

SPECIAL FORECASTS AND WARNINGS. WEATHER AND CROPS.

WEATHER WARNINGS, DECEMBER, 1919.

By EDWARD H. BOWIE, Supervising Forecaster.

[Dated: Weather Bureau, Washington, Jan. 17, 1920.]

On the 1st, when an extensive area of high barometer with very low temperature covered the Northwestern States, cold-wave warnings were ordered for Indiana, Kentucky, Tennessee, Mississippi, and Alabama, and on the 2d the display of warnings was extended to the upper Ohio Valley and the Atlantic States north of the Carolinas. On the afternoon of the 2d, the following bulletin was issued to the press:

Intense cold for the season is now general over the upper Mississippi Valley, the Great Plains States, and the Rocky Mountain Region, and this area of low temperature is advancing eastward and southward. Cold weather will prevail generally east of the Mississippi River within the next 48 hours, and it will be of several days' duration.

The cold wave occurred as forecast over the northern and middle States east of the Mississippi, but did not spread southward beyond Tennessee and North Carolina. The coldest weather of the season, thus far, followed over considerable areas of the region east of the Mississippi. On the afternoon of the 4th small-craft warnings were ordered for Lakes Michigan and Huron, and the evening of the same day southwest storm warnings were displayed on Lakes Erie and Huron. At this time a low of considerable intensity was central north of Lake Huron and moving rapidly eastward. At 8 p. m. of the 5th the weather map showed a low over New Mexico and rapidly falling pressure over the middle Plains States and the Mississippi Valley and on these facts forecasts of snows were issued for the region of the Great Lakes and the North Atlantic States and snows and rains for the Ohio Valley and the Middle Atlantic States. This disturbance advanced rapidly east-northeastward, and the morning of the 6th its center was over southwestern Missouri, with snow and rain in the Ohio Valley and snow in the region of the Great Lakes and over the upper Mississippi and Missouri Valleys. On the morning of the 6th advisory warnings of fresh shifting winds and snow were sent to open ports on Lake Michigan, and on the evening of the same day storm warnings were ordered for the Atlantic coast at and north of Cape Hatteras, when the disturbance was over the Ohio Valley and manifesting a rapid gain in intensity. At 8 a. m. of the 7th the center of this disturbance was over New York and by the 8th the disturbance had passed eastward beyond the coast. The appearance of rapidly rising pressure and falling temperature on the morning of the 7th over the Northwestern States presaged the rapid southward and eastward extension of a cold wave from that region, and at that time cold-wave warnings were ordered for upper Michigan and the evening of the same day for lower Michigan. By the morning of the 8th the cold wave was rapidly spreading southward beyond the Mississippi River, with intense cold prevailing in the Northwestern States. On the afternoon of the 8th, cold-wave warnings announcing a severe cold wave for the night of the 9th and the following day were ordered for the East Gulf States, Tennessee, Kentucky, and Indiana, and the morning of the 9th the display of cold-wave warnings was extended to cover lower Michigan, Ohio, western New York, western Pennsylvania, West Virginia, extreme western Virginia, and northern and western Georgia. Also northwest storm warnings were displayed the morning of the 9th on the Gulf coast at and between Cedar Keys,

Fla., and Bay St. Louis, Miss., and southeast storm warnings were ordered on the New England coast. Later on the same day northwest storm warnings were displayed on the Atlantic coast at and between New York and Jacksonville, and cold-wave warnings were displayed over the Atlantic States, except southern Florida. Strong winds and gales occurred along the coast where storm warnings were displayed, and the weather was decidedly colder, temperature falling 30 to 40 degrees during the 10th and the night of the 10th generally east of the Mississippi, although the cold-wave warnings failed of verification on the south Atlantic and east Gulf coasts.

