, and operation of supertanker ports and offshore drilling rigs depend heavily upon assessments of interacting environmental elements such as winds, waves, currents, seabed characteristics, visibility, air and sea temperatures, atmospheric pressure, storms, and storm surges, seismicity, erosion, and silting. CEAS provides analyses and assessments to support these efforts.

During the heating season, CEAS issues projections of natural gas demand for multi-State regions of the conterminous United



Siting, design, construction, and operation of offshore facilities depend heavily on environmental data and information assessments.
FAO photo by Peyton Johnson

U.S. Forest Service photo.

States on a monthly and seasonal basis. The projections are based on an EDIS gas demand model and on National Weather Service seasonal and monthly outlooks. They are provided to the U.S. Department of Energy and other Federal agencies responsible for energy use and planning, and, as requested, to State energy agencies and to industry. A similar service is being developed for electric power demand in the summer cooling season.

Environmental Pollution

The Departments of the Interior and Transportation are charged with assessing the risks of pollution of coastal and oceanic areas associated with planned or proposed outer continental shelf oil and gas development, deepwater ports, and other tanker operations. To help in the assessment, CEAS developed a statistical oil spill trajectory risk model based on historical meteorological and oceanographic data. The model has been used in the licensing process for deepwater ports in the Gulf of Mexico and in the environmental baseline characterization of the Mid-Atlantic outer continental shelf oil and gas lease area.

A national Strategic Petroleum Reserve of up to 1 billion barrels is planned for implementation over the next few years. It uses a system of storage cavities leached from natural underground salt domes in the western Gulf Coast area. The potential ecological effects of the planned disposal of huge volumes of saturated brine into Gulf waters were analyzed by CEAS for the U.S. Department of Energy, using multidisciplinary environmental data, computer simulations of brine transport and dispersion, and available information on area biota and their tolerance to higher salinities. These studies played a part in decisions regarding the location of storage sites and the design of the brine disposal systems. They are being followed by an EDIS-designed program of physical, chemical, and biological monitoring before, during, and after the salt dome leaching operations.

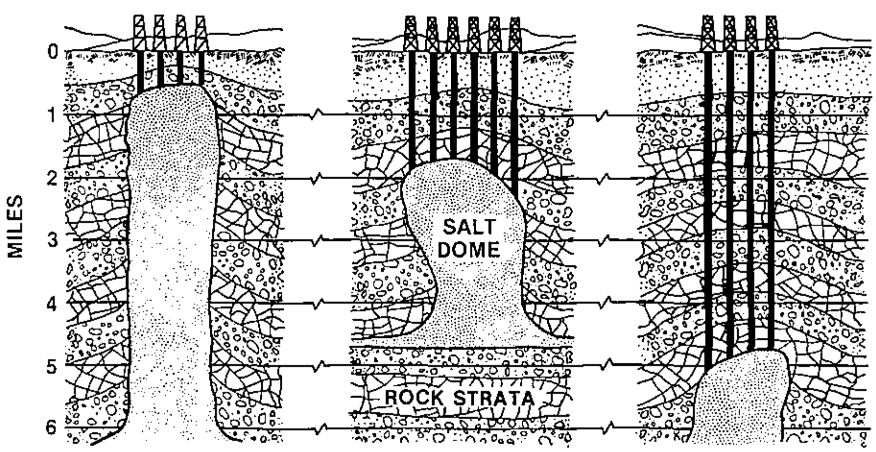
Climatic Anomalies

Climatic anomalies, such as the two recent severe winters in the eastern United States, have heavy impacts on agriculture, energy consumption, and the national economy. To realize the enormous potential benefits of predicting such anomalies, it is necessary to develop the capability to model and predict the general circulation of both atmosphere and oceans, as well as the exchange of energy, momentum, moisture, carbon dioxide, and other substances between them. A series of multination major field experiments has been sponsored by international scientific bodies to collect the interdisciplinary environmental data needed for this effort. Under broad names, such as the Global Atmospheric Research Program (GARP), these experiments have employed sophisticated sensors mounted on extensive arrays of moored and drifting buoys, ships, airplanes, balloons, and satellites, sampling at high rates under careful control. CEAS has played a key role in GARP experiments, providing experiment design, data analysis, and data management support to project managers, and producing merged, validated multidisciplinary data sets for international and national dissemination and study.

Currently, CEAS is assembling a global oceanographic data base from observations taken during the First GARP Global Experiment (FGGE). This data base is needed to design a better monitoring system for ocean climate, which may ultimately lead to improved long-range predictions of climatic trends.

For More Information

The above are examples of some of the services CEAS provides to decision-makers to help them solve environment-related problems. Additional information on these or related services can be obtained by writing: Director, Center for Environmental Assessment Services, National Oceanic and Atmospheric Administration, 3300 Whitehaven Street, N.W., Washington, D.C. 20235; or by calling 202-634-7251.



Typical salt dome structures from which brine will be leached to form oil-storage caverns.

The EDIS Environmental Data Base Directory

By Robert Gelfeld
National Oceanographic Data Center

By the end of 1980, EDIS' National Oceanographic Data Center (NODC) will have documented and described all significant environmental data files that it can find in the coastal States of the United States. Currently, the job is about 80 percent complete. NODC has concentrated its efforts in coastal States because of the current wide interest in coastal zone development and conservation.

The research community is well served by specialized bibliographic and abstracting services for technical literature. Similar services have not been available for data. It is becoming increasingly important that the existence, scope, and content of environmental data files, sample collections, and data reference files be made more widely known, so that they not be unnecessarily duplicated. In many cases, such holdings are inventoried, indexed, and even documented on a local basis. What is needed might be described as a centralized index, for convenience supported by an automated information retrieval system, so that specific referrals may be made rapidly, effectively and inexpensively.

To meet this need, EDIS has established an automated, documented comprehensive index (ENDEX) describing such environmental data collections. (See *EDS*, March 1977, p. 13.) The ENDEX subsystem called the Environmental Data Base Directory (EDBD) enables scientists and managers to answer such questions as: Who has a certain type of data in a particular area? How was it collected? What form (medium) is it in? Who sponsored the collection?

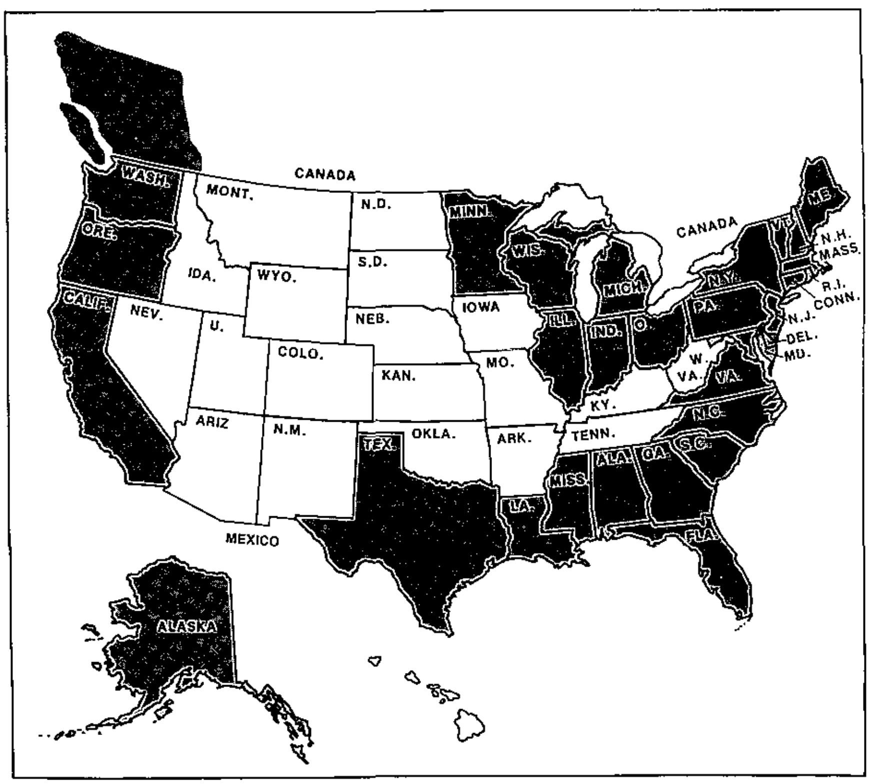
Janet Burton searches the Environmental Data Base Directory.
Photo: Leon LaPorte

EDBD describes many types of environmental data files—pollution, meteorology, biology, chemistry, oceanography, geology, and solar-terrestrial physics. An EDBD data file description lists the types of parameters and volumes of data available, the methods used to measure the parameters, 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, who to contact for further information, and the estimated cost of obtaining the data.

An EDBD file has a separate entry for each variable measured by a single method for a period of time. The coding of time period may vary (i.e., a sensor running continuously except for maintenance for several years will be one entry, but one used sporadically over several cruises might require many entries). Sample collections are classified only generally as to type of sample (plankton, sediment, fish, etc.), type of sampler (vertical tow, bottom grab, or .25mm meshes) and time period (6 cruises over a 3-year period, 1969-1971). Other information is included as appropriate (location, height or depth of sample, etc.).

Holders of environmental data files include Federal, State, and local governments; colleges and universities; private companies; and private individuals. A file is defined as a self-contained collection of data that can be handled as a unit and generally is available to requesters from the holding organization.

Flexible access to EDBD files is available. Searches can be made for virtually any category coded into a file, but generally will be confined to time period, geographic region, institution, and desired parameters. Requests can be phrased and rephrased until a subset of file descriptions satisfying the particular requirements has been located. These may then be displayed in a number of forms. The number of "hits," titles, institution names, or whole file descriptions may be printed.



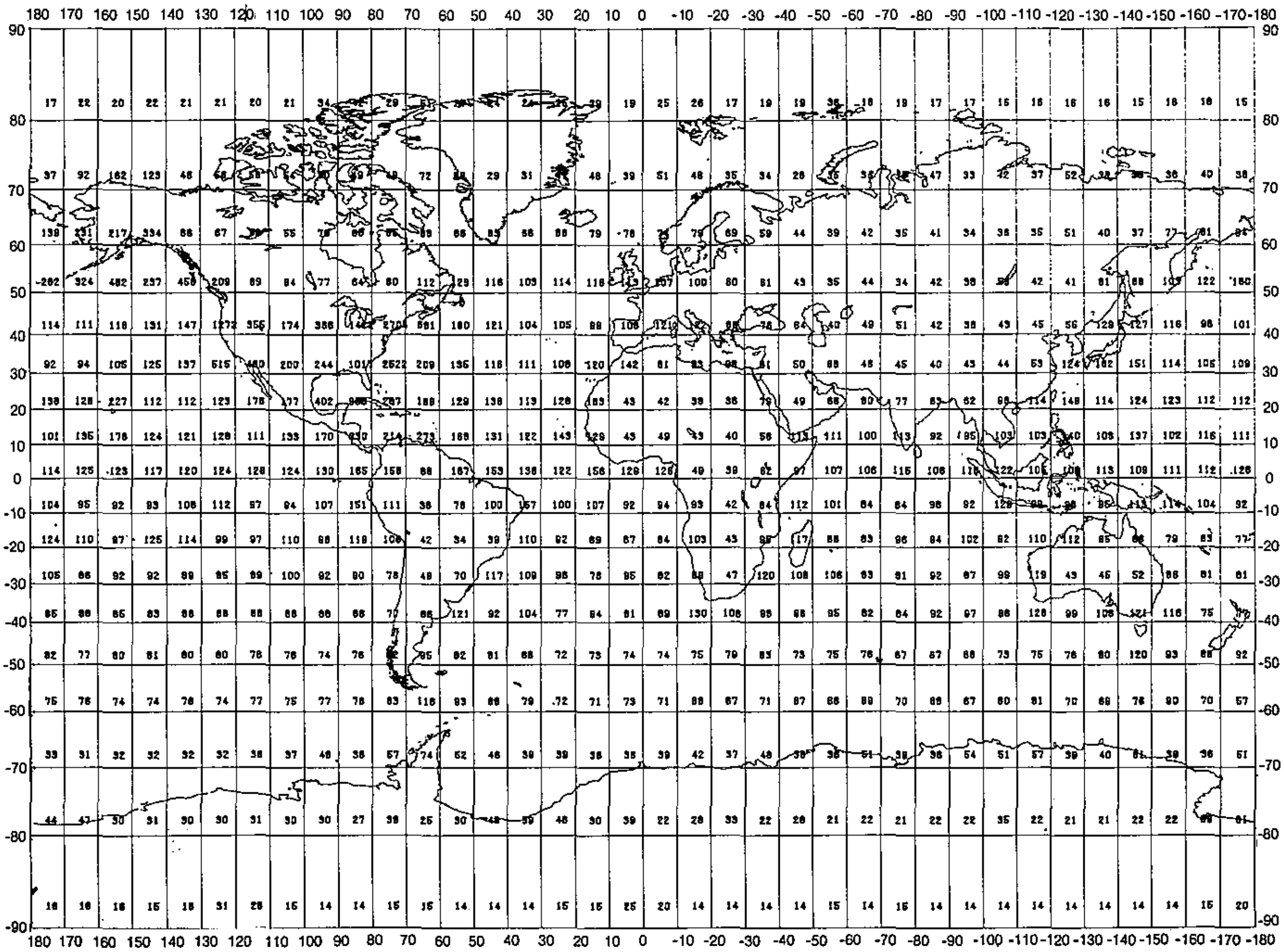
Descriptions of environmental data files located in the shaded states and British Columbia are available in the Environmental Data Base Directory.

It should be emphasized that no data per se are contained in the ENDEX EDBD system, only data descriptions. After receiving a list of possible files of interest, a requester still must make arrangements with the holding institution to obtain the data. These arrangements can be made at cost by EDIS. Data held by Environmental Data and Information Service data centers can, of course, be made readily available at the cost of retrieval.

A critical aspect of data referral is continuing maintenance of file descriptions. New files are constantly being produced. Their descriptions need timely introduction to the system. Availability and/or location of files change. This information also must be sought and entered into the system.

The update technique for EDBD is to regularly (every two years) send to each contributor a listing of his particular data files descriptions, with a request that he update them. In addition, identification of new files that were not described in the original canvas is also requested, so that new file descriptions may be entered. Thus, EDBD files remain reasonably current.

NODC began by EDBDing data files 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 include all types of environmental data. About 1,500 data files had been described for the Great Lakes region, about 400



Geographic coverage of environmental data files described in the Environmental Data Base Directory.

for the New York Bight, and approximately 2,000 for Chesapeake Bay.

The remaining East Coast States underwent the same process. In addition, in conjunction with the Bureau of Land Management/NOAA Outer Continental Shelf Environmental Assessment Program (see January 1977 *EDS*, p. 4), ENDEX contractors have described more than 800 environmental data files in Alaska, as well as 900 files in the States of Washington and Oregon.

The State of California now is being surveyed by a contractor working closely with the California Environmental Data Center. To date, 1,000 California files have been described, and work will continue into 1979.

The national total of searchable data files described to date is about 12,000. EDBDing of Gulf Coast States has just begun. Anticipated extension into Hawaii in 1979 will complete the survey of coastal zone States.

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/EDIS/NODC, Washington, DC 20235. Telephone: 202-634-7298.


HOME HEATING OIL

Heating Degree Days and Winter Fuel Use

Gas and electric company dispatchers, construction engineers, and average homeowners use the concept of "heating degree days" to gage and to predict energy demand and consumption.

Heating engineers developed this index early in the century. They found that when the average daily temperature is lower than 65 degrees, most buildings require heat to maintain an inside temperature of 70 degrees. The average daily temperature is obtained by adding together the maximum and minimum temperatures for the day and dividing the total by two. Each degree of temperature below 65 is counted as one heating degree day.

As an example, if the maximum temperature is 70 degrees and the minimum 52 degrees, four heating degree days would be produced (70 + 52 = 122; 122 divided by 2 = 61; 65 - 61 = 4). When the average daily temperature is 65 degrees or higher, the heating degree day total is zero.

For every additional heating degree day, more fuel is needed to maintain a comfortable 70 degrees indoors. A day with a mean temperature of 35 degrees (30 heating degree days) would require twice as much fuel as a day with a mean temperature of 50 (15 heating degree days), assuming similar meteorological conditions such as windspeed and cloudiness.

The amount of heat required to maintain a certain temperature level is proportional to the heating degree days total. A fuel bill usually will be twice as high for a month with 1,000 heating degree days as for a month with 500. Thus, it can be estimated that about four times as much fuel will be required to heat a building in Chicago, where the annual average is 6,100 heating degree days, as would be required to heat a building in New Orleans, where the average is about 1,500. This is true, however, only if building construction and living habits in these areas are similar. Since many factors are not constant, these ratios must be modified by experience.

Exxon Photo.

The use of heating degree days also has the advantage that consumption rates are fairly constant, i.e., fuel consumed for 100 degree days is about the same whether the 100 heating degree days were accumulated on only three or four days or were spread over seven or eight days.

The heating degree day concept has become so valuable that daily, monthly and seasonal totals are routinely computed for about 6,000 temperature-observing stations in the National Weather Service's network. Daily degree-day figures are used by fuel companies to evaluate fuel use rates and for efficient scheduling of deliveries. For example, if a heating system is known to use one gallon of fuel for every 5 heating degree days, oil deliveries will be scheduled to meet this burning rate. Gas and electric company dispatchers use the data to anticipate demand and to implement priority procedures when demand exceeds capacity.

Accumulation of temperature data for a particular location has resulted in the establishment of "normal" degree-day values based on 30 years of record. Maps and tables of heating degree day normals are published by EDIS. The maps are useful only for broad general comparisons, because temperatures, even in a small area, vary considerably depending on differences in altitude, exposure, wind, and other circumstances. Figure 1 illustrates the national distribution. Tables of normal monthly and annual heating degree days for U.S. cities provide a more accurate basis for comparison. The tables show, for instance, that the City of Pittsburgh has a normal annual total of 5,278 heating degree days, while the normal for the Pittsburgh International Airport is 5,930.

Heating degree day comparisons within a single area are the most accurate. For example, March heating degree day totals in the Midwest average about 70 percent of those for January. In Chicago, the coldest 6 months in order of decreasing coldness are January, December, February, March, November, and April.

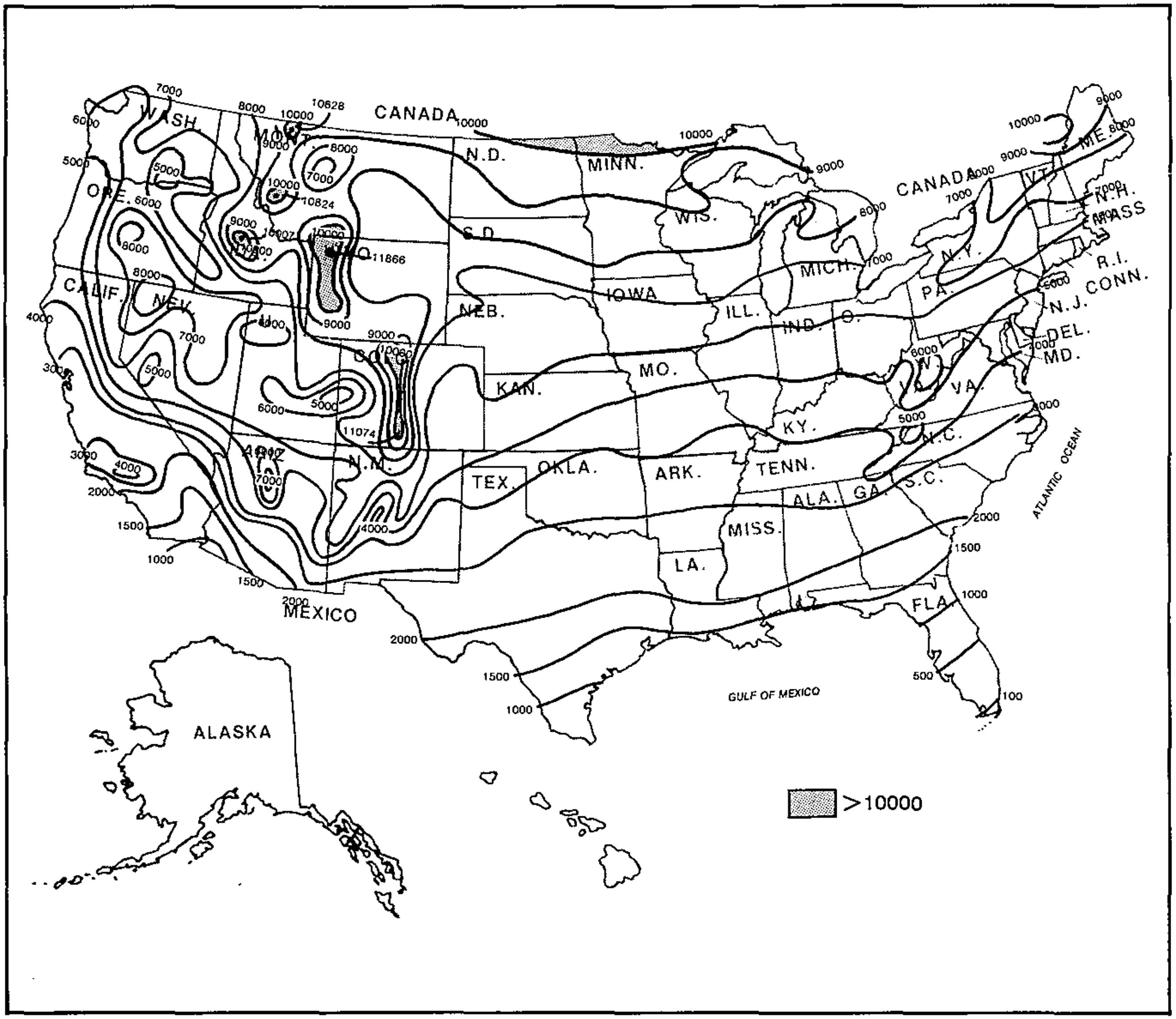
Annual heating degree day data are published by heating season, which runs from July of one year through June of the next year. This enables direct comparison of seasonal heating degree day data and seasonal heating fuel requirements.

The EDIS National Climatic Center (NCC) publishes a series of publications containing heating degree day data. In many instances, however, special tabulations may be necessary to meet special requirements not covered by published data or original observations. An important part of NCC's mission is to help solve individual problems by furnishing data in the form needed.

Using climatic data files, special heating degree day tabulations or other summaries may be prepared on a reimbursable basis. A copy of each resulting tabulation or summary having climatological significance is retained in the files. New requests are reviewed in light of these existing summaries. When one or more of these summaries is pertinent to a request, copies can be provided at the cost of reproduction.

Original data tabulations and summaries are prepared at cost for anyone requesting them, according to mutually agreed upon specifications. The NCC assists the requester in determining his climatological data requirements, but must avoid infringement upon the domain of the private meteorological consultant in those areas where a private user needs assistance in interpreting climatological information and in applying the information to his specific problem. All private requesters needing such special assistance are referred to the American Meteorological Society for a list of qualified meteorological consultants.

For further information contact: National Climatic Center, Federal Building, Asheville, NC 28801. Telephone: (704) 258-2850, ext. 683.



Average seasonal heating degree days.

Museum of the City of New York

Those Chilling Winter Winds

Each winter, millions of Americans dial telephone recordings for the latest weather information. Most are concerned primarily with the temperature and whether or not it is going to rain or snow. The sensation of "cold," however, depends not only on temperature, but also on windspeed. The National Weather Service defines the relationship of these two variables as the "wind chill factor."

The accompanying wind chill chart shows the equivalent temperatures for various combinations of wind and temperature and their "chilling" effect on the human body. For example, a combination of 20°F and a 15-mph wind will feel as cold as a temperature of 0°F and a windspeed of 5 mph.

Human reaction to cold has been studied under many natural and test conditions. In 1939, Paul A. Siple used the term "wind chill" to describe the feel of "coldness" resulting from combinations of wind and temperature. The method used, however, was not applicable to temperatures above 0°C (32°F), because high wind speeds caused exaggerated wind chill values.

Later, during the Antarctic winter of 1941, Siple and Charles F. Passel developed a new formula to determine wind chill from experiments made at Little America. They measured the time it takes to freeze 250 grams of water in a plastic cylinder under a variety of conditions of wind and temperature. They assumed that the rate of heat loss was proportional to the difference in temperature between the cylinder and the temperature of the surrounding air. The results were then plotted against wind speed.

Heat loss also depends on which part of the body is being cooled. Siple's wind chill formula measures the cooling power of the wind and temperature in complete shade and does not consider the gain of heat received from sunshine.

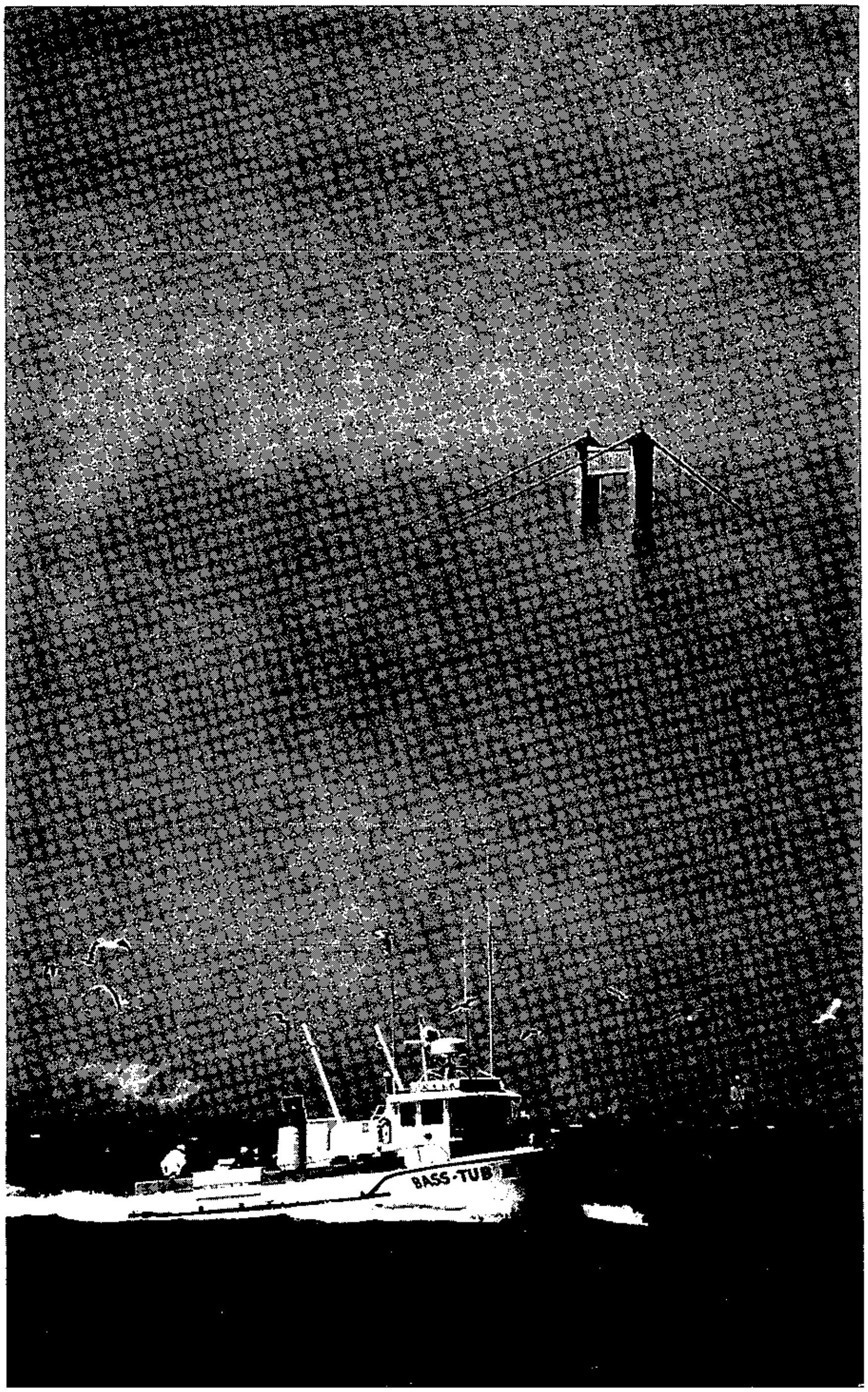
While the wind chill chart does not take into consideration all possible heat losses of the body (such as that caused by contact with cold surfaces and by breathing in cold air that causes loss of heat from the lungs), it does measure convective cooling, which is the major source of body heat loss. The state of one's health and metabolism also affects how cold one feels.

If you plan winter outdoor activities and want to avoid a "chilling" experience, remember that the temperature is not the only consideration. Check the windspeed.

Air Temperature (°F)

Windspeed (MPH)	45	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
4	45	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	43	37	32	27	22	16	11	6	0	-5	-10	-15	-21	-26	-31	-36	-42	-47	-52
10	34	28	22	16	10	3	-3	-9	-15	-22	-27	-34	-40	-46	-52	-58	-64	-71	-77
15	29	23	16	9	2	-5	-11	-18	-25	-31	-38	-45	-51	-58	-65	-72	-78	-85	-92
20	26	19	12	4	-3	-10	-17	-24	-31	-39	-46	-53	-60	-67	-74	-81	-88	-95	-103
25	23	16	8	1	-7	-15	-22	-29	-36	-44	-51	-59	-65	-74	-81	-88	-96	-103	-110
30	21	13	6	-2	-10	-18	-25	-33	-41	-49	-56	-64	-71	-79	-86	-93	-101	-109	-116
35	20	12	4	-4	-12	-20	-27	-35	-43	-52	-58	-67	-74	-82	-89	-97	-105	-113	-120
40	19	11	3	-5	-13	-21	-29	-37	-45	-53	-60	-69	-76	-84	-92	-100	-107	-115	-123
45	18	10	2	-6	-14	-22	-30	-38	-46	-54	-62	-70	-78	-85	-93	-102	-109	-117	-125

Wind chill equivalent temperature (°F).



San Francisco Recreational Brochure

The second in a series of brochures on coastal resort areas of the United States emphasizing climatological information has been released by EDIS' National Oceanographic Data Center and the Sea Grant Marine Advisory Service at the University of California. Entitled *San Francisco Bay—A Recreational Climate,* the brochure provides information on the Bay Area's vacation weather and recreational facilities.

The weather information is slanted toward the vacationer and recreational user of the Bay. Sections on sailing and boating weather are included. The facilities portion includes a detailed chart and listing of public and private marinas, piers, and yacht clubs. There is also a section on sport fish, their seasons and their locations.

The first brochure in this series was *Rhode Island's Vacation Climate.* Future subjects include coastal North Carolina, New York's Lake Erie, and the Michigan coast of Lake Michigan.

Copies of *San Francisco Bay—A Recreational Climate* may be obtained free of charge from Marine Advisory Program, Extension Wildlife and Sea Grant, University of California-Davis, 544 Hutchinson Hall, Davis, CA 95616.

Copies of the Rhode Island brochure are available from the Rhode Island Department of Economic Development, Tourist Promotion Division, One Weybossett Hill, Providence, RI 02903.

NODC Establishes 24-Hour Service

EDIS' National Oceanographic Data Center (NODC) has established a 24-hour telephone service (202-634-7500) on a 6-month trial basis, to make its services more readily available to ocean data users. The new service will provide a better opportunity for oceanographers in different time zones and other users to contact NODC outside its regular hours. The phone will be answered by marine information specialists from 7 a.m. to 5 p.m. Eastern Standard Time and by a recording unit during other hours. If successful, the telephone service will be made permanent. Questions recorded after hours generally will be answered within two working days. For more extensive queries, an estimate of the time and resources required to fill the request will be given.

Oceanographic data available from NODC include:

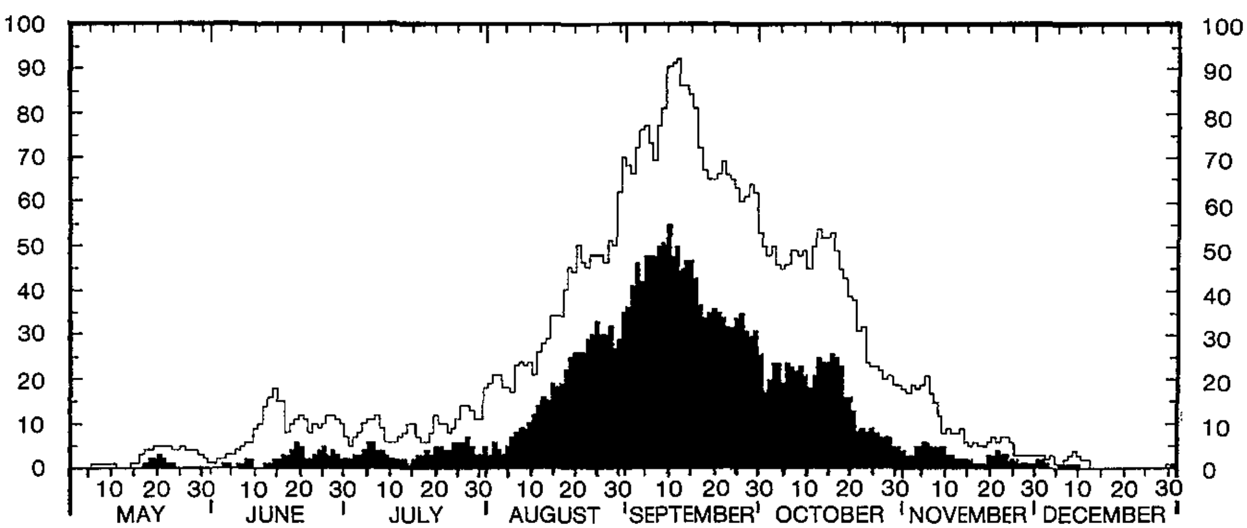
- Mechanical and expendable bathythermograph data in analog and digital form.
- Oceanographic station data for surface and serial depths, giving values of temperature, salinity, oxygen, inorganic phosphate, total phosphorus, nitrite-nitrogen, nitrate-nitrogen, silicate-silicon, and pH.
- Continuously recorded salinity-temperature-depth data in digital form.
- Surface current information obtained by using drift bottles or calculated from ship set and drift.
- Biological data, giving values of plankton standing crop, chlorophyll concentrations, and rates of primary productivity.

North Atlantic Tropical Cyclones Summarized

EDIS' National Climatic Center (NCC) recently published *Tropical Cyclones of the North Atlantic Ocean, 1871-1977.* This is an update and revision of U.S. Weather Bureau Technical Paper No. 55, *Tropical Cyclones of the North Atlantic Ocean,* published in 1965. The new publication is a joint effort of NCC and the National Weather Services' National Hurricane Center.

The publication contains a general discussion of tropical storm characteristics and data sources, as well as statistical presentations of tropical cyclone occurrences. Two sets of tropical cyclone track charts are included: one shows storm tracks by year (107 charts); the second (26 charts) by month (May through December), and by 10- or 11-day periods (June 1 through November 30) for the years 1886 through 1977. Five blank pages are provided for entering storm tracks for five future years (1978-1982). Such tracks normally appear in the April issue of the *Monthly Weather Review,* published by the American Meteorological Society. (Subscription price available on request from the American Meteorological Society, 45 Beacon Street, Boston, MA 02108.)

Copies of the new publication may be purchased from the National Climatic Center, Federal Building, Asheville, NC 28801 or from the Superintendent of Documents, Government Printing Office, Washington, DC 20402. The price is $3.50 per copy. The GPO Stock No. is 003-017-00425-2.



Daily distribution of tropical storms (white) and hurricanes (black), May 1 - Dec. 30, 1886 through 1977.

Great Lakes Data Catalog Available

EDIS' National Climatic Center recently published *International Field Year for the Great Lakes (IFYGL) Data Catalog: United States Data Archive* (NOAA Technical Memorandum EDIS NCC-3). This 203-page publication is the final IFYGL Data Catalog. It describes the data archived from investigations by scientists in Canada as well as the United States. Several disciplines are represented, including meteorology, limnology, biology, and chemistry. Indexes and cross-indexes are given to aid in ordering data from the U.S. IFYGL Data Archive.

IFYGL was a joint Canadian and U.S. coordinated program of research into the physical, chemical, and biological aspects of Lake Ontario. Its purpose was to better understand those mechanisms essential to better management of Great Lakes resources. The two-nation project was a contribution to the International Hydrological Decade, a worldwide program of water studies.

Copies of the catalog are available from the National Climatic Center, Federal Building, Asheville, NC 28801.

Observation systems and types of data	No. of observations
Buoys and towers: water currents, water temperature, air temperature, dew point, wind, pressure, radiation, precipitation	5 x 10^7
Automatic meteorological stations: Wind, temperature, dewpoint, radiation, pressure, precipitation	8 x 10^6
Radar and precipitation networks	3 x 10^7
Rawinsonde soundings	2 x 10^3
Ship: BT, 0_2 soundings	5 x 10^3
surface meteorological data, water temperature	3 x 10^6
water samples (nutrients, heavy metals, chemicals)	4 x 10^6
biological (chlorophyll, zooplankton, biomass, phytoplankton, particle count, fish)	1 x 10^4
Aircraft: wind, air temperature, pressure, dewpoint, humidity, vertical fluxes, solar radiation, lake surface temperature, gamma radiation, multispectral radiation	1.3 x 10^6
Basin hydrologic stations: stream gages, wells, soil moisture probes, snow courses, etc.	2.6 x 10^6
Lake hydrologic stations: water levels, water temperature, precipitation	1.1 x 10^5

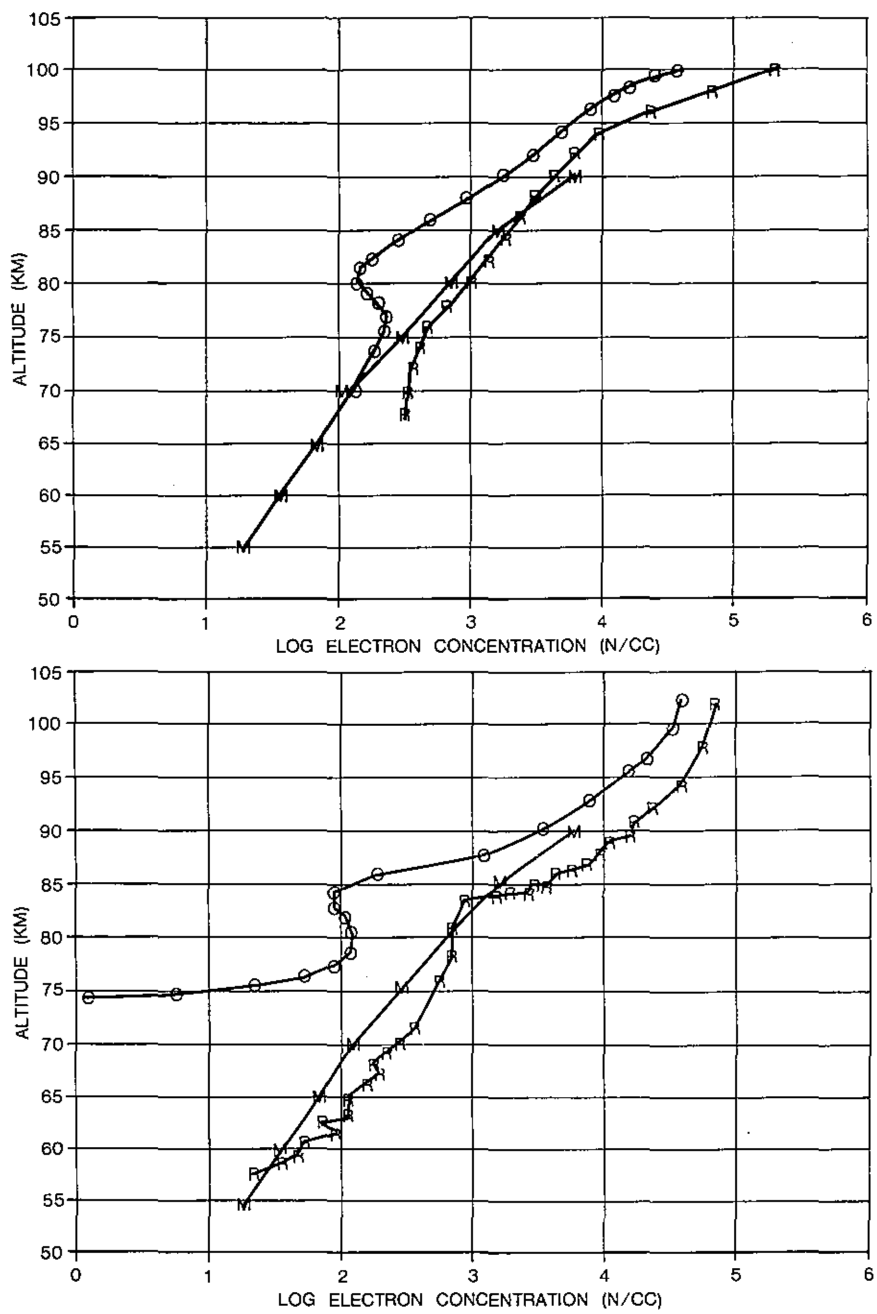
IFGYL data volumes.

New Ionospheric Data Publications

L. F. McNamara of the Ionospheric Prediction Service, Sydney, Australia prepared a series of special reports concerning the D region of the ionosphere while a guest worker at World Data Center A for Solar-Terrestrial Physics in Boulder, Colo.

Upper Air Geophysics Report UAG-67, *Ionospheric D-Region Profile Data Base,* provides a collection of computer-accessible experimental profiles of the D and lower regions of the ionosphere. The collection includes about 700 digitized profiles previously published in journals and reports. The data themselves are available on magnetic tape, along with the computer programs. The data detail the conditions under which each profile was obtained, a list of references from which the experimental data were extracted, and digitized profiles.

Report UAG-68, *A Comparative Study of Methods of Electron Density Profile Analysis,* describes the current methods used by scientists in real-height analysis of ionograms. Each expert in the field analyzed a series of numerical ionograms using a distinct method. The results were then compared to determine the most promising method of analysis. The report gives a brief introduction to the problems encountered in ionogram analysis, conclusions reached by the Union of Radio Science Subgroup, historical surveys of the development of the methods used by members, and a bibliography



Effects of a total eclipse (11/12/66) on D-region electron density profiles. O=observed profiles; R and M = reference and model profiles, respectively, in an undisturbed ionosphere.

dating from 1969 to the present.

Report UAG-69, *Selected Disturbed D-Region Electron Density Profiles,* presents plots of the observed profiles for disturbed conditions. These conditions include solar exlipses, solar flares, solar x-ray events, sudden ionospheric disturbances, winter anomaly days, mid-latitude particle precipitation, solar proton events, polar cap absorption, auroral absorption, daytime absorption events, polar substorms, polar radio blackouts, and auroral arc conditions. Where possible, each disturbed profile has been associated with a suitable reference profile corresponding to the undistrubed ionosphere. In addition, a model electron density profile corresponding to the undisturbed ionosphere has been calculated to use as a reference profile when no suitable experimental profile is available. The computer programs used are also published in the appendices. These selected profiles are a subset of the data base described in Report UAG-67.

All three reports are available from World Data Center-A for Solar-Terrestrial Physics, NOAA, Boulder, CO 80303. The prices are $0.88, $1.41, and $1.29, respectively, for Reports UAG-67, 68, and 69. Checks and money orders should be made payable to Department of Commerce, NOAA/NGSDC.

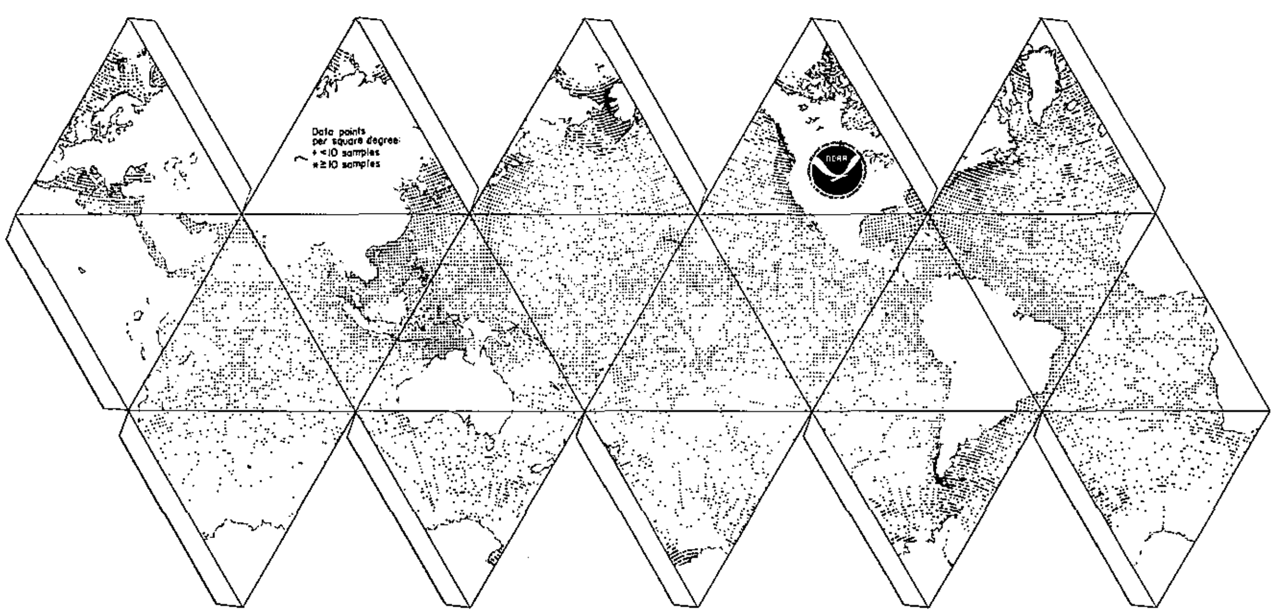
Marine Geological Sample Distribution Shown on Icosahedron Globe

EDIS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) has prepared a "do-it-yourself" icosahedron globe showing worldwide distribution of marine geological samples cataloged at NGSDC. The 20-sided cutout can be assembled as an attractive desk ornament.

NGSDC maintains a computerized inventory file of information on 72,000 geologic samples collected worldwide from beneath the seas. These samples include: sediment cores, grab samples, drill cuttings, dredge hauls, and in-situ measurements from mid-ocean ridges, abyssal plains, and continental margins. The inventory identifies the availablity of data pertaining to manganese nodules, chemical analyses, paleontology, petrology, sediment texture and physical properties, and radioactivity.

The file may be searched by the NGSDC computer according to location, sampling device, analysis type, water depth, archival format, date of collection, funding organization, or combinations of the above criteria. Once a data sample has been selected, NGSDC makes available a copy of the original data in such formats as: paper listing, magnetic tape, microfilm or microfiche, or special maps and graphs.

For further information on the icosahedron globe, contact: Marine Geology/Geophysics Branch, NOAA/EDIS/NGSDC, Code D621, Boulder, CO 80303. Telephone (303) 499-1000 ext. 6338, or FTS 323-6338.



Glaciology Workshop

The World Data Center-A for Glaciology (Snow and Ice), operated for EDIS' National Geophysical and Solar-Terrestrial Data Center by the Institute of Arctic and Alpine Research, held a two-day Workshop at the University of Colorado, November 2-3 to plan standards for classifying, coordinating and storing major snow and sea-ice research data. Thirty scientists from the United States, Canada and England participated and presented 17 scientific papers.

Research on snow and sea ice is important for prediction of world climate changes and the impact those changes may have on such areas as agriculture, flood forecasting and water supply. The scientists agreed that no adequate universal data bank exists for this research.

During the sessions, the group exchanged information on techniques and products, identified current problems, and suggested future improvements for archiving and digitizing data products. The workshop scientists recommended that the World Data Center explore questions related both to access and to standardization of information. The following specific problems were addressed:

What data should be archived?

Where should the data be archived?

When should data sets be collated, digitized, updated?

How should data be collected from the various sources and subsequently made accessible to users?

Papers from the Workshop will be published in a future issue of *Glaciological Data*.

IDOE Progress Report

The seventh in a series of progress reports on the International Decade of Ocean Exploration (IDOE) has been published by EDIS under a National Science Foundation (NSF) contract. IDOE is a long-term, international cooperative program to enchance utilization of the ocean and its resources.

The report, prepared for the NSF IDOE Section, covers the period April 1977 to April 1978 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, EDIS also is under contract to NSF to manage the scientific data collected during IDOE. EDIS 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, Washington, DC 20235. Telephone: 202-634-7301.

WDC-A Publishes Data Directory

World Data Center-A for Solid Earth Geophysics, maintained by EDIS' National Geophysical and Solar-Terrestrial Data Center, has prepared a directory of U.S. data repositories to support the International Geodynamics Project (IGP). IGP is an international program to study present and past movements in the Earth's crust linked to the concepts of plate tectonics. The program, sponsored by the International Council of Scientific Unions, combines techniques, experience, and approaches of geologists, solid Earth geophysicists, and geochemists in a concerted effort to advance understanding of the Earth's behavior from geologic time to the present.

The directory contains information for 19 categories applicable to the geodynamics project. Repositories are listed under each category with mailing addresses, contacts, telephone numbers, and type of service provided. The repositories are also cross-indexed by state and geographic data coverage.

This 40-page directory, prepared at the request of the U.S. Geodynamics Committee, is titled *Directory of U.S. Data Repositories Supporting the International Geodynamics Project, Report SE-14.* Copies are available from WDC-A for Solid Earth Geophysics, NGSDC, NOAA/EDIS, Boulder, CO 80303 at $0.95 each.

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In this issue: *Implementing the National Climate Program (p.4), evaluating a global wheat-yield estimation experiment (p.8), assessing the environment (p.12), finding environmental data files (p.15), gaging winter fuel demand (p.18), and avoiding those chilling winter winds (p.21).*

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Cover: A solar eruption. *An international study of solar disturbances will begin in August, at the peak of an 11-year sunspot cycle. The study is discussed in an article beginning on p.13.* *NASA photo*

EDIS is designed to inform Environmental Data and Information Service (EDIS) cooperators, colleagues, and contributors of recent developments in EDIS programs and services and in the general field of scientific data and information management. EDIS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Enviromental Science Information Center, and Center for Environmental Assessment Services. In addition, under agreement with the National Academy of Sciences, EDIS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology (Snow and Ice).

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.

EDIS (USPS 353-850) is published bimonthly by the Environmental Data and Information Service, NOAA, Page Building 2, Room 533, 3300 Whitehaven St., N.W., Washington, D.C. 20235. For address changes, cancellation, or information write to the Editor at this address. Controlled Circulation Postage is paid to the Finance Department, USPS, Wash., D.C. 20260.

The Status of International Oceanographic Data Exchange

By James Churgin, Director
World Data Center-A Oceanography

The IOC Working Committee on International Oceanographic Data Exchange (IODE), meets in UN Headquarters in New York City in January of this year. From the left: C. Druet of the Institute of Oceanology of Poland, Vice-Chairman of IOC; T. Winterfeld (U.S.), Chairman of IODE; A. Tolkachev, Asst. Secretary of IOC.
United Nations Photo by Saw Lwin

The Intergovernmental Oceanographic Commission (IOC) recently reviewed the status of international oceanographic data exchange. The following is extracted from a report prepared by World Data Center (WDC) A, Oceanography as part of that review.

In general, the WDC System for international exchange of oceanographic data has dramatically increased the availability of data and information to the worldwide user community. A major part of this increase is attributable to the close cooperation of the WDC's (Oceanography) with the IOC and in particular with its Working Committee on International Oceanographic Data Exchange (IODE). There are, however, changes taking place in the nature of oceanographic experiments due to technical and scientific advances, the increased interest in the oceans as a source of natural or energy resources, and because of increased awareness of the dangers of pollutants in the oceans. These changes will necessitate new and innovative data management techniques and standards in order to maintain the viability of the WDC's for

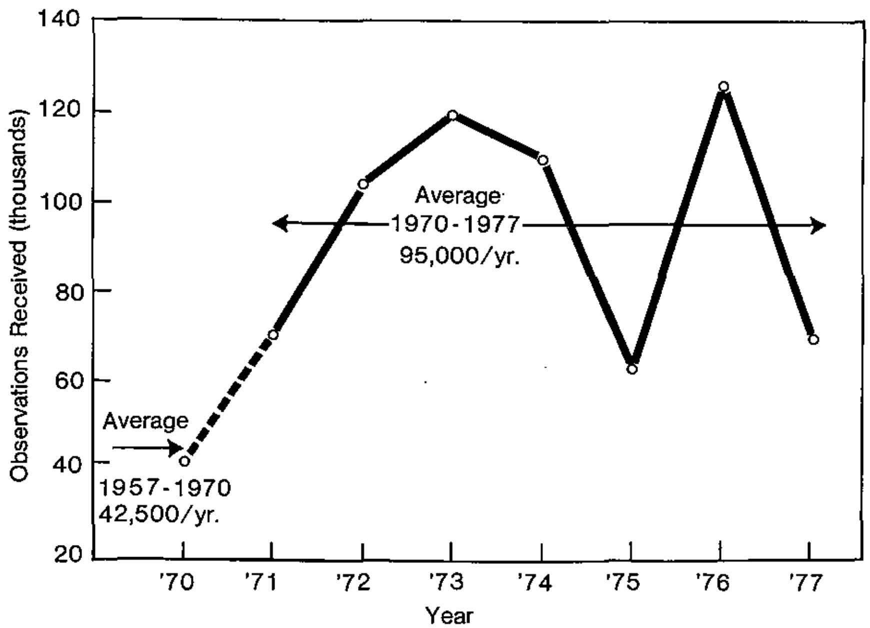


Fig. 1. Total number of observations exchanged, all types.

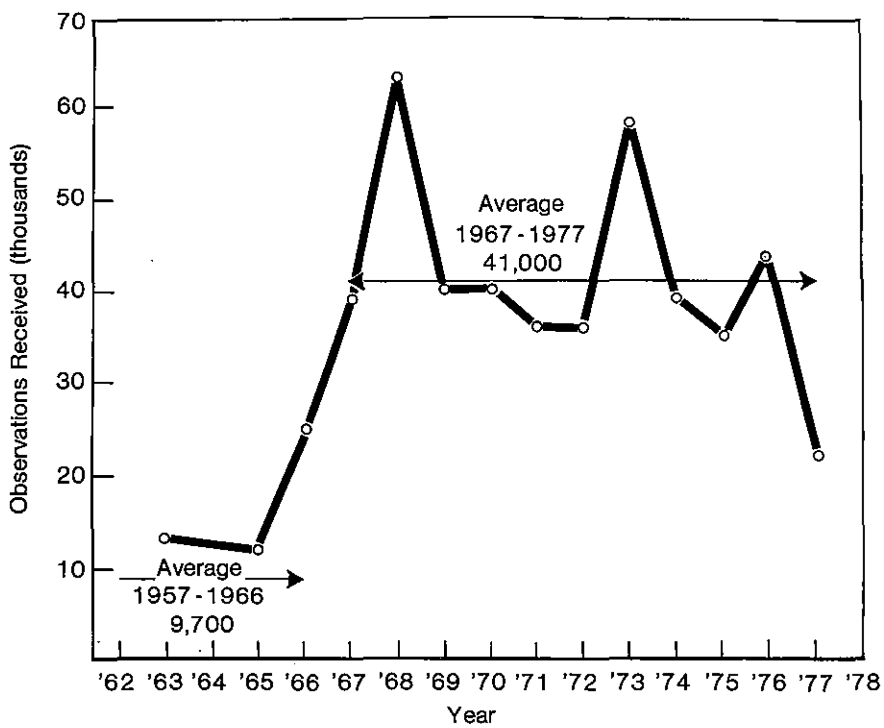


Fig. 2. Number of oceanographic serial stations exchanged.

Oceanography. Among the high priority items that will need to be coordinated between the WDC's and the IOC are establishment of formats for biological, chemical and biochemical data, standard magnetic tape exchange formats, a coordinated WDC/Responsible National Oceanographic Data Center (RNODC) scheme, and improvement of the Declared National Program (DNP)/National Ocean Program (NOP) for acquisition of internationally exchangeable data. The IOC and WDC's also will need to work jointly with other international regional programs such as the World Climate Program, Regional Seas and Open Ocean Programs, and cooperative investigations of large ocean areas. A strong, positive program should lead to increases in data and in data services available to requesters throughout the international community.

Data Exchange Statistics

Each year the WDC subcenters for oceanography present complete statistics of data exchange in annual and semiannual reports. These reports are available to anyone wanting a detailed knowledge of data exchange. This report will examine only a few general considerations.

Since the inception of the WDC System more than 1.2 million observations have been exchanged. These include various physical measurements in chemistry, biology, geology, and geophysics. In addition, about 15,000 documents and formatted descriptions of data collected by more than 6,000 cruises also have been submitted. Figure 1 summarizes annual data receipts for all types of data for the past eight years. Annual statistics for previous years are not readily available; however, it is significant that the average number of annual observations for the period 1957-70 was about

42,500. Since 1970, the average number of observations received has been more than 95,000 per year. There is a good deal of variability from year to year; for example, the number of observations received in 1976 was about double that received in 1975.

In order to assess the impact of the IOC/IODE program on volumes of data exchanged, we have used the figures for oceanographic serial stations depicted in Figure 2. These data were selected because they have the longest continuous record for exchange and represent a class of data for which standard observational methods have existed for some time. Included in these figures are both bottle casts and a relatively small number of conductivity (salinity)-temperature-depth observations. As with the figures for total observations, the number of stations has varied considerably from year to year, but there has been a significant rise in the average number of stations received during the past 11 years over the first 10 years. From 1957-66, an average of about 10,000 stations a year were received, while for the period 1967-77 more than 40,000 stations per year were received. Note that 1977 showed a marked drop in receipt of data for oceanographic stations. Thus far, figures for 1978 have not been tabulated, but the number of stations already cataloged exceeds 1977 by a small amount, with a number still uncounted. It appears that 1978 will exceed 1977 by a substantial amount, but probably will not reach the 1967-77 average.

Another measure of the impact of IOC/IODE programs on data exchange through the WDC's is the Report of Observations/Samples Collected by Oceanographic Programs (ROSCOP) Inventory System. ROSCOP was designed and developed by the WC/IODE to provide better access to information on contemporary oceano-

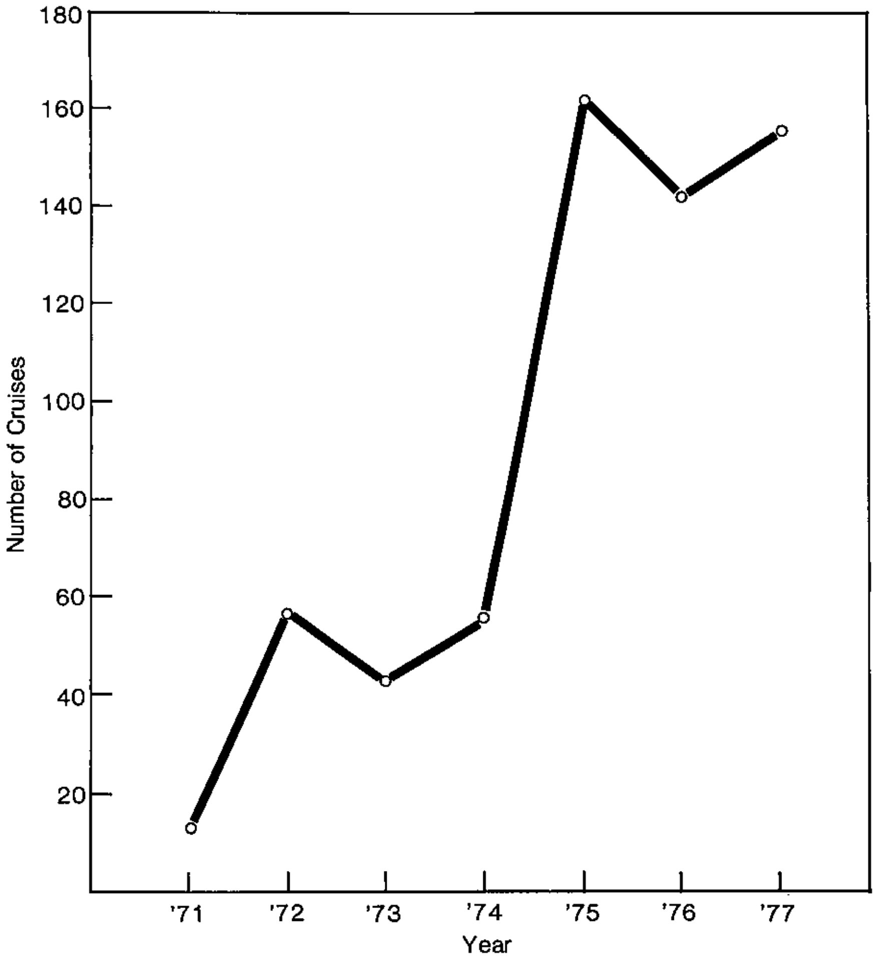


Fig. 3. Number of ROSCOP cruise inventory forms exchanged.

Year	IGY/IGC	NOP/DNP	Other	Total
1966	21.3	20.4	58.3	100.0
1967	18.8	28.8	53.2	100.0
1968	0.9	28.0	71.1	100.0
1969	5.9	28.8	65.3	100.0
1970	2.3	26.2	71.5	100.0
1971	0.5	23.5	76.0	100.0
1972	0.0	25.8	74.2	100.0
1973	8.2	15.3	76.5	100.0
1974	0.0	29.5	70.5	100.0
1975	1.7	30.3	68.0	100.0
1976	21.1	37.1	41.8	100.0
1977	0.1	53.9	46.0	100.0

Table 1. Percentage classes of data received.

Declared National Programs (DNPs)/ National Oceanographic Programs (NOPs)

A National Ocean Program (NOP) is an announcement of oceanographic projects made to the Intergovernmental Oceanographic Commission (IOC) by a member state. It is used to inform other member states of planned research cruises. This announcement does not obligate the state to exchange data resulting from the cruises through the World Data Center system. The announcement may therefore include research cruises that will result in data not suitable for international exchange or may indicate that the member state wishes to delay commitment of data for international exchange until the data have been collected and processed.

A Declared National Program (DNP) is a public declaration by an IOC member state to exchange data internationally from all or part of its oceanographic expeditions. The DNP data will be deposited, cataloged, and made available for exchange through the World Data Centers for Oceanography located in Washington, D.C. and Moscow, U.S.S.R.

IOC member states prepare lists of oceanographic projects annually and forward them to the IOC Secretariat for distribution to the international community. It is essential that each country declare its intentions to exchange data if the World Data Center system is to be preserved. NOPs and DNPs provide the basic framework on which the system is built.

graphic programs and as a data management tool for countries to be used in connection with their National Oceanographic Programs (NOP's) and preparation of the Declared National Programs (DNP's). Figure 3 shows the number of ROSCOP forms received by the WDC's since inception of the program. The low numbers in the early years represent primarily an experimental format which in more recent years has virtually been phased out and replaced with the latest IOC approved version, ROSCOP II.

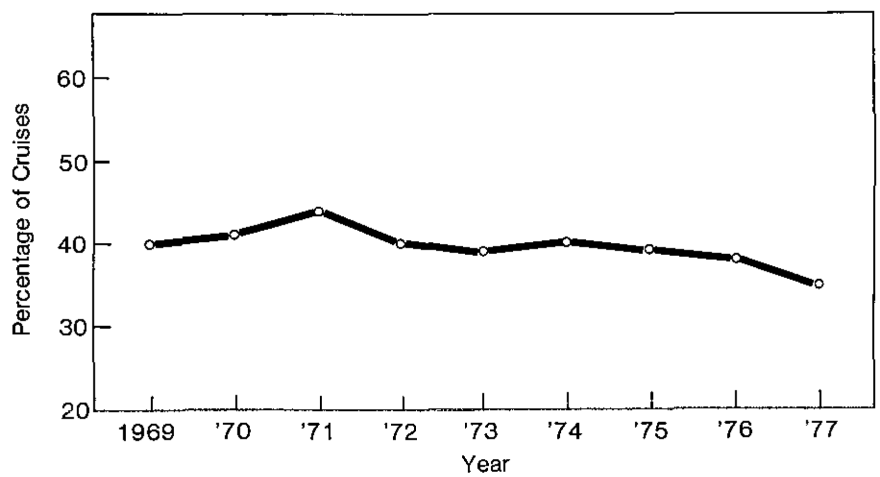


Fig. 4. Percentage of DNP cruises vs. all cruises received by WDC-A.

Yet another method for assessing the status of international exchange and its relationship to IOC is to examine the percentage of data received from NOP/DNP Declarations, from the International Geophysical Year/International Geophysical Cooperation (1957-59), and from voluntary contributions. Table 1 lists the percentages of oceanographic serial stations received in these three categories for the past 12 years. Note that there does appear to be a slight increase in NOP/DNP receipts for the past two years but generally only 1/4 to 1/3 of the stations received are listed in DNP/NOP declarations distributed by the IOC.

Since the DNP is a delcaration of intent to exchange data internationally, one may also look at what percentage of the data that have been declared are actually sent to the WDC's. Table 1 is a year-by-year percentage of these receipts and shows clearly that considerably less than 50% of the cruises which have been declared as DNP are actually sent to the WDC's for international exchange. Of course, not all cruises declared are actually made, and not all cruises taken yield data suitable for exchange.

Analysis and Future Trends

An examination of Figures 1 and 2 indicates that there has been a general increase in data exchange internationally in the past eight to ten years. In comparing this in-

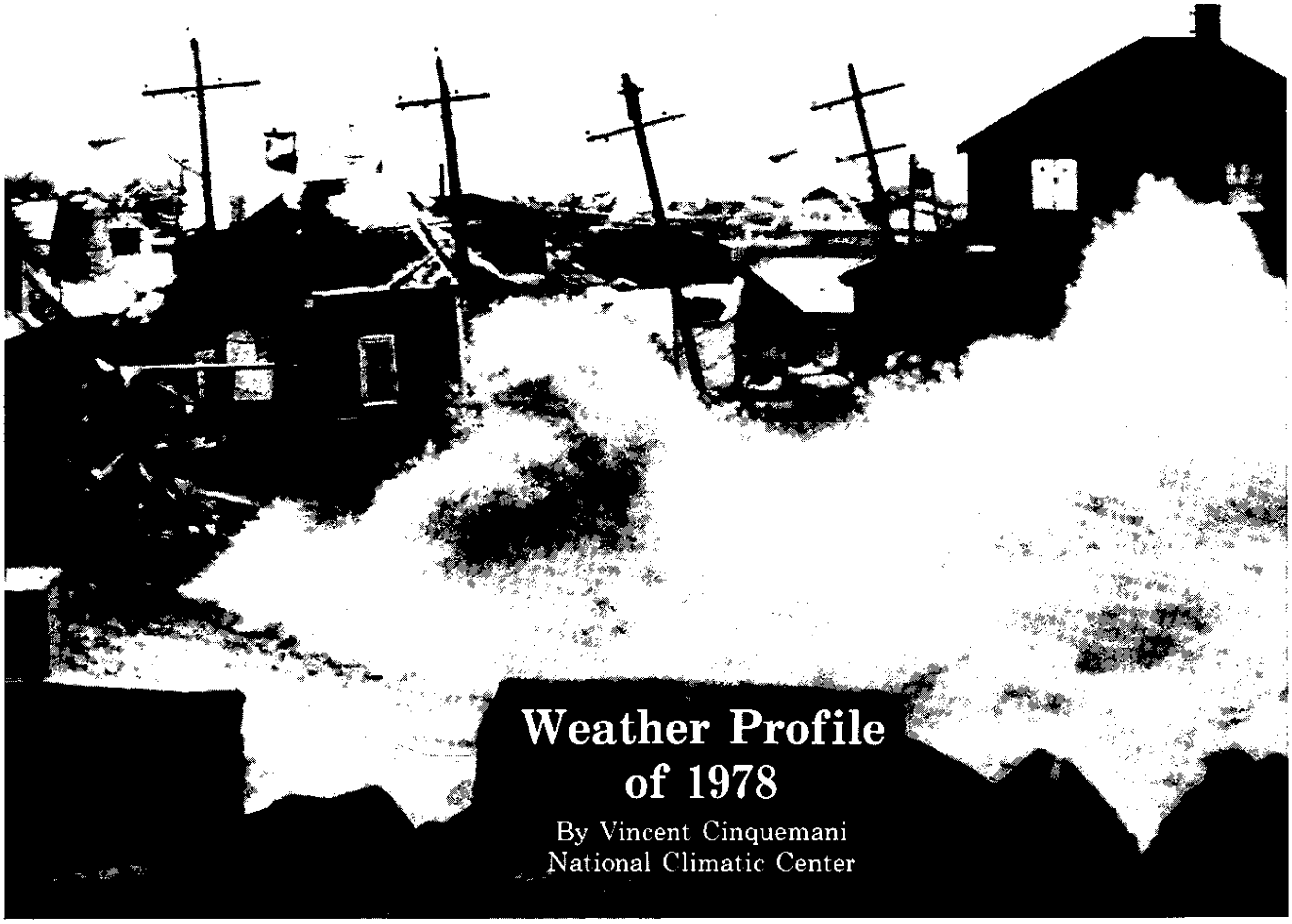
James Churgin, Director, WDC-A Oceanography, and Pearn Niiler, a member of the U.S. delegation, at a 1975 IODE meeting in Rome

crease with activities and recommendations of the IOC through its Working Committee on IODE, there does appear to be a correlation between efforts of that group and increased data flow. Of course, other factors such as cooperative investigations, large-scale experiments, and increased national programs are contributing factors which must also be considered. The drop in serial observations noted in 1977 should be watched, as it may be indicative of a trend. The advent of salinity-temperature-depth and other electronic instrumentation which result in large volumes of data without internationally accepted methods for data reduction, as well as increases in biological and chemical pollution studies (which also have few international standards), may result in net decreases in data to be exchanged unless IOC, the International Council of Scientific Unions' Scientific Committee on Oceanic Research, and other international organizations actively pursue methods for exchange of such data. With such activity and with the development of RNODC's to aid the WDC's in the processing of high volume and complex data sets, data exchange should continue to grow. It is hoped that the IOC and its subsidiary bodies will continue to encourage complete freedom of exchange of data without restriction. Some recent developments may indicate a trend toward confidentiality of certain data types.

The ROSCOP Inventory appears to be producing a considerable amount of information. It is being used not only for national data management but in the management of large international and multinational programs. It does not appear, however, to have had much influence on the addition of increased NOP/DNP declarations or on the amount of data actually exchanged. ROSCOP's also may be used as an acquisition tool for studies requiring data not normally archived in the WDC's. Current usage of ROSCOP information by the scientific community appears to be quite limited.

The use of the DNP as a method of obtaining data for international exchange appears to be only partially effective. Little progress seems to have been made in substantially increasing the number of DNP's submitted, increasing the percentage of DNP data received versus voluntary data, or increasing the percentage of data received versus that which has been declared. DNP's seem to be poorly understood or accepted by many IOC Member States although they have been in existence for nearly 18 years. Nevertheless, this has not stopped the flow of data, and, as has been noted, increased data flow internationally has actually occurred. The full implementation of IODE VIII recommendations concerning the issuance of a brochure and publication of NOP/DNP lists should result in more NOP/DNP announcements from more member states and in an increase in the percentage of DNP data received by the WDC's.

Large ocean experiments begun in the 1970's are almost sure to continue into the 1980's, using new methods for data acquisition such as satellites and automatic recordings devices. International exchange of such data through the WDC's can be accomplished using techniques now under development by the IOC/IODE, provided that these are given sufficient backing by all member states. It will be most important, expecially for the developing countries, to have easy access not only to these high volume data but to resulting data products which can be used without recourse to costly processing equipment.



Weather Profile of 1978

By Vincent Cinquemani
National Climatic Center

Heavy surf continues to pound beachfront houses at Peggotty Beach in Scituate, Mass., on February 9, 1978, following one of the most severe storms in New England history.

AP laserphoto

This is the second in a series of annual reviews of significant weather in the United States. Subsequent summaries will appear in March issues.

Temperature

Very large temperature departures below normal for January and February 1978 produced the second of two consecutive severe winters in the eastern two-thirds of the United States. Previous cases of bitterly cold, back-to-back winters occurred in the East in 1903-04 and 1904-05 during this century, and in 1855-56 and 1856-57 in the 19th century.

February 1978 was the coldest February on record in six eastern states, and the January-February mean temperature was the lowest ever recorded in 19 states. For example, the mean of -8.8°C (16.1°F) in Ohio for February 1978 broke previous records of -7.1°C (19.3°F) set in 1885, and in this century, -6.2°C (20.8°F) in 1905. The State's 1978 January-February mean of -8.1°C (17.5°F) was colder than the record set for the same period in 1977, -7.0°C (19.4°F). The combined January-February mean of -7.6°C (18.4°F) for 1977-78 toppled the old record of -5.7°C (21.8°F) set in 1904-05. In January, many parts of the Midwest reported readings 7°C (13°F) below normal and this temperature anomaly increased to 9°C (16°F) in February. However, in the Rocky Mountains west of the Continental Divide, temperatures remained above the monthly normal, with average departures of 3°C (6°F).

During March, warmer temperatures in the western United States worked their way east, gradually thawing the rest of the country. By the end of the month,

Scituate was the hardest hit area on the Massachusetts coast. During the storm, 100 mph winds drove waves over the sea wall.
American Red Cross photo by Philip Gibson

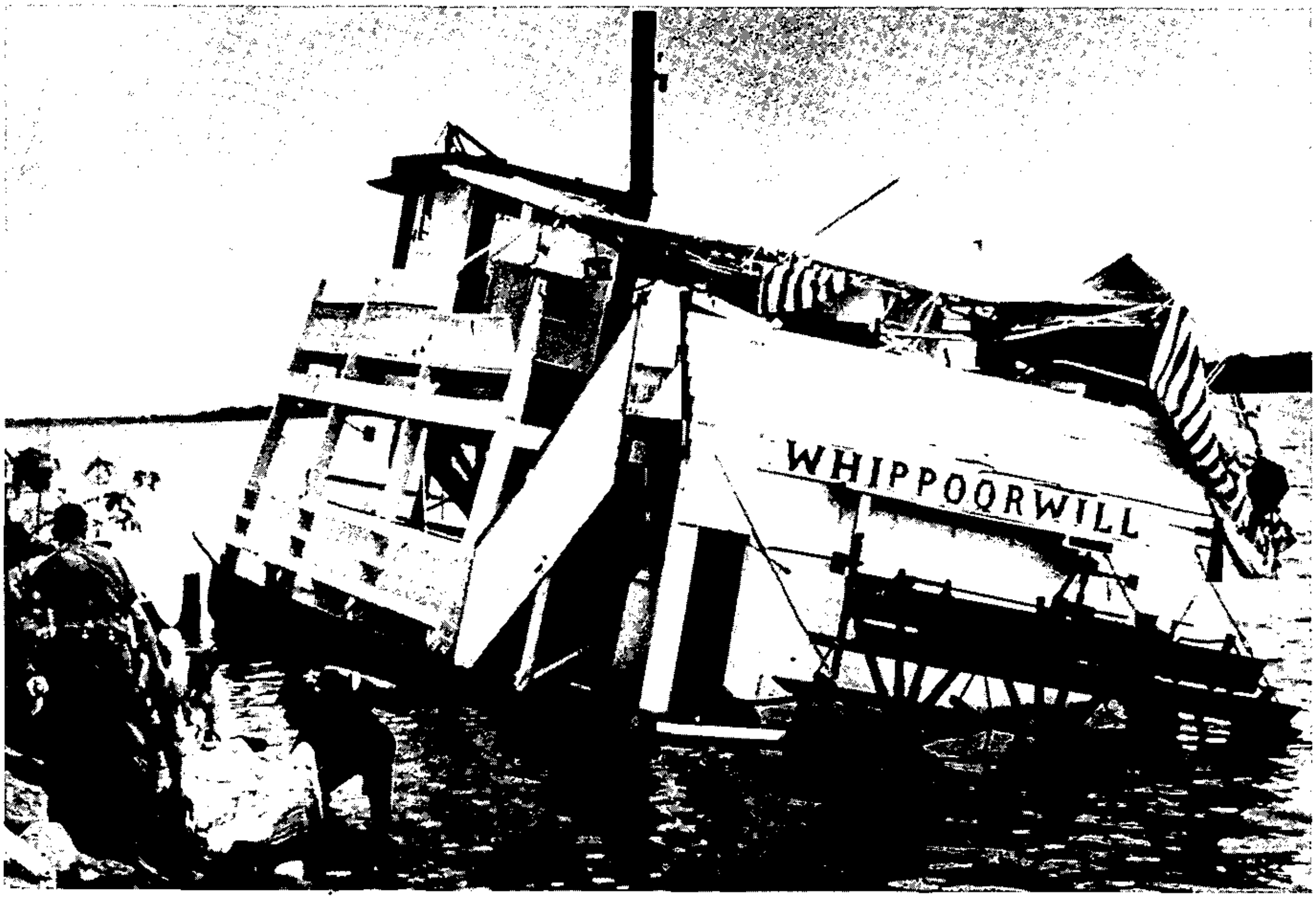
temperatures warmed to record highs, with Grand Island, Nebr. reaching 32.2°C (90°F) and Chicago, Ill., climbing to 28.3°C (83°F). Spring temperatures averaged slightly below normal in the eastern half of the United States and were about 2°C (4°F) above the seasonal normal in the western half.

Summer saw a return to normal temperatures across the country with seasonal, localized, short term heat waves also occurring. Readings at El Paso, Tex., equalled or exceeded 37.8°C (100°F) on 18 days in June, 14 of which occurred consecutively. Former corresponding records of 16 and 11 days duration were set in 1960. Early in August, maximum daily temperatures soared well above 38°C (100°F) in the valleys of northern California. Red Bluff's high of 48.3°C (119°F) on August 8 tied the previous yearly maximum set in July 1972 and broke the former August record of 47.8°C (118°F). In the latter part of September, the heat wave focused on southern California, with Los Angeles averaging 7°C (13°F) above normal and recording daily readings above 37.8°C (100°F) on four consecutive days.

Autumn temperatures were near normal until cold incursions from the northwest, accompanying the first major snowstorms of the season in early November, plunged readings as much as 15°C (27°F) below weekly normals in the northern Rockies. Temperatures in parts of Montana and Wyoming averaged 6°C (11°F) colder than normal for the entire month. In December, extremely cold weather again gripped the Rockies and extended into the Southwest. Los Angeles, Calif., on December 8, registered -1.1°C (30°F), breaking its all-time record of 0.0°C (32°F) set in 1958.

Rain, Floods, and Droughts

Early in 1978, the worst drought of the twentieth century in California ended suddenly. Indeed,



Above: Divers bring the body of a passenger to shore after a tornado capsized the showboat Whippoorwill.

AP laserphoto

Left: Aerial view of storm damage at Scituate, Mass. The irregular pattern on the right marks the inland advance of waves during the February storm. Note that many of the houses have been knocked off their foundations.

drought-stricken areas were deluged by flash flood waters, seemingly overnight. Precipitation, which began in mid-December 1977, was above normal in January 1978, particularly in northern sections. In February, changing storm patterns resulted in excessive rainfall for central and southern California. The weather station at Bakersfield reported 119 mm (4.68 in) of rainfall in February, which was 422 percent of normal for the month and the greatest monthly total ever recorded at the station. From February 8-10, major flash flooding and mudslides took their toll in southern California, causing 20 deaths and property losses estimated at $83 million.

During March flood losses of $1.8 million and one fatality were reported in Arizona. Major snowmelt flooding struck eastern Nebraska, with one death and losses near $67 million, and in the Maumee River Basin in northeastern Indiana where losses were $35 million. Snowmelt flooding continued into April with record stages on the Red River of the North near West Fargo, N.D., where property losses of $13 million and two deaths occurred. On May 3, severe urban flooding in New Orleans, La., caused four deaths and losses approaching $100 million. Flooding in northern Wyoming and southern Montana, on the tributaries of the Big Horn and the Little Big Horn, took two lives and caused losses of $50 million. Later in the month, on May 26-27 in Texas, widespread flooding took place on both the Palo Duro and Tierra Blanca Creeks; losses were estimated at $30 million and four lives were lost.

Major flash flooding along the South Fork of the Zumbro River in southeastern Minnesota on July 6 took nine lives with losses of $56 million. A record rainfall of more than 381 mm (15 in) in about a 12-hour period caused severe urban and flash flooding near Fairhope, Ala., on July 26. The big hydrological event of the summer occurred when the remnants of tropical storm Amelia brought excessive rainfall and disasterous flash flooding to the hill country of south central Texas on July 31-August 4. Thirty-three lives were lost and property losses were estimated at $100 million. Rainfall, which exceeded 762 mm (30 in) in 36 hours at some reporting stations, secured for Amelia a place among the greatest storms in the recorded history of Texas because of the widespread heavy rainfall and runoff. Record high stages were reported on several streams including the Guadalupe, Brazos, and Medina Rivers. A flash flood, which roared out of the Organ Mountains of New Mexico, claimed five lives on the White Sands Missile Range on August 19.

During September, urban and flash flooding caused 10 deaths and $25 million in property losses in the vicinity of Little Rock, Ark.; $25 million losses around Monroe, La.; and two deaths and losses of $6 million in Puerto Rico.

Heavy rains drenched portions of the Appalachian region during early December, with major flooding reported in Kentucky. Record high stages were reached on the Kentucky, Licking, and Red Rivers, where there were four deaths and initial estaimates of property losses in excess of $135 million. Major flooding also occurred in Arizona and New Mexico during the third week of December. Average rainfall of 127 mm (5 in) on a snowpack of about 1.5 m (5 ft) caused record flood levels on several streams including the Gila, Verde, and San Francisco, Agua Fria, and Salt Rivers. Preliminary reports for the area listed six flood-related deaths and damage in the millions of dollars—mostly to roads and bridges.

Total flood losses in 1978 were estimated at $1.0 billion in property damage and more than 120 lives. There were 18 Presidential flood-related disaster declarations.

Drought in 1978 was significantly less severe in the United States than during the preceding two or three years. Near normal rainfall in November ended the severe dry spell along the eastern slopes of the Appalachian Mountains from Virginia southward. Also in November, twice the normal rainfall amount ended the drought in Oklahoma and Arkansas. Drought-causing conditions began in February, when much less than normal precipitation occurred over many areas of the eastern United States as the record heavy winter snowfalls ended abruptly early in the month. The dry trend continued during the summer and fall. Asheville, N.C., for example, recorded 11.2 mm (0.44 in), 16.0 mm (0.63 in), and 7.6 mm (0.30 in) total precipitation in February, July, and October, respectively. These amounts—12, 13 and 9 percent of normal—also set new low total monthly precipatation records.

Storms

A series of severe storms and blizzards battered many areas in the northeast quadrant of the United States in January and the first week of February. Many new records were set. Greatest total snowfall amounts were reported by stations in the Lower Great Lakes region. Some weather stations recorded total winter departures larger than 213 cm (84 in). Cleveland, Ohio, broke its maximum monthly total record with 109 cm (42.8 in); South Bend, Ind., nearly doubled its former snowfall monthly maximum with 219 cm (86.1 in); and farther east, Albany, N.Y., easily broke its previous January record with 104 cm (40.8 in).

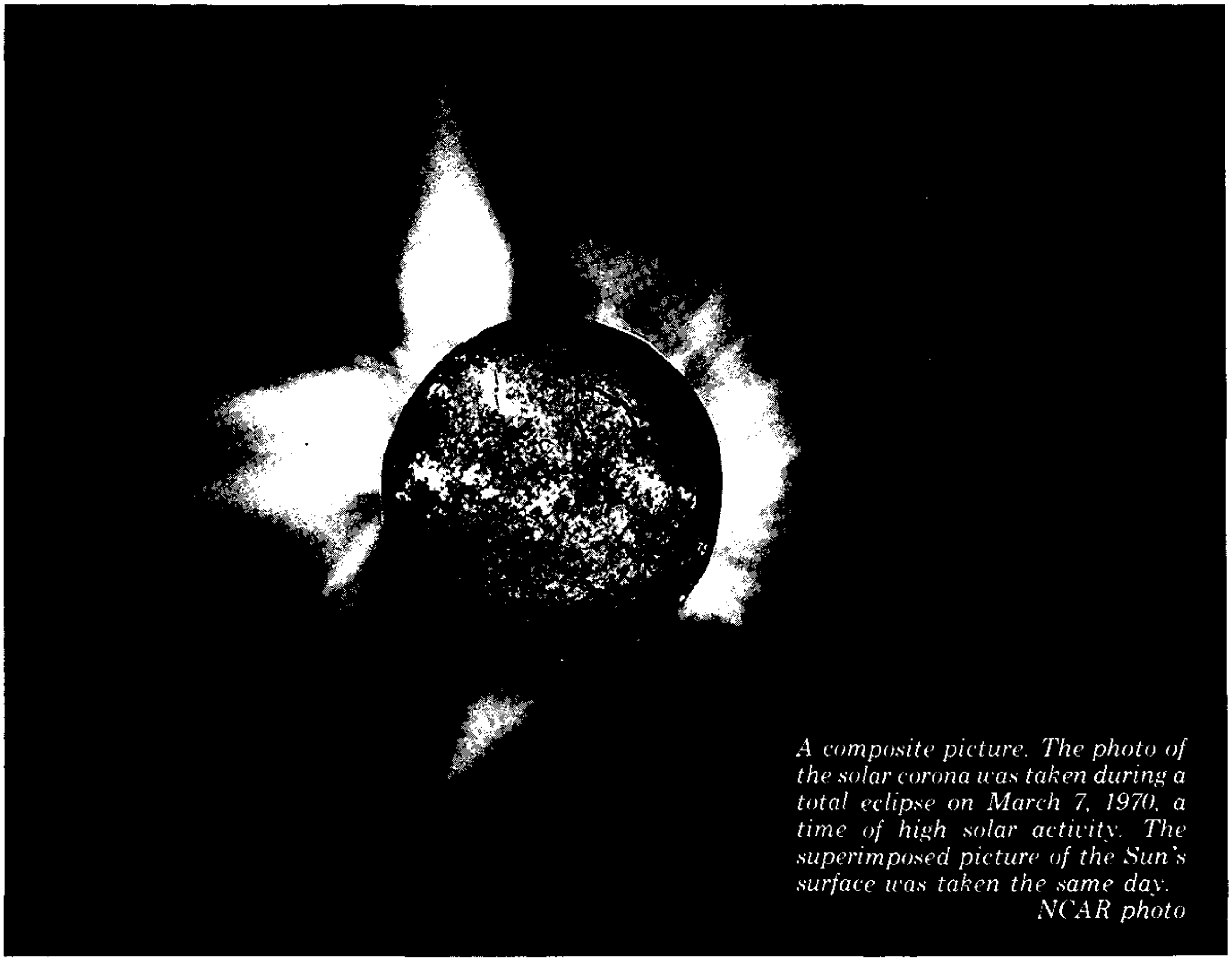
Ohio and Massachusetts bore the brunt of the winter storms. On January 26-27, Ohio was struck by the area's worst blizzard of the century. The controlling low pressure center deepened explosively as it moved rapidly northward from Mississippi to Lake Erie. Numerous stations along its path reported record low sea level pressures, with one of the lowest—(95.8 kPa) (28.28 in)—recorded at Cleveland, Ohio. Sustained surface wind speeds exceeding 27 ms^{-1} (60 mph) with peak gusts greater than 45 ms^{-1} (100 mph), lasted for 12 hours or more, piled up snowdrifts 8 m (25 ft) deep and caused extensive damage. Total property, crop, and economic losses were estimated in excess of $500 million. Fifty-one people died as a result of the blizzard.

On January 9, the coast of Massachusetts was pounded by 37 ms^{-1} (82 mph) winds and storm tides 1.0-1.5 m (3-5 ft) above normal high tide. Coastal flood damage resulted. On the 20th, the same area was hit with 30-61 cm (12-24 in) of snowfall. Boston broke its 24-hour snowfall record with a fall of 53 cm (21 in). On February 6-7, the region was battered by one of the three most intense, severe, and persistent winter storms in its history. Boston harbor was raked by winds of up to 41 ms^{-1} (92 mph), storm tides 1.0-1.5 m (3-5 ft) above normal high tide, and heavy snow. Property losses exceeded $50 million.

Preliminary reports list 787 tornadoes in the United States in 1978 which directly contributed to 52 deaths. This was the first year since 1972 that the total number of tornadoes fell below 800. The most deaths from a single storm occurred on June 17 when a tornado capsized the Whippoorwill showboat on Lake Pomona, Kan., killing 16 of the 58 persons onboard. The greatest property losses were caused by the December 3 tornado that struck Bossier City, La. The twister left four dead, about 250 injured, and caused damages estimated at $100 million.

The Solar Maximum Year and the Middle Atmosphere Programs: Evolving Roles for Data Centers

By Joe H. Allen
National Geophysical and Solar-Terrestrial Data Center



A composite picture. The photo of the solar corona was taken during a total eclipse on March 7, 1970, a time of high solar activity. The superimposed picture of the Sun's surface was taken the same day.
NCAR photo

Two new international scientific programs are about to begin: the Solar Maximum Year (SMY) and the Middle Atmosphere Program (MAP). NOAA will be involved in both through its research components such as the Space Environment Laboratory and the Aeronomy Laboratory and through its Environmental Data and Information Service centers such as the National Geophysical and Solar-Terrestrial Data Center (NGSDC).

SMY begins in August 1979 when the Sun again goes through a period of enhanced activity at the peak of the 11-year sunspot cycle. This will be characterized by occurrences of extensive active regions, large sunspots, and major flares associated with emissions of energetic radiation. Scientists will take this opportunity to study problems in cosmic space related to the generation and propagation of energetic radiations and particle streams in sufficient detail to understand and interpret these processes.

MAP is a major international scientific study of the middle atmosphere—a region of which little is known. The physical processes of this region are complex and inaccessible to direct investigation. The major goal of the Middle Atmosphere Program is to develop an adequate description of the region and to understand it in relation to density, pressure, and temperature; composition; motion (on all scales); and how that region couples the upper and lower atmospheres.

Such international studies involving active cooperation between so many different nations are scientific recognition of many universal global problems. The view of our planet Earth as a small, self-contained ecosystem whirling through space bearing all of us as passengers has been an appealing one to astronauts with their direct look from space vehicles. It has also gained acceptance with the general public, perhaps from their daily viewing of weather satellite images from NOAA and other spacecraft. This viewpoint is popularly summarized in the description "Spaceship Earth." After almost 100 years of international scientific programs in geophysics, it is clear that scientists also have recognized the need to study the Earth as a whole in its spatial environment, and the continued emergence of such programs seems to point to a future of multinational, coordinated scientific studies.

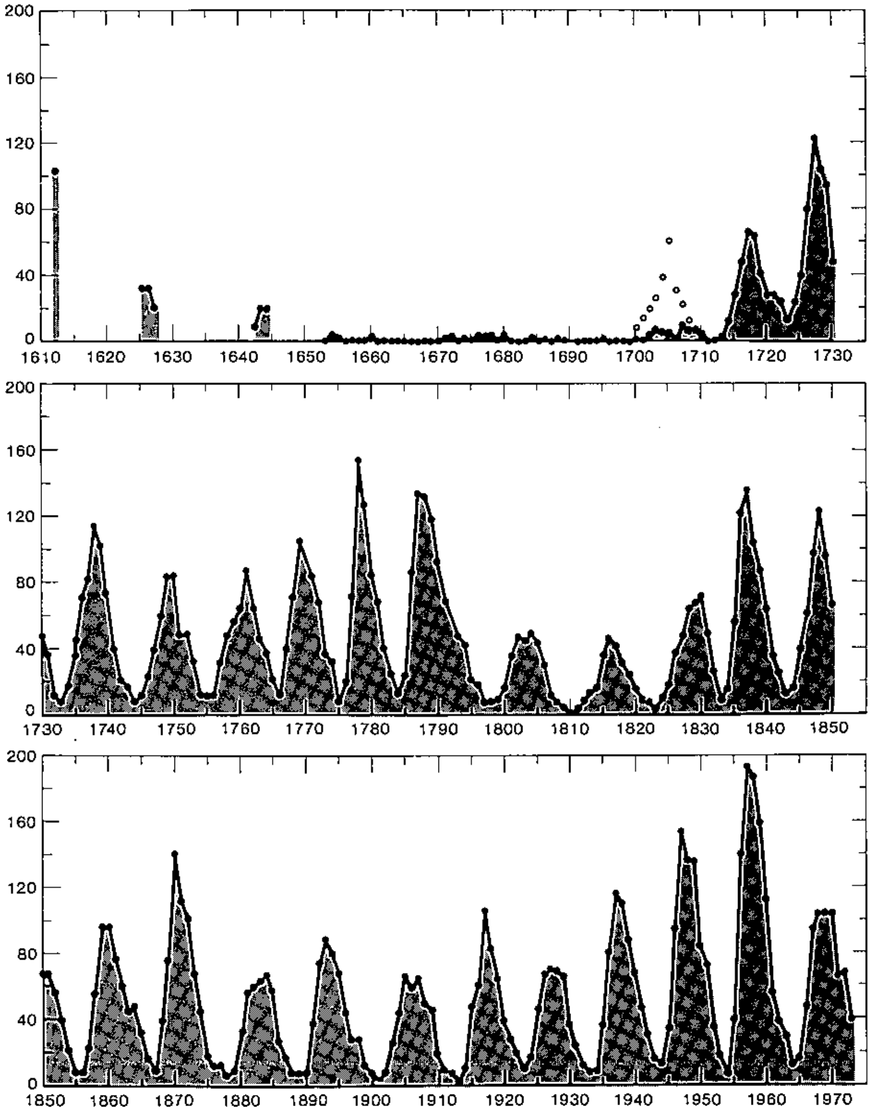
The "First Polar Year" of 1882-83 and the second one in 1932-33 established a pattern for cooperative research between scientists of many nations. A pattern of more or less loosely organized periods, from months to years, evolved when there was an attempt to conduct coordinated campaigns and research to achieve common goals. Typically, such programs produce large data sets.

The most well-known program is the International Geophysical Year (IGY) 1957-58. The IGY was scheduled to coincide with the peak of an 11-year sunspot cycle, when there are a maximum of solar disturbances and related effects on Earth. Out of the IGY emerged, not only a vast data collection, but also a system of World Data Centers (WDC's) to serve as data repositories. Usually located as part of corresponding national data centers, the WDC's established a role to safeguard the global scientific data collection and to make it widely available for the greatest possible use. Since the IGY, the national and world data centers have continued to be active in ongoing systematic observational programs and also to participate in organized global studies such as the International Decade of Ocean Exploration, International Geodynamics Program, Global Atmospheric Research Program, International Quiet Sun Years and, currently, the International Magnetospheric Study (IMS). 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 observations by groups of satellites.

A new role for NGSDC has emerged from work in connection with the IMS—one of information collection and exchange. At the request of the international steering committee for IMS, NGSDC/WDC-A for Solar-Terrestrial Physics (STP) established a Temporary IMS Central Information Exchange (TIMSCIE) office. Its role was to collect information about, planned IMS campaigns, results from data collection efforts, meetings, and workshops, and to distribute this to an IMS Directory of experimenters, theoreticians, administrators, and others interested in the IMS. This information was collected from a network of correspondents, including the project scientists for the campaigns (satellite, rocket, balloon, aircraft, ocean- and ground-based), national and institutional IMS contacts, and regional information/coordination offices. The chief means for distributing the information collected was through a monthly *IMS Newsletter*.

Responses of the scientific community to the IMSCIE efforts were overwhelmingly favorable. (The "T" for "Temporary" was dropped after the first year of operation, when scientists from other countries agreed to supplement the NGSDC staff. Opportunities to improve the effectiveness of separately planned campaigns were realized by coordinating scientists' launch windows or their locations to achieve better global coverage and the opportunity for complementary observations. Through enhanced cooperation, the IMS participants became a recognized scientific community engaged in a common effort. Those who kept informed through the *IMS Newsletters* immediately knew who was conducting research (keeping up with the competition) and where to go to share data that might complement their own data collections. Cooperation between nations in sharing IMS information was accompanied by improved sharing of actual data through the WDC's. The traditional role of the data centers also was enhanced.

One result of the IMSCIE Office's success is that NGSDC/WDC-A for STP has been asked to provide similar services for both the forthcoming international scientific programs, SMY and MAP. Formal relationships are still evolving, but it is clear that some information service roles will fit into the plans for each of these major international studies.



Annual mean sunspot numbers, 1610 to 1973. The highest sunspot number occurred during the International Geophysical Year (1957-58).

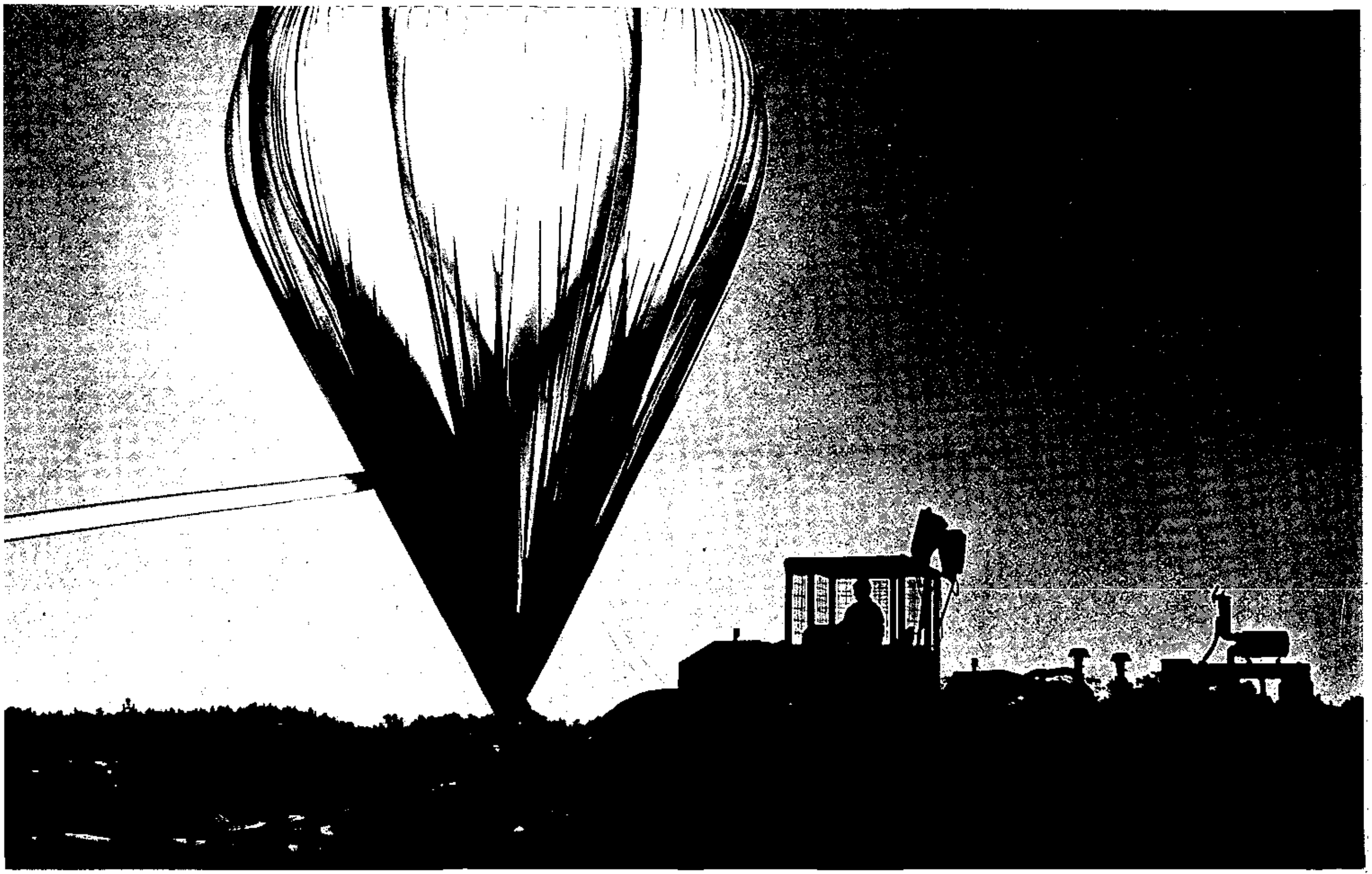
Solar Maximum Year (SMY)

The SMY recently was announced officially through the first issue of the *SMY Newsletter*, produced at NGSDC. SMY is to run from August 1979 through February 1981 (a 19-month year), coinciding with the present surge of sunspot activity toward what may be a record maximum. Constellations of satellites poised around the Sun and Earth will record detailed development of active regions on the solar surface, while arrays of Earth-surface solar observatories conduct coordinated viewing of the growth of these regions. This is the Flare Build-Up Study (FBS), one of the three major subprograms of SMY. Other groups of solar physicists will concentrate on observing the mechanisms in action during the ejection of particles and radiation into space from solar flares that emerge from the active regions. This is the Study of Energy Release in Flares (SERF). Other scientists will monitor the effects of the solar activity as they are propagated through interplanetary space in the solar wind and contrast these excited phenomena with the quiet-time background otherwise present. These are participants in the Study of Travelling Interplanetary Phenomena (STIP). Complementing these studies is a major NASA satellite program, the Solar Maximum Mission (SMM), which will take an unprecedented comprehensive look at the Sun and its nearspace environment.

If the elements of the Solar Maximum Year are successful, scientists will begin to accumulate an accurate, detailed understanding of the growth of solar disturbances, their erruption from the solar surface, and their propagation through space to the Earth. Combined with the understanding arising from IMS and continuing studies of how the magnetosphere couples this solar activity into the near-space environment of Earth, scientists will have almost tracked the events to the surface.

Middle Atmosphere Program (MAP)

Although there is no well-defined inner boundary where one is clearly below the altitude at which the magnetosphere controls what is happening, most IMS studies relate to phenomena occurring above 90 km altitude, even when recorded by instruments on the Earth's surface. Nearer the surface, up to some 10 km, the atmosphere is a much studied region because of the vital importance of Earth weather. In between is a region called the middle atmosphere sometimes called the "ignorosphere," due to limited knowledge of the processes there. The purpose of the Middle Atmosphere Program (MAP) is to explore this region and, in effect, make continuous the chain from



Research balloons are used to study the middle atmosphere by direct sampling.

NCAR photo

the Sun to the Earth's surface.

From 1982 through 1985, the national representatives to the Special Committee for Solar Terrestrial Physics (SCOSTEP) have agreed to sponsor a multinational, interdisciplinary study called the Middle Atmosphere Program. MAP will involve coordinated observations of the region from about 15 to 85 km altitude. Ground-based instruments such as laser sounders and radars will probe the physics of this region and its coupling to the higher and lower boundary regions. In-situ flights of rockets and balloons will provide direct observations to sample the region and calibrate indirect sensors. Arrays of satellites will be looking down into the middle atmosphere to sense its physical response to solar stimulus and to effects rising from below. MAP has specific scientific objectives in the areas of the dynamics, structure, chemistry, and electromagnetics of the middle atmosphere.

Coordination and planning for MAP involve many national and international groups and are organized by an international steering committee. This group has requested the assistance of NGSDC/WDC-A for STP in both planning data collection and distribution services to supplement existing mechanisms and to provide an IMSCIE-like information exchange service. This service will be important even before the beginning of MAP in 1982, because of preparatory MAP projects that are already starting this winter.

Even after the end of coordinated data acquisition periods for international scientific programs, there will be a continuing role for both information and data dissemination. Data from such programs are requested for years and years—IGY data are still "good sellers."

It is clear from programs such as Skylab and the IMS that scientific workshops with better access to composite data collections will be a recurring feature of large scientific programs in the future. During what are now being called "analysis phases," there are emerging coordinated data analysis workshops, and groups of scientists are converging upon sites where there are comprehensive digitial and analog data collections and the latest computer, interactive graphics, and reproduction facilities to perform coordinated studies. Data centers are being called upon to afford this type of access to their collections for onsite use, and the information exchange offices are being asked to keep the user community informed about progress with the data analysis and of prospects for future programs.

The National Climatic Center's Role in the Global Weather Experiment

By William Hodge
National Climatic Center

Data have begun flowing into the EDIS National Climatic Center (NCC) from a massive project designed to observe the entire atmosphere of the Earth in detail for the first time. The World Meteorological Organization (WMO) originally dubbed the effort "The First GARP (Global Atmospheric Research Program) Global Experiment," or FGGE, but it is also known as the Global Weather Experiment (GWE).

The collection of weather observations from remote locations is not new. For years, the international community exchanged observations by telecommunications within minutes of the observation time. But, even with observatories in remote places, such as the South Pole and on ships in mid-ocean, no reports come from vast areas. Accurate forecasting by computer requires precise and nearly complete global input data. The study of climate fluctuations using numerical models demands correct baseline data. The Global Weather Experiment will provide them.

No single observing system is capable of providing the obser-vaitons needed to meet the goals of the Experiment. Thus, a composite system has been devised which is based upon the operational World Weather Watch (WWW) global observing system, but which fills the gaps in that coverage with reports forwarded by mail and by the deployment of special observing systems.

The World Weather Watch is an observing, telecommunications, and processing system that makes basic meteorological and related geophysical data available to WMO member countries. Essential elements of the WWW are the Global Observing System, consisting of regional networks and other land, sea, atmospheric, and space stations established to take necessary observations; the Global Data Processing System, designed to make basic processed data available through world, regional, and national meteorological centers; and the Global Telecommunications System, designed to collect, exchange, and distribute observed data between national, regional, and world meteorological centers.

NCC is one of four Area GWE Subcenters which collect, process, and quality control operational WWW observations. The other centers are operated by the Japan Meteorological Agency in Tokyo, Japan; the United Kingdom Meteorological Office in Bracknell, England; and the All-Union Research Institute of Hydrometeorological Information in Obninsk, USSR. Each is responsible for a section of the world. NCC's area covers North, Central, and South America, the Caribbean, Antarctica, and part of the Pacific.

The WWW data are merged with data arriving from foreign countries by mail, checked, and then sent to a world center for such data at Obninsk, USSR. There, the inputs from the four area subcenters are combined and duplicate observations eliminated. Next stop for the observational data is the GWE Space-Based and Special Observing System Centre operated by the Swedish Meteorological and Hydrological Institute in Norrkoping, Sweden. Satellite and other unique data are incorporated at this point. The final observational magnetic tapes are sent from Sweden to World Data Centers in Asheville and Moscow and to the Geophysical Fluid Dynamics Laboratory (GFDL) in Princeton, N.J., and the European Centre for Medium Range Weather Forecasts (ECMWF) in Reading, England. The two latter centres will analyze the observational data and generate GWE products.

The GWE has been on the drawing board for years; NCC's planning for it began in 1972. Activity increased in 1977 with the writing of computer programs and the publication of operations plans for each step of the work. Pretesting took the first 11 months of 1978. During this period, data were treated in the same way they now are being processed in the field year (December 1978 thru November 1979). The shakedown resulted in many improvements.

The NCC GWE Area Subcenter's work is made difficult by the numerous data formats in use around the world. Each type of data has its own code: surface, upper air, satellite-sensed, ship, commercial and special aircraft, fixed and free-drifting buoy, and free-floating balloon observations. Further, individual countries have modified these codes to suit local needs. Writing computer programs to decode all of these variations was a formidable task. The way weather messages are relayed, it is not unusual to get the same observation from several sources, couched in different codes. How does one tell the computer to keep the best report and delete the others? How can the computer be

The Global Weather Experiment

The Global Weather Experiment is a concerted effort by more than 140 countries, the World Meteorological Organization (WMO), and the International Council of Scientific Unions to observe almost all of the world's weather at the same time. This unprecedented experiment seeks to gage the practical limits of weather forecasting and to determine the statistical properties of the general circulation of the atmosphere, which would lead to a better understanding of the physical basis of climate. All 147 member nations of the WMO, 70 countries, and five international organizations are contributing to this $300 million effort.

NOAA is coordinating this giant effort with other U.S. participating agencies including the Departments of Defense, Energy, Interior, Transportation, and State, the National Aeronautics and Space Administration, the National Center for Atmospheric Research, the National Science Foundation, the Defense Nuclear Agency, the Air Force, Army, Navy, and Coast Guard, and academic institutions. The National Academy of Sciences is providing scientific advice and liaison with the international scientific community.

For a one-year period that began December 1, 1978, the weather in every part of the world will be monitored by a vast array of observing systems: 10 space satellites, more than 50 research vessels, 110 aircraft (including 10 research planes), 300 high-altitude constant-level balloons, and 300 instrumented drifting buoys. These systems will be adding to the mass of data already generated daily by the surface-based World Weather Watch, which produces observations from 3,400 land stations, more than 7,000 merchants ships, some 800 upper air stations, 9 weather ships, and 1,000 or more commercial aircraft.

Prior to the beginning of the Global Weather Experiment, only about 15 percent of the Earth's surface was regularly monitored—all in the Northern Hemisphere. Of particular concern to the experimenters is the other 85 percent of the Earth's area—the Southern Hemisphere—which is not now covered by the World Weather Watch. What happens south of the Equator profoundly affects the weather of the Northern Hemisphere and knowledge about this vast heat sink is vital to accurate long-range forecasting. The Global Weather Experiment is necessary because the longer the forecast, the more of the atmosphere and oceans need to be observed.

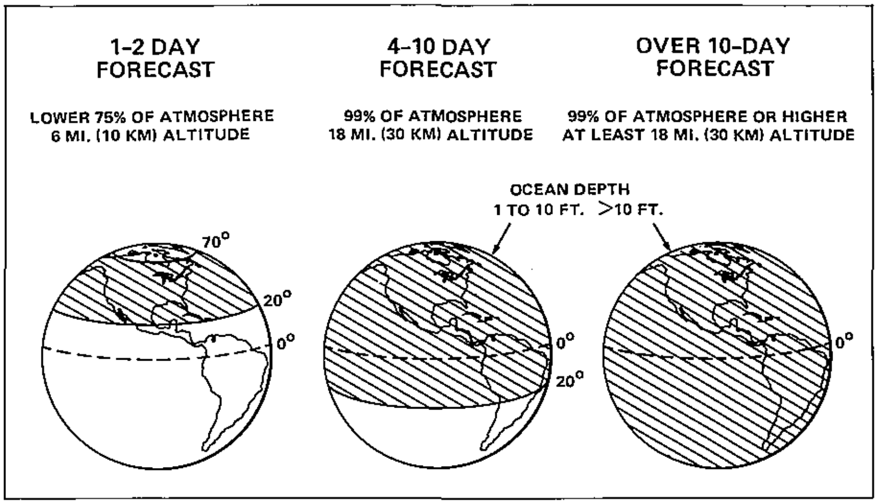
With the improved satellites, special observing systems, and existing World Weather Watch, meteorologists will be able to monitor the planet's atmosphere more comprehensively than ever before. The new giant supercomputers will be able to process the resulting flood of data, enabling scientists to gain a better understanding of the world's weather.

The torrent of information gathered will be funneled, via a worldwide communications network, to various data centers around the globe. Some of the data are being relayed in "real time" almost as soon as they are generated. The information will be used to prepare daily weather forecasts. Other information will be delayed and will take hundreds of scientists more than a year to fully process, even using the most powerful computers available.

The result of the Global Weather Experiment will be the most comprehensive record of the state of the world's atmosphere and oceans ever constructed. This immense data set should prove invaluable in learning more about the causes of weather behavior, constructing more accurate models for forecasting, determining the practical limits of weather prediction and its impact on worldwide socioeconomic conditions, and designing the most practical and comprehensive global weather observation system the world can reasonably afford.

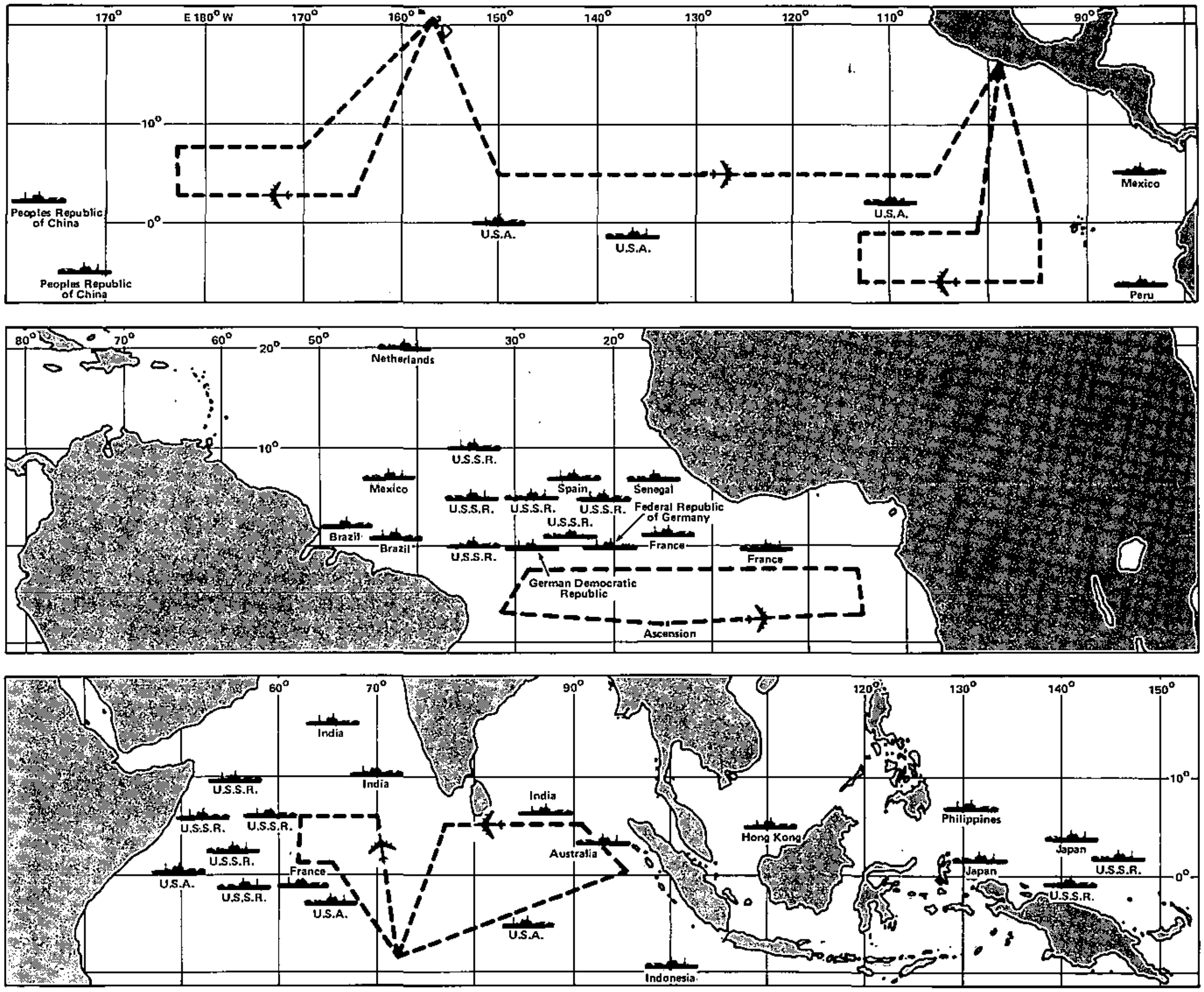
programmed to recognize and flag, or correct, erroneous data? Once these problems were solved, however, the final one was to convert all of the data to the internationally agreed-upon GWE data format.

Each NCC division is involved in some aspect of the global experiment. Data messages from the global telecommunications system are received weekly via magnetic tape from the National Meteorological Center in the Washington, D.C., area. These data are sorted for processing through a number of computer subroutines. In the meantime, letters are sent every four days to the individual foreign countries telling them which observations did not reach NMC via telecommunications. Their mailed replies must reach NCC in time to meet a system of constantly changing deadlines. The new data are keyed to magnetic tape and are merged



Left: Data coverage needed for various weather forecast periods.

Below: Ship and aircraft deployment during the Global Weather Experiment.



with the other data. After a final check, the tapes are airmailed to the USSR world center ever 10 days.

The high data volume permits no stoppages once the program has started. Instead of one data pipeline, there are multiple pipelines with data in various stages of processing. Each must be monitored continually in order to maintain the international schedules.

One of the NCC's areas of expertise is marine meteorology. The Center has been asked to make a unique contribution to GWE by collecting as many reports as possible from ships plying the world's oceans. In cooperation with the National Weather Service's surface marine observation program, the NCC is having ships' weather logs mailed directly from ports to the Center. They are placed on tape, edited, and sent to the GWE Mobile Ship Data Center in Hamburg, Germany. After being incorporated with similar tapes from other countries, this data set will be returned to the WDC-A to supplement the marine reports received by telecommunications.

The NCC has a further role in GWE in the operation of the World Data Center-A for Meteorology. Several forms of the data are, or will be, available to the scientific community through WDC-A:

- the basic global data
- internally consistent data obtained by applying 4-dimensional assimilation techniques
- selected data for climatic investigations.

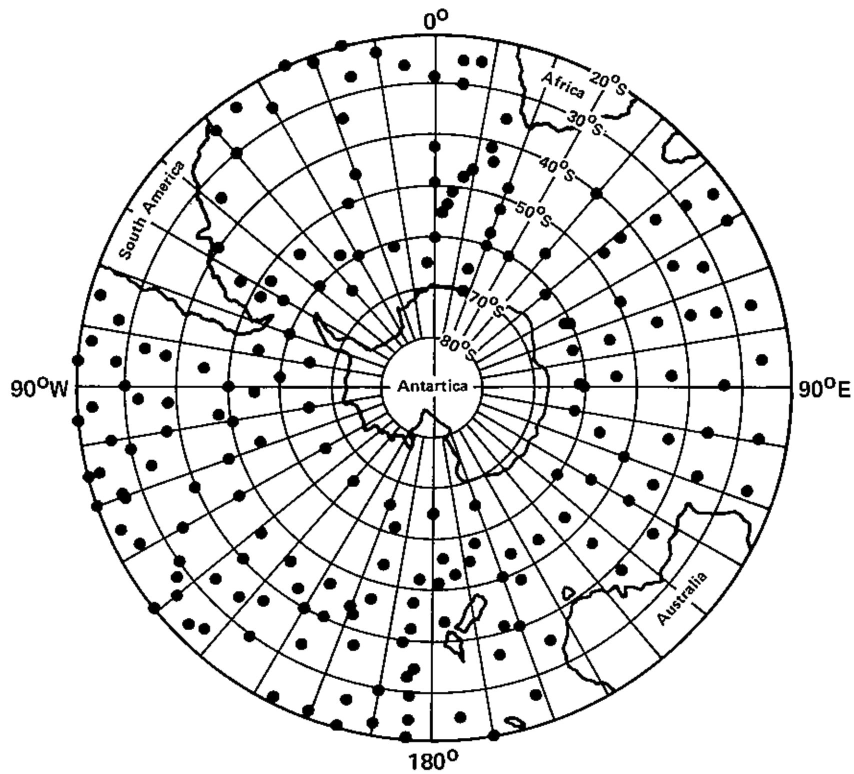
The WDC-A prepares inventories of WWW data received each 3 hours by the United States. These will be compared with the final data counts to measure the effectiveness of the GWE effort of adding to the operational data base. Similar inventories will be received from the World Meteorological Centers (WMC) in Melbourne, Australia, and Moscow, USSR. Also in WDC-A are the operational upper air analyses from the World Meteorological Center, Washington, D.C., on magnetic tape in the GWE format, starting with January 1, 1978, the beginning of the buildup year. Similar data are to be received from Melbourne and Moscow. The enhanced analyses to be received from GFDL and ECMWF will begin arriving in July 1979.

With the arrival of the first data, WDC-A for Meteorology published a looseleaf GWE Data Catalog. It will increase to several hundred pages as supplements are issued quarterly to the 450 catalog subscribers around the world. The supplements will continue until 1981 when the archives will be complete. The data distribution activity will remain at a high level during the GWE research and application stage which ends in 1985.

During GWE, special emphasis will be placed on the Monsoon Experiment (MONEX) to study the Asian monsoon, which has great social and economic impact in the Eastern Hemisphere. The West African Monsoon Experiment (WAMEX) will serve a similar purpose. Data from both will be available from NCC's WDC-A.

The NCC has a long history of involvement in large data projects but the Global Weather Experiment promises the greatest potential benefits. The major goal of GWE is to assess the ultimate limit of predictability of weather systems.

Further information about the data resulting from the GWE can be obtained from W.T. Hodge, World Data Center-A for Meteorology, National Climatic Center, Federal Building, Asheville, NC 28801. The telephone number is (704) 258-2850, extension 754 (FTS 672-0754).



Drifting data buoys deployed in the Southern Hemisphere during the Global Weather Experiment.

Marine Geological Data and the Core Curators' File

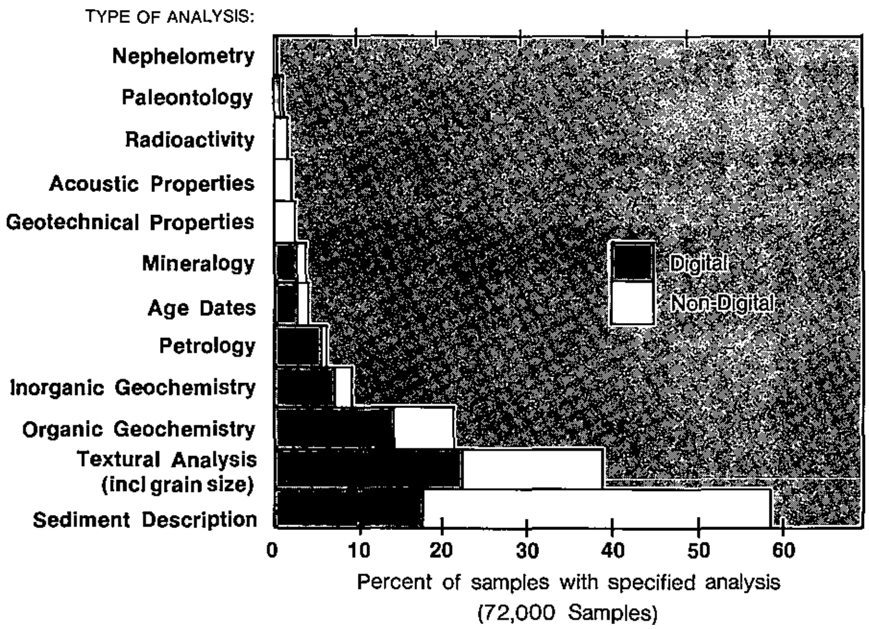
By Carla J. Potter
National Geophysical and Solar-Terrestrial Data Center

NOAA scientists inspect a core sample taken from the New York Bight area.

Marine sediment cores are a unique source of many types of information. Because of their many uses, and the amount of time and money necessary for their collection, marine cores are a precious commodity. By disseminating geological data derived from cores and other marine samples and by cooperating with the major U.S. core-curating facilities in establishing a central index of marine geological samples, the EDIS National Geophysical and Solar-Terrestrial Data Center (NGSDC) in Boulder, Colo., is helping to ensure the fullest possible use of this valuable resource.

Material from marine samples may be analyzed for many different properties using a wide spectrum of techniques. Each laboratory has its own standard set of analyses. Routine analyses may be as simple as a few words or paragraphs describing the appearance of the sample, or as complex as a complete battery of tests for grain size, mineralogy, geochemistry, engineering properties, acoustic properties, age dates, and paleontology. Each type of analysis may be made using different methods, depending on laboratory equipment available or individual preference. For example, grain size analyses may be made using sieves, hydrometers, pipettes, computerized scanners, or by a combination of these or other methods.

Scientists within the collecting institution or from the outside scientific community may perform further analyses on material from marine samples. Portions of samples are frequently passed from one scientist or institution to another. This means that, in addition to



NGSDC geological sample inventory (September, 1978).

data produced by the initial routine laboratory analyses, data also may be generated by non-routine, often highly specialized analyses made by other scientists at a later date.

Data from different types of analyses often are combined to solve a particular problem. In the Climate: Long-Range Investigation, Mapping, and Prediction project (see *EDS*, Jan. 1978, p. 4) of the International Decade of Ocean Exploration (IDOE), for example, paleontological, geochemical, and age-date data together give researchers an insight into past climates. By studying the sediment record for patterns of past climatic change, and by comparing these patterns to computer models or theories, scientists can better understand how the Earth's climate fluctuates between temperate and ice ages. By analyzing the mechanisms of climatic change, researchers hope to be better able to predict the effect that man's activities, as well as natural phenomena, may have on future changes in the Earth's climate.

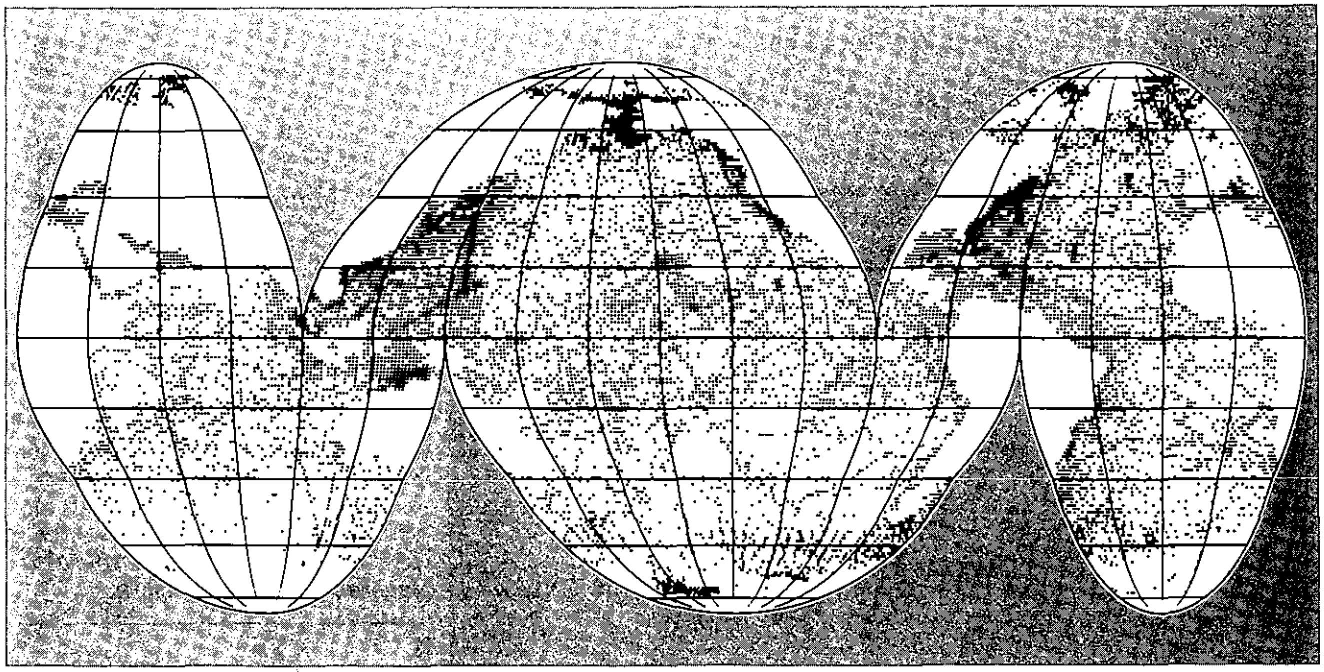
Identification of tiny organisms such as foraminifera, radiolaria, and diatoms that make up part of the sediment in marine cores can help scientists to estimate sea-surface temperatures at specific times in the Earth's past. Changes in carbonate preservation at different depths within a core can indicate variation in the size of former ice sheets. Pollen identification (see *EDS*, March 1978, p. 9) can help to determine accompanying changes in past terrestrial climate. Each of these types of data, vital to climate studies, is obtainable through the study of marine sediment cores.

With expanding interest in exploration for and development of marine mineral resources, geochemical and engineering property data have become increasingly important. Geochemical analysis of core material can give insights into how certain types of economic mineral deposits are formed. The geochemistry of pore water "squeezed" from cores can be studied to evaluate fluid migration in areas of high iron and maganese concentration on the ocean floor. Vertical migration of certain metals through sediments is analyzed to learn more about the formation of maganese nodules on the sea floor, a valuable marine resource of the future. The relationship of concentrations of certain metals and hydrocarbons to hydrothermal activity and to continental drift also may be studied by analyzing deep marine cores, such as those collected by the Deep Sea Drilling Project (DSDP), and by relating these data to other geological and geophysical observations.

Engineering property data on such parameters as void ratio, pore pressure, and shear strength used in combination with grain-size data are essential in the recovery of marine resources. Engineering property data are useful in determining where to place structures on the ocean floor and must be taken into account when designing items such as deep-ocean mining equipment, foundations for offshore platforms, and anchoring systems in general.

Evaluation and prediction of the environmental impact of activities such as marine mineral resource recovery and radioactive and other waste disposal is yet another important use of marine sediment data. Variables such as slope stability, sediment transport patterns, and fluid migration through sediment can be evaluated, at least partially, by the analysis of cores. Programs such as Marine Ecosystems Systems Analysis (MESA), Deep Ocean Mining Environmental Studies (DOMES), and the Outer Continental Shelf (OCS) program all use marine sediment analysis data in their studies.

The National Science Foundation supports much of the research involving marine samples through the IDOE program, by grants to oceanographic institutions, and by contracts to endeavors such as DSDP. Some other major funding



NGSDC marine geological data coverage (September, 1978).

sources for marine geological research include the Bureau of Land Management (through the Outer Continental Shelf program), the Office of Naval Research, and the National Oceanic and Atmospheric Administration (NOAA), of which NGSDC is a part.

NGSDC archives most major types of marine geological data as part of its responsibility as the major U.S. repository for marine geological and geophysical data gathered under national and international programs. In addition, NGSDC has data-exchange agreements with most of the major U.S. oceanographic institutions, as well as data from several foreign countries, including major data sets from Japan and France.

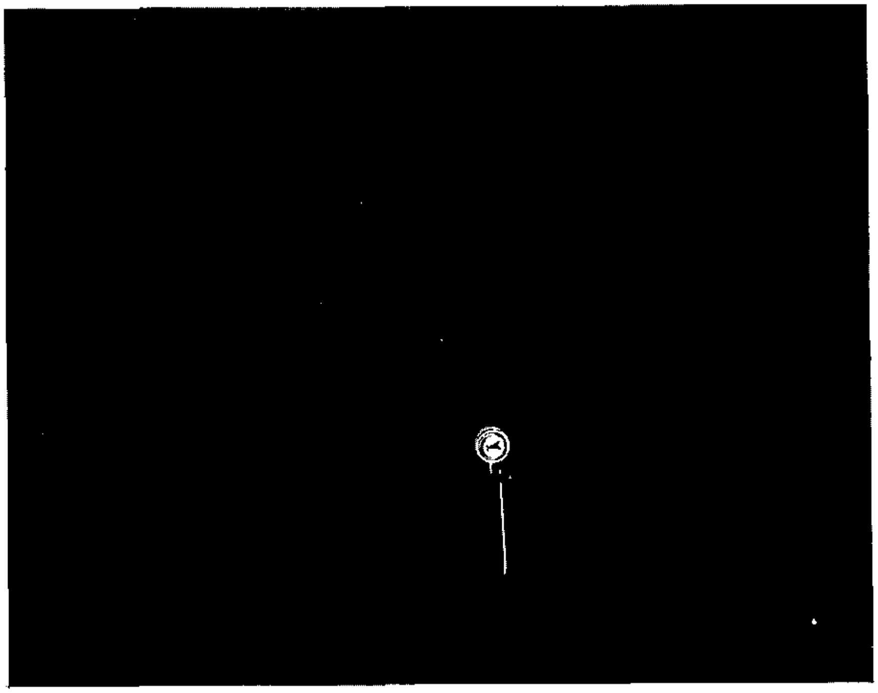
A breakdown of the marine geological data that NGSDC presently has to offer is given in Figure 1. A summary plot of data locations is shown in Figure 2. Complete inventory listings from the requestor's area or topic of interest are available to the public free of charge; actual data are available at cost of reproduction.

By archiving data generated by analysis of marine sediment cores, and making these data available to the public, NGSDC is helping to ensure the fullest possible use of such data. In addition, some of the burden of data reproduction and distribution is lifted from the shoulders of the collecting individual or institution. NGSDC also provides documentation to data users as to collecting institution, ship, cruise, and so on, which allows the user to contact the original data sources, if necessary.

In 1977, two meetings were held by the curators of marine geological samples—the first, in La Jolla, Calif., and the second in Seattle, Wash. One of the subjects discussed was how best to provide the scientific community with information on the holdings of the major repositories for marine geologic samples.[1] A common format for basic descriptions of the samples would make life simpler for both the users of the information and the curators, and a central distribution point for inventory and basic descriptive information would eliminate the need for users to make multiple requests of several institutions.

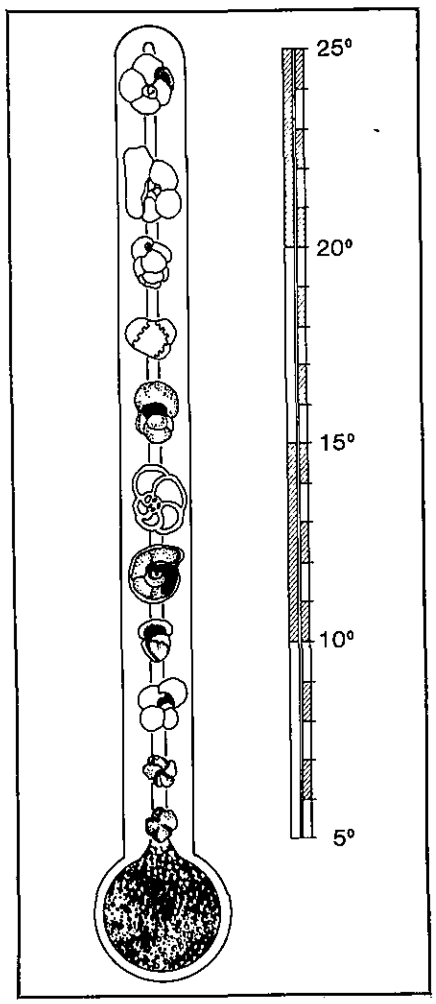
A standard format including curating facility, ship, cruise, sample number, geographic position, water depth, sample dimension, type of sampler, basic lithology, and age was conceived at the curators' first meeting and refined at the second. All of the institutions involved have agreed to code this information for all of their core holdings into the new format, beginning with recent collections. The resulting file is called the "Index to Marine Geological Samples," or more informally, the "Core Curators' File." At this time (January, 1979) nearly 5,000 entries have been received for the file from the University of Washington, Scripps Institution of Oceanography, the University of Southern California, the University of Texas at Galveston, the

[1]"Marine Curators Gather," Floyd W. McCoy, GEOTIMES, December 1977, pp. 26-28.



Left: Manganese nodules at a depth of approximately 5,000 meters in the equatorial Pacific.

Below: A paleothermometer that illustrates the use of fossil sediments to estimate sea-surface temperature. Microorganisms live near the ocean surface, then die, sink, and concentrate in bottom sediments. When large numbers of a certain species are found in a sediment layer, this indicates a particular surface temperature favorable to their growth.



U.S. Geological Survey-Menlo Park, and the University of Wisconsin. New contributions are received regularly.

The NGSDC was selected as the central distribution point for the curators' file, and it has agreed to provide certain services. File listings by parameter, such as curating facility or geographic position, will be issued initially for the most recent collections, and eventually for all past acquisitions of the participating institutions, as the data center receives information from the curating facilities. Basic lithologic descriptions and relative geologic age will accompany the station, collection, and storage information on listings. In addition, the center will provide search services on the file. Searches may be made on any combination of parameters. Station summaries and map plots also will be distributed periodically. These services should be available in the second half of 1979 on sample information that has been received by that time.

The agreement on a standard format and central location for the file will benefit not only the core repositories and users, but also the scientific community as a whole by facilitating the flow of information about marine geologic samples. Improved communications between the major repositories and NGSDC should result in a savings of time and effort for collectors, users, and curators, and anyone else interested in information about marine geologic data or samples.

Please address inquiries to:
NOAA/EDIS/NGSDC, D621
Boulder, CO 80303
Tel: 303-499-1000, Ext. 6338

Climate and Moving

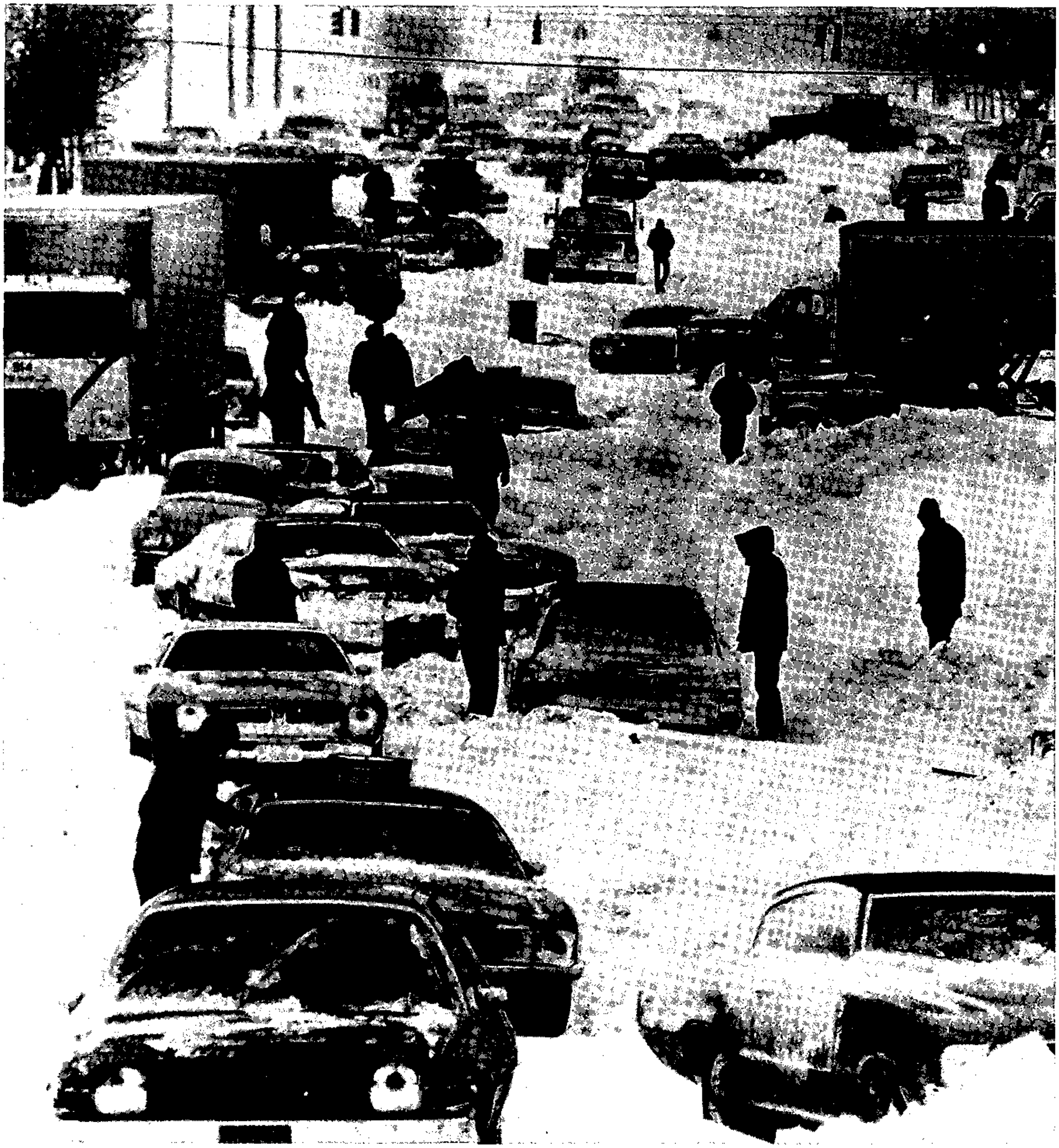


Photo: Newsday, *Long Island*

A move is sometimes planned for retirement or health purposes; for example, a person may have a physical impairment aggravated by local weather conditions. Thus, information about the type of weather likely to be encountered in the new area can be useful in the decision-making process.

Obviously, one way to learn about climate in a particular area is to spend some time in the area. Ideally, such visits should be made at different times of the year to ensure exposure to the entire range of weather conditions common to that locality. Another way of obtaining information about the climate of an area is to secure publications or other material prepared by the EDIS National Climatic Center (NCC), which contain summaries of weather elements over a period of years. This information is available in a variety of forms, for both individual stations and groups of stations within the United States and worldwide.

In seeking an "ideal" climate, people frequently ask whether a move to a different area would be beneficial to their health. Although there is some evidence to support the idea that weather conditions influence human diseases, the effects of daily weather changes on the physiology and pathology of man are extremely difficult to ascertain. Some reasons for this are: (1) specific weather conditions do not affect every individual to the same degree, (2) all factors related to illnesses are not equal, and (3) weather observations taken at a single location do not precisely describe the actual atmospheric conditions at all points in an area. Human comfort is a complex function involving many weather elements; however, neither their individual nor collective influence is always readily apparent. Some combinations of weather may have a pronounced psychological (or physiological) effect on some individuals and little or no effect on others.

Since each person is affected in an individual way by his environment, probably no group could agree on an "ideal" climate. Certain climates may be more healthful than others for some people, but it would be difficult to determine which element or combination of elements contributes most. If one were to specify the type of climate he prefers (in terms of temperature, wind, cloud cover, sunshine, rainfall, humidity, pressure, etc.), it might than be possible to make a comparison between those same elements reported in the vicinity of the proposed retirement site. There are both published and unpublished climatological information available from NCC to assist in making comparisons of climate at various locations. The following sources of information may be useful.

Local Climatological Data issued monthly and annually for each of approximately 300 National Weather Service stations. Each monthly issue contains daily and monthly temperature data including cooling and heating degree days, relative humidity, dewpoint, precipitation (including snowfall), pressure, wind, sunshine and sky cover data. The annual issue summarizes the monthly data for the station. It also contains a narrative description of the climate for the station; a table of normals, means, and extremes; and tables listing by month and year (or season) data for average temperature, total precipitation, total snowfall, and heating and cooling degree days for a number of years.

Climates of the States issued for every State or combination of States. Each issue contains normals, means and extremes tables for selected National Weather Service and cooperative stations in the State, and a narrative summary describing the climatological features of the State.

Comparative Climatic Data contains 16 tables of long-term monthly and annual averages and extremes of selected meteorological elements. Data for temperature, precipitation, wind, sunshine, cloudiness, and relative humidity are presented for approximately 300 stations. The stations are listed alphabetically by State so that values for the same element may be easily compared for different locations by use of a single table.

Climates of the World, a 28-page brochure containing temperature and precipitation data for approximately 800 stations throughout the world. Also includes brief descriptions of the climate of each continent and maps showing the worldwide distribution of temperature and precipitation.

Unpublished Summaries. These are summaries of specific weather elements, or combinations of elements, for particular locations. They often represent the nearest location to the point of interest for which summarized data are available.

Direct inquiries to the National Climatic Center, Federal Building, Asheville, NC 28801.

U.S. Travel Service photo

National Report

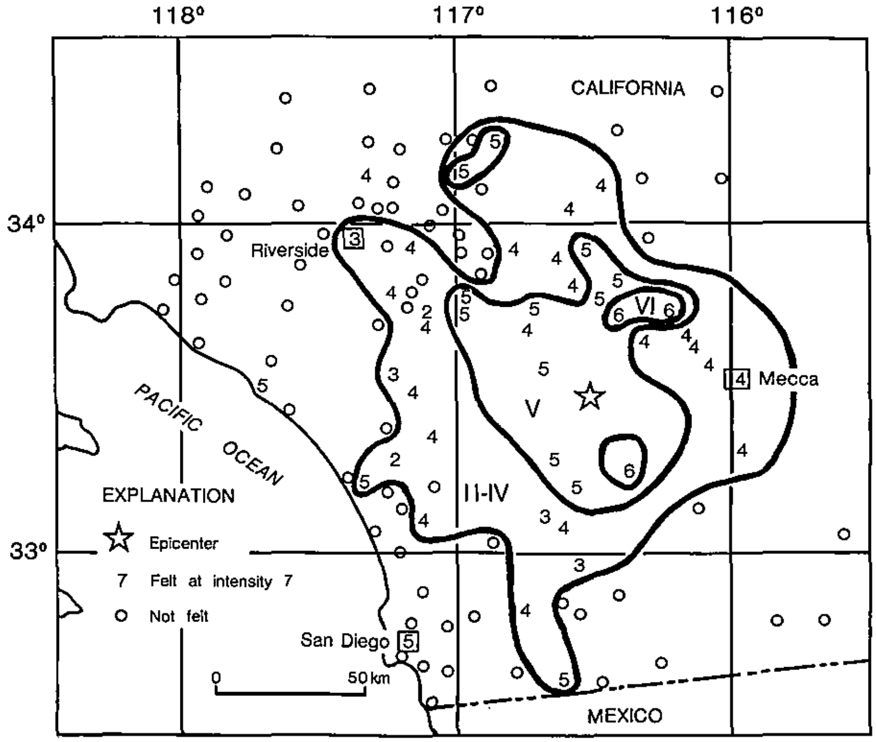
U.S. Earthquakes—1976

United States Earthquakes—1976 has been published jointly by the U.S. Geological Survey (USGS) and the EDIS National Geophysical and Solar-Terrestrial Data Center.

This publication summarizes earthquake activity in the United States and nearby territories for 1976. It includes brief descriptions of all earthquakes reported by residents of the United States, Puerto Rico, the Virgin Islands, and the Panama Canal Zone. Each description contains date, time of occurrence, location, felt area, and damage details. Also included is a table of pertinent data covering all felt or damaging earthquakes in the United States.

Several illustrations accompany the earthquake descriptions, including isoseismal maps for moderate earthquakes in Arizona, California, Kentucky, New Mexico, Oregon, Virginia-North Carolina border region, and Washington, as well as Canada. The report contains sections on geodetic work of seismological interest, tidal disturbances of seismic origin, fluctuations in well-water levels with corresponding earthquakes, and principal earthquakes of the world for 1976. A summary of accelerograph records obtained from the USGS strong-motion network also is given.

Copies of the report are for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price: $2.75. Stock No. 003-019-00045-4.



Area affected by an earthquake in southern California, August 11, 1976.

Data Sets for OCS Lease Sale Areas 48 and 49

EDIS' National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo., has data available from high-resolution surveys conducted offshore from Southern California and the Baltimore Canyon Trough. The surveys were made by private corporations under contract to the U.S. Geological Survey to provide information on potentially hazardous geologic structures or conditions prior to scheduled oil and gas lease sales.

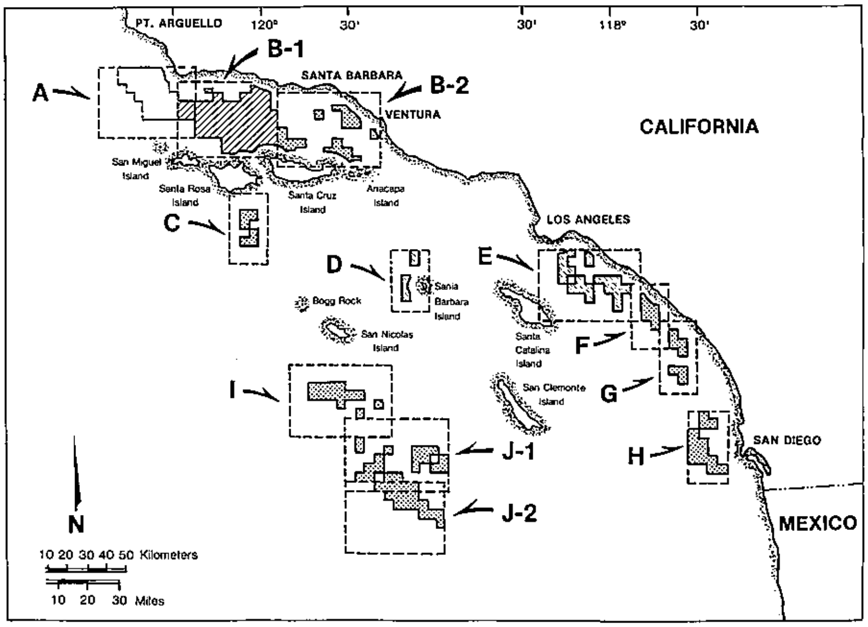
McClelland Engineers, Inc., collected data offshore from Southern California from September 1977 through March 1978 over tracts tentatively selected for Outer Continental Shelf Lease Sale No. 48. About 8,000 line-km of bathymetric and high-resolution seismic reflection data were acquired on a rectangular grid of traverses.

The data set consists of 13 reels of microfilm containing bathymetric data, sediment profile, shallow seismic and digitally processed shallow seismic records; one 9-track magnetic tape of navigation data; and 3 microfiche of the field operations report and technical report of data interpretation. Maps of the area also are available.

Offshore Navigation, Inc., performed the Baltimore Canyon Trough survey from December 1977 through June 1978 to test geologic conditions before the scheduled Lease Sale No. 49. This is the second sale on the mid-Atlantic Outer Continental Shelf. Blocks within this sale area cover 774,273 acres (313,344 hectares) and extend farther north, south, and seaward than those of the first sale. The blocks in the Baltimore Canyon Trough are located 80 to 160 km offshore and extend from New York to Virginia in water depths of 35 to 1,425 meters.

A total of 8,366 km of data, acquired over 602 separate survey lines, was collected. These comprise an 800- by 3200-meter grid over 226 lease blocks. In September 1977, 136 of these blocks were selected for leasing by the Department of the Interior.

The Baltimore Canyon data set contains 38 reels of raw data on continuous flow 35-mm microfilm, both interpreted and uninterpreted, side scan sonar records, and echosounder records. The sparker data were collected in digital form using a 12-group cable and were processed by Sytech Corporation to 0.5-second travel-time below water bottom with 12-fold stacking, deconvolution, controlled gain, and normal automatic gain control. The original sections were plotted at a vertical scale of 15 in/sec and a horizontal scale of 25 traces/in before filming. Five sets of interpretative maps (six maps per set) are available at a scale of 1:48,000 for bathymetry, sediment isopachs, shallow structure, potential hazards, and nagivation. The final two-volume technical report in the set describes survey methods and equipment, data preparation and processing, and survey results.



Location map for Outer Continental Lease Sale No. 48.

For further information on prices and availability of the data sets, contact: NGSDC, Code D621, NOAA/EDIS, Boulder, CO 80303. Telephone (303) 499-1000, ext. 6338 or 6542, FTS 323-6338 or 323-6542.

Input Data for Solar Systems

EDIS' National Climatic Center has prepared and published for the Department of Energy a 192-page compilation of climatological data for 248 U.S. stations. The publication, *Input Data for Solar Systems,* contains tables of monthly and annual normals (1941-70) of temperature and of total heating and cooling degree days for those stations with available data. Also included in the tables are corresponding values of average daily global solar radiation on a horizontal surface, based upon corrected (rehabilitated) hourly measurements for 26 stations, and similar derived values for 222 additional stations. Most of the statistics are based upon a 24- to 25-year period, generally from 1952-1976.

Copies of the publication are available for a $2.00 handling charge. Address requests to the Director, National Climatic Center, Federal Building, Asheville, NC 28801, or telephone (704) 258-2850, ext. 683. For requests about the same data on magnetic tape, call ext. 203.

