UNITED STATES DEPARTMENT OF COMMERCE
WEATHER BUREAU
WASHINGTON

December 9, 1964

IN REPLY, PLEASE ADDRESS
CHIEF, U. S. WEATHER BUREAU
WASHINGTON 25, D. C.
AND REFER TO
C-3.1

MEMORANDUM

TO : Regional and State Climatologists, NWRC, Field Aides (HC), Field Aides, River Forecast Centers, River District Offices, Regional Substation Management Units, and Regional Hydrologists (with copies to Regional Offices, Agricultural Service Offices, and Agricultural Forecast Offices for information)

FROM : Director of Climatology

SUBJECT: Climatological Services Memorandum No. 106

CLIMATOLOGICAL SERVICES OF THE U. S. WEATHER BUREAU 1964

In June 1963 Climatological Services Memorandum No. 99 was issued summarizing the status of the climatological program as it existed at that time. In order to bring the information up-to-date, the attached new summary has been prepared.

H. E. Landsberg

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U. S. DEPARTMENT OF COMMERCE
WEATHER BUREAU

CLIMATOLOGICAL SERVICES
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CLIMATOLOGICAL SERVICES OF THE U. S. WEATHER BUREAU, 1964

I. HISTORICAL BACKGROUND

We can attribute to Thomas Jefferson the early recognition of a need for systematic records of the climate of the United States. His lifelong interest in climatological work found only limited response in his own era. About a century after Jefferson published his first climatological notes a firm framework emerged for a survey of this most important natural resource of the country.

We can follow this development from a review in the "List of Climatological Records in the National Archives." * Although private records of United States weather had been kept for various lengths of time in a number of scattered localities, we read there that "No organized systems of taking meteorological observations were developed until agencies of the Federal Government interested themselves in the matter in the early part of the nineteenth century." Weather records were collected during the 19th Century by the Surgeon General's office, the General Land Office, the Smithsonian Institution, the Patent Office, and the Signal Corps of the Army. Finally the U. S. Weather Bureau was established in 1891 in the Department of Agriculture. This followed some twenty years of weather service rendered by the Office of the Chief Signal Officer of the U. S. Army. The new civilian Bureau inherited an operating system of work processes along with the personnel, instruments, and a national network of stations and offices from the Signal Service. Reports of storms and effects of weather on crops, and a growing literature on weather and climate in general were part of the Signal Service inheritance.

Army Post Surgeons were first required by Dr. James Tilton, Surgeon-General, to "....keep a diary of the weather" in a May 2, 1814 order, and specific climatological objectives were outlined in the Surgeon General's order of 1817 which specifically relates the purposes of Army post weather observations to "medical topography...prevalent regional complaints...change of climate...cultivation of soil...density of population...." Around the middle of the century the Smithsonian Institution set up a system whereby voluntary observers were for the first time supplied with standard instruments, and this cooperative observer system continues in operation in the Weather Bureau today. Because of the possibility of forecasting destructive storms on the sea coasts and Great Lakes, Congress was persuaded to authorize the Weather Service from which the present Weather Bureau developed. The Act of October 1, 1890, creating the Weather Bureau, however, farsightedly included among the specific duties of its Chief "the taking of such meteorological observations as may be necessary to establish and record the climatic conditions in the United States."

The beginnings of a Climatological Service were already in operation on July 1, 1891, when the civilian Weather Bureau began its work. Over 2,000

* List of Climatological Records in the National Archives, Washington, D.C.: March 1942, The National Archives Special List No. 1.

stations were recording daily amounts of precipitation and maximum and minimum temperatures, and 180 more were observing atmospheric pressure, wind, clouds, and sunshine duration. Weekly reports were being published on the effects of weather on cotton and other crops. The published Annual Reports of the Chief Signal Officer and the Monthly Weather Review contained summaries, tabulations, and discussions of the nation's weather, pressure, temperature, precipitation, winds, atmospheric electricity, droughts, forest and prairie fires, sunspots, sandstorms, and other weather phenomena.

The public need for an agency to record and interpret the climates of the United States was recognized early in the history of the Weather Bureau by establishment of a Division of Climatology and Hygiene in 1892. The name was later changed to Climate and Crop Weather Division. The Office of Climatology is the direct descendant of these Divisions.

Industrial and agricultural developments have placed further emphasis in the last half-century on the demands for climatological information: a need for data and interpretations useful for planning of crops, housing, marketing, shipping, aviation, air conditioning, flood control, manufacturing, insuring against weather risks, and many other agricultural and commercial aspects.

This survey summarizes the program and facilities of the Office of Climatology as of the Fall of 1964. It shows our present operations and some of our plans for the future.

II. PRESENT ORGANIZATION

The Office of Climatology is located in Suitland, Maryland. It is part of the Central Office of the Weather Bureau, Department of Commerce (Washington, D. C. 20235).

The Director of Climatology and his staff serve in an advisory capacity to the Chief of Bureau on all matters pertaining to climatological organization policy. They also plan and control the climatological operations.

Along with the 1964 reorganization of the Weather Bureau, Climatology was divided into three Division-level segments: the Laboratory of Climatology; Field and User Services Division; and the National Weather Records Center (NWRC) located at Asheville, N. C.

The Laboratory of Climatology carries on research and developmental work in methodology and applications of climatic data. It is organized on the basis of projects, at present, seven in number. These are Statistical Climatology, Synoptic Climatology, Climatic Change, Bioclimatology, Environmental Climatology, Severe Storm Climatology, and Three-Dimensional Global Climatology.

The Field and User Services Division operates the Weather Bureau climatological services in the field. In carrying out these functions, the Division acts for the Director of National Meteorological Services and maintains close coordination with the Data Acquisition Division of the Office of National

Meteorological Services, as well as with the Regional Climatologists. For the Director of Climatology, the Field and User Services Division also coordinates the program of data dissemination from the National Weather Records Center.

In addition to this the Division provides staff support of the program of the Office of Climatology both in the Central Office and at the National Weather Records Center.

The Division consists of two branches, Field Services and Advisory Services.

The objectives of the Field Services Branch are to ensure adequate user services by that portion of the Weather Bureau Field Services concerned with climatological problems. This is done through two sections - Programs and Requirements.

The objectives of the Advisory Services Branch are to provide adequate climatic information to the public and government agencies, and the scientific community through the services of the Domestic, Marine and Foreign Sections.

The Programs Section

The Section assists the Chief of Branch in coordinating field climatological programs by preparing advices and instructions to Regional Climatologists, to State Climatologists, and to cooperative observers. It coordinates with Data Acquisition Division and the Office of Hydrology the establishment, maintenance, and adjustment of climatological observing networks. The Section also takes action to ensure high cooperative observer morale and to facilitate recruiting and retaining volunteer cooperative observers.

The Requirements Section

The Section defines the needs for climatological station networks required to provide an adequate sample of climatological data. Personnel of the Section act for the Office of Climatology in conferences concerning field operations in collecting, checking and storing surface and upper air records. They direct action for storage and ultimate disposition of original climatic records of the U. S., design the content and direct the preparation of climatological documentation summaries, and assist in the design of experiments to test the applicability of new instruments to climatological requirements. Other functions of the Requirements Section are the preparation of instructions concerning climatological records and maintenance of cost estimates for routine climatological processing, printing and archiving.

The Domestic Section

This Section prepares for publication the Weekly Weather and Crop Bulletin for the benefit of agriculture and other important user groups. It provides consultant services to other Weather Bureau and government and non-governmental offices on domestic area climatic problems, using mainly the climatological publications of the Weather Bureau. The Section prepares summarized material in applied climatology; handles requests from the general public and recommends format and content specifications for climatic data

publications. Letter Supplements are prepared for information dissemination and Atlas charts are prepared as required.

Marine Section

The marine climatological work concentrates on services to civilian and military maritime interests of the government. The climatic material for the United States Coast and Geodetic Survey publication Coast Pilots, The U. S. Navy Oceanographic Office Sailing Directions and Pilot Charts are a primary job. Other routine work includes climatological data for foreign surveys, and data for cases in Admiralty courts; also articles on marine climatology for Oceanographic Office Pilot Chart map backs, and for the Weather Bureau Climatological Data monthly and annual national summaries.