On the 10th and 11th the pressure fell decidedly over the western Plateau and increased over the Northwestern States. The western low moved eastward during the 12th, and the pressure continued to increase and the weather became much colder over the Northwestern States. On the 12th cold-wave warnings were ordered for the region of the Great Lakes, the Ohio Valley, Tennessee, and the interior of the East Gulf States, and southwest storm warnings were displayed on the Atlantic coast at and north of Delaware Breakwater. On the 13th cold-wave warnings were repeated for the regions previously warned and extended to the Atlantic States south of Pennsylvania, except the Florida Peninsula. Storm warnings were continued on the north Atlantic coast and ordered for the Gulf coast between Bay St. Louis, Miss., and Cedar Keys, Fla. On the 14th cold-wave warnings were ordered for the Atlantic States north of Maryland and for the northern and central portions of the Florida Peninsula, and northwest storm warnings were ordered at 9.30 a. m. for the Atlantic coast at and between Boston, Mass., and Jacksonville, Fla. On the 15th northwest storm warnings were again displayed over the limited area of the coast between Sandy Hook, N. J., and Provincetown, Mass. The cold wave and storm warnings set forth above were generally fully verified, storm winds occurring as forecast and cold weather prevailing over the entire region east of the Mississippi River, except in extreme southern Florida. On the 23d cold-wave warnings were ordered for northern Michigan, and on the morning of the 24th storm warnings were displayed on the Atlantic coast north of Cape Hatteras in connection with a disturbance that had passed eastward along the northern border to New York followed by steep gradients and northerly winds. At 8 p. m. of the 24th the center of this disturbance was off the southern New England coast, and the night of the 24th north and northwest gales set in over the region where warnings were displayed. On the morning of the 26th when a disturbance of considerable intensity was over the Great Lakes, southwest storm warnings were displayed on the Atlantic coast at and north of Sandy Hook, N. J. On the morning of the 28th cold-wave warnings were ordered for northern Vermont and on the evening of the 29th storm warnings were displayed on the Atlantic coast at and north of Delaware Breakwater, at that time there being a disturbance of considerable intensity over the Great Lakes. On the morning of the 30th, when this disturbance was central over western New York, northwest storm warnings were displayed at coast stations between Cape Hatteras and Delaware Breakwater, and later in

the day the southwest storm warnings at and north of Delaware Breakwater were changed to northwest storm warnings. This storm passed eastward off the New England coast the night of the 30th, attended by strong shifting winds and gales. Cold-wave warnings were ordered on the 31st for parts of upper Michigan, and the afternoon of the same day an advisory message containing information of the eastward movement of a disturbance which was then over the Ohio Valley was sent to ports on the Atlantic coast at and north of Cape Hatteras.

Frequent warnings of strong winds and squalls were sent during the month to open ports on Lake Michigan; also warnings of frosts were sent on a number of occasions during the month to the truck and fruit regions of the East Gulf and South Atlantic States.

WARNINGS FROM OTHER DISTRICTS.

Chicago Forecast District.—The month opened with unusually cold weather prevailing in practically all portions of this forecast district, with the exception of Illinois and Missouri.

On the morning of the 5th advices were telegraphed to Wyoming, north and west South Dakota, and west Nebraska, containing warnings of conditions dangerous to stock interests. During the following 36 hours, while snow fell over a portion of these States and fresh winds occurred, no unusual cold ensued.

On the morning of December 8, unusually cold weather with high pressure prevailed in the northern tier of States, and a marked low was centered over the southern plateau region. These conditions made necessary the issuing of live-stock warnings for the States of Nebraska and Kansas and southeastern Wyoming; and with the southeastward movement of the disturbance in question, these warnings were fully justified.

Live-stock warnings were again issued on December 11 for Wyoming, South Dakota, and Nebraska, and cold-wave warnings for Wyoming and portions of Nebraska, South Dakota, and Iowa, and on the morning of the 12th the warnings were extended to include the eastern and southern portions of the district, and repeated for eastern Wisconsin and eastern and southern Illinois that evening, these warnings being fully verified.

Upon advice received from the central office on the afternoon of December 23, cold-wave warnings were issued for Minnesota, Wisconsin, eastern North Dakota, and northeastern Iowa, but the warning failed of verification because of the high passing rapidly eastward with its center far to the north.

