

UNITED STATES DEPARTMENT OF COMMERCE

Jesse H. Jones, *Secretary*

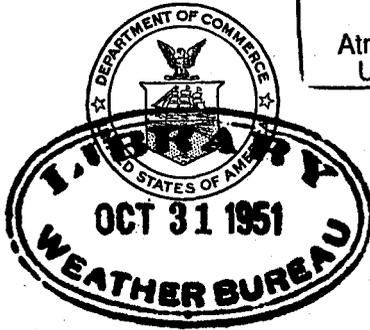
U.S. WEATHER BUREAU • F. W. Reichelderfer, *Chief*

*[Administrative]*  
**Report of the**

**CHIEF of the WEATHER  
BUREAU**

**1941**

LIBRARY  
MAY 24 2007  
National Oceanic &  
Atmospheric Administration  
U.S. Dept. of Commerce



RAREBOOK  
QC  
983  
.S64  
1941

Reprinted from the Annual Report of the  
Secretary of Commerce, 1941

UNITED STATES GOVERNMENT PRINTING OFFICE

WASHINGTON : 1942

# **National Oceanic and Atmospheric Administration Report of the Chief of the Weather Bureau**

## **ERRATA NOTICE**

One or more conditions of the original document may affect the quality of the image, such as:

Discolored pages  
Faded or light ink  
Binding intrudes into the text

This has been a co-operative project between the NOAA Central Library and the Climate Database Modernization Program, National Climate Data Center (NCDC). To view the original document contact the NOAA Central Library in Silver Spring, MD at (301) 713-2607 x124 or [Library.Reference@noaa.gov](mailto:Library.Reference@noaa.gov).

HOV Services  
Imaging Contractor  
12200 Kiln Court  
Beltsville, MD 20704-1387  
December 13, 2007

## WEATHER BUREAU

---

*Half century of progress.*—On June 30, 1941, the Weather Bureau had been operating as a civil-service unit for exactly half a century and as an agency of the Department of Commerce for a year. For 20 years previous to its establishment as a civilian bureau, the meteorological service of the United States was conducted by the Signal Corps of the Army, where its usefulness for civilian purposes was so effectively demonstrated that on July 1, 1891, Congress transferred the functions, equipment, and personnel to the Department of Agriculture, creating the Weather Bureau as a civilian organization. Under the Army the main responsibility of the service was to “give notice of the approach of storms on the northern lakes and seacoasts.” Under the Departments of Agriculture and Commerce that responsibility has grown to the job of serving the meteorological needs of the entire Nation.

These needs, related to collective and individual enterprises of every sort, are served in two ways: (a) By the general output of weather information and forecasts distributed continuously through the radio, the press, published bulletins, and automatic telephone; and (b) by special services created for specialized national interests. Examples of the latter: The Aviation weather service; the Fruit-frost warning service for the prediction of critical temperatures in the orchard regions of California and Florida; the Fire-weather warning service to aid in the prevention and spread of forest fires; the River and flood service for predicting river stages and floods; the Hurricane warning service for forecasting destructive tropical storms in the South Atlantic and Gulf States and adjacent waters; the Corn-and-wheat-region and Cotton-region services for determining the effects of weather on growing crops; the Winter-sports service for informing the public of weather conditions and prospects for skiing and other winter sports.

During the last decade, under the pressing demand created by aviation developments, the Weather Bureau has experienced the most rapid stage of its growth, with these significant results: The number of reporting stations has been approximately trebled; instrumental improvements have increased the accuracy of observations and made possible the measurement of conditions in the atmosphere above the earth; and facilities for communication have been vastly improved. The importance of these changes is that they represent collectively a very great improvement in the prime operating facilities of the national weather service.

The process of converting this improvement to the greatest public advantage has necessarily entailed far-reaching organizational and operating changes in the Weather Bureau. Better observations, opening the way to improved forecasting, have made necessary the

training of scientists to interpret them. Better communication facilities have made possible a more rapid and efficient distribution of weather information. Better forecasts and faster distribution have produced a flood of demands for definite, quantitative predictions, necessitating a wholesale revision in forecast terminology and dissemination methods to fit specific requirements of marketing, travel, reservoir regulation, livestock movement, advertising, and a host of other public concerns. Efficient operation under the new conditions has called for material reductions in the size of forecast districts and the transfer of a large number of offices from the centers of cities to airport quarters where the continuous flow of weather information offers greatly improved local service. Finally, the need of large-scale industrial, engineering, and utilities interests for a kind of weather service exactly suited to their operations has created the new profession of meteorological consultant, which the Weather Bureau has encouraged by making basic observational data and professional advice directly available to all legitimate practitioners, whether individual or in the employ of organizations requiring such specialized service.

