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FORECASTS AND WARNINGS.

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

Over the greater part of the United States the month of August, 1899, was notably free from severe atmospheric disturbances.

The meteorological event of the month was a West Indian hurricane, which appeared east of Martinique on the morning of the 7th. During the afternoon and night of the 7th this storm devastated the more southern of the Leeward Islands of the Lesser Antilles, and on the 8th caused the loss of hundreds of human lives and destroyed millions of dollars' worth of property in Porto Rico. Moving thence north of west the disturbance crossed the Bahama Islands during the 11th and 12th, attended by a considerable loss of life and property, and from the 13th to the 17th skirted the south Atlantic coast of the United States, after which it disappeared in the direction of Newfoundland. At Porto Rico and Hatteras, N. C., where its vortex passed near regular reporting stations of the Weather Bureau, the hurricane was of exceptional severity, and at Hatteras it will go on record as the severest storm within the recollection of the oldest inhabitants.

From the time this hurricane appeared within the region of observation until it disappeared off the Virginia coast accurate advices regarding its character and course were telegraphed along the line of its advance and preceded its arrival by periods which varied in length from a few hours in the Leeward Islands to thirty-six and forty-eight hours along the south Atlantic coast.

A history of this storm appears under the heading "The

West Indian Hurricane of August 7-17, 1899," and its track is platted on Charts IX-XII.

From the 29th to the 31st a tropical storm of moderate intensity moved from the vicinity of Dominica westward over the Caribbean Sea and recurved northward during the early days of September. A discussion of this storm will appear in the MONTHLY WEATHER REVIEW for September, 1899.

Several severe storms of a local character occurred during the month. On the 1st and 2d a violent storm visited Carabelle, Fla., and vicinity, causing the death of six persons and destroying vessels, property, and crops to the value of \$575,000. On the 2d a group of storms, which in places assumed the intensity of tornadoes, occurred in the Middle Atlantic States. On the 10th about two million bushels of wheat in North Dakota were destroyed by hail. The causes which produce storms of this class are, as a rule, so obscure that it is not possible to define or localize the region in which they will develop.

No special warnings were issued during the month by the forecast officials at Chicago and San Francisco.

Mr. B. S. Pague, Forecast Official at Portland, Oreg., reports that on August 26 the grain crop was threatened with destruction by continuous rains and that a positive assurance from that office that a change to fair, warm weather would occur within thirty-six hours prevented wholesale men from calling in traveling men and a suspension of credits, which would have seriously embarrassed rural merchants, bankers, and, especially, farmers.

AREAS OF HIGH AND LOW PRESSURE.

During the month of August there were six high areas and nine low areas sufficiently well defined to be traced on Charts I and II. During this month the center of high and low is very difficult to determine, and very often the point fixed is only approximate.

The accompanying table exhibits the principal points regarding the origin, velocity, and disappearance of these highs and lows, and the following description is added:

Movements of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long. W.	Length.	Duration.	Daily.	Hourly.
High areas.										
I.....	1, p. m.	48	130	12, p. m.	46	58	3,840	11.0	349	14.5
II.....	8, a. m.	36	123	18, a. m.	44	62	4,260	10.0	426	17.7
III.....	20, a. m.	52	108	23, p. m.	43	80	2,040	3.5	583	24.3
IV.....	23, p. m.	44	101	28, a. m.	48	59	2,520	4.5	560	23.3
V.....	26, a. m.	46	112	28, a. m.	48	76	1,740	2.0	870	36.2
VI.....	29, a. m.	45	129	†2, p. m.	45	60	3,240	4.5	720	30.0
Total.....							17,640	35.5	3,508	146.0
Mean of 6 paths.....							2,940		585	24.3
Mean of 35.5 days.....									497	20.7
Low areas.										
I.....	*28, p. m.	43	116	3, a. m.	49	67	2,780	5.5	496	20.7
II.....	1, a. m.	40	115	5, p. m.	36	94	2,130	4.5	473	19.7
III.....	4, a. m.	40	94	6, p. m.	36	76	1,110	2.5	444	18.5
IV.....	4, p. m.	51	117	10, a. m.	44	85	2,130	5.5	387	16.1
V.....	8, p. m.	52	114	14, a. m.	50	61	2,580	5.5	469	19.5
VI.....	12, a. m.	26	78	20, p. m.	41	69	1,380	8.5	162	6.8
VII.....	13, a. m.	44	116	23, a. m.	43	70	3,480	10.0	348	14.5
VIII.....	20, a. m.	43	118	23, a. m.	53	104	1,260	3.0	420	17.5
IX.....	24, a. m.	53	117	26, a. m.	51	99	810	2.0	405	16.9
Total.....							17,610	47.0	3,604	150.2
Mean of 9 paths.....							1,957		400	16.7
Mean of 47.0 days.....									375	15.6

* July. † September.

Highs.—Three of the highs, Nos. I, II, and VI, were traced from the North Pacific, nearly due east, to the North Atlantic. No. III was first noted to the north of Montana and disappeared over Lake Erie. No. IV began in South Dakota and disappeared over the Gulf of St. Lawrence. No. V began in extreme southwest Montana and was last noted in Ontario.

Lows.—Four of the storms, Nos. I, II, VII, and VIII, began in the middle Plateau region. Three more, Nos. IV, V, and IX, began to the north of Montana. No. III was first noted in north Missouri. No. VI was a West India hurricane, and was first noted off the southeast point of Florida on the 12th. Its motion, north or a little east of north, was extremely slow; it was last noted off Cape Cod on the evening of the 20th, having moved only 6.8 miles an hour. The motion of these storms, except the hurricane, was generally eastward. No. II was last seen in Arkansas; No. VIII, in Assinaboia; No. IX, in Manitoba; No. IV, in lower Michigan; No. III, off the middle Atlantic coast; No. VII, off the coast of Maine; and Nos. I and V, in the Gulf of St. Lawrence. During the progress of these lows the following maximum winds were reported on the coasts and lakes: On the evening of August 5, as No. III approached the middle Atlantic coast, New York City experienced a northwest wind of 64 miles an hour; the morning of the 6th Cape Henry reported a west wind of 56 miles; on the evening of the 11th, as storm No. V approached the upper Lakes, Chicago had a northeast wind of 52 miles. In connection with the very slow-moving hurricane, the following velocities were reported: Jupiter, a. m. of the 13th, north 52 miles, evening of the same day the same station reported 51 miles; a. m. of 15th Charleston had a northeast wind of 52 miles;

evening of 16th Kittyhawk and Cape Henry had northeast 52 miles; morning of 17th Hatteras reported 74 miles, and on the evening of 17th it reported 105 miles, with an estimated extreme maximum velocity of 140 miles. At the 8 p. m. observation of 17th Hatteras reported a barometer reading of 28.62 inches, the lowest ever experienced on the middle Atlantic coast.—*H. A. Hazen, Professor.*

THE WEST INDIAN HURRICANE OF AUGUST 7-17, 1899.

While there is evidence that this hurricane had its origin far to the eastward of the West Indies its approach toward the region covered by reporting stations of the United States Weather Bureau was not indicated until the morning of August 7. At 8 a. m., seventy-fifth meridian time, of that date the hurricane center was east-northeast and distant about 150 miles from the Island of Dominica. At Roseau, Dominica, the barometer read 29.72 inches, with rain and wind from the northwest blowing at a rate of 12 miles an hour. Up to this time the maximum wind velocity at Roseau had been 18 miles an hour from the northeast. Immediately upon the receipt of the 8 a. m. telegraphic reports the Central Office of the Weather Bureau at Washington ordered hurricane signals at Roseau, Dominica, Basseterre, St. Kitts, and San Juan, Porto Rico, and sent advisory messages to all other stations in the Lesser Antilles and also to Santo Domingo, Kingston, Jamaica, and Santiago, Cuba, with information regarding the position and probable course of the hurricane. This information was also telegraphed to important seaports on the Atlantic and Gulf coasts, and furnished the Bureau of Navigation, Navy Department, the Maritime Associations, and the Press. On the afternoon of the 7th hurricane signals were ordered at Santo Domingo.

During the next twenty-four hours the hurricane traveled in a west-northwest direction at a speed of about 16½ miles an hour, crossing directly over the Island of Guadeloupe early in the afternoon, and passing 50 to 75 miles south of St. Kitts late in the afternoon of the 7th, and reached the southeast coast of Porto Rico shortly after 8 a. m. on the morning of August 8. At St. Kitts the lowest barometer, 29.268 inches, was reached at 5 p. m., and the maximum wind velocity was 72 miles an hour from 4:22 to 4:27 p. m., with an extreme velocity for one minute of 120 miles at 4:40 p. m. Along this portion of the track the destruction of life and property was most marked on the islands of Guadeloupe, Montserrat, and St. Croix, which lay along the path covered by the storm's vortex.

Tuesday, August 8, 1899, will go on record as a day during which Porto Rico experienced one of the most disastrous hurricanes noted in the history of the West Indies. In the morning the hurricane center struck the southeastern part of the island and moved west-northwest, passing very near and apparently to the northward of Ponce. The lowest barometer reading noted at the Weather Bureau station at San Juan was 29.23 inches at 8.30 a. m. Reports of readings of aneroid barometers in the possession of voluntary observers who were located nearer the path of the storm's center show a barometric gradient which will account for the terrific violence of the hurricane. At Guayama a reading of 27.75 corrected for elevation and instrumental error, was registered; and at Juana Diaz a reading of 28.11 inches was recorded at 9:30 a. m.