All this requires continuous liaison with other government offices concerned with marine climatological problems. For the operational use of our merchant marine cooperative observers on the "4th seacoast", the Marine Section prepared Weather Bureau Technical Paper No. 35, Climatology and Weather Services of the St. Lawrence Seaway and Great Lakes. The outstanding work, now almost finished, is a 7-volume Marine Atlas sponsored by the U. S. Navy. An adaptation of this Atlas entitled Climatological and Oceanographic Atlas for Mariners is underway. Volume I, North Atlantic Ocean, and Volume II, North Pacific Ocean, are now available. This Atlas is designed for maritime use and includes oceanographic material. Most of the work on this is done at the National Weather Records Center.

Research in Hurricane Climatology is conducted in the Marine Section. Two of the latest reports are Technical Paper No. 36 - North Atlantic Tropical Cyclones, Tracks and Frequencies of Hurricanes and Tropical Storms, 1886-1958; and National Hurricane Research Project Report No. 42 - Climatology of 24-Hour North Atlantic Tropical Cyclone Movements.

Foreign Section

The Section maintains a capability in the climatology of foreign areas. The staff acts in a consultant capacity and keeps current as to the availability of climatological data and information for all non-U. S. regions. Requests for such information may originate in other Weather Bureau units or in other government agencies including those concerned with national defense. Requests from commercial interests, educational institutions, research foundations, or the general public are either answered or referred to other sources, such as libraries or private consultants, in cases where the amount of work involved is appreciable. Reimbursable projects in foreign climatology supported by Air Weather Service or other government agencies include the preparation and publication of bibliographies or surveys of information or maps available in the libraries in the Washington area. Information is collected by subject matter as well as by country or area. A small translation unit facilitates the use of foreign language materials. English versions of foreign articles are occasionally published in another series.

The interest in and need for foreign climatological information is growing with the increasing importance of tourist travel, international air traffic,

the marketing of U. S. products abroad, and the expansion of U. S. commercial activity in other countries. Careful planning requires intimate and detailed knowledge of the climatic hazards or advantages found in unfamiliar areas.

The National Weather Records Center (NWRC) is located physically at Asheville, North Carolina, but it operates in most respects as the major operating Division of the Office of Climatology. It has broad autonomy with direct responsibility for its own administrative and personnel actions and much of the total program. It furthers the interests of the National Weather Service and those of the specialized weather services operated by the military departments. The latter make use of the NWRC as a common facility, but maintain there, as required, units of their own. The Air Weather Service, U. S. Air Force, for example, has a staff of some 200 people and computer facilities engaged in checking observations from its global network and providing climatological support to the Air Force.

The NWRC receives and processes (punches, verifies and publishes) surface data from more than 12,000 surface weather observing stations (regular Weather Bureau and Navy), and upper air data from over 250 locations. Under an NWRC quality control program, the data are checked for accuracy and printer's copy for various climatological data publications is prepared. NWRC is the official agency designated by the National Archives as repository of all historical U. S. weather records. NWRC is responsible primarily for the assembly, quality control, processing and analysis, publication and final storage of U. S. climatic records, and a fast-growing file of weather records around the world on land and sea. This includes everything recorded about weather, from the contents of widely scattered weather journals kept in the 18th Century to the standardized regular entries being made now at upwards of 12,000 observing stations in the U. S., some hundreds of which record not merely the familiar once-daily temperature and precipitation values but hourly observations of these and a dozen other elements, as well as upper-air soundings of wind, pressure, temperature and humidity. NWRC furnishes many information services and specialized analyses based on its vast collections. The real purpose of the Center is to make the climatological data available in a suitable form for use in making decisions involving strategy, time and money. Collection and checking the records provide the raw material for this purpose.

Since 1947 most U. S. weather observations have been recorded on punch cards and processed by machines. The expanding capabilities of punched card and magnetic tape systems have permitted continually increasing statistical summarizations and specialized studies without increasing the staff of less than 400 people. Requests from private citizens, industry, other government agencies, universities and foundations are filled by the NWRC. The client pays the actual costs for his project.

The Climatic Field Service is guided by Regional and State Climatologists. There are four Regional Climatologists in the coterminous United States, one in Alaska and one in Hawaii. Regional Climatologists are members of the technical staff of the Regional Offices. They furnish technical guidance to State Climatologists and are concerned with regional climatological problems, maintain contact with regional, private and governmental organizations,

carry on developmental activities in climatology and implement the policies of the Office of Climatology in the Region.

State Climatologists are responsible for climatological services within their respective States. These include some recurring duties (for example, cooperation in preparing a weekly weather and crop bulletin for the State, collection of reports on severe storms, and writing of climatological narratives to accompany data summaries). They cooperate with Agricultural Experiment Stations on studies of relations between climate and crops, irrigation problems, influence of climate on pests, etc. They encourage the use of climatological data for industrial, engineering and commercial applications in their States and help State agencies, where appropriate, with climatological problems.

Advisory Committee on Climatology

The program of the Office of Climatology is under scrutiny by an Advisory Committee on Climatology appointed by the National Research Council. The Committee was established in 1955 at the request of the Chief of the Weather Bureau. Its objectives are to advise on requirements, methods and future plans in climatology. The Committee meets about twice a year.

III. STATION NETWORK FOR CLIMATOLOGICAL NEEDS

The networks of observing stations which yield weather information useful for climatological purposes comprise (in 1964) more than 12,000 localities in the United States and the Caribbean. Since continuity in climatic records is very important, stations of four networks are maintained with a minimum of change. These four networks are: (1) the network of Principal Climatological Stations, called the 24-hour climatic network, (2) the network consisting of the foregoing plus the Ordinary Climatological Stations, called the "a" network, (3) the Upper Air Network, and (4) the Climatological Bench-Mark network of long-record temperature - and - precipitation stations. These climatically representative stations were chosen for continuity value and prospective permanence.

The 24-hour Climatic Network of 178 First Order Weather Bureau and Federal Aviation Agency stations, with few exceptions, record each hour a complete surface weather observation. This includes wet- and dry-bulb temperatures, dewpoint, relative humidity, sky cover, cloud types with height and direction of movement, wind direction and speed, atmospheric pressure and tendency, ceiling, visibility, and present weather. Although far less numerous than those of the basic "a" network these 24-hour stations represent a fairly uniform national grid. They add to the data obtained by the "a" network in important ways: they provide dependable records of important climatic elements not observed at the "a" stations, and they supply data about the diurnal variation of temperature, wind, cloudiness, and other weather characteristics.

The "a" Network consists of about 5,000 temperature and precipitation stations manned chiefly by cooperative volunteer observers. It includes only

those stations required to provide an adequate sample of data for areal statistics on weather and climate. The network ordinarily contains about one station per 600 square miles.

The Upper Air Network consists of 70 Weather Bureau rawinsonde stations. Observations at these stations are made to altitudes of at least 100,000 ft. Data from this network are used climatologically to provide guidance for (1) aircraft designers, (2) airline operators, (3) the structural design of aircraft and rockets, and (4) for planning against dangers from nuclear fallout, as well as in research regarding a more thorough knowledge of the atmosphere's behavior.

The Climatological Bench-Mark Network has as its primary purpose the collection of data in local environments with minimal anticipated man-made changes, so that they are suitable for monitoring climatic changes. The number of stations considered necessary for this purpose is between 30 and 50 in the coterminous United States, plus about 10 in the other States and Territories (most of them in Alaska). Of 29 continental stations, 18 of them are fully qualified for the network, having met strict criteria involving stability of location, freedom from environmental influence and change, reasonably long history of homogeneous observations, and good prospects of future continuity. The stations are located for the most part on property owned by the Federal or State governments or public institutions (e.g., in National Parks, at Experiment Stations, or on University campuses) where supervision of the observing program, uniform instrument exposure, completeness and accuracy of record, and freedom from molestation are fairly well assured. Additional stations will be established where the exposure is ideal for an augmented future observational program. At these, as well as at some of the present stations, it is planned to add recording equipment for observations other than precipitation and temperature (e.g., wind, solar radiation, soil moisture, soil temperature, lightning stroke count, and eventually, also electric potential, atmospheric pollution and radioactivity).