#### PRESENT ORGANIZATION OF THE WEATHER BUREAU

*Basic forecast operation.*—Primarily, the daily weather forecasting service consists of three steps: (1) The collection and charting of reports from an extensive network of observing stations, (2) the analysis of weather charts to identify the character and forecast the actions of meteorological elements, and (3) the public issue of weather predictions. The observations upon which these operations are based comprise measurements or descriptions of every visible or measureable meteorological condition prevailing at the time of observation. At 700 stations these are made simultaneously according to schedule at 6-hourly, 3-hourly, or hourly intervals and placed within the Civil Aeronautics Administration Weather Bureau national teletype system to be distributed to all stations upon these circuits, including the forecasting centers throughout the continental United States. Charts are prepared and local forecasting is done at practically all first-order Weather Bureau stations; but only at specially designated forecast centers are the general analyses made, and the State, district, aviation, and other forecasts of more exacting demands prepared. Upon completion, these forecasts are redistributed to all interested stations (Civil Aeronautics Administration and Weather Bureau alike) either by telegraph or teletype, and to the public by telegraph, telephone, radio, printed bulletin, automatic telephone, and the press. Related to the three basic steps are a number of other activities, briefly defined in the functional description following:

*Organization.*—As now organized, the operating structure of the Weather Bureau consists of three main branches—administrational, technical, and scientific. The administrative functions, including personnel, finance, procurement, printing, and general business management are conducted under direct supervision of the Chief of Bureau. The technical services, operating under an Assistant Chief for Technical Services, administer the distribution and staffing of field stations, the schedules of observation, the maintenance of communications, the forecasting services, the distribution of weather in-

formation to the public, the checking, compilation, and publication of meteorological and climatological data of all sorts for the United States and possessions, the meteorological safeguards for the civil airways, the procedures for determining effects of weather on crops, the development and installation of meteorological equipment and instruments, the hydrologic and river services for the determination of water supplies from snow storage and for the prediction of river stages and floods, and the hydrometeorological service for determining potential rainstorm intensities as required in the flood-control work of the Departments of War and Agriculture. The scientific services, under the direction of an Assistant Chief for Scientific Services, administer professional training, scientific research, evaluation and development of meteorological theory, consultation on problems relating to meteorological physics, investigations of the relation of solar activity to the weather, the library, special statistical interpretations of meteorological and climatological data, and investigations of methods for extending the time-period of weather forecasts.

At the beginning of fiscal year 1941 the directive functions of the Bureau in Washington were completely rearranged from a specific service to a functional pattern, and plans were completed by the year's close for a broad-scale decentralization of service supervision in order to effect more flexible and efficient management throughout the Nation. This decentralization, to take effect early next year, will involve the establishment of seven field regions paralleling those of the Civil Aeronautics Administration and directed from regional offices with liberal powers of control and coordination.

The organization of the field service as of June 30, 1941, is given in the following table:

Stations		Employees	
		Paid	Unpaid
302	First-order stations (commissioned personnel).....	1,826	
	14 general forecasting centers.		
	16 airway forecasting centers.		
	14 airway general supervising centers.		
	75 river district centers.		
	9 hydrologic regional centers.		
	45 climatological section centers.		
	Marine service activities in 26 port offices.		
153	Special stations (meteorological, hurricane, frost, and fruit).....	53	
1211	Airway stations (86 in Alaska).....	320	
181	Cooperative airway stations (23 in Alaska).....		
1110	Off-airway stations (15 in Alaska).....	100	
225	Civil Aeronautics Administration cooperative airway stations.....		
1304	Storm-warning display stations.....	89	215
11,500	Marine radio and mail reporters.....		1,500
12,096	Weather and crop reporting stations.....	396	1,700
11,733	River, rainfall (for river work), snowfall, winter sports, evaporation and special reporting stations.....	1,253	480
11,700	Hydrologic stations.....	610	1,060
14,100	Climatological stations (non crop-reporting).....		4,100

1 Part-time service only.

#### THE WEATHER BUREAU AND NATIONAL DEFENSE

In the early stages of the Government's program for national defense, the Weather Bureau began laying plans for the use of its facilities for defense purposes. The initial step, on the recommendation of the Chief of the Weather Bureau, was the formation of the

Defense Meteorological Committee, representing the Army, Navy, Civil Aeronautics Administration, and the Weather Bureau. Actions taken during this fiscal year with direct bearing upon the national defense program include the assembly of a vast amount of climatological data for military and naval purposes, the establishment of new reporting stations in the continental United States and its possessions, the conducting of instruction courses for meteorological personnel of the Army and Navy and National Guard at several field stations, the inauguration of specific forecasting programs to serve camps, munitions plants, and transportation, the complete revamping and extension of the weather services in Alaska and the Caribbean, and the establishment of improved and increased weather reporting from the Pacific and Atlantic Oceans and the Canal Zone.

Because of the magnitude of the defense demands for meteorological service, \$646,820 was made available to the Bureau to meet them—\$146,820 by transfer from the Army, and \$500,000 by direct appropriation under the First Supplemental Civil Functions Appropriation Act.

