terests were given ample warning that this storm would be unusually severe. On the north Pacific coast the most important storm of the month occurred on the 14th and 15th. The principal storm of the month in the Atlantic States occurred on the middle Atlantic and south New England coasts on the 24th.

The display of wind signals was discontinued for the season on Lake Pepin, November 30; on Lake Michigan, December 10; on Lake Huron, December 12; on Lakes St. Clair, Erie, and Ontario, December 15; and on December 17, the date of the closing of the locks, at Sault Ste. Marie, Mich.

Referring to the movements of vessels on the Great Lakes during the close of the season of 1899, Mr. Harvey C. Beeson, publisher of Beeson's Marine Directory, remarks in the Milwaukee Sentinel of December 21, 1899, as follows:

A number of vessels have been making trips, with comparatively little danger, in the past few weeks, without insurance. They have relied a great deal upon the weather forecasts in determining their action; and I want to say here that the value of our Weather Bureau service has never been so signally shown as it has this season.

CHICAGO FORECAST DISTRICT.

Up to the time of closing of navigation warnings were issued for storms which occurred on the upper Lakes on the 1st, 5th, 11th to 13th, and 24th and 25th. The storm of the 11–13th was particularly severe, and special forecasts and warnings regarding its progress and character were issued as follows: Storm signals were ordered 9:45 a. m., 11th, for Lakes Huron and Superior. On Lake Michigan warnings were sent to open ports, the display of signals for the season having terminated. All upper Lake stations were advised to hold vessels in port, as a severe storm was central over Illinois and moving northeastward, which would cause dangerous easterly shifting to northerly gales, with rain turning to snow and much colder weather. At 9:15 p. m. of the 11th the following message was sent to all observers:

Storm central over northern Illinois, increasing in intensity. Dangerous gales indicated. Colder and snow. Continue to hold vessels in port.

At 9:45 a. m., December 12, the signals on Lake Superior were changed to storm northwest, and the following message was sent to all upper Lake stations:

Dangerous northwest gales, diminishing Wednesday. Snow and colder.

During the gale the steamer *Arthur Orr* went ashore on Lake Huron at Cove Island. She was badly damaged, but later released. The whaleback barge *No.* 115, which was in tow of the steamer *Colgate Hoyt*, broke away off the Portage Canal and foundered on the north shore of Lake Superior. Ample warning that the storm would be unusually severe was given, and all vessel masters had an opportunity to seek shelter.

Ample and detailed warnings were given of the cold weather which overspread the Western States on the 3d and 4th and 24th and 25th.—*H. J. Cox, Professor.*

SAN FRANCISCO FORECAST DISTRICT.

On the morning of the 6th conditions were such as to warrant a forecast of light to heavy frost in citrus fruit belt; temperatures below freezing were reported on the morning of 7th.

Southeast storm signals were displayed along the north coast on the 7th and justified. On the 9th citrus fruit growers were again warned that conditions were favorable for heavy frosts Sunday morning. Minimum temperatures of 29° and 30° were reported on the mornings of the 10th, 11th, and 12th. On the 13th it was stated that conditions were favorable for the heaviest frost of the season to date, and it may be noted that in the center of the orange belt the lowest minimum temperature, 28°, which occurred during the month of December was reported.

From December 19 to 29 an area of high pressure covered the country between the Sierras and the Rocky Mountains. Connected with this pressure distribution was the prevalence of tule fog in the great valleys of California. For about ten days in the San Joaquin Valley, in the Sacramento Valley, and also in the other valleys of California peculiar temperature inversions were reported. The cold air from the northeast was evidently slowly drained into the valleys and, owing to the absence of wind, gradually settled to the low lands. This ground or tule fog was so dense as to seriously inconvenience farming operations. Day after day the morning and evening temperatures would remain at about 36°, the amplitude of the diurnal curve, which is generally about 10°, ranging from 40° to 50°, ranging from about 36° to 38°. The persistence of this condition is noteworthy, and also the fact that the breaking up of this condition was accurately forecast on the morning of the 29th. On the 29th the approach of an extensive storm of considerable energy was forecast, and southeast storm signals were displayed from San Francisco to Eureka.—*A. G. McAdie, Forecast Official.*

PORTLAND, OREG., FORECAST DISTRICT.

The river forecasts issued during the month were of much interest and value.

On the 14th the outlook was such that a special warning to stockmen was included in the forecasts for Idaho, and Oregon and Washington east of the Cascades. It was stated that severe weather of four to six days' duration was indicated for the country east of the Cascades. Although the fall in temperature was not as great as was anticipated, yet there ensued six days of cold weather—the coldest yet this season—during which a temperature of 10° occurred at Spokane, 8° at Walla Walla, 6° at Baker City, and zero at Kalispell.—*G. N. Salisbury, Section Director.*

No special warnings were issued for the Havana forecast district.

