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Bulletin P.

COLD WAVES AND FROST IN THE UNITED STATES.

Prepared under direction of WILLIS L. MOORE, Chief U. S. Weather Bureau.

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture, Weather Bureau,
Washington, D. C., March 12, 1905.

Hon. James Wilson,
Secretary of Agriculture, Washington, D. C.

Sir: I have the honor to transmit herewith a paper on the subject of cold waves and frosts in the United States by E. B. Garriott, Professor of Meteorology, and to recommend its publication as a bulletin of the Weather Bureau.

The paper notes briefly the general distribution of the colder areas of the Northern Hemisphere, refers to general conditions that are associated with cold waves, and presents a chronological account of historical cold periods in the United States. It then summarises and classifies the more important cold waves and frosts that occurred from 1888 to 1902, inclusive, and presents 328 charts that exhibit the meteorological conditions that attended the principal cold waves of that period.

Very respectfully,

Willis L. Moore,
Chief U. S. Weather Bureau.

Approved:
James Wilson,
Secretary.

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COLD WAVES AND FROSTS IN THE UNITED STATES.

INTRODUCTION.

Contrary to common belief, the lowest temperatures of the Northern Hemisphere have not been observed in the neighborhood of the North Pole.

Polar expeditions that have wintered in the Arctic Archipelago near the eightieth parallel of latitude have experienced temperature extremes ranging from 65° to 75° below zero, while in Siberia an absolute minimum temperature of 90.4° below zero and a January monthly mean of 63.5° below zero have been recorded at Werkhoyansk, in latitude north 67° 5′, longitude east 134°.

The lower temperatures of the great interior area of Asia are ascribed to the relative dryness of the air that overlies that region, an atmospheric condition that promotes a rapid radiation of heat into space. Modified conditions similar to those that obtain in Siberia are presented in the relatively smaller British American area, and in the United States beyond the southern confines of this area temperatures 40° to 60° below zero have been registered with an absolute minimum of 63.1° below zero at Poplar River, Mont.

It therefore appears from available data that the greatest depressions in temperature in the Northern Hemisphere are found in a belt about twenty degrees in width that crosses the continents between latitude 50° and 70° north, with the lowest known temperatures near the Arctic Circle in Siberia. The cold belt, which practically bounds the Arctic region on the south, is necessarily broken where it crosses the moist and warmer water surfaces of Bering and Greenland seas, and the intensity of its temperatures is also modified by ocean influences over northern Europe and in the northern Pacific coast regions of the American Continent.

East of the Rocky Mountains the principal track of American winter areas of low barometric pressure, or general storms, lies south of the fiftieth parallel of latitude, and the mechanical action of energetic storms that follow this track disturbs the British American cold belt and draws southward, and probably downward in their wake, masses of cold air that constitute the cold waves of the United States.

The supposition has been advanced that the British American cold belt may be reinforced by air masses that advance, via the Arctic Ocean, from Siberia; a more probable supposition, however, is that the cold of the northern interior of the American Continent is due to air that flows over that region from the northern Rocky Mountain ranges where its moisture has been precipitated. The result of a loss of moisture in the passage of the mountains leaves this air clear and dry, and promotes the process of heat radiation that continues during the passage of the air over British America. It seems, therefore, that slow or stagnant conditions of the atmosphere over British America are favorable to one of the conditions (that are represented by accumulations of great air masses, or areas of high barometer of great magnitude) that produce cold waves in the United States. The other necessary condition is the passage, or development, of an area of low barometric pressure along or near the southern margin of the cold air mass or belt, within the western quadrants of which the cyclonic circulation will produce powerful air currents from the north.

The following remarks and correspondence bearing upon this subject appear in the Monthly Weather Review for March, 1904, Prof. Cleveland Abbe, Editor.

ORIGIN OF AMERICAN COLD WAVES.

In a letter of January 26 to Prof. R. F. Stupart, the Editor said: "I have just read an old excerpt from the Cœur d'Alene Sun.

" ' We have taken careful note of the development of these cold waves in the Klondike, and it usually takes three weeks for them to travel down to the weather stations at Edmonton, Qu'Appelle, and Havre.'

" I myself suppose that the cold of cold waves is due entirely to the radiation of heat from the lower strata of the atmosphere to the ground and to the clear sky overhead, as explained in my article on ' Atmosphere radiation and its importance in meteorology ', published in the American Journal of Science in 1892, and reprinted in the American Meteorological Journal, vol. 8, p. 537. I suppose, therefore, that a cold wave may originate anywhere along the western slope of the Rocky Mountains, and its coldness when it reaches Montana would depend on the slowness with which it has moved southward, so that it may possibly be true that the very coldest temperatures come with cold waves that have taken three weeks to move from the Klondike southward. I am rather inclined to doubt whether any of our cold waves, at least those worthy of the name, originate north of British America, but that they all begin with the clear air that flows over the northern part of the Rocky Mountain range."

Under date of February 9, 1904, Professor Stupart replied as follows:

" I am studying the question, using the data from Dawson, Fort Good Hope, Chippewyan, Fort Churchill, York Factory, Edmonton, and Winnipeg. In a short time I shall hope to send you something further. I am almost satisfied that the Cœur d'Alene Sun is astray in supposing that it takes three weeks for cold waves to travel from the Klondike to Alberta and Havre, There is, I think, some ground for the belief that in some seasons the cold waves take about six days. This is indicated in the winters of 1901–2 and 1902–3, but it is certainly true that in some seasons waves of intense cold which are experienced in the far north never reach Alberta or even Winnipeg. This present winter, in December, the coldest weather seems to have occurred simultaneously at Dawson, Edmonton, and Winnipeg. In January the greatest cold wave set in at Dawson on the 9th or 10th, and the coldest weather of the month began at Edmonton on the 15th. This is also about six days. But this present month another great cold wave set in over the Yukon on the 2d, and almost coincidently the weather turned decidedly colder at Edmonton.

" I spent the winter of 1884–85 in Hudson Strait on the barren grounds. February of that winter was there exceedingly mild for that region, while in Toronto it was the coldest month, but one, recorded in seventy years. I quite agree with you that probably none of the cold waves originate north of British America, but it appears to me that they may originate almost anywhere over the more northern portions of the continent. The cold waves which have passed across the Great Lakes and the St. Lawrence Valley this winter do not appear to have originated in the far Northwest, or at least they have become much more intense as they approach Ontario and Quebec.

" With regard to the cold of cold waves being entirely due to the radiation of heat from the lower strata of the atmosphere to the clear sky overhead, I can not offer other explanation, but at the same time I doubt whether it is the full explanation. In some winters great cold waves persistently form, while in other years, with barometric and cloud conditions as far as we can judge almost identical, the resulting cold waves are relatively unimportant.

" I do not believe in moon or planets having any appreciable effects on the terrestrial weather. The sun alone is to be considered, and I hope there is now some ground for belief that the physicist may shortly give us information regarding solar radiations which may assist in solving some of the perplexing problems in meteorology."

In the Monthly Weather Review for October, 1904, Rev. Marc Dechevrens refers briefly to this theory of cold waves as follows:

Allow me to add some reflections on the subject of your correspondence with Professor Stupart in the Monthly Weather Review for March, 1904, on the primary and principal cause of cold waves. Already in 1898, on the occasion of the cold wave of November 26, discussed at length and with charts in the Monthly Weather Review, I was convinced that these cold waves of the United States proceed from the same cause as our cold waves in Europe. Both accompany anticyclones, or follow cyclones, or more often still, appear between two centers of low pressure. Professor Stupart is no longer willing to regard radiation as a sufficient cause for such cold, and he now repeats what I said in 1886 and what I have not ceased to say since; some other cause than radiation is needed to explain this phenomenon. In my belief, the only truly efficacious and adequate cause of these great cold waves is the dispersion of aerial masses, which descend in the high pressures and expand over two gradients in the directions of the two centers of depression. Consider the chart of November 26, 1898. You will see there a complete sheet of winds from the southeast and south, whose direction is toward Montana, where the temperature is 20° F. at the center of a low; and another sheet of winds from the northwest, whose direction is toward another low over Lake Erie, with a temperature of 28° F. The dividing line between these two systems is over an area of high pressure with a temperature of about —10° F. Impossible that such a fall of temperature should be due to radiation, especially that the fall should be greater in the wind from the south, to which one attributes a temperature naturally higher than in a wind from the north.

The cold waves, therefore, are no more confined to polar currents, than are the warm waves to equatorial currents. Cold will always be found associated with currents of dispersion, and heat with currents of concentration.

If to this idea of horizontal winds of dispersion and concentration is added another conception, to which I gave equal emphasis in 1886, the conception of two superposed eddies forming together the cyclone, and two others forming together the anticyclone, we may thus most simply explain the distribution, so curious, of temperature along the axes of cyclones and anticyclones, such as have been revealed to us by observations on mountains, and more recently and completely by balloons.

Farmers' Bulletin No. 104, U. S. Department of Agriculture, and several pamphlets issued by the Weather Bureau have discussed the subject of frost and cold waves, and have indicated methods of protection against frost and cold that have been found practicable by actual experiment and use.

As methods for protecting plants and perishable products from cold, can be utilized only on the eve of the occurrence of damaging temperatures, it is apparent that bulletins on frost heretofore issued can be profitably supplemented with data and references that will assist in recognizing for periods of one to three days in advance the general atmospheric conditions that will result in frost or cold waves in certain sections of the United States. And it is believed that the graphic representations on the charts herewith of conditions that have preceded and attended the more important cold waves and frosts that occurred in the United States during the 15-year period, 1888 to 1902, inclusive, will aid materially in interpreting the data presented by the daily weather maps of the Weather Bureau.

Official forecasters and students will find the charts valuable for reference in connection with the principal frosts and cold waves of the period they cover, and agriculturists and others, who by reason of isolated places of residence or business are unable to receive promptly the warnings of the Weather Bureau, can profit by a study of the facts presented, and in many instances can supplement the information thus acquired with a study of local weather signs and by data contained in daily weather maps and bulletins that are issued at about one hundred stations of the Weather Bureau.

The charts present for the period of years named the more important winter cold waves, and the principal frosts of the spring, summer, and fall months. In this classification, cold waves proper have been confined to December, January, February, and March, when damage to crops by cold is confined largely to southern California and the fruit, cane, and trucking interests of the Gulf States and Florida, to perishable merchandise, and to stock ranges of the western plains. The spring frosts indicated by the charts were of a character to injure fruit in the bud, and those of the fall months damaged immature and unharvested crops in the sections specified. Instances of summer frosts are given, not on account of any material damage that the frosts of this season are likely to cause, but for the purpose of showing the regions to which they are usually confined, and presenting exceptional cases of damaging summer frosts that have occurred in other than mountainous and extreme northern districts of the United States.

In connection with the charts, brief notes are made regarding the character of the more important cold waves in specified sections of the United States, and preceding these notes a chronological record is given of severe cold periods in the United States that has been given historical notice.

HISTORICAL COLD PERIODS IN THE UNITED STATES.

Blodget's Climatology of the United States, published in 1857, cites the following instances of severe cold periods:

1717.—The "great snow" occurred, which is often mentioned in New England history of that date. It continued for several days, February 19 to 24, and remained five or six feet deep on a level at Boston and over all the settled parts of New England, and continued so long and severe that multitudes of all sorts of creatures perished in the drifts. This winter is the most conspicuous, if not the only one noted for extreme cold for a long period previous to 1740.

1740–1741.—This winter was distinguished both in the United States and Europe for intense cold. Jefferson speaks of it as having been in Virginia only less severe than that of 1779–80; it was commonly called the "cold winter," and was noted in Virginia history for extreme severity. Doctor Lining made observations at Charleston, S. C., for December, 1740, and this is the coldest month in his series of fifteen years; 1741 was not given in his published records. Dr. Noah Webster says the winter of 1741 was one of great severity, and equal to that of 1780. The Boston News Letter of March 5, 1741 (?) says: "We hear from Stratford, Conn., that the Sound is frozen over three leagues across, so that people ride every day thence to Long Island." In a subsequent number a certificate of several people appears, testifying that they had crossed the Connecticut River on the ice, on horses, on the 1st of April.

1748.—Cited by Gayarre as a cold winter at New Orleans, the cold being defined as the measure of injury in the South to tropical fruits.

1765–66.—One of the four winters in a century in which the Hudson River was frozen over at Paulus Hook. On January 3, 1766, frost destroyed all tropical fruits, except oranges, in northern Florida, and 26° was the lowest temperature observed at that time on the St. John's River.

1768 and 1772 are cited by Gayarre as severe winters in Louisiana. How general the cold of these winters was can not now be ascertained, though at the localities named they were very severe, as the destruction of oranges and other tropical trees proves.

1780.—The most signal and severe depression of temperature occurred belonging to our entire history, except, perhaps, 1856. Jefferson (notes on Virginia) says that "in 1780 the Chesapeake Bay was frozen solid from its head to the mouth of the Potomac. At Annapolis the ice was five to seven inches in thickness, quite across, five and a half miles, so that loaded carriages went over it. "York River was frozen over (at Williamsburg, Va.,) so that people walked across it,"—the lowest temperature observed there was 6°. Webster remarks an immense snowfall in New England; for six weeks no snow melted. The Sound was entirely covered with ice between Long Island and the main, and between New York and Staten Island." Troops crossed from New Jersey to Staten Island to attack the British forces on that island. Washington "supposed that an attack on about 1,200 British troops posted on Staten Island might be advantageously made, especially in its present state of union with the continent by an unbroken body of solid ice." The crossings to and from the island were effected on the ice. "In this winter Bayou St. John (New Orleans) was frozen for a considerable time, a phenomenon that did not occur again until 1814." (Darby.) The Delaware River was closed from the 1st of December to the 14th of March, the ice being two to three feet thick. During the month of January the mercury was several times at 10° to 15° below zero, and only once during the month did it rise to 32°. From all the notices accessible we can not doubt that the average depression of temperature in the entire United States was more than 50° from the mean, and this was at several intervals in a period of some weeks in which the depression was always great.

1783–84.—The winter was severe at Philadelphia; "the Delaware River closed as early as November 28, and continued ice bound until the 18th of March; the mercury was several times below zero." (Cor. Phil. Mag.) The lowest temperature noted at Philadelphia was —12°. Dr. Noah Webster gives some extreme readings of the thermometer at Hartford, Conn., the lowest being —20° on February 14, 1784, and the highest minimum from February 10 to 17, inclusive, being —12°, and remarks "this is the most extraordinary instance of intense cold that I have ever known."

1787–88.—This winter was severe in lower Georgia and the South; below Savannah the ground was frozen in January, and ice formed in ditches; at Midway, 30 miles southeast of Savannah, the lowest temperature observed was 22° in January and 20° in February. At Philadelphia "the whole winter was intensely cold; the Delaware was closed from December 26 to March 10." At Salem, Mass., the winter was not particularly severe.

1792.—Darby says that the Ohio at Wheeling was frozen for upwards of forty days, so that heavy carriages crossed it, and "the quantity of snow was the greatest known there since 1780."

1796–97.—The winter was severe, all the rivers of the West being frozen up, according to Darby; but in the early months of 1796 the greatest severity of cold was felt there. "In 1796 the Mississippi and Ohio and their confluents were frozen to their junction." (Drake.) Of 1796 Jefferson says, "that should he revise the notes on Virginia, he should place the minimum temperature assigned to the eastern portion of the State lower than before as he had observed it at $1\frac{3}{4}$° above zero on January 31 of that year at Monticello." (Jefferson's Works.) There are several notices of severe cold in 1796 and 1797 which are difficult to place in regard to the months intended, but it appears that the winter of 1796–97 was unusually cold. Doctor Wilson observed the thermometer at 17° at Charleston, S. C., in December; "the coldest days on record are December 23 and 24, 1796." (Ramsey, Vol. II, p. 52.) In this month the thermometer fell to —14° at Cincinnati, and on January 8, 1797, to —18°. (Drake.)

In 1800 the severest cold since 1780 was experienced in the Southern States, though it was not unusually cold in Massachusetts. "On January 10, 1800, there fell at Savannah the deepest snow ever known in Georgia. By a letter from Midway, Ga., of February 17, 1800, I am informed that the snow has been three feet deep in places, and sixteen to eighteen inches deep on a level. Great quantities of sleet fell also." (Holmes, Mem. Am. Acad.) Snow and hail fell the whole day on January 10 at St. Mary's River, Fla., and on the 11th the snow was five inches deep. The lowest temperatures were, 10th, 37°; 11th, 28°; 12th, 34°. (Forbes.) At Natchez, the lowest observation was 17° by Gov. Winthrop Sargent's record; and the mean of January was 6°, and of February 9.5° below the average. Near Natchez, Mr. Dunbar observed the lowest at 12°, and the means 5.8° and 9.3° below the averages for January and February, respectively. (American Philosophic Transactions.) Darby speaks of the severe storms of sleet and snow in Louisiana in January, 1800, a heavy fall of snow occurring at Opelousas, with general and severe injury to tropical fruits and tender growths.

1811–1817.—During this period the most remarkable depression of temperature in the summer months known to all history of thermometric measurements occurred, and of these 1812 and 1816 were the coldest, the reduction in both cases having continued over all the months in each year in a greater or less measure, but of no considerable amount in winter. 1812 and 1816 were memorable as "cold summers" for all of the northern United States. From May to September of 1812 each month was from 3.6° to 7.2° below the average, a most unprecedented refrigeration, and equaled for two months only, June and July, in 1816, which were 5.0° and 5.8° below. In the Northern States

snows and frosts occurred in every month of both summers; Indian corn did not ripen, fruits and grains of every sort were greatly reduced in quantity or wholly cut off. Professor Dewey, at Williamstown, Mass., remarks that "there was frost in every month of this summer (1816); on June 7, a light snow." (Mem. Am. Acad. Vol. IV.) In Thompson's History of Vermont, similar facts are stated: "It is universally conceded that the year 1816 was the coldest ever known in Vermont. Snow is said to have fallen and frosts to have occurred in every month of the year. On the 8th of June snow fell in all parts of the State, and on the highlands and mountains to the depth of five or six inches. It was accompanied by a hard frost, and on the morning of the 9th ice was half an inch thick on shallow, standing water, and icicles were to be seen a foot long. The weather continued so cold that several days elapsed before the snow disappeared. Corn and other vegetables were killed to the ground, and very little Indian corn came to maturity, etc." "In 1816 snow fell at Norway, Me., on the 6th, 7th, and 8th of June." (Boston Am. Almanack.) Frost occurred even at Philadelphia in July, 1816. (Darby).

1818.—In February, various *lauracea*, the sassafras tree and others, were killed by cold in Ohio. At Marietta the thermometer fell to 20° and 22° below zero; peach trees were killed, and not again until January, 1852, and the still more severe cold of 1856, was there similar injury by frost to fruit trees in the State. (Doctor Hildreth, Am. Jour. Science, 1832, 1852, etc.) The cold of 1818 can not be compared generally for want of observations.

1818–19.—The winter was severe in New England, the mean temperature at Salem being 21.5° for the three months, or 6.4° below the mean of the winter for forty-three years. This is also difficult to trace further, and it could not have been unusually severe.

In January, 1820, the mean at Fort Snelling, was 0.9° only, a fraction lower than at any subsequent date to 1856, but no other part of the United States was similarly cold.

In January, 1821, the temperature at Fort Snelling was lower than in any other winter month since 1792, and 6.2° below the average; at New Bedford the mean was 5.7° below the average, with a single observation at 10° below zero.

1820–21.—At New York the winter was also "one of the four during a century in which the Hudson between Paulus Hook and New York was covered with ice." (Caldwell.)

1825–26.—The winter was cold in New England. On January 31, 1826, a temperature of —27° was observed at Portland, Me., —24° at Amherst, —18° at Springfield, —12° at Boston, Mass., zero at Washington, D. C., and 14° at Natchitoches, La.; on January 31, and February 1, a reading of —38° was observed at Montreal, and on February 5, a reading of —40.5° at Cape Diamond, Quebec. On February 22, mercury solidified at Plattsburg, N. Y., a condition requiring a reduction of —40.5°.

1830–31.—In this winter the single readings were frequently at 22°, 24°, and 26° below zero at the military posts of Wisconsin in each of the three months. In Florida the winter was also severe. The monthly means were 10° below the average in the latitude of St. Louis, Mo., for January and February, 1831, and at New Orleans, La., Tampa Bay, Fla., etc., 5° below for the same months. Though this is an extreme degree of cold at the south, the injury to tropical vegetation was not important.

At the close of 1831 a severe and universal depression of temperature occurred. The month of December was 15° below its average in the Northwest, and from St. Louis to New York and Norfolk. At New Orleans it was 9° below, at St. Augustine, Fla., 5°, and at Tampa Bay, 3.4° below the mean; showing that the depression was central to this part of the continent, diminishing in degree both at the north and south, as in most other severe extremes. Of this winter Doctor Hildreth says: "The Mississippi River was frozen over in December for 130 miles below the mouth of the Ohio, a circumstance before unknown. The river was covered with floating ice below Natchez, and at New Orleans ice formed strong enough to skate upon. At Fayettville, Vt., the mean temperature was 8.3° colder than any month in the last half century." (Field.)

1835.—A destructive period of cold occurred in the Middle East and Northeastern States January 4, and in the central valleys and Southern States February 8. In the Southern States tropical fruits were cut off which had been uninjured for more than half a century. The following temperatures observed during these periods, taken mainly from Niles's Register for April 11, 1835, and other sources of the same period, represent extremes of temperature reached during this period:

On the St. Johns River, five miles above Jacksonville, Fla., evergreen oaks shed their leaves from this frost, and began to show new leaves again on the 20th of March, following. The orange trees were split to the roots, and, of course, were killed, root and all.

In January, it will be observed, a large area of the Northeastern States, with a part of New York, was at 40° below zero, with a depression of 65° from the mean temperature. This depression has occurred but twice, the second time in 1856. In February nearly all the surface of the United States as then observed, or all that east of the Great Plains, was below zero on the 8th—Natchez at the southwest and Savannah on the Atlantic coast being the limits.

In 1835 a second series of low temperatures began in the warmer months which were nearly as severe as those of 1812 and 1816, and the winter of 1835–36 was very severe in New England. In many parts of New England snow remained uninterruptedly from December until May, and at Washington, D. C., snow lasted two months, a very rare occurrence. In Ohio the cold wave was very severe, and many tropical trees were destroyed at New Orleans and in the Southwest. Long Island Sound was closed by ice, and Boston Harbor was nearly closed; this winter was con-

sidered "next to that of 1779-80 along the Atlantic coast." (Am. Jour. Science.) The cold was greatest in February, and it was continued through March and April.

January 4, 1835.

	°		°
Bangor, Me	—40	Pittsfield, Mass	—32
Bath, Me	—40	New Lebanon, N. Y	—40
Portland, Me	—21	Albany, N. Y	—32
Montpelier, Vt	—40	Utica, N. Y	—34
White River, Vt	—40	Poughkeepsie, N. Y	—35
Rutland, Vt	—30	New York, N. Y	— 5
Burlington, Vt	—26	Pottsville, Pa	—24
Franconia, N. H	- 40	Lancaster, Pa.	—22
Concord, N. H	—35	Baltimore, Md	—10
Dartmouth College, N. H	—32	Washington, D. C	—16
Boston, Mass	—15	Alexandria, Va	—16
Salem, Mass	—17		

January 5, 1835.

	°		°
Hartford, Conn	—27	Philadelphia, Pa	— 6
New Haven, Conn	—23	Hagerstown, Md	—12
Providence, R. I	—26		

February 8, 1835.

	°		°
Chicago, Ill	- 22	Richmond, Va	— 6
St. Louis, Mo., (Dr. Engleman)	- 25.4	Norfolk, Va	4
Cincinnati, Ohio	—18	Fayetteville, N. C	— 1
Evansville, Ind	—18	Greenville, S. C	—11
Lexington, Ky	—20	Charleston, S. C	2
Nashville, Tenn	—10	Savannah, Ga	3
Greenville, Tenn	—12	Athens, Ga	—10.5
Huntsville, Ala	— 9	Clarksville, Ga	—15
Natchez, Miss	0	Milledgeville, Ga	— 9
Baton Rouge, La	10	Augusta, Ga	— 2
Jacksonville, Fla	8		

1838.—In February another characteristic depression of temperature occurred, the mean of the month being 15° below the average at Fort Gibson, Ind. T., 6° below at St. Augustine, Fla., 8° below at Norfolk, Va., and 7° below at New York, N. Y.

1843.—A general and characteristic depression of temperature that, as in many other cases, was severest in the South. In Georgia it was considered second only to that of 1855; there was snow in Mississippi and ice in abundance at New Orleans. December was the coldest month and the mean was 6° to 10° below the average over the entire coast of the Gulf. It was relatively most severe at points on the coast of Texas.

1847.—A cold extreme occurred along and west of the Mississippi, but not in the east.

1849.—January and February were quite generally below the average by from 5° to 10°, though this extreme disappeared at the Gulf coast.

1851-52.—The winter was 3° to 8° below the average for each month in the Eastern States, but was warmer than usual in the West. In the Central and Southeastern States January was 6° to 10° below the average, with severe effects on the subtropical vegetation. The following are some of the observations reported: St. Louis, —14°; New Orleans, 17°; Pensacola, 10°; Key West, 49°; Charleston, 14°; Norfolk, 7°; Washington, —7°; New York, —8°; Salem, —14°; Marietta, —23°. The Susquehanna River was frozen over at Havre de Grace for seven weeks, and the Potomac at Washington for three weeks; snow fell at New Orleans and remained several days; snow fell at Charleston and Jacksonville through the entire day of January 13; orange trees were killed at Charleston and thick ice was formed for several days from January 13 to 20. The East River at New York was closed, and crossed on the ice from January 20 to 24.

1854.—Cold was more general and extended over the interior of the Pacific coast. At Fort Snelling and in the Northwest the thermometer fell below the congealing point of mercury. The following are some of the temperatures reported: Great Salt Lake, Utah, —14°; Fort Dalles, Oreg., —15°; Fort Defiance, N. Mex., —20°; Santa Fe, N. Mex., —6°; San Francisco, Cal., 27°; San Diego, Cal., 31°.

1856.—In the first three months of 1856 a still more severe degree of refrigeration occurred, which was central to the middle latitudes of the United States, disappearing at the north at about the forty-sixth parallel. This was a reproduction of the winter of 1780 more nearly than any other, both in degree and in position. The district of the Great Lakes was but little affected and the line of greatest severity was at the thirty-fifth to the thirty-eighth parallels. The following citations will show the measure of depression: Washington, January 10, —10°; Philadelphia, January 10, —7°; Pittsburg, January 9, —18°; St. Louis, January 9, —18°; Chicago, January 10, —30°; Fort Snelling, January 9, —26; Fort Gibson, January 29, —15°.

The severity of the cold continued nearly three months, and in both the months following the dates given the extremes of temperature fell nearly as low as those cited. Snow remained in large quantities at Washington from the first of January to the middle of March; ice covered the Potomac for the same period; Chesapeake Bay at Annapolis was closed from January 8 to March 14; the harbors at Baltimore and Philadelphia were closed until late in March; Long Island Sound was closed to navigation from January 25 to February 27; and the harbor of New York was much obstructed by ice, which several times made temporary communication across the East River. The western rivers were equally obstructed by ice, and it formed in the Mississippi as low as Vicksburg, floating in vast quantities below Natchez. At all points in Louisiana ice formed for weeks and some places had heavy falls of snow. It was the same through all the States bordering on the Gulf; and in lower Texas December gave the greatest depression.

The winter of 1855–56 was one of the coldest on record over the eastern half of the United States. In a compilation by Mr. Wm. B. Stockman, Chief of the Division of Meteorological Records, Weather Bureau, of temperature data for the months of December, January, and February, at a number of selected stations, published in the Monthly Weather Review for May, 1904, it appears that for the period 1854–55 to 1903–4, inclusive, the winters of 1855–56 and 1903–4 had the lowest mean temperatures for 50 years generally from the Mississippi and lower Missouri valleys to the Atlantic coast, the former being the coldest in Washington, D. C., Charleston, S. C. (equaled in 1901–2), Cincinnati, Ohio, Chicago, Ill., St. Louis, Mo., and Fort Leavenworth, Kans., and next to the coldest at Cleveland, Ohio, and New Orleans, La.; and the latter the coldest for the period named at New Bedford, Mass., and Cleveland, Ohio, and next to the coldest at Washington, D. C. (equaled in 1767–68), Charleston, S. C., Cincinnati, Ohio, and Chicago, Ill.

1857.—In January one of the severest cold spells known for the month of January developed in the middle latitudes of the United States east of the Rocky Mountains.

The following information regarding cold periods has been obtained from various sources, and mostly from the Monthly Weather Review:

1864.—January opened with a cold wave of exceptional severity over the interior of the country, from Canada to the Gulf of Mexico, and at many points in the central valleys the lowest absolute temperature on record occurred on the 1st. The following are some of the lowest readings reported: Fort Laramie, Wyo., —40°; Salt Lake City, Utah, —8°; Chicago, Ill., —25°; Milwaukee, Wis., —30°; Dubuque, Iowa, —29°; Peoria, Ill., —22°; St. Louis, Mo., —20°; O'Fallan, Mo., —23°; Cincinnati, Ohio, —5°.

1866.—In January very low temperatures were experienced in the eastern part of the country, and on the 8th, minimum readings 9° to 20° below zero were observed in the Middle Atlantic and New England States, and readings ranged to —6° in the Ohio Valley. February was also cold in the Middle-eastern and Northeastern States.

1867–68.—January was very cold in the Mississippi Valley, and ice was unusually heavy in the middle and upper Mississippi River. The winter of 1867–68 was severe over the northern part of the country east of the Rocky Mountains. In December a minimum of —10° was reported at Wytheville, Va., and a reading of —30° was reported at Lunenburg, Vt. January was very cold in the northwest, where, at St. Paul, Minn., a minimum of —39° was observed. Freezing weather continued in the Middle-eastern and Northeastern States until the middle of April.

1872–73.—A cold winter over the northern part of the country. In December the following minimum temperatures were observed: Chicago, Ill., —23°; Peoria, Ill., —22°; Lunenburg, Vt., —45°. In January a minimum of —53° was reported at Fort Ellis, Mont., and in the interior of New York, the minimum readings ranged from —12° to —22°. The following are among the minimum tempera-

tures reported in January: Fort Garland, Colo., —40°; Fort Brady, Mich., —47°; Leavenworth, Kans., —29°; New Ulm, Tex., 10°; Logansport, Ind., —30°; Woodstock, Vt., —38°; New Haven, Conn., —14°. In the Southern States the month was exceptionally cold. In the early part of February heavy snow and temperature far below zero was experienced in the Northwest, and from February 21 to 24, heavy snow fell from Kansas and Missouri northeastward to Canada. From April 13 to 16 a violent gale, with low temperature and blinding snow, caused a great loss of live stock in the Dakotas.

1874.—February 24 was a very cold day in the Rocky Mountain region and minimum temperatures ranged from —24° at Cheyenne, Wyo., to 0° at Santa Fe, N. Mex.

1874–75.—December was very cold in New Mexico, with heavy snow in the Rio Grande Valley as far south as the northern boundary of Mexico. East of the Rocky Mountains many observers mentioned January, 1875, as the coldest month in many years. The following are among the minimum temperatures reported on the 9th of that month: Denver, Colo., —29°; Cheyenne, Wyo., —38°; Embarras, Wis., —40°; St. Paul, Minn., —30°; Omaha, Nebr., —19°; Chicago, Ill., —20°; St. Louis, Mo., —15°; Louisville, Ky., —6; Cincinnati, Ohio, —10°; Erie, Pa., —16°; and the following were observed on the 10th: Pittsburg, Pa., —12°; New York, N. Y., —6°; Barnegat, N. J., —10°; Washington, D. C., —3°. February was noted as the coldest February on record at points in the lower Ohio and upper Mississippi valleys, and the ice blockades on the New England and middle Atlantic coasts were the most formidable since 1780.

1876, March 19 to 22.—Destructive frosts in the Gulf States, and many orange and fruit trees destroyed in northern Florida.

1876–77.—The December mean temperature was 2° to 8° below the average east of the one hundreth meridian, and during the early part of the month a severe cold wave swept over the Southern States, attended by the following minimum temperatures: Galveston, Tex., 26°; Cincinnati, Ohio, —10°; New Orleans, La., 28°; Jacksonville, Fla., 24°. A report from Puntarasa, Fla., states that snow fell, and that fish were killed by cold. The first days of January were cold in the central and southern districts, and on the 9th a minimum of —26° was recorded at Shelbyville, Ind.

1878–79.—December was cold in the middle Rocky Mountain region. Very low temperatures prevailed from the Ohio Valley over the middle and east Gulf States and Florida in the first decade of January. On January 3 the minimum at Cincinnati, Ohio, was —16°, and ice formed during the period named on the middle Gulf coast and in northern Florida. From January 30 to February 1, thousands of cattle perished in a snowstorm in Nebraska.

1880–81.—The winter was unusually long and severe east of the Rocky Mountains. In November on the 9th, temperatures far below zero were experienced in the Ohio Valley, a minimum of —12° being reported at Cincinnati. "For 153 days, from November 22, 1880, to April 23, 1881, the average temperature at New Brunswick, N. J., was 29.3°, this being the average for the three winter months." (Smith.) At Freehold, N. J., 75 inches of snow were reported for the winter. In December frost was unusually frequent and severe in the Gulf States, injuring vegetation in Texas to the mouth of the Rio Grande River and in Florida nearly to Puntarasa. The December minimum was —10° at Wytheville, Va., and —5° at Lynchburg, Va., and at Charlotte, N. C. In January, 1881, the greatest departures below the normal temperature occurred from Texas northward to British America and northeastward over the Lake region, where the deficiency was 6.5° to 9°. In the northern and eastern districts it was the coldest month observed by the Weather Bureau, except that of 1875, and in the Southern States the only years of lower January temperatures were 1872 and 1873. At Washington, D. C., it was the coldest January on record, with an absolute minimum of —14°. February was also cold, especially in the Atlantic States, and from the 9th to the 14th the weather was cold in southern California and thence over Texas, and a great loss of stock was caused in Dakota, Nebraska, and Kansas by low temperature and heavy snow. From March 2 to 4 the severest cold wave and snowstorm experienced in many years visited Illinois, Indiana, Iowa, Wisconsin, and Michigan. For several days

railroad traffic was generally suspended in the States named, owing to drifted snow. An almost similar storm was experienced in that group of States on the 19th, 20th, 29th, and 30th of March.

1882.—From January 10 to 13 the weather was very cold in California; Fresno had a minimum of 21°, and at Los Angeles ice formed and the surrounding hills were covered with snow. On the 2d and 5th ice formed at Jacksonville, Fla. On the 24th the temperature was 10° to 37° below zero in New England, and on the 25th was 16° to 20° below in eastern and northern New York. A cold wave visited the Southwest February 18 to 20.

1882–83.—A cold winter generally. From December 16 to 17 a cold wave visited the Southern States, with killing frost as far south as central Florida. In January, 1883, the temperature was 7.9° to 11.5° below normal in the upper Lake region, upper Mississippi and Missouri valleys, and the extreme Northwest. The weather was especially cold in the above districts from the 18th to the 25th and considerable loss of live stock was reported. The following are minimum temperatures reported for this period: Bainbridge Island, Wash., 12°; Eagle Rock, Idaho, —38°; Salt Lake City, Utah, —20°; Elko, Nev., —54°; Denver, Colo., —20°; Santa Fe, N. Mex., —13°; Marshall Pass, Colo., —30°; Gunnison, Colo., —40°; Buffalo, Tex., 16°; Fort Worth, Tex., 12°; Leavenworth, Kans., —20°; Cresco, Iowa, —34°; Peoria, Ill., —22°. In the Red River of the North Valley the readings were 30° to 40° below zero, and in North Dakota and northern Minnesota 30° below zero. February was cold west of the Mississippi, and in the Rocky Mountain and northern Plateau regions the mean temperature was 8° to 16° below normal. On the 4th a minimum temperature of —3° was observed at Dallas, Tex.

1884.—From January 4 to 7 a cold wave of unusual intensity advanced from the British Northwest Territory to the Atlantic and Gulf coasts. On the 4th the temperature was 40° below zero in northeastern Montana, North Dakota, and northern Minnesota. On the 5th the following representative low temperatures were observed: St. Louis, Mo., —21.5°; Chicago, Ill., —18.5°; Cincinnati, Ohio, —20°; Louisville, Ky., —18°; Olney, Ill., —30°; Cairo, Ill., —16°. On the 6th the minimum at Knoxville, Tenn., was —16°; Nashville, Tenn., —10°; Atlanta, Ga., —1.3°; Montgomery, Ala., 8°; Mobile, Ala., 14°; Jacksonville, Fla., 21°. From the 24th to 26th the temperature was unusually low in New England. February was cold in the Missouri Valley, the West, and Northwest, and at Las Animas, Colo., a minimum of —22.7° was observed on the 14th.

1884–85.—December temperatures were 10° to 23° below normal in the Northwest, with heavy snow. The month was cold in New England, where readings of —21° and —9° were reported at Eastport, Me., and Narragansett Pier, R. I., respectively. January was decidedly cold from the Ohio Valley and lower Lake region westward over the eastern parts of Montana, Wyoming, and Colorado. On the 1st the lowest temperature on record for the United States, —63.1°, was observed at Poplar River, Mont.; at West Las Animas, in southeastern Colorado, —25.9°, and at St. Paul, Minn., —35.6°, were registered on the 1st, and —41.2° at Duluth, Minn., on the 2d. From the 22d to the 28th extremely low temperatures occurred in the upper Mississippi Valley and the western Lake region, and on the 22d a reading of —50° was observed on Mount Washington, N. H. February was cold east of the Rocky Mountains; in the central valleys and Lake region the mean temperature was 10° to 15° below normal, and in the central Mississippi and Ohio valleys and on the Atlantic coast south of New England it was the coldest February shown by previous Weather Bureau records. On the 11th Milwaukee, Wis., had a minimum of —23.6°, Chicago, Ill., —13.7°, and Buffalo, N. Y., —12.6°.

1886.—From January 6 to 12 a cold wave swept the country east of the Rocky Mountains, with a great loss of life and stock in the western districts and produced the lowest temperatures noted for many years in the Southern States, where there were heavy losses to agricultural and fruit growing interests. In Florida, alone, the estimated damage to crops was $3,000,000. The following are some of the temperatures that attended the cold wave: January 7, Dodge, Kans., —10.1°; 8th, Palestine, Tex., 0°, Galveston, Tex., 11°, Shreveport, La., 1.3°; 9th, Memphis, Tenn., —8°, New Orleans, La., 15.2°, Mobile, Ala., 11°; 11th, Atlanta, Ga., —2.4°; 12th, Jacksonville, Fla., 15.3°,

Savannah, Ga., 12°. Records show that in the Southeastern States this was the coldest period since 1835. From February 3 to 5 the lowest February temperatures on record were observed in the Ohio Valley and Tennessee and the Atlantic and Gulf States.

1887.—February showed means 10° to 20° below normal in the Northwest and on the night of the 3d–4th a minimum of —55.4° was recorded at Fort Assinniboine, Mont. Many cattle were frozen to death during that cold period.

1888.—The second decade of January was cold over the entire country, and on the Pacific coast and in the Plateau and northern districts temperatures were the lowest on record. In California killing frosts occurred and ice formed as far south as San Diego from the 6th to 12th. During the 11th and 12th the cold wave extended over the western and northwestern States and over Texas on the 14th and 15th. The following are some of the low temperatures reported for this month: San Diego, Cal., 33°; Los Angeles, Cal., 30.9°; Fort Bidwell, Cal., —25.5°; Fort Klamath, Oreg., —39°; Spokane, Wash., —30.2°; Fort Buford, N. Dak., —49.2°; Winnemucca, Nev., —28°; North Platte, Nebr., —34.6°; St. Vincent, Minn., —53.5°; La Crosse, Wis., —42°; Fort Elliott, Tex., —14.2°.

The following is a summary of the more important cold waves exhibited by the charts:

COLD WAVES IN THE SOUTHEASTERN STATES.

Charts No.	Dates.	Details of temperature.
1 to 4.....	Dec. 18 to 21, 1888.	First killing frost with ice formation at New Orleans, La., 20th. Freezing and killing frost in northern Florida, 21st, Jacksonville, 28°; Titusville and Cedar Keys, 32°.
33 to 36....	Dec. 24 to 27, 1892..	Exceptionally cold in Gulf States from 26th to 29th. Ice ¾ inch in thickness formed at Corpus Christi, Tex.; sugar cane frozen and orange trees nipped in Louisiana; temperature fell to 28° and remained below freezing 7 hours at Delano, Fla., on the 29th.
49 to 52....	Dec. 26 to 29, 1894..	Severe cold wave and freeze in the Gulf States. Temperatures on the 29th: Mobile, 16°; Jacksonville, 14°; Tampa, 19°; Jupiter, 24°, and Key West, 44°.
89 to 92....	Dec. 18 to 21, 1901..	Severe cold wave. Temperature 19.5° at Jacksonville on the 21st.
113 to 116..	Jan. 14 to 17, 1893..	Cold wave in east Gulf and South Atlantic States. In Florida fruit was damaged in the vicinity of Jupiter, and on the 17th frost was reported as far south as the southern extremity of the "Everglades."
141 to 144..	Jan. 1 to 4, 1898....	Severe cold in Florida on the 2d, 3d, and 4th, freezing temperature on the 2d and 3d, and heavy frost on the 4th, extending as far south as the latitude of Jupiter. On the 2d, minimum temperature 24° at Jacksonville, 28° at Tampa, and 30° at Jupiter; on the 3d, minimum temperature 26° at Jacksonville and Tampa and 30° at Jupiter; on the 4th, minimum temperature 38° at Jacksonville and Tampa and 34° at Jupiter.
153 to 157..	Jan. 1 to 4, 1900....	Cold wave in east Gulf States and Florida on the 2d and 3d. On the morning of the 3d temperature 22° at Jacksonville and 28° at Tampa, and light frost as far south as Jupiter.
157 to 160..	Jan. 27 to 30, 1900..	Low temperature in Gulf and South Atlantic States. Freezing as far south as Tampa on the morning of the 30th.
173 to 176..	Feb. 25 to 28, 1890..	A cold wave of unusual severity for the season in the Gulf States on the 27th and 28th. Early vegetation, crops, and fruit blossoms greatly damaged as far south as the Gulf coast.
177 to 180..	Feb. 24 to 27, 1891..	Early vegetables and fruit in the Gulf and South Atlantic States injured by cold on the 26th and 27th.
193 to 196..	Feb. 5 to 8, 1895 ...	Severe cold wave from the Rocky Mountains to the Atlantic and Gulf coasts. The 8th, with a minimum of 14° at Jacksonville, was the coldest day experienced at that station during the period of Weather Bureau observations, and the temperature was below freezing at all stations in the State except Key West. More snow

COLD WAVES IN THE SOUTHEASTERN STATES—*Continued.*

Charts No.	Dates.	Details of temperature.
193 to 196..	Feb. 5 to 8, 1895—Continued.	fell in Florida during February than in any month since the establishment of Weather Bureau stations. On the 14th snow fell at Tampa, and was reported deep enough for sleighing at Pensacola. The month was the severest February on record in the middle and east Gulf, Middle and South Atlantic States, and Ohio Valley. Within a week after the cold wave here noted snow lay from a depth of a few inches at the Mississippi jetties to a depth of two feet in southwest Louisiana. Average temperature the lowest on record for February over a greater portion of the Gulf and South Atlantic States.
197 to 200..	Feb. 1 to 4, 1898 ...	Severe cold wave in Florida on the 2d, 3d, and 4th, with frost on the 2d as far south as Jupiter. The following minimum temperatures were reported from Jacksonville, Tampa, and Jupiter, respectively: February 2, 26°, 31°, 40°; February 3, 32°, 38°, 50; February 4, 34°, 34°, 52°.
201 to 204..	Feb. 10 to 13, 1899..	During the first half of the month the most remarkable cold wave or series of cold waves, in the history of the Weather Bureau, traversed the United States from the north Pacific to the south Atlantic coasts, damaging crops and fruit in the Southern States to the extent of millions of dollars. On the 13th, the lowest temperatures on record for that section occurred from the southern Rocky Mountain slope to the south Atlantic coast, accompanied by zero temperature to the Gulf coast of Alabama, and by a snowstorm of unprecedented severity in the Middle Atlantic States. At the following-named stations the minimum temperature on the 13th was the lowest on record:

	°		°		°
Concordia	—26	San Antonio	4	Vicksburg	zero
Dodge	—24	Galveston	6	New Orleans	7
Wichita	—22	Springfield, Mo.	—28	Mobile	— 1
Oklahoma	—18	Little Rock	—12	Montgomery	— 4
Amarillo	—16	Nashville	—12	Atlanta	— 6
Abilene	— 6	Chattanooga	—10	Savannah	8
Palestine	— 4	Shreveport	— 4	Jacksonville	10

		At Havana, Cuba, the temperature fell to 54° during the evening of the 13th. At Washington, a minimum of —15° was reported on the 11th. The snow attending this cold wave was particularly heavy in the Potomac Valley and Chesapeake region, and at Washington, the aggregate depth was three feet, and huge drifts formed.
213 to 216..	Feb. 22 to 25, 1901..	Cold wave in the Southern States 24th and 25th, with freezing temperature as far south as Tampa.
225 to 228..	Mar. 14 to 17, 1890..	On the 16th and 17th a cold wave swept the Southern and Southeastern States, and on the 17th thousands of young orange trees at Homeland, Fla., were killed by freezing weather, and heavy frost did much damage at Jupiter and Manitee.
229 to 232..	Mar. 9 to 12, 1892..	On the 11th and 12th, cold and frost injured vegetation in the Gulf and South Atlantic States.
233 to 236..	Mar. 16 to 19, 1892.	From the 17th to 19th low temperature and frost seriously injured crops and early vegetation from the southeastern slope of the Rocky Mountains over the Gulf and South Atlantic States and the northern half of the Florida Peninsula.
237 to 240..	Mar. 1 to 4, 1893 ...	A cold wave overspread the central valleys and the Southern States during the 3d and 4th, carrying the line of freezing temperature to the immediate Gulf coast and over the northern part of the Florida Peninsula, and causing the lowest temperature on record for March in the South Atlantic States, Tennessee, and Arkansas.
241 to 244..	Mar. 12 to 15, 1893..	A severe cold wave advanced from the Rocky Mountains to the Atlantic coast from the 12th to the 15th, attended by freezing weather in northern parts of the east Gulf States.
257 to 260..	Mar. 4 to 7, 1899...	A cold wave crossed the country east of the Rocky Mountains from the 4th to the 7th, causing frost and freezing temperature in the Gulf and South Atlantic States on the 6th and 7th.

GENERAL COLD WAVES EAST OF THE ROCKY MOUNTAINS.

Charts No.	Dates.	Details of temperature.
69 to 72....	Dec. 11 to 14, 1898..	A well-marked cold wave appeared over the upper Missouri Valley on the 12th, extended over the States of the upper Mississippi Valley and the western Lake region during the 13th, carrying the line of zero temperature to southern Iowa, and reached the Atlantic and Gulf coasts on the 14th, with a minimum temperature of 30° at New Orleans, 28° at Mobile, 30° at Savannah, and 38° at Jacksonville.
73 to 76 ...	Dec. 28 to 31, 1898..	A second wide spread cold wave extended over the northern Rocky Mountain region and the upper Mississippi Valley on the night of the 28th, and reached the Atlantic and Gulf States on the 31st, with zero temperatures to the southern line of Kansas and freezing weather almost to the Gulf coast.
77 to 80 ...	Dec. 2 to 5, 1899 ...	A cold wave advanced from the northwest to the Atlantic and Southern States from the 3d to the 5th. The temperature fell to 20° in the Middle Atlantic States and heavy frost occurred to the south Atlantic and Gulf coast on the 4th.
109 to 112..	Jan. 16 to 19, 1892..	A severe cold wave appeared in the Northwest on the 16th, and reached the Atlantic coast the night of the 19–20th. Attending this cold wave the temperature fell 40° to 50° below zero in eastern Montana and North Dakota, and the line of zero temperature extended to northern Texas. Cold weather caused loss of stock on the ranges from Kansas to Texas and vegetation on the west Gulf coast was killed by frost.
121 to 124..	Jan. 23 to 26, 1894..	A severe cold wave advanced from the Northwest over the central valleys and the Gulf States from the 23d to 26th, attended by heavy snow in the central, Middlewest, and Northwest States, by extreme cold, sleet, and snow in the Southwest, and by a destructive freeze in the Middle Gulf States.
181 to 184..	Feb. 13 to 17, 1892..	An important cold wave appeared in the Northwest on the 13th and reached the Atlantic coast during the night of the 15–16th. On the 15th the temperature fell 20° to 30° from the lower Mississippi Valley over the Lake region, was below zero in northern Missouri and northern Illinois, and the line of freezing temperature extended from central Texas to Virginia. In the north-central districts the lowest temperatures of the month occurred, the minimum being 20° to 30° below zero in North Dakota and Minnesota.
209 to 212..	Feb. 15 to 18, 1900..	During the 12th and 13th a cold wave advanced over the West and Northwest States, carrying the line of freezing temperature to central Texas, and causing heavy snow in the Western States and the Lake region. On the 14th this cold wave was supplemented by marked fall in temperature in the extreme Northwest, and from that date until the 18th the crest of this unusually severe cold wave moved southward and eastward to the Atlantic and Gulf coasts, attended on the 16th and 17th by heavy snow in the Middle Atlantic and south New England States, and on the 17th by heavy snow and gales in the North Atlantic States. On the 16th the temperature fell to 24° at Mobile; to 26° at New Orleans and Galveston; and to 30° at Corpus Christi; the line of zero temperature was traced to southern Illinois, southern Missouri, and southern Kansas. At New Orleans the coldest weather of the winter prevailed from the 16th to 19th. By the morning of the 18th the temperature had fallen to 18° at Jacksonville; to 28° at Tampa; and to 38° at Jupiter.
245 to 248..	Mar. 24 to 27, 1894..	After a period of extremely warm weather a cold wave of exceptional severity for the season swept the country east of the Rocky Mountains from the 22d to the 28th. Zero temperatures were noted in the Northwest, the line of freezing weather reached almost to the Gulf coast line, and crops and fruits were damaged by cold and frost as far south as the western and northern counties of Florida. The cold wave was very destructive to tender plant life throughout all districts east of the Rocky Mountains.
265 to 268..	Mar. 14 to 17, 1902..	A severe cold wave and snowstorm extended from the middle and northern Rocky Mountain districts on the 14th to the Atlantic coast by the 17th, with intense cold for the season from the middle Rocky Mountain districts over the States of the upper Missouri Valley.

A COLD WAVE OF THE MIDDLE-EASTERN AND NORTHEASTERN STATES.

Charts No.	Dates.	Details of temperature.
217 to 220..	Mar. 10 to 13, 1888..	From the 10th to the 13th a remarkable cold wave and snowstorm visited the Atlantic coast States from Virginia to New England. This was one of the most severe wind and snowstorms that has ever occurred in the eastern part of the United States. Aside from immense losses to shipping by gales, the following notes regarding snowfall and temperature are of interest and importance: In New York City snow drifted at some points to depths of 15 to 20 feet on the 12th, and the temperature fell to 4.8° on the 13th. In the Hudson Valley and over a great part of Connecticut snow fell to depths of three to four feet, drifted badly, and practically paralyzed traffic.
COLD WAVES OF THE MIDDLE-WESTERN AND NORTHWESTERN STATES.		
149 to 152..	Jan. 26 to 29, 1899..	Following the passage of an energetic storm from the British Northwest Territory to the St. Lawrence Valley from the 24th to the 26th, a severe cold wave overspread the upper Missouri Valley the night of the 27th, and by the morning of the 28th the temperature was 22° to 26° below zero in North Dakota, and by the morning of the 29th the line of zero temperature was traced to southern Missouri and southern Kansas. During the 29th, 30th, and 31st a cold wave advanced from the northern Rocky Mountain region to the west Gulf and Middle Atlantic States, carrying zero temperatures to southern Kansas and freezing weather to west-central Texas on the 30th, and zero temperatures to Oklahoma and northwestern Texas by the morning of the 31st.
165 to 168..	Jan. 24 to 27, 1902..	A cold wave appeared over the extreme northwest British Territory on the morning of the 23d, extended over the middle and northern Rocky Mountain districts by the morning of the 24th, and was reinforced during the 25th by intense cold which attended the advance over the Middle West and Northwest of an extensive area of high barometer, by the 26th the line of freezing temperature extended into the interior of southern California, to extreme southern New Mexico, and to central Texas. On the morning of the 27th freezing temperature was reported to the Texas coast, the zero line reached northwestern Texas, and thermometer readings were 20° to 30° below zero in the States of the middle and upper Missouri and Red River of the North valleys. The advance of this cold wave to the south Atlantic coast was interrupted by an area of low barometer that advanced from the western part of the Gulf of Mexico northeastward during the last three days of the month.
249 to 252..	Mar. 20 to 23, 1898..	Severe cold waves in the West and Northwest from the 20th to the 23d and from the 24th to the 28th were attended by high winds and snow. The storm and cold wave was exceptionally severe in Montana, and at Great Falls was described as follows: "The severe blizzard which raged here on the 23d and 24th was certainly the worst ever experienced during the writer's life in Montana. The temperature fell 42° in 36 minutes. Great herds of cattle could be heard lowing and moaning above the roar of the tempest. The drift was so furious that a few crevices no longer than a pencil in the side of a building were sufficient to fill the structure with snow from floor to ridge."
PACIFIC COAST AND SOUTHWESTERN STATES.		
17 to 24....	Dec. 23 to 30, 1891..	A cold wave appeared on the north Pacific coast on the 24th and swept thence eastward and southward. The temperature fell below freezing on the Pacific slope, except at points along the immediate coast, the zero line reached central New Mexico, and freezing weather was experienced along the Gulf coast and in northern Florida. The minimum temperatures attending this cold wave were lower than previously recorded for December over the southwestern districts, and tender vegetation, oranges, and nursery stock were injured in southern California and Arizona. Ice half an inch thick formed in shallow pools about San Diego, and in Mission Valley ice formed one inch thick and oranges were frozen. At Peoria, Ariz., young orange trees were badly frozen.
57 to 60.... 61 to 68....	Dec. 1 to 4, 1897.. Dec. 15 to 22, 1897	Frosts and freezing weather in the citrus fruit districts of California on the 2d and 3d, and 16th to 22d, inclusive. On the 2d and 3d the temperature fell below freezing as far south as Los Angeles and Riverside counties, and on the 17th a temperature of 26° was recorded at Riverside.

PACIFIC COAST AND SOUTHWESTERN STATES—*Continued.*

Charts No.	Dates.	Details of temperature.
81 to 84....	Dec. 28 to 31, 1900..	Cold wave extended from the British Northwest Territory over interior and western parts of the country during the last three days of the month, causing frost in the valleys of southern California, and in Arizona, and carrying the line of freezing temperature into northern New Mexico.
85 to 88..	Dec. 11 to 14, 1901..	A cold wave of remarkable persistency and exceptional severity covered practically the entire United States during the second decade of the month. The cold wave extended over the Plateau and Pacific coast districts during the 12th, 13th, and 14th, carrying the line of freezing temperature to extreme southern Arizona and the interior of extreme southern California by the morning of the 14th.
117 to 120..	Jan. 4 to 7, 1894....	The first part of the month was remarkably cold in California; the minimum temperatures generally occurred on the 6th, but a few on the 5th and 7th.
145 to 148..	Jan. 24 to 27, 1898..	Frosts and freezing temperatures in the citrus regions of California, the most generally severe conditions occurring on the morning of the 27th.
161 to 164..	Jan. 6 to 9, 1901....	On the 9th, frost occurred generally throughout southern California, and at some points, ice formed.
221 to 224..	Mar. 10 to 12, 1890..	On the morning of the 12th heavy frost injured fruit in the valley of the Gila River.

SPRING FROSTS AND COLD WAVES.

269 to 272..	Apr. 18 to 21, 1890..	Fruit and tender vegetation injured by frost in Atlantic coast States from New Jersey to Virginia on the 19th and 20th, and to South Carolina on the 21st.
273 to 276..	Apr. 2 to 5, 1891....	Killing frost injured fruit and tender vegetation in the Gulf and South Atlantic States and in Florida as far south as Jupiter Inlet and Lee County from the 3d to the 7th. Over the Florida Peninsula the coldest weather ever experienced for the season prevailed on the 7th. The following minimum temperatures were observed in Florida and in the Gulf and South Atlantic States: Jacksonville, 34°; Key West, 54°; Pensacola, 34°; Mobile, 32°; Charlotte, 26°.
277 to 280..	Apr. 5 to 8, 1898....	Heavy frost occurred on the mornings of the 6th to 9th in the South Atlantic and Gulf States, with light frost on the 8th at Jacksonville.
281 to 284..	Apr. 6 to 9, 1899....	Heavy frost extended from the west Gulf States on the 7th over the middle and east Gulf and South Atlantic States on the 9th and 10th.
285 to 288..	May 18 to 21, 1894..	From the 19th to the 21st the temperature was very low for the season from the Missouri Valley to the Atlantic coast, and snow fell in eastern Kentucky, eastern Tennessee, southwestern Virginia, and in the mountains of North Carolina. Serious damage was caused in the central valleys and the Middle Atlantic States, and the growth of crops was checked in the Southern States and Florida.
289 to 292..	May 11 to 14, 1895	Heavy frost killed early vegetation and fruits in northwestern Pennsylvania and western New York from the 12th to the 14th and from the 19th to the 21st.
293 to 296..	May 18 to 21, 1895	
297 to 300..	May 2 to 5, 1900....	Heavy frost in the western Lake region on the 3d and in the Ohio Valley, Tennessee, and western and northern New York on the 4th; ice formed in northern Ohio and the Lake region and thence eastward over the interior of the Middle and North Atlantic States. On the 10th heavy damage to fruit and berries in Wisconsin and northern Indiana.
301 to 304..	May 29 to June 1, 1889.	On June 1 damaging frost occurred in the interior of the South Atlantic and east Gulf States, with the lowest temperature on record for June.

SUMMER FROSTS.

The occurrence in summer of frost in mountain regions and extreme northern districts is too common to justify detailed comment. Two instances of summer frosts in agricultural districts are, however, illustrated:

Charts No.	Dates.	Details of temperature.
305 to 308..	Aug. 20 to 23, 1890.	From the 22d to the 24th a frost-bearing cool wave advanced from the Dakotas over the Lake region and the interior, or mountain districts, of the Middle Atlantic States.
309 to 312..	Aug. 28 to 31, 1892.	A cool wave advanced from the Rocky Mountain and Plateau regions, with frost, from New Mexico over the Dakotas, Iowa, Minnesota, northern Wisconsin, and northern Michigan.

FROSTS AND COLD WAVES OF THE AUTUMN MONTHS.

313 to 316..	Sept. 17 to 20, 1901.	The first general frost-bearing cold wave of the season swept from the northeastern Rocky Mountain slope southward to Arkansas and Tennessee and eastward to the North Atlantic States from the 17th to the 20th.
317 to 320..	Oct. 18 to 21, 1891..	Heavy frost in the interior of the west Gulf States from the 19th to the 23d, light frost in the northern portion of the Florida Peninsula from the 20th to the 24th, and as far south as Pasadena on the 24th.
321 to 324..	Nov. 15 to 18, 1891..	A well-defined general cold wave advanced from the Pacific to the Atlantic coast from the 16th to the 18th, with heavy frost to the middle and east Gulf coasts and northern Florida.
325 to 328..	Nov. 19 to 22, 1898..	A severe cold wave for the season swept from Montana on the 19th over the upper Missouri Valley on the 20th, with temperature below zero in Montana, carried the line of freezing temperature, with snow and high northerly winds, as far south as Oklahoma on the 21st, and reached the Lake region, Ohio Valley, and the middle and west Gulf States, with freezing temperature as far south as San Antonio, on the 22d. By the morning of the 23d the cold wave had reached the Alleghany Mountains, and freezing weather was reported at Mobile, and on the 24th the minimum temperature at New Orleans and Mobile was 34° and 30°, respectively. The temperature continued low over the eastern part of the country during the latter part of the month.

While the winter of 1903–4 was one of the coldest on record from the Mississippi and lower Missouri valleys to the Atlantic coast, and in parts of the region east of the Mississippi the average temperature was the lowest since 1855–56, the low average temperature was due to persistent and uniformly cold weather and not to extreme temperature bearing cold waves, and its severity was, therefore, more real than apparent. In this respect it differed from the succeeding winter during which the entire country was subjected to marked and varied meteorological experiences.

The winter of 1904–5 set in early and continued late, and was progressive in severity. It was exceptionally cold east of the Rocky Mountains, and at points in the central valleys and the Atlantic districts was the coldest winter experienced during the last half century. In December, 1904, the average temperature was 6° to 9° below the normal in Pennsylvania, New York, and New England, and the period from the 25th to 30th showed over the greater part of the country, the lowest temperatures of the month. During this period a widespread cold wave advanced from the British Northwest Territory over the Rocky Mountains and western plains to Texas, and thence eastward to the Atlantic coast. In the Missouri and upper Mississippi valleys the cold wave was attended by heavy snow and westerly gales. In January, 1905, the greatest depression of temperature covered the interior river valleys east of the Rocky Mountains, where the monthly average was more than 6°

below normal. Several cold waves traversed the interior and eastern portions of the United States, the most severe being that of the 24th to 27th, which caused great damage to vegetables and citrus fruits, pineapples, and strawberries in Florida, and at Jupiter was attended by a temperature of 24° that equalled the lowest previous record at that place.

On January 10th and 11th one of the most widespread and severe snowstorms on record visited the United States. In fifteen States and Territories snow covered the ground to a depth of 6 to 30 inches. In the Southwest the snow varied in depth from 1 foot in northern Texas to 2 feet in Arkansas, and a heavy fall of snow occurred in New Mexico and Arizona.

February, 1905, showed remarkable and, at some points, unprecedented departures from the normal temperature from the Rocky Mountain region to the Atlantic coast, and in some parts of the Mississippi and Ohio valleys and the Southwest, the departures below the monthly averages exceeded 12°. The lowest temperatures of the month occurred generally from the 11th to the 14th. The following are among the minimum temperatures that attended the cold wave of the dates named: St. Paul, Minn., —26°; Chicago, Ill., —18°; Kansas City, Mo., —22°; Pueblo, Colo., —26°; Santa Fe., N. Mex., —4°; Roswell, N. Mex., —26°; Dodge, Kans., —20°; Amarillo, Tex., —8°; Palestine, Tex., 6°; New Orleans, La., 18°; Memphis, Tenn., 0; St. Louis, Mo., —18°; Pittsburg, Pa., —6°; Albany, N. Y., —8°; Washington, D. C., 4°; Charleston, S. C., 20°; Atlanta, Ga., 2°; Jacksonville, Fla., 26°.

An additional noteworthy feature of the winter of 1904–5, and one that was possibly associated with the general and pronounced depression in temperature, is found in the heavy rains that repeatedly swept portions of New Mexico and Arizona, where heavy winter precipitation has hitherto been practically unknown.

Chart I. December 18, 1888—8 a. m.

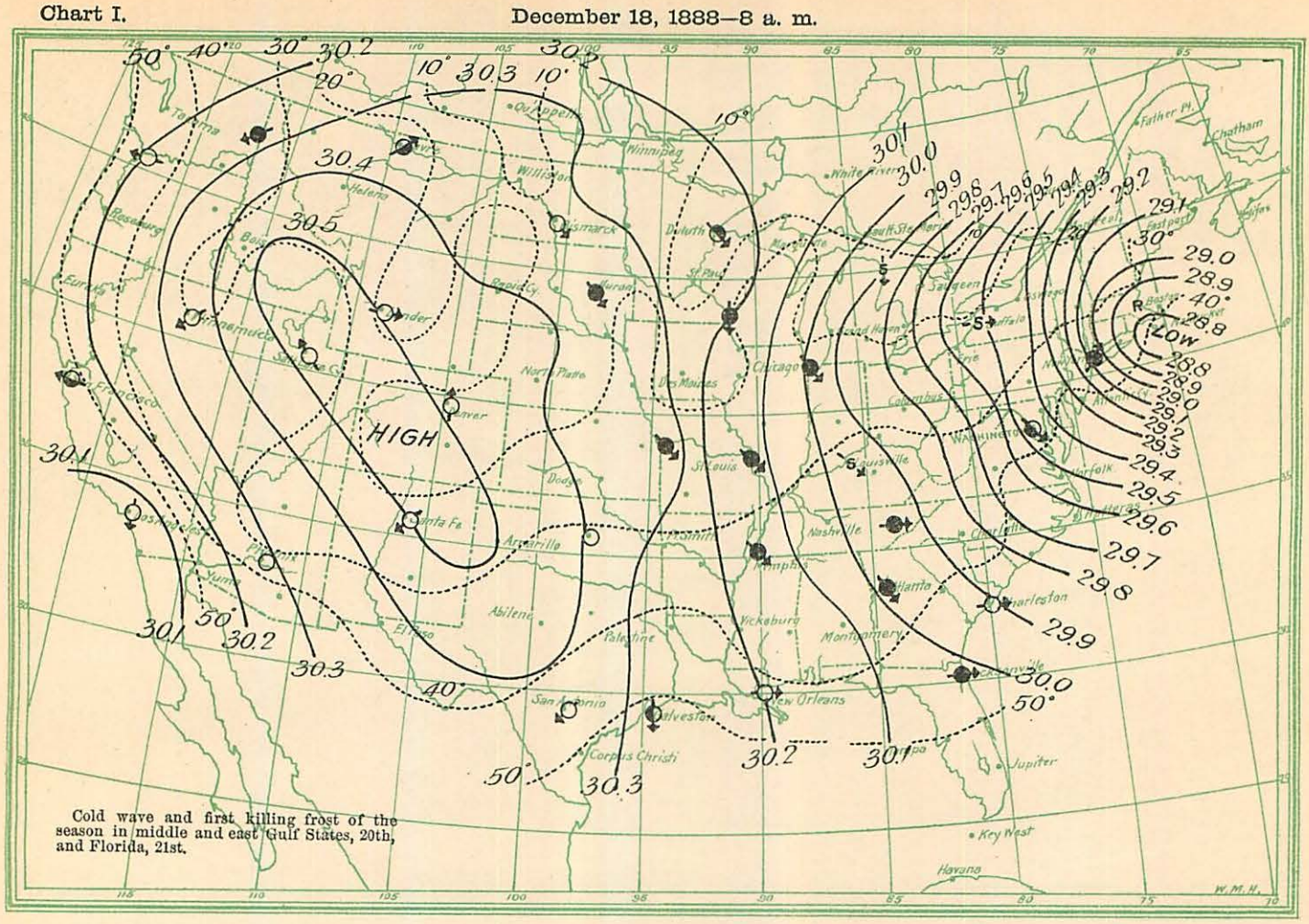


Chart II. December 19, 1888—8 a. m.

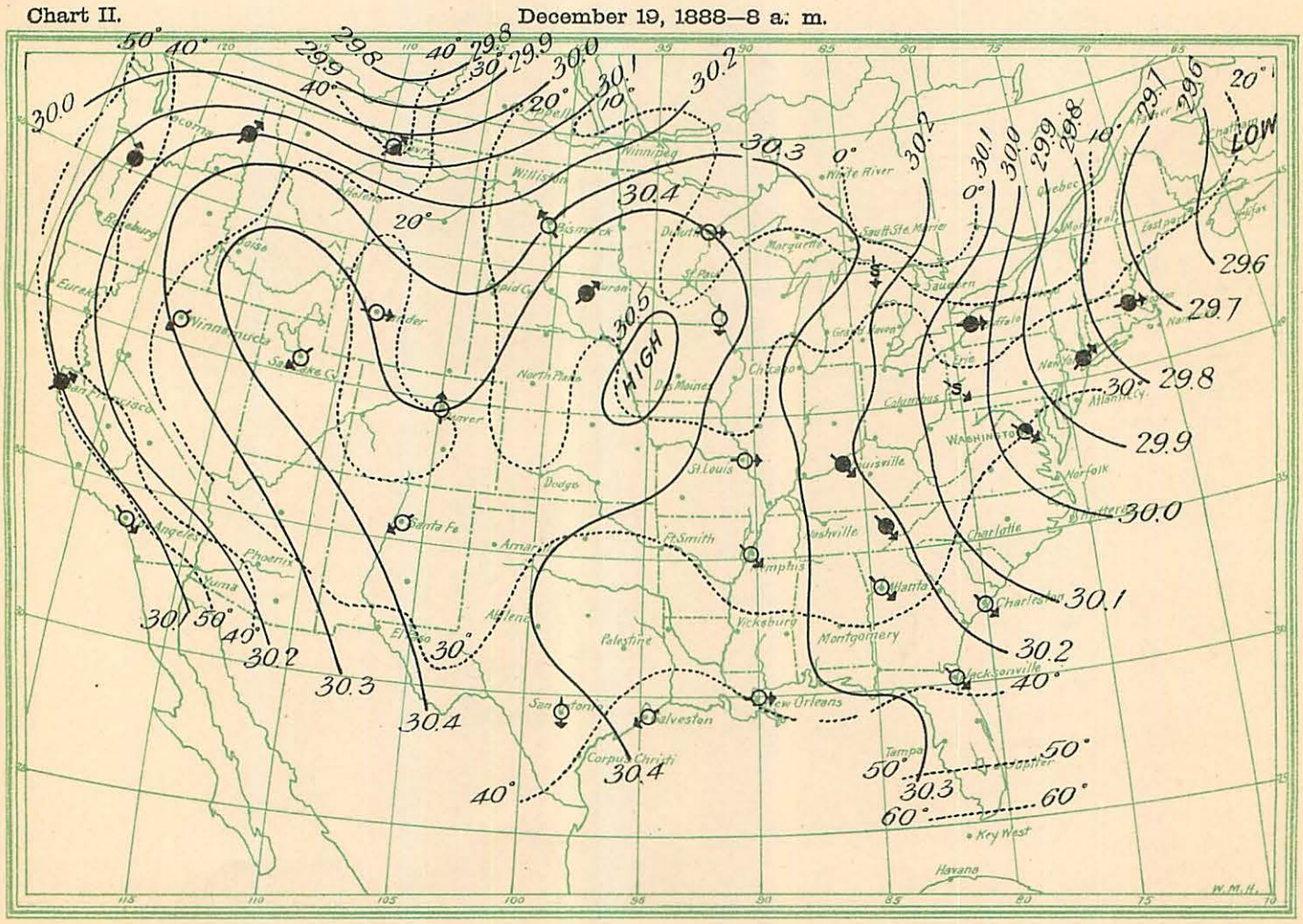


Chart III. December 20, 1888—8 a. m.

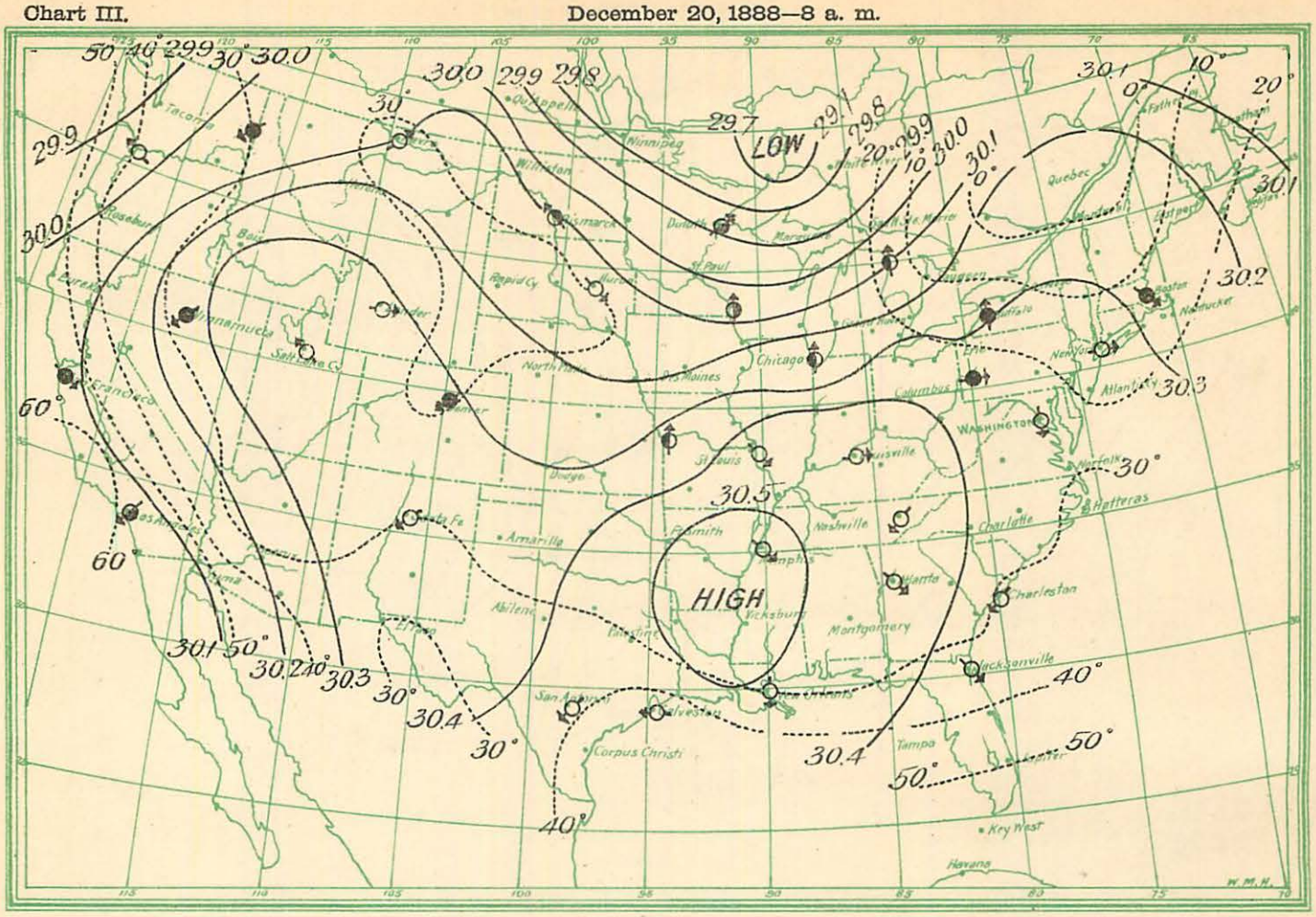


Chart IV. December 21, 1888—8 a. m.

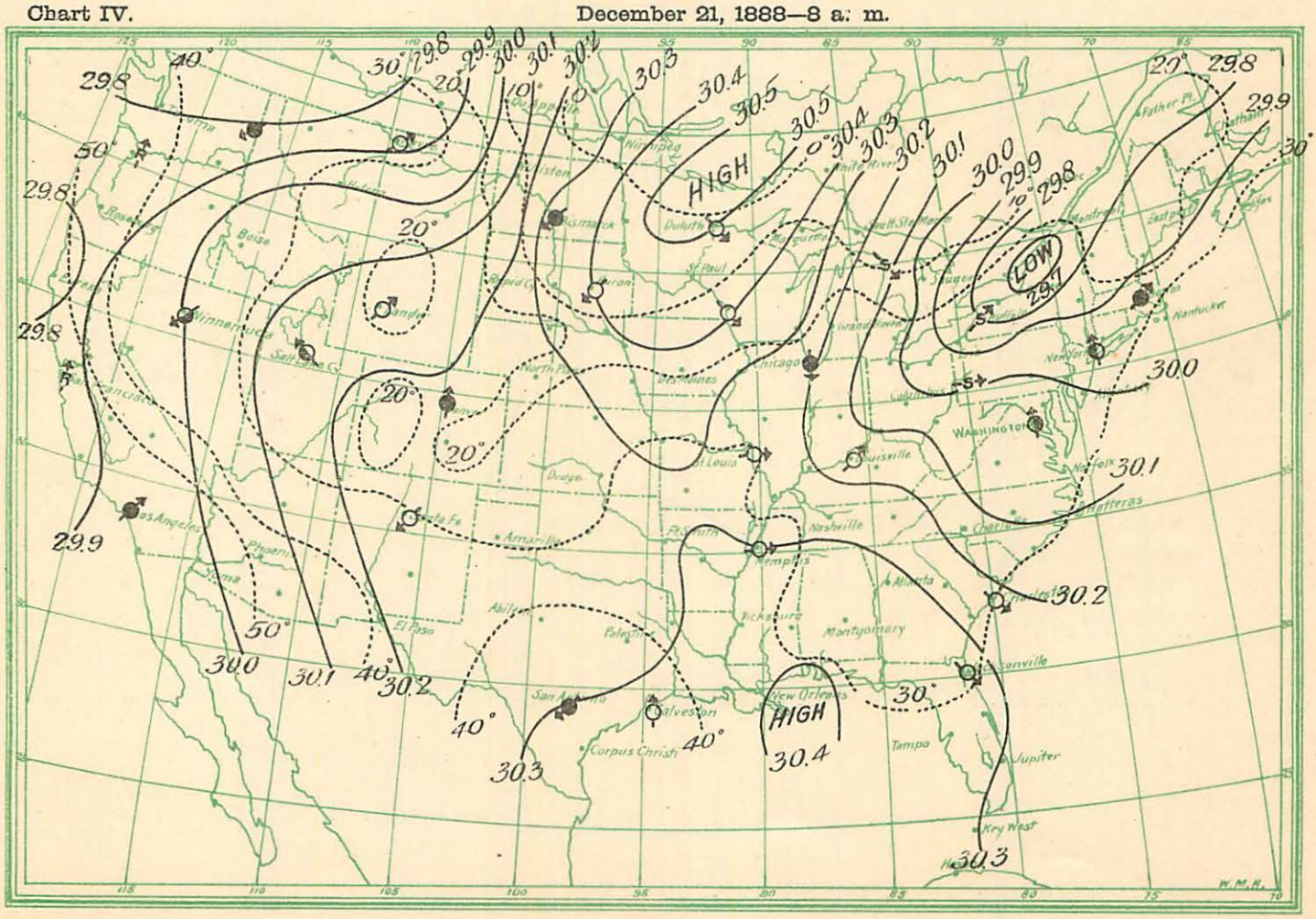


Chart V. December 28, 1889—8 a. m.

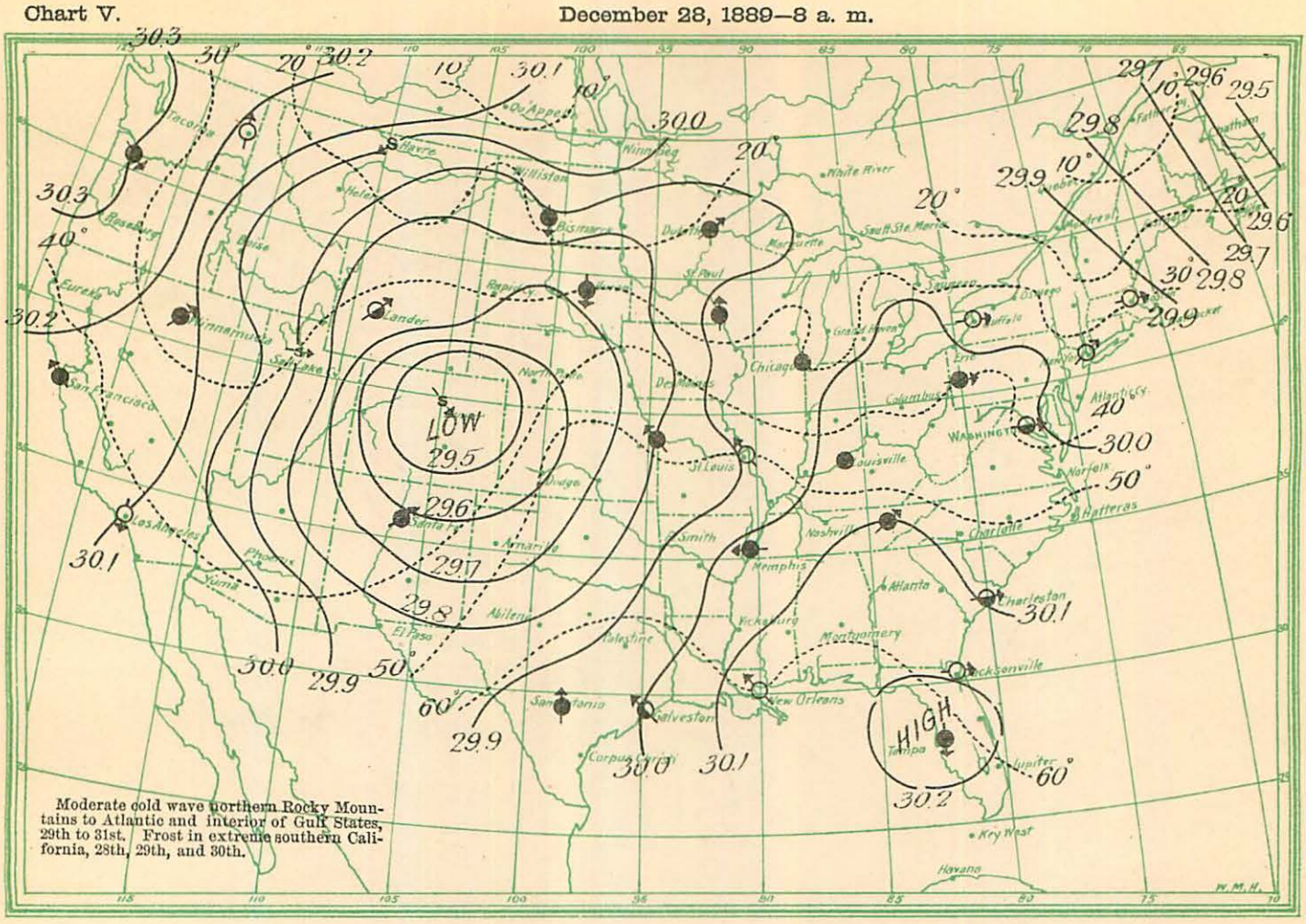


Chart VI. December 29, 1889—8 a. m.

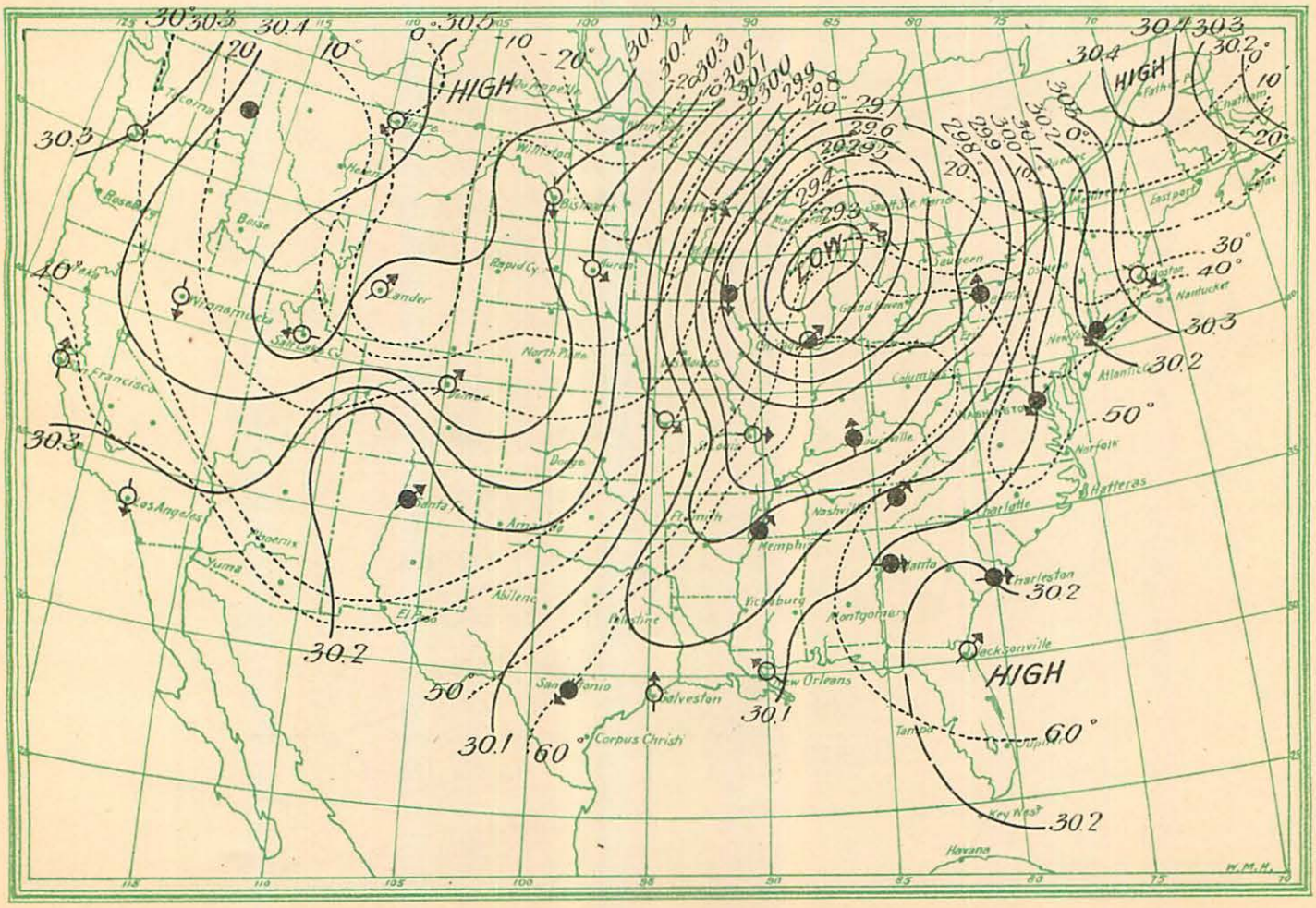


Chart VII. December 30, 1889—8 a. m.

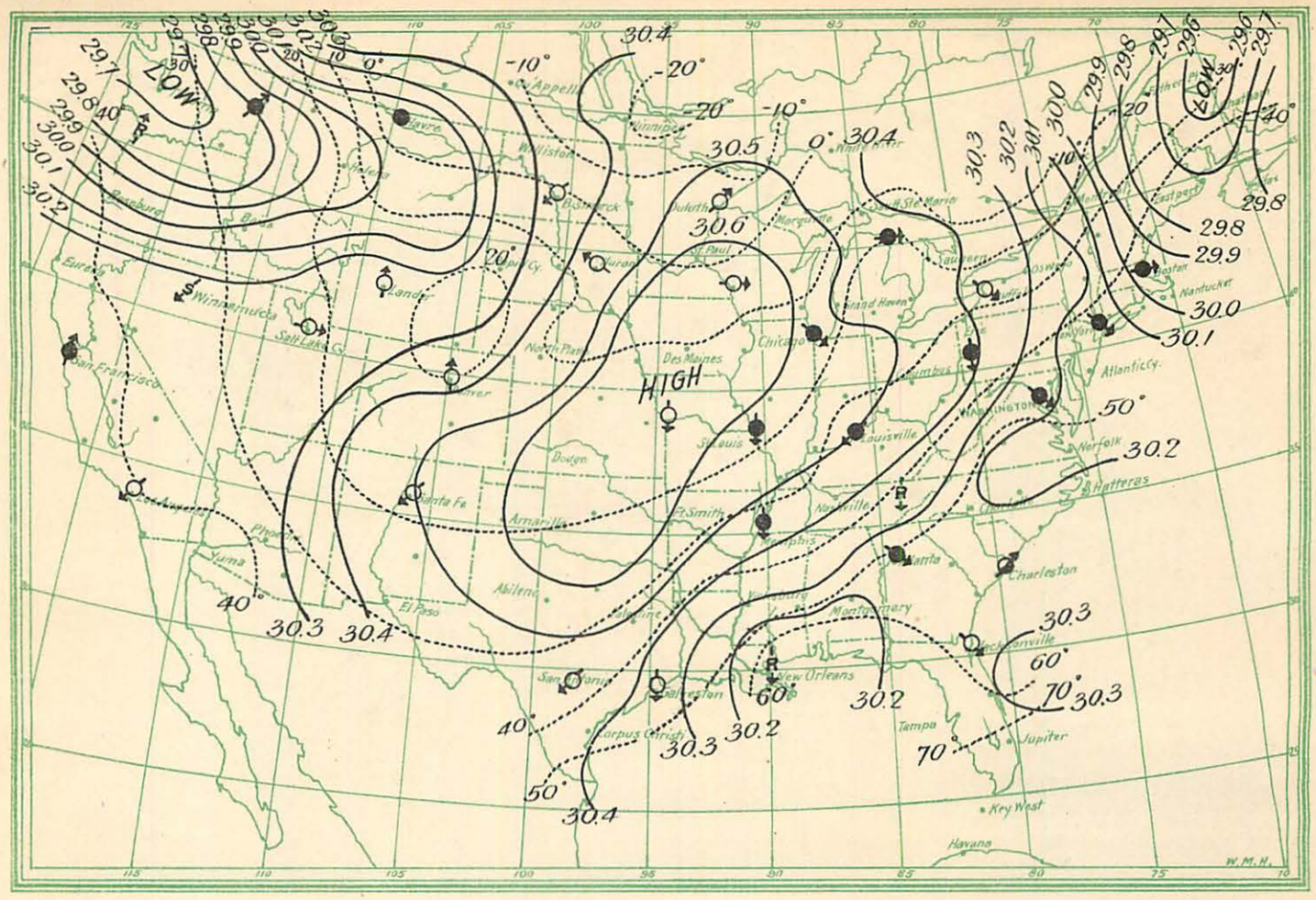


Chart VIII. December 31, 1889—8 a. m.

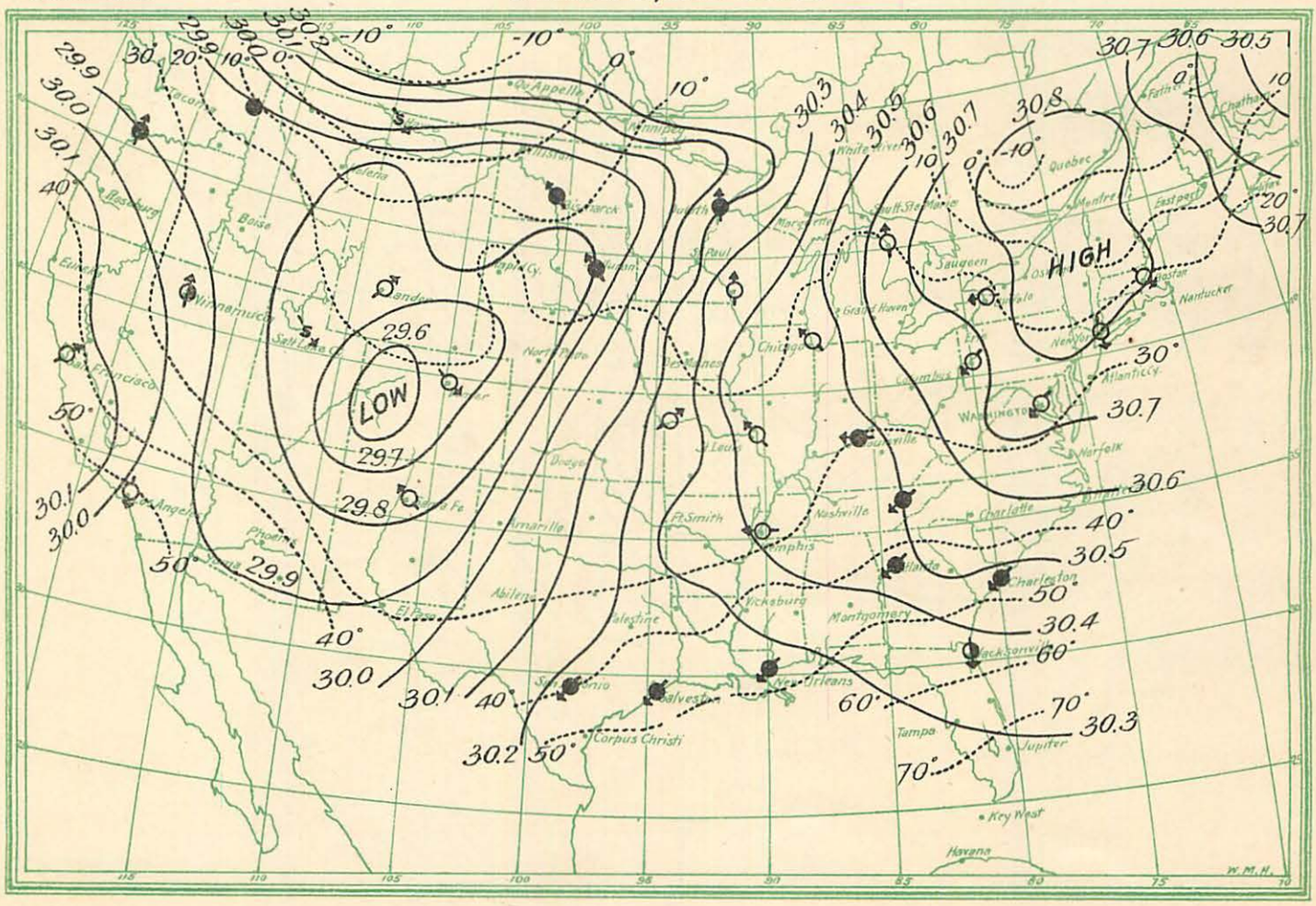


Chart IX. December 6, 1890—8 a. m.

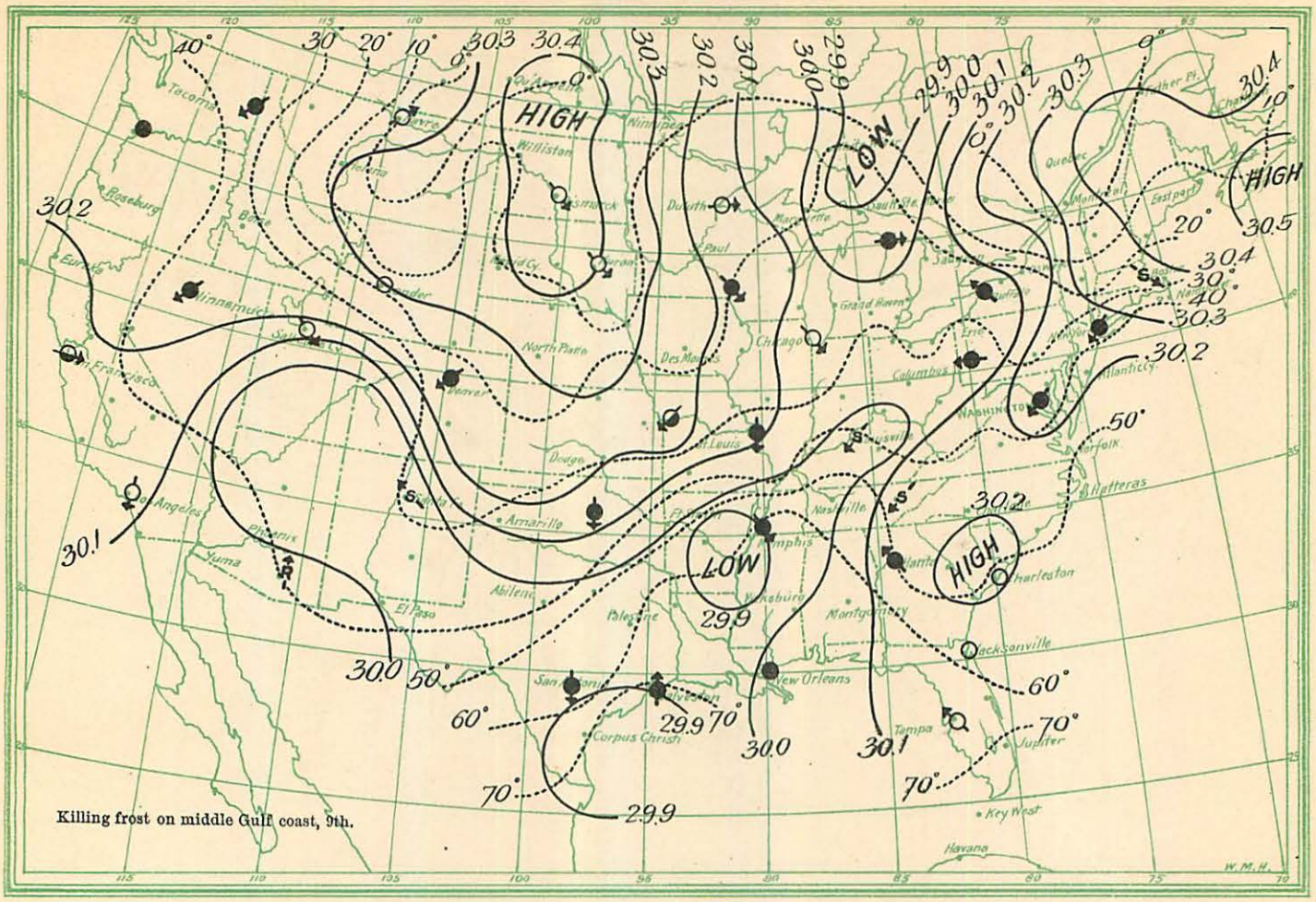


Chart X. December 7, 1890—8 a. m.

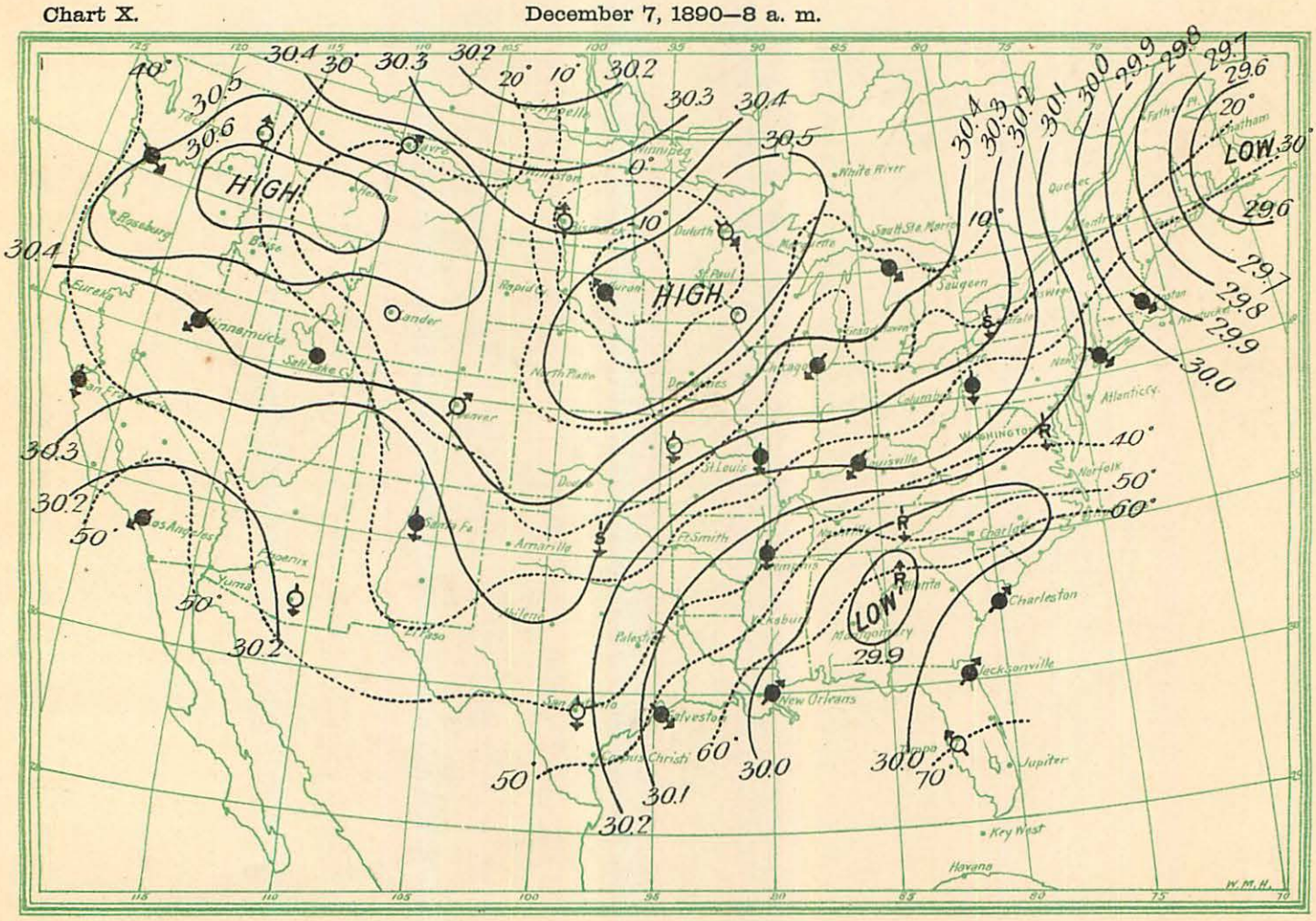


Chart XI. December 8, 1890—8 a. m.

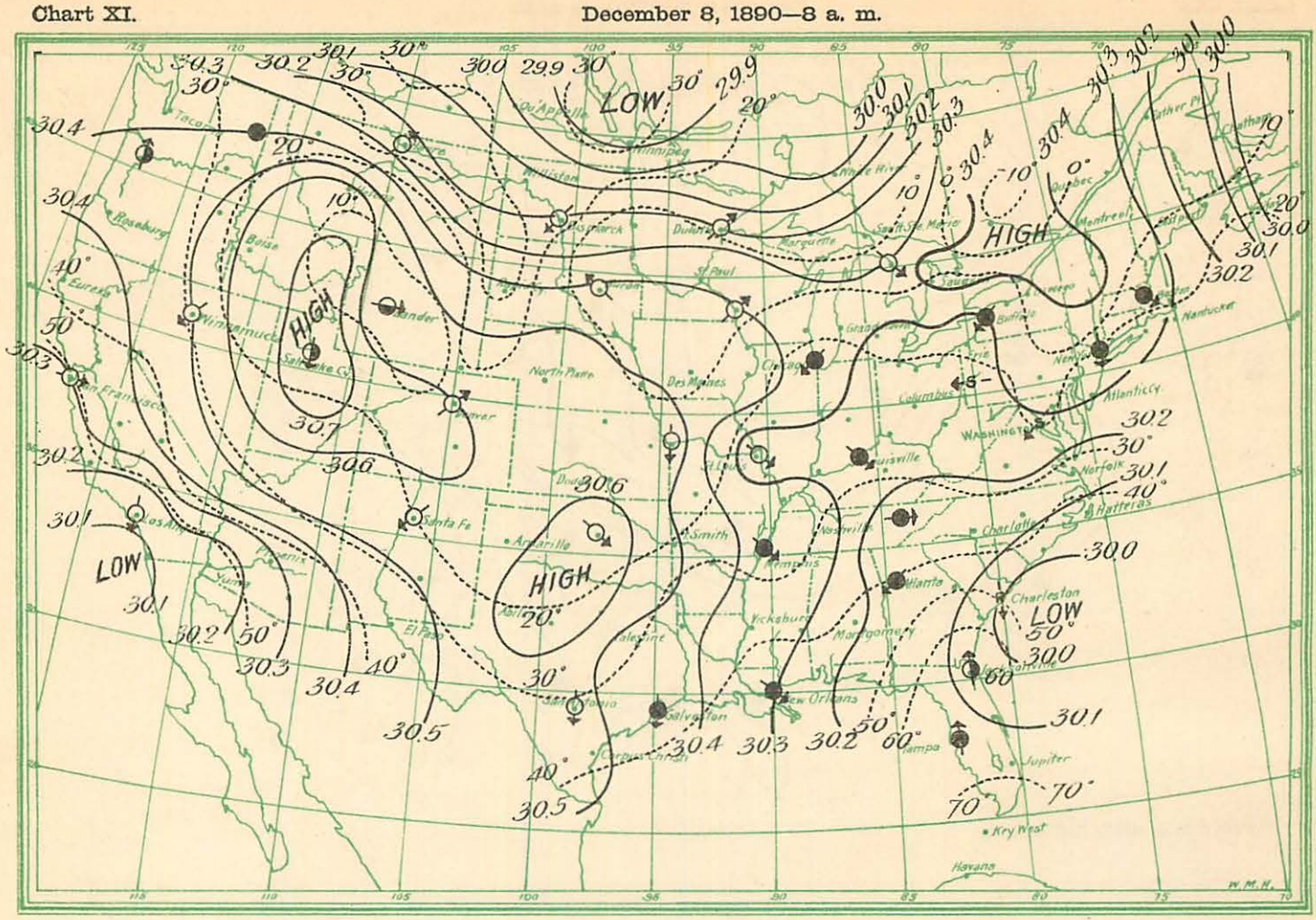


Chart XII. December 9, 1890—8 a. m.

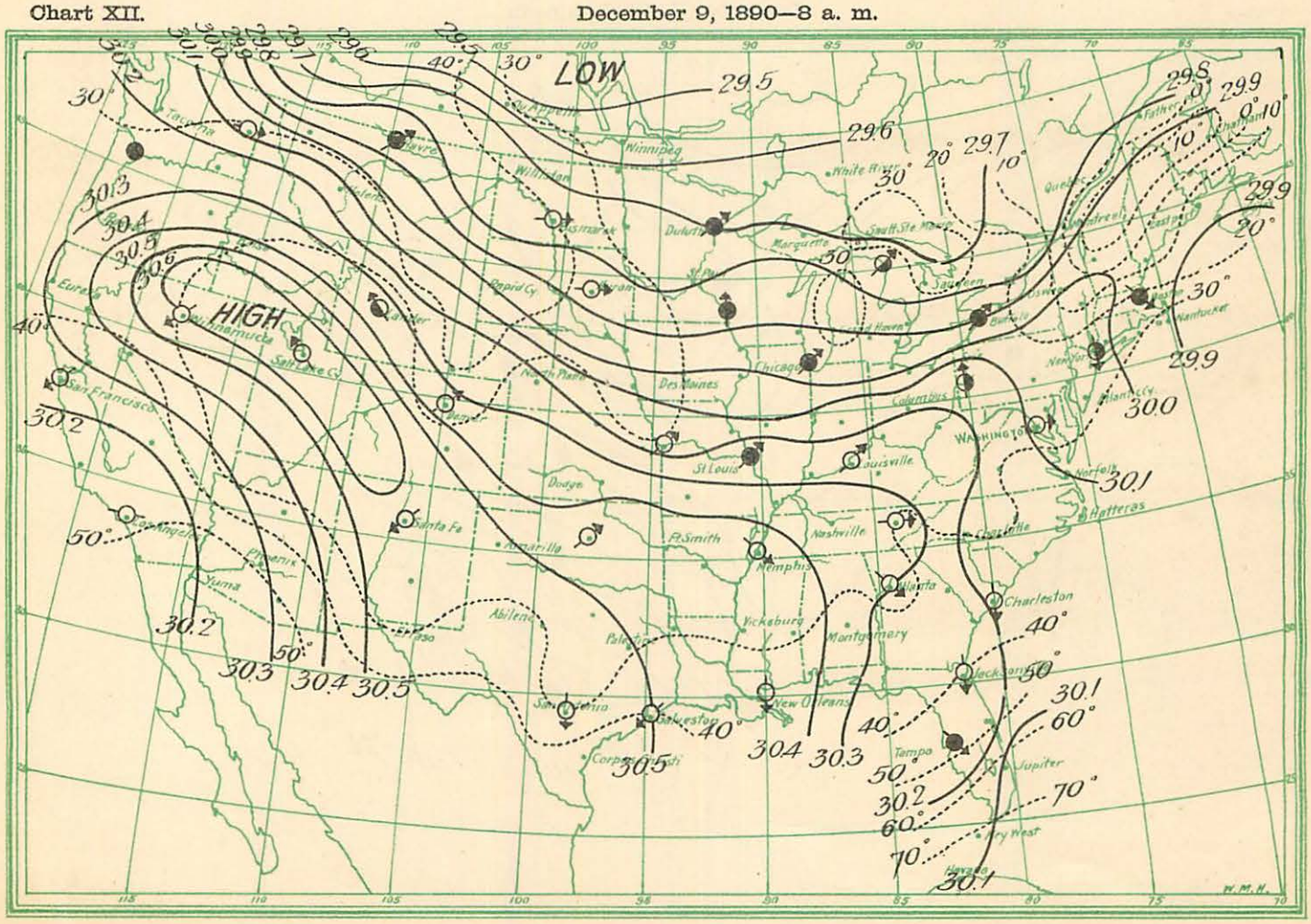


Chart XIII. December 26, 1890—8 a. m.

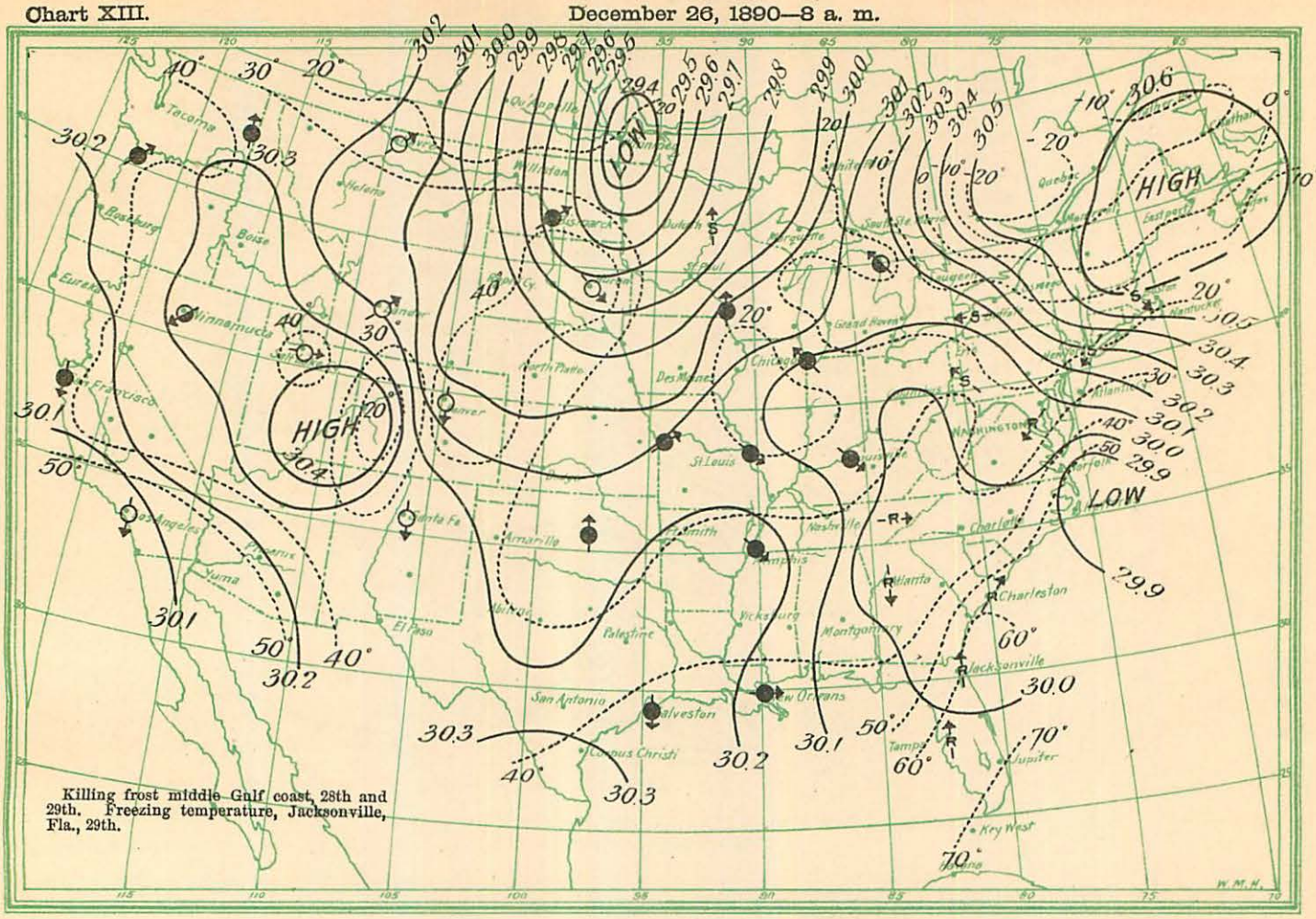


Chart XIV. December 27, 1890—8 a. m.

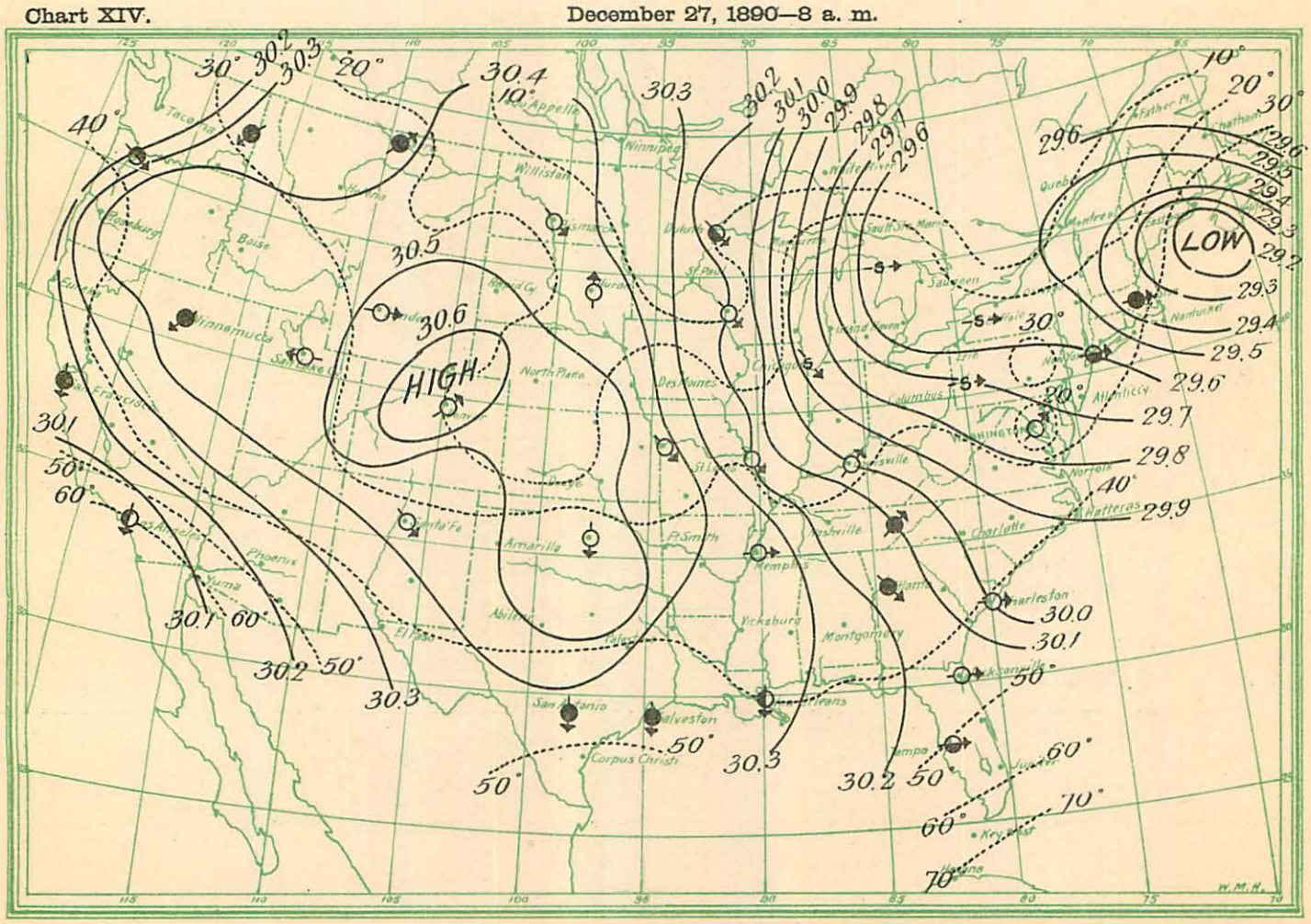


Chart XV. December 28, 1890—8 a. m.

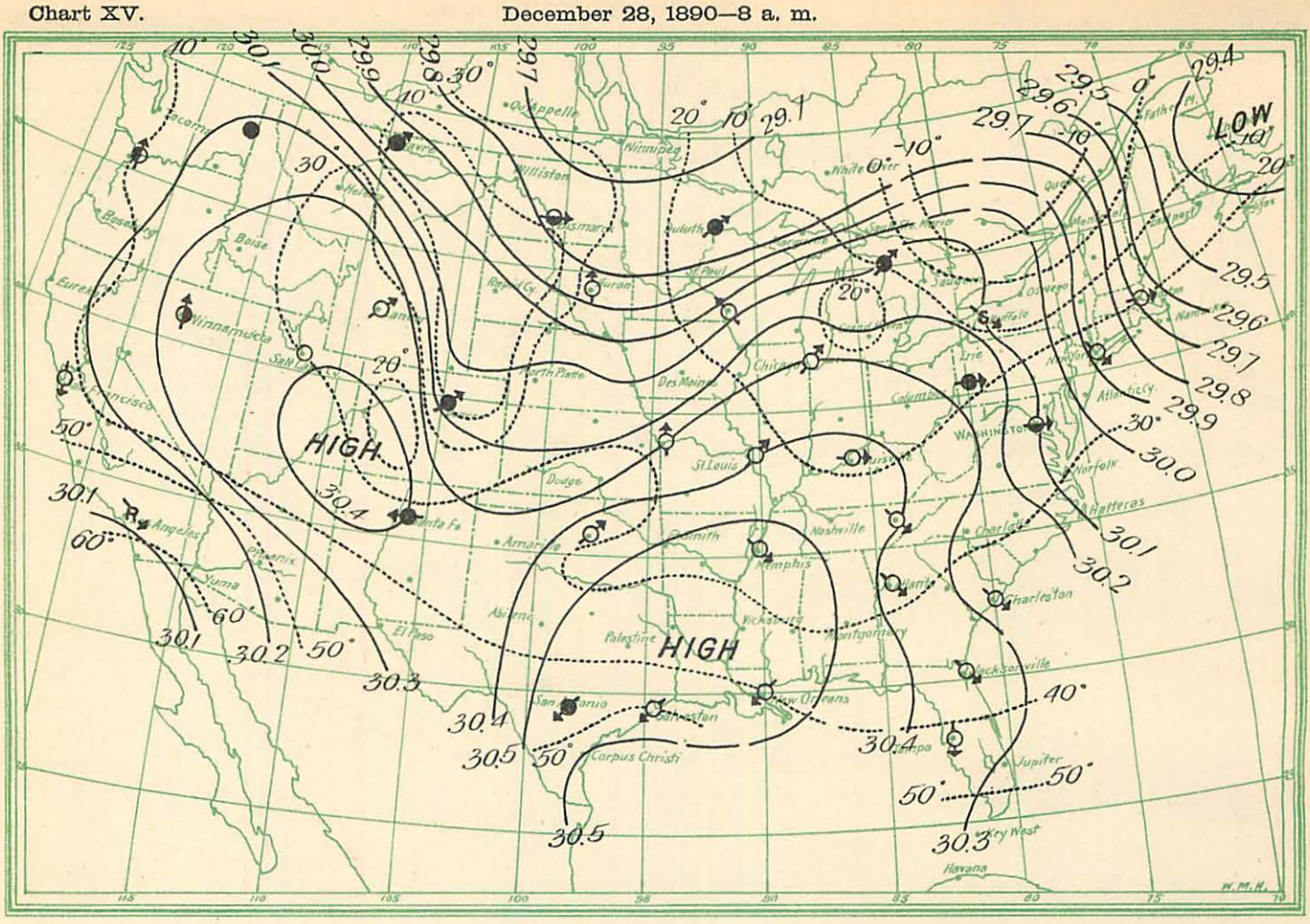


Chart XVI. December 29, 1890—8 a. m.

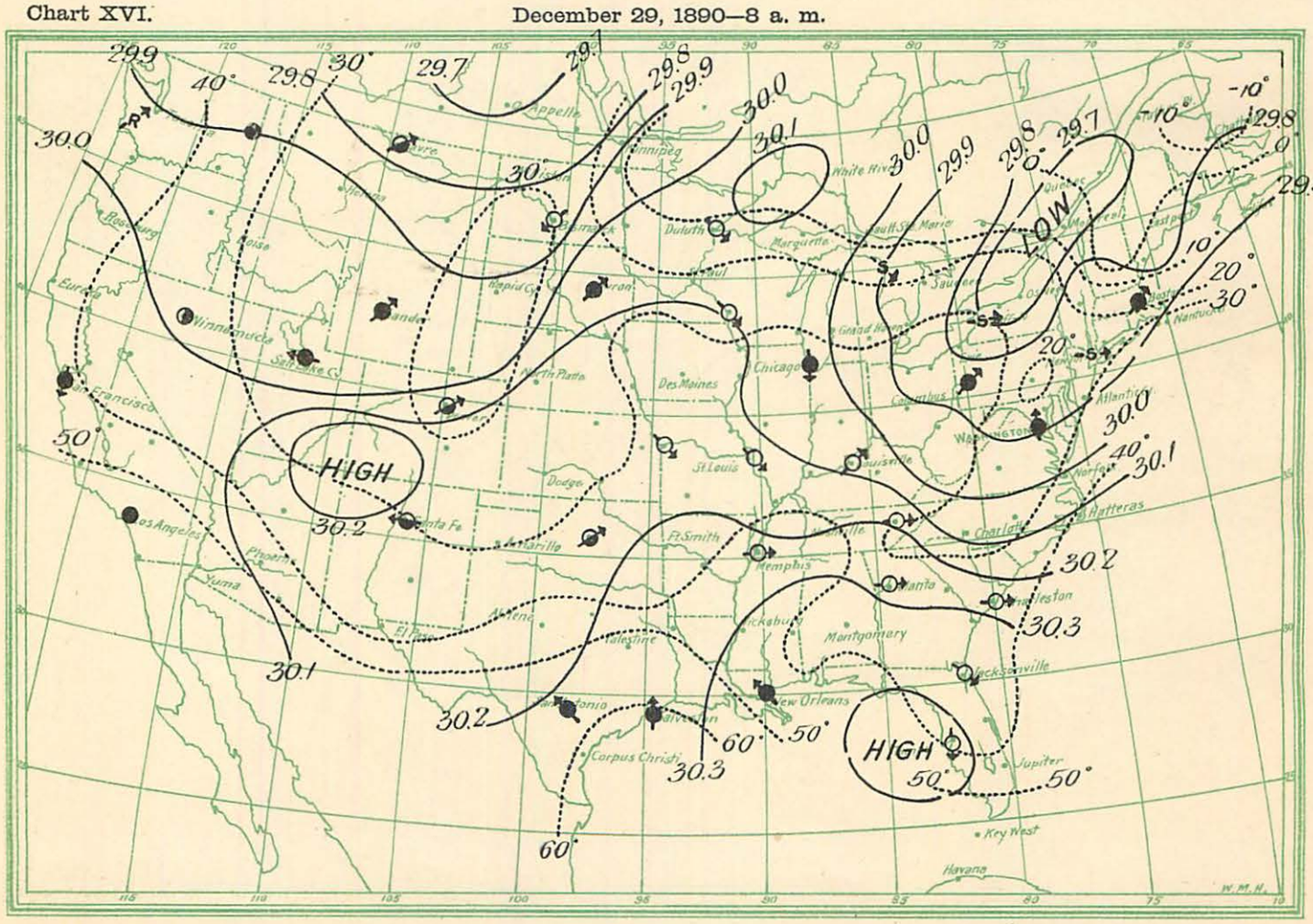


Chart XVII. December 23, 1891—8 a. m.

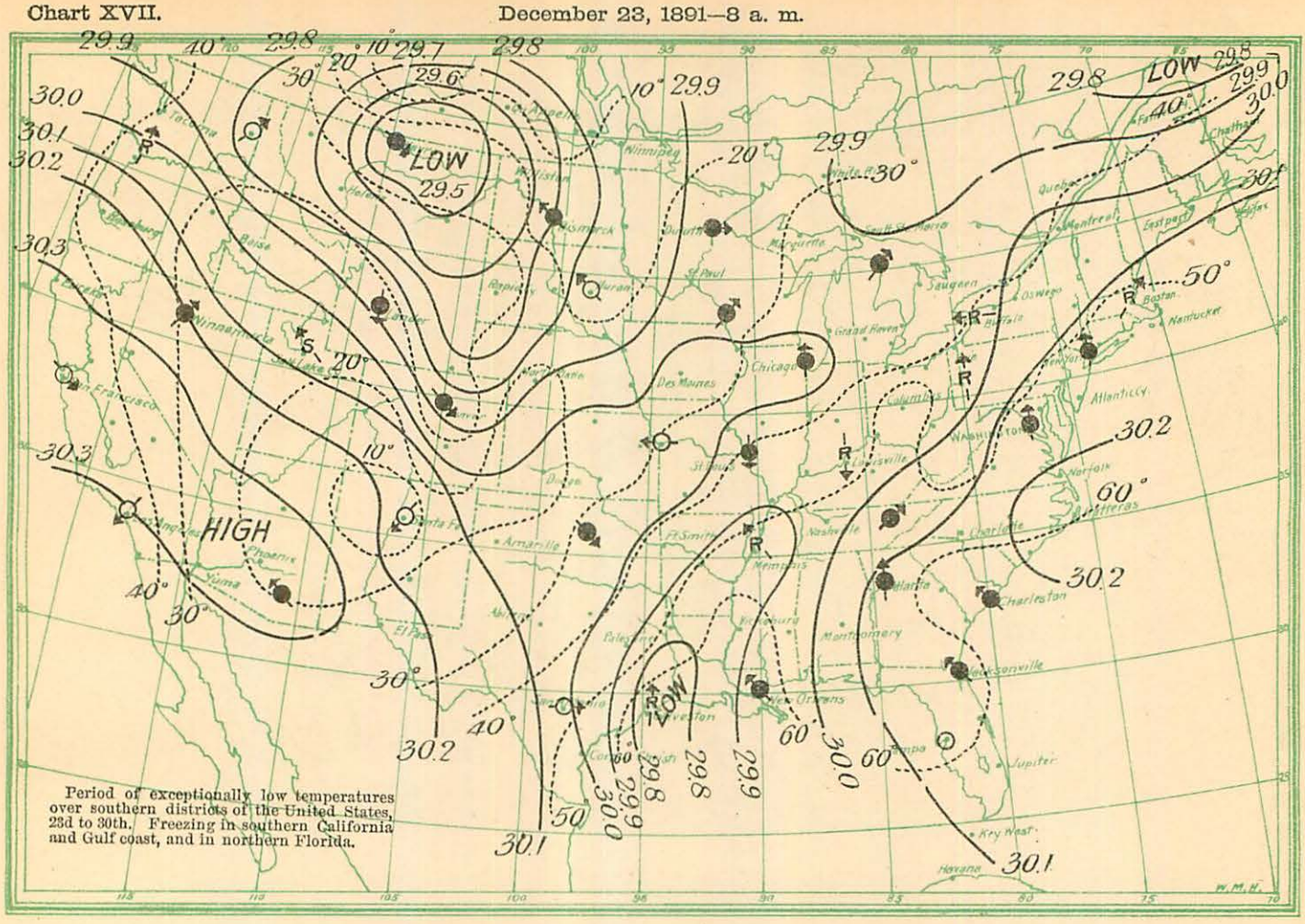


Chart XVIII. December 24, 1891—8 a. m.

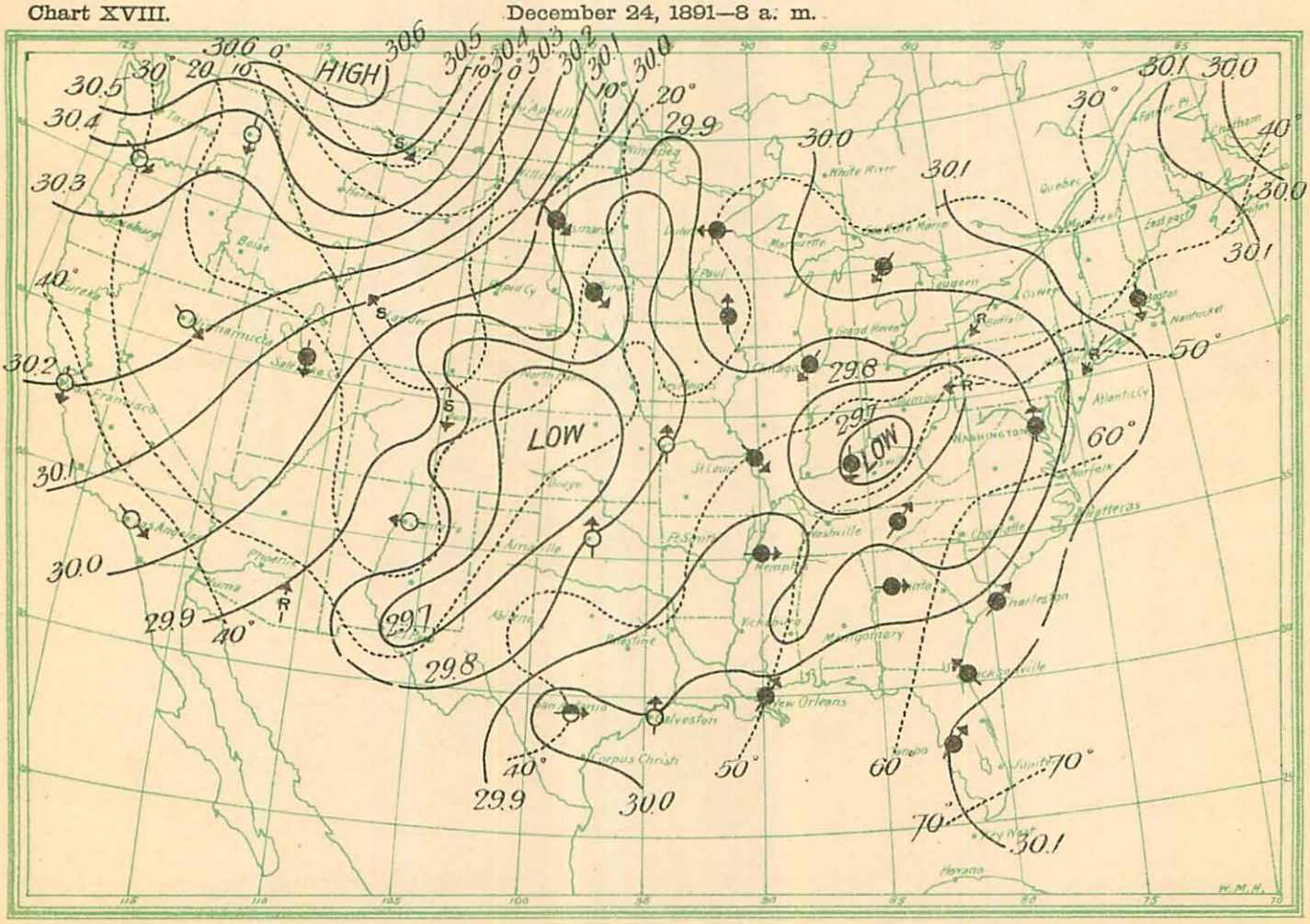


Chart XIX. December 25, 1891—8 a. m.

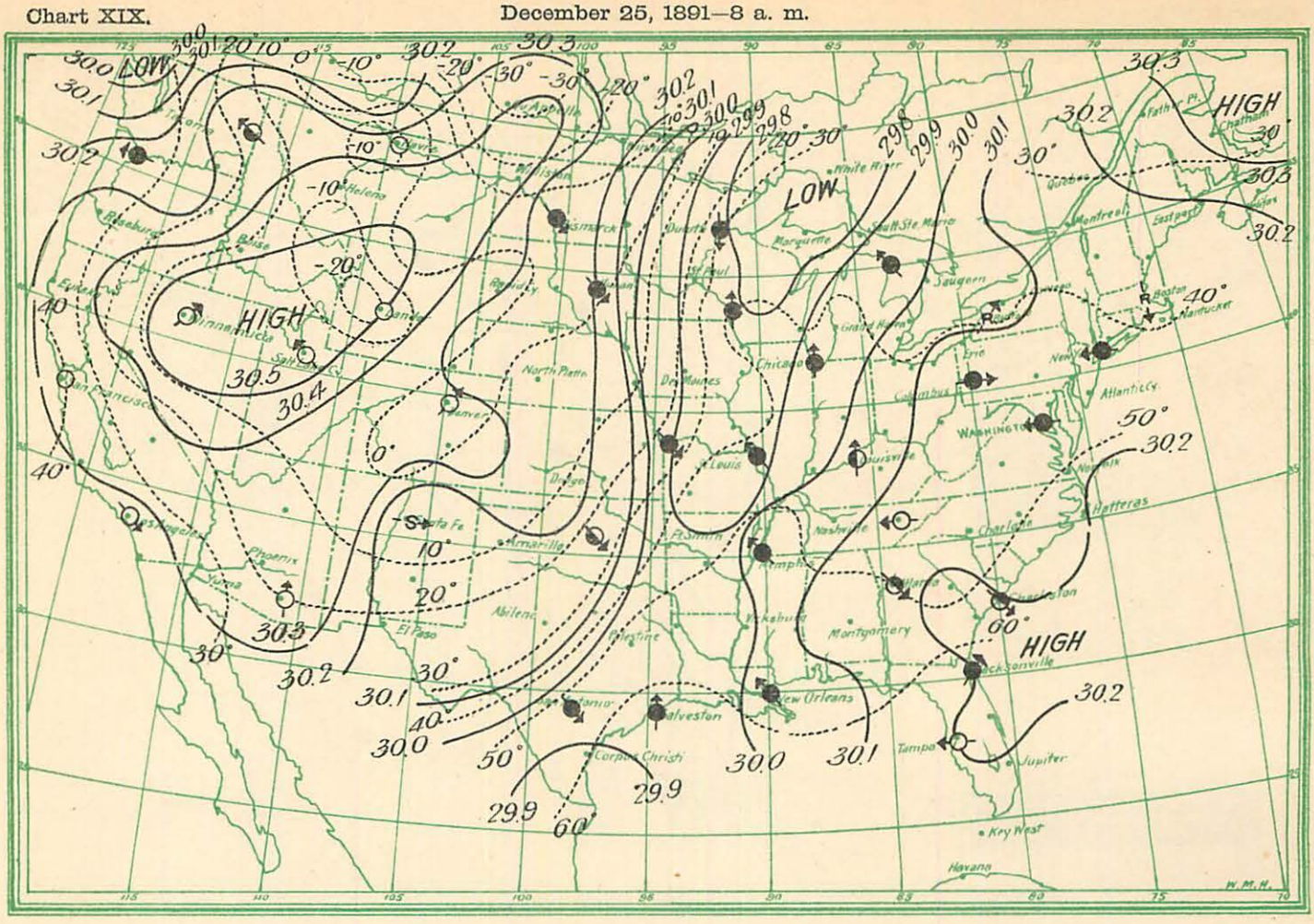


Chart XX. December 26, 1891—8 a. m.

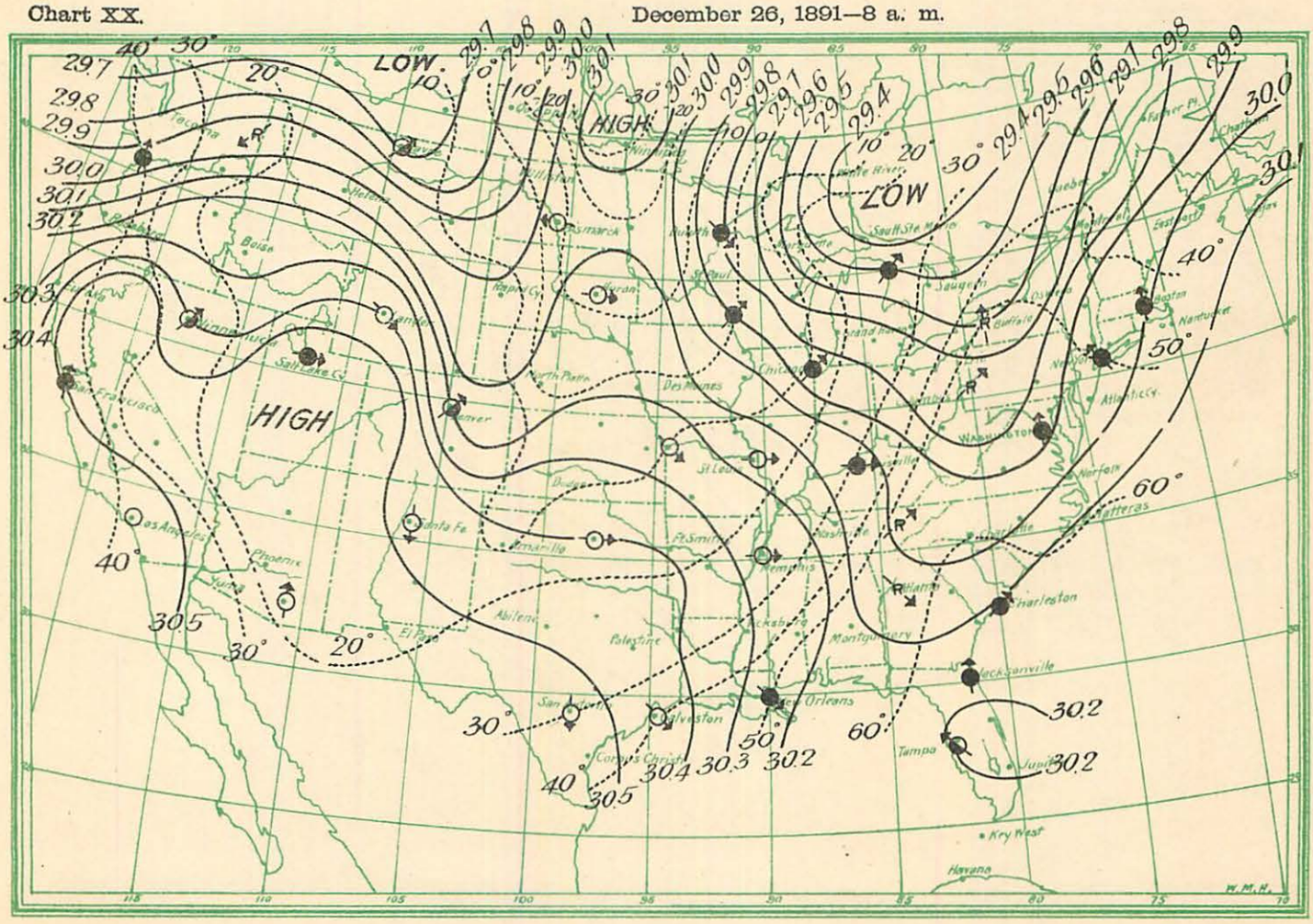


Chart XXI. December 27, 1891—8 a. m.

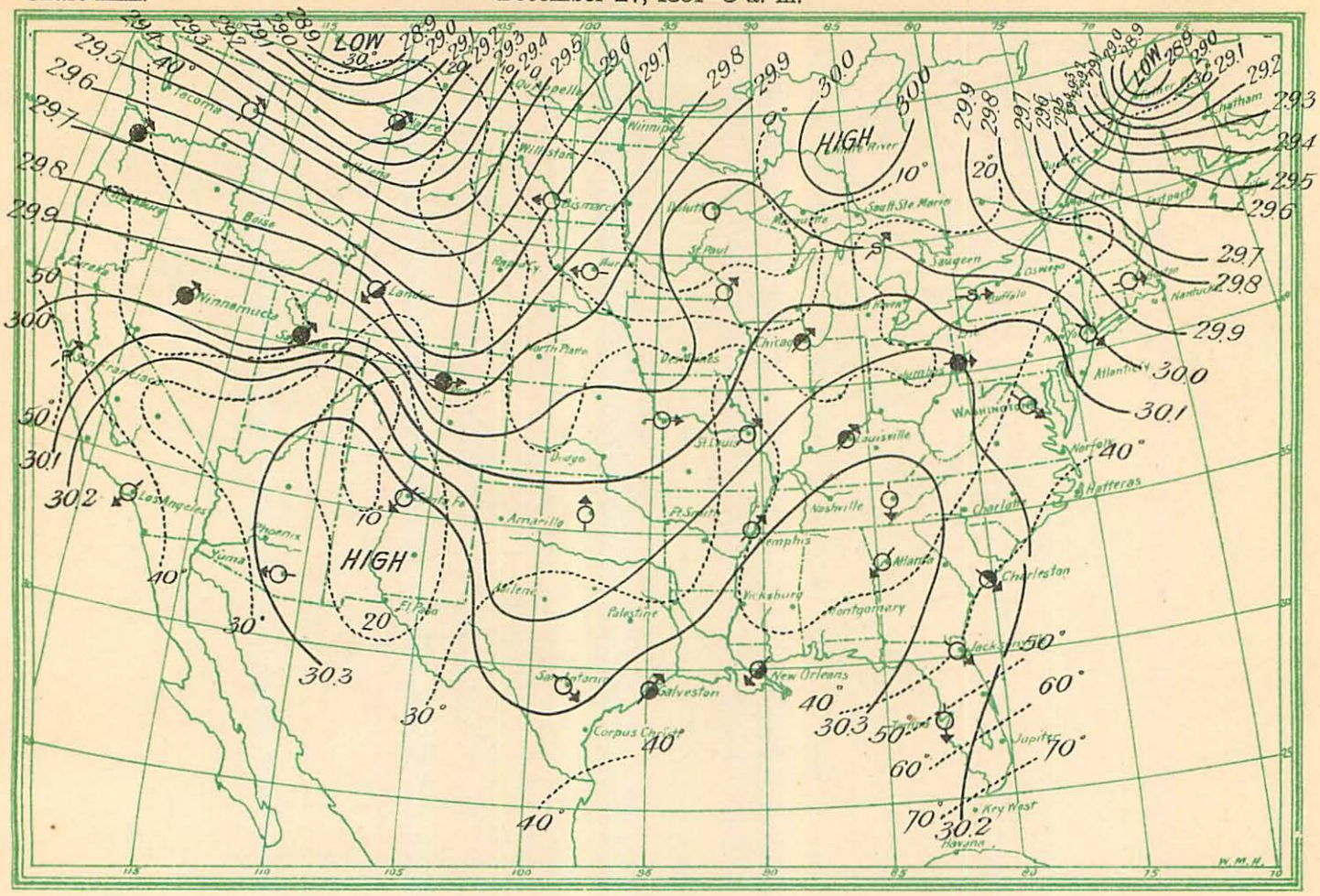


Chart XXII. December 28, 1891—8 a. m.

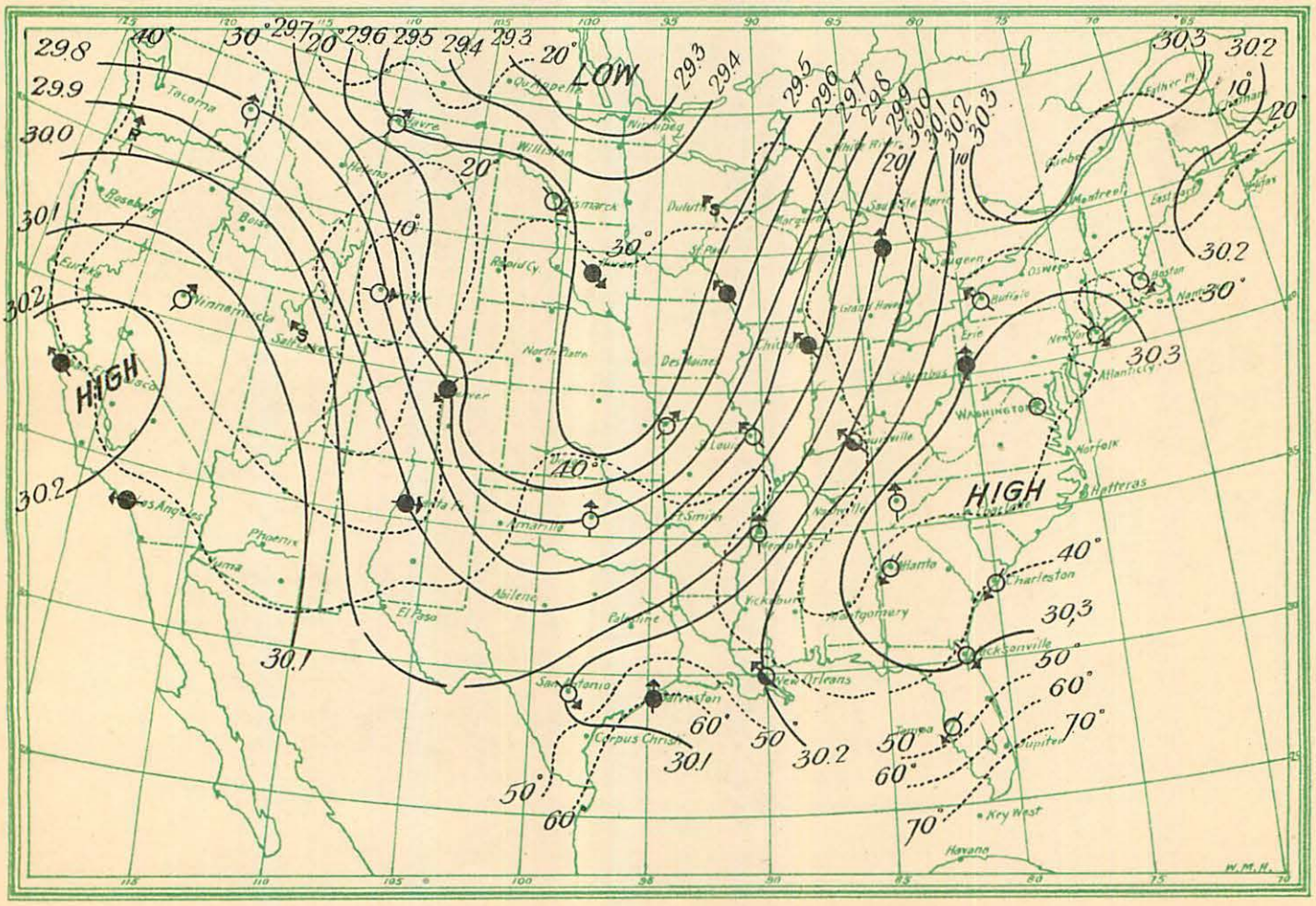


Chart XXIII. December 29, 1891—8 a. m.

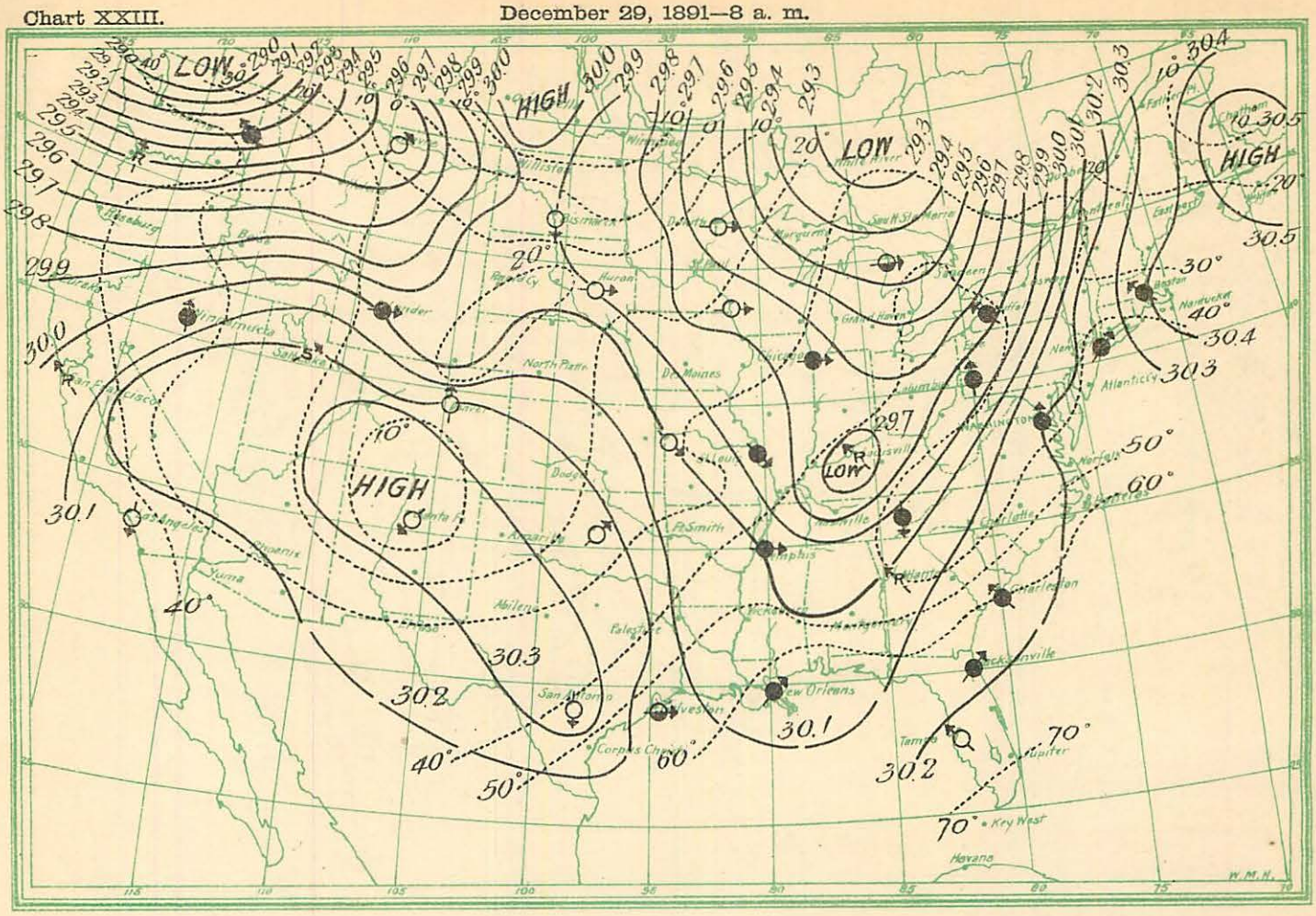


Chart XXIV. December 30, 1891—8 a. m.

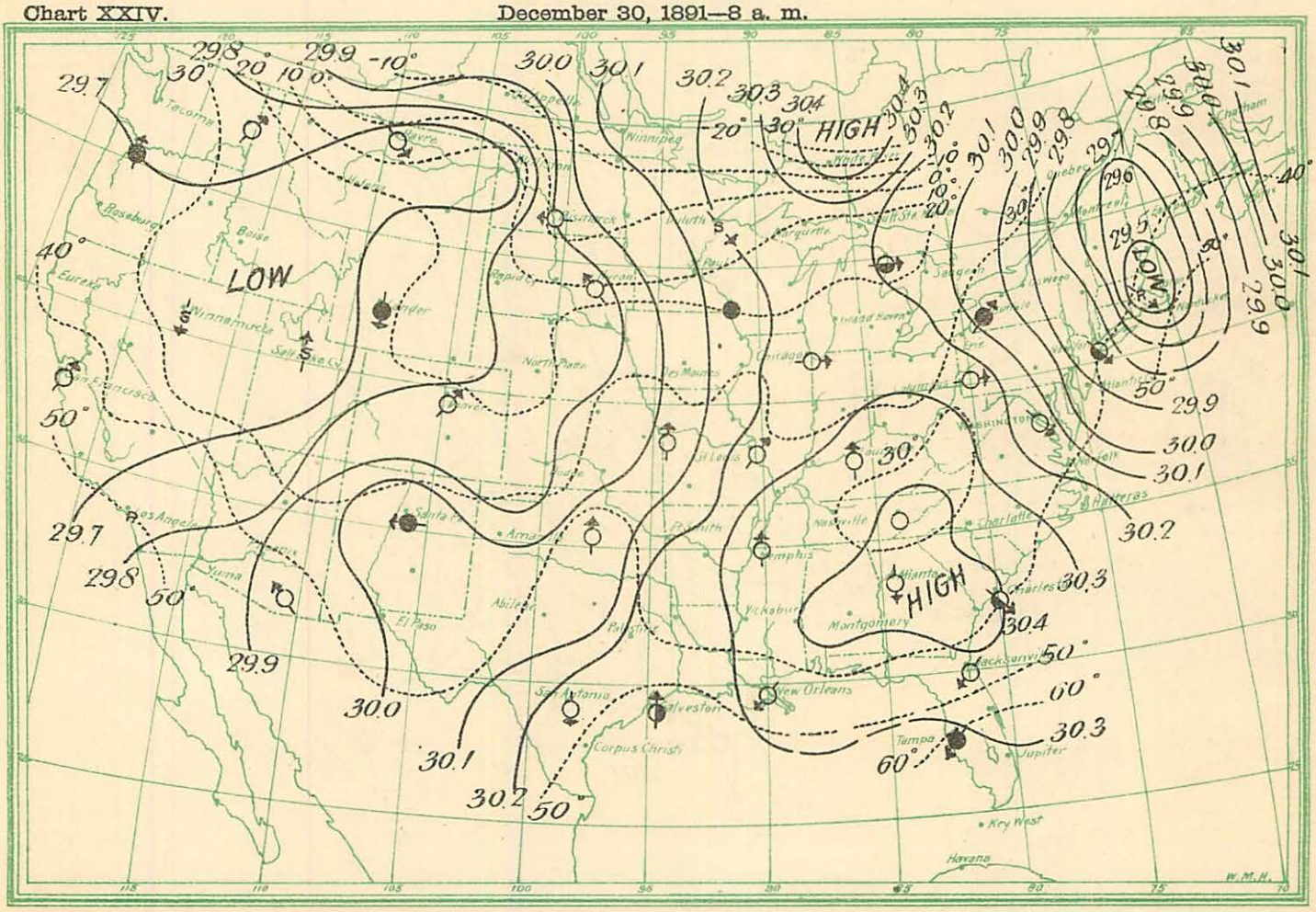


Chart XXV. December 4, 1892—8 a. m.

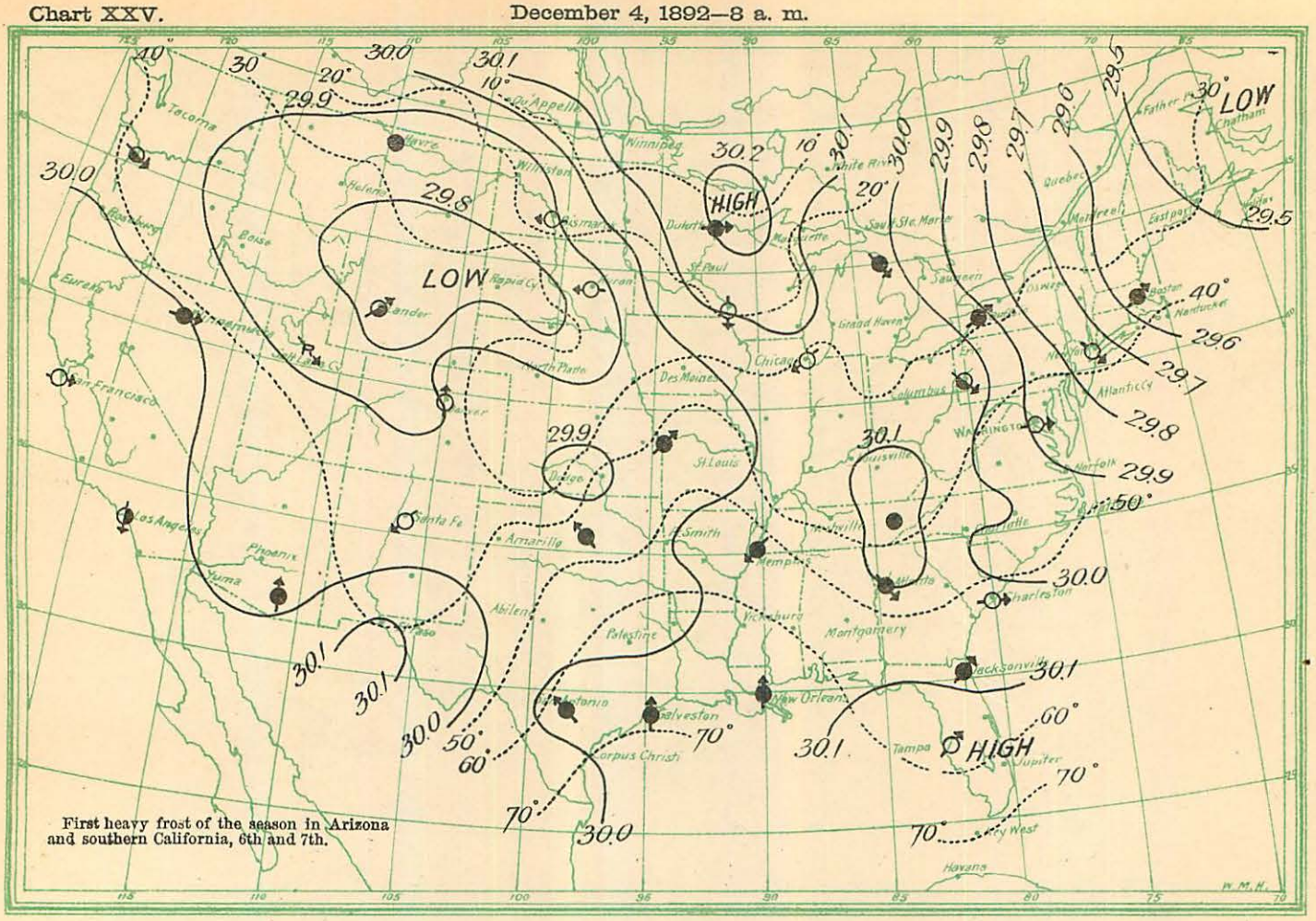


Chart XXVI. December 5, 1892—8 a. m.

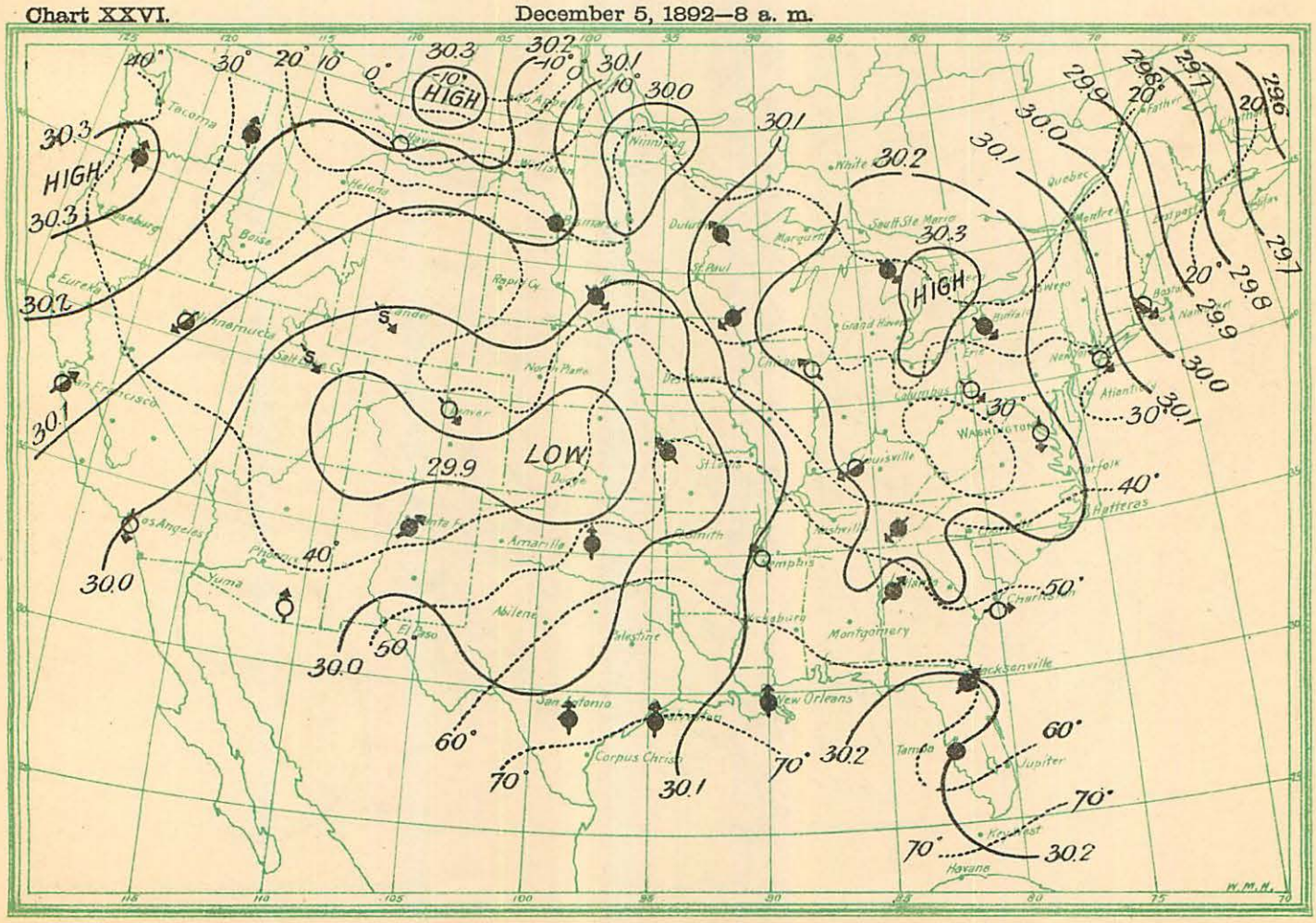


Chart XXVII. December 6, 1892—8 a. m.

