

MONTHLY WEATHER REVIEW.

Editor: Prof. CLEVELAND ABBE.

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INTRODUCTION.

The MONTHLY WEATHER REVIEW for February, 1899, is based on about 2,762 reports from stations occupied by regular and voluntary observers, classified as follows: 162 from Weather Bureau stations; numerous special river stations; 32 from post surgeons, received through the Surgeon General, United States Army; 2,385 from voluntary observers; 96 received through the Southern Pacific Railway Company; 29 from Life-Saving stations, received through the Superintendent United States Life-Saving Service; 31 from Canadian stations; 10 from Mexican stations; 7 from Jamaica, W. I. International simultaneous observations are received from a few stations and used, together with trustworthy newspaper extracts and special reports.

Special acknowledgment is made of the hearty cooperation of Prof. R. F. Stupart, Director of the Meteorological Service of the Dominion of Canada; Mr. Curtis J. Lyons, Meteorologist to the Hawaiian Government Survey, Honolulu; Dr. Mariano Bárcena, Director of the Central Meteorological and Magnetic Observatory of Mexico; Mr. Maxwell Hall, Government Meteorologist, Kingston, Jamaica; Capt. S. I. Kim-

ball, Superintendent of the United States Life-Saving Service; and Commander J. E. Craig, Hydrographer, United States Navy.

The REVIEW is prepared under the general editorial supervision of Prof. Cleveland Abbe.

Attention is called to the fact that the clocks and self-registers at regular Weather Bureau stations are all set to seventy-fifth meridian or eastern standard time, which is exactly five hours behind Greenwich time; as far as practicable, only this standard of time is used in the text of the REVIEW, since all Weather Bureau observations are required to be taken and recorded by it. The standards used by the public in the United States and Canada and by the voluntary observers are believed to conform generally to the modern international system of standard meridians, one hour apart, beginning with Greenwich. Records of miscellaneous phenomena that are reported occasionally in other standards of time by voluntary observers or newspaper correspondents are sometimes corrected to agree with the eastern standard; otherwise, the local meridian is mentioned.

FORECASTS AND WARNINGS.

By Prof. E. B. GARRIOTT, in charge of Forecast Division.

During the first half of February the most remarkable cold wave, or series of cold waves, in the history of the Weather Bureau traversed the United States from the north Pacific to the south Atlantic coasts, damaging crops and fruits in the Southern States to the extent of millions of dollars. During the first eight days of the month the lowest temperatures on record were reported at points in the north Pacific coast States; from the 9th to the 12th many places in the Central, Western, and Northwestern States reported the coldest weather on record. During the 13th and 14th the cold wave overspread the Southern and Eastern States, attended, on the 13th, by the lowest temperatures on record from the southern Rocky Mountain slope to the south Atlantic coast, by zero temperatures to the Gulf coast of Alabama, and by a snowstorm of unprecedented severity in the Middle Atlantic States.

The visible cause of this period of intense cold is found in a series of barometric depressions in the South, combined with an area of high barometer of great magnitude which persistently occupied the British Northwest Territory until the 11th, inclusive, when the highest sea-level pressure ever reported within the region of observation covered by the Weather Bureau and Canadian services, 31.42 inches, was telegraphed from Swift Current, Assiniboia. After the 11th this area of high barometer settled southward over the eastern Rocky Mountain slope and the central valleys, causing the severest winter weather ever experienced generally over the southern

half of the country east of the Rocky Mountains. The meteorological conditions presented by the daily weather maps during the eastern and southern advance of the cold wave are shown on Charts X and XI. It will be observed, by a comparison of these maps with the Weather Bureau forecasts and warnings issued, that ample and timely warning of the advance of the cold wave was given to all interests that were likely to be injuriously affected by intense cold. It will also be noted that special reports and newspaper comments made in connection with the cold-wave visitation give unquestionable evidence that the warnings prompted protective measures, whereby crops, live stock, and perishable goods and merchandise to the value of hundreds of thousands of dollars were saved.

As early as the evening of February 10, Santa Fe, Oklahoma, and stations in the interior of Texas were notified of the approach of a severe cold wave. On the 11th cold-wave signals were ordered for the Texas coast, New Orleans, Mobile, Meridian, Pensacola, Atlanta, and Montgomery, and the warnings were distributed throughout the States represented by the stations named. Jacksonville, Fla., was advised on the 11th that freezing temperature would probably occur over the northern third of Florida Sunday night.

On the morning of the 12th the truck-growing centers about Galveston, Tex., were notified, by telegraph and telephone, that a hard freeze was indicated for Sunday night and that

crops should be given all possible protection. The afternoon papers of New Orleans, issued at 1 p. m., published a special bulletin, in which the citizens of that city were informed that the temperature at New Orleans was likely to fall as low as 6° or 8° above zero, and that without doubt all records for cold weather in New Orleans would be broken Sunday night. Storm signals were displayed along the middle and east Gulf coasts, with warnings of high gales and freezing weather on the Gulf. Emergency warnings, stating that freezing weather would extend as far south as Tampa, were given the most complete distribution that was feasible with the existing telegraph, telephone, and mail facilities of Florida. Storm signals were displayed on the south Atlantic coast; from Wilmington to Eastport signals for northeast gales were ordered; and from New Jersey and Pennsylvania over New York and New England special warnings of heavy snow were telegraphed to all Weather Bureau stations, with instructions to notify railroad and transportation interests.

During the night of Sunday, the 12-13th, the cold wave swept southward to the Gulf of Mexico, breaking all previous low-temperature records in the South and Southwest, as shown in the following table:

Station.	Lowest previous temperature recorded.	Minimum temperature February 13, 1899.	Departure below lowest previous temperature.
Concordia, Kans.....	-25	-26	1
Dodge, Kans.....	-20	-24	4
Wichita, Kans.....	-14	-22	8
Oklahoma, Okla.....	-11	-18	7
Amarillo, Tex.....	-14	-16	2
Abilene, Tex.....	-5	-6	1
Palestine, Tex.....	-1	-4	3
San Antonio, Tex.....	6	4	2
Galveston, Tex.....	11	6	5
Springfield, Mo.....	-17	-28	11
Little Rock, Ark.....	-5	-12	7
Nashville, Tenn.....	-10	-12	2
Chattanooga, Tenn.....	-7	-10	3
Shreveport, La.....	1	-4	5
Vicksburg, Miss.....	3	zero	3
New Orleans, La.....	15	7	8
Mobile, Ala.....	12	-1	13
Montgomery, Ala.....	5	-4	9
Atlanta, Ga.....	-2	-6	4
Savannah, Ga.....	12	8	4
Jacksonville, Fla.....	14	10	4

✱ The situation the morning of the 13th was as follows: The line of zero temperature extended to central Louisiana, southern Mississippi, southern Alabama, and central Georgia. At New Orleans a minimum of 6.8° was registered, a reading which was 8.2° lower than any previous record. Throughout the Gulf States the minimum temperatures were 3° to 9° lower than ever before noted. Heavy snow was falling in the Atlantic coast States, the snowfall being particularly heavy in the Potomac Valley and Chesapeake region. In the morning additional warnings were telegraphed to Florida that temperature would be much below freezing again Monday night as far south as Tampa, and possibly freezing as far south as Jupiter, and a warning of a norther for the north coast of Cuba was sent to Havana, Cuba. Along the Atlantic coast from Breakwater to Eastport hurricane warnings, the extreme storm warnings of the Bureau, were displayed. Storm signals were continued southward along the coast to North Carolina. The night of the 13th a further fall in temperature occurred over southern Florida, the morning minimum of the 14th being 29° at Miami.

The following reports from along the line of the advance of the cold wave in the Southern and Southwestern States, where a temperature approaching zero is especially disastrous to live stock and products of the soil, as well as a source of serious discomfort to man, indicate the intensity of the cold experienced and the benefits derived from the warnings:

Galveston, Tex., I. M. Cline, Local Forecast Official, Weather Bureau:

About 800 warnings of a hard freeze Sunday night were distributed by telegraph and telephone Sunday morning, and many truck growers made heroic efforts to protect their crops. Conservative estimates place the value of crops saved as a direct result of the warnings at \$100,000. Besides, live stock to the value of \$200,000 was given all possible protection, and heavy losses in that direction were averted.

Referring to the warnings distributed throughout western Texas, the Abilene West Texas Sentinel, of February 23, 1899, remarks as follows:

The freeze was by all odds the severest ever known in this part of Texas. The local Weather Bureau office gave out the forecast twenty-four hours in advance of the arrival here of the cold wave. If every one interested, and who received or could have received the information, had taken prompt advantage of the warning there is no telling how much saving in the matter of live stock alone would have resulted. As it was many of our stockmen and farmers who have learned to rely largely on the weather forecasts took steps at once to protect their stock from the cold wave they knew was fast approaching. They didn't act upon the idea that a cold wave might be coming, but they knew it was coming when Mr. Oliver, the Weather Bureau Observer, said so, and went to work accordingly and secured their stock. Where the telegraph and telephone could not be used messengers were sent out to warn people to get ready for the cold wave.

New Orleans, La., Alexander G. McAdie, Forecast Official, Weather Bureau:

On the 12th a special bulletin and a special map were issued giving warning of still colder weather. In telegrams sent to different places in the State it was stated that zero temperature would probably be reached throughout the greater portion of the Gulf States. For New Orleans it was thought that the temperature might fall to about 8° by Monday morning. The lowest temperature recorded at New Orleans was 6.8° on Monday morning. This temperature is the lowest ever recorded in New Orleans by the Weather Bureau. Replies to a letter of inquiry sent to nearly 150 crop correspondents of the Weather Bureau showed that it was impossible to estimate the loss to crops by the freeze, but it is thought that it will amount to several millions of dollars. The early vegetable crop was entirely destroyed, the orange crop was a total loss, and trees were killed, the cane crop was considerably injured, and fruit, aside from oranges, was seriously injured. The freeze benefited the rice land. The evening of the 13th there was one inch of snow on the ground, and ice two inches in thickness had formed.

Montgomery, Ala., F. P. Chaffee, Local Forecast Official, Weather Bureau:

The month of February was not only the coldest of which the Weather Bureau has a record, but in all probability gave, on the 12th and 13th, the lowest temperature ever experienced in this section. The morning of the 13th the minimum at Montgomery was -5°, or 10° lower than any previous record. Several persons were frozen to death and streams that were never known to freeze before were covered with ice. At Montgomery there was sleighing for three days. The Weather Bureau cold-wave warning, which was issued about thirty-six hours in advance of the lowest temperature, was widely distributed, but the cold was so severe that ordinary protective measures availed but little, and the damage to crops and other interests in Alabama will approximate a million of dollars.

Atlanta, Ga., J. B. Marbury, Local Forecast Official, Weather Bureau:

The cold wave was by far the most severe on record. The temperature fell to zero almost to the southern limit of the State, while in the north portions it reached 10° or 12° below zero. The damage to crops in Georgia will amount to several millions of dollars. While the entire State suffered severely the damage was greatest in the southern half, where peaches, as well as a number of young trees, were killed. Grain was generally protected by a covering of snow. Stock suffered, and in some counties cows and goats were frozen to death. The cold spell, though disastrous in many ways, will be of much future benefit. The freezing and thawing will improve the condition of the soil and kill insects injurious to plant life.

Jacksonville, Fla., A. J. Mitchell, Local Forecast Official, Weather Bureau:

Freezing conditions covered the territory set forth in the warnings, and ample time was given all interested to take the necessary precautions. The warning was telegraphed to 118 points, and every possible avenue was utilized to apprise the public of the expected severe weather. Railroads notified fruit and vegetable growers along their lines, cold-wave and frost signals were sounded by locomotives and river steamers, and along the 400 miles of the Florida Coast Line every station was promptly served. The night of the 12th heavy sleet and snow prostrated telegraph lines north and cut off communication with Washington, and on the 13th reports were not received in time to be

of use. With a temperature of 10° at Jacksonville on the 13th, the official in charge sent the following warning throughout the central and southern portions of the State, the sections most vitally affected by a freeze at this time of year: "Severe freeze to-night throughout the Peninsula. Give widest possible distribution." The warning was lodged not only with every station and settlement, but special messengers were sent out by the Florida East Coast Line Railway notifying individuals throughout the extent of their lines. The action of this road was such that every point south of St. Augustine, except Key West, was notified. Other roads showed the same activity. The saving to fruit and vegetable growers was enormous. The methods of protection used varied with the object to be protected. Orange trees were wrapped, banked, and some groves were covered. Additional protection was given by building fires. Pineapple fields were protected by a covering of lattice work under which fires were distributed. In every case through the north and north-central parts of the State the most heroic measures were necessary to save anything. The cold was so severe over the western and parts of the northern districts that cattle, horses, and sheep died from exposure. The lowest temperature reported was 4° below zero over the western district. The temperature fell to 29° in the southern part of Dade County. The vegetable crop over central, northern, and western portions of the State has been destroyed; oats, peaches, and pears damaged, and probably the greater portion of young citrus trees over the north-central counties has been seriously damaged. Citrus trees between latitudes 29° and 25° are thought not to be severely damaged, excepting young growth. Those south of the twenty-eighth parallel will escape with no serious consequences.

The total value of fruit, vegetables, and property saved in Florida, as given by those who were benefited by the warnings, amounts to nearly \$60,000. The figures are, however, necessarily incomplete; as many groves were saved whose values are not included in the above estimate.

It is a matter of sincere congratulation that, with the severest freeze in the history of the State and with more property subject to loss or serious damage, the Weather Bureau so met the demands and expectations of the public that not one complaint has been received regarding the accuracy of the forecasts.

The Jacksonville, Fla., Daily Metropolis of February 17, 1899, contained the following editorial:

The splendid service rendered the orange growers of Florida by the weather reports sent out by Director Mitchell of the Weather Bureau predicting the recent extraordinary cold wave, is most highly appreciated by our people, and there is no branch of the Government service to-day that is more favorably commented upon.

The timely warnings sent out by Director Mitchell were heeded by the orange growers, who hastened to protect their trees by burning log fires and taking other precautions, and the result is that millions of dollars were saved to the State.

Mr. Mitchell, the capable director here, has made his office a center of attraction, and he has by arduous work succeeded in establishing reliable correspondents all over the State. He has imparted his enthusiasm to these correspondents, and to-day a better established Weather Bureau can not be found in any State in the Union, and his reports on the condition of the weather and crops are always read with interest, as they are reliable.

In regard to the distribution of warnings along his line of road, Mr. R. T. Goff, Superintendent of the Florida East Coast Line, writes as follows:

The information was received by us about fifteen hours in advance of the cold wave, and was thoroughly distributed to every station on the line of our road, and in the vegetable region messengers were sent out to warn the people of the expected freeze. It is estimated that about half the crop of vegetables was saved by our receiving this warning. I believe the value of the vegetables is estimated at about one million dollars.

The following reports from Weather Bureau officials show that this cold wave was felt as a norther over, probably, the entire area of the Gulf of Mexico, and also on the north coasts of the islands of the Greater Antilles:

Havana, Cuba, William B. Stockman, Forecast Official:

13th. Unusually cold with temperature falling to 54° in the evening. Barometer rose rapidly and rain ended about 4 a. m. Wind veered to northeast 12:30 a. m. and increased to high and continued high until sunset; maximum 36 NW., 12:35 p. m.

Much damage by storm along coast front. The water and waves were the highest known in twenty-five years, and a number of houses were washed away, and many others, including their furniture, damaged or ruined. No estimate of amount of damage can be made. Camps and corrals of United States troops along the ocean front greatly damaged. No lives lost.

14th. Temperature remained below 60° until after 2 p. m., inclusive. Maximum, 54°.

The Times of Cuba, Havana, Cuba, February 14, 1899:

Yesterday winds and waves created sad havoc in many a household on the beach. The huge waves toppled over three houses at the ends of Aguila and Laza streets as if they were egg shells. Several persons in the houses were badly injured. From 6 to 7 in the morning those who live on the beach noticed the increasing height and periods of the waves, and by 8:30 a. m. the water was dashing upon the houses skirting the edge of the shore. The waves mounted higher and higher as the wind became more savage, and for a few hours it seemed as if a small sized cyclone was at work. The day was unusually tempestuous at sea.

Santiago de Cuba, W. I., A. V. Randall, Observer:

The norther of February 13-14 was quite severely manifested in this section, and I have been told by the native inhabitants that it was the severest ever known in this island. Its approach was first felt at about 5 p. m. of the 13th, the wind veering at that time from southwest to northwest, and at 10 p. m. to north, blowing from that time until midnight of 14th at a velocity from 9 to 18 miles per hour, then passing to the northeast, blowing with less force, and finally to southwest again at about noon of 15th.

Beginning with the change of wind to northwest, the temperature fell gradually, reaching the lowest point, 62°, at 3 a. m. of 14th, remaining nearly stationary until 8 a. m., then slowly rising to 74°, the maximum for the day, at 4 p. m. By 11 p. m. of 14th the temperature had nearly regained the normal for that time.

The barometer rose from 29.98 inches at 8 p. m. of 13th, to 30.02 inches at 9 p. m., and remained very nearly stationary until noon of 14th, then fell to 29.98 again at 1 p. m. and continued at about normal during the balance of that day.