Alaskan Seismic Reflection Data Available

Common-depth-point (CDP) seismic reflection data relating to the National Petroleum Reserve in Alaska (NPRA) have been transferred to the National Geophysical and Solar-Terrestrial Data Center (NGSDC) by the U.S. Geological Survey (USGS). The data now are available for public use.

The data are a product of the seismic survey programs undertaken by the U.S. Navy from 1972 through 1977 in the Naval Petroleum Reserve No. 4. Jurisdiction of this reserve was transferred in 1977 from the Department of the Navy to USGS, and the area was renamed National Petroleum Reserve in Alaska.

The data consist of CDP seismic sections as sepia or blackline copies or on 35-mm microfilm, shotpoint location maps and seismic line copies or on 35-mm microfilm, shotpoint location maps and seismic line location index maps (general and Barrow area) as sepia or blackline copies, and velocity analyses on 35-mm microfilm. The data are offered in three separate geographical packages (Northeast area and Barrow area, Northwest area, and Southern area).

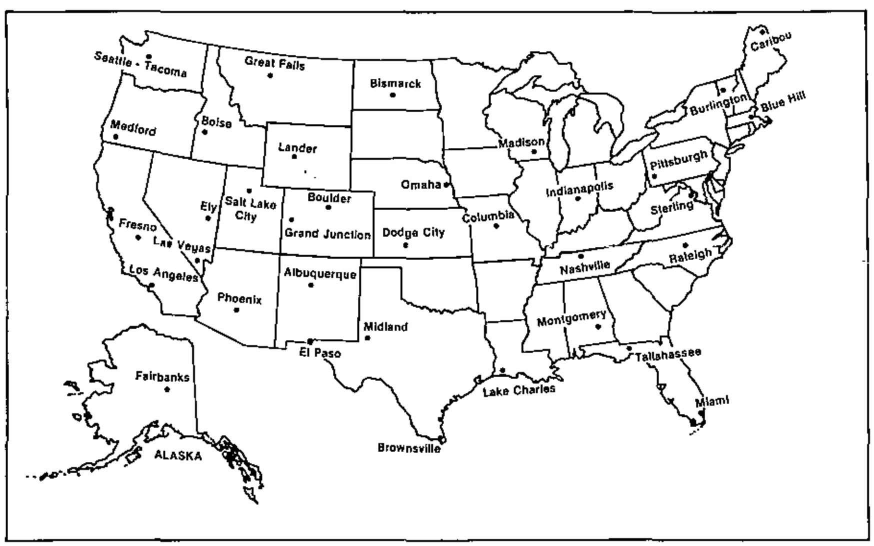
The CDP seismic data were recorded and processed by Geophysical Services, Inc., at a 2-msec sample rate. The data were recorded at magnitudes of either 300 or 600 percent for the 1972 through 1976 surveys and at 600 and 1,200 percent for the 1977 survey. The vertical scale of the sections is 2.5 in/sec (Barrow area 5 in/sec), and the horizontal scale is either 24 or 36 traces/in.

Purchasers of all three data packages also will receive an interpretative report of the CDP seismic data and gravity stations at no added cost. The report is being prepared by Tetra Tech for Husky Oil NPR Operations, Inc., under contract to the USGS. The report will contain data interpretation, structure maps (both in time and depth), isopach maps, a Bouguer gravity map, and 15 illustrative CDP seismic sections. The report also may be purchased separately. Logs and well histories for 17 wells drilled in the NPRA also are available from NGSDC (see *EDIS*, September 1978).

Inquiries regarding purchase of any of the above data and reports should be directed to: NOAA/EDIS/NGSDC, Code D621, Boulder, CO 80303. Telephone: (303) 499-1000, ext. 6338 or 6542, FTS 323-6338 or 323-6542

Solar Radiation Data Publication

The EDIS National Climatic Center has published the January 1977 issue of *Monthly Summary Solar Radiation Data*. This publication, sponsored by the Department of Energy, contains edited hourly totals, daily totals, and monthly means of total hemispheric (global) solar radiation on a horizontal surface for the new 38-station NOAA Solar Radiation Network. Data are shown in kilojoules per square meter for each hour of Local Standard Time. The January 1977 issue contains measurements from 23 stations. Subsequent issues will include additional stations as they become operational.Monthly issues will be published as rapidly as possible in order to decrease the backlog.



NOAA solar radiation network.

The subscription price for the publication is $8.40 per year (domestic), $19.70 (foreign); 70 cents for a single copy (domestic), and $1.64 (foreign). There is a minimum charge of $2.00 for each order of shelfstocked issues. Address requests to: Director, National Climatic Center, Federal Building, Asheville, NC 28801, or telephone (704) 258-2850, ext. 683 (FTS 672-0683).

First Shipment of Geomagnetic Data From the People's Republic of China

EDIS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) has received a block of solid-earth geomagnetic data from the Institute of Geophysics in Peking. This is the first geomagnetic data received from the People's Republic of China and inaugurates an exchange of geomagnetic data between the two institutions.

Eight "yearbooks" of geomagnetic observatory results, hourly values, and derived means were received for four stations: Peking, Shanghai, Canton, and Lanchow, covering varying intervals between 1950-1968. The Chinese institution has promised to send later data as compilation is completed.

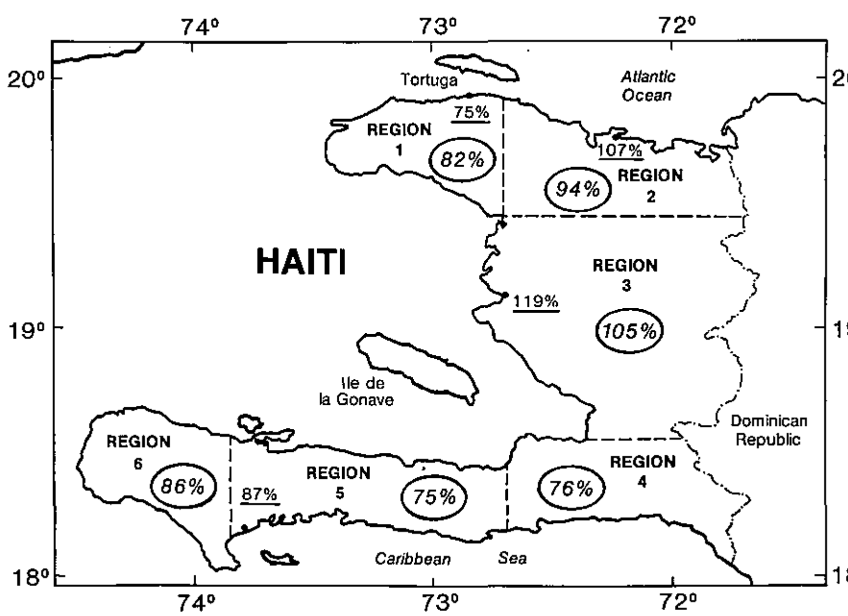
NGSDC has the national responsibility for maintaining the official U.S. file of worldwide main field magnetic data. The Chinese data will fill a gap in the data base that has been a concern of geomagnetic field analysts for many years.

The type of data received is particularly useful in determining secular or long-term changes in the Earth's magnetic field. Coefficients for secular change corrections are a part of any mathematical model representing the Earth's magnetic field. The International Geomagnetic Reference Field model—probably the most useful of the various models developed—is used, for example, by oil and deep ocean mining companies in identifying areas of magnetic anomalies, which are areas of potential interest for drilling.

Verifying Haitian Rainfall Estimates

The EDIS Center for Environmental Assessment Services (CEAS) has developed special assessment techniques to monitor Caribbean Basin rainfall for the State Department's Office of Foreign Disaster Assistance. The requirement to specify drought locations, intensities, and durations could not be satisfied by data from the meager surface observational network in much of this region.

The accompanying figure, covering the period November 1, 1977 thru September 30, 1978, illustrates one of the CEAS rainfall (and drought) estimation capabilities. The circled percentages are CEAS rainfall estimates which, in the absense of useable surface rainfall reports, were wholly dependent upon satellite imagery. In December 1978, actual surface rainfall accumulations (underlined) for the November 1977-September 1978 period for four coastal stations became available from a heretofore unavailable source. Despite the obvious limitations in comparing point and areal averages, the apparent correlation seems impressive.



Percent of Normal Rainfall, Nov. 1, 1977 to Sept. 30, 1978. Underlined values are station measurements, enclosed values are CEAS estimates.

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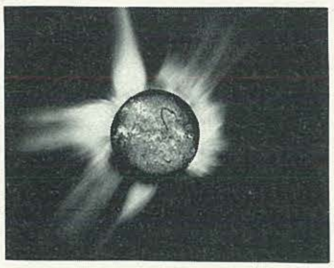

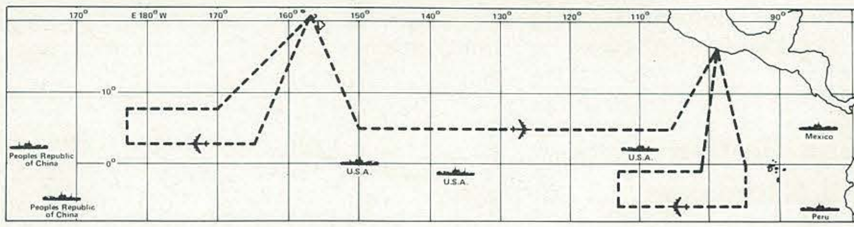

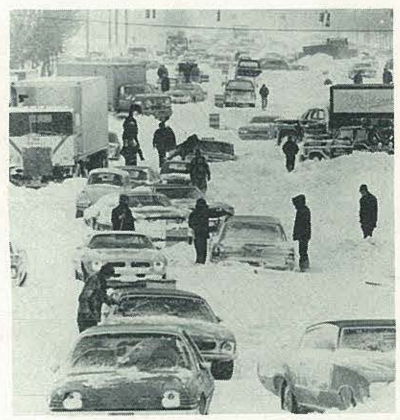

In this Issue: *The status of international oceanographic data exchange (p.3), 1978 weather profile (p.8), data center roles in the Solar Maximum Year and the Middle Atmosphere Program (p.13), and in the Global Weather Experiment (p.17), marine geological data and the core curators' file (p.21), and climate and moving (p.25).*

EDIS

Environmental Data and
Information Service
Volume 10 Number 3
May 1979

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EDIS

Cover: *A scene in Senegal in the African Sahel. The relationships between climate and human societies are examined in the first two articles.*
Agency for International Development

EDIS is designed to inform Environmental Data and Information Service (EDIS) cooperators, colleagues, and contributors of recent developments in EDIS programs and services and in the general field of scientific data and information management. EDIS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, and Center for Environmental Assessment Services. In addition, under agreement with the National Academy of Sciences, EDIS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology (Snow and Ice).

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.

EDIS (ISSN 0364-0116) is published bimonthly by the Environmental Data and Information Service, NOAA, Page Building 2, Room 533, 3300 Whitehaven St. N.W., Washington, D.C. 20235. For address changes, cancellation, or information write to the Editor at this address. Controlled Circulation Postage is paid to the Finance Department, USPS, Wash., D.C. 20260.

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Climate at the Millennium*

By Robert M. White, Chairman
World Climate Conference

The World Climate Conference has been convened to assess the state of man's knowledge of climate and to consider the effects of climate variability and change on human society. The issues we will address are as old as mankind and as new as our interdependent social and economic systems. During this Conference we will hear how climate has shaped our past, molds our society today, and may affect our future. We can learn from the past, endure the present, but the future is in our hands. We can contribute to a bright future for mankind by national and international actions to provide for the wise use of climatic resources to improve the economic and environmental welfare of people everywhere and to mitigate destructive impacts of climate. This conference can be the beginning of that process.

One may ask, "Why a World Climate Conference now?" The timing of our meeting is a response to several concerns. The first is the worldwide reaction to the climatic events that have so disrupted human society over the past decade. The second arises from a growing appreciation that not only is humanity vulnerable to variations in climate, but climate is also vulnerable to the acts of humanity. The third is a perception of a broader climatic vulnerability stemming from world population growth, increased world demand for food, energy, and other resources, increased interdependence of nations, and the pace of economic development. It is a vulnerability that can only increase because the underlying causes will intensify, not diminish.

The disastrous consequences of climatic events of the past decade are well known. No part of the world has been immune. During the late sixties and early seventies the southern border regions of the Sahara desert, the Sahel, succumbed to a five-year drought with famine and death on a continental scale. The year 1972 saw a worldwide epidemic of costly climatic episodes, including drought in the Soviet Union and the occurrence of El Nino off Peru. In 1974, poor monsoons reduced food production in India. In 1975, cold waves in Brazil badly damaged coffee crops. In 1976, drought in Europe caused widespread economic dislocations. In the United States, the recent cold winters forced many industries and schools to close.

These events have demonstrated the sensitivity of human welfare and international relations to climatic events. They have demonstrated the fragility of world food production and trade systems and the extent to which income and employment continue to depend on the workings of the natural world. The remarkable aspect of these climatic fluctuations is that they are not unusual. Similar events have occurred frequently in the historical record. What is new is the realization that vulnerability of human society to climatic events has not disappeared with technological development.

Moreover, we cannot allow shorter period fluctuations of climate to lull us into complacency. We have been blessed by a benign climate in most of the world during the past several years, save for parts of the Sahel in the past year. As a result there has been a lessening of attention in the public press and among governmental officials in their concerns about climate.

To connect human suffering exclusively to natural events is utterly mistaken because the vulnerability or resilience of a society to climate obviously depends on many factors. To illustrate, it is interesting to observe that during the decade of the seventies the world grain trade went through one full cycle of surplus to shortage and back to surplus. In the early 1970's, there were large world grain reserves. During the period 1972-1974 world food production on a per capita basis suffered its sharpest decline in 20 years. Crop failures due to climatic stress occurred in many parts of the world. We then reached a stage in which the stocks of grain, on a worldwide basis, had been reduced from a normal 20 percent of world consumption to about 10 percent. But, by 1977 and 1978, global grain harvests were setting records. With such fluctuations in the world food grain picture, it is easy for decision-makers to forget the dis-

*Condensed from the Keynote Address of the World Climate Conference, Geneva, Switzerland, February 12-23, 1979. The Conference was organized by the World Meteorological Organization (WMO), which will publish the full conference proceedings in the near future.

aster of yesterday and remember only the good times of today. As climate specialists, we know better.

If natural climate disasters had not been enough to motivate governments and the scientific community to action, the ominous possibilities for man-induced climatic changes would have triggered our presence here. Until the beginning of the industrial age some 100 years ago, variations in climate and their associated impacts could be considered as natural events beyond the control of man. In recent years, we have come to appreciate that the activities of humanity can and do affect climate. We now change the radiative processes of the atmosphere and perhaps its circulation by emission of the products of our industrial and agricultural society. We now change the boundary processes between earth and atmosphere by our use of the land.

We are only dimly beginning to understand some of the potential consequences of human impacts on the climatic resources of the world. However, it is difficult to remain complacent. The potential consequences of increasing atmospheric carbon dioxide resulting from fossil fuel combustion are already a major world concern. But evidence continues to accumulate that the growth of human habitations and the consequent destruction of forests reduces the terrestrial reservoir of carbon and further increases airborne carbon dioxide. Recent findings that other gases reinforce and amplify the effects of carbon dioxide further intensify this concern. It is hard to be complacent when we know that the population of the world will need increasingly to turn to nitrogen fertilizers to maintain agriculture production with the potential for releasing nitrogen compounds which can alter the photochemical balance of the stratospheric ozone. The potential effect on stratospheric ozone of the oxides of nitrogen released in supersonic flight, and of chlorofluoromethanes used as refrigerants or propellants also raise the issue of human impact upon climate.

Moreover, it is the future course of these trends that must be a central concern of this Conference. In little more than 20 years, we will celebrate the year 2000. This millennium may very well represent the ending of one era in the relation of humanity to the planet and the beginning of another. The millennium may mark a fundamental change in the ability of the planet to sustain its people or at least in the ways in which this will be done. There are many who will disagree with the timing of this fundamental change but few who will disagree with its likelihood. By any criteria, whether relating to population, food, energy, or the state of the global environment, we are likely to pass to a new world condition around the year 2000. This transition will also signal a new level of importance of climate to society.

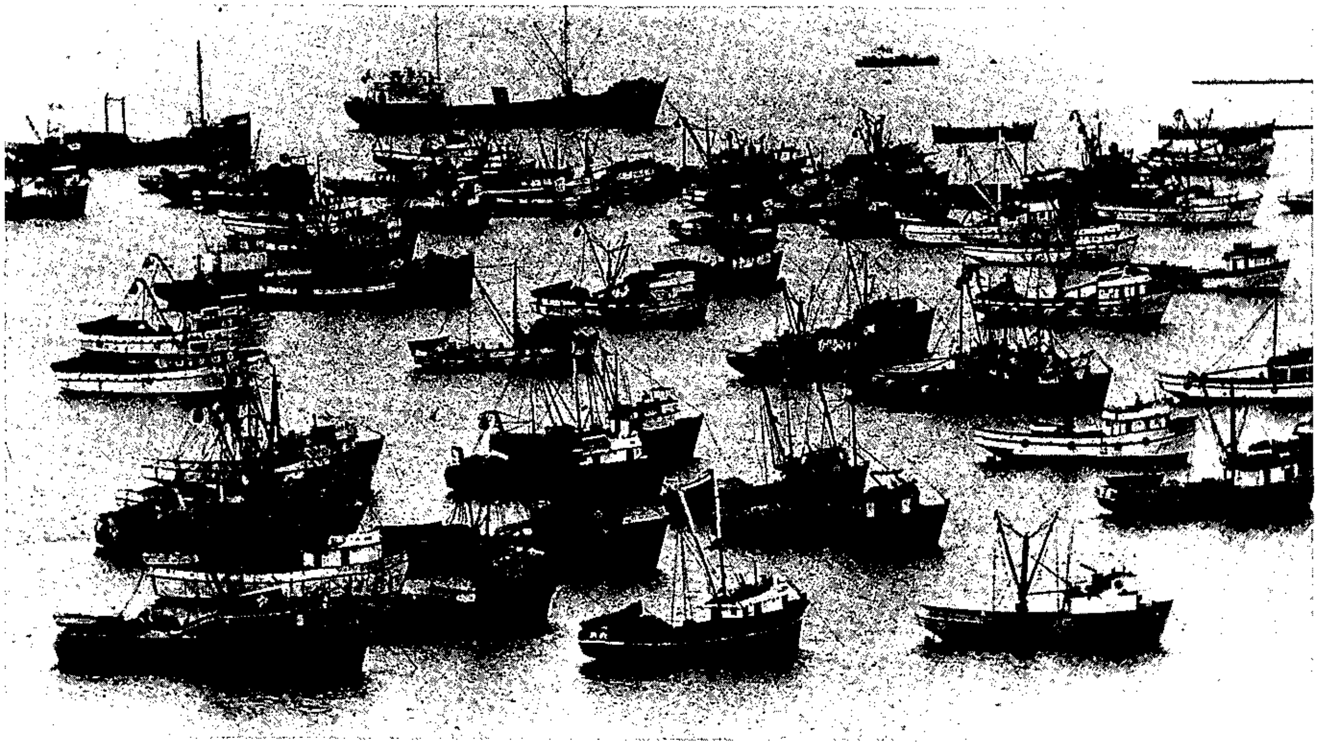
Let us look at what the millennium holds. Conservative projections indicate that the population of the world, which in 1970 was approximately 3.5 billion, will increase to approximately 6.5 billion by the year 2000. Projections made by the United Nation's Food and Agricultural Organization indicate that, as a result, world aggregate food demand will rise by about 44 percent by 1985 and 112 percent by the year 2000—a doubling by the millennium. The challenge facing the world to increase its food production by this amount is staggering. Fortunately, surveys of additional land and water potential for agricultural expansion indicate that the developing areas of the world (except in Asia) possess abundant underused land and water resources with great agricultural potential. While it will be costly to bring these virgin lands and water resources into production, it can be done if the best in technology and science is brought to bear.

Beyond the year 2000, the world will face a different food situation. We will need to move beyond bringing virgin lands into agricultural production. Agricultural scientists will have to look to new strains of crops, crops that can be grown in brackish or salt water, multiple cropping, and other new approaches to meet the situation. However, projections of world food demand and supply indicate a continuing and growing imbalance. In the next 20 years, climatic information and services derived from strengthened climate data bases in the developing world will be particularly critical to assure the necessary agricultural productivity. Eventually, perhaps by the year 2000, it will become necessary to advise on how agricultural lands of the entire globe and their characteristic climates can be used in an optimum fashion to maximize the world production of food and fiber. We must therefore begin to think of climate itself as a resource to be allocated wisely.

By the millennium, the world energy situation will be no less ominous. Estimates are that by the year 2000 the desire of the world for oil will have far surpassed world oil production, even with a 50 percent increase in oil prices. In seeking to meet our energy needs we may pose a threat to global climate with formidable consequences for world society. In the next 20 years, we will see both the introduction of new sources of energy and a growing dependence on coal and nuclear power.

Tuareg and Fulani refugees in central Niger during the Sahelian drought in July 1973.

WFP photo by Peyton Johnson



Peruvian fishing vessels await a run of anchoveta, which make up practically all of Peru's fisheries' catch. When climate-related change (El Niño) causes the anchoveta to disappear off Peru's coast, the whole fishing industry can be shut down.
FAO photo by S. Lavrain

The growing dependence of the world on coal may create the most serious threat to the world's climate. By the addition of carbon dioxide to the atmosphere, we change its fundamental temperature controls. It is estimated that the burning of fossil fuels and destruction of forests—also, incidentally, a source of fuel—have already, in the short span of one half century, increased atmospheric carbon dioxide content over 10 percent. The implications of further projected increases are uncertain, but the weight of scientific evidence predicts a significant global surface temperature increase. Other energy sources also have important climatic implications. The increasing use of renewable forms of energy derived from the Sun, the wind, and the ocean will call for a new level of climatic services and present a new set of challenges to climate science.

As with food, we will need credible projections of consequences by the millennium, if energy policies are to be modified in time to avoid adverse climatic impacts. The implications of the world food and energy outlooks for our science are clear—we have no time to lose. The complex interplay between climate and man and the environment, as exemplified by food and energy, forces us to realize the degree to which climate is a key element in a global ecological system involving the atmosphere, the oceans, the cryosphere, the solid earth, and the biosphere. Because no social system, or economic condition of development, renders nations impervious to the physical processes of nature, and because in the modern world environment we are so dependent on one another, it is essential that we join together to consider what we can do collectively and individually about climatic issues in the interest of all.

At the same time, this Conference must take a long view. It must bring to the attention of governments the fact that the problems we are dealing with will not be solved in a day, a year, or even a decade. They are problems for all time and we must address them with fresh concepts.

One important new concept that arises from the material prepared for this Conference is that we should begin to think of climate as a resource. Climate does not conform to our normal idea of a resource. However, its variability in time and space does, in fact, confer upon it many of the characteristics of a resource. For example, on a small scale, farmers and communities located no more than a few kilometers apart may enjoy remarkably different climate

assets. The slopes of the Rhine Valley produce fine white wines at northerly latitudes normally hostile to such production. Tea is produced in Soviet Armenia, and the citrus groves along the Mediterranean shores of Egypt enjoy the benefits of the Mediterranean moisture which only a few kilometers inland is nonexistent.

Furthermore, while access to climatic resources is restricted by national boundaries and property rights, climate also has some of the characteristics of a common property resource because it can be modified by the remote actions of man. It is the common aspect of the climate resource that will raise the most difficult issues for governments and humanity. For example, while the consequences of a global warming can only be speculated at this time, it is clear that such a change would have vastly different impacts in various regions of the world. There would be winners, and there would be losers. A climate change could be the cause of a major redistribution of wealth, and from the point of view of mankind, quite an arbitrary one.

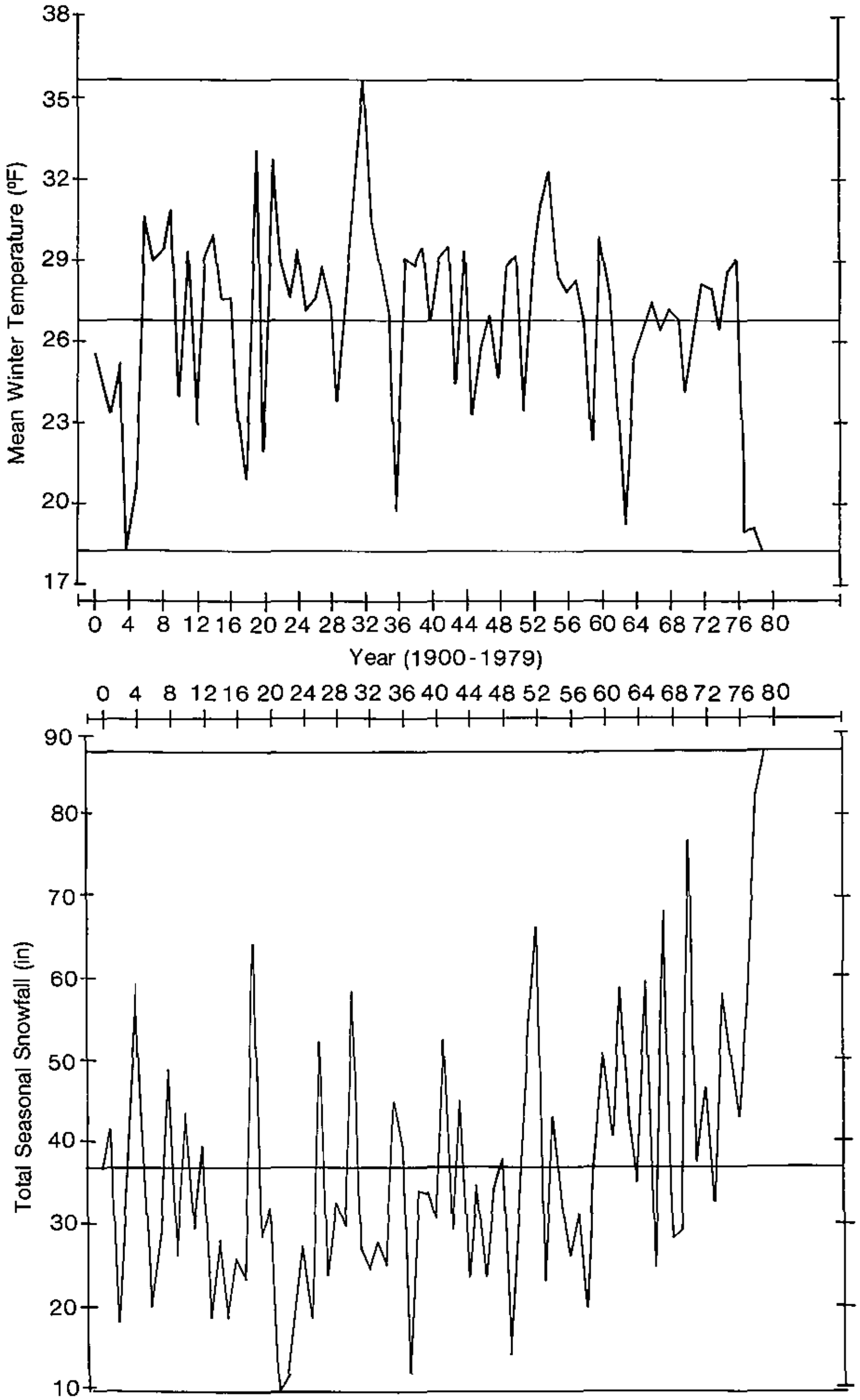
The possibility that actions by individual nations may influence the climate of others may demand new types of international action. Accords have already been reached in the United Nations to prevent the deliberate use of potential techniques of climate modification as instruments of warfare. However, nations can still proceed unilaterally with a variety of projects in energy, land use, or water resource development that may conceivably affect climate beyond their borders. We thus see emerging a need for some mechanism to develop global environmental impact assessments that will be accepted by all nations. Thus, for certain purposes we must put climate alongside such global commons as the deep seabed and outer space as a concern of mankind for which new international obligations must be derived. Let us hope that this Conference marks the commencement of a new level of collaboration for the protection and productive use of climatic resources.

Indian women watering buffalo in a tributory of the Ganges River. When the monsoon rains don't come, the river dries to a trickle.
WFP/FAO photo by Peyton Johnson

International concern about the future global condition has been manifest in the remarkable series of World Conferences convened by the United Nations during the past decade. The United Nations Conference on Environment in 1972 in Stockholm was the first occasion on which the world confronted common problems of global concern whose solution could be achieved only by the closest collaboration among nations. Even at this first World Conference, climate impacts were central concerns. Indeed, understanding climatic fluctuations and their impacts became one of the high priorityaction items. As a result, the United Nations Environment Program, which resulted from this conference, has maintained a strong interest in climate. Two years later, in 1974, the United Nations World Food Conference recognized the central role of climate in world food production and the need for improved understanding of climatic fluctuations by calling upon the World Meteorological Organization and the Food and Agricultural Organization to establish a climate warning system. In 1976 the United Nations convened a World Water Conference at Mar Del Plata in Argentina. That conference emphasized the importance of understanding climatic variations and their effects upon water supplies and usage throughout the world. Most recently, at the United Nations Conference on Desertification, the nations unanimously adopted resolutions emphasizing the need to understand climate and the United Nations Economic and Social Council adopted a resolution endorsing the World Meteorological Organization initiation of a World Climate Program.

The importance of climate, recognized in these conferences, suggests that the time is at hand to view world affairs through a climatic prism. This is what we will do at this World Conference. We will recognize the central role of climatic processes in the shaping of the world's economic and environmental welfare, its political stability, and even world peace.

The challenge to our science is unprecedented. Indeed, it is a challenge to all of science because the problems we must confront are not strictly meteorological, although they have a high meteorological content. The scientific problems that must be solved involve complex environmental and ecological systems. What other



Average winter (Dec.-Feb.) temperatures (top) and seasonal (Oct.-April) total snowfall at Chicago since the turn of the century. Chicago was actually colder last winter than during the previous two severe winters, while the total snowfall far exceeded that of any other winter during the period.

Agricultural scientists are working to increase crop yields to provide more food for the growing world population.

Inter-American Development Bank

problems of global concern invoke a knowledge of the photochemistry of the upper atmosphere as well as the chemistry of the depths of the ocean? What other problems engage our knowledge of astronomy and solar physics, at the same time they invoke our knowledge of geophysical and geological structures of the earth and the seabed? What other problems require a knowledge of the interrelation between the processes of the biosphere as they are impacted by human settlements and their effects on the chemical composition of the atmosphere? What other problems engage us in the science of the radiative properties of gases and the dynamics of geophysical fluids? How many scientific problems have the potential for shaping the economy of nations and disrupting the economic and political relations among them?

Thus, this Conference must represent diverse disciplines. We need to be not only atmospheric scientists but geologists and oceanographers and geophysicists. And we need those who are expert in the fields of agriculture, land use, energy, and water resources, those who are knowledgeable about health and fisheries and marine transport, and economists, geographers and sociologists to assist us in the documentation of the nature of climatic impacts. And because climate is a global problem, it is so important that representation come from all over the world, from countries with different economic and social systems. We believe this "Conference of Experts on Climate and Mankind" has brought together the diversity of experts who can address the complex issues before us.

The findings and recommendations of this Conference will have a broad impact throughout the world. They will be transmitted to the Congress of the World Meteorological Organization which will be held in this city two months from now, to serve as a basis for decisions by governments on the scope of a new World Climate Program. They will also be transmitted to other United Nations agencies, to nongovernmental international groups, and to governments.

It is through the World Climate Program, a program sponsored by the WMO, and other international governmental and nongovernmental bodies, that the recommendations of this Conference will be most readily and directly translated into programs of international action. It is important, therefore, to understand the emerging shape of this World Climate Program because it will set the context within which our deliberations can be most fruitful. The World Climate Program will be a program of international action addressing the full range of climatic issues that confront mankind. The World Climate Program will mount three major interacting streams of international effort.

The first of these will seek to attack the problems of climate science. Through this effort we will seek to improve our understanding of climate change and variability and improve our ability to predict the natural variations in climate and the consequences of man's effects. This research effort will build upon the remarkable achievements of the Global Atmospheric Research Program launched a decade and a half ago to examine the possibilities of extending the time range of weather forecasts and to achieve an understanding of the dynamics of climate. The Global Atmospheric Research Program was set in motion in response to the new global observational capabilities of earth-orbiting satellites at the beginning of the space age, and will culminate this year in the most comprehensive international scientific experiment ever conducted. This experiment, known as the Global Weather Experiment, will see the international deployment of five geostationary and two polar-orbiting satellites, all in simultaneous orbits. It will involve fleets of aircraft to explore the tropical atmosphere and an armada of more than 40 ships and networks of automatic data buoys distributed throughout the northern and southern oceans to probe the seas. A unique global meteorological data base should result, which can serve as a focus for the study of seasonal and interannual variations in climate.

The second stream of activity of the World Climate Program will provide a new level of climate data and applications throughout the world. This international effort will seek to improve the climatic services principally in developing nations. Development planning for agriculture, energy, water resources management, human settlement and land use could be

Sand-dune fixation experiments with drought-resistant plants is one approach to fighting desertification.

FAO photo by H. Null

markedly improved by more effective use of climatic information. Even the simplest climatic observations are lacking in many parts of the world. Fortunately, this situation is remediable through national and international actions to provide necessary education, training, and technical assistance.

The third stream of activity addresses the need to understand the impacts of climate variability and change upon society. We all appreciate the direct effects of drought upon crops, or cold winters upon energy demand. What we do not understand clearly, and what governments are concerned about, is the question of the integrated impact of climatic change and variability upon society. Climatic events are but one element in complex worldwide, regional, and national economic structures. We wish to learn how the chain of interactions that may ultimately result in malnutrition or unemployment or other critical situations is dependent upon climate. Why are some social and economic structures more resilient to climatic events than others? Do these differences depend on factors we can do something about? If so, what can be done about them? The examination of these impacts is the major objective of this Conference.

You may ask, "Why should the climate community extend its concerns so far beyond scientific and technical matters into the realm of economics and structure?" The answer is clear: Our task is to identify not just what it is that science should do, but what it is that governments should know. Unless there is a better comprehension of the chain of events and the complex interactions that take place, governmental decisions to mitigate the economic, social, and other effects of climatic impacts may very well provide the wrong remedies.

Ultimately, what we do about climate issues depends upon the state of our scientific knowledge. Only to the extent that we have understanding can we help our governments. Governments wish to know where to focus effort and resources. The international resources that can be made available to deal with climatic problems are limited. This is not so merely because finances are limited, but because the number of scientists capable of working effectively on these problems is limited. Because of this, efforts must be focused on those climatic problems where there is an urgent need for answers, and where the state of our scientific knowledge leads us to believe that it may be possible for science to make a useful contribution. Mere assertions that the socioeconomic impacts of climate will be severe will not be accepted by governments confronted with many urgent requests for resources for programs all directed at improving socioeconomic conditions. It is incumbent upon us not just to assert, but to make the case for international investments in climate research and services.

The Climate-Society Interface

The following is an edited version of part of a report resulting from a workshop on climate-society interactions held in Toronto, Canada, December 10-14, 1978. Conducted by the Scientific Committee on Problems of the Environment of the International Council of Scientific Unions, the workshop examined the impacts of climatic change and variability on society. The workshop, cosponsored by the Canadian Climate Centre and the Institute for Environmental Studies of the University of Toronto, was conducted in preparation for the World Climate Conference, subsequently held February 12-23, 1979. (See p. 3.) Ian Burton, a member of the Institute, was the main author of this section.

WFP photo by F. Mattioli

Vulnerability and Resilience

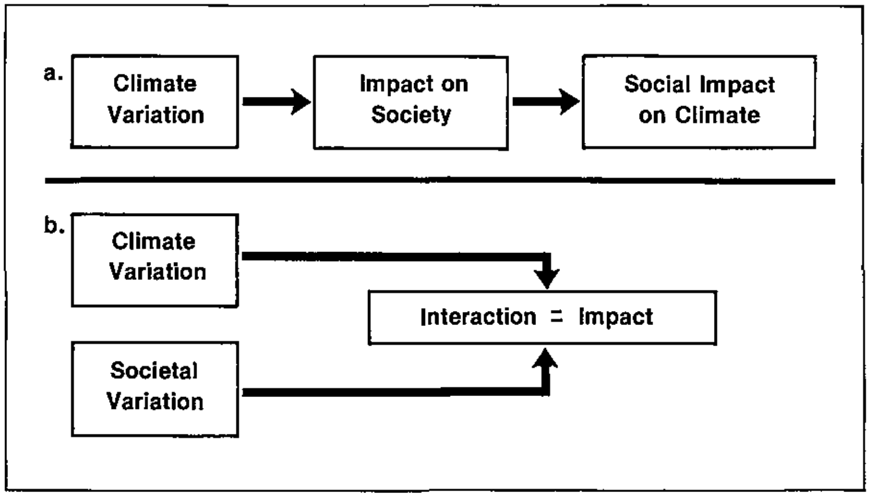
Human societies differ markedly in the extent to which they suffer damage and loss through climatic events. This variation seems to be at least as much due to the varied attributes of human societies as to the variations in global climate. The extent to which a human community is susceptible to damage by climatic causes can be termed its vulnerability. There is now no satisfactory quantitative scale of measurement for degrees of vulnerability, but a description can be given in qualitative terms. Broadly speaking, a society is more vulnerable:

—the more its economic activity depends upon weather-sensitive factors of production;
—the greater the unreliability and variability of certain key climatic variables, e.g., moisture availability;
—the lower its level of reserves of food and other materials;
—the less developed the capacity of its transport system to move supplies from surplus areas to deficit áreas;
—the less its has planned and prepared to deal with adverse climatic impacts.

Closely related to vulnerability is the concept of resilience. Resilience is the ability of a society to "bounce back" when adversely affected by climatic impacts. There is also no quantitative scale for resilience, but it is generally known that resilience depends upon a set of factors similar to vulnerability factors. A society is likely to "bounce back" more effectively if it has accumulated stocks or reserves; if it has spare capacity built into the design of its infrastructure; if it has a great command of resources, transportation, technology, and accumulated wealth. Also, less tangible factors may be important, such as social cohesion, morale, and the trust and confidence enjoyed by governments and social institutions. Where these are lacking, impacts may be greater and resilience much reduced.

It follows that the capacity of any society to absorb climatic impacts is not a simple linear function of its degree of development. Relatively poor and underdeveloped societies may be stronger and in some respects better able to absorb the shock of a climatic impact than some wealthier and more developed societies.

The relationship between vulnerability and socioeconomic development is not well understood and requires a lot of careful research. It is hypothesized (Burton, Kates and White, 1977*) that the most vulnerable societies are neither the poorest and least developed nor the wealthiest and most highly developed, but rather those societies in process of rapid transition or modernization, where the traditional social mechanisms for absorbing losses and sharing them among the community have been eroded and not yet replaced



The relationship between climate and society.

by the accumulated wealth and response capabilities of more modern societies. This tentative hypothesis merits further testing.

If this finding is valid, it means that extra care must be taken to guard against adverse climatic impact in precisely those situations where development is taking place more rapidly and apparently most successfully. If attention is not paid to this problem, then the hypothesis suggests that apparent success may quickly turn into disaster. The world has recently experienced unforeseen consequences of development heedless of climatic dangers, suggesting that this is indeed a widespread occurrence.

It can be inferred that considerable opportunity may well exist to reduce climatic impacts and to increase resilience: in a minor way through attempts to modify or control climate; in a major way through a clearer understanding of the resilience of the pattern and character of development activities themselves. Remarkably little is known in detail, however, about the increase or decrease in vulnerability that comes with types and levels of socioeconomic

* Burton, I., R. Kates, and G. White (1977): The Environment As Hazard, Oxford University Press.

During the devastating Sahelian drought, disaster relief and emergency aid were provided to the region's nomadic peoples.
WFP photo by F. Mattioli

development. It is crucial that more systematic observations and measurements be made as a basis for improved understanding and action.

The relationship between climate and society is often thought of in terms of a simple model (figure 1a) in which climatic variation has an impact on society, and society in turn has an impact on climate. While this model may be useful for some purposes, it is more accurate to recognize that impact is a function of the interaction, simultaneously, of social and climatic variation (figure 1b).

The implication of figure 1b is that a change in either climate or society affects impact. Since both climate and society are constantly changing, the magnitude and character of impacts also is not constant. Impact studies must therefore involve investigations of climatic variability and social change. The question to be addressed to any society at any time is: "Is the society becoming more or less vulnerable to climatic variability?" Or to put the matter differently, "Will any specific proposed social change or development have the effect of increasing or decreasing vulnerability?"

The climate/society interface may be thought of in terms of adjustment. Adjustment means the extent and ways in which a society functions harmoniously with its climate and the rest of its environment. Development activity which leads to the overstocking of range land and thus a greater moisture deficit in times of drought can be described as diminishing adjustment or increasing maladjustment.

When any climatic impact is felt, therefore, a human society is faced with choices of response or adjustment. Responses are likely to be both short-term (disaster relief and emergency aid to those affected), and long-term (rehabilitation of the economy and livelihood of the population). Both short-term and long-term adjustment choices need to be examined to see if they increase or decrease vulnerability.

Choices of adjustment broadly fall into two categories (figure 2): feedback to change in climate and feedback to change in societal characteristics. Examples of the former are shelter belts, terraced slopes, and oil smoke to protect against frost. An example of the latter is the decision not to grow frost-sensitive species in a frost-prone area.

Research investigations are needed into the different kinds of adjustment that may be made, and the relative costs and benefits of each or each possible combination. Economic analysis may therefore be used to suggest or prescribe the most cost-effective sets of adjustment.

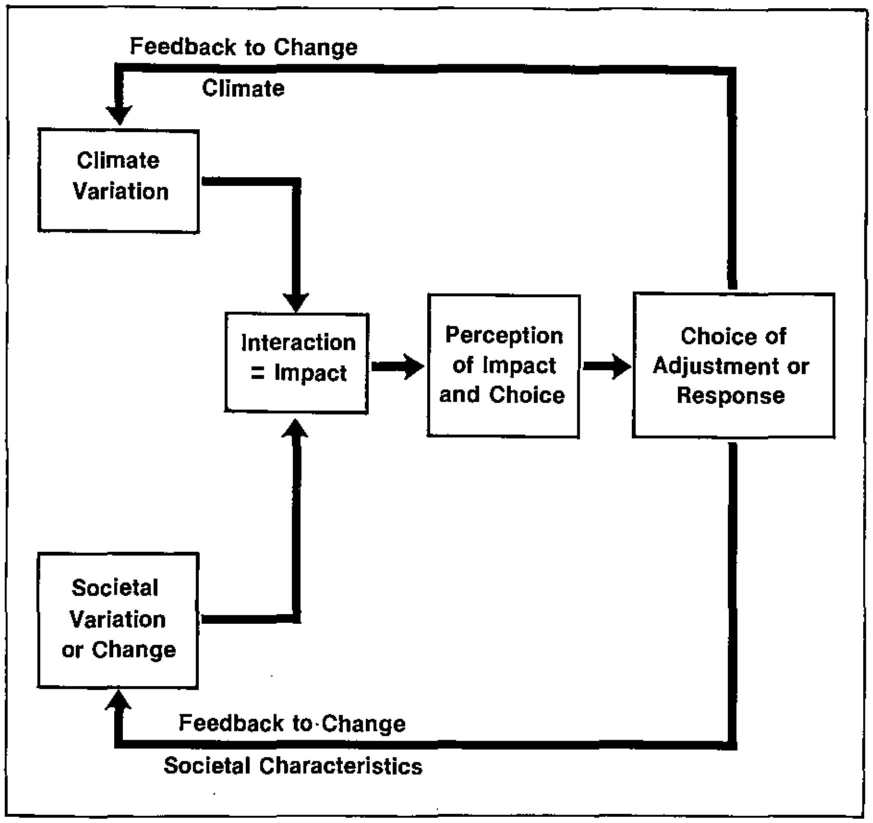
In addition to such prescriptive studies, it is desirable to gain better understanding of the present process of societal and individual choice of response. Experience suggests that many social choices are made without considering their implication for human interaction with climate and hence the possible effects. Climate is assumed to be benign, harmless or irrelevant, and choices are made regardless of the climate/society consequences.

Thus at the same time that a society's capacity to absorb climatic impact is being increased by the creation of new wealth (building dams, expanding irrigation projects, using new crops or new varieties, etc.), the developments themselves may increase the vulnerability by inviting adverse consequences from future climatic variation. The same climatic events which previously caused little trouble may in fact turn out to have devastating consequences.

It has not been customary in project evaluation or other development activities to examine net long-term effects in terms of increasing vulnerability to climatic changes. The appropriate methodology and procedures for such studies need to be developed as a matter of urgency. Objective economic assessments are important in the choice of adjustments to climate. So, too, are the perceptions of those who make decisions about economic and social activity.

Choice of societal action depends upon the recognition of likely impacts and responses available to them by "decision makers." "Decision-makers" can be anyone from national government ministers or officials to the managers of large corporate enterprises, such as the state energy-producing bodies to large-scale agribusiness, including commercial livestock operations and collective and cooperative farms down to the level of the peasant farmer or the seminomadic pastoral herdsmen of the Sahel.

In addition to economic studies, it would be useful in the World Climate Program to carry out empirical investigations of the way in which choices are made in relation to climatic variability: the perception of climatic variability, and the perception of increased or decreased vulnerability according to choices made.



Adjustments to climatic impact can involve feedback both to changes in climate and to changes in the society's characteristics.

In trying to devise ways to incorporate information about climate into economic decisions, it is important to recognize that many economic decisions with profound implications for the environment are made by literally millions of small-scale decision-makers. It is generally not decisions by national governments or planning agencies or large corporations that determine the damage from floods or droughts or the process of desertification, deforestation, soil loss, land degradation and the like. It is much more the cumulative effect of the decisions of many people. It seems important therefore to attempt to gain better understanding of the decisions, choices, and perceptions of such people. Often to the external observer, or to the national planner, the decisions seem to reflect ignorance, short-sightedness, irrationality or downright intentional contrariness. Looked at from the point of view of the peasant farmer, pastoralist, or other decision-maker, the behavior adopted and the choices made may seem entirely rational, or unavoidable. From the same perspective, the advice of the soil scientist, or agricultural extension agent may seem irrational, perverse, or mischievous.

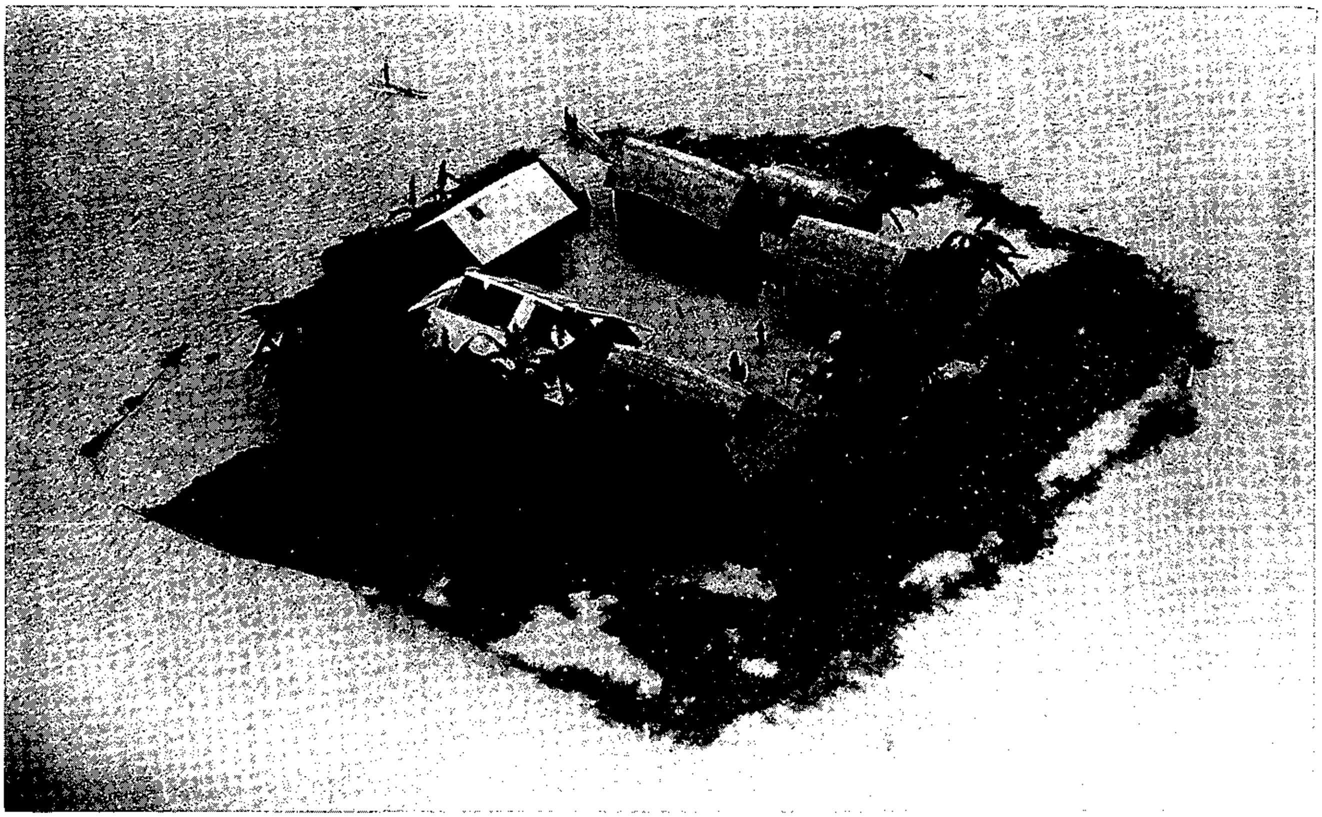
An important role therefore exists for studies to try to gain improved understanding of the problems of communication and miscommunication between scientists and decision-makers. It makes little sense to allocate large sums of money to scientific studies of the atmosphere, and to the assessment of social and economic

Above: Irrigation projects to lessen today's climatic impact could increase vulnerability to future climatic variations, such as increased rainfall.

WFP photo by T. Page

Right: A Buroro nomadic cattleman, a decisionmaker in his society's reaction to climate and climatic variations.

FAO photo by Banoun/Caracciolo



A Bangladesh flood in June 1976. Such environmental events often cause the most suffering among the poorest members of a society.

WFP photo by T. Page

impacts, in the absence of adequate understanding of how decision-makers at all levels will respond to information provided or be able to use and apply the new knowledge gained. The impact of climatic variability can be less, sometimes far less, than the impact of variability in perceptions and understanding.

Social scientific studies of the factors that increase or reduce the vulnerability of societies to climatic variation are deficient if they focus solely on total or aggregate impact and apply economic efficiency criteria in a search for solutions. There are important differences both within societies and between societies. As far as variability of climate is concerned, it is not true that all are affected equally. Within a given society, important questions arise of who suffers the most. Questions of fairness, equity, distributive justice, and of compensation necessarily arise. Experience with floods, droughts and the like suggests that it is often the poorest sections of a society that suffer most. Those people, those regions, and those economic activities that have least resilience are least able to cope. Poorer people have less accumulated reserves to withstand the consequences.

The distributional question applies to segments of society, (agriculture may lose while industry gains) to socioeconomic groups (high income farmers may benefit while low income farmers may lose) and between regions (the humid regions may benefit while the subarid or the semiarid lose). Similar discrepancies also occur between nations as well as within nations. Where the territory of a nation falls completely within the region of impact of a climatic fluctuation, e.g., a country entirely or largely in the Sahel, the effect will be much greater than on a similar country which nevertheless has national territory extending into savannah and rainforest areas. In international studies of climatic impact, the factors of equity must be taken into account. They also must be considered in the formulation of any program of action to prevent, prepare for, or alleviate the adverse effects of climatic variability.

Any program of studies into the impacts of climatic variability must therefore include not simply aggregate studies, but also assessments of how the benefits and costs of change are distributed.

Developing a National Measured Ocean Wave Data System

By Wellington Waters
National Oceanographic Data Center

A 20-ft. wave breaks over the Ventura Beach (Calif.) pier during a December 1969 storm.
Star-Free Press *photo by Dan Poush*

The Federal Government, a number of State governments, educational and research institutions, and a portion of the private sector are discussing plans for a more cooperative and coordinated national program to systematically collect, process, and analyze measured ocean wave data. Immediate interest is in wave measurements made primarily in the ocean area between the continental slope and the surf zone and in the Great Lakes.

Initially, familiar and time-tested data-collecting instrumentation—such as wave staffs, pressure transducers, large discus buoys, Waveriders and Waverider-type buoys, and shipboard wave measuring systems—will be used. Later, more sophisticated instrumentation is expected to be employed. Examples of the latter include: shore-based radar measuring techniques, such as the NOAA Wave Propogration Laboratory's High Frequency (HF) Over-the-Horizon Radar System; Stanford University's HF Skywave Radar System; and measurements made from the GEOS-3 and other satellites.

There are many reasons for this increased national effort. One of the more compelling, and one of great concern to the U.S. Army Corps of Engineers, is the property loss due to wave action along our coastlines. This runs into the hundreds of millions of dollars annually. Other reasons for this national effort include the need for reliable wave data:

- to efficiently plan, design, and construct offshore structures for drilling, shore protection, etc.;
- to design, test, and safely and economically operate ships used for commercial, military, and other purposes;
- to route ships;
- to construct harbors and dredge channels and to plan their maintenance;
- to aid search-and-rescue missions;
- to combat pollution and aid in pollutant cleanup;
- to support and calibrate wave hindcast and forecast modeling;
- and to be used by those developing techniques to extract energy from waves.

Since 1976, several important ocean-wave-related conferences have been held. One of these was the National Ocean Survey's Wave Climate Symposium, held in the Washington, D.C., area in July 1977. Many important recommendations for a national ocean wave data collection program came out of this conference. One of the recommendations having direct bearing on the mission of EDIS was that wave data collections should be made available to secondary users on a near realtime basis.

To carry out this recommendation, the EDIS National Oceanographic Data Center (NODC) has begun the development of a system to access, process, analyze, store, and retrieve instrument-measured wave data. One of the first things done was to review the highly successful wave data system developed by Canada's Marine Environmental Data Services (MEDS), which has been in operation for more than nine years. NODC personnel also studied other existing wave data systems, such as those of the U.S. Army Corps of Engineer's Coastal Engineering Research Center (CERC), NOAA's National Data Buoy Office (NDBO) and California's Department of Navigation and Ocean Development (DNOD). All of these organizations, but most especially MEDS and CERC, have supplied information that is most helpful to NODC in developing its systems.

Also very beneficial to the NODC effort were responses received from potential data contributors and users to an NODC system's requirements polling letter. About 150 letters were sent out nationally and about 35 percent of the recipients responded. A full 90 percent of those responding indicated that the five routine statistical outputs, or recommended alternatives, of Canada's MEDS system would be useful to them. These routine outputs are: (1) scatter diagrams showing distribution of waves having various significant wave heights and peak periods, (2) peak period histograms, (3) significant wave height exceedance diagrams, (4) significant wave height versus time plots, and (5) listings of equivalent wave heights tabulated by wave periods for individual wave records. These data users also expressed a strong desire for wave spectra plots as well as displays of wave persistence.

To date, NODC has developed a wave data storage and retrieval system design—a product which describes, in some detail, what our major services outputs will be and identifies the systems inputs as well as the programs, procedures, and other details of the system. Inputs to the system will be digitial raw and analyzed wave data, as well as meteorological and ocean current data observed essentially at the same time as the wave data. These data are to be edited, to the extent practical, by the data originators. Except for automated logical entry checks for such things as limits of latitude, longitude, dates, time, numeric or alpha entries and the like, the raw data will be stored at NODC as originally received from the data contributors.

When analyzed by NODC, the raw time-series data will first be filtered primarily for low and high frequency "noise," using accepted filtering techniques. Next, these filtered time-series data will be analyzed for their variance density spectra using the Fast Fourier Transform (FFT) technique. The variance in each time series will then yield the Rayleigh Wave Height Distribution, from which Longuet-Higgins wave parameters such as the significant wave height, the root-mean-square (RMS) wave height, the expected maximum wave height in N waves, and the mean height of the pth highest waves will be obtained. These parameters, together with the peak period, the significant and average periods, and other

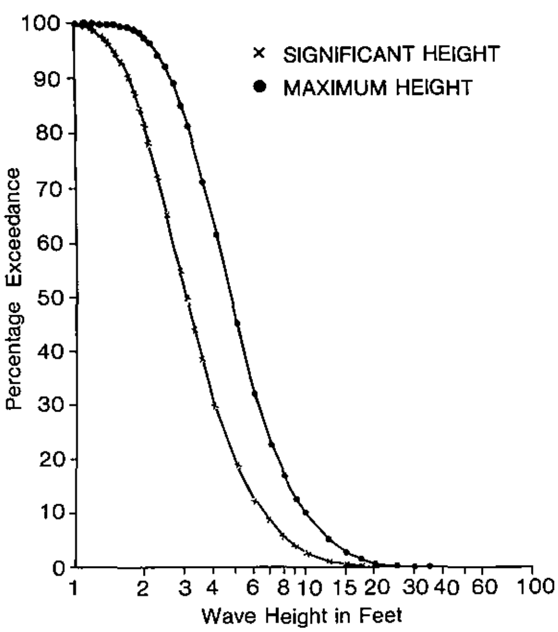


Figure 1. Percentage of 2,831 wave observations in which the significant and probable maximum wave heights exceeded a specified value.

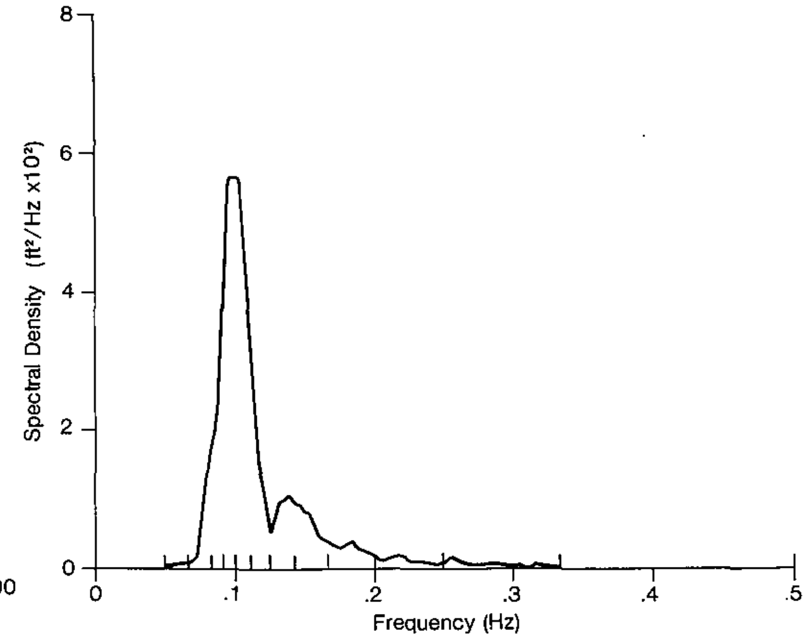


Figure 2. The variance spectral density of the water surface elevation as a function of frequency.

parameters will be stored in NODC's wave data archives. Additionally, NODC will have the capability to produce variance density spectra using the Tukey Spectral (autocorrelation) Analysis Technique. Raw and analyzed data will be stored for their respective locations in chronological order.

Outputs from the system can be either raw or analyzed data on magnetic tape or cards, as well as copies of wave spectra plots, exceedance diagrams, persistence tables, etc., for the locations and time periods requested. Approximations of some planned hard copy outputs are shown in figures 1 to and 2. As currently planned, the exceedance diagrams will include 3 curves—one each for significant height, actual measured maximum wave heights, and the statistically determined most probable maximum wave height in a 3-hour period. NODC also plans to provide listings of the spectral density per frequency band. For spectra, NODC intends to show the limits of the 90 percent confidence limits. For persistance, it will show the duration wave heights are above or below selected wave height classes, and the mean duration of these conditions during a relative long (month, season, etc.) period. The metric system will be employed to the extent practicable. Dr. Lloyd S. Simpson, formerly of the Naval Oceanographic Office but now an NODC employee, is primarily responsible for the theoretical aspects of NODC's wave analysis techniques.

Raw, analyzed, and other wave data retrieved for requests will be stored on 7-or 9-track magnetic tape with a density of 800 or 1600 BPI, odd parity, and recorded in character (BCD, EBCDIC, etc.) mode. Hard copy products will be labeled appropriately for location, time period, and so on.

NODC estimates that during 1979 about 157,000 wave records will be collected nationally. By 1983, the annual total of wave records may be as high as 815,000. These numbers translate to about 4 billion and 25 billion bytes of data, respectively. These figures actually may be on the conservative side, since they pertain only to data records collected by conventional means such as Waveriders, wave staffs, pressure transducers, shipboard wave devices, large discus buoys, and the like. They do not include output from the more sophisticated systems discussed earlier.

National Report

Herders drive buffalo in Yellowstone Park in 1925.
National Park Service photo

Climatic Summary for Yellowstone Park

The National Climatic Center (NCC) has published *Ninety-One Years of Weather Records at Yellowstone National Park, Wyoming, 1887-1977*—the second in a series of planned summaries for climatological stations with long-term records which also have the advantage of being located in distinctly nonurban environments. The first publication, *A Long Record of Weather Observations at Cooperstown, New York, 1854-1977* is also available from NCC. (See EDIS November 1978.)

The Nation's first national park, established on March 1, 1892, provides an ideal location for taking weather observations free from the contaminating effects of human activities. Continuous observations have been taken at the Park's headquarters in Mammoth Hot Springs since 1887.

The Mammoth Hot Springs area is located in the extreme northern portion of Yellowstone Park on the mountain slopes above the Gardiner River. The station elevation is 6,241 feet above mean sea level with mountains to the east and south generally rising 2,000 to 3,000 feet higher than the valley. The highest nearby mountain is Electric Peak topping out at 10,992 feet msl. The station is at a lower elevation than most of the Park, which varies from 7,000 to 8,500 feet, with several ridges and peaks rising to around 11,000 feet.

The Grand Canyon of the Yellowstone River.
National Park Service photo by M. W. Williams

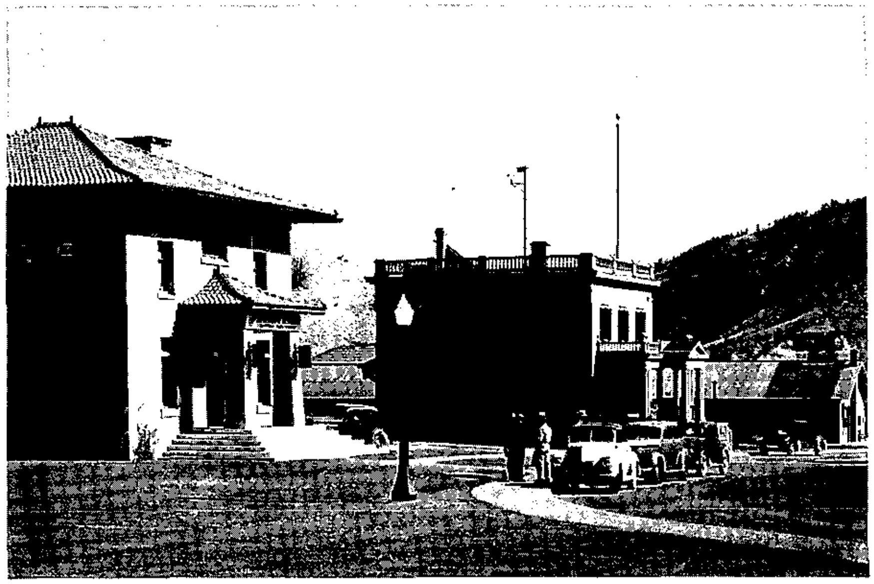
The following tables are presented in the publication: (a) mean monthly and annual temperature; (b) monthly and annual total precipitation; (c) mean monthly and annual maximum and minimum temperature; (d) total monthly and seasonal snowfall (July-June); (e) seasonal mean temperature (winter: December-February, spring: March-May, etc.); (f) seasonal total precipitation (seasons as defined above); (g) highest and lowest monthly and annual temperature; and (h) the dates of the last frost in spring and the first one in fall. (Because of the high elevation of this station, dates for the latter have been as close together as the end of June and early July.) Time series graphs are also presented for seasonal and annual temperature and precipitation, and seasonal snowfall totals.

The modern history of the area began in the early 1800s, when men like John Colter, Jim Bridger and others first entered the region in search of furs. However, it was not until 1869 that scientific exploration truly began in Yellowstone and, in 1871, the results of a U.S. Geological Survey expedition were instrumental in persuading Congress to set aside and preserve the 2¼ million acres of land that make up the Park.

Weather observations were started at Park Headquarters by U.S. Army personnel in January 1887, in what was then named Fort Yellowstone. The Signal Service maintained the records until 1894 when the duties were turned over to National Park Rangers. A first-order Weather Bureau station was established in December 1903 and records of barometric pressure, wind, sunshine, and humidity as well as temperature and precipitation were kept until May 1941. Since then, the National Park Service has again been in charge of the observations.

There have been two climatological summaries published for this station under Climatography of the United States No. 20. The first one provides a summary for the period 1930-59; the second one is for the period 1951-74. Other published sources of data include the *Climatic Summary of the United States, 1930 ed.* (known as the Bulletin W), the *1931-52* and *1951-60 Supplements* and *Climatological Data* summaries. All are available from the National Climatic Center, Federal Building, Asheville, NC 28801.

A particularly useful reference for Park visitors is *Climate of Yellowstone Park, A Visitor's Guide to Yellowstone Seasons*, by James F. Wirshborn, Mountain States Weather Services, 904 E. Elizabeth Street, Fort Collins, CO 80521. This publication also contains an excellent bibliography of articles and various studies about the environment of the Yellowstone region.



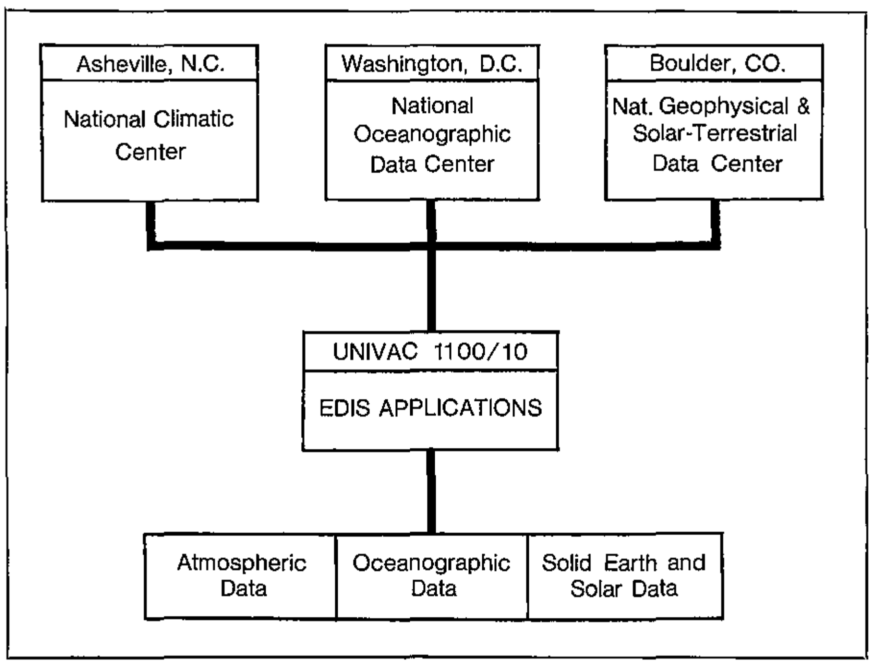
The Weather Bureau office (second from left) at Mammoth Hot Springs in 1939.

National Park Service photo by Grant

EDIS Data Management and User Service System

During the coming decade, EDIS expects the volume of environmental data and information requests to continue increasing, many new applications to be developed, and demand for shorter response time to user data requests to accelerate. To meet these and other user needs, EDIS will integrate its current separate data base operations under a single data archive management and user service (DAMUS) system.

Presently, EDIS' data processing operations involve three separate, independently operated computer systems with different hardware and software capabilities. These three systems have met EDIS' requirements in the past; however, due to the need for quicker, multidisciplinary access from different geographic locations, increasing volumes of incoming environmental data in frequently changing data formats and modes, processing costs, and



The large-scale computer support system for DAMUS will provide user access to a single, multidisciplinary environmental data base.

shrinking manpower, it has become necessary to develop alternative approaches to maintain a viable data and information service. To achieve the degree of integration required to meet national needs, the independent systems must be replaced by a single computer system.

EDIS will consolidate the data bases of its National Oceanographic Data Center, Center for Environmental Assessment Services (Washington, D.C.), and National Geophysical and Solar-Terrestrial Data Center (Boulder, Colo.) with that of its National Climatic Center in Asheville, N.C. Telephone lines and communications equipment have been installed at the Washington and Boulder-based centers to provide a direct link to the Asheville data processing facility. The availability of a high density mass storage system at the Asheville facility will improve EDIS' ability to handle increasing volumes of incoming data in a more effective manner than would otherwise be possible.

Implementation of the DAMUS system will provide EDIS with a solid base for continued data systems improvements in the future.

Four New Marine Recreation Brochures

EDIS' National Oceanographic Data Center recently released three new marine recreation brochures. The result of a joint effort with NOAA's Sea Grant Marine Advisory Service, the new brochures concern New York's Lake Erie, Michigan's Lake Michigan and the North Carolina coastal area. In addition, a brochure for Chesapeake Bay is scheduled for release next month.

The brochures emphasize climatological information and are slanted toward vacationers and other recreational users. The local climate is described in terms of good weather days, sailing winds, fishing weather, and other practical statistics. Information on fishing, boating, facilities, swimming and diving locations, and other local recreational activities (including winter sports, where appropriate) is also included.

The format for each brochure is tailored for its region. Lake Erie activities, for example, range from camping, fishing, and boating in the summer, to cross-country skiing, ice boating, and snowmobiling in the winter. Thus, the year-round climate is described. A unique feature is a daily suggested activity guide for various weather conditions. The brochure also

Canoeing on Lake Michigan.

National Park Service photo by M. W. Williams

stresses the clothing needed for various activities, as well as safety tips for winter storm situations. The Lake Michigan brochure also contains year-round information.

The Great Lakes area contrasts with the North Carolina coast, where the summer season stretches from May through September and activities range from surfing to hand gliding. Suitable sites and weather for such activities is included in the brochure for this area. For the surf fisherman there is a section on early morning and evening conditions, while sailors can find information on afternoon sea breezes. The interests of offshore and freshwater fishing enthusiasts are also considered. While good weather is the main concern, there is a section on hurricane frequencies for 2-week periods at five different sites.

The Chesapeake Bay brochure features weather and climate information for the period from May through October. This is the time when the Bay is a recreational haven for the sailor, boater, beachcomber, and fisherman. Detailed local tips on where rain is least likely, and sailing breezes are most likely are included.

The new publications bring the total number of brochures published to six. Also available are *Rhode Island's Vacation Climate* and *San Francisco Bay—A Recreational Climate*. To obtain any or all of these brochures at no cost, write to: Resort Guides, National Oceanographic Data Center, D762, Room 400, Page Building 1, Washington, DC 20235.

1890-1977 Atmospheric Sciences Collection Cataloged

The Library and Information Services Division (LISD) of EDIS' Environmental Science Information Center has published a 24-volume catalog describing atmospheric sciences materials in its collection. Books, reports, journals, manuscripts, and data publications acquired by the former Weather Bureau Library between 1890 and 1971 make up the first 20 volumes. The remaining four volumes cover material acquired by NOAA's Library and Information Services Division (LISD) from September 1971 through 1977.

The atmospheric sciences collection covered by the catalog contains approximately 170,000 volumes. Major subject areas are meteorology, climatology, hydrology, physical oceanography, and air chemistry. A large portion of the collection consists of meteorological and climatological data from all over the world.

Special holdings include 19th-century weather records from France and England, Russian narratives and observations from the Tsarist weather station at St. Petersburg dating back to 1830, photostats of captured German and Japanese weather observations made during World War II, surveys, explorations, and a large collection of eyewitness records of historic sea-voyages.

Most of the material covered by the first 20 volumes of the catalog is located in LISD's central building at 6009 Executive Boulevard, Rockville, Md. However, items in continual demand, such as continuous runs of climatological data, or books considered to be standard references, are located at the Gramax Building, 8060 13th Street, Silver Spring, Md., where the newer (post-1971) material acquired by NOAA is concentrated. Card catalogs in both locations provide access to material added to the collection since the catalog was completed.

The catalog was produced by a commercial publisher, G. K. Hall and Company, with the cooperation of the LISD. It is available for use at the LISD central building in Rockville, at its Camp Springs center (World Weather Building), its Georgetown center, its Suitland center, its Silver Spring center (Gramax), and its Miami and Coral Gables centers.

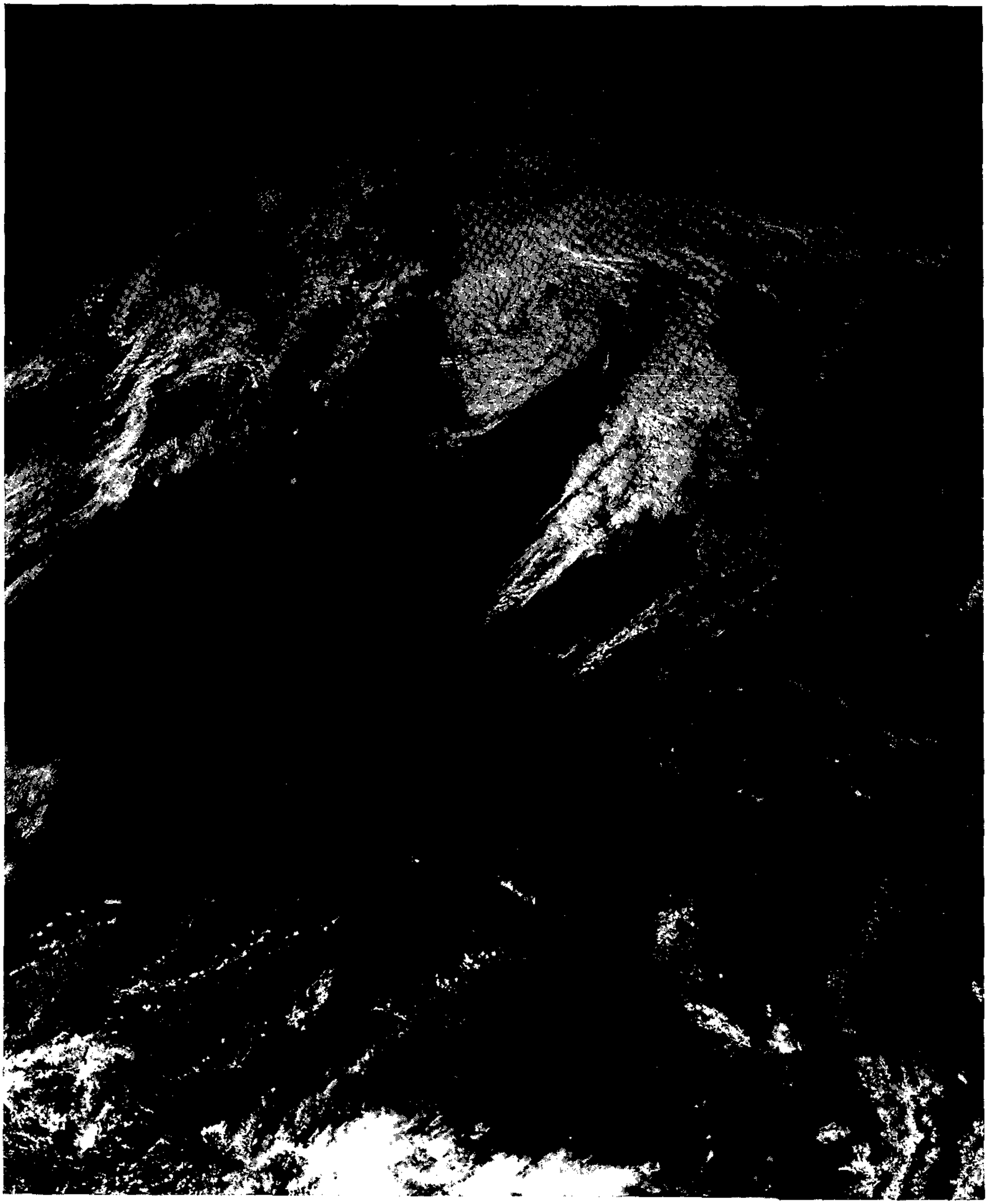
Satellite Data Bulletin Available

The first issue of the *Satellite Data Users' Bulletin* has been published and distributed to several hundred users by the Satellite Data Service Division (SDSD) of EDIS' National Climatic Center. The purpose of the *Bulletin* is to keep satellite data users appraised of noteworthy developments and of the types and volume of satellite data archived at SDSD.

The first issue concentrated mainly on the status of data available from the newly launched SEASAT and TIROS-N satellites and from the Coastal Zone Color Scanner onboard Nimbus-7. The *Bulletin* will be published by SDSD as the need arrises.

Copies of the *Bulletin* can be obtained from the Satellite Data Services Division, Room 606, World Weather Building, Washington, DC 20233 or call (301) 763-8111 or FTS 763-8111.

A Feb. 23, 1977 satellite picture shows a deep low-pressure system over the central United States, as well as two duststorms to the south, one over Colorado, the other over Oklahoma and Texas. Copies of this and other satellite pictures are available from EDIS.



International Report

Global Ocean Data Inventory and Climate Data Base

In response to a request by the UN's Intergovernmental Oceanographic Commission (IOC) for member states to provide data management services for oceanographic data collected during the First GARP (Global Atmospheric Research Program) Global Experiment (FGGE) (also known as the Global Weather Experiment), EDIS will serve as a Responsible National Oceanographic Data Center for the FGGE Operational Year (RNODC-FOY). In this capacity, EDIS will (1) develop a global inventory of all ocean data collected during FOY and (2) create a global ocean climate data base of selected FOY physical oceanographic parameters. All data will be exchanged through normal international exchange channels.

The global ocean data inventory will contain directory information regarding all known oceanographic data of any kind recorded during FOY (December 1, 1978 through November 30, 1979). The inventory will be available both in published form and online to computer terminal users internationally via either TYMNET or TELENET. The global ocean climate data base will include physical oceanographic data for this same period acquired by the RNODC-FOY. Bathythermograph data, Nansen/Nisken bottle data, salinity-temperature-depth data, current meter data, as well as phosphate, silicate, oxygen, and sea level data will be formatted and quality controlled.

The French oceanographic data center in Brest (BDNO), will serve as European consultant for the inventory, and will edit and oversee inventory information for the Atlantic. BNDO also will digitize Atlantic XBT traces for countries that are unable to accomplish this themselves.

The Japan Oceanographic Data Center (JODC) will serve as an RNODC for the Western Pacific region, and as part of their activity will aid in RNODC-FOY activities wherever possible. The JODC recently provided inventory information covering 130 cruises scheduled during the first half of 1979, and more cruise information is expected for the remainder of the year.

In November and December 1978, under the sponsorship of the UN's Intergovernmental Oceanographic Commission, explanatory letters and survey forms were mailed to some 11,000 marine scientists worldwide. Responses have been received covering 330 cruises/projects from 34 countries. These range over all the major oceans of the world, from 84°N to 70°S. Some of the scientific concerns of these activities include Equatorial circulation, Antarctic biology and circumpolar circulation, coral reef ecology, and the effect of logging on estuarine circulation and pollution. Many scientists plan studies of heavy metal content of ocean waters and of tar distribution.

The first published version of the global ocean data inventory is planned for release in mid-1979, to be updated and reissued at six-month intervals until December 1982, when the final edition is scheduled for release. Periodic newsletters concerning the RNODC-FOY also are planned.

The global ocean climate data base currently is in the design stage. Implementation will begin in December 1979, and the final data base is scheduled to be released to users through the World Data Center system in December 1982. Scientists who want additional information should contact the project manager, Robert Dennis, at (202) 634-7344 or FTS 634-7344.

Foreign Use of NOAA-Supported Abstract Data Bases

Foreign use is increasing of three computerized abstract data bases supported or formerly supported by NOAA. The data bases are: Aquatic Sciences and Fisheries Abstracts, Meteorological and Geoastrophysical Abstracts, and Oceanic Abstracts (NOAA-supported first 6 months of 1978). These data bases are accessible to both national and international users through the Lockheed Corporation in Palo Alto, Calif.

About a quarter of the users of the three data bases are foreign users. An analysis for calendar year 1978 reveals that of a total of 4,938 users, 1,283 were foreign. A further breakdown of foreign data base users is as follows:

Aquatic Sciences and Fisheries Abstracts	360

Meteorological and Geoastrophysical Abstracts	259
Oceanic Abstracts	664

(Oceanic Abstracts also is available through System Development Corp. of Santa Monica, Calif. The user total above represents usage only through Lockheed.)

Aquatic Sciences and Fisheries Abstracts were available only in a six-month test file (January-June 1975) for the period examined. An up-to-date file (beginning with January 1978) will be accessible in spring 1979. Once the newer material is online, use of the data base should increase. (Canadian users, however, now will access this file only through a Canadian system.)

The most frequent foreign searchers of all three data bases in 1978 were Canada and England. Other participating countries were Austria, Australia, Chile, Denmark, Italy, Japan, Kuwait, Mexico, the Netherlands, the Philippines, Portugal, South Africa, and Sweden.

A one-month sampling showed that private companies use the data bases most frequently, followed by government affiliates, then academia. Private individuals represent the smallest category.

Please direct any inquiries concerning these data bases to: User Services Branch (D822), Library and Information Services Division, ESIC/EDIS/NOAA, WSC-4, 6009 Executive Blvd., Rockville, MD 20852, USA.

POLYMODE Data Exchange

Seven oceanographers from the Soviet Union met with the Director, World Data Center A (WDC-A) for Oceanography at EDIS' National Oceanographic Data Center (NODC) during February to discuss data exchange arrangements for POLYMODE—an expanded program of the Mid-Ocean Dynamics Experiment (MODE). MODE, conducted from 1975 through 1978, was a project to investigate the role of medium-scale, geostrophic eddies in the general circulation of the oceans. POLYMODE is being conducted under the US/USSR agreement on Cooperation in World Ocean Studies. The Director, WDC-A, Oceanography is also Chairman of the U.S. POLYMODE Data Exchange Committee.

A data exchange agreement was reached at the meeting under which the Soviet Union will make available for exchange 1,335 hydrographic casts and about 150,000 current measurements. U.S. POLYMODE scientists have already received 4,300 Soviet bathythermograph profiles.

J. Churgin (left) of NODC and Russian POLYMODE visitors B. Filyushkin, A. Yampolsky, V. Bishev, B. Kostoglodov, I. Timchenko, V. Byshev, and V. Drozdov.

Initially, shipments of data will be sent to the POLYMODE Office located at the Massachusetts Institute of Technology, Cambridge, Mass., and to the Computer Laboratory at the Shirshov Institute of Oceanology in the Soviet Union. Subsequently, all data will be forwarded to the national data centers of each country and to the World Data Centers (Oceanography). Plans are that all data will be exchanged by mid-1980, with inventories and partial shipments in 1979 and early 1980.

A report on the status of data preparation efforts and inventory information will be presented at the September 1979 meeting of the POLYMODE Joint Data Exchange Working Group in the Soviet Union.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmosphere Administration
Environmental Data and Information Service
EDIS Magazine
Washington, D.C. 20235

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Penalty for Private Use, $300

Postage and Fees Paid
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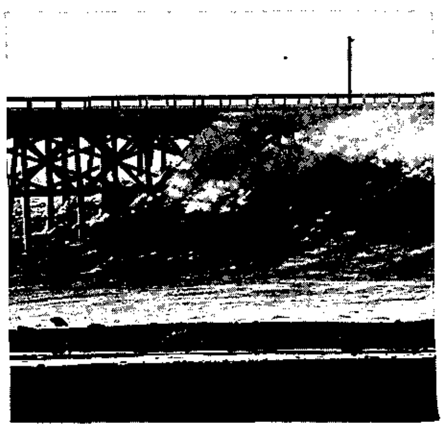

In this issue: *An assessment of the impact of climatic fluctuations on the global community (p.3); a closer look at the interactions between climate and human societies (p.11); and a discussion of efforts to develop a measured ocean wave data system (p.17).*

EDIS

Environmental Data and Information Service
Volume 10, Number 4
July 1979

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EDIS

Cover: *Lightning plays havoc with electrical transmission lines. The relationships between weather and energy are examined in the article beginning on p. 9.*
Photo: Noel M. Klein

EDIS is designed to inform Environmental Data and Information Service (EDIS) cooperators, colleagues, and contributors of recent developments in EDIS programs and services and in the general field of scientific data and information management. EDIS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, and Center for Environmental Assessment Services. In addition, under agreement with the National Academy of Sciences, EDIS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology (Snow and Ice).

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.

EDIS (ISSN 0190-3365) is published bimonthly by the Environmental Data and Information Service, NOAA, Page Building 2, Room 533, 3300 Whitehaven St. N.W., Washington, D.C. 20235. For address changes, cancellation, or information write to the Editor at this address. Controlled Circulation Postage is paid to the Finance Department, USPS, Wash., D.C. 20260.

U.S. DEPARTMENT OF COMMERCE
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Taking Stock

Thomas S. Austin retired as Director of the Enviromental Data and Information Service (EDIS) on July 1. He had been director since October 1970. The activities and accomplishments of EDIS during the intervening years are examined in the following interview, conducted by the editor.

Q. Dr. Austin, in your opinion, what has been the most significant change in EDIS since you came on board?

A. Actually, there have been two changes. The first has been the evolution of EDIS from a traditional data and information archival and dissemination service to an agency heavily involved in applying its data, information, and expertise to problems such as the energy crisis, potential global food shortages, environmental pollution, and the development of the coastal zone. The second significant change has been in the user audience.

Q. Taking the applications change first, how did this evolution come about?

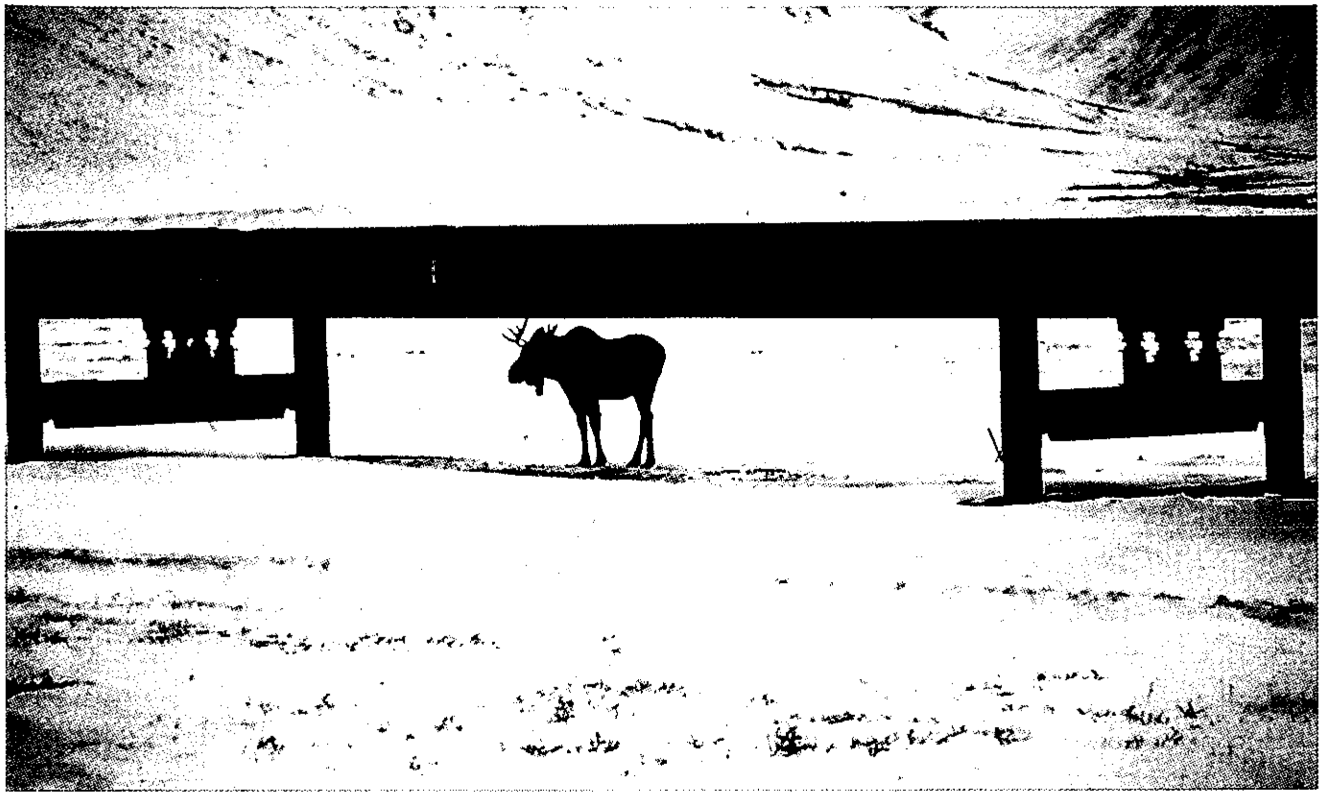
A. I'm not sure that I can pinpoint the process, but evidently the people concerned with these problems reasoned that we had the computers, the scientists, and the know-how—as well as the data and information—so why not ask us for the environmental answers and products they needed?

Q. Can you give some examples?

A. Well, in support of early national efforts to increase energy supplies, for example, EDIS provided tailored data and information products needed to plan, design, build, operate, and monitor the environmental impact of the Alaska pipeline, floating nuclear powerplants, supertanker ports, and offshore drilling rigs. EDIS also played a significant role in the U.S. Department of the Interior's national heating oil allocation program for the winter of 1973/74.

Q. And today?

A. Today, EDIS issues projections of natural gas and electricity demand for multistate regions of the country on a monthly and seasonal basis during the heating and cooling seasons. These go to the U.S. Department of Energy and to other Federal agencies responsible for energy use and planning, and, upon request to State energy agencies and to industry. DOE also uses EDIS data in its formula to allocate Federal funds to the States to insulate the homes of low-income citizens.



Q. How about energy-conservation applications?

A. Well, we are working with the American Institute of Architects Research Corporation to provide climatic guidelines to architects and home builders so homes can be designed to respond to climate and save fuel. The results of a joint pilot project were published in the U.S. Department of Housing and Urban Development's regional guidelines for building passive, energy-conserving homes. Currently, we are developing tailored climatic guidelines for major U.S. cities for architects and home builders.

Q. With oil and gas supplies dwindling, other sources such as the Sun, the oceans, and geothermal energy are being studied as possible supplements or substitutes. Since these are all "environmental" sources, EDIS should be in a good position to help.

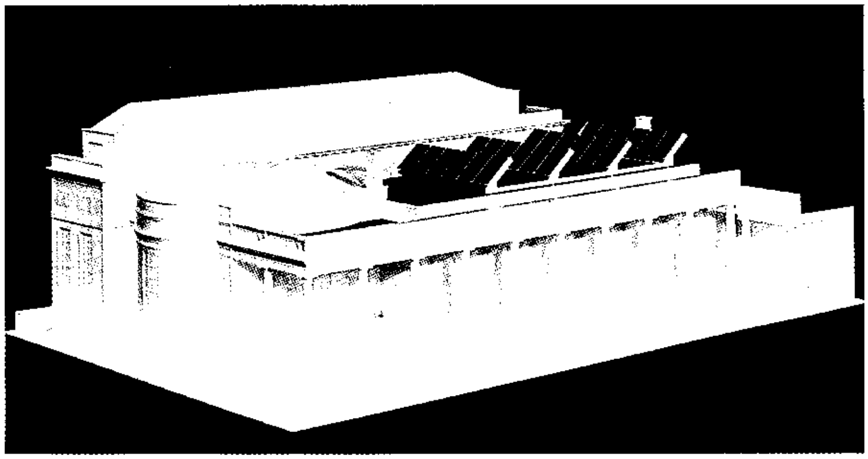
A. We are. We have worked with other NOAA components and with the U.S. Department of Energy to rehabilitate existing solar radiation data and make it available in a form most useful for solar energy applications. In addition, in response to DOE requests, we established a test data base for their Ocean Thermal Energy Conversion (OTEC) program, identified areas requiring additional observations, provided tailored data products to DOE, and implemented an operational OTEC data base. And in another project—in cooperation with DOE and the U.S. Geological Survey—EDIS developed the first detailed maps of geothermal energy sources for the Western United States, Alaska and Hawaii. and the Gulf Coast.

Q. All of the applications and activities you have mentioned concern the energy crisis. How about food shortages?

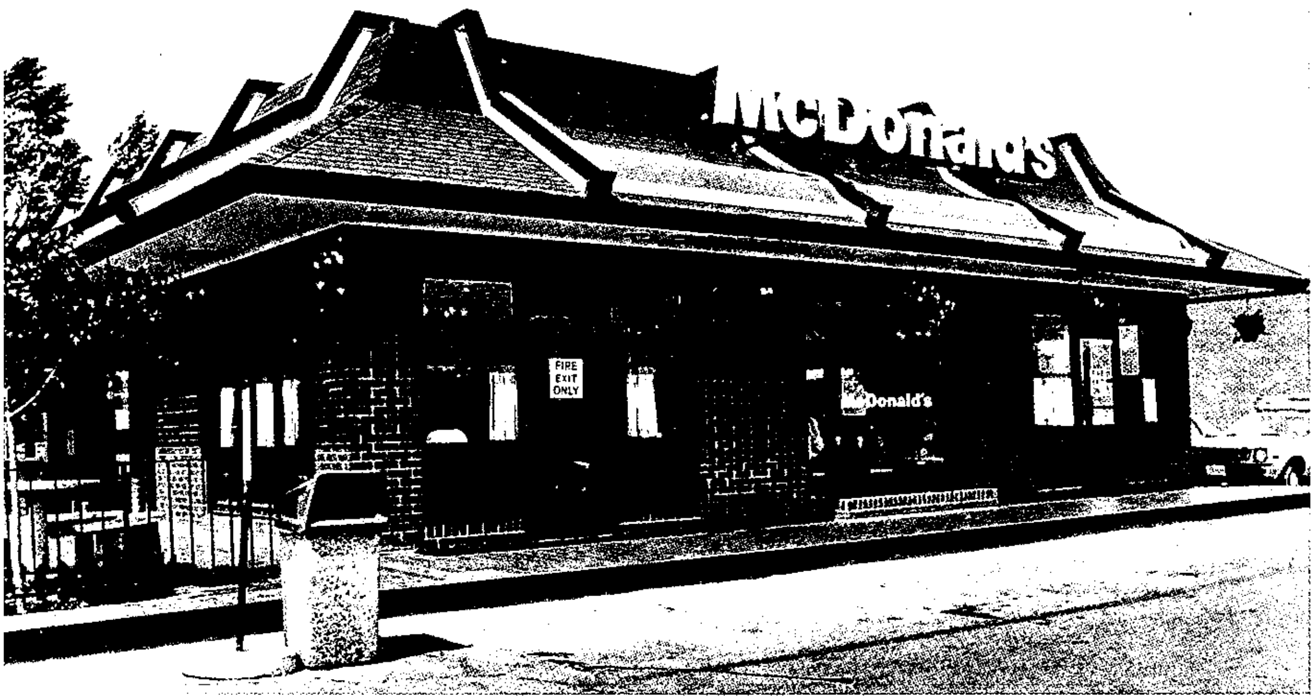
A. Between 1972 and 1976, world grain reserves fell to a level close to the difference between annual production in years with good weather and years when the weather is bad. A bad year could have exhausted the reserves. Although the reserves have since risen substantially, historical climatic data suggest that climate may be more variable and unfavorable weather more likely in coming decades than in the recent past. In response to this situation, we established a Center for Climatic and Environmental Assessment. This office, now part of EDIS' Center for Environmental Assessment Services, prepares weekly assessments and data-based studies evaluating the potential effects of climatic fluctuations on national and global

Left: Besides having to withstand extreme weather conditions, the Alaska pipeline must permit the passage of wildlife.

Right: Proposed White House solar installation.
White House photo.



Below: Solar collectors in the roof of a McDonald's Restaurant in Kingston, Ontario, Canada. The solar system heats water for the kitchen and rest rooms.
Photo: Grumman



grain supplies. These reports are used by the U.S. Department of Agriculture in its crop-yield assessments. They are also used by the State Department in awarding disaster relief to Caribbean and Sahelian countries.

Q. **How accurate are these assessments?**

A. They seem quite reliable. In early July 1978, for example, EDIS climate/wheat-yield models indicated that near-to-record yields could be expected in both the Russian winter and spring wheat crops. This was confirmed in early November of that year, during a Russian news broadcast by Premier Kosygin. This was the first time in recent years that the USSR had good yields simultaneously in both their winter and spring wheat regions.

Q. **You also mentioned EDIS applications concerning environmental pollution.**

A. Yes. To help the U.S. Departments of the Interior and of Transportation assess the risks of pollution associated with proposed outer continental shelf oil and gas development, deepwater ports, and other tanker operations, EDIS scientists developed a statistical oil spill trajectory risk model based on historical meteorological and oceanographic data. The model has been used in the licensing process for deepwater ports in the Gulf of Mexico, during the ARGO MERCHANT oil spill emergency, and in the environmental baseline characterization of Mid-Atlantic, New England, and California outer continental shelf oil and gas lease areas.

Q. EDIS is also concerned with environmental pollution in connection with the National Strategic Petroleum Reserve Program. Just what is its role in this program?

A. The reserve program uses oil storage cavities leached from natural underground salt domes in the western Gulf Coast area. EDIS scientists are studying the potential ecological effects of the planned disposal of huge volumes of saturated brine into Gulf waters for the U.S. Department of Energy. These studies play a part in decisions regarding the location of brine discharge sites and the design of the brine disposal systems. EDIS also designed and is implementing a program of physical, chemical, and biological monitoring before, during, and after salt dome leaching operations.

Q. And coastal zone development applications?

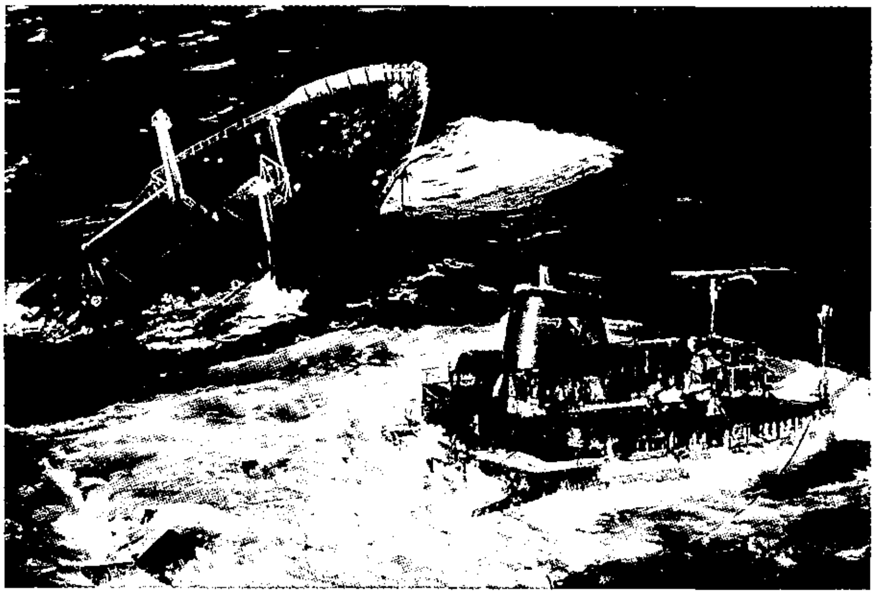
A. Well, we have been involved in several ways in addition to some of the ocean applications I have already mentioned. EDIS scientists provided environmental impact assessments and expert testimony in connection with licensing procedures for deepwater port construction. In the economic area, we have provided inventories and econometric models to NOAA's Office of Coastal Zone Management. More recently, EDIS has been a prime force in the establishment of a Regional Coastal Information Center program.

Q. What's the purpose of the program?

A. The RCIC program was established to provide better information and data services to local users and marine resource managers in coastal states. To date, three RCIC's have been established. The Northeast RCIC is located at the University of Rhode Island. The Northwest RCIC has two service centers—one at Oregon State University in Corvallis, the other at the University of Washington in Seattle. The Great Lakes RCIC is located at the University of Michigan and the Great Lakes Basin Commission. Six more RCIC's are planned to cover all U.S. coastal regions, including those of Alaska and Hawaii.

A Sahelian nomad awaits an air-drop of food.

World Food Program-FAO



*The **ARGO Merchant** breaks up off New England, December 1976.*

Q. **At the beginning of the interview you mentioned EDIS "traditional" data and information services. How have these fared while EDIS has been involved in all these new programs and projects?**

A. During the same period, the EDIS user community has grown substantially. Last year there were more than 130,000 user requests. We have made extensive organization and program changes to improve user services and products, increased automation to reduce costs and provide faster service, strengthened EDIS capability to provide multidiscipline data and information, broadened our participation in international data exchange activities, and developed a prototype national referral system for environmental data, information, and literature.

Q. **Besides assessments and traditional services, EDIS has also been heavily involved in interagency and international research programs.**

A. Right. In 1971, the National Science Foundation gave us responsibility for data management and information services for U.S. programs in the International Decade of Ocean Exploration (1970-1980). The data collected during the IDOE will be used to measure future changes in the quality of the marine environment, forecast ocean and climate fluctuations, locate sea-floor minerals, and improve the use of the ocean's living resources.

EDIS has also provided experiment design, data management, and analysis support to large-scale, field research programs such as BOMEX—the interagency Barbados Oceanographic and Meteorological Experiment; IFYGL—the International Field Year for the Great Lakes; and GATE—the Atlantic Tropical Experiment of the Global Atmospheric Research Program. More recently, we began operation of the U.S. Global Weather Experiment (GWE) archive for national and international data exchange and have developed a complementary global ocean data inventory for GWE.

Q. **In the beginning, you mentioned a major change in the EDIS user audience. Would you explain what you meant?**

A. Well, over the past decade or so, our user audience has expanded to include more public policymakers at the national, state, and local levels; attorneys; regional planners; business executives; citizens' groups; and individual taxpayers. A recent EDIS analysis for coastal zone data and information, for example, shows that from 1973 to 1978 this user audience grew from 29 percent to 45 percent of the total user population.

Q. **How does this affect EDIS?**

A. These new users often need data and information in different forms from those traditionally provided to the scientist and engineer, and their applications frequently require multidisciplinary assessments and interpretations. This, in turn, requires greater emphasis on packaging data to meet user needs.

Q. **Do you expect this trend to continue, and, if so, what is EDIS doing to meet the challenge?**

A. During the coming decade, we expect the volume of user requests for multidisciplinary environmental data and information products to continue increasing, many new data applications to be developed, and user demands for shorter response time to accelerate. To meet these and other changing user needs—and to achieve the degree of data integration needed to better meet national needs—EDIS is integrating its formerly separate data base operations into a single data archive management and user services system.

Q. **What does this involve?**

A. Well, until now, EDIS' data processing operations involved three separate, independently operated computer systems. In implementing the new single system, EDIS will consolidate the data bases of its National Oceanographic Data Center and Center for Environmental Assessment Services, in Washington, D.C., and National Geophysical and Solar-Terrestrial Data Center, in Boulder, Colo., with the data base of the National Climatic Center in Asheville, N.C. Telephone lines and communications equipment already have been installed at the Washington and Boulder-based centers to provide a direct link to NCC. The installation of a high-density mass-storage system at NCC will increase the amount of data accessible online, and further reduce costs and response time.

Q. What are some of the other advantages of the new system?

A. It will be user-oriented. It will provide direct access not only to multidisciplinary environmental data, but also to data analysis, application, and product-generation subsystems. Access will be provided at EDIS centers and liaison offices, Regional Coastal Information Centers, and NOAA libraries across the country—or the user may buy an inexpensive terminal and participate from his own office or home.

Q. How long will it take to get the new system operational?

A. The skeleton of the system is already in place, and EDIS personnel have begun a system concept "shakedown." Hopefully, the skeleton can be fleshed out over the next 18 to 24 months. The implementation of a fully operational service system should then take another year or two.

Q. Once the system is operational, what specifically will it mean to users?

A. It will mean that multidisciplinary user requests that today might take several weeks to answer, will be answered in an hour or two. And relative to present costs, the quicker answer will cost less; it will be cheaper for EDIS to provide the answer, and the savings will be passed on to the user. Moreover, the user with his own terminal will be able to plug directly into the system. And the user will get better data products; instead of three separate products in three different formats, the output will be an integrated, designed product.

Q. How will the new system affect EDIS applications and assessments with respect to national problems and programs?

A. The system envisioned will allow us to do things that are impossible today—or possible only by the application of enormous amounts of manpower, time, and money. For example, when an oil spill threatens a coastal area, it will be possible to get an integrated data product needed to plan defenses and cleanup operations before the oil hits the beach. Today, the three data bases would have to be searched separately, and their integration done manually. Even with top priority and sufficient resources, there probably would not be enough time.

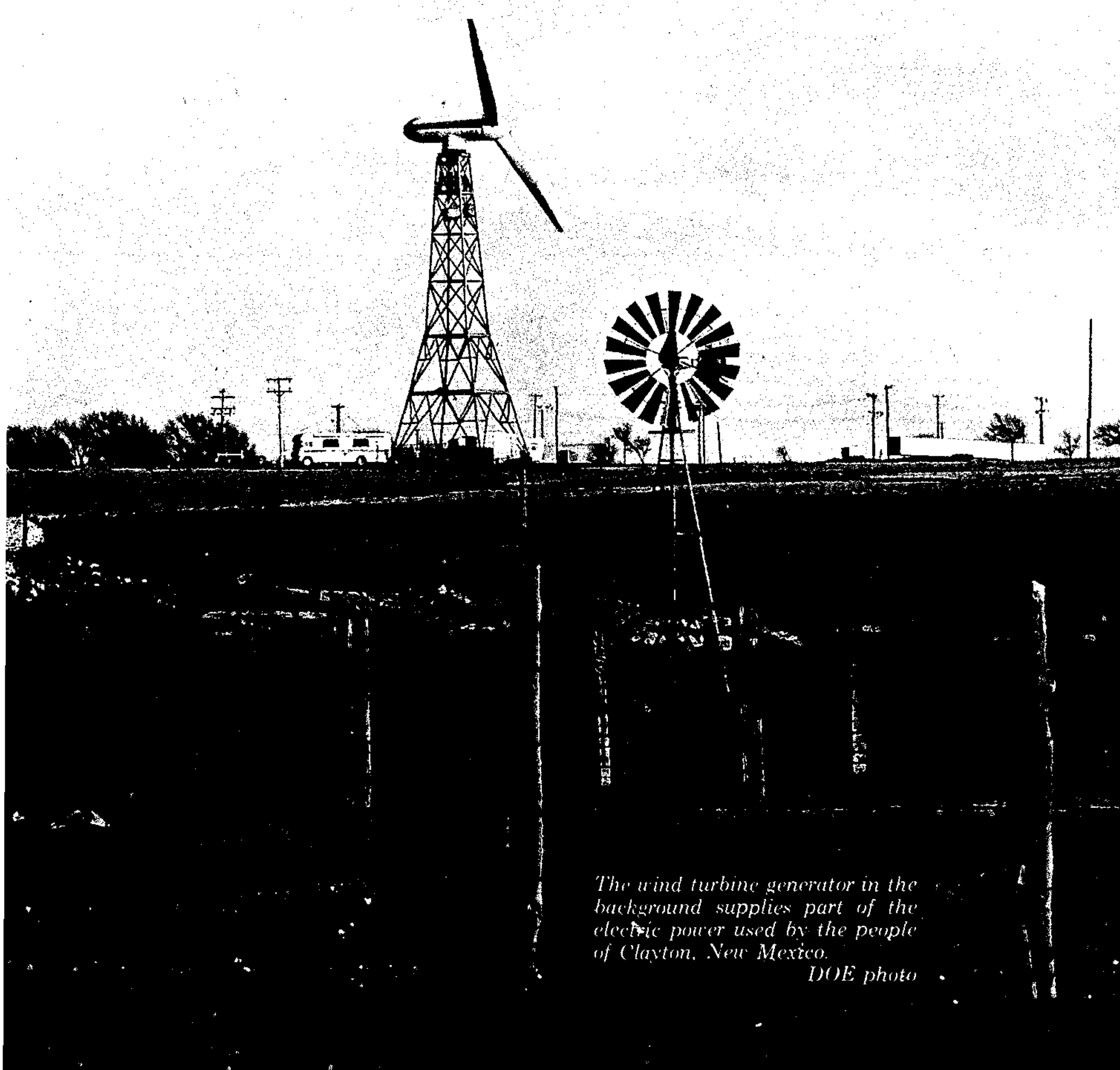
Q. How would you sum up the benefits and the outlook for the new service system?

A. The new system will maximize the value of our environmental data and information holdings. And it will permit us to respond effectively despite the rapidly closing window of time available to deal with environmental problems. The new system also will have the flexibility our Nation needs to respond to constantly changing environmental problems and concerns. Finally, it will help EDIS/NOAA to develop national environmental data and information resources as necessary to meet both national and individual user needs for the foreseeable future.

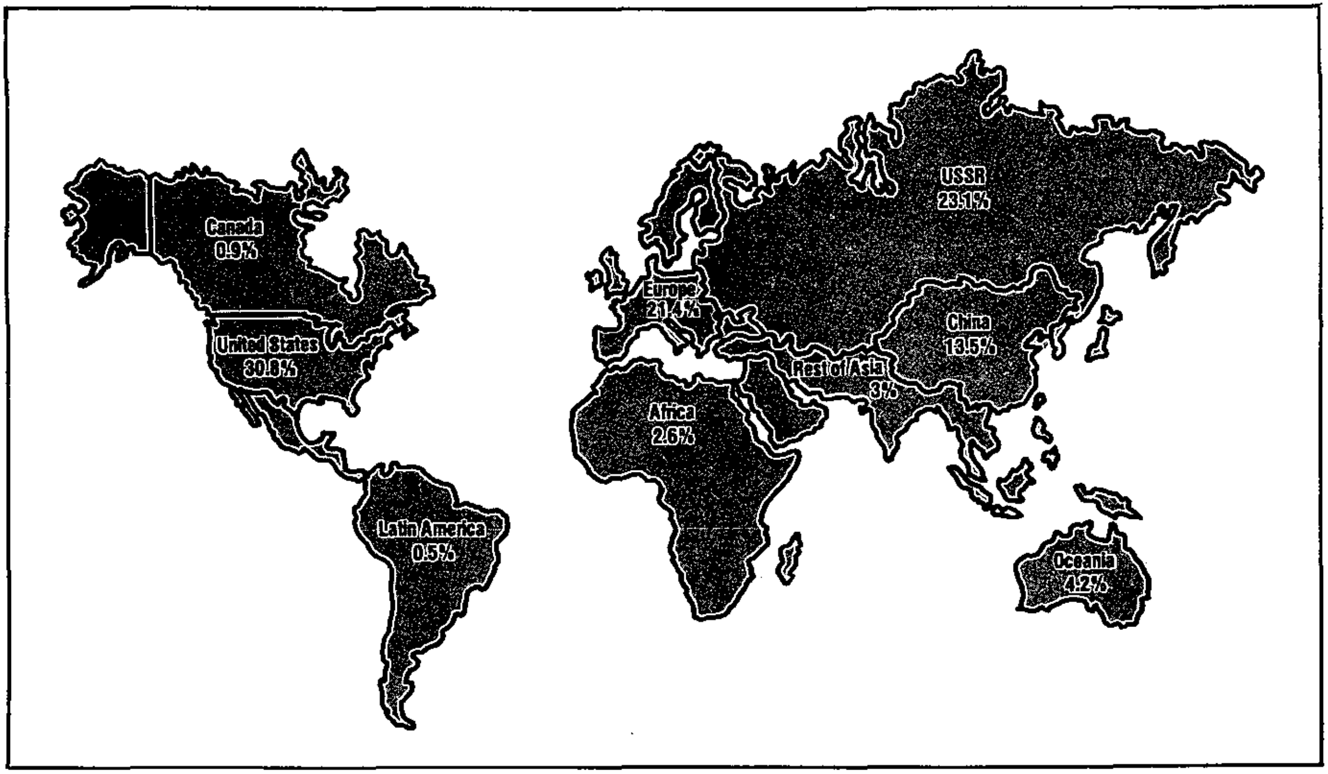
Dr. Austin (seated) talks with Air Force representatives following dedication of the new joint NOAA/Air Force computer system in Asheville, N.C., April 25, 1979. Dr. Thomas Potter, now Acting Director of EDIS, is on the right.

Meteorology and Energy

Condensed from a World Meteorological Organization release.

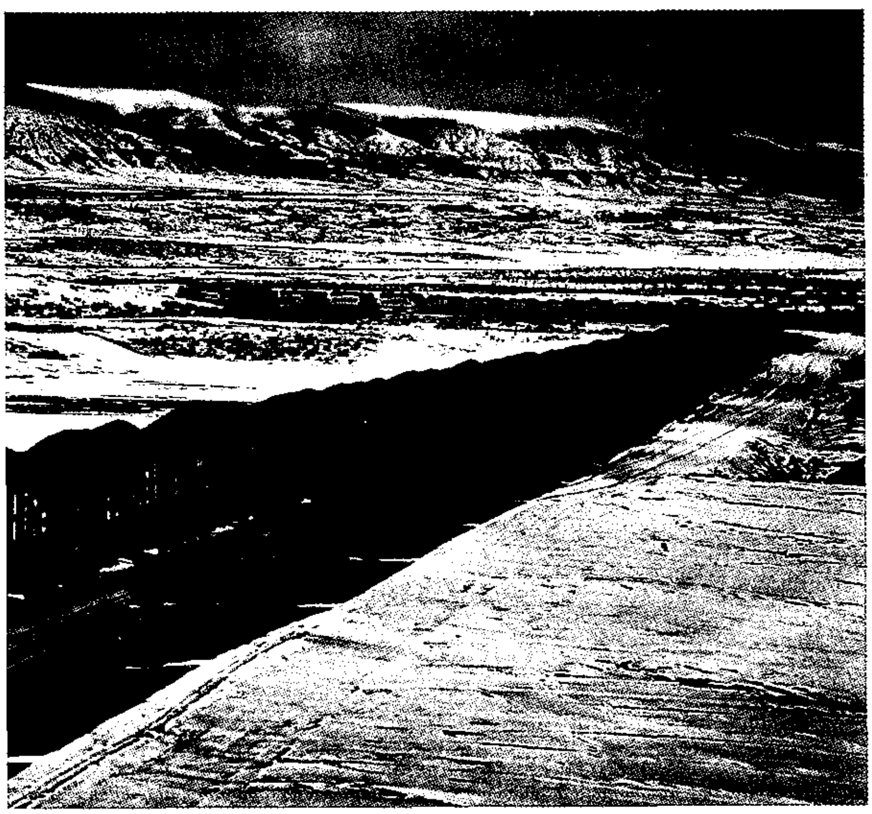


The wind turbine generator in the background supplies part of the electric power used by the people of Clayton, New Mexico.
DOE photo



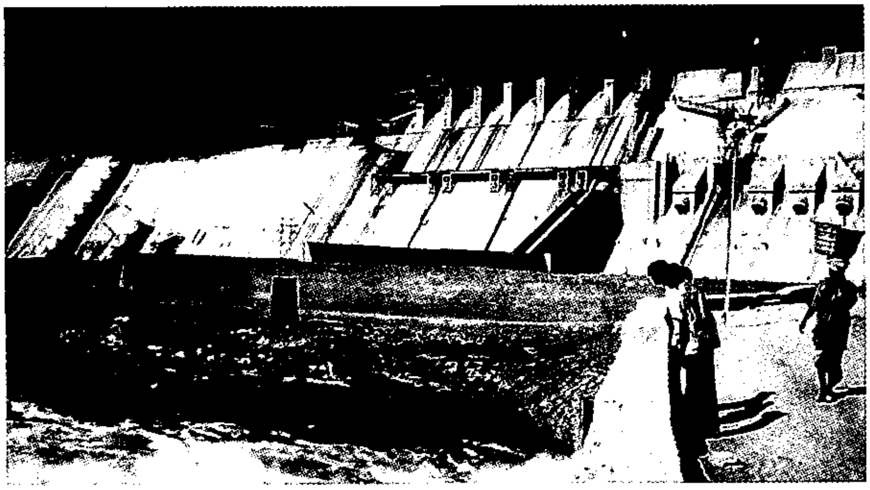
Above: Recoverable coal reserves of the world. Source: World Energy Conference Survey of Energy Resources, 1974.

Map by Edison Electric Institute



Right: About 75 percent of all coal is moved by rail. During transit, it is vulnerable to the vagaries of weather.

Union Pacific Railroad



Construction of a dam in India.
FAO photo

The oil crisis of 1973-1974 focused the world community's attention on the fact that energy is one of the most important commodities supporting modern civilization. The dramatic events of that period also made thinking people uncomfortably aware that the Earth's conventional sources of energy are finite. Indeed, the world's fossil fuels—oil, gas, and coal—on which we are largely dependent, are being used up at an ever-increasing rate. At some time not far hence they will be completely exhausted.

Against this background humans are particularly discomforted by the knowledge that each day three factors inevitably increase global energy use: the continuing growth of world population, the economic and social aspirations of the developing nations, and the increasing demands of the industrialized countries.

Concerted efforts are now being made to cope with the world's energy problems. If a drop in our present living standard is to be avoided, it is imperative that new sources of energy be found and developed. In all of these efforts, meteorology and operational hydrology will play an increasingly important role. In fact, it can be said that satisfactory solutions to present and future energy problems are not likely to be found without maximum use being made of the science and skills of these two disciplines. There is virtually no aspect of the development and utilization of energy in which the practitioner of these disciplines cannot make a significant and sometimes fundamental contribution. This is so whether the source of energy is conventional (thermal or hydro) or new (nuclear fission, wind, solar, geothermal, tidal, etc.).

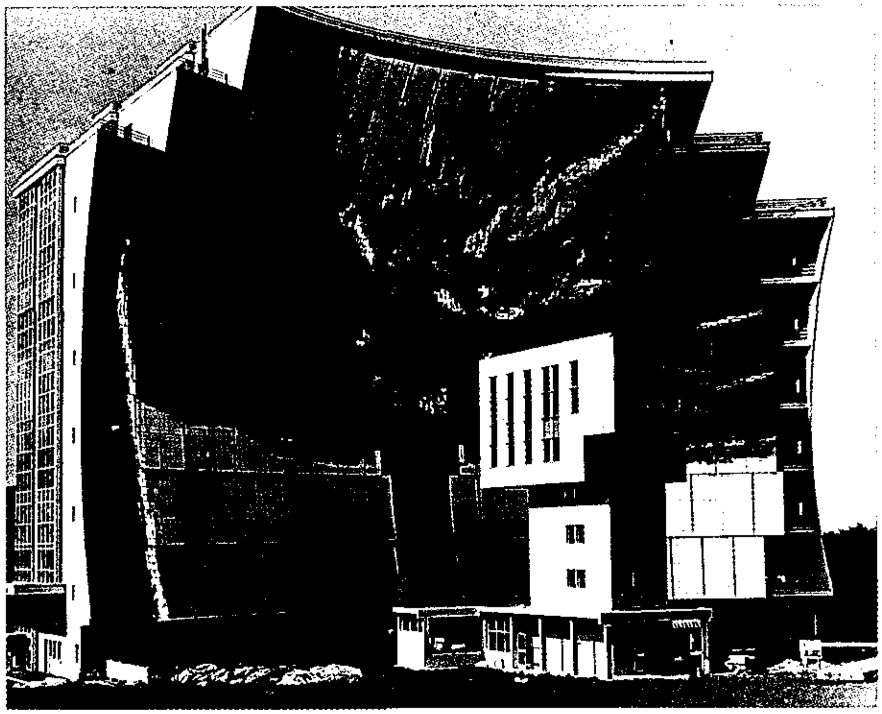
Before noting some of the specific contributions of meteorology (and this, of course, includes operational hydrology), let us examine briefly the heavy burden imposed on global energy resources by some of the factors mentioned earlier. It is very likely that global population will increase from its present 4 thousand million to about 6 thousand million people by the end of the century. Most of this increase will take place in the developing countries. Here about 80 percent of the global population consumes less than 0.2 kW of energy per capita. In contrast, some 6 percent of the world population uses more than 7 kW per capita.

Present global consumption of primary energy resources is 8 Terawatts (a Terawatt is one million megawatts) of which 4 TW comes from oil and about 2 TW from natural gas. Economists have calculated that with an average rate of growth of primary energy use of 2 percent per year, the global demand in 50 years' time would amount to 22 TW. This immense increase in demand brings into the sharpest focus just how finite are the Earth's resources.

The estimated lifetime of reserves of oil is about 35 years, and of natural gas perhaps 5 to 10 years longer. At present rates of consumption of coal—with which the world is more plentifully endowed—estimated lifetime of reserves is more than 200 years. But most of these reserves are in three countries: United States, USSR, and China. It is estimated that the current known reserves of uranium (less than 4 million tons) will scarcely meet the needs of reactors planned to the year 2,000. Finally, waterpower for the generation of electricity has virtually reached its limits in the developed countries. It can, in any case, satisfy but a very small part of world demand for energy.

To meet ever-increasing energy requirements there will have to be a transition period while the world turns from the finite to the more or less infinite sources of energy (solar, wind, geothermic, tidal, wave, nuclear fission, etc.). During this transition period, which we are now entering, coal and nuclear energy will play a more and more important part. This in turn will have an environmental impact and substantially increase the demands made on the science and technology of meteorology and operational hydrology.

To consider meteorological aspects of energy problems, it is convenient to divide the latter into three main groups: energy production, energy transport and exploration, and new energy resources.



A French solar furnace. The curved mirror on the building focuses sunlight on a hole in the tower, producing temperatures of 7,000 degrees F.—enough heat to melt any known substance.

DOE photo

Energy Production

Much of the primary energy used today, particularly in the industrialized countries, is electric energy generated thermally by burning hydrocarbons—oil, gas, and coal. There is no doubt that the continuous increase of these fuels in energy production to meet the needs mentioned above has an impact on the global, regional, and local environment. As a consequence, greater quantities of heat, carbon dioxide (CO_2), and particulate matter are released into the atmosphere. The difficulty of assessing the effects of these increases has not prevented irresponsible and often sensational statements which largely ignore meteorological facts and information. As both socioeconomic and natural factors are involved, there is a special need for caution. At present, meteorologists and scientists, in general, have insufficient information to make precise forecasts. However, enough is now known so that meteorologists will be able to make reasonable assumptions for the future.

The services of meteorologists and hydrologists are very much in demand in the development of hydroelectric schemes and the regulation of rivers for such purposes. The efficient planning and operation of such development projects is not possible without adequate meteorological and hydrological forecasts, and related data. This is so because of the effect on hydroelectric systems of the variability of weather. The water which flows through the turbines does not arrive in a steady flow from the atmosphere. The basic requirements for data on precipitation and discharge for planning purposes are therefore obvious. This in turn calls for the establishment in many countries of meteorological and hydrological stations.

Energy Transport and Exploration

Human use of energy is strongly influenced by variations of weather events in time and space. Such systems as electric power transmission networks, shipping of hydrocarbons by sea, and pipelines for the transportion of large quantities of oil and gas, are all particularly sensitive to weather and climate.

The most significant weather phenomena causing disturbances in the transfer of electricity are thunderstorms, ice accretion on conductors, rain and moisture in polluted areas, and strong winds.

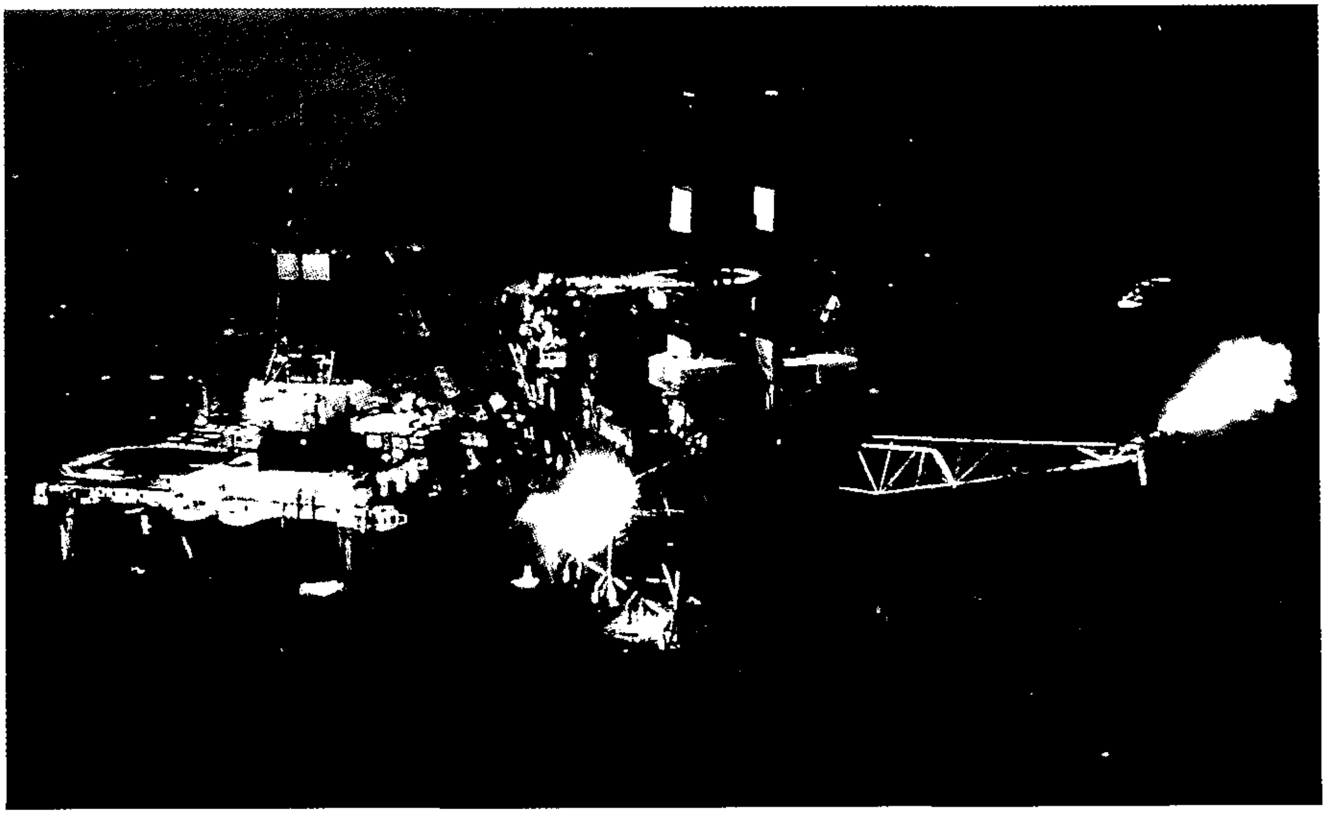
The application of meteorology to the shipping of hydrocarbons by sea (tankers, etc.) is particularly relevant in planning route selection and in the structural design, safety, and operation of vessels.

Important climatological factors affecting the construction and use of gas and oil pipelines are essentially those limiting or preventing outdoor work. Many of these pipelines are in areas of extreme cold or extreme heat. The meteorologist has an important function in making statistical climatological material available for use in the early planning stage for pipeline projects.

The meteorologist has a similar role to play in providing basic data on weather and climate to facilitate energy exploration. The exploitation of new sources of oil and gas often takes place in areas with extreme climate conditions (such as the North Sea and the offshore Australian fields) vulnerable to bad weather. Interruption of work involves the loss of large sums of money. It is the task of meteorological services to minimize these losses as well as to facilitate the protection of exposed installations in all regions.

New Energy Resources

Among the less conventional



sources of energy that have come into the news in recent years are wind and solar energy. While not exactly new—far more laundry is still dried by wind and Sun than by electric driers, and the technique of producing salt by solar-evaporation of sea water is thousands of years old—the urgent search for renewable energy sources have given them special prominence. Meteorological information is essential for any proper assessment of potentialities for and design of solar energy and wind energy systems.

It is little wonder that much attention is now being lavished on solar energy. The flow of energy from the Sun to the Earth is virtually infinite. And yet but one billionth part of that energy is intercepted by the Earth. Scientists have estimated that in 15 minutes the Sun radiates as much energy on our globe as humanity consumes in every other form during an entire year. The technological problems of harnessing this enormous source of energy are formidable. The mastery of the appropriate technology requires the fullest cooperation of meteorologists because of its fundamental characteristics: diurnal and seasonal cycles, the largely unpredictable vagaries of weather, and the low power density of the direct radiation, not to mention the fact that it cannot be directly stored in its primary form (photons).

Like solar energy, wind is also a very promising though unconventional source of energy. It is clean and plentiful—more so in some places than in others. This situation is particularly so in the winter in the higher latitudes when energy needs are greatest. Unfortunately at the same time it is unreliable and can at present only supply energy on a small scale.

In spite of this and because of the urgency of finding alternative sources of energy, considerable effort is being made to develop the exploitation of wind energy. Meteorological information is essential for any proper assessment of potentialities for, and design of, wind energy systems. Of special importance is information on the speed of wind at different heights above the surface. The development of new types of air turbines appears promising. Scientists have estimated that by the end of this century wind power could supply more than 10 percent of the United States' electricity. Dutch scientists have calculated that 5,000 wind turbines placed along the 250-mile stretch of their west coast would yield about 20 percent of the electricity produced in the Netherlands by other means.

A drilling platform in the North Sea.

Courtesy of Bechtel

Castle Geyser, Yellowstone Park.
U.S. National Park Service

The tapping of the enormous quantities of geothermal heat inside the Earth has been developed in a number of countries where it is at relatively shallow depths in the form of hot water or steam. Ninety percent of the houses in Reykjavik, capital of Iceland, are heated by geothermal hot water. In Hungary it heats 1.5 million m^2 of greenhouses. Geothermal energy is converted into electricity in a number of countries including Italy, Japan, New Zealand, and the United States. The services of meteorologists and hydrologists are called for in the development and exploitation of geothermal energy because of the pollution problems engendered by it, e.g., the water or steam which surfaces is heavy with salts, minerals, and certain poisonous gases.

By far the most important of the newer forms of energy is that provided by nuclear reactors. The introduction of nuclear reactors for industrial purposes has made it necessary to look carefully at possible dangers of air and water pollution. Meteorological and hydrological observations should start at an early stage of planning, construction, and location of atomic reactors.

Aware of the importance and urgency of coping with ever-pressing energy problems, the World Meteorological Organization's Executive Committee developed a plan of action to establish a set of priorities for the various appropriate technical commissions and other bodies. Of particular concern was the need for a transfer of technology to and preparation of guidelines for developing countries.

The Executive Committee's priority items are:

a. Preparation of technical notes on meteorology as related to wind and solar energy.

b. Arrangements of joint meetings between WMO and other solar radiation and wind specialists to study the relevant meteorological data required for the utilization of solar and wind energy.

c. Review of the present state of knowledge concerning the application of meteorology to nuclear plant site selection and operations.

d. Preparation of a basic WMO guideline document or statement of meteorological aspects of possible local and regional consequences of heat release to the atmosphere.

e. Preparation of a special environmental report on the various uses of meteorology in solving relevant problems in the energy field.

Work is well advanced on these tasks, and every effort will continue to be made to ensure that WMO plays its full role in this important field.

Right: This section of a digitally processed Seasat synthetic aperature radar image shows the southern California coast near Oceanside. The bright features on the ocean are caused by local wind effects on waves. Interstate 5, a 4-lane highway, shows as a dark line along the coast.
Courtesy Jet Propulsion Laboratory

Environmental Satellite Data Products and Services

By Eugene R. Hoppe and Bruce H. Needham

Introduction

Nearly everyone is aware that the United States and other nations have various satellites in orbit around the Earth. Not many people, however, are aware of the many uses of the data from these satellites. Even fewer people are aware of the types of data that are available and where they may obtain them.

The Satellite Data Services Division (SDSD) of EDIS' National Climatic Center (NCC), is the United States archive for environmental satellite data. It is a unique source of data and information relevant to many scientific disciplines. While primarily intended for meteorological purposes, many of the sensors orbited on the more recent spacecraft also provide data of great value to hydrologists, agronomists, oceanographers, and geologists.

The SDSD is collocated with the operations center of NOAA's National Environmental Satellite Service (NESS). NESS manages the National Operational Environmental Satellite Program. Collocation expedites SDSD acquisition of environmental satellite data. It also allows SDSD personnel to monitor the latest satellite data applications, to note outstanding environmental events which may be of interest to subsequent users, and to ensure that original imagery negatives and magnetic data tapes reach the Division undamaged and as economically as possible.

Users

Potential users of environmental satellite data include just about everyone, so pervasive has the view from space become in our society. Users may generally be divided into two categories—real-time and retrospective. Real-time users are primarily concerned with the evaluation of current meteorological conditions or the forecasting of near-term future conditions. These users are generally Government organizations such as the National Weather Service and the U.S. Navy's Fleet Weather Central, but they also include private individuals such as consulting meteorologists and radio and television weatherpersons.

Real-time weather data, forecasts, and satellite picture facsimile transmissions are used by shipping firms to route ships around major storms and high seas and to take advantage of ocean currents; by the oil and ocean mining industries to schedule ship operations; by the fishery industry to indentify sea surface conditions favorable to finding certain species of fish; and even by sportspersons who compete in the Newport to Bermuda Sailboat Races. The U.S. Coast Guard uses satellite data to monitor sea ice conditions, to locate and track the movement of major icebergs, and to find navigable leads in icebound waters for ship transport.

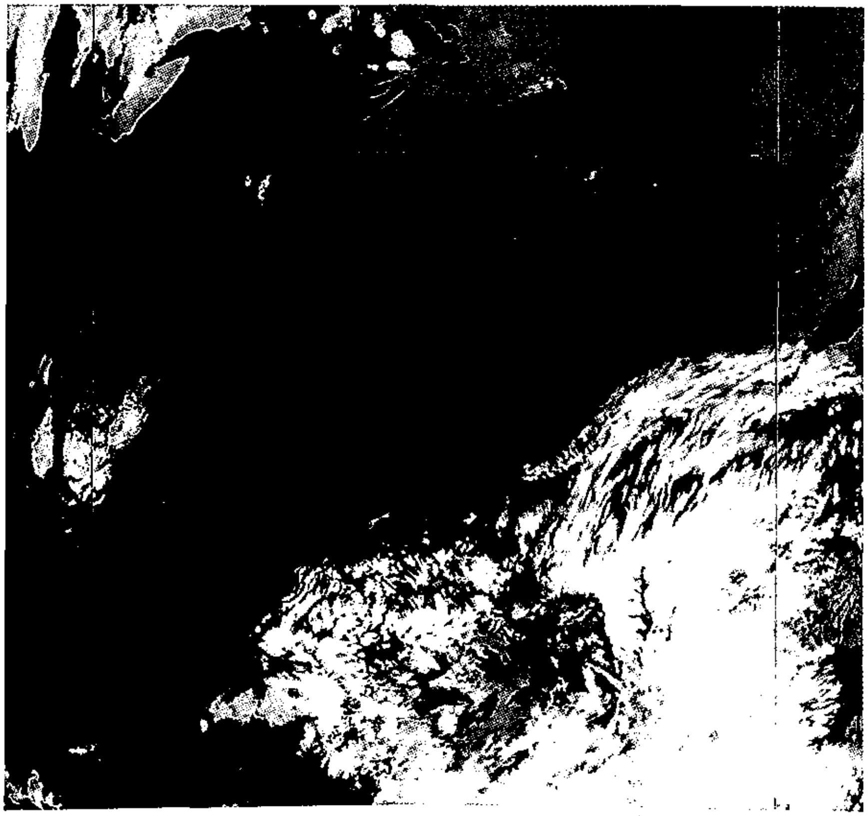
The retrospective, or non-real-time users comprise an interesting cross-section of the population. Scientists seek satellite data for studies related to climatology, coastal zone management, oceanography, deepwater port planning and management, hydrology, agriculture, geology, geophysics, and a host of other areas of research. Lawyers use satellite data in weather-related court cases. Editors use satellite pictures to illustrate publications. Many Federal agencies require satellite documentation of current environmental conditions. People want satellite views of their hometowns and states. Students and educators at every level seek satellite information. Many requests for satellite data come from foreign users.

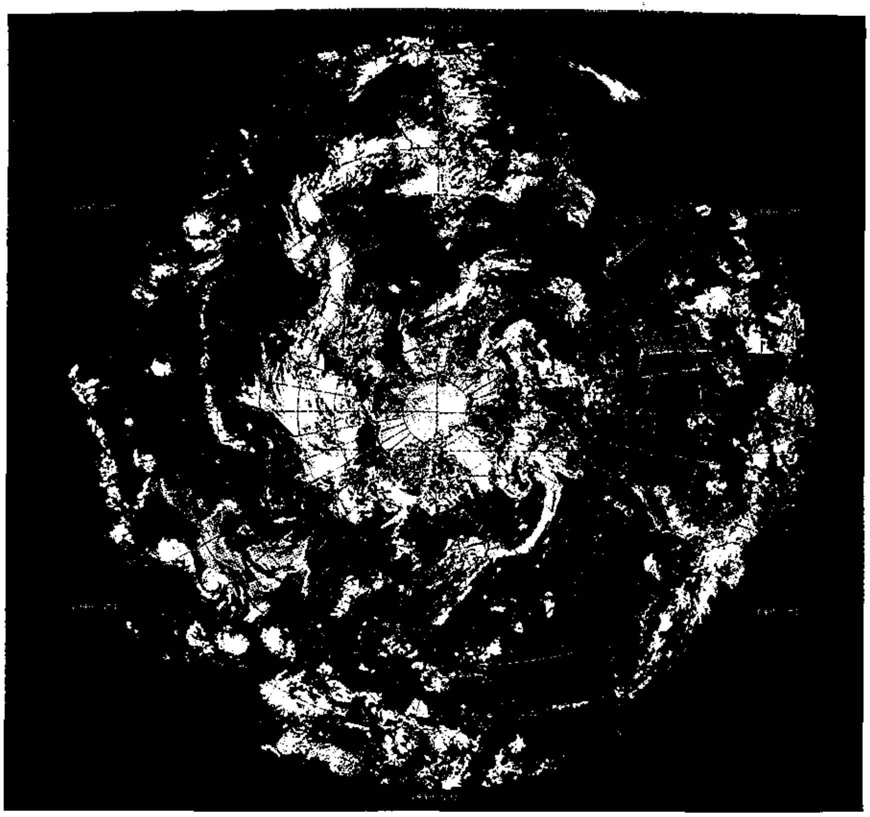
Types of Satellites

Two basic types of satellites routinely produce the environmental data archived at the SDSD—polar-orbiting and geostationary. Polar-orbiting satellites are in a relatively low orbit around the Earth (approximately 500 to 900 miles or 800 to 1,500 km above the Earth). This allows them to circle the globe from 12 to 14 times a day and obtain imagery and quantitative digital data along a path on the surface up to 1,550 miles (2,500 km) in width during both daytime and nighttime. Data from these satellites are transmitted to the Earth for archival in real-time when the satellite is within readout distance of a Ground Receiving Station, or they may be recorded on onboard tape recorders for later playback.

The geostationary satellites are essentially "parked" in an orbit about 22,000 miles (36,000 km) above the Earth's surface and travel at a rate of about 6,820 mph (11,000 km/hour). At this altitude and speed, a satellite remains continuously above the same point on the Earth, and thus is termed geostationary, geosynchronous, Earth-synchronous, or merely synchronous. The sensors on board acquire data and imagery of the complete Earth disc or of about one-fourth of the Earth's surface every 30 minutes, 24 hours per day.

At present the United States has five functional geostationary satellites in space. Three are currently "active" and two are in "standby." The active U.S. satellites are located above the Equator at 75°W and 135°W. The third is on station at 60°E (in place of a proposed USSR satellite) and is under the control of the European Space Agency (ESA). ESA also maintains their own geostationary satellite (METEOSAT) located at 0° longitude. The National Space Development Agency (NASDA) of Japan maintains the fifth geo-





Left: A NOAA-5 infrared image, 0900 EST, April 13, 1977. The entire East Coast and much of the Gulf Coast are shown. The multitone patterns off the East Coast depict the thermal structure of the Gulf Stream and adjacent waters. The white imagery in the lower right and elsewhere depicts clouds.

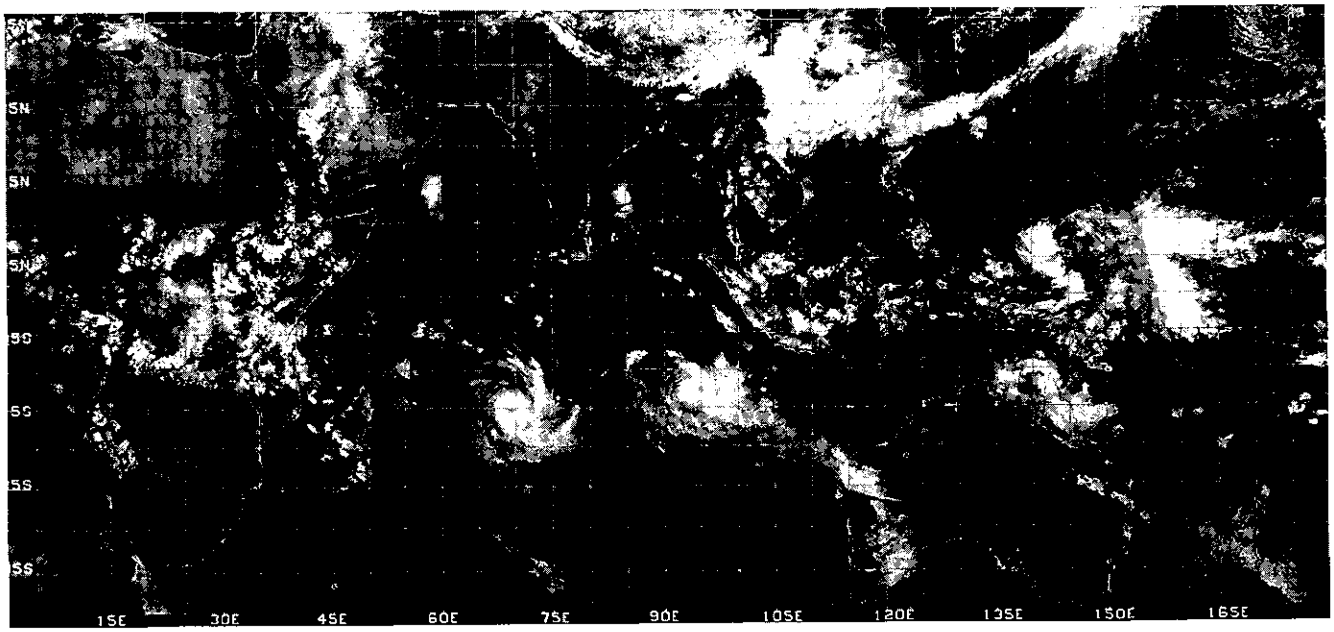
Below: A visible-image Northern Hemisphere Polar Stereographic Projection mosaic constructed from 14 single-pass images from the NOAA-2 polar orbiting satellite.

stationary satellite located at 140°E. With all these satellites in operation, complete global coverage is maintained from approximately 60°N to 60°S.

New Satellites

While most satellites whose data are archived at SDSD are designed for use by meteorologists, two satellites were recently launched with sensors on board that are especially interesting to oceanographers. The first is SEASAT (see *EDS*, July 1978, p.8), which was launched in June of 1978. Although SEASAT, designed for a one-year mission, malfunctioned only 3½ months after launch, the data it acquired will help prove the feasibility of future missions. This was the first proof-of-concept satellite specifically designed to gather data from the world's oceans. Of particular interest is the fact that the majority of sensors on SEASAT operated in the microwave region of the spectrum; this allowed continuous acquisition of data during daylight and at night during all weather conditions. Microwave sensors can "see" through clouds, whereas normal visible and infrared sensors on other satellites cannot penetrate through cloud cover to observe surface features and conditions.

Three of the five SEASAT sensors did not actually acquire imagery, but measured surface



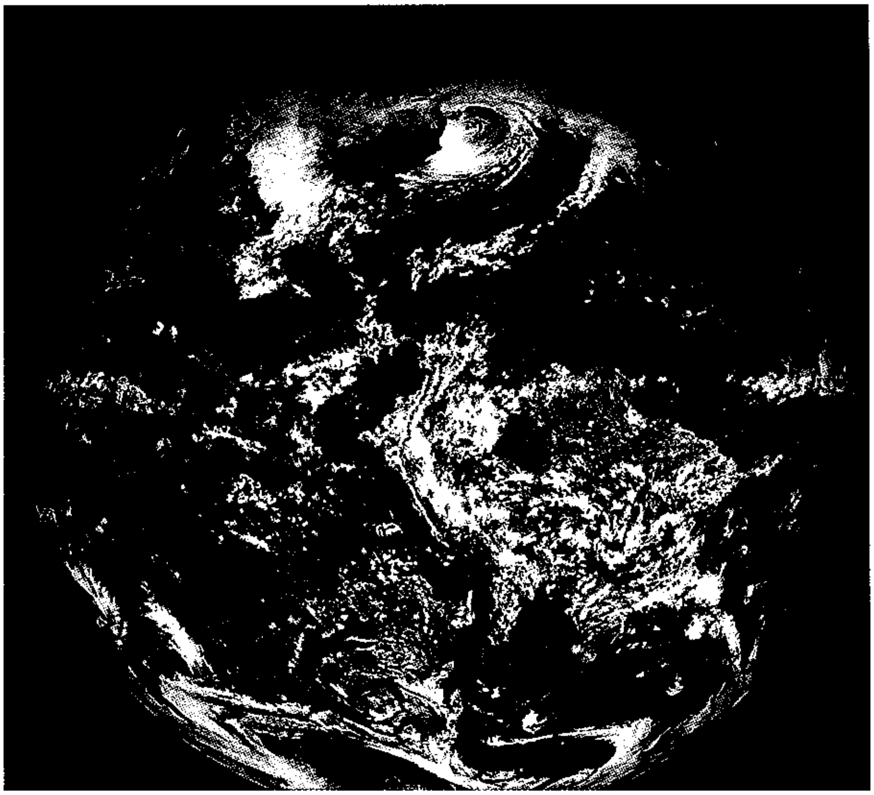
Above: A TIROS-N visible-image Tropical Mercator Projection. Data were acquired during daylight hours on April 9 and 10, 1979. Two tropical cyclones are shown in the southern Indian Ocean.

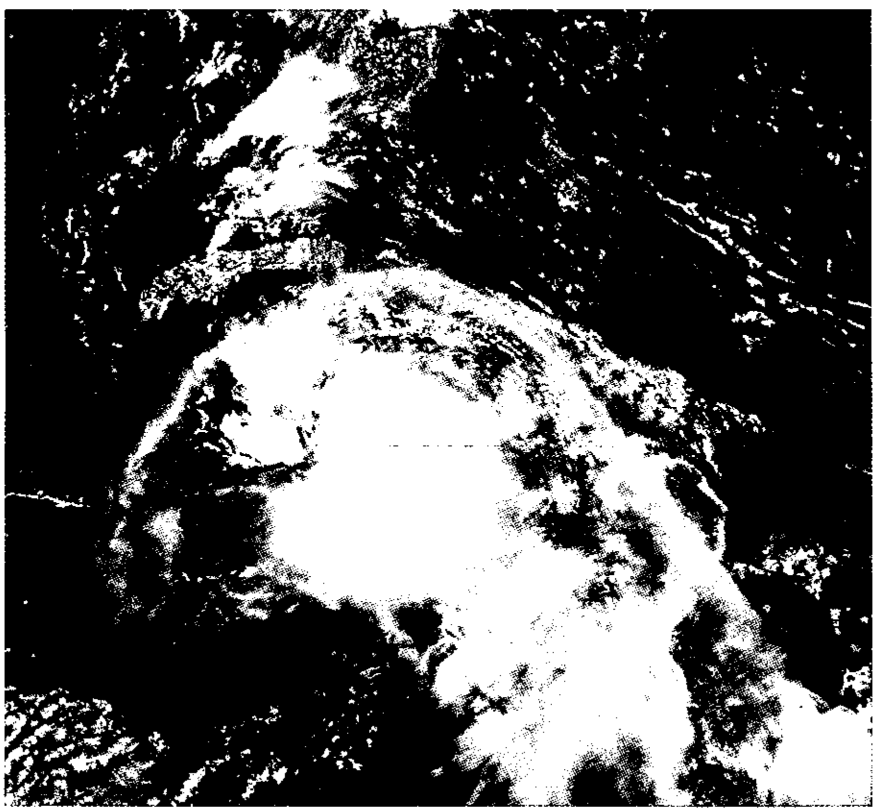
Right: A TIROS-N single-pass image, April 9, 1979. The tropical cyclone shown is one of the two shown in the Mercator Projection above.

characteristics to derive such parameters as windspeed and direction; sea-surface temperature; wave height, direction and speed; and the precise altitude of the spacecraft. The two "imaging" sensors included a microwave radar to "see" a ground swath 100 km in width with a resolution of approximately 25 meters day and night in all weather conditions; and a visible and infrared radiometer similar to those flown on previous satellites for feature identification (i.e., clouds, coastlines, etc.).

The second new satellite is NIMBUS-7. While NIMBUS-7 carries a host of sensors designed to obtain atmospheric and meteorological data, the SDSD will only archive and distribute data from one of its sensors—Coastal Zone Color Scanner (CZCS). The CZCS is designed primarily for oceanographic use. It is an imaging instrument with six very special channels in the visible and infrared regions of the spectrum. The CZCS is designed to detect and measure ocean color, suspended sediment and chlorophyll concentrations, and ocean pollutants.

A third generation, polar-orbiting operational environmental satellite, TIROS-N, was launched in October 1978. It is designed to provide improved data for meteorological warning and prediction, oceanic and hydrologic services, and space environmental monitoring. The onboard array of sensors consists of atmospheric sounders including microwave, infrared, and near-infrared; space environmental monitors; high-resolution infrared radiometers; and data collection and platform location systems. TIROS-N is to be followed by the launch of similar NOAA spacecraft (NOAA-A to G), starting with NOAA-A in mid-1979. This will continue the program begun in 1960 with the launch of TIROS-1.





Left: A full-disc visible image from GOES-East, noon EST, Feb. 7, 1978. The weather pattern off the U.S. East Coast represents a major snowstorm.

Below: A visible "sector" image from GOES-East, Sept. 19, 1975. The picture includes Cuba (center) and the southern tip of Florida (top). Hurricane Eloise is shown south of Cuba.

