DEPARTMENT OF COMMERCE / National Oceanic and Atmospheric Administration

FEDERAL COORDINATOR FOR METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

Federal Plan For National Climatic Services

FCM 74-1

Washington, D.C.
January 1974

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
FEDERAL COORDINATOR FOR METEOROLOGICAL
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PREFACE

The Federal Plan for National Climatic Services was prepared by the staff of the Office of Federal Coordinator for Meteorological Services and Supporting Research in response to Bureau of the Budget (now Office of Management and Budget) Circular A-62 (Nov. 13, 1963), with the advice and assistance of the Interdepartmental Committee for Meteorological Services.

The goal of the plan is to improve the national climatic programs and services of the Federal Government during the 1974-79 period. The primary concern of the plan is to apply climatological data more effectively to the problems of the national economy and defense.

CONTENTS

INTRODUCTION

Climatology is a division of meteorology. Meteorology deals with the complete study of the atmosphere with special emphasis on forecasting weather; climatology is concerned with the study and analysis of past weather conditions and the application of that knowledge to a wide range of planning and operational activities.

The principal function of the national climatic services is to provide and apply the necessary historical weather, or "climatological," data base to the solution of weather-related problems, both civilian and military, national and international. Applications of climatological data are usually based on the distillation of statistical parameters from past weather records. Insofar as historical climatic trends prefigure those of the future, an invaluable statistical predictive potential--the climatological probability--lies within the data archives.

In the United States climatic applications principally in the field of agriculture, date back to colonial days. Before World War II, climatology was largely concerned with generalized presentations of weather averages, extremes, or totals for geographic locations or divisions; the war, however, generated a great demand for exhaustive climatological analyses and applications for problems as complex as planning a large-scale amphibious invasion and as single purposed as designing a weapon to withstand jungle humidity.

Climatology had even greater application after peace came. Immediately after the war there was a housing boom, and climate is an essential consideration in building design and construction at any location. The Nation's billion-dollar airport building program also needed climatological data and information to choose sites and to determine the number, direction, and length of runways, to provide for drainage and ice and snow removal, to install instrument landing equipment, and to plan the location and construction of buildings. In addition, climatic data and information were required to determine the safest and most economical air routes and schedules, as well as to design the aircraft that would fly them.

Today climatological information is applicable to practically every human activity from recreation to space flight. Table 1 is a partial list of current applications; it does not include the use of climatological data in research efforts in meteorology, oceanography, space science, and other interactive environmental disciplines.

In recent years increasing interdisciplinary approaches to environmental problems have placed new demands on climatology. The Nation's space program, for example, has led to study of the interrelation and interaction of the Earth's boundary layer with the space environment, particularly with respect to the planning, design, development, testing, and operation of space vehicles and systems. A similar situation exists in the study of the interface and interaction of atmosphere and ocean.

Table 1.--Examples of Uses of Climatological Services

Agriculture.	Freeze dates, soil temperature conditions, irrigation, solar radiation, wet and dry spells, antecedent precipitation, livestock shelters, shipment hazards, lightning protection, insurance risks, forest fire risks, insect control, hardiness zones, heat units, evaporation, and disease monitoring.
Aviation.	Runway design, route planning and scheduling, aircraft design, instrument landing facilities, snow removal equipment, drainage, load limitations, accident investigations, turbulence (passenger comfort).
Building industry.	Heating and cooling design, wind loads, snow loads, school design (e.g., multipurpose vs. cafeteria and gym), construction design-frost line.
City needs.	Water supply, snow removal, sewer design, air pollution control, building codes.
Communications.	Tower and pole design, rainfall (signal attenuation).
Disaster studies (Insurance).	Hurricane frequencies, floods, droughts, lightning.
Health.	Air pollution studies of winds and solar radiation, solar radiation vs. skin cancer, wind chill, auto and home air conditioning, transport of dust and fungus, radiation hazards, and pollution.
Legal.	Data certification for accident investigations.
Power and light.	Reactor site studies, tidal and wave action conversion to electrical energy as well as solar sources, load distribution, fuel supply requirements, air conditioning.
Recreation.	Sunshine, rainy days, temperatures, windiness, scheduling athletic events, travel conditions.
Transportation.	Snow removal, surface drainage design, icing, cargo damage, river water levels, freeze thaw damage, snow fence installation, ocean vessel design, cargo humidity protection, deck storage.
Space activities.	Missile design, wind profiles, solar activity, launch planning.
Weather control.	Baseline data.

No longer can the atmosphere, or climatology, be considered in isolation. Climatological, space, and oceanographic data systems can no longer operate independently of each other; nor can scientists or data users in these fields.

Internationally, expansion of the World Weather Watch system, with its potential for improving weather prediction on a global scale, will also provide a unique opportunity for the expanded collection and application of international climatological data.

Nationally, energy, clean air and fresh water, food supply, disaster mitigation, urban development, and natural resource management are some of the areas of concern in which climatological data, data products, and data services are essential to decisionmaking. Table 2 outlines the contributions climatology can make to the future study, analysis, and planning needed to solve these critical problems.

I. NATIONAL CLIMATIC SERVICES

INTRODUCTION

As indicated earlier, almost every human endeavor is affected by weather and climate. Thus, many Federal agencies have developed programs in climatological research and applications pertinent to their specific missions. They have done so with minimum overlap by use of reimbursement procedures or by joint task forces operating on an ad hoc basis.

Following is a brief description of activities of the several Federal agencies concerned with climatology.

DEPARTMENT OF COMMERCE

National Climatic Center

The National Climatic Center (NCC) in Asheville, N.C., is the United States civilian repository for climatological data. A facility of the Environmental Data Service of National Oceanic and Atmospheric Administration (NOAA), NCC's holdings range from the 18th-century weather diaries of private citizens to the more than 100 million weather observations now received annually from national and global observation networks.

After processing, data for which there is general demand are statistically summarized, published, and distributed to a wide variety of users. One million copies of monthly and annual climatological publications are mailed to some 65,000 subscribers each year. NCC also provides microfilm, punched cards, magnetic tapes, radar and satellite film, original weather records or duplicate copies, and automatic instrument traces at nominal cost. Special hand and machine summaries and tabulations are available on request. Besides the general public, data customers include

Table 2.--Climatological Input to National Problems

Problem	Subcategory	Climatological contribution
Energy.	Wave energy.	Analysis of historical files of waves and wave sprectra.
	Solar energy.	Analysis of solar radiation data collections.
	Load distribution.	Analysis of historical temperature data.
	Critical loads and requirements.	Analysis of historical temperature data.
Fresh water.	Solar distillation.	Analysis of solar radiation and temperature data.
	Increased precipitation.	Establish baselines of rainfall and snow storage.
	Flushing of streams, lakes, reservoirs.	Probabilities of areal precipitation.
Food sources enhancement.	Fertilizers.	Rainfall probabilities.
	Insect and pest control.	Moisture variables, precipitation probabilities.
	Animal shelter and protection.	Design, ventilation.
	Growing seasons.	Frost probabilities, degree days.
	Drought or excessive rainfall.	Frequencies, areal coverages (concurrent).

Disaster mitigation.	Building design.	Wind loads, gust factors.
	Flood potential.	Rainfall.
	Severe weather patterns.	Snowstorms, tornadoes, droughts, excessive rainfall.
Recreational development.	Winter sports.	Snow probabilities and snow cover, duration of ice.
	Summer sports.	Temperature, rainfall.
	Travel.	Weather patterns, temperature, precipitation, probabilities.
Communications.	Construction.	Glaze on towers and lines.
	Transmission.	Precipitation interference or alteration.
Urban and industrial development.	Pollution.	Meteorological parameters, contributing.
	Water supply.	Precipitation.
	Heating requirements.	Temperature, wind, cloudiness.
	Cooling.	Temperature, cloudiness, humidity.
	Building design.	Temperature, winds.

Federal, State, and local agencies, the scientific and engineering professions, and the Nation's business community.

National Weather Service

A considerable amount of local climatological data and information is also disseminated by NOAA National Weather Service offices throughout the country.

DEPARTMENT OF DEFENSE (DOD)

DOD climatological programs are designed to support planning and decisionmaking in areas where climatic variables influence military policies or operations. Such support requires--in addition to extensive technical capabilities in personnel and equipment--rapid, dependable access to specialized climatological data and fast, flexible data processing. These requirements are met by specialized units: The USAF Environmental Technical Applications Center in Washington, D.C., the Naval Weather Service Environmental Detachment at Asheville, and local service units. There is considerable exchange of climatic data between the military centers and the civilian National Climatic Center.