On the morning of the 30th, after a prolonged period of temperature above normal in nearly all sections of the district, a cold high area appeared in the Canadian northwest. Warnings were issued well in advance of this cold weather as it spread rapidly eastward and southward, reaching the southeastern limits of the district on the morning of January 1. A decided drop in temperature occurred in the eastern and southern portions of this district, although in some sections the verifying limit for cold waves was not reached.

Upon the request of the official in charge at Sheridan, Wyo., a special forecast was telegraphed to him on December 22, 1919, as follows:

From pressure conditions existing Alaska this morning indications point to a continuation of moderate temperature and fair weather north Wyoming next three days. No severe cold now imminent. Conditions latter part of week doubtful.

This forecast was made in the interests of stockmen in the northern portion of Wyoming, who had planned on a large movement of cattle if assured of a continuation of moderate temperature. Ensuing conditions fully justified this advice; in fact, moderate temperatures continued in that section until the close of the month.

Beginning with Tuesday, December 2, and continuing weekly on that day throughout the month, a special forecast was telegraphed to the Weekly Star, Kansas City, Mo., containing the probable weather conditions for the next three days for Kansas, Missouri, southern Iowa, and southern Nebraska, and, when advisable, for the balance of the week. Generally speaking, these forecasts have been most successful.—*E. H. Haines.*

New Orleans Forecast District.—During the first two weeks, storms and cold waves were more frequent than is usual at this time of year; but thereafter the conditions were largely influenced by high pressure over the Great Basin, with comparatively uneventful weather.

Northeast storm warnings were ordered for the east coast of Texas from Port Arthur to Velasco on the morning of the 2d, at which time an area of high pressure was central over the Missouri Valley, with a moderately strong barometric gradient southward. Fresh north winds occurred during the afternoon and night of the 2d.

Another area of high pressure was over the Missouri Valley and northern Rocky Mountain States on the 9th, but with conditions southward more intense than on the 2d. A trough of moderately low pressure was over the West Gulf coast extending northeastward to the Ohio Valley. Northwest storm warnings were ordered at 8.15 a. m. from Port Arthur to Rockport, Tex., and small-craft warnings elsewhere on the west Gulf coast. The small-craft warnings were changed at noon to northwest storm warnings. The warnings were generally verified.

The next "norther" on the Gulf coast occurred on the 13th-14th, for which also timely warnings were issued, northwest storm warnings being ordered on the Texas coast at night on the 12th and on the Louisiana coast the following morning.

No storm occurred without warning.

Cold-wave warnings were issued on the morning of the 1st for Oklahoma and the northern portion of west Texas and were verified the following morning. The warnings were extended in the early afternoon of the 1st over Arkansas and the northern portion of east Texas and at night over the remainder of the district except southern Louisiana, for which cold-wave warnings were issued on the morning of the 2d. A large fall in temperature occurred, with freezing in Arkansas and to the central portion of east Texas; but as the movement of the area of high pressure was eastward, with attendant cloudiness, low temperatures did not reach the verifying limit in the eastern and extreme southern portions of the area for which the cold wave was forecast.

Cold-wave warnings were issued for the Texas Panhandle on the morning of the 5th, and as conditions were critical, 1 p. m. special observations were called for, and warning of a severe cold wave was issued in the early afternoon for the entire district except southern Louisiana, warning for the latter being issued the following morning. The warnings were verified. Zero temperatures and lower were recorded in the extreme northwestern portion of the district, temperature of 3° to 20° in Arkansas, mostly below 25° in the interior of east

Texas and Louisiana, and below freezing to the coast except in extreme southeastern Louisiana.

The night reports of the 11th showed an intense disturbance central over northern Utah and a high over western Canada. Cold-wave warnings were issued for Oklahoma and the northern portion of west Texas and were extended the following morning over northwestern Arkansas, northern east Texas, and southern west Texas. On 1 p. m. special observations the warning was further extended over the remainder of Arkansas and the southwestern portion of east Texas, and at night over northern and western Louisiana and the southeastern portion of east Texas. On the morning of the 13th cold-wave warnings were extended over southeastern Louisiana. The warnings were fully verified except at El Paso, where the lowest temperature was about freezing. Over most portions of the district, temperatures were about as low as they were during the cold wave of the 9th-10th and agreed closely with the minimum temperatures forecast, as in the case of the 9th-10th.