With these funds the number of regular observations at the 30 established radiosonde stations in the United States was doubled and 4 new stations of this type were established. At 25 synoptic observation points in the continental United States, observations were stepped up from a 6-hourly to a 3-hourly schedule. A new airport-and-pilot-balloon station was opened at Raleigh, N. C., and pilot-balloon observations were inaugurated at Hatteras, N. C. In Alaska, a supervising forecast center was established at Fairbanks to work with the Army Air Corps, 30 outlying stations were installed for furnishing hourly surface weather reports through a 12-hour daily schedule, and ten 6-hourly and sixteen 3-hourly reporting stations were established for round-the-clock operation. Radiosonde observations were inaugurated at Fairbanks and Juneau (twice daily) and at Anchorage, Point Barrow, Bethel, Ketchikan, and Nome (once daily); and ceiling-balloon observations were provided for at 63 Alaskan airway stations. Seven Civil Aeronautics Administration weather reporting stations were opened on Hawaiian and Pacific Equatorial Islands, and a forecasting center was opened at Honolulu. At Johnston and Palmyra Islands arrangements were completed for the initiation of pilot-balloon observations; radiosonde observations were inaugurated at Midway Island and Swan Island (once daily) and at San Juan, P. R. (twice daily); and a ship supervising station was established at Honolulu to direct pilot balloon work on ships plying between the continental United States and Hawaii.

Primarily for military purposes also a program of four complete major weather broadcasts per day was inaugurated in cooperation with the Naval radio stations NPG at San Francisco, NBA at Balboa, and NPM at Honolulu. Besides carrying weather forecasts and storm information, these broadcasts describe fully the weather prevailing between southern North America and northern South America, and from the Bahamas to the mid-Pacific. In addition, the Caribbean weather code was revised to embrace reporting of additional meteorological data important to marine and aviation operations; Caribbean weather observations, formerly limited to the hurricane season, were placed on a year-round basis; and teletype

connections were established between the Weather Bureau's hurricane circuit and Army camps in the southeast to give these camps the benefit of weather information carried on that circuit.

Special forecasting services were established for Army construction work in Missouri, Michigan, Indiana, and West Virginia; for operation of a powder plant in Virginia; for trip flights to Bermuda; for movement of military aircraft from the west to east-coast bases; for movement of horses in the plains region; for flood protection in Kansas; for Coast Guard ice-breaking activities in the Great Lakes during the spring of 1941 to facilitate the movement of ores. Primarily for military purposes also, numerous increases were made in the frequency and flow of airway and off-airway weather reports, notably along the Detroit-Sault Sainte Marie airway, in the southern Appalachians, in New Mexico, and in the Gulf region and Texas.

Requests from the Army and Navy for meteorological and climatological data and for their analysis and interpretation have been extremely heavy. Typical instances: Climatological data for various localities in the United States where these data have an important bearing upon construction, airport locations, maneuvers, locations of camps, care of animals, drill facilities, water supply, and transportation; advance copies of charts to be included in the atlas of airway and upper-wind records for the United States, to aid the Army in planning for increased airport facilities; sunset tables for 35 locations in Alaska; special wind-rose data for various localities; comparative flying-weather data along the Atlantic seaboard and in the southwestern United States; marine weather data for the eastern North Atlantic Ocean and for waters adjacent to South America and the Hawaiian Islands; complete climatological data for Alaska; flying-weather data for the Atlantic between Northern Africa and South America; climatological data of importance in the planning of naval and air bases in the Caribbean; aerological records for the southeastern United States to aid the Army in selecting the site for a flying school; summaries of meteorological records for points in Alaska to facilitate programs of aerophotography; basic meteorological data for the preparation of Navy sailing directions in the western hemisphere; and special studies of fog data for the North Atlantic.

In cooperation with the Civil Aeronautics Administration, the Weather Bureau arranged for instruction courses for the training of prospective meteorological officers of the Army and Navy, at the University of California at Los Angeles, California Institute of Technology, University of Chicago, New York University, and Massachusetts Institute of Technology. Successful candidates for these courses numbered 68 college graduates having major prerequisite qualifications in mathematics, physics, and engineering, and willing to accept military commissions or other Government assignments upon completion of the course. Because of the shortage of instructors in meteorology it was possible to conduct these courses only after the Weather Bureau granted six of its best trained meteorologists leave of absence without pay to enable them to serve on the teaching staffs of some of these universities. The Bureau maintained general contact with the progress of students under this program, and collaborated in arranging courses. These 68 graduates are in addition

to 10 regular Weather Bureau students and a large number of Air Corps cadets and several naval officers, all of whom were assigned to the foregoing institutions. To meet the continued urgent demand for qualified military and other governmental meteorologists, plans were completed for a second course which began in July 1941, 3 months ahead of the usual academic year, and which will graduate a large number of trainees in the spring of 1942.