USAF Environmental Technical Applications Center

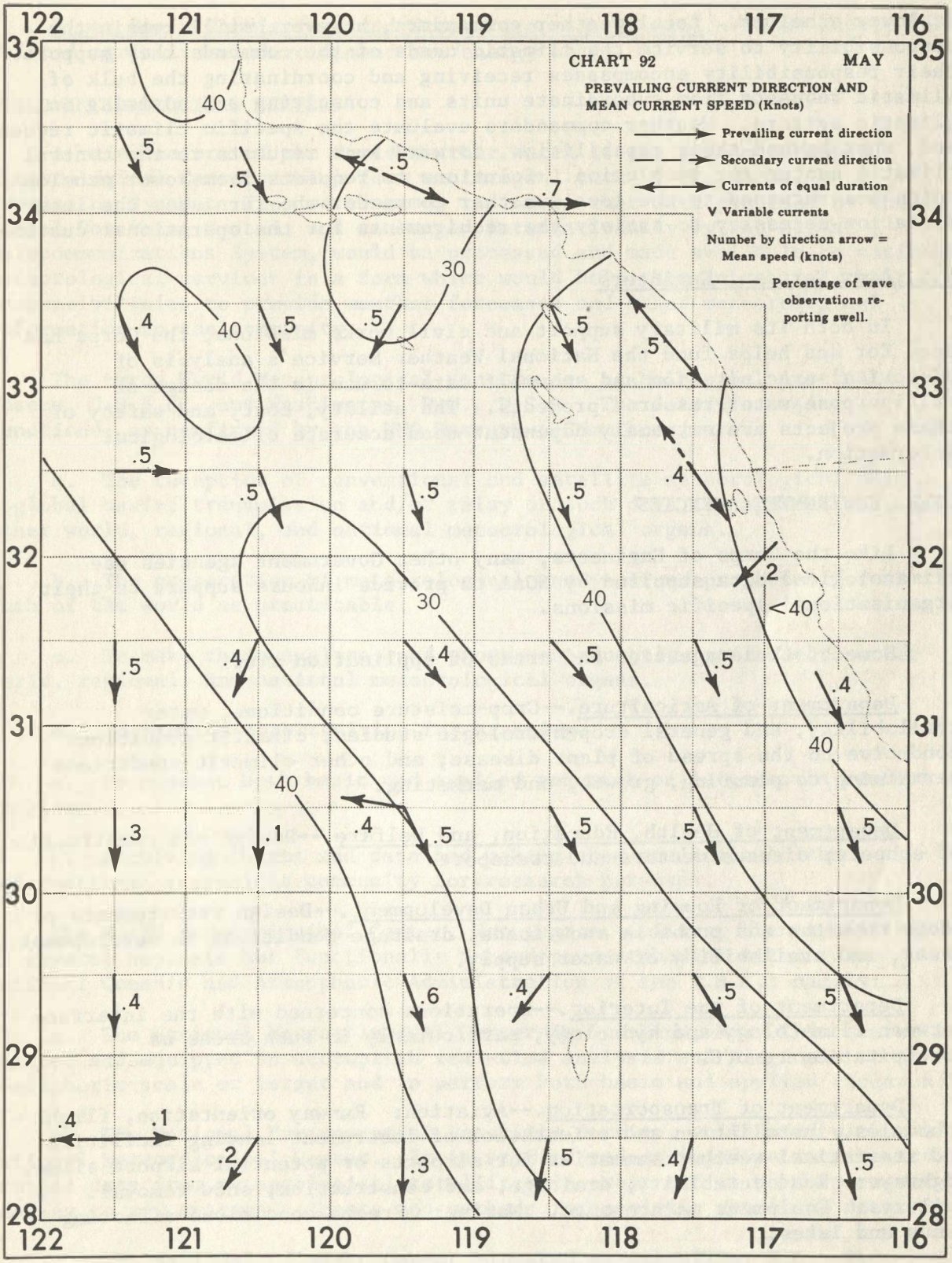
The Air Force's Environmental Technical Applications Center's (USAFETAC) primary mission is to make quantitative studies on the effects of the natural environment on military operations, plans, and weapons systems for DOD, U.S. Army, U.S. Air Force, and their authorized contractors. To make these studies, USAFETAC collects, stores, retrieves, and processes worldwide meteorological data. USAFETAC's Data Processing Branch is collocated with the National Climatic Center in Asheville, N.C. to process and summarize a major portion of the climatological data required for the studies. As a specialized computer oriented climatic center, USAFETAC prepares basic standardized climatic summaries and publications for worldwide DOD customers. These products are supplemented as required by similarly prepared specialized summaries and studies. Raw climatic data are not normally provided to DOD customers.

Naval Weather Service Environmental Detachment

The climatological needs of Navy and Marine Corps components and their authorized contractors are served through the Naval Weather Service Environmental Detachment (NWSED), Asheville, through use of the joint data files (which include Navy observations) of NCC and USAFETAC. The Navy's climatological tasks require the collection and processing of marine environmental data and the application of these data to support fleet operations and logistics.

Local DOD Climatological Service Units

The establishment of a centralized climatic center (i.e., USAFETAC) has substantially curtailed the military need for smaller climatological units



A chart from a study prepared by the Naval Weather Service Environmental Detachment in Asheville, N. C. to provide detailed climatological data to fleet units operating off Southern California.

at lower echelons. Local weather commanders, however, still retain the responsibility to service the climatic needs of the commands they support. Their responsibility encompasses receiving and coordinating the bulk of climatic requests from subordinate units and consulting and advising on climatic matters. Weather commanders evaluate the specific climatic request and, when beyond their capabilities, forward such requests to the central climatic center for resolution. Solutions to requests from lower echelon units are returned to the local weather commander who furnishes the interpretation necessary to satisfy the requirements for the operational customer.

U.S. Army Corps of Engineers

In both its military support and civil works missions, the Corps has need for and helps fund the National Weather Service's analysis of historical precipitation and snowmelt data to use in the design of multipurpose water resource projects. The utility, cost, and safety of these projects are extremely dependent upon accurate climatological information.

OTHER GOVERNMENT AGENCIES

Like the Corps of Engineers, many other Government agencies use climatological data supplied by NOAA to provide inhouse support to their organizations' specific missions.

Some of these agencies and areas of application are:

Department of Agriculture.--Crop-moisture conditions, water availability, and general crop-hydrologic studies; climatic conditions conducive to the spread of plant disease; and other climatic conditions pertaining to planting, growth, and marketing.

Department of Health, Education, and Welfare.--Design and construction of schools; disease vectors and transport.

Department of Housing and Urban Development.--Design requirements of roofs to withstand probable snow loads, drainage conditions in development areas, and availability of water supply.

Department of the Interior.--Operations concerned with the interface between climatology and hydrology, particularly in such areas as precipitation runoff.

Department of Transportation.--Aviation: Runway orientation, flight schedules, installation and orientation of instrument landing facilities, and statistical weather summaries for airports or potential airport sites. Highways: Road durability, drainage, and construction; snow removal. Railways: Equipment maintenance. Marine: Freeze conditions affecting ponds and lakes.

Environmental Protection Agency (EPA).--Standards and regulations concerning air and water pollution.

River Basin Commissions and Water Resources Council.--Water supply and related agricultural development and energy usage.

WORLD METEOROLOGICAL CENTERS

A main feature of the World Weather Watch is the system of World Meteorological Centers which form an integral part of the Global Data Processing System. They were set up to insure that data provided by the Global Observing System, and exchanged internationally by the Global Telecommunications System, would be processed and made available to national meteorological services in a form which would help them in meeting their responsibilities to provide weather forecasts and other meteorological information to the community.

The three World Meteorological Centers are at Melbourne, Australia, Moscow, U.S.S.R., and Washington, D.C., U.S.A. The data processing functions, as confirmed by the WMO Executive Committee, are:

a. The reception of conventional and satellite meteorological data on a global basis; transmission and/or relay of such data, as appropriate, to other world, regional, and national meteorological organs.

b. The preparation of meteorological analyses and prognoses for as much of the world as practicable.

c. To make these analyses and prognoses promptly available to other world, regional, and national meteorological organs.

d. To provide opportunities for training.

e. To conduct both basic and applied research on large-scale weather problems.

f. Archiving charts and data and making them available to the international scientific community for research purposes.

The World Meteorological Center, Washington, utilizes the capabilities of several separate but functionally interdependent bodies within the National Oceanic and Atmospheric Administration of the U.S.A.; namely:

a. The National Meteorological Center in Suitland, Md. This center is staffed and equipped to accomplish real-time analysis and prognosis on a hemispheric scale or larger and to perform both basic and applied research.

b. The National Environmental Satellite Service, collocated with the National Meteorological Center. It is staffed and equipped to receive and process data from meteorological satellites in orbit and to perform research leading to new systems concepts and methods for applying satellite data.

c. The National Climatic Center, located at Asheville, N.C. This center is staffed and equipped to receive, reformat, store, and retrieve

meteorological data of all kinds and to provide statistical and other forms of summarization on demand in support of climatological research.

