

an area of high pressure, bringing much colder weather progressively over most of the district during the 18th and 19th. In connection with this disturbance stock warnings were issued on the 17th for South Dakota, Nebraska, and Wyoming, and on the 18th for Kansas.

On the morning of the 21st a low pressure area of moderate intensity was centered over southern North Dakota and, during the ensuing 24 hours, moved rapidly eastward, followed by the coldest weather of the present winter thus far. Minima of 40° to 50° below zero were registered on the 22d in Manitoba and Saskatchewan and 30° to 40° below in North Dakota and northern Minnesota, the line of zero temperature reaching southward as far as central Illinois and the northern portions of Kansas and Missouri. This severe cold was preceded by warnings issued on the 21st for most of the district from the Rockies eastward to Lake Michigan and Illinois. Stock advices were also sent to South Dakota.

On the evening of the 27th, as it was apparent that an area of high pressure would soon appear over the northwest, cold-wave warnings were issued for Montana, northern Wyoming, North Dakota, and western South Dakota, these warnings being repeated on the morning of the 28th. During the 28th the high-pressure area developed and moved slowly southward, being blocked in its advance by an immense field of high barometer over Ontario. On the 29th and 30th the warnings were extended eastward to include western Minnesota, Nebraska, eastern Kansas, western Iowa, and northwest Missouri. On the 28th and 31st stock advices were telegraphed to points in the Dakotas, Wyoming, and Nebraska.

Cold-wave warnings were ordered from the evening map of the 31st for eastern and central South Dakota, western Nebraska and extreme southeastern Wyoming.—*E. H. Haines.*

#### NEW ORLEANS FORECAST DISTRICT.

Northwest storm warnings were ordered displayed on the Texas coast at 1 p. m. on the 10th because of an eastward-moving disturbance over the lower Mississippi Valley, which was followed by moderate gales that afternoon and night. Small-craft warnings were displayed on the Louisiana coast. The wind continued strong at Galveston, Tex., throughout the 11th. The area of high pressure in the rear of the disturbance extended well to the southward over the Rio Grande Valley and northeastern Mexico on the morning of the 12th and was attended by gales on the coast of Mexico. "Norther" warnings were issued at 8 p. m. on the 11th for Tampico and Progreso, Mexico.

Small-craft warnings were displayed on the Texas coast on the 16th and were justified.

Northwest storm warnings were ordered displayed from Morgan City, La., to Brownsville, Tex., at 8:20 p. m. on the 18th and were extended over the Louisiana coast east of Morgan City the following morning. The warnings were justified on the Texas coast; but the "norther" lost its force before reaching the Louisiana coast and the warnings were lowered at night on the 19th.

The pressure conditions showed considerable and rapid fluctuations along the middle Gulf coast on the 29th, the fluctuations at New Orleans being most evident in the early part of the night. Small-craft warnings were issued at 9:30 a. m. for the Louisiana coast and the eastern coast of Texas, and northeast storm warnings at 8:30 p. m. on the Louisiana coast east of Morgan City. Mod-

erate easterly gales occurred at New Orleans and fresh to strong easterly gales at Burrwood, La., during the early part of the night. However, the wind diminished greatly by 7 a. m. of the 30th and the warnings were lowered at 9 a. m.

A cold-wave warning was issued for Oklahoma and extreme northwestern Arkansas on the morning of the 4th and was extended in the early afternoon over northeastern Texas, northern Louisiana, and the remainder of Arkansas. The warning was verified in a considerable portion of the area named and the temperature fall was large in all portions.

The temperature fall which overspread the district on the 11th-12th was generally somewhat less than a true cold wave and the warnings issued for much of the northwestern portion of the district on the 10th failed of verification.

During the 18th, 19th, and 20th, a cold wave moved slowly southward over the district to the Texas coast but did not reach the Louisiana coast. Ample warnings were issued well in advance of the cold wave.