The "b" (hydrologic) network comprises precipitation-observing stations used primarily for river and flood forecast purposes, but important climatologically, too.

Another group of substations is generally referred to as the "c" network. It is not a network in the true sense of the term since the stations comprising it do not follow a planned system for one specific purpose such as those that make up the "a" or "b" networks. These "c" stations consist of (1) those required primarily for local public services; (2) those having a long record of observations but which are not included in the "a" or "b" network; and (3) special purpose stations such as those at experiment or research farms, at tower sites, and those reporting soil temperature or soil moisture data.

Plans for Specialized Observations. Basic temperature and precipitation readings taken at unpaid climatological stations have been practically the only observations made primarily to serve climatological needs. The observations of other elements - e.g., surface wind, sunshine, clouds, humidity, etc. - have been made mainly to serve forecasting and other purposes. Any value the observations might have for climatology was secondary and coincidental.

In effect, we have had a fairly good coverage (2,000-12,000 stations) for 60 to 80 years of temperature and precipitation values for the 3,000,000 square miles of the U. S. proper.

However, for the numerous other elements that make up the climate we have had for the same area and time-period only from 200 to 300 predominantly urban observing stations. For some purposes (related primarily to forecasting practices and local interests) this number and kind of observing points has served more or less satisfactorily. For many other needs where local influences of topography or environment, for instance, might distort the natural measures of weather or where a small-scale survey required a greater density of registering points, neither the number nor the type of these stations has been sufficient.

How to correct this deficiency is both an important and complex problem. Agriculture needs more information on temperature, humidity, wind, and radiation in the lower layers of the atmosphere and on temperature and moisture in the soil. Engineering, now reaching into all corners of the country with housing and highway construction, stream regulation, heating and air conditioning, has ever increasing requirements for local climatological information. Heating and cooling load, water supply and drainage, health and recreation all depend on climatic factors. The question of how best to get data for these purposes also includes questions of how many observing points are needed, whether the number per thousand square miles should be the same for the Great Plains as for the Rocky Mountain States, how this number compares for Arizona and Alabama, for the Pacific Coast and the Great Basin.

Besides this general question of the spread and density of stations-for-climate there is also the question of instrumentation. A new recording precipitation gage now being used for hydrologic purposes may form the basis for development of a gage of more general applicability. A dial-type maximum-minimum thermometer employing a mercury-in-steel sensing element has been disappointing in tests as an air thermometer, but is being used as a soil thermometer. A substation wind recorder is nearly ready for field testing, and will then be purchased for installation at climatological bench-mark stations. Also, automatic recorders for isolated island and mountain stations are under development; plans for microclimatic observations (probably at State or Federal Experiment stations) are part of the larger plan for expanded cooperative work with other agencies in agriculture, and exploratory work is well under way in a program for gathering much-needed data on soil-moisture, subsurface temperatures, evaporation, and evapotranspiration.

Because the only means of meeting many requirements for climatic data is through finely detailed micro-climatic observations, while for others the values obtained in the regular network are sufficient, plans for a way to serve both needs have been included in the Weather Bureau decadal plan. One favored idea is to establish in significant areas mobile observing units to pin down the relations between micro- and ordinary climatic observations by correlating a short-period micro-record made by the mobile station with records from stations in the macro-network. This should provide guidance for more specific interpretations than is now possible without micro-observing facilities or data.

IV. PRESENT PRACTICES IN CLIMATOLOGICAL DATA PROCESSING

Historically, after weather observations have served their immediate operational uses in weather intelligence and forecasting, they have always been subjected to three major climatological treatments. First, they were checked and edited, both to assure the quality of the observational program and to avoid inclusion of errors in the climatological record. Second, they were summarized and prepared for publication in current monthly and annual bulletins. Third, they were organized, catalogued and stored for use in long-term climatic studies and research analyses.

Prior to 1948, these three actions were handled at several hundred stations. In 1948, however, with the establishment of Weather Records Processing Centers (WRPC), the manipulation of climatological data was drawn together, standardized, and streamlined into an integrated procedure which operated on a current basis and used modern punched card processing techniques. This streamlining has continued with the consolidation (in 1962 and 1963) of the last three WRPCs with the National Weather Records Center (NWRC) at Asheville, N. C.

The observational records from more than 12,000 observing points now flow directly into the NWRC. There the data from operational weather stations and from cooperative climatological stations are assembled in punched card form. The cards are immediately put through a variety of machine runs which screen all elements of the data for reasonableness, flagging entries that fall outside tolerances established by the meteorologist. Observational specialists edit the flagged entries in detail, and correct the errors disclosed by this editing. It is thus possible, within a period of a few weeks, to keep observing stations fully informed about the accuracy of their observing programs and records.

After editing the punched card record, data are prepared for current publication in monthly and annual state Climatological Data bulletins. Machine methods are used throughout this process, even to the preparation of final printer's copy. This machine-prepared copy is finally assembled, photographically reduced, and printed on high-speed offset presses.

The data forms and punched cards ultimately become part of the centralized weather records library at the National Weather Records Center. At the Center many long-term climatological summaries and analyses of the data for research programs are carried out. A wide array of automatic data processing and computing machines is used there, including electronic digital computers capable of performing very sophisticated statistical and mathematical operations.

Development Work in Progress and Planned. Problems in servicing and processing climatological data, by no means completely solved, have in one sense even been aggravated by the accelerating advances in automatic data-handling and processing techniques. An example of this is the need for reduction of the growing mountain of perishable punched card records to a more efficient size, more permanent record-medium, and lower storage and maintenance costs.

In cooperation with the Bureau of Standards and the Census Bureau, equipment has been developed to reduce our punched card library to microfilm, with automatic future recall of the data whenever and in whatever form required. The Census Bureau has built, to Weather Bureau specifications, a punched-card-feeding microfilm camera that will microfilm 840 cards per minute, placing approximately 13,000 card images on a 100-ft. roll of 16 mm film. With this camera our entire present card library, jammed into 30,000 sq. ft. of floor space, could be housed in less than 300 sq. ft. of microfilm files. (If the present rate of accumulation is maintained, the presently allotted 30,000 sq. ft. of library space would be adequate for the next 1,000 years!) . More than 100,000,000 cards have already been microfilmed, and the cards disposed of.

This reduction of punched cards to microfilm as a medium for machine processing has been made practical by the development of a Film Optical Scanning Device for Input to Computers called FOSDIC, a prototype of which has been built by the Bureau of Standards to Weather Bureau specifications. FOSDIC is a high-speed automatic means for reading the microfilm of punched cards. It employs the flying spot of an electron gun to scan the image of a punched card projected onto the screen of a cathode ray tube similar to the picture tube in a TV set. The prototype FOSDIC scans the microfilm for selection of desired microframes at a rate of 4,000 frames per minute, and reads the data from the selected frames into a card-punching machine, for re-creation of the punched card record. A second model has been built and serves as input to conversion of the data to magnetic tapes; this new FOSDIC operates at four times the speed of the prototype.

The reduction of the ever-growing volume of original meteorological observations forms another problem in data handling. In the past, attempts have been made to utilize standard microfilm techniques, but this has not been entirely satisfactory because it is impossible to organize data on film in a manner sufficiently versatile for their utilization in varied types of technical investigations.

The obvious solution is to develop a unitized type of micro-record similar to the micro-card but one which will provide a negative film copy at a cost comparable to standard microfilm. Such negative film facilitates the preparation of inexpensive positive (paper) copy which can be used with standard micro-card viewers. Equipment for inexpensive conversion of reel microfilm to microfilm sheets has been put into operation, preparing "microfiche" for such data sources as the Northern Hemisphere Data Tabulations and the WBAN 10 forms. (A "microfiche" is a microfilm transparency carrying many document images.) For example, a station month of WBAN 10 forms are carried on a single 4" x 6" microfiche. A unitized microfilm approach, using equipment which will automatically convert roll film to the sheet format, is also being planned for meteorological satellite cloud pictures.