The internal operations of these bodies, which contribute directly to the support of the World Weather Watch, are closely integrated. The climatological portion of the World Weather Watch World Meteorological Center, Washington, is carried out at the National Climatic Center. The NCC's climatological archive is the core of the operation, and the depository of records is an accumulation of original manuscript observation forms, autographic records of various meteorological elements, international and domestic records, and meteorological data received on a global scale. A number of nations mail monthly transcripts of observations and other published data to the Center, and numerous nations regularly exchange information. A comprehensive index of all data is maintained.

Weather charts and operational products of the analysis and forecasting function are retained in this archive, and there are now some 60 years of completed historical Northern Hemisphere maps for the surface level and about 16 years for the 500-mb level.

The satellite data are also processed into usable archival formats for permanent storage. The data thus stored have been of two distinct types: (a) Television photographs, and (b) radiation measurements in various parts of the infrared and visible portions of the spectrum.

World Data Center A for Meteorology and Nuclear Radiation.--The NCC houses the World Data Center A (WDC-A) for Meteorology and Nuclear Radiation under the sponsorship of the National Academy of Sciences. WDC-A functioned during both the International Geophysical Year (1957-58) and the subsequent International Geophysical Cooperation 1959 as the repository for data in these disciplines. As in subsequent international data collection periods (like International Year of the Quiet Sun 1964), these data were archived, cataloged, and made available on a loan or at-cost basis to any researcher throughout the world. Activities of the WDC-A have been expanded recently to include the publication of data obtained from meteorological rocket soundings made in the United States, Canada, and Great Britain. Radiosonde (balloon) observations made nearest the time of rocket firing are also contained in this publication.

II. COOPERATIVE CLIMATOLOGICAL PROGRAMS

DATA ACQUISITION

Nationally, climatological data acquisition depends upon the real-time collection networks of the civilian and military weather services, the Federal Aviation Administration, the Coast Guard, and cooperative observers. These networks provide surface and upper air meteorological observations, as well as solar radiation data.

Imagery and other meteorological data, collected by civilian and military satellites, are also archived. NESS rectifies, indexes, and

catalogs satellite data, which are then transferred to the National Climatic Center to be made available to users.

Selected observational data from military bases, ships and aircraft around the world are processed and read into the common-use data files at Asheville by personnel of the USAF Environmental Technical Applications Center (USAFETAC) collocated with NCC.

Additional worldwide meteorological data are obtained through international exchange under the sponsorship of the World Meteorological Organization and through the World Data Center System of the International Union of Geology and Geophysics, under the aegis of the National Academy of Science.

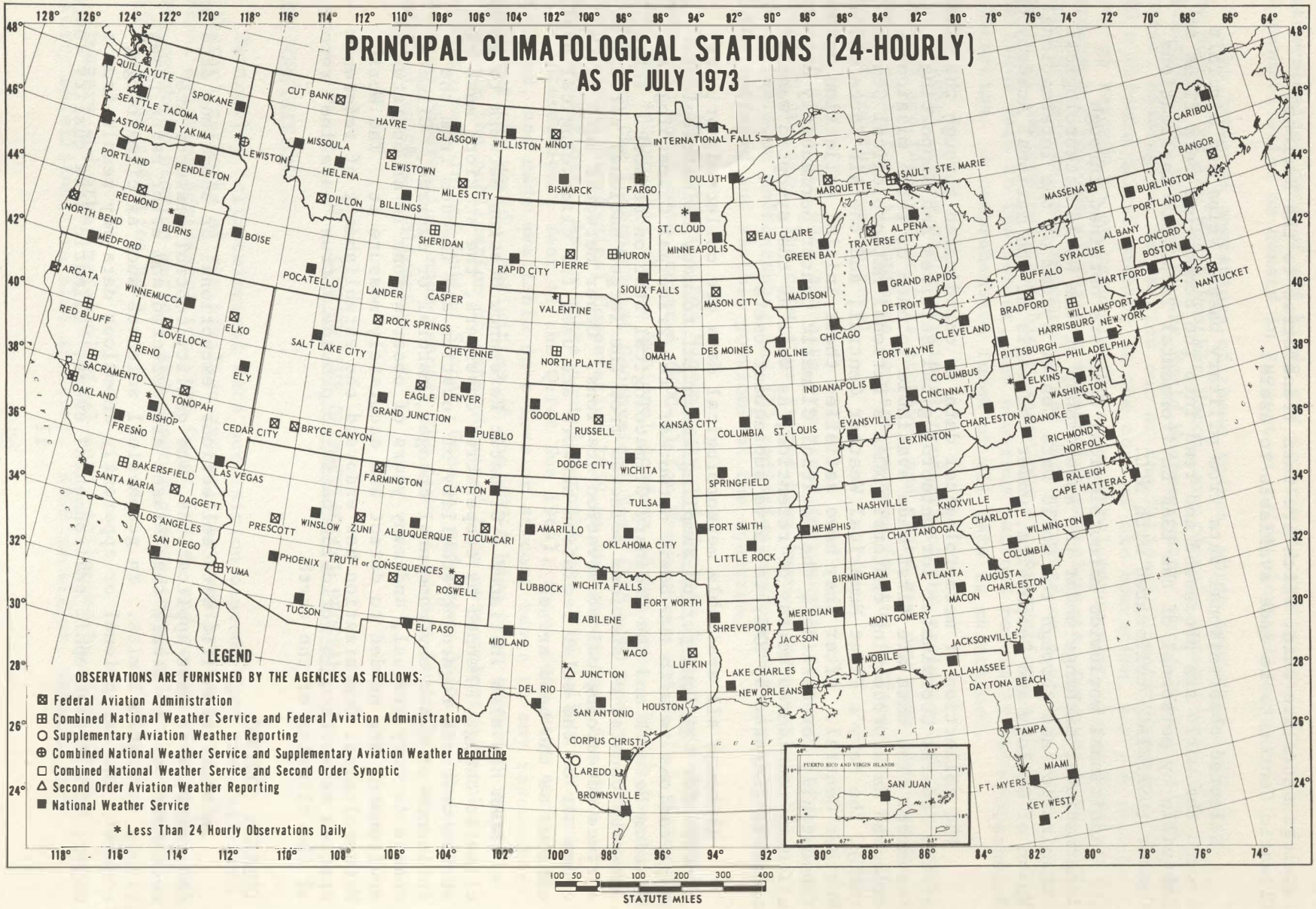
The collection of meteorological data is coordinated through the Office of the Federal Coordinator for Meteorological Services and Supporting Research. The data are first made available to each of three mission-oriented data processing centers: NOAA's National Meteorological Center (NMC), the Navy's Fleet Numerical Weather Central, and the Air Force Global Weather Central. After they have satisfied their initial collection purposes (essentially forecasting), the National Climatic Center permanently archives all data considered worthy of retention, as well as the synoptic weather analyses prepared by NMC, to serve subsequent users.

Although all available meteorological data are collected, primary concern for the long-period sampling essential to many climatological applications is with two basic networks: the Principal Climatological Station Network and the Ordinary Climatological Station Network. These networks consist of stations selected from the larger national network of surface meteorological observation stations. Other networks such as the upper air or the solar radiation network are used for climatological applications as the need arises.

NOAA has also initiated a Climatic Reference Station Network to monitor climatic change. Manned by cooperative observers, the stations must meet strict criteria regarding stability of location and freedom from the influence of other environmental changes, natural or manmade. Climatic change is very gradual, and many years of observations in an undisturbed environment are needed to detect and accurately measure it. The World Meteorological Organization has endorsed the establishment of reference station networks on a worldwide basis to provide a true "baseline" record of the climates of the earth.

QUALITY CONTROL

In some scientific data collections, exceptional or anomalous data are not critical to most applications, and quality control measures are necessary only to assure that biases are detected and error rates remain within tolerable limits. In geophysical sciences such as climatology, however, the exceptional or apparently anomalous data may result from a major, even catastrophic environmental event. Climatic data quality control