Data Holdings

Every few seconds around the clock, sensors aboard polar-orbiting and geostationary satellites scan a segment of our planet's surface, reduce it to line patterns "seen" at various light wavelengths, and transmit the image to receiving stations on Earth. These satellites, aloft in an environmental role only since 1960, are voluminous data producers and do much to improve the scope and precision of our day-to-day view of the Earth. But satellite images, like measured weather parameters, go into real-time forecasting and warning systems only once. This initial use, however, is only the beginning of their long lifetime of use. The effective management of these images from space in the form of archived, retrievable data is SDSD's mission. Each day hundreds of satellite images in a variety of forms—negatives, film loops, digital data on magnetic tape—are received for quality control and archival for ready retrieval for retrospective use. While the Archives in their present form were initiated only in late 1974, several million photographic images from the earliest meteorological satellites of the 1960's through the latest geostationary and polar-orbiting spacecraft are included in the files.

The types and quantities of data held are too numerous to completely describe in this brief article; however, the files contain photographic images, digital tapes, and derived products from all of these satellites. The photographic products include 35mm, 70mm, and 25cm negatives from both the polar-orbiters and the geostationary satellites.

The products from the geostationary satellites include full Earth disc images with ground resolutions of 4 to 8 km. In addition, smaller "sectors" (i.e., the eastern United States) are routinely produced. All of these products are obtained both during the daytime (both visible and infrared products) and at night (infrared only). Major land masses and latitude/longitude line are superimposed on the imagery to assist in location and identification.

The data from polar-orbiting satellites are available in several formats including an individual swath (12-14 per day), a North or South Polar Stereographic Projection (one per day), and a Mercator Projection (one per day).

Derived products include: *Mapped Snow-Covered River Basin Charts, Northern Hemisphere Snow and Ice Boundary Charts,* and *Global Operational Sea-Surface Temperature Computation Charts.* Film loops (16mm) are prepared from the geostationary satellites. These show a time-lapse "movie" of cloud motion. They are available in 6-, 12-, 24-, and 36-hour segments.

Digital tape products from most all of the satellites listed in Table 1 are available for varying periods of record.

Additional Information, Data Costs, and Ordering Procedures

In addition to maintaining satellite data and reproducing these data for retrospective users, SDSD employs data-processing specialists, meteorologists, and oceanographers to assist users in selecting the correct data for their specific investigation, produces special products as required, and will assist in analysis of the data, if requested. SDSD encourages all interested readers to contact the Division at the address or telephone number below for additional information.

Costs for each type of satellite data vary according to product type, size, and quantity. Generally, the cost for a 25cm (10" x 10") black and white contact print of satellite imagery, similar to those appearing in this article, is approximately $3.50 per copy. Digital tape products generally cost about $60 per tape. When ordering satellite data, furnish as much of the following information as possible.

- Name of satellite.
- Date, time, and geographical location of data needed.
- Type of data (visible or infrared).
- Format desired (print, transparency, film, or magnetic tape).
- How data will be used (to be sure that what you are requesting is what you need).
- Person or organization to be billed.
- Address where data should be sent and your telephone number.

For further information, contact:

Satellite Data Services Division (SDSD)
NOAA/EDIS/NCC
Room 606, World Weather Building
Washington, DC 20233
Tel.: (301) 763-8111

Should you be in the Washington, D.C. area, you are invited to stop by our office to see samples of our holdings and to tour our archive and reproduction facility. Call us for directions.

Satellites	Polar Orbiting	Geostationary	Dates of Archive Data Starting	Ending
TIROS (I through X)	X		4/1/60	4/2/66
ESSA (1,3,5,7,8,9)	X		2/4/66	11/16/72
ITOS/NOAA	X		10/31/66	Present
ATS (1,3)		X	1/1/67	9/2/74
DMSP	X		2/24/73	Present
SMS-1		X	6/27/74	1/7/76
SMS-2		X	3/10/75	Present
GOES-1		X	1/8/76	Present
GOES-2		X	6/16/78	Present
GOES-3		X	7/13/78	Present
SEASAT	X		7/7/78	10/10/78
NIMBUS-7	X		10/24/78	Present
TIROS-N	X		10/31/78	Present

EDIS satellite data holdings.

Satellite Acronyms

Spacecraft in the current NOAA series of polar-orbiting satellites are also called ITOS, for Improved TIROS Operational System. TIROS is an acronym for Television Infrared Observational Satellites, with TIROS-N being the third generation satellite in the series. ESSA is an acronym for the Environmental Science Services Administration (the forerunner of NOAA). ATS stands for Applications Technology Satellite; DMSP stands for Defense Meteorological Satellite Program; SMS stands for Synchronous Meteorological Satellite; GOES is an acronym for Geostationary Operational Environmental Satellite; and SEASAT stands for SEA Satellite.

Invitation to Make Meteorological Observations According to a Common Plan*

By Jacob Jurin

Translated by H. E. Landsberg

The following article was written in 1723. Its publication inspired some of the early meteorological observations taken in England and in the American colonies. The translation is fairly literal to preserve the ponderous neo-Latin phraseology of the original.

The changing conditions of the air we breathe, such as cold and heat as well as the fluctuations and changes of humidity, especially large and sudden ones which affect human health deserve assessment. The effort and labor involved is slight and through the ages this has been not only of medical interest but to all students of nature. In this century there have been ingenious instruments and philosophical equipment invented and carefully made, which make weight, heat, humidity and motion of the air obvious and permit accurate measurements of these conditions.

Distinguished men are as yet unable to ascertain the causes of these changes but love of learning and knowledge will entice them to investigate them where possible. To this end the recently invented instruments enable one to note diligently the weight, humidity, and heat [of air] in diaries; there also a wealth of information on weather and sky aspect can be added, that in philosophical articles elsewhere is rarely found.

A better way or methods for observing are not readily in evidence. Since there are many observers and also worthwhile, convenient places spread over the globe and also a variety of diaries, which correspond or diverge from each other, and since we certainly have already for many years a history of the atmosphere, its weather and breezes, its laws should become understood.

It has to be ascertained why in sudden severe storms notable wind shifts occur; we also need to learn by scientific observation, as explained above, where they originate, what path they take, the timing, and the area covered by these winds; thus one perhaps learns the origin, cause, and paths of winds. There are already a multitude of opinions before us and by pushing these studies with most reliable observations, will show which are true and which are false. It was the opinion of the very learned Edmund Halley that when the barometric mercury rose winds coverging from different regions would pile up air and, in contrast, if the mercury fell winds diverging from that place would carry air away, as if to exhaust it.

And thus we ask educated persons, who want to improve this branch of natural science, to collect and diligently note down in a diary, at least once or more often each day, the level of the barometer and thermometer, the wind direction and an estimate of its force, the sky aspect, and the amount of rain or snow fallen since the time of the previous observation. If convenient it would be worthwhile to add observations of the hygroscope and or the magnetic needle.

If a severe storm breaks out it would be useful to note accurately the times of beginning, increase, highest intensity, waning, and disappearance and to give the height of the barometer at these times.

Let me remind that the filled and ready barometer, commonly called open barometer, be skillfully used. The tube should be a quarter, or, perhaps, a third of an inch in diameter, as in narrow tubes the mercury will stick below the right level. The cistern, or mercury storage vessel should at least have a diameter eight or ten times that of the tube, such that with both rising and falling mercury level in the tube the level in the cistern should not vary or at least change as little as possible.

The closed barometer, which—if desired—can be transported, is manufactured with great care, and comparable to others, by the laudable artisan, Francis Hauksbee [1687-1763] who resides in that section of London generally known as Crane-Court; he also furnishes thermometers with exact graduations of his own scale and has been for many years well known among the learned for his excellent thermometers.

We request those who use thermometers of another manufacture to note in the thermometric diary,

*"Invitatio ad Observationes Meteorologicas communi consilio instituendas." A Jacob Jurin, M.D., Soc. Reg. Secr. & Colleg. Med. Lond. Socio. Philosophical Transactions: London, N.379 Sept.-Oct. 1723, 422-427.

the model, the degrees on the scale and the name of the maker. As the most appropriate site for the thermometer we recommend a room with northern exposure where the fireplace is never kindled, or at least very rarely.

In order to make the diaries readily comparable, it is advisable to have them all follow a specific format.

The first column should indicate the date and hour of observation; here we ask observers to use the Julian, or old-style, date in their diaries.

The second column should indicate the height of the mercury in the barometer above the mercury level in the cistern in inches, i.e., twelfths of London feet, and tenths thereof. The London feet are between 1/15 and 1/16 larger than Parisian feet [The exact ratio is 1/15.21 or 6.6% more].

The third column gives the height of the alcohol in the thermometer in degrees and tenths.

In the fourth the wind direction and force is noted; with the force indicated by the numbers 1,2,3,4, where 1 indicates the lightest air motion, which hardly moves the tree leaves, while 4 designates the most violent winds, and the numbers 2 and 3 wind strengths between those two; a 0 will designate complete calm.

The fifth shows sky aspect and a summary of the course of the weather.

The sixth and final one is for the height of rainfall or melted snow accumulated since the last observation, in London inches and tenths.

In order to facilitate these estimates a funnel with reservoir attached so that the water can run in, about 2 to 3 feet large, and a measuring cylinder with a ruler divided in inches and tenths are needed. The funnel should be so located that whatever wind blows, none of the rain should be intercepted by buildings and other obstacles. Also the reservoir should be properly closed so that no vapors can escape, save for only a narrow orifice to empty the funnel. Further, the diameter of the measuring cylinder should be given a tenth of the diameter of the funnel; in that case if water in the measuring cylinder is one inch high, the amount collected by the funnel and—as can be assumed to have fallen on the nearby ground—is one tenth of an inch and similarly for a decimal part of an inch.

Finally to be added are the monthly and annual means of the heights of the barometer and thermometer, as well as the sums of the rainfalls for the months and the entire year. Also, the means of all barometric daily observations and those made in the morning, the thermometer observations made in the early morning and the daily highest readings (which occur around 3 or 4 p.m.); with all sums to be divided by the number of days.

We ask that all who will engage in the above listed observations, whether in their entirety or partially, send copies of the diaries at the end of each year to the Secretaries of the Royal Society; so that they can be brought together with the diary for London arranged by the Royal Society and that a collection of these diaries be communicated in individual years in the Philosophical journals to the public.

Format of the Diary

Date & Hour 1723 Nov. old style		Height of Barometer in.tenths	Height of Thermometer degr.tenths	Wind	Weather	Rains in tenths
1.	8 a.m.	29.75	49.6	S.W.1	Sky cloud covered intermittent rain	0.035
	4 p.m.	29.56	47.3	S.W.2	occ. sunshine	0.043
2.	7 a.m.	29.24	48.5	S. 1	steady rain	0.725
3.	9 a.m.	29.95	49.7	N. 1	bright sky	0.032
	5 p.m.	30.4	49.2	N. 1	bright sky	0.000
4.	7 a.m.	29.9	47.0	S.W.1	few clouds	0.000
	10 a.m.	29.7	46.2	S.W.2	scattered showers	0.103
	12	29.4	45.0	S. 3	cloud cover increasing to overcast	0.050
	5 p.m.	28.8	46.0	S. 4	few clouds	0.000
	7 p.m.	28.9	48.0	S.W.2	raining	0.000
	9 p.m.	28.9	48.2	0	steady rain	0.305
5.	7 a.m.	29.7	53.4	N.E.1	clear, frost	0.250

Early Weather Observations in America

By
H.E. Landsberg

It is very likely that the first documented instrumental observations made in the British colonies in America were stimulated by Jurin's appeal. These observations are found in a manuscript diary by a "Mr. Feveryear" of Boston. The diary records daily barometric pressure and weather conditions from 1725 to 1726. No temperature or rainfall values are given. The diary is in the archives of the Royal Society and has never been published.

It is known that thermometers were sent to the New World as early as 1715, but no readings have yet been found for this early period. The earliest regular temperature observations were made in 1730/31 in Germantown, Pa., but these were stimulated by the Royal Astronomer, Christfried Kirch of Berlin and published by him in the Berlin Academy publications.

The best early instrumental observations in the American colonies were made by John Lining, a physician of Charleston, S.C., who emigrated from Scotland at the age of 22. Six years of data were published for the months starting with January 1738. Lining sent the material to Charles Pinkney, a later Chief of Justice of South Carolina, who was then in London. Lining's letters were forwarded to Jurin who published them in the *Philosophical Transactions* (Aldredge, 1940).

In 1742, Professor John Winthrop of Harvard College started four decades of excellent observations at Cambridge, Mass. Winthrop's data stayed in manuscript form and are preserved in the Archives of Harvard University.

Thermometer data and weather conditions were noted for four years from 1753 on by Richard Brooke, physician and surgeon in Maryland. They were communicated by Mr. Henry Baker to the Royal Society and are published in the *Philosophical Transactions* for 1759. Brooke also presented epidemiological information with the weather data. Although not indicated in the publication, we have identified Nottingham, Prince George's County, Md., as the locale of these observations.

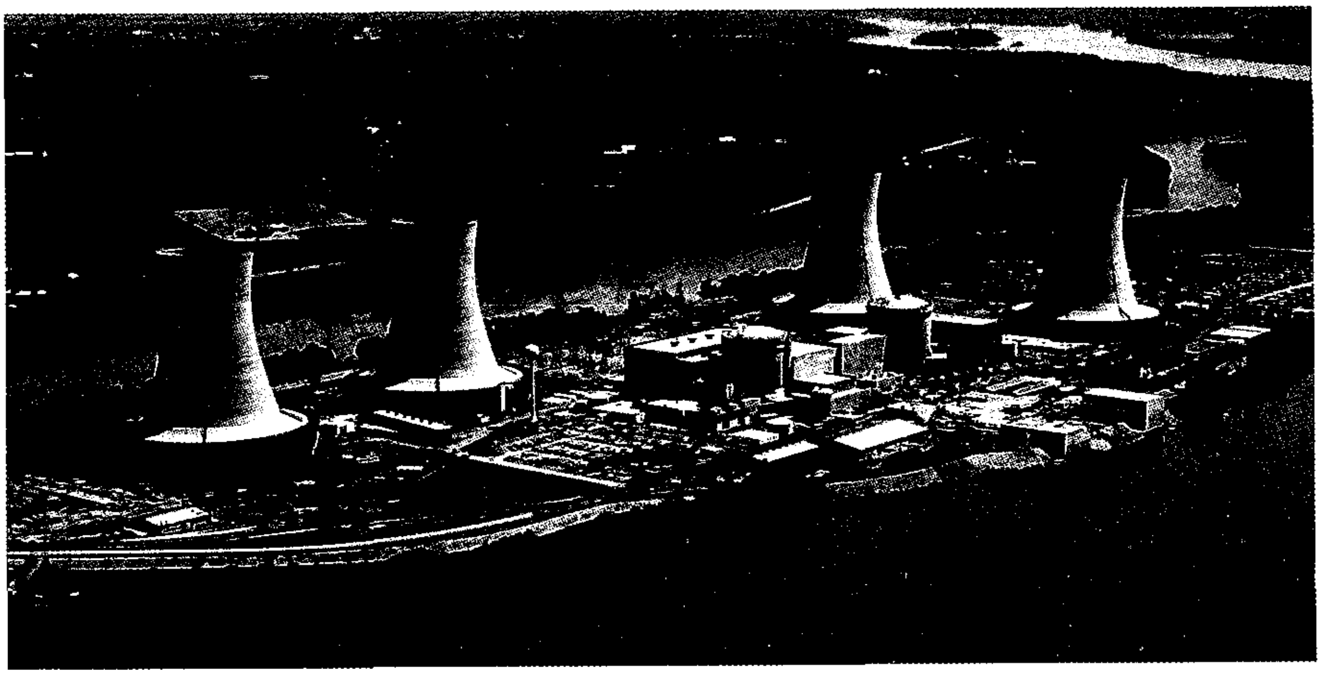
How much influence Jurin's call for action had on Lining, Winthrop, and Brooke is unknown. Their observations were made quite a few years after the appearance of Jurin's article. And in the cases of the two physicians, Lining and Brooke, it is quite clear that they were motivated by the prevailing hypothesis that epidemics of yellow fever and other diseases were promoted by weather conditions.

Relatively few observers outside England responded to Jurin's eloquent appeal. Perhaps the need to purchase instruments and their somewhat uncertain transport to distant points may have been factors. In any event, we must praise Jurin for his truly scientific attempt to check by observations a hypothesis of the cause of barometric variations. His instructions for raingage construction and precipitation observations were a pioneering venture. Less fortunate were his instructions to measure temperatures indoors, even in an unheated northern room.

It remains only to add that real network observations did not get started until the free distribution of calibrated instruments with detailed instruction by the Meteorological Society of the Palatinate in 1780 under the leadership of the Rev. Johann Jacob Hemmer, financed by the Prince Elector Karl Theodor. Not only were observations made regularly at 30 localities but, equally important, the data all were published (see *EDS*, February 1973) Malcolm Rigby; Ephemerides of Meteorological Society of the Palatinate; pp. 10-16).

Reference

Robert Croom Aldredge (1940); Weather Observers and Observations at Charleston, S.C., 1670-1871; Historical Appendix of the Year Book of the City of Charleston, pp. 190-257.



Three Mile Island Data Set

The National Climatic Center has received a set of low level atmospheric observations taken during the Three Mile Island nuclear powerplant incident. These data were gathered by the U.S. Air force's 6th Weather Squadron Mobile Unit in Middletown, Harrisburg International Airport, Pa.

There are 94 radio soundings and 13 pilot balloon observations in this set, taken from March 31 through April 18, 1979, with as many as 8 observations per day taken at 3-hour intervals from April 3 through April 9. The data collected include temperature, humidity, pressure, and wind direction and speed measurements made up to the 700 mb level (approximately 10,000 ft). The collection includes Adiabatic Charts, Form WBAN 31A, as well as Winds Aloft Computation Sheets, Form WBAN 20. Quality control and validation procedures have been completed and the forms will now be microfilmed.

Copies of the Adiabatic Charts can be provided for 25 cents each, or $23.50 for the entire set. Copies of Form WBAN 20 can be provided for 25 cents each, or $47 for the entire set. Copies of the microfilm also can be provided. Requests for these data should be directed to the National Climatic Center, Federal Building, Asheville, NC 28801, or telephone 704-258-2850 extension 683, (FTS 672-0683).

U.S. Radiometric Age Data Bank

Scientists frequently rely on radiometric techniques for age-dating rock and mineral samples to determine when geological events occurred. In an effort to organize the more than 100,000 radiometric age dates that have been published for samples in the United States, the U.S. Geological Survey (USGS) has established a computerized data base, known as the "Radiometric Age Data Bank (RADB)." The USGS is making these data available to the public through EDIS' National Geophysical and Solar-Terrestrial Data Center (NGSDC).

During the next several years, NGSDC will be receiving these data from USGS on a State-by-State basis, with semiannual updates. Approximately 1,000 records are available for localities in Michigan, Minnesota, Wisconsin, and Wyoming. Each data entry contains information on field acquisition, sample description, radiometric age, type of analysis, percentage of radiogenic materials found, name of laboratory, and age comments.

The data may be requested in digital form on magnetic tape, as computer printout, or as a map of data locations. Inquiries about this data bank should be directed to John Kinsfather, NGSDC, EDIS/NOAA, Boulder, CO 80303. Telephone: (303) 499-1000, ext. 6404 (FTS 323-6404).

Gus Shumbera of EDIS and Wayne Darnell and Morris Tepper of NASA at the climate data management workshop.
Photo: Josh Holland

Climate Data Management Workshop

NOAA's National Climate Program Office (NCPO) and EDIS jointly sponsored a Climate Dat Management Workshop, May 8-11, 1979. The Workshop goals were to: (1) begin development of a climate data inventory, (2) assess the status of existing climate data, and (3) outline steps to enhance their accessibility and utility.

Approximately 80 scientists and data managers from the United States and Canada participated. Working groups considered problems in basic atmospheric, hydrologic, oceanic, radiation, chemistry, physics, proxy, noninstrumented, geophysical, land use and assessment, and inventory data and information.

A pre-workshop survey of existing data sets in the U.S. and Canada resulted in approximately 900 replies. These replies and other material were used by the working groups to make recommendations for actions to improve data and information services for the National Climate Program.

The workshop proceedings and reports are scheduled for publication this summer.

Canadian Publication On Great Lakes Oil Spills

The Environmental Protection Service of Canada recently released a 252-page report prepared by E. H. Owens of Woodward-Clyde Consultants (Victoria, B.C.) entitled, *The Canadian Great Lakes: Coastal Environments and the Cleanup of Oil Spills.* Although the coasts of the Canadian Great Lakes make up less than 5 percent of Canada's total coastline, the region is the country's most densely populated.

The report focuses on the protection of the Great Lakes shorelines from spilled oil and the cleanup of oiled shorelines. Because of the density of shipping, the Lakes are high risk areas for spills. In the report, the Great Lakes system is initially divided into 32 coastal environments on the basis of shore-zone sediment transport systems. Following a brief definition and description of each environment, the author reviews shoreline and process characteristics relevant to oil spill response operations to provide a framework to assess the expected impact and persistence of stranded oil in a particular environment.

The report deals with shoreline sensitivity or vulnerability to oil spills in terms of normal shore-zone processes and ecology, man's use of the shore zone in Canada's densest population area, and the impact of cleanup operations. It then presents criteria for the determination of onshore and offshore protection priorities, the selection of effective shoreline protection methods, and cleanup techniques for particular shoreline types.

The report (EPS 3-EC-79-2) can be obtained by writing the Publications Coordinator, Environmental Impact Control Directorate, Department of Environment, Ottawa, Ontario, Canada, K1A 0C8.

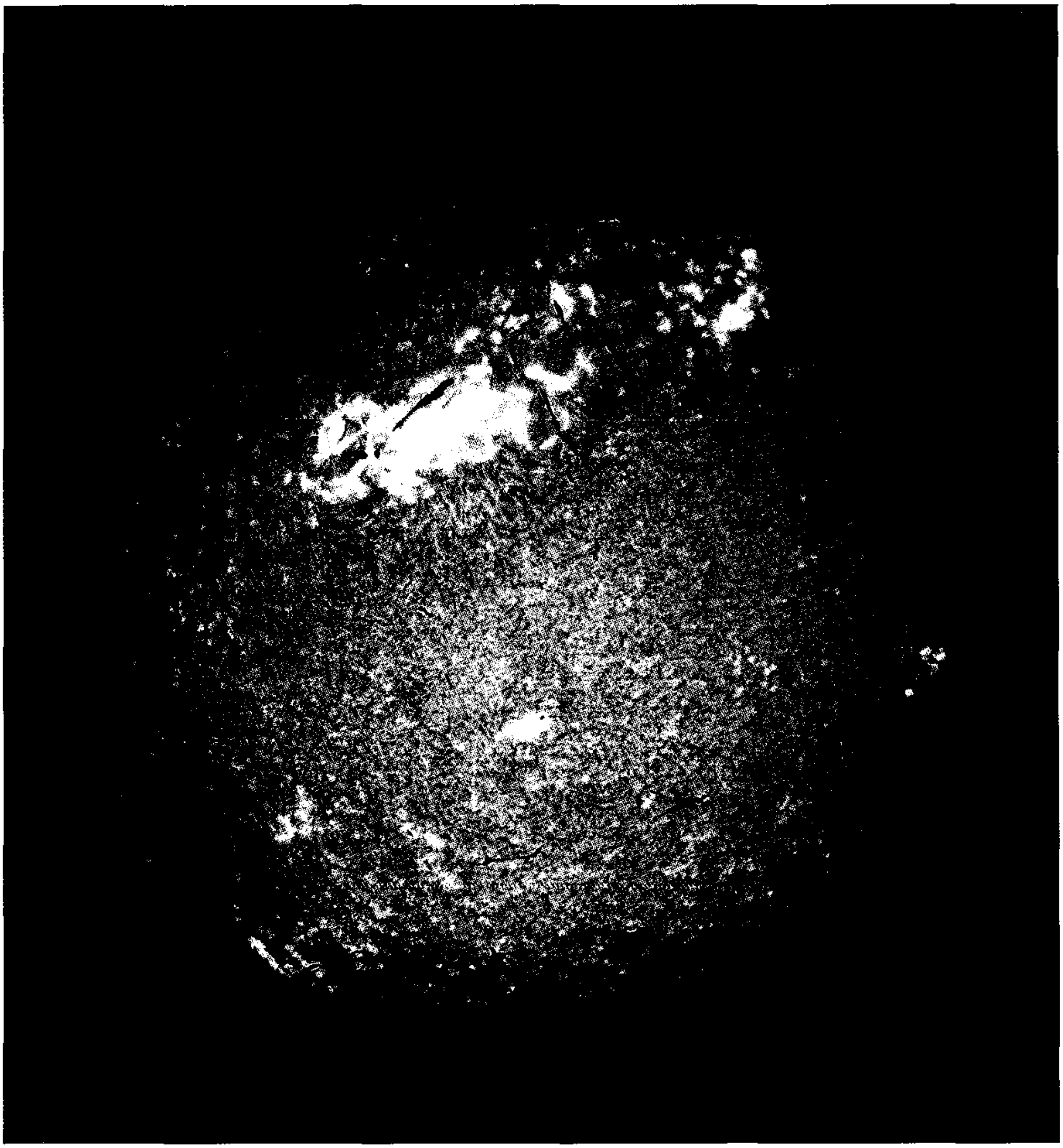
Solar Observing Optical Network Data

NGSDC is now disseminating Solar Observing Optical Network (SOON) data from three U.S. Air Force Air Weather Service observatories (Holloman, Palehua, and Ramey). The data formats are novel. While 35-mm film data are also available, the basic data are quantative brightness-area telescope scans of selected solar regions, usually taken at intervals of less than 1 minute and recorded on magnetic tape. These data can be combined into a 3-dimensional plot to show the detailed time-history of a solar flare. Other possible products might include the time variation of the area of maximum brightness and energy calculations.

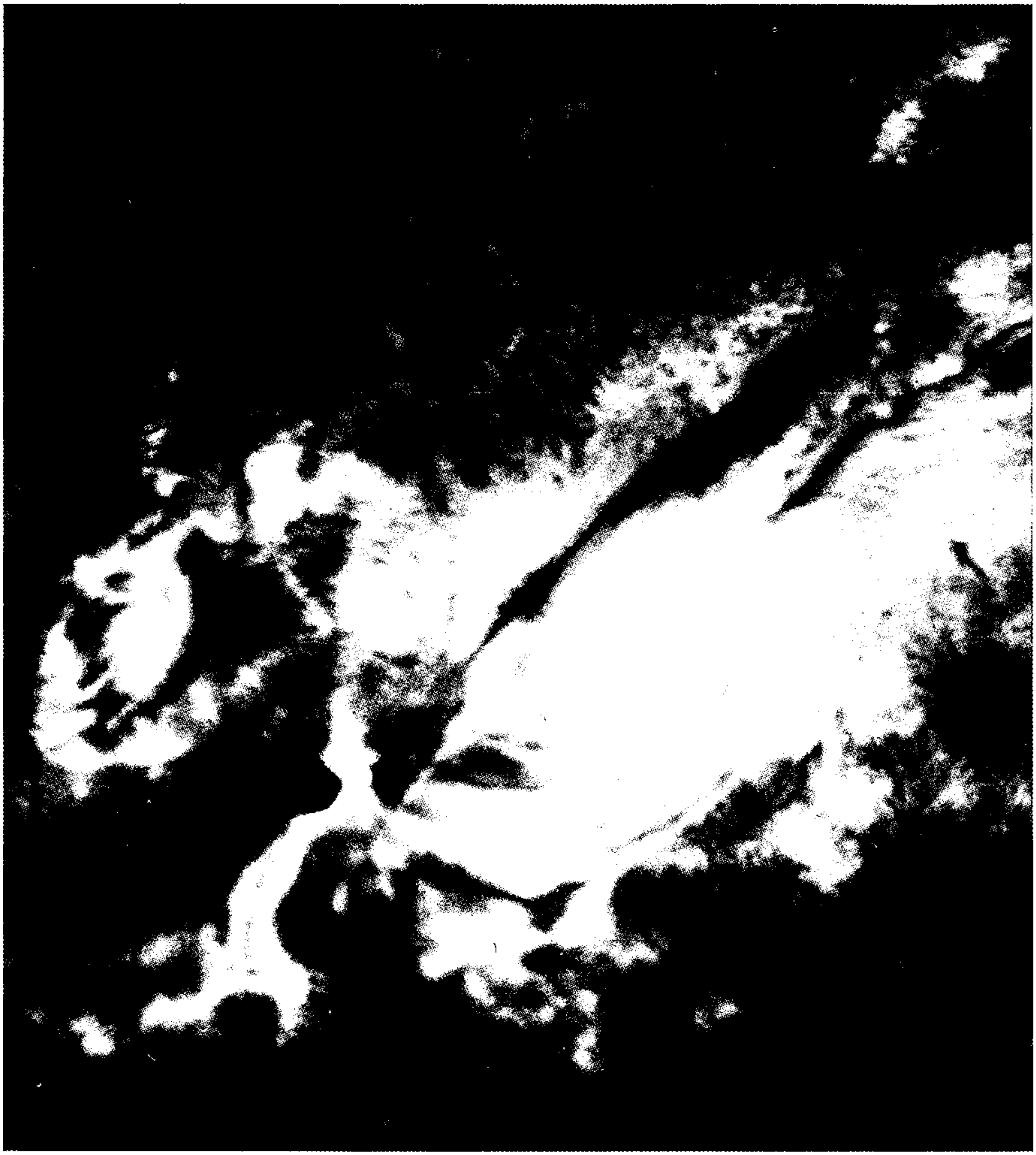
Digital H-alpha brightness-area data are the major data product from a SOON telescope. These data present brightness versus area information from flare-producing regions on the Sun. The brightness ranges from dark shades, indicating relatively cool absorbing plasma, to very bright shades, indicating hot emitting plasma or flares. The automated SOON telescope system allows brightness-area information to be collected from as many as six regions per 5-second interval. The system is usually programed to collect 1 to 3 brightness-area scans per minute from each selected region.

The data are archived chronologically for each observing station. The maximum possible daytime coverage for the three stations is from about 11 UT on one day to 4 UT the following day in winter, and 10 UT on one day to 5 UT the following day in summer. For the Holloman observing site (254E longitude) the starting date is November 1977, for Palehua (202E) December 1977, and for Ramey (293E) February 1978.

The data reach the Data Center about 6 months after observation. The observing programs at each observatory are determined by the duty observer depending on the level and type of activity and the needs of real-time services. There is about one archival magnetic tape per observatory month for normal observations; the number is about doubled when additional offline observations are made, as at Holloman. There also are about 700 feet of 35-mm photographic film each observatory month, archived in strip sequences covering one to a few days. These se-



The Sun seen through a monochromatic filter in red light. This picture was taken at the SOON Observatory at Ramey AFB, Puerto Rico. A flare is in progress (bright area). A magnified view of the flare area appears overleaf.



An enlargement of the flare area shown on the previous page. The two small, dark circular areas are sunspots; each is approximately the size of Earth. There is a very strong magnetic field gradient in the area immediately between the sunspots. The long black feature is a filament; it marks the approximate location of a magnetically neutral line that bisects the region.

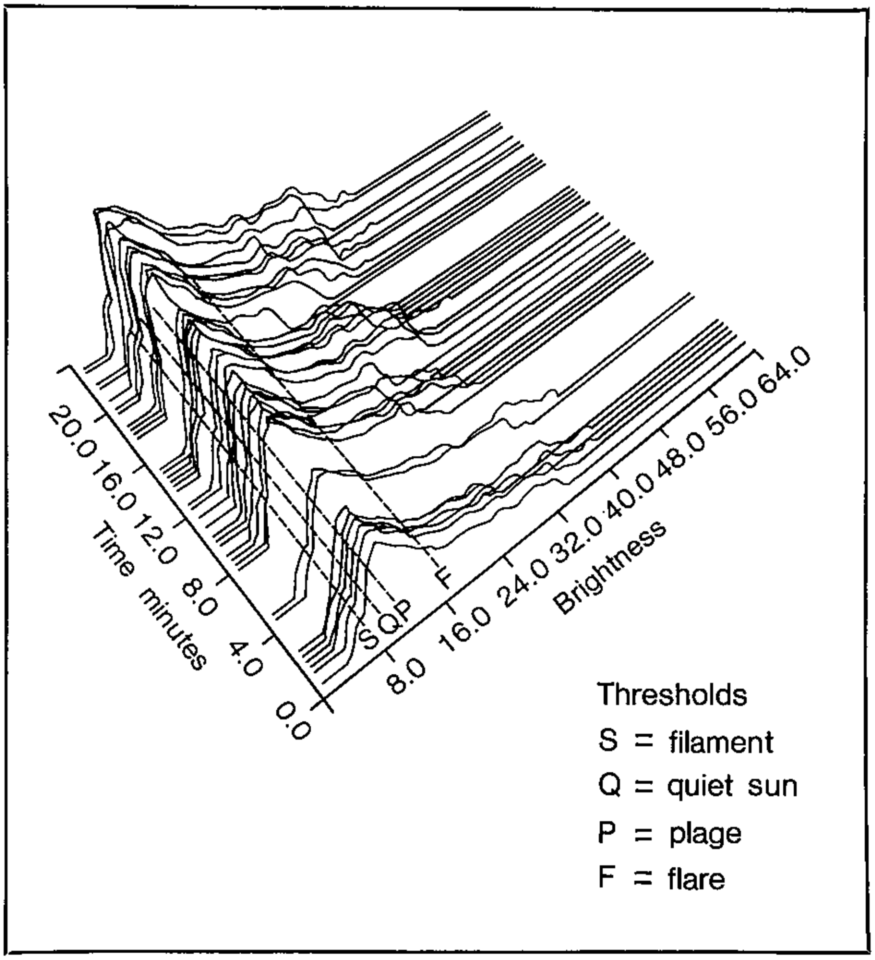
quences include whole disk images about once every 1 to 5 minutes and all regions of activity on the observing program at frequent intervals.

At this point in the solar cycle, the data comprise about 60,000 digital brightness-area scans per observatory per month. Also on the tapes are logs of the photographic images taken and a teletype record of the real-time reports that can serve as a rough index of the observed activity. NGSDC archives these data on 1600-bpi magnetic tapes in packed format.

Major users may want all ditigal information and photographic images in order to do their own data analysis and display. Many may want data products prepared by the NGSDC staff for selected flares. Some may want to obtain data on visits to the Center, using the NGSDC computer and data display facilities. And some users may want only the photographic correlation data.

Since charges for these products and services vary, users should consult the Data Center staff before ordering data. Routine SOON data inquiries should be addressed to: Helen Coffey, NOAA/EDIS, D63, Boulder, CO 80303 U.S.A., Telephone: (303) 499-1000, ext. 6467; FTS 323-6467.

Requests concerning data products or technical information should be directed to: Ronald W. Buhmann, NOAA/EDIS, D64, Boulder, CO 80303, U.S.A., Telephone: (303) 499-1000, ext. 6501; FTS 323-6501.



A 3-dimensional plot showing the detailed time-history of a solar flare (multiple scans) seen from the Holloman observatory.

Upper Wind Data for Airship Design

The National Climatic Center has prepared special stratospheric wind analyses for the NASA Wallops Flight Center. NASA plans to use the analyses in developing engineering specifications for construction of a lighter-than-air, high altitude, powered platform capable of carrying a 500- to 1,000-pound payload of telecommunications and remote-sensing equipment. The analyses describe the upper wind climatology by season for three areas: the Continental United States; the Pacific area from Alaska to the Sea of Japan; and the Norwegian, North, and Mediterranean Seas.

The analyses include maps for four to eight standard pressure levels within the 100 to 25 mb zone (16-25 km) displaying iospleths of average winds; isopleths of percent frequencies of wind speeds less than 30, 40, 50, and 75 knots, with plots of 95% and 99% confidence limits; and 16-point wind roses showing mean speed by direction for selected stations. Also produced for selected stations were seasonal wind profiles (surface to 10 mbs) that include scalar mean speed, the one standard deviation confidence band, and the 95 and 99 percentiles values. There are 448 maps and 170 profiles in the analysis package.

World Volcano Maps

World Data Center-A for Solid-Earth Geophysics recently published a map, *Volcanoes of the World*, for the International Association of Volcanology and Chemistry of the Earth's Interior. The map, a contribution to the International Geodynamics Project, was compiled by Leslie D. Morris and Herbert Meyers of EDIS' National Geophysical and Solar-Terrestrial Data Center, and Tom Simkin of the Smithsonian Institution. It is a companion to *Volcanoes of the World: A Regional Directory, Gazeteer and Chronology of Volcanism During the Last 12,000 Years* by Tom Simkin, Lee Siebert, Lindsay McClelland, William G. Melson and David Bridge, 1979, Smithsonian Institution, Washington, D.C.

The map shows the volcanoes known or believed to have erupted during the last 12,000 years (Holocene epoch). The names of about 700 volcanoes with historic or dated eruptions are shown on the map. The volcanoes are shown by colored symbols to indicate frequency of eruption and date of the last eruption. Earthquake epicenters also are shown for magnitude 5.5 or greater earthquakes, 1963-1977.

The map is in six colors, and measures approximately 57 by 36 inches. Copies are available, either rolled or folded, for $2.50 per map, from NOAA/National Ocean Survey, Distribution Division, C44, Riverdale, MD 20840. Data from the map are available in digital or listing form from the World Data Center-A for Solid-Earth Geophysics.

Regional Seismicity Maps

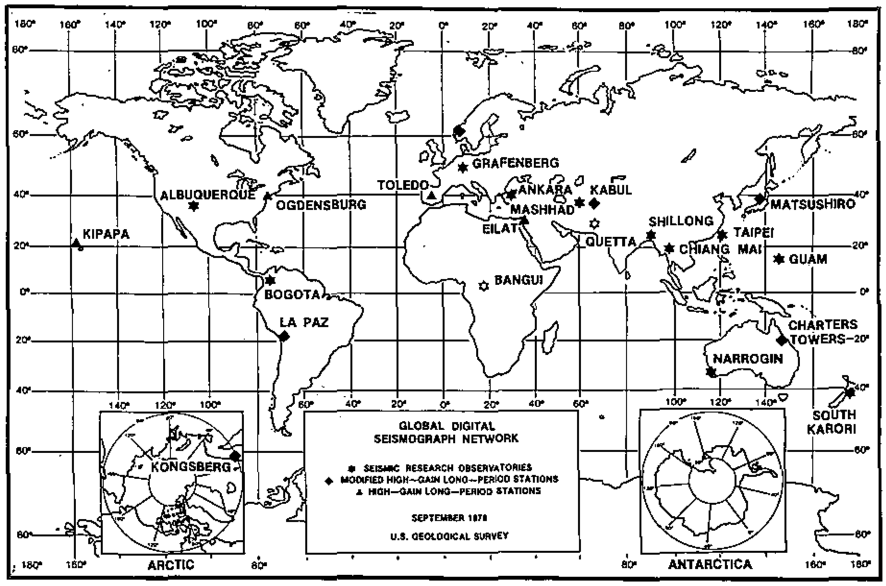
The National Geophysical and Solar-Terrestrial Data Center, in cooperation with the U.S. Geological Survey (USGS), is producing a new edition of the world set of regional seismicity maps. The new edition will consist of 16 regional maps in five colors. The maps will indicate both the depth and magnitude of earthquake epicenters, and will show all epicenters identified by the USGS preliminary determination of epicenters program for 1964 through 1977. In addition, for the period 1900 through 1977, all earthquakes with surface wave magnitudes of 7.5 or greater and all earthquakes that resulted in significant casualties or damage will be identified. Data for these large and destructive earthquakes will be presented in tabular form. Locations of active volcanoes will also be shown.

The Mid-America map (covering 5°S to 35°N and 55°W to 125°W), the first map in this new series, will be released this year. Maps for the other 15 regions will be released as they are printed during the next several years.

Special Worldwide Seismic Data Available

EDIS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) now archives and disseminates analog and digital data from the Seismic Research Observatory (SRO), Abbreviated Seismic Research Observatory (ASRO), and High-Gain, Long-Period (HGLP) seismic networks. These data are available as digital network-day data, computer plots, digital event tapes, punched cards, and analog copies.

Beginning in 1969, a network of digital and analog-recording long-period seismographs (HGLP) was established in which the instruments are packaged in environmentally controlled containers that allowed them to operate at relatively high gain. Subsequently, new instrumentation permitted the development of a network of long- and short-period seismometers (SRO), which was installed in boreholes 100m deep. In 1975, installation of the SRO stations was begun by the U.S. Geological Survey's Albuquerque Seisomological Laboratory. The stations continuously record three components of long-period data in analog and digital form. The



Special seismic networks. The "modified" station category corresponds to the ASRO networks discussed in the text.

recording packages of some of the HGLP instruments were later upgraded to match the SRO configuration, and were designated ASRO stations, but these seismometers are not operated in boreholes.

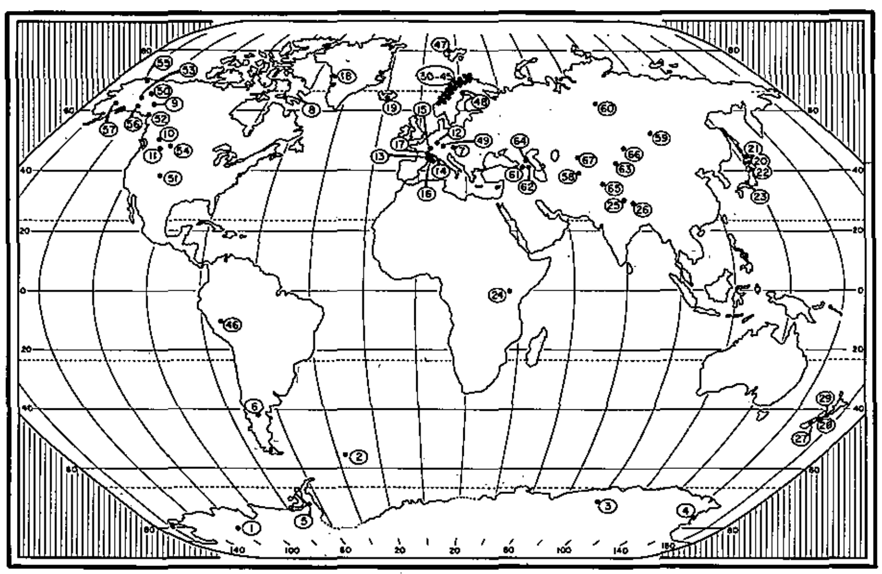
The SRO-ASRO-HGLP digital data are available for network-days. Usually 10 or more stations will submit data. Generally, there will be one or two tapes for each network-day that contain available SRO, ASRO, and HGLP data.

Information on data availability, formats, and changes can be obtained from the National Geophysical and Solar-Terrestrial Data Center, NOAA/EDIS, Code D622, Boulder, CO 80303. Telephone: (303) 499-1000, ext. 6591 (FTS 323-6591).

New Glaciological Data Publications

The World Data Center-A for Glaciology (Snow and Ice) recently published two issues in its *Glaciology Data* (GD) series. *GD-3, World Data Center-A Activities*, presents an overview of current activities of the data center, including a description of the bibliographic data file project and the results of a user survey distributed with GD-1. This issue also presents a preliminary report on an ongoing inventory study of ice cores. Another significant article included is "An Outline of Glaciological Data Categories." This concerns data types suitable for submission to the World Data Center for Glaciology.

The results of a survey of glaciological field stations compiled by Robert Vivian, Institut de Geographie Alpine, Grenoble, France, are published in *GD-4, Glaciological Field Stations,* issued in two parts. The questionnaire was developed by Professor Vivian during his stay as visiting scientist with the WDC in 1977. Sixty-seven stations in 18 countries are described in terms of their facilities, access, and research programs. Publication lists are also provided. While not exhaustive, the survey results provide a guide to a large number of facilities and organizations involved in field research.



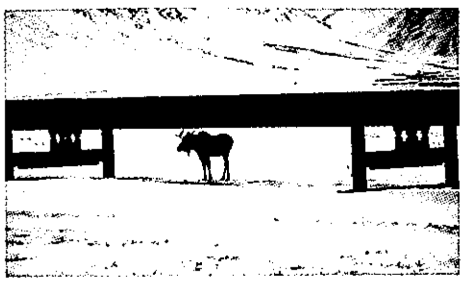
Global distribution of glaciological field stations surveyed.

Copies of the two publications may be obtained free of charge from: World Data Center-A for Glaciology (Snow and Ice), Institute of Arctic and Alpine Research, University of Colorado, Boulder, CO 80309.

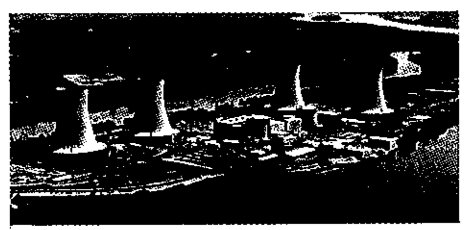
U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmosphere Administration
Environmental Data and Information Service
EDIS Magazine
Washington, D.C. 20235

OFFICIAL BUSINESS
Penalty for Private Use, $300

Postage and Fees Paid
U.S. Department of Commerce
COM-210
Controlled Circulation Rate



In this issue: A review of EDIS activities (p. 3); meteorology and energy (p. 9); environmental satellite data products and services (p. 15); and atmospheric observations taken during the Three Mile Island incident (p. 28).



EDIS

Environmental Data and
Information Service
Volume 10, Number 5
September 1979

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EDIS

***Cover:** In Uganda wood is converted to charcoal for use as an energy source. The global energy crisis involves more than fossil fuels. See the lead article.*
FAO Photo

EDIS is designed to inform Environmental Data and Information Service (EDIS) cooperators, colleagues, and contributors of recent developments in EDIS programs and services and in the general field of scientific data and information management. EDIS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, and Center for Environmental Assessment Services. In addition, under agreement with the National Academy of Sciences, EDIS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology (Snow and Ice).

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.

EDIS (ISSN 0190-3365) is published bimonthly by the Environmental Data and Information Service, NOAA, Page Building 2, Room 533, 3300 Whitehaven St. N.W., Washington, D.C. 20235. For address changes, cancellation, or information write to the Editor at this address. Controlled Circulation Postage is paid to the Finance Department, USPS, Wash., D.C. 20260.

U.S. DEPARTMENT OF COMMERCE
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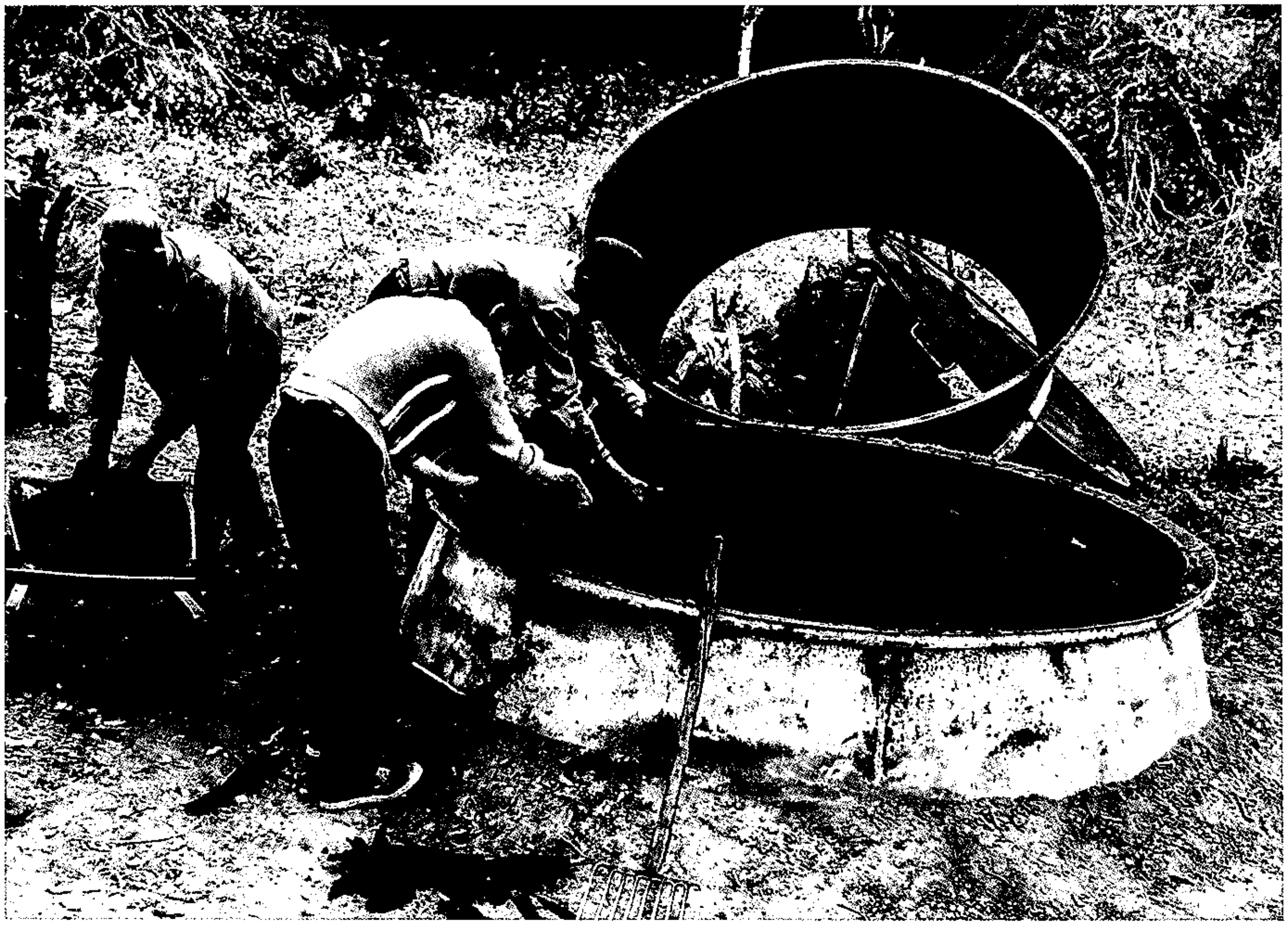
A Different Perspective on the Energy Crisis

These women must travel several miles to gather the firewood they need.
World Food Program photo by F. Hattioli



Forestry workers in Tunisia open an oven to extract charcoal made from oak trees.

FAO Photo

The following is condensed from a United Nations Environment Program press release issued in connection with an International Workshop on Energy and Environment held in Nairobi, Kenya, East Africa, May 7-10, 1979.

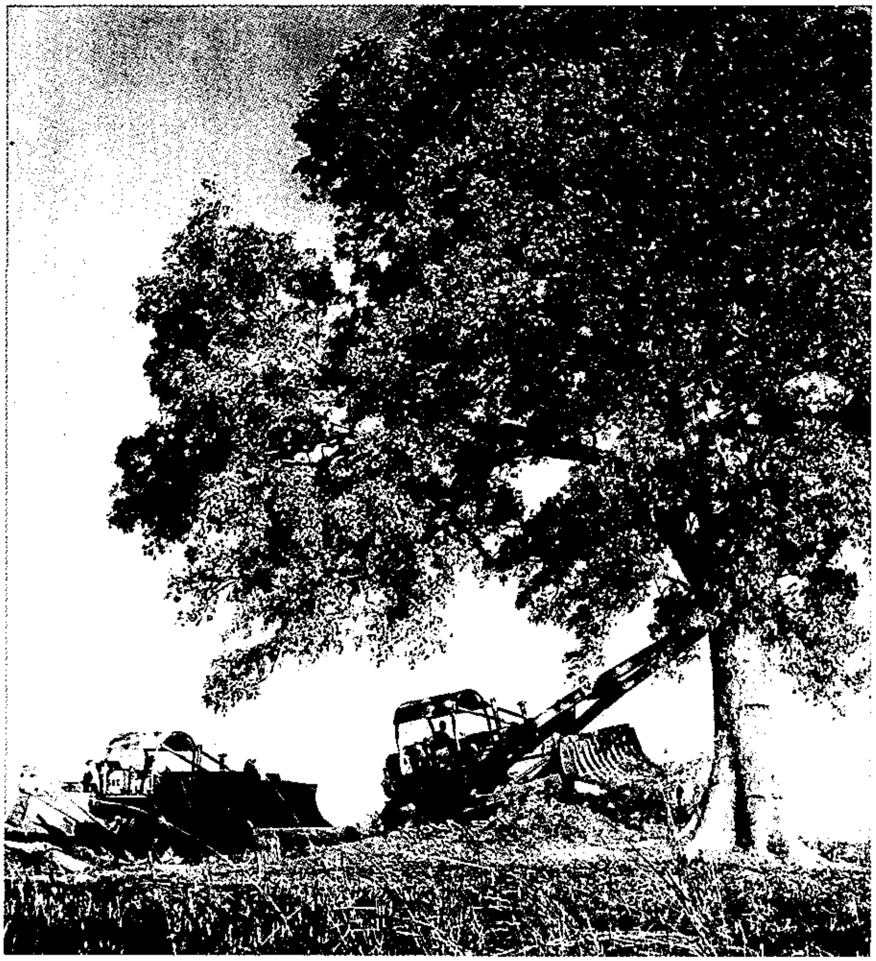
Studies note that developing countries at present use only up to 10 percent of the world's annual supply of commercial energy (principally fossil fuels and hydropower) with the remaining 90 percent going to industrialized countries.

Furthermore, the use of noncommercial energy (principally wood fuel, charcoal, and dung) is virtually negligible in the industrialized world while in the developing countries it counts for at least as much again as the commercial energy use. In many of these countries noncommercial energy constitutes up to three times as much.

The growth of additional requirements in this informal sector is expected to be just as dramatic as the commercial energy growth in the Third World. This means that although the basic energy needs as seen from the 1980's picture will still be the same in both developed and developing countries, on top of this there will be an extra annual burden to be borne. This extra energy burden will be roughly similar in both developed and developing nations by the year 2000.

If this is the case, the implications for the Third World are very serious. Developing nations already spend a disproportionately high percentage of their gross domestic product (GDP) on oil imports (frequently 10 to 20 percent compared with 3 to 5 percent in industrialized countries).

The problem of finding currency to pay for the very large amounts of additional energy will be overwhelming, particularly in the present oil-price situation in a hardening global market, which is already forcing some Third World



Tractors and bulldozers clear trees to plant rice. Many countries are forced to decide between food and fuel supplies.

FAO Photo

energy users back onto charcoal and wood.

In the noncommercial sector, the existing rate of depletion of forests and woodlands, especially in the tropical regions of the world, casts grave doubts on how sustainable a fuel-wood supply will be in the future. This situation is well illustrated in parts of East Africa.

Like several other East African nations, approximately 70 percent of Kenya's total energy consumption is presently provided by wood fuels. Over the coming decades, a 3.5 percent annual growth in population will increase the fuelwood demand among subsistence and small farmers to levels well beyond the potential supplies in most provinces. Most of the reduction in wood supplies will result directly from land placed under arable agriculture. However, the additional energy demand of the increased population will further accelerate the depletion of available fuelwood supplies to the extent that by the mid-1990's most sources will be confined to the low rainfall rangelands which cover 70 percent of Kenya.

Here the growth production of wood per unit area is so low and the distances from the centers of consumption so great that the economic feasibility of wood fuel is dubious. The long distances involved to gather fuel-wood will mean an increased conversion to charcoal to reduce the transport costs of fuel.

The existing forest plantation program is unlikely to play an important role in the future of Kenya's energy demand, even if it were considerably increased in scale.

In common with other parts of East Africa, most of Kenya's wood energy is provided by the higher rainfall areas which cover 30 percent of its land surface. The demand for land is already acute, and within the next two decades agriculture will occupy the remaining areas within the cultivable zones, thus displacing most of the fuelwood areas.

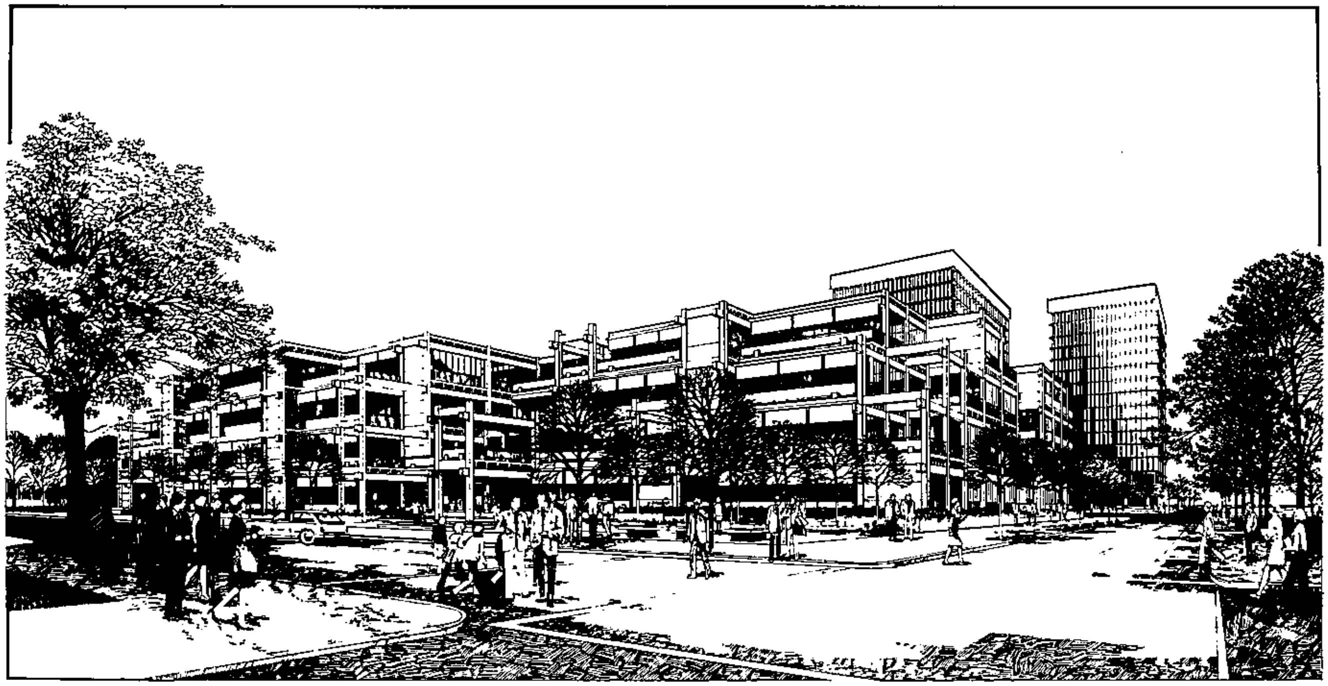
This situation is a regional problem and is repeated throughout East Africa. The major role that wood fuels play in the energy profile of East Africa, and will continue to play during the coming decades, necessitates an urgent review of energy policies research and development. A conflict over land for agricultural production and energy supply is inevitable and already acute in some areas; it will probably become a regional dilemma within two decades.

Woodlands and bushlands progressively further from the agricultural and urban areas will steadily be stripped of cover unless alternative solutions are urgently sought. Until this is done, the effect of higher erosion rates on the productivity of the agricultural sector and on the silting up of hydroelectric dams, and hence on electricity output, will be significant. Vigorous agro-forestry programs are also urgently needed.

Climate and Architecture*

By Kevin W. Green

Earlier this year, the energy crisis brought weather experts and building designers together for the first time in nearly 30 years. Their mutual goal: Buildings that save energy by responding to the dynamics of climate.



Courtesy: Office of the California State Architect.

"Weather scientists to tackle building problems at parley here." That was the headline 29 years ago, when 30 of the nation's leading "weather scientists, building technologists, and architects" converged on Washington, D.C., for the first-federally sponsored conference ever held on climate and architecture. And the last.

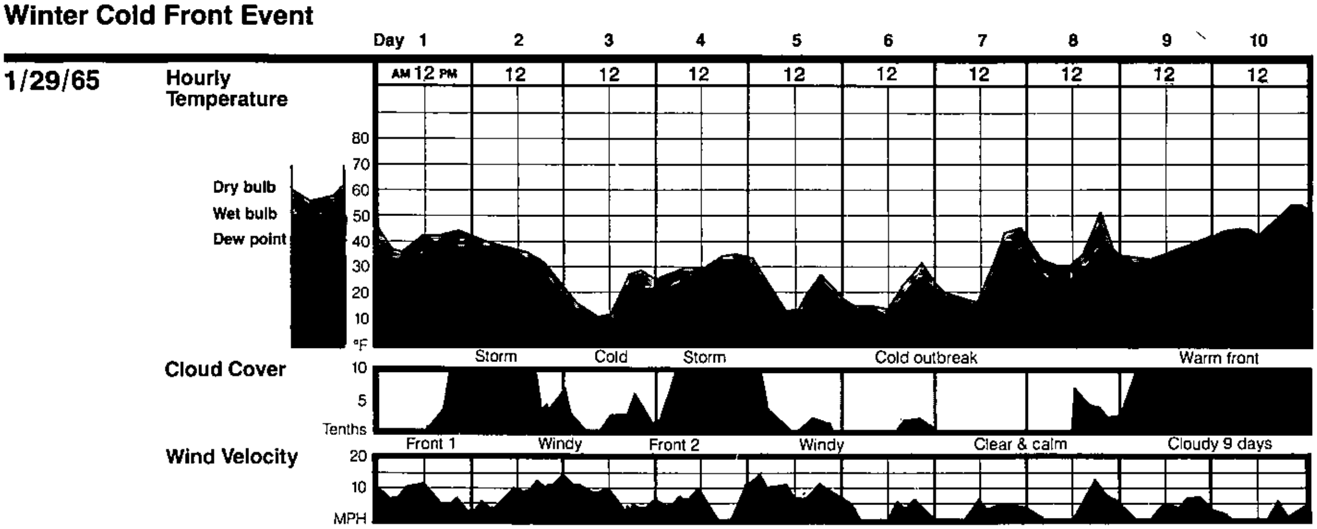
The National Academy of Sciences' Building Research Advisory Board (BRAB) sponsored that weekend gathering in 1950, and despite a general slant toward engineering the conference reflected a burgeoning interest in climate's influence on architectural design.

An architects' roundtable on the first evening was opened by James Marston Fitch, then architectural editor for House Beautiful. Fitch talked about the nation's first significant study of climate and design, completed only months earlier under the joint sponsorship of House Beautiful and the American Institute of Architects. After 27 months of research, House Beautiful was beginning to publish the results of the project, and for close to two years, from October, 1949 to June, 1951, virtually every issue of the magazine featured articles on climatic variations in the U.S., homes designed to take advantage of climate, and techniques for controlling climate "inside and outside the home." House Beautiful went on to publish the material in book form; AIA serialized it in the AIA Bulletin. Within three years, Progressive Architecture joined the movement, publishing Jeffrey Ellis Aronin's *Climate and Architecture,* calling it "the first book to *do* something about the weather."

And that, suddenly was that. By 1953, the "technological miracles" to which House Beautiful had given a nod in its climate book—better construction technology, better conditioning systems, and,

*Reprinted from Research & Design, published quarterly by the American Institute of Architects Research Corporation.

Winter Cold Front Event



A graphic recommended by the conferees shows the effects of representative weather sequences on Chattanooga, Tenn.
Art: Research and Design

most important, cheap and plentiful energy—were firmly charting the course of American architecture. Climate consciousness was out; curtain walls, inoperable windows, and airconditioning were in, and thus, by and large, has it been ever since.

Until this year. In February, more than 50 architects, engineers, homebuilders, and climatologists convened again in Washington for the first climate and architecture conference to be held since the BRAB event 29 years ago. Like their predecessors, these conferees were here at the behest of federal sponsors. The National Research Council (NRC) has been directed by Congress to develop a national research agenda linking climate and energy. The Department of Energy (DOE) and the National Oceanic and Atmospheric Administration (NOAA), where the nation's energy and climate research efforts are centered, called the conference to itemize the needs of the design community for that agenda.

DOE is no stranger to the influences of climate on buildings and building design. In the recent research for the nation's approaching building energy performance standards, co-sponsored by DOE with the Department of Housing and Urban Development, architects cut energy consumption nearly in half by redesigning their buildings to adapt to local climatic conditions. One of the reasons the architects—together with engineers and homebuilders participating in the project—achieved such energy savings was that they approached climate as the first factor to be evaluated in their design problems. And their evaluations were made in terms of weighing climatic assets and climatic liabilities.

Four key elements of climate exert influence on buildings: temperature, humidity, Sun, and wind. Depending on where a building is located and whether the comfort of its users depends more heavily on heating or cooling, each element may be either an asset to both comfort and energy consumption, or a liability.

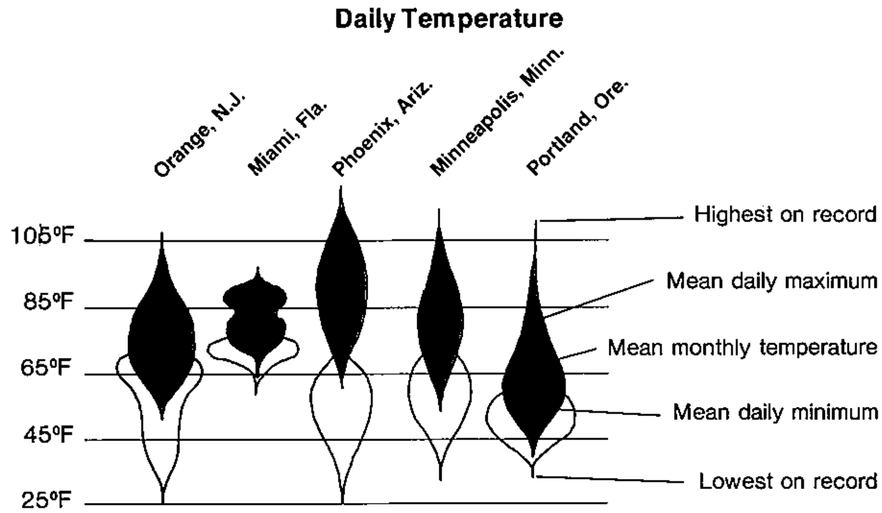
The liabilities crop up when those elements make seasonal climatic conditions less tolerable for humans. Temperature is a liability when it is consistently too hot or too cold; wind, when it adds a wind chill factor to already chilled temperatures, or when, in hot, dry climates, it causes dehydration and overheating; humidity is a liability when it's so high the body can no longer sweat, and evaporative cooling is prevented; sun, a liability when it overheats already tropical conditions.

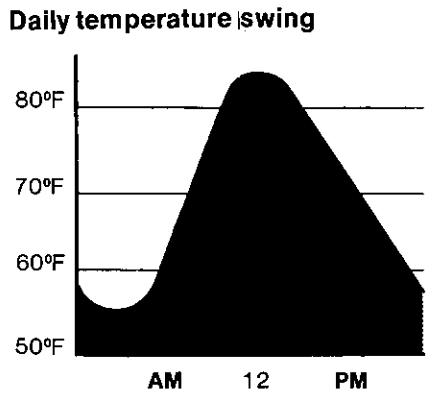
The same elements become climatic assets when they ease extreme seasonal conditions. Temperature becomes an asset when its diurnal (day to night) swings are large enough that the thermal-lag inherent in massive construction can flatten out the diurnal curve, keeping days cooler and nights warmer. Wind becomes an asset in hot, humid climates, when natural ventilation can evaporate perspiration and dispel humidity. Humidity itself is an asset in dry climates; adding moisture to the air cools temperatures perceptibly. And in cold climates, the sun's energy can be trapped to provide heat.

Every location has its own climate, its own set of assets and liabilities. The differences from point to point within a given region are often slight, but the differences from region to region can be tremendous. In those differences lie the origins of regional architectural styles. New England's saltbox homes, with long sloping north-facing roofs that deflected winter winds and bore snowloads well, were ideal solutions to a harsh climate. New Mexico's adobe constructions provided the thermal lag necessary to ease the region's wide and uncomfortable diurnal temperature swings. The breezy piazzas of Charleston dispelled hot, humid conditions, while Nebraska's early sodhouses insulated themselves against the sweeping arctic winter winds of the Great Plains. But those were indigenous solutions to climate, reached intuitively. Today's designers can rely on climatic data that is lightyears ahead in its accuracy and precision.

NOAA's National Climatic Center in Ashville, N.C. collects and summarizes data from major weather stations around the nation, each one recording detailed (hourly or three-hourly) data on numerous weather elements. Adjunct to those major stations are literally thousands of smaller recording points, collecting and reporting temperatures and precipitation levels. In addition, the U.S. Air Force and hundreds of airports maintain weather stations around the country, and many universities have similar, if smaller, climatic installations. All told, those sources generate more climate data than most designers will ever need.

But do most designers know what they need, or how to use it? Those questions were first being asked back in 1950, and they weren't even partially answered until the energy performance standards research of the past three years. The designers involved in that research picked up quickly on what their forebears have been doing for centuries, adapting it to modern design techniques, building systems, and energy equations with general success. The process was so natural and the products so satisfactory in both energy and aesthetic terms that a good many designers came out of the project calling climate-conscious architecture—by some dubbed "neo-dynamism" for its renewed interest in natural energy





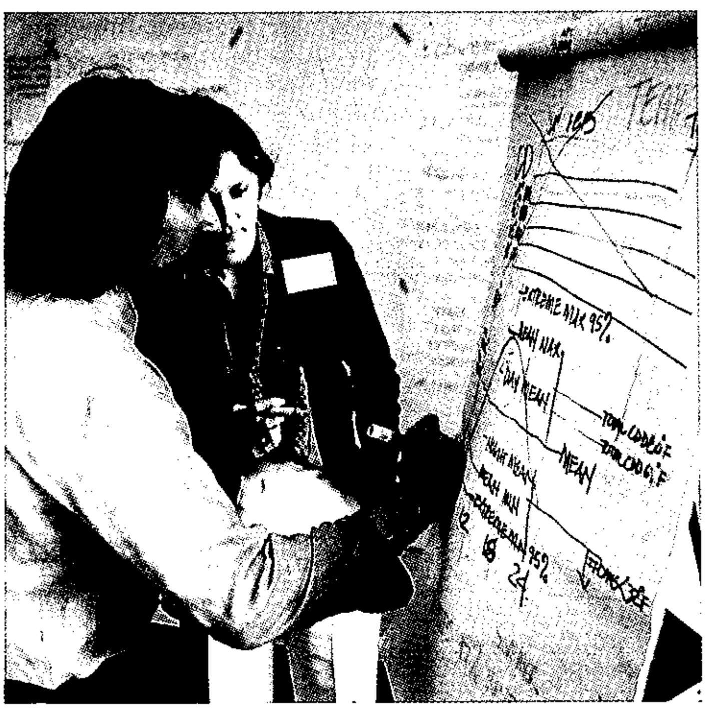
Above: Temperature graph for an average July day from the AIA/House Beautiful project of 1950. The width of a drop indicates relative duration of a given temperature. The greater the overlap of dry-(shaded) and wet-bulb temperature drops, the higher the humidity. The greater the diurnal temperature swing (left), the more thick walls will damp the impact of temperature extremes.
Art: Research and Design

flow—the logical successor to the fractious and fractured styles of post-modernism.

That assessment could turn out to be correct. But before climate-conscious design sweeps the nation, a nation of architects will have to learn to understand the often abstruse language and imagery of climate data, to extract from it the information they need to make intelligent design decisions, and to respond with techniques they weren't taught in school. Those were the problems put by DOE and NOAA to the climate and architecture conferees gathered in Washington last February.

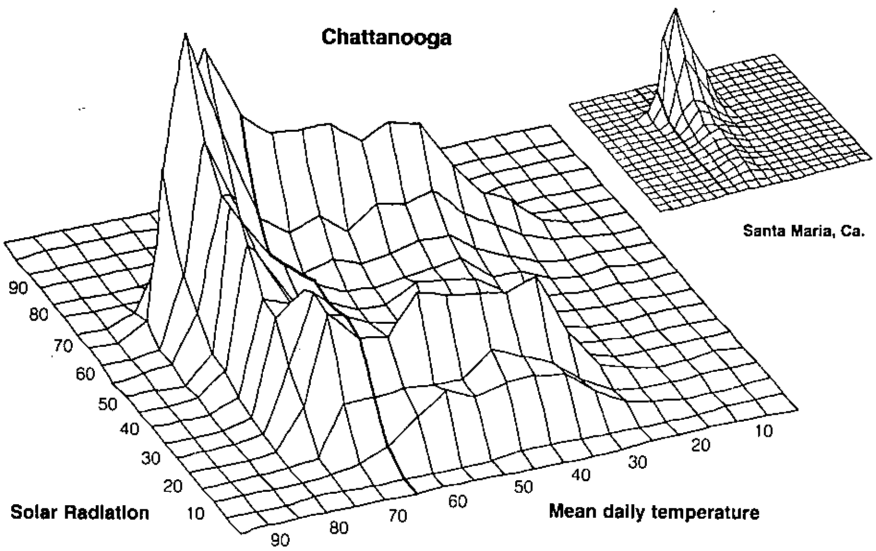
The answers came back quickly. After a day of presentations from most of the 52 conference participants, each detailing a particular aspect of recent practice or research, the conference broke into six working groups charged with developing statements of the immediate, near future, and long term needs of the design community. After one long day there, they returned to plenary session in the circular board room of AIA's headquarters building and hammered out their differences, which were few.

Immediately necessary, they said, is a standard building climatological summary for the nation's major urban areas. Their recommended format opens with a map and a narrative summation of climate, defining the regional parameters of the information and giving a quick picture of general trends; then the summary moves into specific data on sun, wind, temperature, humidity, and the constant interplay of those ele-



Climate and architecture conferees gathered at AIA headquarters in Washington, D.C. (above). Later (left), they broke into working groups to develop statements of immediate, near-future, and long-term climatological needs of the design community.

Photos: Kevin Green



Solar mountains. Changing elevation represents percentages of simultaneous occurrence of daily solar radiation values (percent of possible sunshine) and mean daily temperatures. Elevations left of the 65 °F line show a potential for solar overheating. Elevations in the upper right quadrant—sunny days and lower temperatures—indicate optimum solar design conditions. Chattanooga's "mountain" indicates a difficult location for passive solar design, but Santa Maria's shows idea conditions. The solar mountains were computer-generated by Raymond Bahm of the University of New Mexico.

Art: Research and Design

ments. Taken together, that information will give designers a quick and accurate tally of the assets and liabilities of local climate. When such summaries are developed for areas across the nation they will be invaluable for practitioners who can interpret them.

Interpretation, said the conferees, should be aided by published guidelines for architects, engineers, and homebuilders, another immediate need. The guidelines should cover everything from understanding climate data to designing solutions for specific problems.

Most important, the climate and architecture conferees agreed, is that designers understand the two fundamentals of climate-conscious architecture. Designs that respond to climate—and the research that supports such work—can't be approached as "solar" or "geothermal" or "underground construction," but as solutions that consider all the elements of climate in a holistic approach to energy-conservative design for human comfort. And, as important as this recognition of the interplay of climatic elements, designers must realize that the climatic matrix differs from region to region. The climate-conscious designer must be ready with flexible design strategies, applicable to changing conditions.

Given those fundamentals and the tools to implement them—design handbooks and climatological summaries—the conferees said the field will be ready for new research in a host of areas.

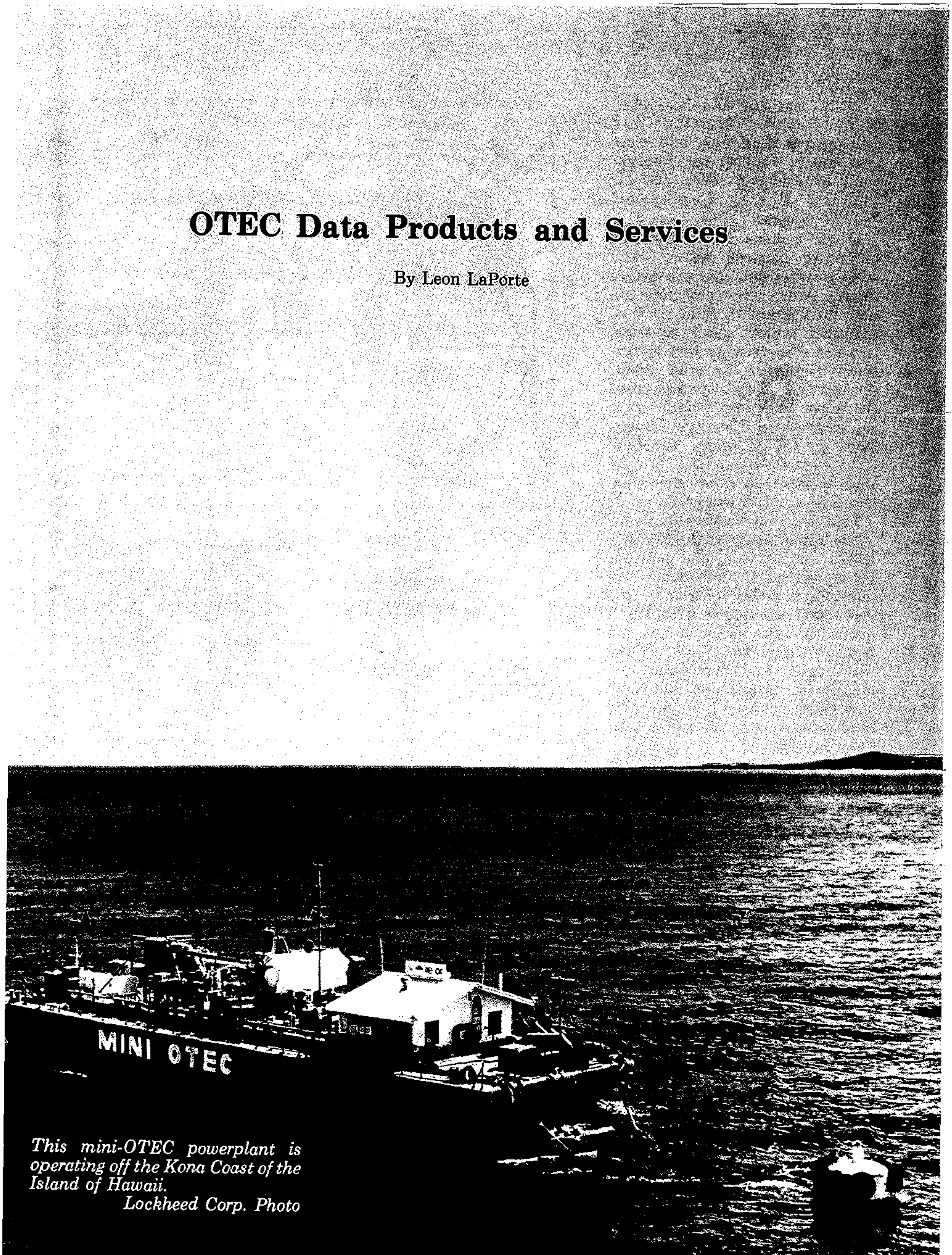
The exploration of techniques relatively new to design—dessicant cooling, induced ventilation, earth-air heat exchange, annual and diurnal thermal storage—will radically increase the number of design strategies available to climate-conscious designers. Understanding microclimatic variations and measuring them with compact recording units developed for use on actual design sites will permit finely tuned design responses. Understanding and measuring the effects of buildings themselves, on themselves and the exterior environment, may elevate building climatology to its most sophisticated level.

These long range research goals, however, have little to do with the current state of climate-conscious design. It is thriving, in a small way, and as energy conservation becomes a larger concern for architecture's avant garde and mainstream alike, it will grow. The federal government, architecture's single largest client, is already conferring most-favored status on projects that conserve maximum energy. In 1977, the office of California State Architect Sim Van der Ryn sponsored an energy-conscious design competition for a state office building, documenting Sacramento area climatic conditions in the program. The competition eventually generated *three* climate-conscious buildings for the state. It also developed the formats for climate documentation that Tennessee Valley Authority architects are using now in their sizeable development program. The same formats appear in the Climate and Architecture Conference's recommended building climatological summary.

Climate-conscious architecture gives all indication of being an idea whose time has come. With the world's oil-rich nations raising prices at regular intervals and America's own energy alternatives—gas, coal, nuclear—extremely uncertain, the need for energy conservative design solutions is as clear as a cloudless sky. With more buildings going up without benefit of an architect's services (if not without one's stamp) than with them, architects may also be in need of solutions that have more to offer than delight to the eye. What better solutions than those climate-responsive designs which, to quote Vitruvius, "remedy by art the harm that comes by chance"?

OTEC Data Products and Services

By Leon LaPorte



This mini-OTEC powerplant is operating off the Kona Coast of the Island of Hawaii.
Lockheed Corp. Photo

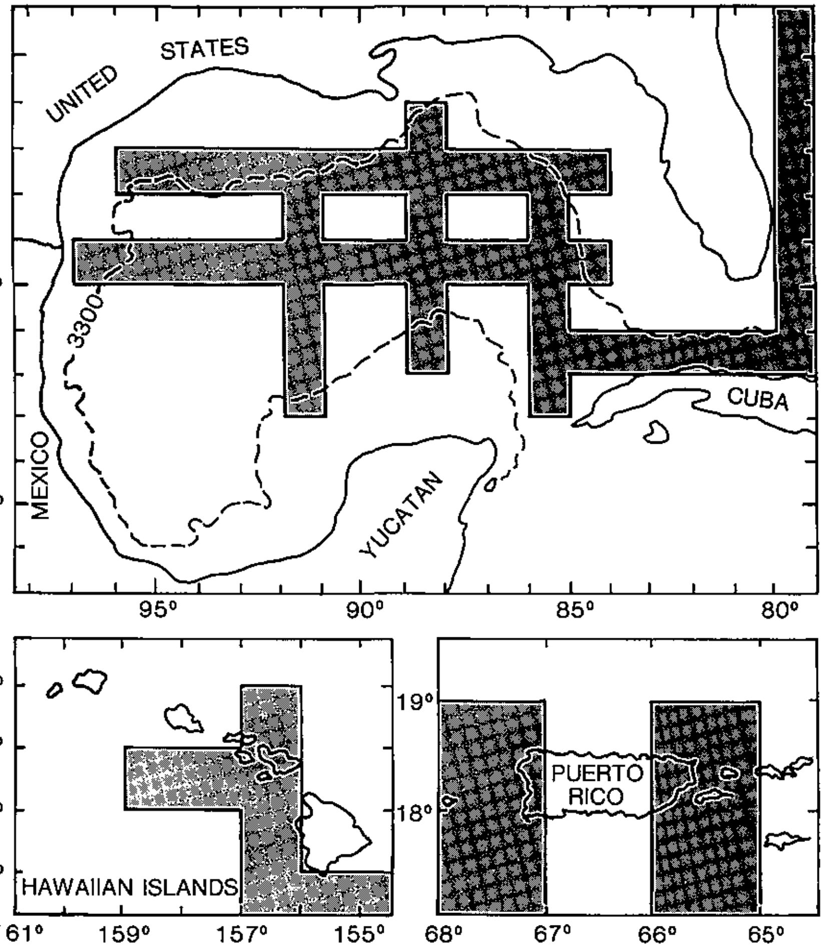
EDIS' National Oceanographic Data Center (NODC) has developed a data base and data products to support the Department of Energy's (DOE) Ocean Thermal Energy Conversion (OTEC) program.

OTEC utilizes the temperature difference between warm ocean surface water and cold subsurface water. Warm surface waters are used to vaporize a fluid such as ammonia which, as it expands, turns an electricity-generating turbine. Exposure to cold deep-seawater raised up by pumps turns the vapor back into a liquid so it can be recycled. Electrical current from an OTEC plant, which is tethered to the ocean floor, is transmitted ashore by submarine cable and into an electrical grid.

Last year, the President's Council on Environmental Quality projected that OTEC could generate the equivalent of 1 quadrillion to 3 quadrillion BTUs (quads) by the year 2000, compared with the 3 quads that the nation today gets from hydroelectric power. DOE plans to have a 1 megawatt test facility in operation by mid-1980. The OTEC process is expected to produce electricity at commercial rates by 1985.

Siting of OTEC plants depends on the identification of areas of a large and persistent temperature difference between surface and subsurface waters. The effect of the surface and subsurface environments on the platforms and coldwater pipe, the effect of biofouling and corrosion on the heat exchangers and other components, and a host of other environmental and engineering concerns will have to be evaluated. Two years ago, in anticipation of data management needs, DOE requested that EDIS provide data and data products for OTEC.

In response, NODC has prepared an OTEC data base for ocean areas near Puerto Rico and Hawaii, the eastern and western sections of the Gulf of Mexico, and the Atlantic coast of Florida. The base files contain 3,637 oceanographic stations, 13,125 mechanical (MBT) and 8,633 expendable bathythermograph (XBT) records, 896,827 surface current observations, 66 subsurface current observations, and 20 salinity-temperature-depth profiles. The data are retrievable in automated format by geographic coordinates, year, season, month, or sample depth.



Shaded areas represent DOE-selected potential OTEC sites. NODC has established a special data base for these areas.

The station data files contain identifying information such as latitude, longitude, year, month, day, hour, wind direction, wind speed, air temperature; observed depth values for such parameters as temperature, salinity, sigma-t, sound velocity, oxygen, nutrient chemistry, and PH; and interpolated standard depth values for the same parameters.

Mechanical and expendable BT records contain both identifying information and temperature-versus-depth values.

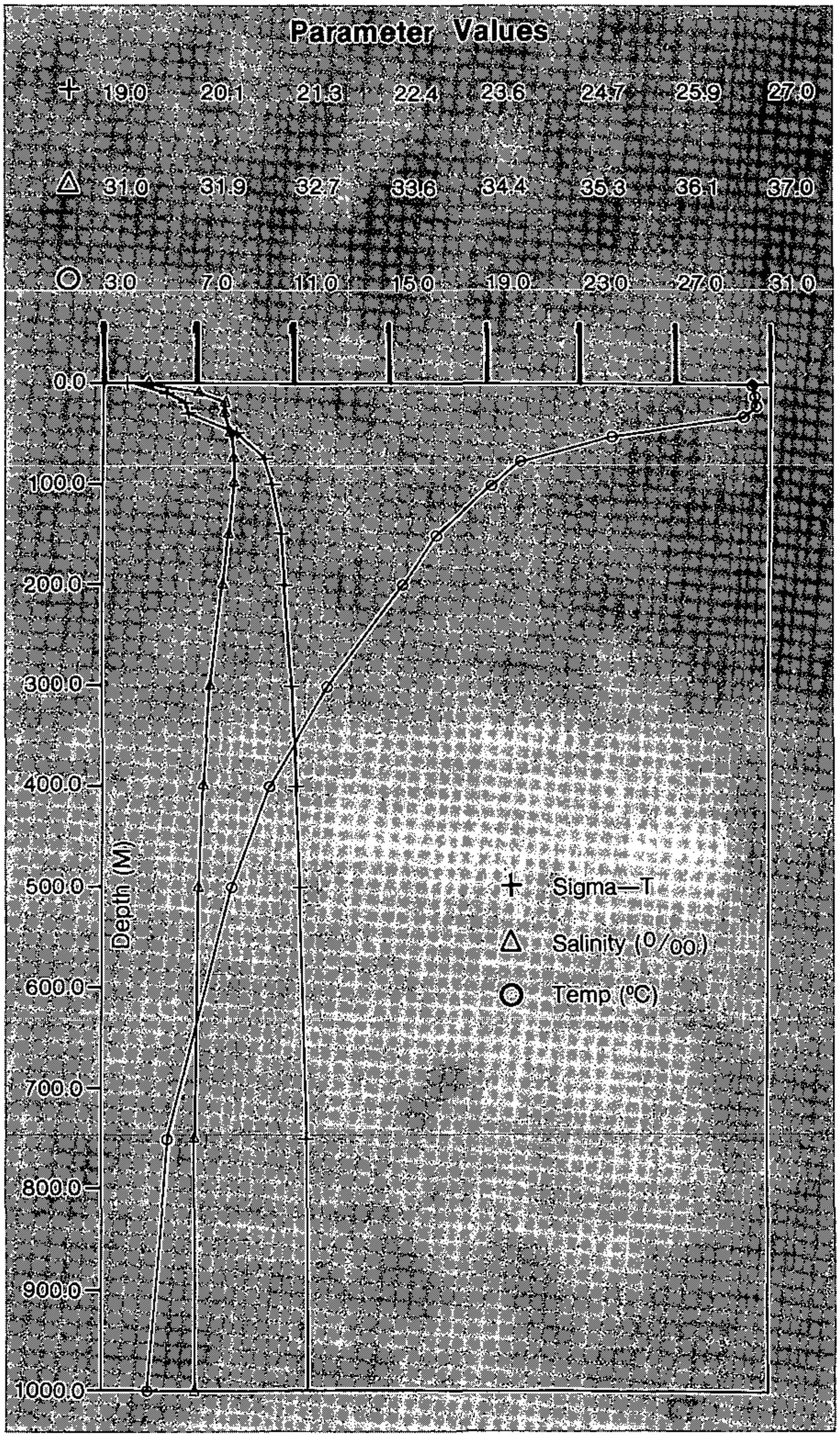
The surface current data file contains ship-set-and-drift observations from the Netherlands, Japan, Britain, France, and the United States. It also contains a large number of Geomagnetic Electro-Kinetograph (GEK) observations, mostly of Japanese origin. The file spans the period from the early 1850's through 1974.

Subsurface current measurements have been received from the University of Miami, University of Rhode Island, Naval Oceanographic Office, and NOAA's Atlantic Oceanographic and Meteorological Laboratories. The measurements were made off Florida, Puerto Rico, and the Hawaiian Islands. The records contain east and north current components, speed, and direction, as well as simultaneous measurements such as temperature and conductivity, and associated identifying information for the observations. The observations themselves may be either time-series data collected at one depth or current-depth profiles collected over several depths in the same location.

Arrangements have been made to obtain associated synoptic sea surface meteorological observations from the National Climatic Center in Asheville, N.C.

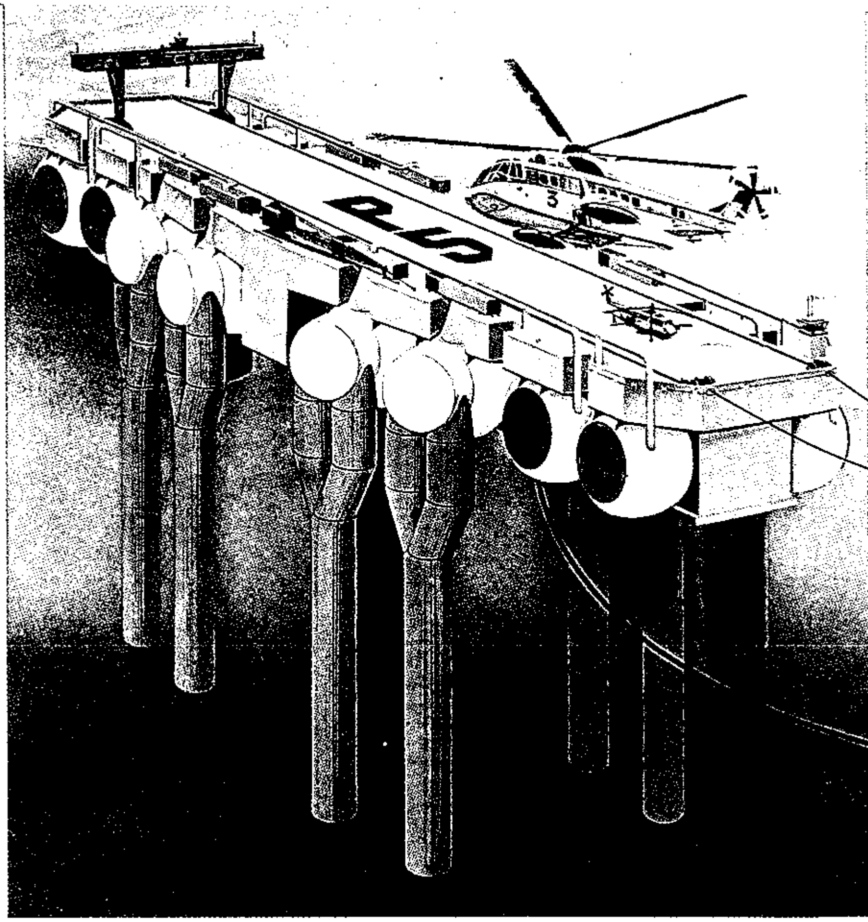
Inventories of data in the OTEC Data Base are available in a variety of formats and presentation options. Information on data for specific regions can be made available for 1° squares of ocean area by individual years, months, seasons, or decades. Presentation options include listings, map presentations showing the observation points by geographic area, or map plots showing the numerical distribution of available data.

Once data of interest have been identified, users may obtain copies of the data themselves as computer printouts, on magnetic tape, as products, or as data summaries. Some examples of off-the-shelf data summaries are:



This multi-parameter plot is one of a variety of data products available for OTEC areas.

Vertical Array Summary. A tabular listing of a specified parameter for a given geographic area that provides maximum, average, and minimum values, computes standard deviation, and lists the total number of observa-



Artist's concept of an OTEC plant ship that can move to find favorable ocean temperature conditions.

tions used in the calculations. These values are normally computed for standard depth levels.

Horizontal Array Summary. A map plot summary for any specified area that provides mean, minimum, and maximum values, and lists the number of observations used in the calculations for any designated parameter. The plots are normally produced at standard depths.

Temperature Difference Summary. A tabular listing that presents average temperature differences between successively increasing depth levels at prespecified differentials of 10, 15, or 20 meters. Data are presented by 1° square areas and month. This type of summary is now available only for mechanical bathythermograph data.

Graphics products for OTEC are also now available. Some of these are:

Parameter versus Parameter Plots. Any specified parameter from the OTEC data base plotted against any other parameter for a specified region and designated time period. One variation is parameter versus sampling depth. Sigma-t lines are available on temperature-salinity plots.

Combined File Plots. A map plot of specified data fields from any of the files making up the OTEC data base. An example of such a plot would be a numerical presentation of ocean temperature values from the station data, MBT, and XBT files for the Gulf of Mexico from August to November 1975. Any combination of parameters, time period, and area could be employed.

Exceedence Diagrams. Illustrates the range and cumulative percentage occurence of any parameter for a given time period and geographic area.

Histogram Plots. Bar graphs showing frequency distribution of one parameter versus another, or a parameter versus sampling depth. Class interval may be specified, and distribution is shown by percentage of data points per class.

In addition to those cited, other off-the-shelf options, such as horizontal and vertical machine-contoured sections, are readily available.

Besides the products already available, there are several OTEC products under development. These are: current histograms representing time percentage of total currents flowing in a specified direction; virtual displacement and per-unit occurrences of component speeds from moored current meter observations; and parameters contoured over a depth-time grid.

In the future, NODC expects to develop computed Brunt-Vaisala frequency for high-resolution data, various spectra plots, and biological histograms.

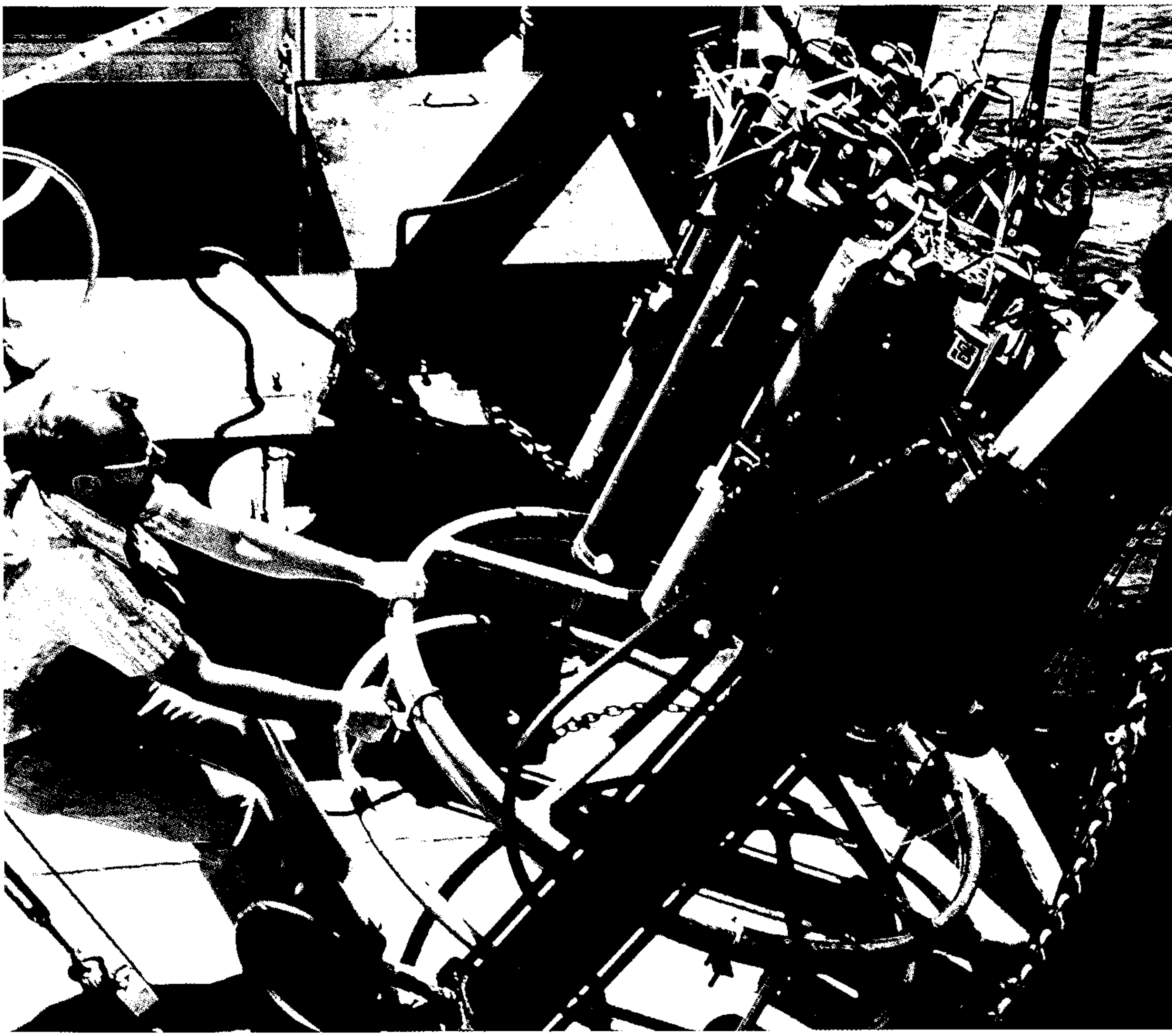
Numerous publications from OTEC contractors and the Department of Energy have been received by NODC. The center is in the process of developing an automated publications inventory listing and will have these reference materials available for use at NODC.

For further information, contact E.F. Johnson, NODC, EDIS, NOAA, 2001 Wisconsin Avenue, NW, Washington, DC 20235; Tel: 202-634-7479.

Niskin sampling bottles collect water for biological, as well as chemical and physical measurements.

The Need to Improve Data Acquisition and Processing in Biological Oceanography

By T. T. Packard, Bigelow
Laboratory for Ocean Sciences

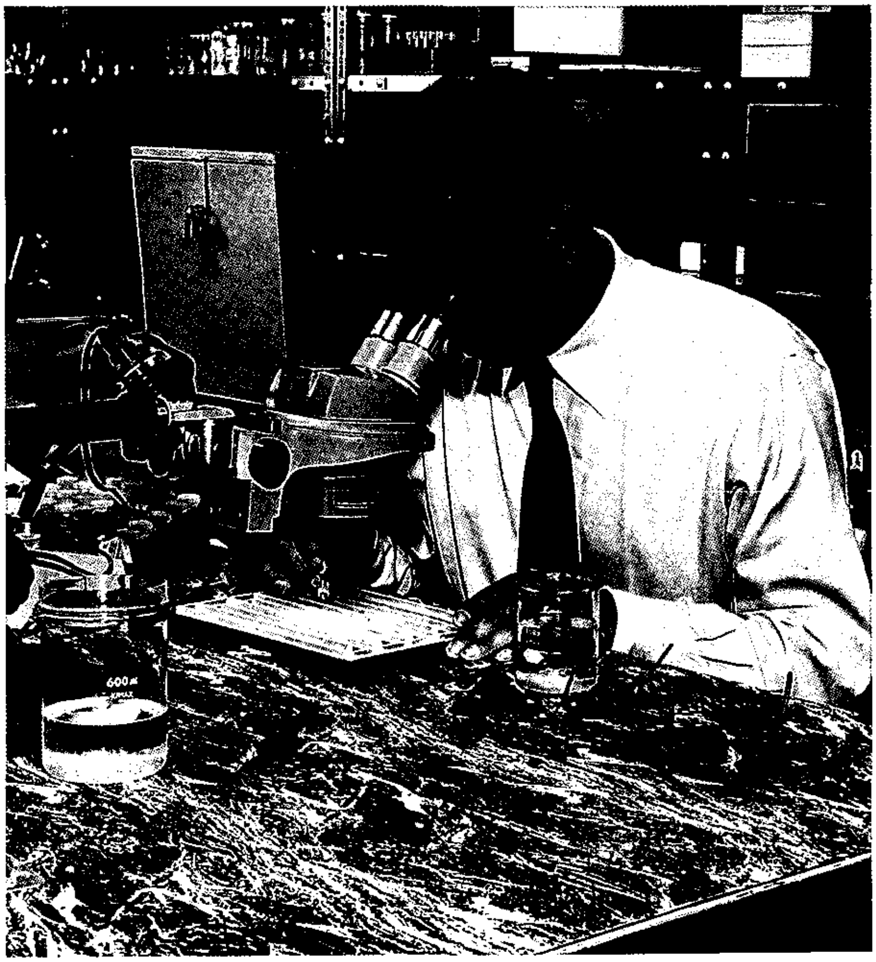


The solution of certain oceanographic problems requires a multidisciplinary research effort. To achieve a predictive understanding of problems like "understanding the formation, maintenance and decay of the oxygen minimum zone" or "understanding the responses of eastern boundary ecosystems to Pacific equatorial disturbances" requires the input and measurements of physical, chemical and biological oceanographers. Furthermore, to synthesize this multidisciplinary input and develop a predictive understanding on a reasonable time scale, the ideas must be coordinated and made available at the right time. This type of coordination is not being achieved today because there exists in oceanography a large data-acquisition and data-processing gap between the physicists and geochemists on one side, and the chemists, biologists, microbiologists and biochemists on the other side.

If a physicist wants to know the density structure of a water column, he can lower an instrument, and within minutes locate on a plotter the major pycnoclines and major water masses in the water column.

If a biologist wants to know the biomass structure of the same water column he can lower a fluorometer or he can acoustically survey for fish schools, but that effort gives him the distribution of only two parts of the biomass, the phytoplankton and nekton. If he

This article will also be published in the forthcoming volume: *Advanced Concepts in Ocean Measurements for Marine Biology*, edited by Ferdinand P. Diemer, F. John Vernberg, and Donna Z. Mirkes, Belle W. Baruch Library in Marine Science, Number 10. University of South Carolina Press, Columbia, South Carolina 29208.



After plankton are captured in the jar at the end of the net shown at the left, they must be painstakingly sorted into groups by specialists as shown above.

wants to know the total biomass, he must lower water bottles and nets to discrete depths to collect samples. Then, after lengthy sample preparation, he must measure carbon, nitrogen, or dry weight in each sample, and calculate and plot the data before he can locate any of the major features of the depth distribution.

Where the physicist waits only an hour, the biologist may wait as long as several months before he sees his results.

As another example, if we compare the physicist's ability to measure particles by beam transmittance or volume scattering with the biologist's ability to measure carbohydrate or protein by wet chemistry, we again find that the physicist can review his results at the end of the station, while the biologist must wait until the end of the day to review his data.

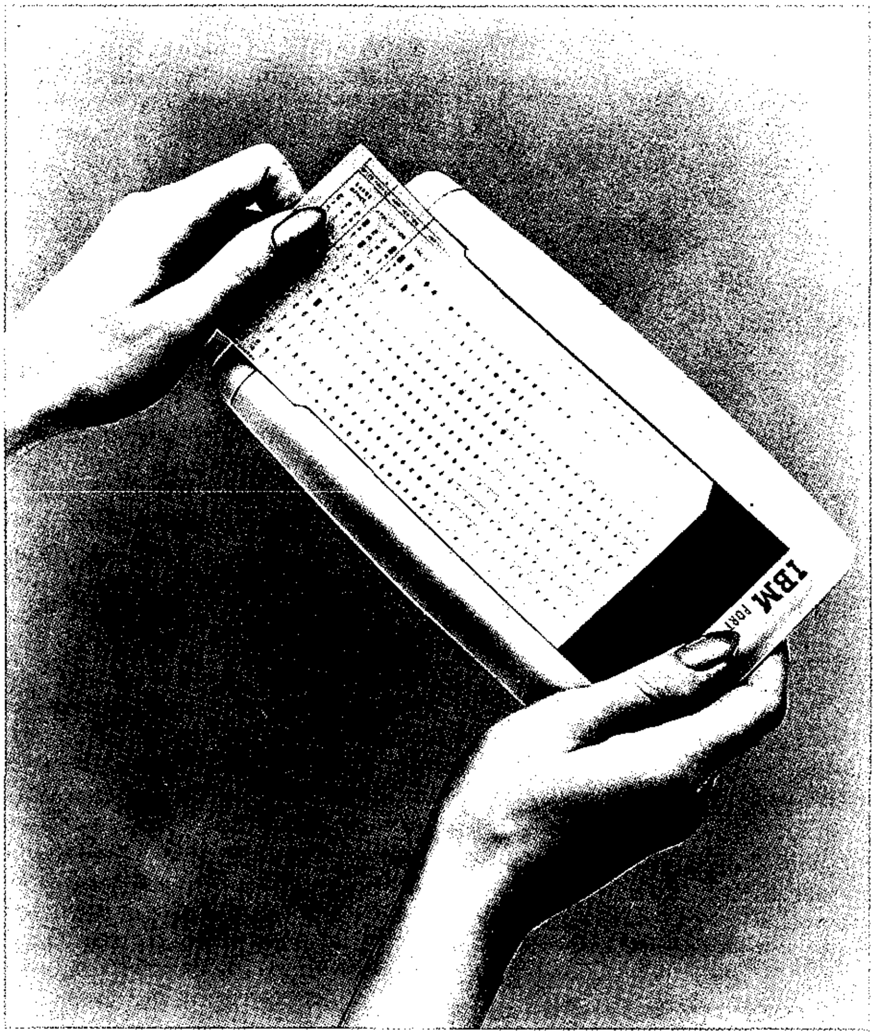
This is the situation with the static properties; with dynamic properties, such as ocean currents and biological rates, the situation is just as bad. The physicist can moor an array of current meters and return months later to recover the taped data. To measure rates of photosynthesis or nitrate uptake over this same period, the biologist must daily sample the water column, incubate his samples in deck inc oators onboard ship, run the filtered samples through a scintillation counter or mass spectrometer, record the data by hand, and finally enter the data by hand into a computer.

Instead of hand recording and entering, the physicist runs the current meter tapes on a computer's tape reader. Once in the computer, the data can be machine filtered, calculated, plotted and statistically analyzed. Within a short time, the physicist is ready to synthesize his data with the biology and biochemical data, but that biological data, unfortunately, is still on filters in a drying oven.

With regard to mapping biological and chemical properties on a horizontal plane, the gap between the physical and biological sciences is as large. Station positioning on research cruises can be improved by reconnaissance mapping. Biologists currently conduct mapping surveys at night to assess the movement of chlorophyll patches, fish schools, and boluses of upwelled water.

These maps are very useful for experimental physiologists who need seawater with different combinations of chlorophyll and nutrients. They also are useful for ecologically oriented research focussed on determining and understanding the changes in the biomass level and species composition at fixed positions in an upwelling area. For this type of work, the maps help distinguish insitu biological changes from advective ones.

At the current level of development biological mapping is a useful tool, but it would be even more useful if other biological properties of the seawater could be mapped. The most important, for



Taking the computer into the field can mean using portable card punches such as this one under water.

a euphotic zone biologist, would be phytoplankton productivity and zooplankton biomass and, secondarily, respiration of either plankton group. To a biologist working in deeper waters, microplankton biomass and metabolism would be key variables to map. This mapping cannot be done now because reliable indices of these variables have not been developed.

Thus, regardless of how a survey is conducted, the only variables which can be continuously assessed in real-time are phytoplankton and nekton biomass. How can this situation be improved? One of the first steps is to employ microprocessors to minimize the human interaction between the primary instrument and the central data file.

Microprocessors can be programed to acquire raw data and calculate results, thereby eliminating the data recording, manipulating, and entering that are routinely done by hand. In doing so, time could be saved and human errors avoided. Alone, this step will not yield automated, real-time assessment of biological variables, but, by reducing the time-gap between data acquisition and data reporting, it will enable biologists to collaborate in interdisciplinary research projects more effectively.

The second step towards improving the situation is to focus attention on the primary sensor and develop indices of biomass and physiological rates. We could adapt existing technology about particle counters to develop continuous flow and insitu microplankton and zooplankton counters as has been explored by Boyd (Boyd, 1973; Mackes and Boyd, in press). Existing knowledge about fluorescent dyes could be adapted to develop continuous flow and insitu assessment of particulate protein (Udenfriend *et al.,* 1972; Torres *et al.,* 1976; Schiltz *et al.,* 1977) and other chemical constituents of plankton. It may even be possible now to use immunofluorescent techniques to develop real-time assessment of plankton species (Richards and Cowland, 1967; Anonymous, 1973).

The use of these fluorescence approaches or the adaptation of particle counters will advance "real-time" assessment of the static aspects of biology, the stock assessment. But to advance the real-time assessment of rate measurements (i.e. productivity, respiration, or excretion) another approach must be taken.

In plankton research there are three difficult problems inherent in the measurement of physiological rates: 1) the rates are low and challenge the sensitivity limits of conventional methodology, 2) the organisms responsible for the rates require a simulated natural environment for the rate measurements to be representative, and 3) the organisms are widely dispersed and require concentration at some stage of the rate measurement.

One approach to developing continuous real-time assessment of physiological rates in plankton is to focus attention on the chemical basis of these rates. This basis involves enzyme chemistry, since all of the physiological rates (i.e., photosynthesis, respiration, nitrogen assimilation and nitrogen excretion) are controlled by a series of enzymatic reactions. If the activity level or the concentration of the controlling enzymes could be measured, then the potential magnitude of the physiological rate would be known. Furthermore, if the mechanism by which the rate-limiting enzyme is controlled, and if the concentration of the controlling compound were known, then the insitu rate could be calculated from the potential rate.

Most of these conditions can be met. Many of the rate-controlling enzymes are known, and their activity in plankton is easy to measure. Quantifying their control mechanisms is more difficult. This work has been started with respiration (Packard 1969 and 1971), photosynthesis (Mukerji and Morris, 1976) and nitrate uptake (Eppley *et al.*, 1969) and could be extended to other processes (Packard, 1969 and 1971). Enzyme analysis could be automated like nutrient analysis and thus physiological rates could be mapped and monitored in the same way nutrient salts and fluorometric chlorophyll are today.

In summary, improvement in the assessment of biological fields in the ocean, and conversion to real-time data processing will enable biologists to interact more effectively in interdisciplinary research projects. The first step should be made in data processing by using more microprocessors. The second step should be made in field assessment by adapting fluorescence techniques to measure static biochemical properties, enzymes techniques to measure dynamic physiological rates, and particle-counting technology to measure stocks of microplankton and zooplankton.

Acknowledgements

I thank R. C. Dugdale, J. O'Brien, P. Sherman, B. Jones and N. Breitner for helpful discussions about this paper and V. Jones and B. Royal for help in preparing it. This effort was supported by ONR contract #N00014-76-C-0271 and the State of Maine.

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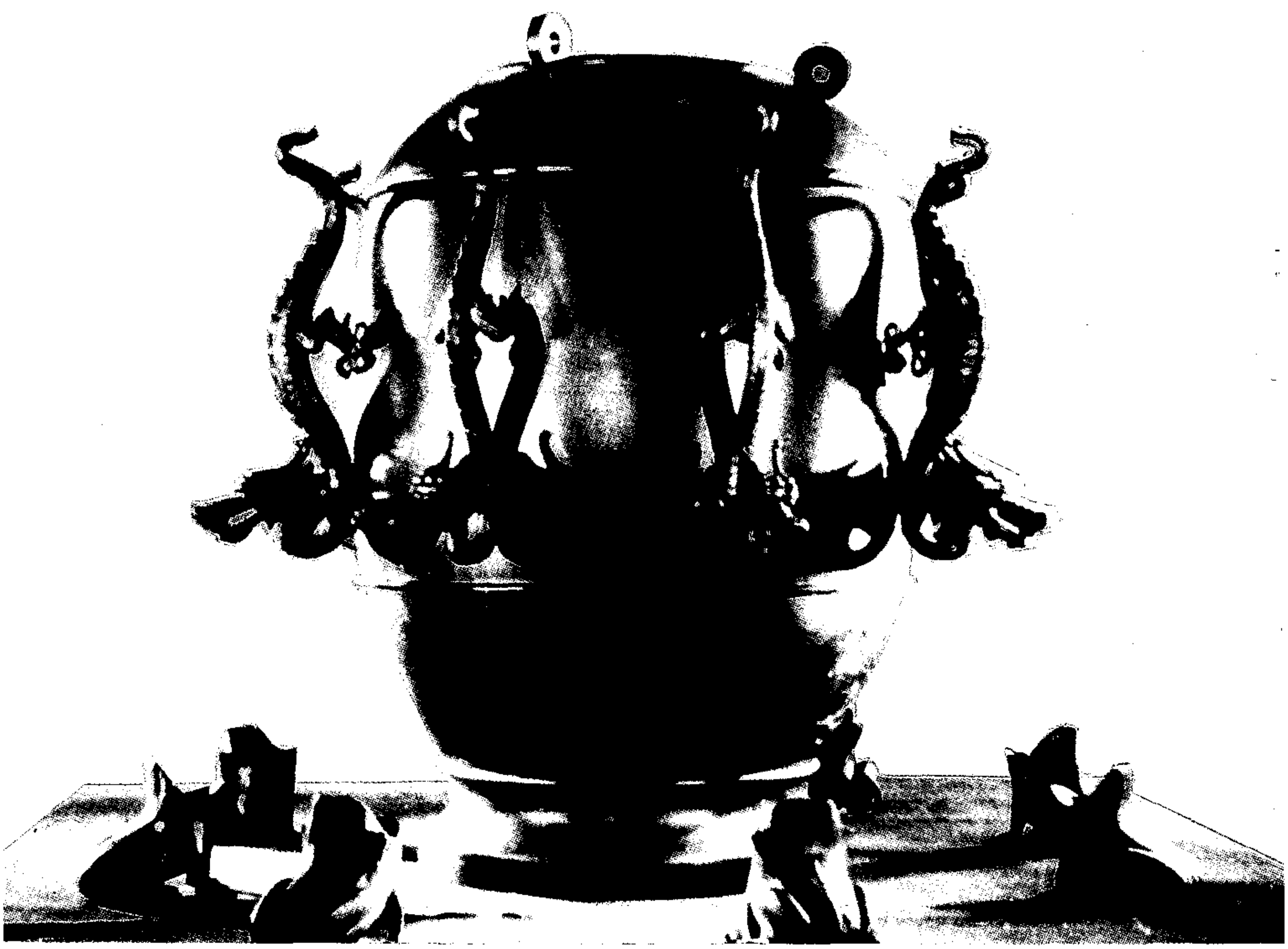
Recording Earthquakes

By Jerry Coffman



Throw a rock into a pond or lake and watch the ripple of waves as they move out in all directions from the location of impact. Just as this impact sets waves in motion on a quiet pond and sends them to the farthest shore, an earthquake generates *seismic* waves that speed throughout, and to the farthest reaches of the Earth. They carry the message to recording instruments, sometimes thousands of miles away, that an earthquake has occurred.

The waves lose much of their energy in traveling over great distances, but today's sensitive detectors can obtain a picture of the waves emitted by even the smallest earthquakes.

What sort of detector captures a picture of these waves as they pass beneath the recording station? Seismologists call it a *seismometer*. When it is connected to a system that produces a permanent recording, they call it a *seismograph.*

There are many different types of seismometers, and they vary from a few ounces in weight to several tons. But all are based on the same fundamental principle that the differential motion between a free mass (which tends to remain at rest) and a supporting structure anchored in the ground (which moves with the vibrating Earth) can be used to record seismic vibrations.

For example, the apparatus diagrammed in fig. 1 consists of a vertical support *AB* and a mass *M*, held in position by a strut *MB*,

Left: This ancient Chinese seismograph once was used to record earthquakes. The Earth's motion drops a ball from the mouth of a dragon into that of a waiting frog. Each frog represents a different compass point, thus indicating the direction of the quake.
U.S. Geological Society

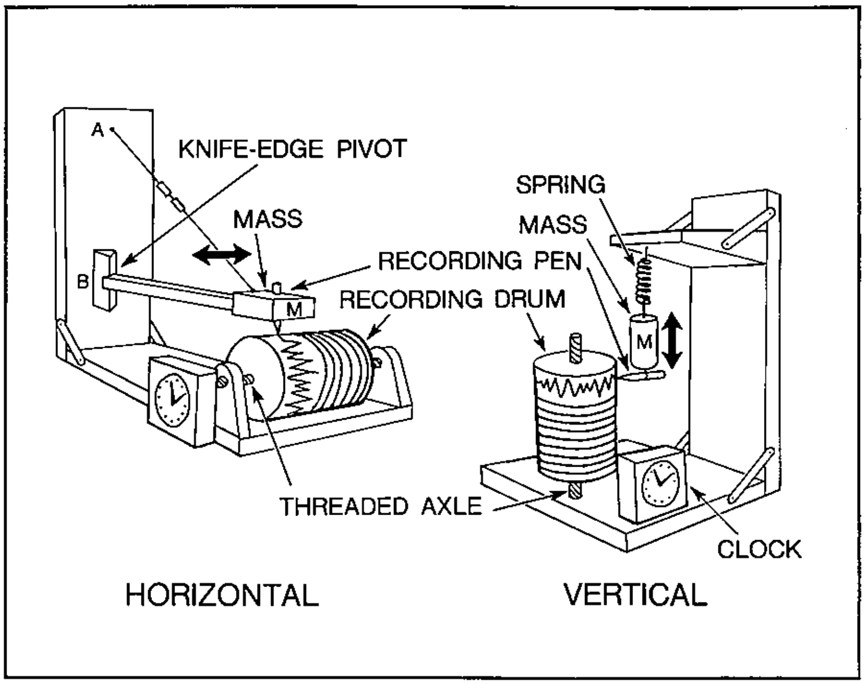
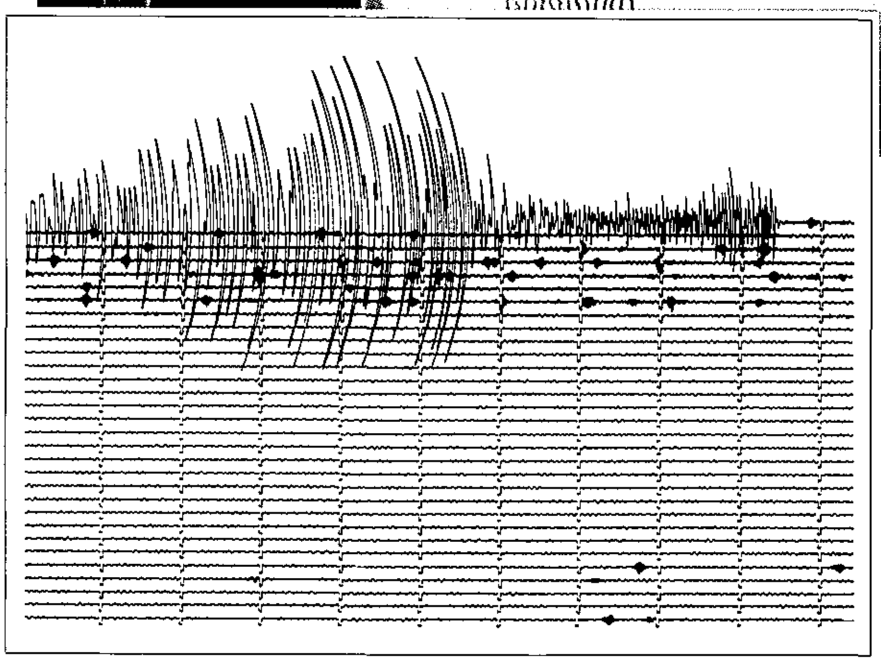


Figure 1. See text.

pivoted at the Point *B*, and by a wire *AM*: its system is a seismometer when the vertical support is embedded in a concrete pier attached to the Earth. If there is no friction at the pivot *B*, and the mass *M* is reasonably large, the movement of the pier and the attached upright support in response to an incoming earthquake wave will set up a differential motion between the mass and the pier (the inertia of the mass will make it remain at rest). This motion—the signal of an earthquake wave—can then be recorded on a revolving drum. When the pier is steady, the pen attached to the mass writes a straight line, but when it shakes, the hand becomes wiggly, recording waves from the earthquake that started the boom in motion.

Usually, the drum rotates on a screw-threaded axle, so that the recording pen moves on a continuously advancing record and does not simply repeat the same circle over and over. Time—both the time of day and the synchronization of events—is an important element in seismology, and clocks are always part of a seismograph system. In a simple home instrument, however, an old alarm clock can also be used to drive the recording drum at a regular rate, as, for example, by coupling the minute-hand mechanism and the drum to get a steady rate of one revolution per hour.

A single seismograph pendulum works in only one direction, and cannot give a complete picture of wave motions from other directions. To overcome this problem modern seismograph stations are equipped with separate instruments, one to record the north-south and the other the east-west waves. They also employ a vertical instrument, in which a weight resting on a spring tends to stand still and record the vertical motions of the ground. The spring-



A modern seismograph records Earth motions on a strip chart such as the one below the photo. This seismogram shows the trace made by the August 6, 1979 California earthquake.

Credit: Dr. Henry Spall
U.S. Geological Survey

suspended mass lags behind the motion caused by the earthquake, making the pen record the waves on the drum. This combination of instruments tells a seismologist the general direction of the seismic wave source, the magnitude at its source, and the character of the wave motion. Instruments in other locations must be employed to get a precise fix on the earthquake's epicenter.

There have been numerous clever devices used throughout history which told of the occurrence of an earthquake. Some were designed to stop clocks, ring bells, flash lights, or release sand, but all were set into action by the passing of earthquake waves in the ground beneath the instrument.

Perhaps one of the first and most ingenious recorders has been attributed to Chang Heng, the Director of the Chinese Bureau of Almanac and History. However, it could not be called a seismometer, for it only indicated, at most, that a shock had occurred. It could not measure the arriving waves, nor could it help much in telling where the earthquake had occurred.

In about A.D. 132, Chang invented the first pendulum-type seismograph. Using dragon- and frog-like objects, mystic symbols of that age, and a highly decorated copper jar of barrel shape three feet across, he constructed an instrument that indicated earth motion—that an earthquake had occurred in some region of the earth.

Inside the copper sphere, Chang suspended a ball on a long cord, so close-fitting that any ground motion would move the jar and make some part of it touch the ball. On the sides of the jar were eight dragon figures, each with a small pellet in its mouth. When the ball responded to the motion of the jar, one of the pellets would be knocked out of the mouth of a dragon into the mouth of a waiting frog directly below. Upon finding a pellet in the mouth of one of the eight frogs, Chang knew there had been an earthquake, or some sort of ground disturbance. He surmised that the frog with the pellet indicated the direction from which the disturbance originated.

Chang was later given official charge of earthquake reporting making him the world's first known seismologist. But he was first ridiculed and laughed at.

On finding a pellet had been thrown down from the pedestal one day, Chang immediately sounded the news that an earthquake had occurred, say to the north of his city. But no one in that area had noticed an earthquake. Chang's instrument was apparently in error, the townspeople decided. So Chang made an ignominious retreat to his observatory.

Some days later, news arrived that in a distant northern city, a destructive earthquake actually occurred on the day Chang had reported it. He was quickly restored to his original position and named official earthquake reporter. Chang's device became the prototype of the seismograph of today, his pendulum the heart of most modern seismographs.

John Milne of England introduced a distinct improvement to the seismograph in the 1880's. His invention used photographic paper which cut down on friction between pen and recording drum. He also installed recording paper that moved, and designed a time inscriber which automatically made time signals on the record. Although imperfect, it was a great step forward.

A Lithuanian continued the development of the seismograph in 1906, when he used the principle of magnetic induction to make a true record of seismic waves.

Galitzin, a Prince in the Russian Empire, placed a coil of fine wire around the penulum and let it swing between the poles of a magnet. This produced a small electrical current in the coil, which drove a sensitive electrical indicator called a *galvanometer*. This relieved the pendulum of its mechanical burden, and, when the Earth and frame were excited by seismic waves, the pendulum stayed stationary, producing a true record of the earthquake waves.

Through the last century or so, many have made vital contributions to further development of seismic instruments. Some modern instruments use Galitzin's galvanometer system with Milne's photographic recording. Some use pen and ink recorders, and most recently, magnetic tape. The electrical systems employed make possible the magnification of ground motion a million times or more, and the recording of microearthquakes imperceptible to humans.

Modern seismographs, no longer the randomly designed devices of a century ago, can locate earthquakes within an accuracy of ± 1 second in time of occurence, 20 kilometers in depth, and 25 kilometers in location. If the Earth moves as little as the diameter of one atom, these sensitive instruments will detect and record it.

The U.S. Geological Survey supervises 115 identical recording systems in 61 countries and territories which, combined with many additional seismic stations that cooperate in this effort, give the most precise seismic record man has ever had.

Reprinted from the *Earthquake Information Bulletin*.

National Report

Federal Natural Hazards Data Sources

An *Inventory of Natural Hazards Data Sources in the Federal Government*, compiled by James F. Lander of NOAA, Robert H. Alexander of the U.S. Geological Survey, and Thomas Downing of the University of Colorado's Institute of Behavioral Science, is now available. Listings are presented for more than 100 data sources in 19 Federal departments and agencies.

The inventory is intended as a convenient reference to natural hazards information sources in the Federal Government. It is a collection of single sheet summaries listed alphabetically by major department or agency identifying data resource, location, content and format of material, and available reference information. Data types presented include not only raw data of natural hazards occurrences and effects, but also information useful for hazards prediction, evaluation, mitigation, and planning.

The inventory was prepared as a result of recommendations stemming from an April 1978 Workshop on Natural Hazards Data Resources organized by the University of Colorado's Natural Hazards Research and Applications Information Center. (See *EDIS* July 1978.)

Requests for copies of the publication should be addressed to the National Geophysical and Solar-Terrestrial Data Center, NOAA/EDIS, Boulder, CO 80303.

Comparative Climatic Data for U.S. Cities

The National Climatic Center recently published *Comparative Climatic Data for the United States Through 1978*. This 94-page publication contains normals, means, and extremes data for selected climatic elements for approximately 300 locations in or near major cities in the 50 states and the Pacific Islands, as well as for San Juan, Puerto Rico. The data tables are arranged so that values of the same element can be compared for different locations by the use of a single table. The cities (stations) are listed alphabetically by state in each of the ten tables of observed means and extremes and in the six tables of normals.

Copies of the publication may be ordered from the National Climatic Center, Federal Building, Asheville, NC 28801, or by calling (704) 258-2850, ext. 683. The publication is priced at $2.00 per copy, but there is a minimum charge of $3.00 per order for shelf-stocked publications. Checks or money orders should be made payable to Commerce, NOAA, NCC.

Extreme Wind Speeds in the U.S.

Exteme Wind Speeds at 129 Stations in the Contiguous United States, prepared by Emil Simiu and James J. Filliben of the National Bureau of Standards' Center for Building Technology and Center for Applied Mathematics, respectively, and Michael J. Changery of EDIS' National Climatic Center, was published in March. This 314-page, NBS Building Science Series 118 publication was produced in a cooperative effort by the National Bureau of Standards and EDIS' National Climatic Center.

The publication contains probability statistics for extreme winds at 129 airport stations in the contiguous United States for which reliable wind records are available over a number of consecutive years. The information provided can serve as basic documentation from which appropriate decisions can be made on values of design wind speeds. Included are: recorded wind speeds and anemometer elevations; predicted wind speeds based upon probability distributions of the largest values; estimates of the sampling errors inherent in the predicted wind speeds; a description of the statistical procedures used in the analysis of the data; and a discussion of the results of the analysis.

This publication is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20407 for $5.25 per copy. The GPO Stock Number is 003-003-02041-9. The Library of Congress Catalog Card No. is 79-600018.

Building a Pollution-Response Data Base for the Northeast

More than seven million gallons of industrial oil spilled from the wrecked tanker *Argo Merchant* into the Atlantic on December 15, 1976. At the time, little was known on how quickly the oil would move over the surface water and how quickly it would break up and enter the water column.

To increase the information available during a similar situation, the Northeast Coastal Information Center (NECIC) at the University of Rhode Island is acting as information coordinator for the Pollution Response Data Base. At the request of the northeast Regional Response Team, NECIC will help the Coast Guard and the Environmental Protection Agency construct a data base which will ultimately be used by the individual On-Scene-Coordinators to make decisions at oil-spill sites. This data base will form the foundation for the northeast portion of the National Oil and Hazardous Substances Pollution Contingency Plan.

NECIC is locating and verifying all available information on the region from the scientific, industrial, and governmental communities. Input into the data base will include, but is not limited to, the following:

- Physical characteristics of sea and adjacent land formation
- Industrial uses of land and water, including waterborne traffic
- Current and tide characteristics
- Fish, wildlife, and local vegetation information

Once the data base is compiled and organized, an overall strategy for combatting oil spills will be established. To maintain its accuracy, the data base will be continually updated.

Oil from the Campeche spill stains the beach of Mustang Island, Texas on August 19, 1979.
Photo: Richard V. Harris
National Park Service

Sponsored by the New England Marine Advisory Service, NECIC is one of three pilot Regional Coastal Information Centers which are funded jointly by the Office of Coastal Zone Management, the Sea Grant Program, and the Environmental Data and Information Service. For further information contact: Charlene Dunn, Coastal Information, URI-MAS, Bay Campus, Narragansett, RI 02882, Tel: (401) 792-6211.

Data and Information Referral Guide Revised

EDIS' Environmental Science Information Center (ESIC) recently published the *Guide to NOAA'S Computerized Information Retrieval Services, April 1979.* The guide supersedes the *User's Guide to ENDEX/OASIS, 1976.*

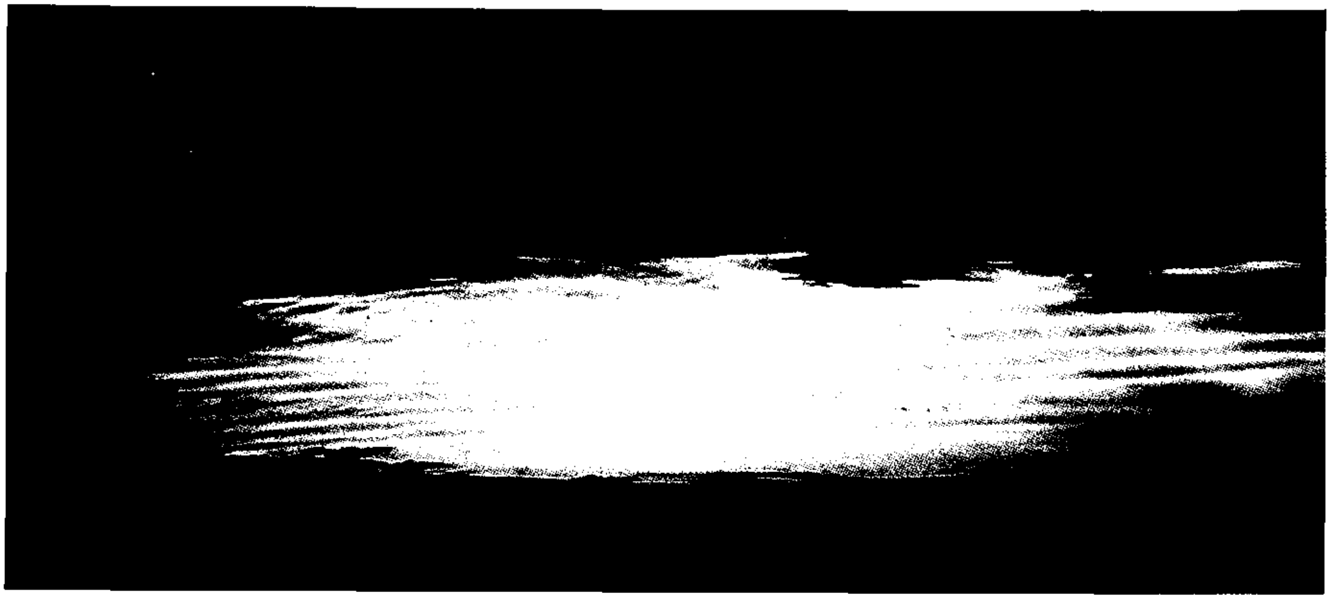
The new guide provides a description of (1) computerized information in the Environmental Data Index (ENDEX) data bases, maintained by EDIS' National Oceanographic Data Center (NODC), and (2) references to published technical literature and ongoing research concerning atmosphere, oceans, and coastal environments provided by ESIC's Library and Information Services Division.

A selection of approximately 38 data bases are described in the new edition. While the previous edition listed all available data bases, the number has grown so rapidly that the new edition covers only those of greatest interest to the NOAA community. Data bases on many additional specialized topics are available.

Instructions on how to request services, their costs, and the addresses of facilities providing services are included.

Further information and a copy of the new publication may be obtained from:

User Services Branch, D822
Library and Information Services Division
Environmental Science Information Center
6009 Executive Boulevard
Rockville, MD 20852
Tel: (301) 443-8330



Noctilucent cloud photographed at 1:42 a.m., July 16, 1965.

Noctilucent Cloud Data Set

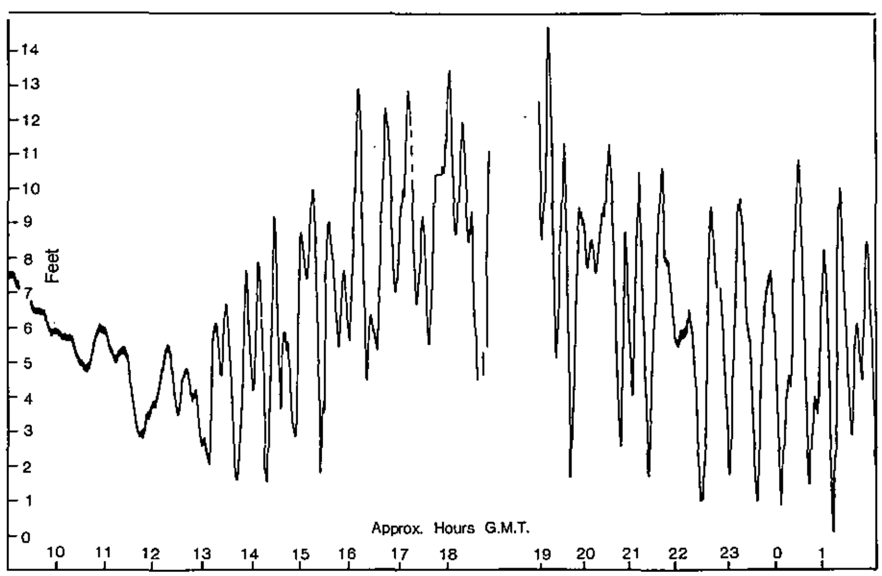
Relatively few people realize that the month of March began the 1979 noctilucent (night light cloud) season, but those few who care know that EDIS' National Geophysical and Solar-Terrestrial Data Center now has data on them. This shy and rare species of clouds that glow in the dark are visible only in high latitudes (82 km altitude) after the Sun sets over North America during the warmer months from March to October. These special clouds are formed of ice crystals near the mesopause and often show wave action and turbulence.

Noctilucent cloud data was formerly the responsibility of Canada. Data in the form of monthly one page tables from each of about 100 observers in Canada, Alaska, and Greenland are routinely received during noctilucent cloud season.

For further information regarding the availability of these data, contact: Chief, Data Studies Division, National Geophysical and Solar-Terrestrial Data Center, RB-3, Boulder, CO 80303.

Tsunami Studies Data Base

Tsunami data are now available from EDIS' National Geophysical and Solar-Terrestrial Data Center. The data are cataloged as tide gauge mareograms, photographs, and seismograms. NGSDC considers the photographic data collection and the tide gauge mareogram files the most active data areas in the field of tsunami studies. The tide-gauge



Tide gage record of tsunami that struck Crescent City, Calif., on May 23-24, 1960.

mareogram data are available in 35mm microfilm and microfiche formats. They are principally from two major collections, those of the International Tsunami Information Center and of NOAA's National Ocean Survey.

Photographs are available in black and white in either 35mm slides or 8 x 10 prints. Some show the actual tsunami wave or the resulting damage. Seismograms for all major events that generated tsunamis in the last 20 years are also available in microfiche or paper copy.

Tsunami Flier 1979-N gives a more detailed description of the tsunami data files. Copies are available from the National Geophysical and Solar-Terrestrial Data Center, NOAA/EDIS, Boulder, CO 80303.

A tsunami swamps streets in the business district of Hilo, Hawaii on April 1, 1946.

Historical Seismogram Microfilming Project

The U.S. Geological Survey and the World Data Center-A for Solid-Earth Geophysics in Boulder, Colo., are embarking on an ambitious multiyear project to microfilm historical seismograms for intervals prior to 1964 from a select group of stations and earthquakes worldwide. The purpose of the project is to preserve and to make these important records available for present and future researchers.

A small network of stations has been selected for which the entire chronological file of selected seismograms will be filmed. A larger network has been selected for filming significant events only.

The microfilming of historical seismograms began on May 4, 1979. The initial filming emphasis is being concentrated on those few United States stations that have been identified for entire interval filming. As of July 6, 1979, 29,000 seismograms had been microfilmed for Vieques and San Juan, Puerto Rico; Honolulu, Hawaii, and College, Alaska. During the remaining months of the calendar year, additional U. S. seismograms will be filmed. Filming of U.S. seismograms will continue in 1980 but key foreign seismograms will also be added to the project.

WDC-A for Solid-Earth Geophysics and the Geological Survey also are developing files of historical seismic information which are important in analyzing historical earthquakes and will add to the usefulness of the filmed seismograms. Plans are underway to film historical worldwide station bulletins and U.S. "felt" reports, to develop regional station directories, and to improve the computer readable files of historical earthquake epicenter data.

An announcement of the availability of film copies of the historical seismograms will be made via fliers and journal articles later this year. These film copies will be made available to requesters at the cost of production. Browse files for use by visiting seismologists will be made available at WDC-A/National Geophysical and Solar-Terrestrial Data Center in Boulder, Colo., at U.S. Geological Survey in Golden, Colo., and at the Geological Survey Office in Menlo Park, Calif.

Radio Solar Telescope Network Data

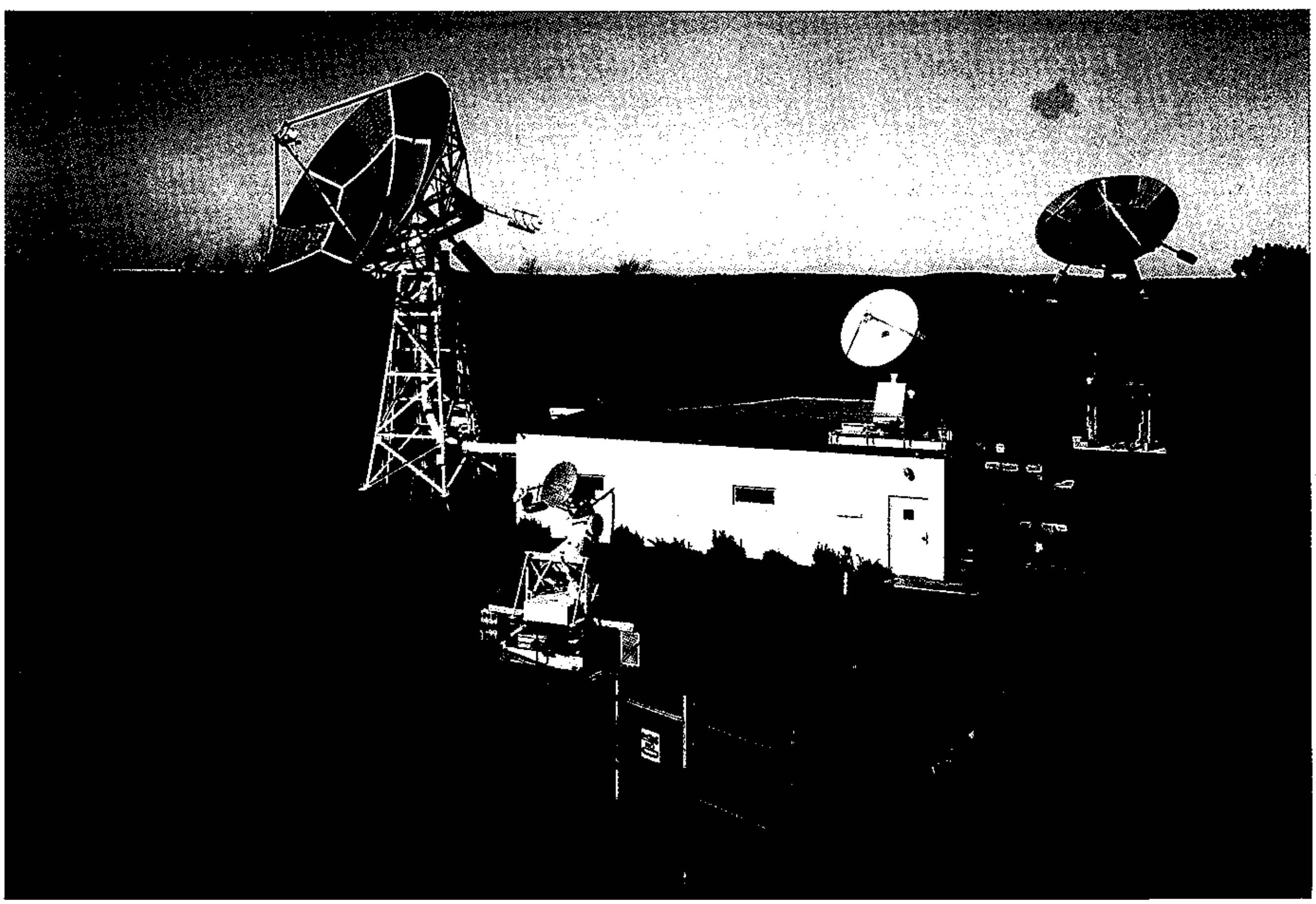
A Memorandum of Agreement has been signed between the Department of the Air Force's Air Weather Service and the Environmental Data and Information Service to archive Radio Solar Telescope Network data. The agreement became effective January 1979.

The network, when completed, will consist of four observatories: Palehua, Hawaii; Learmonth, Australia; Kryoneri, Greece; and Sagamore Hill, Oyster Bay, N.Y. These observatories are spaced around the world to insure 24-hour coverage of solar radio emission.

The data will be recorded on magnetic tape. During sunspot maximum years a total of about 100 magnetic tape reels per year will be produced. The outstanding solar radio emission events as recorded at these observatories will be combined with other worldwide reports and published in the NOAA's monthly *Solar-Geophysical Data*. Data requesters can also obtain copies of the magnetic tapes for their individual use.

For further information on the availability of these data, contact: National Geophysical and Solar-Terrestrial Data Center, RB-3, Boulder, CO 80303.

The Air Force solar radio observatory at Sagamore Hill, Maine.
U.S. Air Force photo

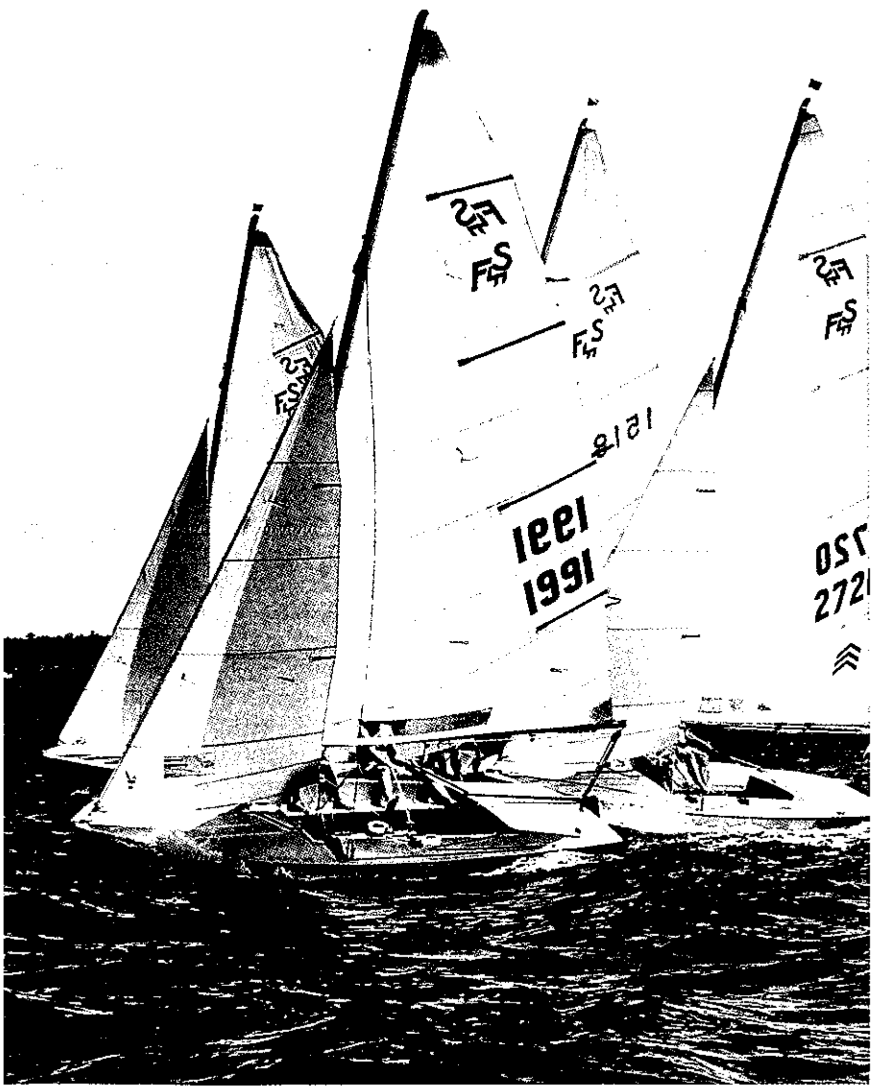


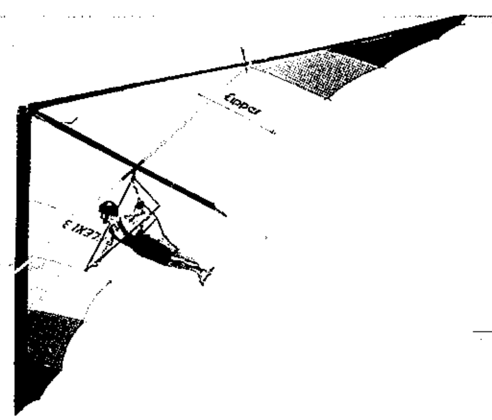
North Carolina Vacation Guide Published

A brochure entitled "Vacation and Weather Guide to Coastal North Carolina," which provides information on recreational opportunities and climate along the entire coast of North Carolina, has been published. EDIS' National Oceanographic Data Center and the University of North Carolina Sea Grant College Program produced the brochure.

The weather information is geared to the vacationer and recreational user of the coast. Included are sections on 2-week hurricane frequencies, a surf and fishing weather guide, an offshore weather guide, and a summary of available beach days. Recreational activities from fishing to hang gliding are highlighted, and sectional maps show roads and attractions all along the coastal sections.

This brochure is part of a series. Others that are still available include brochures for New York's Lake Erie and San Francisco Bay. They are available, free of charge, from Resort Guides, National Oceanographic Data Center, D762, EDIS/NOAA, Washington, DC 20235.





North Carolina recreation activities: Ideal sailing winds frequently occur during spring and summer afternoons. Northeasterly winds north of Cape Hatteras raise some good surf, particularly in late August and September. Winds favorable for hang gliding over the Outer Banks blow 50 percent of the time from March through September.

Prince Edward Island Oil Spill Report

The Environmental Protection Service of Canada has released a 167-page report prepared by Dr. E. H. Owens of Woodward-Clyde Consultants (Victoria, B.C.) entitled *Prince Edward Island: Coastal Environments and the Cleanup of Oil Spills.*

This review of the shoreline and characteristics of Prince Edward Island and the expected impact and cleanup of spilled oil was prepared as part of a contingency plan for oil spills in the Atlantic region.

The shoreline types of Prince Edward Island range from exposed, high-energy barrier beach or cliffed coasts to the sheltered lagoons of estuaries. The author divides the shore zone of the Island into eight coastal environments on the basis of shore-zone sediment transport systems. Each unit is then defined and described in terms of the coastal processes and geomorphology.

The report reviews information on the nature and degradation of oil and on the shoreline processes and shoreline types. The expected impact and persistence of spilled oil is related to the major shoreline types that occur on the island. The author recommends protection and cleanup procedures. Each of the available onshore protection and cleanup techniques is reviewed and shoreline sensitivity is discussed in terms of spill-response priorities and operational decisions. A series of checklists is presented that can be used to identify relevant spill and shoreline information requirements for response decisions.

The report is the fourth in a series prepared by Dr. Owens as part of the oil spill research and contingency plan program of the Environmental Protection Service. Other reports cover the coastal environments and the cleanup of oil spills in the Canadian Great Lakes, the Bay of Fundy, and the coasts of Canada.

This report (EPS 3-EC-79-5) can be obtained by writing to the Publications Coordinator, Environmental Impact Control Directorate, Department of Environment, Ottawa, Ontario, Canada, K1A 0C8.

Two New Glaciology Data Sets Acquired

The World Data Center A for Glaciology (Snow and Ice) at the University of Colorado has acquired for microfilming two new data sets from the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL)—13,000 cards of snow data and 5,000 sheets of ice thickness observations.

From the late 1940's through 1976, CRREL operated a network of 63 snow reporting stations with the cooperation of the U.S. Air Force, U.S. Weather Bureau, U.S. Soil Conservation Service, and the Canadian Department of Transport's Meteorological Division. The network covered Alaska, the Canadian Arctic, and several sites in the Continental United States. Data collected include weather conditions, air temperature and snow depth at the time of observation, and detailed information on the snow layer profile.

The ice thickness data set contains observations along the coasts of eastern Canada and southern Greenland. The observations were made at 22 stations by the U.S. Air Force in cooperation with the Canadian and Danish governments between 1943 and 1951. In addition to ice thickness, information surface conditions of the ice and depth of snow on the ice were also included.

For further information, contact: Marilyn Shartran, World Data Center for Glaciology (Snow and Ice), Institute of Arctic and Alpine Research, University of Colorado, Boulder, CO 80309, Tel: (303) 492-5171 or FTS 323-4311.

Magnetic Plots Over the Northern Hemisphere

Report UAG-71 by A. D. Richmond, H. W. Kroehl, M. A. Henning and Y. Kamide was published by World Data Center-A for Solar-Terrestrial Physics (NOAA/NGSDC) in April 1979. This data report is a further contribution to the growing collection of published data and analytical reports covering events during the months of March through May 1976, a time of surprisingly high solar activity when the Sun was expected to be at minimum.

