

14th, which were for practically the entire forecast district, except extreme southern Florida. At 8 a. m. of that date a shallow trough of low pressure was advancing eastward over the Atlantic States and the Appalachian region and an area of high pressure of great magnitude (Rapid City, S. Dak., 31.10 inches), accompanied by much colder weather, had already overspread all sections between the Rocky Mountains and the Mississippi River. By 8 a. m. of the 15th the line of zero temperature extended southward to Kentucky, and 10° to Birmingham, Ala. and Atlanta, Ga. During the following night the temperature fell to 20° in extreme northern Florida and 28° at Tampa.

On the 22d cold-wave warnings were issued for portions of the Ohio valley and the northern border States and on the 25th-26th for the Atlantic States as far south as North Carolina. The warnings of the 22d were not verified, while those of the 25th-26th were well verified in most States.

Frost warnings were issued for the extreme South on the 1st, 2d, 9th, 10th, 11th, 14th, and 15th. The most important of these warnings were for the freeze of the night of the 15th-16th, when the temperature fell to 20° or slightly lower in extreme northern Florida and to 28° at Tampa, with frost nearly to the extreme southern coast of Florida. No frost warnings were required after the middle of the month.—*C. L. Mitchell.*

#### CHICAGO FORECAST DISTRICT

January in the Chicago forecast district was not characterized by unusual storm movement. The mean temperature was above normal over most of the district, especially west of the Mississippi, and close to normal east of it. Precipitation was heavy to excessive in the Ohio Valley and southern Missouri, but below normal almost everywhere else. The low pressure areas, as a rule, passed rapidly eastward with their centers well to the north; but in a few instances they passed directly eastward across the center of the country, especially those of January 12-13, 18-19, and 20-22; these were the storms responsible for the heavy precipitation in the southern portion of the forecast district.

The cold waves were not severe; and warnings of them were given over most of the areas affected, either through forecasts of cold waves or much colder weather.

Advisory warnings of strong winds were issued for the open ports on Lake Michigan from time to time.

Perhaps the principal feature of the month was the passage over the district of two exceptionally high pressure areas. One, on the 14th-15th, with a pressure of 31.10 inches in South Dakota, decreased in magnitude with its eastward movement; while the second, on the 25th-26th, pushed southeastward from eastern Manitoba across the upper Mississippi Valley and Great Lakes region with increasing pressure. In the northern lakes region it was as high as 31.06 inches. At Chicago the highest pressure observed since the establishment of the station in 1870 was registered on the 26th, 30.97 inches.

This high-pressure area was accompanied by extremely low temperatures in the northern portion of the forecast district, a minimum of 32° below zero being registered at Sault Ste. Marie, the lowest of record for the month of January at that point.—*H. J. Cox.*

#### NEW ORLEANS FORECAST DISTRICT

Weather throughout the district was generally mild for the season during the first 10 days of the month. Cold-wave warnings were issued on the night of the 12th

for Arkansas, Oklahoma, the northern portion of east Texas, and northern Louisiana, and on the morning of the 13th were extended to the Texas coast and over Louisiana, except the southeast portion, with forecast of freezing to the Louisiana coast by the morning of the 15th. A severe cold wave occurred, giving temperatures near zero over the extreme northern portion of the district, and freezing to the west and middle Gulf coast.

Cold-wave warnings were issued on the morning of the 17th for Oklahoma, northwest Arkansas, and northern and western Texas. The warnings were verified in portions of the area but the verifying temperature did not occur in Texas. Warnings were issued on the 21st and 22d for the district except southeastern Louisiana. A decided cold wave occurred over the northern portion of the district, extending as far south as central Texas, but the high-pressure area changed its course to the eastward and the cold wave did not extend to the Gulf coast.

Storm warnings were issued for portions of the Texas coast on the 13th, 14th, and 22d; the warnings of the 13th and 14th were justified but no high winds occurred following the warnings of the 22d. No general storm occurred without warning, but high winds occurred at Galveston on the night of the 9th.