Warnings were issued at night on the 30th for a cold wave in the northwestern portion of the district, and on the morning of the 31st the warnings were extended over Arkansas. The cold wave occurred as forecast, except in the Texas Panhandle, where the temperature did not go below 20°, due to a division of the area of high pressure, the main part lagging behind the part which was following a trough of low pressure moving northeastward from the middle Mississippi Valley.

Forecasts of minimum temperatures and weather conditions attending the cold waves of this month proved to be of timely value to stockmen and others. The forecast distributor at Garden City, in the southeastern portion of west Texas, states that the "special warnings are proving useful and helpful to stock raising and farming interests." The following is quoted from a letter dated Hope, Ark., December 13, 1919, from the Hope Brick Works, receiving "collect" messages of minimum temperature forecasts on request:

The message you sent us Monday afternoon of this week caused us to save about \$1,200 to \$1,400 worth of brick that would otherwise have been lost.

Warnings of frost or freezing temperature for the coast and adjacent areas were issued on the 10th, 14th, 15th, 16th, 24th, 25th, 26th, 27th, and 29th, and were generally verified.

Fire-weather warnings for the forest reserves of Arkansas and Oklahoma were issued on the 12th and 31st and were verified.—*R. A. Dyke.*

Denver Forecast District.—The weather during the early part of the month was dominated by Pacific lows, and precipitation occurred in some part of the district nearly every day. During this period sharp changes in temperature were a feature of the weather in the more eastern parts of the district, under the influence of Alberta anticyclones which skirted the eastern slope. After the storm of the 12th, however, strong anticyclonic conditions became established in the Plateau region and continued with more or less intensity during the remainder of the month. Abnormally low temperatures resulted on the western slope, and the temperature at Grand Junction and Salt Lake City was below the normal almost continuously after the 12th. This pressure distribution was attended on the eastern slope by the usual type of weather—mild temperature and fair weather, with at times a pronounced chinook

effect. Moreover, fair weather prevailed generally throughout the district during the remainder of the month, except on one or two dates in parts of New Mexico.

Cold-wave warnings were issued for eastern Colorado on the morning of the 1st and for eastern New Mexico on the evening of that date. The warnings were followed by subzero (F.) temperatures in eastern Colorado and a sharp fall in temperature in southeast New Mexico. On the evening of the 7th cold-wave warnings were issued for nearly all of eastern Colorado, with warnings of heavy snow in Utah, strong westerly winds in Arizona, and much colder weather in eastern New Mexico by the 9th. The cold wave overspread eastern Colorado on the 8th, while heavy snow occurred in eastern Utah and adjacent portions of Colorado and fresh to strong winds prevailed in Arizona and parts of southern Utah and western New Mexico. On the morning of the 8th cold-wave warnings were extended to include Utah, western Colorado, northern and central Arizona, and northern and eastern New Mexico, and repeated on the evening of the 8th for New Mexico. In Colorado the temperature fall on the morning of the 9th ranged from 15 to 40 degrees (F.). At Pueblo the temperature fell to 20° (F.) below zero, the lowest of record at that station for December, while at Grand Junction the lowest temperature ever recorded there was reached on the 9th. Subzero temperatures occurred in Utah, northern Arizona, and New Mexico. Warnings of fresh to strong westerly winds were issued for Utah on the morning of the 11th and for Colorado on the evening of that date. Wind velocities exceeding 40 miles per hour from a westerly direction were reported at Modena, Salt Lake City, and Pueblo. At Denver the highest velocity recorded was 38 miles per hour from the north.