The interval March 15-May 15, 1976 was pre-selected by the organizers of the Study of Travelling Interplanetary Phenomena (STIP) as STIP Interval II, a time for intensive, coordinated data collection. Selection was based on anticipated constellations of interplanetary spacecraft during this time which would permit taking of unprecedented particle, plasma and magnetic field observations between the Earth and Sun. Satellite, ground-based, rocket, balloon and other experimenters, as well as monitoring observatories were encouraged to optimize data acquisition during these months.

As a result of the interesting solar activity and its effects monitored at Earth, this period became a self-declared "special interval" attracting the interest of many scientists. International Magnetospheric Study (IMS) scientists and the Committee for Monitoring the Sun-Earth Environment (MONSEE) designated the period March 28-May 5, 1976 a "Retrospective World Interval." A collection of data reports for this interval was published in Report UAG-61 in August 1977. Special, enhanced data collections have been established at the World Data Centers, and this period continues to be intensively studied.

Report UAG-71 describes a data analysis technique and shows results from its application to magnetic variations records of the Northern Hemisphere on the days March 26-28, 1976. This technique provides a means for combining and summarizing the detailed record of magnetic variations for 52 observatories into a single global quantity and associated pictures. The pictures were produced on NGSDC's computer to show the changing contours of magnetic potential (equivalent current contours) over the Northern Hemisphere from minute-to-minute in a cinematic format. Also, each frame shows a detailed summary of the extremes of magnetic variations in the auroral zone. Contour map frames for each 18 minutes of the 3-day period are reproduced in the UAG Report, together with a plot of the AU and AL indices for the 24-hour interval centered on the time displayed by the contours. Each contour map is shown in two different formats: with the symmetrical "ring-current" effects included and with the ring-current removed.

This report will be of special interest to anyone analyzing data collected during these days and which might be responsive to the magnetic field changes or other related effects. Also, it will be of interest to those who study the general effects of magnetospheric substorms and magnetic storms.

New Glaciology Accessions List

The World Data Center-A for Glaciology (Snow and Ice) has published *New Accessions List No. 2*—the second in a series of computerized bibliographic listings containing the quarterly list of documents acquired and cataloged by the center. This latest issue covers the period from September to December 1978. Books, technical reports, conference proceedings, and reprints are included. The subject headings are those used by the U.S. Army Cold Regions Research and Engineering Laboratory in their *Bibliography of Cold Regions Sciences and Technology*.

Items indexed in the list are accessible both by subject headings and by principal author. Because of these features, the list is valuable to the researcher interested in a particular subject area, as well as to libraries in related subject fields to use as an acquisition tool.

Direct inquiries to World Data Center-A for Glaciology (Snow and Ice), Institute of Arctic and Alpine Research, University of Colorado, Boulder, CO 80309, Tel: (303) 492-5171 or FTS 323-4311.

Special Ionospheric Data Services

World Data Center-A for Solar-Terrestrial Physics has detailed ionospheric vertical sounding data available on magnetic tape.

This data base of 2,040 station months is a computer-compatible master file of the hourly ionospheric vertical sounding characteristics and monthly statistical data (medians, counts, quartiles and deciles) for 44 stations around the world. The data are placed on the tapes by year in the following order: year, station, month, and characteristic, followed by the hourly values of that characteristic for all days of the month, and then by the monthly statistical data for that characteristic. A single tape can hold about 280 station months. The characteristics are scaled in accordance with the *Union Radio-Scientific International Handbook of Ionogram Interpretation and Reduction.*

The cost to copy, block, and format any single tape in the data set (19 tapes in all) will not exceed $100 each. Single stations or specific times or separate characteristics can be retrieved, upon request, at the cost of retrieval. Requests and inquiries should be addressed to R. O. Conkright, NOAA/EDIS, D632, Boulder, CO 80303, U.S.A., Tel. (303) 499-1000, Ext. 6467 or FTS 323-6467.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmosphere Administration
Environmental Data and Information Service
EDIS Magazine
Washington, D.C. 20235

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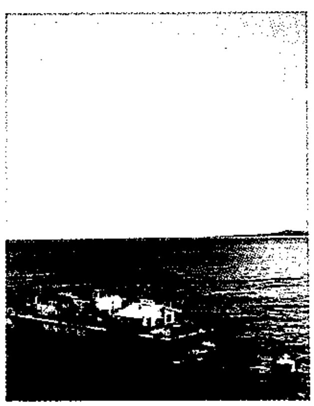
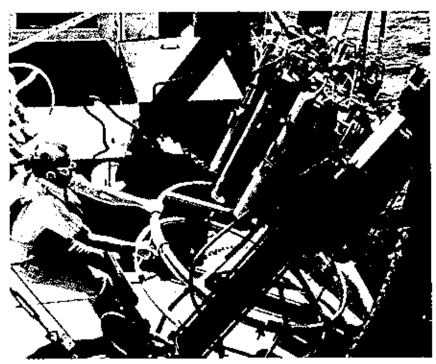
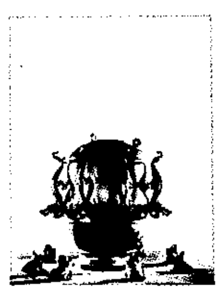




In this issue: *The energy crisis in developing nations (p. 3); climate and architecture (p. 6); OTEC data products and services (p. 11); data acquisition and processing in biological oceanography (p. 15); and recording earthquakes (p. 20).*



EDIS

Environmental Data and Information Service
Volume 10, Number 6
November 1979

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Cover: *Since man first saw the ocean, he has been developing tools to help him understand it. Here, an oceanographer uses a Nansen water sampling bottle. See "Reach into the Sea," beginning on page 15.*

EDIS is designed to inform Environmental Data and Information Service (EDIS) cooperators, colleagues, and contributors of recent developments in EDIS programs and services and in the general field of scientific data and information management. EDIS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, and Center for Environmental Assessment Services. In addition, under agreement with the National Academy of Sciences, EDIS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology (Snow and Ice)..

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.

EDIS (ISSN 0109-3365) is published bimonthly by the Environmental Data and Information Service, NOAA, Page Building 2, Room 533, 3300 Whitehaven St. N.W., Washington, D.C. 20235. For address changes, cancellation, or information write to the Editor at this address. Controlled Circulation Postage is paid to the Finance Department, USPS, Wash., D.C. 20260.

Reducing Disaster-Caused Suffering and Deaths in Less-Developed Countries

Christian R. Holmes, Acting Director, Office of U.S. Foreign Disaster Assistance, Agency for International Development, U.S. Department of State, is interviewed by the editor.

According to the United Nations, most of the people killed in natural disasters live in less-developed societies. NOAA's Environmental Data and Information Service is cooperating in a pioneering AID program to reduce this tragic toll.

Mr. Holmes, How Does The Program Work?

The basic idea is to use existing technology to reduce human misery. Until recently, the less-developed countries have not had access to the technology and techniques used by the United States and other developed nations to protect their citizens. To my knowledge, this is the first large-scale effort to develop a natural disaster early warning system for these nations.

How Bad Is The Problem?

Hurricanes, floods, drought, earthquakes, and other natural hazards threaten us all, but in terms of death and devastation, they discriminate against less-developed societies. According to the United Nations Disaster Relief Office, approximately 95% of the people killed in natural disasters live in less-developed countries. Ideally, all the people of the world should have an equal right to protection from natural disasters.

What Has Been Done About It In The Past?

Traditionally, the tendency has been to react, to bury the dead, help the injured, and provide food and shelter. We have been patching up the survivors and the damage after a disaster strikes. But the technology is available to improve disaster preparedness and reduce potential losses before the disaster strikes or reaches the critical stage. The basic problem is that the available knowledge and techniques have not been applied.

And This Is Now Recognized?

Yes. The Sahel and Ethiopian droughts of 1973-75, as well as the 1976 earthquake in Guatemala, drastically changed our thinking on coping with natural disasters.

In What Ways?

Well, essentially, the disaster-assistance community adopted three major objectives:

(1) To help less-developed nations become better able to protect their people and to respond to their own disasters.

(2) To develop an early warning system for slow-developing or "creeping" disasters, such as drought, and

(3) to react earlier, to keep a serious situation from worsening into an almost unmanageable crisis.

What Is Your Role In These Activities?

The Office of U.S. 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 responsibilities of the Office include monitoring potential and incipient disasters throughout the world and developing new ways to determine the probability of disasters. I have been delegated day-to-day responsibility for the U.S. international disaster assistance effort. With the aid of members of the OFDA staff, such as Paul Krumpe, our Science Advisor and drought-monitoring program coordinator, we identify and implement specific actions to reduce the toll of natural disasters. This includes assistance before a potential disaster strikes.

An Earlier Response?

Right. If we act in an early stage of a slowly-developing disaster, we can greatly reduce human suffer-

ing and also preclude the need for a much larger effort later on. In effect, we save both lives and money.

You Are Talking Now About Disasters Such As Drought, Rather Than Say A Catastrophic Earthquake?

Earthquakes and volcanic eruptions, compared to droughts, provide little advance warning. In the case of drought, however, with its widespread, long-term effects, a system could and should be devised to monitor potential problem areas and warn of food shortages, so that a timely, cost-effective, and well-planned assistance program can be established to minimize human suffering. And drought-induced famine is the most difficult of all natural disasters to cope with, because it evolves slowly. Too often in the past, it has been recognized only when the situation has reached the crisis stage.

Like The Sahelian And Ethiopian Droughts?

Yes. Early detection and estimation of the severity and extent of drought is the most important element in any drought/famine relief effort. That's why the support provided by NOAA is so critical to our program. The suffering that follows drought in tropical countries can be allievated if help arrives in time. To get food and

Left: Drought victims search for water in a remote area of Wollo Province, Ethiopia in 1973.
FAO photo by B. Imevboro

Above: Trees are chopped up to provide livestock with leaves for food in the African Sahel during the 1973-75 drought.
Agency for International Development photo

medical supplies to a disaster area when it it needed, however, requires some lead time, depending on the type of disaster. 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.

And These Objectives Tie In With The Work NOAA/EDIS Is Doing In Crop-Yield Modeling And Weather Assessment?

Definitely. My office and EDIS' Center for Environmental Assessment Services (CEAS) have been working together for several years to develop ways to assess drought severity and extent in various less-developed countries.

Specifically, What Type Of Support Does EDIS Provide?

We expect that by this fall, EDIS scientists will be using the statistical modeling and climatic analyses techniques they have developed to project relative crop yields in the Sahel and the Caribbean on a regular basis. In the future, we anticipate extending the same approach to Southeast Asia and the India subcontinent. These projections can be used to alert both U.S. and international agencies to the need for disaster preparedness and contingency planning. They are used by AID/OFDA officials and also distributed to participating Governments, the Food and Agricultural

Organization (FAO) in Rome, the World Meteorological Organization in Geneva, and to U.S. Department of Agriculture officials. When potential problem areas are identified, full briefings are given to State Department personnel by EDIS scientists. AID-Mission personnel are alerted and oftentimes are able to provide supplemental onsite information. In addition, CEAS crop-yield estimation models provide an historical agronomic and meteorological data base for longer-term development assistance planning and program design considerations.

So There Is A Tie-in With International Programs?

Yes. We are working to integrate the results of our program into the FAO global monitoring and early warning systems on food and agriculture. FAO is enthusiastic. They are designing a system analogous to the AID/NOAA system. In addition, we have an Interagency Agro-Climatic Monitoring Working Group (AID, NOAA/EDIS, and USDA) with liaison representation from FAO and other international organizations, to assist us in disseminating research results, evaluating pre-operational weather/crop assessment reports, and establishing the institutional mechanism for operational assessment reporting.

This Is Still A Test Program Then?

Yes. We anticipate an operational capability in the Caribbean and Africa in 1981 and in Asia in 1982.

How Useful Have The EDIS Assessments Been To Date?

We have a high degree of confidence in them, based on preliminary performance, and they are of great utility in decisions concerning food aid and disaster relief. We believe that if this system had been in place before the 1973-75 Sahelian drought, there could have been considerable savings in suffering and resources. Use of the system to date has resulted in earlier shipments of food, improved efficiency in planning and implementing emergency operations, and a general confidence in AID's ability to deal with the many food production shortfall emergencies that arise annually.

Can You Cite Any Specific Benefits?

Yes. The AID African Bureau has informed our office that it was able to design and implement a highly cost-effective $45 million Drought Emergency Program for the Sahel, largely on the basis of the NOAA/EDIS weekly African weather assessments. The continual use of these reports, both in Washington and in the field, has greatly enhanced AID contingency planning decisions, resulting in probable savings of many millions of dollars.

Don't You Also Conduct A Disaster Preparedness Training Program?

We conduct disaster preparedness workshops overseas. These concentrate on local and regional problems, alternative solutions, and resources available to provide reasonable protection from risk. At these seminars, foreign disaster assistance managers learn how best to meet their own needs and, ultimately, to become independent of outside help. EDIS scientists participate in these programs.

Floods also cause hunger. Honduran children search through flooded fields to salvage ears of corn.
Agency for International Development photo

And Your Programs Provide The Technical Assistance Needed To Develop Their Own Programs?

Right. In terms of technology transfer, for example, the NOAA/EDIS estimates represent significant technological progress in crop-yield assessments in less-developed nations. The models and techniques developed by EDIS scientists are made available to the countries concerned for their own uses.

Didn't You Also Work With NOAA On A Cyclone Early-Warning System For Bangladesh?

Yes. People from NOAA's National Environmental Satellite Service worked with NASA technicians to help us install a weather-satellite direct readout (APT/WEFAX) station in that country to track cyclones. This has given Bangladesh the capacity to monitor these storms and provide early storm warnings to its people. As you know, such cyclones have claimed hundreds of thousands of lives in the past.

Sea-Surface Temperature and Climate

By Sydney Schultz

Climatic variations are likely to arise from complex interactions among the atmosphere, the oceans, and the Earth's surface. Empirical observations as well as studies using climate models have suggested that variation of oceanic conditions, especially variation in sea-surface temperatures, may be the key to understanding monthly and seasonal climatic anomaly patterns.

When air passes over the surface of the ocean, its temperature and humidity levels change. For example, cool, dry air blowing over warmer water will gain heat and moisture; the rate of gain depends on the temperature difference. The additional moisture may be released some distance away, modifying the atmospheric conditions at that point.

Thus, sea-surface temperature has the potential for producing short-term weather variations as well as long-term climatic changes.

Scientists have recorded and monitored sea-surface temperatures for many years, and their studies have linked these temperatures to subsequent weather states in an attempt to improve long-range forecasting. They have cited sea-surface temperatures (SST's) and unexpected sea-surface temperature variations (SST anomalies) as contributing factors in hurricanes, monsoons, rainfall, typhoons, length of seasons, wind patterns, and severity of winter weather.

What factors determine large-scale variations in sea-surface temperature? Several conditions are believed to be responsible:

(1) amount of solar radiation absorbed in the sea, which varies with the amount of cloud cover.

(2) evaporation and cooling, which are related to vapor pressure, temperature, and wind speed over the sea surface.

(3) depth of the mixed ocean layer affected by factors (1) and (2).

(4) heat transfer in the oceans, both horizontally in currents, and vertically through upwelling or downwelling.

Because climatic changes have such obvious and far-reaching economic, social, and political effects, any refinement in long-range forecasting capability is desirable.

Research on SST and Climate

SST anomalies ranging from 1° to 2° above or below normal (with extremes to 4.5° above or below normal) have been found in patches of water that may exceed 100 meters in depth and 1,000 kilometers in breadth. These unusually warm or cold patches have been observed to change rapidly in spring and fall (April - May/October - November), and often to persist throughout the winter and summer.

The specific processes by which these abnormal patches of water influence climate over the years are still not completely understood. Also, it is not certain whether SST anomalies initiate atmospheric changes or whether they are formed in response to such changes. The investigation of temperature and pressure relations at the air-sea boundary is a priority among oceanographers and meteorologists, who have been monitoring SST and relating the data to weather patterns in all parts of the world and to possible global climatic trends. Findings suggest an association between SST and atmospheric factors and the resulting conditions in areas located downwind or downstreem.

For example, correlations have been found between SST anomalies near Newfoundland and the atmospheric conditions over Great Britain and Europe, between SST in the North Pacific and weather in Europe and North America, between SST's in the equatorial Pacific and rainfall patterns in Australia, and between SST's in the Bering Sea and the Okhotsk high-pressure system that brings cool, cloudy weather to northern Japan.

Jerome Namias of the Scripps Institution of Oceanography of the University of California (San Diego) has done extensive research in his studies of the relation between sea-surface temperatures in the Pacific Ocean and the climate throughout the United States since the 1950's. His analysis of 26 years of SST data suggests a relationship between SST and the winter season weather patterns over the United States. He has uncovered a tendency for unusually cold SST's in the mid-Pacific, together with warm SST's off the California coast, to be associated with colder than normal winters in the eastern half of the United States and warmer than normal winters in the western half. The opposite pattern has also been observed: anomalously warm SST's in the mid-Pacific and unusually mild winters in the eastern half of the country, with correspondingly cold weather in the west.

Winters were colder than normal in the east and warmer than normal in the west during 1958-71, and Namias associated marked SST anomalies with the temperature pattern change in 1958 and again in 1971, the beginning and the end of a period of unusual winter weather.

Namias has attempted to clarify the relationship between SST and climate by studying wind patterns. SST data for 26 years indicate that summer SST's in the area of the Aleutian Islands influenced the strength, each autumn, of that vicinity's semipermanent low-pressure area known as the Aleutian low. The behavior and wind pattern of the Aleutian low have been associated with climatic conditions over North America.

Jeffery Rogers, in work done at NOAA's Great Lakes Environmental Research Laboratories at Ann Arbor, Mich., analyzed monthly SST data for the eastern portion of the North Pacific Ocean from National Marine Fisheries Service charts for January 1960 through September 1973. Statistical treatment of the data revealed three large regions of SST variability in the Pacific from 1960 to 1970. A subsequent change producing a new region coincided with the reversal in the trend toward unusually cold winters in the eastern portion of the United States (noted above). These SST areas were found to be related to fluctuations in atmospheric pressure over North America.

SST variations have been related to specific air-sea interactive weather systems such as hurricanes. C. Sergio Serra at the Institute of Geophysics in Mexico City documented the relation in the Gulf of Mexico and the northeastern Pacific Ocean between a higher SST and the resulting decrease in surface pressure, causing an increase in a hurricane's maximum winds. When hurricanes passed over a Gulf of Mexico area containing an anomalously high SST, they were seen to intensify. Conversely, when hurricanes in the northeastern Pacific passed over the cooler waters west of the Lower California peninsula, their intensity was observed to diminish. SST anomalies in the equatorial Pacific have been related to tropical cyclonic activity; to the recurrence of the El Nino phenomenon off the coast of northern Peru, which affects fish stocks and weather patterns; and to the intensity of the rainy season in northeastern Brazil, allowing a warning of potential drought or flood conditions.

The studies cited here suggest a relation between long-term, large-scale SST anomalies and atmospheric changes, which influence weather and climate. Do these results suggest that changes in SST can be used in weather forecasting or to predict global climatic events?

A 2-week experiment using the GISS (Goddard Institute for Space Studies, NASA) model of global atmospheric circulation was performed by Jerome Spar and Robert Atlas of the University Institute of Oceanography, City University of New York. They found that using observed SST's in place of expected average temperatures in the model did not lead to any general improvement in forecasting. However, these findings are preliminary only, and they serve to highlight the need for additional research of SST's, air-sea interactions, and their relation to both short-term weather patterns and long-term climatic change.

Unanswered Questions

Current work by oceanographers and meteorologists is focused on the following questions:

(1) How can current technology be applied to allow more accurate and efficient sampling of SST and SST fluctuations?

(2) How are anomalous SST patches formed and later broken up, and what are their characteristic motion and longevity?

(3) How do SST anomalies interact with the atmosphere at the air-sea boundary? What is the nature of the heat transfer mechanism at the air-sea boundary? What are the space and time scales of the interaction?

(4) To what extent can SST be used to predict unusual weather phenomena, seasonal abnormalities, and longer term climatic anomalies? In what parts of the world might this means of prediction be found useful?

Large-Scale Research Projects

Three major research efforts in the United States are investigating these issues. NORPAX (North Pacific Experiment), based at the Scripps Institution of Oceanography, is a combined effort of research, academic, and government agencies to study ocean temperatures. FGGE (First GARP Global Experiment—GARP is Global Atmospheric Research Program) is an international project to provide a 1-year examination of the global weather system. EPOCS (Equatorial Pacific Ocean Climate Study) is a new NOAA program to study SST fluctuations in the equatorial Pacific Ocean.

This is one of a series of Current Issue Outlines developed by the Library and Information Services Division of EDIS' Environmental Science Information Center. The outlines provide objective background material on current topics of general interest. This issue outline is available as a separate publication from: User Services Branch, LISD, Environmental Science Information Center, WSC#4, 6009 Executive Boulevard, Rockville, MD 20852. The original report contains an extensive bibliography that has been omitted here.

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Tsunami!

The following is a slightly edited and condensed version of an article that appeared in the July-August issue of *The New Pacific* Magazine.

For more than 200 years, the small group of volcanic islands in the Sunda Strait between Sumatra and Java had been dormant, and by the 1880's the local inhabitants were confident that the volcanoes were dead.

In the spring of 1883 this confidence was broken by a sudden explosion that could be heard 100 miles away in Batavia, now the Indonesian capital of Djakarta. It was the first indication that Krakatoa, the sleeping guardian of the straits, was awakening.

During the next few months there was continued volcanic activity in the islands, and on August 26 another huge eruption took place. At the same time, a new phenomenon appeared: a large wave, created by the underwater activity of the volcanoes, bore down on the neighboring coasts, swamping villages and causing death and destruction.

The next morning Krakatoa was torn apart by a series of colossal detonations, the third of which may have been the biggest explosion in the Earth's history and was heard 3,000 miles away on the other side of the Indian Ocean. Three more giant waves thundered onto shore, completely destroying villages and settlements all along the coasts of Java, Sumatra, Borneo, and other islands. At Merak, a town situated at the end of a bay that narrowed rapidly, the water was forced higher as it advanced and the wave grew. When it hit the town, completely destroying it, the wave was more than 135 feet high. By the end of the day, more than 37,000 people had been killed in the East Indies.

The giant wave that resulted from the eruption of Krakatoa was probably the most destructive in history. At the time, it was generally referred to as a tidal wave, but it had nothing to do with tides. Today, waves of the same type are more generally referred to as tsunami, the Japanese word for "harbor wave."

Just 13 years after the Krakatoa eruption, the coast of Honshu—the largest of the Japanese islands—was struck by a series of waves that were almost as deadly. On June 26, 1896, a mild earth tremor was felt, and almost immediately afterwards the sea began to withdraw from the coast. Then came a far-off hissing that came steadily closer, grew louder and louder, and turned into a roar as a wave estimated at 110 feet high towered above the coast and smashed down. When it was all over, more than 27,000 people were dead.

Tsunamis are probably the most destructive of all waves, not only because of their size, but because they are so difficult to detect or predict. Unlike other oceanic disturbances, they are not a product of weather, but of seismic activity. The most frequent cause is a fault produced by tension in the earth's crust: a large mass of rock, subject to enormous stress, finally drops or rises. If this takes place beneath the sea, the water above will either drop or be forced upwards. In either case, the result will be a giant wave, or waves, that race off from the center of activity at an incredible speed. It has been estimated that some of these waves can travel at more than 500 miles per hour and cover enormous distances.

Tsunamis can also be caused by underwater landslides, themselves generally caused by earthquake activity, or, more rarely, by volcanic eruptions such as Krakatoa, and the eruption of the Greek island of Santorini around 1500-1400 B.C. that probably destroyed the Minoan civilization of Crete.

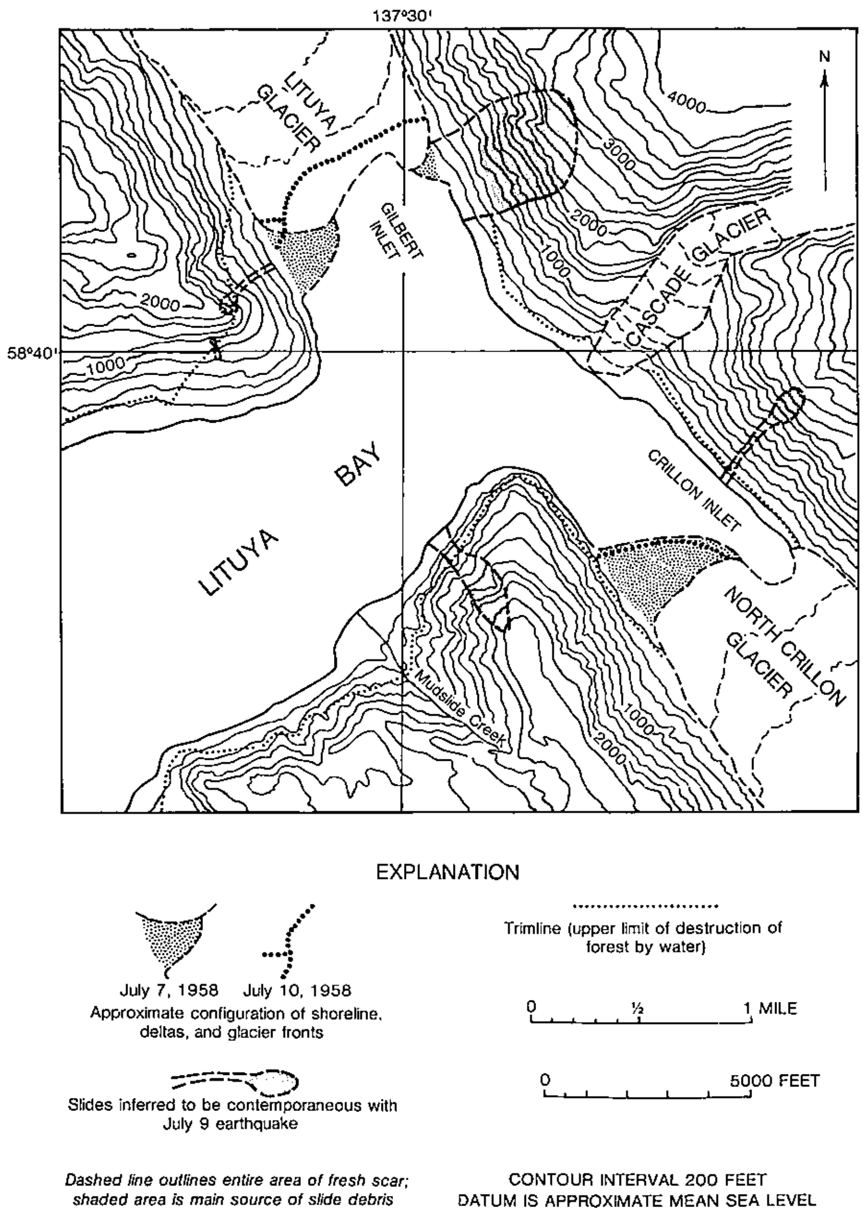
In the open sea, tsunamis are almost undetectable. When a tsunami struck Hilo, Hawaii, in 1946, the crew of a freighter a mile offshore watched the waves crashing over the tops of buildings in Hilo, without being aware that anything was passing beneath the keel of their ship. The successive waves of a tsunami in deep water are so far apart—perhaps 100 miles and fifteen minutes—and so low—maybe only a couple of feet high—and so extremely gradual in slope that they are literally undetectable. It is when they reach shoal areas that they are transformed into terrifying monsters as tall as 100 feet.

A tsunami wave is a shallow-water wave, even when passing through the deepest part of the oceans. A shallow-water wave is one where the wave length (the distance between crests) is much greater than the water depth. So, even though a tsunami may be crossing an ocean basin three miles deep, the waves are still classified as shallow-water waves, because

Right: This Kuomintang Political Party Clubhouse in Hilo, Hawaii was wrecked by a tsunami in 1960.
Corp of Engineers photo


中國國民黨分部

The effects of a great sea wave on Lituya Bay, Alaska, are shown in a "before and after" map.



their length is so great—often more than a hundred miles.

Another characteristic of a shallow-water wave is that its speed is proportional to the square root of the depth of the water: a tsunami wave in water 18,000 feet deep travels about 500 miles an hour; in water 900 feet deep, 115 miles an hour; and in 60 feet, 30 miles an hour. When a tsunami approaches shore, shoaling causes its waves to telescope by increasingly restricting their forward motion as the water becomes shallower. Also, the waves grow taller and the distance between them shrinks. In this fashion, a 2-foot wave traveling 500 miles an hour in deep water becomes a 100-foot killer traveling 30 miles an hour when it approaches shore. Throughout, however, the time interval between crests tends to remain large; this is one of the most significant characteristics of a tsunami at any stage.

On shore, the effect of the same tsunami wave may be vastly different from one point to another. Local topography is usually responsible: a bay or an estuary has a funneling effect, which accentuates the height of the wave; an offshore shoal or sandbar diminishes it. This is why in one area the wave may be 50 feet tall, while at a point a few miles away it might be only 5 feet in height.

It is the fundamental relationship between the speed of a tsunami wave and the water depth which has permitted scientists to produce a workable warning system. Accurate tsunami travel-time charts have been prepared for populated points throughout the Pacific basin and its borders, allowing monitoring of the progress of the tsunami as it travels across the Pacific. A substantial period of watchful waiting before issuing an "all-clear" is advised for good reason: the long gap between successive tsunami waves has lulled people into returning too soon to evacuated areas, only to be trapped and drowned by a successor wave, perhaps the biggest of all.

Although predictions of arrival times for first waves of tsunamis are satisfyingly accurate, predictions of tsunami magnitude are not. In fact, scientists say, because of the bewildering number of local effects that can cause variations in tsunamis, it is not now possible even to tell if a known tsunami will have any significant effect at all on shore. Consequently, there is an inescapable amount of overwarning.

Another puzzle involving tsunami is that it is usually not the

first wave that causes the most damage, but a later one. Sometimes the biggest tsunami wave will be what is known as a "bore," which occurs when one wave overtakes a preceding wave, producing a steep-faced wall of water. One of the most destructive of these was associated with the Chilean tsunami of May 1960, which inflicted major damage on Hilo, Hawaii. It was triggered by an earthquake which shook Chile on May 22; the destructive waves reached Hilo just after midnight on May 23. The tsunami had traveled the 6,600 miles in just under fifteen hours, at an average speed of 442 miles an hour. Because of timely warnings, the death toll of 61 was much less than for previous, comparable tsunamis.

Refinement of the tsunami warning system through faster communications between far-flung seismological observatories and tide stations, and coastal dwellers, is perhaps the limit of man's defense against the awesome power of tsunamis.

In 1958, an earthquake in Alaska sent 90 million tons of rock crashing 3,000 feet into Lituya Bay in a remote coastal area of Alaska. A huge wave was sent across the bay at 100 miles per hour, and rose above the land on the other side to a claimed maximum height of 1,740 feet. Against a natural force of that scale, there can be no real defense."

A tsunami-collapsed road on the Island of Kauai, Hawaii.
Corp of Engineers photo

More on Krakatoa

A tsunami, seismic sea wave, or—erroneously—tidal wave, is a rare underwater seismic phenomenon that has been responsible for some of the worst calamities. One of the most devastating tsunamis in recent recorded history was generated by the eruption and explosion of the volcanic island Krakatoa, located in the Sunda Strait between Java and Sumatra, Indonesia, in 1883.

The Krakatoa Island Group consisted of three islands, all situated at least in part on the rim of the volcano's caldera. The main island of the group, Krakatoa, consisted of three overlapping cones 2,700 feet high.

The eruption and subsequent explosion associated with the Krakatoa event began on May 20, 1883, when the seemingly extinct giant began to stir for the first time in over 200 years. With almost 50 active volcanos in Java alone, there was no way to anticipate the impending calamity signaled by these initial rumblings.

The first sporadic salvos of activity involved only one of the three cones of Krakatoa. By early August 1883, the activity had increased to the point where all the cones were actively spewing out volcanic ash, which collected to a depth of over two feet on the island. The ash completely denuded it of all the formerly lush vegetation.

The climax of the eruption came suddenly. At 1 p.m. on August 26, the first of more than 30 violent explosions occured. These explosions increased in intensity through the rest of the day and night. A cloak of falling ash accompanied the explosions. This ash rained on an area of 100 miles radius for as long as two and a half days. During this time, visibility, even with lamps, was restricted to no more than a few feet. The sound of the explosions could be heard all over Java and Sumatra.

The first of the tsunamis associated with the eruption occurred about 5 p.m. on August 26. The waves from this initial tsunami were a preview of the destruction to come as they swept over the low-lying coastal regions of Java and Sumatra. As the explosions continued and increased in intensity through the night, so did the tsunamis.

Then at 7 a.m. on August 27, there came the sound of a much larger explosion. The great wave accompanying this explosion lifted the gunboat *Berouw* over the beach and deposited it in the center of the remains of the coastal town of Telok Betong. A short time after this great wave, an even larger explosion occurred which has been called "the loudest noise on Earth." It was heard over 2,200 miles away in Australia. Accompanying this greatest of explosions was a tsunami whose waves far exceeded those of any other tsunamis produced during the event. This tsunami had waves associated with it that were more than 130 feet high. These waves picked up the gunboat *Berouw* from where it had been originally deposited and carried it over a mile inland, leaving it deposited 30 feet above sea level.

The tsunamis that were generated by the explosions of Krakatoa were accompanied by atmospheric pressure waves. These waves were said to have circled the Earth more than three times and to have caused ocean waves that were recorded worldwide.

The destruction caused by the eruption and explosion of Krakatoa spread ash up to tens of feet thick over a 300,000 square mile area, wiped out coastal towns and facilities over a wide area of Indonesia, and killed over 36,000 people.

There have been five significant tsunamis generated in modern times: April 1, 1946; November 5, 1952; March 9, 1957; May 22, 1960; and March 27, 1964. These events, although not of the magnitude of the tsunamis associated with Krakatoa, have together caused more than 1,000 deaths and property damage in excess of $150 million.

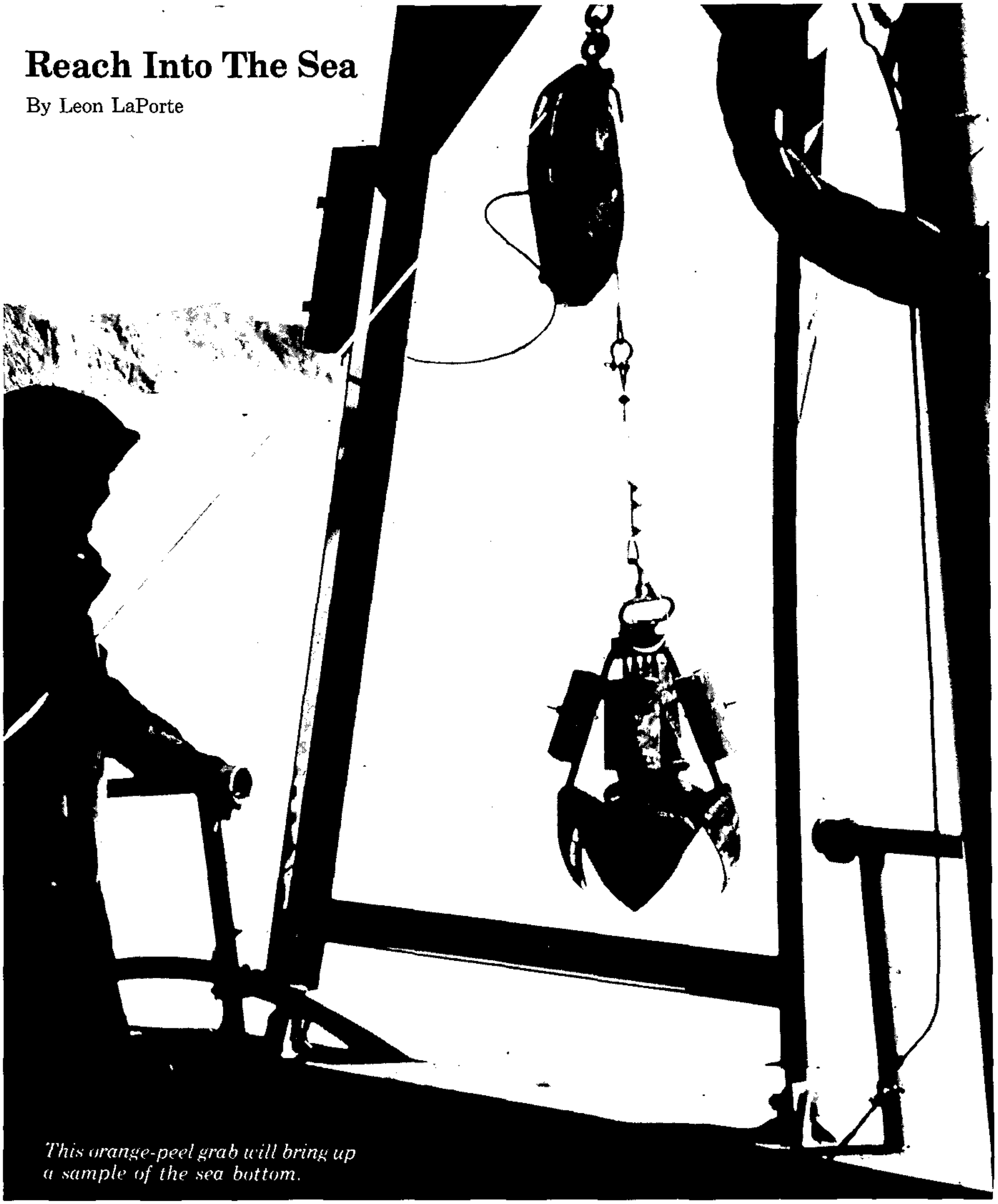
In December 1974 the National Geophysical and Solar-Terrestrial Data Center (NGSDC) of the Environmental Data and Information Service (EDIS) accepted the responsibility of maintaining World Data Center-A for Tsunamis. As a result, NGSDC is compiling a comprehensive tsunami data base to aid researchers in understanding one of the most complex, catastrophic, and misunderstood natural disasters.

NGSDC has obligated a considerable portion of its resources to doing its part in helping to better understand this devastating natural hazard. By compiling a comprehensive tsunami data base, NGSDC hopes that researchers can draw the necessary knowledge from these data to develop a practical program to reduce the destructive effects of these seismic sea waves.

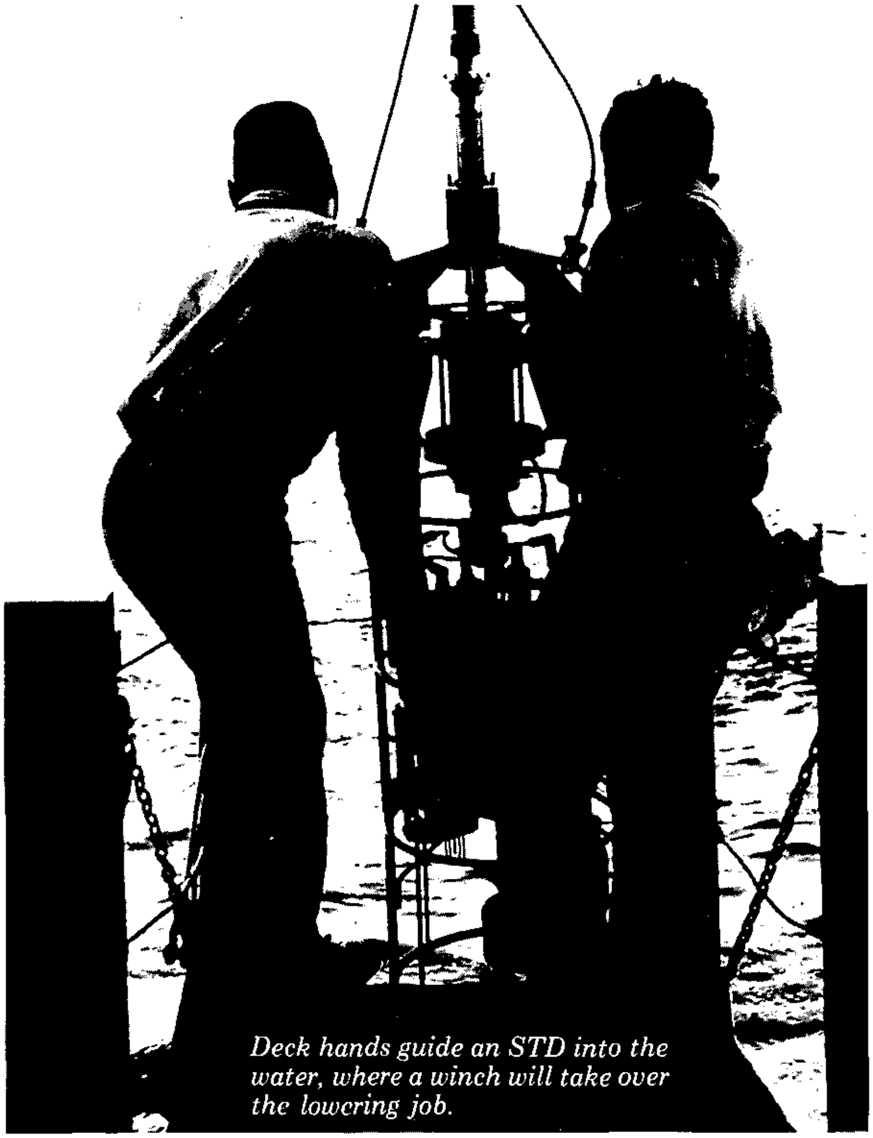
By Lt. John Nelson, NOAA Corps

Reach Into The Sea

By Leon LaPorte



This orange-peel grab will bring up a sample of the sea bottom.



Deck hands guide an STD into the water, where a winch will take over the lowering job.

The first man to appear on our planet must have been curious about his environment.

One day he came upon the ocean—perhaps the Persian Gulf or the Arabian Sea—and undoubtedly began to explore it with his five senses: he could see the ocean stretching beyond the horizon, he could smell it, he could hear its surf pounding the beach, he could feel its coldness and wetness, and he could taste its salt. This prehistoric man can be considered the world's first oceanographer.

Even early man soon realized that his senses were limited in what they could tell him about his environment. He knew, for instance, that the ocean had depth. But how deep was it? It was deeper than his arm could reach, so he extended his reach by using a stick. Now he could reach the bottom in shallow water, but not in deep water. So he extended his reach still further by tying vines together, weighting them with a rock, and lowering away. As man progressed, his instruments—the extensions of his senses—became more complex, culminating in today's sophisticated array of oceanographic sensors and samplers.

Although surface water samples can be collected with a bucket, water samples from the deep ocean require special sampling bottles. Some open bottles are attached to a wire, at intervals determined by the scientist, and are lowered into the ocean. When they reach the desired depth, a weight is sent down the line. The weight trips the first bottle, causing it to turn over. As the bottle turns, it closes, trapping a sample of water. It then releases another weight to trip the next bottle. When all the bottles are closed, they are brought back on deck. The water samples now can be analyzed to determine how much salt or oxygen they contain. Another kind of bottle is placed in groups on a circular frame as horses are placed on a merry-go-round. The frame is lowered on a cable, and the individual bottles closed when desired by a signal from a shipboard scientist.

One instrument used for measuring ocean temperatures at great depths is the deep-sea thermometer. This mercury-in-glass thermometer was developed by the Negretti and Zambra Firm of London, England, in 1874. Today, 105 years after its invention, this thermometer is still used in obtaining precise temperature data from the deep ocean. Its accuracy is within 0.04 degrees.

The deep-sea thermometers can be attached to the water sampling bottles, to determine the water temperature at each sampling depth, down to the ocean floor. Down to 900 feet, the temperature can also be measured by a mechanical bathythermograph, a device that draws a continuous temperature graph on a goldplated glass slide carried within. To make continuous temperature recordings to 1,500 feet, another type of bathythermograph can be used.

With this instrument, a probe dropped into the water measures the temperature while descending and relays the information through a wire to a recorder aboard ship. Since the probe falls to the bottom and remains there, this instrument is called an expendable bathythermograph.

An instrument called the STD—for salinity (salt content), temperature, and depth—can continuously measure and record these data to depths of 18,000 feet. This instrument also may be equipped with an audio sender-receiver unit, to measure the velocity of sound through the water. Sometimes, water sampling bottles are placed around an STD merry-go-round style.

Postcard-sized cards can be placed in plastic bags and used to study ocean currents. Glass bottles have also been used. Either drifter may be washed up on land, many years later, thousands of miles from the launch site. If scientists know when and where the drifter was launched and recovered, they may be able to reconstruct the path of the currents which carried it ashore. However, these findings may not always be exact. Meters that measure the speed and direction of currents that pass a certain location are also in use.

To catch tiny floating organisms called plankton, a net similar to a nylon stocking is used. By weighing the plankton sample, or by determining how much water it displaces, scientists can determine the amount of food available for fishes and other marine animals (such as whales or clams).

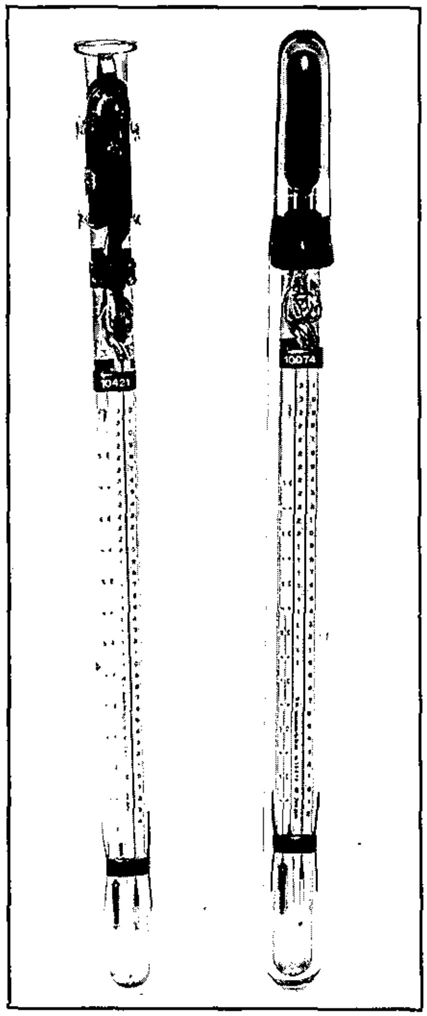
Several types of instruments may be used to take samples of material found at the ocean bottom. One is a grab which scoops up bottom sediments in a manner similar to the way a person grabs a handful of sand. Another is a dredge which drags up bottom material just as a rake picks up leaves. Still another instrument, a corer, takes a tube full of bottom material just as we remove the core from an apple.

The result of man's probing of the sea is oceanographic data—measurements of temperature and salinity, of oxygen available to fish and other sea creatures, of phosphorus and nitrogen available to plants, of silicon available to sponges and plankton, of water acidity, and of the currents that circulate large volumes of water from one part of the ocean to another.

For all these data, there must be a place where they can be centrally processed, then disseminated in their most useful form to all users. Thus, in 1960, the United States established the world's first National Oceanographic Data Center, now a part of NOAA's Environmental Data and Information Service. Since its founding, other countries have established similar data centers.

At the Center, the data are processed by high-speed computers, and geographically sorted so that the user will receive only data pertaining to the part of the ocean he wishes to study. The computer can also draw charts to show where samples were taken, or plots to depict oceanographic parameters—for example, average water temperatures versus depth—in a certain part of the ocean for one or several months.

Data users apply the information in many ways: temperature data are used to determine the location of fishes; salinity data to determine the best areas for oyster farming; nutrient data to determine the availability of material for growth of drug producing plants; current data to design oil rigs and to aid navigation; descriptions of core contents to determine the location and quantity of minerals; water density data to determine underwater sound velocity for SONAR equipment; temperature, salinity, nutrient, current, core, and density data to study changes in the ocean environment due to pollution or construction of an offshore facility.



Reversing thermometers in lowering position (before reversal). Protected (left) and unprotected (for measuring pressure).

Through the use of instruments and data centers, man has learned much about the ocean. He has applied his knowledge to make better use of the resources and characteristics of the sea. But one enormous task remains—to use this knowledge to determine the ecological balance of the ocean so that some day we may return it to the unspoiled state in which the first curious man found it.

Eratosthenes: Founder of Geodesy

By Patrick Hughes

Four hundred years before the birth of Christ—and nineteen hundred years before Columbus set sail—Greek scholars had already concluded that the world was round. About 240 B.C., one of the ablest and today least known of these scientists of antiquity, Eratosthenes of Cyrene, succeeded in scientifically and accurately calculating the circumference of our planet.

Eratosthenes was a man of many talents. A mathematician, poet, astronomer, grammarian, the first geographer of note, and the founder of scientific cartography, his nickname was "Beta," the second letter of the Greek alphabet, which some historians think meant he was considered the second greatest scholar in each of the scientific fields of his day. His students called him "the second Plato," after the greatest of ancient Greece's wise men.

Born in Cyrene about 276 B.C., Eratosthenes was educated at Athens and Alexandria and, in 235, was appointed head of the Library of Alexandria, then the world's greatest center of learning. The Library had been founded by Ptolemy 1, one of the leading generals of Alexander the Great and the first Macedonian king of Egypt, who had earlier established the school of mathematics where Euclid, the father of modern geometry, taught. A few simple principles of Euclid's geometry were all that Eratosthenes needed to make his amazingly accurate measurement of the earth.

The above article is reprinted from *NOAA* Magazine.

Eratosthenes knew that at noon on the longest day of the year, June 21, the summer solstice—when the sun (sol) was farthest from the Equator and appeared to pause (sti) before starting southward again—an upright column at Syene (now modern Aswan) in central Egypt cast no shadow on the ground, indicating that the sun was directly overhead. (Eratosthenes checked this by noting that the sun's rays shown directly down a deep well at Syene, illuminating it to its depths, with the sides casting no shadows on the water's surface.)At the same time, however, in Alexandria, a similar column did cast a shadow; there the sun was not directly overhead.

Now Eratosthenes assumed that Syene was exactly south of Alexandria (not quite), and he knew that at noon the shadow on the ground at Alexandria lay due north and south. From this he reasoned that the columns at Syene and Alexandria, the center of the earth, and the center of the sun—as it paused directly over Syene—must all lie in the same plane. Working from this assumption, the solution to the problem of the earth's circumference was simple.

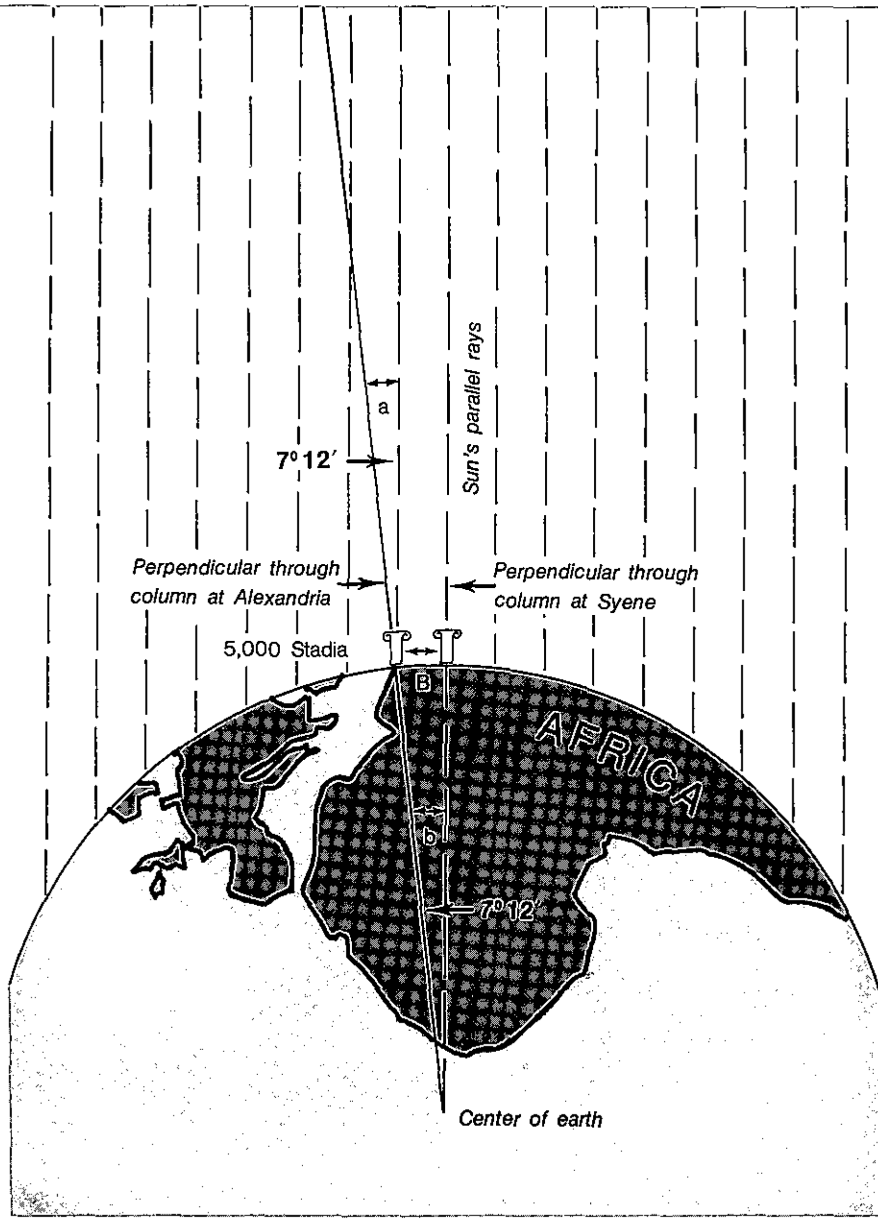
Since perpendicular lines through the columns at Alexandria and Syene must meet at the center of the spherical earth, and since the rays of the sun are parallel to each other as they strike the earth, Eratosthenes knew—from Euclid's geometry—that the angle between the perpendicular lines meeting at the center of the earth was equal to the angle between the column at Alexandria and the sun's rays.

By measuring the length of the column's shadow, he calculated that the angle made by the sun's rays and the column was equal to seven degrees, twelve minutes, or 1/50 of the circumference of a circle, 360 degrees. Therefore, the angle at the center of the earth,and its arc—the distance between Alexandria and Syene—also equaled seven degrees, twelve minutes, or 1/50 of the earth's circumference. To find the circumference of the earth, all Eratosthenes now had to do was to multiply the distance between the two cities by 50.

Such distances had been measured by the surveyors of Alexander the Great and King Ptolemy during a conquest of Egypt. Eratosthenes used a figure of 5,000 "stadia" (a measure based on the length of a stadium) for his calculations, probably an approximation to enable him to work with round numbers.

Thus, the polar circumference (since he was measuring north and south) was equal to 5,000 stadia multiplied by 50, or 250,000 stadia. Since the usually accepted value of Eratosthenes' unit of measurement is roughly 1/10 of a modern mile, this would give a circumference of approximately 25,000 miles; the actual polar circumference is 24,860 miles. Eratosthenes' magnificently accurate measurement was, no doubt, due in part to a happy cancelling out of minor errors and approximations, but his logic was clear, his concept brilliant, and his method scientific.

Using his value for the circumference, Erathosthenes computed the length of the polar axis of the



Eratosthenes' Calculation: According to Euclid, when a straight line (the perpendicular through the column at Alexandria) intersects two parallel lines, the corresponding angles are equal. Therefore, angle "b" equals "a" which equals 7 degrees 12 minutes or 1/50 of the circumference of the circle. Arc "B," then, 5,000 stadia long, represents 1/50 of the Earth's circumference.

earth to be about 7,850 miles—only 50 miles less than the modern value. According to Plutarch, the famous Greek biographer, he also calculated the distance to the sun to be 804,000,000 stadia or 80,400,000 miles. This was also a remarkable measurement, considering the crudeness of the instruments available; today we know that this distance, on the average, is equal to about 92,900,000 miles.

Later in life, around 200 B.C., Eratosthenes constructed a map of the then-known world, the first map, so far as we know, on which lines of latitude and longitude appeared. He called his latitude lines "parallels" and those of longitude "meridians," as man has done to our own day. Eratosthenes' map really marked the beginning of the science of navigation, just as his accurate measurement of the earth's circumference was a major milestone in the science of geodesy. His work was a forerunner of the extensive programs in both cartography and geodesy carried on today by NOAA's National Ocean Survey.

The earth was later "measured" by Posidonius, a native of Apameia, Syria, who came up with a figure of 18,000 miles for its circumference. This value was accepted by Claudius Ptolemy, whose maps underestimating the size of the earth were to dominate cartography and geography for some 1,500 years and play a decisive role in convincing Columbus that he could reach Asia by sailing westward. If Ptolemy's maps had been based on Eratosthenes measurement of the earth's circumference, rather than that of Posidonius, Columbus might never have attempted his historic voyage.

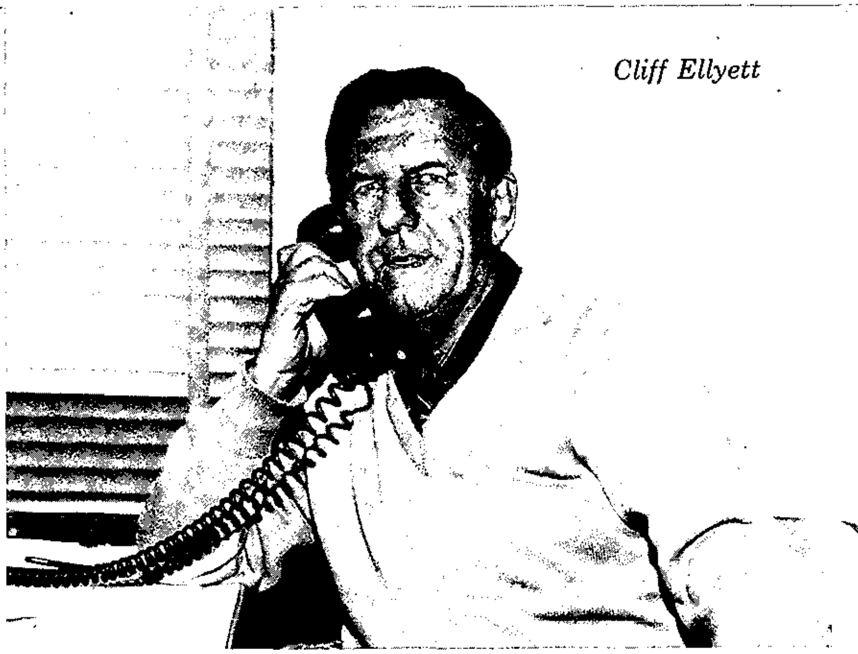
NGSDC Guest Worker Program

By Doris Stewart

Dr. Maurizio Candidi

In fulfilling its role as both a national and a world data center, EDIS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) conducts an informal Guest Worker Program to encourage interested scientists to visit and make onsite use of the varied data collections and analysis facilities. NGSDC operates the World Data Centers A for Solid Earth Geophysics, Solar-Terrestrial Physics, and Glaciology on behalf of the International Council of Scientific Unions (ICSU).

All Guest Workers at NGSDC are provided with office workspace, access to graphics facilities such as CRT/hardcopy units or computer produced microfilm, use of special viewing and display devices, and the opportunity to share new ideas within a creative scientific research environment. Also, all visitors are provided with nominal, shared secretarial support and access to local communication facilities. While it is not practically possible for NGSDC to assign support staff, such as a programmer to work with each visitor, every effort is made to provide



Cliff Ellyett

Peter Davies

enough interactive support to permit the visitor to use the archives efficiently and to apply personal programming skills on the local computer system.

For further information about the NGSDC Guest Worker Program, contact: Chief, Data Studies Division, National Geophysical and Solar-Terrestrial Data Center, RB-3, Boulder, CO 80303.

Toyohisa Kamei came to NGSDC/WDC-A under the sponsorship of Kyoto University and the Japanese Society for the Promotion of Science (Japan's equivalent of the U.S. National Science Foundation). During his almost 2-year stay as a Guest Worker and Cooperative Institute for Research in Environmental Sciences (CIRES) Research Associate, Kamei assisted in collecting information about the International Magnetospheric Study (IMS). NGSDC operates the IMS Central Information Exchange (IMSCIE) office. Kamei also computerized the IMS Directory of Participants, which included some 2,000 persons, institutes and organizations; improved the collection of information about Japanese IMS programs; initiated a more effective channel for relay of information about U.S. and European IMS activities to Japan; and conducted research into solar variations and lunar effects on geomagnetic indices. In addition, Kamei used his knowledge of Japanese computers to interpret digital tapes from Japan that had resisted previous efforts by experienced NGSDC computer staff.

Peter Davies is a visiting scientist from Australia's Ionospheric Prediction Service in Sydney. Davies was given a year off from his duties of predicting the quality and details of radio communication to come to NGSDC/WDC-A to participate in IMS office programs. Davies trip was sponsored by the Ionospheric Prediction Service and the Australian Ministry of Science. He has also participated in the work of the NOAA Space Environment Laboratory's Space Environment Services Center—the U.S. counterpart of his home institution in Sydney.

Dr. Maurizio Candidi is a space scientist from the Laboratory for Space Research of the National Research Council in Frascati, Italy. Candidi has been a Guest Worker at NGSDC/WDC-A since September 1977. He came to the Center under contract to the European Space Agency as a part of their contribution to the International Magnetospheric Study (IMS). While at NGSDC, Candidi has prepared IMS Newsletters; established liaison with U.S. scientists involved in IMS programs; and prepared weekly telexes to inform the satellite community about high- and low-altitude satellites and their interaction with ground-based arrays and experiments. In addition to IMS contributions, Candidi has studied the U.S. Air Force's precipitating data in an attempt to identify characteristic signals when satellites pass through the intense radiation regions of the northern and southern auroral ovals. Of further interest to Candidi is how these regions change their shapes and locations during increased solar activity. He has also begun processing data collected by the European Space Agency's GEOS-1 satellite magnetometer—a project for which he is one of the principal scientists.

Clif Ellyett from the University of Newcastle in New South Wales, Australia recently spent 3 months at NGSDC as both a Cooperative Institute for Research in Environmental Sciences (CIRES) Research Associate and Guest Worker to complete a paper on the services provided by NGSDC to its user public. Ellyett also completed a bibliographic search to collect papers published in the field of Solar and Earth Weather/Climate. His search involved publications available since NGSDC's Second Working Document was published on this subject in August 1977. Ellyett returned to his duties as head of the University of Newcastle's Physics Department in March 1979.

Thomas N. Gautier and Dr. Newbern Smith are two U.S. non-supported NGSDC Guest Workers who are now retired after long careers in ionospheric sciences. Gautier, the first chief of NGSDC's Data Studies Division, is working on two research papers. Dr. Smith, former Director of the National Bureau of Standards' Central Radio Propagation Laboratory, is continuing research into the measurement of properties of the ionosphere. He has conducted surveys of old data collections, evaluated new ionospheric techniques, and provided advisory services to NGSDC staff.

Toyohisa Kamei

Thomas N. Gautier (left) and Dr. Newbern Smith

Oil Well Data Packages Made Public

The U.S. Geological Survey (USGS) recently released well logs and auxiliary reports and information to the National Geophysical and Solar-Terrestrial Data Center (NGSDC) from the COST (Continental Offshore Stratigraphic Test) Wells B-2 and B-3, located in the Baltimore Canyon area. These data sets are now available for public sale.

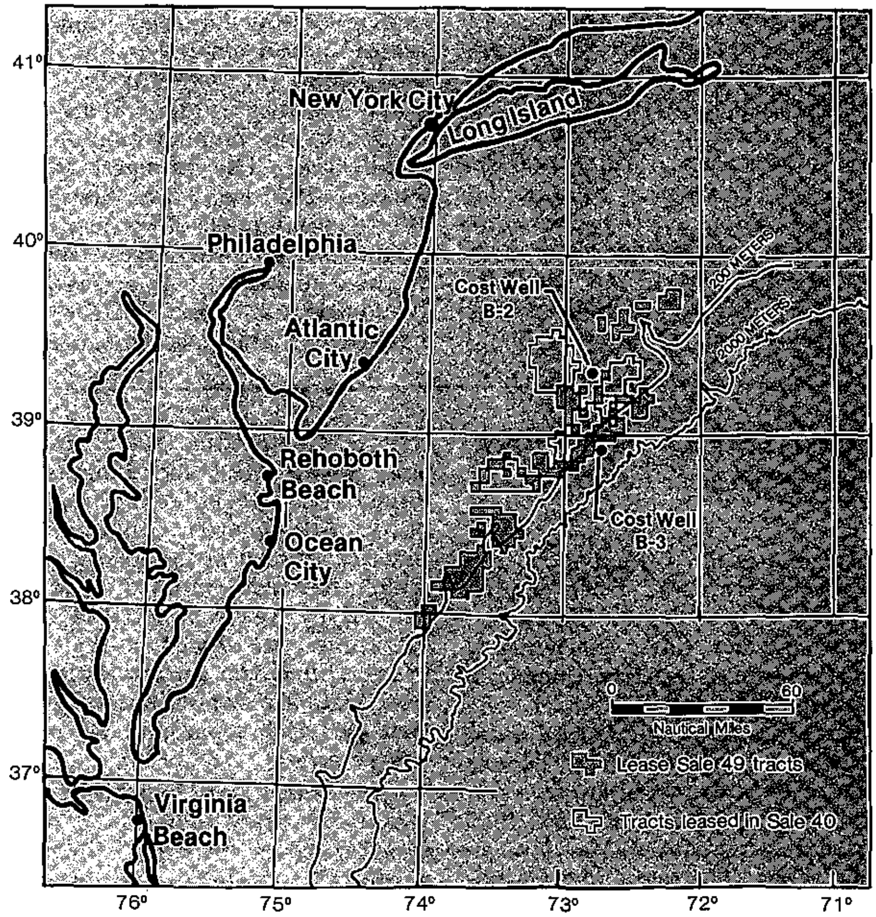
Well B-2 is the first test well on the Mid-Atlantic Outer Continental Shelf drilled for a group of oil companies from December 1975 to March 1976 to help evaluate the petroleum potential in the Baltimore Canyon Trough. Drilling results indicated a potential for oil and gas in that area.

Well B-3 is the second deep test well on the Mid-Atlantic Outer Continental Shelf to be drilled for the oil companies from October 1978 to March 1979. The well was drilled in 2,686 feet of water to a depth of 15,820 feet and revealed reservoir rocks with good potential for oil and gas below 14,000 feet, and a significant show of gas in a sandstone interval between 15,744 and 15,752 feet.

Technical reports (on microfiche) and raw data (on microfilm) for Wells B-2 and B-3 are available, respectively, at costs of $40 and $100 each.

USGS also provided NGSDC with a data set from high-resolution marine geophysical surveys of the Baltimore Canyon Trough. The surveys, performed June through December 1978 provided USGS with information regarding potentially hazardous geological structures or conditions prior to the scheduled oil and gas lease sale. The data set consists of raw data and documentation, interpretive maps, and a technical report. The cost of the total package is $345 for sepia and $305 for blackline.

An additional well log data package provided to NGSDC by USGS is from the National Petroleum Reserve in Alaska (NPRA). These logs and histories represent data acquired from six wells drilled in NPRA during the 1977-78 drilling season. The wells were drilled under the direction of the Geological Survey to provide data for an assessment of petroleum reserves in that area. Inquiries concerning the cost of these data packages should be addressed to NGSDC/NOAA/EDIS, Code D21, Boulder, CO 80303.



Wells B-2 and B-3, Baltimore Canyon area, Outer Continental Shelf.

United States Earthquakes, 1977 Published

The annual summary of earthquake activity in the United States and nearby territories has been published for 1977. This report covers the Panama Canal Zone, Puerto Rico and the Virgin Islands, in addition to the fifty states. The publication is prepared jointly by EDIS' National Geophysical and Solar-Terrestrial Data Center and the U.S. Geological Survey. The *United States Earthquakes* series has been published since 1928, when the Coast and Geodetic Survey started regular annual summaries of information on all felt and damaging earthquakes in the United States.

The purpose of this publication is to provide a continuous history of U.S. earthquakes for studying seismic risk, evaluating nuclear power plant sites, designing earthquake-resistant structures, and answering inquiries from the scientific and general public. Descriptions of earthquakes as small as magnitude 1.5 are included in the main section of the publication. The strongest shock during 1977 was an Aleutian Islands earthquake of February 19, magnitude 6.7. The largest tremor in the continental U.S. occured on November 22 near Willits, in northern California, magnitude 5.2. This earthquake was felt over an area of about 15,000 square km.

The annual report contains sections on geodetic work of seismological interest, tidal disturbances of seismic origin (tsunamis), and principal earthquakes of the world for 1977. A summary of accelerograph records obtained from the Geological Survey strong motion network is also included.

United States Earthquakes, 1977 is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, for $3.50. The stock no. is 003-019-0007-1. This publication is also available through local GPO bookstores.

Digital Bathymetric Data for Alaska

The National Geophysical and Solar-Terrestrial Data Center (NGSDC) has detailed hydrographic data (bathymetry, bottom characteristics, dangers to navigation) available for 247 one-degree areas of the Alaska coast, including the Aleutian Islands. These data are from surveys conducted between 1930 and 1965. About 97 percent of the data are soundings. The remainder are bottom characteristics (clay, mud, soft, sticky, etc.) and dangers to navigation (wrecks, pilings, rocks, etc.). All records contain the registry number of the survey from which they were obtained, the date the survey was completed, a cartographic code describing the type of data, and the geographic position. Data are sorted by geographic position and separated by one-degree areas.

The data are available on magnetic tape. They are also available in various plotter products, including sounding plots, gridded data plots, bottom profile plots, and bottom characteristic plots.

The data may be obtained from NGSDC at the following prices: tapes and documentation, $60; plots, $100. Prices for special plots or tape products, such as gridded data, might exceed listed prices to cover computer costs. Estimates of additional charges will be provided upon request.

Address inquiries to NGSDC/EDIS/NOAA, Code D621, Boulder, CO 80303 or call (303) 499-1000, ext. 6338, FTS 323-6338.

Free Guides to U.S. Publications

As the principal agent for the sale of U.S. government publications, the Superintendent of Documents has nearly 25,000 titles in stock. Two free guides describing the services provided by the Superintendent of Documents are available. Domestic customers should ask for the *Consumers Guide to Federal Publications*. Customers outside of the continental United States should ask for the *International Buying Guide to U.S. Government Publications*.

To obtain copies of the Guides, address your request to: C.A. LaBarre, Assistant Public Printer, Superintendent of Documents, Government Printing Office, Washington, DC 20401.

Domestic customers may now purchase publications by charging them to Master Charge or Visa accounts. Customers wishing to use one of these services should furnish their credit card number and date of expiration. Master Charge customers must also furnish their interbank number. Credit card purchases will be accepted in all Government Printing Office bookstores and on mail orders to the central office in Washington, D.C. Telephone orders may also be placed at any bookstore or by calling the order desk in Washington at 202-783-3238.

Solar-Terrestrial Physics and Meteorology Bibliography

Solar-Terrestrial Physics and Meteorology: Working Document II, a bibliography compiled by A.H. Shapley, C.D. Ellyett, and H.W. Kroehl of the National Geophysical and Solar-Terrestrial Data Center, has been issued. The Scientific Committee for Solar-Terrestrial Physics (SCOSTEP) sponsored the 131-page pulication.

In recent times, there has been increased interest in solar-terrestrial physics and meteorology (STP-M) by the World Meteorological Organization. In addition, major undertakings of assessment of STP-M are underway in several countries, and major international programs are underway or in the early planning stages which, though not devoted to STP-M as such, should provide important scientific information and data towards solution of the problems. Progressing are the First GARP Global Experiment (FGGE) and the International Magnetospheric Study (IMS). Planned experiments are the SCOSTEP Solar Maximum Year (SMY), the Middle Atmosphere Program (MAP), and the World Climate Program.

This bibliography seeks to address three problems in STP-M: the processes in the magnetosphere and ionosphere which are involved in the coupling of solar particle radiation with the atmosphere; the processes in the middle atmosphere which must be involved in any coupling of the solar-terrestrial physics-influenced magnetosphere and the troposphere; and the detailed study of the lowest atmosphere which will help identify weather anomalies that may be traced to solar-terrestrial physics effects.

Aquaculture Data Base Available Online

The NOAA Aquaculture Data Base is now available to the public through DIALOG—a nationally accessible information retrieval system operated by the Lockheed Corporation. The data base provides information from domestic and foreign sources on the growing of marine, brackish, and freshwater organisms. The Aquaculture file is produced jointly by the Virginia Institute of Marine Sciences and EDIS' National Oceanographic Data Center, with funds provided by the National Marine Fisheries Service and NOAA's Office of Sea Grant. Domestic and foreign books, periodicals, and conference and symposium proceedings are scanned routinely. Experts in all aspects of aquaculture were consulted to insure inclusion of the most useful information. The file contains more than 4,300 records dating from 1970 to the present. Subjects covered include life history, growth requirements, engineering, economics, legal aspects, disease, and feed and nutrition.

NODC edits input to the file and furnishes tapes to EDIS' Environmental Science Information Center (ESIC). In turn, this Center sponsors availability to the file on DIALOG. Inquiries should be addressed to: User Services Branch, NOAA/EDIS/ESIC/LISD, 6009 Executive Blvd., Rockville, MD 20852.

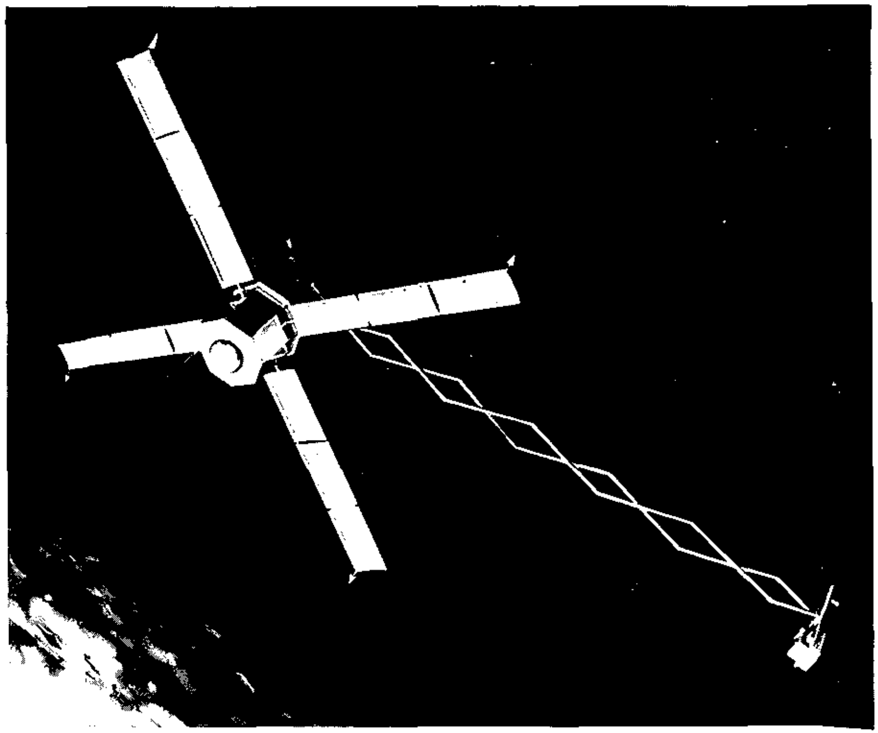
NGSDC Supports NASA Satellite Program

EDIS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) is participating in the support of the National Aeronautics and Space Administrations's MAGSAT Satellite Program. MAGSAT is a satellite scheduled for launch in the fall of 1979 and is designed to measure the Earth's main geomagnetic vector field. This is the first satellite specifically designed for measuring the Earth's magnetic field as applied to solid earth studies, including the development of better geomagnetic reference field models. The satellite will occupy a low polar orbit (325 to 525 km). NGSDC's responsibility will be to obtain recent secular change data (the slow shift in the main field over a period of years) for the magnetic field and to provide a range of archival and data services to investigators engaged in the MAGSAT program.

The most serious problem with geomagnetic references field models is the uncertainty of the secular magnetic change terms. This is due to a lack of current information for many parts of the world. NGSDC has unique knowledge of, and professional contacts with, worldwide magnetic observatory programs and the resulting annual means and repeat station data. A special effort will be made to get current data.

Contacts and visits to the observatories will be made to encourage the establishment of new observatories in areas of sparse data; stimulate interest in continued operation (or even reopening) of old observatories; encourage new repeat surveys; and investigate the possibility of periodic reoccupation of old observatory sites for secular change information. Also, NGSDC will evaluate instruments and quality of operations; assist in computation of important data; attempt to resolve known data discrepancies and discontinuities in observatory annual means; locate data not in the MAGSAT program file and compare such data with local file data.

NGSDC will establish and maintain services to accession MAGSAT data and perform such services as data filing, retrieval, plotting, gridding and derivation of magnetic anomaly information.



MAGSAT will use a 20-foot boom to extend magnetometers out into space.

NASA photo

Two New Solar-Terrestrial Physics Reports Published

World Data Center-A for Solar-Terrestrial Physics in Boulder, Colorado, has just published and distributed Reports 72 and 73 in its UAG series of data reports on the solar, interplanetary, and near-Earth environments.

David M. Rust and A. Gordon Emslie compiled and edited Report UAG-72, entitled *Energy Release in Solar Flares*. This 65-page document presents the proceedings of a workshop held in Cambridge, Mass., from February 26 to March 1, 1979. Thirty-two scientists from the United States, U.S.S.R., the United Kingdom, the Netherlands, France, Japan, and West Germany contributed to the recommended observations and objectives outlined in the report. The participants designed a scientific program to test current theories of thermalization, particle acceleration, and mass motions in flares during the Solar Maximum Year. Due to the complex physics of the flare problem, almost all tests require many simultaneous observations by ground-based and satellite-borne instruments. Report UAG-72 helps to provide the rationale for the worldwide collaboration.

J.H.Allen, C.C. Abston, J.E. Salazar, and J.A. McKinnon coauthored Report UAG-73: *Auroral Electrojet Magnetic Activity Indices AE (11-12) for January-June 1975*. This 111-page report represents the thirteenth such compilation of derived Auroral Electrojet (AE) indices. Published AE indices in UAG Report form span the years 1966 through 1975 and the first 4 months of 1976. This index provides a global, quantitative measure of auroral zone magnetic activity produced by enhanced ionospheric currents flowing below and within the auroral oval. Specifically, the total range of deviation at an instant of time from quiet day values of the horizontal magnetic field component around the oval defines this index. UAG-73 includes tables of the hourly average AE and related indices for each day, as well as tabulations of the stations making the main contribution to these hourly values. Daily graphs of the index variations and of the frequency and amplitude of extreme variations at each site are also included. AE has been used both qualitatively and quantitatively as a correlative index in the studies of magnetic substorm morphology, the behavior of communication satellites, radio propagation and radio scintillation, and to study the coupling between the interplanetary magnetic field and the Earth's magnetosphere.

World Data Center-A for Solar-Terrestrial Physics, NOAA, D63, Boulder, CO 80303, sells Report UAG-72 for $1.50 and UAG-73 for $1.75 each. Checks or money orders should be made payable to Department of Commerce, NOAA/NGSDC.

GATE Seminar Held

Five years after the field phase of the GARP (Global Atmospheric Research Program) Atlantic Tropical Experiment (GATE), the National Academy of Sciences' National Research Council called together a group of GATE observational analysts, atmospheric and oceanographic theoreticians and numerical modellers at its Woods Hole Center, August 20-29, 1979. Arranged by the GATE Panel of the U.S. Committee for GARP, the seminar assessed the significance and validity of new concepts and capabilities which have emerged from that massive 100-day experiment.

The experiment focused on the dynamics of cloud clusters such as those shown by satellite images in the Intertropical Convergence Zone (ITCZ). The following conclusions were brought out at the seminar:

- A systematic relationship was established between the cloud clusters and the wave-like disturbances in the easterly wind currents of the mid-troposphere which passed from West Africa out across the GATE ship array in the tropical Atlantic about every 5 days. The brightness of cloud cluster images shown by satellites, the rain patterns shown by radar, and the horizontal and vertical motion patterns in the atmosphere, derived from shipboard rawinsonde observations, fit together in a distinct cyclical structure in space and time. This structure undergoes a cyclical evolution in phase with the oscillating easterly wind current.
- Some cloud clusters produced squall lines which passed rapidly across one or two ships of the array producing heavy rain and strong winds within a short period of time. Most clusters had less well-defined structures. But as data from both squall and non-squall clusters are analyzed, they appear to have common features. In both types, cumulus convection of the general type familiar in tropical regions dominated the early stages and produced about 60% of the total precipitation in small-scale (1 to 10 km diameter), intense showers. In this stage, the upward motion was fed by horizontal convergence in the lowest kilometer of atmosphere, and with some of the updrafts penetrating to the top of the troposphere (about 17 km), and downdrafts penetrating to the ocean surface. Much less familiar were the later stages, which produced approximately 40% of the precipitation in both types of clusters. These were characterized by thick stratified clouds, larger in horizontal dimensions (100 km) and mostly above a mid-tropospheric convergence zone (3 to 6 km). The cool air injected into the surface layer during the early stage of vigorous convection was warmed only very slowly by the sea, due to the very stable stratification and the lack of any wind. Such stagnant, stable, "wakes" persisted for many hours after the showery episodes in the doldrum conditions of GATE.
- Numerical models of cumulus populations which had been verified previously with data from the trade-wind regime, such as those from the 1969 Barbados Oceanographic and Meteorological Experiment (BOMEX), appear to account reasonably well for the early-stage heat and moisture budgets of the cloud clusters. However, the models underestimated the heating observed at higher tropospheric levels in the later stages of the GATE cloud clusters. Needless to say, the modelers are very busy developing new numerical simulations to reflect the new physical insights.

Already, the models are better able to simulate the conditions over the tropical oceans. This is necessary not only to provide better weather forecasts in the tropics, but also to increase the time span for accurate forecasting in higher latitudes.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmosphere Administration
Environmental Data and Information Service
EDIS Magazine
Washington, D.C. 20235

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Penalty for Private Use, $300

Postage and Fees Paid
U.S. Department of Commerce
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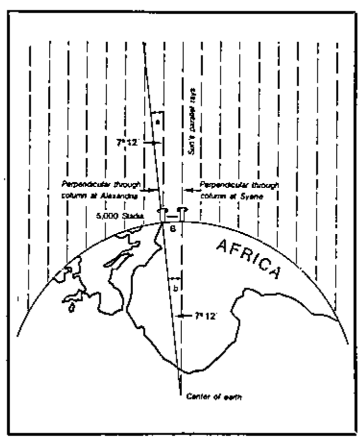
Controlled Circulation Rate



In this issue: *Reducing disaster-caused suffering in developing nations (p.3); the awesome tsunami (p.10); reach into the sea (p.15); geodesy in Ancient Greece (p.18); and guest scientists work at EDIS center (p.10).*

EDIS

Environmental Data and Information Service
Volume 11, Number 1
January 1980

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EDIS

Cover: *Lillian Bunn of Akron, Ohio describes a 1977 snowstorm. An article on the past three severe winters begins on page 3.* Beacon Journal *photo by Marcy Nighswander*

EDIS is designed to inform Environmental Data and Information Service (EDIS) cooperators, colleagues, and contributors of recent developments in EDIS programs and services and in the general field of scientific data and information management. EDIS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, and Center for Environmental Assessment Services. In addition, under agreement with the National Academy of Sciences, EDIS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology (Snow and Ice).

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.

EDIS (ISSN 0109-3365) is published bimonthly by the Environmental Data and Information Service, NOAA, Page Building 2, Room 533, 3300 Whitehaven St. N.W., Washington, D.C. 20235. For address changes, cancellation, or information write to the Editor at this address. Controlled Circulation Postage is paid to the Finance Department, USPS, Wash., D.C. 20260.

Those Recent Extreme Winters*

By Henry F. Diaz and Robert G. Quayle
National Climatic Center

This paper compares the past three consecutive winter seasons (from 1976-77 through 1978-79) with an 85-year record of temperature and precipitation averages. These winters, which will be called 1977, 1978, and 1979 respectively, were truly extraordinary in terms of the extreme temperature and precipitation anomalies recorded in the United States (figs. 1, 2, and 3). The fact that they occurred consecutively adds further significance to the anomalies.

*Condensed from "An Analysis of the Recent Extreme Winters in the Contiguous United States," submitted for publication to *Monthly Weather Review*.

Records of temperature and precipitation on file at the National Climatic Center in Asheville, N.C., extend back into the latter part of the 19th Century. A plot of average winter temperatures for the contiguous United States is shown in fig. 4

The occurrence of three consecutive severe winter seasons over the United States (1977-79) has no parallel in the modern historical record (since the 1890's). Many temperature records were set throughout the country during each of the past three seasons. The core of the anomalous cold weather shifted westward in each succeeding season.

Feb. 1977. A volunteer delivers emergency food and medical supplies in Buffalo, N.Y.
American Red Cross photo by Smith

The 1977 winter was notable for its extreme January cold, attendant fuel shortages and transportation disruptions, and for extreme drought in the West. We described this winter in great detail in an earlier paper (Diaz and Quayle, 1978), noting that January 1977 was, up to that time, probably the coldest month on record during the period of instrumentally measured data in the United States. This was based on nationally averaged figures for the contiguous 48 states, weighted by area to reflect their

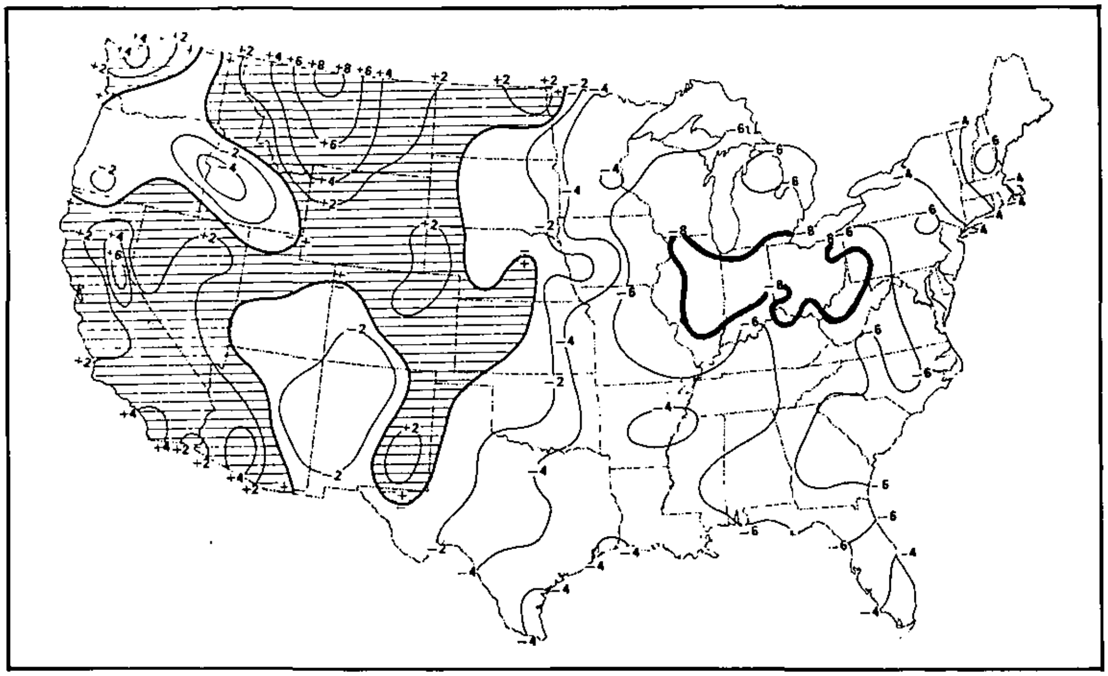


Fig. 1. Temperature departure (°F) from 30-year average, December 1976-February 1977.

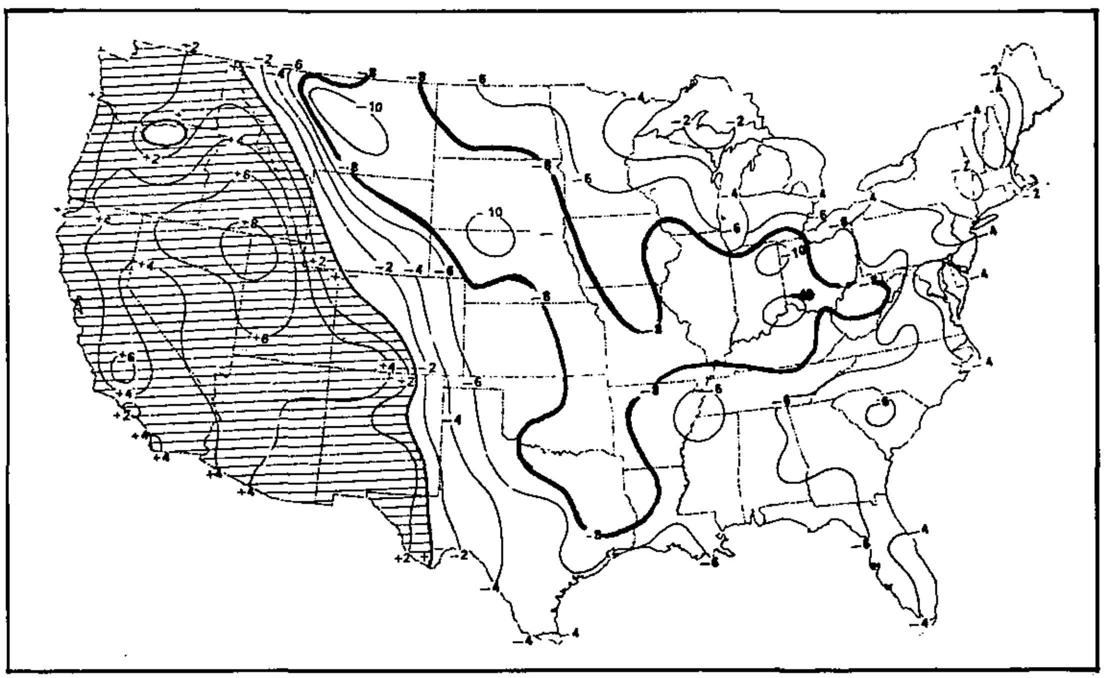


Fig. 2. Temperature departure (°F) from 30-year average, December 1977-February 1978.

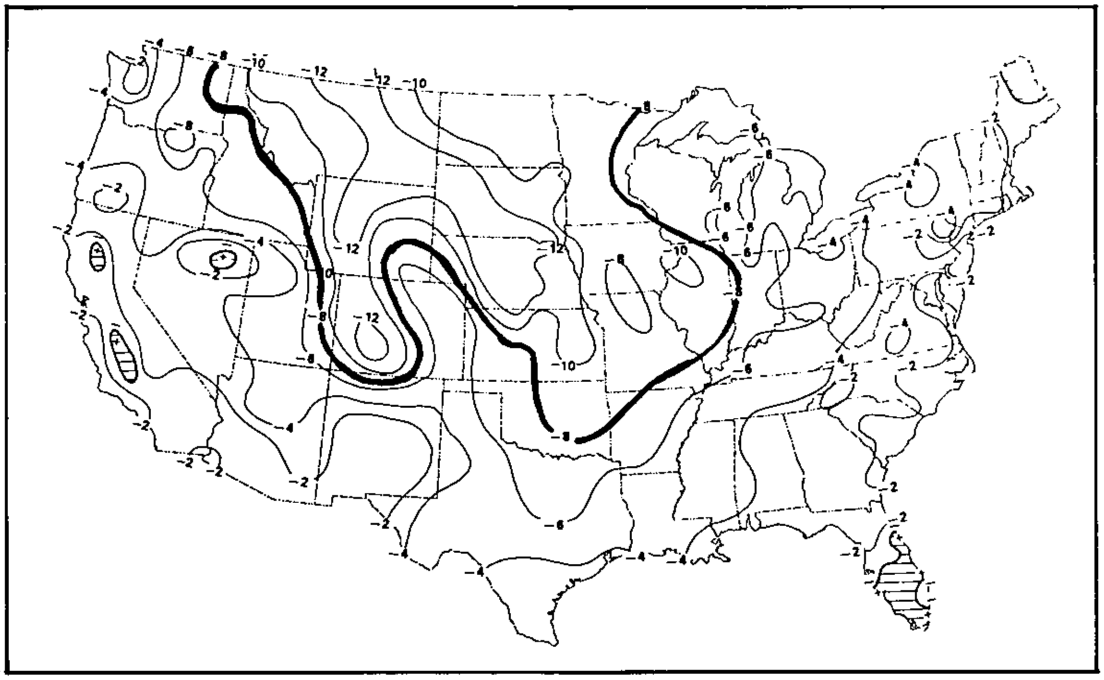


Fig. 3. Temperature departure (°F) from 30-year average, December 1978-February 1979.

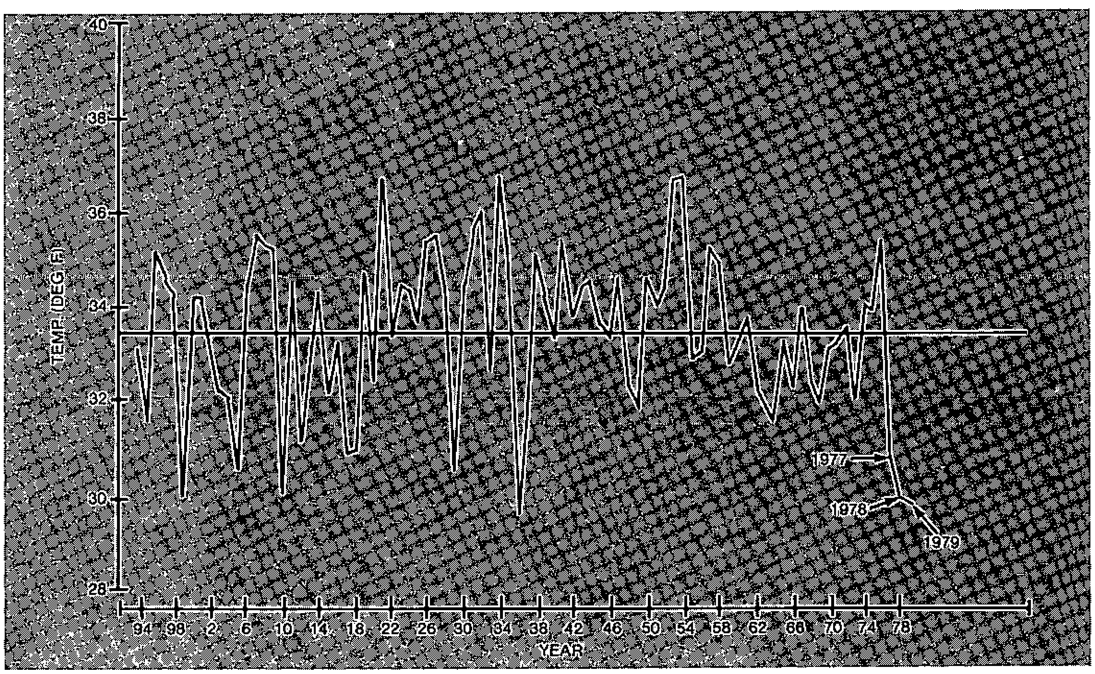


Fig. 4. Average winter temperatures for the contiguous United States.

A wrecker rescues stalled snow-plow in Akron, Ohio.
Akron Beacon Journal
photo by Ron Kunep

proportional contribution to national values. Remarkably, January 1979 has since broken that record.

The 1978 winter was memorable for a number of reasons. Severe cold was accompanied by several intense low-pressure systems which brought very heavy snows to the Midwest, Middle Atlantic, and New England regions. The extreme two-year drought in the West was decisively broken by a series of storms that brought heavy precipitation (with serious flooding) to California and the southwestern states and a heavy snowpack to the Sierras and the Colorado Rockies.

The 1978 winter temperature anomalies were more than 10°F (5.6°C) below normal in a few areas. Compared to the severe winter of 1977, the area of greatest negative departures in 1978 was displaced further west; the area enclosed by the -8°F (-4.4°C) anomaly isoline was considerably larger and extended into central Montana, where a year earlier temperatures had been considerably above normal. It was warmer than normal, however, throughout most of the mountain region west of the Continental Divide, with positive temperature departures extending westward to the Pacific Coast. Unlike 1977, cool temperatures continued to prevail during most of 1978 throughout most of the contiguous United States. This caused the annual average temperature to rank third coldest since 1893.

The occurrence in 1979 of yet a third severely cold winter—colder nationally than 1977 or 1978—established an unprecedented string of three consecutive severe winters. In contrast to the two previous seasons, colder-than-normal average temperatures occurred over nearly all of the contiguous United States. January 1979 had the coldest monthly average temperature on record.

Table 1.
Coldest Months in the United States 1895-1979
(Weighted Average of the 48 Contiguous States)

Rank	Year	Month	Temp. (°F)
1	1979	January	22.8
2	1977	January	23.9
3	1930	January	25.1
4	1940	January	25.4
5	1918	January	25.6
6	1963	January	25.7
7	1912 & 1937	January	26.5
8	1978	January	26.7
9	1899 & 1936	February	27.2
10	1978	February	28.0

The areal extent of the negative departures (covering about 98 percent of the Nation) also appears to be unprecedented in the available historical record. The -8°F (-4.4°C) anomaly isoline in 1979 covered an area equivalent to that in 1978, but shifted further west.

The 1979 season was one of the coldest on record in the West. Compared to 1977 and 1978, the East enjoyed somewhat milder temperatures despite a very cold February. Precipitation, on the other hand, was generally abundant throughout the Nation.

Among the notable features of the 1979 winter are: (1) January 1979 set a new record for the coldest month on record nationally (see Table 1), surpassing the previous record set by January 1977; (2) record snow and ice cover in North America exceeded the previous maximum values set consecutively in each of the preceding two seasons (Wiesnet and Matson, 1979); (3) record ice cover occurred on the Great Lakes, which during February (except on Lake Erie) was close to 100 percent, (Assel and Quinn, 1979); and (4) record low temperatures during February in the East were coupled with record snowfall amounts in the Middle Atlantic States.

The article following examines the behavior of continental snow cover during these three winters.

References

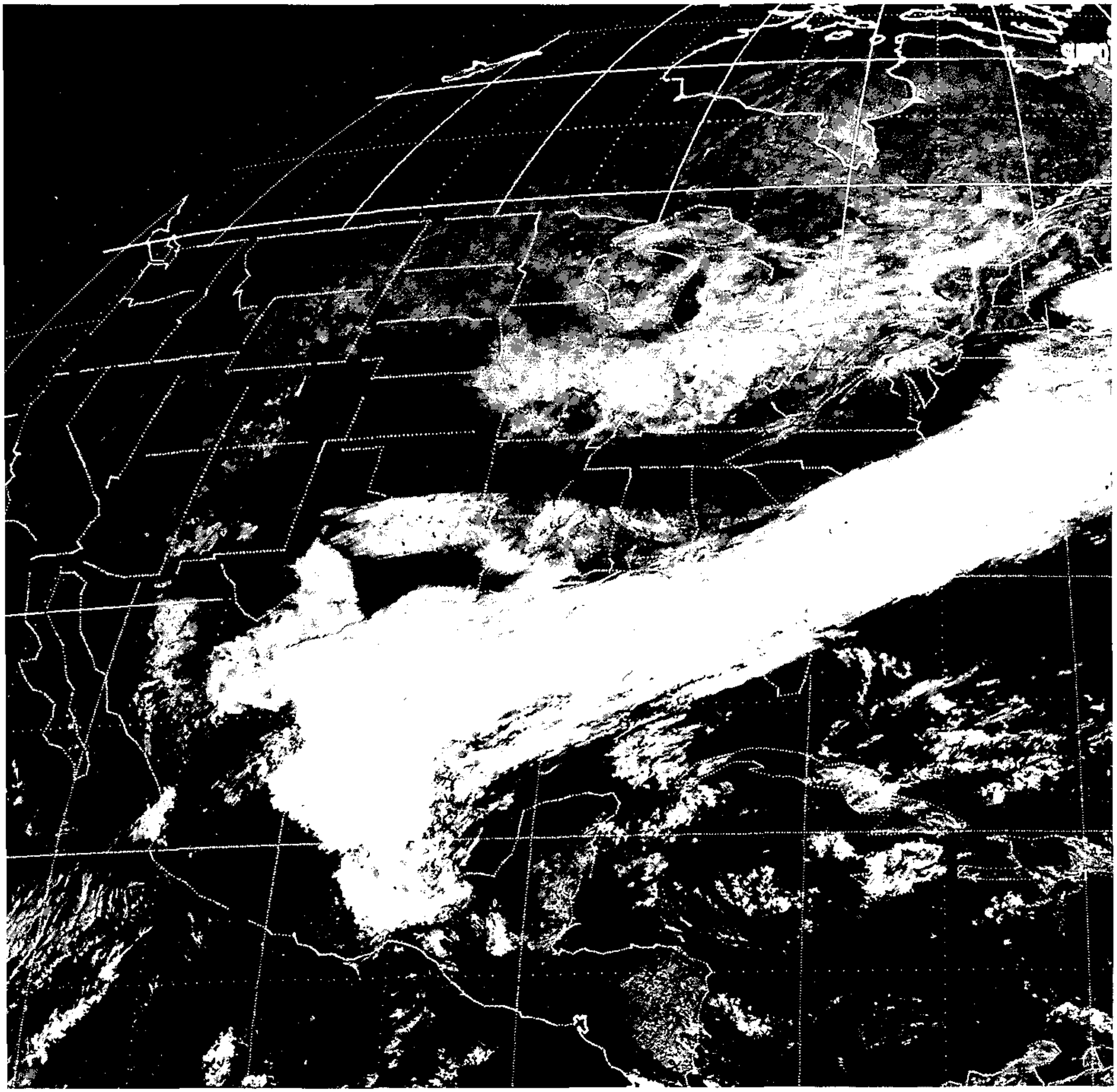
Assel, R. A. and F. H. Quinn, 1979: A historical perspective of the 1976-77 Lake Michigan ice cover. *Mon. Wea. Rev.*, 107, 336-341.

Diaz, Henry F. and Robert G. Quayle, 1978: The 1976-77 Winter in the contiguous United States in comparison with past records. *Mon. Wea. Rev.*, 106, 1393-1421.

Wiesnet, Donald R. and Michael Matson, 1979: The satellite-derived Northern Hemisphere snowcover record for the winter of 1977-78. *Mon. Wea. Rev.*, 107, 928-933.

NOAA Satellite-Derived Continental Snow Cover Data Base

By Donald R. Wiesnet and Michael Matson
National Environmental Satellite Service



The severe North American winters of 1977, 1978 and 1979 (see previous article) stimulated renewed interest in continental winter weather. Snow cover is an important indicator of the severity of winter weather. The capability to monitor snow cover on a continental basis using NOAA satellite data has existed since autumn 1966. The NOAA satellite data base is in the form of weekly snow and ice cover charts that have been issued for every week from November 1966 to the present. Kukla and Kukla (1974), Wiesnet and Matson (1976), Kukla, et al (1977), and Matson (1978) have examined this data base and derived a provisional satellite "climatology" of monthly, seasonal, and annual Northern Hemisphere snow cover, i.e., the areal extent and location of continental snow cover for North America and Eurasia. The NOAA satellite snow cover record of the past 12 years is the most complete record of the hemispheric snow cover known to exist. NOAA, NASA, and Defense Department satellites provide a reliable and rapid method of monitoring worldwide snow cover, which has important effects on global temperature and albedo, with attendant impact on hydrology, energy use, agriculture, and weather forecasting.

GOES satellite image, January 31, 1977. All 48 contiguous states have snow on the ground. A snow-dumping storm system is moving out over the Atlantic.

The NOAA Weekly Snow and Ice Cover Chart

The NOAA weekly snow and ice cover chart (fig. 1) is prepared from satellite imagery for the current week and represents all snow and ice visible throughout the period. Areas of previous snow and ice cover that are cloud-covered during the week are included, unless subsequent cloud-free imagery shows that the extent of snow in these areas has changed. The weekly snow and ice boundaries are drawn on a 1:50,000,000 polar stereographic projection of the Northern Hemisphere. The snow-covered area is characterized by three types of reflectivity, of which class 1 is lowest (see fig. 1). Areas of scattered mountain snow are so indicated but are considered to be of moderate (class 2) reflectivity.

The quality of the weekly charts is affected by several factors:

1. The weekly snow maps are based on subjective interpretation by a number of observers.
2. The satellite images have come from a variety of satellites and sensors, all subject to instrumental variation, degradation, and drift.
3. The skill of the meteorologists who prepare the weekly maps has presumably increased with time, so today's charts are probably more detailed than those of the first few years. When considering the above factors, the error in positioning the snowline on the weekly charts is estimated to be 5 to 7 percent from 1966-70, 5 percent from 1970-73, and 3 percent from 1974 to the present.

Monthly Mean Continental Snow Cover

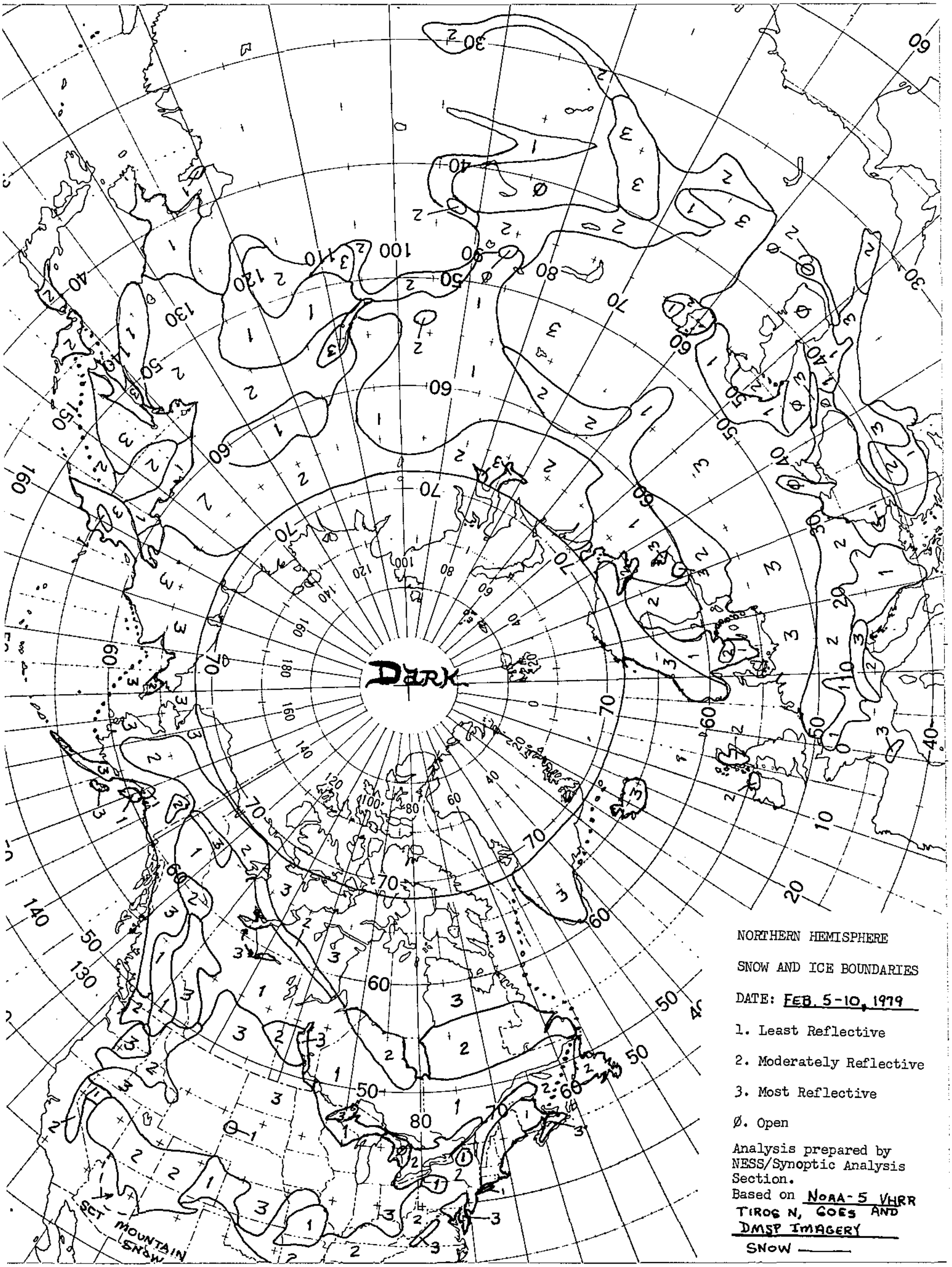
Monthly mean snow cover charts (fig. 2) are constructed from the

This article is reprinted (with some updating) from *Snow Cover*, the sixth in a series of *Glaciological Data* publications published by the World Data Center-A for Glaciology (Snow and Ice). GD-6 presents an overview of the importance of snow and the organization of snow research in Norway and the United States, as well as descriptions of global and regional data sets.

Other articles included in the publication are:

- Snow and Ice Indices
- Global Snow Depth Data: A Monthly Summary
- Alaskan Snow Cover
- Snow Survey of Great Britain
- Snow Investigations in Norway
- Focus on U.S. Snow Research
- Snow and Ice Research at the Goddard Laboratory for Atmospheric Sciences
- Snow and the Organization of Snow Research in the United States
- SNOTEL: An Operational Data Acquisition System Using Meteor Burst Technology

Copies of *GD-6, Snow Cover* and all other publications in this series may be obtained free of charge from: World Data Center-A for Glaciology (Snow and Ice), Institute of Arctic and Alpine Research, University of Colorado, Boulder, CO 80309.



NORTHERN HEMISPHERE

SNOW AND ICE BOUNDARIES

DATE: FEB. 5-10, 1979

1. Least Reflective

2. Moderately Reflective

3. Most Reflective

Ø. Open

Analysis prepared by NESS/Synoptic Analysis Section.
Based on NOAA-5 VHRR TIROS N, GOES AND DMSP IMAGERY

SNOW ———

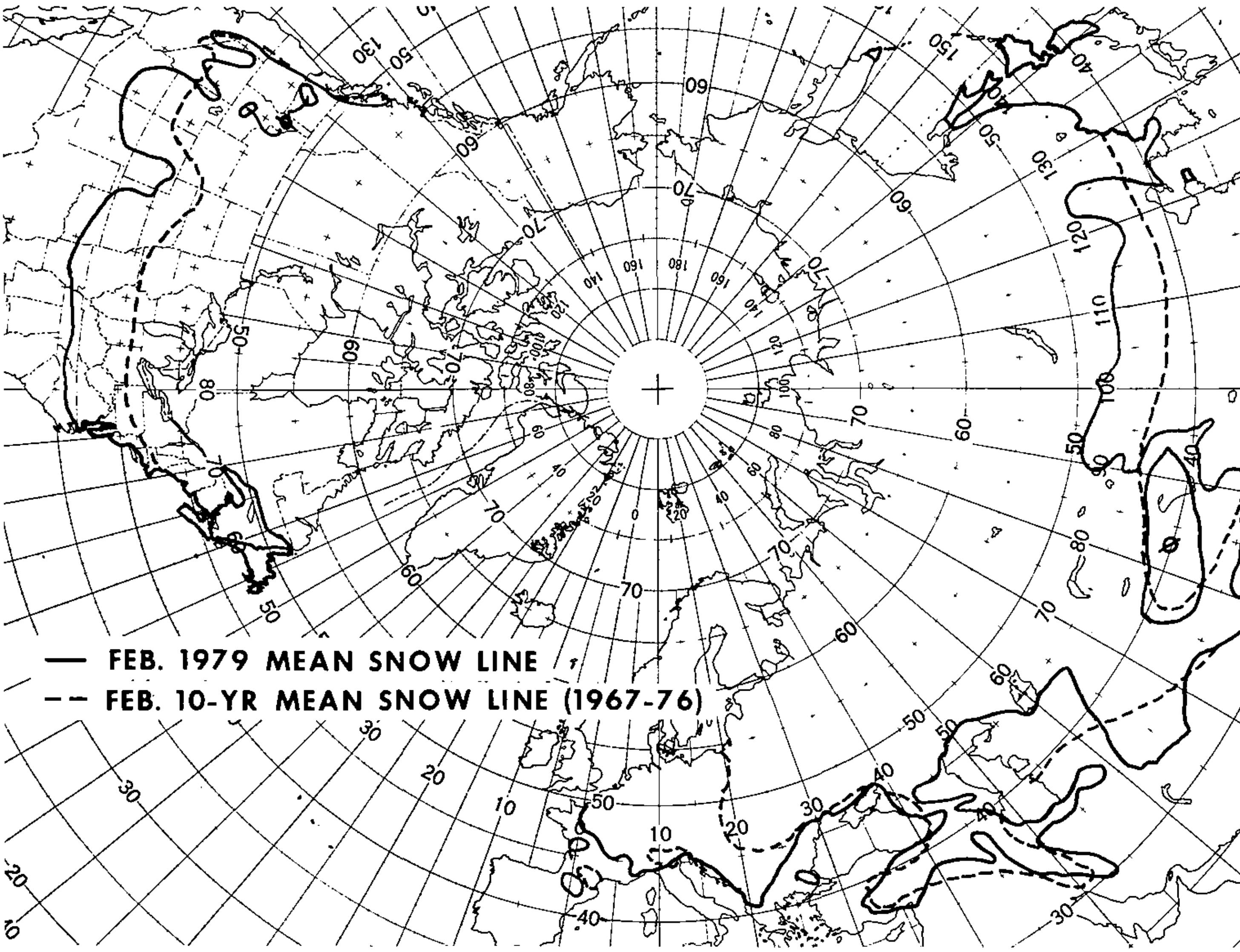


Fig. 1. (left) is a hand-drawn, weekly snow and ice cover chart prepared from satellite imagery.

Fig. 2. (above) is a monthly mean snow cover chart constructed from weekly charts.

weekly charts by the Environmental Sciences Group of NOAA's National Environmental Satellite Service (NESS). The mean monthly snow boundary is determined by subjective analog averaging of the weekly snowline boundaries. The area measured within this boundary includes all three classes of reflectivity, as well as scattered mountain snow, and the measured area is corrected to represent true surface area.

During the months of October and November and the period December through March, northern boundaries of 70°N, 60°N, and 52°N, respectively, are chosen for snow cover analyses. The lack of solar illumination for satellite visible imagery north of these latitudes during these months is the reason the boundaries were chosen. Fortunately, the area covered by snow north of these boundaries is nearly constant during the winter season when considered on a continental basis. All winter snow cover values given, however, are for each entire continent and not just the area south of these latitudes. Land area measurements north of the latitudinal boundaries are considered completely snow-covered, so their area is added as a constant to the snow cover areas south of the boundary.

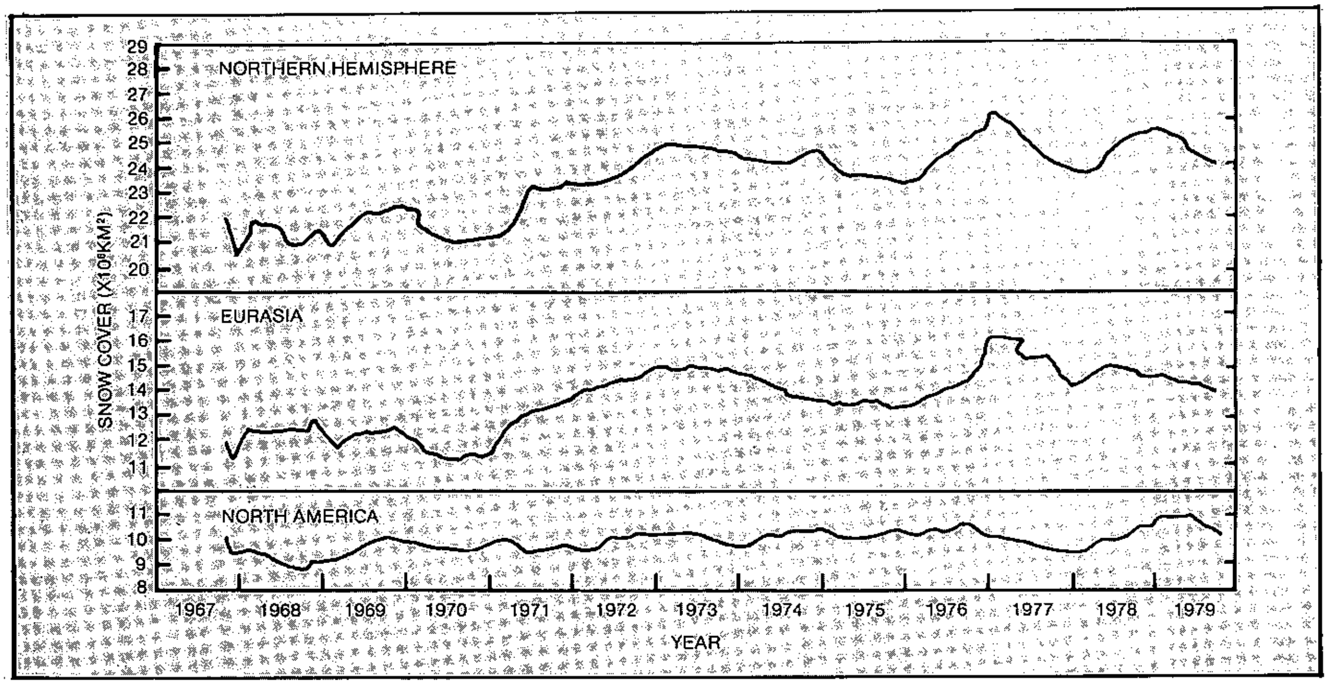


Fig. 3. The 12-month running average of monthly mean snow cover for the Northern Hemisphere, Eurasia, and North America for the period 1967-79.

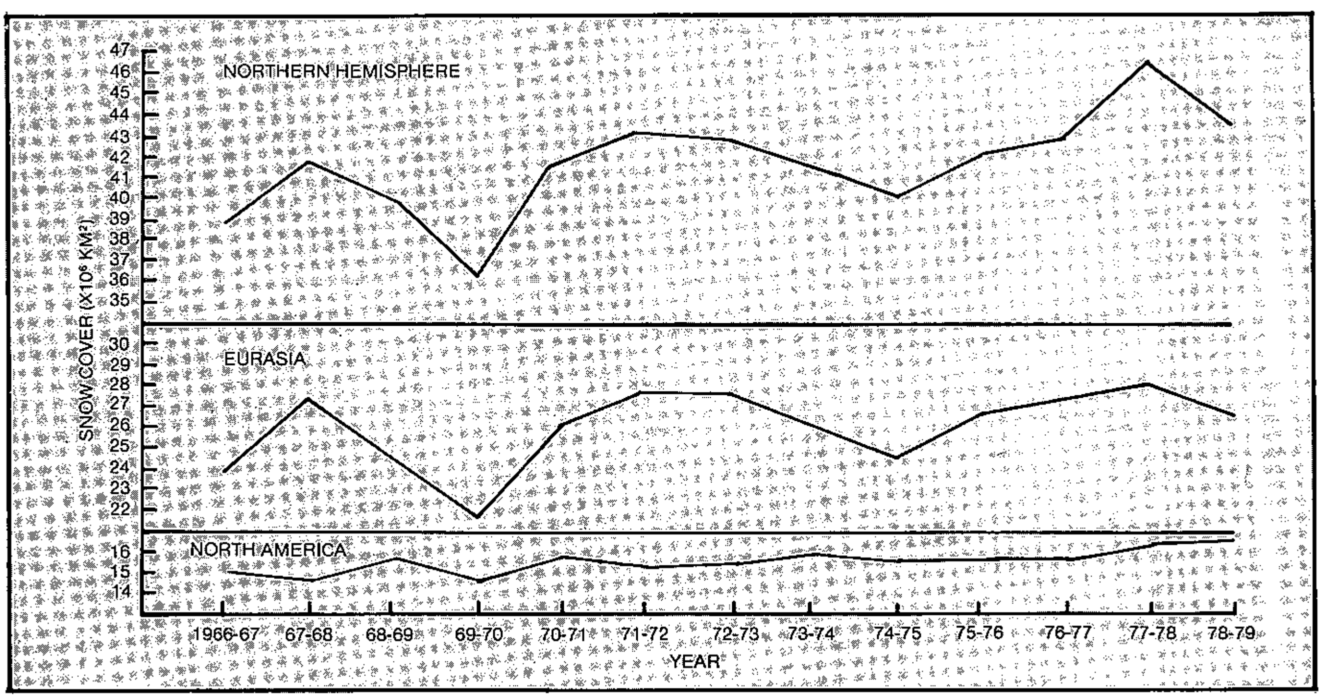
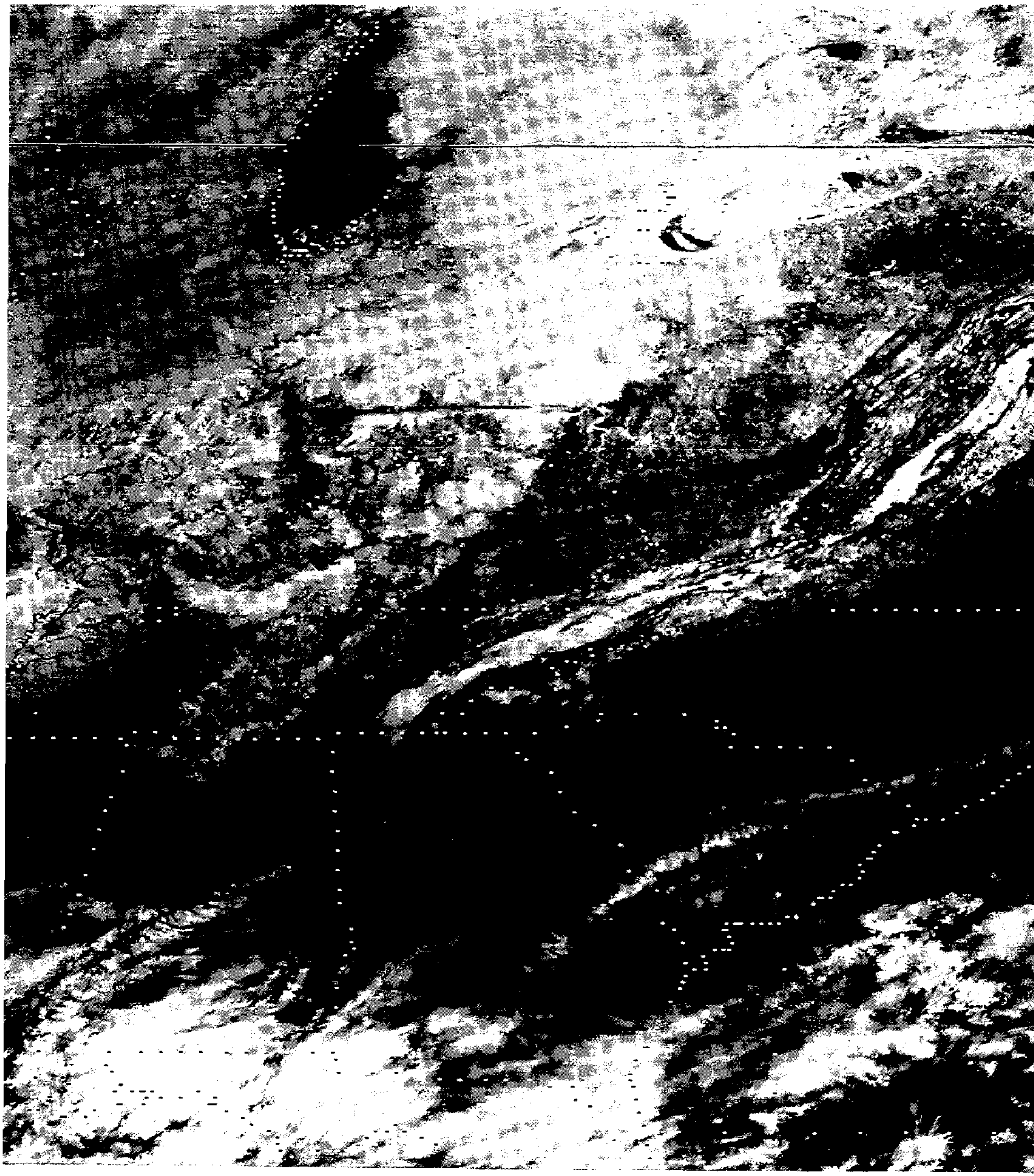


Fig. 4. Mean winter snow cover (Dec.-Feb.) for the Northern Hemisphere, Eurasia, and North America for the period 1967-79.



GOES satellite image of the eastern and midwestern United States, January 23, 1978. Snow cover extends southward into Virginia, North Carolina, Tennessee, Georgia, Mississippi, and Alabama.

The NOAA Satellite-Derived Snow Cover Record

Fig. 3 is a 12-month running average of monthly mean snow cover from 1967-79 as determined for North America, Eurasia, and the Northern Hemisphere. The plot shows no systematic increase or decrease in North American snow cover extent. Thus, it appears that even if North American snow cover fluctuates widely on a regional scale (e.g., the winters of 1977 and 1978), the continental snow cover over time remains fairly constant. Two large increases in snow cover extent occurred in Eurasia and the Northern Hemisphere; one during 1971-72, and the second during 1976-77. An overall increasing trend in snow cover extent is also evident for both of these areas in the decade shown.

Mean winter snow cover (December-February) from 1967-79 is shown in fig. 4. Beginning in 1976, North American mean winter snow cover has increased steadily, reaching a 13-year record high of 16.9×10^6 km^2 in 1979. This represents an 8 percent increase in North American mean winter snow cover over the 4-year period. Eurasian winter snow cover is even more variable, ranging from approximately 22×10^6 km^2 to 29×10^6 km^2 in area. This represents a 10 percent variability in Eurasian winter snow cover when compared with the entire continental area of Eurasia. Extensive Eurasian snow cover occurred in the winters of 1968, 1972, and 1978. A notable feature is the cycle nature of Eurasian winter snow cover.

The vast winter snow-covered areas of Eurasia statistically dominate the smaller areas of snow cover on the North American continent. The result is that the trends in the winter Northern Hemisphere and Eurasian data are similar. The large North American winter snow cover of 1978, however, combined with the 13-year record high 1978 Eurasian winter snow cover to produce a 13-year record high Northern Hemisphere winter snow cover (3.2×10^6 km^2 or 7.4 percent greater than the 1972 peak).

Conclusions

The use of satellite data for certain aspects of climate monitoring, especially in the polar regions, is not merely a potential application of a new technology; it is the application of an established observation system that has been operational for many years. As the satellite sensors improve and become more varied, workers in the field of climate monitoring and climate change will become increasingly dependent upon this reliable and relatively unbiased source of data. The satellite data provide a rapid means of synthesizing global snow cover information to assess current conditions. Although the satellite snow cover data comprise only 12 years of record, they establish a provisional climatological base for monitoring Northern Hemisphere snow cover variability. As the data base expands, it will undoubtedly be carefully considered and critically evaluated by those whose research deals with climate variability and its attendant impact on humans and their environment.

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Where to Obtain Data

The Weekly Northern Hemisphere Average Snow and Ice Boundary Charts and Monthly Mean Snow Cover Maps shown in figs. 1 and 2 are available as paper copies for the period from November 1966 to the present. They cost 35 cents a copy. The graphs shown in figs. 3 and 4 are continuously updated and also are available at 35 cents each. The associated, individual, daily NOAA satellite imagery used to derive these charts are available in polar-stereographic format at a price of $3.25 for each 10 x 10 inch black and white print, or on 35mm microfilm containing 2 or 3 months data per roll, at $13 each. (No NOAA satellite polar-stereographic imagery exists for the period from March-December 1978.) Copies of these charts, graphs, and imagery may be obtained by writing to: Satellite Data Services Division, NOAA/EDIS/NCC, Room 606, World Weather Building, Washington, DC 20233 or by calling (301) 763-8111; FTS 763-8111.

Climatic Changes May Be Related To Variations In Solar Luminosity

By William E. Hardy
Environmental Science Information Center

Sunspots. Dark centers are called umbras, surrounding areas penumbras.

Courtesy Patrick S. McIntosh, NOAA Space Environment Laboratory

Douglas V. Hoyt,* then a NOAA scientist, related the ratios of the areas of sunspot umbras (dark centers of sunspots) to penumbras (gray areas surrounding the centers) to the plot of the normal annual surface temperature of the Northern Hemisphere.** Working in NOAA's Air Resources Laboratories in Boulder, Colo., Hoyt found a high correlation between the two over the period of record (1874-1970). The ratio varies with changes in the Earth's climate so closely that it would appear a large portion of climatic change is caused by fluctuations in the solar luminosity, or so-called solar constant. Variations and trends established by these highly correlated factors may prove to be important in forecasting climatic changes, and more particularly, droughts.

The umbras and the penumbras

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*Present affiliation: Cooperative Institute for Research in the Environmental Sciences, Boulder, Colo.

**Hoyt, D. V. 1979: "Variations in Sunspot Structure and Climate." *Climatic Change* 2(1): 79-92.

of sunspots have rather distinct boundaries and can easily be distinguished one from the other, and from the Sun's surrounding, quiet photosphere. Their areas have been accurately measured and recorded for the past 100 years, and the ratio of the areas of umbras to penumbras can be computed so that a single number provides a measure of sunspot structure on an annual basis. With a few exceptions, the ratio varies between 0.15 and 0.27. A plot of the annual ratios shows that the variations are not random, but follow long-term secular trends.

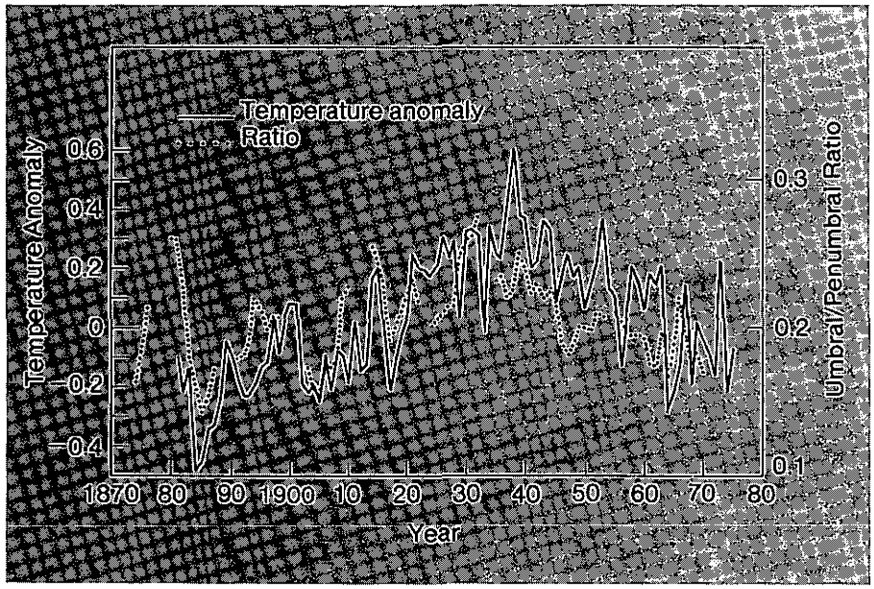
Superimposed in the long-term trends is a cycle of about 20 years, and a possible, much weaker cycle of about 11 years. The umbral-penumbral ratio is the only known solar feature other than the Sun's general magnetic field with a cycle approaching in character the 22-year double sunspot cycle.

When plotted together, the curve of Northern Hemisphere mean annual surface temperatures and the variations of the umbral-penumbral ratios are notably similar. Also, in general, the colder years are associated with lower values of the umbral-penumbral ratios (smaller solar constant). The cross-correlation of the two curves is 0.57, which is highly significant statistically.

The umbral-penumbral ratio may be a measure of the convective energy transport in the Sun's photosphere and an index of a global property of the Sun which is proportional to the solar luminosity (Jansen et al. 1955, 1956; Nordo 1955). The variations in sunspot structure also parallel variations in solar rotation. Before about 1930 the solar rotation was decreasing to a minimum; from 1930 to the present, the solar rotation has been increasing (Eddy et al. 1978). It appears that energy which goes into or out of the rotational energy reservoir results in a decrease or increase respectively in solar luminosity.

The maximum values of the umbral-penumbral ratios coincide rather closely with the years of observed droughts in the western United States and may prove to be a valuable forecast tool (Mitchell et al. 1978). On the basis of this relationship, the larger the solar constant, the greater the probability of a drought; there is no case in the period of record when a drought occurred that was not successfully "predicted" by the solar ratios.

Remeasurement of available records of umbral-penumbral areas using more accurate techniques, and continued monitoring of sunspot areas will help in determining if the ratio again peaks before the next western U.S. drought.



Annual umbral/penumbral ratios vs. mean annual surface temperatures in the Northern Hemisphere.

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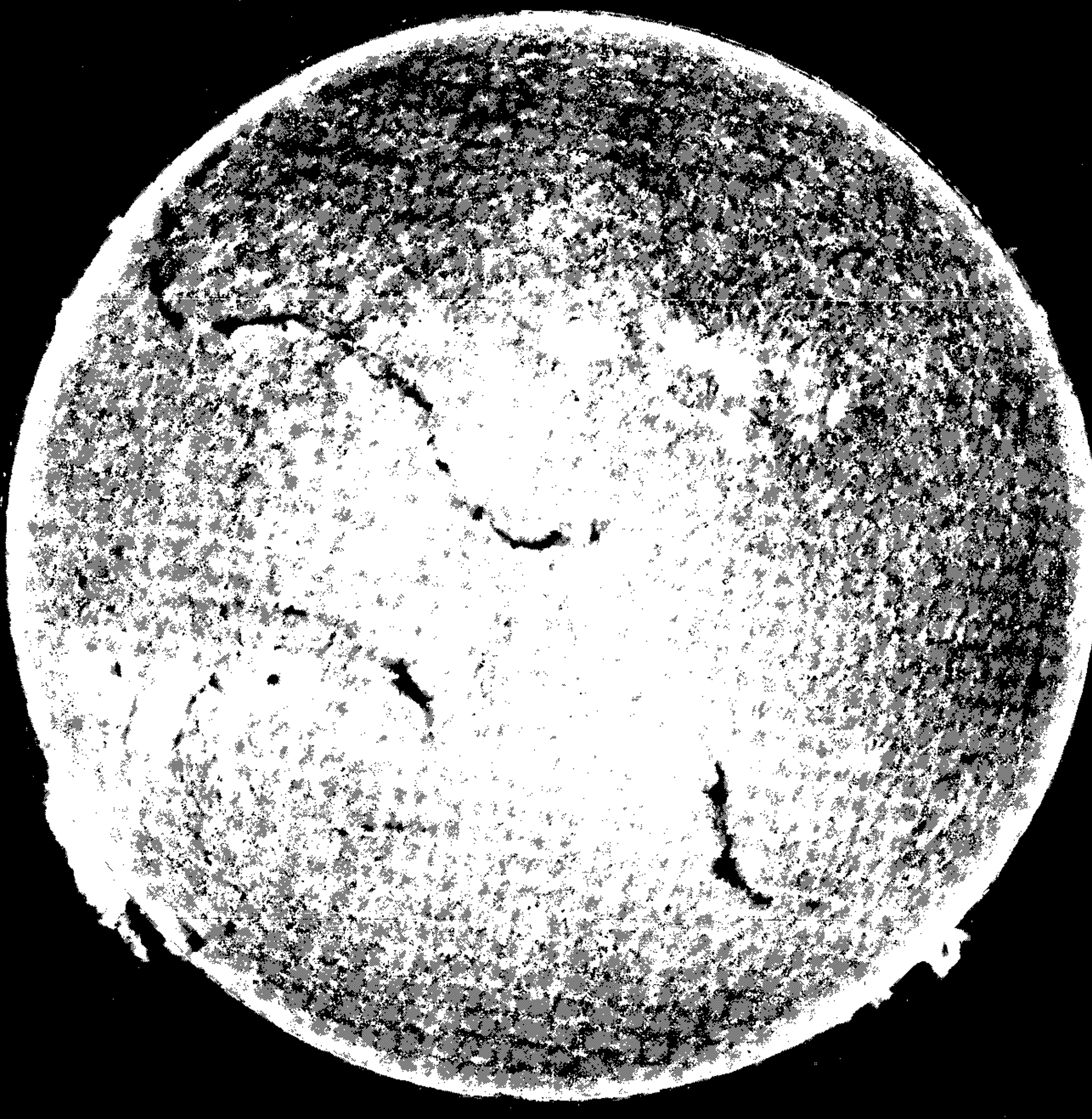
Status of the Current Solar Sunspot Cycle

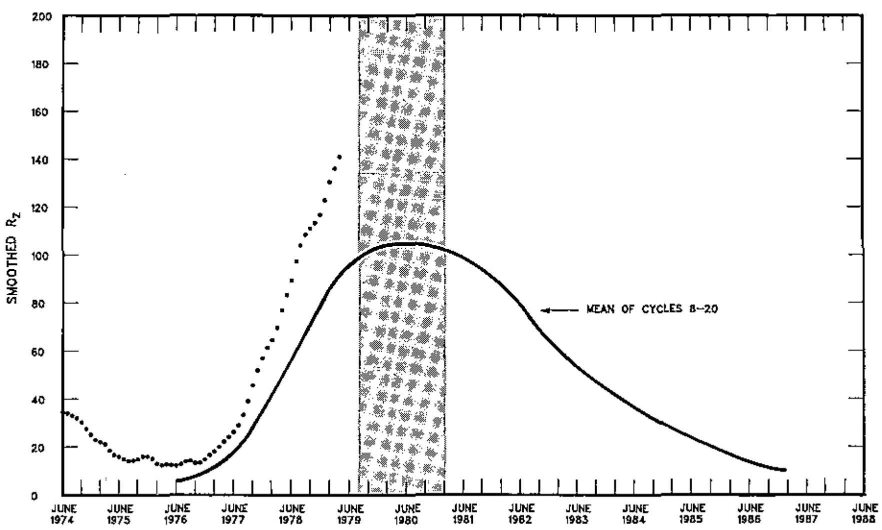
By J. Virginia Lincoln
National Geophysical and Solar-Terrestrial Data Center



Full disc solar photo. Black areas are sunspots. (See sunspot close-up, p.15.)

TABLE 1. Relative Sunspot Numbers NOV 1978 - OCT 1979												
DAY	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
1	109	110	158	116	116	131	108	121	158	115	165	213
2	122	110	158	127	138	134	106	152	168	96	141	187
3	125	117	191	148	141	135	103	161	205	121	148	167
4	129	115	157	123	142	138	112	178	219	110	157	156
5	121	104	146	134	135	109	113	207	232	93	139	168
6	108	122	173	146	144	91	122	226	249	104	139	168
7	112	138	163	144	146	77	148	222	223	110	170	179
8	118	148	172	142	143	69	165	220	219	132	192	190
9	108	152	165	139	146	61	162	231	191	115	190	210
10	120	144	163	137	140	87	145	205	163	92	177	178
11	118	170	157	137	156	109	148	186	155	84	167	183
12	99	188	159	138	170	107	158	199	145	87	156	189
13	90	165	159	152	169	113	163	172	142	91	175	211
14	78	150	162	163	159	116	203	149	127	119	186	213
15	59	140	178	161	155	117	207	127	121	135	177	198
16	77	143	164	159	130	119	187	103	114	122	170	185
17	92	146	164	160	142	107	184	122	109	138	155	221
18	93	132	146	162	142	98	148	126	109	157	177	224
19	85	95	138	166	138	79	109	110	135	176	195	221
20	76	84	177	169	120	68	107	111	158	187	191	219
21	68	68	181	171	134	68	114	124	151	218	184	215
22	77	63	178	155	140	79	121	108	152	216	178	198
23	55	59	188	127	139	79	117	96	154	206	219	186
24	61	65	209	99	118	80	119	90	143	203	236	161
25	85	81	209	88	114	85	124	120	144	201	252	153
26	101	93	173	108	114	118	123	132	142	182	261	145
27	118	110	162	97	117	125	118	112	146	189	256	143
28	118	122	157	95	114	132	110	128	132	174	239	142
29	111	135	153		110	132	113	124	148	158	235	191
30	103	159	149		127	120	96	154	150	150	233	197
31		177	130		147		120		144	168		223
MEAN	97.9	122.7	165.8	138.0	137.0	102.8	134.6	150.5	159.6	143.5	188.7	188.2

Table 1 (above) gives daily observed sunspot numbers from November 1978 through October 1979. Fig. 1 (right) shows smoothed sunspot numbers (dots) for Solar Cycle 21, as well as the mean of Cycles 8-20. The shaded area represents the Solar Maximum year. Fig. 2 (opposite) shows observed monthly mean sunspot numbers (light lines) and smoothed values (heavy line) from 1944 to the present.



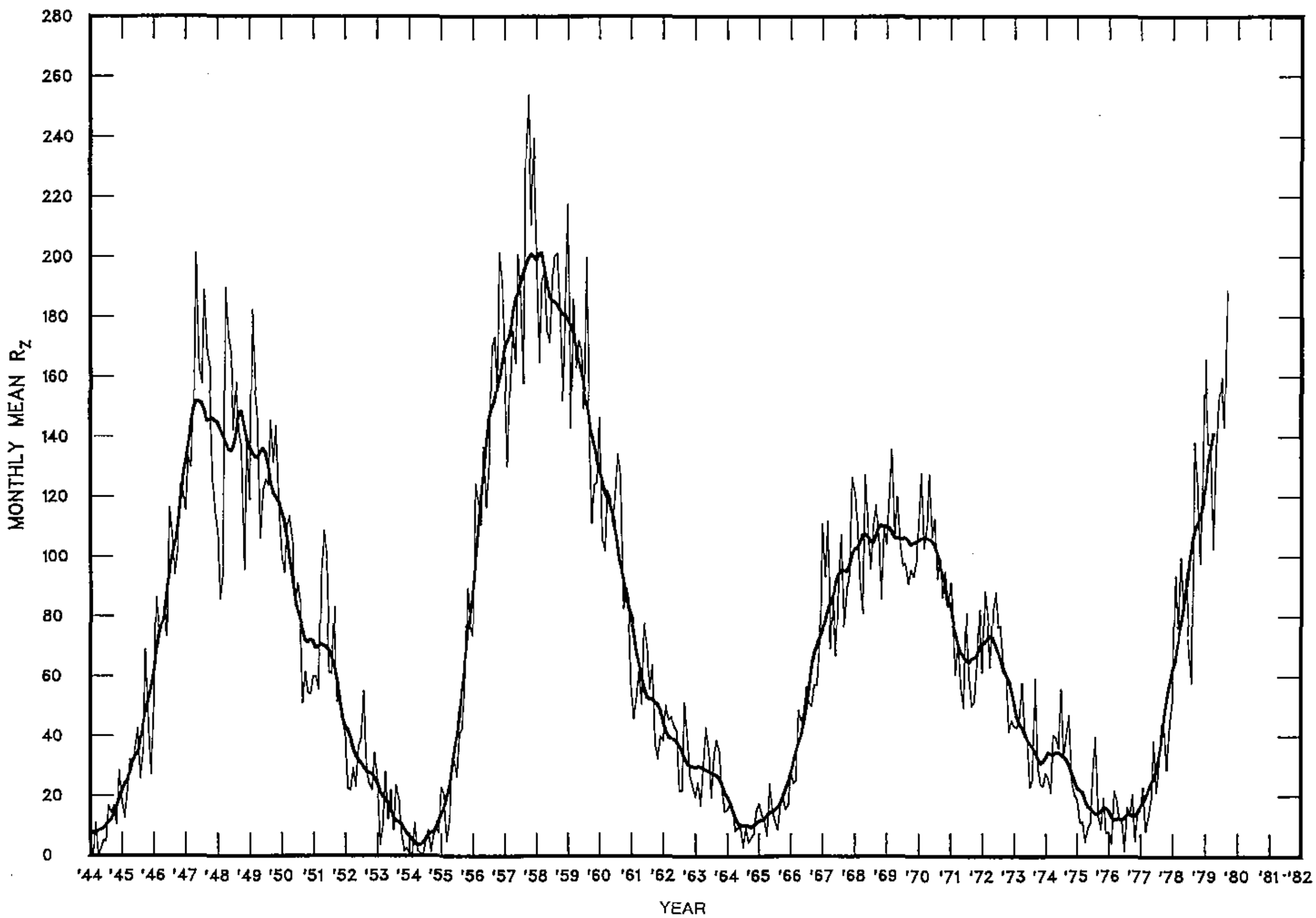
The Solar Maximum Year (SMY) began August 1, 1979. This international cooperative scientific program will continue through February 28, 1981. It involves fundamental research on enhanced activity of the Sun characterized by such phenomena as extensive active regions, large sunspots, and major solar flares which usually accompany sunspot maxima.

The SMY has created renewed interest in following the present stage of this sunspot cycle Solar Cycle 21. Table 1 gives the daily record of observed sunspot numbers for the most recent 12-month period. It is of interest to note that the monthly mean numbers exceeded 150 in Jan., June, July, Sept. and Oct. 1979 When active regions have been visible on the Sun, the daily numbers have exceeded 200 for several days in a row in June through October 1979.

The size and timing of a sunspot maximum epoch is usually measured by a 12-month smoothed sunspot number index. The course of Solar Cycle 21 is shown in fig. 1 (the last "observed" smoothed value, 141, is for April 1979). For comparison we show the mean of Cycles 8 to 20 (1834 to 1976). Cycles 1-7 (1755 to 1833) are excluded from the mean since they have been shown not to be of the same statistical population.

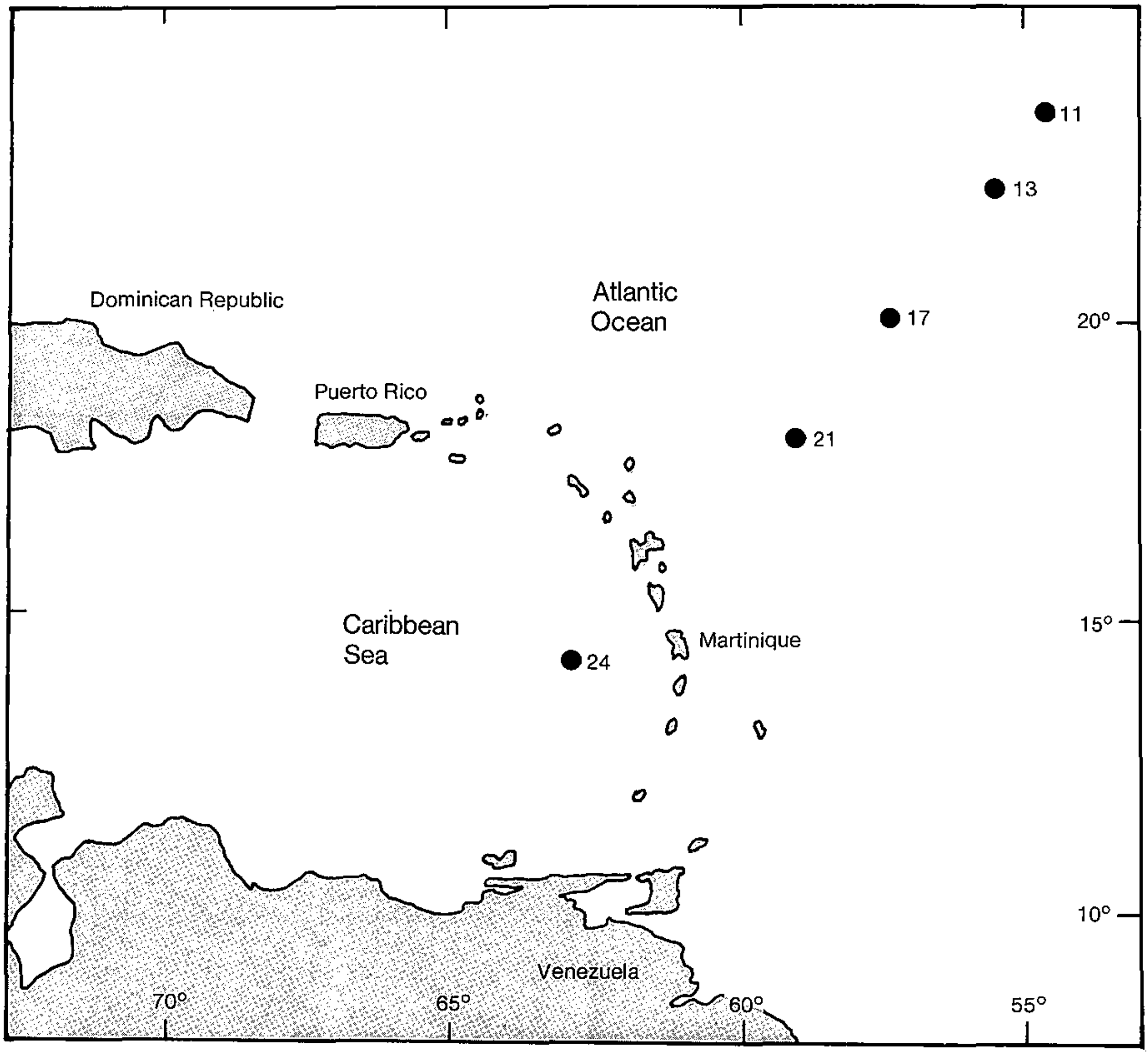
The current Cycle 21 is clearly well above the mean sunspot cycle. The NOAA prediction for maximum epoch is 160 ± 24 in November 1979. (The data needed to determine the actual maximum occurrence are not yet available.) By comparison, the height of the 1968 maximum was 111 and the 1958 (International Geophysical Year) maximum was 201, as shown in fig. 2, where the curve of smoothed numbers is superimposed on the monthly data.

From the evidence presented here, the maximum period of Solar Cycle 21 should be high enough to expect the types of solar activity the Solar Maximum Year program is seeking. All of the data presented are available from World Data Center A for Solar-Terrestrial Physics, NOAA, D63, Boulder, CO 80303.



Natural Oil Seepage May Exceed Estimates

By Carl Posey
NOAA Office of Public Affairs



NOAA scientists have reported discovery of an oil-rich layer hundreds of feet beneath the surface of the southwestern North Atlantic. It has been estimated that the layer contains at least a million tons of crude oil.

Apparently caused by a natural oil-seep in the sea floor, the oily layer appears to contain nearly twice the amount used by many scientists (0.6 million tons) as an estimate of the amount of oil annually leaked into the global ocean

The dots mark sampling stations where the oil-rich layer was discovered. The heaviest concentrations were centered at a depth of about 650 ft. or 200 m.

from all natural sources. The NOAA discovery could force drastic revisions in estimates of how much oil is naturally present in the sea.

"If our estimates have been that far off considering just this one area of the ocean, without considering seeps in the Gulf of Mexico, South China Sea, Persian Gulf, and other oil-rich areas," explained Dr. George Harvey, an ocean chemist with NOAA's Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla., "then there must be many times more oil in the sea than we formerly believed."

Harvey noted that since such large quantities of petroleum are being chronically introduced naturally, marine organisms are not strangers to an environment containing large concentrations of petroleum. "Our conception of petroleum as a pollutant could change. It seems now to be a natural component of the marine ecosystem, occasionally exceeding the natural organic carbons in the ocean."

Writing in *Science* (September 7,1979), Harvey and colleagues Adolfo G. Requejo, Philip A. McGillivary, and John M. Tokar, reported that the oil-rich layer was some 800 nautical miles (1,290 kilometers) long, by one nautical mile (1.9 kilometers) wide, by 328 feet (100 meters) thick. It contained crude oil concentrations amounting to three to twelve milligrams of oil in every liter of sea water taken at the 650-foot (200-meter) depth.

