

MONTHLY WEATHER REVIEW.

Editor: Prof. CLEVELAND ABBE.

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No. 8

FORECASTS AND WARNINGS.

By Prof. F. H. BIGELOW, in charge of Forecast Division.

WIND SIGNALS.

No storm signals were ordered on the Pacific coast and the Great Lakes during August, 1898, and no severe wind storms appeared during the month in the West Indies or over the Caribbean Sea.

Two rather severe storms visited the southeastern coasts of the United States, one passing over western Florida the night of the 2-3d, and the other crossing the Georgia and southern South Carolina coasts the night of the 30th-31st.

The Florida storm first appeared as a feeble disturbance near Jupiter the night of the 1st, and passed thence north-westward to the vicinity of Tampa by the morning of the 2d. Anticipating a development of strength on the part of this disturbance information signals were ordered on the Florida, Alabama, and Louisiana coasts the morning of the 2d, and interests in those sections were telegraphed that "a storm appears to be developing in the east Gulf." That the signals and warnings were warranted and timely is shown by the following report of Mr. A. J. Mitchell, Observer and Section Director, Weather Bureau, Jacksonville, Fla.:

The storm approached the coast in the vicinity of St. Josephs Bay during the evening of the 2d. No marked premonition of an existing disturbance was observed during the early hours of the day. The wind velocity gradually increased from about 8 p. m. of the 2d and continued until 3 or 4 a. m. of the 3d. Near the coast the maximum wind was felt about 2 a. m. from the southeast. The storm track was about 60 miles wide and embraced mainly the section of country between the Choctawhatchee and Apalachicola rivers. Throughout this

section great damage was done to crops, turpentine farms, and other property. Three barges, four tug boats, several pile drivers, and a number of sailing craft were sunk, and wharves and dwellings were damaged. The inland progress of the storm was characterized by diminishing force, and the disturbance was practically dissipated before it reached the Alabama line.

During August 27, 28, and 29, a feeble disturbance drifted eastward over the Gulf of Mexico, and on the morning of the 30th there were premonitory signs of a storm formation off the south Atlantic coast. The regular morning and special reports of the 30th located the point of the storm's inception off, and not far distant from, the Georgia coast; although these reports did not indicate the hurricane intensity of the storm over the very limited area it covered, northeast storm signals were ordered, and storm warnings were telegraphed to south Atlantic ports from Jacksonville, Fla., to Norfolk, Va., and the Chief of Bureau of Navigation, Navy Department, was notified of the threatening conditions in that section, during the afternoon of the 30th, twelve hours before the storm center reached the coast line. The greatest wind force was apparently experienced at Tybee Island, where a velocity of 84 miles per hour was recorded about 4:30 a. m. of the 31st. In addition to destruction and damage by wind heavy losses were caused by torrential rains and floods along the Georgia coast, and to river plantations between Augusta and Savannah. The territory ravaged by this storm was confined to Savannah and vicinity, and the following extract from the report of the observer at that point indicates the general

character of the storm. It will be observed that the lowest barometer reading, 29.23, occurred at 4:30 a. m., indicating that at that time the center of the storm passed over that city:

30th.—Wind fresh from north to northeast during the morning with a shower and slowly falling barometer; thunder, with very heavy rain in the afternoon, with a northeast wind squall of 34 miles per hour. As the afternoon advanced the general conditions became threatening and the wind began to show a backing tendency to the northwest. The barometer fell slowly during the evening until 10 p. m., when a very rapid decline began, with wind increasing from the northwest. At midnight the wind velocity had risen to 45 miles per hour from the northwest and the barometer had fallen to 29.73.