In addition to these formal courses of training, a preliminary course in military meteorology was given at the Rensselaer Polytechnic Institute at Troy, N. Y.; and the Weather Bureau authored the Civil Aeronautics Administration instruction manual "Meteorology for Pilots," distributed an instructive new form of weather map to 700 schools giving training under the Civilian Pilot Training Program, and made available to 50 officers of the United States Army Engineers the Weather Bureau correspondence course in meteorology used for in-service instruction of the Bureau's subprofessional civilian personnel.

*Defense meteorological work benefits general service to public.*—The foregoing operating services established for national defense purposes will in most instances produce improvements also in the service to the civilian public. For example, the increase in synoptic surface and radiosonde observations in the continental United States will facilitate materially the formulation of all types of weather forecasts. The expansion of service in Alaska will do the same thing for that Territory with particular benefit to commercial aviation. The increase in reports in the Pacific and Atlantic Oceans and the Caribbean region, in conjunction with the improved naval radio schedules in San Francisco, Balboa, and Honolulu, will be of direct assistance to commercial shipping within the Western Hemisphere; and the Caribbean expansions especially will be of value in the Hurricane-warning Service. Conversely, the civilian-service improvements reported in the following pages will in most instances contribute more or less directly to defense operations. The development of meteorological instruments brings better observations for military as well as civil use; the training of military meteorologists produces practical scientists useful alike in the military and civil fields; improvement in aviation weather service saves lives and safeguards equipment in a bomber-delivery program as well as in commercial air transport. Better forecasts for shipping in the Great Lakes facilitate both the movement of ore for defense purposes and the regular shipping service.

#### SERVICE OPERATIONS, FISCAL YEAR 1941

*Service distribution.*—The problem of optimum distribution of meteorological service in the United States is complicated by at least two major circumstances: Complexity of the national activity and the complexity of North American weather. In general every individual, every small business, every industry, every institution of any kind has some use for weather service to fit a peculiar need, which adds up to a service problem of practically immeasurable possibilities of usefulness. The recent increase in the number of forecast centers and the decentralization of supervisory control mentioned above are both designed specifically to deal better with this problem.

A current in-service training program, instituted to increase both the abilities and the responsibilities of individual station officials, is another step in the same direction. To the same end, there was organized during 1941 a field liaison unit with headquarters in Washington whose prime objective is to keep at maximum performance-standard the field morale and understanding of service-wide operating principles and procedures. During 1941 also there was established and repeatedly emphasized a service policy placing upon qualified field officials considerably increased responsibility for direct, independent, and effective local service; at 15 cities having both airport and downtown Weather Bureau offices all activities were consolidated at the airports in order to provide 24-hour service for these communities; timing of forecasts was advanced (as described under Earlier Forecast Issue below) and the terminology used in all types of current publications and broadcasts was revised and enlarged to accomplish greater clarity and wider applicability of weather information.

These and other operating and administrative changes designed to increase the flexibility of field operations have required the strengthening of forecast personnel, the realignment of field administration and policy, the relaxation of restrictions on telephonic and wire communications, frequent prolonged service without regard for office hours and leave privileges; but their value has already been abundantly proved in an increased public satisfaction with the service and a redoubled demand for more of the same.

*Distribution of reports.*—During recent years the national distribution of weather observations for charting, forecasting, publication, and other essential uses has been conducted in part through the use of a Civil Aeronautics Administration teletype circuit known as Schedule A. The late greatly increased demands by aviation, by the national defense program, and by industrial interests and others for more and better reports have absorbed the full capacity of Schedule A to carry them. A new circuit, to be designated as Schedule C, will go into full operation during September 1941 to carry surface and upper-air reports, forecasts, bulletins, warnings, weather observations radioed from planes in flight, and other essential weather data, leaving Schedule A free for transmission of a much needed increase in hourly spot weather information for military and civilian aircraft operations.

Besides the new Schedule C there was established during fiscal 1941 an independent Weather Bureau telemeter circuit connecting the district forecast centers at Jacksonville, Fla., Washington, D. C., LaGuardia Field, N. Y., and Boston, Mass. Like Schedule C, this new telemeter circuit was a direct result of a communication necessity—namely, to make available at all offices on the circuit complete Atlantic seaboard weather information. Arrangements were completed also for direct transmission to all radio broadcasting stations, numbering approximately 800, of special warnings of the approach of critical or dangerous weather conditions. Under this system the regular 6-hourly forecasts will be supplemented by special warnings, to be issued at any time of the day or night and telegraphed or telephoned direct to the radio stations for general broadcast.

*Earlier forecast issue.*—Weather Bureau maps, forecasts, and bulletins have for many years been based upon observations taken at 7:30 a. m. eastern standard time. In spite of the excellence of the system under which these observations were distributed and charted, and the speed with which the bulletins, maps, and forecasts were issued and publicized, the final output could not be made available to the public until some hours after the working day had begun. The result, often vigorously expressed by various users of weather data and particularly by the press, has been a continued legitimate insistence that weather information be made available earlier in the working day. To accomplish this, mapping and forecasting and dissemination procedures were adjusted during 1941 to employ observations taken at 1:30 a. m. (instead of at 7:30 a. m.). The results have been eminently satisfactory.