The layer was detected durin 1978 voyage of the NOAA ship *Researcher*, as part of an effort to trace the movement of the "Subtropical Underwater"—a water mass that forms in the Sargasso Sea and flows into the Caribbean and around the Gulf of Mexico.

While sampling some 700 nautical miles (1,129 kilometers) northeast of the Antilles island chain, scientists aboard the *Researcher* began to detect high concentrations of hydrocarbons in water taken at the 650-foot (200-meter) depth. The hydrocarbon-rich samples continued as the ship sailed southwestward, into the Caribbean. "But samples taken above and below the oily layer, and northeast and southwest of the layer, had hydrocarbon concentrations and distributions typical of the open ocean," they reported.

Shipboard analysis of water samples, and subsequent analysis made at the Miami laboratories and by scientists at Woods Hole Oceanographic Institution, Mass., and Scripps Institution of Oceanography at LaJolla, Calif., confirmed that the hydrocarbon was crude oil in an "accommodated state"—a kind of chemical middle ground between being dissolved and in droplet form.

Other tests indicated that the oil was a biochemically weathered crude that had not lost any constituents to evaporation, indicating that it had never surfaced at sea. Comparisons between the characteristics of sunken tars and the subsurface oil indicated the oil had weathered underwater for one to two years before the NOAA scientists found it.

Harvey described the average oil concentration of 6 milligrams per liter as five to 10 times that found in "what we call 'polluted' waters." Most organisms, according to Harvey, would be sickened or killed by this level of oil contamination.

But not all organisms. A followup voyage by the *researcher* made in early 1979 failed to locate the oily layer in the same area; hydrocarbon levels had returned to values that were typical of the open ocean. Harvey noted, however, that "one hundred percent of the microorganisms at 200 meters were those which can use petroleum as a carbon source. In normal waters they are typically only one or two percent of the population. We think the oil supported a large population of these oil-loving microorganisms, and that even when the oil was gone, these opportunistic creatures were hanging around, waiting for more."

The NOAA scientists concluded that the most likely source of the oily layer was a seep located on the Venezuelan or Trinidad continental shelf at a depth of about 200 meters, in an area where many offshore seeps have been reported.

Such oil, they speculated, could have been carried north underwater, probably in a dispersed state, by the Guiana and Antilles currents until entrained by midwater easterly flows into the southern Sargasso Sea. In fact, they added, detecting the subsurface oil east of the Antilles was itself a further indication that there is a mid-depth easterly return of water into the subtropical North Atlantic, which oceanographers have suspected for many years.

Harvey stressed that the discovery of large quantities of oil naturally present in the sea did not reduce the destructive potential of oil spilled at the surface.

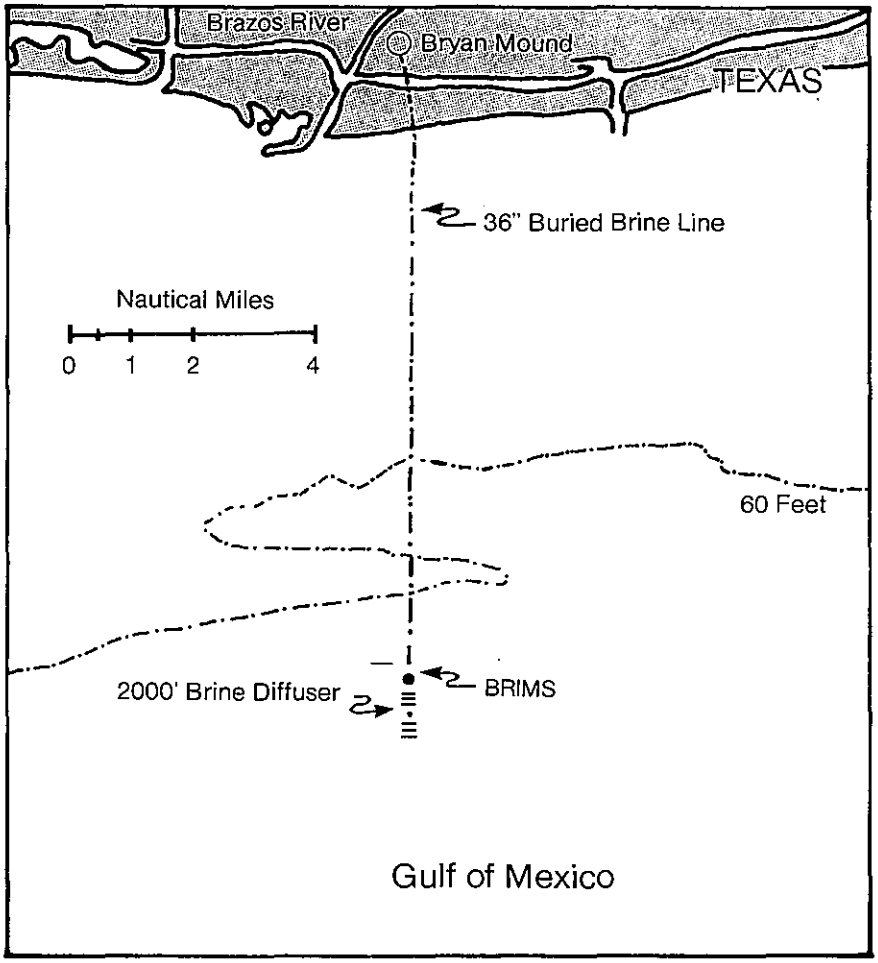
"Oil dumped on the surface can wind up on beaches and in the upper layers—the most productive layers—of the ocean. This oil-rich layer is way below the light zone. If it ran into Bermuda, it would just coat the [underwater] rocks of the Bermuda Rise; but spilled oil on the surface would go into the beaches."

Brine Measuring Buoy Deployed Off Texas Coast

In support of the National Strategic Petroleum Reserve and NOAA's Brine Disposal Analysis Program, the Naval Ocean Research and Development Activity (NORDA) has developed and installed a unique system designed to measure brine concentrations resulting from the discharge of highly saline brine pumped from an onshore salt dome to a point 12.5 miles offshore Freeport, Tex. Called the Brine Measurement System or BRIMS, the telemetering buoy will monitor the spread of the brine in the sea as it is evacuated from the Bryan Mound salt dome through a pipeline.

EDIS's Center for Environmental Assessment Services is responsible to the Department of Energy for developing and implementing an environmental monitoring program to determine whether the discharge of the saline brine might have an adverse effect on the local marine environment. Theoretical studies already conducted indicate that the brine will disperse rapidly and cause no significant danger to marine life or create any extreme threat to the fishing industry. Until now, however, there has been little actual experience of what happens to the brine when it is discharged into the sea in large quantities.

Salt domes located in Texas and Louisiana have been designated to be used for the Strategic Petroleum Reserve to be available in the event of a future halt in foreign oil imports. There is limited storage space in some of the domes, which previously were used to store hydrocarbon products. About 91 million barrels of crude oil have been stored in the available space to date, but this is only a small portion of what is needed to meet this country's requirements in an emergency. Additional space is to be developed by leaching new caverns, which involves pumping in water to mix with the salt to produce a brine solution that is then pumped out.



Location of the Brine Measurement System (BRIMS) off the Texas coast.

The last 3,000 feet of the 36" brine pipeline, which has been installed below the sea floor, contains 52 ports or openings (30 of which will be initially activated) for discharging the brine into the sea. The main component of BRIMS is a cylindrical buoy 14 feet in diameter and seven feet high that has been anchored over one of the inactive ports. Connected to the buoy are a series of cables which have been implanted into the sea floor to suspend sensors about three feet off the sea floor. These sensors will record salinity, temperature, and currents. Additionally, a brine flow sensor has been placed inside one of the discharge ports to allow an assessment of pipeline integrity.

The sensor array has been designed to minimize the probability of entanglement with trawl nets. The sensors are protected by smooth surfaces to allow trawl nets to slide over them, and the sensor cables are buried beneath the sea floor.

On top of the main surface buoy there is an eight-foot high structure containing an analog-data telemetry system capable of transmitting on 62 channels. The data will be telemetered to a shore-based station, probably on an hourly schedule. Enough battery power will be provided to enable a 6-month unattended operation.

The BRIMS system has been designed so that sensors can be readily added or repositioned to a more desirable location. This will permit a rapid response to changing or evolving environmental measurement requirements.

One of the uses of BRIMS will be to validate a computerized mathematical model developed by the Massachusetts Institute of Technology for NOAA which simulates the brine plume for various oceanic conditions. If the measurements made by BRIMS closely match the results of the prediction model, then the model can be used confidently in planning for the creation of additional storage caverns in other salt domes along the Texas/Louisiana coast. Plans for the full development of BRIMS include a network for processing, storing, and transmitting the data collected by BRIMS to EDIS.

Coastal Data Sources

A new 32-page booklet *Coastal Data Networks and Sources* has been compiled by Robert Quayle of EDIS' National Climatic Center. It was prepared for a meeting of the American Meteorological Society Committee on Meteorology of the Coastal Zone held in Boston, November 5-6, 1979 and has been reprinted as an NCC correspondence aid. The booklet contains descriptions of U.S. coastal data sources, listing addresses and telephone numbers for appropriate contacts. Several map presentations are also included.

Among the data types covered are:

- Meteorological/land-based
- Meteorological/ocean (or Great Lakes)-based
- Oceanographic/physical, chemical, biological
- Tides
- Geology and Geophysics
- Satellite
- Literature/Bibliographic/cross-reference
- Fisheries
- Coastal Zone Management
- Aerial Photography

The publication can be obtained from NOAA/EDIS/NCC, Federal Building, Asheville, NC 28801.

State Climatologists Meet

EDIS' National Climatic Center in Asheville, N.C., hosted the annual meeting of the American Association of State Climatologists (AASC) from October 16 to 18, 1979. There were 53 attendees, including 28 state climatologists, as well as representatives from NOAA and EDIS Headquarters, the National Weather Service's central and regional offices, and Dr. Ian W. Marceau of Congressman Jerome A. Ambro's (D-N.Y.) staff.

The objectives of the Association are to:

1. Promote cooperation between State Climatologists and those Federal, State, and private agencies whose functions include collecting, analyzing, and disseminating climatic information;
2. Promote information exchange among State Climatologists; and
3. Provide mutual assistance in developing effective State Climatologist programs.

There were 16 State Climatologists in 1976, 25 in 1977 and the present number is 42. In most cases, they are located at State universities and perform faculty duties, in addition to their climatic activities. A few full-time State Climatologists, with supporting staff, operate State Climatology Service Centers that provide a variety of public services, State consultations, liaison, applied research, education, climatic assessments, and public information releases. The service activities vary according to the support provided.

EDIS, primarily through the National Climatic Center (NCC), assists the States in establishing and maintaining their climatological programs by providing limited, but essential, Federal support. NCC provides the State's climatic archives to the State Climatologists and NCC climate publications to State Climatology Service Centers. In addition, in 1978, NCC approved a $500 account for NCC data services for each State Climatologist.

The annual AASC meetings provide the setting for most of the State Climatologist's information exchange, problem identification and solving, policy determination, and interaction with cooperating agencies. Between meetings, the AASC Executive Board provides advisory information to the membership. The need for internal communication is also met by the *NCC News Letter,* issued quarterly by NCC in cooperation with the AASC.

OTEC Issue Outline

EDIS' Environmental Science Information Center has issued a new publication in its *Current Issue Outline* (CIO) series, entitled *Ocean Thermal Energy Conversion* (OTEC). The OTEC CIO provides background information on the use of the oceans as a collector of solar heat to produce electrical power and other products.

Current Issue Outlines are short overviews of environmental topics accompanied by selective, sometimes annotated, bibliographies. They are designed to provide objective, analyzed information on high-interest issues for NOAA decision-makers, legislators, public officials, environmentalists, citizen's groups, and the general public. Other titles in the CIO series are: *Icebergs for Use as Freshwater, Harnessing Tidal Energy, Sea-Surface Temperature and Climate,* and *Water Desalination.*

Copies of any of the above publications may be obtained from the ESIC Library and Information Services Division's User Services Branch, D822, EDIS/NOAA, 6009 Executive Boulevard, WSC#4, Rockville, MD 20852, or by calling (301) 443-8330 (also an FTS number).

U.S. Earthquake History Update

EDIS' National Geophysical and Solar-Terrestrial Data Center recently published a supplement to Publication 41-1, *Earthquake History of the United States.* The supplement updates the basic work by including events for the years 1971 through 1976.

The supplement period was highlighted by major earthquakes in Southern California, Alaska, and Hawaii. A magnitude 6.4 shock near San Fernando, Calif., about 50 miles from Los Angeles, occurred on February 9, 1971. It killed 58 people, injured over 2,000 more, and caused property damage in excess of $500 million.

Two earthquakes measuring 7.6 on the magnitude scale caused moderate damages in widely separated areas of Alaska. The first occurred July 30, 1972 in southeastern Alaska, near Sitka. A few chimneys cracked and fell at Sitka, some minor landslides were noted, and power was disrupted briefly.

Another major earthquake, also magnitude 7.6, was centered in the Aleutian Islands near Shemya Island. Fifteen people were injured and severe damage occurred on Shemya. On April 26, 1973, a magnitude 6.2 earthquake near the Northeast coast of Hawaii Island injured 11 people and caused an estimated $5.6 million damage.

NASA Data Listing

NASA's National Space Science Data Center (NSSDC) has published a data listing that provides a convenient reference to space science and supporting data available from the Center.

The first part of the listing, "Satellite Data," is in an abbreviated form similar to that of the data catalogs normally published by the World Data Center A for Rockets and Satellites. It is organized by spacecraft name, followed by launch data and NSSDC identification. The experiments are listed alphabetically by the last name of the principal investigator. The data set name, data form code, quantity of data, and the time span of the data are printed for each data set.

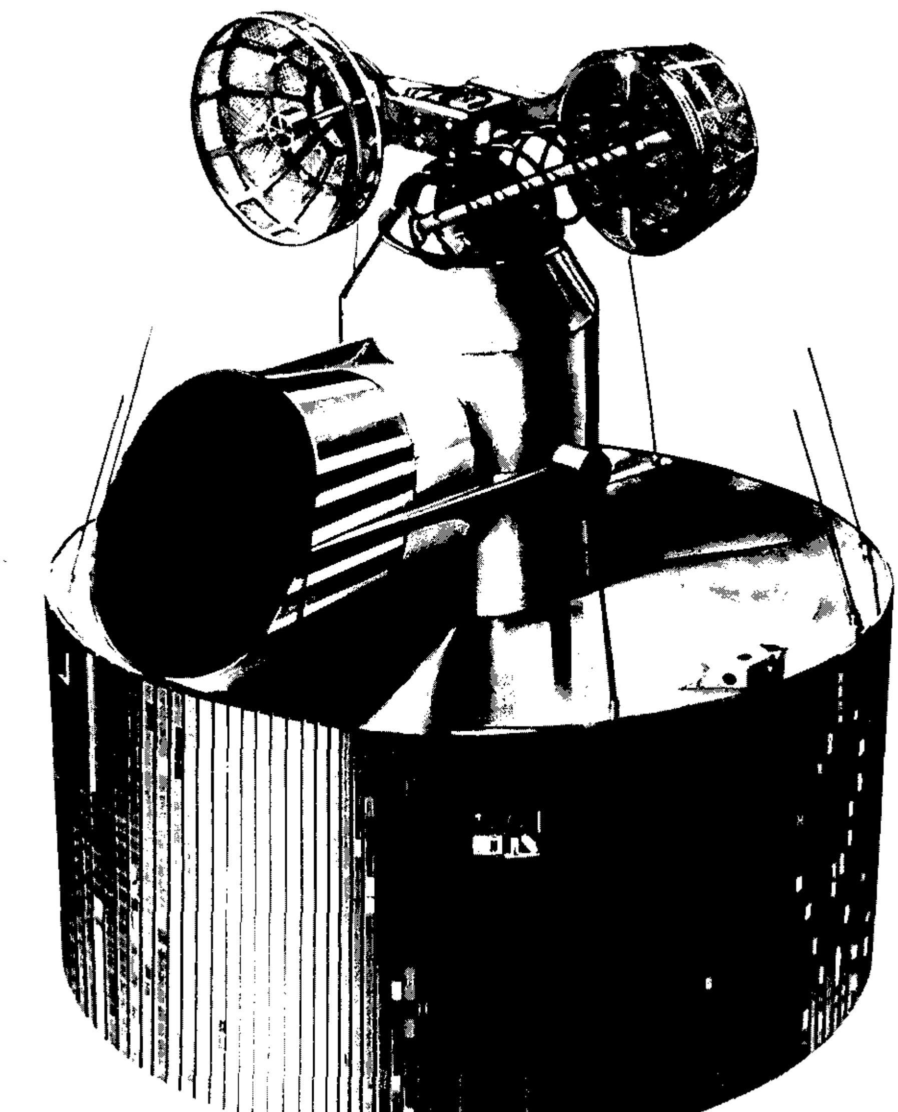
Part two of the listing contains titled nonsatellite data, ground-based data, models, computer routines and composite spacecraft data are available from NSSDC. This section also gives the data set name, data form code, quantity of data, and the time span covered. In addition, Appendix 2 contains information on NSSDC facilities and ordering procedures.

Copies of this publication may be obtained from the National Space Science Data Center, World Data Center A for Rockets and Satellites, NASA Goddard Space Flight Center, Greenbelt, MD 20771.

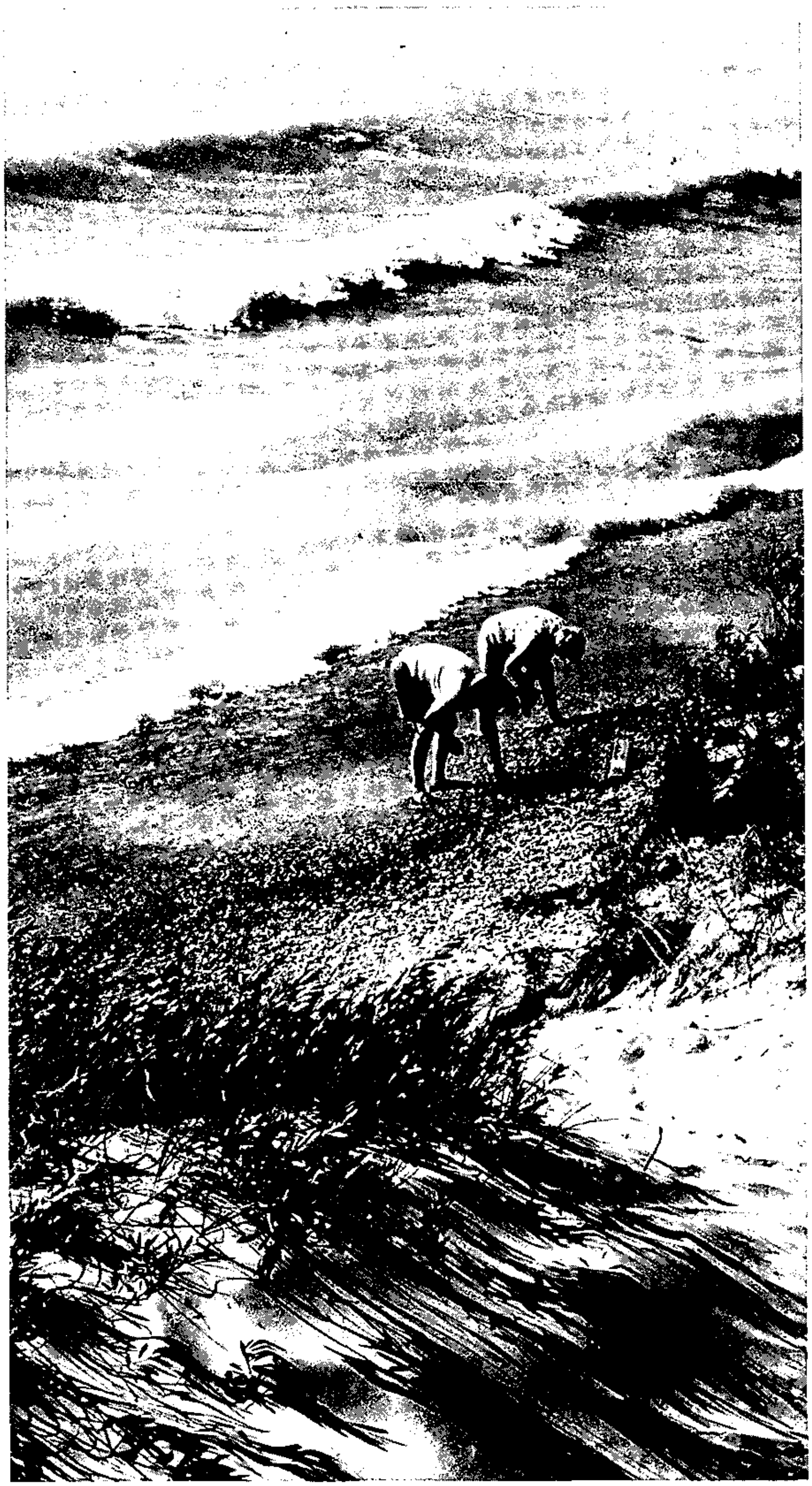
Satellite Data Users Bulletin

The Satellite Data Services Division has issued the second edition of the *Satellite Data Users Bulletin*. Contained in this issue are: up-to-date descriptions of data available from SEASAT, including a series of illustrations depicting all synthetic aperture radar acquisitions; a description of the evolution of the geostationary satellite system and of products available, including sources of data from the Japanese and European geostationary satellites (HIMWARI-1 and METEOSAT); a similar description of the evolution of the ITOS/NOAA polar-orbiting satellites and of products available; an update on TIROS-N, NOAA-6, and NIMBUS-7 coastal zone color scanner. Also included are points of contact for information and data pertaining to LANDSAT and other NASA satellites.

Copies of the current and the previous issues may be obtained by writing to: Satellite Data Services Division, NOAA/EDIS/NCC, Room 606, World Weather Building, Washington, DC 20233 or calling (301) 763-8111 or FTS 763-8111.



Japanese geostationary satellite, HIMWARI-1, which is positioned over the Equator at 140°E.



Lake Michigan Climatic Guide

The Visitor's Climatic Guide to West Michigan's Shore—the latest in a series of environmental resort brochures—has been published. This handy guide was produced by the Michigan Sea Grant Advisory Service and EDIS' National Oceanographic Data Center. It contains a seasonal breakdown of weather and recreational opportunities. The pamphlet divides the Michigan coast of Lake Michigan into three regions, each with its own activities and climate.

The guide includes climatic tables for each season. These summaries stress the elements of interest for the particular season. It contains the number of sunny and rainy days in summer, along with morning and afternoon temperatures and wind. The winter guide is, of course, concerned with snow days for skiing and freezing weather for ice activities such as ice fishing and ice skating. For each season there is also a table of activities best suited for that time of the year.

In addition to fishing, boating, and swimming, the guide describes events such as the Seaway Festival in Muskegon, Holland's Tulip Festival, and the many Oktoberfests during the colorful fall season. Harbors along the coast are pinpointed on a chart as are the major roads and airfields. There is also a section on where to obtain additional specialized information. This brochure and others for North Carolina, San Francisco, and Lake Erie resort areas are available free of charge from Resort Guides, National Oceanographic Data Center (D762), EDIS/NOAA, Washington, DC 20235.

Shell collectors on Lake Michigan's shore.

Michigan Travel Commission

International Report

International Marine Data Specialists Meet

The World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC) recently held ajoint Informal Planning Meeting on Marine Environmental Data Management at the WMO Secretariat in Geneva, Switzerland. The 25 participants represented a broad diversity of environmental programs and data activities.

Present were representatives of the IOC/Working Committee on International Oceanographic Data Exchange (WC IODE) and of IODE and WMO data centers; the WMO Commission on Marine Climatology (CMM); the Committee on Climate Change and the Ocean (CCCO) which is a new joint IOC/SCOR (Scientific Committee on Oceanic Research) body with a major role in planning the ocean component of the World Climate Program; the United Nations Environment Program (UNEP); and the International Council of Scientific Unions (ICSU) Panel on World Data Centers.

Topics discussed included:

- existing data archiving practices and service capabilities;
- long-term needs of the "secondary" data user community in the coming decade;
- problems of incorporating remotely sensed data in overall data management schemes; and
- arrangements between IODE and the WMO to respond to the future data needs of the Climate Program.

The group's recommendations call for continued cooperation between IODE and WMO through increased mutual representation at meetings; regular exchange of information and compilation of a joint document on data activities; and convening of joint meetings to address specific subjects requiring common action or advice.

NOAA participants included Robert V. Ochinero, Director of EDIS' National Oceanographic Data Center (NODC), representing the IOC's Responsible National Oceanographic Data Center structure; Thomas Winterfield, NODC advisor for International Programs and Chairman of the Working Committee on International Oceanographic Data Exchange (WC IODE); Robert Dennis, EDIS' Center for Environmental Assessment Services, representing the oceanographic data management system for the Global Experiment Year (FGGE); and John Leese of NOAA's National Environmental Satellite Service, who attended as an expert on satellite data.

RNODC Experts Meet in Tokyo

The Second Session of the Intergovernmental Oceanographic Commission's (IOC) Group of Experts on developing a pilot program for Responsible Oceanographic Data Centers (RNODCs) was convened in September 1979 by its chairman, Robert V. Ochinero, Director of EDIS' National Oceanographic Data Center. The Hydrographic Department of Japan and its Japan Oceanographic Data Center (JODC) hosted the meeting in Tokyo.

First row (l. to r.) Dr. V. Alexseev and Dr. T. Ragova, USSR; R. Ochinero, U.S.; Dr. D. Shoji, Japan; A. Tolkachev, Assistant Secretary IOC UNESCO; C. Lozano Lopez, Columbia; and V. Korotkov, USSR. Back row (l. to r.) S. Yoshida, A. Takuhiro, Dr. H. Nitani, and Y. Oyamado, Japan.

RNODCs are part of the permanent network for oceanographic data exchange and are supplementary to and support the International Council of Scientific Unions' World data centers. RNODCs are generally existing national oceanographic data centers that have voluntarily assumed the additional responsibility of accessioning, archiving, and servicing data to be exchanged by international agreement.

Although, the RNODCs are not to become operational until 1980, a few already exist. For example, the JODC, U.S. NODC, and U.S.S.R. NODC serve as RNODCs for the Integrated Global Ocean Station System. JODC was the RNODC for the now completed Cooperative Study of the Kuroshio. The JODC will serve as RNODC for WESTPAC, a new IOC regional association for programs in the western Pacific.

During the meeting, the group discussed plans to develop a detailed users guide to RNODCs to include:

- Definition of an RNODC,
- Relationship of RNODCs with other elements of the IOC's national oceanographic data exchange program,
- Functions of an RNODC,
- Procedures for selecting and designating RNODCs, and
- Existing RNODCs and samples of their products and services.

The group also deeveloped two generalized flow charts to provide interim guidance to the IOC Secretariat, as well as for inclusion in the guide. One flow chart depicts the steps involved in the selection and designation of an RNODC for international programs and projects (e.g. WESTPAC or the proposed CLIMATE Program); the other chart shows how requests for services and/or products from an RNODC would be handled. The Guide will make use of the answers to two questionnaires distributed prior to the meeting. One inquired about the requirements of international programs for RNODC support. The other inquired about the capabilities, products, and services available from those NODCs that volunteered to serve as RNODCs. The group set June 1980 as the target date for completion of the guide.

Indonesian Earthquake Data Qualifies for International Exchange

On September 12, 1979 a major earthquake occurred near the Indonesian Islands of Yapen and Biak, generating a destructive seismic sea wave or tsunami. Data on this event have been declared eligible for the International Data Exchange program. Seismograms from about 300 stations worldwide will automatically be sent to the World Data Center A for Solid Earth Geophysics, collocated with EDIS' National Geophysical and Solar-Terrestrial Data Center in Boulder, Colo.

The Indonesian earthquake measured 8.1 on the Richter magnitude scale; it was the world's strongest earthquake in 2 years. The hardest hit area appeared to be Yapen Island, directly south of Biak, and northern coastal areas of Irian Jaya south of Yapen. Yapen reported 15 people killed and many injured.

Only last July, the remote Island of Lomblen, 1,000 miles southwest of Yapen, was hit by 30-foot waves (tsunami) triggered by volcanic eruptions. Hundreds of people in four villages were swept away; only 23 survivors were rescued.

For more information write to: World Data Center A for Solid Earth Geophysics, NGSDC, Boulder, CO 80303.

Solid Earth Data Reports

Three new Solid Earth Data Reports, SE-18, SE-19, and SE-20 were recently published by EDIS' National Geophysical and Solar-Terrestrial Data Center (NGSDC). SE-18, the *Homogeneous Magnitude System of the Eurasian Continent: P Waves,* includes data compiled by three Eastern seismologists. It describes a method for making more consistent the magnitudes of Eurasian continental events. SE-19, *Geodynamics International-15,* like similar predecessors, contains a series of reports of the Inter-Union Commission on Geodynamics, as well as various data documentation items. SE-20, a *Manual of Seismological Observatory Practice,* edited by P. L. Willmore, is a revised second edition of the original published by the International Seismological Center in 1970. The manual is intended as a guide for governments in setting up or reviewing seisomological networks; it also includes a selection of designs for recording stations and suggestions for staffing and organizations, as well as all necessary information on instruments and procedures to enable the stations to fulfill normal functions.

Chinese Delegation Visits NCC

Seven meteorologists from the People's Republic of China recently visited EDIS' National Climatic Center (NCC) in Asheville, N.C., accompanied by Dr. Kenneth C. Spengler, Executive Director of the American Meteorological Society and Alice Hogan, NOAA, who acted as the American interpreter.

U.S. meteorologists went to China in 1974, and a group of Chinese scientists returned the visit in 1975. There have been other exchanges since, with the most recent American visit to China in June and July of 1979.

While in the United States, the current group of Chinese meteorologists also visited the Massachusetts Institute of Technology and Harvard University, in Boston, Mass.; the National Center for Atmospheric Research and the Environmental Research Laboratories in Boulder, Colo.; and the National Hurricane Research Laboratory in Miami, Fla.

The Chinese were given a comprehensive tour of NCC, were shown recently acquired computer and data digitizing equipment in operation, and briefed on future plans of the Center.

Dr. Kenneth Spengler (striped tie), Executive Director of the American Meteorological Society, explains the workings of a weather instrument array that is carried aloft by a rocket. Shown (l. to r.) are: W. McMurray, Deputy Director of NCC; A. Hogan, NOAA interpreter; Spengler, Xiangsui Wang; Xiyou Wang; Guang Chu; Kuei Jin; Xingmiao Yu; Yian Zhang; and Youxian Wei.

International Marine Information Service

The international Aquatic Sciences and Fisheries Abstracts (ASFA) data base is now available to the public for nationwide online computer searching through Lockheed DIALOG information retrieval system under NOAA sponsorship. EDIS' Environmental Science Information Center (ESIC) is the United States participant in ASFA.

The ASFA data base provides the world's most comprehensive coverage of published information on the science, technology, and management of marine and freshwater environments. About 24,000 publications per year are covered. The data base initially will provide coverage from January 1978 to the present. Publications from 1975-77 will be added during 1980.

ASFA is a cooperative effort of three international organizations—the Intergovernmental Oceanographic Commission, the Food and Agricultural Organization, and the United Nations' Ocean Economics and Technology Office—as well as national agencies in nine countries, and a private publisher, Information Retrieval Ltd. of London. ASFA is the major product of the Aquatic Sciences and Fisheries Information System (ASFIS) developed in response to resolutions by the Intergovernmental Oceanographic Commission Assembly in 1971 and 1973, and by the United Nations' Conference on the Human Environment in 1972.

The data base is accessible throughout the United States and other countries through the Lockheed Missiles and Space Corporation (800-227-1960 or 800-982-5838 in California). Data base searches may be requested through ESIC's Library and Information Services Division, WSC-4, Rockville, MD 20852, telephone: 301-443-8330. There is a charge for services to requestors who are not NOAA employees. Other questions regarding the ASFA data base should be addressed to Director, Environmental Science Information Center, D8, NOAA, 11400 Rockville Pike, Rockville, MD 20852.

Two New Climatic Publications

World Weather Records, 1961-1970, Volume I, North America has been published. It contains monthly temperature, precipitation, and sea-level and station pressure data for selected stations in the United States, Canada, and Mexico. This volume also contains mean monthly lake level data for the Great Lakes, dates of freezing and thawing of selected lakes and streams, and relative sunspot numbers. This is the first volume of the sixth series of publications entitled *World Weather Records*. Five more volumes in this series will be published during the next several years. Copies of this volume may be obtained from the Superintendent of Documents, GPO, Washington, DC for $6.00 per copy.

Station Climatic Summaries, a 245-page publication prepared by EDIS'National Climatic Center for the Commander, Naval Oceanography Command is now in print. It contains a narrative climatic summary, a means and extremes table, flying weather statistics, and station history information for each of 59 U.S. Navy or Marine Corps stations and 2 U.S. Air Force stations in the United States, Puerto Rico, Antarctica, Europe, Japan, the Phillipines, and selected bases in the Caribbean and Mediterranean Seas and the Indian, Pacific, and North Atlantic Oceans. Sequential tables of monthly and annual values of mean temperature, total precipitation, and heating- and cooling-degree days are also included for the Navy and Marine Corps stations. Each station summary covers the period of available record from the mid-1940's through 1977. Copies of this publication may be secured from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

PRC Marine Data Exchange

A U.S. delegation of experts from the Environmental Data and Information Service (EDIS) and the U.S. Geological Survey visited the Peoples Republic of China (PRC) from November 1-25 to assist the PRC in modernizing its national marine data center and to establish a marine data exchange program. The visit is part of an agreement NOAA signed with the PRC's National Bureau of Oceanography in May 1979 that listed general principles of cooperation between the two countries.

The types of data that have been collected by the PRC, the form in which the data are available, the quality of the data, and the best format in which to receive such data are of primary concern. One of EDIS' initiatives will be to assist the PRC in establishing programs geared to upgrade their data center's activities, i.e., to improve computer hardware and software and scientific quality control methods, so as to establish a data exchange system that will be mutually beneficial.

EDIS' team includes James Churgin, Director of World Data Center-A for Oceanography and Director of the National Oceanographic Data Center's Services Division; Dr. Michael Loughridge, an expert in marine geology and geophysics from the National Geophysical and Solar-Terrestrial Data Center in Boulder, Colo.; and George Saxton, a computer systems analyst from the National Oceanographic Data Center.

International Geophysical Calendar for 1980

The International Geophysical Calendar for 1980 has been prepared in cooperation with the world scientific community and distributed by EDIS' 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 1980 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 80303.

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JANUARY 1981

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- 17 Regular World Day (RWD)
- 14 Priority Regular World Day (PRWD)
- 16 Quarterly World Day (QWD) also a PRWD and RWD
- 2 Regular Geophysical Day (RGD)
- 16 Day of Solar Eclipse
- 16* Dark Moon Geophysical Day (DMGD)
- 7 8 World Geophysical Interval (WGI)
- 6 7 Airglow and Aurora Period
- [3, 27] Day with unusual meteor shower activity, Northern, [, or Southern,], Hemisphere

NOTES:

1. Solar Maximum Year continues throughout the year.
2. Flare Buildup Study (FBS) Alert Period May-June, 1980.
3. Study of Energy Release in Flares (SERF) Alert Period September 15 - October 15, 1980.
4. IAGA/URSI Working Group on Passive Electromagnetic Probing of the Magnetosphere International Campaign June 22 - July 19, 1980.
5. Middle Atmosphere Program, MAP, will have:
   - **Preliminary Map Project-1** Coordinated Study of the Behavior of the Middle Atmosphere in Winter continues January-March 1980.
   - **Preliminary Map Project-2** Equatorial Wave Dynamics throughout 1980 corresponding to NIMBUS-G observations.
   - **Preliminary Map Project-3** Study of Photochemical Processes in the Upper Stratosphere and Mesosphere by Complementary Spacecraft, In Situ and Ground Measurements - July 1980.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Environmental Data and Information Service
EDIS Magazine
Washington, D.C. 20235

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Penalty for Private Use, $300

Postage and Fees Paid
U.S. Department of Commerce
COM-210
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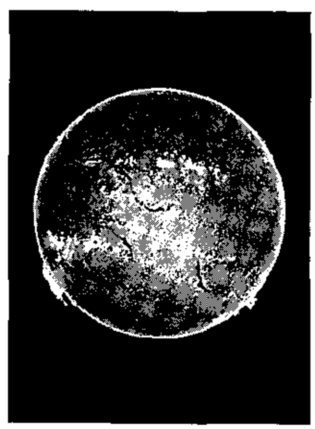

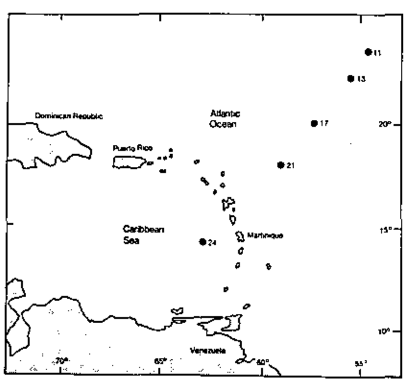

In this issue: *Those recent extreme winters (p.3); Northern Hemisphere snow cover (p.8); climatic changes linked to sunspot variations (p.15); the current sunspot maximum (p.17); and marine natural oil seepage may exceed estimates (p.20).*

EDIS

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Information Service
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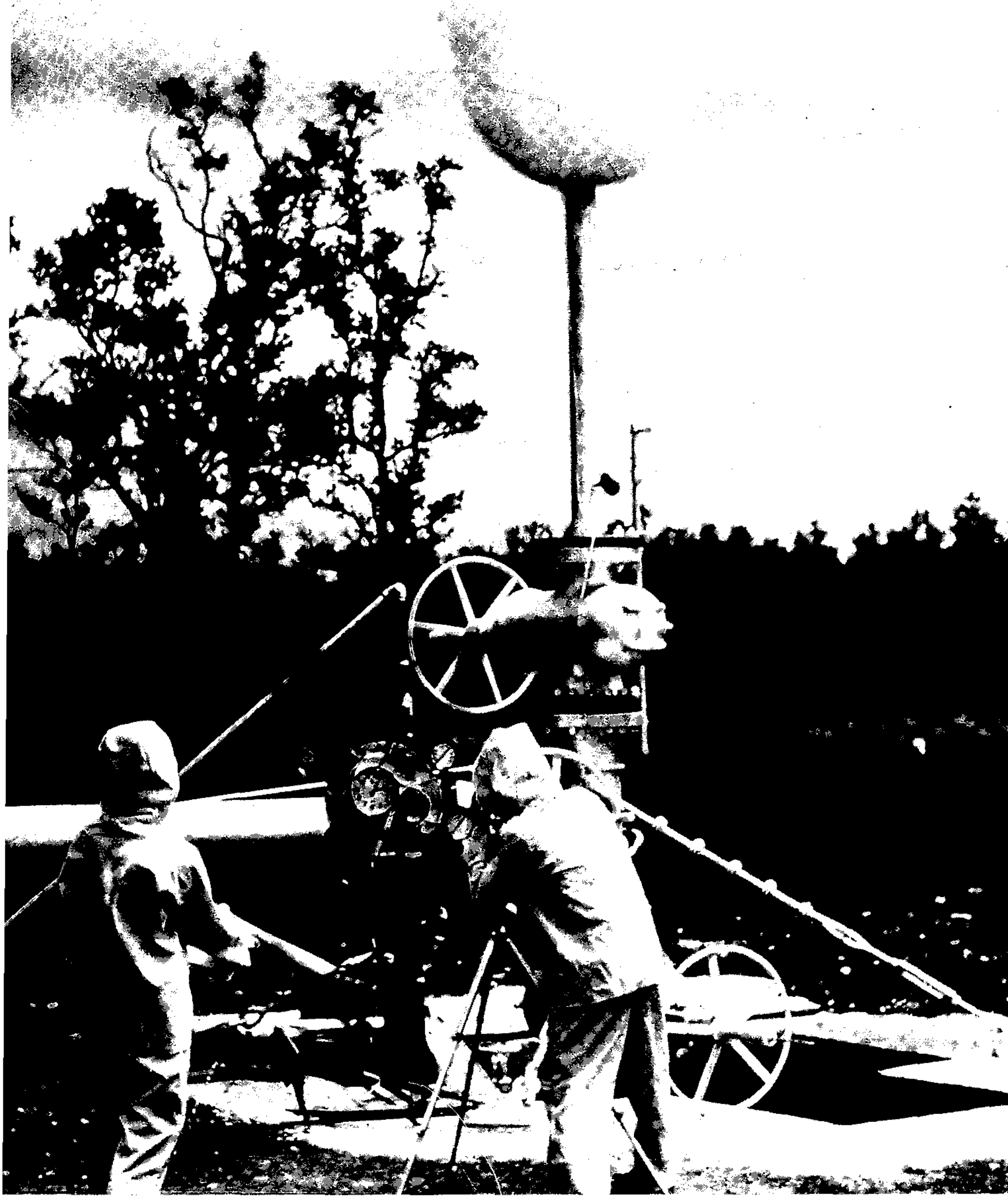

EDIS

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***Cover:** Steam spews skyward from a geothermal well on the Island of Hawaii. The well is the hottest (357°C) in the United States. See article on geothermal energy beginning on page 4.*

Department of Energy Photo

EDIS is designed to inform Environmental Data and Information Service (EDIS) cooperators, colleagues, and contributors of recent developments in EDIS programs and services and in the general field of scientific data and information management. EDIS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, and Center for Environmental Assessment Services. In addition, under agreement with the National Academy of Sciences, EDIS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology (Snow and Ice).

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.

EDIS (ISSN 0109-3365) is published bimonthly by the Environmental Data and Information Service, NOAA, Page Building 2, Room 533, 3300 Whitehaven St. N.W., Washington, D.C. 20235. For address changes, cancellation, or information write to the Editor at this address. Controlled Circulation Postage is paid to the Finance Department, USPS, Wash., D.C. 20260.

EDIS Users in the 1980's

EDIS currently provides environmental data and information products and services to over 138,000 users a year. We expect the number of users to continue to increase at an annual rate of 5 percent to 7 percent.

The EDIS user community is in a state of flux. During the last two decades, increasing concern with environmental, ecological, energy, and other public issues with a scientific base has increasingly shifted the national focus of environmental data and information applications. The emphasis has been moving from the advancement of science toward the use of scientific data and information in seeking solutions to socio-technical problems, in formulating public policy, and in choosing among potential alternative futures.

Reflecting this trend, the EDIS user community has expanded to include more public policymakers at the national, State, and local levels; attorneys; regional planners; business executives; citizens' groups; and individual taxpayers. These new users and applications often require synthesis and evaluation of multidisciplinary environmental data and information. This results in greater emphasis on products and services that cut across traditional disciplines, missions, programs, and agencies.

During the coming decade, we expect the following with respect to our three main user types:

1. *Decision- and policymakers* at Federal, State, and local levels of government, and regulatory bodies, will require multidisciplinary assessments of environmental impacts, as well as supporting data bases with near-real-time update capabilities. Usually, the assessments will have to be presented in non-technical terminology.
2. *Individuals.* Citizens, attorneys, engineers, architects, business and professional people will continue to make the largest number of requests. They will require relatively small amounts of data or information, concise summaries, tailored products, and interpretive guidance in non-scientific formats and presentations.
3. *Environmental scientists and other technically sophisticated users* will require large volumes of scientific data, often in near-real-time, remote terminal access, and multidisciplinary products and services.

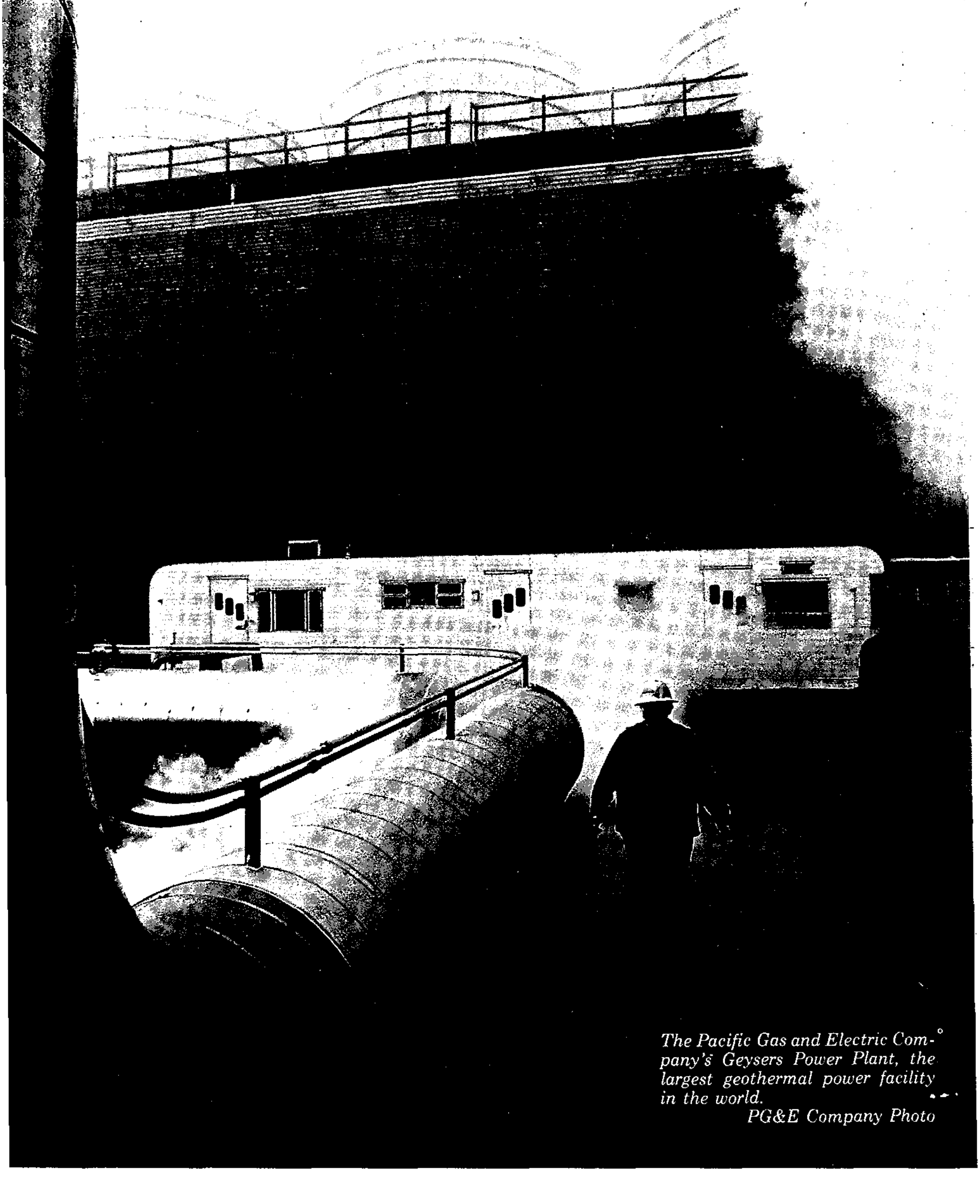
To meet emerging user needs, EDIS currently is integrating its discipline-oriented operations into a single, user-oriented management and service system. The new system will provide access not only to multidisciplinary environmental data and information, but also to analysis, applications, and product-generation subsystems. Access will be provided at EDIS centers and liaison offices, and at NOAA libraries across the country; eventually, users may be able to buy an inexpensive terminal and participate from their office or home. Emphasis will be placed on providing distilled information and answers to specific questions, as distinct from raw data or bibliographic listings.

Thomas D. Potter

Thomas D. Potter
Director, EDIS

U.S. Geothermal Resources

By Paul J. Grim and Leon LaPorte



The Pacific Gas and Electric Company's Geysers Power Plant, the largest geothermal power facility in the world.
PG&E Company Photo

Just 90 miles north of San Francisco, heat from the interior of the Earth is used to generate 663 megawatts of inexpensive electricity for customers of the Pacific Gas and Electric Company.

In Klamath Falls, Oregon, over 400 buildings are warmed by heat from the Earth's interior.

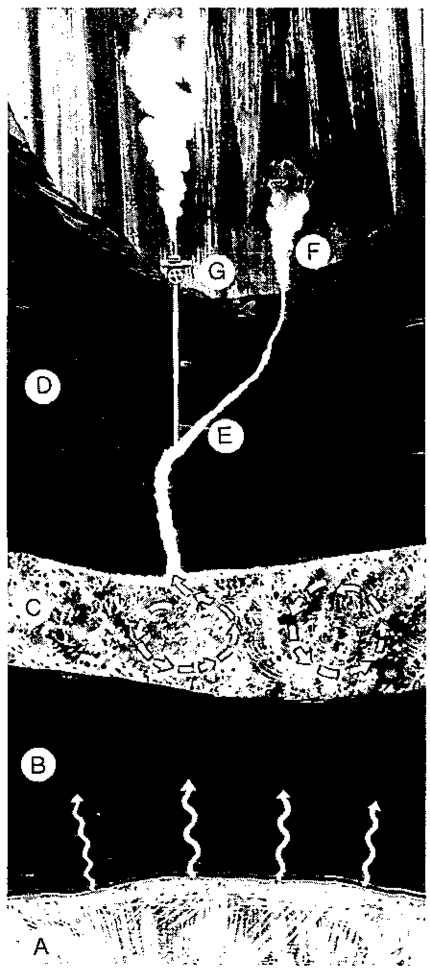
These are applications of an alternate energy source known as geothermal energy. Many more applications will be made as planners, engineers, and scientists become aware of the availability and potential of geothermal energy.

To increase awareness and to encourage the use of geothermal energy resources in the United States, the U.S. Geological Survey has published *Assessment of Geothermal Resources of the United States—1978* (L.J.P. Muffler, ed.). The publication discusses many details of geothermal resources within the United States, including the likelihood of new resources being discovered.

The publication also contains large, multi-colored maps for the Western United States, Texas and Louisiana, and Alaska and Hawaii. The maps were prepared for U.S. Geological Survey by EDIS' National Geophysical and Solar-Terrestrial Data Center, with funding from the Department of Energy. The three maps show graphically both the known geothermal resource areas and other complementary information, such as locations of interstate highways, major cities, and National parks and monuments.

Perhaps the best known geothermal area discussed (although off limits to geothermal exploitation) is Yellowstone National Park, in the northwestern part of Wyoming. Yellowstone, as all visitors can testify, has many thermal features such as hot springs and geysers.

The publication and maps also give details on areas not as well known as Yellowstone Park. These are located throughout the United States, especially in the western states. They have abundant energy that in many cases is being used for practical purposes or has great potential for use.



Cross section of a geothermal field: (A) molten mass; (B) solid rock conducts heat upward; (C) porous rock contains water boiled by heat from below: (D) more solid rock prevents steam from escaping; (E) fissure allows steam to escape through geyser hot spring (F); (G) well taps steam from fissure.

PG&E Company Photo

The geothermal area north of San Francisco is called the Geysers. It is the world's largest geothermal electricity-generating development. Drilling and construction are underway to expand the generating capacity to 1,128 megawatts by 1982. The geysers yield dry steam, which is most suitable for electrical generation. The steam is transported to nearby power stations and fed directly into turbogenerators.

Klamath Falls, Oregon, uses geothermal energy from warm water (below boiling) temperature fields. Homes, businesses, churches, and schools in Klamath Falls long have used geothermal warm water, mostly for space heating. There now are nearly 500 wells in the area, and plans call for the development of a district heating system to serve the central part of the city.

Geothermal water at 77°C (171°F) has been used for a small part of Boise, Idaho's heating requirements since 1892, but to a decreasing degree, owing to competition from cheap petroleum. Since the 1973 petroleum crisis, however, renewed interest in geothermal energy has resulted in a demonstration project for heating state and Federal buildings, as well as plans for a district space-heating utility.

At Brady Hot Springs, Nevada, water from existing geothermal wells at 150°C (302°F) are being used in a new vegetable dehydration plant. These wells are examples of wet steam fields, where hot water under high pressure is obtained by drilling. A separator is normally put on the well head, and by reducing the pressure, about 20 percent of the water changes into steam. The steam is sent to a power station for generation of electricity. The remaining hot water can be used for heating and other purposes.

A food processing plant near Reno, Nev., uses superheated water from a geothermal well to heat the air to dry onions.

The Raft River Valley, Idaho is the site of a Department of Energy project to use hot geothermal water for electrical generation, aquaculture, food processing, and crop irrigation. Wells tapping a 150°C (302°F) reservoir will supply water to a 5-megawatt pilot power plant.

In Hawaii, hot geothermal water will be used to power an electrical generator in 1980. A well, drilled on the east rift of Kilauea Volcano, encountered hot water with temperatures up to 358°C (676°F), which will soon drive a 5-megawatt wellhead generator.

Geothermal energy also comes from geo-pressure zones. In these, water is under high pressure, natural gas is dissolved in the water, and the water itself is hot. As a result, it will be possible to use the mechanical power of the water under high pressure, the natural gas dissolved in the water, and the heat of the water. Large geo-pressure zones exist in Texas, Louisiana, and other parts of the United States.

The first geopressured-geothermal energy test in the United States was sponsored by the Department of Energy in 1977 in an abandoned gas well located in the Tigre Lagoon Field west of New Orleans. The gas recovered and the high flow rates achieved are very encouraging for the development of this resource. Water temperatures were sufficiently high for steam and hot water applications.

Drilling sponsored by DOE began in June, 1978 on the General Crude Oil Co., Pleasant Bayou no. 1 well, which is just west of Galveston. If this well is successful, the drilling of additional wells in this area and the construction of a surface facility will be considered for production of electric power and extraction of methane gas.

Although the maps show geothermal resources located from the Rocky Mountains westward and in many areas along Texas and Louisiana, large parts of the coastal plain in the eastern United States also may be developed in the future.

The coastal plain areas in the eastern United States have warm water that may be extracted for use in direct applications such as heating buildings. These areas currently are being investigated mainly by university teams with Department of Energy funding.

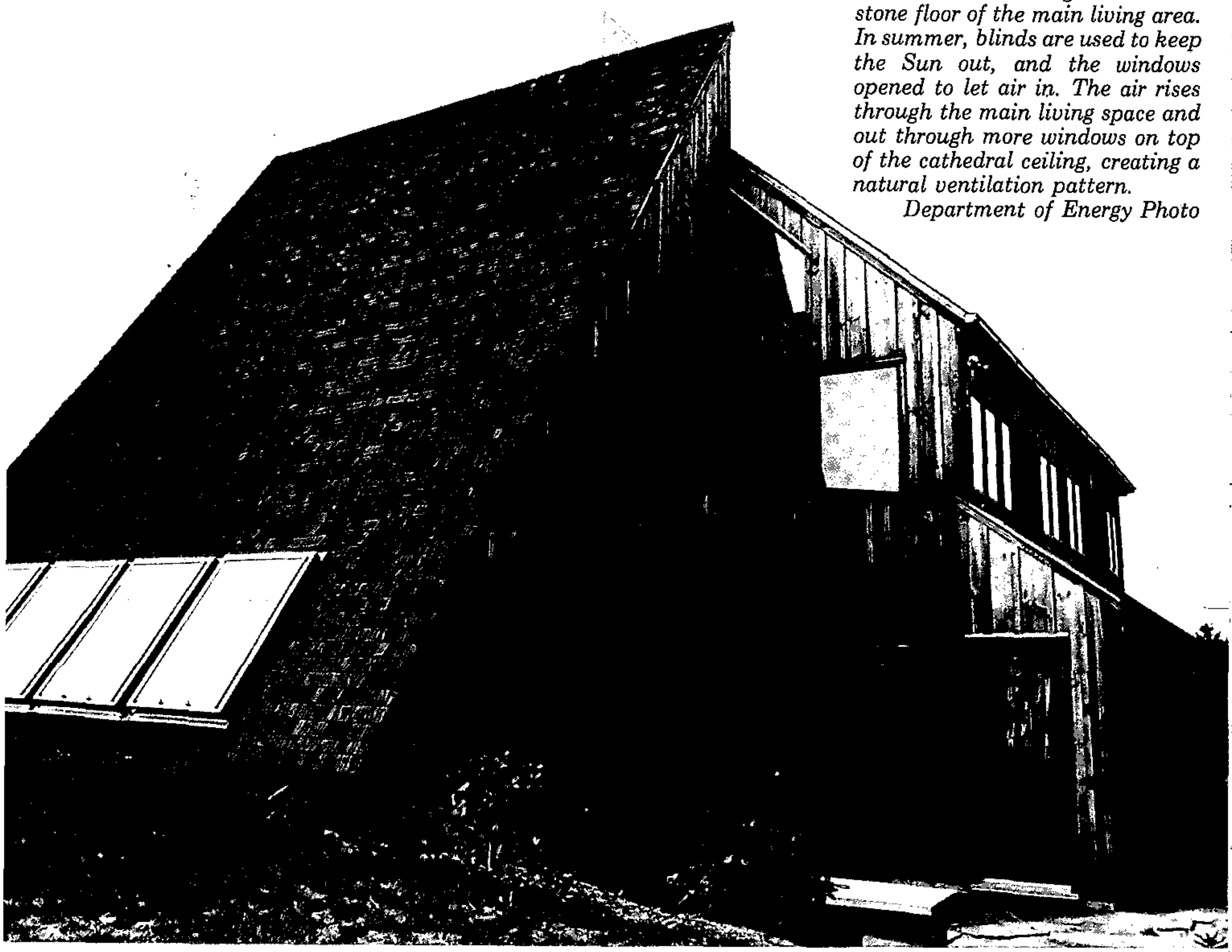
These areas are characterized by thick sediment overlying granitic rock that generates relatively large quantities of heat. It is thought that this combination will result in temperatures increasing downward much more rapidly than in normal areas. As a result, usable hot water may be encountered at relatively shallow depths. Even though the thermal resources are much less abundant on the East Coast than in the West, they are considered important because of the large population concentration in the East.

The USGS publication, Circular 790, and the three maps (folded), are available free of charge from: Branch of Distribution, U.S. Geological Survey, 1200 South Eads St., Arlington, VA 22202.

The maps alone are available (unfolded) at a cost of $2.50 each ($7.50 for all three) from: NOAA/ National Ocean Survey, Distribution Division, C44, Riverdale, MD 20840.

NOAA Contributions to the National Climate Program

By Norman Canfield, Acting Director,
NOAA Climate Office



This house in Maryland takes advantage of the local climate for natural heating and cooling. Windows on the sloping, south-facing wall let winter sunlight warm the stone floor of the main living area. In summer, blinds are used to keep the Sun out, and the windows opened to let air in. The air rises through the main living space and out through more windows on top of the cathedral ceiling, creating a natural ventilation pattern.
Department of Energy Photo

In addition to hosting the National Climate Program Office, the Department of Commerce National Oceanic and Atmospheric Administration (NOAA) is progressing toward a balanced program of climate services and research that complements the efforts of other agencies, focuses on related NOAA statutory responsibilities, and utilizes unique NOAA capabilities. During Fiscal Year 1979, there have been a number of achievements by various NOAA Centers and Laboratories across the Nation related to each of the major components defined in Chapter I, National Climate Program Preliminary 5-Year Plan, July 1979. A few of the more noteworthy achievements are highlighted below.

Climate Impact Assessment

In terms of the National Climate Program Act's call for assessments by mission agencies, NOAA's primary climate-sensitive mission is marine fisheries. Several recent papers by NOAA National Marine Fisheries Service (NMFS) scientists have shown that environmental indicies such as wind-driven circulation and oceanic upwelling offer much more promise as tools for predicting fisheries yields than direct use of variables such as temperature and salinity. In one new application, for example, NMFS has developed a climate-population multiple regression model for Pacific mackerel now being used in management of that fishery by the State of California. The model also will serve as a useful prototype for yield modeling of several other species.

NOAA's Environmental Data and Information Service (EDIS) has increased or accelerated its routine production of numerous climate assessments of domestic energy demand and foreign crop yields in cooperation with the Departments of Energy, Agriculture, and State. For example, EDIS recently has streamlined and speeded its monthly production of estimates of residential and commercial natural gas demand. The operational procedure uses National Weather Service 3-month outlooks in combination with current and historical temperature (heating degree-day) data. Such a systematic combination of weather statistics, station observations, and long-range predictions represents a new approach that will be used in other applications in the future.

In February 1979, EDIS and the Department of Energy cosponsored a Climate and Architecture Conference held at the American Institute of Architecture Research Corporation (AIARC) in Washington, D.C. The 16-page Spring 1979 issue of *Research and Design,* the Quarterly of the AIARC, summarizes the conference in part by pointing out that the energy crisis brought weather experts and building designers together for the first time in close to 30 years, and that their mutual goal was buildings that save energy by responding to the dynamics of climate.

Climate System Research

A key NOAA initiative to investigate the role of the oceans in global climate fluctuations began in Fiscal Year 1979 with long-term mooring arrays and transects on the Equator at Longitude 110°W as part of the Equatorial Pacific Ocean Climate Studies (EPOCS). The new measurements yielded data on the location and mass transport of the equatorial undercurrent, as well as estimates of the mean vertical velocity and surface temperature variations. Thus NOAA's Environmental Research Laboratories have taken the first step in a global ocean climate project that intends to identify and clarify the oceanic processes contributing to year-to-year climate change, and to apply the resultant understanding to the development of conceptual and numerical models for use in the simulation and prediction of climate.

Major emphasis of climate dynamics research at NOAA's Geophysical Fluid Dynamics Laboratory has been and will be placed upon the investigation of the impact on climate of future anthropogenic increases in atmospheric carbon dioxide concentration. For this study, a global model of climate with realistic geography and with seasonal variation of insolation was constructed. The model consists of (1) a spectral model of the atmospheric general circulation, (2) a simple mixed-layer ocean model with a uniform thickness and (3) a heat and water balance model of the continents. It is encouraging that this climate model successfully reproduces many of the basic characteristics of the seasonal variation in the geographical distribution of atmospheric temperature. The climatic effects of a CO_2 increase were evaluated by comparing two model climates, with the normal and four times the normal concentration of carbon dioxide.

It was noted that the warming of the model atmosphere in response to the quadrupling of CO_2-concentration is most pronounced in the lower troposphere at high latitudes due to the poleward retreat of the highly reflective snow cover and sea ice. The warming over the Artic Ocean and the surrounding regions is at a maximum in early winter and is at a minimum in summer (see fig.1). It was found that the reduction of sea-ice thickness is responsible for the seasonal asymetries in warming.

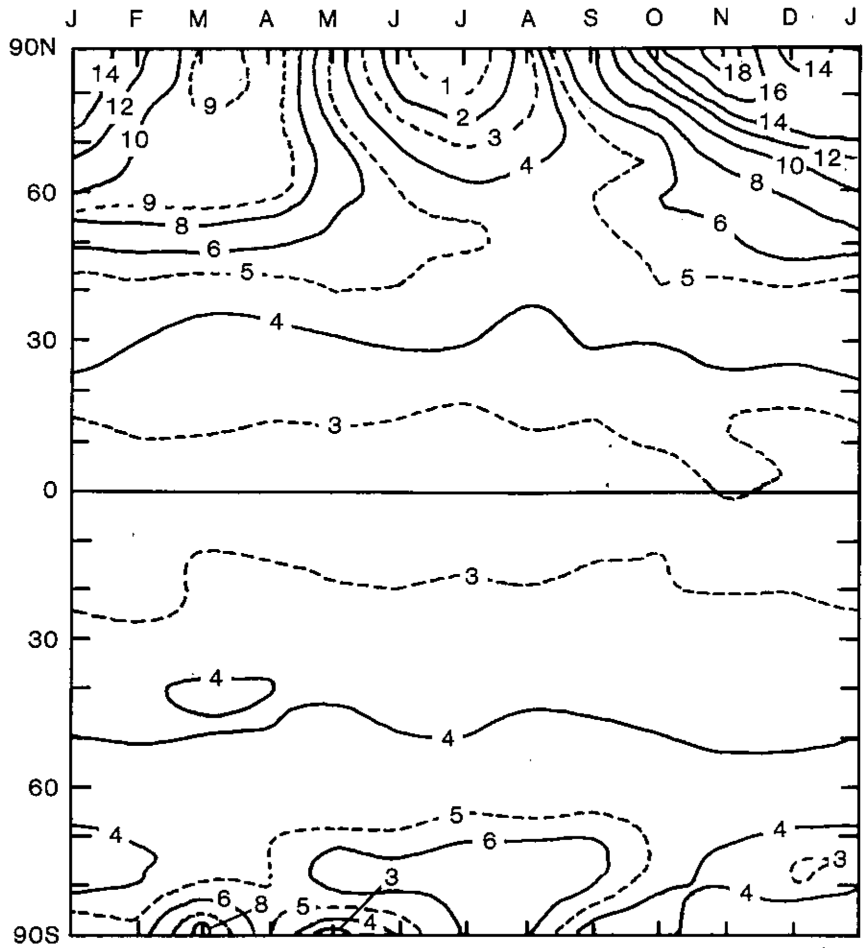


Fig. 1. Global latitude-seasonal differences in surface air temperature (°K) between present CO_2 levels and four times present levels.

The spectral model of global climate used for the CO_2-climate sensitivity study described above has a low computational resolution. Therefore, it was not possible to discuss with confidence the geographical distribution of climate change in response to an increase in the CO_2-concentration in the atmosphere. During Fiscal Year 1980, the CO_2-sensitivity study will be repeated with a spectral climate model having higher computational resolution to determine the geographical distribution of climatic response.

Earth-Atmosphere Radiation Budget Analyses Derived from NOAA Satellite Data, June 1974-February 1978, was published in August 1979. Monthly, seasonal, and annual averages are presented in two separate volumes, the first containing map analyses and the other graphed meridional profiles of zonal averages. Quantities displayed are albedo, absorbed solar radiation, outgoing longwave radiation, and net radiation. These quantities represent an important diagnostic tool for climatic studies and serve as a new source of information to the growing number of scientists who are interested in climate fluctuations. The data also are useful for deriving indirect evidence on variations in cloudiness, ice and snow, and heat sources other than radiation. Research on complex radiation monitoring problems is continuing at NOAA's National Environmental Satellite Service using data acquired from the TIROS-N Advanced Very High Resolution Radiometer and NIMBUS 6 and 7 Earth Radiation Budget experiments.

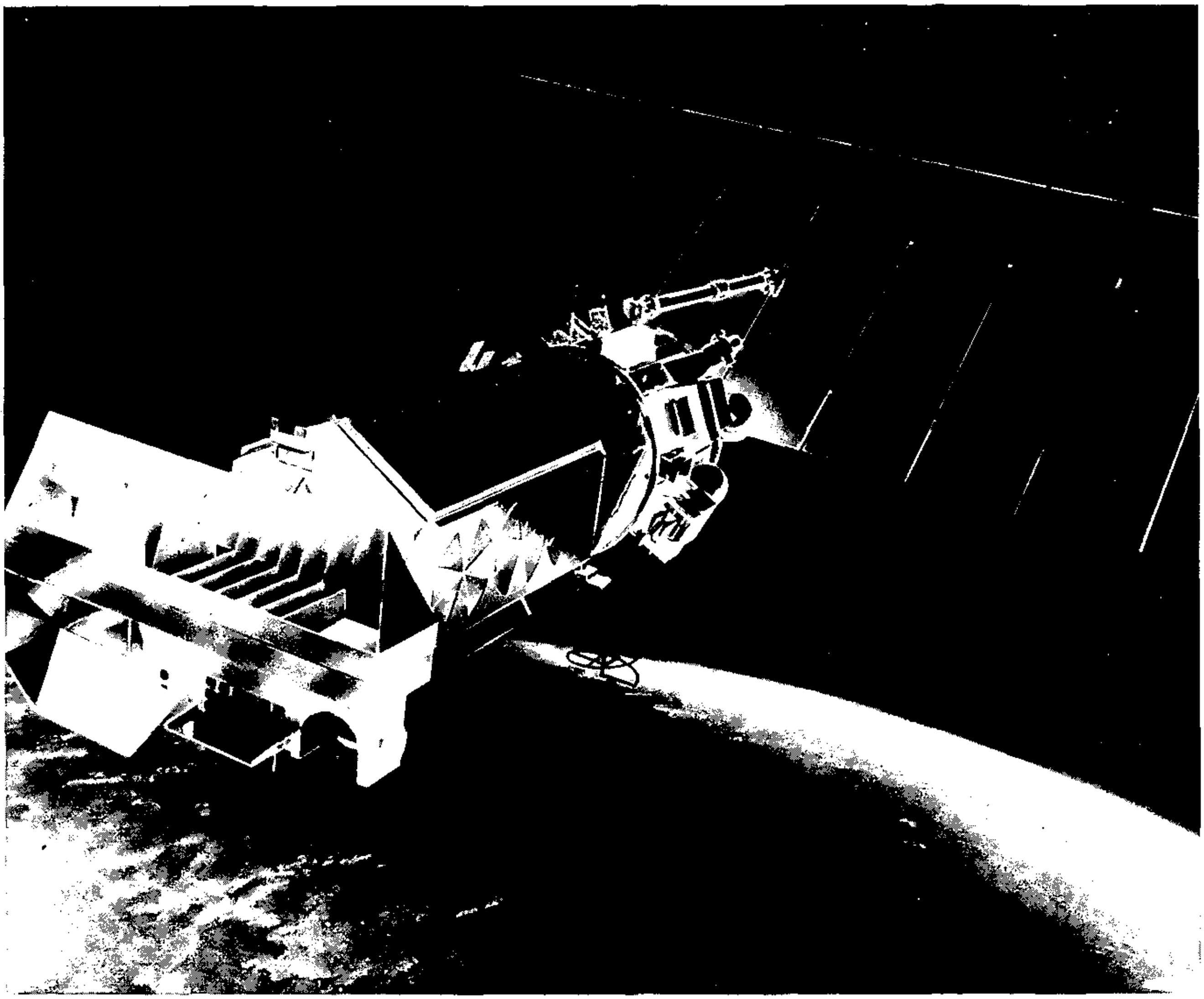
Climate Data, Information and Services

Achievements were realized in all four subdivisions of this component; they are highlighted below.

Climate Observations and Monitoring. Most of NOAA's extensive operational surface, upper-air, and satellite meteorological observing programs also provide data vital to climate services and research. These programs continued during Fiscal Year 1979, generally without changes of major significance to climate activities.

Regarding cooperative weather stations (often called substations), the total number of official substations across the Nation stood at 11,565 on July 1, 1979 (September 30 data not available). This total was 88 stations less than the count 12 months earlier. However, this reduction is accounted for entirely by single-element hydrologic substations. The number of official substations of types vital to climate, i.e., where at least two elements (temperature and precipitation) are recorded, actually increased by nearly three percent from 5,245 to 5,379 during the 12 months ending July 1, 1979.

Climate monitoring by operational satellite and by specialized measurements of atmospheric composition and solar radiation at remote baseline observatories continued without significant change during Fiscal Year



1979. In each case, however, data analysis presented interesting results. During the winter of 1978-1979, for example, satellite data analyses showed that North American snow cover extent (December through February average) reached a 13-year record high of 16.9 million square kilimeters (see Jan. 1980 *EDIS*, P.11). Meanwhile, recent analyses of baseline observatory measurements confirm that the transparency of the atmosphere on a global scale decreases by as much as several percent after explosive intrusions of volcanic debris into the stratosphere.

Climate Data Management. It is clear that requirements for climatic data resulting from the National Climate Program already are increasing. As resources have permitted, NOAA's Environmental Data and Information Service has begun the first steps of a large task to make climatic data more readily accessible to users—in formats they can use, within a reasonable time and at a reasonable cost. Examples of data-set development recently initiated are:

The solar-powered TIROS-N advanced weather satellite transmits the most extensive range of meteorological and environmental data yet produced by the nation's space program.
RCA News Photo

- Reformatting of summary of the day data sets for cooperative weather stations; this project, for which processing of the 19th Century data recently has been completed, has as its goal the reduction of a diverse 740-reel magnetic tape file to 230 reels of magnetic tape.

- Historical extreme wind data for the Atlantic and Gulf of Mexico coastlines.

- Thunderstorm duration data for 450 stations nationwide for 30 years.

- Several snow and ice data sets beginning with the 1930s or 1940s.

The extreme wind and thunderstorm data sets will be first used by or for the Nuclear Regulatory Commission in site development.

An essential first step in addressing the total climate data management problem was taken in May 1979, when NOAA's Environmental Data and Information Service and the National Climate Program Office cosponsored a comprehensive Climate Data Management Workshop. (See July 1979 *EDIS*, P.25) A 300-page report of the Workshop, held at Harpers Ferry, WV, has been published by the Department of Commerce/NOAA and is available in limited supply from the National Climate Program Office in Rockville, MD.

Earlier, in November 1978, the Environmental Data and Information Service and the National Science Foundation had cosponsored a specialized paleoclimate data management workshop in preparation for the May meetings.

Climate Diagnosis and Projection. NOAA has consolidated several previously scattered activities into a Climate Analysis Center (CAC) within the National Weather Service (NWS) to attain a more concentrated and better coordinated diagnosis and projection effort and thereby provide better service to realtime users. The former NWS Long Range Prediction Group and analysis units from three NOAA elements were merged during Fiscal Year 1979 and are now operating under the direction of Dr. Jay S. Winston.

An example of improved service already being rendered (to and at the request of the Department of Energy) is the monthly updating of seasonal (3-month) outlooks throughout the colder half of the year. Although in formal operation for only a few months, CAC already has carried out case studies of significant climate events of 1978-1979, has awarded grants and contracts to universities for diagnostic and related studies totaling $353,000, and in cooperation with the U.S. Department of Agriculture, has increased significantly the data and information content of the *Weekly Weather and Crop Bulletin.*

Looking toward the future, CAC has laid out a detailed and time-phased five-year agenda of service improvements, as well as the research and techniques development necessary to realize the improvements.

Climate Information Services. NOAA's National Climatic Center (NCC) in Asheville, NC answered 67,806 user requests for climatic data and information during Fiscal Year 1979, up about 4½ percent from the previous year. 415,800 back-issue data publications were furnished in response to some of the requests, an increase of about 2½ percent over the previous year. Subscriptions to climatological data periodicals continue to number over one million.

NOAA scientists produced several dozen scientific papers and technical reports that provided substantial climate information of general or specialized interest. Two general interest examples published (by NCC) in 1979 are:

- *Climatic Guide to the Winter Olympics, 1980, Lake Placid, NY.*

- *Ninety-One Years of Weather Records, Yellowstone National Park, Wyoming, 1887-1977* (Second of a new "Historical Climatology Series").

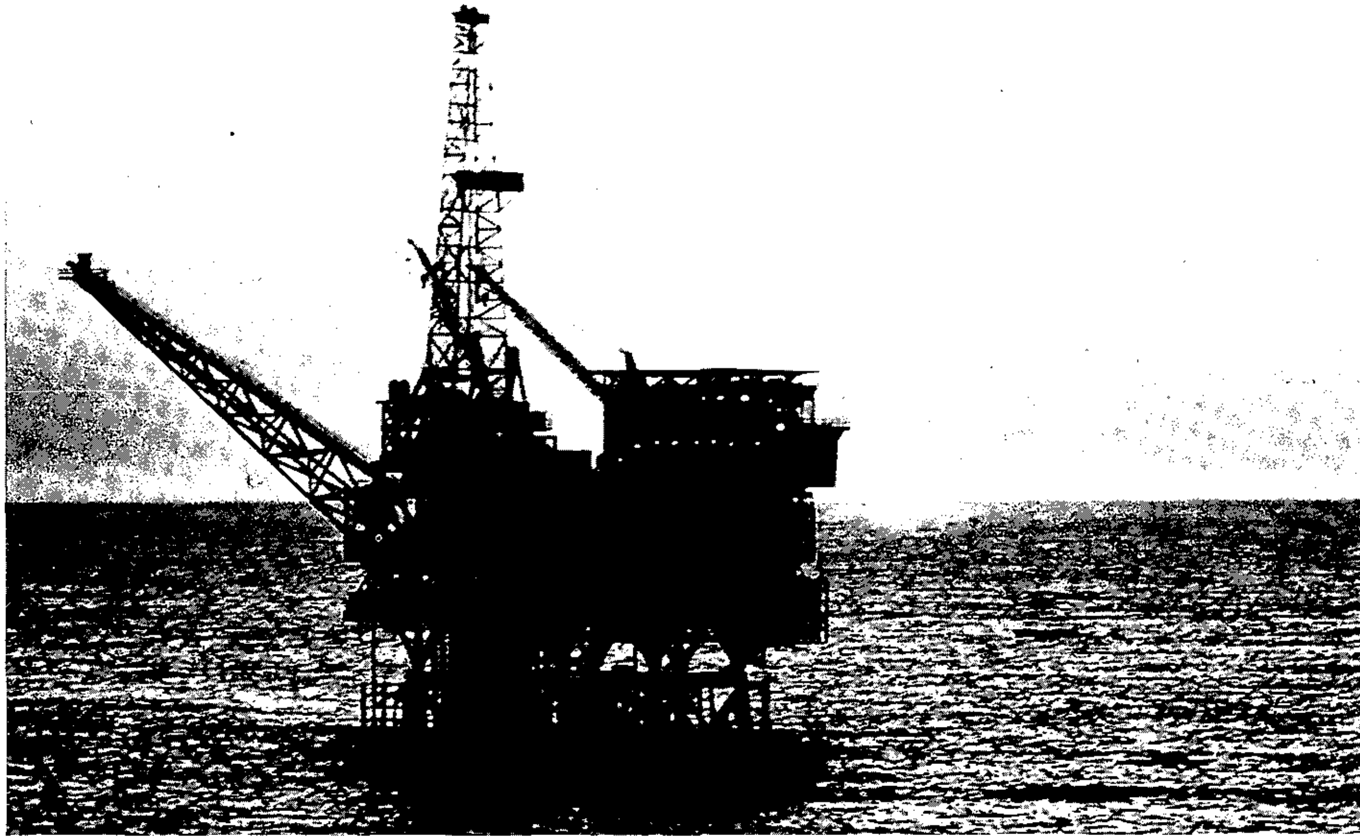
Specialized climate publications typically result from cooperation with other agencies. Such ad hoc publications issued in Fiscal Year 1979 include several directly related to energy planning or conservation and three NOAA Technical Reports giving results of extensive hydroclimatic analyses.

A new NCC climatic data periodical, *Monthly Summary, Solar Radiation Data,* was initiated January 1979. Also in January, the first issue of an occasional *Satellite Data Users Bulletin* was distributed.

Production of an 18-page multipurpose standard *Airport Climatological Summary* also continued at the National Climatic Center. Summaries for 20 additional airports were published bringing the total number of airports for which the summaries are available to 80; a total of 170 are planned. These concise ten-year summaries of 3-hourly surface weather observations are particularly useful to aviation interests as well as other scientists and engineers dealing with a variety of climate-sensitive activities.

As the foregoing summary of achievements indicates, NOAA is making noteworthy progress in climate services as well as research. It has several hundred people at more than a dozen Centers and Laboratories performing their specialized climate work. These range from technicians performing data processing and archiving functions to world-renowned scientists advancing the frontiers of climate research. Prospects for continuing progress in both services and research appear to be very good.

EDIS Ocean Products and Services



Atmospheric, marine, and geophysical data and information are needed to plan, design, construct, and operate offshore oil platforms.

EXXON *Photo*

In the United States, ocean environmental data products and services are provided to the user public principally by the National Oceanic and Atmospheric Administration (NOAA). A great variety of these products and services are provided by the Environmental Data and Information Service (EDIS) of NOAA's Oceanic and Atmospheric Services.

NOAA gathers worldwide, multidisciplinary environmental data about the oceans, Earth, air, space, and Sun and their intricate interactions. Other agencies and individuals acquire similar data for their special missions and purposes. Once the primary collection purposes have been served, the data are made available to subsequent users through EDIS.

Although EDIS' sister agencies in NOAA use EDIS products and services, approximately 80 percent of our customers are non-NOAA users—the national and international scientific and engineering communities, other Federal agencies, State and local agencies, industry, commerce, university research scientists, consultants, and the general public. In many instances, their cumulative applications of environmental data are of equal or greater value than the purposes for which the data were originally collected.

Over 135,000 users a year request data and information products and services from EDIS. Concurrently, EDIS is deeply involved in the application of its data and information resources to help resolve pressing national environment-related problems.

In response to the energy crisis, for example, the United States has had to greatly accelerate development of oil and gas deposits on the continental shelves. Efficient and effective planning, site selection, design, construction, operation and monitoring the environmental impacts of supertanker ports and offshore drillings rigs, however, depend heavily upon assessments of interacting environmental elements. These include winds, waves, currents, seabed characteristics, visibility, air and sea temperatures, atmospheric pressure, storms and storm surges, seismicity, erosion, and silting. To support these activities, EDIS provides tailored interdisciplinary environmental data and information packages, analyses, and assessments to other Federal agencies and to industry. EDIS also provides reconnaissance marine geological and geophysical data sets to offshore petroleum exploration efforts.

In general, EDIS ocean products and services fall into two broad categories:

(1) Data and information.

(2) Applications and assessments based on EDIS' data and information resources and expertise.

Environmental Data and Information Bases

EDIS is the focal point for historical data in oceanography (including marine geology and geophysics) and marine meteorology. Each day large numbers of observations are made on, in, under, over, or near the world's oceans. Eventually, a large number of these observations are acquired by EDIS and made available to subsequent users through three major data centers: the National Oceanographic Data Center (NODC), the National Geophysical and Solar-Terrestrial Data Center (NGSDC), and the National Climatic Center (NCC).

The *National Oceanographic Data Center* (NODC) is the largest source of unclassified oceanographic data in the world. It provides:

(1) Mechanical and expendable bathythermograph (temperature vs. depth) data, in digital form.

(2) Oceanographic station data from the surface to the depths, including measurements of temperature, salinity, oxygen, nutrient chemistry and organic compounds.

(3) Continuously recorded salinity-temperature-depth data in digital form.

(4) Surface and subsurface current information.

(5) Biological data, including values of plankton standing crop, chlorophyll concentrations, and rates of primary productivity.

(6) Other marine observations, including hydrocarbons, trace metals, and marine mammal and bird sightings.

NODC products and services include data plots, statistical summaries, evaluations of data records to meet specific requirements, library searches, referral services, general marine sciences information, and publications that include data processing manuals, catalogs, data reports, and atlases. The *User's Guide to NODC's Data Services* provides detailed information on data holdings.

The *National Geophysical and Solar-Terrestrial Data Center* (NGSDC) provides bathymetric measurements, seismic reflection profiles, gravimetric measurements, geomagnetic total field measurements, and geological data—including data on heat flow, cores, samples, and sediments. It also disseminates data on offshore oil-lease areas acquired from the Department of the Interior, academia, and industry. World Data Center-A for Glaciology (Snow and Ice), collocated with NGSDC, provides specialized information services relating to sea-ice, including ice data for the Great Lakes.

NGSDC data are available in reports and publications; on microfilm, punched cards, or magnetic tape; in inventories, summaries, and tables; in the form of maps, charts, and graphs; or as copies of analyses or descriptions.

The *National Climatic Center* (NCC) is the world's largest climatic data center; it acquires and disseminates more surface marine weather data than any other center in the world. NCC ocean products include weather observations from coastal stations, ocean weather stations, and moving ships on the global sea. It also is the U.S. archive for the special data sets resulting from the Barbados Oceanographic and Meteorological Experiment (BOMEX), the International Field Year for the Great Lakes (IFYGL), and the Atlantic Tropical Experiment and Global Weather Experiment of the Global Atmospheric Research Program.

NCC's Satellite Data Services Division provides worldwide satellite cloud photos and analyses, infrared imagery and data, and computer-derived products from the various families of operational and experimental environmental satellites. These data concern clouds, weather systems, the Gulf Stream, ocean currents, sea ice, and tropical cyclones. Radar data from SEASAT also are available.

NCC ocean service products include global marine climatic atlases, numerous special publications, selected weather maps and charts, derived and summary data statistics and tabulations, copies of original manuscript records, and computer-prepared magnetic tape, microfilm analyses, or graphics. The center's extensive collection of marine weather summary products is listed in its booklet *Index of Surface Marine Climatic Data Products.*

Environmental Data Index (ENDEX)

The EDIS ENDEX system provides rapid, automated referral to available environmental science data, information, and sources within NOAA, other Federally agencies, and scattered nationally, as well as documentation on the quantity, quality, and character of the data. Subject areas include cartography, coastal zone management, environment-related engineering, hydrography, hydrology, marine biology, marine geology, and oceanography.

By the end of 1980, EDIS will have documented and described all significant environmental data files that it can find in the coastal States of the United States. Currently, the job is about 90 percent complete. EDIS has concentrated its efforts in coastal States because of current concerns for coastal zone development and conservation.

Information and Assessment Centers

In addition to its three national data centers, OAS/EDIS operates complementary information and assessment centers.

The *Environmental Science Information Center* (ESIC) provides library information and technical publication services. The former are used extensively by the marine community, while the latter produces many NOAA marine-related publications.

ESIC provides references and referrals, document loans, publications announcements, and facilities for use of information collections in the Washington, D.C., Miami, and Seattle areas. The center is the United States' participant in the international Aquatic Sciences and Fisheries Information System, which provides the world's most comprehensive computerized reference data base to marine science, technology, and policy literature. (See "Special Data Bases" section.)

ESIC provides computer-based literature search services for over 100 data bases, including Aquatic Sciences and Fisheries Abstracts, Energyline, Environline, Environmental Impact Statements, Meteorological and Geoastrophysical Abstracts, National Technical Information Service (NTIS), Oceanic Abstracts, and Pollution Abstracts. ESIC also can provide custom searches in areas such as the legal aspects of aquaculture or the hazards of dumping nuclear wastes into the sea.

In addition, ESIC information facilities provide library information and reference services. The extensive NOAA library collections cover a wide spectrum of ocean topics, including aquaculture, hydrography, marine ecology, marine fisheries, marine geology, marine geophysics, ocean engineering, ocean policy, and oceanography.

The EDIS *Center for Environmental Assessment Services* (CEAS) provides data analyses, applications, assessments, and interpretations. These include assessments concerning supertanker ports, oil spills, outer continental shelf environmental studies, and the Strategic Petroleum Reserve program, among others. Some of these applications are described below.

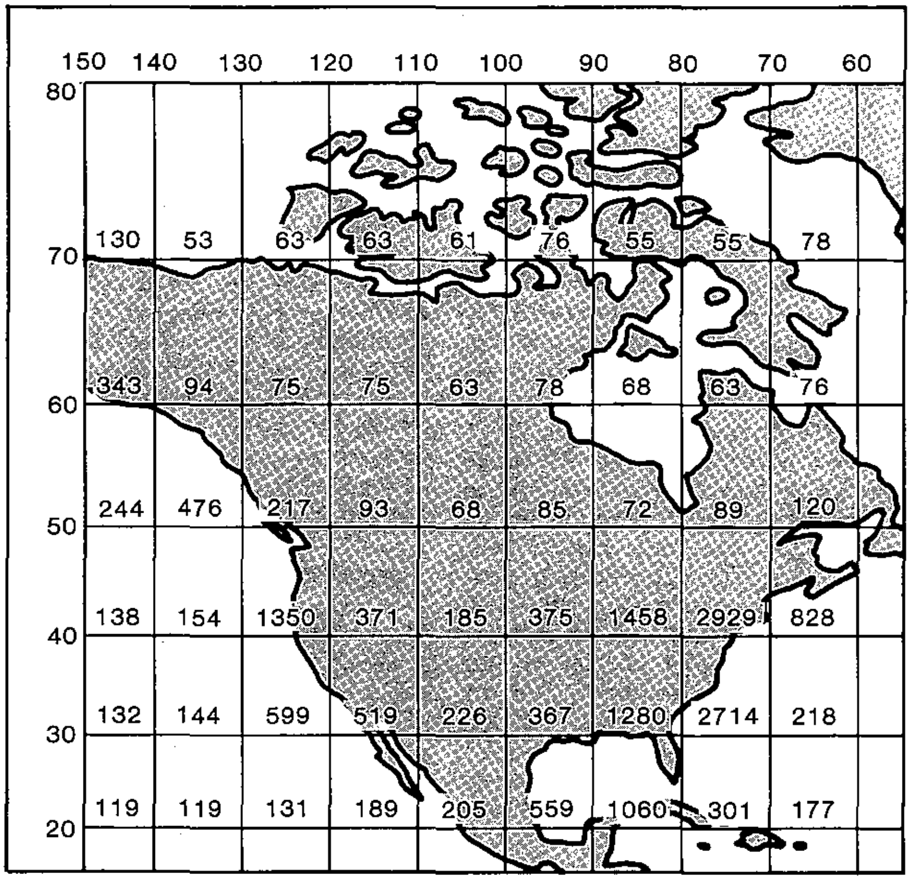
Marine Assessments

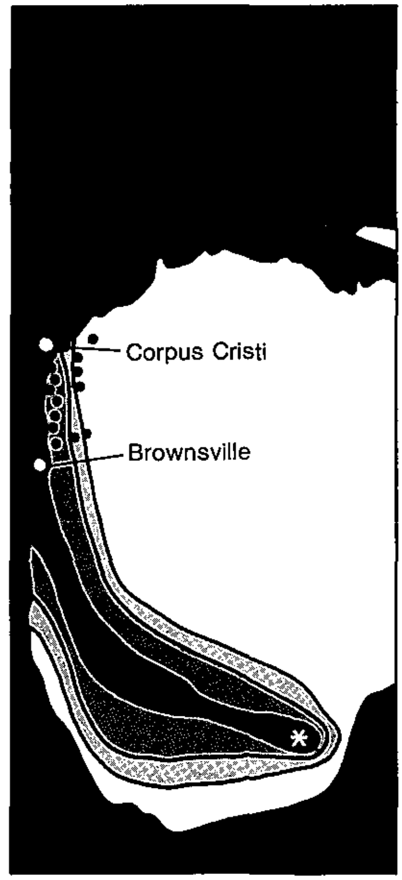
The Departments of the Interior and of Transportation are charged with assessing the risks of pollution of coastal and oceanic areas associated with planned or proposed outer continental shelf oil and gas development, deepwater ports, and other tanker operations. To help in these assessments, EDIS has developed a statistical oil-spill trajectory model based on historical meteorological and oceanographic data. The model has been used in the licensing process for deepwater ports in the Gulf of Mexico, during the ARGO MERCHANT oil spill emergency, in an environmental baseline characterization of the Mid-Atlantic outer continental shelf oil and gas lease area, and, most recently, following the Campeche blowout.

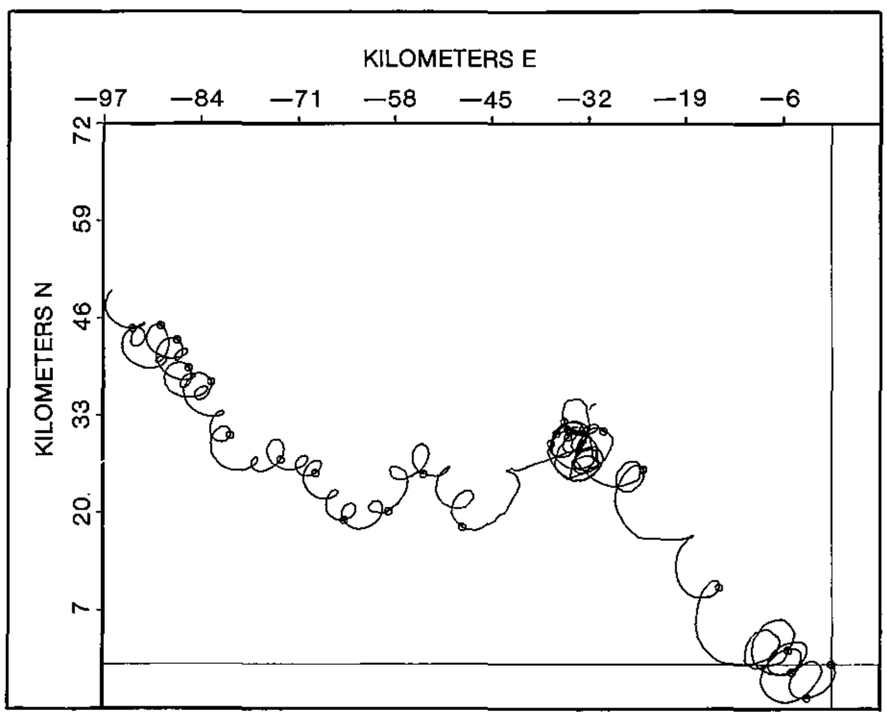
A National Strategic Petroleum Reserve of 500 million barrels is being planned for implementation over the next few years. It will use a system of storage cavities leached from natural underground salt domes in the western Gulf Coast area. The potential ecological effects of the planned disposal of huge volumes of saturated brine into Gulf waters are being analyzed in a project led by EDIS for the Department of Energy. The project involves the integration of multidisciplinary environmental data, computer simulations of brine transport and dispersion, and information on area biota and their tolerance to higher salinities. These studies play a part in decisions regarding the location of storage sites and the design of the brine disposal systems. During 1979, an OAS/EDIS-designed program, of physical, chemical, and biological monitoring before, during, and after the brine disposal operation was begun.

Special Ocean Data Bases

NOAA's *Outer Continental Shelf Environmental Assessment Program* (OCSEAP) has been undertaken to provide the interdisciplinary data needed by the Department of the Interior to assess ecological consequences of offshore oil and gas exploration, development, and production on Alaska's outer continental shelf. More than 200 scientists are collecting data for OCSEAP. A comprehensive, multidisciplinary data management system developed







Top left: Numbers indicate Environmental Data Index (ENDEX) files available for each 10° square. Top right: EDIS trajectory prediction for the Campeche oil spill. Six-month trajectories were projected from the spill site (asterisk), shaded areas show probable oil risk. Dots show where oil was actually observed. Right: Computer display for the OCSEAP program of current movement past meter in lower right of graph. About 1,670 measurements were used to compute the current ocillation and direction over a 1-month period in the Bering Sea south of Nunivak Island, Alaska.

with EDIS guidance and participation is critical to the success of the program. Policies and procedures followed are consistent with those previously developed by EDIS and the Bureau of Land Management for continental shelf oil and gas exploration areas of the Atlantic, Gulf, and Pacific coasts of the "lower 48."

EDIS has developed a special data base to support DOE's *Ocean Thermal Energy Conversion* (OTEC) program. The data base covers ocean areas near Puerto Rico and Hawaii, the eastern and western sections of the Gulf of Mexico, and the Atlantic coast of Florida, where the vertical temperature structure is suitable for such applications.

The United States now imports the bulk of its supplies of manganese, cobalt, nickel, and copper from foreign countries. However, large quantities of these key metals exist in extensive marine deposits of potato-size masses, commonly referred to as *manganese nodules*. EDIS has established a data base on manganese nodule distribution, metal content, density of occurrence, depth of water, associated sediment descriptors, and other relevant information, including a bibliography of literature on manganese nodules. EDIS provides selective searches of the data base to mining companies to assist them in locating, evaluating, and recovering these deposits.

In response to a request by the UN's Intergovernmental Oceanographic Commission (IOC) for member states to provide management services for oceanographic data collected during the First GARP (Global Atmospheric Research Program) Global Experiment (FGGE) (also known as the Global Weather Experiment), EDIS is (1) developing a *global inventory of all ocean data* collected during the FGGE Operational Year (December 1, 1978 through November 30, 1979) and (2) creating a *global ocean climate data base* of selected physical oceanographic parameters for the same period. The inventory is available online through existing international telecommunications networks. A published version will be distributed by the IOC this year.

The international *Aquatic Sciences and Fisheries Abstracts* (ASFA) data base is available to the public for nationwide online computer searching. ASFA provides the world's most comprehensive coverage of published information on the science, technology, and management of marine and freshwater environments. About 24,000 publications per year are covered. The data base initially provides coverage from January 1978 to the present, with coverage from 1975-77 to be added during 1980.

The *NOAA Aquaculture Data Base* also is available to the public, through a nationally accessible information retrieval system. It provides information from domestic and foreign sources on the growing marine, brackish, and freshwater organisms. The Aquaculture file is produced jointly by the Virginia Institute of Marine Sciences and EDIS, with funds provided by NOAA's National Marine Fisheries Service in 1979 and its Office of Sea Grant for several prior years.

National Marine Pollution Systems. The final design has been completed for a management information system for the National Ocean Pollution Research and Monitoring Planning Act of 1978. Formats have been designed to collect fiscal and program data from Federal agencies. Meanwhile, EDIS is working to complete development and to implement a National Marine Pollution Information System.

Special Products and Services

Marine Recreation Brochures are products of the joint efforts of EDIS and NOAA's Sea Grant Marine Advisory Service. Brochures have been published for Rhode Island, San Francisco Bay, New York's portion of Lake Erie, Michigan's Lake Michigan, and the North Carolina coastal area. In addition, two brochures for Chesapeake Bay are scheduled for release soon. The brochures emphasize climatological information and are written for vacationers and other recreational users. The local climate is described in terms of good weather days, sailing winds, fishing weather, and other practical statistics. Information is

Salt mine excavation for oil storage in the National Strategic Petroleum Reserve.
Department of Energy Photo

also included on fishing, boating facilities, swimming and diving locations, and other local recreational activities (including winter sports, where appropriate).

Current Issue Outlines are state-of-the-art reviews of environmental topics accompanied by bibliographies. They are designed to provide objective, integrated information on high-interest issues for NOAA decision makers, legislators, public officials, environmentalists, citizen's groups, and the general public. Ocean-related titles in the series are: *Icebergs for Use as Freshwater, Harnessing Tidal Energy, Sea-Surface Temperature and Climate, Water Desalination,* and *Ocean Thermal Energy Conversion.*

The *Mariners Weather Log* is issued bimonthly by the National Oceanographic Data Center and contains articles, descriptions, and data on marine meteorology and oceanography. The Marine Weather Review section contains information on cyclone tracks, climatological data from U.S. Ocean Weather Buoys, as well as storm tables. Other sections discuss general weather features such as gales, winds, cyclones, sea heights, and visibility, as well as a special section on hurricanes. Primary users of the publication include cooperating commercial weather reporting ships, admiralty lawyers, marine (both public and private) academia interests, and research institutions and scientists.

Coastal Data Networks and Sources was recently compiled by EDIS' National Climatic Center. This booklet contains descriptions of U.S. coastal data sources, listing addresses and telephone numbers for appropriate contacts. Several map presentations also are included. Meteorological, oceanographic, geological and geophysical, fisheries, and coastal zone management data and information are covered, including satellite and aerial photography data.

Sea Ice. Glaciological data reports are published by WDC-A for Glaciology. Report no. 2 contains a bibliography on arctic sea ice; no. 7 provides an inventory of sea-ice data sets.

New Directions

Wave Data. Since 1976, several major ocean-wave-related conferences have been held. One of these, the National Ocean Survey's Wave Climate Symposium, met in the Washington, D.C., area in July 1977. Many recommendatons for a national ocean wave data collection program came out of this conference. One recommendation was that wave data collections should be made available to users on a near-realtime basis.

In response to this recommendation, EDIS' National Oceanographic Data Center (NODC) has begun development of a system to access, process, analyze, store, and retrieve instrument-measured wave data. To date, NODC has developed a wave data storage and retrieval system design. The design describes what the major services output will be and identifies the systems inputs, as well as programs, procedures, and other details.

Changing Users. The marine data user community is changing. Today, it includes not only scientists, engineers, and managers, but also elected officials at the national, state, and local levels; attorneys; economists; regional planners; citizens groups; and individual taxpayers. This development reflects increasing public concern over environmental, ecological, energy, and other issues with a scientific base.

A Better Service System. Partly because of the changes in the user community, EDIS is faced with a rapidly widening gap between user demands and its service response capability. Increasing demand for multidisciplinary data and information products make it essential that we change our system orientation from one of individual files (oceanography, meteorology, marine geology, etc.) to that of a common, integrated, environmental data and information base. Greater emphasis also has to be given to packaging data and information to meet specific user needs.

During the coming decade, EDIS expects the new user communities to continue growing, the volume of requests for multidisciplinary environmental data and information products to continue increasing, many new data applications to be developed, and user demand for shorter response time to accelerate. To meet these and other changing user needs, EDIS is integrating its formerly separate data base operations under a single data archive management and user services system.

The new service system will be user-oriented, providing improved access not only to multidisciplinary environmental data and information, but also to analyses, applications, and product-generation subsystems. Access will be provided at EDIS centers, liaison offices, and NOAA libraries across the country; eventually, the user may be able to buy an inexpensive terminal and participate from his own office or home. The user also will get better products; instead of several separate products in several different formats, the system will provide an integrated, designed product.

The new system, as well as the other developments and plans discussed, should provide the capability and the flexibility both our nation and individual users need to respond to new or changing marine problems whose solutions depend on environmental data and information.

WDC-A Glaciology Ice Core Inventory Project

By Peter K. MacKinnon

Workman drains water from ice core drill.

The field collection of glaciological data has undergone rapid change in recent years with the establishment of large-scale national and international programs such as the Greenland Ice Sheet Program (GISP) and the International Antarctic Glaciology Program (IGAP), each designed to develop a basic understanding of cryospheric processes. Resource and data management practices must improve because no comprehensive system yet exists for assembling these multi-faceted data and making them conveniently available to the user community. Accordingly, WDC-A Glaciology (Snow and Ice), with NOAA-EDIS support, is identifying and inventorying existing core data as the first step toward facilitating digital data exchange and developing a computerized data base.

A wealth of information can be gleaned from ice cores, particularly those recovered from polar ice sheets. In addition to providing an insight into the internal structure and condition of an ice mass, ice cores reveal many tell-tale signatures of past climate, anthropogenic activity, and other geophysical processes. Consequently, the importance of ice core data for fundamental research on global paleoclimate is recognized in national and world climate programs.

Following assessment of North American ice core and ice core data holdings (see *EDS*, May 1978), WDC-A, Glaciology established a two-phase program to determine the needs, concerns, and constraints of the international ice core community before embarking on further acquisition of core-related data. First, the data center convened a 3-day international ice core workshop to bring together representatives of various groups involved in core drilling, core research, and data management. Twenty participants from seventeen organizations gathered in Boulder, Colo., last autumn to take part in discussions on the status and needs of the ice core community, the role of WDC-A Glaciology, and interactions between data generators and data users. The workshop delegates produced a set of recommendations which addressed a wide range of key technical, scientific, and data management problems. These recommendations will be published in *Glaciological Data*, Report *GD*-8.

The meeting provided the data center a set of concerns and a series of objectives that a representative selection of the ice core community felt were important issues. These included a recognized need for, and support of, an ice core inventory. At the same time, this meeting provided a sharper focus for the participants on the problems of core and core data management. In addition, there was ample time to discuss current research problems and new research ideas.

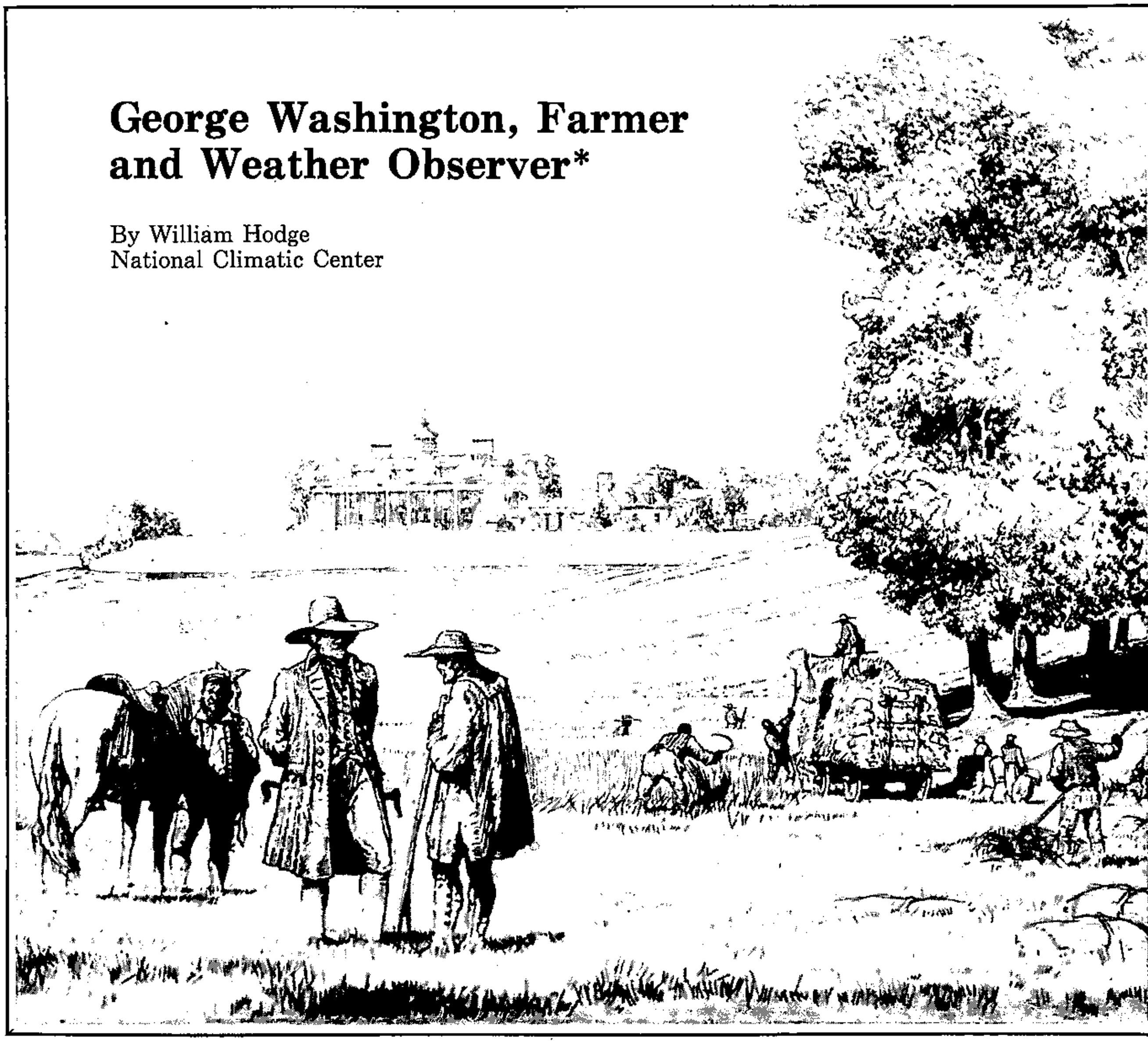
The second phase of the program involved working visits to a number of European and Canadian ice core research facilities. The primary purposes of the visits were to present first-hand the conceptual plan for an international ice core inventory, to broaden international support for this program, and to assess the range, quantity, and availability of ice core and core-related data. At every stop there was an affirmative response for an international ice core data inventory. Further, each organization expressed a willingness to contribute data. What is now being developed is a mechanism that permits effective and efficient transfer of data from diverse research efforts into a central repository while giving appropriate protection to the interests of the scientists who generate the data.

The first data sets to evolve from the visits will be assembled and sent to WDC-A Glaciology following the termination of the current Antarctic field season.

Technician weighs ice core. Inset: Cross section through 1,000-year old ice.

George Washington, Farmer and Weather Observer*

By William Hodge
National Climatic Center



Above: Washington inspects his farm.
Mt. Vernon Ladies Association Photo

Right: The last entries in George Washington's weather diary.

George Washington's accomplishments as Commander-in-Chief and first President are well-known. His remarkable achievements in other areas of work have, to a large extent, been overlooked. These talents spanned several endeavors, as documented by volumes of letters, notes, and diaries. Farming served as an occupation and fascination for Washington; thus weather observations became important in his daily routine in Virginia. Weather notes are woven throughout his writings, and number so many that editors of his papers usually omit them as being trivial and inconsequential.

Washington's interest in the weather might have been scientific as well as agricultural. There was a growing curiosity in all the natural sciences during the 18th century. Benjamin Franklin raised questions about the movement of storms. Two future Presidents, James Madison and Thomas Jefferson, observed and recorded the weather in other parts of Virginia. Their observations were listed in tables—Washington wrote his notes in narrative form making dif-

*Reprinted from the *Weeky Weather and Crop Bulletin.*

December 1799

8th Morning perfectly clear, calm and pleasant; but about 9 oclock 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. W. 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. Law. 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 oclock the Wind shifted to No. W. & it ceased raining but contd. Cloudy.—Lord Fairfax, his Son Thos. and daughter—Mrs. Warner Washington & son Whiting—and Mr. Jn. 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 oclock 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 oclock—and abt. 4 it became perfectly clear—wind in the same place but not hard—Mer 28 at Night.—

ficult reading for historians. Later years would provide still another President, John Adams, recording the temperature three times daily while residing at the White House.

Short descriptions of the weather dotted Washington's earliest diaries. As a 16-year old surveyor, he kept a detailed weather record during a trip to the Valley of Virginia. His notes became more systematic after he turned from soldiering in the French and Indian War to planting along the Potomac River. He divided his diaries into three sections during these years—"When and How My Time is Spent," "Remarks of the Weather," and "Observations."

Washington faced several hardships in taking up the life of a farmer. When he settled at Mt. Vernon in 1759, only about half of the 2,500 acres was tillable. Most fields were of mediocre quality, markets were far away, and the cost of transportation was high. Many nearby plantation owners plunged into debt because of these conditions.

At first, his goal was to raise the finest tobacco in the Potomac Valley. It soon became obvious that the soil was unsuitable, so he turned to wheat. By 1766 wheat had replaced tobacco as the principal cash crop at Mt. Vernon, though he continued to raise tobacco on other plantations. Wishing to enlarge his profit, he built a grist mill, divided the flour into superfine, fine, and middling grades, and marketed his own brand. Present-day farmers will understand his frustrations when, in 1772, he shipped 273 barrels of flour to Barbados only to have the agent pocket the money received.

Washington attempted to broaden his knowledge of the science of agriculture. Once when he asked his purchasing agent for "the newest and most approved" books on agriculture, he received "A New System of Agriculture, or a Speedy Way to Grow Rich." He tried extensive experiments on seeds and fertilizers, grafting of fruit trees, and new kinds of farm implements. When he travelled throughout the new country as President, he conversed with farmers writing down their practices for future reference. One day President Washington wrote: "According to Col. West, the greatest part of this next moon should be as this day—i.e., the same kind of weather that happens upon the Thursday before the change will continue through the course of the next moon or at least the first and second quarters of it." A later entry showed some skepticism of this entry.

Everyday farming operations were so time-consuming that extensive writing would appear to have been difficult. Simply buying supplies required planning months ahead, since nearly all items had to be shipped from England. He protested to his agents in England about low prices received for his tobacco and high prices he was charged for the low quality and poorly packed goods sent to him in return.

He often rode 60 miles a day on horseback overseeing what was being done on the land surrounding Mt. Vernon. He began fishing for herring on a commercial scale. Rarely idle, he worked hard even in the winter months. During that season, hogs were slaughtered and meat cured; repairs were made to buildings, dams, fences, and piers damaged by winter storms; and preparations began for the coming season.

During Washington's Presidential absences, Mt. Vernon's farm operations were entrusted to a manager. Washington required a complete formal report each week from him, which started with a meteorological table. Usually, temperature, wind direction, and sky condition or type of precipitation were given three times each day. Then followed a full description of the work accomplished, the harvest, and the receipts. Washington probably used the weather tables to judge the efficiency of the work and the progress of the crops. He maintained close touch with the farm's daily routine sending detailed instructions to the manager by mail.

Many visitors paid social calls to Mt. Vernon and, in the later years, accounts of the weather and the social visitors were sometimes combined into one narrative of the day's happenings. Occasionally he used blank spaces in an almanac to write remarks about the weather. Almanacs were considered an almost indispensable facet of farming and daily life. Ruled paper was scarce in America at that time; he spaced his lines by using a heavily ruled guide sheet below the page. Evidence of his failing eyesight in later years were apparent when the writing dropped off the edge of the paper onto the guide sheet.

Washington continued his observations through to his death. He installed a thermometer and noted the temperatures at morning and night. It is believed the last lines Washington wrote were his weather account for December 13, 1799. The entry was written as follows:

> Morning snowing and about 3 inches deep—wind at NoE & Mer-(cury) at 30—Contd snowing till 1 o'clock—and about 4 it became perfectly clear—wind in the same place but not hard—Mer 28 at night.

On the next page, in someone else's handwriting, this following note appeared: "This paper probably contains the last words that General Washington committed to writing. On the night of the 13th he was attacked by the disorder of which he dies."

Climate/Economics Workshops

The second in a series of Economics/Climate Workshops sponsored by EDIS' Center for Environmental Assessment Services (CEAS) was held in Columbia, Mo., November 30-December 1, 1979. The topic for this session focused on energy/climate modeling for operational and management planning and decisionmaking within utility companies and by State regulatory agencies. On November 30, Mike Proctor, Missouri Public Service Commission, and Don Murray, Stone and Webster Management Consultants, Inc., Bethesda, Md., provided an indepth view of the role and uses of climate and weather data by the Nation's utilities.

The session held the following day stressed methods to couple energy model results to regional input/output models and the national macroscale econometric models presented by Dr. Charles Lamphere, economist at the University of Nebraska, and Dr. Abner Womack, agricultural economist at the University of Missouri, at an earlier November workshop. Both professors are cooperating with CEAS' Climatic Impact Assessment Division staff to develop a feasible approach to economic/climate modeling.

The two presentations scheduled for the April 11-12, 1980 workshop are: *Agricultural Models,* by Drs. Stanley Johnson and Abner Womack, economic professors at the University of Missouri, and *Housing Models,* by Drs. Johnson and Henry Warren, an economist with CEAS' Climatic Impact Assessment Division.

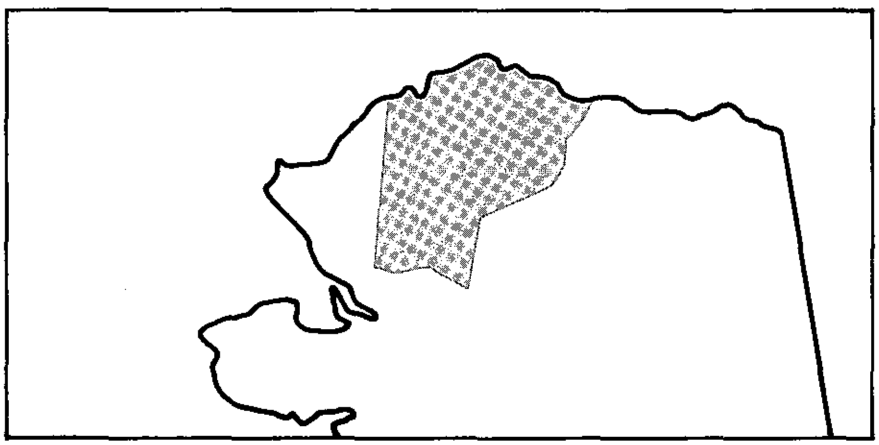
On April 25-26, Dr. Herb Grubb, hydrologist, will make a presentation on *Groundwater Models* for the Texas region and Dr. Freeman Smith, Professor at Colorado State University, will talk on *Ecosystems Modeling.*

A final workshop in June 6-7, 1980, at Columbia, Missouri, will provide a synthesis of the series of presentations and prepare recommendations for the next step in developing EDIS capabilities to assess the economic impacts of climatic variability.

Seismic Survey Data Report for NPRA

The U.S. Geological Survey (USGS) recently provided a summary report on the interpretation of seismic reflection and gravity data from the National Petroleum Reserve in Alaska (NPRA) to the National Geophysical and Solar-Terrestrial Data Center (NGSDC). This report is now available for public dissemination. The report, *Interpretaion of the FY 77 Seismic Survey Data, National Petroleum Reserve in Alaska,* revised May 1978, was prepared for Husky Oil NPR Operations, Inc., prime contractors for the USGS, by Tetra-Tech, Inc., of Houston, Texas.

Data from seismic and gravity surveys conducted during the winter-spring field season of fiscal year (FY) 1977 were integrated with FY74 to FY76 data for a total of 7,680 miles (12,288 km) of seismic coverage. Seismic data were shot at a multiplicity of either 600% or 1200%; gravity stations were occupied at an interval of either 1,760 or 1,320 feet (536 or 402 m) along each seismic line.



Shading indicates Alaskan National Petroleum Reserve area.

The report consists of 18 pages of descriptive text (16-mm microfilm and Xerox copy), 6 pages of an analysis of seismic velocities in southern NPRA (16-mm microfilm and Xerox copy), 15 illustrative seismic sections (sepia or blackline copies), and 18 maps (sepia or blackline copies).

Previous purchasers of full sets of the NPRA multichannel seismic data from flier 1978 (Q-Q) will receive the present offering at no cost. Purchasers of the present offering, who later (within six months) purchase full sets of the seismic data (flier 1978 Q-Q), can apply the full cost of this new summary toward such purchase.

Orders and inquiries should be addressed to: NGSDC/NOAA/EDIS, Code D621, Boulder, CO 80303, telephone (303) 499-1000, ext. 6338 or 6542, FTS 323-6338 or 323-6542.

Bathymetric Data for U.S. Coastal Regions

NGSDC has detailed hydrographic (bathymetric, bottom characteristics, and navigational dangers) data for 58 one-degree-square areas off the California and Hawaii coasts for sale to the public. All data were obtained as part of a program by NOAA's National Ocean Survey to automate nautical chart production and were digitized from surveys conducted between 1930 and 1965.

Most of the data (about 97 percent) contained on magnetic tapes are soundings. The remainder refer to bottom characteristics (e.g., clay, mud, soft, sticky, etc.) and dangers to navigation (e.g., wrecks, pilings, rocks, etc.). All records contain the registry number of the survey from which they were obtained, the date of completion of the survey, and the geographic position to the nearest 0.01 second. Data are grouped by 1-degree-square blocks, but are available for any size area. Data on magnetic tape are available in 9-track (6,250, 1,600, or 800 BPI) and 7-track (800 or 556 BPI) formats.

Various plotter products are available in addition to data on magnetic tape. These include plots of soundings (standard, average depth per unit area), bottom characteristics, dangers to navigation, and bottom profiles.

A catalog indicating precise areas and densities of NOS digital hydrographic data is available for the northern Atlantic coast. Similar catalogs will be published for other areas when additional data become available. Data coverage plots are available on request. Address all inquiries to NGSDC/NOAA/EDIS, Code D621, Boulder, CO 80303, telephone (303) 499-1000, ext. 6338, FTS 323-6338.

Interactive Inventories for Marine Geology/Geophysics Data

Interactive data inventories in marine geology and geophysics (MGG) have been established at the National Geophysical and Solar-Terrestrial Data Center (NGSDC). They include underway geophysical data, marine geologic sample analyses, and descriptions and availability of actual geologic core samples.

Retrievable information includes geologic samples locations and descriptions, sortable by collecting institution, sample type, analysis tape, output medium, and other properties. Geophysical data searches return information on trackline mileages for each parameter measured (bathymetry, magnetic field, gravity, seismic profiles) and, with the proper data terminal hardware, immediate plots of trackline maps for the requested data; trackline plots are also produced on computer output to microfilm for mailing to the requester. Ancillary software for geologic data inventories can produce plots of data locations, coded by institution or other parameter choice.

For additional information write: Marine Geology and Geophysics Branch, NGSDC/EDIS/NOAA, Boulder, CO 80303; or call (303) 400-1000, ext. 6487.

Marine Habitat Data

Geological and geophysical data are now available for locations in the Eastern Gulf of Mexico associated with the Bureau of Land Management (BLM) Lease Sale No. 65. BLM contracted with Woodward-Clyde Consultants in 1978 to collect and interpret these data to identify and delineate areas of potential constraints to oil and gas development. BLM has provided these data to the National Geophysical and Solar-Terrestrial Data Center (NGSDC) for public dissemination.

The primary objective of the study was to identify and delineate marine habitat areas in 49 of the proposed lease blocks included in OCS Sale No. 65. The 49 blocks were divided into 10 map areas for the purposes of discussion and data presentation.

Over 1,930 km of geophysical data were collected. These data, along with data previously collected for the U.S. Geological Survey and BLM, were used to produce maps of bathymetry and seafloor sediment characteristics and a geologic cross section for each of 10 map areas.

The data set consists of the following documents and raw data:

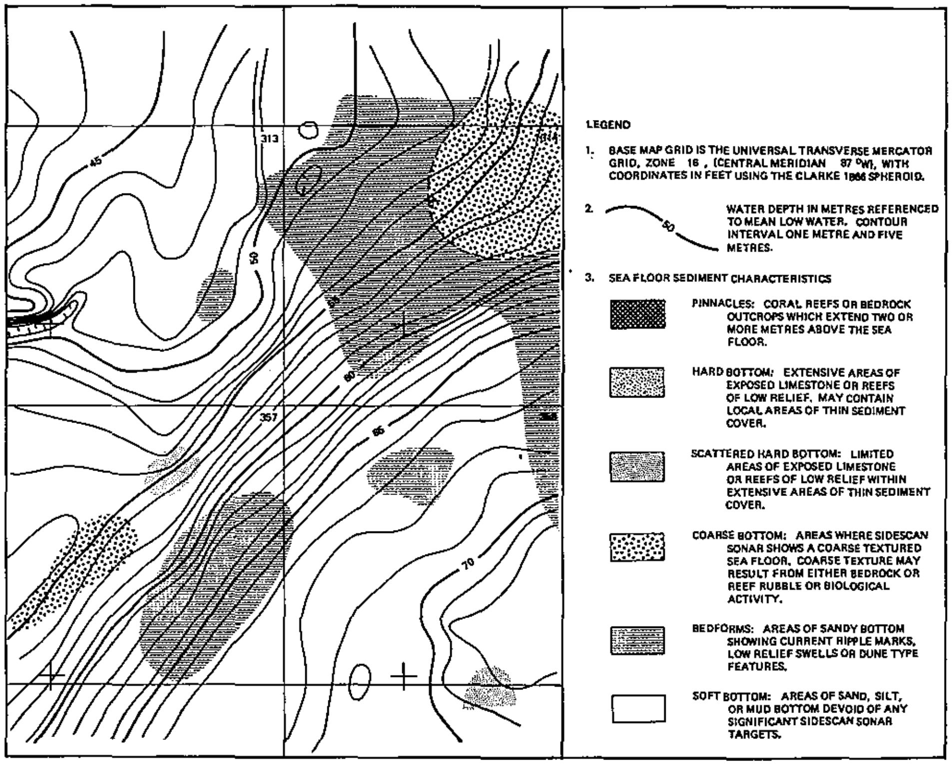
a. Volume 1 is the technical report. It describes the geophysical and biological surveys that were previously conducted in Lease Area 65; field operations with this survey; basic procedures for data handling, analysis, mapping, and presentation of the data from this study; results of this survey; and presents recommendations for areas that may require further studies to accurately assess the impact of offshore petroleum operations.

b. Volume 2 contains the maps and geologic cross sections produced for each of the 10 study areas. These include 11 navigation and survey plots, 10 bathymetry and seafloor sediment characteristics maps, and 3 geologic cross sections (a total of 24 sheets).

c. Volume 3 contains operations and instrumentation logs and are intended for use only by those scientists who will be utilizing the original field data.

d. Geophysical data include subbottom profiles (3.5 kHz), bathymetry records, sidescan sonar records, and high-resolution seismic reflections.

e. Also available are color slides (35-mm) of bottom features and associated macro-benthic assemblages.



One of 10 bathymetry and sea-floor sediment characteristics maps prepared for the Eastern Gulf of Mexico.

For additional information contact: NGSDC/EDIS/NOAA, Code D621, Boulder, CO 80303. Telephone: (303) 499-1000, ext. 6338 or 6541; FTS 323-6338 or 323-6541.

Geophysical Data Offshore Kodiak Island, Alaska

Seismic reflection survey data from offshore Kodiak Island, Alaska are now available. Under contract to the U.S. Geological Survey, the Petty-Ray Geophysical Division of Geosource, Inc., performed the surveys between June 1976 and June 1977 and interpreted the data to provide information regarding potentially hazardous geologic structures or conditions prior to the OCS Oil and Gas Lease Sale No. 46 scheduled for late 1980. The USGS has provided these data to the National Geophysical and Solar-Terrestrial Data Center (NGSDC) for sale to the public.

The data (approximately 10,000 km) in the survey area were collected in a rectangular grid of traverses located in the offshore area east and south of Kodiak Island; 564 blocks have been tentatively selected for leasing by the Department of the Interior. These blocks are located from 7 to 75 km offshore in water depths of 30 to 600 m. The contractor's interpretation is included in the data set; however, a separate interpretation is being released through the USGS publications system. This is the first in a series of Alaskan data sets to be released by the Conservation Division, USGS, related to their effort in support of the Department of Interior's Outer Continental Shelf leasing program.

The USGS data set consists of 7 reels of raw data on microfilm including 6 reels of side-scan sonar records; 129 interpretative maps in both sepia and blackline; a final, three-volume technical report in microfiche format including velocity analyses, which describes survey and navigational equipment, methods, auxiliary data processing, and results of the survey. Microfiche sheets total 24, of which 13 are velocity analyses. Also included in the data package are 2 magnetic tapes of navigation data.

Inquiries should be addressed to: NGSDC/NOAA/EDIS, Code D621, Boulder, CO 80303, telephone (303) 499-1000, ext. 6338 or 6541, FTS 323-6338 or 323-6541.

Geophysical Data Offshore Southern California

Data are now available from high-resolution geophysical surveys offshore from southern California. McClelland Engineers, Inc., performed the surveys under contract to the U.S. Geological Survey (USGS) from September 1977 through March 1978. Data were collected over tracts tentatively selected for Outer Continental Shelf (OCS) Lease Sale No. 48, and were interpreted to identify potential geologic hazards and constraints to operations on these tracts. The USGS has provided these data to the National Geophysical and Solar-Terrestrial Data Center (NGSDC) for public dissemination. About 8,000 line-km of bathymetric and high-resolution seismic reflection data were acquired on a rectangular grid of traverses. These comprise an 0.8- by 2.4- km grid over a total of 217 tracts.

The data set consists of bathymetric, sediment profile, shallow seismic, and digitally processed shallow seismic records on 13 reels of microfilm; navigation data on one 9-track magnetic tape; a field operations report and technical report of data interpretation; program maps; and 12 interpretative maps each for postplot navigation, bathymetry, sediment isopach, shallow structure, and potential hazards.

Inquiries should be addressed to: NGSDC/NOAA/EDIS, Code D621, Boulder, CO 80303, telephone (303) 499-1000, ext. 6338 or 6542, FTS 323-6338 or 323-6542.

Core Curators' File

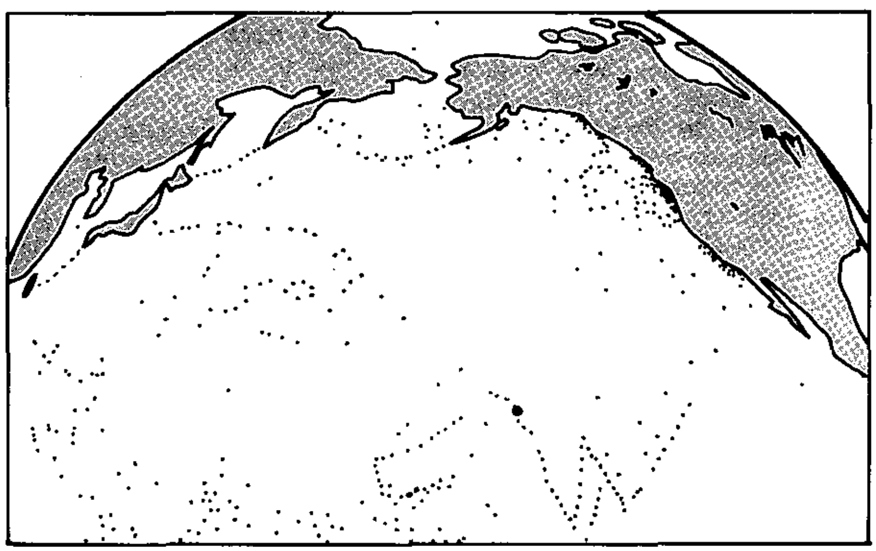
The Core Curators' File is a unique data base designed by participants from all of the major U.S. repositories for marine cores. It is the first attempt to provide basic inventory information, collection and storage information, and basic lithology and age for all marine geologic samples presently archived in the U.S.

In addition to providing a valuable service both to the institutions and data users, the Curators' File will help the National Geophysical and Solar-Terrestrial Data Center (NGSDC) maintain a comprehensive list of locations where samples have been collected for which additional data analyses may exist.

Since the last curators' meeting in November, 1979, at the Geological Society of America meeting in La Jolla, California, NGSDC has received both 10,000 additional entries for the file and related data for nearly 1,000 samples. The Deep Sea Drilling Project is in the process of preparing all of its samples for entry. These will consist of nearly 100,000 lines of code to be contributed, 2,000 samples at a time. The Lamont-Doherty Geological Observatory is preparing its backlog of nearly 10,000 samples.

Searches are performed at a cost of $20.00 to nonparticipants and at no charge for participating institutions. Magnetic tape or 35-mm microfilm copies of listings may also be produced at an extra charge. Plots of station locations for samples selected are available on a variety of projections.

For additional information contact: NGSDC/EDIS/NOAA, Code D621, Boulder, CO 80303. Telephone (303) 499-1000, ext. 6338; FTS 323-6338.



The Core Curators' file contains information for nearly 8,000 marine geologic samples. Locations for some are shown.

International Report

Global Oceanographic Data Inventory

EDIS has published a global inventory of oceanographic data collected from September 1978 to March 1980. The inventory was compiled in response to a request by the Intergovernmental Oceanographic Commission (IOC) for member states to provide data management services for oceanographic data collected during the First GARP (Global Atmospheric Research Program) Global Experiment (FGGE). The inventory is the result of a worldwide survey of marine scientists, augmented by published data plans and reports.

Copies of the published inventory have been sent to all scientists who responded to the survey and to all oceanographic laboratories and university departments in the United States. The IOC is distributing copies to non-U.S. scientists and institutions.

The inventory is also available to all U.S. scientists free of charge via a computer telecommunications network. This interactive inventory is being updated continuously and is more current than the published version. In general, the published version may be used to guide later computer searches.

To access the inventory interactively or to request a published copy, contact Robert Dennis, CEAS D21, 3300 Whitehaven St., NW, Washington, DC 20235 or call (202) 634-7344.

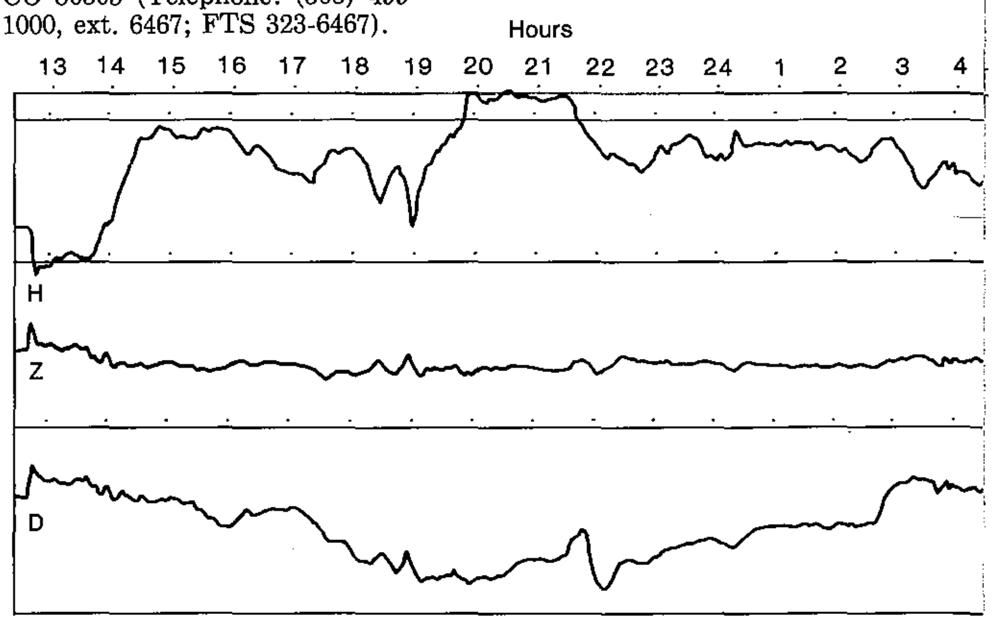
New Magnetograms Acquired

The National Geophysical and Solar-Terrestrial Data Center (NGSDC) recently acquired about 90 observatory-years of magnetograms from institutes in Italy, Turkey, Egypt and India. Magnetograms represent the daily records of the time variation of declination and horizontal and vertical intensity of the Earth's magnetic field. These new acquisitions increased World Data Center A archives by 4 to 5 times for the six observatories concerned: Capri, L'Aquila, and Roburent sponsored by Italy; Kandilli sponsored by Turkey; Helwan sponsored by Egypt; and Sabhawala sponsored by Italy.

In addition to magnetograms, hourly value data from the Kandilli Observatory were obtained for the years 1960-69. Hourly values data are represented as tables of hourly averages derived from the analog traces of the declination, horizontal, and vertical components. Magnetograms and hourly value data are available as electrostatic copies or on microfilm.

Address inquiries and requests to William Paulishak, World Data Center A for Solar-Terrestrial Physics, NOAA/EDIS, Boulder, CO 80303 (Telephone: (303) 499-1000, ext. 6467; FTS 323-6467).

Magnetogram for Kandilli, Turkey observatory shows a moderately active period. The record indicates changes in horizontal intensity (H), vertical intensity (Z), and declination (D).



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National Oceanic and Atmospheric Administration
Environmental Data and Information Service
EDIS Magazine
Washington, D.C. 20235.

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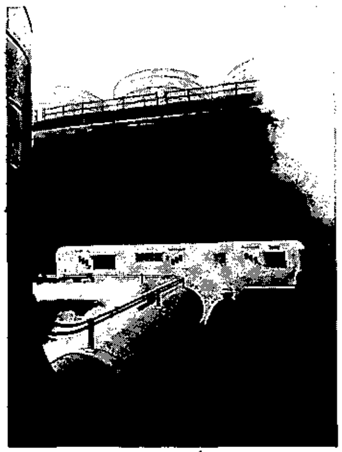

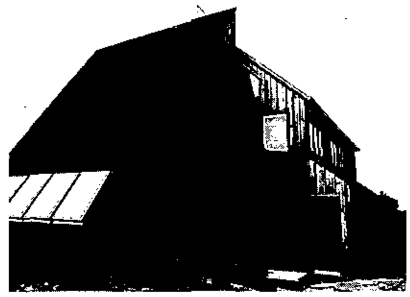

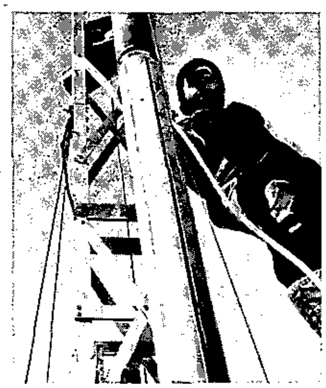

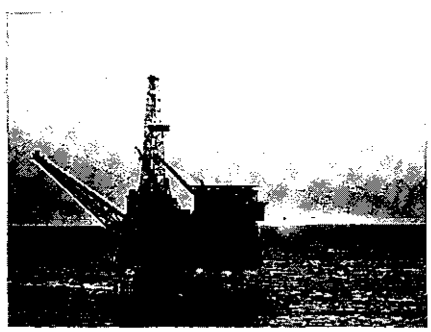

In this issue: *Geothermal resources in the U.S. (p.4); NOAA contributions to the National Climate Program (p.7); EDIS marine products and services (p.12); ice core inventory (p.18); and George Washington, farmer and weather observer (p.19).*

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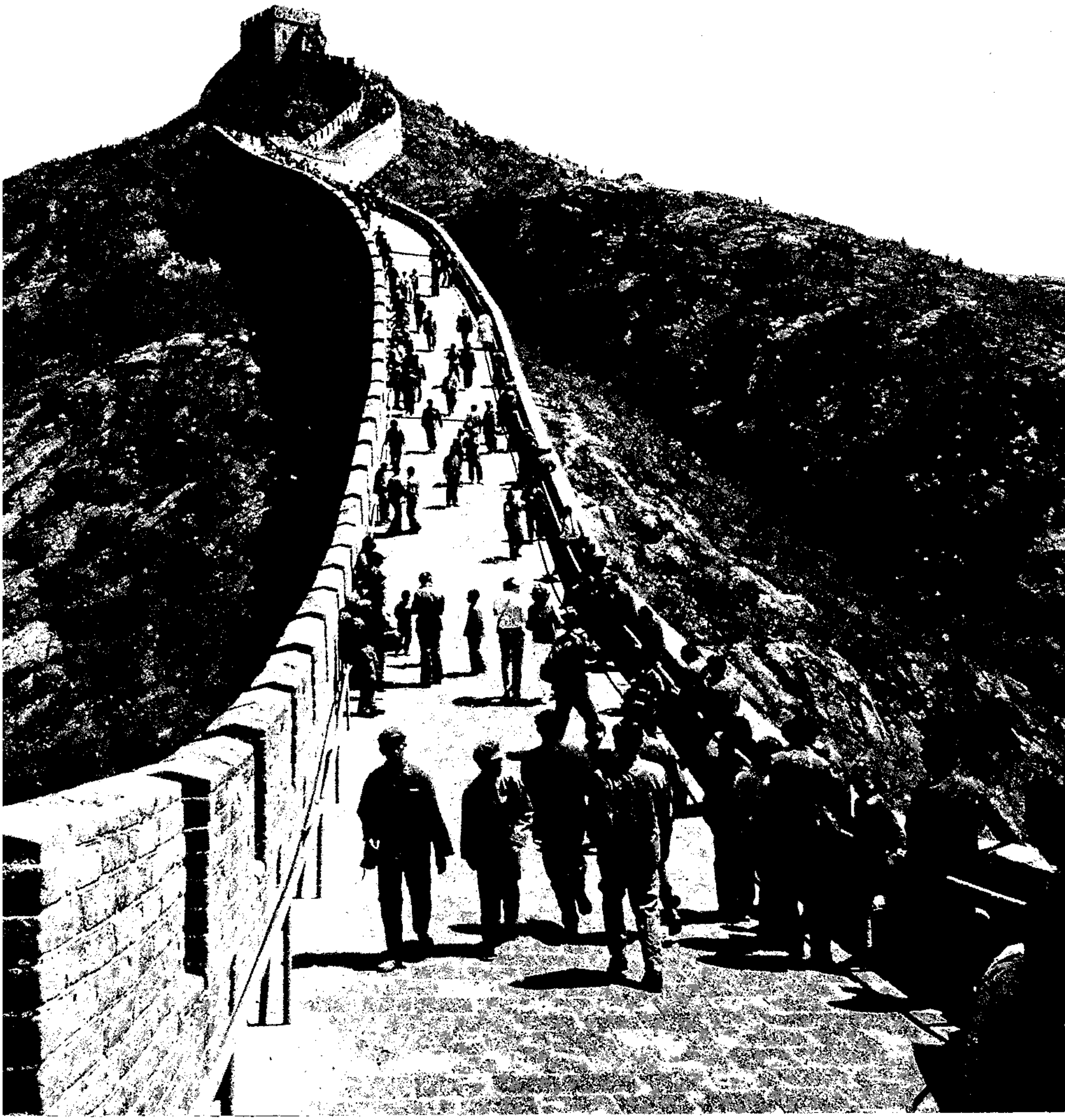
May 1980



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Cover: *EDIS scientists recently returned from a visit to the Peoples Republic of China. The article that begins on page 3 summarizes their findings concerning the status of PRC marine science programs.*

Department of Commerce photo by John Davis

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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.

EDIS (ISSN 0109-3365) is published bimonthly by the Environmental Data and Information Service, NOAA, Page Building 2, Room 533, 3300 Whitehaven St. N.W., Washington, D.C. 20235. For address changes, cancellation, or information write to the Editor at this address. Controlled Circulation Postage is paid to the Finance Department, USPS, Wash., D.C. 20260.

Richard A. Frank, NOAA Administrator (left) and Xue Weimin, First Deputy Director of the Central Meteorological Bureau of the Peoples Republic of China sign a Protocol on cooperation in marine sciences in May 1979. Department of Commerce photo by John Davis

Marine Science Programs in the People's Republic of China

By James Churgin
National Oceanographic Data Center

A delegation of U.S. marine scientists visited the People's Republic of China (PRC) from November 1 to 25, 1979. The purpose of the visit was to establish a basis for marine data exchange between the two countries and for U.S. assistance in the establishment of a PRC National Oceanographic Data Center. The visit was made under the terms of a Protocol on Cooperation in the Field of Marine and Fishery Science and Technology between NOAA and the PRC's National Bureau of Oceanography. The delegation was led by James Churgin of EDIS, the author of the following article.

Picture yourself in a country with a cultural background entirely foreign to your own, a different political system, a different and difficult language, and a national marine sciences program as "simple" as the myriad of marine institutes, organizations and government agencies in the United States. You will now have some comprehension of the problems I and my colleagues faced upon entering the People's Republic of China (PRC) at Guangzhou (Canton).

It was only because of the patient help of our Chinese hosts that we were able to finally understand what is happening in the PRC today by the time we left from Beijing (Peking), nearly one month later. Fortunately, we were aided by several rather long train rides between cities. These gave us an opportunity to learn more about both the programs and the people who run them.

Since the establishment of a Communist political system in 1949, the country has undergone several distinct periods of change. Noteworthy is the "Cultural Revolution," from the late 1960's to the late 1970's. During this period, virtually all scientific research, learning and exploration stopped. Almost none of the usual scientific exchanges took place, and most foreign scientific literature was unavailable. Considering the enormous strides made in the marine sciences during the period, it is not surprising to find that most PRC scientific personnel express a great eagerness to catch up.

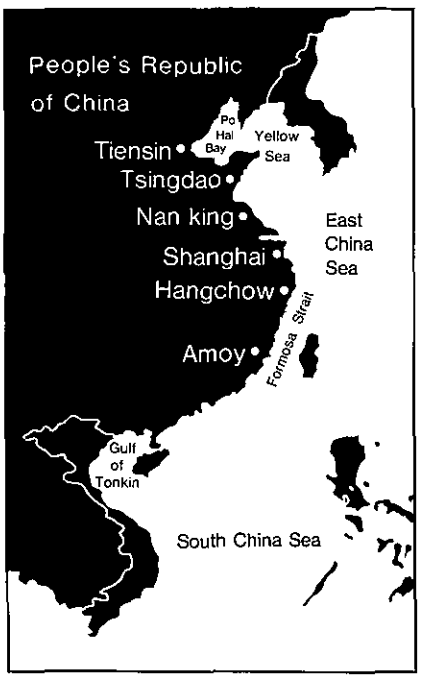
To understand the present state of the marine sciences in China, it is important to understand the history of marine programs there during the past 30 years. This history is divided into three periods. The first period, from 1949 until the mid-1950's was characterized by a number of diverse programs in fishery research, biological oceanography, and some physical/chemistry measurements. Data were not collected in a systematic manner, and quality was extremely variable. Techniques and programs improved as experience was gained.

The second period lasted from the mid-1950's through the early 1960's. This was the time that the Chinese refer to as the "Great Leap Forward." It included a 12-year Plan for Ocean Science Research. Beginning in 1956 with single ship investigations of variability in the shallow seas surrounding China, this work grew to multi-ship, regular (4 per year) observational stations in 1957-58. With experience, the techniques and quality of observations improved.

In 1958, a massive 30-ship, 16-institution survey was launched. This multidisciplinary survey included the Yellow Sea, East China Sea, South China Sea, and Po Hai Bay. As a result of this effort, the following data were collected: 12,000 ocean stations (temperature, salinity and nutrient chemistry), 10,000 stations of current observations (1/hour for 24 hours), 10,000 biological and geological samples, 92,000 investigation data sheets, 30,000 tables and charts.

During the 3 years following this observational program, the data were processed, analyzed, and compiled into an Atlas containing information on physics (water mass structure and circulation), plankton, nutrients, bottom sediments, bathymetry, etc. This experiment also enabled the PRC to train a cadre of people knowledgeable in the collection, processing, and analyses of oceanographic data.

The third period of oceanographic development began in the mid-1960's and continues. It includes the period of the Cultural Revolution in China, when virtually all investigations were suspended, and almost all progress in science ceased. It was during this period (in 1965) that the National Bureau of Oceanography established the Institute of Marine



Above: Location of PRC marine institutes. Right: The train from Hong Kong to Guangzhou (Canton) was equipped with a color TV. Programs featured Chinese scenes and events, including information for visitors.

George Saxton photo

Scientific and Technological Information. This Institute contains a Data Collecting and Processing Division, which is the PRC's closest equivalent to a national oceanographic data center and which I will henceforth refer to as the PRC Data Center.

This third period of marine activity has been characterized by single-ship area surveys, an increase in the number of coastal stations, the beginning of time-series observations at specific locations, and studies on marine meteorology, particularly on the cause, effect, and prediction of storm surges.

The coastal station network operated by the National Bureau of Oceanography (NBO) now has 51 stations collecting data on tides, tidal currents, water temperature, salinity, and surface weather on a regular basis. Daily summary sheets are forwarded to the NBO by mail. They plan to submit these by teletype in the future. Altogether, 52,000 station/months of data have been collected; these data are stored at several locations, including the data center in Tianjin (Tiensin). This center also receives similar data from coastal stations operated by the Ministries of Aquatic Products, Transportation, and the Navy.

NBO officials indicated that future plans include more investigations in deep ocean areas of the Pacific and Indian Oceans. A PRC research vessel and scientists did participate in the recent FGGE* program in the western Equatorial Pacific, and they would like to continue this type of association with international oceanographic programs.

My personal conclusion regarding the state-of-the-art in PRC marine sciences is th .t the marine science community has, for the past 3 years, been very busy obtaining and reading as many papers and publications as possible to gain an understanding of modern scientific concepts and technology. They have some older scientists trained at Western Institutions such as Stripps, some trained at Soviet Universities, some trained within the PRC, and a generation of people who received some training, but have little practical experience because of the Cultural Revolution.

Front row (from left) Frank Wang, USGS; George Saxton, James Churgin, and Michael Loughridge of EDIS/NODC. Dr. Zeng Chengkui (front row center) is Director of the PRC Academia Sinica Institute of Oceanography. Institute staff, interpreters, and escorts are in second row.

* First GARP (Global Atmospheric Research Program) Global Experiment.

Marine Science Programs in The People's Republic of China (PRC)

National Bureau of Oceanography

The Bureau is responsible for programs in all disciplines of oceanography and marine meteorology. It is organized as follows:

- South China Sea Sub Bureau
- East China Sea Sub Bureau
- North China Sea (Yellow Sea) Sub Bureau
- First Institute, Qingdao (Tsingdao)
- Second Institute, Hangchow
- Third Institute, Xiamen (Amoy)
- Institute of Marine Scientific and Technology and Information
- Institute for Environment Protection

The Sub-Bureaus conduct operational programs such as a network of tide stations and buoys, provides ships and other logistical support. The First, Second, and Third Institutes are primarily research facilities. The Institute of Marine Scientific and Technology Information provides support resources such as chart production, printing, information services, data collecting, data processing, and atlas preparation.

Bureau of Aquatic Products (Fisheries)

This Bureau is the national fisheries organization including both marine and freshwater fish. They conduct a number of large observational programs for physical as well as chemical and biological data. It is a major contributor to the general data base for China Seas. Organizations under the Bureau include:

- Yellow Sea Fisheries Research Institute
- South China Sea Fisheries Research Institute
- East China Sea Fisheries Research Institute
- Institutes and Laboratories in Inland and Coastal Provinces

Ministry of Petroleum

The Ministry programs have a strong marine geology and geophysical component which appears to be well funded. They operate:

- Institute for Petroleum Geology
- Institute for Po Hai Bay and Yellow Sea

Ministry of Transportation

This organization seems to have interests in marine projects similar to those of the U.S. Corps of Engineers. These are port and harbor construction and water transportation. Facilities operated included:

- Academy of Water Transportation and Development
- Academy of Waterway Engineering
- Nanjing (Nanking) Water Research Academy
- Institute of Ship Research, etc.

Ministry of Chemistry

We were told that this Ministry conducted marine chemistry research and observational programs, but no details were given.

Bureau for Environmental Protection

This Bureau has offices for Po Hai Bay and the East China Sea. Though it may conduct some inhouse programs, they seem to also sponsor programs within the other Bureaus and Ministries.

PRC Navy

The Navy operates an Institute for Ocean Science Research and collects data.

Ministry of Education

This organization has overall Responsibility for College and University System.

