Barker

UNITED STATES DEPARTMENT OF COMMERCE
WEATHER BUREAU
WASHINGTON

July 30, 1958

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MEMORANDUM

TO: Area and State Climatologists, Substation Inspectors, Field Aides, WRPCs, River Forecasts Centers, River District Offices, and Area Engineers (with copies to Regional Offices and First Order Stations for information)

FROM : Office of Climatology

SUBJECT : Climatological Services Memorandum No. 66

CLIMATOLOGICAL SERVICES OF THE U. S. WEATHER BUREAU 1958

In November 1955, Climatological Services Memorandum No. 50 was issued summarizing the status of the Climatological Services Division as it existed at that time. In order to bring the valuable information contained in that issuance up to date, the attached summary has been prepared.

H. E. Landsberg
Director, Office of Climatology

U. S. DEPARTMENT OF COMMERCE
WEATHER BUREAU

CLIMATOLOGICAL SERVICES

OF THE

U. S. WEATHER BUREAU

Washington, D. C.
July 1958

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CLIMATOLOGICAL SERVICES OF THE U. S. WEATHER BUREAU, 1958

Introductory Note

The program of the Office of Climatology is under constant 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 to furnish advice on progress in climatology, and to evaluate independently the technical program of the Bureau in climatology. The present membership of the Committee is as follows:

1. J. H. Longwell, Chairman
   Director, Division of Agricultural Science
   University of Missouri
2. Phil E. Church - Executive Officer
   Department of Meteorology and Climatology
   University of Washington
3. E. Wendell Hewson
   Department of Civil Engineering
   University of Michigan
4. T. F. Malone, Director
   The Travelers Weather Research Center
5. William E. Reifsnyder
   School of Forestry
   Yale University

The Committee meets twice a year. Its most recent meeting was held in March, 1958, and a report of this meeting was included in Climatological Service Memorandum No. 65.

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 life-long 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."

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

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.

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 ..." Professor Joseph Henry's mid-century wish for "exhaustive studies of American climatology" remained a fond hope because it was the possibility of forecasting destructive storms on the sea coasts and Great Lakes that persuaded Congress 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 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 Cfficer 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 during the mid-1890's by establishment of the Climate and Crop Weather Division of the Weather Bureau. The Office of Climatology is the direct descendent of this unit.

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 risk and many other agricultural and commercial aspects.

This survey summarizes the program and facilities of the Office of Climatology as of spring 1958. It will show 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 25, D. C.). There are four operating branches in the Office each with three or four sections, (see organization chart at the end).

The Climatological Investigations Branch carries on developmental work in methodology and applications of climatic data. It is made up of 1) the Dynamic Climatology Section whose function is to study problems of aerological and synoptic climatology, microclimatology, and climatic trends; 2) the Bioclimatology Section which explores applications of climatology to plant, animal, and human life processes; 3) the Analytical Climatology Section which develops new procedures in statistical climatology and adapts machine and computer techniques to climatological problems; and 4) the Special Projects Section which handles special development programs.

The Climatic Field Service Branch handles all staff functions for the climatic field activities of the Weather Bureau through 1) its Field Programming Section which determines areal requirements for climatic observations, establishes bench-mark stations, and coordinates network operations, including staffing; 2) the Field Liaison Section which maintains operating contact with the National Weather Records Center, the three Weather Records Processing Centers, and climatic personnel at State and Territorial offices; and 3) the Climatic Documentation Section which determines methods and procedures for recording, processing, reproducing, and publishing climatic data.

The Climatic Advisory Branch handles the dissemination of climatic information to the general public and other government agencies. It consists of 1) the Domestic Area Section, which is responsible for supplying climatic information about the continental United States and territories, and which maintains service liaison with agricultural and commercial interests; 2) the Foreign Area Section which supplies United States users with climatic information about foreign land areas. It surveys foreign data and maintains liaison with foreign climatological services; and 3) the Marine Area Section which is responsible for furnishing all climatic information for ocean areas. It plans for care and use of all marine climatic data, and maintains liaison with maritime interests.

The National Weather Records Center (NWRC) is located physically at Asheville, North Carolina, but it operates as the fourth Branch of the Division. 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 NWRC as a common facility but maintain there, as necessary, units of their own. 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, mechanical 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 supervised daily 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 informatinn services and specialized analyses based on its vast collections.

Since 1947 the bulk of U. S. weather observations have been recorded on punch cards and processed by machines. The flexibility of this system has permitted many statistical summarizations and specialized studies. The still-growing demands already require 280 persons. Of these 70 percent are employed on reimbursable projects for other government agencies and private interests. The archive of weather data also provides the raw material for analyses performed by a large processing unit maintained at Asheville by the Air Weather Service for quality control of Air Force weather observations and climatological studies.

The Weather Records Processing Centers (WRPC) located at San Francisco, Kansas City, and Chattanooga serve the Western, Central and Eastern States, respectively. They receive and process the recorded surface data forms from about 12,000 weather observing stations (First order Weather Bureau, CAA, Air Force, Navy, Cooperative). They handle accuracy check and quality control programs and prepare most of the printers' copy for various climatological data publications. Contact with the many thousand voluntary weather observers is part of the function of these Centers. Each of the Centers has a staff of about 30 people. The territories they serve are shown in Fig. 1. The records of each station (about 3000-4000 in each WRPC area) are punched into cards and later shipped, with the original record forms, to the NWRC at Asheville for inclusion among the general climatological archives.

The Climatic Field Service is handled by Area and State Climatologists. Present plans call for five Area Climatologists in the continental United States, and another for the Pacific Area including Hawaii and the Trust Territory. Figure 2 shows their respective regions. As of July 1958 four positions have been filled. The Area Climatologists are members of the scientific staff of the Office of Climatology. Their primary purpose is to furnish technical guidance to the State Climatologists and to handle larger regional problems. They also maintain contacts with regional private and government organizations. In the past six years Area Climatologists have been instrumental in developing a number of special studies of climate-crop relations. These have resulted from their cooperation with the various regional groupings of Agricultural Experiment Stations. Area Climatologists have negotiated many cooperative agreements with State Universities whereby weather data taken prior to 1947 were placed on punched cards by University personnel. Various analyses of these cards are now under way.

The State Climatologists are responsible for climatological services within their respective States. This includes some routine duties (for example, cooperation in preparing a weekly weather and crop bulletin for the State, collection of reports on severe storms, 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.

III. Station Networks for Climatological Needs.

The networks of observing stations which yield weather information useful for climatological purposes comprise (in 1958) between 12,000 and 15,000 localities in the U. S. proper, Alaska, Hawaii, and the Caribbean. Since continuity in climatic records is very important, stations of three networks are maintained with a minimum of change. These three 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, and (3) the Climatological Bench-Mark network of long-record temperature - and - precipitation stations. These climatically representative stations were chosen specifically for continuity value and prospective permanence.

The 24-hour Climatic Network of 179 First order Weather Bureau and Civil Aeronautics Administration stations is shown in Fig. 5. With few exceptions, these stations 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, gustiness, atmospheric pressure and tendency, ceiling, visibility, present weather. Although 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 supply data about the diurnal variation of temperature, wind, cloudiness, and other weather characteristics.

The "a" network consists of about 5,000 stations manned chiefly by cooperative volunteer observers. They take one observation each day of precipitation and maximum and minimum temperature, and keep notes on the ocurrence of frosts, thunderstorms, and other weather events.

The Climatological Bench-Mark Network has been tentatively defined. It has as its primary purpose the collection of data in negligibly changing local environments in order to monitor climatic changes. The number of stations considered necessary for this purpose is at least 25, and preferably, about 50 in the United States. Twenty-eight continental stations have thus far met strict criteria involving stability of location, freedom from environmental influence and change, reasonably long past record, and good prospects of future continuity. These stations are shown in Fig. 6; other supplemental stations have also been named. Homogeneity analyses of the records themselves are in progress. 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. It is planned to add recording equipment for observations other than precipitation and temperature (e.g., wind, solar radiation, soil moisture, soil temperature and eventually also electric potential, atmospheric pollution and radioactivity).

The other networks of climatological stations consist of Precipitation Stations, and Stations for Specific Purposes. Precipitation Stations comprise the bulk of the "b" (hydrologic) network, used for river and flood forecast work. The network of Stations for Specific Purposes includes all other climatological stations, and is called the "c" network.

The "c" network is composed of all First order stations that are not included in the "a" network, stations that measure only soil temperature or soil moisture, and stations measuring temperature and/or precipitation which are maintained for public information and similar general purposes.

The so-called First order stations used to be called "Commissioned" stations. The First order station is the oldest kind of Weather Bureau station. It is operated by one or more professional salaried employees. It is usually located in a sizable community and maintained primarily to serve public needs for meteorological service. Among the tasks of these stations are observations (sometimes 24 a day), dissemination of forecasts and weather warnings, weather information for the press, radio, and television.

Fig. 3 shows the combined networks for one State, as an example. The "a" network, regarded as the basic climatological network, is shown in Fig. 4 for comparison.

Upper-Air Stations. The history of the observation, processing, analysis, and publication of climatic data for the upper-air closely parallels the history of developing air traffic. However, 19th century climatologists already clearly recognized the importance of this part of atmospheric climate. The lack of workable data precluded anything like the study and evaluation of the forces in the third dimension. With the development of aviation demands for information about the upper levels of the atmosphere multiplied. Instruments and methods were developed to obtain better data from the higher layers of the air. Fig. 7, Upper Air Sounding Network, illustrates the growth and changes in the Weather Bureau's technique of upper-air measurements. Kite observations preceded regular aircraft operations and continued until they were displaced by the airplane-observations (APOBS) of the 1920's. They consisted of mechanically recorded data on temperature, barometric pressure, relative humidity, and wind velocity to heights of about 3,000 meters. They were the chief data for early theoretical work on atmospheric structure. They proved the very great importance of upper-air information, at all levels, for explanation and prediction of the weather.

The expansion of aviation required regular weather information for safety and economy of operations. This led to the beginning of scheduled APOBS, in which an improved meteorograph (for automatically recording humidity, pressure, and temperature) was carried aloft in airplanes to heights of 4 to 5 kilometers. In many ways these APOBS were superior to the kite observations, but there were also bad limitations. They had to be made near localities with airport facilities. When the weather was hazardous, but most interesting to meteorologists because of high winds, icing, low clouds, the flights were often cancelled.

The number of APOB stations increased to 30 by 1937. In that year radiosondes were adopted as the upper-air recording instruments (for temperature, humidity, and pressure) and the first two radiosonde stations were established. In the next few years the APOBS were discontinued altogether. The military services established scores of radiosonde stations as aids in wartime aviation activities in the United States and abroad. At the same time the number of such stations operated by the Weather Bureau for civilian aviation, weather forecasting, and research needs steadily increased. By 1958 the number of radiosonde stations operated by the Weather Bureau and military services exceeded 160. Wartime needs and restrictions began to relax and basic facilities of the National Weather Service were consolidated in the Weather Bureau for the U. S. and its territories. Fig. 8 shows the complete radiosonde-rawinsonde network. The rawinsonde includes wind direction and speed as well as temperature, pressure, and humidity.

In addition to the elements of air-pressure, humidity, and temperature discussed above, observations of cloud base and upper level winds have also improved greatly with the progress of aviation. The heights of cloud bases were measured by ceiling balloons in earlier years. Now this is done with greater accuracy by the ceilometer, an instrument that measures electronically the angle between the horizon and a spot of light projected to the cloud base. Mathematical relations are then worked out mechanically by the instrument to give a value of cloud height. The cost of ceilometers has so far prevented their placement at all stations, so that ceiling balloons are still widely used.