During the 8th the storm center continued a west-northwest course and reached the northeast coast of Santo Domingo the morning of the 9th. Hurricane signals were ordered at Santiago, Cuba, and all Cuban stations were notified of the position and course of the storm, and vessels in Cuban ports bound north and east were advised to remain in port. In

Santo Domingo the storm was severe in the northeast and north parts of the island, while in the southern part but little damage was done.

From the morning of the 9th to the morning of the 12th the path of the hurricane was without the region of observation, and during this period it moved from the northeast coast of Santo Domingo to a position some 50 miles south of Nassau, Bahamas, a distance of about 700 miles at a velocity of less than 10 miles an hour. In its passage over the Bahamas the storm was quite severe, and at Nassau a minimum barometer reading of 29.10 inches was reported. In the mean time all interests in its line of advance were from time to time advised of its calculated movements, and all shipping bound for the South Atlantic were informed of the danger of sailing for that region. The evening of August 10 Nassau, Bahamas, was advised to take precautionary measures in view of a probable hurricane visitation. By the morning of the 13th the storm center had reached a position off Jupiter, Fla., with a minimum barometer reading of 29.22 inches at 8 a. m.

The subsequent course of the storm lay off and nearly parallel with the south Atlantic coast of the United States, where, as shown by the detailed reports from Weather Bureau stations, herewith, it apparently acquired its greatest intensity in the region about Hatteras from the 16th to the 18th, with a minimum barometer reading of 28.620 at 8 p. m. of the 17th, an unprecedentedly low reading for the Hatteras station.

The following reports from points along the path of the hurricane contain data in detail regarding its character and effects from the 7th to the 18th, inclusive, and also indicate the action taken by the Weather Bureau to disseminate warnings of its approach:

Basseterre, St. Kitts, W. I., W. H. Alexander, Observer, Weather Bureau:

The day preceding the hurricane was the warmest of the season thus far, the temperature reaching 88°, and the afternoon was characterized by gusty, whirling winds from the northeast, with an occasional momentary calm, and by a hazy atmosphere, with scattered strato-cumulus clouds moving from the east rather rapidly, and above which there seemed to be a thin sheet of cirro-stratus clouds, through which the sun shone with a pale, sickly light. The sea was wonderfully clear, so much so that one could see very distinctly the stones on the bottom, but gave no sign of unusual agitation. The sunset was not marked by saffron skies, nor did the barometer, up to this time, show the slightest tendency to depart from its normal condition. At 3:30 p. m. the wind set in steadily from the northeast at the rate of 12 miles per hour, with a gradually increasing force. At 10:00 p. m. the barometer began to fall, and the wind, still increasing, had attained a velocity of 18 miles per hour. By 3:00 a. m. of the 7th the barometer dropped .01 of an inch, and the wind was blowing at the rate of 24 miles per hour, and there was an apparent tendency to cloudiness, so that by 5:30 a. m. the sky was almost entirely overcast with low clouds, from which frequent showers fell.

The storm came from the southeast and moved toward the northwest, the center passing near but a little to the southwest of St. Kitts. The behavior of the barometer before and during the storm is clearly indicated in the readings made at the time and given below, viz:

AUGUST 7, 1899.

8:00 a. m.	29.854	5:45 p. m.	29.299
9:00 a. m.	29.838	6:00 p. m.	29.330
10:00 a. m.	29.793	6:15 p. m.	29.357
11:00 a. m.	29.786	6:30 p. m.	29.379
12:00 m.	29.744	6:45 p. m.	29.411
12:30 p. m.	29.724	7:00 p. m.	29.506
1:00 p. m.	29.675	7:15 p. m.	29.548
1:30 p. m.	29.650	7:30 p. m.	29.566
2:00 p. m.	29.624	7:45 p. m.	29.603
2:30 p. m.	29.572	8:00 p. m.	29.655
3:00 p. m.	29.530	8:30 p. m.	29.686
3:30 p. m.	29.450	9:00 p. m.	29.704
4:00 p. m.	29.381	9:30 p. m.	29.716
4:15 p. m.	29.360	10:00 p. m.	29.726
4:30 p. m.	29.299	10:30 p. m.	29.737
4:45 p. m.	29.279	11:00 p. m.	29.740
5:00 p. m.	29.268	12:00 midnight	29.760
5:15 p. m.	29.270	2:45 a. m. (8th)	
5:30 p. m.	29.287		

As shown by the above readings, the barometer made a decided start downward about 10:00 p. m. of the 6th and reached the lowest reading, 29.268, at 5:00 p. m. of the 7th.

The wind continued from the northeast until about 6:00 p. m., when it veered to the east, where it remained until about 8:00 p. m.; then it changed to the southeast and so continued to the end of the storm. The verifying velocity (45 miles per hour) began at 2:34 p. m. and ended at 12:25 a. m., the storm lasted, therefore, nine hours and fifty-one minutes. The maximum velocity (the greatest velocity for any five minutes) was 72 miles per hour, and occurred between 4:22 p. m. and 4:27 p. m. The extreme velocity (1 mile in the shortest time) occurred at 4:40 p. m., when the wind made 1 mile in half a minute, or at the rate of 120 miles per hour. The total wind movement during the storm was 478 miles, as follows, viz: from the northeast 196, from the east 112, and from the southeast 170.

The hurricane was accompanied by a light rain, the total amount of which was 1.28 inches. The heaviest rainfall occurred between 4:53 p. m. and 5:10 p. m. There was neither thunder nor lightning during the hurricane.

The order to hoist hurricane signals was received at 12:13 p. m. of the 7th, and diligence was used to give the warning the greatest possible publicity. A copy was given to the Daily Express, and a message was filed to the United States Consul at Antigua. To my surprise and disappointment the agent told me late that evening or early next morning that my message to Antigua was not sent; that it was "crowded out." I tried to reach Nevis but could not. That the entire Island of St. Kitts was warned in good time is shown by the fact that not a death resulted from the hurricane.

The office was besieged by those seeking information. Among those who called were the acting administrator, the president and cashier of the bank, the United States Consul, the inspector of police, the magistrate, and many others. It is remarkable how many people seek the Weather Bureau "under stress of weather." The following communications, illustrating the general feeling which prevails here relative to the Weather Bureau and its work, have been received:

ST. CHRISTOPHER, NEVIS,
ADMINISTRATOR'S OFFICE,
St. Kitts, W. I., August 12, 1899,

I beg to tender on behalf of the government and the public generally sincere thanks for the information and timely warning afforded by you as to the approach of the late destructive hurricane, whereby this island was, no doubt, saved from more serious damage.

I have the honor to be, sir, your obedient servant,
F. S. WIGLEY,
Acting Administrator.

CONSULAR SERVICE, UNITED STATES OF AMERICA,
St. Kitts, W. I., August 19, 1899.

I take this opportunity to express my sincere thanks to you for the service rendered by you on the 7th instant, and I have no hesitation in stating that the prompt and efficient manner in which you gave notice of the approaching cyclone was of the greatest benefit to this island, and was much appreciated by its inhabitants.

I am, dear sir, yours truly,
EMILE S. DELISLE,
United States Vice Com. Agent.

COLONIAL BANK,
St. Kitts, W. I., August 15, 1899.

The warnings and information given by you prior to and during the hurricane of the 7th instant, have proved very valuable and of the greatest use to the inhabitants of this island and must have been of similar value to some of the islands northwest of us, and the usefulness of the Weather Bureau must be considered as fully established.

Yours truly,
U. U. GEDDES,
Manager.

WEST LODGE,
St. Kitts, August 10, 1899.

Allow me to thank you for your courtesy on Monday the 7th instant, when I called at your office, and to express my appreciation of the timely warning you gave of the cyclone then approaching us, which was of great value to the people of this island, as they were able to make every possible preparation before the storm reached us.

I am, yours, respectfully,
F. W. DRATON.

ST. PETER'S RECTORY,
St. Kitts, August 19, 1899.

As I think it the duty of citizens on this island to testify their appreciation of the United States Weather Bureau, it affords me much pleasure in expressing my thanks for the great and valuable use of such an institution. Monday, the 7th of this month, showed us all the necessity of such an establishment. I for one can bear testimony to

your great skill, kindness, and readiness in affording the information which enabled us to use all the precautionary measures for our safety.

Hoping that you may continue in your invaluable post, I am yours, faithfully,

GEORGE ED. YEO,
Rector.

St. Martin, Dutch West Indies, C. W. Doelitzsch, Officer of Customs:

The morning of August 7, dense clouds, heavy and threatening, appeared at 8 a. m., with the appearance of cirro-stratus clouds to the windward, with heavy gusts of wind from the east-northeast, alternating with calms during the morning with heavy sea. During the afternoon the weather was gloomy and squally, with wind increasing from east-northeast and going to northeast. At 10:20 p. m. the barometer read 29.81, and the storm was increasing. This was the last observation taken of this hurricane.

