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INTRODUCTION.

This REVIEW treats generally the meteorological conditions of the United States and Canada for December, 1887, and is based upon the reports of regular and voluntary observers of both countries. Descriptions of the storms that occurred over the north Atlantic Ocean are also given, and their paths shown on chart i, on which also appear the distribution of icebergs and the limits of fog-belts west of the fortieth meridian.

A noteworthy feature of this month was the severe weather which prevailed over the West India Islands during the first decade, attending the passage of three cyclones, most unusual occurrences for December, two of which moved northwest to the vicinity of Bermuda, and thence recurved northeastward, and one advanced westward over the Caribbean Sea.

The mean temperatures were below the normal in all parts of the country, except on the north Pacific coast, in Florida, and from the upper lakes eastward to the New England and middle Atlantic coasts, in which districts the month was slightly warmer than the average. The deficiencies in the monthly mean temperatures were greatest over the region from the Rio Grande Valley northwestward to Arizona and Utah, where they ranged from 4° to 8°.

The rainfall was deficient over an area extending from eastern Tennessee and western North Carolina northward to the lower lakes, and also in California and portions of the Rocky Mountain region; it was above the average on the Atlantic and Gulf coasts, in the Missouri, Mississippi, and lower Ohio valleys, the excess being most marked in the Gulf states and Rio Grande Valley.

Under "Notes and extracts" will be found a table showing means of a series of hourly barometric observations at Washington City for a period of eight months—May to December, 1887, with a brief discussion of same.

Chart iii for this month shows the normal and current temperature curves for three stations in addition to those given in November chart.

In the preparation of this REVIEW the following data, received up to January 20, 1888, have been used, viz., the regular tri-daily weather-charts, containing data of simultaneous observations taken at 133 Signal Service stations and 23 Canadian stations, as telegraphed to this office; 173 monthly journals and 171 monthly means from the former and 23 monthly means from the latter; 260 monthly registers from voluntary observers; 52 monthly registers from United States Army post surgeons; marine records; international simultaneous observations; marine reports through the co-operation of the Hydrographic Office, United States Navy, and the "New York Herald Weather Service;" monthly weather reports from the local weather services of Alabama, Illinois, Indiana, Louisiana, Michigan, Mississippi, Missouri, Nebraska, New England, New Jersey, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, and Tennessee, and the Central Pacific Railway Company; trustworthy newspaper extracts, and special reports.

ATMOSPHERIC PRESSURE (expressed in inches and hundredths).

The distribution of mean pressure for December, 1887, determined from the tri-daily telegraphic observations of the Signal Service, is shown by isobarometric lines on chart ii.

The area of maximum mean pressure for December, 1887, embraces the middle plateau, and is indicated by the isobar of 30.20 which incloses portions of Oregon, Idaho, Utah, and Nevada; areas of minimum pressure occupy the north Pacific coast and the Gulf of Saint Lawrence, where the mean falls to 29.95 and slightly below. The stations reporting the extreme monthly means are: Port Angeles, Wash., 29.93, and Winnemucca, Nev., 30.26. Over the greater part of the country east of the Rocky Mountains the range of mean pressure is between 30.0 and 30.1.

As compared with November an increase in the monthly means is shown in the central and southern Rocky Mountain regions and thence westward to the Pacific coast; an increase also occurs in the upper Missouri valley, and from the lower lakes and Ohio Valley eastward to the Atlantic. While the excess is generally less than .05 it amounts to .10 on the middle Pacific coast and from .05 to .09 in the New England and middle Atlantic states. In other districts than those above-named the mean pressure for December is below that for November, but the deficiency nowhere exceeds .04, except on the west Gulf coast, where it amounts to .05.

The departures from the normal pressure at the various Signal Service stations are given in the table of miscellaneous meteorological data. The mean pressure for December, 1887, is above the normal, as follows: in the middle and southern Rocky Mountain districts and thence westward to the Pacific coast, in the states on the Atlantic from the Carolinas northward, in the upper Ohio valley, along the northern border from Montana eastward, and in southern Florida. In all other districts the mean pressure is below the normal. The most marked excess, .10, occurs on the central Pacific coast, and the greatest deficiency, .05, on the west Gulf coast.

