MONTHLY WEATHER REVIEW.

Editor: Prof. Cleveland Abbe.

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INTRODUCTION.

The Monthly Weather Review for March, 1904, is based on data from about 3300 stations, classified as follows:

Weather Bureau stations, regular, telegraph, and mail, 167; West Indian Service, cable and mail, 4; River and Flood Service, regular 43, special river and rainfall, 190, special rainfall only, 56; voluntary observers, domestic and foreign, 2565; total Weather Bureau Service, 3025; Canadian Meteorological Service, by telegraph and mail, 20, by mail only, 13; Meteorological Service of the Azores, by cable, 2; Meteorological Office, London, by cable, 8; Mexican Telegraph Company, by cable, 3; Army Post Hospital reports, 18; United States Life-Saving Service, 9; Southern Pacific Company, 96; Hawaiian Meteorological Service, 75; Jamaica Weather Service, 130; Costa Rican Meteorological Service, 25; The New Panama Canal Company, 5; Central Meteorological Observatory of Mexico, 20 station summaries, also printed daily bulletins and charts, based on simultaneous observations at about 40 stations; Mexican Federal Telegraph Service, printed daily charts, based on about 30 stations.

Special acknowledgment is made of the hearty cooperation of Prof. R. F. Stupart, Director of the Meteorological Service of the Dominion of Canada; Mr. R. C. Lydecker, Territorial Meteorologist, Honolulu, Hawaii; Señor Manuel E. Pastrana, Director of the Central Meteorological and Magnetic Observatory of Mexico; Camilo A. Gonzales, Director-General of Mexican Telegraphs; Capt. S. I. Kimball, Superintendent of the United States Life-Saving Service; Lieut. Commander H. M. Hodges, Hydrographer, United States Navy; H. Pittier, Director of the Physico-Geographic Institute, San José, Costa Rica; Commandant Francisco S. Chaves, Director of the Meteorological Service of the Azores, Ponta Delgada, St. Michaels, Azores; W. N. Shaw, Esq., Secretary, Meteorological Office, London; Rev. José Algué, S. J., Director, Philippine Weather Service; and H. H. Cousins, Chemist, in charge of the Jamaica Weather Office; Señor Enrique A. Del Monte, Director of the Meteorological Service of the Republic of Cuba.

Attention is called to the fact that the clocks and self-registers at regular Weather Bureau stations are all set to seventy-fifth meridian or eastern standard time, which is exactly five hours behind Greenwich time; as far as practicable, only this standard of time is used in the text of the Review, since all Weather Bureau observations are required to be taken and recorded by it. The standards used by the public in the United States and Canada and by the voluntary observers are believed to conform generally to the modern international system of standard meridians, one hour apart, beginning with Greenwich. The Hawaiian standard meridian is 157° 30′, or $10^h\ 30^m$ west of Greenwich. The Costa Rican standard meridian is that of San José, $5^h\ 36^m$ west of Greenwich. Records of miscellaneous phenomena that are reported occasionally in other standards of time by voluntary observers or newspaper correspondents are sometimes corrected to agree with the eastern standard; otherwise, the local standard is mentioned.

Barometric pressures, whether "station pressures" or "sea-level pressures," are now reduced to standard gravity, so that they express pressure in a standard system of absolute measures.

FORECASTS AND WARNINGS.

By Prof. E. B. Garriott, in charge of Forecast Division.

Stormy weather prevailed over the eastern part of the Atlantic Ocean during the first decade of the month. From the 1st to the 6th the barometer continued low over the Bay of Biscay, Spain, and Portugal, and during the 7th and 8th a disturbance evidently moved from that region toward the Irish coast, where the barometer fell to 29.48 inches at Valentia. By the 9th this disturbance had apparently united with a barometic depression of great energy that appeared in the vicinity of the Azores, where, at Horta, the barometer fell rapidly to a minimum of 29.10 inches, with a maximum wind velocity of 60 miles an hour from the south. During the 13th and 14th a disturbance that was probably identical with a storm that passed eastward over Newfoundland during the 11th, crossed the north part of Scotland, and a disturbance that moved eastward over the Canadian Maritime Provinces on the 16th apparently passed north of the British Isles during the 19th. On the 22d a disturbance passed southeastward over the British Isles. From the 23d to 25th the barometer continued high over the British Isles, and fell from the 26th to 30th to a reported minimum of 29.00 at Stornoway, Scotland, with gales on the British coasts during the 29th and 30th.