Cold wave was preceded and accompanied by rain at intervals between 9:18 a. m. and 8:10 p. m. of 13th.

San Juan, Porto Rico, Mark W. Harrington, Section Director:

There was no sign of the cold wave in our skies or winds or waters, and only a doubtful sign in the fall of our minimum temperatures by a degree or two.

Kingston, Jamaica, R. M. Geddings, Observer:

The norther of the 13-14th was but little felt here, but reports from the north side of the island would seem to indicate that it was felt quite severely in that locality.

The mountain ranges which extend along the east and north of the station at a distance of but a few miles offer such protection that northerly winds attain usually but little force at this point.

Port Antonio, Jamaica, Mr. J. A. Jones, Boston Fruit Company:

We are subject to northers of more or less severity every year. They are not usually productive of much damage, except possibly loss of a few boats which are moored in open roadsteads, and making it rough and uncomfortable shipping fruit.

The norther of the 13th referred to was, perhaps, more severe than usual, but there was no particular damage done. A few surfboats were stranded on the beach and broken up, and one or two small sloops were driven on shore. Some bananas were blown down in different districts, a few here and there, but there was no general blow down in any one locality. There was no damage done to shipping, that is, steamers in the island for produce.

Montego Bay, Jamaica, Mr. Maxwell Hall:

The wind set in from the north-northwest at Montego Bay between 4 and 5 p. m., February 13, 1899, 15 miles per hour, and gradually increased to a maximum of 20 to 25 miles and blew from that direction all through the night with squalls of rain. Two or three lighters went ashore; a fine schooner in the open harbor sailed out (very near the wind) and made Luce a close harbor; but the sea did a great deal of damage to the wharfs which were in bad state of repair. The temperature fell very little. The barometer was high, say 30.10.

News Letter, Kingston, Jamaica:

In consequence of the heavy norther which prevailed at Montego Bay the schooner *Ocean Flamer* had to slip anchor and leave port without clearance. She came on to this port yesterday. She had a narrow escape and had her sails torn and other damage.

Bridgetown, Barbados, P. McDonough, Observer:

Brisk east winds; sharp fall in temperature between 9 and 10 a. m. 15th.

Basseterre, St. Kitts, W. I., George Kingsbury, Observer:

On the 12th the weather was cloudy, a rapid rise in pressure, high easterly winds 30 miles, and a heavy sea swell; 13th, weather clear and conditions normal; 14th, continued heavy sea swell and higher

pressure; brisk easterly winds; 15th, continued high pressure and heavy sea swell, and high easterly winds 30 miles; 16th and 17th high pressure; heavy sea swell and high easterly winds, with velocities of 28 and 30 miles.

Colon, Colombia, Charles F. Tallman, Observer:

On the 13th a moderate storm of the norther type prevailed in the afternoon. The weather became threatening at noon, with a sudden increase in the wind, and a few drops of rain fell. The sky cleared partly at 12:15 p. m., but the wind continued to increase, and after 2:30 p. m. varied between north and northwest, with a velocity of 16 to 20 miles an hour. The sea became high during the evening. The wind decreased somewhat during the night of the 13th, and gradually shifted to northeast during the morning of the 14th, backing to north in the evening. The sea continued high, and steamers left their wharves in the early morning and sought anchorage in the mouth of the harbor.

This was the only disturbance of this type during the present norther season.

The character of the storm along the middle Atlantic and New England coasts is shown by the following reports of observers and remarks by newspapers:

New York, S. L. Mosby, Assistant Observer:

Monday, February 13, a blinding snow storm, in conjunction with vast fields of moving ice, closed New York bay and brought ocean traffic to a full stop.

On Saturday morning, February 11, snow was forecast for Saturday night and Sunday. This forecast was published by the afternoon papers, and again by the Sunday morning papers. At 9:10 p. m. (11th), light snow commenced and continued without intermission during Sunday. At 12 o'clock Sunday (12th), warning of heavy snowfall was received, and the warning was repeated in the morning forecast of Monday, February 13. This warning was sent out Sunday afternoon by telegraph and telephone to all lines of railroad whose interests are centered here.

During Sunday night and Monday heavy snow fell without intermission. Up to midnight Sunday (12th), owing to light winds there had been but little confusion on account of snow, notwithstanding the ground was covered to an average depth of 14 inches. About 4 a. m. Monday (13th), a gale came on from the northeast, which continued with increasing force till 4:30 p. m., when it shifted to northwest and continued throughout the night with hurricane velocity. The snow was very dry, and drifted badly; street traffic, which before had not been interrupted, was maintained with great difficulty, and finally abandoned altogether, with the exception of two cable lines. At 8 p. m. (13th), the conditions were worse. The average depth of snow on the ground was 23 inches, and it drifted to a depth of 6 feet in many places. After 8 p. m. the snowfall became lighter, and ceased during the early morning of February 14, with a fall of 15.6 inches during the storm, and a total depth on the ground of 24 inches.

The railroads received most ample warning of the conditions which prevailed on Monday, but they were powerless in the face of such overwhelming odds.

Monday was very generally observed as a holiday, and all business was suspended. When Tuesday morning came, with clearing weather and a resumption of business, the scene in lower Broadway was one of indescribable confusion. All traffic was confined to the narrow space covered by car tracks, while snow was piled on either side to a depth of 8 feet.

The hurricane winds which prevailed Monday night were forecast in ample time, and every effort was made by the station force to distribute the warning.

It is most gratifying to know that the unprecedented weather conditions which prevailed from February 8 to 13, inclusive, were forecast accurately, in ample time to protect all endangered interests. The cold wave was heralded nearly twelve hours in advance; the beginning of snow about the same length of time; more than twelve hours notice of heavy snow; and about eight hours notice of hurricane winds.

Through the afternoon and evening papers these warnings were given to more than a million people engaged in every field of business interested in, and affected by, weather changes. Full credit has been given the Weather Bureau; and the fact that protection was thus afforded the enormous interests concentrated here, will compensate for many minor failures.

The Times Union of Albany, N. Y., of February 13, 1899:

In accordance with the warning sent out yesterday afternoon by the Weather Bureau, this city is to-day experiencing one of the heaviest snowfalls of the year. It is seldom that the Weather Bureau fails in predicting a big storm, and it has been more than successful this year. At the office of the Central Hudson Railroad this morning it is stated that the warning of yesterday saved them thousands of dollars in getting freight that was of a perishable nature under cover.

Boston, Mass., John W. Smith, Local Forecast Official:

A prompt and thorough dissemination of the warning was made by telegraph, telephone, bulletins, and the press. Especial care was taken

to notify all transportation companies and the shipping interests generally. Copies of the message were furnished to officials of the United States Revenue Service, United States Life Saving Service, Light House Service, etc. Great and general interest was manifested. While the wind at this station attained a maximum velocity of only 40 miles from the northeast, it reached hurricane force, and hurricane conditions generally prevailed in the vicinity of this city, especially along the coast. The warnings were timely and fully verified. All shipping remained in port.

Boston Herald, February 15, 1899, editorial:

The Weather Bureau is entitled to distinguished consideration for its services anent the late great storm. It foretold the widespread disturbance with remarkable accuracy, and gave everybody a chance to take a reef.

Portsmouth, N. H. Displayman:

Storm very severe, but shipping was warned in time to prevent sailing. A large number of vessels were notified and remained in harbor, and 13 fishing vessels, manned by crews which aggregated 88, and valued at \$21,300, were detained.

Eastport, Me., D. C. Murphy, Observer:

Hurricane signals on the 13th were posted in all conspicuous places in the city, and the railroad and steamboat lines were notified. Two steamers and two steam ferryboats, valued at about \$150,000, were the only vessels in port, with cargoes valued at about \$25,000, and with crews and passengers numbering about 100 persons. No damage to vessel property is reported. Travel to and from the city was entirely suspended for two days. The snow drifted badly, some drifts being 12 to 15 feet high. The wind reached a velocity of 70 miles from the northeast at 11:30 p. m. on the 13th.

CHICAGO FORECAST DISTRICT.

The severe cold weather which prevailed in the district the last week in January continued during the first half of February, caused by the persistence of high pressure areas of great magnitude in the Western and Northern States and the movement of low areas southward of the district. Temperatures, lower than previously recorded at many stations, occurred on the 8th, 9th, 10th, 11th, and 12th. The continued cold weather was, as a rule, accurately forecasted, and on the afternoon of the 10th a special bulletin was issued as follows:

Noon specials show that the cold wave in the extreme northwest is moving rapidly eastward and southward, thus preventing appreciable moderation in the temperature. Severe cold weather will continue several days.

The warnings must have been of great value to the public. Under date of February 12, Mr. J. C. Piercy, North Platte, Nebr., writes:

The norther and cold-wave warnings of the 10th instant were of inestimable benefit to Mr. Max Beer, a ranchman of this city, who had 200 cows and calves, valued at \$5,000, on cars and on the road. The warnings enabled him to save them, as they could not have stood the storm. It was 35° below zero this morning, the lowest temperature recorded in twenty-six years.

The shipment of perishable goods was almost entirely suspended for three weeks, not even the most improved refrigerator cars affording safety.

On account of the absence of snow the ground in the vicinity of Chicago was frozen in many places to the depth of five and one-half feet, causing great damage by the freezing up of the water and gas mains and service pipes. Plumbers have been unable to meet the demands for their services, and the exigency has brought forward the novel method of thawing out frozen pipes by the use of an electric current. Great suffering was caused by the severe cold among the poorer classes, and many people were frozen to death. Several steamboats which maintain winter service on Lake Michigan were blocked by the thick ice and unable to reach port for three or four days.

Over the greater portion of the district the weather during the second half of the month has been moderate and even mild, but interrupted by the movement of two cold waves,

the first moving across from the 21st to 24th, and the second on the 26th and 27th. Warnings of these two cold waves were issued well in advance of their approach.

Vessels on Lake Michigan were kept fully informed as to the expected movement of storms during the month, and no casualty from stress of weather has been reported.—*H. J. Cox, Professor.*

SAN FRANCISCO FORECAST DISTRICT.

From the 2d to the 7th, inclusive, warnings of severe frosts, probably injurious to citrus fruit in exposed places, were issued throughout California. These warnings were fully verified, all Weather Bureau stations reporting heavy or killing frosts on those dates. The usual precautions were taken in the citrus belt to prevent injury, and it is believed that no damage was sustained. There were no important conditions which were not forecasted in due time.—*G. H. Willson, Local Forecast Official.*

PORTLAND, OREG., FORECAST DISTRICT.

River forecasts were issued on the 6th, 7th, 8th, 9th, and 10th, and were most favorably commented upon by people along the water front. The feature of the month was the cold period from the 1st to the 8th. Temperatures of zero and slightly below were reported from a few of the more exposed places west of the Cascades, and zero temperatures were general east of them. In portions of Washington, Oregon, and Idaho the lowest temperature on record was observed; this was especially true in the region about Baker City, Oreg. The accuracy of the forecast during this period was made the subject of much favorable comment. During the last half of the month much damage to grain and orchards was reported; the damage was not, however, as great as estimated. The unusual severity of the weather of the month caused a great demand for information upon the local office.—*B. S. Pague, Forecast Official.*

AREAS OF HIGH AND LOW PRESSURE.

During the month there were six highs and nine lows sufficiently well defined to be traced on Charts I and II. In these charts the center of each circle represents the position of the high or low on the date and hour inscribed within. There is also entered in the circle the reading of the barometer near the center. In many cases this reading is quite approximate, especially when the high or low is on the border of the observation region. It should also be noted that sometimes the center has been located by the direction of the winds about it, and not necessarily by the highest or lowest reading of pressure. This is especially the case in the mountain and Plateau regions.

The principal facts regarding the date and place of first and last appearance, the duration, and velocity of these highs and lows are given in the accompanying table, and the following remarks are added:

Highs.—The month has been remarkable in a good many respects. Nearly the highest pressure ever observed in the United States and Canada, 31.42 inches, was reported at Swift Current on the morning of the 11th, and this was a reinforcement of a high area that had been nearly stationary there, or stretching in a ridge of high pressure in a southeast direction to the middle Mississippi Valley since the morning of the 6th. In connection with this ridge of high pressure extremely low temperature was noted in a rather narrow strip from Montana to the middle Atlantic coast. At Washington

a temperature of 15° below zero was experienced at 8 a. m. of the 11th, which was 1° below the lowest ever noted by the Weather Bureau, and this was a radiation cold rather than the cold of a cold wave.

All the highs were first noted to the north of Montana and moved in a southeast direction to the Mississippi Valley, and thence east and northeast to the Atlantic coast. Numbers I and V disappeared off the south Atlantic, II off the middle Atlantic, and the remaining three could be traced to Newfoundland. The severe temperature conditions of the month were mostly in the first half, and were prevalent more in the Southern and Western States than in the Northeast States; at 8 p. m. of the 1st Denver reported a fall in temperature of 48° in twenty-four hours and to -4°, but this cold wave had practically disappeared by the next a. m.; at 8 a. m. of the 7th, in connection with the ridge of high pressure noted above, there was quite a sharp fall in temperature in the middle Gulf States; Mobile had 30° fall in twenty-four hours. This cold spell culminated in Florida at 8 p. m. of the 8th. Jacksonville reported a fall of 40° at 8 a. m. of the 9th. In connection with same ridge the Middle Atlantic States experienced decidedly low temperatures. Atlantic City and New York had a fall of 32°, and Washington a temperature of -6°. The low temperature of this period continued till a. m. of the 11th; at 8 a. m. of 10th Washington reported -8°, and the next morning, -15°.

At 8 p. m. of the 11th, as high III approached the middle Mississippi Valley, Amarillo and Oklahoma reported a fall of 40°, and to -10° and 4°, respectively, and the next a. m. Galveston had a fall of 32° and to 10°. This cold wave moved eastward with the high area, and culminated in Florida on the 13th; at 8 a. m. Jacksonville reported a fall of 38° and to 10°.

As high No. V moved to the middle Mississippi Valley sharp falls in temperature occurred in the Missouri Valley; Moorhead reported a fall of 28°, and to -4° at p. m. of the 26th; at 8 a. m. of the 27th this cold wave reached the lower Lake region, Cleveland reporting a fall of 28° and to 26°.

Movements of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long. W.	Length.	Duration.	Daily.	Hourly.
High areas.										
I.....	*29, a. m.	54	109	2, a. m.	33	78	Miles. 2,700	Days. 4.0	Miles. 675	Miles. 28.1
II.....	7, a. m.	52	108	11, p. m.	41	76	1,980	4.5	440	18.3
III.....	9, p. m.	50	116	17, a. m.	47	56	5,370	7.5	716	29.8
IV.....	21, p. m.	52	117	27, a. m.	46	58	3,660	5.5	665	27.7
V.....	24, p. m.	53	118	28, p. m.	32	77	2,780	4.0	682	28.4
VI.....	27, a. m.	53	110	†3, a. m.	47	59	2,910	4.0	728	30.3
Total.....							19,350	29.5	3,906	162.6
Mean of 6 paths.....							3,225		651	27.1
Mean of 29.5 days.....									656	27.3
Low areas.										
I.....	1, a. m.	47	126	4, p. m.	45	54	4,470	3.5	1,277	58.2
II.....	3, p. m.	29	101	6, a. m.	36	75	1,740	2.5	696	29.0
III.....	5, p. m.	28	95	9, p. m.	49	54	2,790	4.0	697	29.0
IV.....	8, p. m.	30	107	14, p. m.	48	53	3,690	6.0	615	25.6
V.....	13, a. m.	32	116	17, a. m.	39	70	2,910	4.0	728	30.3
VI.....	14, p. m.	51	117	19, p. m.	46	59	2,790	5.0	558	23.3
VII.....	20, p. m.	37	98	24, a. m.	48	56	2,460	3.5	703	29.3
VIII.....	23, a. m.	32	115	28, a. m.	47	59	3,420	5.0	684	28.5
IX.....	26, p. m.	48	124	†1, a. m.	50	62	3,090	2.5	1,236	51.5
Total.....							27,360	36.0	7,194	299.7
Mean of 9 paths.....							3,040		799	33.3
Mean of 86 days.....									760	31.7

*January. †March.

Lows.—Three of the storms were first noted on or near the north Pacific coast, and three more on the south Pacific coast, the remaining three in the west Gulf. The general motion was toward the east and northeast. Seven of the storms dis-

appeared over Newfoundland, and two, No. II and No. V, off the middle Atlantic coast. High winds occurred as follows: At 8 a. m. of 8th, as low No. III approached the New England coast, Block Island reported an east wind of 66 miles an hour. During the 13th, as No. IV moved up the Atlantic coast, Hatteras and Sandy Hook experienced north winds of 60 miles, and the same afternoon Block Island had a north wind of 72 miles, Sandy Hook northwest 60, Boston east 52, Hatteras west 50, Eastport northeast 48, and a northwest wind of 48 miles occurred at Atlantic City, Cape May, and Cape Henry; at 8 a. m. of the 26th, as No. VIII approached upper Lake region (the only severe storm of the month in the Lake region), Chicago reported a south wind of 48 miles.—*H. A. Hazen, Professor.*

RIVERS AND FLOODS.

