

was no indication of a resumption of navigation. On the 29th the first boats of the season arrived at Manistee, Mich., and the channel at Green Bay, Wis., was free from ice.

The lower Mississippi River continued high during the month, and several crevasses were reported in the levees in Mississippi and Louisiana; no serious damage was caused. The middle Ohio river was above the danger-line at the open-

ing of the month, but subsided rapidly. Damaging floods occurred along the Cumberland and Tennessee rivers in Tennessee and along the Savannah River in Georgia, and high water caused damage along the Little Colorado River in Arizona, and along the Sacramento River in California. At Yuma, Ariz., the rivers fell rapidly and railroad communication to the west was resumed on the 4th.

ATMOSPHERIC PRESSURE (expressed in inches and hundredths).

The distribution of mean atmospheric pressure for March, 1891, as determined from observations taken daily at 8 a. m. and 8 p. m. (75th meridian time), is shown on Chart II by isobars. The departure of the mean pressure for March, 1891, obtained from observations taken twice daily at the hours named, from that determined from hourly observations, varied at the stations named below, as follows:

Station.	Departure.	Station.	Departure.
Duluth, Minn.....	+ .001	Saint Louis, Mo.....	-.002
Atlanta, Ga.....	+ .002	Memphis, Tenn.....	-.002
Cleveland, Ohio.....	+ .003	Omaha, Nebr.....	-.002
Albany, N. Y.....	+ .004	Bismarck, N. Dak.....	-.002
Pittsburgh, Pa.....	+ .005	Saint Paul, Minn.....	-.004
New York City.....	+ .007	Moorhead, Minn.....	-.004
Key West, Fla.....	+ .007	Denver, Colo.....	-.005
Eastport, Me.....	+ .009	Salt Lake City, Utah.....	-.006
Jacksonville, Fla.....	+ .009	Abilene, Tex.....	-.009
Washington City.....	+ .010	Santa Fe, N. Mex.....	-.010
Lynchburgh, Va.....	+ .011	San Francisco, Cal.....	-.015
Wilmington, N. C.....	+ .014	El Paso, Tex.....	-.019
Boston, Mass.....	+ .016	Fort Assiniboine, Mont.....	-.017
Chicago, Ill.....	-.000	Yuma, Ariz.....	-.022

The mean pressure was highest over the middle Missouri and Red River of the North valleys, over the east part of the Lake region, in the middle Atlantic and New England states, and from the Pacific coast between the 40th and 45th parallels northeastward over the valley of the Columbia River, where it was above 30.10. East of the Rocky Mountains the mean pressure decreased southward to the Gulf coast, where it was below 30.05, while to the west of the Rocky Mountains the mean pressure decreased from the valley of the Columbia River and west Oregon southward to less than 29.95 over the southern plateau, and northward to less than 30.00 in the British Possessions north of the northern plateau.

A comparison of the pressure chart for March, 1891, with that of the preceding month shows that there was a general increase in mean pressure north of the 40th parallel, save on the northeast slope of the Rocky Mountains, and on the Pacific coast there was an increase in pressure as far south as the 35th parallel. The greatest increase in mean pressure occurred on the north Pacific coast, where it exceeded .20, and the increase exceeded .10 over the north part of the Lake region and thence east over the Saint Lawrence Valley. The most marked decrease in mean pressure occurred along the south Atlantic and east Florida coasts, and at Fort Du Chesne, Utah, where it was more than .10, and the decrease was more than .05 over the east Gulf states, over a great part of the southern plateau, and at stations in the British Possessions north of Montana. In the preceding month the mean pressure was highest along the south Atlantic coast, and lowest on the north Pacific coast, while for the current month it was highest in areas over the northern part of the country from the Atlantic to the Pacific coasts, and lowest over the southern plateau.

The mean pressure was above the normal east of a line traced from the Dakotas to South Carolina, over the northern plateau, and along the Pacific coast north of the 40th parallel; elsewhere it was below the normal. The greatest departure above the normal pressure occurred over the Canadian Maritime Provinces, where it exceeded .20, and on the north Pacific coast it exceeded .05. The most marked departure below the normal pressure occurred over the southern part of the country from Florida to south California, where it was more than .05.

The monthly barometric range at each station of the Signal Service is given in the table of Signal Service data.

HIGH AREAS AND STORMS.