For upper-level wind observations of speed and direction, pilot balloons (pibals), followed by theodolite and plotted (azimuth and elevation angles at 1-minute intervals) progressively throughout the observation, have been used since the beginning of the Weather Bureau winds-aloft program in 1917. Since 1917 wind observations have increased from 5 to 290 observing points, including a large network of stations taking rawin (winds aloft observation made by balloon and radio methods, without optical aid) in addition to pibal observations. The value of these data, both in furthering knowledge of the atmosphere's behavior and in guiding the establishment of lines and levels for air commerce, is incalculable. Similar information is of vital concern in planning for Civil Defense against the dangers of fall-out from nuclear blasts. The structural design of rockets, and the programming of the portion of their flights within the earth's atmosphere also employ these climatological analyses of upper-level winds.

Plans for Specialized Observations. It is evident from some of the foregoing that the basic daily temperature and precipitation readings taken at the unpaid climatological substations were practically the only observations made to serve primarily climatological needs. The observations of other elements - e. g. surface wind, sunshine, clouds, humidity, etc. - were 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,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. Specific items, at present very much alive in this question, are a dial-type maximum-minimum thermometer employing a mercury-in-steel sensing element, a recording precipitation gage, a sub-station wind recorder, a recording hygrothermograph. 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 are under consideration. 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.

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

Prior to 1948, these three actions were conducted in a loosely organized fashion at several hundred stations, and all too often lack of funds, indifference, or pressures of other work led to neglect of the program.

In 1948, however, with the establishment of the Weather Records Processing Centers (WRPC), the previously diffuse processing of climatological data was drawn together, standardized, and streamlined into an integrated procedure which operates on a current basis and uses modern punched card processing techniques.

In this program the observational records from more than 10,000 observing points now flow directly into the WRPC's. There the data for all cooperative stations are transcribed currently to punched cards. At the several hundred First order stations observers punch their own cards and mail them weekly to the WRPC. 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 then edit the flagged entries in detail, and correct the errors disclosed by this editing. It is thus possible, within a time lag of a few weeks at most, to keep observing stations fully informed about the quality of their observing programs and records.

After editing the punched card record, the WRPC's prepare the data for current publication in monthly and annual state and local Climatological Data bulletins. Punched-card machine methods are used throughout this process, even to the preparation of final printer's copy on punched card tabulators. This machine-prepared copy is then assembled, photographically reduced, and printed on high-speed offset presses at the National Weather Records Center (NWRC) in Asheville, N. C.

When the routine is completed at the WRPC, the data and punched cards are shipped to the National Weather Records Center where they become part of the centralized weather records library. Long-term climatological summaries and analyses of the data for research programs are carried on at the NWRC. A wide array of punched card data processing and computing machines is used there, including a variety of electronic digital computers which are capable of performing the most sophisticated statistical and mathematical operations on the data.

The unexploited potential of the climatic archives is immeasureable. Production of long-term data tabulations is presently restricted by financial limitations, but plans for greater use are in the making.

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, and co-sponsored by Air Force and Navy weather agencies, 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 420 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!)

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 employes 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. Subsequent models will serve as direct input to high-speed electronic computers, or as input to conversion of the data to other high-speed media, such as magnetic tape.

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 could be used in the preparation of inexpensive positive (paper) copy which could be used with standard micro-card viewers. An automatic document-feeding 70 mm microfilm camera has been built which places several small images across the 70 mm film, resulting in a film negative similar to a micro-card. This camera has been named MIMiC (multiple image microcopy camera).

In accordance with the Federal Records Act of 1950 the Weather Bureau has established a disposal program which, in general, provides for destruction of original recorder charts after 5 years, if microphotographic copy has been prepared. Similarly it provides for destruction of manuscript observational records after 30 years if microphotographic copy has been prepared.

V. Routine Publications.

The processing and storing of weather data for future reference represent the conservation part of our job. In addition we have a responsibility to disseminate the information. 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 protests combined with Weather Bureau capacities and limitations. It can only serve to make the basic data available on a broad scale, rather than 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 please large cities, and that its Supplement favors aviation; but a closer look at these publications will show that each actually reflects the motive to serve as many users as well as possible.

The Weekly Weather and Crop Bulletin is usually published each Tuesday at noon. It carries information of particular interest to agriculture. Crop data are collected in cooperation with the Agricultural Marketing Service of the Department of Agriculture and 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 (Fig. 9) publication is prepared monthly for about 300 cities in the United States and for representative territorial stations. This publication includes daily climatological information and summaries for the month. Also included, where available, are hourly precipitation data. Brief summary tables of averages, departures, and extremes of temperature, precipitation barometric pressure and heating degree-days are also included.

A monthly Supplement to the Local Climatological Data (Fig. 10) is published for stations where 24-hourly observations are taken each day. The supplement contains seven basic tables as follows:

a. Temperature and Wind Speed-Relative Humidity Occurrences (hourly observations).
b. Wind Direction and Speed Occurrences.
c. Hourly and Daily Occurrences of Precipitation Amounts.
d. Ceiling-Visibility Occurrences (hourly observations).
e. Occurrences of Weather by Hour of Day.
f. Occurrences of Weather by Wind Direction.
g. Means for Synoptic Hours.
h. Hourly Observations.

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.

For each State a periodical Climatological Data is issued. It covers observations from all regular networks. The monthly issue contains daily maximum and minimum temperatures, daily precipitation, snowfall and snow on the ground, evaporation and wind, and soil temperature in addition to monthly summaries and analyzed maps of monthly average temperature and total precipitation. The annual issue contains monthly and annual averages and departures from long-term means of temperature, precipitation, evaporation and total wind movement, and soil temperature, as well as a table of temperature extremes and freeze data.

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. Also included is a table showing the place, time, character and estimated damage of all reported severe storms. Average monthly radiosonde and pilot-balloon data are presented in tabular form; so are solar radiation data. Fifteen charts of the United States graphically portray temperatures, precipitation, snowfall, sky cover, 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.

Climatic Data for Northern Hemisphere and World. For research and as an historical record, the value of a series of maps which show the continuity and the developments and actions of weather over the largest possible area has been obvious for a long time to everybody concerned with the study of meteorology and the history of weather. The first successful attempt to do something about it was launched in 1873 by the Chief Signal Officer of the Army, before the Weather Bureau was established, and on July 1, 1875, with the United States defraying all expenses, the daily issue of the "International Bulletin of Simultaneous Reports" began in Washington. By 1878, with the cooperation of other countries, it became possible to start a series of daily international weather charts covering the Northern Hemishpere principally. This series continued through 1887.

By 1891, when the Weather Bureau was established, this series had stopped, and thereafter was not resumed for half a century. There were probably several reasons for this, including two wars and the beginning of another, but the most compelling reason was the lack of sufficient money to gather and publish the material. In 1941, however, with aviation established as a major war weapon, and with demands for world-weather knowledge critically increased, the Army, Navy, and Weather Bureau joined forces to produce the first ten years of a series of analyzed Historical Northern Hemisphere maps. Thanks to the help of the Air Force this historical series was extended back to 1899, and carried forward. It is now a series of synoptic surface and 500-mb charts and listings of data for the entire Northern Hemisphere for 1200 Greenwich Mean Time. It is prepared by a special section at the National Weather Records Center in Asheville. In the post-war period it was jointly supported by the Weather Bureau, Navy, and Air Force, but the Weather Bureau assumed complete responsibility for this publication in 1955. Because of their proved value in many fields, the "Data Listings" are now published as a daily bulletin containing all available upper air observations over North America. In order to cover more fully the meteorology of extreme weather conditions (hurricanes, for example) it is planned to publish many more surface and special data associated with critical weather periods and events.

The Mariners Weather Log is a bi-monthly publication containing meteorological information for the maritime industry, including weather and shipping on the Great Lakes as well as oceanic areas. 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, normal charts on pressure, storm tracks, gales and fog, 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 appeared 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 these 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 became very selective in 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 increasingly acute. The advent of jet aircraft, with requirements for flight at higher elevations, made new data imperative. This is how the needs were met:

The Weather Bureau, under Navy sponsorship, produced 3 volumes of wind data from 111 stations ranging from Korea across the Pacific, the United States and the Atlantic to the coast of Europe, including data to heights of 40,000 feet based primarily on rawin observations. Bias at higher elevations was eliminated by geostrophically scaling winds for missing observations, with the effect of including as many values at 40,000 feet as at lower elevations. These are presented in the form of wind rose tabulations, by direction and speed groups. Also, wind aid values for aircraft flying in any of the 16 cardinal directions were computed for each observation by a new method and presented in frequency distributions. Summaries showing the percentage probability of any given amount of wind aid or retardation were shown by seasons for various routes.

The Weather Bureau, in cooperation with the Sandia Corporation, computed wind vector and vector deviation values for 13 surfaces ranging from 950 to 30 mb., for a large network of stations. All missing values at each level were filled in, so that this five year summarization is based on as many observations at 30 mb as were available at 950 mb. These data will be presented in Part III of Upper Air Climatology of the United States, which is expected to go to press soon. This publication will also contain statistics on wind shear between each of the surfaces for which data are available.

In 1957, the Weather Bureau published Part I of Upper Air Climatology of the United States (issued as Technical Paper No. 32). This 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 of the same publication will contain extremes and standard deviations of height and temperature. This has already gone to press.

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 will henceforth formally sponsor this publication, which will continue to be issued by the Weather Bureau. These arrangements are expected to pave the way for collection of basic data for such world-wide summaries as appeared earlier in Clayton's "World Weather Records".

Climatological Atlas. For a long time there has been a need for a modern presentation of U. S. climate. Kincer's contribution to the "Atlas of American Agriculture: in the 1920's was splendid for agricultural purposes. Considering the geography that makes this country extremly rich in climatic diversity - three sea coasts, mountain ranges, plains, inland lakes, deserts, forested lands - and considering also the almost limitless uses the people have for climatic information, the need for up-to-date climatic charts becomes obvious.

This is a large undertaking. It requires climatologists, statisticians, business-machine operators, and draftsmen to do the work, which takes a great deal of money. Also, anything less than half a century of reliable records would be insufficient for dependable conclusions about trends, normals, and some other details of climatic dynamics. Only in the last decade or so, enough of the right kind of data have become available for a modern Climatic Atlas of the U. S.

Considerable progress has been made on production of a great National Atlas of the U. S. Basic plans have been prepared by the Earth Sciences Division of the National Research Council - National Academy of Sciences. This Atlas, designed to present all significant material on geography and resources of the country, is to be in loose-leaf form with a standardized format. The Weather Bureau will cooperate by issuing, from time to time, new climatological charts to become part of this Atlas. A copy of the first chart in the series is shown in Figure 11.

Data Surveys of Foreign Stations and regions are accomplished by the Foreign Areas Section. This Section in addition to other duties, surveys and annotates weather data for foreign areas for use by civilian and military agencies and has the support of the Air Weather Service, the Navy, and Army. Basic surveys for particular areas of the world, compilations on particular weather elements, basic data in the available literature or climatic summaries applicable to specified problems are prepared. A continuing annotation of periodicals for information on foreign climates is maintained. Finally, special projects, based on collections of world-wide data resulting from these surveys, are undertaken. An example of this type of work is the World Sunshine Map, Fig. 13. The various foreign aid programs of the government often require climatological information, which is being provided as far as possible. Increased travel, international air traffic, marketing of U. S. products abroad have increased demands for foreign climatic data. There is urgent need to expand this service for the benefit of U. S. industry and commerce.

Marine and Ocean Projects. 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 Hydrographic 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 Hydrographic Office Pilot Chart map backs, the "Hydrographic Bulletin" 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. The outstanding work now in preparation is a six volume Marine Atlas sponsored by the U. S. Navy, three of which have been completed. Most of the work on this is done at the National Weather Records Center, Asheville, North Carolina. Fig. 12 illustrates the handling of marine climatological data.

