

world at large of advances in the period of forecasting, and are inclined to believe that the twentieth century will mark the beginning of another period in meteorological science.

OBSERVATORY BUILDINGS.

Carrying out the policy of the Department, the Weather Bureau has continued to cooperate with the leading universities throughout the country, and at the present time the relations existing are more cordial and the work done more important than at any time in the history of the service. Several universities and colleges have donated ground for the erection of buildings, notably the Bradley Polytechnic Institute of Peoria, Ill., and the Epworth University of Oklahoma, Okla. Appreciation of the value of the work being done by the Weather Bureau has also been demonstrated by several other universities in placing at the disposal of the Bureau, without cost, office quarters in their buildings for recently established stations, among them being Brown University of Providence, R. I., and the University of Wisconsin, at Madison, Wis.

Buildings owned by the Weather Bureau.

Location.	Value of lot.	Value of buildings.	Total value.
Amarillo, Tex.	\$1,255.00	\$6,503.00	\$7,758.00
Atlantic City, N. J.	(a)	6,000.00	6,000.00
Bismarck, N. Dak.	(a)	10,000.00	10,000.00
Block Island, R. I.	1,100.00	7,700.00	8,800.00
Cape Henry, Va.	(a)	9,104.25	9,104.25
Devils Lake, N. Dak.	2,300.00	8,000.00	10,300.00
Duluth, Minn.	2,100.00	7,900.00	10,000.00
Hatteras, N. C.	125.00	4,875.00	5,000.00
Havre, Mont.	1,850.00	5,700.00	7,550.00
Jupiter, Fla.	(a)	6,094.95	6,094.95
Key West, Fla.	2,020.00	7,991.75	10,011.75
Kittyhawk, N. C.	(a)	1,616.00	1,616.00
Modena, Utah.	(a)	4,346.00	4,346.00
Mount Weather, Va.:			
Observatory building	2,000.00	18,000.00	20,000.00
Power house and balloon building	650.00	8,000.00	8,650.00
Stable		2,000.00	2,000.00
Mount Washington, N. H.	(b)	300.00	300.00
Narragansett Pier, R. I.	4,100.00	8,000.00	12,100.00
North Head, Wash.	(a)	4,000.00	4,000.00
Point Reyes Light, Cal.	(a)	3,000.00	3,000.00
Port Crescent, Wash.	82.00	1,000.00	1,082.00
Sand Key, Fla.	(a)	5,593.00	5,593.00
Sault Ste. Marie, Mich.	(a)	3,000.00	3,000.00
Southeast Farallon, Cal.	(a)	5,211.22	5,211.22
Tatoosh Island, Wash.	(a)	5,000.00	5,000.00
Washington, D. C.	25,000.00	150,000.00	175,000.00
Yellowstone Park, Wyo.	(a)	11,500.00	11,500.00
Yuma, Ariz.	(a)	1,500.00	1,500.00
Total	42,582.00	311,938.17	354,520.17

a Government reservation.

b Leased.

Weather Bureau buildings in course of construction, and approximate cost of each.

Location.	Cost of lot.	Cost of buildings.	Total cost.
Columbia, S. C.	\$3,799.00	\$9,170.00	\$12,969.00
Peoria, Ill.	54.00	7,915.00	7,969.00
Nantucket, Mass.	1,236.50	3,968.00	5,204.50
Mount Weather, Va. (3 buildings):			
Absolute building	(a)	6,500.00	6,500.00
Variation building	(a)	8,000.00	8,000.00
Kite building	(a)	3,000.00	3,000.00
Total	5,089.50	38,583.00	43,672.50

a Government reservation.

The erection of buildings by the Weather Bureau not only saves the amount previously paid for rent of office quarters, but adds very much to the prestige of the service here and abroad. This prestige will be further increased upon the completion of the group of observatory buildings at Mount Weather, Va., at which place it is intended to conduct extensive experimental and research work. The present appropriation provides for the erection of not less than five buildings, but this number has proven inadequate to the growing demands from all sections of the country, and it is hoped that Congress will soon increase the appropriation sufficiently to provide for the erection of not less than ten buildings annually.