BAROMETRIC RANGES.

The monthly barometric ranges at the various Signal Service stations are also given in the table of miscellaneous meteorological data. The ranges, as usual, conform to the general rule, that is, they increase with the latitude and decrease slightly, though somewhat irregularly, with increasing longitude. In all of the northern districts the barometer ranges of December, 1887, are decidedly greater than the normal for the month, the difference amounting to .20 on the north Pacific coast, to .30 in the lower Missouri and upper Mississippi valleys, and from .50 to .60 in New England. In the states bordering on the Atlantic the extreme ranges are: .47 at Key West,

Fla., and 2.01 at Block Island, R. I.; between the eighty-fifth and one hundredth meridians, .91 at New Orleans, La., and 1.55 at La Crosse, Wis.; on the Pacific coast, .36 at San Diego, Cal., and 1.50 at Port Angeles, Wash.

AREAS OF HIGH PRESSURE.

Eight areas of high pressure were traced over the United States and adjoining territories during the month of December. They were generally first observed in the northwest portion of the continent and, with one exception, to the north of the fortieth parallel. Six approached the stations from the region north of Montana, and two were first observed on the Pacific coast, where, after extending over the plateau regions, they disappeared by a decrease of pressure while within the limits of observation. A secondary area of high pressure formed to the east of one of these high areas and afterwards passed over the central valleys, while the principal area moved northwest from the central plateau region to the north Pacific coast. Five of these areas of high pressure passed eastward to the Atlantic, the direction of their movement being first to south of east, and as they approached the coast the direction changed to east or north of east, this change being most marked in the high areas moving over the lower latitudes. The high areas observed were slightly more to the north than those usually observed during December.

The following are detailed descriptions of the more important weather changes attending each area of high pressure:

I.—This area of high pressure appeared to the north of the Lake region before the close of the preceding month, and was referred to in the November REVIEW. At 7 a. m. of December 1st it extended over the Saint Lawrence Valley, the central area of high pressure being inclosed by an isobar of 31.10. It passed southeast over New England and the Maritime Provinces and extended southward along the Atlantic coast, causing strong northeast winds, which were followed by fogs and light local showers on the 2d and 3d. The maximum pressure occurred before the centre reached the coast line, but the barometer continued to rise during the 1st from New England southward to Florida. The temperature fell below zero in northern New England, and to freezing in the Gulf and south Atlantic states during the passage of this area.

II.—The 3 p. m. report of the 3d indicated the approach of this area from the region north of Montana, the pressure having increased at stations in the northern and central plateau regions during the preceding eight hours, while an extended depression covered the eastern slope of the Rocky Mountains. The winds were northerly at Rocky Mountain stations, and by 7 a. m. of the 4th a secondary area of high pressure had formed, central over Colorado, the barometer, however, remaining high in the region where this area was first observed. From the succeeding reports of the 5th, 6th, and 7th this secondary area has been traced to the Atlantic coast, attended by fair weather, causing no marked change in temperature.

III.—This area appeared off the California coast on the afternoon of the 5th, and although no marked weather changes occurred in its passage over California into the central plateau region it is noteworthy as having approached the stations from the Pacific and as having disappeared within the limits of the stations by a gradual decrease in pressure. It extended over southern California and thence eastward over Arizona and Utah during the 6th, 7th, and 8th, after which it moved northwestward, but its centre could not be definitely located.

IV.—This high area appeared north of Dakota on the 5th, and moved slowly eastward north of Minnesota and Lake Superior; it was not central within the limits of the United States until it reached northern New England on the morning of the 9th. The pressure increased during its easterly movement, and reached the maximum, 30.60, while passing over the Saint Lawrence Valley. After passing the coast line it apparently moved more directly to the east and disappeared rapidly in advance of a depression moving northeastward from the Ohio Valley.