31st.—Until 3:30 a. m. the wind continued from the northwest increasing steadily in force, with squalls, steady rain, and rapidly falling barometer. At 3:30 a. m. a terrific wind squall occurred, during which a velocity of 76 miles per hour was recorded for five minutes with an extreme velocity (one mile) of 80 miles per hour. From that hour there was a slow but perceptible decrease in the wind force, although heavy gusts and squalls continued, and the barometer fell until 4:30 a. m. At 4:05 a. m. the wind shifted from northwest to west, to southeast at 5:40 a. m., and to south at 8 a. m., with rapidly rising barometer. During the nine hours ending 3 p. m. the rainfall amounted to 5.41 inches. Great damage was done to roofs, etc., the streets being littered with debris. The damage to shipping was considerable; lighters were blown ashore, dredges went adrift, and two barges were stranded on the river front; railroad roadbeds were washed out and telegraph and telephone lines were prostrated, leaving the city without communication. The estimated damage in the city of Savannah was \$250,000, and rice plantations suffered to the extent of over \$150,000.

The storm was not severely felt at Charleston, S. C., and did not extend to Jacksonville, Fla.

Maximum wind velocities.

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
Buffalo, N. Y.....	3	51	sw.	Havre, Mont.....	3	54	nw.
Charleston, S. C.....	30	52	e.	Do.....	21	60	sw.
Chicago, Ill.....	16	72	sw.	Pierre, S. Dak.....	5	60	nw.
Do.....	15	60	sw.	Savannah, Ga.....	31	76	nw.

LOCAL STORMS.

2d-3d.—A Gulf hurricane having a comparatively narrow track struck the Florida coast at Apalachicola about midnight of the 2d. The velocity of the wind for a time was estimated at 80 miles per hour, and considerable damage was done to vessel property. The tug *Ocean Gem* was wrecked, becoming a total loss, three other tugs were sunk and a number of sailboats were damaged. The casualties of the storm in the Gulf were as follows: Tug *Keyser* foundered 15 miles off Cape San Blas with a loss of three lives; the dredge *Herndon* was cut adrift when the *Keyser* went down and afterward foundered with the loss of one life. The hurricane passed inland and broke up into general rains in western Florida and southeastern Alabama.

MONTHLY WEATHER REVIEW.

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SEPTEMBER, 1898.

No. 9

FORECASTS AND WARNINGS.

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

The most important meteorological event of September, 1898, was the hurricane which visited the Windward Islands of the West Indies on the 10th and 11th.

As shown by the report, published herewith, of the United States Weather Bureau observer at Bridgetown, the storm was particularly destructive throughout the Island of Barbados, where 83 persons were killed, 150 injured, and property to the estimated value of \$2,500,000 was destroyed. At St. Vincent and St. Lucia the violence of the hurricane during the 11th appears, from a report rendered by Mr. H. Powell, Curator of the Botanic Garden at Kingston, St. Vincent, to have equaled or exceeded that manifested at Barbados the night of September 10. Accurate information regarding losses on these islands is not, however, at hand. After the 11th the hurricane center moved northwestward with a very marked loss of strength, and finally disappeared east of the Bahamas during September 14.

The action of the Weather Bureau in issuing warnings and advisory reports in connection with this hurricane is detailed in the description of the storm which follows, and the hurricane track, together with the general distribution of atmospheric pressure which attended the progress of the storm is plotted on special charts which appear in this issue of the REVIEW.

On September 25 a second storm of tropical origin appeared as a feeble disturbance over the eastern part of the Gulf of Mexico. During the 26th this storm moved northeastward

over the Bahamas, where it developed almost hurricane violence and caused considerable damage on some of the more northern islands of that group. Atlantic coast ports and interests were advised of the progress and character of this storm, which was not, however, severely felt on the United States coasts. Unfortunately the Nassau, Bahamas, morning report of the 26th was not received, and warning of the storm's increasing intensity could not, therefore, be given until the receipt of a special noon report from Nassau. The path of this storm is platted as low area X.

During the last two days of September a storm developed in the vicinity of the island of Santo Domingo, and moved thence northwestward to the south Atlantic coast of the United States, where it raged with hurricane violence during October 2. This storm will be made the subject of a descriptive article in the MONTHLY WEATHER REVIEW for October, 1898.

No reports showing severe storms have been received from the Pacific coast districts, and no serious disturbance occurred in the Chicago forecasting district.

THE WINDWARD ISLANDS HURRICANE OF SEPTEMBER 10-11, 1898.