Norther warnings were issued on the 13th for American interests at Tampico, Mexico. High winds occurred as forecast.—*I. M. Cline.*

#### DENVER FORECAST DISTRICT

Except in portions of southern and western Montana and northeastern Wyoming, where the temperature was somewhat below normal, the month was considerably warmer than the average throughout the district. Precipitation was deficient everywhere except in northern and eastern Utah and northwestern Colorado.

Temperatures much below normal, however, prevailed from Montana southward to eastern Colorado on the 12th and 13th, the cold continuing in Montana and Wyoming and eastern Colorado until the 14th. Another cold wave made its appearance over Montana on the 16th-17th and rapidly extended southward to northern Texas. Severely cold weather in Montana and northern Wyoming continued until the 22d, temperatures below -30° occurring in north-central Montana on the 20th and in most of eastern Montana on the 21st, with readings below zero as far south as extreme northeastern Colorado on the morning of the 21st. Moderating weather on the eastern slope attended lower pressures in western Canada on the 22d.

Warning of a moderate cold wave in eastern Wyoming was issued on the evening of the 11th. The warning was extended to eastern Colorado on the morning of the 12th and to eastern New Mexico on the evening of the 12th. These warnings were fully verified. On the morning of the 16th, warning was issued of a moderate cold wave in eastern Montana. This was extended on the evening of the 16th to eastern and southern Wyoming and Eastern Colorado. On the morning of the 17th the warning was repeated for eastern and southern Wyoming and eastern Colorado, and stockmen were notified. The warnings were justified, the cold wave being attended by light snows in the region specified. On the morning of the 18th, warning of a severe cold wave was issued for northwestern Wyoming, which was verified during the following day. A warning of a severe cold wave, with stockmen's warnings, was issued on the morning of the 21st for Utah, southern and western Colorado, northern and extreme eastern New Mexico, and north-central and northeastern Arizona. Warnings of a moderate cold

wave in western Colorado, northeastern Arizona, and southeastern Utah were also distributed on the morning of the 20th. Snows occurred in the region mentioned, with a cold wave in southern Utah and extreme eastern New Mexico. The required fall in temperature, however, failed to occur in western Colorado, north-central and northwestern New Mexico, and northeastern Arizona, as the low which was over western Colorado decreased slowly in intensity and finally disappeared over New Mexico on the morning of the 23d. Warning of a moderate cold wave in eastern Montana, issued on the evening of the 29th, was verified in the extreme eastern portion of the State.

Local cold waves without warning occurred on the 13th at Lander; on the 20th and 25th at Havre, and on the 31st at Miles City. More general cold waves without warning occurred in eastern Montana on the 17th, and in southern and western Montana and eastern Wyoming on the 21st, due to the unexpected development of HIGHS along the northwestern border. In the latter instance the temperatures throughout about all of that region were already severely low on the morning of the 20th.

Warnings of strong southerly to westerly winds in eastern Colorado and Wyoming were issued on the evening of the 6th for the benefit of aviation interests. A warning of strong westerly winds in the same region was furnished to these interests on the evening of the 28th. Both warnings were fully verified.—*J. M. Sherier.*

#### SAN FRANCISCO FORECAST DISTRICT

The month opened with a disturbance of marked intensity central over the Gulf of Alaska, in which the minimum pressure was below 28.50 inches. This disturbance moved east-northeast and caused rains over the north and central portions of this forecast district and southerly gales along the Washington-Oregon coast, for which storm warnings were issued the morning of the 1st. The highest wind velocity reported during the prevalence of this disturbance was 76 miles an hour from the south at North Head, Washington. This disturbance was the first of a number to move eastward over the northeast Pacific Ocean and give rains over the north and central parts of this forecast district and high winds on the coast. On 15 days of the month storm warnings were ordered for some part of the coast, principally the coast north of Cape Mendocino, but on the 9th, 10th, 14th, and 19th, storm warnings were displayed on the north part of the California coast. The record shows that six well-defined disturbances crossed the coast line during the month.