The general weather conditions of this month have shown two remarkable characteristics, a lowering of temperature below the normal over the whole country, except in northern New England, where it was nearly stationary, and an increase of precipitation, above the normal, over the whole country, except in a few isolated spots. No March in 19 years has shown such departures from the normal. In 1876 there was a similar excess of precipitation, and an examination of the charts shows a marked coincidence in weather conditions for these two months. In 1885 there was also a marked diminution in temperature for nearly the whole country, but the progress of high areas and storms was different from that in this month. We may regard the conditions in 1876 and 1891 as typical, and hence it is of great importance to determine the causes of these anomalies. It should be noted that there has been no change in seasons or in the average conditions of temperature, precipitation, and pressure. The most marked peculiarity in this type, if it may be so regarded, was a tendency for high areas to either remain nearly stationary in the Lake region or to move in paths far to the north. As a consequence the storms made a sweep far to the south, circling this condition of high pressure. The cold north winds blowing into these storms lowered the temperature and at the same time produced the conditions favorable to increased precipitation. It should be noted that both high areas and storms presented very few marked contrasts, and consequently these peculiar characteristics were due to general and not special conditions.

At the close of this description will be found a table giving some of the more important facts relating to high areas and storms, and on Chart I are given storm tracks for this month.

AREAS OF HIGH PRESSURE.

During the month of March there have been 10 high areas whose paths were well enough defined to be traced. Their average duration was 4.9 days and the mean velocity 28.1 miles per hour, while during this month the storms have had a duration of 4.3 days and a velocity of 27.6 miles per hour. Of these high areas VIII started in Texas and IX on the middle Pacific coast. The other eight first appeared to the north of Montana. No. IV disappeared in Texas, IX in Ohio, X in the Saint Lawrence Valley, and the other seven reached the Atlantic coast.

I.—This was a continuation of VI of February. It was central over Lake Erie on the 1st and moved northeast, passing into the Gulf of Saint Lawrence on the 4th. A pressure of 30.78 and temperature of -42° were reported from White River, Ont., but only a few stations in the extreme north reported temperature below zero during its passage.

II.—On the first day of the month this high area had just appeared at Edmonton, N. W. T., where the pressure was 30.68 and temperature -18° . Its track was a very little south of east to Lake Huron and then east-northeast to the Atlantic off Nova Scotia. The lowest temperatures ever observed during the first ten days of March were reported during its progress on the 2d and 3d in Montana, Dakota, and northern Nebraska. At Fort Assiniboine, Mont., -32° , or 6° below the lowest; Bismarck, N. Dak., -32° , or 12° below; Valentine, Nebr., -26° , or 10°

below. Temperatures below zero occurred as far south as Kansas, and below freezing over the entire country east of the Rocky Mountains, except the south Atlantic and east Gulf states and on the west Gulf coast. Highest pressure reported was 30.76, at Swift Current, N. W. T., 3d, and lowest temperature, -42°, at Prince Albert, N. W. T., 5th. This had the slowest motion of any in the month and its duration, 9.5 days, was the longest.

III.—A stationary area of high pressure occurred from the 5th to the 8th just north of North Dakota. The effects of this high area will be described under "Storms." Connected with this an area of high pressure started just to the west on the 6th, and moving southeast reached Texas on 9th. Thence the path was nearly due northeast to Newfoundland on the 13th. The track was the longest of all this month.

IV.—This high area started in the same place as III and moved southeast to Texas, where it lost its identity or joined with V afternoon of 13th.

V.—Started a day later from the same spot as the last and moved nearly southeast reaching the Atlantic off the Carolina coast 16th.

VI.—Started a little north of V and moving east-southeast reached the New Jersey coast on 17th; thence it moved along the coast to Nova Scotia 18th.

VII.—Started in Manitoba on the 17th and moved nearly east reaching Newfoundland on the 21st.

VIII.—This is the only high area of the month that had its origin within this country. It was first noted in north Texas on 19th and moved a little south of east, reaching the Florida coast on 21st.

IX.—This was first noted off the middle Pacific coast on the 19th. Moving southeast it reached Texas on the 21st; thence it moved northeast, disappearing in Ohio on 23d.

X.—This started to the north of Montana morning of 22d and moving a little south of east it disappeared in the Saint Lawrence Valley on 27th.

STORMS.