Although the weather over the Lesser Antilles had been unsettled for several days there was no certain evidence of an approaching hurricane until September 10, when the

regular morning reports, supplemented by a special report, cabled at 12:40 p. m. by the United States Weather Bureau Observer at Bridgetown, Barbados, showed the presence of a cyclonic disturbance southeast of the Windward Islands.

Hurricane warnings were immediately cabled to Weather Bureau stations in the Lesser Antilles, and the officials in charge were directed to give the widest possible distribution to the warnings in their respective districts. They were informed that the hurricane would move from a point south-east of Barbados slowly northwestward with increasing force. Advisory messages were sent to other islands cooperating in the work of observation and report as far west as Jamaica and eastern Cuba, and to points on the South American coast of the Caribbean Sea, and also to Admiral Watson's fleet lying in the harbor of Caimanera, Cuba.

Moving in a northwesterly direction the storm passed over Barbados the night of September 10, and reached St. Vincent and St. Lucia during the day of September 11. The character of the hurricane at the islands visited is indicated by the following extracts from the local press and reports of observers:

The Barbados Agricultural Reporter, September 13, 1898:

Saturday night, the 10th of September, 1898, will live forever in the memory of the present generation of Barbadians. Never since the memorable 11th of August, 1831, has the island been visited by such a fearful hurricane, which extended over the period of ten hours during the dark and dreary watches of the night. For days previous much rain had fallen, but the barometer remained steady, and it was only on Saturday evening that it gave signs of the approach of a hurricane. By 7 p. m. it had dropped to 29.669, and the howling, fitful gusts of wind proclaimed the rapid approach of the storm. Previous to this the observer at the United States Weather Bureau, Mr. P. McDonough, had warned the harbor authorities of the situation, and the captains of the various craft in port were also warned to be on the outlook. The blow began about 7:30 p. m. on Saturday, and continued until 4 a. m. Sunday.

The Barbados Advocate, September 17, 1898:

Fiercer and more destructive hurricanes may have visited the West Indies in years past, but taking into consideration the general condition of her industry and its gloomy prospects, never has a more appalling calamity fallen on this island since first it rose out of these western seas, than the fearful hurricane that ravaged it from shore to shore on Saturday night last.

Saturday morning was dark and lowery, and the indications of approaching bad weather were strong. At noon Mr. McDonough, of the United States Weather Bureau, notified the public that a hurricane was fast approaching Barbados. The barometer had been falling rapidly. At 6 p. m. the clouds gathered densely in the northeast, and the wind commenced to blow freshly from that point. The rain fell heavily, and the clouds continued to gather in dark, ever-wheeling volumes, the higher banks forming scuds flying rapidly to various points; at 7 p. m. the barometer had fallen to 29.66, and the wind had increased in force and violence until a strong gale was blowing. At 9 p. m. the wind was blowing with hurricane force.

Report of Mr. P. McDonough, observer, United States Weather Bureau:

The weather on the days immediately preceding the date of the hurricane was nothing out of the ordinary. Showers had been frequent from the 1st to the 10th without any material change in the barometer. A sharp look out was kept for the movement of the upper clouds when the state of the sky permitted, and those observed were principally cirro-stratus from the south. Three or four days preceding the date of the hurricane the sky was unusually overcast, and but little opportunity presented for observing the movement of the upper clouds. In the early forenoon of the 8th cirrus clouds appeared moving from the southwest, with the wind northeast, and some cumulus which in the early morning moved from the northeast, changed direction to the southeast, the weather becoming rapidly threatening, with an unusual number of showers. During the 9th there were frequent light showers with intervals of sunshine, but in the afternoon the sky put on an unusually threatening appearance with alto-stratus moving from the east and cumulo-nimbus from the northeast. A very faint solar halo was observed at 4 p. m. The wind was generally from the northeast, with the barometer falling slightly. A thunderstorm occurred in the early morning of the 10th with light rain which ended at 4 a. m. There was a light shower between 10:50 a. m. and 12:30 p. m., and from 1:15 p. m. throughout the night.