The Mississippi River remained frozen during the entire month to below Hannibal. From the mouth of the Illinois southward, and in the Missouri east of Kansas City, the stage of water varied but slightly until the 26th and 27th when there was rise of 2 or 3 feet, owing to the heavy rains of the 25th and 26th. The Missouri also remained frozen north of Kansas City, and was likewise frozen at Kansas City from the 1st to the 17th, inclusive.

Rains on the 20th caused a rise to set in along the Ohio, but not to an alarming extent. The crest passed Pittsburg on the 23d, Wheeling on the 24th, Parkersburg on the 25th, Cincinnati on the 27th, and Louisville on the 28th.

In the lower Mississippi the crest of the January rise reached New Orleans on the 3d, but nothing of importance occurred during the month.

The heavy rains of the 3d and 4th resulted in a great rise in the Tennessee and Cumberland rivers. At Carthage, Tenn., on the Cumberland, the water rose 35.2 feet from the 3d to the 8th, reaching 41.7 feet, or 11.2 feet above the danger line. At Nashville the danger line of 40 feet was exceeded by 0.8 foot on the 11th. No losses or damage worth mentioning occurred.

In the Tennessee, however, a very different state of affairs prevailed. The rains were much heavier along this watershed and the rivers generally rose above danger lines, except at Knoxville.

The following extracts relative to this flood are taken from the special report of Mr. L. M. Pindell, Official in charge of the United States Weather Bureau office at Chattanooga, Tenn.:

Heavy rains (3d to 5th) occurred over the Tennessee River watershed, producing a sudden rise of 13 feet in twenty-four hours in the Hiawasse River; 14 feet in the Clinch River at Speers Ferry; 7 feet in the Tennessee at Knoxville, and 3.5 at Chattanooga. On the morning of the 4th the river forecast stated that the Hiawasse would rise slowly Saturday night and Sunday (4th and 5th); the Clinch would rise rapidly Saturday night and slower Sunday, and the Tennessee rapidly till Sunday morning, and slower Sunday afternoon and night, reaching about 20 feet at Chattanooga by Sunday night or Monday morning. Heavy drift began passing down by night of the 4th, with the river rising at the rate of three and one-half tenths per hour. On the morning of the 5th (Sunday), heavy rains with thunderstorms having occurred during the preceding twenty-four hours, and the river having reached the stage of 20 feet ten hours sooner than forecast, with the rise still continuing at the rate of seven and one-half tenths per hour, special reports were called for from the upper river and the following forecasts issued:

"The river (at Chattanooga) will reach 29 feet by Monday morning (actual stage reached, 29.5 feet); the crest from the Clinch will produce a second rise here, and the river will probably reach the danger line Monday night or Tuesday."

River men were notified to protect all property under the 33-foot mark.

As the rains continued, the following supplementary forecast was issued on the morning of the 6th (Monday):

"The Tennessee will continue to rise, reaching the 35-foot stage by

Tuesday afternoon. From data in hand at the present time it seems probable that the crest rise will not exceed 37 feet."

On the 7th the forecast stated that the river at Chattanooga would rise steadily, reaching about 38 feet on Wednesday morning (8th). Warnings of this probable 38-foot stage at Chattanooga were also telegraphed to different points as far as Cairo.

Business men were quite uneasy about their goods in cellars, and some were advised to move their stock, which they did, and in no case was unnecessary expense incurred by the merchants. Poor people living in the lowlands consulted the office frequently. Some were advised to move, and others advised to remain and consult the office again on Wednesday morning, as ample notice and time would be given them. No one moved unnecessarily, as was proven afterward by the crest stage attained. The 3 p. m. special bulletin of the 7th showed all rivers rising except the Clinch at Clinton, Tenn., and the following forecast was issued:

"The river will continue to rise to-night, and slower Wednesday. The stage Wednesday morning will be between 37 and 38 feet. The crest rise will occur sometime between Wednesday night and Thursday morning, and will not exceed 40 feet."

The cold wave checked the rise, and at 3 p. m. of the 8th (Wednesday) advisory messages of a falling river were issued. It is estimated that the severely cold weather prevented an additional rise of at least 2 feet.

The property loss from the flood was comparatively small, and none happened that could have been avoided.

Navigation was impeded by heavy drift from the 5th to 10th, and by heavy floating ice from Knoxville to Chattanooga from the 13th to the 16th.

The forecasts were gratifyingly accurate, and the Official in charge at Chattanooga received many exceedingly commendatory notices relative to the work of the Weather Bureau. At Knoxville property to the value of \$90,000 was removed and saved. The value of that saved at other places can not be estimated.

The melting of the snow and ice at the headwaters of the Tennessee produced a splendid logging stage, and about 9,500,000 feet of logs were rafted down the river by the end of the month.

At the close of the month the river was again rising on account of heavy rains, and another 20-foot stage was indicated on March 1.

The James River was also in flood from the 17th to 21st, inclusive, particularly in the vicinity of Richmond, and a detailed account by Mr. E. A. Evans, Official in charge of that station, follows:

It is probable that the history of this flood will never be written in a manner which will set forth its various phases exactly as they occurred, or without exaggeration or underestimation. The length of time during which it presented threatening conditions, as well as its rapidly changing aspects, combine to prevent full, accurate justice being done it.

On account of the unusual conditions prevailing for several days prior to the flood, it is deemed advisable, as necessary to a full understanding of subsequent events, to summarize them briefly.

From the beginning of the month the weather was stormy, days with freezing rain, sleet, and snow succeeding each other at short intervals, until the great sleet storm of the 5th to 7th, which, in its turn, was followed on the 11th by a snowstorm lasting fifty-four consecutive hours, and causing a depth on a level of 16 inches, or a total amount of unmelted precipitation on the ground at 8 p. m. of the 14th of about 18 inches, inclusive of that which was in evidence prior to the beginning of the blizzard. And neither the sleet nor snow was local, but prevailed with equal energy over the entire basin of the James. At the same time the temperatures ranged unusually low for this section during the period from the 1st to the 17th, with the exception of the 4th to 8th, when they were about normal. Thus both temperature and precipitation seemed to unite to build up by degrees a situation which was pregnant with danger, and which only awaited the coming of rising temperature, thawing southerly winds, and warm rains to materialize from a possibility to an actuality; from an indicated to a present danger. These then were the conditions obtaining up to the morning of the 16th, and it is needless to say that they were regarded with increasing anxiety by this office. As early as the 12th, while the snowstorm was still raging, advisory information was sent out to the various transportation companies, steamboat lines, and individual and corporate interests liable to injury, giving the existing and expected river conditions, and suggesting that all heavy material, freight, etc., be moved to places of safety. From time to time after this date and up to the 16th additional precautionary advice along the same line was issued.

Early in the morning of the 16th, or more precisely, at 7:30 a. m., rain set in with warmer weather, and the unlocking of the frozen

streams and melting of the great mass of snow and sleet was begun. This rain continued throughout the day without intermission, and was heavier, as afterward appeared, in the upper watershed than in the vicinity of this station. Many inquiries were received during the day by telephone from interested persons, as to the probabilities of high water and to all the same information was given. "Outlook very threatening, and material liable to damage should be moved."

At 9:35 p. m. a telegram was received from the observer, Weather Bureau, Lynchburg, Va., "Rainfall one sixty." The day and night passed with gauge readings about stationary.

At 10:14 a. m. of the 17th the special river observer at Columbia, Va., telegraphed as follows: "River 21 feet, rising 8 o'clock, weather cloudy."

Here was the information long and anxiously awaited, coming from a critical point, the key to the local situation. Immediately upon its receipt telephone and messenger were put into use and flood warnings for the upper river from Norwood to Sabot issued, while locally the railroad and water transportation companies and other interests were notified as follows: "The James River will reach a 14-foot stage on the Bureau gauge by 8 p. m. and higher later."

Occasionally throughout the day advisory information was issued. A personal inspection of the river gauge at 11:30 a. m. showed no change in the height of the water as compared with the morning observation, but Superintendent W. T. West of the Southern Railway, whose bridge crosses the river at the point where the gauge is located, was seen and given verbal information of the approaching flood.

Late in the afternoon the river began to rise rapidly, bringing down masses of ice, which, lodging in the shallows at the heads of various islets with which the river is dotted, soon formed the nuclei for the gorge which developed later. Immense quantities of this ice passed under the steel bridge of the Southern Railway, and upon reaching Mayo bridge, about 200 feet below, began to gorge in the channel. This, narrow under the most favorable circumstances, soon choked with the fast accumulating pack, and damming up the waterway backed the river into the cellars and lower floors of buildings in the depressed portions of the city adjacent to the river. By 11 p. m. the gauge reading was 22 feet and the river was nearly level with the under girders of the railway bridge. Ice masses and logs scraped and ground their way under the structure only to pile up immediately below it against Mayo bridge, which at that hour seemed certain of destruction. So great was the press of the jam at this point that the superstructure was lifted and shifted from its position several inches, while heavy oaken beams and other timber work were snapped and crushed.

In the meanwhile, the south or Manchester side of the river was full of floating ice, which, lacking sufficient exit, formed a floe of large dimensions. Backwater gradually lifted it and finally started it down the stream. It passed the south end of the railway bridge without material damage, but massed against Mayo bridge and the plant of the Manchester Paper and Twine Company, doing considerable damage. A span of the bridge was badly wrecked and one of the buildings of the paper company crushed in.

Up to the hour of midnight, when the official in charge went off duty, there was practically no change in the river height, and the ice jam continued to hold the augmentation from small floes coming down from time to time. Early the following morning, 6:30 a. m., the official in charge was again on duty. At this hour the conditions were still unchanged, though less ice was then coming down. The railway officials had the previous night, after consultation with this office, run two freight trains loaded with coal upon the bridge where they remained during the acute phase of the flood. Toward noon a personal examination of the gorges in the north and south channels was made at the request of Superintendent West, who upon report, decided to use dynamite to break through the jam. During the afternoon this plan was put in operation successfully, and by 4 p. m. a free outlet was made to a point just below the Mayo bridge. This at once relieved the pent up condition of the river at and above the gauge, and subsequent readings showed first a rapid and then slow fall in the water level. It proved to be the beginning of the decline from extreme high water reading, 22 feet, but serious conditions still prevailed from below Mayo bridge to the extreme east limits of the city, to floating and wharf property, as well as residence property, in the Shockoe and Rocketts districts. Immense ice fields filled the river in all directions and were of sufficient thickness to almost entirely interrupt its outflow. Gorges were also reported at Chaffins Bluff and Dutch Gap, reliable authority, an official of the U. S. Engineer's Office, giving the former a height of 15 to 30 feet above water. Under these circumstances the subsidence of the flood was unusually slow, and it was not until the 22d that it became low enough to bring the dock again above water. This was brought about by the removal of the jam at, and below, the city.

There were some noteworthy features connected with the flood which deserve mention. First, the fact that the river at Columbia did not, at any time reach 22 feet. Under normal high water conditions this would have given not more than a 14-foot stage at this station. In this case it reached 22 feet locally, a height altogether out of proportion to its true value, and made possible only by the ice jam. Fortunately, warnings of this condition were issued. Second, regular 12-hour fluctuations in the gauge readings at Columbia, a fall and rise

due to the daily melting from the Rivanna basin. The amount reaching the stream in this way took about twelve hours to move from the upper courses down to Columbia.

As to the damage done, the greatest was unavoidable; that is, to fixed objects. Much was also done which could have been avoided had the persons interested paid heed to the warnings given them. Others acted on the advice of this office and removed their material to safe places. Among these were the water transportation interests, railroads, business houses, and some individuals. One firm received the warning at 11 a. m. for a 14-foot stage at 8 p. m. They have written this office that at 7:30 p. m. the water entered their warehouse door. The intervening time had, however, been ample, and they saved a quarter of a million pounds of tobacco by intelligent use of the warning.

The damage to floating property was unusually small and in no known instance serious.

The station gauge received some damage from the ice, the full extent of which can not yet be ascertained. It is probable that a new gauge will be needed to replace it.

The North Carolina rivers also rose rapidly from the 7th to the 9th, passing the danger line of 38 feet at Fayetteville, on the Cape Fear River, on the 7th and reaching a stage of 52 feet on the 9th. The rise about the middle of the month also resulted in a stage of 43 feet on the 20th.

The rivers of South Carolina were near or above the danger lines generally from the 6th to the 10th, longer over the lower portions, and ample and accurate warnings were issued regularly after the 5th. Danger lines were again reached after the 17th, and due notice was given at the proper time. No reports of serious loss or damage were received.

The rivers of eastern Alabama were also affected by the heavy rains in early February, and flood stages resulted generally from the 4th to the 11th. Mr. F. P. Chaffee, the Official in charge at Montgomery, Ala., rendered the following special report relative to this flood:

Heavy rains over the drainage area of the Alabama and tributaries on the 3d and 4th, amounting to 2.40 inches during the twenty-four hours ending 8 a. m. of the 4th at Resaca, Ga., and 1.51 during the same time at Tallahassee, Ala., started rapid rises in the upper rivers of this section. While the rivers were then at moderate stages (only about 9 feet) at Rome, Ga., and Gadsden, Ala., warnings for rapid rises were telegraphed to these two places on that date, and special reports called for from all river stations for Sunday morning (5th). These special reports showing continued rises in the upper rivers (averaging 6 feet in twenty-four hours) and the rains continuing, a supplemental warning was telegraphed to Gadsden on the 5th for flood stages at that place. Heavy rains continuing over the upper watersheds through the night of the 5th, necessitated further warning to Gadsden on the 6th, when a flood warning was also telegraphed to Wilsonville, and the river observer at Rome was notified of a probable stage of 25 feet at that place. On the 7th additional warnings were sent to Gadsden, Rome, and Wilsonville, and a warning for about a 33-foot stage was telegraphed to Selma. On the 8th the stage of 33 feet, predicted for Selma, was raised to about 36 feet.

On the 7th, warning was widely distributed by telephone and mail that stock and other property, liable to damage, should be moved from lands between Wetumpka and about 100 miles south of Selma, subject to overflow at 30 feet. During the period from 4th to 8th, warnings were also given well in advance of the rises at Wetumpka and Montgomery. All these warnings were widely distributed by telephone, through the local press, and mailed to postmasters at 25 river towns in this section.

At stations for which flood stages were predicted the water went to slightly above the danger line. In no case did the water go above the specific stage forecasted, while the greatest deviation from the stage forecasted was at Selma, where it reached 34.4 feet, or 1.6 foot less than the stage specified.

The fact that the warnings were so well in advance of the high waters, and were so approximately correct, has, it is thought, been the means of maintaining public confidence in this branch of the Bureau's work in this section. While flood stages were attained only from about Wilsonville to Gadsden, still the expense of telegraphing rapid-rise warnings to other points was justified, from the fact that much stock is wintered in the canebrakes of the low grounds of this section, which were all submerged. It is known that the warnings were the means of saving a large number of cattle, which otherwise would have been drowned; the warnings were of special value to the lumber interests of the Coosa River, and were of great use to the railroads in protecting their roadbeds.

High stages also prevailed generally throughout the month in the rivers of western Alabama, the lowest stage at Demopolis for the month having been 25.9 feet on the first day.

A stage of 47.9 feet, 12.9 feet above the danger line, was reached on the 15th, falling to 31.2 feet by the 26th, when another sharp rise set in, continuing at the close of the month. Warnings were issued when necessary, and no damage of consequence resulted.

Nothing of importance occurred along the rivers of the Pacific coast, although the Willamette was above the danger line at Eugene, Oreg., on the 9th and 10th.

ICE IN RIVERS AND HARBORS.

There was ice, either floating or solid, throughout the entire Mississippi watershed. It became solid as far south as Cairo by the 7th, and remained so until the 21st, when it commenced to move. At Chester the gorge broke on the 19th; at St. Louis on the 22d, and at Grafton, Ill., on the 27th. After these dates floating ice, gradually decreasing in quantity, was present until the end of the month.

East of Kansas City the Missouri was practically gorged from the 1st to the 22d, although not actually so east of Hermann, Mo., until the 6th. At St. Louis the ice gorged both above and below the city on the 8th, and on the 9th only a ferryboat channel remained. On the 11th the ice was sufficiently strong for pedestrians and skaters, and on the 12th was from 12 to 16 inches in thickness. The ferryboat channel was opened by tugs on the 17th, and on the 18th the ice was slowly breaking. It began to move on the 20th, and on the 22d moved out with little damage.

At Cairo the Mississippi froze back of the city on the 5th, and railroad ferryboats were working night and day to keep navigation open at the mouth of the Ohio. By the 7th the ice had become solid, and navigation was suspended, not to be resumed until the 22d. On the 13th it was 13 inches thick.

In the Ohio there was ice in greater or less quantities during the major portion of the month, and navigation was suspended from two to ten days at various places. The Allegheny and Monongahela were practically frozen until the 20th. At Freeport, Pa., on the Allegheny River, when the gorge moved out, it carried with it two spans of the Allegheny Valley Railroad bridge.

There was also heavy floating ice in the Tennessee and Cumberland rivers from the 13th until about the 18th.