Saba, Dutch West Indies, Mr. John B. Simmons:

At daylight on the 7th the barometer was noticed to have a downward tendency; at noon it had fallen two-tenths of an inch, with wind from east-northeast and strong. At 4 p. m. the wind was from northeast and increasing. The barometer continued to fall until 11 p. m., when I judged the wind to be from the north, after which it remained steady until midnight when it shifted to southwest and the barometer began to rise. The minimum reading by an aneroid barometer was 29.40 inches. There was no means of measuring the velocity of the wind, but I estimated it at 55 to 65 miles an hour. This island is high and mountainous and contains no low land. I know from reports that neighboring islands have suffered to a greater extent than Saba.

R. M. Geddings, Section Director, Weather Bureau, San Juan, Porto Rico:

For several days previous to the 8th the meteorological conditions had been peculiar. During the 3d and 4th the air was almost calm. There were, however, no indications of a hurricane until the morning of the 7th, when the barometer read 29.96. About noon of the 7th the sky assumed a hazy appearance and ragged cumulus and cumulo-stratus clouds were observed moving rapidly from the northeast. At that time a cablegram was received ordering up the hurricane signals and announcing that the hurricane was central east of Dominica. The barometer at that time read 29.91, wind northeast, velocity 12 miles an hour. The barometer continued to fall rapidly, and at 3 p. m. the sky began to be covered with thick alto-stratus and stratus clouds, the former moving from the southeast and the latter from the east-northeast. The barometer stood at 29.865. From that time on the sky became more and more overcast, the barometer fluctuated between 29.78 and 29.80, and at 5.25 p. m. light rain began and continued until 8.15 p. m. At 10 p. m. the barometer began a downward movement which continued until the lowest recorded reading was reached, 29.23, at 8.30 a. m. of the 8th, when it "pumped" violently and then began to rise and reached 29.55 at noon of the 8th.

The wind did not attain a high velocity until 2 a. m. of the 8th. At 5 a. m. of the 8th it was blowing hard and raining, both increasing until between 7 and 9 a. m. of the 8th, when the hurricane was at its worst, an estimated wind velocity of 85 to 90 miles an hour being reached.

Immediately upon the receipt of the hurricane signal order on the 7th, hurricane signals were ordered at Arecibo, Aguadilla, Mayaguez, Ponce, Arroya, Humacao, and Fajardo. The signals were displayed from the Weather Bureau office flag pole, and also from the signal flag on Fort Cristobal, the same pole from which all marine signals at this port are displayed. As soon as they were hoisted vessels began to move to a safe anchorage, and the warning was the means of saving many of them.

A peculiar feature of the storm was that there was practically no thunder or lightning. But two flashes of lightning were observed and they were not severe. During the afternoon of the 8th the rainfall was extremely heavy, continuing into the night. The total amount during the storm was 6.37 inches, of which 4.18 inches fell between noon and 8 p. m.

The hurricane center apparently passed over the City of Ponce. Several readings of barometers were made during the passage of the storm. At Guayama a reading of 27.80 was made on an aneroid barometer which has since been compared and found to read .20 inch too high; allowing for difference in elevation the reading of the instrument, corrected, was about 27.75 I was disposed at first to doubt this reading, but a report from the voluntary observer at Juana Diaz records a reading of 28.11 at 9.30 a. m. It thus appears that the center passed over the southern part of the island, and with such a barometric gradient its violence is not to be wondered at.

Reports from Ponce to date (August 16) show that already 500 bodies have been recovered, and it is thought that there are many yet to be found. In Humacao 60 persons were killed, and from every side come

reports of tremendous loss of life and destruction of property. The smaller fruits and vegetables are reported as utterly lost, and of these, with bananas, are the principal food of the inhabitants, it can be seen that possible famine stares the island in the face.

The Bureau has been much complimented on its warnings here. A gentleman from Guayama told me that the warning was received in good time at that place, and was the means of saving much life and property.

The observer at Juana Diaz reports that the rainfall from 6 a. m. of the 8th to the same hour on the 9th was 11.20 inches. This report agrees with those from Ponce, where the rainfall is said to have been torrential, many of the deaths at that place being the result of drowning.

Along the military road from Coamo desolation reigns on every side. But two houses were left standing at Aibonito, and 6 persons were reported dead at that place. But two houses were left standing between Coamo and Aibonito, and the road was blocked in many places by huge boulders which were blown and washed down from the cliffs which border the road. The celebrated baths at Coamo were utterly destroyed. As San Juan is built of brick and the houses have thick walls and flat roofs comparatively little damage was done in this city.

The following are extracts from reports received from the various Weather Bureau displaymen in Porto Rico.

Mayaguez.—The authorities and all masters of vessels in port notified. A number of vessels which were about to sail remained in port, and the information proved most valuable to them. The lowest barometer was reached at Mayaguez at 1:25 p. m. of the 8th. In my experience of tropical hurricanes this is the severest that has chastened the island, nor have the oldest men heard of the like before. In the city the damage to property is large, and from the country the news is appalling. One-fourth of the coffee crop only will be saved, the loss of cane was considerable, and crops of minor fruits, which are the sustenance of the poor, have disappeared. The loss of life is greater than ever before, houses with all the inmates being washed away by the floods.

Aguadilla.—The wind began blowing about 8 a. m. 8th and increased in force to about 1 p. m., when perfect stillness reigned up to about 2 p. m. After that the wind blew from the south, sometimes with tremendous velocity until 7 p. m., after which it slackened gradually. The loss of property in this district was considerable, but no lives were lost. The timely advice was very valuable to the inhabitants.

Ponce.—Hurricane order 11 a. m., 7th, came to hand on Playa of Ponce at 5 p. m. It was immediately posted in the most public place, advised numerous persons thereof, and also on that afternoon personally informed by writing the different vessels in port of the probable approach of the hurricane, and gave them the text of your telegram. The owners of boats, lighters, etc., availed themselves thereof in order to place craft out of all possible danger. I have been told of persons in the "pueblo" who availed themselves of the notice to place their families out of harm's way. The two flags, one above the other, were hoisted and kept flying during the hurricane until flood and heavy breakers from the sea washed the pole down.

Arroya.—Order to hoist hurricane signal received 3 p. m. of the 7th, and signals were immediately hoisted. The Spanish steamship *Alava*, 1,445 tons, left the harbor at once to take refuge in the Port of Jobos, and was followed by the schooner *Guillermo*, sloop *Maria Artan*, and British schooner *Brudenell*. All lighters and boats in the harbor were put out in places of supposed safety. At 5:30 a. m., 8th, barometer, 29.30, the hurricane began with such force that, not having instruments to gage the wind, I can only estimate to have been over 100 miles an hour. The barometer fell rapidly until 8 a. m., when it read 27.90, the wind blowing from the north all the time until about 8:30, when there was a lull of about one-quarter to a half hour, when the wind changed and came upon us with such terrific force from the south that it appeared that nothing could stand against it. As regards the damage and destruction it is so enormous that it is difficult to make an estimate. A very conservative estimate of the actual losses of the districts of Guayama, Arroya, Patillas, and Maunabo can be safely placed at \$1,000,000. Your advice was of great service to the shipping, as, although the coasters that went to Jobos were driven ashore on the mangrove swamps and also the schooner *Brudenell*, the steamship *Alava* was saved. The captain of the *Alava* states that with all anchors down and machinery working full speed ahead, he dragged for half a mile, went on a mud bank, and stuck there twelve hours. Owing to the timely warning no lives were lost among the shipping. All minor crops were completely lost.

Arecibo.—Hurricane signals were hoisted upon the receipt of telegram at 2 p. m., 7th. The authorities were notified and the news was spread as much as possible among the people. The flood of the three rivers, which by a common mouth, empty into the sea near this town, was such an enormous one that old people here have no recollection of anything to equal it. The loss of life and property is beyond an approximate estimate at the present time. Some give the number of the drowned and killed at 500 more or less, while others place the figure as being nearly 1,000. Almost all the peasantry houses and

huts in the plains, and higher up on the river sides, have been carried to sea or destroyed, while in the lower part of this town, which was several meters under water, the loss of property was immense, and most of the poor people were deprived of shelter. Crops sustained damage amounting to many hundred thousand dollars. The dam of the aqueduct, situated on the hills, broke, carrying away everything in its path. Thousands of cattle from the pasture lands in which the district abounded, as well as stock from the estates, has disappeared into the sea. Railroads and bridges were destroyed and ruin and desolation reign supreme.

Fujardo.—The flags were not hoisted, as I was out of the city, but the warnings prevented damage of importance, as word was immediately sent to all plantations to prepare for an emergency. Two schooners in port took convenient positions and were saved. One of them was to sail on that day, and the warning kept her from sailing. No lives were lost in this district, but the damage to property was material and crops were ruined. I can say that good service was rendered by the Weather Bureau on this occasion.

Humacao.—The signal was hoisted and was well justified. The hardest wind came from the southeast, very little from the south. The estimated loss of property is \$1,000,000; loss of life nearly eighty, though the count is not accurately kept, as many of the dead were buried in the place where the loss of life occurred. A schooner was warned and cleared for Jobos. A tidal wave came in and destroyed almost all houses in this port. A large vessel, the *Monroe*, of New York, was driven ashore. The display was of little benefit, because during the last twenty-three years we have been warned of storms that never arrived, and the people believed this would be the case this year. It also happens that this hurricane was the strongest we have ever had, and all precautions would have been useless.