Cirrus clouds were observed moving rapidly from the south in the morning of the 10th, changing formation to strato-cumulus and nimbus from the northeast early in the forenoon. The weather was muggy and oppressive, but temperatures were not abnormally high. Wind generally northeast, but backing to the north. The barometer rose slightly until about 9 a. m., and began to fall from about 11 a. m. The weather in the meantime became very threatening, with light sprinkling rain. The sea became heavy, with a heavy swell from the southeast. From 2 p. m. to 5:45 p. m. the barometer fell very slightly, and there was no increase in the wind force, which changed to the north. Immediately after 6 p. m. the barometer fell very rapidly, the wind freshening up and almost suddenly attained the velocity of a gale, with a heavy down-pour of rain, which continued during the night. The wind blew steadily from the northeast from 7 p. m. to near midnight, when it changed to the north. While the wind may appear from the records to have increased in force steadily, yet it is characteristic of the winds at this place to blow in strong gusts, and during the passage of the hurricane on the night of the 10th, winds of this character were quite frequent and they must have attained a much greater velocity than is shown on the anemometer record sheet. It was one of these blasts that carried the instrument shelter from the roof, and blew down the wind vane and anemometer support. The greatest velocity for five minutes was 62 miles per hour, N.E., 10:01 p. m., and the greatest for one minute, when the apparatus was blown down, 10:18 p. m., was at the rate of 75 miles per hour. The instrument shelter was destroyed and the instruments within it were broken or rendered unserviceable. The wind vane support was bent out of shape and vane was broken. The tipping bucket rain gauge was upset, but not rendered unserviceable. There is no self record of wind or rainfall from 10:18 p. m. until after the a. m. observation on the morning of the 11th, as the wind blew with such violence during the night of the 10th that it was impossible to make any temporary repairs by which the record could be continued. The wind changed to the north about 11 p. m., and it is my belief that it attained a much greater velocity between 11 p. m. and midnight than at any other time. It abated some after midnight, but a strong gale was maintained up to the observation on the morning of the 11th.

The barometer reached its lowest, 29.462 at 9:20 p. m., after which it rose rapidly.

During the storm there was a remarkable electric display over the entire heavens, but no thunder was heard. In the southwest, at a great distance, there appeared a brilliant, permanent light, but no explanation can be given of this phenomenon. Many persons have reported having experienced an earthquake shock, but none was felt at this office.

The rainfall from 6 p. m. of the 10th to 10:30 a. m. of the 12th was very heavy, 11.42 inches falling in that time.

In the table which follows will be found the most salient meteorological features connected with the storms.

Time.	Barometer, reduced to sea level.		Wind, Sept. 10.		Rainfall, inches.	
	Sept. 10.	Sept. 11.	Vel.	Dir.	Sept. 10.	Sept. 11.
1 a. m.	29.90	29.65	9	ne.	.....	.60†
2	29.88	29.63	6	ne.	.....	.40†
3	29.88	29.71	9	ne.	.....	.30†
4	29.88	29.74	8	ne.	.....	.25†
5	29.88	29.77	7	e.	.....	.25†
6	29.89	29.80	7	ne.	.....	.45†
7	29.90	29.81	9	ne.	.....	.36
8	29.91	29.85	11	ne.	.....	.17
9	29.92	29.88	11	ne.	.....	.19
10	29.91	29.89	12	ne.	.....	.29
11	29.90	29.89	9	ne.	.....	.02
12 noon	29.87	29.88	8	ne.	.01	.07
1 p. m.	29.81	29.87	7	n.	T.	.11
2	29.79	29.86	11	ne.	.08	.10
3	29.76	29.83	9	n.	.02	.42
4	29.75	29.83	10	n.	.01	.59
5	29.73	29.87	13	n.	.02	.28
6	29.70	29.88	17	n.	.13	T.
7	29.68	29.88	31	ne.	.07	.07
8	29.55	29.90	36	ne.	.20	.19
9	29.47	29.92	43	ne.	.59	.27
10	29.49	29.91	54	ne.	.63	.01
11	29.55	29.90	*	n.	1.00†	T.
12 midnight	29.59	29.88	*	n.	.85†	

*Anemometer blown down. †Estimated.