In the lower Mississippi ice was first observed at Memphis

and Helena on the 8th, and navigation was suspended at Memphis on the 10th. On the 14th heavy ice damaged some of the boats in the harbor, and two of them sank. The ice reached Greenville, Miss., on the 11th, and Vicksburg on 12th. From the 13th to the 16th it was very heavy at the latter place, much more so than had ever before been observed. It gorged on the 13th one mile above the city in the main channel, and navigation was suspended. New Orleans was reached on the 17th, and on the 19th floating ice was passing out into the Gulf of Mexico. It ceased at New Orleans on the 20th.

South of Cairo navigation was resumed as follows: at Memphis on the 18th, and at Vicksburg on the 17th.

The Arkansas River was frozen over at Fort Smith from the 11th to the 16th, inclusive, and was free from ice on the 17th. At Little Rock the conditions were, as a whole, unprecedented, and are well described in the following report by Mr. E. B. Richards, the Official in charge of that station:

The extreme cold which swept over the State, like a breath from the frozen pole, from the 8th to, and including, the 16th, broke all records both as to the minimum temperature and the protracted character of the cold spell. Only once "within the memory of the oldest inhabitant" was it equaled, and that was in "the winter of '63, when the Union forces hauled their cannon across the Arkansas River on the ice," and only once since the establishment of the Weather Bureau in this city was the river frozen over for a greater length of time. The records show but two previous occasions when the river was frozen over. On February 3, 1886, it was frozen over from shore to shore; in February, 1895, it was again frozen from shore to shore from the 7th to the 17th, both dates included.

Floating ice was first observed on the morning of February 7. On the 8th the ice became gorged, about a mile east of the city, about 10 a. m. On the morning of the 9th the river was frozen solid from bank to bank, and continued in this condition until about 9 a. m. of the 17th, when the ice began to break and pass out. Floating ice continued during the 18th and 19th, entirely disappearing on the last-mentioned date. On the 13th the thickness of the ice was 5 inches.

At Newport, Ark., on the White River, there was floating ice from the 8th to the 11th, and a gorge from the 12th to the 16th, inclusive.

In the Atchafalaya River ice from 8 to 14 inches in thickness was running at Melville, La., from 16th to 20th, inclusive.

In the rivers of the East there was ice as far south as Camden, S. C., on the Wateree River, where there was ice and snow on the 13th. At Cheraw, S. C., the Pedee was full of ice on the 16th and 17th.

Thickness of ice in rivers (in inches), winter of 1898-99.

Stations.	December.				January.				February.			March.		April.					
	5.	12.	19.	26.	2.	9.	16.	23.	30.	6.	13.	20.	27.	7.	14.	31.	28.	4.	11.
Moorhead, Minn	13.5	15.0	18.0	20.0	24.0	26.0	26.0	26.0	28.0	32.0	33.0	42.0	42.0						
St. Paul, Minn	10.0	14.0	16.0	18.0	22.0	23.5	22.5	22.5	24.5	28.0	30.0	25.0	23.0						
La Crosse, Wis	6.5	*	13.0	14.0	15.0	20.0	22.0	19.0	26.0	27.0	32.0	22.0	20.0						
Dubuque, Iowa	8.0	10.0	11.0	10.0	14.0	15.0	13.0	10.0	18.0	20.0	27.5	22.0	18.0						
Davenport, Iowa		1.0	11.0	11.0	12.5	14.0	13.0	12.0	14.0	14.5	21.5	21.5	21.0						
Keokuk, Iowa		7.0	8.5	10.0	14.0	13.0	12.0	11.0	13.0	15.0	26.0	15.0	10.0						
Hannibal, Mo		7.0	9.0	6.0	*	11.0			5.0	11.0	16.0	10.0	9.0						
Williston, N. Dak	12.0	12.0	12.0	12.0	16.0	18.0	20.0	20.0	21.0	32.0	32.0	32.0	32.0						
Bismarck, N. Dak	10.0	16.0	18.0	18.0	20.0	20.0	24.0	24.0	*	27.0	34.0	30.0	30.0						
Pierre, S. Dak	11.0	14.0	14.5	15.0	17.0	19.5	19.0	17.5	20.0	23.0	25.0	18.0	14.0						
Yankton, S. Dak	8.0	11.5	15.5	15.5	16.0	16.0	16.0	16.0	18.5	21.5	25.0	25.0	25.0						
Sioux City, Iowa	8.5	12.0	12.0	11.0	15.0	16.5	17.5	16.5	18.0	21.0	24.0	17.0	19.0						
Omaha, Nebr.	6.0	8.0	10.0	10.0	*	12.0	*	6.0	10.0	14.0	22.0	20.0	20.0						
Topeka, Kans		2.5	3.0	2.5	4.0				3.5	11.0	15.0	4.0	6.0						
Kansas City, Mo									3.0	8.0	13.0								
Wichita, Kans.		3.0							4.0		12.0								
Pittsburg, Pa.											1.4								
Parkersburg, W. Va											5.0								
Columbus, Ohio		8.0	8.0	5.0	0.5	2.5			4.0	6.0	8.0	6.0							
Memphis, Tenn										0.5	1.0								
Fort Smith, Ark											9.0								
Little Rock, Ark											5.0								
New Orleans, La											2.0								
Brattleboro, Vt	2.0	2.5	6.5	*	8.0	10.0	9.0	11.0	13.0	17.0	18.5	18.0	17.5						
Concord, Mass	2.0	3.0	*	*	11.0	*	*	12.0	15.0	16.0	*	22.0	17.0						
Albany, N. Y.			5.0	3.0	6.5	1.0	6.0	8.0	10.0	9.5	11.0	9.0	8.5						
New Brunswick, N. J.					1.5														
Harrisburg, Pa										5.0	8.0	13.0							
Lynchburg, Va											12.0	12.0							
Richmond, Va											5.0								
Columbia, S. C											6.0	2.0							
											2.0								

* Missing.

The James at Richmond was gorged from the 13th to the 21st, inclusive, and the Potomac at Harpers Ferry from the 10th to the 21st, inclusive.

At Williamsport, Pa., the Susquehanna was frozen over from the 7th to the 22d, inclusive, the ice going out below the dam on the 23d. At Harrisburg the river was closed from the 9th until the 23d, when the ice went out gradually without causing any damage.

At Albany, N. Y., the ice harvest ceased by the end of the month. All was cut that could be handled, and the crop was unexcelled both as to quality and quantity.

Considerable inconvenience was also caused by the ice in the Columbia River on the north Pacific coast. At Umatilla there was floating ice from the 1st until the 15th, and at The Dalles navigation was suspended on the 3d by ice, which blocked the river until the 16th. Navigation was resumed on the 17th, and by the 19th the river was clear of ice. At Portland there was much floating ice in the Columbia on the 4th, and on the 5th navigation above the mouth of the Willamette was suspended owing to ice. The Willamette was frozen over a short distance above the railroad bridge on the 5th and 6th, but not enough to impede navigation. The ice began to break in the Columbia on the 8th, and on the 9th it had also disappeared from the Upper Willamette. On the 14th boats were again running on the Columbia, although there was still considerable ice.

The intensification of the winter conditions and their unprecedented extension southward to the Gulf of Mexico can be seen in the preceding table, which shows the thickness of the ice in the rivers for each week since December 5, 1898.

On February 6 there was 1/2 inch of ice at Memphis; by the 13th this had increased to 1 inch and had extended to New Orleans, where there were 2 inches, a record unparalleled in the history of the city, as far as is known.

At Moorhead, on the Red River of the North, there was an increase during the month of 14 inches, from 28 to 42 inches. In the Upper Mississippi there was a gradual decrease in the amount except at Davenport and Hannibal, where there were increases of 7 and 4 inches, respectively. In the Missouri the changes were irregular, but, as a whole, there was more ice at the close of the month, except at Pierre, where there was a loss of 6 inches. The greatest thickness in the Missouri was found at Williston, where it was 32 inches, while at Omaha there were 20 inches.

The highest and lowest water, mean stage, and monthly range at 115 river stations are given in the accompanying table. Hydrographs for typical points on seven principal rivers are shown on Chart V. The stations selected for charting are: St. Louis, Cairo, Memphis, and Vicksburg, on the Mississippi; Cincinnati, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—H. C. Frankenfield, Forecast Official.

Heights of rivers referred to zeros of gauges, February, 1899.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
<i>Mississippi River.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>
St. Paul, Minn.	1,957	14	Frozen					
Reads Landing, Minn.	1,887	12	— 0.4	1,21-24,28	— 0.6	8-13,15-19	— 0.5	— 1.0
La Crosse, Wis.	1,822	12	Frozen					
North McGregor, Iowa.	1,762	18	8.6	28	1.0	1,13,14	1.9	2.6
Dubuque, Iowa.	1,702	15	Frozen					
Leclaire, Iowa.	1,612	10	Frozen					
Davenport, Iowa.	1,596	15	Frozen					
Galland, Iowa.	1,475	8	Frozen					
Keokuk, Iowa.	1,466	14	Frozen					
Hannibal, Mo.	1,405	17	Frozen					
Grafton, Ill.	1,307	28	10.2	28	2.9	2	4.6	7.3
St. Louis, Mo.	1,264	30	13.6	28	— 0.7	1	5.0	14.3
Chester, Ill.	1,189	26	6.8	25	— 1.3	2	2.8	10.1
Cairo, Ill.	1,073	45	33.9	15	20.2	6	27.7	13.7
Memphis, Tenn.	843	38	24.3	1	14.0	7,8	19.8	10.3

Heights of rivers referred to zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
<i>Mississippi River—Con.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>
Helena, Ark.	787	42	36.1	1	32.6	10	29.3	13.5
Arkansas City, Ark.	635	42	40.2	1	28.0	12	32.9	12.2
Greenville, Miss.	595	42	34.6	1	23.4	12	27.9	11.2
Vicksburg, Miss.	474	45	39.6	1,2	28.5	14	33.4	11.1
New Orleans, La.	108	16	14.3	3,7,8	11.5	19	13.0	2.8
<i>Arkansas River.</i>								
Wichita, Kans.	720	10	1.9	9	1.4	28	1.6	0.5
Fort Smith, Ark.	345	22	10.9	28	3.0	10	4.5	7.9
Dardanelle, Ark.	250	21	4.8	28	2.1	9-11	3.1	2.7
Little Rock, Ark.	170	23	7.5	28	4.0	18	4.9	3.5
<i>White River.</i>								
Newport, Ark.	150	26	15.7	28	3.4	15	6.8	12.3
<i>Des Moines River.</i>								
Des Moines, Iowa.	150	19	Frozen					
<i>Illinois River.</i>								
Peoria, Ill.	135	14	10.6	28	5.3	19-21	6.9	5.3
<i>Missouri River.</i>								
Bismarck, N. Dak.	1,201	14	4.6	9-11	3.7	22,23	4.2	0.9
Pierre, S. Dak.	1,006	14	Frozen					
Sioux City, Iowa.	676	19	Frozen					
Omaha, Nebr.	561	18	Frozen					
St. Joseph, Mo.	373	10	2.9	9	0.7	1,2	1.8	2.0
Kansas City, Mo.	280	21	7.7	27,28	7.0	18	7.4	0.7
Boonville, Mo.	191	20	12.2	27	4.2	4	6.7	8.0
Hermann, Mo.	95	24	10.5	27	1.6	3	4.9	8.9
<i>Ohio River.</i>								
Pittsburg, Pa.	966	22	14.7	23	2.3	3,12,16	6.7	12.4
Davis Island Dam, Pa.	960	25	14.1	23	9.2	7	7.9	4.9
Wheeling, W. Va.	875	36	20.6	24	5.1	3	11.7	15.5
Parkersburg, W. Va.	785	36	20.9	25	6.0	14	12.3	14.9
Point Pleasant, W. Va.	703	39	27.9	24	6.0	16	16.8	21.9
Portsmouth, Ky.	651	50	36.0	8	7.5	17	23.2	28.5
Cincinnati, Ohio.	612	50	36.5	8	8.7	17	23.4	27.8
Cincinnati, Ohio.	499	50	39.4	27	11.5	18	25.9	27.9
Louisville, Ky.	367	28	15.9	28	6.8	18	10.7	9.1
Evansville, Ind.	184	35	33.0	28	13.8	19	23.3	19.2
Paducah, Ky.	47	40	33.0	18	19.5	5,6	26.1	13.5
<i>Allegheny River.</i>								
Warren, Pa.	177	7	4.1	24	0.8	10,14,19	1.6	3.3
Oil City, Pa.	123	13	6.2	23	1.3	13-16	2.2	4.9
Parkers Landing, Pa.	73	20	5.6	28	1.2	9	1.5	4.4
Freeport, Pa.	26	20	13.0	22	1.3	14-17	5.3	11.7
<i>Conemaugh River.</i>								
Johnstown, Pa.	64	7	5.2	22	2.0	10	3.0	3.2
<i>Red Bank Creek.</i>								
Brookville, Pa.	35	8	1.9	22	0.7	1-21	0.8	1.2
<i>Beaver River.</i>								
Ellwood Junction, Pa.	10	14	6.5	23	1.3	3	2.1	5.2
<i>Cumberland River.</i>								
Burnside, Ky.	494	50	45.6	6	4.9	2,16	16.3	40.7
Carthage, Tenn.	257	30	41.7	8	6.0	18	19.3	35.7
Nashville, Tenn.	175	40	40.8	11	10.5	3	24.5	30.3
<i>Great Kanawha River.</i>								
Charleston, W. Va.	61	30	19.9	6	4.6	3	9.7	15.3
<i>New River.</i>								
Hinton, W. Va.	95	14	9.0	6,7	2.0	15	4.8	7.0
<i>Licking River.</i>								
Falmouth, Ky.	30	25	11.5	6	4.5	2	8.5	7.0
<i>Miami River.</i>								
Dayton, Ohio.	69	18	5.5	27	1.9	6,7	2.7	3.6
<i>Monongahela River.</i>								
Weston, W. Va.	161	18	7.5	4	0.0	2,15	1.8	7.5
Fairmont, W. Va.	119	25	13.5	4	1.7	2,3	5.3	11.8
Greensboro, Pa.	81	18	16.0	5	7.5	2,3	10.1	8.5
Look No. 4, Pa.	40	28	22.0	5	8.0	2,12-16	12.0	14.0
<i>Cheat River.</i>								
Rowlesburg, W. Va.	36	14	9.0	4	4.0	26	5.5	5.0
<i>Youghiogheny River.</i>								
Confluence, Pa.	59	10	7.5	27	1.6	15,16	3.8	5.9
West Newton, Pa.	15	23	11.0	4	3.0	9	3.0	8.0
<i>Muskingum River.</i>								
Zanesville, Ohio.	70	20	14.7	28	7.0	3	9.7	7.7
<i>Tennessee River.</i>								
Knoxville, Tenn.			23.1	7	0.6	1,2	6.6	22.5
Kingston, Tenn.			26.1	8	2.4	2,3	9.3	23.7
Chattanooga, Tenn.			33.2	9	5.4	3	16.2	32.8
Bridgeport, Ala.			26.7	10	3.9	1	12.5	22.8
Florence, Ala.			20.5	14	4.5	1	12.8	16.0
Johnsonville, Tenn.			29.6	17	7.7	2	20.9	21.9
<i>Clinch River.</i>								
Spears Ferry, Va.	156	20	16.0	6	0.3	1,2	4.2	15.7
Clinton, Tenn.	46	25	28.0	6,7	5.3	2	13.0	22.7
<i>Wabash River.</i>								
Mount Carmel, Ill.	50	15	15.2	28	5.5	22,23	9.0	9.7
<i>Red River.</i>								
Arthur City, Tex.	688	27						
Fulton, Ark.	565	28	5.8	1	3.0	15	4.2	2.8
Shreveport, La.	449	29	11.5	1	3.8	27	6.5	7.7
Alexandria, La.	139	33	16.8	1	7.2	26	10.7	9.6
<i>Achafalaya Bayou.</i>								
Melville, La.	100*	31	31.2	2-6	28.2	17	29.6	3.0
<i>Ouachita River.</i>								
Camden, Ark.	340	39	14.8	28	7.0	18	9.7	7.8
Monroe, La.	100	40	32.3	5	25.0	28	29.6	7.8
<i>Yazoo River.</i>								
Yazoo City, Miss.	80	25	20.0	6,7	17.3	15,16,25	18.5	2.7
<i>Flint River.</i>								
Albany, Ga.	80	20	21.8	15	8.3	1	13.7	13.5
<i>Cape Fear River.</i>								
Fayetteville, N. C.	100	38	52.0	9	10.0	15	27.7	42.0
<i>Columbia River.</i>								
Umatilla, Oreg.	270	25	4.1	22	0.8	12	2.3	3.3
The Dalles, Oreg.	186	40	7.0	23	2.2	9	5.2	4.8