Academia Sinica

Academia Sinica is the PRC Academy of Sciences. Unlike its U.S. couterpart, the Academy operates research institutions in all areas of science. For Marine Sciences these include:

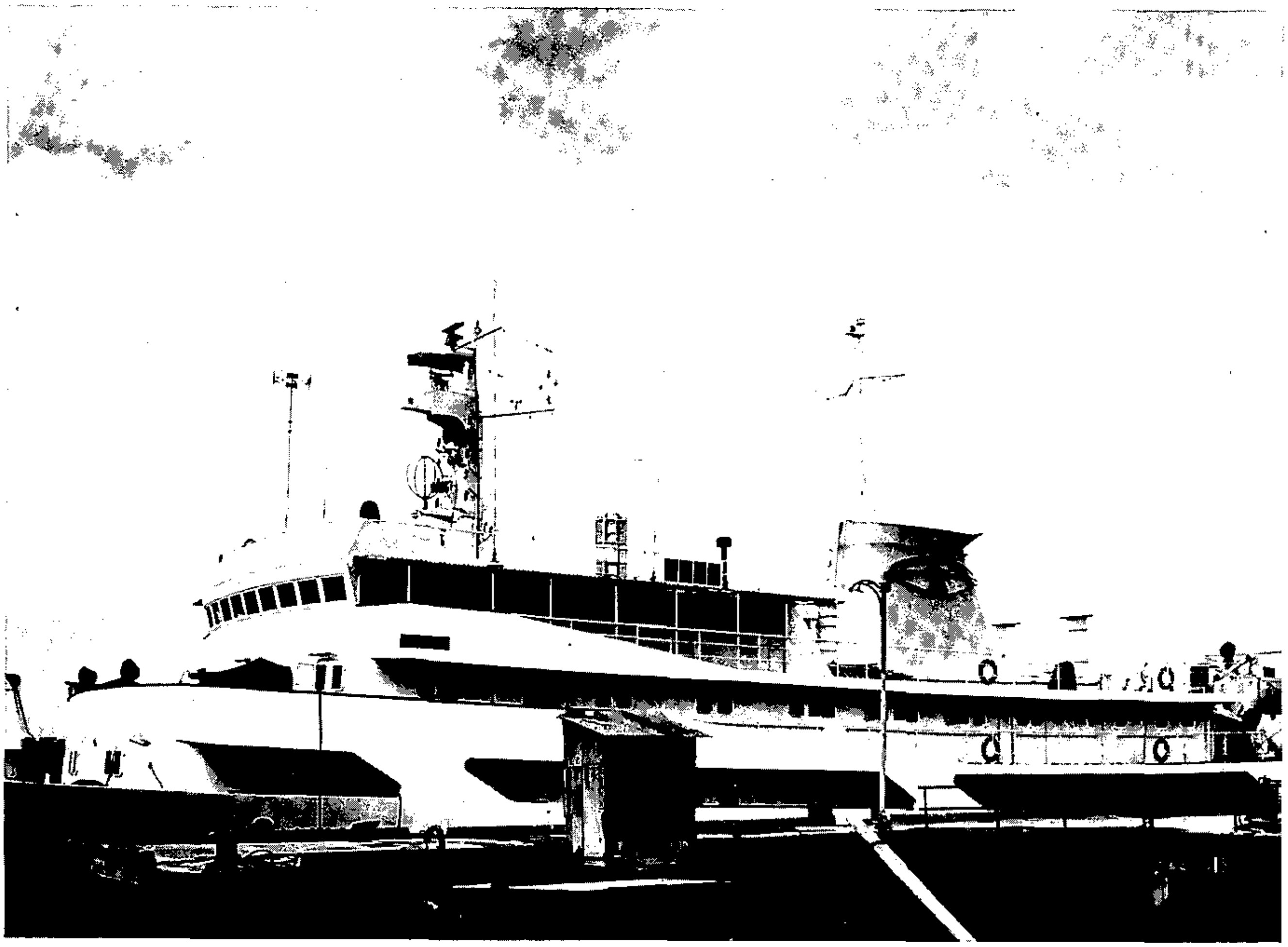
- Institute of Oceanography, Quingdao (Tsingdao)
- South China Sea Institute of Oceanology

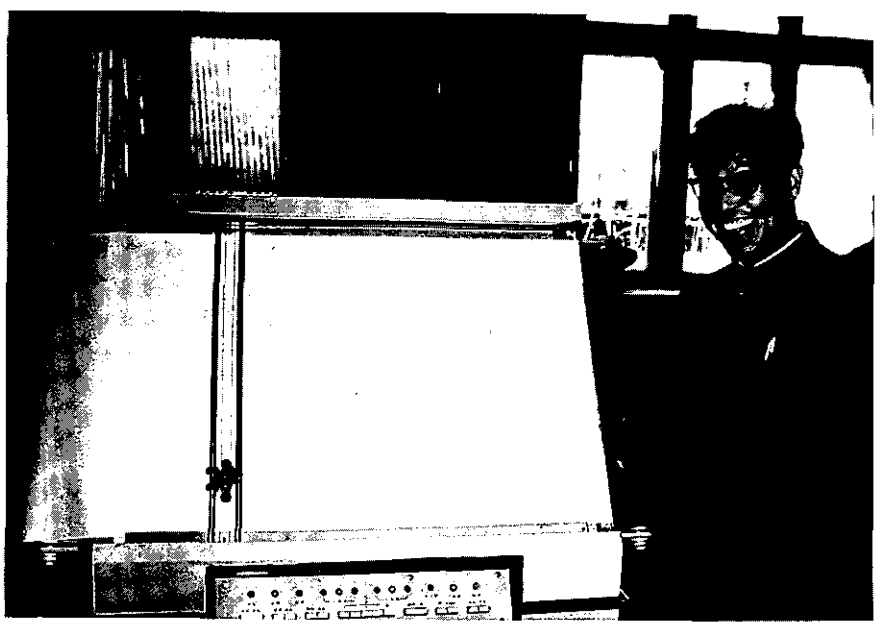
Universities

There are a number of colleges and universities that have both course curricula and research projects dealing with marine disciplines. The principal oceanographic institution is the Shandung University School of Oceanography in Quingdao (Tsingdao). The Shanghai Normal University, Estuarine and Coastal Institute is another example of the type of university programs being conducted.

Provincial Institutes

Coastal Provinces operate some facilties which are related to marine sciences e.g., the Shanghai Institute of Computer Technology has developed a number of marine related computer programs.





Above: Geophysical Survey Vessel HAIYANG I, built in 1972, recently was converted from a general research vessel. The PRC is strongly emphasizing offshore surveys for petroleum development. Left: How Wenfeng, Director of the Data Collecting and Processing Division of the National Bureau of Oceanography's Institute of Marine Science and Technology, greets the U.S. Delegation in Chinese and English.

George Saxton photos

The PRC Data Center is reminiscent of the U.S. National Oceanographic Data Center in the early 60's. Much of the work is done manually. Their computer is equivalent to a second generation U.S. machine, with punch tape rather than magnetic tape and automated plot capability; few, if any, data products (summaries, graphics, contours, etc.) are generated.

The Chinese are extremely eager to catch up, both personally and as a matter of government policy. Most of the individual scientists we met were bright and eager to learn. The Cultural Revolution not only caused a setback in technological development but, because foreign languages (especially English) were forbidden, caused a communications gap which now makes discussion at a detailed technical level difficult and slow. There is a major effort underway to overcome this problem, but it will take time.

Since the objective of our visit was simply to explore areas of possible agreement, there were no formal negotiations. I did explore several areas of potential exchange, whereby EDIS' National Oceanographic Data Center (NODC) and National Geophysical and Solar-Terrestrial Data Center (NGSDC) might provide automation and development assistance in exchange for historical data collected in the China Seas in all oceanographic disciplines. The EDIS centers could, in turn, disseminate these data to users in the United States. U.S. data and information would probably be provided to the PRC data center for dissemination within their country. It is expected that further discussions and negotiation will take place during 1980.

Before an agreement can be concluded, the Chinese must first send a delegation to the United States, so that they may gain an understanding of U.S. capabilities to process, validate, and disseminate data and data products. Later this year, we expect the return visit of about five PRC marine data specialists. While no firm itinerary has been arranged, we expect that they will be visiting both NODC and NGSDC, as well as EDIS' five Liaison Offices around the country.

The arrangements made by NBO for our trip were excellent. At each city, we met local officials. The marine organizations we visited provided interpreters, transportation, and other needs. I was especially pleased that Mr. Hou Wenfeg of the PRC Data Center accompanied us during our entire trip. He was able to provide excellent background information on both Data Center activities and on the structure of marine sciences in the PRC. Since he spoke no English, the services of Mr. Jiao Yongke as interpreter also were invaluable.

Our visit established a firm basis for future negotiations that should culminate in an effective exchange program. As is the case with many other bilateral exchanges, the United States is more advanced technologically in marine data management practices, however, the data we expect to obtain and the working relationships we have established are, in my opinion, in the national interest. Most of the data and information we will obtain are in areas of sparse data coverage and have a high degree of interest for scientific, commercial, and other applications. Because labor seems to be readily available in the PRC, we may also be able to trade our technological skills for manual efforts, such as coding or keypunching in data preparation.

My intuitive feeling is that whatever lack of knowledge there may be regarding modern practices will be more than offset by the determination and attitude of PRC data specialists we encounter. I am looking forward to a long and fruitful period of cooperation and exchange between U.S. and the PRC.

J. Churgin (left) and G. Saxton at the Great Wall of China.

Motion in the Ocean

By George Alexander

"There is weather in the sea, much as in the atmosphere. The storms are called eddies, the winds are called currents . . ."
—Walter Munk

Satellite view of the Gulf Stream from Cape Cod to Virginia shows eddies (dark area right of center) spinning off into the colder coastal waters (central white area).

A slightly condensed version of "Ocean Circulation: A Stirring Tale," which appeared in the Sept/Oct. 1979 (Vol. 10, No. 5) edition of *Mosaic*, published by the National Science Foundation.

A Chinese puzzle

Every recent advance in oceanography has been reminiscent of the Chinese nested-box puzzle; each finding has disclosed still another unanswered question. In the 1950's, says Carl Wunsch, head of the Department of Earth and Planetary Sciences at the Massachusetts Institute of Technology, the consensus was that there was a close and direct linkage between the causes of such large-scale winds as the westerlies or the trades, solar radiation, and the effects of oceanic currents. Together, these forces drove the water smoothly and slowly along huge, ocean-basin-circling paths.

"It was as if someone studying the atmosphere said there was only climate," says Wunsch, "with certain large-scale features—a hot equatorial zone, mild temperate regions, cold poles and an air mass that drifts slowly from one to the other. In this simplistic model, there would be no weather, no storms, no hurricanes, no squalls, no cold fronts. And, of course, it would be incomplete and incorrect for lack of these elements."

This ignorance of the true conditions in the ocean was largely attributable to inadequate instruments and the strategies they dictated, according to Wunsch and others. About the most oceanographers could do until the late 1950's was to measure temperature and salinity, their variations with depth, averaged current velocities and generalized current directions.

But with the cruise of the research vessel *Aries* in 1959-1960, the nested puzzle-box was opened; oceanographers were startled by what they found inside.

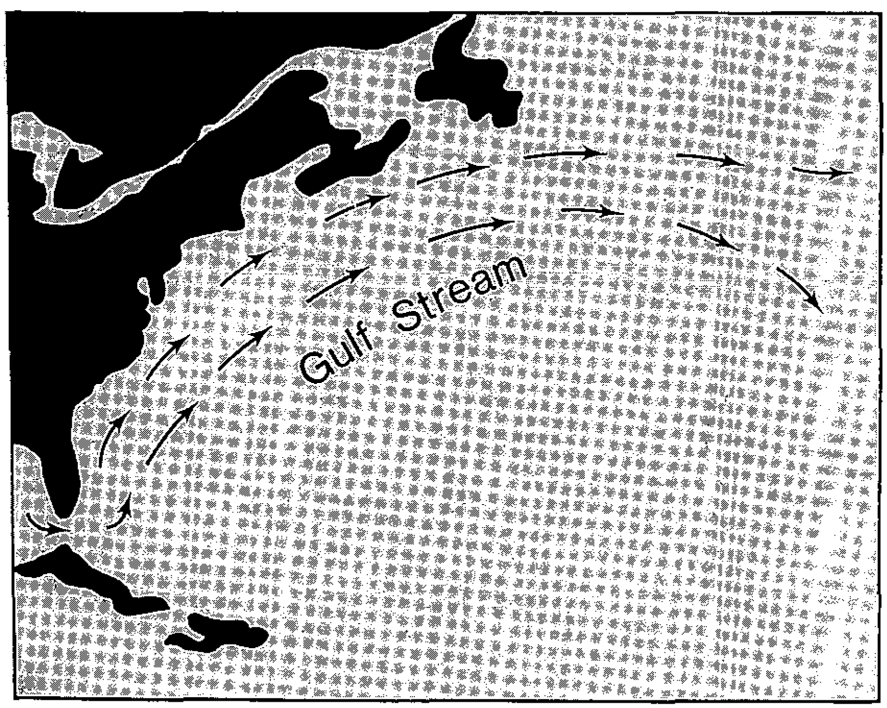
Aboard the ship was a group of American and British scientists including Britain's John C. Swallow, a physical oceanographer. Swallow had invented a neutrally buoyant float, a sealed aluminum tube ballasted with gasoline that would sink it to a predetermined level. The float would be borne along by the currents; its acoustic pulses—emitted by a sound generator in the tube—could be tracked by the launching ship on the surface. It was the goal of that *Aries* cruise and its scientist-crew to use the floats in a search for deep currents, 2,000 to 3,000 meters or more below the surface, currents that apparently flowed counter to those in the uppermost layers of the ocean.

These countercurrents had been proposed a year or two earlier by Henry Stommel of the Woods Hole Oceanographic Institution. One of the foremost theoreticians in oceanography, Stommel had suggested that the abyssal circulation was the inverse of the surface patterns, that cold polar waters sank to the ocean bottom through two specific "sink-holes," one in the North Atlantic, near Greenland, and one in the Weddell Sea in the Antarctic. Then they moved equatorward along well-defined tracks, In the North Atlantic for example, Stommel proposed, the abyssal waters rolled southward along the Eastern Seaboard of North America, directly counter to the flow of the warm Gulf Stream at the surface.

This inverse, balancing pattern should exist throughout the ocean basins, Stommel reasoned. Where the surface flow is to the south, then the abyssal flow ought to be toward the north. It was to test this theory that the *Aries* sailed to a point off the Iberian Peninsula in 1958 and prepared to launch the new Swallow floats.

Brownian motion

The scientists were looking for a slow, steady countercurrent, on the order of a few millimeters or, at



The Gulf Stream originally was believed to be a uniform northeasterly current.

most, a centimeter per second, in keeping with the then-prevailing oceanographic orthodoxy. At that snail's pace, they felt, the floats would probably cluster and drift along together as if they'd been dropped into a sluggish river. They shouldn't cover more than a few hundred kilometers in a year or two. It would be easy, or so they thought, to track the acoustic pulses from the floats for a few weeks, mark their last known position carefully, return to port for resupply and crew changes and then return to the site to resume tracking.

A slow current is not what they found. When the floats were dropped into the water, they sank to the proper depths—but then scattered in all directions, like a school of shark-frightened fish.

"The observed currents were significantly stronger (than anticipated) and variable both in time and space," Swallow was to recall years later. "One float, nearly three kilometers deep, moved southeast for three weeks, then southwest for another four weeks, at speeds of one-half to one centimeter per second. Two floats at two-and-one-half kilometers depth were tracked simultaneously for two weeks; they moved in straight lines and passed within 25 kilometers of each other, but one moved at an average of five centimeters per second, while the other did half a centimeter per second."

The trace of the floats resembled nothing so much as "large-scale Brownian motion," to use Reid's words. No one quite knew what to make of the floats' odd behavior. The best hunch was that they had been scattered by powerful currents thrusting out of the Mediterranean Sea.

To resolve this puzzle, the scientists took the *Aries* out to sea the following season, 1959-1960. But this time the scientists sailed to the Sargasso Sea, that large pool of relatively calm and biologically poor water in the middle of the North Atlantic. There, it was hoped, the deep currents might be weak enough to enable the oceanographers to get some idea of what was happening down below.

Once again, however, the scientists were thwarted. Instead of revealing deep currents moving at no more than a centimeter a second, the tracked floats disclosed flows of 10 centimeters a second. Revising its goals on the spot, the *Aries* crew gave up the attempt to capture an overview of mid-oceanic processes. Instead, the researchers went chasing after the variable currents their floats had revealed.

Weather in the sea

That cruise of 20 years ago provided considerable information about the velocities and directions of these variable currents. Scientists at that time, however, were still unable to see that what they were dealing with were organized flow patterns. It wasn't until much later—the Mid-Ocean Dynamics Experiment (MODE) of the 1970's—that these variable currents were revealed to be eddies—large (upwards of 200 kilometers in diameter), deep (4 kilometers or more), rotating structures of water that had temperature profiles markedly different from those of the surrounding ocean.

Of course, variable currents were not a complete unknown, an *aqau incognita* as it were, in the North Atlantic. Eighteenth and 19th-century mariners noted in their logs that their ships drifted differently at the same latitude and longitude coordinates at different times. More recently, researchers in the 1930's and 1940's had found that columnar rings of water from the slope off eastern North America were being formed along the turbulent edges of the Gulf Stream and sent spinning off north and south of this surface current once it swept past the Grand Banks. Rings are a form of eddies, although the two are not at all identical; mid-ocean eddies have proven to be in a class by themselves.

Mid-ocean eddies, it turned out, drift through the Pacific and Indian Oceans, as well as the North Atlantic. They appear to be intermediate in size, between such larger features as the gyral currents, which flow completely around basins, and such smaller features as either the temperature gradient between layers of water, or the transitional boundaries between less saline and more saline patches of water.

Identifying eddies did more than simply fill the gap between micro- and macromotions in the ocean. These eddies and their energies seemed clearly and significantly involved in a wide range of physical, geochemical, atmospheric and biological processes in the oceans. Here was a means of transporting heat from one part of the ocean to another, of moving quantities of salts and nutrients, perhaps of effecting as well as being affected by winds. In eddies, the oceanographers now had some oceanic "weather" to work with.

"There is 'weather' in the sea, much as there is in the atmosphere," says Walter H. Munk, associate director of the Division of Geophysics and Planetary Physics at the Scripps Institution. "The storms are called eddies, the winds are called currents and, while there is no humidity (gradient) as such in the oceans, the varying levels of salinity in different parts could perhaps be considered comparable to the relative amounts of water vapor in the air."

Realizing this, however, and doing something about it were two different things; oceanography in the early 1960's lacked the tools to make any kind of serious investigation into eddies and their properties. New observational techniques were needed, techniques better matched to the things being observed and compatible with both the temporal and spatial extent of the eddies. "Until the neutrally bouyant floats, the moored arrays and the recording current-meters came along," says Wunsch, "all you had to work with was a ship. And you couldn't keep a ship at the same spot on the ocean for three months at a time."

The system

Interest in ocean eddies, a main thrust of oceanography for most of the past 20 years, is more than academic. They are part of an ocean system to which whole ecological systems and food chains have adapted over evolutionary time. To press the analogy, understanding them is as important as understanding the weather patterns on which so much of terrestrial life depends.

A typical ocean basin comprises a system of large and small gyres—rotating current flows like so many gears and cogs inside an old-fashioned watch. The mainspring among these gyres is a huge vortex, roughly in the middle latitudes, called the main subtropical gyre. In the Northern Hemisphere, it flows clockwise. To the north of it is a smaller, polar gyre rotating counterclockwise; to the south of the main gyre is a smaller but more complex equatorial current loop that also rotates counterclockwise.

But it is the main gyre that dominates the basin. As it swings against the continental land mass on the western rim of the basin (North America or South America in the Atlantic, Asia in the Pacific) and turns toward the pole, it narrows and intensifies. So strong is this "bunching" effect that there may be as much as 40 centimeters of height difference between the water off North America and the water off the west coast of Africa. Height differences can be even more prominent across a swift-flowing current like the Gulf Stream. There, the warm side of the stream, the boundary facing out into the ocean basin, can be 80 centimeters or more higher than the cold side facing the land. Inside the main gyre, and sometimes outside but related to it, can be found several distinctly different kinds of eddies, some of which are presently explainable and some not.

Rings

Among the explainable are Gulf Stream rings. These eddies are formed when the Gulf Stream peels away from its coastline-hugging path, along the North American Continent, and turns to the northeast. Coincidentally or not, the stream begins to meander as it passes over the New England Seamounts, a chain of underwater peaks several hundred kilometers offshore, giving rise to a series of big, *cul-de-sac* loops.

Since the Gulf Stream separates cold, northern water from warm, southern water, the orientation of the open end of a loop determines whether the core of water it captures is cold or warm: cold if the open end faces out into the northern pool, warm if it faces toward the ocean's interior. Then, as the loop closes and buds off, that core of water is enclosed and forms a ring. Both cold-core and warm-core rings appear to form in equal numbers (anywhere from five to eight every year).

There are important differences besides temperatures between the cold-core and warm-core rings. The warm rings tend to be shallower columns of water, extending down 1,000 meters or so; the cold rings go down 2,500 to 3,000 meters. Warm-core structures typically last only six months or so. Then they are swept down the alley between the Gulf Stream and the coastline and reabsorbed into the Stream. Cold-core rings, on the other hand, may be 100 or 200 kilometers in diameter, be 8 to 10 degrees centigrade below the temperature of the surrounding ocean field, stand a meter or more lower that surrounding water, and persist as an identifiable structure for upwards of two years.

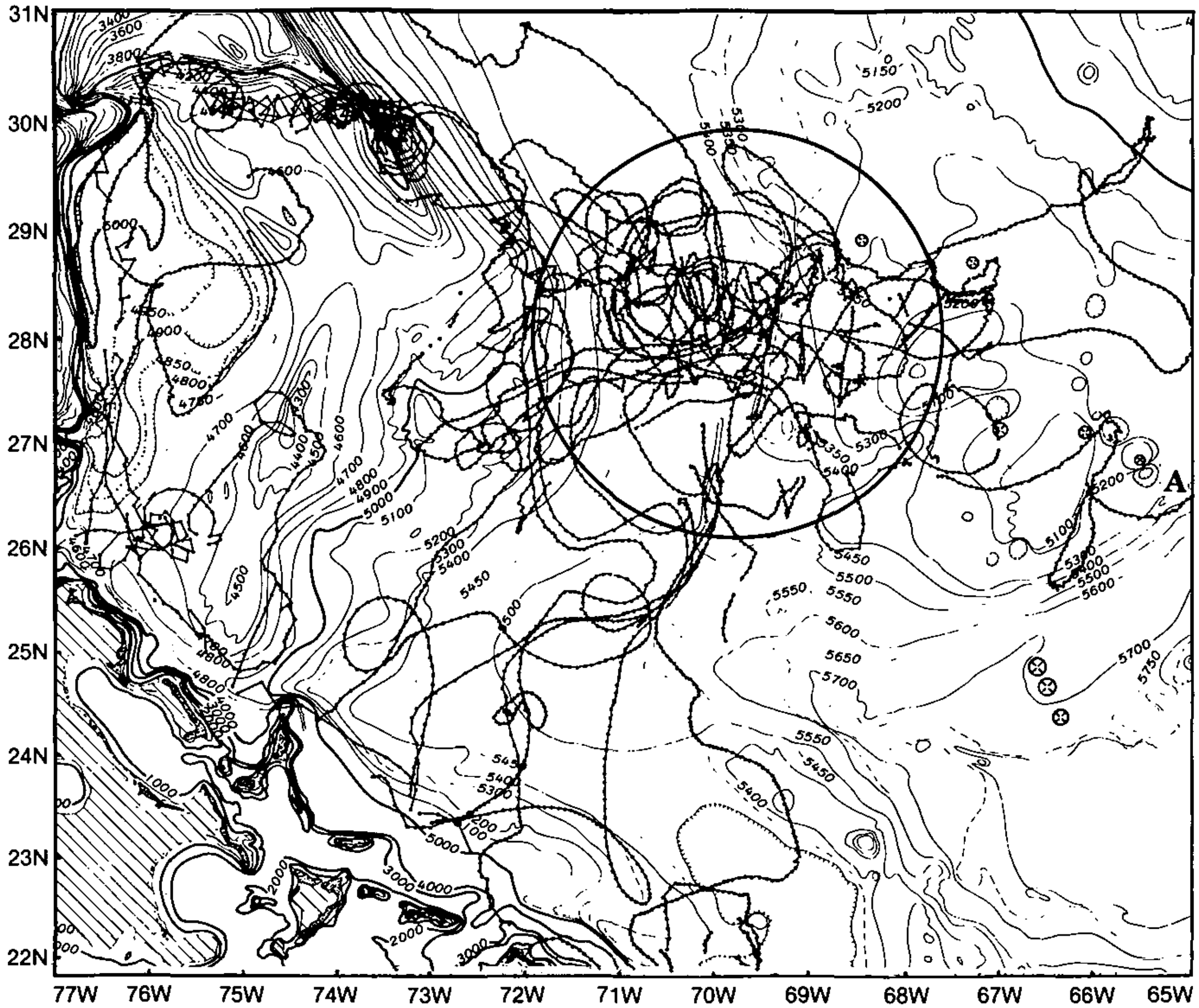
Evolutionary pressures

As a ring ages, it also decays. And here, especially in cold-core rings, may be seen some of the biological effects of this particular class of eddies. There are marine animals and plants that prefer a certain thermal environment—some like it warm, some like it cool. As a consequence, since the Gulf Stream effectively divides the North Atlantic into two different temperature regimes, one finds thermophilic and thermophobic species on the appropriate sides of the current.

But when a cold-core ring forms, the formation process traps and isolates members of thermophobic species inside as the ring is injected into a different regime. Initially, the ring retains most of its thermal, saline and nutrient characteristics. Scientists find little or no difference in the varieties or abundances of organisms in the young rings as compared to those in parental waters.

After several months adrift in the warm interior of the Atlantic, however, changes appear. The temperature and salinity of the core water rise; its nutrient content drops. The depth at which the concentration of dissolved oxygen falls off also drops. And with these environmental changes, Woods Hole investigators have discovered come profound changes in the biology within the eddy.

There are, for example, several species of tiny, shrimplike crustaceans that are found in cold water and which follow a set pattern in vertical distribution. At sunset, they swim up from depth to within



Twenty MODE floats released (at about 1,500 meters depth) within the circle followed a variety of paths and moved at various speeds.

Thomas Rossby plot

100 meters of the surface to feed upon other plankton. As the sun comes up the next morning, these creatures cease feeding and swim back down to depths between 350 and 700 meters. There they pass the daylit hours. Other species do not migrate vertically on a daily basis; instead they live just below the well-lit surface layers (upper 100 meters) where the plants and small animals on which they feed are found.

But as the ring becomes warmer and saltier, the nonmigratory, shrimplike euphausiids no longer maintain their normal vertical distribution. Instead, they move to successively greater depths. Whether because of the changes in the water itself or because of the adverse effects of these different water properties on the planktonic populations that sustain these crustaceans, or a combination of the two, the fact is that the creatures stop feeding normally. Many die.

Some individuals do manage somehow to survive the months- or year-long excursion inside the ring. If the ring coalesces with the Gulf Stream during this time, they are returned to the body of cold water in which they originated. This survival almost certainly is important to the evolution of the species. "If, as appears to be the case," says Peter Wiebe, a Woods Hole biologist concerned with life inside these eddies, "populations of slope-water species living in the rings are under increasing environmental stress, this stress may provide a progressive selection mechanism. Cold-core rings may therefore be a means by which genetically altered populations are introduced into the parent population."

Another class

But these rings are only one class of eddy. Another class, called MODE (for Mid-Ocean Dynamics Experiment) eddies, share only a rotational property with Gulf Stream rings; in virtually all other respects, they are distinctly different. "The rings are stronger," says Wunsch, "having velocities of as much as 50 centimeters per second or more, whereas the MODE eddies are warm and are 20 to 30 centimeters higher at their center than the surrounding water: from this fact alone we know that they can't be very old Gulf Stream rings. They're definitely in a class by themselves."

Several efforts were undertaken to explore these other kinds of eddies after the *Aries* cruise of 1959-1960 had revealed how prevalent they were. In 1965, for example, Woods Hole researchers placed a moored array of buoys, many containing novel oceanographic instruments, into the Atlantic some 300 kilometers south and east of their Massachusetts facility. The area was between the Gulf Stream and the continental mainland.

And in 1970, Soviet oceanographers laid out a cruciform network of surface-float moorings in the eastern North Atlantic, west of Cape Verde Islands, in a project they called "POLYGON." Despite their limitations, both efforts succeeded in detecting mesoscale eddies as they drifted slowly westward past the arrays. Additionally, to obtain a more definitive picture of these swirling structures, the United States and the United Kingdom joined together for their 1973 MODE-1 investigation.

"Understanding the eddies and their role in the general circulation has emerged as a central problem (in dynamic oceanography)," the joint American-British team declared. "Moreover, understanding eddy dynamics is a prerequisite for both valid modeling of large-scale exchanges of momentum and energy, heat and salt, geochemicals, nutrients and other passive solutes and for realistic, coupled, ocean-atmosphere models necessary for longer range weather prediction and climate modeling."

The MODE-1 task force involved more than 50 oceanographers from 15 American and British institutions and universities, several hundred technicians, six ships and two aircraft. The instruments included arrays of moored current meters, hydrographic stations (measuring conductivity, salinity, temperature and depth), neutrally buoyant SOFAR (Sound Fixing and Ranging) floats, vertical profilers and bottom-mounted tidal gauges and pressure sensors.

All this came together in a 600-kilometer circle centered on a patch of ocean about halfway between the island of Bermuda and the Florida Peninsula. It lay not only between the westerly winds to the north and the trade winds to the south, but was also accessible to ports on the U.S. Eastern Seaboard and convenient for land-based tracking stations for the SOFAR signals.

For four months, MODE-1 oceanographers recorded water properties on a fixed grid of sampling positions spaced 33 to 50 kilometers apart. From these, they were able to calculate the all-important density field with the MODE area.

The density of ocean water can and does vary both horizontally and vertically; like the variations in atmospheric pressure, this affects the flow of currents. Temperatures and salinity concentrations can also provide a great deal of information about the vertical and horizontal structure of a column of water (which an eddy is, basically).

When, at the end of the four-month experiment, the oceanographers sat down to pore over their harvest of data, they found that they had caught an elliptically shaped eddy, some 400 kilometers long on its major axis. The eddy was drifting westward as a cell at a speed of four to six centimeters per second. Inside the eddy, water was swirling in an anticyclonic (clockwise) direction at speeds of up to 30 centimeters per second. It soon was apparent, recalls Munk, that 99 percent of the kinetic energy in an ocean basin was contained by the eddies and only 1 per cent in the mean circulation.

Eddies and eddies

The instruments provided additional detail on this one MODE-1 eddy, pinning it as surely as an entomologist's pin transfixes a rare butterfly. Its core water was warmer and rode higher by several tens of centimeters than the ocean water in which it was embedded. Its long axis was oriented more north-south than east-west, and the flow pattern inside the eddy, at depth, ran parallel to lines of constant temperature just as winds in the atmosphere blow parallel to isotherms.

MODE-1 succeeded in proving that these mesoscale, circulating cells were present in the middle of the ocean and that they had an organized structure. And while there were a lot of unanswered questions, there were some hints about where eddies came from and what their role was.

There may be several mechanisms generating different kinds of mesoscale cells, explain Wunsch and Peter Rhines of Woods Hole. The warm- and cold-core rings spun off by Gulf Stream-type meanders appear to represent only one such category of eddy and its sources. These rings, which Rhines has called the "supernovae" of eddies, are so energetic that they may radiate waves into the deep interior of the oceans and trigger the formation of other, less energetic cells.

For others, "We could find that, for example, surface winds are driving an eddy (type)," says Wunsch, "or that they're being formed by a flow of large-scale circulation over some topographic feature, or by instabilities of the large-scale flow, or by the interaction of two (existing) eddies moving adjacent to each other."

"We're still trying to figure out all these different kinds," Wunsch notes, but whether oceanographers are seeing an eddy "zoo" or—except for the distinctive Gulf-Stream rings—diverse members of a single family, genus or species of eddies is still a subject of speculation. There may in fact, even be "mongrel" eddies.

When all of the factors so far identified in eddy formation—such as density variations, the bunching effect, average current flows, wind stresses and ocean bottom features—are plugged into a computerized simulation, Rhines observes, the resultant eddies often turn out to be hybrids; their differences appear to be related to the weight given to a particular factor or combination of factors. "What's sort of interesting," Rhines adds, "is that you can't omit any of these factors without making the outcome turn out to be grossly in error."

Polymode

As for their role, the different kinds of eddies seem to function more or less the same. They redistribute heat and chemicals throughout the basin. They shuffle the biological deck, absorb energy from the atmosphere and put some back into it. And they modulate the larger gyral flows of which they are part.

Further, "The interconnection between large-scale gyres and eddies is a vital one, a close intimate coupling," says William R. Holland of the oceanography section of the National Center for Atmospheric Research in Boulder, Colorado, "To understand gyral circulation—something that oceanographers have been trying to do for the past 30 to 40 years—one must understand first how eddies extract energy out of the gyres."

Eddies are a braking mechanism on gyres, Holland explains, and without them, the large-scale circulation would tend to run away. "In the absence of eddies," he says, "the Gulf Stream, for example, would get faster and faster. Eventually, the basic organization of the Stream would start to come apart if it weren't for the slowing effect of the eddies." In some instances, however, it looks as if eddies put energy into the large-scale flow.

To sort out these various uncertainties, as well as to answer some of the questions left unanswered by MODE-1, the United States, the United Kingdom, the Soviet Union, Canada, France and West Germany collaborated in a more intensive research project called POLYMODE (for the earlier Soviet POLYGON and the American-British MODE). It was carried out in 1977 and 1978, and the data were still being reduced and analyzed by the principal investigators in mid-1979.

"MODE-1," says Wunsch, "really saw only one eddy in detail during its four months. It took about that long for the eddy to go by and, at 400 kilometers, was on about the same scale as the resolution of the MODE arrays."

POLYMODE, on the other hand, observed many different kinds of eddies; each participating nation took on designated patches of the ocean and a particular aspect of these cells to measure. The geographical extent of POLYMODE was basin-wide. It included the French/British/German arrays at 45 degrees north latitude and 20 degrees west longitude, Soviet instruments at 35 degrees north and 50 degrees west (about mid-Atlantic), Canadian deployments along the northern boundary of the Gulf Stream and below Newfoundland and American networks in the western Atlantic, in both the MODE-1 area and roughly between Bermuda and Puerto Rico.

"POLYMODE showed that there are enormous variability in eddies," Wunsch reports. "They change shape, they change in time scale, they change in energy; there is a spectrum of eddies. That's one of the things we wanted to find out. We also wanted to find out how eddies interact with themselves. That's one of the things we're working on right now."

Clouded theory

The oceans, it is beginning to appear, are considerably different than we have been accustomed to think. Take, for example, the image of the roiled, turbulent sea that is so often used as a metaphor for a thoroughly confused or mixed-up situation. It works as far as it goes, which would be at depths somewhere between 200 and 700 meters. But it fails from about 1,000 meters on down to the bottom. At depth, there is a stability, even an inertia of sorts, at work that tends to distribute water properties horizontally but not vertically.

This clouds classical oceanographic theory, based on water samples taken at intervals of 250 meters from the surface down to the bottom. Classical theory holds that there is a slow, vertical mixing of water properties going on in the deep interiors of the oceans. But well-defined, stable turbid layers, anywhere from 20 to 250 meters thick, have been found hundreds of kilometers from their points of origin. According to Laurence Armi of Woods Hole, the fact that these layers have retained their cohesiveness over such long distances is a strong argument against the classical theory of vertical mixing.

"Where a deep current collides with a wall, like a seamount, we know that there's mixing (of sediments, salt and water)," Armi explains. "But then, as the current moves on into the deep interior (of the ocean basin), the layered structures will persist almost as if they were immiscible in the vertical plane. Horizontally, however, these layers do diffuse."

There are practical as well as theoretical implications of such findings, made on the abyssal plains offshore from the eastern United States. They could bear significantly, for instance, on plans to use the oceans as dumping grounds for various wastes. "If you dump something into the ocean, expecting it to be dispersed over a volume as great as the entire basin, that may prove to be an erroneous expectation," says Armi. "Waters may instead be spread out over a narrow, horizontal plane, and not mix very much vertically, except where the deep currents make contact with walls." That happens along the western rims of ocean basins, where turbulent oceanic rivers like the Gulf Steam are found and where there are important fishing grounds. There, toxic wastes might be concentrated rather than dispersed.

On the verge

Currently, even as this great catch of data from MODE and POLYMODE is being reduced and analyzed, oceanographers are eagerly looking forward to returning to the sea and collecting with even more. They sense that they are on the verge of a unified synthesis of oceanic behavior, from the microscale of temperature changes across a few tens of meters to the mesoscale of the eddies to the macroscale of mean circulation. And they hope that future programs will continue the progress that began with MODE-1 and POLYMODE.

One novel and experimental technique, being advanced by Wunsch, Munk and Robert Spindel of Woods Hole, is akin to the tomographic techniques developed in recent years by medical researchers, but it is based upon acoustics instead of X-rays. "The ocean is transparent to sound but opaque to radio waves," Munk points out. "You can detonate a stick of dynamite in the water off Portugal and pick up the sound of it off New York."

The speed with which that sound pulse travels through the ocean water is not always constant, however, but will vary depending on conditions in the intervening water mass. An eddy that drifts between a transmitter and a receiver, as envisioned by these three oceanographers, would—because of its thermal properties—affect the passage of a sound pulse, delaying it anywhere from a tenth to a half second during its typical ten-minute transit time.

What Wunsch, Munk and Spindel, along with Ted Birdsall of the University of Michigan, would like to do is to measure the arrival times of a series of acoustic pulses, each pulse traveling along a multiray path (because the structure of the ocean splits a single path into many). Knowing by how much each portion of a pulse has been delayed—and Munk has said that they should be able to time arrivals to accuracies of twenty-five thousandths of a second—inferences might then be drawn about the temperature regimes in the intervening water.

With four transmitters and six receivers deployed at depth at opposite sides of a 300 x 300-kilometer square southwest of Bermuda, the system would "see" slices of the ocean, just as a medical tomographic scanner "sees" sections of the human body. A six-receiver pilot array, Munk says, should detect any cell bigger than 50 kilometers across that drifts past the array. "Acoustic tomography could give us the presence, the size and the speed of these eddies," Munk says, "in a lesss expensive, more effective manner (than the MODE-1 or POLYMODE approach)."

With a new generation of instruments—Wunsch notes that even the sophisticated devices of today are no match for the extremely energetic currents of, say, the Gulf Stream—and a new generation of computers capable of handling the stupendous number of instantaneous variables involved, oceanographers hope to fashion more realistic models of the oceans. They hope to picture not only the oceans themselves but, in ever-finer detail, the impacts the oceans have on the atmosphere—and *vice-versa.* "In the end," says Holland, "we want to have models that will allow us to predict the future course of the earth's climate, including short-term events—those that occur on time scales of a few years to a decade or two, like droughts or severely cold winters—as well as long-term developments, spanning several decades to several centuries, involving little ice ages and the like."

The National Science Foundation contributes to the support of research discussed in this article through its Ocean Sciences Division.

NOAA's Atmospheric Sciences Library and Information Services*

By Laurie Stackpole
Environmental Science Information Center

*A similar article appeared in the *Bulletin of the American Meteorological Society,* Vol. 61, No. 4, April 1980.

Gwendolyn Jackson researches the 24-volume catalog describing the atmospheric sciences collection dating from 1890 to 1977.
Robert Williams photo

A university professor of environmental studies from California needs material for a book he is writing on weather for the outdoorsman. A TV producer in Great Britain wants reports of strange weather-related phenomena for his series, *Mysterious World*; his immediate interest: showers of frogs. A landscape architect planning the gardens for the U.S. ambassador's residence in Pakistan needs to know the temperature and rainfall extremes for the selected location. A worried housewife with a new furnace wonders if the wind chill factor could be contributing to her heating problems. Planners of an astronomical observatory in Saudi Arabia want nighttime cloud cover data to help them select a favorable site. A high school student working on a science fair project wants information on the relation between sunspots and climate.

These are but a few of the problems librarians of the National Oceanic and Atmospheric Administration (NOAA) have helped solve in recent months. The books, reports, journals and data reports that are their working tools constitute a unique national resource. The atmospheric sciences collection, the focus of this article, dates from the 1970's and the early days of a National Weather Service.

The Collection

NOAA has one of the largest and most comprehensive collections of meteorological and climatological material in the world. The atmospheric sciences collection contains more than 170,000 volumes covering meteorology, climatology, hydrology, physical oceanography, and air chemistry. It includes books, documents, reports, theses, periodicals, and pamphlets. A large portion of the collection consists of published meteorological and climatological data from all over the world, much of it extending over long periods of time.

The collection contains material that predates the formal creation of a library, including many items that are unique and historically valuable. For example, an 1884 typed manuscript by Professor Cleveland Abbe (the first Federal forecaster) sketching the history of meteorology in the United States offers both an interesting perspective and sense of having bridged the gap with the past.

A perusal of the minutes of the first national meeting of Weather Bureau personnel, held in 1898, shows that in some areas "the more things change, the more they remain the same": included are two papers expressing concern over the claims of private forecasters that they could perdict the weather months in advance.

The report of the International Meteorological Congress (Leipzig 1872) leads the long list of such conference reports and proceedings in the collection. In addition, several hundred books have been officially designated as a rare book collection. Begun in the 1880's by Professor Abbe, the collection is housed in a special room where the temperature and humidity are closely controlled.

Some of the oldest and most valuable of these rare works have been restored in recent years, in an ongoing effort to assure their preservation and continued availability. Restoration is the work of a specialist. It includes deacidifying the pages, and it may require that the book be completely taken apart and resewed. Books are then rebound and placed in specially constructed protective boxes. The result is a handsome volume, which will outlast even the most carefully cared for, but untreated book.

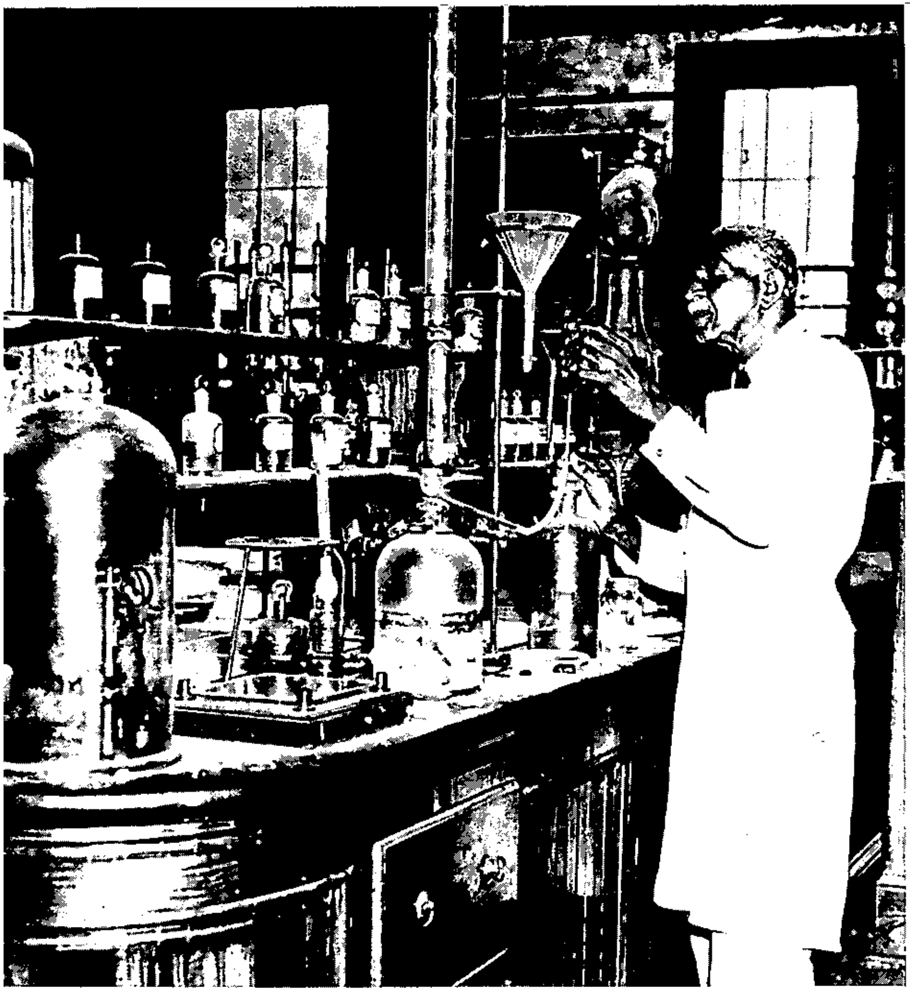
One particularly interesting book that has been restored contains the text of Aristotle's *Meteorologica*, with commentaries by St. Thomas Aquinas. It was published in Venice in 1561.

So far about 35 rare books in the atmospheric sciences collection have been restored, including Francis Bacon's *De Ventis* ("Concerning Winds"), published in 1648, and Robert Boyle's *The General History of Air* published in 1692.

The most recent addition to the rare book collection is noteworthy not so much for its age, as for its potential value as an historical record. It is a set of bound volumes containing the original daily weather observations made by American botanist George Washington Carver (Hughes, 1978). The observations were made at Tuskegee Institute and cover the period 1899 to 1932, when Carver was a volunteer cooperative weather observer.

The foreign data holdings of the library were described as a "treasure trove" by a recent visitor searching for long-term records to be used in evaluating climatic models. His particular geographic focus happened to be the USSR, but data are available for virtually every country in the world. The Russian material starts with observations from the tzarist weather station at St. Petersburg, dating back to 1838. Other holdings of special historical interest are the publications of the German "Deutsche Seewarte," starting in 1870 and containing data from around the world. Continuous records from France and England dating from the nineteenth century also are available.

Some idea of the scope and depth of the foreign data holdings can be obtained from two series of bibliographies produced from the mid-1950's through the early 1970's. One series deals primarily with climatic descriptions and data, the other covers climatic maps. Compilations concern well



George Washington Carver's daily weather observations are part of the library's rare book collection.
National Archives photo

over 100 countries and typically contain several hundred items. Although not limited to inhouse material, many (and in some cases, most) items are in the NOAA collection.

The bibliographies are one of the tools employed by the staff to help users find specific information they need. The bibliographies are subject-indexed and annotated, making them particularly helpful to those working with foreign language material.

Climatic data for the United States go back to the earliest years of record and are kept current by subscriptions to many of the publications produced by the EDIS National Climatic Center in Asheville, N.C. Two of the more extensive series received are: (1) individual monthly reports for about 300 National Weather Service stations, and (2) monthly State-by-State summaries giving data for many more locations. These records are in heavy demand, particularly when the weather conditions on a given day may have affected liability or legal issues. In one recent use, for example, agronomists from the Environmental Protection Agency were provided with weather data needed in an investigation of a pesticide spraying incident in Tennessee.

Published weather charts and maps also are collected on a regular basis. Many of these are on microfilm, which is available for onsite use with a microfilm reader-printer or for loan to other libraries.

As would be expected, the atmospheric science collection includes publications associated with the "Weather Bureau" over the years. These include not only individual reports and report series, but long-term serial publications as well. For example, *Daily Weather Maps*, the *Monthly Weather Review*, and the *Weekly Weather and Crop Bulletin* are available from their initial issues in the early 1870's. Runs of other meteorological journals also are available in their entirety. One of the oldest is the *Quarterly Journal of the Royal Meteorological Society*, which began publication in 1871.

This discussion of earlier material and data is meant to highlight some of the more unusual aspects of the collection. Now, as in earlier years, the library also continues to seek out and purchase current meteorological and climatological information. Exchange agreements with many foreign governments assure the uninterrupted receipt of weather reports, report literature, and journal publications. Blanket orders provide for library purchase of entire categories of material from essential sources, such as the World Meteorological Organization. All Government and Government-sponsored reports in meteorology, hydrology, and air pollution received by the Department of Commerce's National Technical Information Service automatically are provided to the library on microfiche. Some 350 journals, magazines, and newsletters that pertain to or support the atmospheric sciences are received regularly.

Efforts to collect all substantive meteorological books and monographs have passed a self-imposed success "test": a recent check against an earlier *AMS Bulletin* "book issue" showed that virtually all items listed were in the library collection.

An early view of the U.S. Weather Bureau library, established in 1914.

National Archives photo

Services and Products

NOAA library information and services are provided by the Library and Information Services Division of EDIS' Environmental Science Information Center. The major part of the atmospheric sciences collection is located in Rockville, Md. Specialized information and research services are provided by a smaller center in Silver Spring, Md. The Silver Spring, collection consists of books and reports acquired since 1971, as well as core materials such as classic works, Weather Bureau papers and reports, and the principal meteorological journals. It exists primarily to serve the daily needs of scientists from the National Weather Service and other NOAA components housed in the same building.

The "Weather Bureau Library" originally was established to meet such internal needs. However, from its earliest days it also played a national role in alerting the meteorological community to new publications and in making its own collection available for use.

One form this early "information transfer" took was a column published regularly from 1897 to 1940 in the *Monthly Weather Review* (MWR). New publications of interest received by the library were listed. The first column, for example, announced the receipt of meteorological data from 15 foreign countries, a trend in collection which continues to the present day. Later columns were frequently supplemented with a listing of papers published in journals and periodicals that the librarian felt were "of particular interest in connection with the work of the Weather Bureau."

Today, NOAA continues this tradition of supporting access to meteorological information. Some of the methods employed are recognizable as present day counterparts of the MWR library column; others would undoubtedly astound MWR founder Cleveland Abbe, an avid book collector and early library supporter. In the 1980's, information transfer utilizes and depends upon the capabilities of 20th century computer technology. Even the familiar monthly list of new library materials is today a computer-generated product.

New meteorological publications in the NOAA library collection are still publicly announced in a journal widely disseminated throughout the meteorological community: the AMS *Meteorological and Geoastrophysical Abstracts* (MGA). The library is used by MGA staff as a principal source of new books and reports. Each week, an MGA editor visits the Silver Spring Center where new materials are located, reviews the latest additions, and borrows those that would not otherwise be covered. After being indexed, abstracted, and classified, these items appear in MGA with the code "DAS" followed by the library's call number. These materials can be borrowed by other libraries or used onsite by individuals visiting Silver Spring.

As part of its responsibility to improve the accessibility of atmospheric information, NOAA, in cooperation with the American Meteorological Society, makes a computerized version of MGA available to the public. The MGA data base covers the years 1970 to the most recent issues, making more than 72,000 citations (as of April 1980) searchable at one time. Users throughout the United States, Canada, Western Europe, and Australia are able to dial into a host computer through local networks and search the data base using computer terminals in their offices, laboratories, or, most frequently, libraries and information centers.

Users deal directly with the company providing online access, arranging for passwords and paying for connect time and any offline printing that is requested. Search output consists of full bibliographic citations, including author, author affiliation, title, publication source, and indexing terms. For most years, abstracts also are included. As in the hard copy MGA, the holding institution, often NOAA, is usually indicated.

Since 1975, MGA has been searchable on the Lockheed DIALOG system. Searches can be requested through the Library and Information Services Division. For about $40, a search on any subject or combination of subjects can be run on MGA by an experienced information specialist. Up to 100 citations are included in this base price.

Searches (for a fee) are provided for non-NOAA requesters on a number of other data bases as well. A custom-made bibliography can be produced on any topic related to NOAA's areas of responsibility. Fees have been set to cover average search costs and vary from data base to data base. Files cover journal and report literature, ongoing research, and referral sources, and span a variety of scientific disciplines and missions. Files other than MGA of interest to meteorologists deal with agriculture, air pollution, chemistry, computers, energy, environment, geology, physics, and water resources. A booklet describing NOAA computerized information retrieval services is available on request (see below).

In certain high-interest areas, computer-generated bibliographies, called "Packaged Literature Searches," are published. These extensive bibliographies, which contain relevant information from one or more data bases, are available free to the public. Topics of meteorological interest on which bibliographies have been produced include tsunamis, tornadoes, and weather modification. Suggestions for topics are welcome.

Another publication that originates with computer searching is known as a "Current Issue Outline." Compiled for decisionmakers—administrators, legislators, public officials, environmentalists, and citizen groups—these publications provide an objective discussion of a topic of current interest, backed by a selected, annotated bibliography (Yeates and Stackpole, 1978). "Sea-Surface Temperature and Climate" is a recent title in this series. Free copies of Current Issue Outlines are available to requesters.

Other publications are more traditional in nature, although they too rely on computer technology in one way or another. A monthly listing of new materials in the NOAA collection is produced from a cataloging data base shared by many university, Government, and research libraries throughout the country. A biweekly announcement of NOAA scientific and technical publications is produced from a data base of Government and Government-sponsored reports. Both publications series are available on request.

Such "spinoff" products are a tangible benefit of NOAA's participation in major national information networks. The cataloging data base, which is used in an outline mode, tells members which institutions own a particular book or journal and allows them to use the computer to request a loan of the needed item. Prompt response is made to such requests, as well as to requests received from other organizations by mail. NOAA's library collection is thus as near and as available as a user's own library. Requests come from all types of libraries—industrial, academic, foreign, and State and Federal Government—even the library servicing the White House.

The Government reports data base mentioned above lists publications available on a continuing basis from the National Technical Information Service. The data base is searchable online and is the basis of a number of hard copy publications subscribed to by other libraries. The inclusion of NOAA reports assures that the latest results of research in meteorology, oceanography, and related fields are widely disseminated. NOAA reports are retained as part of the library collection as well. Limited quantities of new reports also are maintained and distributed as requested.

Reference services provided by the information and library staff employ a variety of approaches in responding to information inquiries (Yeates, 1977). Computerized information sources are used where practical; NOAA reports are provided when they can serve as an answer. Referral to other NOAA offices is sometimes the best solution to a problem. However, the major resource for providing answers to meteorological inquiries is the 100 year-old collection dating back to the establishment of a national weather service.

Most material in the collection is available for loan, although in some cases the physical condition of the material—its age or its size, for instance—necessitates onsite use. In Rockville and in Silver Spring stacks are open to visitors and staff can provide assistance. Study areas are available, and photocopying, subject to copyright restrictions, is permitted. The Rockville location has the master catalog for the entire collection.

To make the contents of this master catalog more widely available, a 24-volume book catalog has been produced in cooperation with a commercial publisher*. This catalog is currently available in over 25 libraries well distributed throughout the United States. The first 20 volumes cover the material acquired between 1890 and 1971, which is for the most part located in Rockville. The last 4 volumes cover newer material located in Silver Spring.

Continuing the tradition of ex-

* Please address inquiries to: G. K. Hall and Co., 70 Lincoln Street, Boston, Mass. 02111.

Laurie Stackpole (left), Maurice Galloway and Gwendolyn Jackson locate requested information from one of the numerous published weather maps that are part of the NOAA collection.

John Roseborough photo

cellence, both in service and in resources, established by the "Weather Bureau Library" has been and will continue to be a challenge. The United States has never had an official National library in meteorology to parallel those in agriculture and medicine. But because of its intrinsic connection in development of the National Weather Service and its predecessors, the atmospheric sciences collection, now residing in NOAA, has unofficially played that role. It is a national resource serving a broad constituency. Its information capabilities are at the disposal of the scientist at the cutting edge of knowledge and the student just beginning his studies, the professional with specific information requirements, and the citizen with a passing interest.

Visitors are welcome at both the Rockville and Silver Spring locations. The Rockville central facility is located at 6009 Executive Boulevard, Rockville, Md. 20852. For questions about the availability of materials or in the collection, call (301) 443-8334. Reference staff, including computer search specialists, are available at (301) 443-8330.

The Silver Spring center is located at 8060-13th Street, Room 816, Silver Spring, Md. 20910. The number is (301) 427-7800. A TTY (teletypewriter) reference service is also available at Silver Spring. Hearing-impaired persons with similar TTY-equipped phones should call (301) 427-7806.

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National Report

Social and Economic Assessment Report

In February, major mudslides in southern California caused 25 deaths and property damage in excess of $50 million.

Don Witten photo

EDIS' Center for Environment Assessment Services has begun issuing a monthly publication intended to qualitatively assess the impact of major climatic and other natural events on construction, economics and commerce, energy, food and agriculture, government and taxes, recreation and services, society, and transportation.

This monthly report considers those unusual or abnormal meteorological or geophysical events (unusual in time, location, intensity, frequency or persistence) that will likely have an impact on societal or economic activities in a special and significant manner. The report covers (1) non-violent meteorological events, including mild, unusually pleasant; poor visibilities; and temperature extremes; (2) violent meteorological events such as damaging thunderstorms, tornadoes, and tropical and winter storms; (3) meteorologically related events, particularly drought, floods, forest fires and ice jams; and (4) such geophysical events as avalanches, landslides, earthquakes, volcanoes, tsunamis, waves, tides, and shoreline erosion.

Information compiled from offices of the Environmental Data and Information Service, National Weather Service and National Environmental Satellite Service is used to construct a comprehensive monthly summarized panorama of anamalous events. Societal-effect estimates are derived from the Association of State Climatologists, current and historical abstracts from the New York Times Information Bank, and storm reports from the National Weather Service.

Oil Spill Manuals

Dr. Joseph Bishop of EDIS' Center for Environmental Assessment Services has written *A Climatological Oil Spill Planning Guide* for the New York Bight, prepared as a report to the oil-spill Regional Response Team, Third Coast Guard District.

The concept of a report of this type was developed initially during the grounding of the ARGO MERCHANT. At that time, there was no source of key environmental data related to oil spills available for regional response planning. The objective of the Guide is to provide this information in a format useful to decisionmakers.

Oil spills are a major concern associated with both offshore oil production and the movement of oil through the Mid-Atlantic Bight area. This report summarizes appropriate environmental data, discusses the movement of oil at sea, and attempts to predict the effects of oil spills for the region lying between Montauk Point, N.Y., and Cape May, N.J.

The U.S. Environmental Protection Agency has released a comprehensive *Manual of Practice for Protection and Cleanup of Shorelines* from oil spills. The two-volume manual was prepared by

Woodward-Clyde Consultants of San Francisco.

The manual is designed as a decisionmaking guide to provide the onscene coordinator (OSC) and his staff with a systematic, easy-to-apply method that can be used: (1) to assess the threat of an oil spill or the extent of shoreline contamination, and (2) to choose the most appropriate and effective shoreline protection, cleanup and restoration techniques for specific shoreline types in a given oil spill situation.

Volume I, Decision Guide gives instructions on how to gather information on a spill, to assess the type and extent of a spill, and to decide which protection and cleanup actions are appropriate. *Volume II, Implementation Guide* presents background information on oil characteristics, behavior and movement of oil, shoreline processes and sensitivity, and impacts associated with cleanup operations. The volume provides detailed instructions on how to implement various protections and cleanup procedures and presents criteria for terminating cleanup operations as well as a discussion on handling of oily wastes.

The Manual, Report #EPA-600/7-79-187a, can be obtained from the National Technical Information Service (NTIS) in Springfield, Virginia.

Global Topographic Data

The National Geophysical and Solar-Terrestrial Data Center (NGSDC) recently collated four-one degree topographic files into a convenient data set. These data originally were generated by the Scripps Institution of Oceanography, the Rand Corporation, and the Defense Mapping Agency.

The four merged files include: (1) worldwide ocean depths and continental elevations, averaged for approximately 1° squares of latitude and longitude, from the Scripps Institution. The data, consisting of 45,360 records, are based on visual estimations from contour charts; (2) a Defense Mapping Agency file compiled during the mid-1960's containing global 1° topographic data from numerous sources. This file contains 64,555 records; (3) the Rand Corporation published a topographic report in 1973 for the Defense Advanced Research Projects Agency. These data, which were on a precise 1° grid, were also based on visual estimations from contour charts; (4) based on GOES-III satellite radar altimetry, geoidal heights were computed by the Defense Mapping Agency. These data are for ocean areas between 65°N and 65°S. Each of the 28,920 records are based upon 32 altimetry points surrounding a 1° x 1° surface element. All four files can be provided on magnetic tape.

Inquiries should be addressed to: NOAA/EDIS/NGSDC, Code D621, Boulder, CO 80303. Telephone: (303) 499-1000, ext. 6376 or 6338.

New Degree Days Guidelines Available

EDIS' National Climatic Center has published *Annual Degree Days to Selected Bases*—a new publication to aid builders. This publication contains the 1941-70 annual normal heating and cooling degree days for base temperatures of 45, 50, 55, 60, and 65°F and is available only on microfiche. This is the first time that degree days have been published for a base other than 65° F. The publication was produced in response to a number of requests resulting from the Department of Energy's notification of public release of Building Energy Performance Standards imposed on builders, architects, and engineers.

Copies are available from: National Climatic Center, Federal Building, Asheville, NC 28801. Telephone: (704) 258-2850, ext. 683.

New Packaged Literature Searches

Tornadoes (No. 79-4); *Ocean Thermal Energy Conversion* (No. 79-5); and *Tsunamis* (No. 80-1) are three new Packaged Literature Searches available from EDIS' Environmental Science Information Center.

Packaged searches are broad introductions to the literature of high-interest topics, and are taken from selected data bases. They cover a limited time period of the literature and should be regarded as samplers. Each computerized literature search contains from 50 to 200 citations.

Copies 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 telephone (301) 443-8334.

New Madrid Fault Zone Profiles

About 280 km of multichannel common depth point (CDP) seismic reflection profiles now are available from the National Geophysical and Solar-Terrestrial Data Center (NGSDC). These data were obtained in the central Mississippi River Valley by Geophysical Service, Inc., and Western Geophysical Company for the U.S. Geological Survey (USGS).

The specific area of the profiles is southeastern Missouri, northeastern Arkansas, and northwestern Tennessee. The area is located in the northern part of the Mississippi Embayment. The seismic profiling was done to improve knowledge of regional geologic structure and to investigate tectonic features associated with the seismicity. Use of the seismic reflection method to describe seismogenic structures is necessary due to the thick section of quaternary, tertiary, and late cretaceous sediments that cover the Paleozoic and Precambrian rocks underlying the Embayment.

Three large earthquakes with magnitudes in the range 7 to 7.5 on the Richter Scale occurred in the study area in the winter of 1811-12,

A tree lies across a crevice following the disastrous earthquake of 1911 in New Madrid, Mo.

USGS photo (M. L. Fuller)

damaging the town of New Madrid, Missouri, and profoundly affecting the land surface. Seismicity has continued in the region at a relatively high level compared with other locations in the central and eastern United States.

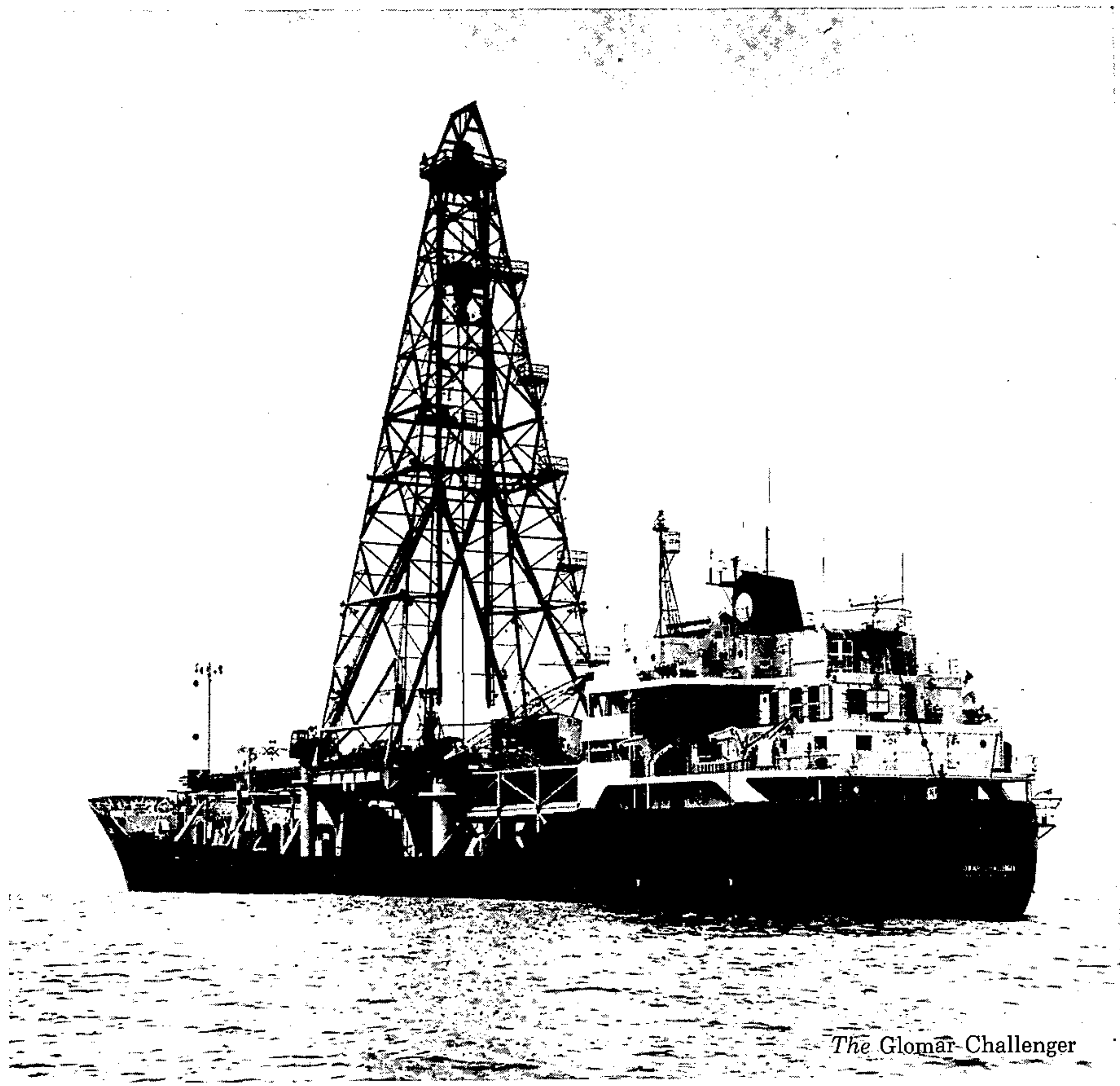
Inquiries about the profiles should be addressed to: NGSDC/NOAA/EDIS, Code D62, Boulder, CO 80303.

Marine Climatic Atlas for the South Pacific

U.S. *Navy Marine Climatic Atlas of the World, South Pacific Ocean,* Volume V, was recently published. This volume, based on nearly 125 years of data (1854-1978), is an update of an earlier atlas published in 1959 and is designed as an authoritative reference for large-scale operational planning and applied research. The volume is not a one-for-one revision. Some of the data presentations have been changed and wave statistics have been added. No upper air charts are presented, since in recent years several comprehensive volumes of upper air data have been published separately.

In 1969, the Naval Weather Service Command and Naval Oceanographic Office conducted a joint feasibility study for producing a combined climatological/oceanographic atlas of the water areas of the world. The results of the study showed a significant increase in surface marine observations since publication of the original Navy *Marine Climatic Atlas of the World.* The additional data plus recommendations for revised content and format, provided by various Naval Weather Service fleet units and field activities, warranted the updating of the entire series of marine climatic charts of the world. The data base for this revision of Volume V contains about 45 percent more data than was available when Volume V was first published in 1959.

The 350-page volume is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.



The Glomar Challenger

Geophysical Data From the Deep Sea Drilling Project

In cooperation with the Scripps Institution of Oceanography and the Deep Sea Drilling Project (DSDP) geophysical data from the DSDP are now available from EDIS' National Geophysical and Solar-Terrestrial Data Center (NGSDC). These data were collected by the drill ship GLOMAR CHALLENGAR while enroute between and in the vicinity of DSDP drilling sites.

Bathymetric, magnetic and seismic profiling data are available on 35mm microfilm for legs 4 through 64. Additionally, digital navigation, bathymetry and magnetics are available for most of the legs on magnetic tape. Details of the data are provided in NGSDC Data Announcement, 1980(H). Additional information and prices of the data are available from NGSDC's Marine Geology and Geophysics Branch, Mail Code D621, NOAA/EDIS/NGSDC, Boulder, CO 80303. Telephone: (303) 499-1000, ext. 6338, or FTS 323-6338.

International Report

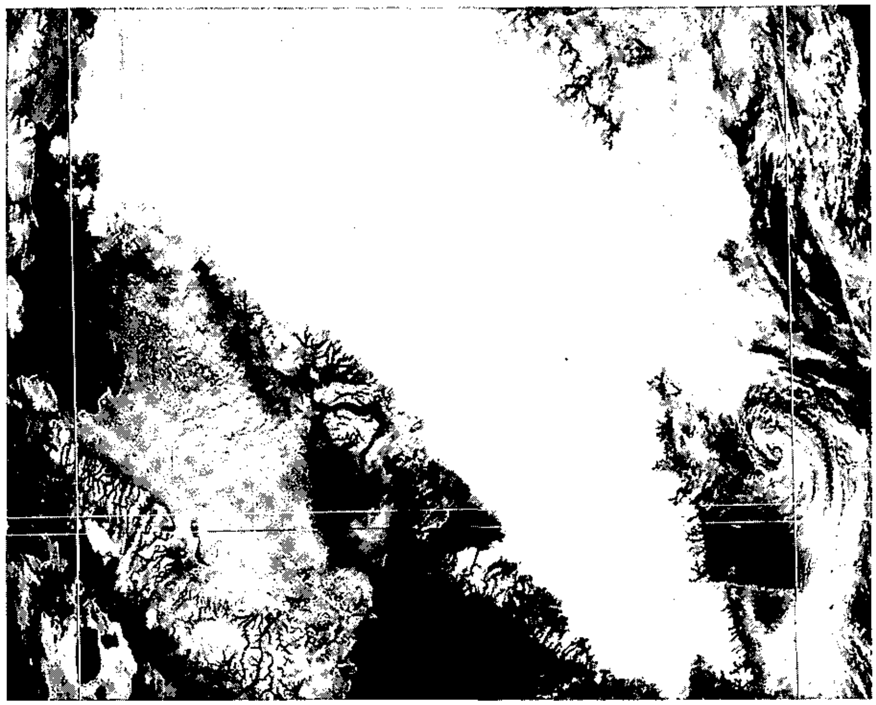
Global Inventory of Snow Cover and Sea Ice Data

Glaciological Data, Report GD-7: Inventory of Snow Cover and Sea Ice Data was published in December, 1979, by the World Data Center A for Glaciology (Snow and Ice).

This issue contains the results of a questionnaire circulated to North American and European producers of map series and cryospheric indices relating to the extent of sea ice and snow cover. In view of the global focus of both the U.S. and the World Climate Programs with respect to climate variability, the inventory includes data on global, hemispheric, and regional scales. The questionnaire dealt with the space and time coverage of each data set analyzed, and information is provided on the consistency and internal homogeneity of the various data sources and products. The format and availability of the data are described.

The publication should provide greater awareness of the available data sources and products relating to snow cover and sea ice that are of value to scientific research in the environmental sciences such as hydrology, forestry, transportation and engineering.

Report GD-7 and all other publications in the Glaciological Data series are available without charge from: World Data Center A for Glaciology, Institute of Arctic and Alpine Research, Box 450, University of Colorado, Boulder, CO 80309.



Sea ice on Baffin Bay separates Canada (lower left) from snow-and-ice covered Greenland (center) in this satellite photo.

Cooperative Seismogram Microfilming with PRC

On January 25, 1980 a Protocol for Scientific and Technical Cooperation in Earthquake Studies was signed by representatives of the National Science Foundation, the U.S. Geological Survey of the People's Republic of China in Peking. Among other exchanges in seismology, the agreement called for a cooperative program to make copies of seismograms from the 17 station national seismic network of China and to supply them to the World Data Center A for Solar-Terrestrial Physics. The World Data Center will supply a specially designed camera system and supplies to assure the high quality copies are obtained. Plans for installation of the camera will be made in the near future.

High quality copies of seismic data from the PRC have not previously been available and this data set should be of considerable interest to researchers studying the Asian continental crust and its seismicity. In recent years, China has had a series of disastrous earthquakes including a magnitude 8.0 earthquake on July 27, 1976 which killed 240,000 people and injured 164,000 more.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Environmental Data and Information Service
EDIS Magazine
Washington, D.C. 20235

OFFICIAL BUSINESS
Penalty for Private Use, $300

Postage and Fees Paid
U.S. Department of Commerce
COM-210
Controlled Circulation Rate

In this issue: *Marine science programs in the Peoples Republic of China (p. 3); motion in the ocean (p. 9); and NOAA's atmospheric library and information services (p. 17).*

EDIS

Environmental Data and Information Service
Volume 11, Number 4
July 1980

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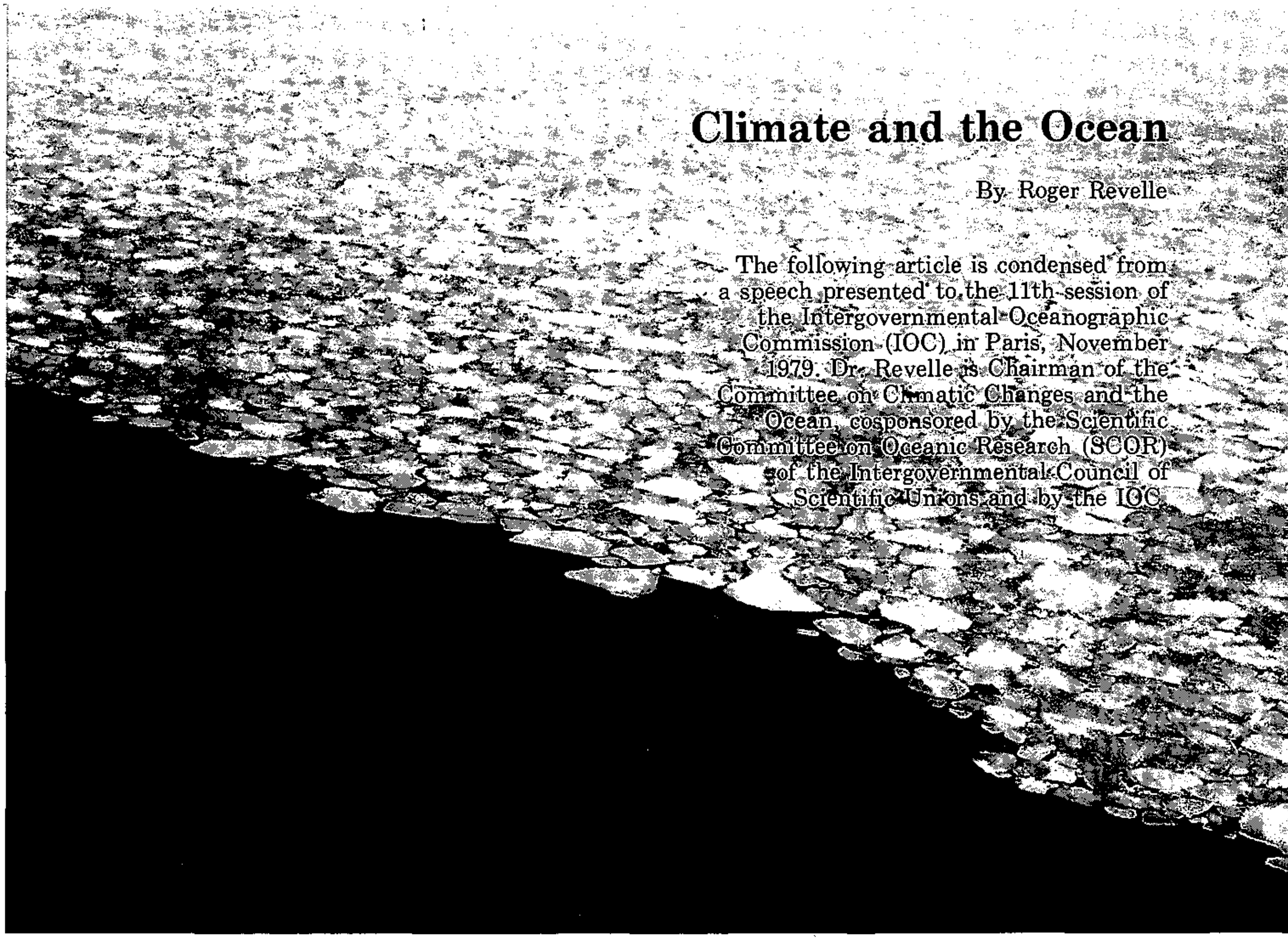
Cover: *Changes in the extent of sea ice are an important signal of changes in climate. See "Climate and the Ocean," beginning on p.3.*

EDIS is designed to inform Environmental Data and Information Service (EDIS) cooperators, colleagues, and contributors of recent developments in EDIS programs and services and in the general field of scientific data and information management. EDIS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, and Center for Environmental Assessment Services. In addition, under agreement with the National Academy of Sciences, EDIS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestrial Physics, and Glaciology (Snow and Ice).

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, April 16, 1980; this approval expires June 30, 1983.

EDIS (ISSN 0109-3365) is published bimonthly by the Environmental Data and Information Service, NOAA, Page Building 2, Room 533, 3300 Whitehaven St. N.W., Washington, D.C. 20235. For address changes, cancellation, or information write to the Editor at this address. Controlled Circulation Postage is paid to the Finance Department, USPS, Wash., D.C. 20260.



Climate and the Ocean

By Roger Revelle

The following article is condensed from a speech presented to the 11th session of the Intergovernmental Oceanographic Commission (IOC) in Paris, November 1979. Dr. Revelle is Chairman of the Committee on Climatic Changes and the Ocean, cosponsored by the Scientific Committee on Oceanic Research (SCOR) of the Intergovernmental Council of Scientific Unions and by the IOC.

During my lifetime, one of the articles of faith of oceanographers has been that the ocean somehow controls the climate—that the ocean, because of its slow response time and slow relaxation time, affects the climate over periods at least of months and possibly of years. We are getting some support for this idea from theoretical models and also from statistical analyses.

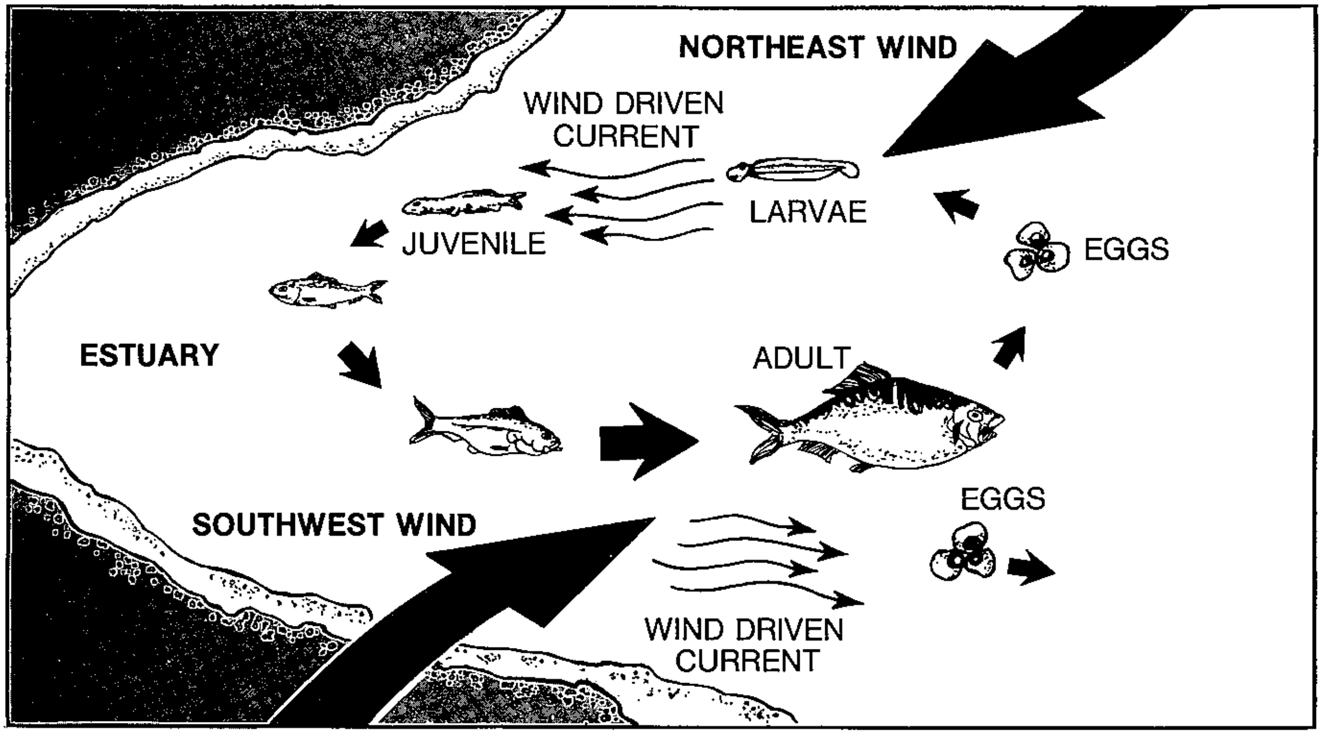
For example, there is a phenomenon called the Southern Oscillation, first discovered by Sir Gilbert Walker of the British Meteorological Office, in which there are what the climatologists call "teleconnections," that is correlations between events thousands of miles apart; the climate over a very large area from the eastern part of Africa to the west coast of South America seems to be affected by one very large-scale phenomenon. And this phenomenon is reflected in, and may be the result of, conditions in the upper layers of the western Pacific Ocean.

As another example, there is fairly good evidence that the average temperature and precipitation over North America can be predicted, even if only roughly at the present time, but nevertheless with some skill, from the anomalies of temperature over a large area of the North Pacific during the previous summer. As still another example, the intensity of the Monsoon in India, the amount of rainfall and the duration of the Monsoon, seem to be related to cooling in the Arabian Sea and this, in turn, is related to the strength, duration, velocity and transport of the Somali Current off the Horn of Africa.

Influence of Ocean Weather

Interestingly enough, it may well be that the weather in the oceans determines short-range variations of climate in the atmosphere. We are now finding in the ocean a phenomenon that has been given the name of the "mesoscale eddies." These are strictly comparable hydrodynamically to the cyclones in the temperate latitudes of the Northern Hemisphere, the cyclones being phenomena that extend over 2,000 kilometers and last for several days and which are the principal causes of weather in mid latitudes.

In the ocean, the mesoscale eddies are much smaller in spatial



Above: Northeast winds blow menhaden eggs laid at sea into estuaries for development. Southwest winds blow eggs out to sea and destruction. Right: A drifting Gulf Stream eddy over a 2 month period may reflect average atmospheric conditions.

dimensions, they are only 100-200 kilometers in diameter, but they persist for periods of up to 3-6 months. The configuration of the eddies, their location, the velocities of motion, and the temperature and heat transport, which are really the ocean weather, may be, in fact, closely related to the variations in the average conditions over several months in the atmosphere.

Similarly, at greater depths in the sea, the eddies may have effects which persist for long periods, so the ocean weather at depths of perhaps 500-1,000 meters, reflecting the mesoscale eddy phenomena in the upper layers, may persist for years and may give at least some possibility of forecasting the climate for years in advance. One of the concepts that we are starting out with is that the ocean weather lasting for a considerable time period may be related to variations in the atmospheric climate.

The climate of the ocean itself has an impact on human concerns, and in particular, we believe, on fish abundance and fish locations. The abundance is closely related to the success of the recruitment of a particular fish population and this recruitment success may be related to changes in the ocean circulation, in other words in the ocean climate. We must deal not with single species but with the entire ecosystem of the ocean as it is affected by variations in climate.

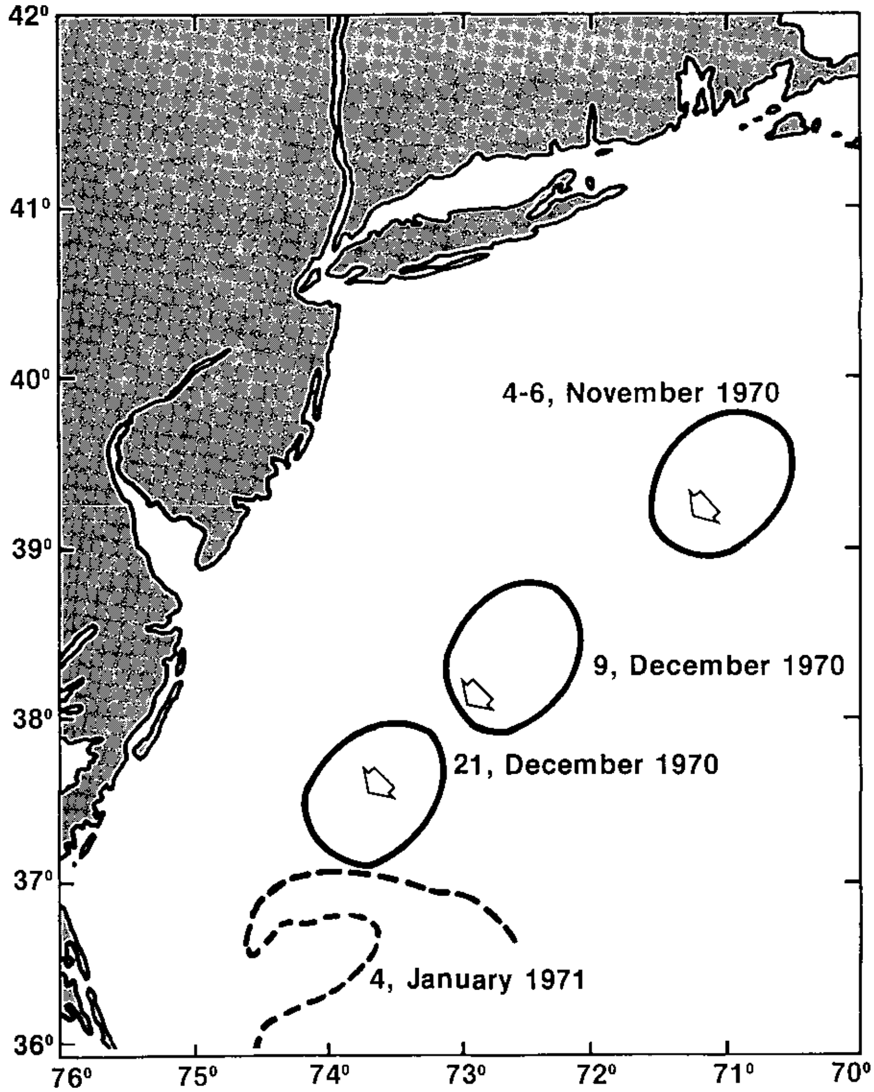
Sea Ice as Signal of Climate Change

Sea ice variation is one of the strongest signals of variations in climate in both the ocean and the atmosphere, because a very slight variation in meridional heat transport from south to north in the polar regions causes variations in the extent of sea ice, and there is a positive feedback relationship. If the sea ice extends a little bit, the albedo increases, less radiation is received, the air and water are cooled, and therefore the sea ice extends further. The problem with this positive feedback is, of course, determining what stops the ice from extending all over the ocean.

One of the important oceanographic aspects of the sea ice problem is that in those areas where sea ice is continually formed, that is in areas of divergence in the sea ice, where the sea ice is splitting and new ice is forming, the salinity of the water near the surface is increased and consequently its density is increased, with the result that bottom water formation is accelerated and amplified.

"High Resolution Paleoclimatology"

Unlike the studies that have been made up to now of ocean bottom



:ores, which give the variations of :onditions over centuries and at :he minimum over a few decades, t may be possible by studying ,ediments accumulated in certain ,pecial environments, for example, :he Black Sea or the anaerobic)asins off Southern California, to 'ind year by year variations in past :onditions as they are reflected in :he sediments.

An equally promising idea is the ,tudy of the growth rings of corals. Corals in tropical waters grow very 'ast, and we know that at least in :he Pacific the greatest variations .n ocean water temperatures, greater than the seasonal variations, are those from year to year. This should be reflected not only in the rate of growth of the individual corals but also in the ratios of oxygen 16 to oxygen 18 and of carbon 13 to carbon 14 in the carbonate laid down by these organisms. Large molluscs, like the so called man-eating clams of the Pacific, may also show the same kinds of variations in annual growth rings in the oxygen and carbon isotope ratios.

And if this idea works out, it may be possible to multiply the numbers of time-series of climate over past decades and centuries, at least in terms of the temperature and possibly the salinity of the waters near the surface in the tropical and sub-tropical areas where these large invertebrate organisms grow. It may also be possible to get some similar time-series in high latitudes from corals that live at somewhat greater depths.

Ocean and Atmospheric Models

One of the most important unsolved problems of the relationship for climate between the ocean and the atmosphere is the amount of heat transported from low latitudes to high latitudes by the ocean. We know how much heat must be transported by the ocean and the atmosphere together, because we know what amount of out-going radiation from high latitudes must be compared to the incoming radiation at low latitudes. But how much is carried in the ocean and how much is carried in the atmosphere is not known within a factor of two, and the role of the mesoscale eddies is not understood at all.

The GAGE Experiment

We have proposed what we called a "GAGE Experiment," an experiment which will probably be conducted in the North Atlantic, starting either near the Equator and going up to 25°N or starting at 25°N and going perhaps to 45°N, with east-west "fences" across the ocean at these two latitudes. The cage would, of course, have to be bounded on all sides. It would be bounded on the east and west by measurements of the meteorological processes taking place at the continental shorelines, which would tell how much heat is carried across from the sea to the land or from the land to the sea. It would have to be bounded on the top by the upper limit of the troposphere; how much radiation is going out of the troposphere and how much is coming in.

A second experiment, which will take years of preparation, will be what we have called "the global ocean circulation experiment," an actual attempt to map the currents in the upper water layers of the entire ocean. This is made possible by the existence of satellites which for the first time make it possible for us to see the ocean as a whole on virtually a day-by-day basis.

Another major decision was to accept the idea that there should be standard hydrographic sections in the ocean, along which standardized measurements should be made at regular intervals, particularly where these are of interest to more than one country. We made a list of what we called "pilot ocean monitoring sections," including several of those which have been occupied repeatedly by our colleagues from the Soviet Union; a long section along the meridian of 137°E which has been occupied for many years by the Japanese; and a similar section out from the coast to weather station PAPA which is occupied by the Canadians; and a few others.

Scientists study coral growth to determine year-to-year variations in water temperatures.

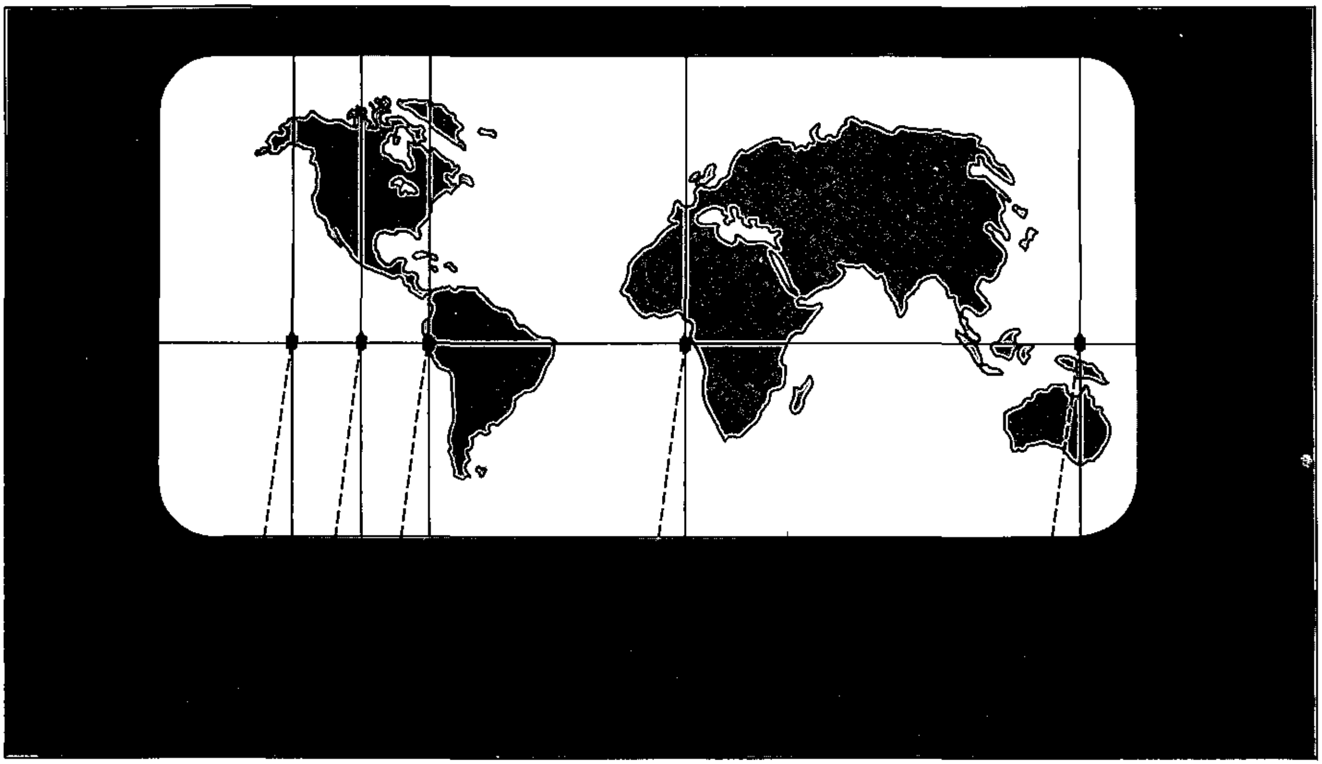
Long Time-Series of Data

We also decided on two conferences we would like to hold in the next 2 years. One would be a conference on experience that has been gained from time-series. There are a great many time-series of oceanographic measurements; for example, the Soviet Union has for nearly seventy years conducted measurements along a section which shows marked variability from year to year. Similarly, my own institution, the Scripps Institution of Oceanography, has measured the temperatures and salinities along the California Coast for about seventy years, and there are many other long time-series of observations.

But few of them, as far as I know, have ever really been examined to find out what could be learned from them. What we propose is to call a conference of people who have made these series, ask them to give us all the interpretation they can, all the ideas they can glean from these sections, and also, of course, what the unknowns still are.

The second conference would be on the impact of the oceans on global climate. We want to gain greater understanding of the ideas that I have been touching on very generally about the relationships between ocean phenomena and atmospheric phenomena in so far as climate is concerned.

We also considered the problems of data management and instrumentation. The present systems of ocean data management are inadequate from the standpoint of attempts to predict short-range variations in climate, variations from several weeks to several months, because the data do not come in soon enough. The temperature, salinity, and conductivity sounding observations from ships-of-opportunity in the North Pacific pass through about half a dozen hands with all the errors that are likely to be experienced by repeated manipulation or repeated transmission of the data.



Moreover, much of the data come in about 3 months after the observations are taken, so an attempt to use these Pacific Ocean data to say what the climate during the next season in North America will be, is completely impossible—the data are just not available until the climate is upon us. We need an automatic data transmission system for these observations so that they will be immediately transmitted to a data center where they could be compiled, manipulated and used.

Potential of Satellite Measurements

There are a whole series of exciting, new instrumental possibilities, the most important being, perhaps, those that are related to the satellites. It turns out that at least four countries or groups of countries may be putting up satellites that can observe the ocean—the European Space Agency, Japan, the Soviet Union and the United States.

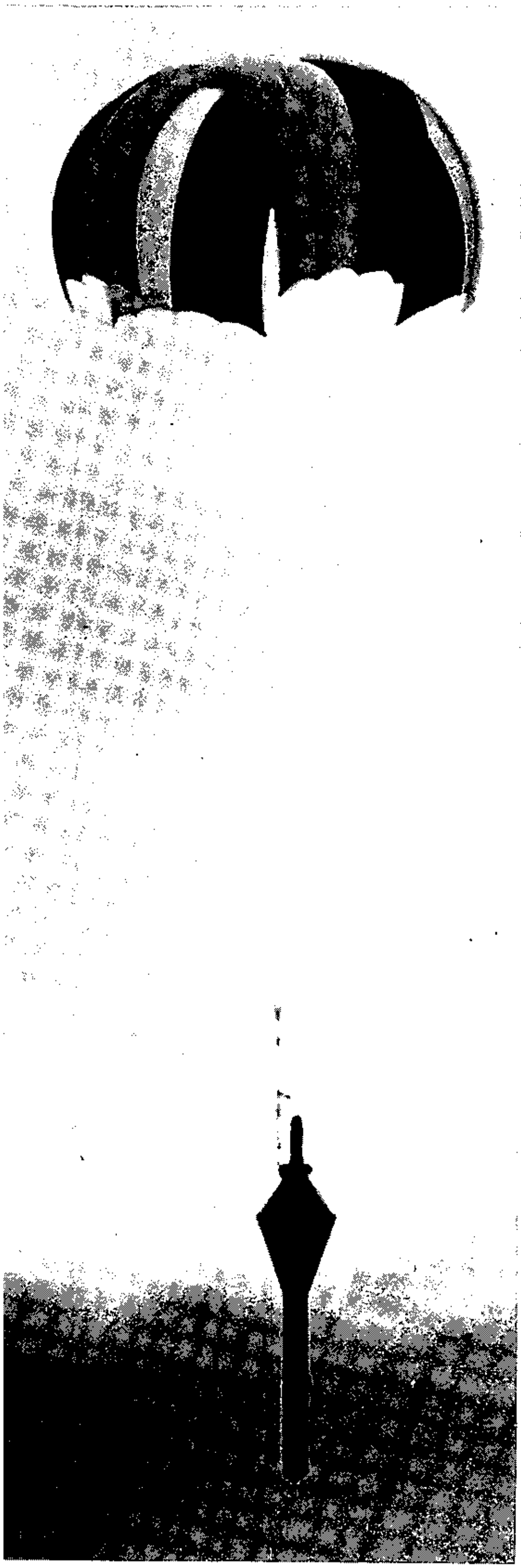
The satellites may have at least four very important measurement capabilities, the most important being the measurement of sea level. If we could map the sea level of the ocean, we would be mapping the geostrophic currents at the surface, that is the total current motion at the surface related to the pressure field. If we could at the same time know the temperature and the density distribution below the surface, and thereby the baroclinic circulation, we would have a real understanding of the large-scale motions in the oceans. The problem of the reference velocity can be solved if you have these two measurements, that is, both the surface measurements and the measurements giving the baroclinicity.

Other things that the satellites can measure are wind stress on the sea surface, currents near the surface by doppler signals of various kinds and, very roughly at the present time, the surface temper-

Geostationary satellites are providing worldwide coverage of ocean current movement.

ature. By very roughly, I mean with errors of several degrees, 2 to 3 degrees or more, due to the moisture content of the atmosphere. The problem is to correct the signal received from the sea surface by removing the part due to atmospheric moisture. We need to be able to measure the ocean temperature from satellites to within a degree Celsius because the interannual variations are of the order of a degree Celsius.

In general, with the satellites we need not ground truth but sea truth, and one of the most important kinds of sea truth will be the measurement of sea level from tide gauges. So we should have an extensive program, particularly on islands, of tide gauges installation, maintenance and operation. Member states of the IOC can contribute to this important part of the monitoring program.



A Global Weather Experiment buoy parachutes its way to the ocean surface.

One of the most successful components of the Global Weather Experiment, and of previous Global Atmospheric Research Program Experiments, has been the drifting buoys, which are now scattered, several hundred of them, all over the Southern Oceans, and they have behaved very well. Unfortunately, these buoys give only meteorological information at the present time, that is, surface ocean temperature and atmospheric pressure. What needs to be done is to develop these buoys so they will also measure the temperature of the water and maybe even the salinity of the water below the surface and the currents in the upper water layers.

One of the most successful monitoring programs of the last few years has been the use of ships- and fleets-of-opportunity, and this is related to the enormous growth in open-ocean shipping over the past 15 years. It is actually possible now to obtain fairly continuous XBT measurements over a broad area in the Pacific and also along a series of tracks across the Pacific. There are still big gaps between these tracks but it may be possible to fill these out with buoys.

Finally, the standard instrument of the oceanographer is the oceanographic research ship. One of the problems with oceanographic research ships is that they are becoming more and more expensive; the rate of increase in their cost is far greater than the rate of inflation. A ship that used to cost $800/day twenty years ago now costs $8,000/day, so that oceanographic research ships have to be carefully husbanded and used only for those things for which they are absolutely necessary. But they are absolutely necessary for many kinds of monitoring observations.

Synoptic Mapping of the Oceans

Between all of these different kinds of instruments, it should be possible, as I suggested earlier, to make ocean synoptic maps of the same kind that we now obtain of the atmosphere. Unfortunately, these maps need to be in considerably greater detail than maps of the atmosphere, because of the size of the mesoscale eddies. Here we have some hope of a new type of measurement which has been given the fancy name of acoustic tomography in honor of the two scientists who recently won the Nobel Prize for inventing X-ray tomography. Instead of X-rays, the travel time of an acoustic signal from one buoy to another will be measured.

If we have a sufficient number of buoys and a sufficient number of paths along which the sound signal is received, we can make an essentially three-dimensional map of the temperature distribution of the water within a certain level of accuracy. Here the oceanographers are utilizing the ideas, the theory and the experience of the seismologists, who have developed inverse theory as a powerful tool in understanding the interior of the Earth. It may be possible to use the same kind of theory and acoustic signals to understand the mesoscale eddies in the ocean and perhaps to arrive at statistical descriptions of these eddies, which will be sufficient for giving us forecasting skill in climate.

In concluding, let me say that there are two important aspects of the world climate problem. One is in statistics, that is the average conditions, and the variance. And second is actually the possibility of forecasting climate. We cannot forecast it now, we may never be able to forecast it, but if we could, the results would be so valuable that the gamble is worth taking.

AgRISTARS improved crop information will be used by AID to help farmers like this one in Senegal.
Photo: Agency for International Development

AgRISTARS

By Norton D. Strommen
U.S. Department of Agriculture

Introduction

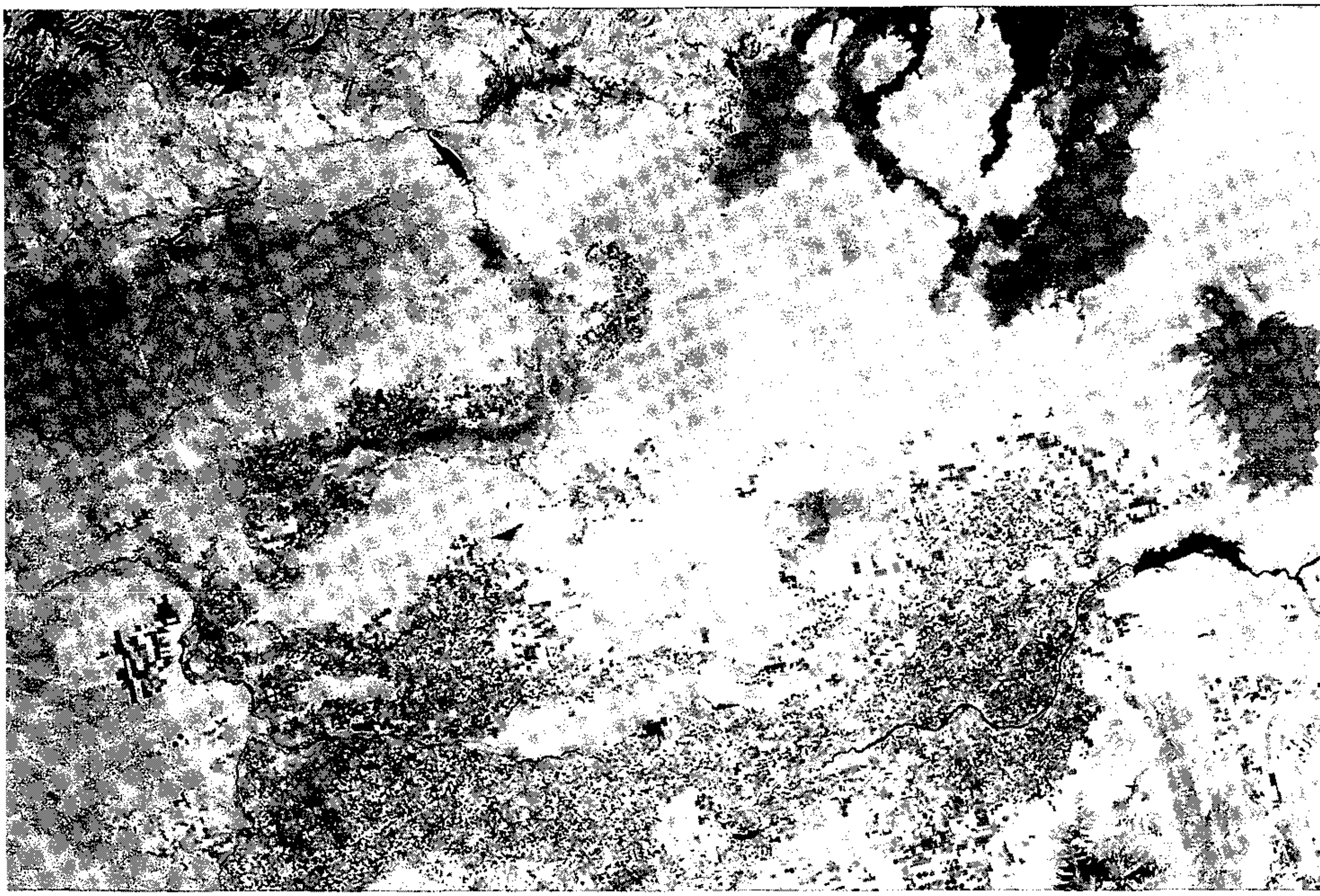
The 1970's emphasized the need for improved global commodity information. The greater variability in climatic patterns since 1972 has resulted in greater fluctuations in crop yields. The Soviet wheat shortfall in 1977 is an example where identification of crop losses was not made until U.S. wheat farmers were over five months into their marketing season. The small Brazilian soybean crop of 1978 was not correctly assessed until U.S. farmers had marketed about 60% of their soybean crop. These two short crops impacted world supplies and were responsible for a 20% price increase in wheat and a 10% increase in soybean prices.

The Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), has joined four other Federal agencies in a six-year research effort designed to determine how satellite technology can be applied to better serve the growing need of the American farmer, consumer, and businessmen for improved agricultural information.

The program is called AgRISTARS—the Agricultural Resource Inventory Through Aerospace Remote Sensing. It is designed to improve application techniques for satellite data to best meet the information needs of the U.S. Department of Agriculture (USDA). USDA, NASA, and NOAA scientists will provide AgRISTARS with expertise in agriculture, remote sensing, and meteorology. The Department of Interior, through its EROS Data Center, will provide LANDSAT remote-sensed data. In addition, the Agency for International Development (AID) will monitor progress to determine the usefulness of the research results for application in developing countries.

Goals and Objectives

The goals of AgRISTARS are to determine the usefulness and costs of the application of aerospace remote-sensing technology to a wide range of potential applications in agriculture. The program will emphasize the development of techniques to improve the objec-



tivity, reliability, and timeliness of information needed to carry out the respective agency missions of USDA and AID. This will require the development of remote-sensed data interpretation capabilities to provide early warning and assessment of changes in crop conditions, to forecast crop production, and to assist in the inventorying of land, water, and other renewable resources.

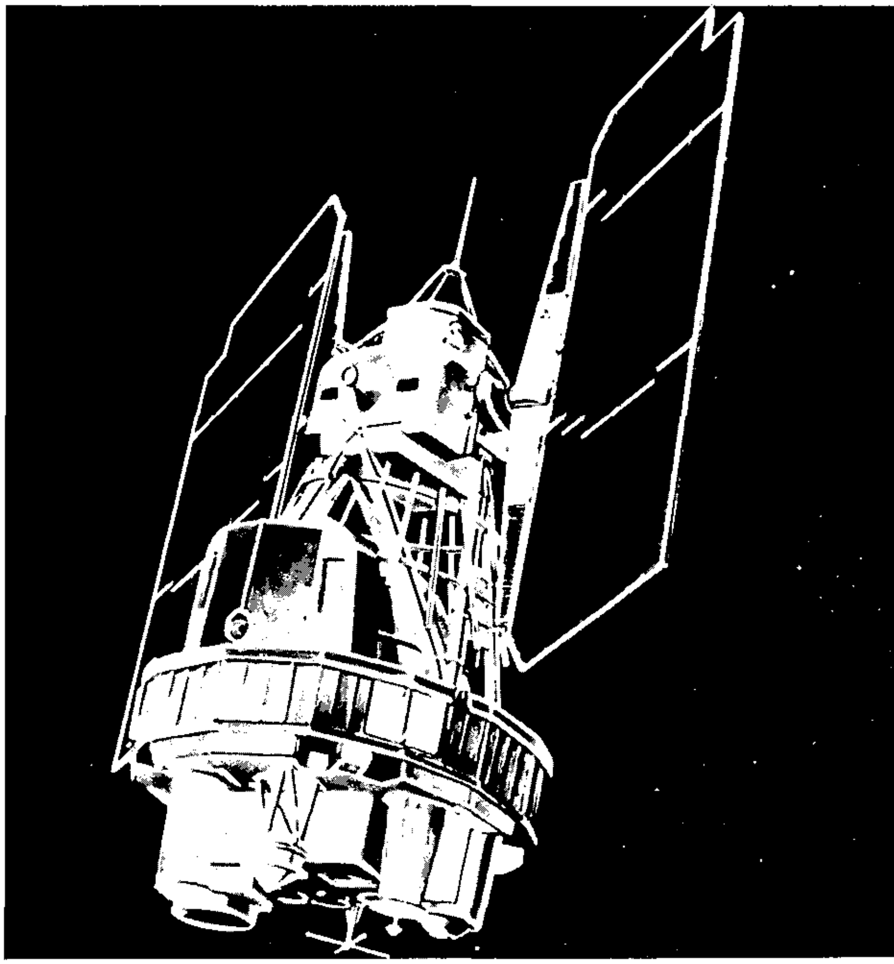
In planning AgRISTARS, the NOAA, NASA, and USDA agencies were able to draw heavily on the experience gained in an earlier project called LACIE (Large Area Crop Inventory Experiment), which dealt only with wheat. AgRISTARS will extend this work to other crops, including corn, soybeans, sorghum, sunflowers, cotton, rice, and barley. Crop-yield models will use environmental and remote-sensed data to determine the plant response characteristics to observed climatic events. The models will provide early, mid and late season (harvest) yield estimates that will help USDA to assess the progressive potential impact of cumulative weather events throughout the crop season.

LANDSAT data will be used to estimate acreage, to identify the areal extent of regions experiencing plant disease or drought stress, and to determine the crop stage of development. NOAA meteorological satellite data will be used to determine solar radiation and daily temperature extremes, to detect the areal extent of drought and untimely freeze events, and to estimate precipitation amounts. As AgRISTARS progresses, the new technology and applications developed will be transferred to support operational programs within USDA and AID.

Approach and Management

The AgRISTARS program is organized into eight project areas designed to meet the priority needs for improved agricultural information defined by the Secretary of Agriculture. These are:

- Early warning of events that may affect agricultural production (quality and quantity), and possibly impact other renewable resources.
- Commodity production forecasting.
- Land use classification and measurement.
- Renewable resources inventory and assessment.
- Land productivity estimates.
- Conservation practice assessment.
- Pollution detection and impact evolution.



Above: LANDSAT. Opposite: LANDSAT image of farmlands along the Snake River in Idaho. Farms in the lower center produce wheat, corn, barley, and other crops.

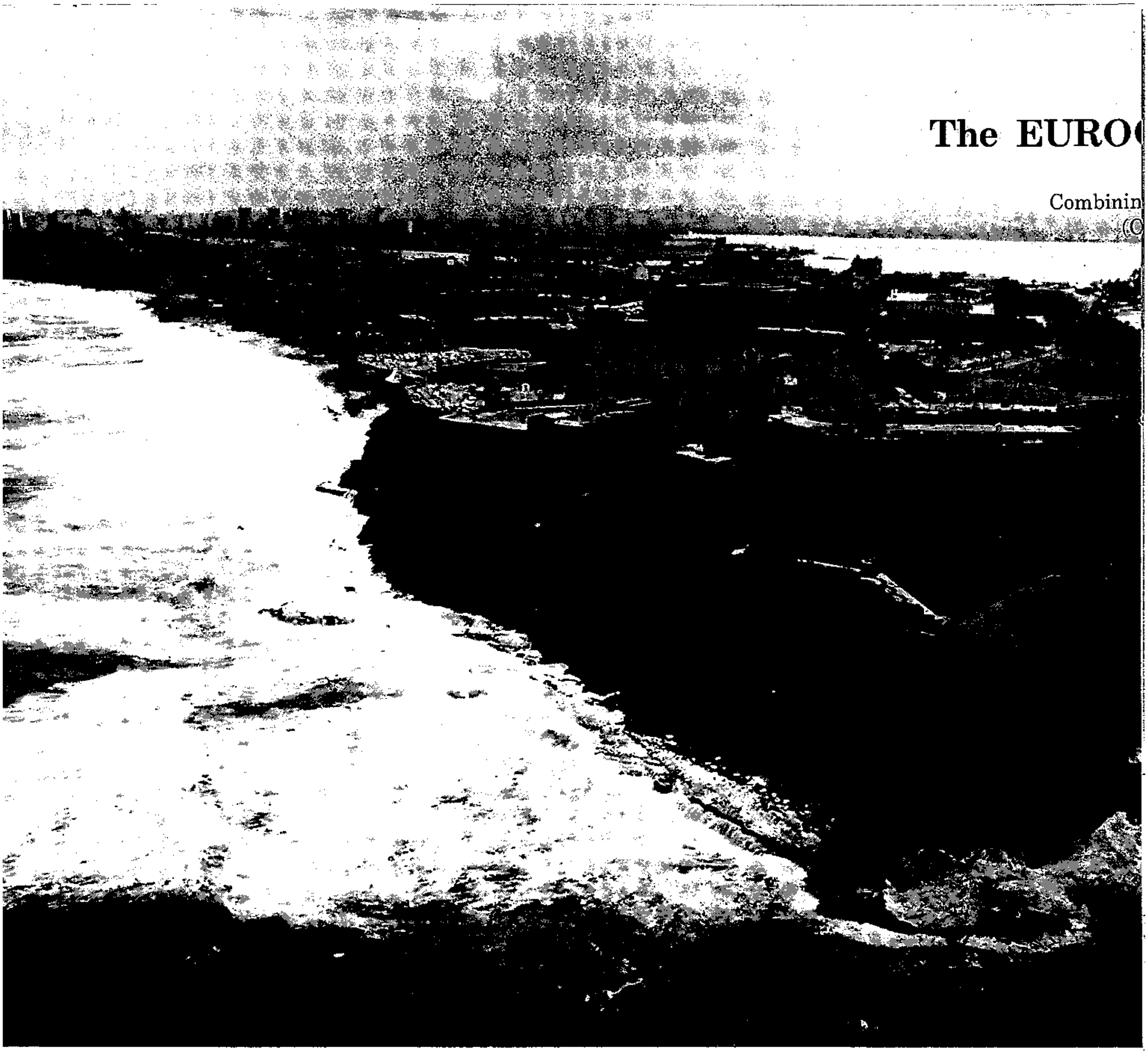
The five-agency planning effort for AgRISTARS, led by USDA, was implemented on October 1, 1979. The program will continue through September 1986. AgRISTARS will use the latest advances in remote-sensing and data processing technology. USDA has the agronomic, statistical, and economic expertise needed for this research program. NASA has the expertise to work with, and interpret remote-sensing data, and the technical data processing skills to extract the informational content from LANDSAT imagery. NOAA has the expertise to work with meteorological satellite data; to collect, process, and summarize the flow of surface-based weather observations; and to develop crop-yield models that use these data. The EROS center provides the necessary LANDSAT data and selected aircraft remote-sensing observations.

AgRISTARS will address potential remote-sensing applications for eight crops in seven countries. The initial research efforts will be tested and evaluated in the United States, where abundant ground truth information needed to verify results of new techniques are available. The technology will then be applied to foreign situations, where the greatest need for improved information exists. However, the need to improve domestic agricultural information is also great at the county and other substate levels, without having to ask farmers to complete more forms.

LANDSAT has demonstrated its ability to identify changes in forest cover, the condition of range lands, the effectiveness of conservation practices, and to measure the conversion of prime agriculture lands or citrus orchards to urban housing developments, as well as to monitor the impact of agricultural practices on water quality. NOAA's meteorological satellites have a demonstrated capability to monitor changing cloud cover (used to estimate solar radiation totals), identify areal extent of subfreezing temperatures in the citrus and winter vegetables regions, monitor changes in areal extent of snow cover, track intense storms, estimate precipitation amounts, and monitor areal extent of drought.

The research scientists assigned to the AgRISTARS program will share quarters at the Johnson Space Center, Houston, Tex., in Columbia, Missouri, and in Washington, D.C., where the major efforts to work with LANDSAT data, test and evaluate yield models and analyze meteorological satellite data are located, respectively. Field research experiments and data collection will take place at over 25 additional locations around the United States, many manned by USDA agricultural research staff working cooperatively at the Nation's agricultural universities.

AgRISTARS is designed to determine how remote sensing capabilities can be efficiently and effectively integrated with existing information systems to meet the growing need for improved agricultural information. The end user of AgRISTARS products will include people in all walks of life. As the work progresses, Americans will more fully benefit from the new technologies that have been developed during the past 10 to 15 years.



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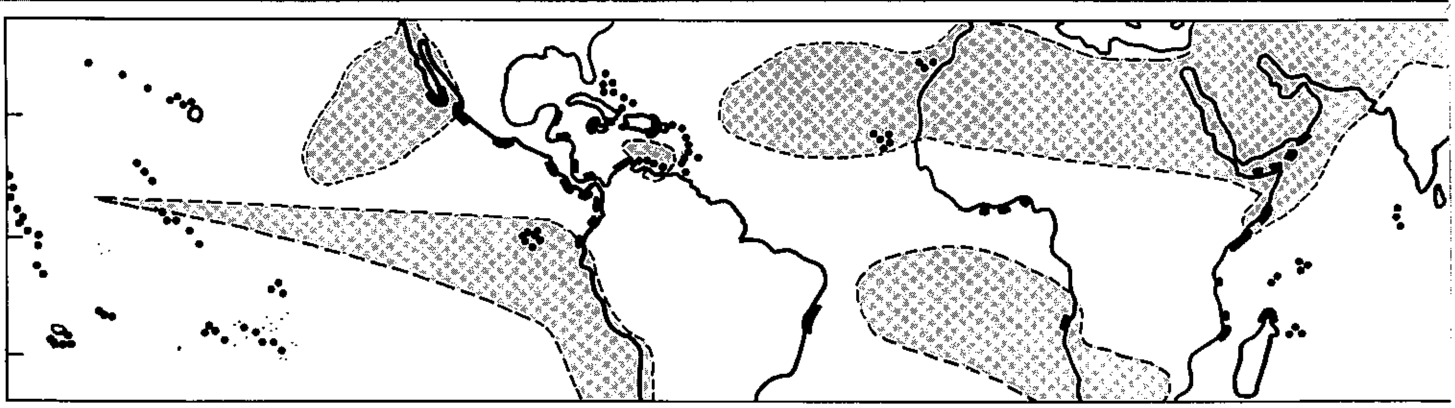
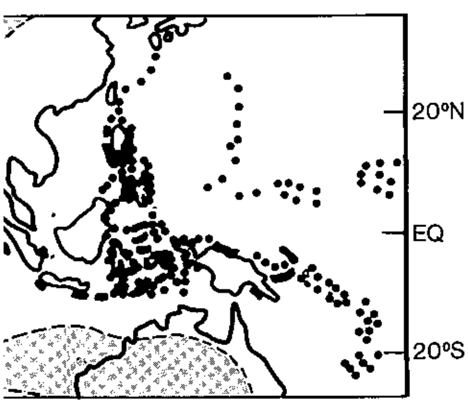


N ODA Project

ı Thermal Energy Conversion
desalination, and aquaculture.



EUROCEAN is an association of European industrial companies concerned with development of ocean resources. The following interview with J.E. van Stein Callenfels, Study Manager of the ODA feasibility study, is condensed from *Eurocean Report,* No. 2, Spring 1980, Monaco. Mr. Callenfels is a Project Engineer with Marine Structure Consultants (Bos Kalis) in Holland.

Q: Why such a combination?

A: The possibility of combining these three processes was recognized a long time ago. In fact, the first OTEC concepts from our French pioneers were designed to produce both electricity and fresh water, and if you study the phenomenon of natural upwelling in the ocean, it is clear that the deepwater which is pumped up for OTEC, because of its high nutrient content, has a potential for mariculture, and this study aims to make the maximum use of this cold water.

Q: Is the OTEC part of this ODA project comparable to similar previous OTEC designs?

A: Yes and no. For this project, we are looking at a small land-based installation rather than an offshore one. This requires a completely different design approach for the cold water pipe. The size is also different—we are thinking in terms of a 1 MW plant. The principle, however, is similar to that of its larger OTEC brothers, a closed cycle with heat exchangers and ammonia as the cycle fluid, which is technically the most developed scheme.

Above: San Juan, Puerto Rico, a possible ODA site. Left: Worldwide distribution of potential ODA sites (black dots and bars). Shading shows areas of low precipitation.

Q: How exactly can OTEC be combined with the desalination and aquaculture processes?

A: OTEC uses the temperature difference between deep and surface water and produces electricity. Desalination needs electricity for pumping and perhaps also a temperature difference to produce fresh water. Aquaculture needs the nutrients from the deep water (but at a sufficiently high temperature) and also some electricity for pumping and mixing.

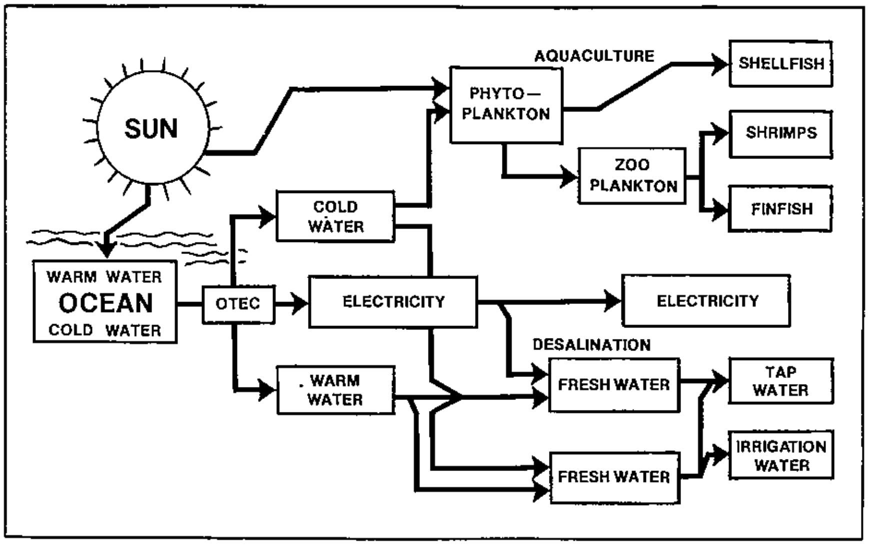
These processes can be organized in such a way that, with only the input of the Sun and ocean, a considerable range of basic products can be delivered which perfectly suit the basic requirements of, for example, small remote oceanic islands. Electricity, fresh water, drinking water, various kinds of shellfish, shrimps or even fin fish can be produced.

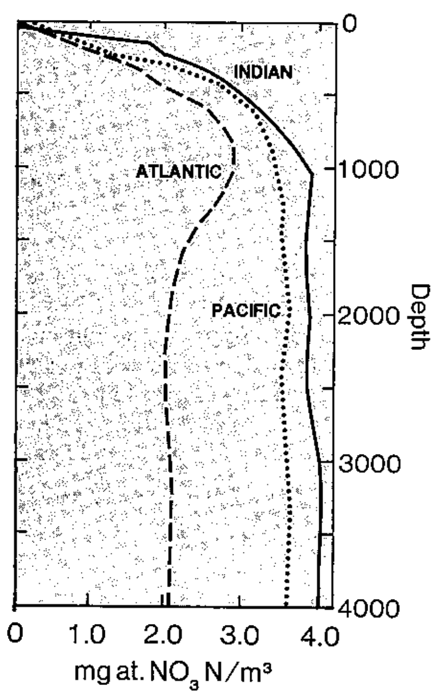
Pumping up the deep water is rather expensive and when only OTEC electricity is produced, it is not competitive with today's electricity production costs. If OTEC is combined with freshwater and fish production, the economics will become quite attractive.

Q: So you are considering remote islands?

A: Yes, but there are of course a number of requirements for a suitable site for ODA. The most important is a very steep sloping seabottom close to a protected part of the shoreline, as only this feature enables the arctic intermediate water to be pumped up from 800 meters to the shore with a relatively simple pipeline system.

Of course there must also be a demand for the products.





Above: ODA output. Left: The worldwide distribution of nitrates at 600-800m ODA water intake level is sufficient for the growth of phytoplankton.

Q: Are there other better process combinations than ODA alone?

A: Certainly there are other possibilities such as large scale air-conditioning installations, ice-making plants and various cooling applications in combination with conventional energy production or other industrial processes.

We believe, however, that the envisaged combination is the most feasible at the present time. It is also attractive because of its small size and the fact that the operation is completely self-supporting.

Q: So the freshwater and fish production can help a small OTEC plant over its cost constraints?

A: Yes. Especially on islands or areas where there is a shortage of fresh water, and where it is necessary to produce additional fresh water by the Multi-Stage Flash or the Reverse Osmosis Process, it is very attractive to produce freshwater in combination with OTEC. The principle could be called OTFP 'Ocean Thermal Flash Process (or Freshwater Production)'. It is, in fact, a low temperature flashing process of warm surface water under vacuum, followed by condensing the vapour on the surface of a deepwater cooled condenser.

Again, this process has the same constraints as OTEC—the principle is not new but no full-scale installation has yet been built. I am convinced that, within 5 years, we will have a number of these installations in operation.

Q: How is the aquaculture combined with such processes?

A: Aquaculture in general needs a large flow of clean, non-polluted water for optimum output. With an ODA installation, water is available which is not only very clean but also has dissolved nutrients in it. The AIW is perfectly suitable for culturing phytoplankton and shellfish, after its temperature has been raised sufficiently by passing through OTEC or OTFP.

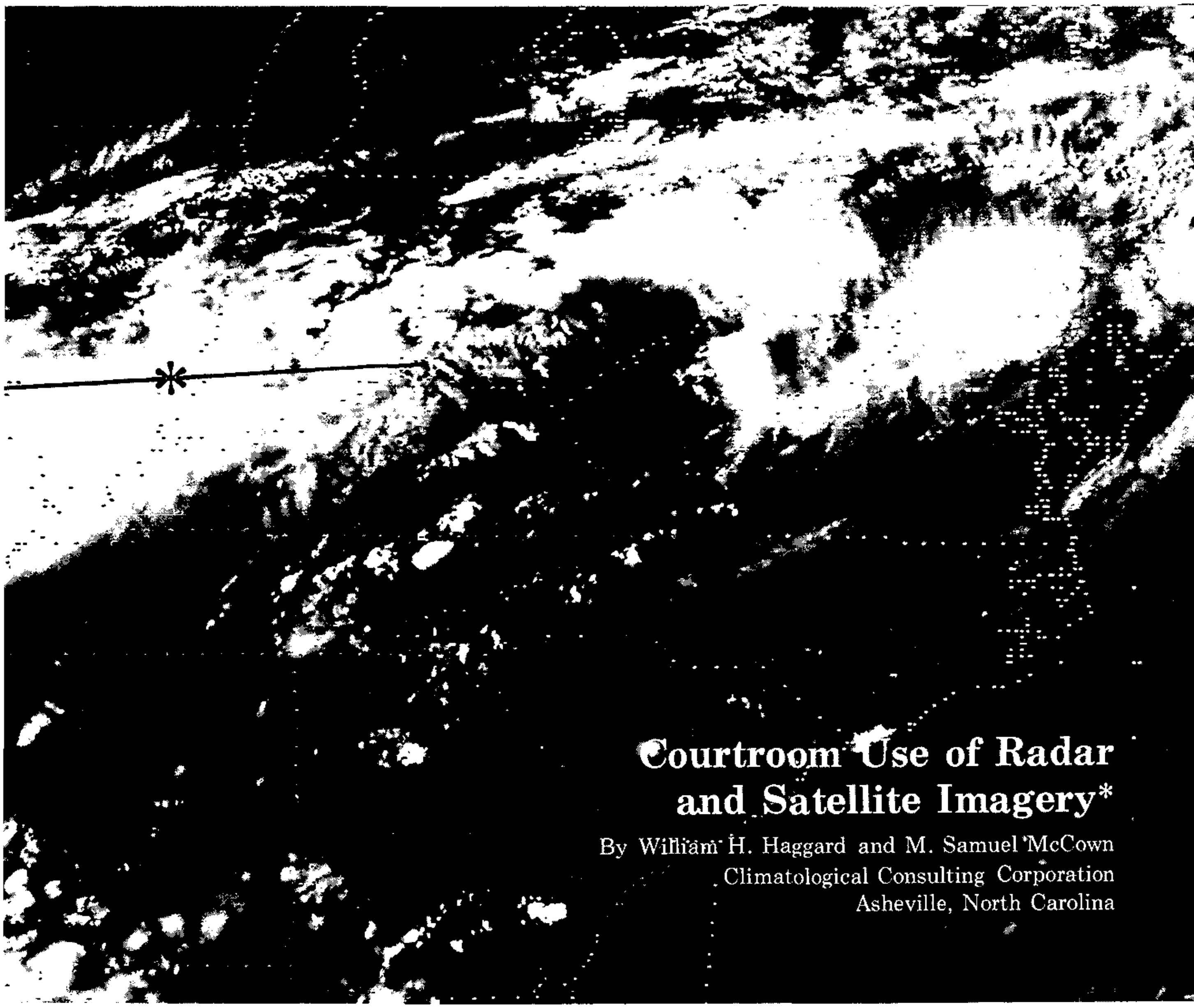
The main effort here is being directed towards finding the best solution between a highly managed, intensive system with corresponding high growth rates and a non-controlled, low investment system with growth rates which are low and difficult to predict. Biological processes are not so easy to calculate as physical processes.

Q: Is this type of aquaculture experience already available?

A: Yes, the technique of using deepwater for aquaculture is practised at the St. Croix Station in the Virgin Islands. There are no other experimental artificial upwelling programs, but these will start as soon as OTEC becomes an established method of energy production. For our ODA project, it is envisaged that the aquaculture will be in a test phase for the first years of operation.

Q: When will ODA start production?

A: We hope to have an installation running before 1985.



Satellite view of clouds over Missouri, Illinois, and Indiana. Black line shows an aircraft flight path, the asterisk marks aircraft accident site.

Courtroom Use of Radar and Satellite Imagery*

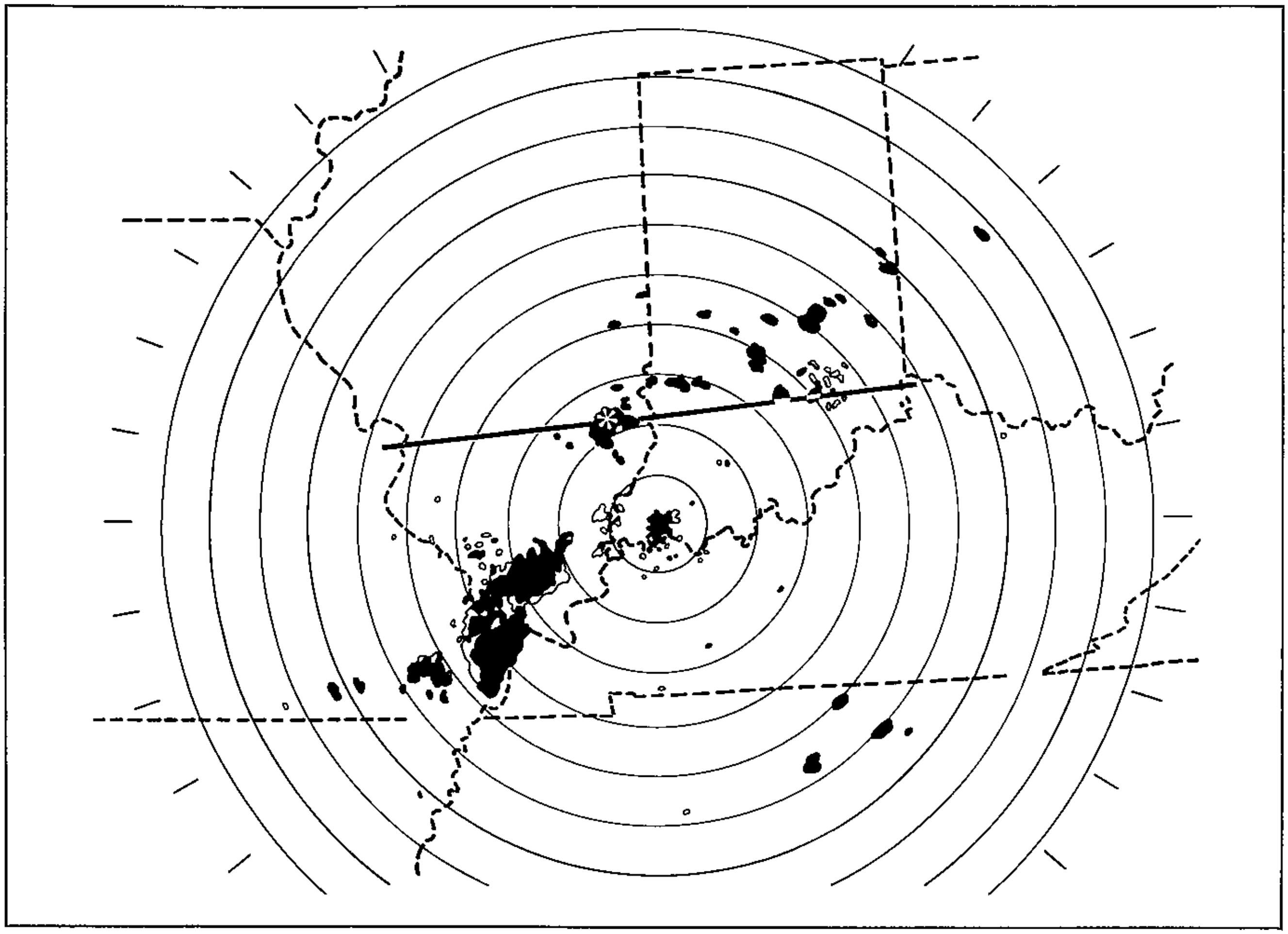
By William H. Haggard and M. Samuel McCown
Climatological Consulting Corporation
Asheville, North Carolina

Meteorologists specializing in forensic climatology soon learn that the old adage about one picture being better than 10,000 words is nowhere more applicable than during a courtroom explanation of a meteorological situation. Confronted by intelligent persons educated in other disciplines, it becomes essential to demonstrate the meteorological facts in visual representations.

Radar and satellite photography are particularly well suited for this purpose. Experience has shown us, however, that the basic photos—obtainable from the Environmental Data and Information Service of NOAA—are better understood if they are specially adapted to the circumstances of the case. This is often accomplished by combining the information of the photos with other visual representations, such as topographic features, highway maps, air routes, or even the direct relationship between features present on the separate radar and satellite photographs.

Initially we had thought 35-mm color slides projected on a screen would provide effective visuals. It did not take long to learn that, while this technique is well suited

*Condensed from Preprint Volume: Conference on Climate and Energy: Climatological Aspects and Industrial Operations, May 8-12, 1978, Asheville, N.C. Published by the American Meteorological Society, Boston, Mass.



for scientific symposia and perhaps some civic club meetings, it is quite inappropriate for many courtroom situations.

We have found that hard copy visuals of sufficient size to be clearly seen from distances of 20-30 feet, yet small enough to be transported comfortably are most effective in the courtroom. Most visuals we use are now mounted on 30 inch by 40 inch Bristol Board Display, which can be crated, air freighted, carried in cars or taxis in a (specially constructed) carrying case, set up on easels, and yet be filed (in map drawers) as part of the permanent court record. They have the added advantages that they may be readily recalled and studied in the jury room or judge's chambers.

For smaller permanent files, 8" x 10" glossy photos of the visual displays are convenient.

Often it is necessary to have a certified copy of the original radar or satellite photograph introduced as an exhibit. These are usually limited to 5" x 7", 8" x 10", 9" x 9" or 20" x 20" size when ordered from NOAA. Most courts will permit the introduction of the certified exhibit in these smaller sizes and still allow the use of the larger and more versatile visual displays as long as the meteorological witness—having been accepted by the court as an expert witness—can testify that the visuals are made by him, or under his direct supervision, from the same source material as the certified exhibits.

Radar image of part of the area shown in the satellite view (previous page) filters out weaker clouds and precipitation and reveals an intense storm at the accident site.

The certified exhibits become the official documents. The enlarged visual displays become the mechanism for communicating the content of the official documents in an effective manner to the attorneys, judge and jury.

The tying together of the wealth of detailed information preserved on film from radars and satellites greatly facilitates demonstration in the courtroom of the time, place, and intensity of significant weather in relation to events in litigation.

National Report

Winter Temperature Departure Atlas

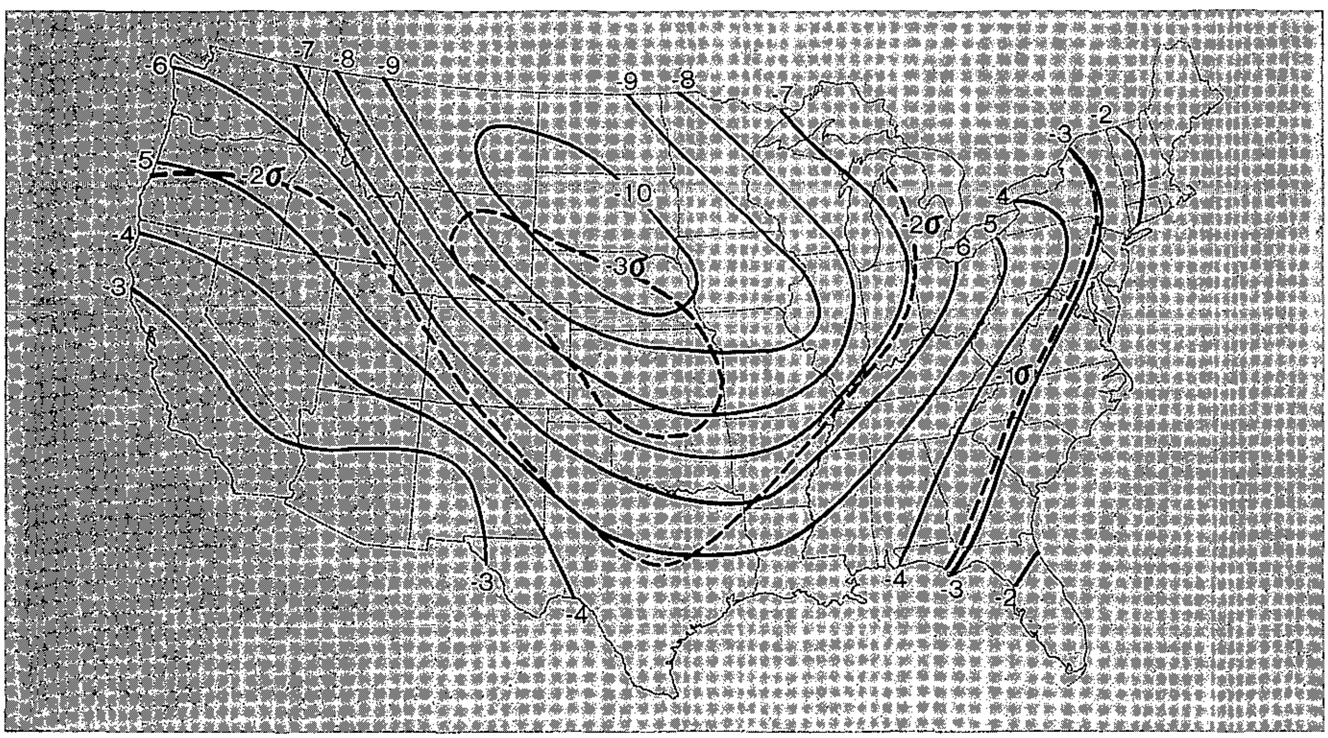
The National Climatic Center has published the *Atlas of Mean Winter Temperature Departures From the Long-Term Mean over the Contiguous United States, 1895-1979.* The purpose of the publication is to provide the many users of climatic information with a reference containing the longest available series of maps depicting the spatial distribution of winter temperature relative to the long-term mean, and to present a statistical measure of the degree of rarity of these temperature departures.

The maps are based on statewide values. Winter mean temperatures were derived for each state, by averaging together the monthly mean temperatures for December, January, and February over each season from 1894-95 to 1978-79. Standardized departures (seasonal values minus the long-term mean divided by the standard deviation) are included on the maps as an aid in assessing the relative magnitude of the seasonal departures as compared to the natural variability of the area.

Many interesting features can be noted from these maps for these 85 seasons; for instance, high interannual variability occurs in the years preceding the 1920's. A major change in the departure patterns occurs thereafter, and the frequency of below average seasonal temperatures drops off markedly until the mid-1950's. The decade of the 1940's shows remarkable quiescence by comparison with other decades, such as the 1910's and 1930's, which were periods with high winter temperature variability. The record ends with the remarkable occurrence of three of the most severe winters on record, and the occurrence, in 1978-79, of below-average temperatures over all the continguous United States.

Copies of the atlas can be obtained from the National Climatic Center, NOAA, EDIS, Federal Building, Asheville, NC 28801.

Map of mean winter temperature departures (°F, solid line) for the 1978-79 season. Dashed lines indicate departures equal to or exceeding 1, 2, or 3 standard deviations.



Acid Rain Bibliography Available

EDIS' Environmental Science Information Center provided partial funding for *Health and Environmental Effects of Acid Rain, an Abstracted Literature Collection, 1966-1979,* which contains 961 references on the subject. The abstracts were prepared for the Information Response to Chemical Crisis Project, an interagency effort of members from NOAA, the Department of Agriculture, the Environmental Protection Agency, and the Department of Health and Human Services. The group was formed after the kepone crisis to provide a coordinated multi-agency information search.

Acid "rain" can occur as rain, snow, sleet, and fog. Contaminants of primary interest are sulfuric and nitric acids, sulfates and nitrates, and ammonium. The long distance transport and deposition of acidic contaminants along air sheds has made acid rain both a regional problem and an international concern. Acid rain has been reported in Sweden, Norway, Japan, the United States, and Canada. This abstract bibliography was designed to provide researchers and other users with a collection of current information pertinent to the subject.

The acid rain literature encompasses several major topics—environmental effects, health effects, and atmospherics. Changes in terrestrial (soils, wildlife, microbes, vegetation, and structural materials) and aquatic (primarily freshwater quality and organisms) environs are considered environmental effects. Human and animal data concerning the effects of inhaling sulfuric acid, sulfates, or particulates are included, as are references to eye and/or skin irritation from these substances. Atmospherics includes the characterization of acid rain (occurrence, pH measurements, and chemistry), environmental transport of acid rain, and mechanisms of removal from the atmosphere.

References about the development and evaluation of new techniques/equipment for rain characterization, atmospheric acidity measurements, and related topics are considered in the measurement methods section. Modeling studies include all topical areas, i.e. environmental studies, health effects, and atmospherics. Papers concerned solely with sulfur dioxide transport were included only when directly concerned with atmospheric acidification.

The research directory, found at the end of the bibliography, contains information on current research projects, including the title of the project, organization conducting the research, principal investigator, sponsor, and supplementary material with brief project description. An index has been prepared for the arrangement of citations by subject category.

The publication was prepared by N.S. Dailey and S.G. Winslow of the Toxicology Information Response Center at Oak Ridge National Laboratory, Oak Ridge, Tenn., in cooperation with the National Library of Medicine. It is available from the Federation of American Societies for Experimental Biology, 9650 Rockville Pike, Bethesda, MD 20014 for $15.

Oil Spill Modeling Workshop Proceedings

EDIS has published the abstracts of invited papers presented at the U.S. Government Oil Spill Modeling Workshop held at Wallops Island, Va., November 7-9, 1979. In addition to the abstracts, the publication includes a table listing principal Federal Oil spill modeling activities by organization, principal activity, product, and user. Recommendations of participants also are included.

The workshop brought together oil spill modelers and model users from the Bureau of Land Management, the U.S. Geological Survey, the Environmental Protection Agency, Brookhaven National Laboratory, the U.S. Coast Guard, and NOAA components of NOAA's National Marine Fisheries Service, National Weather Service, Office of Marine Pollution Assessment, Great Lakes Environmental Research Laboratory, and Environmental Data and Information Service.

Workshop participants documented user needs, described ongoing modeling programs, and discussed supporting research for such efforts. The basic goals were to assure that current efforts are consistent with user needs.

A consensus among workshop participants was that a similar forum should be convened periodically to maintain a dialog between oil spill model users and modelers. The theme developed throughout the workshop was that model users should be given a more responsible role in model development. Ideally, this input should concern the type and complexity of the model.

Specific user recommendations include the development of an oil spill model user library which identifies and describes available models. Another user concern was the development of models for the long-term fate and effect of spilled oil. Users also designated the top and bottom meter of the water column as regions of primary concern with respect to nearshore impact.

Users and modelers developed the following characterization of oil spill models:

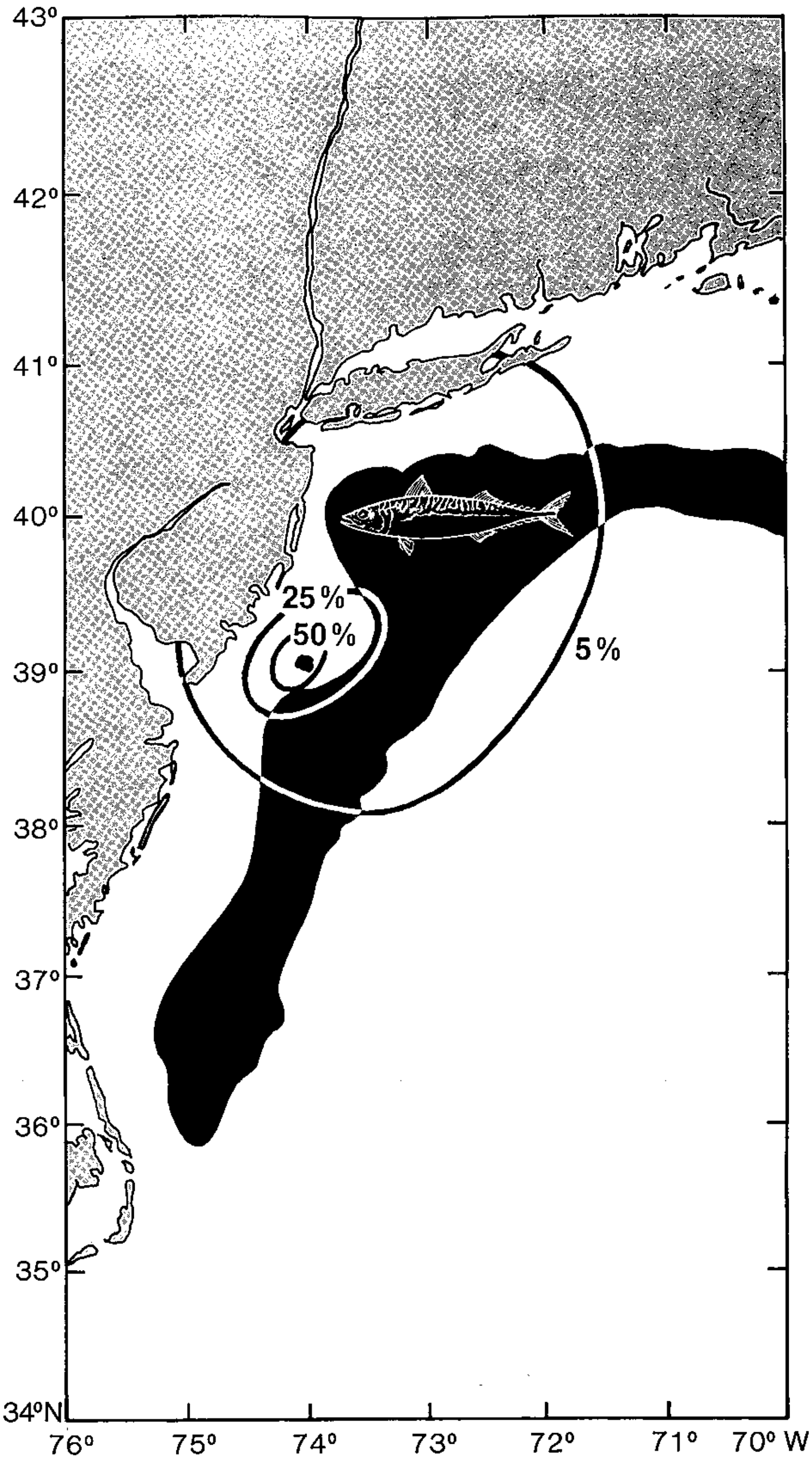
Type I models: Multiple trajectory models for long-term strategic forecasts, based on archived data,

Type II models: Single event (highly structural) models for specific day-to-day tactical forecasts, usually based on up-to-date data, and

Type III models: Type I or Type II models implemented in a receptor (reverse) mode such that one can project areas from which trajectories would impact resources.

Modelers also identified the need to incorporate data concerning oceanographic and meteorological frontal locations in future modeling efforts. The use of satellite data presents a potential solution to this problem. Improved information concerning the weathering of oil at sea was also identified as a major issue.

Single copies of the proceedings are available at no charge from Dr. Joseph M. Bishop, Environmental Data and Information Service, CEAS/MEAD, National Oceanic and Atmospheric Administration, Washington,D.C. 20235.



Planning Guide *chart of spring Atlantic mackerel habitat (black area) and projection of oil spill spread (ovals).*

Geothermal Map of Idaho

The Data Mapping Group of the EDIS National Geophysical and Solar-Terrestrial Data Center (NGSDC) recently published the map, *Geothermal Resources of Idaho*. The first of a new series of data products, the map locates probable areas for discovery of additional geothermal resources in Idaho and also advertises the current availability and uses of this relatively environmentally benign energy resource. Sixteen maps are planned for the series. The next maps will cover the States of California, Colorado, New Mexico, Montana, and Utah.

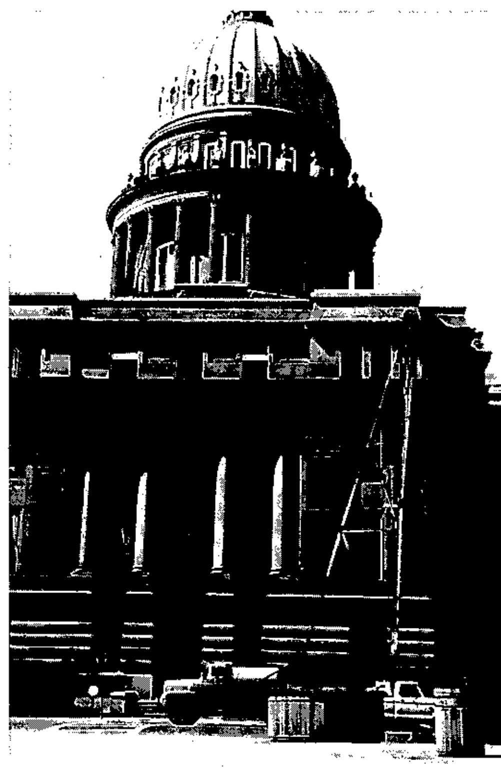
Data sets on the map include thermal springs, anomalous thermal wells, heat flow measurement points, areas having a high probability of encountering additional thermal waters, and numerous land classification items such as Native American lands, military reservations, Department of Energy lands, Forest Service lands, and protected areas such as national parks, national monuments, and wilderness areas.