V.—On the morning of the 9th this area of high pressure was observed north of Montana. It first moved slowly eastward during the following twenty-four hours and was central north of Manitoba on the morning of the 10th. The temperature fell decidedly in the Missouri Valley during the 10th, and snows were reported generally throughout the Northwest, attended by fresh to brisk northerly winds. During the 11th this area of high pressure was transferred to the southern Rocky Mountain slope, the pressure having diminished from 30.60 to 30.30. After reaching Indian Territory and Arkansas on the 12th, it passed eastward over Tennessee and Virginia during the 12th and 13th, attended by fair weather. After reaching the Atlantic coast it apparently moved northeastward to Nova Scotia, where it disappeared on the 15th.

VI.—This high area was central off the Oregon coast on the 12th. It moved slowly eastward over the northern plateau region, and after the centre had reached the eastern portion of Idaho a secondary depression formed in the Missouri Valley while the principal area of high pressure moved slowly northeastward to the north Pacific coast, where it disappeared as a separate depression, but probably formed a part of the succeeding high area which was passing eastward over British Columbia on the 19th.

VII.—This area of high pressure was attended by a cold wave which extended southward to the Gulf coast. The barometer reached a maximum of 31.00 at stations north of Montana at midnight of the 19th, where the temperature ranged from 20° to 30° below zero. The cold wave extended southward to northern Texas by the morning of the 20th. A severe "norther," with killing frost, was reported from southern Texas during the night of the 20th and morning of the 21st. The cold wave attending this high area extended over the central valleys during the 21st, but the area of high pressure did not pass to the east of the Mississippi Valley. The pressure remained high over the plateau region until the 24th.

VIII.—This area of high pressure was observed north of the upper Missouri valley on the morning of the 26th, with well-defined areas of low pressure to the east, south, and west. The depression that was central over Colorado was apparently forced southeastward to northern Texas, after which it moved rapidly northeastward to the Lake region, attended by heavy snows, and followed by decidedly colder weather in the central valleys and Lake region. The temperature fell during the morning of the 29th to —40° in northern Minnesota and below zero as far south as central Missouri and Kansas. Killing frosts were reported from New Orleans and freezing weather throughout the Gulf states and northern Florida on the same date. The centre of this area of high pressure remained north of Minnesota until midnight of the 29th, after which it moved southeastward over the upper lake region and the upper Ohio valley, the pressure decreasing from 31.00 inches to 30.50. After reaching the upper Ohio valley the direction of movement changed to the northeast, and at the close of the month it was central in northern New England, the pressure at the centre remaining near 30.50.

AREAS OF LOW PRESSURE.

Eleven well-defined areas of low pressure have been traced over the territory occupied by the stations of observation during the month of December. Of these, three apparently originated in the Gulf of Mexico and passed northeastward, following the coast line from Florida to Nova Scotia; two were first observed to the west of the north Pacific coast and disappeared to the north of the Lake region; and the remainder apparently originated in the Rocky Mountain regions. All low areas observed to the west of the one hundredth meridian moved first in a direction south of east, and, with two exceptions, all low areas east of the one hundredth meridian moved to the north of east, the change of direction generally occurring near that meridian. The average rate of movement of these depressions was twenty-nine miles per hour, and generally the velocity of each depression differed but slightly from the average.

The following table shows the latitude and longitude in which each area was first and last observed, and the average hourly velocity in miles per hour:

Number of area.	First observed.		Last observed.		Average hourly velocity.
	Lat. N.	Long. W.	Lat. N.	Long. W.	
	° ′	° ′	° ′	° ′	*Miles.*
I	37 00	108 00	48 00	85 00	35.0
II	41 00	127 00	50 00	85 00	26.0
III	30 00	101 00	47 00	59 00	20.0
IV	25 00	95 00	46 00	62 00	25.0
V	52 00	114 00	48 00	83 00	26.0
VI	28 00	89 00	48 00	92 00	27.0
VII	51 00	109 00	43 00	89 00	27.0
VII*a*	35 00	100 00	41 00	71 00	30.0
VIII	50 00	100 00	43 00	84 00	27.0
IX	28 00	88 00	38 00	71 00	39.0
X	41 00	108 00	50 00	66 00	35.0
XI	44 00	124 00	45 00	90 00	30.0

Average rate of progress, 29.0 miles per hour.

