Administrative Report of the Chief of Weather Bureau for Fiscal, 1946

[Reprint from Thirty-Fourth Annual Report of the Secretary of Commerce, 1946]

Without increase in total employee-time available for serving public demands, the Weather Bureau during fiscal year 1946 handled a 28 percent increase in direct requests from the public for weather advices, as compared with the number of such requests in the preceding year. All requirements in the basic programs of weather observing, general forecasting, and climatological work were met, and in some of these the scope and usefulness of programs were increased. There was a large reduction in volume of work conducted for war purposes which had been supported by funds transferred from war appropriations.

Conclusion of the war saw a rapid demobilization of the military air-transport organizations, which was paralleled by large developments in civilian overseas traffic and in plans for the future of such commerce. As a consequence, some additions to staff and facilities were made during the year in units which render specialized service to international aviation. Domestic air commerce also increased with restoration of numbers of air-transport planes for use by commercial air-line companies.

Censorship restraints on public distribution of weather information were lifted completely after VJ-Day. Radio broadcasts were resumed immediately on a peacetime basis and by the end of the year weather information was being distributed over more than 600 commercial broadcasting stations, approximately 100 of which maintained their own microphones in Weather Bureau offices for direct use by the Bureau in disseminating weather information and advices.

The volume of weather news carried in daily papers also increased greatly during the year and by the end of the year weather charts were being carried regularly in about 40 daily papers, most of them in large cities. These maps were supplied by the Weather Bureau through two wire-photo news services.

New projects of noteworthy scientific and practical significance were begun during fiscal year 1946. Both involved generous cooperation by the Army and Navy. The first undertook to make exhaustive investigations into the causes and mechanisms of thunderstorms. The field observations were made principally in Florida where the thunderstorm season is lengthy and the storms are commonly of an elemental type. Extensive instrumentation was required, much of it carried aloft through the thunderstorms by military aircraft and some by soaring aircraft. Analysis of results was begun through cooperation of the National Advisory Council for Aeronautics and the Meteorological Department of Chicago University.

One other new project was directed toward establishing additional weather observing and reporting stations in the Arctic, north of lati-

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

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tudes from which regular weather reports have heretofore been received. Transport and surplus equipment for this project were provided by the military services. Specially qualified personnel were recruited, and the actual work of establishing the first stations was to be undertaken in the summer of 1946.

Unusual administrative and technical problems had to be met during the year. Most of them arose from the general requirement for reconversion from a wartime to a peacetime basis of operation. International contacts in meteorological organization had to be reestablished or strengthened. Legislation restoring the 40-hour work week in Government employment created difficult problems in recruitment, training, and staffing the field stations of the Weather Bureau, most of which are units of small size.

Scientific developments, originated in furtherance of the military effort, have many applications to peacetime weather service; research and development in weather science look to this source for assistance, and some practical adaptations to peacetime use were already under way by the end of the year.

More detailed discussion of the various activities and developments significant to maintaining a modern national weather service during fiscal year 1946 is given below:

AVIATION WEATHER SERVICES

Domestic aviation.—The demands for aviation weather services continued to grow. As the number of commercial and private aircraft in operation increased, a corresponding increase was felt in the requirements for weather services directly contributing to aviation. In general, these requirements brought a more intensive use of existing stations and facilities rather than an expansion of station networks. There was, in fact, reduction in the number of weather observing stations operated by the military branches, the reports from which had been carried on the national weather communications systems.

The basic weather forecasts for airway routes were prepared at 15 district forecasting centers in the continental United States. These indicated in general the weather developments prospectively affecting air routes throughout these districts. Terminal forecasts, issued several times daily, particularized these basic forecasts and applied them specifically to major airway terminals throughout the country. Terminal forecasts were issued at all airway district forecasting centers and in addition at seven terminal forecasting subcenters. Three stations in Alaska issued both types of forecasts. Dissemination of these weather data was made through 261 local airport weather stations.