Santo Domingo, West Indies, Louis Dorman, Observer, Weather Bureau:

Ample warning of the approach of the hurricane was received here, the flags being hoisted at 5 p. m., August 7, while the storm was not felt here until 5 a. m., August 9. Four schooners, two Dominican men-of-war, and the U. S. S. *New Orleans* were anchored off Santo Domingo. The schooners were towed into the river, a safe harbor; the Dominican men-of-war sailed for Cardenas, a safe refuge harbor, 30 miles southwest of here, and Captain Longnecker, of the *New Orleans*, finding that his ship drew too much water to enter here, took a southerly course after having been notified by this office of the probable track of the storm. The observer also sent a message to the Commander of the U. S. S. *Machias*, then anchored off Macoris, 40 miles east of here, and he also took a southward course. The displaymen at Macoris, Sanchez, Samana, Puerto Plata, and Monte Christo were promptly notified by telegraph to hoist signals immediately. The S. S. *American Carib*, of the Clyde Line, which arrived at Macoris the evening of the 7th, was also warned by the display of the storm flags, and, after receiving further information from the displaymen, also sailed southward. The information regarding the storm was thoroughly distributed in the city during the afternoon and evening of the 7th, and, owing to the precautions taken, no casualties occurred and no vessels were lost. It is believed that the northeast coast of the island suffered more than the southern. The greatest wind velocity recorded here was 35 miles an hour, from the south, at 3:45 p. m. of the 9th.

The storm was accompanied by excessive rains, both in the interior and on the coast. The Ozama River rose very high, causing a freshet, during which one-half of the iron bridge spanning the river in this city was carried away. Much damage was caused in the San Christobal district along the banks of the Heina River, 30 miles northeast of here. Many houses were washed away by the overflow of the river, but no particulars can as yet be obtained. The entire city is loud in its praises of the timely warning of the hurricane.

Nassau, Bahamas, Thomas J. McLain, United States Consul:

The storm began at Nassau about 4 p. m. on Friday, the 11th, and ended late in the afternoon of Saturday.

Warning of its approach had been given per cable of the Weather Bureau at Washington, so that the storm was expected and preparations were made for its arrival, which lessened the amount of damage done very materially.

The wind commenced from the northeast and hauled gradually around to the south, the center of the storm passing about 30 miles west of New Providence. The velocity of the wind at one time reached 90 miles an hour and the barometer registered at its lowest 29.10 inches.

The hurricane was the same that swept over Porto Rico and traversed these islands from southeast to northwest. It struck six or eight islands, doing at all of them great damage in the way of blowing down or unroofing houses, destroying crops, uprooting fruit orchards, and wrecking or injuring vessels. The loss of life has been considerable, and further advices from the more distant islands are awaited with much anxiety. In this island the loss is quite severe. There were about fifty vessels in port, mostly small fishing and sponging craft, at least one-half of which were torn from their moorings and dashed against the rocky shores of the islands or were sunken at their anchorages. The only

American vessel in port was the S. S. *Cocoa*, of St. Augustine, which moved high up the harbor, kept up steam, and rode out the gale in safety. The British S. S. *Richmond*, belonging to the Imperial Light-House Service, was also in port and escaped injury. The steam tug *Nassau*, formerly tender for Ward's New York and Cuba Line of steamers, broke her moorings, drifted down the harbor, and was wrecked on the reefs west of the city. Two steam yachts drifted over the bar out to sea and have not been heard of since.

On shore the damage was considerable. A large fruit-preserving factory, a big sponge warehouse, a music hall, a dancing pavilion, and about one hundred smaller buildings being blown down. Some damage was done to the roofs of the public buildings, and the contents of the Government House were damaged by water. A general look of desolation and destruction pervaded the entire city. It is already known that at least one hundred lives were lost, mostly fishermen and spongers, and it is expected that the number will be increased when news comes from the outlying islands.

Vigorous steps have already been taken by the colonial authorities to relieve the suffering caused in this vicinity among the poor.

The only disaster to American shipping thus far reported is that of the S. S. *Winifred*, of New York, bound from New York to New Orleans with a general cargo, which was towed into this port on the 18th instant with a loss of funnel and many other damages. She will in all probability be towed to her destination, as proper repairs can not be made here.

P. H. Burns, Superintendent of Bahamas Cable, Nassau:

The scattered position of our islands, slow means of communication, and a tendency to exaggerate make it difficult to obtain accurate information. The following data, though not strictly accurate, may be as close as we can ever get to it.

Number of small craft lost, 50. A few of these, including two steam launches, were swept out of Nassau harbor by the east wind; others were lost on Exuma Cays, some on Berry islands, but a majority on the sponge beds on both sides of Andros Island. The value of these craft was about \$50,000. The damage to house property in Nassau was about \$5,000. Estimated saving in Nassau harbor by timely warnings about \$7,500. The other islands can get no warnings except from the barometer, which, in this storm fell very slowly and gave but slight warning. The center of the storm passed between Nassau and Green Cay, a point 60 miles south, striking the settlement of Red Bays on Andros Island. Northeast wind did some damage there, backed to northwest, and fell dead calm. People came out to gather their scattered effects when the wind came from the southwest with great force, bringing in heavy seas which caused great damage. The storm was severe at Bimini, where a few houses were destroyed. At Grand Bahama the storm was stronger than at Bimini and a few lives were lost. Conservative estimates place the total loss of life at 125, probably 100 occurring at Red Bays. A few sponge vessels are missing which may swell the totals given.

Jupiter, Fla., J. W. Cronk, Observer, Weather Bureau:

The most notable feature connected with the approach of this hurricane was the almost total lack of the so-called usual premonitory signs. The sky took on no brilliant or brickdust colored hues, and did not bank up with masses of threatening clouds. The sea remained light up to the time of the increase of wind with but little swell, and no moaning sounds. The tide was not high, and there was but little thunder and lightning during the passage of the storm. Without warning from the Central Office, or other telegraphic information, the storm would have found this section almost totally unprepared, and, as a consequence, it would have been particularly destructive to life and property.

On the 10th, Nassau, New Providence, Bahamas, was given, as directed by the Central Office, advisory message as to probable visitation of hurricane, in response to a request of the Governor of the Bahamas for information; all other information received was also given Nassau.

Not until the 12th was the approach of the hurricane toward Jupiter indicated by falling barometer, increasing wind, and rising sea and tide at that station, although the entire population was on the alert owing to the hurricane warnings issued on the 11th. The wind increased to high in the early morning and to a gale by midnight, with maximum velocity, on this date, 41 miles from the northeast, at 10:45 p. m. In the early morning of the 13th the hurricane struck Jupiter with great force and continued blowing a gale during the day, with wind shifting to north, northwest, west, and southwest; maximum velocity 52 miles an hour from the north at 6:20 a. m. with an extreme velocity of 63 miles. At 11:30 a. m. 51 miles an hour was registered. Heavy rain fell in the morning and light rain in the afternoon. The barometer fell rapidly until shortly before 8 a. m., and then remained nearly stationary until shortly before noon, when it began to rise steadily. At 8 a. m. the barometer read 29.22, which was within .04 of the lowest recorded reading at this station. All telegraph lines went down, and no telegraphic communication was to be had until the afternoon of the 14th.

Never in the observers experience were more timely or better warnings given the public, and great praise is freely tendered the Weather Bureau for its work. The benefits derived have to be roughly estimated, but the value of property saved by the warnings in the coast section between Titusville and Miami will reach \$30,000, or more, principally in boats of small size. Property that it was impracticable to protect to the value of about \$5,000 was destroyed in this section. No lives are known to have been lost.

Charleston, S. C., L. N. Jesunofsky, Observer, Weather Bureau:

Not a casualty occurred along the coast of South Carolina during the passage of the hurricane center at close range on the 15th and 16th, which may be attributed to the timely hoists of the hurricane signal, which caused vessels to seek safe harborage. Fortunately the storm tides along the coast reached only 2.8 feet above normal, and the rice and sea-island cotton crops escaped injury. Much rice would have been spoiled if timely warnings had not been given.

All available means were taken to disseminate the hurricane warnings, and it can be safely said that they were the most successful warnings of the year, in that the time which elapsed between the hoist and the beginning of the gale gave mariners and business interests along the south Atlantic coast more than ample time in which to prepare for the dreaded visitor.

Nine steamers, 3 barks, 4 brigs, 26 schooners, and many smaller craft were detained in port; the crews and passengers numbered 319, and the vessels and cargoes were valued at \$2,110,000.

Hatteras, N. C., S. L. Doshier, Observer, Weather Bureau:

The wind began blowing a gale from the east the morning of the 16th, varying in velocity from 36 to 50 miles an hour, and gradually shifting to northeast by 6 p. m., with nearly stationary pressure. During the early morning of the 17th the wind increased to a hurricane and at 4 a. m. was blowing at the rate of 70 miles an hour; 10 a. m. it had increased to 84 miles; and at 1 p. m. it was blowing 93 miles an hour, with occasional extreme velocity of 120 to 140 miles an hour. The record of wind after about 1 p. m. was lost, but it is estimated that it blew with even greater force from about 3 p. m. to 7 p. m., and it is believed that between these hours the wind reached a regular velocity of at least 100 miles an hour. The barometer began to fall rapidly about 8 a. m. of the 17th, and 8 p. m. of that date it had reached the unprecedentedly low reading of 28.620 inches, where it remained about an hour, when it began to rise rapidly, and by midnight it had risen nearly one-half inch. From 7:30 to 8 p. m. of the 17th there was a lull in the gale when it veered to southeast and begun to blow at an estimated velocity of 60 to 70 miles, which continued until well into the morning of the 18th.