*Modernization of weather maps.*—In line with the recent adoption of the air mass system in forecasting, corresponding improvements in the style of weather descriptions and the form of weather map presentation have been adopted. Under the new methods the weather is described or illustrated by identification of air mass types so as to tell users of the data in plain terms what kind of weather prevails currently in the regions of their interest, and what kind is to be expected within the forecast period. These improvements have likewise been favorably received, particularly by radio listeners and recipients of the new type of weather map issued from Washington, D. C. This latter, instituted as an instructional aid in the Civilian Pilot Training Program of the Civil Aeronautics Administration, proved so much more explicit and informative than the earlier style of map that it was adopted as a model for general weather map construction. To assure uniformity in these publications and in the analyses they illustrate, experiments have been made and test equipment purchased looking to national distribution of weather maps by facsimile transmission process.

*Aviation weather service.*—The dependence of aviation upon foreknowledge of weather conditions constitutes one of the most active problems of the Weather Bureau. Some contributions to its solution during 1941 are described in foregoing sections, for example, the doubling of the number of radiosonde observations, the establishment of new stations for pilot balloon and surface observations, increases in communication facilities, the strengthening of field forecasting staffs. In addition, arrangements have been completed for twice-daily specific predictions of air-mass frontal displacements; possibilities are now being investigated of improved upper-wind forecasts and the issue of cross-section atmospheric analyses for pilots; special studies of weather by predictable types are in progress: closer and more effective liaison between airlines and Weather Bureau meteorologists has been established; and, through cooperation with airlines, Weather Bureau forecasters' familiarization flights have been inaugurated to give the forecaster first-hand knowledge of the weather problems encountered by pilots in flight.

*River and Flood Service.*—One of the oldest of the special services of the Weather Bureau, the River and Flood Service is now organized under 75 field river centers for providing forecasts of river stages and warnings of floods for the rivers of the United States, for the determination of available water supply by measurement of

snow in natural storage in the mountain regions of the West, and for the determination of evaporation characteristics of the United States. Problems now under active consideration by this Service are (1) the provision of flood warnings on the smaller tributaries not heretofore included in the general flood forecasting work and (2) the formulation of exact river prediction schemes for all rivers whose overflow might endanger life or property.

During fiscal year 1941, Congress authorized a small-tributary warning service on the Elkhorn River and Omaha and Logan Creeks of Nebraska. Its operation, which is expected to prove the feasibility of community cooperation for this type of community benefit, involves direct reporting by river observers.

Because of the magnitude of the job and the current shortage of hydrologists qualified to do it, the systematic formulation of river schemes for the entire United States necessarily progressed slowly. However, work was completed or well advanced during 1941 for the following basins: Potomac, Upper Ohio, Kanawha, and Upper James (of Virginia).

Other improvements in the river and flood service during fiscal year 1941:<sup>1</sup> Reorganization of the station network and reporting system in the Ohio basin to expedite the distribution of river stage and rainfall information for uses of Weather Bureau flood forecasters, the Army Engineer Corps, and river navigation interests; the complete revamping<sup>1</sup> of the river and flood work of the Willamette River basin of Oregon; the establishment of new river district centers at Austin, Tex., and Huntington, W. Va., to improve river forecasting for the Colorado River of Texas and the Kanawha and Big Sandy Rivers of the Ohio basin; revision of methods for collecting flood-loss data by statistical sampling procedures; engagement of the United States Geological Survey in a cooperative plan to resurvey Weather Bureau river gages wherever necessary throughout the United States. In addition, under the hydrologic network program, financed by the Departments of Agriculture and War, for assembling precipitation data for the flood-control programs of those Departments, 625 additional precipitation gages were installed during the year. Further, the investigation of evaporational characteristics of various sections of the country was advanced by an increase in the number of evaporation stations from 130 to 145, and by the development of instruments for the practical application of modern theories of atmospheric turbulence to the measurement of evaporation from open-water surfaces. Anticipating the difficulties likely to be experienced by Army camps from floods, the River and Flood Service circularized the field offices of the U. S. Engineer Corps to determine in each case the character of flood information required for the protection of property and activities in newly established Army camps. In two instances (Concordia and Topeka, Kans., districts) the responses indicated a need for expanded river and rainfall reporting networks, which were accordingly established.