PRINCIPAL CLIMATOLOGICAL STATIONS (24-HOURLY)
AS OF JULY 1973
LEGEND
OBSERVATIONS ARE FURNISHED BY THE AGENCIES AS FOLLOWS:
Federal Aviation Administration
Combined National Weather Service and Federal Aviation Administration
Supplementary Aviation Weather Reporting
Combined National Weather Service and Supplementary Aviation Weather Reporting
Combined National Weather Service and Second Order Synoptic
Second Order Aviation Weather Reporting
National Weather Service
* Less Than 24 Hourly Observations Daily
QUILLAYUTE
SEATTLE TACOMA
SPOKANE
ASTORIA
YAKIMA
PORTLAND
PENDLETON
LEWISTON
CUT BANK
HAVRE
GLASGOW
WILLISTON
MINOT
INTERNATIONAL FALLS
MISSOULA
HELENA
LEWISTOWN
MILES CITY
BISMARCK
FARGO
DULUTH
MARQUETTE
SAULT STE. MARIE
CARIBOU
BANGOR
REDMOND
DILLON
BILLINGS
ST. CLOUD
ALPENA
TRAVERSE CITY
MASSENA
BURLINGTON
PORTLAND
NORTH BEND
BURNS
BOISE
SHERIDAN
MINNEAPOLIS
EAU CLAIRE
GREEN BAY
ALBANY
CONCORD
MEDFORD
RAPID CITY
PIERRE
HURON
SYRACUSE
BOSTON
ARCATA
POCATELLO
LANDER
CASPER
SIOUX FALLS
MASON CITY
MADISON
GRAND RAPIDS
BUFFALO
HARTFORD
NANTUCKET
WINNEMUCCA
VALENTINE
DETROIT
BRADFORD
WILLIAMSPORT
RED BLUFF
ELKO
ROCK SPRINGS
CHICAGO
CLEVELAND
HARRISBURG
NEW YORK
LOVELOCK
SALT LAKE CITY
CHEYENNE
PITTSBURGH
PHILADELPHIA
RENO
NORTH PLATTE
OMAHA
DES MOINES
MOLINE
FORT WAYNE
SACRAMENTO
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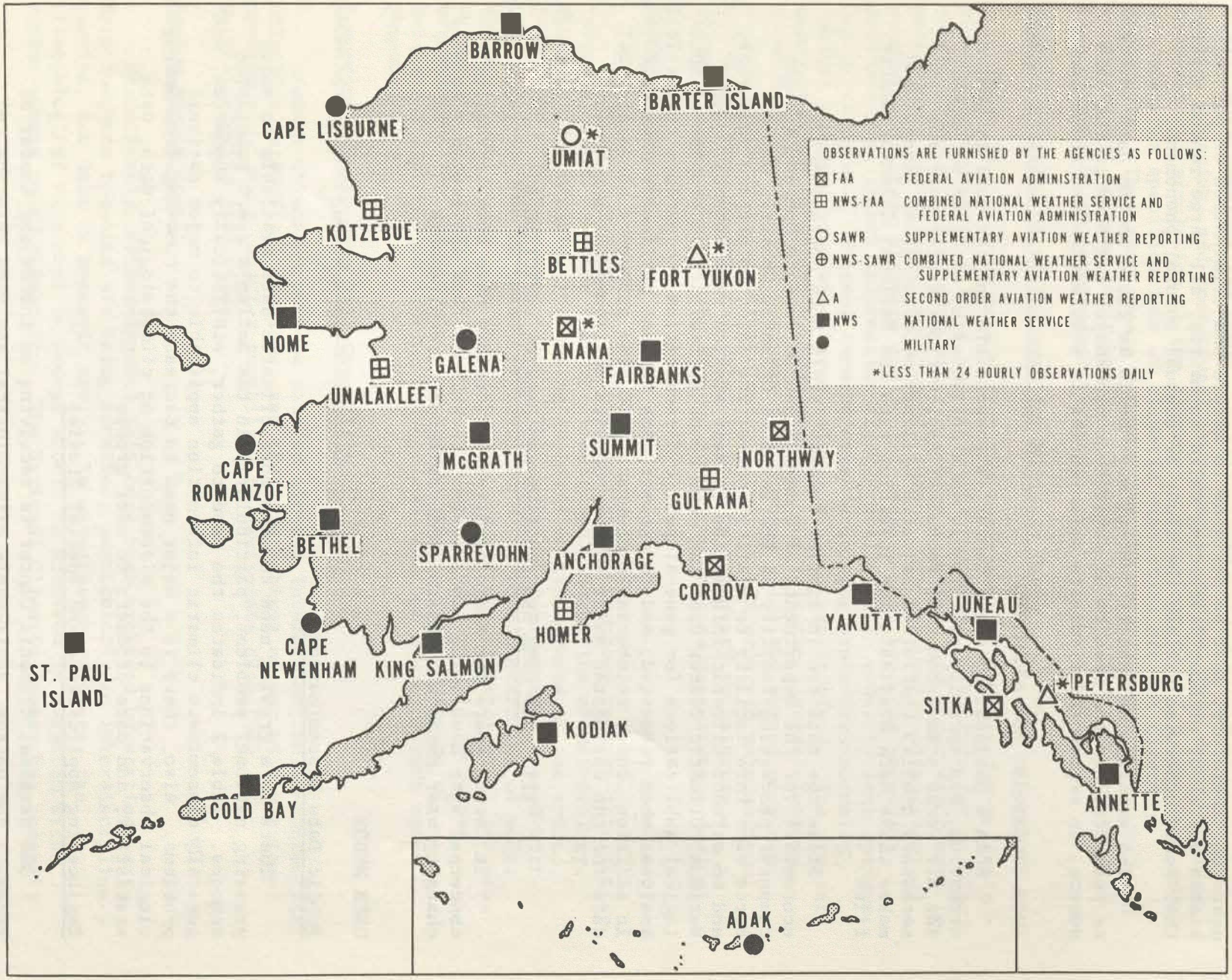
COLUMBUS
ELKINS
OAKLAND
TONOPAH
EAGLE
DENVER
INDIANAPOLIS
CINCINNATI
WASHINGTON
BISHOP
GRAND JUNCTION
GOODLAND
KANSAS CITY
COLUMBIA
ST. LOUIS
EVANSVILLE
CHARLESTON
ROANOKE
FRESNO
CEDAR CITY
BRYCE CANYON
PUEBLO
RUSSELL
LEXINGTON
RICHMOND
NORFOLK
BAKERSFIELD
LAS VEGAS
DODGE CITY
WICHITA
SANTA MARIA
FARMINGTON
CLAYTON
SPRINGFIELD
RALEIGH
CAPE HATTERAS
DAGGETT
TULSA
NASHVILLE
KNOXVILLE
CHARLOTTE
LOS ANGELES
PRESCOTT
WINSLOW
ZUNI
ALBUQUERQUE
TUCUMCARI
AMARILLO
FORT SMITH
MEMPHIS
CHATTANOOGA
WILMINGTON
SAN DIEGO
OKLAHOMA CITY
LITTLE ROCK
COLUMBIA
YUMA
PHOENIX
TRUTH or CONSEQUENCES
ROSWELL
LUBBOCK
WICHITA FALLS
BIRMINGHAM
ATLANTA
AUGUSTA
MACON
CHARLESTON
TUCSON
FORT WORTH
MERIDIAN
MONTGOMERY
EL PASO
ABILENE
SHREVEPORT
JACKSON
JACKSONVILLE
MIDLAND
WACO
LUFKIN
MOBILE
TALLAHASSEE
JUNCTION
LAKE CHARLES
DAYTONA BEACH
DEL RIO
NEW ORLEANS
SAN ANTONIO
HOUSTON
TAMPA
CORPUS CHRISTI
MIAMI
LAREDO
FT. MYERS
BROWNSVILLE
KEY WEST
PUERTO RICO AND VIRGIN ISLANDS
SAN JUAN
GULF OF MEXICO
ATLANTIC OCEAN
PACIFIC OCEAN
100 50 0 100 200 300 400
STATUTE MILES

PRINCIPAL CLIMATOLOGICAL STATIONS (ALASKA) (24-HOURLY)
AS OF JANUARY 1973



measures, therefore, must be designed to assure the elimination of not only biases but also, without discarding valid anomalies, all large random errors that would otherwise vitiate the study of unusual natural phenomena.

The emphasis on quality control must begin as close to the data source as possible, and the results of subsequent procedures fed back to the data source, to expose and eliminate deficiencies in acquisition and reduction.

DATA PROCESSING AND ARCHIVING

NOAA's National Climatic Center is responsible for the quality control, archiving, and security of climatic data collected by civilian networks. The Air Force's Environmental Technical Applications Center performs necessary quality control of selected military meteorological records and makes these data available for insertion into the National Climatic Center files.

Since the data are in similar formats, it is both convenient and economical for the Departments of Commerce and Defense to operate a joint computer processing facility at the National Climatic Center. The Air Force uses this facility to quality control its data, to prepare summaries, and to extract climatic information to meet mission requirements. The National Climatic Center uses the same computer facility to prepare climatological publications for general public dissemination, to perform statistical analyses when requested, and to extract data to meet particular user needs. In addition, under reimbursable contract, NCC also processes climatological data for the collocated Naval Weather Service Environmental Detachment.

III. NEW USER REQUIREMENTS AND SERVICE DEFICIENCIES

In recent years the National Climatic Services have been increasingly concerned with developing new programs, techniques, and applications to meet changing user needs and related program support requirements.

USER NEEDS

Public Data Dissemination

There is a growing need to make more climatic data available to solve pressing national problems, particularly in the Nation's great population centers. Table 2 indicates the need to gather, statistically summarize, and generally disseminate climatic information applicable to major national problems. Also, there is a major need to decrease the time lag from meteorological observations to the dissemination of climatological data, data statistics, and data products to user groups.