In the United States there was a succession of disturbances that moved from the north Pacific coast southeastward over the Rocky Mountain districts to the Mississippi Valley, and thence northeastward over the Canadian Maritime Provinces.

The severest storm of the month appeared on the north Pacific coast during the night of the 9th, and on the morning of the 10th barometric pressure was below 29.00 inches on the Washington and Oregon coasts. The gales that attended this storm were severe from British Columbia to San Diego, Cal., and heavy rain fell in the coast districts and heavy snow in the mountain regions of the North Pacific States. After leaving the coast this storm rapidly lost intensity.

The Humboldt Standard, Eureka, Cal., of March 10, 1904, remarks as follows regarding the work of the Weather Bureau in connection with this storm:

> One of the most violent storms that ever occurred on the coast of northern California was heralded yesterday morning by the display of southeast storm warnings at the local Weather Bureau station. The warnings were ordered up by district forecaster McAdie twelve hours before the storm struck this city. All of the shipping in the bay having ample notice from the Weather Bureau there was no damage to vessels, all shipping being securely tied up, with no vessels at anchor.

Another severe storm appeared on the north Pacific coast on the 19th.

Chart II shows the remarkably uniform progression across the United States of the barometric depressions of the month, and the following are notable features reported in connection with the more important disturbances that traversed the country:

A disturbance that appeared on the north Pacific coast on the 1st moved rapidly south of east over the Plateau and

Movements of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocity.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long. W.	Length.	Duration.	Daily.	Hourly.
High areas.		°	°		°	°	*Miles.*	*Days.*	*Miles.*	*Miles.*
I	*29, p. m.	54	114	5, p. m.	45	64	3,225	5.0	645	26.9
II	4, a. m.	41	125	6, p. m.	39	95	1,775	2.5	710	29.6
III	7, p. m.	53	108	11, a. m.	46	73	1,700	3.5	486	20.2
IV	13, a. m. 14, a. m.	53 27	105 97	17, p. m.	39	75	2,075	4.5	462	19.2
V	17, a. m.	40	100	19, a. m.	43	75	1,450	2.0	725	30.2
VI	19, a. m.	53	108	21, p. m.	47	65	2,100	2.5	840	35.0
VII	21, p. m.	48	110	24, p. m.	42	70	2,100	3.0	700	29.2
VIII	24, p. m.	54	114	29, p. m.	38	75	2,800	5.0	560	23.3
Sums							17,225	28.0	5,128	213.6
Mean of 8 paths							2,153		641	26.7
Mean of 28 days									615	25.6
Low areas.										
I	1, a. m.	48	125	3, p. m.	48	68	2,950	2.5	1,180	49.2
II	3, a. m.	33	115	8, p. m.	47	65	3,525	5.5	641	26.7
III	8, a. m.	51	120	12, a. m.	47	65	3,400	4.0	850	35.4
IV	10, p. m.	48	125	16, a. m.	47	65	4,050	5.5	737	30.7
V	14, a. m.	45	125	19, a. m.	44	66	4,050	5.0	810	33.8
VI	17, a. m.	48	125	20, p. m.	46	60	3,400	3.5	971	40.5
VII	19, p. m.	48	125	23, a. m.	47	65	3,375	3.5	964	40.2
VIII	22, a. m.	48	125	26, p. m.	47	60	3,750	4.5	833	34.7
IX	28, a. m.	42	108	†2, p. m.	47	60	2,950	5.5	536	22.3
Sums							31,450	39.5	7,522	313.5
Mean of 9 paths							3,494		836	34.8
Mean of 39.5 days									796	33.2

*February. †April.

For graphic presentation of the movements of these highs and lows see Charts I and II.—*C. C. Cooper.*

Rocky Mountain districts by the morning of the 2d, attended by high winds and followed by a cold wave over the middle and northern Rocky Mountain and Plateau districts. The storms that appeared on the north Pacific coast on the 10–11th and 19th were sufficiently severe to prostrate forest trees. After the 20th the Pacific coast was comparatively free from high winds.