AREAS OF HIGH AND LOW PRESSURE.

During the month there were nine highs and fifteen lows which were sufficiently well defined to admit of being charted. See Charts I and II.

The following table gives the principal facts regarding the place of origin and disappearance of these highs and lows, together with other pertinent data. Some descriptive data is also added.

Highs.—The three highs which were first noted on the the Pacific coast. Nos. I, III, and V, disappeared in the central Rocky Mountain region. Of the three which first came within the field of observation in the British Northwest Territory, two, Nos. II and IX, moved southeastward to the south Atlantic coast, while the other, No. VI, moved eastward, disappearing toward Hudson Bay. No. VIII originated in southeastern Colorado, moved eastward to northern Maryland, and thence northeastward to Nova Scotia. Nos. IV and VII were of minor importance.

A high of considerable magnitude remained practically stationary in the British Northwest Territory from the morning of the 14th to the evening of the 16th, reaching its crest on the morning of the 15th. On the 18th the characteristic winter type of high peculiar to the northern and middle Plateau, appeared over those districts, and still persisted at the close of the month, but with much diminished intensity and many indications of early dissipation.

Lows.—Four of the fifteen lows, Nos. III, V, VIII, and X,

were first noted on the extreme north Pacific coast. No. III disappeared over the Saskatchewan Valley by the time the one hundred and fifth meridian was reached; No. V disappeared a short distance east of Manitoba within two days; No. VIII moved southeastward to a vanishing point in northern Kansas, while No. X remained stationary for two days, and then moved entirely across the country, disappearing into the ocean off Newfoundland, after causing considerable heavy snow over the northern tier of States east of the Mississppi River. No. VII, which first appeared on the Mexican Gulf coast, developed into the severest storm of the month, and moved almost due northward up the Mississippi Valley, then slightly northeastward beyond Lake Superior. Some of the high wind velocities attained as a result of this low are as follows: Chicago, 56 miles an hour; Buffalo, 64; Cleveland, 52; New York, N. Y, 56, and Boston, 40. Nos. XIII and XV originated over Lake Superior, and disappeared over the St. Lawrence Valley. No. XIV, although of limited duration and extent, resulted in severe freezing temperatures in northern and central Florida on the night of January 1, 1900. No. IX, during the passage of which the lowest pressures of the month were recorded, first appeared in southern Texas, moved almost due northeastward through the St. Lawrence Valley, and thence eastward by way of Newfoundland. During this storm New York, N. Y., reported a wind velocity of 60 miles an hour; Cleveland, 52; Buffalo, 46, and Block Island, 48. Low No. XII moved rapidly from northern Alberta to western Gulf of Mexico. No. XI consisted in reality of two separate storms, one first appearing in northern Alberta, and the other in Misisssippi. The two joined forces in western Ontario in two and one-half days, and moved eastward as one storm to about the seventieth meridian, where it disappeared. The remaining lows were not of great importance.—*H. C. Frankenfield, Forecast Official.*

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.		°	°		°	°	*Miles.*	*Days.*	*Miles.*	*Miles.*
I	1, p.m.	46	124	3, p.m.	42	109	1,450	2.0	725	30.2
II	3, a.m.	53	108	7, p.m.	33	79	3,955	4.5	719	30.0
III	5, a.m.	41	124	7, a.m.	39	109	1,140	2.0	570	23.8
IV	8, p.m.	48	85	10, a.m.	44	68	970	1.5	647	27.0
V	9, a.m.	41	124	10, p.m.	41	105	1,150	1.5	767	31.9
VI	12, a.m.	53	108	14, a.m.	48	85	1,250	2.0	625	26.0
VII	12, a.m.	30	90	13, p.m.	33	80	750	1.5	500	20.8
VIII	14, p.m.	38	105	17, p.m.	46	60	2,730	3.0	910	38.0
IX	25, p.m.	48	100	27, a.m.	34	78	1,680	1.5	1,120	46.7
Sums							15,075	19.5	6,583	274.4
Mean of 9 paths							1,675		731	30.5
Mean of 19.5 days									773	32.2
Low areas.										
I	2, a.m.	41	96	5, a.m.	50	64	2,250	3.0	750	31.2
II	4, p.m.	50	100	6, a.m.	45	77	1,125	1.5	750	31.2
III	4, a.m.	48	125	5, p.m.	53	105	1,225	1.5	817	34.0
IV	6, p.m.	54	114	10, a.m.	46	60	2,750	3.5	786	32.7
V	7, a.m.	46	124	9, a.m.	50	97	1,485	2.0	742	30.9
VI	9, a.m.	38	100	10, a.m.	49	89	1,020	1.0	1,020	42.5
VII	10, a.m.	26	98	12, a.m.	46	87	1,610	2.0	805	33.5
VIII	10, p.m.	48	125	12, a.m.	40	98	1,600	1.5	1,067	44.4
IX	13, p.m.	30	99	16, a.m.	46	54	2,800	2.5	1,120	46.7
X	16, p.m.	46	124	20, a.m.	48	54	3,600	3.5	1,029	42.9
XI*	22, p.m.	32 54	91 114	25, a.m.	47	71	1,920 2,150	2.5	768 860	32.0 35.8
XII	24, p.m.	54	114	27, a.m.	26	98	2,290	2.5	916	38.2
XIII	27, p....	46	84	30, a.m.	49	64	1,725	2.5	690	28.8
XIV	30, p.m.	30	95	31, p.m.	28	88	980	1.0	980	40.8
XV	31, p.m.	46	84	†2, a.m.	48	64	1,380	1.5	920	38.3
Sums							29.910	34.5	14,020	583.9
Mean of 16 paths							1,869		876	36.5
Mean of 34.5 days									867	36.1