*Fire-Weather Warning Service.*—The successful prevention and control of forest fires in the timbered areas of the United States depends in large part upon foreknowledge of the weather. The effect of

<sup>1</sup> Cooperative project; funds provided by transfer from War Department.

weather upon these fires is not limited to the extinction or check, by rain, of those already started. Lightning storms and periods of dry weather have a critically important bearing on ignition; and the wind direction and velocity, the stability of air masses, and variations in relative humidity influence strongly the intensity and spread of going fires. The Fire-Weather Warning Service of the Weather Bureau, whose business it is to inform Federal and State protective agencies of expected weather conditions in the forested areas, operates directly from 8 field district offices. Reports and predictions are based upon the complete synoptic data gathered for the general weather service, plus reports from approximately 1,600 fire-weather observers located in the forest regions. In addition to the regular fire-weather forecasts issued from the base stations, going-fire forecast service is conducted from field trucks equipped with 2-way radio and full charting facilities. In these mobile units, fire-weather specialists are dispatched to large forest fires where they collect weather information continuously by radio for immediate interpretation and communication to forest officials directing fire-control operations.

During fiscal year 1941 a new fire-weather subdistrict was established at Boise, Idaho, under the supervision of the Missoula, Mont., office; the subdistrict headquarters at Pasadena was moved to Los Angeles to gain the advantage of consolidated map and communications facilities; the headquarters at San Francisco and Mount Shasta added ultra-high frequency radio equipment loaned by the United States Forest Service, with the effect of gaining several hours in the collection of fire-weather station reports and the issuance of forecasts; and, to effect a similar gain in the Northwest, improved intermediate frequency radio equipment is now under construction for the Portland and Seattle mobile units. A 2-year thunderstorm research study with special application to fire-weather forecasting was completed in cooperation with the United States Forest Service and the Massachusetts Institute of Technology; fire-weather forecasts and reports were inaugurated in Indiana for the protection of State woodlands; and the regular Weather Bureau offices at Albuquerque and Denver began the operation of an extended fire-weather warning service by broadcasts from commercial radio stations, to aid protective agencies in Arizona, New Mexico, and Colorado.

*Fruit-Frost Warning Service.*—This service is organized to provide forecasts of critical temperatures in the greater orchard regions of California and Florida and other places where such interests are large. During 1941 agricultural extensions necessitated the establishment of approximately 30 new fruit-frost stations, and the time-period of fruit-frost forecasts was extended wherever possible to give growers and shippers from 2 to 3 days advance notice of the approach of dangerous weather. In some regions, important special investigations were made on the relation of temperature and precipitation to pest-control and spraying and harvesting operations.

*Great Lakes Region Forecasts.*—The moving of more than 70,000 tons of ore for defense purposes during the 1941 shipping season in the Great Lakes necessitated opening the Lake traffic more than 2 weeks in advance of the usual time. This in turn called for an amplified weather service to provide information on winds, storms, and the presence and movement of ice. Accordingly, the Weather

Bureau initiated special broadcasts of weather conditions 4 times daily by radio-telephone to carry reports from strategic points on the Lakes and from vessels en route between Lake points. These reports are used at the forecast centers in Chicago and Cleveland in the formulation of 6-hourly forecasts and warnings for Lakes shipping. To facilitate the collection of observations, exchange of information between forecast centers, and final distribution of forecasts and warnings, special teletype circuits were established connecting the Weather Bureau forecasting centers with the broadcasting stations.

*Winter Sports Service.*—This service, providing current information and forecasts for the widespread skiing areas of the western, north-central, and northeastern United States, was extended to embrace a number of western areas previously served by the Soil Conservation Service of the Department of Agriculture and relinquished by them this year to bring the entire activity under uniform national supervision. Established 3 years ago to serve week-end skiers, sledgers, skaters, tobogganers, ice fishermen, and ice boaters, this service was improved significantly during fiscal year 1941 by the addition of specific forecasts for transportation and other organizations dealing with equipment, traffic regulation, and supply, and an additional mid-week bulletin was inaugurated to serve New York and Boston and other northeastern cities.

*Five-day forecasts.*—During August 1940, the practice of issuing general weekly outlooks for the 10 forecasting districts of the United States was displaced by a twice-weekly issue of an extended forecast for 5-day periods. Under the new system, a description and prediction of significant basic elements, with indications of expected change for the entire United States, is distributed from Washington to 11 general forecast centers. Using this as a basis, each center then constructs and issues the 5-day forecast for its own district. In points of specific terminology and definite applicability, these extended forecasts represent a distinct improvement over the earlier weekly outlooks.

*The Climate and Crop Weather Division.*—The basic activity of this Division is to determine climatic characteristics of the United States and its possessions, to publish significant climatic data in interpretable form for public use, to make such studies of the climates of the world as may be necessary in the interests of the American public, to supervise the collection and publication of reports of the effects of weather upon American agriculture, and in general to conduct the extensive climatico-statistical work of the Weather Bureau. Under the Division's supervision there were completed and placed in process of publication during 1941 two outstanding climatological publications: (1) Tabulations of normal values of upper air temperatures and humidities, based upon all available aerological observations made by kites, airplanes, and radiosondes; and (2) a complete atlas of airway weather for the United States, based upon airport weather records through the year 1938. This atlas contains tabular and graphical presentations of the percentage-frequencies of such elements as fog, thunderstorms, ceiling heights, visibility, and surface and upper winds. The most complete and extensive publication of its kind ever issued by a meteorological service, this atlas has required the continuous employment of an average of 200 persons for more than 2 years under a special WPA project conducted in New Orleans, La.