In connection with a storm from the Pacific that crossed the middle Mississippi Valley during the 17th, exceptionally heavy rain occurred in the lower Mississippi Valley, a depth of 2.58 inches being noted at New Orleans where streets were flooded. On the 21st, when a storm from the Pacific crossed the lower Missouri Valley, severe local storms occurred in Missouri. During the evening and night of the 24th a disturbance from the Pacific moved from the lower Missouri Valley to Lake Superior, attended by severe local storms in Missouri, Illinois, Indiana, Wisconsin, and Michigan, that destroyed a number of buildings and caused some loss of life. It appears from a report of the Weather Bureau observer at Grand Rapids, Mich., that a well-defined tornado crossed the southeastern part of that city in the evening, traveling in a northeast direction. At the Weather Bureau office the wind attained a velocity of 52 miles an hour, for a five-minute period, with an extreme velocity of 60 miles an hour, at 10:05 p. m., and the tornado was attended by the usual electrical display, and by large hailstones. The storm track varied in width from 25 to 200 feet and was about 2 miles in length. The tornado cloud touched the ground at intervals, and there were many chimneys blown down, windows blown out, barns and outhouses demolished, and residences destroyed or twisted off their foundations. The property loss at Grand Rapids aggregating about $15,000, and four persons were injured.

The principle cold waves of the month swept from the British Northwest Territories over the southern and eastern districts from the 1st to the 4th, and from the northwest and middle-western districts eastward and southward from the 23d to the 26th. In the Rocky Mountain districts the cold waves were more frequent and general than during the winter months. An estimate of the value of the Weather Bureau frost warnings finds expression in the following article that appeared in the San Francisco Chronicle of March 20, 1904:

The farmer shares equally with the merchant the advantages of Weather Bureau warnings, and every year this service increases in efficiency and value. Many millions of dollars have already been saved by the fruit growers of California by timely warnings sent out, enabling citrus growers to protect their crops against frost, and the raisin, prune, and apricot growers to stack their trays of drying fruit before overtaken by rain.

The Daily States, New Orleans, La., March 4, 1904, remarked as follows:

The warnings of the United States Weather Bureau were as usual timely and accurate, and they enabled the protection of the berry crops and truck gardens and have thus saved thousands of dollars to the farming interests.

The Advertiser, Montgomery, Ala., March 5, 1904, referred to the warnings as follows:

The Weather Bureau's warning saved many thousand young cabbages and tomatoes which were exposed in cold frames, almost ready to transplant, and which would have been killed had warnings not been received. This item of benefit from the Bureau's warnings means upward of of $50,000 or more to the truckers of this section. Had these young plants been killed, an entire new crop of early sets would have had to be started, which would make the vegetables too late to demand lucrative prices in the northern markets. The warning, verified to the degree, was far enough in advance to be of great benefit.

During the early part of the month mild weather and heavy rain, in connection with heavy ice gorges, threatened property along rivers of the Eastern States, notably in eastern Pennsylvania, New Jersey, and parts of New York and New England. As the month advanced the gorges broke and passed down with almost a minimum amount of the damage anticipated. Serious floods occurred in the Sacramento River during the first decade of the month, and during the third decade heavy rain caused freshets in Illinois, Indiana, Michigan, Wisconsin, and, to some extent, in adjoining States. All of the floods of the month were carefully watched and advices and warnings concerning them were promptly issued for the benefit of all concerned. Full descriptions of the floods will be found under the heading "Rivers and floods."

NEW ENGLAND FORECAST DISTRICT.

The storms of the month were not so severe as those that usually occur in March. The greatest inconvenience to shipping resulted from the high winds of the 1st. The local papers commented upon this storm as follows:

From the Boston Herald:

Thanks to the forecaster, the mariners down on the water front got their warnings as early as 3 p. m. yesterday afternoon, and no craft stirred abroad. In consequence no disasters were reported this morning.

From the Boston Globe:

The storm was anticipated by the Weather Bureau officials, who caused warnings to be hoisted along the coast as early as 2 p. m. yesterday. So far as known at this office no disasters resulted to shipping in this vicinity.

J. W. Smith, District Forecaster.

WEST GULF FORECAST DISTRICT.

Frost or freezing temperature occurred in some parts of the district on several dates, and timely warnings were issued in connection therewith. No general storms occurred on the west Gulf coast.—*I. M. Cline, District Forecaster.*

NORTH CENTRAL FORECAST DISTRICT.