The average velocity of the 13 storms traced this month has been 27.6 miles per hour, which is 4.2 miles below the average for the past 19 years. It stands 5th on the list, 1876, 1878, 1881, and 1879 only being below. It is an interesting fact that the storms of 1876 had a corresponding low velocity, and this may, in part, account for the increased precipitation. It may also be noted that the driest year of the 19 was 1885, and this stands 3d in the list of high velocities. The following table shows the average velocity during the 19 years from 1873 to 1891:

Year.	Velocity.	Number.	Year.	Velocity.	Number.
1873	29.7	12	1883	38.0	11
1874	30.4	11	1884	33.3	12
1875	32.1	10	1885	39.0	9
1876	26.6	9	1886	31.0	14
1877	34.5	11	1887	37.0	11
1878	24.3	10	1888	34.5	9
1879	24.3	10	1889	25.8	10
1880	35.2	13	1890	37.0	12
1881	35.8	14	1891	27.6	13
1882	26.8	9	Mean	31.8	11
	34.8	10			

GI.—On the 1st a storm of some intensity appeared on the middle Pacific coast. A portion of this storm seems to have been transferred to the east-middle Rocky Mountain slope p. m. of this date, and the precipitation extended in its front to Wisconsin and Illinois. In the next 24 hours the storm remained almost stationary while the precipitation extended in a remarkable manner clear to the Atlantic coast, and, in fact, into the high area I, already described. High area II, to the north of Montana, seems to have had some influence upon the precipitation. In the next 24 hours this storm made a rapid advance in a curve, passing to the north of Louisiana and on to the lower lakes. In the next 12 hours gales were experienced in the Lake region, amounting to 52 miles per hour at Buffalo, N. Y. This storm was last noted in Ontario p. m. of 4th.

OII.—There seems to have been a division in I, or a development of a secondary from it, on the middle Atlantic coast a. m. of the 3d. This storm increased very rapidly in energy as it passed up the coast, the pressure falling from 30.1 to 29.1 in 2 days. A maximum velocity of 56 miles per hour was experienced at Sandy Hook, N. J., and Block Island, R. I., 4th.

OIII.—Originated in the south plateau region and had very slight energy for 48 hours. On the a. m. of 5th a secondary appeared to develop in the west Gulf, and from this the precipitation rapidly extended over nearly the whole country with very slight motion in the storm. By far the heaviest precipitation of the month was noted while this storm remained nearly stationary in the west Gulf. At Vicksburg, Miss., 5.42 fell in the 24 hours ending p. m. of 7th, and 4.14 in 12 hours ending at the same time. This storm was undoubtedly held back by the high areas in Canada, but it is hardly probable that any cool winds from there assisted in producing the excessive precipitation. From the a. m. of 6th to p. m. of 7th there was nearly continuous precipitation over a large part of the country. On a. m. of 8th this storm had moved to Illinois and in the succeeding 12 hours it divided the wide extended high area to the north and disappeared to the north of Lake Superior on 9th.

IV.—A secondary from the above storm split off during the 8th in the middle Gulf and moved rapidly to the Saint Lawrence Valley, where it disappeared on the 10th. High area III followed up this storm and dominated the weather in the Eastern States till a. m. of 11th.

V.—This storm originated in N. W. T. on 8th. The origin of this storm was remarkable in the fact that though the pressure fell to 29.12 and there were very steep gradients, producing winds which reached 46 miles per hour, yet there was almost no precipitation in the first 72 hours, or until a secondary (VI) had moved with some rapidity to the southwest. These conditions, so extremely different from those prevailing only a few hours before, demand a special study and treatment, which cannot be given here. It should be noted, however, that the position of the storm and high area in this case was almost opposite to that in III. With the great precipitation there was little or no movement of the storm, which had very slight intensity and was situated in the west Gulf, while a high area of great magnitude stretched across almost the whole north boundary of the country. On the other hand, with little or no precipitation, a storm of great intensity and extent was situated in the Northwest, with a high area of great magnitude dominating the weather conditions throughout the states east of the 100th meridian. It has been repeatedly observed that this latter distribution of pressure is very favorable to fair skies throughout the country. The evidence from these storms, corroborated by that from scores of others, seems to prove almost conclusively that precipitation is not needed to develop storms of great extent and intensity. As noted above, a secondary from V split off on the 10th and the two moved as a trough of low pressure toward the east, continuing their identity till 12th p. m., when the trough extended from Lake Superior to the middle Atlantic coast.

OVI.—A secondary seems to have formed from the above trough over the middle Gulf states on the 12th, and 12 hours later all three storms are included in a single storm of great extent and intensity, with a pressure of 29.40 at Parkersburgh, W. Va. The conditions were considered so threatening that on the afternoon of the 12th, although no high winds were prevalent, information signals were hoisted along the middle Atlantic and south New England coasts, and these were changed to cautionary that night. On the next day the storm reached the New England coast, and at 10.30 p. m. of the 13th the U. S. S. "Galena" and tug "Nina" went ashore on Gay Head. This storm moved ne. down the Saint Lawrence Valley and disappeared on the 14th. The pressure at Rockliffe, Ont., 28.98, p. m. of the 13th, was the lowest reported at any station during the entire month. High area VI followed in the wake of this storm and dominated the weather for 48 hours.