Special Funding Arrangements. The unique data collection in possession of the Weather Bureau gives a peculiar responsibility. This is a monopoly, equally valuable to scholars and operators in the meteorological field, which calls for considerable administrative wisdom. We have to steer a course between avaricious concealment of the treasure and careless dispersal. It seems best to perform centrally as many services as possible at NWRC on a strict, business-like cost-reimbursement basis. In this way data, tabualtions, and analyses can be made available at extremely low cost to other agencies, industrial consumers, private meteorological consultants, and research workers. Our motto is prompt and efficient service. Nearly half of our overall effort in climatology is carried on under special funding arrangements. Among our primary customers are the U. S. Navy (Aerology and Hydrographic Office), U. S. Army (Corps of Engineers, Signal Corps), TVA, Forest Service and many other government agencies. A legion of private firms have larger or smaller work agreements with us. It is natural that we would like to serve climatological and meteorological research more and better than we were able to in the past. Wherever possible, research data are given priority treatment.

Investigations. An operating service is prone to be satisfied with furnishing answers to questions placed before it and to discharge its routine duties competently. There is always the danger that its work may become stereotyped. The best guard against this occupational hazard of bureaucracy is a forward look toward the frontiers of knowledge. In applied climatology a great deal remains to be done, and hence, efforts by all our professional personnel toward improvements of theory, practice, and techniques of climatology are encouraged. Examples of projects under way are: homogeneity testing and power-spectrum analysis of long-period records; development of human comfort indices; study of climatological factors in plant growth and water consumption; and production of new means for presenting high level wind, temperature, and density data. This is not an exhaustive list but an indication of our interest in contributing to the development of the science of climatology.

VII. Outlook.

The preceding presentation should leave no impression of smug satisfaction with our program. Rather it is an account of where the climatological work in the Weather Bureau now stands. We have plans for the future. Some are mere hopes, others are well along toward fulfillment.

Most important in our plans is the establishment of full-time positions of State climatologists where these are not now in existence. These jobs are intended to furnish better climatological service in all parts of the country. Close cooperation with State agencies, land-grant colleges, agricultural experiment stations is envisaged. 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.

In fulfillment of the legal responsibility of the Weather Bureau adequately to describe the Climate of the United States, its territories and possessions, a series of climatological summaries is planned. These will comprise the climatography of the U. S. Multi-year compilations of tables of climatic data for first-order and substations are the first step. A comprehensive revision and publication of long-term records (as a sequel to the old Bulletin W) is planned for the next decade. The same basic data are to serve for new climatological maps of the country. These, as mentioned above, will become part of the National Atlas.

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 development work directed toward new approaches to climatological problems by use of specially adapted machines, computers, 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.

KEY PERSONNEL IN CLIMATOLOGY

Office of Climatology - Washington, D. C.

Director - Helmut E. Landsberg
Assistant to Director - Robert W. Schloemer
Consulting Services - Herbert C. S. Thom
Climatic Advisory Service Branch - William H. Haggard
    Domestic Area Section - John L. Baldwin
    Foreign Area Section - Pauls H. Putnins
    Marine Area Section - Arthur I. Cooperman
Climatic Field Services Branch - Harold B. Harshbarger
    Field Programming Section - Joseph H. Hagarty
    Field Liaison Section - Vacant
    Climatic Documentation Section - Harold S. Lippmann
Climatological Investigations Branch - Milton L. Blanc
    Dynamic Climatology Section - Benjamin Ratner
    Bioclimatology Section - Wayne F. Palmer
    Analytical Climatology Section - Julius F. Bosen
    Special Projects Section - Earl C. Thom

Weather Records Processing Centers

Chattanooga, Tennessee
    Supervising Climatologist - V. D. Steves
    1st Assistant - Jacob T. B. Beard
Kansas City, Missouri
    Supervising Climatologist - G. E. Stegall
    1st Assistant - M. Oliver Asp
San Francisco, California
    Supervising Climatologist - H. C. Steffan
    1st Assistant - H. E. Torbitt

National Weather Records Center - Asheville, North Carolina

Director - Roy L. Fox
Assistant Director - Gerald L. Barger
Technical Advisory Staff - Harold L. Crutcher
                                          Raymond L. Joiner
Administrative Services Section - Milton G. Johnson
Synoptic Climatology Section - William M. McMurray
Climatography Section - Allen B. Elam, Jr.
Climatic Analysis Section - Norman L. Canfield
Data Reduction Section - Henry L. Bent
Climatic Information and Reference Section - Sherman M. Brewster

AREA CLIMATOLOGISTS

Northeastern Area Climatologist - WBO, New York City - James K. McGuire
Southeastern Area Climatologist - WB Regional Administrative Office, Fort Worth, Texas - Claude K. Vestal
Central Area Climatologist - Vacant
Northwestern Area Climatologist - WBO, Seattle, Washington - Marvin D. Magnuson
Southwestern Area Climatologist - Vacant
Pacific Area Climatologist - WBO, Honolulu, T. H. - David I. Blumenstock

LOCATIONS OF STATE AND TERRITORIAL CLIMATOLOGISTS

Alabama - Weather Bureau Airport Station, Montgomery *
Alaska - Weather Bureau Regional Administrative Office, Anchorage - C. E. Watson
Arizona - Weather Bureau Airport Station, Phoenix - Paul Kangieser
Arkansas - Weather Bureau Airport Station, Little Rock *
California - Weather Bureau Office, San Francisco - Robert F. Dale
Colorado - Weather Bureau Office, Denver - Joseph W. Berry
Connecticut and Rhode Island - Weather Bureau Airport Station, Hartford, Conn. - A. Boyd Pack
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 - L. A. Joos
Indiana - Purdue University, Lafayette - Lawrence A. Schaal
Iowa - Weather Bureau Office, Des Moines - C. Robert Elford
Kansas - Weather Bureau Office, Topeka - A. D. Robb
Kentucky - Weather Bureau Airport Station, Louisville *
Louisiana and Mississippi - Weather Bureau Office, New Orleans *
Maine, Massachusetts, New Hampshire, and Vermont - Weather Bureau Office, Boston, Mass. - Robert E. Lautzenheiser
Maryland and Delaware - Weather Bureau Airport Station, Baltimore, Md. - Howard H. Engelbrecht
Michigan - Weather Bureau Office, East Lansing - A. H. Eichmeier
Minnesota - Weather Bureau Office, Minneapolis *
Missouri - Weather Bureau Office, Columbia - James D. McQuigg
Montana - Weather Bureau Airport Station, Helena - R. A. Dightman
Nebraska - Weather Bureau Office, Lincoln *
Nevada and Utah - Weather Bureau Airport Station, Salt Lake City, Utah - Merle J. Brown
New Jersey - Weather Bureau Office, Trenton - Donald V. Dunlap
New Mexico - Weather Bureau Airport Station, Albuquerque - George F. Von Eschen
New York - Weather Bureau Office, Albany *
North Carolina - Weather Bureau Airport Station, Raleigh - Charles F. Carney

North Dakota - Weather Bureau Airport Station, Bismarck *
Ohio - Weather Bureau Office, Columbus - L. T. Pierce
Oklahoma - Weather Bureau Airport Station, Oklahoma City - Hugo V. Lehrer
Oregon - Weather Bureau Office, Portland - Gilbert L. Sternes
Pennsylvania - Weather Bureau Airport Station, Harrisburg - Nelson M. Kauffman
Puerto Rico and Virgin Islands - Weather Bureau Office, San Juan - David Smedley
South Carolina - Weather Bureau Airport Station, Columbia - Nathan Kronberg
South Dakota - Weather Bureau Office, Huron - William T. Hodge
Tennessee - Weather Bureau Airport Station, Nashville - Robert R. Dickson
Texas - Weather Bureau Airport Station, Austin - Richard D. W. Blood
Virginia - Weather Bureau Airport Station, Richmond *
Washington - Weather Bureau Office, Seattle - Earl L. Phillips
West Virginia - Weather Bureau Office, Parkersburg *
Wisconsin - University of Wisconsin, Madison - Paul J. Waite
Wyoming - Weather Bureau Airport Station, Cheyenne *

* State Climatological duties performed by Meteorologists in Charge or designated assistants.