Rented buildings occupied wholly by the Weather Bureau.

Station.	Annual rent.	Other items included.
Cape May, N. J.	\$650.00	Heat, cleaner, light.
Durango, Colo.	440.00	Heat, cleaner, water.
Flagstaff, Ariz.	300.00	
Lewiston, Idaho	540.00	
Williston, N. Dak.	450.00	Heat, cleaner, light, water.
Winnemucca, Nev.	360.00	Heat, light, water.
Helena, Mont.	504.00	Heat, water.
Santa Fe, N. Mex.	360.00	
Charles City, Iowa	420.00	Heat, light, water.
Roswell, N. Mex.	720.00	Heat, cleaner, light.

Stations at which observers' quarters are furnished by the Government separate from offices.

Station.	Annual rent.	
	Office.	Residence.
Havana, Cuba	(a)	\$300.00
Honolulu, Hawaii	\$480.00	540.00

a Public.

CLIMATE AND CROP DIVISION.

IMPROVEMENT OF ESTABLISHED LINES OF WORK.

The amount of funds allotted this division for this work during the year ending June 30, 1904 was the same as for the previous year. Therefore only those lines of work previously established have been pursued. The maintenance and improvement of established lines of work and the extension of the distribution of weather forecasts and special warnings as far as available means would permit have constituted the work of the year. The last-mentioned feature affords about the only item for especial remark in this report. Some of the older methods of distribution have in some instances been abandoned for the quicker, more effective, and less expensive means of dissemination by the telephone through rural telephone exchanges, the details of which are given elsewhere under the proper heading.

Action was taken during the latter part of the year to purchase a supply of thermometer supports of a new design, with a view of determining the advisability of their adoption for use at voluntary stations. These supports were not received in time to be given a test before the close of the fiscal year, but they are promised at an early date. It may be stated in this connection that there was a decided decrease in the breakage of thermometers at voluntary stations during the year, no doubt due in a great measure to a change in the method of mounting authorized in the previous year. From opinions expressed by some prominent section directors who have seen the new device, it is expected that the contemplated tests will lead to its adoption, and that a further decrease in the breakage of thermometers will result.

VOLUNTARY METEOROLOGICAL STATIONS.

Although nearly 300 voluntary stations were established during the year, the total number, 3367, but slightly exceeds the number in operation at the close of the previous year, nearly as many stations as were opened having been discontinued. No serious injury, however, has been sustained by the loss of a majority of the stations discontinued, as in but few instances were they located where it was important to have the records continued. Of the new stations opened a number have been located in the higher and less accessible places in the mountain districts in the semiarid States, with a view to meeting more fully the demands from irrigation engineers for rainfall data. Efforts have been continued to improve the instrumental equipment and the character of the exposure of instruments. More than 400 stations were inspected by section directors, and the inspection reports received show that, while most observers are efficient and painstaking in their work, there are but few stations that were not in some way benefited by the section director's visit.

Correspondence with the Chief Signal Officer of the Army resulted in securing the generous cooperation of that official in the opening of a number of voluntary stations in Alaska along the military telegraph lines. For this purpose twenty sets of instruments, constituting the voluntary observer's equipment, were sent to officers having charge of the telegraph lines, for the equipment of stations under charge of the Signal Corps telegraph operators. As a result of this action meteorological records are already being received from new Alaskan stations, and, with the establishment of the full number of stations for which equipments have been provided, the Bureau will receive meteorological data from a region concerning which available information is very meager.

In March, 1904, action was taken to establish a section of the Climate and Crop Service of the Bureau in the Hawaiian Islands. Twenty complete instrumental outfits were sent to Honolulu for this purpose and other arrangements, incident to the inauguration of a section of the Climate and Crop Service, had so far advanced by the close of the year as to justify the hope that the section would be in full operation and issuing the standard publication before the close of the succeeding year.

#### CLIMATE AND CROP BULLETINS.

No change has been made in the character of the National Climate and Crop Bulletin, nor in the method of collecting the reports used therein. This bulletin continues to be one of the most important publications of the Bureau, supplying, as it does, very complete information as to current weather conditions and their effect upon farm work and the growth and development of crops. The scope and purpose of this publication have been fully stated in previous reports.