The following are detailed descriptions of the weather conditions attending the more important areas of low pressure:

I and II.—At the close of the preceding month an area of low pressure was central in the Rocky Mountain region over Colorado, a second depression covering the north Pacific coast, attended by southerly winds and rains as far south as southern California. During the 1st day of the month this depression extended northeastward to the upper lake region, and a barometric trough extended from Lake Superior southwestward to Texas, the low area previously noted as central on the north Pacific coast advancing eastward over the northern plateau region. During the 2d the area traced as number i disappeared to the north of the Lake region while number ii moved eastward, and by the morning of the 3d the centre had reached its most southerly latitude in western Kansas. The 3 p. m. report of the 3d showed that the direction of movement of low area number ii had changed to the northeast, and that it was then central in western Iowa, attended by general rains from the Gulf to the Lake region and by snow from the upper lake region westward to the Rocky Mountains. The barometric pressure at the centre remained about constant, near 29.50, during the movement of this depression from the Pacific coast to the Missouri Valley. The pressure decreased rapidly and the disturbance became more contracted as it approached Lake Superior, where it attained its maximum energy on the morning of the 4th, the disturbance being well-defined, circular in form, and the lowest isobar bounding the centre being 29.4. When the depression disappeared to the northeast of Lake Superior it was followed by severe westerly gales and a decided fall in temperature in the Northwest and Lake region.

III.—This area of low pressure developed in the southern Rocky Mountain region to the southeast of a high area which advanced from the Pacific over California, Nevada, and Utah, the barometer being high at the same time to the north of Minnesota and on the Atlantic coast. It moved slowly eastward over the west Gulf states, Mississippi, and Alabama during the succeeding forty-eight hours, attended by heavy rains, but with low wind velocities, the barometric gradient remaining very slight, the lowest isobar bounding the centre being 29.9. This easterly movement continued until the 9th, when the direction changed directly to the north, causing the disturbance to pass over the Ohio Valley to the lower lake region. During the passage of this area over the eastern portion of the United States general rains occurred in the Southern and Eastern States and snows in the upper lake region and Northwest, which were quickly followed by clearing weather. After the disturbance reached the upper Saint Lawrence valley a secondary disturbance developed on the middle Atlantic coast and moved rapidly northeastward to Nova Scotia, causing the primary area to disappear. The barometer fell slowly at the centre of this disturbance as it advanced northeastward, and when last observed over the Maritime Provinces the barometer had fallen to 29.42 at Bird Rocks, Gulf of Saint Lawrence. Westerly gales, however, continued at these stations until the 14th.

IV.—This low area was first observed in the west Gulf, southeast of Brownsville, Tex., on the night of the 12th. Vessel reports indicate that a severe storm occurred to the southeast of this location on the 10th and 11th. This disturbance developed but slight energy while moving eastward along the west Gulf coast and south Atlantic states during the 13th and 14th. After reaching the south Atlantic coast on the morning of the 15th it moved rapidly northeast and reached the southeastern New England coast as a severe storm by midnight of the 15th. The barometer fell at the centre .90 in twenty-four hours during its passage from Hatteras, N. C., to Yarmouth, N. S. Gales were unusually severe on the New England coast during the 16th, and the disturbance probably reached its maximum energy when the centre was between Yarmouth and Halifax, N. S., the barometer falling to 28.9 at 3 p. m. on the 16th. The pressure rose slowly at the centre of this depression as it passed northeastward from Halifax, and the reports indicate that it became more extended and lost energy as it moved to the northeast.

V.—This disturbance passed north of the stations of observation from the Rocky Mountains to Lake Superior from the 14th to 17th, without causing any marked change in the weather conditions within the United States.

VI.—This area developed in the Gulf of Mexico, where it was first observed on the morning of the 16th. The barometer at the centre when passing over the Gulf coast was below 29.8, and the pressure decreased rapidly as the disturbance approached Cape Hatteras, where the barometer was 29.28 on the afternoon of the 17th. Dangerous winds occurred in Florida and along the south Atlantic coast during the passage of this depression over those regions, and the intensity of the storm continued to increase until the centre reached the New England coast. On the morning of the 18th the pressure had fallen to 28.88 at southeast New England stations, and the direction of the wind indicated that the centre of disturbance passed near Cape Cod. The storm apparently moved in a more northerly direction after the centre reached Cape Hatteras than its previous course indicated, until it reached the coast of Maine, where the direction changed to the northeast. The barometer continued low at the centre, but it rose slowly after the disturbance left the New England coast.