This hurricane was the most severe in the history of Hatteras. The scene on the 17th was wild and terrific. By 8 a. m. the entire island was covered by water from the Sound, and by 11 a. m. all the land was covered to a depth of from 4 to 10 feet. This tide swept over the island at a fearful rate carrying everything movable before it. There were not more than four houses on the island in which the tide did not rise to a depth of 1 to 4 feet, at least half the people had to abandon their homes and seek safety with those who were fortunate enough to live on the higher grounds. The frightened people were crowded 40 or 50 in a house. All this day the gale, the tide, and the sea continued with unabated fury. During the lull in the evening the tide ran off with great swiftness, causing a fall in the water of several feet in less than half an hour. Domestic stock was drowned, and it is believed that the property loss to Hatteras alone will amount to \$15,000 or \$20,000. The fishing industry has, for a time, been swept out of existence, and of the 13 fish-packing houses, which were situated on the water front, 10 with all their equipments and contents were lost. A great proportion of the houses on the island were badly damaged and many families are without homes. All bridges are swept away and roadways are piled high with wreckage. All telegraph and telephone lines are down.

The following vessels are known to be lost between Hatteras and Big Kinnakeet:

A large steamship foundered about one mile off Hatteras beach the night of the 17th, and it is thought all on board were drowned. From the marks on some of the wreckage which drifted ashore it is supposed her name was the *Agnès* and that she was German or Norwegian. She was loaded with cotton and staves, a portion of which cargo drifted on the beach. The Diamond Shoals Light Ship which was stationed off Hatteras broke loose from her moorings the morning of the 17th and was carried southward by the gale; when the wind shifted to the southeast she was carried ashore near Creeds Hill Life-Saving Station, where she now lies high on the beach. The crew was saved by the Creeds Hill life-saving crew. The three-masted schooner *Florence Randall* went ashore 1 mile north of Big Kinnakeet Life-Saving Station the night of the 16th. The crew was saved by the Kinnakeet life-saving crew. The schooner will be a total loss. The damage to the instruments and property of the Weather Bureau office was considerable, the anemometer being carried away before the storm attained its maximum

strength, and the rain gage was swept away the early morning of the 17th.

The people of this locality had ample warning of this storm, yet such preparations as could be made were of little avail in a storm of this character. All of the stores, warehouses, and other buildings in which property is stored for safe keeping are situated along the water front, and in this case they were either flooded or swept away. No lives were lost at Hatteras, although there were many narrow escapes. At Ocracoke and Portsmouth, 16 and 20 miles south of this station, the storm was about as severe as at Hatteras; reliable details are, however, lacking.

The foregoing reports show that maritime and commercial interests have been lavish in commendatory utterances regarding the value of the Weather Bureau warnings and advices issued in connection with this hurricane. The Bureau of Navigation, United States Navy Department, has acknowledged the prompt and valuable telephone and telegraphic notices of the hurricane, whereby action calculated to provide against damage or disaster to vessels of the United States Navy could be taken, and the press of the United States and the West Indies has given full credit for the accurate and invaluable forecasts and reports that were furnished for the information and benefit of the public.

THE CARABELLE, FLA., STORM OF AUGUST 1-2, 1899.

The following is the substance of a report by Mr. A. J. Mitchell, Observer and Section Director, Weather Bureau, on a storm which visited a small part of western Florida on the 1st and 2d of August, 1899:

At Carabelle, Fla., over which the center of the storm doubtless passed, the wind was fresh to brisk from the northeast on July 31, and increased gradually until sunrise of August 1, when the gale was furious. About noon of the same day almost a calm prevailed. Within a short time the wind increased to a furious gale from the west, which continued until nearly sundown, the wind gradually diminishing with a west backing to south direction. At 3 a. m. of the 2d a severe thunderstorm with torrential rain, occurred.

The diameter of the storm was not more than 40 miles, and its force was spent before it progressed 50 miles inland.

Great damage befell the town of Carabelle, where not more than a score of unimportant houses withstood the storm. The result to shipping was disastrous. The following vessels, most of them loaded, were wrecked: 14 barks, 40 small boats under twenty tons, and 3 pilot boats. The value of the vessels and cargoes lost was \$375,000. Carabelle was damaged to the extent of \$100,000, other towns to the extent of \$50,000, and crops were destroyed to the value of \$50,000. The number of persons drowned and killed was 6.

This storm was purely local in character, and could not, therefore, be made the subject of a specific forecast. The weather conditions were somewhat threatening July 30 and 31, and on the 30th an advisory message, stating the likelihood of strong winds, was sent to all stations on the Florida Peninsula. The displayman at Cedar Keys, Fla., reports that "40 vessels, coasting schooners, and spongers were detained in port by the warning, and but for this information of the storm they would have sailed and some would have been lost."

MONTHLY WEATHER REVIEW.

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No. 9

FORECASTS AND WARNINGS.

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

During the last two days of August, 1899, a West Indian disturbance of moderate strength moved from the vicinity of Dominica and Martinique west-northwest toward the Island of Santo Domingo and on the morning of September 1 was apparently central near Port au Prince, Haiti. During September 1 and 2 the center of this disturbance recurred northward over Haiti, and moving thence northeastward passed near the Bermuda Islands during the 4th.

On the morning of the 8th a storm of pronounced energy appeared east of the Island of St. Kitts, from which position it moved northwestward until the 10th, when it began to re-curve to the northward. During the 11th and 12th the re-curve changed to the northwestward and the storm passed over the Bermuda Islands during the night of the 12-13th. This storm was quite severe over the more eastern islands of the Leeward group of the Lesser Antilles during the evening and night of the 8th, and also over the Bermuda Islands during the night of the 12th.

The action taken by the Weather Bureau in giving warnings of the tropical storms above referred to is indicated in the more detailed descriptions of the storms which follow.

The most important storm of the month in the Lake region occurred on the 24th when wind velocities of 40 to 50 miles an hour were reported at a number of lake stations. A second storm of notable strength crossed the Great Lakes during the night of the 27th and the day of the 28th. The

advice and warnings issued in connection with these storms were ample and timely.

The first killing frost of the season occurred in the Dakotas, western Minnesota, and Wyoming on the morning of the 28th, in Nebraska, northern Kansas, eastern Minnesota, western Wisconsin, and Iowa on the morning of the 29th, with light frost as far south as northern Arkansas, and on the morning of the 30th killing frost was reported generally in the Lake region and the middle and lower Ohio Valley, heavy frost was noted at Memphis, and light frost in central and eastern parts of Tennessee. Ample warnings were issued in connection with the frosts referred to.

In the Pacific coast districts the weather of the month was not marked by specially notable features.

THE WEST INDIAN DISTURBANCE OF AUGUST 29- SEPTEMBER 4, 1899.

This disturbance was of moderate strength throughout a course which lay from a point east of Guadaloupe to a position south of Santo Domingo from the 29th to the 31st of August, thence northwest and north over western Haiti, and thence northeastward to the vicinity of the Bermuda Islands by September 4. Shipping and other interests were advised of the approach and character of this disturbance and pre-

cautions which were justified by reports were recommended. Observations taken on the U. S. Transport *Kilpatrick* on September 3, when in about latitude north 25°, longitude west 68° 35', show that hurricane winds were encountered in that position. It appears, therefore, that while the storm possessed but moderate intensity over the Caribbean Sea, Santo Domingo, and Haiti it acquired great strength after its re-curve northward and northeastward over the ocean.

THE WEST INDIAN HURRICANE OF SEPTEMBER 8-13, 1899.

The center of this hurricane did not reach any of the islands of the West Indies, and the winds of its west quadrants were severely felt only over the outlying Leeward Islands of the Lesser Antilles.

On September 7 the Central Office of the Weather Bureau at Washington advised its observers in the eastern West Indies that conditions were threatening over the Lesser Antilles, and to be alert to take local action if necessary. The morning of the 8th the approach of a severe storm from the eastward of St. Kitts was indicated, and hurricane signals were ordered on that island, and advisory messages were telegraphed to all other observers in the threatened district. It was calculated at that time that the hurricane would reach only the extreme northeast islands, and subsequent events show that this was a correct calculation. At St. Kitts the wind reached a velocity of 62 miles an hour at 8:18 p. m. of the 8th, and an extreme velocity for one minute of 120 miles an hour was recorded at 5:51 p. m. The islands to the east and northeast of St. Kitts experienced correspondingly severe winds, and reports from vessels show that the violence of the hurricane did not lessen during its subsequent northwest, north, and northeast course over the ocean. During the night of the 12-13th the hurricane center passed over or very near the Bermuda Islands, causing considerable damage in that group.