#### MONTHLY REPORTS AND ANNUAL SUMMARIES OF CLIMATE AND CROP SECTIONS.

Each of the forty-three section centers has without interruption issued monthly reports and annual summaries containing the data afforded by the reports of the regular and voluntary stations. The demand for these publications is constantly increasing, rendering it necessary to secure the strictest economy in their distribution. They answer so fully and in such detail so many requests for information as to the climate of the different sections of the country that an application for information of this character can nearly always be satisfactorily met by supplying a monthly report or an annual summary.

#### SNOW AND ICE BULLETIN.

This publication, issued from the first week in December to the last week in March, shows the depth of snow on ground and the thickness of ice in rivers and other bodies of water. It meets an important need in supplying information as to protection afforded by snow to the winter wheat crop during the trying periods when the crop is exposed to injury from alternate thawing and freezing of the ground. It also continues to be of value to ice dealers and the manufacturers of rubber and other goods, the sale of which is largely governed by the presence or absence of snow or ice.

#### CORN, WHEAT, COTTON, SUGAR, RICE, AND FRUIT SERVICES.

These services have continued without change in the method of collection or publication of reports. Daily bulletins are issued from the several district centers, containing the full report from each substation, with the averages for all stations in each of the various districts.

#### SECTION SNOW BULLETINS.

The snow bulletins issued by the climate and crop sections in the Rocky Mountain and Plateau regions were more complete during the winter of 1903-4 than in any previous year, owing in a large measure to a plan of cooperation with the General Land Office, whereby was secured the aid of a large number of forest-reserve officers in reporting the depth of snow, more particularly at high altitudes. As these section snow bulletins show the amount of snow in the mountains, they afford a reliable basis for estimating the probable water

supply and flow of streams for the succeeding spring and summer, and are therefore of much value to the important interests affected thereby.

#### DISTRIBUTION OF FORECASTS AND SPECIAL WARNINGS.

With no increase in the allotment for work in this direction, a repetition of the remarks in the annual report of last year would nearly cover the present situation. All that it was possible to do with available funds has been done, and every opportunity for extension where it could be done without exceeding the appropriation has been embraced.

There is a slight increase (61) in the number of places receiving daily forecasts by telegraph or telephone at Government expense; and as these points are, as a rule, selected on account of their eligibility as centers of distribution, the forecasts have been distributed in many sections not heretofore supplied with this information.

About 200 addresses were dropped from the emergency warning list, which has been revised and now provides for the distribution of special warnings of tropical hurricanes or storms and cold waves of unusual severity to postmasters at 6152 points, who pass the bulletins in their offices for the benefit of the public and in many instances telephone the warnings to adjacent points having special interests to be protected.

The railway telegraph and train services have continued in operation, supplying in the aggregate over 5000 railroad stations with the daily forecasts, which are bulletined in the waiting rooms for the benefit of the employees and the traveling public.

Comparatively little change is shown in the number of card forecasts issued daily. This portion of the work has been so carefully examined into in previous years that nearly every post-office which could be reached in time to make the predictions of value is now being served. As mail schedules are changed the lists are modified, and as a rule the number added about equals that discontinued. Postmasters continue their cooperation in this, as well as in the Rural Free Delivery Service, and in a large number of instances have extensive lists to which the card forecasts are distributed daily. Action was taken to prevent the printing of names of individuals or firms on cards in connection with the forecasts. The Bureau is now free from this annoying advertising feature, and, so far as known, the cards as now issued contain nothing but the official forecasts, with occasionally a date and the name of the center from which the cards are distributed. The stand taken by the Bureau in this matter resulted in the loss of the cooperation of a few of the oldest distributors, who kept up the work on account of its advertising possibilities; but arrangements were quickly effected whereby others took up the work, or the substations were supplied from adjacent centers.

Through several causes the number of addresses on the rural free-delivery lists has been largely decreased as compared with that of the previous year, owing principally to the discontinuance of the afternoon forecast distribution from Columbus, Ohio, and the transfer of a large portion of this work in Iowa from the rural free delivery to the free telephone service. There are now available sufficient data to enable us to extend the rural free-delivery distribution, when practicable, to every route on which the carrier leaves the distributing office at an hour sufficiently late to receive the morning forecasts by telegraph from the district center.