Two marked cold waves occurred. The first was present in the British Northwest Territories at the opening of the month. It moved southward and eastward, and by the evening of the 3d it had reached the eastern limits. Warnings were issued on the 1st and 2d well in advance of the cold wave. The temperature continued low in the Northwest, and on the morning of the 23d it showed evidence of extending eastward and southward.

Warnings were therefore issued on the 23d and 24th well in advance, and by the morning of the 26th the cold had extended over the entire district.

Several warnings were sent to open ports on Lake Michigan when severe storms were threatened. However, winter navigation was retarded more by ice than by windstorms. No losses to shipping have been reported.—*H. J. Cox, Professor and District Forecaster.*

ROCKY MOUNTAIN FORECAST DISTRICT.

Early on the 2d warnings of a cold wave were given general distribution in Utah, Wyoming, and eastern Colorado, with the information that high westerly winds were indicated for Utah and westerly shifting to high northerly winds for Wyoming and eastern Colorado. This storm proved to be the most severe of the winter, on account of the high winds that accompanied it, together with an unusually great and rapid fall in temperature. Warnings were also given distribution in Wyoming and northeastern Colorado during the morning of the 9th. On the 23d warnings were issued for Utah, Wyoming, and eastern Colorado, and were renewed the following morning in southern Wyoming and eastern Colorado.—*F. H. Brandenburg, District Forecaster.*

SOUTH PACIFIC FORECAST DISTRICT.

The month was unusually stormy, and while the intensity of the rain in central California has been exceeded in other Marches, the frequency, or number of rainy days, broke all records. In northern California the rainfall was so heavy as to cause serious floods in the Sacramento River and its tributaries. Storm warnings were displayed with unusual frequency, and warnings of rapid rises in the rivers of northern California were issued.—*A. G. McAdie, Professor and District Forecaster.*

NORTH PACIFIC FORECAST DISTRICT.

In the North Pacific States the month was unusually cold and stormy, and heavy snow in the mountains of eastern Oregon resulted in disastrous avalanches. The windstorms of the 10–11th and 19th were very severe, the wind on the 10th reaching a velocity of 84 miles an hour at North Head, Wash. Timely warnings were issued for the gales of the month.—*E. A. Beals, District Forecaster.*

RIVERS AND FLOODS.

The ice situation in the principal rivers of the United States during the month may be summarized as follows:

In northern New England the ice remained firm throughout the month and in southern New England until about the 20th. At the opening of the month the Mississippi River was frozen from Davenport northward, and the Missouri River north of Sioux City. At the close of the month the Missouri River was frozen from Bismarck northward, and the Mississippi north of La Crosse, with floating ice observed at considerable distances below these places. There was no ice of consequence in the Ohio and Potomac rivers.

The ice gorges that formed in the Susquehanna River in January continued until the latter part of the month, causing numerous floods and the loss of a large amount of property. The following report on these gorges was prepared by Mr. E. R. Demain, official in charge, United States Weather Bureau office, Harrisburg, Pa.:

The ice which broke up on the Juniata during the latter part of February gorged near Duncannon. On the morning of March 2 the ice at the mouth of the Juniata moved, increasing the size of the gorge at Duncannon and causing the flooding of some houses and industrial plants. The ice on the West branch broke at Lockhaven about 2 p. m., March 3, and moved out on a 12-foot flood. Warnings were immediately wired to Williamsport and Selinsgrove on the receipt of the information, and the postmaster at Duncannon was informed that the flood from the West branch would probably increase the danger from backwater at that point. The Paxton furnaces and other industrial plants in south Harrisburg and Steelton were advised to prepare for a big flood, and this was done in many instances. When the flood from the West branch reached Duncannon on the morning of March 4 it swept away the gorge at that place without destroying the Clarks Ferry bridge, which was thought by many to be in great danger, and the whole mass of ice and water moved down, breaking up the ice on the river as it advanced. The ice broke at Fort Hunter, 7 miles above Harrisburg, at 10:05 a. m., March 4, and at 10:55 a. m. the ice began to move at Harrisburg, the water rising steadily from 13.5 feet at 8 a. m. to 16 feet at noon. Between noon and 1 p. m. the river at Harrisburg rose 4 feet, to a stage of 20 feet. After 1 p. m. the rise was more gradual until 3:15 p. m., when 23.3 feet was registered on the gage at the pumping station. The water receded slowly from that time till 11 p. m., when the stage was 21.3 feet. The ice at Harrisburg broke on both sides of the island at the same time. This great mass of ice, moving down and increasing the congestion below, formed a gorge near Middletown and another a short distance below Highspire. The ice on the west side of the island at Harrisburg soon stopped, but the ice in the east channel continued to move till about 2:30 p. m., when the channel became choked. About 4:30 p. m. the ice in the west channel began to move, and this channel continued open the rest of the day. All the lowlands from south Harrisburg to Middleton, a distance of about 9 miles, were submerged, the water at Middleton being 1.5 feet higher than in the great flood of June 2, 1889, and at Highspire about 0.8 of a foot higher, but by midnight the water at both of these towns had receded about 2 feet.