Heights of rivers referred to zeros of gauges—Continued.									Heights of rivers referred to zeros of gauges—Continued.								
Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.	Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.						Height.	Date.	Height.	Date.		
<i>Willamette River.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>	<i>Roanoke River.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>
Albany, Oreg.....	99	20	18.4	11	4.1	7	8.6	14.3	Clarksville, Va.....	155	12	9.9	7	2.0	1	5.8	7.9
Portland, Oreg.....	10	15	11.7	12	2.4	6	6.8	9.3	<i>Sacramento River.</i>								
<i>Edisto River.</i>									Red Bluff, Cal.....	241	23	4.1	21,22	0.6	10	2.5	3.5
Edisto, S. C.....	75	6	6.5	13	5.0	1,2	5.8	1.5	Sacramento, Cal.....	70	25	14.1	1	11.6	15-19	12.3	2.5
<i>James River.</i>									<i>Santee River.</i>								
Lynchburg, Va. ³	257	18	7.5	28	1.3	2,3	4.2	6.2	St. Stephens, S. C.....	50	12	15.3	15	8.0	3-8	10.4	7.3
Richmond, Va.....	110	12	22.0	18	0.2	1	6.6	21.8	<i>Congaree River.</i>								
<i>Alabama River.</i>									Columbia, S. C.....	37	15	21.8	8	1.8	4	7.6	19.5
Montgomery, Ala.....	265	35	33.0	28	13.0	1	21.2	20.0	<i>Waterlee River.</i>								
Selma, Ala.....	212	35	34.4	11	10.8	1	24.6	23.6	Camden, S. C.....	45	24	31.0	8	8.0	4	17.5	23.0
<i>Cosa River.</i>									<i>Savannah River.</i>								
Rome, Ga.....	225	30	24.0	8	5.0	14,15	11.7	19.0	Augusta, Ga.....	130	32	30.9	8	11.5	26	17.8	19.4
Gadsden, Ala.....	144	18	21.5	8	6.7	1,16	13.4	14.8	<i>Susquehanna River.</i>								
<i>Tombigbee River.</i>									Wilkesbarre, Pa.....	178	14	12.0	24	5.2	20,21	7.5	6.8
Columbus, Miss.....	285	33	21.0	8	3.8	1	9.9	17.2	Harrisburg, Pa.....	70	17	9.0	28	1.9	3	4.6	7.1
Demopolis, Ala.....	155	35	47.9	15	25.9	1	39.4	22.0	<i>Juniata River.</i>								
<i>Black Warrior River.</i>									Huntingdon, Pa ¹⁴	80	24	7.0	27	4.8	21,22	5.1	2.7
Tuscaloosa, Ala.....	90	38	51.7	8	18.5	22,26	29.9	33.2	<i>W. Br. of Susquehanna.</i>								
<i>Pedee River.</i>									Williamsport, Pa.....	35	20	8.3	28	2.3	14,15	3.6	6.0
Cheraw, S. C.....	145	27	34.9	8	5.5	15	18.4	29.4	<i>Waccamaw River.</i>								
<i>Black River.</i>									Conway, S. C.....	40	7	8.4	28	4.9	5-7	6.8	3.5
Kingstree, S. C.....	60	12	11.6	19-21	8.8	4,5	10.3	2.8									
<i>Lumber River.</i>																	
Fairbluff, N. C.....	10	6	7.5	15	4.9	1,3	6.6	2.6									
<i>Lynch Creek.</i>																	
Effingham, S. C.....	35	12	17.2	12	8.6	1,2	12.8	8.6									
<i>Potomac River.</i>																	
Harpers Ferry, W. Va....	170	16	13.6	23	2.6	5-14	5.3	11.0									

* Distance to Gulf of Mexico. ¹ Record for 27 days. ² Record for 22 days. ³ Record for 24 days. ⁴ Record for 19 days. ⁵ Record for 11 days. ⁶ Record for 12 days. ⁷ Record for 25 days. ⁸ Record for 20 days. ⁹ Record for 21 days. ¹⁰ Record for 26 days. ¹¹ Record for 18 days. ¹² Record for 7 days. ¹³ Record for 16 days. ¹⁴ Record for 8 days. ¹⁵ Record for 14 days.

THE WEATHER OF THE MONTH.

By ALFRED J. HENRY, Chief of Division of Records and Meteorological Data.

The overshadowing event of the month was the severe and widespread cold lasting from January 26 to February 14, and culminating in a freeze that for duration and severity stands unparalleled in the history of the Weather Bureau.

Strictly speaking, there were at least two, possibly three, separate and distinct cold waves, each of which followed a course somewhat different from that of the others. The cold was doubtless greatly intensified by the snow covering of the northeastern Rocky Mountain slope and other regions to the eastward.

As stated in the January MONTHLY WEATHER REVIEW, page 5, a succession of snowstorms, accompanied by high winds, swept southeastward from the Northwest Territories during the closing days of January, carrying the snow covering to northern Texas, and cold weather to the Gulf and Atlantic coasts. During this period the Rocky Mountains seemed to act as an effective barrier to the movement of cold air westward over the Plateau region. On February 1, however, a low moved inland from the Pacific, striking the continent about latitude 45°, and moving thence southeastward over the Great Basin and around southern New Mexico to southwest Texas. The passage of this low into the interior appears to have been the key move to the changes that rapidly followed.

Close upon the retreating low an area of high pressure and cold weather advanced from Alberta, crossing to the western side of the Rocky Mountains and settling over the northern Plateau, where it remained almost stationary until the 7th. The temperature fell throughout the Plateau region and on the Pacific coast on the 3d, 4th, 5th, and 6th, the lowest points reached being within a degree or so of the lowest temperatures previously recorded. The minimum temperature at San Diego was 33.5°, lowest previous minimum 32°, while at Cuyamaca Dam, only 60 miles distant, but in the mountains, the temperature fell to 5° below zero. Heavy snows fell in the middle Plateau and Rocky Mountain regions on the 7th, thus reinforcing the heavy covering of snow already upon the ground.

A second high appeared over Assiniboia on the 7th, moving southeastward and the plateau high began an eastward move-

ment, uniting with it on the 8th. This second high, however, apparently remained stationary north of Montana from the 8th to the 11th; pressure gradually increased until the morning of the last-named date, when a maximum of 31.42 inches was reached at Swift Current. In the mean time an offshoot had moved southeastward over the upper Mississippi Valley, the Ohio Valley, the lower lakes, and the Middle Atlantic States, reaching the Atlantic coast in the vicinity of Chesapeake Bay on the morning of the 11th and causing extremely low temperatures in its course, in many cases the lowest recorded in the last twenty-eight years.

On the morning of the 11th, the high which had been apparently stationary over Assiniboia for three days began its southeastward movement, reaching the Texas coast by 10:00 a. m. of the 12th as a violent norther, with temperature 3° lower than ever before recorded. Moving rapidly eastward, it passed successively over the Gulf States, reaching the Florida Peninsula by the morning of the 13th, and thence northeastward along the Atlantic coast, but after reaching Virginia the minimum temperatures were not so low as those of the 10th, 11th, and 12th. We have thus seen that there were three separate and distinct periods of cold and that all sections of the country were visited, except Arizona and a portion of New Mexico on the southwest and portions of the Lake region and New England on the northeast.

The minimum temperatures recorded in the several States and Territories are shown in Tables I and II and graphically on Chart VI. A word of explanation in regard to minimum temperatures registered at Weather Bureau stations in large cities may be appropriate. Generally, Weather Bureau thermometers are installed at a height of 10 to 15 feet above the roofs of high buildings; rarely over sod at an elevation of from 10 to 20 feet above ground. When there is little or no movement of wind, especially at night, the colder air settles in the lowlands and valleys. It may easily happen in such cases that a thermometer on the top of a high building is entirely above the layer of cold air near the surface of the ground.

Thermometers exposed on the tops of buildings in large

cities, moreover, respond to a slight increase in temperature due to the consumption of large quantities of fuel and doubtless to a local heating of the building over which they are placed. The effect on the minimum thermometer must be most appreciable on those buildings in which fires are kept up all night and we should, therefore, expect that the nocturnal readings would be higher than those reported from voluntary stations in the neighborhood. The differences in the minimum readings will vary, of course, according as the building is kept at a uniform temperature or allowed to grow cool during the night. Still another feature should be taken into consideration, viz, the relation of the Weather Bureau building to the topography of the ground for several miles around the station. The effect of topography in general is to lower the night temperatures at stations situated in valleys or natural amphitheatres as compared with those located on the surrounding hills or plains. The City of Washington is a fair illustration of the valley station and it may be compared with Baltimore as a neighboring plains station. The annual means of the two stations are almost identical, Baltimore being three-tenths of a degree warmer. The minimum temperatures registered at Washington, however, are almost invariably lower than those registered at Baltimore. Prior to the current month the lowest minimum temperatures were, Washington, -14° in 1881; Baltimore, -6° in the same year. These values were increased by 1° during the current month, viz, to -15° at Washington and to -7° at Baltimore. The lower minimum temperatures of Washington are believed to be largely the result of topographic influence. The minimum temperatures recorded in the neighborhood of Washington during the current month were: United States Naval Observatory, about 2 miles northwest of the Weather Bureau building and nearly 200 feet higher, -15° ; Great Falls, Md., about 16 miles northwest in the Potomac River Valley, -14° ; Alexandria, Va., about 5 miles southwest, -12° ; Laurel, Md., about 18 miles northeast, -18° . In all cases the altitude of the thermometers was less than 15 feet above ground, and it is to be noticed that the minimum temperatures in this city were about as low as those of the country nearby. In the suburbs of Baltimore the minimum temperatures ranged from 4° to 6° lower than was recorded at the Weather Bureau office, and we are of opinion that these figures express about the average difference between the minimum temperatures of Weather Bureau thermometers placed on the roofs of tall buildings and those exposed in the open country from 10 to 20 feet above the ground, other things being equal. Minimum temperatures of 25° below zero were observed at several places between Washington and Baltimore, but the accuracy of the thermometers at low temperatures is not known.

These cold waves established many new landmarks or datum points for future reference, whether we consider the instrumental readings or the physical phenomena resulting from the cold. The most striking of the latter perhaps was the flow of ice down the Mississippi River on the 17th, past New Orleans and into the Gulf of Mexico, an event never before witnessed within the memory of man. Ice an inch thick formed at the mouth of the Mississippi in East and Garden Island bays, and the temperature fell to 10° on the 13th.

The swift flowing streams of the Southern States were covered with ice, and great numbers of fish were killed by the extreme cold. Game birds perished in large numbers, poultry and domestic animals suffered greatly, and in some cases froze to death on account of insufficient shelter. The loss of live stock on the plains and in the great grazing States is not known, but it must have been large by reason of the depth of snow and the duration of the low temperatures.

The loss of human life, from January 29 to February 13, by freezing and avalanches (in Colorado), as near as can be ascertained, was 105 persons distributed as follows:

Colorado, 24; Texas, 15; Pennsylvania, 11; New York, 10; Illinois, 8; Missouri, 6; Ohio, 3; Maryland, 3; Iowa, 4; Wyoming, Delaware, Virginia, North Carolina, Alabama, Arkansas, Kentucky, South Carolina, and New Jersey, 2 each; Washington and Georgia, 1 each.

The usual accompaniments of blizzard weather, viz, snow-bound trains, delayed travel, interrupted communication of all kinds and unusual suffering among the poor were present in greater or less degree from the Lakes to the Gulf, and generally from the Atlantic to the Pacific. Schools were generally closed; the usual functions of both city and country life were greatly deranged; and food and fuel famines were threatened in many of the larger cities.

The money loss occasioned by the storms aside from the loss of prospective crops can not be easily computed. Municipalities and transportation companies paid large sums of money to remove the snow, but these expenditures can scarcely be classed as losses pure and simple. Undoubtedly the greatest financial loss fell upon shipping and stock raising interests.

The distribution of the observed monthly mean temperature of the air is shown by red lines (isotherms) on Chart VI. This chart also shows the maximum and the minimum temperatures, the former by black and the latter by dotted lines. As will be noticed, these lines have been drawn over the Rocky Mountain Plateau region, although the temperatures have not been reduced to sea level; the isotherms relate, therefore, to the average surface of the country in the neighborhood of the various observers, and as such must differ greatly from the sea-level isotherms of Chart IV.

The average temperatures of the respective geographic districts, the departures from the normal of the current month and from the general mean since the first of the year, are presented in the table below for convenience of reference:

Average temperatures and departures from the normal.

Districts.	Number of stations.	Average temperatures for the current month.	Departures for the current month.	Accumulated departures since January 1.	Average departures since January 1.
New England	10	24.5	- 2.7	- 2.2	- 1.1
Middle Atlantic	12	27.9	- 6.6	- 6.6	- 3.3
South Atlantic	10	44.0	- 5.5	- 5.3	- 2.6
Florida Peninsula	7	61.0	- 2.9	- 1.6	- 0.8
East Gulf	7	45.2	- 9.3	-10.1	- 5.0
West Gulf	7	41.1	-10.4	- 9.8	- 4.9
Ohio Valley and Tennessee	12	27.4	-10.6	-10.2	- 5.1
Lower Lake	8	21.2	- 5.3	- 5.1	- 2.6
Upper Lake	9	12.8	- 6.3	- 6.8	- 3.4
North Dakota	7	0.2	- 6.0	- 2.2	- 1.1
Upper Mississippi	11	16.4	- 9.7	- 6.5	- 3.4
Missouri Valley	10	14.5	- 9.8	- 4.8	- 2.4
Northern Slope	7	8.6	-12.2	- 8.0	- 4.0
Middle Slope	6	20.3	-12.1	- 9.1	- 4.6
Southern Slope	5	30.3	-11.3	-10.7	- 5.4
Southern Plateau	13	44.0	- 0.8	- 1.2	- 0.6
Middle Plateau	9	30.0	- 1.3	+ 3.2	+ 1.6
Northern Plateau	11	24.1	- 4.4	+ 0.4	+ 0.2
North Pacific	9	39.5	- 1.6	+ 0.8	+ 0.2
Middle Pacific	5	49.2	0.0	+ 2.8	+ 1.4
South Pacific	4	53.2	- 0.2	+ 3.1	+ 1.6

In Canada.—Professor Stupart says:

Temperature was below average in all portions of Canada, except along the St. Lawrence Valley, between Montreal and Father Point, where it was from average to 1° above. From the coast line of British Columbia to the Lake region, the amount below average was very considerable, and this was especially the case over southern Alberta and also in Assiniboia, where the deficiency was as much as from 9° to 12° .

PRECIPITATION.

The numerical values of total precipitation and total depth of snowfall are given in Tables I and II, and the geographic distribution is graphically shown on Charts III and VIII. The depth of snow on the ground is also shown on Chart IX.

are given in Table VII, which shows the number of stations from which meteorological reports were received, and the number of such stations reporting thunderstorms (T) and auroras (A) in each State and on each day of the month, respectively.

Thunderstorms.—Reports of 708 thunderstorms were received during the current month as against 492 in 1898 and 426 during the preceding month.

The dates on which the number of reports of thunderstorms for the whole country were most numerous were: 3d, 190; 25th, 108; 26th, 102.

Reports were most numerous from: Tennessee, 78; North Carolina, 68; Florida, 63; Missouri, 46.

Auroras.—The evenings on which bright moonlight must

have interfered with observations of faint auroras are assumed to be the four preceding and following the date of full moon, viz, 20th to 28th.

The greatest number of reports were received for the following dates: 11th, 85; 12th, 32; 13th, 8.

Reports were most numerous from: North Dakota, 23; Minnesota, 21; Iowa, 16; South Dakota, 15; Michigan, 14.

In Canada.—Auroras were reported as follows: Charlotte-town, 11th; Quebec, 11th, 12th, 27th; Montreal, 14th; Ottawa, White River, Swift Current, and Banff, 12th; Kingston, 11th, 23d; Port Arthur, 12th, 13th; Minnedosa, 9th, 10th, 12th; Medicine Hat, 16th; Prince Albert, 28th; Battleford, 3d, 10th, 11th.

No thunderstorms were reported.

CLIMATE AND CROP SERVICE.

By JAMES BERRY, Chief of Climate and Crop Service Division.

The following extracts relating to the general weather conditions in the several States and Territories are taken from the monthly reports of the respective sections of the Climate and Crop Service. The name of the section director is given after each summary.

Rainfall is expressed in inches.