The following reports are descriptive of the hurricane and indicate the character of the action taken by the Weather Bureau in issuing warnings of its approach:

Basseterre, St. Kitts, W. I., W. H. Alexander, Observer, Weather Bureau:

The day preceding the hurricane was marked by considerable haze, a red sunset, low barometer, and a clear, smooth sea. The night preceding the hurricane a close watch was kept on the weather, and at 5 a. m., local time, a precautionary warning was issued quickly and thoroughly by telephone, and the information was telegraphed to the United States Consul at Antigua, which is about 60 miles east from St. Kitts. At 11:41 a. m. an order to hoist the hurricane signal was received from Washington. The storm began at 3:40 p. m., nearly ten hours after the first warning was issued, and three hours after the actual display of the signals. There was neither thunder nor lightning during the storm. The total rainfall was 3.13 inches, the heaviest fall occurring during the first two hours of the storm. The variations in temperature were very slight, and the clouds, though rapid in motion, did not present such a confusion and whirling as characterized the clouds during the storm of August 7, 1899. (The maximum wind velocities are given in a table on another page of this REVIEW). The lowest barometer, 29.506, was reached at 5 p. m. on the 8th.

This hurricane, as compared with that of August 7, was slightly less intense, and far less disastrous, owing, no doubt, to the fact that only the strong trees and buildings were left, and these were able to successfully resist the attacks of the weaker storm. Otherwise there would have been very much the same story to tell. A few small huts were destroyed, rendering about 200 people homeless; two schooners, with cargoes, total value \$25,000, wrecked; one small boat, valued at \$240, wrecked, and cane crop badly damaged. The neighboring islands to the east suffered about the same as St. Kitts, except the little island of Anguilla, where as many as 200 houses were demolished and 800 people were rendered homeless. The steamship *Caracas*, of the Red D Line, met the storm 400 miles north of Porto Rico, and experienced its fury from midnight on Saturday until Monday morning. In about the same region the schooner *Isaac Newton* was dismasted and waterlogged on Sunday, the 10th. The crew of this schooner, when rescued

on the 13th by the steamship *Fontabelle*, were standing in water waist deep, and had been without food and fresh water for three days. They report the occurrence, during the hurricane, of a severe hailstorm, lasting about half an hour, and producing intense cold. The hailstones were very large, and fell with great force. The steamship *Fontabelle* encountered the hurricane at midnight the 11th, in latitude 29° 20' N. and longitude 68° 20' W. From 2 to 8:30 a. m. of the 12th the wind blew at an estimated velocity of 90 miles per hour, first from east-southeast, then backing to east-northeast, after which, with diminished force, it backed to southwest. Heavy rain fell from 1:30 a. m. to 4:30 a. m. The lowest pressure noted was 28.40 inches. The Captain reports the loss of a large quantity of deck cargo and live stock, also that the storm was intensely severe, and that the escape of the vessel from damage was remarkable.

On the morning of the 9th the following message was sent to the central office of the Canadian Meteorological Service at Toronto, through which reports from Bermuda are transmitted to this Bureau:

Hurricane central northeast of Porto Rico, moving northwest, and is likely to pass near Bermuda.

Similar messages were at the same time sent to the New York and Philadelphia Maritime Exchanges and to the Press Associations. The hurricane reached Bermuda the night of the 12th; hence the message above quoted gave warning of the storm three days in advance of its arrival.

The following, which shows the violent nature of this hurricane during its passage over or near the Bermuda Islands, is furnished by the Associated Press:

Island of Bermuda, September 13.—A hurricane swept over this island last night. Many houses were blown down and others were unroofed. The storm raged during all of last night. No lives were lost, but heavy damage was done to public and private property, fruit and cedar trees. The causeway was wrecked and the government house was damaged.

The weather looked threatening early Tuesday morning, with a falling barometer. The storm began with heavy rain at 2 p. m., after which there was a slight lull for a few hours, with the wind south-southeast and the barometer steadily falling. The wind suddenly backed to east, blowing with cyclonic gusts. From 8 p. m. to midnight it blew with hurricane force and was at its worst from 1 a. m. to 1:45 this morning, when, after a lull, the wind changed to the south west, when the principal damage was done. Giant cedars were uprooted, ornamental and fruit trees were destroyed, and wharfs were washed into the sea. All communication with St. Georges was cut off and news from the western end of the island and the dockyard is not procurable at present. The telephone and telegraph poles and wires are down, causing a total interruption of business.

There has been considerable damage at the military camp. The city hall, public gardens and hotels, and several public and private dwellings were also damaged, and numerous small craft in the harbors were sunk or driven ashore. The British steamer *Duart Castle*, Captain Seeley, from Halifax, September 8, for the Windward Islands and Demarara, was to have left port at 4 p. m. yesterday, but the storm delayed her sailing.

Cedar avenue was practically ruined, many of its trees being prostrated, and others are badly injured. The storm was the worst known here since the hurricane of 1880; in fact, many of the inhabitants say it exceeded that of 1880 in violence. The weather now is moderating and the barometer is rising. It is rumored that damage amounting to £100,000 has been done at the dockyard alone.

On Ireland and Boaz Islands everything is more or less injured. The damage is roughly estimated at £100,000. At Somerset all the boats and small craft were destroyed, trees demolished, and houses unslated and otherwise damaged. At Prospect Camp the damage is estimated at £3,000.

More than half a mile of the causeway connecting the mainland with St. Georges is totally destroyed. It will cost £13,000 to repair it. News from St. Georges, received by a whaleboat, says serious damage has been done there to trees, houses, etc. All the boats have been destroyed or badly injured.

Reports from outlying parishes are slowly coming in. They all show that there has been great destruction of trees and serious injury to houses and other property. From what can be learned here there has been no loss of life. It is a curious coincidence that the great gale of 1839 occurred on September 11 and 12 and this one was on September 12 and 13. No correct estimate of the amount of damage to private property can at present be obtained, but it will be fully £100,000.

From press reports received it appears that this hurricane advanced from Bermuda to the vicinity of the Newfoundland coast, where on the night of the 14th violent gales occurred which caused considerable damage to fishing craft and the loss of four lives.

MONTHLY WEATHER REVIEW.

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No. 10

FORECASTS AND WARNINGS.

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

The most important storm of October, 1899, advanced from the west part of the Caribbean Sea along the Atlantic coast of the United States from the 28th to the 31st. For several days preceding the 28th unsettled weather had prevailed over the Greater Antilles and the western Caribbean Sea, and a marked barometric gradient between that region and an area of high barometer over the southeastern part of the United States caused high northeasterly winds over southern Florida, western Cuba, and adjacent waters. During this period Gulf and Atlantic coast shipping interests were advised of the conditions which prevailed, and careful watch was kept for a storm development which, at this season, these conditions favored. The evening reports of the 27th showed the looked-for storm development south of central Cuba, and storm signals were ordered at Key West and Miami, Fla., with the information that the center of the disturbance would probably move northwestward during the next twenty-four hours and cause high northeast winds over southern Florida and western Cuba. Similar advices were telegraphed to all Florida ports. During the 28th the storm signals were extended along the Atlantic coast to Jupiter, Fla., and the Bureau of Navigation, Navy Department, the Philadelphia and New York Maritime Exchanges, and Atlantic and eastern Gulf shipping interests, and also the Colonial Government of the Bahamas, were advised that the Caribbean Sea disturbance was approaching the south coast of central Cuba and that dangerous northeast

gales were indicated for the southern Florida and west Cuban coasts, and southeast gales for the east Cuban coasts. The morning of the 29th south Atlantic and east Gulf ports were notified that the storm was moving northward over central Cuba, and in the evening of that day storm signals were ordered as far north as Norfolk, Va., with the information that the storm had advanced to a position east of Key West, Fla., and that during the following day northeast gales would prevail from Virginia southward, and that northeast gales would shift to northwest over the Florida Peninsula. During the 30th the center of disturbance moved northward, and in the evening was central off the Carolina coast. On the morning of the 30th the display of storm signals was extended to Sandy Hook, N. J., and advisory messages regarding the character and course of the storm were sent northward to Boston, Mass. The morning reports of the 31st showed a marked increase in the intensity of this storm, and coast interests along the middle Atlantic and south New England coasts were notified that dangerous northeast gales might be expected. During the northward passage of this storm severe gales were encountered along the south and middle Atlantic and south New England coasts.

In Cuba and Jamaica the feature of the storm was the exceptionally heavy rainfall. In Florida, Georgia, and South Carolina no special damage was caused, although dangerous gales prevailed off the coasts. At Charleston, S. C., the wind

reached a velocity of 58 miles an hour from the northwest at 10:05 p. m. of the 30th. The night of the 30th the storm was one of the severest on record along the North Carolina coast near Wilmington, and an enormous amount of damage was caused by exceptionally heavy seas and high tides. The total loss of property in that section was placed at a quarter of a million dollars. A number of coasting vessels were lost, and the steamer *Catherine Whiting* was wrecked on Goss Beach, Brunswick County. The value of sailing vessels and their cargoes, which were lost along the North Carolina coast, was placed at \$144,000. The ravages of the storm along the Virginia coast the night of the 30th, and during the 31st represented losses of thousands of dollars. The tide was the highest noted in years, and the high wind caused the water to overflow lowlands. At Cape Henry the wind reached a velocity of 60 miles an hour from the northeast at 6:55 p. m. of the 30th. On the New Jersey coast thousands of dollars worth of fishing property was saved by fishermen who profited by the Weather Bureau warnings, and nets to the value of thousands of dollars were lost by fishermen who did not heed the warnings. Severe gales were reported at the more exposed points along the south New England coast, but as shipping had been warned more than twenty-four hours before the storm arrived no damage was caused.