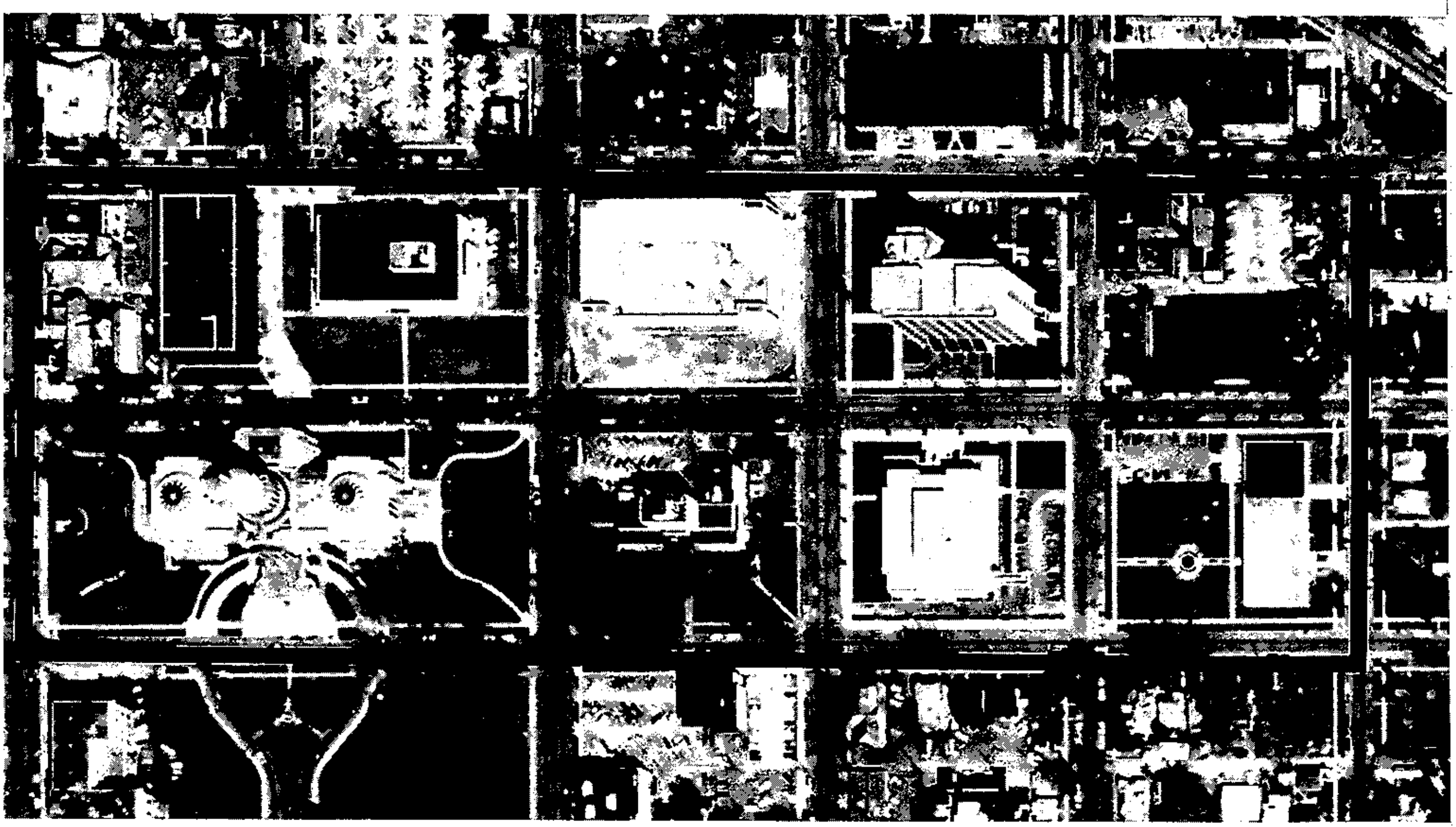
This multi-color map of Idaho, published at a scale of 1:500,000, is the prototype for "public usage" maps to follow. These maps stress data which can be of potential value to land-use planners, entrepreneurs, environmentalists, and regulatory agencies.

A followup map series stressing geotechnical information will be produced for the Earth science

Below: Idaho Capital Mall (marked-off area) in Boise is converting to heating by geothermal steam. Right: An old geothermal well near the Statehouse is used for geothermal tests.

Photo: Idaho State Office of Energy





community. These maps will display items such as tectonic features, geochemical data, and recent volcanics, as well as basic geothermal data. As pertinent data sets are received from the various Federal and State agencies, they will be used to enhance World Data Center A files for data sets such as radiometric age, dating, heat flow, earthquake epicenters, etc.

For ordering information concerning the Idaho map and publication of subsequent state mapes, contact: NOAA/NGSDC, Data Mapping Group, Code D64, Boulder, CO 80303.

Changing Concepts of Appalachian Geology

Approximately 130 km of common-depth-point seismic reflection profiles are now available for sale to the public from EDIS' National Geophysical and Solar-Terrestrial Data Center (NGSDC). The data were obtained in the Tennessee/North Carolina region for the U.S. Geological Survey (USGS). These seismic sections have proved significant in revising concepts of Appalachian geology and in developing a new "thrust-plate" tectonic model. USGS geologists believe that the model will double current areas of natural gas exploration extending from Virginia to Alabama in the Eastern Overthrust belt.

The Appalachian Mountains form a linear geologic system that trends southwestward for over 1,000 miles from New York to Alabama. In the past, the Appalachian Mountains have been divided into two main parallel parts: an eastern part, the Blue Ridge and Piedmont, composed of crystalline rocks; and a western, faulted part, commonly called the Valley, Ridge, or the Eastern Overthrust Belt and composed of sedimentary rocks. The latter area is presently being explored for natural gas.

For the first time, enough subsurface data from seismic reflection surveys have become available to test older concepts and theories that were based on surface geologic relations. Recent seismic surveys, using refined geophysical methods to probe deep into the Earth, have revealed that faulting has moved the crystalline rocks of the Blue Ridge and Piedmont westward at least 100 miles (165 kilometers), burying a large section of sedimentary rocks of the Eastern Overthrust belt.

From central Virginia southward, where the USGS data mainly are concentrated, this buried segment of sedimentary rock ranges from 10,000 to more than 20,000 feet thick and extends eastward more than 60 miles beneath the faulted crystalline rocks.

Inquiries concerning the cost and availability of the new seismic data should be addressed to: EDIS/NGSDC, Boulder, CO 80303. Telephone: (303) 499-1000, ext. 6338 or FTS 323-6338.

Maximum Rainfall Study

NOAA technical Report NWS 25, *Comparison of Generalized Estimates of Probable Maximum Precipitation With Greatest Observed Rainfalls,* is a new publication issued by the National Weather Service's Office of Hydrology. The study summarizes known storms of record for the United States east of the 105th meridian and for the region west of the Continental Divide and gives generalized estimates of probable maximum precipitation (PMP).

PMP is defined as "the theoretically greatest depth of precipitation for a given duration that is physically possible over a particular drainage basin at a certain time of year." PMP values are referred to as estimates due to gaps in understanding of the physical process responsible for extreme rainfall.

Generalized PMP estimates provide results for large regions and are presented on a series of maps or a combination of maps and computational procedures. Thus, the user can obtain PMP estimates for any basin within the range in area sizes and durations now required or expected to be required in the future.

Both local or thunderstorm PMP and general storm PMP were determined for the western states. These are both needed, since the most intense rainfalls of record in these States occur locally, rather than in connection with large-scale weather patterns that produce rains over large areas for durations of a day or more. (The area of Oregon and Washington west of the Cascade Divide is an exception.) This differs from storm experience in the United States east of the 105th meridian, where extreme rainfalls occur within general longer duration rain situations covering large areas.

PMP studies are used extensively by Federal, State and local government agencies, as well as by private companies and individuals, as a standard in planning and designing water control structures. This report lists those storms of record that are within 50 percent of PMP. Additionally, it shows ratios of point PMP values to values for the 100-year recurrence interval.

Information on the availability of this publication can be obtained from EDIS' Environmental Science Information Center (D822), Environmental Data and Information Service, 6009 Executive Blvd., Rockville, MD 20852.

New Guide to Climatic Data Sources

The National Climatic Center (NCC) has published an updated version of *Selective Guide to Climatic Data Sources.* The Guide is designed to assist potential users of climatological data (in published and unpublished form). It is arranged to show the publication(s) in which data in various climatological categories may be found. The categories include temperature, precipitation, wind, atmospheric pressure, and humidity (both surface and upper air). A brief review of pertinent historical facts about each publication is given where appropriate. The various climatological tables, charts, and graphs included in each publication also are listed. In many cases, abbreviated samples are shown.

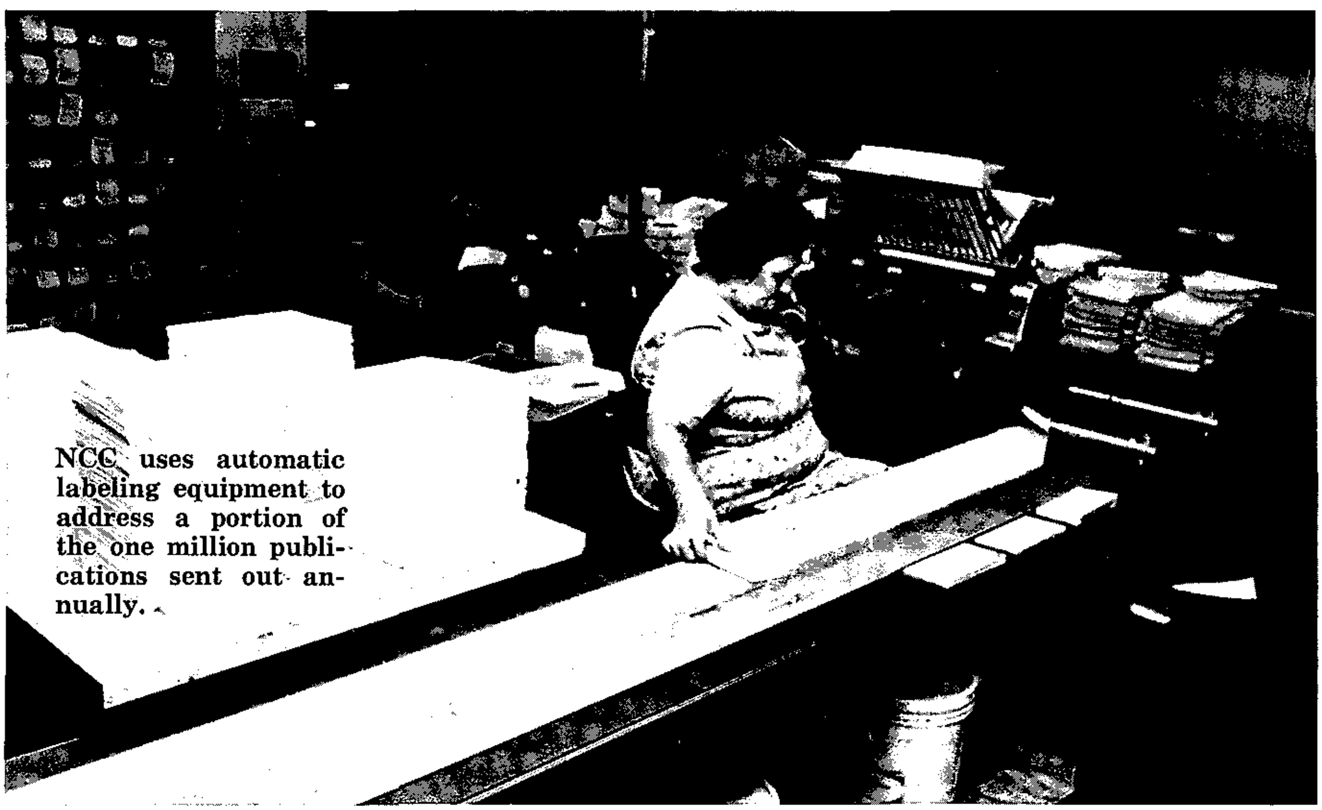
Most of the publications described in Part I are available on subscription from NCC. Subscription rates are available upon request to the Director, National Climatic Center, Federal Building, Asheville, N.C. 28801. Copies of back issue publications also are available. There is a minimum charge of $3.00 per order for shelf-stocked publications, if in print; copies of out-of-print issues can be made for a minimum charge of $5.00 per order (1979 prices). Names and addresses from which subscriptions or copies of publications not distributed by NCC may be obtained are shown where appropriate.

Several climatological atlases have been prepared by the National Oceanic and Atmospheric Administration and by agencies in the Department of Defense. The Guide provides ordering information for these publications.

Although the Guide refers primarily to published climatological data, unpublished data and/or summaries are also available from NCC. Part V describes indexes to many of these.

All back issues of NCC serial climatological publications and many one-time issues containing specialized climatic data are available on 4- by 6-in microfiche. In addition, some unpublished data compilations have been placed on 100-foot reels of 16mm film. Film copies of existing microforms or paper copies of publications can be provided as required. If microforms are desired, contact NCC (see below) to determine the availability and cost of desired materials.

The Guide is available free from the National Climatic Center, EDIS/NOAA, Federal Building, Asheville, NC 28801.



NCC uses automatic labeling equipment to address a portion of the one million publications sent out annually.

Weather Records for Europe

The National Climatic Center has published *World Weather Records, 1961-70, Volume 2, Europe.* This is the second of six volumes planned in this decennial series, which is sponsored by the World Meteorological Organization's Commission for Climatology and Applications of Meteorology.

Volume I, North America, is already available. Volumes 3 through 6 will be published as data are received from World Meteorological Organization participating members. Volume 3 will cover South and Central America, the West Indies, the Caribbean, and Bermuda; Volume 4, Asia; Volume 5, Africa; and Volume 6, Australia, New Zealand, Antarctica, Oceanic Islands, and Ocean Weather Stations.

Volume 2 presents data for about 350 stations in sequential tables. The data include monthly and annual average station pressure, average sea-level pressure, monthly and annual mean temperature, and monthly and annual total precipitation. It also contains monthly Dead Sea levels and monthly Zurich relative sunspot numbers.

Copies of Volumes 1 and 2 are available for $7.00 each from Superintendent of Documents, Order Preparation Section, Code SSOP, Washington, DC 20402.

Antarctic and Greenland Ice Soundings Available

The World Data Center-A for Glaciology (Snow and Ice), operated by EDIS' National Geophysical and Solar-Terrestrial Data Center, has acquired Antarctic and Greenland ice thickness profiles and related geomagnetic data sets. This acquisition results from an agreement with the U.S. National Science Foundation, which funded remote-sensing flights over the two areas.

Data are available in a combination of digital and/or analog forms. Cross references in time and geographical position exist for all digital and analog records. Radar soundings of ice thickness have been recorded as continuous analog traces. At present, Antarctic data are achieved for 1977-78 (25,000 km) and 1978-79, Greenland data for 1978 (18,000 km) and 1979 (19,000 km). The files will be updated as new data become available. Data may be selected for either complete flights or user-selected geographic areas.

Digital data are acquired via the Airborne Research Data System (ARDS). Original ARDS data require special software for decoding; processed ARDS data are available as a computer listing or on magnetic tape. Costs depends on the amount of digital and analog data requested and computer processing required. Specific cost estimates will be provided on request. For further information, contact: WDC-A for Glaciology (Snow and Ice), Institute of Artic and Alpine Research, University of Colorado, Boulder, CO 80309. Telephone: (303) 492-5171 or FTS 323-4311.

Electron Content Measured From Space

Report *UAG-74, ATS-6 Radio Beacon Electron Content Measurements at Octacamund, India,* has been published by the World Data Center-A for Solar-Terrestrial Physics. This data report presents an atlas of total free electron content measured along a ray signal path between the synchronous satellite ATS-6 and the Octacamund ground station in southwest India near the Earth's magnetic equator. Six investigators from the Environmental Research Laboratories' Space Environment Laboratory in Boulder, Colo., cooperated with four colleagues from India to synoptically measure the electrons.

The 51-page document contains two total electron content data sets presented in tabular and graphical form: observations taken with a digital recorder and those taken with a chart recorder. Tables of hourly values for each day and daily plots of these same hourly subsamples form the bulk of the report. The digitally recorded electron data also have been corrected for their sensitivity to sudden satellite maneuvers.

Report UAG-74 and UAG-58 in the same data report series document total electron content measurements via the ATS-6 Radio Beacon Experiment in an almost unbroken sequence from July 1974 to July 1976.

World Data Center-A for Solar-Terrestrial Physics, NOAA, Boulder, CO 80303, sells UAG-74 for $2.50 and UAG-58 for $1.04. Checks or money orders should be made payable to Department of Commerce, NOAA/NGSDC.

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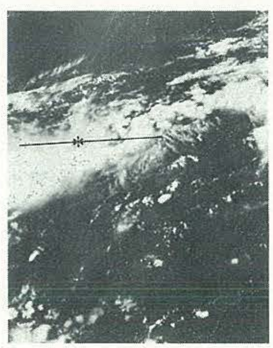

In this Issue: Climate and the ocean (p.3); agriculture evaluation by satellite (p.9); ocean thermal energy, desalination, and aquaculture project (p.12); and courtroom use of satellite and radar images (p.15).

U.S. GOVERNMENT PRINTING OFFICE: 1980—311-065/133

EDIS

Environmental Data and
Information Service
Volume 11, Number 5
September 1980

EDIS

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Volume 11, Number 5
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***Cover:** A pulp mill swirls pollution into Puget Sound. Marine pollution data and information are the subject of the first two articles.*

Photo: EPA Documerica, Doug Wilson

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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, April 16, 1980; this approval expires June 30, 1983.

EDIS (ISSN 0109-3365) is published bimonthly by the Environmental Data and Information Service, NOAA, Page Building 2, Room 533, 3300 Whitehaven St. N.W., Washington, D.C. 20235. For address changes, cancellation, or information write to the Editor at this address. Controlled Circulation Postage is paid to the Finance Department, USPS, Wash., D.C. 20260.

Managing Marine Pollution Data and Information

By Kent H. Hughes
National Oceanographic Data Center

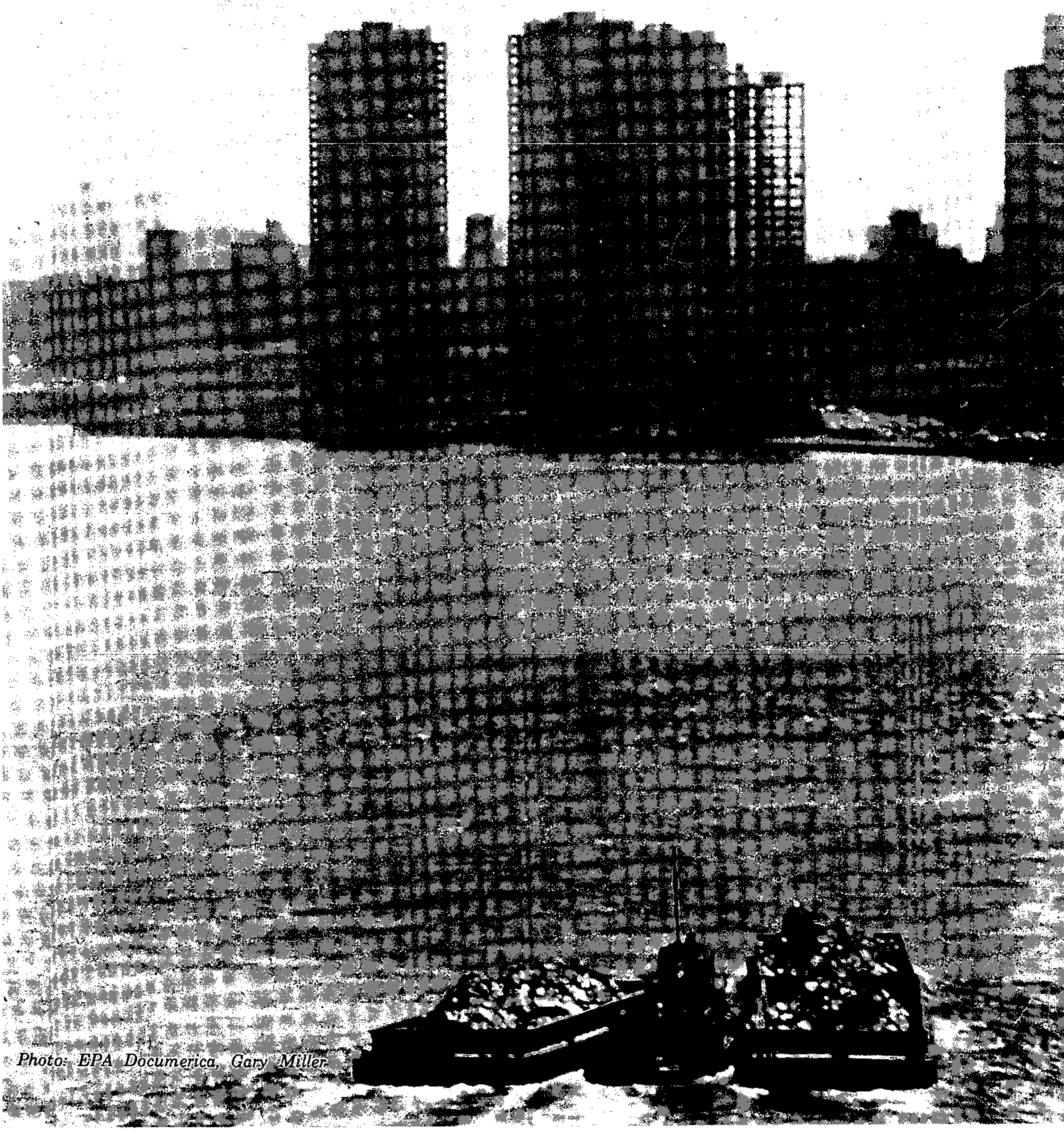


Photo: EPA Documerica, Gary Miller

Prolog

Scientific and technical data and information on marine pollution is becoming available at an alarming rate; evaluated information, however, is available only in a very limited fashion. New mechanisms and organizational arrangements spanning Federal, State, local and private lines are required to speed data and information to the user in timely and useful formats. The National Ocean Pollution Research and Development and Monitoring Planning Act of 1978 (PL95-273) provides an opportunity for effective and efficient dissemination of marine pollution data and information.

I. Introduction

In May, 1978 the President signed Public Law 95-273—the National Ocean Pollution Research and Development and Monitoring and Planning Act of 1978. The Act requires that the Executive Branch "establish a comprehensive 5-year plan for Federal ocean pollution research and development and monitoring programs in order to provide planning for, coordination of, and dissemination of information with respect to such programs within the Federal Government."

Specifically the Act requires that the plan include a detailed inventory of existing Federal programs, an assessment and ordering of national needs and programs, an analysis of the extent to which existing programs exist in meeting these priorities, recommendations for changes in the overall Federal effort where necessary, and a report on budget coordination efforts. The Act designates the Administrator of the National Oceanic and Atmospheric Administration (NOAA) as responsible for preparation of a Federal Plan for marine pollution research, development and monitoring and generally for the implementation of the Plan.

NOAA's approach to implementing the Plan was to establish an Interagency Committee on Ocean Pollution Research, Development, and Monitoring. This interagency approach has contributed significantly to Federal ocean pollution coordination by improving the dialog among Federal agencies. Importantly, this dialog provides an effective avenue for implementation of Section 8 of the Act—Information Dissemination. This Section requires that the "Administrator shall ensure that results, findings, and information regarding ocean pollution research and development and monitoring programs conducted and sponsored by the Federal Government be disseminated in a timely manner, and in useful forms, to relevant departments, agencies, and instrumentalities of the Federal Government, and to other persons having an interest in ocean pollution research and development and monitoring." The Environmental Data and Information Service through the National Oceanographic Data Center is now implementing provisions of this Section.

To improve Federal planning and coordination the Interagency Committee formulated two major goals for the Federal effort:

1. Develop and provide the information base of environmental data necessary to support rational, efficient, and equitable decisions about conservation, use, and the development of the nation's oceanic coastal and Great Lakes resources.

2. Develop and provide assessments and predictions of the state of the marine, coastal, and Great Lakes environment that are relevant for use in protecting and managing such environments.

The management of marine pollution data and information in support of these goals dictates that data and information flow should be influenced to the maximum extent possible by the need for assessments and syntheses. These in turn can be used in predicting and understanding the marine environment. The development and implementation of the Ocean Pollution Data and Information Network described below is predicated on timely flow of data from the point of generation through a series of data processing and quality control steps to the ultimate synthesis use of such data, i.e., assessments and predictions.

II. Pollutants of Concern

Ocean pollution has been defined by the Interagency Committee on Research, Development and Monitoring as follows:

> ". . . the results of human activities (that) cause, directly or indirectly, dilatory various effects on the condition of the ecosystem, hazards to human health, or reductions in socieconomic or quality of the marine environment."

Certain classes of pollutants in the marine environment were identified and discussed in the Proceedings of the Workshop on Scientific Problems Relating to Ocean Pollution, Estes Park, Colorado, July 10-14, 1978 (Working Paper No. 6) (March, 1979). With minor differences, the Estes Park report agrees with the Federal Plan for Ocean Pollution Research, Development, and Monitoring, Fiscal Years 1979-83 (August, 1979) that pollutants of concern can be grouped into the following categories:

- Petroleum and petroleum products
- Metals and inorganic chemicals
- Synthetic organic chemicals
- Artificial radionuclides
- Habitat modifications and sediment disposition
- Nutrients and biostimulants
- Cooling water use
- Micro-organisms and pathogens
- Chlorination products

Figure 1 shows the availability of certain classes of marine pollution data and information, as described in the EDIS Environmental Data Base Directory.

With respect to these classes of pollutants, the Federal Program describes two general categories of studies—generic and pollutant-specific. The former collects baseline data and defines natural processes. In FY 1978 pollutant specific studies accounted for 65 percent of the Federal Program, with generic studies accounting for the remaining 35 percent (Figure 2).

The Act also requires that the Plan establish initial priorities for the Federal Program of Ocean Pollution Research Development and Monitoring. Criteria for assigning these priorities are as follows:

- Immediacy of the pollution threat.
- Value and importance of the polluting activity to society and the economy.
- Distribution of the polluting activity whether local, regional, or global.
- Value of the resources at risk.
- Likelihood of solving the problem in the near term, availability of expertise, and cost effectiveness.

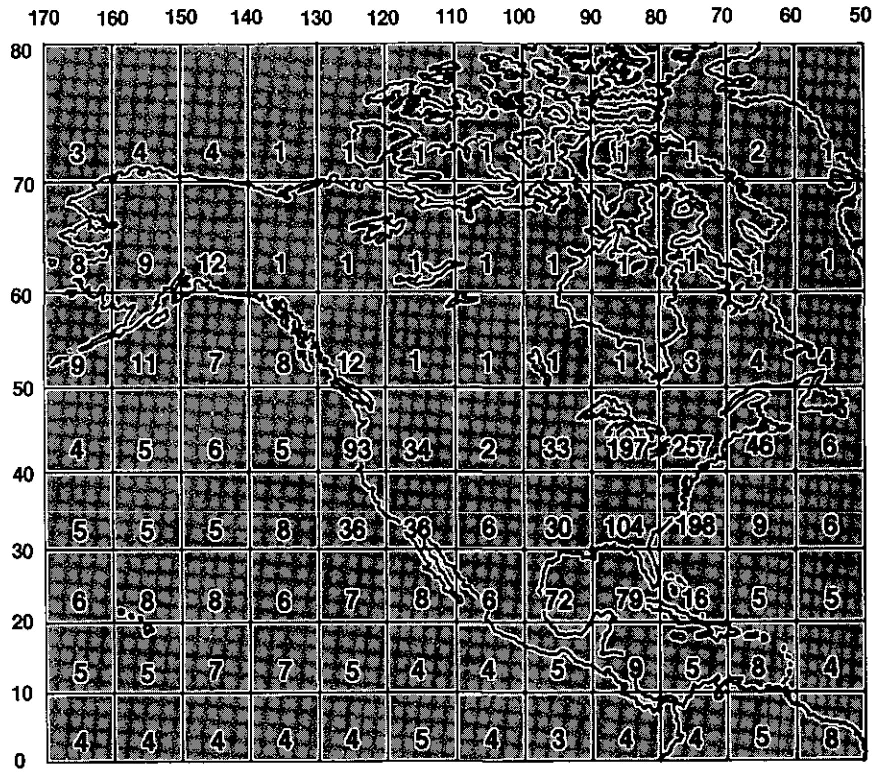


Fig. 1. Trace metal data files (1,013) described in the Environmental Data Base Directory.

III. Causes of and Tools Used to Study Marine Pollution

The ocean and coastal zone uses and activities of highest priority concern include: Land use practices, outfalls from municipal sewage disposal and industrial waste, disposal of radioactive waste, steam and electric power plants, disposal of dredge material, oil and gas.

Land based activities are by far the greatest contributor to ocean pollution. The Federal Plan divides the analysis of Federal marine pollution programs into the following categories: Coastal land use practices, waste disposal, marine energy, marine mineral resources, marine transportation, and other sources of pollution. Figure 3 shows the relative level of effort devoted to each of these activities. Major program elements required to effectively evaluate ocean pollution are research, monitoring, technology development, measurement technology, quality assurance, and data/information management. Each of the areas have been examined by the Federal Plan. Figure 4 shows the distribution of Federal budget among several of these activities.

IV. Ocean Pollution Data and Information Management

Of specific importance for managing marine pollution data and information are technical recommendations made by a Subcom-

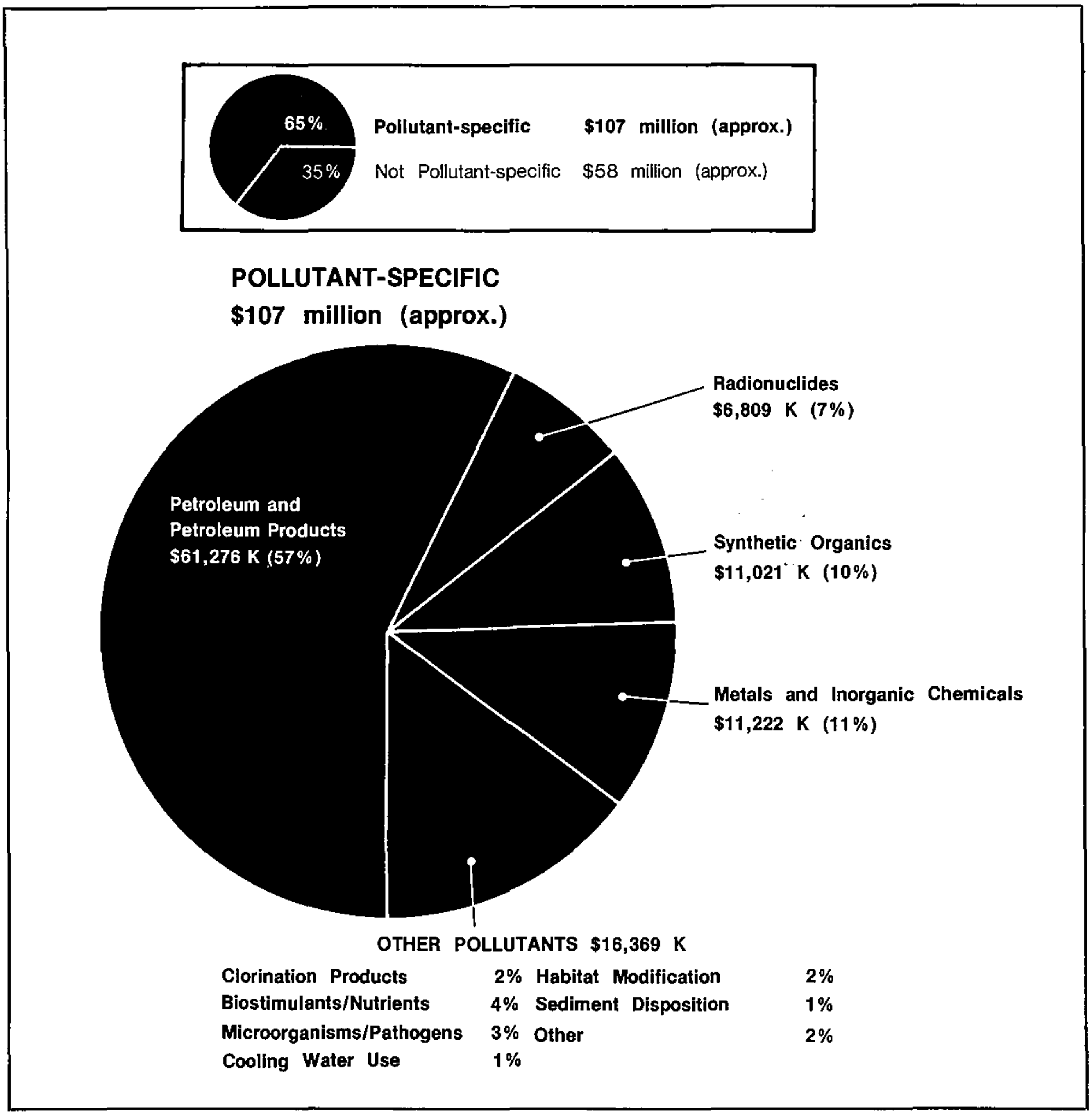


Fig. 2. FY 1978 Federal expenditures for pollutant-specific studies.

mittee of the Interagency Committee on Ocean Pollution Research Development and Monitoring. The Subcommittee on Data Collection, Storage, and Distribution (August, 1979) recommended that "to assure maximum benefit from ocean pollution research and monitoring programs information must be available in a timely manner and easy to understand forms." The following specific actions are recommended:

- Establish a programmatic (fiscal) information system for ocean research, development, and monitoring programs.
- Inventory privately funded

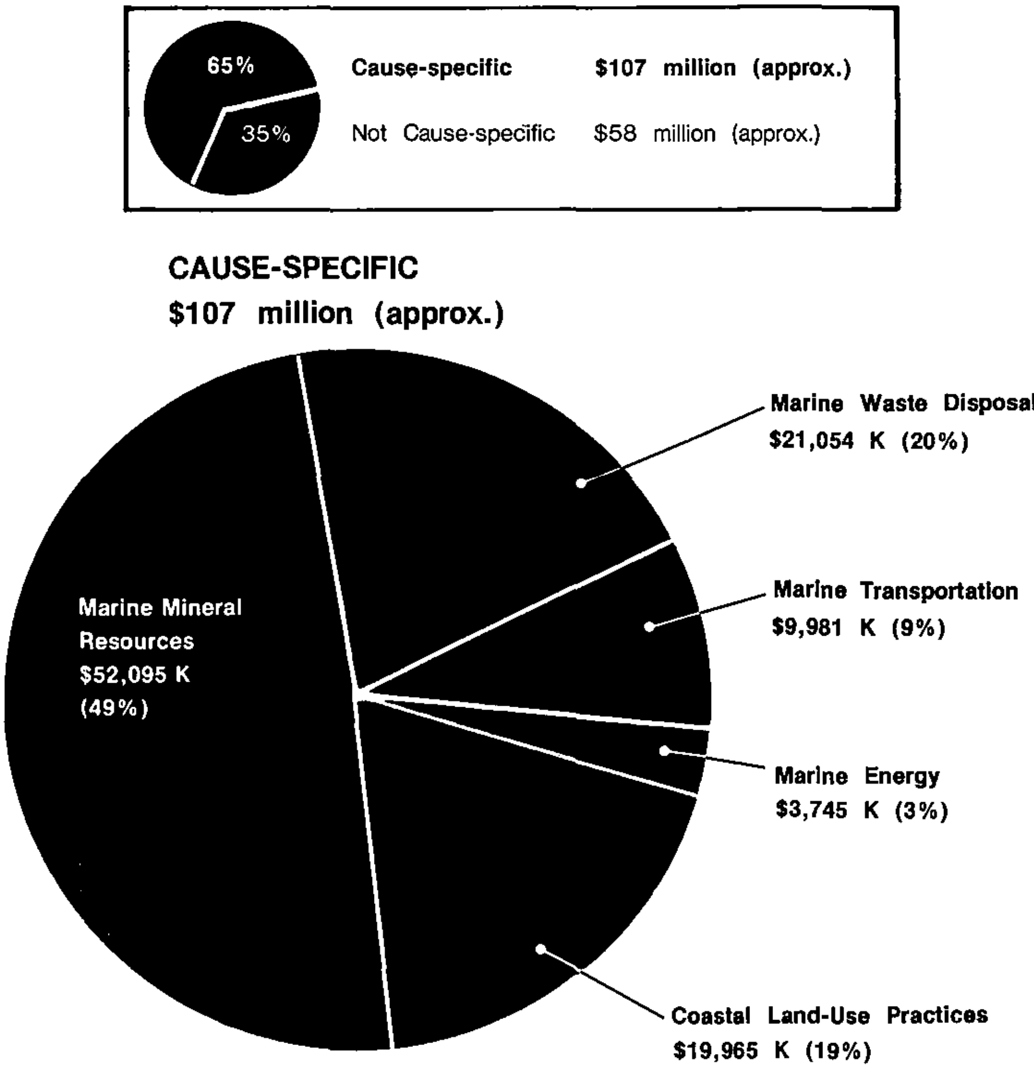


Fig. 3. FY 1978 Federal marine pollution expenditures for cause-specific studies.

programs of ocean pollution research, development, and monitoring on a regional basis. This information should be combined with the catalog of Federal Programs.

- Coordinate the network of existing environmental data centers by encouraging the use of standardized formats and reporting procedures.
- Develop a centralized capability to analyze, organize, and present results through coordination of information from diverse agencies.

- Organize and support forums for information exchange at the national and regional level, including periodic workshops and conferences.

The Administrator of NOAA delegated responsibility for implementing provisions of Section 8 of the Act to the Assistant Administrator for Oceanic and Atmospheric Services. The EDIS National Oceanographic Data Center (NODC) is, in turn, charged with managing the program of marine pollution data and information dissemination.

The NODC will establish an *Ocean Pollution Data and Information Network* (OPDIN) to plan and implement data management activities including the accessioning, processing, quality control, archiving and dissemination of marine pollution data and information. The Network will:

- build largely upon existing capabilities,
- provide responsive central coordination in marine pollution data and information affairs, and
- develop a system for synthesizing results, findings and information from individual programs into useful forms.

Three basic components of the OPDIN are proposed: A *Central Coordination and Referral Office, Subject Area Data/Information Centers*, and a *Marine Pollution Information Center*.

The *Central Coordination and Referral Office (CCRO)* will play a major role in the operation of the data and information network. The CCRO provides one-stop service to assist the public and other users in their search for data, information and synthesis products concerning ocean pollution research, development and monitoring programs. Two primary functions of this office are:

- *Coordination*: Coordination and direction will be provided by the CCRO as required to maintain smooth and efficient operation of the proposed network of data and information centers; and
- *Referral*: A central referral point is needed where the public can be supplied with or receive direction regarding ocean pollution data and information needs.

The Central Coordination and Referral Office will refer requesters of ocean pollution data and information to the best supplier of such information, which in many cases would be a Subject Area Data/Information Center. The CCRO will have broad access to bibliographic material generated by marine pollution programs, and to marine literature, regardless of discipline. The Office will have access to inventories of ocean-related environmental data resources, generally by automated systems, and will have its own automated files and directories for purposes of referral. The CCRO will work closely with the National Marine Pollution Program Office, the NOAA Office of Marine Pollution Assessment, the EDIS Center for Environmental Assessment Services, and other interested parties in the development of marine data synthesis procedures and products. These products are generally the

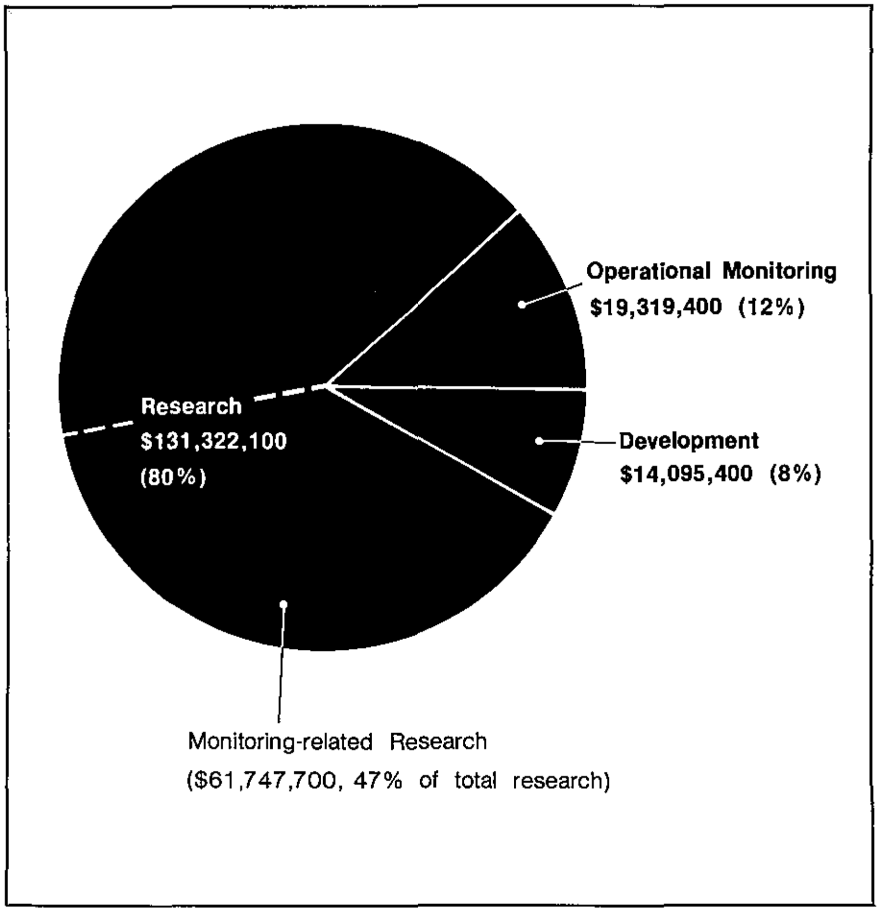
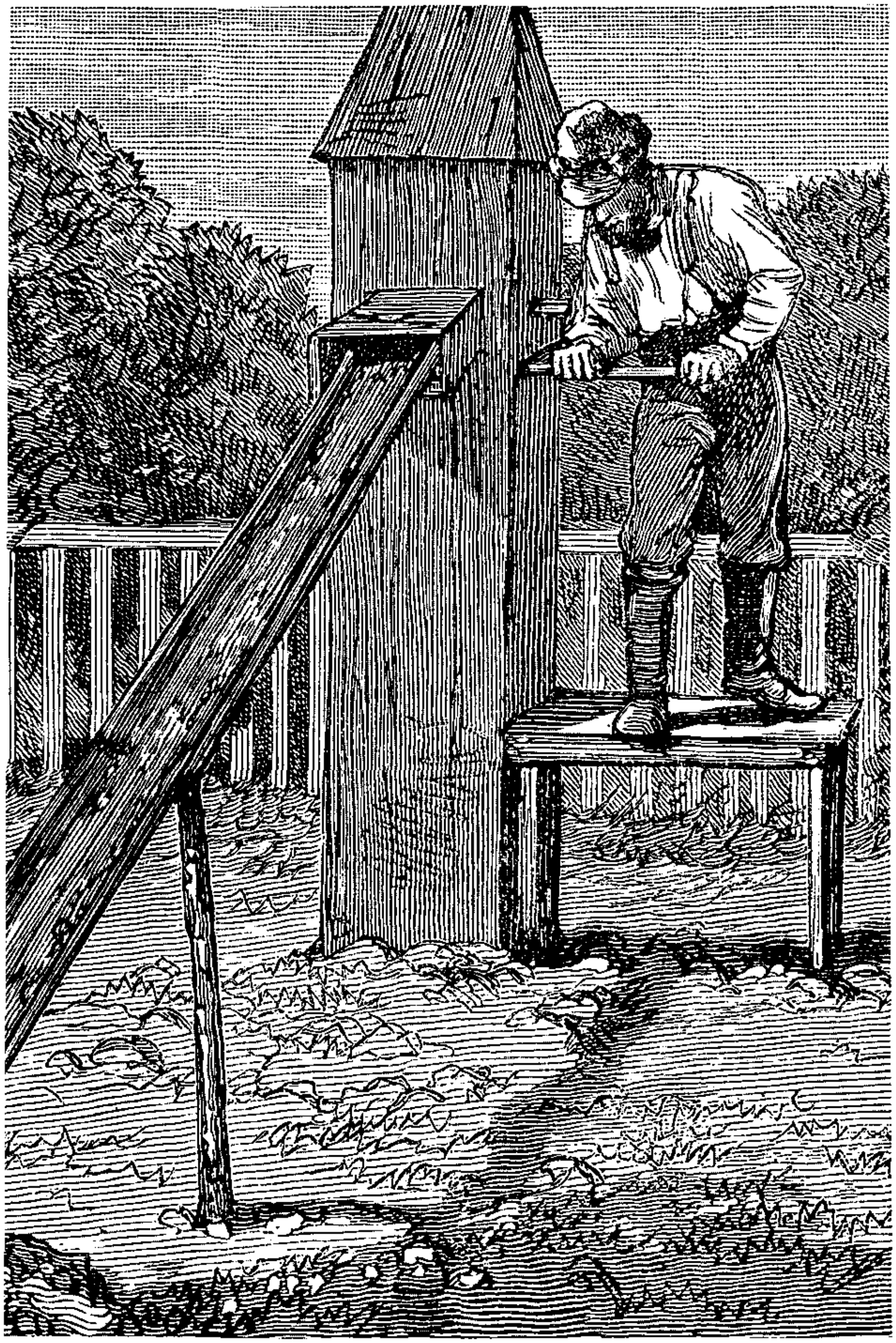


Fig. 4. FY 1978 total Federal expenditures for programs in ocean pollution research, development, and monitoring.



This illustration from Harper's Weekly *in 1881 shows one way to recycle sewage, pumping it for use as fertilizer on a farm.*
Library of Congress

result of merging data, or analytical procedures, from differing data sources and differing data types. National needs and priorities as expressed in the Federal Plan for Ocean Pollution Research Development and Monitoring will be interpreted in the development of these analytical products. Operations of the Ocean Pollution Data and Information Network will conform generally to the guidance generated by the CCRO in fulfilling the need for marine data synthetic products.

In addition to coordinating daily operations of the data network, the Central Coordination and Referral Office will develop data and information flow guidelines, such as the specification of standard formats, quality control measures and exchange procedures for other levels of the system.

Subject Area Data/Information Centers will serve as processing centers and depositories for numeric data, textual reports and information, and management and referral information in their area of expertise. The term "subject area" should not be interpreted too narrowly. Their central mission is to establish and organize collections of data—each of which is related to some phenomena, academic discipline, or perhaps a major program activity or a geographic area. Some of these Centers are, or could be, multidisciplinary in nature and function. Staffs of these Centers are experts in their specific subject areas. Within the context of this proposal, a series of these activities will be identified as the Subject Area Data/Information Centers (SAD/IC) to serve with the CCRO as the ocean pollution data and information network.

These Centers will receive copies of numeric and other data and information in their respective subject areas from data generators (who may be submitting different kinds of data to more than one center). They will then process, store, and disseminate the data as required. Numeric data will accumulate at this level. Normally, verified archival forms of marine pollution data would rise no higher in the network than the Subject Area Data/Information Centers. In addition to providing requesters data and information from automated data bases, these Centers would produce catalogs, bibliographies, or other data products. They also might provide analyses of summarized data from completed research projects or general analyses of work being done in their subject area.

Centers would implement prescribed standards for data quality and uniformity, including standard formats for recording, archiving and exchanging data. Working closely with data generators and higher levels of management, and based on ocean pollution program priorities and best use of available resources, each Center would decide what data are needed and what should be collected to satisfy the needs of their community of users and what data should be subject to referral. Project management information would be submitted by the data generators to both the Central Coordination and Referral Office and the Subject Area Data/Information Centers.

Subject Area Data/Information Centers are likely to vary in size and breadth of subject area coverage. Many existing data/information centers and systems could now serve as, or could be developed into, one of these Centers.

The Marine Pollution Information Center (MAPIC) will deal primarily with published information resulting from, or describing marine pollution efforts. This type of information is not easily available to the general public, decision-makers or even to the scientific community.

The MAPIC proposes to provide several services:

- *Document Availability*: Reports published by or under the sponsorship of Federal agencies are made available through a wide variety of different mechanisms. In many cases these reports are distributed in limited quantities and quickly go out of print. NTIS will be used as a clearinghouse for federally sponsored technical reports.

- *Bibliographic Control*: Even if all documents are readily available to the public, identifying what is relevant to a particular need from among the millions of existing publications can be difficult and time consuming unless special consideration is given to a fast, easy, nationally available means of access. The best available data base that covers the literature of marine pollution and all related aspects of the marine environment and marine resources is Aquatic Sciences and Fisheries Abstracts (ASFA). Produced by a cooperative arrangement among three United Nations agencies and nine national governments, ASFA provides greater coverage of marine pollution than any other data base.

- *Document Delivery*: Because Federally-sponsored technical reports are a small percentage of the total published information on marine pollution, implementation of Section 8 must allow for public delivery of relevant publications. Numerous private document fulfillment services now perform this service.

- *Information Awareness Services (Marine Pollution Periodical)*: The major continuing task for MAPIC will be the preparation of a quarterly periodical on marine pollution. This document is intended to become a major vehicle for the dissemination of synthesized data and information on marine pollution. Emphasis of the periodical will be initially on Federal activities because though there are several reports to Congress on agency programs, there remains a need to provide coordinated information on a more timely basis to fill between the times that the formal reports are available. In time comprehensive reporting of academic, State and local programs will follow.

The periodical will include news and current articles about research, monitoring, laws, regulations, and court decisions. The "articles" section will contain a condensation or synthesis of various agency reports, as well as summaries on current topics of interest, e.g., synthetic organics, or petroleum hydrocarbons.

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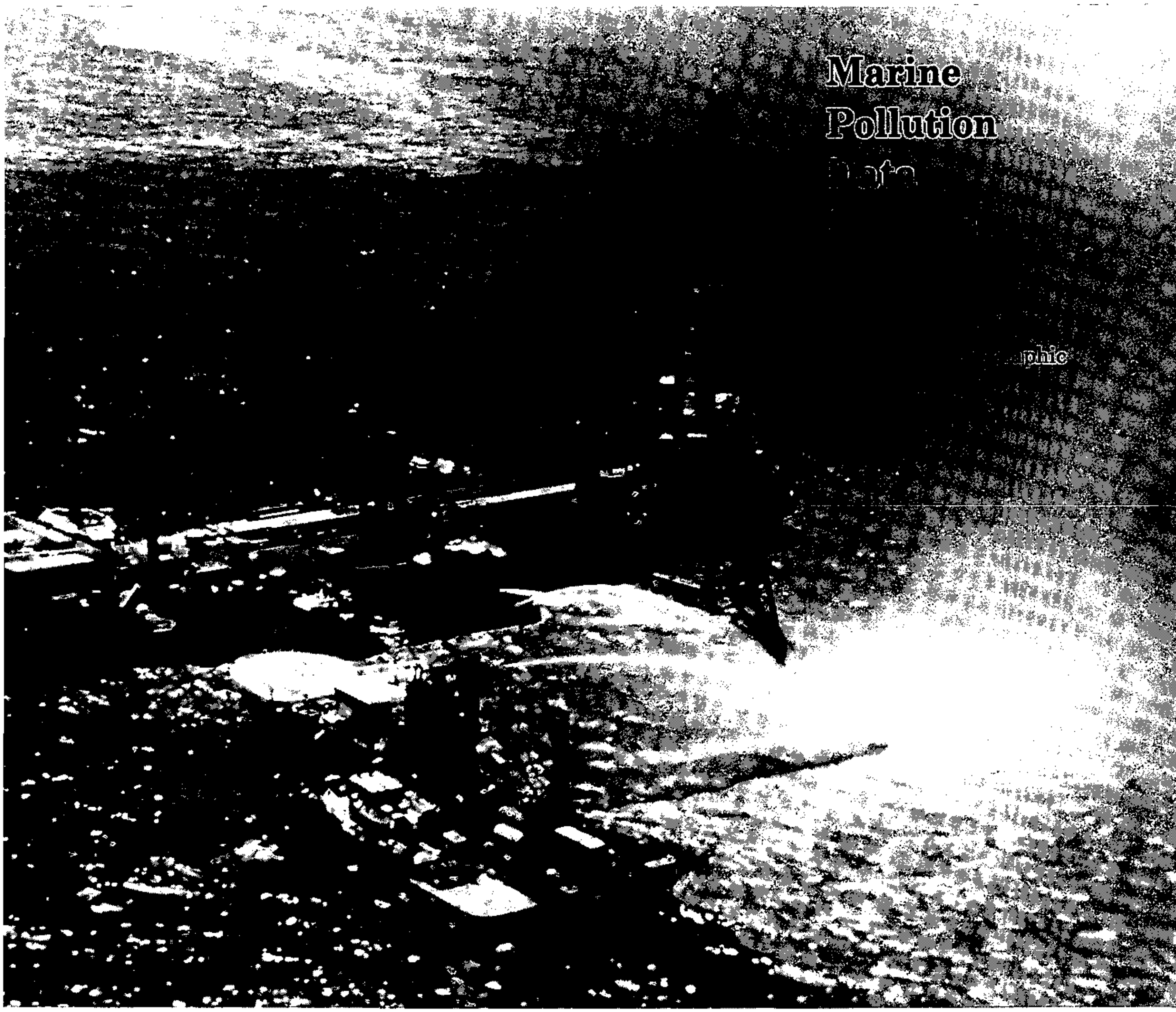


On June 3, 1979, the IXTOC-1 oil well in the Bay of Campeche blew out and began spewing oil in the Gulf of Mexico at an estimated rate of 15,000 to 30,000 barrels a day. When the full extent of this disaster became known, and the oil began drifting north toward Texas beaches and biologically rich coastal lagoons, scientists from the National Oceanic and Atmospheric Administration (NOAA) and other Federal, State, and local agencies began mobilizing to study and combat this threat. Soon data being collected by these researchers began to give indications of how the oil was being dispersed, transported, and altered by the seawater environment.

Among the NOAA personnel called to the Damage Assessment Team headquarters in Corpus Christi were EDIS Liaison Officers John Sylvester from Miami, Florida and George Heimerdinger from Woods Hole, Massachusetts.

The IXTOC-1 oil well explosion began a flurry of environmental and pollution data collection, as well as the synthesis of historical baseline data to determine the probable trajectory and behavior of the spilled oil.

Photo: U.S. Coast Guard

John and George contributed their experience in data management to the task of seeing that the water samples and data collected during this project were properly documented and organized.

Investigations of the effects of marine pollution, like other complex environmental assessment studies, depend not only on data collected in response to an immediate crisis like a major oil spill, but also on data painstakingly gathered over periods of years to determine "baseline" conditions in the marine environment. In either case, however, if data collected at different times by different researchers are to be comparable and of maximum value to secondary users, they have to be properly collected and processed—preferably in standard formats—and then organized and archived into a usable collection. And like other environmental problems that transcend political boundaries, marine pollution studies rely not only on data collected in U.S. waters by U.S. researchers, but on data collected by countries around the world.

In the United States, the National Oceanographic Data Center (NODC) is responsible for building and maintaining a global data base on the physical, chemical, and biological properties of the waters of the oceans. The NODC acquires and archives oceanographic data from individuals, organizations, and agencies in the United States and dozens of foreign countries. As part of its reponsibilities, the NODC has formal obligations to provide data base management, data product development, and related supporting services to marine pollution related projects of both national and international scope. After data from these projects have been gathered and transferred to the NODC, they are made available both to project scientists and to secondary users in industry, academia, government, and the general public.

U.S. Outer Continental Shelf Pollution Studies

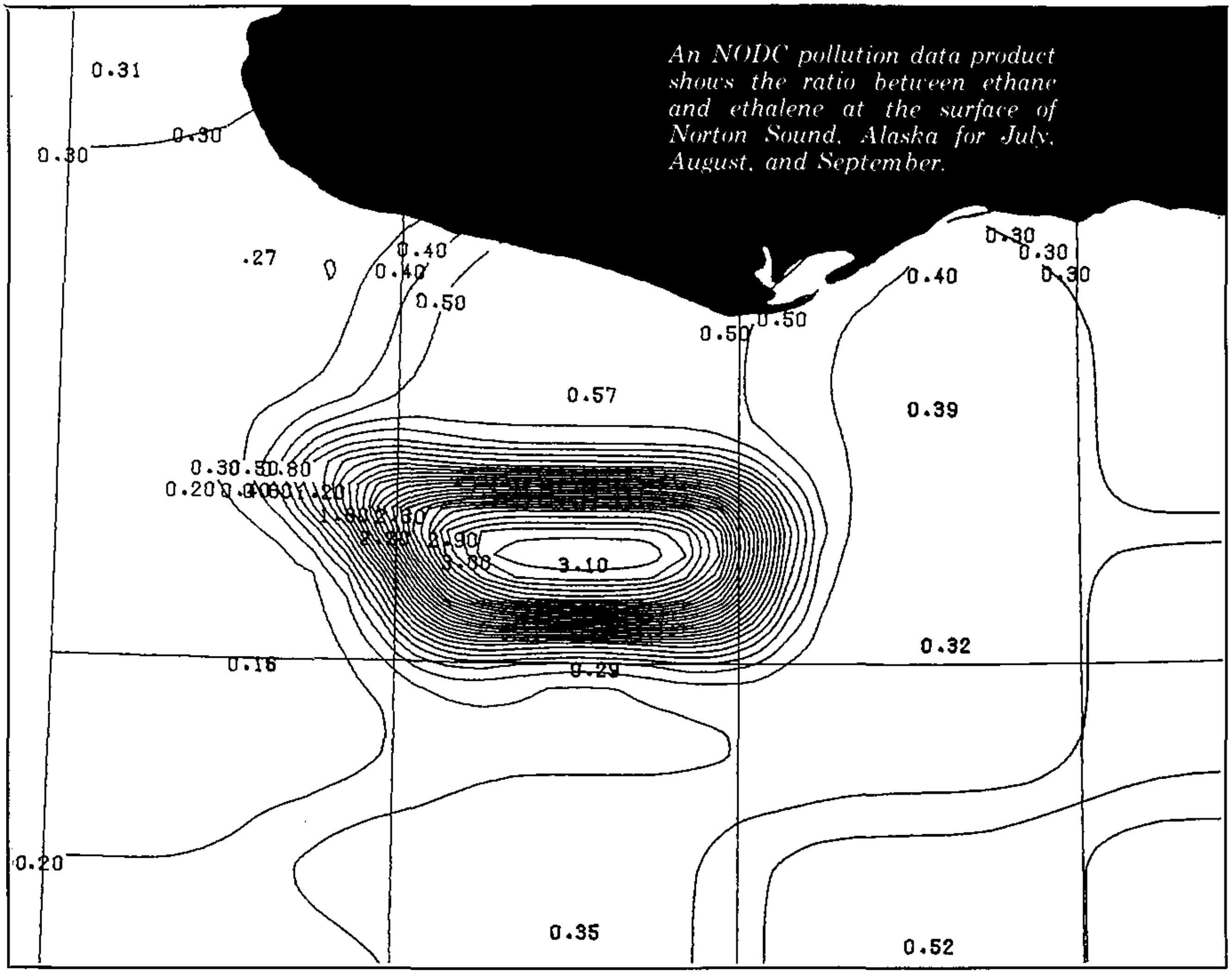
The largest and most important of the U.S. projects from which the NODC is receiving, processing, and disseminating environmental quality data are NOAA's Marine Ecosystems Analysis (MESA) project, and the Outer Continental Shelf Environmental Assessment Program (OCSEAP) being conducted by NOAA for the Department of Interior's Bureau of Land Management (BLM). The MESA studies have focused on three areas: the New York Bight, Puget Sound, and the central Pacific Ocean manganese nodule belt that is of interest to MESA's Deep Ocean Mining Environmental Study (DOMES). Work has also recently begun on Alaska's Prince William Sound, the waterway traversed by tankers going to and from the oil terminal at Valdez. Because the development of new petroleum resources and facilities on the Alaskan continental shelf is farther advanced than in other lease areas around the "lower 48," much of the BLM Environmental Studies Program effort has been concentrated on the Alaskan Outer Continental Shelf. Data have also been collected and received, however, from areas along the Atlantic and Gulf coasts.

Multidisciplinary data collected by OCSEAP and other similar projects—from observations of marine mammal behavior to measurements of trace metal concentrations—are recorded and archived in over 50 specially designed digital data formats referred to as "File Types." A File Type is defined as a digital format for coding, processing, and archiving a specific category of environmental data. Each File Type has been agreed on by project management, one or more Principal Investigators, and the EDIS data centers as an acceptable exchange format.

While many of the File Types contain data relevant to pollution studies, some are concerned with direct pollution measurements or pollution baseline data. Examples of these are: File Type 001 - Trace Metals in Organisms, Sediment, and Water; File Type 021 - Trace Metals; File Type 043 - Light Hydrocarbons; File Type 044 - Heavy Hydrocarbons; and File Type 061 - Trace Elements. The NODC has also recently developed File Type 144 - Marine Toxic Substances and Pollutants, a new format that it expects to be widely used for collecting and reporting pollution data. In this format, substances are identified by their Chemical Abstracts Service (CAS) Registry Number, a five to eight digit number assigned to each unique chemical substance under this system supported by the American Chemical Society. Therefore, File Type 144 can be used for data on any chemical pollutant.

A complete list of all the File Types, as well as full record layouts of each one giving descriptions of the data fields, and the data codes used to record information in certain fields, are available on request from the NODC.

OCSEAP data available from the NODC are documented in the multi-volume *NODC Catalog of OCSEAP Data*. Part 1 of this Catalog, Distribution of Digital Data, contains computer-generated plots showing the locations and numbers of observations of different kinds of data collected in and around the oil lease areas. It has already been revised several times and the most recent edition (April 1980) shows all data received by November 1979, with the exception of data sets being held for correction or resubmission



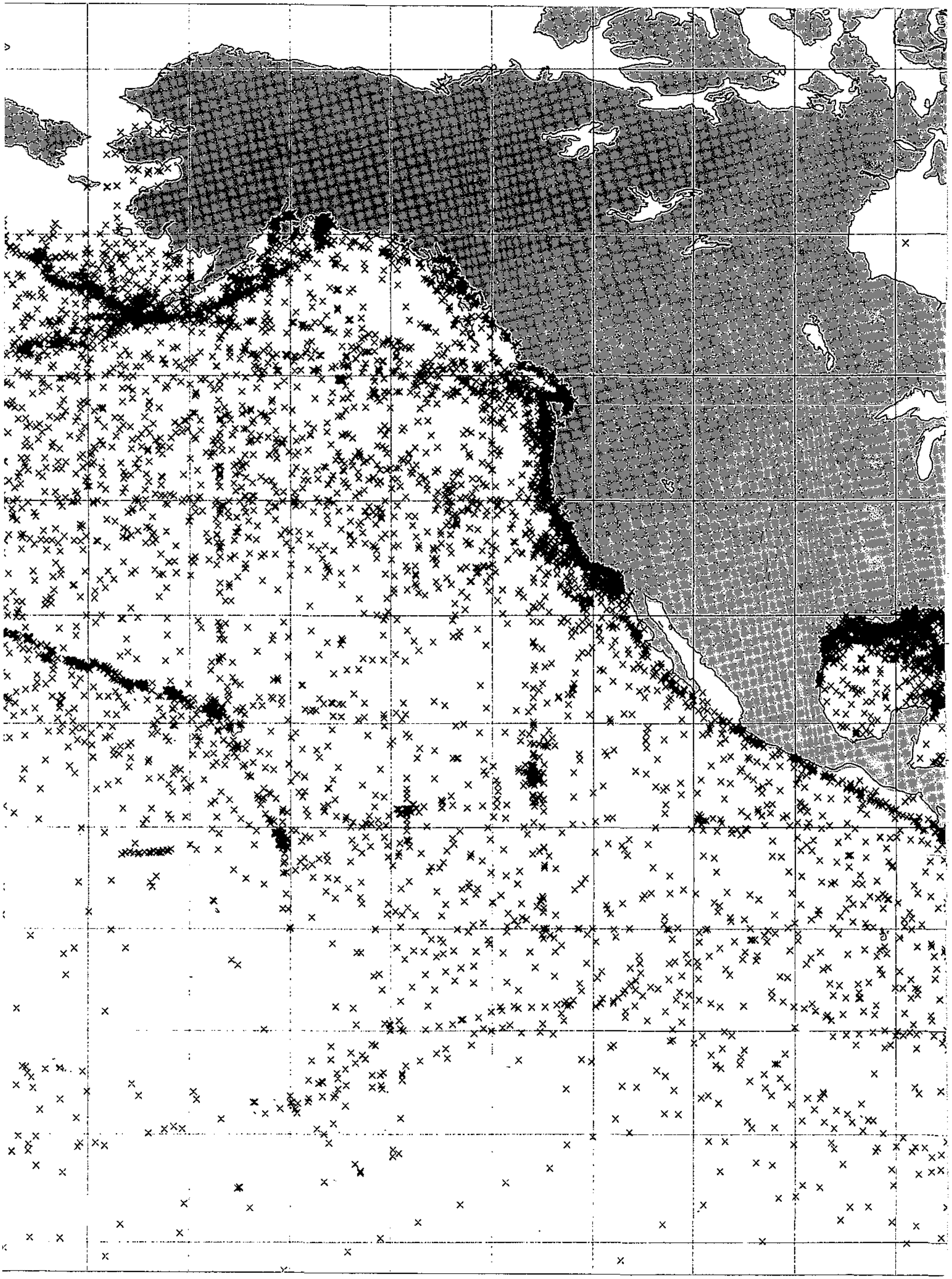
An NODC pollution data product shows the ratio between ethane and ethalene at the surface of Norton Sound, Alaska for July, August, and September.

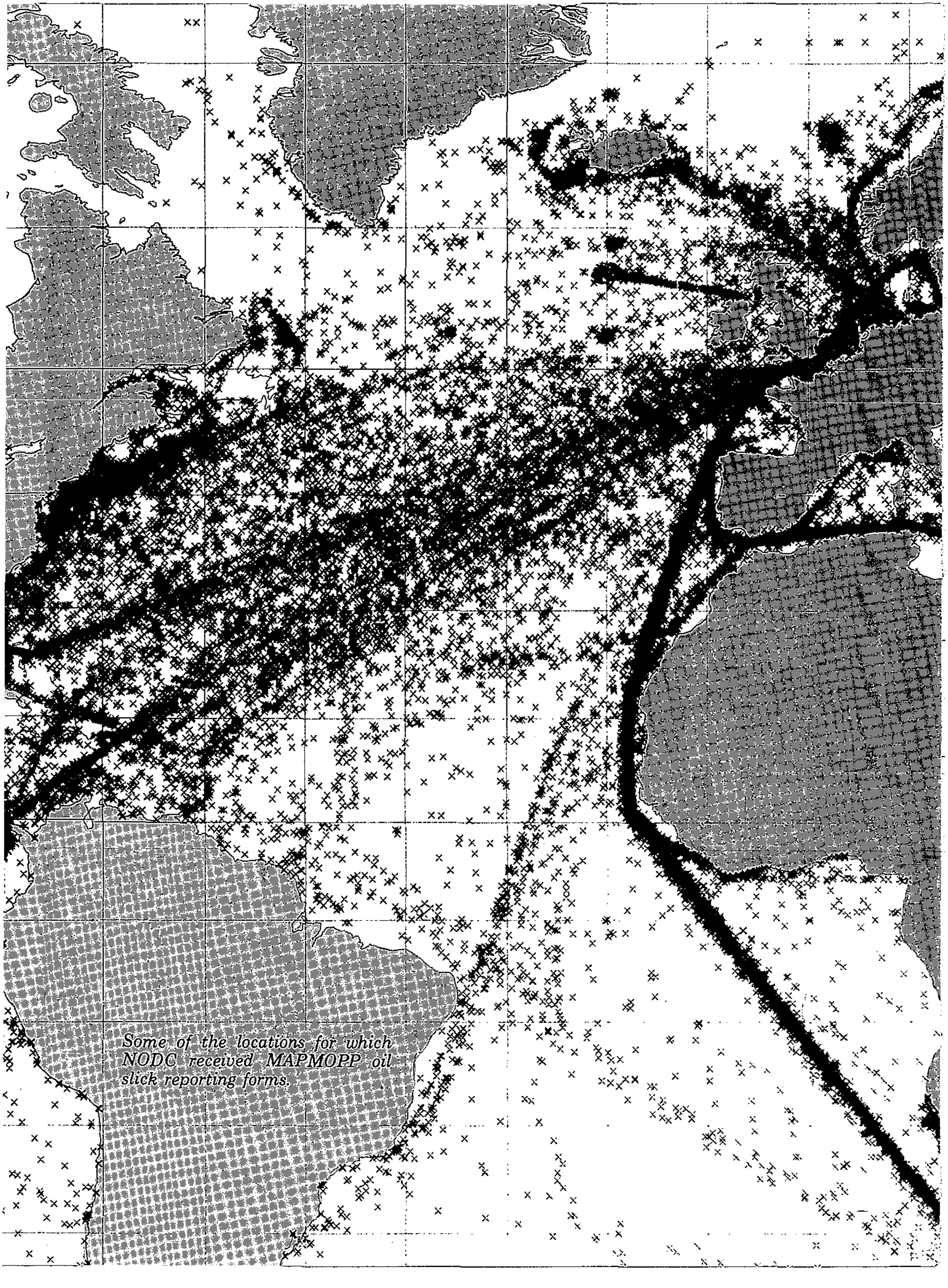
FILE TYPE 144

NODC has developed a new data format to support studies of toxic substances, including pollutants in marine and estuarine waters. The format is identified as File Type 144—Marine Toxic Substances and Pollutants. The format allows for reporting both ambient concentrations near marine discharge sites and results of monitoring surveys for broad ocean areas.

The format consists of data fields for reporting effluent information as well as survey locations, and dates of measurements for samples collected in the water column, the sediment, or biota. Two major code files are employed in the format—the NODC Taxanomic codes (a hierarchical 12-digit code) and the Chemical Abstract Service (CAS) codes of the American Chemical Society (a series of registry numbers of up to 8 characters preceded by an NODC-assigned alpha character). Other code groups are available for reporting analytical methods, gear types and other relevant parameters.

It is intended that this format will eventually replace current NODC trace element and hydrocarbon formats and provide a more flexible and comprehensive form for reporting most pollution and toxicity levels in the marine environment.





Some of the locations for which NODC received MAPMOPP oil slick reporting forms.

by Principal Investigators. Part 2, Inventory of Digital Data by Lease Area, is a detailed list of information about the individual data sets. Each entry includes the name and institution of the Principal Investigator, survey dates and platform, and the number of stations or observations within designated limits surrounding each lease area. The most recent revision of Part 2 was released in July 1979 and includes information on all data received through March 1979.

Part 3 of the Catalog consists of descriptions of the digital data formats (File Types) used for recording, archiving, and exchanging multidisciplinary data; the data codes used for recording information in certain fields; and a list of which codes are used with which File Types. Because of numerous changes and additions, this information about the File Type formats and codes was not formally published. Instead, it was entered into a word processing system, so that changes could be made easily and requested printouts would always be up-to-date.

Part 4 of the Catalog, which is in preparation and will be published in 1980, contains examples of graphic data products and summaries generated from OCSEAP data. A catalog of MESA/Puget Sound data is also being compiled now and should be available soon.

Marine Pollution Data Products

The plots and summaries of NODC-archived OCSEAP data that are shown in Part 4 of the OCSEAP Catalog were generated by NODC's Generalized Applications System (GAS). GAS is an integrated set of computer programs for preparing data products from NODC's major oceanographic data bases. GAS exploits the fact that most NODC data bases have a common structure—measured parameters versus depth taken at a fixed location either as single observations or a time series. Data products are created by extracting the required data from one of the archive files, converting it to a common GAS format, and then passing it to the required application program. In this way a single set of applications programs can operate on data that is stored in different formats in any number of archive data files. For example, the GAS horizontal contour program can be used equally well to produce contour charts of temperature, phytoplankton concentration, or hydrocarbon concentration.

GAS data products now available include parameter versus depth and parameter versus parameter plots, statistical summaries such as histograms and horizontal or vertical array summaries (which give maximum, minimum, and average observed values of a parameter by unit area or depth level), horizontal contour plots, vertical section plots, species count per station plots, and species versus habitat matrix summaries. A sample of one the GAS data products from Part 4 of the *NODC Catalog of OCSEAP Data* is shown in Figure 1. Users interested in obtaining GAS data products of OCSEAP or other data held by NODC should contact the NODC at the address or telephone number given later in this article. NODC personnel can assist users in formulating specifications for these computer-generated data products that are made-to-order to meet user requirements. These data products are provided at cost and a cost estimate can be given before any work begins.

Multidisciplinary Data Archival and Retrieval System

All of the multidisciplinary data that NODC acquires from OCSEAP, MESA, and similar projects is incorporated into a single data base from which it can be selectively retrieved in response to user requests. This system has been dubbed the Multidisciplinary Data Archival and Retrieval System (MULDARS). MULDARS is already partially operational and will be completed and refined to provide a flexible service capability. Currently the MULDARS data base contains over 3,000 data sets representing about 6.5 million individual observations.

An online inventory system is available to help the NODC provide quick answers to users who ask "How much data do you hold in my area of interest?" This system enables NODC personnel to determine the number, location, and other information about observations held in the MULDARS data base. Initial searches can be made either by geographic area or by File Type depending on user requirements. Secondary selection criteria such as time period, platform, cruise, and project can then be specified to further refine the search. Location plots of the selected observations can be produced on a video terminal and a hard copy of this plot generated to be sent to the user.

International Marine Pollution Projects

On the international level the NODC has received and processed data collected by researchers and observers working under the auspices of two major pollution-related projects. The first of these is the Environmental Quality Program of the International Decade of Ocean Exploration (IDOE), a major cooperative program planned to last from 1971 to 1980 and to lead to further large-scale international research programs. The Environmental

Quality Program consists of four major investigations: Geochemical Ocean Sections Study (GEOSECS) makes detailed measurements of physical and chemical characteristics of ocean waters along Arctic to Antarctic transects; Pollutant Transfer Program investigates mechanisms and pathways by which pollutants are transported to and within the oceans; Biological Effects Program assesses the impact of selected pollutants on marine organisms; and Controlled Ecosystem Pollution Experiment (CEPEX) provides information on the effects of pollutants on pelagic marine communities contained in large plastic enclosures.

An example of the kind of data the NODC has received from these investigations is the set of 147 ocean stations, including oxygen, silicates, phosphates, and nitrates, taken in the Pacific Ocean by GEOSECS. Detailed information about IDOE data accessioned by the NODC is contained in the series of annual IDOE Progress Reports prepared and distributed by the Environmental Data and Information Service for the National Science Foundation. These Progress Reports, which can be requested from the NODC, also contain a description of each of the IDOE subprograms and useful bibliographies of papers resulting from IDOE research.

The second major international project from which the NODC is receiving pollution data was organized by the United Nations' Intergovernmental Oceanographic Commission (IOC) and World Meteorological Organization (WMO) within the Integrated Global Ocean Station System (IGOSS). This project itself is subdivided into two evolutionary stages, the first of which was called the Marine Pollution Monitoring Project (MAPMOPP). The success of this project has led to creation of an operational Marine Pollution Monitoring (MARPOLMON) project.

As its name indicates, MAPMOPP was essentially a feasibility study. It was devised as a means of testing the ability of nations of widely varying technical expertise to conduct a cooperative study of global pollution. MAPMOPP data consist of observations and analyses of a single, specific pollutant—petroleum. Petroleum was selected as the test substance both because it is a major pollutant and because it is capable of being monitored by nations of different scientific and technical levels. Four hand-coded log forms were adopted by the IOC and WMO for recording and reporting four kinds of observations. These four log forms and the parameters they record are:

(1) Log for Observation and Reporting of Oil Slicks and Other Floating Pollutants

(2) Log for Sampling and Reporting Particulate Petroleum Residues (Tar Balls)

(3) Log for Sampling and Reporting Tar on Beaches

(4) Log for Sampling, Analysis, and Reporting Dissolved—Dispersed Hydrocarbons

The U.S. NODC and the Japan NODC are the two designated Responsible National Oceanographic Data Centers (RNODCs) for MAPMOPP. These two centers collect and exchange the observations made worldwide and provide archival and retrieval services for these data. At the U.S. NODC, incoming log forms are checked for gross errors, keypunched and verified, and transferred to magnetic tape where they are available for exchange and for data product generation. Since MAPMOPP became operational in 1975, the NODC has accumulated approximately 68,000 oil slick observations, 4,400 tar ball observations, 2,500 observations of tar on beaches, and 1,400 observations of hydrocarbons dissolved or dispersed in the water column.

At the Third Workshop on Marine Pollution Monitoring held in New Delhi in February 1980, experts from around the world gathered to evaluate the scientific and organizational aspects of the Pilot Project and to plan an operational Marine Pollution Monitoring program for the 1980's. The concensus was that MAPMOPP had fully achieved its goals and provided a sound basis for an operational program. This new program, MARPOLMON, will continue the global watch on petroleum pollution and may also include monitoring of other pollutants when this is determined to be technically feasible. The application of remote sensing and other advanced techniques to the problem of pollution monitoring will also continue to be actively explored.

It was also proposed that MARPOLMON be transferred from the IGOSS program to a newer UN program called Global Investigation of Pollution in the Marine Environment (GIPME). GIPME would provide an organizational framework conducive to the goals of MARPOLMON. The National Oceanographic Data Centers of the United States and Japan would continue as the RNODC's for MARPOLMON, Japan collecting data from the Asian countries and the United States from all other countries. These two Centers would also continue to exchange data so that each would archive a complete, worldwide data base for MARPOLMON. Further planning and decisions about this program will be made at the GIPME meeting to be held in 1981.

NODC provides data on oily birds, one of the effects of offshore oil spills on marine ecosystems.
Photo: U.S. Coast Guard

Data Referral Services

Besides providing data from its own holdings, the NODC can refer users to other data collections by means of a computerized system called ENDEX, the Environmental Data Index. ENDEX is comprised of a number of individual data bases containing descriptions of environmental data collections held by Federal, State, and local government agencies, universities and research institutions, and private companies throughout the coastal States of the United States. The ENDEX data bases particularly relevant to ocean pollution studies are the Report of Observations/Samples Collected by Oceanographic Programs (ROSCOP), and the Environmental Data Base Directory (EDBD).

The ROSCOP form is recommended for use by the Intergovernmental Oceanographic Commission as a mechanism for providing timely information about oceanographic projects that are ongoing or recently completed and whose data are not yet archived and available from one of the National Data Centers or World Data Centers. Each ROSCOP form includes information on survey area, time period, ship, institution, and data collected. Various categories of marine pollution studies are among the disciplines and types of measurements that can be reported.

The NODC receives completed ROSCOP forms and keys them into an online searchable data base. A search of the ROSCOP file might be able to provide useful information to a requester looking for recent data (perhaps as far back as 1 or 2 years) that had not yet been released by its collector and transferred to the NODC for dissemination to other users.

EDBD is one of the largest and most comprehensive environmental data referral data base in the world. It now contains over 12,000 records. All fields in each record—institution, dates of observations, platform type, measured parameters, methods of measurement, and so on—are searchable so that searches can be as broad or as narrow as the user requires. An online search of EDBD can be used to answer questions such as "Who holds data on PCB's in Chesapeake Bay?" While NODC's data collections are of global or national scope, many of the data collections described in EDBD are of regional or local significance. Data collected by a power company or state environmental agency, for example, could provide useful supplementary data to a researcher who needs a finer degree of resolution than could be provided by NODC data alone.

Users interested in obtaining any of the NODC publications or data products and services mentioned in this article should write or call the NODC. More detailed information about NODC products and services, including information about costs for those products and services for which there are charges, can be provided on request. Address: National Oceanographic Data Center, NOAA/EDIS, D761, Washington, DC 20235. Telephone: (202) 634-7500.

Besides data from the major research efforts described in this article, the NODC also holds data from many other pollution-related programs and projects. For example, NODC holds data collected in the Buccaneer Oil Field off the Texas Gulf Coast in support of an Environmental Protection Agency project to evaluate the effects of offshore oil production activities on marine ecosystems. NODC also holds data collected by NOAA under an agreement with the Department of Energy to provide an assessment of the environmental consequences of brine discharges in the Gulf of Mexico from coastal salt domes being prepared as the nation's Strategic Petroleum Reserve. Data from these and numerous other projects are also available to requesters.

NODC anticipates greatly increased activity in its acquisition and management of pollution data, and in the dissemination of that data to users around the globe.

Using Climatology to Estimate Elevations of Alpine Timberlines in the Appalachian Mountains

By

Robert J. Leffler
Center for Environmental Assessment Services

Author and alpine timberline on Mount Washington, N.H.

Introduction

The elevations of alpine timberlines depend on climatic factors. The primary factor appears to be temperature. Using temperature-altitude relationships developed for Appalachian mountain tops, the author undertakes to (1) estimate the elevations of alpine timberlines for all latitudes encompassing the Appalachian Mountains, (2) show that the latitudinal slope of the elevation of average July temperature isotherms in the Appalachians closely parallels observed alpine timberline slopes in the western United States, and (3) compare temperature-estimated alpine timberline elevations to conditions on higher Appalachian summits.

This article will deviate somewhat from previous articles on Appalachian mountain top areas that exhibit alpine timberlines or timberline-like areas (Antes, 1932, Mark, 1958), which for the most part, centered around observed conditions.

The Alpine Timberline

Definitions of alpine timberline vary considerably. This author's definition is: the natural, climatically controlled highest elevation on a mountain at which a continuous cover of dwarf trees may be found. In the Appalachians the dwarf trees, sometimes 100 to 150 years old, consist of spruce and fir (both conifers), which form dense mats only 4 to 12 inches in height.

Contrary to its name, timberline is frequently found to be irregular in elevation. Although often appearing from a distance as a "line" on mountain slopes, a closer examination frequently reveals a zone which may vary hundreds of feet in vertical distribution.

Many factors, differing locally with topography and exposure, alter the elevations at which alpine timberlines occur. Thus, in the following discussion, the reader should keep in mind that an average zone of demarcation, not necessarily a consistent one, is the case.

Climatic Factors Affecting Elevation of Alpine Timberlines

Numerous studies have been done on factors which affect and/or create alpine timberlines. Not all timberlines are controlled by the same factors. Parker (1963) listed nine factors that have been suggested to affect, in varying degrees, the elevations of alpine timberlines. They are:

1. Lack of soil.
2. Desiccation of leaves in cold weather.
3. Short growing season.
4. Lack of snow, exposing plants to winter drying.
5. Excessive snow lasting through the summer.
6. Mechanical aspects of high winds.
7. Rapid heat loss at night.
8. Excessive soil temperature during the day.
9. Drought.

Variables 2 through 9 can be condensed into three basic climatic factors: temperature, moisture, and wind.

Daubenmire (1954), in his examination of North American alpine timberlines (mostly western), suggested that temperature is the most critical of the three basic factors. Although moisture and wind conditions may alter the elevations, they are not the primary causes of alpine timberlines. His conclusions are supported by previous findings that alpine timberlines coincided roughly with those elevations exhibiting a 50°F average temperature for the warmest month.

The existence of tropical timberlines, which occur at wet, relatively windless heights, add additional weight to the signal importance of temperature.

Summits Displaying Timberlines in the Appalachians

Timberline-like areas may be found on numerous summits throughout the Appalachian Mountains. These summits vary in latitude from around 35°N to 47°N. Only a few in northern New England, however, are thought to exhibit true, climatically controlled alpine timberlines (e.g., Mt. Katahdin, Me., Mt. Washington, N.H.). Some, such as Mt. Rogers, Va. (5,729 ft), can be explained by long-past logging activities. Others, such as Table Rock Mountain, S.C. (3,124 ft) are a result of bedrock and soil characteristics. Still others, usually referred to as "balds" from West Virginia south, exist for reasons still somewhat a mystery. Possible explanations offered for their origin included: use by aborigines, lightning strikes and resultant fires, and summit elevations which lie in transitional zones between plant species.

Observed Elevations of Appalachian Alpine Timberlines

Appalachian alpine timberlines lie at the highest levels of zones (covering about 1,000 feet of altitude) in which trees are gradually reduced in stature (Antevs, 1932). The elevation of alpine timberlines in the Appalachians is, latitude for latitude, thousands of feet lower than for both the Coastal Mountains and Rocky Mountains of the West (Daubernmire, 1954). Lower temperatures over the Appalachians probably account for most of this, although wind may also be part of the explanation. Table 1 illustrates the extreme velocities reached by maximum wind gusts at two well-separated Appalachian mountain locations; one at 44.3°N and the other at 36.1°N. The periods of records are 46 years (1933-78) and 19 years (1955-73) respectively.

Although wind, as previously mentioned, is not the primary cause of North American alpine timberlines, its deforming effects on tree growth are readily visible in a tree form called "flagging." Usually most pronounced in the Appalachians on exposed western slopes (the direction from which the prevailing winds blow), its existence is distinguished by trees whose limbs "point" almost exclusively to the East. In severely exposed locations, it is not unusual to find deformed trees with lower limbs two or three times longer than the height of the tree. In fact, it is sometimes observed locally that alpine timberline conditions extend hundreds of feet below the elevation of upper timberline on exposed knobs, shoulders or passes.

To determine the actual elevations of alpine timberlines in the Appalachians, three peaks in New England having summits at or above the alpine timberline level were examined. Topographic maps, previous studies and/or on-site observations were used to determine the average elevation for each location. The results are displayed in Table 2. As expected, the elevation at which alpine timberline occurs decreases as latitude increases.

Estimating the Elevations of Alpine Timberlines Throughout the Appalachians

Since many Appalachian summits either have no alpine timberline or have timberline-like areas of questionable nature, it is useful to attempt to estimate the elevation these summits would have to attain before temperature conditions would create an alpine timberline. The estimated elevation can be determined by:

1. finding the average monthly temperature of the warmest month with which timberline coincides on Appalachian mountain tops.

2. find the various elevations between 33°N and 47°N at which this average monthly temperature would be found.

Table 1: Maximum Wind Gusts Recorded at Two High Locations

Month	Grandfather Mt., N.C. 5,300 ft., 36.1°N	Mt. Washington, N.H. 6,262 ft., 44.3°N
Jan.	120	170
Feb.	102	166
Mar.	145	180
Apr.	120	231
May	120	164
June	120	136
July	96	110
Aug.	96	142
Sept.	61	157
Oct.	122	161
Nov.	150	160
Dec.	120	175

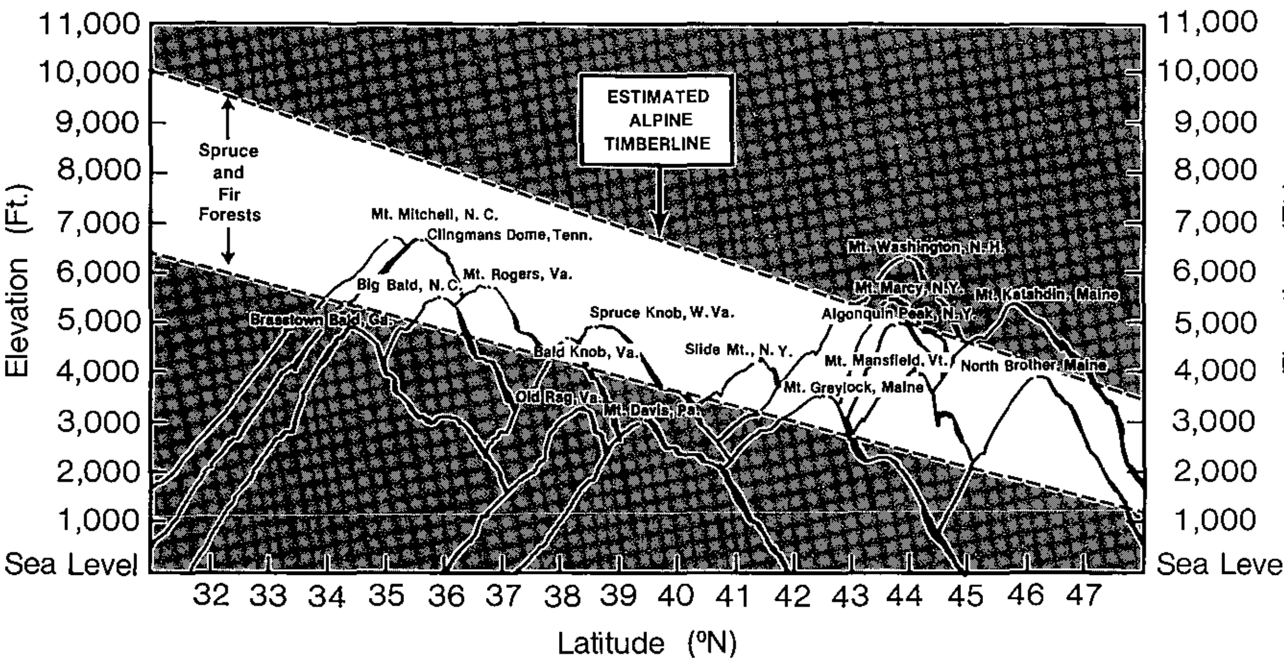
Table 2: Average Elevation of Alpine Timberline on Three Mountains

Mountain	State	Elevation of Timberline (ft)	Lat. (°N)
Presidential Range	N.H.	4,800	44.3
Whiteface Mt.	N.Y.	4,800	44.4
Mt. Katahdin	Me.	4,400	45.9

Table 3: Average July Temperature at Alpine Timberline

Mountain	State	July Temp. (F) at Timberline
Presidential Range	N.H.	53.8
Whiteface Mt.	N.Y.	53.5
Mt. Katahdin	Me.	53.7

To accomplish this, lapse rates for Appalachian Mountains computed by Leffler (1980) were used. The lapse rates, and a correction for latitudinal variations, were applied to the timberline elevations on the three New England summits previously mentioned. This produced the 1941-70 average July temperature with which each timberline coincided (Table 3). Notably all three closely coincided with the 53.5°F isotherm. Next, again from methods outlined by Leffler (1980), the various latitudes and elevations throughout the Appalachians at which the 53.5°F. July isotherm would exist, was computed. This computation yielded the estimated elevations of alpine timberlines through the Appalachians and is expressed by $y = -395.4\ x = 22{,}395$, where y is the average elevation of alpine timberline (in feet) at some point, and x is the latitude (in degrees) of the point. According to the formula, for each degree increase in latitude (33°N minimum) the timberline decreases in elevation 395 feet. This compares quite favorably with Daubenmire's (1954) figures. He found an



Estimated elevation of alpine timberline in the Appalachian mountains versus selected higher summits.

observed decrease in timberline elevations of 361 feet per degree increase in latitude in western North America.

Thus, it can be concluded that the north-south slope of observed alpine timberlines in the western United States nearly parallels the latitudinal variations of elevations for isotherms representing average July temperatures in the Appalachians. This parallel adds further supporting evidence to some previous author's beliefs that alpine timberlines generally follow isotherms representing the average warmest month temperature.

Now that the various elevations of alpine timberlines in the Appalachians have been estimated, a comparison between them and some of the higher Appalachian summit elevations can be made. This comparison is illustrated in Figure 7. It should be noted that, south of about 44°N latitude there are no summits within even 1,000 feet of the estimated average alpine timberline. Thus, even allowing for significantly lower than average alpine timberlines resulting from local wind and slope variables, there are no summits south of 44°N latitude high enough to reach the zone of temperature controlled alpine timberline.

Conclusions

The average elevations of alpine timberlines in the Appalachian Mountains coincide closely with the isotherm representing a 53.5°F average July (warmest month) temperature. The latitudinal slope in elevation of this isotherm closely parallels the observed latitudinal slope of alpine timberlines in the western United States.

Although numerous Appalachian summits from Maine to Georgia exhibit timberline-like areas, only a few north of 44°N latitude are high enough to have true temperature-controlled alpine timberlines.

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National Report

Lightning Summary, 1959-1979

EDIS' National Climatic Center NCC) has published a *General Summary of Lightning, 1959-1979* by Henry Vigansky of the center. It includes a narrative of unusual lightning-associated deaths and injuries, tables of occurrences by state for the year 1979, and nationwide statistics (by year) for the period 1959-1979.

During the 21-year period 1959 through 1979, some 15 percent of the 2,210 recorded lightning victims in the United States were standing under trees. Twelve percent of those killed during the period were boating, fishing, or swimming.

The year 1979 saw the fewest number of recorded deaths during the 21 years, 63. The greatest number occurred in 1963, when 210 people were reported killed by lightning. This figure includes 81 people killed in a lightning-associated airline crash in December 1963.

The greatest number of deaths from lightning in 1979 were recorded in Texas, where seven people were killed; but during the 21-year period Florida, with 223 fatalities, led the list.

A magnetic tape has also been prepared containing lightning statistics for the period 1959-1979. The tape contains the date/time (year, month, day and hour), location (State and county), number of fatalities, number of injuries and estimated amount of property damage for each lightning-associated report appearing in the NCC's *Storm Data* publication. There are approximately 14,000 individual reports for the 21-year period. Inquiries about the availability of the summary and tape should be addressed to: Henry Vigansky, National Climatic Center, Federal Building, Asheville, NC 28801.

U.S. Energy Consumption and Population Change

EDIS' Center for Environmental Assessment Services (CEAS) investigators have analyzed population changes for U.S. Standard Metropolitan Statistical Areas from 1960-80 and compared population change to heating and cooling requirements and gas and electricity demand.

Between 1975 and 1978, out-population migration accounted for a loss of 1.49 percent in the Northeast and 1.26 percent of the population in the North Central States. In migration accounted for a growth of 1.53 percent in the South and 1.02 percent in the Western States. CEAS determined that population change had influenced both the quantity of fuel consumption by U.S. regions and the fuel mix. Population shifts from Frostbelt to Sunbelt States directly accounted for a decline of $53.7 million in natural gas revenues from residential consumption. This amounted to a reduction of 16.87 trillion thermal units of fuel used between 1975 and 1978.

CEAS also is involved in a Department of Energy study on the use of factor and cluster analysis to determine regional impacts. The study involves the application of cluster analysis to evaluate and reduce large environmental data sets. This method is particularly useful to scientific applications, since it allows analysts to emphasize differences between regions and to identify those characteristics which are the most typical and prevalent within each region.

Degree Days and Energy Demand Publication

The political and climatological events of the 70's combined to focus the attention of Americans on the supply and demand balance of energy for space heating during the winter and cooling during the summer. Since 1975 the National Weather Service (NWS) and the Environmental Data and Information Service (EDIS) have developed several products to assist governmental, scientific, and industrial planners in utilizing information on weather and climate to determine current and future energy needs.

Three NOAA centers have produced climate energy-related information products, both jointly and separately. They are the NWS Climate Analysis Center, the EDIS

National Climatic Center, and the EDIS Center for Environmental Assessment Services (CEAS). To acquaint potential users with products available and their utilization, CEAS has published *Climate Degree Days for Energy Demand Assessment*.

This publication presents to users and decisionmakers the procedures for using real time heating and cooling degree day information for States. It also provides a description of the development and components of this information. In addition, it contains climatological normals and ranges of heating and cooling degree days presented in tabular and graphical form.

This publication is available from: CEAS/NOAA, Federal Building, Room 200, 600 E. Cherry St., Columbia, MO 65201.

Climate/Economics Workshops Proceedings Published

The first two volumes of climate/economic workshops proceedings titled, *Climate-Weather Systems*, have been issued by EDIS' Center for Environmental Assessment Services (CEAS). The series of six workshops, supported by an EDIS/CEAS contract to the University of Oklahoma, represents an effort to bring together scientists from the fields of meteorology, climatology, mathematics, economics and agriculture. The goals of the workshops were to initiate communication between the disciplines, define possible qualitative approaches to the study of the effects of climate on man and the economy, and present a work plan for developing quantitative assessment tools.

Volume I summarizes the first two of the six workshops to investigate the economic impact of climate. CEAS wants to make use of current economic modeling practice to find the best methodology to use in analyzing the effect of climate on the U.S. economy. This analysis would subsequently permit significant questions to be answered concerning the responsiveness of the economy to climate fluctuations. Water, food and energy supply and distribution are all functions of climate and play an important role in any econometric model.

The first two workshops dealt mainly with the anatomy of two types of economic models: input-output and econometric. The first chapter of Volume I summarizes the possibilities of investigating climate-economic interactions; the remaining chapters discuss some of the relevant mechanisms of economic modeling, while bringing in possibilities for climate-economic interactions from the economist's point of view.

Volume II summarizes the third and fourth workshops held to investigate the economic impact of climate. The volumes' three chapters deal with energy supply and demand. One contribution illustrates supply problems using the electric power utility. Examples are given of load variations as a function of temperature and of time. The setting of rates by State regulatory commissions is also shown to be weather sensitive. Two such models, as well as the standard concepts behind their structure, are discussed.

An example is given which illustrates the manner in which climate-sensitive building design might affect a regional economy through experimental use of input-output analysis. The last chapter discusses space heating requirements for communities which range in size from a town to a city. The study involves the tuning of an adaptive control statistical model to observations of energy consumption data as a function of climate.

Volume III, when published, will treat water and agriculture in specific regional contents; Volume IV will be a user-oriented non-technical summary.

Coastal Zone Literature Search

Coastal Zone: An Executive Overview (No. 80-2) is the latest in a series of packaged literature searches published by EDIS' Environmental Science Information Center (ESIC). The publication consists of approximately 325 abstracts covering international cooperative efforts, international agreements, public trust doctrine, law, pollution, recreational planning, and inventories. Covering the period November 1977 to February 1980, it highlights material of interest to managers and executives.

Packaged searches are broad introductions to the literature of high-interest topics and are taken from selected data bases. They cover a limited time period of the literature and should be regarded as samplers.

These prepackaged searches are available without charge. Requests should be made to EDIS/ESIC, Document Dissemination, Library and Information Services Division, WSC-4, 6009 Executive Blvd., Rockville, MD 20852, or by telephone (301) 443-8334.

Bryan Mound Environmental Handbook

EDIS' Center for Environmental Assessment Services has submitted a *Handbook of the Marine Environment: Bryan Mound* to the Department of Energy (DOE) as part of an Interagency Agreement to address environmental effects associated with a proposal to dispose of large amounts of a saturated brine solution into Gulf of Mexico waters. The report depicts seasonal marine environmental conditions and trends in the offshore waters surrounding the brine disposal site off Bryan Mound, Texas.

Over the past few years, EDIS has managed marine environmental surveys in the Bryan Mound offshore area for DOE's Strategic Petroleum Reserve Program. These surveys were made within a few miles of the disposal site and directly shoreward of the site. Because the Gulf of Mexico has important fishery resources, and due to increased interest in developing the mineral and petroleum resources beneath its waters, numerous oceanographic surveys have been made in the general area adjacent to the Bryan Mound site in recent years. Therefore, considerable amounts of new data have become available since 1977.

The objectives of this handbook are (1) to bring together and analyze the marine environmental data and information available to date, and (2) to provide this information in useful reference form to those responsible for disposal and monitoring operations.

During brine disposal operations, EDIS will continue to manage marine environmental surveys in the disposal area—assimilating and processing the needed data, and making the results available.

U.S. Digital Hydrographic Data Base Completed

The National Geophysical and Solar-Terrestrial Data Center (NGSDC) has completed a 1930-65 digital hydrographic data base for United States coastal waters. These data (bathymetry, bottom characteristics, dangers to navigation) were digitized from surveys conducted by the National Ocean Survey. Data from surveys conducted after 1965 will become available over the next 2 years.

The data base consists of approximately 27.5 million records. About 97 percent of the data are soundings; the remainder are bottom characteristics (clay, mud, soft, sticky, etc.) and dangers to navigation (wrecks, pilings, rocks, etc.). All records contain the registry number of the survey from which the data were obtained, the date of completion of the survey, a cartographic code describing the type of data, and the geographic position. Data are sorted by geographic position and separated by 1-degree areas.

The data are available on magnetic tape. Data also are available in various plotter products including sounding plots, gridded-data plots, bottom-profile plots, and bottom-characteristic plots. The user can specify most plot parameters such as depth units, scale, and projection.

Inquiries concerning this data base should be addressed to: NOAA/EDIS/NGSDC, (D621), 325 Broadway, Boulder, CO 80303.

Regression Models Used to Estimate Water Equivalent

A publication entitled *Estimating Water Equivalent Snow Depth From Related Meteorological Variables* has been published by the Nuclear Regulatory Commission. This study was made to determine the relationship of water equivalent measurements to other meteorological variables for the Northeastern United States. Several predictor models were evaluated for use in estimating water equivalent values from cooperative station data.

Nonlinear models have preference over other models. They are used to obtain water equivalent for a dense network of meteorological stations where predictor variables are available but not water equivalent measurements. The possibility of superior performance of some models developed in foreign areas with consistently greater snow loads than the United States is noted in the publication.

The linear, nonlinear and Scandinavian models are used to generate annual water equivalent estimates for approximately 1,100 cooperative data stations in the Northeastern United States. These estimates are used to develop probability estimates of snow loads for mean recurrence intervals of 2-, 10-, 25-, 50- and 100-years for each station.

Analyses of seasonal extreme water equivalents for the 2-, 50-, and 100-year return periods are presented. Individual station analyses of the data are available on magnetic tape from EDIS/National Climatic Center, Federal Building, Asheville, NC 28801.

International Report

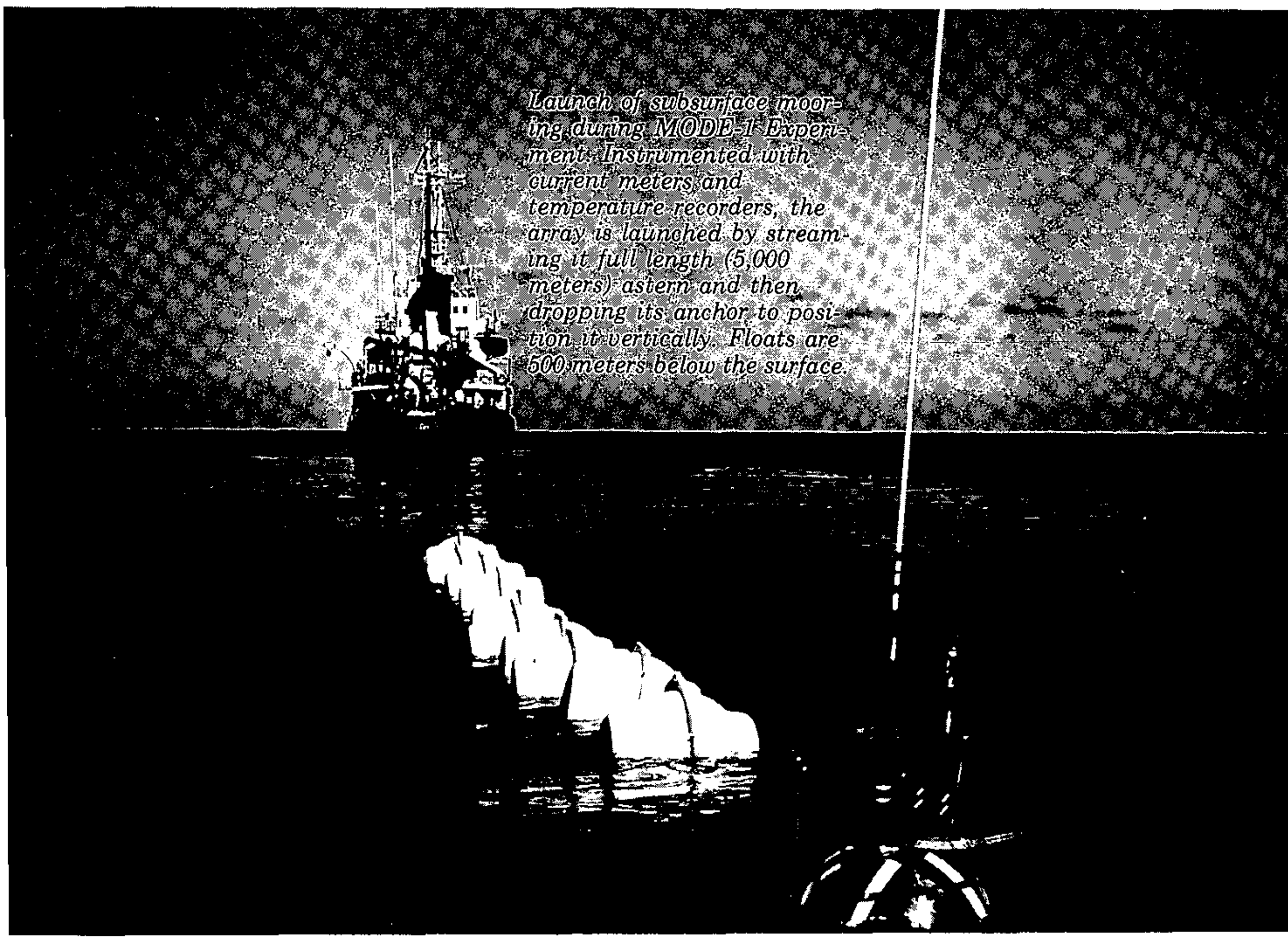
Oceanographic Data for MODE-1

EDIS' National Oceanographic Data Center (NODC) recently issued *Environmental Information Summary No. 80-1*, citing the data from the Mid-Ocean Dynamics Experiment (MODE-1) available from the Center. MODE-1 is a major data collection and analysis program of the internationally coordinated International Decade of Ocean Exploration (IDOE). MODE-1 data were collected in the Western North Atlantic within the general area 26°-30°N, 68°-71°W from March to July, 1973.

The data set inventories listed in the announcement are grouped according to the MODE Programs: Moored Current Meter Arrays, Bottom-Mounted Instruments, Free-Fall Instruments, Expendable Bathythermographs, and Conductivity/Salinity-Temperature-Depth (C/STD) measurements. In addition to this set of MODE-1 data, Pre-MODE (or MODE-0) and Post-MODE-1 (after 1973) data also are listed and available.

Principal support for the MODE-1 Program came from the National Science Foundation and the United States Office of Naval Research. Additional funding came from the National Oceanic and Atmospheric Administration. Under an agreement with the National Science Foundation, the National Oceanographic Data Center and the National Geophysical and Solar-Terrestrial Data Center are responsible for the archival of data collected in the IDOE.

Requests for selective retrieval, graphic plots, statistical summaries, and other data products derived from the MODE-1 data sets will be considered on a case-by-case basis. A cost estimate will be provided before any special job is begun. All inquiries should be addressed to: EDIS/NODC, Oceanographic Services Branch, D761, Washington, DC 20235.



Launch of subsurface mooring during MODE-1 Experiment. Instrumented with current meters and temperature recorders, the array is launched by streaming it full length (5,000 meters) astern and then dropping its anchor to position it vertically. Floats are 500 meters below the surface.

Glaciological Data, Ice Cores Published

The World Data Center A for Glaciology (Snow and Ice) has issued *Report GD-8, Glaciological Data, Ice Cores* as part of the Data Center's long-term program to establish data bases on global snow and ice parameters. The objectives of this work, as initially described in *Glaciological Data, Report GD-3*, are to locate index information about worldwide ice core research as part of a larger effort to identify and consolidate climate data.

This issue on ice cores combines several elements: the recommendations of a Workshop on the Status and Future of Ice Core Research and Ice Core Data; the results of an inventory of North-American-sponsored ice core programs; and invited papers from scientists working in the field.

To date, deep ice cores to bedrock have been obtained from a 1390 m hole at Camp Century in northern Greenland and a 2100 m hole at Byrd Station in Antarctica. Numerous intermediate cores of 100-400 m in depth also have been collected from these ice sheets, as well as in various other parts of the world. Recently, shorter cores have been obtained from glaciers on mid-latitude and even equatorial mountains.

The value of paleoclimatic information from ice cores is widely recognized. Paleotemperature trends, atmospheric turbidity, snow accumulation rates, and volcanic activity are among the more frequently studied climatic parameters related to ice core material. Annual values can be determined in some cases for several millenia, and the total time-scale spans more than 100,000 years for the deep cores.

GD-8 documents most of the ice cores so far collected on a worldwide bases, information on literature sources and on the current status of research activities that may affect the types of data that can be archived. The characteristics and structure of the WDC's data base system for ice core data also are described.

World Data Center publications are distributed without charge to interested individuals and institutions. Address correspondence to: World Data Center A for Glaciology (Snow and Ice), Institute of Arctic and Alpine Research, University of Colorado, Boulder, CO 80309. Telephone: (303) 492-5171.

Environmental Impact Assessment Bibliography

A new reference, *Environmental Impact Assessment (EIA): A Bibliography With Abstracts*, is now available from the R. R. Bowker Company. The volume is divided into five parts covering all aspects of EIA.

Part 1, "Aids to Impact Assessment," describes the various means of collecting and classifying information that are now employed, with 61 models listed and annotated. Also included in this section is a descriptive listing of 112 manuals, presenting a variety of approaches on implementing assessments. "Critiques and Reviews of Environmental Assessments" are covered in Part 2. Here, 27 general reviews, textbooks, and symposia are abstracted. Additionally, 91 various materials critical of EIA are described, as well as a survey of 30 alternative methods for preparing impact statements. Part 3 compares the literature on "Environmental Impact and Other Aspects of Planning" with descriptions of 85 materials. Treated separately in this section is the subject of social impacts and social impact assessment, with 132 studies detailed.

"Environmental Impact Assessment in Selected Countries" comprises Part 4. In the United States, 79 printed works are surveyed on Federal requirements for EIA, and 68 on state and local requirements. Ninety-six publications covering legal aspects are discussed, as well as 60 studies on the effects of EIA on Federal agency decisionmaking. EIA in Canada, the United Kingdom, Australia, and Continental Europe plus other countries completes this section, with a review of some 50 materials for each geographical region.

Part 5, "Information Sources," covers a bibliography of 18 works on various aspects of EIA plus a listing of selected periodicals. Each section of the volume contains a descriptive introduction highlighting the main themes covered and the most important publications. The bibliography is cross-referenced throughout and indexed by author and subject.

Environmental Impact Assessment: A Bibliography With Abstracts is designed for planners in government, private consultants and academic institutions, and for all those in major industry and large-scale development whose planning and decisions affect the human and natural environment, and for libraries serving these groups.

Copies of the 516-page volume are available from R. R. Bowker Company, 1180 Avenue of the Americas, New York, NY 10036 at $59.95 plus shipping and handling.

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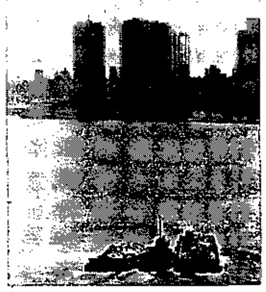
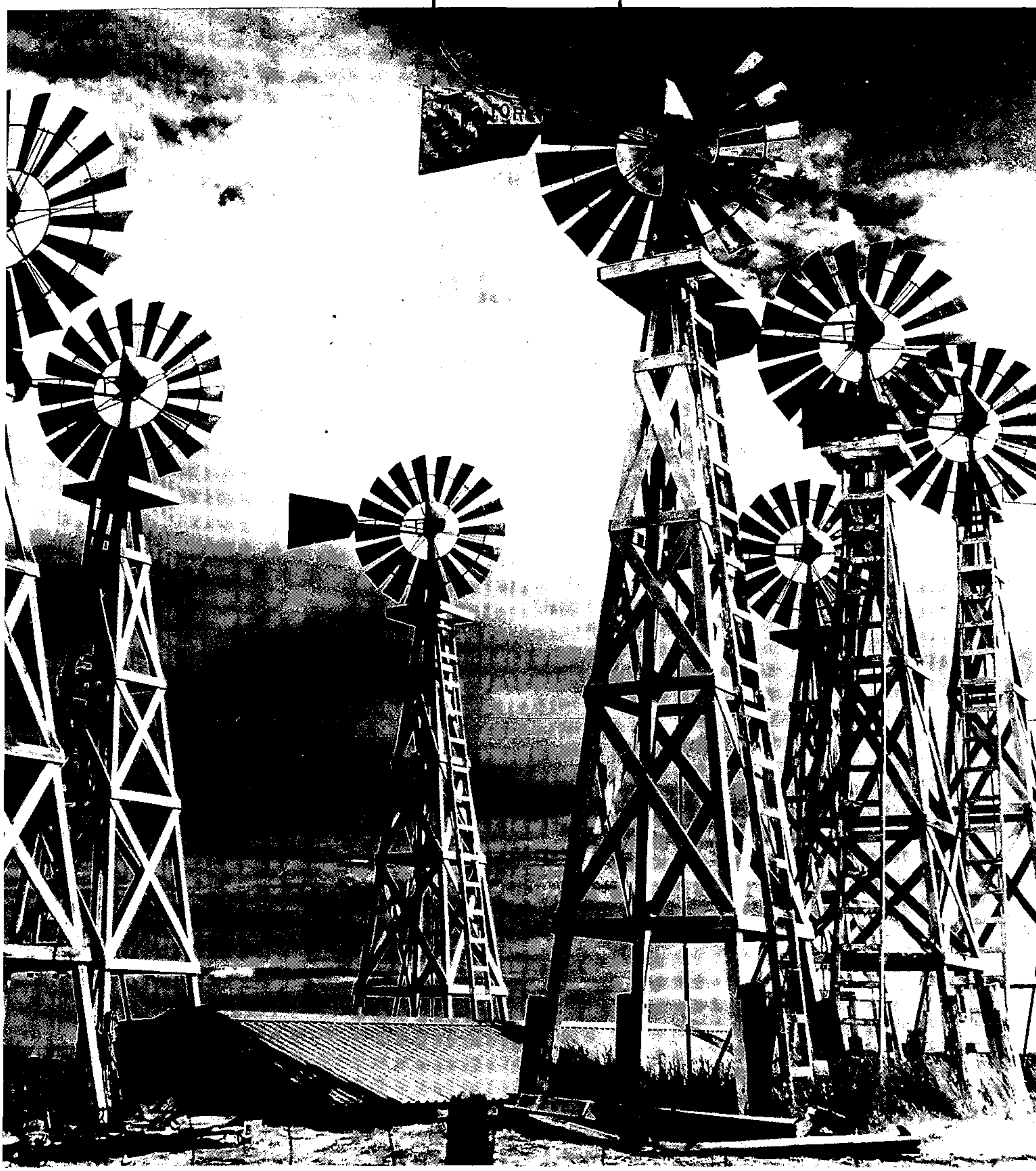


In this issue: *marine pollution data management (p. 3); marine pollution data services (p. 11); and climate and alpine timberlines (p. 19).*

EDIS

Environmental Data and
Information Service
Volume 11, Number 6
November 1980



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Cover: *How the West was pumped. Prairie windmills are still used today to raise cistern stored water for cattle in Nebraska. See article beginning on p. 12 on the use and history of windmills.* *Photo: Leona Smith*

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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, April 16, 1980; this approval expires June 30, 1983.

EDIS (ISSN 0109-3365) is published bimonthly by the Environmental Data and Information Service, NOAA, Page Building 2, Room 533, 3300 Whitehaven St. N.W., Washington, D.C. 20235. For address changes, cancellation, or information write to the Editor at this address. Controlled Circulation Postage is paid to the Finance Department, USPS, Wash., D.C. 20260.

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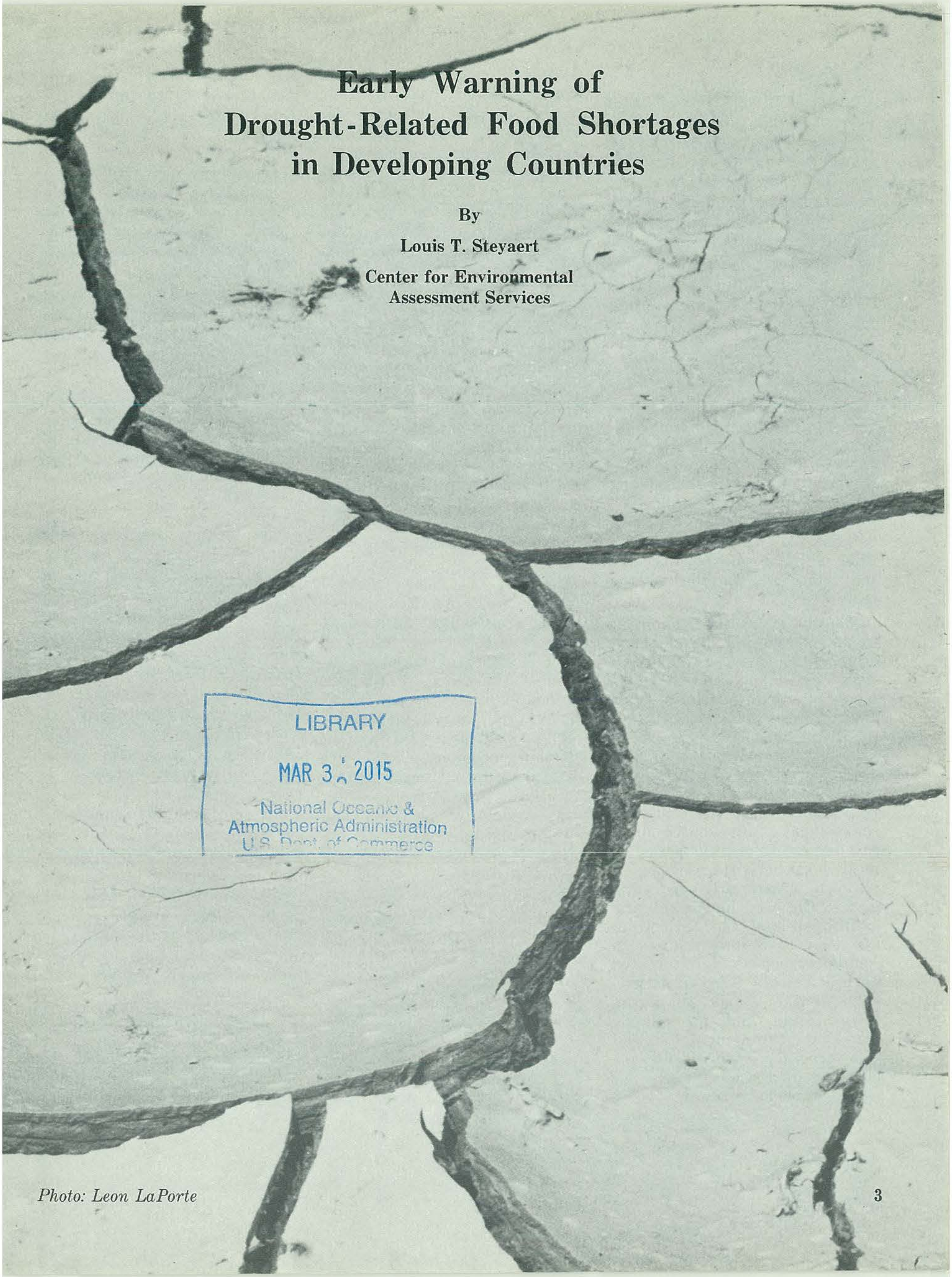


Early Warning of Drought-Related Food Shortages in Developing Countries

By

Louis T. Steyaert

Center for Environmental Assessment Services

Photo: Leon LaPorte

Introduction

Drought is a "creeping" natural disaster which can lead to crop failures and economic losses. Many developing countries in semi-arid subtropical zones are prone to disastrous food shortages and famine. This is particularly true of those countries facing increasing population pressure with diminishing natural resources or uncertain potential for growth in the agricultural sector.

For example, several countries in Africa currently are confronting severe food shortages. These shortages are directly associated with severe drought during critical crop growth stages in 1979. In fact, many countries in Africa also received sub-par rainfall during 1978. In general, these problems parallel those which were experienced in the Sahel Region during the early 1970's.

The risk of food shortages due to meteorological drought is compounded in some cases by less than optimum land-management practices which decrease agricultural productivity. Also, in many developing countries questions involving energy and agriculture are interrelated. Unlike most mid-latitude countries where fossil fuels represent the primary energy source, charcoal derived from wood is used by most households in developing nations, particularly in rural areas. The need for energy and additional land for agriculture can lead to deforestation. In countries such as Haiti, located on the western third of Hispanola in the Caribbean Basin, deforestation and poor land-management practices have lead to severe soil erosion which probably has increased the risk of potential food shortages.

When a country experiences drought-related food shortages, there frequently is a request for international relief assistance. Decisions on such requests must be based objectively on an evaluation of all available information to determine the magnitude of the problem and human needs. A reliable early-warning program designed to alert decision makers to potential problems is a key element of disaster preparedness, as well as a basis to support decisions for assistance. Knowledge of the antecedent conditions associated with the disaster also is important. The information, and particularly the data, necessary to develop an operational early-warning system frequently are quite limited in those developing countries where the potential for drought-related food shortages is greatest.

Because of these considerations, the NOAA/EDIS center for Environmental Assessment Services (CEAS) was asked by the U.S. Office of Foreign Disaster Assistance (OFDA), Agency for International Development, to investigate (1) early-warning procedures for disaster assistance needs associated with drought in developing countries, (2) relationships between large-scale circulation patterns and regional drought, and (3) the impact of deforestation and soil erosion in Haiti.

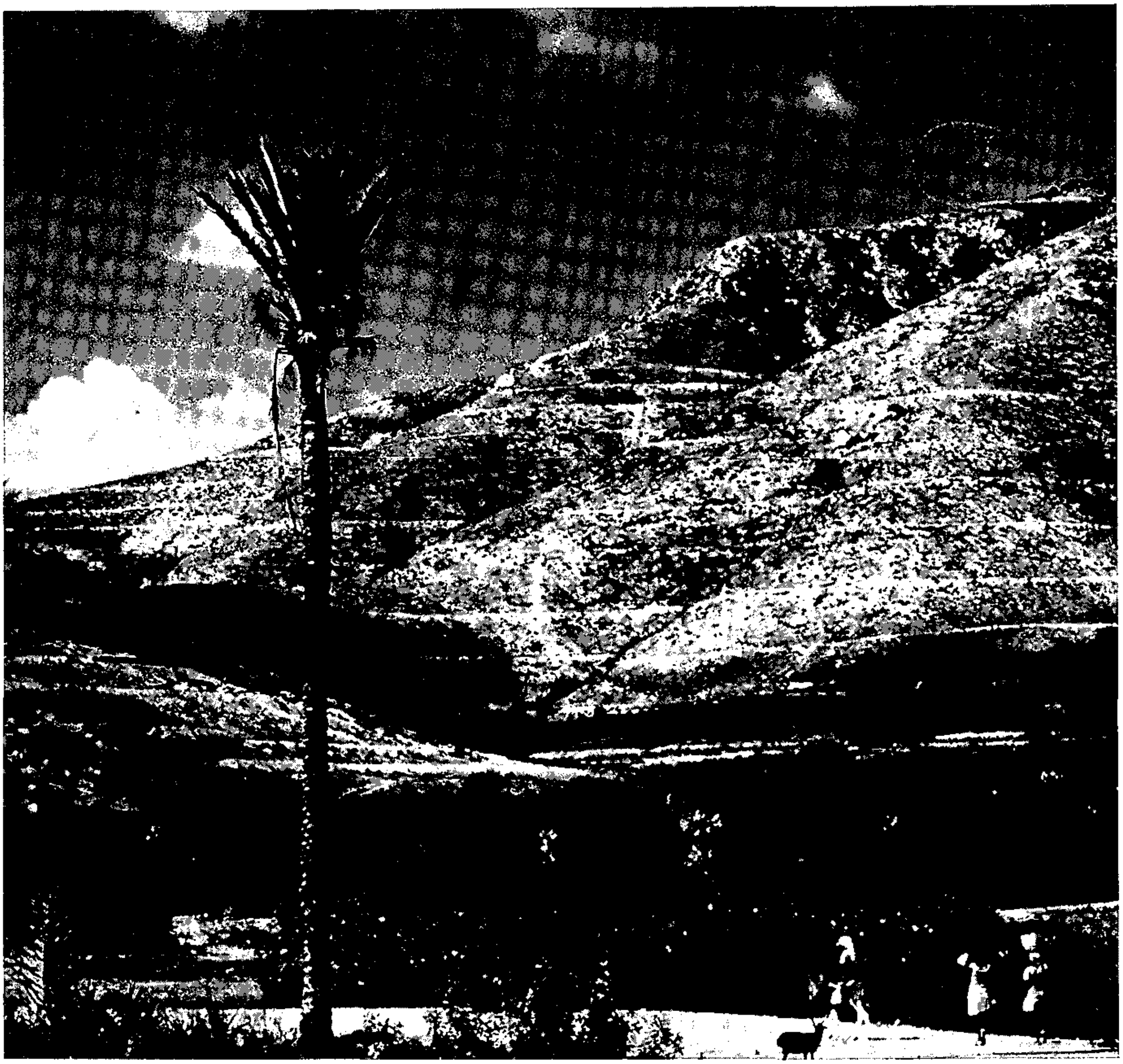
This multidiscipline effort, initiated in 1977, is being conducted by the Climatic Impact Assessment Division (CIAD)-Models Branch located in Columbia, Missouri, and the Climatic Assessment Branch (CAB) located in Washington, D.C. Additionally, the Models Branch of the CIAD also works in close cooperation with the University of Missouri, Columbia in the development of this program.

The goals of the program include:

- providing AID/OFDA with qualitative weekly weather assessment reports on the impact of anomalous weather events and short-term climatic conditions.
- developing an agroclimatic data base to investigate interrelationships among climate, agriculture, food shortages, and deforestation.
- developing a low-cost Climate/Subsistence Food Monitoring System to provide reliable early-warning of potential food shortages due to drought.

The initial project (CEAS, 1979a), *A Study of the Caribbean Basin Drought/Food Production Problem*, was completed in May 1979. Questions involving food security in Haiti were integral to this study. A second study (CEAS 1979b), *Development of Weather-Crop Relationships for Drought-Prone Countries of Sub-Saharan Africa*, was completed in July 1979. Climate/crop assessment procedures proposed by CEAS (1979a,b) for early-warning of drought-related food shortages currently are in the final phase of test and evaluation, and are scheduled to be completed in December 1980. Aspects of these studies recently were discussed at the Conference on Climate and Risk, by Strommen, Krumpe, Reid, and Steyaert (1980).

A current project, "Climatic Analysis and Development of Climate/Crop-Yield Models for Southeast Asia and the Indian Sub-Continent" is scheduled for



Deforested land in Haiti is terraced to conserve water and reduce soil erosion.
Photo: Agency for International Development

completion in May 1981. Two other projects involving analysis for countries in southern Africa and selected countries in Latin America are expected to begin during 1981.

For a given geographic region the above analysis can be subdivided into two broad phases. The developmental phase includes regular weekly weather assessment reports, acquisition of meteorological and other data, climatic analysis, and development of quantitative, early-warning procedures based on climate/crop relationships. The test and evaluation phase is designed to refine, verify, and validate assessment procedures, as well as complete the necessary documentation and computer software to make the system routinely operational.

This paper focuses on the developmental phase and discusses some of the approaches that have evolved as more experience has been gained in working with limited-data countries. For example, limited meteorological and agronomic data frequently preclude the development of a traditional regression-type climate/crop yield model. In such cases an appropriate crop index must be developed. Historical information on the causes of crop failure and occurrences of food shortages is vital to the selection and verification of the index. Furthermore, these studies involve subsistence-type agriculture which has built-in safeguards against adverse climate. The latter include the planting of several diverse crops and extended planting periods at the beginning of the rainy season to guard against short-term dry spells. Additionally, low-yielding, indigenous crop varieties are frequently preferred to improved varieties, due to their higher tolerance to drought. The type of crop and where it is grown also can vary widely in a country, depending on the climate and soil. Finally, the cultural use of water, particularly in rice cultivation, is another factor which must be considered prior to developing even a very simple model.

Weekly Weather Assessment Reports

Initiated by CAB for the Caribbean Basin in late 1977 (LeComte, 1978), assessments currently are made for 18 countries in the Caribbean Basin (27 agroclimatic regions), 50 countries in Africa (109 agroclimatic regions), and 14 countries in southern Asia (107 agroclimatic regions). Climatological normals, satellite imagery, weather charts, and statistical summaries of daily synoptic weather reports from 8,000 plus stations received over the WMO Global Telecommunication System are some of the primary input data. Anomalous weather events, weekly weather, and short-term climatic conditions are discussed, as appropriate, for each agroclimatic region.

Daily weather observation either are limited or non-existent for some regions. Missing or incomplete reports, inadequate spatial coverage, and erroneous reports represent some common limitations. These problems preclude the development of computer software designed to provide a straight-forward statistical summary of rainfall data for use in preparing the weekly assessments or for input to the crop models. In this regard, CAB performs two functions which are critical to the success of the overall program. These involve quality control of the data and in many cases estimation of daily precipitation from a variety of sources as discussed by LeComte (1978) and by Strommen, Krumpe, Reid, and Steyaert (1980). The importance of this facet of the program should not be underestimated. Several highly drought/prone regions which are susceptible to food shortages are exactly those regions where quality control and estimation of precipitation data are required.

The Data Base

The meteorological data base consists of long-term records of monthly precipitation and mean temperature data for the Caribbean Basin (1920-1978), Sub-Saharan African countries (1950-1977), and southern Asia (1950-1979). Monthly maximum and minimum temperatures, the number of rainy days, cloud cover, and humidity data also have been assembled for some countries in southern Asia. Other supporting data include monthly upper air and marine data (i.e., sea surface temperature and sea level pressure), which are used to examine relationships between large-scale circulation patterns and drought.

Agronomic data include crop statistics (i.e., acreage, production and yield) as available, crop calendar information, management and agricultural practices, and "technology" data for southern Asia. Technology data generally include gross fertilizer application (usually at the national level), percent area planted to high-yielding varieties, and percent area irrigated.

The episodal data include documented reports on the historical occurrences of drought, flooding, damage due to hurricanes or typhoons (as regionally appropriate), crop failure or damage due to these factors or others such as plant disease or pests, incidences of civil unrest and other non-weather factors likely to have been disruptive to agriculture production, and incidences of abnormal food shortages or famine.

Sources for meteorological data included WMO records, official government publications and records obtained through the cooperation of officials in many of the countries under study, and published reports of various research groups. Frequently, the data available from separate sources were compared for consistency. Agronomic data, if available, were obtained from agriculture reports or published research studies. Episodal data were primarily obtained through an extensive literature search and through personal interviews with knowledgeable officials. Most episodal data are qualitative in nature.

Because the availability and quality of these various types of data range from adequate to limited, an attempt was made to augment possible deficiencies in one data set with information from an associated data set, particularly, if crop-yield data were considered unreliable. Important considerations addressed through integrated analysis of these data bases included: (1) the determinants of crop yield, (2) the relative importance of non-weather and weather factors to crop failure, (3) unique characteristics and problems associated with local agriculture practices, (4) the relationship between crop failure and abnormal food shortages, and (5) the type of modeling approach best suited for a given region.

Crop Modeling Approaches

Because of data limitations, traditional climate/crop yield models, such as discussed in *EDIS* (1979) and Hill, *et al.* (1980), could not be developed in many cases. The availability and quality of both historical and real-time data determine the appropriate type of modeling approach. The modeling was restricted primarily to the impact of drought in semi-arid regions and did not address the impact of excessive moisture conditions or flooding. Physiologic damage to a crop due to drought generally results in yield reductions which have an approximate direct relationship with drought severity. However, crop damage due to excessive moisture or flooding

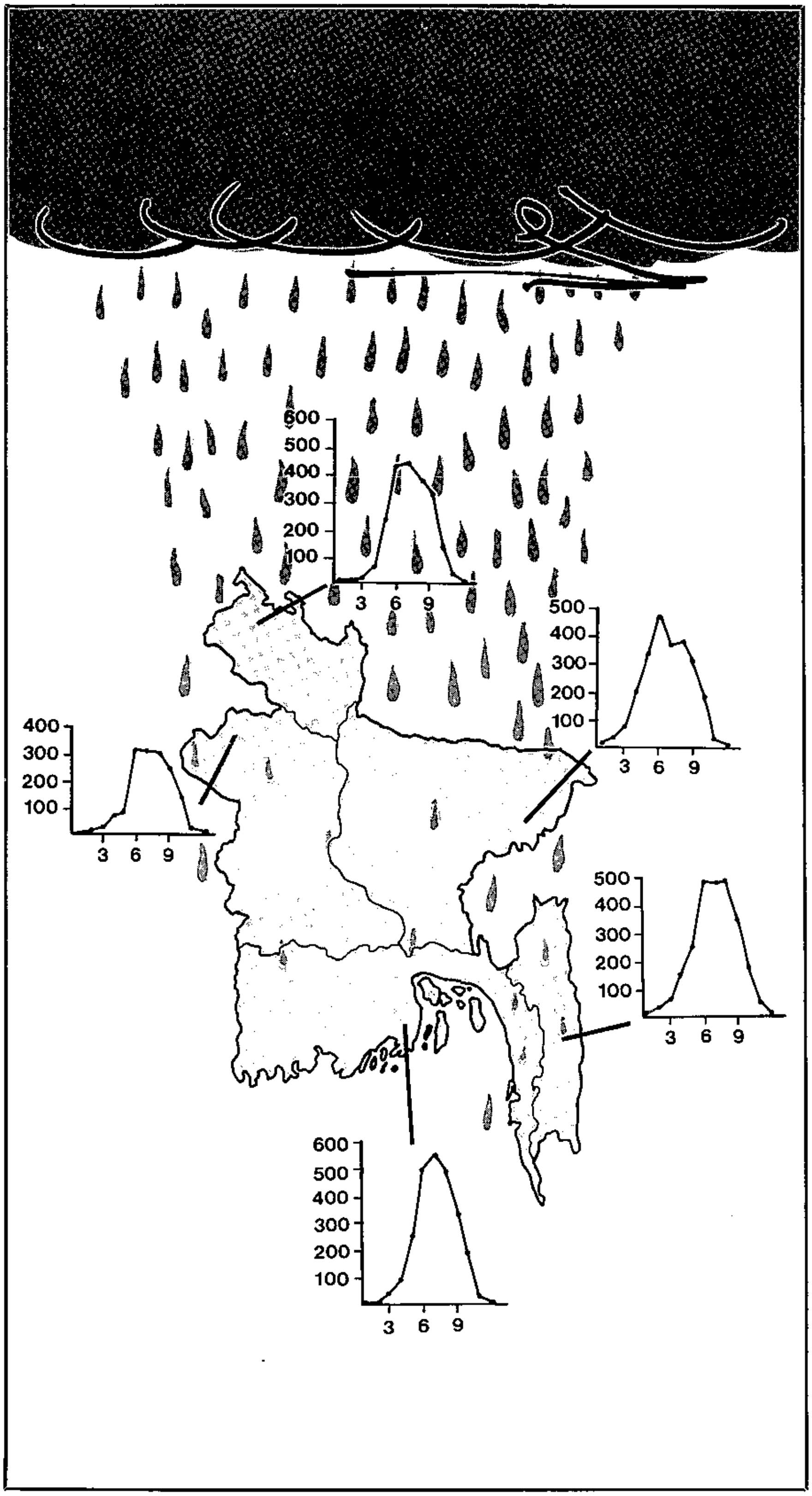
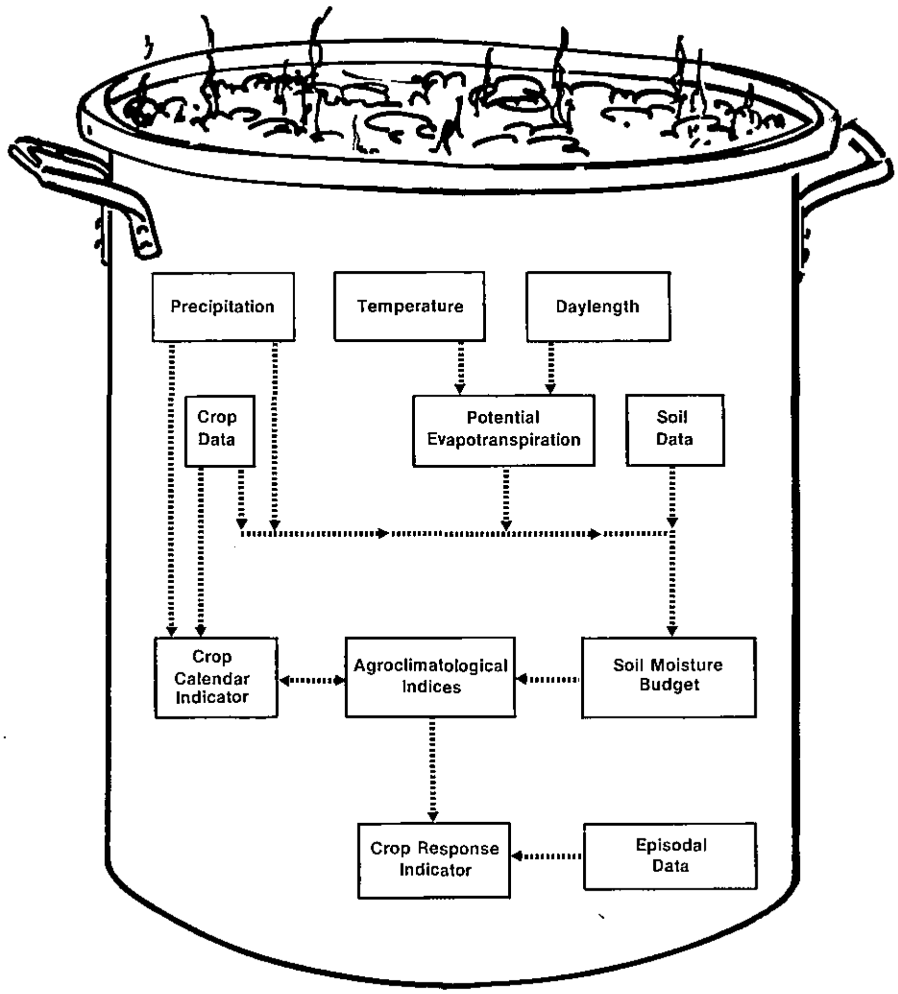


Figure 1. Bangladesh mean monthly rainfall (mm) by agro-climatic regions.



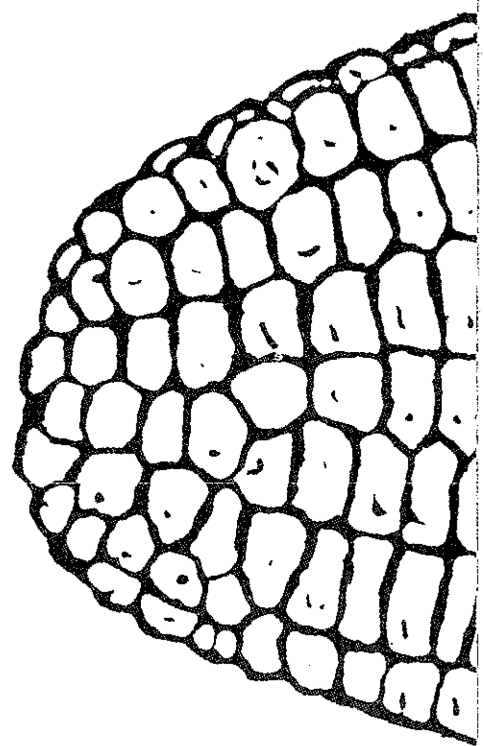


Figure 2. Inputs and outputs for a model that predicts probable crop response to weather events.

is a more complex problem, in that physical and/or physiologic damage can occur. Another requirement was that predictor variables must be physically related to the biologic requirements of the crop and, ideally, the primary factor associated with year-to-year variations in yield.

Whenever feasible an attempt was made to develop more than one type of model for a given crop. This permits crop conditions to be assessed in terms of the known strengths and weaknesses of particular crop models.

Models were developed for agroclimatic regions generally defined according to such factors as climate, cropping practices, and soils information. Figure 1 shows the agroclimatic regions for Bangladesh, as well as the distribution of "normal" precipitation for each region. (If feasible, the agroclimatic regions are defined for use in both crop modeling and weekly weather assessments).

Figure 2 shows the various inputs and outputs for the agroclimatic analysis used in this modeling. For example, monthly precipitation, temperature, and daylength are used in conjunction with crop and soil data to derive a soil moisture budget, various agroclimatic indices, and information to verify the "fixed" crop calendar. Crop data include results of controlled experiments in which climate/crop relationships have been investigated and quantified.

The primary output is the Crop Response Indicator which should be, a priori, related to year-to-year variations in yield, i.e., a predictor variable. As discussed above, episodal data and information on cropping practices were used to verify the physical importance of this variable to the crop.

Three types of climate/crop-yield models were developed, depending on the quality of the data. In countries where at least marginal crop-yield data were available, the more traditional

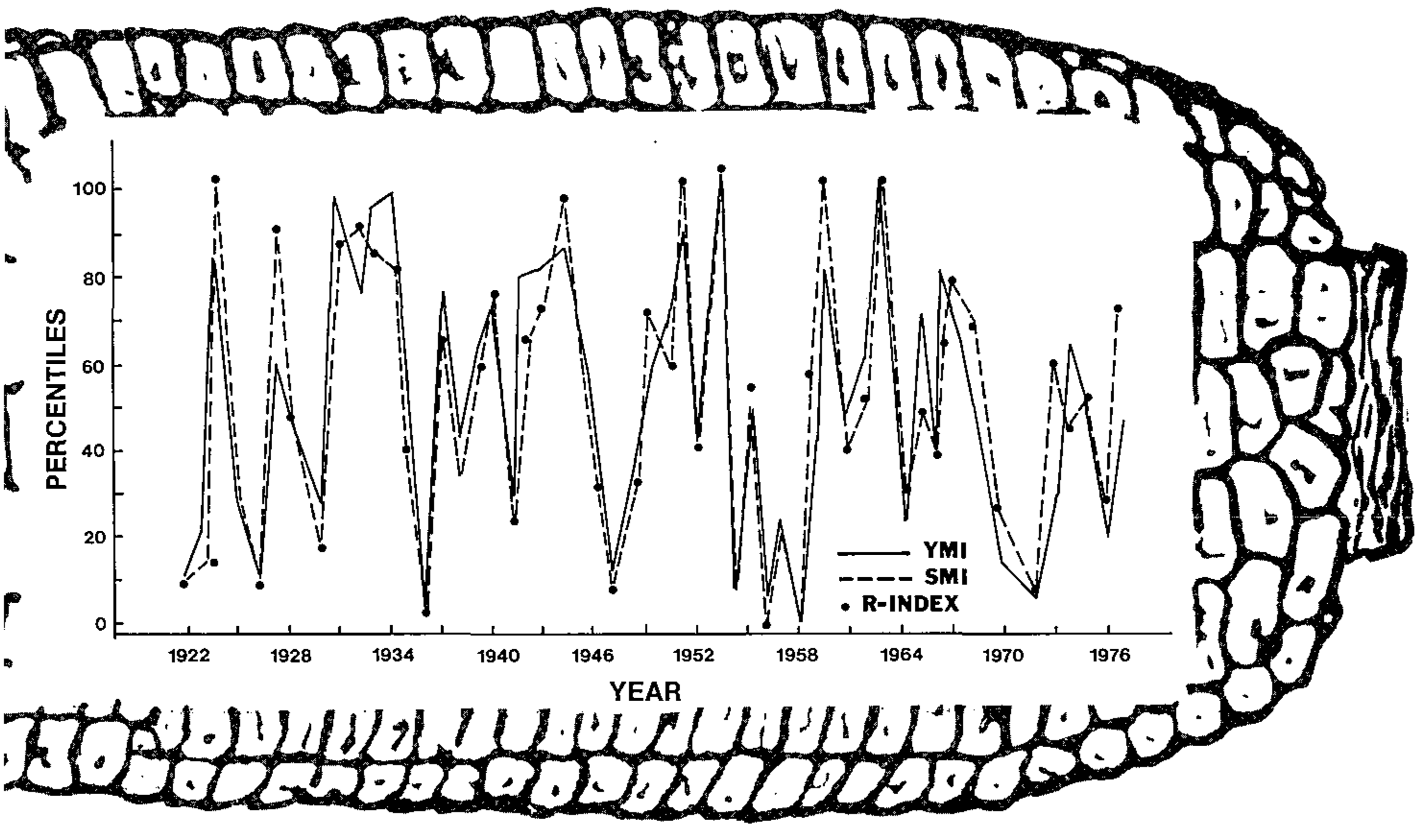


Figure 3. Three response indexes for Cap Haitien, Haiti corn.

linear regression of yield with respect to agroclimatic predictors was used.

The second approach involved the use of traditional climate-crop yield models as analogues for other regions to provide relative yield information. Analogue regions were defined as having climatic conditions and cropping practices very similar to the region which had available climatic data, but limited crop-yield data.

The third approach was based on agroclimatic crop indices developed from historical data and used to provide relative yield information. For example, Figure 3 shows the application of three different agroclimatic crop response indicators to develop historical indices for corn at Cap-Haitian, Haiti. The indices have been expressed in percentiles determined for the years 1922-1977.

The R-index and Soil Moisture Index (SMI), are based on soil moisture accounting procedures. The index labeled "YMI" is based on cumulative precipitation weighted according to the specific water requirements of corn during the planting, vegetative, and flowering growth stages. At this particular location the indices are very consistent with one another; however, differences among the indices would suggest a potentially anomalous year.

Crop indices such as those in Figure 3 can be used to provide relative yield information after the historical occurrences of crop failure or food shortages have been used to verify and interpret the index. For example, drought was reported in northern Haiti during 1947, 1956-1958, and the early 1970's. Corresponding to these drought years were abnormal food shortages reported during 1948, 1959, and 1970's.

Climatic Analysis

Climatic analysis for these NOAA/AID projects also involves examination of seasonal rainfall data for short-term

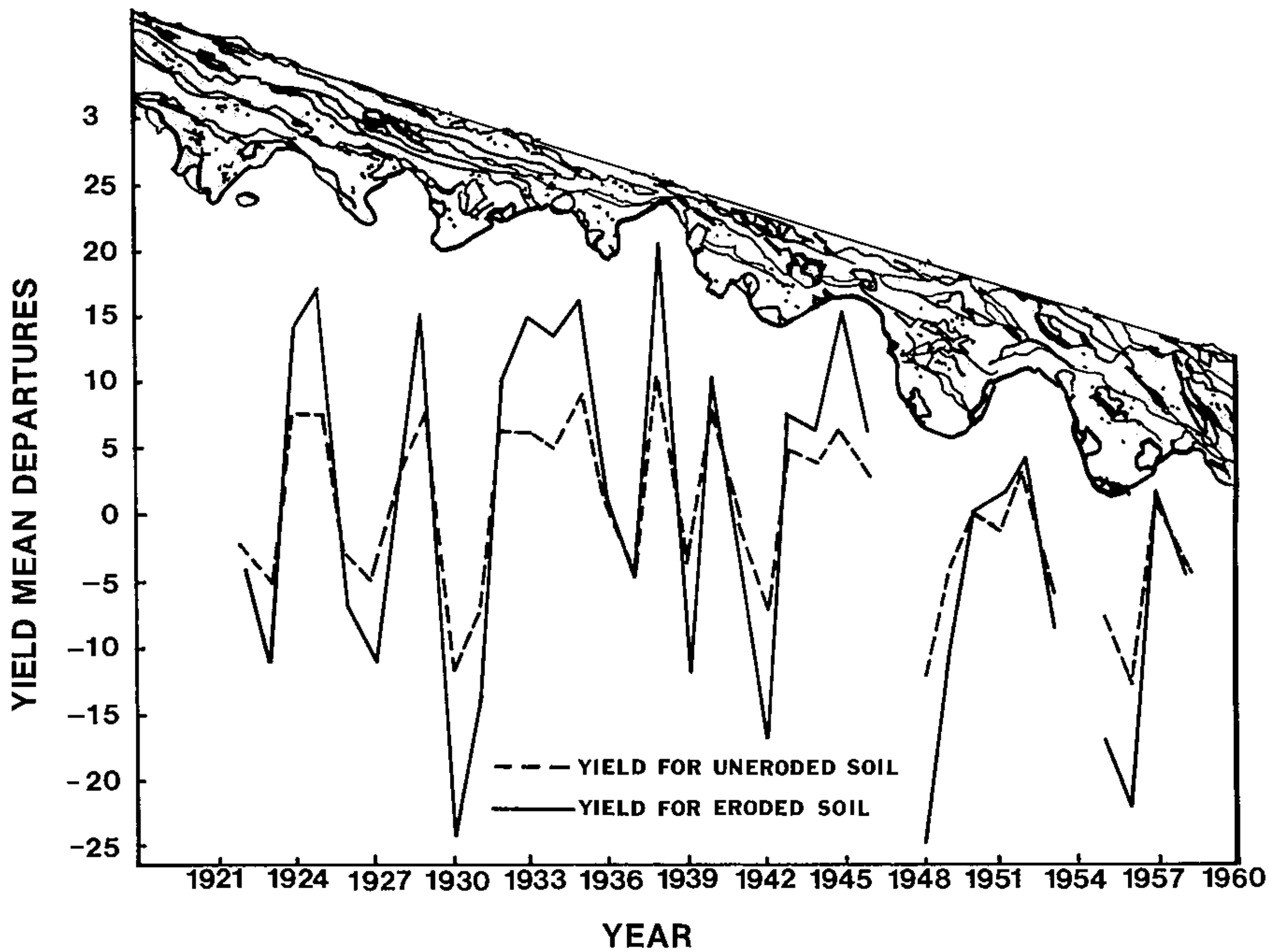


Figure 4. Impact of soil erosion on corn yield, Port-de-Paix, Haiti.

trend, possible changes in variability, or other unusual behavior which would be of importance to potential food supplies, agricultural planning, or land-use considerations. Another goal is examination of possible relationships between large-scale circulation patterns and seasonal rainfall to gain a better understanding of regional drought.

Climatic analysis for the Caribbean Basin as discussed in CEAS (1979a) was undertaken as a necessary step to investigate possible environmental reasons for the frequent occurrence of disastrous food shortages in Haiti, but not in adjacent countries. For example, some of the explanations for the drought-related food shortages in Haiti during the period 1975-1977 included: (1) recent large-scale climatic change in the Caribbean Basin, (2) microclimatic change leading to reduced rainfall in Haiti as the result of massive deforestation, or (3) "pseudo-drought" conditions associated with soil erosion.

Seasonal rainfall data (1920-1978) from approximately 75 stations in the Greater Antilles were analyzed for climatic change. Analysis suggested that: (1) extreme drought conditions tend to occur simultaneously in one or more countries. In 9 of 12 years when Haiti experienced severe drought, drought conditions of at least the same magnitude also were observed in at least two adjacent countries (Dominican Republic, Jamaica and Puerto Rico); (2) although the 1970's were relatively dry years, climatic conditions were not statistically different from previously observed conditions; (3) although seasonal rainfall data for the period 1920-1978 revealed essentially random behavior, there have been short-term trends towards increasing or decreasing rainfall during the period. These short-term trends are associated with 25-30 year fluctuations in the data and are of importance to agricultural production.

Diagnostic analysis of upper air data for the Caribbean Basin and of seasonal rainfall for the period 1958-1978 suggested that: (1) anomalously cool (warm) conditions within the lowest 1.5 km layer of the atmosphere are associated with drought (wet) conditions in the Greater Antilles; (2) increased (decreased) atmospheric stability within this same low-level layer is associated with dry (wet) conditions; and (3) regional drought in the Greater Antilles region can be linked directly to anomalous large-scale circulation patterns.

Microclimatic change in Haiti also was considered as a possible reason for frequent abnormal food shortages. However, a more plausible explanation was first made by Ewel (1977). He suggested that soil erosion has reduced the water holding capacity of the soil, thus, reducing potential soil moisture reserves and increasing the vulnerability of crops to short-term dry-spells. Ewel termed this condition "pseudo-drought".

An analog corn-yield model was used in scenario analysis to investigate "pseudo-drought" conditions at Port-de-Paix, Haiti (CEAS 1979a). Figure 4 shows a portion of the simulated yield data (expressed in departures from the mean) for the period 1921-1960. The same climatic data were used as input to the model to generate separate time-series of yield for "eroded" and "uneroded" soils. Yield for the eroded soil was 30 percent lower than the yield for the "uneroded" soil. Furthermore, the variance of corn yield for the "eroded" soil was more than *four* times as large as for the "uneroded" soil.

This analysis suggests that "pseudo-drought" associated with soil erosion and the subsequent reduced water holding capacity of the soil is probably the key factor in the frequent occurrences of drought-related food shortages in Haiti. This should represent useful information to those involved in long-term agricultural planning and development of a food security program for Haiti.

Concluding Remarks

The EDIS-developed climate/Subsistence Food Monitoring System is designed to provide reliable early-warning information on the potential for disastrous food shortages due to drought in developing countries. It is sufficiently general to consider the various crops produced in subsistence-type agriculture (corn, millet, beans, rice and others), yet sufficiently economical for practical real-time operation. Preliminary results from the test and evaluation of the system are very encouraging.