Alabama.—The mean temperature was 40.0°, or 7.1° below normal; the highest was 80°, at Healing Springs on the 4th and at Alco on the 22d, and the lowest, 17° below zero, at Valleyhead on the 12th. The average precipitation was 6.61, or 0.66 above normal; the greatest monthly amount, 9.39, occurred at Clanton, and the least, 1.67, at Daphne. The month was the coldest on record. Several persons were frozen to death; stock suffered very much; in some counties cows, hogs, and goats froze to death, and poultry froze on the roost; large numbers of game birds perished, and swift-running streams, never before known to freeze, were covered with ice; the ice on ponds in middle counties was thick enough for skating on the 13th and 14th, while at Montgomery sleighing was indulged in for three days.—*F. P. Chaffee.*

Arizona.—The mean temperature was 46.8°, or 1.0° below normal; the highest was 90°, at Parker on the 21st and 22d, and the lowest, 24° below zero, at Fort Defiance on the 7th. The average precipitation was 0.45, or 0.57 below normal; the greatest monthly amount, 2.58, occurred at Flagstaff, while none fell at a number of stations.—*W. G. Burns.*

Arkansas.—The mean temperature was 31.8°, or 11.9° below normal, and was the coldest February on record; the highest was 75°, at Conway on the 28th, and the lowest, 25° below zero, at Corning and Winslow on the 12th and at Keesees Ferry on the 13th. The average precipitation was 2.18, or 1.72 below normal; the greatest monthly amount, 4.15, occurred at Brinkley, and the least, 0.63, at Texarkana.—*E. B. Richards.*

California.—The mean temperature for the State, obtained by weighting the reports from 280 stations, so that equal areas have about equal weight, was 48.5°, or 0.1° below normal; the highest recorded was 100°, at Tres Pinos, San Benito County, on the 19th, and the lowest, 30° below zero, at Boca, Nevada County, on the 6th. The average precipitation for the State, as determined by the records of 299 stations, was 0.45; the deficiency, as indicated by reports from 168 stations which have normals, was 2.88; the greatest monthly precipitation was 10.95, at Crescent City, Del Norte County, while none fell at many stations.—*W. H. Hummon.*

Colorado.—The mean temperature was 18.2°, or 8.8° below normal; the highest was 68°, at Minneapolis on the 27th, and the lowest, 45° below zero, at Greeley on the 12th. The average precipitation was 0.98, or normal; the greatest monthly amount, 5.08, occurred at Breckenridge, and the least, 0.06, at Garnett.—*F. H. Brandenburg.*

Georgia.—The mean temperature was 43.6°, or 4.2° below normal; the highest was 82°, at Mauzy on the 22d, and the lowest, 12° below zero, at Diamond and Tallapoosa on the 13th. The average precipitation was 7.47, or 2.40 above normal; the greatest monthly amount, 10.32, occurred at Diamond, and the least, 1.90, at Gunde. On the 12th and 13th the State was under the influence of the most intensely cold weather ever experienced in this section, so far as available records show. The extreme cold did immense damage to crops and caused untold suffering. Traffic was seriously interrupted and many cattle perished. Reports from several hundred correspondents show that the peach crop was totally killed in many sections, and more or less damaged in all sections of the State. Many orchards of young trees were killed outright and will have to be replanted. The oat crop was

almost entirely killed in many counties, but wheat fared better, and in many sections is still very promising. The mantle of snow which covered the fields was a great protection to this crop, and it is only where the snow was blown off that any material damage was done. The damage to the fruit interests of the State means the loss of several millions of dollars to the fruit growers. It is thought apples are badly injured. Peaches on high ground suffered least. Orchards in the northern section of the State were not so far advanced and, consequently, suffered less than in the central and southern counties.—*J. B. Marbury.*

Illinois.—The mean temperature was 19.6°, or 8.3° below normal; the highest was 69°, at Plumhill on the 20th, and the lowest, 29° below zero, at Morrisonville on the 12th. The average precipitation was 2.08, or 0.21 below normal.—*C. E. Linney.*

Indiana.—The mean temperature was 21.9°, or 8.7° below normal; the highest was 67°, at Bedford on the 26th, and the lowest, 29° below zero, at Cambridge City on the 13th. The average precipitation was 2.25, or 0.48 below normal; the greatest monthly amount, 4.20, occurred at Vevay, and the least, 0.50, at Valparaiso.—*C. F. R. Wappenhans.*

Iowa.—The mean temperature was 12.2°, or about 9.0° below normal; the highest was 75°, at Mount Pleasant on the 20th, and the lowest, 40° below zero, at Sibley on the 9th. The average precipitation was 0.89, or 0.17 below normal; the greatest monthly amount, 4.32, occurred at Ridgeway, and the least, 0.12, at Toledo.—*J. R. Sage, Director; G. M. Chappel, Assistant.*

Kentucky.—The mean temperature was 26.2°, or 9.6° below normal; the highest was 71°, at Paducah and Russellville on the 20th, and the lowest, 33° below zero, at Sandyhook on the 11th. The average precipitation was 3.96, or 0.34 above normal; the greatest monthly amount, 8.34, occurred at Williamsburg, and the least, 1.84, at Louisville. The extremely cold weather during the early part of the month caused much damage to fruit.—*H. B. Hersey.*

Louisiana.—The mean temperature was 44.3°, or 9.2° below normal; the highest was 85°, at Oakridge on the 3d, and the lowest, 16° below zero, at Minden on the 13th. The average precipitation was 3.42, or 1.47 below normal; the greatest monthly amount, 6.55, occurred at Lawrence, and the least, 1.47, at the Northern Louisiana Experiment Station, Calhoun. During the cold wave of the 12th and 13th all previous records of cold weather in Louisiana were broken. On the morning of the 17th large blocks of ice appeared in the Mississippi River at New Orleans, passing in a steady stream southward at the rate of about five miles per hour, and reached the Gulf on the 19th. It is impossible to estimate the direct loss resulting from the freeze, but it is thought that it exceeds several million dollars, while the direct loss is even greater.—*A. G. McAdie.*

Maryland and Delaware.—The mean temperature was 26.6°, or 6.6° below normal; the highest was 67°, at Cumberland, and Frostburg, Md., on the 21st, and the lowest, 26° below zero, at Sunnyside, Md., on the 10th. The average precipitation was 5.51, or 1.37 above normal; the greatest monthly amount, 8.85, occurred at Coleman, Md., and the least, 2.07, at Boettcherville, Md.—*F. J. Walz.*

Michigan.—The mean temperature was 14.1°, or 6.9° below normal; the highest was 62°, at Clinton and Grape on the 26th, and the lowest, 49° below zero, at Humboldt on the 7th. The average precipitation was 1.44, or 0.43 below normal; the greatest monthly amount, 3.18, occurred at Olivet, and the least, 0.39, at Traverse City. The month was remarkable for excessive cold, it being the coldest on record. Lake Michigan was almost frozen over on the 15th. Much fruit was destroyed and considerable game, especially quail, partridge and ducks, perished on account of the extreme cold.—*C. F. Schneider.*

Minnesota.—The mean temperature was 4.5°, or about 8.0° below nor-

Average precipitation and departures from the normal.

Districts.	Number of stations.	Average.		Departure.	
		Current month.	Percentage of normal.	Current month.	Accumulated since Jan. 1.
New England	10	Inches. 3.80	106	Inches. +0.2	+0.1
Middle Atlantic	12	5.13	154	+1.8	+1.4
South Atlantic	10	6.40	173	+2.7	+2.5
Florida Peninsula	7	4.80	171	+2.0	+3.8
East Gulf	7	4.28	91	-0.4	-0.2
West Gulf	7	1.78	53	-1.6	-0.5
Ohio Valley and Tennessee	12	3.49	83	-0.7	-0.6
Lower Lake	8	1.92	71	-0.8	-1.1
Upper Lake	9	0.92	48	-1.0	-1.8
North Dakota	7	0.16	24	-0.5	-0.7
Upper Mississippi	11	1.66	89	-0.2	-0.8
Missouri Valley	10	0.91	69	-0.4	-1.0
Northern Slope	7	0.70	117	+0.1	+0.2
Middle Slope	6	0.46	61	-0.3	-0.8
Southern Slope	6	0.15	13	-1.0	-1.7
Southern Plateau	13	0.28	32	-0.6	-0.8
Middle Plateau	9	1.33	118	+0.2	+0.2
Northern Plateau	11	1.45	88	-0.1	-0.1
North Pacific	9	7.98	129	+1.8	+4.8
Middle Pacific	5	1.14	28	-3.0	-2.5
South Pacific	4	0.16	6	-2.5	-2.1

HAIL.

The following are the dates on which hail fell in the respective States:

Alabama, 22. Arkansas, 21, 25. California, 1, 2, 8, 15, 24. Florida, 22. Georgia, 22. Indiana, 26. Louisiana, 2, 23, 26. Michigan, 26. Mississippi, 26. Ohio, 26. Oklahoma, 25. Tennessee, 3. Texas, 15, 24. Washington, 21, 27, 28.

SLEET.

The following are the dates on which sleet fell in the respective States:

Alabama, 4, 7, 8, 11, 12, 15. Arizona, 5, 6. Arkansas, 2, 3, 4, 5, 6, 14, 15, 18, 19, 25, 26, 27. California, 1, 2, 3, 28. Colorado, 10, 16, 21. Connecticut, 3, 8, 13, 16, 17, 20, 25, 26, 27. Delaware, 5, 6, 7. District of Columbia, 16. Florida, 12, 13, 14. Georgia, 8, 10, 11, 12, 15, 25. Illinois, 2, 3, 21, 22, 24, 25, 26, 27. Indiana, 2, 3, 4, 5, 8, 16, 18, 22, 25. Indian Territory, 2, 4. Iowa, 18, 21, 22, 24, 25, 27. Kansas, 2, 3, 10, 21, 22, 25. Kentucky, 4, 5, 6, 9, 11, 15, 16, 17, 18, 19, 23, 24, 25, 26. Louisiana, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 19, 25, 28. Maine, 22, 26, 27. Maryland, 3, 5, 6, 7, 8, 9, 15, 16, 17, 26. Massachusetts, 3, 4, 13, 16, 17, 18, 19, 25, 26, 28. Michigan, 3, 20, 22, 25, 26, 28. Minnesota, 21, 25, 26. Mississippi, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 18, 24, 25. Missouri, 2, 3, 4, 23, 24, 25, 26. Montana, 16, 22. Nebraska, 1, 2, 21, 22, 25, 26. Nevada, 2, 8. New Hampshire, 17, 18, 26, 27. New Jersey, 3, 7, 8, 12, 13, 26. New York, 3, 4, 16, 25, 26, 27. North Carolina, 3, 11, 12, 13, 16, 22. North Dakota, 15. Ohio, 3, 4, 15, 16, 18, 19, 22, 23, 25, 28. Oklahoma, 2, 3, 12, 25. Oregon, 1, 2, 5, 7, 12, 20, 21, 23, 24, 25, 26, 27, 28. Pennsylvania, 2, 3, 4, 8, 16, 17, 26. South Carolina, 11, 12. South Dakota, 20. Tennessee, 2, 3, 4, 5, 6, 7, 15, 16, 18, 22, 23, 26. Texas, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 16, 24. Utah, 2, 3, 15, 17. Vermont, 3, 7, 26. Virginia, 3, 4, 5, 6, 7, 8, 9, 12, 15, 16. Washington, 7, 8, 9, 12, 25. West Virginia, 3, 5, 16. Wisconsin, 25, 26. Wyoming, 5, 6, 7.

WIND.

The maximum wind velocity at each Weather Bureau station for a period of five minutes is given in Table I, which also gives the altitude of Weather Bureau anemometers above ground.

Following are the velocities of 50 miles and over per hour registered during the month:

Maximum wind velocities.

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
Do.	23	50	sw.	Independence, Cal.	1	54	nw.
Atlantic City, N. J.	13	50	n.	Mount Tamalpais, Cal.	14	61	nw.
Block Island, R. I.	13	50	e.	Do.	15	64	nw.
Do.	13	50	n.	Do.	21	50	n.
Buffalo, N. Y.	9	52	w.	Do.	23	64	nw.
Do.	19	55	w.	Do.	24	73	nw.
Do.	26	52	sw.	Do.	25	75	nw.
Do.	27	54	w.	Do.	26	84	nw.
Cape Henry, Va.	1	52	nw.	Nantucket, Mass.	13	52	ne.
Do.	13	60	n.	New York, N. Y.	9	60	nw.
Cape May, N. J.	13	50	nw.	Do.	13	57	nw.
Do.	14	50	nw.	Do.	14	61	nw.
Do.	27	55	w.	Do.	27	64	s.
Carson City, Nev.	1	58	sw.	Point Reyes Light, Cal.	4	51	nw.
Cheyenne, Wyo.	19	50	nw.	Do.	10	52	ne.
Do.	27	58	w.	Do.	14	56	nw.
Eastport, Me.	13	72	ne.	Do.	15	52	nw.
Do.	14	60	ne.	Do.	23	71	nw.
El Paso, Tex.	25	58	sw.	Do.	24	75	nw.
Eric, Pa.	26	52	s.	Do.	25	70	nw.
Fort Canby, Wash.	14	54	se.	Do.	26	60	nw.
Hatteras, N. C.	13	52	w.	Winnemucca, Nev.	28	51	sw.
Havre, Mont.	15	52	sw.	Woods Hole, Mass.	1	54	nw.
Do.	18	51	sw.	Do.	8	60	nw.
				Do.	14	72	nw.

SUNSHINE AND CLOUDINESS.

The distribution of sunshine is graphically shown on Chart VII, and the numerical values of average daylight cloudiness, both for individual stations and by geographical districts, appear in Table I.

Average cloudiness and departures from the normal.

Districts.	Average.	Departure from the normal.	Districts.	Average.	Departure from the normal.
New England	5.9	+0.4	Missouri Valley	5.0	-0.4
Middle Atlantic	6.1	+0.5	Northern Slope	5.8	+1.0
South Atlantic	5.8	+0.2	Middle Slope	4.4	0.0
Florida Peninsula	4.8	+0.2	Southern Slope	3.9	-0.9
East Gulf	6.2	+0.7	Southern Plateau	2.2	-0.8
West Gulf	5.6	-0.2	Middle Plateau	5.2	+0.4
Ohio Valley and Tennessee	6.3	+0.1	Northern Plateau	6.5	-0.2
Lower Lake	7.0	+0.2	North Pacific Coast	8.0	+1.0
Upper Lake	5.8	-0.5	Middle Pacific Coast	4.1	-0.7
North Dakota	4.9	-0.8	South Pacific Coast	2.4	-1.7
Upper Mississippi Valley	5.3	0.0			

HUMIDITY.

The relative humidity of the air continued low in the middle and south Pacific coast districts as well as the southern Plateau region; elsewhere the changes from the normal were slight.

Average relative humidity and departures from the normal.

Districts.	Average.	Departure from the normal.	Districts.	Average.	Departure from the normal.
New England	76	+1	Missouri Valley	72	-5
Middle Atlantic	79	+2	Northern Slope	77	+8
South Atlantic	80	+5	Middle Slope	72	+6
Florida Peninsula	83	+1	Southern Slope	65	-5
East Gulf	81	+3	Southern Plateau	86	-12
West Gulf	76	+3	Middle Plateau	64	+2
Ohio Valley and Tennessee	77	+3	Northern Plateau	75	-3
Lower Lake	75	+2	North Pacific Coast	85	0
Upper Lake	83	+2	Middle Pacific Coast	65	-11
North Dakota	77	+4	South Pacific Coast	61	-10
Upper Mississippi Valley	76	+1			

ATMOSPHERIC ELECTRICITY.

Numerical statistics relative to auroras and thunderstorms

mal; the highest was 55°, at Pleasant Mounds, Tower, and Luverne on the 19th, and at Winnebago City on the 20th, and the lowest, 59° below zero, at Leach Lake Dam on the 9th. The average precipitation was 0.78, or about normal; the greatest monthly amount, 1.80, occurred at Rolling Green and Tower, and the least, 0.05, at Crookston.—*T. S. Outram.*

Mississippi.—The mean temperature was 36.3°, or about 10.0° below normal; the highest was 80°, at Leakesville on the 2d, and the lowest, 16° below zero, at French Camp on the 13th. The average precipitation was 4.15, or 1.35 below normal; the greatest monthly amount, 8.99, occurred at Agricultural College, and the least, 1.60, at Burke. The cold weather of the 11th, 12th, and 13th caused great damage to fruit and fruit trees; orange, fig, and persimmon trees, except possibly the Satsuma oranges, were killed to the ground. Oats were killed to the ground but are coming up again.—*W. T. Blythe.*

Missouri.—The mean temperature was 20.4°, or 11.9° below normal; the highest was 72°, at Zeitonia on the 19th and at Marblehill on the 20th, and the lowest, 32° below zero, at Birchtree and Zeitonia on the 13th. The month was the coldest February on record, and during the first two weeks of the month the temperature averaged about 25° below normal. The average precipitation was 2.17, or about normal; the greatest monthly amount, 6.84, occurred at New Madrid, and the least, 0.71, at Unionville. As a result of the extremely low temperatures of the first half of the month peach buds were very nearly all killed and a large per cent of the trees badly frozen, many being killed to the snow line. Pears, plums, and apricots also suffered severely, a large portion of the buds being killed and, in some instances, the wood badly damaged. The hardier varieties of cherries generally escaped, but sweet cherries were killed to a considerable extent. Apples were reported badly damaged in some localities but it is believed that, as a rule, they were not seriously injured. The hardy varieties of grapes are generally safe. In most of the east-central, southeastern and south-central counties winter wheat was well protected by snow during the severe cold weather and was not seriously injured, except in localities where some of the late sown was killed, but generally throughout the northern and western sections the ground was nearly or quite bare and much of the crop was greatly damaged. Clover was also badly killed in some sections, especially where closely pastured, but in many counties was reported in good condition at the close of the month.—*A. E. Hackett.*

Montana.—The mean temperature was 10.6°, or 11.4° below normal; the highest was 60°, at Utica on the 13th, and the lowest, 61° below zero, at Fort Logan on the 11th. The average precipitation was 0.87, or 0.29 above normal; the greatest monthly amount, 3.85, occurred at Darby, and the least, trace, at Billings.—*E. J. Glass.*

Nebraska.—The mean temperature was 12.1°, or 12.2° below normal, and the coldest February on record; the highest was 74°, at Tecumseh on the 20th, and the lowest, 47° below zero, at Camp Clarke on the 12th. The average precipitation was 0.61, or 0.06 below normal; the greatest monthly amount, 1.60, occurred at Superior, and the least, trace, at Haigler and Loup.—*G. A. Loveland.*

Nevada.—The mean temperature was 33.3°, or 1.1° above normal; the highest was 73°, at Candelaria on the 19th, and the lowest, 27° below zero, at Wells on the 5th. The average precipitation was 0.55, or 0.45 below normal; the greatest monthly amount, 2.47, occurred at Clover Valley, while none fell at Las Vegas.—*J. H. Smith.*

New England.—The mean temperature was 21.1°, or 2.0° below normal; the highest was 60°, at Somers, Mass., on the 21st, and the lowest, 30° below zero, at Flagstaff, Me., on the 9th, and at Woodstock, Vt., on the 12th. The average precipitation was 3.74, or 0.30 above normal; the greatest monthly amount, 6.91, occurred at New London, Conn., and the least, 1.24, at Burlington, Vt. The month was rough and stormy; the precipitation of the first half was all in the form of snow, and of the second half rain.—*J. W. Smith.*

New Jersey.—The mean temperature was 25.8°, or 5.3° below normal; the highest was 60°, at Bridgeton and Paterson on the 22d, and the lowest, 17° below zero, at Deckertown on the 10th and at Rivervale on the 15th. The average precipitation was 6.06, or 2.00 above normal; the greatest monthly amount, 8.77, occurred at Staffordville, and the least, 3.78, at Atlantic City. The cold wave of February 9-11 will go on record as the most severe during this century, certainly during the present generation; the records covering a period of fifty years show nothing to compare with it. In some portions of the State the mean temperature for the 11th was from 1.5° to 6° below zero. The minimum was below zero at all stations on the 10th and 11th, and ranged from 3° below in the extreme southern, to 17° below in the northern portions of the State. The extreme cold was followed by one of the most severe snowstorms on record. Snow began to fall on the evening of the 11th, and continued until early in the morning of the 14th. During this period it fell to the depth of from 30 inches in the southern to 44 inches in the northern portions. All railroad travel was suspended by the 13th, and country roads were impassable for several days, the drifts being from 3 to 8 feet high in many places.