Cold-wave warnings were issued for the district on the 12th and repeated on the evening of the 12th and morning of the 13th for parts of New Mexico, a depression of marked intensity being central in southeast Colorado. The fall in temperature in eastern Colorado was even greater than during the cold wave of the 9th but the minima were not so low. No other cold-wave warnings were issued after the 13th, except for eastern Colorado at the close of the month. While this warning failed of verification, a fall in temperature of 20 degrees or more occurred with temperatures 10 degrees or more below the freezing point.—*Frederick W. Brist.*

San Francisco Forecast District.—Rain fell in California during the fore part of the month, which was caused by a weak low-pressure area overlying that State. This depression moved so slowly eastward that it affected the weather in this district for five or six days. It was followed on the 9th by another depression of decided character, which was first noted along the Oregon coast. It moved slowly southeastward and not only caused rain in California but considerable snow in western Oregon and western Washington. It was not until December 12th that its influence was no longer felt in this district. On this date a high-pressure area advanced south from British Columbia to the North Pacific States and caused much colder weather in that section of this district. This cold wave lasted several days.

About the middle of the month the pressure over the central Plateau States became unusually high and the lows therefore passed eastward too far north to materially affect the weather in California or Nevada. They, however, caused occasional rain, high winds, and warmer weather in the North Pacific States.

The presence of the high-pressure area over the central Plateau States caused cold-air drainage into California, and frosty mornings were of almost daily occurrence. The frosts did no great damage, as almost all the staple crops had been harvested before they occurred. In southern California the frosts were not so severe as they were farther north, and the orange and lemon crops on this account escaped serious injury.

No less than 23 frost warnings were issued for places in California and practically all of them were verified. Storm warnings were issued for different parts of this district on 18 occasions, and small-craft warnings were displayed on three days.

Only one cold-wave warning was issued, though more than one cold wave occurred. The others, in which the falls in temperature were sufficient to justify a cold-wave warning, in several instances were covered by predictions of colder or much colder weather, because the drop in temperature was somewhat greater than expected.

RIVERS AND FLOODS, DECEMBER, 1919.

By A. J. HENRY, Meteorologist.

DAMAGING FLOODS IN THE EAST GULF STATES.

Light rains fell in the northern portion of Mississippi, Alabama, and Georgia and in Tennessee on the 6th. These were followed by heavy rains on the 7th, especially in northern Alabama and northwest Georgia, and these in turn by still heavier rains on the 8th and 9th practically throughout Alabama and northwest Georgia. The rains ceased before midnight of the 9th. The daily amounts for representative stations in Mississippi, Alabama and Georgia are shown in Table No. 1 below. In Table 2 the rainfall for all stations in the Chattahoochee and other river basins in Georgia are given. These tables show that the intensity of the rains was greatest in northern Alabama on the 7th, southeastern Mississippi on the 8th, and central Alabama and northwest Georgia on the 9th. The rainfall was not uniformly heavy at all stations, the maximum for the 3 days being as much as 12 inches in local areas. From these areas as a center the fall diminished to the northwest and the southeast to 4 to 6 inches and even less.

TABLE 1.—Daily precipitation (inches and hundredths—Midnight to midnight).

1919.	Meridian.	Montgomery.	Birmingham.	Chattanooga.	Atlanta.	Augusta.
Dec. 7.....	2.54	2.20	4.12	0.81	2.70	0.70
8.....	6.75	1.64	3.39	1.24	3.34	.89
9.....	1.11	4.78	.81	.71	5.71	T.
Total.....	10.40	8.62	8.32	2.76	11.75	1.09

TABLE 2.—Rainfall of Dec. 7 to 10, 1919, in Georgia.

[Measurements made about 5 p. m., except at stations otherwise indicated.]

WATERSHED OF THE CHATTAHOOCHEE RIVER.

Stations.	Dec. 7.	Dec. 8.	Dec. 9.	Dec. 10.	Total.
	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
Dahlouega.....	0.81	1.08	3.74	1.53	7.16
Gainesville.....	0.90	1.35	2.20	3.00	7.45
Canton.....	0.97	1.93	4.57	1.93	9.40
Norcross ¹	1.10	1.62	4.92	5.22	12.86
Atlanta ¹	2.70	3.34	5.71	.00	11.75
Lost Mountain.....	1.40	2.15	4.68	0.79	9.02
Newnan.....	1.01	1.80	2.12	4.20	9.13
West Point.....	0.24	2.70	3.33	2.50	8.77
Goat Rock.....	0.06	1.58	2.75	2.51	6.90
Talbotton.....	1.45	2.00	0.93	1.09	5.47
Columbus.....	0.04	0.03	2.48	0.87	3.42

¹ Measurements midnight to midnight.