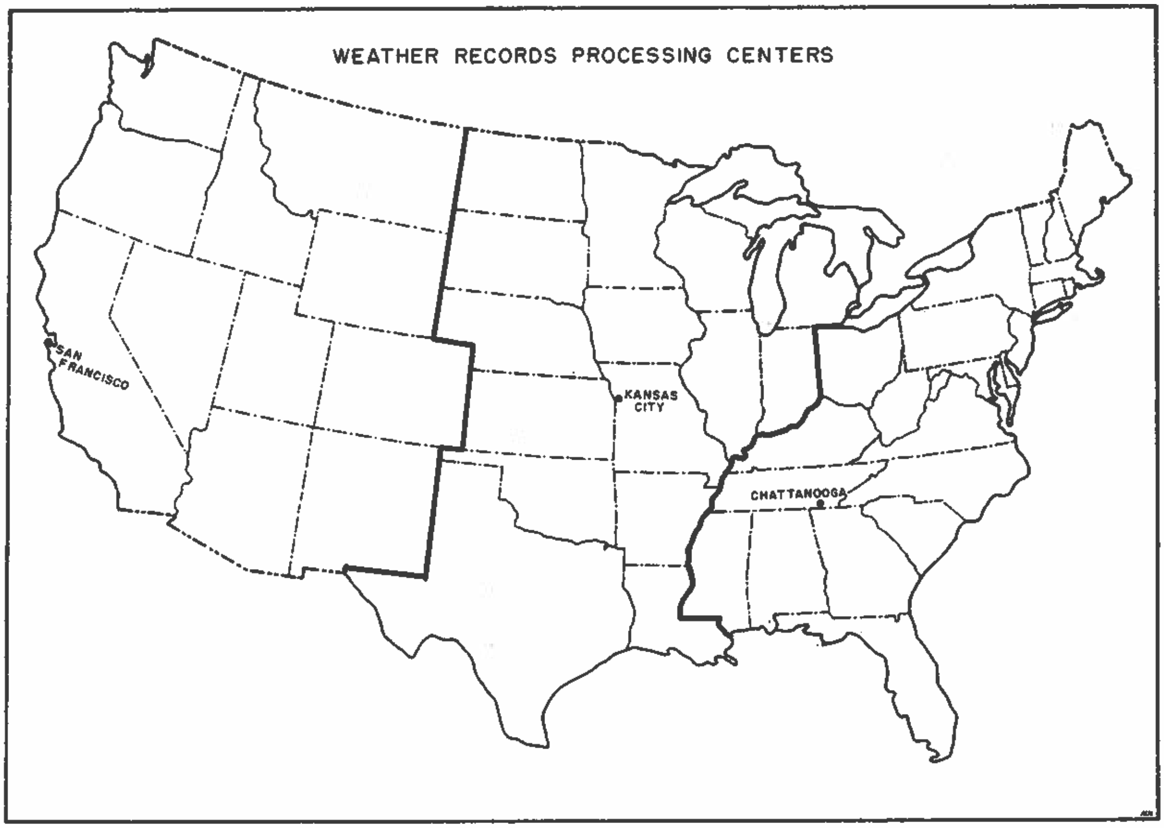

WEATHER RECORDS PROCESSING CENTERS
SAN FRANCISCO
KANSAS CITY
CHATTANOOGA

Fig. 1

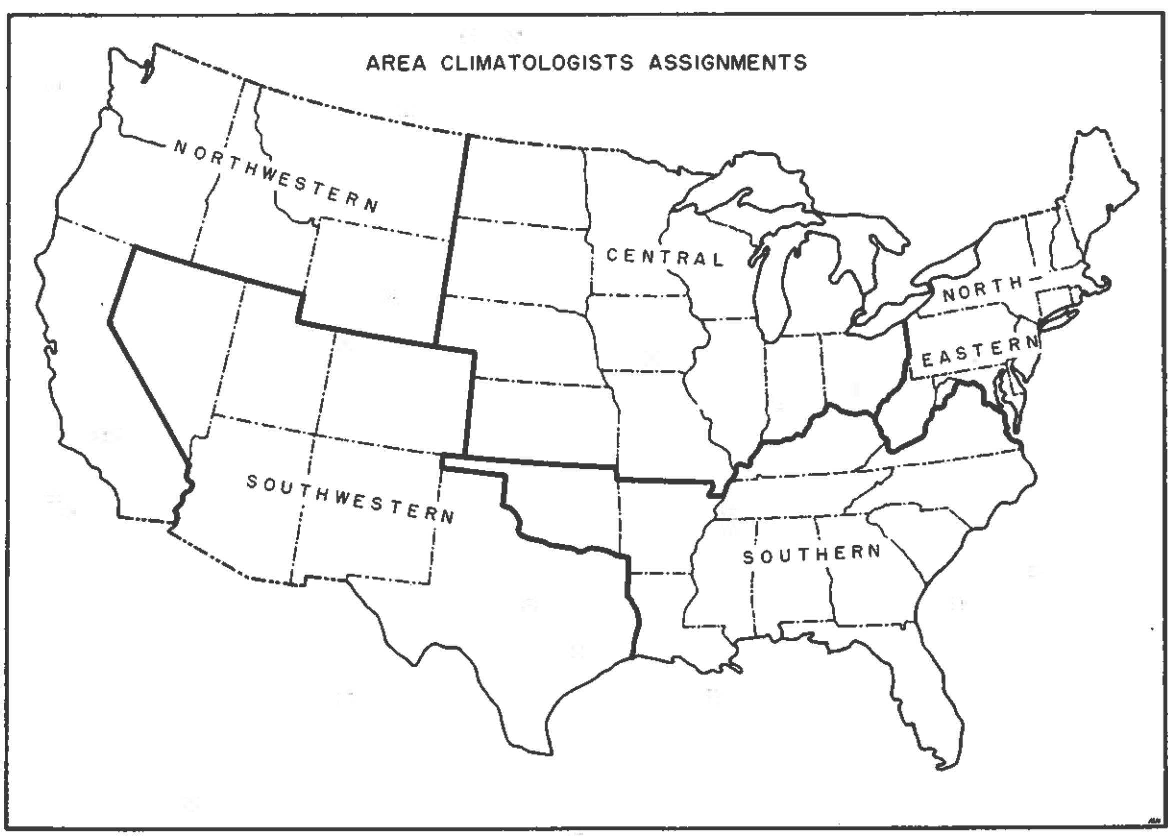

AREA CLIMATOLOGISTS ASSIGNMENTS
NORTHWESTERN
CENTRAL
NORTH EASTERN
SOUTHWESTERN
SOUTHERN

Fig. 2

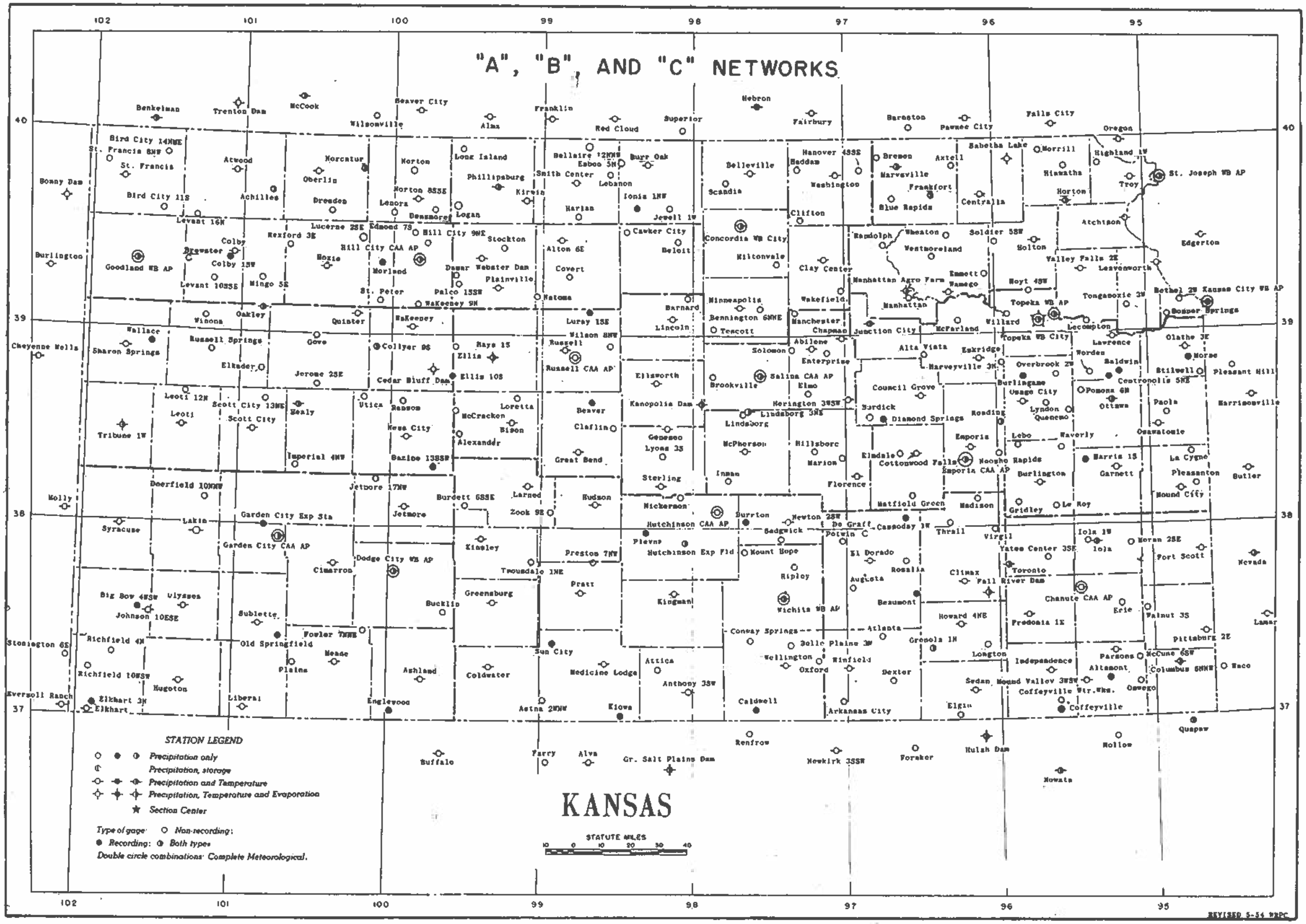

"A", "B", AND "C" NETWORKS
KANSAS
STATION LEGEND
Precipitation only
Precipitation, storage
Precipitation and Temperature
Precipitation, Temperature and Evaporation
Section Center
Type of gage: Non-recording; Recording; Both types
Double circle combinations: Complete Meteorological.
STATUTE MILES
REVISED 5-54 WRPC

Fig. 3

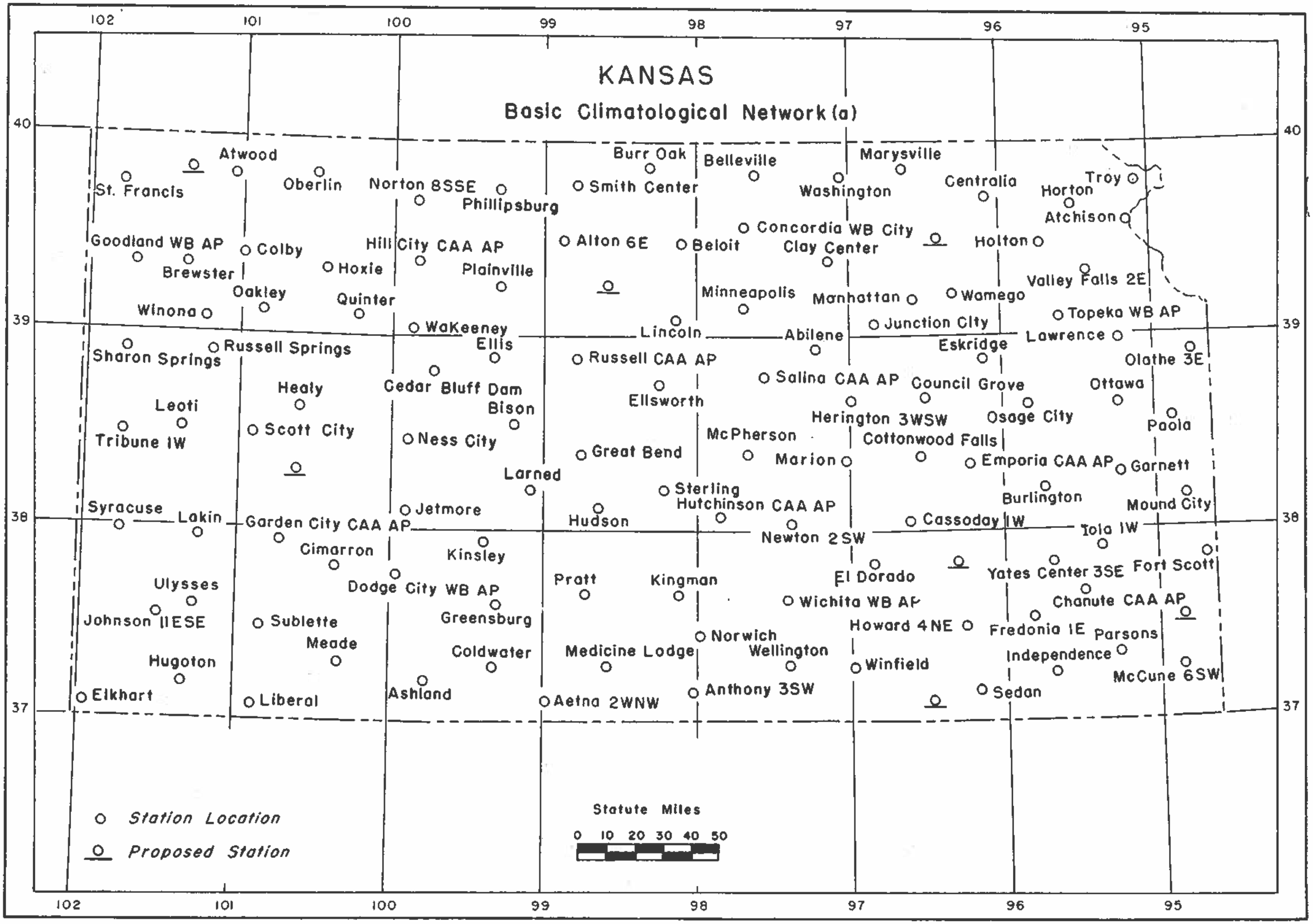

KANSAS
Basic Climatological Network (a)
102
101
100
99
98
97
96
95
40
39
38
37
St. Francis
Atwood
Oberlin
Norton 8SSE
Phillipsburg
Smith Center
Burr Oak
Belleville
Washington
Marysville
Centralia
Horton
Troy
Atchison
Goodland WB AP
Brewster
Colby
Oakley
Hoxie
Hill City CAA AP
Plainville
Quinter
Alton 6E
Beloit
Concordia WB City
Clay Center
Holton
Minneapolis
Manhattan
Wamego
Valley Falls 2E
Topeka WB AP
Winona
Junction City
Lawrence
Lincoln
Abilene
Eskridge
Olathe 3E
Sharon Springs
Russell Springs
WaKeeney
Ellis
Russell CAA AP
Salina CAA AP
Council Grove
Ottawa
Healy
Cedar Bluff Dam
Ellsworth
Herington 3WSW
Osage City
Paola
Leoti
Bison
McPherson
Cottonwood Falls
Tribune 1W
Scott City
Ness City
Great Bend
Marion
Emporia CAA AP
Garnett
Larned
Sterling
Hutchinson CAA AP
Burlington
Mound City
Syracuse
Lakin
Garden City CAA AP
Jetmore
Hudson
Cassoday 1W
Iola 1W
Newton 2SW
Cimarron
Kinsley
El Dorado
Yates Center 3SE
Fort Scott
Ulysses
Dodge City WB AP
Pratt
Kingman
Wichita WB AP
Chanute CAA AP
Johnson 11ESE
Sublette
Greensburg
Howard 4NE
Fredonia 1E
Parsons
Meade
Norwich
Coldwater
Medicine Lodge
Wellington
Winfield
Independence
Hugoton
McCune 6SW
Anthony 3SW
Sedan
Elkhart
Liberal
Ashland
Aetna 2WNW
Station Location
Proposed Station
Statute Miles
0 10 20 30 40 50