V. ROUTINE PUBLICATIONS

The number of people and purposes requiring climatological data is so great, and the variety of uses so wide, that the problem of publication will perhaps never be solved to the satisfaction of everybody. The program now in effect has been shaped by three-quarters of a century's experience with public needs

and only limited by Weather Bureau capabilities. It serves to make the basic data available on a broad scale, rather than to serve specific applications. Even so a casual examination of the publications might suggest that the Climatological Data and the Weekly Weather and Crop Bulletin are purposely intended to serve non-urban and agricultural interests, that the Local Climatological Data is meant to fill needs of large cities, but a closer look at these publications will show that each actually reflects the motive to serve as many users in the best possible manner.

The Weekly Weather and Crop Bulletin, National Summary is usually published each Tuesday at noon. It carries information of particular interest to agriculture. Crop data are collected in cooperation with the Statistical Reporting Service of the U. S. Department of Agriculture and with State agricultural agencies, and are combined with descriptions of concurrent weather. The section "Weather of the Week" is presented along with special discussions of the effects of weather on crops and farm activities. In season, small grains, pastures, corn, cotton, soybeans, and other crops are discussed separately. Weekly temperature and precipitation and monthly heating degree-day data are given in chart or tabular form. Near the 1st and 15th of the month the monthly Weather Outlook of the Extended Forecast Section is included, and in the first issue of each month charts of total precipitation for the previous month and departures from normal are given. When farm activities are at their peak, a written summary of conditions in each State is included covering the status of crops and the weather effects. Special articles of general interest to agriculture, such as droughts, are written from time to time, and charts and tabulations of current importance are also included. During the spring, ice conditions on the Great Lakes are discussed prior to opening of the shipping season.

The Local Climatological Data publication is prepared monthly for nearly 325 cities in the United States and outlying stations. This publication includes daily climatological information and summaries for the month. Also included, where available, are hourly precipitation data and the 3-hourly observational data. Brief summary tables of averages, departures, and extremes of temperature, precipitation, barometric pressure, and heating degree days are also included.

For stations issuing the Local Climatological Data, an annual issue, Local Climatological Data with Comparative Data, contains a brief description of the general climate of the locality and a station history. One table shows data recorded for the past year - monthly totals, averages, and in some cases extremes of the elements of temperature, precipitation, relative humidity, wind, sunshine, and degree days. In addition, there is a table of normals, means, and extremes of the same elements for the period of record. Tables of average monthly and annual temperature, precipitation, degree days, and snowfall cover the period of record since the beginning of this century.

Hourly Precipitation Data is published monthly with an issue for each state or combination of states (Maryland-Delaware, New England) except Hawaii.

Hourly and daily precipitation values are presented from stations equipped with automatic recording gages. The annual issue contains monthly and annual totals of precipitation.

Climatological Data is issued for each State (or group of States). It presents surface observations from all regular networks. The monthly issue contains daily maximum and minimum temperatures, daily precipitation, snowfall and snow on the ground, evaporation and winds, and soil temperature in addition to monthly summaries. The annual issue contains monthly and annual averages and departures from long-term means of temperature, precipitation, and evaporation; total wind movement; soil temperature and soil moisture tables; a table of temperature extremes and freeze data; a station index; and a location map.

Climatological Data, National Summary contains pressure, temperature, precipitation, and wind data for selected U. S. stations. There is a general summary of weather conditions over the country. Special articles describe hurricanes, unusual weather, and river and flood conditions. A table summarizing severe storm damage by States is also included. Average monthly radiosonde and pilot-balloon data are presented in tabular form; so are solar radiation data. Charts of the United States graphically portray temperatures, precipitation, snowfall, percentages of sunshine, tracks of cyclones and anticyclones, solar radiation, and monthly average upper air winds and heights. The annual issue presents summaries of all these data for the year and includes information on excessive rainfalls, hurricane tracks and tornado paths.

Monthly Climatic Data for the World contains monthly mean values of surface temperature, pressure, relative humidity, and precipitation; and of upper air temperature, dew point and wind direction and speed for many locations throughout the world. It is sponsored by the World Meteorological Organization in cooperation with the U. S. Weather Bureau.

Storm Data presents by States the place, time, character, and estimated damage of all reported severe storms or unusual weather phenomena. It is published monthly.

Synoptic Series, Daily Weather Maps, Northern Hemisphere consists of Part I and Part II. Part I is a publication which presents the Northern Hemisphere daily synoptic maps on a monthly basis. Each volume of the series consists of Northern Hemisphere maps for one month, with one sea level map and one upper air constant pressure surface map (500 millibars) for each day.

Part II, Northern Hemisphere Data Tabulations, is made available in microfilm and contain daily synoptic surface and upper air reports.

The Mariners Weather Log is a bimonthly publication containing meteorological information for the maritime industry. Included is material on weather and shipping on the Great Lakes as well as on the oceanic areas in the Northern Hemisphere. Each issue usually contains two major articles and several smaller contributions of current maritime interest. Recent ocean weather is described and a table of selected ship gale observations is included. Regular features include cyclone tracks North Atlantic and North Pacific, Climatological Data U. S. Ocean Station Vessels, and a marine diary of average weather conditions.

VI. SPECIAL SERVICE PROGRAMS

Upper Air Summaries. Up to about 1950, the best summaries of winds over the United States were found in the Weather Bureau's 1941 Airways Meteorological Atlas. This contained upper-level wind data for 58 stations in the continental United States. The bulk of the observations were for 500-, 1000-, 3000-, and 5000-meter elevations. Above these levels the data were extremely biased towards lower-speed and fair-weather winds. The reason for this was that the summaries were all based on pilot-balloon observations, which usually failed to record data during high winds and foul weather.

With the development of aircraft capable of flight in almost all types of weather, the need for better summaries became acute. The advent of jet aircraft, with requirements for flight at higher elevations, also made new summaries imperative. This is how the needs were met:

The Weather Bureau, under Navy sponsorship, produced 3 volumes of summarized wind data from 111 stations extending from Korea across the Pacific, the United States and the Atlantic to the coast of Europe. Data extending to heights of 40,000 feet were based primarily on rawin observations. Bias was eliminated by geostrophically estimating winds for any missing observations. This had the effect of including as many values at 40,000 feet as at lower elevations. Data are presented in the form of wind rose tabulations, by direction and speed groups. Also the wind aid values for aircraft flying in any of the 16 cardinal directions were computed for each observation. Frequency distributions of wind aid or retardation were expressed in summaries showing the percentage probability of occurrence for various routes at different seasons.

In another project the Weather Bureau, in cooperation with the Sandia Corporation, computed wind vector and vector standard deviation values for 13 surfaces ranging from 950 to 30 mb., for a large network of stations. All missing values at each level were estimated, so that this 5-year summarization is based on as many values for 30 mb. as were available at 950 mb. The Weather Bureau has published the Upper Air Climatology of the United States (issued as Technical Paper No. 32) in three parts. Part I contains average monthly values of height, temperature, humidity, and density for all standard pressure surfaces for all raob stations having at least an 8-year record for the period 1946-1955. Part II contains extremes and standard deviations of height and temperature. Part III is a summary of vector winds and wind shear at various pressure surfaces between 500 and 30 mb.

Under the sponsorship of the then Federal Civil Defense Administration, the Weather Bureau prepared Civil Defense Technical Bulletin 11-31, June 1957, "Probability of Fallout Debris Deposition". This shows the probability of fallout occurring in distance and direction around a large network of selected locations, in event of a nuclear detonation.

The Weather Bureau, in cooperation with and under sponsorship of the FAA, has also prepared a series of publications to describe the weather to be expected by aircraft flying at levels between 50,000 and 80,000 feet. These were

urgently needed for design and feasibility studies for the projected supersonic commercial airlines.