A specialized type of airway weather information was provided through the Flight Advisory Weather Service (FAWS). Twenty-six FAWS units, paralleling the Airway Traffic Control Centers of the CAA, functioned in close cooperation with those CAA units in meeting the weather problems of traffic control, and they also provided a large amount of preflight weather briefing and clearance for military and personal plane operations.

Special transoceanic aviation forecasting units at New York, N. Y., Baltimore, Md., Washington, D. C., and Miami, Fla., provided explicit service for civil and military transoceanic flights.

International organizations for aviation.—With the expansion of air transport between nations, international cooperation in meteorology has become even more important that it was before the war. The International Meteorological Organization, established in 1878, has since that time actively promoted meteorological cooperation among the nations by establishing standards for reports, codes, and other techniques, and by fostering the international exchange of weather data. Relatively inactive during the war, the IMO was reactivating its organization during the year. The Chief of Bureau attended a meeting of IMO interests in London in late February, and subsequently the Bureau took further steps to participate in extending the activities and plans of that organization.

Another international organization which plays a large role with respect to international aviation is PICAO (Provisional International Civil Aviation Organization). The Weather Bureau participated in several important conferences of the Meteorological Division of this organization.

To further the coordination of Weather Bureau interests abroad with those of other national weather services, a Weather Bureau meteorological attaché was assigned to London and designated for regular duty in England, France, Russia, and other European countries.

SPECIALIZED WEATHER SERVICES

Hurricane warning service.—Specialized hurricane forecasts continued to be an important service of the Weather Bureau. Twenty-three local stations along the Gulf coast and the Atlantic coast engaged in this service, which is maintained from June to November each year. Forecast offices at San Juan, New Orleans, Miami, and Boston had the direct responsibility for issuing hurricane warnings. Other local stations participated in the collection of special information and in the dissemination of warnings and advices. Three severe hurricanes reached the coast line of the United States and resulted in property damage of more than $80,000,000. Only seven lives were lost, however. This was the lowest mortality rate in the history of the hurricane warning service.

Horticultural protection service.—A horticultural protection service, often referred to as the fruit-frost service, furnished specialized forecasts for orchard heating and other frost protection measures in the west coast and Florida areas. This service is responsible for preventing the loss of enormous quantities of fruits each year. The service is centered from two key stations located at Pomona, Calif., and Lakeland, Fla. Altogether, however, some 60 stations participated in the program by issuing special horticultural warnings. Forecasts and advices were issued specifically according to local conditions and problems, and served as a basis for the application of protection measures. The value of this service in terms of savings to agriculture has been estimated as not less than $20,000,000 annually.

Fire-weather service.—The fire-weather service, which furnishes localized forecasts to fire control units in forest areas, was an important activity of 18 stations. This service contributes materially to the successful control of forest fires, and also makes it possible to deploy fire fighters to the best advantage and with minimum hazard when wind and other weather elements produce critical fire conditions. Although it is impossible to measure the practical value of this service, available evidence indicates that it makes possible savings in timber amounting to more than $10,000,000 annually. One indication of the value of such service is the reduction of annual timber losses by 25 to 30 percent during the last 6 years. This reduction is largely the result of improved protection, of which the fire-weather service was an important part.

Ocean weather observations.—A start was made under deficiency appropriations toward reestablishing radio weather reporting from merchant ships on the high seas. This program was discontinued for security reasons during the war. The increase in transoceanic flying makes more essential than ever before the extensive coverage of ocean weather developments by all feasible means, and with greater attention to standards of observations and regularity of reports. Most of the merchant ship organization that effectively contributed to this work prior to the war has been completely disrupted. A large number of vessels and their officers were lost; most of the postwar merchant marine will be new, and will require building up from the bottom the elements of an effective ocean weather reporting service. Weather Bureau stations at Boston, New York, New Orleans, San Francisco, and Seattle have a key place in this program, but personnel at many other of the larger ports will give particular attention to reestablishing relations with the ships that follow regular trade routes, to enlist their cooperation and support for weather reporting.