Fig. 4

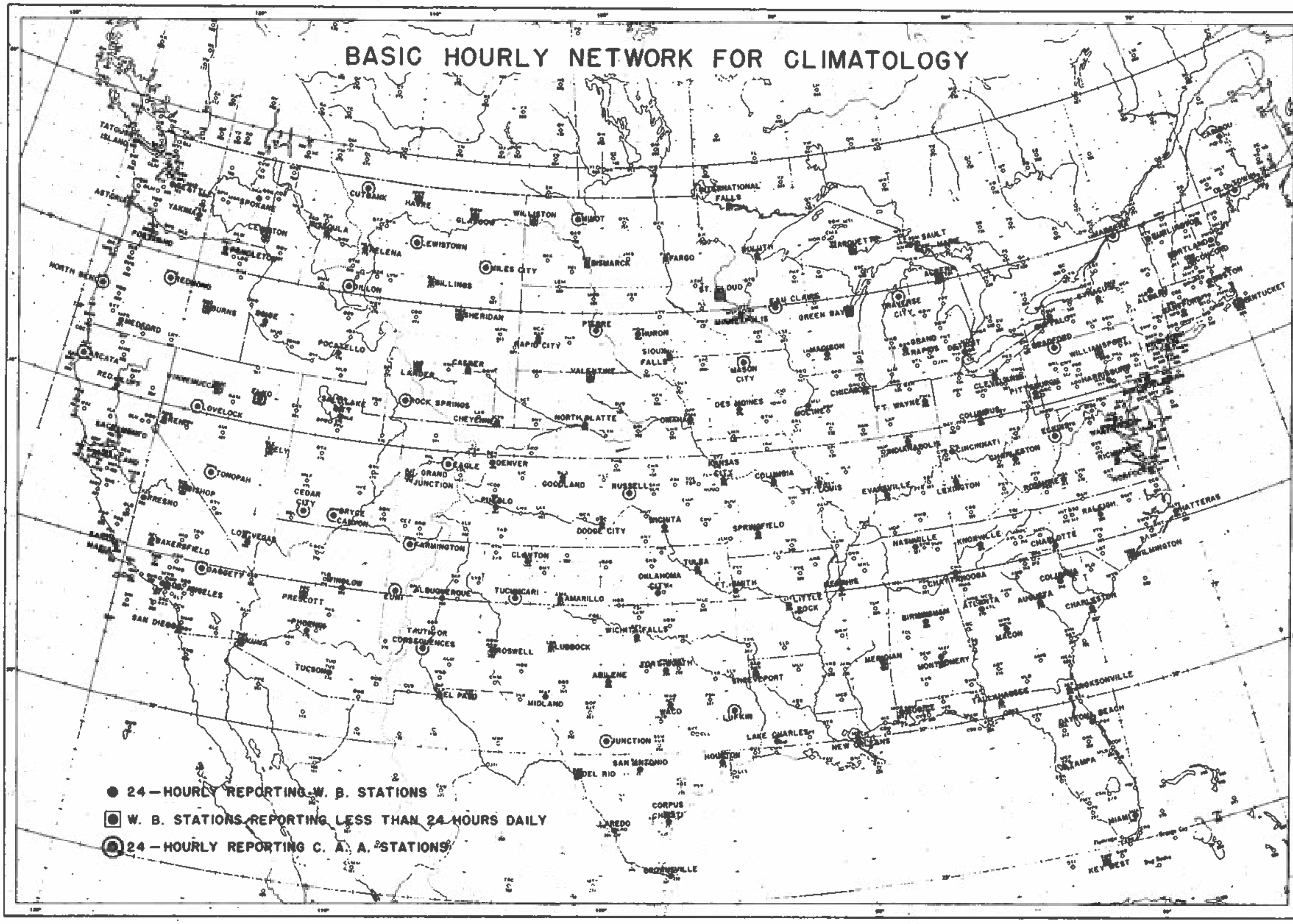
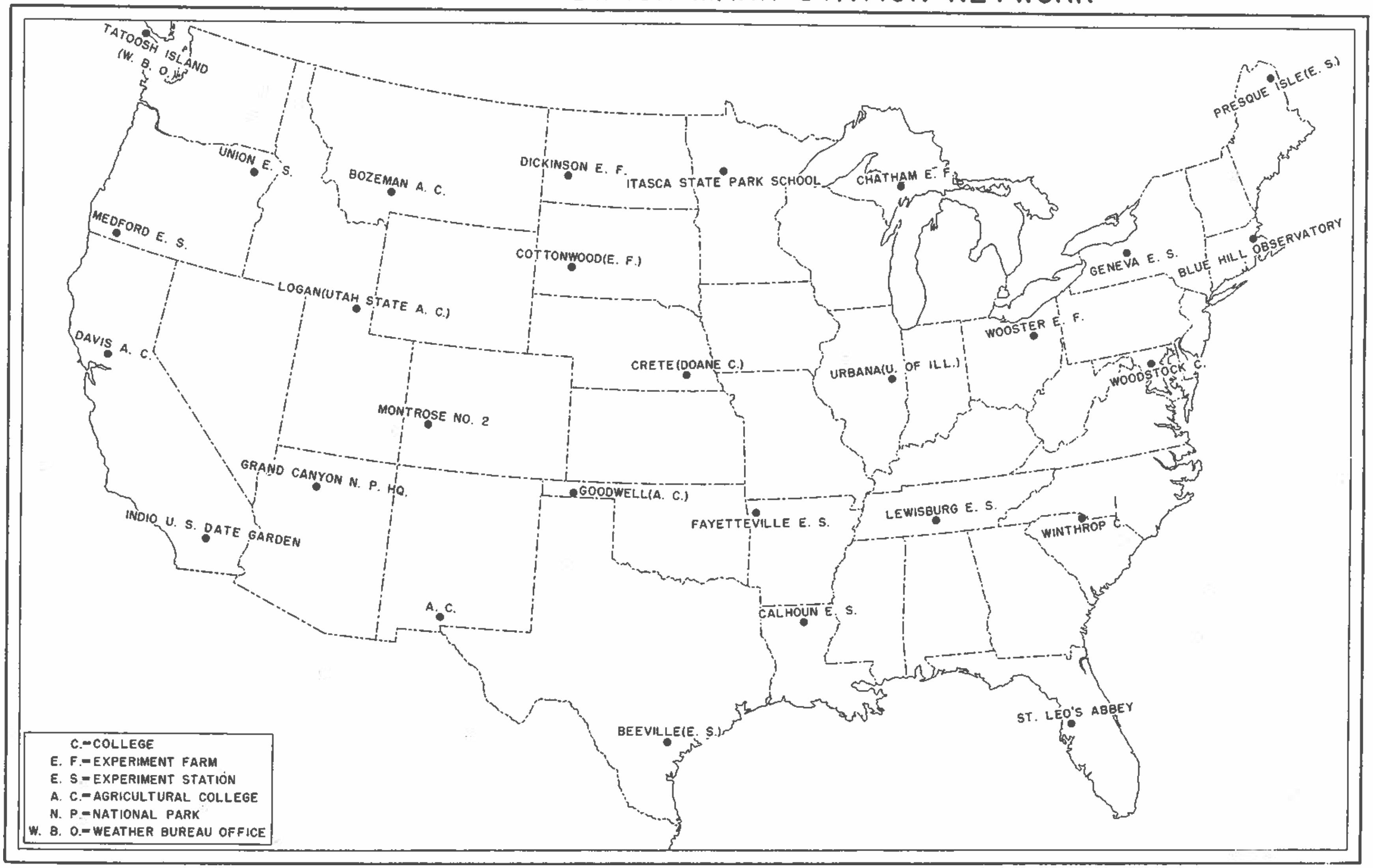
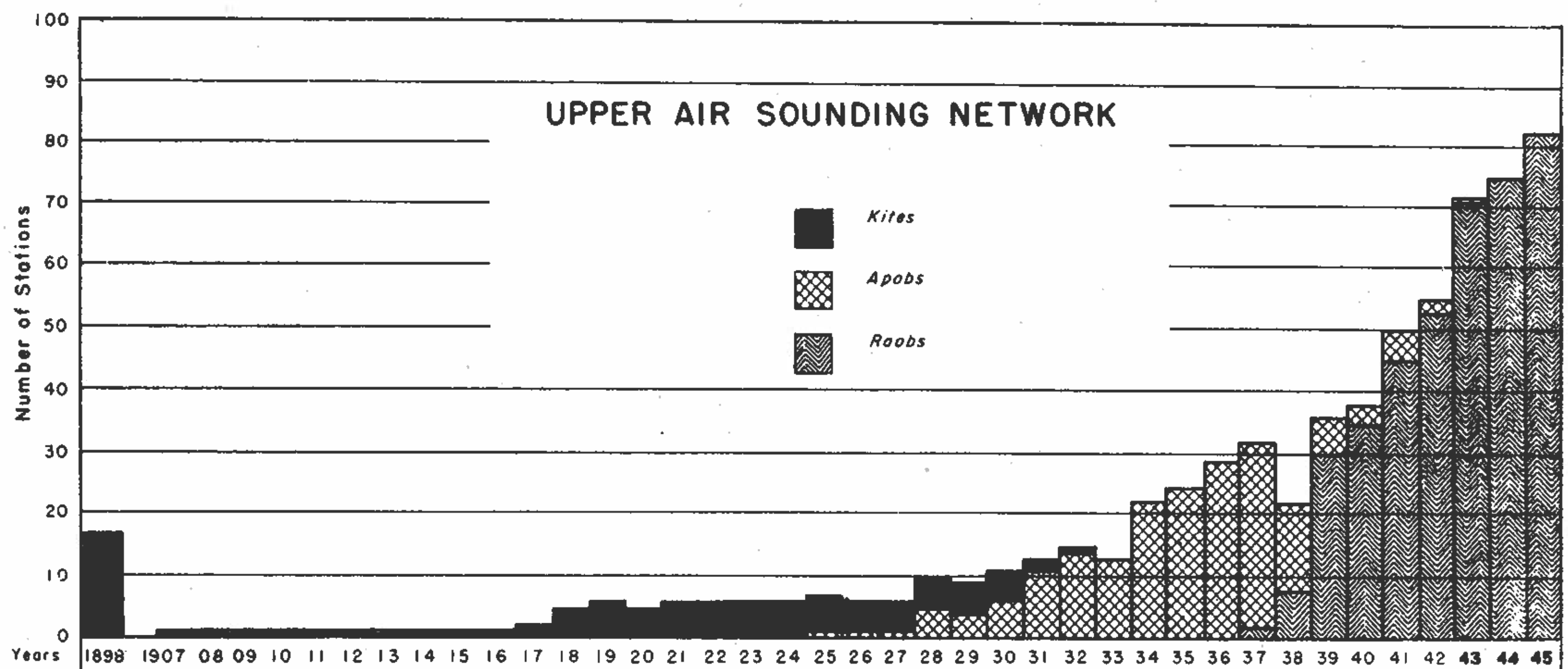

BASIC HOURLY NETWORK FOR CLIMATOLOGY
24—HOURLY REPORTING W. B. STATIONS
W. B. STATIONS REPORTING LESS THAN 24 HOURS DAILY
24—HOURLY REPORTING C. A. A. STATIONS

FIG. 5

CLIMATOLOGICAL BENCH MARK STATION NETWORK





Number of Stations

Years	1898	1907	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Raobs																			
Apobs																			
Kites	17	1	1	1	1	1	1	1	1	1	1	2	5	6	5	6	6	6	6