Agreements reached by the World Meteorological Organization (WMO) have led to an international exchange of climatological data. Mean monthly values of surface temperature, humidity, rainfall, and of upper air height, temperature, and humidity at standard pressure levels, have been furnished as promptly as possible by most countries of the World for publication early the following month in the Weather Bureau's bulletin Climatic Data for the World. As a result of action by the Second Congress of WMO in 1955, the World Meteorological Organization sponsors this publication, which continues to be issued by the Weather Bureau. These arrangements have helped in the collection of basic data for such world-wide summaries as appeared earlier in Clayton's World Weather Records.

Climatic Atlas. Work is nearly completed on a series of new or revised climatic atlas maps for the U. S. Wherever possible these maps are based on the 30-year records for 1931-1960. Maps have been prepared and printed on a base map with a scale of 1:10,000,000 or on convenient multiples, e.g., a 1:30,000,000 scale allows 9 maps on a page instead of one.

The maps prepared under this plan are printed in black and white. They depict monthly and annual precipitation, temperature, cloudiness, bright sunshine, relative humidity, freeze data, evaporation, wind, etc. Tabular data on frequency diagrams are sometimes included. Alaska and Hawaii are included as inset maps. The maps are available as separate sheets. Additional information can be obtained upon request.

The Weather Bureau is also cooperating in providing climatic maps for a newly announced National Atlas. A project of the U. S. Geological Survey, this Atlas will have maps in several colors and will cover many other features (physical, economic, etc.) besides the maps on climatology. Most of the maps mentioned above will be converted to color and used. Other maps will be modified and some new ones prepared. The Atlas will be in hard cover binding and should be available by about 1967.

Climates of the States presents in a publication for each of the 50 States tabular, textual, and map information concerning the climate of the State.

Letter Supplements dealing with various climatological aspects such as Tornado Occurrences in Major Cities, Temperature Extremes (Highest and Lowest), etc., are issued from time to time.

VII. OUTLOOK

The preceding presentation is an account of the climatological work in the Weather Bureau as it now stands.

Most important in our plans is the establishment of full-time positions of State Climatologists where these are not now in existence. These positions are intended to furnish better climatological service in all parts of the

country. Close cooperation with State agencies, land-grant colleges, and agricultural experiment stations has proven to be mutually advantageous and it is believed that eventually almost all State Climatologists will be closely aligned with and in fact physically located at these educational institutions. The duties of the State Climatologists, in addition to the routine work on weather and crop bulletins, severe storm reports, and descriptive climatological summaries for the State, include analytical and developmental work. Particularly, attention will be devoted to use of climatological data for general agricultural purposes, irrigation, water supply problems, recreation, industrial and urban development planning in the State.

Climatology will take an important place in the planning and development of the modern aviation program. Airport runway alignment, route studies and terminal probabilities, as well as aids to forecasters, are all essential to a well-planned system.

With progress in the establishment of bench-mark stations there will be an analysis of the older records in search of climatic trends.

Better documentation practices for old and new climatic data and improved techniques of processing and storing will remain one of our most important aims. In this respect we feel keenly the need for active participation in developmental work directed toward new approaches to climatological problems by use of specially adapted machines, computers and reproduction equipment.

We hope to explore, preferably cooperatively with colleges and universities, the potentialities of synoptic climatology. We are conscious of the valuable "feed-back" mechanism inherent in climatic material for the forecaster. In addition, there are new avenues of applying climatology to problems of plant and animal life, and human health and well-being. We hope to make some useful contributions in these fields.

In addition, efforts will be made to streamline and automate the routine climatological work of the Bureau. Certain types of routine summary work have now been superseded by longer term summaries and the former will be discontinued. Instead this effort will be applied toward the machine preparation of routine publications previously prepared manually at first order stations.

KEY PERSONNEL IN CLIMATOLOGY

OFFICE OF CLIMATOLOGY

DIRECTOR	H. E. Landsberg
ASSISTANT DIRECTOR	R. W. Schloemer
CHIEF CLIMATOLOGIST	H. C. S. Thom
AUTOMATIC DATA PROCESSING STAFF ADVISOR	J. F. Bosen
SECRETARY	Mrs. Gladys Crown
ADMINISTRATIVE ASSISTANT	Mrs. D. H. Cartwright
FIELD AND USER SERVICES DIVISION	H. B. Harshbarger
Field Services Branch	H. B. Harshbarger (Acting)
Program Section	J. H. Hagarty
Requirements Section	H. S. Lippmann
Advisory Services Branch	L. A. Joos
Domestic Section	J. L. Baldwin
Foreign Section	D. Smedley
Marine Section	A. I. Cooperman
LABORATORY OF CLIMATOLOGY, DIRECTOR	H. E. Landsberg (Acting)
Statistical Climatology Project	H. C. S. Thom
Synoptic Climatology Project	P. H. Putnins
Climatic Change Project	J. M. Mitchell, Jr.
Bio-Climatology Project	W. C. Palmer
Environmental Climatology Project	R. H. Frederick
Severe Storm Climatology Project	W. H. Haggard
3-Dimensional Global Climatology Proj.	H. L. Crutcher
Field Research Coordinator	M. L. Blanc (Tempe, Arizona)
NATIONAL WEATHER RECORDS CENTER	
Director	W. H. Haggard (Acting)
Assistant Director	W. H. Haggard
Scientific Advisor	H. L. Crutcher
Digital Systems Advisor	R. L. Joiner
Data Management Advisor	S. M. Brewster
Quality Control Advisor	W. P. Nash
Project Coordinator	E. M. Ritchie
Climatic Operations Branch	G. E. Stegall
Climatic Information Section	W. T. Hodge
Climatography Section	G. E. Stegall (Acting)
Data Verification Section	H. C. Steffan
Applied Climatology Branch	W. M. McMurray
Climatic Analysis Section	(Vacant)
Synoptic Climatology Section	W. M. McMurray (Acting)
Data Reduction Section	G. F. McKay
Administrative Operations Branch	M. G. Johnson (Acting)
Administrative Services Section	M. G. Johnson
Personnel Section	G. W. Ehrsam
Technical Services Section	S. M. Brewster (Acting)