The maintenance of special ocean weather stations at a few key locations in the North Atlantic, begun as a prewar measure, was continued during the year, although on a somewhat reduced scale. These stations are covered by Coast Guard ships, each carrying a small unit of Weather Bureau observers who operate a full schedule of weather observations including the regular measurement of conditions in the upper atmosphere by pilot balloon and radio-sounding techniques. This program for the Atlantic is managed from headquarters stations at Boston, Mass., and Argentia, Newfoundland.

CLIMATOLOGICAL SERVICES

Climatological network.—The climatological service of the Weather Bureau was extended and its long record of activity further amplified. During the year climatic data were collected from more than 5,000 substations, for the most part manned by unpaid observers. The daily observations reported from these stations were checked and tabulated in 43 climatological section centers, most of them located at State capitals. The compiled information was made available through a number of publications, including The Monthly Weather Review and weekly, monthly, and annual bulletins of the Climate and Crop Weather Service.

One of the more significant trends during the year was the increased demand for specialized applications of climatological information in the fields of agriculture, industry, commerce, shipping, and aviation. To keep abreast with this trend, the Bureau made long-range plans for providing the information needed in these fields, in a pilot project of major scope and having important implications for the future, as follows:

Machine tabulation of climatological data.—A pilot project was established for the States of Louisiana and Mississippi to test the feasibility of transcribing and compiling weather observations by the use of tabulating machines. Each of the 10 primary stations in these States was provided with a hand punch with which to transcribe the records of surface and upper-air observations on punched cards. These cards were then forwarded to a tabulating center at New Orleans, where they were summarized and processed by machine. The immediate success of this initial project led to development of a considerably expanded program to include the States of Arkansas, Oklahoma, and Texas. This program calls for the complete use of machine tabulation in summarizing climatological data for a total of approximately 900 stations. (It is anticipated that eventually these methods may be applied throughout the country.) Machine tabulation proves to be not only more economical of time than the manual methods of compilation heretofore used, but more complete analysis of available climatological information is made possible. In the past, the climatological compilations have been limited almost entirely to the simplest statistical elements—averages, extremes, and accumulated totals. Machine tabulation will provide complete summarizations, including frequency distribution and probability of important elements of weather and climate in various forms, according to the particular requirements of the interests being served.

The pilot project during the year was carried out in cooperation with the Army and Navy, who likewise transcribed observations taken at 911 military weather stations. Funds totaling over $900,000 were transferred by the Army and Navy to the Weather Bureau in support of the tabulating center at New Orleans and related activities, but most of the activities thus supported were directed to specialized military needs.

Punched card library.—Machine tabulation has been used during the past several years for making extensive climatological studies of strategic importance in the war effort. Out of this has come into being a vast library of 60,000,000 punched cards representing weather observations recorded in the United States and abroad. During the past year the Weather Bureau became the central repository for this punched card library. Over a hundred reference manuals were prepared during the year to summarize and make permanently useful the various decks of cards available in this library. These manuals explain how the cards were punched and are the key to future use as new climatological studies become necessary.

HYDROLOGIC SERVICES

Development of seasonal forecasts.—Seasonal forecasts of water supply for the water year (October to September) were developed

for the Columbia River Basin, the Great Salt Lake Basin, and the Rio Grande Basin. These forecasts were issued monthly in bulletin form from January to May, and provided invaluable guidance in planning water use for irrigation, electric power, and other activities requiring advanced knowledge of probable water supply.

River flood forecasting.—Forecasting relationships useful for more accurate flood forecasting were determined for the Black River in Arkansas, the James River in Virginia, and for the Pearl and Pascagoula Rivers in Mississippi. These and other improved techniques in practical river stage forecasting were put into practical application through training programs for the river district officials who are responsible for the forecast work in the affected localities.