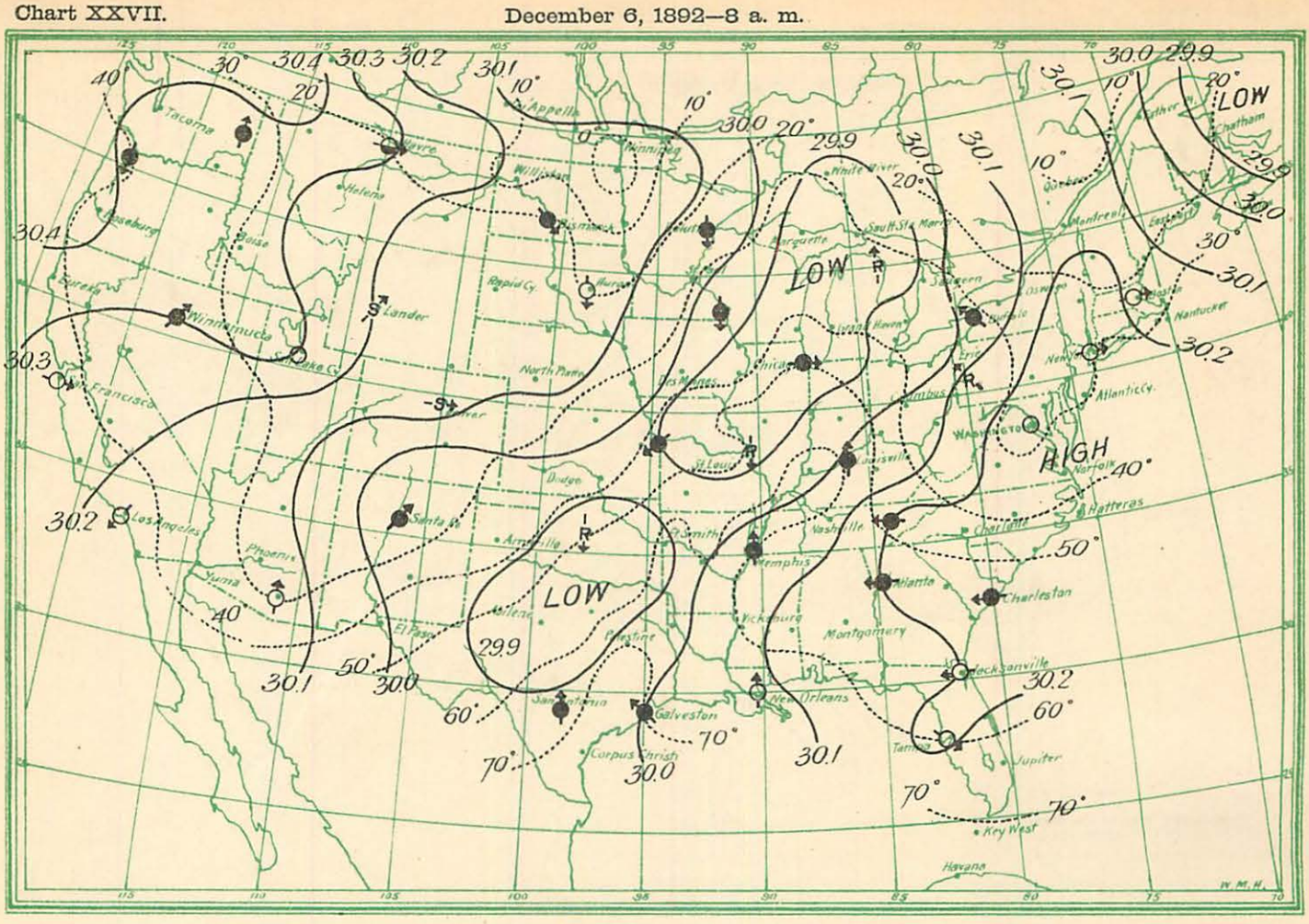


Chart XXVIII. December 7, 1892—8 a. m.

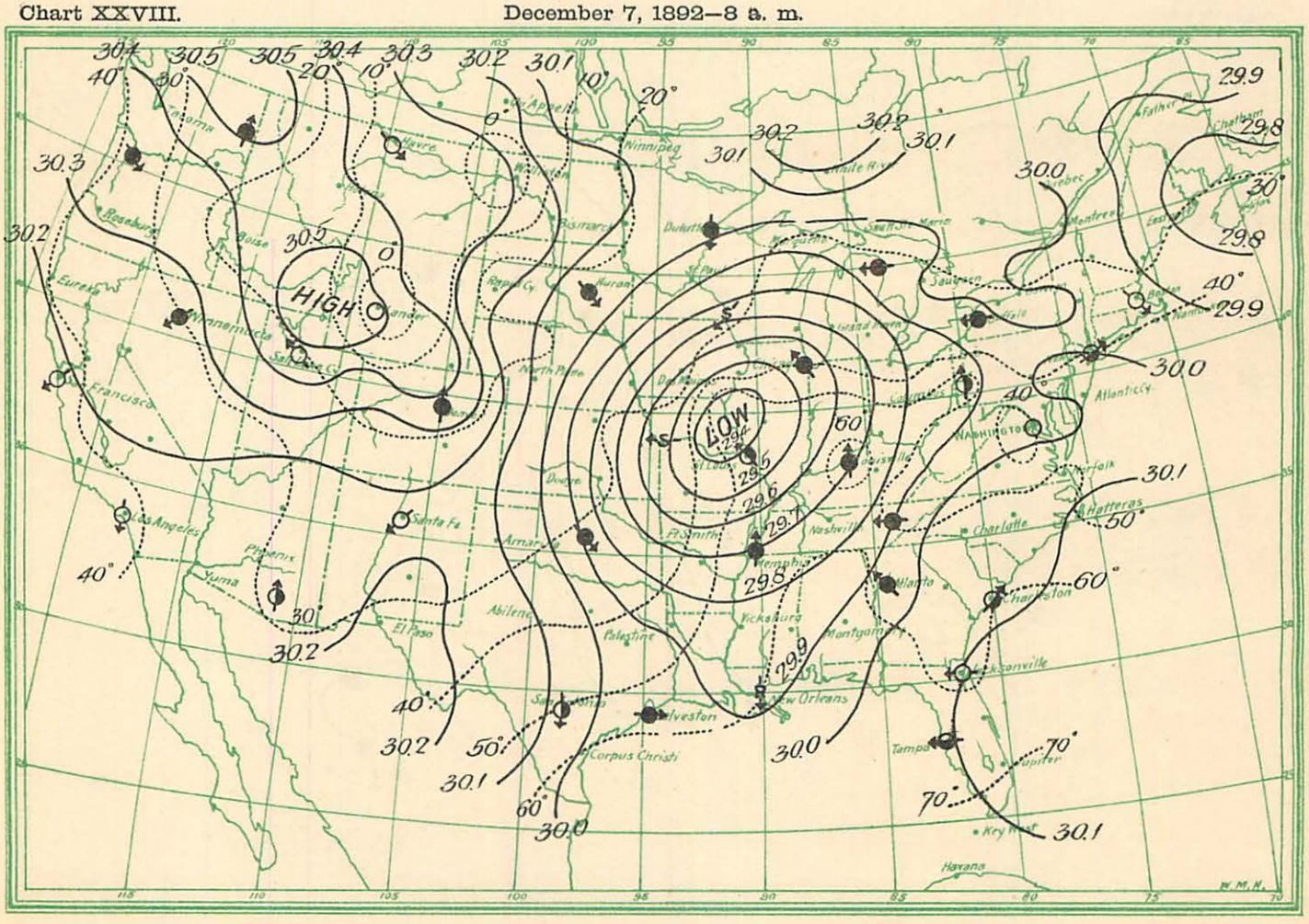


Chart XXIX. December 8, 1892—8 a. m.

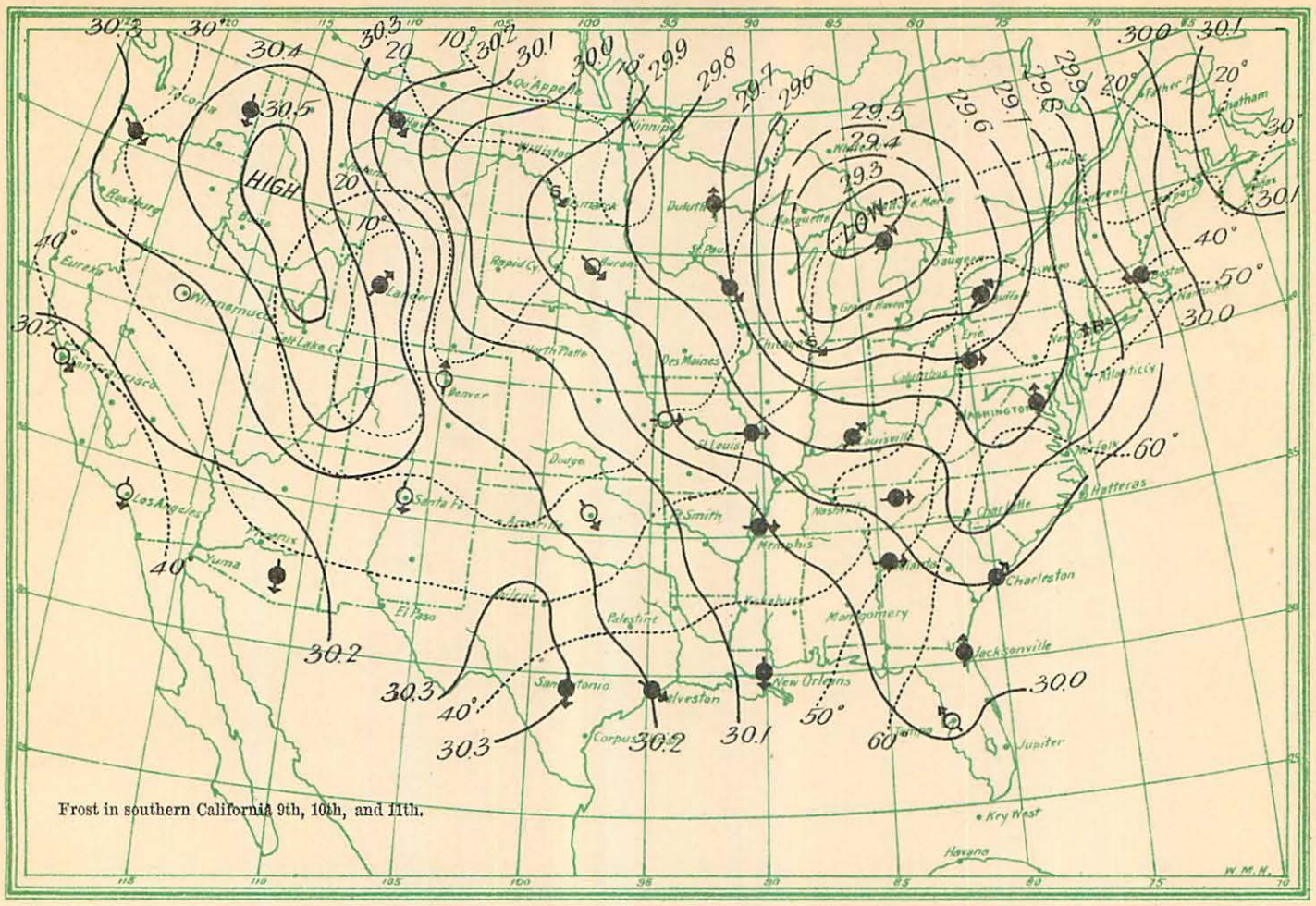


Chart XXX. December 9, 1892—8 a. m.

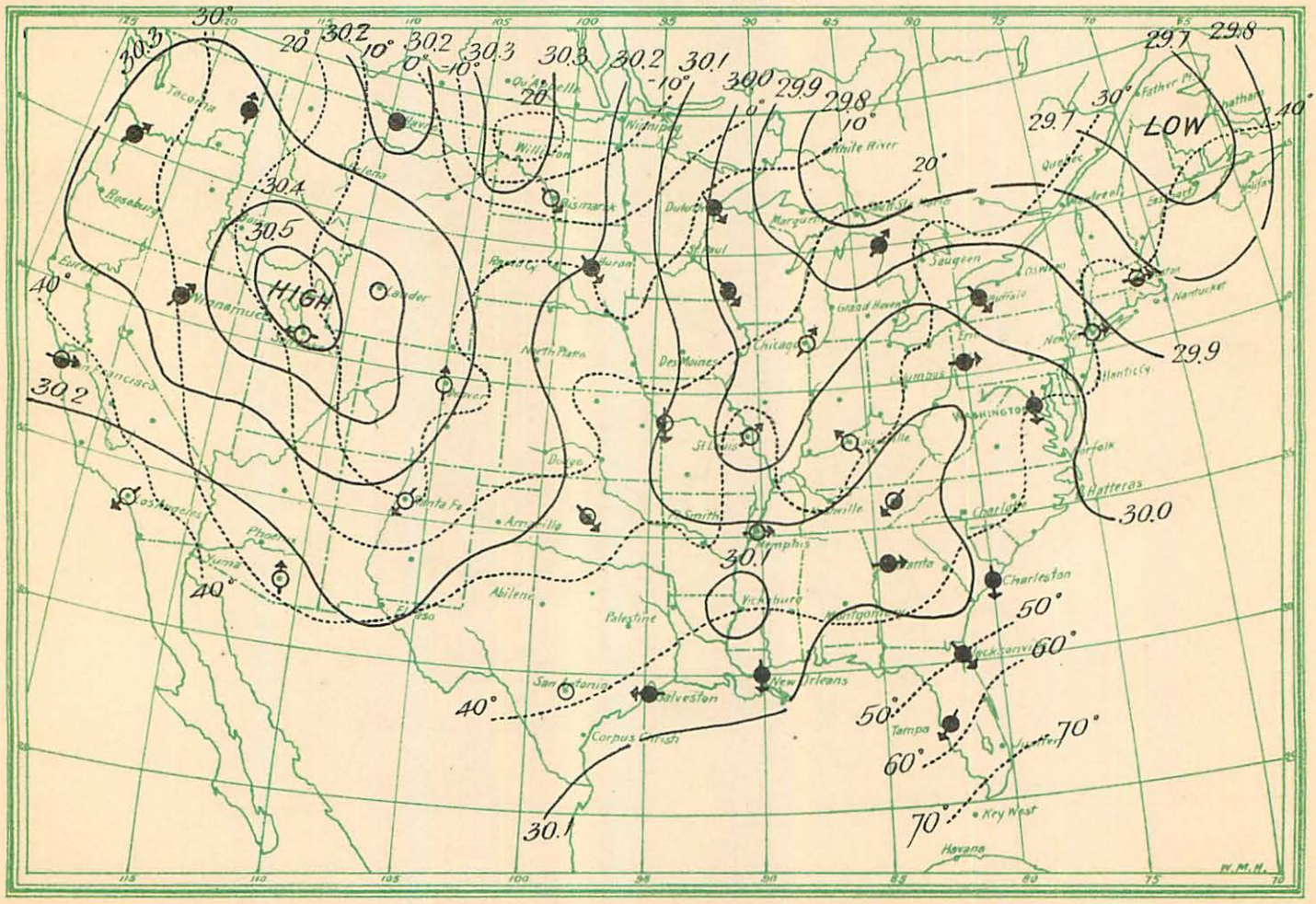


Chart XXXI. December 10, 1892—8 a. m.

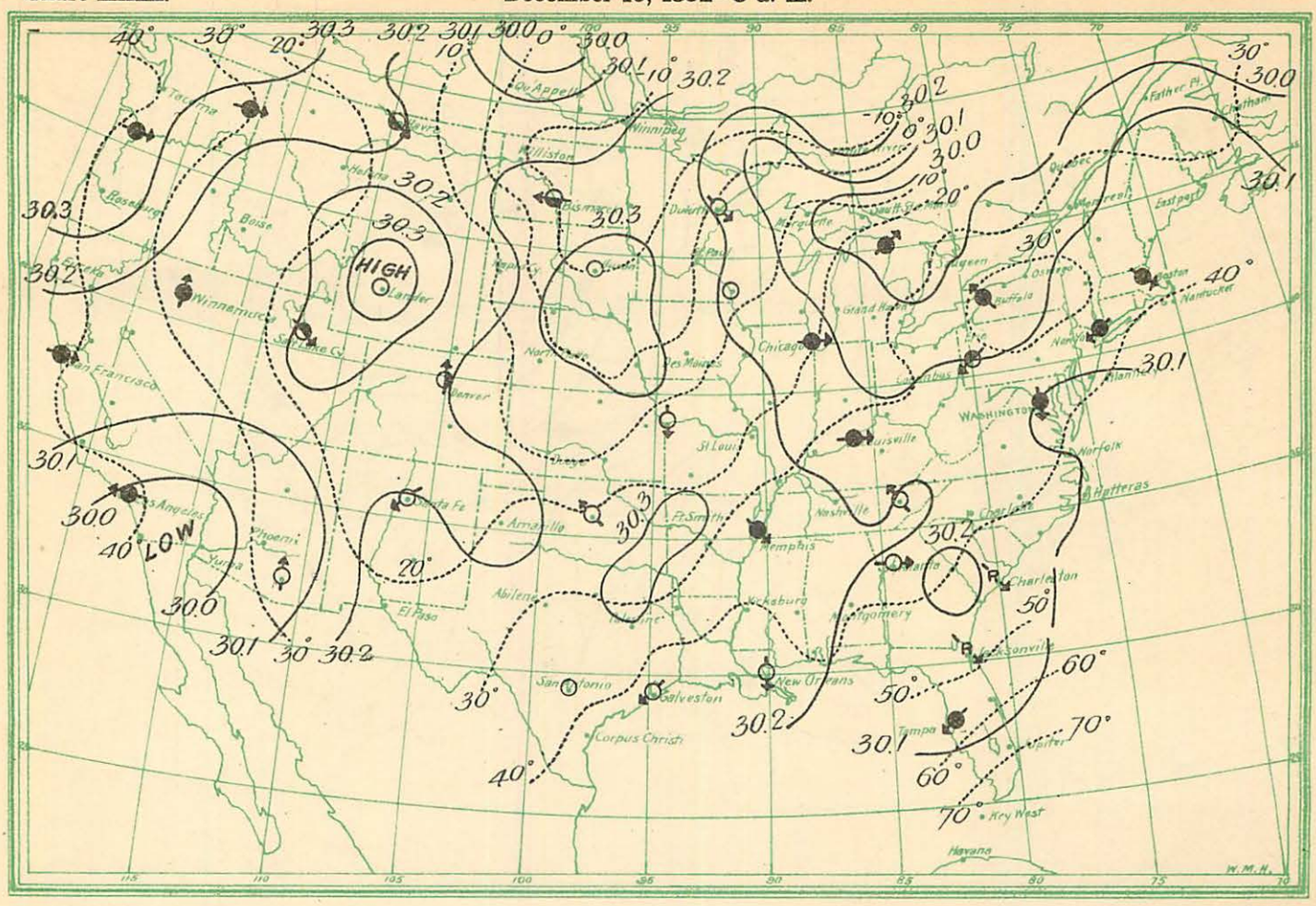


Chart XXXII. December 11, 1892—8 a. m.

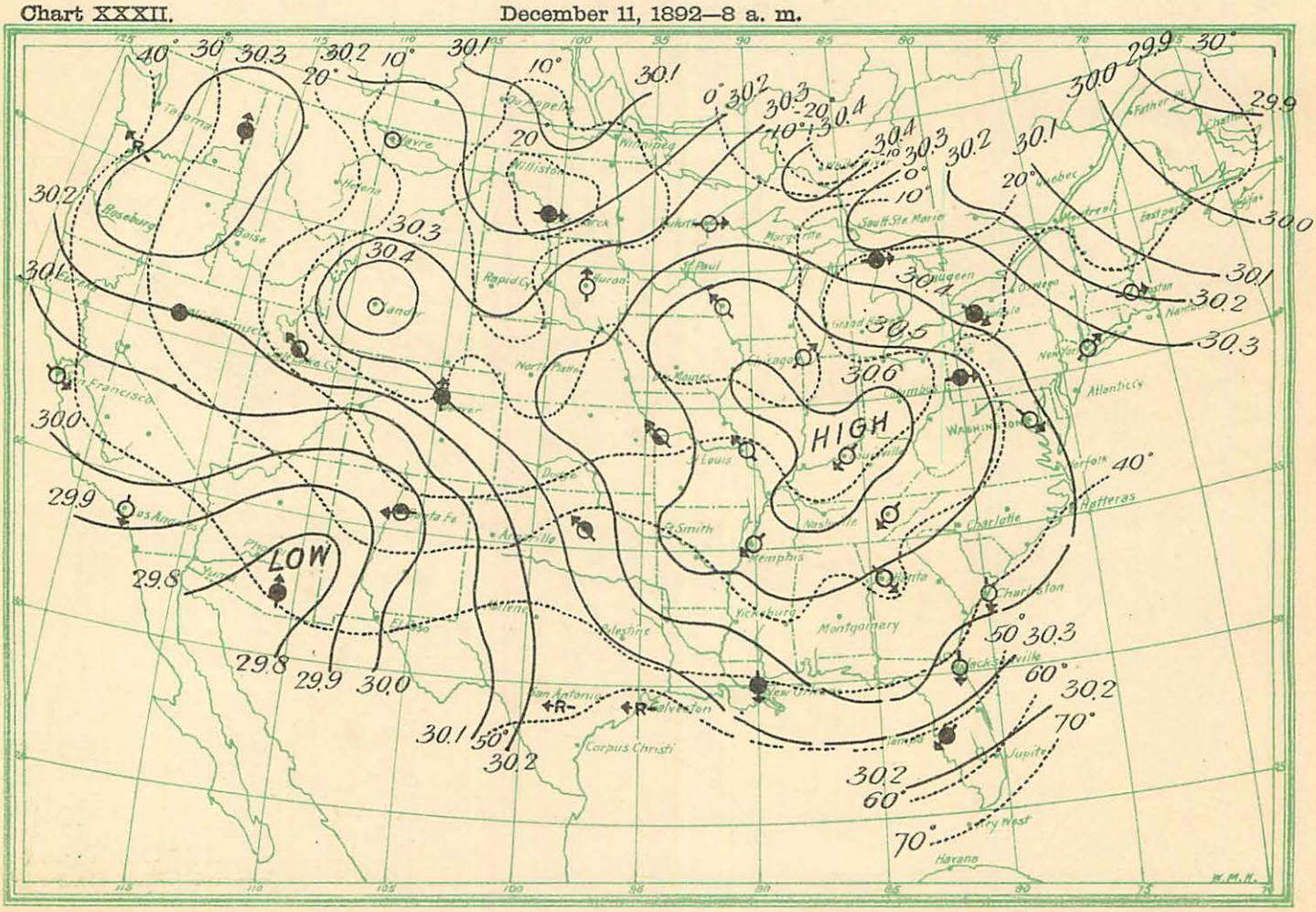


Chart XXXIII. December 24, 1892—8 a. m.

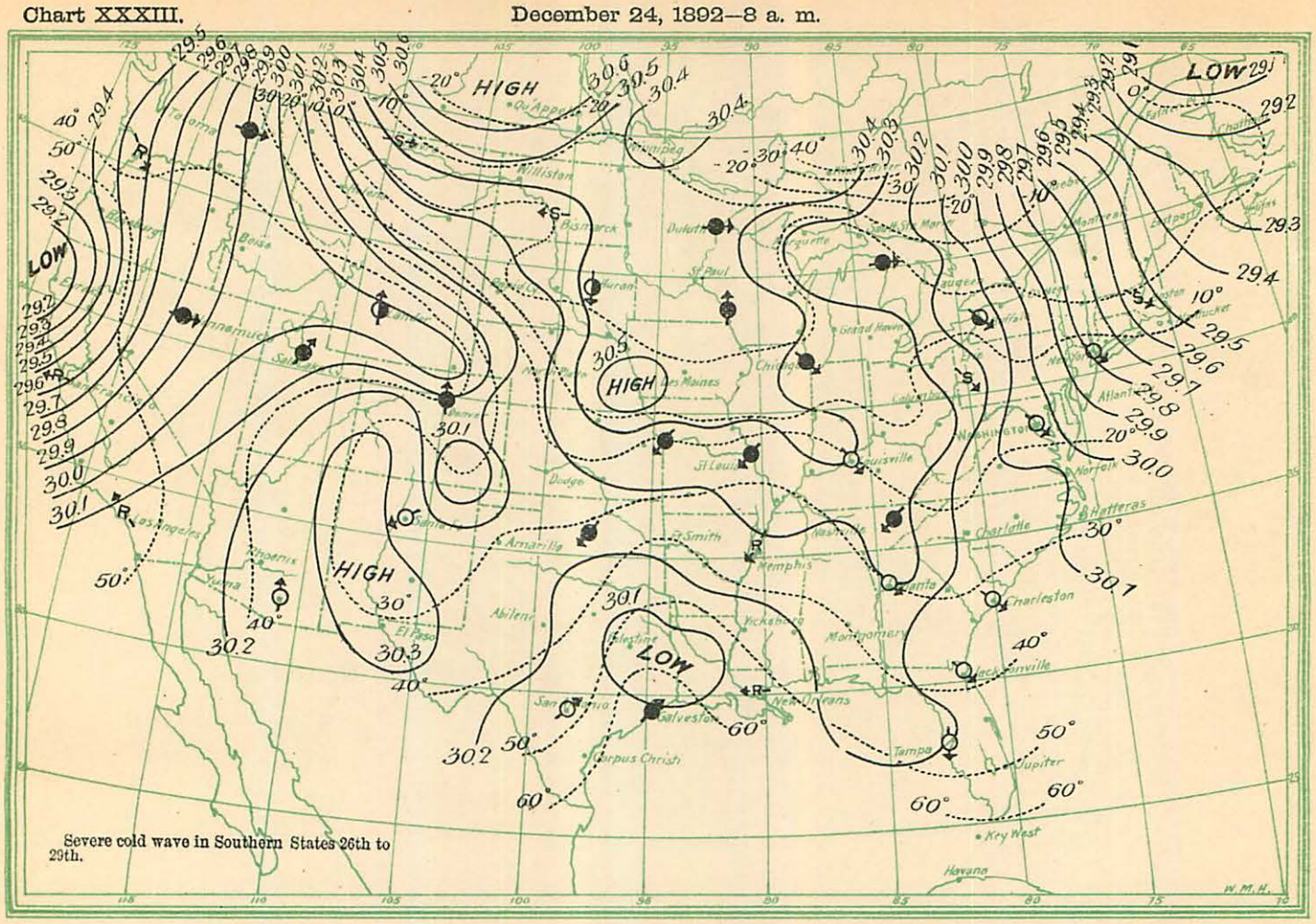


Chart XXXIV. December 25, 1892—8 a. m.

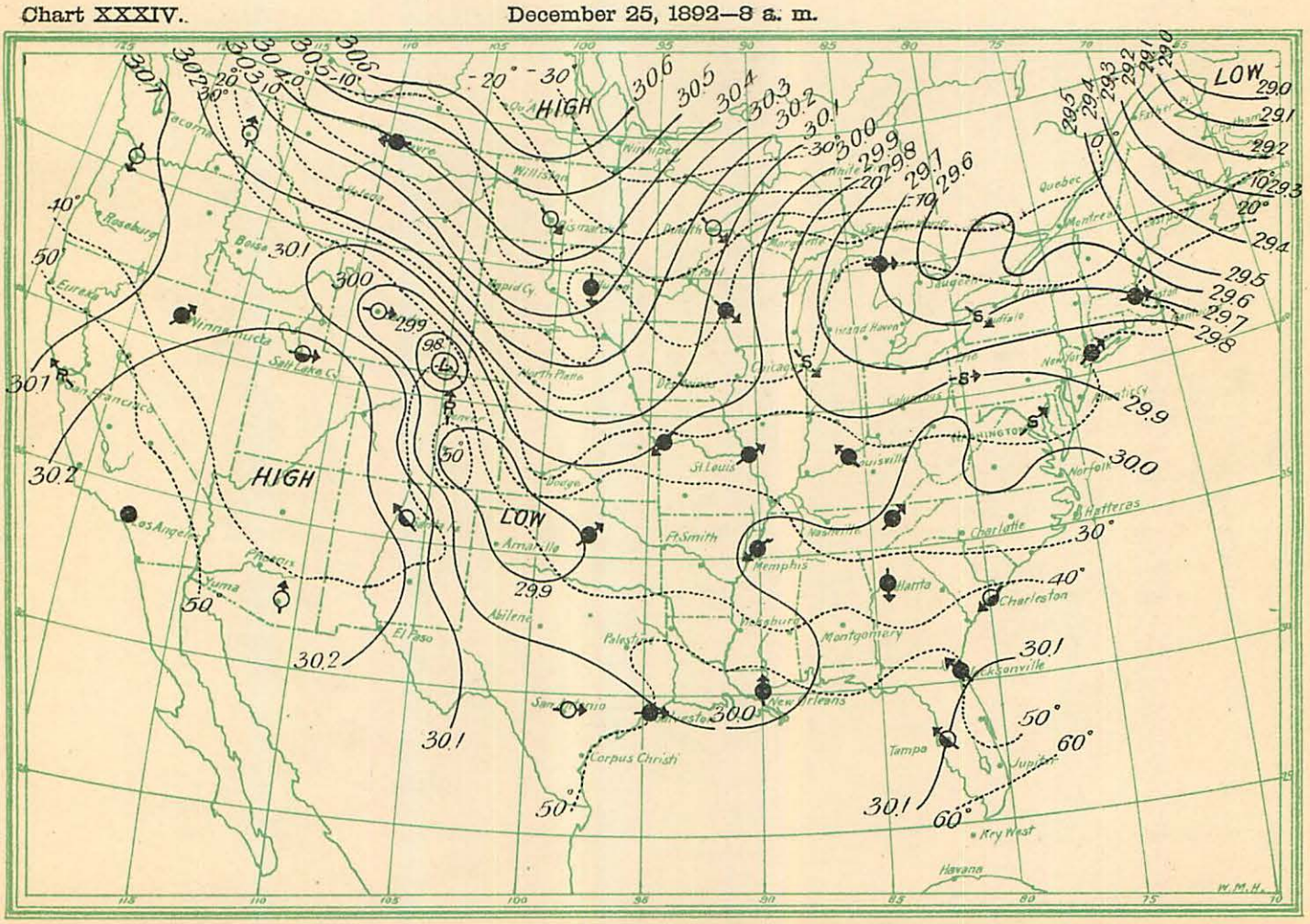


Chart XXXV. December 26, 1892—8 a. m.

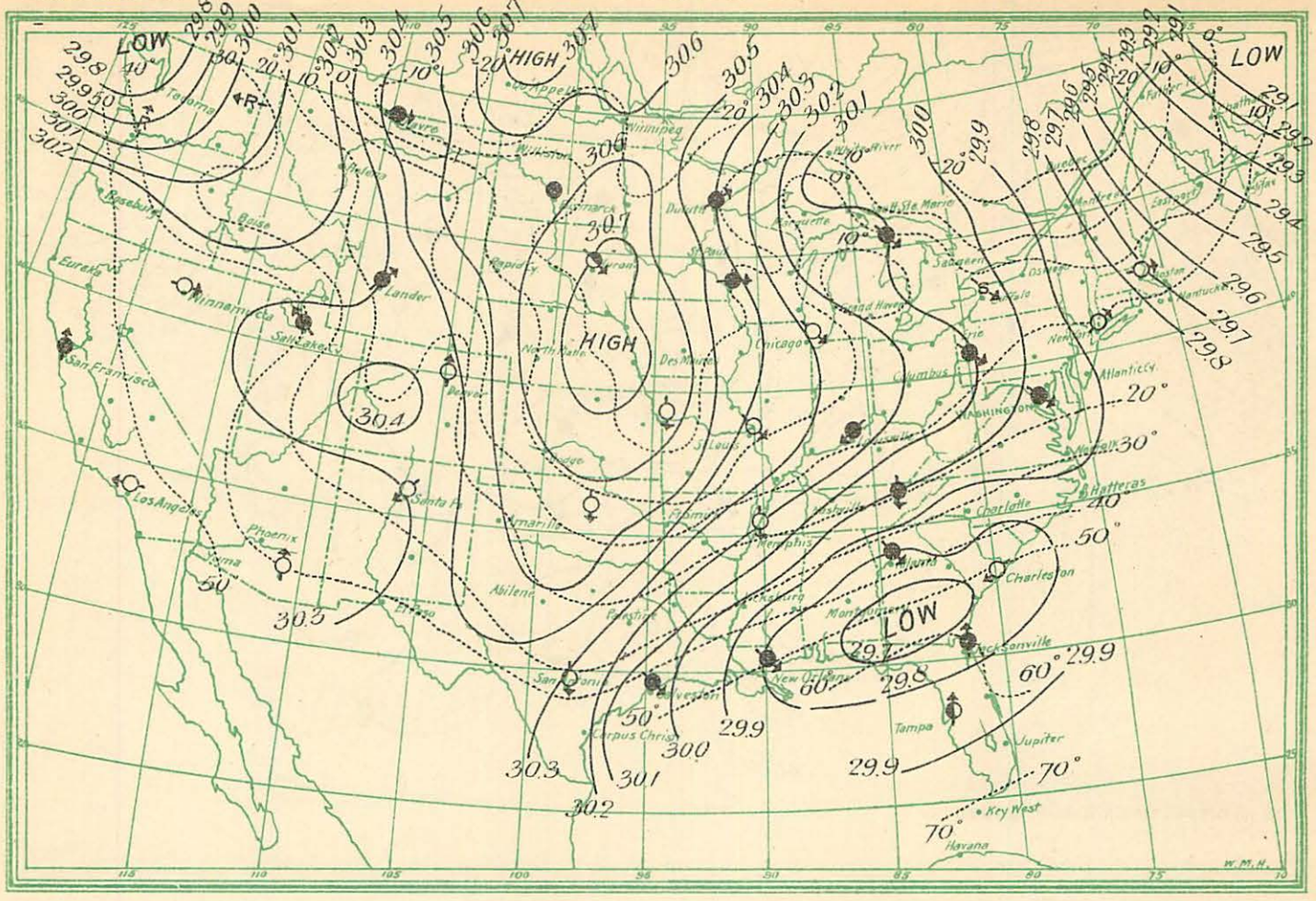
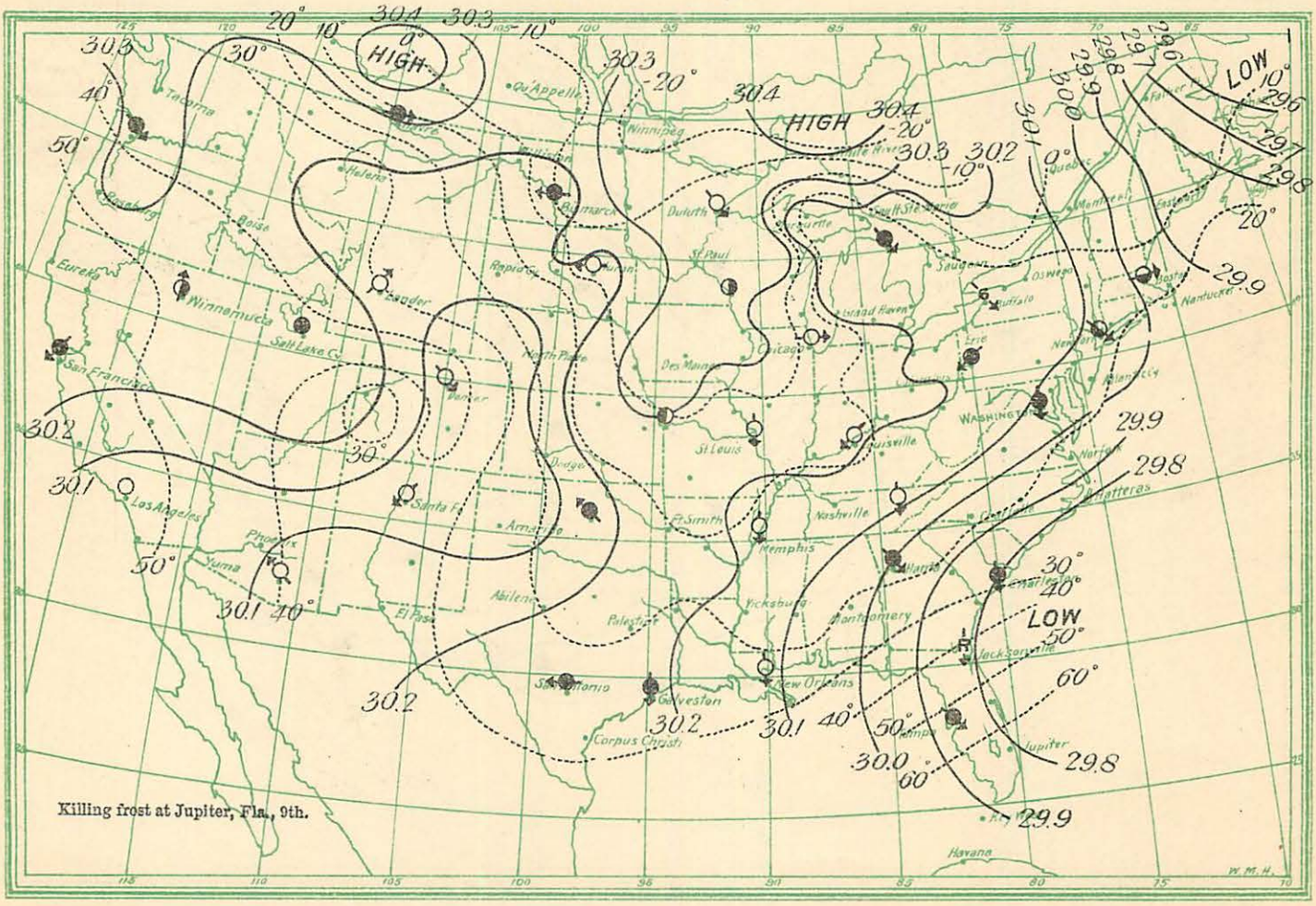


Chart XXXVI. December 27, 1892—8 a. m.



Killing frost at Jupiter, Fla., 9th.

Chart XXXVII. December 3, 1893—8 a. m.

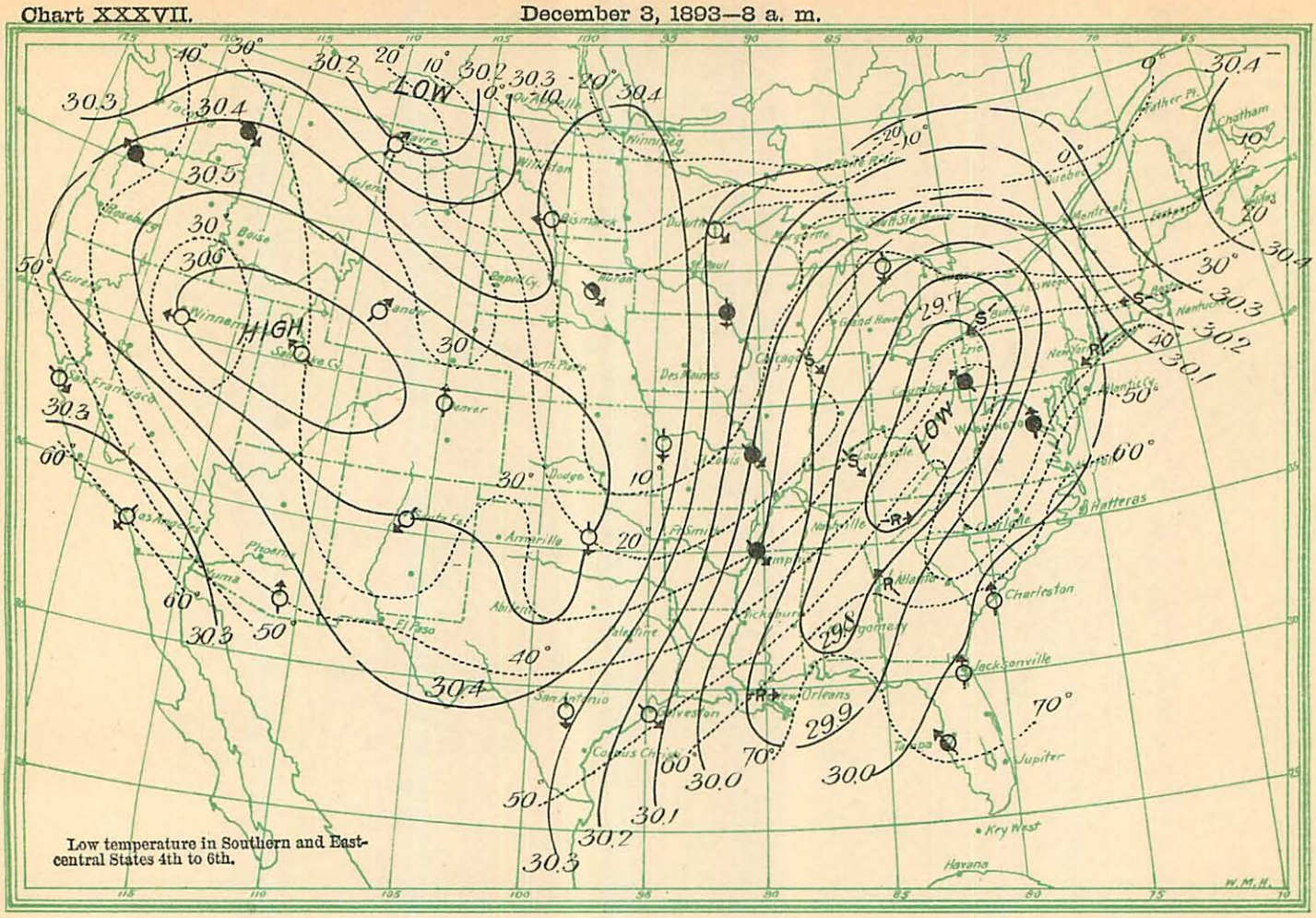


Chart XXXVIII. December 4, 1893—8 a. m.

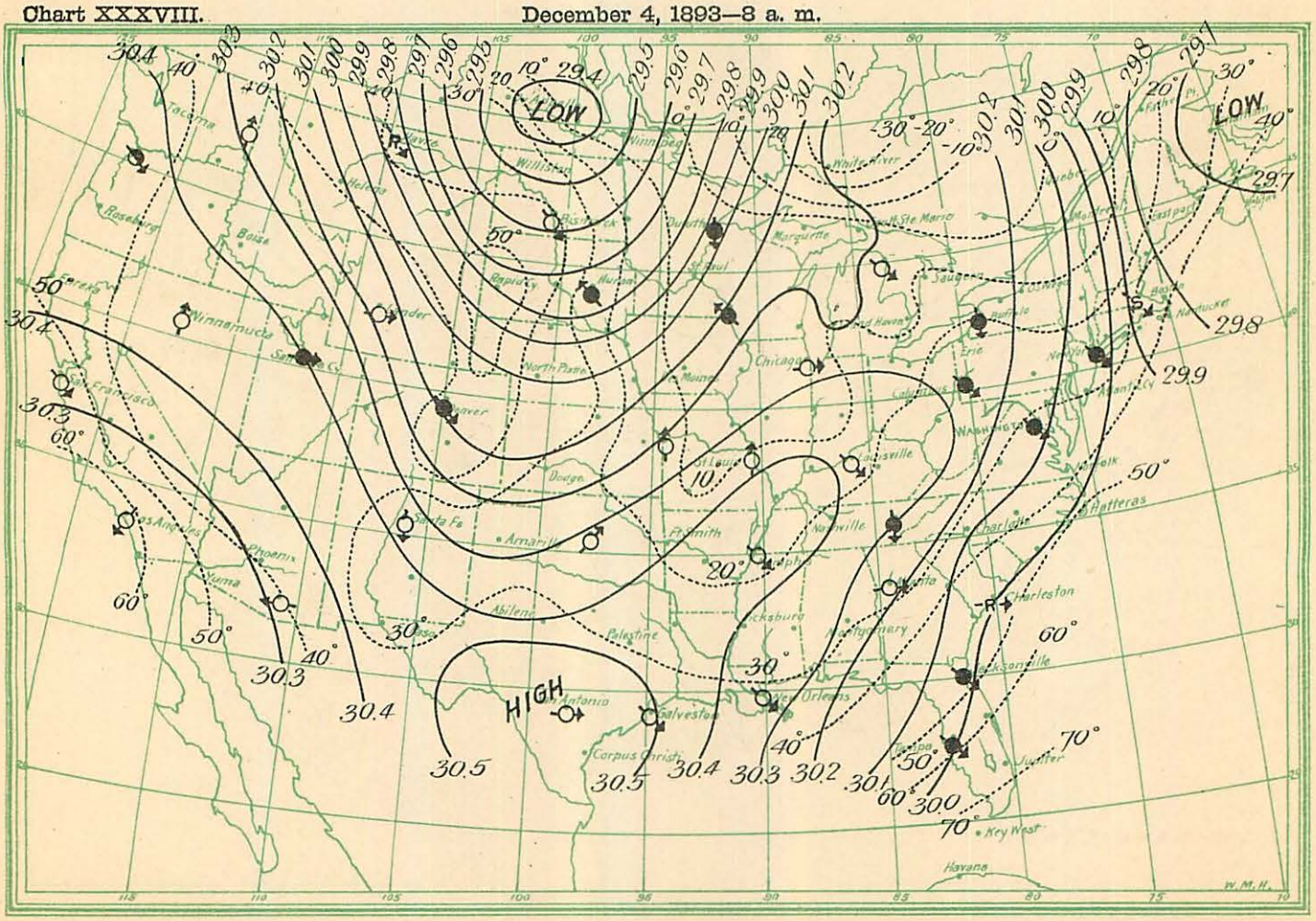


Chart XXXIX. December 5, 1893—8 a. m.

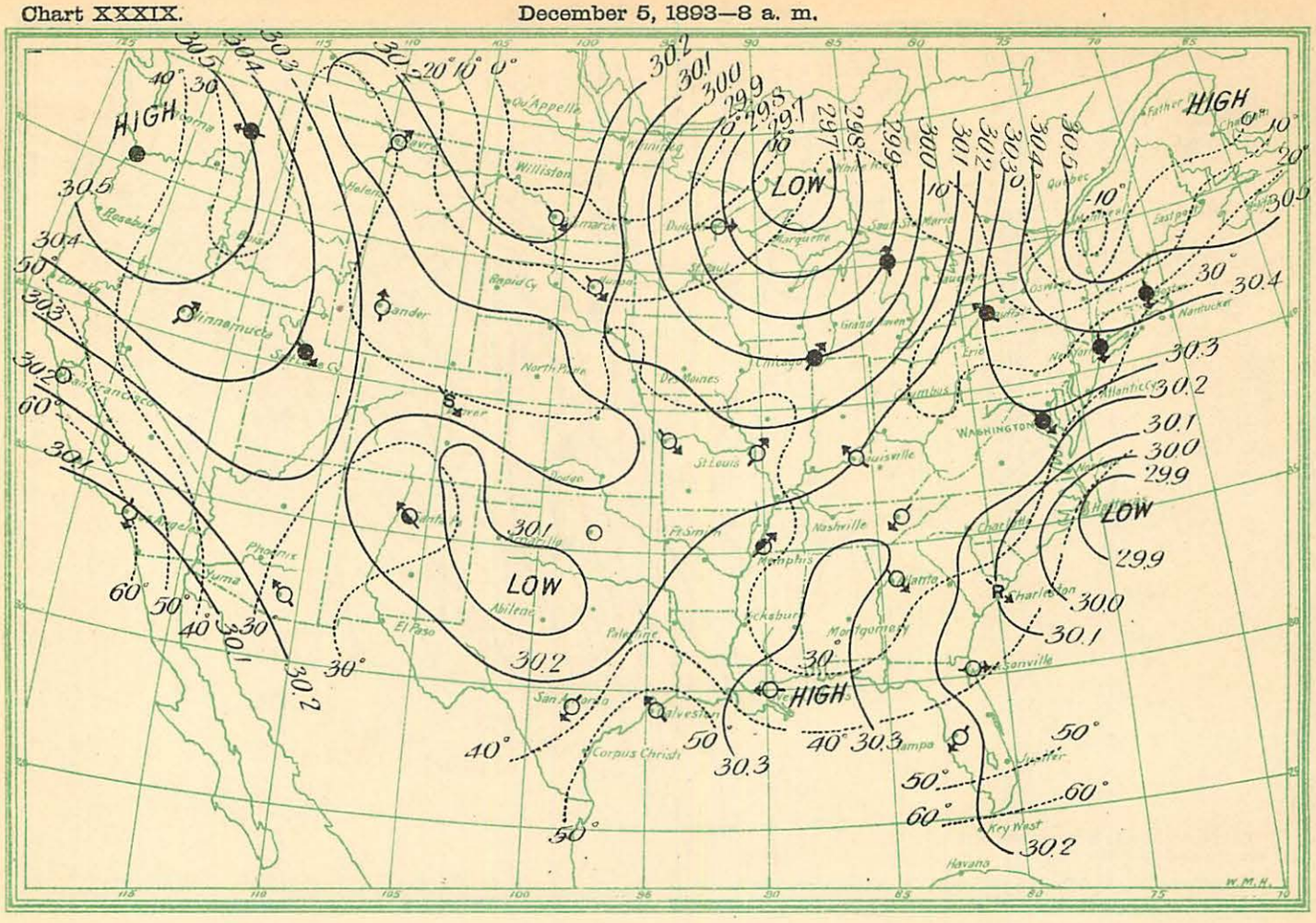


Chart XL. December 6, 1893—8 a. m.

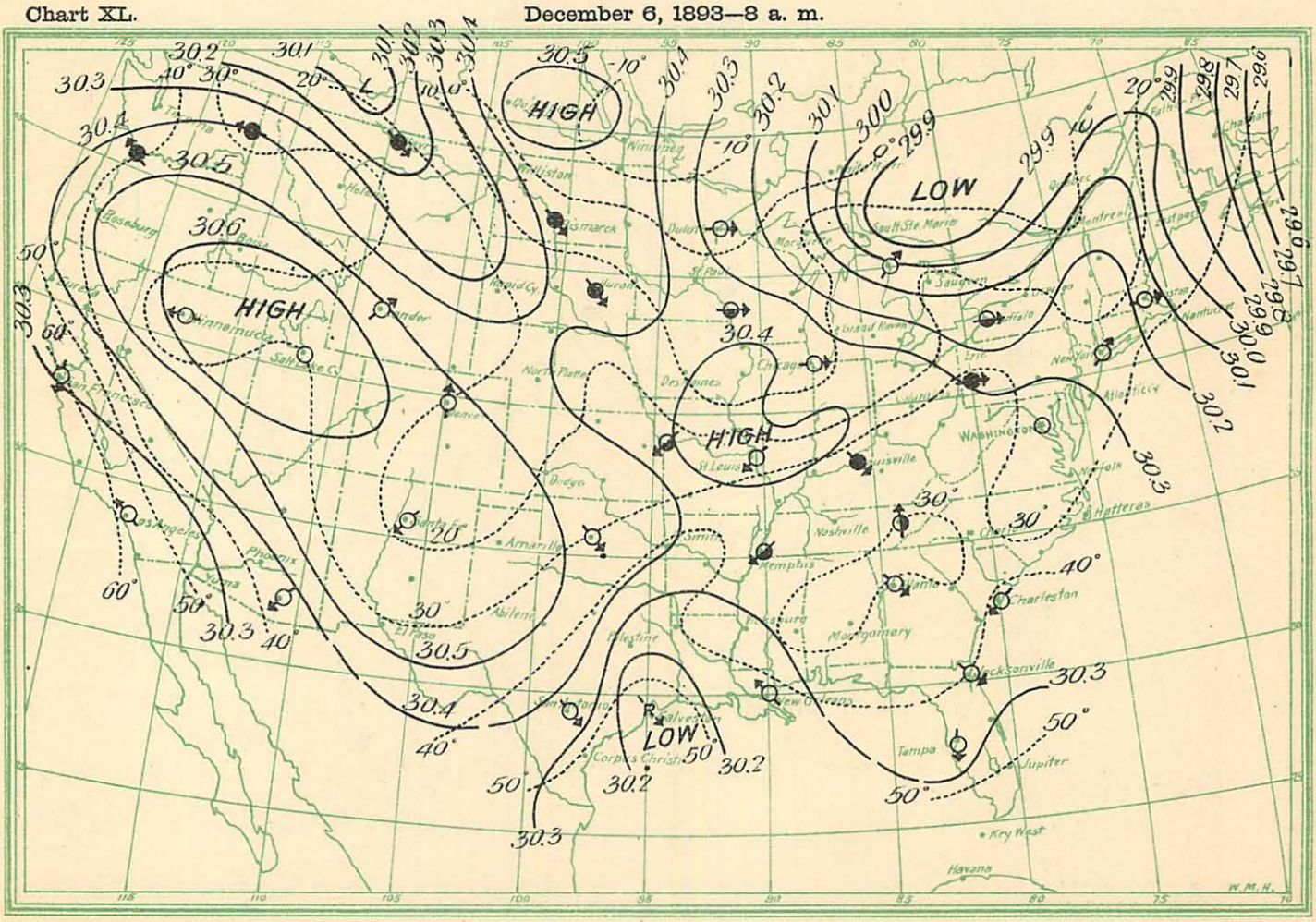


Chart XLI. December 11, 1893—8 a. m.

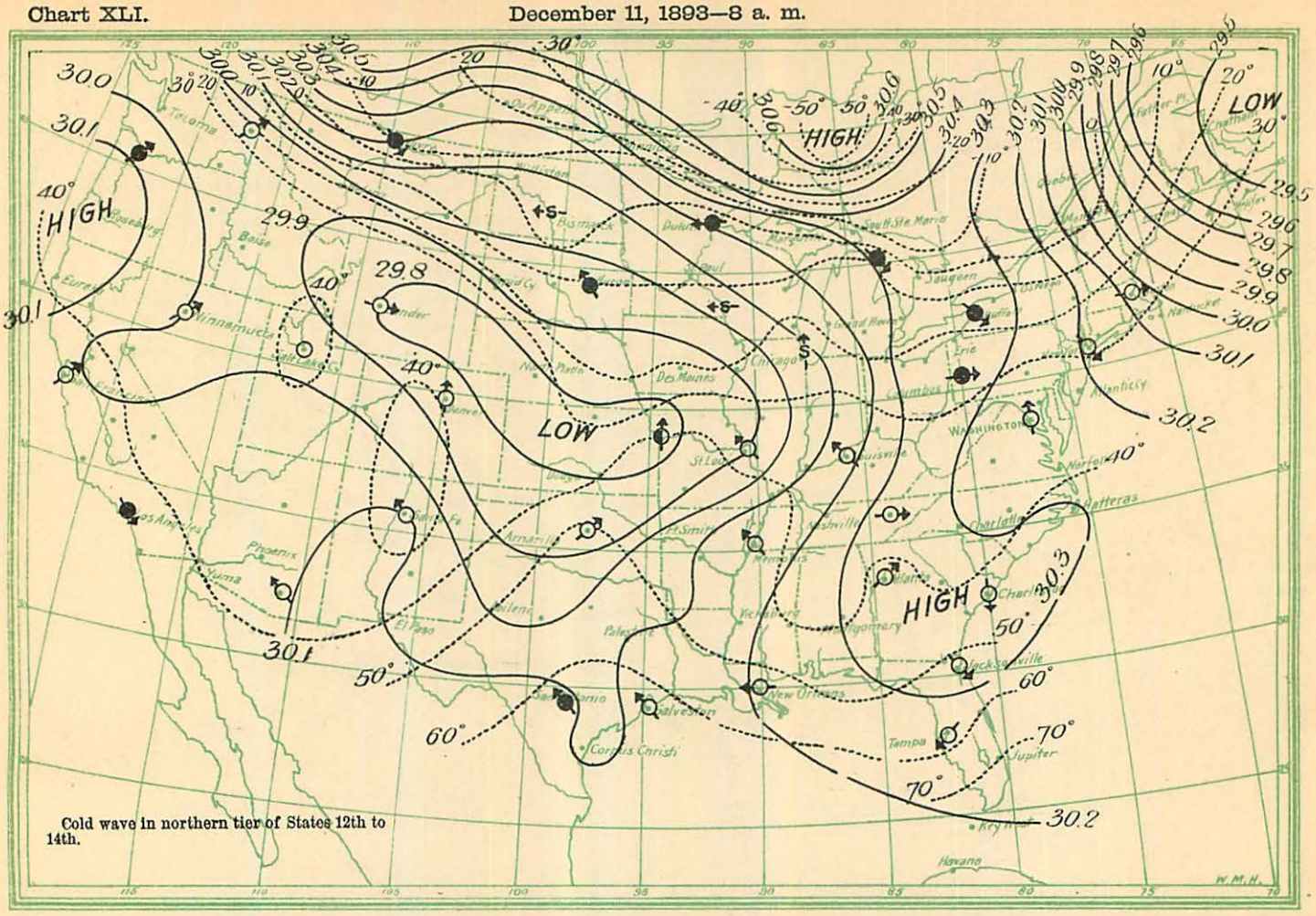


Chart XLII. December 12, 1893—8 a. m.

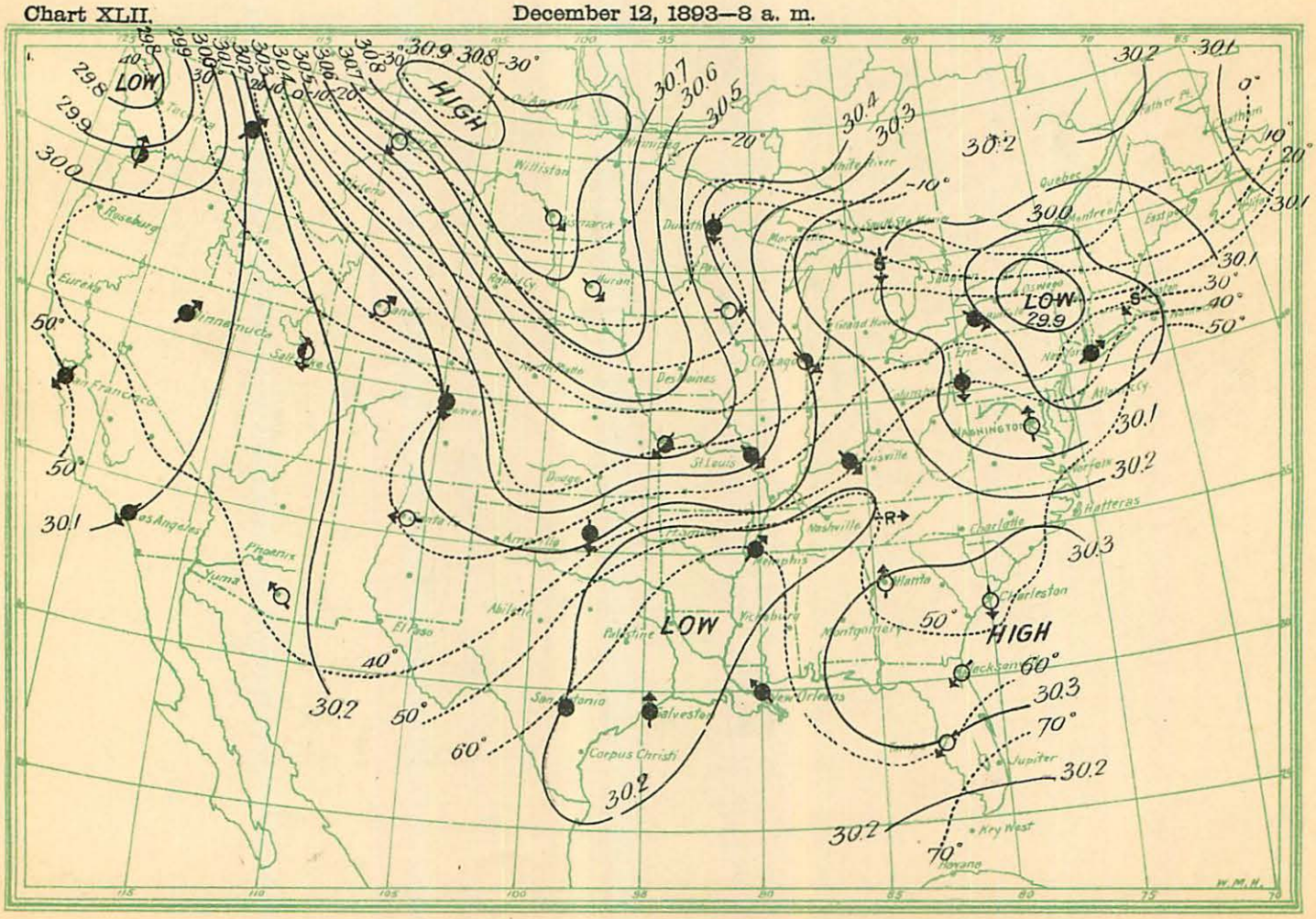


Chart XLIII. December 13, 1893—8 a. m.

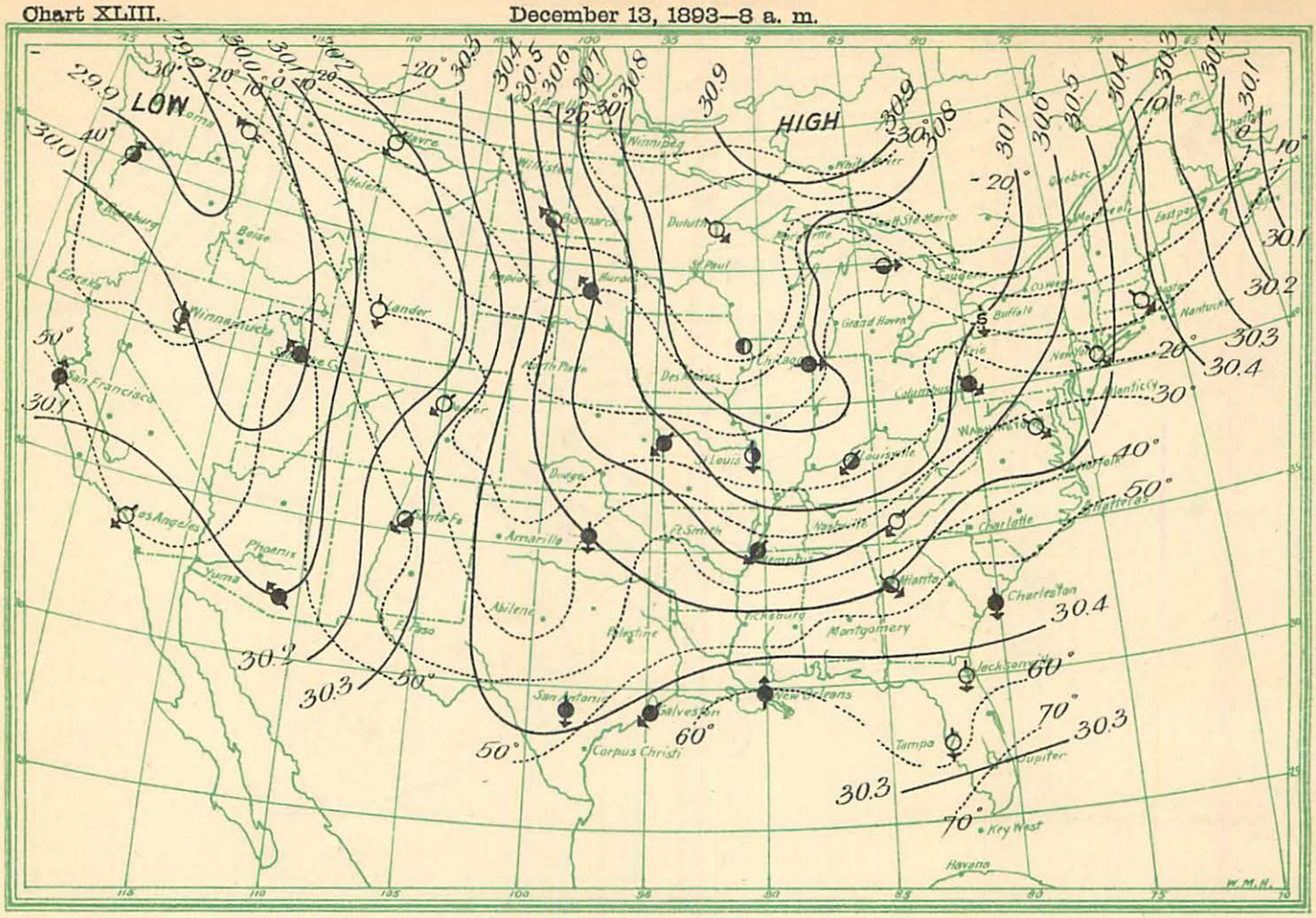


Chart XLIV. December 14, 1893—8 a. m.

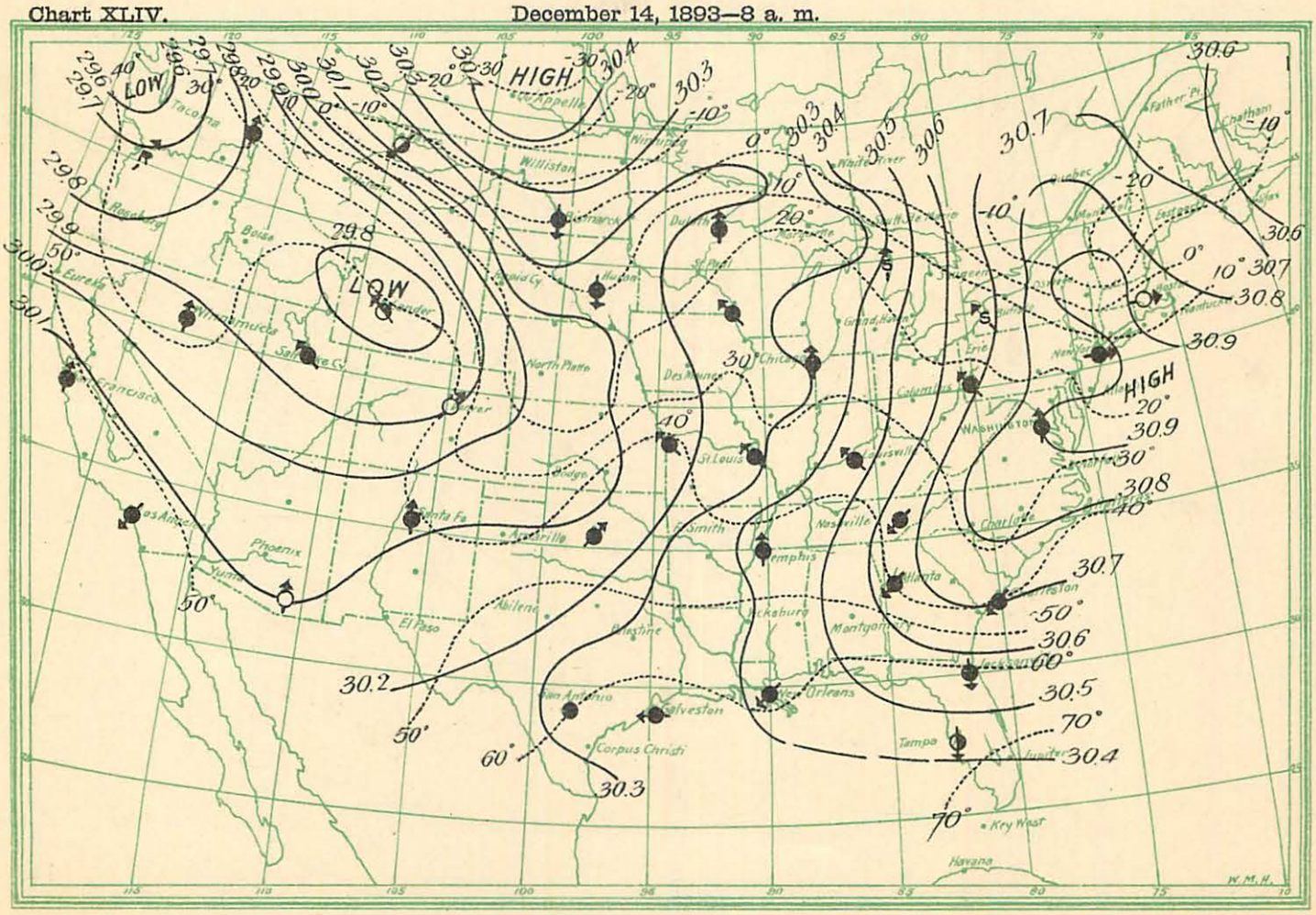


Chart XLV. December 27, 1893—8 a. m.

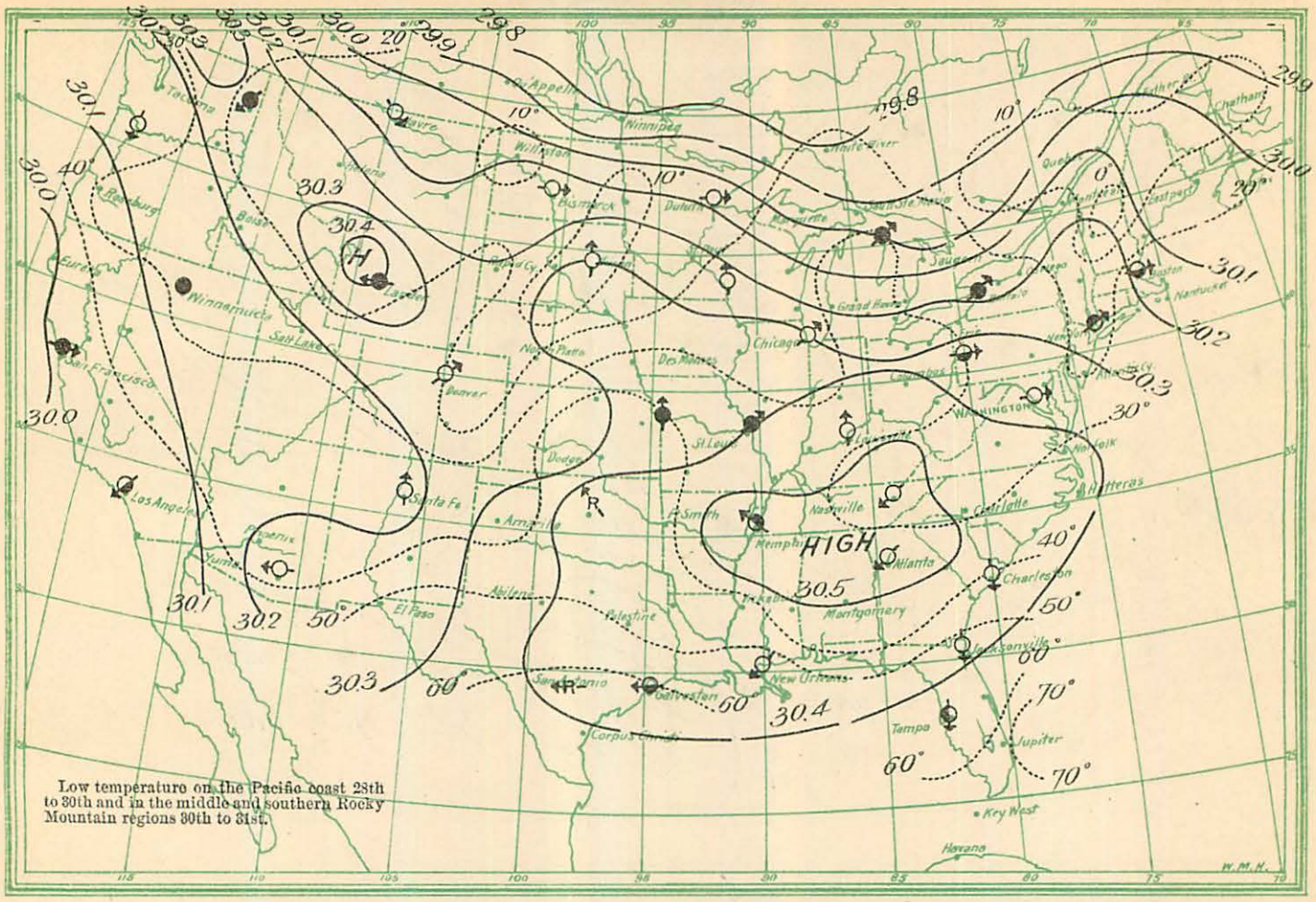


Chart XLVI. December 28, 1893—8 a. m.

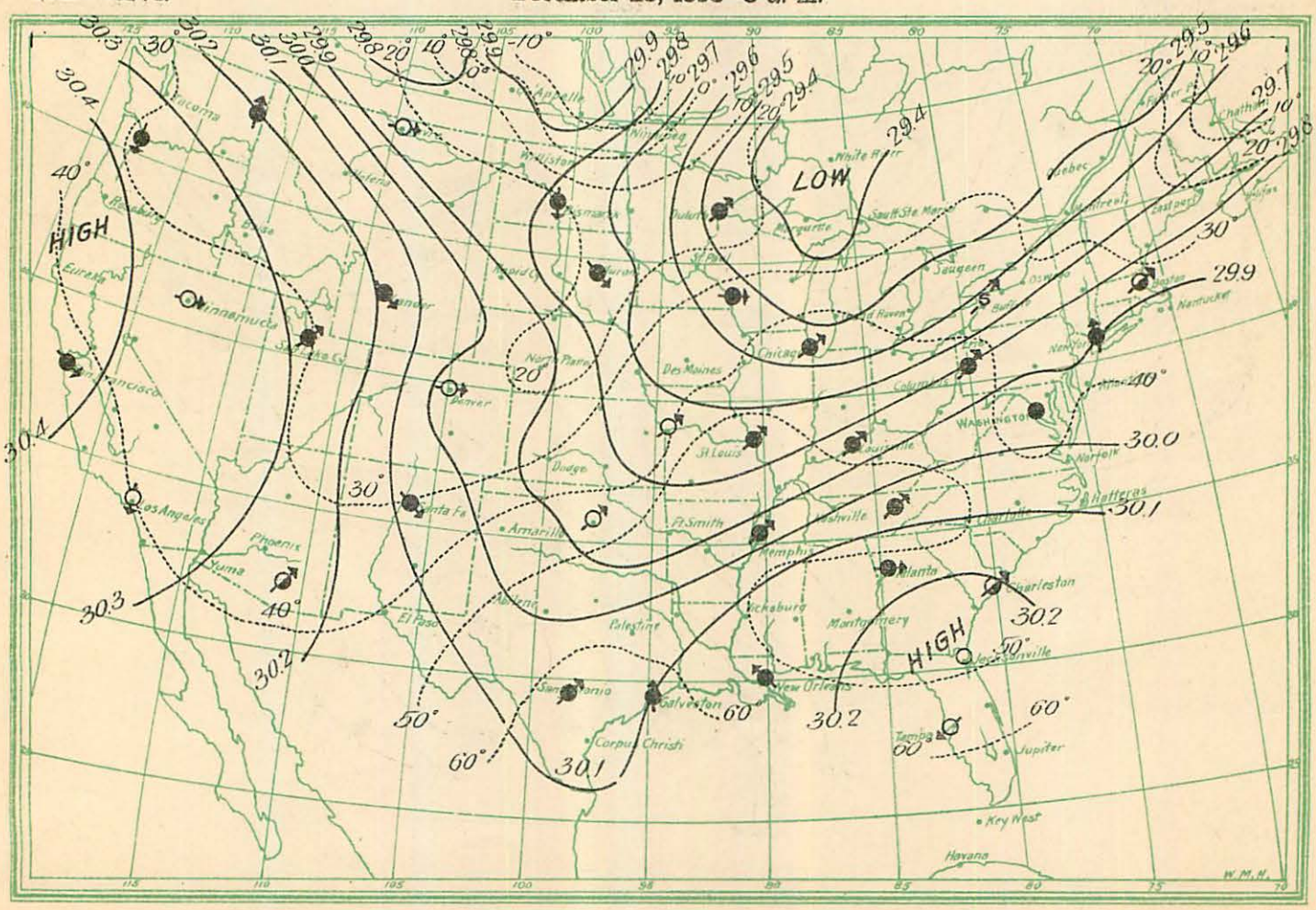


Chart XLVII. December 29, 1893—8 a. m.

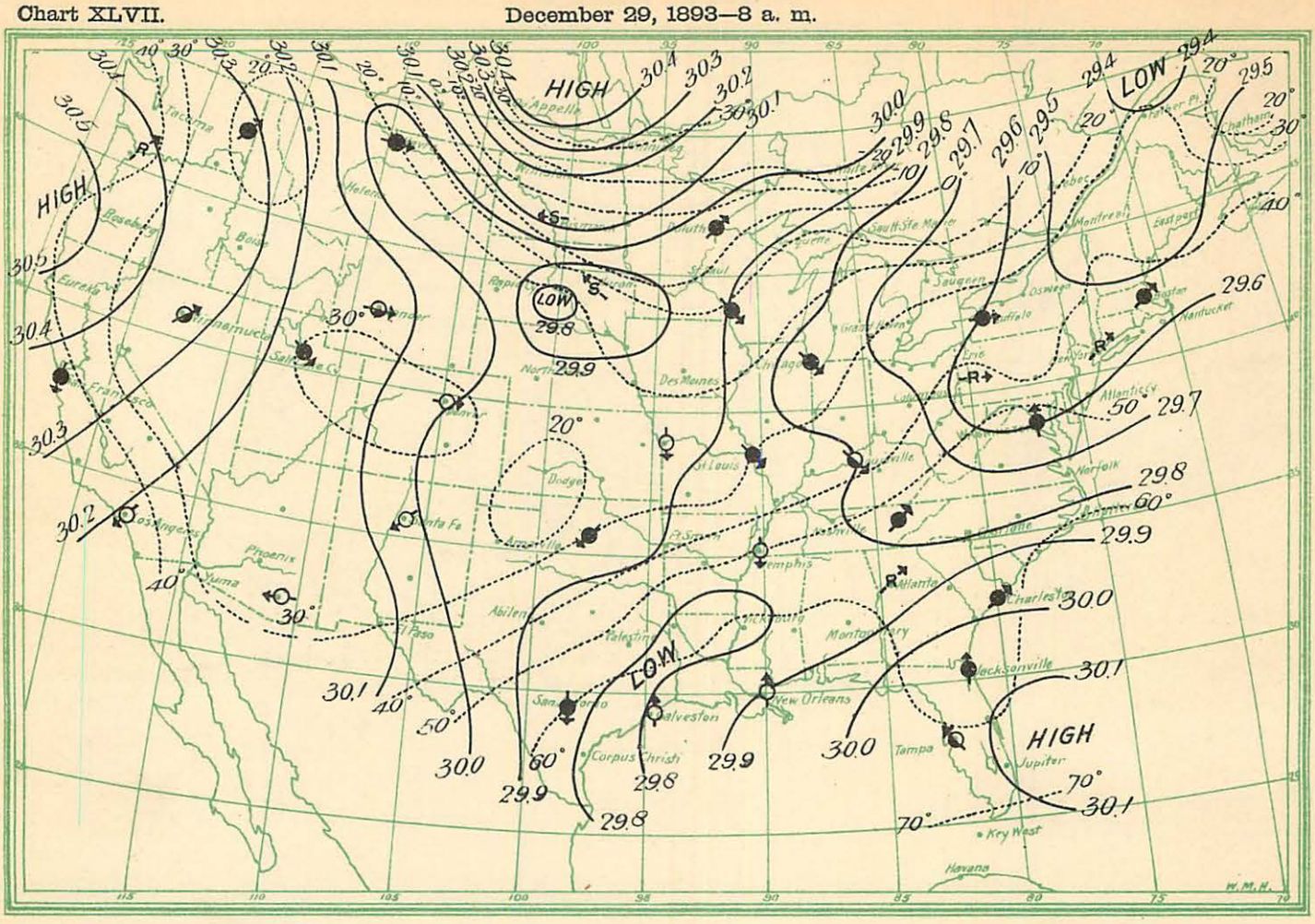


Chart XLVIII. December 30, 1893—8 a. m.

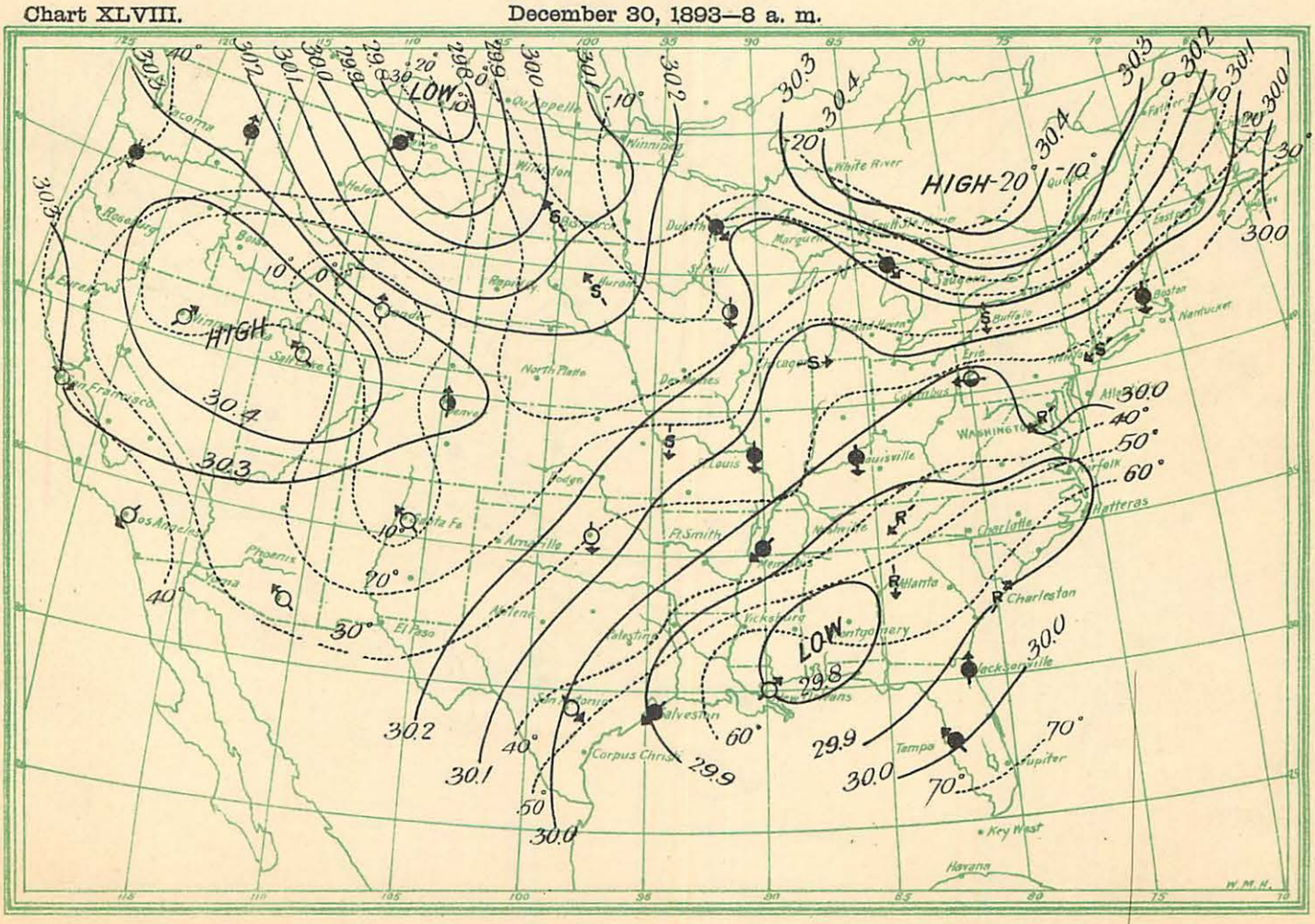


Chart XLIX. December 26, 1894—8 a. m.

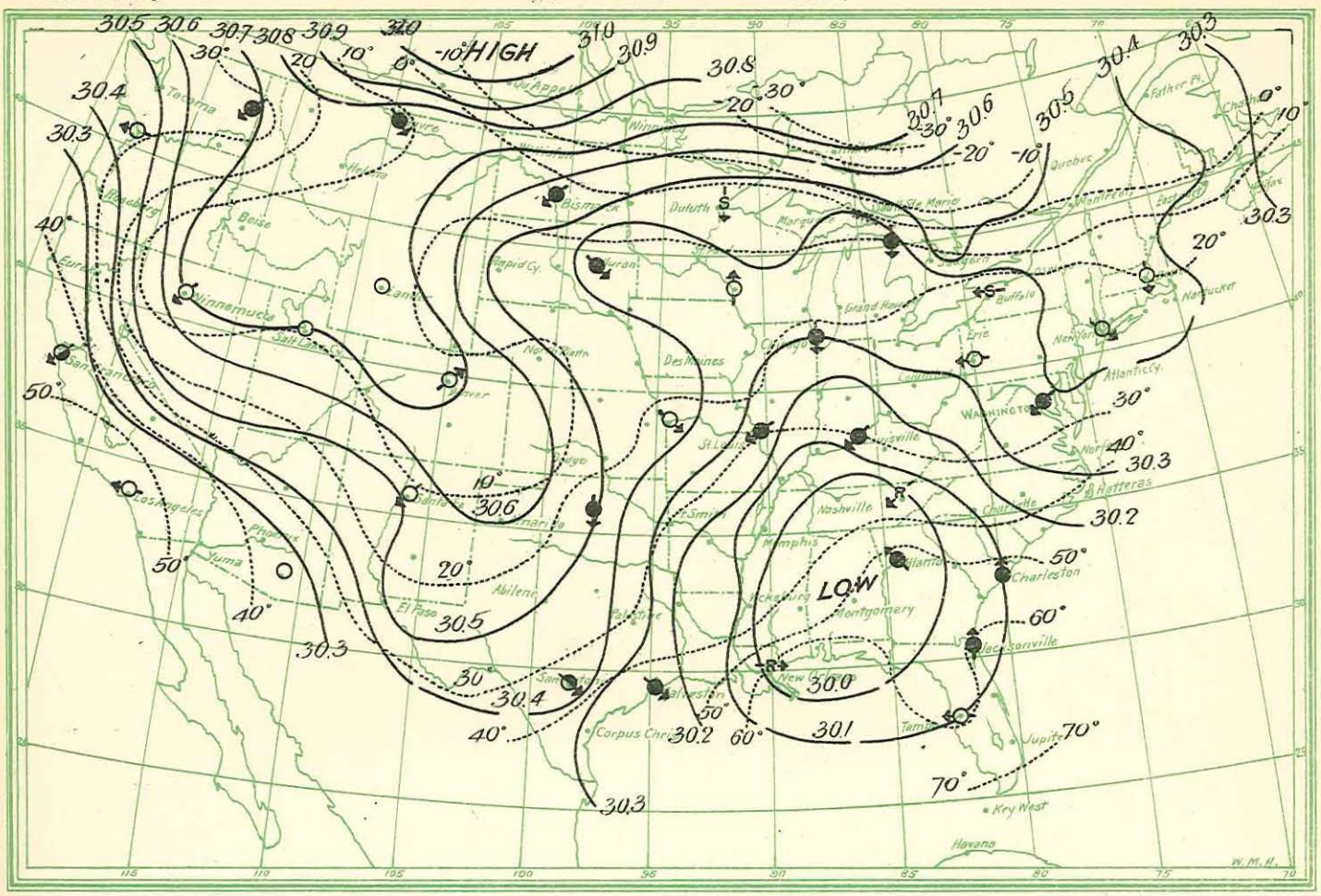


Chart L. December 27, 1894—8 a. m.

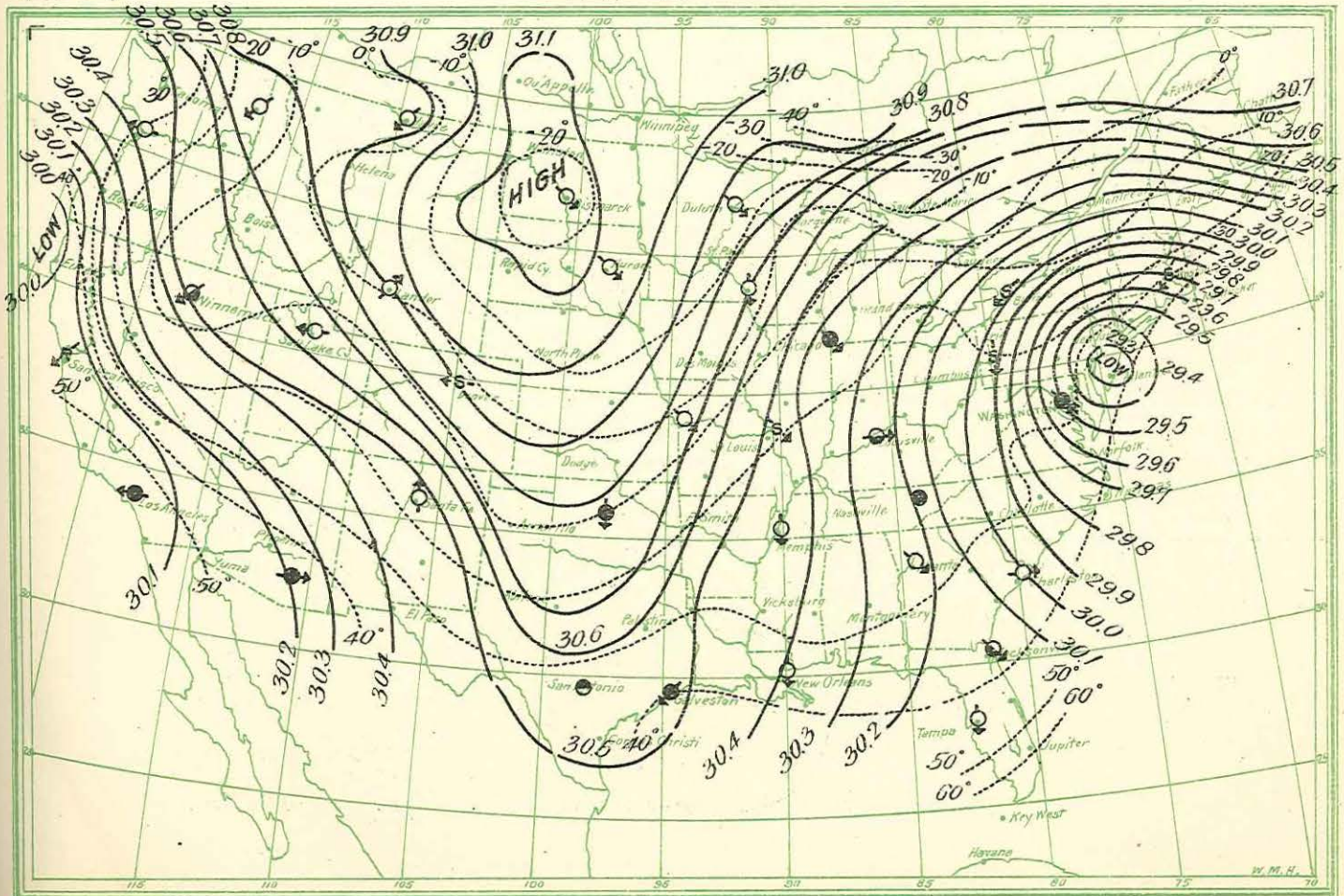


Chart LI. December 28, 1894—8 a. m.

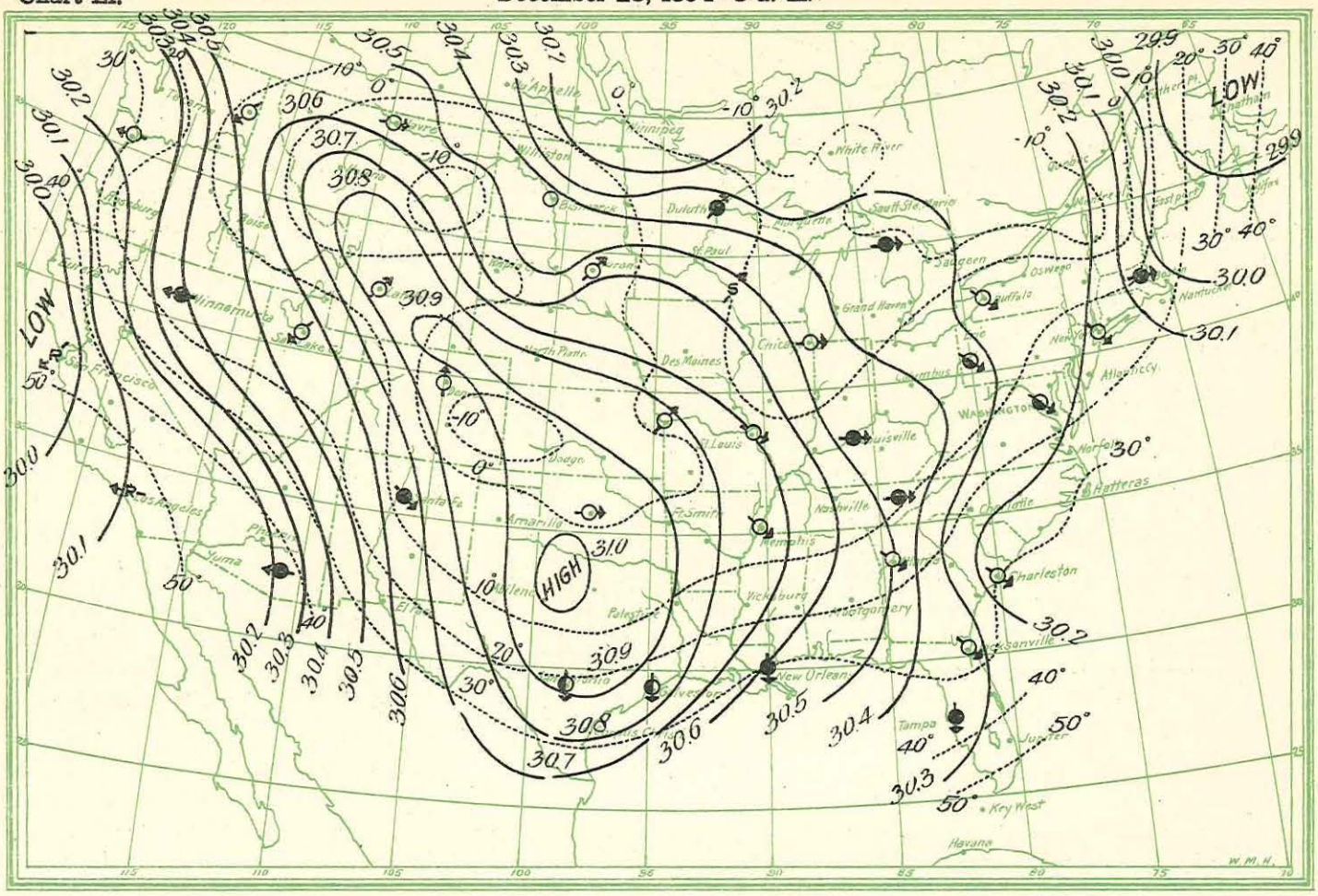


Chart LII. December 29, 1894—8 a. m.

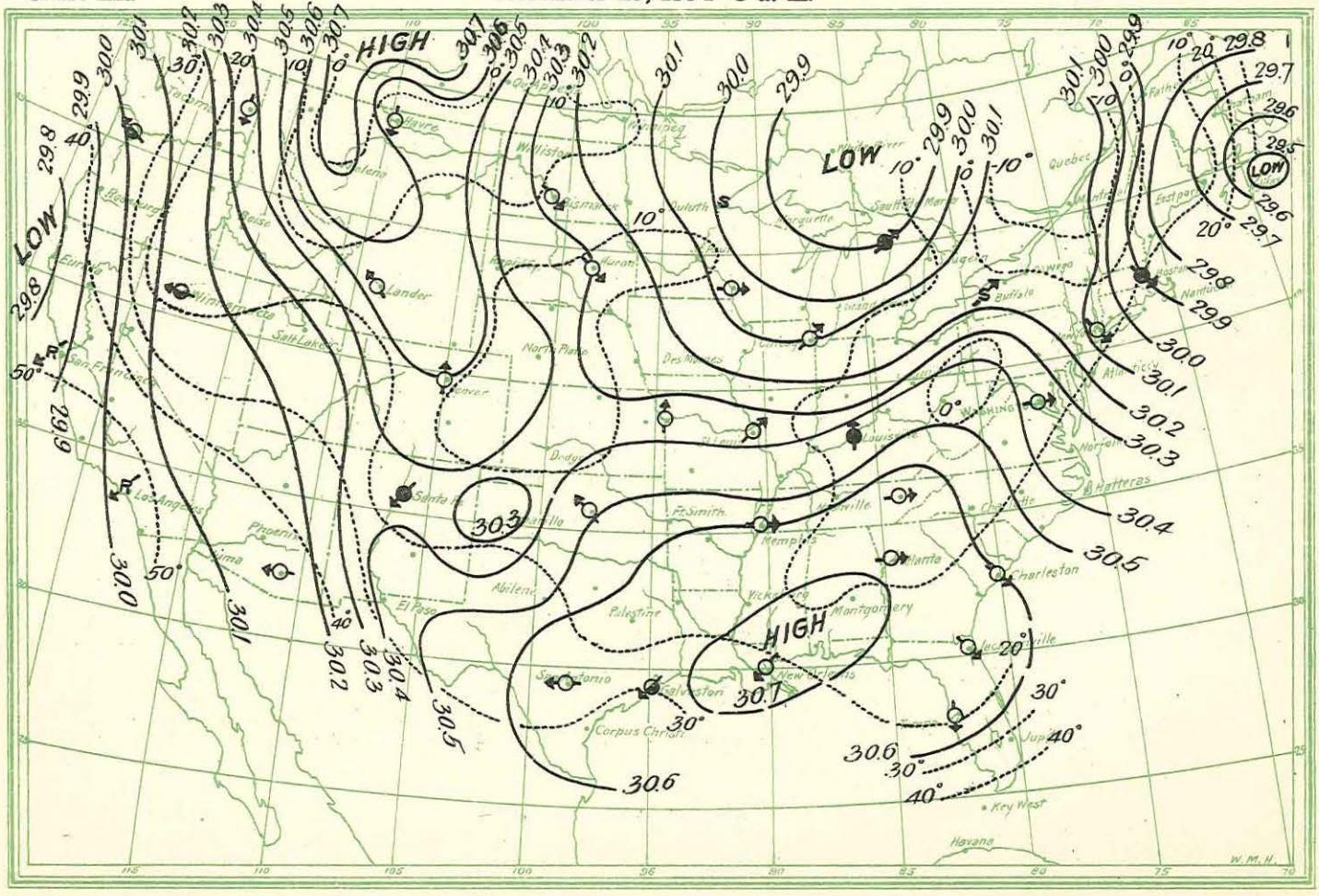


Chart LIII. December 2, 1895—8 a. m.

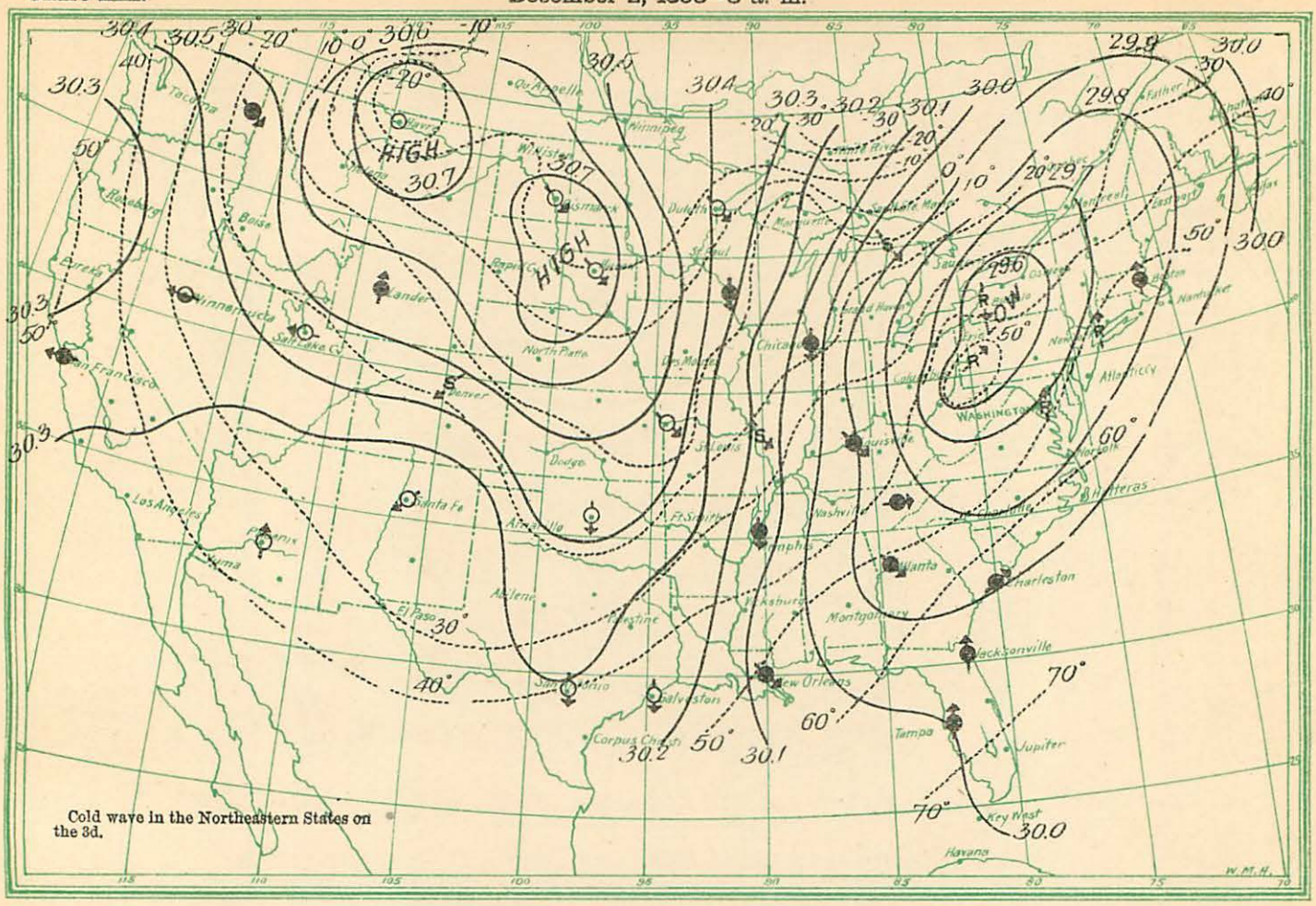


Chart LIV. December 2, 1895—8 p. m.

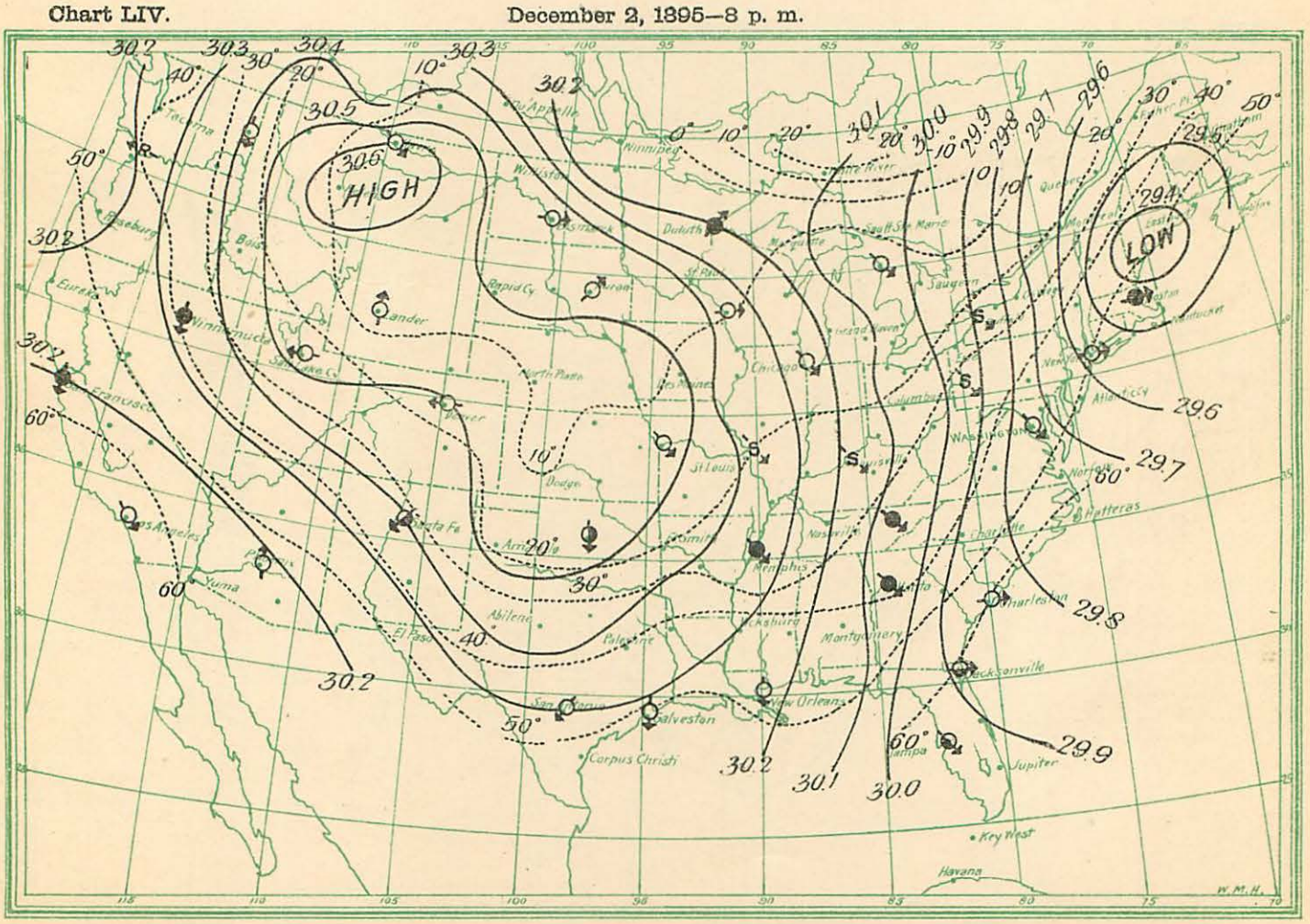


Chart LV. December 3, 1895—8 a. m.

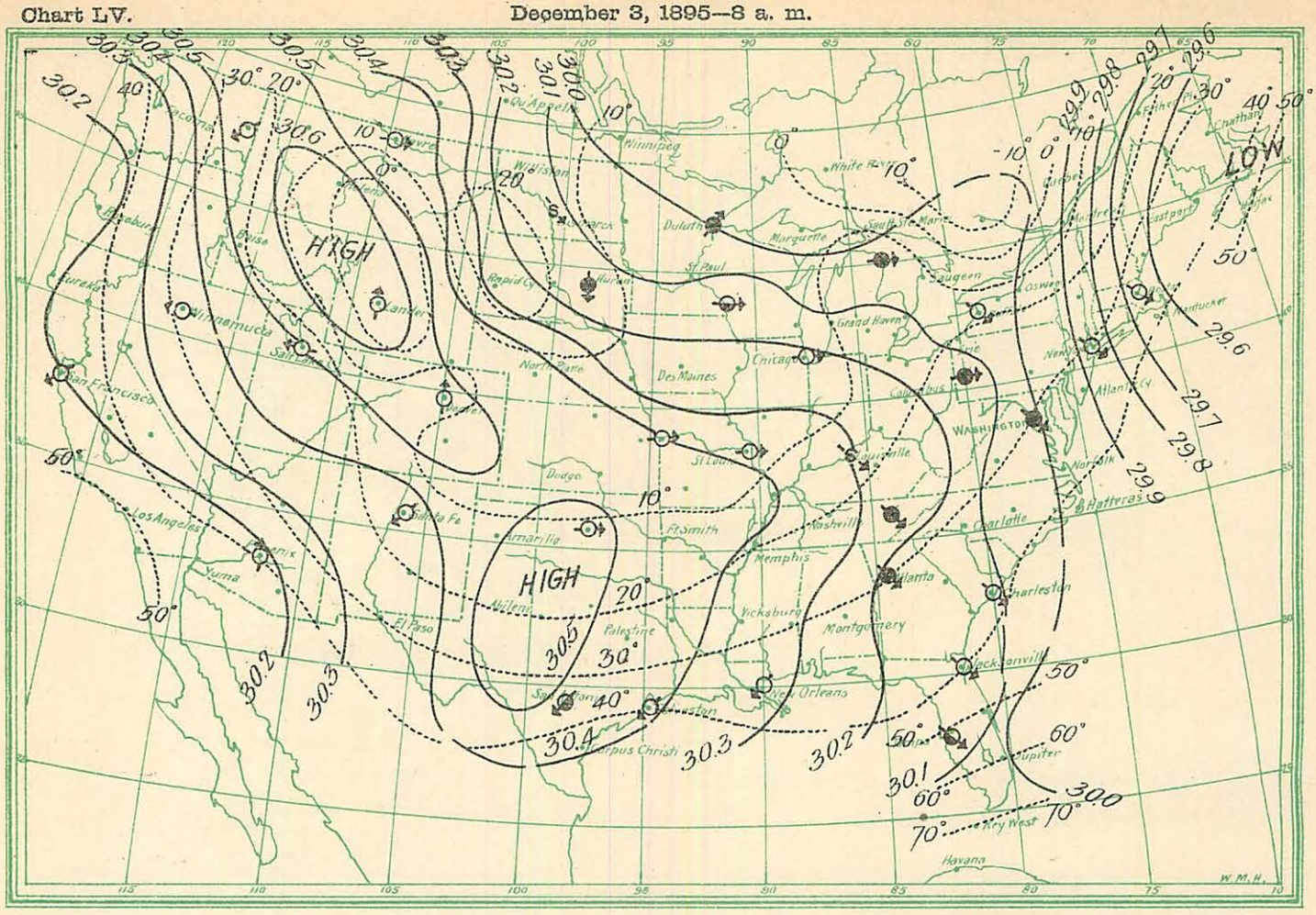


Chart LVI. December 3, 1895—8 p. m.

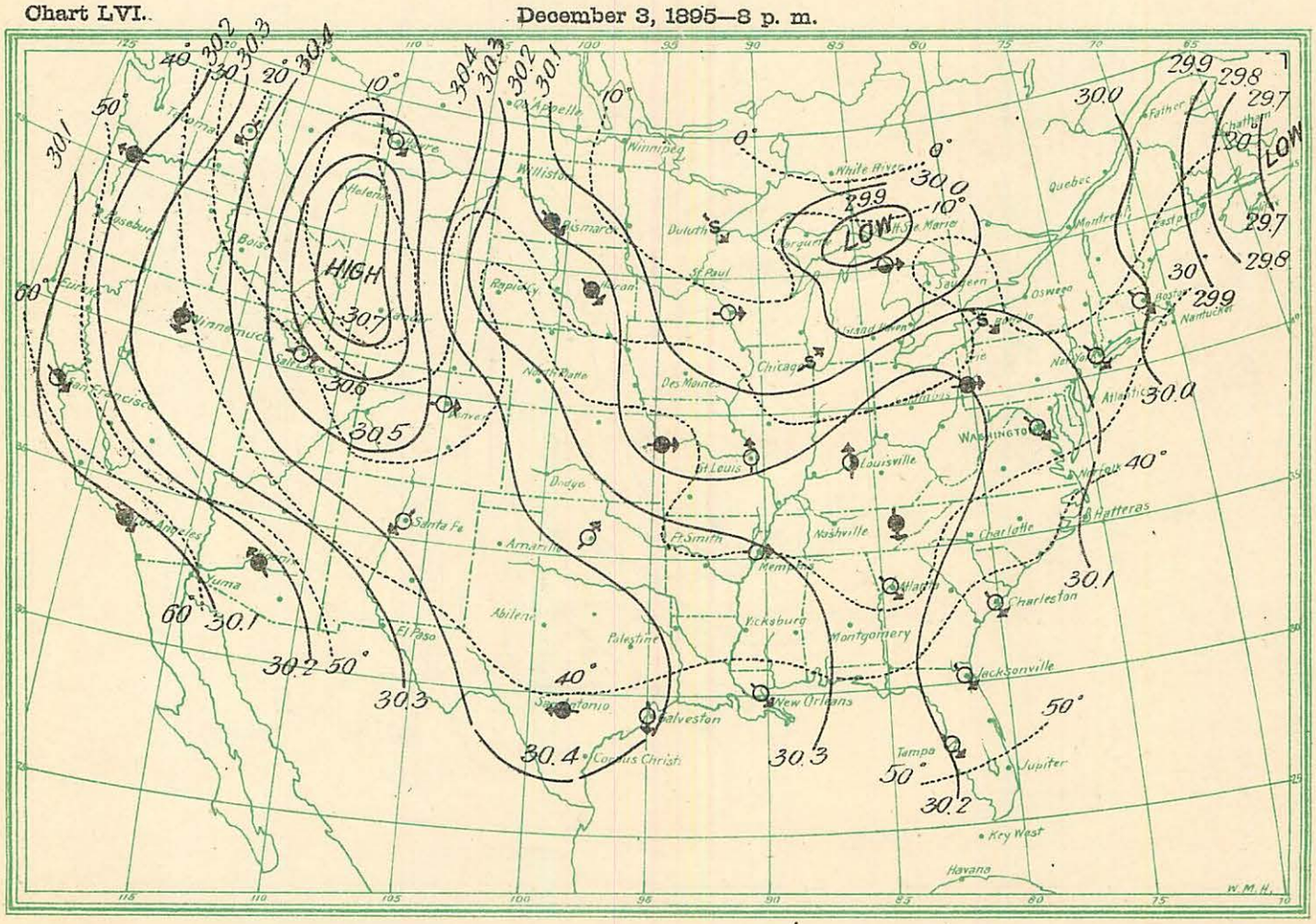


Chart LVII. December 1, 1897—8 a. m.

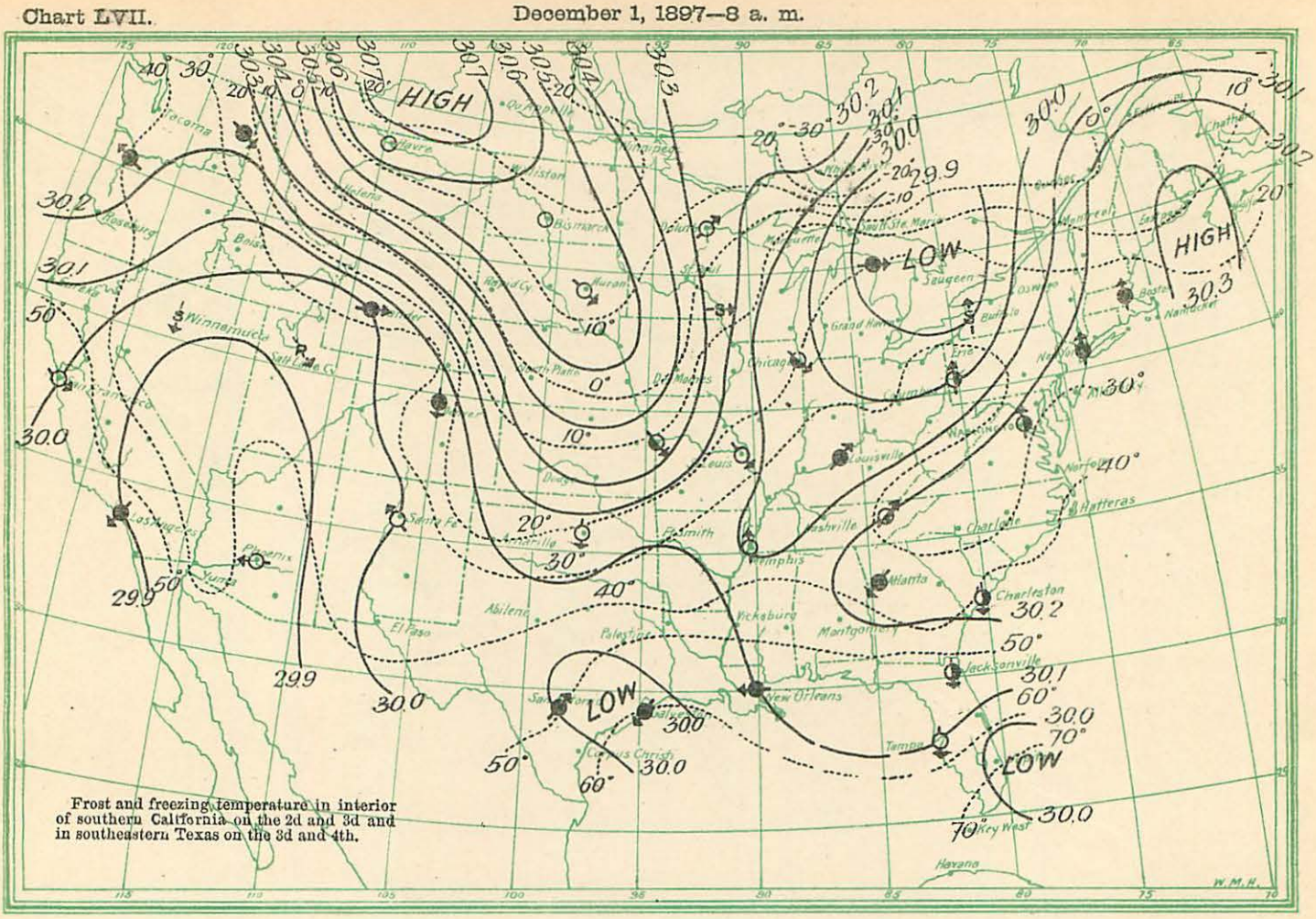


Chart LVIII. December 2, 1897—8 a. m.

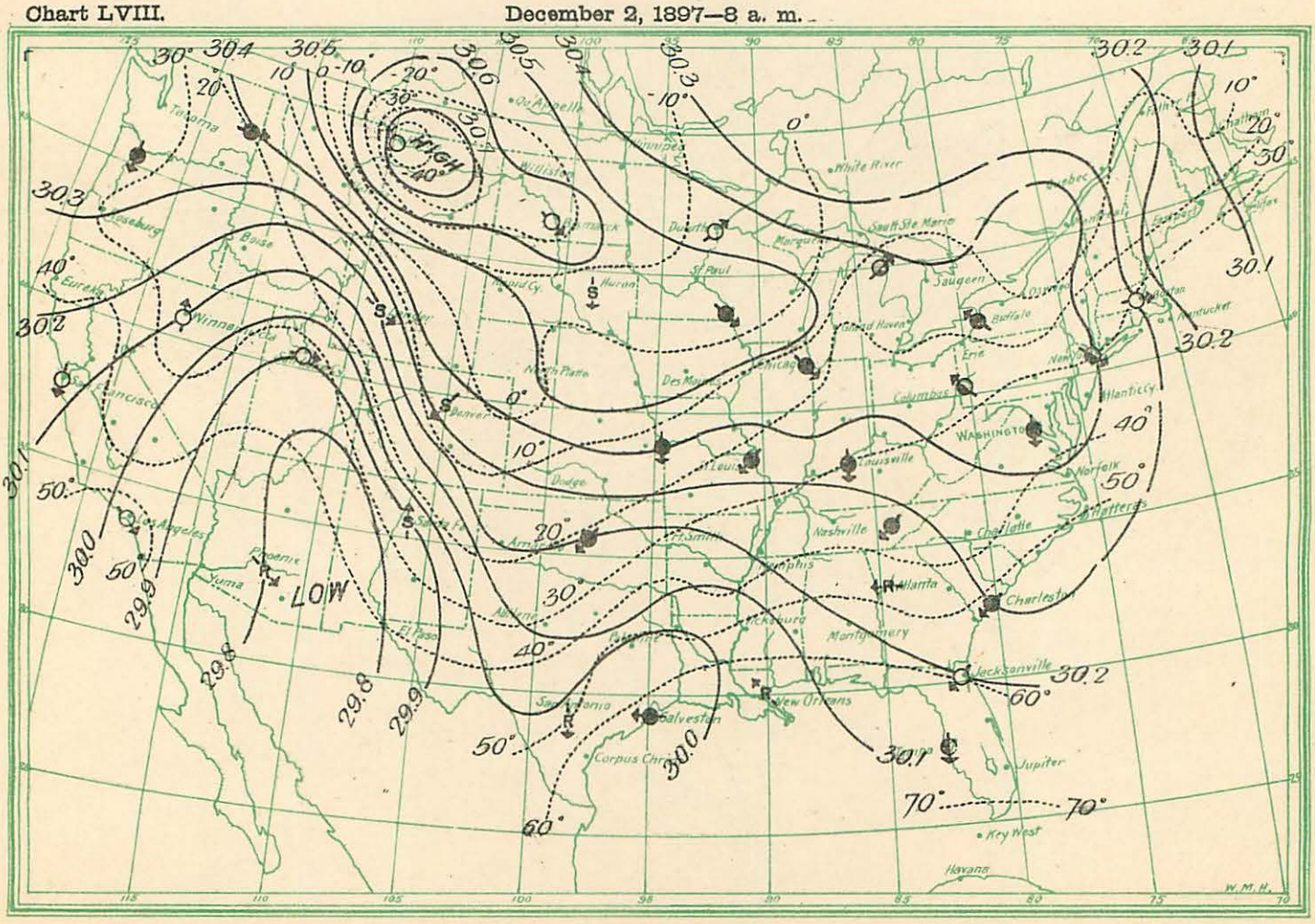


Chart LIX. December 3, 1897—8 a. m.

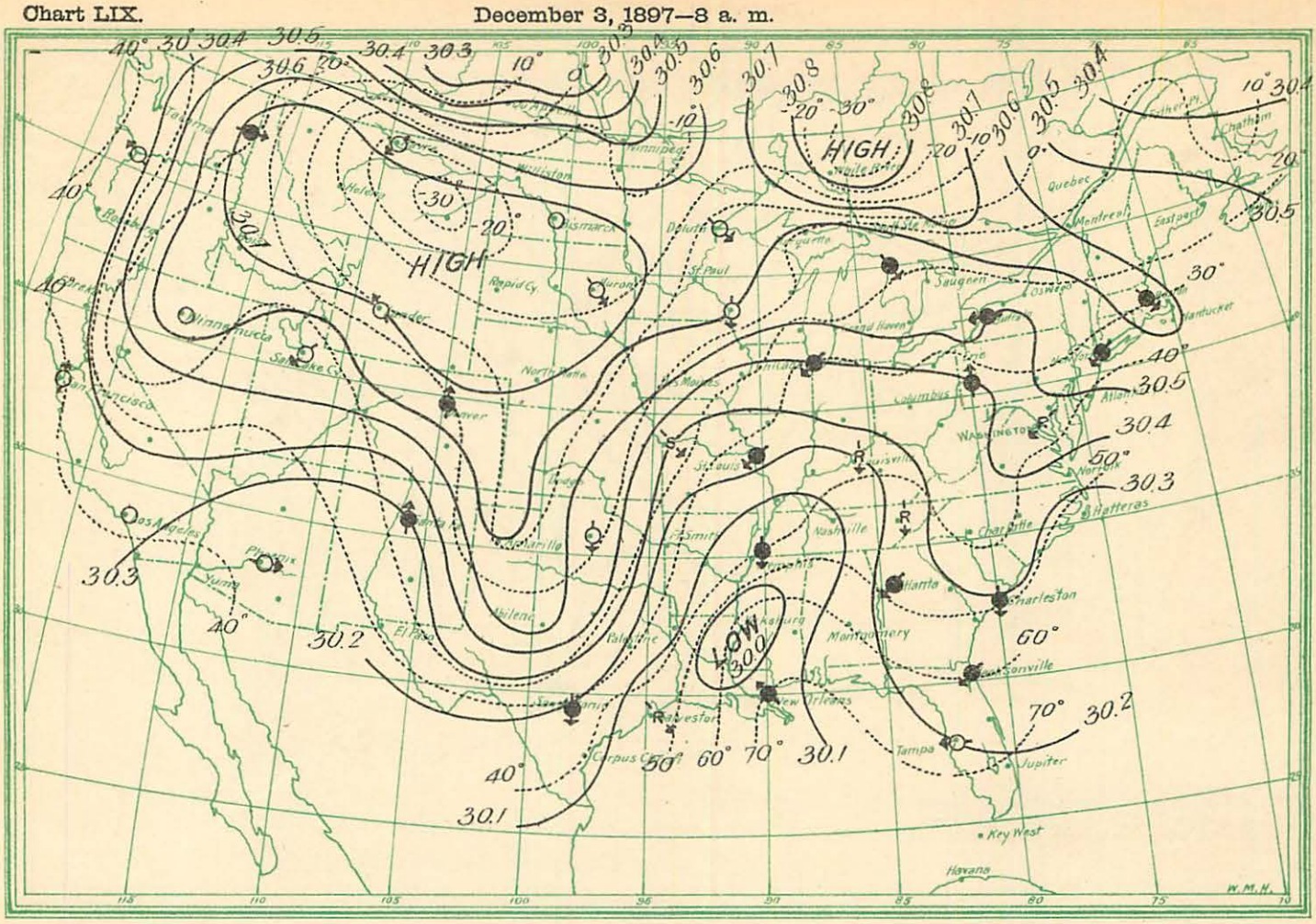


Chart LX. December 4, 1897—8 a. m.

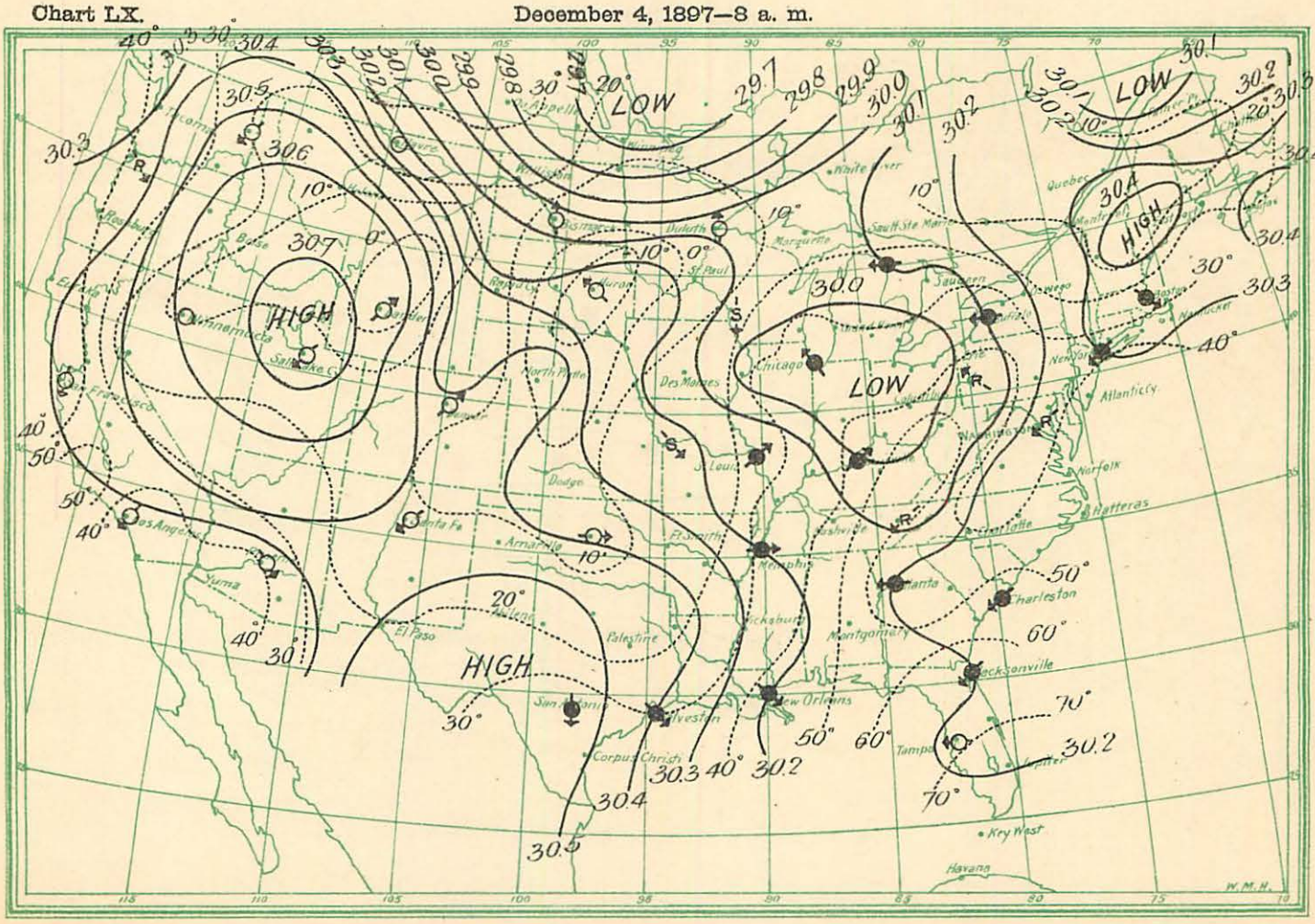


Chart LXI. December 15, 1897—8 a. m.

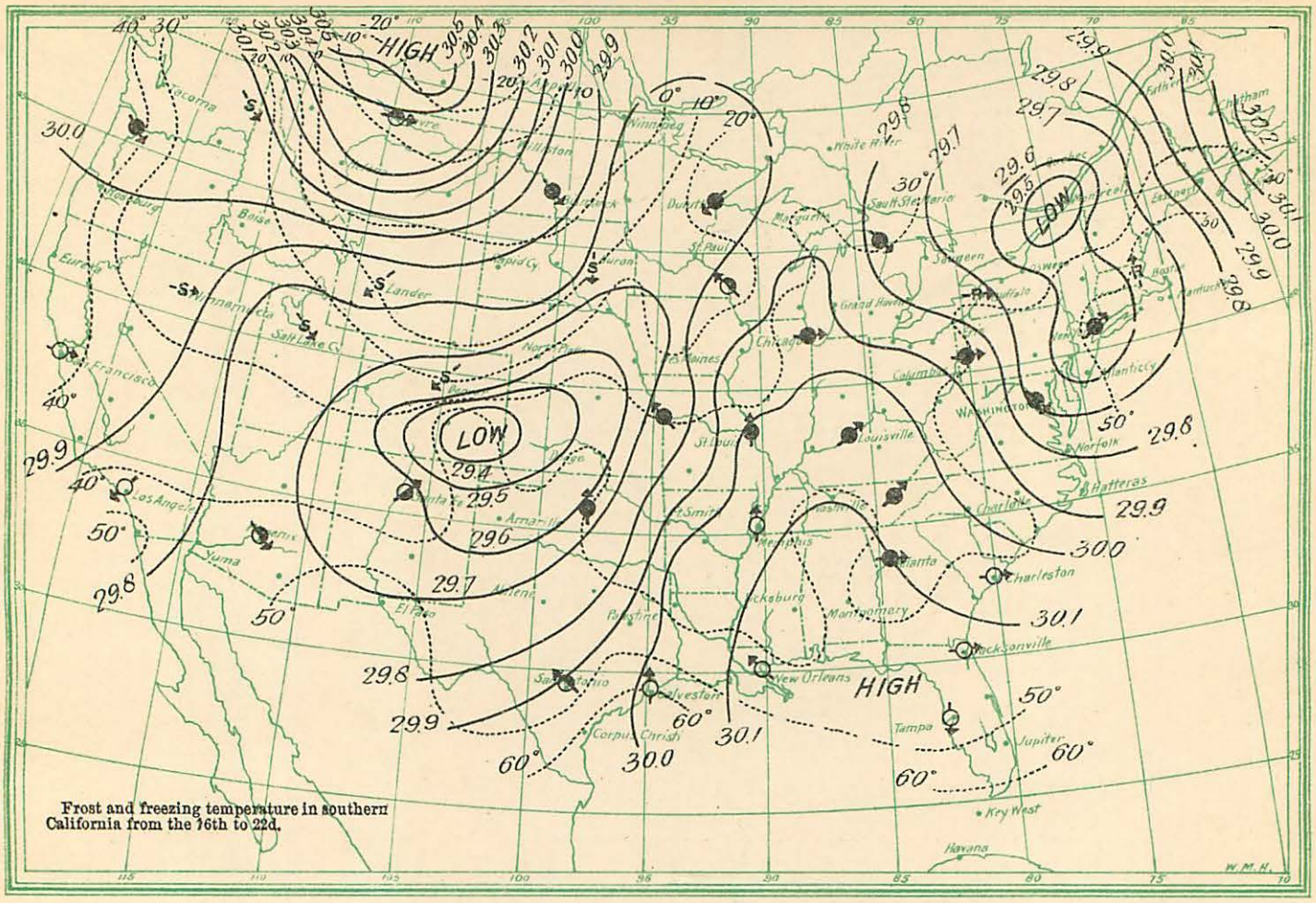


Chart LXII. December 16, 1897—8 a. m.

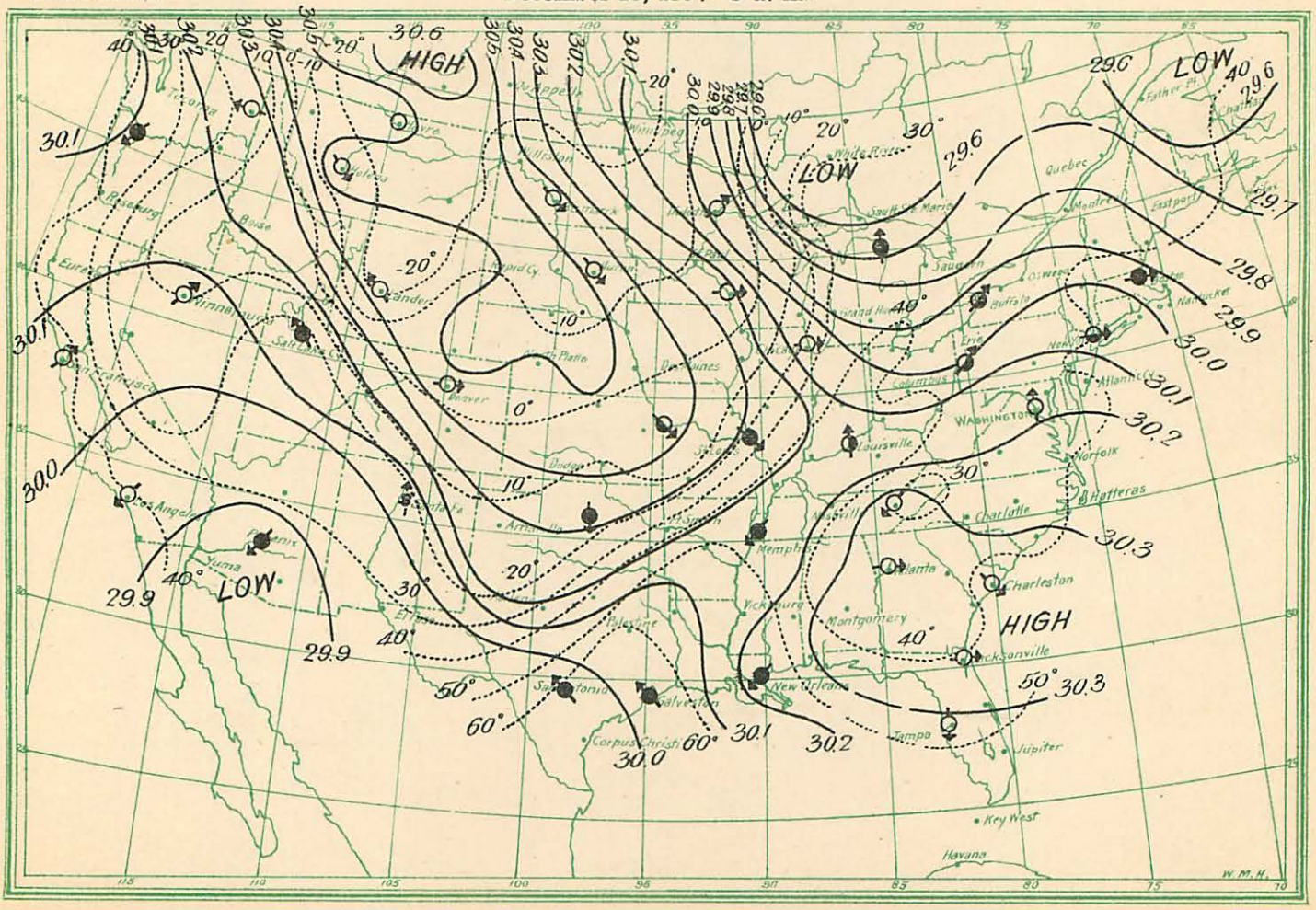


Chart LXIII. December 17, 1897—8 a. m.

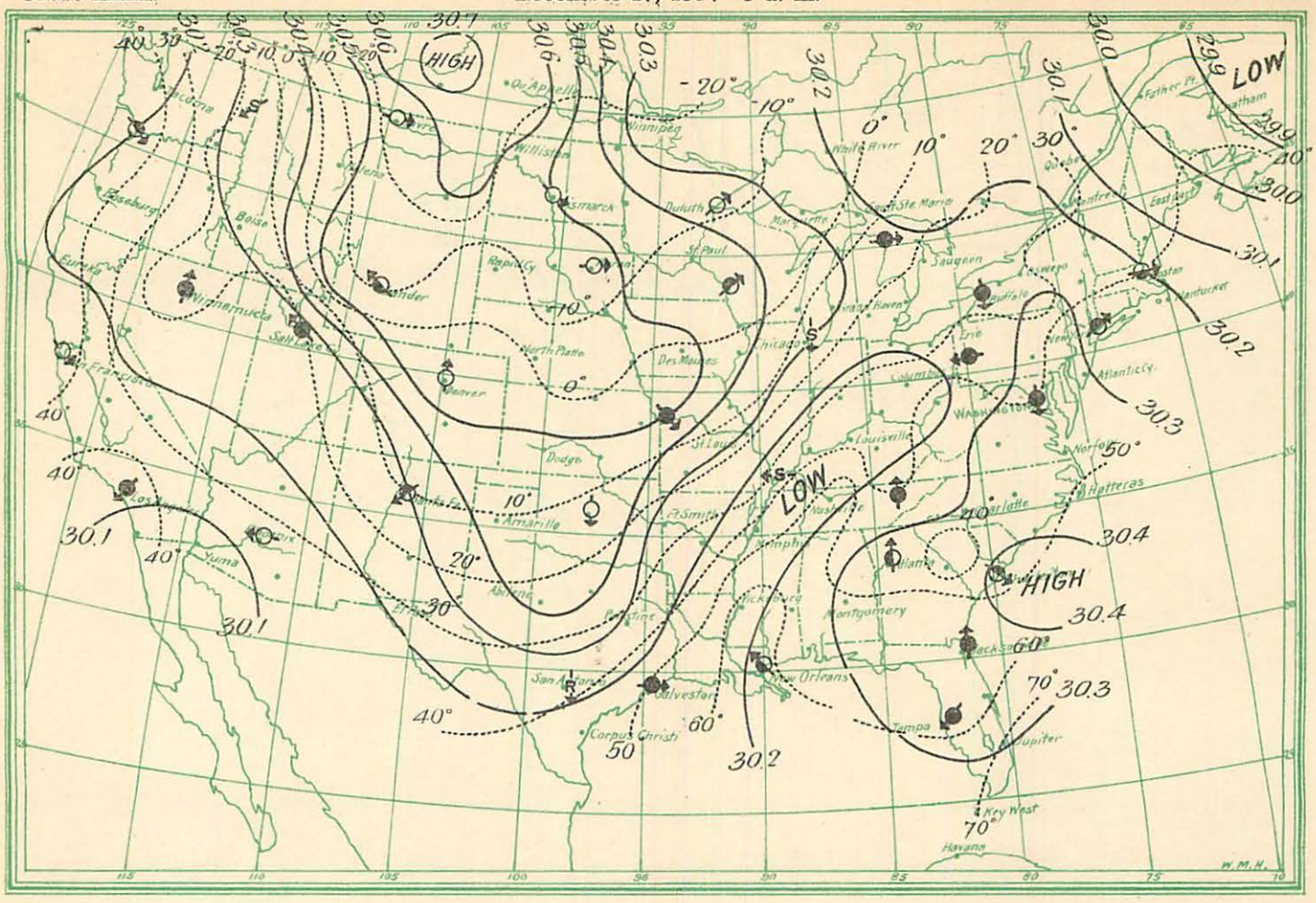


Chart LXIV. December 18, 1897—8 a. m.

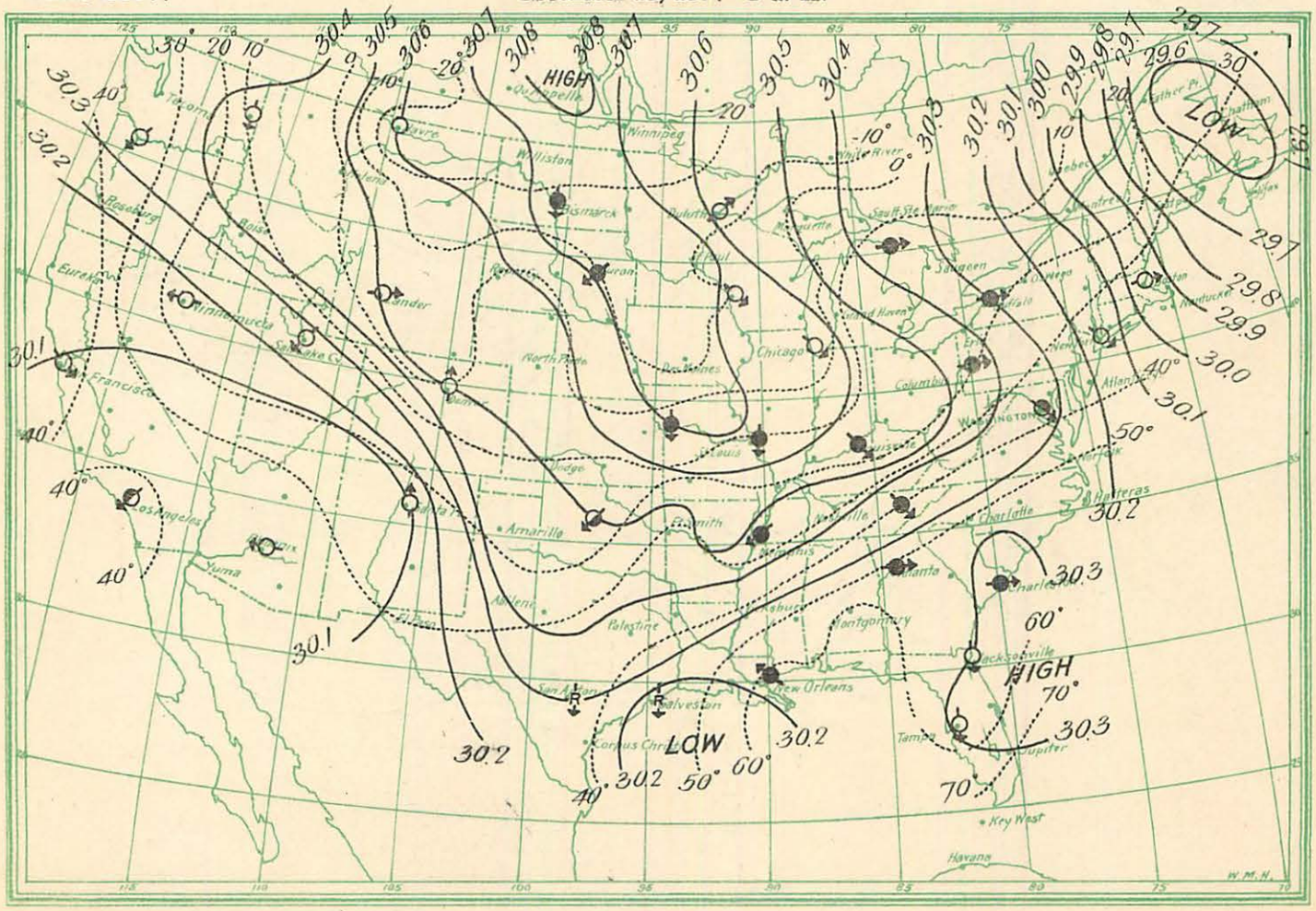


Chart LXV. December 19, 1897—8 a. m.

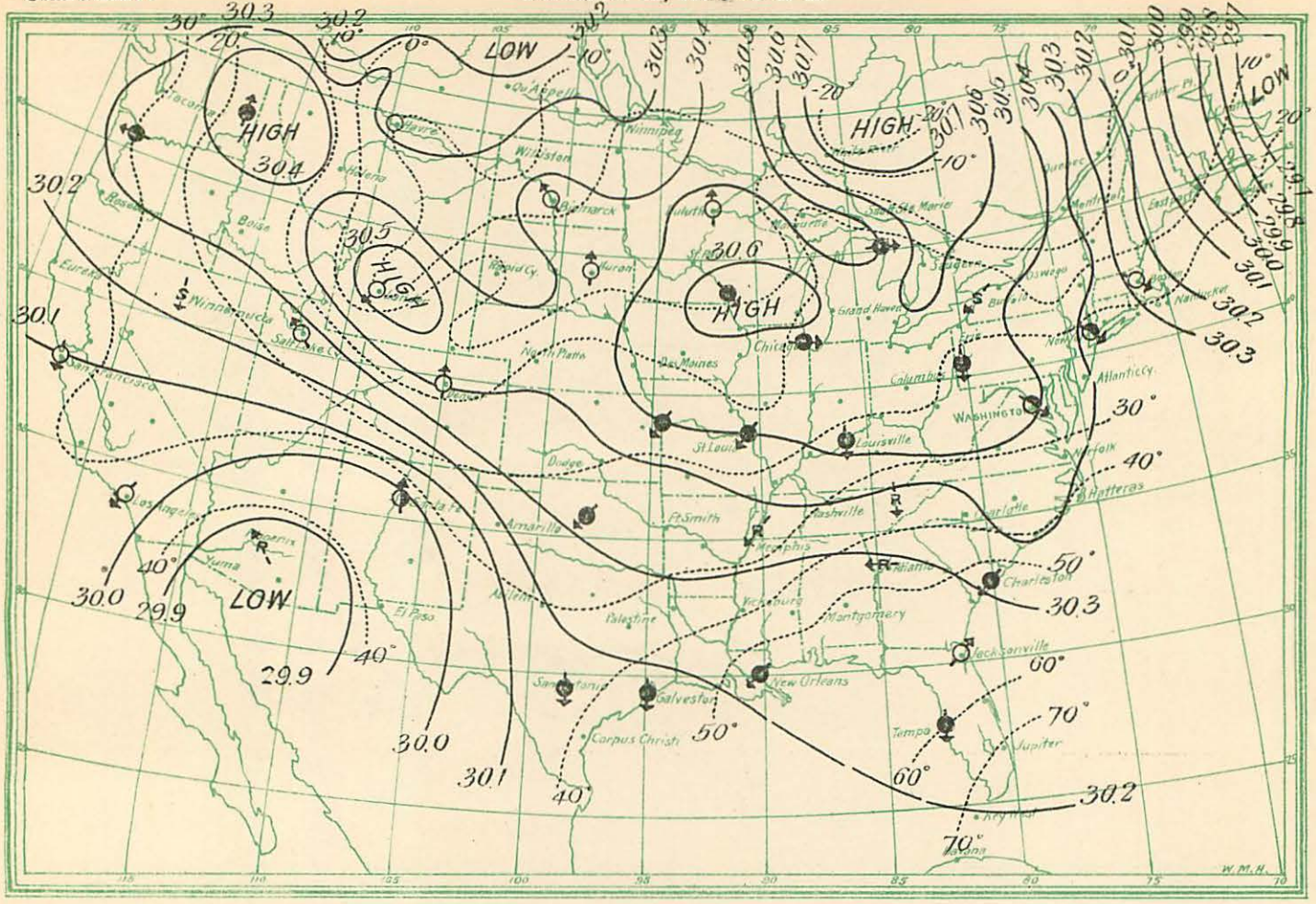


Chart LXVI. December 20, 1897—8 a. m.

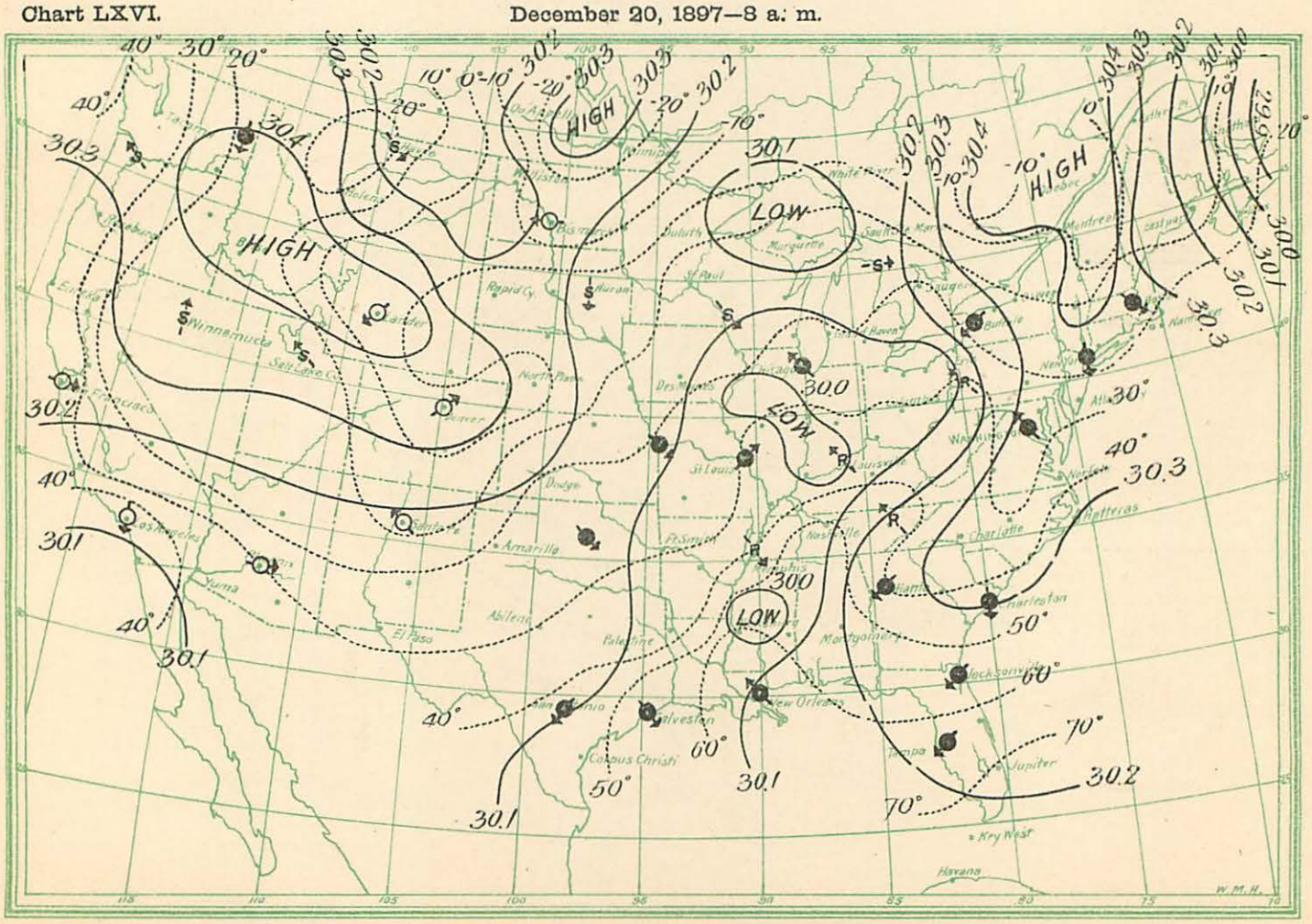


Chart LXVII. December 21, 1897—8 a. m.

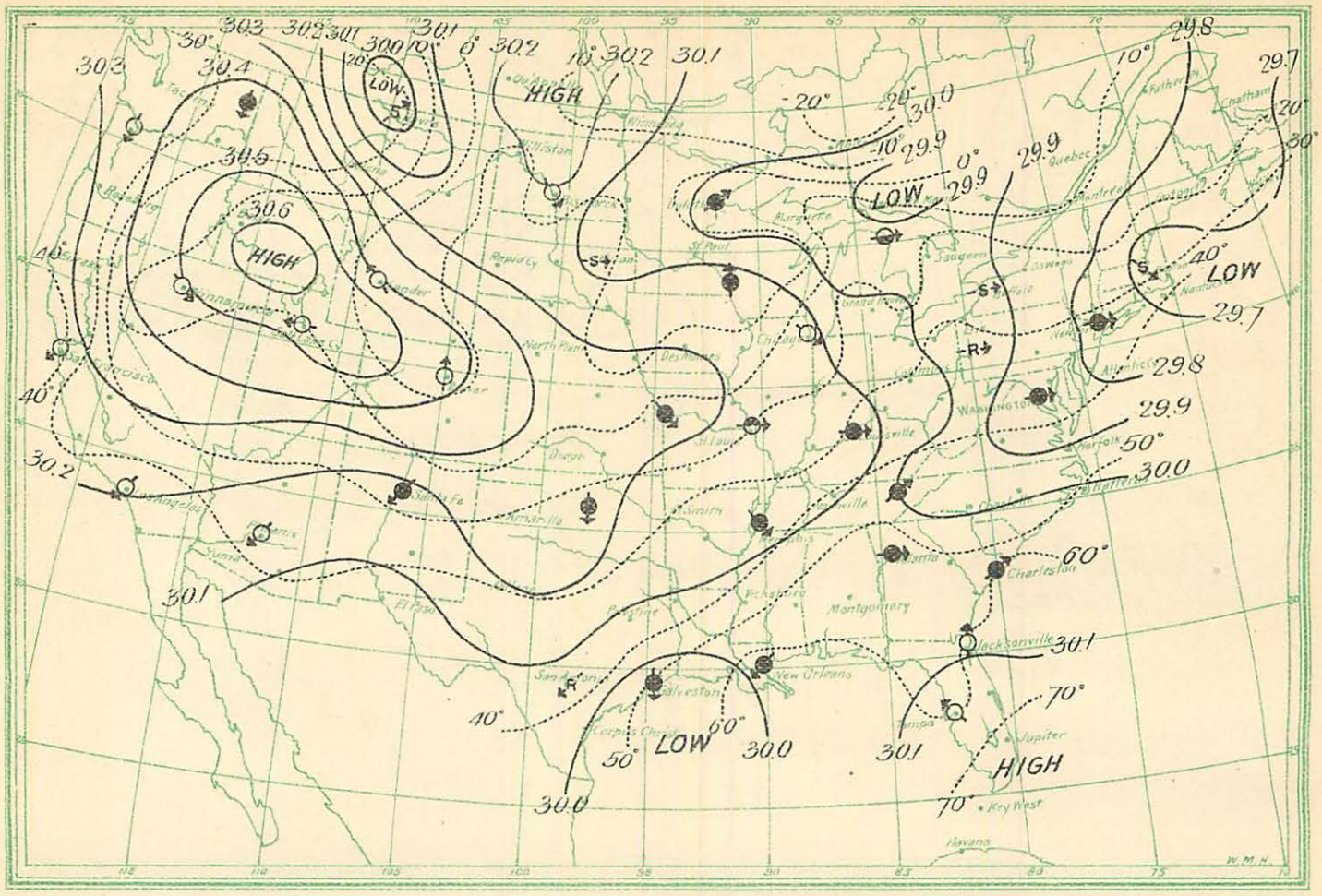


Chart LXVIII. December 22, 1897—8 a. m.

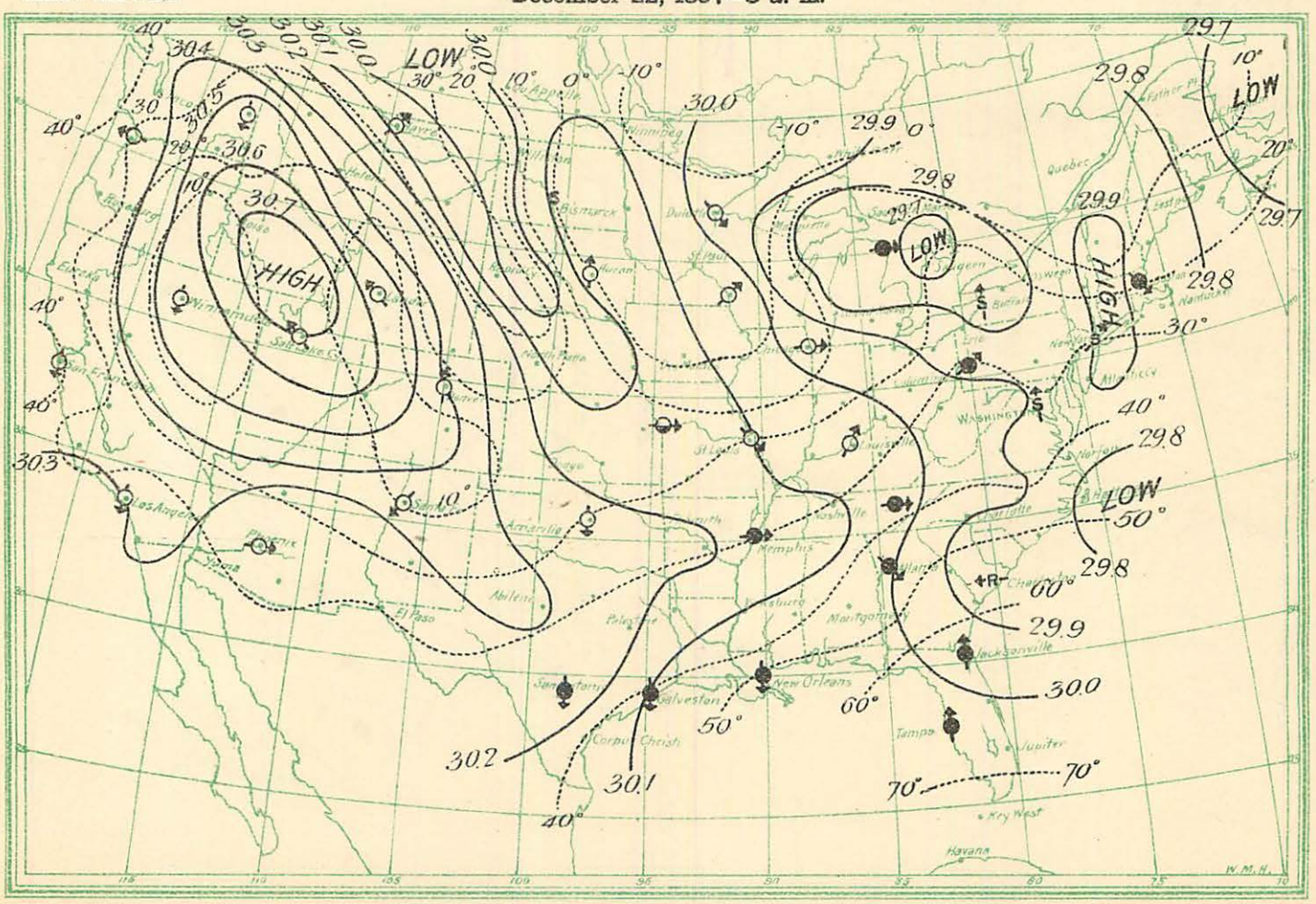


Chart LXIX.

December 11, 1898—8 a. m.

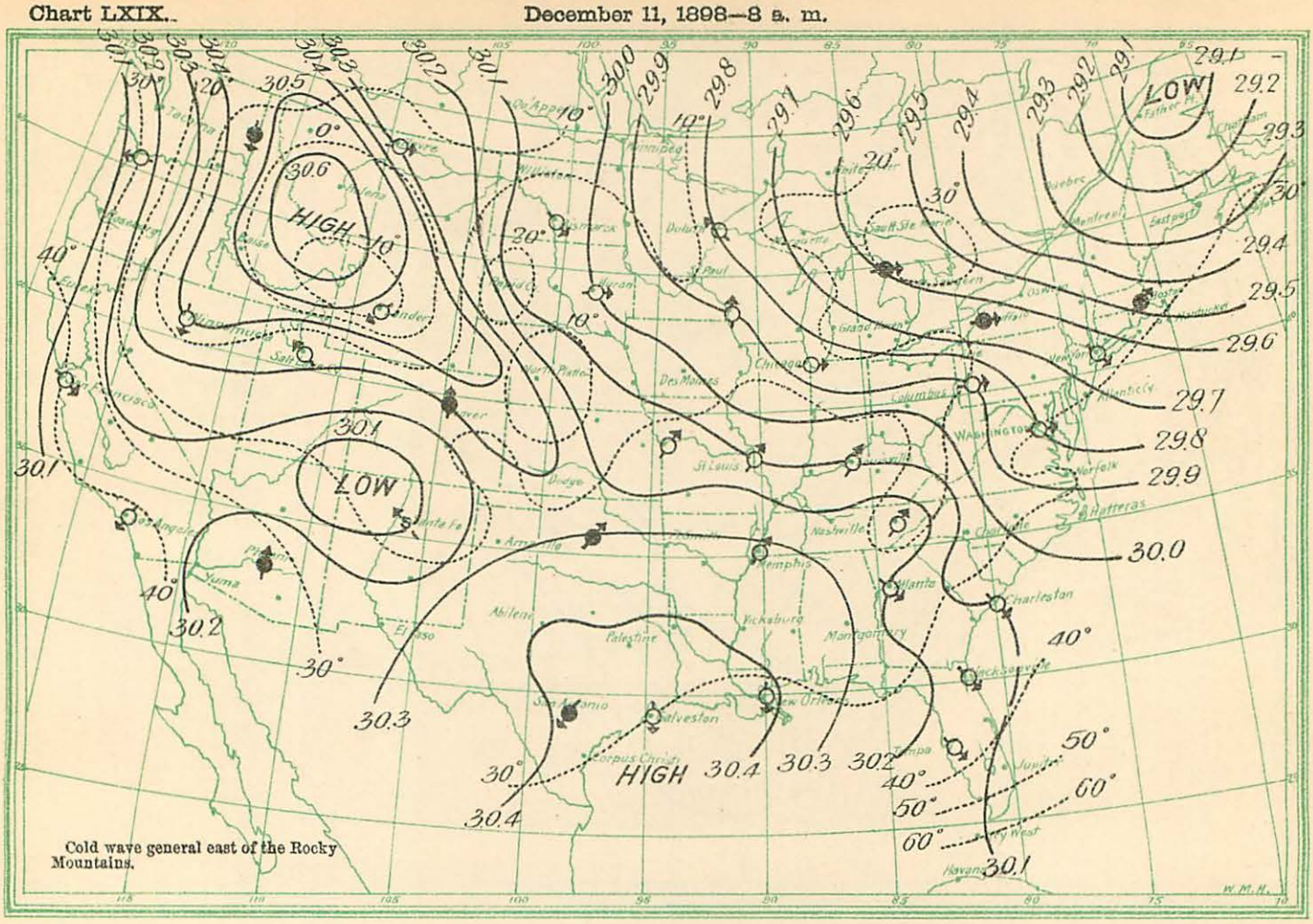


Chart LXX.

December 12, 1898—8 a. m.