REGIONAL CLIMATOLOGISTS

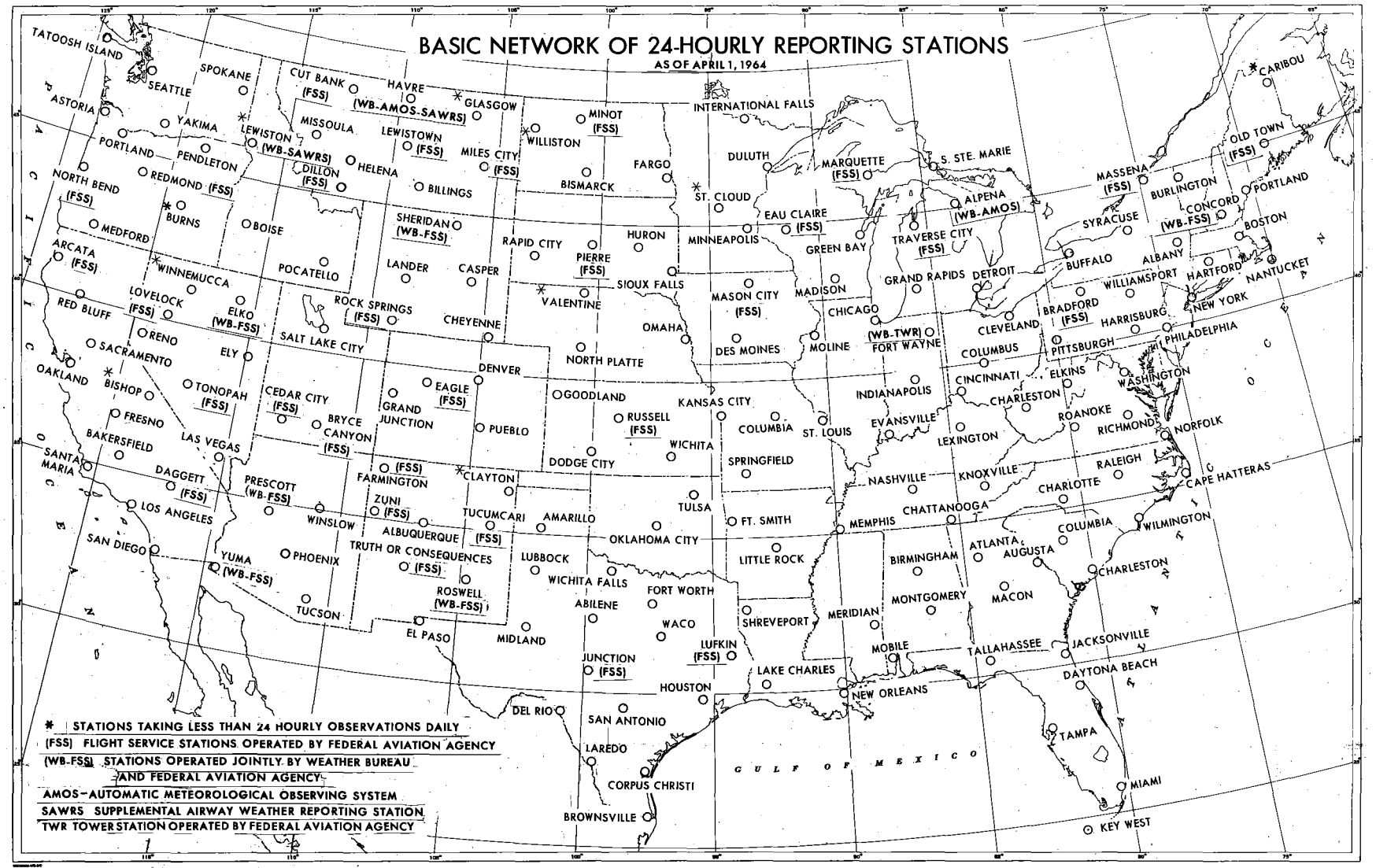
New York Region.	Norman L. Canfield New York, New York
Fort Worth Region.	C. K. Vestal Fort Worth, Texas
Kansas City Region	Dr. R. F. Dale Ames, Iowa
Salt Lake City Region.	M. D. Magnuson Seattle, Washington
Alaska Region.	C. E. Watson (Acting) Anchorage, Alaska
Pacific Region	Saul Price Honolulu, Hawaii

LOCATIONS OF STATE AND TERRITORIAL CLIMATOLOGISTS

Alabama - Weather Bureau Airport Station, Montgomery* - A. R. Long
Arizona - Weather Bureau Airport Station, Phoenix - Paul Kangieser
Arkansas - Weather Bureau Airport Station, Little Rock* - Robert O. Reinhold
California - Weather Bureau Office, San Francisco - C. R. Elford
Colorado - Weather Bureau Office, Denver - Joseph W. Berry
Connecticut and Rhode Island - Weather Bureau Airport Station, Windsor Locks, Conn. - J. J. Brumbach
Florida - University of Florida, Gainesville - Keith Butson
Georgia - University of Georgia, Athens - Horace S. Carter
Idaho - Weather Bureau Airport Station, Boise - David J. Stevlingson
Illinois - University of Illinois, Champaign - W. L. Denmark
Indiana - Purdue University, Lafayette - Lawrence A. Schaal
Iowa - Weather Bureau Office, Des Moines - Paul J. Waite
Kansas - Kansas State University, Manhattan - Merle J. Brown
Kentucky - University of Kentucky, Lexington - A. B. Elam, Jr.
Louisiana and Mississippi - Weather Bureau Office, New Orleans*- E. J. Saltsman
Maine, Massachusetts, New Hampshire, and Vermont - Weather Bureau Office, Boston, Mass. - Robert E. Lautzenheiser
Maryland and Delaware - Weather Bureau Airport Station, Baltimore, Md. - W. J. Moyer
Michigan - Weather Bureau Office, East Lansing - A. H. Eichmeier
Minnesota - Weather Bureau Office, Minneapolis* - (Vacant)
Missouri - Weather Bureau Office, Columbia - James D. McQuigg
Montana - Weather Bureau Airport Station, Helena - R. A. Dightman
Nebraska - Weather Bureau Office, Lincoln - Richard E. Myers
Nevada and Utah - Weather Bureau Airport Station, Salt Lake City, Utah - Arlo Richardson

New Jersey - Weather Bureau Office, Trenton - Donald V. Dunlap
New Mexico - Weather Bureau Airport Station, Albuquerque - Frank E. Houghton
New York - Cornell University, Ithaca - A. Boyd Pack
North Carolina - North Carolina State, Raleigh - A. V. Hardy
North Dakota - Weather Bureau Airport Station, Bismarck* - H. G. Strommel
Ohio - Weather Bureau Office, Columbus - L. T. Pierce
Oklahoma - Weather Bureau Office, Oklahoma City - Stanley Holbrook
Oregon - Weather Bureau Office, Portland - Gilbert L. Sternes
Pennsylvania - Weather Bureau Airport Station, New Cumberland - Nelson M. Kauffman
Puerto Rico and Virgin Islands - Weather Bureau Office, San Juan, P. R. - Robert J. Calvesbert
South Carolina - Weather Bureau Airport Station, Columbia - N. D. Strommen
South Dakota - South Dakota State College, Brookings - Walter Spuhler
Tennessee - Weather Bureau Airport Station, Nashville - J. V. Vaiksnoras
Texas - Weather Bureau Airport Station, Austin - Robert B. Orton
Virginia - Weather Bureau Airport Station, Richmond - Daniel L. Sala
Washington - Weather Bureau Office, Seattle - Earl L. Phillips
West Virginia - West Virginia University, Morgantown - Robert O. Weedfall
Wisconsin - University of Wisconsin, Madison - Marvin W. Burley
Wyoming - Weather Bureau Airport Station, Cheyenne - John D. Alyea

*Full time State Climatologist position not yet established.



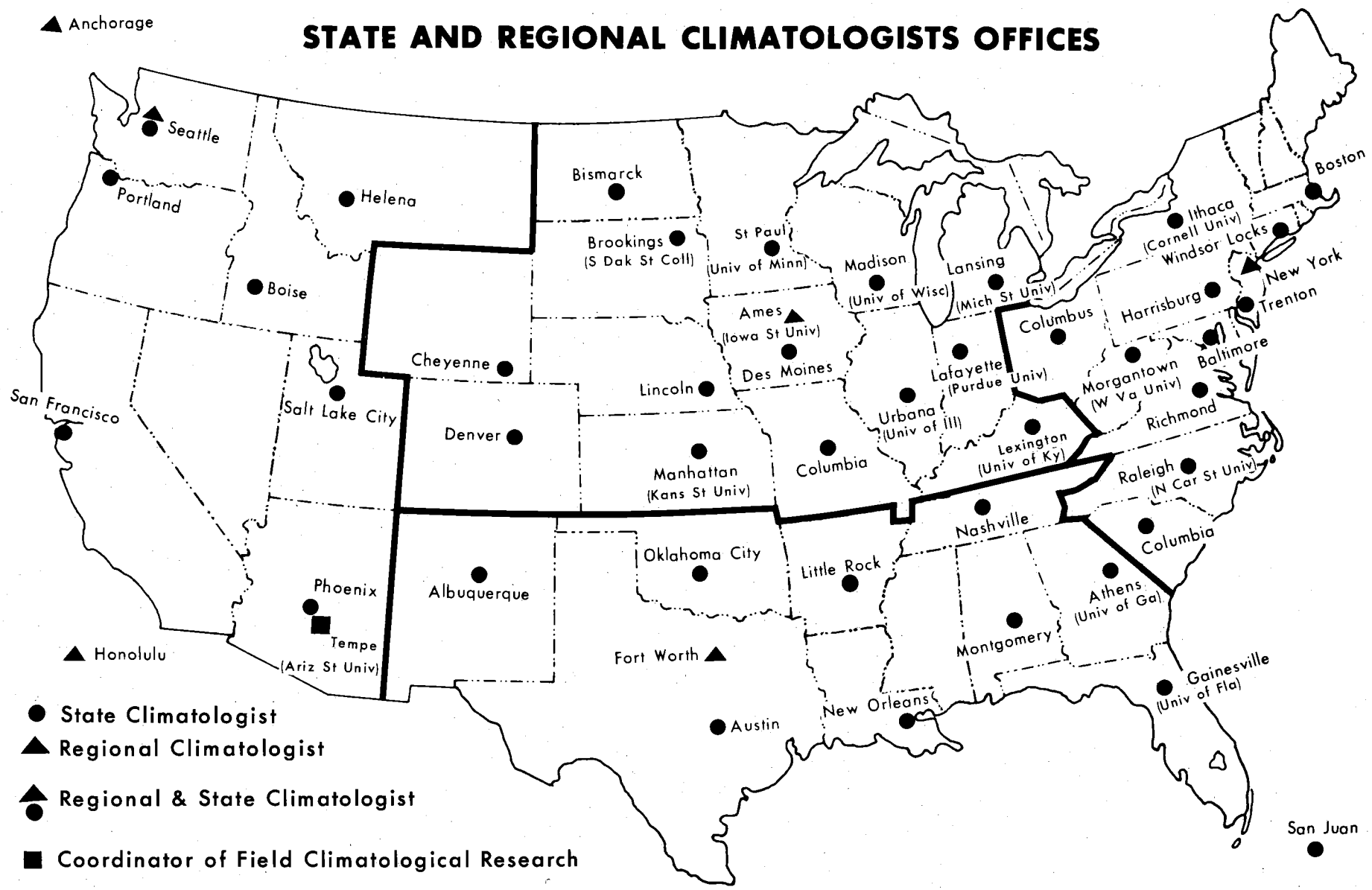
Base map by United States Weather Bureau