Flood warnings.—One of the vital services performed by the Weather Bureau is the flood-warning service. During the year 40 major floods in the United States caused $50,000,000 of damage to property. Reports covering the value of the flood warnings issued indicate that at least $4,000,000 in damage was prevented by the timely issuance of warnings. Detailed reports on the floods that occurred are available in the pages of the Monthly Weather Review.

Hydrometeorological investigations.—Some 73 storm studies were completed during the year. These studies cover available information as to maximum depths of rainfall accumulated within specified time periods, for each area, as shown by the actual records. From such data, preliminary estimates on maximum possible rainfall were prepared for 28 river basins. Most of these estimates related to drainage basins above projected dams, and provided data essential for correct design of these structures.

These investigations were made specifically for the Corps of Engineers, War Department, and were supported by approximately $100,000 of transferred flood-control funds.

Cooperative flood control activities.—For several years the Weather Bureau has operated an extensive network of stations which make regular measurements of precipitation and furnish reports of river stages. These reports, together with synoptic weather observations and weather forecasts, are relayed directly to offices of the Corps of Engineers, War Department, and become the basis for the operation of flood control works. Precipitation data from 4,369 stations are published regularly in the monthly Hydrologic Bulletins, which serve a basic need in connection with the planning of flood-control activities. Another aid to flood control consists in the preparation of rainfall forecasts, made 24 to 48 hours in advance and giving day to day estimates of the amounts of precipitation that are to be anticipated. During the year the Bureau was strongly supported in the maintenance of its hydroclimatic networks and precipitation reporting program through the transfer of approximately $420,000 from flood control funds of the Corps of Engineers.

Cooperative reclamation studies.—In another cooperative project, studies were conducted under funds transferred from the Bureau of Reclamation to determine from snowfall and rainfall data the maximum possible flood-producing conditions in the upper Colorado and Gunnison River basins, the Big Horn River basin, the Grand River basin, and the North Platte River basin. The results of these investi-

gations will come to bear on design of irrigation dams, spillways, and other engineering works.

SPECIAL PROJECTS ESTABLISHED BY LEGISLATION

Thunderstorm investigations.—To acquire basic knowledge of thunderstorms, a joint program was undertaken during the year by the Army, Navy, National Advisory Committee for Aeronautics, and the Weather Bureau. The Bureau is administering this project, the other agencies cooperating. Violent thunderstorms constitute one of the most serious hazards to flying. Meteorologists have lacked sufficient knowledge of thunderstorm structure and the dynamics of development, to solve the practical problems of forecasting the degree of violence to be expected when thunderstorms arise. Moreover, there is no clear knowledge of the best means by which an aviator may avoid or minimize the hazards as he undertakes to make a flight through an area in which these storms exist or are expected. The first phase of the project was conducted at Orlando, Fla., which is centered in an area subject to maximum thunderstorm activity of a rather simple, cellular type. A special network of 56 meteorological stations in the vicinity of Orlando recorded complete atmospheric data as thunderstorms developed. P–61 aircraft and gliders, equipped with the latest types of automatic recording instruments, were flown through the thunderstorms at various intervals to secure intensive observations at various levels of the storm. Control of all the activities was maintained by following flight paths with recording radar, and a high-frequency radio communications network among the ground stations provided the means for coordination of all observations.

Thunderstorms have passed over this observational network at a frequency of about 45 per month. Approximately two-thirds of these are selected for detailed analysis.

Upon completion of the present investigations at Orlando, the second phase of the project will involve a similar analysis of middle latitude continental thunderstorms. It is expected that the entire project will be completed by the close of the fiscal year 1948.

Arctic meteorological service.—During the year the Weather Bureau was authorized by Public Law No. 296 (79th Cong., 2d sess.) to establish a network of stations at high latitudes of the Western Hemisphere, in cooperation with other interested countries, for the purpose of making surface and upper air weather observations and other meteorological studies of Arctic weather conditions. By the end of the year, plans had been completed for the first phase of this project. Supplies and personnel were scheduled to leave for the Arctic base establishment during July 1946. Supporting facilities for the transportation of personnel and supplies were provided by the Army and Navy. Plans call for the establishment of additional stations in the spring of 1947. The observations taken under this program will fill a serious gap in the collection of meteorological data necessary for weather forecasting.