Years	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Raobs													2	8	30	35	45	53	71	75	82
Apobs	1	1	1	5	4	6	11	14	13	22	24	29	30	14	6	3	5	2	1		
Kites	6	5	5	5	5	5	2	1													

Fig. 7

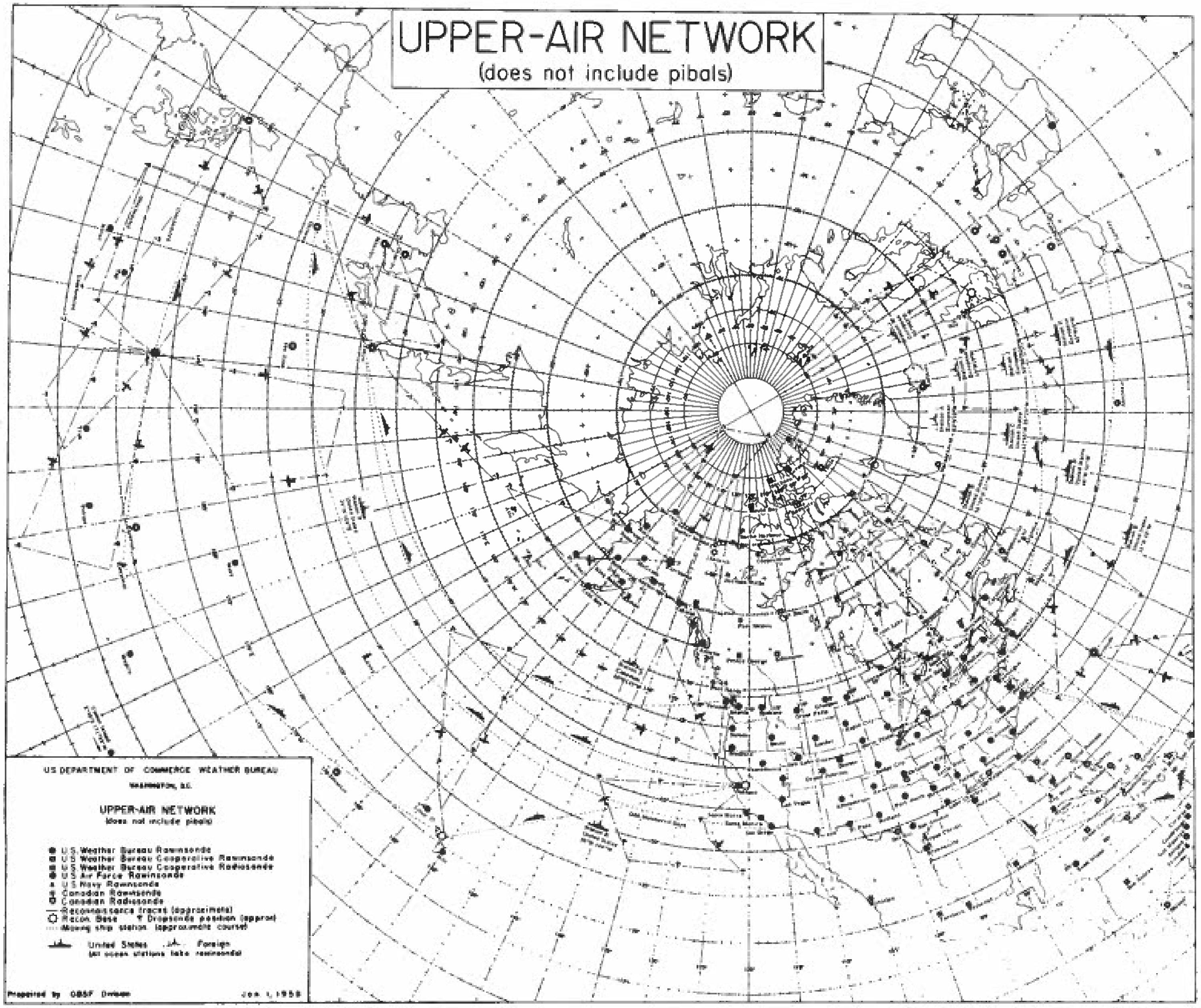

UPPER-AIR NETWORK
(does not include pibals)
US DEPARTMENT OF COMMERCE WEATHER BUREAU
UPPER-AIR NETWORK
(does not include pibals)
U.S. Weather Bureau Rawinsonde
U.S. Weather Bureau Cooperative Rawinsonde
U.S. Weather Bureau Cooperative Radiosonde
U.S. Air Force Rawinsonde
U.S. Navy Rawinsonde
Canadian Rawinsonde
Canadian Radiosonde
Reconnaissance tracks (approximate)
Recon. Base
Dropsonde position (approx)
Moving ship station (approximate course)
United States
Foreign
(all ocean stations take rawinsonde)
Prepared by OBSF Division

Fig 8

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU

LOCAL CLIMATOLOGICAL DATA

DETROIT, MICHIGAN (CITY AIRPORT) MAY, 1958.

Latitude 42 ° 24 ′ N. Longitude 83 ° 00′ W. Elevation (ground) 619 ft. EASTERN Standard time used

Date	Temperature (°F) Maximum	Minimum	Average	Departure from normal	Degree days (base 65°)	Precipitation Total (Water equivalent) (In.)	Snow, Sleet (In.)	Snow, Sleet, or Ice on ground at 7:00 A.M. (In.)	Wind Prevailing direction	Average speed (m. p. h.)	Fastest mile Speed (m. p. h.)	Direction	Sunshine Total (hours and minutes)	Percent of possible	Sky cover Sunrise to sunset (tenths)	Midnight to midnight (tenths)	Thunderstorm or distant lightning	Weather restricting visibility to ¼ mile or less					Date
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*
1	73	40	57	+6	8	T	0	0	SW	16.5	26	W	12:16	87	3	2							1
2	58	39	49	-4	16	0	0	0	E	14.8	20	E	12:26	88	3	6							2
3	77	51	64	+11	1	0.15	0	0	WSW	11.6	20	W	1:47	13	10	10							3
4	54	34	44	-10	21	0.06	0	0	NNE	13.0	22	N	1:02	7	10	8							4
5	58	34	45	-9	20	0	0	0	NE	12.5	20	E	10:41	75	9	9							5
6	58	39	48	-6	17	0	0	0	NE	13.6	23	NE	4:46	33	10	9							6
7	64	37	51	-4	14	0	0	0	N	10.5	22	NE	12:42	89	1	2							7
8	69	38	54	-1	11	0.08	0	0	W	10.4	42	NW	8:46	61	5	3	T						8
9	56	38	47	-8	18	0	0	0	NW	13.3	23	NW	14:23	100	0	1							9
10	81	43	62	+6	3	0	0	0	W	13.3	24	W	12:11	85	5	5							10
11	83	55	69	+13	0	T	0	0	W	11.3	18	W	12:04	84	3	2							11
12	67	45	56	-1	9	0	0	0	ENE	9.4	20	E	14:29	100	0	0							12
13	73	40	57	0	8	0	0	0	N	5.6	12	E	14:25	99	0	0							13
14	82	54	68	+11	0	0	0	0	W	12.7	22	W	11:49	81	8	7							14
15	82	56	69	+11	0	0.03	0	0	NW	11.2	23	W	8:57	61	7	6							15
16	77	47	62	+4	3	0	0	0	S	7.0	16	S	14:37	100	1	0							16
17	82	50	66	+7	0	0.06	0	0	S	8.3	23	SW	11:49	81	4	5	DL						17
18	79	64	72	+13	0	0.23	0	0	SW	14.0	41	NW	9:02	62	6	5	T						18
19	71	54	63	+4	2	0	0	0	W	16.5	30	W	14:08	96	1	1							19
20	70	51	61	+1	4	0	0	0	W	17.8	36	NW	14:45	100	0	0							20
21	71	50	61	+1	4	0	0	0	W	15.3	22	NW	14:44	100	4	2							21
22	66	45	56	-4	9	0.36	0	0	SSW	13.7	26	SW	3:11	21	8	6	DL						22
23	60	39	50	-11	15	0	0	0	E	8.2	13	E	14:31	98	0	0							23
24	70	42	56	-5	9	T	0	0	S	6.9	12	S	12:38	85	4	4							24
25	70	46	58	-4	7	0.01	0	0	NW	14.0	26	W	13:37	91	4	3							25
26	64	40	52	-10	13	0	0	0	SE	7.2	13	SW	14:55	100	1	2							26
27	80	45	63	+1	2	0.08	0	0	SSW	11.3	26	W	10:58	73	5	6	T						27
28	66	49	58	-5	7	T	0	0	N	12.2	22	NW	10:46	72	5	6							28
29	71	44	58	-5	7	T	0	0	NW	9.9	19	W	11:04	74	4	3							29
30	84	58	71	+6	0	0	0	0	SW	13.0	20	W	12:04	80	5	5							30
31	81	61	71	+7	0	0.10	0	0	SSW	10.6	21	NW	2:04	14	9	9	T						31
Sum	2193	1427	—	—	—	1.16	0	—	—	361.6	—	—	537:39	—	135	126	—	—					Sum
Avg.	70.7	46.0	—	—	—	—	—	—	—	11.7	Fastest	Dir.	Possible	%	4.4	4.0	—	—					Avg.
										Misc.	'42	NW	452:32	75	—	—	—	—					Misc.

T in columns 7, 8, 9 and in the Hourly Precipitation table indicates an amount too small to measure.

TEMPERATURE: (°F)

Average monthly 58.4
Departure from normal +0.6
Highest 84 on 30
Lowest 34 on 5
Number of days with –
Max. 32° or below 0
Max. 90° or above 0
Min. 32° or below 0
Min. 0° or below 0

HEATING DEGREE DAYS (base 65°):

Total this month 228
Departure from normal -23
Seasonal total (since July 1) 6157
Seasonal departure from normal -187

BAROMETRIC PRESSURE (In.)

Avg. station (elev. 730 *feet, m.s.l.) 29.217
Highest sea level 30.44 on 2
Lowest sea level 29.65 on 8

PRECIPITATION: (In.)

Total for the month 1.16
Departure from normal -2.45
Greatest in 24 hours 0.36 on 22
Snow, Sleet–
Total for the month 0
Greatest in 24 hours 0 on
Greatest depth on ground 0 on
Dates of – Hail 0
Sleet 0 Glaze 0

Symbols used in columns 18-19

A = Hail
BS = Blowing snow
DL = Distant lightning
D = Dust
E = Sleet
F = Fog
H = Haze
K = Smoke
L = Drizzle
N = Sand
R = Rain
S = Snow
T = Thunderstorm
ZL = Freezing drizzle
ZR = Freezing rain

*When this elevation differs from the present station elevation this level was selected to permit comparison of data for a longer period of homogeneous record.

MAY, 1958, WAS THE FIFTH CONSECUTIVE MONTH WITH A PRECIPITATION DEFICIENCY OF OVER ONE INCH. THIS BRINGS THE PRECIPITATION DEPARTURE TO 8.56 INCHES BELOW NORMAL SO FAR THIS YEAR AND MAKES IT THE DRIEST JANUARY THROUGH MAY PERIOD ON RECORD IN DETROIT.

HOURLY PRECIPITATION (In.)