The break in the period of unseasonable high temperature over the interior of the country was accurately covered by forecasts from the 24th to the 27th.

Warnings of the beginning and ending of the first autumnal rains in California were of great value to raisin growers, fruit driers, and shipping interests.

Ample warnings were sent of the first heavy frosts of the season to the various sections which were visited by heavy frost.

On the 14th and 15th an exceptionally severe snowstorm for the season visited the foothills of the main range of the Rocky Mountains in northern Montana, causing the death of a number of men and the loss of several thousand sheep.

HAVANA FORECAST DISTRICT.

From the 22d to the morning of the 30th unusually stormy weather prevailed over Cuba, Jamaica, and the western Caribbean Sea. The only serious damage done by the storm was the sinking of the small schooner *Helén E. Russell*, and the loss of four lives at 4 a. m. of the 23d, 8 miles northwest of Juraco; the following is extracted from local newspapers:

Evening of 28th 13 houses blown down and tobacco seed plants and banana plants destroyed; night of 28th considerable damage done by inundation of a portion of Camajuani and the blowing down of several houses at Sancti Spiritus; damage and loss of one life at Santiago, and damage by the overflowing of the Canti River.

All necessary action was taken to acquaint commercial and shipping and other interests of the development, character, and course of this storm.—*W. B. Stockman, Forecast Official.*

THE PORTO RICAN HURRICANE OF 1899.

By C. O. PAULLIN, Nautical Expert, United States Hydrographic Office.

Soon after the occurrence of the Porto Rican hurricane of 1899, the United States Weather Bureau published a complete account of the passage of this storm through the West Indies and along the American coast. The daily maps of conditions over the Atlantic Ocean, compiled by the United States Hydrographic Office from the reports of its voluntary observers, make it possible to furnish some additional information of exceptional interest to meteorologists concerning this storm, both previous and subsequent to the period of its history covered by the Weather Bureau.

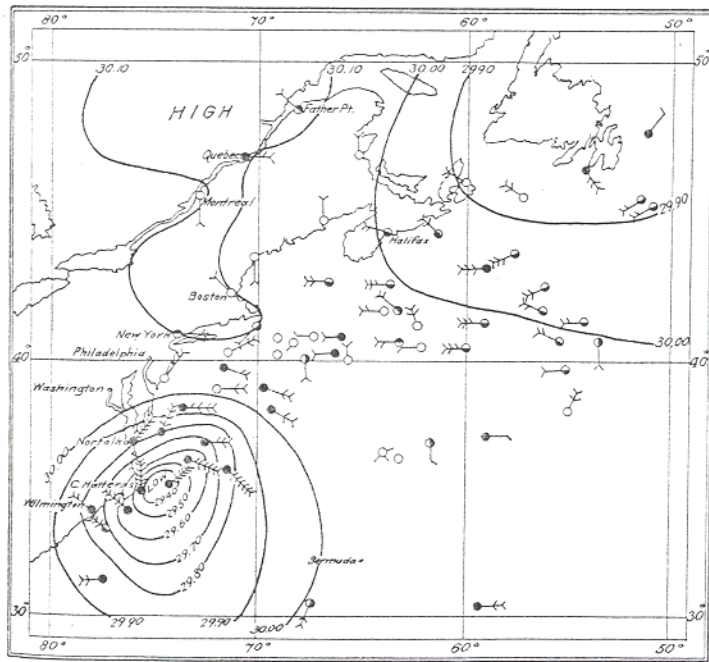


FIG. 13.—Greenwich noon, August 17, 1899.

The tropical storms of the North Atlantic generally originate to the eastward of the Lesser Antilles within the belt of calms which covers the ocean from latitude 5° to 15° north. Owing to the scarcity of observing vessels in this part of the Atlantic, and the relatively small area which the hurricane

here attains, reports of these storms to the eastward of the fiftieth meridian are seldom received. Information concerning tropical storms at or near their place of origin is, consequently, almost wholly lacking, and much interest attaches to the report of the British steamship *Grangense*, which vessel encountered the late hurricane 1,800 miles east by south of the Island of Guadeloupe. The *Grangense* passed through the center of the storm and took very careful and complete observations, warranting the publication of her log in full, as follows:

At noon of August 3, when in latitude 11° 51' north, longitude 35° 42' west, we experienced a sudden change in the weather, which, being most unusual in this part of the world, is worthy of note. Early in the afternoon the barometer began slowly to fall from 29.93 inches. At 2 p. m. it stood 29.73, the sky becoming overcast with cumulo-nimbus clouds and the wind freshening to a moderate gale from north-northwest. At 4 p. m. the barometer read 29.53 inches, the wind remaining from the same direction with force increased to a fresh gale, accompanied with heavy rain. At 5 p. m. the barometer reached its lowest reading, 29.38 inches, while the wind fell calm and the rain ceased; very heavy nimbus clouds traveled overhead at a high speed from the southwest and a high, short, and dangerous sea from the northeast, caused the ship to pitch heavily and made it necessary to let her head fall off to the east in order to make headway, the ship being very light. At 6:30 p. m. a light breeze came out of the south-southwest and the barometer rose to 29.43 inches, clearly indicating that the center had passed. At 7 p. m. the wind increased to a strong south-southwest gale, with excessive rain beating down the northeast sea and enabling us to return to our course, northeast one-quarter east. At 8 p. m. the barometer stood at 29.58 inches, with a moderate gale hauling gradually southward. After two heavy squalls at 10 p. m. the weather cleared; barometer 29.73 inches, steadily rising; sea coming up from south-southeast; sky clearing and stars shining out again; strong breeze hauling to east. And so finished this little storm which showed all the symptoms of a genuine West Indian hurricane undeveloped, with the exception of the sea in the vortex, which, instead of being confused, came almost suddenly from the northeast, and remained from that quarter until the wind and sea from the receding semicircle overwhelmed it. Captain Spedding, who has been in this particular trade, from Europe to the river Amazon, for many years, and many others on board who have been long acquainted with these regions, say they have never experienced any weather of a cyclonic character so far to the eastward before.

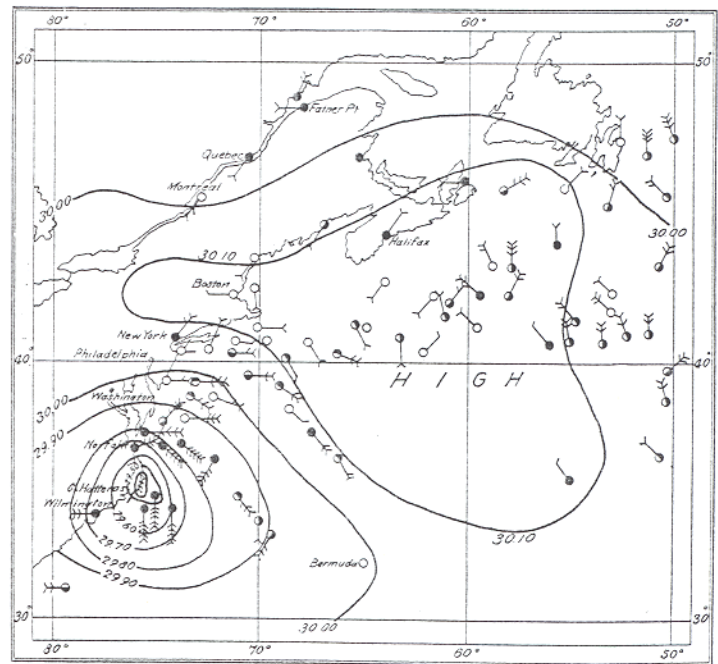


FIG. 14.—Greenwich noon, August 18, 1899.

From the foregoing log it appears that when the *Grangense* encountered the hurricane its development was not complete. The exceedingly low barometer which characterizes the tropical storm in its maturity was lacking, and neither the winds nor the sea had as yet attained dangerous violence. At the same time, according to the above account, this storm

"showed all the symptoms of a genuine West Indian hurricane undeveloped." There was a well defined storm area, with low barometer and calm center, and a complete cyclonic circulation of the winds, together with heavy rainfall. Four days later, when the hurricane reached Montserrat, the area of the storm had increased; the barometer was almost two inches lower, having fallen to 27.45 inches; the winds blew with hurricane force, causing immense damage and loss of life, and the rainfall was excessive. The storm which the *Grangense* encountered in its infancy had become the fully developed hurricane whose destructiveness will make it ever memorable in the annals of Porto Rico.

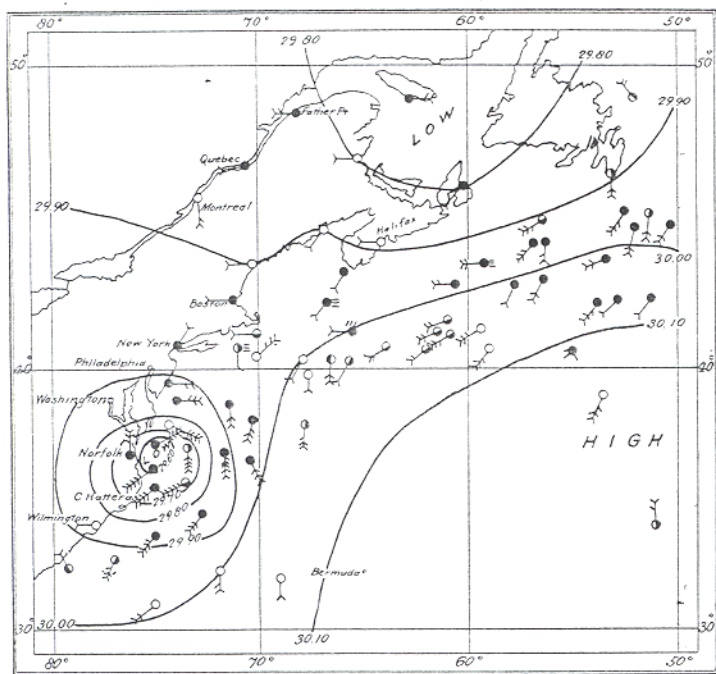


FIG. 15.—Greenwich noon, August 19, 1899.