Philippines rehabilitation.—Under the Philippines Rehabilitation Act (Public Law No. 370, 79th Cong., 2d sess.), the Weather Bureau was assigned the responsibility by Congress of assisting the Philippine

Republic to establish a national meteorological service in that country. Preliminary plans for this project were made during the year. The Weather Bureau will furnish technical assistance, equipment, and certain key personnel during the establishment of this service. The aim is to assist the Philippines in providing a national weather service with stations and techniques that meet modern standards, and capable of taking its place in international meteorology.

RESEARCH ACTIVITIES

Short range forecasts.—A new appropriation of $25,000 permitted the establishment of a short range (24- to 48-hour) forecast development unit in the Central Office at Washington during the year. The unit conducted research on forecasting techniques looking to objective methods for betterment of the following types of forecasts regularly issued for specific areas: quantitative precipitation forecasts in the area of interest to the Tennessee Valley Authority; and winter minimum temperature and precipitation and summer precipitation forecasts for Washington, D. C., and New York, N. Y. Objective methods were developed, which can be used by inexperienced personnel to produce localized forecasts comparing favorably with those prepared by the most experienced forecasters using the general weather maps. The results will assist experienced forecasters in conserving their time and in making their forecasts more explicit.

The unit also made progress in developing methods whereby the likelihood of occurrence of weather elements can be expressed in terms of statistical probabilities.

Another important function of the unit has been to design methods and techniques which regular staff forecasters can use in solving local forecasting problems. Objective methods for forecasting rainfall at Los Angeles have been a valuable aid to the forecasters working in that area. A similar study on thunderstorm forecasting was pursued in the Chicago office.

Extended forecasts.—Research in methods of extended forecasting was conducted by the Central Office group and by the Massachusetts Institute of Technology through a cooperative contract. The work is aimed at devising methods of forecasting circulation patterns and determining the relationships between the circulation patterns and the weather to be anticipated 5 days to a month ahead. There has been some progress, but as in the case of all types of forecasting research, progress will continue to go slow until more is known about the general circulation of the atmosphere and related problems, especially the complex controls on large scale atmospheric changes. Some of these relate to changes in the high atmosphere and solar and electronic influences.

Solar radiation.—The program of solar radiation observations and investigations was somewhat expanded. Special measurements of radiation received on vertical surfaces were made to meet a demand from engineering and architectural interests, and the relationship between the radiation received on vertical surfaces and that received on horizontal surfaces was investigated. This work is of importance in the development of new types of construction and building design.

A new station for measuring solar radiation was established at Climax, Colo., in cooperation with Harvard University; this station will provide observations from an altitude of about 10,000 feet, making it the second highest such station in the United States.

Electronic computer.—The Weather Bureau is taking a small part in projects sponsored by the military service on high altitude research and the use of the electronic computer in solving basic meteorological problems. The electronic computer was developed during the war at the University of Pennsylvania. It makes possible the rapid solution of complex problems which heretofore could not be solved by older methods of computation.

Vertical motion and cyclogenesis.—A study of vertical motion in the atmosphere and the generation of cyclonic disturbances was carried on by New York University under the joint sponsorship of the Army, Navy, and Weather Bureau. The project sought basic information on large-scale vertical motion in the atmosphere and the relationship of such motions to cyclogenesis and the formation of clouds and precipitation. This is fundamental to progress in forecasting these weather conditions.

Technical publications.—During the year, no technical articles were included in the Monthly Weather Review because increased printing costs limited the amount of matter that could be published and the Review could include only regularized tables of data and summaries. Means of reducing printing costs are being investigated to make the Monthly Weather Review once more a medium of publication for research papers in the fields of meteorology and climatology.