Date	A. M. Hour ending at 1	2	3	4	5	6	7	8	9	10	11	12	P. M. Hour ending at 1	2	3	4	5	6	7	8	9	10	11	12	Date
1																	T	T							1
2																									2
3			.01	T	.04	T	T	T	.05	.04	T	.01	T												3
4		.02	T	.01	.02	T	T	.01	T	T		T													4
5																									5
6																									6
7																									7
8													T	T	T		.06	.02							8
9																									9
10																									10
11																T									11
12																									12
13																									13
14																									14
15							.02	.01																	15
16																									16
17																				T	.02	.03	.01	T	17
18								.08	T				.11	.01	.03										18
19																									19
20																									20
21																									21
22								.01	.02	.30	.02	.01	T												22
23																									23
24																								T	24
25	T	.01																							25
26																									26
27																				T	.07	.01		T	27
28	T																								28
29																		T							29
30																									30
31							T	T	.07	.01													.02	T	31

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USCOMM-WB-Asheville - 5-4-58 - 560D

Fig. 9

Supplement
(Based on one month's record)

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU

LOCAL CLIMATOLOGICAL DATA

EASTERN STANDARD TIME

DETROIT, MICHIGAN
CITY AIRPORT
MAY 1958

A TEMPERATURE AND WIND SPEED—RELATIVE HUMIDITY OCCURRENCES (HOURLY OBSERVATIONS):

WIND	0-4 MPH						5-14 MPH						15-24 MPH						25 MPH AND OVER						TOTAL OBS
REL. HUMID. / TEMP. (°F)	0-29%	30-49%	50-69%	70-79%	80-89%	90-100%	0-29%	30-49%	50-69%	70-79%	80-89%	90-100%	0-29%	30-49%	50-69%	70-79%	80-89%	90-100%	0-29%	30-49%	50-69%	70-79%	80-89%	90-100%	
84/80							1	4	2				8	11											26
79/75	1		1				6	6	11	1			7	10	8	1									52
74/70	3	1					11	13	6	3			3	11	5	1	1								58
69/65	2	1		1			8	24	20	8	9		16	24	3	2			5	1					124
64/60	1	4	2				15	19	18	6	2	3	8	21	3	4	1		2						109
59/55		3	4				2	43	25	3	1	6	7	6	6	3									109
54/50		3	5	1				32	18	5	3	1	6	13	3	2									92
49/45		2	4	7	1		1	15	32	10	1		1	9	3										86
44/40		1	5	3	6			11	22	3				8	5										64
39/35			1					3	13	1						1									19
34/30									4	1															5

B WIND DIRECTION AND SPEED OCCURRENCES:

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 & OVER	TOTAL	AV. SPEED
	HOURLY OBSERVATIONS OF WIND SPEED (IN MILES PER HOUR)										
N	6	14	24	19						63	9.8
NNE	4	5	22	16						47	10.2
NE	1	8	24	37						70	12.1
ENE		2	9	13	1					25	12.6
E		1	11	10						22	12.0
ESE	1	4	4	7						16	10.7
SE	1	9	14	6						30	9.1
SSE	1	2	7							10	8.9
S	2	20	34	4						60	8.3
SSW	1	5	29	16						51	10.6
SW	1	7	22	36	6					72	12.5
WSW		2	14	19	2					37	12.7
W	4	4	32	39	6	3				88	12.9
WNW	2	4	6	27	10	5				54	16.2
NW	3	5	17	39	6					70	13.5
NNW	1	1	4	12	1					19	13.8
CALM	10									10	0.0
TOTAL	38	93	273	300	32	8				744	11.7

C HOURLY AND DAILY OCCURRENCES OF PRECIPITATION AMOUNTS:

FREQUENCY OF OCCURRENCE FOR EACH HOUR OF THE DAY

INTENSITIES	A.M. 1	2	3	4	5	6	7	8	9	10	11	NOON	P.M. 1	2	3	4	5	6	7	8	9	10	11	MID.	NO. OF DAYS WITH	INTENSITIES
TRACE	2	1	1	1		2	3	2	2	1	1	1	3	1	1	1	1	2		2				4	5	TRACE
.01 IN.		1	1	1				3		1		2		1								1	1		1	.01 IN.
.02 TO .09 IN.					2		1	1	3	1	1				1		1	1			2	1	1		5	.02 TO .09 IN.
.10 TO .24 IN.													1												3	.10 TO .24 IN.
.25 TO .49 IN.										1															1	.25 TO .49 IN.
.50 TO .99 IN.																										.50 TO .99 IN.
1.00 TO 1.99 IN.																										1.00 TO 1.99 IN.
2.00 IN. AND OVER																										2.00 IN. AND OVER
TOTAL	2	2	2	2	2	2	4	6	5	4	2	3	4	2	2	1	2	3		2	2	2	2	4	15	TOTAL

D CEILING—VISIBILITY OCCURRENCES (HOURLY OBSERVATIONS):

VISIBILITY (MILES)	CEILING (FEET) 0	100-200	300-400	500-900	1000-1900	2000-2900	3000-4900	5000-9500	OVER 9500	TOT
0 TO 1/8										0
3/16 TO 3/8										0
1/2 TO 3/4			4							4
1 TO 2 1/2			1	1					2	4
3 TO 6				3	4	4	4	7	33	55
7 TO 15					1	11	18	45	606	681
20 TO 30										0
35 OR MORE										0
TOTAL			5	4	8	15	22	52	641	744

E OCCURRENCES OF WEATHER BY HOUR OF DAY:

HOUR OF DAY	CLOUDS SCALE 0-10: 0-3	4-7	8-10	WIND SPEED (M.P.H.): 0-3	4-12	13-24	25 & OVER	RELATIVE HUMIDITY (%): 0-29	30-49	50-69	70-79	80-89	90-100	WEATHER TYPES: RAIN	FREEZING RAIN	DRIZZLE	SNOW, SLEET	HAIL	FOG	FOG WITH SMOKE	SMOKE OR HAZE	THUNDERSTORM
00	20	4	7	3	23	5			13	13	5			1							1	
01	20	4	7	2	26	3			13	11	7			1							1	
02	21	3	7	5	21	5			11	13	6	1		1							1	
03	22	2	7	5	19	7			7	16	5	3		2							1	
04	22	3	6	6	15	10			5	17	4	5		2					1	1	4	
05	19	4	8	4	21	6			5	15	6	4	1	2					1		6	
06	19	4	8	3	22	6			5	15	8	2	1	1					1		6	
07	20	2	9	3	18	10			8	16	6		1	2		1			1	1	7	
08	20	1	10	1	13	17			14	14	1	1	1	4		1			1	1	6	
09	22	1	8		14	17		3	14	10	1	2	1	3					2	2	6	
10	21	1	9	1	11	18	1	5	17	5	1	1	2	2					3	2	3	
11	20	3	8	1	12	17	1	7	18	3	1		2	2					2	1	2	
12	18	5	8	1	10	19	1	9	16	3	1	1	1	2					1	1	2	
13	16	7	8	1	6	24		8	17	3	2	1		2							2	
14	12	6	13		7	24		11	14	4	2			1							1	
15	12	7	12		8	23		14	13	2	2										1	
16	11	8	12		7	23	1	14	12	4	1			1								
17	9	9	13		9	21	1	11	13	6	1			2								
18	8	10	13		7	22	2	10	15	5	1			1								
19	14	3	14		9	21	1	9	16	6												
20	15	4	12		17	14		6	16	9				2							2	1
21	16	3	12	1	24	6		3	16	9	2	1		2							1	
22	16	4	11		23	8		2	12	14	2	1		1							1	
23	15	7	9	1	24	6		2	9	16	2	2		1							1	1
	408	105	231	38	366	332	8	114	299	229	67	25	10	38		2			13	9	55	2

F OCCURRENCES OF WEATHER BY WIND DIRECTION:

WIND DIR.	CEILING (FT.): 0	100-200	300-400	500-900	1000-1900	2000-2900	3000-4900	5000-9500	OVER 9500	VISIBILITY (MI.): 0-1/8	3/16-3/8	1/2-3/4	1-2½	3-6	7 AND OVER	WEATHER TYPES: RAIN	FREEZING RAIN	DRIZZLE	SNOW, SLEET	HAIL	FOG	FOG WITH SMOKE	SMOKE OR HAZE	THUNDER-STORM
N						3	3	6	51					2	61	1							2	
NNE						5	3	3	36						47	5								
NE						3	3	2	62						70	3								
ENE						1			24						25									
E									22						22									
ESE									16						16									
SE								4	26						30									
SSE									10						10									
S			3			1	1	2	53			2	1	4	53	2		1			4	2	5	
SSW			1	1	1		4	5	39			1		11	39	6		1			3	3	12	
SW			1	1	1	1	6	4	58			1	1	18	52	10					3	2	18	1
WSW				2	2	1	1	5	26					7	30	5					3	2	5	1
W					1			6	81				2	6	80	4							6	
WNW								4	50					2	52	2								
NW								5	65					2	68								2	
NNW							1	6	12						19									
C									10					3	7								3	
			5	4	5	15	22	52	641			4	4	55	681	38		2			13	9	55	2

G MEANS FOR SYNOPTIC HOURS:

HOUR (LOCAL TIME)	SKY COVER (IN TENTHS)	STATION PRESS. (IN.)	DRY BULB (°F)	WET BULB (°F)	REL. HUM. %	DEW PT. (°F)	WIND DIR.	WIND SPEED	HOUR (LOCAL TIME)	SKY COVER (IN TENTHS)	STATION PRESS. (IN.)	DRY BULB (°F)	WET BULB (°F)	REL. HUM. %	DEW PT. (°F)	WIND DIR.	WIND SPEED
01	3	29.34	52	45	55	36	SW	8	07	4	29.36	52	46	59	38	W	10
13	4	29.33	67	53	38	38	W	15	19	5	29.31	65	51	37	37	WNW	14

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Fig. 10a

DETROIT, MICHIGAN
CITY AIRPORT
MAY 1956

HOURLY OBSERVATIONS:

0000

Day	Sky cover (tenths)	Visibility (miles)	Ceiling (hunds. of ft.)	Station press. (in.)	Dry bulb (°F)	Wet bulb (°F)	Rel. hum. (%)	Dew pt. (°F)	Wind dir.	Speed (knots)
1	0	15	UNL	29.36	51	42	44	30	SW	12
2	0	15	UNL	29.43	40	34	54	25	NE	12
3	10	15	50	29.39	52	46	63	40	SE	11
4	10	12	26	29.37	53	48	70	44	NE	14
5	4	15	UNL	29.32	34	30	62	23	N	4
6	9	15	UNL	29.44	43	33	45	19	NE	8
7	2	15	UNL	29.30	42	34	41	20	NNE	7
8	0	10	UNL	29.12	45	36	40	22	NNW	3
9	0	15	UNL	29.08	48	43	60	30	N	9
10	1	12	140	29.33	45	38	54	29	SSE	9
11	7	10	UNL	29.29	63	54	57	40	WSW	6
12	0	15	UNL	29.41	55	45	44	34	NE	5
13	0	12	UNL	29.63	48	39	42	24	N	6
14	0	6	UNL	29.61	50	44	39	33	SW	3
15	10	15	100	29.39	70	55	35	41	W	10
16	8	15	UNL	29.44	57	49	55	41	NNE	3
17	0	12	UNL	29.29	60	47	35	33	S	7
18	6	15	UNL	29.29	68	62	70	59	S	8
19	0	15	UNL	29.23	64	59	58	48	W	8
20	3	30	UNL	29.33	59	46	37	31	W	7
21	0	15	UNL	29.31	52	41	38	26	SW	8