0 50 100 200 300 400 500 MILES

SCALE 1:10,000,000

ALBERS EQUAL AREA PROJECTION — STANDARD PARALLELS 29½° AND 45½°

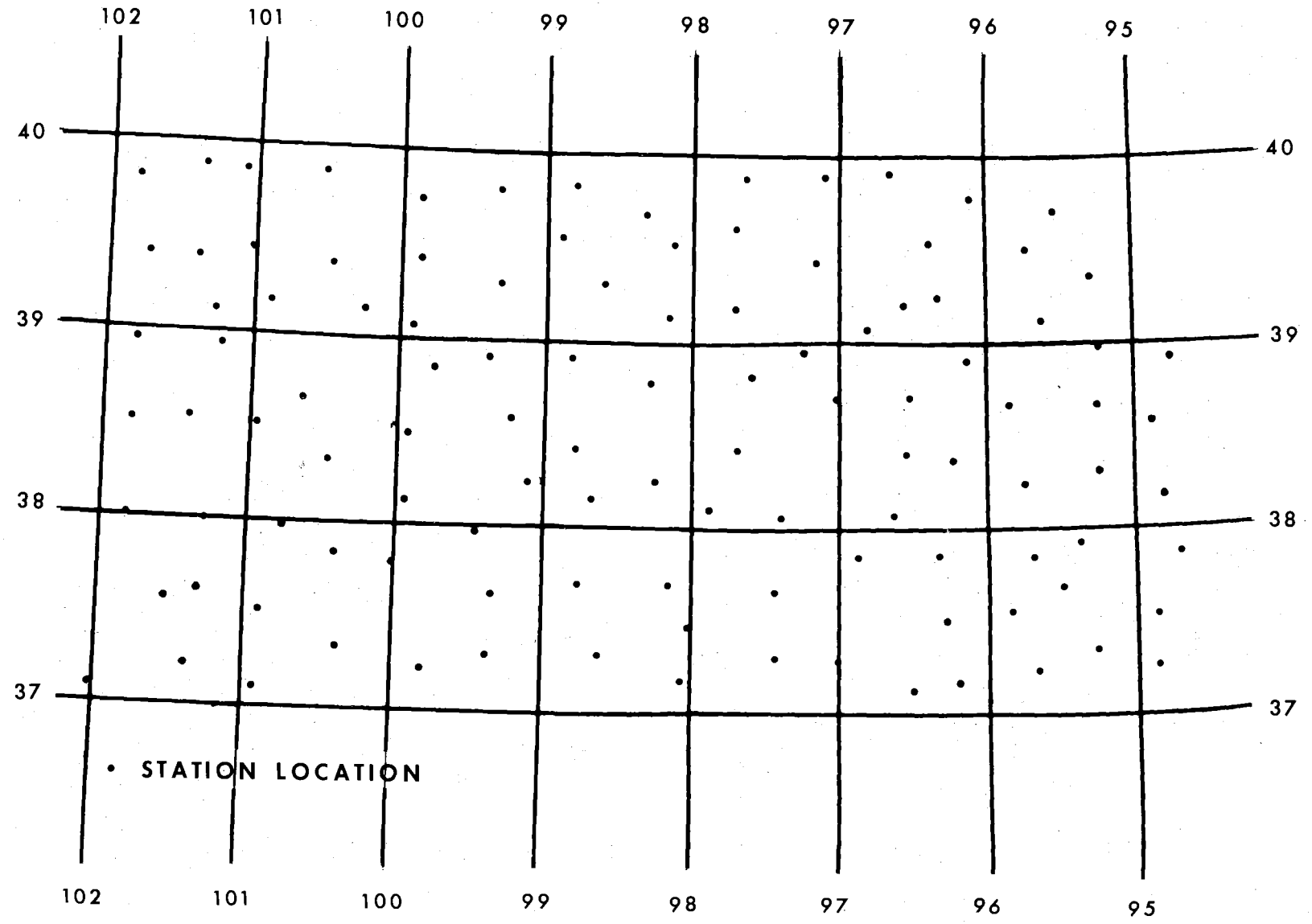
PRINTED BY U. S. WEATHER BUREAU WASHINGTON, D. C.


Anchorage
STATE AND REGIONAL CLIMATOLOGISTS OFFICES
Seattle
Portland
Helena
Bismarck
Brookings
(S Dak St Coll)
St Paul
(Univ of Minn)
Madison
(Univ of Wisc)
Lansing
(Mich St Univ)
Ithaca
(Cornell Univ)
Windsor Locks
Boston
New York
Trenton
Harrisburg
Columbus
Boise
Ames
(Iowa St Univ)
Des Moines
Cheyenne
Lincoln
Lafayette
(Purdue Univ)
Urbana
(Univ of Ill)
Morgantown
(W Va Univ)
Baltimore
Richmond
San Francisco
Salt Lake City
Denver
Manhattan
(Kans St Univ)
Columbia
Lexington
(Univ of Ky)
Raleigh
(N Car St Univ)
Nashville
Columbia
Oklahoma City
Little Rock
Albuquerque
Phoenix
Tempe
(Ariz St Univ)
Athens
(Univ of Ga)
Honolulu
Fort Worth
Montgomery
Gainesville
(Univ of Fla)
Austin
New Orleans
San Juan
State Climatologist
Regional Climatologist
Regional & State Climatologist
Coordinator of Field Climatological Research