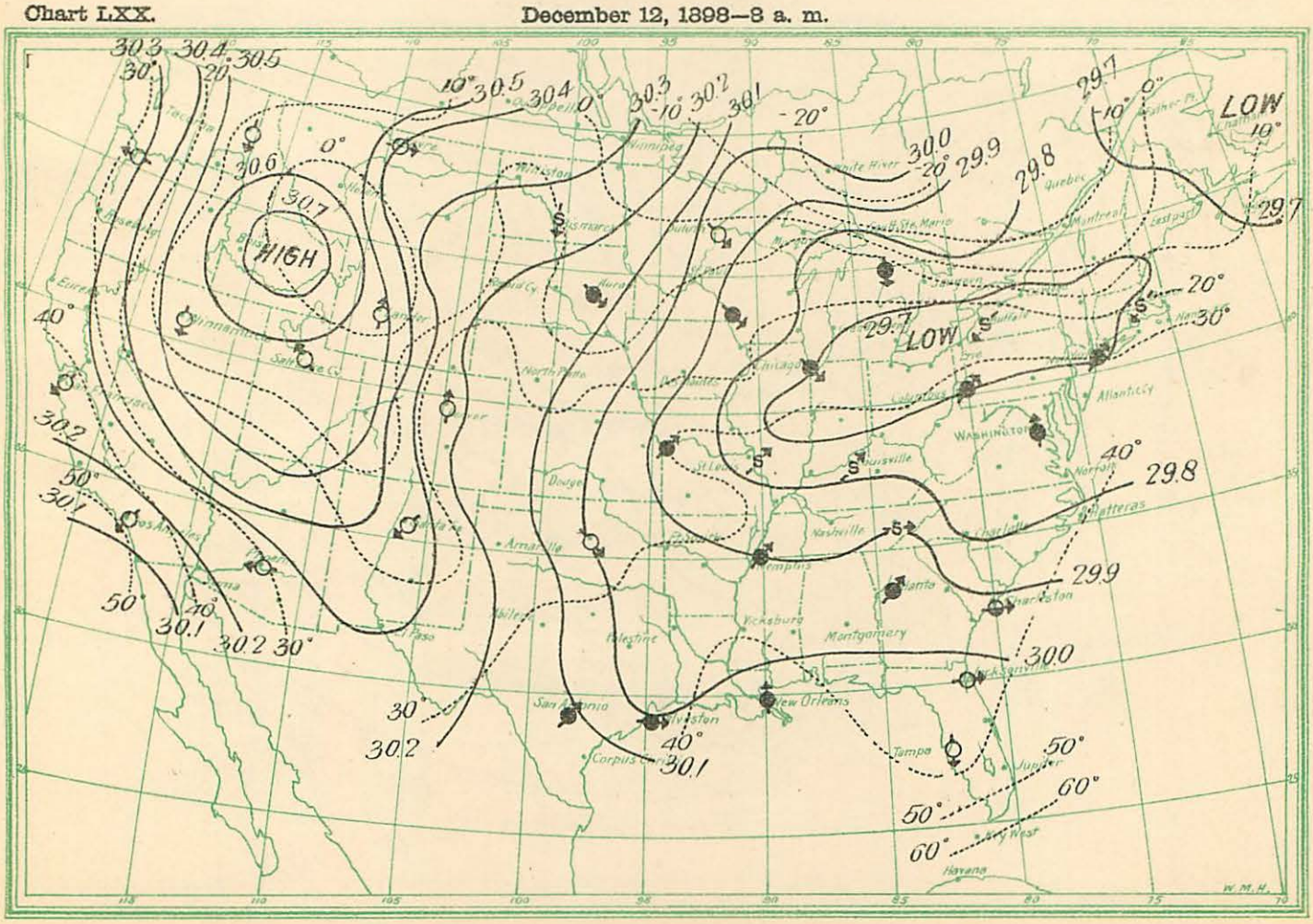


Chart LXXI. December 13, 1898—8 a. m.

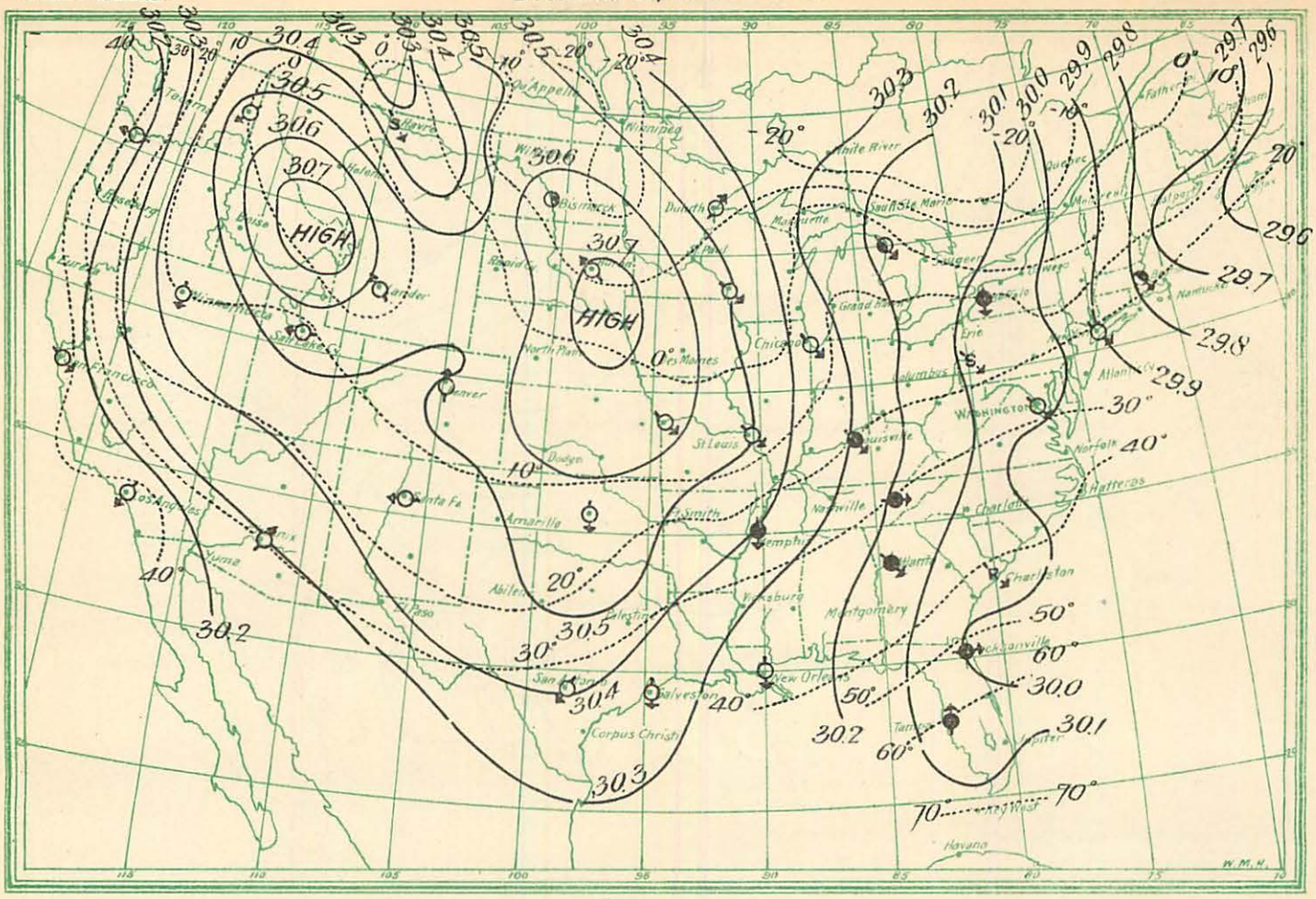


Chart LXXII. December 14, 1898—8 a. m.

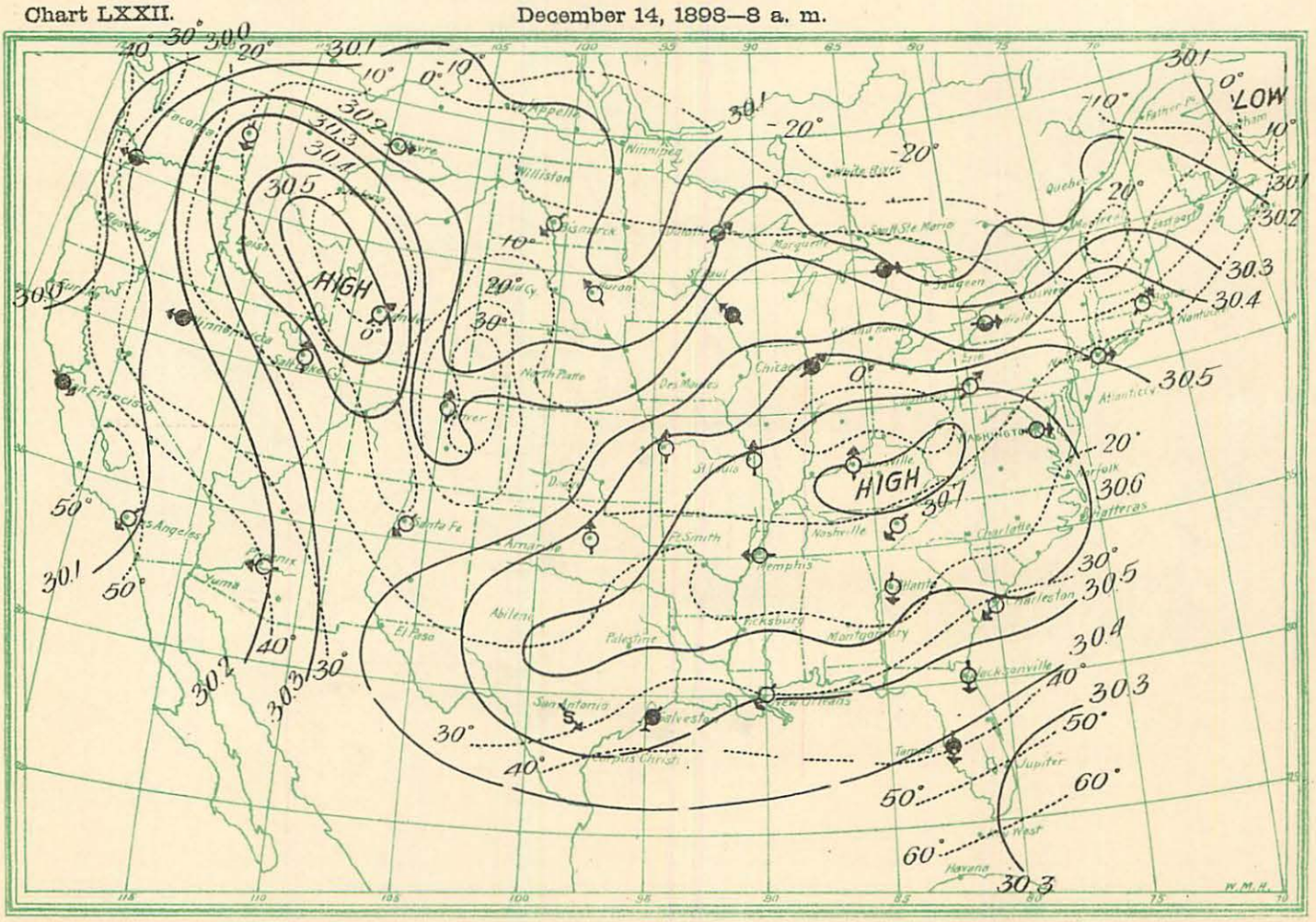


Chart LXXIII. December 28, 1898—8 a. m.

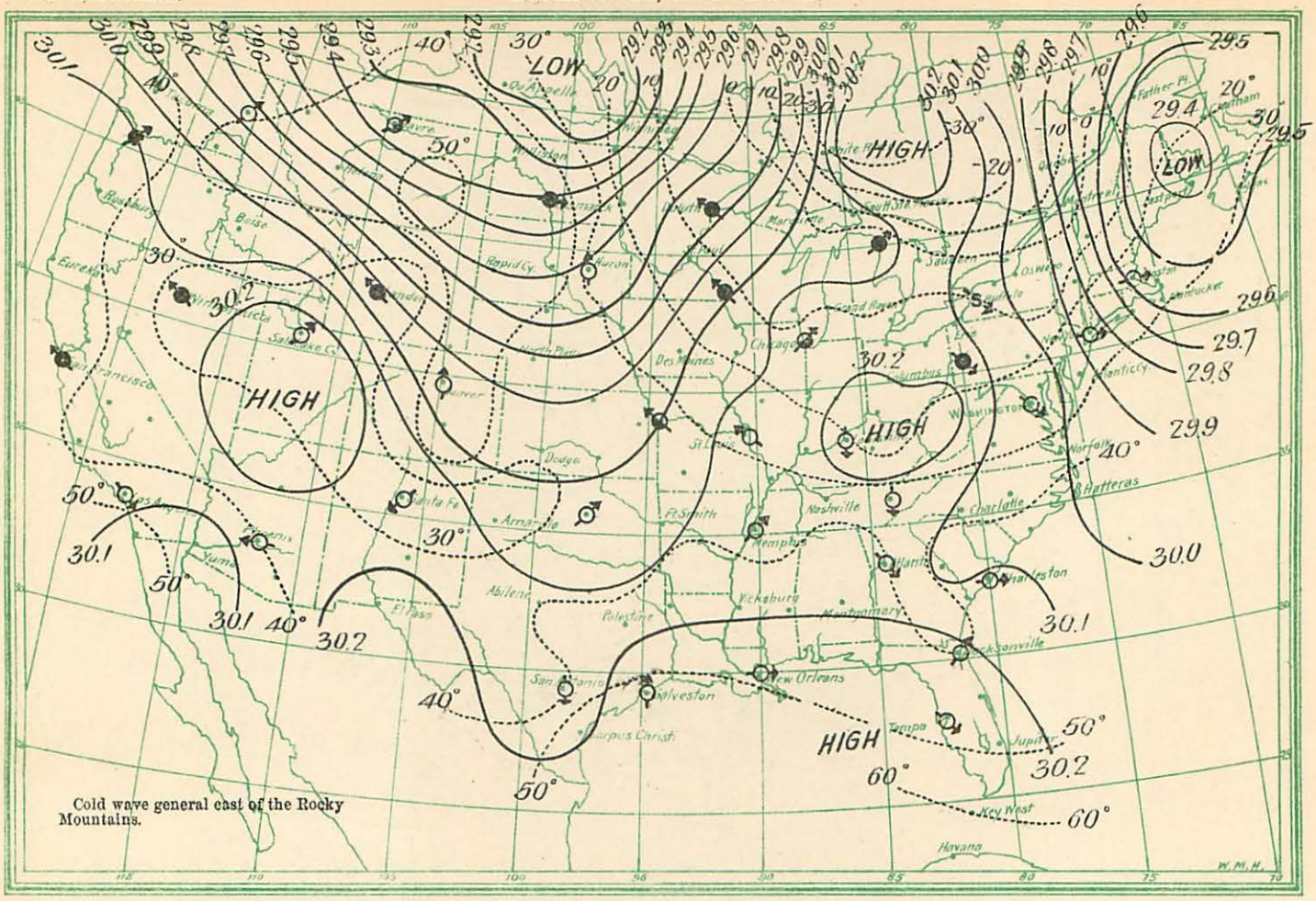


Chart LXXIV. December 29, 1898—8 a. m.

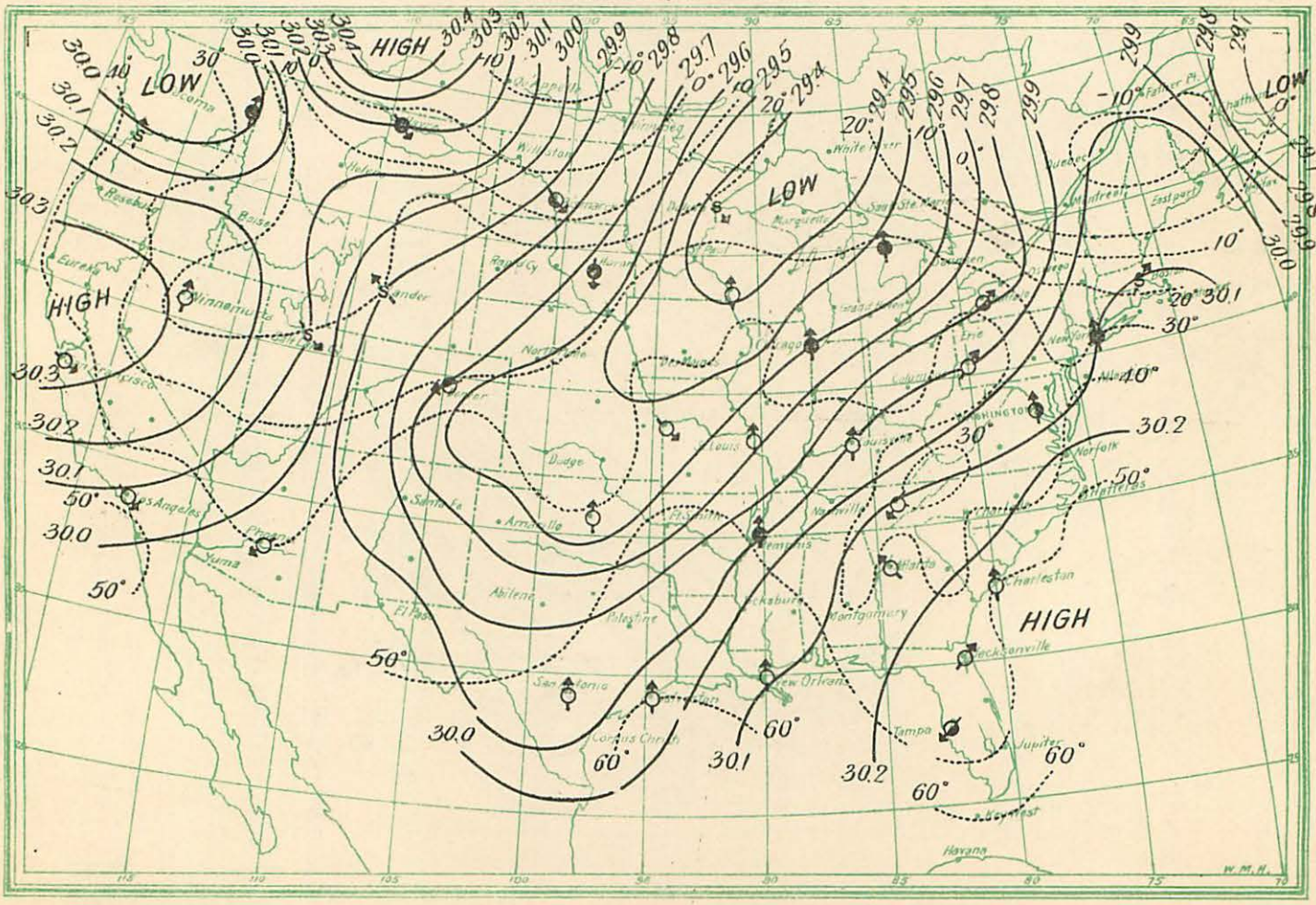


Chart LXXV. December 30, 1898—8 a. m.

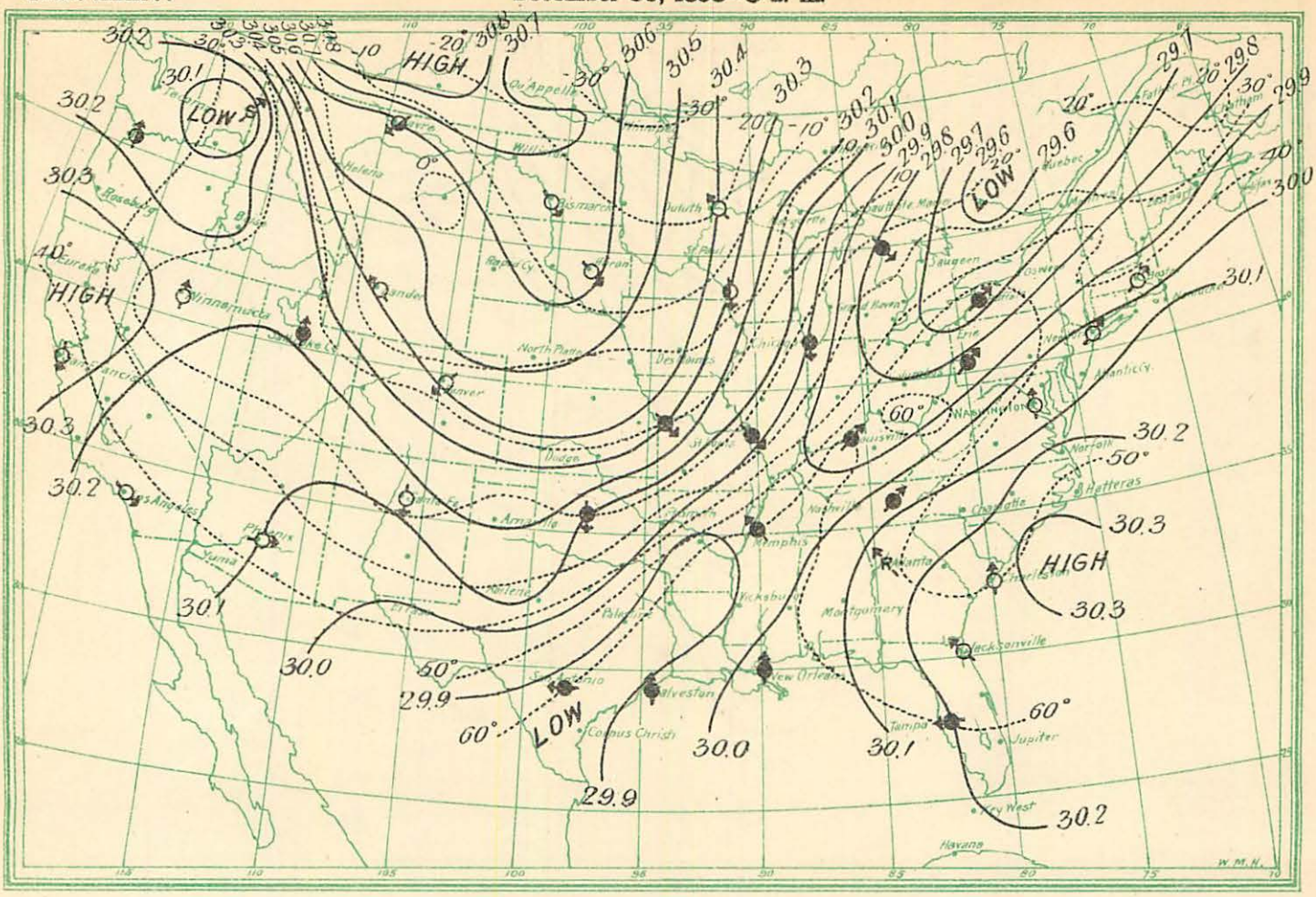


Chart LXXVI. December 31, 1898—8 a. m.

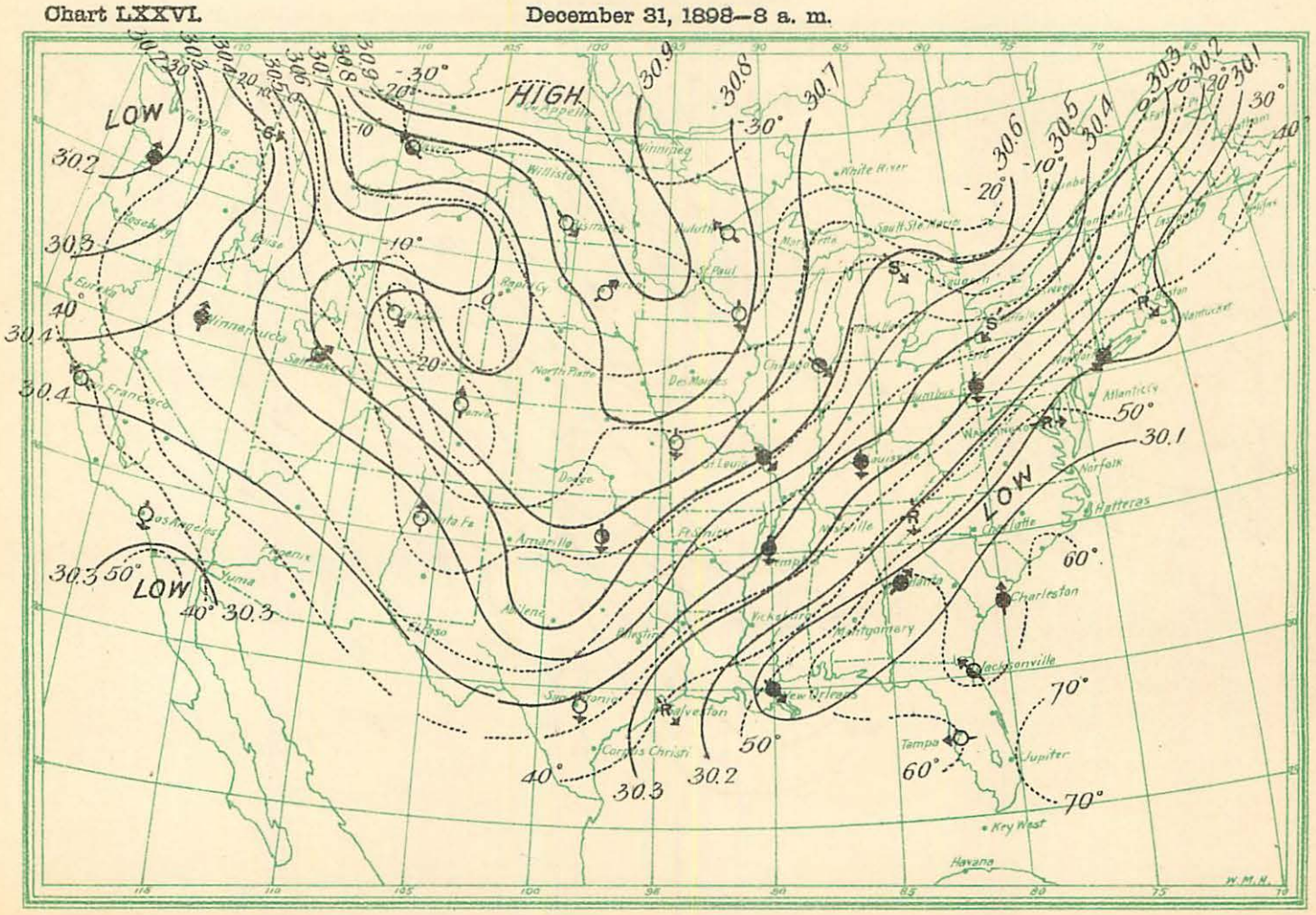


Chart LXXVII. December 2, 1899--8 a. m.

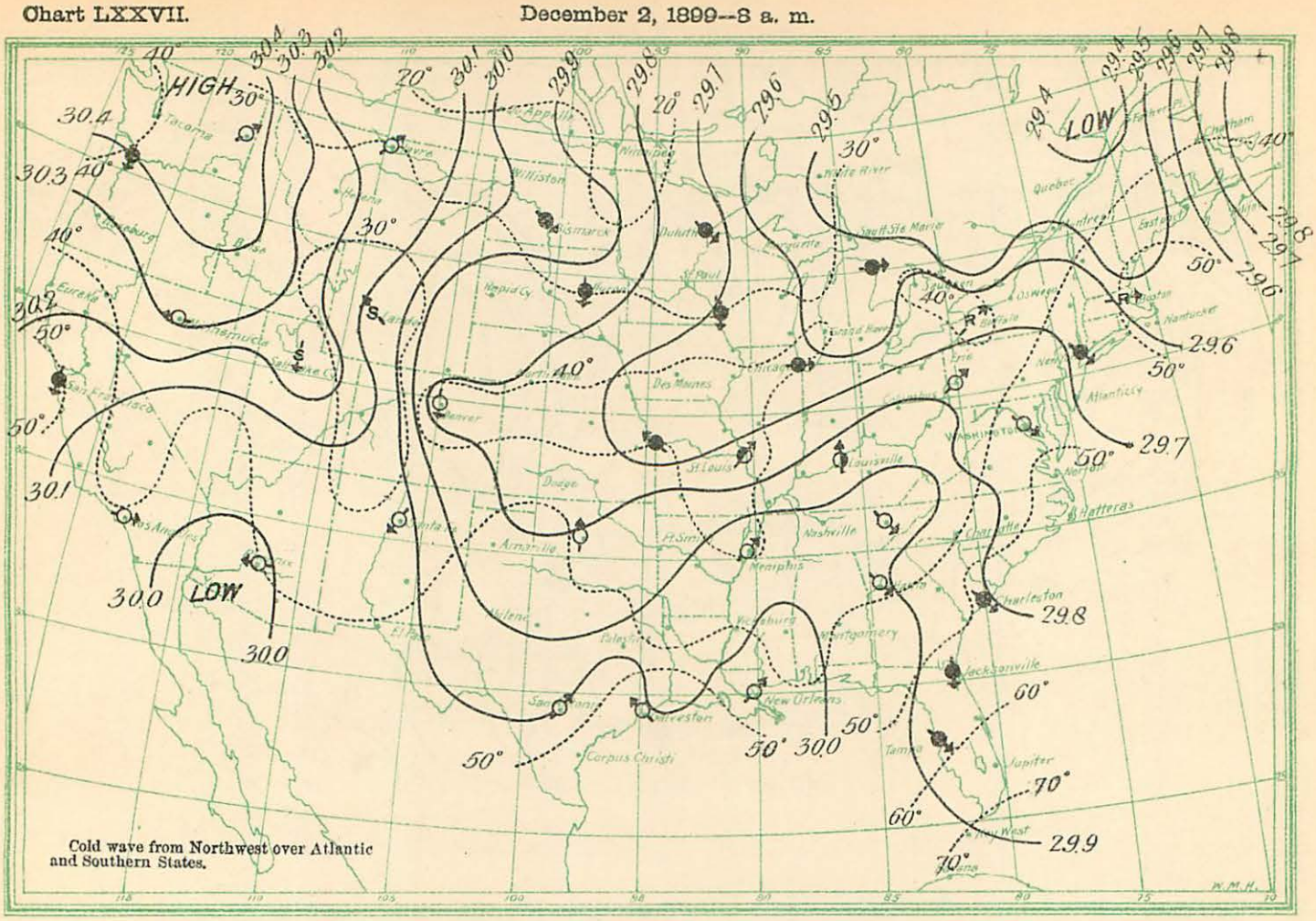


Chart LXXVIII. December 3, 1899—8 a. m.

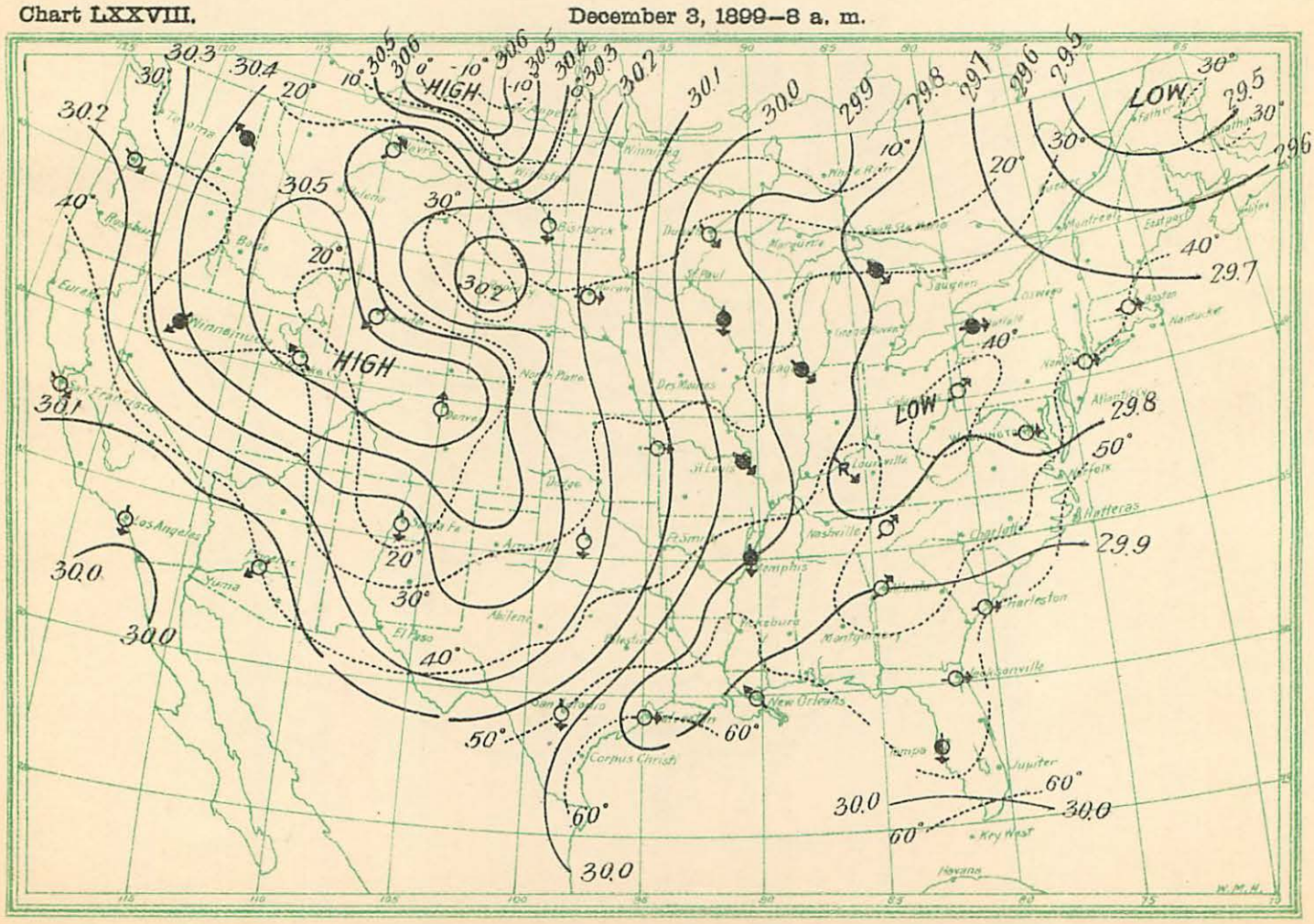


Chart LXXIX. December 4, 1899—8 a. m.

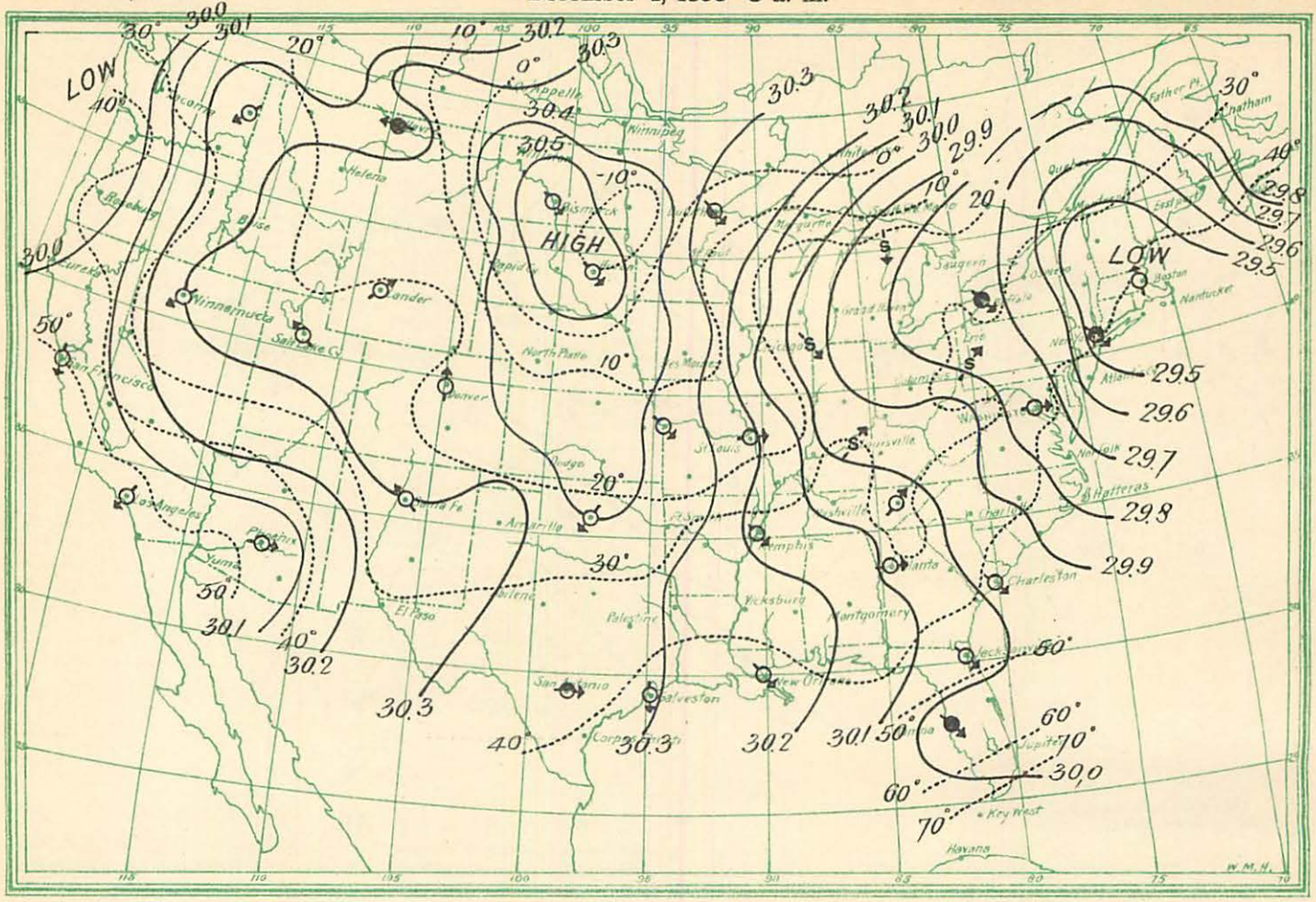


Chart LXXX. December 5, 1899—8 a. m.

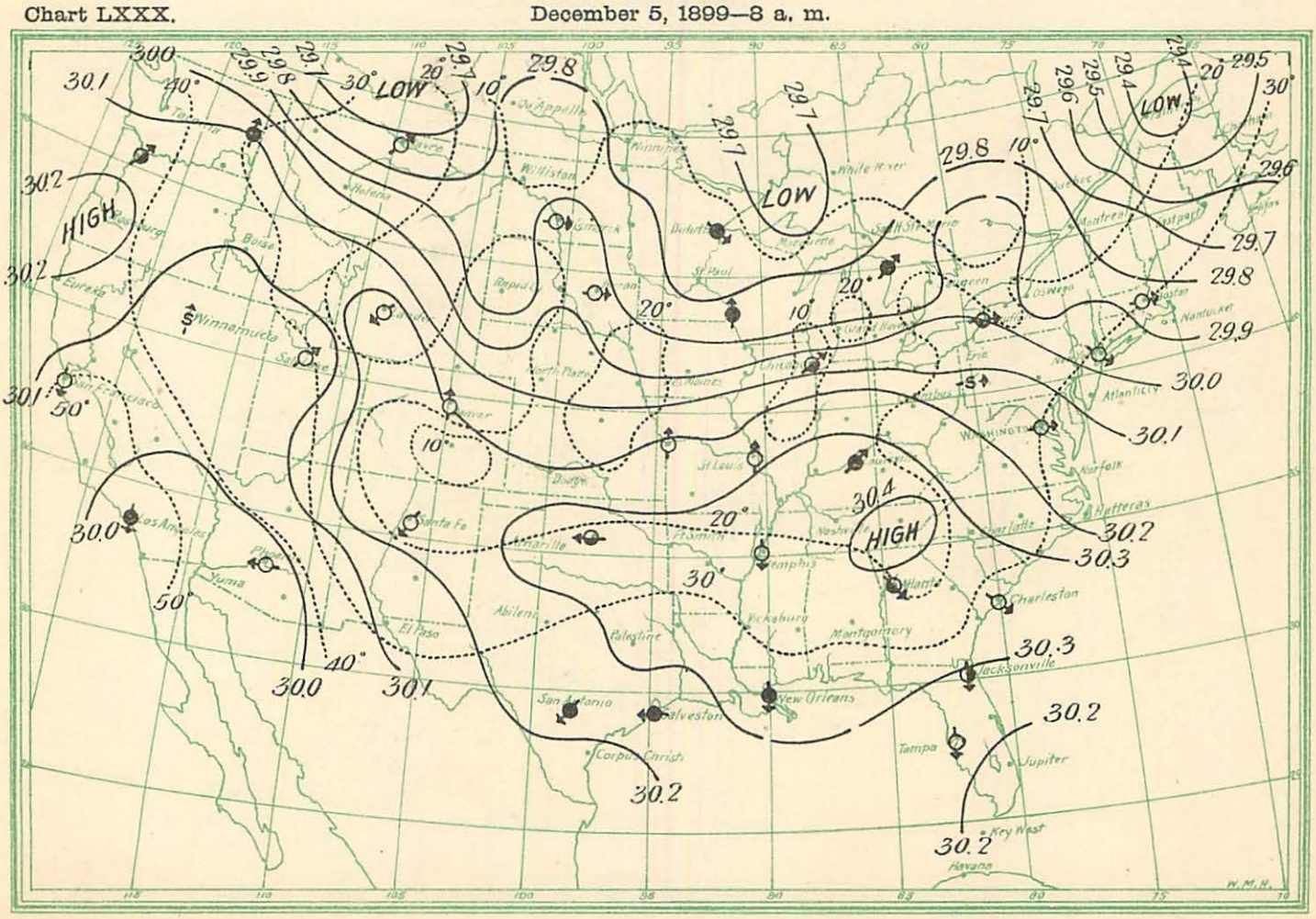


Chart LXXXI. December 28, 1900—8 a. m.

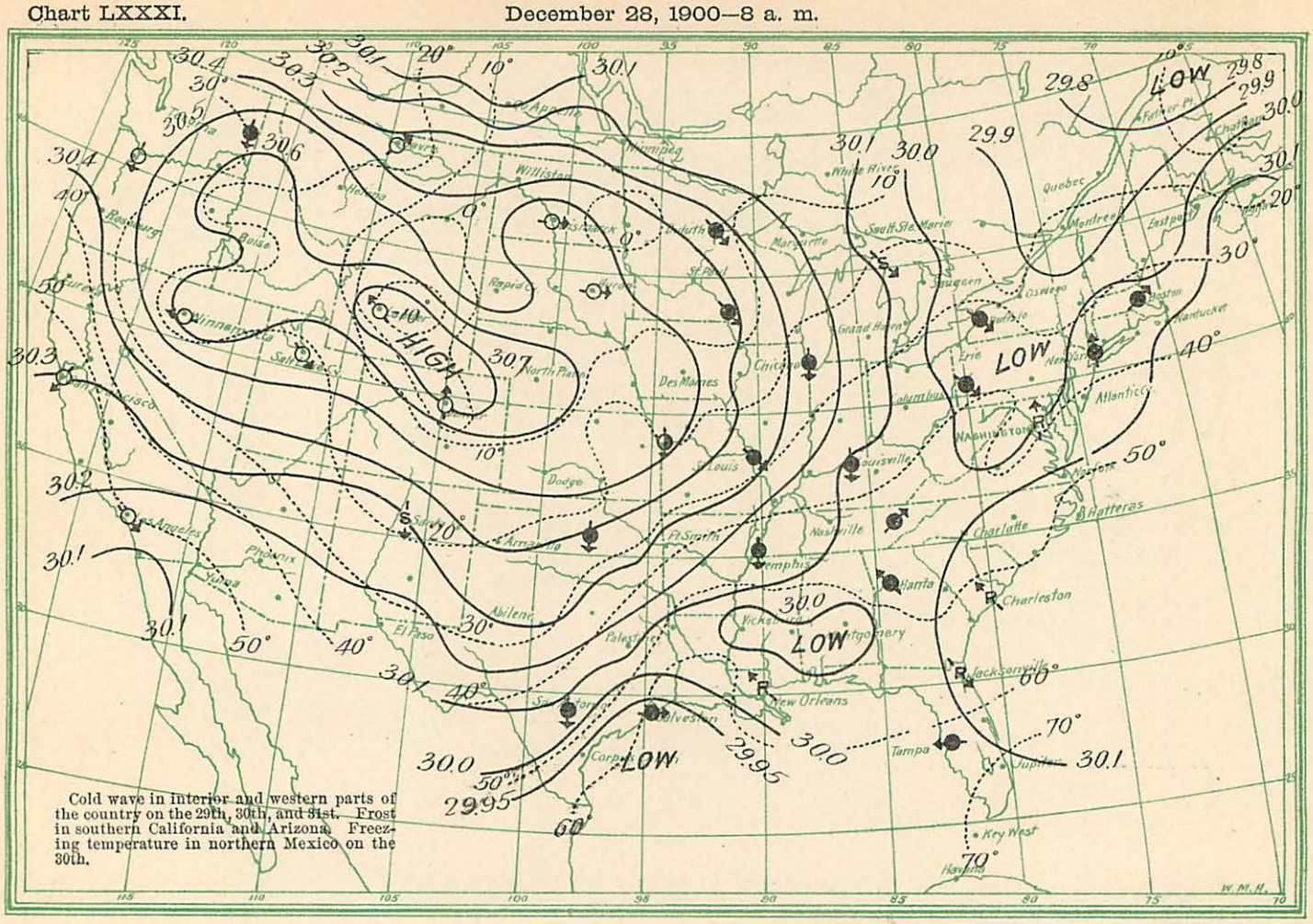


Chart LXXXII. December 29, 1900—8 a. m.

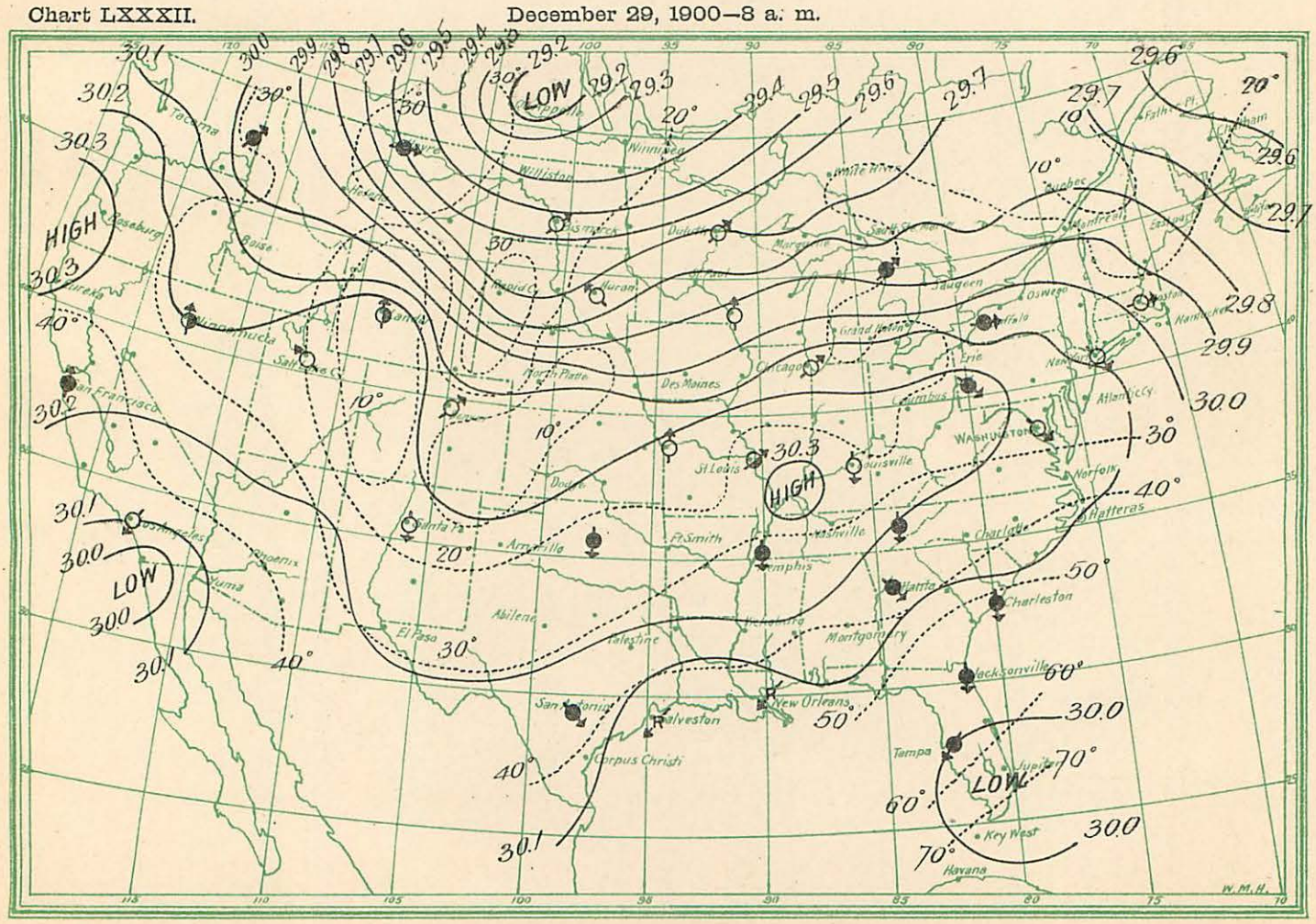


Chart LXXXIII. December 30, 1900—8 a. m.

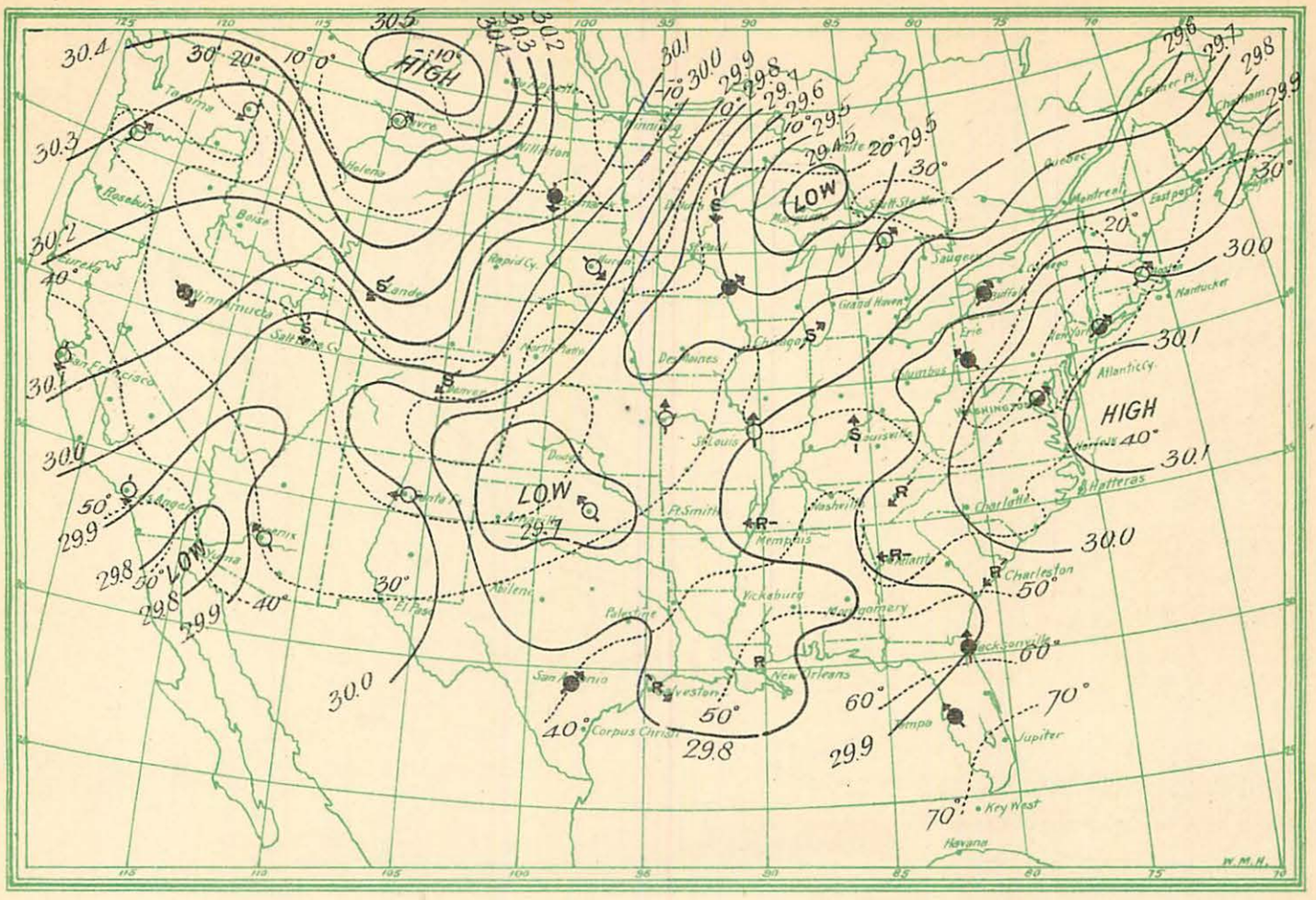


Chart LXXXIV. December 31, 1900—8 a. m.

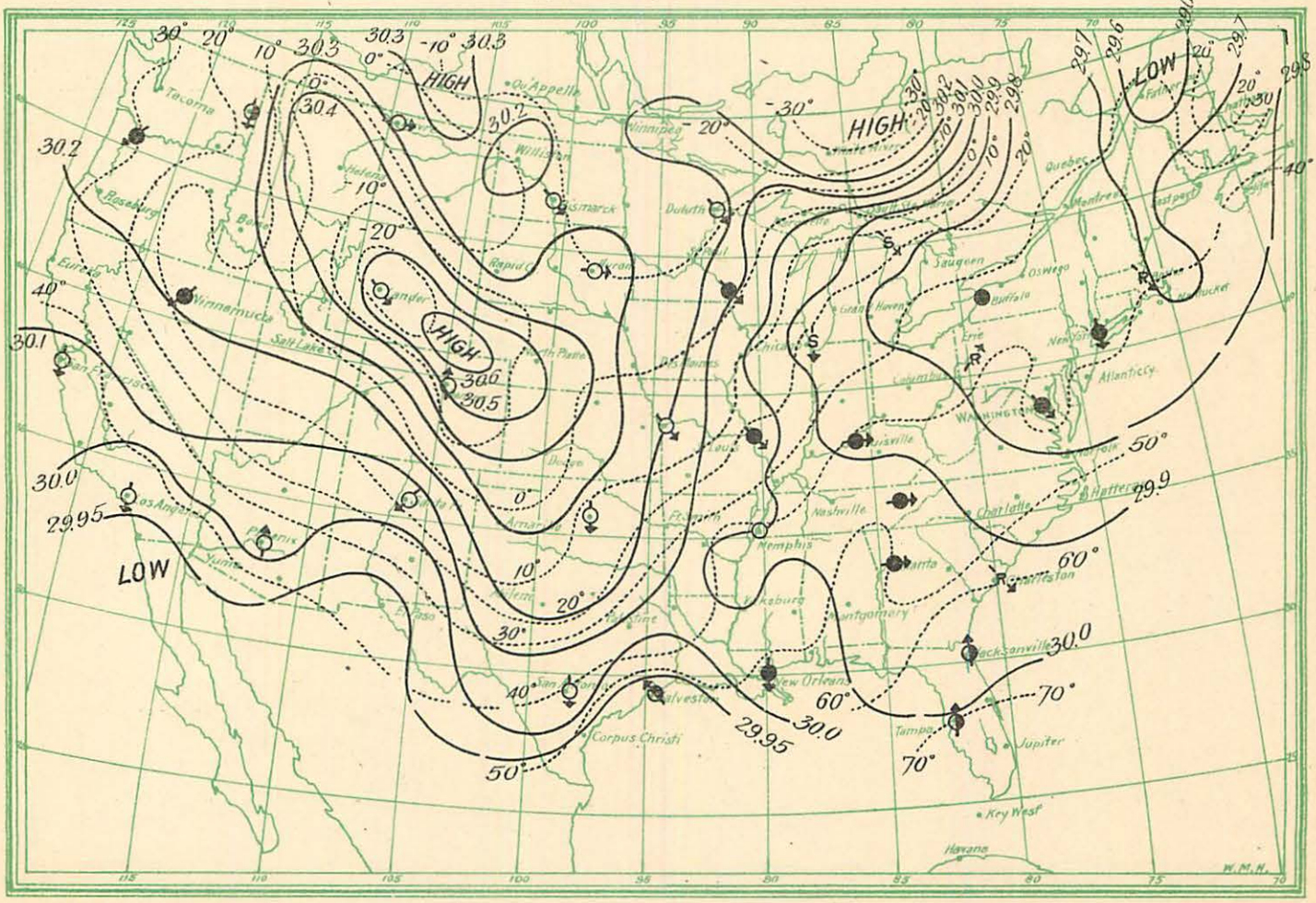


Chart LXXXV. December 11, 1901—8 a. m.

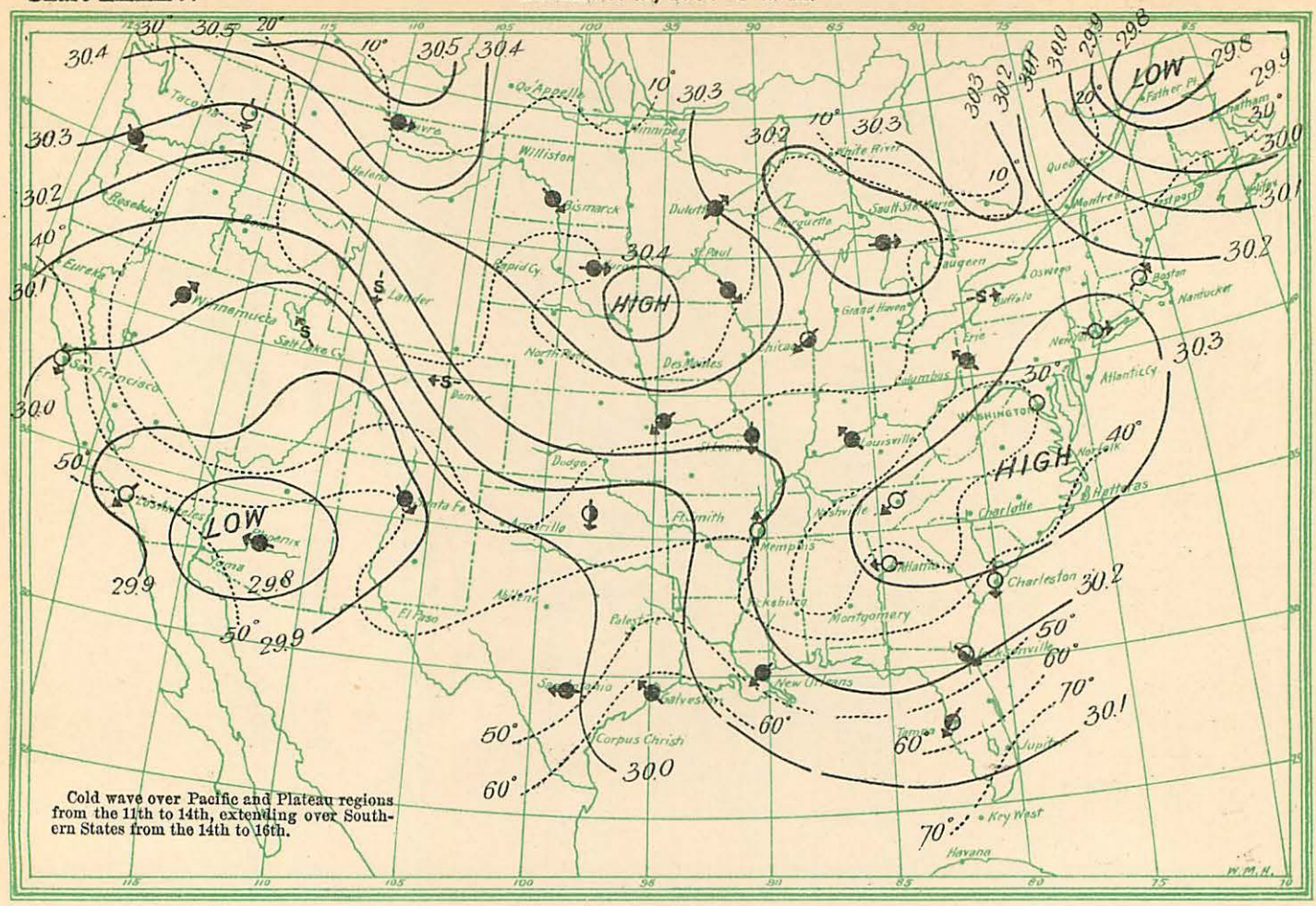


Chart LXXXVI. December 12, 1901—8 a. m.

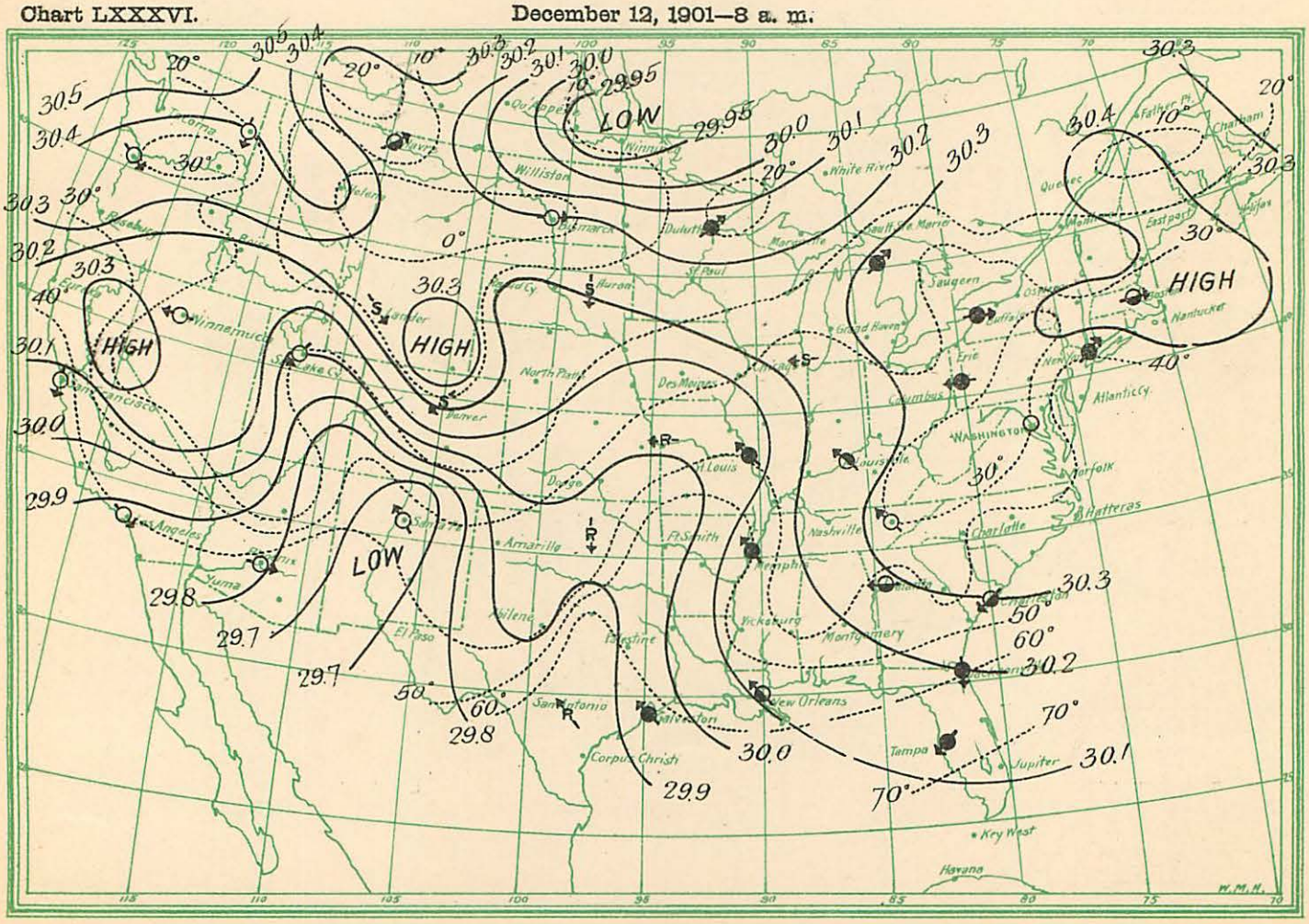


Chart LXXXVII. December 13, 1901—8 a. m.

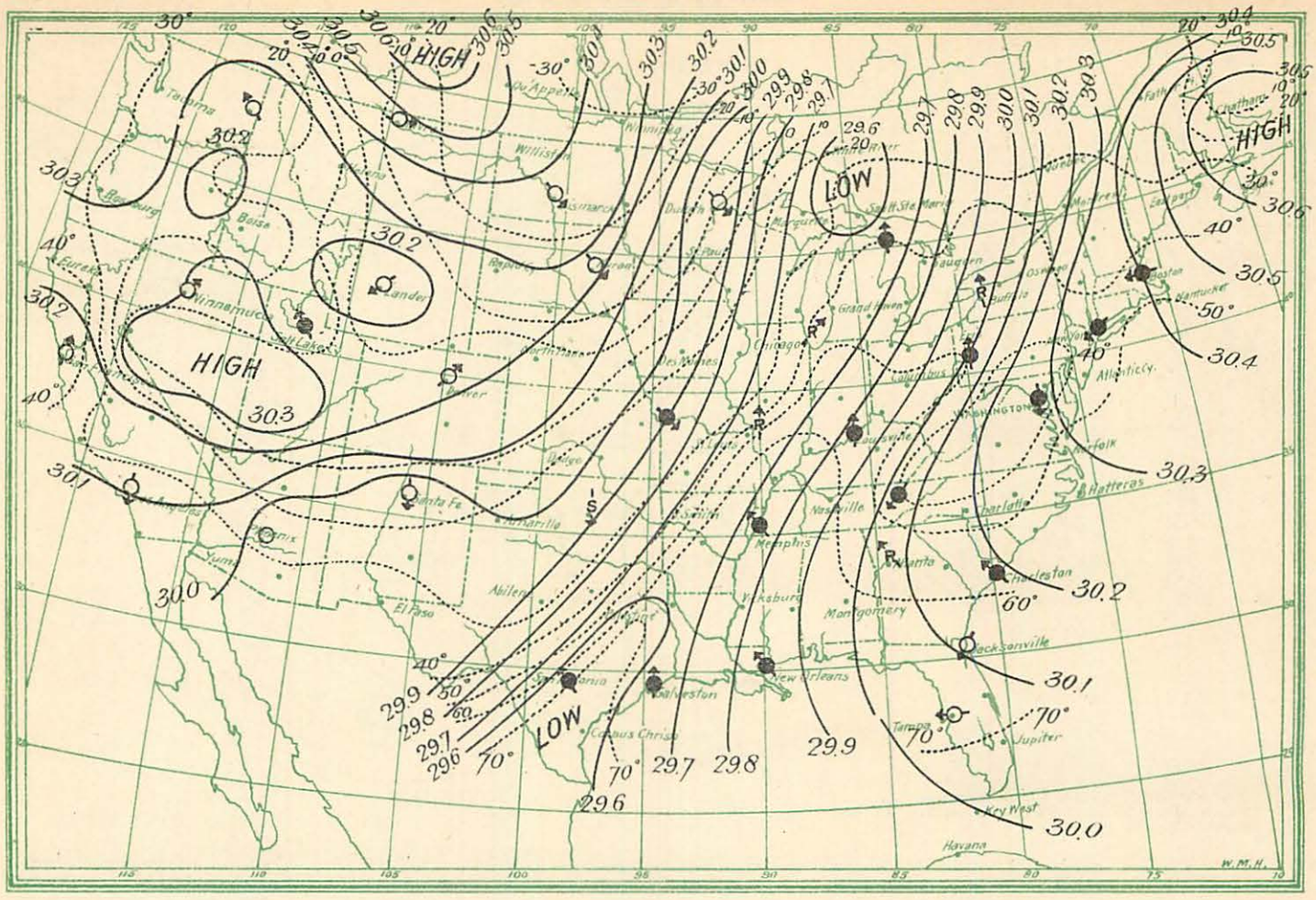


Chart LXXXVIII. December 14, 1901—8 a. m.

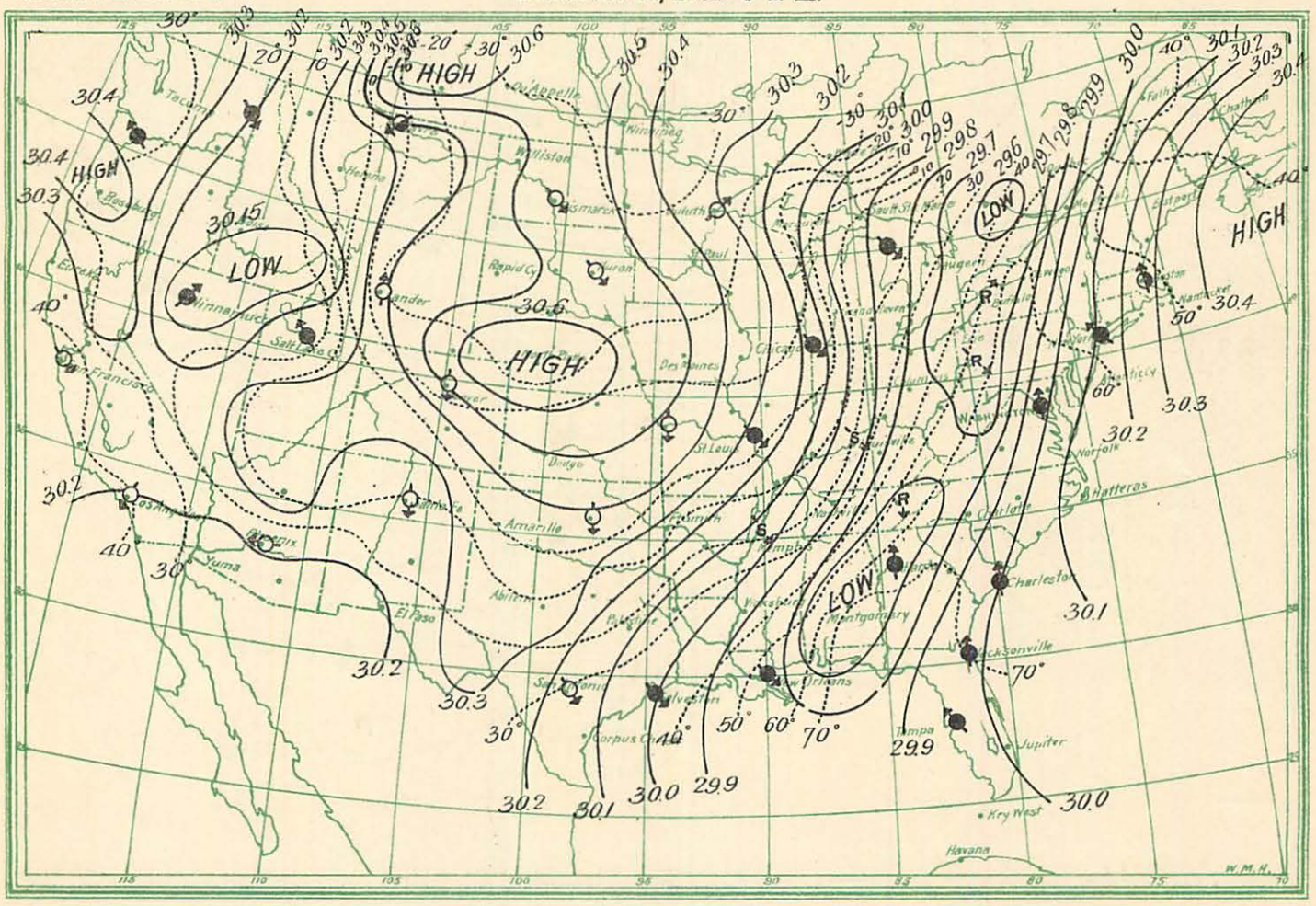


Chart LXXXIX. December 18, 1901—8 a. m.

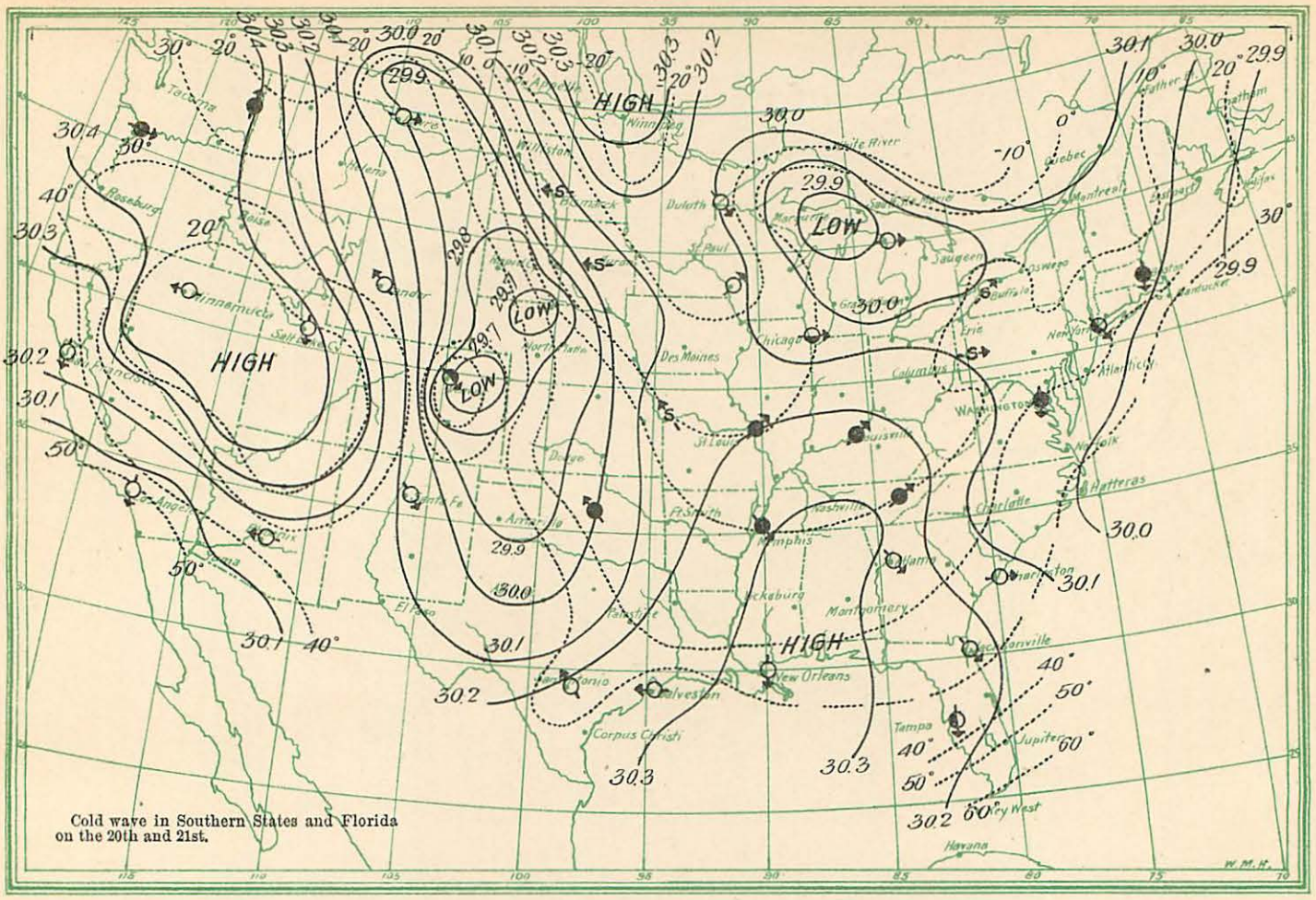


Chart XC. December 19, 1901—8 a. m.

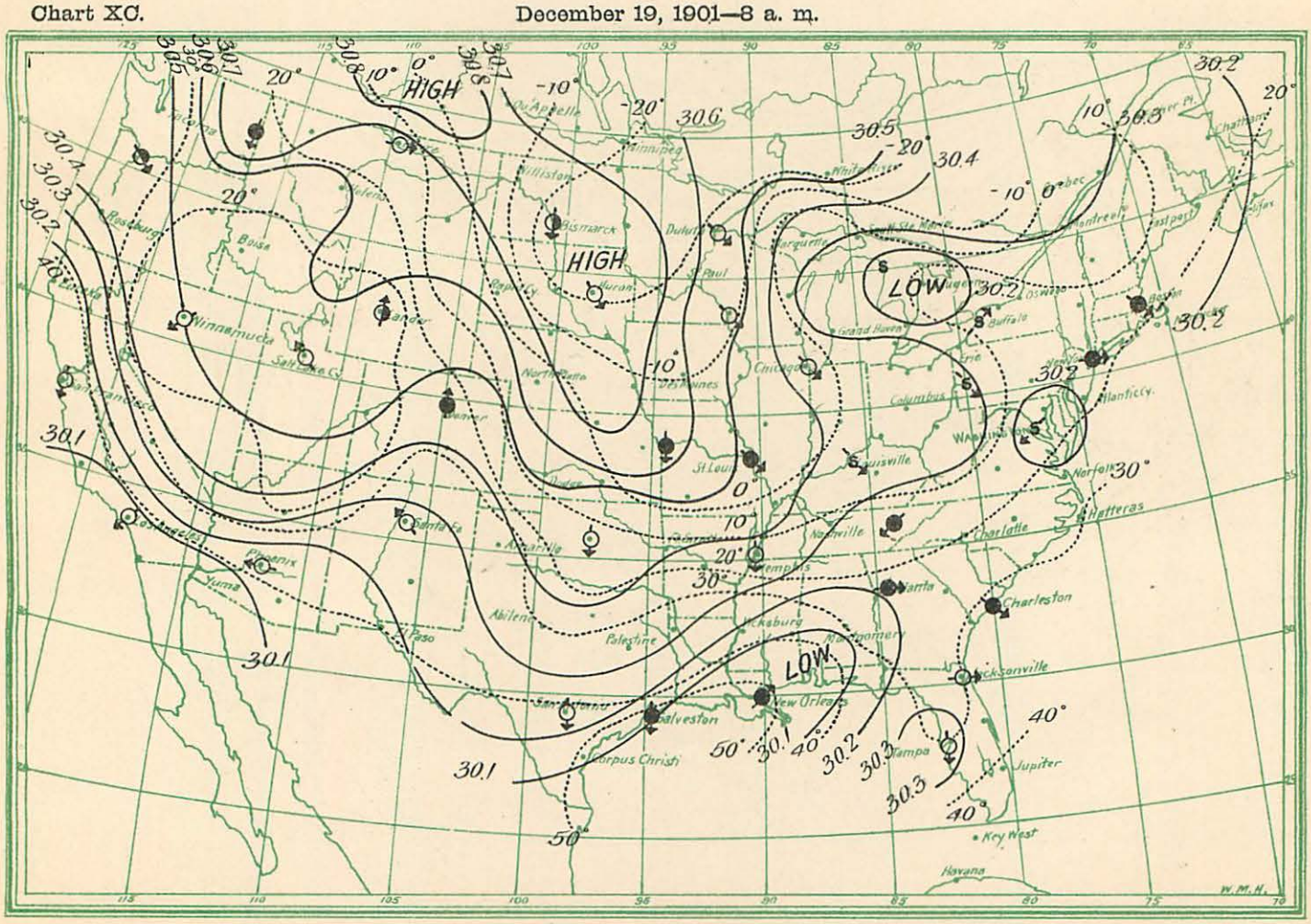


Chart XCI. December 20, 1901—8 a. m.

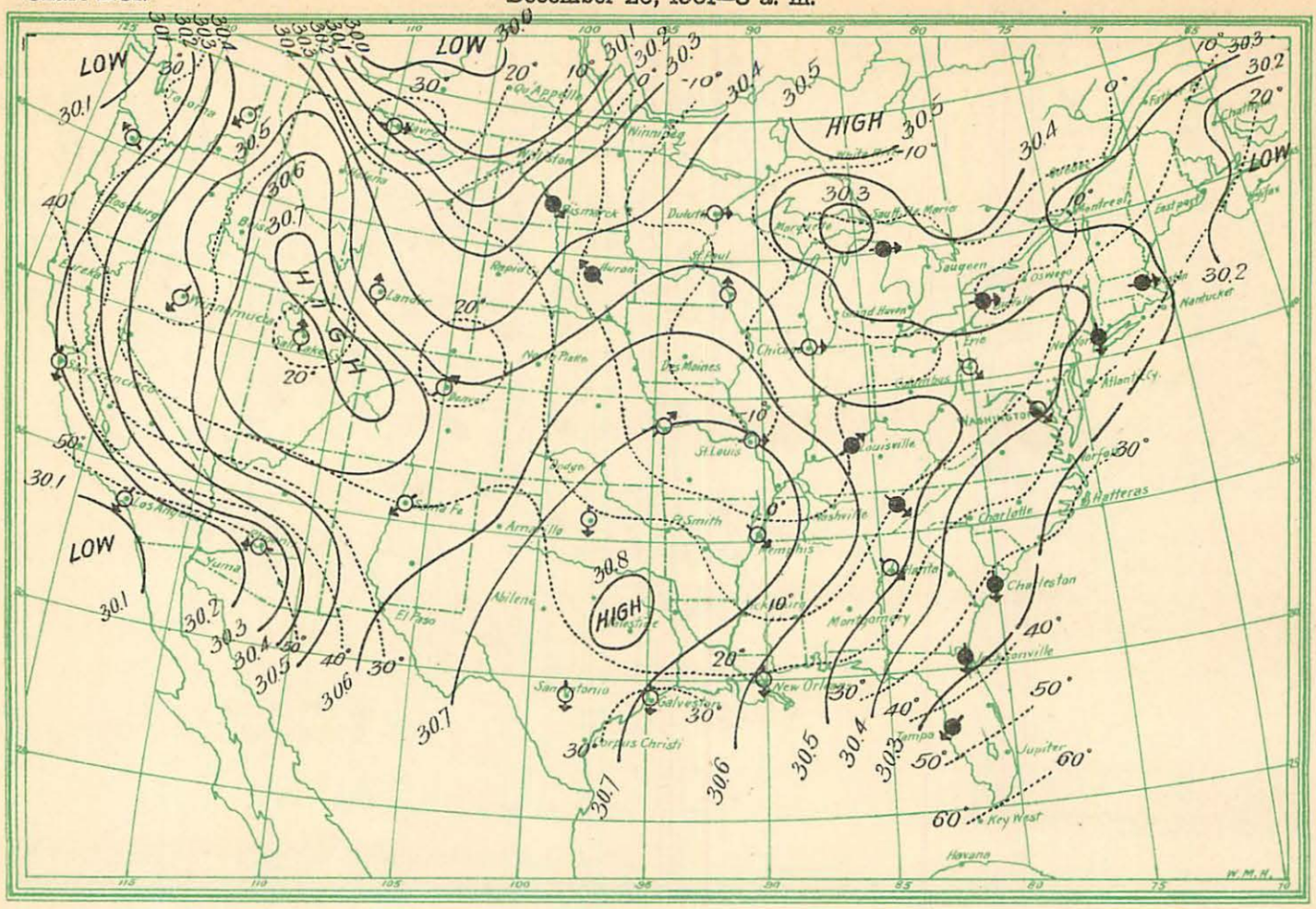


Chart XCII. December 21, 1901—8 a. m.

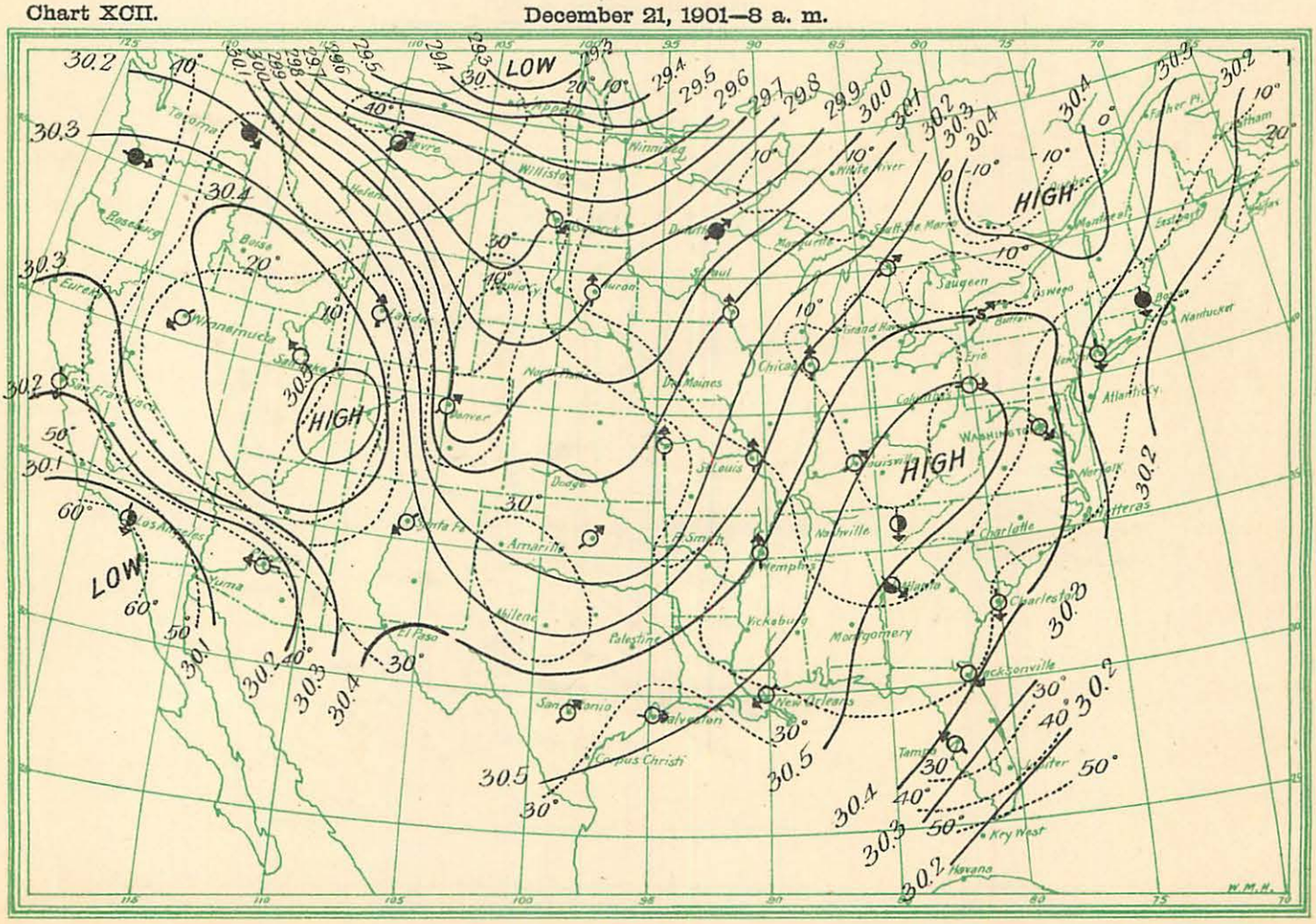


Chart XCIII. December 2, 1902—8 a. m.

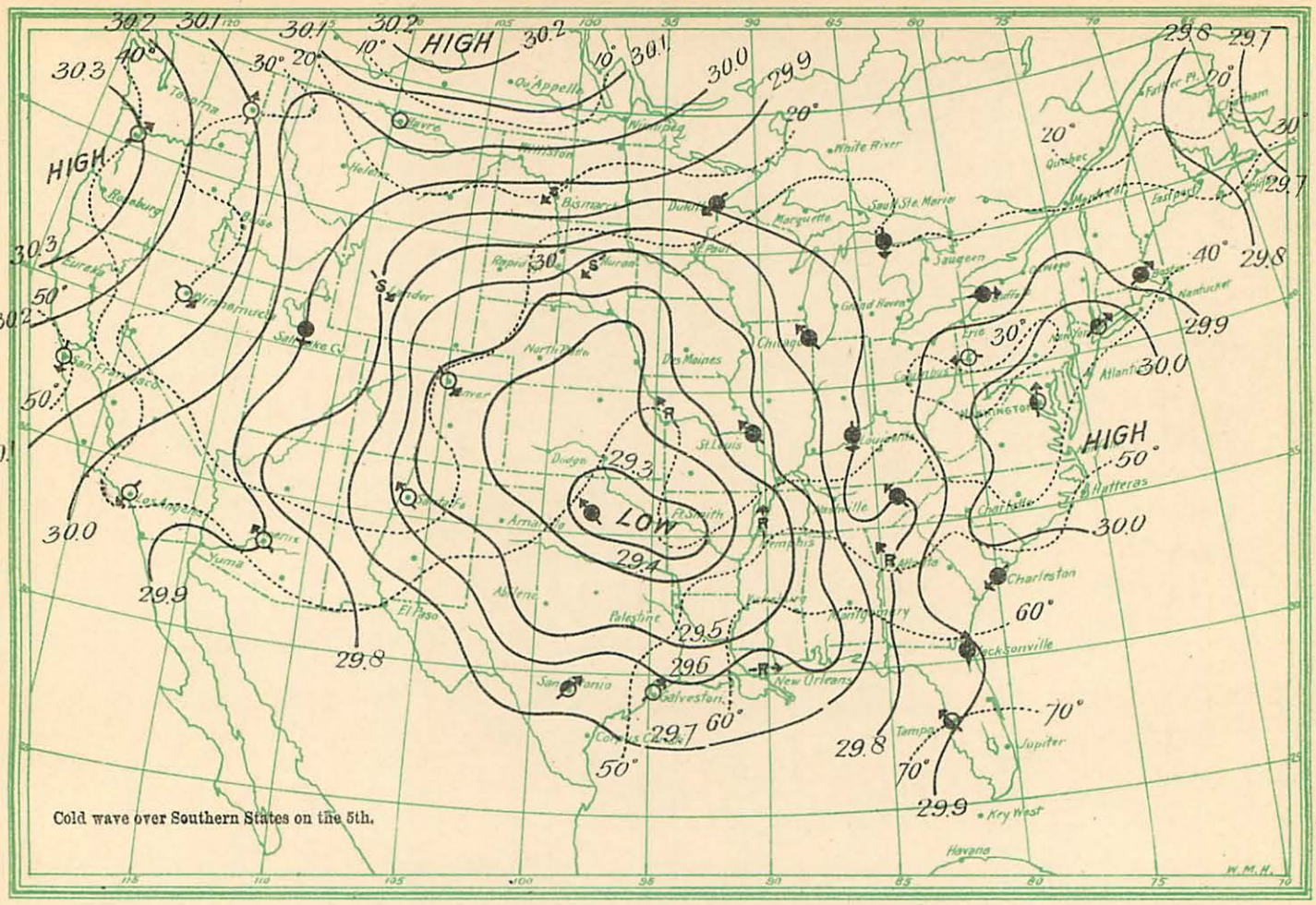


Chart XCIV. December 3, 1902—8 a. m.

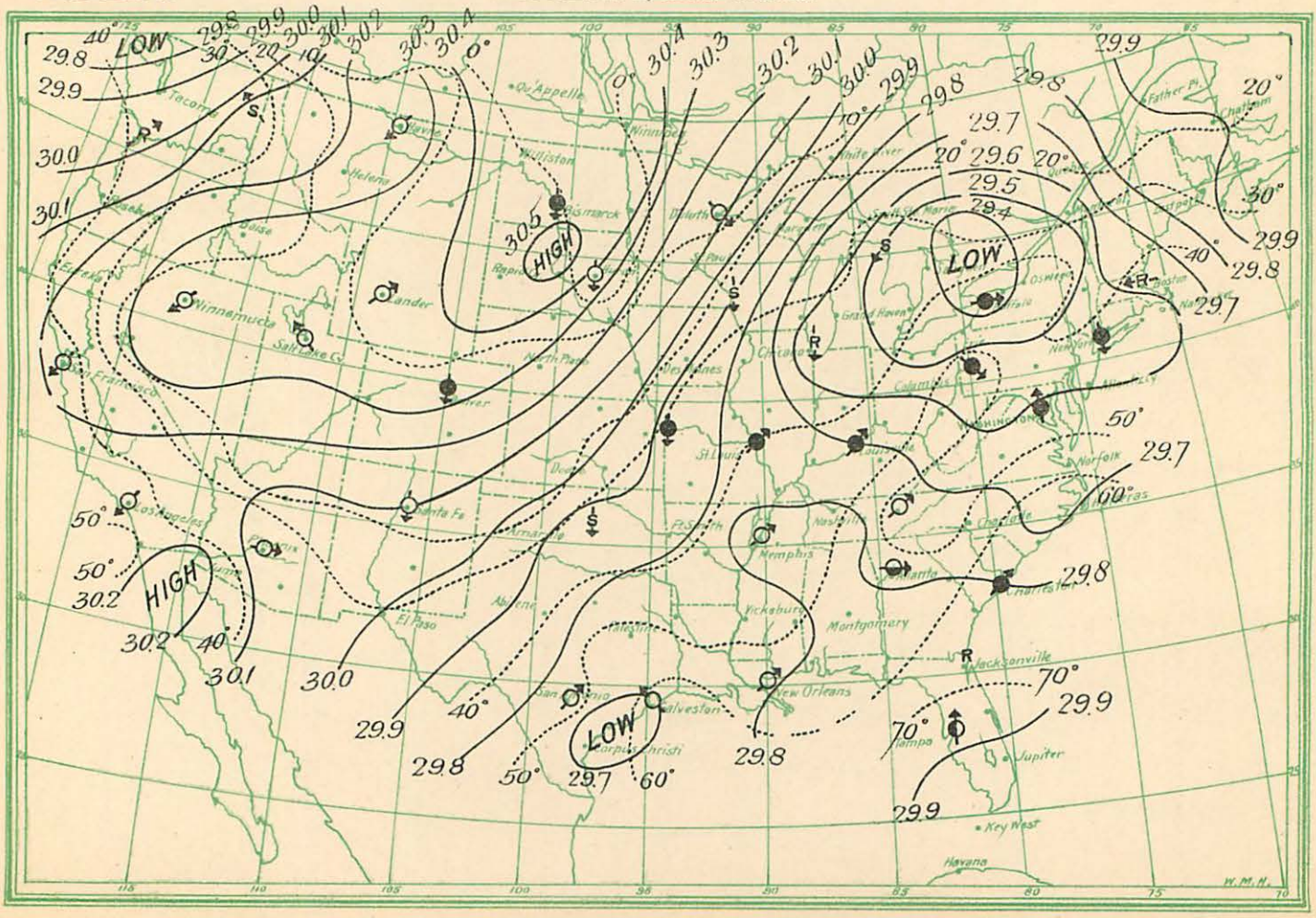


Chart XCV. December 4, 1902—8 a. m.

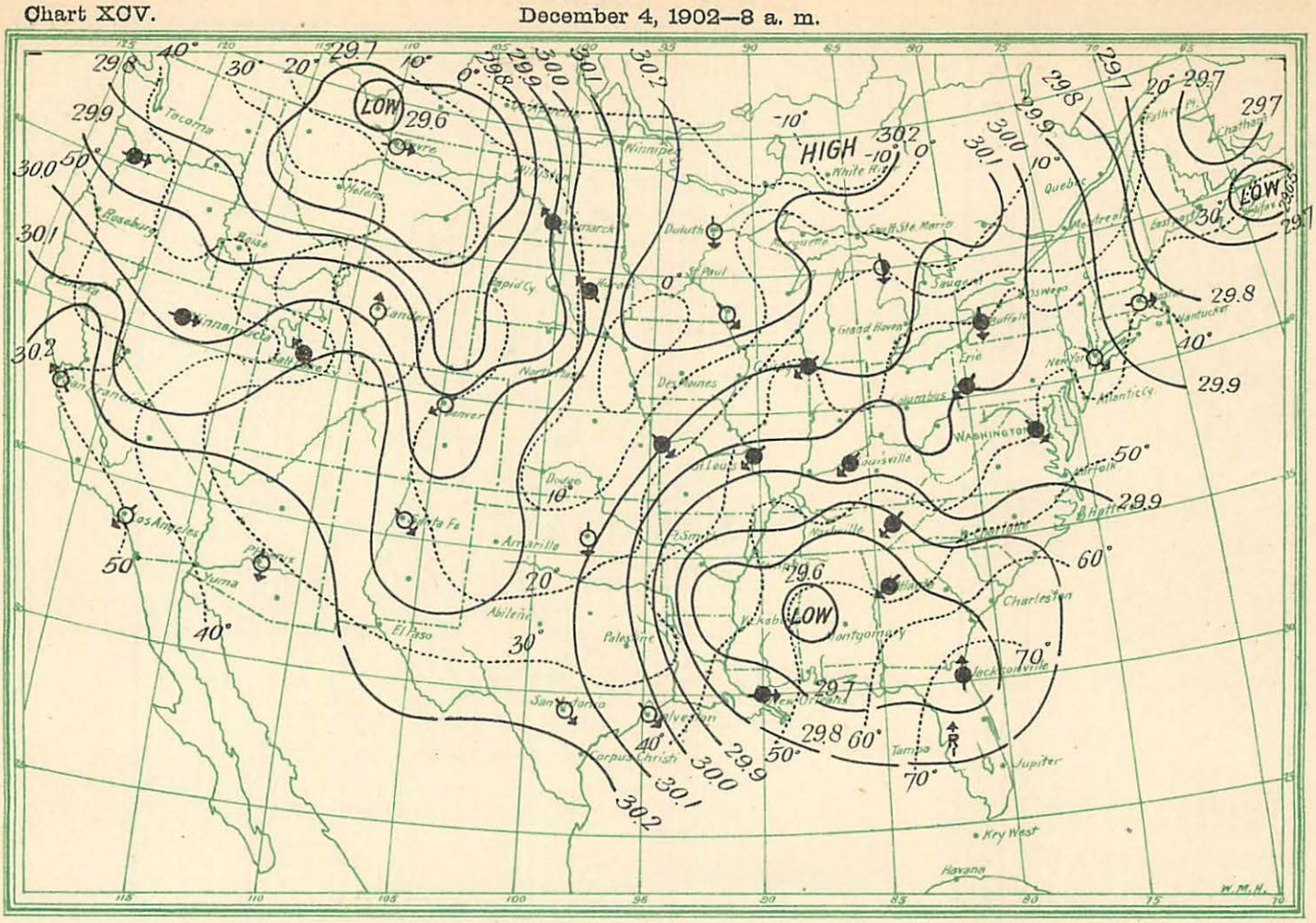


Chart XCVI. December 5, 1902—8 a. m.

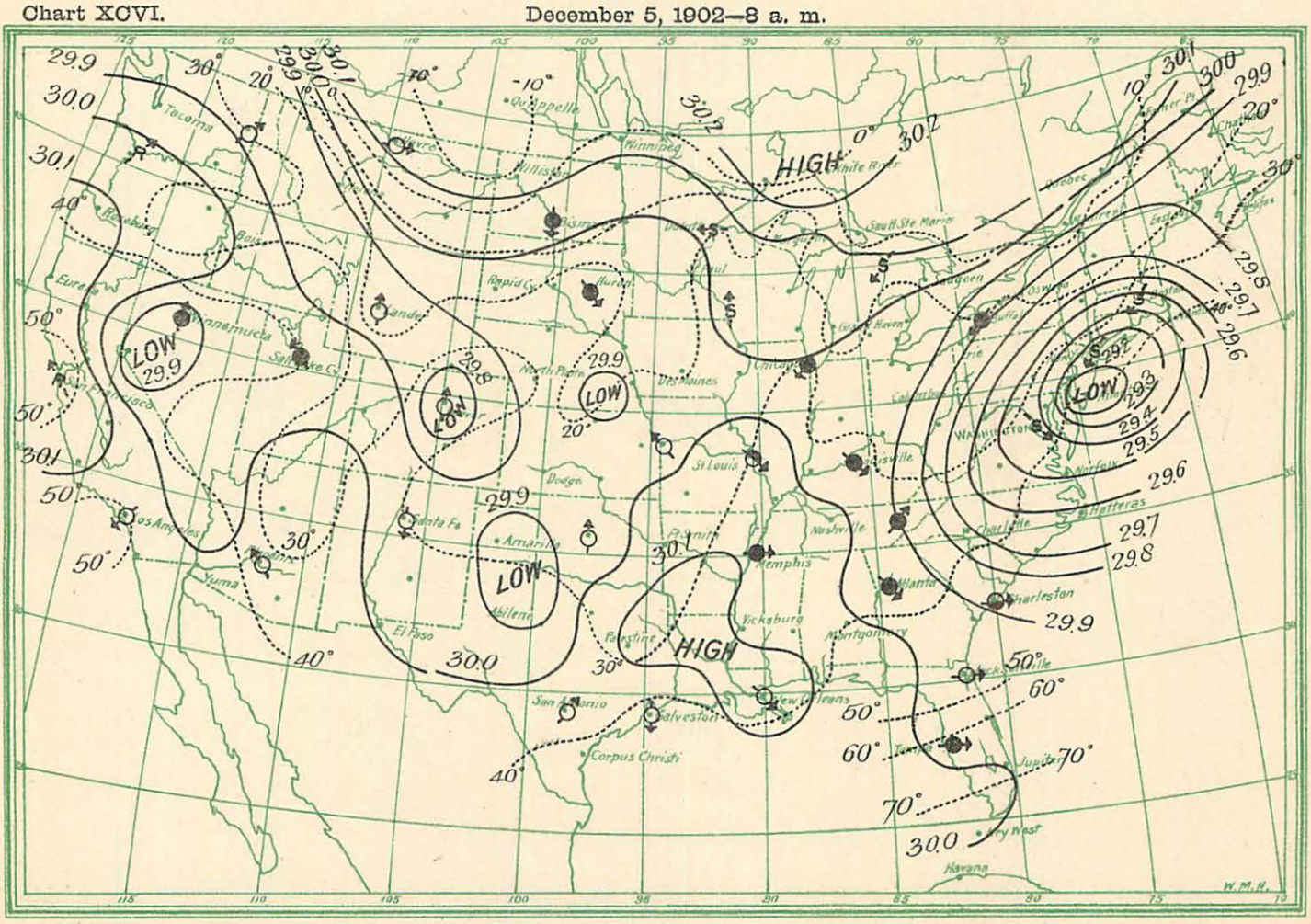


Chart XCVII. December 24, 1902—8 a. m.

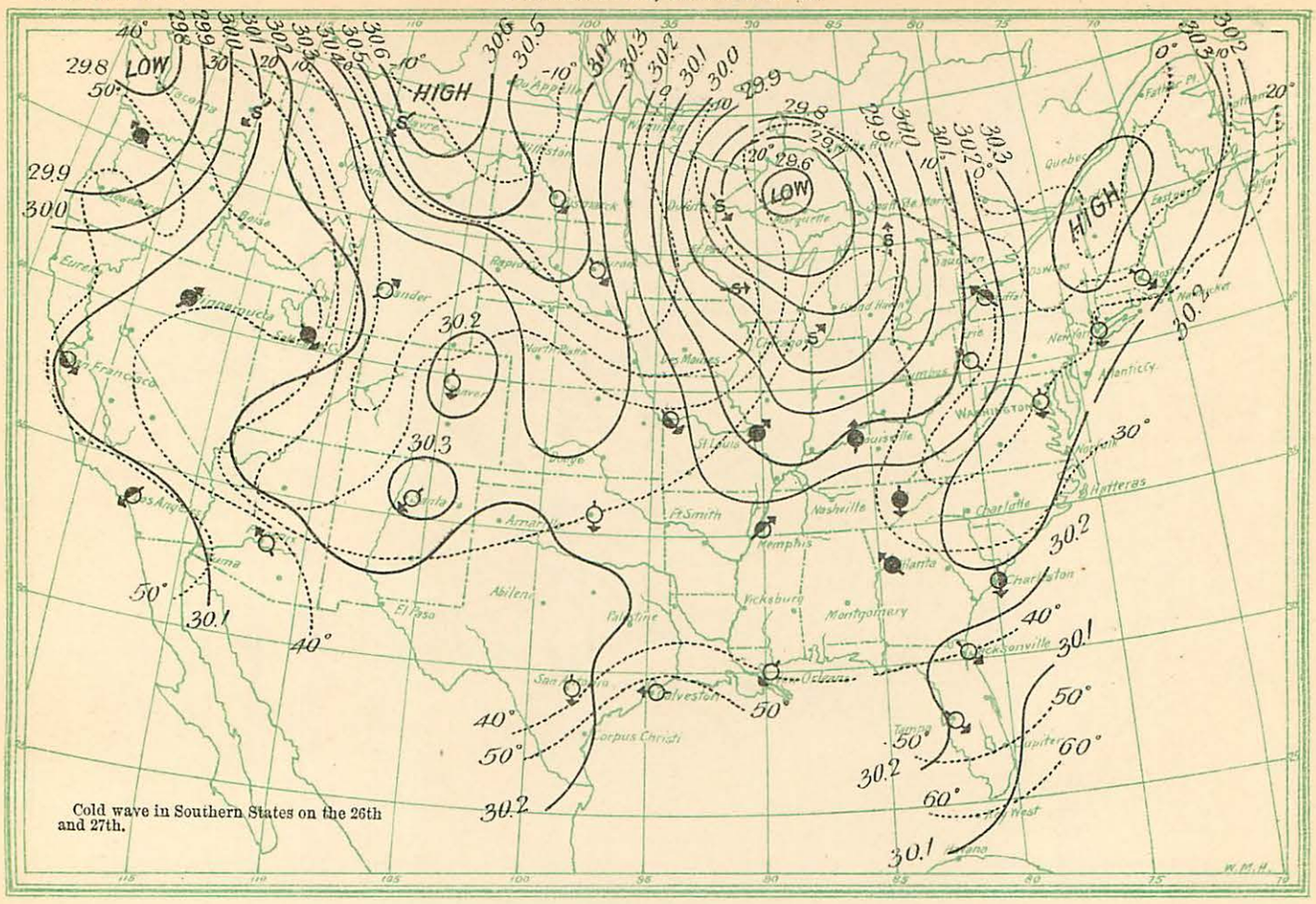


Chart XCVIII. December 25, 1902—8 a. m.

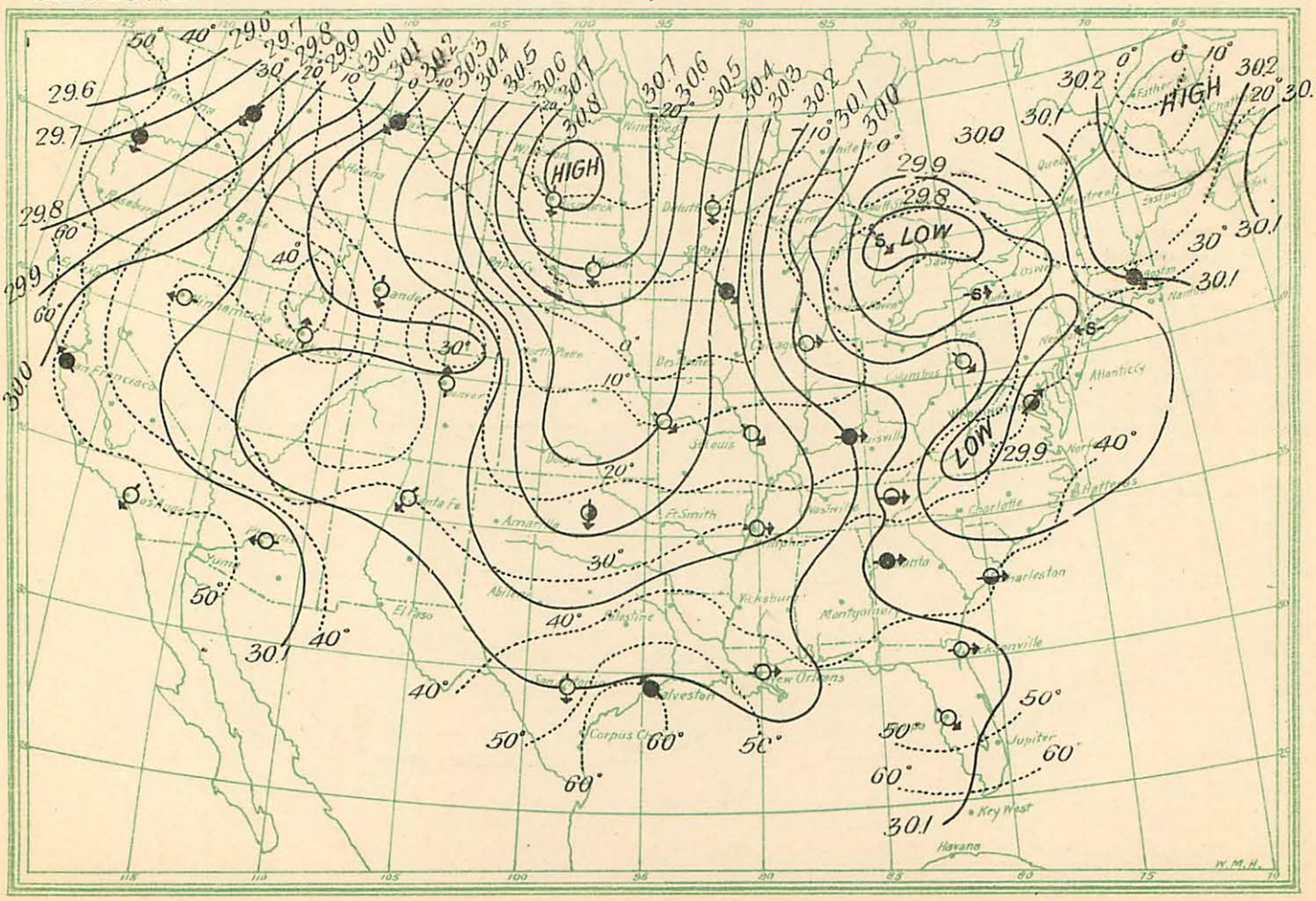


Chart XCIX. December 26, 1902—8 a. m.

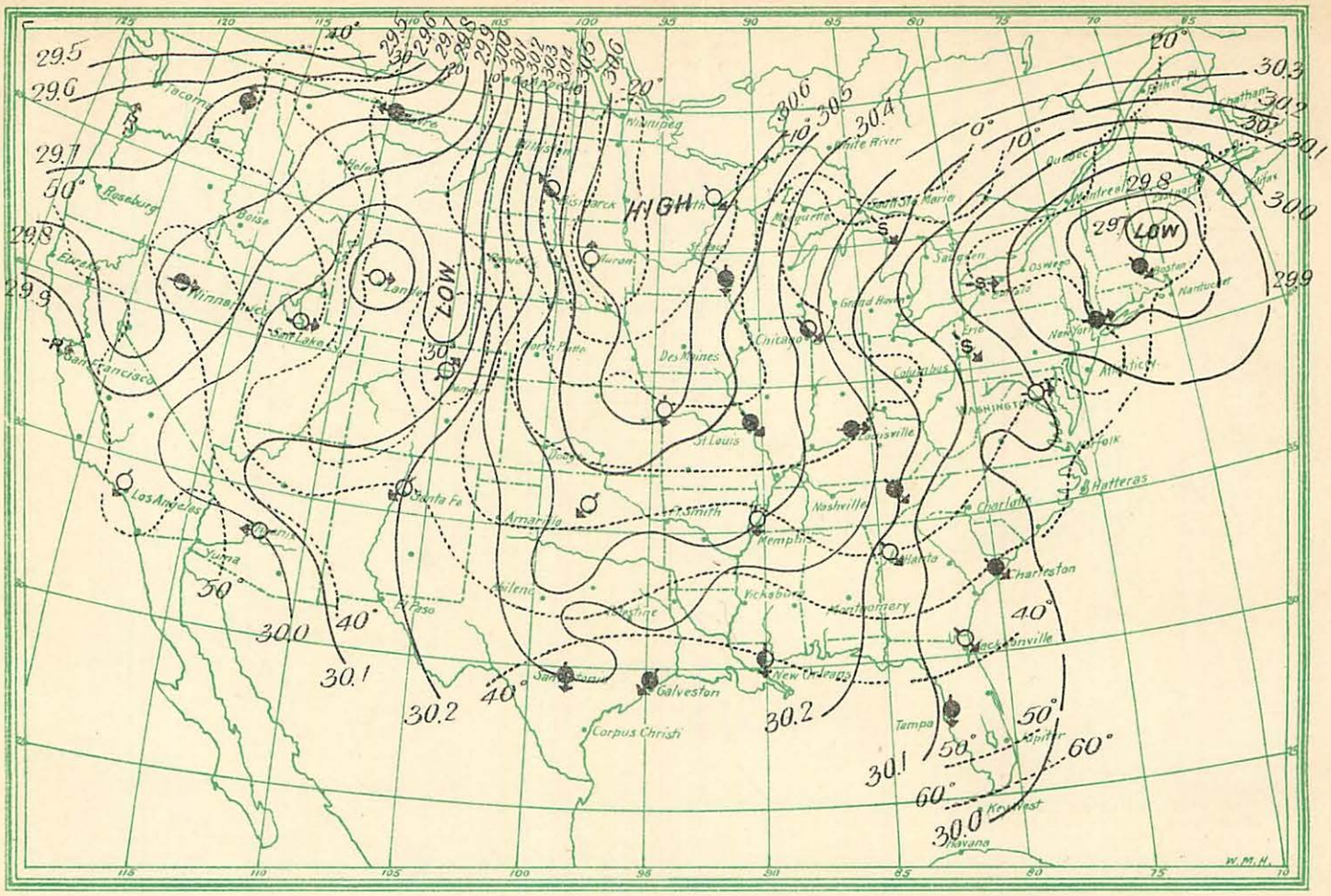


Chart C. December 27, 1902—8 a. m.

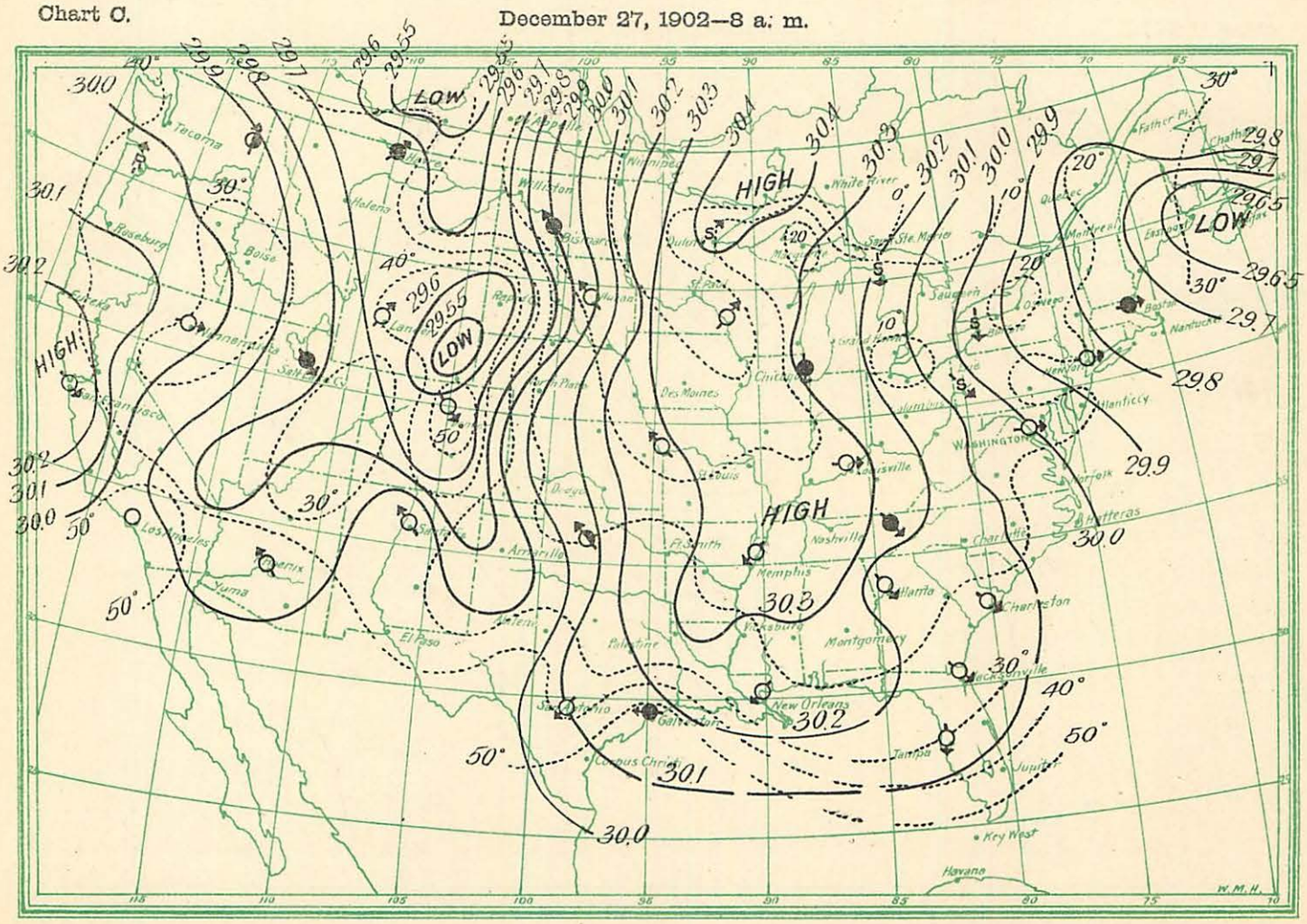


Chart CI. January 3, 1890—8 a. m.

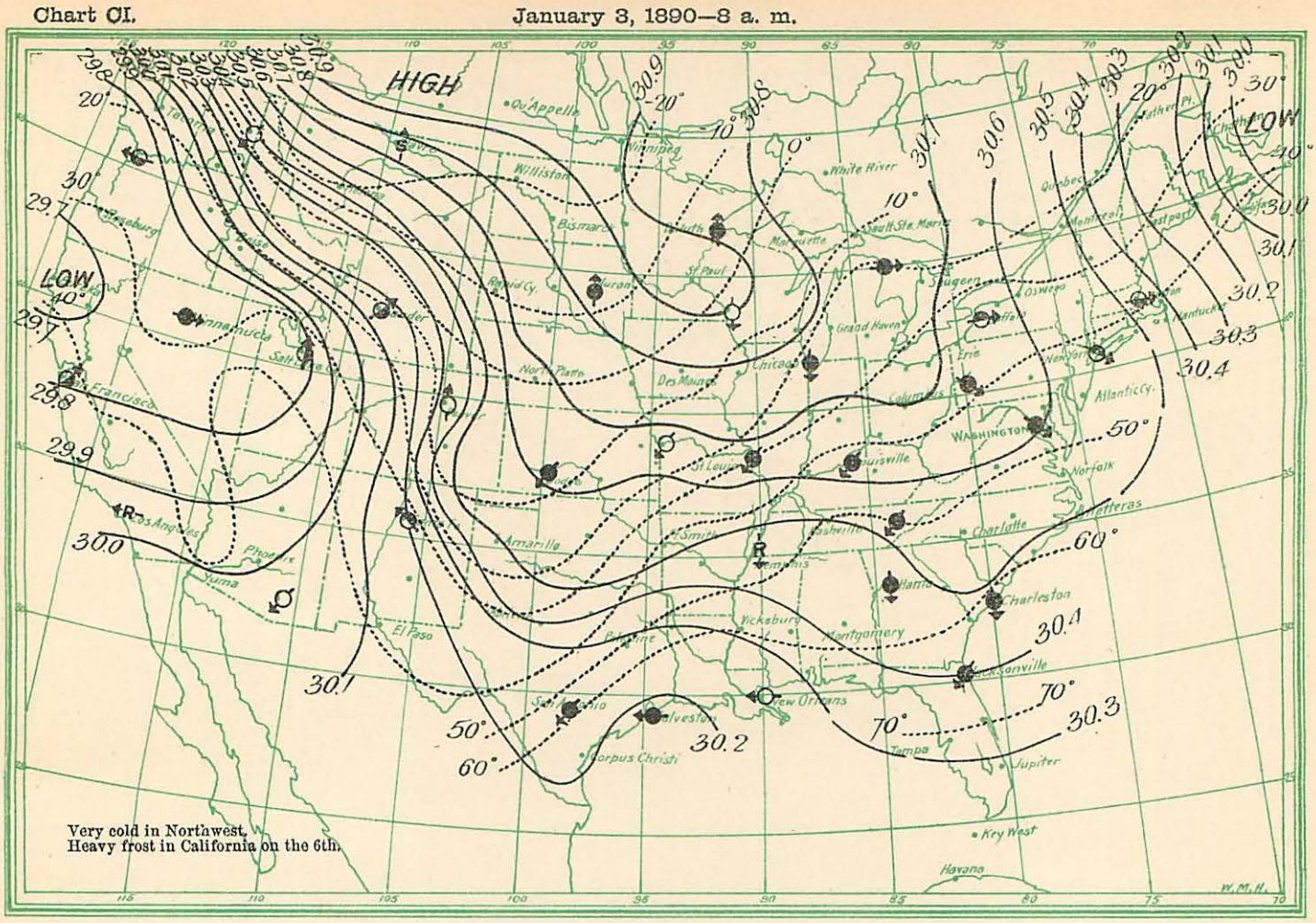


Chart CII. January 4, 1890—8 a. m.

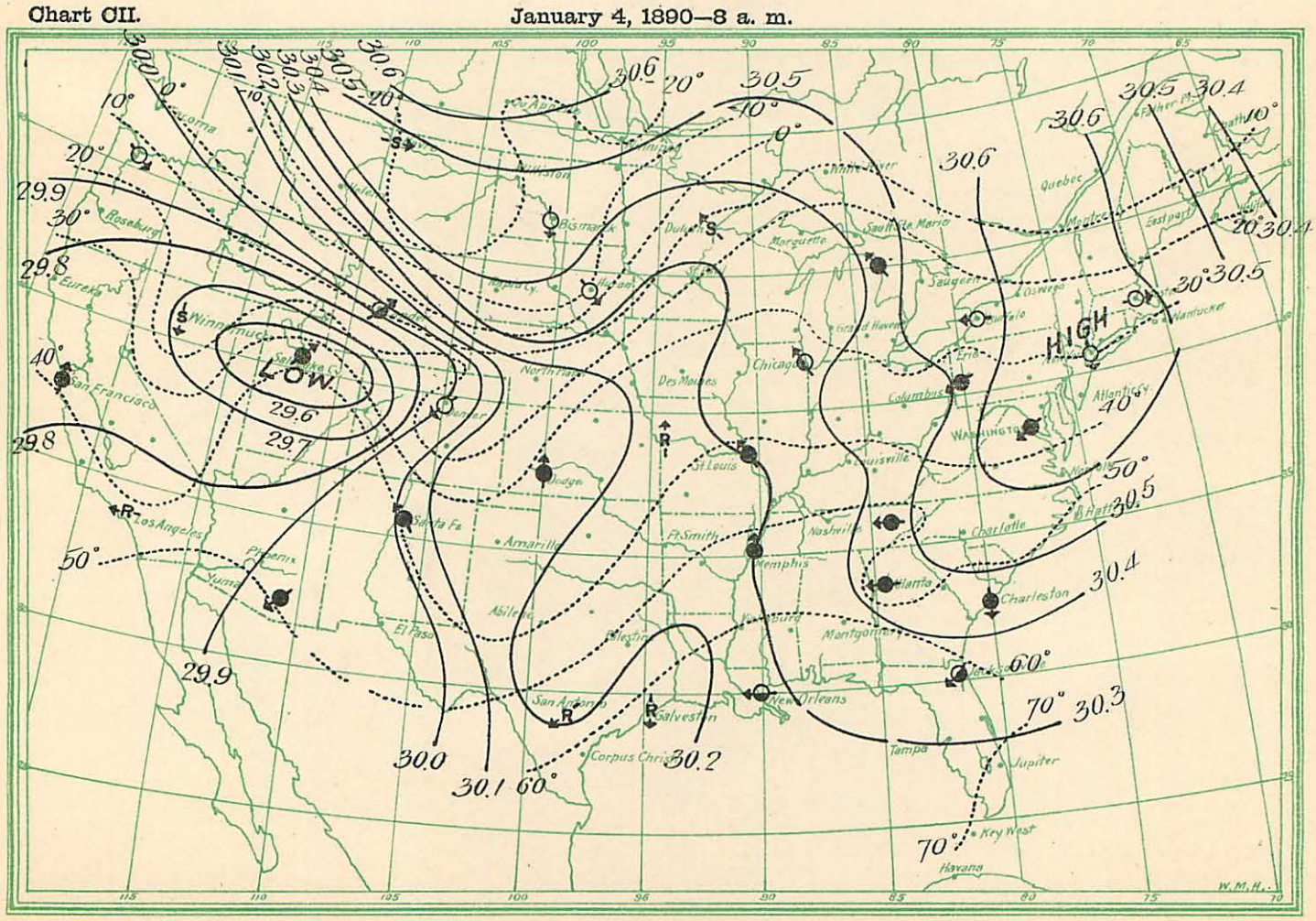


Chart CIII. January 5, 1890—8 a. m.

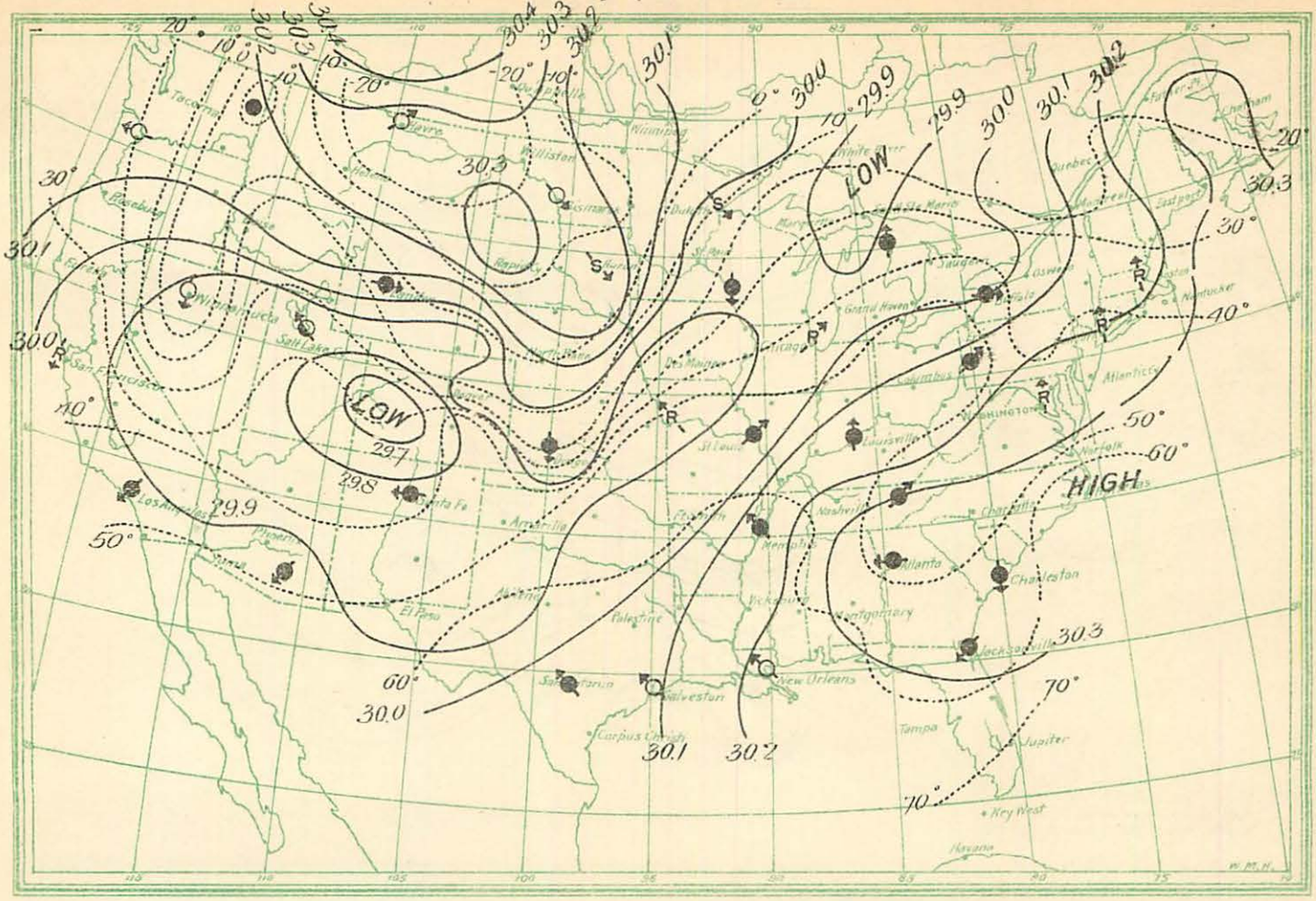


Chart CIV. January 6, 1890—8 a. m.

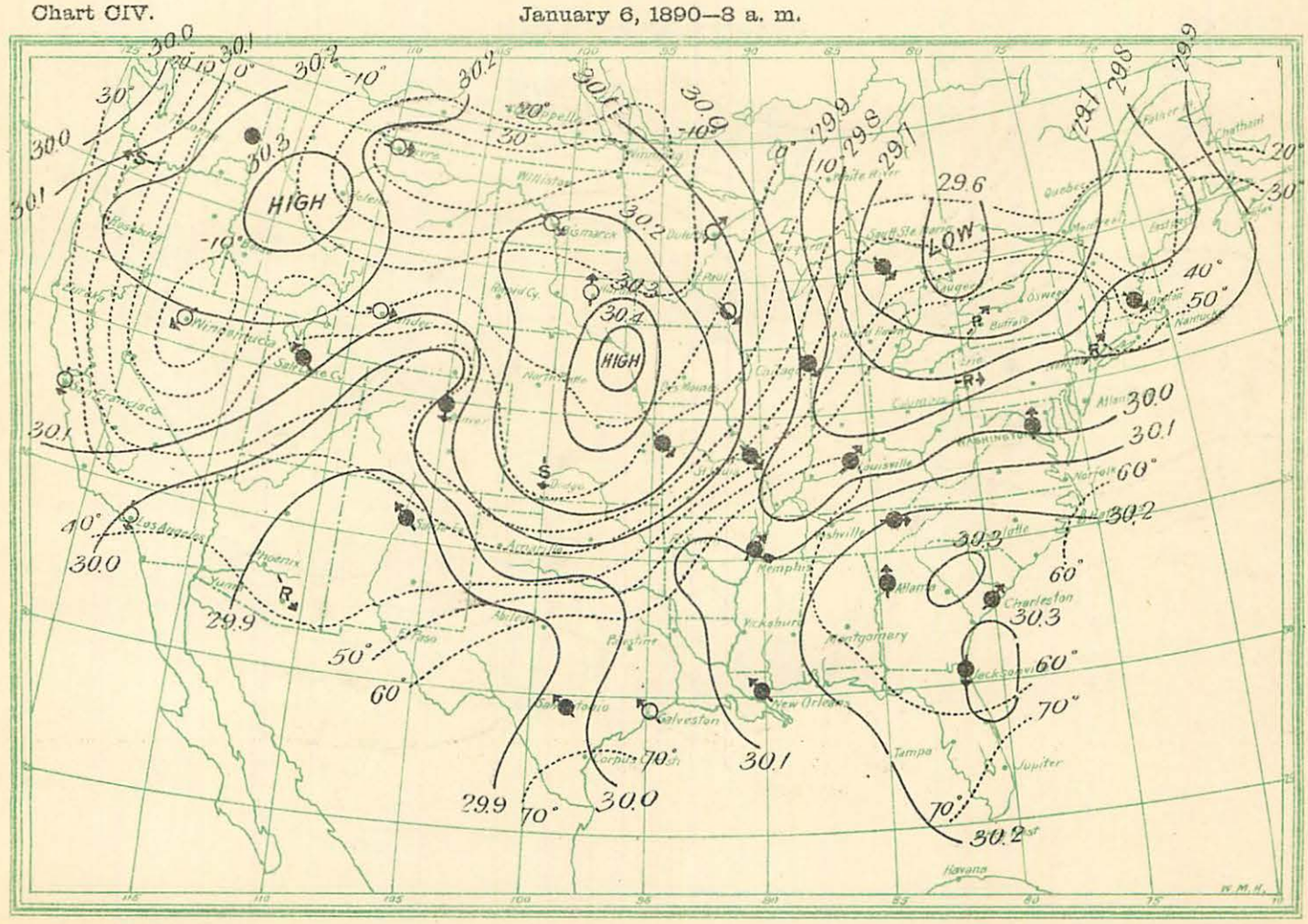


Chart CV. January 11, 1891—8 a. m.

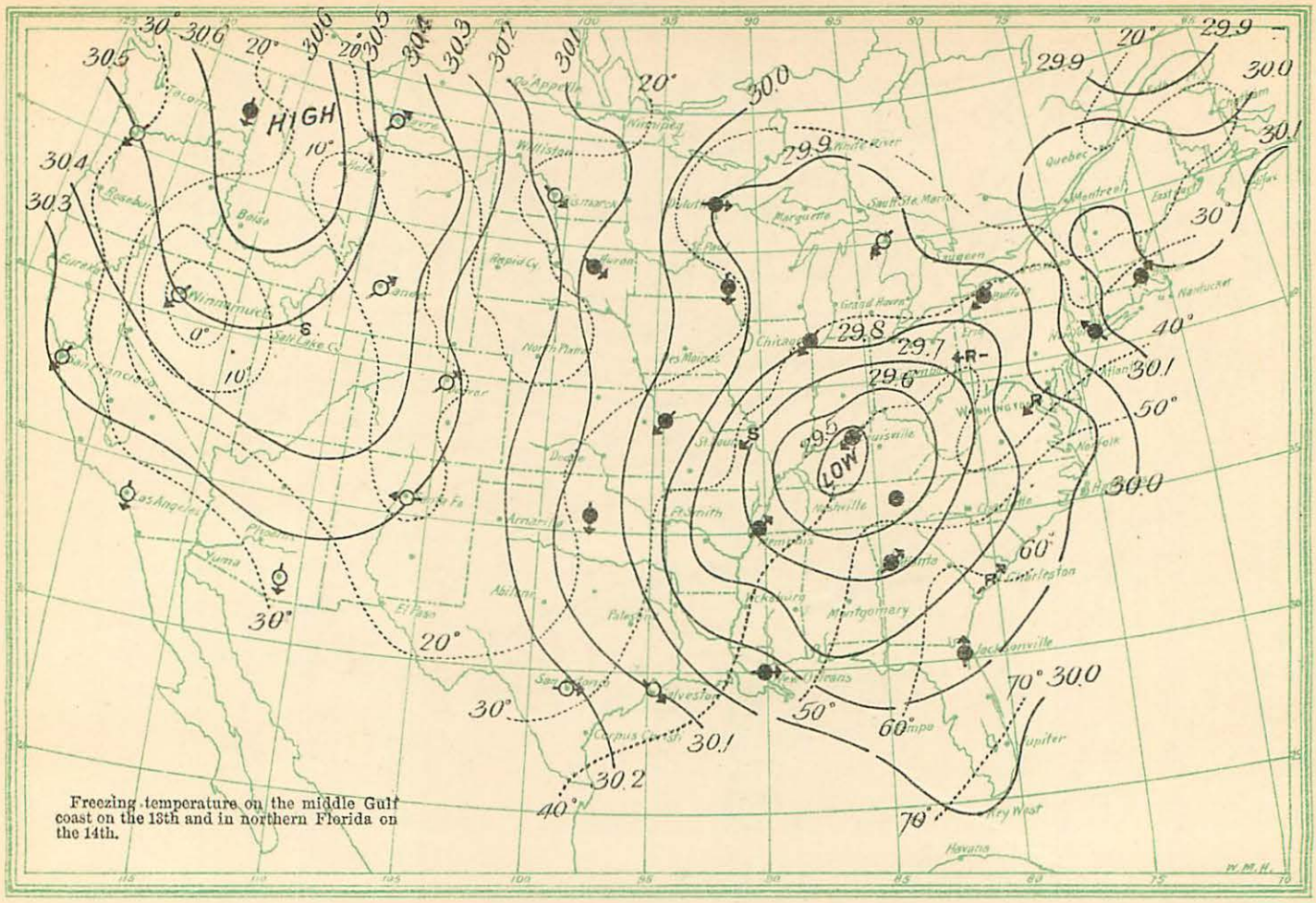


Chart CVI. January 12, 1891—8 a. m.

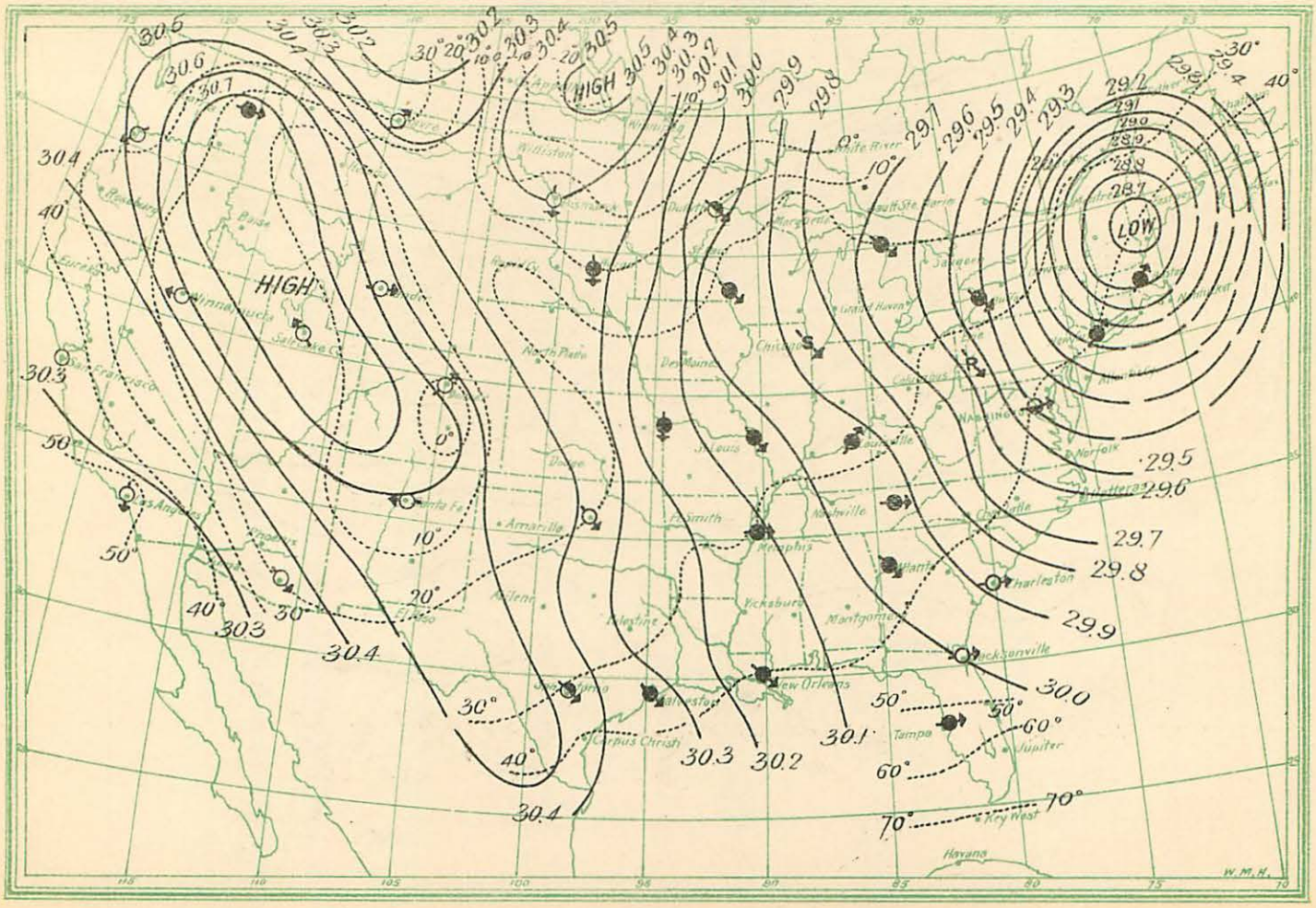


Chart CVII. January 13, 1891—8 a. m.

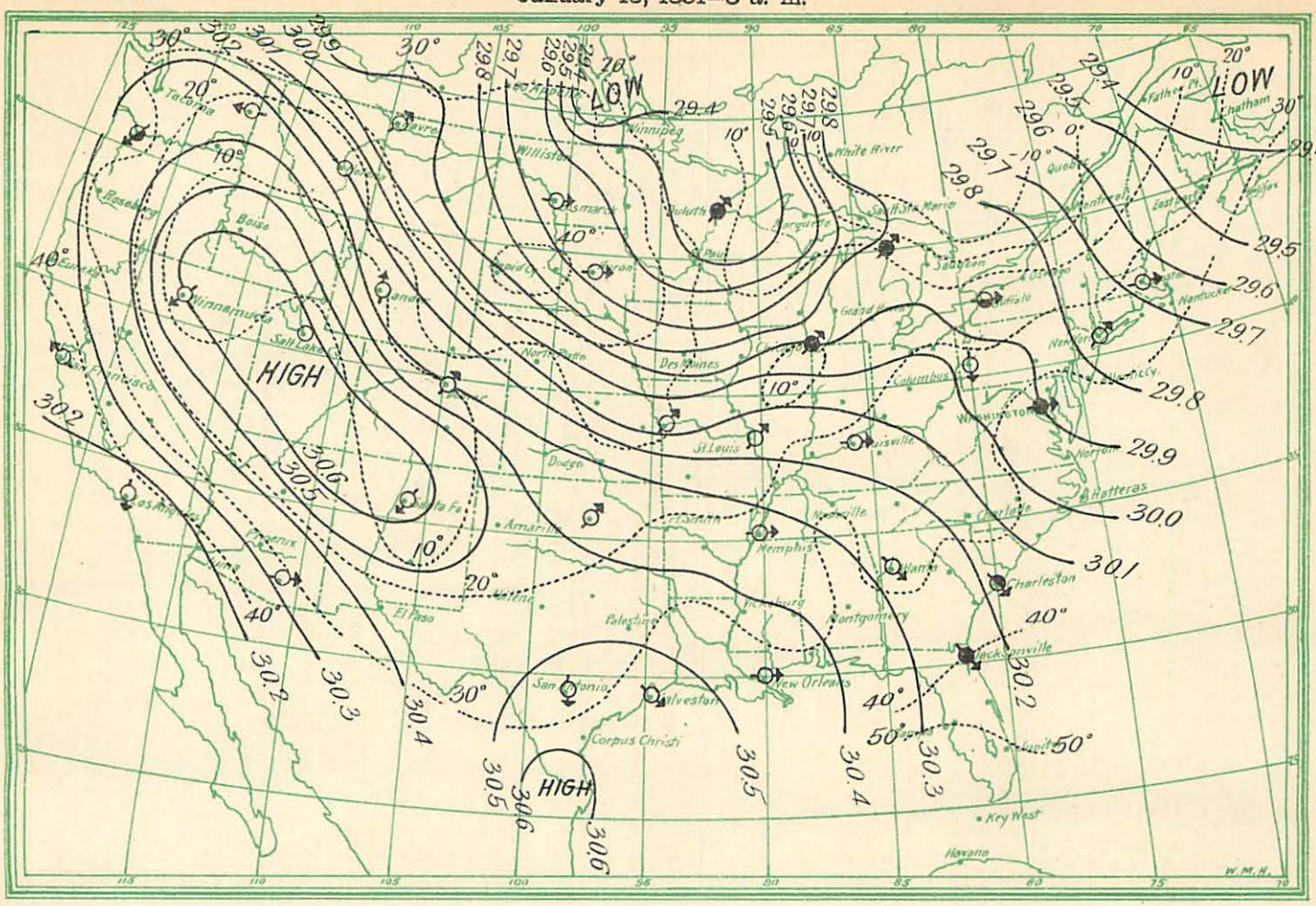


Chart CVIII. January 14, 1891—8 a. m.

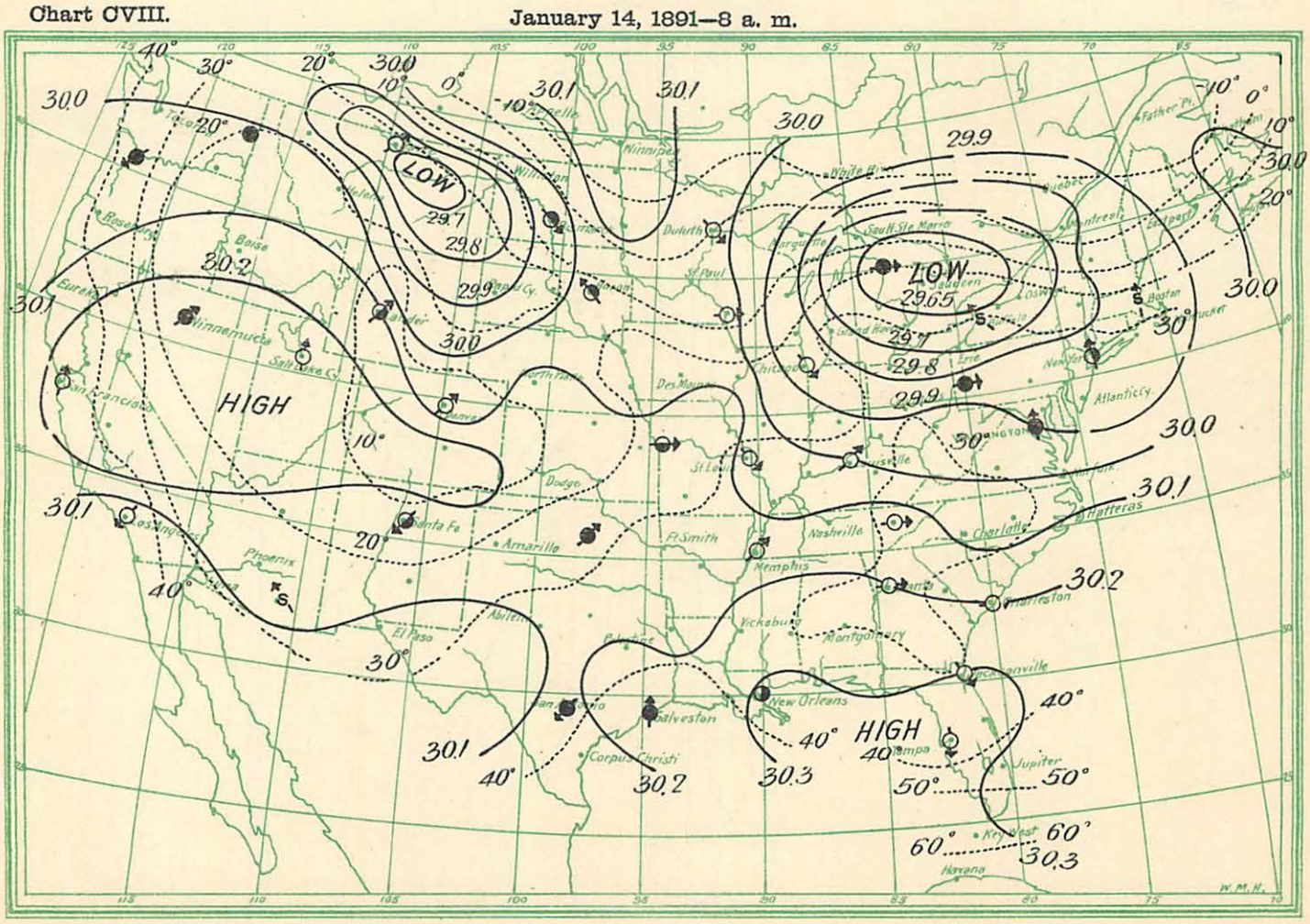


Chart CIX. January 16, 1892—8 a. m.

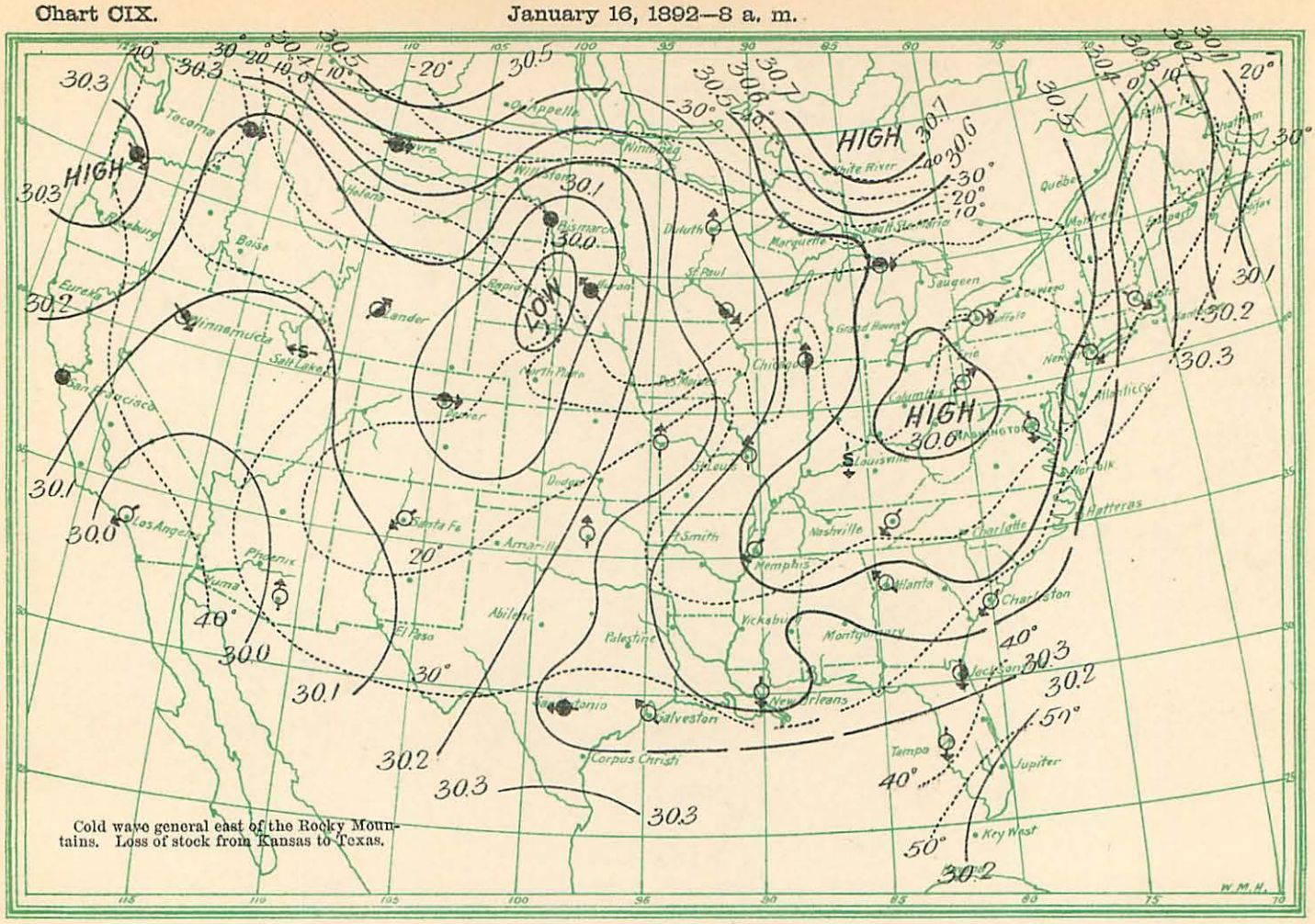


Chart CX. January 17, 1892—8 a. m.

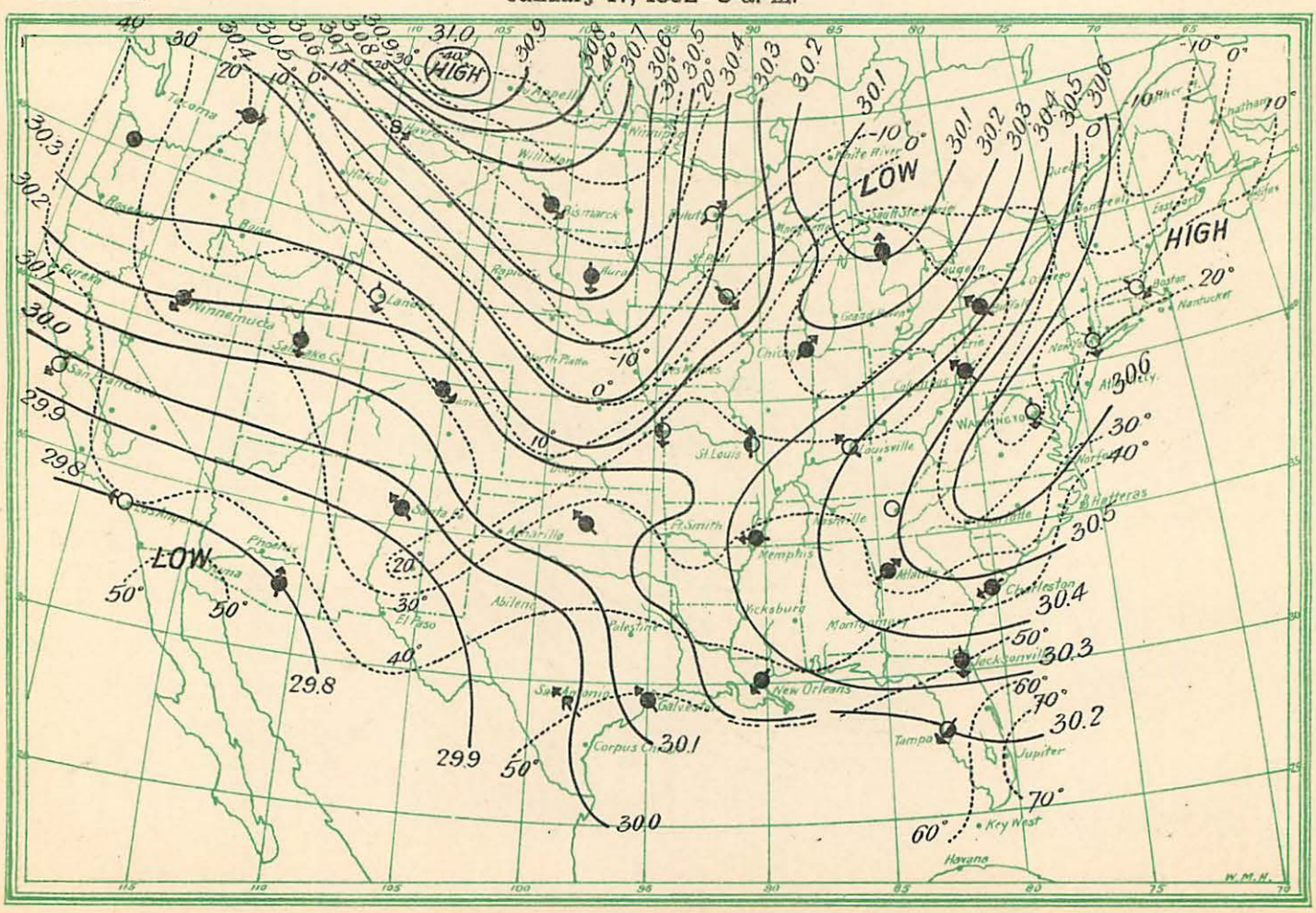


Chart CXI. January 18, 1892—8 a. m.

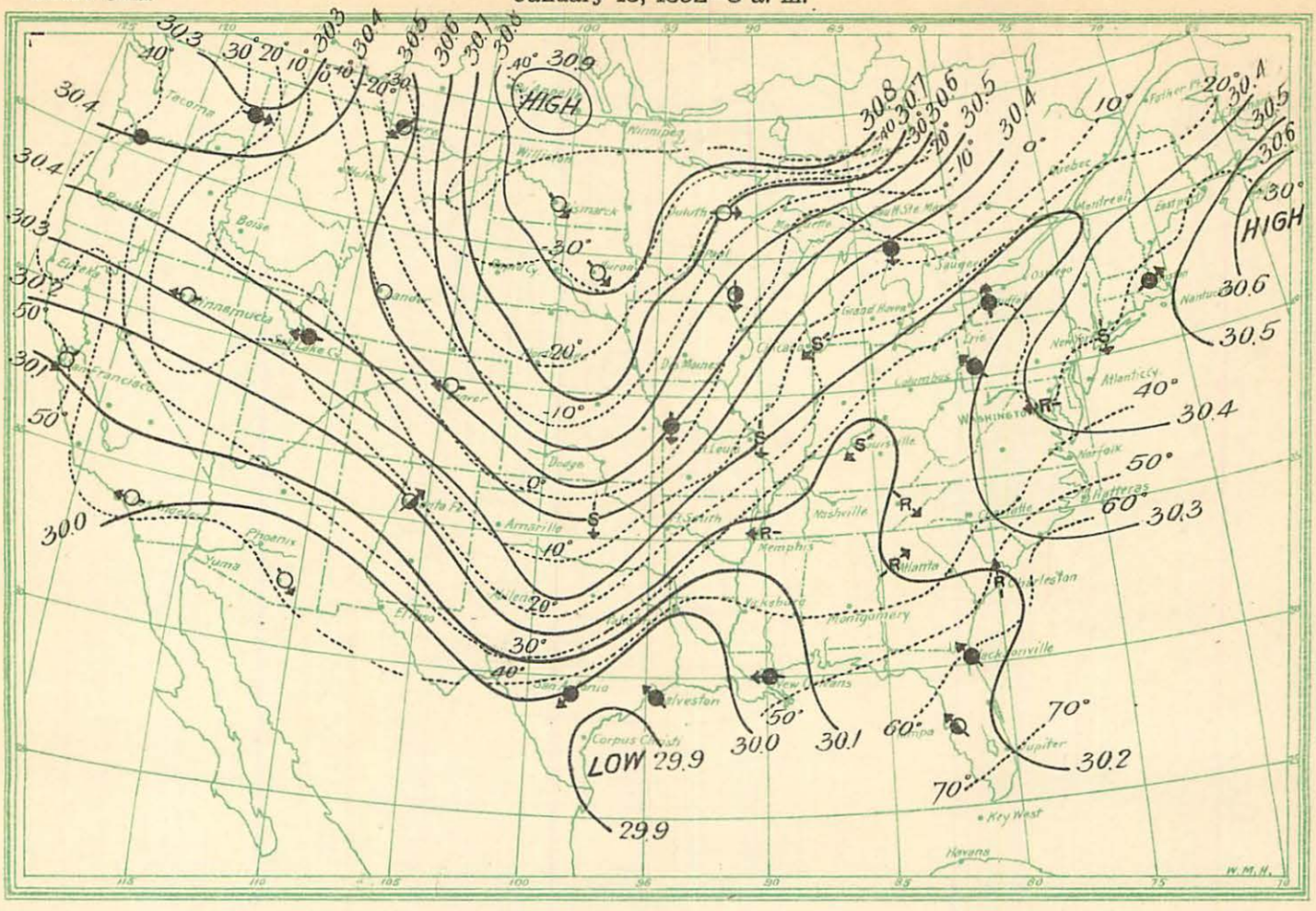
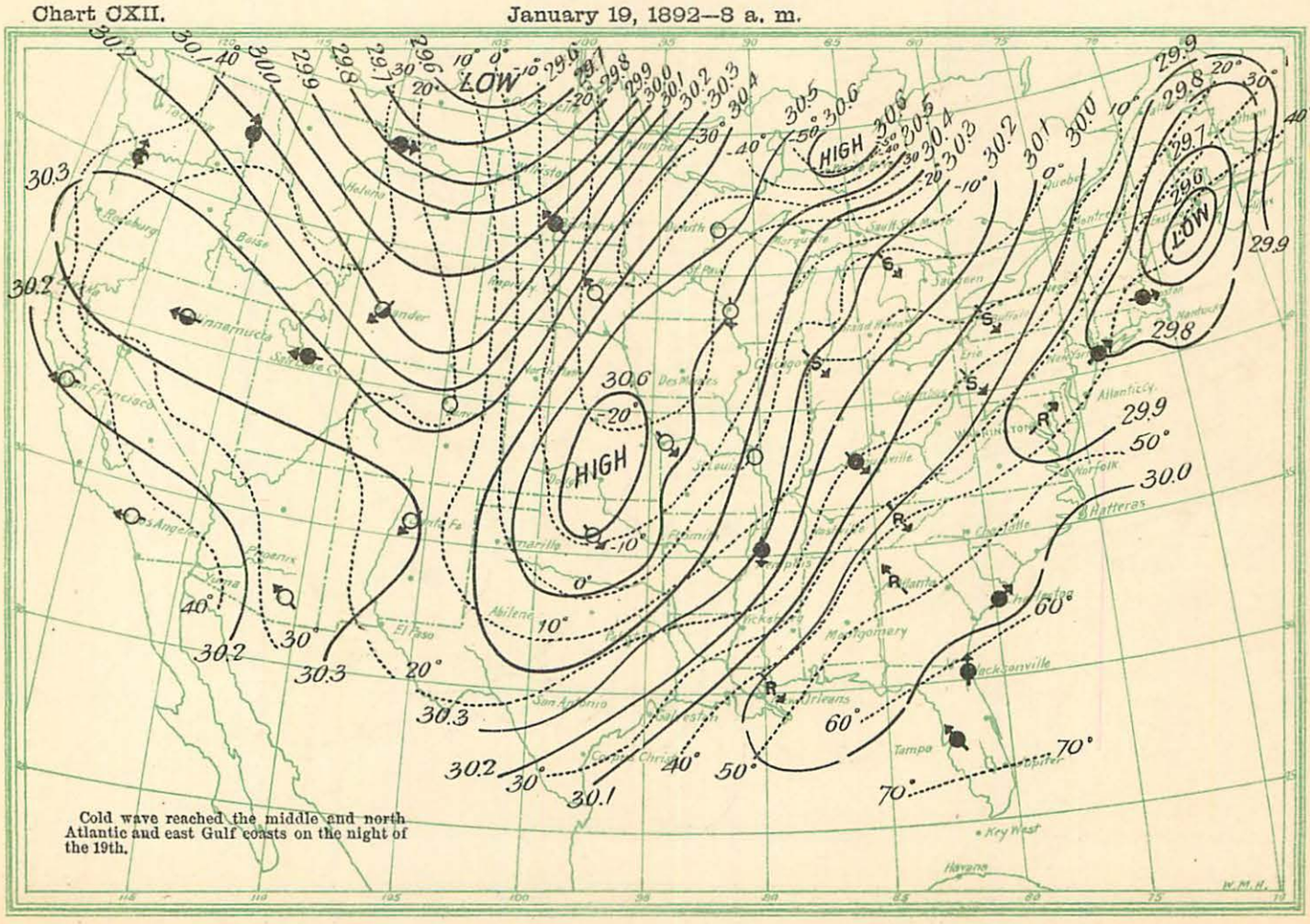


Chart CXII. January 19, 1892—8 a. m.



Cold wave reached the middle and north Atlantic and east Gulf coasts on the night of the 19th.

Chart CXIII. January 14, 1893—8 a. m.