In addition, special compilations of climatic data for all classes of Weather Bureau stations over a uniform period of 40 years ending with 1938 were completed for inclusion in the 1941 Yearbook of the Department of Agriculture, to be published under the title "Climate and Man." This work, also accomplished by a special WPA project and constituting the most extensive and complete climatic survey ever undertaken in this country, includes climatic charts and complete tabular summaries relating to temperature, frost, precipitation, and other meteorological data recorded at some 5,000 stations distributed throughout the United States.

As indicated in the foregoing section on national defense, many special summaries were made of upper air and airway weather records upon special requests by military investigators and others engaged in national defense activities. New text material and tables were prepared for the United States Hydrographic Office covering coastal localities and adjacent sea areas for publication in "Sailing Directions" and "Navy Air Pilots." Material was completed and furnished for seven pilots: Mexico, British Columbia, the central Mediterranean, the Bay of Bengal, the Bay of Biscay, the eastern North Atlantic, and southern South America; and tables and charts covering the surface climatology of eastern South America were also completed for the "Navy Air Pilot." Other activities by the Climate and Crop Weather Division: Inauguration of a project to establish normal values of temperature and precipitation at new airport locations; publication by division personnel of important studies, including "The Intensity and Duration of Exceedingly Heavy Rainfall in the United States," "The Relation of Gusts of Wind to the Velocities Recorded," "Pressure Variations and Trends in Relation to Variance of Weather," "Precipitation—Its Trends and Tendencies."

*Scientific Services.*—The activities of this office relate primarily to meteorological research and scientific training. During 1941, it fostered the development of extended forecasting as a service activity. In the same field, this office is now conducting research upon the general problem of ocean forecasts, and in addition is developing statistical methods for the verification of all weather predictions, and investigating the meteorological significance of atmospheric ozone and solar radiation intensity-variations and the relation of weather types to the practical questions of forest-fire incidence, intensity of light in large cities, and flying weather in the Caribbean and Atlantic and Pacific regions.

*Training.*—Stimulated by a constant demand for refinements and extensions, and implemented by the recent manifold increase in observations, the science of meteorology has advanced rapidly during the last few years, not only in the spread of its applications but in the development of its theories and the revision of its techniques. To convert these improvements as effectively as possible to the public benefit, the Weather Bureau has had to stress and encourage advanced professional training to a greater extent than ever before in its history. In-service training was conducted during fiscal year 1941 as follows: Three regional technical conferences were held (two in Washington and one in Oakland, Calif.), each attended by approximately 20 Weather Bureau officials through a 12-week period of intensive study of new air-mass concepts and weather-map analysis techniques;

a correspondence course composed of 10 lessons and 9 discussions upon basic principles of applied meteorology was completed by approximately 900 subprofessional employees; and, under authority of the Civil Aeronautics Act, 10 professional employees were sent to universities for advanced courses in meteorology and the same number attended similar courses on leave without pay. In addition, prerequisites to advancement in the subprofessional and professional grades were revised so as to encourage the acquisition of additional scientific background by all employees and to assure proper qualifications in active scientific personnel.

*The Hydrometeorological Section.*—Financed by funds transferred from the flood-control appropriations of the Departments of War and Agriculture, this section is organized to produce the answers to all meteorological questions bearing upon the flood-control works programs of those Departments. Basically, the objective of this work is to determine the maximum potential precipitation characteristics for any drainage basin upon which flood-control work is contemplated. These determinations require a highly expert coordination of statistics, history, topographical influences, and meteorological theory. A representative accomplishment in this field for 1941 is the report on maximum possible precipitation of the Ohio River tributary basins above Pittsburgh, lately completed for the Army Engineers. Reports and studies of this type are of value not only in dealing with the immediate flood-control problem but also in providing indices of lasting meteorological, hydrologic, and engineering importance. In the 1941 Ohio Basin report, for example, a general theory of basic physical controls as related to maximum possible precipitation was formulated and applied for the first time, and definite evaluations of restrictive geometric properties were developed. Thus the study has disclosed two primary points never before formulated and capable of general application. Other activities of the hydrometeorological section during fiscal year 1941: Good progress in the meteorological classification and analysis of storm rainfall data of several hundred flood-producing storms; development of a method for applying weather map analysis to the study of mass rainfall curves; formulation of a practical method of application of modern theories of atmospheric turbulence to the study of maximum rates of snow-melt; extensive research on several major storms of the nineteenth century; completion of several studies of characteristics and frequency of flood-producing storms over various sections of the United States.