An extract from a letter received from Mr. Thomas J. Beans, Voluntary Observer, Moorestown, N. J., will prove of interest:

"I was nine years old when the snow of 1836 fell. From that time throughout my residence in Pennsylvania it was always spoken of as

'the big snow.' Enquiring of many of the old people in New Jersey, they say it was called here, 'the great snow.' At my father's home I remember the sheep were covered out of sight, and after a long search were found by holes in the snow made by their breath. The young timber was bent over in the woods so that many trees kept their bent form after they had attained size years after. A rain and freeze covered the snow with ice, so that skating over its surface was the usual way for going to school. My father hauled his hay to Philadelphia, 18 miles, on a hay body with sled runners. This corresponds with what I have gathered from old people in Jersey."—*E. W. McGann.*

New Mexico.—The mean temperature was 33.3°, or 2.7° below normal; the highest was 79°, at Eddy on the 21st and 22d and at Rincon on the 24th, and the lowest, 27° below zero, at Winsors on the 7th. The average precipitation was 0.42, or 0.25 below normal; the greatest monthly amount, 2.20, occurred at Winsors, while at Aztec and Socorro there was no precipitation, and only a trace at Bernallio, Deming, Hillsboro, and Los Lunas.—*R. M. Hardinge.*

New York.—The mean temperature was 20.5°, or 3.5° below normal; the highest was 58°, at Elmira on the 20th, and the lowest, 31° below zero, at Number Four on the 11th. The average precipitation was 2.47, or 0.19 below normal; the greatest monthly amount, 6.20, occurred at Kings Station, and the least, 0.65, at Mount Morris.—*R. G. Allen.*

North Carolina.—The mean temperature was 36.5°, or 6.8° below normal; the highest was 77°, at Fayetteville on the 4th, and the lowest, 19° below zero, at Highlands on the 13th. The average precipitation was 7.95, or 3.61 above normal; the greatest monthly amount, 13.28, occurred at Highlands, and the least, 3.94, at Wilmington. Farm work was entirely suspended throughout the month. The damage by the freeze to the truck crops in the east is not thought to have been very great.—*C. F. von Herrmann.*

North Dakota.—The mean temperature was 3.0°, or 4.7° below normal; the highest was 60°, at Berthold Agency on the 16th, and the lowest, 48° below zero, at McKinney on the 8th. The average precipitation was 0.23, or 0.26 below normal; the greatest monthly amount, 0.52, occurred at Medora, and the least, trace, at Jamestown, Larimore, Melville, and Steele.—*B. H. Bronson.*

Ohio.—The mean temperature was 21.6°, or 6.8° below normal; the highest was 67°, at Hanging Rock on the 20th, and the lowest, 39° below zero, at Milligan on the 10th. The lowest temperature ever recorded was experienced in many towns, and water pipes were badly frozen in all sections of the State. The average precipitation was 2.11, or 0.76 below normal; the greatest monthly amount, 4.52, occurred at Wauseon, and the least, 0.89, at Killbuck.—*J. Warren Smith.*

Oregon.—The mean temperature was 34.8°, or 1.8° below normal; the highest was 74°, at Winona on the 19th, and the lowest, 27° below zero, at Silverlake on the 4th. The average precipitation was 5.91, or 1.24 above normal; the greatest monthly amount, 22.22, occurred at Government Camp, and the least, 0.01, at P. Ranch.—*B. S. Pague.*

Pennsylvania.—The mean temperature was 22.7°, or 5.9° below normal; the highest was 67°, at Huntingdon on the 21st, and the lowest, 39° below zero, at Lawrenceville on the 11th. The average precipitation was 4.05, or 1.10 above normal; the greatest monthly amount, 10.22, occurred at Coatesville, and the least, 0.98, at Shinglehouse. On the 11th all previous records of low temperatures were broken in nearly all sections of the State, and during the latter part of the day a severe snowstorm, accompanied by high winds, set in, and by the morning of the 12th railroads and trolleys were so badly blocked that transportation of all kinds was almost suspended. The storm continued with unabated energy throughout the 12th and 13th, during which time traffic was at a standstill. The snow was piled up in high drifts and cities and towns were completely cut off from outside communication, except by wire, and the streets were almost impassable to pedestrians. There being no heavy lodgment of ice or snow on the telegraph lines, telegraph and telephone service was but little interrupted. Many employees were unable to reach their places of business in the cities, and in the coal regions mines were shut down because the miners were snowbound in their homes.—*T. F. Townsend.*

South Carolina.—The mean temperature was 43.0°, or 7.0° below normal; the highest was 80°, at St. Matthews on the 4th, and at Summerville on the 5th, and the lowest, 11° below zero, at Santuc and Shaws Forks on the 14th. The average precipitation was 6.98, or 3.32 above normal; the greatest monthly amount, 12.30, occurred at Trenton, and the least, 3.23, at Allendale. The cold wave of the 11-14th exceeded in severity, and gave lower temperatures than any before known in South Carolina, with authenticated records. Tradition, indeed, marks the month of February, 1835, as equally cold, but persistent research and inquiry has failed to bring to light any thermometer readings for that month, unless an article in a daily newspaper correspondence from Summerville, S. C., in which the writer stated that he heard that in 1835 the thermometer fell to 2° above, and from another source that it fell to zero, can be substantiated. Over the western portions of the State the cold period of February 6 and 7, 1835, held the first place in cold weather traditions, but no thermometer readings whatever have been discovered covering those dates.—*J. W. Bauer.*

South Dakota.—The mean temperature was 7.0°, or about 9.0° below normal; the highest was 65°, at Yankton on the 19th, and the lowest, 47° below zero, at Ladelle on the 9th. The average precipitation was

0.36, or 0.56 below normal; the greatest monthly amount, 1.11, occurred at Flandreau, and the least, trace, at Alexandria, Mellette, and Watertown.—*S. W. Glenn.*

Tennessee.—The mean temperature was 30.2°, or about 10.0° below normal; the highest was 76°, at Madison on the 20th, and the lowest, 30° below zero, at Erasmus on the 13th. The average precipitation was 5.83, or about 0.75 above normal; the greatest monthly amount, 14.15, occurred at Oakhill, and the least, 2.70, at Union City.—*H. C. Bate.*

Texas.—The mean temperature was 11.1° below normal; there was a general deficiency, ranging from 8° to 15°, with the greatest in the interior; the highest was 99°, at Fort Ringgold on the 3d, and the lowest, 23° below zero, at Tulia on the 12th. The average precipitation, determined by comparison of 50 stations, distributed throughout the State, was 1.10 below the normal. There was only a slight deficiency over the east coast district and the extreme western portion of west Texas, while the deficit was general in other sections and amounted to more than 1 inch in most places, with the greatest, 2.61, at Longview. The greatest monthly amount, 3.58, occurred at Brazoria, while none fell at several stations in the western portion. The month was very unfavorable for farming operations. The severe cold spell at the opening of the second decade stopped farm work in all sections. Drought is becoming very severe in places over west and north portions, placing farmers considerably behind with their work, especially plowing and making preparations for spring crops.—*I. M. Cline.*

Utah.—The mean temperature was 28.8°; the highest was 77°, at St. George on the 19th, and the lowest, 50° below zero, at Woodruff on the 6th. The average precipitation was 1.73; the greatest monthly amount,

5.85, occurred at Heber, and the least, trace, at Giles and St. George.—*L. H. Murdoch.*

Virginia.—The mean temperature was 30.2°, or 8.1° below normal; the highest was 80°, at Westpoint on the 4th, and the lowest, 29° below zero, at Monterey on the 10th. The average precipitation was 5.50, or 1.99 above normal; the greatest monthly amount, 8.18, occurred at Hampton, and the least, 2.65, at Monterey. The heavy fall of snow which attended the cold period of 10-16th afforded protection to winter crops and no winter killing has been reported.—*E. A. Evans.*

Washington.—The mean temperature was 32.5°, or 4.0° below normal; the highest was 63°, at Centerville on the 14th, at Kennewick on the 17th and at Fort Simcoe on the 18th, and the lowest, 36° below zero, at Usk on the 4th. The average precipitation was 5.43, or 1.30 above normal; the greatest monthly amount, 20.98, occurred at Clearwater, and the least, 0.31, at Sunnyside.—*G. N. Salisbury.*

Wisconsin.—The mean temperature was 9.3°, or 7.5 below normal; the highest was 58°, at Butternut on the 21st, and the lowest, 50° below zero, at Easton on the 10th. The average precipitation was 0.95, or 0.09 above normal; the greatest monthly amount, 2.51, occurred at Dodgeville, and the least, trace, at Racine and Westbend.—*W. M. Wilson.*

Wyoming.—The mean temperature was 11.2°, or 11.2 below normal; the highest was 55°, at several stations on different dates, and the lowest was 51° below zero, at Lowell on the 4th and at Basin on the 5th. The average precipitation was 1.78, or 1.03 above normal; the greatest monthly amount, 5.90, occurred at Centennial, and the least, 0.13, at Alcova. As a whole, the month was one of the coldest and stormiest on record in Wyoming.—*W. S. Palmer.*

SPECIAL CONTRIBUTIONS.

SNOW TEMPERATURES.

By E. B. CALVERT and W. F. R. PHILLIPS.

The snowstorms of February 5-8 and 11-13, 1899, were, for both the depth of the snowfall and the subsequent cold weather, most unusual for the region in which Washington, D. C., is situated. Following these storms the writers made some thermometric observations of the temperature of the snow at different depths from the surface. From the practical value that such observations appear to possess, we think that the series made by us is suggestive and of sufficient importance to publish.

The observations were made in snow that fell on an open plat of sod covered ground on the north side of the Weather Bureau building. Two classes of observations were made. One in snow on which the sun had shone for some hours and the other in snow that had been shaded for some time by the building.

Snow began to fall on the morning of February 5 and continued at intervals till the morning of the 8th. At the end of the storm the snow was about 13 inches deep. At the beginning of the snow the temperature of the air was 32°, and it gradually fell to 25° at the end of the storm. The tem-

perature continued to fall till on the morning of the 11th it was 15° below zero, the lowest temperature ever recorded for Washington, D. C. The second storm began during the afternoon of the 11th and continued into the night of the 13th. The temperature of the air during this storm ranged from 15° below zero to 11° above. The snow was considerably drifted by the high winds that prevailed during its fall. On the morning of the 14th the snow measured from 25 to 30 inches deep in level places in front of the Weather Bureau building.

The first set of snow temperature observations was made on the afternoon of February 9 in snow 10 inches deep. At this time the atmospheric temperature was 8°. A thermometer lying immediately on the surface of the snow indicated, in the shade, a temperature of 3°, and, in the sun, a temperature of 9°. The results of the other readings made in the shade were as follows, viz: Three inches below the surface of the snow (or 7 inches from the surface of the ground) the temperature was 16°; 6 inches below the surface (4 inches from the ground) it was 20°; and 10 inches below the surface, the bulb of the thermometer touching the ground, the temperature was 31°.

On the following morning, with an air temperature of 6°

February, 1899.

Distance of thermometer bulb from surface of—		9th.		10th.				11th.				14th.			
		3 p. m.		10 a. m.		3 p. m.		10 a. m.		3 p. m.		10 a. m.		3 p. m.	
Snow.	Ground.	Shade.	Sun.	Shade.	Sun.	Shade.	Sun.	Shade.	Sun.	Shade.	Sun.	Shade.	Sun.	Shade.	Sun.
On surface	10 inches above	3.0	9.0	— 7.5	— 7.5	— 3.0	5.5	3.0	15.5	11.0	14.0	8.0	.....	.....	.....
Just below	9-10 inches above	.....	.....	— 5.5	— 5.5	— 4.0	3.5	1.0	14.5	9.5	15.5	8.0	.....	.....	.....
3 inches below	7 inches above	16.0	15.0	3.5	5.5	5.0	11.0	5.0	11.0	15.0	15.0	6.5	.....	.....	.....
6 inches below	4 inches above	30.0	20.0	14.0	15.0	15.0	16.5	16.0	20.0	18.5	20.0	9.5	.....	.....	.....
6 inches below	On ground	.....	31.5	.....	27.0	.....	28.0	.....	.....	.....	.....	.....	.....	.....	.....
9 inches below	1 inch above	.....	27.0	29.0	28.0	28.0	29.0	.....	.....	.....	.....	.....	.....	.....	.....
10 inches below	On ground	31.0	31.0	31.0	29.5	31.5	30.0	27.0	32.0	31.0	29.0	9.5	.....	.....	.....
25 inches below	On ground	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
19 inches below	6 inches above	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	30.5	.....	.....	31.5
16 inches below	9 inches above	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	25.0	.....	.....	24.5
13 inches below	12 inches above	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21.0	.....	.....	23.5
7 inches below	18 inches above	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18.0	.....	.....	18.0
On surface	25 inches above	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.0	.....	.....	11.5
Temp. of air 65 feet above snow	.....	8.0	.....	— 6.0	.....	3.0	.....	— 1.0	.....	.....	.....	12.0	.....	.....	.....
Temp. of air 1 foot above snow	.....	6.0	.....	— 5.0	.....	2.0	.....	1.5	.....	.....	.....	11.0	.....	22.0	.....
Velocity of wind, in miles per hour	.....	22.0	.....	14.0	.....	12.0	.....	6.0	.....	.....	.....	4.0	.....	.....	.....

to 8° below zero, a thermometer on the surface of the snow, in the shade, indicated 7.5° below zero; at the same time one 6 inches below the surface read 14° above zero; and one 10 inches below the surface and touching the ground read 31°, the same as the evening before.

On the morning of the 11th, when the average temperature of the air had been 2° below zero for the preceding twenty-four hours, a temperature of 27° was registered by a thermometer 10 inches below the surface of the snow and in contact with the ground. This was the lowest temperature observed in the layer of snow immediately touching the soil.

Observations were made also in a spot of several square yards in extent from which the snow had been blown till it measured but 6 inches in depth. The temperature of the snow in contact with the ground was found to range from 31.5° to 27°. The snow in this place was exposed to the sun throughout the day.

On the 14th, observations were made in snow 25 inches deep, the depth of the snow having been greatly increased by the storm of the 11-13th. The results were the same as had been previously found so far as regards the temperature of the snow immediately on the surface of the ground.

It was noticed in all our observations that the temperature of the snow layer immediately touching the ground was fairly uniform, being on the average 31°. During the period covered by our observations the extreme range of temperature of the snow layer in contact with the ground was but 5°, while that of the atmosphere was 37°. The greatest difference observed between the atmospheric temperature and that of the snow near the ground was 38.5°, on the morning of the 10th, the temperature of the air being 7.5° below zero, and that of the snow layer touching the ground 31° above zero.