In connection with the movement and development of the hurricane the following extracts furnished by Captain Mortois, of the French barque *Touray*, sailing from Calcutta, may be of interest:

Midday, September 9, latitude 12° 2' N., longitude 54° 2' W., from Paris, ran into hurricane. Strong wind blowing from northeast, with heavy swell. Barometer 29.6, wind increasing in force after midday, and barometer falling one-tenth inch per hour from 4 p. m., reaching 29.1 at 7 p. m. Wind during that time changing from northeast to north-northeast, with heavy rain squalls. At 7 p. m., bright lightning in the southwest, barometer rising, reaching 29.5 at about midnight.

and wind went to southwest, blowing exceedingly strong. At 11 p. m., relative calm, but tremendous sea. On the 10th, about 350 miles to the east of Barbados, 7 a. m., the barometer read 29.7. Calm until midday, wind afterwards going to the northeast. From 10th to 12th, vessel driven 60 miles northward out of her course. Strong current during that time moving toward the northwest. On the 13th, it was observed that another current, but not so strong, was moving toward the northwest. The vessel lost all sail, and her cargo of rice nearly a total loss. The vessel reached Barbados on the 15th. While on board the vessel an examination was made of the captain's barometer and it was found to read about 0.25 too low.

It was very fortunate that there were so few vessels in the bay and harbor on the day of the storm, as it affords little or no protection. The British man-of-war *Alert* departed at about 6 p. m. to avoid the storm. Of the small vessels in the harbor and bay, nearly all of them took precautions to weather the storm by putting out extra anchors and lines, which proved of little value, as most of them were driven out to sea or else beached. The following ships were anchored in the bay and with extra anchors out were driven before the wind and totally wrecked on the reefs at St. Vincent, about 100 miles to the westward:

Full-rigged ship *Loando*, 1,448 tons; bark *Laplana*, 582 tons; and barkantine *Grace Lynwood*, 600 tons. The crews of these vessels were saved.

Barkantine *Lordahl*, 342 tons; local vessels, *Kate Florence*, *Florence B. Parr*, Government water boat *Florence*, steam crane and dredger all were driven out to sea and have not been heard from.

The following local vessels were driven on the reefs on the shore at this city:

Campania, *Elmo*, *Ocean Traveller*, and a large number of lighters, all of which are a total loss. The water department steamer, *Ida*, was also driven on the reefs here, but was gotten off without much damage. A large number of shore boats and lighters were driven out to sea and swamped.

The destruction of property throughout the island has been very great. Every part of the island suffered, but the eastern and southern portions most. It will take some time to get anything like an accurate estimate as to its value.

In this city the damage to property has been very great, especially in the suburbs. The business part of the city suffered very little, other than that caused by rain. The residential and unprotected portions of the city suffered very much, and it would be impossible to give a detailed description of the houses and trees strewn over the various streets in those sections of the city on the morning of the 11th. Such chaos I never witnessed, and have no desire to experience anything of the kind again. While the houses blown down are frail—frame buildings—yet the largest kind of trees were either broken in two or lifted out of the ground by the roots. Nearly all the trees that were blown down, as far as I have seen, were blown down toward the east or south, and a large number of the houses fell outward. The trees left standing had their foliage cut off as if done with a knife or an axe, this is especially true of the palms. Two stone bridges are seriously damaged, one so badly that it has been railed off to prevent traffic. A portion of the wharf was undermined and carried away, and during the night of the 10th the seas came over portions of the wharf into the streets.

Many of the streets were impassible for several days after the storm, especially for vehicles. The street car service was prostrated on the 11th, and but little service given on the 12th.

The entire telephone system was prostrated, thousands of poles being blown down and the repairs necessary will be almost equal to establishing a new plant.

No storm of like nature is remembered by the oldest reputable citizens, and many compare it to that of 1831, but statistics do not support them in that assertion as will be seen from the following comparative data:

Hurricane of August 10-11th, 1831, total killed, 1,477 outright; total injured, 310, of which 114 died; value of property destroyed, \$7,397,532.