Engineering Applications and Special Studies

The National Climatic Center is receiving an increasing number of requests for unique, small-scale climatological analyses relating to

engineering problems and environmental operations and research projects. Design, planning, and operational or research studies often demand complex mathematical simulation of the climate; simulations to which the usual mean-max/mean-min specifications of climatic statistics are not directly applicable. They also create a demand for the establishment of conditional relationships between environmental elements, rather than the treatment of each element as an independent variable.

Special Climatological Packages for Military Users

There is a growing need within the Department of Defense for a limited-volume, ready-access file of selected climatological parameters for military users. The increasing complexity of weapons systems and their deployment to meet global operational requirements demand more responsive climatological support. Military planners and decisionmakers must have the necessary environmental impact information readily available in order to make optimum use of resources. Present tape-oriented archiving procedures normally inhibit response time when large volumes of data are involved. The present meteorological satellite program has made possible the high-resolution three-dimensional cloud analysis (3-D Nephanalysis) and opened many new avenues for performing climatological studies. In order to make maximum use of new and conventional data, it will be necessary to maintain a climatological data working file on some ready-access mass storage device.

Space "Climatology"

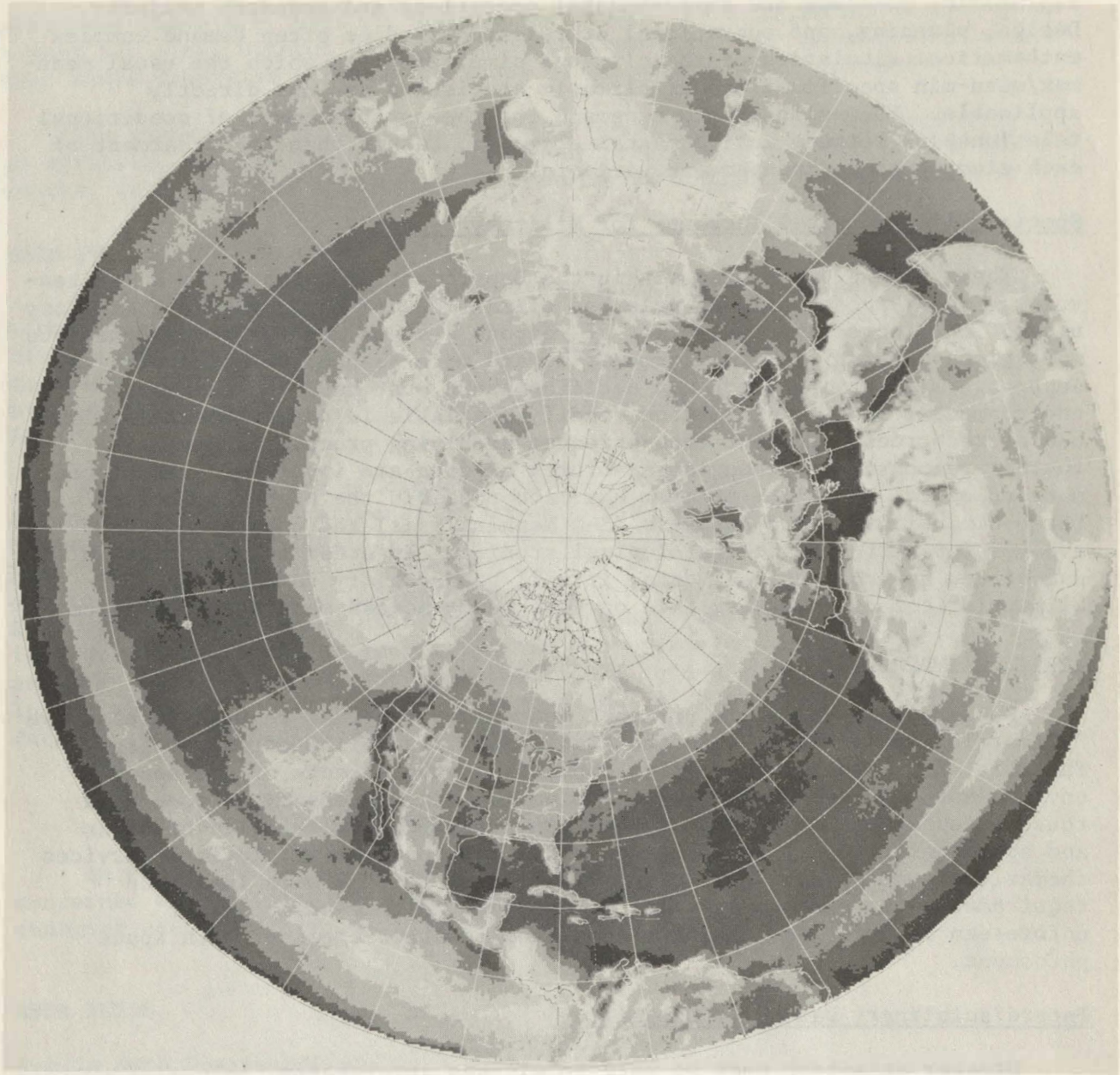
Fundamental changes in national and agency programs require interactive "climatologies" in other than the traditional discipline of meteorology. There is, for example, increasing emphasis on the effects of the space environment on space operations. The engineering necessary to cope with these effects must be based, at least in part, on climatologies of solar and space influences. In addition, the traditional climatological services themselves must develop sufficient flexibility to cope with increased requirements for space operations support and to take advantage of unforeseen discoveries linking conventional weather elements with space phenomena.

Interdisciplinary Data File Capability

Greater attention must be paid to air-sea interaction, solar-terrestrial relations, biomedical problems, and the interactions of man with his total environment, using computer capability to manipulate data from multidiscipline data files.

Random Access Recall

Historically, climatological data have been archived by station year. More and more requests are being received, particularly in interdisciplinary queries, for data in synoptic array. To answer such requests, the climatological data most in demand should be archived in a system with random access recall capability. The National Climatic Center has recently



One of the new areas of climatological study resulting from the meteorological satellite program is that of global cloud climatology. This computer-generated, composite representation of relative cloud cover over the Northern Hemisphere during June, July, and August, 1967-70, was prepared by the Air Force's Environmental Technical Applications Center and NOAA's National Environmental Satellite Service.

established a Synoptic Data File, with data in a synoptic array, to partially meet this need.

While the basic data set is still being filed in a station-year system, the National Climatic Center currently archives taped grid-point data and microfilm of most synoptic analyses prepared from the data and is gradually developing a synoptic file beginning with 1971 data. Specific questions to be resolved are how much more and what other types of data need to be archived in a random access, synoptic recall mode.

DATA ACQUISITION DEFICIENCIES

Satellite Data Surge

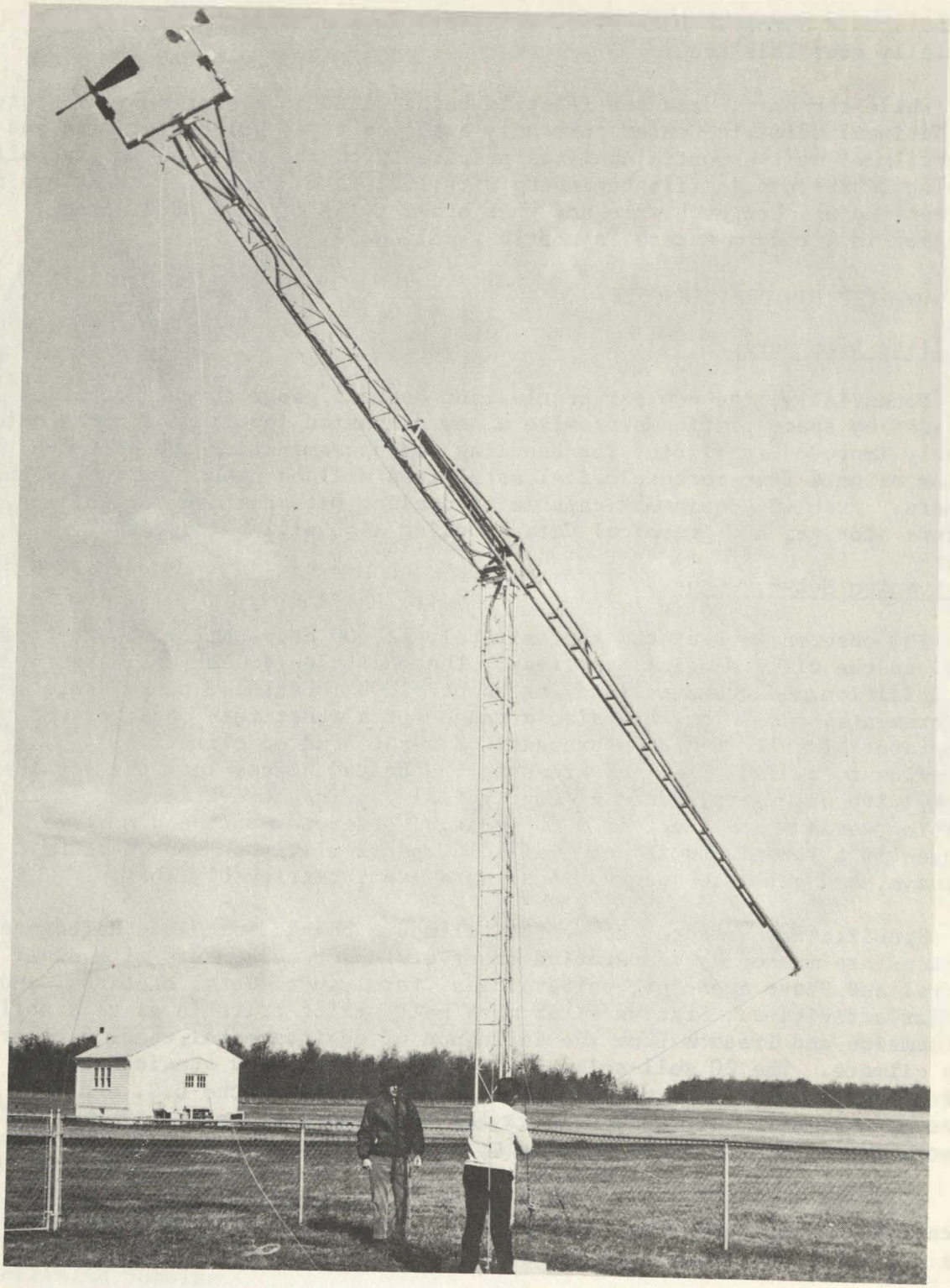
Potentially, the new perspective and overall geographical coverage provided by space platforms promise a new dimension in climatological data. Greatly improved facilities for handling and disseminating the enormous inflow of data from meteorological satellites will be needed during the next 5 years. Archival equipment capable of dealing with pattern recognition, picture storage, and graphical data handling also will be required.