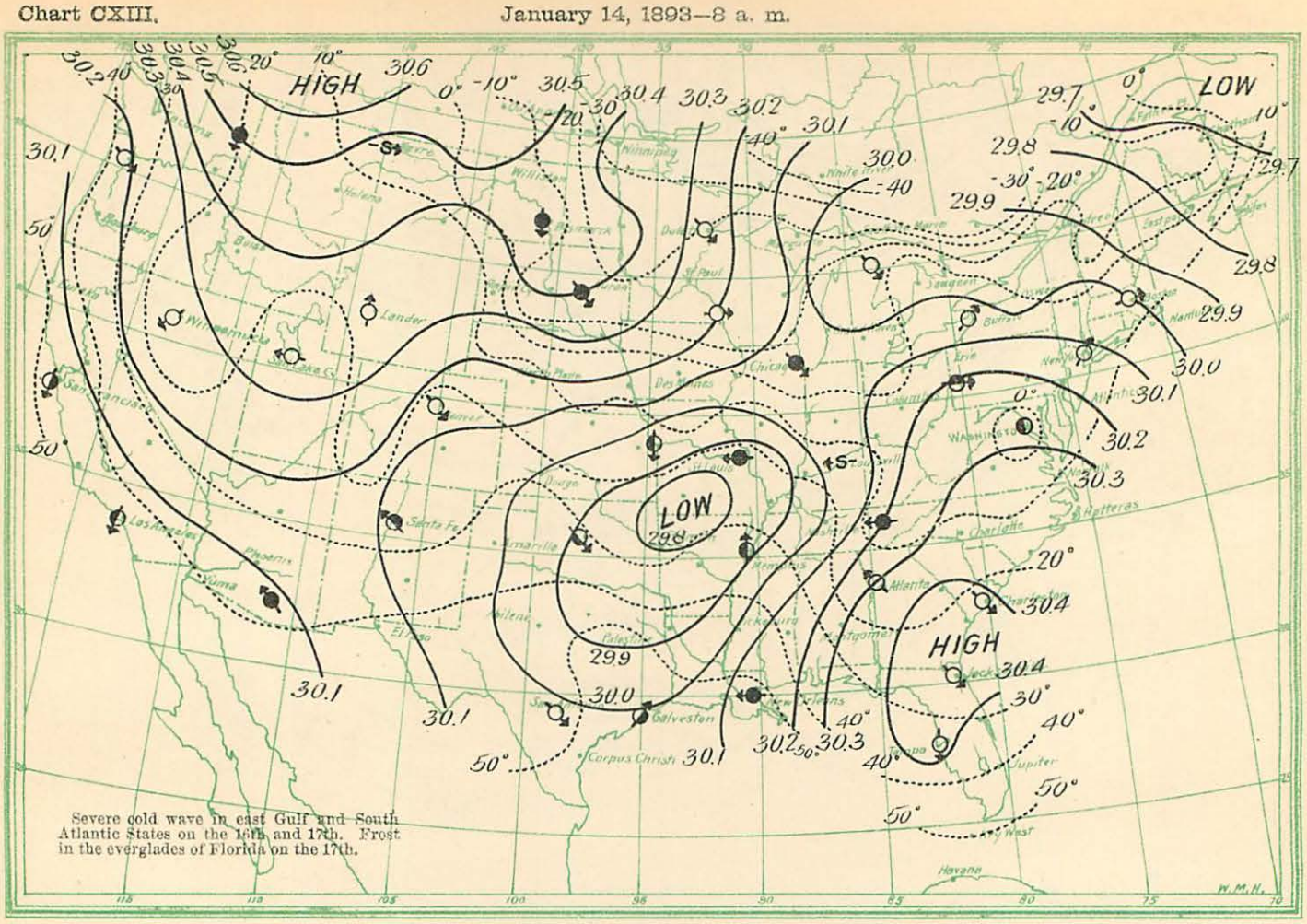


Chart CXIV. January 15, 1893—8 a. m.

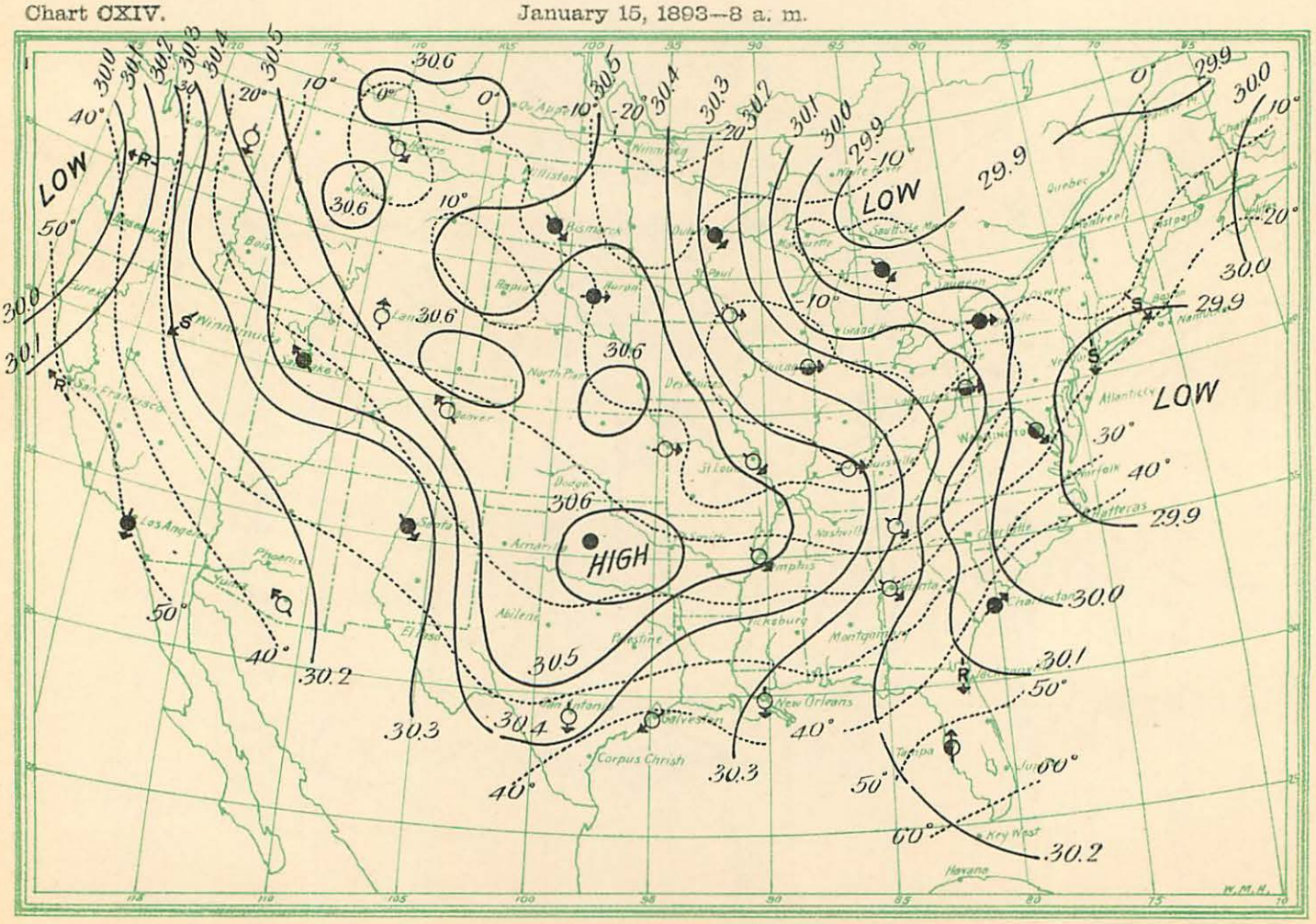


Chart CXV. January 16, 1893—8 a. m.

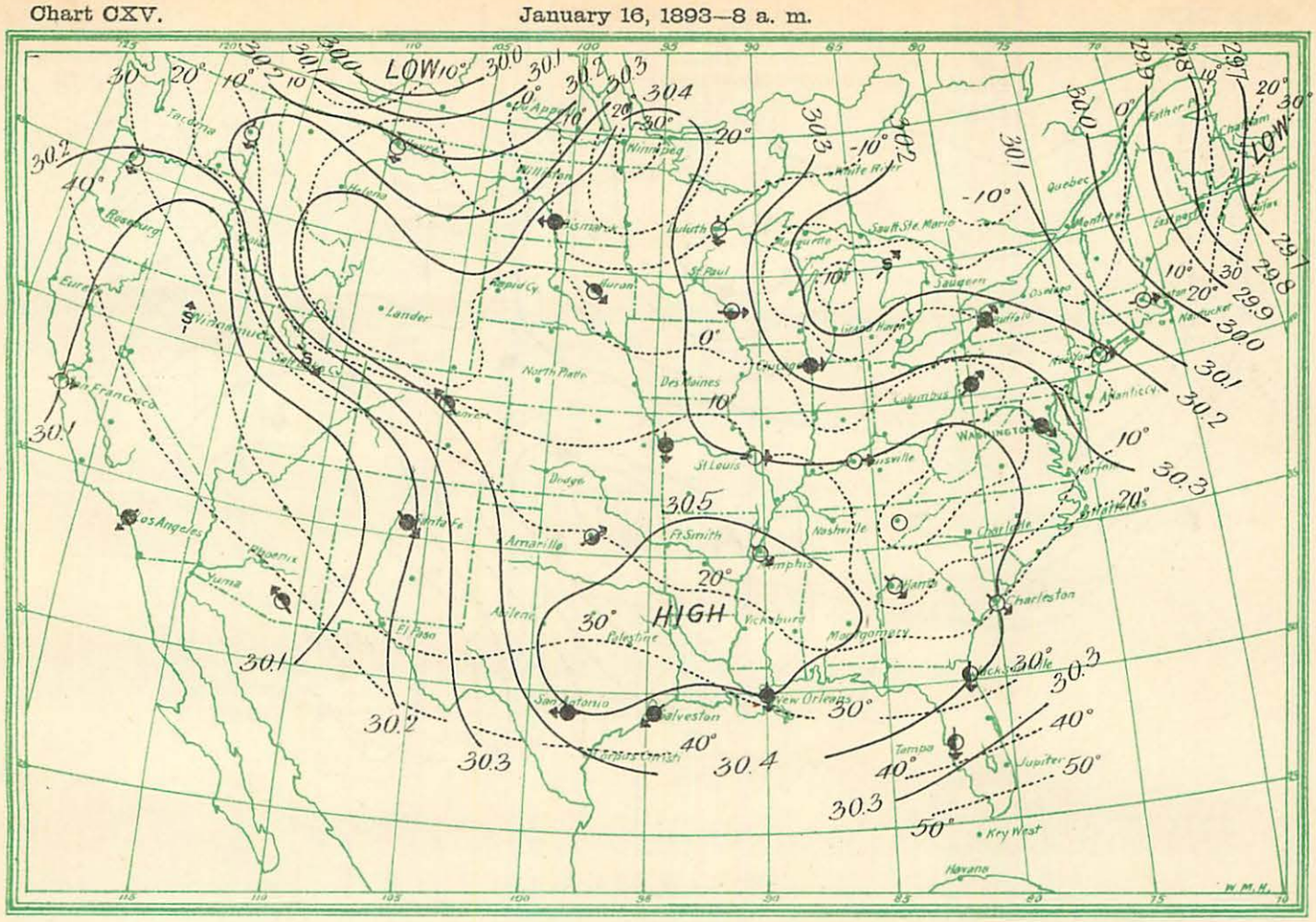


Chart CXVI. January 17, 1893—8 a. m.

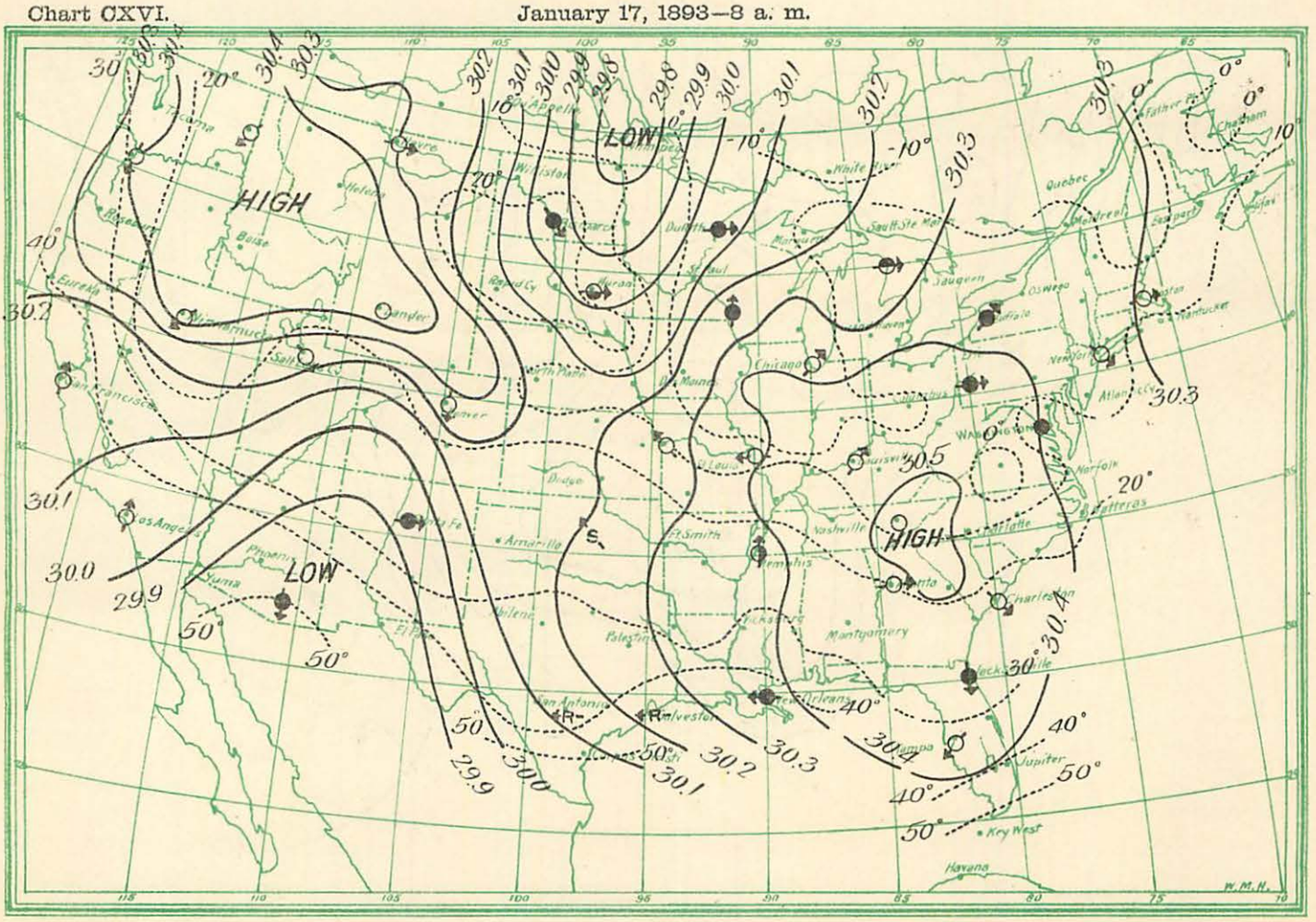


Chart CXVII. January 4, 1894—8 a. m.

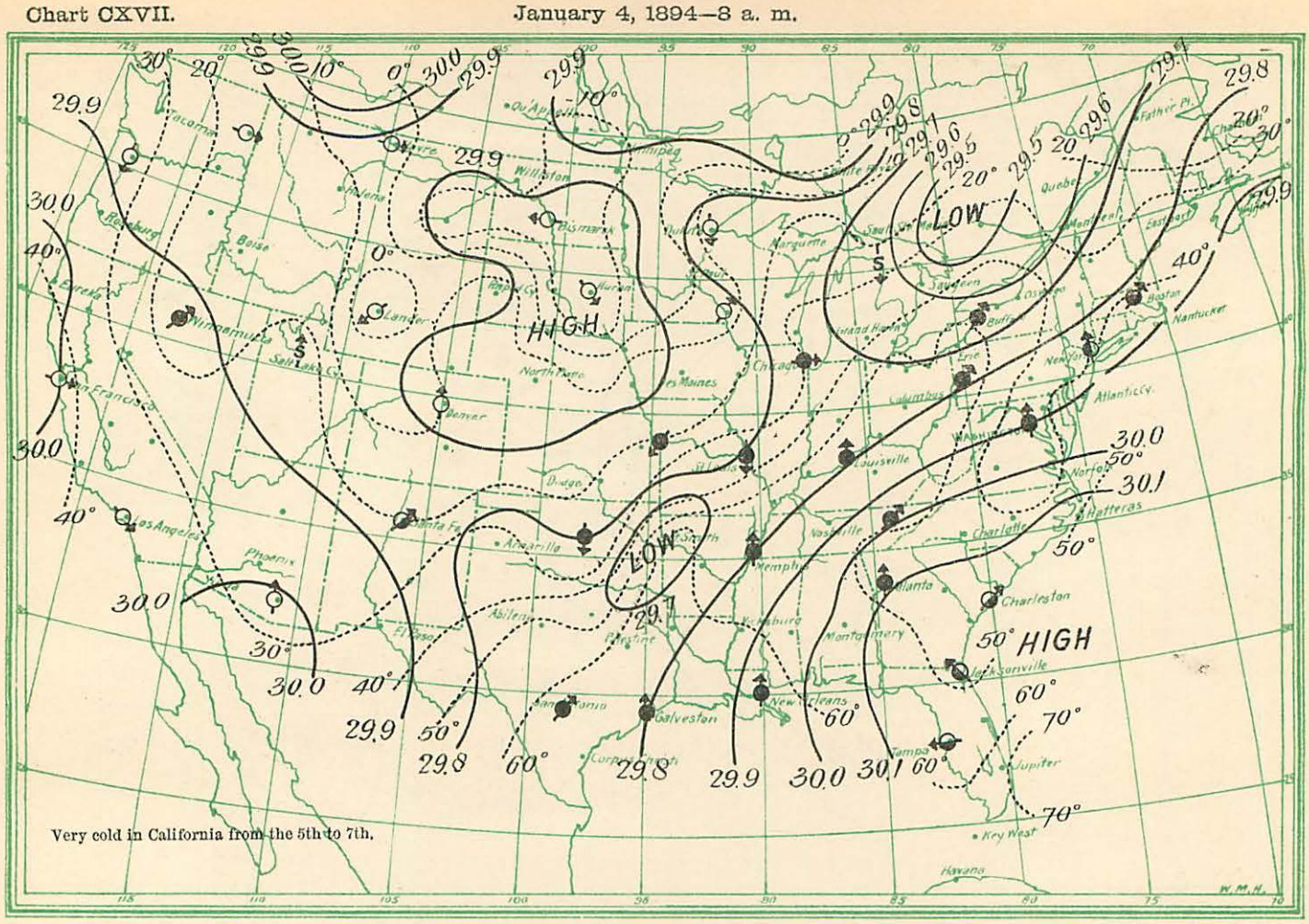


Chart CXVIII. January 5, 1894—8 a. m.

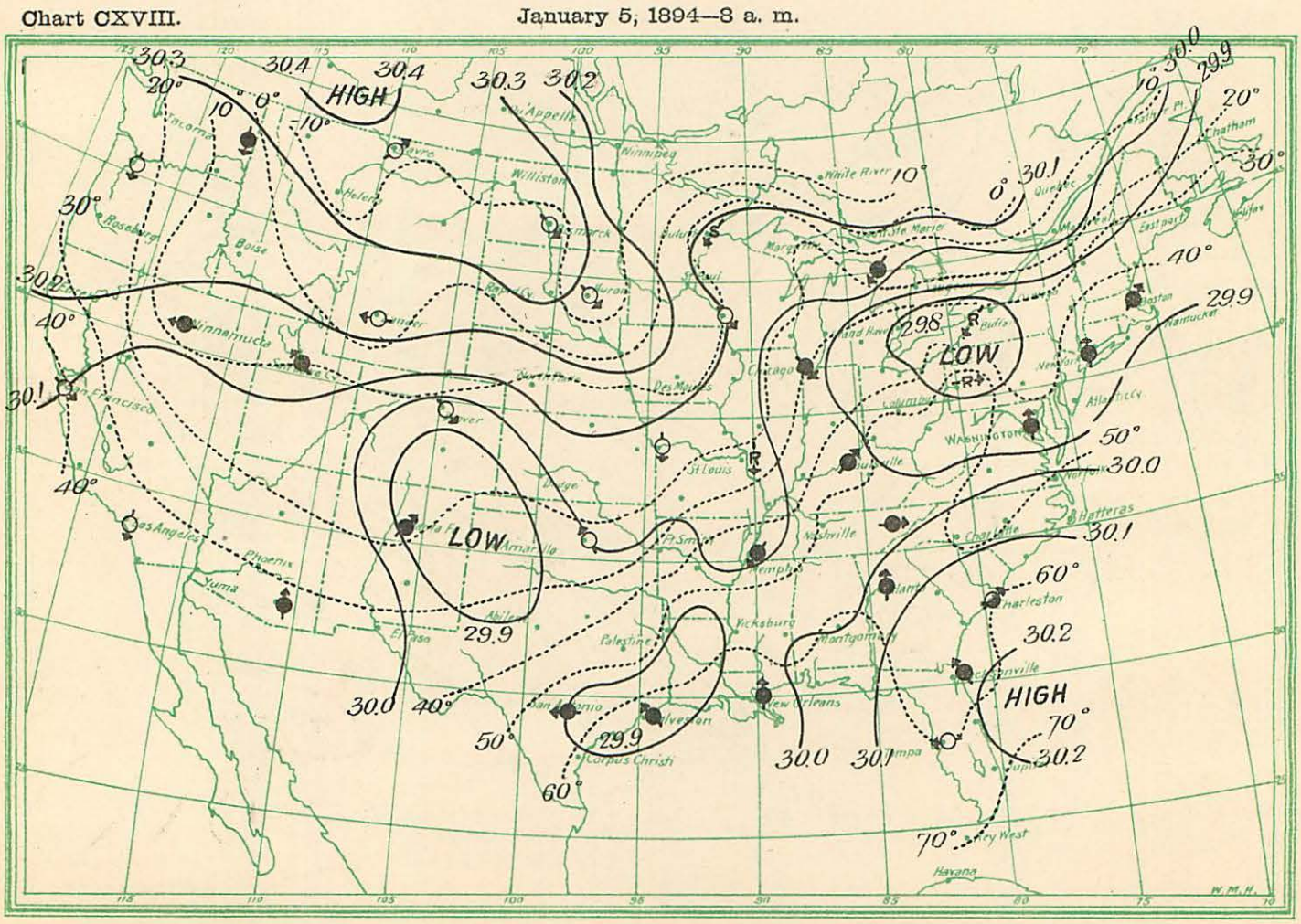


Chart CXIX. January 6, 1894—8 a. m.

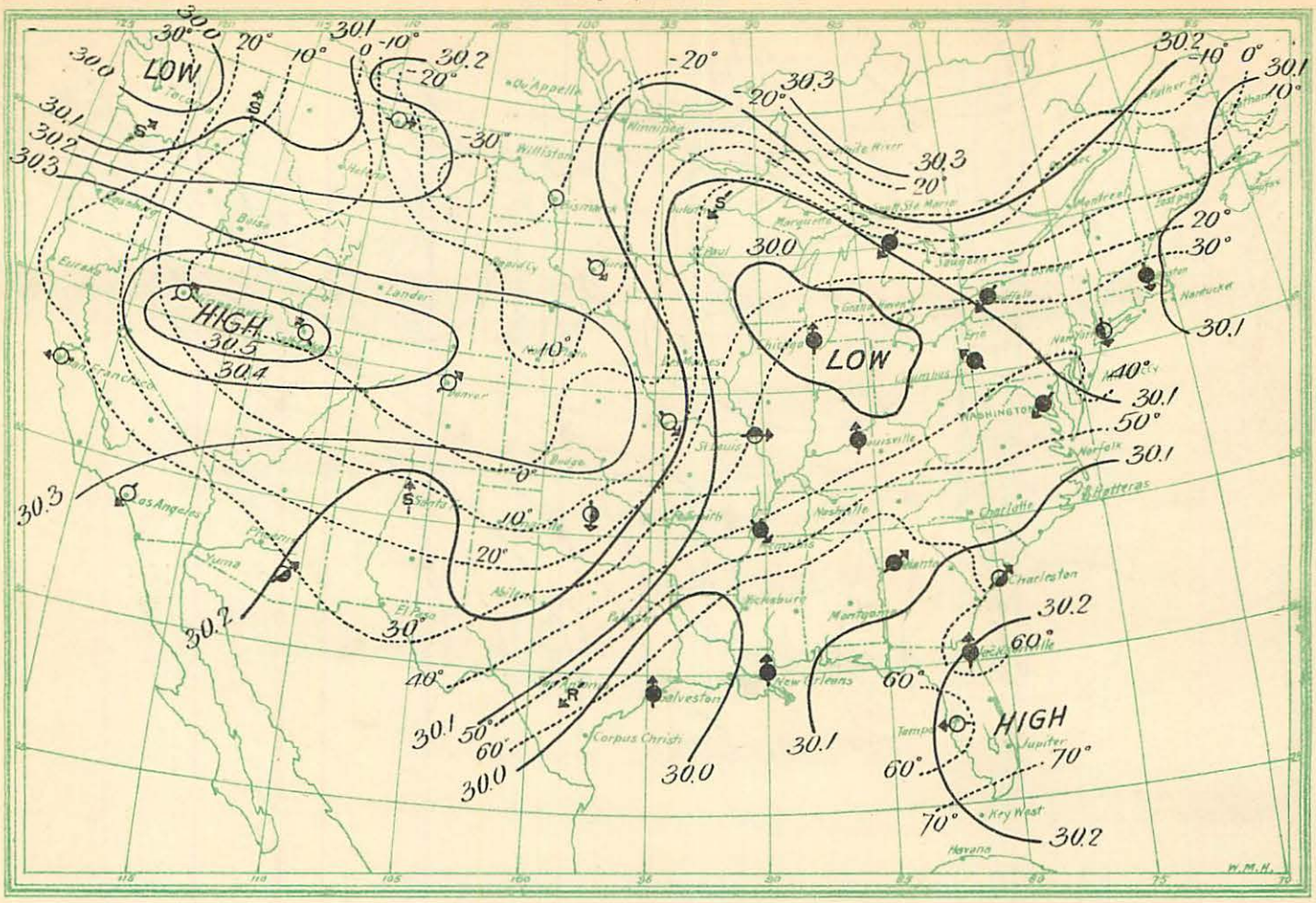


Chart CXX. January 7, 1894—8 a. m.

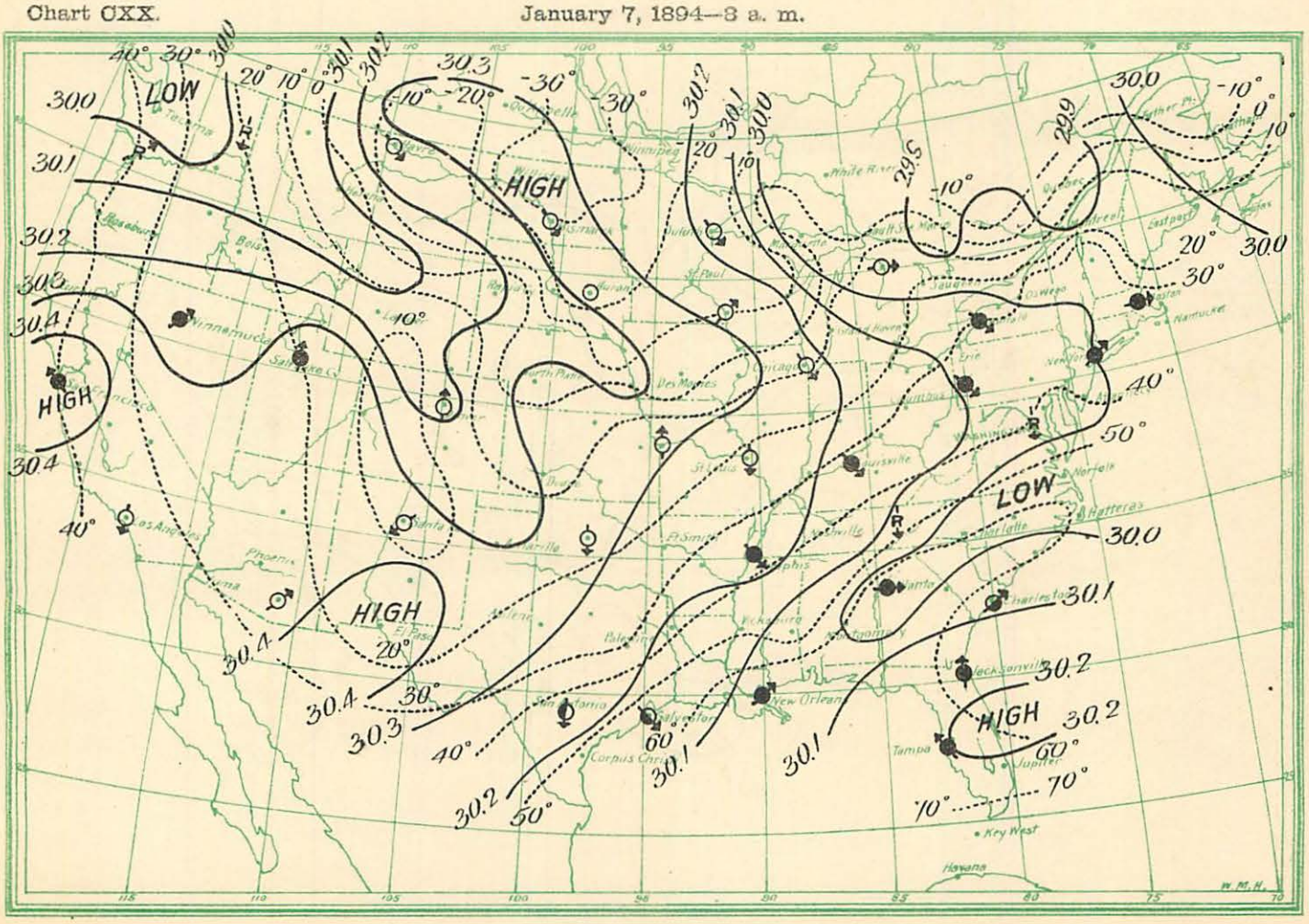


Chart CXXI. January 23, 1894—8 a. m.

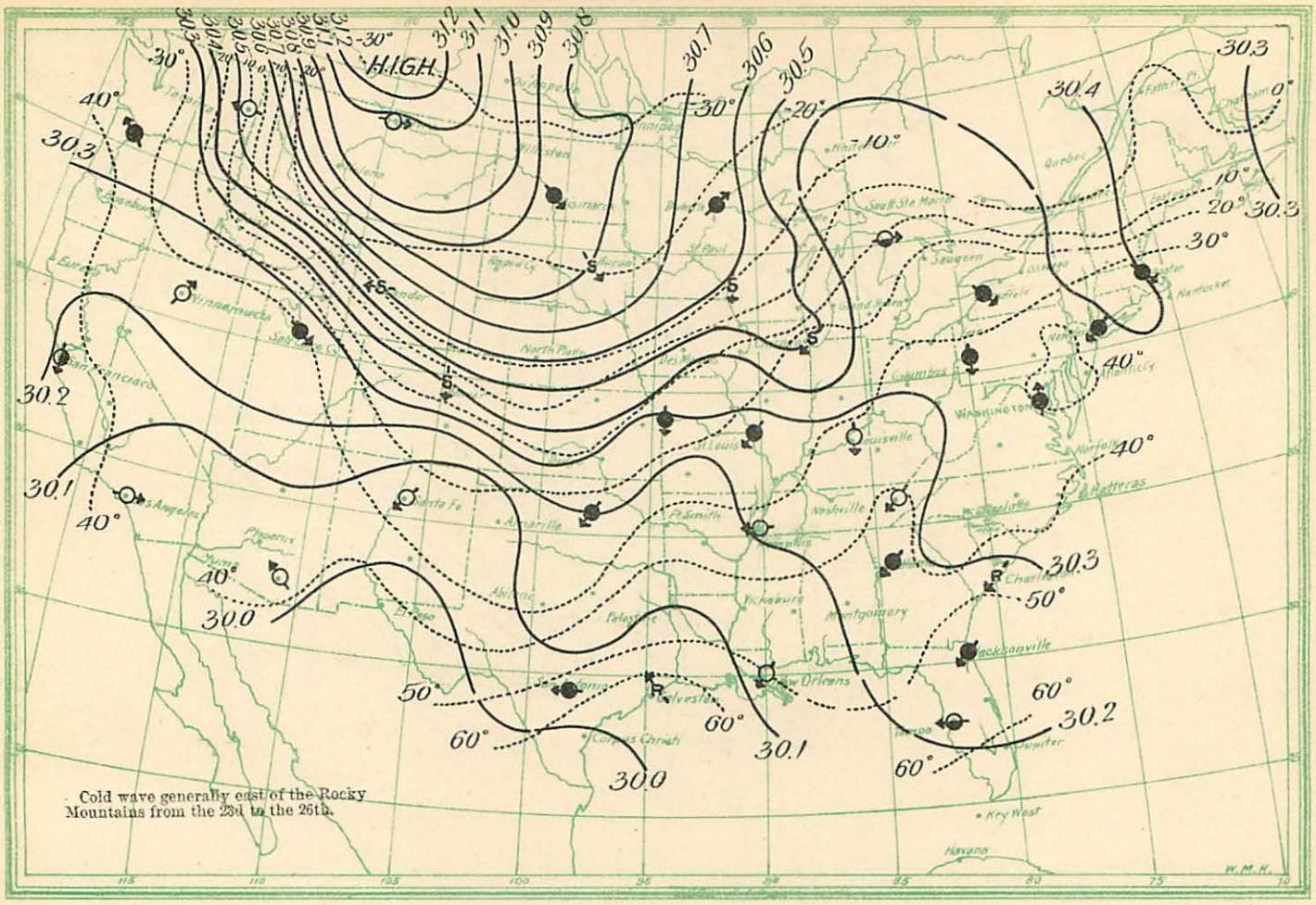


Chart CXXII. January 24, 1894—8 a. m.

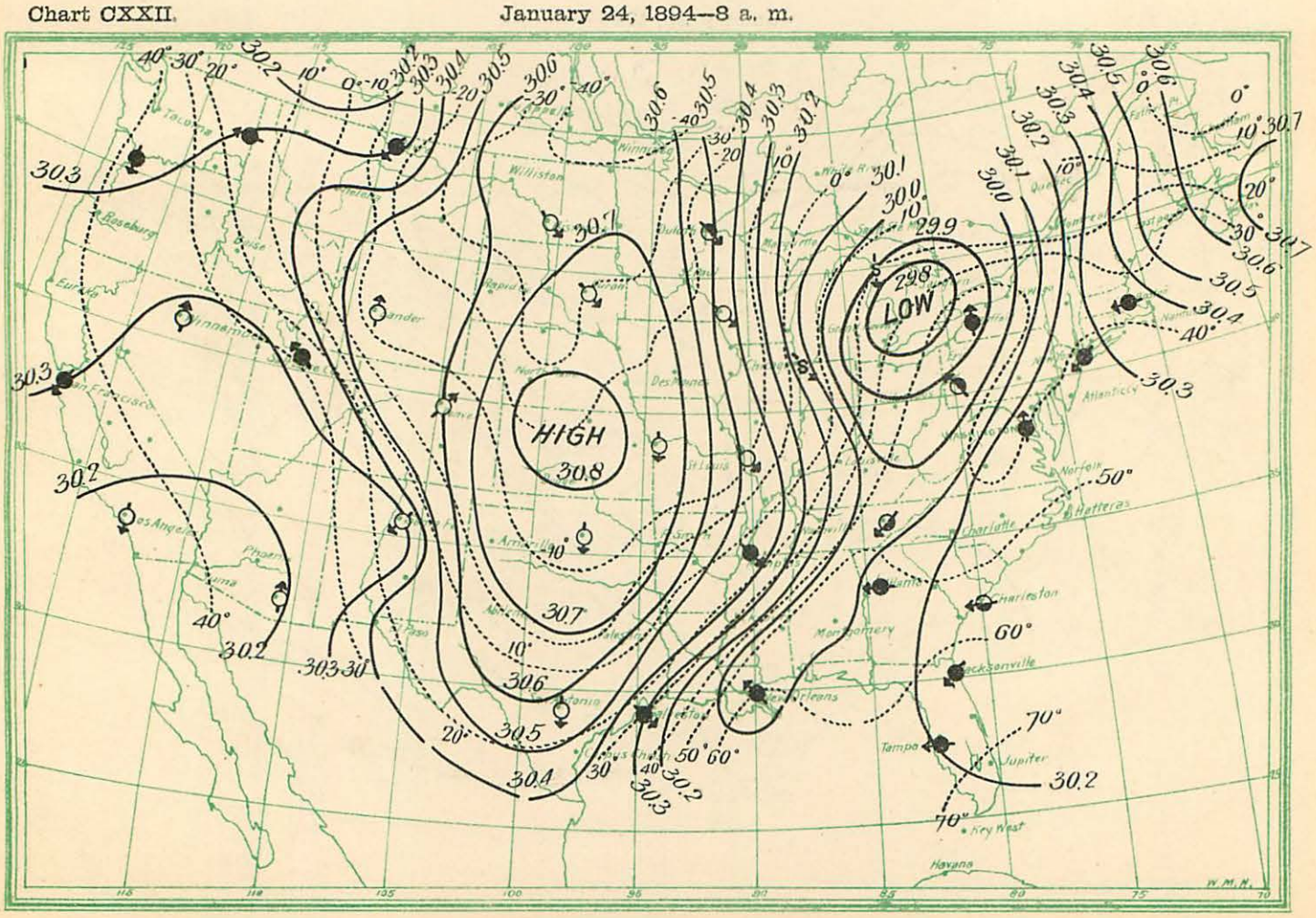


Chart CXXIII. January 25, 1894—8 a. m.

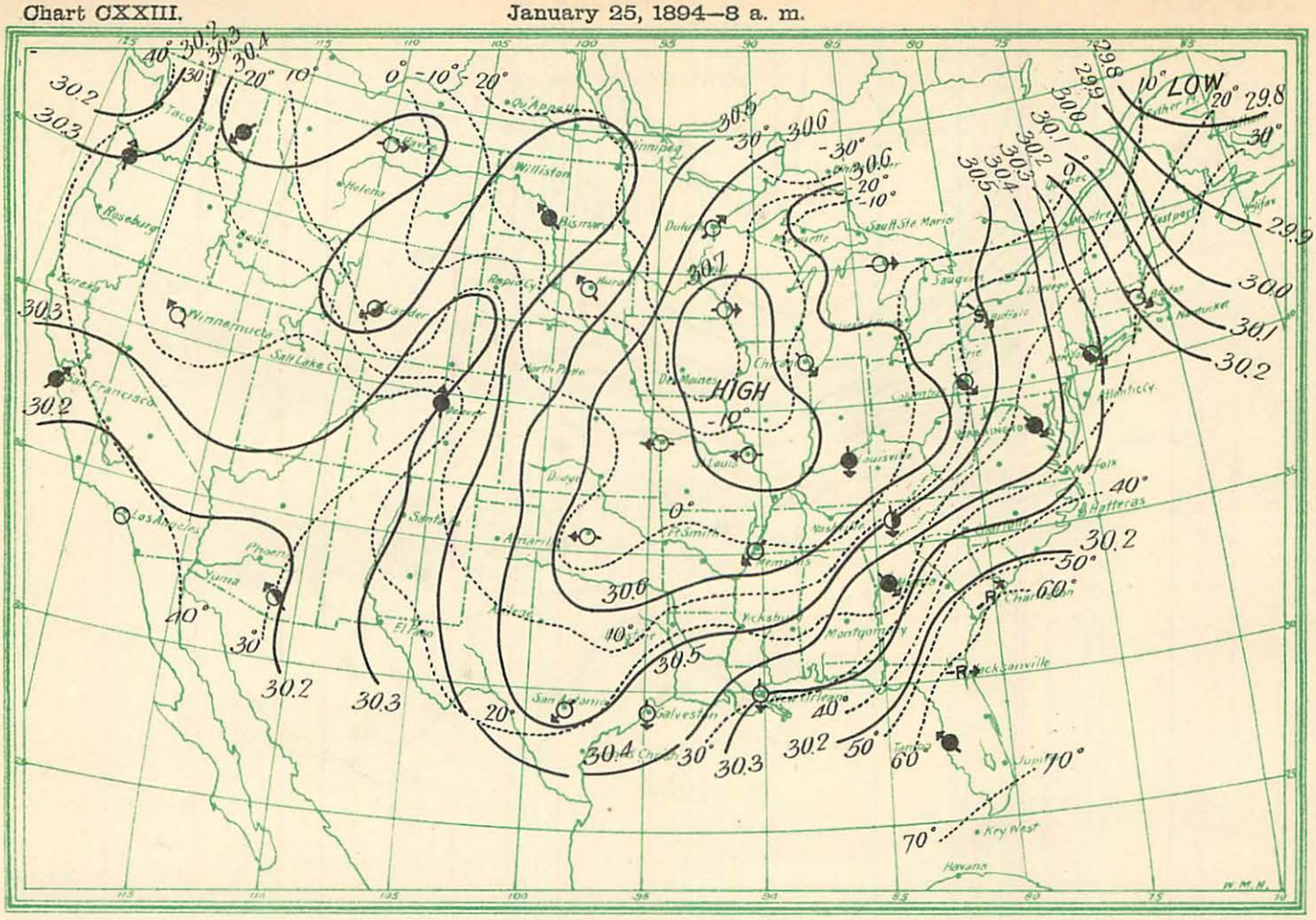


Chart CXXIV. January 26, 1894—8 a. m.

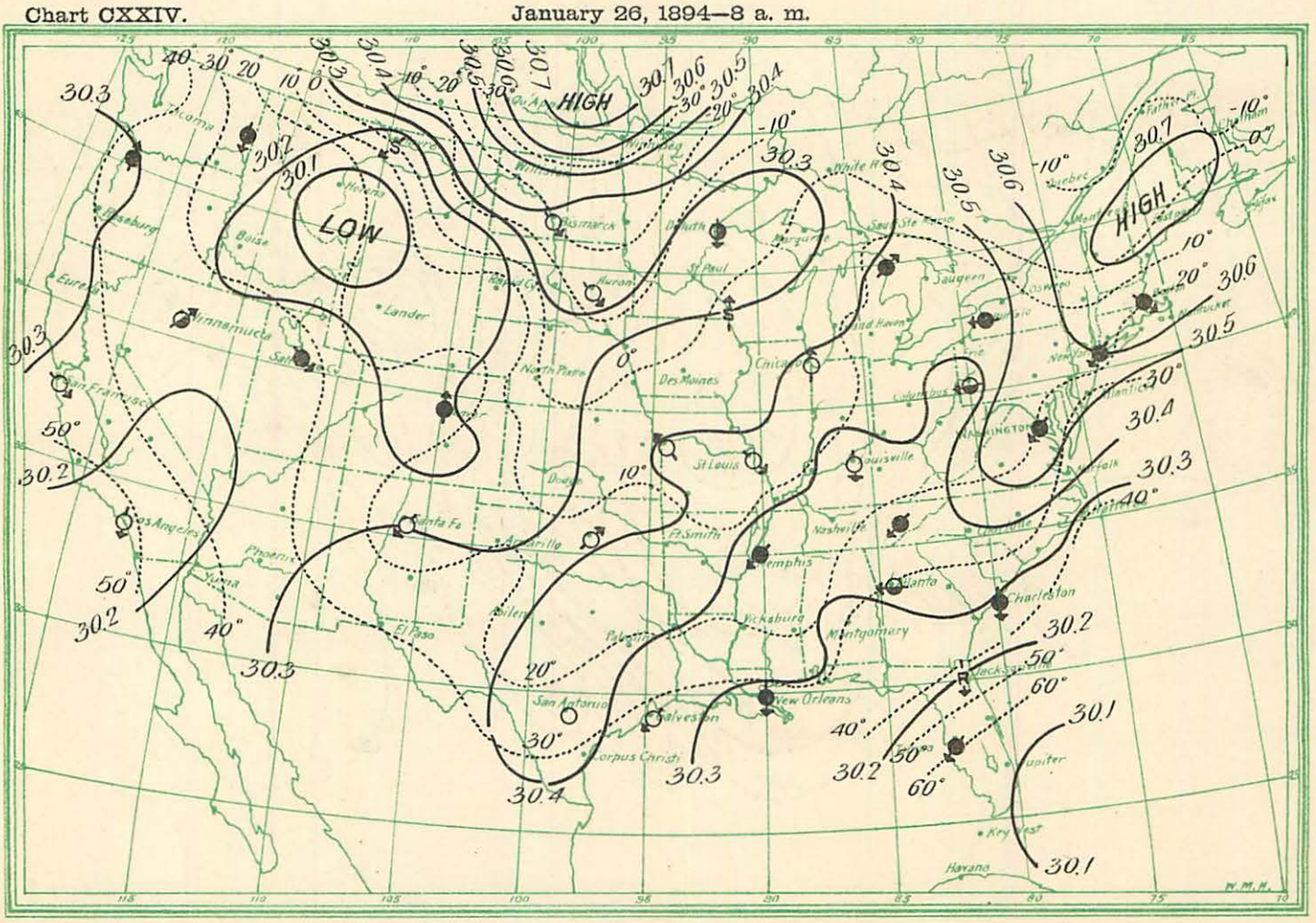


Chart CXXV. January 10, 1895—8 a. m.

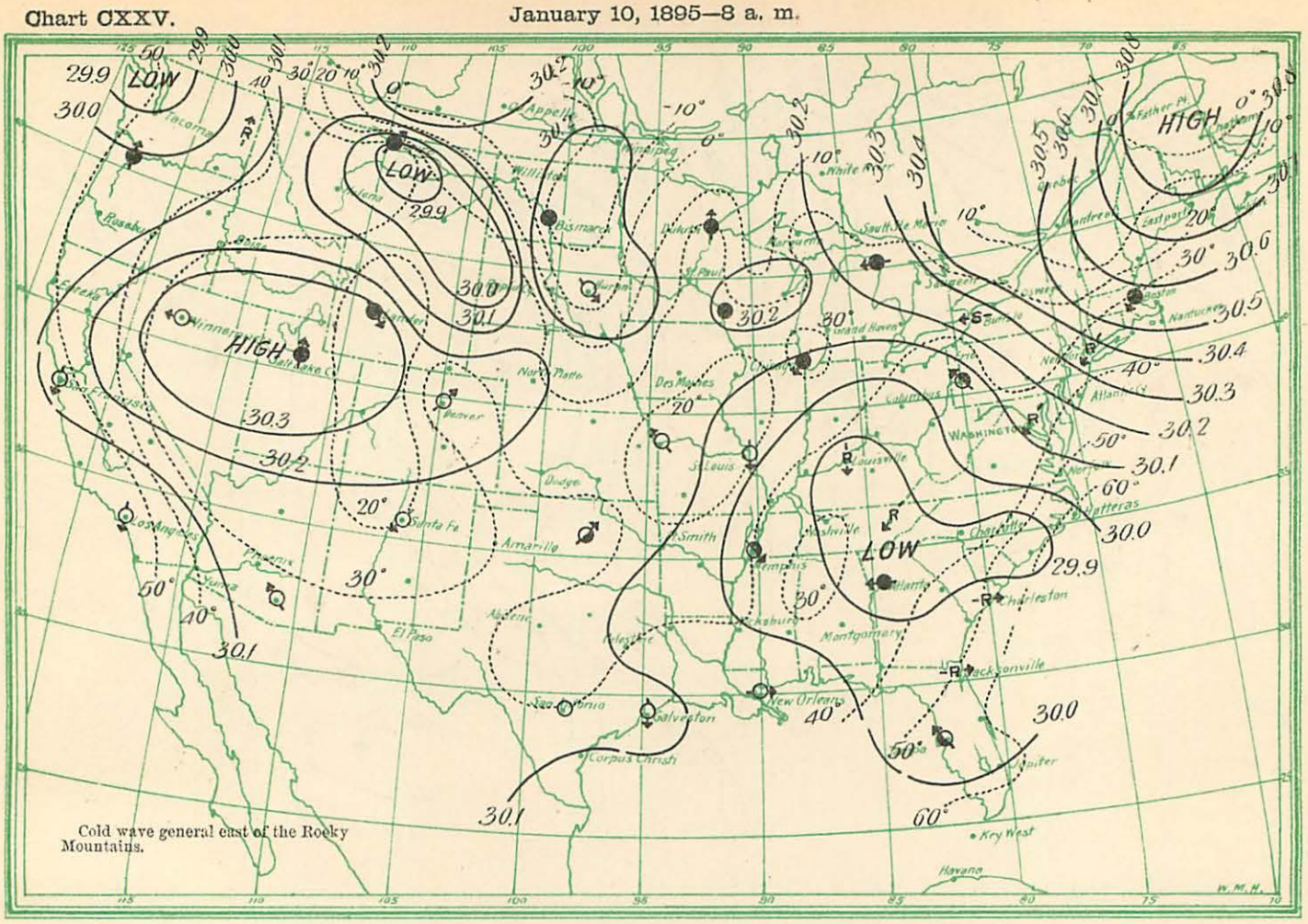


Chart CXXVI. January 11, 1895—8 a. m.

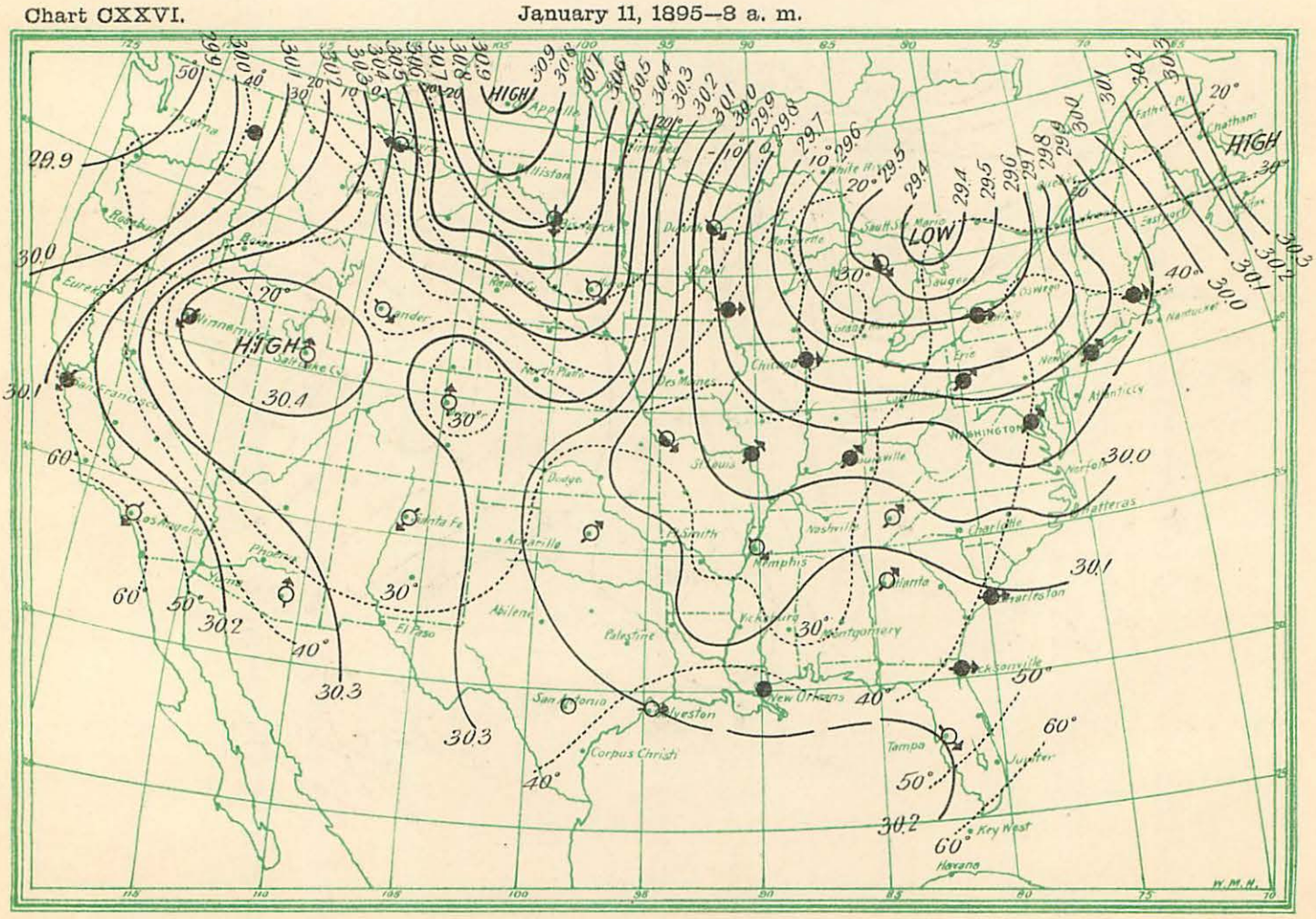


Chart CXXVII. January 12, 1895—8 a. m.

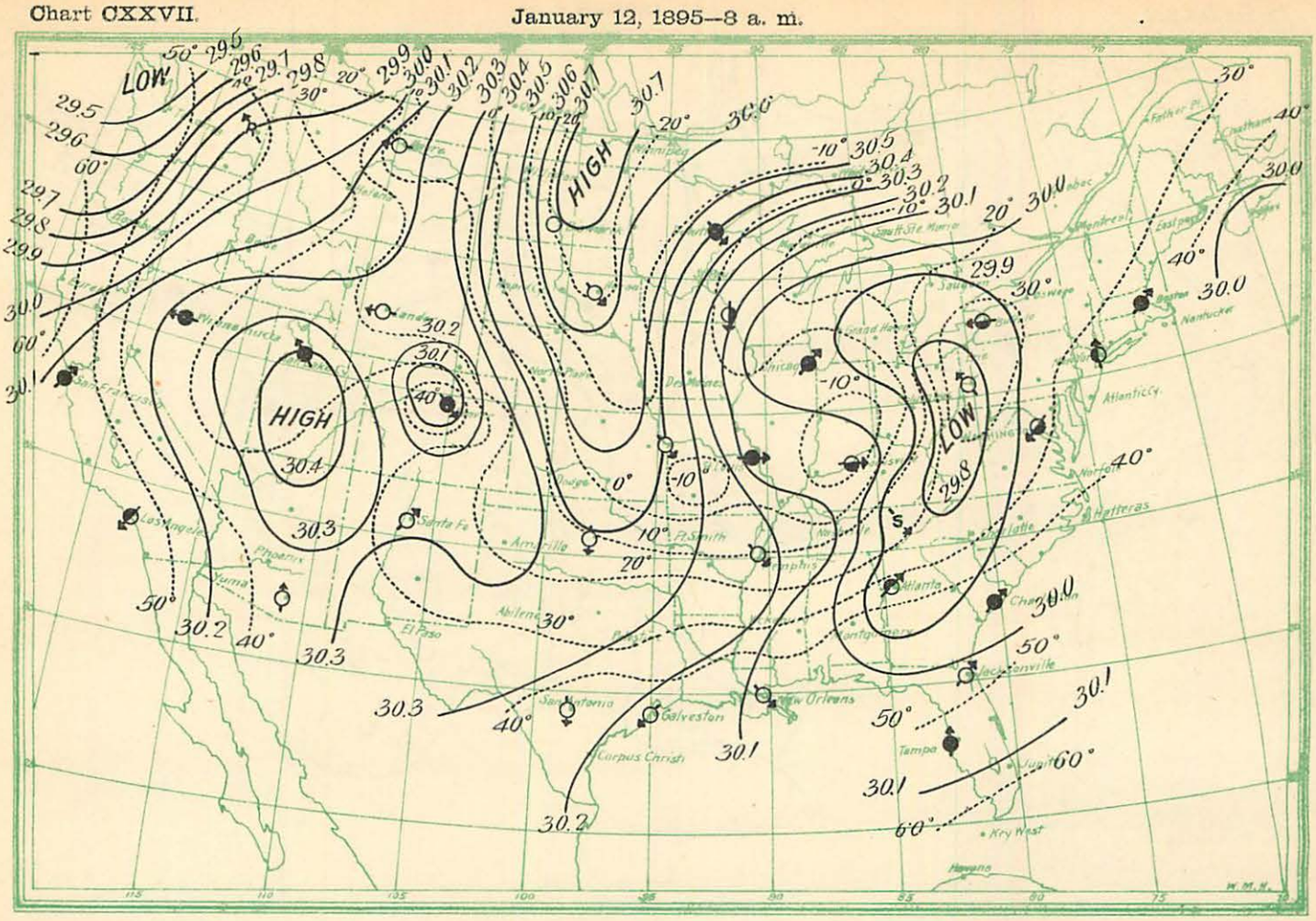


Chart CXXVIII. January 13, 1895—8 a. m.

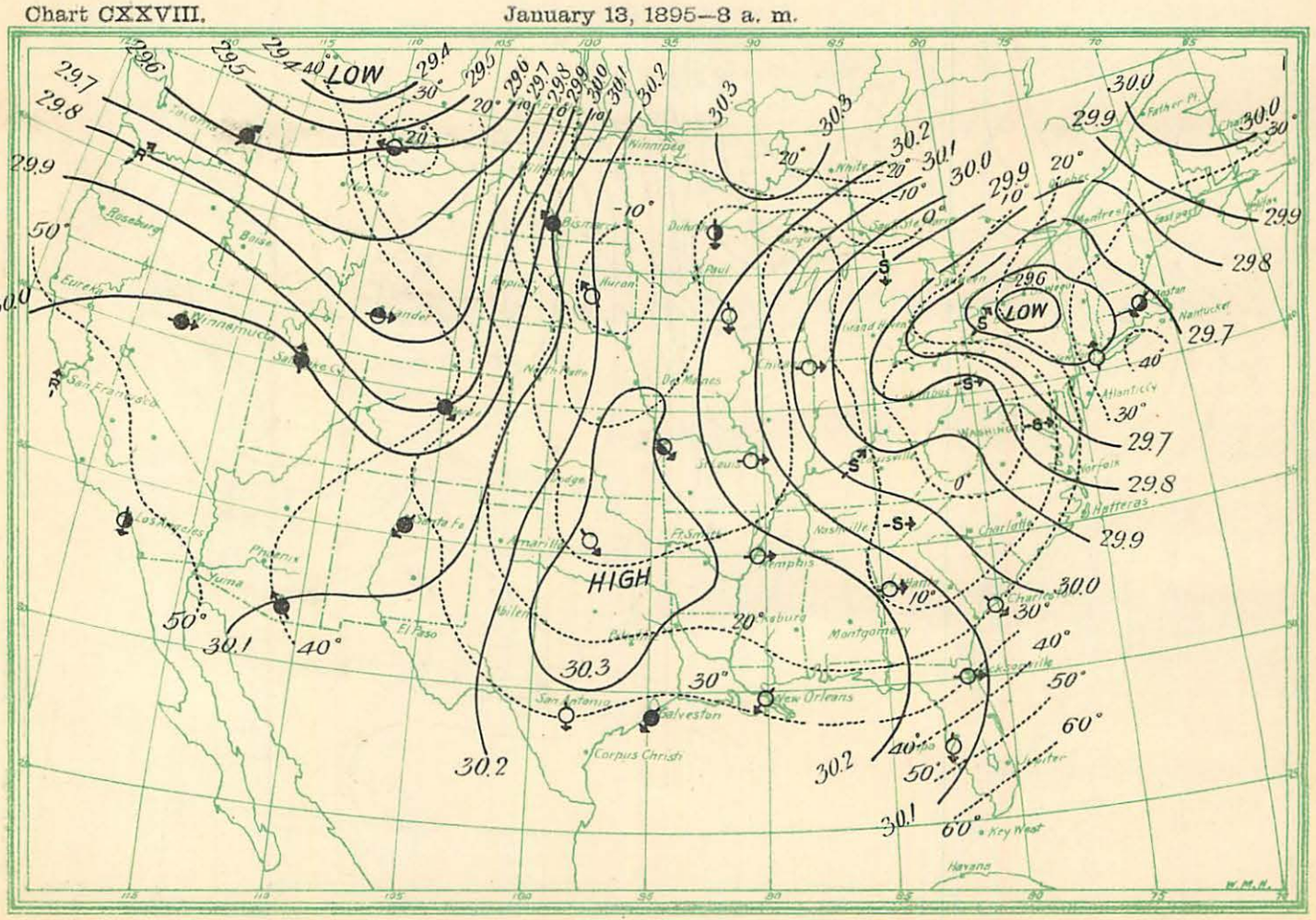


Chart CXXIX. January 25, 1895—8 a. m.

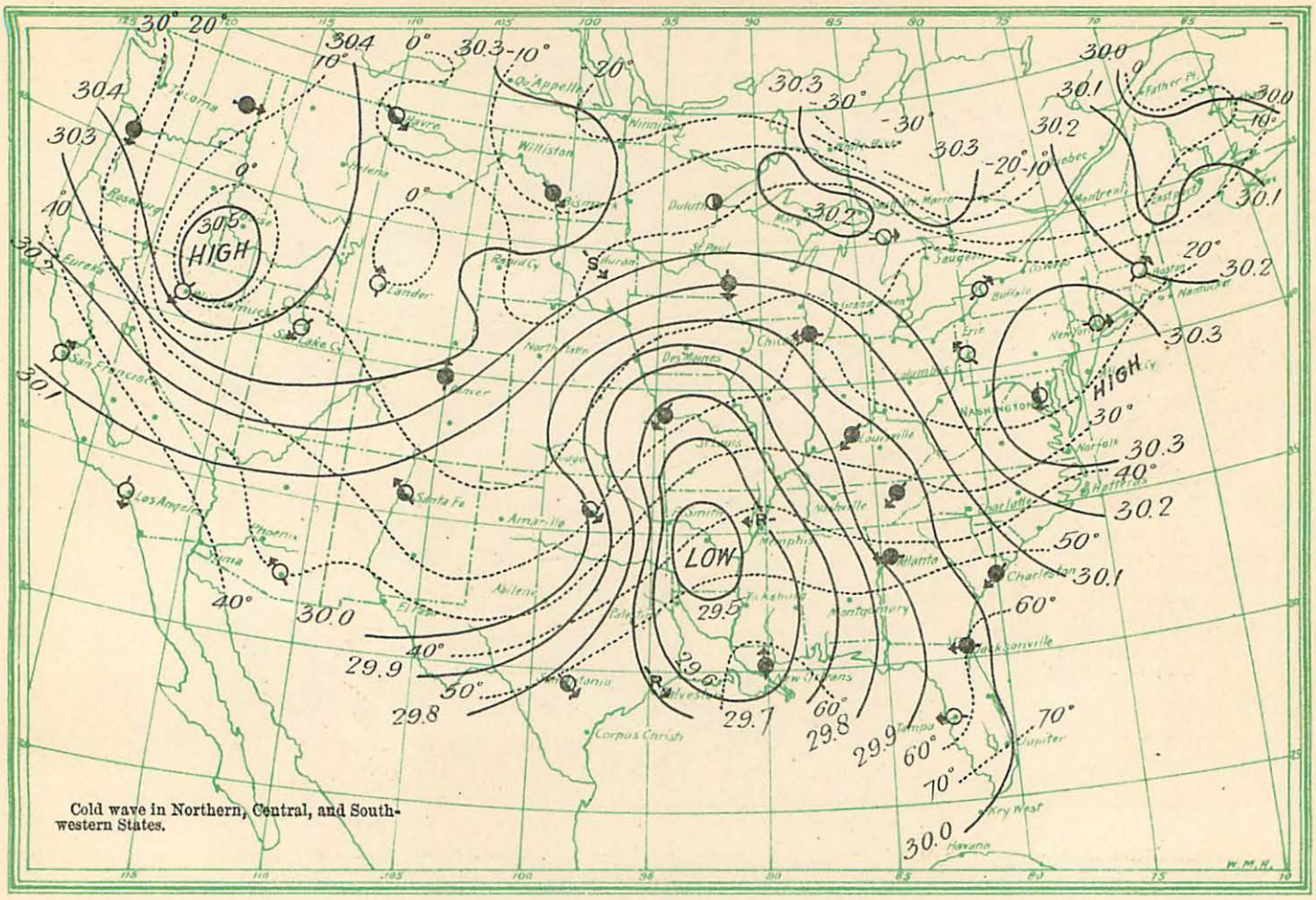


Chart CXXX. January 26, 1895—8 a. m.

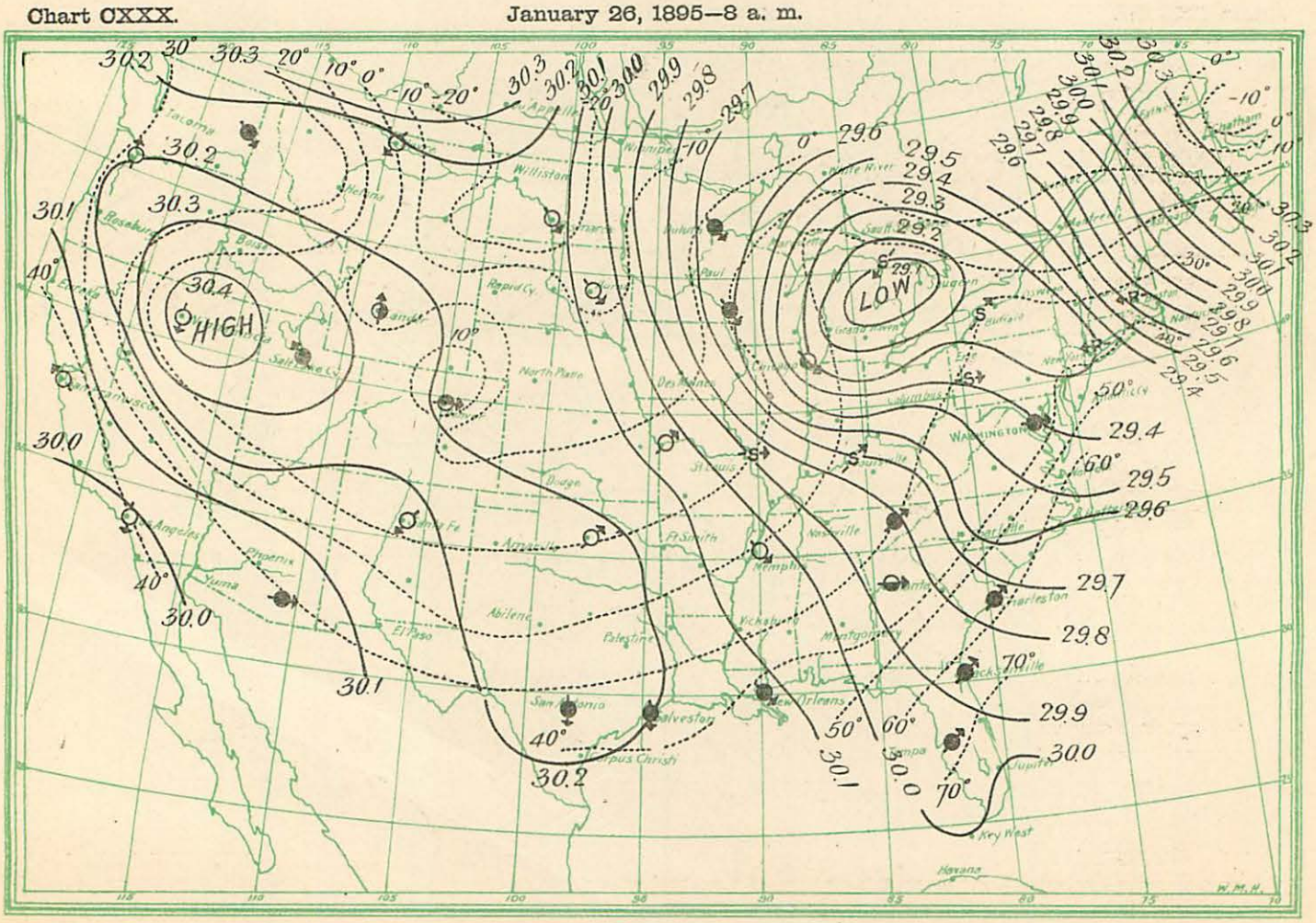


Chart CXXXI. January 27, 1895—8 a. m.

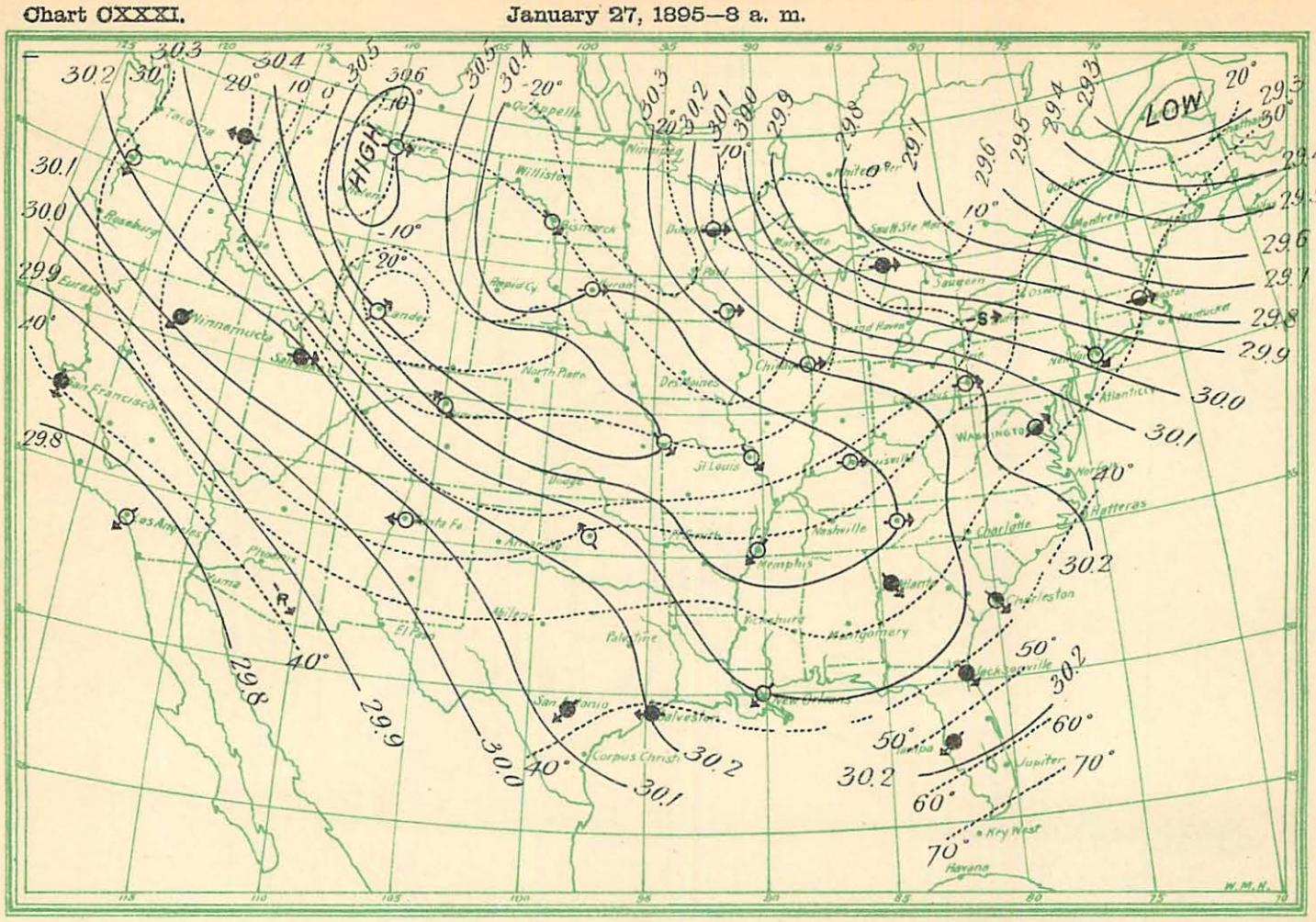


Chart CXXXII. January 28, 1895—8 a. m.

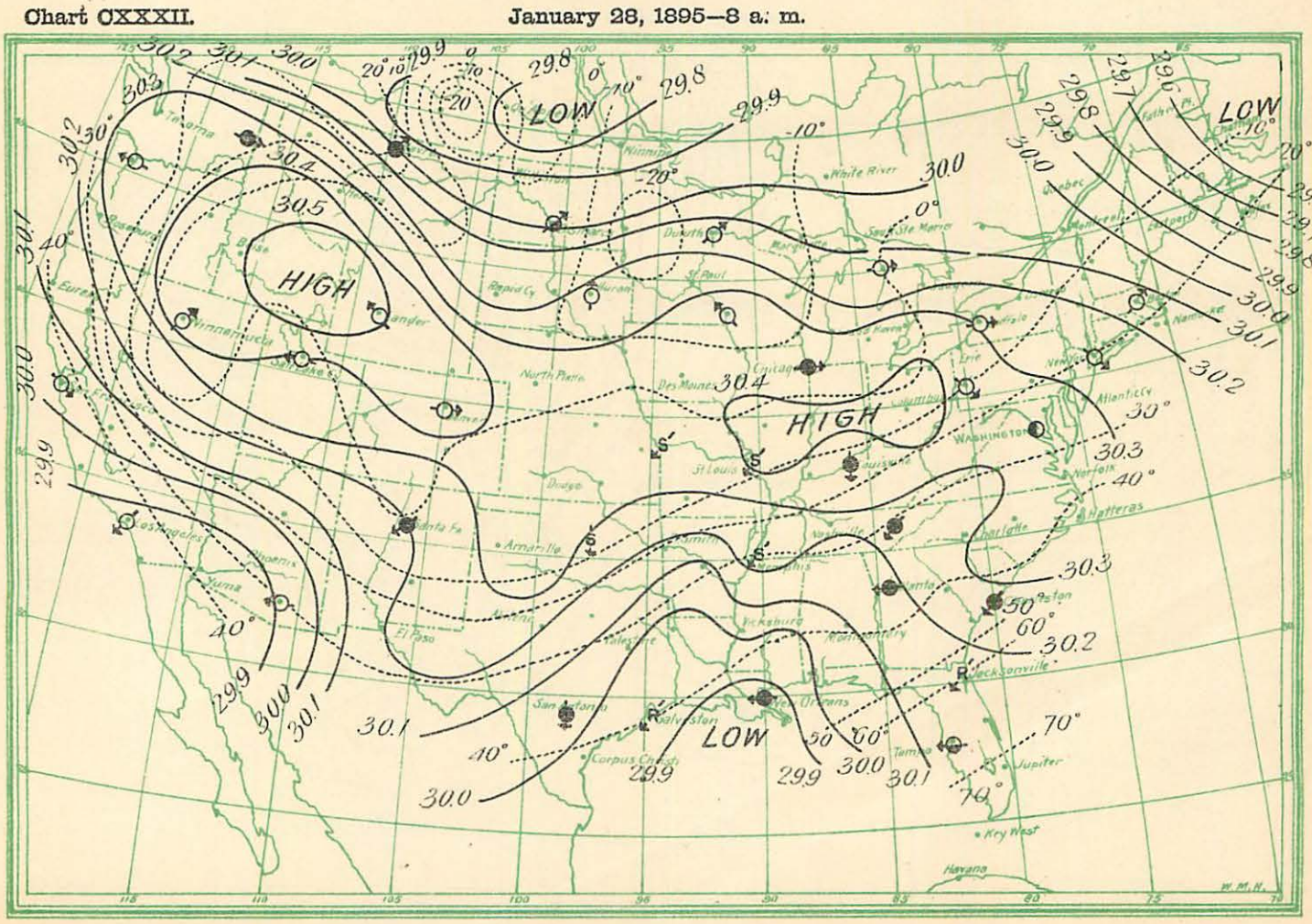


Chart CXXXIII. January 1, 1896—8 a. m.

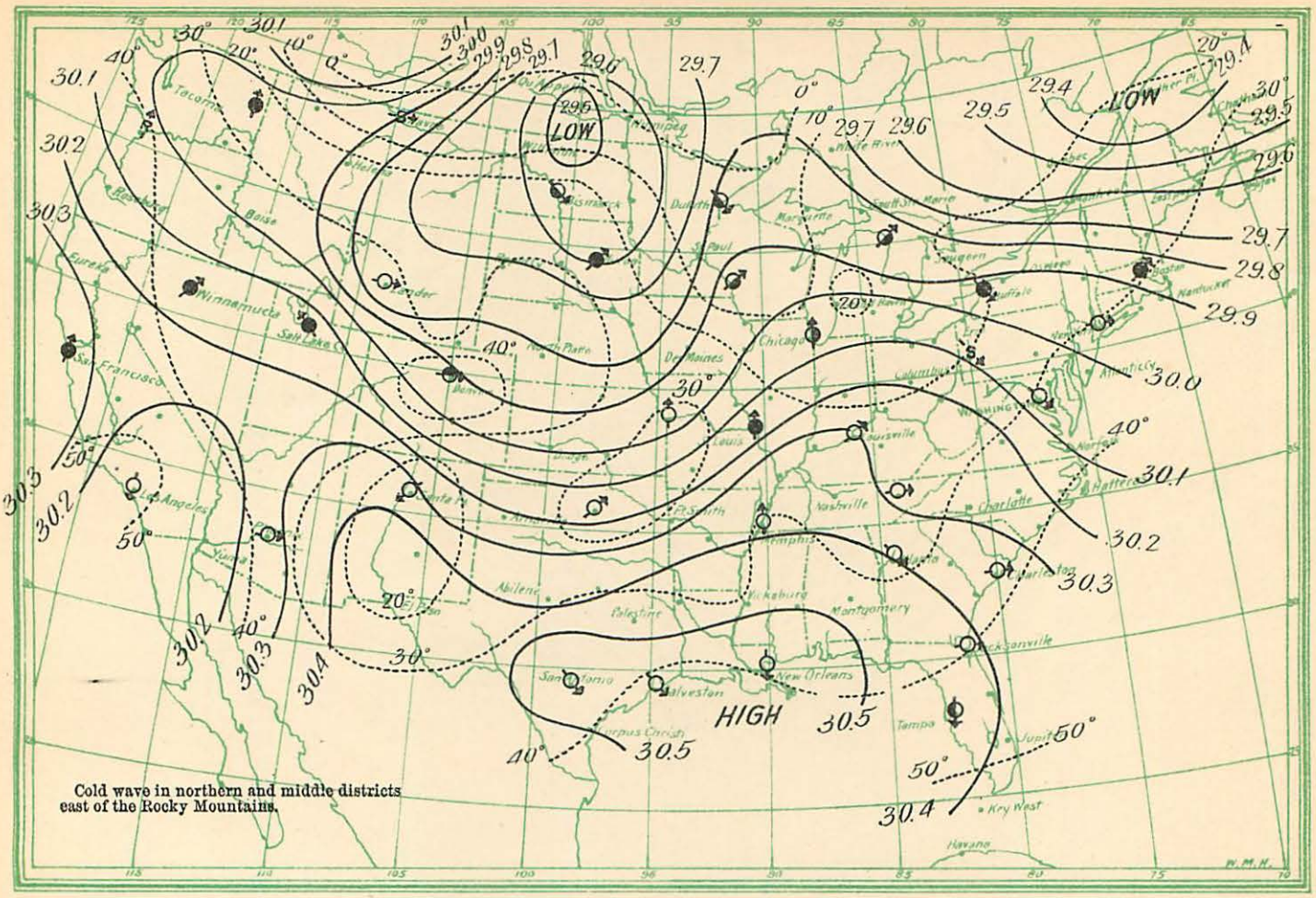


Chart CXXXIV. January 2, 1896—8 a. m.

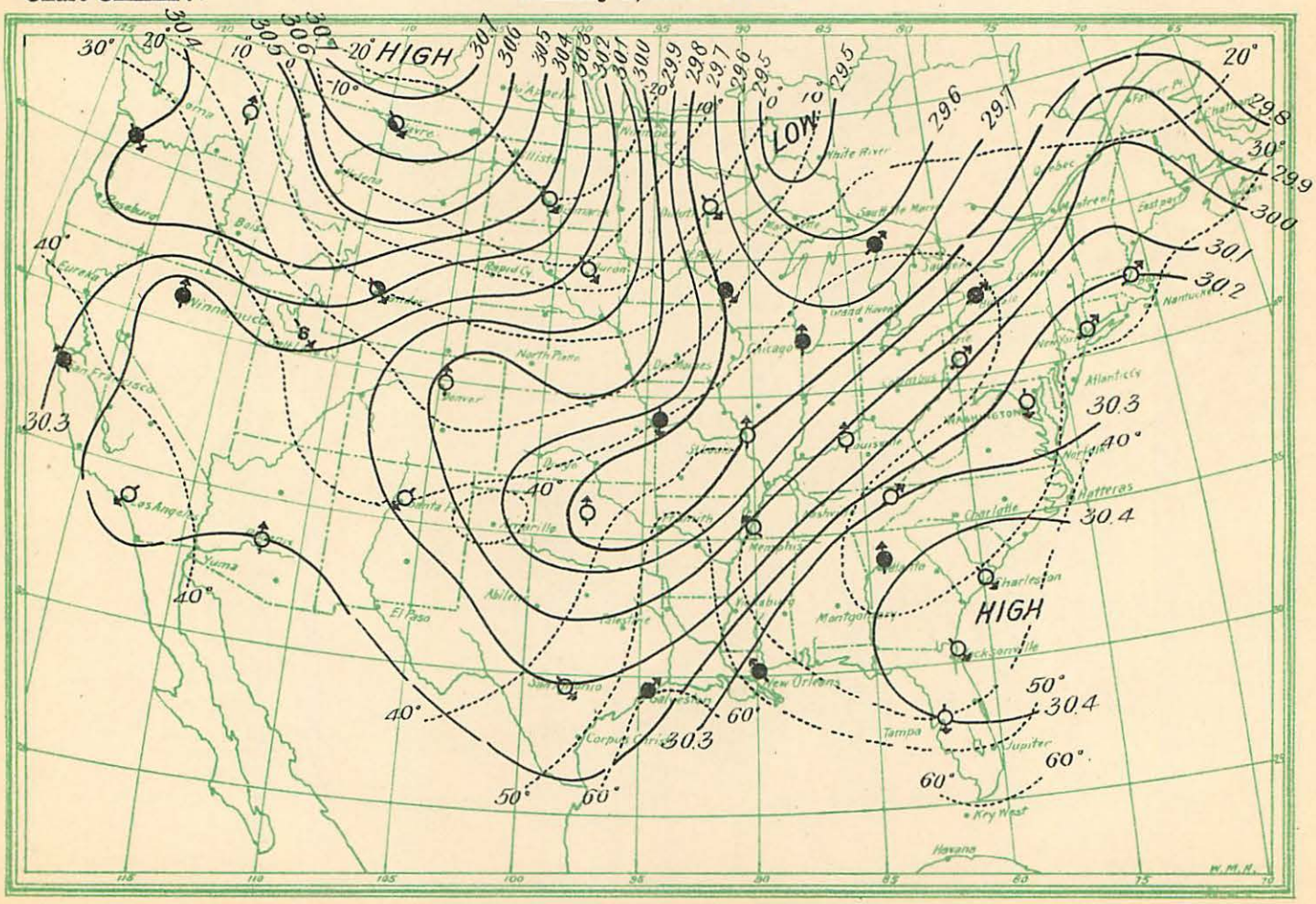


Chart CXXXV. January 3, 1896—8 a. m.

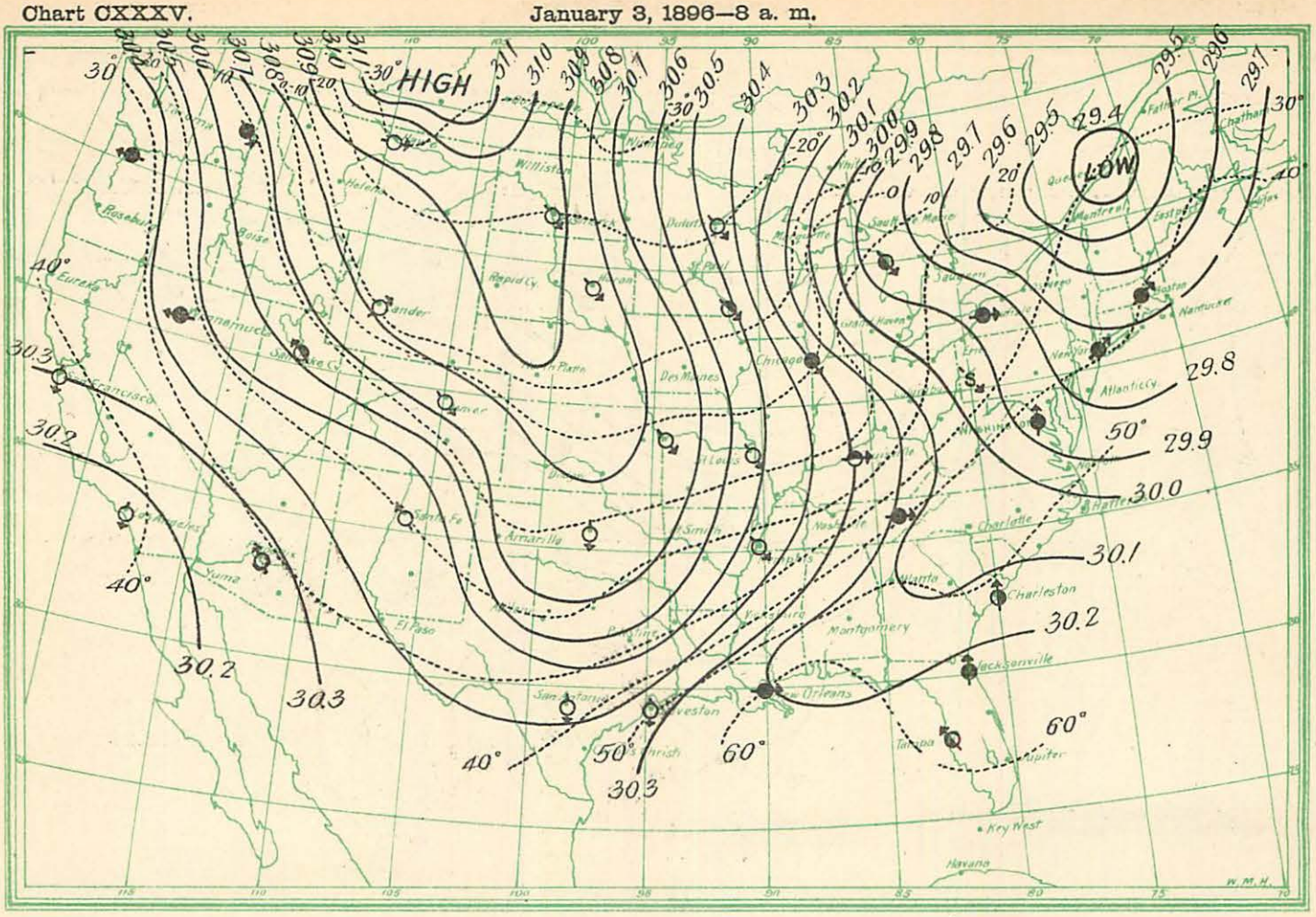


Chart CXXXVI. January 4, 1896—8 a. m.

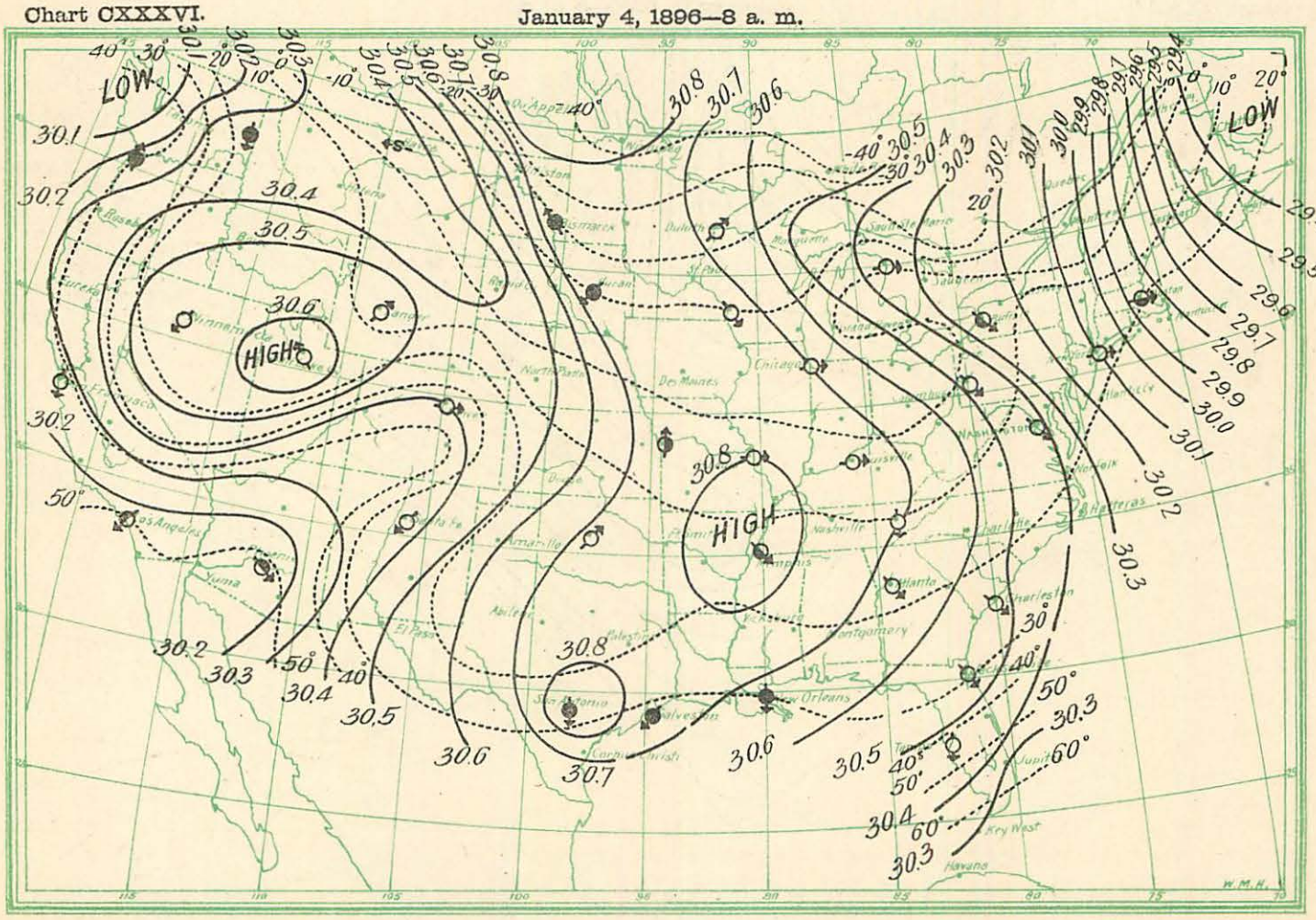


Chart CXXXVII. January 22, 1897—8 a. m.

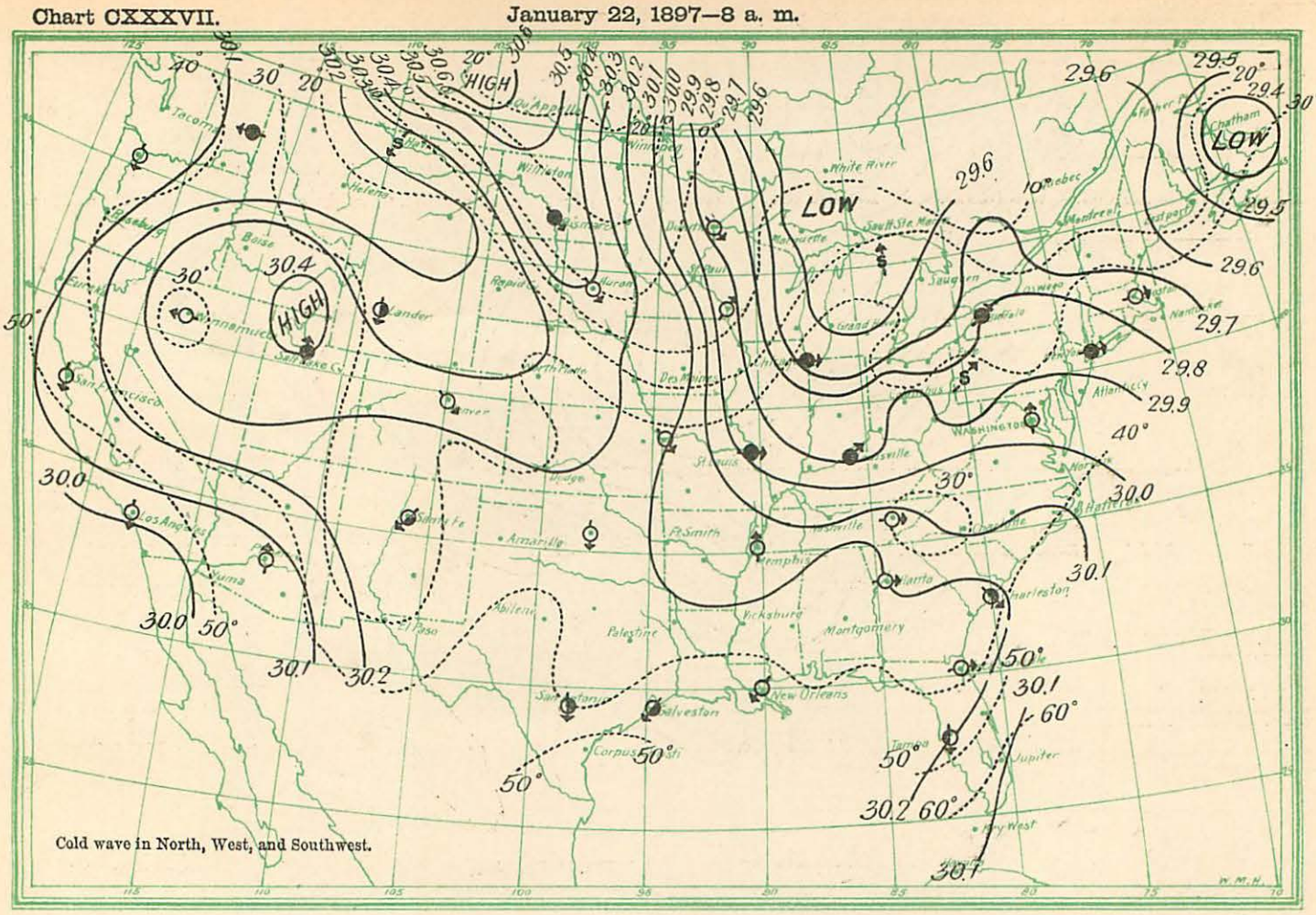


Chart CXXXVIII. January 23, 1897—8 a. m.

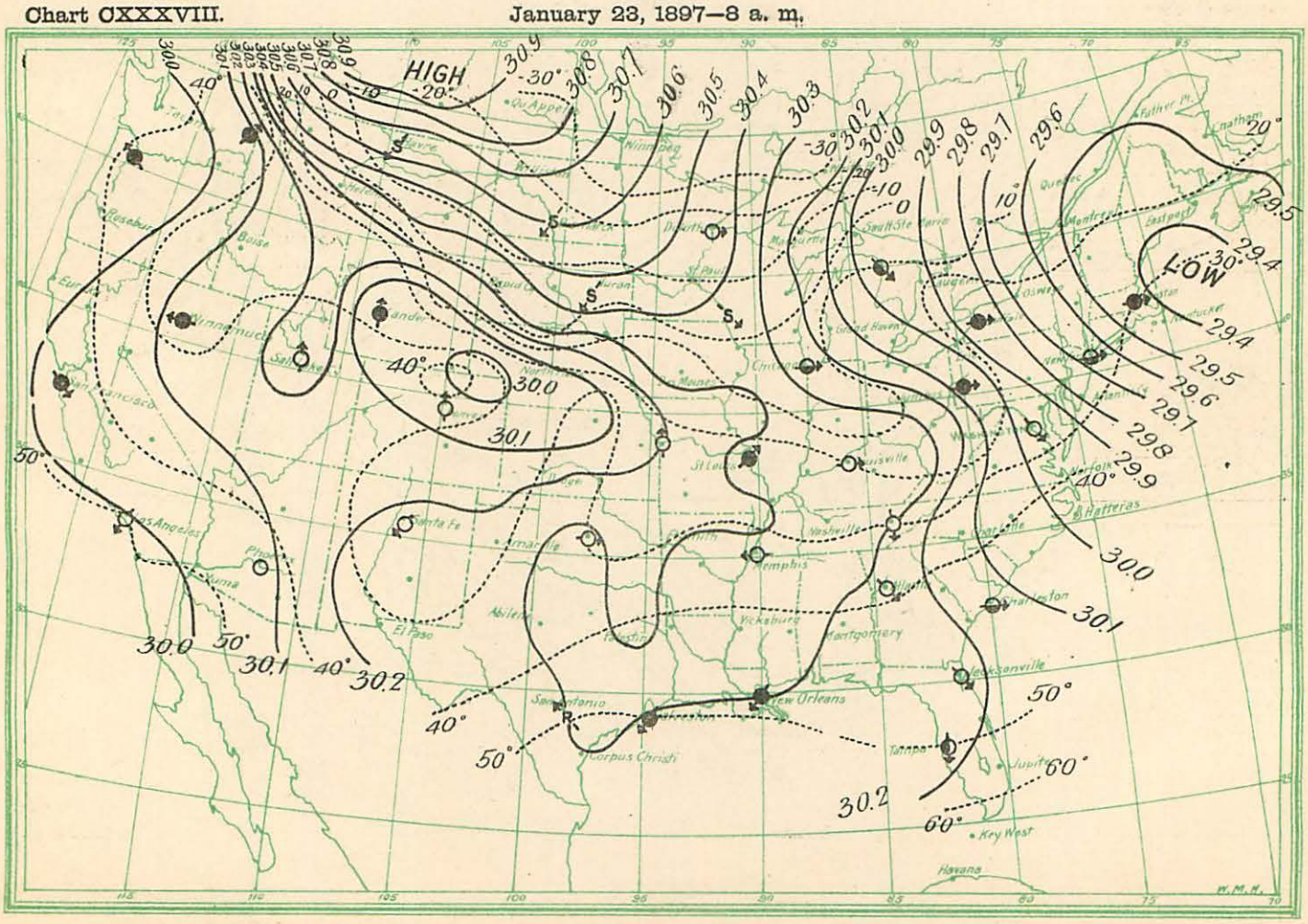


Chart CXXXIX. January 24, 1897—8 a. m.

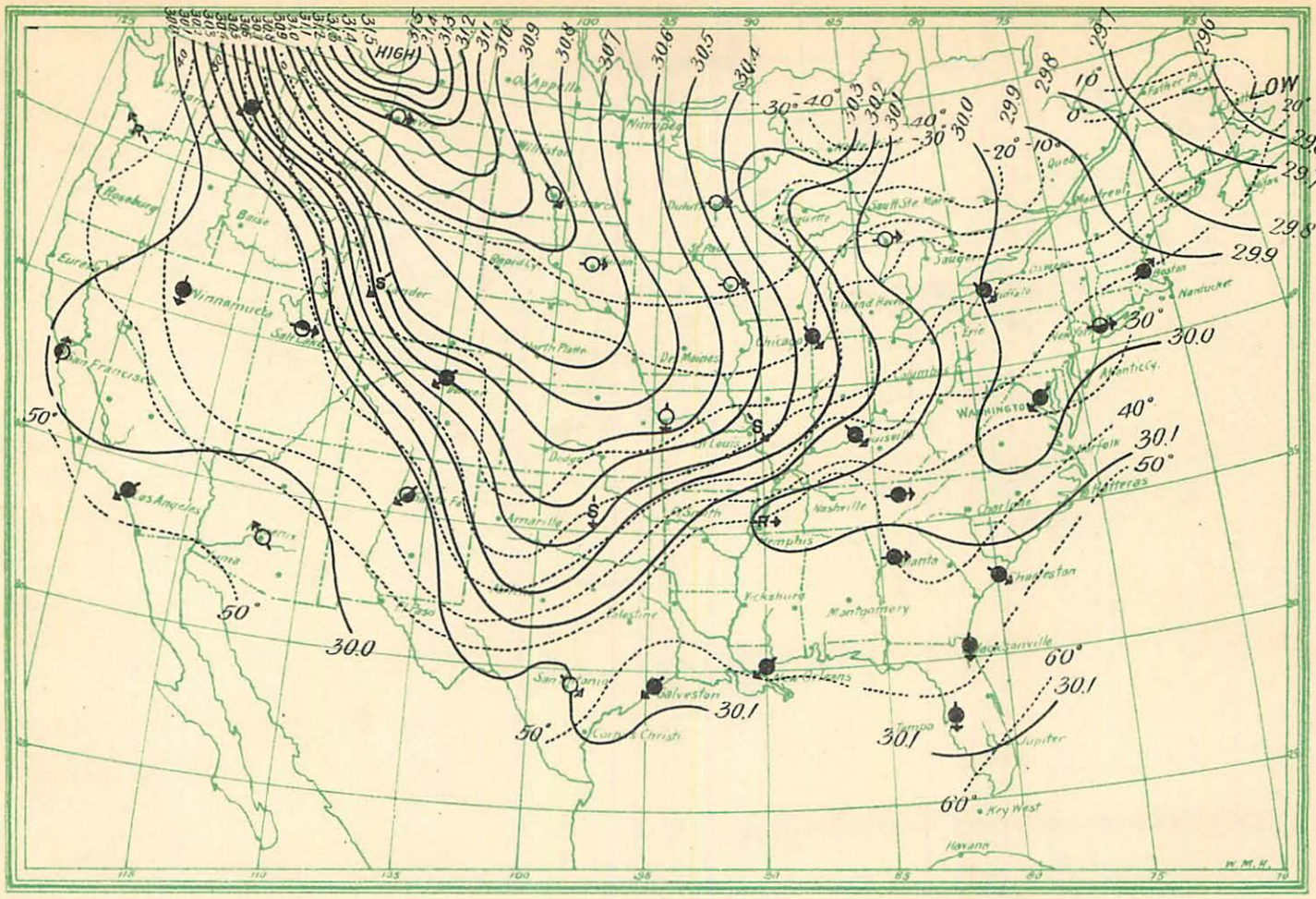


Chart CXL. January 25, 1897—8 a. m.

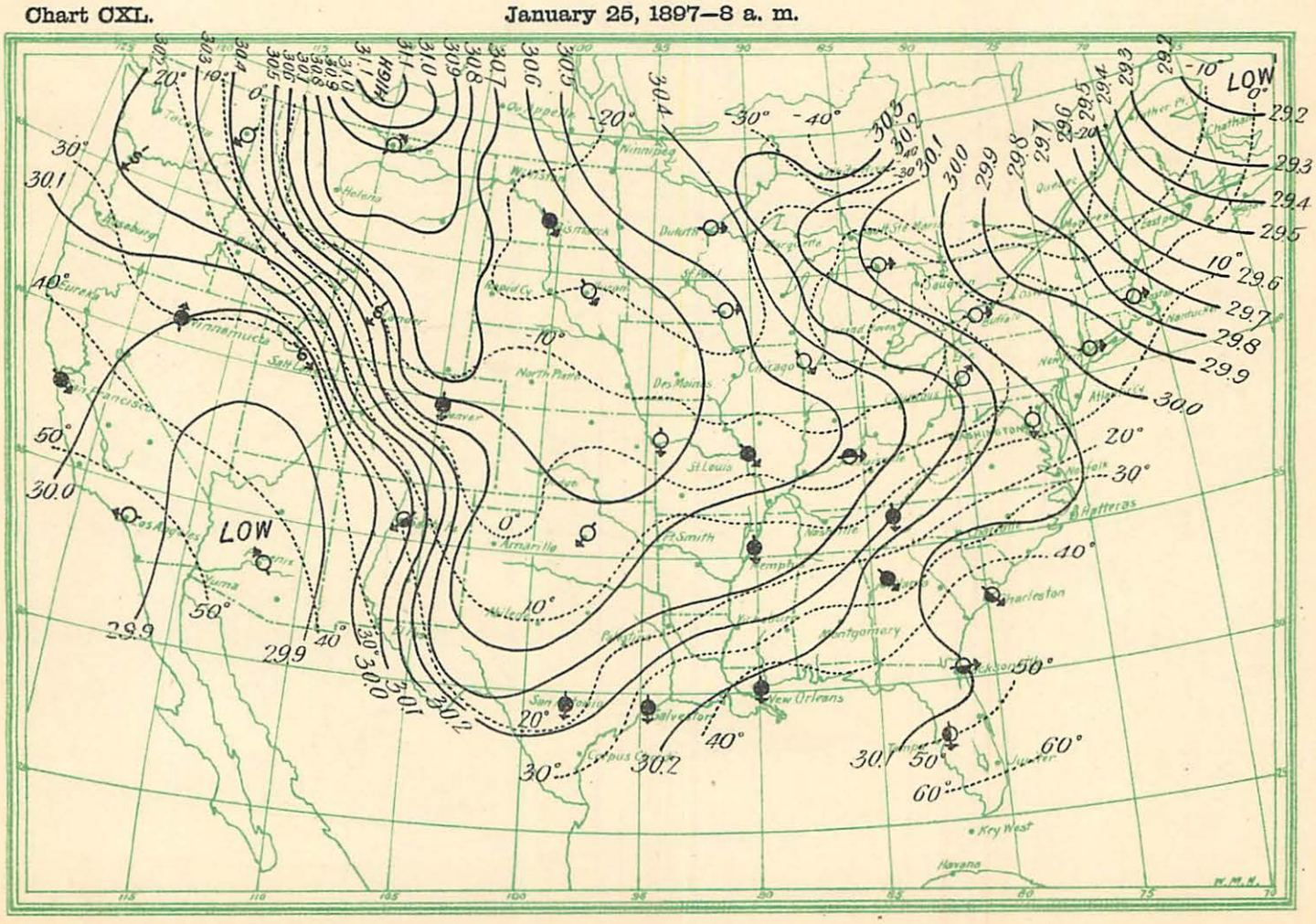


Chart CXLI. January 1, 1898—8 a. m.

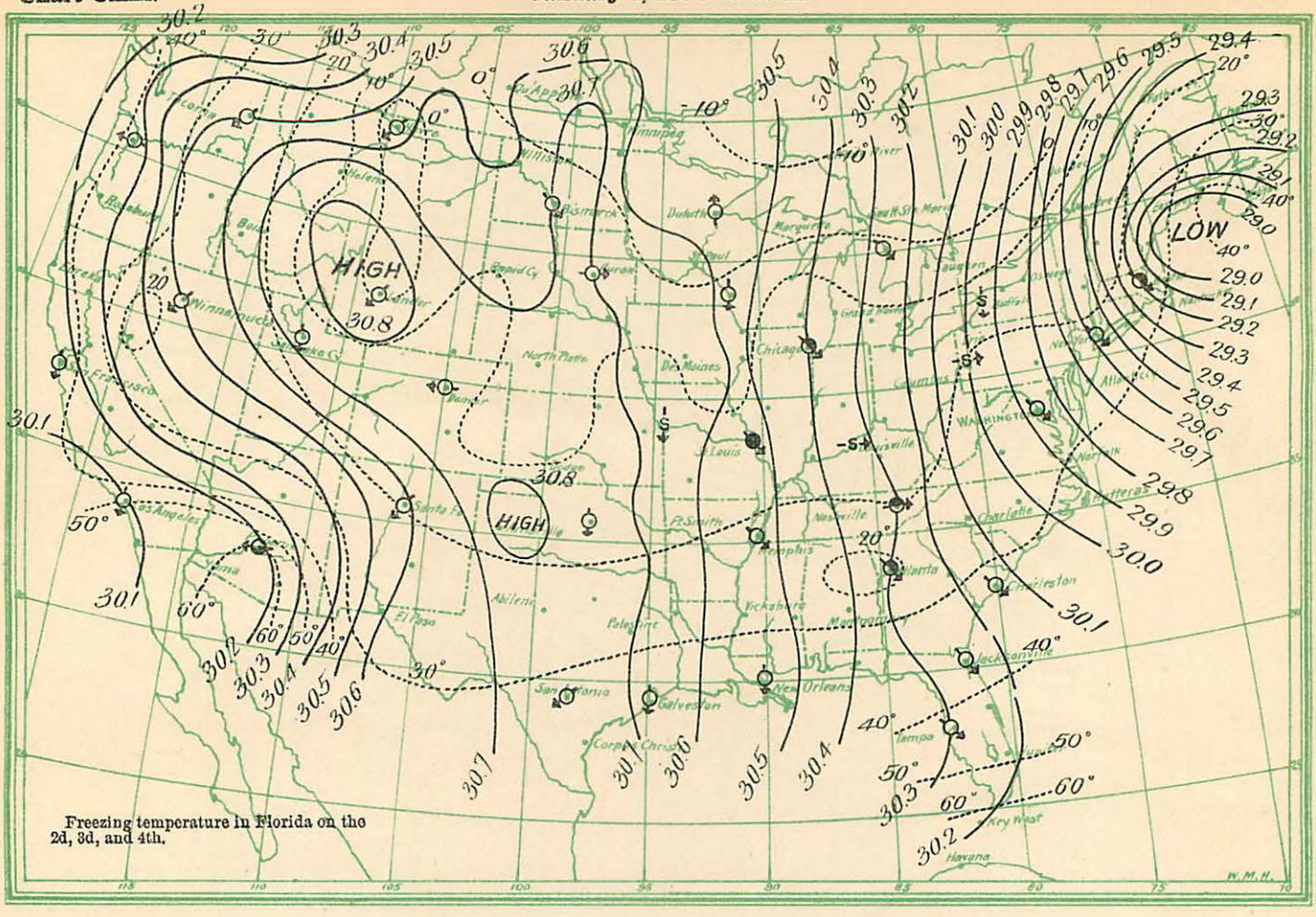


Chart CXLII. January 2, 1898—8 a. m.

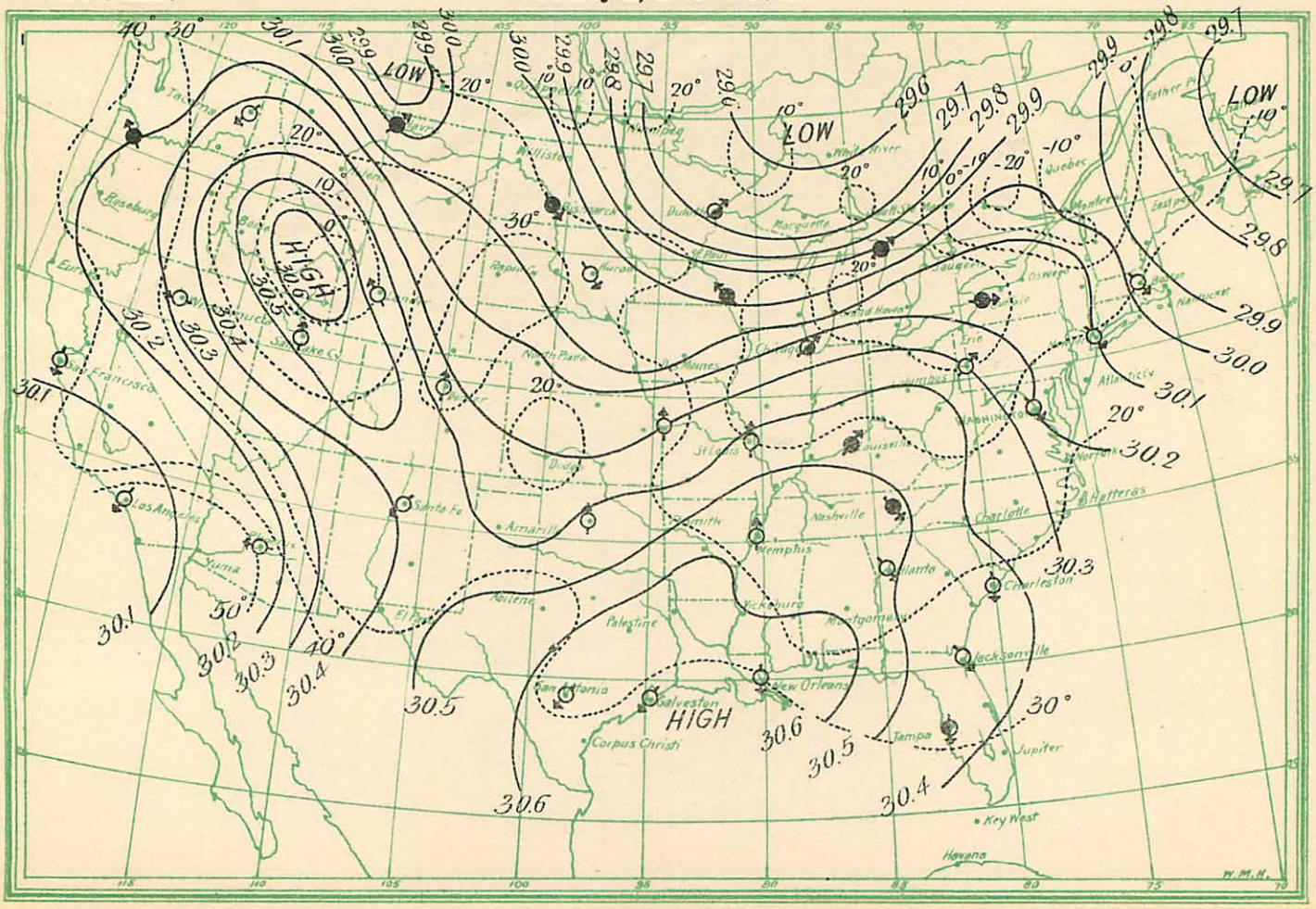


Chart CXLIII. January 3, 1898—8 a. m.

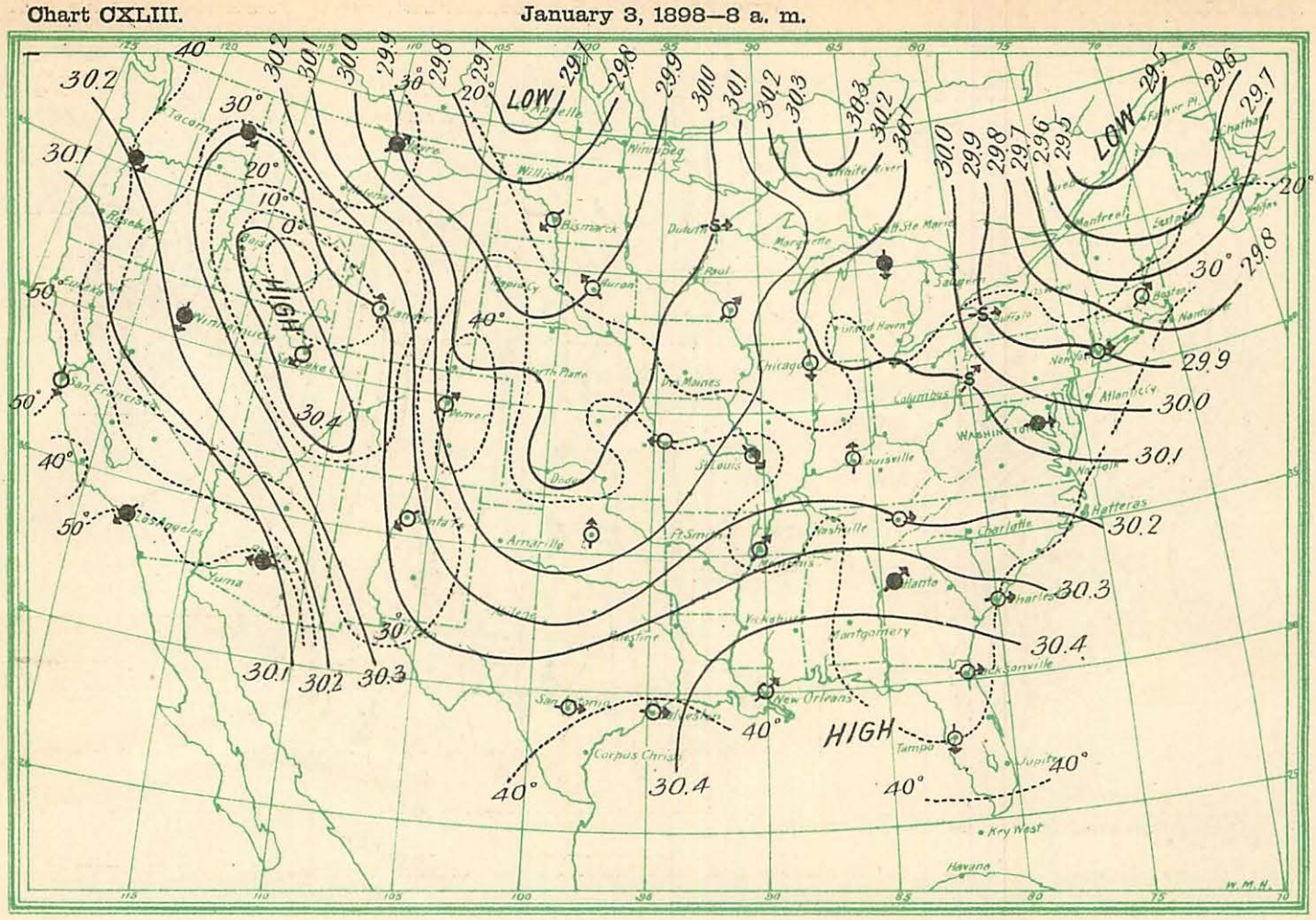


Chart CXLIV. January 4, 1898—8 a. m.

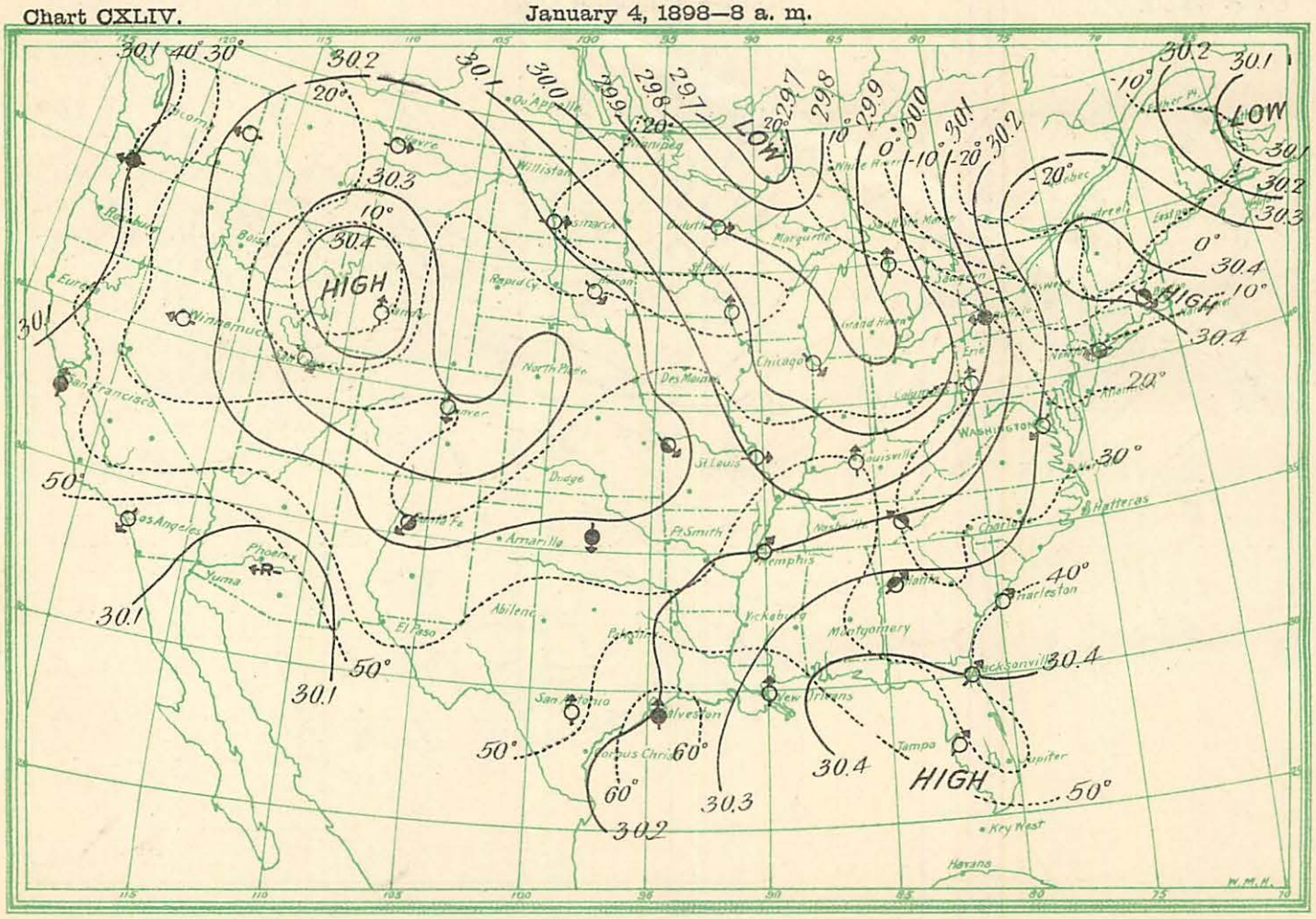


Chart CXLV. January 24, 1898—8 a. m.

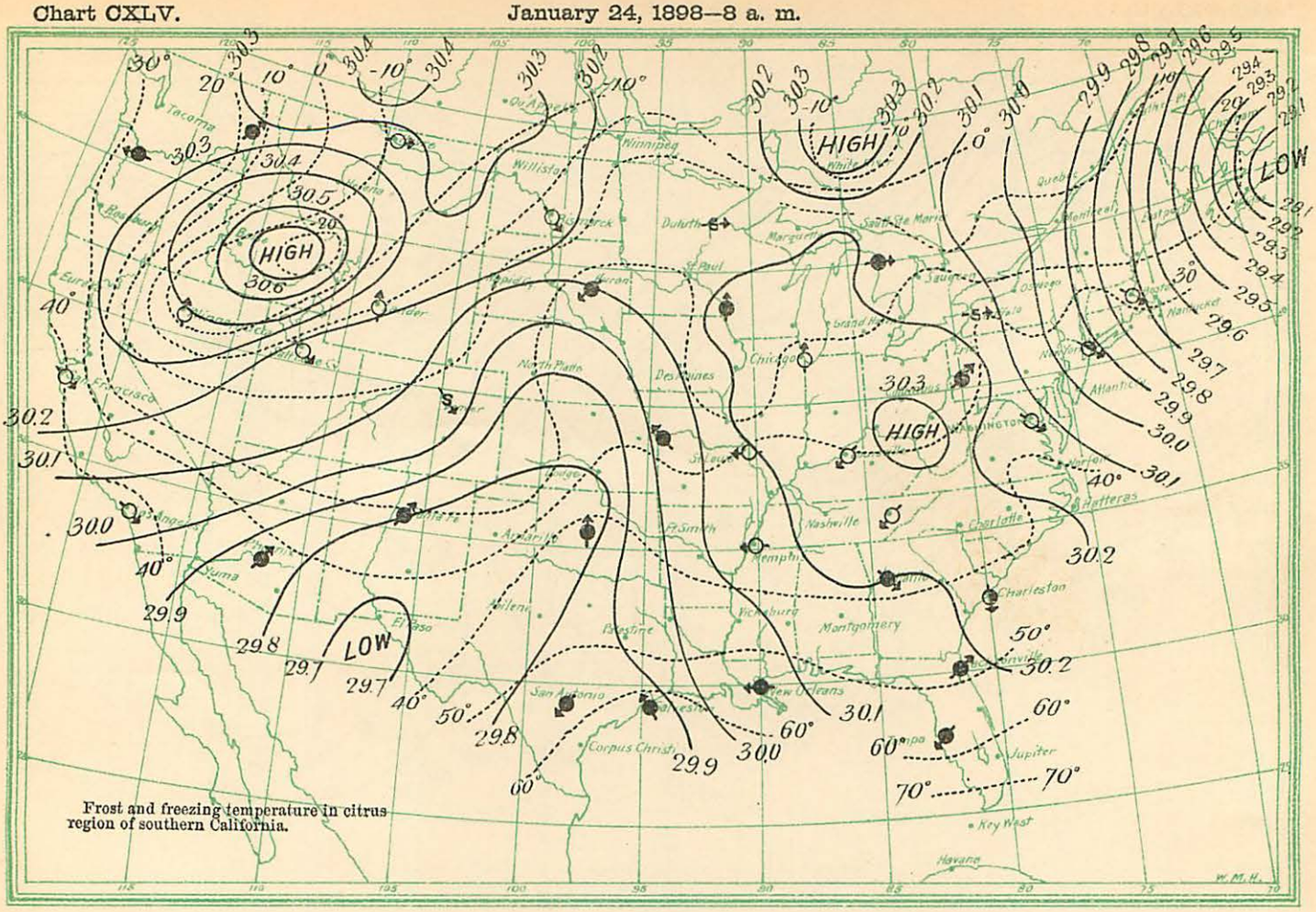


Chart CXLVI. January 25, 1898—8 a. m.

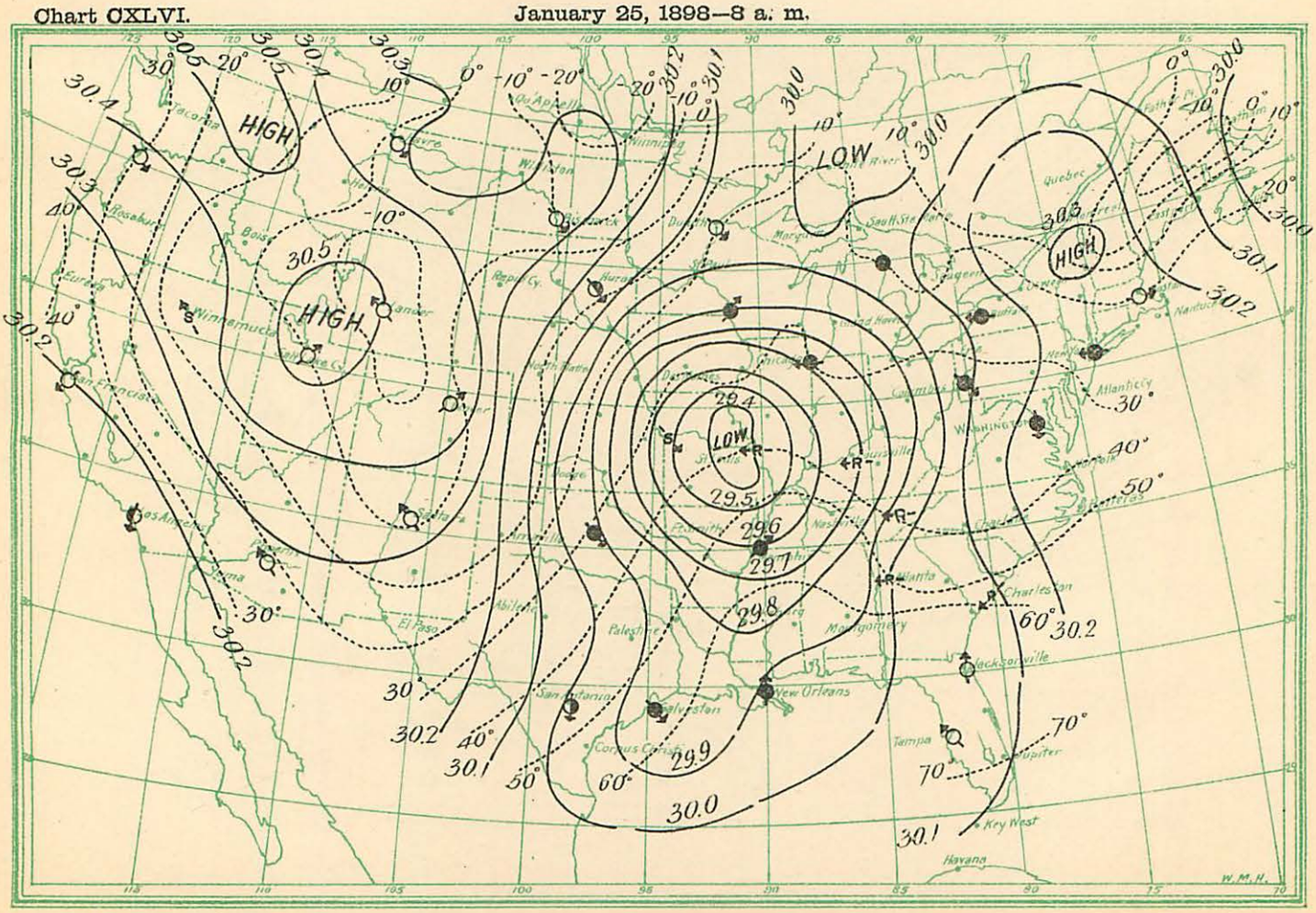


Chart CXLVII. January 26, 1898—8 a. m.

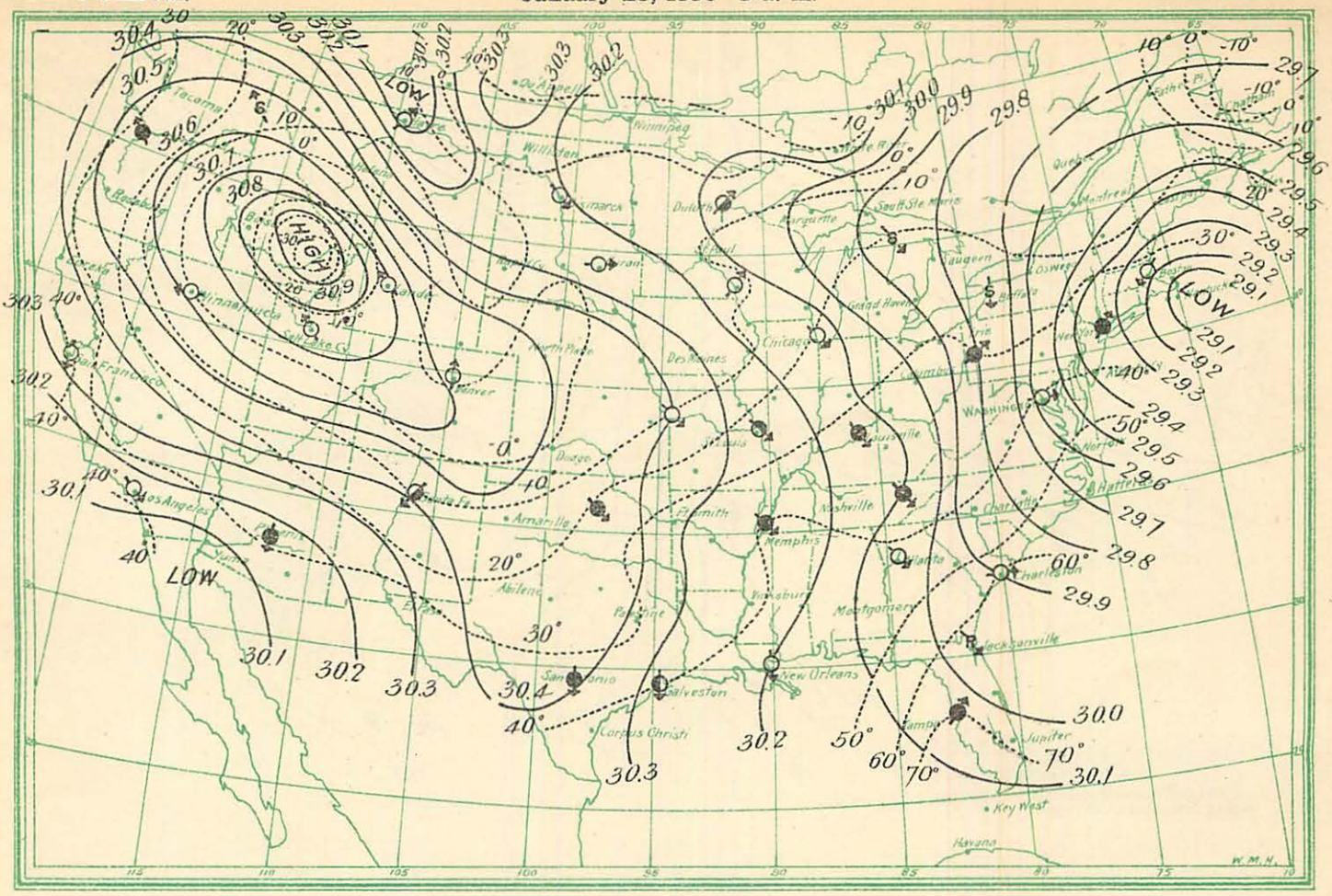


Chart CXLVIII. January 27, 1898—8 a. m.

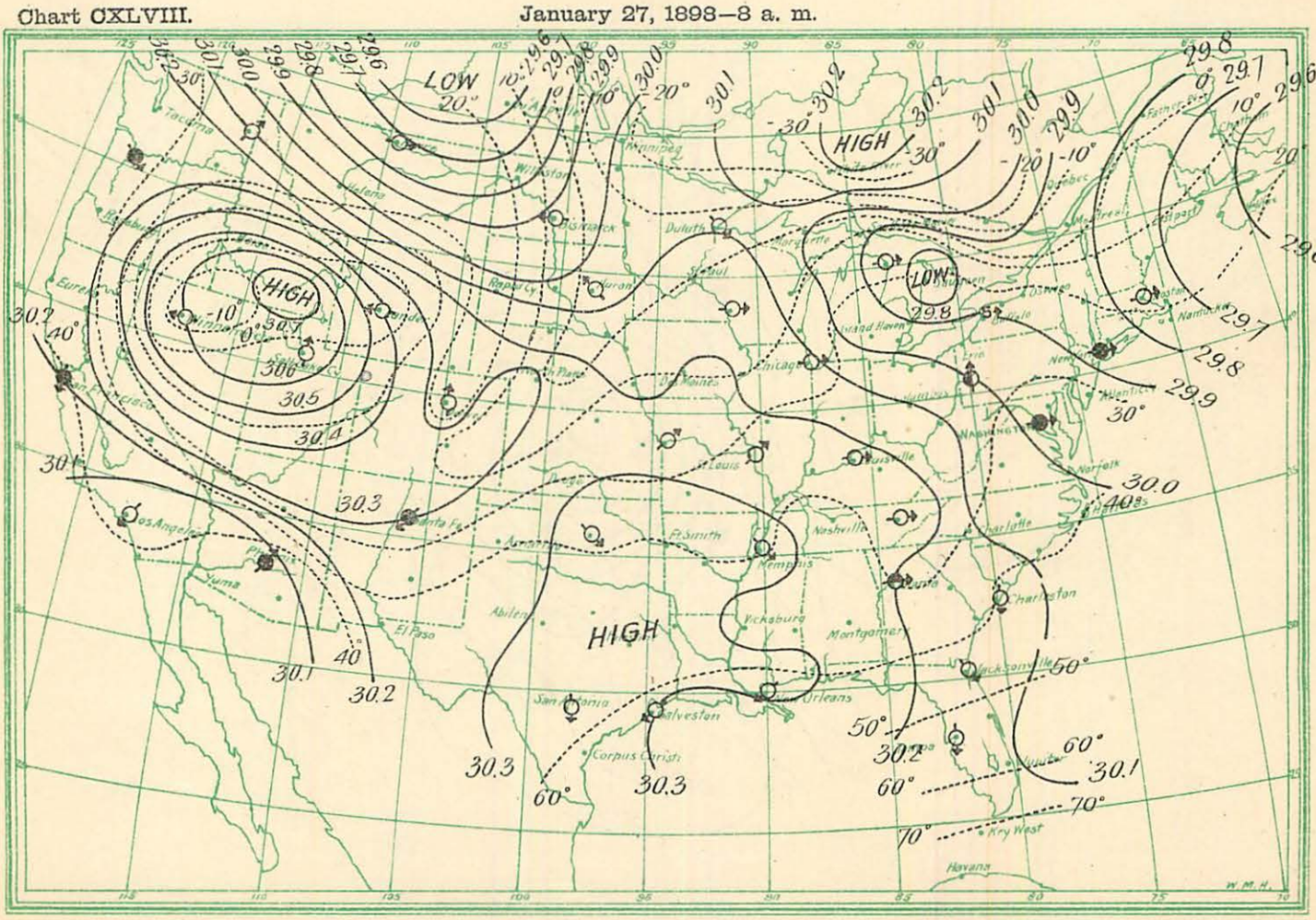


Chart CXLIX. January 26, 1899—8 a. m.

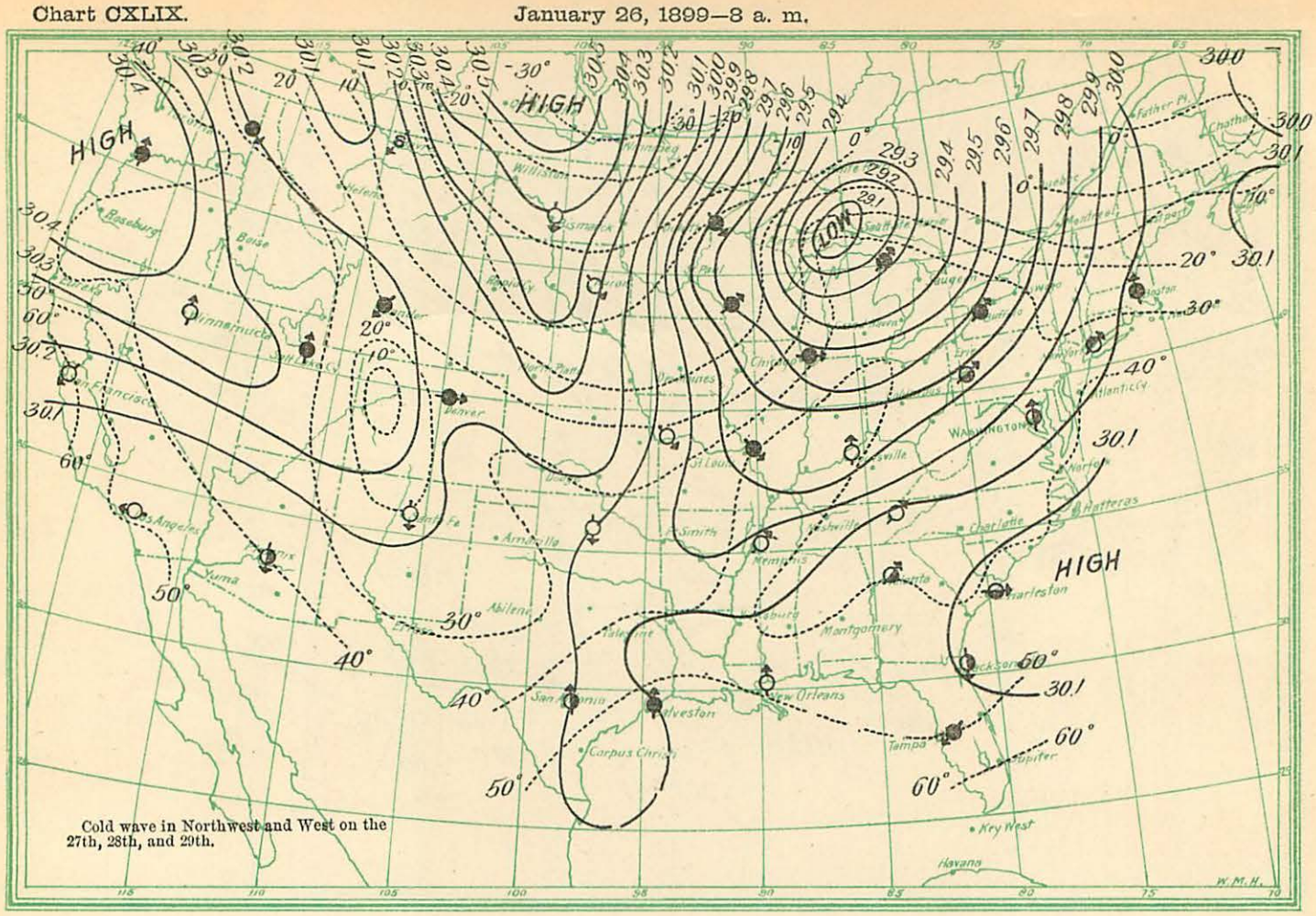


Chart CL. January 27, 1899—8 a. m.

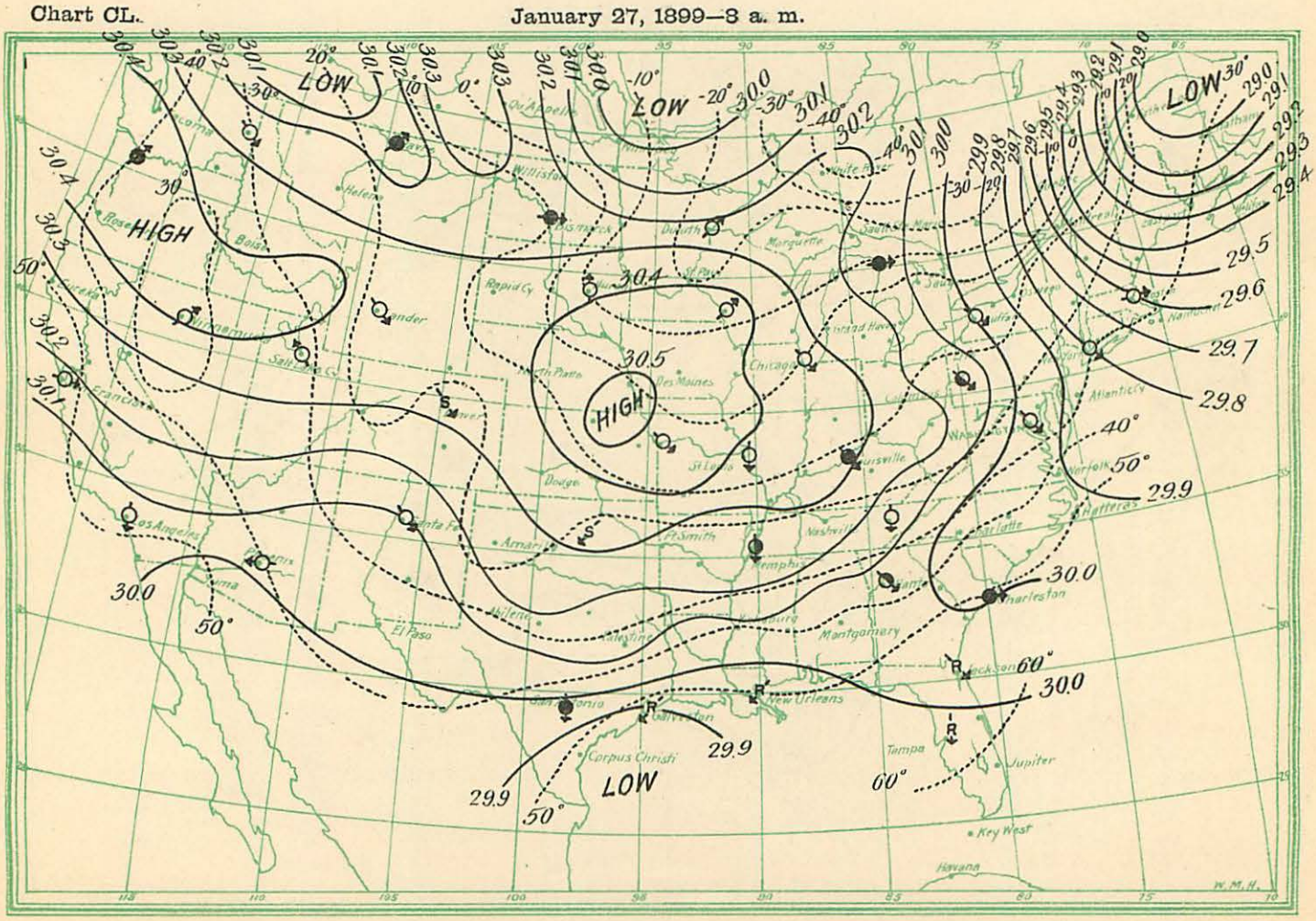


Chart CLI. January 28, 1899—8 a. m.

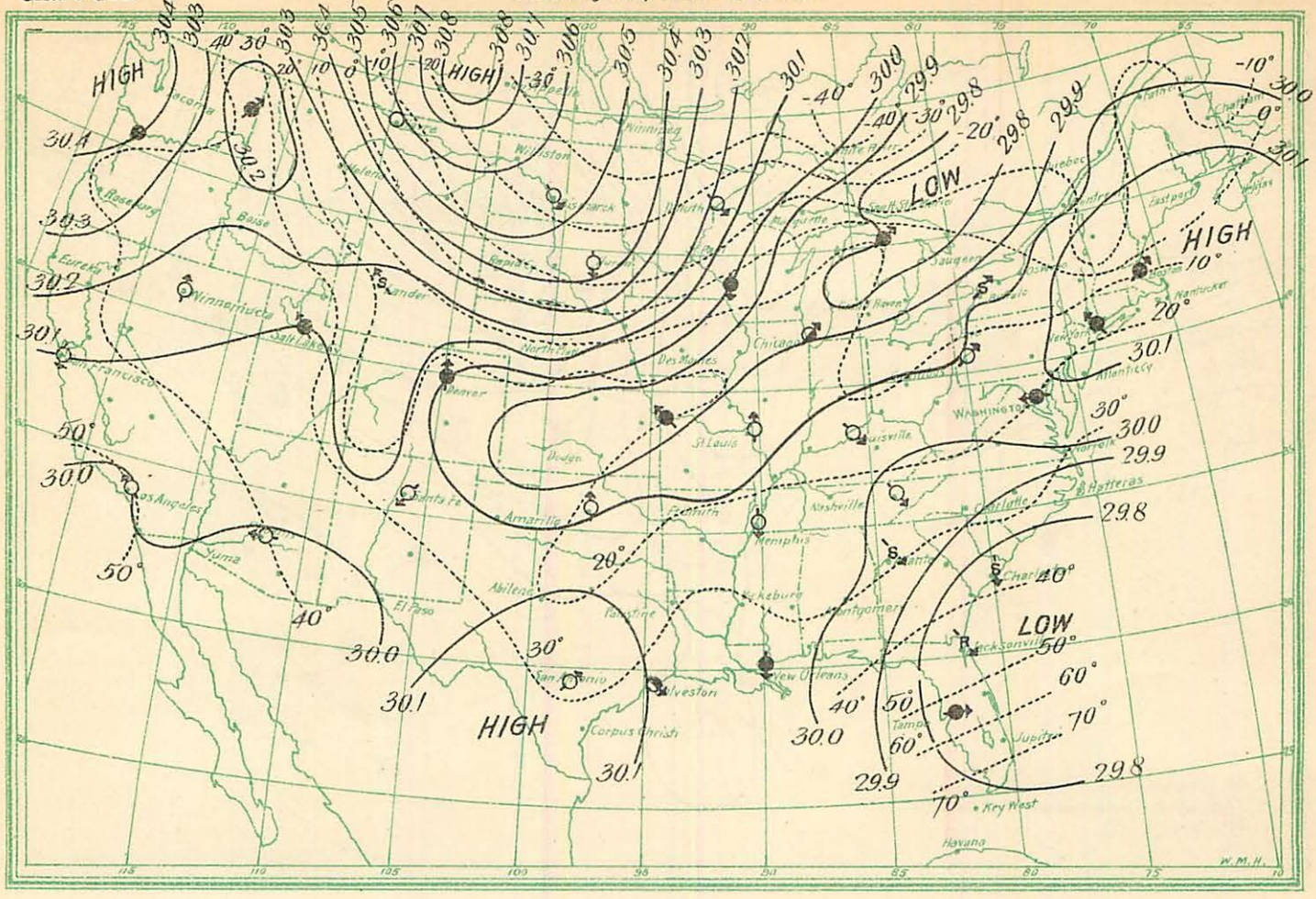


Chart CLII. January 29, 1899—8 a. m.

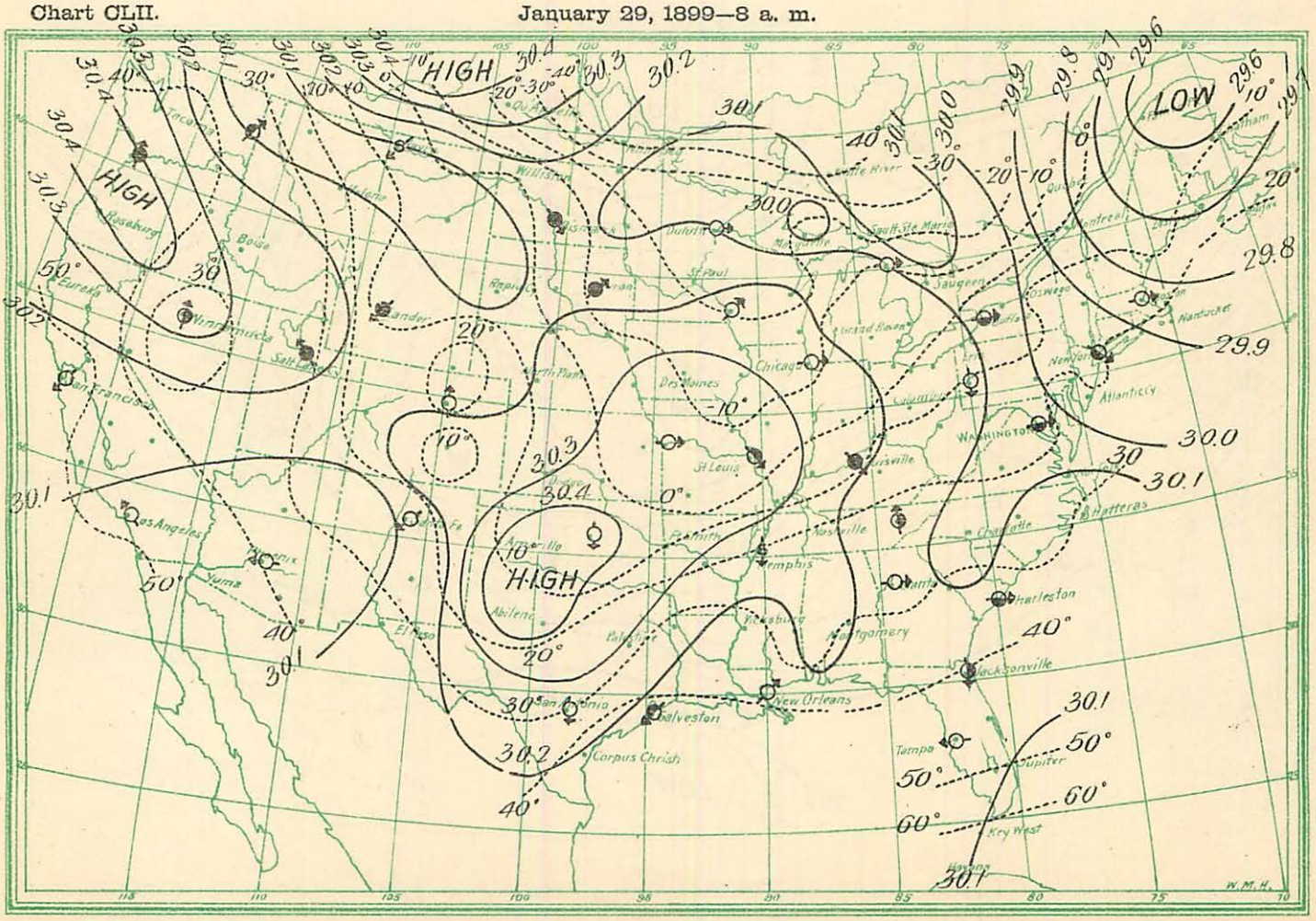


Chart CLIII. January 1, 1900—8 a. m.

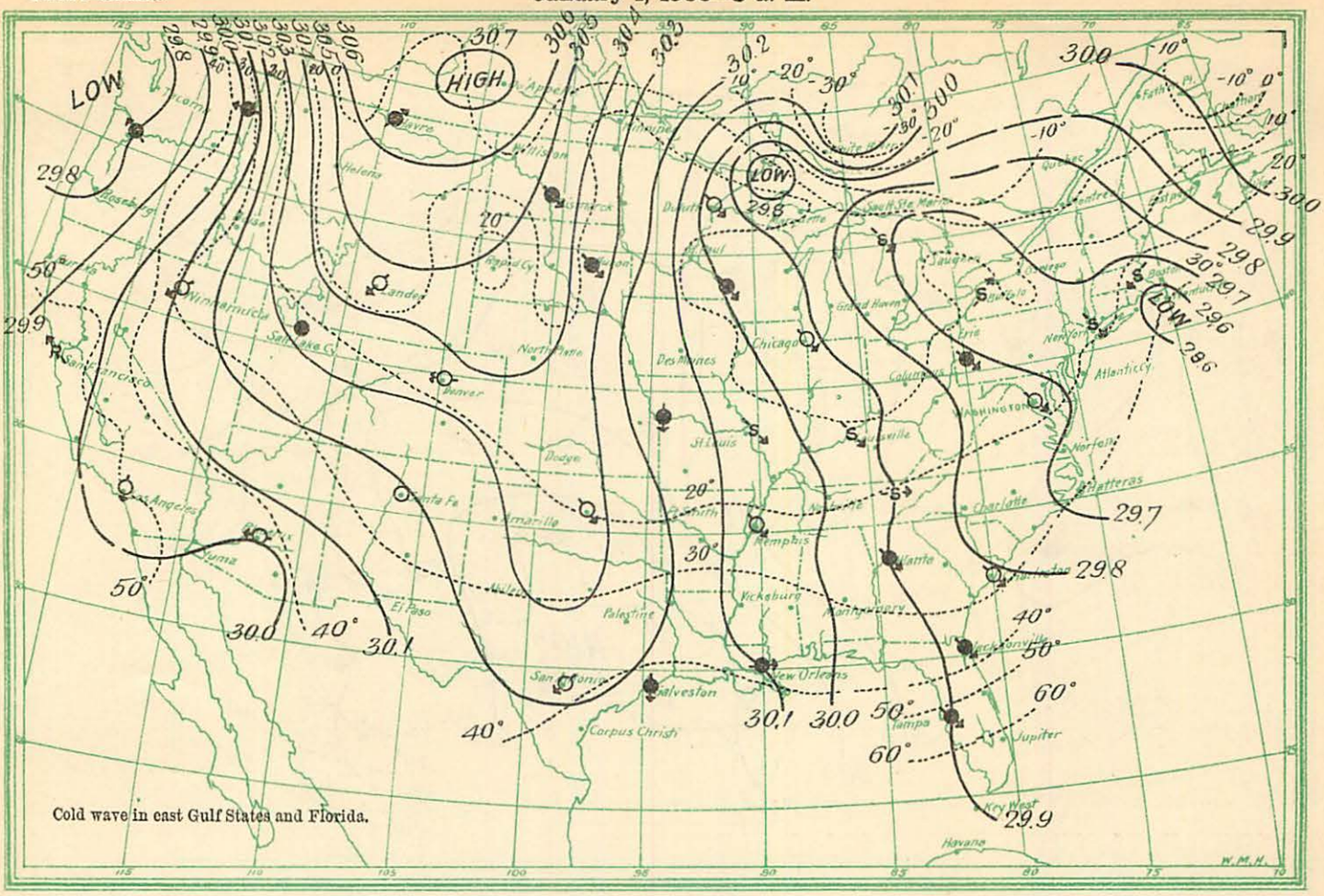


Chart CLIV. January 2, 1900—8 a. m.

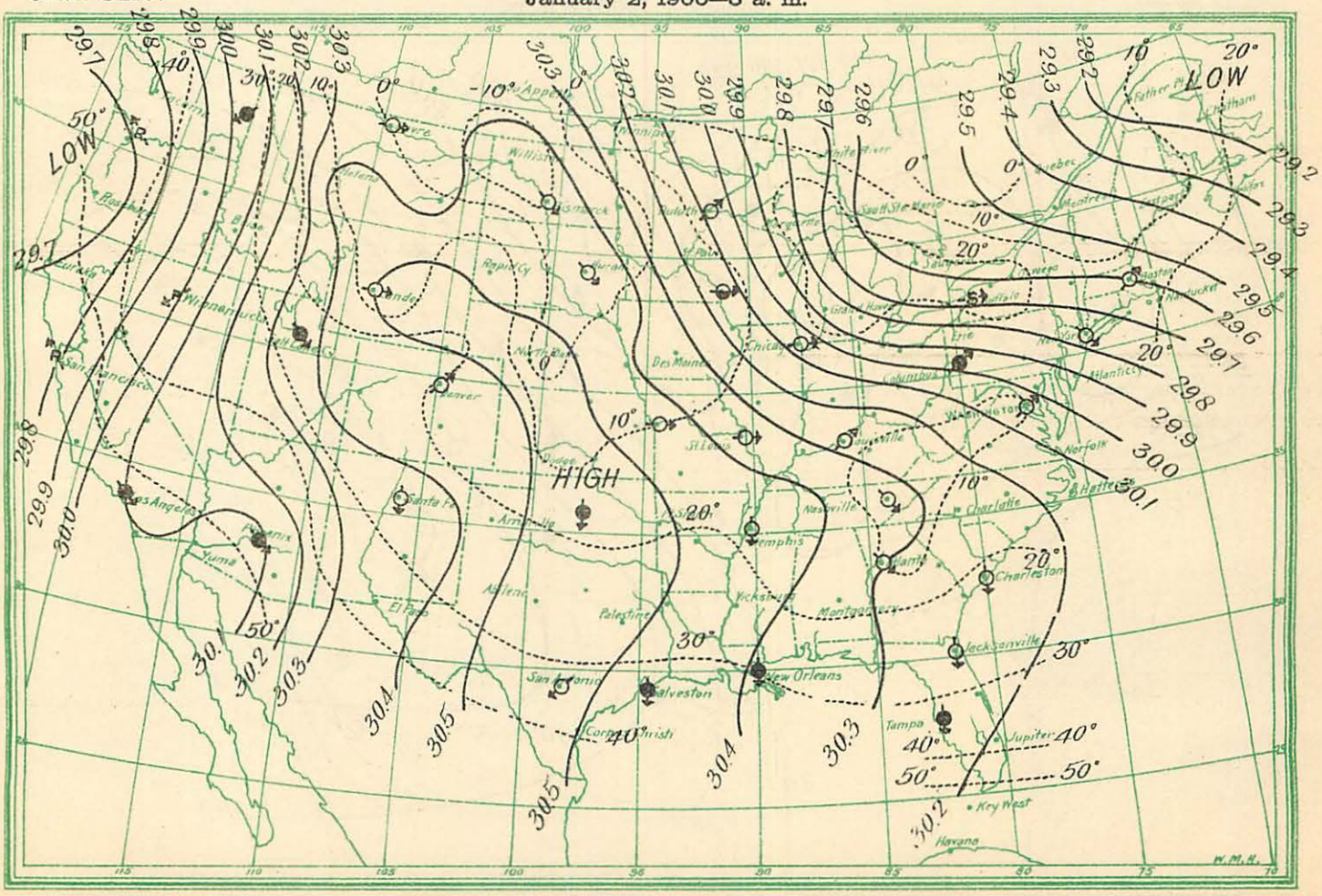


Chart CLV. January 3, 1900—8 a. m.

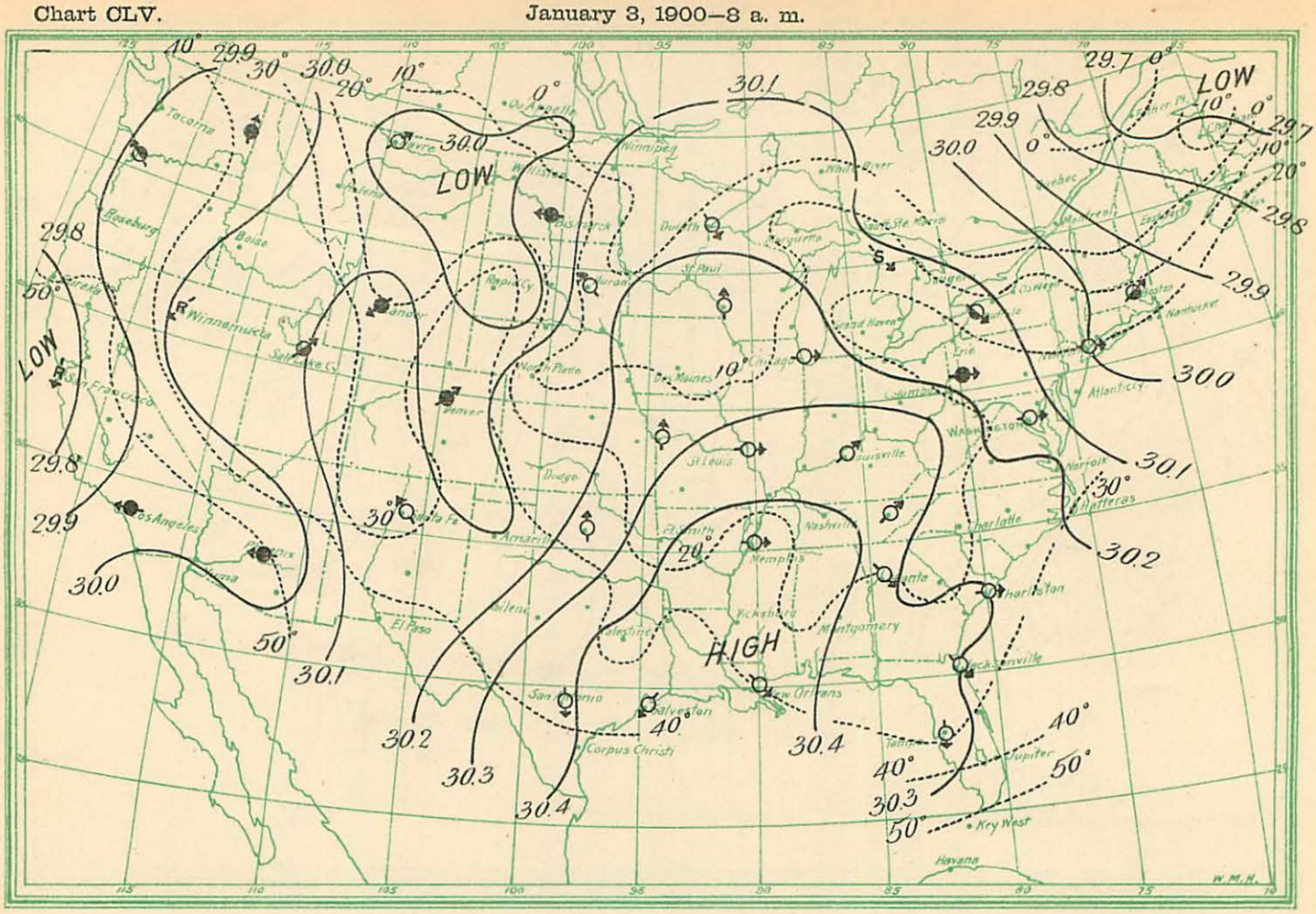


Chart CLVI. January 4, 1900—8 a. m.