The place of origin of this storm is as yet undetermined. The stage of development which it had reached on August 3, however, indicates that it originated as far eastward, at least, as the longitude of the Cape Verde Islands.

The hurricanes of the West Indies have been observed since the discovery of America, and lists of these storms covering the last four hundred years have been tabulated. It was not, however, until the present century that Redfield (and especially the international work since 1873,) collated sufficient observations to enable us to trace these hurricanes and ascertain approximately their life history. The period embraced between the birth of those tropical storms that originate to the east of the West Indies and their disappearance from the North Atlantic Ocean ranges from ten to twenty days, the average being less than fifteen days. Reference to the track of the late Porto Rican hurricane, which appears upon the accompanying chart, giving the positions of the center at successive Greenwich mean noons, shows that its length of life greatly exceeded that of any other whose records are sufficiently complete to justify a comparison and lasted almost three times the average period. From August 3, when the storm was encountered by the *Grangense*, until September 7, when it passed from the North Atlantic to the eastern coast of France, there is embraced a period of thirty-six days. This remarkable longevity has a close connection with the exceptional path of the hurricane and its slow velocity.

When the storm was reported by the *Grangense*, latitude $12^{\circ} 40'$ north, longitude 35° west, it was moving west by north. Its course gradually became more northerly, reaching a northwesterly direction in the Bahamas. Off the coast of Florida

the storm recurved and was moving northeasterly in the vicinity of South Carolina. From August 3-7 the hurricane had a velocity of 20 miles an hour, and from the Lesser Antilles to Porto Rico, 16 miles. Between Porto Rico and the storm's position off the Carolinas on the morning of August 16 its rate of movement was 9 miles an hour, having suffered the usual retardation due to the American coast. Up to this point the storm's velocity and course may be considered normal, and it was to be expected that it would continue in a northeasterly direction, greatly increase in velocity and area, and move rapidly over the Grand Banks, disappearing to the north of the fiftieth parallel. Instead, the storm changed its course to north by west, slowed down during August 16-19 to a rate of 3 miles an hour, and remained practically unchanged in area. The recurving of the hurricane brought its center near the shore in the neighborhood of Hatteras, causing, for this reason, greater damage here than elsewhere along the coast of the United States, being specially destructive to shipping. On August 19 the storm moved seaward with increased velocity and with a general easterly direction. During the week of August 24-30 it remained almost stationary near the forty-fifth meridian, the center on August 26-28 shifting westward and northward. To the east of the Azores the storm curved northeastward, bending to southward near the fifth meridian west. On September 9 it was central off the coast of Provence, France, gales prevailed in this region until September 12, on which date the storm apparently had united with an area of low barometer covering southeastern Europe.

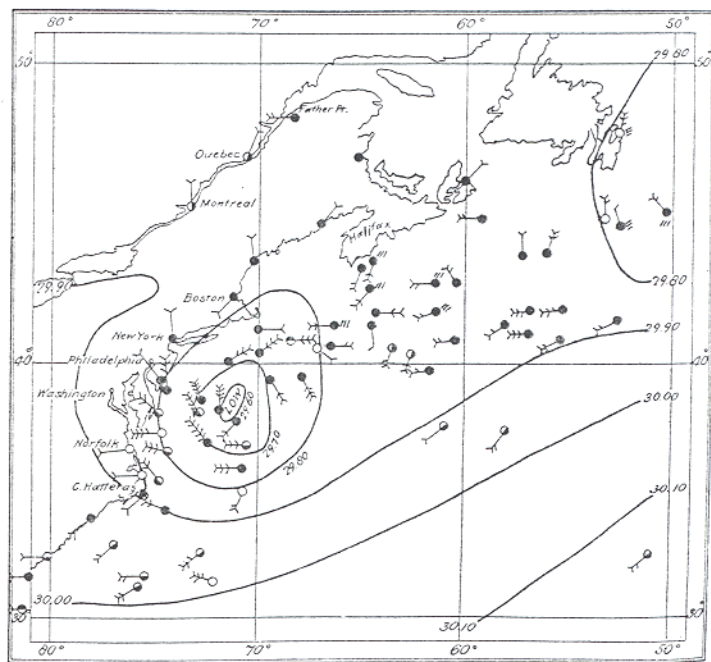


FIG. 16.—Greenwich noon, August 20, 1899.

Barometric readings below 29 inches and winds of hurricane force were frequently reported during the storm's passage through the West Indies and along the coast of the United States. Observations of the hurricane during its course in recrossing the Atlantic show a slight decrease in the violence of its winds and a diminution in the depth of the barometric depression, but one reading below 29 inches having been reported; however, whole gales and winds of storm force were still encountered. San Miguel, Azores, had a minimum barometric reading of 29.08 inches; the storm at this island caused much damage to property, besides with the reported loss of several lives. The log of the French steamship *Château Lafitte*, which vessel met the storm of September 6 in latitude 46° north, longitude 8° west, shows that on that date it

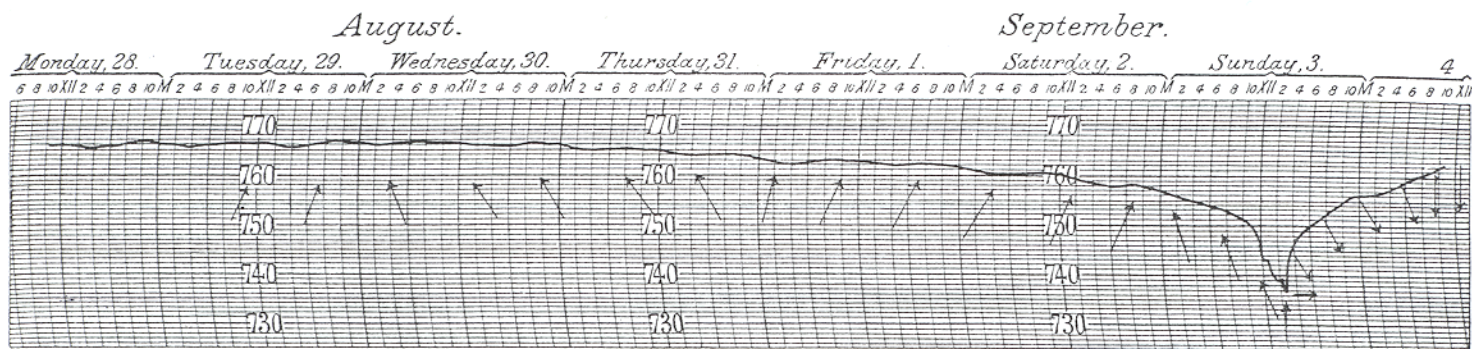


FIG. 17.

had lost but little of the severity which it exhibited within the Tropics. The *Château Lafitte* reports: "At noon the wind blew almost a hurricane from the southwest; sea very heavy from the same direction; barometer, 29.50 inches."

While the hurricane was central over the Lesser Antilles, the radius of the area within which the winds reached gale force was approximately 100 miles. Along the coast of the United States the radius had increased, ranging from 150 to 250 miles. In mid ocean the average radius was 200 miles, decreasing materially by the time the storm reached the coast of France.

The accompanying barogram, fig. 17, furnished the Hydrographic Office through the courtesy of Capt. F. A. Chaves, Director of the Meteorological Observatory at Ponta Delgada, San Miguel, Azores, shows the shifting of the wind and the movement of the barometer during the passage of the storm over that place. The barogram points to a still lower minimum for Ponta Delgada than the one given above. The storm apparently passed almost over this town, slightly to the northward.

The daily charts of Atlantic weather show that both off the coast of the Carolinas and between the fortieth and fiftieth

meridians, where the movement of the center of the storm was slow and irregular, areas of high barometer were present to the northward. The conditions of the wind and weather in the former case are shown by the accompanying synoptic charts for August 17-20. (See figs. 13, 14, 15, 16.) The observations on these charts were taken at noon, Greenwich mean time, which corresponds to 7 a. m., local time, on the seventy-fifth meridian. The general track is shown on Chart XIII.

On August 15 an area of high barometer covered the Great Lakes and Ontario with a maximum reading of 30.35 inches. The decrease in the rate of the storm's movement was coincident with the southeastward passage of this high, as is shown by the synoptic charts. On August 17 the position of the high is directly to the north of the storm area. On August 20 the high had decreased in height and moved to the eastward of the fiftieth meridian; the storm had moved off the American coast and increased in velocity.

In these charts the isobars are drawn for every tenth of an inch apart. The following symbols are used: ☉, clouds not given; ☼, variable winds, force 2.