Observation Network Gaps

The observations of the approximately 12,000 cooperative observers are vital to the climatological services. These citizen volunteers take precipitation measurements (and, at about 5,000 locations, temperature measurements) once a day and also arrange for a substitute observer when the cooperator himself cannot be present. Several hundred climatically significant, sparsely settled areas in the United States lack the services of cooperative observers, hence a geographical gap in network coverage. In addition, even where there is a cooperative observer, more and more frequently a substitute is not available, particularly on weekends and holidays, and valuable observational data are irretrievably lost.

Specifically selected to monitor climatic change, Climatic Reference Stations are manned by cooperative observers under agreements with other Federal and State agencies, universities, farm experimental stations, and similar activities. Station sites must meet strict criteria as to stability of location and freedom from the influence of environmental changes other than climate. The 20 well-selected and well-distributed stations are sufficient to sample historical climatic variations in the U.S. and to serve as a primary reference network for the observations of other meteorological and climatological stations.

Fourteen stations in the Climatic Reference Station Network are operational. The remaining six stations will be activated as soon as possible.



Special fold-over towers are used at Climatic Reference Stations. The towers "bow" from the waist, permitting easy and safe servicing of the wind instruments mounted on top.

Changes in Observational Techniques

The climatological services must adapt to changes in observational format, yet still be able to convert data to a uniformly useful archival medium. An important example is the National Weather Service's ongoing program to change from manual to automated observations, which must be fully coordinated with climatic data acquisition plans to insure a smooth, effective transition. These changeovers are being coordinated with the National Weather Service, and no difficulties are anticipated.

Standardization Deficiency

A principal shortcoming of the climatological services is the lack of standardized observing procedures. Data from rocketsondes, satellites, and solar observatories all suffer from a lack of standardization and central quality control.

Communications Problems

The automation of raw sensor data in the next few years by the National Weather Service (NWS) will require a new mode of modern communication. This system must provide for an interface between NWS field units and the EDS National Climatic Center for rapid delivery of error-free data from the field to the climatic center and vice versa.

International Data Base Deficiency

The international climatological data base must be enlarged to meet the needs of a growing number of international projects and programs. There is a particularly critical need for a greater density of surface meteorological observations in the Southern Hemisphere and of upper air observations worldwide.

QUALITY CONTROL DEFICIENCIES

Implementation of effective quality control measures has been severely restricted because of inadequate resources. The most effective quality control techniques involve the use of a computer as a diagnostic tool to make analytical tests for smoothness and consistency of the data fields in time and space and statistical tests for bias. The unusual, impossible, or biased data points are flagged by the computer, whereas final error determination and correction for each suspect datum is the responsibility of a subject-matter specialist.

Technological improvements in computer methods for quality control have been neglected, even for climatological data that are routinely screened. An outstanding deficiency is the lack of electronic plotting equipment capable of economically reducing the data to charts and graphs for visual inspection by the data reviewer.

IV. IMPROVING CLIMATIC SERVICES

Acquisition of appropriate data and modernization of the data file for ready access are basic to the operation of a climatic service. A summary chart (Table 3) showing the projected plans over the next 5 years to meet anticipated user needs and the projected costs (table 4) are at the end of this section.

USER NEEDS

Public Data Dissemination

During the next 5 years, NOAA's Environmental Data Service (EDS) and National Weather Service (NWS) will work together to make more climatic data available to data users, particularly in urban areas. Initially, NWS plans to establish small climatic data files in one first-order NWS office in each State with which to answer public requests for climatological data. EDS' NCC will provide the master data files, in microfiche form, to be used with an onsite microfiche reader/printer. A small four-drawer file cabinet can store well over a quarter of a million pages of climatic data in microform.

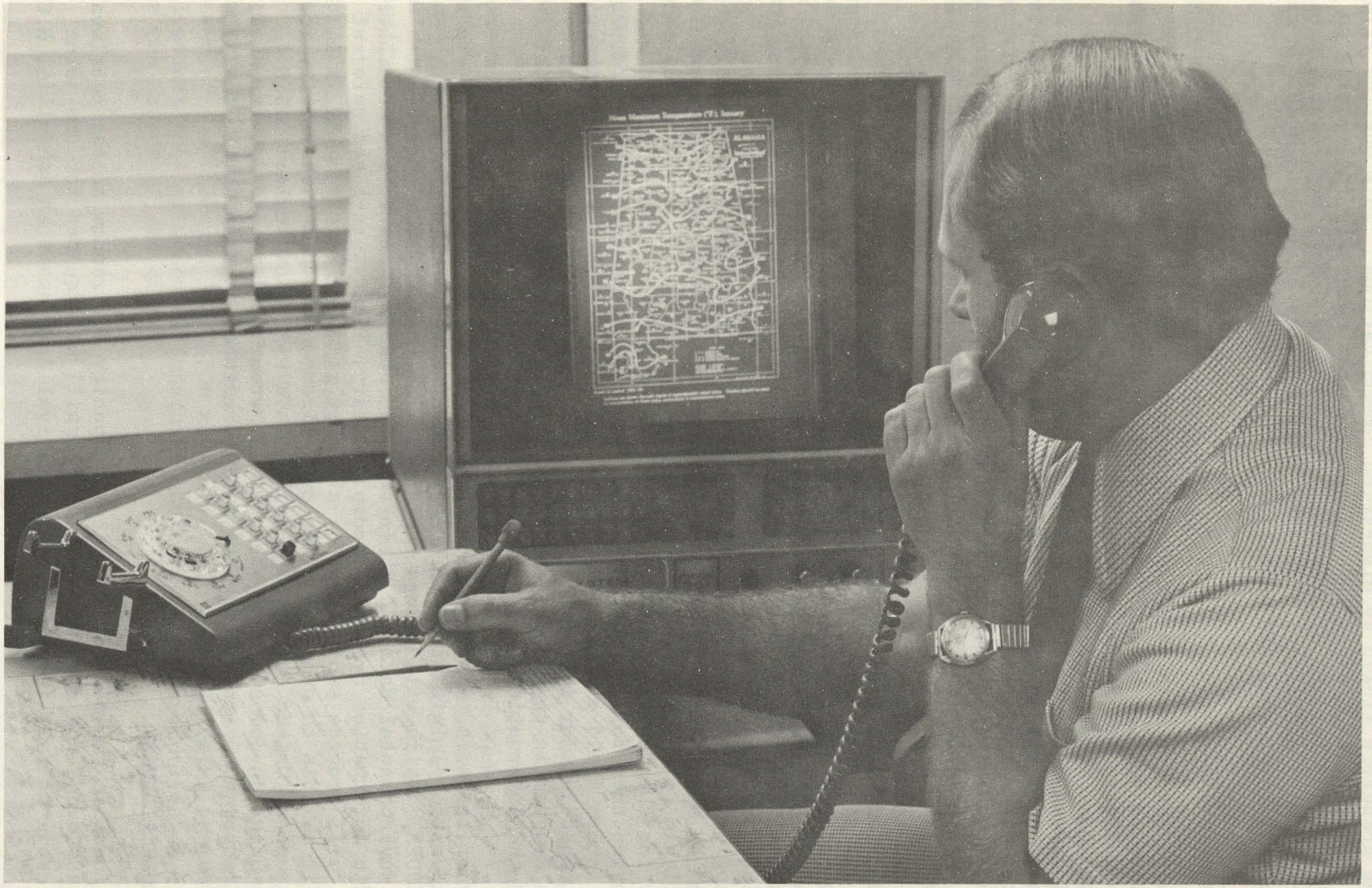
To provide specific data needed to meet growing national needs, the civilian climatic services will give greater emphasis to gathering data on urban atmospheric contamination, as well as on such parameters as frequency of lightning strikes, duration of thunderstorms, depth of frost penetration in various soils, vegetation covers, and soil moisture content. National Climatic Center data, data summaries, and information sources of a nonroutine nature not now disseminated in large-circulation publications will be computerized to an automatic microfiche retrieval and duplication system. This conversion, already begun, will materially speed up NCC access to and dissemination of these data to answer user requests.