VIII.—This storm appeared in the rear of high area VI in the Northwest Territory on the 13th. It skirted the high area on the north side and passed along the north border of the country with almost no precipitation, and disappeared in the Gulf of Saint Lawrence on 17th.

IX.—Appeared on the extreme north Pacific coast on 14th. Its motion was se. to Indian Territory on 17th, then ne. to Lake Erie, where it disappeared 20th.

X.—This storm started on 17th to the north of Montana, and moved se. to Missouri 20th. It then moved e. to the middle Atlantic coast, where it disappeared 23d.

XI.—This storm originated like the last three in or near the Northwest Territory. Its motion was in a gentle curve to the

south, reaching the Saint Lawrence Gulf on the 25th. Almost no precipitation attended its progress.

XII.—Originated in the south plateau region on the 22d. It moved east to the middle Gulf on the 26th, then turned due north and disappeared over Ohio on the 28th. A secondary from this storm, a. m. of the 27th, was the beginning of a storm which is described among "North Atlantic Storms."

XIII.—This storm also began in the N. W. T. on the 25th. It moved se. to Indian Territory on the 29th, then northeast and was noted on the last day of the month over Lake Michigan. This storm was also remarkably dry in its inception. The lowest pressure was 29.42 on the first few days and maximum winds of 36 and 40 miles were reported from several stations.

Tabulated statement showing principal characteristics of areas of high and low pressure.

Barometer.	First observed.			Last observed.			Duration.	Velocity per hour.	Maximum pressure change and maximum abnormal temperature change in twelve hours and maximum wind velocity.											
	Date.	Lat. N.	Long. W.	Lat. N.	Long. W.	Days.			Miles.	Station.	Rise.	Date.	Station.	Fall.	Date.	Station.	Direction.	Miles per hour.	Date.	
High areas.																				
I.....	*	50	109	48	64	5-5	25	Montreal, Que.....	.46	1	Eastport, Me.....	21	1	Block Island, R. I.....	ne.	32	2			
II.....	1	55	113	46	57	9-5	16	Parry Sound, Ont.....	.42	5	Cheyenne, Wyo.....	43	2	Oswego, N. Y.....	nw.	26	5			
III.....	6	51	119	49	54	7-5	30	Norfolk, Va.....	.62	10	Palestine, Tex.....	29	7	Kitty Hawk, N. C.....	n.	34	10			
IV.....	10	51	117	31	96	3-0	26	Fort Buford, N. Dak.....	.72	10	Denver, Colo.....	38	10	Galveston, Tex.....	n.	38	13			
V.....	11	50	114	33	75	5-0	27	Parkersburgh, W. Va.....	.60	13	Wilmington, N. C.....	17	15	Kitty Hawk, N. C.....	nw.	38	15			
VI.....	15	54	108	44	60	3-5	38	White River, Ont.....	.72	16	Saint Vincent, Minn.....	22	15	do.....	ne.	44	17			
VII.....	17	51	92	48	56	3-6	30	Father Point, Que.....	.50	19	Rockliffe, Ont.....	24	19	Winnipeg, Man.....	ne.	20	17			
VIII.....	19	36	100	29	80	2-0	36	Little Rock, Ark.....	.24	19	Cairo, Ill.....	15	19	Wichita, Kans.....	n.	26	19			
IX.....	19	42	124	40	84	4-0	35	Abilene, Tex.....	.42	21	Abilene, Tex.....	20	21	Abilene, Tex.....	n.	36	21			
X.....	22	53	109	49	71	5-5	18	Fort Buford, N. Dak.....	.46	22	Minnedosa, Man.....	22	22	Block Island, R. I.....	n.	36	26			
Mean.....						4-9	28		.52			25					33			
Low areas.																				
I.....	1	43	121	46	77	3-5	39	Parry Sound, Ont.....	.42	4	Montgomery, Ala.....	15	3	Buffalo, N. Y.....	sw.	52	4			
II.....	3	35	75	49	57	3-0	21	Sydney, C. B. I.....	.56	5	Montreal, Que.....	14	3	Block Island, R. I.....	e.	64	4			
III.....	3	38	115	51	83	6-0	23	Port Arthur, Ont.....	.56	8	Atlanta, Ga.....	17	8	Chicago, Ill.....	e.	46	8			
IV.....	8	28	94	49	64	2-5	39	Eastport, Me.....	.38	10	Northfield, Vt.....	14	9	Boston, Mass.....	w.	46	10			
V.....	8	50	115	50	82	3-5	23	Fort Buford, N. Dak.....	.50	9	Rapid City, S. Dak.....	26	9	Fort Buford, N. Dak.....	nw.	48	10			
VI.....	10	42	105	36	76	2-5	40	Norfolk, Va.....	.36	12	Augusta, Ga.....	16	12	Fort Sill, Okla. T.....	s.	48	10			
VII.....	12	32	88	50	67	2-0	36	Rockliffe, Ont.....	.75	13	New Orleans, La.....	14	12	Buffalo, N. Y.....	sw.	60	13			
VIII.....	13	48	126	48	60	4-0	32	Minnedosa, Man.....	.60	14	Fort Buford, N. Dak.....	33	14	Chicago, Ill.....	w.	52	15			
IX.....	14	48	127	42	81	6-0	22	do.....	.42	16	Swift Current, N. W. T.....	24	16	do.....	sw.	48	17			
X.....	17	52	117	37	72	5-5	23	Valentine, Nebr.....	.36	19	Moorhead, Minn.....	20	19	Kitty Hawk, N. C.....	e.	56	22			
XI.....	20	53	117	47	63	4-5	26	Rapid City, S. Dak.....	.40	21	Rapid City, S. Dak.....	20	21	Fort McKinney, Wyo.....	nw.	48	21			
XII.....	22	35	111	41	84	6-0	16	Manistee, Mich.....	.28	26	Shreveport, La.....	13	24	Chicago, Ill.....	ne.	42	25			
XIII.....	25	51	122	46	87	6-5	19	Green Bay, Wis.....	.42	30	Palestine, Tex.....	21	27	do.....	se.	52	30			
Mean.....						4-3	28		.46			19					51			