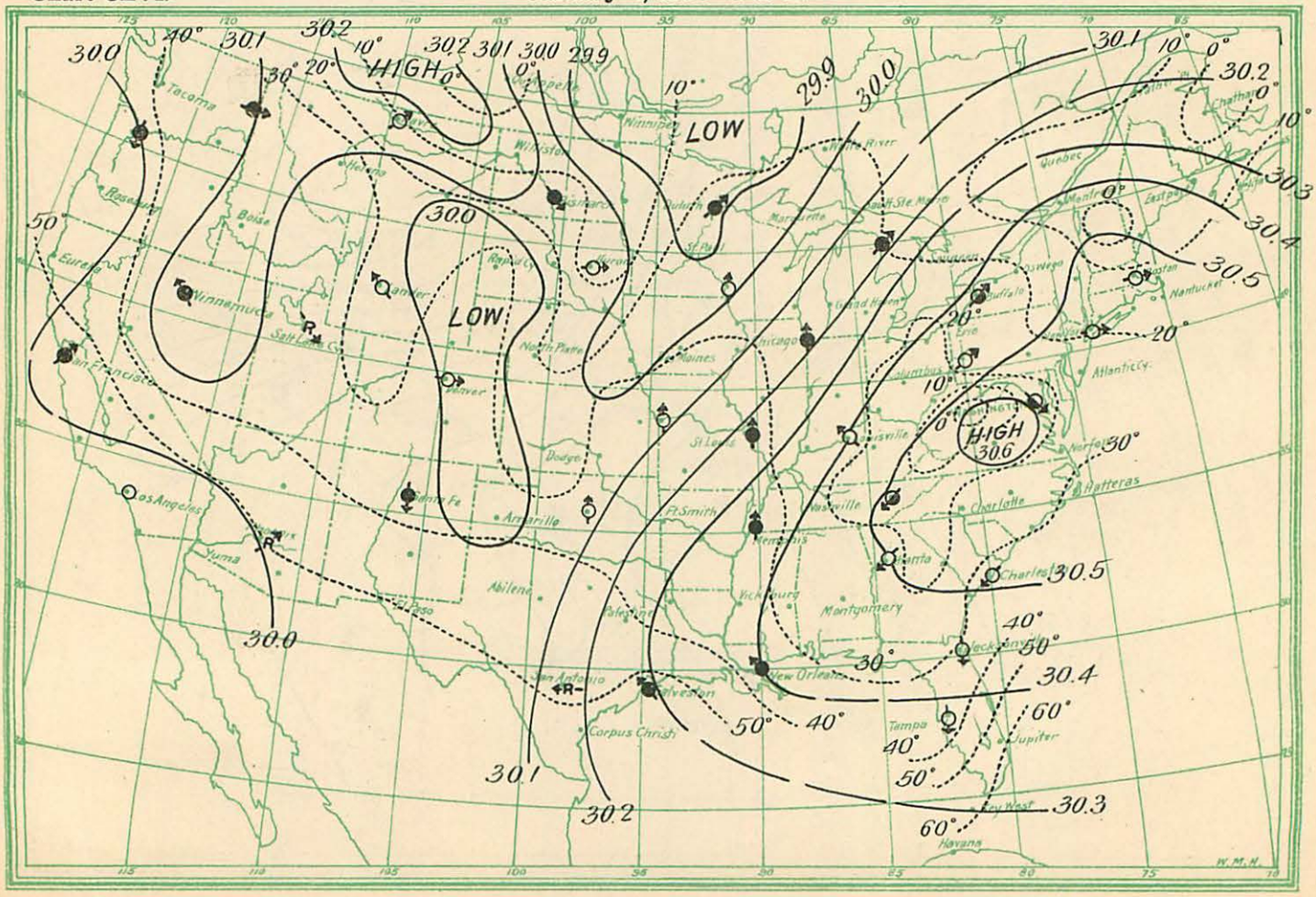


Chart CLVII. January 27, 1900—8 a. m.

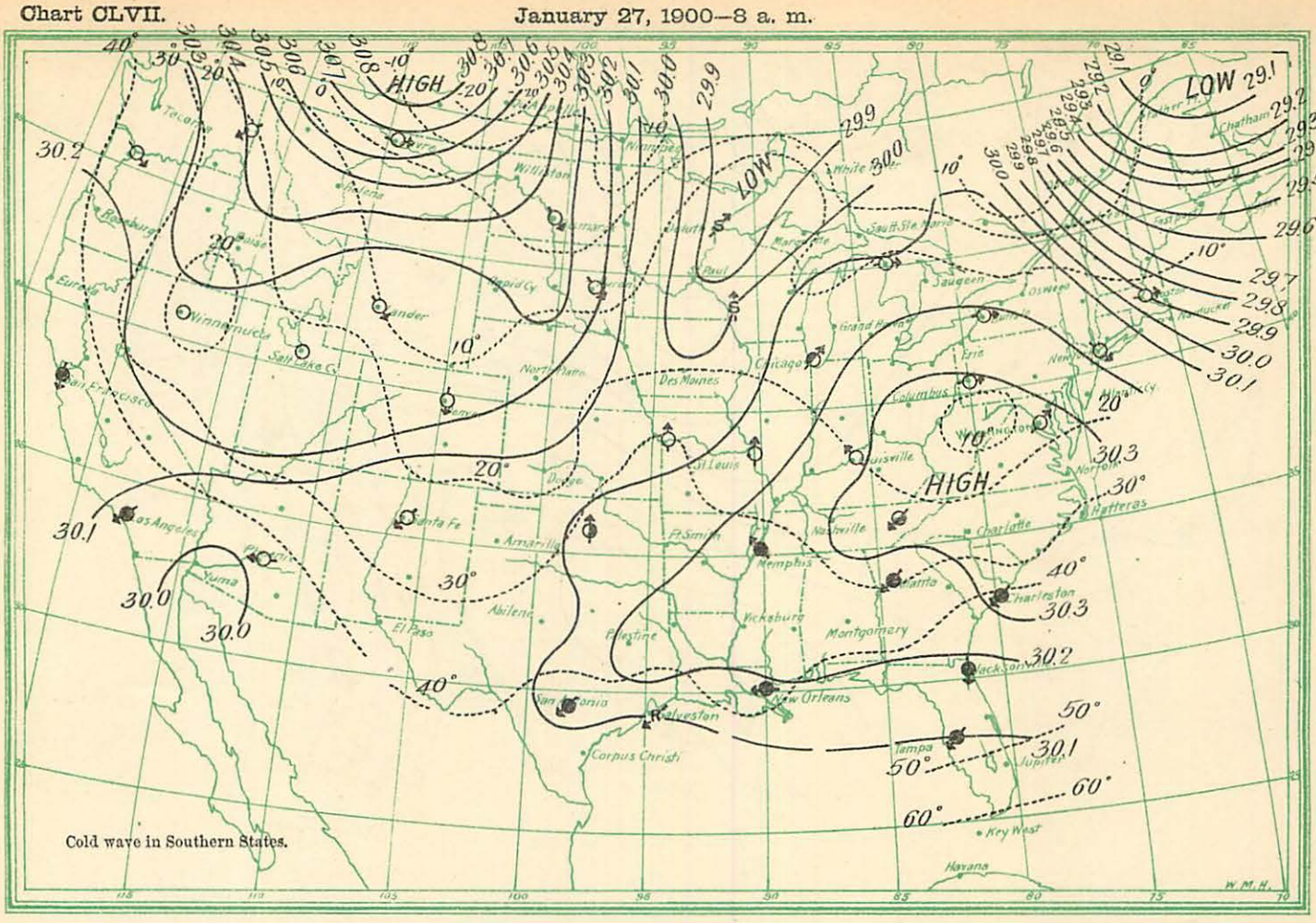


Chart CLVIII. January 28, 1900—8 a. m.

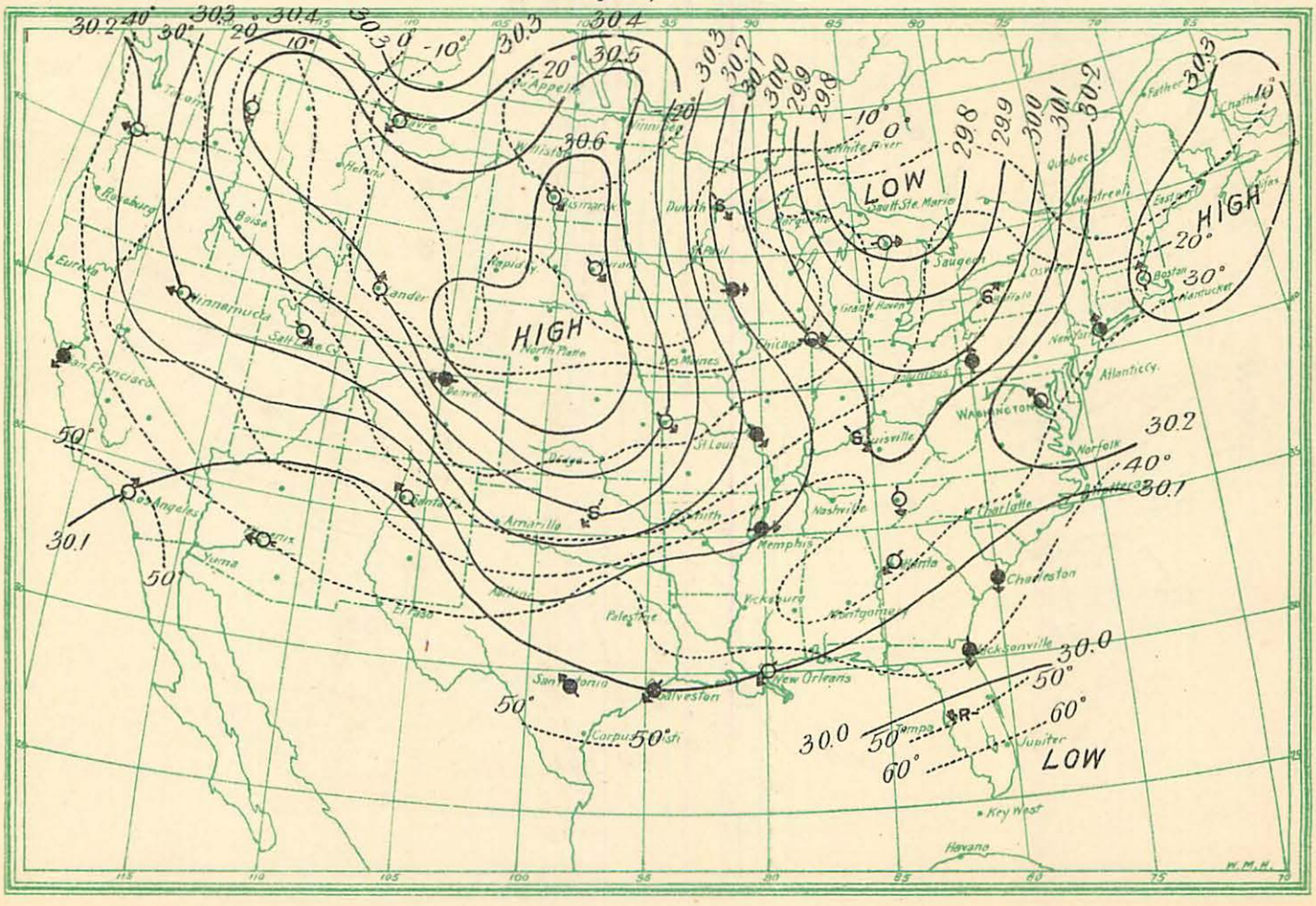


Chart CLIX. January 29, 1900—8 a. m.

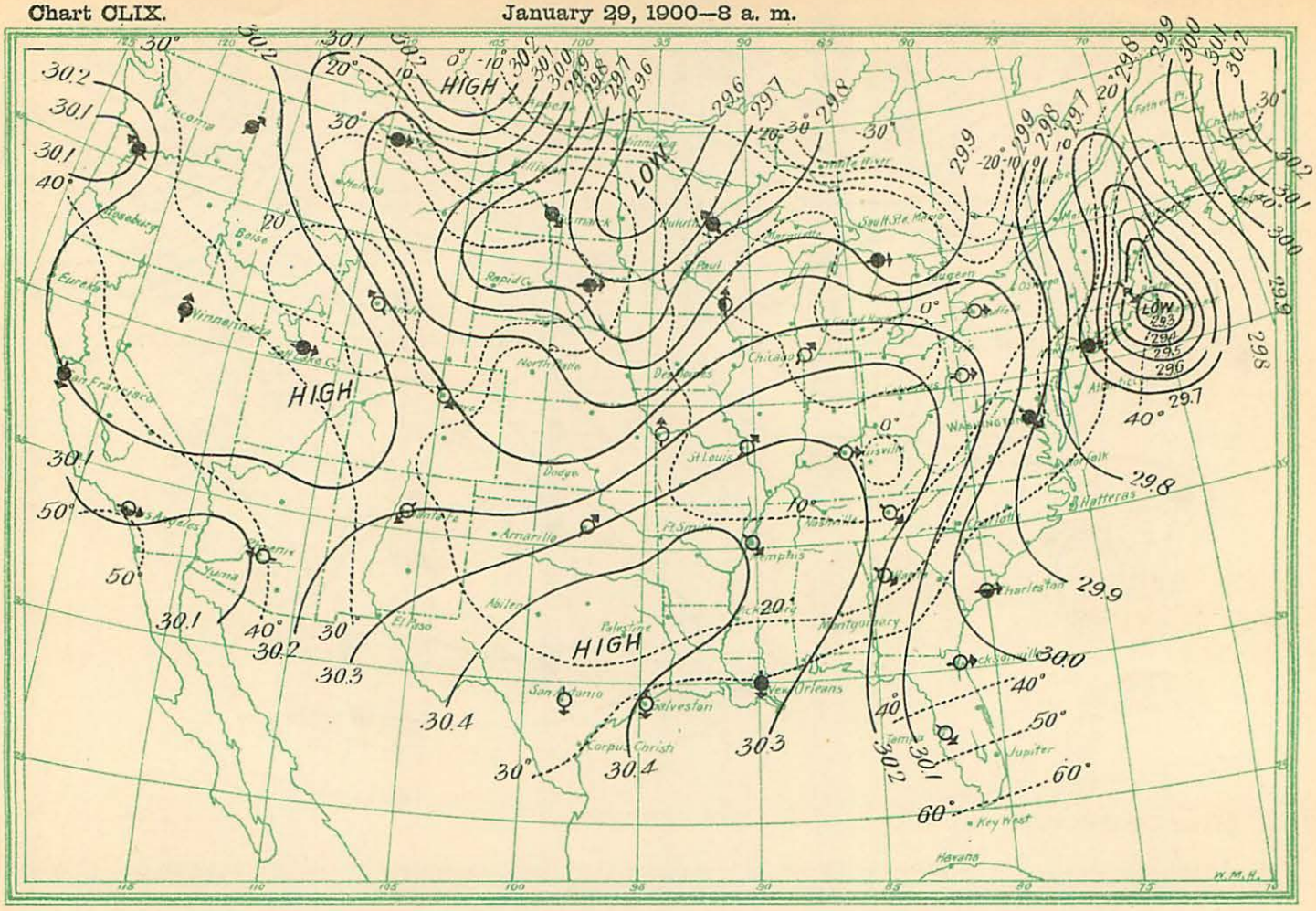


Chart CLX. January 30, 1900—8 a. m.

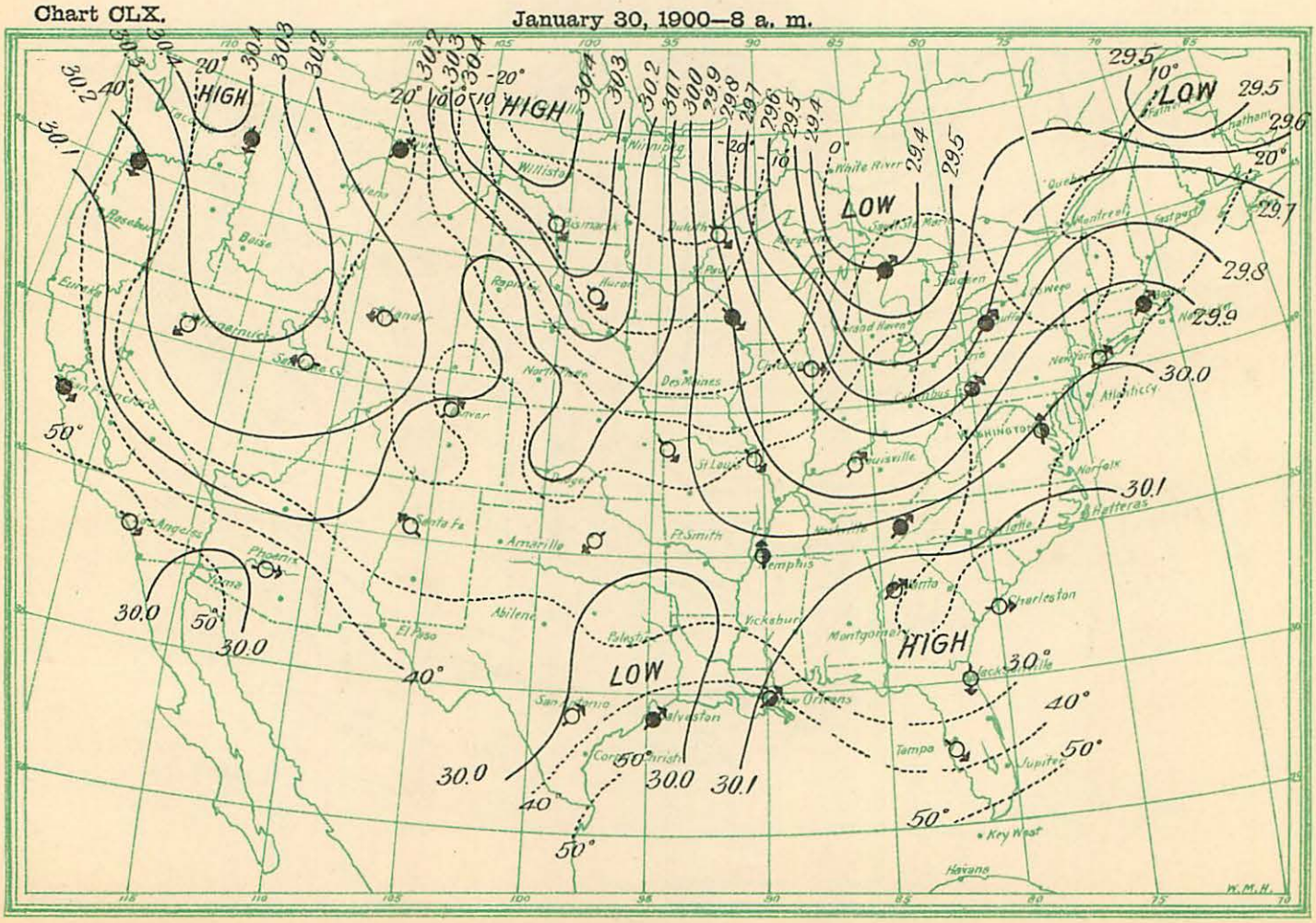


Chart CLXI. January 6, 1901—8 a. m.

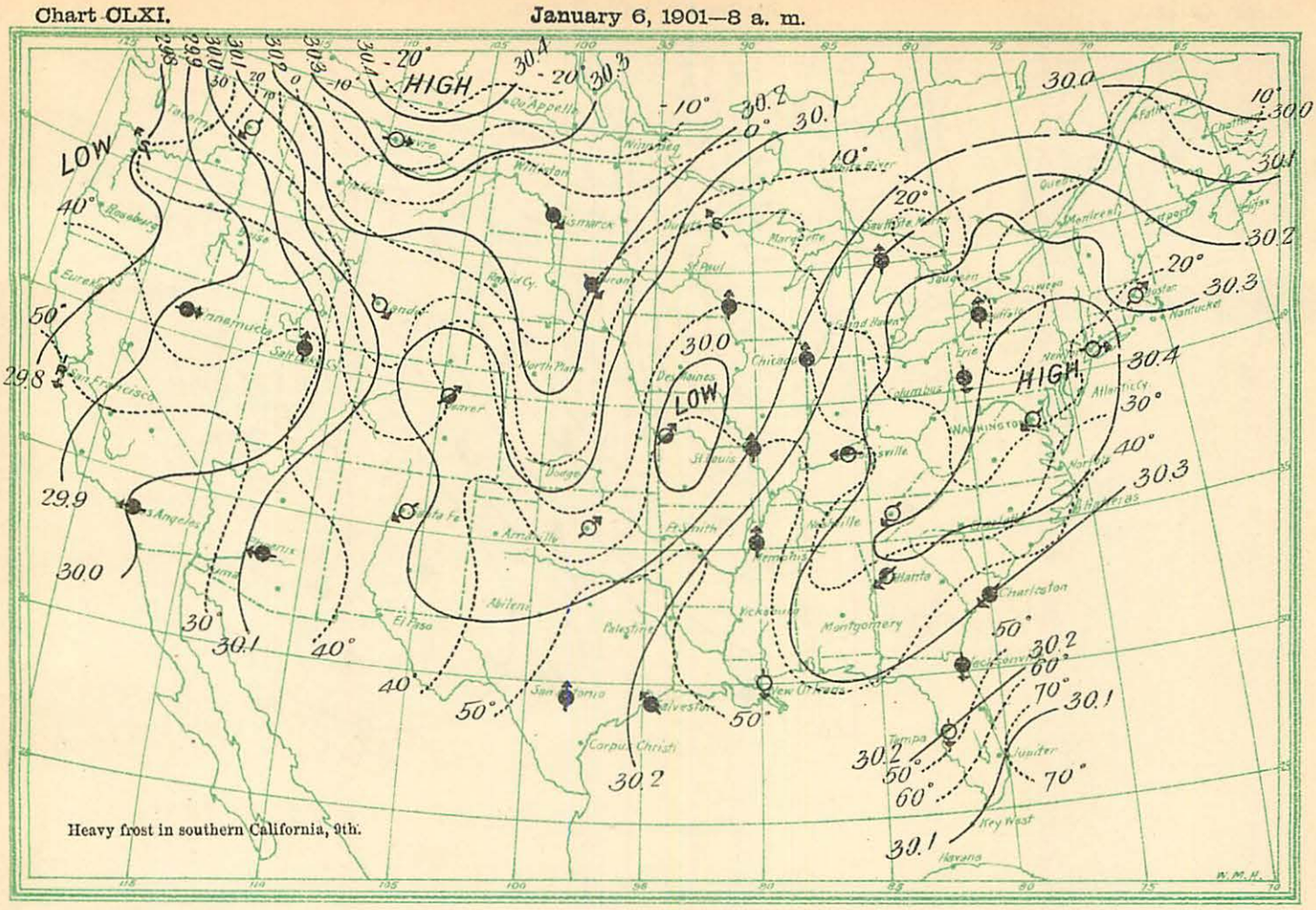


Chart CLXII. January 7, 1901—8 a. m.

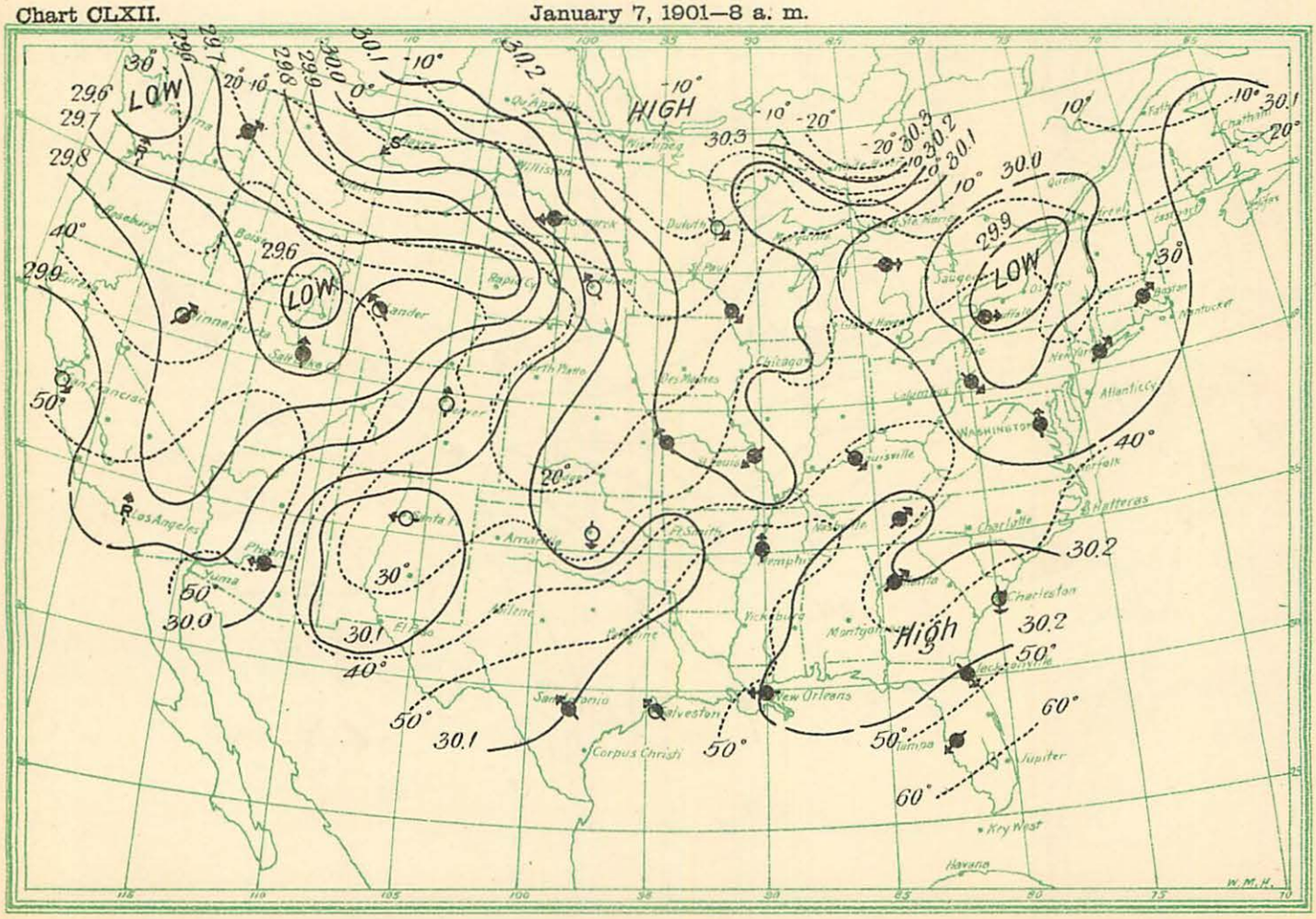


Chart CLXIII. January 8, 1901—8 a. m.

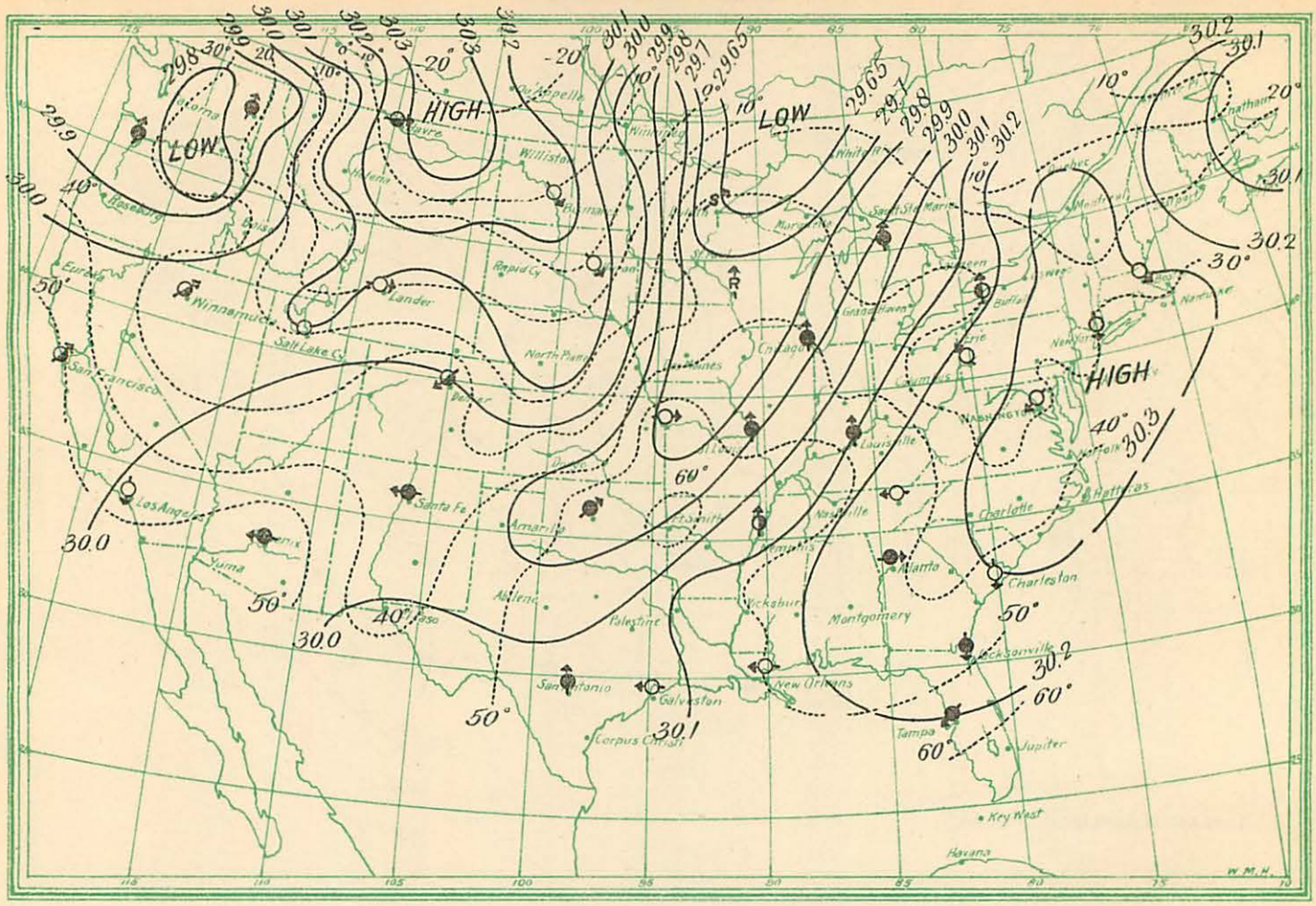


Chart CLXIV. January 9, 1901—8 a. m.

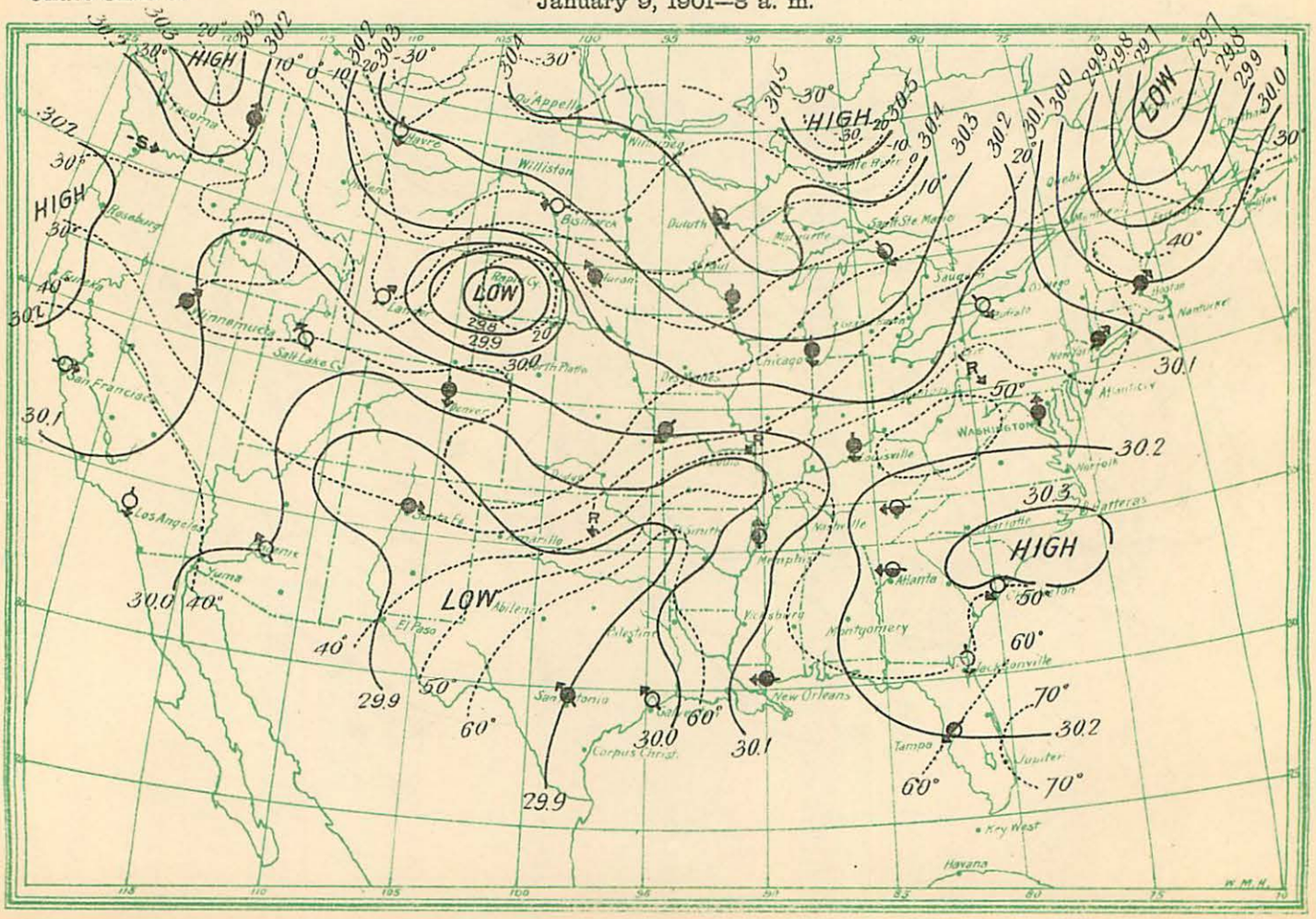


Chart CLXV. January 24, 1902—8 a. m.

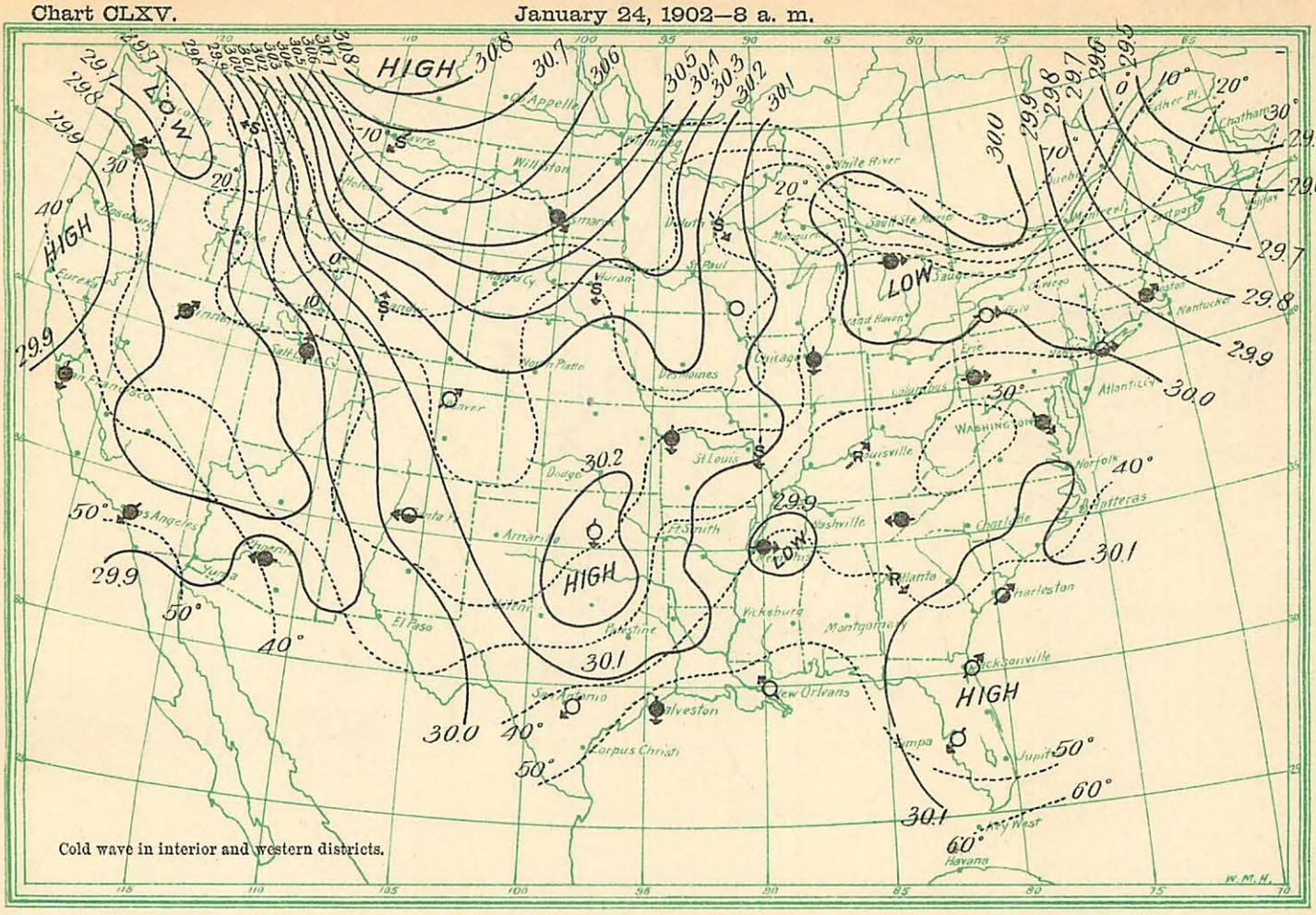


Chart CLXVI. January 25, 1902—8 a. m.

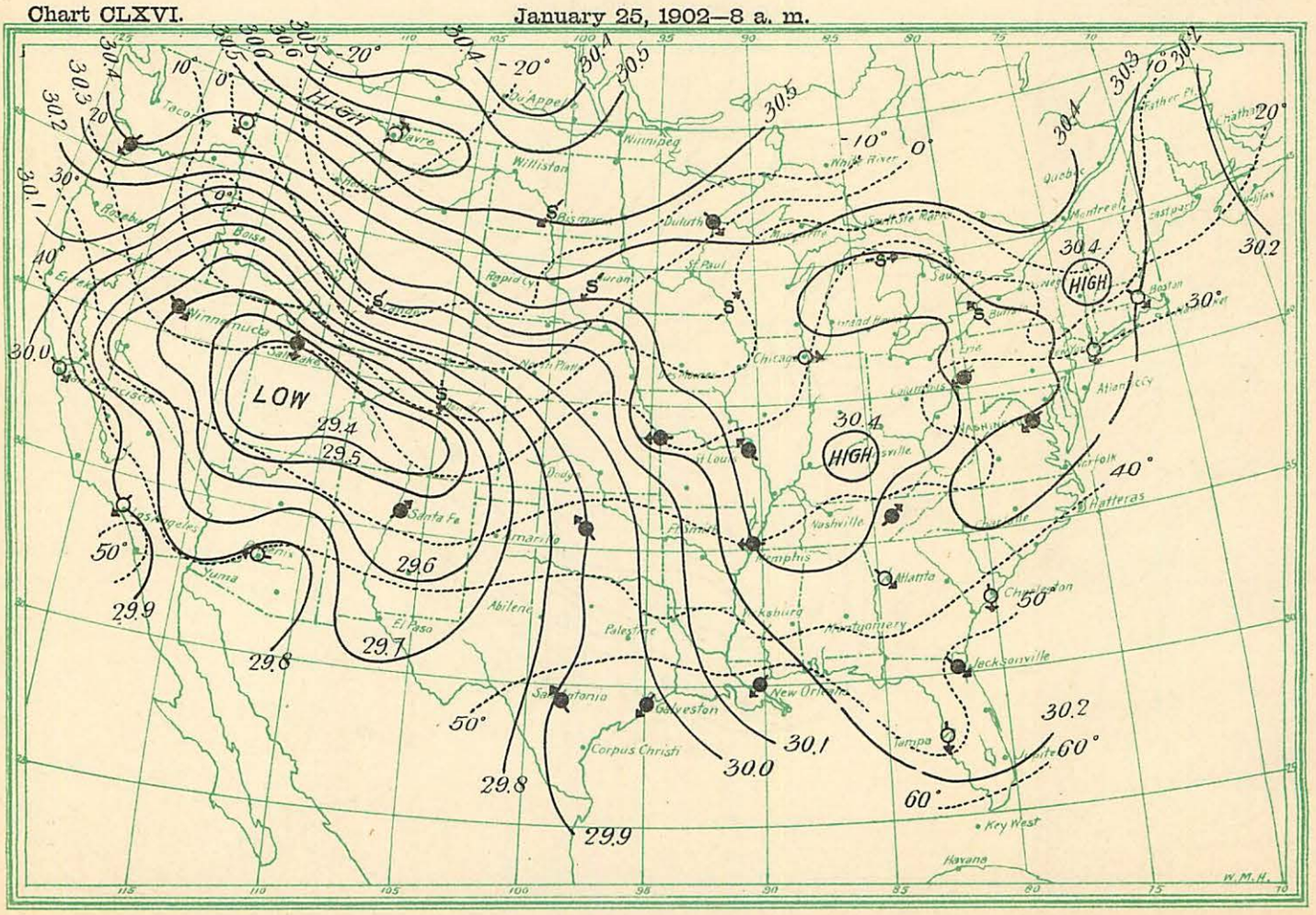


Chart CLXVII. January 26, 1902—8 a. m.

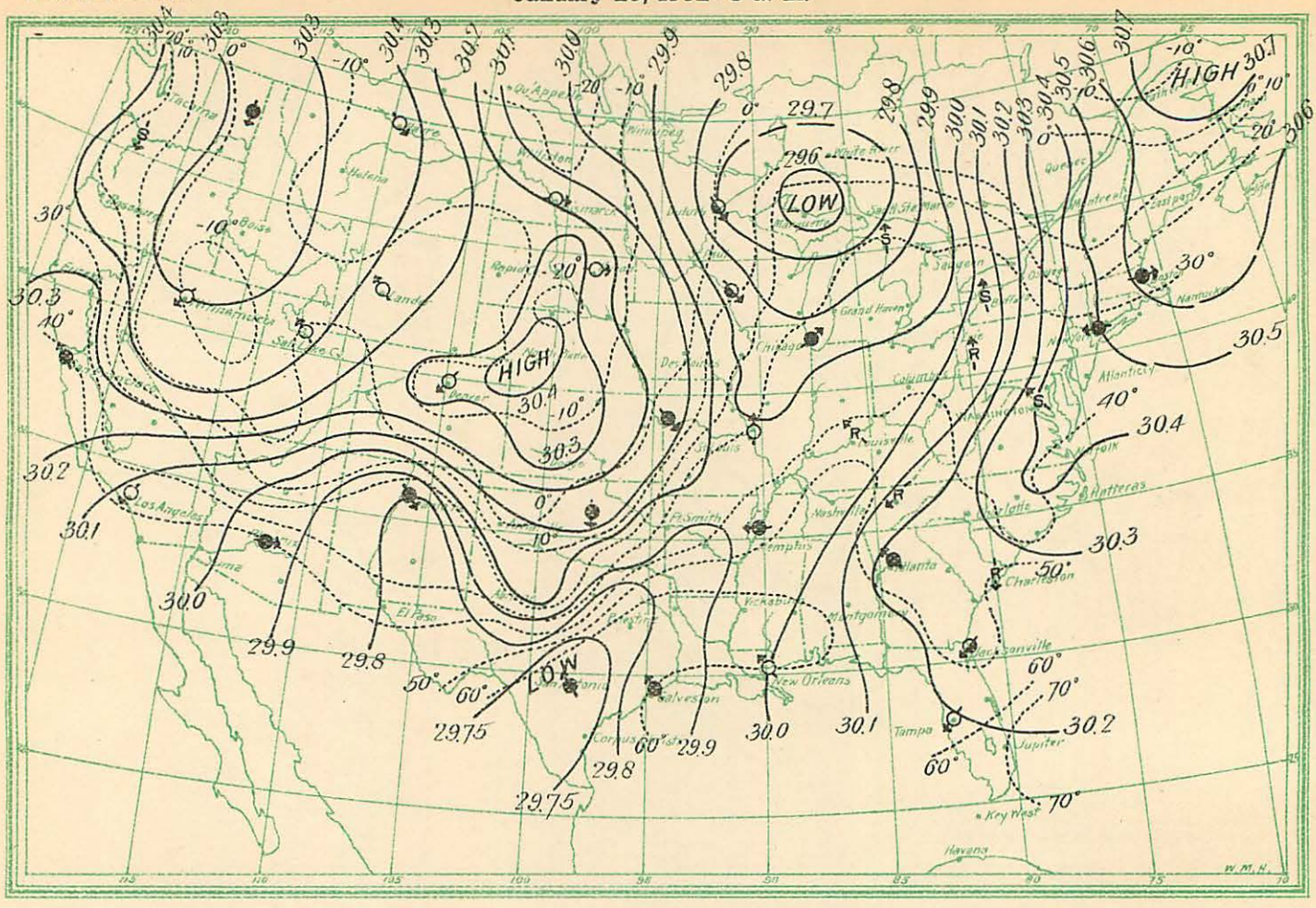


Chart CLXVIII. January 27, 1902—8 a. m.

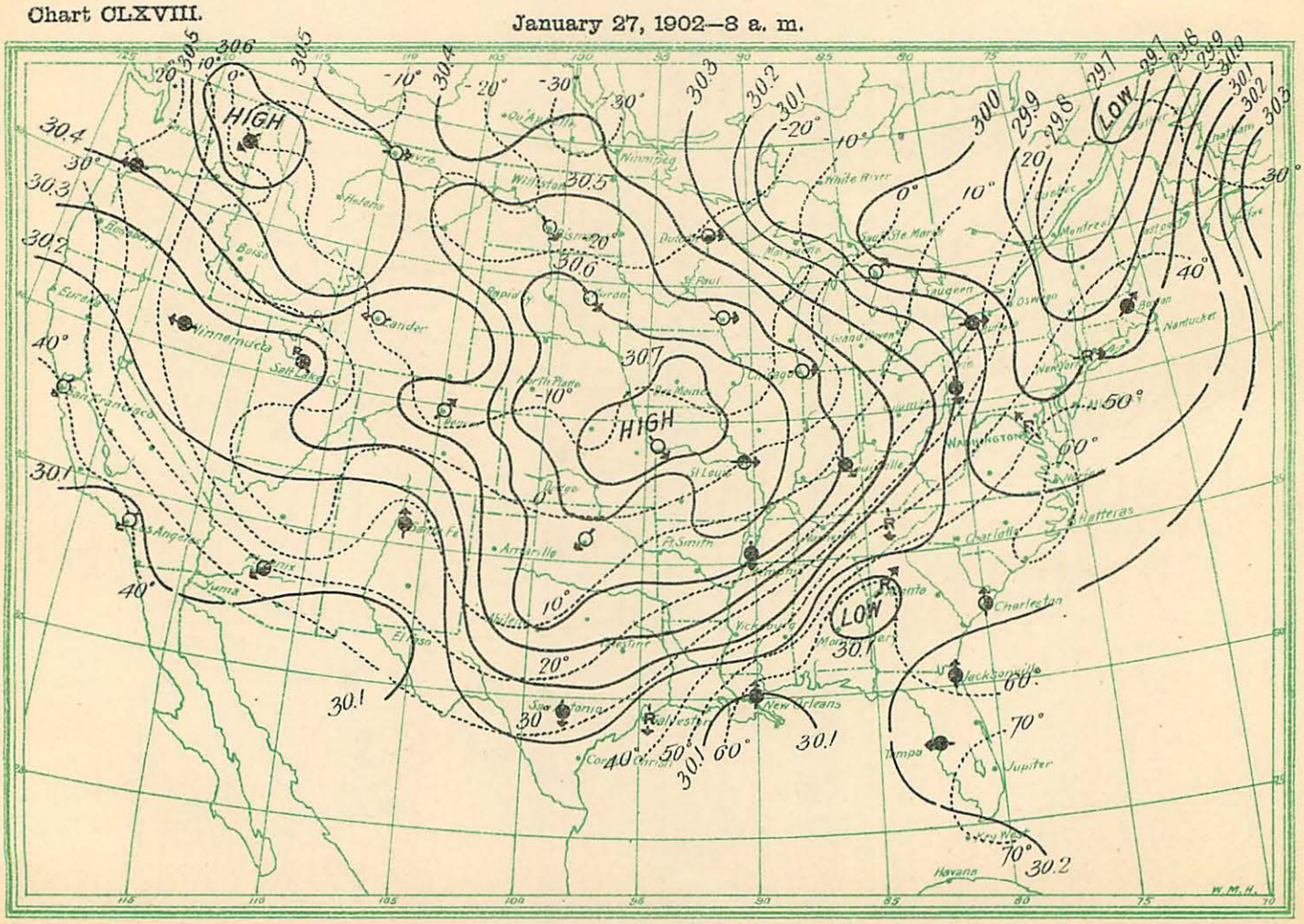


Chart CLXIX. February 21, 1889—8 a. m.

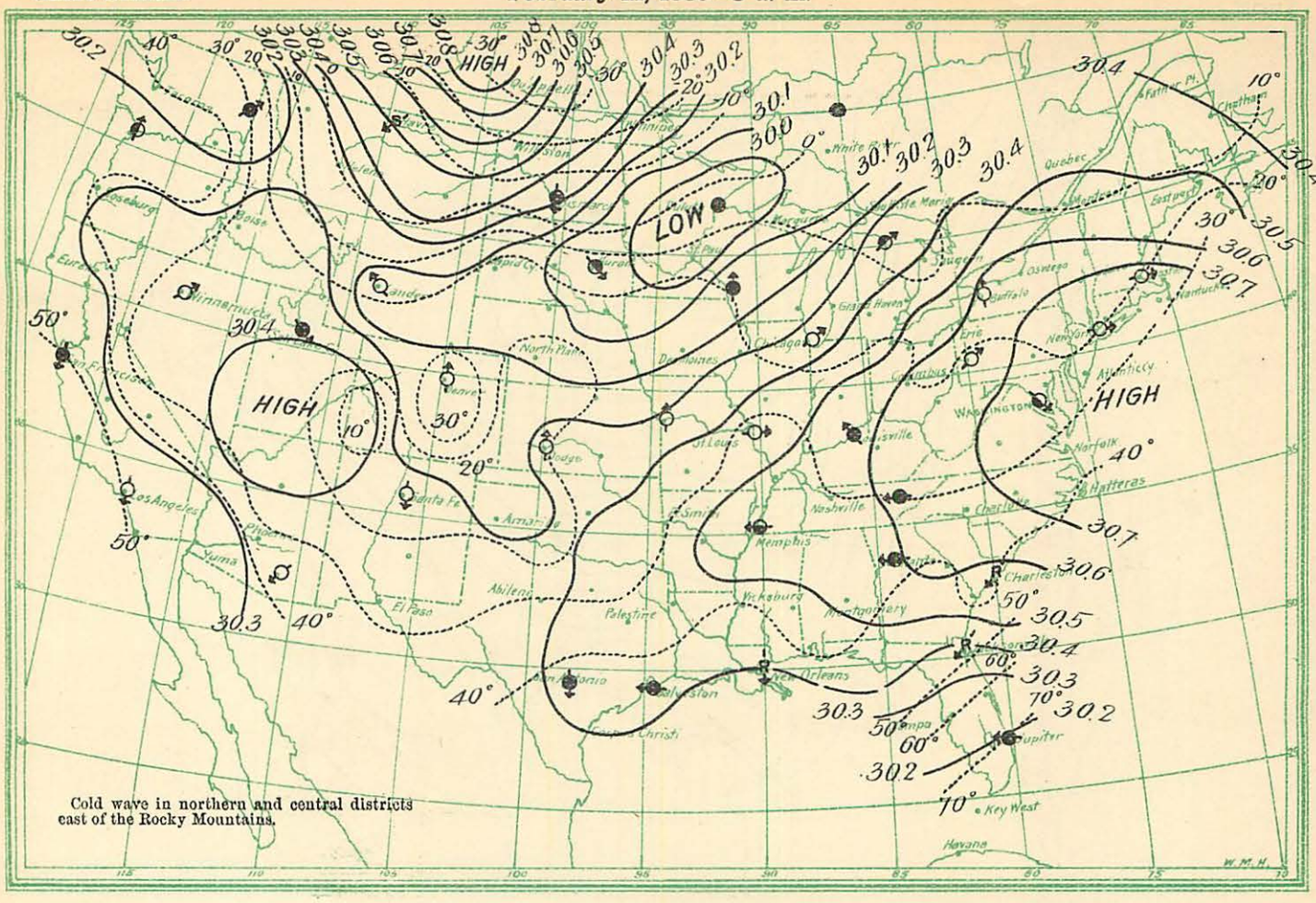


Chart CLXX. February 22, 1889—8 a. m.

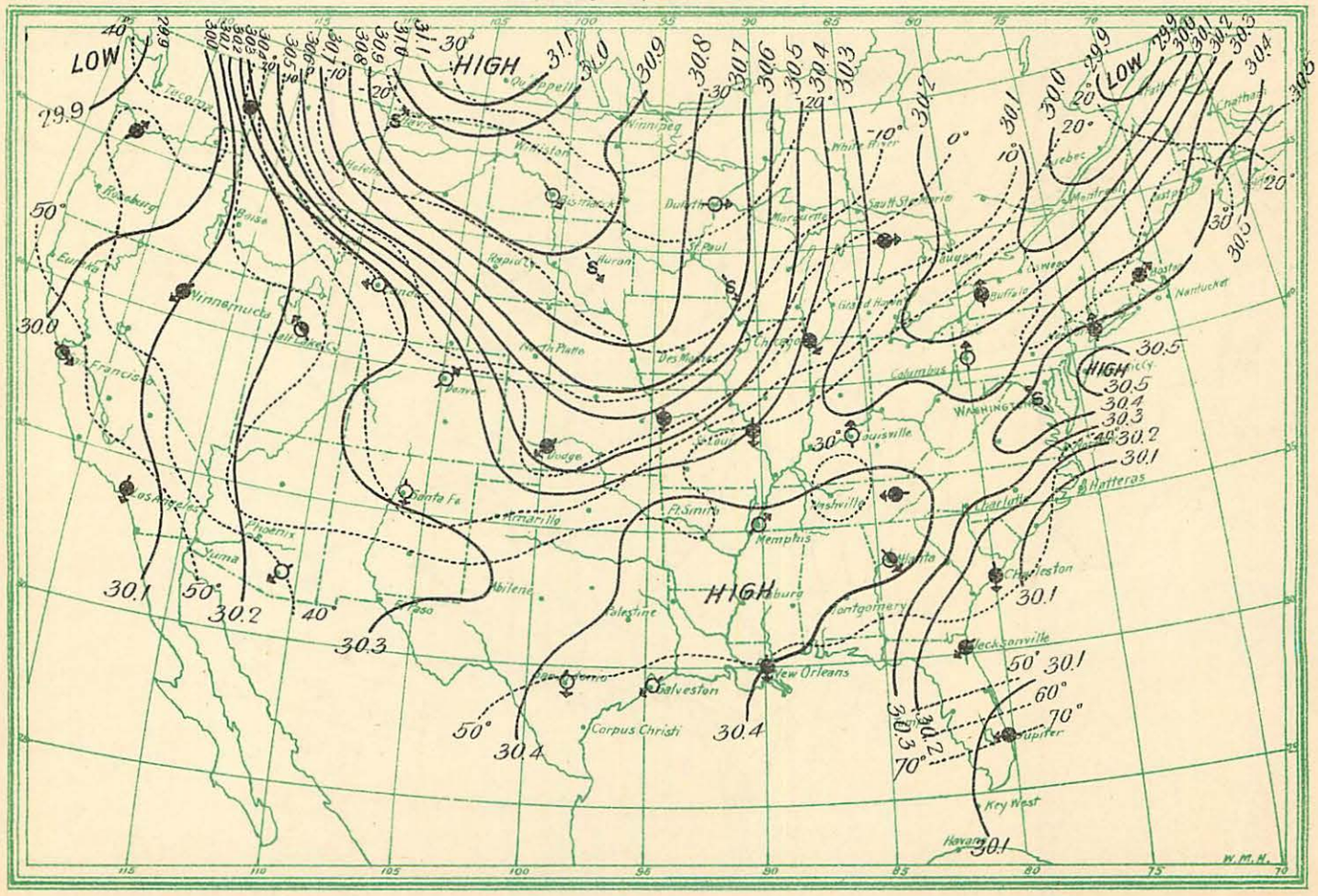


Chart CLXXI. February 23, 1889—8 a. m.

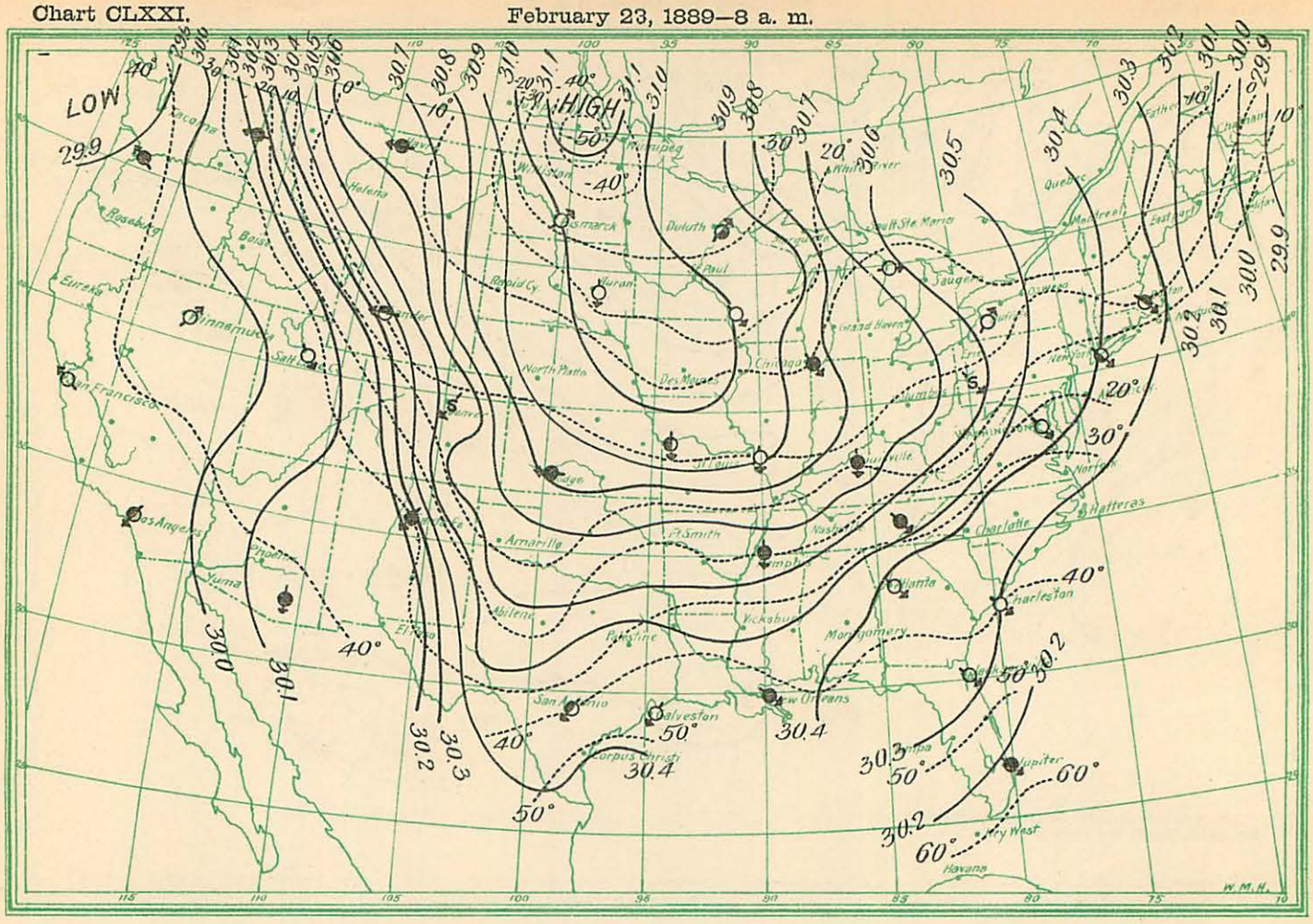


Chart CLXXII. February 24, 1889—8 a. m.

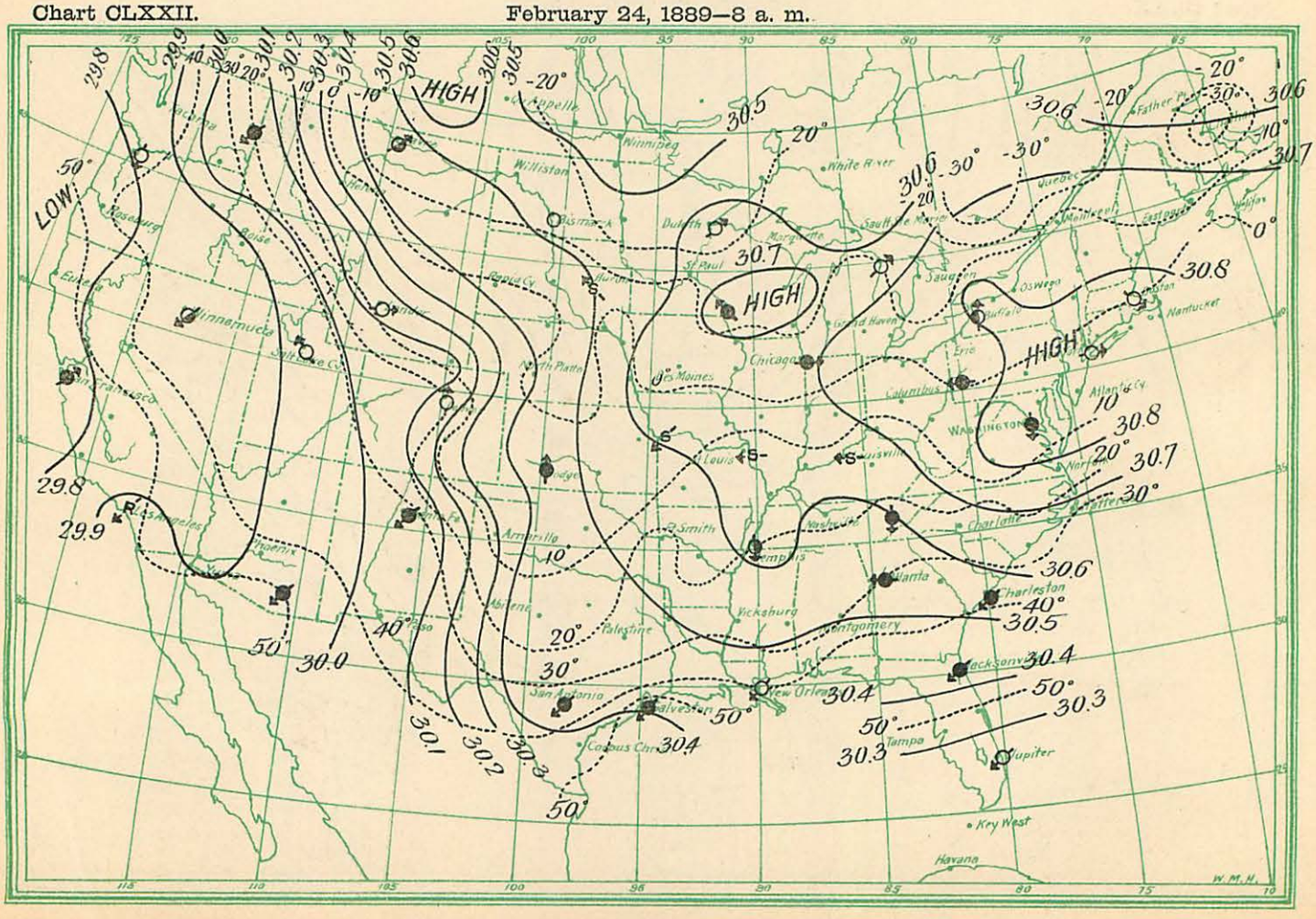


Chart CLXXIII. February 25, 1890—8 a. m.

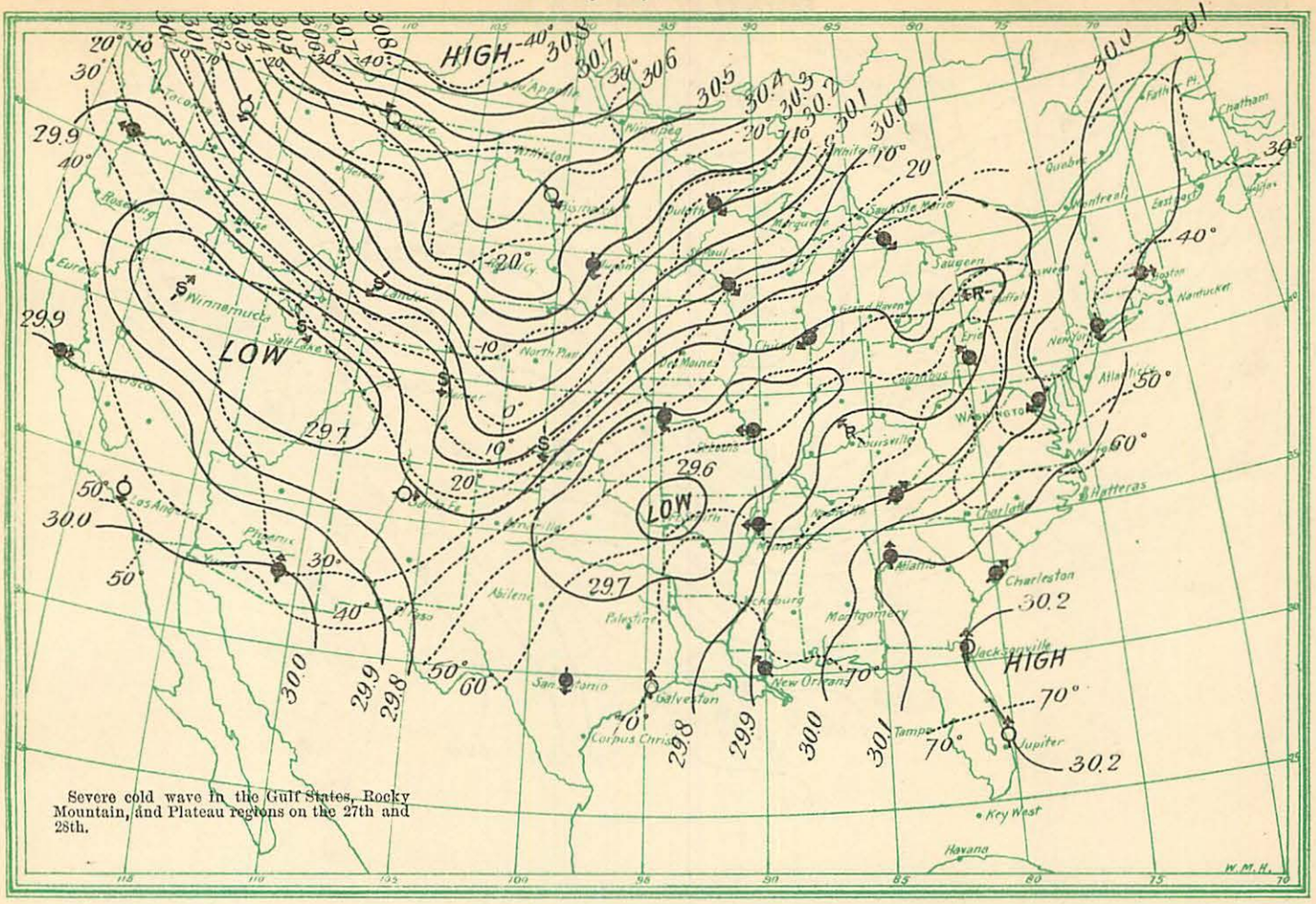


Chart CLXXIV. February 26, 1890—8 a. m.

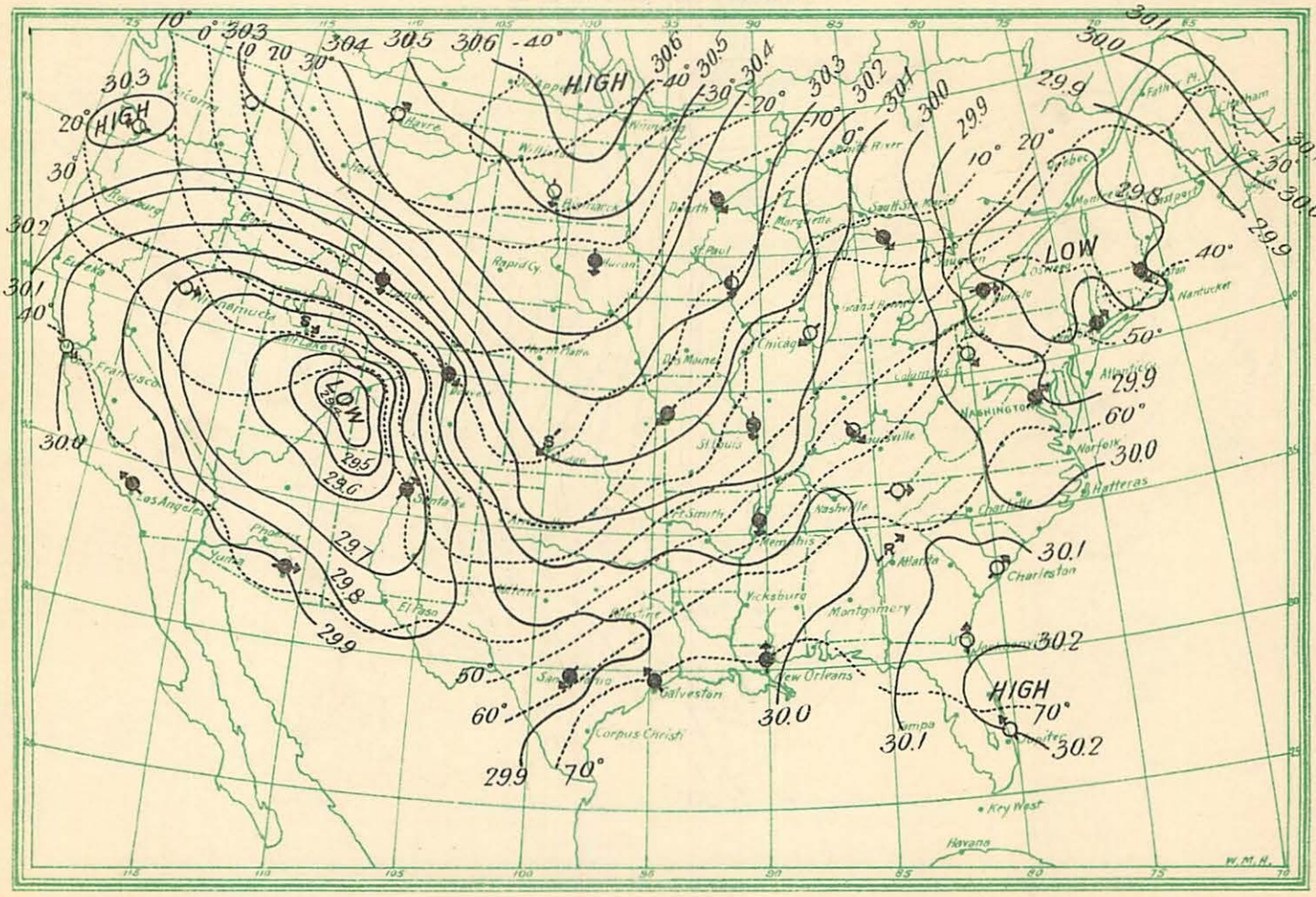


Chart CLXXV. February 27, 1890—8 a. m.

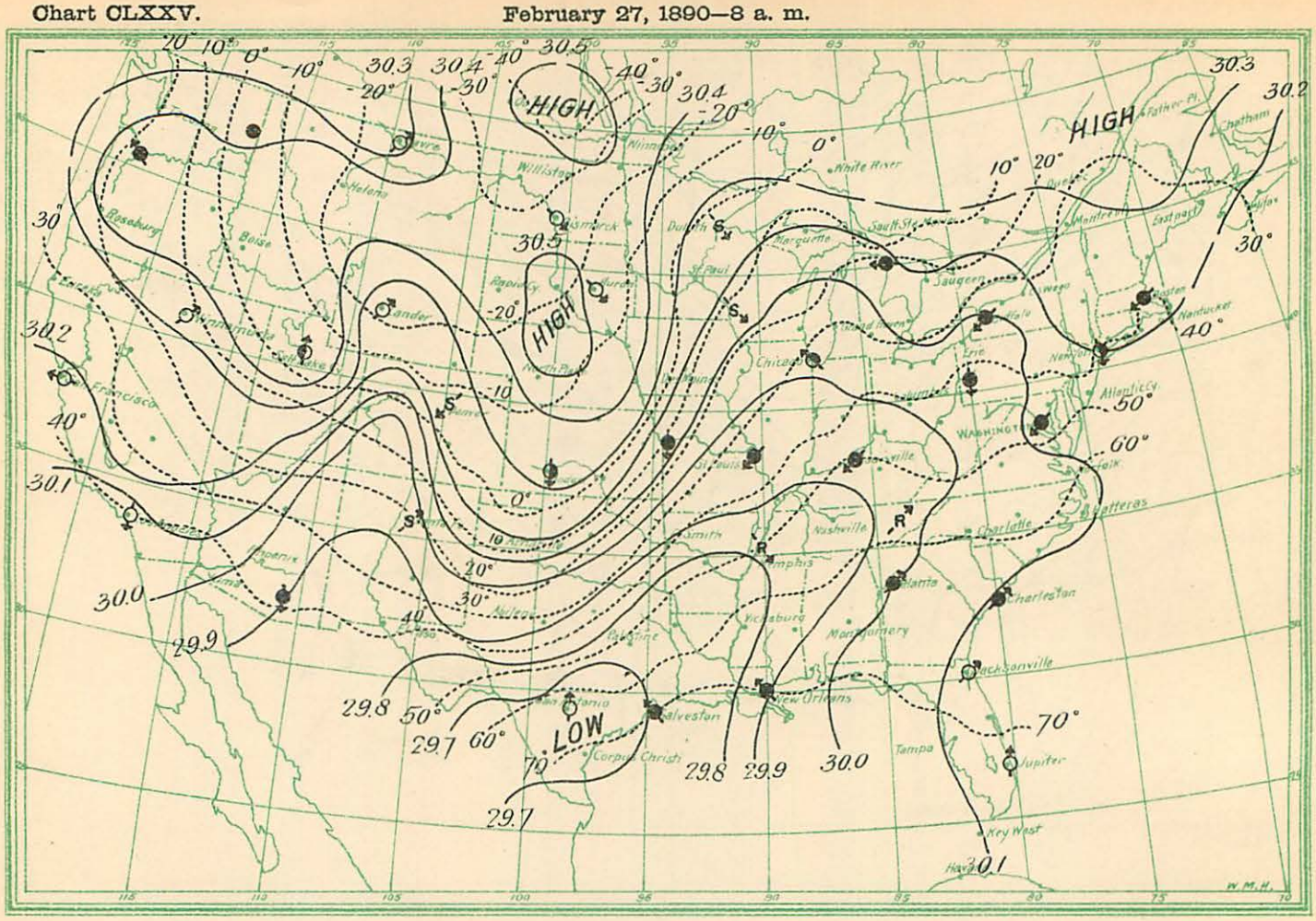


Chart CLXXVI. February 28, 1890—8 a. m.

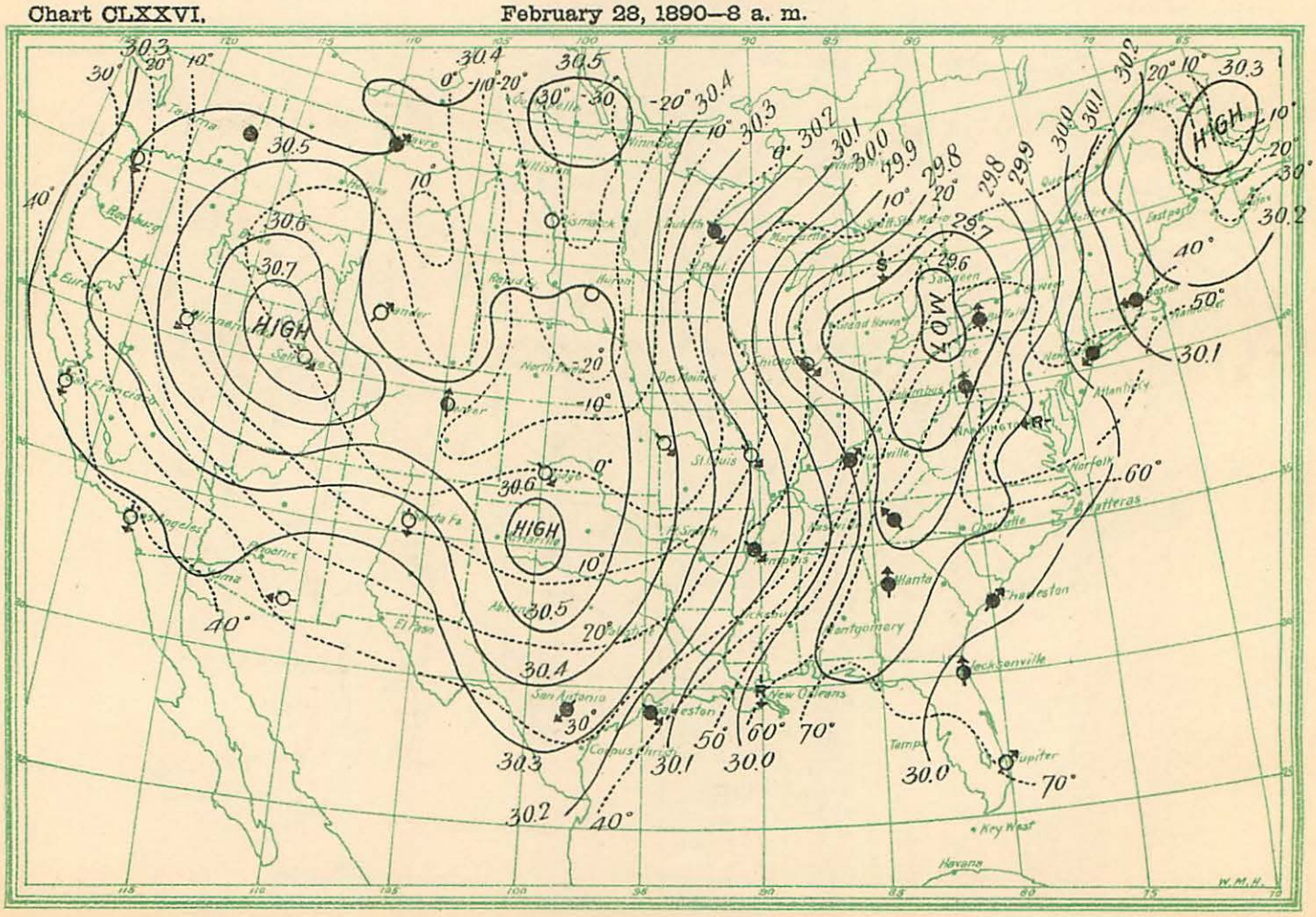


Chart CLXXVII. February 24, 1891—8 a. m.

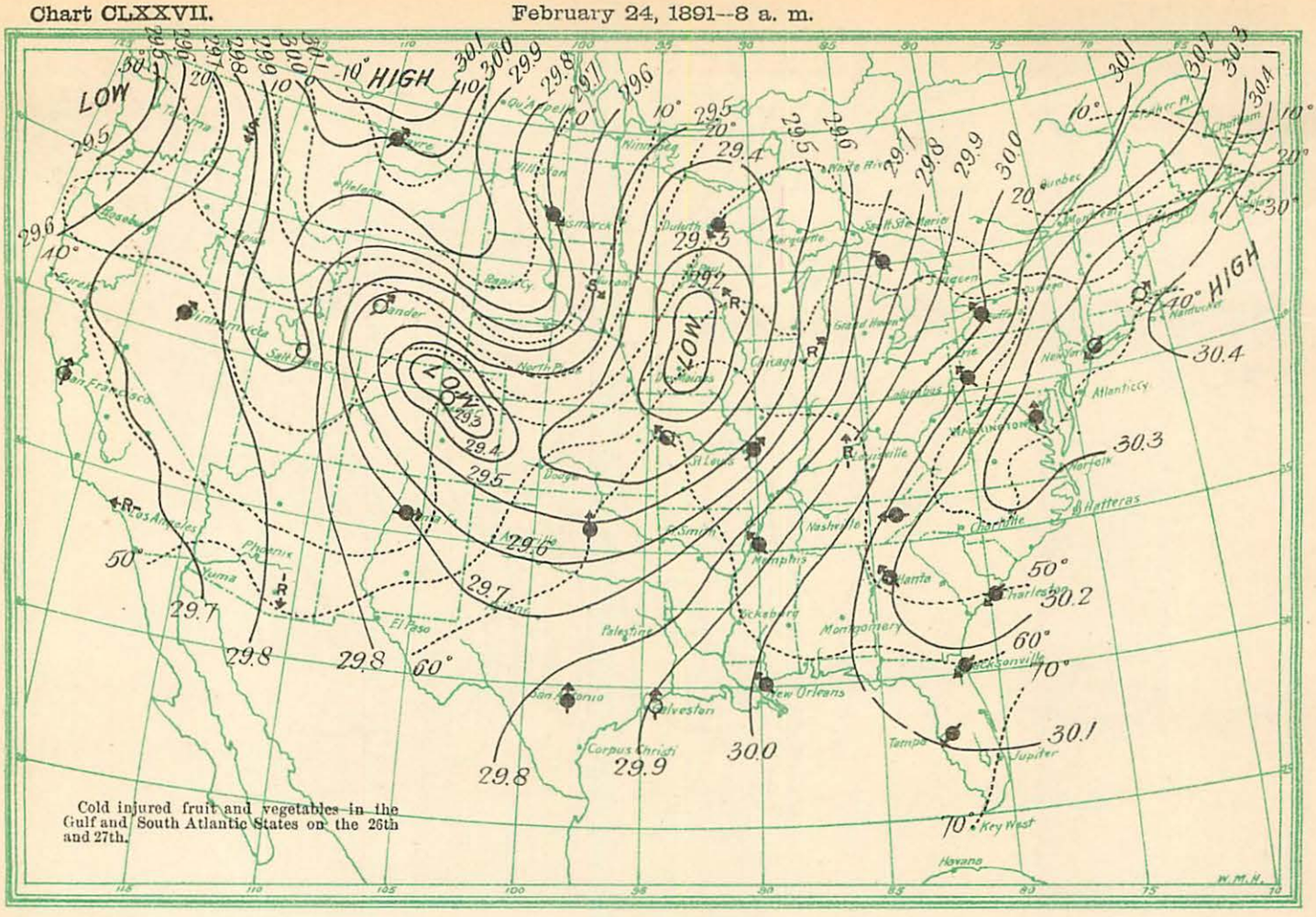


Chart CLXXVIII. February 25, 1891—8 a. m.

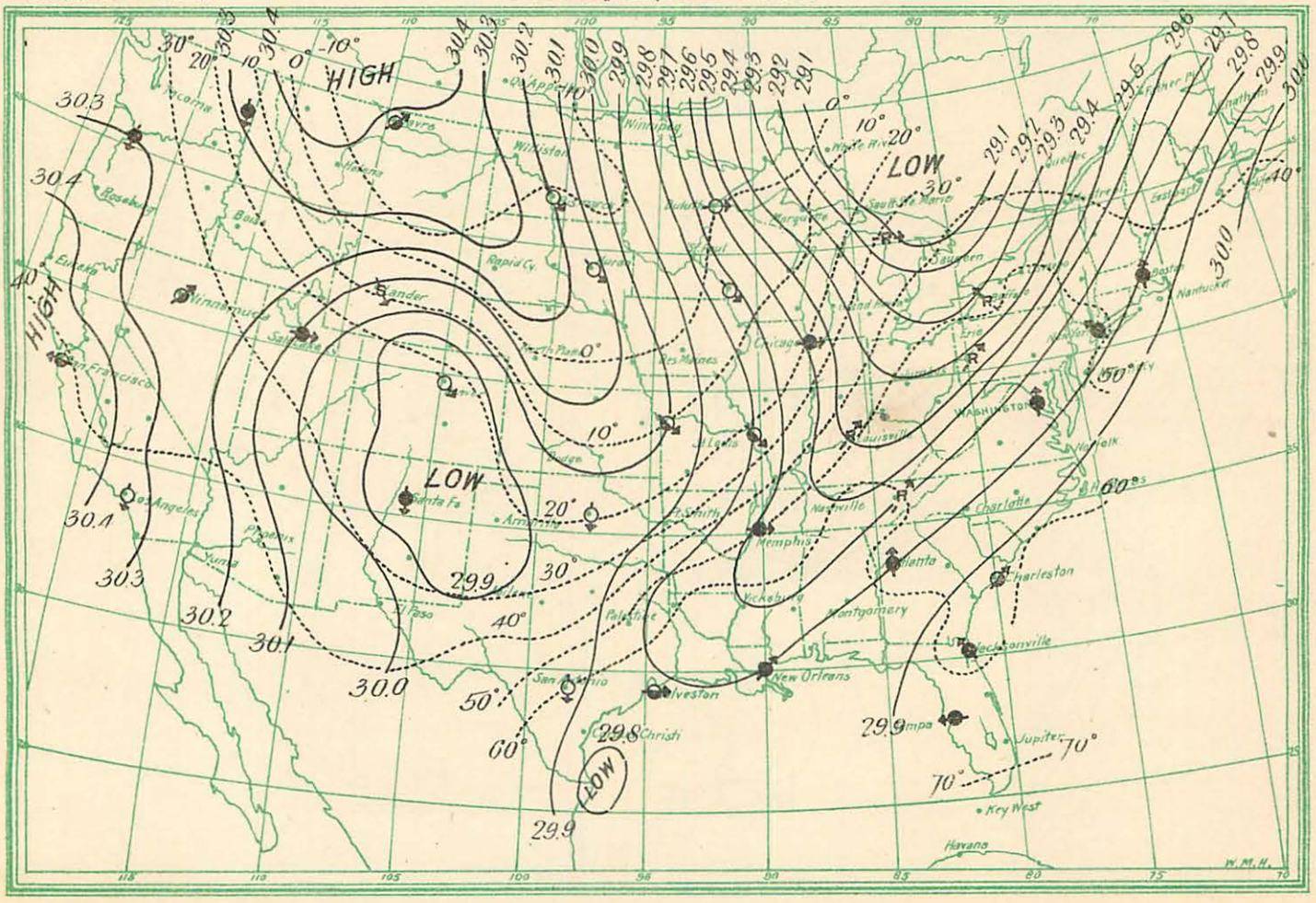


Chart CLXXIX. February 26, 1891—8 a. m.

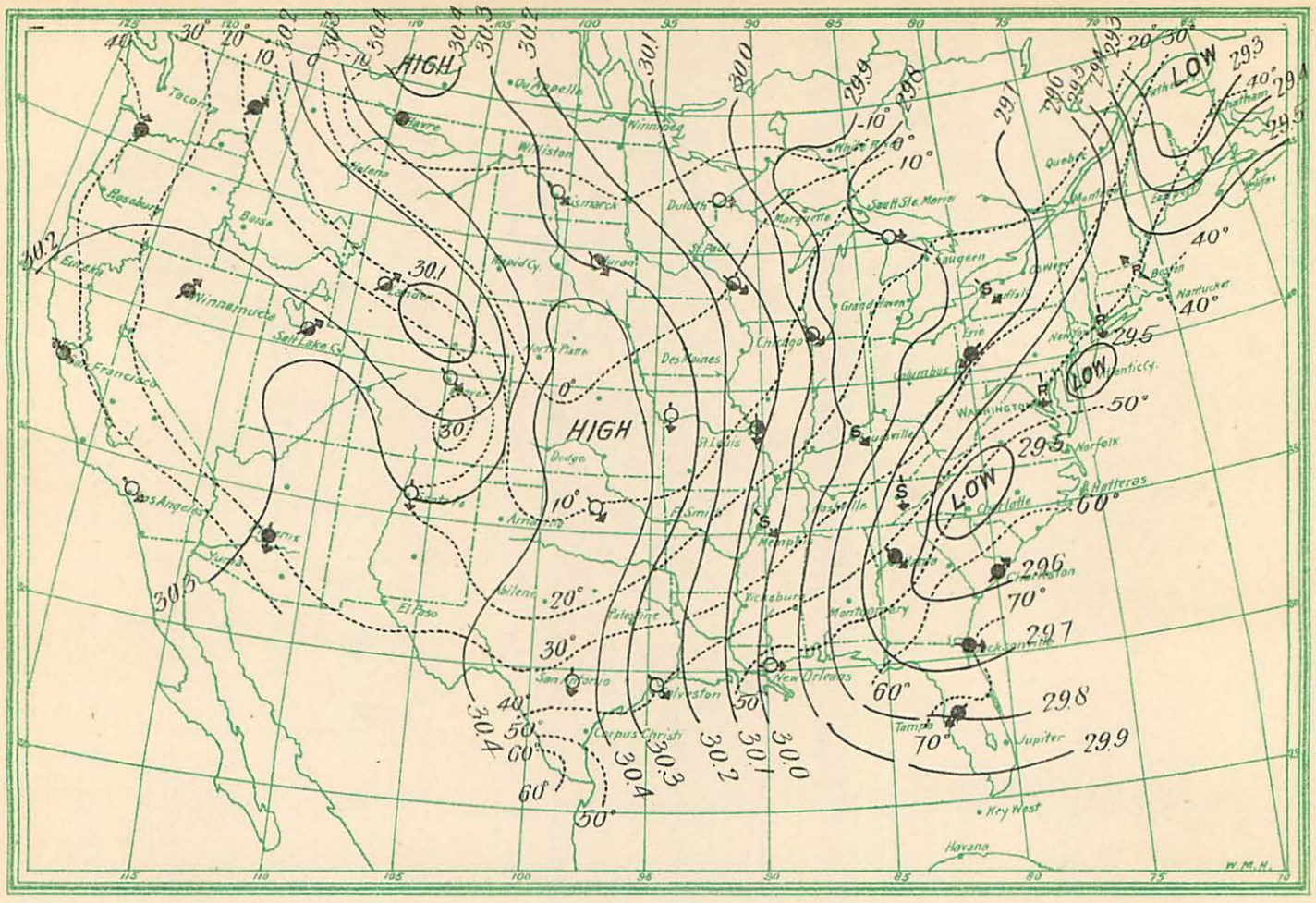


Chart CLXXX. February 27, 1891—8 a. m.

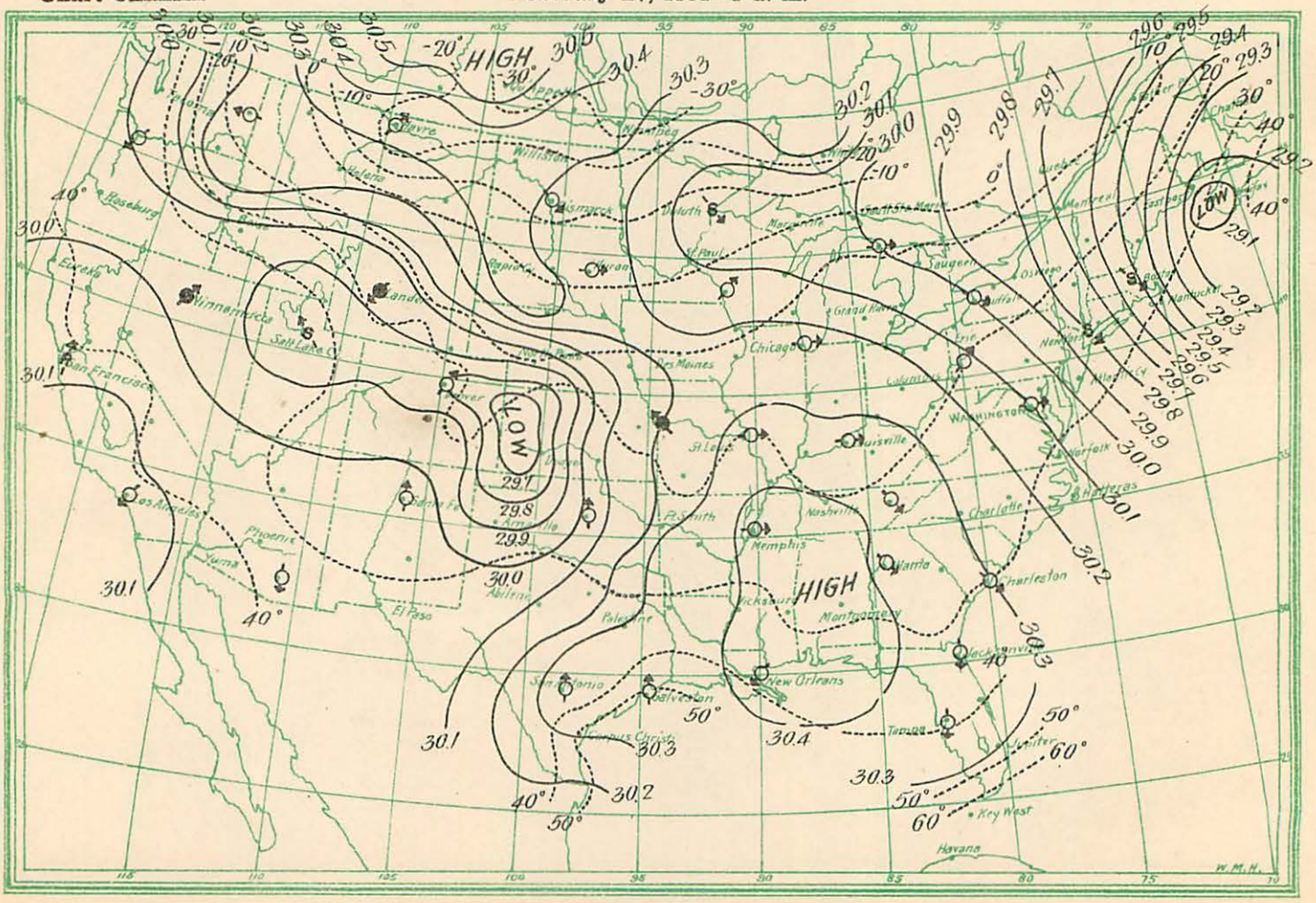


Chart CLXXXI. February 13, 1892—8 a. m.

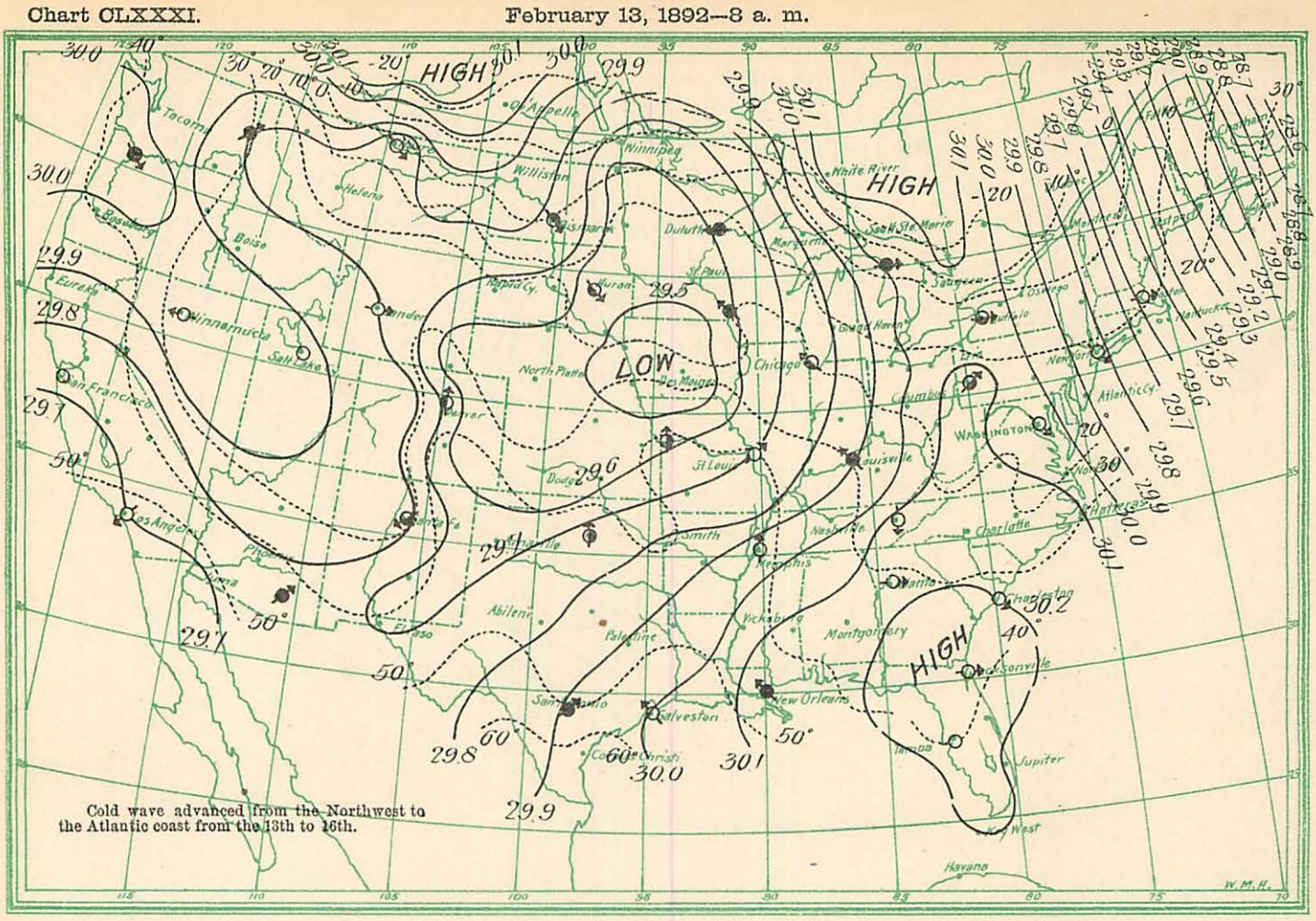


Chart CLXXXII. February 14, 1892—8 a. m.

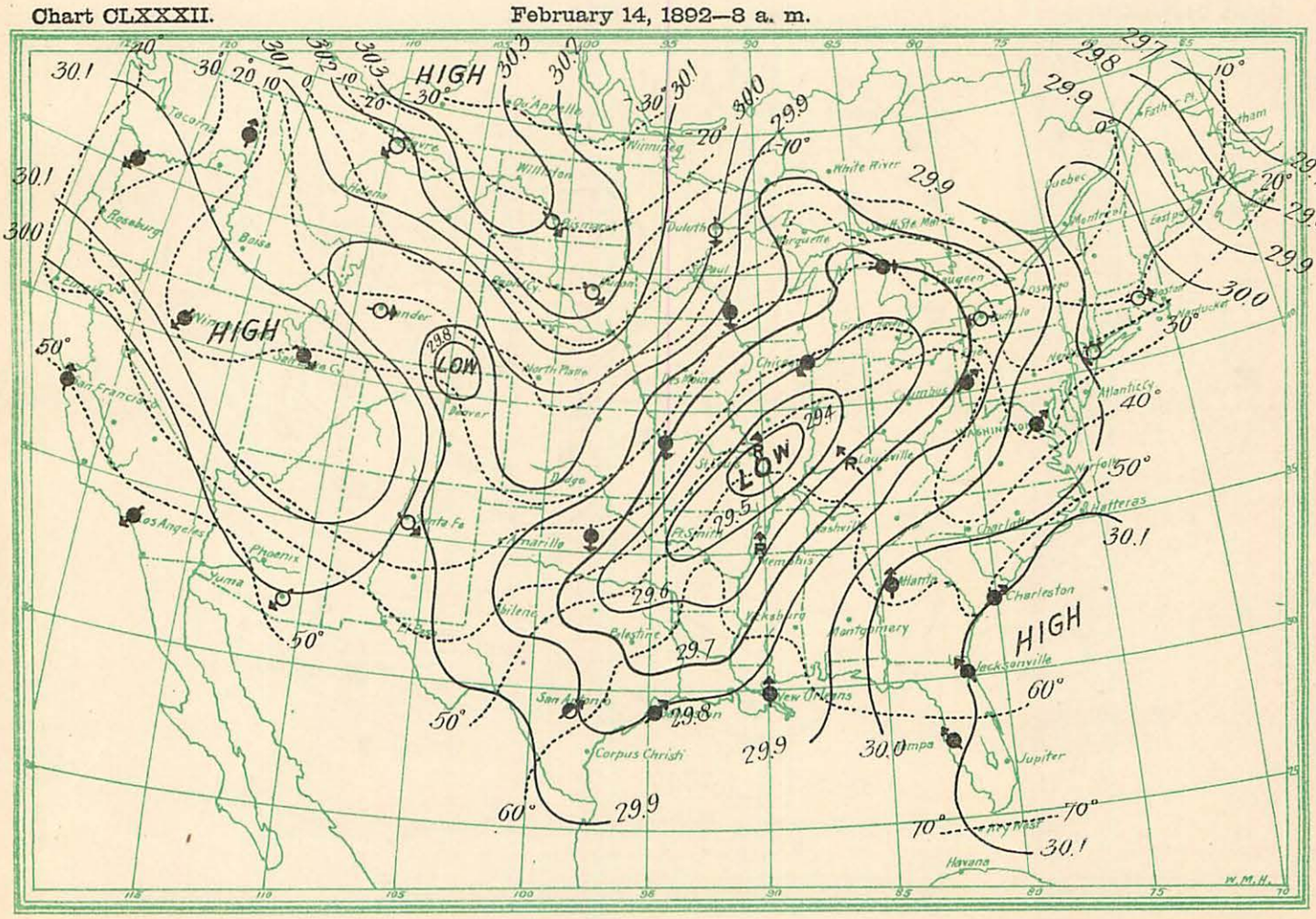


Chart CLXXXIII. February 15, 1892—8 a. m.

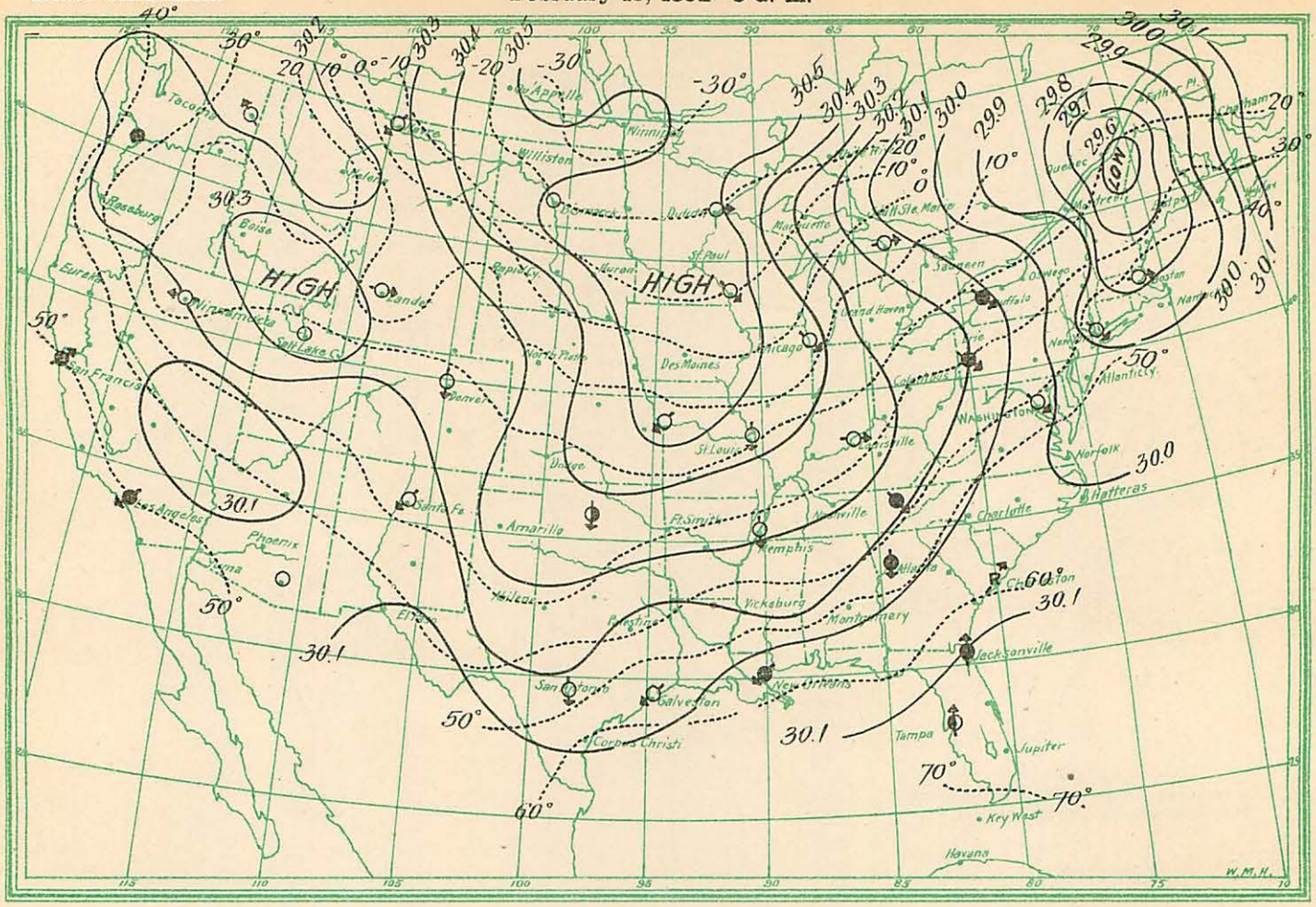


Chart CLXXXIV. February 16, 1892—8 a. m.

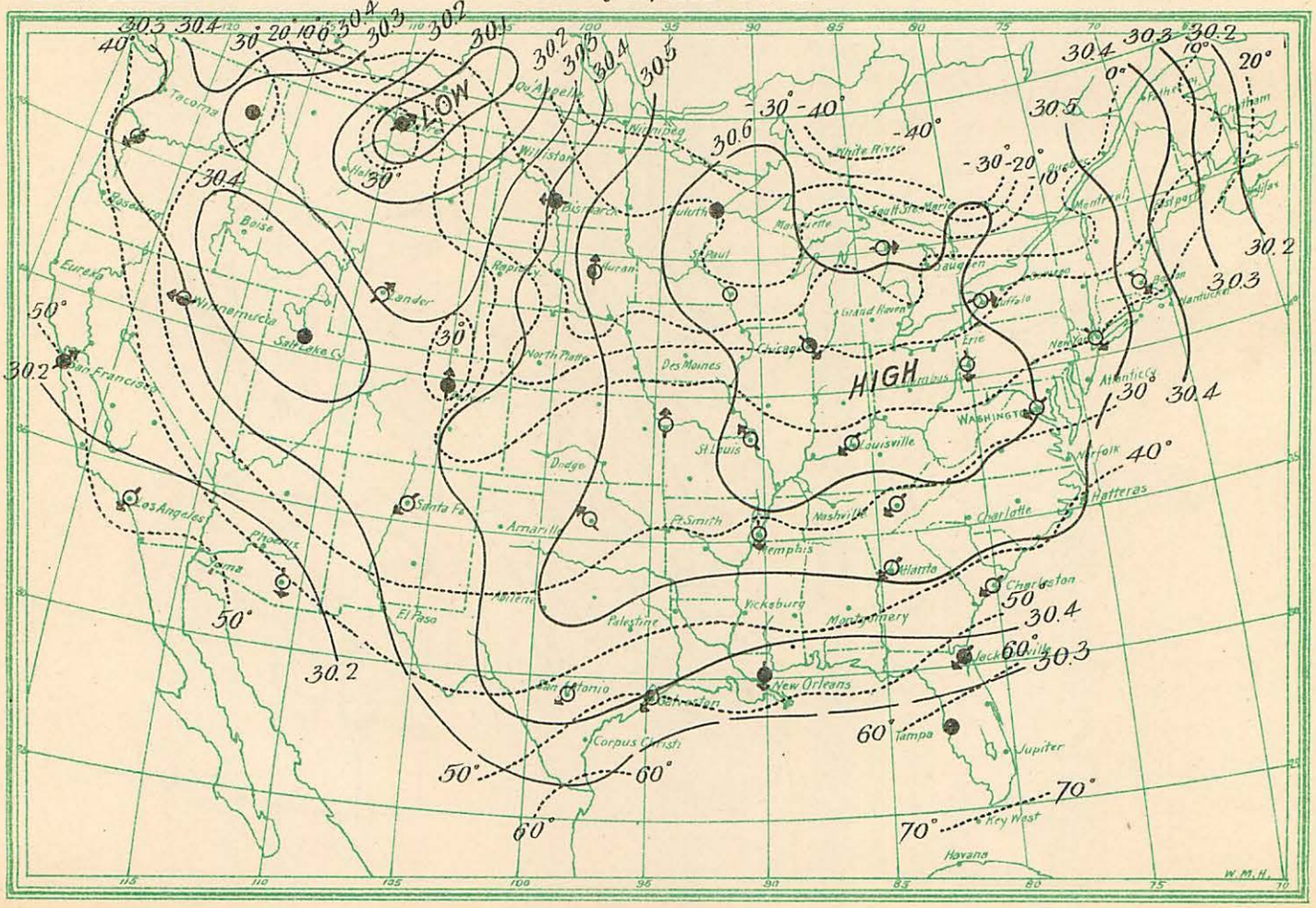


Chart CLXXXV. February 5, 1893—8 a. m.

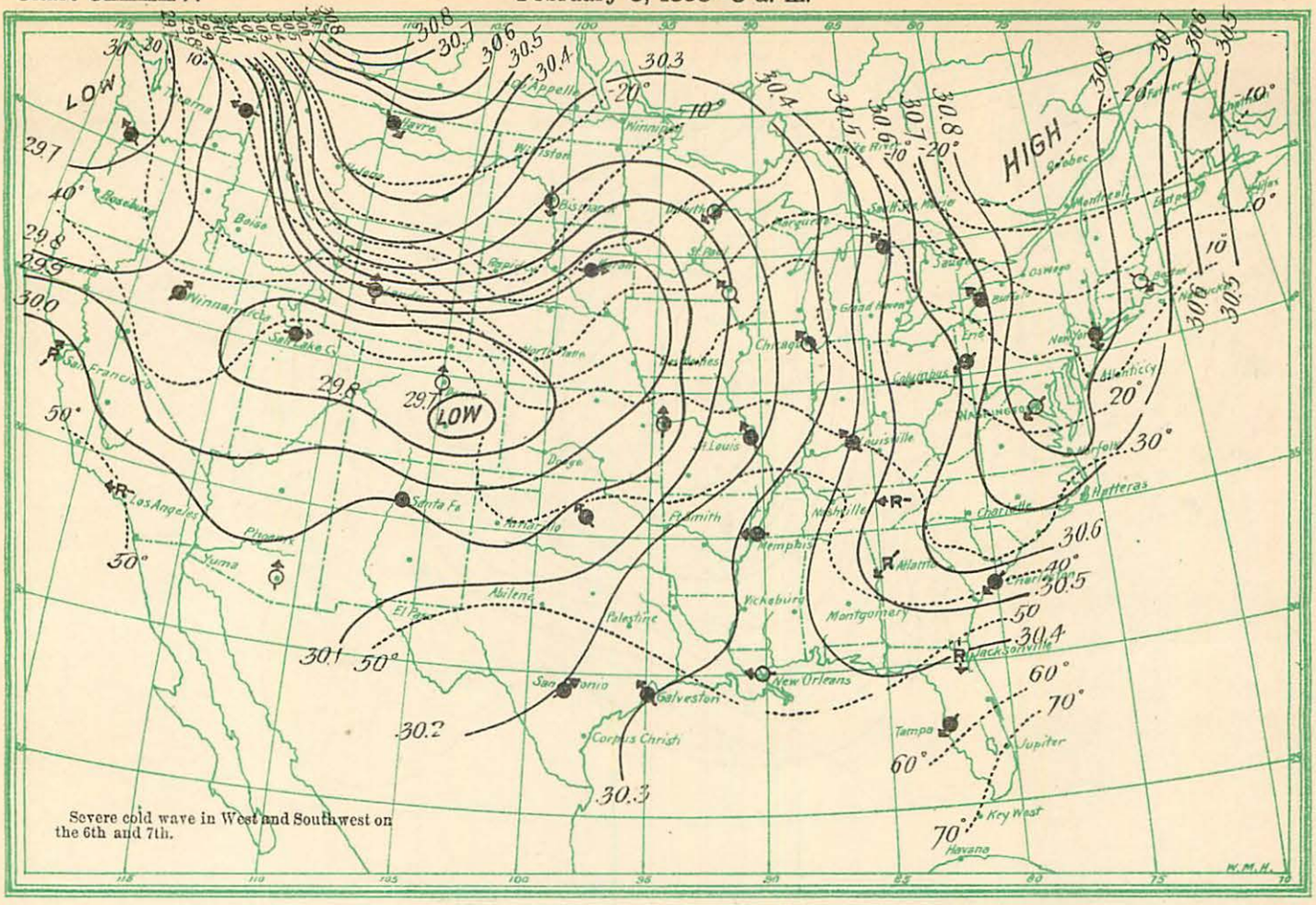


Chart CLXXXVI. February 6, 1893—8 a. m.

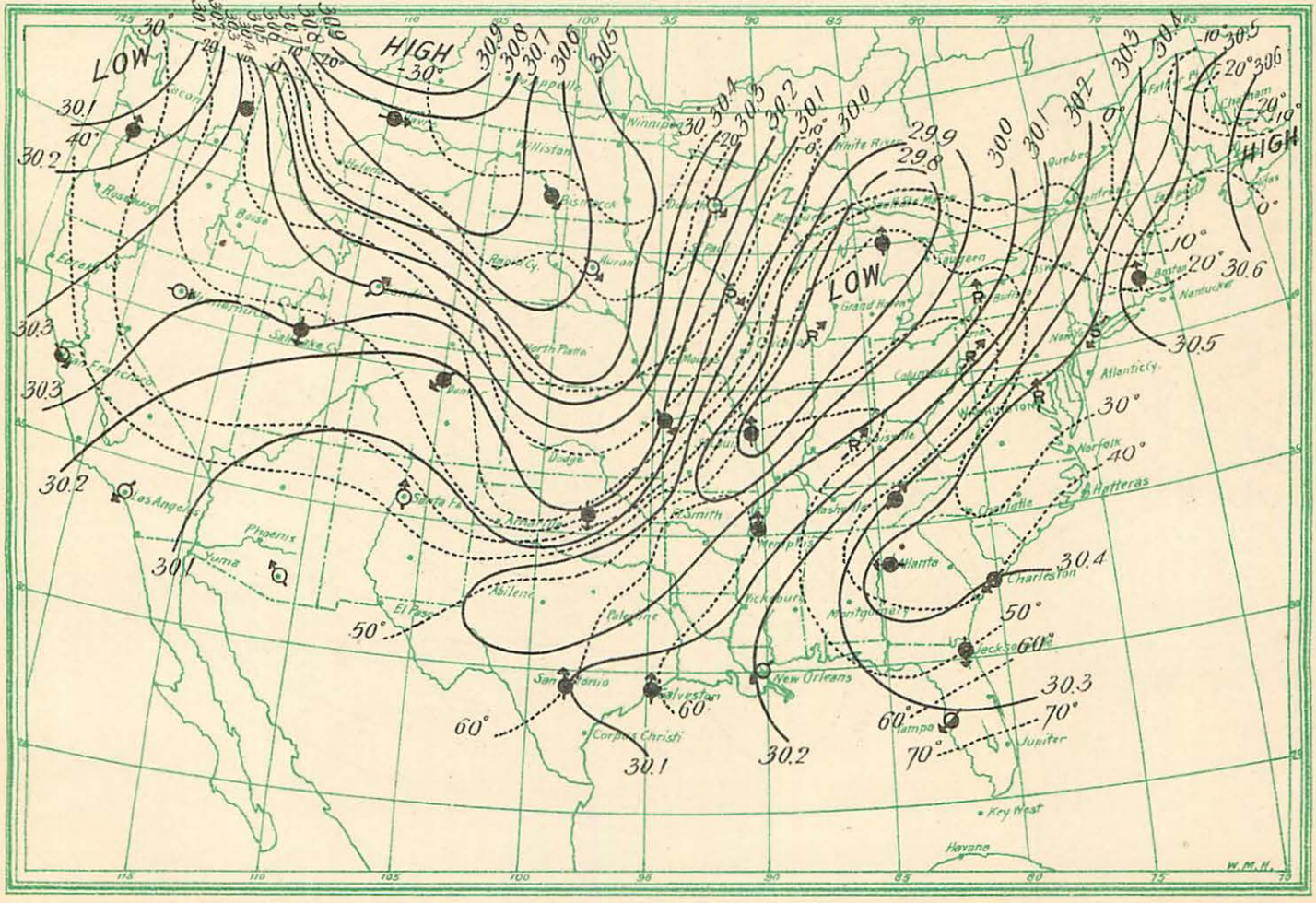


Chart CLXXXVII. February 7, 1893—8 a. m.

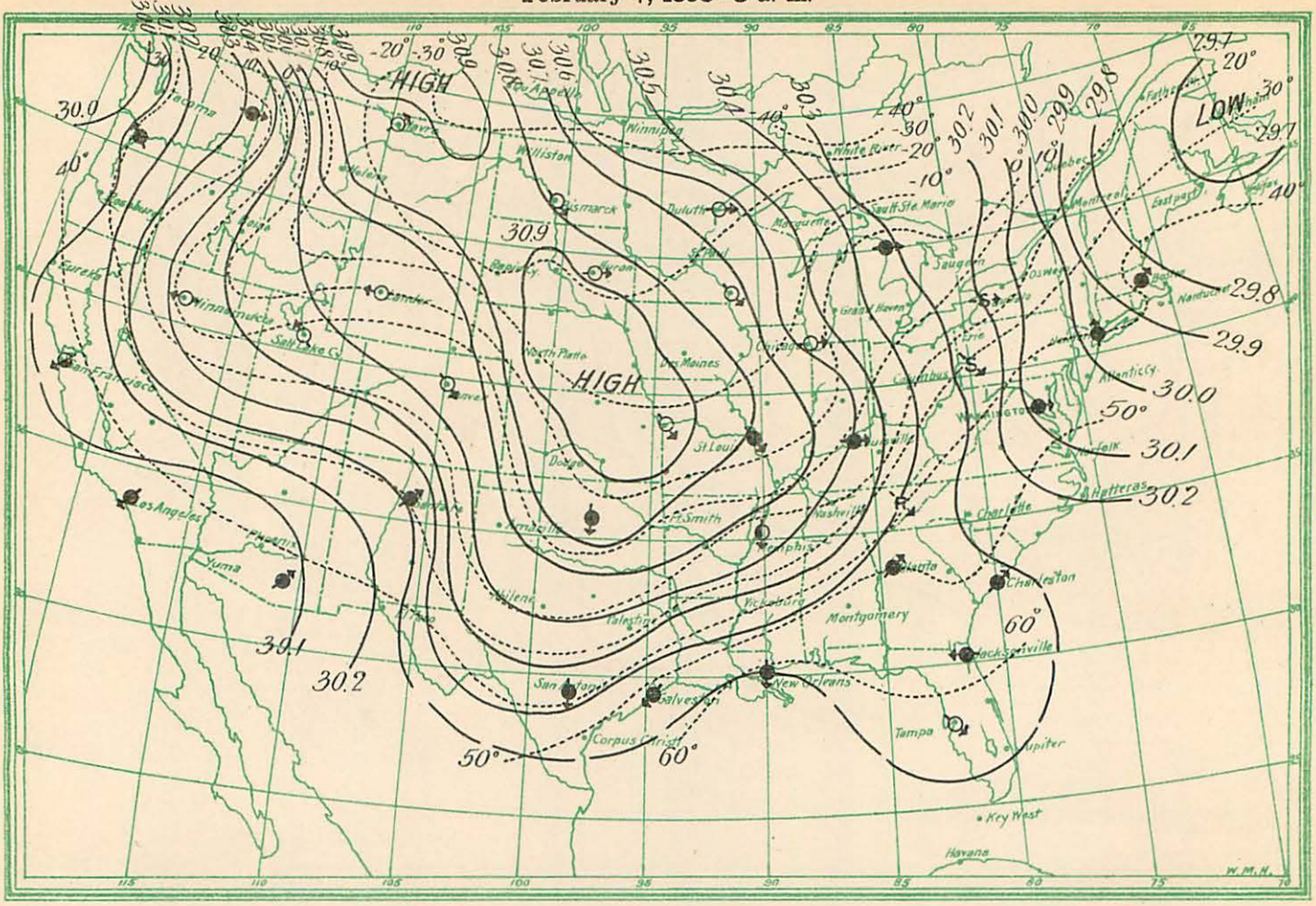


Chart CLXXXVIII. February 8, 1893—8 a. m.

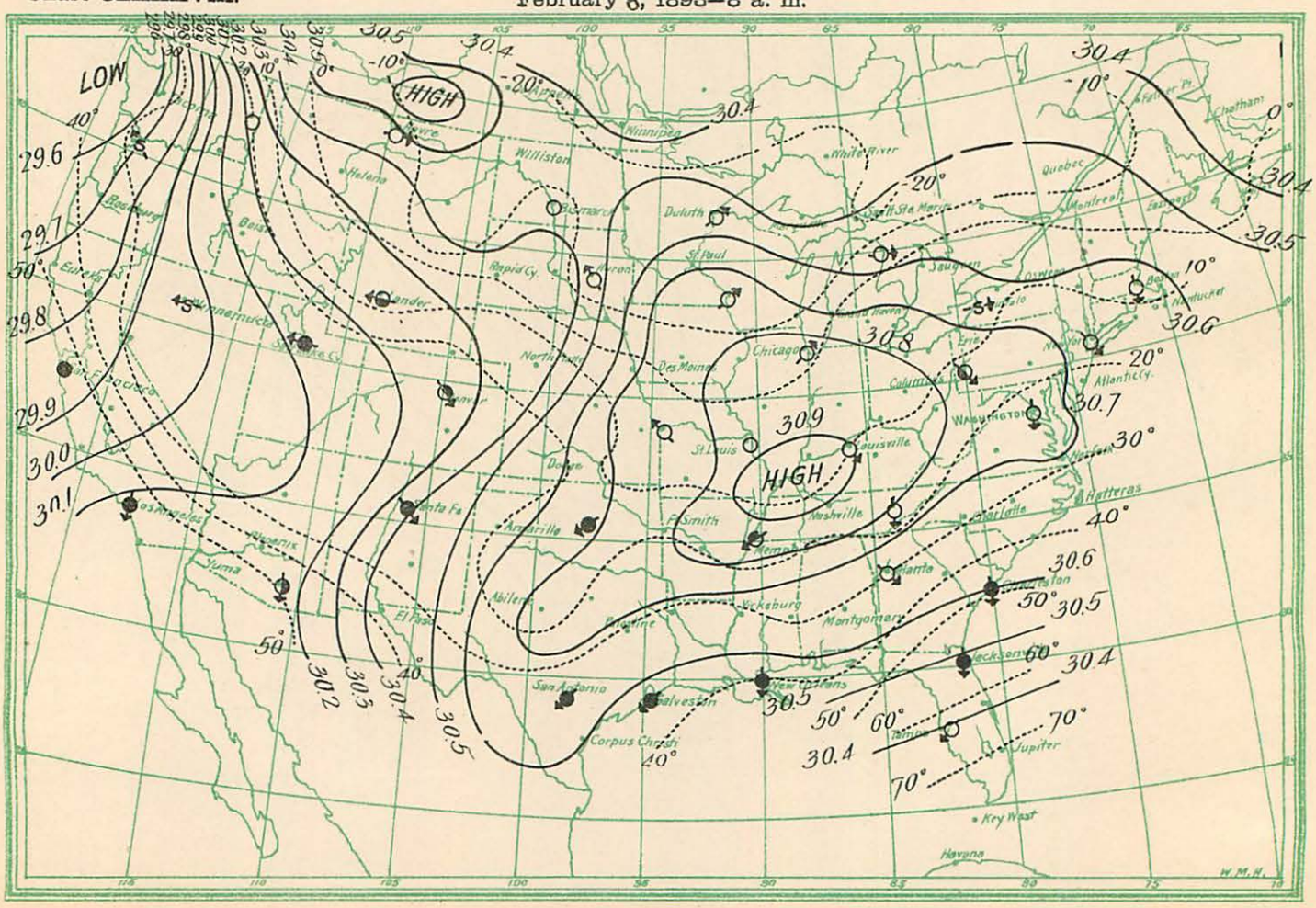


Chart CLXXXIX. February 9, 1894—8 a. m.

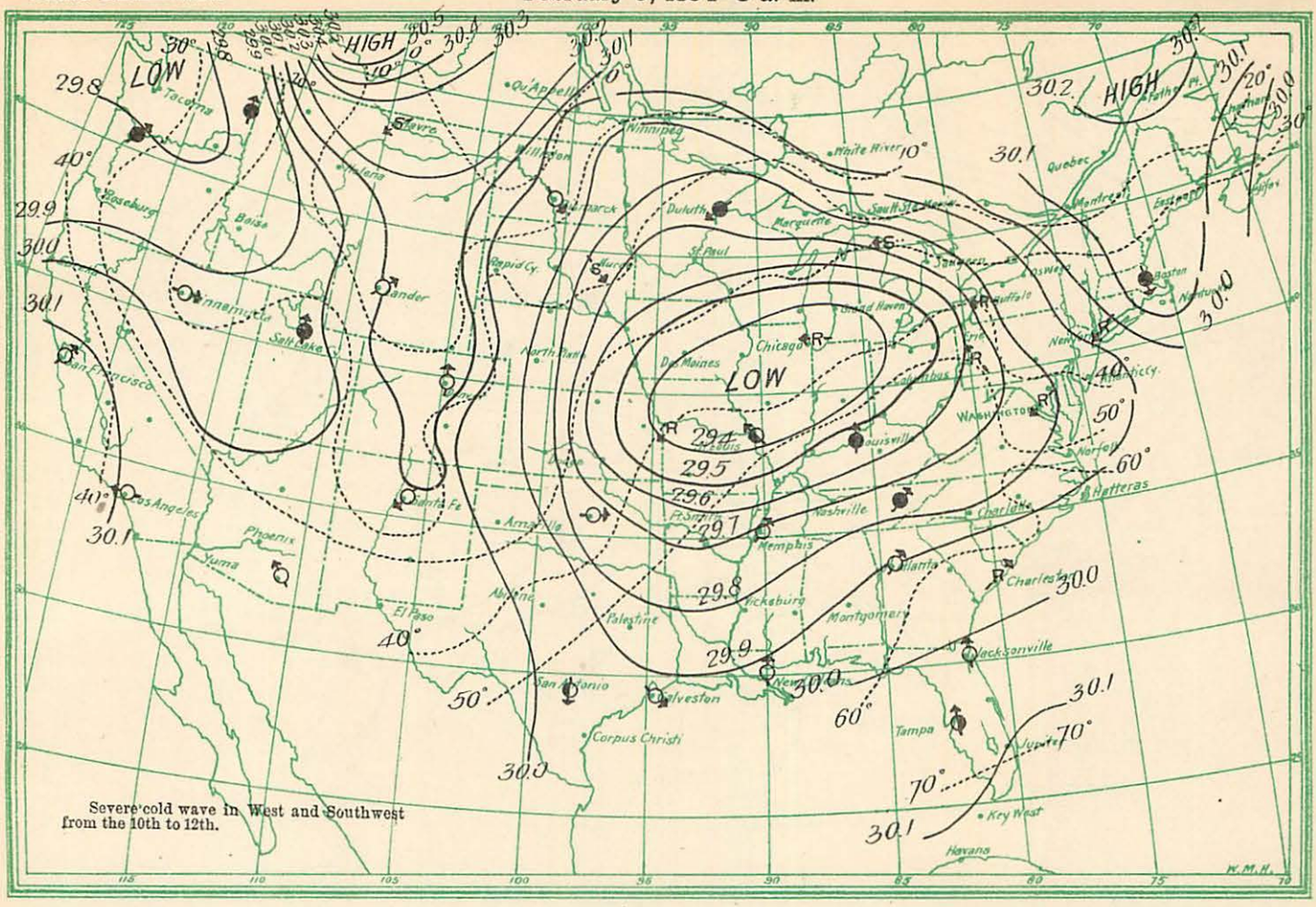


Chart CXC. February 10, 1894—8 a. m.

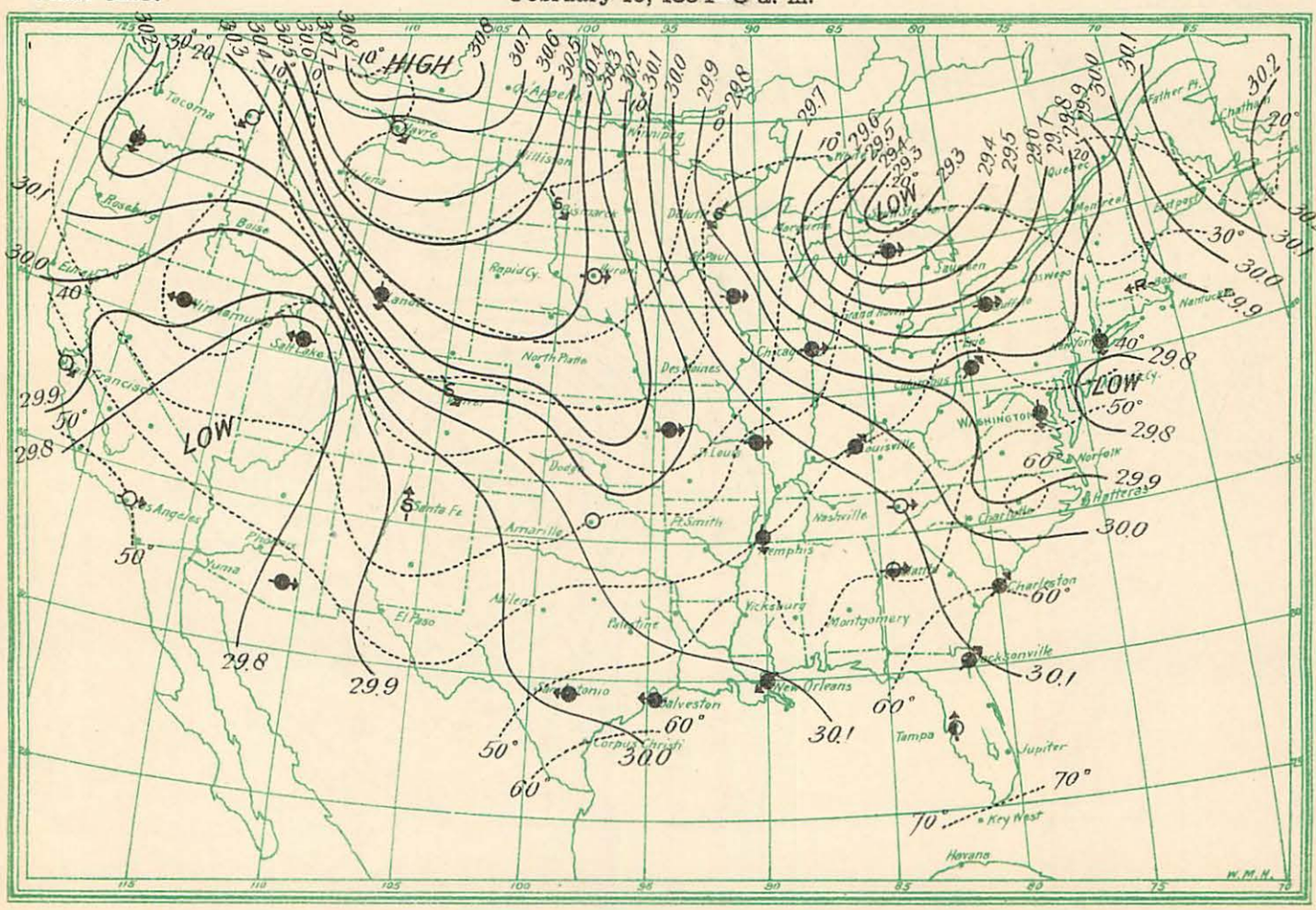


Chart CXCI. February 11, 1894—8 a. m.

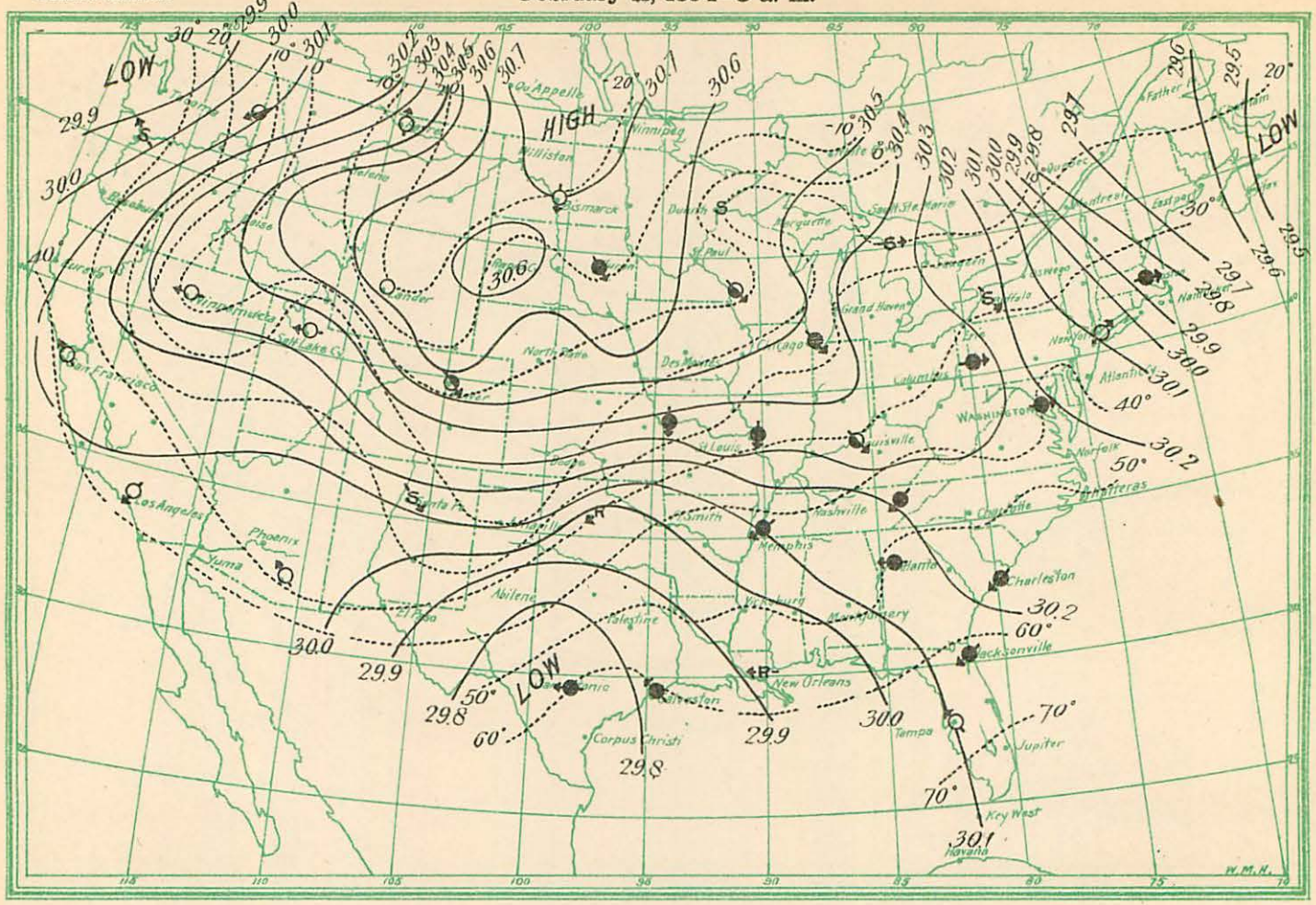


Chart CXCII. February 12, 1894—8 a. m.

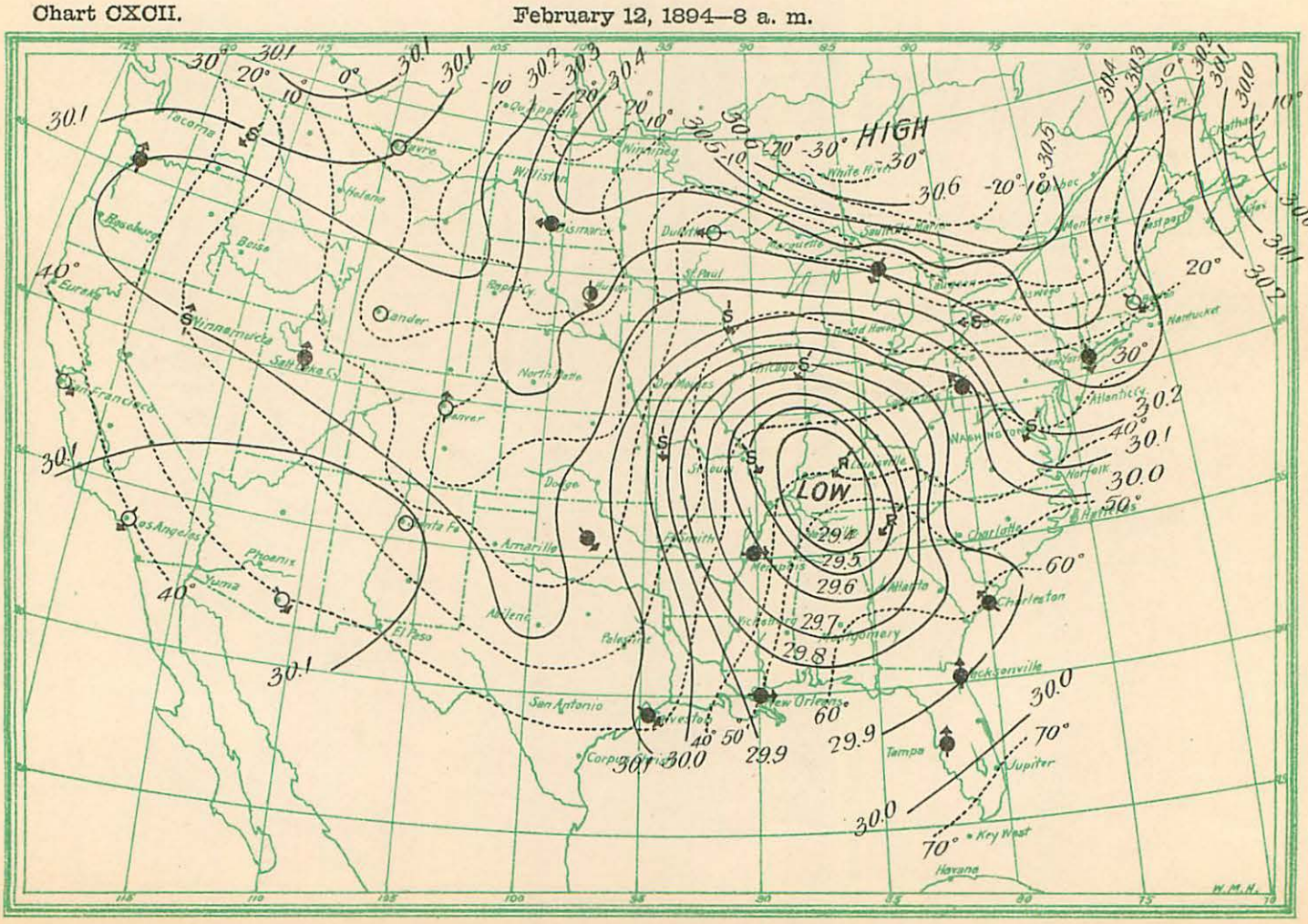


Chart CXCIII. February 5, 1895—8 a. m.

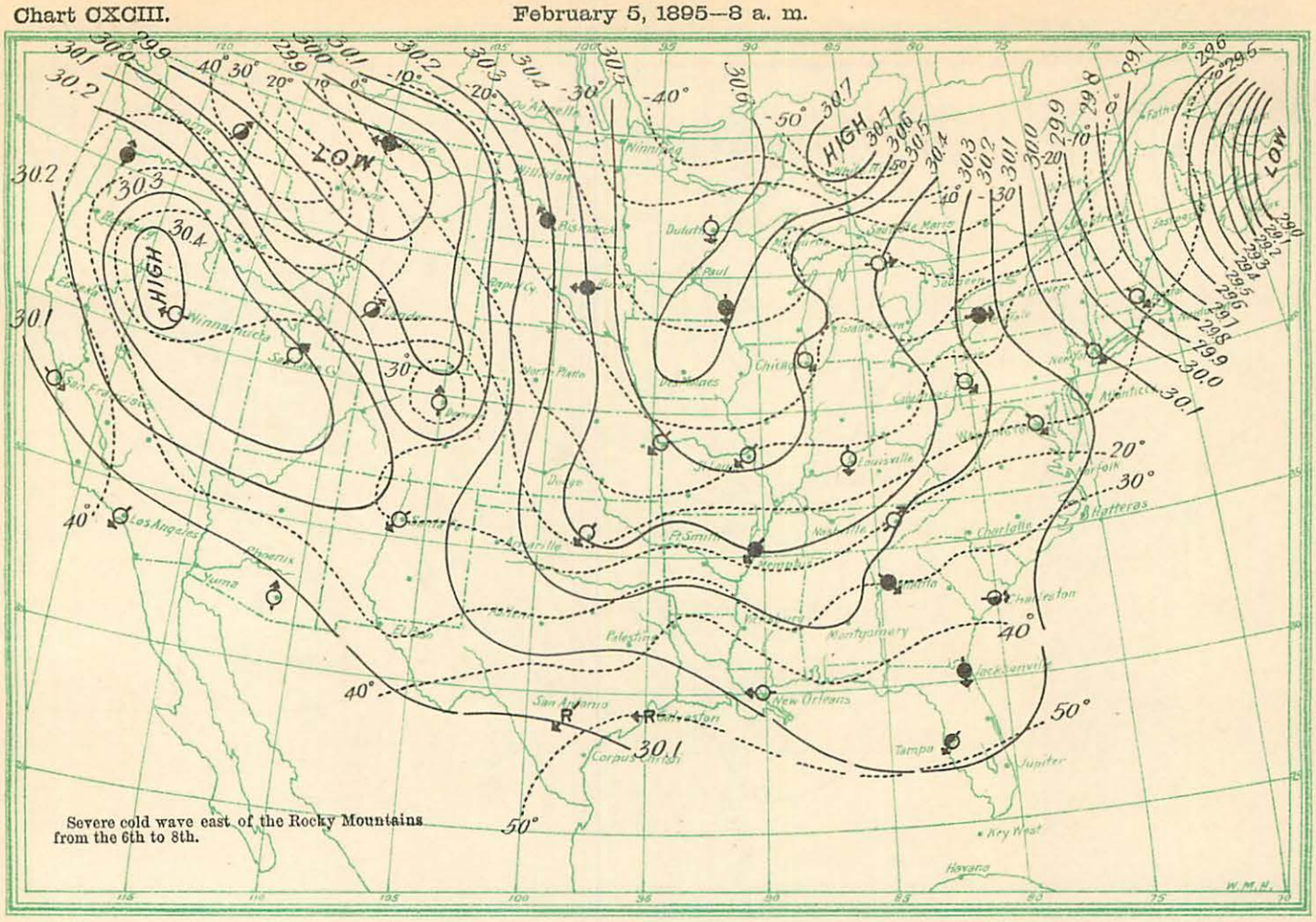


Chart CXCIV. February 6, 1895—8 a. m.

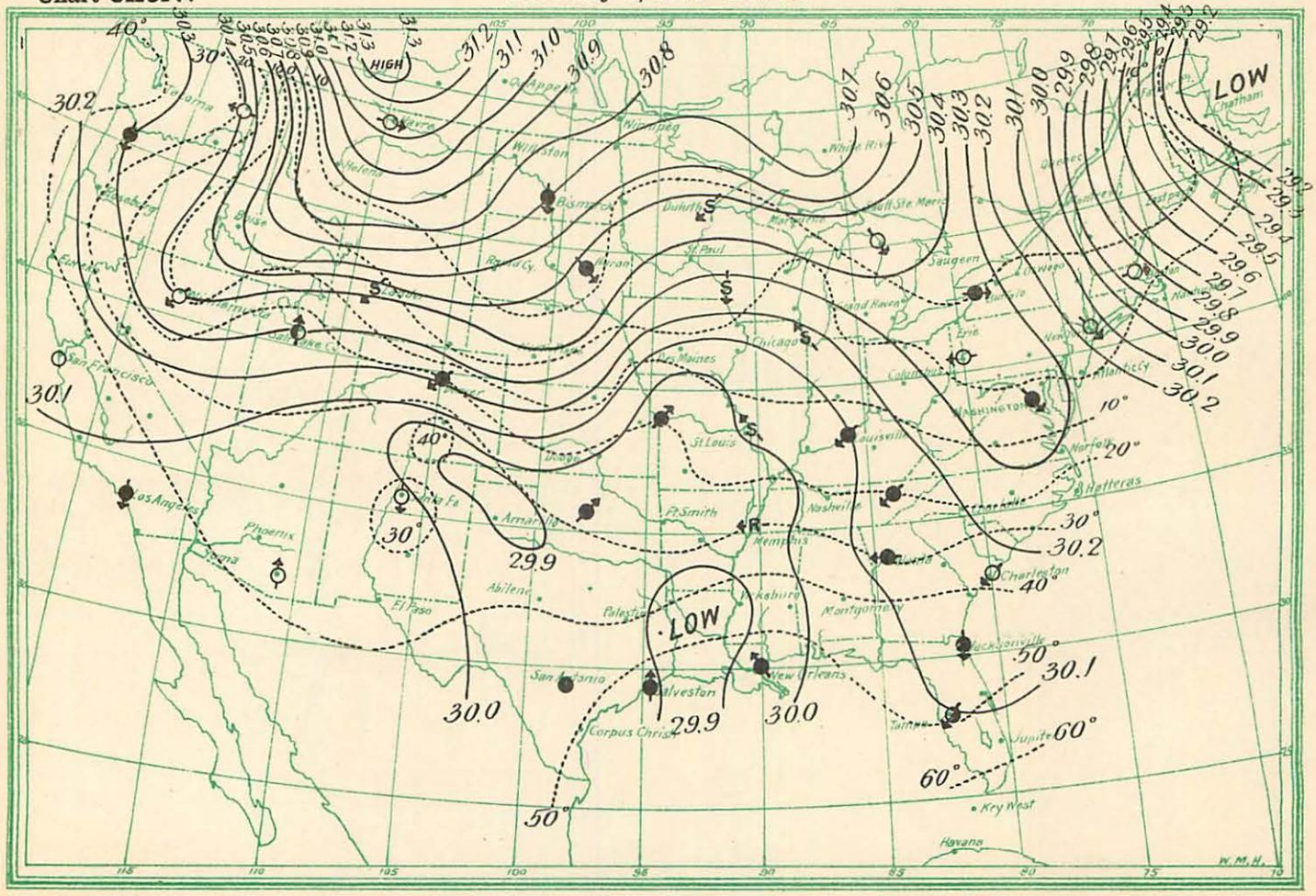


Chart CXCV. February 7, 1895—8 a. m.

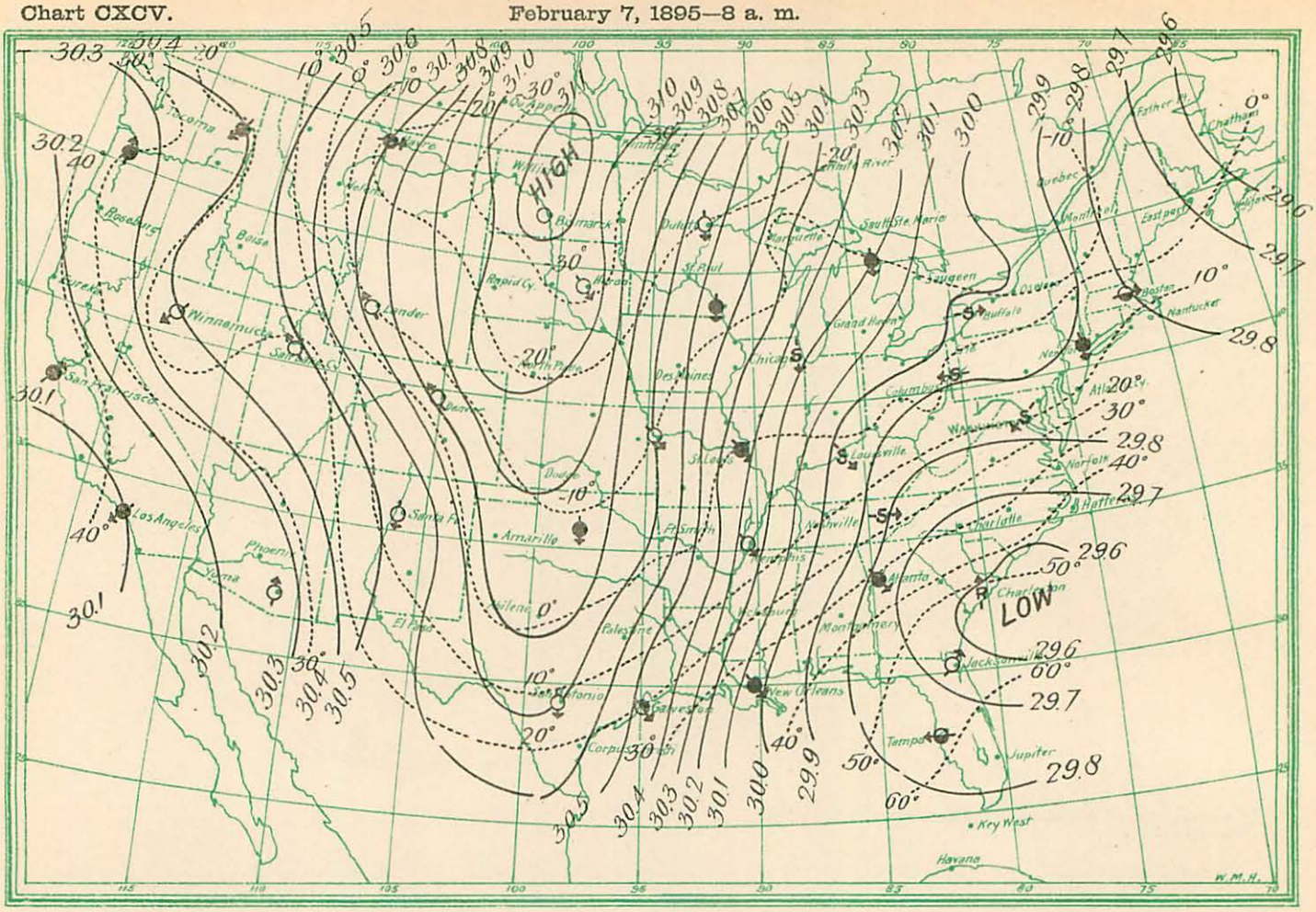


Chart CXCVI. February 8, 1895—8 a. m.

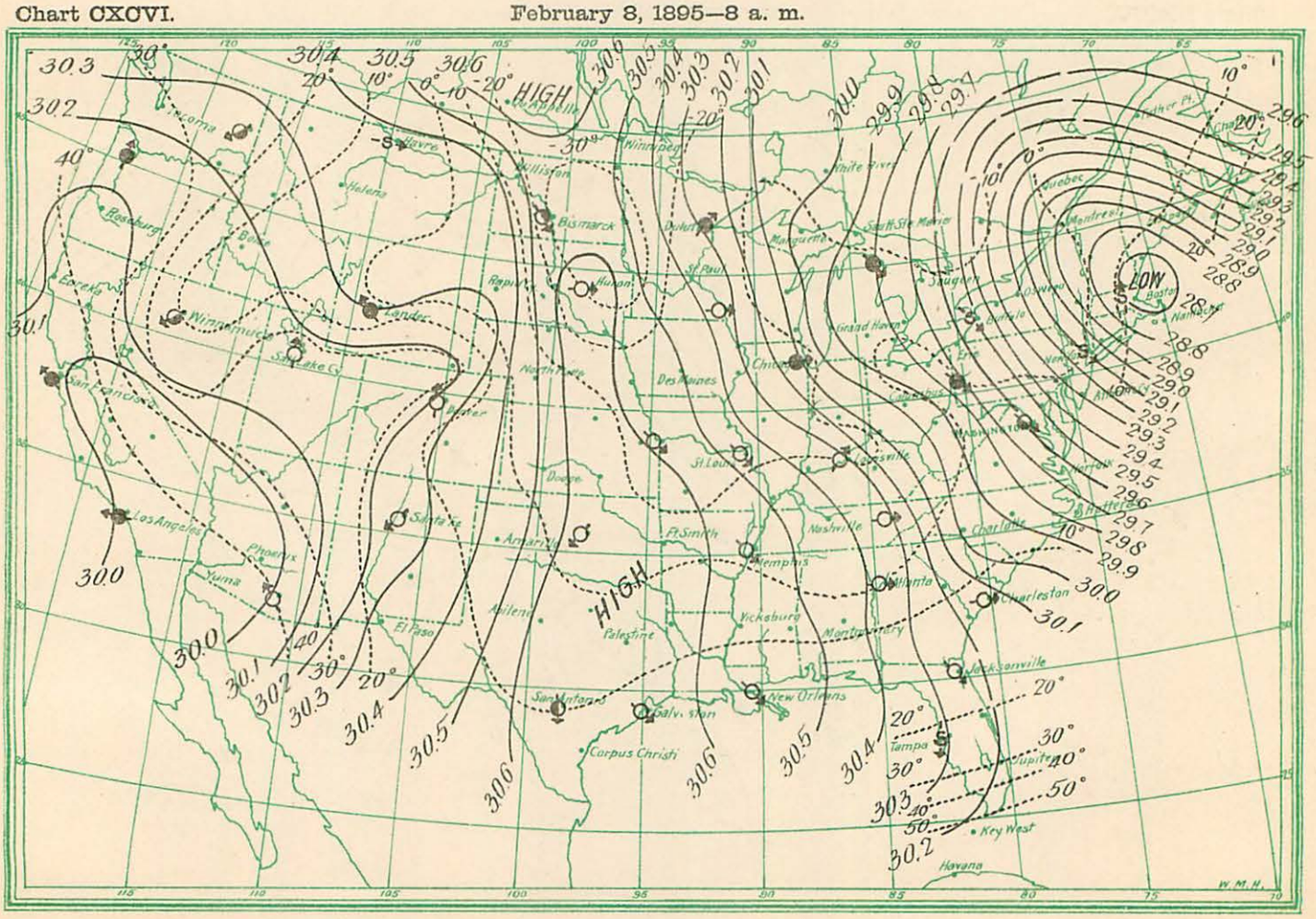


Chart CXCVII. February 1, 1898—8 a. m.

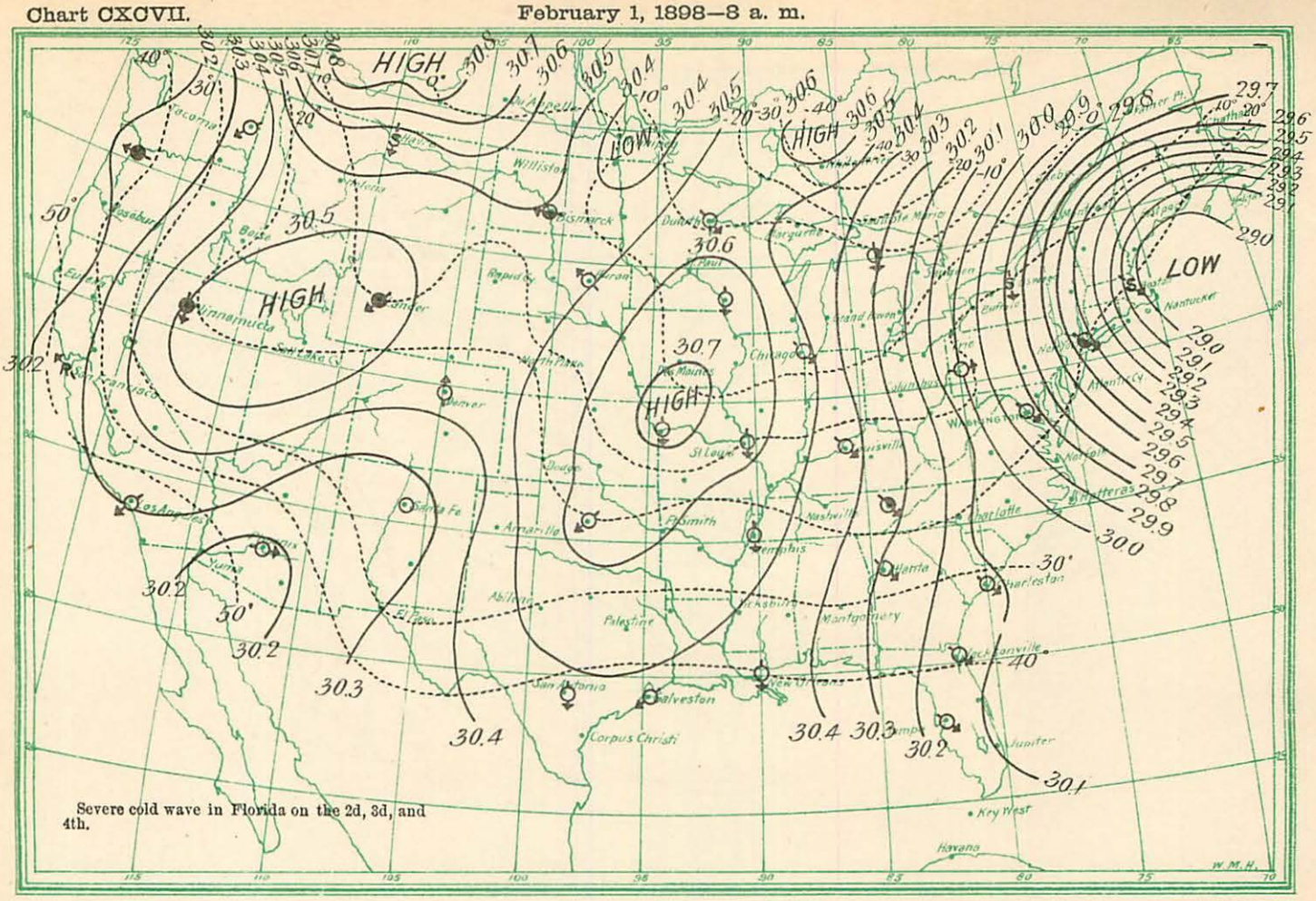


Chart CXCVIII. February 2, 1898—8 a. m.

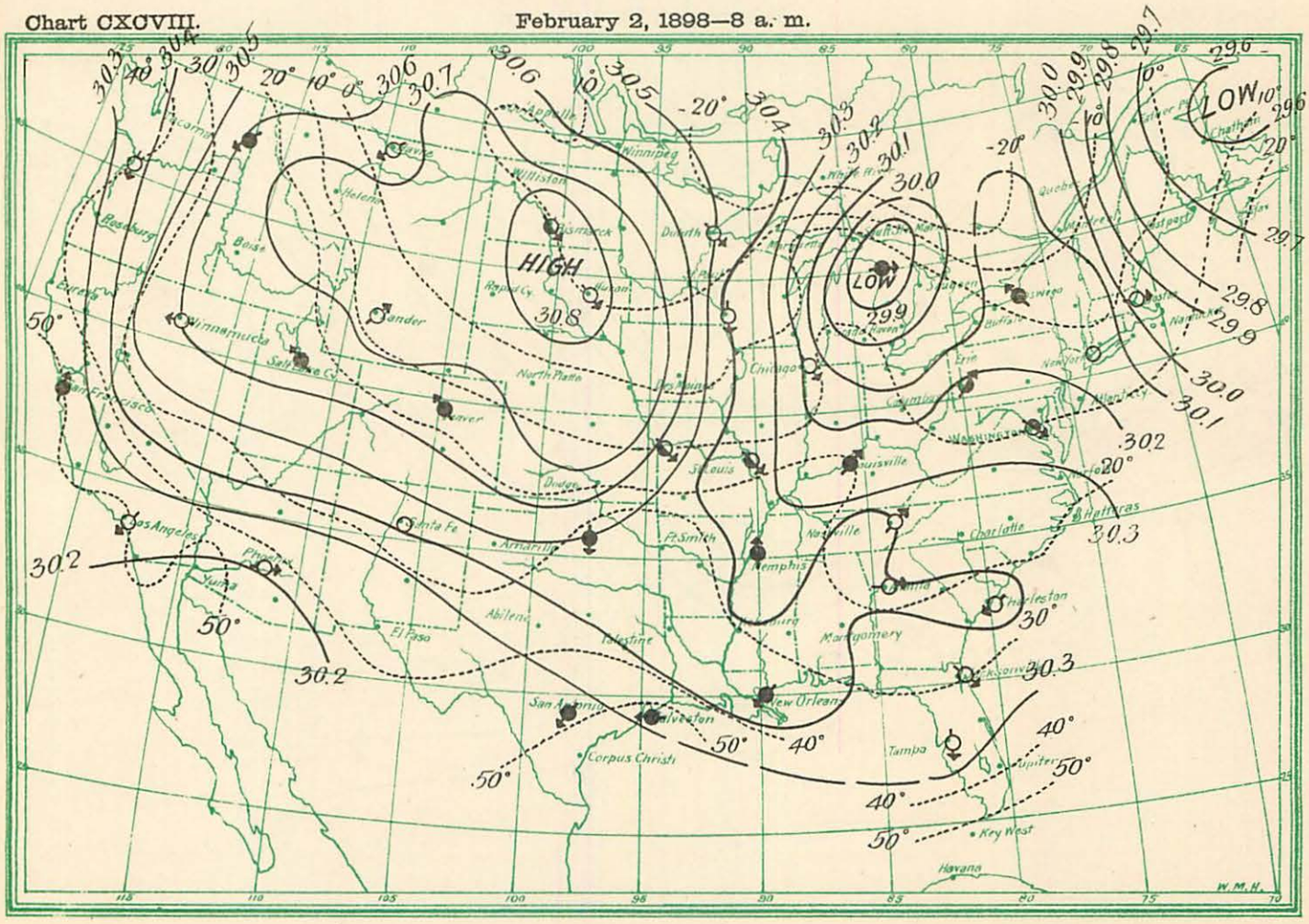


Chart CXCIX. February 3, 1898—8 a. m.