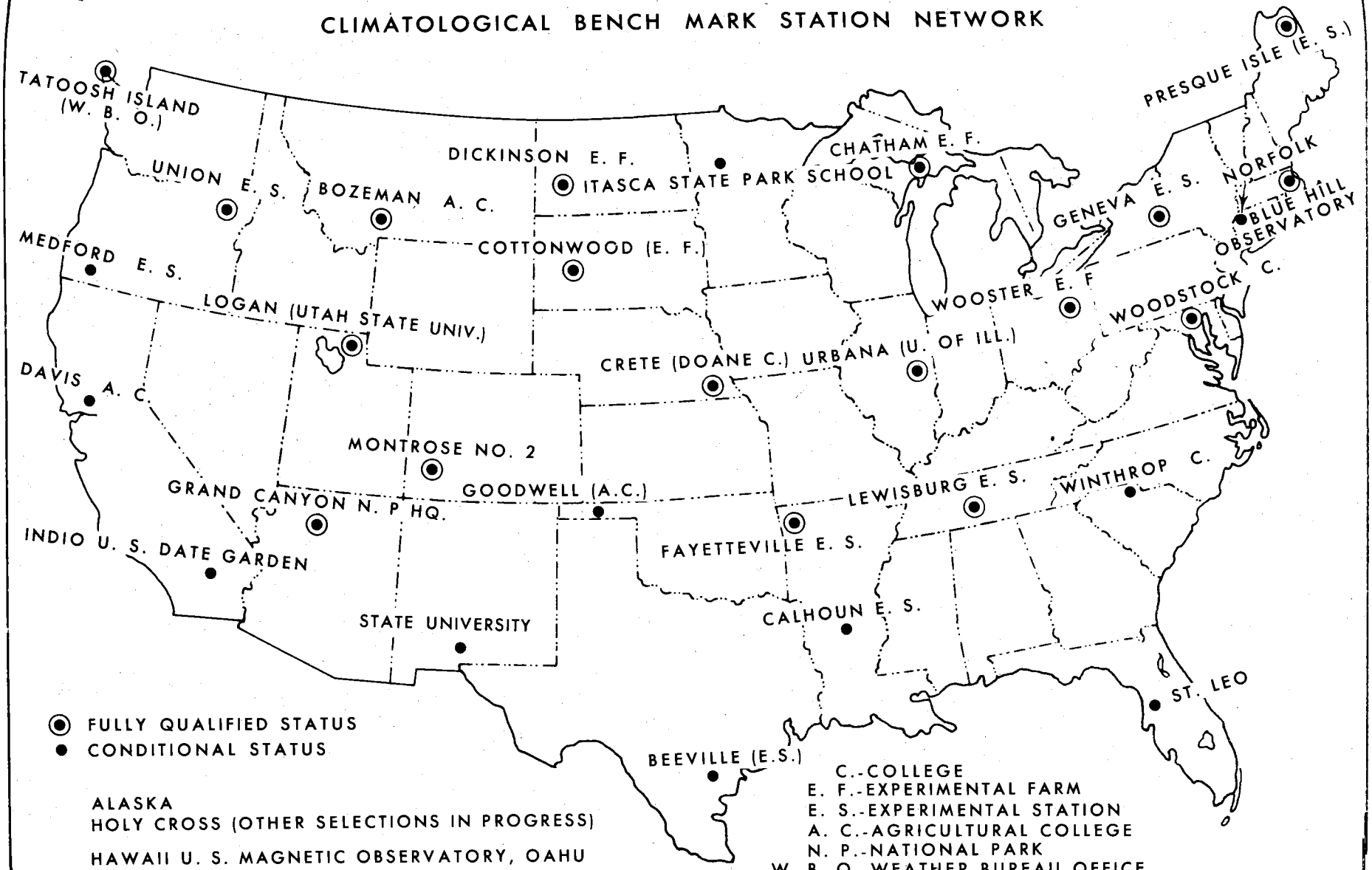
KANSAS

BASIC CLIMATOLOGICAL NETWORK(a)

AS OF JANUARY 1964



CLIMATOLOGICAL BENCH MARK STATION NETWORK



◉ FULLY QUALIFIED STATUS
● CONDITIONAL STATUS

ALASKA
HOLY CROSS (OTHER SELECTIONS IN PROGRESS)

HAWAII U. S. MAGNETIC OBSERVATORY, OAHU

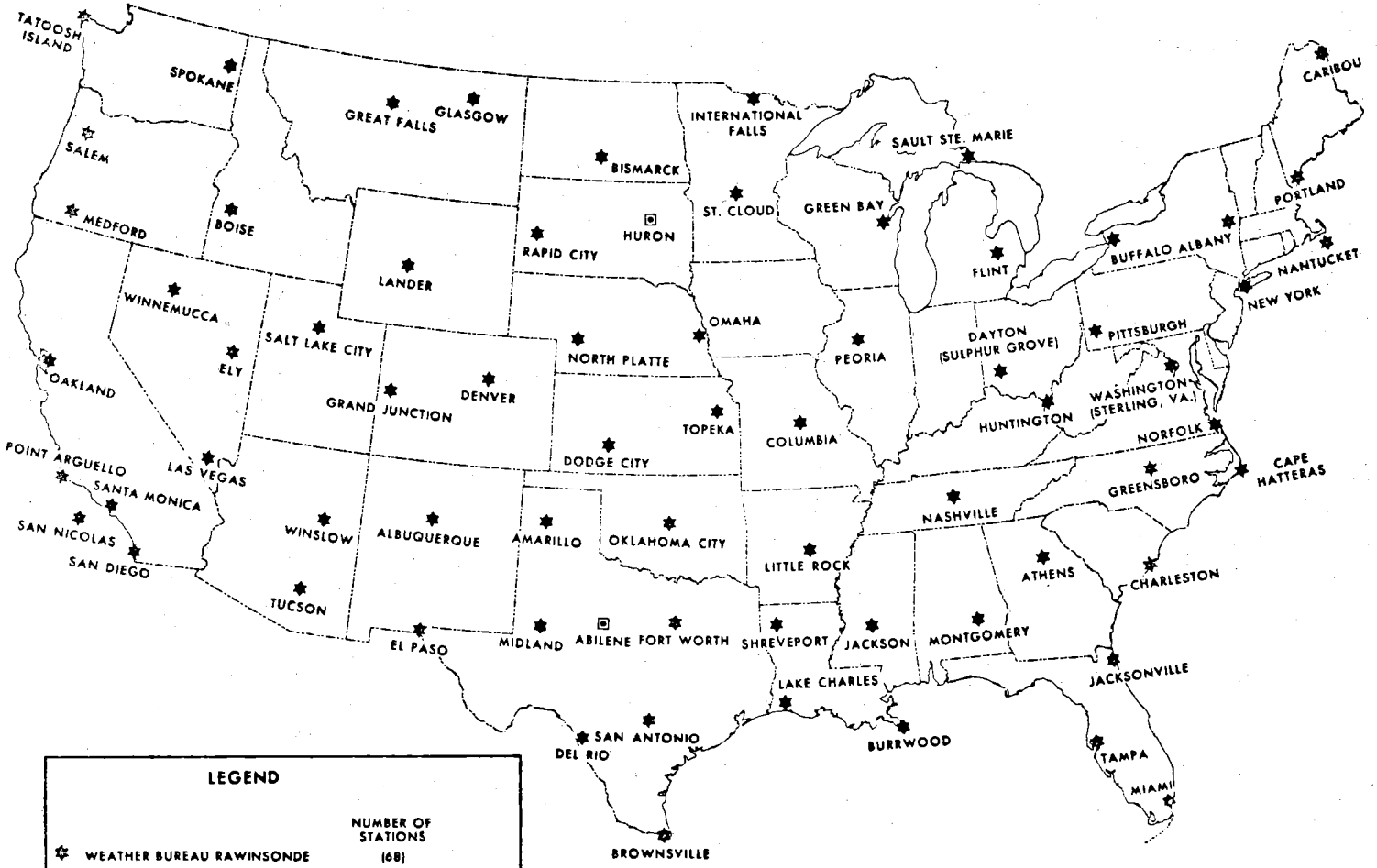
PACIFIC ISLANDS (SELECTIONS IN PROGRESS)

PUERTO RICO SAN JUAN (W. B. O.)

C.-COLLEGE
E. F.-EXPERIMENTAL FARM
E. S.-EXPERIMENTAL STATION
A. C.-AGRICULTURAL COLLEGE
N. P.-NATIONAL PARK
W. B. O.-WEATHER BUREAU OFFICE

RAWINSONDE REPORTING NETWORK

As of July 1, 1964



LEGEND

	NUMBER OF STATIONS
✡ WEATHER BUREAU RAWINSONDE	(68)
⊡ WEATHER BUREAU MOBILE STATION	(1)*

*AT ABILENE, TEX. FEB. 1-MAY 31 & HURON, S.D. JUNE 1-SEPT. 30

USCOMM-WB-DC