The rural telephone lines are now the best and most economical means of distributing weather information. The forecasts are quickly disseminated, cover a large territory, and at little or no expense to the Government. Through arrangements made between the Weather Bureau officials at Cleveland and Columbus and two of the great trunk telephone lines, the daily morning forecasts are now available for the use of more than 100,000 subscribers in the State of Ohio, and the records

at hand indicate that nearly one-half of that number are taking advantage of this opportunity to get the forecasts in their homes within a few minutes after their preparation at the district center. Officials of telephone companies operating lines in other States are rapidly signifying their desire to cooperate in this work, and it may be safely stated that the close of another fiscal year will show a gratuitous distribution of daily forecasts over the greater proportion of all independent telephone lines between the Atlantic seaboard and the western borders of Kansas, and as far south in the Middle West as the northern portion of Texas. The general manager of one of the largest independent lines in the State of Ohio stated in a circular letter to the managers of his exchanges that "intelligent handling of these reports will do much to make your service attractive, and whenever your service is attractive it is popular, and whenever popular it is a revenue producer." As these independent lines are merged with the long-distance companies the necessity for telegraphic forecasts to individual exchanges will cease to exist, making it possible to further extend the distribution over rural free-delivery lines into agricultural sections not now supplied with the forecasts.

The following statement shows the distribution by States and Territories and the changes, as compared with work of the previous year:

Distribution of daily forecasts and special and emergency warnings.

State or Territory.	At Government expense.			Without expense to United States by—				
	Forecasts and special warnings.	Special warnings only.	Emergency warning.	Mail.	Rural free delivery.	Telephone.	Railroad telegraph.	Railroad train service.
Alabama	23	4	139	1,175	257	107	83	12
Arizona	3	1	0	0	0	1	0	0
Arkansas	19	3	102	541	249	97	5	0
California	128	10	0	2,549	2,218	35	0	0
Colorado	17	67	39	980	1,016	1,889	0	7
Connecticut	11	3	49	1,074	100	0	15	151
Delaware	9	0	0	36	520	0	41	0
District of Columbia	0	0	0	1,199	0	0	0	0
Florida	27	127	61	917	0	42	91	0
Georgia	39	39	241	1,527	1,532	30	222	41
Idaho	10	1	0	371	0	4	0	17
Illinois	109	24	468	3,082	6,783	7,962	115	459
Indiana	93	16	208	1,913	5,488	6,658	68	287
Indian Territory	7	0	4	194	0	630	0	0
Iowa	168	30	400	1,730	7,667	51,083	13	0
Kansas	69	9	186	889	4,187	1,164	15	15
Kentucky	41	34	96	2,095	75	3,606	18	0
Louisiana	26	45	61	921	0	28	0	0
Maine	21	4	40	1,107	920	4	0	77
Maryland	26	4	42	1,778	1,384	15	101	0
Massachusetts	24	20	63	3,040	10,025	12	1	331
Michigan	115	21	379	4,894	4,888	4,208	253	457
Minnesota	62	18	196	1,961	2,342	1,744	13	0
Mississippi	55	6	118	703	0	49	6	0
Missouri	84	10	240	5,254	6,581	1,505	25	0
Montana	15	20	18	499	0	5	0	0
Nebraska	63	9	221	1,110	1,227	1,133	0	0
Nevada	3	0	0	205	0	0	0	0
New Hampshire	18	1	34	1,184	1,205	0	0	31
New Jersey	23	25	45	1,219	255	3	189	0
New Mexico	3	3	0	15	0	84	7	0
New York	106	68	365	7,549	9,359	3,467	363	168
North Carolina	56	20	189	1,131	268	24	1	16
North Dakota	16	9	99	0	258	74	0	0
Ohio	136	89	437	7,951	6,693	46,328	37	17
Oklahoma	7	2	13	214	0	2,598	9	0
Oregon	16	2	0	689	600	0	0	104
Pennsylvania	59	18	367	4,299	485	1,525	660	0
Rhode Island	4	0	12	105	0	1	0	28
South Carolina	34	5	109	1,123	456	193	30	23
South Dakota	33	19	77	800	195	2,981	0	0
Tennessee	43	11	291	1,534	1,370	217	23	2
Texas	57	66	240	1,769	1,583	250	154	0
Utah	14	62	0	372	290	6	0	0
Vermont	10	1	46	547	100	0	3	13
Virginia	43	9	96	1,572	228	118	60	96
Washington	21	5	0	737	876	8	0	29
West Virginia	18	11	55	987	232	1,619	18	26
Wisconsin	85	24	298	1,952	1,687	10,787	0	16
Wyoming	7	3	8	112	40	1	11	0
Total June 30, 1904	2,076	983	6,152	77,605	83,639	152,302	2,655	2,423
Total June 30, 1903	2,015	926	7,096	78,164	97,648	28,251	3,087	2,423
Changes	+61	+57	-944	-559	-14,009	+124,051	-432	0