The observations made in snow upon which the sun had shone for some hours showed that the temperature of the superficial layer of the snow was considerably influenced by direct solar radiation.

The most striking fact developed in our observations was the relatively high and uniform temperature observed at the surface of the ground. This was due undoubtedly to the barrier to radiation interposed by the snow mantle. From the 5th to 14th, inclusive, the average temperature of the air was 13°, and the average temperature of the snow covered soil was certainly not below 31°. In other words, notwithstanding the fact that the temperature of the air was for 240 hours 18° lower than that of the soil, yet the latter apparently lost none of its heat. That the surface soil actually lost heat there can be no doubt, but the loss was gradual and no more rapid than the rate of conduction upward from the warmer underlying layers of earth.

The practical benefits resulting from these two snow storms, storms in which few perhaps saw any good, may now be mentioned. Had the severe cold that came with and stayed after the snows occurred without snow, or without a snow covered ground, the temperature of the soil would have fallen many degrees below freezing, and the damage to vegetation resulting from the freezing of the roots would have been enormous. But wherever the ground was covered by snow no such damage was done.

The observations are shown in detail in the table.

OBSERVATIONS AT HONOLULU.

Through the kind cooperation of Mr. Curtis J. Lyons, Meteorologist to the Government Survey, the monthly report of meteorological conditions at Honolulu is now made nearly in accordance with the new form, No. 1040, and the arrange-

ment of the columns, therefore, differs from those previously published.

Meteorological observations at Honolulu.

FEBRUARY, 1899.

The station is at 21° 18' N., 157° 50' W.; altitude 50 feet. Pressure is corrected for temperature and reduced to sea level, and the gravity correction, -0.06, has been applied. The average direction and maximum force of the wind and the average cloudiness for the whole day are given unless they have varied more than usual, in which case the extremes are given. The scale of wind force is 0 to 12, or Beaufort scale. Two directions of wind, or values of wind force, connected by a dash, indicate change from one to the other. The rainfall for twenty-four hours is now given as measured at 1 p. m. Greenwich time on the respective dates. The rain gauge, 8 inches in diameter, is 1 foot above ground. Thermometer, 9 feet above ground. Ground is 50 feet above sea level.

Date.	Pressure at sea level.		Temperature.		During twenty-four hours preceding 1 p. m., Greenwich time, or 2:30 a. m., Honolulu time, of the respective dates.									
	Dry bulb.	Wet bulb.	Temperature.		Maximum.	Minimum.	Dew-point.	Relative humidity.	Wind.		Total rainfall.	Average cloudiness.	Sea-level pressures.	
			Maximum.	Minimum.					Prevailing direction.	Maximum force.			Maximum.	Minimum.
1.....	29.83	64	63.5	78	62	63.3	76	nne.	3	0.00	5-2	29.99	29.88	
2.....	29.76	63	62	78	62	64.5	82	nne-w.	1	0.00	1-1	29.85	29.74	
3.....	29.82	64	62	77	62	64.5	84	sw.	1	0.00	3-2	29.85	29.76	
4.....	29.82	66	64	78	62	63.5	81	sw-w.	1	0.00	2-2	29.88	29.78	
5.....	29.85	69	66.5	79	63	65.5	79	sw-w.	2	0.00	5-2	29.88	29.82	
6.....	29.92	70	69	79	68	66.3	86	sw.	2-1	0.01	5-2	29.93	29.86	
7.....	29.91	69	67	80	69	69.0	88	sw.	2-1	2.33	8-10	29.97	29.90	
8.....	29.94	68	67	78	67	68.5	87	sw-w.	2	0.00	1-1	29.98	29.91	
9.....	29.99	67	66.5	78	67	68.5	92	sw.	2-0	0.00	3-8	29.99	29.92	
10.....	30.06	64	63	78	67	67.7	90	sw-s.	1-0	0.02	2	30.05	30.00	
11.....	30.04	63	62.5	80	63	64.0	69	sw-s.	1	0.00	1	30.10	30.00	
12.....	30.00	64	63	81	62	64.7	80	se-ne.	2-0	0.00	1-3	30.08	29.99	
13.....	30.01	69	64	79	63	64.0	81	sw-nw.	2	0.01	3-7	30.04	29.97	
14.....	30.00	68	64	78	63	62.7	71	ne-s.	2-0	0.00	5	30.07	29.98	
15.....	30.03	67	65	80	67	64.0	74	sw.	1	0.00	5	30.07	30.01	
16.....	30.01	69	67.5	80	64	66.0	81	s.	1	0.06	5	30.09	30.00	
17.....	30.01	65	64	80	65	67.5	84	ne-sw.	1-0	0.00	6-1	30.06	29.97	
18.....	30.00	72	64	79	64	63.5	76	s-ne.	1	0.00	5	30.04	29.96	
19.....	29.97	72	67	78	71	60.7	64	ne.	3	0.05	6	30.03	29.96	
20.....	29.99	72	65	79	70	63.0	68	ne.	3-0	0.00	4	30.04	29.96	
21.....	29.99	72	65.5	80	66	62.0	66	ne.	2	0.01	3-6	30.03	29.96	
22.....	29.97	71	64.5	78	71	61.7	67	ne.	3-4	0.03	4	30.03	29.95	
23.....	29.94	71	65	77	69	62.0	68	ne.	3-4	0.08	2-6	30.00	29.90	
24.....	29.95	71	66	76	69	63.3	73	ne.	4	0.04	5-8	29.99	29.91	
25.....	30.01	72	67	80	68	64.0	70	ne.	3-0	0.09	7	30.01	29.96	
26.....	30.07	72	66	79	68	64.5	70	ne.	3-5	0.01	5	30.09	30.01	
27.....	30.05	69	66	78	71	61.5	64	ne.	4-6	0.15	8	30.10	30.01	
28.....	30.05	71	65	77	68	63.3	76	ne.	5-6	0.03	9-6	30.10	30.01	
Sums..											4.01			
Means.	29.961	68.4	65.0	77.0	66.1	64.4	76.3					30.012	29.931	
Departure..	-0.01					+2.2	+0.3				-1.00			

Mean temperature for February, 1899 (6+2+9)+3=71.9°; normal is 70.3°. Mean pressure for February is 29.96; normal is 29.97. *This pressure is as recorded at 1 p. m., Greenwich time. †These temperatures are observed at 6 a. m., local, or 4:30 p. m., Greenwich time. ‡These values are the means of (6+9+2+9)+4. §Beaufort scale. ¶Mean for the daytime is 1.0. ¶The mean during daylight is 4.4.

RECENT PAPERS BEARING ON METEOROLOGY.

W. F. R. PHILLIPS, in charge of Library, etc.

The subjoined list of titles has been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau:

- Annales Agronomiques, Paris, Tome 25.*
- Pagnoul. Influence des pluies et de la nature des terres sur le rendement des fourages. P. 83.
- Scottish Geographical Magazine, Edinburgh, Vol. 15.*
- Taylor, W. A. Meteorology of Mount Etna. [Abstract from Ciel et Terre.] P. 147.
- Nature, London, Vol. 59.*
- Arcimis, A. Probable Weather Conditions in Spain, during the Total Solar Eclipse of May 28, 1900. P. 439.
- MacDowall, A. B. American and English Winters. P. 416.

TABLE I.—Climatological data for Weather Bureau Stations, February, 1899—Continued.

Table with columns for Stations, Elevation of instruments, Pressure, Temperature of the air, Precipitation, and Wind. Rows include various locations like Up. Miss. Val., St. Paul, La Crosse, Davenport, Des Moines, Dubuque, Keokuk, Cairo, Springfield, Ill., Hannibal, St. Louis, Missouri Valley, Columbia, Kansas City, Springfield, Mo., Topeka, Lincoln, Omaha, Sioux City, Pierre, Huron, Yankton, Northern Slope, Miles City, Helena, Rapid City, Cheyenne, Lander, North Platte, Middle Slope, Denver, Pueblo, Concordia, Dodge, Wichita, Oklahoma, Southern Slope, Abilene, Amarillo, Southern Plateau, El Paso, Santa Fe, Flagstaff, Phoenix, Yuma, Independence, Middle Plateau, Carson City, Winnemucca, Salt Lake City, Grand Junction, Northern Plateau, Baker City, Boise, Idaho Falls, Spokane, Walla Walla, N. Pac. Coast Reg., Fort Canby, Neah, Port Crescent, Seattle, Tacoma, Astoria, Portland, Ore., Roseburg, Md. Pac. Cst Reg., Eureka, Mount Tamalpais, Red Bluff, Sacramento, San Francisco, Point Reyes Light, S. Pac. Coast Reg., Fresno, Los Angeles, San Diego, San Luis Obispo, West Indies, Basseterre, Bridgetown, Colon, Havana, Kingston, Port of Spain, Roseau, San Juan, Santiago de Cuba, Santo Domingo, Willemstad, Alaska, Sitka.

NOTE.—The data at stations having no departures are not used in computing the district averages. Letters of the alphabet denote number of days missing from the record. *Two or more dates. †Received too late to be considered in departures, etc.

TABLE I.—Climatological data for Weather Bureau Stations, February, 1899.

Table with columns: Stations, Elevation of instruments, Pressure, Temperature of the air, Precipitation, Wind, and various weather metrics. Rows are categorized by region: New England, Mid. Atl. States, S. Atlantic States, Florida Peninsula, East Gulf States, West Gulf States, Ohio Val. & Tenn., Lower Lake Region, Upper Lake Region, and North Dakota.

TABLE II.—Climatological record of voluntary and other cooperating observers, February, 1899.

Stations.	Temperature. (Fahrenheit.)			Precipitation.		Stations.	Temperature. (Fahrenheit.)			Precipitation.		Stations.	Temperature. (Fahrenheit.)			Precipitation.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.		Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.		Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
<i>Alabama.</i>						<i>Arizona—Cont'd.</i>						<i>California—Cont'd.</i>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Alco	80	-8	46.8	4.20	3.0	San Simon* ¹	72	10	43.9	0.30	3.0	Corning* ¹	80	25	46.9	Ins.	Ins.	Coronado	75	42	56.2	0.00	0.00	Craftonville	86	27	53.8	0.72	0.72	Crescent City	58	23	44.0	10.95	4.0	Crescent City L. H.				9.30	9.30	Cuyamaca	62	4	37.1	1.53	16.5	Delta* ¹	78	23	47.7	T.	T.	Delano* ¹	76	15	46.4	0.00	0.00	Drytown	81	24	53.2	0.25	0.25	Duarte	75	29	50.4	0.00	0.00	Dunnigan* ¹	77	28	52.8	T.	T.	Durham* ¹	82	24	50.6	0.00	0.00	East Brother L. H.				0.15	0.15	Edmonton* ¹	63	3	36.4	3.01	21.0	El Cajon	84	25	52.5	0.55	0.55	Elsinore	88	22	53.2	0.48	0.48	Escondido	79	20	48.1	1.13	1.13	Folsom City* ¹	81	25	50.6	0.07	0.07	Fordyce Dam				3.68	39.0	Fort Bragg				0.62	0.62	Fort Ross	72	29	48.6	0.85	T.	Fort Tejon				0.50	0.50	Georgetown	72	18	44.2	0.61	5.0	Gilroy Hot Springs				0.21	0.21	Gilvora				0.10	0.10	Goshen* ⁶	75	20	54.4	0.25	0.25	Grand Island* ⁶	81	28	52.8	0.00	0.00	Grass Valley				0.47	1.0	Greenville	68	-9	35.4	0.59	9.0	Hollister	80	20	50.0	0.25	0.25	Humboldt L. H.				3.59	3.59	Hydesville	66	20	47.2	4.20	4.0	Indio* ¹	87	30	62.2	0.00	0.00	Iowa Hill* ¹	72	22	46.7	0.83	2.0	Irvine	92	32	58.3	0.53	0.53	Jackson	70	20	47.2	0.57	1.8	Jolon				0.18	0.18	Keene* ¹	65	28	41.8	1.17	4.0	Kennedy Gold Mine	70	18	44.7	0.53	0.53	Kernville				0.40	0.40	King City* ¹	78	26	48.6	0.18	0.18	Kingsburg* ⁶	75	23	48.6	0.20	0.20	Kono Tayce	71	25	48.3	T.	T.	Lagrange* ⁶	76	26	51.4	0.85	0.85	Lakeside				0.78	0.78	Lamesa				0.59	0.59	Laporte* ¹	61	4	34.4	2.69	26.9	Las Fuentes Ranch				0.00	0.00	Lemoncove	80	23	53.7	0.00	0.00	Lemoore* ⁶	73	16	48.6	0.26	0.26	Lick Observatory	61	13	41.0	0.75	4.0	Lime Point L. H.				0.15	0.15	Lodi	82	25	50.4	0.16	0.16	Los Alamos				0.44	0.44	Los Gatos* ⁶	76	29	50.1	0.44	0.44	Malakoff Mine	78	14	46.2	1.01	5.5	Mammoth Tank* ¹	85	29	60.0	0.00	0.00	Manzana	73	24	48.4	T.	T.	Mare Island L. H.				0.28	0.28	Merced* ¹	75	26	50.6	0.00	0.00	Mills College				0.15	0.15	Milo				0.52	1.5	Milton (near)* ¹	73	25	49.4	0.24	0.24	Modesto* ¹	92	28	54.8	0.21	0.21	Mohave* ¹	72	18	48.3	0.00	0.00	Mokelumne Hill* ⁸				44.8	0.70	Monterey* ¹	72	29	53.2	0.66	0.66	Mountain View				0.28	0.28	Mount Frazier				0.40	1.5	Mutah Flat				0.00	0.00	Napa* ⁶	86	25	52.1	T.	T.	Needles	79	28	57.4	T.	T.	Nevada City	72	14	42.4	0.49	2.5	Newhall* ¹	85	22	50.5	0.00	0.00	North Ontario	80	22	50.8	0.63	0.63	North San Juan* ¹	84	16	47.3	0.85	3.5	Oakland* ⁶	82	31	50.7	0.07	0.07	Ogilby* ¹	80	40	53.9	0.00	0.00	Oleta* ¹	70	20	43.9	0.96	1.5	Orland* ¹	82	26	53.2	T.	T.	Palermo	81	24	49.2	0.00	0.00	Paso Robles* ⁶	77	20	49.4	0.08	0.08	Peachland* ⁶	83	24	51.2	0.19	0.19	Piedras Blancas L. H.				0.45	0.45	Pigeon Point L. H.				0.55	0.55	Pilot Creek				1.08	11.0	Pine Crest	82	31	56.6	T.	T.	Placerville	76	22	46.8	0.15	0.15	Point Ano Nuevo L. H.				0.50	0.50	Point Arena L. H.				1.54	1.54	Point Bonta L. H.				0.47	0.47	Point Conception L. H.				0.17	0.17	Point Firmin L. H.				0.20	0.20	Point George L. H.				1.78	1.78	Point Hueneme L. H.				0.00	0.00	Point Lobos	74	33	48.2	0.18	0.18

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Table with 15 columns: Stations, Temperature (Fahrenheit) [Maximum, Minimum, Mean], Precipitation [Rain and melted snow, Total depth of snow]. Data is organized into three main sections: Idaho-Cont'd., Illinois-Cont'd., and Iowa-Cont'd., each listing various locations and their corresponding weather statistics.

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Table with 12 columns: Stations, Temperature (Fahrenheit), Precipitation, and sub-columns for Maximum, Minimum, Mean, Rain and melted snow, and Total depth of snow. Data is organized by state: Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, and Maine.

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Table with columns for Stations, Temperature (Fahrenheit), and Precipitation. It is divided into three main sections: Michigan, Michigan-Cont'd, and Mississippi-Cont'd. Each section lists various locations and their corresponding weather data for February 1899.

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Table with 15 columns: Stations, Temperature (Fahrenheit), Precipitation, and their respective sub-categories (Maximum, Minimum, Mean, Rain and melted snow, Total depth of snow). The table is organized into three main sections: Missouri, Montana, Nebraska, Nevada, and New Hampshire.

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Table with 12 columns: Stations, Temperature (Fahrenheit), Precipitation, and sub-columns for Maximum, Minimum, Mean, Rain and melted snow, and Total depth of snow. The table is divided into sections for New Jersey, New York, New Mexico, North Carolina, North Dakota, and Ohio.

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Table with columns for Stations, Temperature (Fahrenheit), and Precipitation. It is divided into three main sections: Ohio-Cont'd., Ohio-Cont'd., and Oregon-Cont'd. Each section lists various locations and their corresponding weather data for February 1899.

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Table with 5 main columns: Stations, Temperature (Fahrenheit), Precipitation, Stations, Temperature (Fahrenheit), Precipitation, Stations, Temperature (Fahrenheit), Precipitation. Sub-sections include Utah-Cont'd, Vermont, Virginia, West Virginia, Wyoming, Mexico, Porto Rico, and Late reports for December, 1898.

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Table with 12 columns: Stations, Temperature (Fahrenheit), Precipitation, Stations, Temperature (Fahrenheit), Precipitation, Stations, Temperature (Fahrenheit), Precipitation. Rows include Pennsylvania, Rhode Island, South Carolina, South Dakota, and Texas.