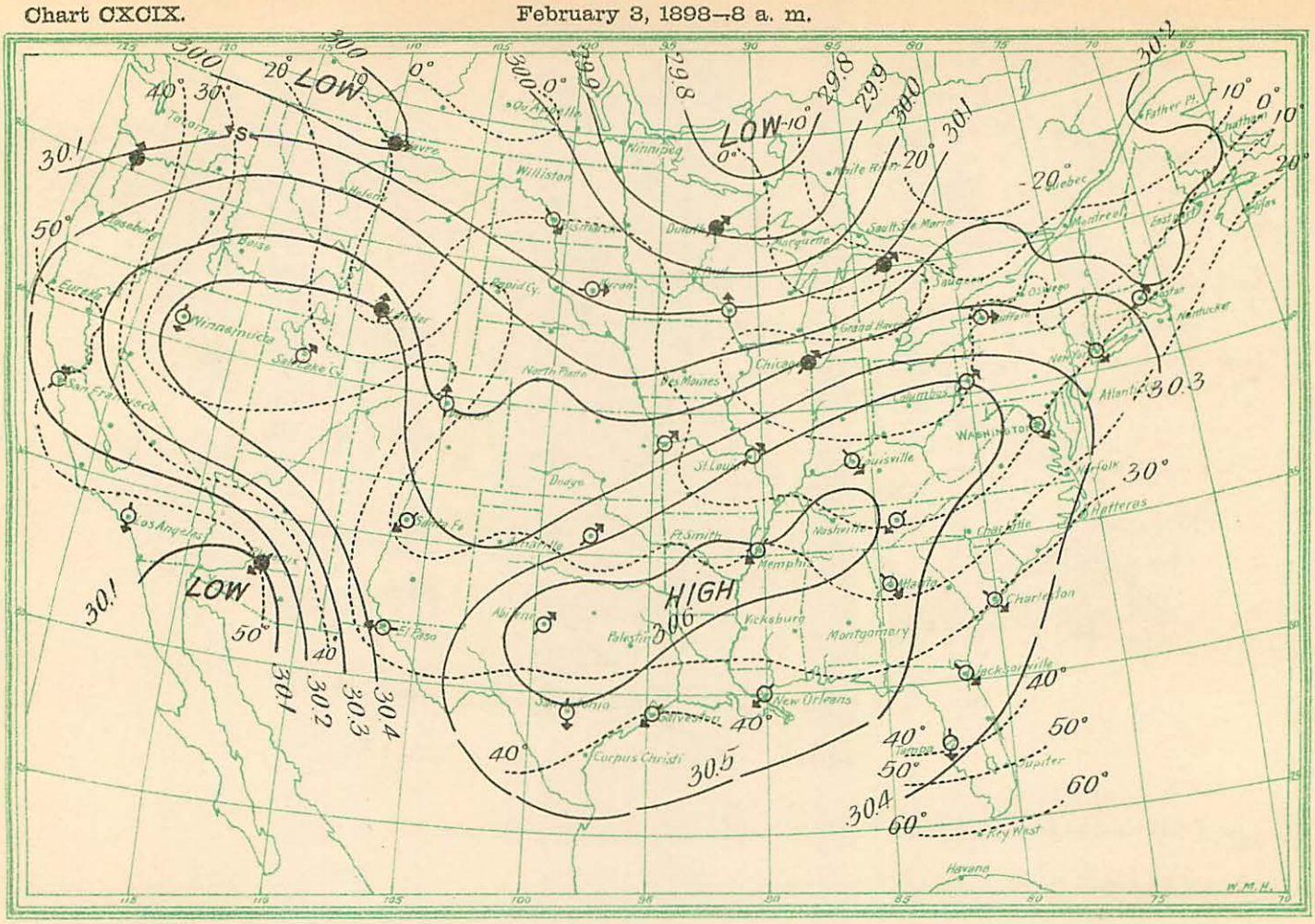


Chart CC. February 4, 1898—8 a. m.

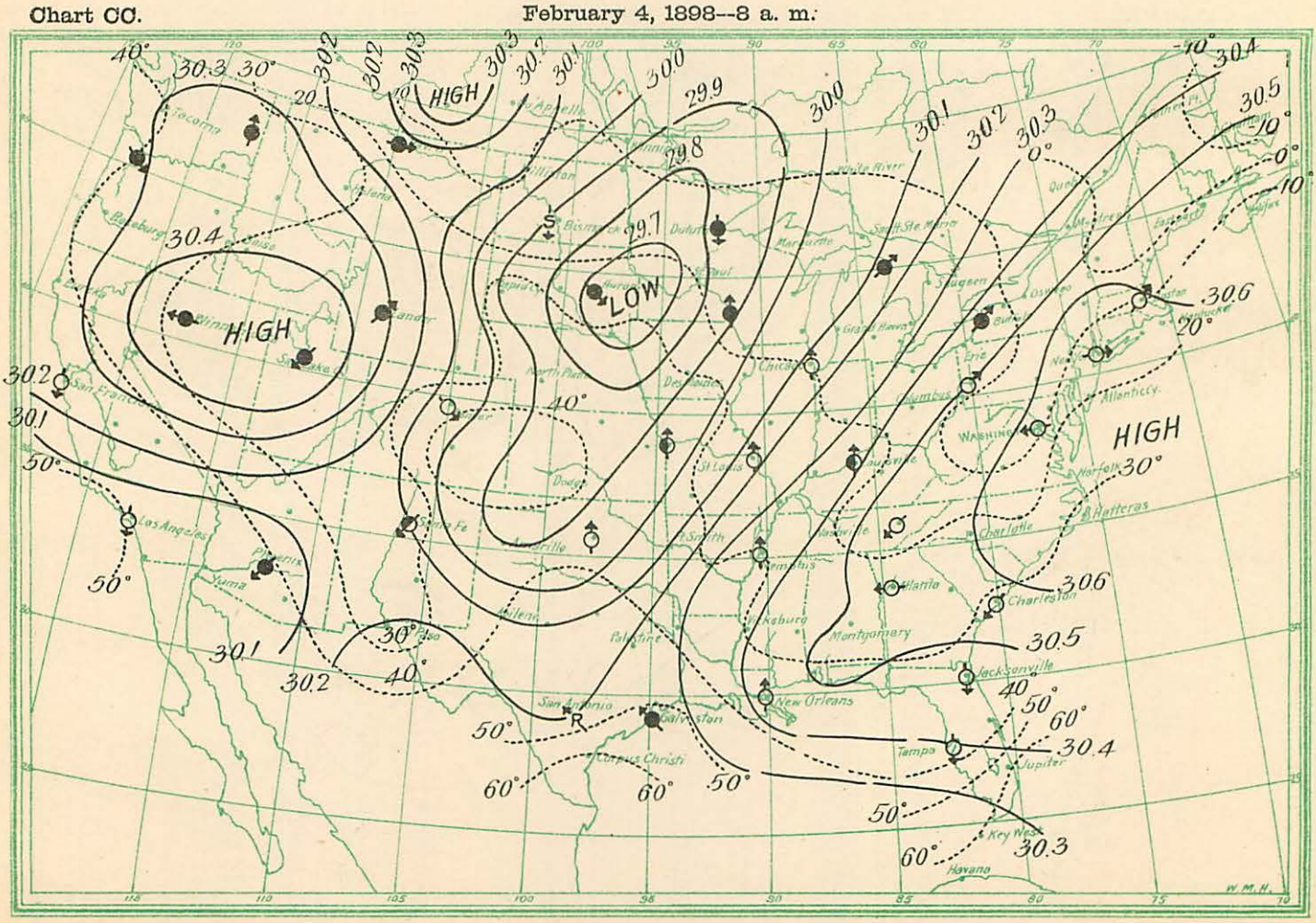


Chart CCI. February 10, 1899—8 a. m.

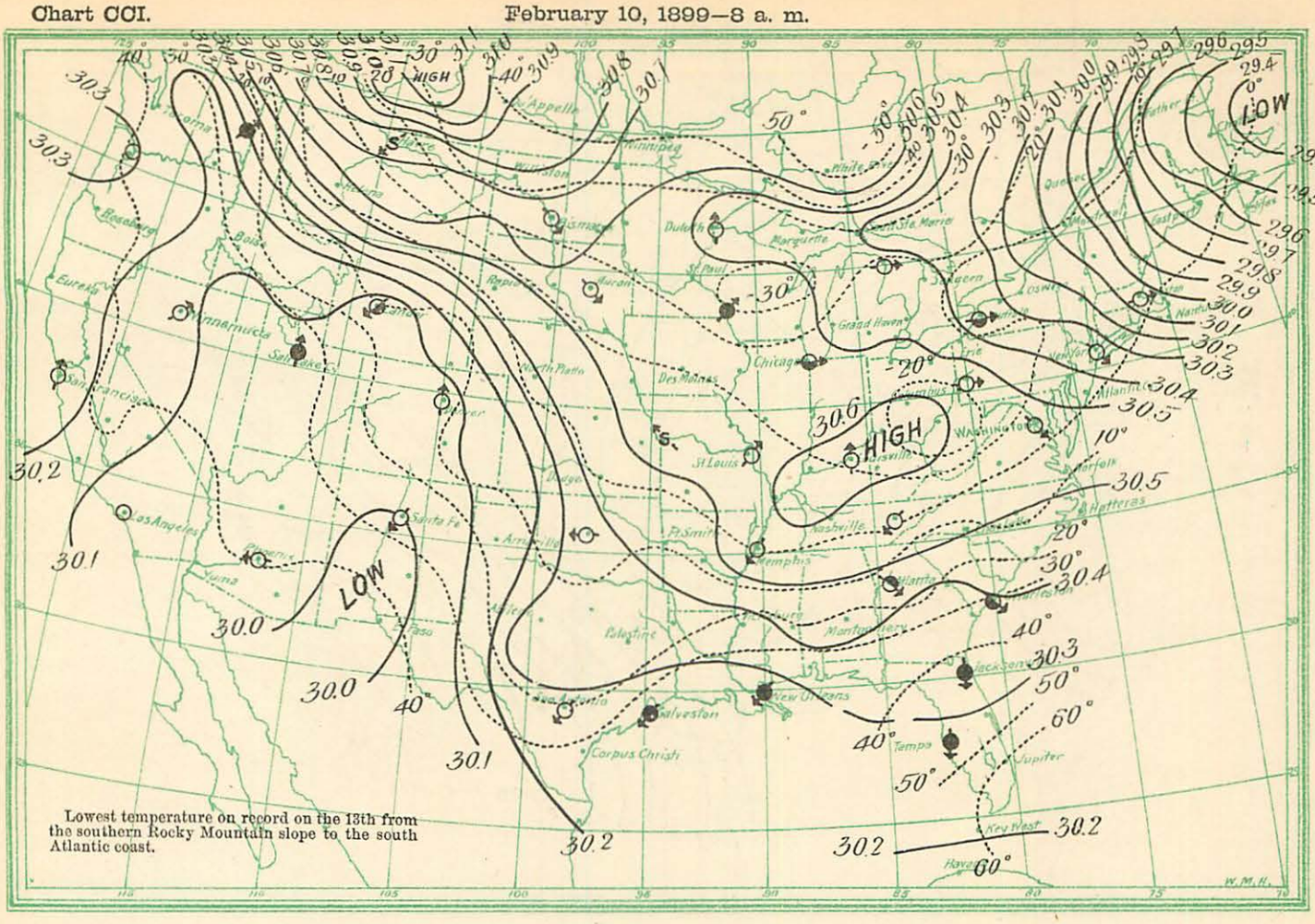


Chart CCII. February 11, 1899—8 a. m.

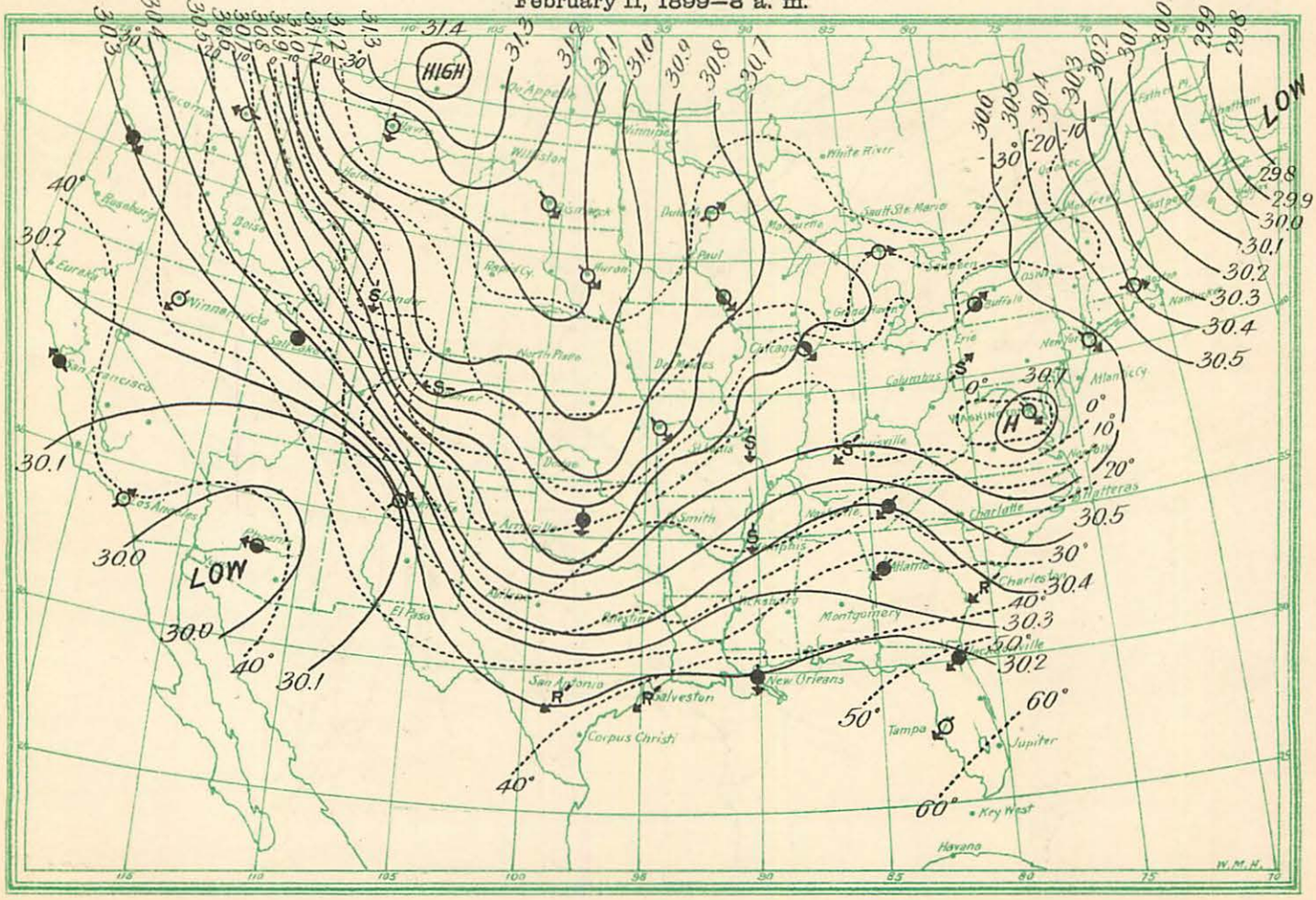


Chart CCIII. February 12, 1899—8 a. m.

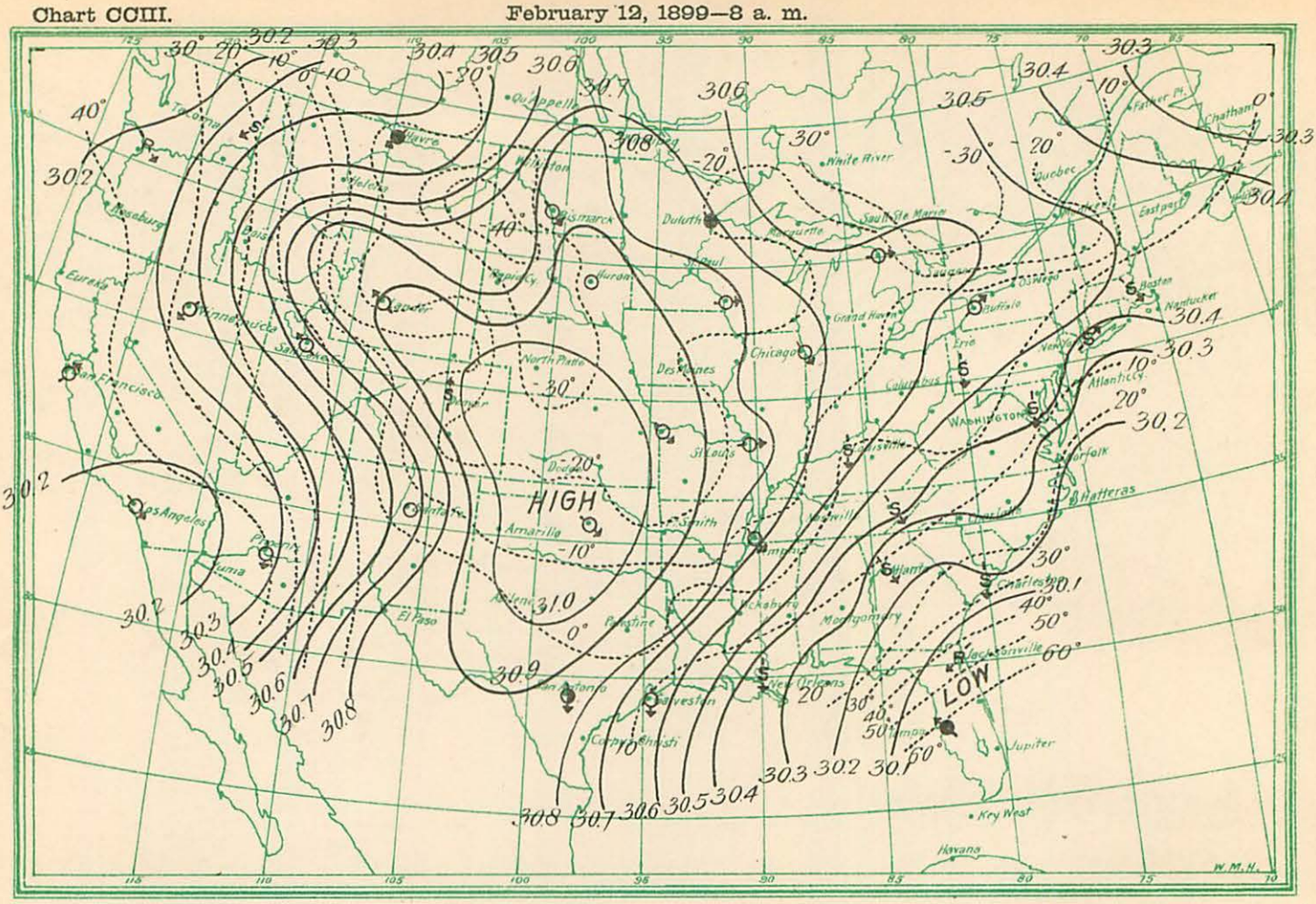


Chart CCIV. February 13, 1899—8 a. m.

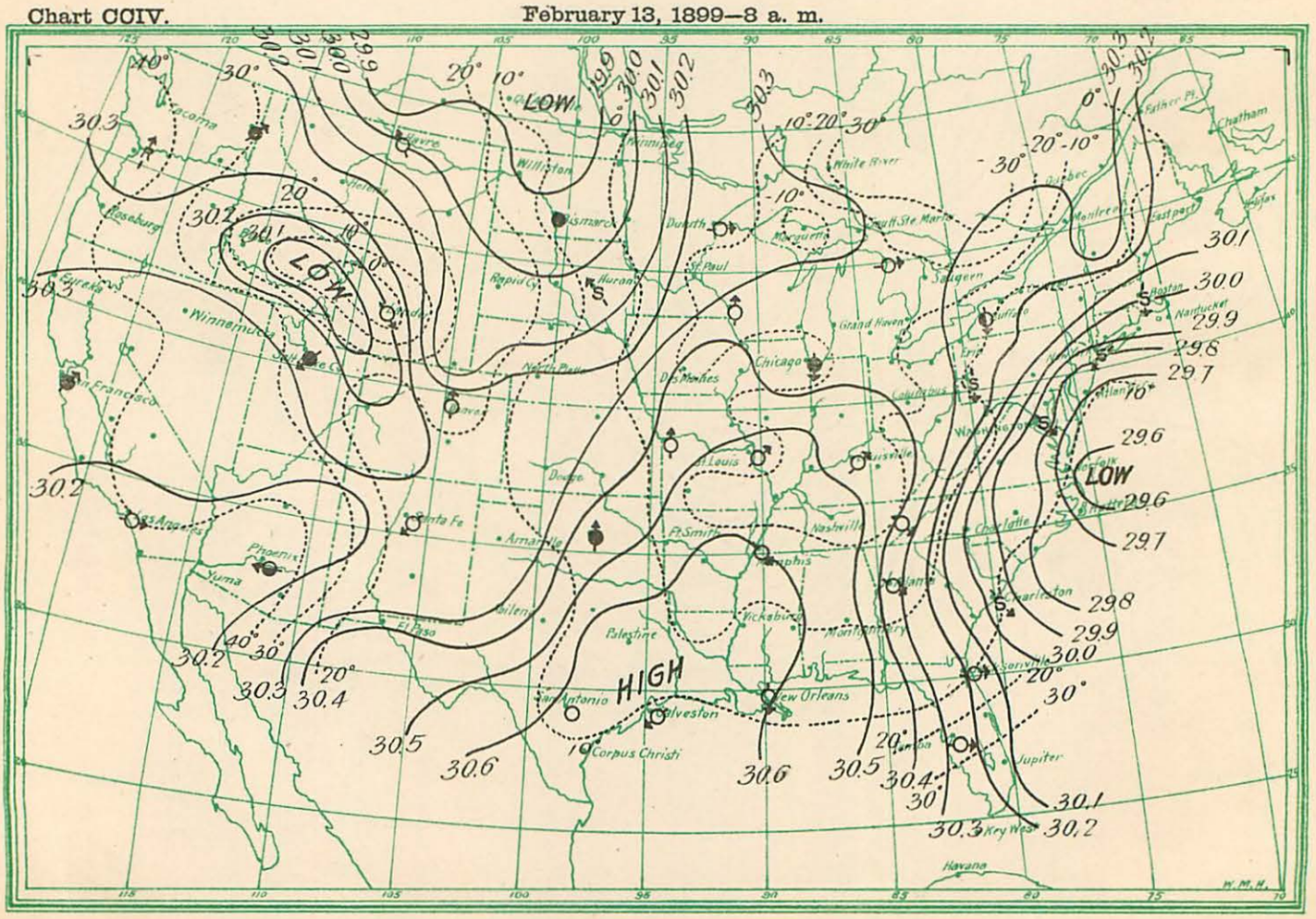


Chart CCV. February 6, 1900—8 a. m.

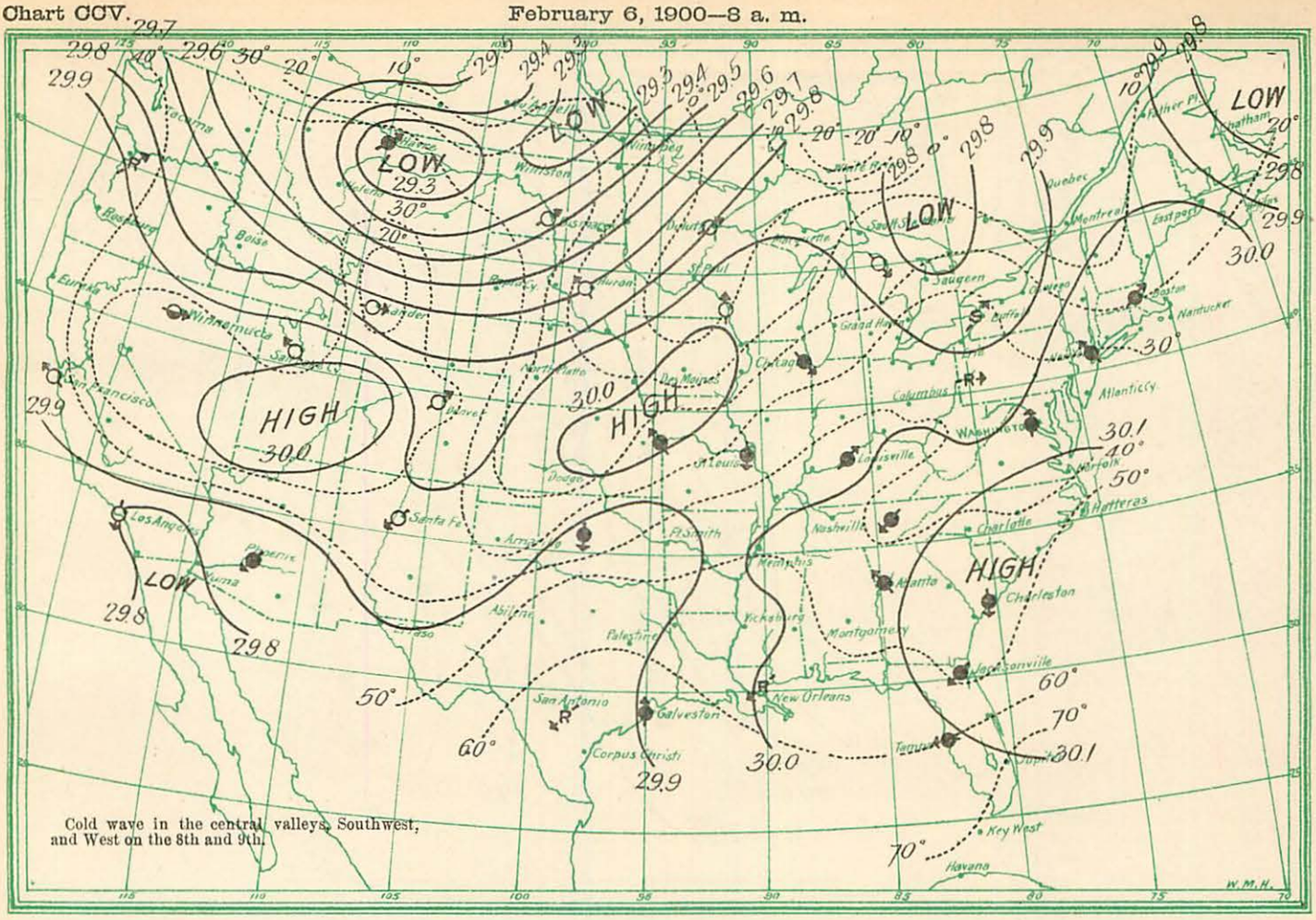


Chart CCVI. February 7, 1900—8 a. m.

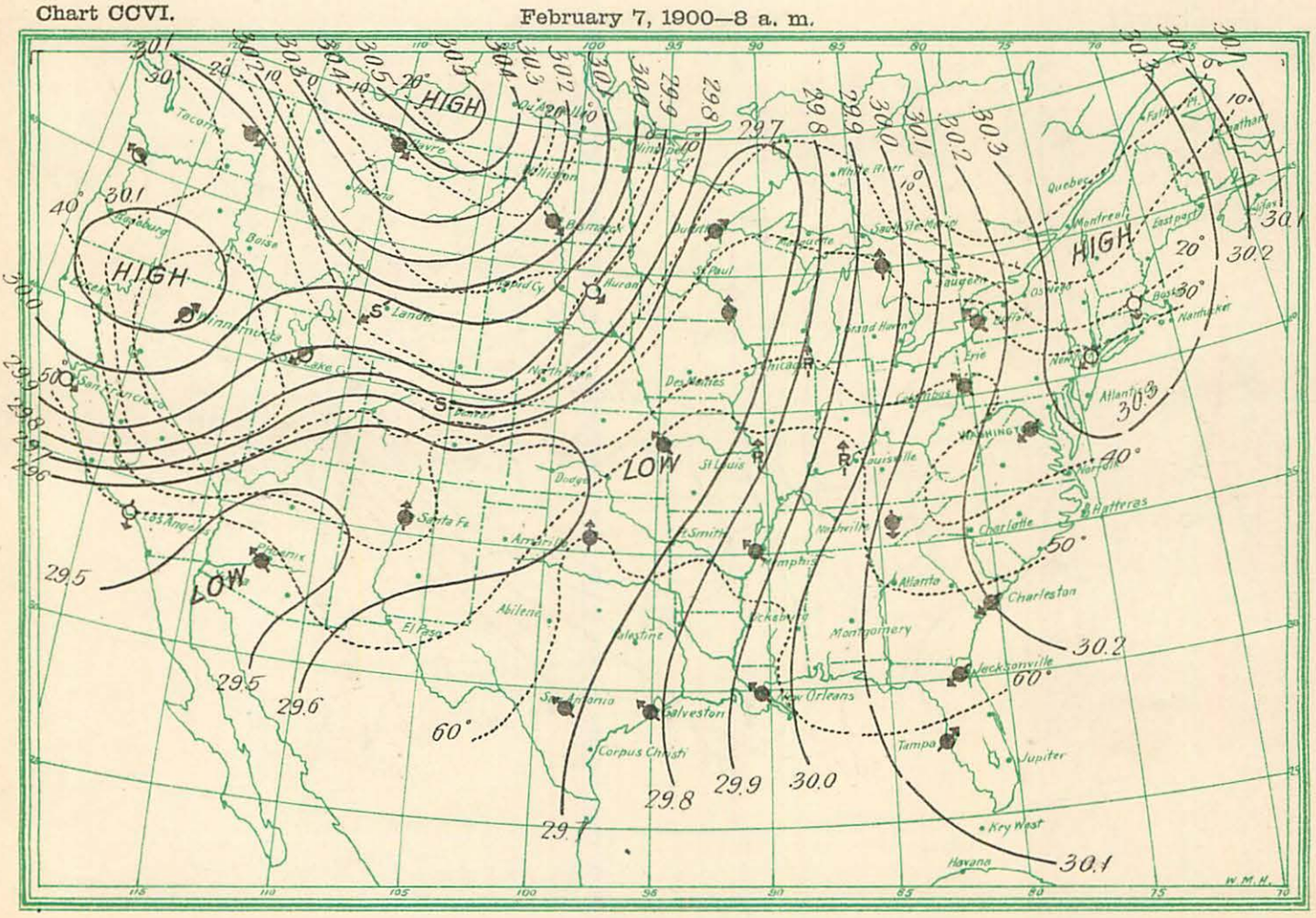


Chart CCVII. February 8, 1900—8 a. m.

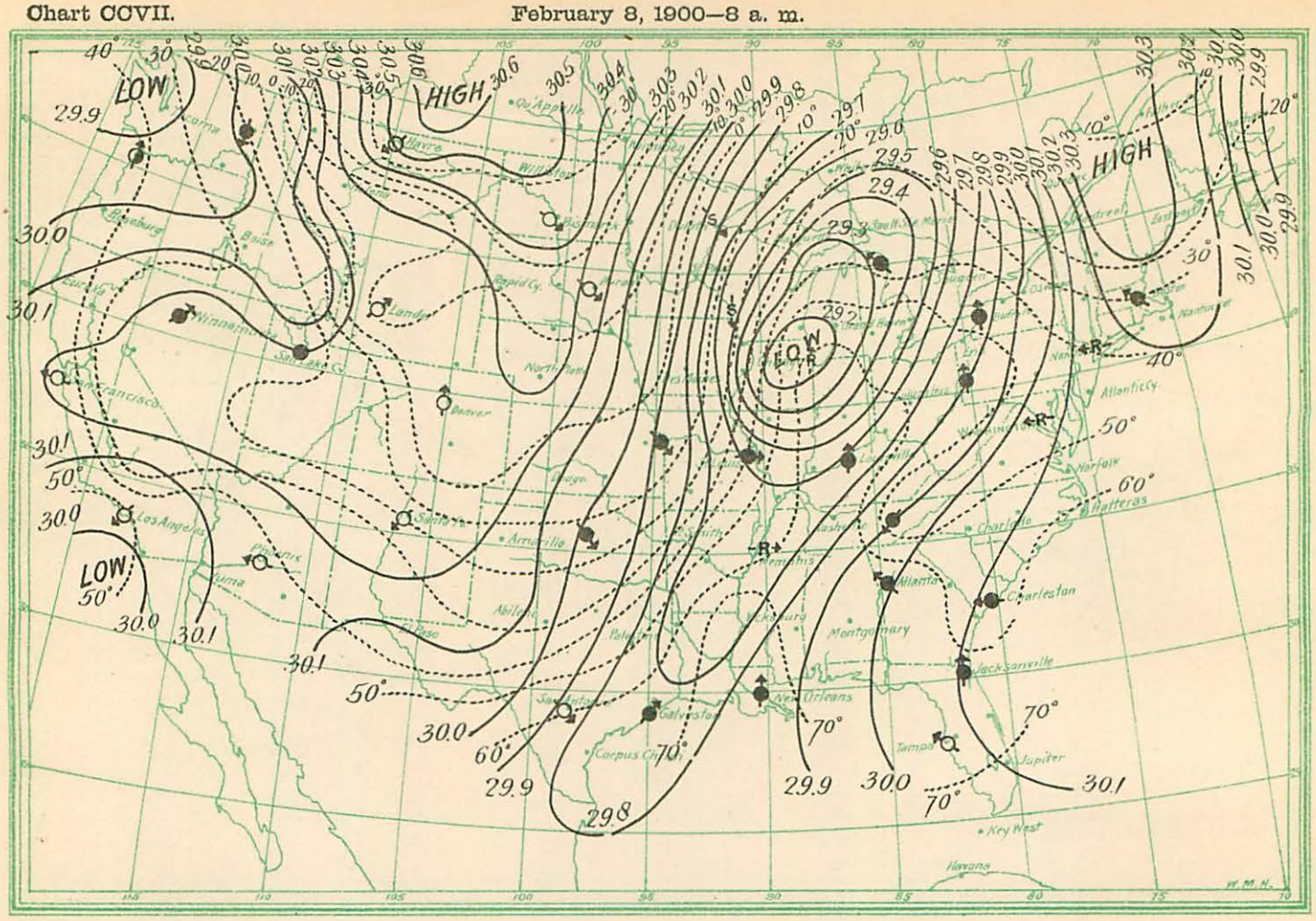


Chart CCVIII. February 9, 1900—8 a. m.

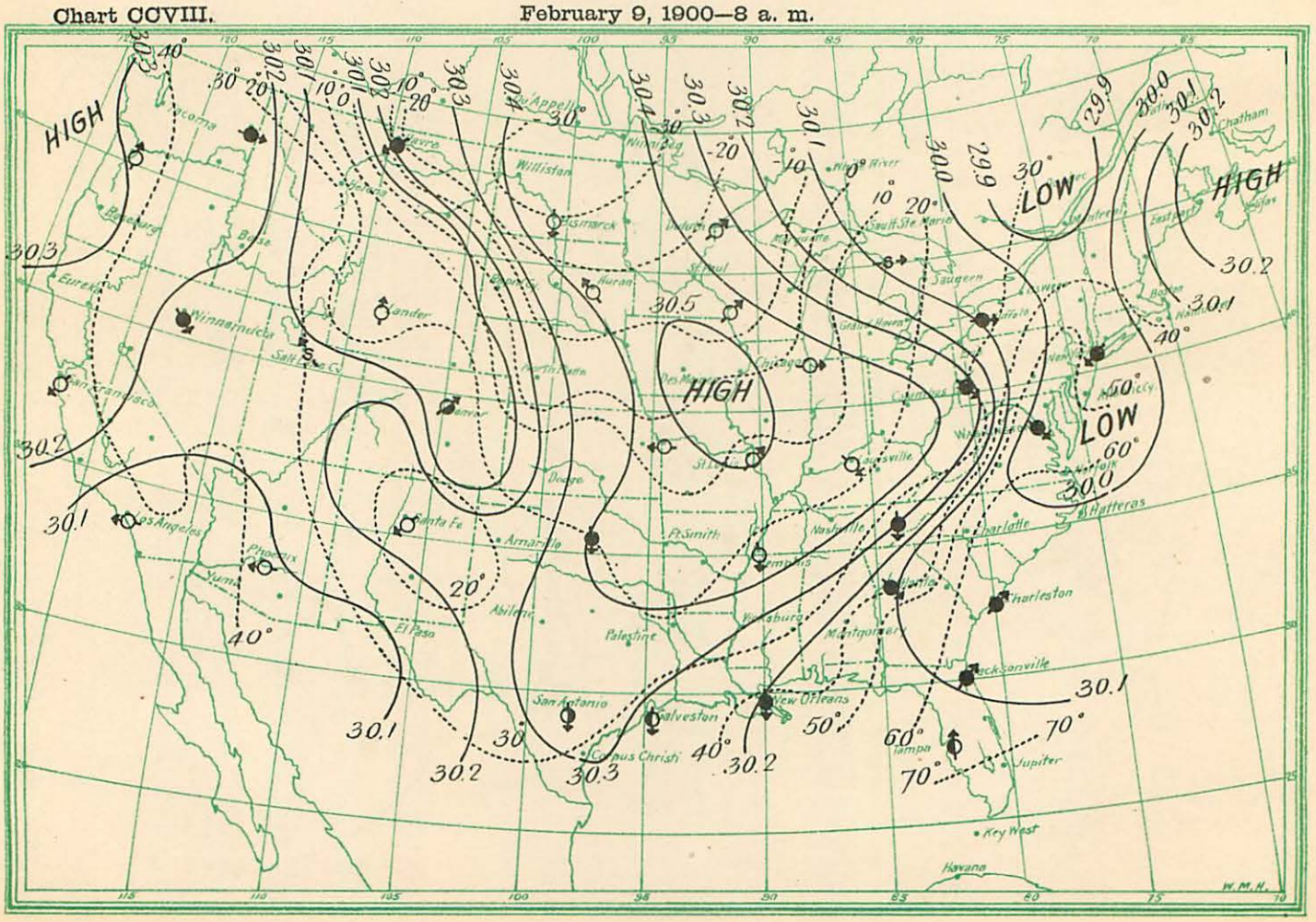


Chart CCIX. February 15, 1900—8 a. m.

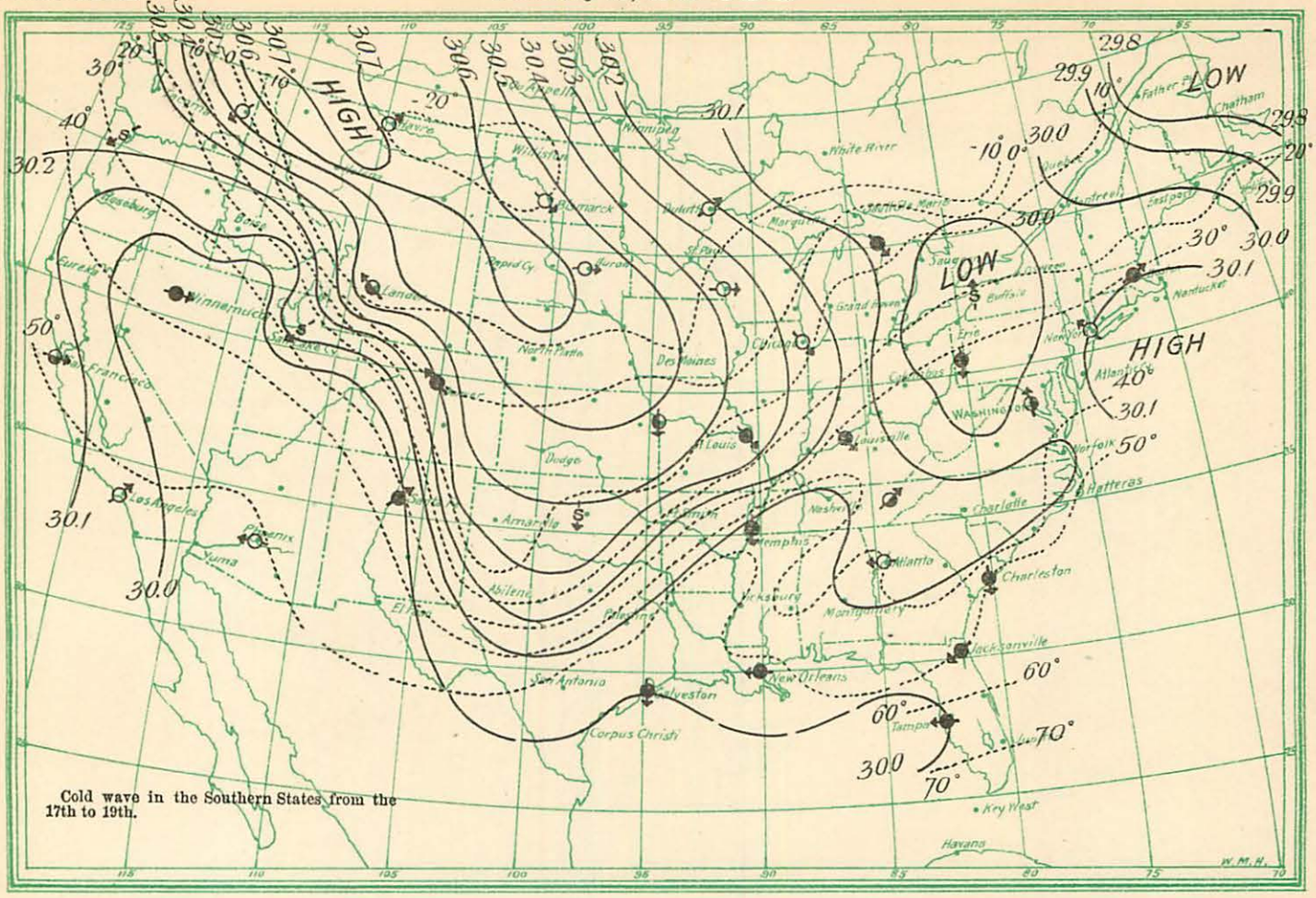


Chart CCX. February 16, 1900—8 a. m.

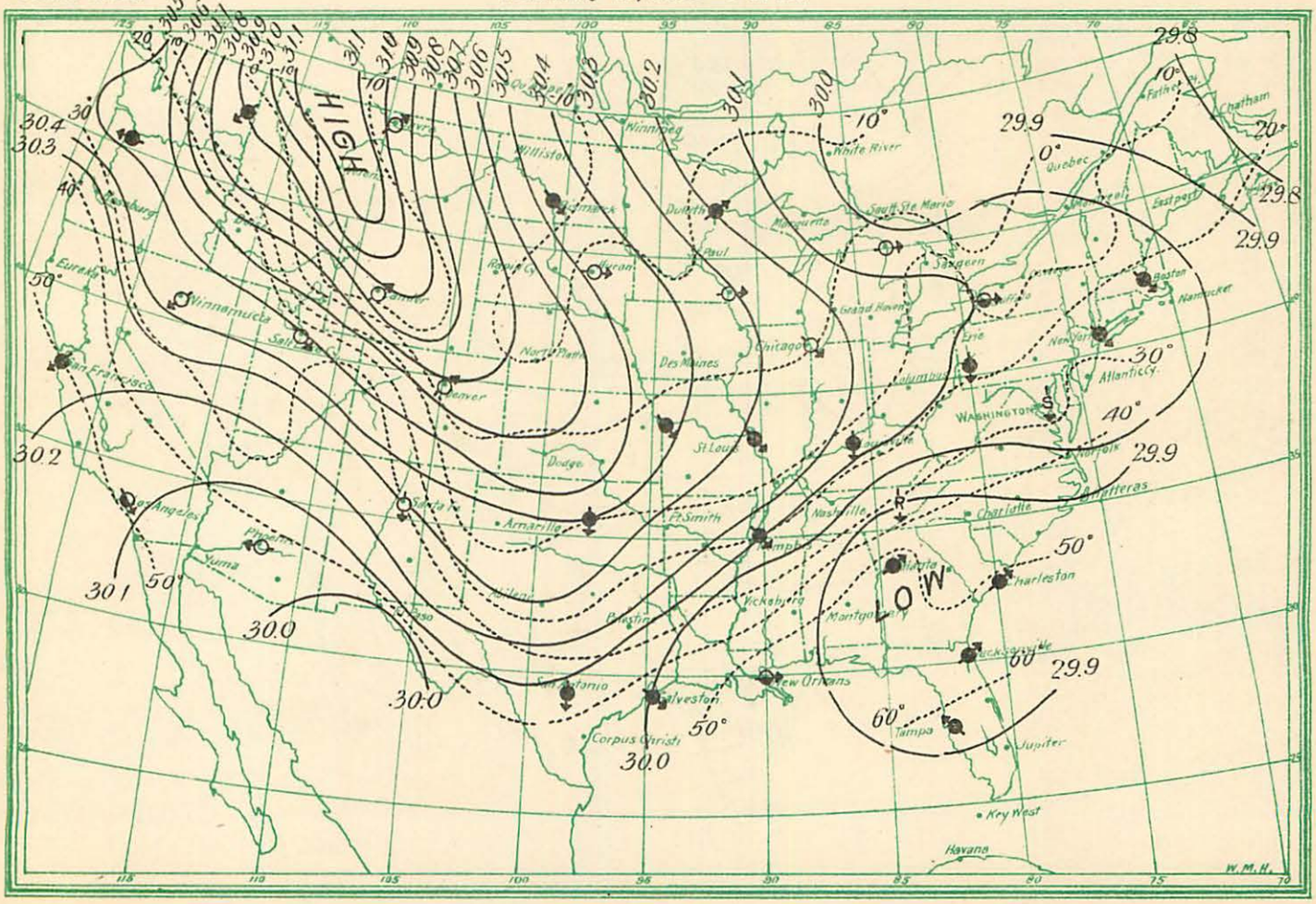


Chart CCXI. February 17, 1900—8 a. m.

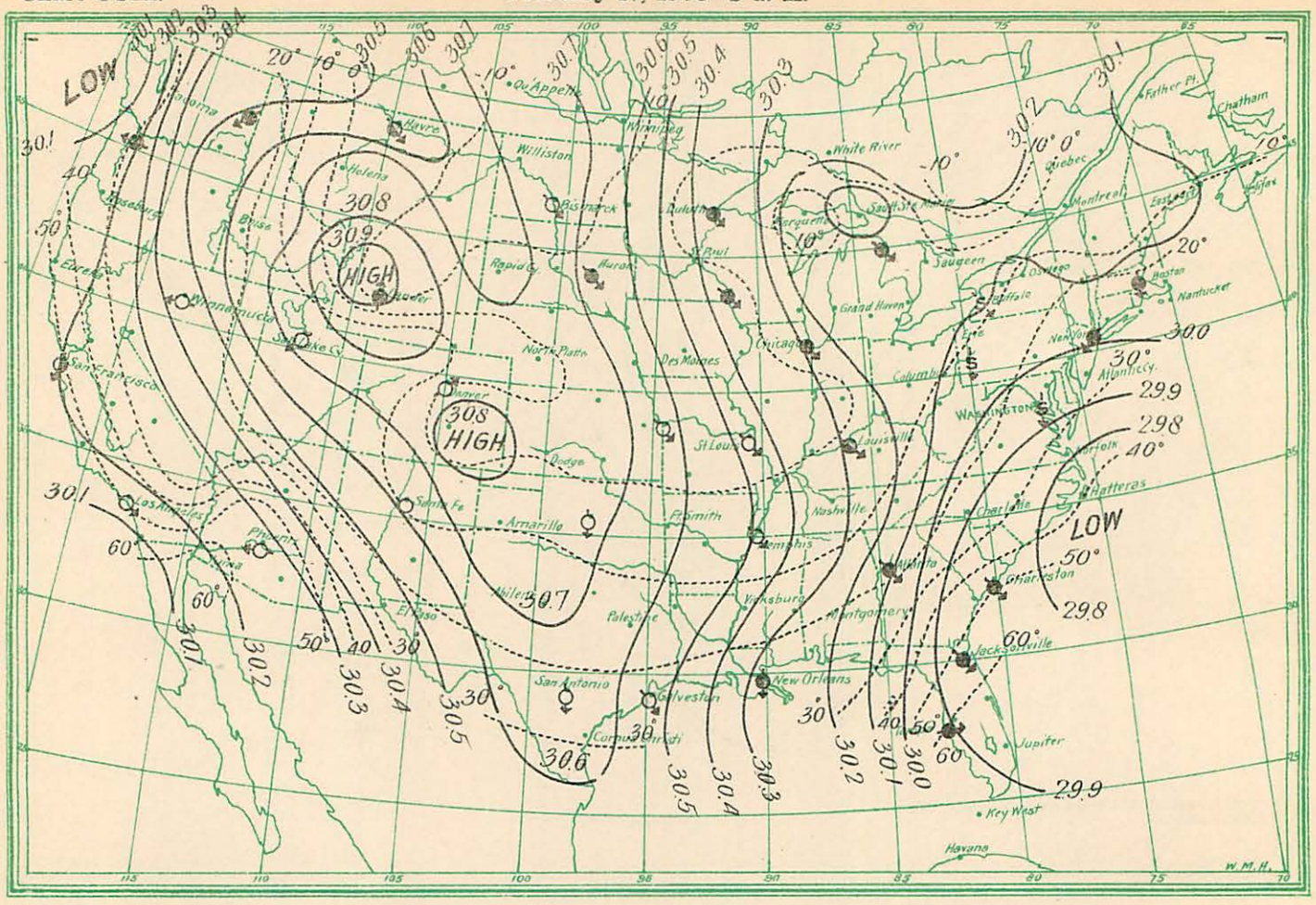


Chart CCXII. February 18, 1900—8 a. m.

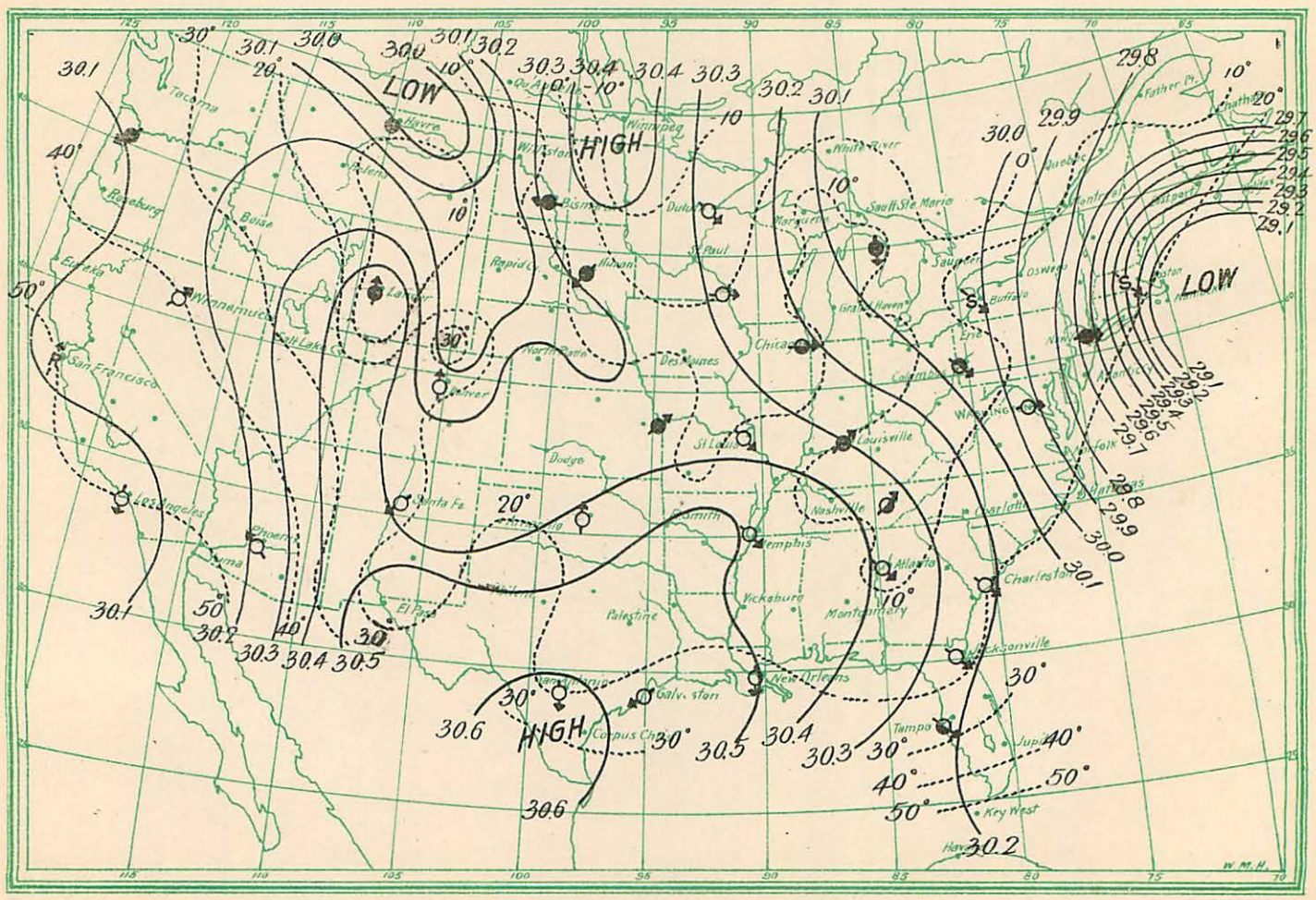


Chart CCXIII. February 22, 1901—8 a. m.

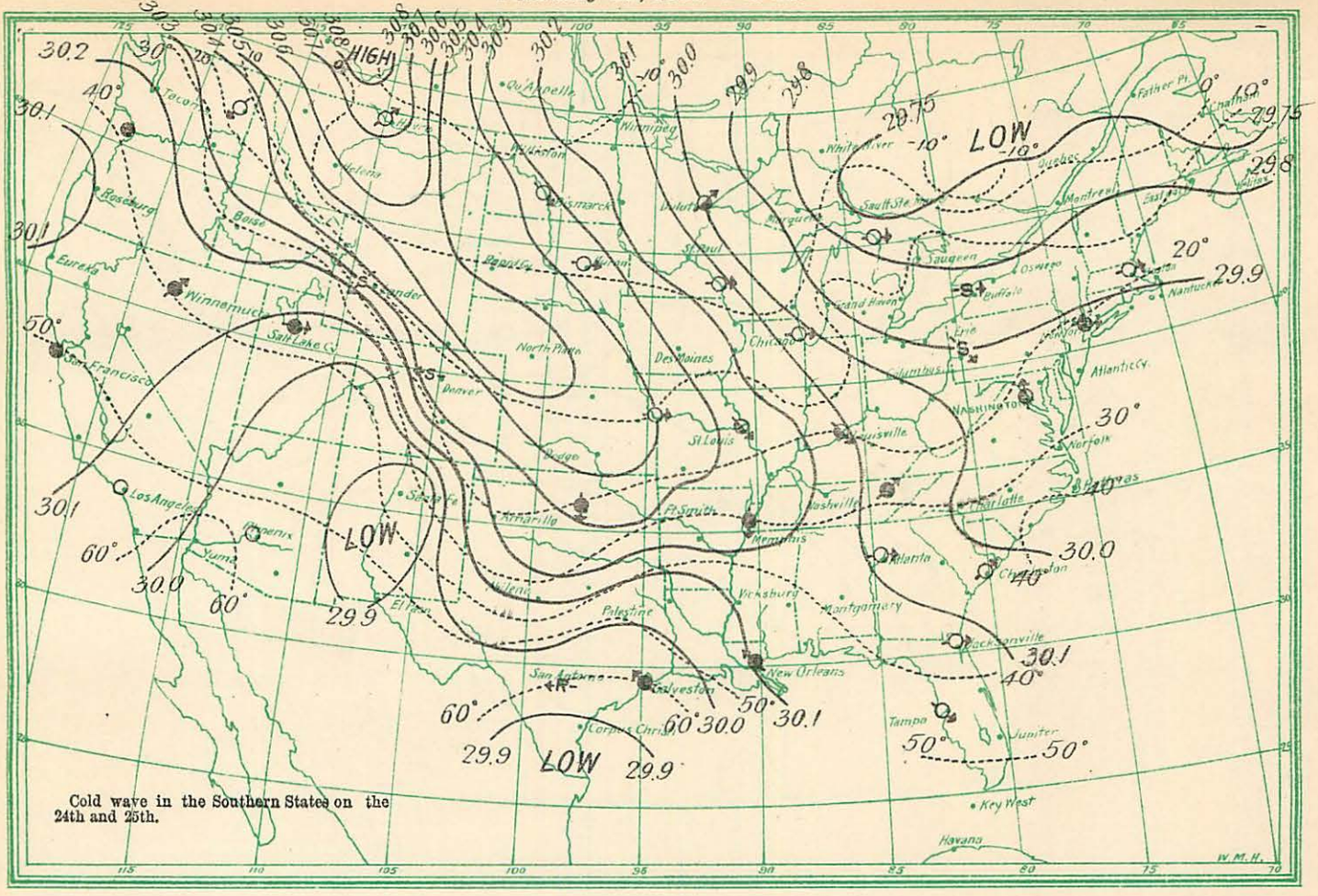


Chart CCXIV. February 23, 1901—8 a. m.

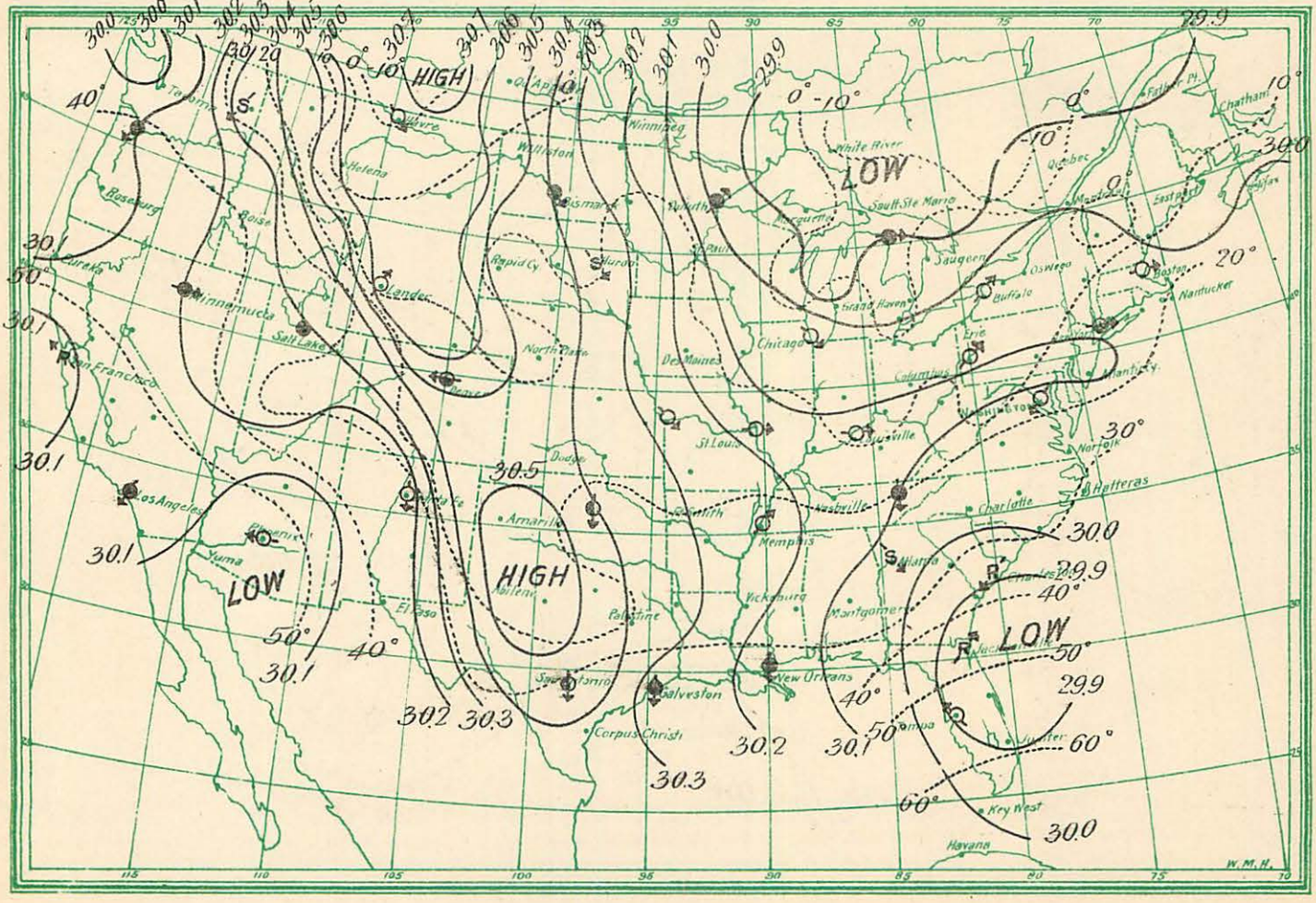


Chart CCXV. February 24, 1901—8 a. m.

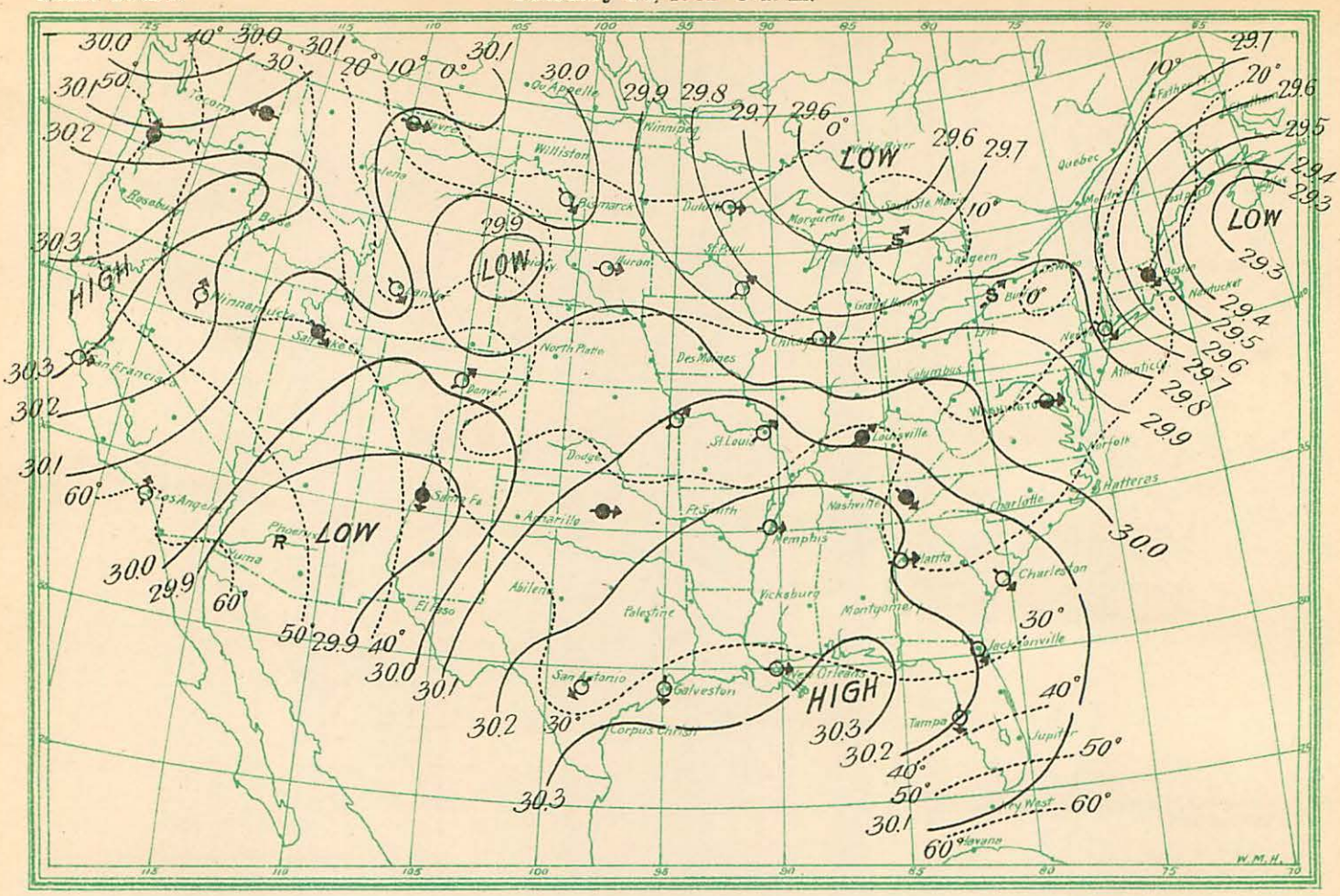


Chart CCXVI. February 25, 1901—8 a. m.

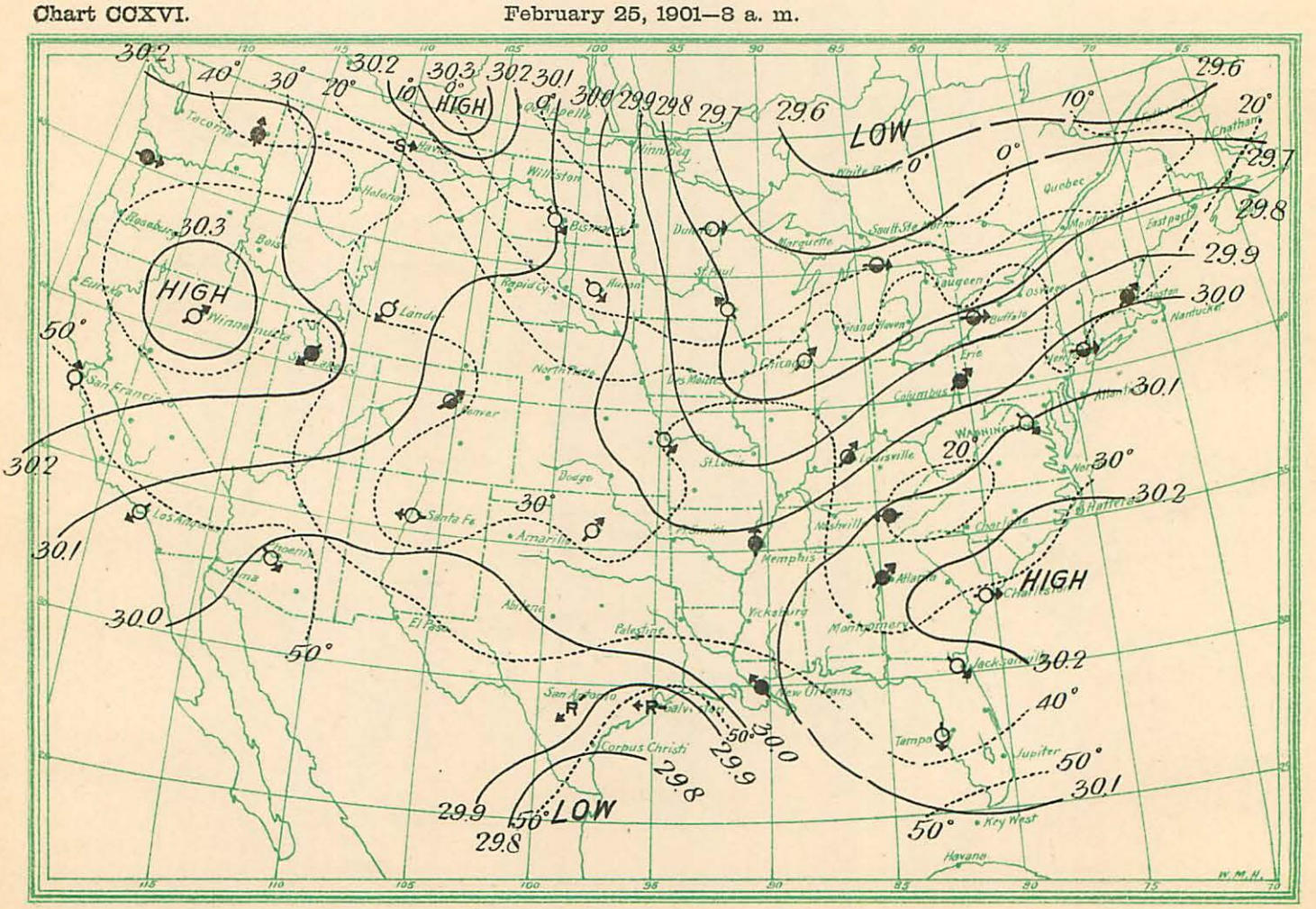


Chart CCXVII. March 10, 1888—8 a. m.

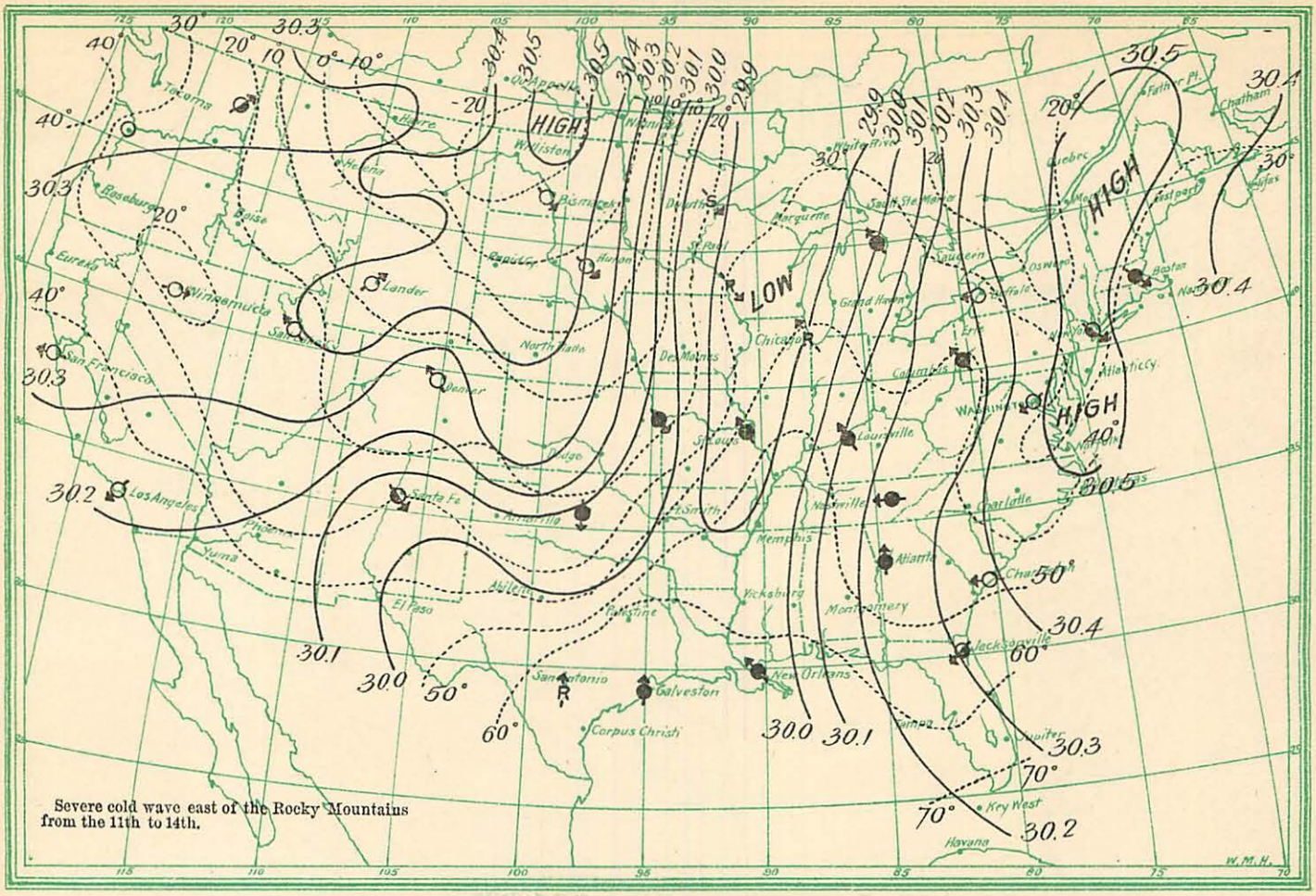


Chart CCXVIII. March 11, 1888—8 a. m.

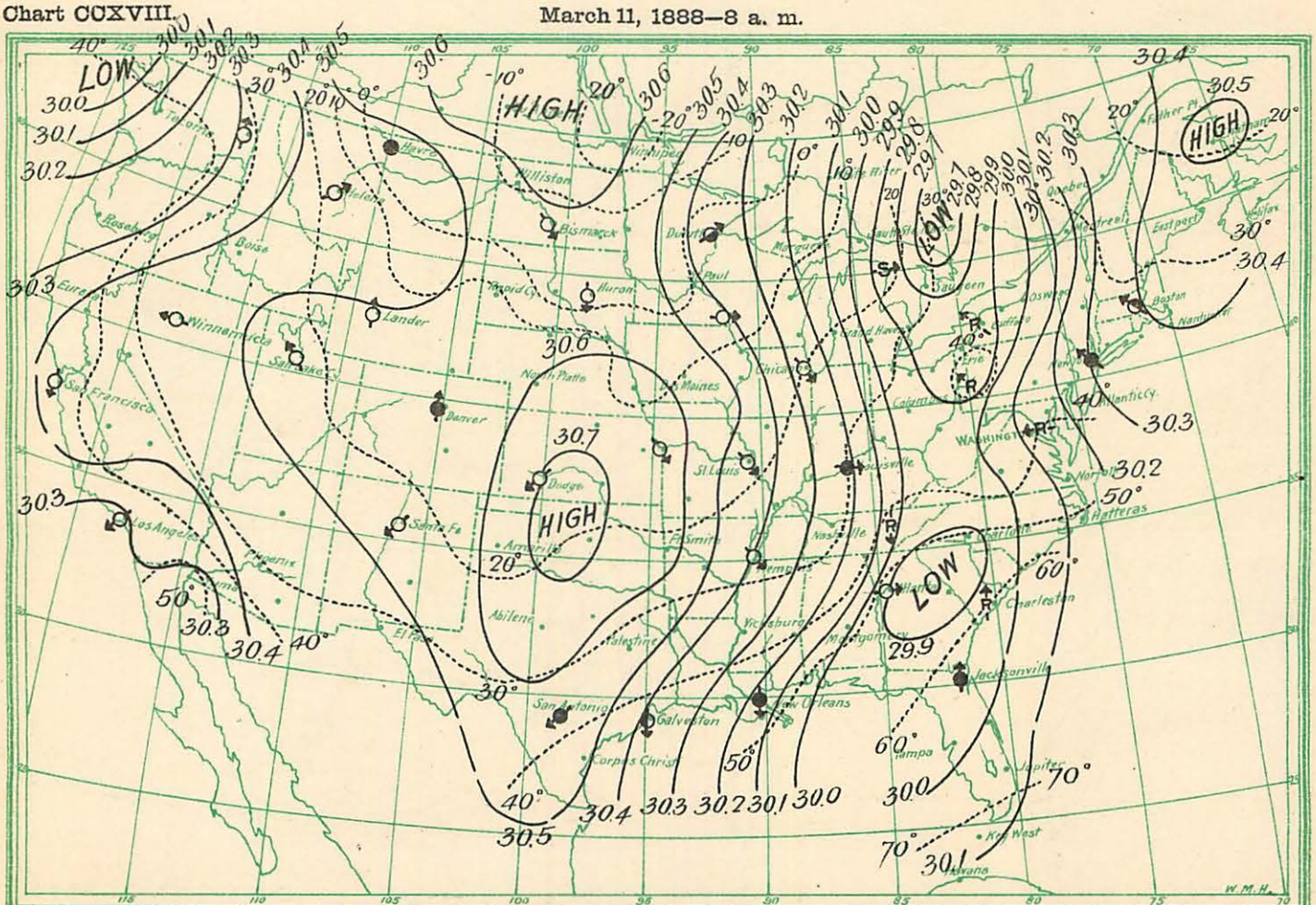


Chart CCXIX. March 12, 1888—8 a. m.

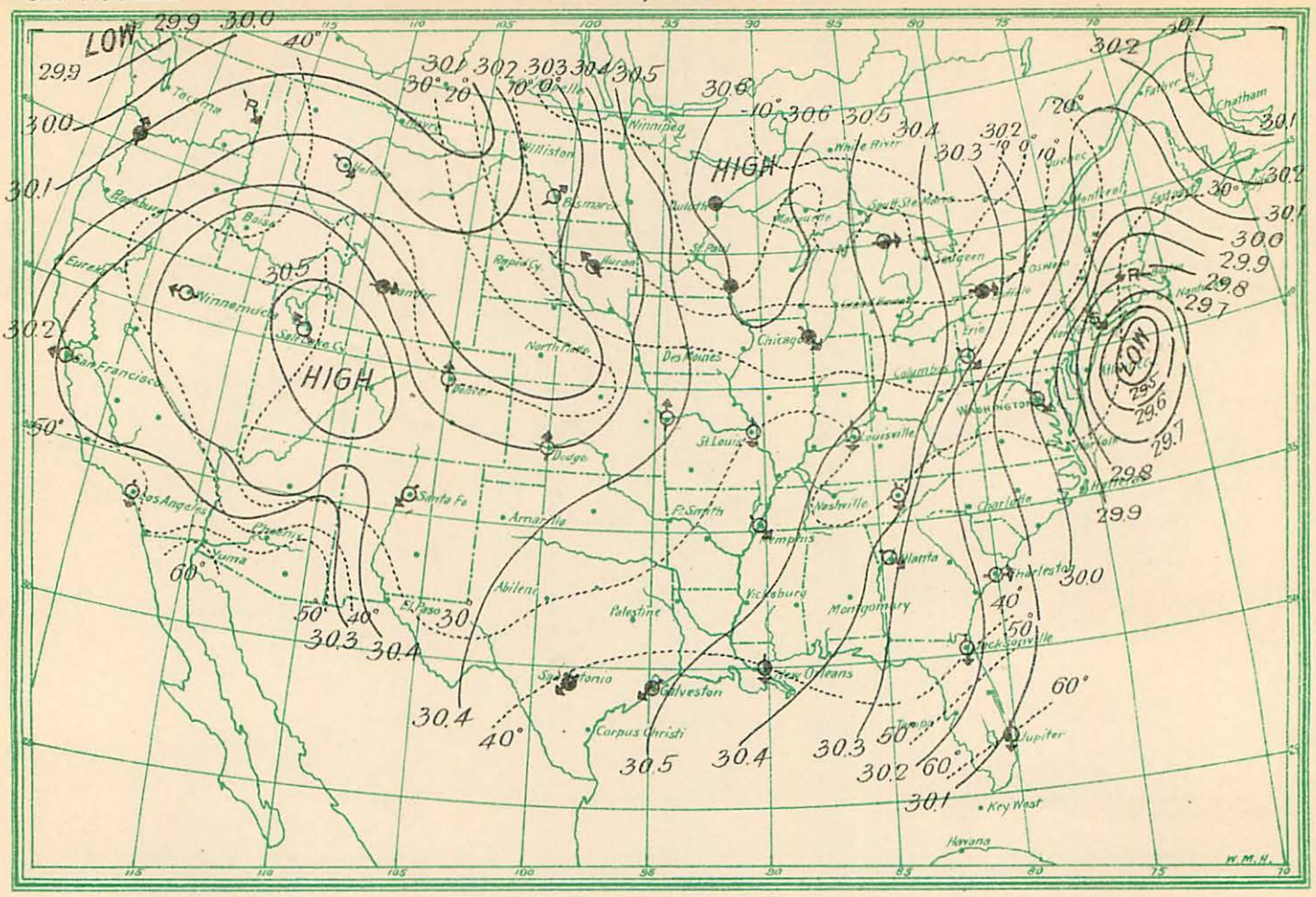


Chart CCXX. March 13, 1888—8 a. m.

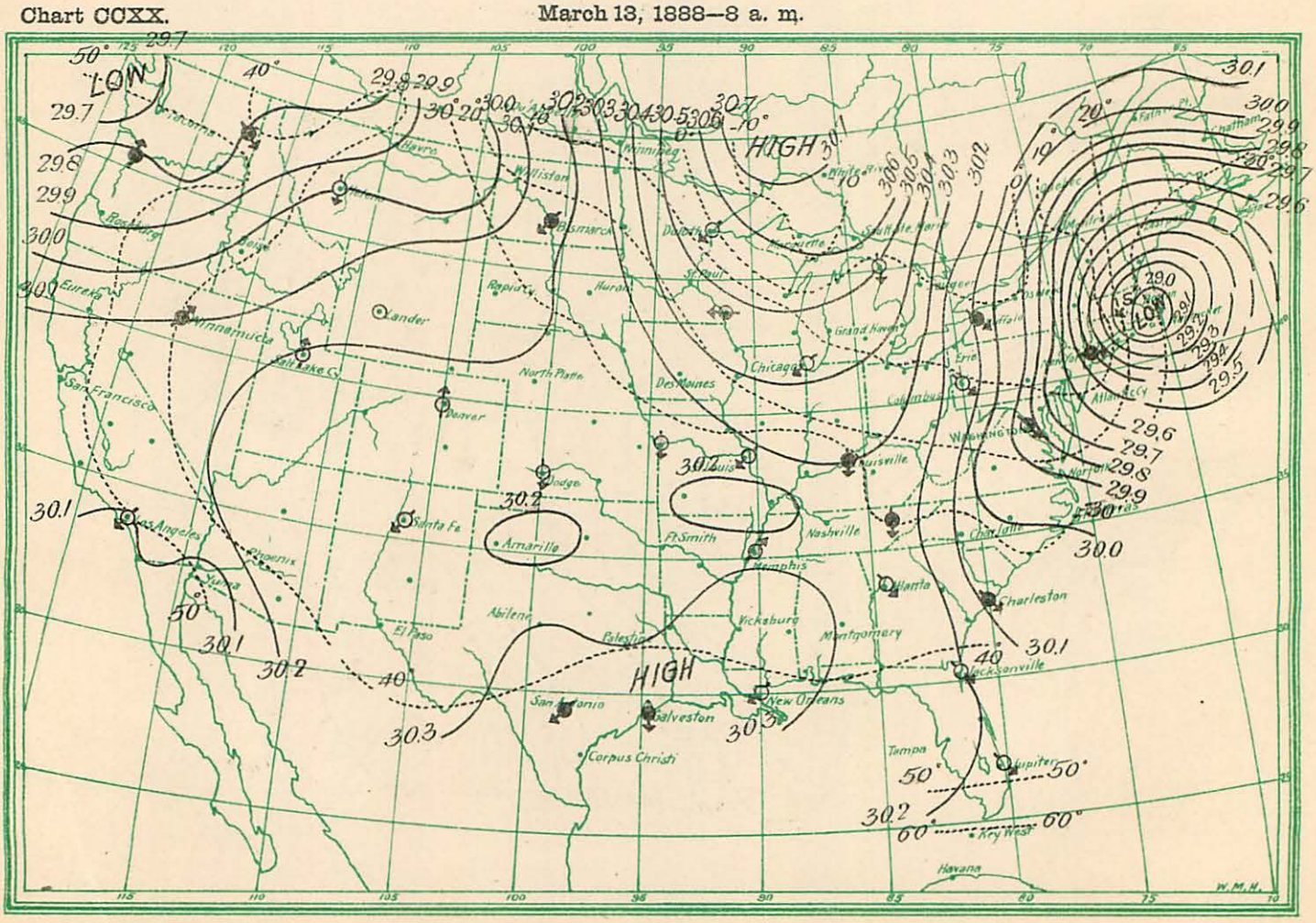


Chart CCXXI. March 10, 1890—8 p. m.

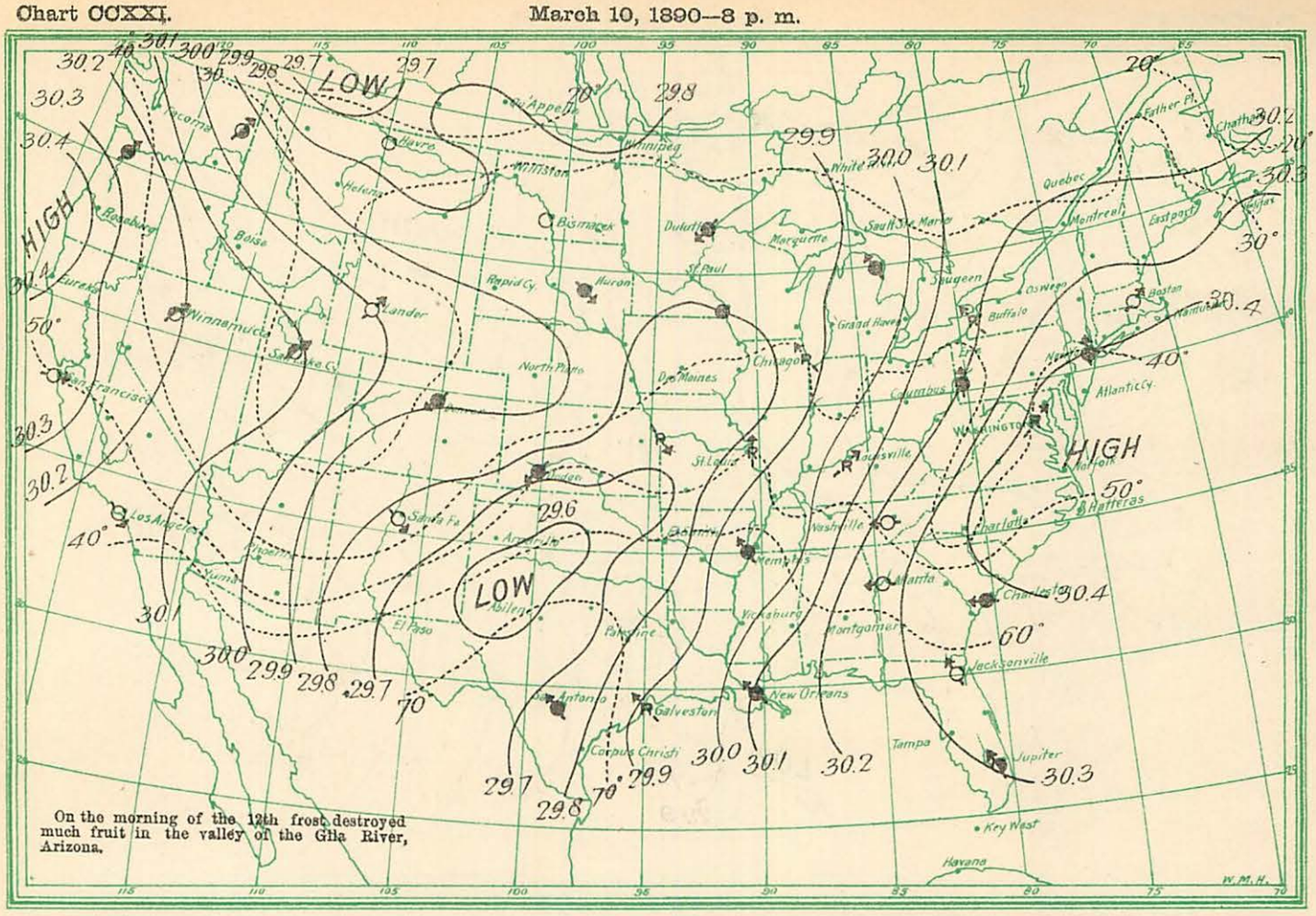


Chart CCXXII. March 11, 1890—8 a. m.

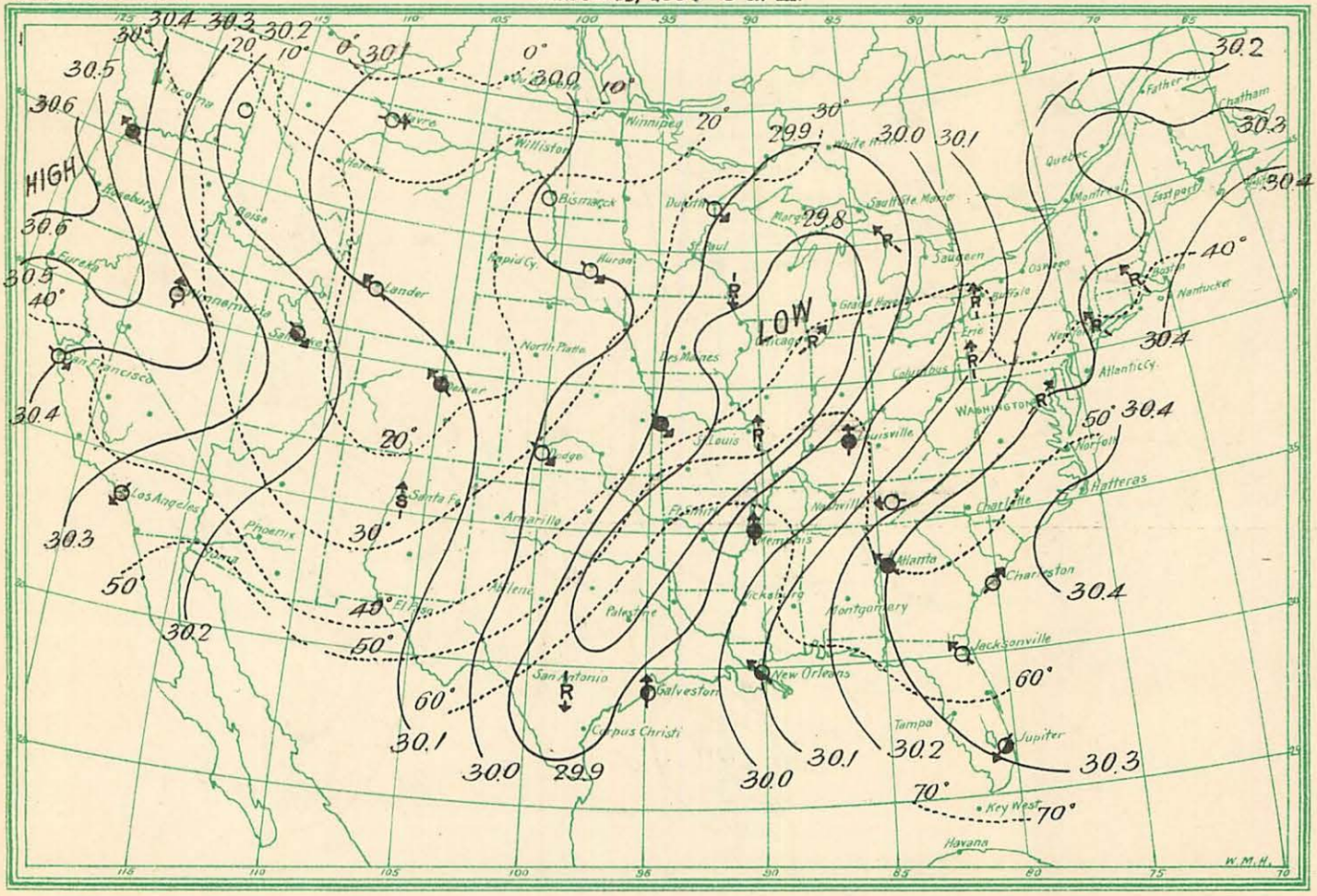


Chart CCXXIII. March 11, 1890—8 p. m.

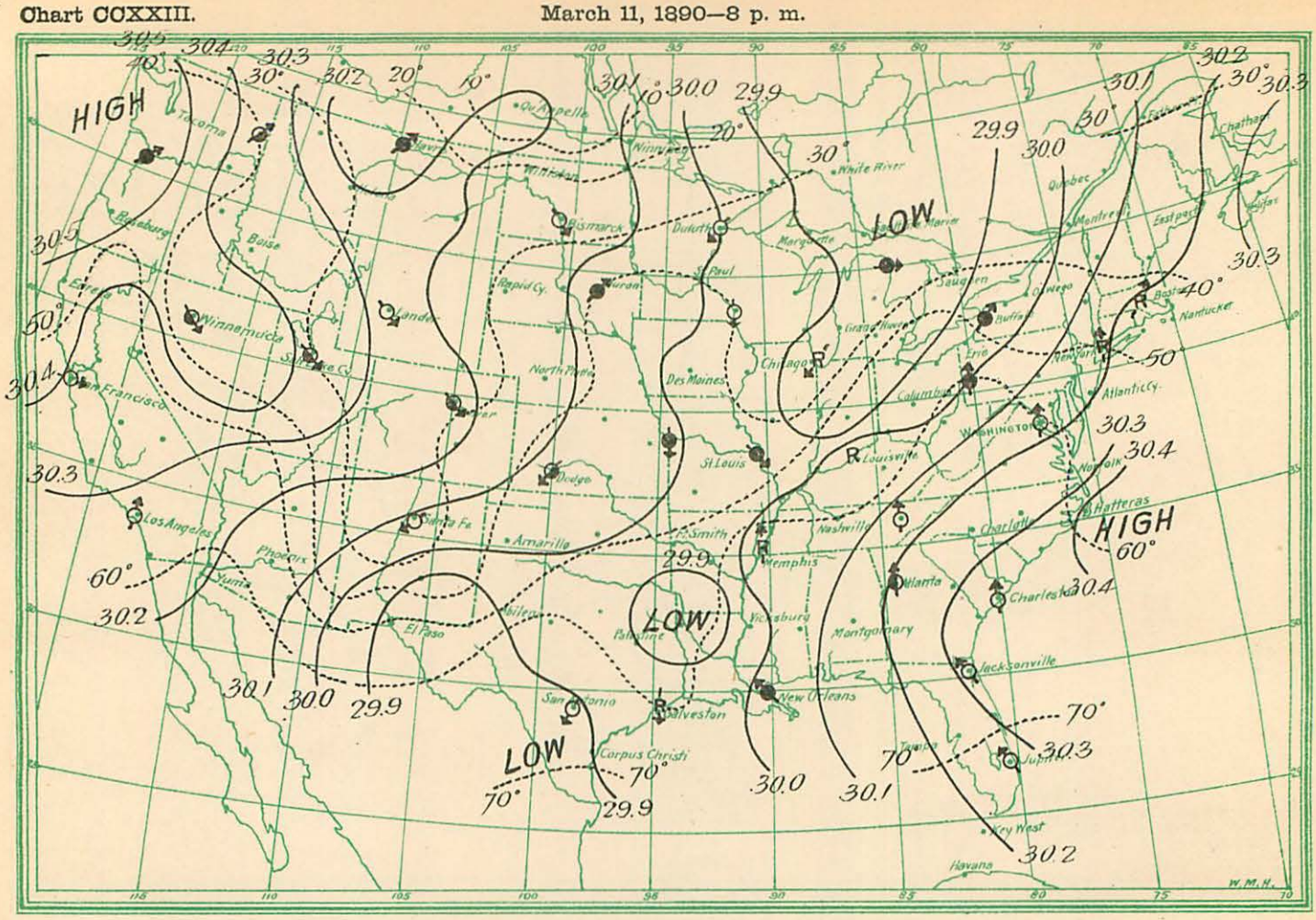


Chart CCXXIV. March 12, 1890—8 a. m.

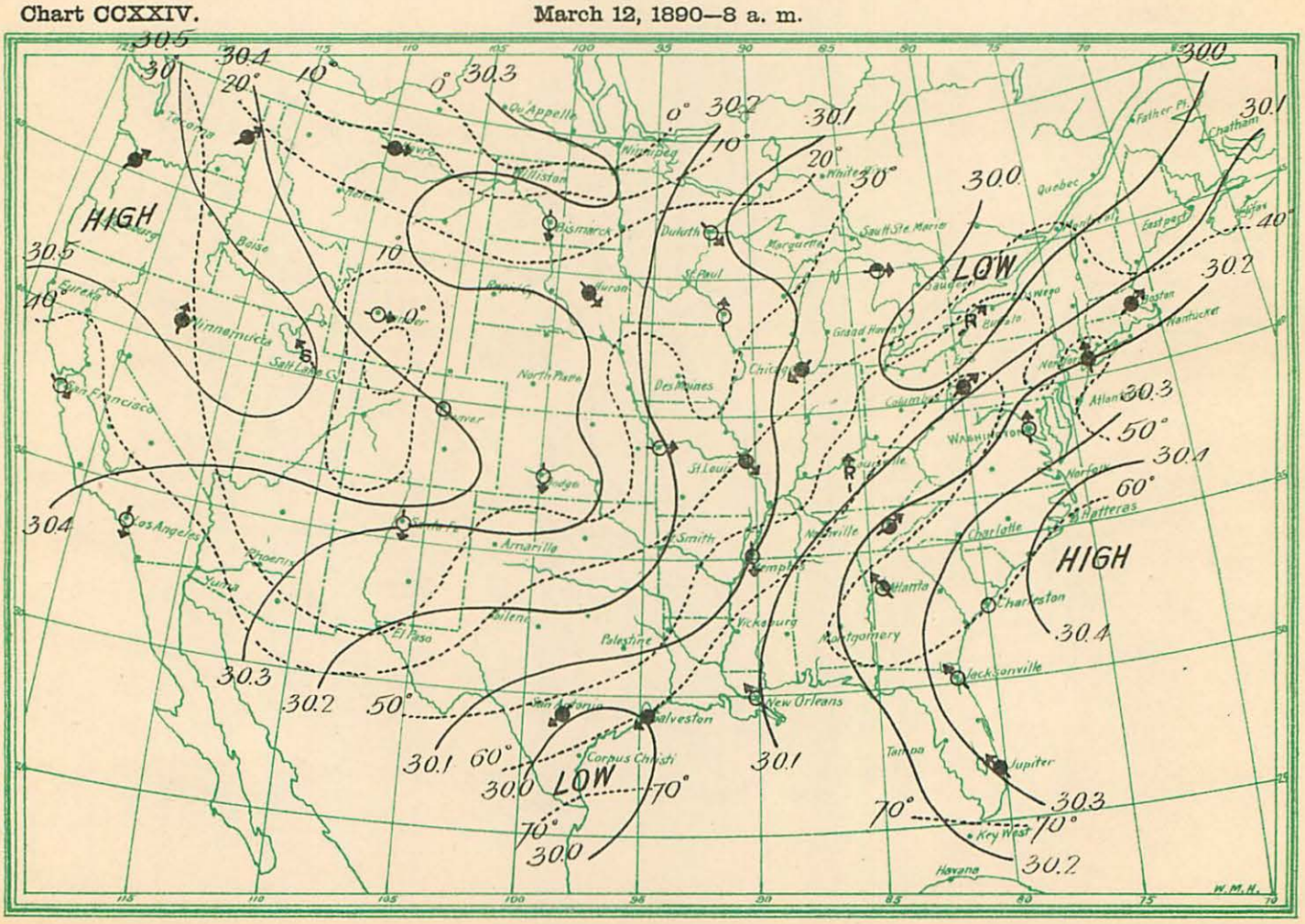


Chart CCXXV. March 14, 1890—8 a. m.

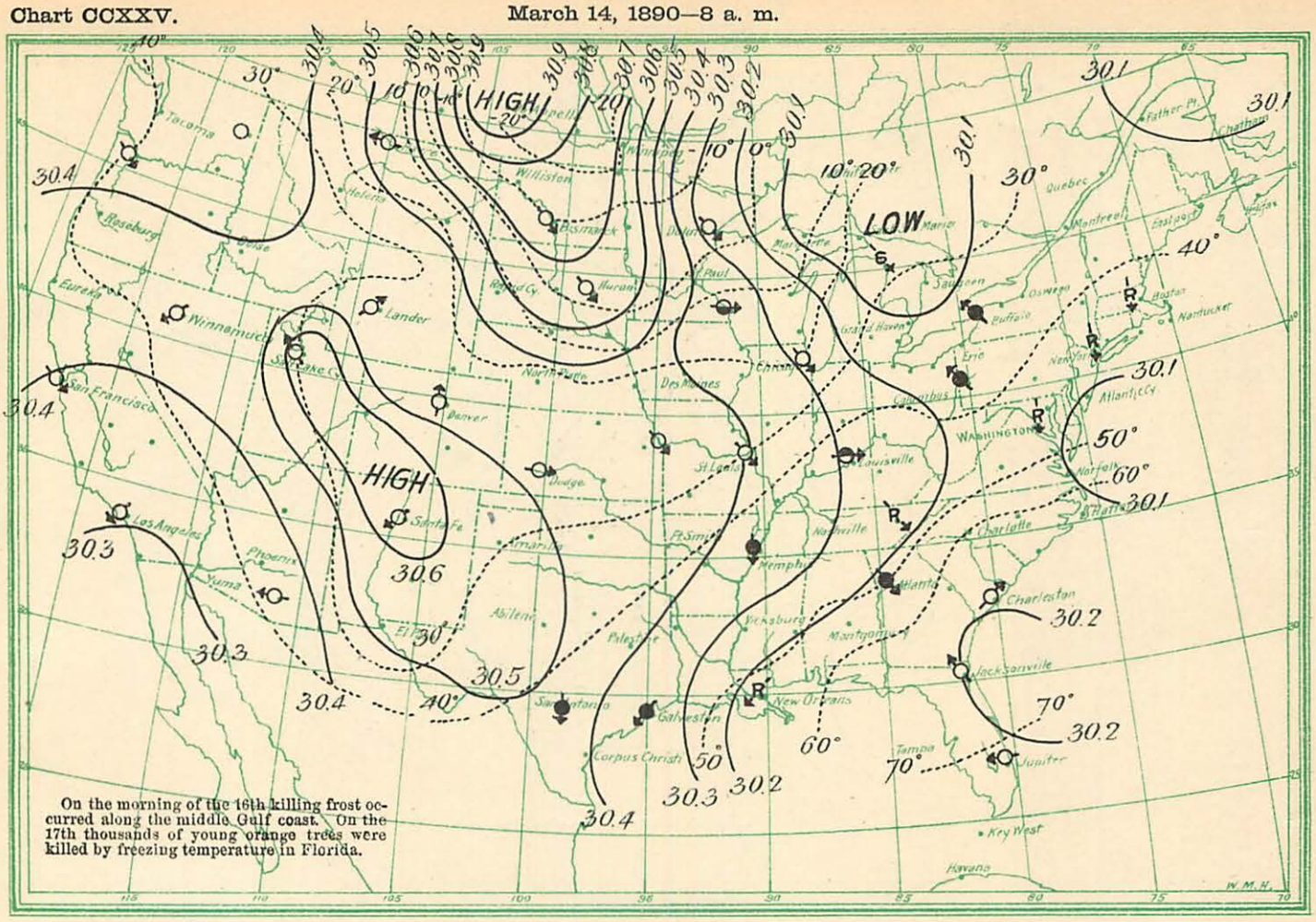


Chart CCXXVI. March 15, 1890—8 a. m.

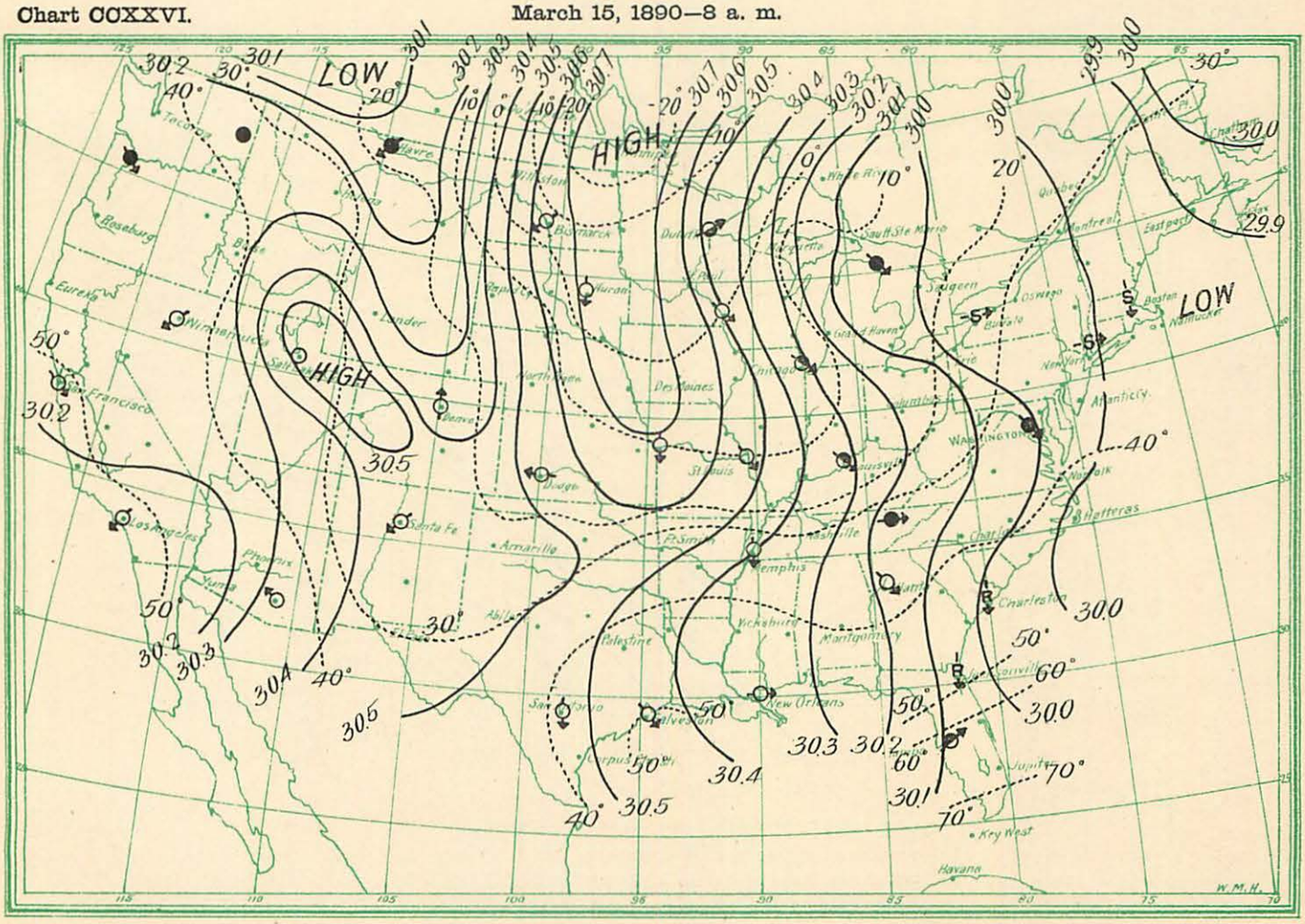


Chart CCXXVII. March 16, 1890—8 a. m

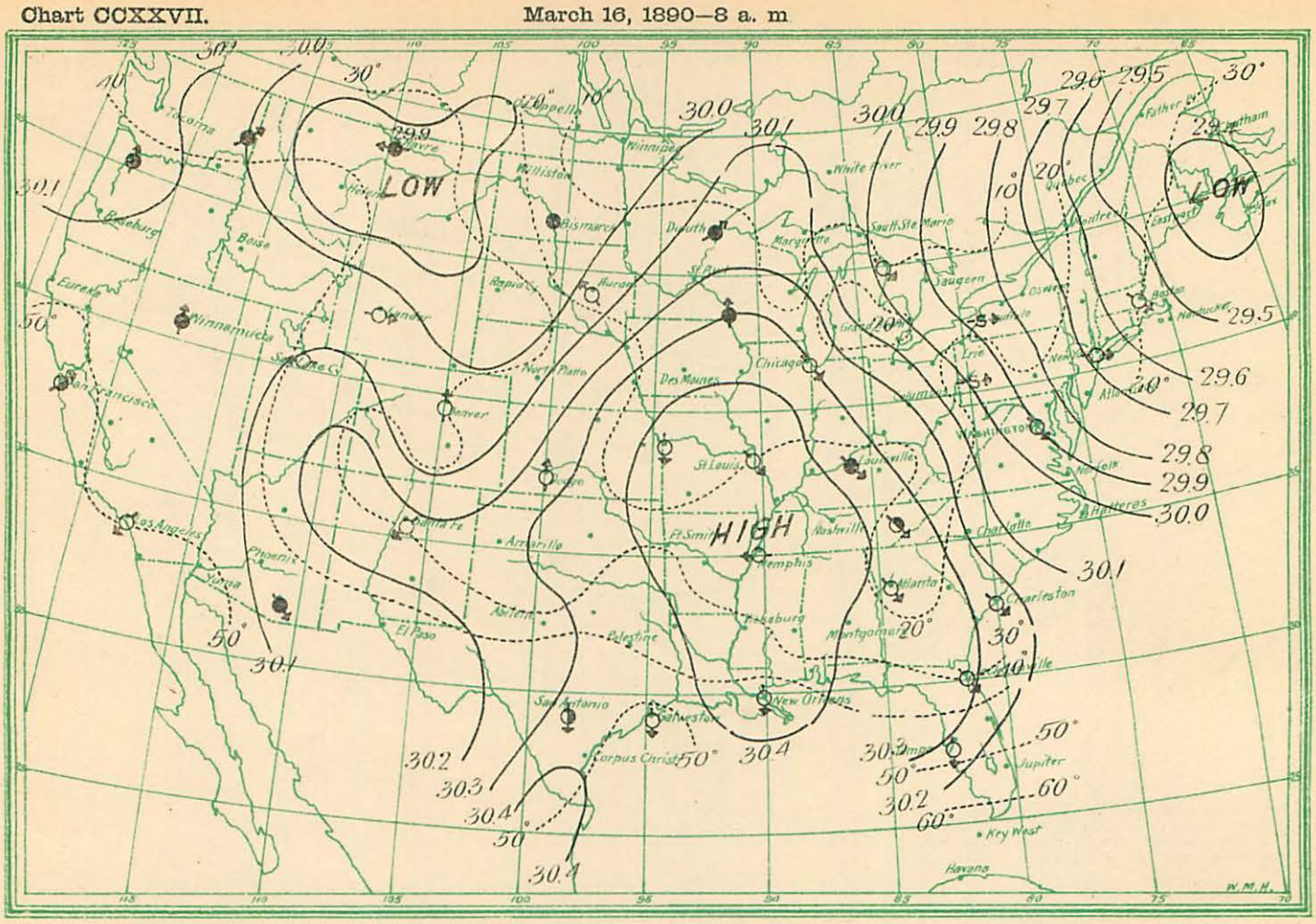


Chart CCXXVIII. March 17, 1890—8 a. m.

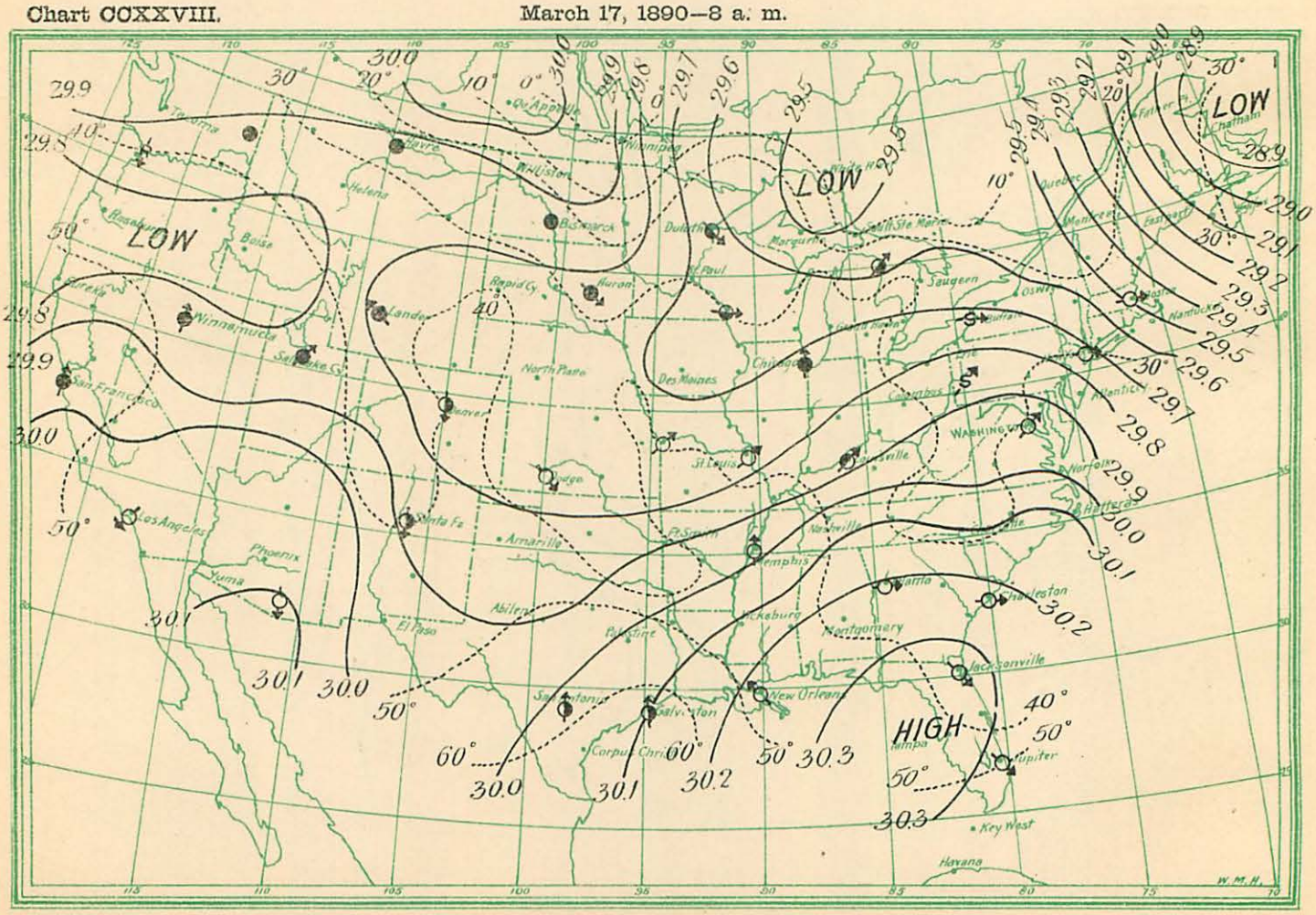


Chart CCXXIX. March 9, 1892—8 a. m.

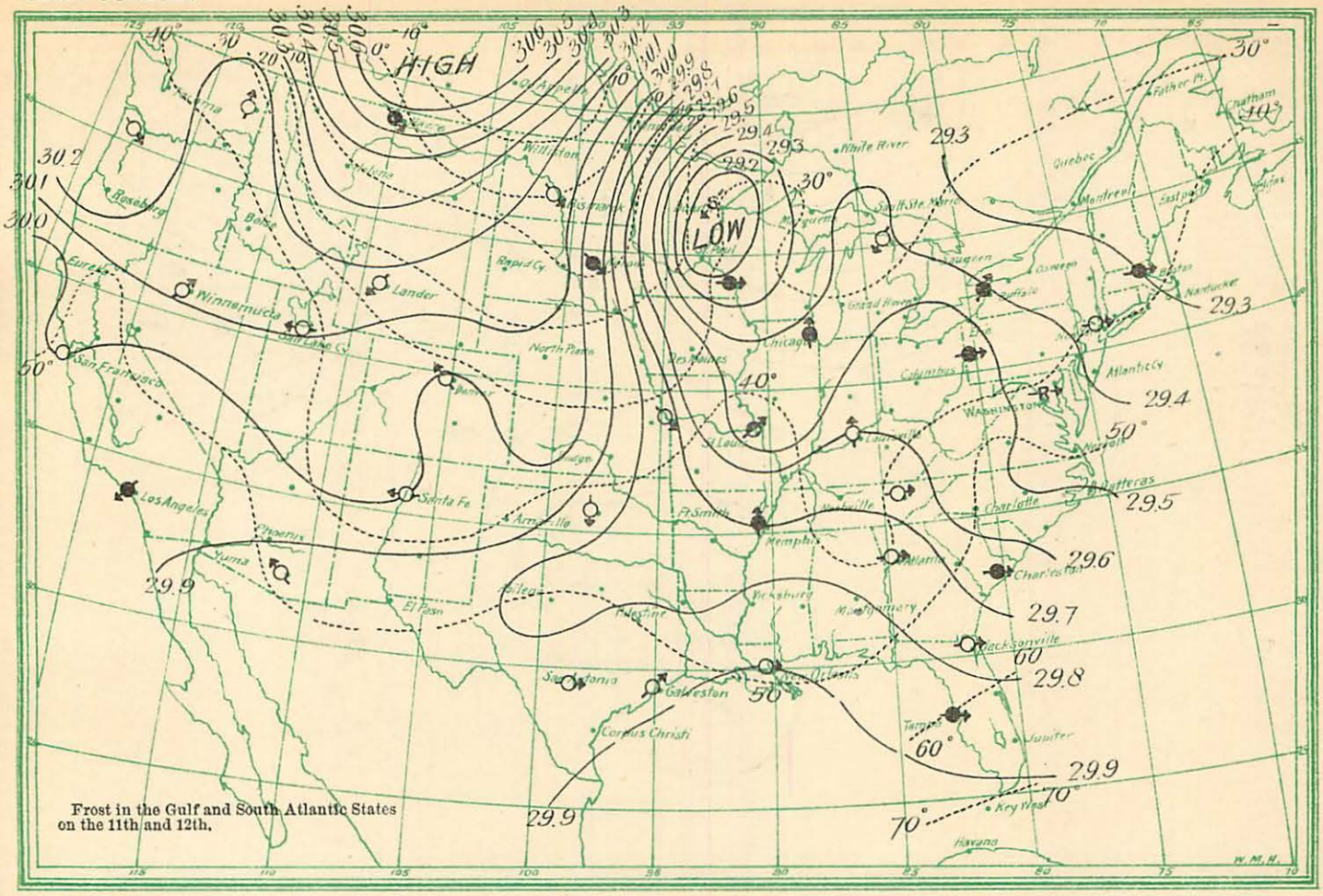


Chart CCXXX. March 10, 1892—8 a. m.

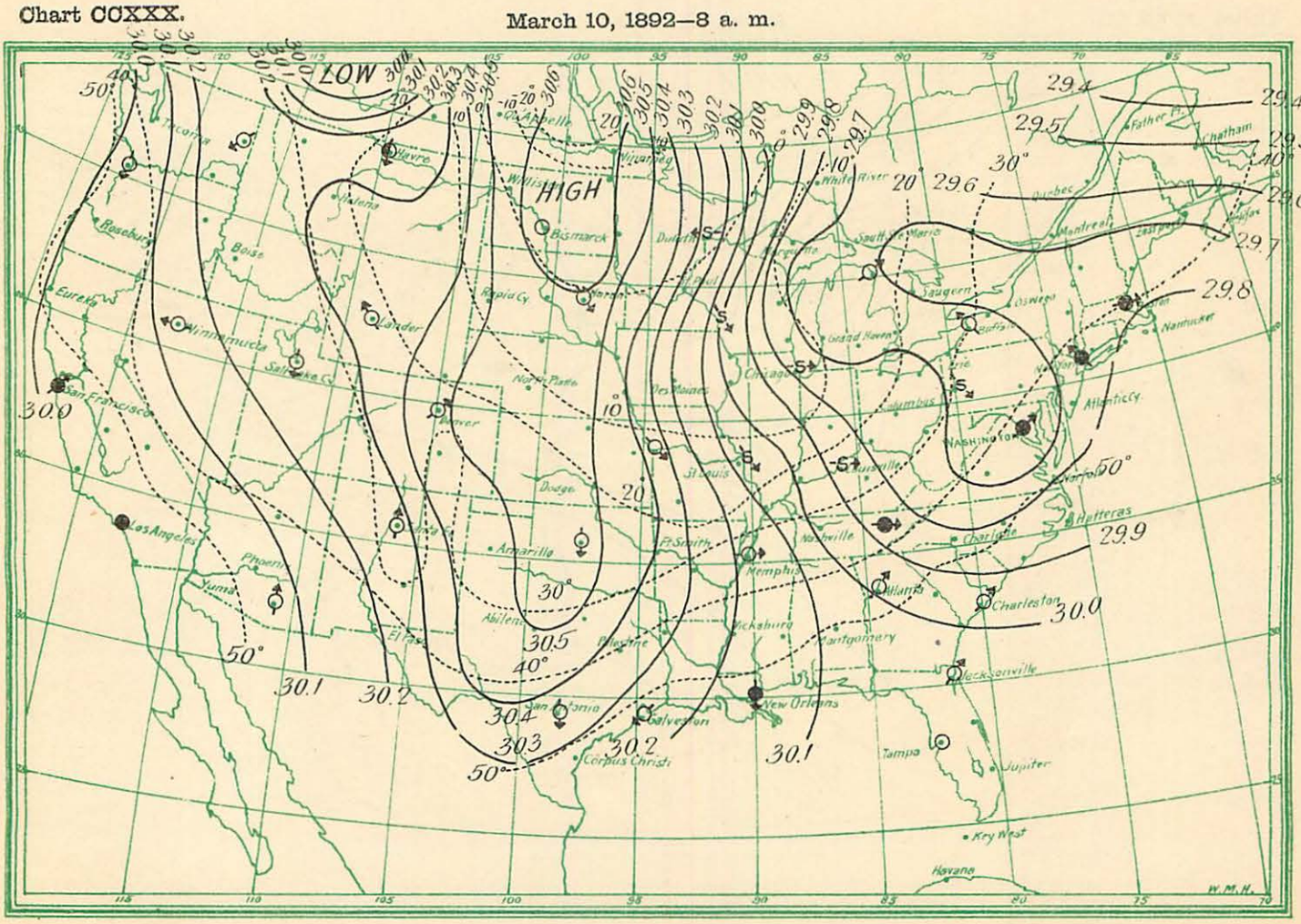


Chart CCXXXI. March 11, 1892—8 a. m.

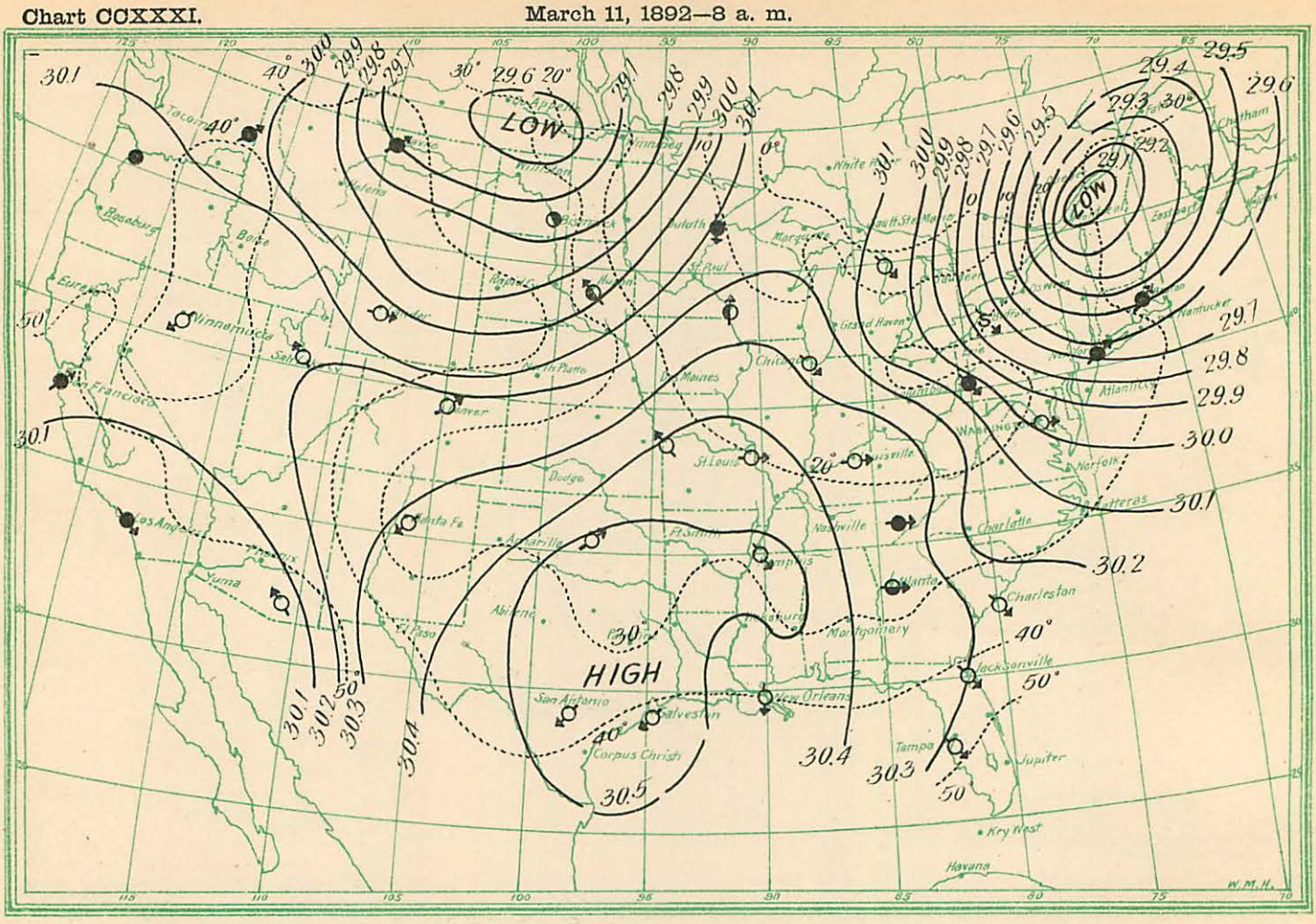


Chart CCXXXII. March 12, 1892—8 a. m.

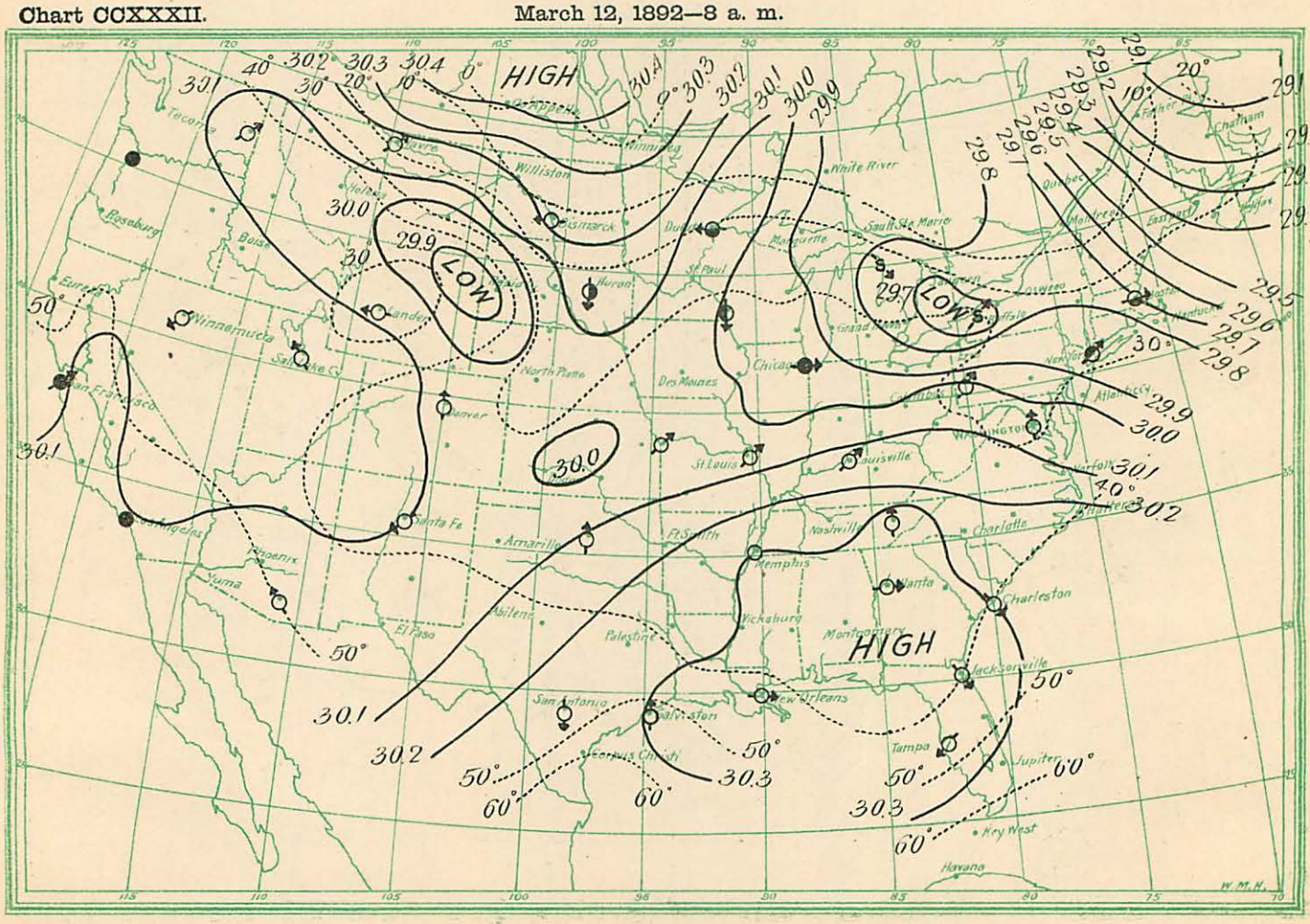


Chart CCXXXIII. **March 16, 1892—8 a. m.**

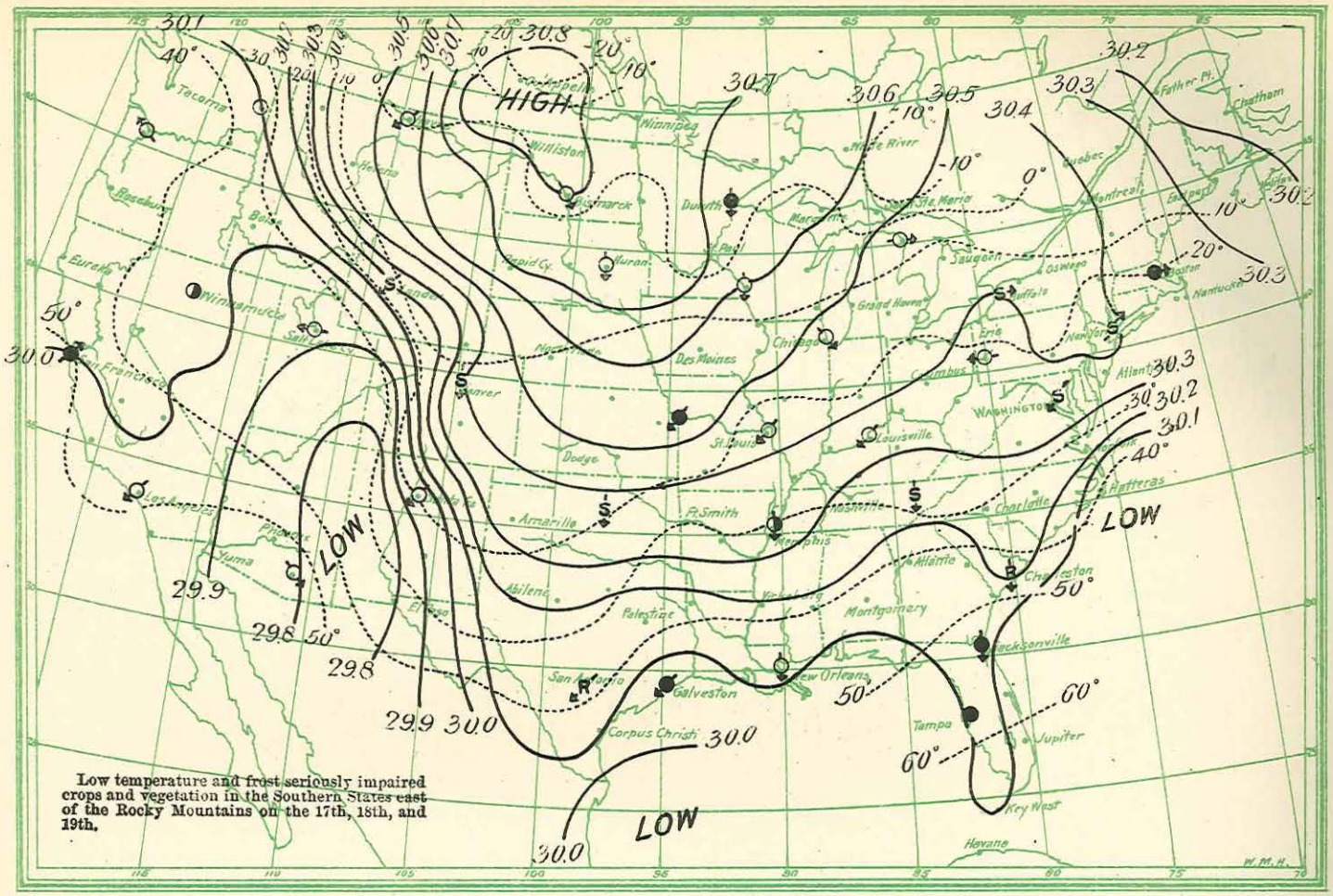


Chart CCXXXIV. **March 17, 1892—8 a. m.**

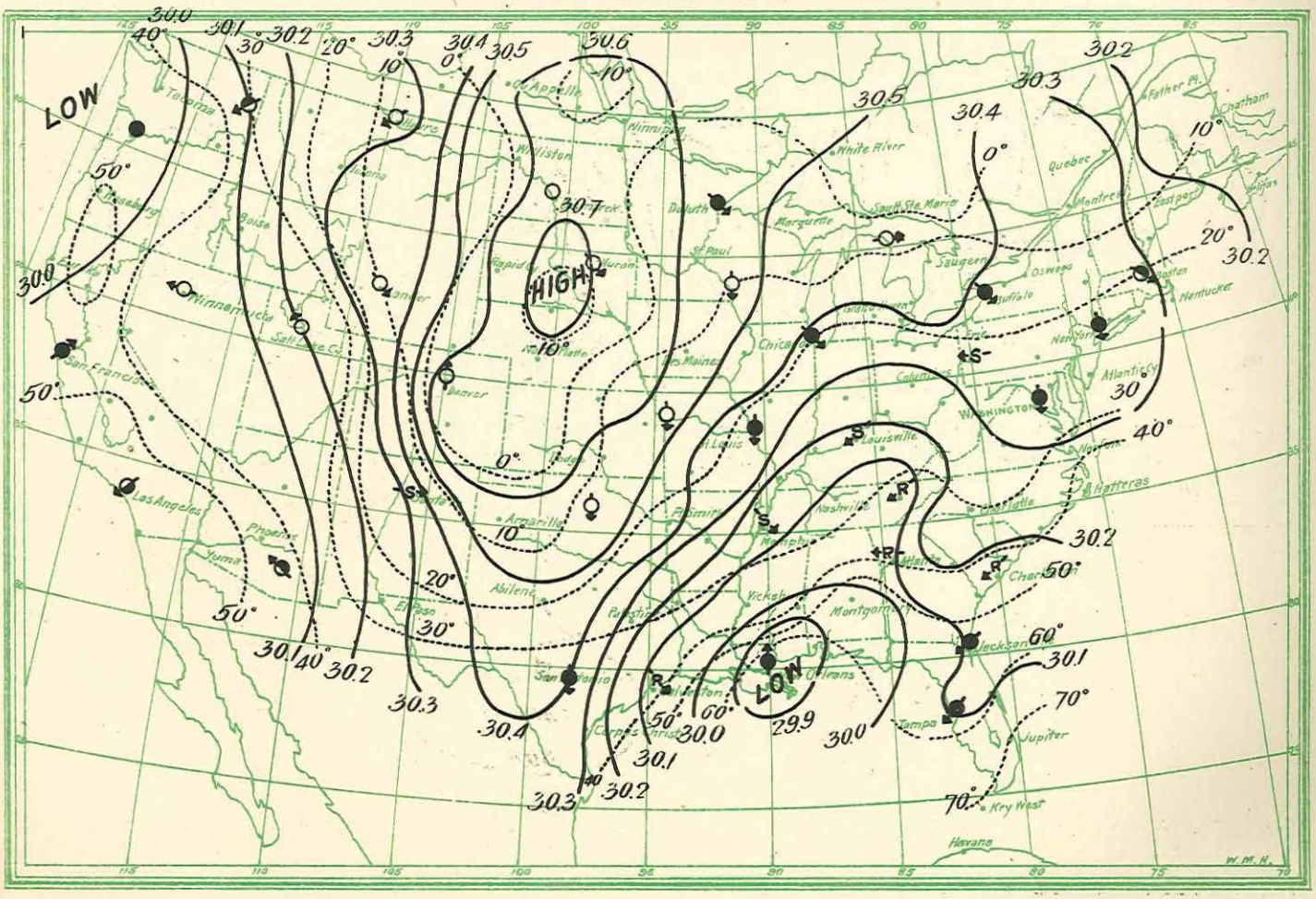


Chart CCXXXV. March 18, 1892—8 a. m.

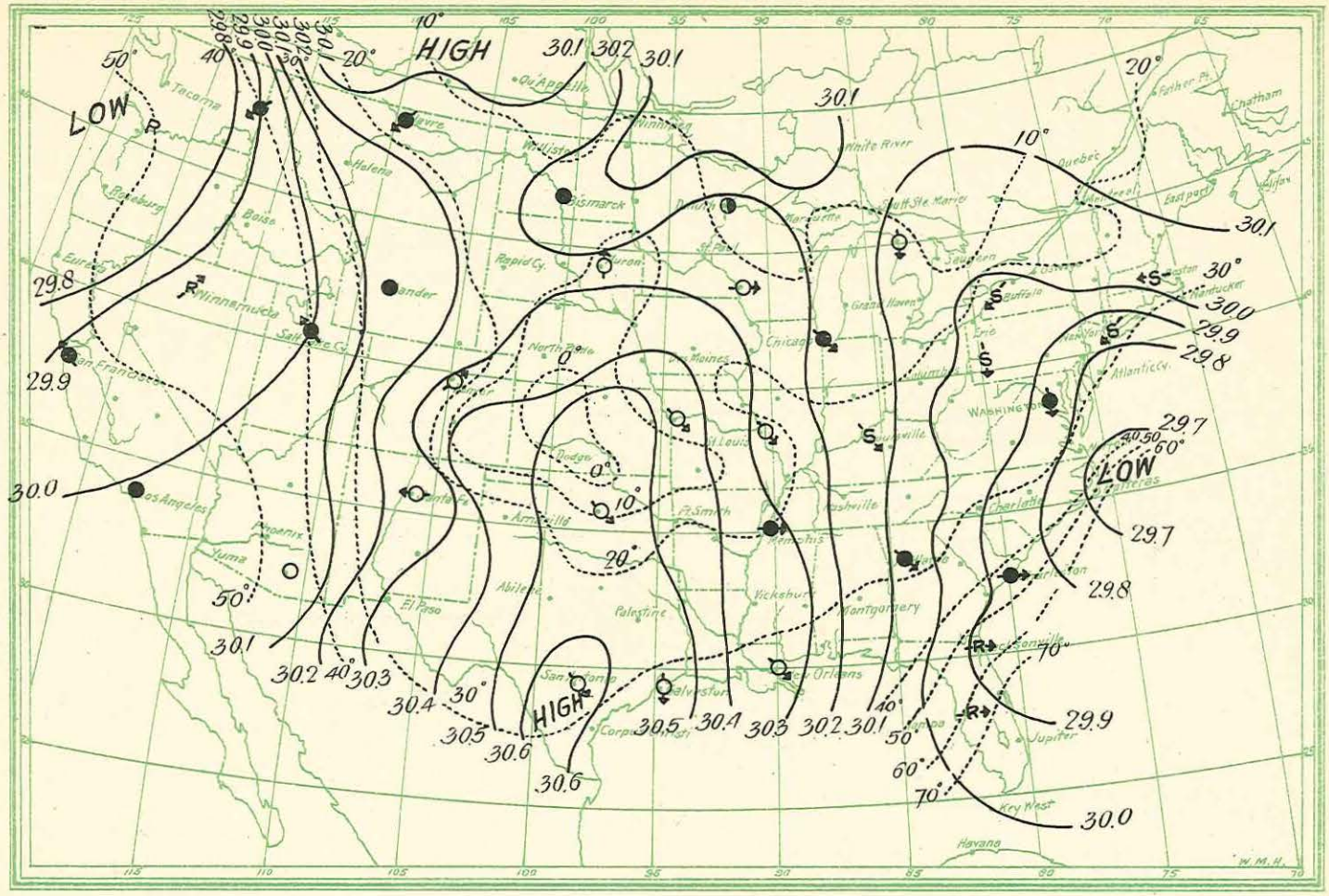


Chart CCXXXVI. March 19, 1892—8 a. m.

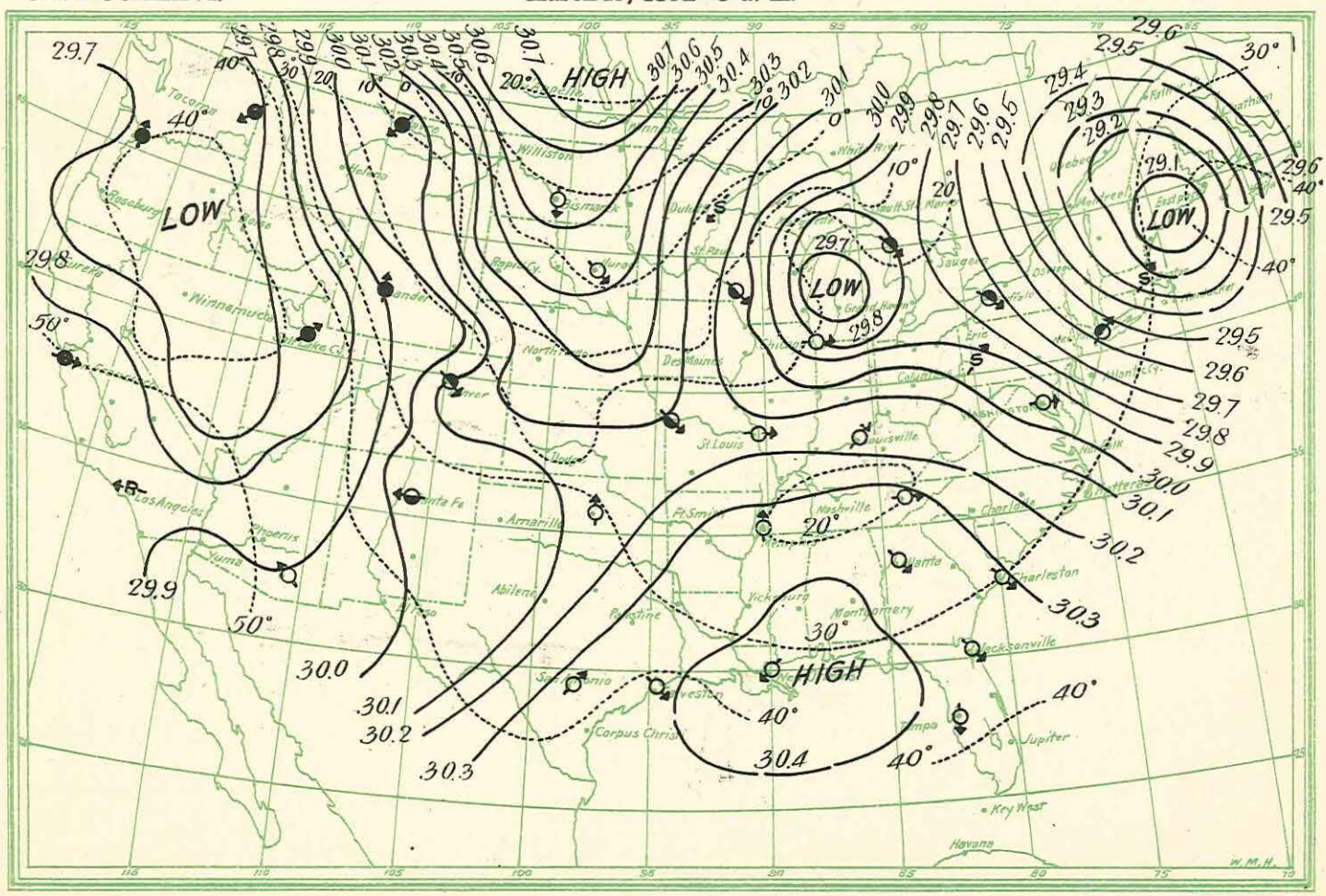


Chart CCXXXVII. March 1, 1893—8 a. m.

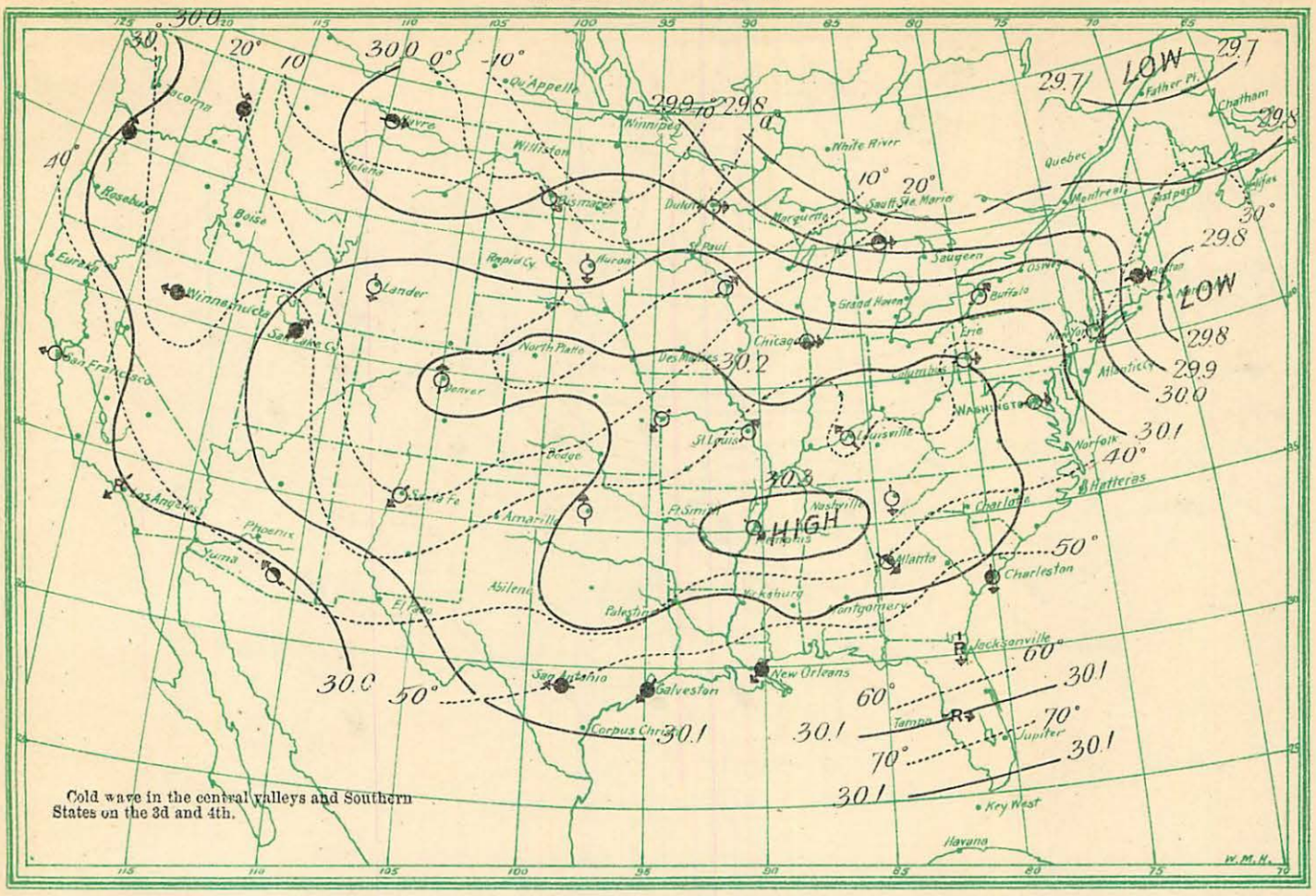


Chart CCXXXVIII. March 2, 1893—8 a. m.

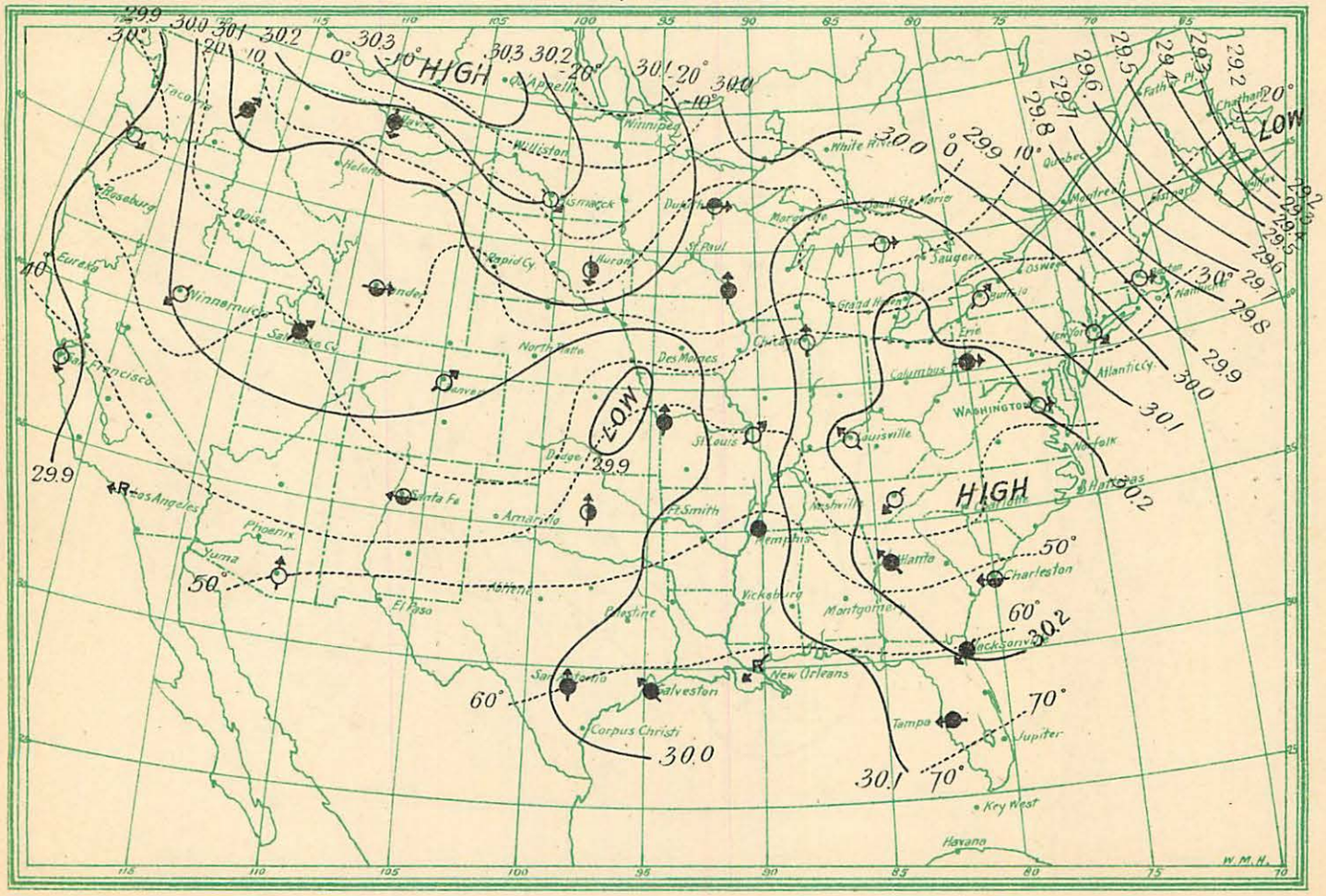


Chart CCXXXIX. March 3, 1893—8 a. m.

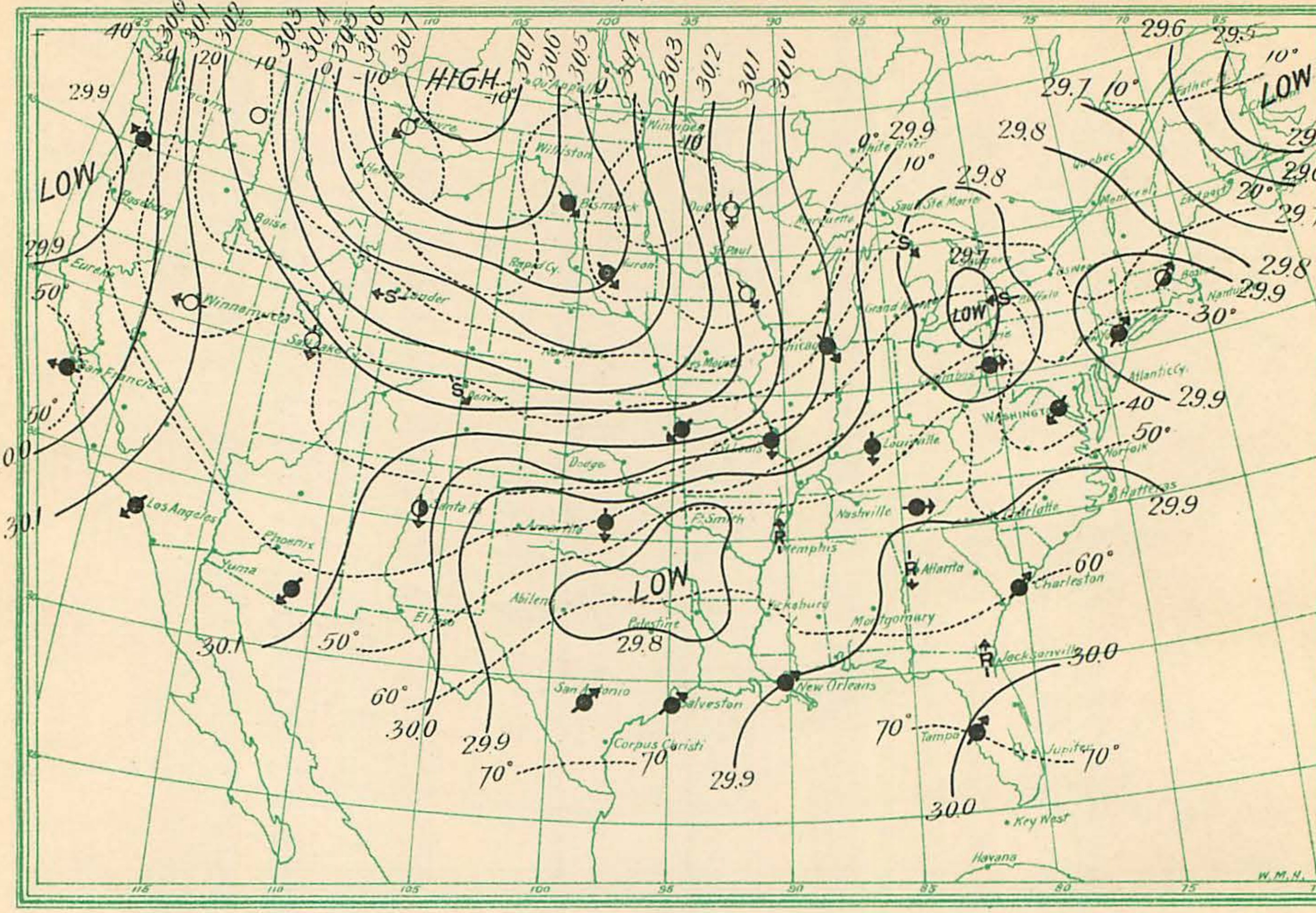


Chart CCXL. March 4, 1893—8 a. m.

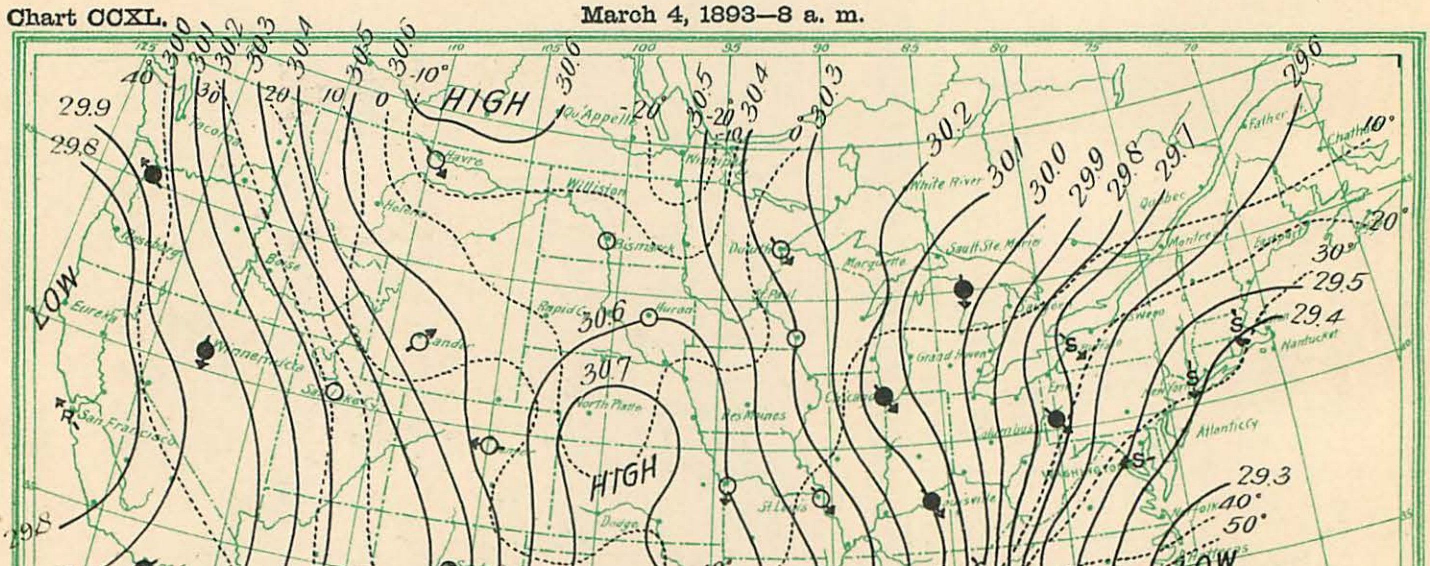


Chart CCXLI. March 12, 1893—8 a. m.

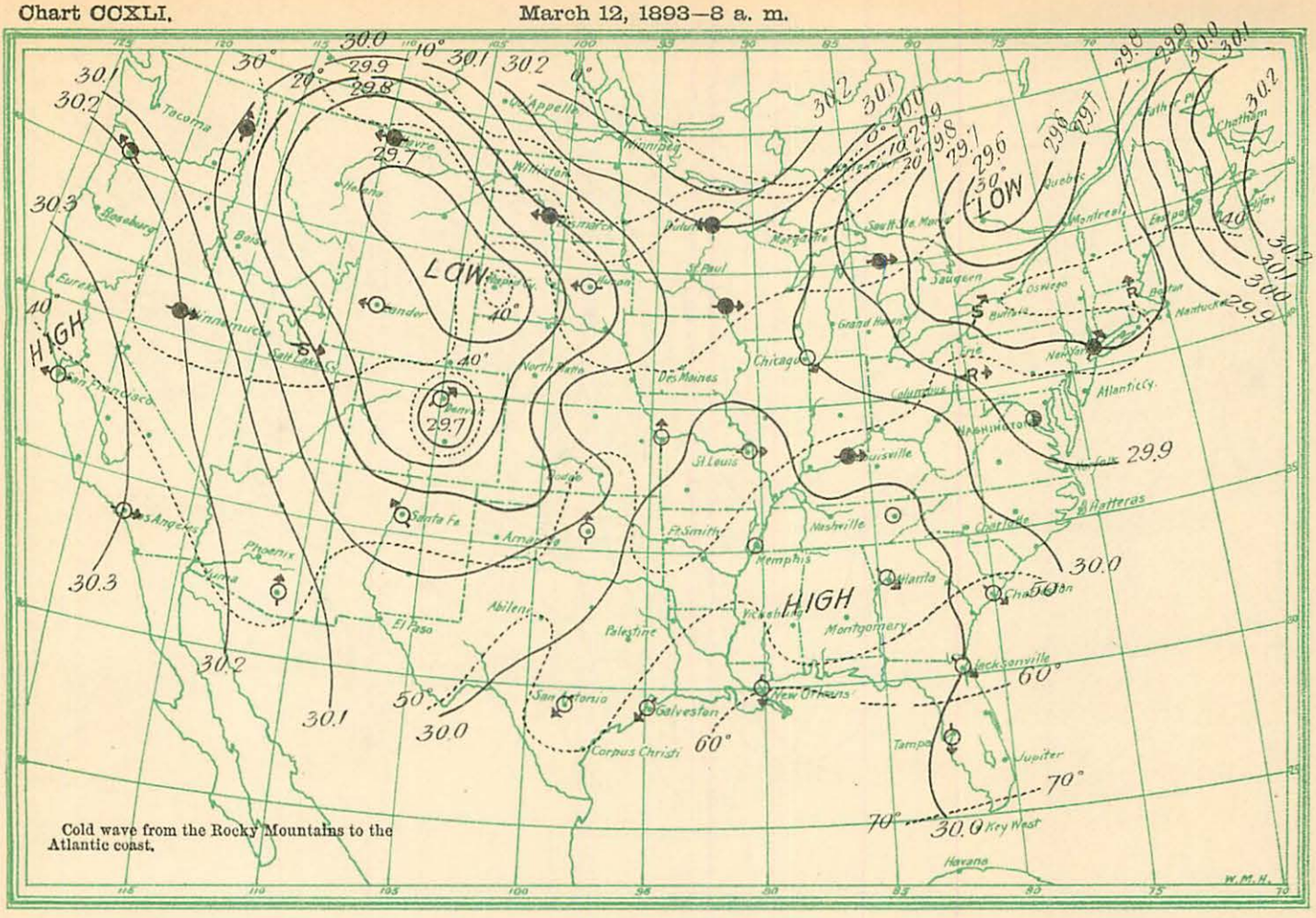


Chart CCXLII. March 13, 1893—8 a. m.