Beginning on the 11th and continuing through the 19th rains and snows became general over the Pacific Northwestern States and following the series of disturbances that passed over this area the barometer rose rapidly, the wind became north and northeastward, and the coldest weather of the winter overspread Washington, Oregon, Idaho, and Nevada during the 20th to 24th. This cold wave was attended by temperatures below zero over the eastern parts of Washington and Oregon and over Idaho and northern Nevada. Except in Idaho and northern Nevada, for which cold wave warnings were ordered, the fall in temperature was not sufficient to verify cold-wave warnings. Nevertheless, cold-weather forecasts were issued for all of these States well in advance of the occurrence of the cold weather. Advancing southward the cold wave was greatly modified, but it brought freezing temperature or frosts to nearly all parts of California and necessitated the issue of frost warnings for the benefit of fruit growers and others.

On the 26th when the pressure was low and falling rapidly over the Gulf of Alaska storm warnings were displayed on the Washington-Oregon coast and were repeated on the 27th for the inland waters of Washington. This was a pronounced disturbance and was attended by general rains except in southern California and southern Nevada. The highest wind velocities of the month were recorded at northern stations during this storm, maximum 80 miles an hour from the south at North Head, Wash., on the 27th.) On the 31st, when a disturbance was detected far to the westward, southeast storm warnings were ordered for the Washington-Oregon coast. This disturbance moved eastward, causing general rains and snows over the northern half of the forecast district and southerly gales along the north coast.—*E. H. Bowie.*

#### RIVERS AND FLOODS

By H. C. FRANKENFIELD

*Tennessee River.*—As was stated in the MONTHLY WEATHER REVIEW for December, 1926, the flood in the Tennessee River had just about reached Decatur, Ala., by the end of that month. The rise began with the heavy rains of December 20–21, and the still heavier rains of December 23–25 soon carried the stream to flood stage. Above Chattanooga, Tenn., the crest stages were only a foot or two above the flood stages, although some of the tributaries, notably the Clinch River and the North Fork of the Holston River, were relatively much higher. The moderate flood at Knoxville, Tenn., came mainly from the Holston River drainage. The average rainfall below Chattanooga from December 20 to 29 was a little less than 9 inches and the flood was a severe one, with crest stages ranging from 4.3 feet above the flood stages at Bridgeport, Ala., to 17 feet above at Riverton, Ala.

The usual warnings were issued well in advance of the flood and frequent supplementary advices during its progress, although over the middle and lower river the distribution of the latter, as well as the receipt of reports, was much hampered by ice on wires and local interruptions due to the holiday season. Direct losses above Decatur, Ala., were about \$60,000, mainly in corn in river bottoms which for some reason was not removed when the warnings were issued. In the city of Chattanooga about 2,500 persons were out of their homes at the height of the flood, and some relief measures were necessary. Below Decatur reported losses were \$360,000, of which \$269,950 was in matured crops, while the reported value of property saved through the warnings was \$192,000.

*Green River of Kentucky.*—The flood in the Green and Big Barren Rivers was likewise severe. Preliminary warnings were issued on December 21, or as soon as the first reports of heavy rain were received, and frequently thereafter. The highest water reported was 49.3 feet, 16.3 feet above the flood stage, on December 27, at Lock No. 4, Woodbury, Ky. Reports as to losses and damage were so conflicting as to be worthless. They were of the usual character, but probably least in crop losses owing to the time of the year.

*Ohio River.*—During the December-January period the Ohio River was in flood only from Dam No. 44, Leavenworth, Ind., to its mouth, and only moderately so above the mouth of Green River. The crest passed Cairo, Ill., into the Mississippi River on January 12 with a stage of 48.9 feet, 3.9 feet above flood stage. While the warnings issued were timely and accurate, the losses in matured crops were great. The flood was the earliest winter flood of consequence of which there is record, and long periods of wet weather during the