Hurricane of September 10-11th, 1898, lives reported lost to date, 83; estimated injured, 150; estimated value of property destroyed, \$2,500,000; total number of houses totally destroyed, 5,062, and number more or less damaged, 2,359. The number of people estimated to be rendered homeless is set at between 40,000 and 45,000, and this is not considered an overestimate.

It is too early to get an estimate as to the damage to the sugar cane crops, but it is expected to be considerable. The damage done the various plantations in the eleven parishes of the island is very great and means ruin to some.

On Saturday afternoon of the 10th the public, as far as I could do so, was informed of the impending conditions. It being so long since this island was visited by a very destructive storm many believed it immune from such destructive agencies, and pooh-pooed the information given out.

It is not known as to the extent the general public benefited by the information obtained from this office, but I have been informed by some that by acting upon the information given them they were enabled to take measures to protect their property which otherwise might have been lost.

Between 4 and 6 p. m. of the 10th there were about 200 personal inquiries made at this office, and nearly as many telephone calls during the afternoon, relative to the approaching storm, and all were advised as to the danger anticipated.

Extract from report of the hurricane at St. Vincent, W. I., September 11, 1898, by H. Powell, curator, Botanical Gardens:

The barometrical readings have been corrected for index error, elevation, and temperature. Station: Botanic Gardens, Kingstown, St. Vincent, W. I. Height above sea level, 203 feet; longitude, 61° 15' W.; latitude, 13° 10' N.

Indications of the coming storm were manifest in the usual borometrical disturbances. The readings ranged from 29.926 at 3 p. m. on the 6th to 29.838 at 3 p. m. on the 10th.

The latter reading at once caused alarm, and notice of same was sent through the telephone to the police headquarters and other centers, for dissemination.

Later in the evening the barometer continued to fall, and messages were again sent in the usual manner.

At 5:55 on the following morning (Sunday, September 11) the reading was 29.724. The wind at this time was blowing in short but fitful gusts from north and northwest. * * * The barometer continued to fall slowly, and the wind, still blowing from the same quarter, freshened considerably, so much so that a tall cabbage palm was snapped in two and branches of the softer wooded trees were torn off shortly after 7 a. m. Between 7 and 8 a. m. telephonic communication was interrupted. At 9 a. m., the usual ordinary hour of recording observations, the barometrical reading was 29.606. The wind was then rushing from between north and west. At 10 a. m. the barometer had fallen to 29.539, and it was at this hour that the storm was seen to have commenced in earnest. Large branches of trees were being torn off and carried away. The first part of the storm lasted from 10 a. m. to 11:40 a. m. The wind still continued blowing from north, northwest, and west, and increased in such force at 11 a. m. that the largest trees were uprooted.

The following barometrical readings, taken at the time specified, show the rapid fall of the mercury and the awful violence of the storm:

a. m.		a. m.	
10:00	29.539	11:30	28.719
10:30	29.409	11:25	28.609
10:55	29.119	11:35	28.519
11:10	28.819	11:40	28.509

At 11:40 a. m. there was a lull and almost a dead calm for about three-quarters of an hour. * * * The rain gauge was emptied, and 4:94 inches were found to have fallen between 9 a. m. and 12 noon. At about 12:25 p. m. the wind suddenly began to blow from due south and increased in force every minute. Trees and houses in the same exposed positions which had withstood the first part of the hurricane were now hurled to the ground. Between 1 and 2 p. m. the storm reached its highest point, the velocity of the wind far exceeding that of the forenoon. This continued until about 2:20, when the wind slackened considerably. During the lull between 11:40 and 12:30 the barometer remained steady at 28.509, and then commenced to rise slowly, and afterwards arose almost as rapidly as it had previously fallen. At 3 p. m., the usual hour for recording observations, it had risen to 29.533, and the storm had so abated as to render it safe to go outside. Up to now the rain had descended in torrents, but, unfortunately, the rain gauge had been knocked over by a large branch of a tree.