All work on the Weather Glossary, compiled by Maj. Alfred H. Thiessen, which has been in preparation for several years, was completed and it was in process of issue at the close of the year. The glossary fills a long-felt need.

Two scientific papers were published as separates during the year. These were: Research Paper Number 24, "Investigation of Polar Anticyclogenesis and Associated Variations of the Zonal Index," by Jerome Namias, and a paper on "Fundamental Relationships Involving Fields of Pressure and Geopotential," by Louis P. Harrison, both of the Weather Bureau staff at Washington.

A report on "Lightning Discharges to Aircraft and Associated Meteorological Conditions," prepared by Weather Bureau investigators, was published by the National Advisory Committee for Aeronautics; this report contains suggestions to pilots for avoiding damage from lightning or thunderstorms. Another study was made to determine the maximum possible weight of snow per square foot of horizontal surface, and the maximum possible wind load on vertical walls resultant from high wind velocities; a report containing this information, of use in designing houses and public buildings, was prepared at the request of the National Bureau of Standards and the National Housing Agency. A study was also made of the distribution of hail of varying sizes in the atmosphere, with a view to application of the information to the design of aircraft windshields and other equipment.

INSTRUMENTAL DEVELOPMENT

Ceilometer program.—Exact measurement of cloud ceilings has long been a problem associated with aviation weather reporting and forecasting. For some years it has been possible to measure ceiling accurately at night by means of a "Ceiling Light Projector," using a strong vertical beam of ordinary light, and measuring from a distance the angular height of this beam to the point where it shows on the cloud base. Until recently, however, use of this technique was limited to night observations, and no rapid or reasonably accurate means was available for determining ceiling height during daylight. At least a partial solution to this problem came with the development of the "Ceilometer," an instrument which uses a modulated light beam and a sensitive electronic detector to measure ceiling heights day or night. The greater sensitivity of the ceilometer makes it possible to follow the beam of light through thin cloud layers and thus to measure the thickness as well as the height of some clouds and at times to secure measurement of a higher second cloud layer.

During the year the Weather Bureau made over 100 installations of these ceilometers at weather stations throughout the country. It is expected that the program, calling for a total of 140 installations, will be completed during the next year, forming an important contribution to safety of flying.

Electronics development.—The development of radar and similar electronics equipment during the war provides improved means of measuring wind movements at various levels in the free atmosphere. Such measurements are regularly needed for increasing altitudes as aircraft seek higher levels for flight and as the influence of the more elevated parts of the atmosphere on weather changes becomes better known. Direct measurements of free-air currents were previously obtained by visual observations of the motion of free balloons, called "pilot balloons," which were followed telescopically by the observer on the ground. This method gave poor results at night when a small light was attached to the balloon, of insufficient candlepower to be observed at any great distance. Moreover, no observations could be obtained, day or night, beyond the base of the first cloud layer into which the balloon might ascend. Visual methods were of little use during bad weather when the information is most urgently needed. The development of electronic equipment for measurement of currents at all heights day or night, and under all conditions of weather has removed both these obstacles. The following paragraphs summarizes progress made by the Weather Bureau during the year in applying the new techniques:

Radiosonde equipment.—Radiosonde transmitters are carried aloft by balloon and automatically transmit by high-frequency radio impulses, the values of temperature, pressure, and humidity recorded at upper-air levels. Sixty-four weather stations now take regular radiosonde observations. (Installations at most of these stations were made during the last decade.)

Radar wind measurements.—Winds-aloft observations may be made by the use of radar equipment to track a target attached to a free balloon and thereby to measure upper-air wind movement. Such

techniques were used extensively during the war by the armed forces, and experimental use of this device has been made by the Weather Bureau during the past year on Coast Guard ships serving as ocean weather stations.