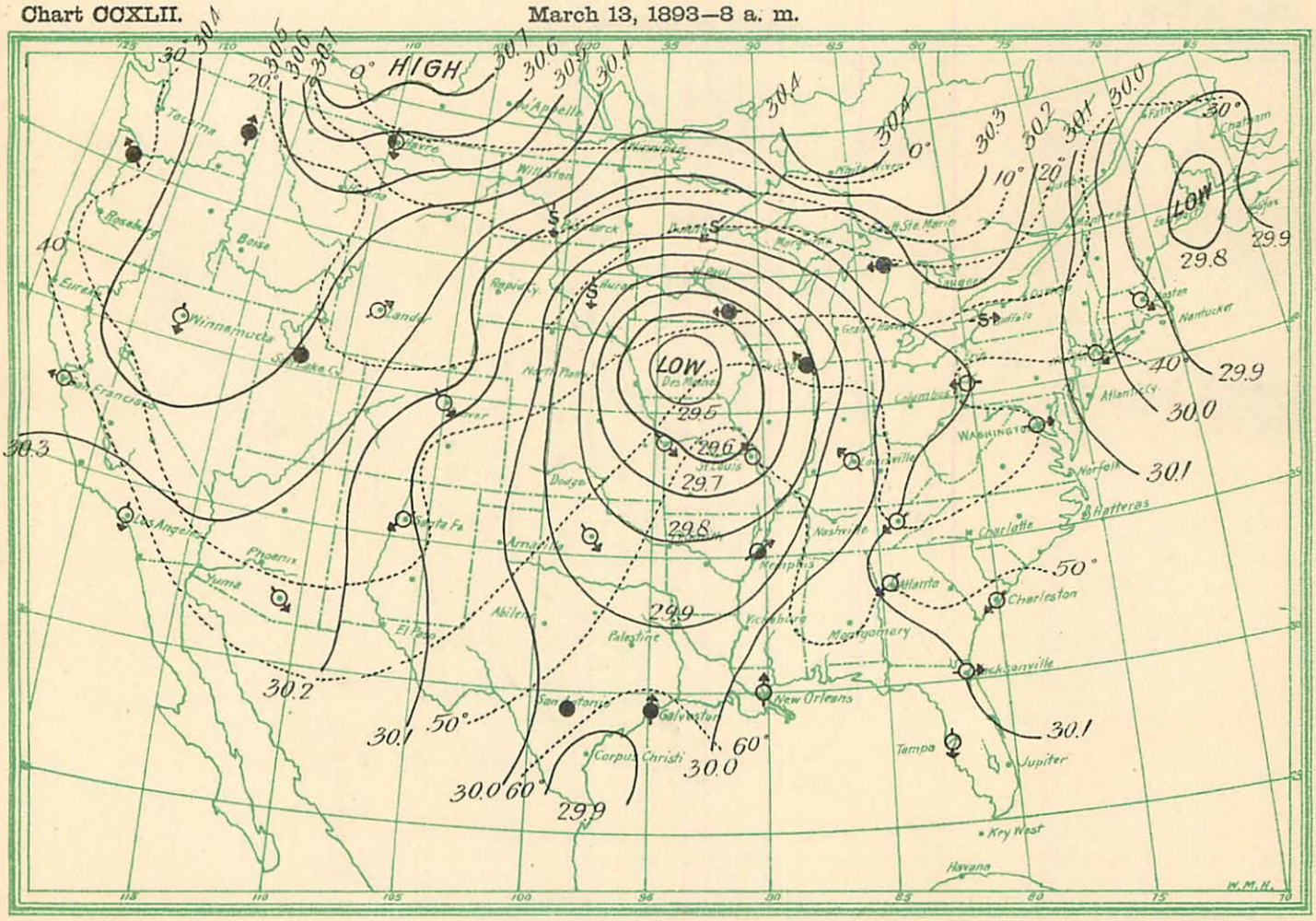


Chart CCXLIII.

March 14, 1893—8 a. m.

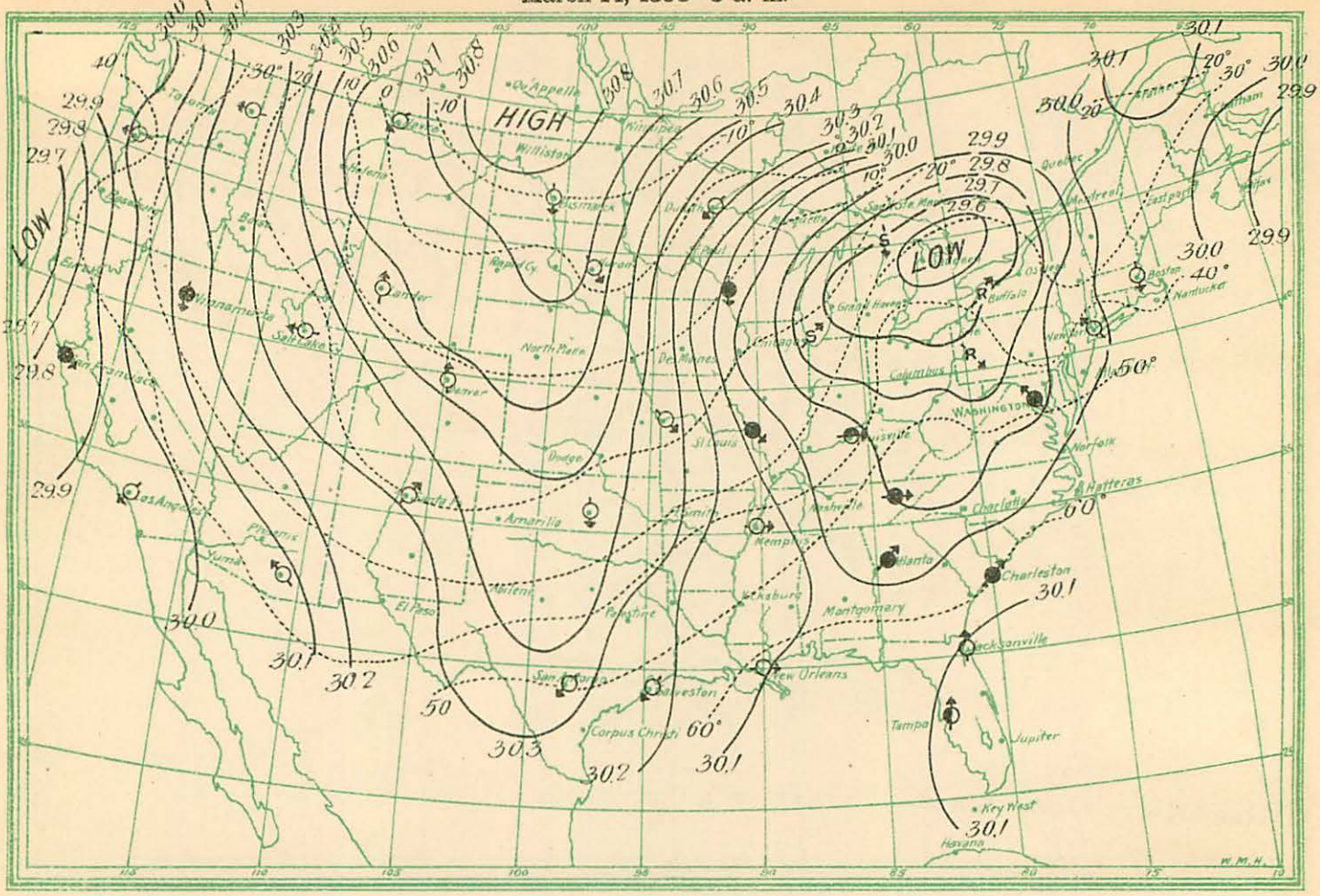


Chart CCXLIV.

March 15, 1893—8 a. m.

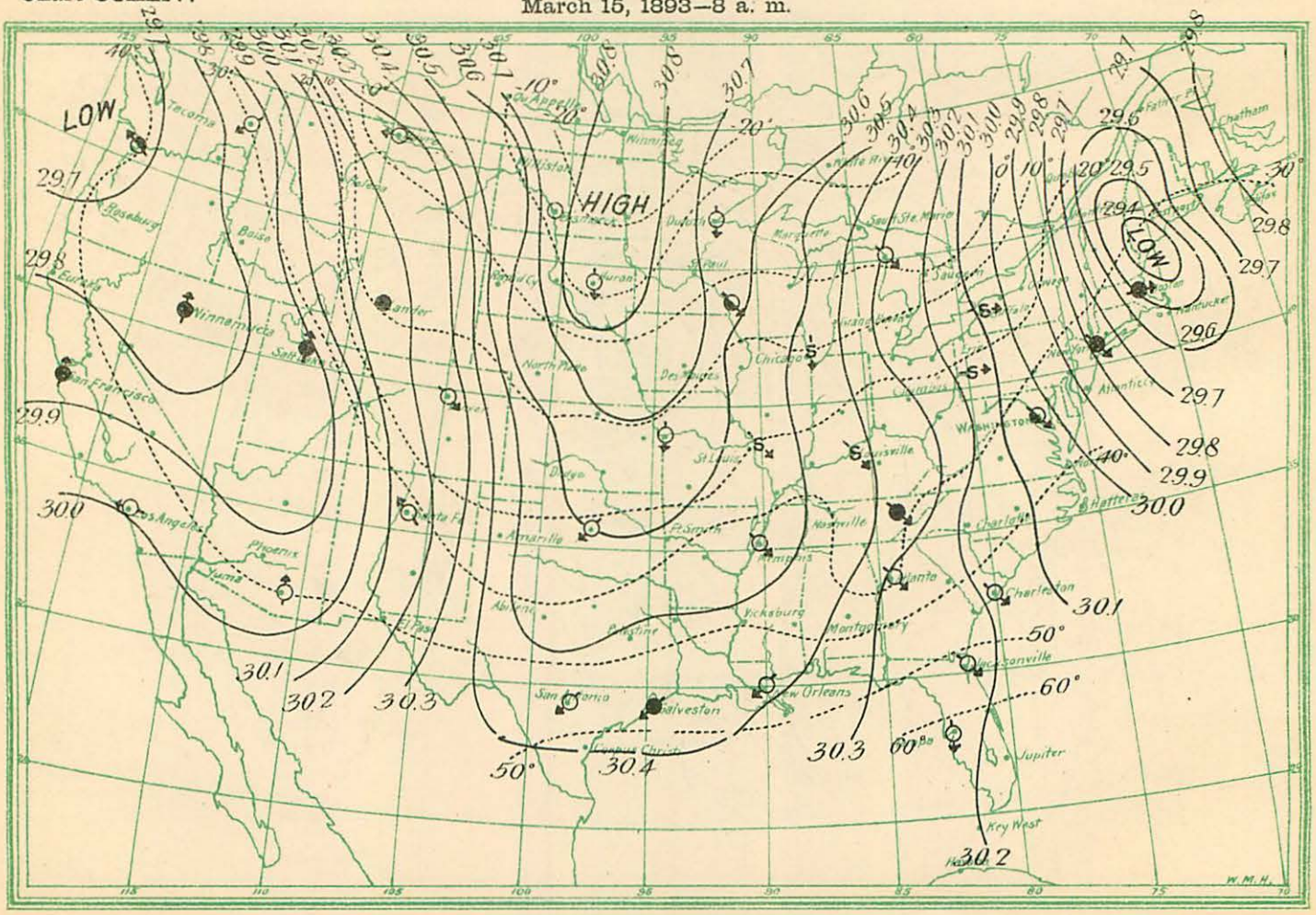


Chart CCXLV.

March 24, 1894—8 a. m.

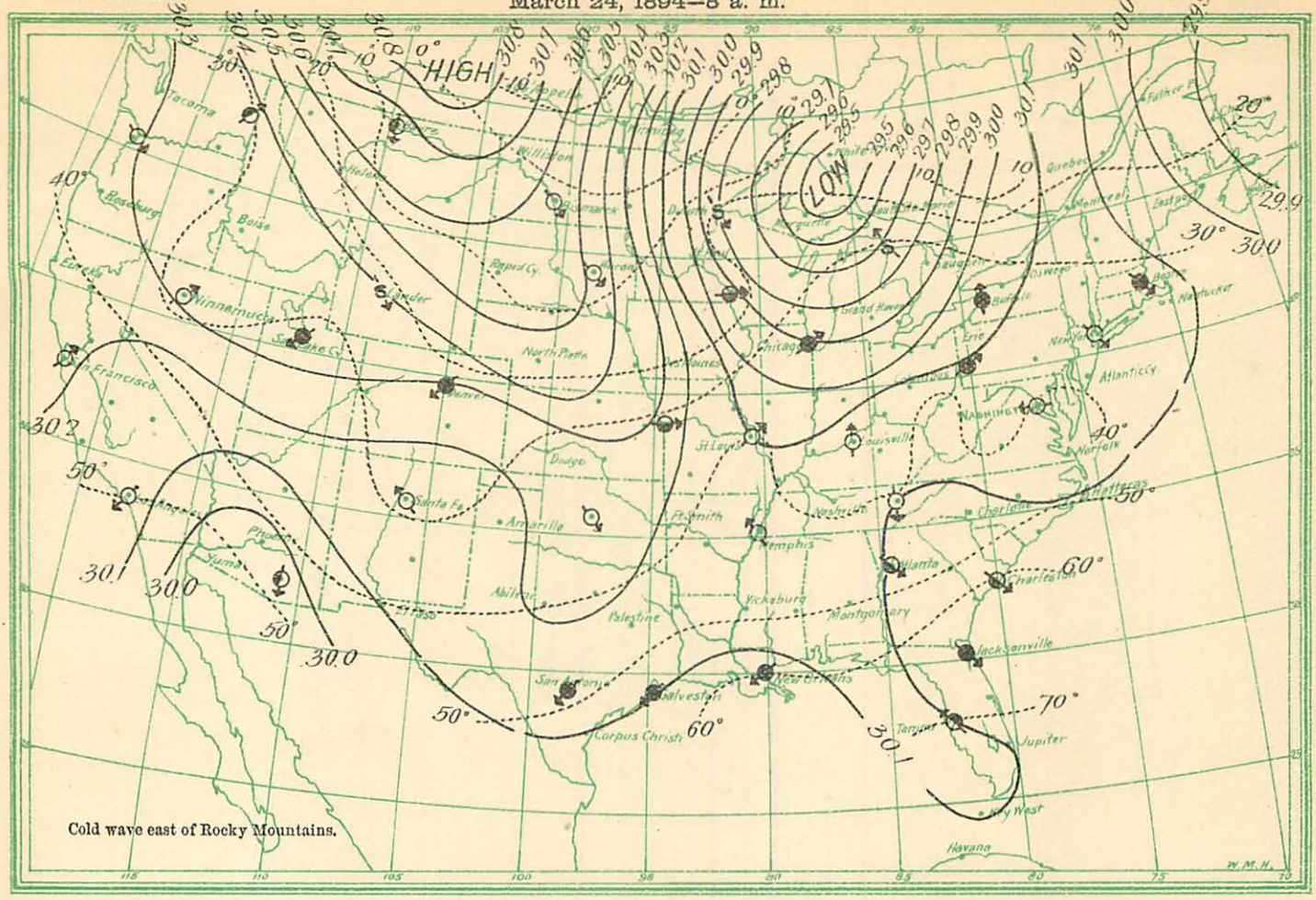


Chart CCXLVI.

March 25, 1894—8 a. m.

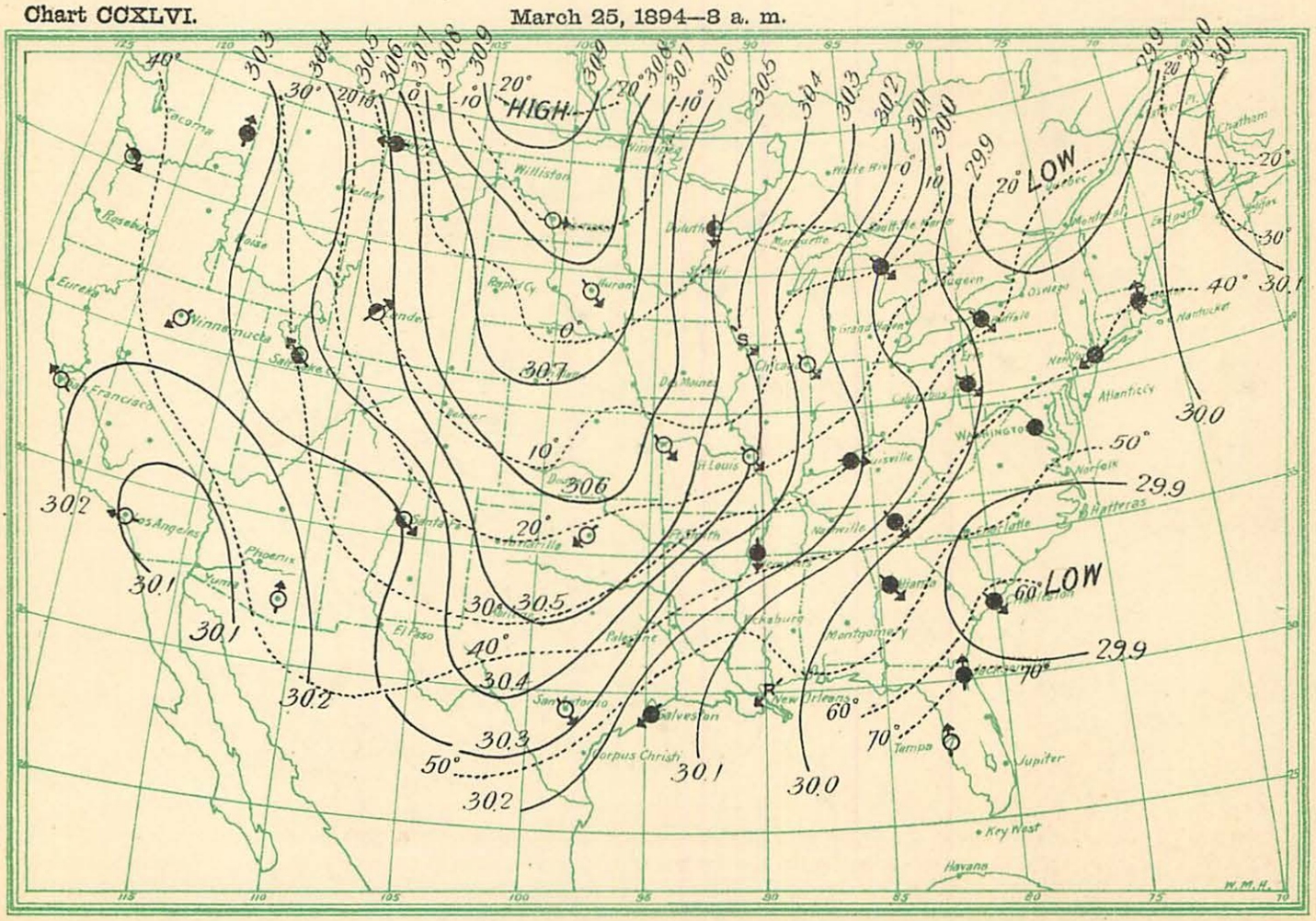


Chart CCXLVII. March 26, 1894—8 a. m.

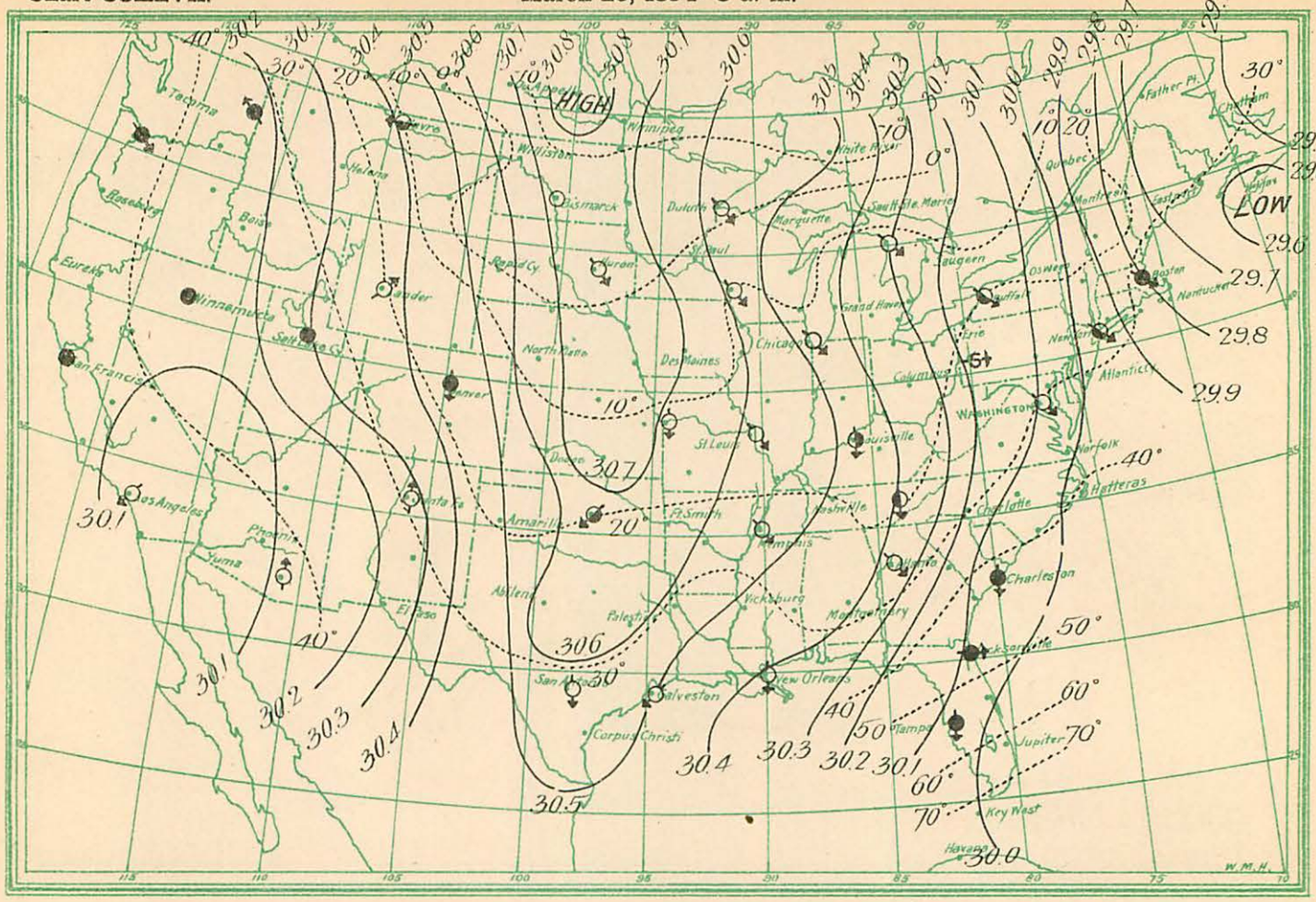


Chart CCXLVIII. March 27, 1894—8 a. m.

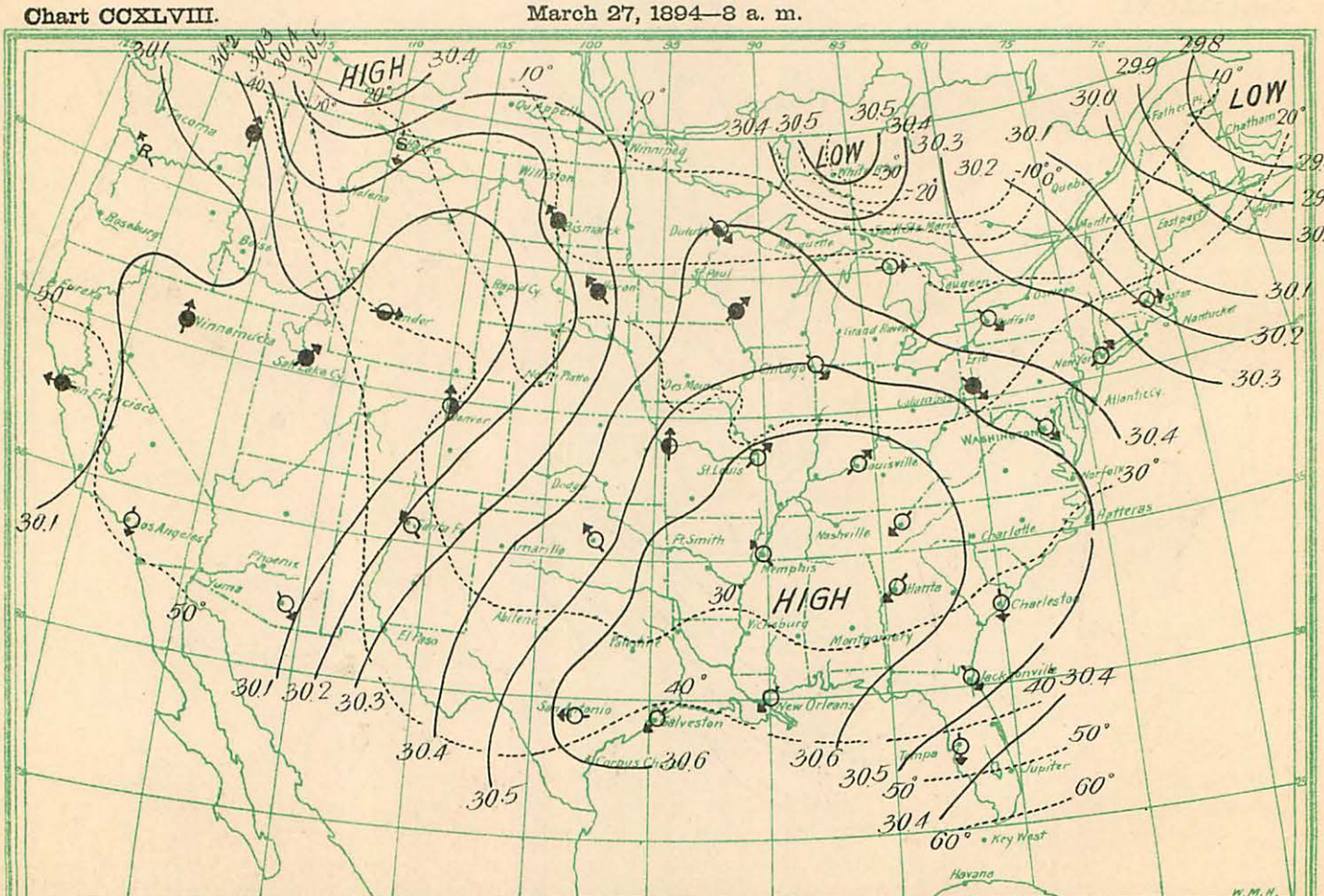


Chart CCXLIX. March 20, 1898—8 a. m.

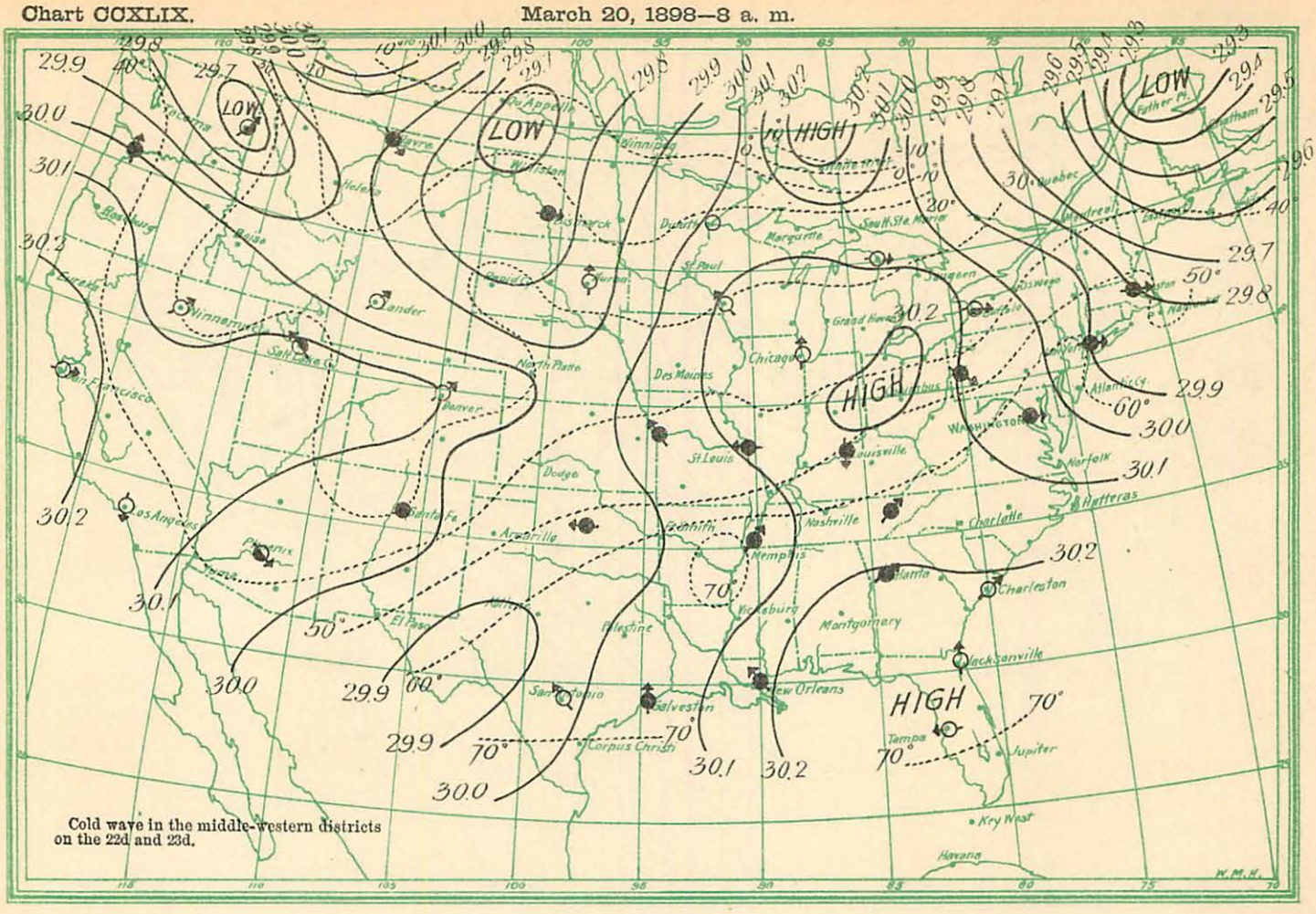


Chart CCL. March 21, 1898—8 a. m.

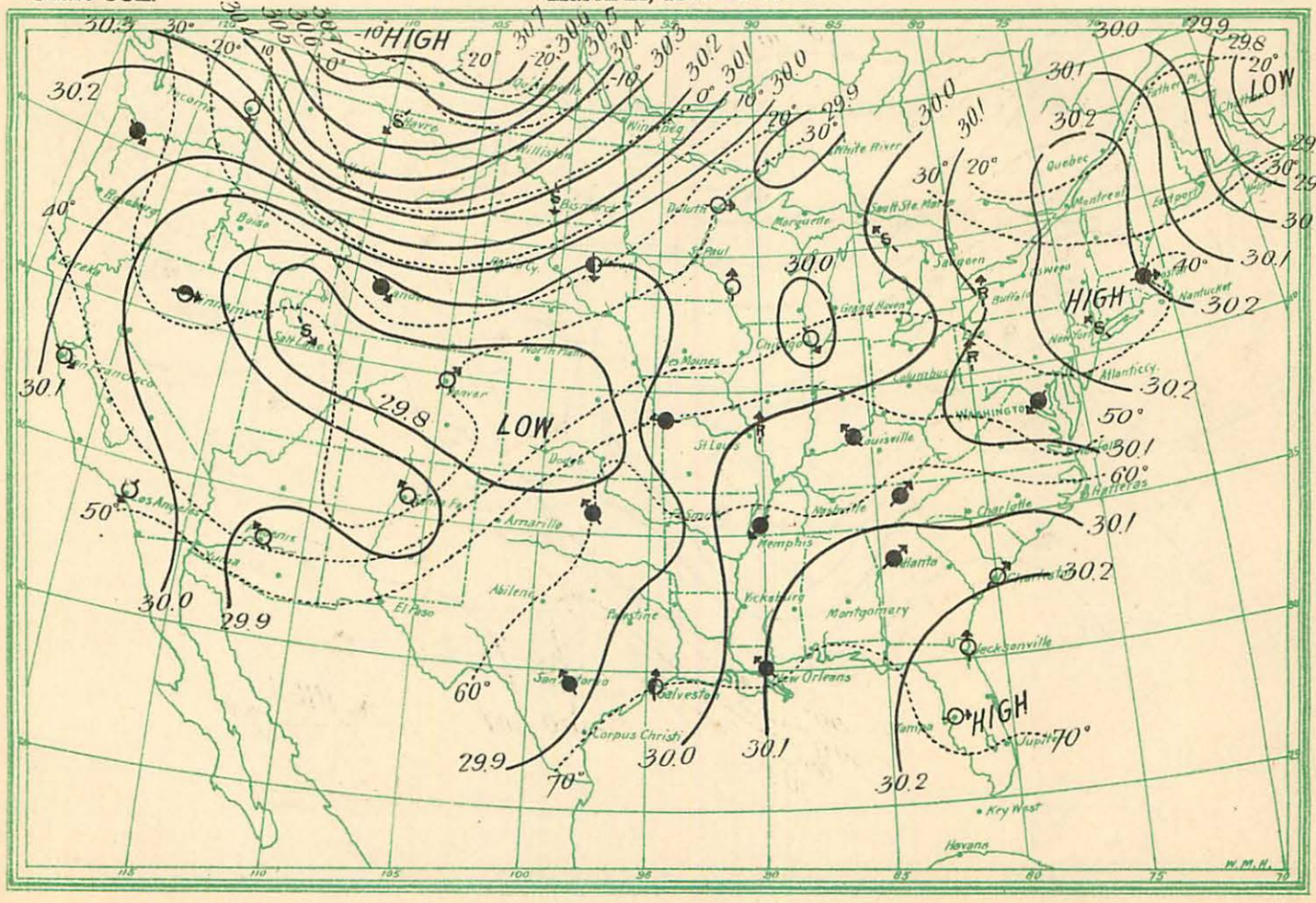


Chart CCLI. March 22, 1898—8 a. m.

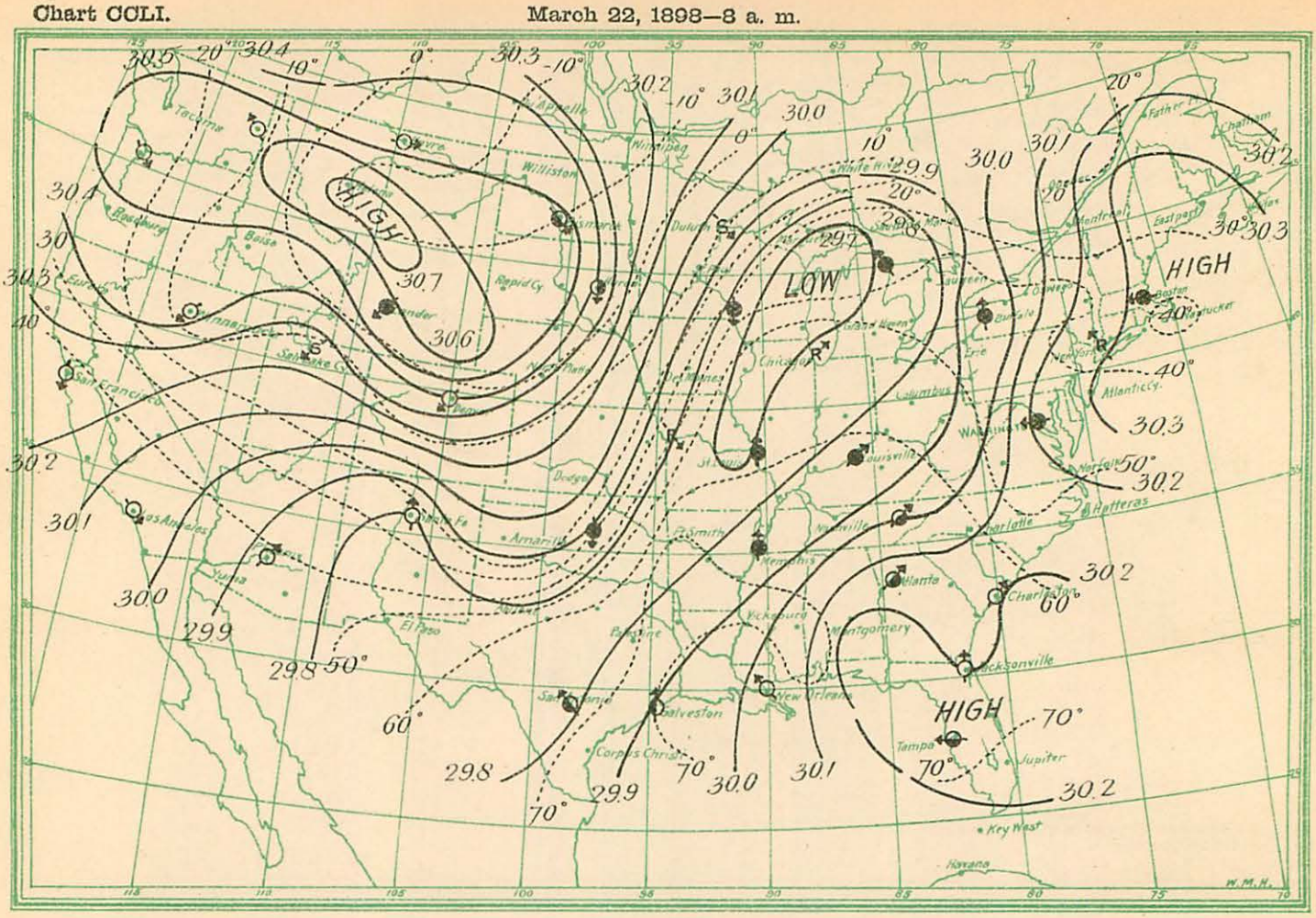


Chart CCLII. March 23, 1898—8 a. m.

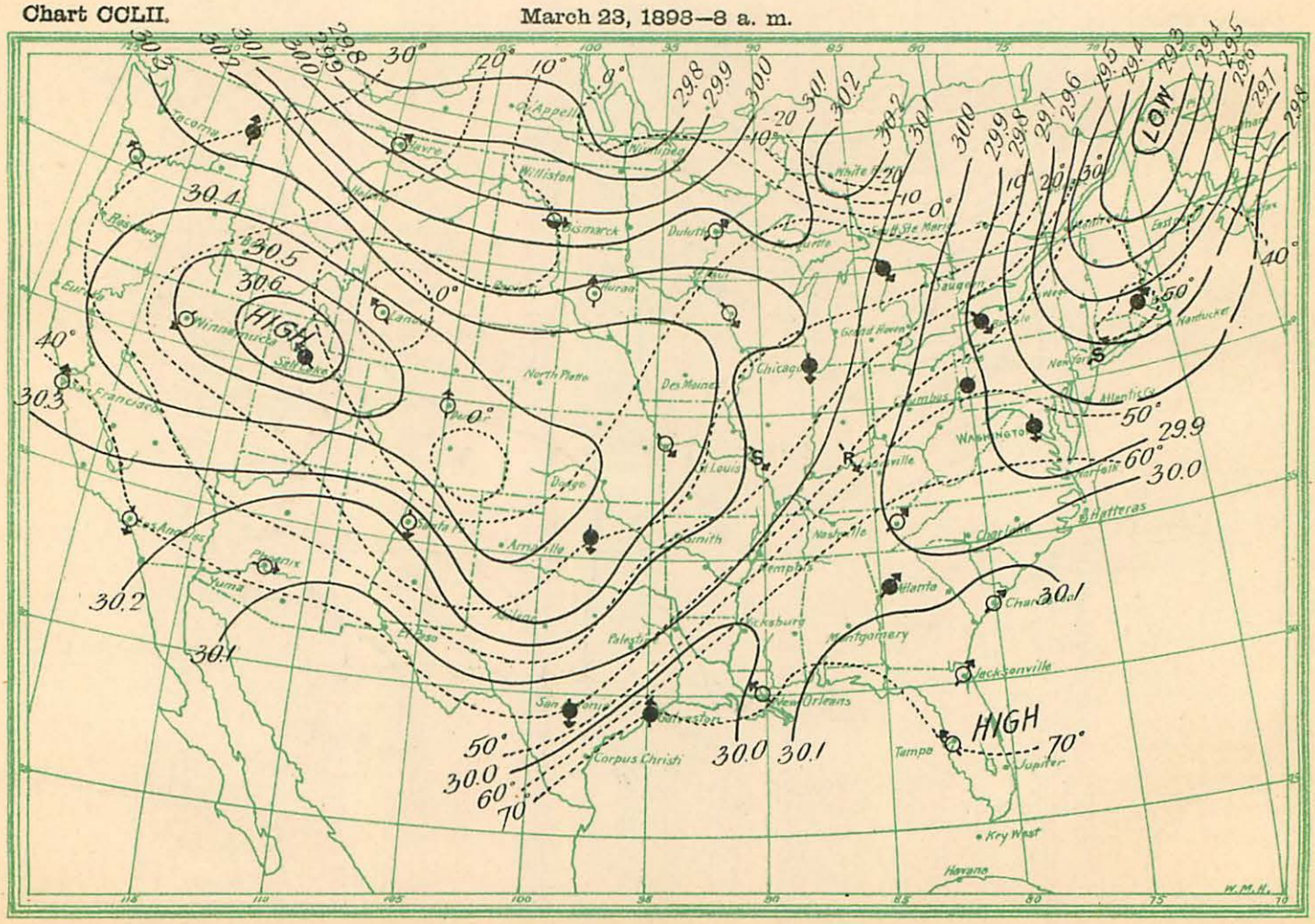


Chart CCLIII. March 24, 1898—8 a. m.

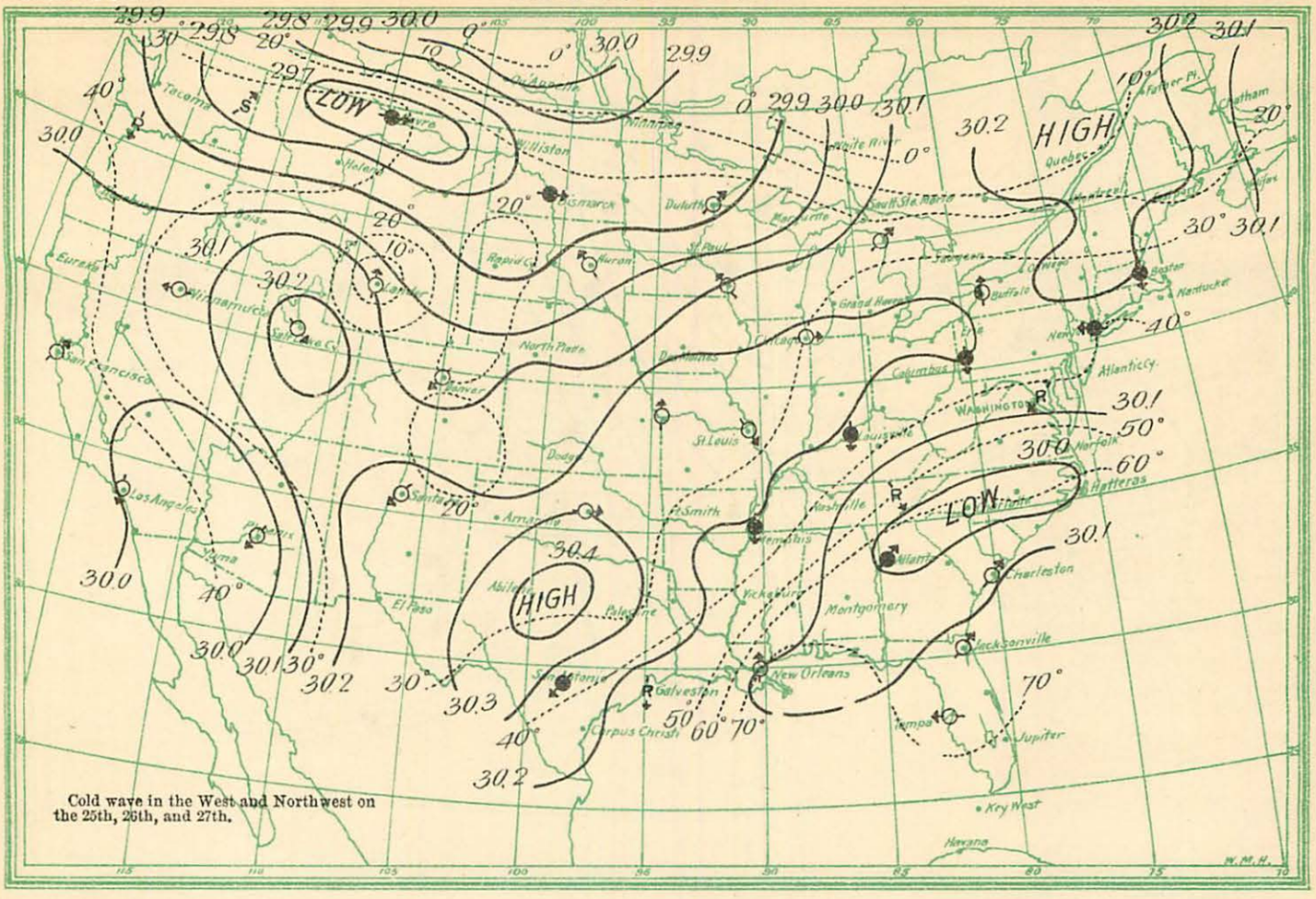


Chart CCLIV. March 25, 1898—8 a. m.

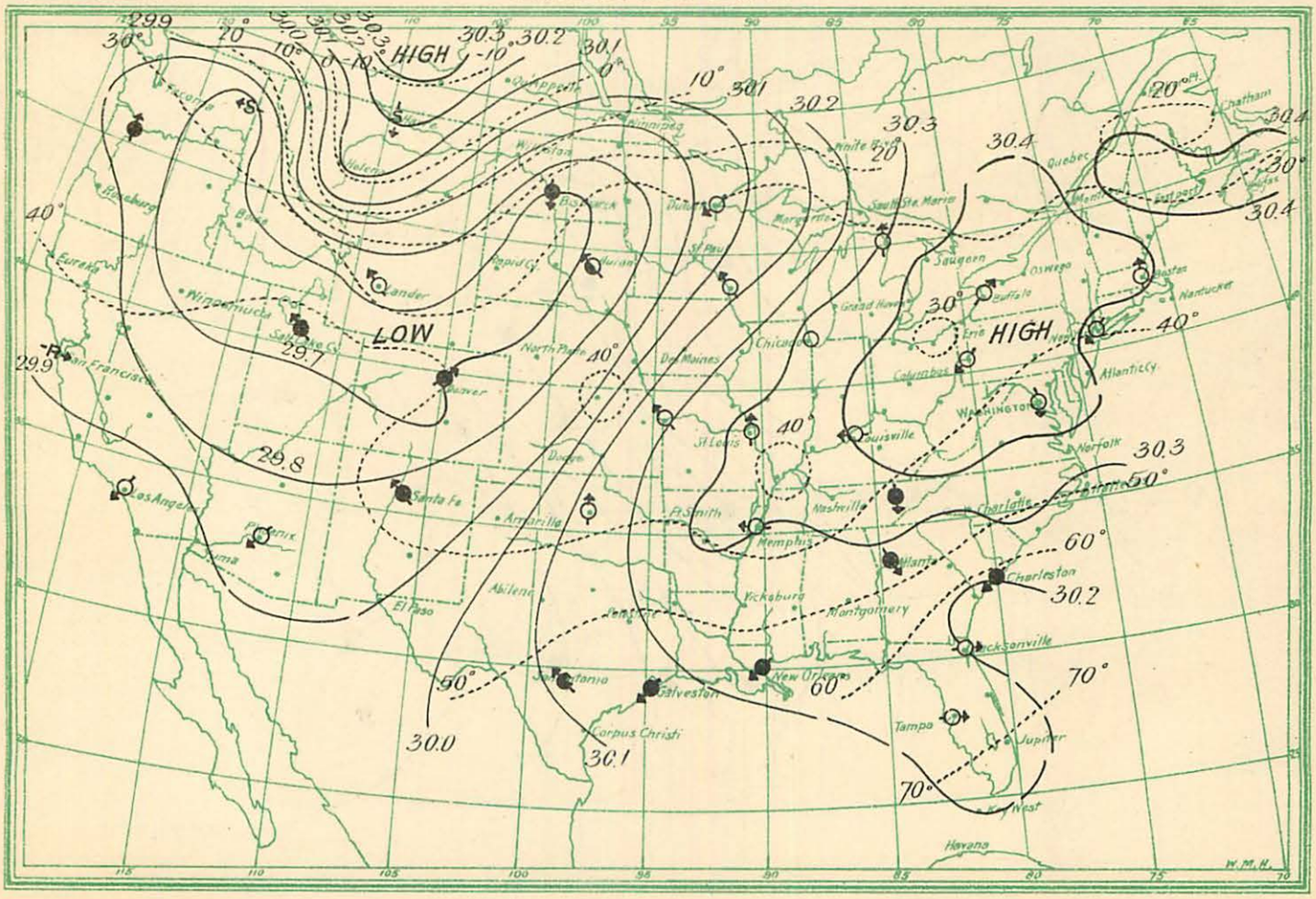


Chart CCLV. March 26, 1898—8 a. m.

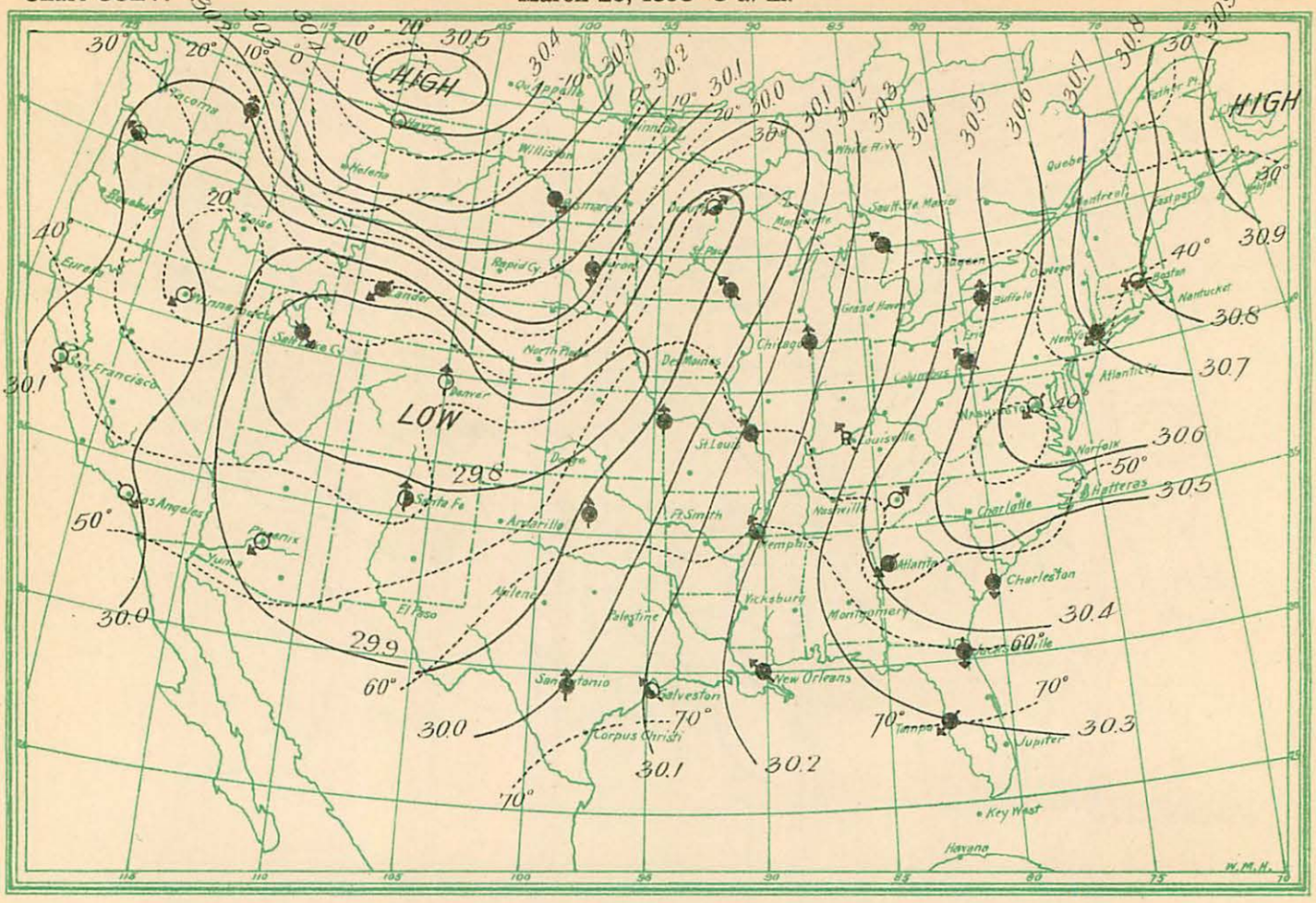


Chart CCLVI. March 27, 1898—8 a. m.

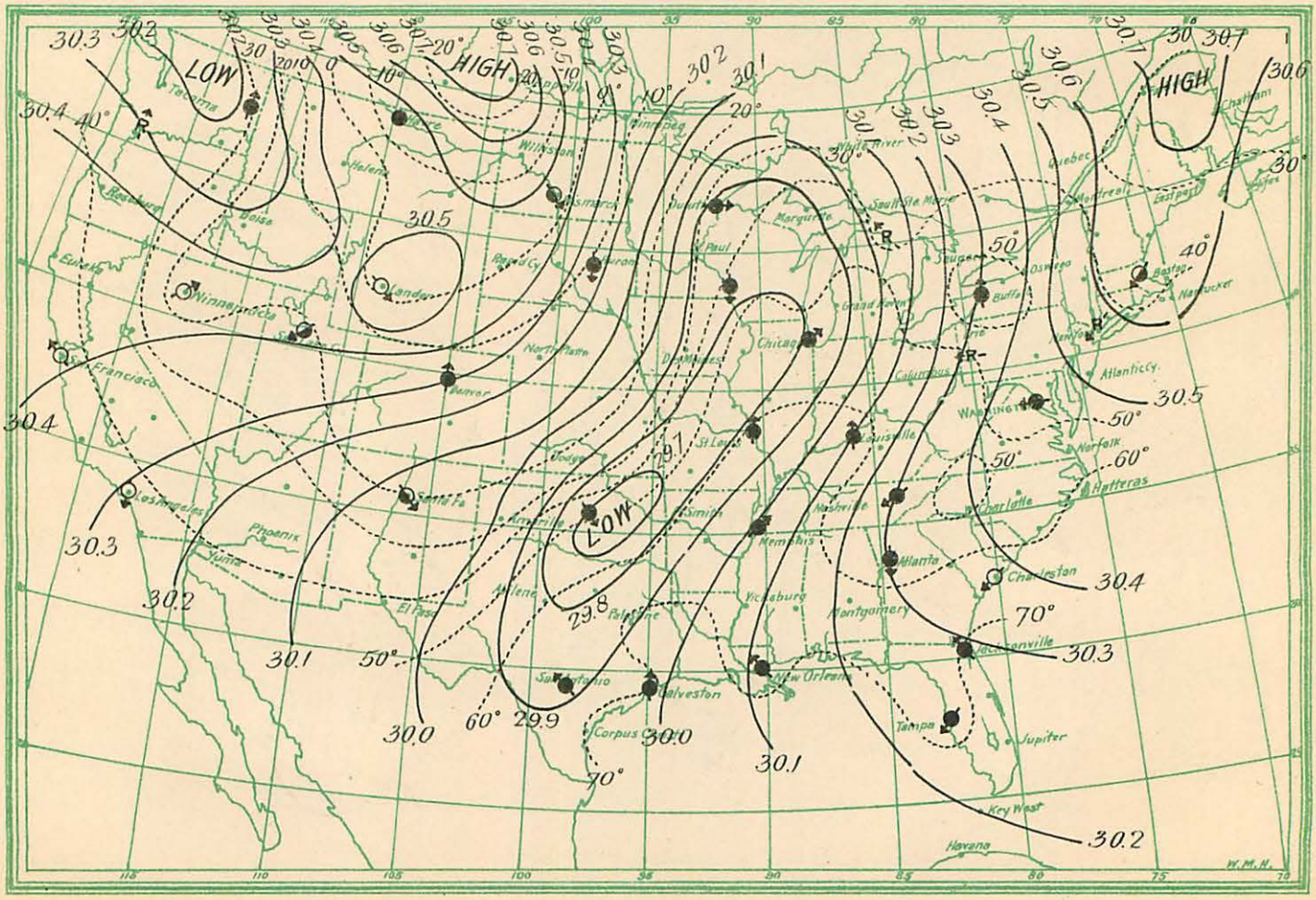


Chart CCLVII. March 4, 1899—8 a. m.

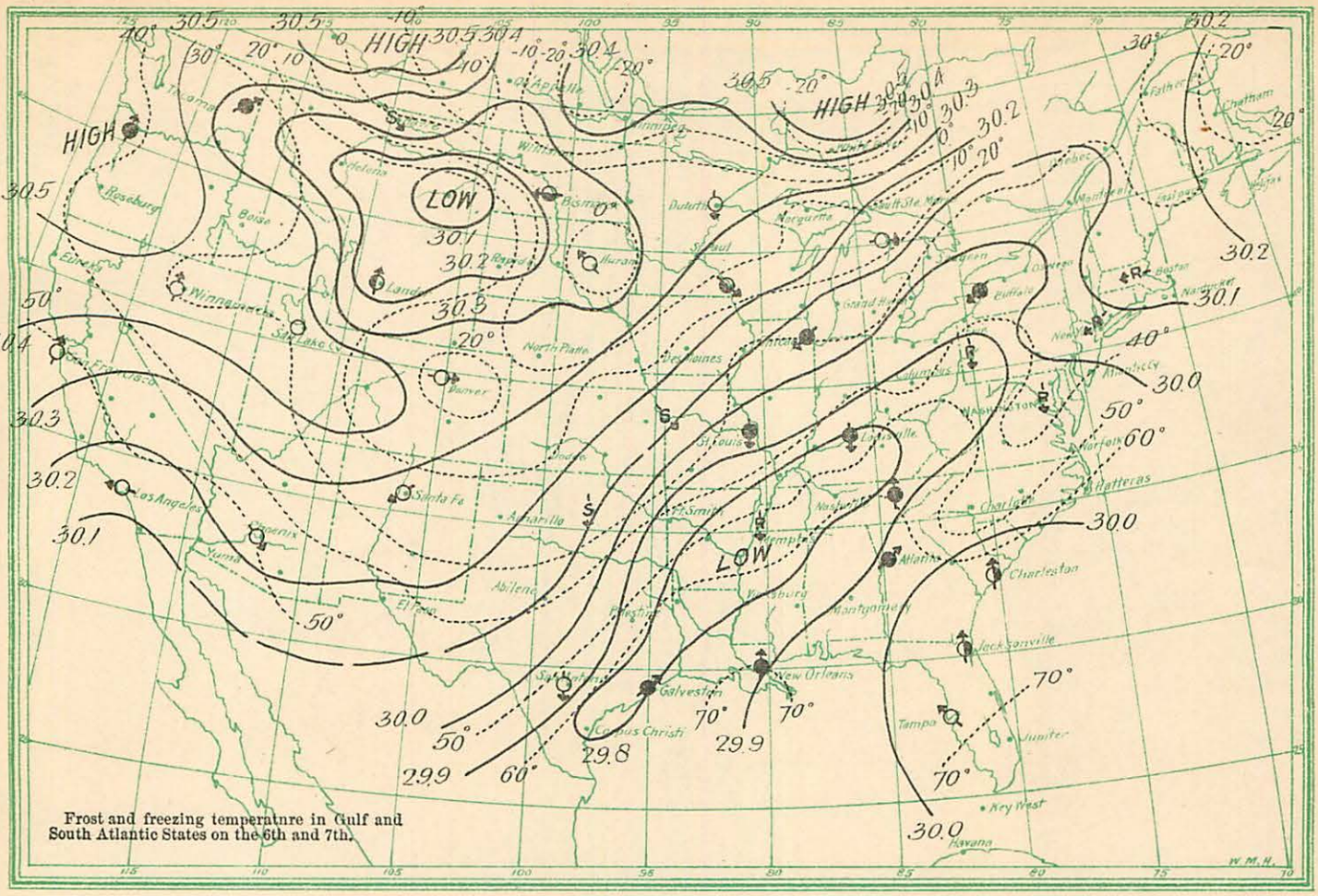


Chart CCLVIII. March 5, 1899—8 a. m.

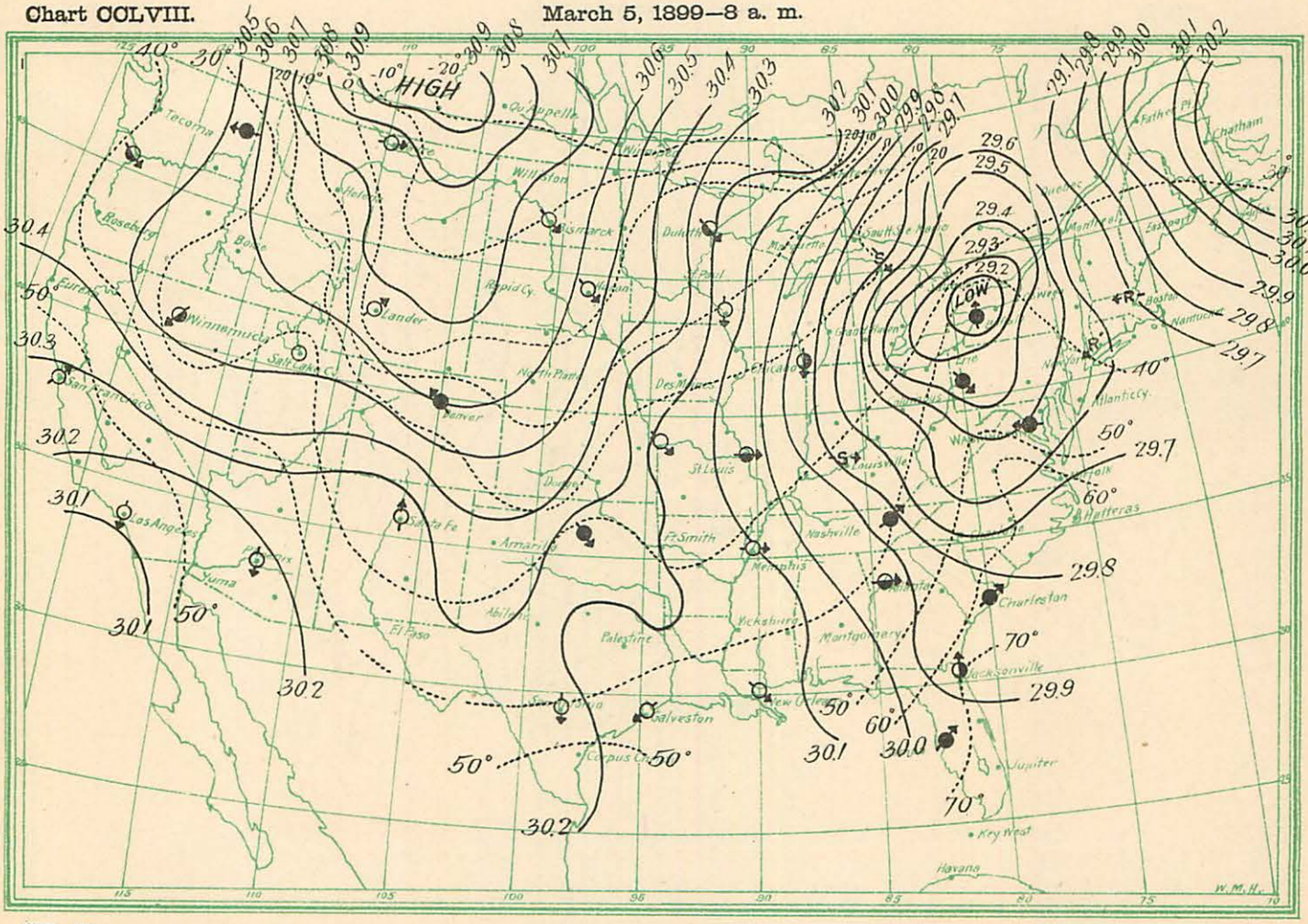


Chart CCLIX. March 6, 1899—8 a. m.

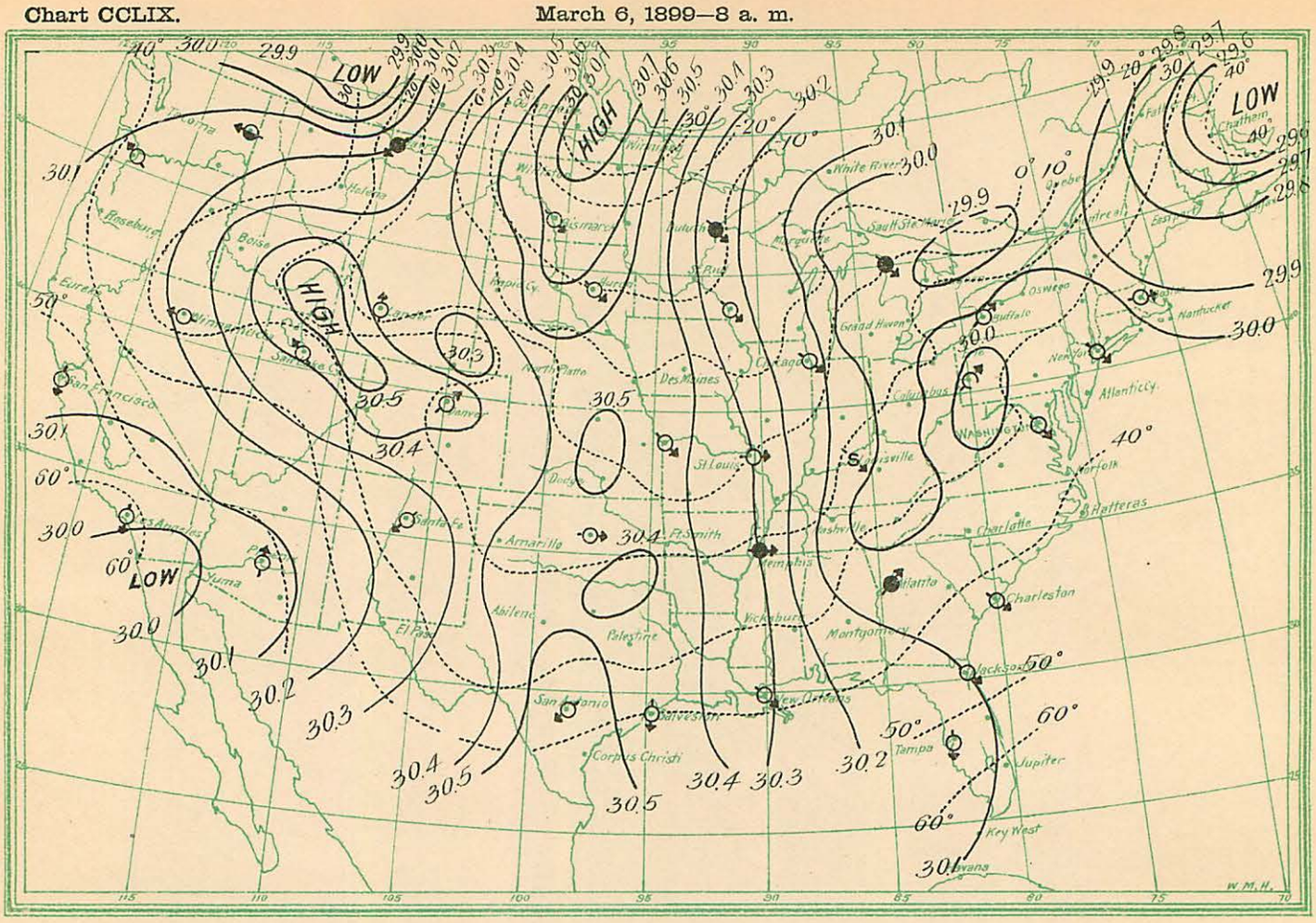


Chart CCLX. March 7, 1899—8 a. m.

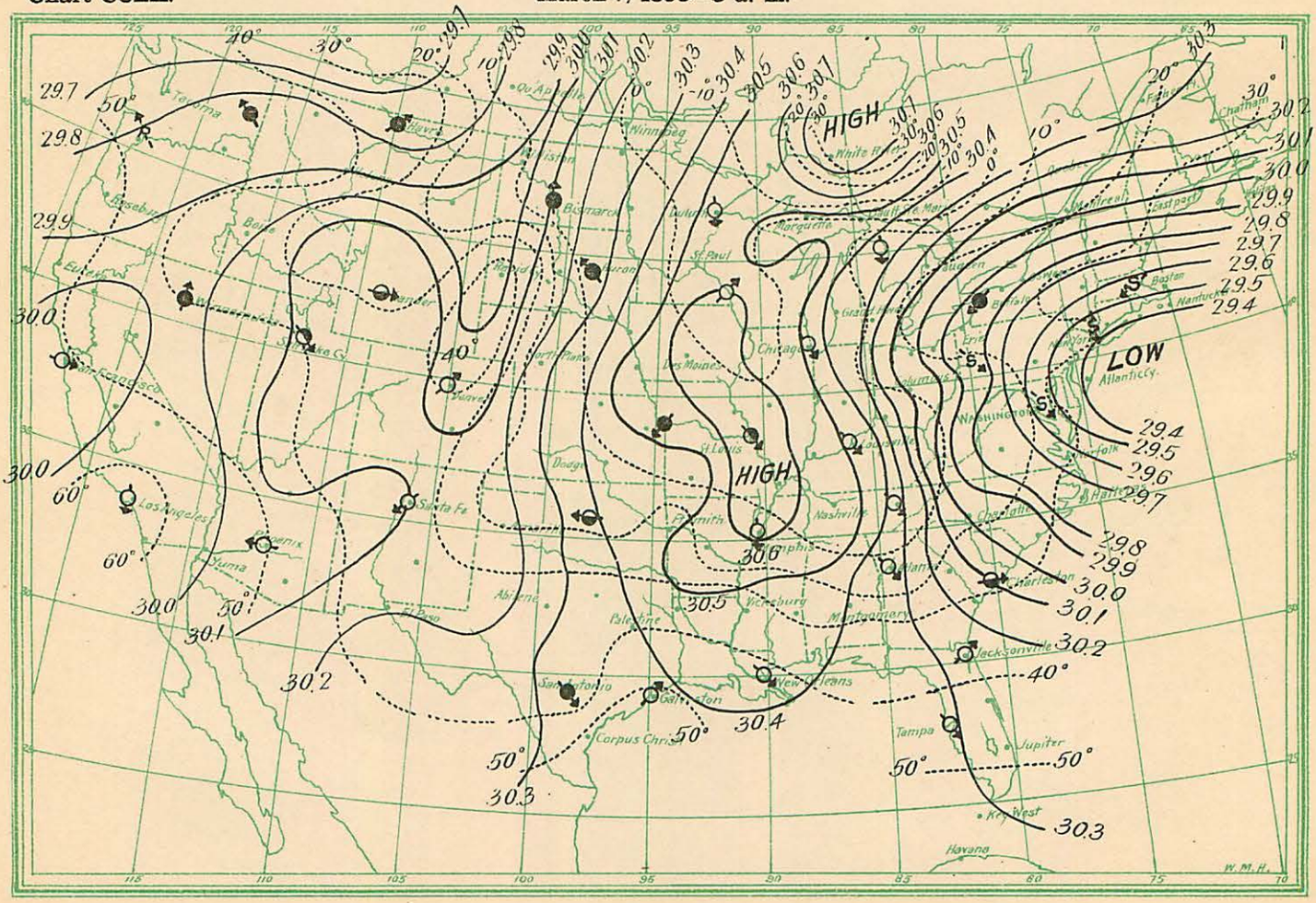


Chart CCLXI. March 3, 1901—8 a. m.

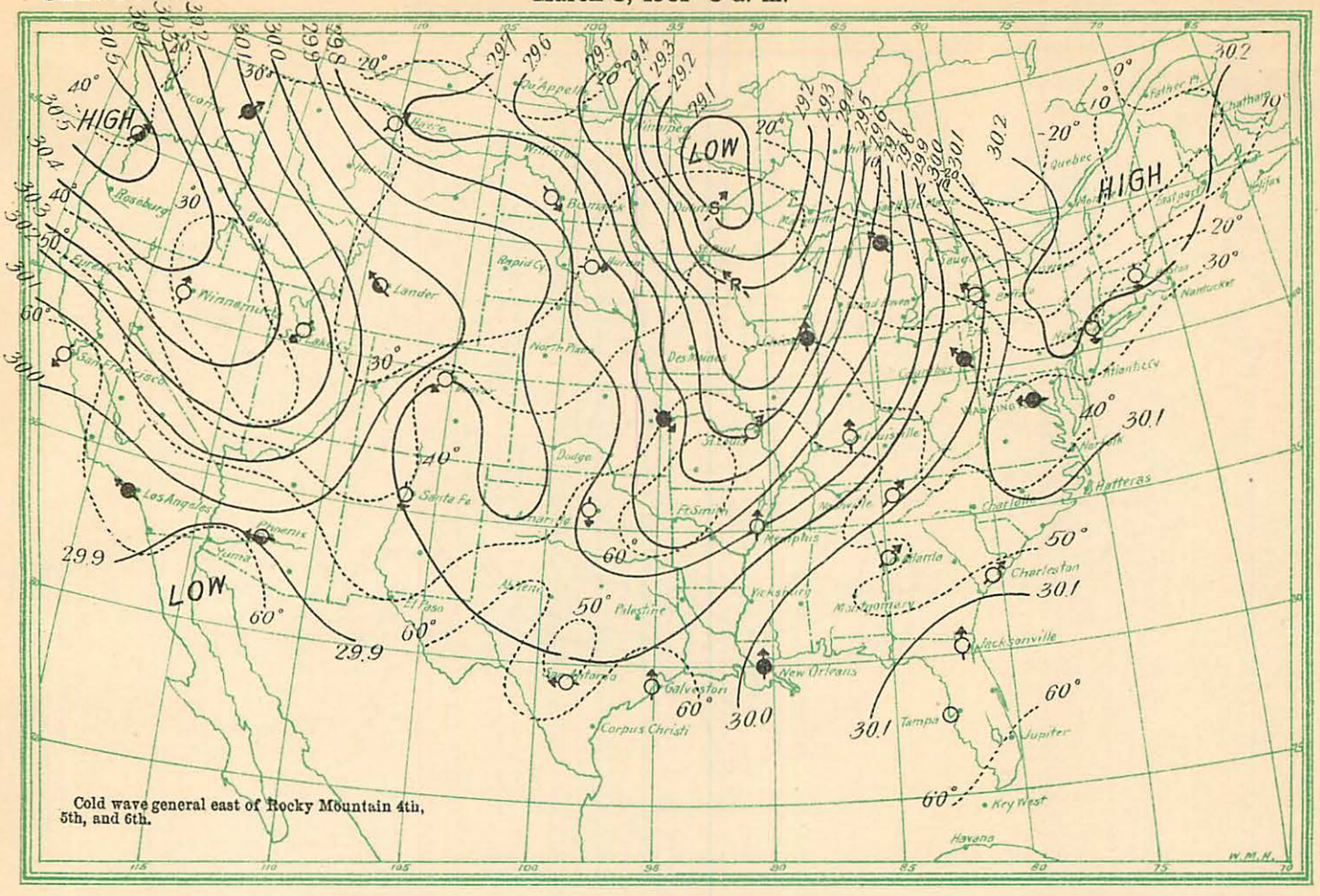


Chart CCLXII. March 4, 1901—8 a. m.

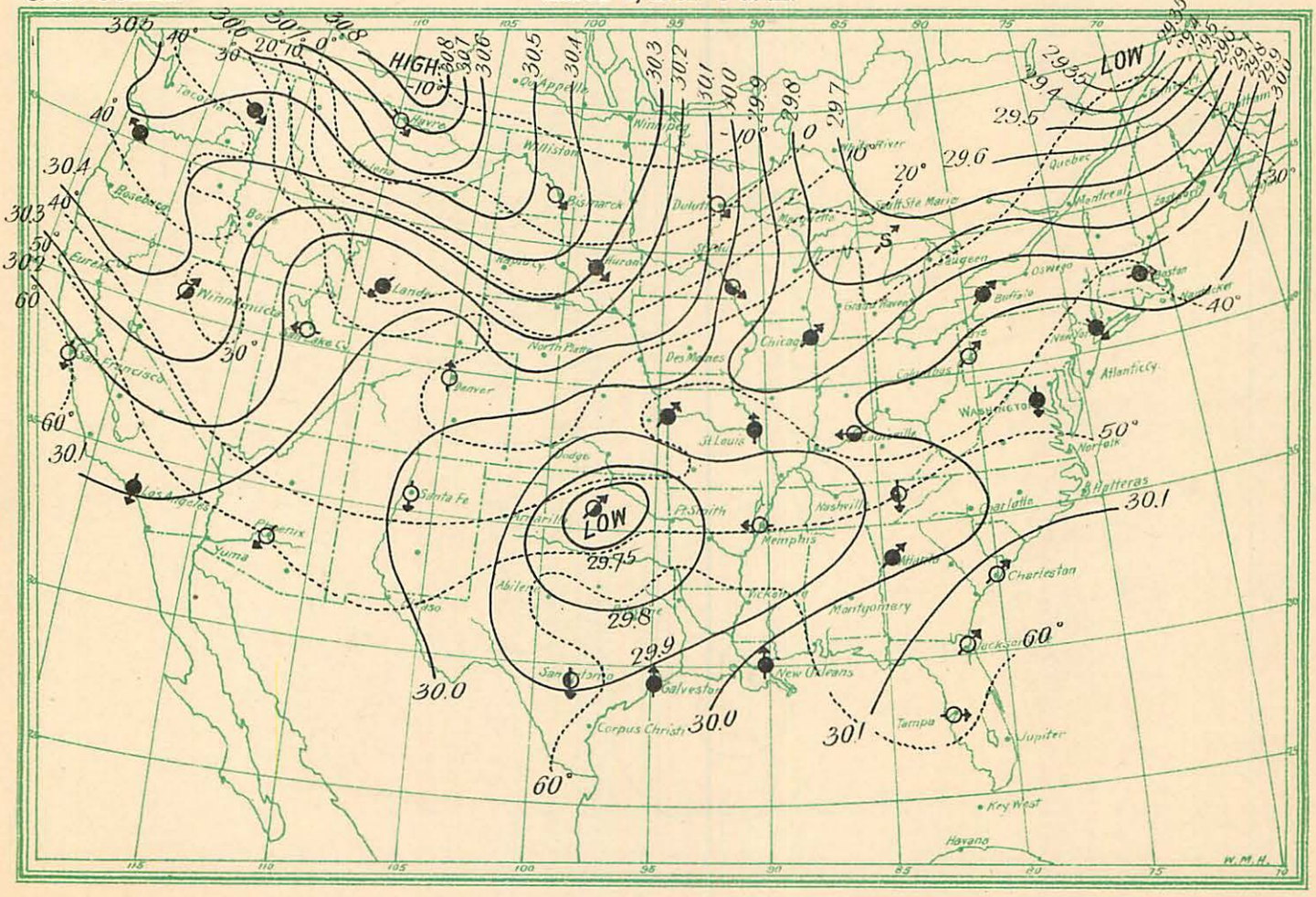


Chart CCLXIII. March 5, 1901—8 a. m.

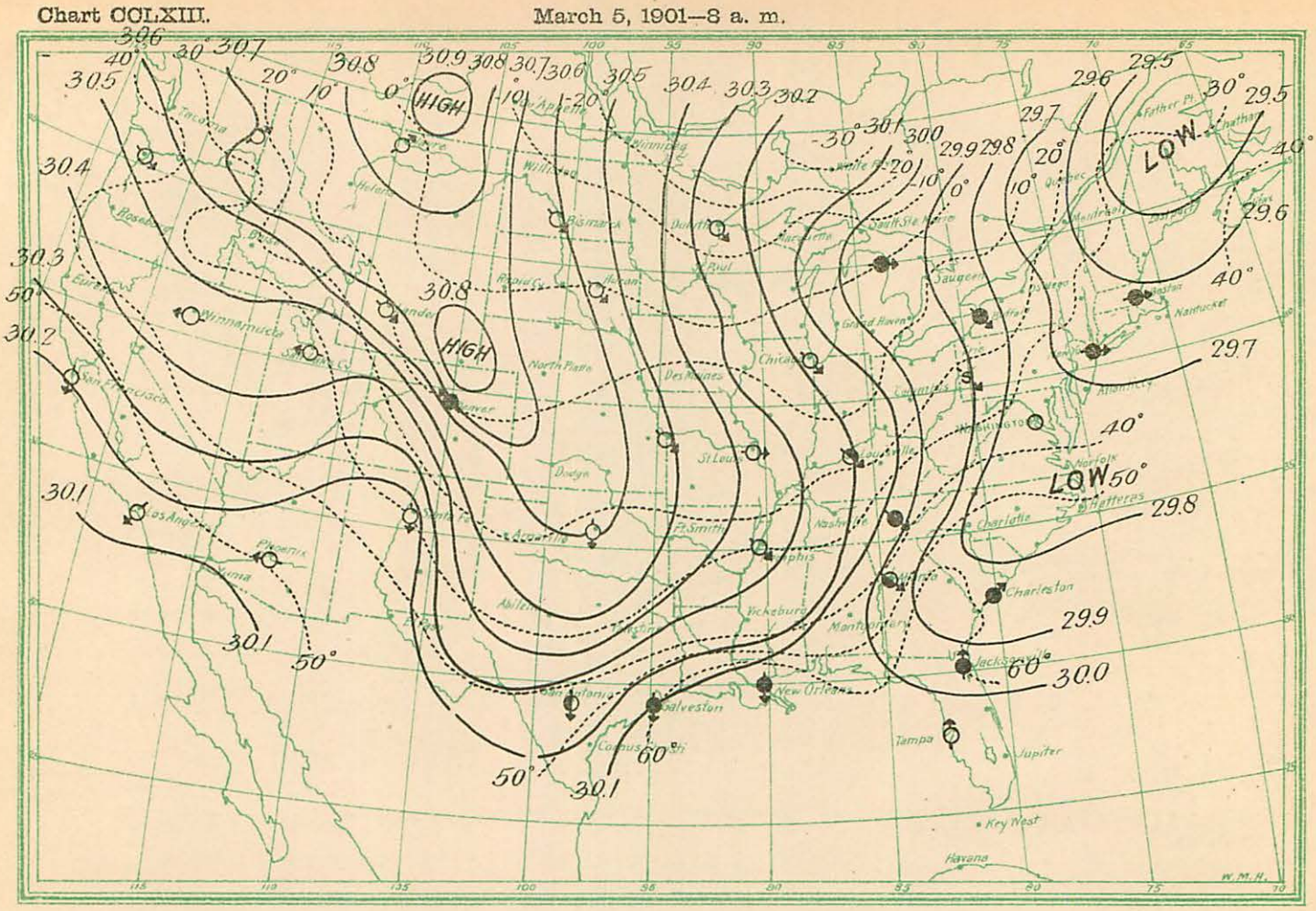


Chart CCLXIV. March 6, 1901—8 a. m.

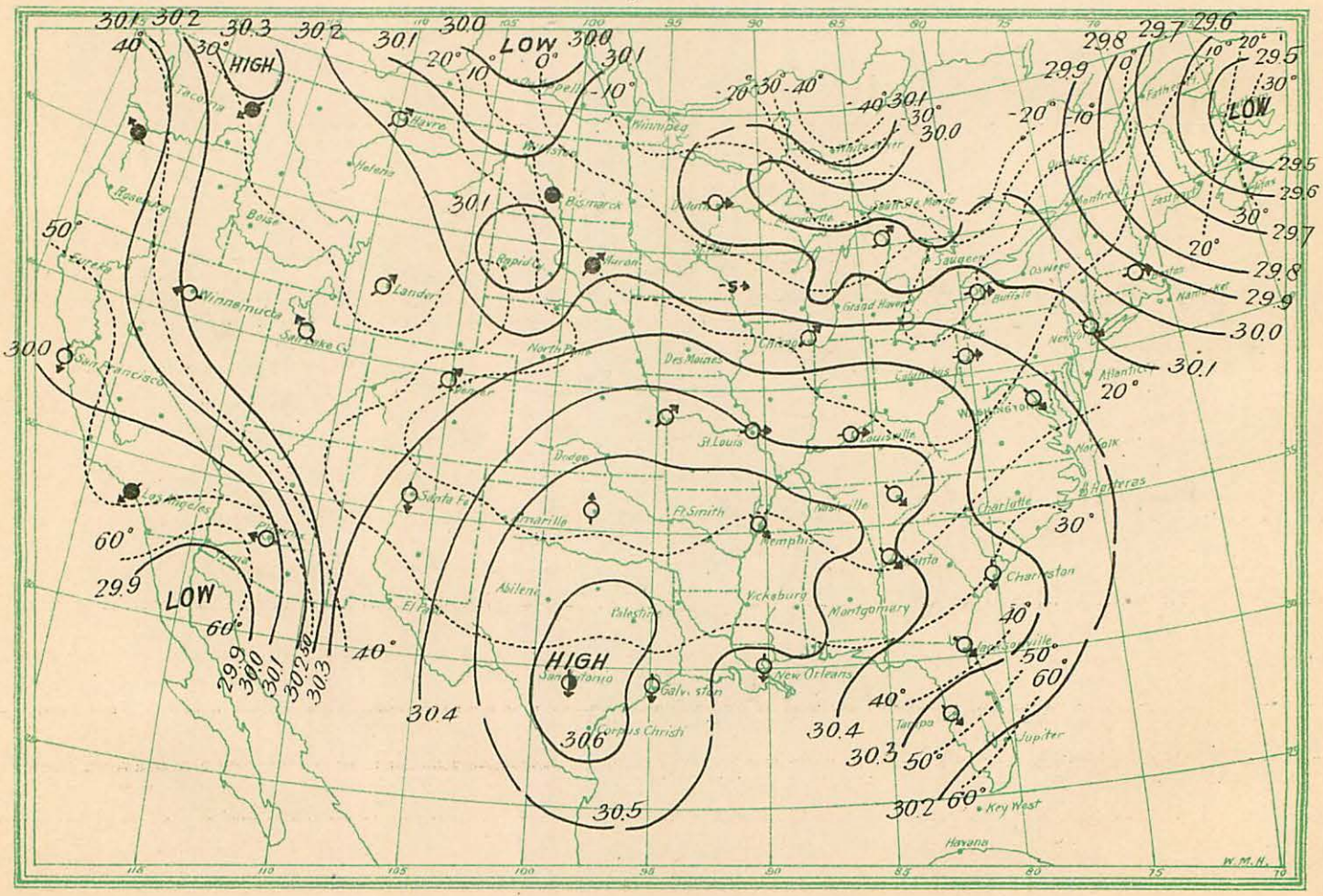


Chart CCLXV. March 14, 1902—8 a. m.

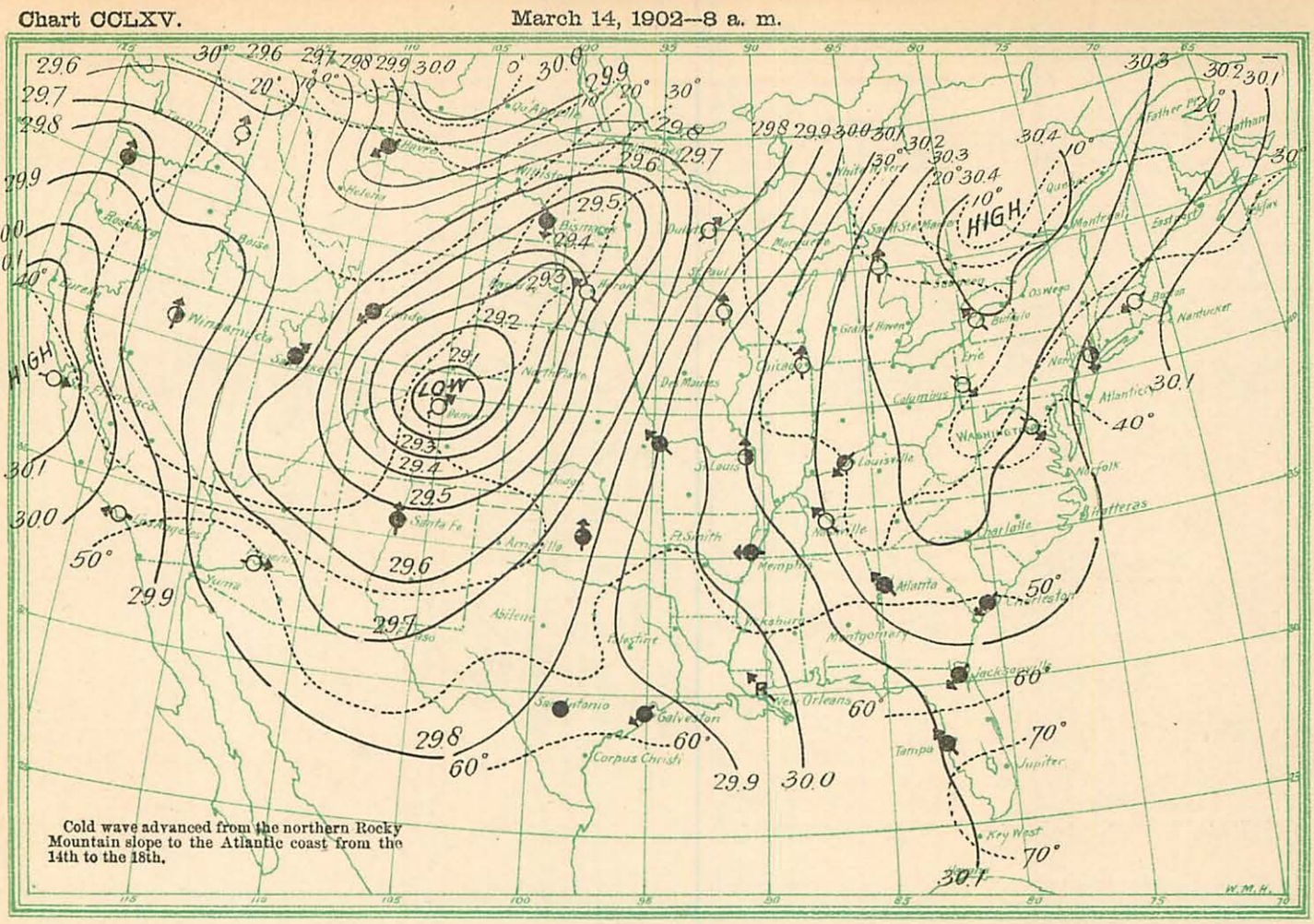


Chart CCLXVI. March 15, 1902—8 a. m.

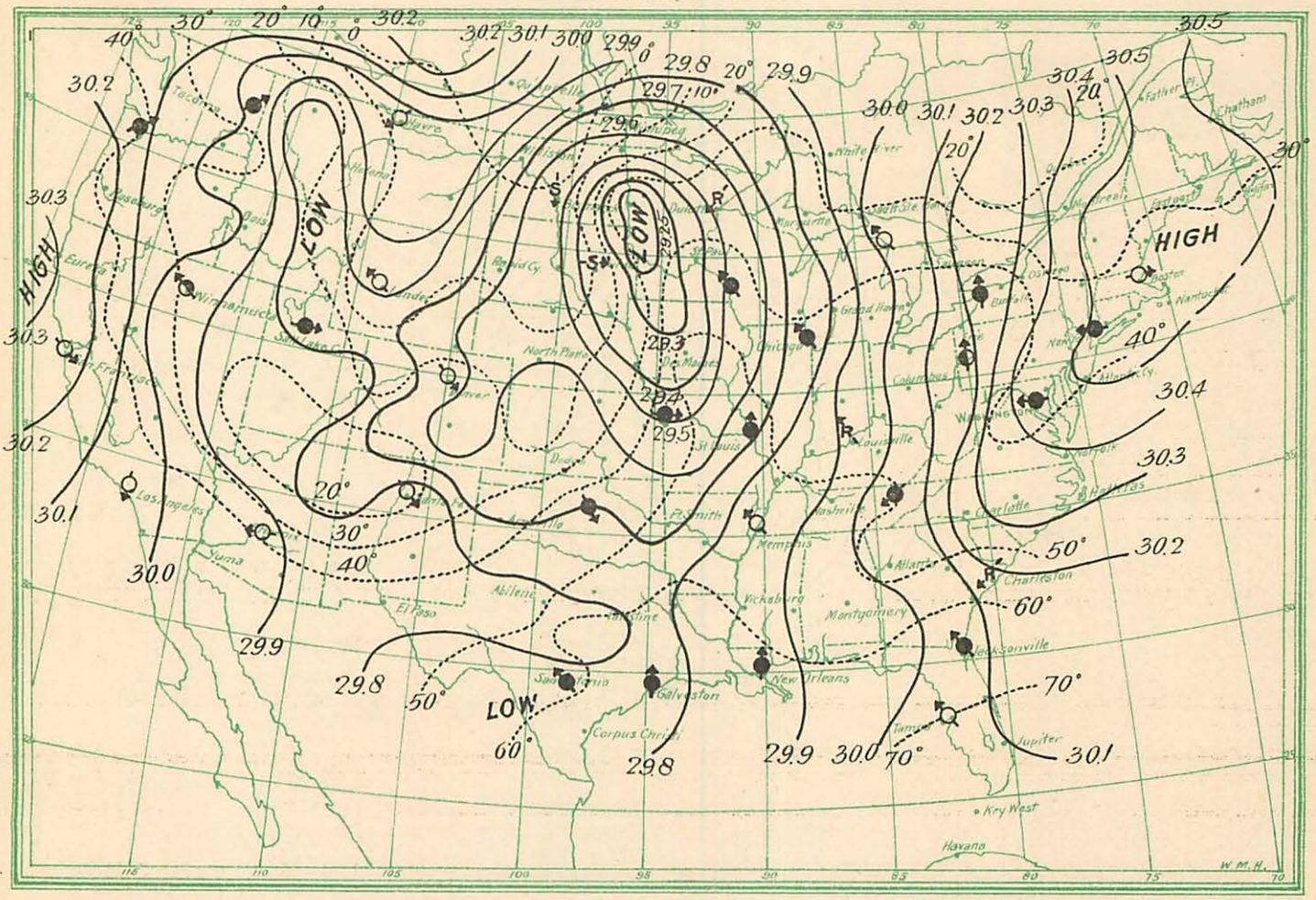


Chart CCLXVII. March 16, 1902—8 a. m.

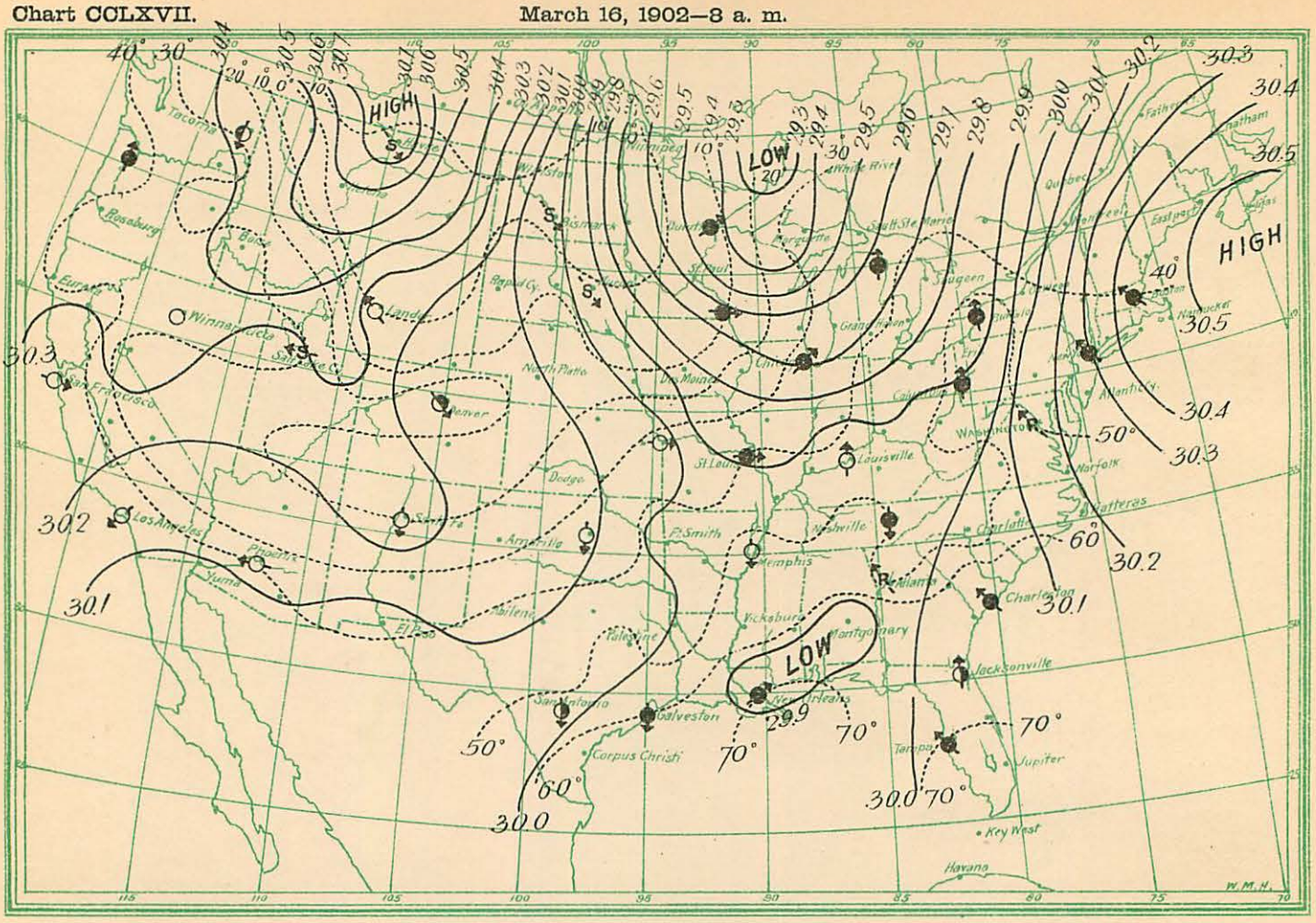


Chart CCLXVIII. March 17, 1902—8 a. m.

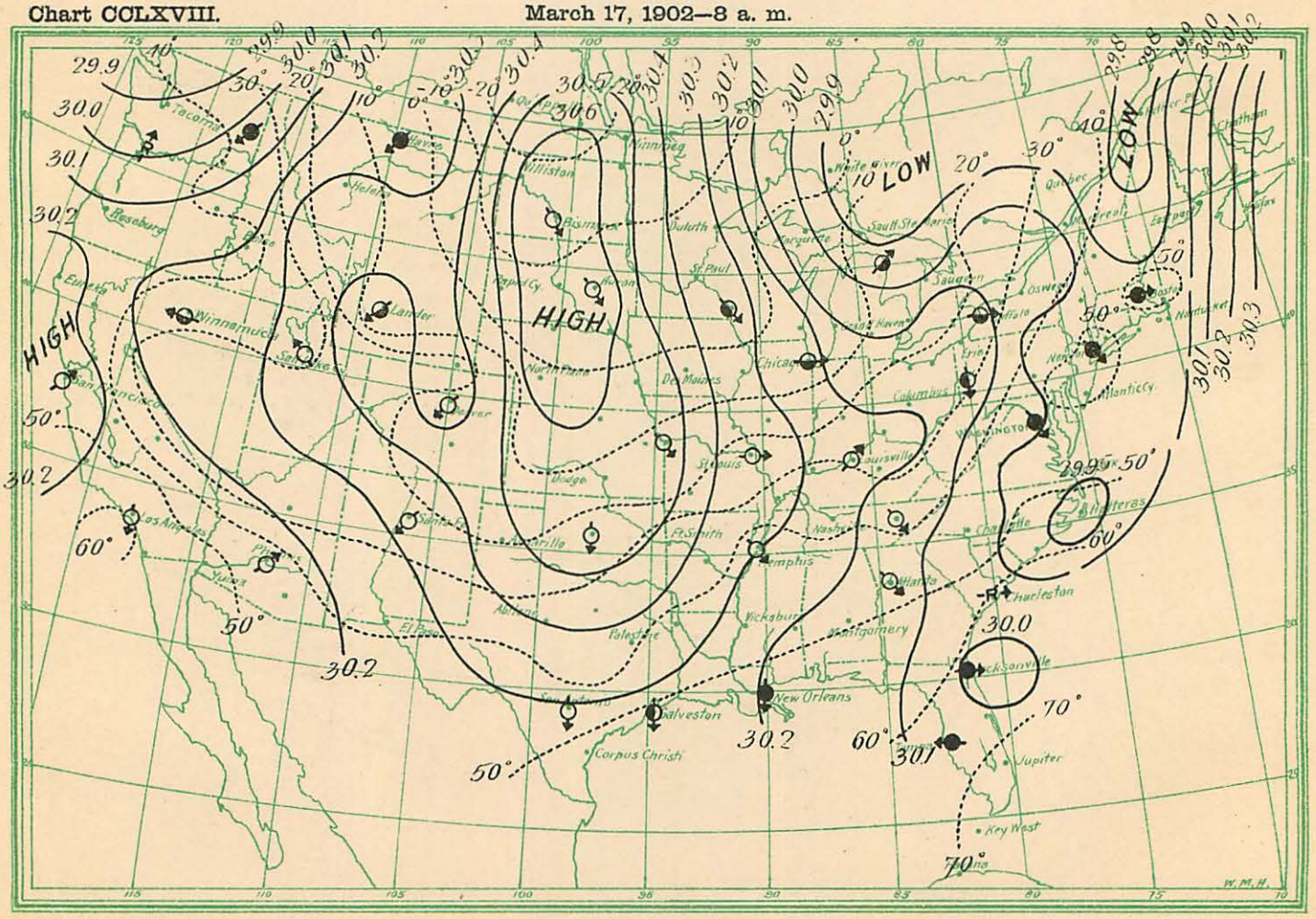


Chart CCLXIX. April 18, 1890—8 a. m.

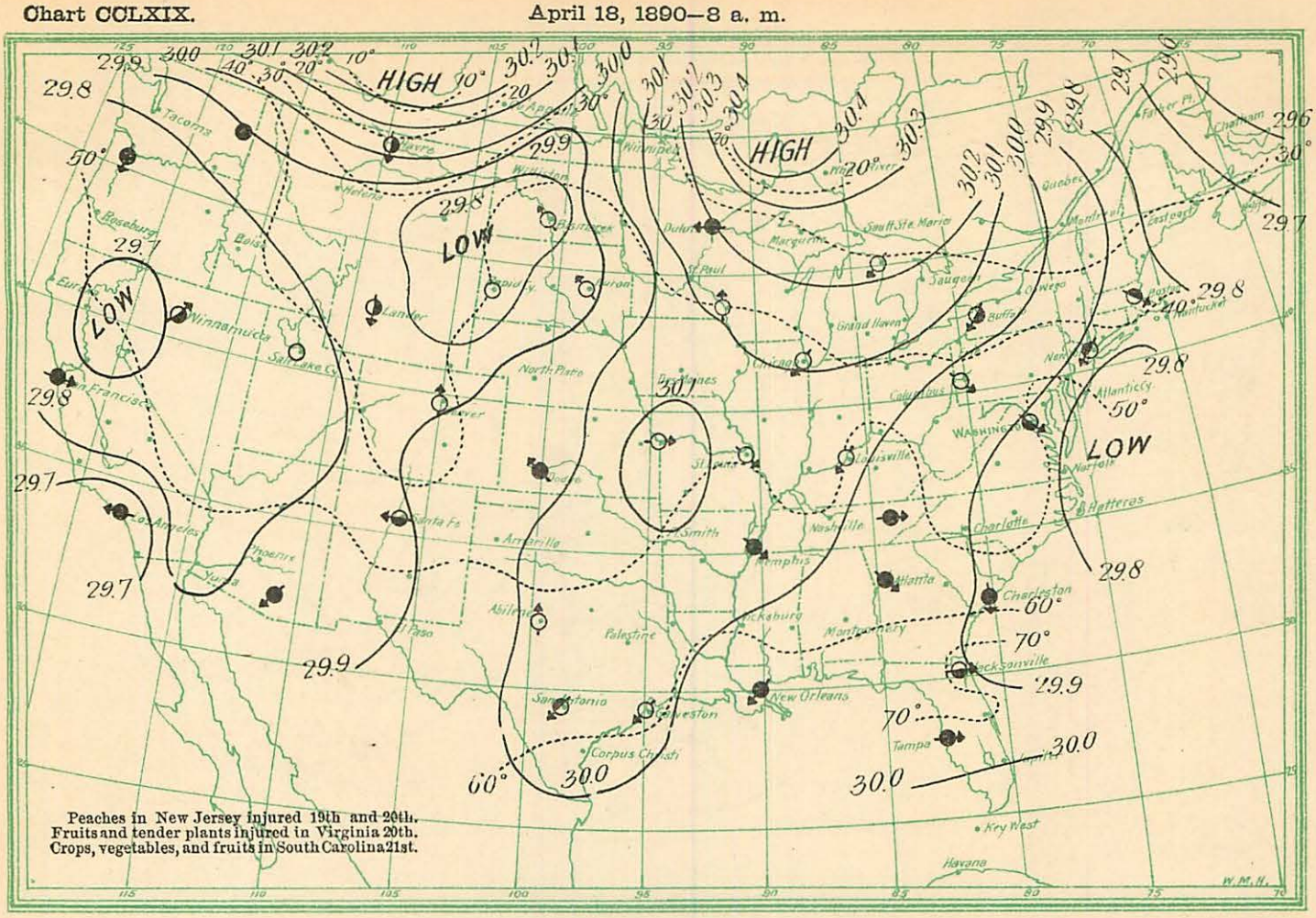


Chart CCLXX. April 19, 1890—8 a. m.

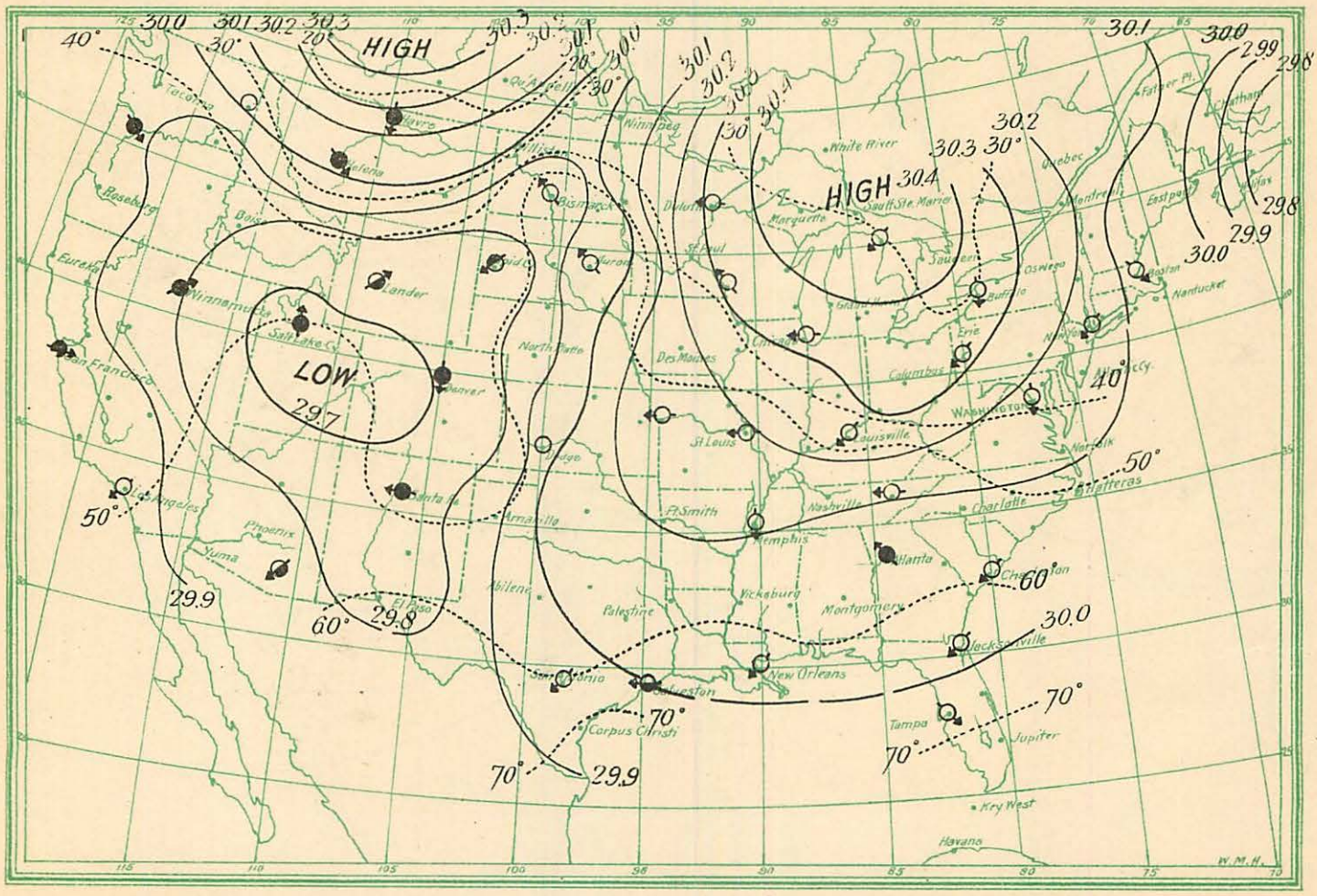


Chart CCLXXI. April 20, 1890—8 a. m.

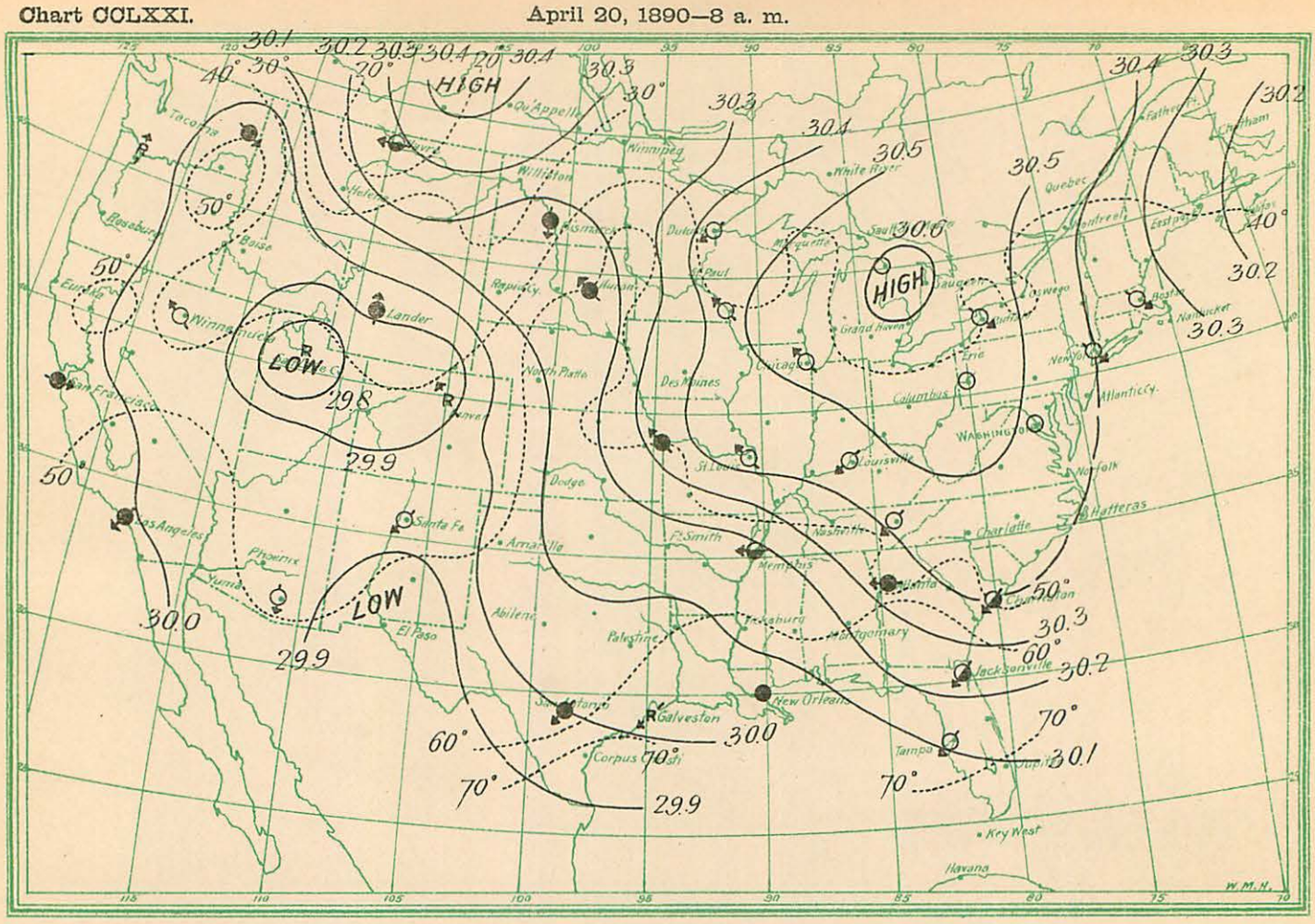


Chart CCLXXII. April 21, 1890—8 a. m.

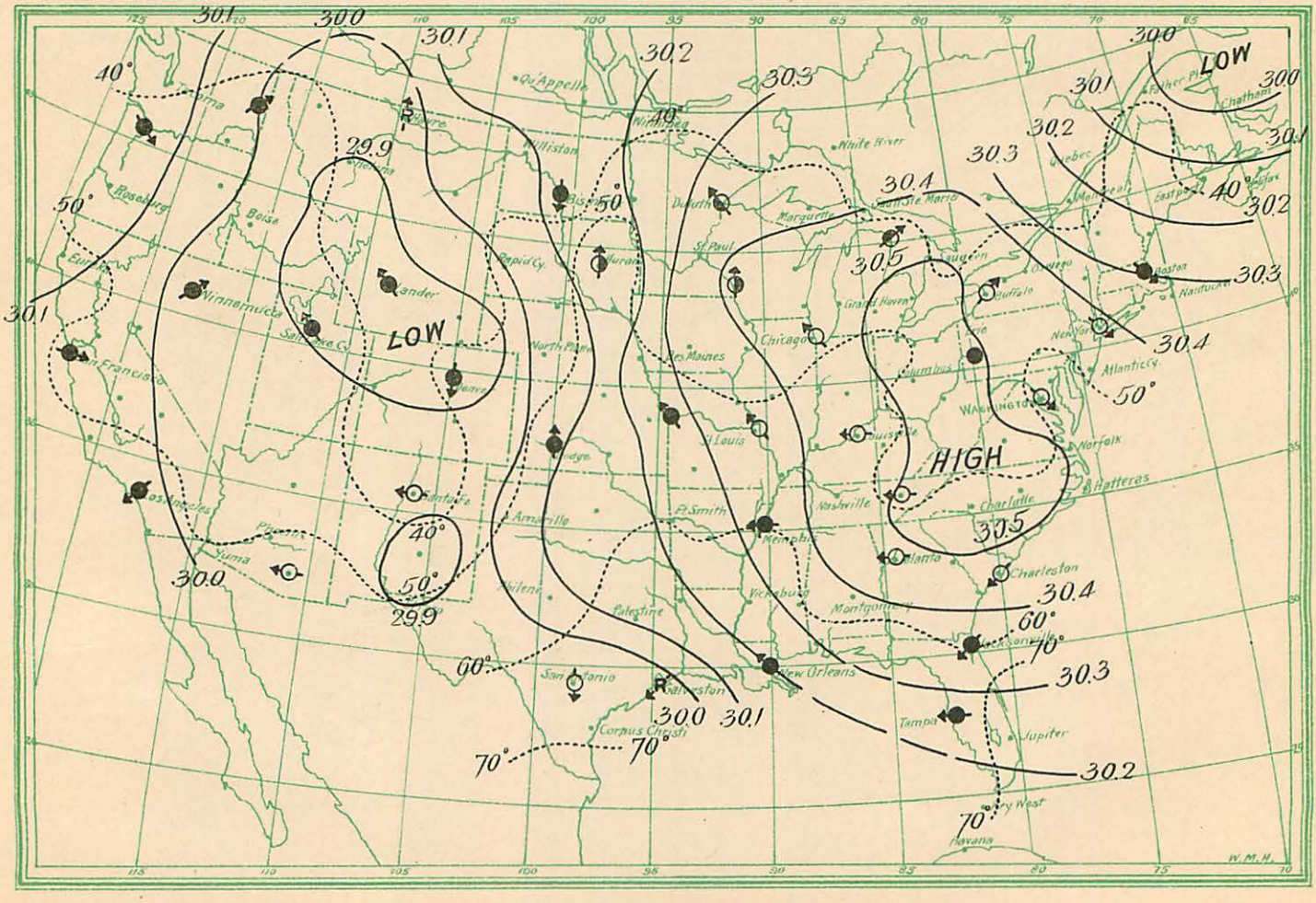


Chart CCLXXIII. April 2, 1891—8 a. m.

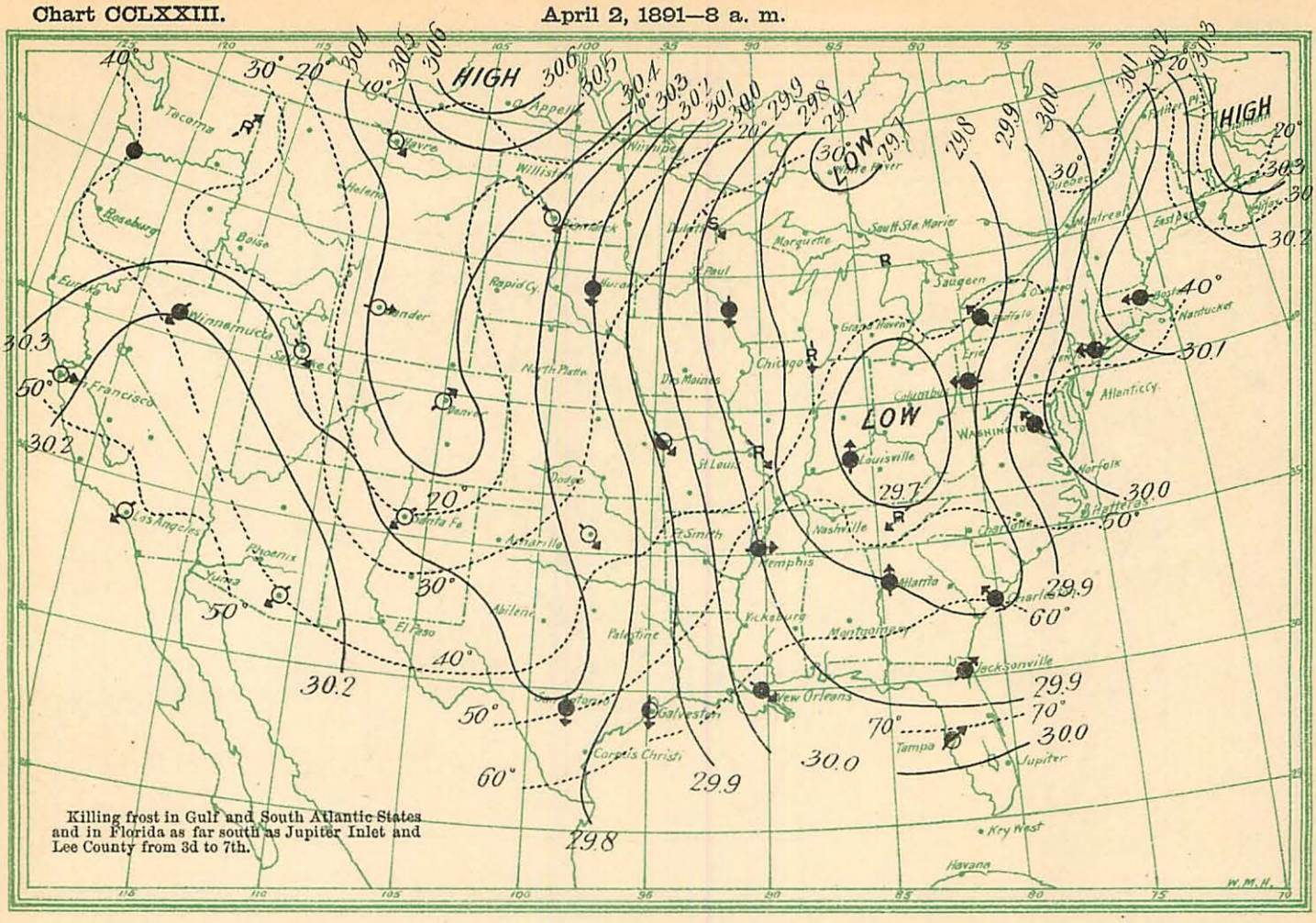


Chart CCLXXIV. April 3, 1891—8 a. m.

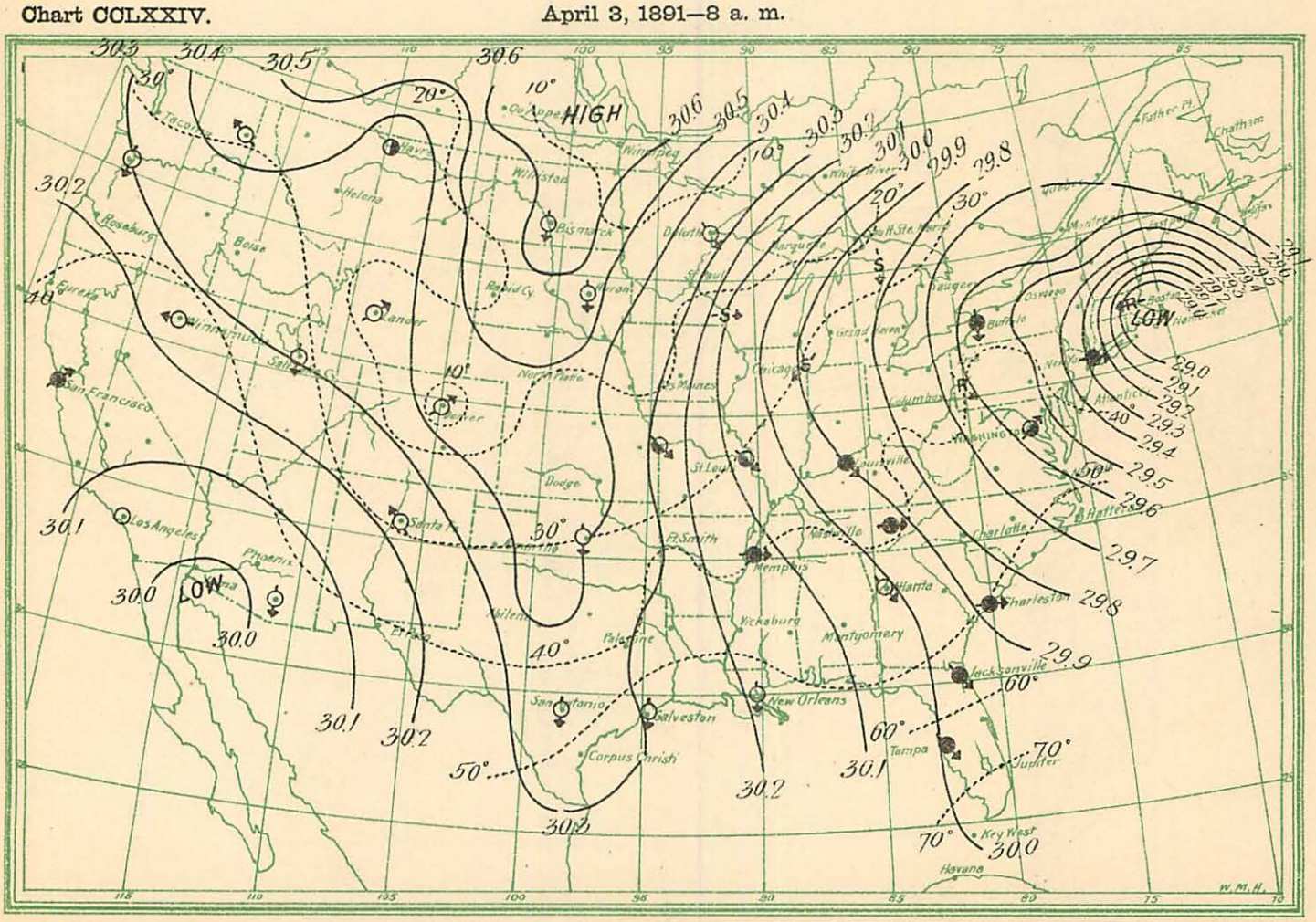


Chart CCLXXV. April 4, 1891—8 a. m.

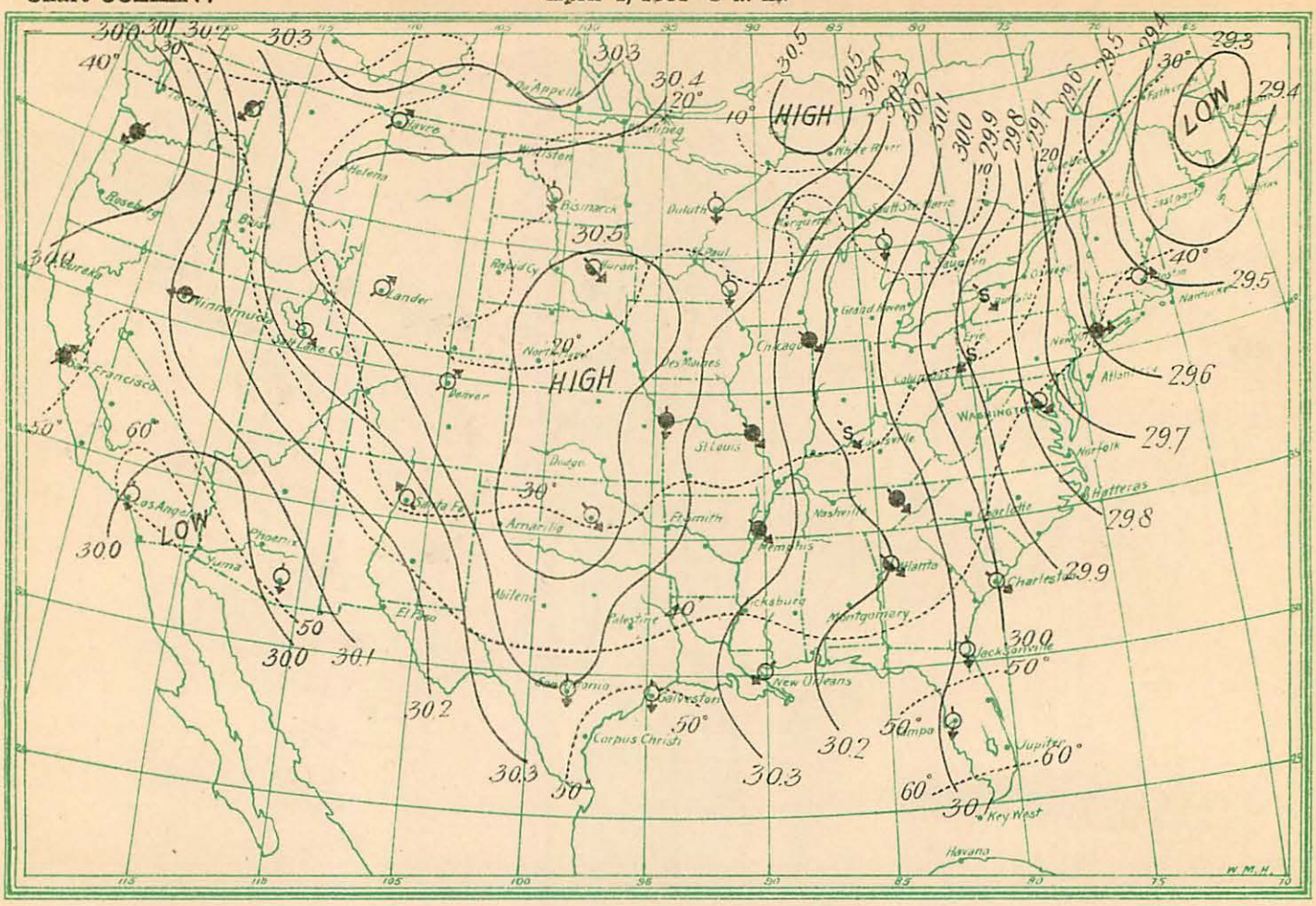


Chart CCLXXVI. April 5, 1891—8 a. m.

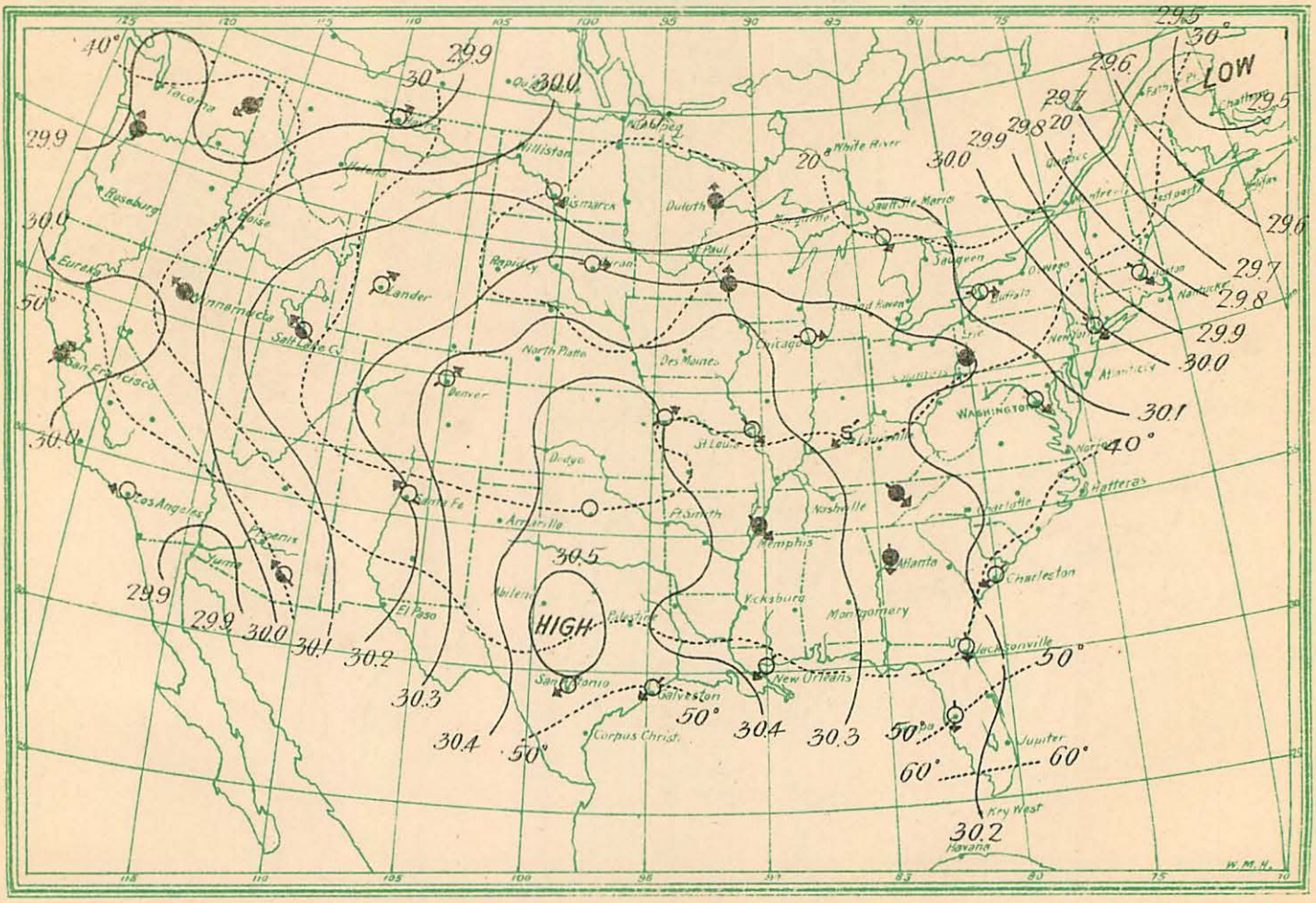


Chart CCLXXVII.

April 5, 1898—8 a. m.

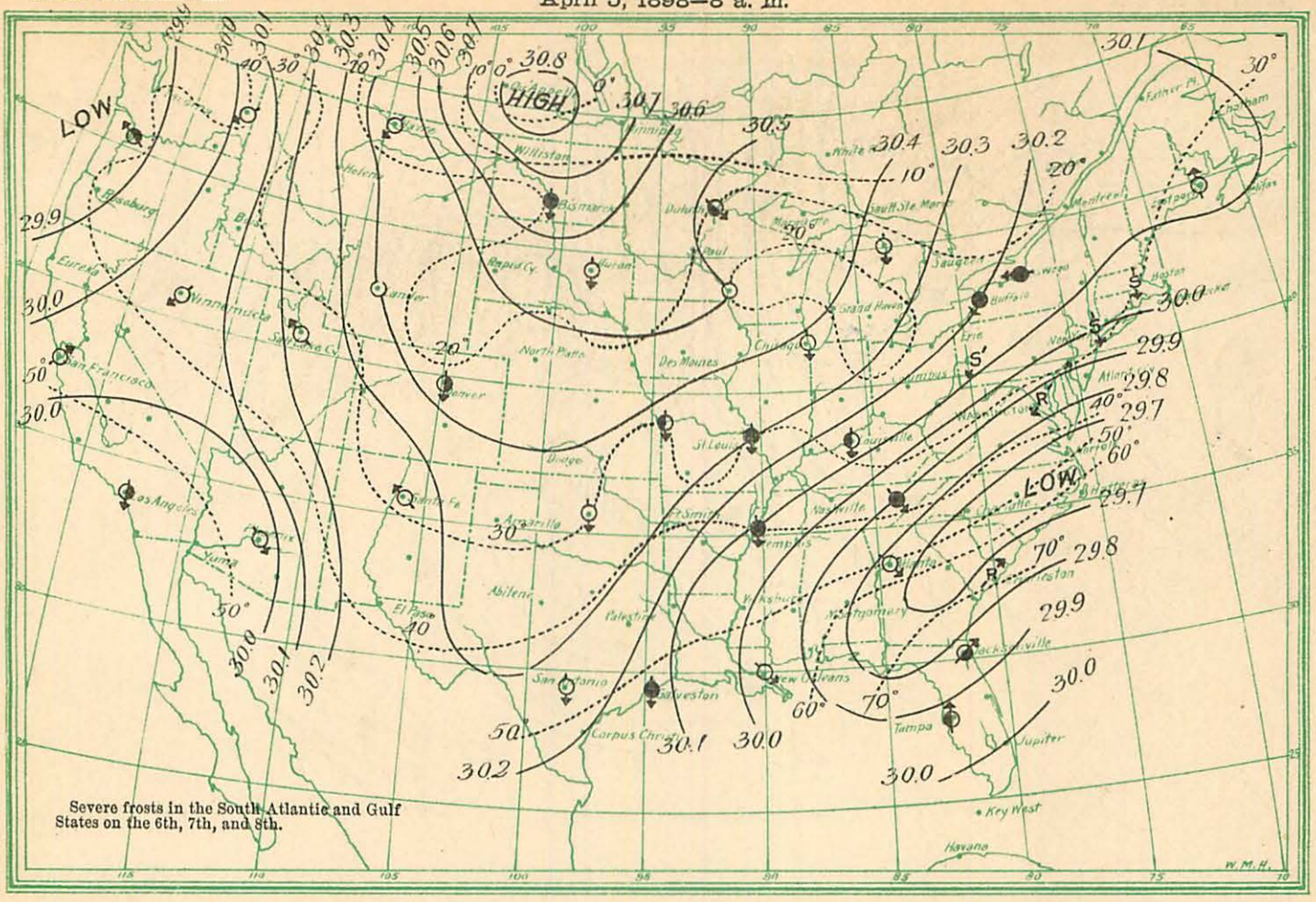


Chart CCLXXVIII.

April 6, 1898—8 a. m.

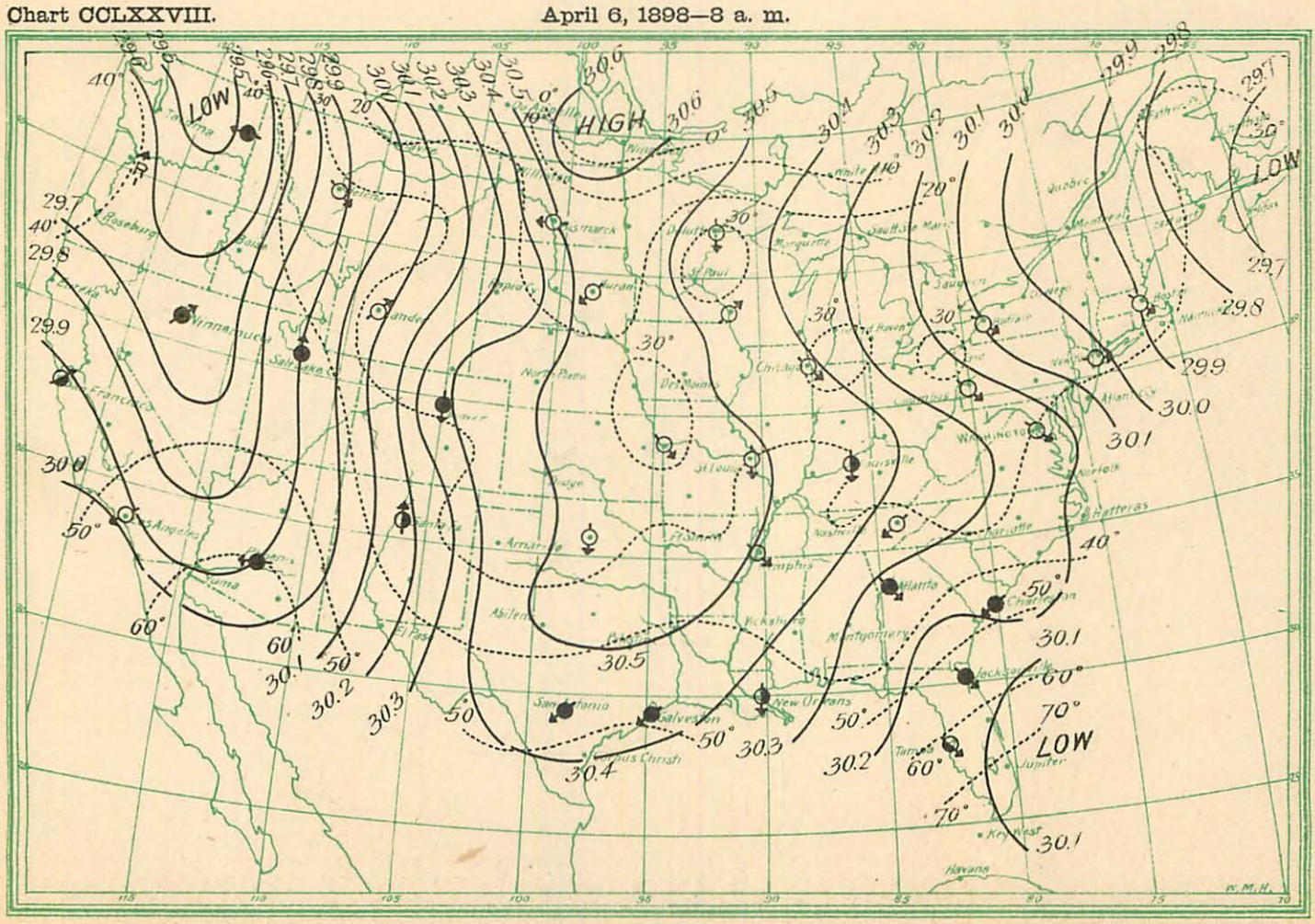


Chart CCLXXIX. April 7, 1898—8 a. m.

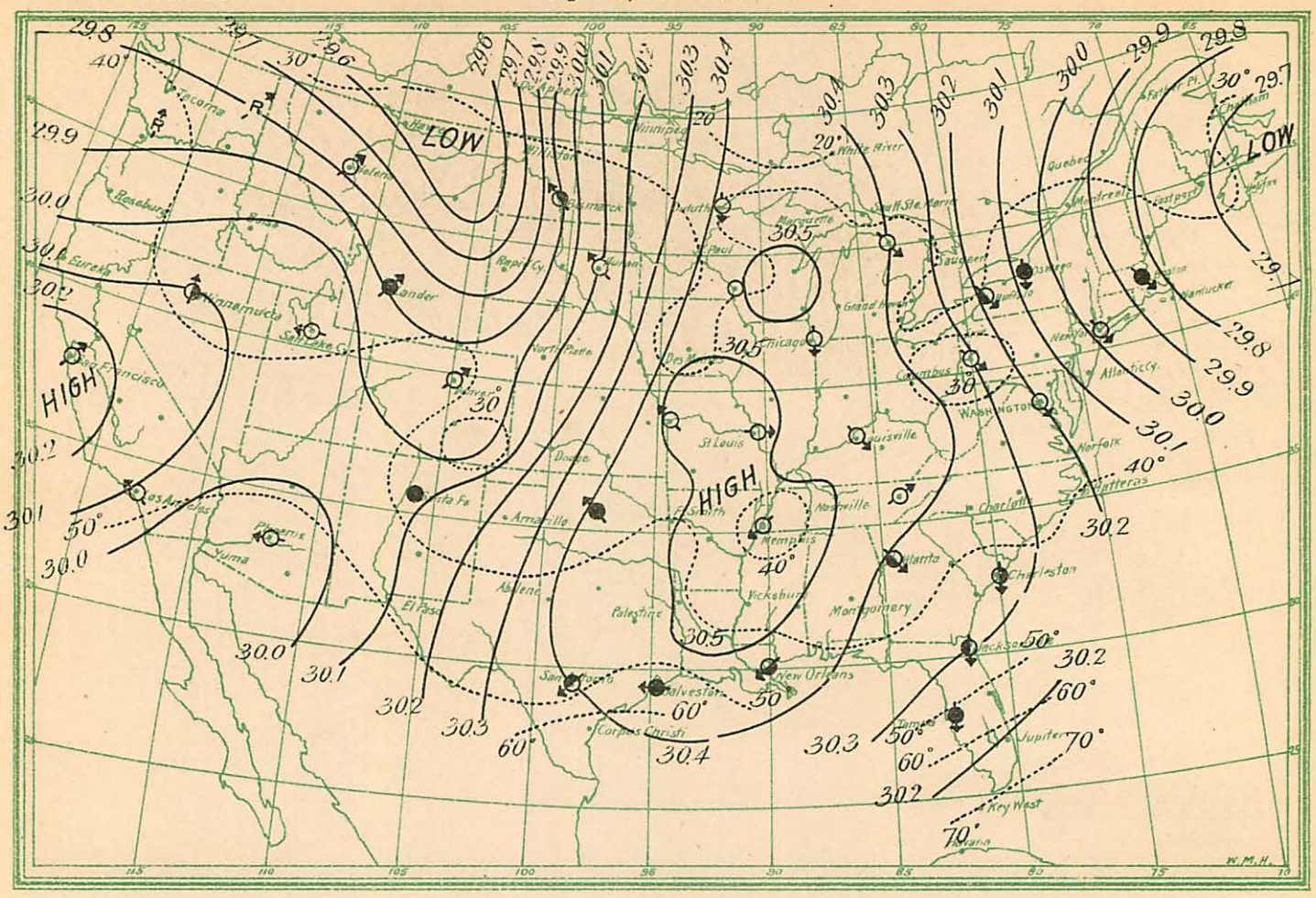


Chart CCLXXX. April 8, 1898—8 a. m.

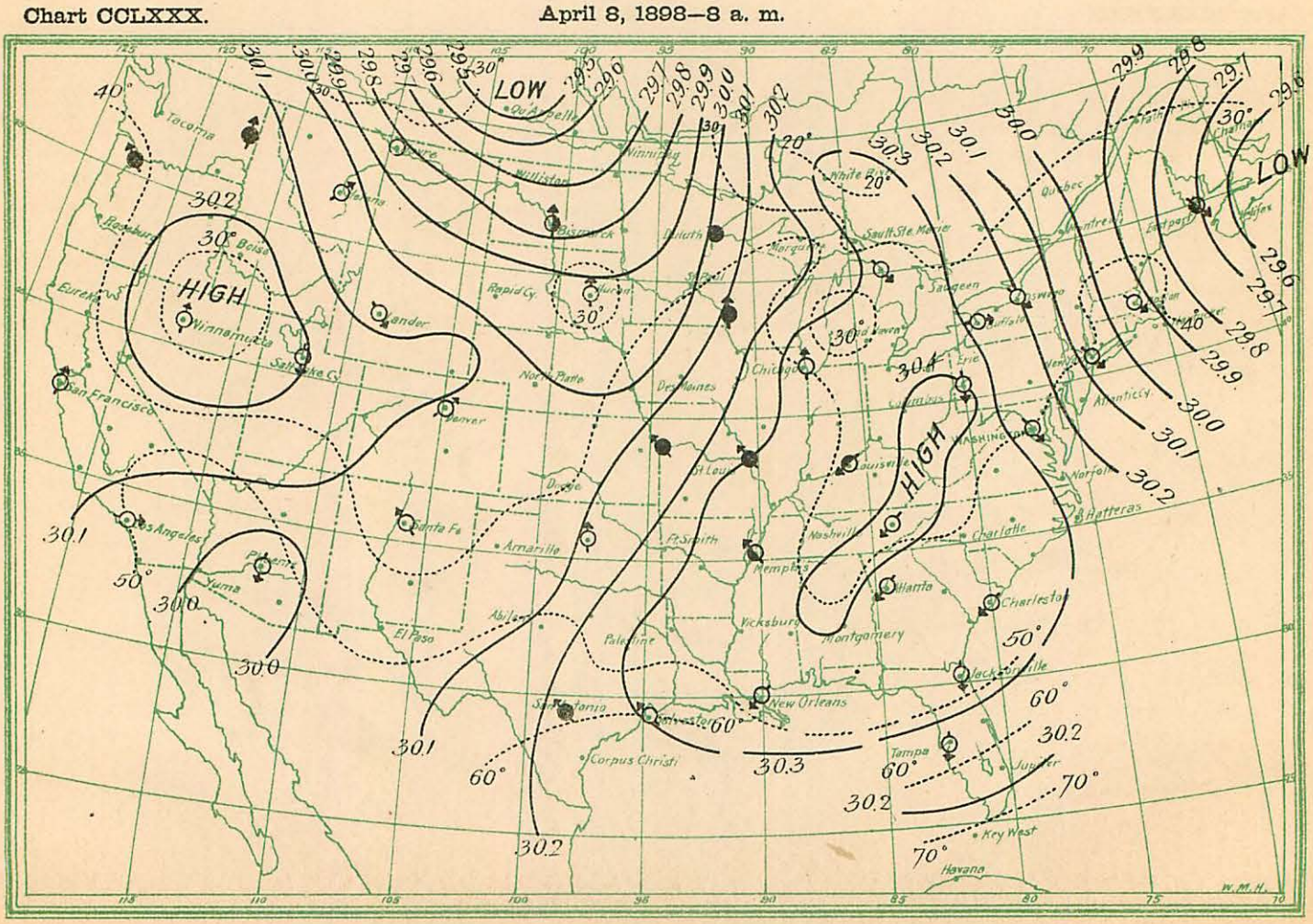


Chart CCLXXXI.

April 6, 1899—8 a. m.

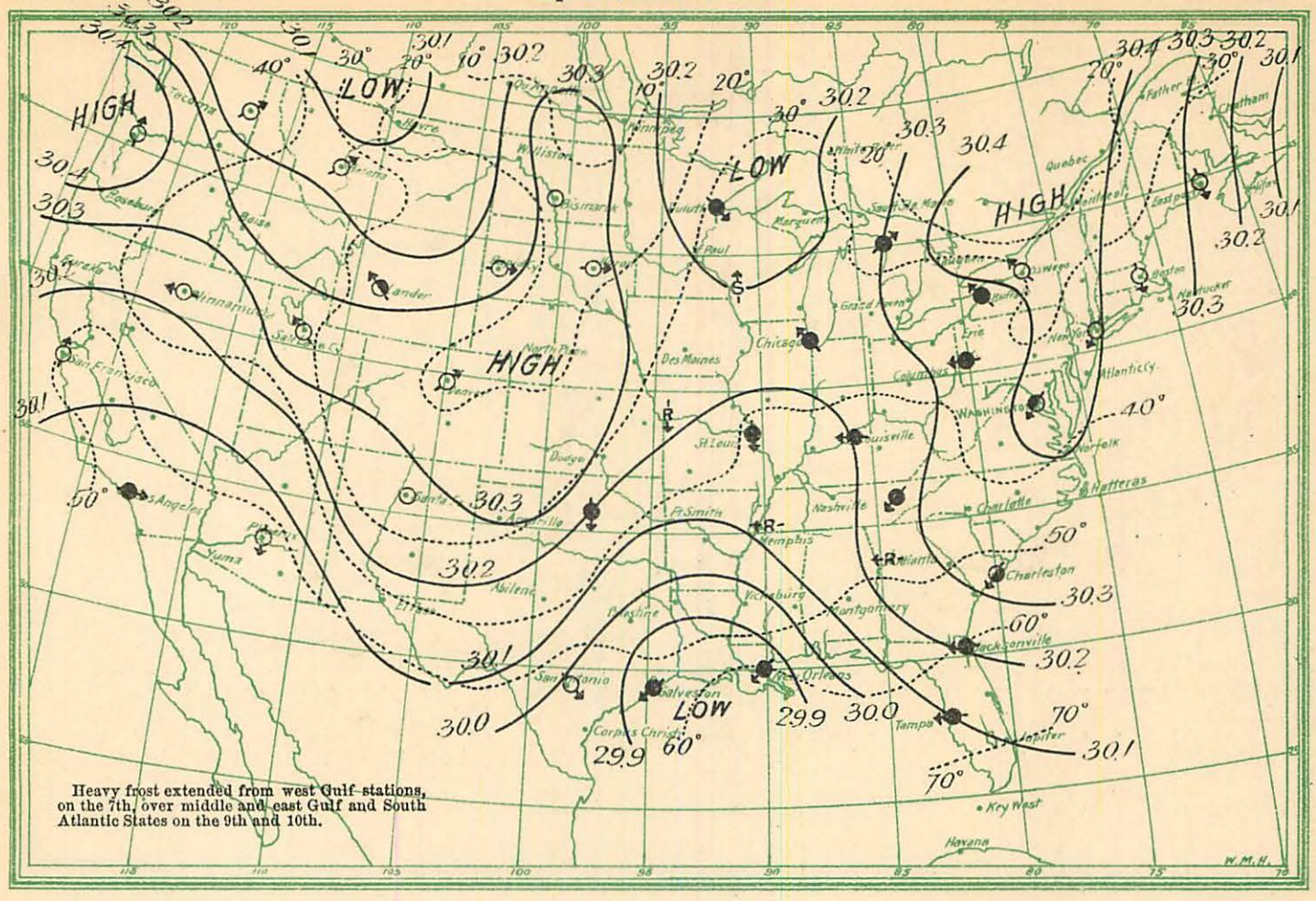


Chart CCLXXXII.

April 7, 1899—8 a. m.

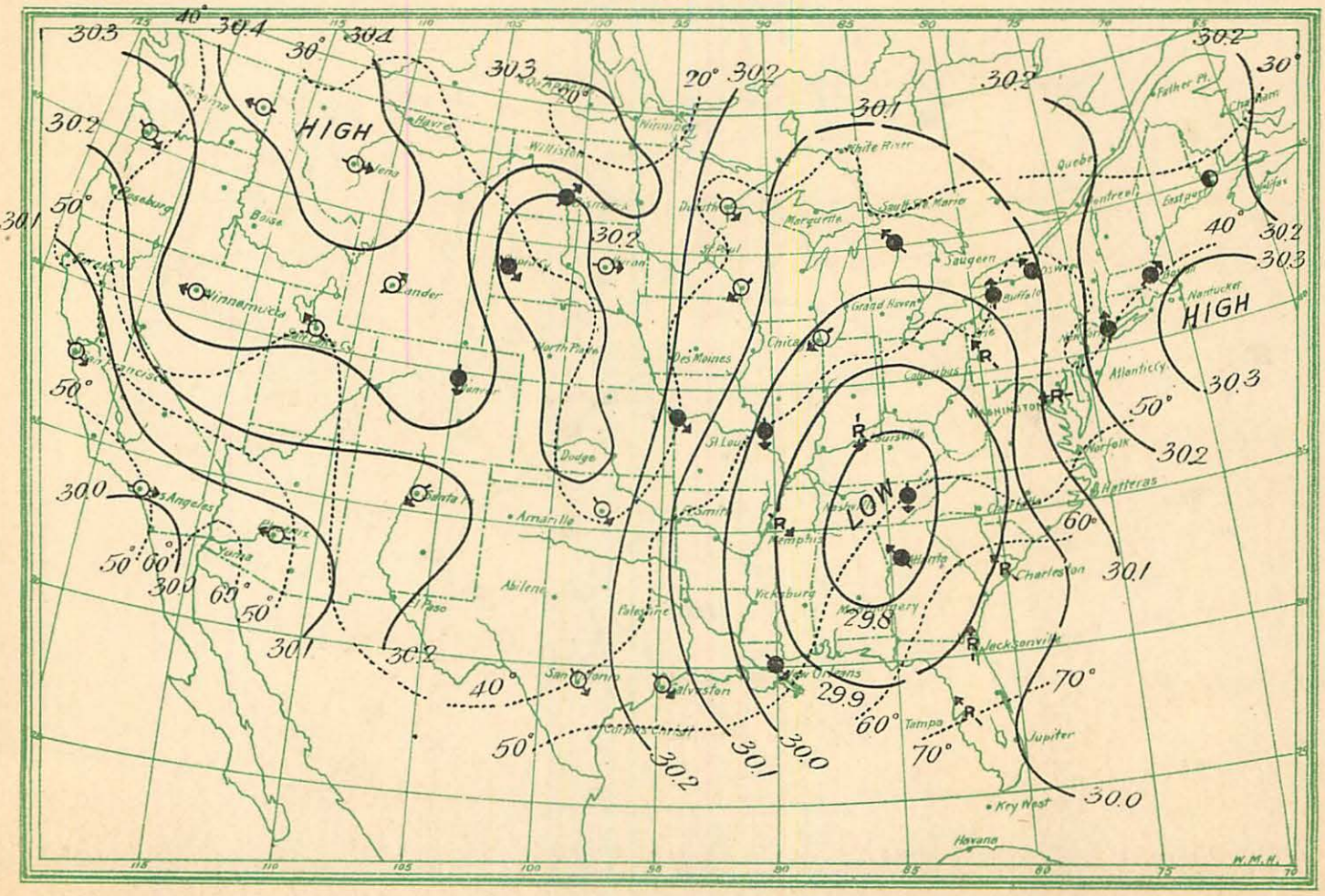


Chart CCLXXXIII. April 8, 1899—8 a. m.

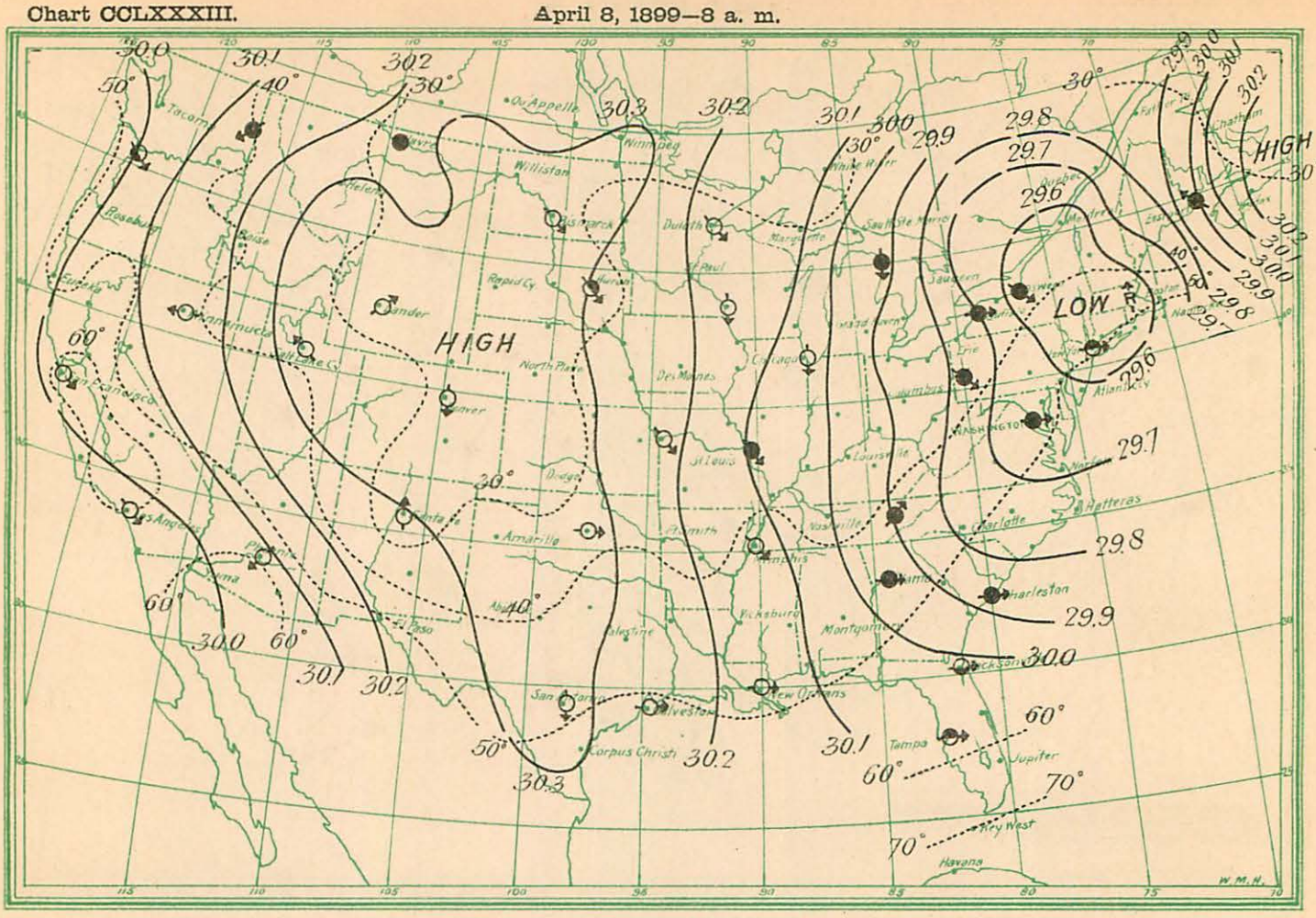


Chart CCLXXXIV. April 9, 1899—8 a. m.

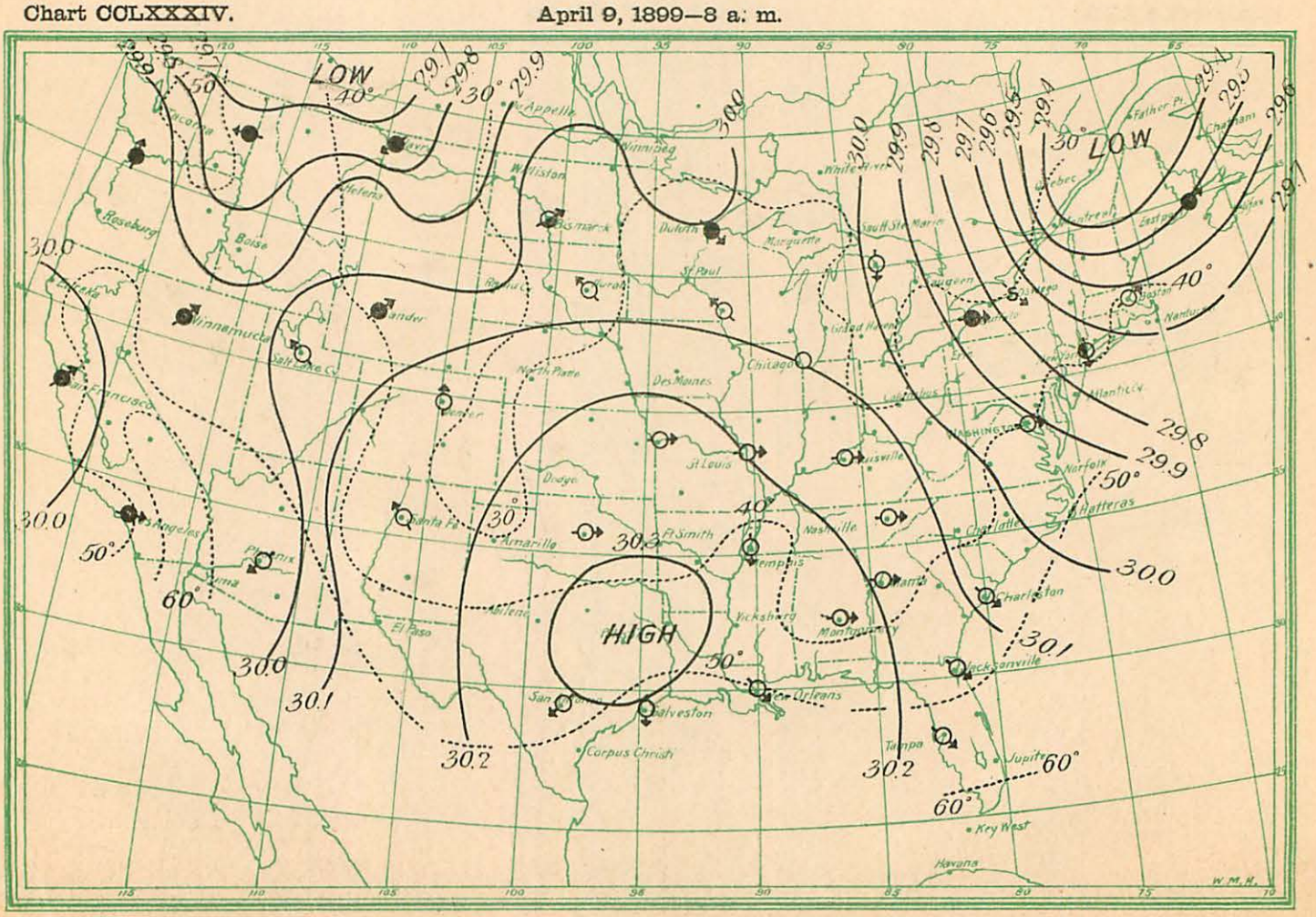


Chart CCLXXXV. May 18, 1894—8 a. m.