Engineering Applications and Special Studies

During the period 1974-79, NCC will meet user demands for new types of climatic data parameters and analyses specifically applicable to engineering projects and to special studies concerning environmental change, the space environment, the higher atmosphere, and small-scale phenomena of the boundary layer. Constant review of user needs will reveal changing requirements and afford reprograming opportunities.

Climatological Packages for Military Users

The USAF Environmental Technical Applications Center (USAFETAC) is preparing a 10-year climatological data base of worldwide surface and upper-air observations. These data will reside within DOD's Advanced Research Projects Agency (ARPA) mass storage device located at NASA's Ames Research Center, Calif. Rapid access to these data bases will be provided to selected stations within the ARPA network, a growing nationwide system of message-



To speed up user services, a microfiche rapid display reader is used to put 41,000 pages of climatic data at the fingertips of NCC climatologists answering public queries.

switching computers linked by high-speed communications. This working file will be periodically updated and will provide the necessary information to accomplish a wide variety of climatological studies. Most important, it will demonstrate the feasibility, viability, and benefits of an automated, extra-large, centrally managed and maintained climatological data base.

Space "Climatology"

The program to archive and disseminate space data from experimental satellites, as well as most of the scientific data obtained from space probes, has been delegated to NASA's National Space Science Data Center (NSSDC) in Greenbelt, Md. During the next 5 years, NSSDC, DOD, and NOAA's National Geophysical and Solar-Terrestrial Data Center will pursue a program of broad-based cooperation to develop and make available to the scientific community relevant historical space data products and applications. In addition, a coordinated program to announce data availability and to promote maximum dissemination and utilization of this costly data will be firmly established.

Interdisciplinary Data File Capability

For major projects in the interdisciplinary collection of data for research purposes, NOAA has already created a Center for Experiment Design and Data Analysis (CEDDA) to integrate interdisciplinary instrumentation, collection, analysis, and archiving. In the Barbados Oceanographic and Meteorological Experiment (BOMEX), for example, this meant that the data collected by numerous instruments and investigators were centrally accessible and available to the scientific user community. CEDDA is providing the same services for the International Field Year for the Great Lakes (IFYGL), and will provide them for the GARP Atlantic Tropical Experiment (GATE), and similar future field experiments, such as the First GARP Global Experiment (FGGE), scheduled for implementation in 1977. GARP (Global Atmospheric Research Program is sponsored jointly by the World Meteorological Organization and the International Council of Scientific Unions.

One of the most important developments planned during the next 5 years is the operational initiation of NOAA's computerized Environmental Data Index (ENDEX), which will afford rapid referral to available interdisciplinary environmental data and their sources. OASIS (Oceanic and Atmospheric Scientific Information System), a complementary, literature-based referral service, will provide subject-author-abstract referral service. By 1974, ENDEX will be able to answer queries on environmental data availability for the continental United States and by 1978 on a worldwide scale. OASIS services based on computerized versions of Meteorological and Geoastrophysical Abstracts and Oceanic Abstracts will be offered experimentally in 1974 and operationally by 1976.

Random Access Recall

To increase the climatic services, capacity for random access retrieval, mass data storage and random recall deviceswill be acquired for the joint DOC/DOD computer facility and for the archival data bases at Asheville, N.C.

The computer facility itself is likely to be upgraded within the next 5-8 years by the acquisition of a fourth-generation system to replace the present third-generation system. This, of course, will be predicated upon continuing study of computer requirements.

OVERCOMING DATA ACQUISITION DEFICIENCIES

Satellite Data Surge

Data studies are underway to determine the best means for archiving, interpreting, and applying satellite imagery to user needs. It is hoped that recent advances in computer graphics will provide the specialized equipment capable of dealing with pictorial information.

Filling Observation Network Gaps

During the next 5 years, the National Weather Service will close gaps in climatological data collection by (1) providing recording instruments to cooperative observers who would otherwise regularly miss certain observations, and (2) expanding the Automated Weather Network by installing automatic observation equipment at several hundred sites in data-sparse areas throughout the country.

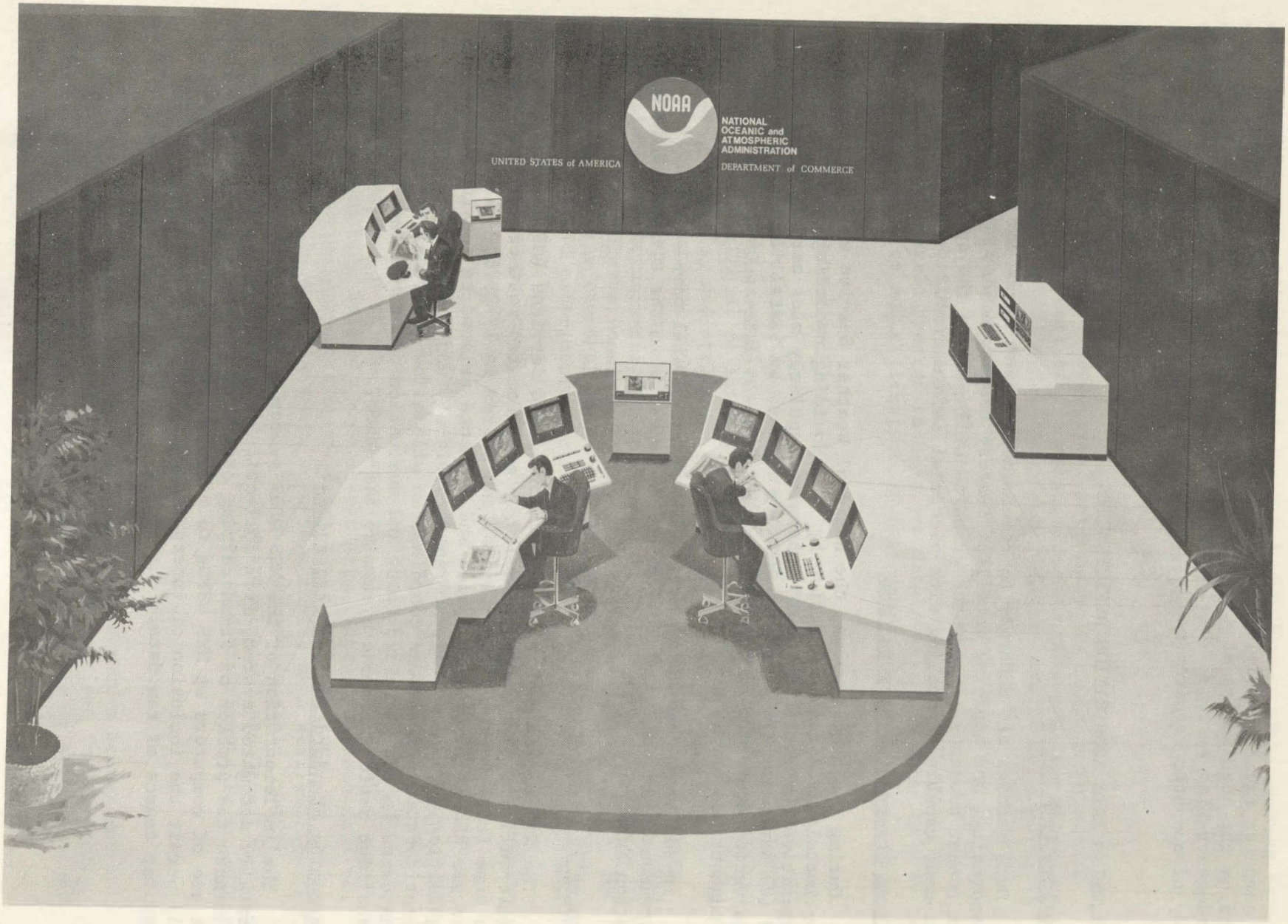
In addition, the Environmental Data Service will complete the instrumentation and activation of all 20 stations in the Climatic Reference Station Network.

Changes in Observational Techniques

The NWS Automation of Field Operations and Services (AFOS) program will result in a changeover from a manual to an automated weather service system. The time frame for implementation of the system is 1973-78. As an invited observer EDS is furnishing advice and comments related to sensing, acquisition, preprocessing, storage, retrieval, and dissemination of climatic data. This close coordination will allow EDS requirements to be considered in the planning, test, and evaluation and normalize the transition period from one system to the other.