THE MOUNT WEATHER METEOROLOGICAL RESEARCH OBSERVATORY.

At Mount Weather, Va., it is proposed to make and send out the apparatus for the exploring of the atmosphere to altitudes of 3 to 10 miles. In this work it is probable that many balloons will be simultaneously liberated from different stations, so as to get records of storms and of cold waves from their four quadrants. With the knowledge thus gained of vertical gradients of pressure and temperature, it will doubtless be possible to gain a better understanding of the mechanics of storms. This exploration will be useful in determining how near right are those who believe that change in temperature other than seasonal is mainly a function of the mechanics of the lower atmosphere—that portion lying below the 10-mile level; that in the study of those aberrations of climate called "weather" investigators need concern themselves only with the atmosphere near the earth; and that variations in the condition and in the intensity of the many forms of solar radiation are inappreciable in their effect on the weather of the earth.

With observations from the magnetic, the electric, and the solar physics observatories which the Department is now building, and which will be equipped with the most approved appliances, opportunity will be given to those who believe that the cyclonic or anticyclonic whirls that constitute storms or cold waves are mainly the result of changes in the amount or intensity of some form of solar radiation. It is the opinion of the writer that the synchronism of changes in the activity of the chromosphere of the sun and the weather of the earth has not yet been established with sufficient definiteness to be of benefit to the forecaster, but a working hypothesis has been formulated which stimulates thought, study, and investigation. This fact must be credited to the patient work of Prof. Frank H. Bigelow. Even those who differ from him in their conclusions relative to the association between astrophysics and meteorology must admit that the fertility of his thought and his earnest seeking after the problems which, when solved, shall raise meteorology from empiricism to a closer approach to an exact science have been highly beneficial. The study of storms has too long been made from a single view point. Daring minds are needed, even those that are willing to take a considerable hazard in the hypotheses which they are willing to lay down and attempt to demonstrate: for to doubt is to investigate. New truths are usually discovered by working inductively along conventional lines, but some of the greatest principles in nature have been made known to the world by deductive reasoning and by the assumption of a hypothesis that could not at the time be demonstrated. Due deference must be given to each other's opinions, and all must strive earnestly for the elucidation of the many difficult problems that now confront the meteorologist.

LINES OF PROPOSED INVESTIGATIONS.

It is proposed to make the research at Mount Weather catholic in its broadness; to look for the truth, and not to despise its source or the means of its conveyance; to discuss meteorological observations from the point of view of their relations to solar physics; to select meteorologic and magnetic elements and compare them with solar observations; to carry on research in the allied subjects of radiation, atmospheric electricity, ionization of gases, radioactivity, etc. Progress in knowledge of the effects of the sun's actions upon weather conditions depends upon introducing more refined processes than have generally been assigned to meteorology. It is hoped to determine the nature of the alliance between meteorology and solar physics. The atmosphere of the sun and of the earth, together with the connecting radiations, will be studied as one branch of science having common interests, which may be designated as cosmical meteorology.

In the seven buildings at Mount Weather the Weather Bureau will have the most approved apparatus for measuring