VII.—When the storm described as number vi was central on the North Carolina coast on the afternoon of the 17th, this disturbance appeared in the Rocky Mountain region north of Montana, while an area of high pressure covered the central plateau region. It moved southeastward to the upper Mississippi valley, where it was central on the morning of the 19th, the barometer being low over the entire eastern slope of the Rocky Mountains, and an area of unusually high pressure was advancing over the northern Rocky Mountain stations. The advance of this area of high pressure over the upper Mississippi valley caused this disturbance to disappear, and a secondary depression formed in the west Gulf states during the 19th. This secondary depression developed great energy, and moved northeastward over the central Mississippi valley during the 20th, followed by a decided cold wave which extended over the Southern States, attended by freezing weather and killing frosts. After the centre of this disturbance reached northern Indiana a secondary disturbance developed on the middle Atlantic coast, and moved northeastward to southern New England, causing severe gales during the night of the 21st. As this disturbance disappeared to the eastward the barometer remained low in the Lake region, with general snows, delaying the advance of the cold wave over the northern stations. Westerly gales continued on the New England coast on the 22d, after this disturbance had moved eastward.

VIII.—This depression approached the stations from north of Manitoba, where it was central at 10 p. m. of the 22d. It moved southeastward with considerable energy until it reached eastern Michigan, causing general snows throughout the Lake

region and Northwest, but the disturbance disappeared by an increase of pressure while central within the Lake region, and when the depression traced as number ix was moving northeastward over the east Gulf. It should also be noted that the depression traced as number v disappeared in almost the same location near Lake Huron, while similar conditions existed in the south Atlantic states.

IX.—This depression was first observed as central in the east Gulf, near Mobile, Ala., at midnight of the 23d. It moved along the south Atlantic coast during the 24th, causing heavy rains and brisk to high winds. It was central near Wilmington, N. C., at 10 p. m. of the 24th, after which it passed northeastward from Hatteras, the direction and force of winds reported from southern New England stations indicating that the centre of disturbance passed to the southeast of, and near, those stations.

X.—This area of low pressure developed in the Rocky Mountain region during the 26th, it having been preceded by a depression on the north Pacific coast, from which it appears to have developed as a secondary disturbance. It moved southeastward to northern Texas during the succeeding twenty-four hours, where it changed direction to the northeast, moving over the central valleys as a trough-shaped depression extending from Lake Michigan to the west Gulf states. It was followed on the 27th and 28th by the most severe cold wave of the month, the temperature changes in the Missouri, Mississippi, and Ohio valleys being rapid, and, in many cases, ranged from 40° to 50° in twenty-four hours. After reaching the Lake region the disturbance became more contracted and the winds increased in force after shifting to westerly throughout the Lake region and on the Atlantic coast, and velocities ranging from fifty to fifty-five miles per hour were reported on the New England coast on the 28th, when this storm was central in northern Maine. The gales continued on the 29th in the Lake region, and from Hatteras, N. C., northward to New England. This storm apparently moved northward from New England, and its centre was last located north of Anticosti on the afternoon of the 29th; after which it probably moved northeastward.

XI.—This area of low pressure appeared on the north Pacific coast on the 28th and moved southeastward with a uniform velocity of about thirty miles per hour, crossing the central Rocky Mountain region on the 30th, and its course changing to northeasterly near the one hundredth meridian. It passed to the upper Mississippi valley, where it was central at the close of the month, attended by general snows throughout the Northern States, and rains from the Ohio Valley southward to the Gulf states. When this disturbance was observed on the north Pacific coast the barometer near the centre was 29.32; while passing the central Rocky Mountain region it fell to 29.20 at Denver and Las Animas, Colo., and at 10 p. m. of the 31st the central area was inclosed by an isobar of 29.3, almost circular in form, extending over central Wisconsin, while areas of high pressure covered the lower Saint Lawrence valley and the region north of the Missouri Valley, the difference of baromter readings between the areas of high and low pressure exceeding one inch, thus causing a decided barometric gradient in both the east and west quadrants of this disturbance.