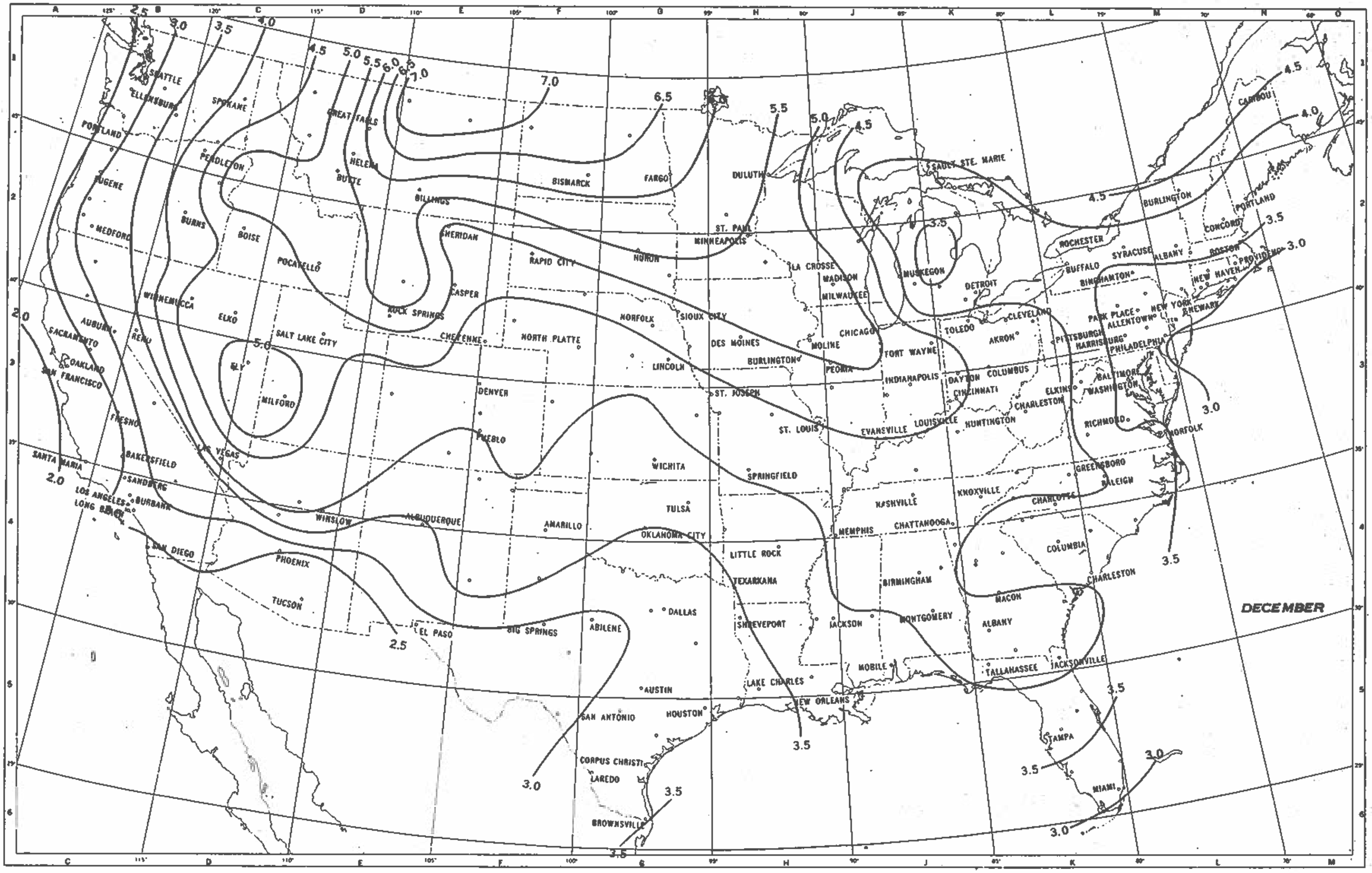
Station pressures in this table apply to the official elevation of 626 feet above mean sea level.
Wind speeds are in knots: multiply by 1.15 to convert to miles per hour.
UNL indicates ceiling unlimited.
CIR indicates a cirriform cloud ceiling with height unknown.

Fig. 10b

UNITED STATES
DEPARTMENT OF COMMERCE
WEATHER BUREAU

STANDARD DEVIATION OF MONTHLY AVERAGE TEMPERATURE DEGREES F

SHEET OF THE NATIONAL ATLAS
OF THE
UNITED STATES



Base map by United States Weather Bureau
Climatic analysis by H. C. S. Thom

SCALE 1:10,000,000

ALBERS CONICAL EQUAL PROJECTION—STANDARD PARALLELS 29° AND 45°

Fig. 11

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STANDARD DEVIATION OF
MONTHLY AVERAGE TEMPERATURE
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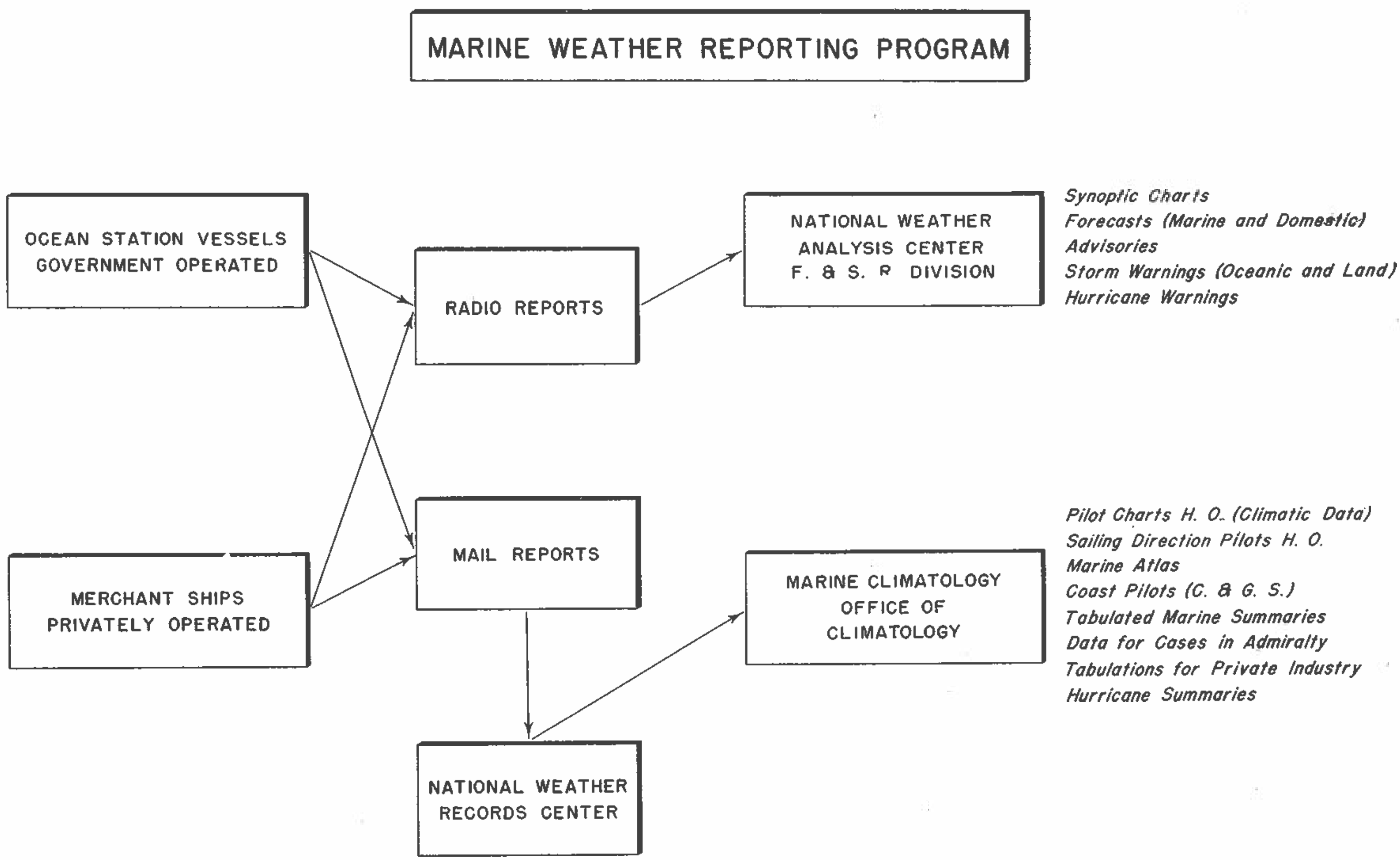
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OCEAN STATION VESSELS GOVERNMENT OPERATED
MERCHANT SHIPS PRIVATELY OPERATED
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Pilot Charts H. O. (Climatic Data)
Sailing Direction Pilots H. O.
Marine Atlas
Coast Pilots (C. & G. S.)
Tabulated Marine Summaries
Data for Cases in Admiralty
Tabulations for Private Industry
Hurricane Summaries

Fig. 12

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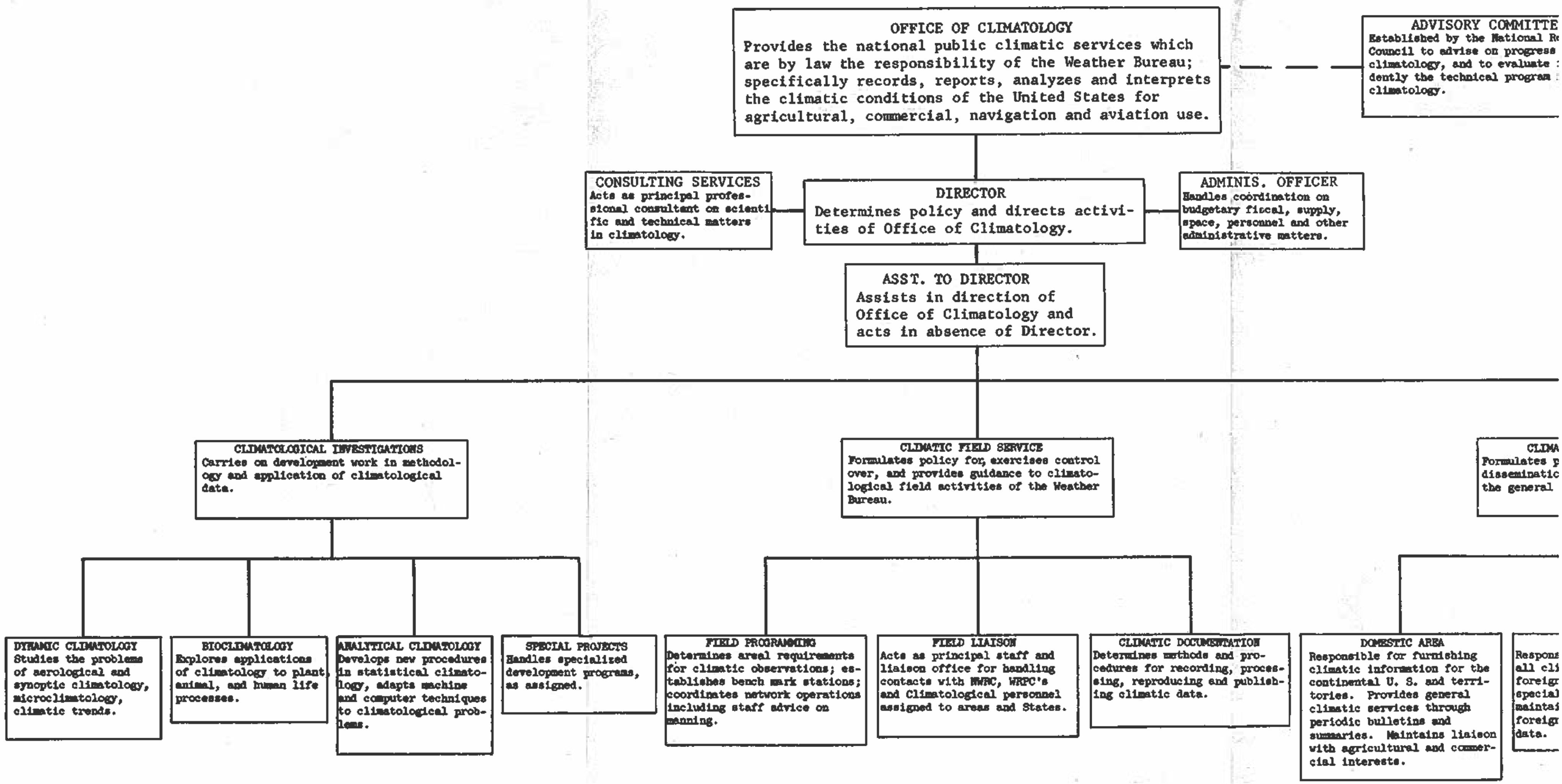

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