*No. XI considered as two in totals and means. †January.

RIVERS AND FLOODS.

On account of the formation of ice, there was less water than during the preceding month in the Mississippi River north of Cairo, and in the Missouri, except at Kansas City, the lowest stages occurring either near the end of the month or at the time the ice closed the rivers.

Floating ice was observed as early as the 4th of the month at La Crosse, on the 5th at St. Paul, the 6th at Davenport, 15th at Keokuk and Hannibal, and 18th at St. Louis and Chester. At St. Paul, on the 19th, the ice gorged above the Robert street bridge in front of the city; on the 27th the river closed at Davenport, and on the 30th at Keokuk. At Hannibal the ice gorged at the Wabash Bridge on the 26th, and on the 30th above Chester, but only for a few hours.

In the Missouri River the first ice reached Omaha on the 4th, Kansas City on the 13th, Boonville, Mo., on the 25th, and Herrmann, Mo., on the 15th. The river was closed at Bismarck on the 10th, at Pierre on the 17th, and at Sioux City on the 20th.

Navigation was suspended by the 15th on the Mississippi River as far south as Hannibal, by the 20th on the Missouri River as far as Sioux City, and on the lower Missouri River on the 26th.

The Ohio and lower Mississippi rivers were higher than during November, 1899, and owing to the abundance of water there was a general resumption of navigation on the former about the 14th. There was some ice during the latter part of the month, reaching Paducah, Ky., on the 31st. It caused some interruption to navigation at various places, and on the 30th resulted in its entire suspension between Pittsburg and Cincinnati.

In the lower Mississippi River and its tributaries the water averaged from one to eight feet higher than during November, except from New Orleans southward, but no high stages were recorded.

The rivers of the Middle Atlantic States changed but little during the month. The Susquehanna River was filled with ice at Wilkesbarre, Pa., after the 25th, and froze over on the 30th. Ice also appeared at Williamsport, Pa., on the West Branch of the Susquehanna River on the 25th.

There was considerable ice in the Potomac River during the last week of the month, interfering somewhat with navigation on the lower river, although a channel was kept open by the larger steamers.

The James River froze over at Lynchburg on the 30th and at Richmond on the 29th. The most southerly point from which ice was reported was Weldon, N. C., on the Roanoke River.

Over the Mobile system and in the rivers of the South Atlantic States the stages were considerably higher than during the preceding month, particularly over the former, where heavy rains during the middle of the month caused a marked rise. At Demopolis, Ala., on the Tombigbee River, there was a rise of 30 feet from the 10th to the 17th, 22 feet of which occurred from the 12th to the 15th. At Tuscaloosa, Ala., on the Black Warrior River, there was a rise of about 39 feet from the 10th to the 13th. Danger line stages were not quite reached, and no loss or damage resulted as far as is known.

On the Pacific coast the only item of interest was the rise in the Willamette River during the early days of the month, the danger line stage of 15 feet being reached at Portland, Oreg., on the 2d. This rise began during the closing days of November, and all interests were kept fully advised as to the probable maximum stage. There was a second rise from the 10th to the 14th, and on the 13th, at Albany, Oreg., a stage of 21.2 feet was recorded, 1.2 feet above the danger line.

A study of the gradual movement of the line of total freezing, and the varying thickness of the ice in the rivers, affords