NORTH ATLANTIC STORMS FOR DECEMBER, 1887.

[*Pressure in inches and millimetres; wind-force by Beaufort scale.*]

The paths of the depressions that appeared over the north Atlantic Ocean during December, 1887, have been determined from international simultaneous observations by captains of ocean steamships and sailing vessels, received through the cooperation of the the Hydrographic Office, Navy Department, and the "New York Herald Weather Service."

Thirteen depressions are traced, of which seven advanced eastward from Newfoundland or the Grand Banks; one occupied the ocean between the British Isles and Iceland during the 1st and 2d; two originated to the westward of the Azores; two moved northwest from the region east of the Windward Islands, and one is given an approximate westward track over the Caribbean Sea. With the exception of numbers 1, 9, and 11 the depressions pursued normal paths.

In December, 1886, ten depressions were traced, of which five passed eastward from Newfoundland; four developed over the ocean south of Nova Scotia; one first appeared over mid-ocean in about N. 55°, and one moved eastward in the vicinity of the Azores. The severest weather of the month attended the passage of a depression from south of Nova Scotia to the British Isles from the 2d to the 8th, inclusive. During the 7th and 8th storms of almost unprecedented violence raged over Great Britain, and the fall in the barometer was reported as having been unparalleled. At Orme's Head a minimum of 27.45 (697.2) was observed, while at Liverpool the barometer fell to 27.48 (698.0). During the second and third decades of the month the weather was seasonable.

In December, 1887, the depressions traced north of the fortieth parallel corresponded closely in number with the December average, and the disturbances which attended their passage were of normal intensity. In the vicinity of the West India Islands, and over the ocean south and southeast of Bermuda, there was an unusual prevalence of cyclonic disturbances during the early part of the month, occasioning loss of life and great damage to property, more particularly at the Island of Hayti. During the first decade of the month stormy weather prevailed over the entire ocean east of the seventieth meridian, and the barometric fluctuations were frequent and marked. During the second decade severe gales continued along the trans-Atlantic tracks, and off the middle Atlantic and New England coasts. During the third decade the region of greatest storm frequency extended from the American coast north of the thirty-fifth parallel to the twentieth meridian. Compared with the corresponding month of previous years, December, 1887, did not present abnormal meteorological features over the Atlantic in the middle and northern latitudes, while over the southern part of the ocean the severe storms of the first decade constituted a noteworthy departure from the usual winter weather in that region.

In the following descriptions of the depressions traced, positions are given in degrees latitude and longitude, except in cases where twenty-five to thirty-five minutes are cited, when they are shown in degrees and half degrees:

1.—This storm was a continuation of depression number 13 traced for November, 1887, and was central December 1st about seven degrees south-southeast from Bermuda, with heavy gales over the West India Islands and northward to Nova Scotia. By the 2d the storm-centre had moved slowly northwest, and at 12 noon, Greenwich time, was located about five degrees south of Bermuda. During this date hard north to northeast gales continued west of the sixty-fifth meridian. By the 3d the depression had slowly recurved north and northeast, and during the succeding twenty-four hours advanced east-northeast to about N. 33°, W. 56°. The chart of the 5th shows that, subsequent to 12 noon, Greenwich time, of the 4th, the centre of depression recurved to the northwest, which fact is attributed to the presence on those dates of an area of high barometer over the ocean to the east and northeast of its position, whereby it was deflected from a normal northeasterly course. During the following four days the depression pursued a somewhat rapid normal course to the British Isles and disappeared over the North Sea after the 10th, accompanied throughout by gales attaining hurricane force. The following reports relative to this storm have been rendered: Bermuda, a heavy ne. to n. gale prevailed during the 2d and 3d. Captain Mollieu, of the s. s. "Marsielle," reports: "3d, in N. 29°,