No material changes occurred in the situation in the main river or in the gorged districts of the North branch from the evening of March 4 till the morning of the 8th, the water in the pools above the gorges fluctuating during this time as the gorges opened and again became choked with floating ice. The Juniata, West branch, and the headwaters of the North branch began to fall on the 4th, the fall continuing until the morning of the 7th, when rain and milder weather occurred over the whole watershed. This started a rise in all streams, and by the night of the 7th all the branches of the system were rising rapidly. On the evening of the 7th Catawissa reported that the ice had moved off Roaring, Catawissa, and Nescopeck creeks, taking away several wagon bridges. The ice moved at Harrisburg, above the upper bridge, at 6 a. m. on the 8th, but the movement continued only a few minutes. The river continued to rise steadily during the morning; at 7 a. m. it registered 21.2 feet and at 10 a. m. 22.3 feet on the Harrisburg gage. At Middletown and other points below Harrisburg, nearer the Middletown gorge, the rise was more rapid. At Middletown the water reached a stage of 34.5 feet about 10 a. m., the highest ever known and said to be 5 feet higher than the flood of June 2, 1889. The excitement at Middletown, Highspire, Steelton, and Harrisburg was great; the telephone in the office was in use constantly during the morning, requiring the attention of an observer to answer the calls for information. Hundreds of people desired to know how much more water was expected, a question which it was impossible to answer definitely; they were informed that the only hope of early relief was in the breaking of the gorges at Middletown and Highspire. Fortunately this occurred about 10 a. m. and at once relieved the seriousness of the situation at Middletown and a little later at Highspire, Steelton, and Harrisburg. The river began to fall at Harrisburg about 10:15 a. m., but the ice did not begin to move till about 11:40 a. m. All the bridges at Harrisburg stood the shock well, except the new Market Street Bridge; several large stones were knocked out of the twentieth pier of this structure, from the Harrisburg side, by heavy cakes of ice, damaging it to such an extent that it was found necessary to close the bridge to traffic. This bridge had been in use only about ten days. Immediately steps were taken to protect the damaged pier, and a wooden "nosing" was hastily constructed and placed over the damaged part before any further movement of heavy ice occurred. This doubtless saved the pier from destruction. The bridge was opened to traffic again early on the morning of March 12.

While the breaking of the Middletown gorge greatly lessened the danger on the main river, the conditions in the gorged district of the North branch were becoming more serious. At Wilkesbarre the river was 29 feet at noon, and the situation in the vicinity of Bloomsburg and Catawissa continued very serious. Early in the morning of the 8th the ice began to move at Wilkesbarre, the movement continuing for about two hours; the ice then gorged solidly and remained stationary the rest of the day. The ice also moved at Boyds, between Catawissa and Danville, early on the 8th. The gorge at Bainbridge, below Harrisburg, was reported to have started on the 8th, moving down on and dislodging the gorge at Turkey Hill, the accumulated ice and water rushing down and gorging below Safe Harbor, submerging the low parts of that town and destroying many houses and one or two county bridges. The ice broke at Pittston, above Wilkesbarre, about midnight of the 8th and moving down lodged on the gorge at Nanticoke, the water rising at 30.6 feet at Wilkesbarre about 1:30 a. m. of the 9th, flooding more houses and causing several coal companies to suspend operations. The ice moved about 400 feet at Catawissa at 11.30 a. m. of the 9th, carrying away the two east spans of the Catawissa Bridge which lodged near the east shore. Several other movements of ice occurred in the North branch on the 9th, and as these movements indicated a general break up of the ice gorges warnings were sent to Selinsgrove and other points below Sunbury to the effect that in case a general break occurred a disastrous flood might