A cold-wave warning was issued at night on the 22d for Oklahoma and the Texas Panhandle and was verified. Because of the threatening position of the area of high pressure and a rapid rise in pressure at Oklahoma City, with temperature fall from 30° to 16° between 7 a. m. and 11 a. m., the cold-wave warnings were extended on the 23d over Arkansas, northern Louisiana, and northeastern Texas, but were not generally verified, though sleet occurred with temperatures below freezing.

A cold-wave warning issued on the morning of the 29th for the extreme northwestern portion of the district was justified. Cold-wave warnings were issued for the remainder of the northwestern portion of the district on the morning of the 30th, but the rapid movement of an area of low pressure from the Pacific coast prevented the cold wave from extending farther.

Warnings of frost or freezing temperature were issued on the 1st, 5th, 10th, 11th, 12th, 13th, 16th, 19th, 21st, 24th, 27th, and 28th. Conditions as forecast prevailed in most instances.

Fire-weather warnings were issued for forested areas in Oklahoma and Arkansas on the 2d and conditions occurred as forecast.—*R. A. Dyke.*

#### DENVER FORECAST DISTRICT.

Precipitation in all portions of this district between the 1st and 4th resulted from a storm which moved from the coast of southern California to the middle Mississippi Valley during that period. The disturbance was followed by much colder weather, with temperatures below zero in southwestern Utah. Occasional light snow or rain in southern Arizona, New Mexico, and southeastern Colorado attended a moderate disturbance which advanced from southern California to central Texas from the 7th to the 9th. High pressures prevailed on the middle Plateau from the 7th to the 16th, on which latter date a storm appeared on the north Pacific coast and moved, with increasing intensity, to New Mexico by the 18th, where it remained, slowly filling up, until the 20th, when it advanced to western Texas. Snow fell in Utah and Colorado on the 17th and 18th and in southwestern Colorado and northeastern Arizona on the 19th and 20th, with a cold wave in eastern Colorado on the 18th and in southwestern Utah and most of New Mexico on the 19th. On the last-named date the temperatures were below zero in central and eastern Colorado and western Utah. High

pressures again prevailed over most of the Plateau region from the 19th to the 26th, with fair weather throughout the district after the 20th. During the 27th a storm moved rapidly southward from Alberta to Utah and thence to northwestern Texas by the 29th, where it apparently dissipated, attended during its progress by light precipitation except in the extreme southern portion of the district. The last disturbance of the month appeared on the coast of California on the 29th and advanced rapidly eastward across the States of Utah and Colorado, its center being over southwestern Nebraska on the evening of the 31st. Snow or rain occurred in every part of the district, except portions of New Mexico and along the eastern slope in eastern Colorado, heavy snows falling in southern Utah, northern Arizona, southwestern Colorado, and extreme northwestern New Mexico. This storm was followed during the night of January 31–February 1 by a cold wave in extreme southern Utah and southwestern Colorado.

Warnings of a moderate cold wave were issued for southwestern Colorado, northwestern New Mexico, northeastern Arizona, and extreme southern Utah on the 3d and were fully verified. A cold-wave warning was also issued on the morning of the 18th for southern and western Colorado, New Mexico, northeastern Arizona, and southern Utah. Temperatures below zero were forecast for southern and western Colorado and southern Utah and a fall in temperature of from 20° to 30° for New Mexico by the following morning. The warning was verified except in western Colorado and western New Mexico, where the temperature remained relatively high on account of the slow movement of the LOW. Warnings of a cold wave in western Colorado, northern New Mexico, northeastern Arizona, and southeastern Utah were repeated at 8 p. m. of the 18th, and for southwestern Colorado, west of the mountains in northern New Mexico, and in extreme southeastern Utah at 8 a. m. of the 19th. Owing to the slow movement of the LOW over northwestern New Mexico, already referred to, these warnings were verified in northeastern Arizona and northeastern New Mexico only. Warnings of moderate cold waves in southwestern Utah and eastern Colorado, which were verified, were issued on the morning and evening of the 28th, respectively. Another warning of a moderate cold wave which was issued for eastern Colorado on the evening of the 31st was verified in the extreme eastern portion of the State but failed of verification near the mountains because of the effect of a portion of the LOW which remained over the eastern slope.