From 12 noon to 3 p. m. fully as much rain must have fallen as that registered between the hours of 9 a. m. and 12 noon. From 3 p. m. of the 11th to 9 a. m. on the 12th, 4.23 inches fell, the total rainfall thus actually measured during the twenty-four hours was 9.17 inches. The actual time of the duration of the hurricane was as follows: 10 a. m. to 11:40 a. m., 12:25 p. m. to 3 p. m. From 10 a. m. to 11:40 a. m. the mercurial barometer fell 1.030 inches, viz, from 29.539 to 28.509. As previously stated the wind at the commencement of the storm blew from north, and subsequently from northwest. When the first part of the storm was at its highest it was blowing from northwest to west, but was hardly stationary at any point.

After the lull between 11:40 and 12:25 it blew directly from the south and occasionally south-southwest. From 3 p. m. the barometer rose very slowly, and at 7 p. m. the reading was 29.771. Distant thunder and lightning was recorded at intervals during the morning and afternoon. * * * As illustrating the violence of the wind the heavy garden seats were toppled over as though they were playthings. Nearly the whole of the large trees in the Botanic Garden and Government House Grounds, and also in the surrounding country, have either been partly destroyed or thrown down.

The velocity of the wind during the first part of the storm, between 11 and 11:40, was from 50 to 60 miles an hour, and between 1 and 2 p. m. during the second part of the storm it was fully 90 to 100 miles.

There are persons still living in St. Vincent who clearly remember the "Great Hurricane" of the 11th of August, 1831, and who state that the present one is in every way far more destructive.

The cyclone of the 16th August, 1886, is said to have lasted but a few minutes. Aneroid readings taken at that time are given as 29.300.

Compared to the present hurricane the one of 1886 is said to have been mere "child's play."

Out of a total number of 356 hurricanes recorded as having taken place in the West Indies during the last 308 years, 246 occurred in the months of August, September, and October.

It is recorded that in the hurricane of Guadaloupe, September 6, 1865, the barometer at Marie Galante fell 1.693 inches (from 29.646 to 27.953 inches) between 6h. 30m. and 7h. 40m. a. m., i. e., in an hour and 10 minutes.

Report of William B. Stockman, Weather Bureau Forecast Official, at the Central Station of the West Indian Weather Service at Kingston, Jamaica:

The conditions obtaining at Port of Spain on the morning of Saturday, September 10, led me to believe that hurricane conditions were indicated to the south-by-eastward of that station, but the apparent rise in barometer from the preceding evening caused me to deliberate, feeling assured that were I correct the conditions would develop sufficiently to insure the voluntary sending of specials from Port of Spain or Bridgetown. Immediately upon the receipt of the p. m. reports of the 10th. I ordered hurricane signals hoisted at Bridgetown, St. Pierre, St. Kitts, and St. Thomas.

From the Daily Gleaner, Kingston, Jamaica, September 16, 1898:

Among the most notable features attending the hurricane, was the action of the United States Weather Station at Half Way Tree. This station was only established a few weeks ago, under the scheme of the Washington Bureau for covering the meteorological observation of the West Indies more effectually than heretofore; and already the new station has more than justified its existence. From the data which, with more or less regularity, have been coming to hand, Mr. Stockman, on Saturday night, cabled hurricane warnings to Barbados, Martinique, St. Kitts, and St. Thomas. The message prognosticated a hurricane, immediately, the central portion of which was south of Barbados, that its direction was moving north-north westerly and increasing with northerly wind and rains. Every one of these details has been substantiated. Fortunately, as we have seen, the warning was not required for the two more northerly of the islands notified; the hurricane abating its force somewhere in the region of St. Kitts. The Weather Bureau has distinctly shown that it can not alone inform people that a hurricane has taken place, after the damage is done, but can give sufficient warning before hand to prepare masters of vessels for impending danger.

The storm did not attain great severity at other of the Windward Islands, except in the effect of heavy sea swells, high tides, and heavy rain. The Weather Bureau Observer at St. Kitts reports that—

While the hurricane passed that island with only a slight brush, doing no material damage, the public expressed a high appreciation of the warning of the approach of the storm, and that the warning, being verified, established confidence in the Service.