* February 26.

NORTH ATLANTIC STORMS FOR MARCH, 1891 (pressure in inches and millimetres; wind-force by Beaufort scale).

The paths of the depressions that appeared over the west part of the north Atlantic Ocean during March, 1891, are shown on Chart I. These paths have been determined from international observations by captains of ocean steamships and sailing vessels received through the co-operation of the Hydrographic Office, Navy Department, and the "New York Herald Weather Service."

The barometric pressure continued high over mid-ocean during the first decade of the month, although it was unusually low near the Azores from the 5th to 9th. The first important storm of the month was central off the southwest edge of the Grand Banks the morning of the 4th, with fresh to strong gales and a heavy snow storm over south Newfoundland. On the morning of this date a storm of considerable strength was off the south New England coast. At night a sw. gale, with squalls and lightning, prevailed at Bermuda. On the 5th the two storms referred to had apparently united and a storm of marked energy was central southeast of Nova Scotia, with pressure about 29.30 (744), heavy gales and sleet, and heavy rain over south Newfoundland. The morning of the 6th the storm was central over or near the east extremity of Nova Scotia, with pressure below 29.40 (747) and fresh to strong gales, from which position it moved east and on the 7th was central southeast of Newfoundland, after which it moved south of east in the direction of the Azores. On the 8th a storm was

central south of Newfoundland, whence it apparently moved southeast and united with an area of low pressure which extended southwest of the Azores from the 5th to the middle part of the month. On the 7th there had been a decided fall in pressure over the British Isles. On the 8th an area of low pressure extended from the British Isles over the Azores. On the 9th a storm of considerable strength, with central pressure about 29.40 (747), was central over the west part of the Bay of Biscay, with severe gales and a heavy snow storm over the south part of Great Britain, where railroad and telegraphic communication was interrupted, and many disasters to shipping were reported. By the 10th the storm-centre had moved eastward over the Bay of Biscay; the heavy storm continued over the south of England, blocking trains with snow, and causing great damage to shipping in the English Channel. Following this storm a severe cold spell set in over England, greatly interfering with the clearing of snow from railroad tracks, and causing loss of life and live stock. From the 11th to 13th a second storm of considerable strength moved eastward from the 20th meridian over the Bay of Biscay. From the 14th to 16th a storm moved eastward from the lower Saint Lawrence valley to the 45th meridian. On the 17th this storm was central about midway between Newfoundland and the Azores; by the 18th it was apparently central near the Azores; by the 19th it had moved east-northeast of the Azores; and by