*Instruments.*—Studies, experiments, tests, and shop work on 34 instrumental and equipment problems pertaining to meteorological observations and their improvement were conducted in the Weather Bureau's Instrument Division in Washington and through collaboration with the Bureau of Standards and the laboratories of several instrument manufacturers. Orders were placed for 250 Weather Bureau type indicators to give continuous visible record of wind-speed in Weather Bureau and Civil Aeronautics Administration airport offices; 200 chronometric radiosondes were purchased for experimental comparison with the modulated audiofrequency type now in use. A wind-sun-rain recorder was designed to obviate future purchases of the more expensive triple-register now in use. This new

instrument, whose parts are commercially available, will be constructed to record additional elements also, such as light intensity, instantaneous beginning of rainfall, and any other that may be susceptible of this type of registering.

Additional Instrument Division problems and projects under active conduct during the year: Horizontal visibility measurement, remote observations of wet-and-dry-bulb temperatures, development of continuous dew-point recorders, improved paint for instrument shelters, wind-speed-and-direction indicators, precision aneroid barometers, pressure-change indicators, a ceiling height alarm, an improved marine theodolite, and photometric recorders of solar radiation. Further, 60 new specifications were prepared to protect the quality and precision of instruments and apparatus for use in Weather Bureau operations.

#### CONTRIBUTIONS BY OTHER AGENCIES

Because of the great variety of uses made of the weather service, its operations necessarily touch upon the activities of many other Government agencies and frequently require their cooperation and assistance. The Weather Bureau desires particularly to make acknowledgment to the following agencies for cooperation of this sort during the fiscal year 1941: The Civil Aeronautics Administration for collaboration on many problems dealing with aviation; the Coast Guard and Navy for their indispensable assistance in gathering observations from the Pacific and Atlantic Oceans and the Caribbean Sea; the Geological Survey for its assistance in field operations of the river and flood work; the Soil Conservation, National Park, and Forest Services for their cooperation in the winter sports work; the Bureau of Standards for invaluable aid in the development and testing of instruments; the Department of Justice for promptness in extending the stays of foreign meteorologists invited by the Weather Bureau to serve as training instructors in the national defense officers' training courses; the Indian Service for invaluable cooperation in the extension of the Alaskan weather service; and the Army Engineers for continued assistance in support of the field hydrologic program.

#### APPROPRIATIONS

Appropriations available for the conduct of the regular work of the Bureau during the fiscal year amounted to \$6,880,900. This sum consists of the following:

Annual Act, 1941.....	\$6,318,870
Second Deficiency Act, Department of Commerce, 1940 (for establishing a district forecast center at Boston, Mass.).....	50,000
First Supplemental Civil Functions Appropriation Act, 1941 (for national defense meteorological services).....	500,000
Transfers pursuant to Reorganization Plan IV:	
To "Weather and Crop Relationship, Department of Agriculture"	—4,000
From "Rent of Buildings, Department of Agriculture" (Transferred to Department of Commerce and made available direct to the Weather Bureau).....	16,030
Total regular appropriations available.....	6,880,900

In addition there were also transferred or allotted to the Weather Bureau the following funds:

<i>Title of fund or allotment</i>	<i>Amount</i>
"Printing and Binding, Department of Commerce, Weather Bureau"-----	\$60,000
"Working Fund, Commerce, Weather Bureau, Advance from Air Corps Army, 1940-41" (for radiosonde stations and a report on long-range forecasting)-----	146,820
"Civilian Pilot Training, Office of Administrator of Civil Aeronautics, 1941" (for publication of a special weather map for pilot training)-----	4,620
"Cooperation with the American Republics (Transfer to Commerce, Civil Aeronautics Administration)" (for promoting and coordinating the aviation weather services in Central and South America)-----	2,500
"Working Fund, Commerce, Weather Bureau, Advance from Flood Control, General" (hydrologic studies)-----	90,000
"Working Fund, Commerce, Weather Bureau, Advance from Flood Control, General" (hydrologic station network and reports from Willamette Basin)-----	189,075
"Working Fund, Commerce, Weather Bureau, Advance from Maintenance and Improvement of Existing River and Harbor Works" (Ohio River reporting network)-----	3,200
"Working Fund, Commerce, Weather Bureau, Advance from Flood Control General (Agriculture)" (for hydrologic station network and hydrometeorological studies)-----	178,141
"Flood Control General (Transfer to Commerce) (Weather Bureau)" (unexpended balance of funds allotted to the Weather Bureau during the fiscal year 1940 for hydrologic station network and hydrometeorological studies)-----	43,700
"Emergency Relief, Commerce, Weather Bureau, Federal Non-Construction Projects (Transfer from Work Projects Administration)" (for compilation and summarization of climatological data)-----	48,873
"Emergency Relief, Commerce, Weather Bureau, Administrative Expenses (Transfer from Work Projects Administration)" (for administration of above project)-----	2,036