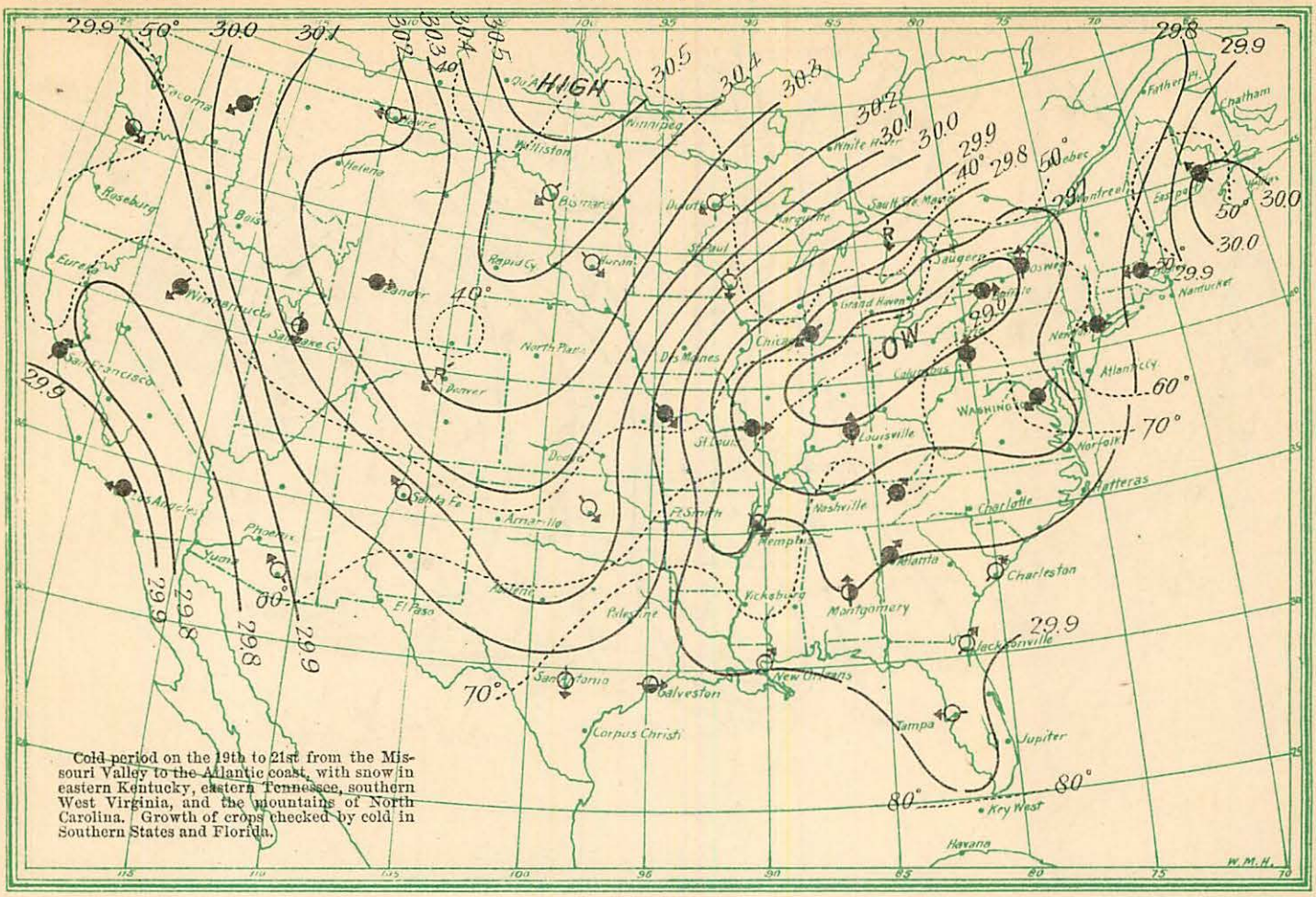


Chart CCLXXXVI. May 19, 1894—8 a. m.

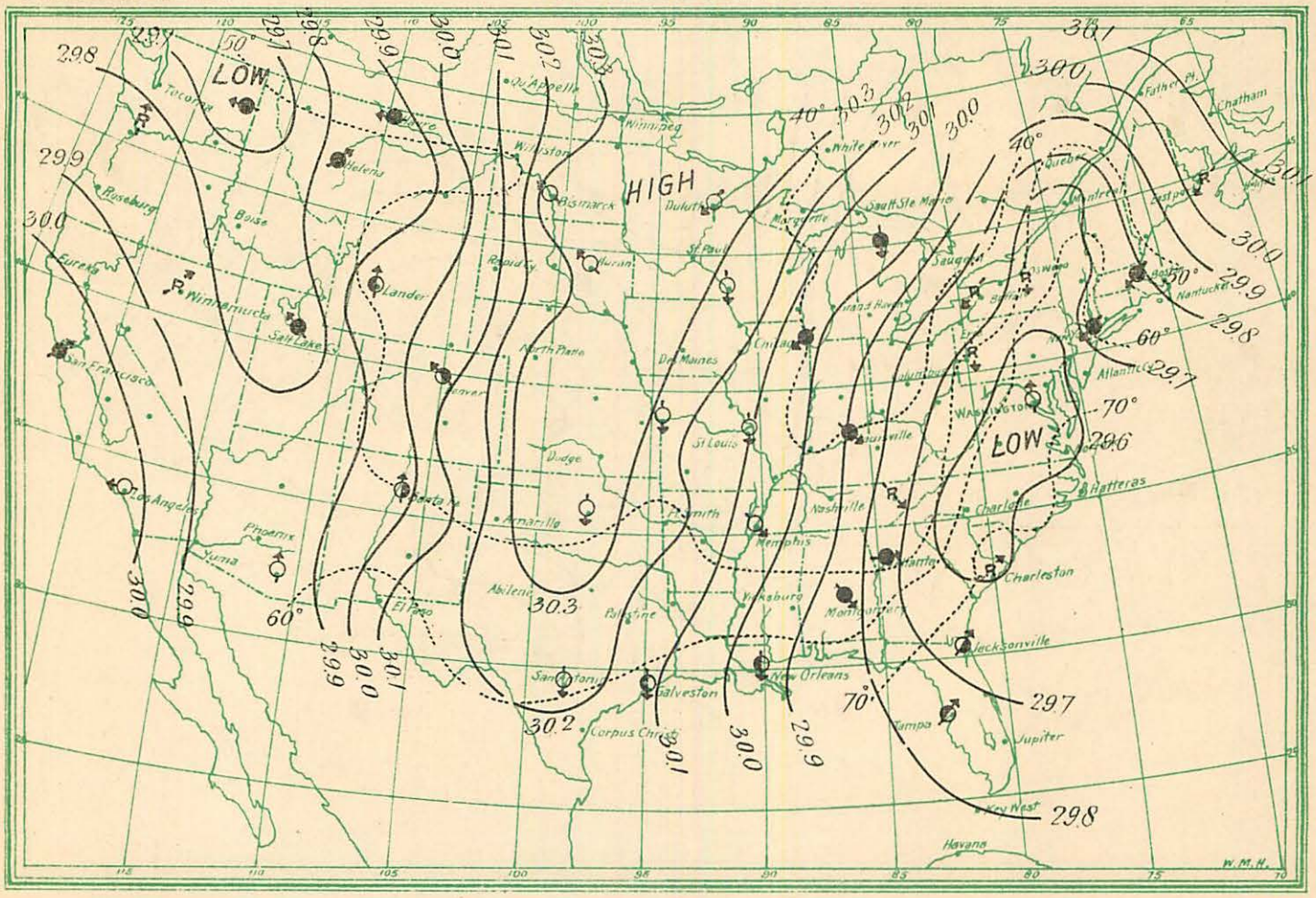


Chart CCLXXXVII. May 20, 1894—8 a. m.

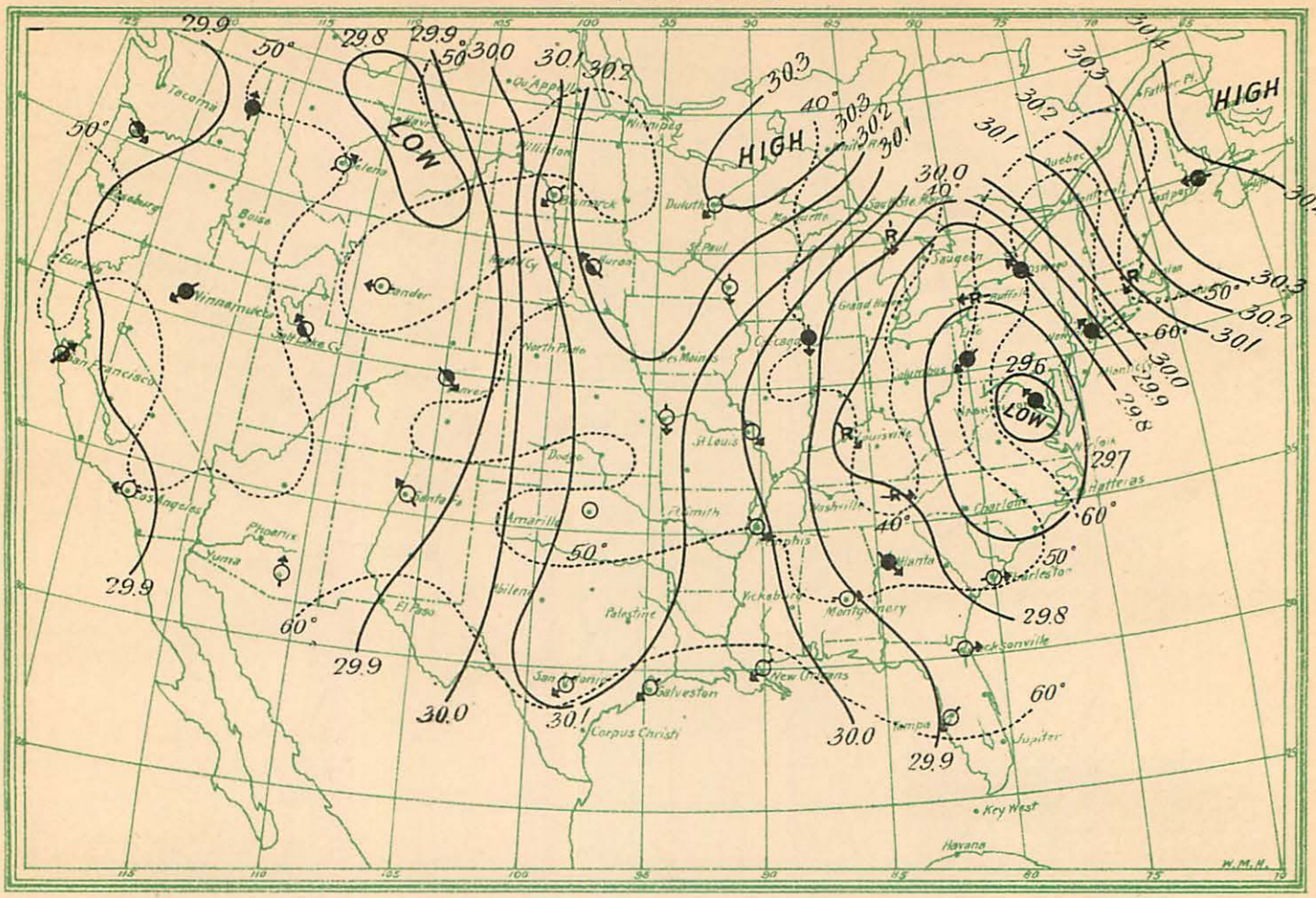


Chart CCLXXXVIII. May 21, 1894—8 a. m.

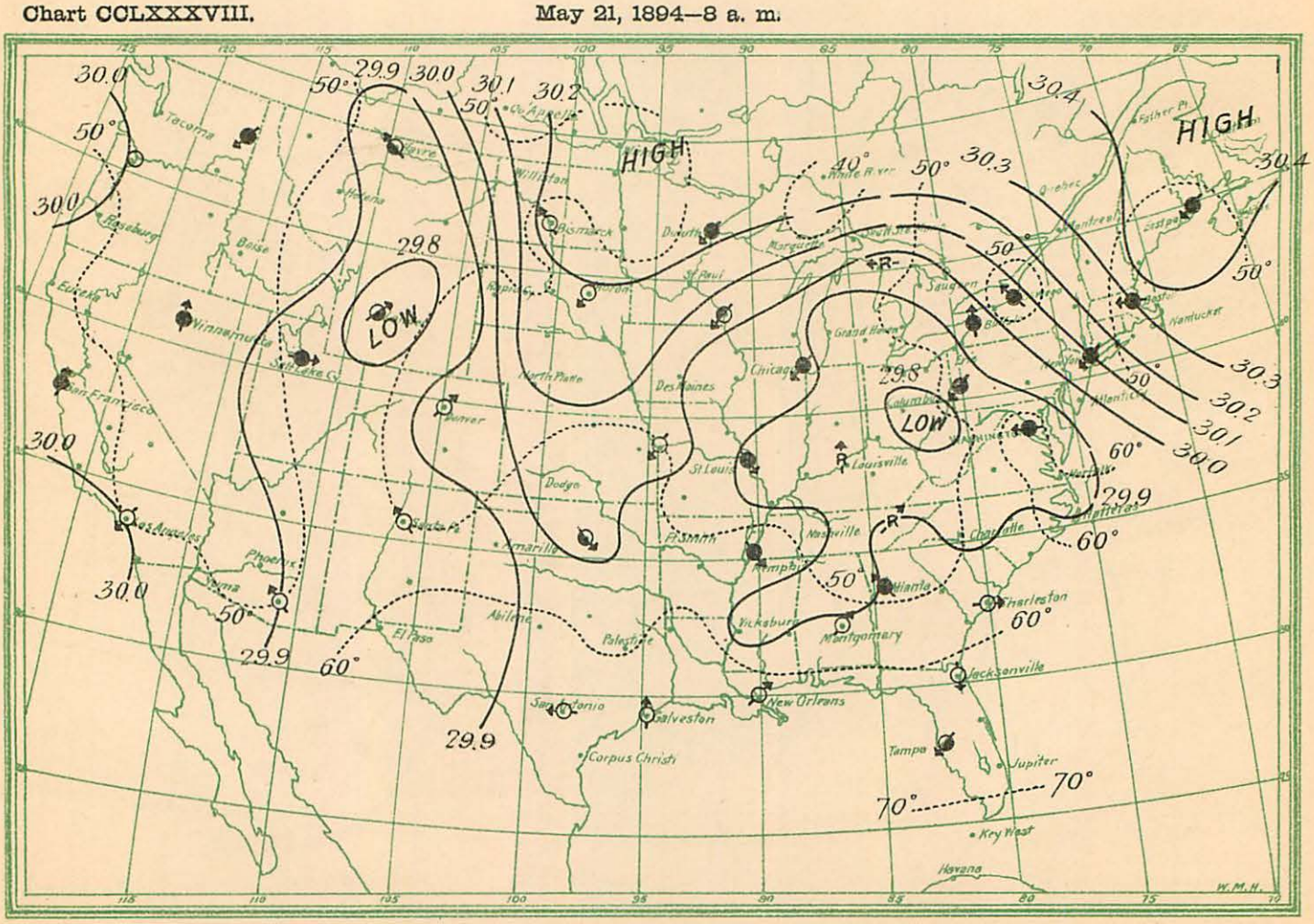


Chart CCLXXXIX. May 11, 1895—8 a. m.

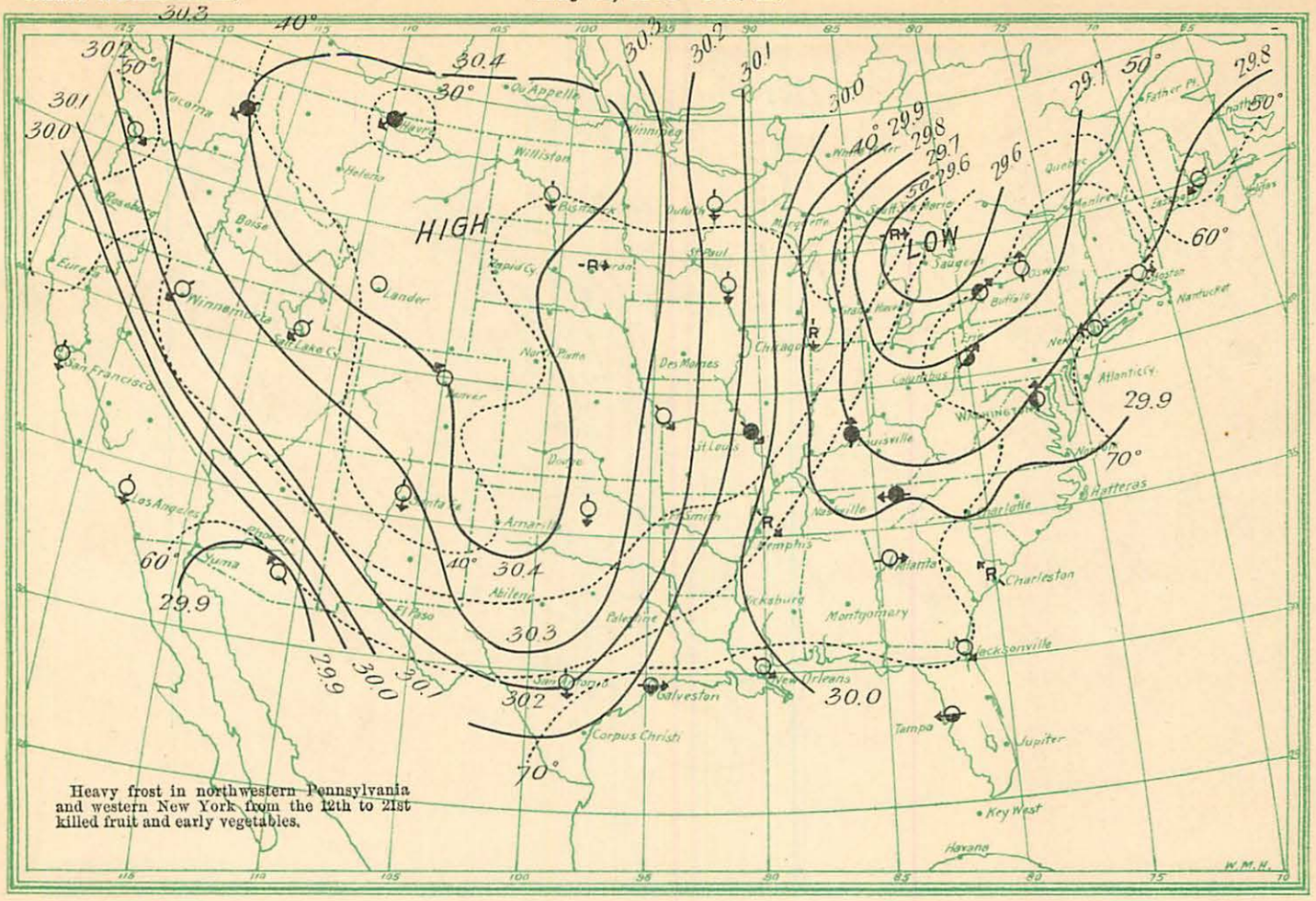


Chart CCXC. May 12, 1895—8 a. m.

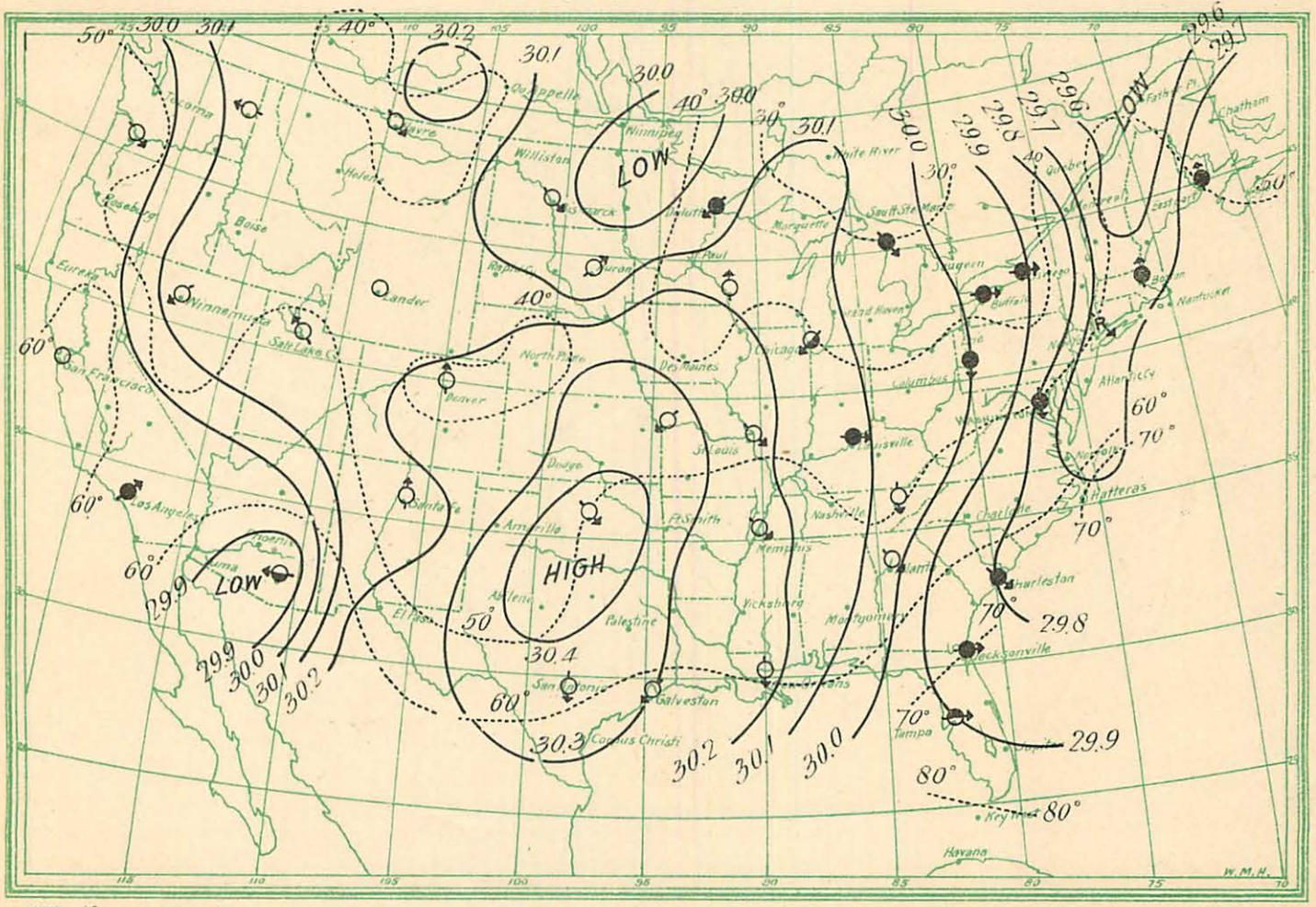


Chart CCXCI. May 13, 1895—8 a. m.

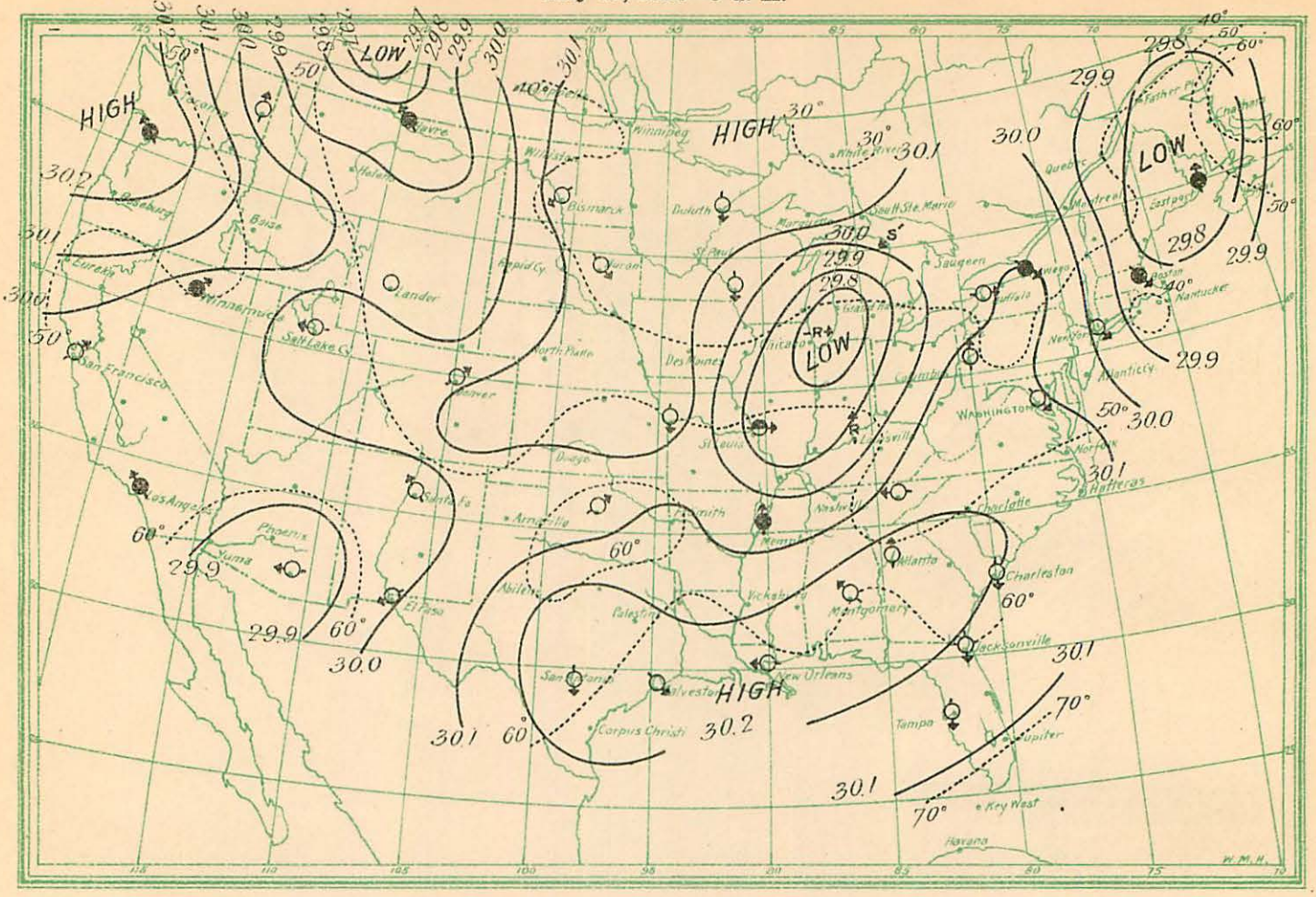


Chart CCXCII. May 14, 1895—8 a. m.

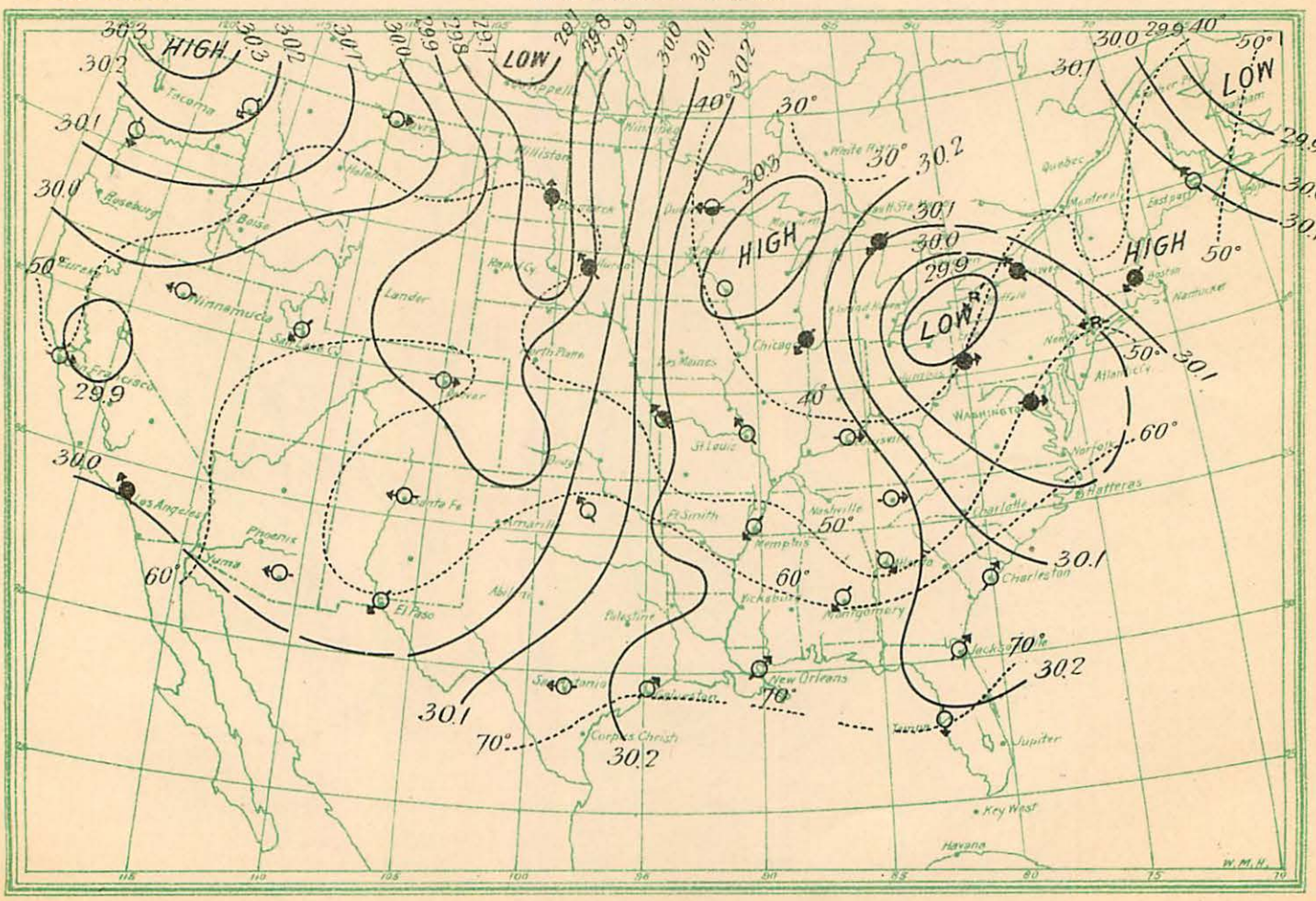


Chart CCXCIII. May 18, 1895—8 a. m.

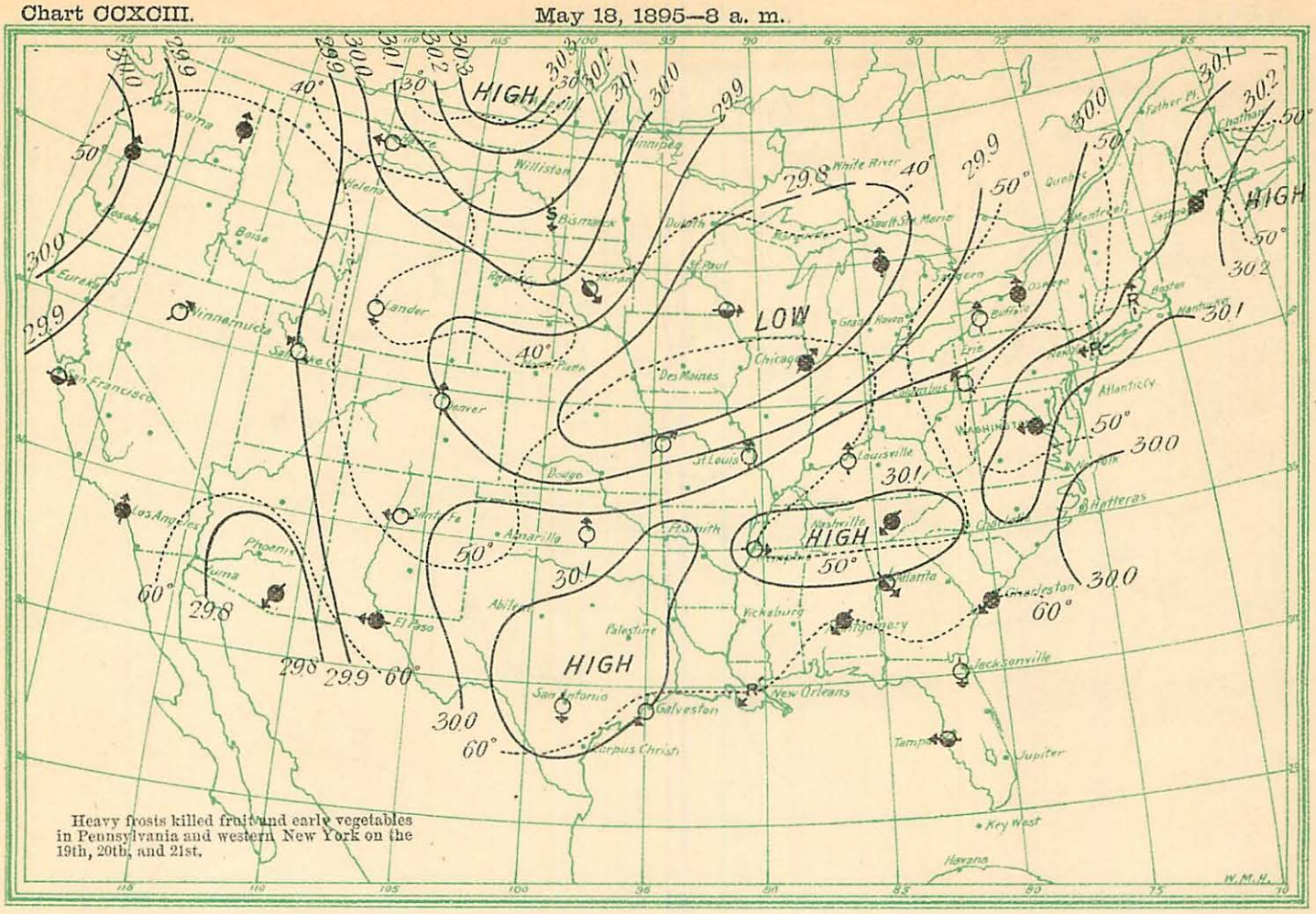


Chart CCXCIV. May 19, 1895—8 a. m.

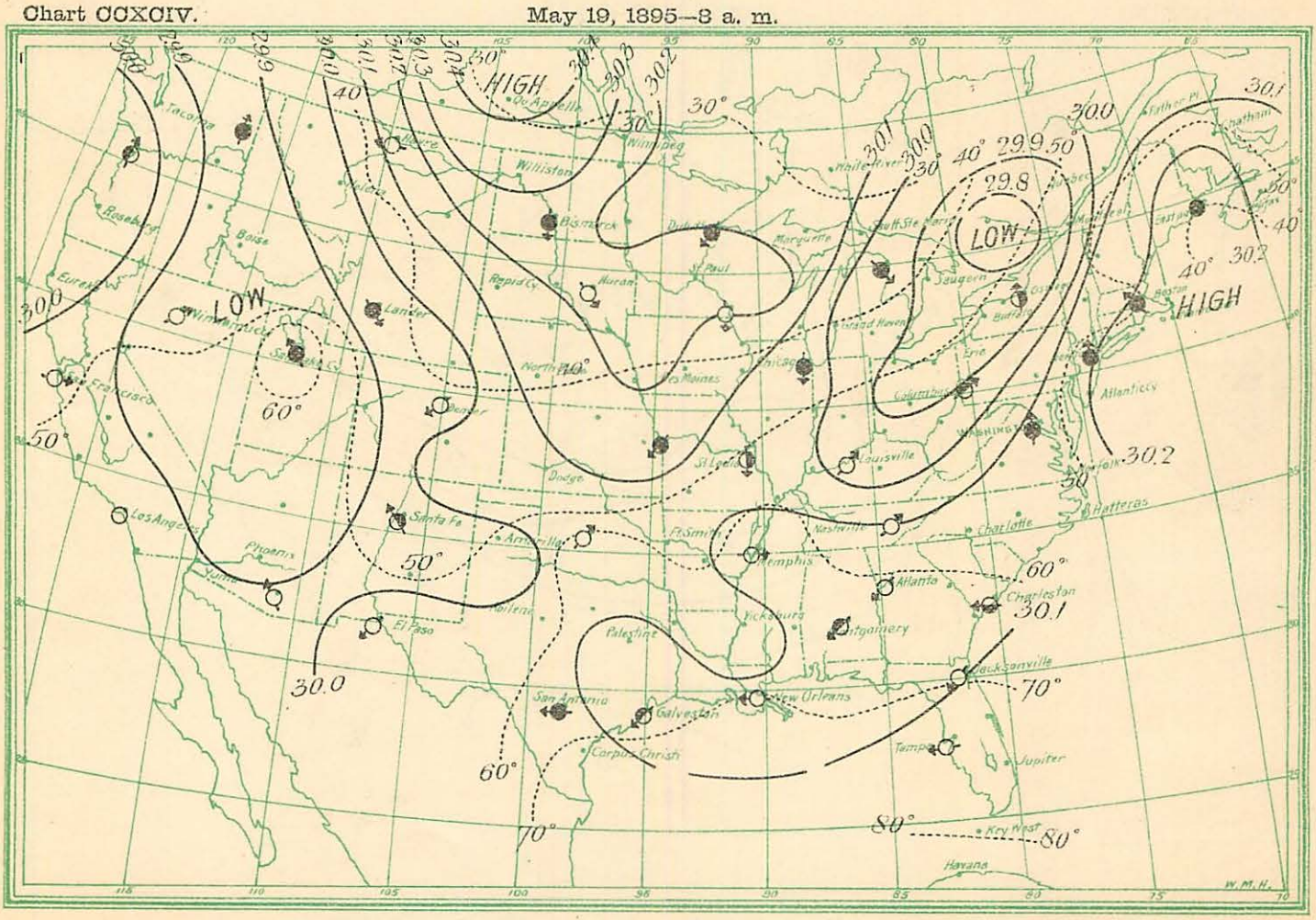


Chart CCXCV. May 20, 1895—8 a. m.

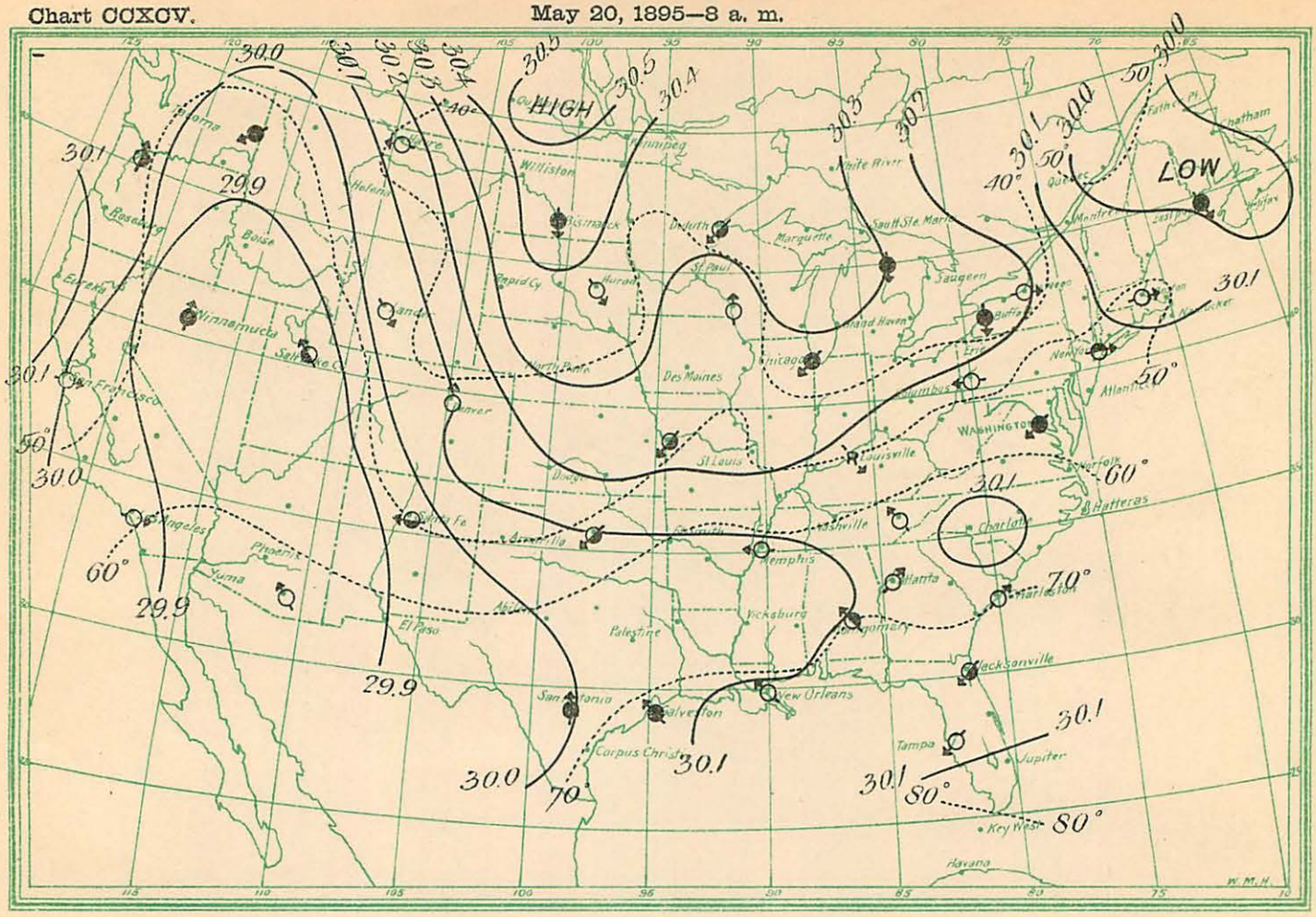


Chart CCXCVI. May 21, 1895—8 a. m.

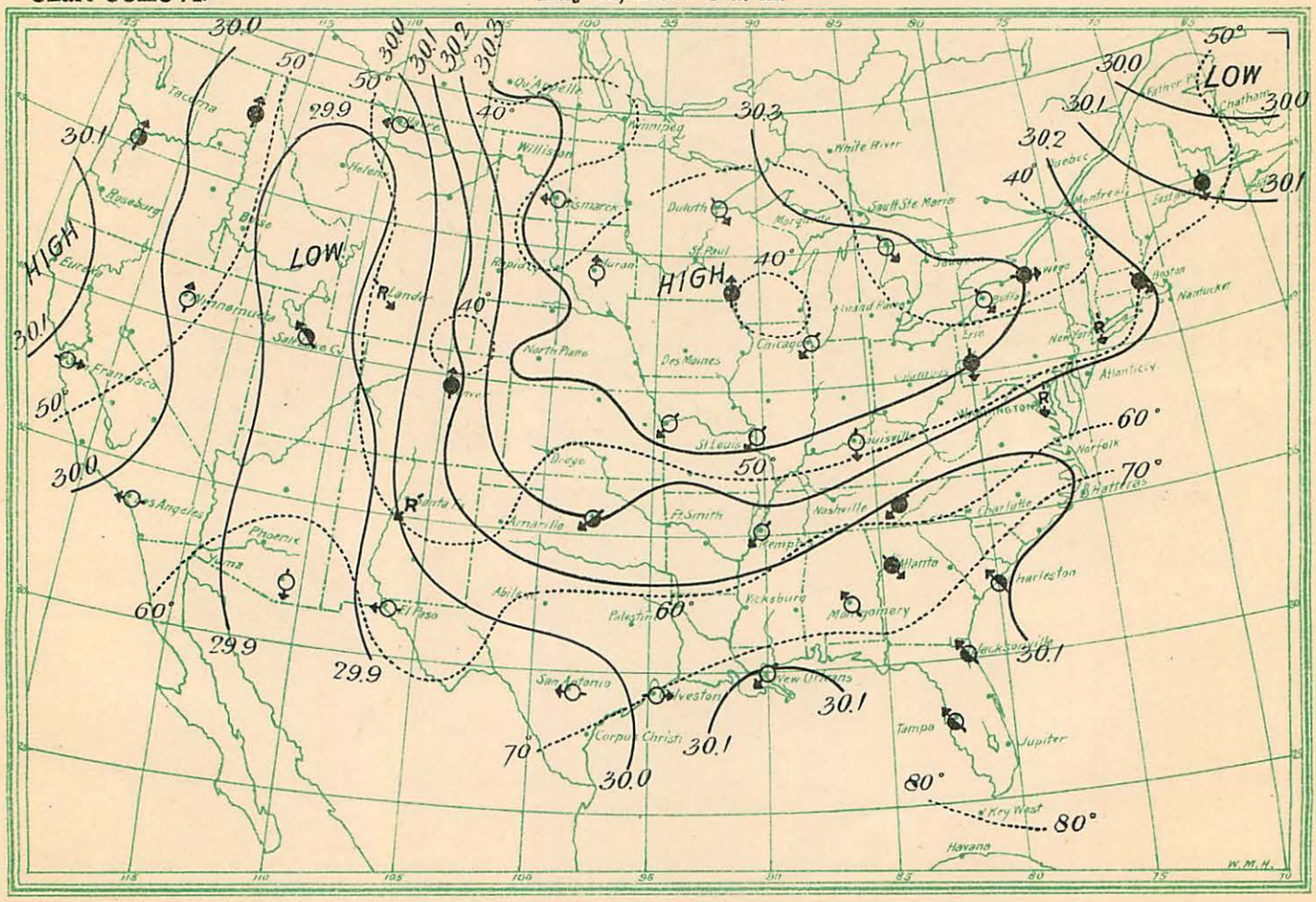


Chart CCXCVII. May 2, 1900—8 a. m.

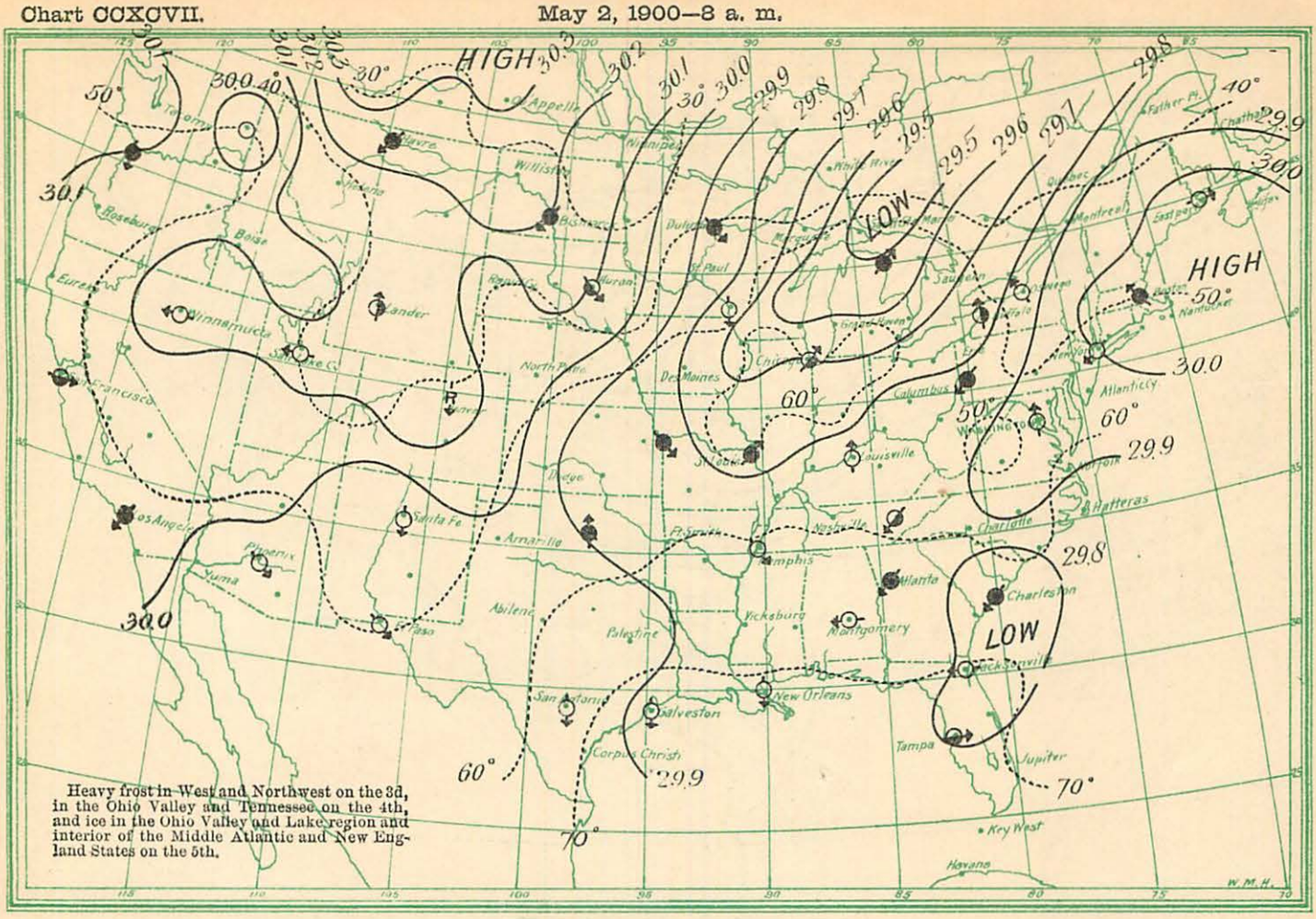


Chart CCXCVIII. May 3, 1900—8 a. m.

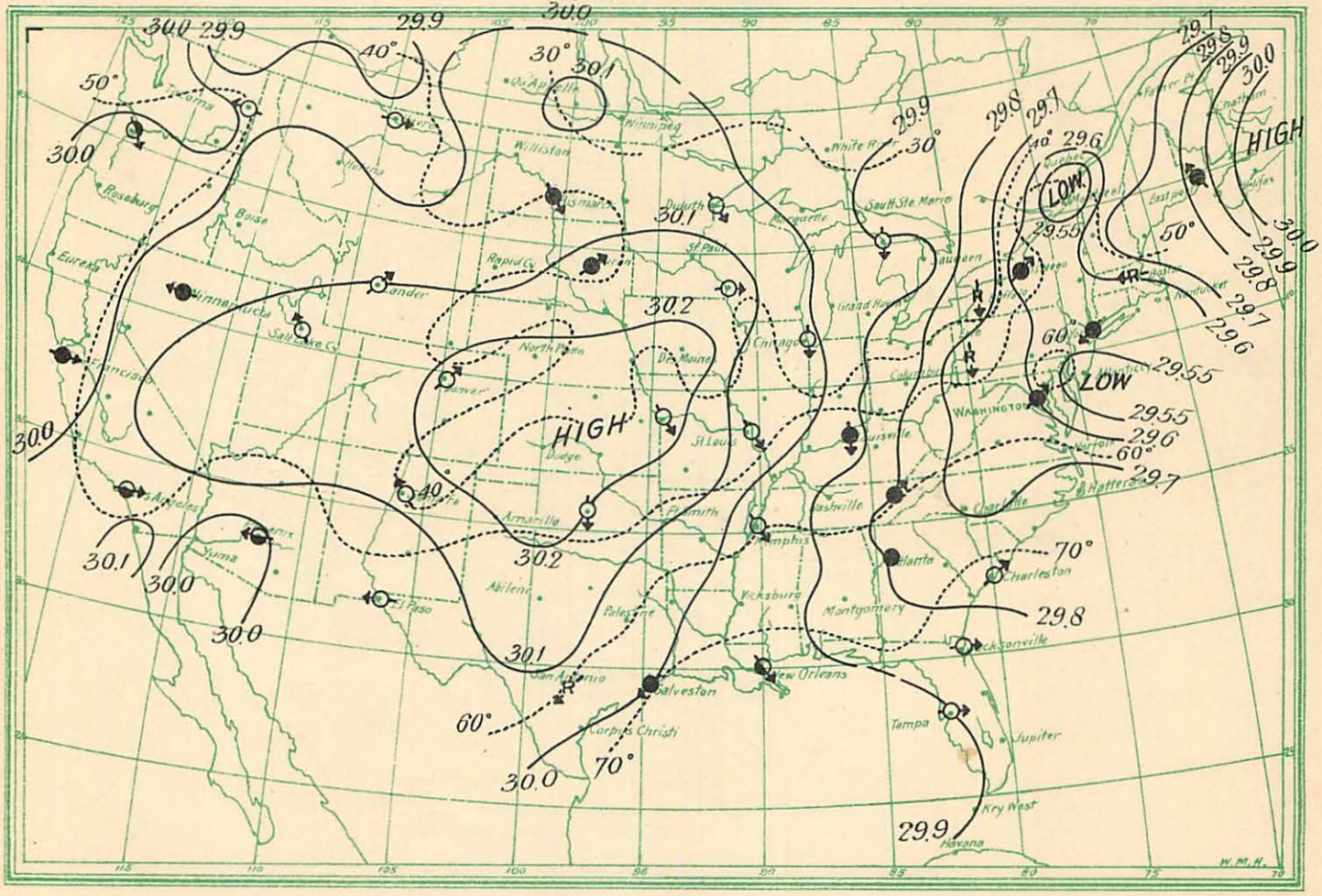


Chart CCXCIX. May 4, 1900—8 a. m.

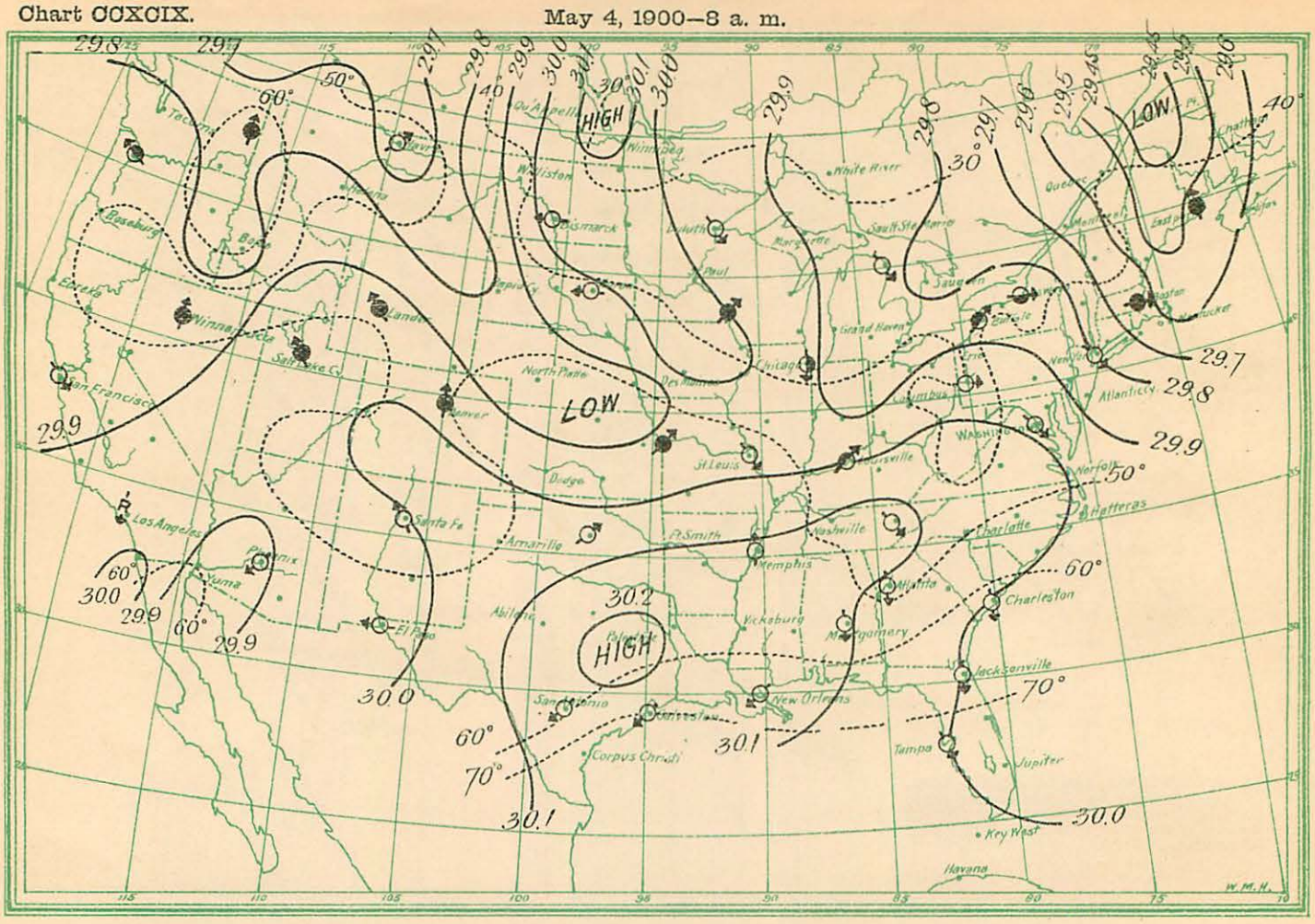


Chart CCC. May 5, 1900—8 a. m.

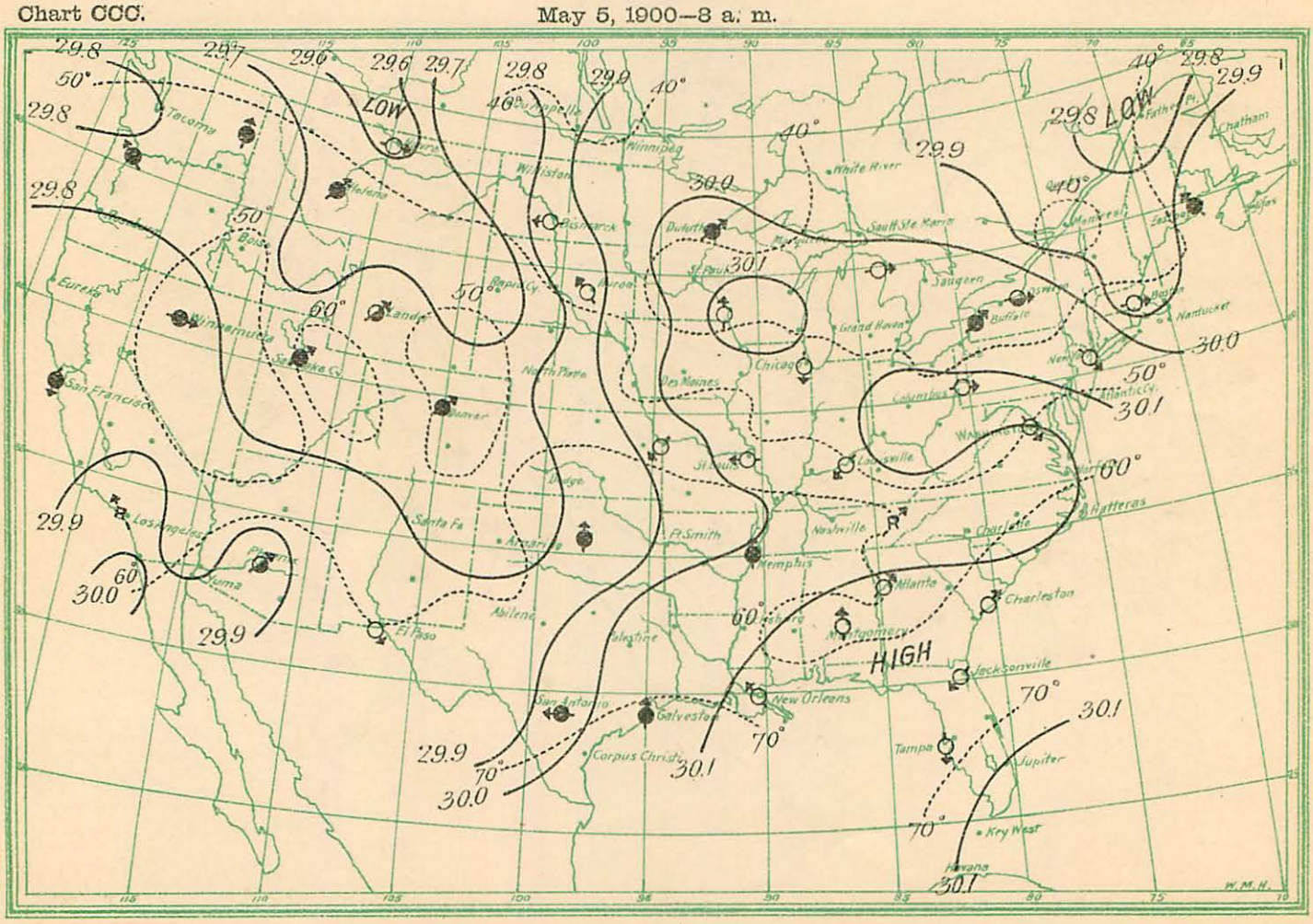


Chart CCCI. May 29, 1889—8 a. m.

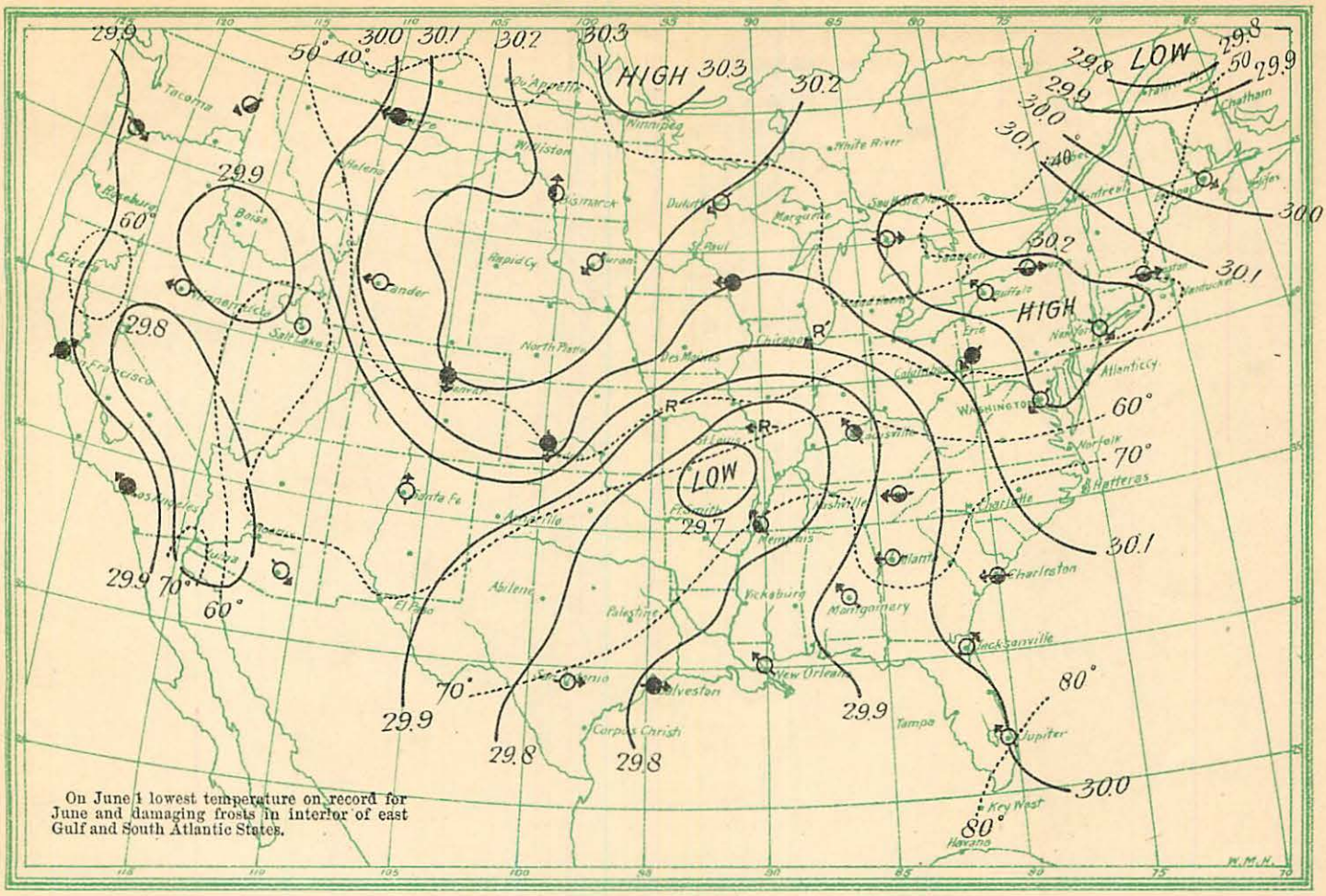


Chart CCCII. May 30, 1889—8 a. m.

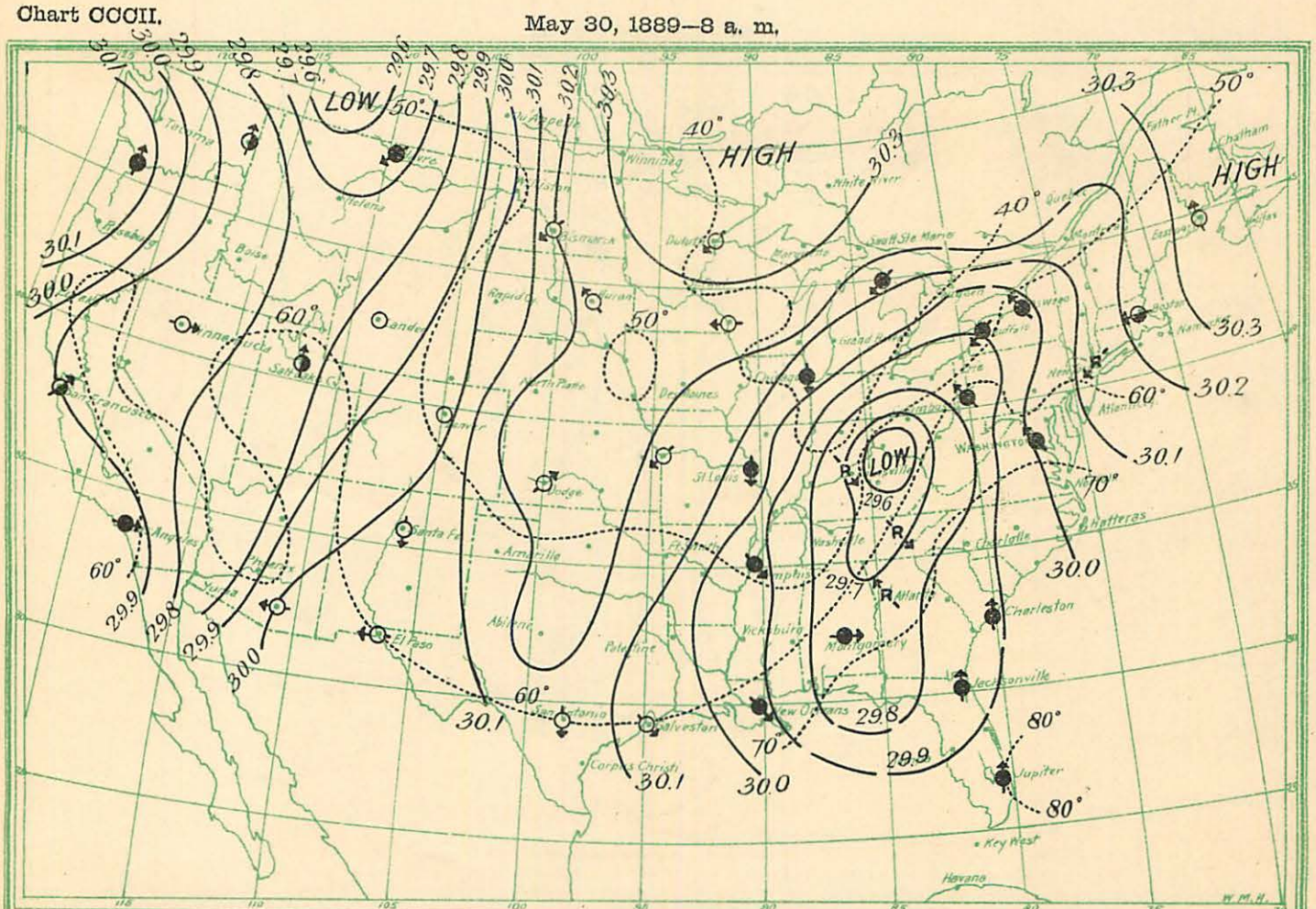


Chart CCCIII. May 31, 1889—8 a. m.

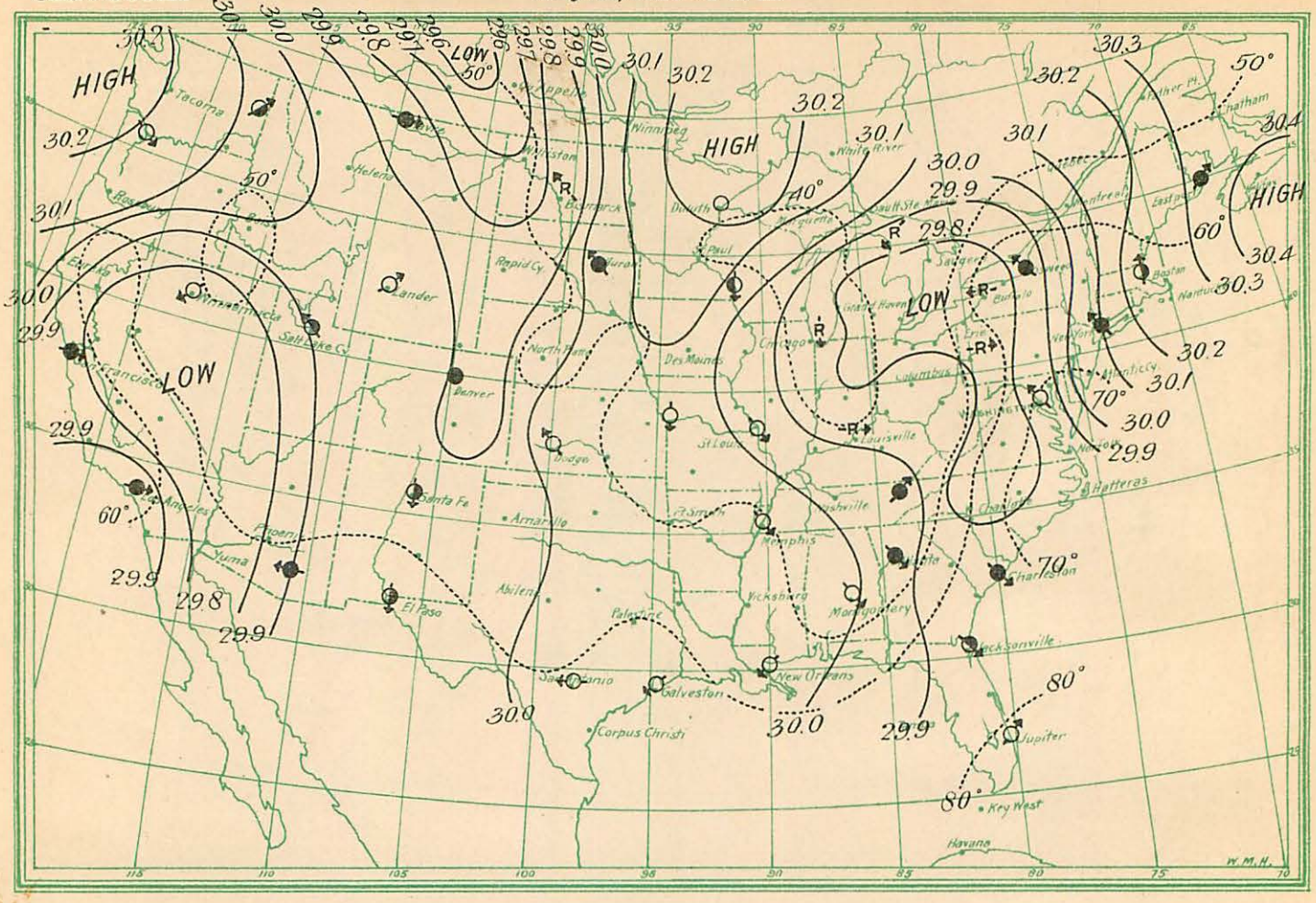


Chart CCCIV. June 1, 1889—8 a. m.

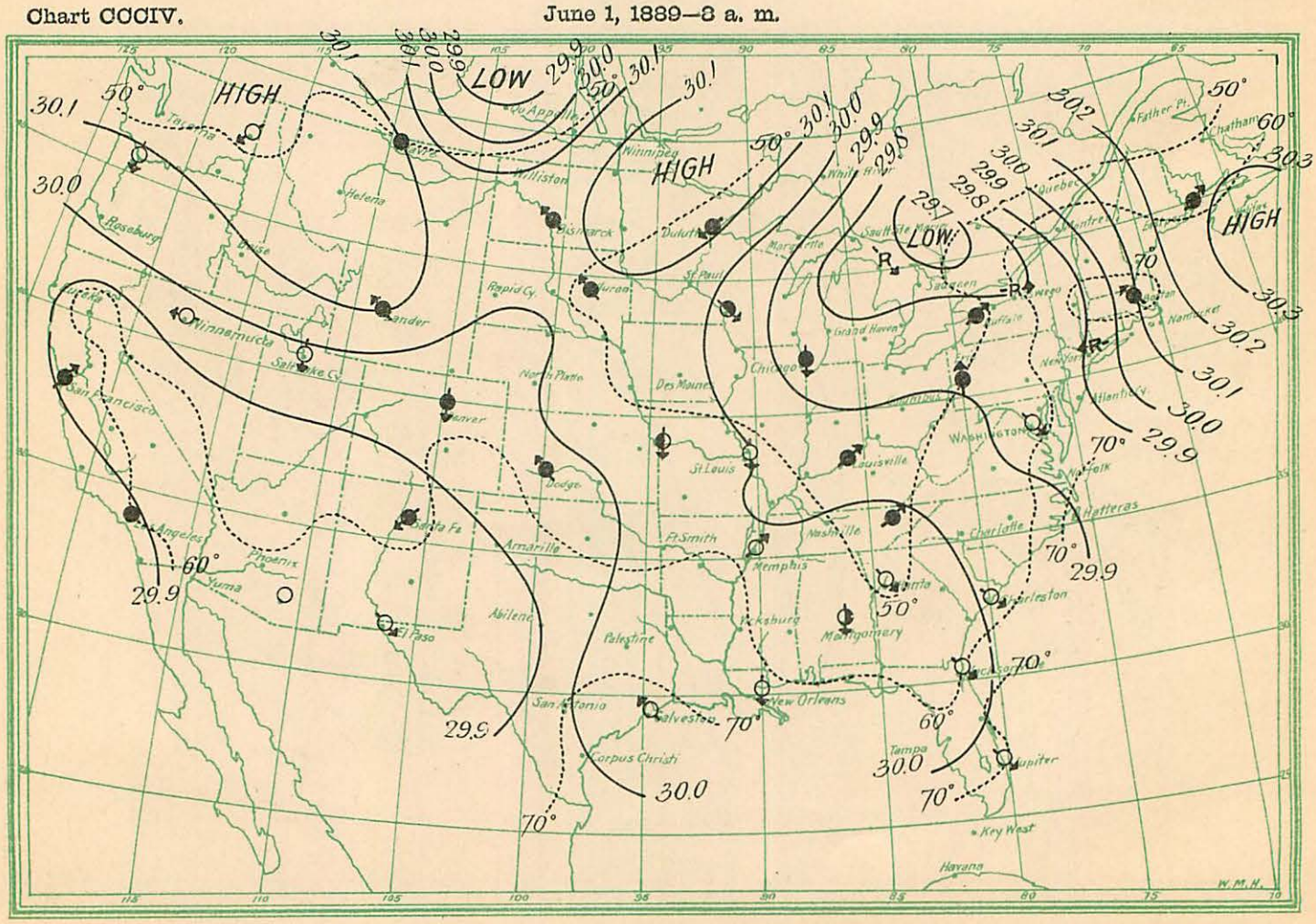
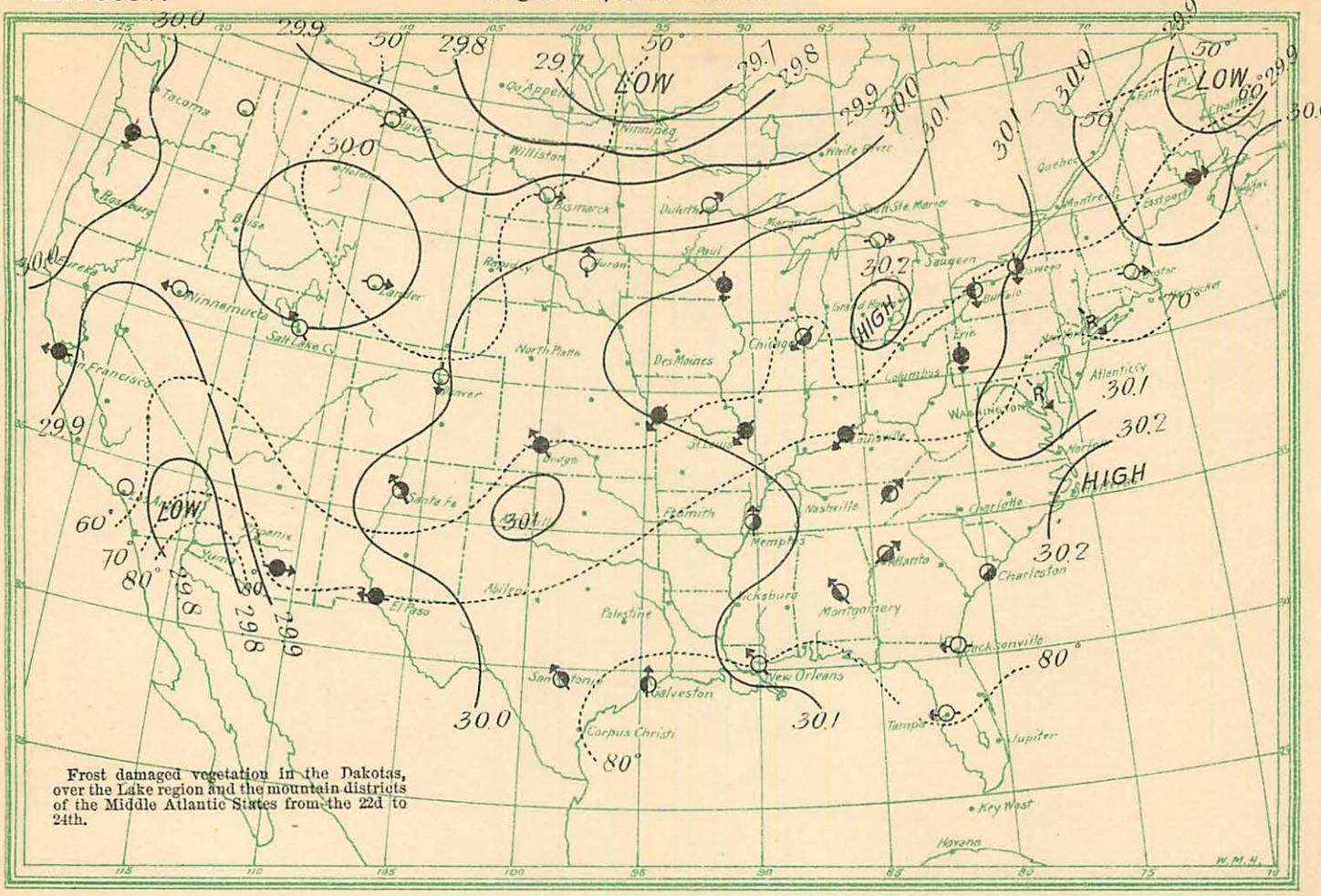


Chart CCCV. August 20, 1890—8 a. m.



Frost damaged vegetation in the Dakotas, over the Lake region and the mountain districts of the Middle Atlantic States from the 22d to 24th.

Chart CCCVI. August 21, 1890—8 a. m.

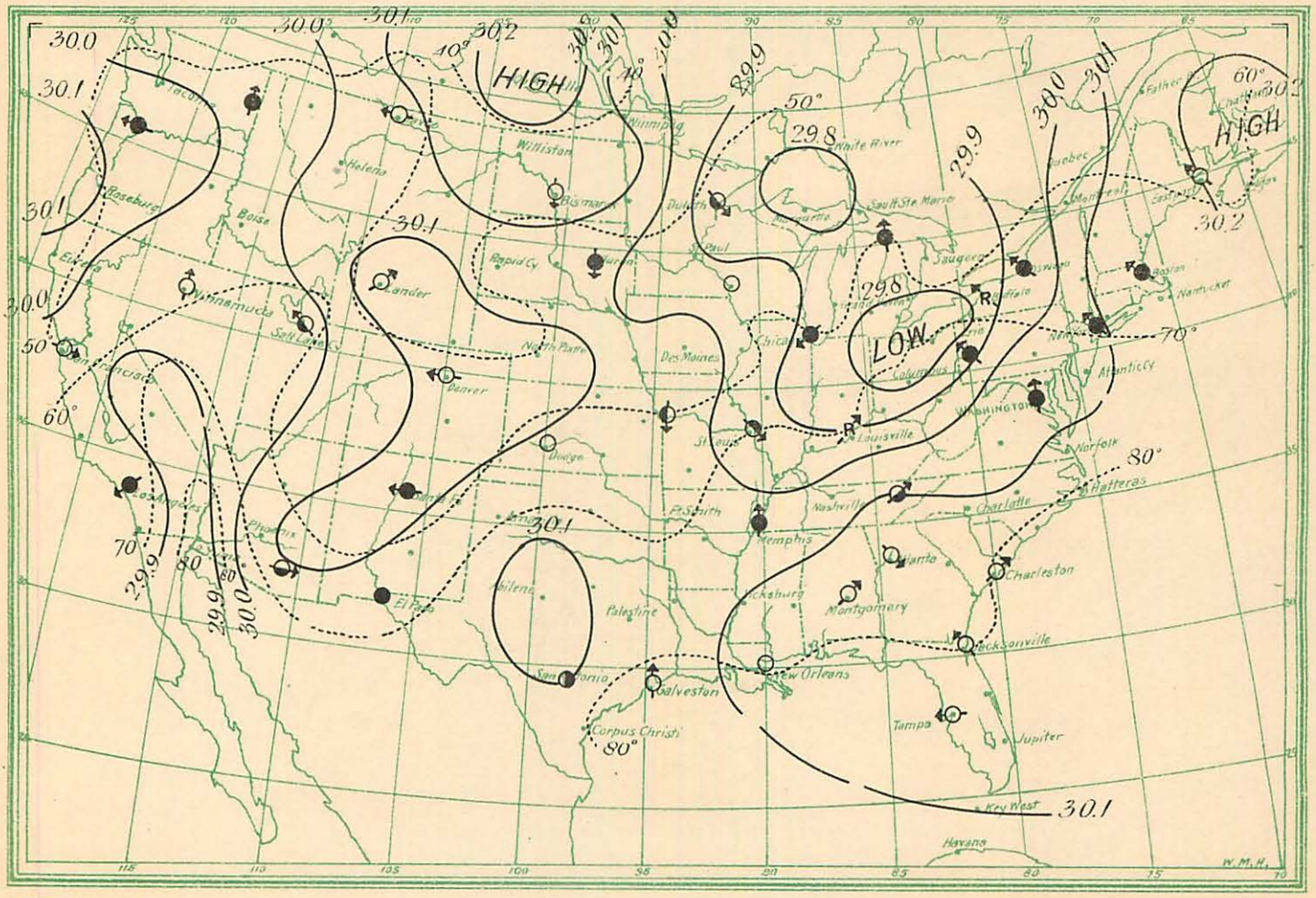


Chart CCCVII. August 22, 1890—8 a. m.

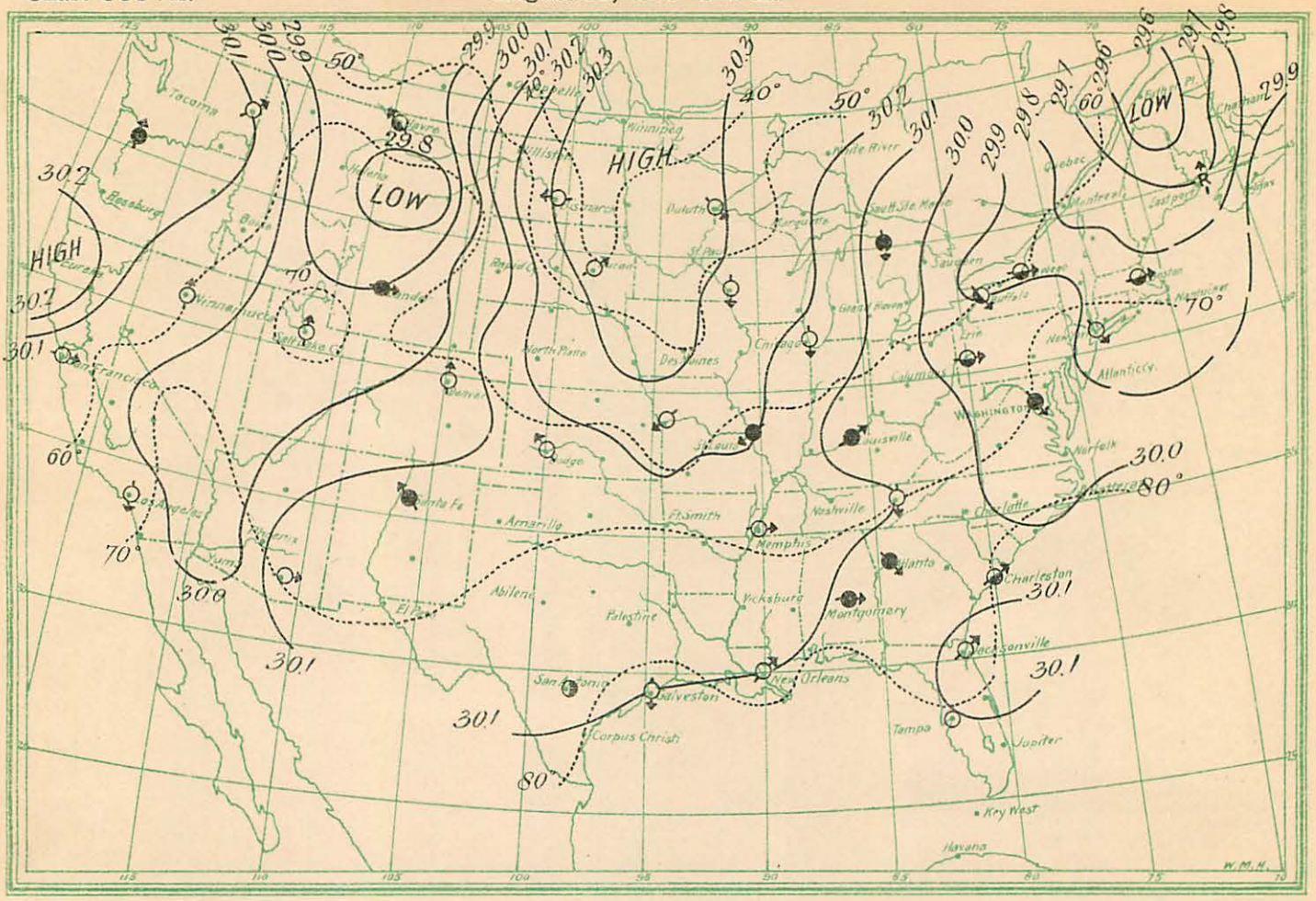


Chart CCCVIII. August 23, 1890—8 a. m.

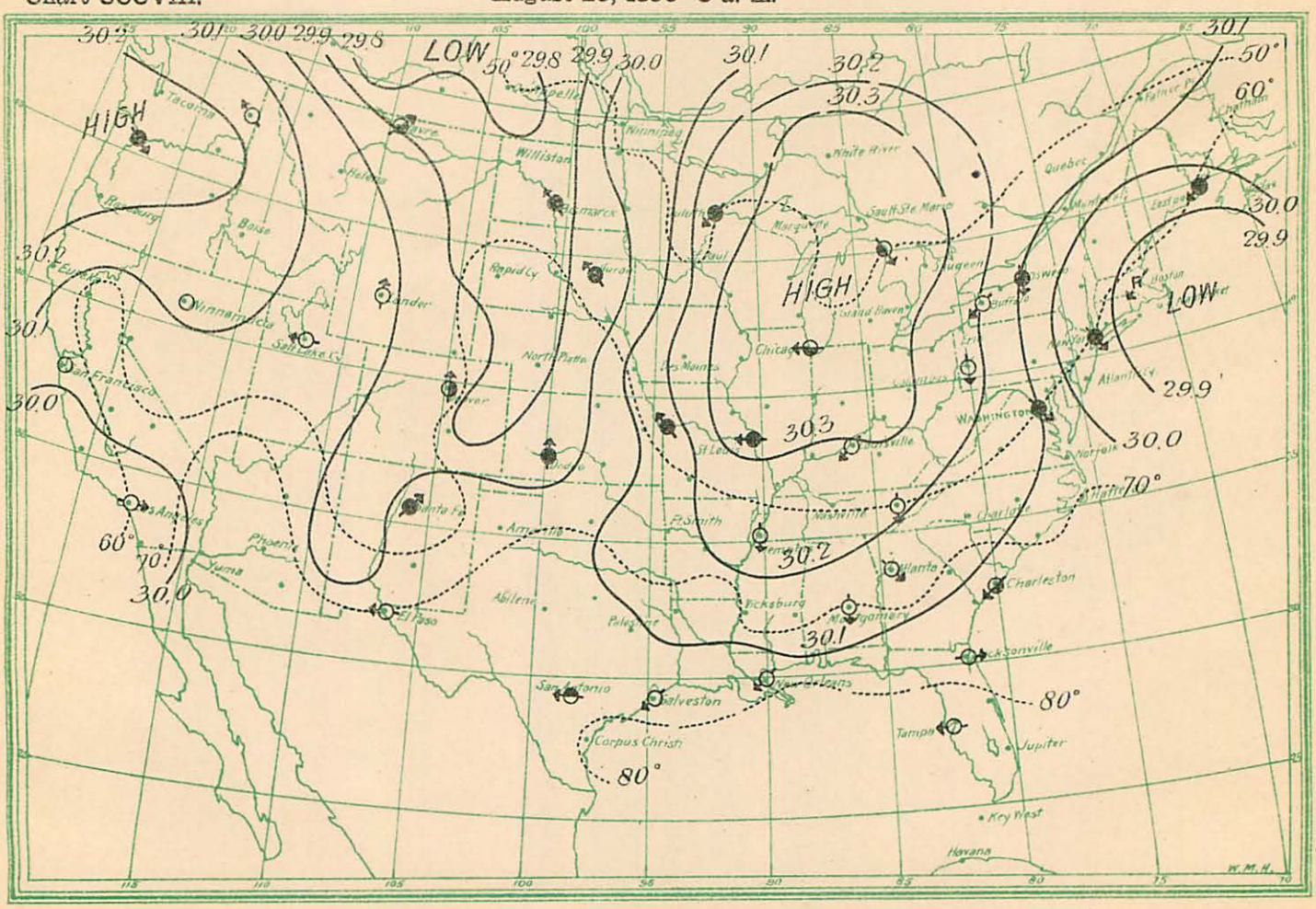
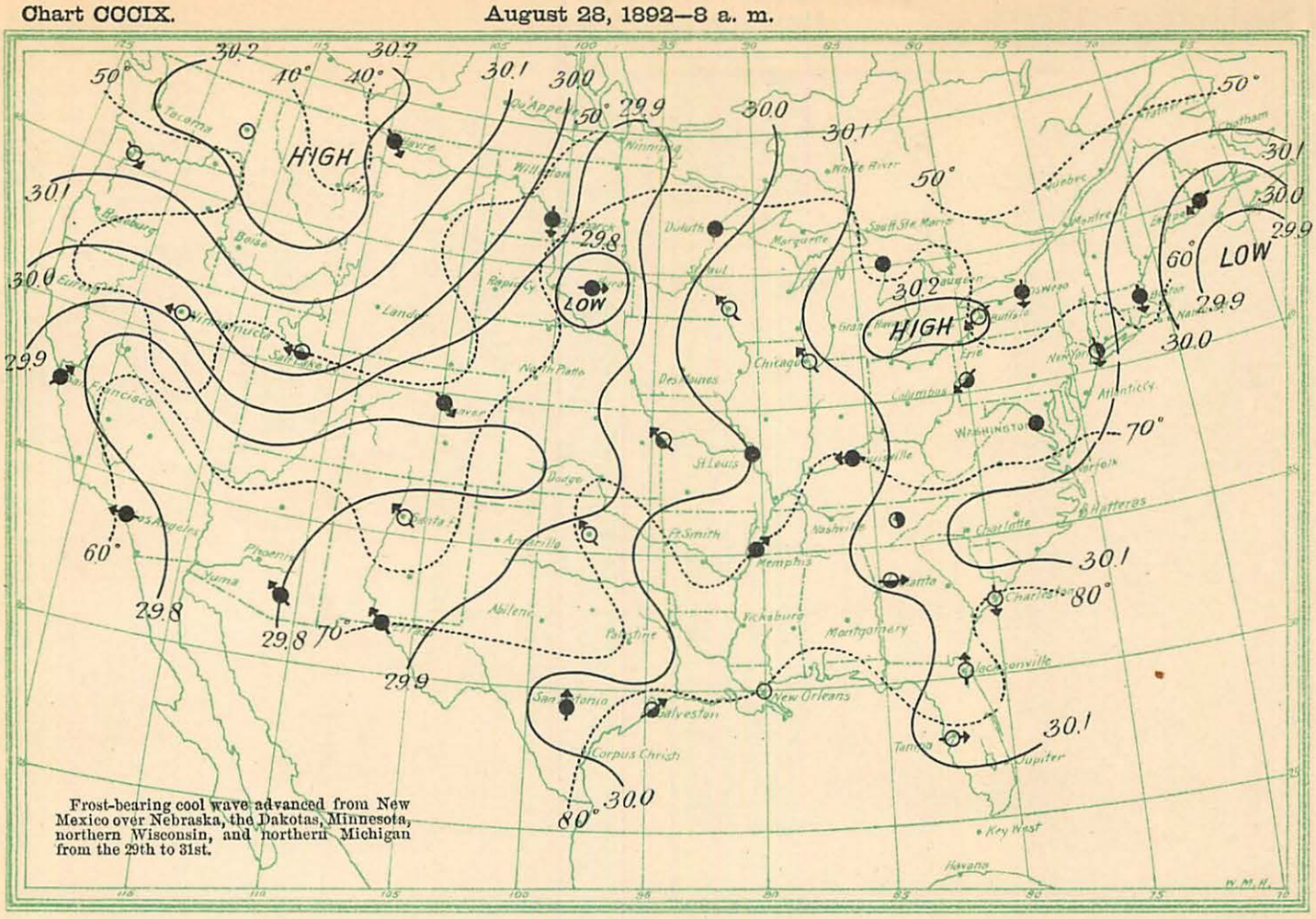


Chart CCCIX. August 28, 1892—8 a. m.



Frost-bearing cool wave advanced from New Mexico over Nebraska, the Dakotas, Minnesota, northern Wisconsin, and northern Michigan from the 29th to 31st.

Chart CCCX. August 29, 1892—8 a. m.

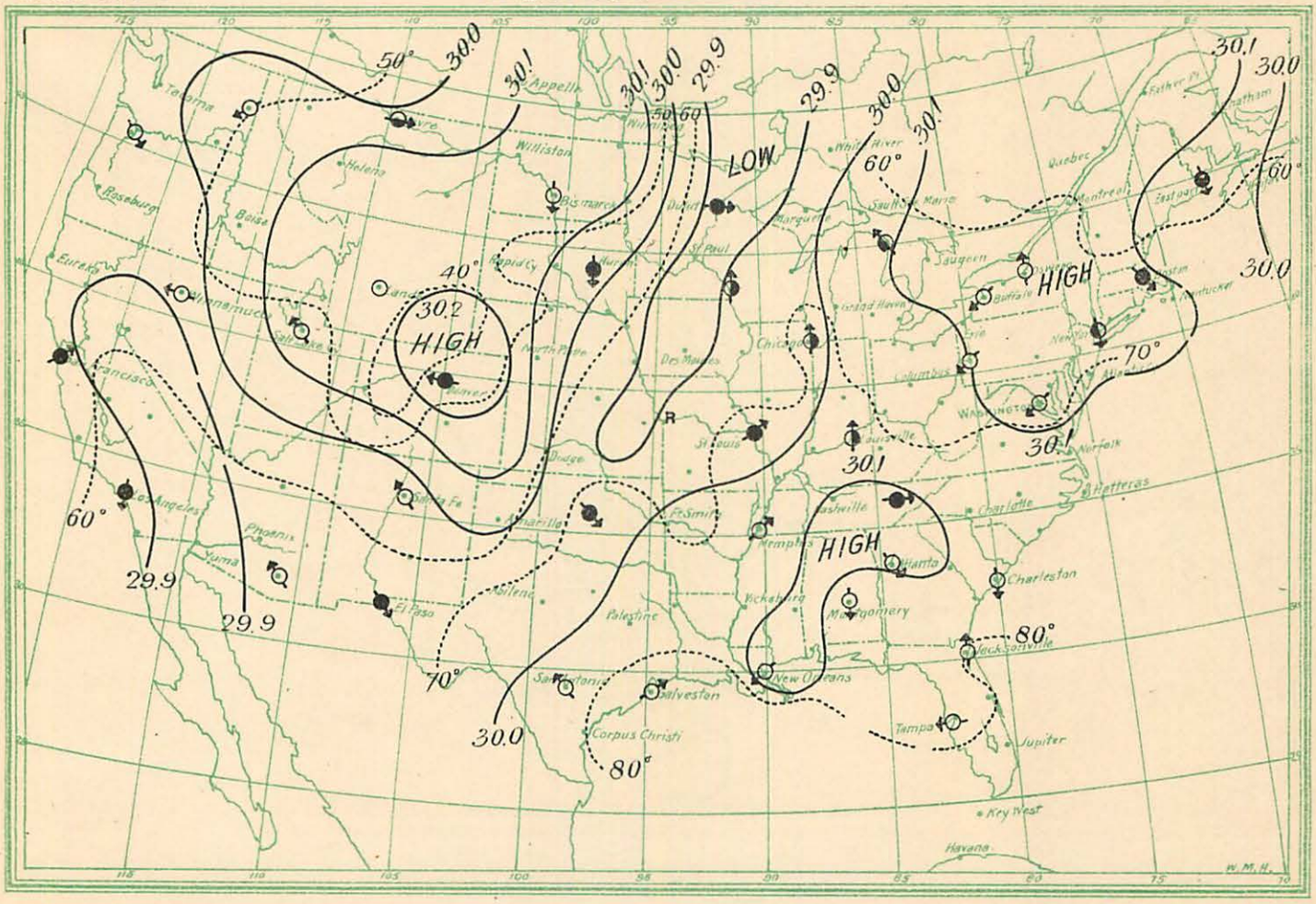


Chart CCCXI. August 30, 1892—8 a. m.

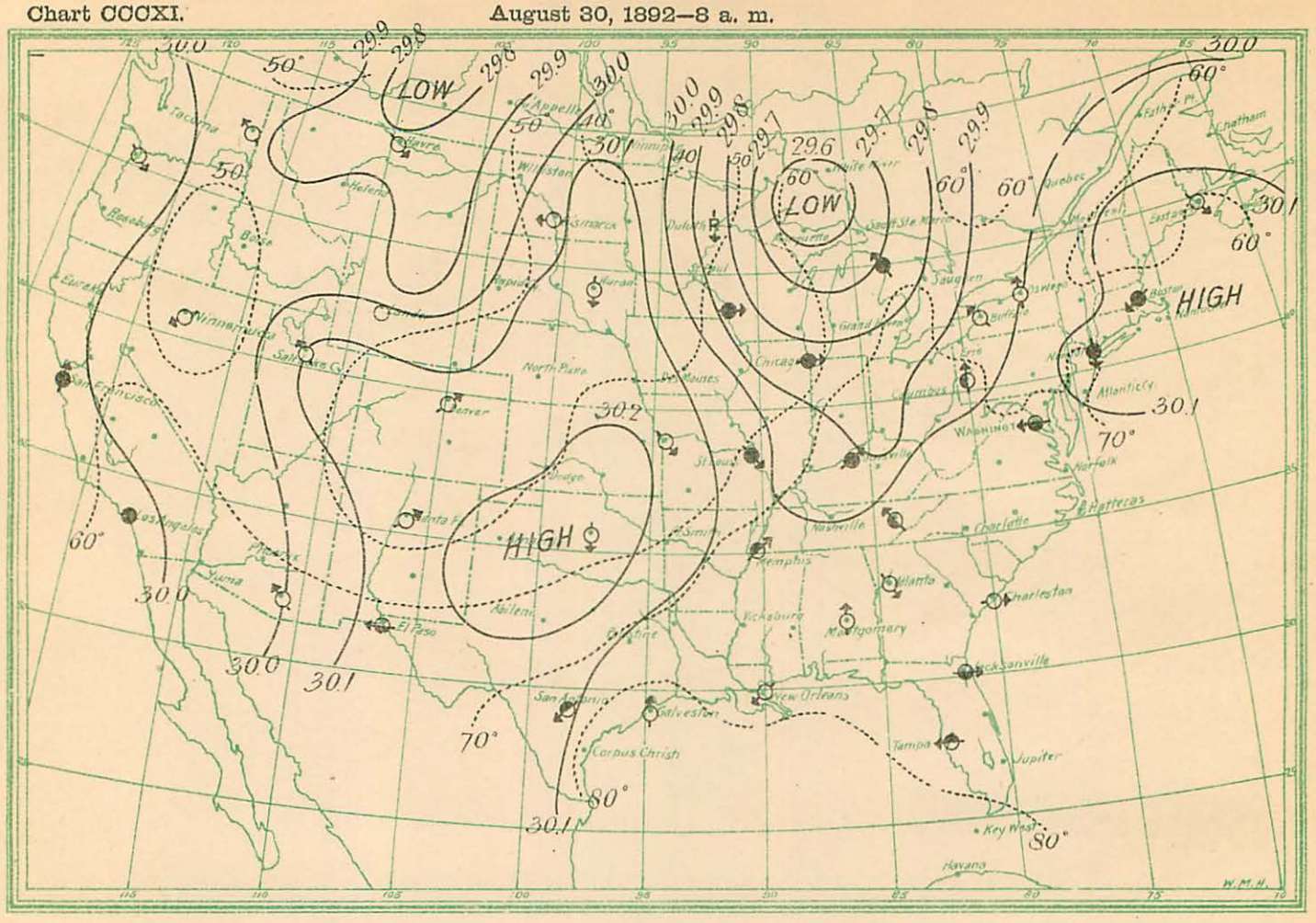


Chart CCCXII. August 31, 1892—8 a. m.

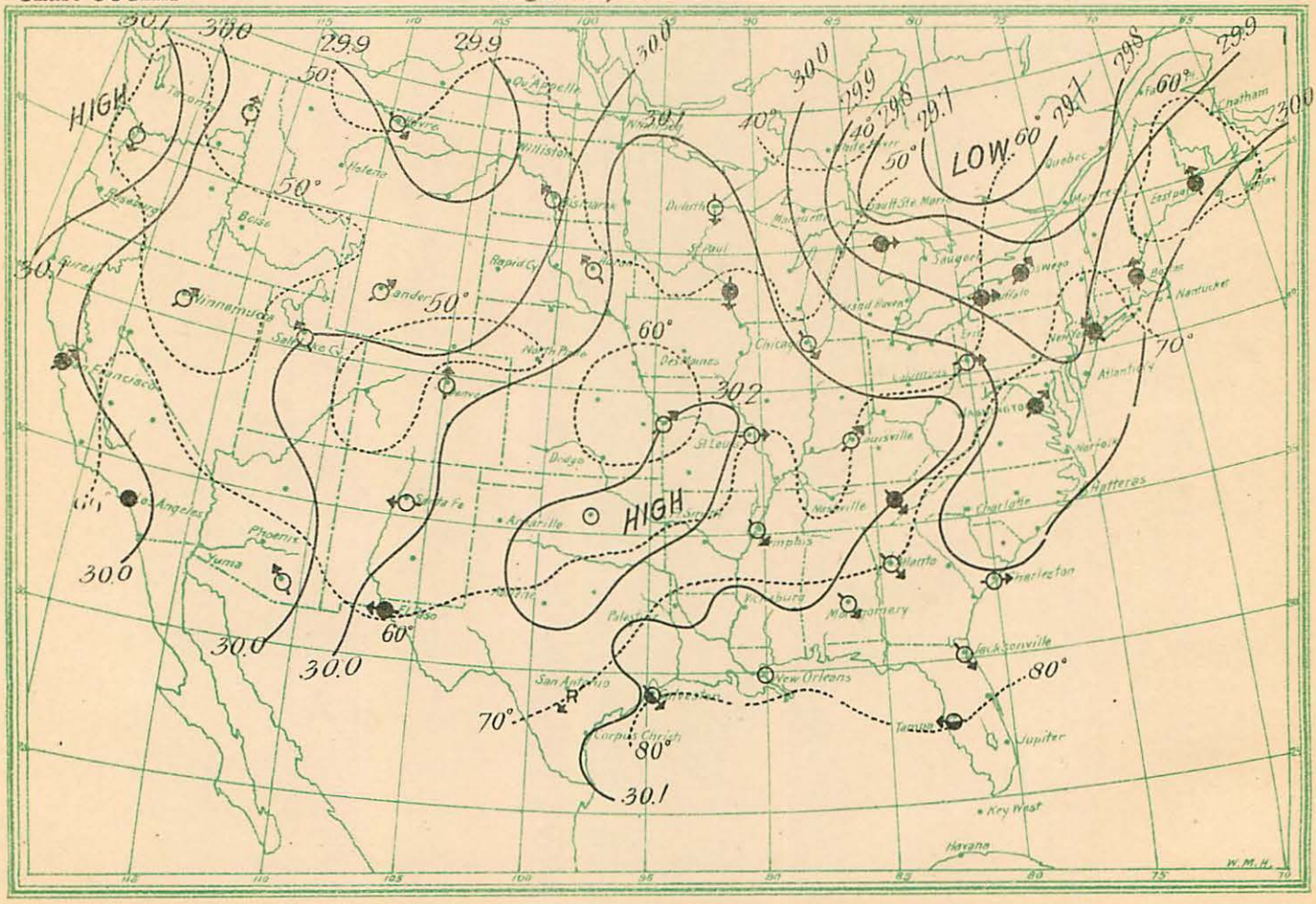
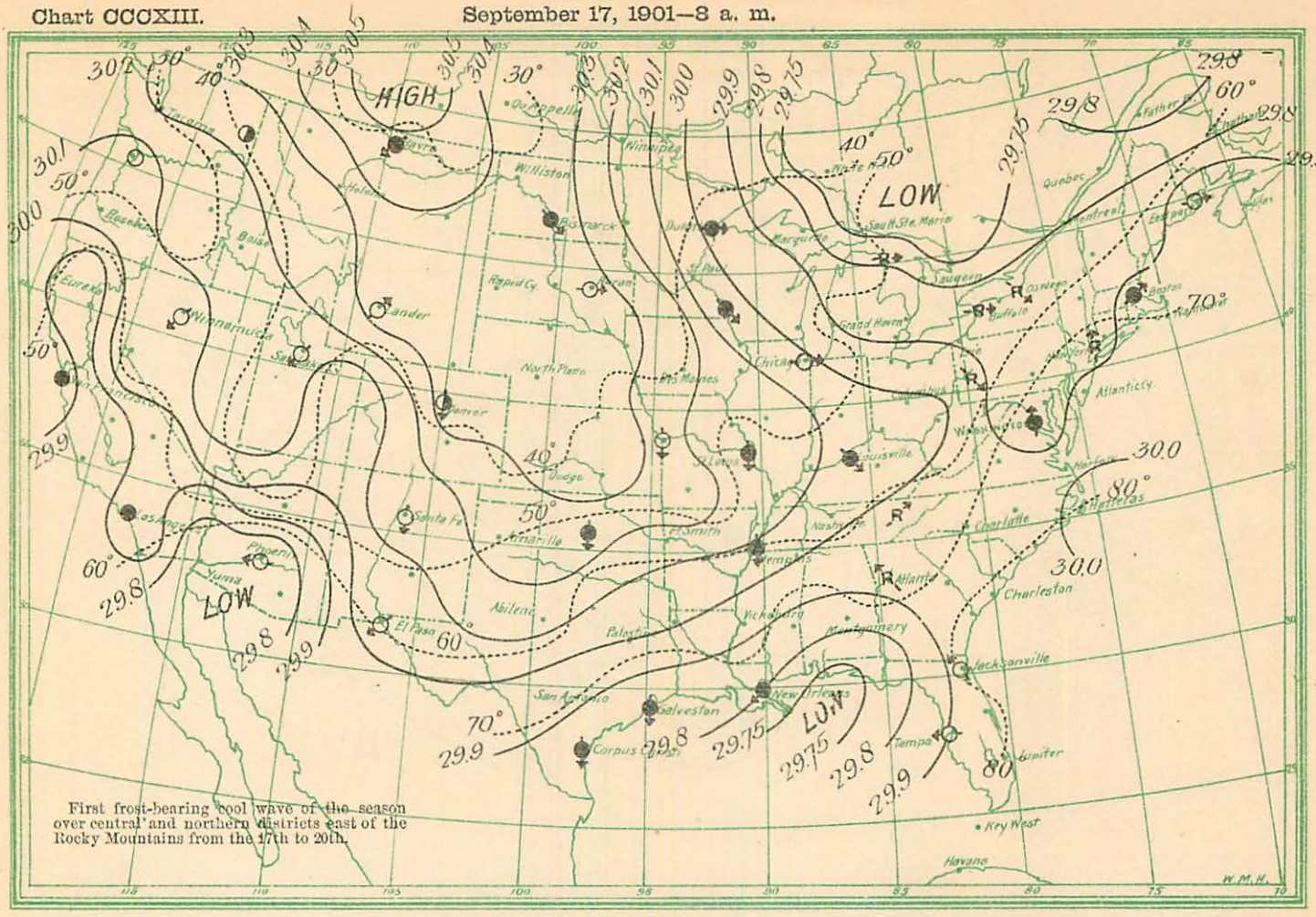


Chart CCCXIII. September 17, 1901—8 a. m.



First frost-bearing cool wave of the season over central and northern districts east of the Rocky Mountains from the 17th to 20th.

Chart CCCXIV. September 18, 1901—8 a. m.

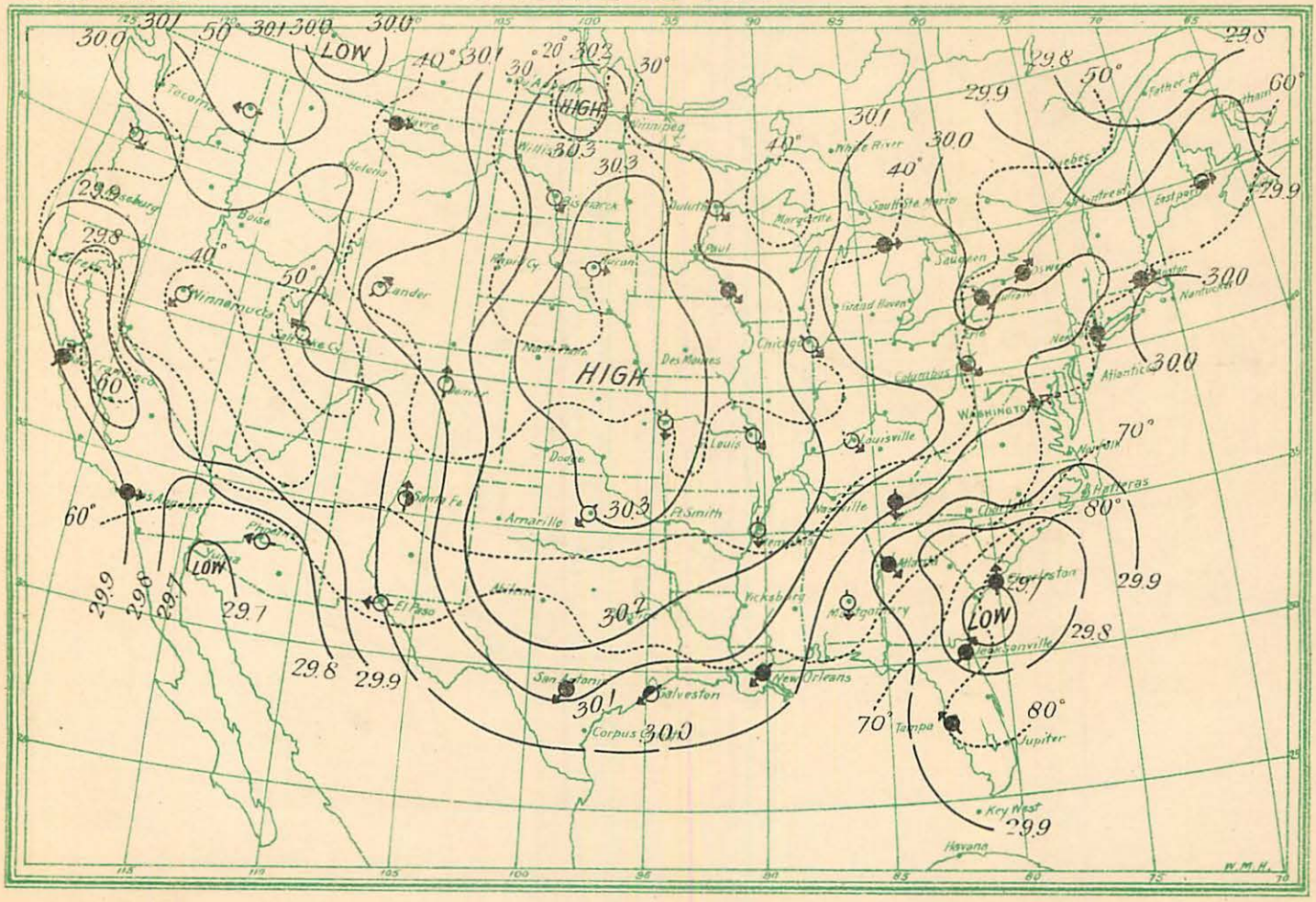


Chart CCCXV. September 19, 1901—8 a. m.

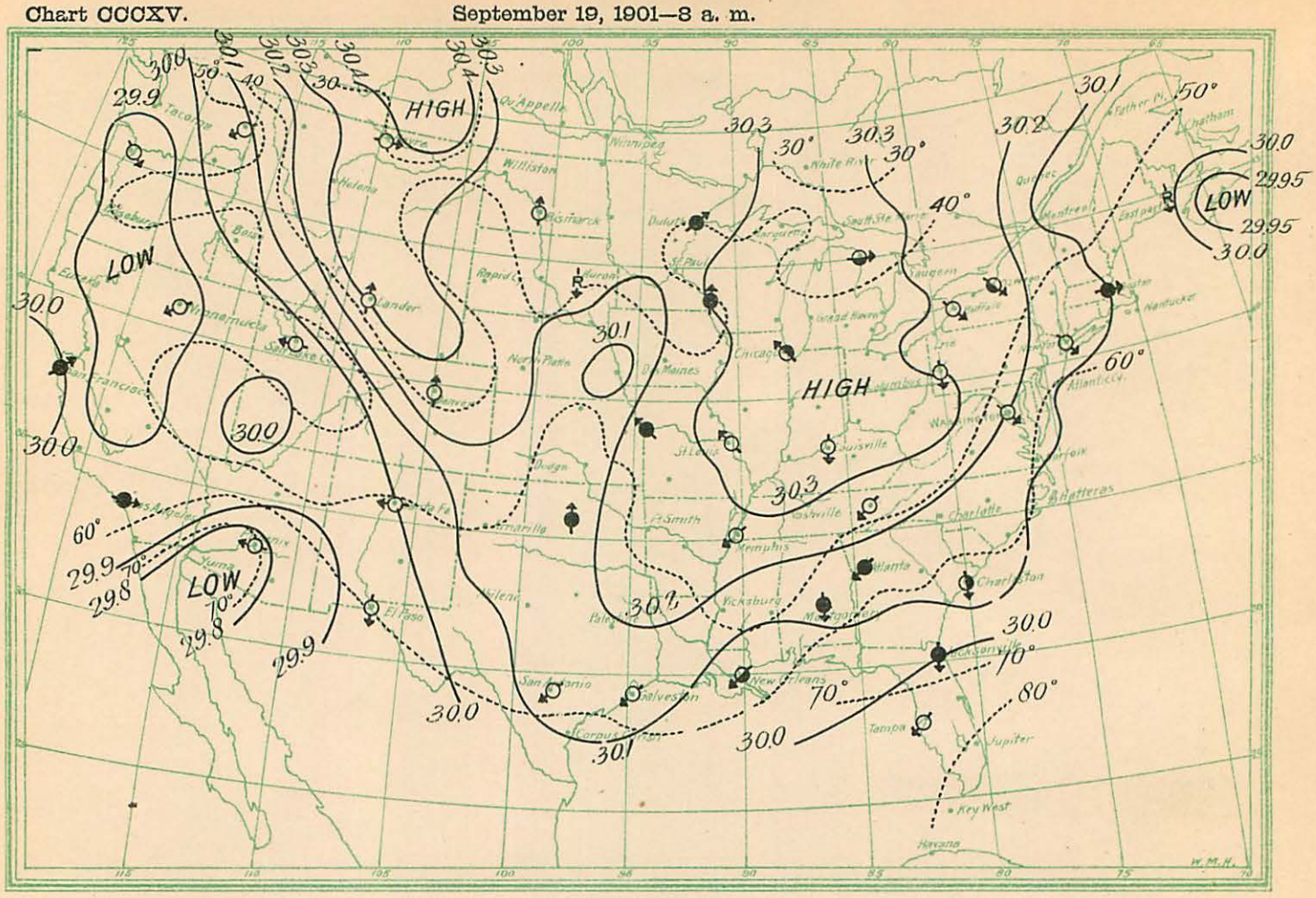


Chart CCCXVI. September 20, 1901—8 a. m.

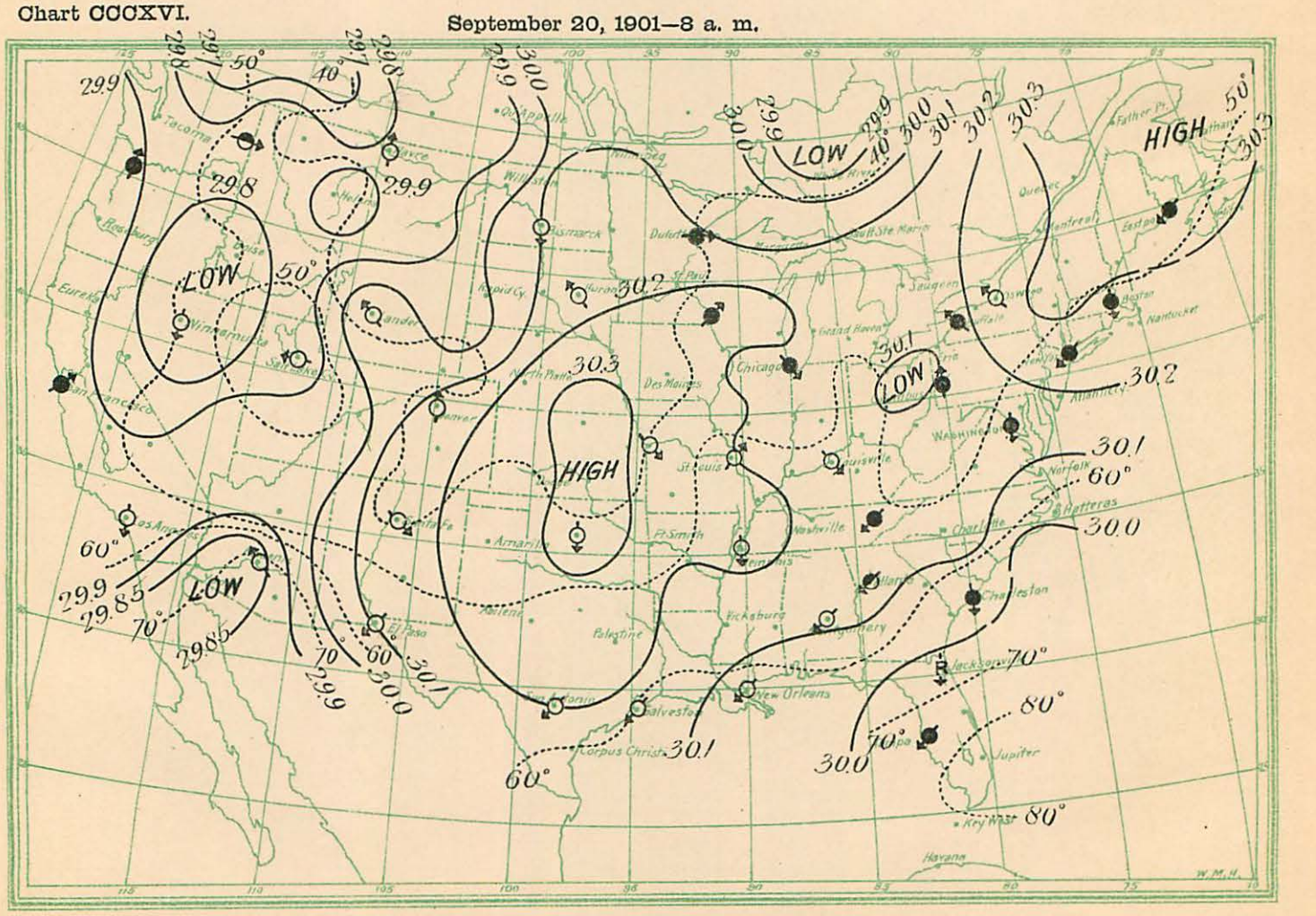


Chart CCCXVII. October 18, 1891—8 a. m.

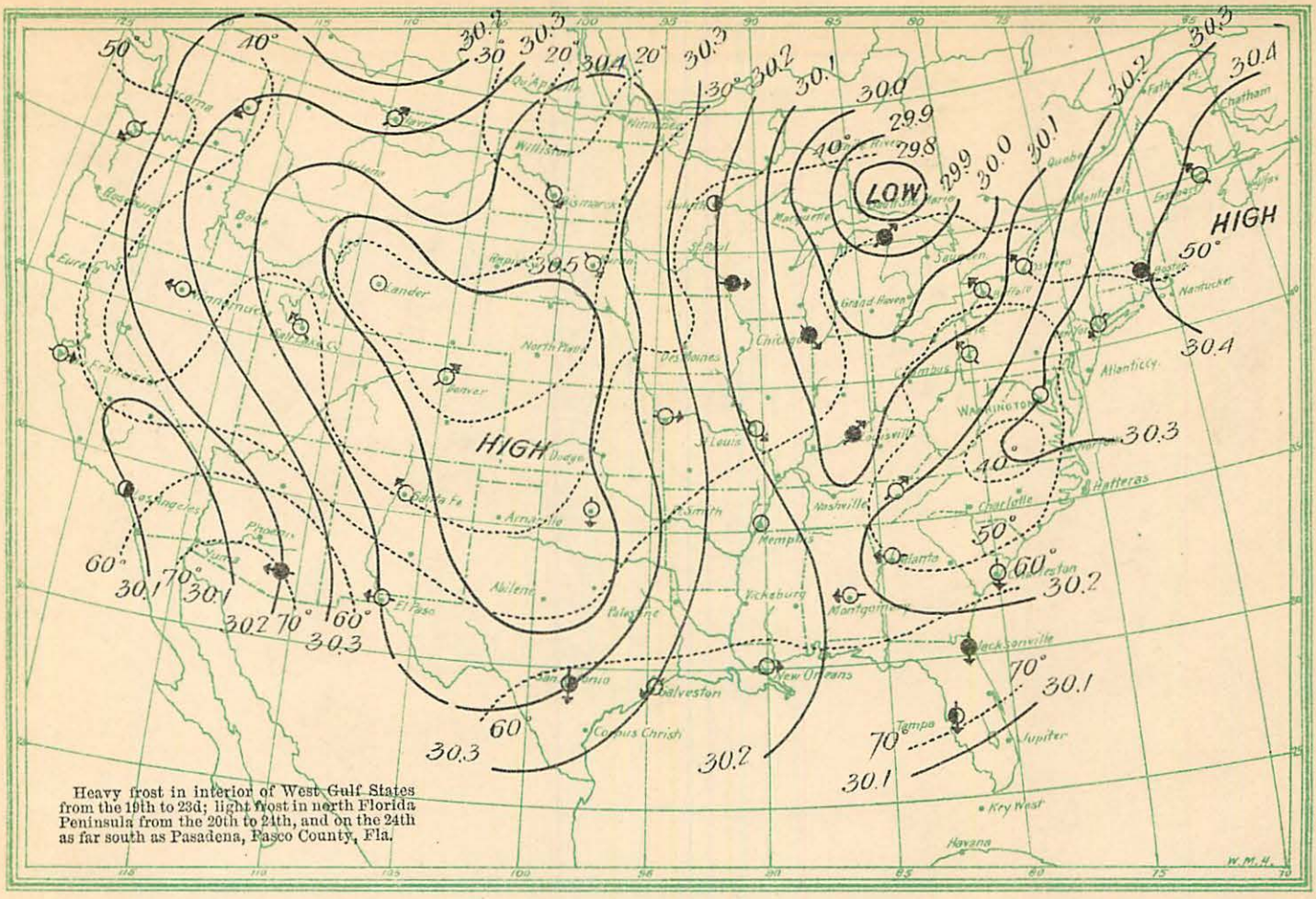


Chart CCCXVIII. October 19, 1891—8 a. m.

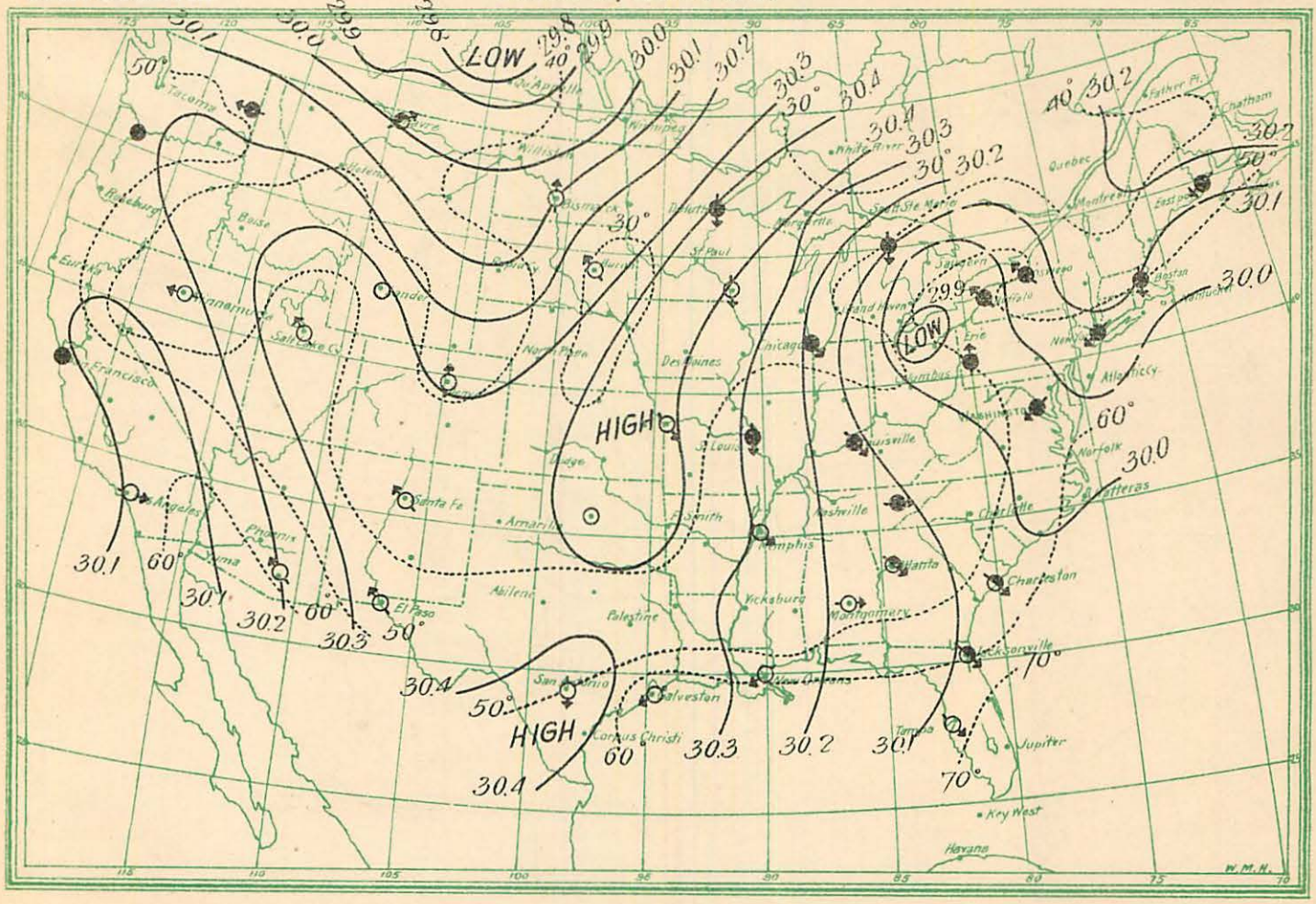


Chart CCCXIX. October 20, 1891—8 a. m.

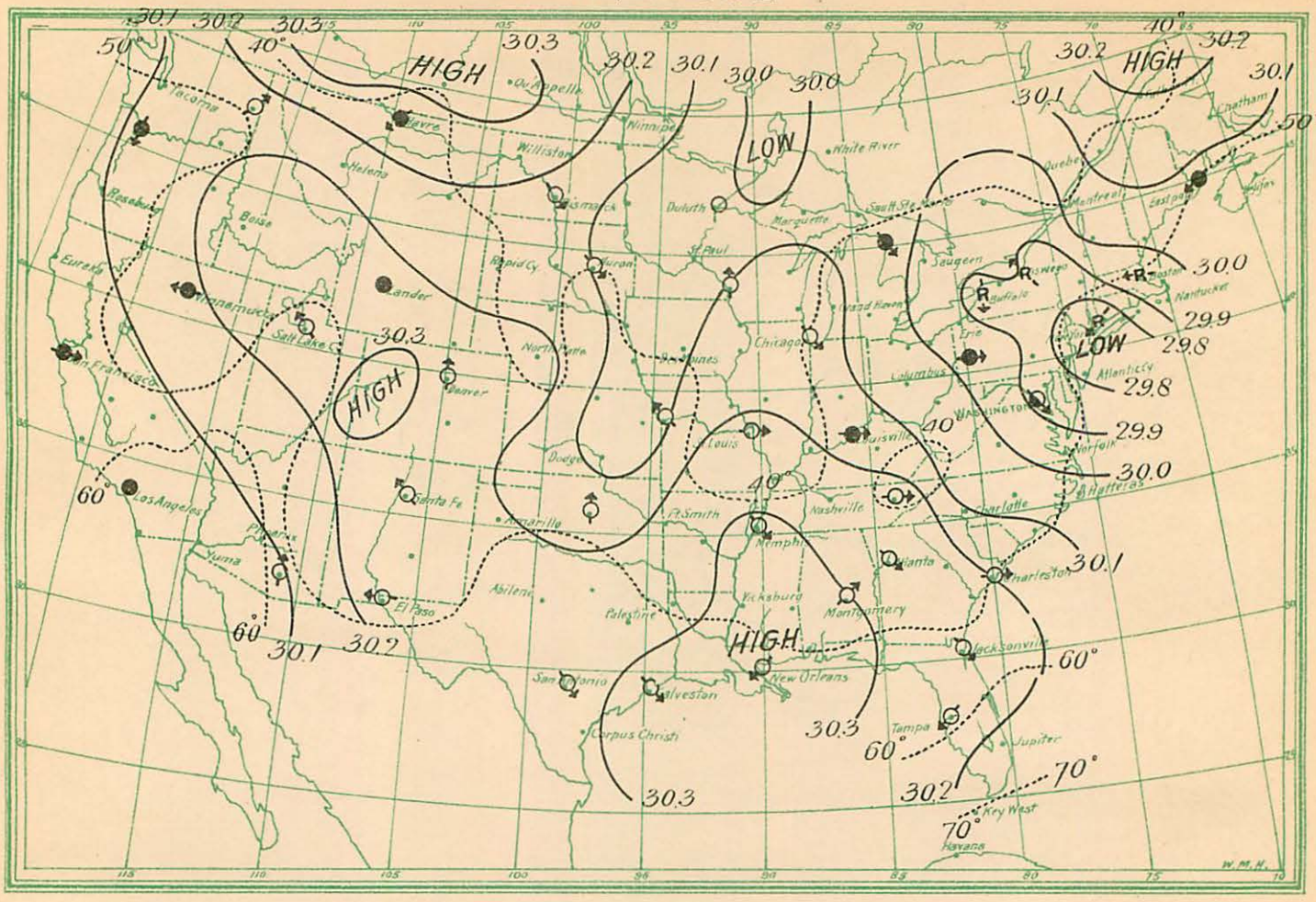


Chart CCCXX. October 21, 1891—8 a. m.

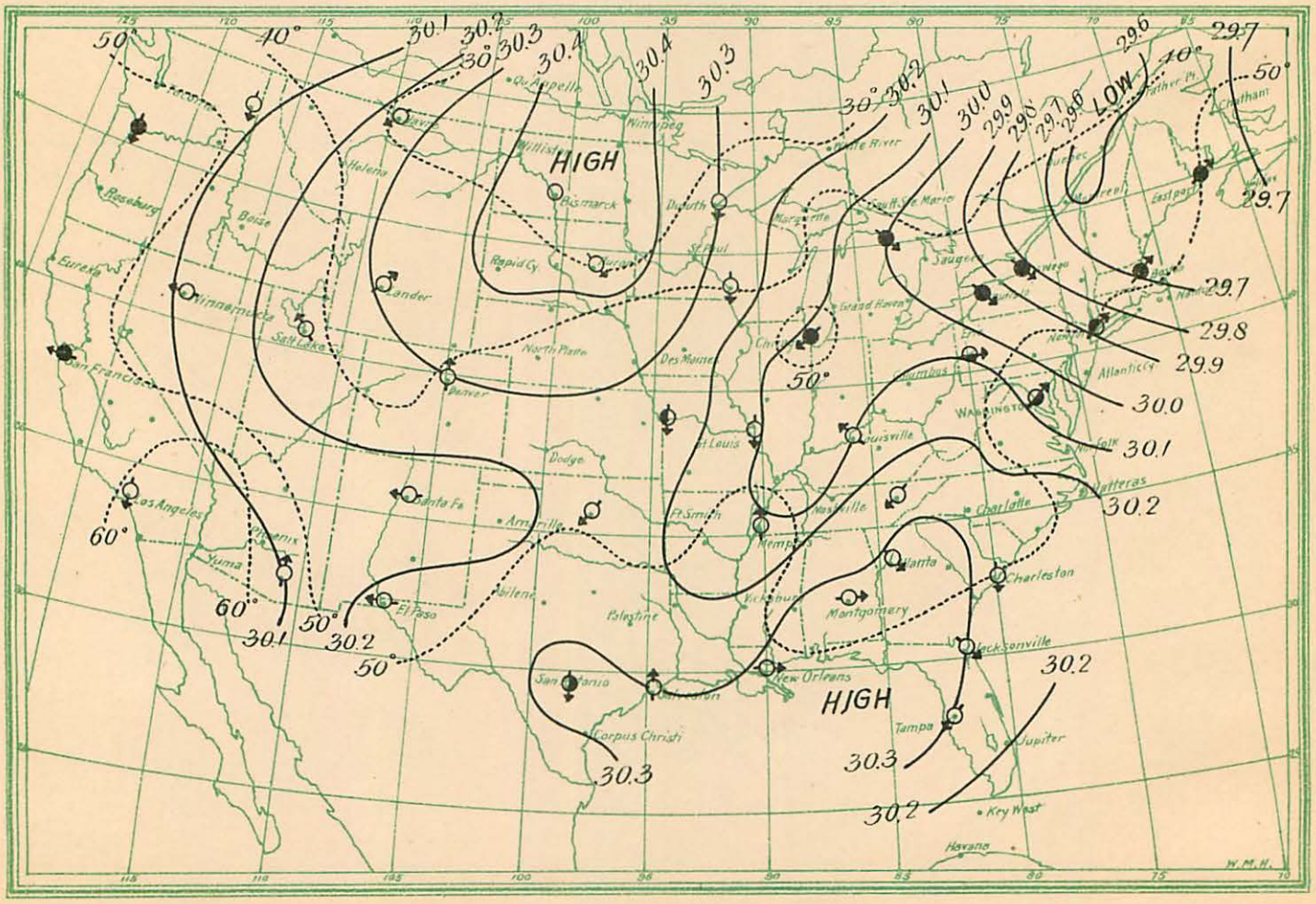


Chart CCCXXI. November 15, 1891—8 a. m.

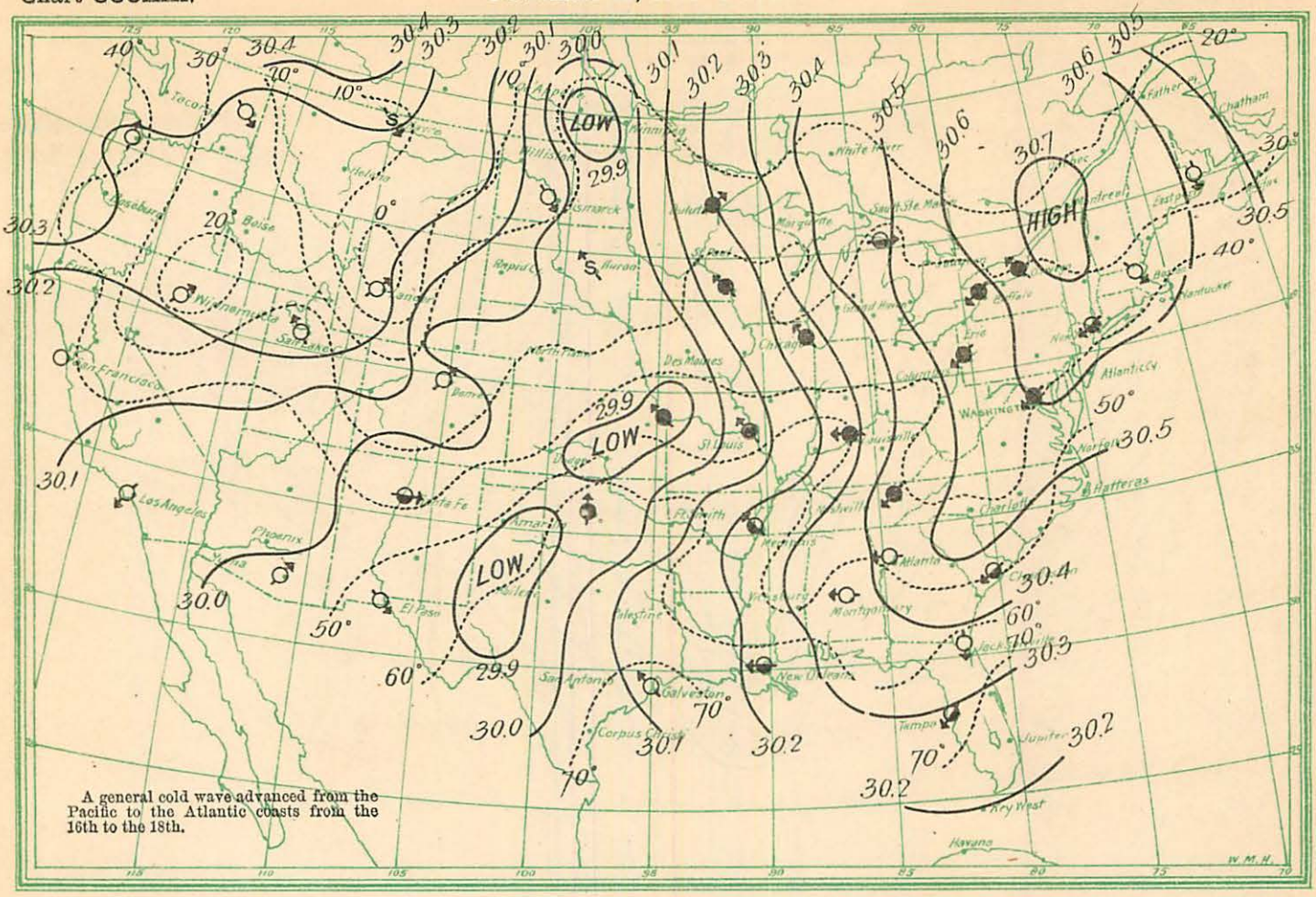


Chart CCCXXII. November 16, 1891—8 a. m.

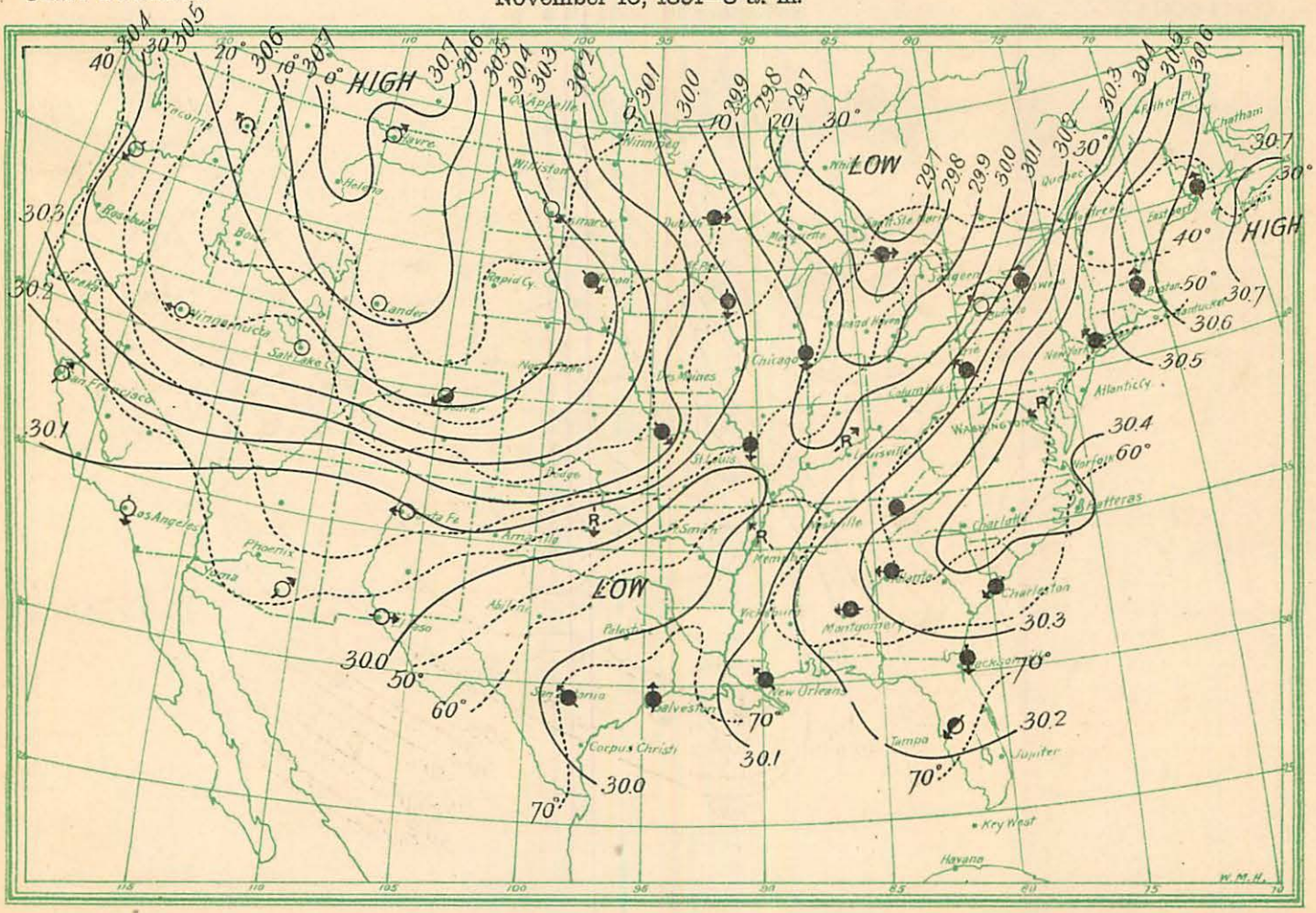


Chart CCCXXIII. November 17, 1891—8 a. m.

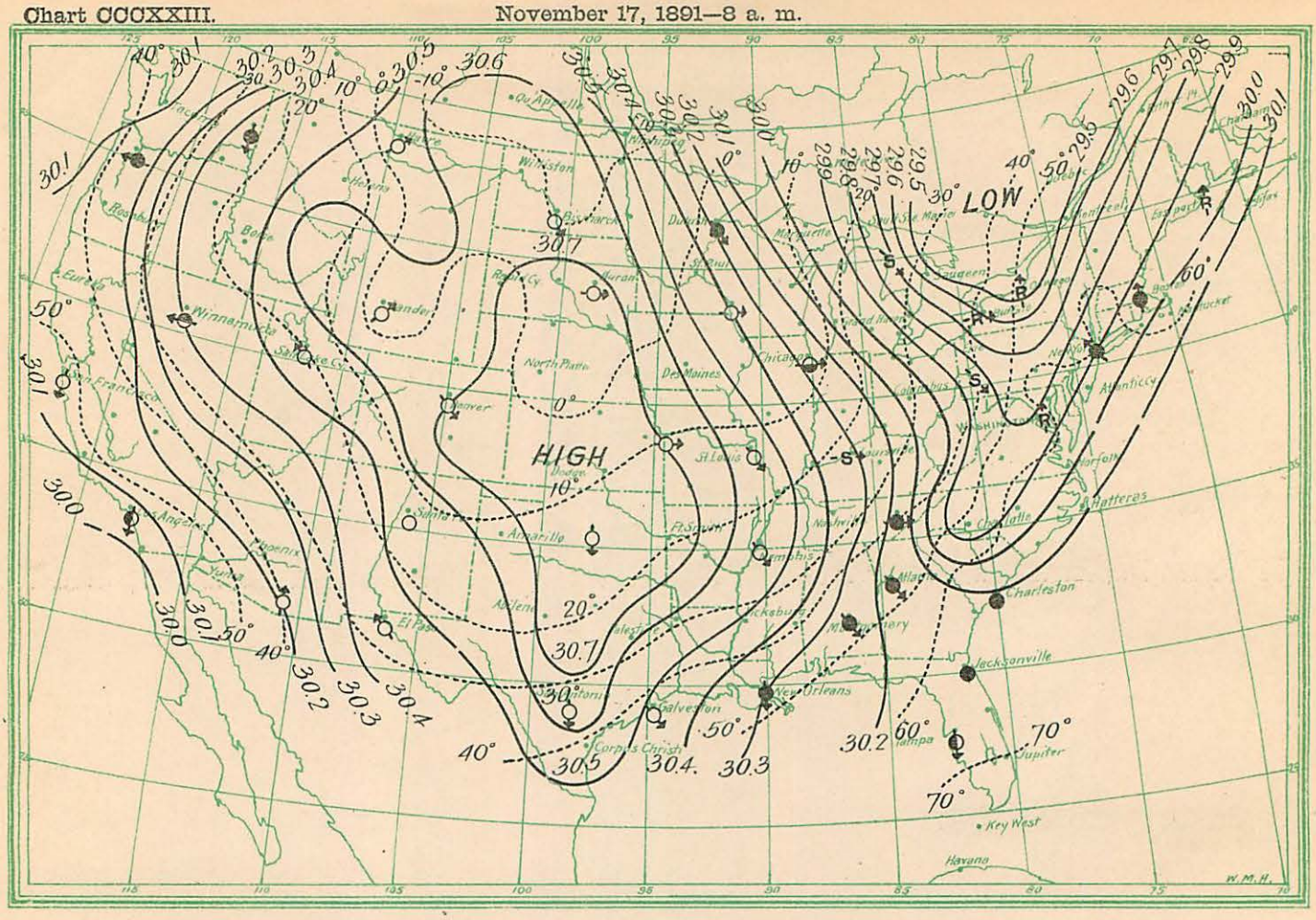


Chart CCCXXIV. November 18, 1891—8 a. m.

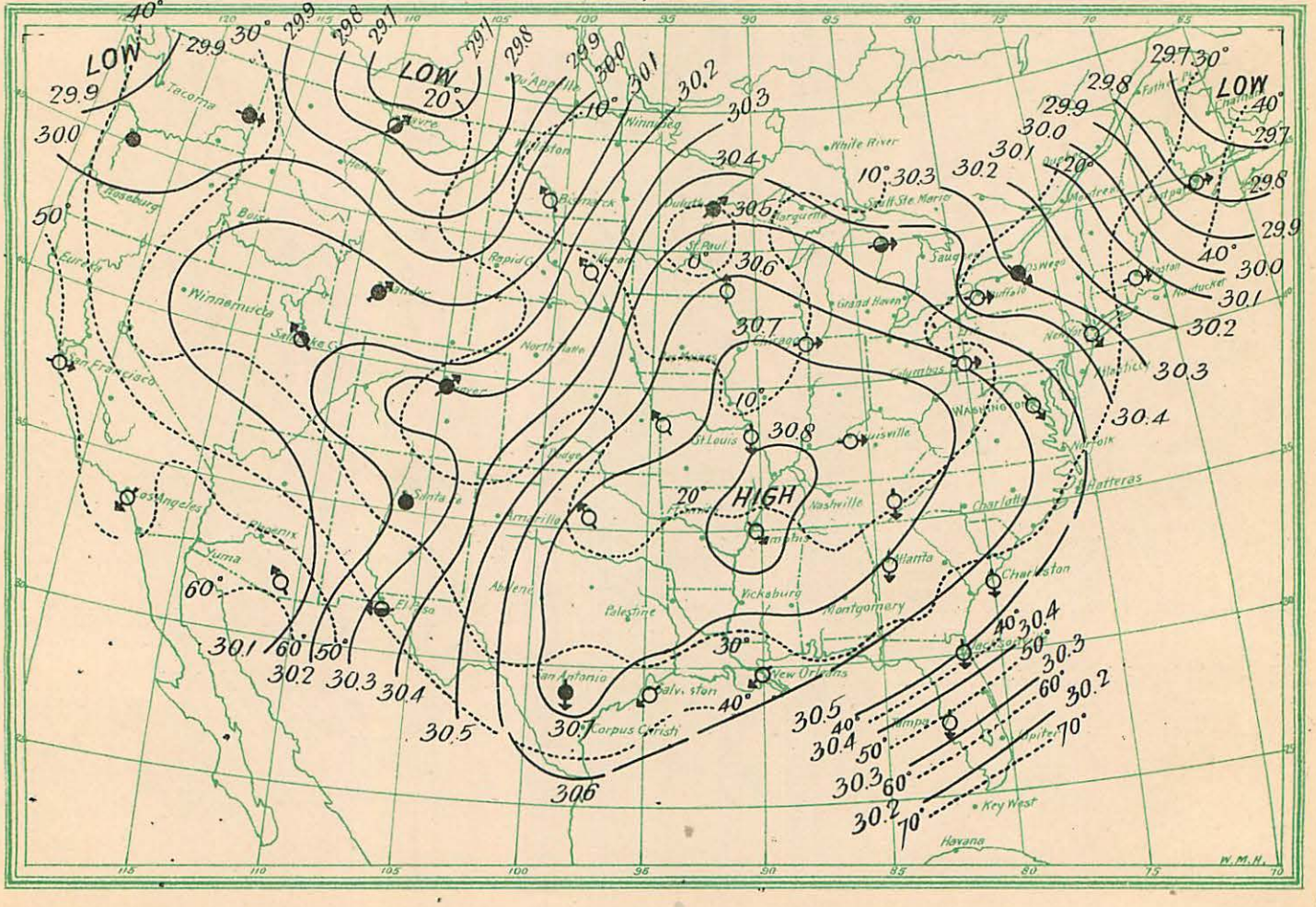


Chart CCCXXV. November 19, 1898—8 a. m.

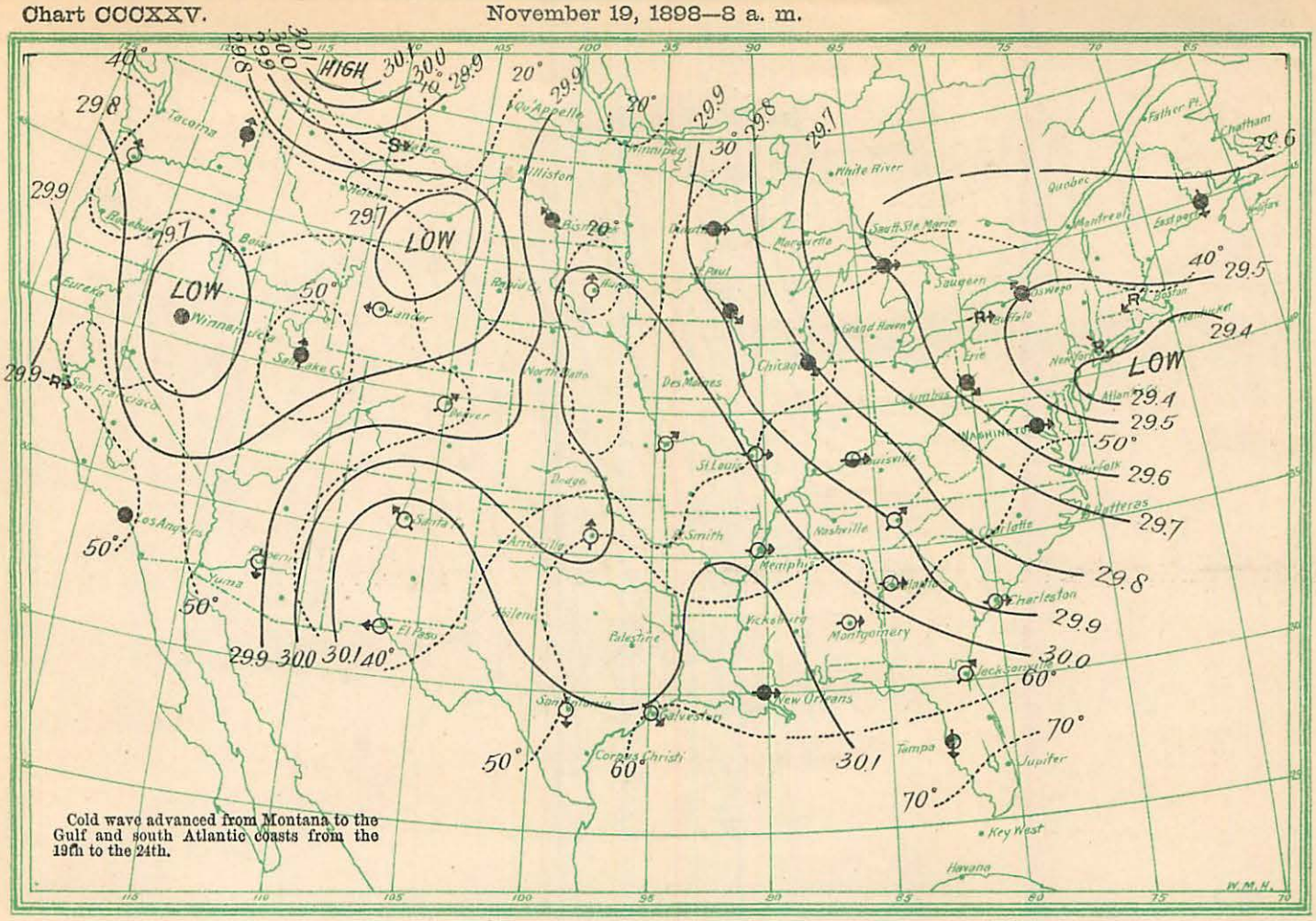


Chart CCCXXVI. November 20, 1898—8 a. m.

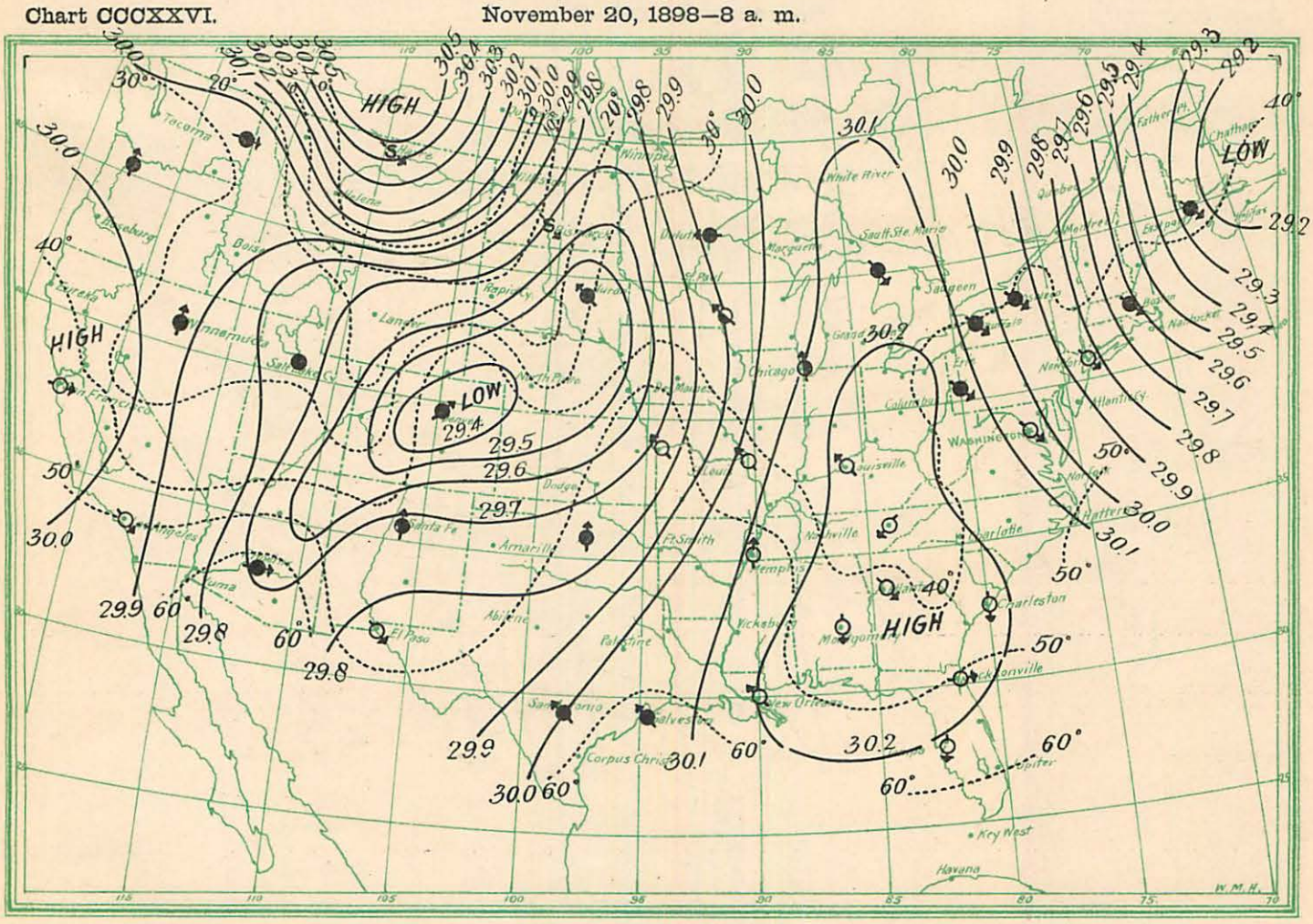


Chart CCCXXVII. November 21, 1898—8 a. m.

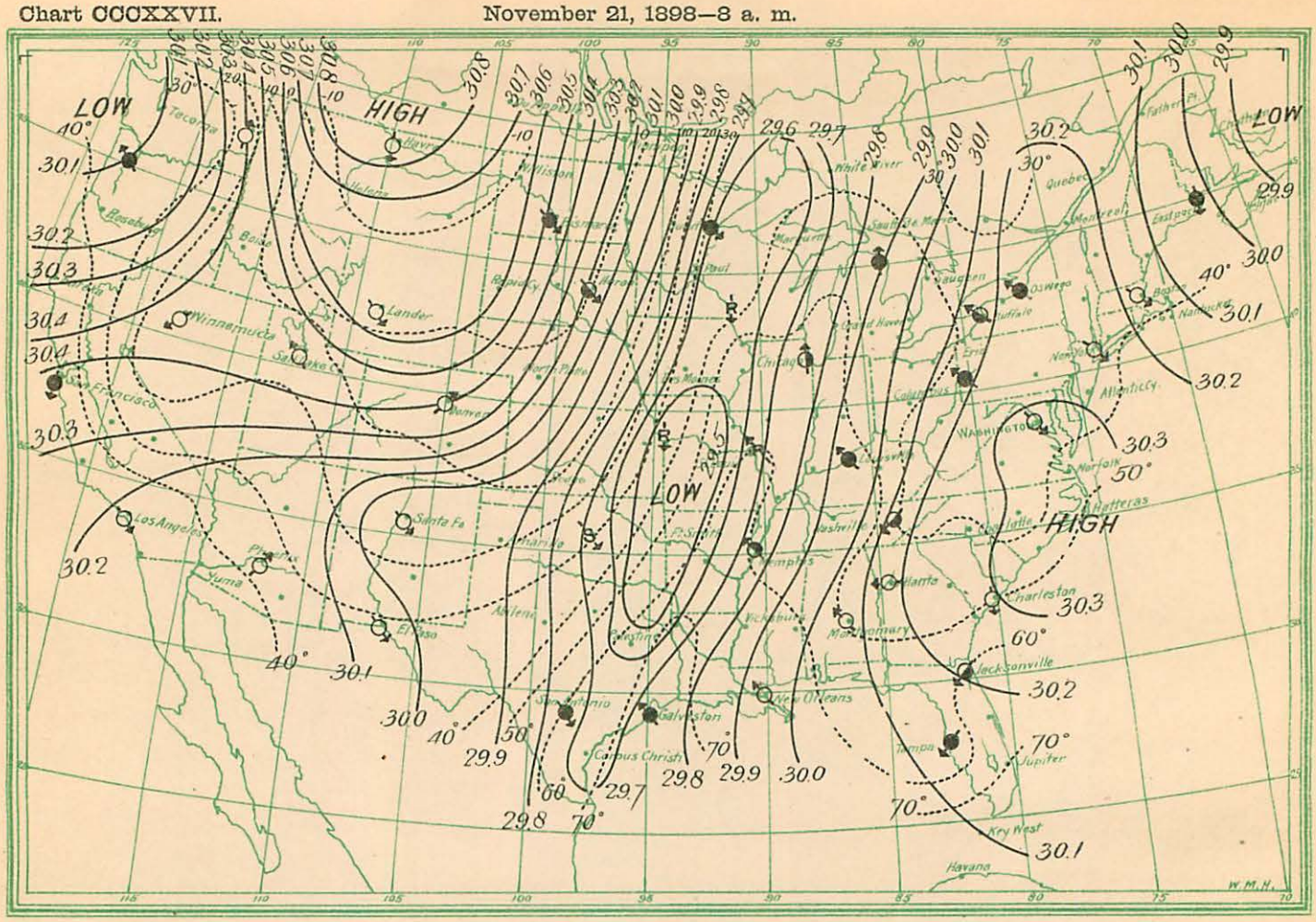


Chart CCCXXVIII. November 22, 1898—8 a. m.