Cold waves without warnings occurred at Denver on the 18th, at Durango on the 21st, and at Modena and Flagstaff on the 29th.

Forecast of heavy snow in southern and eastern Colorado, northern New Mexico, northern Arizona, and southern Utah was made on the morning of the 30th and livestock warnings were issued for those sections. The forecast of heavy snow was repeated for the same territory on the evening of the 30th. Heavy snow fell in all of the region indicated except eastern Colorado and north-central and north-eastern New Mexico, seriously interfering with traffic. Press reports from southwestern Colorado indicate that because of the warnings that were distributed there was no loss of stock in that section at least.

Freezing temperature was forecast for south-central and southeastern Arizona on the 4th, 22d, and 23d and for all of the southern portion of that State on the 20th and 21st. Frost or freezing-temperature warnings were issued for Yuma on the 3d, 4th, 7th, 8th, 9th, 14th, 15th, 16th, from the 18th to the 28th, inclusive, and on the

31st. These forecasts were generally varified, either by the occurrence of freezing temperature or frost, or temperatures at which frost might be expected.—*J. M. Sherier.*

#### SAN FRANCISCO FORECAST DISTRICT.

Precipitation in the San Francisco Forecast District during January occurred in three periods. The first early in the month; the 2d—a short one—near the middle of the month, and the 3d at the close of the month. All three were due to extensions of low-pressure areas from Bering Sea that moved south near the coast. Except at the time of these rainy periods, the weather was controlled by high-pressure areas over the central Plateau States. They from time to time accumulated off-shoots from the permanent Pacific HIGH and in one case from a large HIGH that moved south from the Yukon country. The central Plateau HIGH also sent out offshoots that moved eastward to the Atlantic States.

At the time and for several days after the merging of the Yukon HIGH with the central Plateau HIGH, the coldest weather for many years prevailed in California and Nevada. This HIGH at about this time became so pronounced that it included the entire United States within its boundary.

The lowest barometer readings at the Bering Sea stations were 28.62 inches at Kodiak on January 3, and 28.40 inches at Dutch Harbor on January 5. Neither of these storms was followed by especially severe weather in this district.

On the 23d–24th a rather remarkable change in pressure occurred about 750 miles off the California coast. The barometer reading on the 23d was 29.70 inches, reported by one vessel and confirmed by another. The next day this low area was replaced by a HIGH with a barometer reading of 30.30 inches. Where this disturbance went is not known, but it probably moved southeastward and later crossed Mexico, and appeared in the Gulf of that name. This disturbance was a menace to this district; but fortunately no mistake was made, as it was too far away to affect the forecast on the day it was first noted and it disappeared the next day.

Storm warnings were ordered on 10 days for one or more portions of the district and small-craft warnings were ordered on three occasions. These warnings were timely and justified in whole or in part.

Frost warnings were issued on 24 occasions and in nearly every instance were fully verified. On the 20th, 21st, and 22d killing frosts did great harm to the citrus fruit and winter garden truck in southern and central California. The frosts on the other days were not especially damaging, as the staple crops were mostly dormant and therefore not susceptible to injury by frost.

Two cold-wave warnings were issued, and both were verified.—*E. A. Beals.*

#### RIVERS AND FLOODS.

By H. C. FRANKENFIELD, Meteorologist.

The crest of the Ohio River flood of the last week of December, 1921, reached the Mississippi River on January 3, with a crest stage at Cairo, Ill., of 39 feet, 6 feet below flood stage. As the Cumberland and Tennessee Rivers were not high, there were no flood stages in the Ohio below the mouth of the Wabash River. From Dam No. 48 (Cypress, Ind.), to Shawneetown, Ill.; the crest stages were from 7 to 9 feet above the flood stages. The aggregate of loss and damage was small, not over \$15,000, mainly in crops, while the reported value of