Rawinsonde equipment.—Rawinsonde (radiosonde and radio winds-aloft observation) is, in effect, a combination of pilot balloon (wind) and radiosonde techniques, and has the advantage of obtaining both types of observations simultaneously. The impulses from the radio transmitter carried aloft by the radiosonde instrument are tracked by sensitive direction-finding techniques that permit the course of the currents carrying the balloon to be accurately computed.

Illuminometer.—Important progress was made in developing techniques for the measurement of illumination. Illumination is one of the vital elements of weather which directly affects the operations of such industries as electric power. During extreme cloudiness, for example, power load sharply increases; a power company can anticipate such increased load if means are available for measuring and predicting illumination. During the year progress was made in the use and application of an "Illuminometer" on a project in Baltimore. The practical development of the trial instrument is expected to add illumination data to the weather information now supplied the public.

LATIN-AMERICAN STUDENT-TRAINING PROGRAM

With funds transferred from the State Department, through the Inter-Departmental Committee on Scientific and Cultural Cooperation, awards were made to nine Latin-American students, one each from Cuba, Mexico, Chile, Panama, and Ecuador, and two from Brazil and Peru.

The award provided 3 months of premeteorological training and some refresher work in mathematics and physics, followed by 9 months of instruction at one of the universities conducting advanced courses in meteorology. Three months of practical work at a Weather Bureau forecast center completes the training. During 1945–46 the scholarships were assigned to men already engaged in meteorological work in the country represented; in fact, three selectees were outstanding officials of the Government meteorological services who had already attained distinction.

To supplement the training program, Spanish translations of two pamphlets have been prepared. These make available the official Weather Bureau Circulars on "Clouds," and also the privately published work on "Introduction to Air Mass and Isentropic Analysis," by Jerome Namias. Publication of these pamphlets has been approved by the Central Translating Bureau of the State Department and distribution will be made jointly by the Weather Bureau and the State Department.

PERSONNEL

Veterans.—With the end of the war the return of veterans well trained in the science of meteorology gave greater selection in recruiting for technical and scientific positions in the Weather Bureau. During the year 913 veterans were added to the Bureau's rolls, approxi-

mately half of them former employees of the Bureau returning from military furlough. Applications for employment were at an all-time peak, and the experience and training of applicants were of a caliber not heretofore available on such a general scale.

Employment.—One thousand six hundred and seventy-three new employees were added to the Bureau, while 610 employees were separated. As of June 28, 1946, the Weather Bureau had 4,243 full-time employees on regular appropriations and working funds, with an additional 3,069 part-time employees. In addition to paid employees of the Bureau, 7,436 cooperative observers were engaged without compensation in limited observational activities.

Reclassifications.—Early in 1945 a team of analysts from the Civil Service Commission made a comprehensive study of the professional and subprofessional positions in the field service of the Bureau and prepared new job specifications for such positions in the meteorological series. With the findings of this group as a basis, a board was convened to review the classification of all positions in the field service. By the end of the year, approximately 3,000 positions had been allocated in conformity with the new specifications and the program of reclassification of field positions was largely completed, with about 1,700 positions reallocated to higher grade as result of the survey.

Training.—Training of Bureau personnel at the professional level, which, during the 5 years prior to 1944, was conducted by assignment of personnel to universities that have meteorology departments, was again reduced because of shortage of personnel and limited capacities of the universities to accept students. Emphasis in the training of subprofessional personnel shifted from the wartime requirements of training new and inexperienced personnel, to a program of refresher training designed to assist veterans in familiarizing themselves with Weather Bureau methods and practice. Two employees of the Weather Bureau were in successive classes of the Civil Service Commission for administrative interneship training.

OTHER ADMINISTRATIVE DEVELOPMENTS

Budgetary control.—An entirely new allotment system was instituted at the beginning of the fiscal year to implement improved methods of fiscal control. The system was established following a thorough survey of budget and fiscal procedures, aided by staff members of the Budget Bureau's Division of Administrative Management. In general, the objectives of the new allotment system were to decentralize fiscal operations into regional offices insofar as possible, and, in addition, to provide a more effective over-all control of expenditures. Installation of the new system was followed by a marked improvement in the efficiency of fiscal administration.