Overcoming Standardization Deficiencies

The implementation of the NWS AFOS system (1973-78) and commitment to a totally automated system, from collection to storage of data, should eliminate the problem of standardizing observing procedures. Furthermore, the use of computers at NWS WSFOs to record, process, and disseminate data will permit the inclusion of internal-consistency quality control checks near the source of raw data.



Artist's concept of a fully automated AFOS weather station.

Communication Problems

To make the change from a manual to an automated weather observation system, NWS is developing a modern communications network for its AFOS program. This network will consist of a national digital communication circuit which will tie in all NWS field stations, National Specialized Weather Centers, and the National Climatic Center. It will operate in conjunction with WSFO minicomputers to provide a store and forword network configuration and automated switching capability to off-line low - and higher speed localized circuits. The National Climatic Center terminal link will include a send/receive capability.

Expanding the International Data Base

The need for more meteorological observations in remote or inaccessible regions of the world will be partially met by gradually phasing-in satellite atmospheric soundings. By utilizing a relatively few surface stations to establish "ground truth," it will be possible to roughly approximate some of the observations obtainable from a much denser network of surface and upper air stations.

Coordinated and guided by the World Meteorological Organization, the World Weather Watch will provide an international system for observing, processing, and communicating weather data--a system designed to serve the needs of all nations in warning of weather disasters and, in turn, to feed into the climatic data file synoptic observations usable for research on a worldwide scale. Surface observations, upper air data, satellite data, aircraft data, and data from ocean buoys will all be integrated into a total global synoptic picture.

The Air Weather Service will continue its effort to collect global upper air data with an aim to producing a comprehensive global climatology for regions above the 100-mb level by 1975.

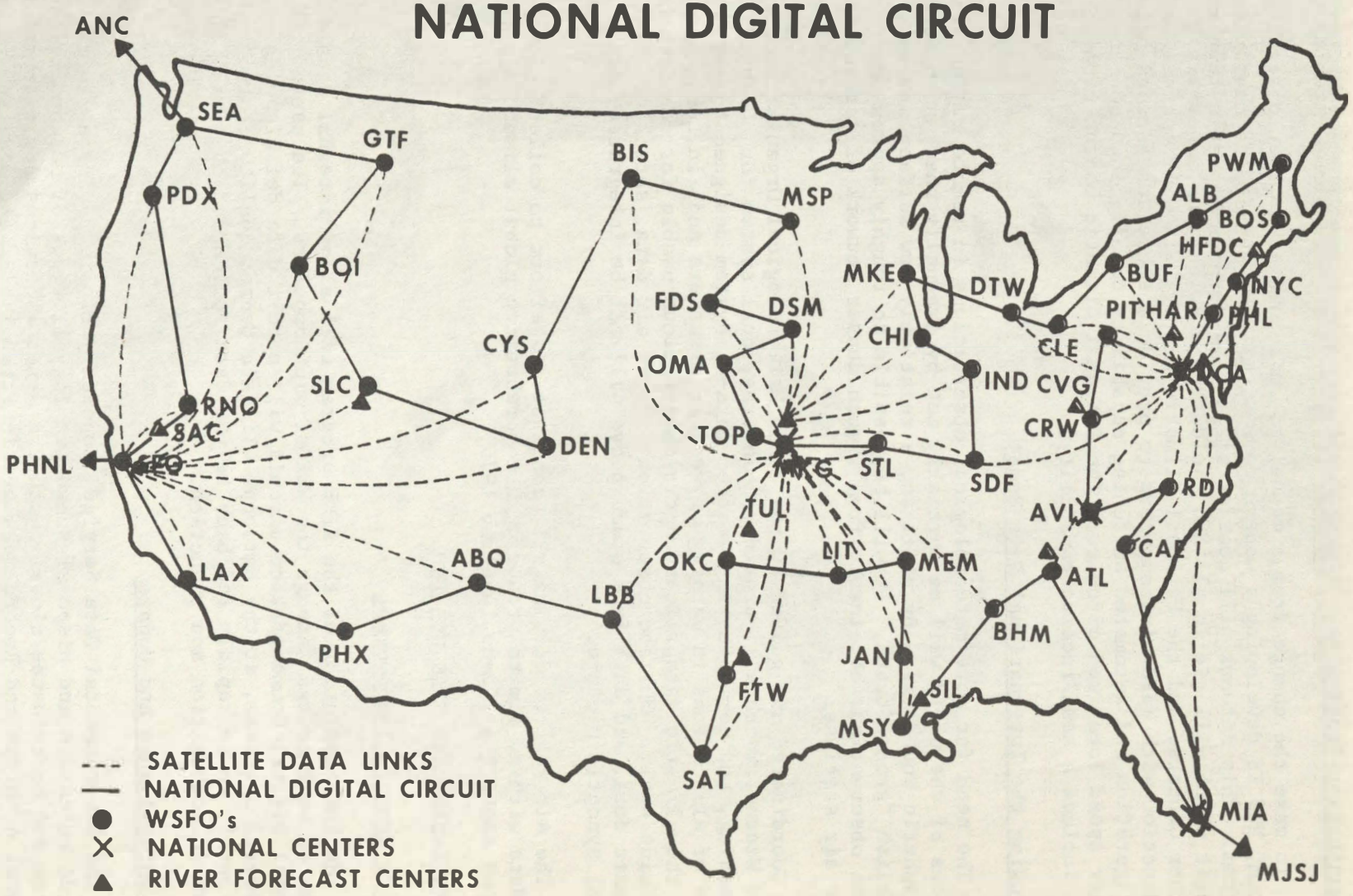
MODERNIZATION AND FILE UPDATE

Quality Control Improvement

The implementation of the AFOS program will allow internal consistency checks to be executed through the WSFOs, minicomputers. The use of the AFOS National Digital Communication circuit will permit data deficiencies discovered upstream, at the National Climatic Center quality control checkpoint, to be rapidly fed back to the data source and thus will eliminate errors in acquisition and reduction.

File Surveillance and Update

The Environmental Data Service proposes periodic revisions to the records retention and disposal schedules for all types of meteorological records and coordinates closely with the General Services Administration, National Archives and Record Service, in establishing and updating retention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SIL
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MIA
MJSJ
SATELLITE DATA LINKS
NATIONAL DIGITAL CIRCUIT
WSFO's
NATIONAL CENTERS
RIVER FORECAST CENTERS

and disposal schedules. Plans have been proposed and will be updated for a priority system of reducing manuscript records to microform images.

The filming of the previous file of half a billion punched cards to FOSDIC (Film Optical Sensing Device for Input to Computer) is nearly complete. A plan has been developed to place highest use data on magnetic tape and retain lower use data on film.

A joint study group is developing proposals for purging and updating specific families of data.

Archives Security

The archives have consisted of separate sets of original records, microfilm, analog instrument traces, etc., and of digital data on cards, tape, and film. Two types of security are being considered; i.e., physical preservation of the data and assurance of ability to recall data intended to be within the file.

The program for backup copies at remote sites is incomplete, with plans being developed for enhancement. It includes provision for offsite storage on film and tape of selected families of high-recall or high-value data or operating programs.

A planning task group has been established at the National Climatic Center and charged with developing specific plans for assuring a reasonable level of file security.

Table 3.--Five-Year Plan for Improving Climatic Services

Objectives	1974	1975	1976	1977	1978
Microform storage and recall	Prepare RFP	Contract for equipment	Operational		
Global atlas >100K ft.		Global atlas complete			
Computer evaluation	Study →		Potential update		
Experiment design and analysis:					
BOMEX	Archive complete				
IFYGL	Data analysis →	Archive complete			
GATE	Data collection	Data analysis →	Archive complete		
FGGE				Data collection →	
Satellite cloud cover	Collection and analysis →				Atlas preparation
ENDEX	U.S. inquiry complete →				Worldwide inquiry complete
OASIS	Establish experimental information services		Operational		
Climatic reference station network	Complete basic installation	Add solar radiation →			
AFOS	Upper air →		Automated surface system →		
FOSDIC filming	Phase out				
Preparation of 10-year climatological data base	Complete - surface data through 1974 →				
	Complete - upper air data through 1977 →				
Climatology above 100 mb.	Begin mid 1974 with data base starting with 1971 data.				

Table 4.--Projected Costs, by Agency

(Dollars in thousands)

Agency	FY 1974	FY 1975	FY 1976	FY 1977	FY 1978
NOAA	3,432	3,604	3,784	3,973	4,171
DOD	4,671	4,280	4,285	5,215	5,215
DOT	80	80	80	80	80
TOTAL	8,183	7,964	8,149	9,268	9,466

Note: The costs reflected in this table beyond FY 1974 are indicated for planning purposes only. They have not been approved by the OMB or by the Congress.

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