This program complements similar programs of FAO. Representatives of USAID, NOAA/EDIS, and USDA currently are working to make the system operational.

An important side benefit of these NOAA/AID projects is the acquisition of substantial climatological data from many remote regions of the world. EDIS will make these data bases available to other users as soon as possible.

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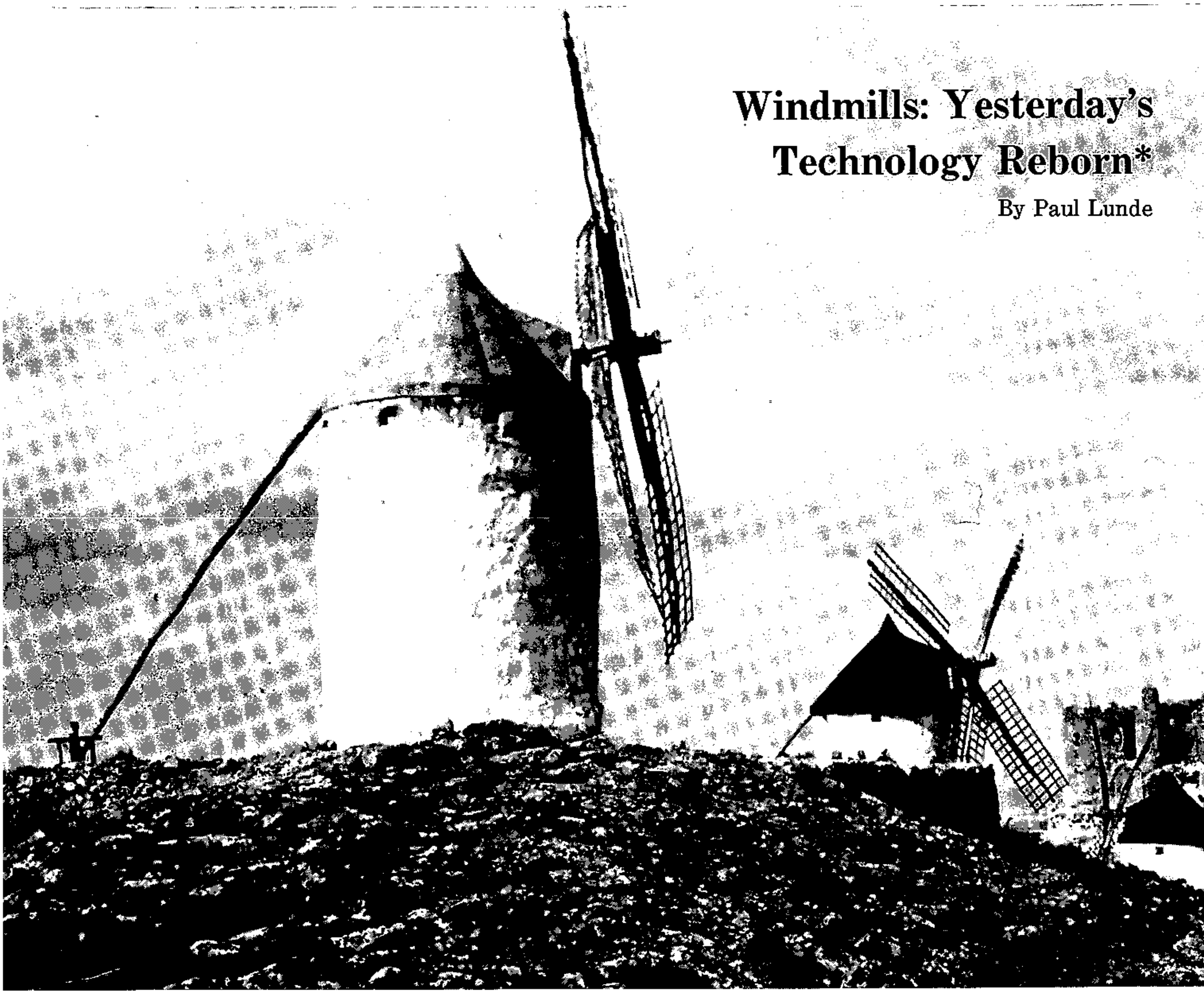
Windmills: Yesterday's Technology Reborn*

By Paul Lunde



In what might seem an ironic footnote to the history of energy, mining engineer Karl Twitchell, in 1931, put up a 16-foot windmill in Jiddah, Saudi Arabia to help pump water. Today, Twitchell's windmill no longer seems odd, because the windmill, as a source of energy, is reentering history.

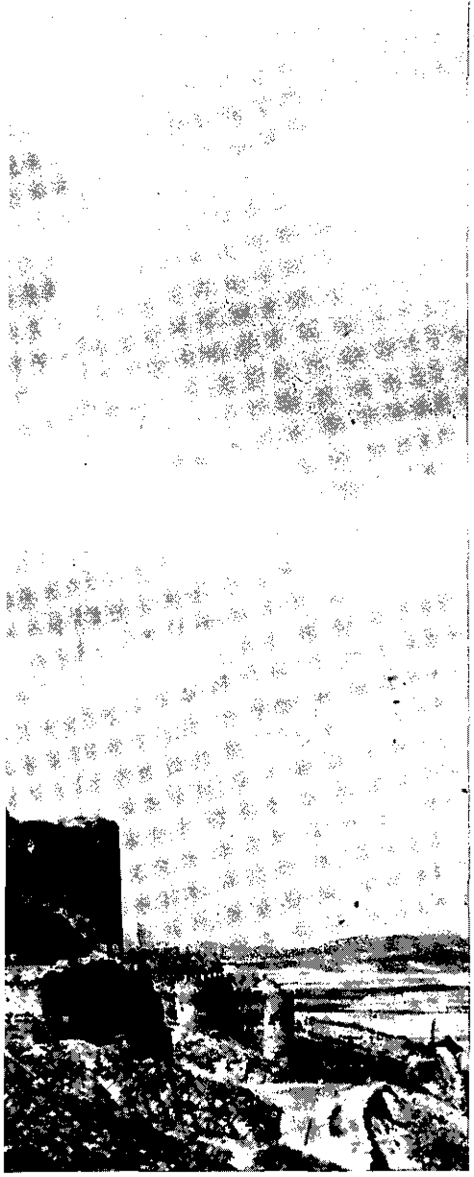
In the fall of 1979, for example, the government of Quebec announced it would build an experimental $17.5-million, 327 foot-high windmill to generate electricity—a recognition of the continuing energy crisis. And Quebec's windmill is only one of many that governments, companies and individuals were constructing in late 1979.

In Yorkshire, England, Sir Henry Lawson-Tancred of Aldborough Manor has already built two experimental windmills and plans, eventually, to manufacture and sell them.

Standing on a rise amid the rolling farmland of Yorkshire, Sir Henry's windmill—or, more accurately, wind turbine—is distinctly different from the windmills of the past. Its blades—56 feet in diameter—are bigger, its ball bearings are more efficient and its gearing and alternator systems are adjusted to permit unattended, wholly automatic operation.

The blades, moreover, unlike the windmills of Holland in other days, are exeptionally light; they are built of hollow fiberglass panels affixed to a steel frame. At speeds of about 30 miles per hour, they can generate an estimated

*Condensed from *Aramco World Magazine*, where it appeared under the title "Windmills: From Jiddah to Yorkshire".



The 16th century windmills of La Mancha immortalized by Cervantes' Don Quixote.
Photo: Ralph Kresge

100 kilowatts—enough electricity for 25 average American homes.

Because the problems of storing power have yet to be solved, Sir Henry's wind turbines—called "Aldborough aerogenerators"—may have a limited market; batteries would cost nearly as much as the turbines. But in some areas of Britain, such as the Hebrides, Wales and the west coast of Scotland, the wind is so strong and constant that wind turbines could prove invaluable, says Rupert Nichols, an aide to Sir Henry. Because the turbine is almost wholly automatic—a satellite windmill on the top of the tower, for example, turns the main blades into the wind automatically—and because it can be shut down in high winds, the turbines could provide small communities and farms with electricity as efficiently as central urban generators do now.

Another, much bigger, experiment is underway in Boone, North Carolina, where the Department of Energy and NASA have built the world's largest wind turbine: a $21-million giant with blades 200 feet in diameter. This turbine, part of the U.S. government's experiments with wind power, can generate two megawatts of electricity—two million watts—from winds of 25 mph, enough to service 500 homes.

Despite the difference in size and output, however, the purpose of the windmills in Quebec, Yorkshire and Boone is the same: to produce power for the present with the technology of the past.

Until the energy crises reminded the industrialized world that petroleum reserves were not inexhaustible, windmills, to most people, were quaint relics of the past—charming structures that were particularly popular in The Netherlands or associated with the story of the gallant Don Quixote. Yet when Cervantes wrote in the 16th century, windmills were a common feature of Renaissance technology in Europe—a technology which would eventually culminate in the Industrial Revolution.

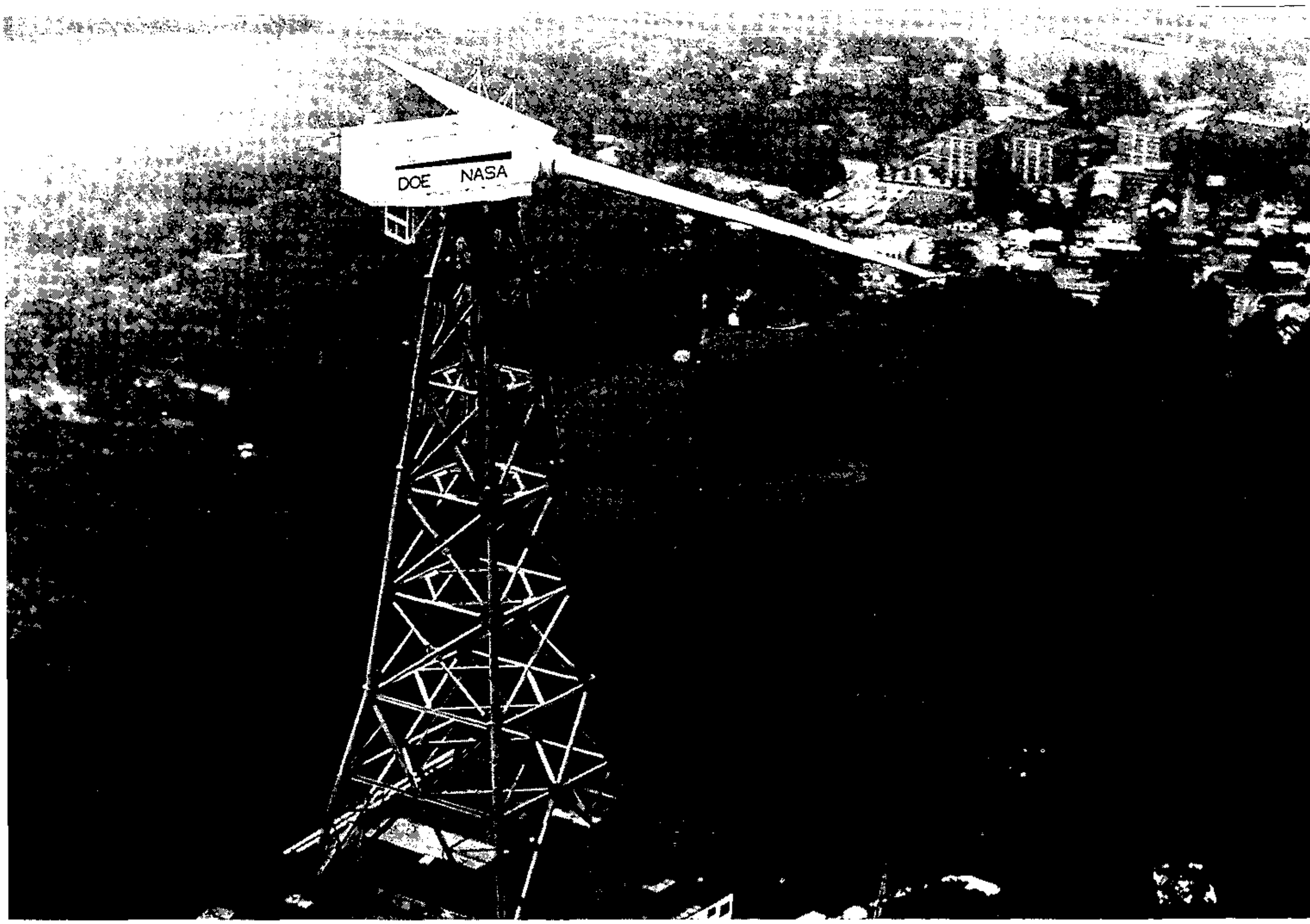
The Industrial Revolution, of course, had to await the invention of the steam engine. In the meantime man's sources of power were limited to his own muscles, draft animals, the watermill and—from the 12th century on—the windmill.

The watermill was known to the Romans' but the windmill did not appear in Europe until the beginning of the 12th century, when it was used for ginding wheat in Normandy. Thereafter windmills spread rapidly throughout Europe and in the early 15th century the Dutch began to use them to pump water out of the marshes and reclaim land from the sea.

Oddly, the windmill, like the tulip—both of which Holland made famous—came from the East: the tulip in the 16th century from Turkey, and the windmill via a longer and more circuitous route.

The first known reference to windmills is in a Hindu book written about 400 B.C., and Hero of Alexandria, a Greek inventor of the third centry B.C., described a small wind-driven "motor" which he had designed to provide air pressure for an organ. There are also references, in 400 A.D., to wind-driven prayer wheels in central Asia, where they are still used today. But Hero's "motor" was really just a toy and although the prayer wheels did embody the principle of the windmill, they never seem to have been developed beyond their initial function. Like other innovations in technology, the windmill was brought to the West by the Islamic world.

The first definite reference to the use of the windmill came early in the Islamic period. 'Umar', the second caliph, had heard that a Persian in his entourage had boasted of being able to construct a wind-driven mill. When challenged to do so, the Persian said, "I will build a mill of which the whole world will talk." Unfortunately, he never



did, but the story shows that windmills were known in Persia in the early seventh century—a fact confirmed by Arab geographers writing somewhat later.

Al-Maśudi, for example, writing in the 10th century, notes that windmills were used in Sijistan to raise water for irrigation, as well as for grinding corn. Still visible today, these mills are scattered through the huge arid expanse between Mashhad and the eastern border of India where, probably, the windmill was invented.

In the 13th century, the Arab writer al-Dimashqi described a typical mill of Sijistan. From this description, these mills were very simple. A hopper filled with grain rested on a fixed stone which had a hole in the middle to allow the grain to sift onto the surface of the lower, moving, stone. That was in turn attached to a vertical axle to which sails—fabric-covered ribs—were affixed. But at some unknown date, this arrangement was reversed so that the sails were above, the hopper and the millstones were below, and the top millstone was the one that moved.

Windmills like this are still used in some parts of Iran and Afghanistan, and it has been estimated that they generate about 75 horsepower and can grind a ton of wheat every 24 hours.

During the Middle Ages improvements in gearing, and the development of watermills with a horizontal shaft and a vertical wheel, led to an increased power output. These improvements were applied to windmills when they were introduced to the West and gave them their characteristic form. In the Middle East, windmills were used more extensively than watermills. Although tidal mills were used in Basra, at the head of the Arabian Gulf, there were few fast-running streams elswhere that would make the construction of watermills practical. Windmills were used, for example, in today's Iraq, as part of the elaborate irrigation systems in that area,

World's largest windmill in Boone, N.C., part of the Department of Energy's alternate energy test program.
Photo: Dick Pebody

WIND ENERGY PROGRAMS AT THE NATIONAL CLIMATIC CENTER

The National Climatic Center (NCC), Asheville, N.C., has been involved in the Federal Wind Energy Program from its inception in the early 1970's. NCC archives, summarizes, and disseminates the majority of wind data collected in the United States.

Engineering and meteorological communities involved in the national wind energy program met in a workshop atmosphere at the NCC in 1974 to discuss meteorological problems encountered in site evaluation, data requirements, and engineering design. Results of an NCC data survey and the workshop discussions were published in *Initial Wind Energy Data Assessment Study*, May 1975. More detailed catalogs of NCC's available summarized and original wind data (in manuscript, digitized, and strip chart form) were published in *Index - Summarized Wind Data*, September 1977, and *National Wind Data Index*, December 1978. The latter publication also contains the anemometer height and location information required for standardizing wind data to a constant height.

In 1975, in response to a request from Sandia Laboratories, pertinent wind summary data for 750 stations were extracated and keyed to magnetic tape. The resulting Sandia publication, *Wind Power Climatology of the U.S.*, included the first assessment of seasonal and annual wind power variability on a national basis.

In the current Department of Energy Federal program, all wind characteristics research is managed by Battelle's Pacific Northwest Laboratory in Richland, Washington. To help guide homeowners and utilities in decisions concerning the use of wind as an energy source, Battelle is assessing the wind resource by dividing the United States into 12 regions and evaluating all wind data avaibable within each region. NCC furnished Battelle 600 station tapes of hourly wind data as part of this assessment. Battelle utilized the data in producing over 50 sets of wind energy-related statistics including mean and cumulative wind power, durations below cut-in and exceeding cut-out speeds, and wind power by direction and interannual variability of power for each station and anemometer height. These data, together with Forest Service, EPA, and state-collected data, were used in the recently published *Wind Energy Resource Atlas - Vol. I, Northwest Region*. The final set of approximately 200,000 tables on 600 microfiche will be archived at NCC and used to answer user requests.

Battelle Northwest also serves as the lead agency in the selection and evaluation of sites for current and future wind turbines developed by DOE/NASA. Meteorologists from the NCC have served on panels selecting appropriate sites for meteorological towers and evaluating data received for wind turbine siting. The NCC has agreed to archive the multi-level wind data for 15 current and approximately 18 planned additional locations.

The Center also is extracting and digitizing selected, summarized wind data for 3,000 locations in Africa, South America, Australia, Europe, and Asia. Data will be furnished to Battelle for an assessment of international wind power potential to be presented at a United Nations-sponsored symposium early in 1981.

and in Egypt, for crushing sugar cane on a large scale. It was from Egypt, in fact, that the Spanish, in the early 16th century, recruited technicians to build windmills in the West Indies.

Today, windmills are not found in the Middle East, except in Iran and Afghanistan. The Mongol conquests of the 13th century destroyed the irrigation systems, and with the decline of the sugar industry in Egypt they fell out of use there as well. The availability of cheap fuels did the rest and even in Iran and Afghanistan today, the old windmills have for the most part fallen to ruins.

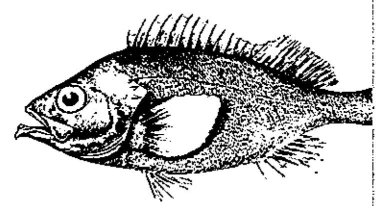
Fortunately, the principle of the windmill had been brought to Spain and Portugal by the Arabs before the Mongol invasions, and this principle, combined with the technical advances which had previously been made in water-mill construction, gave Europe an inexpensive and efficient source of power.

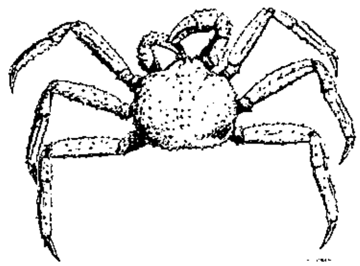
Critical Fishery Species in Alaska Offshore Oil and Gas Lease Areas

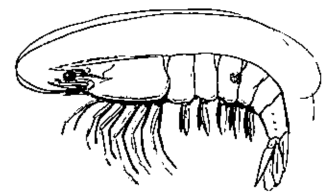
By

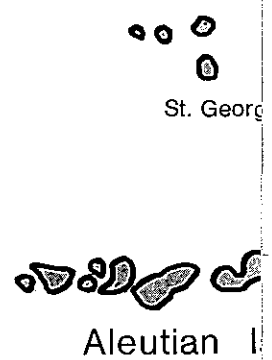
Jan Arbegast*

and Marilyn Allen**









Offshore oil and gas development in Alaska is governed through sales of lease blocks within a designated lease area. The Department of the Interior through the Bureau of Land Management (BLM) manages these sales and prepares the necessary Environmental Impact Statement prior to each sale.

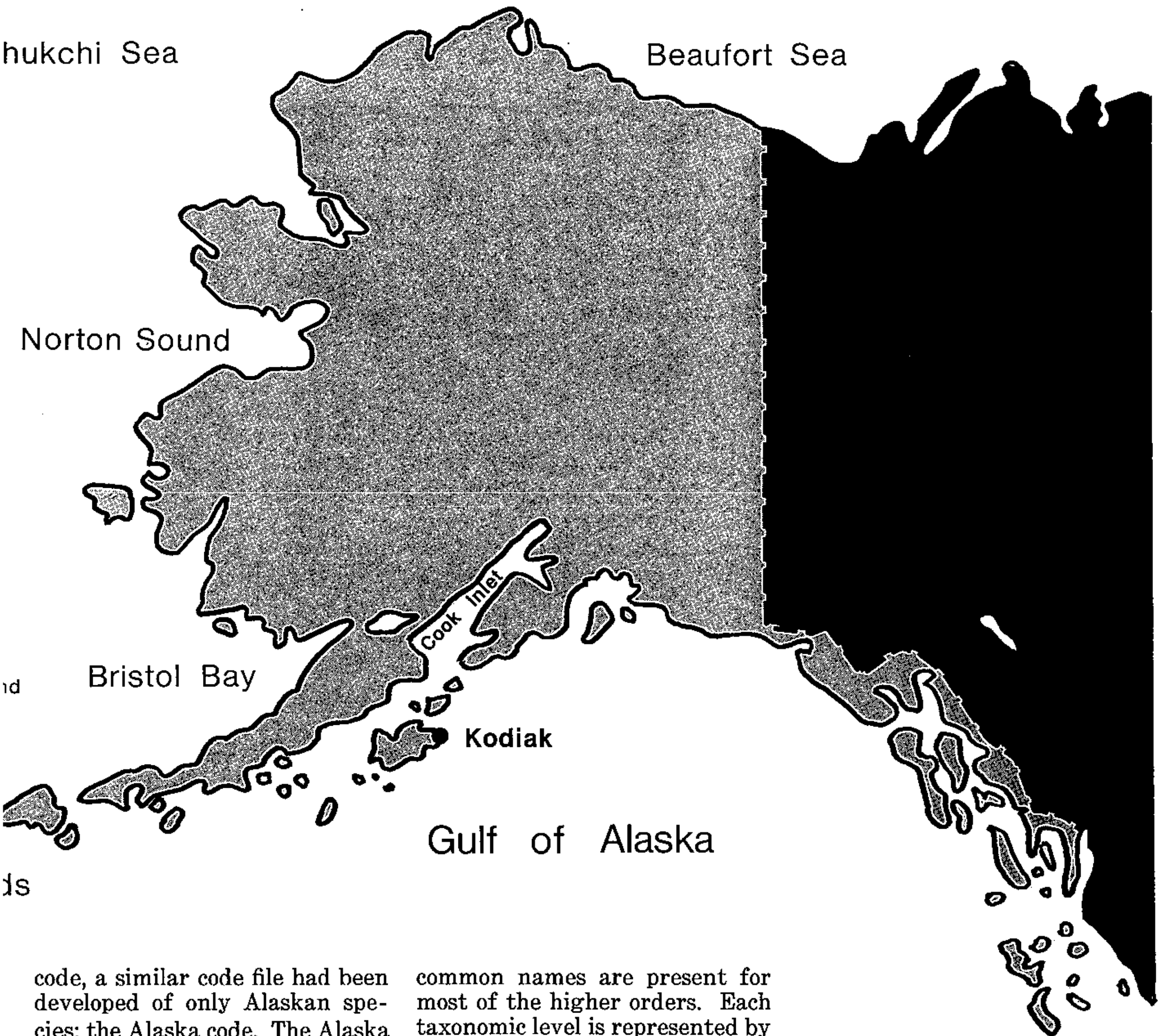
BLM and the National Oceanic and Atomospheric Administration (NOAA) are involved in the Outer Continental Shelf Environmental Assessment (OCSEAP) Program. OCSEAP was initiated by BLM to help assess the impact of outer continental shelf oil and gas development on the environment. NOAA OCSEAP offices conduct study programs for BLM. Data collected in the disciplines of marine biology, chemistry, physics, and geology/geophysics are processed and submitted to the NOAA/EDIS National Oceanographic Data Center and National Geophysical and Solar-Terrestrial Data Center.

Fishery data collected for the OCSEAP Program now have been combined in tabular form with Alaska oil and gas offshore lease area designations. The resulting product provides an important descionmaking tool by linking critical crustacean and fishery species with their associated lease areas. The table of 34 species and 8 lease areas provides a means of bridging the gap between the scientist and the manager involved in the sale decisions.

The scientist submits all OCSEAP data in code form. All species now are coded using the National Oceanographic Data Center's (NODC) worldwide taxonomic code file. (See *EDIS*, September 1980, p.13.) Prior to the development of the NODC

* Bureau of Land Management

** Arctic Environmental Information and Data Center



code, a similar code file had been developed of only Alaskan species; the Alaska code. The Alaska code contained many gaps and problems and was replaced by the more complete NODC code. The equivalent Alaska code number, if one exists, is noted in the code file maintained at NODC, but only the NODC code is now updated. Both taxonomic code numbers are present in the tabular product.

The NODC taxonomic code covers a worldwide distribution of flora and fauna from viruses through mammals. Accepted common names are present for most of the higher orders. Each taxonomic level is represented by a 2-digit number. There are five taxonomic levels, not including possible variations within a level (suborder, subfamily). These levels are phylum, class, family, genus, and species or class, order family, genus, and species. Variations such as suborder are recognized by a variation within the 2-digit order level. Subspecies are recognized by the addition of 2 digits at the end of the 10 digit species code. The organization of the code file enables an animal to be coded to the level at which it

Map of Alaska indicating nine lease areas. Top fish is ocean perch, middle is pink shrimp, bottom is pink salmon. On left is king crab.

CRITICAL FISHERY SPECIES IN ALASKAN OFFSHORE LEASE AREAS

Taxonomic Name	AK CODE	NODC Code	57	60	70	71	75	83	85	55
Pandalus borealis (pink shrimp)	5333040101	6179180101		X	X		X	X		X
Pandalus goniurus (humpy shrimp)	5333040102	6179180102		X	X		X	X		
Pandalus platyceros (spot shrimp)	5333040105	6179180105		X	X		X	X		
Pandalus hypsinotus (coonstripe shrimp)	5333040106	6179180106		X	X		X	X		
Pandalopsis dispar (sidestripe shrimp)	5333040204	6179180204		X	X		X	X		
Paralithodes camtschatica (king crab)	5333120701	6183080701	X	X	X		X	X	X	
Chionoecetes opilio (tanner crab opilio)	5333170301	6187010301	X	X	X		X	X	X	
Chionoecetes bairdi (tanner crab bairdi)	5333170302	6187010302	X	X	X		X	X	X	X
Cancer magister (dungeness crab)	5333180104	6188030104		X	X		X			X
Clupea harengus pallasi (pacific herring)	7903010201	874701020101	X		X		X	X	X	X
Oncorhynchus gorbuscha (pink salmon)	7904010201	8755010201			X		X	X		X
Oncorhynchus keta (chum salmon)	7904010202	8755010202			X		X	X		X
Oncorhynchus kisutch (coho salmon)	7904010203	8755010203			X		X	X		X
Oncorhynchus nerka (sockeye salmon)	7904010205	8755010205			X		X	X		X
Oncorhynchus tshawytscha (chinook salmon)	7904010206	8755010206			X		X	X		X
Mallotus villosus (capelin)	7904020201	8755030201	X		X		X	X	X	
Arctogadus glacialis (polar cod)	7909020102	8791030102	X		X	X	X	X	X	
Boreogadus saida (arctic cod)	7909020201	8791030201	X		X	X	X	X	X	
Eleginus gracilis (saffron cod)	7909020301	8791030301	X		X	X	X	X	X	
Gadus marcrocephalus (pacific cod)	7909020401	8791030401	X		X	X	X	X	X	
Microgadus proximus (pacific tomcod)	7909020601	8791030601	X		X	X	X	X	X	
Theragra chalcogramma (walleye pollock)	7909020701	8791030701	X		X	X	X	X	X	X
Merluccius productus (pacific hake)	7909020501	8791040102	X		X	X	X	X	X	X
Sebastes	79150101	88260101	X	X	X	X	X	X	X	
Sebastes aluts (pacific ocean perch)	7915010102	8826010102			X		X	X		X
Pleurogrammus monopterygius (atka mackerel)	7915020301	8827010501	X		X		X	X		
Anoplopoma fimbria (sablefish)	7915030101	8827020101	X		X		X	X	X	X
Atheresthes stomia (arrowtooth flounder)	7917020102	8857040102	X		X	X	X	X	X	X
Eopsetta jordani (petrale sole)	7917020401	8857040401	X		X	X	X	X	X	
Glyptocephalus zachirus (rex sole)	7917020501	8857040501	X		X	X	X	X	X	
Limanda aspera (yellowfin sole)	7917021001	8857040901	X		X	X	X	X	X	X
Liopsetta glacialis (arctic flounder)	7917021101	8857041001	X		X	X	X	X	X	
Platichthys stellatus (starry flounder)	7917021501	8857041401	X		X	X	X	X	X	
Hippoglossus stenolepis (pacific halibut)	7917020701	8857041901	X		X	X	X	X	X	X

could be identified.

The list of critical species is organized by taxonomic name, associated common name, and the taxonomic code numbers from both the NODC code and its precursor, the Alaska code. The 34 critical crustacean and fish species were determined by the BLM/OSC staff. The NODC common name was used for all the critical fish species as is was present in the NODC file. Critical crustaceans did not have NODC common names, so the BLM-preferred common name was used and noted with a preceding asterisk. The common name was included following each taxonomic name as an important aid in the quick recog-

CRITICAL FISHERY SPECIES IN ALASKAN OFFSHORE LEASE AREA #85—CHUKCHI SEA

Taxonomic Name	AK Code	NODC Code
Paralithodes camtschatica (king crab)	5333120701	6183080701
Chionoecetes opilio (tanner crab opilio)	5333170301	6187010301
Chionoecetes bairdi (tanner crab bairdi)	5333170302	6187010302
Clupea harengus pallasi (pacific herring)	7903010201	874701020101
Mallotus villosus (capelin)	7904020201	8755030201
Arctogadus glacialis (polar cod)	7909020102	8791030102
Boreogadus saida (arctic cod)	7909020201	8791030201
Eleginus gracilis (saffron cod)	7909020301	8791030301
Gadus macrocephalus (pacific cod)	7909020401	8791030401
Microgadus proximus (pacific tomcod)	7909020601	8791030601
Theragra chalcogramma (walleye pollock)	7909020701	8791030701
Merluccius productus (pacific hake)	7909020501	8791040102
Sebastes	79150101	88260101
Anoplopoma fimbria (sablefish)	7915030101	8827020101
Atheresthes stomias (arrowtooth flounder)	7917020102	8857040102
Eopsetta jordani (petrale sole)	7917020401	8857040401
Glyptocephalus zachirus (rex sole)	7917020501	8857040501
Limanda aspera (yellowfin sole)	7917021001	8857040901
Liopsetta glacialis (arctic flounder)	7917021101	8857041001
Platichthys stellatus (starry flounder)	7917021501	8857041401
Hippoglossus stenolepis (pacific halibut)	7917020701	8857041901

nition of each critical species.

Each critical species is linked to one or more of the lease area numbers. The lease areas are derived from BLM planning units. All offshore Alaskan waters from the shoreline to a reasonable distance offshore are blocked off into large sections referred to as planning units. These planning units evolve into lease areas. The lease areas' limits are broad ocean areas surrounding the BLM-designated lease blocks that may environmentally influence the leasing areas. These broad areas have been designated so they do not overlap, but do include all the Alaska offshore waters.

There are a total of 15 planning units or lease areas offshore Alaska. Of the 15, nine have been included in the new 5-year schedule. These nine lease areas are: (1) Northeast Gulf of Alaska, (2) Lower Cook Inlet, (3) Norton Basin, (4) St. George Basin, (5) Beaufort Sea, (6) Kodiak, (7) Aleutians, (8) Bristol, and (9) Chukchi Sea. Each lease area is eventually given a sale area number, which corresponds to the lease area number.

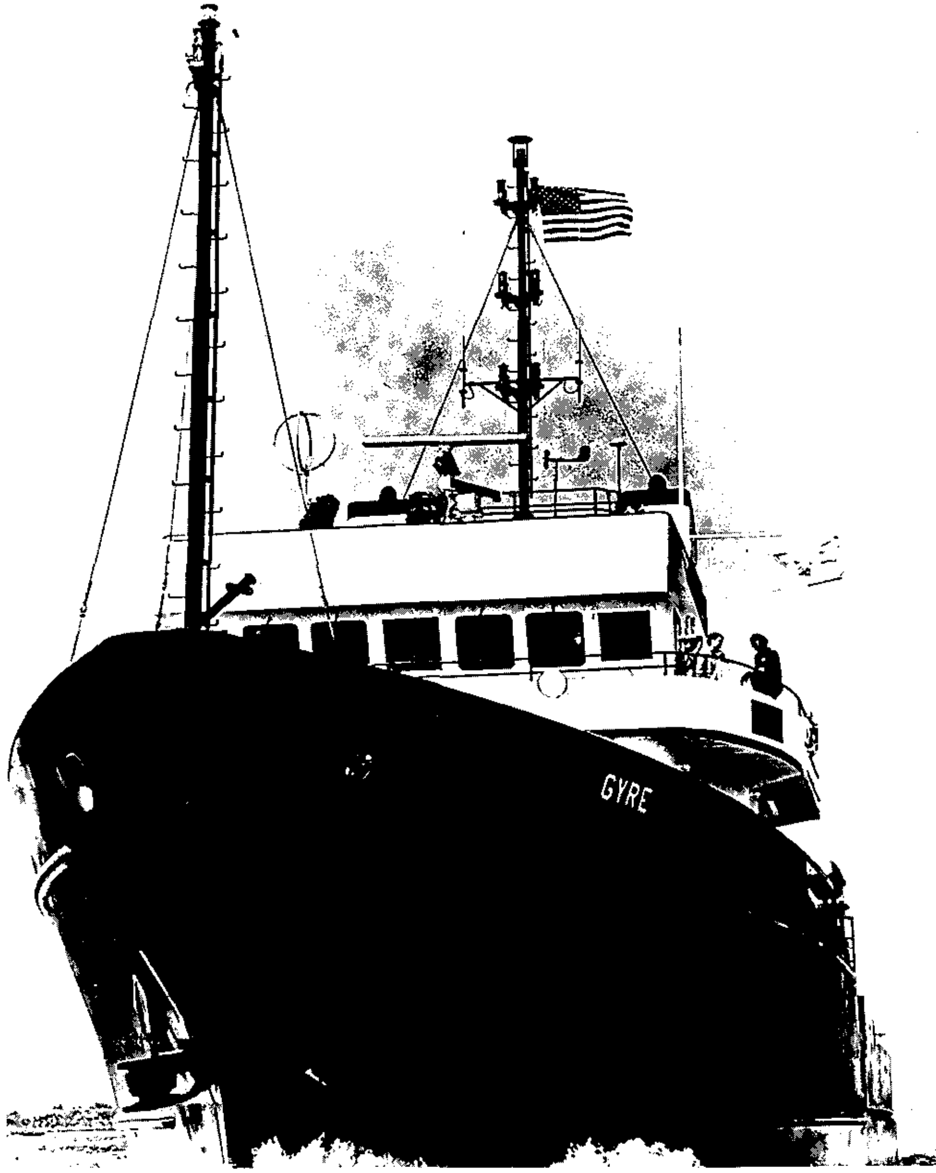
The table is presented in two forms. One is a list of all critical species versus all chosen lease areas. The other is a list of all critical species present in one selected lease area.

Inquiries concerning BLM sale area should be directed to: Jan Arbegast, BLM/Alaska OCS Office, P.O. Box 1159, Anchorage, AK 99510. Telephone: (907) 276-2955.

Inquiries concerning taxonomic coding should be directed to Marilyn Allen, Arctic Environmental Information and Date Center (AEIDC), 707 A Street, Anchorage, AK 99501. Telephone: (907) 279-4523, ext. 47; FTS 271-4063.

The Hawaii-To-Tahiti Shuttle Experiment

By Klaus Wyrtki
University of Hawaii



Texas A&M University Research vessel Gyre.

The Hawaii to Tahiti Shuttle Experiment, conducted from February 1979 to June 1980 as part of the North Pacific Experiment (NORPAX) has been completed. This project studied the equatorial current system in the central Pacific Ocean.

The objective of the experiment is to observe and understand the low-frequency variations of the equatorial ocean's temperature, salinity and density structure, their relation to the equatorial currents, and the forcing of these variations by the wind systems. Of particular interest will be the relationship between the predominantly zonal equatorial currents in the central Pacific Ocean and events in the eastern and western equatorial Pacific.

Another goal of the experiment is to demonstrate how closely the relationships between dynamic topography, thermal structure, sea level, geostrophic flow and geostrophic transports can be determined, and how these relations can be exploited for the monitoring of the low-frequency fluctuations of the equatorial circulation by simple observations, like sea level measured on islands and temperature sections made from ships of opportunity.

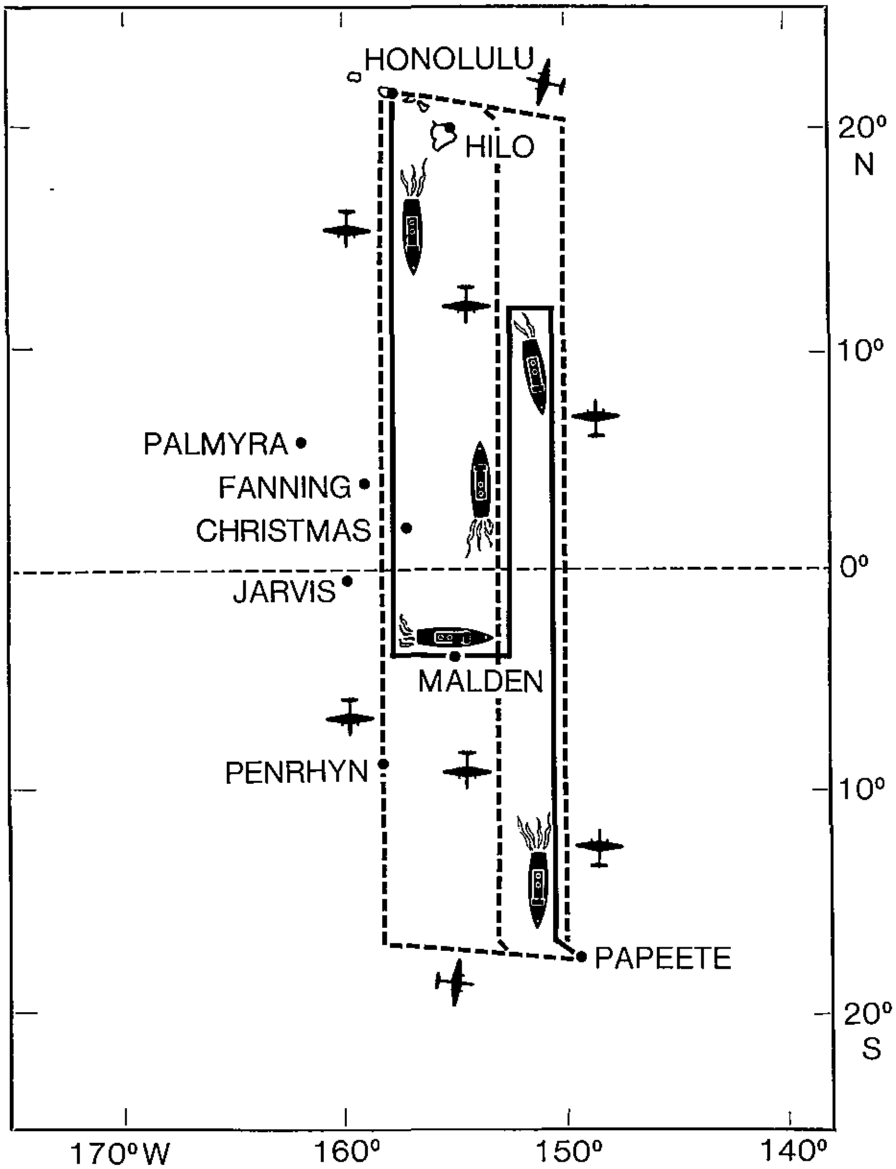


Figure 1. Ship and aircraft tracks during shuttle experiment.

The experiment was scheduled to coincide with the Global Weather Experiment, so that maximum benefit could be derived from the extensive meteorological data coverage of the tropical oceans and from simultaneous oceanographic efforts in other parts of the Pacific Ocean. The project, under the direction of the author, consisted of several individual, but very closely coordinated programs.

The scientific program of the Shuttle Experiment consisted of approximately monthly cruises between Hawaii and Tahiti along three meridians as shown in Figure 1. The first five cruises were made by the research vessel *Gyre* of Texas A & M University, the remaining ten cruises by the research vessel *Wecoma* of Oregon State University.

Additional temperature sections were obtained from aircraft by means of air-expendable bathythermographs (AXBT) along the same meridians. This program is under the direction of Dick Stroup of the University of Hawaii. Thirty of the flights were performed by Navy P-3 aircraft, five by NOAA aircraft. The NOAA research ship *Oceanographer* twice deployed a cluster of current meter moorings near the Equator, with recovery and re-deployment done by the *Wecoma.*

The core program aboard the ships consisted of obtaining vertical profiles of temperature, conductivity and oxygen content to 1000 m depth at every degree of latitude and longitude along the ships track. This work was carried out by the Physical and Chemical Oceanographic Data Facility of the Scripps Institution of Oceanography. Between CTD stations, additional bathythermograph (XBT) profiles were obtained. These measurements, together with the AXBT sections, will document the changing temperature, salinity and density structure and will allow the computation of geostrophic flow.

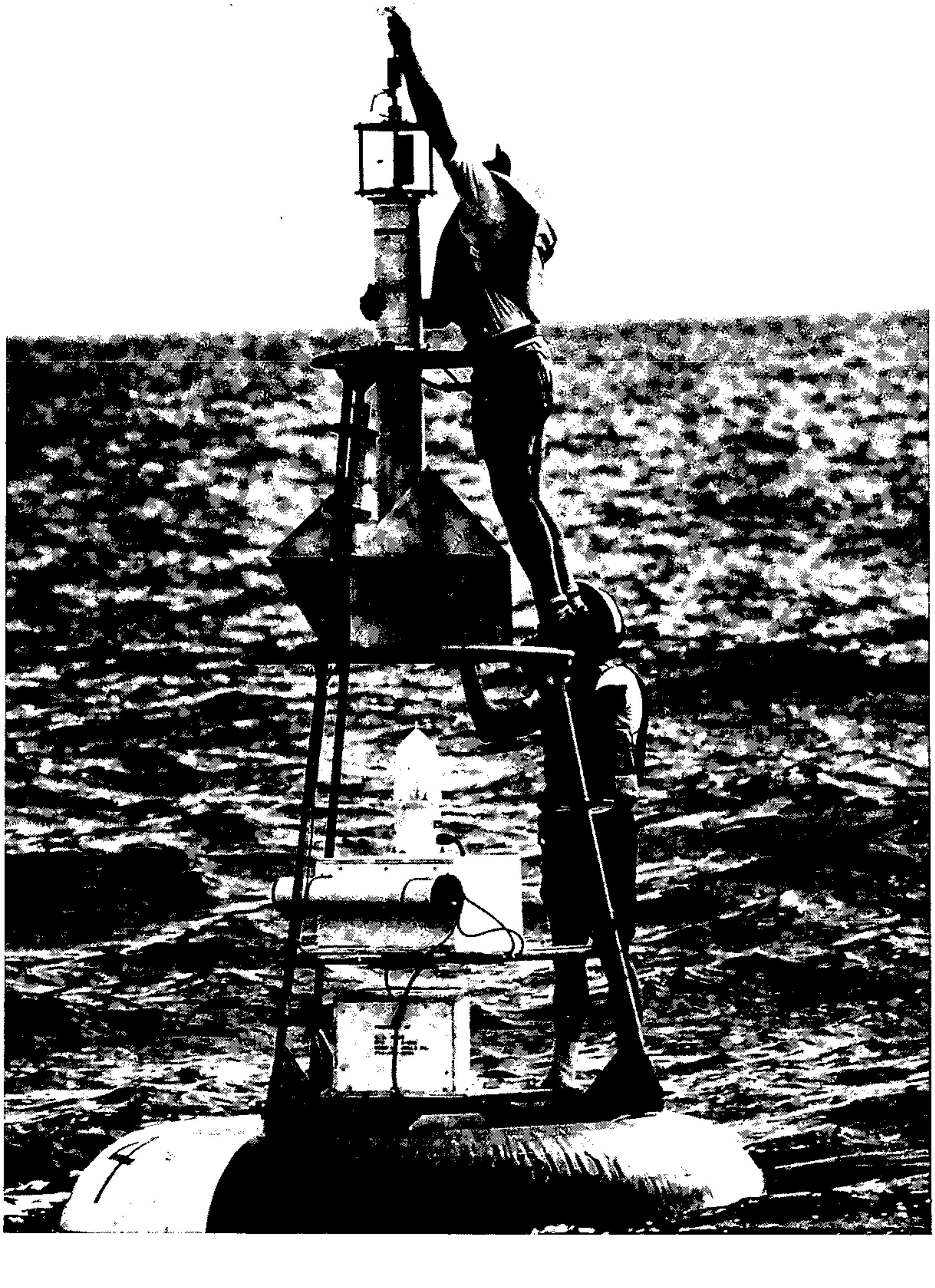
Direct measurements of the flow field also were made from the ships by means of profiling current meters to 500 m depth at all stations between 12°N and 4°S, and at intervals of ½ degree across the equatorial undercurrent, under the direction of Eric Firing of the University of Hawaii. A doppler speed log was used for continuous profiling of the current structure in the upper 150 m.

At the Equator a cluster of three moorings with five current meters in the upper 300 m of the ocean was maintained during the entire experiment to measure the flow in the Equatorial Un-

(Above): Dr. Martin Vitousek (University of Hawaii) checks rawindsonde prior to balloon launch from Fanning Island laboratory.

(Left): Tim Field of the Scripps Institution of Oceanography recovers conductivity-temperature-depth instrument and rosette of water sampling bottles.
Photo: Linda Jean Perry-Plate

(Opposite page): Doug Fenton (top) and Bob Knox (below) adjust anemometer atop a buoy.
Photo: Jim Parks



dercurrent. The current meter work is a joint project between Dave Halpern of the Pacific Environmental Marine Lab of NOAA and of Bob Knox of Scripps Institution of Oceanography.

To measure trajectories of the flow, 60 drifting buoys were deployed during the experiment, their positions being determined from satellites. This project is under the supervision of Bill Patzert and Jerry McNally of Scripps Institution of Oceanography. During the two special observing periods of the Global Weather Experiment, the *GYRE* served as one of the 40 tropical wind observing ships and made upper air soundings with electronically tracked (Omega) ballons to determine the atmospheric wind profiles. Routine meteorological observations also were made from the ships.

Additional data required for the interpretation of the oceanic data set are observations of sea level at islands in the general area of the experiment and the wind field over the entire tropical Pacific, which is available from satellite observations of cloud motion as analysed by James Sadler of the University of Hawaii. Standard meteorological observations also were made at five of the Line Islands in support of the experiment.

The repeated shuttle of a research ship across the equatorial current system also provided opportunity for a number of additional programs. On all northbound cruises nutrient concentrations were determined in the upper 400 m of the ocean. These included oxygen, phosphate, silicate, nitrate, and nitrite. The CO_2 content of the air and the surface water was monitored on all cruises, and tritium, radioactive carbon, and lead concentrations were measured. Biological work included productivity measurements, chlorophyll, nekton, and neuston samples on several cruises. Continuous bathymeteric soundings were made along the ship's track, which was successively offset by 20 nautical miles laterally on each of four cruises.

A preliminary analysis of the data indicates that the thermal structure of the central equatorial Pacific in 1979 developed in an essentially normal fashion, which is very advantageous for the further analysis of the data, since they are not biased by any extraordinary events. The major ocean currents in the region, the North Equatorial Current flowing westward, the Countercurrent flowing eastward, and the South Equatorial Current flowing west again, were very persistent and stable, and changed only slowly throughout the experiment. Only a few eddies were found in the North Equatorial Current and even fewer in the South Equatorial Current. Most of the faster variability was concentrated in the equatorial zone between 5°N and 5°S.

The data from the ship and the aircraft were used in real time to monitor the changing thermal structure across the Countercurrent. It was very strong in February 1979, when the 20° isotherm rose by 110 m across the current and the divergence along 10°N was very intensive. The current strength decreased steadily until the end of May, when the corresponding slope of the 20° isotherm was less than 30 m. Since that time the slope has increased again to more than 100 m in September and has remained that strong at least until February 1980. Transports in the Countercurrent during 1979 changed from a maximum of 35 million m^3/sec to a minimum of only 5 million m^3/sec.

Direct measurements of the Equatorial Undercurrent have found transports which are higher than ever measured before. This subsurface current flows east between about 50 and 250 m depth symmetrically about the Equator between approximately 3°N and 3°S, with a maximum speed of about 1.5 m/sec. The maximum transport measured was 70 million m^3/sec and transports above 60 million m^3/sec were sustained for at least three months. These maximal transports in the Undercurrent were found at the same time when the Countercurrent was weakest. The current meter moorings anchored at the equator confirmed the strong consistent eastward flow of the Undercurrent.

The trajectories of ocean circulation were determined by means of satellite-tracked drifting buoys. Six buoys initially launched in the Countercurrent in July drifted 4,000 km to the east before they turned north in December and entered the westward flowing North Equatorial Current. Their average speed in the Countercurrent was 40 km/day and they remained together as a group.

The evaluation of all the data collected during the Experiment will take several years. The ocean's response to the variable atmospheric forcing will be studied, computer simulation of this response will be made and tested against the observations, and methods will be devised to monitor the changing ocean circulation by simple observation systems. The results of all these studies should enhance our knowledge of ocean circulation and contribute to our understanding of the ways in which ocean and atmosphere interact to shape the fluctuations in our climate.

Long Record of Iowa Weather Observations

EDIS' National Climatic Center has published *A Long Record of Weather Observations in Southeastern Iowa (1839-1979)* edited by Henry F. Diaz. This is the third compilation in the Historical Climatology Series. In this issue, data from three stations in southwestern Iowa are summarized; Clinton, Iowa City, and Muscatine, Iowa. The station histories are interrelated (Iowa City and Muscatine), while the third station was included because of proximity and comparable length of record.

The following variables are summarized: (a) mean monthly and annual temperature; (b) monthly and annual total precipitation; (c) mean monthly and annual maximum and minimum temperature; (d) highest and lowest monthly and annual temperature; (e) seasonal mean temperature (Winter: Dec-Feb, Spring: Mar-May, etc.); (f) seasonal total precipitation; (g) total monthly and seasonal (Oct-Apr) snowfall; (h) the dates of last frost (or 32°F temperature) in spring and the first one in autumn; and (i) the number of clear and cloudy days per month. Time-series graphs are presented for seasonal and annual temperature and precipitation and for seasonal snowfall totals.

The earliest record is that of Muscatine, which starts in 1839. In fact, this is the oldest series of observations in Iowa. Weather observations at Muscatine were begun by Professor T. S. Parvin. In 1848 he became the local weather observer for the Smithsonian Institute network and maintained his records until he moved to Iowa City, about 30 miles away, in the fall of 1860. There he continued to record the weather until 1874, when regular observations were started by Dr. Gustavus Hinrichs at what later became the central office of the state supported Iowa Weather Service.

Following Dr. Parvin's move to Iowa City, observations at Muscatine were continued until 1863 by John Ufford who, in turn, was succeeded by Josiah P. Walton who maintained the records until the spring of 1906. During most of that time, two separate observers recorded daily precipitation amounts at Muscatine, one for the Iowa Weather Service and the other for the U.S. Signal Service. The latter station, located along the banks of the Mississippi River, also possesses a long record of daily river stages. Unfortunately, there is a break in the Muscatine temperature record from 1906 to 1935; however, precipitation data at the River Station is available for this period.

Clinton, like Muscatine, is located along the Mississippi River in the eastern-most section of Iowa, about 140 miles due west of Chicago, Ill. Precipitation data first were recorded there during 1865, but continuous temperature records (except for a 4½ year gap between 1871 and 1875) date back to September 1860. Sections of some interesting monthly original records on file at the National Climatic Center (March 1868) are reproduced elsewhere in the report.

U.S. Magnetic Intensity Data

The EDIS National Geophysical and Solar-Terrestrial Data Center (NGSDC) now has available scalar total magnetic intensity data for the entire conterminous United States. These data were acquired by the U.S. Naval Oceanographic Office's Project MAGNET, an aircraft magnetic survey of the United States conducted from September 1976 through September 1977.

The data were collected at altitudes (above ground level) of 500-700 m in nonmountainous terrain and 900-1,600 m in moutainous terrain. The typical interval of time between the data records is 1 sec (approximately 0.1 km) and aircraft ground speeds were between 380-500 km/hr.

The file contains approximately 650,500 data points. The data are uncorrected for temporal magnetic variations.

The following correlative data sets also are available from NGSDC:(1) topographic files 1° geoidal heights, 5-min average elevations in North America and 30-sec point elevations for the United States, and (2) land gravity data for conterminous United States.

Inquiries should be addressed to: NOAA/EDIS/NGSDC (D62), 325 Broadway, Boulder, CO 80303. Telephone: (303) 497-6338 or 497-6778, FTS: 320-6478.

Boothbay Harbor Air and Sea Temperature Data

The EDIS National Climatic Center has completed digitizing hourly observations of surface air and sea temperatures recorded at Boothbay Harbor, Maine for the period 1905-79, including bottom water temperatures for 1971-79. This historical data set represents perhaps the longest homogeneous time series of coincident air and sea surface temperatures in North America, and will be a significant addition to NCC's historical climatology project. The data were taken from copies of manuscript records on loan from Dr. Walter Welch of the Marine Resources Laboratory in West Boothbay Harbor, Maine.

The hourly manuscript data were keyed as recorded in a 123 character format to provide one record per day for each type temperature (air and sea surface or bottom) for a total of 52,375 records. The early period through June 1949 contains data in units of degrees Fahrenheit for three times each day—0800, 1200, and 1600, 1700, or 1800 local standard time—amounting to 32,749 records.

Data for the remaining years were reported in degrees Celsius for 24 hours, noted as either 00-23 or 01-24 local standard time, and total 19,626 records. The period is continuous, except for a break in water temperature data for July 1949-September 1950, and in air temperature data for July 1949-September 1960. The data are held on one 9-track magnetic tape. Inquiries should be addressed to: Applied Climatology Branch, National Climatic Center, Federal Building, Asheville, NC 28801, or by calling William A. Brower, 704-258-2850, ext. 266 or FTS 672-0266.

Marine Resources Laboratory in Boothbay Harbor, Maine.
Photo: U.S. Navy

Aquatic Sciences and Fisheries Abstracts User Aids

EDIS' Environmental Science Information Center (ESIC) has announced the publication of five special aids for users of the Aquatic Sciences and Fisheries Abstracts (ASFA) data base. ASFA is the bibliographic data base of the Aquatic Sciences and Fisheries Information System (ASFIS), the international information system for the science, technology, and management of marine and freshwater environments.

One of the aids is the *ASFA Data Base User Guide,* which covers the content and structure of the data base as well as other useful information. The guide, prepared by ESIC, complements the instructions issued by Lockheed Dialog, which provides online access to ASFA in the United States. Published in loose-leaf form, the guide is available at $10.00 per copy from ESIC. The price includes updates and additions.

Four other user aids, published by the Food and Agriculture Organization (FAO) of the United Nations, are now available in the United States for the first time. A sixth, the ASFIS Thesaurus, is expected to be published in 1981. The user aids and their prices are:

- List of Periodicals Monitored for the ASFIS Bibliographic Data Base (U.S. $10.00)
- ASFIS Subject Categories and Scope Descriptions with Guidelines for Subject Categorization and Indexing (U.S. $5.00)
- ASFIS Geographic Authority List (U.S. $8.00)
- ASFIS Guidelines for Bibliographic Description: A Self Instruction Manual (U.S. $30.00)

The five special aids described above are available from EDIS/Environmental Science Information Center, D8, NOAA, 11400 Rockville Pike, Room 678, Rockville, MD 20852.

Catalog of Satellite Products Issued

NOAA's National Earth Satellite Service (NESS) has published the third edition of its catalog of operational products and services.

The products described in the catalog range from photographic displays, charts, and teletype messages to the raw data available on computer disk and tape. The publication is an update of the *National Environmental Satellite Service—Catalog of Products* (Dismachek 1977) and is designed to be easily updated as new products become available and old products are improved or replaced.

This edition contains a brief description of each product. An effort has been made to indicate the accuracy of each product, when applicable. A list of primary users also is included, to point out the lines of product dissemination. A summary table of products is provided at the end of this volume for quick reference.

Real-time satellite data products are available by prior arrangement with NESS, after which the product is prepared routinely on a standing order in real-time or in delayed time before the operational master (film, tape, or hard copy) has been achieved. Users supply their own communication links and pick up the product or arrange to have it mailed.

Retrospective satellite data products are produced from operational masters and require search of the archives at the Environmental Data and Information Service's (EDIS) Satellite Data Services Division.

Both NESS and EDIS operate under a user charge and service policy that requires the recovery of the cost of reproduction of satellite data products. The required charge for the product will be specified during the initial arrangements for receipt of the data.

Copies of the *National Environmental Satellite Service Catalog of Products, Third Edition,* NOAA Technical Memorandum NESS 109 are available from the National Technical Information Service, Department of Commerce, Sills Building, 5285 Port Royal Road, Springfield VA 22161. Price quoted on request.

XBT Transect Inventory

The fourth annual *NODC Inventory of XBT Data Along Transects in U.S. Atlantic and Gulf Coastal Waters from NMFS/MARAD Ship of Opportunity Program (for 1978)* is now available from EDIS' National Oceanographic Data Center (NODC).

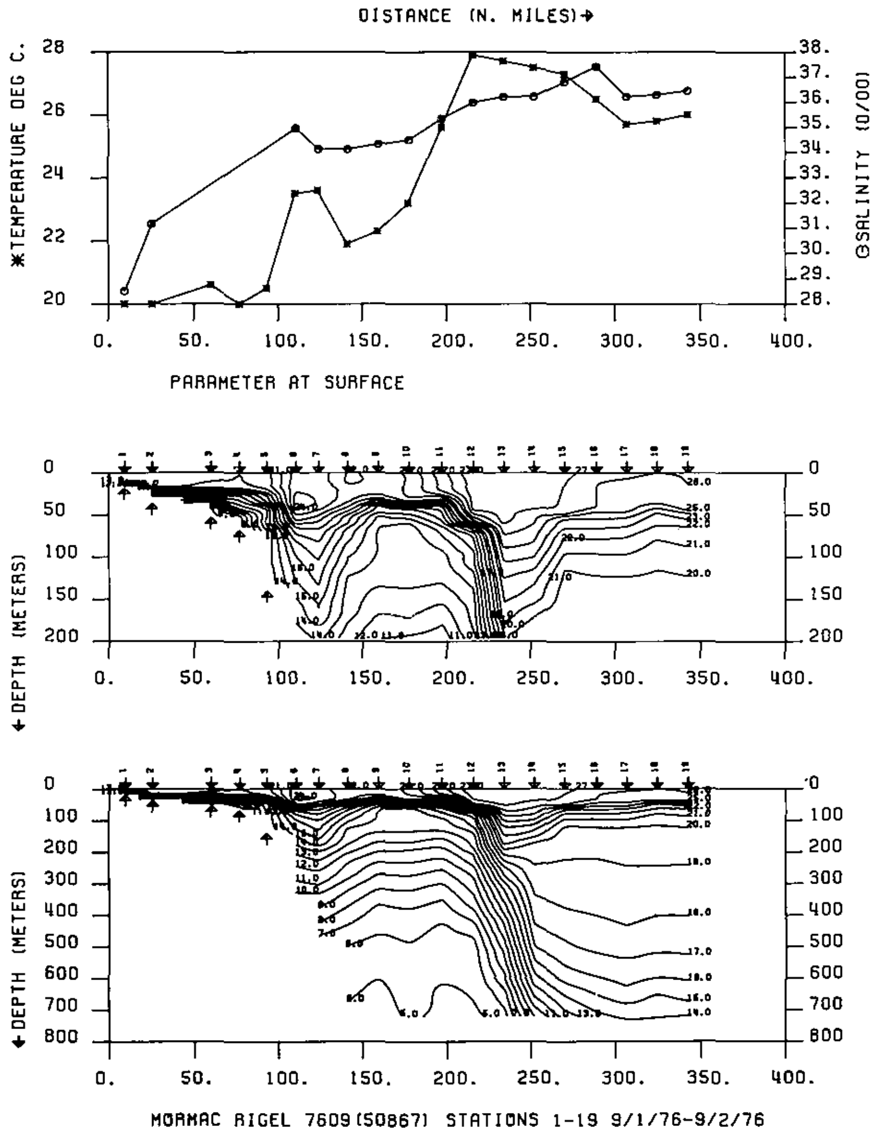
The expendable bathythermograph (XBT) transect data featured in this publication were collected under the guidance of Steven K. Cook of the National Marine Fisheries Service's Atlantic Environmental Group (AEG) as a continuing effort within the Marine Resources Monitoring, Assessment, and Prediction (MARMAP) Program.

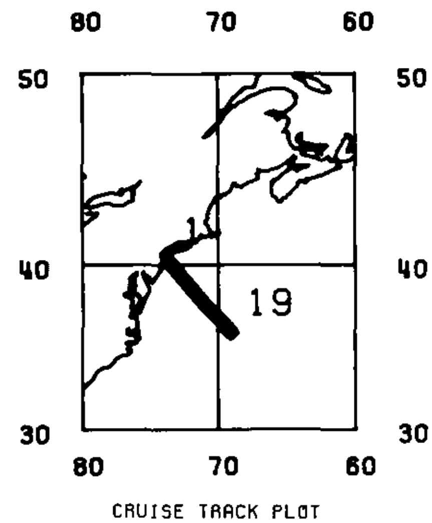
XBT temperature/depth data observed at stations along each transect are being used by AEG to identify and monitor the continental shelf and slope in waters of the Gulf Stream, and certain features such as boundary zones, bottom cold cells and loop currents in the Gulf of Mexico.

Each transect appears as a labelled track of connected station locations plotted on a monthly chart. A table shows for each track label the number of stations, the first and last latitude, longitude, and date of the Transect and the NODC Reference Number of the archive XBT cruise containing the transect.

The data from each transect are available at NODC in the form of a contoured vertical section plot graphic. The same data also can be obtained as an NODC XBT listing, plot, or summary, separate or combined with other data from NODC's archive files.

Inquiries regarding the publication or the data should be directed to the National Oceanographic Data Center, Oceanographic Services Branch (D761), Washington, DC 20235. Telephone: 202-634-7500; FTS 634-7500.





NODC XBT transects. (Top Left): Surface temperature and salinity along trackline shown above. (Middle Left): Vertical temperature profile (0-200 meters) along trackline. (Bottom Left): Vertical temperature profile (0-800 meters) along trackline.

International Report

Historical Earthquake Map and Catalog

The National Geophysical and Solar-Terrestrial Data Center recently published a multicolored wall map of worldwide significant earthquakes. The *Significant Earthquake Map* is useful in assessing the potential for future earthquake events. Produced in cooperation with and partially funded by the Department of State's Office of Foreign Disaster Assistance, the map depicts about 2,472 earthquake events from 1,000 B.C. to the present. Of these, 682 are 20th century events that caused at least 10 deaths and $1 million damage or reached a magnitude of 7.5 on the Richter Scale.

A companion publication, *Catalog of Significant Earthquakes*, also has been published. It was compiled from 118 different sources to describe in tabular form major earthquakes around the world since 2,000 B.C. Location, date, depth, and cultural effects are given for 2,481 earthquakes. Damage is estimated in U.S. dollars at time of occurrence, and a table allows for computation of 1979 values.

Copies of the map and catalog are available from the National Geophysical and Solar-Terrestrial Data Center, NOAA/EDIS, 325 Broadway, Boulder, CO 80303.

New North Atlantic Atlas

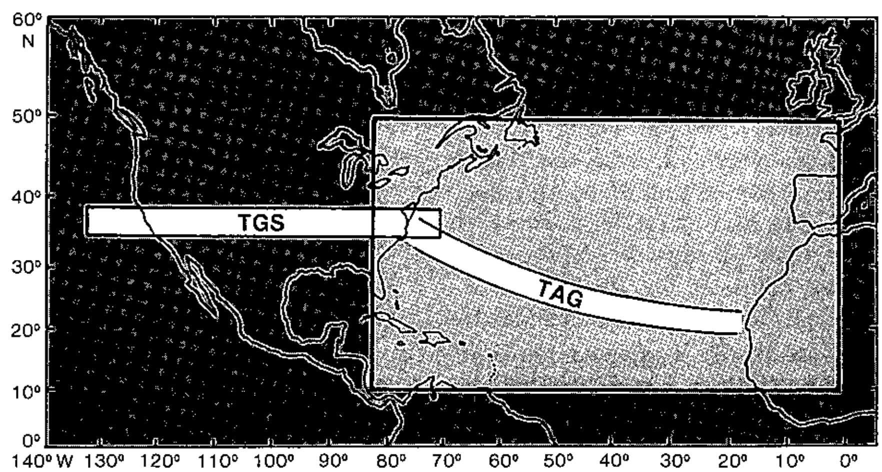
A new NOAA Atlas is now available. *The Central North Atlantic Ocean Basin and Continental Margins: Geology, Geophysics, Geochemistry, and Resources, Including the Trans-Atlantic Geotraverse (TAG)*—was prepared by Peter A. Rona, of NOAA's Environmental Research Laboratories.

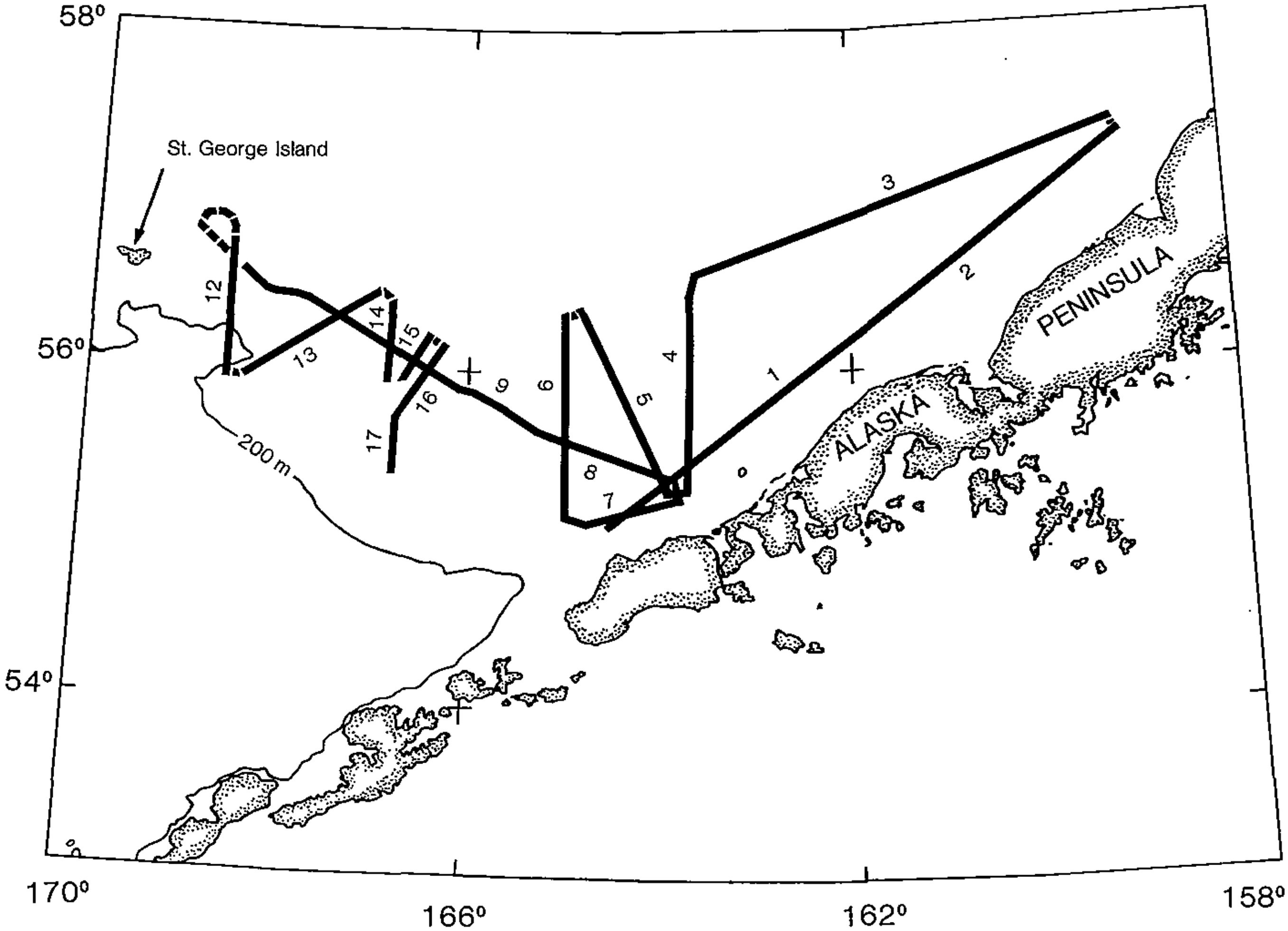
The Atlas provides a comprehensive overview of the geology, geophysics, geochemistry, and mineral and energy resources of the Central North Atlantic Ocean basin and continental margins from latitude 10° North to 50° North. It contains maps, cross sections, profiles, photographs, tables, and references compiled from published and unpublished sources. The Atlas is a unique, previously unpublished set of geotraverses comparing bathymetric, magnetic, and gravity profiles extending across the entire central North Atlantic Ocean from the continental margin of eastern North America to that of northwestern Africa, collected by the Trans-Atlantic Geotraverse (TAG) Project of NOAA. It has 102 pages in a 19 by 30 inch format.

A unique work covering the most extensively utilized region of the world ocean, the publication is designed to meet the need for a multipurpose information base for scientific investigation, resource exploration, marine environmental management, seafloor engineering, oceanographic education, and general interest.

The Atlas is for sale by the Superintendent of Documents, U.S. Government Printing Office (Dept. 50), Washington, DC 20402. Order by stock number S/N 003-017-00475-9, price $17.00.

NOAA Atlas, Volume 3 covers the area within the rectangle and a continuous corridor of geophysical measurement—the Trans-Atlantic Geotraverse, which joins the Transcontinental Geophysical Survey





Lease Sale Area 58, 58A, 70 and 75 Data Available

Seismic reflection data were collected along this track for lease Sale areas 70 and 75.

Drawing: U.S. Geological Survey

Seismic reflection data now are available for the Outer Continental Shelf Oil and Gas Lease Sale areas 70 and 75 in the Bering Sea and areas 58 and 58A in the Gulf of Mexico. These data were collected by the U.S. Geological Survey (USGS) to identify potentially hazardous geologic structures or other constraints to oil and gas exploration and production.

One data set for area 70 consists of approximately 5,939 km of high-resolution seismic reflection data from the St. George Basin in the Bering Sea offshore western Alaska. These data were collected in 1976 and 1977. Additional data for area 70 and also for area 75 are available from a 1976 survey. USGS collected over 1,100 nautical miles of 24-channel seismic reflection data from the Southern Bering Sea Shelf between the Alaska Peninsula and the Pribilof Islands.

The data set for Lease Sale 58 contains approximately 2,100 line miles and for Lease Sale No. 58A approximately 2,575 line miles of high-resolution seismic reflection data collected from the coastal waters off Texas and Louisiana.

Inquiries should be addressed to: NOAA/NGSDC/EDIS, Code D621, 325 Broadway, Boulder, CO 80303. Telephone: (303) 497-6338 or 497-6542, FTS: 320-6338 or 320-6542.

International Geophysical Calendar for 1981

The International Geophysical Calendar for 1981 has been prepared in cooperation with the world scientific community and distributed by EDIS' National Geophysical and Solar-Terrestrial Data Center (NGSDC). The calendar is issued annually to coordinate solar and geophysical observations and data exchange. It is complied 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 Services (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 1981 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, D63, 325 Broadway, Boulder, CO 80303.

JANUARY

S	M	T	W	T	F	S
				1	2	[3
4	5	6*	7*	8	9	10
11	12	13	14+	15	16	17
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25	26	27	28	29	30	31

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30	31					

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27	28	29	30	31		

JANUARY 1982

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[3	[4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

13 Regular World Day (RWD)

14 Priority Regular World Day (PRWD)

18 Quarterly World Day (QWD) also a PRWD and RWD

2 Regular Geophysical Day (RGD)

[4] Day of Solar Eclipse

14+ Incoherent Scatter Coordinated Observation Day

5* 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

3 4 Airglow and Aurora Period

NOTES:

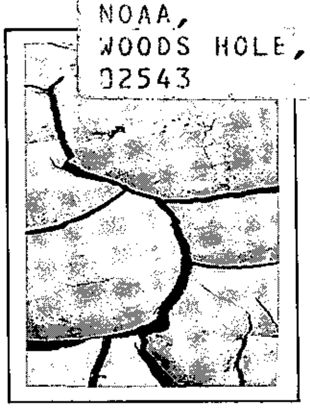
1. Solar Maximum Year continues through February 1981, but with possible extension through September 1981.
2. An Alpine Experiment (ALPEX), of the WMO/ICSU World Climate Research Program, is scheduled for the period 1 September 1981 through 30 September 1982.

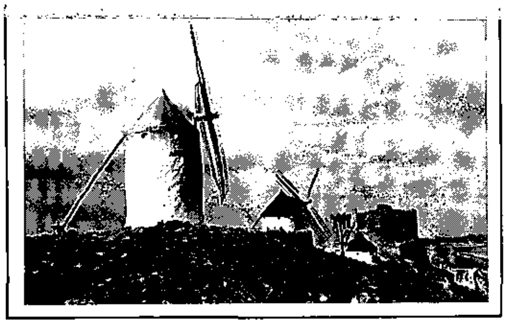
OPERATIONAL EDITION, August 1980

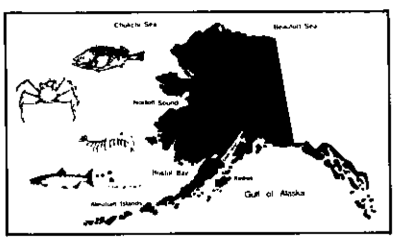
U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Environmental Data and Information Service
EDIS Magazine
Washington, D.C. 20235

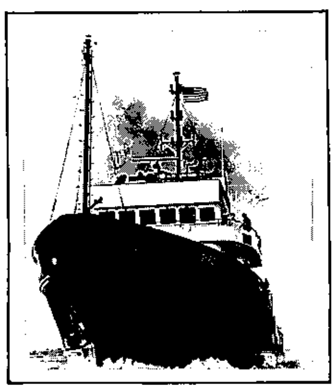
OFFICIAL BUSINESS
Penalty for Private Use, $300

Postage and Fees Paid
U.S. Department of Commerce
COM-210
Controlled Circulation Rate









In this issue: *Early drought warning (p. 3); windmills revisited (p. 12); fish in oil lease areas (p. 16); and the Hawaii-to-Tahiti shuttle experiment (p. 20).*

EDIS

Environmental Data and
Information Service
Volume 12, Number 1
January 1981

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Cover: *Despite his grandfather's fatal exposure 48 years earlier, Benjamin Harrison took his oath of office and delivered his inaugural address in the pouring rain. Bad weather on Inauguration Day is a tradition of American political folklore. It is a tradition that deserves respect, as shown in the article that begins on the opposite page.*
Photo: Library of Congress

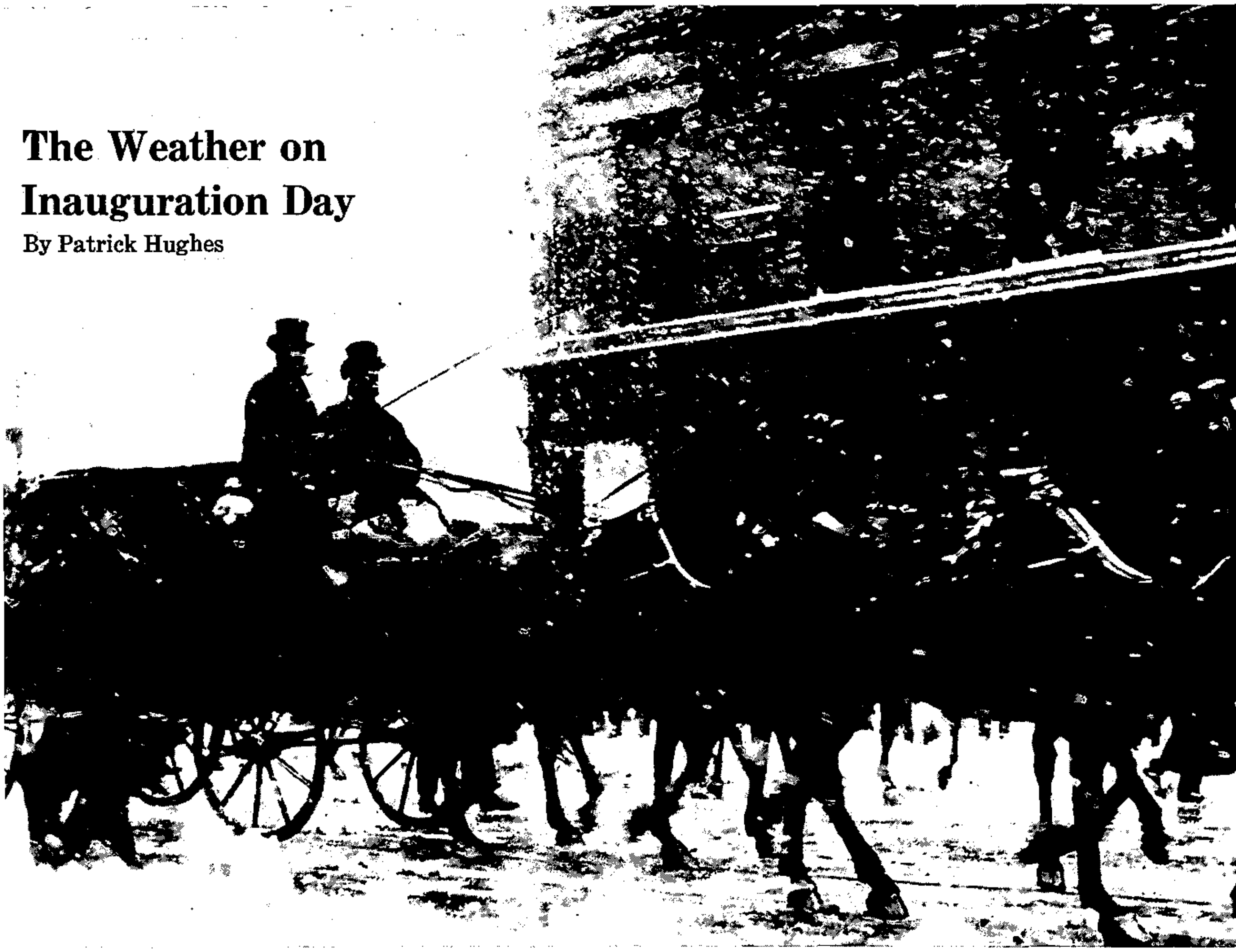
EDIS is designed to inform Environmental Data and Information Service (EDIS) cooperators, colleagues, and contributors of recent developments in EDIS programs and services and in the general field of scientific data and information management. EDIS operates the National Climatic Center, National Oceanographic Data Center, National Geophysical and Solar-Terrestrial Data Center, Environmental Science Information Center, and Center for Environmental Assessment Services. In addition, under agreement with the National Academy of Sciences, EDIS operates World Data Centers-A for Oceanography, Meteorology (and Nuclear Radiation), Solid-Earth Geophysics, Solar-Terrestial Physics, and Glaciology (Snow and Ice).

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 through June 30, 1983.

EDIS (ISSN 0109-3365) is published bimonthly by the Environmental Data and Information Service, NOAA, Page Building 2, Room 533, 3300 Whitehaven St., N.W., Washington, D.C. 20235 (telephone: 634-7305). For address changes, cancellation, or information write to the Editor at this address. Controlled Circulation Postage is paid to the Finance Department, USPS, Wash., D.C. 20260.

The Weather on Inauguration Day

By Patrick Hughes



"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 were immobilized as a thick white mantle submerged the deserted streets of the Nation's Capital.

Six thousand shovelers struggled vainly through the night and forenoon to clear the area 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 an artic 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 fromt 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.

President Roosevelt and President-elect Taft drive to the Capitol through a howling snowstorm.

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."

Mr. Taft was presumptuous, however, in thinking that the elements had singled him out personally; they have been just as attentive to many other presidents.

It was a much colder day, for example, on Ulysses S. Grant's second inaguration in 1873; it was, in fact, the coldest Inauguration Day on record. When cannon-fire announced the dawn, the temperature was four degrees above zero; by noon it had risen only to 16 degrees. Throughout the day, gusty winds up to 40 miles per hour buffeted Washington—bitterly cold blasts that knifed through the heaviest clothing and chilled to the marrow all who ventured outdoors.

Despite the cold and wind, however, large crowds filled the streets. Heavy clothing and earmuffs were the uniform of the day, except for the West Point cadets and Annapolis midshipmen who were scheduled to parade without overcoats. When President Grant delivered his inaugural address, the wind made his words unintelligible to all but those next to him. Meanwhile, a number of the lightly dressed cadets and midshipmen, who had to stand 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.

Franklin Delano Roosevelt's second inauguration in 1937 was the wettest in history. 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.

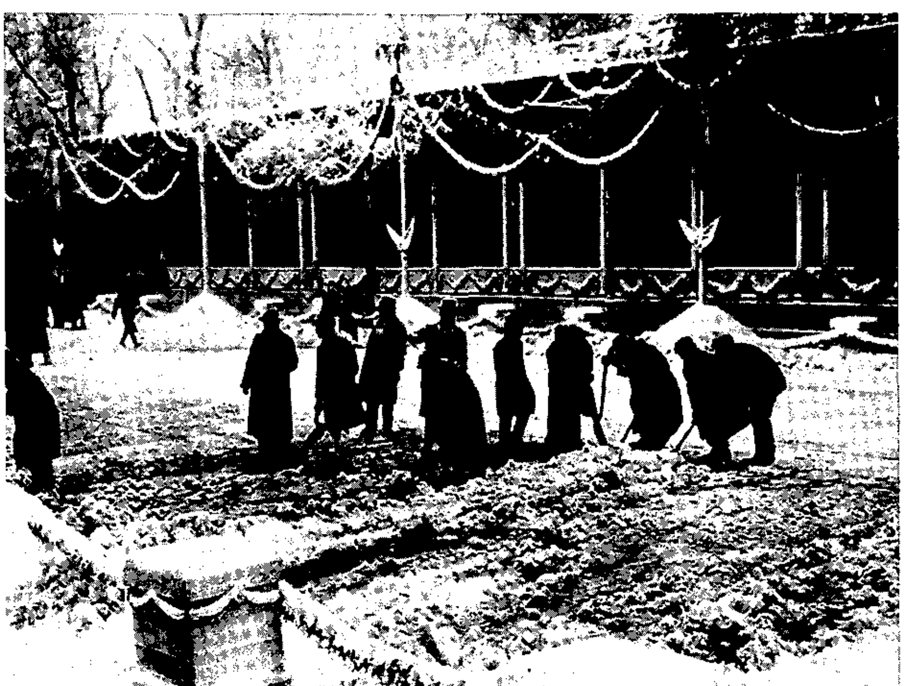
Undaunted by the cold, driving rain, thousands more had massed in front of the Capitol to witness the inaugural oath. Under the umbrellas, overcoats and raincoats predominated, but despite the deluge, some spectators wore formal attire. On the inaugural platform itself, attendants dumped puddles of water from chairs as Cabinet members and Supreme Court justices waded down a water-logged red carpet to their wet seats. Icy torrents blowing in under the roof bathed Congressmen, government officials, and guests alike, as Mrs. Roosevelt raced back and forth, carrying blankets for family and friends.

The head of the Inaugural Committee tried to persuade Roosevelt to take his oath indoors, but Roosevelt replied: "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 bursts 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—her new hat a drooping disaster—rode the mile to the Executive Mansion laughing and waving to the crowds, which often responded in kind. Later, Roosevelt spent another hour and a half reviewing the inaugural parade from a specially constructed reviewing stand, and $11,000 model of Andrew Jackson's home, the Hermitage; he even had the bullet-proof windows removed, the better to be seen and rained on.

Roosevelt's saturated inauguration was particularly ironic. The 20th Amendment had just changed the date of Inauguration Day from March 4 to January 20, and the new date supposedly favored drier, though colder weather. Said Senator George William Norris of Nebraska, author of the 20th Amendment, "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 a beautiful day—sunny, with a high-temperature of 67 degrees, unusually warm for that date.

Bad weather on Inauguration Day is a celebrated tradition of American political folklore. Indeed, as in Mr. Roosevelt's case, it often seems as if a perverse intelligence is orchestrating the event's environmental accompaniment. This impression is reinforced when you consider that the weather was fine 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. Of the 41 regularly scheduled In-



(Above): 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. (Left): Clearing some of the nearly 10 inches of snow off Pennsylvania Avenue in front of the White House.

Photos: Library of Congress

auguration Days that followed, 19 were plagued by rain, snow, sleet, or bitter cold.

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. Official weather records date back only to 1871, shortly after the first national weather service was established by the Army's signal Service. Other source materials, however—in the form of private weather diaries and fragmentary institutional records preserved in the archives of the Environmental Data and Information Service's National Climatic Center in Asheville, N.C., the National Archives, and various historical societies, as well as contemporary newspaper accounts—make it possible to trace the thread of bad weather woven through the pageantry of Inauguration Day celebrations.

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 the next day. 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, but indicated no times nor amounts. Whatever the elemental sequence, Monroe took his oath of office indoors, in the House Chamber, where an "immense crowd" of cold, damp men and women thronged the Gallery to witness the swearing-in.

John Quincy Adams also took weather observations on his own Inauguration Day, four years later, when it rained. Once again, the ceremonies were held indoors.

In 1845, James Knox Polk took his oath of office outdoors in the pouring rain. The Capitol Mall was roofed by a host of glistening umbrellas under which spectators stood densely packed, up to their ankles in mud and water. The roar of the rain on their umbrellas drowned out Polk's words as he delivered his 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.

It also rained on the morning of Abraham Lincoln's first inauguration in 1861, but the rain stopped by midmorning and the sun came out in the afternoon. The elements were not quite as considerate for his second inaugural in 1865.

It had been raining for two days, and the Capital City was a sea of mud. According to the *New York Herald*, the streets were "flooded and aloat with a vile yellow fluid not thick enough to walk on nor thin enough to swim in." Many people who had been unable to fund rooms in the crowded city slept in the Capitol. No one had the heart to put them out in the rain, even when the time came to clear the building for the inaugural ceremonies.

(Above): Senator George W. Norris (R-Nebraska), whose 20th Amendment changed Inauguration Day from March 4 to January 20. (Opposite page): A dripping, smiling President and First Lady drive back to the White House in an open car.

Photos: (Top) Library of Congress (Opposite page): Washington Star News

Despite the downpour, a good-sized 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.

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 the 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 five dollars now sold for fifty 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 one degree above freezing.

It snowed again on Grover Cleveland's second inauguration in 1893. Rain began the evening of March 3, then changed to snow during the night. The next morning the city was being battered by a chill wind, and temperatures were well below freezing. Pennsylvania Avenue was almost deserted, and Cleveland's mustache reportedly glistened with tiny icicles as the President-elect rode to the Capitol for the ceremonies.

Some ten thousand shivering people were huddled around the inaugural platform when he 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 that cracked 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 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, then marched in intermittent rain that began just before he took his oath of office and

(Opposite page): 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. (Above): The snow had stopped for Cleveland's second inauguration, but icy winds chilled marchers and bystanders alike.

Photos: Library of Congress

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 President-elect took his oath of office with water beading his face. By the time he returned to the White House, Hoover was thoroughly soaked; at 3 p.m., however, he took his place in the stand in front of the White House and watched 20,000 military and civilian marchers pass in review, in the pouring rain.

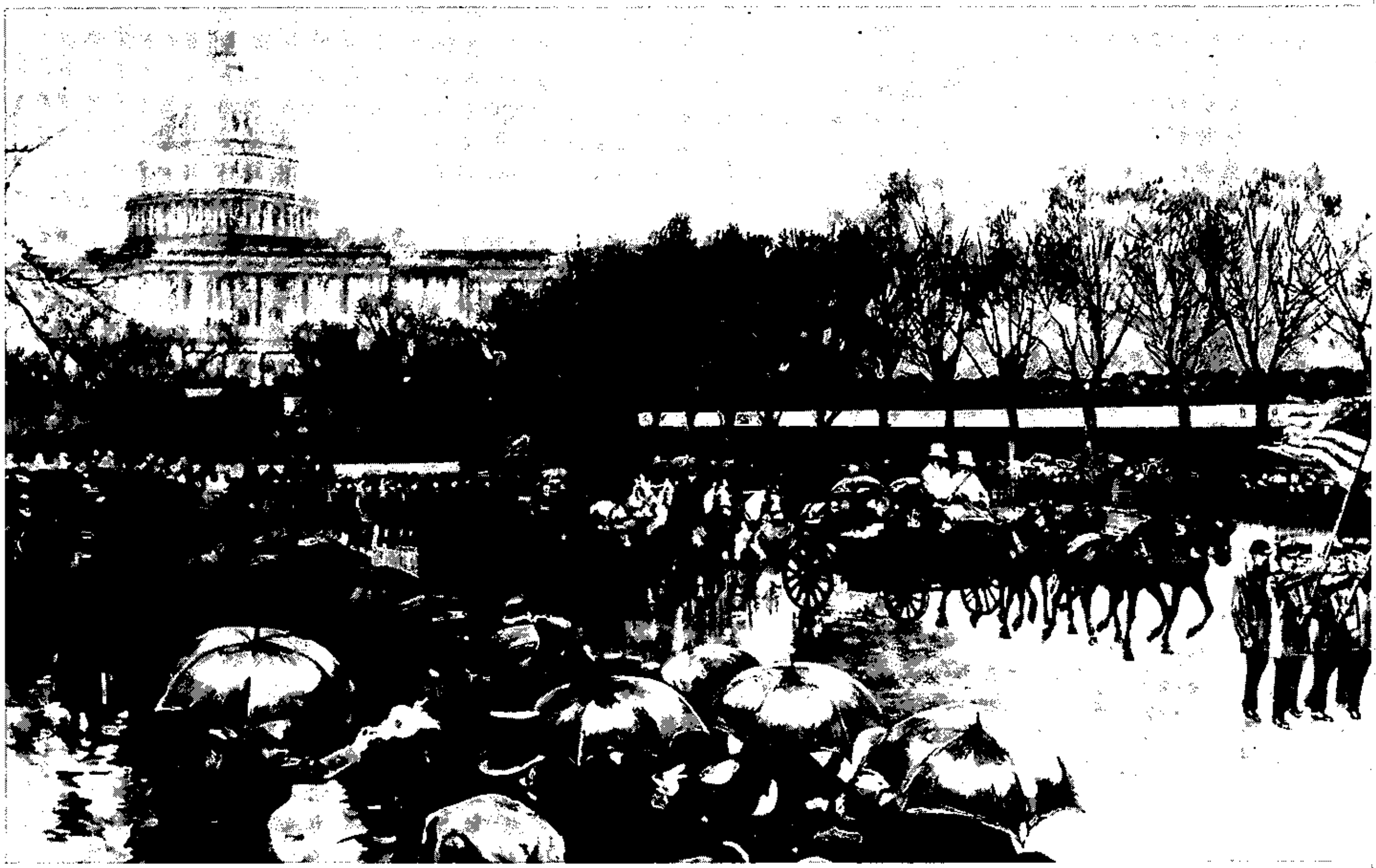
The second worst snowstorm in the history of the event greeted the Inauguration Day of John F. Kennedy in 1961. Only President Taft before him had worse weather, but in 1909 Washington, D.C. did not have the massive traffic tie-up that paralyzed the Capital City on the eve of Kennedy's inauguration.

Heavy snow began falling the afternoon before and by evening most streets and roads were impassable. Thousands of motorists were stranded in the storm. Police switchboards soon 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, and would remain there for hours before help reached them. Others simply abandoned their autos wherever they stalled and set off on foot through the blinding storm.

The snow ended by dawn, but it was bitterly cold, and a biting wind was to blow all day. Snowplows and sanders had worked throughout the night, and the inaugural parade route was in reasonably good shape. At noon, the temperature was a chill 22 degrees as some 20,000 shivering spectators sat huddled between snowbanks at the Capitol Plaza to witness the swearing-in. Later, despite the cutting, icy blasts, an estimated one million people watched the inaugural parade. As twilight came, however, 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.

Despite the event's rather dismal track record, the climatic odds favor fair weather for Ronald Reagan's Inauguration Day. The normal high temperature for January 20 is 44 degrees, the low, 29 degrees. The highest temperature recorded in the last 108 years is 71 degrees, in 1951; the lowest, 8 degrees, in 1940. If it does rain or snow on Inauguration Day, the odds are it will just wet the pavement.

Average weather conditions for noon, when the President-elect is usually sworn in, would be a temperature of about 39 de-



grees, a wind of about 10 miles an hour, and partly cloudy skies. Chances of precipitation during the swearing-in ceremony itself are only about one in four, and of snow, about one in ten.

Of course, it will rain or snow on some January 20th's. Moreover, January temperatures and blustery winds often make standing outdoors for several hours a bone-chilling, foot-stomping experience. This certainly was true of the last three inaugurations, those of Richard Nixon and Jimmy Carter.

For the most part, the weather woes that have afflicted Presidential inaugural ceremonies have meant inconvenience, discomfort, and perhaps a cold to the participants. There have been exceptions, however. The first American President to die in office was a victim of Inauguration Day weather and of his own disregard for its consequences.

William Henry Harrison was the last President born (1773) before the American Revolution. His Inauguration Day in 1841 was overcast, windy, and cold; so cold and chilling, in fact, that building owners along Pennsylvania Avenue were reported to have charged $500 for window space to watch the parade (for one dollar you could step up and take a quick look).

Harrison himself, ever the tough old soldier, showed nothing but contempt for the elements. He refused the offer of a carriage and, without overcoat or hat, rode a white charger in the two-hour procession from the White House to the Capitol. After

Benjamin Harrison's wet inaugural parade.
Photo: Library of Congress

being sworn in as the ninth President of the United States by Chief Justice Taney, he returned to the White House on horseback in another slow-moving parade, then for three hours shook hands with thousands of well-wishers. That night, after attending three inaugural balls, again lightly dressed, he returned exhausted to the Executive Mansion, where he suffered a "chill." In the weeks that followed the weather continued raw and bitter, 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.

Inauguration Day weather alone one was responsible for the death of President Fillmore's wife in 1853. Heavy snow was falling when citizens of the Capital City awoke on March 4, but it stopped shortly before noon. Franklin Pierce, the President-elect, had just finished his oath of office and was beginning his inaugural speech when the snow began again, cancelling plans for a parade back to the White House. Instead, Pierce dropped ex-president Fillmore and his wife off at the Willard Hotel, then continued on to the Executive Mansion to greet the crowd that had gathered there. Meanwhile, Abigail Fillmore had developed a bad cold from her exposure during the swearing-in ceremonies, a cold which soon developed into pneumonia. She died at the end of the month.

In 1889, Benjamin Harrision, despite his grandfather's tragic example 48 years earlier, insisted on taking his oath of office in the pouring rain. It had been raining for several days, and the evening before Harrison also had insisted on taking his usual long daily walk, rain or no rain.

There were fewer than 200 people on the inaugural platform when the dripping Presidential procession arrived at the East Portico of the Capitol for the ceremonies, but some 20,000 spectators stood on the Capitol Plaza, their shiny, black umbrellas buffeted by wind and rain. The elements drowned out Harrison's oath of office. Despite his inaudibility, the President-elect stood in the downpour and delivered a long, rambling inaugural address—a very long one. When he finished, only a few thousand spectators remained; even his wife and daughter had gone indoors.

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 umbrellas. Harrison still stood there ignoring the pouring rain, almost as if settling a personal account with the elements.

Chronology of Inauguration Day Weather

The following table presents a profile of the weather pattern through all of the Presidential inaugurations held to date. Except where noted, all inaugurations to date were held in Washington, D.C. Prior to 1937, the Presiden-

Year	President	Noon Temperature	Weather for Day	Remarks
1789	George Washington		cool and clear	New York City, April 30.
1793	George Washington		pleasant	Philadelphia.
1797	John Adams		fair	Philadelphia.
1801	Thomas Jefferson		mild and beautiful	
1805	Thomas Jefferson		fair	Observation taken by Jefferson himself.
1809	James Madison		probably fair	No specific mention of weather found for
1813	James Madison		probably fair	either Inauguration, but descriptions of the presidential processions, outdoor festivities, and the ladies' finery suggest the weather couldn't have been too bad.
1817	James Monroe		warm and sunny	First outdoor inauguration.
1821	James Monroe	28°	snow	March 5. Observations taken by John Quincy Adams.
1825	John Quincy Adams	47°	rain	Observations taken by the President himself.
1829	Andrew Jackson		warm and balmy	
1833	Andrew Jackson		probably fair	No mention of the weather, but reports of "happy crowds" in the streets, and of many people riding to and from the Capitol indicate the weather was probably pretty good.
1837	Martin Van Buren		sunny and brisk	
1841	William Henry Harrison		overcast, chilling wind	
1845	James Knox Polk		rain	Thunder heard at dawn. Rain during day .40 inch.
1849	Zachary Taylor	42°	cloudy, intermittent snow flurries	March 5. Heavy snow began during Inaugural Ball.
1853	Franklin Pierce		snow throughout the day	
1857	James Buchanan	49°	bright and sunny	
1861	Abraham Lincoln		rain till mid-morning, sunny and warm in afternoon	
1865	Abraham Lincoln	45°	rain	Heavy dash of rain at 6:25 a.m. Rain for day .30 inch.
1869	Ulysses S. Grant	40°	rain 4:50 a.m.-11:50 a.m. sunny afternoon	Rain during day .106 inch.
1873	Ulysses S. Grant	16°	clear, windy, and bitterly cold	
1877	Rutherford B. Hayes	35°	cloudy, brief periods of light snow	March 5.
1881	James A. Garfield	33°	snow until about 10 a.m., sunny and windy afternoon	Snowed all the previous night.

tial oath of office was taken on March 4; after 1937, on January 20. Whenever Inauguration Day falls on a Sunday, the ceremony has traditionally been postponed until the following day.

Year	President	Noon Temperature	Weather for Day	Remarks
1885	Grover Cleveland	54°	bright, sunny day	
1889	Benjamin Harrison	43°	rain all day	Rain during day .86 inch.
1893	Grover Cleveland	25°	snow and chilling winds	Snow began early a.m., ended about 1 p.m. One to two inch accumulation reported.
1897	William McKinley	40°	clear; beautiful day	
1901	William McKinley	47°	rain	Rain during the night. Rain began again during inauguration ceremony, ended 3:45 p.m. Total rain .32 inch.
1905	Theodore Roosevelt	45°	sunny; strong northwest wind	Patches of snow still on the ground from light fall the day before.
1909	William H. Taft	32°	heavy snow and strong winds	9.8 inch snowfall began the previous day, ended 12:20 p.m.; afternoon cloudy and windy.
1913	Woodrow Wilson	55°	overcast	
1917	Woodrow Wilson	38°	partly cloudy, windy	March 5.
1921	Warren G. Harding	38°	clear, sunny	
1925	Calvin Coolidge	44°	mostly sunny	
1929	Herbert C. Hoover	48°	rain	Rain began just before oath of office was administered, and continued for the rest of the day (.40 inch).
1933	Franklin Delano Roosevelt	42°	cloudy	Occasional sunshine.
1937	Franklin Delano Roosevelt	33°	rain	First Inauguration held on January 20. Total precipitation 1.77 inches, with .69 inches falling between 11 a.m. and 1 p.m.
1941	Franklin Delano Roosevelt	29°	clear, with brisk wind	
1945	Franklin Delano Roosevelt	35°	cloudy	Light snow during the night ended about 9 a.m., leaving a thin white mantle on the streets.
1949	Harry S. Truman	38°	mostly sunny, windy	
1953	Dwight D. Eisenhower	49°	cloudy	
1957	Dwight D. Eisenhower	44°	cloudy	January 21. Light snow in early a.m., with a few flurries in mid-afternoon.
1961	John F. Kennedy	22°	snow in early morning; sunny, but with chilling wind rest of the day	Eight inches of snow on ground.
1965	Lyndon B. Johnson	38°	cloudy	One inch of snow on the ground.
1969	Richard M. Nixon	35°	overcast, chill northeast wind	Very light rain and sleet began at 4:25 p.m.
1973	Richard M. Nixon	42°	cloudy and chilly, strong gusty winds	
1977	James Earl Carter	28°	sunny, but cold and windy	Two inches of snow on the ground.

Quakes in Search of a Theory*

By Henry Simmons

Its place on the earthquake-prone "ring of fire" that circles the Pacific Ocean may well justify the popular tendency to equate California with North American earthquake risk. The horrors of the San Francisco earthquake of 1906 are richly chronicled, the fault system that spawned it is graphically familiar, and the tectonic theories of recent years tell us clearly why—if not quite when—another edition of that classic tragedy is likely to occur.

Nevertheless, the most severe earthquake to strike the mainland United States in historic times occurred not in California, but some 2,000 miles east of the San Andreas Fault, in the "boot heel" section southeastern Missouri. And even though another San Francisco quake would be devastating, more damage over a wider area affecting more people can be expected if (or when) the Valley of the Mississippi is ever visited by another shock like the one that wracked it just 165 years ago.

We are not accustomed to thinking of Missouri, South Carolina, New England, upstate New York, or the St. Lawrence River Valley as earthquake regions. The theory of plate tectonics that so neatly explains earthquakes along existing plate boundaries so far does not address quakes in these midplate regions. Nevertheless, they are all quake prone, and it is a major goal of tectonic science today to understand just why.

The greatest of the known midplate quakes occurred in the winter of 1811-12, when a then-thinly settled region west of the Mississippi River was shaken by a series of three major shocks and many hundreds of lesser shocks. The earthquakes originated in what is now called the New Madrid Fault Zone, after the Missouri settlement closest to the epicenters. The quakes left great fissures in the ground, ejected mud, sand, and a poor grade of coal—the so-called "sand blows"—and produced major changes in land elevations, including the submergence of many islands in the Mississippi River itself.

By historical coincidence, the first paddlewheel steamer to ply the river, the *New Orleans*, built in Pittsburgh and on its maiden voyage to New Orleans, had reached a point 120 miles south of New Madrid when the quake struck. In the florid prose of the day, one of the owners reported: "The scene was terrible beyond description; our boat appeared as if alternately lifted out of the water, and again suffered to fall. The banks above, below, and around us were falling every moment into the river, all nature seemed running into chaos .... The crashing of falling trees and the loud screeching of wild fowl made up the horrid concert."

What was particularly striking about the New Madrid quakes was the enormous geographical extent of the damage. In the first of them, which struck December 16, 1811, stone and masonry structures were damaged to a radius of 250 kilometers; chimneys were shaken down in Nashville, Louisville and Cincinnati; a very perceptible ground motion was observed along much of the east coast, ringing church bells and stopping pendulum clocks as far off as Savannah, Charleston, Raleigh, Norfolk, and Washington, D.C.

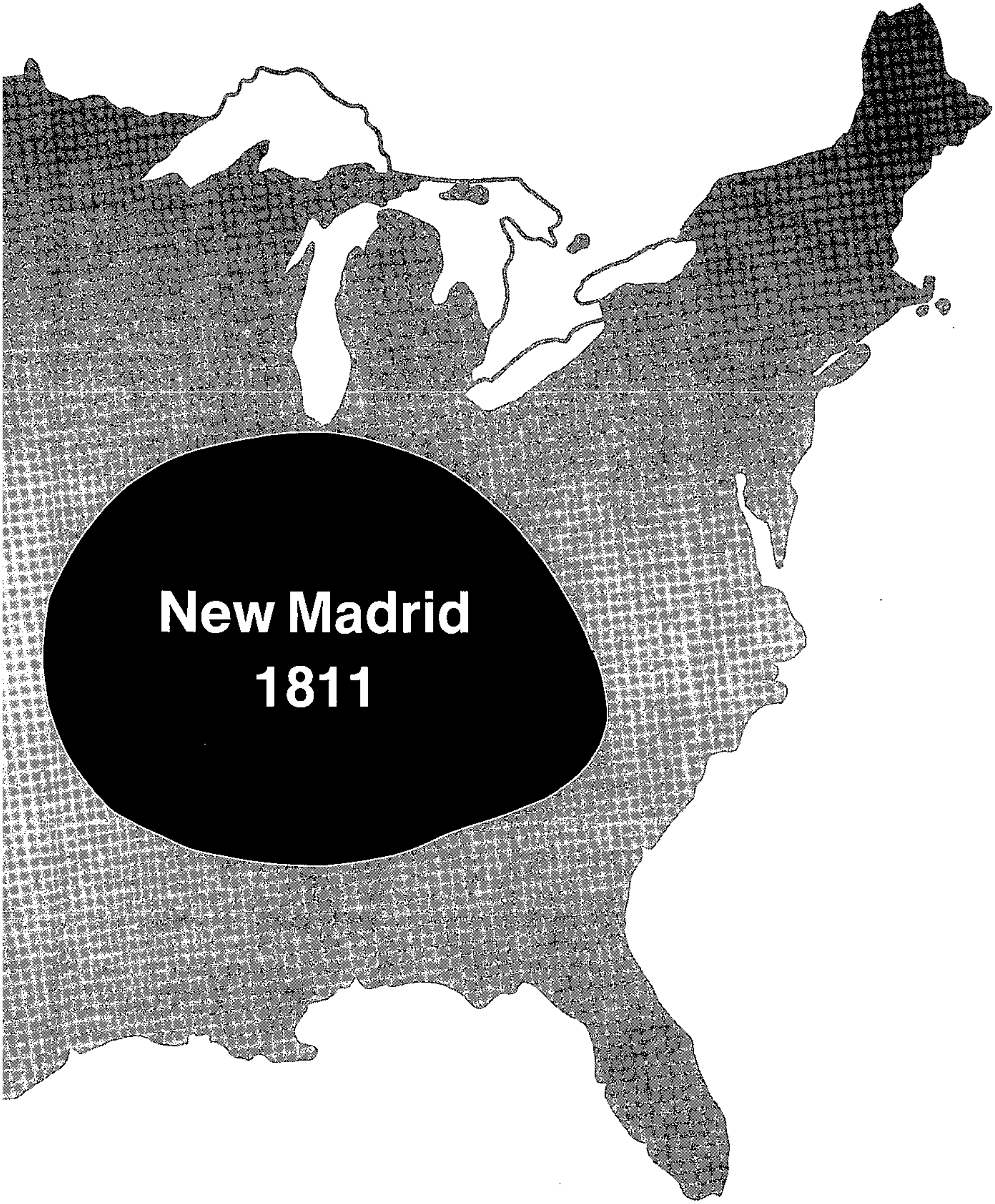
The Midplate Enigma

The New Madrid quakes and their implications for the Mississippi Valley are a major preoccupation of Otto W. Nuttli, a geophysicist and seismologist who has spent all of his professional career at St. Louis University. As a principal investigator who has received a number of National Science Foundation grants for this work during the past several years, Nuttli and his colleagues have made important progress in their efforts to unravel the enigma of the Mississippi Valley quakes and to understand the seismic risks such "intra-plate" quakes can pose for human habitation and industrial development.

Paradoxically, the development over the past decade of scientific understanding of the mechanisms of earthquake production at the margins of the vast plates of the Earth's crust has deepened the mystery surrounding quake-prone regions far distant from the plate margins. There are several reasons

Area of significant damage for the most severe earthquake to strike the United States mainland. Graphic based on Mosaic *drawing.*

* Reprinted from *Mosaic Magazine*, Vol. 7, No. 4, published by the National Science Foundation, Washington, D.C.


New Madrid
1811

for the disparity in our understanding of the two types of events. For one thing, "inter-plate" events occur along active, identifiable fault zones whose surface slippage can be readily correlated with seismic events. Second, quakes in these areas are considerably more frequent than in the intra-plate regions, so that the data base which they provide is considerably richer. Third, because of their frequency and intensity, they have inevitably attracted most of the scientific attention and funding available for instrumentation and research. Finally, and most important, has been the development of a simple, persuasive, and largely verified model of the processes causing the inter-plate seismic activity—the theory of plate tectonics.

According to this theory, the Earth's outer skin—its lithosphere—consists of about a dozen huge plates ranging up to 100 kilometers in thickness which float on a partially plastic layer of the upper mantle. Unlike lily pads on the surface of a still pond, the plates are free to move laterally. They are driven violently together in some places, pulled apart in others, and occasionally one plate is driven to great depths beneath another in the deep trenches of the oceans.

On the west coast of the United States, for example, the Pacific Plate is pressing northwestward, and it is involved in a grazing, grinding collision with the North American Plate. This has produced the great San Andreas fault, which almost bisects California from north to south, along which much of the seismic activity of the western United States occurs.

In contrast to the rather extensive knowledge accumulated about seismic activity at the plate margins, scientific understanding of the intra-plate processes is relatively limited. Nevertheless, important advances have been achieved in the last few years, along with increased interest and funding by Federal agencies like the National Science Foundation, the U.S. Geological Survey, and the Nuclear Regulatory Commission, as well as by private foundations.

Nuttli, for example, has closely studied the effects of the 1811-12 New Madrid earthquakes as reported in newspapers and journals of the period. He has calculated the epicentral intensity of the December 16 shock at a value of XI on the Modified Mercalli Scale: "Few, if any, 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."

The intensity of the second great shock a little more than a month later, on January 23, 1812, was somewhat less, a value of X to XI on the scale, but still sufficient, according to the Mercalli Scale, to throw frame structures out of plumb, causing partial collapse in large structures, shift buildings off foundations, and produce conspicuous ground cracks. According to Nuttli, the third great shock on February 7 was the most powerful of all. At the epicenter he believes it verged on the maximum value of the scale—XII. This level of intensity is described by the Modified Mercalli Scale as: "Damage total. Practically all works of construction are damaged greatly or destroyed. Waves seen on ground surface. Lines of sight and level are distorted. Objects are thrown upward into the air."

The Relative Risk

At the time of the great earthquakes, of course, the region was sparsely inhabited. Nuttli estimates a population of only about 25,000 scattered in settlements along the Missouri-Arkansas stretch of the Mississippi. What buildings existed were severely damaged, and although there was some loss of life, mainly drownings, the death toll was remarkably light.

Today, of course, the story would be far different. A recurrence of the February 7 event would almost certainly produce casualties in the tens of thousands. As for property damage in major industrial areas like St. Louis, Memphis, and Paducah, Kentucky, with its important nuclear facilities, estimates are that the losses would range from $10 billion to $50 billion.

These grim figures underscore the importance of understanding the frequency with which the "reference earthquake"—one of a magnitude equivalent to those of 1811-12—might recur. By means of statistical analysis of the frequencies of the many smaller events which have occured in the New Madrid zone over the past century or more, Nuttli and other investigators have calculated a return rate of about 500 to 700 years for the maximum event. This compares with a return period of about 100 years for the maximum earthquake on the locked portions of California's San Andreas fault. It should be pointed out, however, that seismologists have considerably greater confidence in the 100-year return period for the largest San Andreas events than they do in those calculated for the great Mississippi Valley quakes. This is because they have a much firmer understanding of the underlying mechanisms at work in the San Andreas, and because the actual frequency of earthquakes observed there during historical times has tended

"Nature Itself Seemed Tottering. . . ."

(The following is excerpted from a dispatch to the *New York Evening Post* by correspondent William L. Pierce who was traveling down the Mississippi in a flatboat expedition at the time of the first of the greatest series of earthquakes to strike the United States in historical times. He describes a scene about 45 miles south of New Madrid, Missouri, near the epicenter of the quake, on December 16, 1811).

"It was now light, and we had an opportunity of beholding, in full extent, all the horrors of our situation. During the first four shocks, tremendous and uninterrupted explosions, resembling a discharge of artillery, were heard from the opposite shore; at that time I imputed them to the falling of the river banks. This fifth shock explained the real cause. Wherever the veins of the earthquake ran, there was a volcanic discharge of combustible matter to a great height, an incessant rumbling was heard below, and the bed of the river was excessively agitated, whilst the water assumed a turbid and boiling appearance. Near our boat a spout of confined air, breaking its way through the waters, burst forth, and with a loud report discharged mud, sticks, etc., from the river's bed, at least 30 feet above the surface. These spoutings were frequent. . . .Large trees, which had lain for ages at the bottom of the river, were shot up in thousands of instances, some with their roots uppermost. . . .

"We contemplated in mute astonishment a scene which completely beggars all description and of which the most glowing imagination is inadequate to form a picture. Here the earth and river torn with furious convulsions, opened in huge trenches, whose deep jaws were instantaneously closed; there through a thousand vents sulphurous streams gushed from its very bowels. . . . Everywhere nature itself seemed tottering on the verge of dissolution. . . ."

to bear out their calculations.

In any case, a calculated return period represents only a statistical average, and it is not of practical value for such purposes as designing a structure whose failure would cause immense loss of life or disruption of vital services. In such cases, it is necessary to assume that the largest possible earthquake will occur within the lifetime of the structure—in as short a period as 30 to 40 years—and to design the dam, bridge, powerplant, or other major building to survive its effects.

One of the most interesting—and ominous—results of research on intra-plate earthquakes east of the Rocky Mountains has been the finding that the eastern quakes have a much larger "felt radius" than those in the far west. Nuttli has calculated that the New Madrid sequence of 1811-12 generated ground motion with a Mercalli value of V all the way to the east coast. This is the value "felt by nearly everyone, many awakened; some dishes, windows broken; unstable objects overturned; disturbances of trees, poles; pendulum clocks may stop." The area of the country subjected to this intensity was immense—about 2.5 million square kilometers, according to Nuttli. By comparison, the mightiest of all the known California earthquakes, the 1906 San Francisco event, propagated earthquake waves of Mercalli V or greater over an area of only 150,000 square kilometers. Similarly, Nuttli has calculated the area of Mercalli VII intensity—the threshold of significant structural damage—at 600,000 square kilometers in the case of the New Madrid events, but only about 30,000 square kilometers for the San Francisco quake.

What this means is that a given seismic event east of the Rockies is about 20 times as efficient in transmitting its most destructive ground motions as is a California quake. According to Nuttli, this difference could be due to a higher rate of absorption of elastic wave energy in the thick sediments overlying much of the California coastal region, or, alternatively, a greater subsurface moisture content than in the east, resulting in a poorer coupling at the grain boundaries and greater attenuation of the energy. Curiously, it also means that although the maximum California earthquake may occur five to seven times as frequently as the maximum New Madrid quake, the cumulative area of felt radius and damage of the California shocks over long periods of time will actually be less than the area shaken by a New Madrid event.

Getting At The Mechanism . . .

Because of the vast areas over which the relatively infrequent eastern quakes propagate their damaging waves, it is important both from an engineering and a scientific standpoint to understand the underlying mechanisms at work in generating these events. It is the "body waves," those passing through the solid earth itself and producing fast, high-amplitude jolts at the surface, that are most damaging close to the epicenter; at larger distances the spread-out, sinusoidal type surface waves do all the damage. Neither has received much attention in the central United States, Nuttli notes.

The obstacles to understanding are formidable. Aerial and satellite imagery of intra-plate quake zones provide few reliable clues to the existence of active fault zones on which seismic activity may be occuring today. Indeed, there is growing evidence that current seismic activity is occurring along strikes which are actually perpendicular or transverse to the surface features most suggestive of fault structures.

A single all-embracing model explaining the eastern quakes is not only lacking, but it is also unlikely that they can be explained by a single model because of the variety of forces and the diversity of geological structures which appear to be involved.

Nevertheless, the eastern quake problem is not intractable. With NSF support, Nuttli has been able to deploy seismic instruments at numerous points in several States around the New Madrid Fault Zone to monitor the frequent low-level seismic activity there; more recently the U.S. Geological Survey and the Nuclear Regulatory Commission initiated more elaborate and extensive seismic arrays at New Madrid as well as in the Charleston area of South Carolina. And with Federal, State, and private support, Lamont-Doherty Geological Observatory scientists have established an extensive array of seismic stations in New York—among the most important areas of northeastern seismic activity. As a result of this work, new evidence is coming to light which could lead to a firm theoretical understanding of what is happening.

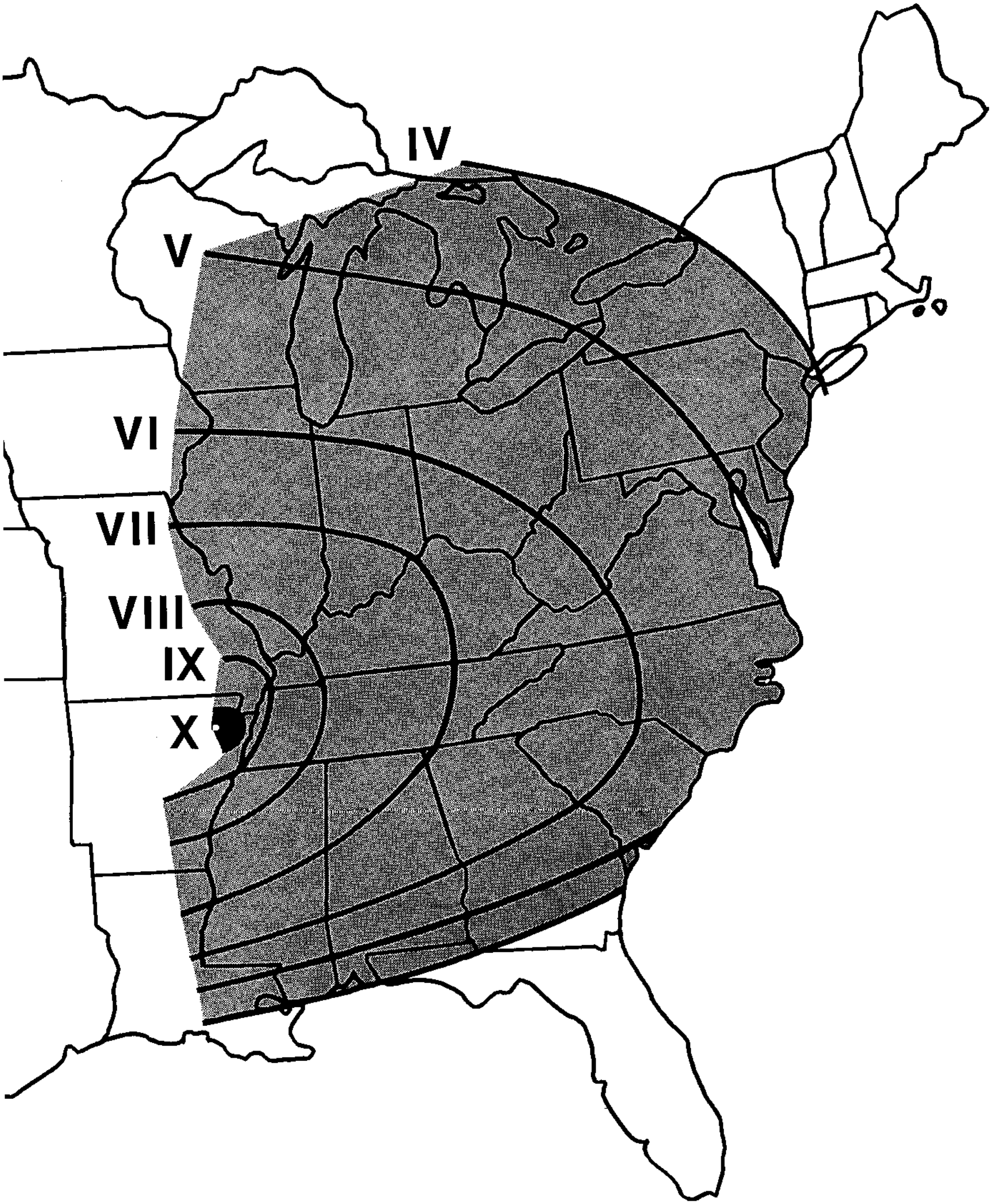
One of the most fruitful techniques for understanding what is happening in earthquake-prone zones is called fault plane analysis. By setting out an extended array of seismic instruments to record occasional small tremors over a period of time, it is possible to construct a sort of "three-dimensional picture," as Nuttli puts it, of the subterranean forces at work. This is based on the fact that each movement radiates waves through the Earth much as a radio transmitter dipole antenna does. Some stations will see compressional or "push" waves first; the first motion at others will be dilatational or "rarefaction" waves. By integrating these readings, it is possible to determine the location and focal depth of the event, the orientation of the fault planes, and the direction of the forces at work.

In an important paper in 1975 in the magazine *Science*, Nuttli and his colleagues reported the results of their analysis of 38 minor earthquakes which occurred within a 400-kilometer radius of New Madrid over the past 13 years. They found that while there is a continuous trend of earthquake epicenters from Memphis northeastward, through New Madrid and into south-central Illinois, the earthquakes themselves fall into two different groups. Above 36.3° N.—where New Madrid is located on the Mississippi River—the seismic analysis shows that most of the quakes occur along faults having a north-south strike. They appear to be "thrust" faults in which crustal blocks to the east are tending to ride upward over those to the west. This finding is in line with an overall model of seismic activity in eastern North America published in 1973 by Marc Sbar and Lynn Sykes of Lamont-Doherty. According to this model, eastern North America is presently experiencing a compressive stress field whose axis runs from the north to the south. Such a stress pattern would produce thrust faults aligned perpendicular to the direction of the force; this is indeed what Nuttli has reported.

. . . Or Mechanisms

However, Nuttli has located and plotted a second group of earthquake epicenters at New Madrid and to the south which behave quite differently. Here the force at work is not compressional but tensional. The fault planes appear to have an east-west alignment, with the units to the south tending to pull apart and slump downward relative to the northern units. In this region, obviously, local conditions have sharply modified the general model proposed by Sbar and Sykes, who agree with the conclusion of Nuttli and his colleagues that a different set of forces is at work in the southern

The felt radius of the earth shock that originated at New Madrid extended to the East and Gulf Coasts and the Great Lakes. Intensity to the west of the epicenter is unknown. Graphic based on Mosaic *drawing.*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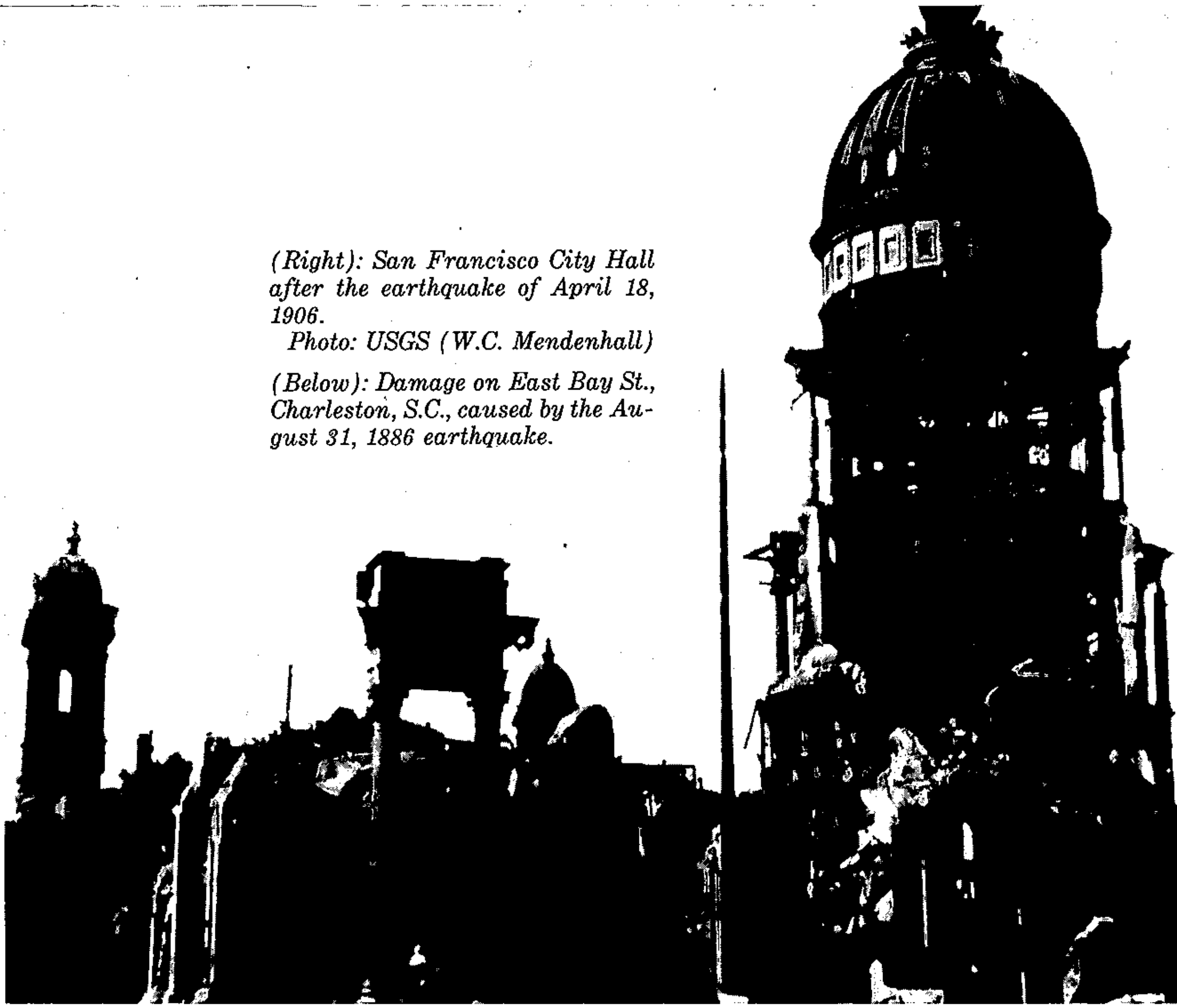


(Right): San Francisco City Hall after the earthquake of April 18, 1906.
Photo: USGS (W.C. Mendenhall)

(Below): Damage on East Bay St., Charleston, S.C., caused by the August 31, 1886 earthquake.

group of epicenters.

Unfortunately, the forces producing this remarkable stress pattern at New Madrid are not well understood. Probably the most important hypothesis concerns The Father of Waters itself, which has been draining the North American Continent for the past 100 million years. The intermittent meanderings of the Mississippi over this span of geological time has produced an enormous feature called the Mississippi Embayment, a huge region of alluvial deposits extending from the Gulf of Mexico northward to the vicinity of New Madrid. It is suggested that the enormous weight of these sediments, perhaps including a phase change that increases their density at considerable depths, is literally bending the Embayment downward, with the New Madrid at the "hinge point."

Many seismologists and geophysicists are uneasy with this explanation. While there is widespread agreement among his colleagues that Nuttli is correct in seeing a tensional stress pattern south of New Madrid, neither they nor he are satisfied that the mere accumulation of alluvial deposits can explain the process. For example, if this were a realistic mechanism, how could one explain the dearth of quake activity along the continental shelves of the United States, where vast amounts of sediments have been deposited over geological time?

There is intriguing evidence that other forces may be involved, the understanding of which could shed important light on the New Madrid phenomenon and on other mysterious sites of eastern quake activity as well: In Arkansas, slightly to the west of the New Madrid region, aeromagnetic and aerogravity mapping have disclosed significant subsurface density anomalies in the Earth's crust. The most likely possibility is that dense ultramafic (characterized by high iron and magnesium content) igneous intrusions from the Earth's plastic mantle have thrust strongly upward into the crust in this region. Interestingly, if this model is correct, the depth of the intrusions is about ten to 15 kilometers—about the same as the depth of the tremors Nuttli and his colleagues have measured in the vicinity of New Madrid.

It is also noteworthy that recent aeromagnetic and gravitational surveys of the Charleston area, where the last major eastern quake, in 1886, killed 83 people and produced wide-ranging damage, have disclosed that the epicentral region of this event borders the eastern edge of a large, circular magnetic and gravitational "high" which appears to be unique as far as the eastern coastal plain is concerned. This body is much shallower than New Madrid intrusions; the U.S. Geological Survey with NRC funding has instituted in the area a drilling program which has gathered cores of an iron-rich basalt at a depth of only 750 meters.

"People have wondered about the role of these strong, rigid masses as possible stress concentrators," observes G.A. Bollinger of the Virginia Polytechnic Institute at Blacksburg. He has been supported by NSF grants for several years as the principal investigator of quake activity in the southeastern United States, and especially in the Charleston area. "The trouble is, we see such masses in many other places, but no seismic activity. The model is plausible, but why this selectivity?"

"We simply don't know how these ultramafic instrusions relate to the seismic activity we see in the New Madrid region," Nuttli admits. "Perhaps they weaken the crustal structure so that bending or slumping occurs right there. On the other hand, maybe the hinge movement in the New Madrid zone weakened the crust and allowed the ultramafic intrusions to rise at that point. We don't know which came first."

A Possible Model

There is growing evidence that deep igneous intrusions, younger than the surrounding crustal rocks, may also play a key role in the complex seismic activity in the northeastern United States and Canada. Much of this activity occurs along a poorly defined zone extending from Massachusetts northeastward to the vicinity of Ottawa. Jon Fletcher, Marc Sbar, and Lynn Sykes of Lamont-Doherty have found that seismic signals from distant nuclear tests, like the Canikin shot deep under the Aleutians in 1971, have faster arrival times at stations inside this zone than outside it. This suggests that the density of the material in the lower crust and upper mantle beneath this zone is greater than in the surrounding regions—an indication of a deep, massive igneous intrusion. Moreover, this intrusion seems to be related to surface features like the White Mountains of New Hampshire and the Monteregian Hills of northern New England and southern Quebec. These volcanic structures were formed between 100 million and about 200 million years ago, a period which followed the early opening of the Atlantic and the separation of North America and Africa.

According to the Lamont-Doherty scientists, the New England Sea Mounts, a southeasterly trending chain of volcanic remnants in the Atlantic off Massachusetts, may be genetically related to the continental volcanism. Together they may constitute a tectonic feature some 2,000 kilometers in length. They propose that the Blake Fracture Zone in the Atlantic to the south represents a similar feature which may extend through Charleston to east Tennessee. And they believe these features to have been formed originally in processes analogous to those at work in the Great Rift Valley of Africa today, where the tectonic forces are splitting the continent from the Nile Valley to Mozambique and forming a chain of volcanoes in the process. The Lamont-Doherty group hypothesizes that these features represent what might have been tectonically active zones during the early period of separation of the major plates.

The stresses and the upwelling of magma which occurred in the early history of the zones have now ceased. Nevertheless, the extensive fracturing they caused has not been "healed" by metamorphic processes, with the result that seismic activity tends to occur in these weakened crustal zones in response to the predominantly compressive stress now at work. The Lamont-Doherty scientists also suggest that the Mississippi Embayment itself may be such a feature of crustal weakness, dating back to the opening of the Gulf of Mexico.

A Need To Know

Although important progress has been achieved in understanding the diverse subterranean forces which may play a role in the seismic activity of the eastern United States, it must be emphasized that scientific understanding of the seismic activity west of the Rocky Mountains is far greater than it is in the east. There is considerable confidence that west coast earthquakes will eventually prove predictable, something to which only the most preliminary attention is being given for major eastern earthquakes. Nevertheless, a deeper understanding of the mechanisms producing eastern earthquakes could have important practical consequences. For example, a recurrence of the New Madrid quakes would not threaten the famous 630-foot St. Louis Arch, the city's trademark, because of its strong, simple construction. But this is not the case for complex, sensitive, high-value structures such as nuclear reactors, dam, bridges, and the like.

As matters now stand, the U.S. Nuclear Regulatory Commission (NRC) specifies that nuclear reactors constructed in the central United States be capable of withstanding the "reference" earthquake—an event of the mignitude of the 1811-12 shocks. But where and when might this reference earthquake occur? To be on the safe side, NRC presumes that it might occur at any time in the region from Memphis, to the south of New Madrid, up to central Illinois and Indiana. In other words, NRC assumes for reactor siting purposes that this whole region is dominated by the New Madrid Fault Zone.

Nuttli sees it differently. "I personally believe that the New Madrid Fault Zone ends about 37° N., at about Cairo, Illinois, and that we have a separate fault system to the north. You see, if you break it up into two separate fault systems, which our data indicate to be the case, you don't have to design against the reference earthquake as far north as Illinois and Indiana."

"The idea of the Mississippi Embayment hinging downward at New Madrid is a comfortable one," admits James F. Devine of the U.S. Geological Survey, who advises the NRC on seismic hazards. "We don't have any evidence to contradict it, but unfortunately we don't have enough evidence to confirm it, either."

"We tend to take a very conservative approach to the maximum credible event which a nuclear reactor must be designed to withstand, and I think properly so," observes Henry Coulter, also of the U.S. Geological Survey. "An initial conservatism in plant design isn't a terrible economic penalty. It's certainly less costly than in the case where you design for a lesser event . . . and then have to backfit the plant to withstand a stronger event."

Is it likely that we will ever learn enough about earthquake mechanisms in the eastern United States to relax the rigid conservatism now imposed on reactor site selection and plant design?

"I don't know how to answer that one," says Coulter. "I guess it depends on how critical your decision is. The more important it is, the harder your data must be to justify a decrease in design conservatism."

Nevertheless, Nuttli and other scientists working on eastern seismic activity are now laying the foundations for a more profound understanding of the mechanisms at work and the true seismic hazards they represent. Ultimately, it should be possible to avoid some of the economic penalties presently imposed by the lack of hard knowledge. Perhaps it will even be possible to forecast the earth movements east of the Rocky Mountains with the kind of accuracy earth scientists are aiming for in the west.

Tsunami Data Services

One of the most complex, catastrophic and misunderstood natural disasters is the tsunami. These earthquake-generated waves have taken a tremendous toll of life and property. The Great Hoei Tokaido-Nankaido tsunami of 1707 claimed 30,000 lives and washed away 8,000 houses. More recently, a tsunami originating in the Gulf of Alaska on March 27, 1964 resulted in $11 million property damage in Crescent City, California and in Alaska.

EDIS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) in Boulder, Colo., has compiled a set of data bases of direct interest to tsunami research and operations. The specific data holdings are as follows:

Seismological Data: Copies of seismograms from the World Wide Standard Seismograph Network of about 120 stations are available on 35 and 70 mm film and since 1978 on microfiche. Since 1972 this collection of about 5,000,000 seismograms has been augmented by about 150 additional stations worldwide for large magnitude (7.5 and larger) and special interest earthquakes. A program has begun to microfilm older seismograms worldwide for all large earthquakes for selected stations since 1900. Digital data from the very long period International Deployment Accelerometers (IDA) worldwide network of gravimeters are available since 1975 and from the digitally recording Seismic Research Observatory (SRO) and High Gain Long Period (HGLP) network since 1977. A digital Earthquake Data File has information on approximately 150,000 earthquakes, including whether or not a tsunami followed.

Hydrographic Data: The term "tsunamigrams" is used for tide records with evidence of tsunami activity. Nearly 1,800 tsunamigrams from U.S. tide stations are available on microfiche. Records in this collection date back to 1850. Future emphasis will be on the collection of records from international sources. Some data has been volunteered through the International Hydrographic Bureau and other data may come from the International Tsunami Information Center (ITIC). A few tsunamigrams have been digitized for review by selected researchers. Demand will determine future digitization of analog records.

Bathymetric Data: The data center has a collection of about 50,000,000 bathymetric observations of U.S. coastal areas collected since 1930 by the U.S. Coast and Geodetic Survey and the successor NOAA organization, the National Ocean Survey. These data are on magnetic tape and can be formatted to provide even space grids or profiles.

Photographic Data: A collection of 667 photographs of tsunami wave activity and effects has been compiled. A catalog describing the photographs is available from NGSDC.

The data center has printed catalogs on tsunamis in both Alaska and Hawaii. It operates a modest guest worker program and can provide space, access to computers, digitizers, plotters and data files to researchers who need to access large amounts of data. Data from the center are available at cost of copying or in exchange to scientists depositing data in the center. For further information on NGSDC's data holdings and prices, contact: Patricia Lockridge, NOAA/EDIS/NGSDC, D622, 325 Broadway, Boulder, CO 80303.

NPRA Data Available

New geological and geophysical data for certain regions in the National Petroleum Reserve in Alaska (NPRA) now are available for public dissemination from EDIS' National Geophysical and Solar-Terrestrial Data Center. The data were collected and processed by various companies under contract to the U.S. Geological Survey to evaluate the petroleum potential of portions of the NPRA.

The five data sets contain approximately 2,000 line-miles of seismic data (both on shore and offshore), palynological and micropaleontological analyses and reports for 8 wells, velocity surveys for 7 wells, and 5 interpretative geological and geophysical reports. The data are summarized in the following data announcements, which are available on request:

NPRA Seismic Data (1978-79) & Aerial Gamma Ray & Magnetic Data. Flier No. 1980 (SE-M).

NPRA Palynology & Micropaleontology Reports. Flier No. 1980 (SE-CC).

NPRA Summary Report: Interpretation of Seismic Data (FY78). Flier No. 1980 (SE-DD).

NPRA Velocity Surveys for 7 Additional Wells. Flier No. 1980 (SE-EE).

NPRA Misc. Geological Reports. Flier No. 1980 (SE-FF).

Inquiries should be addressed to: National Geophysical and Solar-Terrestrial Data Center, NOAA/EDIS (D62), 325 Broadway, Boulder, CO 80303.

The 1980 Heat Wave

Last summer's heat wave and drought took at least 1,265 lives and cost the Nation nearly $20 billion according to an anlysis by EDIS' Center for Environmental Assessment Services (CEAS). Because of the high temperatures and dry conditions:

- Heat related summer deaths were seven times greater than normal;
- Electrical energy use was 5.5 percent above normal, an all-time record;
- Crops and livestock suffered greatly;
- Searing temperatures buckled hundreds of miles of major highways;
- Water resources in many parts of the country were seriously jeopardized.

The analysis was based on information obtained from Federal agencies, private organizations, and 26 States affected by the unusual weather that extended from June into September.

Most of those who died from the heat wave were either elderly or poor, and lived in non-airconditioned homes or apartments. The greatest number of fatalities, 311, occurred in Missouri, even though other States had higher temperatures for longer periods.

The heat wave's greatest impact on energy consumption and costs began during the last week of June and continued for six weeks thereafter. Total electric use during the period averaged 5.5 percent above normal with an accumulated cost of more than $1.3 billion.

Corn, soybean, and next spring's wheat crops were damaged by the drought. The poultry industry also lost millions of birds. However, the winter wheat crop actually benefited from hot, dry weather during the harvesting period.

Parched pastures, poor nutrients, and the heat slowed livestock growth, resulting in widespread sell-off of herds. The destruction of the protective vegetative covers of thousands of acres of Midwest cropland also may cause severe soil erosion this winter.

Because of the drought, the price of finished or ready-for-sale food items rose by 4.4 percent in August alone, while prices for raw agriculture products increased 19 percent during July and August.

The heat wave buckled hundreds of miles of major highways in South Central and Midwestern States, and softened asphalt highways in Texas and Arkansas where surface temperatures exceeded 150 degrees. Illinois alone sustained $100 million in road damage. Highway damage costs throughout the heat belt are estimated at four to five times that amount.

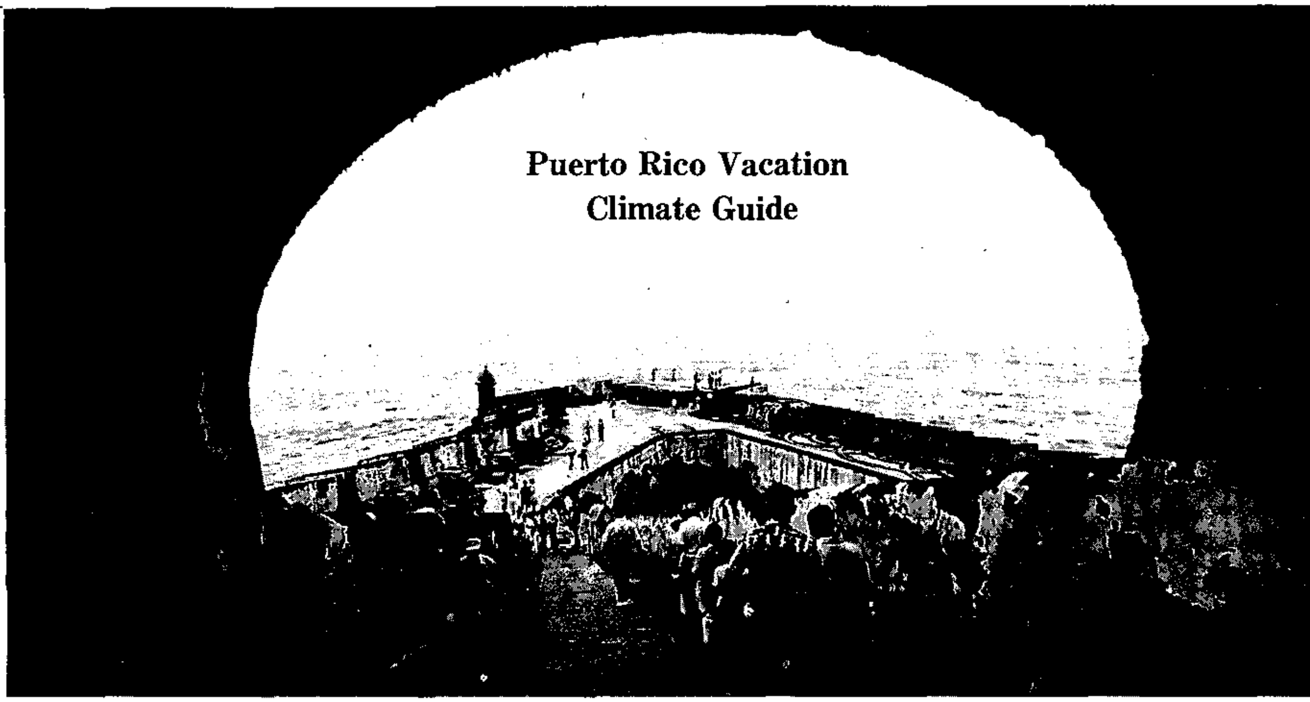
The heat also was blamed for widespread vehicle breakdowns and a surge in auto repair expenditures. Many areas experienced water shortages and rationed their supplies. Texas and Arkansas were the hardest hit. A drop in the water table in those States and in Oklahoma forced farmers to "dry" farm acreage that previously was irrigated. The drop far exceeded yearly normals and also threatened industrial development in the three States.

The heat wave began in mid-June, when temperatures exceeded 100 degrees Fahrenheit in southwest Texas. By the second week in July, it had spread northeastward, with most of the central one-third of the Nation experiencing 100-degree temperatures.

In mid-July the heat spread eastward to the Ohio Valley and mid-Atlantic Region and, despite several brief respites during the next few weeks, covered much of the eastern United States through the week ending September 7.

Temperature records were shattered in more than half a dozen States, and on one day—July 13—three cities broke their all-time maximum temperature records. They were Augusta, Ga., with 107 degrees, Atlanta, Ga., with 105 and Memphis, Tenn., with 108. Temperatures in Dallas, Tex., reached 100 degrees each day from June 23 through August 3.

Puerto Rico Vacation Climate Guide



Puerto Rico's Vacation Climate Guide is the latest in a series of recreation brochures produced jointly by EDIS' National Oceanographic (NODC) and the University of Puerto Rico's Office of Sea Grant. The booklet contains useful environmental information for the fisherman, camper, boater, diver, surfer, or sightseer.

The brochure contains practical information for both visitor and resident alike. There is information on beaches, marinas, fishing, boat rental, campgrounds and popular diving spots. Weather is spotlighted for these recreational activities and indicates a good year-round climate for most. The guide also details weather hazards, for those using the water, including tropical cyclones, thunderstorms, and rip currents.

Copies are available from the NODC's Marine Climatological Services Branch, Room 400, Page 1, 2001 Wisconsin Avenue, Washington, DC 20235, or from the University of Puerto Rico Sea Grant Program, Department of Marine Science, RUM, Mayaguez, Puerto Rico 00708 free of charge.

Photo: The El Morro fortress in San Juan, Puerto Rico attracts many visitors.

Photo: U.S. Travel Service

Georges Bank Study

EDIS' Center for Environmental Assessment Services has published *A Climatologic and Oceanographic Analysis of the Georges Bank Region of the Outer Continental Shelf.* The report describes the results of an environmental study of the Georges Bank and Gulf of Maine areas performed under interagency agreement between the Bureau of Land Management, U.S. Department of the Interior and EDIS.

The 289-page publication includes (1) summaries of historical, meteorological and oceanographic data from the study region; (2) interpretation and analysis of the summaries and a description of the marine environment; (3) conclusions drawn from the analyses that provide information concerning environmental processes and data limitation; and (4) recommendations for future analysis and for use of analytical procedures.

Offshore environmental information for the outer continental shelf is required to support Department of the Interior mineral management programs that deal with environmental protection. Bureau of Land Management information requirements include descriptions of physical and chemical oceanographic characteristics that relate to potential environmental impacts associated with offshore oil and gas resource development. The Georges Bank region of the North Atlantic outer continental shelf includes areas designated for oil and gas exploration leasing.

EDIS' Marine Environmental Assessment Division used environmental data from the National Oceanographic Data Center and National Climatic Center to produce an oceanographic analysis of the Georges Bank region. In addition, climatology and wave analyses were produced to provide information related to ship operations and the surface movement of pollutants.

Visit of PRC Marine Data Specialists

Five marine data specialists from the People's Republic of China visited EDIS October 8 to November, 2, 1980, returing the U.S. marine scientists visit of November 1979. (See EDIS, May 1980.) The purpose of the visits was to further the establishment of marine data exchange between the two countries and to discuss arrangements for U.S. assistance in the establishment of a PRC national oceanographic data center. The visit was made under the terms of Protocol on Cooperation in the Field of Marine and Fishery Science and Technology between NOAA and the PRC's National Bureau of Oceanography (NBO).

The delegation was led by Mr. Luo Chuan-wei, Deputy Director of the Institute of Marine Scientific and Technological Information (IMSTI). Three of the other members of the delegation also were from this Institute, while the remaining member, Mr. Xu Zhizhong, was from NBO Headquarters.

The Chinese delegation delivered PRC data to EDIS, in the form of a printout of 247 ocean stations. This is the first foreign distribution of ocean station data in more than 30 years. Several publications were also presented to EDIS, including a newly published comprehensive atlas of the Sea of Japan.

Proposals were discussed regarding training of PRC professionals (beginning in FY 1982) and provision of computer program documentation and software. These proposals include on-the-job training at EDIS Centers for a minimum of 3 months per trainee. English comprehension is a prerequisite, and trainees must bring PRC-originated oceanographic data with them. They will be trained in processing techniques using their own data sets.

On the matter of data exchange, it was proposed that formal exchange begin in April 1981, with the U.S. providing data in automated form and the PRC in printed form, until such time as the NBO acquires a digital computing system. The proposal also calls for exchange of publications and information as well as answering individual requests on a case-by-case basis.

(Left to right): Zhad Xucai, IMSTI; Chen Shangji, IMSTI; Joan Hock, EDIS; Luo Chuan-wei, IMSTI; James Churgin, EDIS; Xu Zhizhong, NBO; and Wang Deyuan, IMSTI.

Photo: Bill Holt

Exchange of Marine Climatological Data

EDIS' National Climatic Center (NCC) hosted a World Meteorological Organization (WMO) Study Group Meeting on Marine Climatology during the week of September 22-26, 1980. Delegates included experts from Japan, Hong Kong, the United Kingdom, the Netherlands, the Federal Republic of Germany, the USSR (two delegates) and the United States. Bob Quayle chaired the session, assisted by Marc Plantico, both of NCC.

The Study Group was charged by the Commission for Marine Meteorology's Working Group on Marine Climatology to:

1. Draft new surface marine exchange formats in accordance with the new WMO Code which goes into effect January 1, 1982. These non-real-time data are exchanged globally by over 40 maritime nations to accumulate a complete surface marine data bank for the world ocean.
2. Draft new map formats for the Marine Climatological Summaries Scheme. This project provides annual monthly surface marine summaries for the globe for the period since 1961.
3. Review minimal quality control procedures for exchanged data.
4. Review progress on the Historical Sea Surface Temperature Data Project. This project, which is now complete, provides data and summaries of high quality sea surface temperature, air temperature and wind data globally for each year-month from 1860 to 1960.
5. Review programs which will provide guidance on use of telecommunicated data as a climatological resource.

A Draft Report is available in limited quantities from the National Climatic Center, Applied Climatology Branch, Federal Building, Asheville, N.C. 28801. The final report will be published by the WMO in the near future.

International Oceanographic Data Exchange Experts Meet

In November 1980 EDIS' National Oceanographic Data Center (NODC) hosted meetings of two groups associated with the Intergovernmental Oceanographic Commission's (IOC) Working Committee on International Oceanographic Data Exchange (WC IODE).

The WC IODE's Group of Experts on Format Development met during the first week primarily to plan the expansion of IOC's new standard "General Format" for the international exchange of marine environmental data. The new IOC format, which has been under development for many years, is an outgrowth of experience gained with formats developed for other international oceanographic programs. The specifications for the format have been published in IOC's four working languages. The main concerns before the experts were the development of a universal parameter code for all types of data elements, and the systematic international implementation of the format at various NODC's. EDIS, as a "Responsible" NODC for the Global Weather Experiment, will be among the first to establish a marine data base in the new format.

The second week was devoted to intersessional consultation meetings of the WC IODE. The purpose of the meetings was to allow the chairman and vice chairman of IODE to consult with the IOC Secretary for Service on the coordination of activities of IODE's subsidiary bodies and on preparations for the next plenary.

Planning decisions reached during the meeting were related to strengthening IODE's role in the exchange of information, expansion of IODE's support to living resource programs, closer collaboration with the World Meteorological Organization in developing future data management arrangements for the World Climate Research Programs, and modifications in IODE's relationship to IGOSS (the Integrated Global Ocean Station System).

The experts attending both week-long sessions included representatives of Canada, the United Kingdom, India, the Federal Republic of Germany, the USSR, and the United States. Others present represented the World Meteorological Organization and World Data Centers A and B (United States and Russia).

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Environmental Data and Information Service
EDIS Magazine
Washington, D.C. 20235

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Penalty for Private Use, $300

Postage and Fees Paid
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In this issue: *Weathering Inauguration Day (p.3) and theories concerning the causes of earthquakes (p.14).*