² Measurements made daily at 7 a. m. mean local time.

Generally the northern high-pressure areas that cause cold waves move into the United States east of the Rocky Mountains and therefore only slightly affect the weather in this district, but this year several moved directly south from British Columbia to the North Pacific States and thereby caused persistently low temperatures throughout this district for several days at a time.—E. A. Beals.

NORTHER IN THE CANAL ZONE.

The following letter, dated January 8, 1920, from the office of the chief hydrographer of the Canal Zone refers to the warning for "fresh to strong northerly winds next 36 to 48 hours" sent that office on the 29th:

The warning was timely and fully verified. The wind reached a maximum velocity of 30 miles an hour from the northeast on the 30th at Cristobal, with gusts up to 45 miles reported from the naval air station. Cape Mala reported maximum winds up to 60 miles an hour. Windy weather continued for several days.

In addition to serving the shipping interests, the naval air station at Coco Solo considers these warnings beneficial and necessary.

TABLE 2.—Rainfall of Dec. 7 to 10, 1919, in Georgia—Continued.

WATERSHED OF THE FLINT RIVER.

Stations.	Dec. 7.	Dec. 8.	Dec. 9.	Dec. 10.	Total.
	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
Atlanta ¹	2.70	3.34	5.71	0.00	11.75
Newnan.....	1.01	1.80	2.12	4.20	9.13
Griffin.....	0.00	5.08	1.33	3.00	9.41
Woodbury ²	0.00	1.94	1.36	2.16	5.46
Butler.....	0.00	0.00	1.92	0.07	2.59
Marshallville.....	T.	T.	1.17	0.50	1.67
Talbotton.....	1.45	2.00	0.93	1.01	5.37
Montezuma ²	0.00	0.00	0.25	0.95	1.20
Americus.....	0.00	0.00	0.10	0.52	0.62
Albany.....	0.00	0.15	0.00	0.07	0.22
Bainbridge.....	0.06	0.00	1.94	0.00	2.00

UPPER WATERSHED OF THE OCONEE AND OCMULGEE RIVERS.

Atlanta ¹	2.70	3.34	5.71	0.00	11.75
Griffin.....	0.00	5.08	1.33	3.00	9.41
Covington.....	0.00	3.60	1.90	3.60	10.00
Macon ¹	0.14	1.43	0.08	0.31	1.96
Athens.....	0.76	2.52	2.81	3.80	9.89
Greensboro.....		5.39			
Milledgeville ²	T.	0.82	1.10	0.50	2.42

UPPER WATERSHED OF THE SAVANNAH RIVER.

Clayton.....					
Toocoo.....	0.78	0.99	3.32	3.82	8.91
Hartwell.....	0.87	1.68	3.78	1.24	7.57
Carlton.....	0.50	1.95	2.30	2.79	7.54
Point Peter.....					8.00
Lisbon.....	0.80	5.78	0.35	0.16	7.03
Washington.....	0.37	3.00	2.80	0.53	6.70
Augusta ¹	0.70	0.39	T.	0.36	1.45

¹ Measurements midnight to midnight.

² Measurements made daily at 7 a. m. mean local time.

The meteorological conditions associated with or responsible for these rains were in no wise remarkable, but the sequence in which they developed was the controlling factor. Stripped of all technical language, it may be said that the rainstorm of the 6th-7th was immediately followed by one of somewhat greater intensity which passed over the East Gulf States from west to east on the 8th-9th. The rainfall on the dates last named produced damaging floods in all streams of southeastern Mississippi, Alabama, and Georgia. The flood in the Alabama, at Montgomery and Selma, closely approached the greatest flood experienced within historic times, viz, that of April 1, 1886. The flood on the Black Warrior River at Tuscaloosa, however, fell