Space shortages.—The Bureau was severely handicapped by the lack of adequate office space, particularly in the Washington area. Curtailment of building plans during the war, and more recently because of the housing shortage, has forced the Bureau to conduct many of its activities in crowded and unsatisfactory quarters. Alleviation of these serious conditions cannot be anticipated until it becomes possible to complete the construction of additional wings projected for

the present Administration Building, this construction being further delayed by the crisis in national housing.

Consolidation of climatological and hydrologic administrative functions.—As the year ended, plans had been completed for the administrative consolidation of the climatological and hydrologic functions of the Bureau in a Division of Climatological and Hydrologic Services, and the consolidation was to become effective July 1, 1946. The related nature of these services has long required closer coordination, and the consolidation of functions is expected to result in a more efficient and productive program for both services.

Organization of the Weather Bureau field service indicating types of stations and activities performed as of June 30, 1946

Weather Bureau offices manned by full-time personnel	413
Functional activities:	
Regional offices	8
General forecasting centers	15
Airway forecasting centers	18
Climatological section centers	43
River district centers	96
Hydroclimatic computing units	7
Radiosonde observation stations	64
Pilot balloon observation stations	155
Vessel contact stations	27

Number and type of substation reports

(Furnished by cooperative or part-time personnel)

A. Activities under regular appropriations:	
1. Aviation Weather Service	477
(Frequent weather observations reported for aviation.)	
2. Climatological Service	5,644
(Weather data furnished to determine the climatological characteristics of the United States. These stations are, for the most part, manned by unpaid observers.)	
3. General Weather Service	918
(Observations reported for the benefit of agricultural interests, and stations maintained to provide warnings of approaching storms and hurricanes.)	
4. River and Flood Service	2,076
(River stage and rainfall reports furnished for the preparation of streamflow and flood forecasts.)	
Total substation activities related to regular appropriations	9,115
B. Activities under transfers from other appropriations:	
1. Hydroclimatic Service	3,039
(Reports from recording rain gages giving precipitation intensities for storm studies and flood control.)	
Total substation activities (separate types of reports, etc.)	12,154
Reports from "multiple-purpose" stations (resulting in duplicate listing of such stations in above tabulation in 1924 cases). Deduct	2,840
Total reporting stations	9,314

Financial Summary, Fiscal Year 1946

Obligations against direct appropriations:

Purpose	*Amount*	
1. Administration		$1,126,687
2. Direct aid to aviation.		
(a) Terminal and route forecasting for domestic airways	$397,271	
(b) Terminal and route forecasting for international airways	289,831	
(c) Flight advisory weather service	677,504	
(d) Localized airway weather services	971,729	
Total—direct aid to aviation		2,336,335
3. General weather forecasting service		1,204,760
4. Localized daily weather services for the general public (non-specialized)		2,756,315
5. Specialized weather services for the general public.		
(a) Hurricane and storm warning services	$380,226	
(b) Fruit-frost service	135,171	
(c) Fire-weather service	235,426	
(d) Farm operational advices	267,419	
(e) Industrial and commercial weather advices	420,634	
Total—specialized weather services for the general public		1,438,876
6. Climatological and crop-weather services		2,196,027
7. Maintenance of stations serving both aviation and general public requirements		3,804,477
8. River and flood service		347,387
9. Research		272,887
Grand total—obligations against direct appropriations		15,483,751

Obligations against funds transferred from other appropriations:

Source	*Amount*	
Flood control, general (reporting networks, hydrologic studies)	$504,733	
Air Corps, Army (statistics, research, weather reporting stations)	973,591	
Aviation, Navy (statistics, research, weather reporting stations)	132,989	
Reclamation fund, Interior (hydrometeorological studies)	21,270	
Improvement and maintenance of river and harbor works	1,619	
Total obligations against transferred funds		1,634,202
Grand total obligations, all funds		17,117,953

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