After September 11 this storm lost strength rapidly, and there is no evidence at hand to show that during its subsequent northwesterly course over the eastern Caribbean Sea and the ocean to the northward it exhibited destructive violence.

The distribution of atmospheric pressure, as shown by the morning and evening reports of September 10 and 11, is presented on Charts XIV and XV, and the path of the disturbance, after the 11th, is plotted on Chart XV.

In referring to the work of the Weather Bureau in connection with the hurricane of September 10-11, and the south Atlantic coast storm of October 2, the New York Times of October 5, 1898, commented, editorially, as follows:

There is full justification for the pride with which the Weather Bureau officials call attention to the triumphs of their new West Indian service. Though hardly well established yet, that service has already demonstrated its value beyond all question by giving timely warning of two great storms. To be sure, enormous damage was done in the one case at Barbados and St. Vincent, and in the other on our own southern coast, but of course hurricanes will not be made harmless, even when accurate predictions of their approach are made. The most that can be expected is to save many vessels at sea and many lives on shore. That both of these things were done by the Weather Bureau's forecasts of the recent tempests is certain. The new stations have begun extremely well. Even now they have paid expenses for years to come, and it is a source of gratification that their benefits, instead of being monopolized at home, have been shared by friends beyond our frontiers.

The following is an extract from an editorial which appeared in the New Orleans Times-Democrat of September 24, 1898:

We were able to test this new service in the recent hurricane of September 10 and 11. The storm which prevailed then was first noticed in an inchoate condition near Barbados on September 10. All the other West Indian islands were notified from Washington, and it was in consequence of that notice that the Spanish vessels at San Juan de Porto Rico, which were to have sailed for Spain on that day, delayed doing so, escaping the storm and saving, in all probability, many lives by their delay. Every seaport that could be reached by telegraph was notified; the vessels remained in harbor, and the hurricane—a very severe one—swept through the Caribbean and Gulf of Mexico without injuring a single vessel. So much for our new weather stations. There was some loss of life in the interior of the islands where the warning could not reach in time, but this was infinitesimal compared with the damage that might have been done and would have been done had the approach of the storm not been known one or two days beforehand.

The hurricane was very severe among the smaller Antilles, and wasted most of its force before it reached Cuba. All we caught of it was a violent rainstorm. But although it was not as widespread as some other Gulf hurricanes, it was as severe in its intensity where it did rage. By the warning given by our weather service, property in value a hundred times the cost of the service was saved. The wisdom of the new stations is thus clearly proved. Louisiana ought to appreciate the improvement, for probably no part of the country is more affected and more directly interested in hearing of the approach of these hurricanes. With timely notice vessels will not leave here in the face of a storm. The thousands of fishermen along the coast can receive warning in time and escape the fate of their comrades at Cheniere Caminada. Finally, the sugar and rice crops are deeply interested in knowing of an approaching blow, which will give the planters and farmers a chance to care for the crops, to harvest the rice or cut the cane before the storm breaks over them.

In enumerating the benefits of the war we must not overlook the improvement it has assured us in our weather service on the Gulf and south Atlantic, an improvement that would scarcely have been made—certainly not made for years—if the safety of Sampson and Watson's fleets and Shafter's army had not demanded the establishment of additional weather stations in the West Indies.

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FORECASTS AND WARNINGS.

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

During the last two days of September, 1898, a storm developed in the vicinity of the island of Santo Domingo, and moved thence northwestward to the south Atlantic coast of the United States, where it raged with hurricane violence during October 2. A detailed account of this disturbance, and of the action of the Weather Bureau in issuing warnings of its approach is given in the description of the storm which follows, and its track is plotted on Chart II.

Conservative estimates place the damage caused by this storm in Georgia and Florida at \$1,500,000. The value of vessels and cargoes detained by the Weather Bureau warnings of Saturday, October 1, was \$380,000, and the crews numbered 56. These were sailing vessels and would doubtless have suffered the fate of those caught at sea. At Savannah the warnings prompted active measures for the protection of shipping and merchandise, and credit is given the warnings by representatives of business and marine interests, for a saving of many thousands of dollars. At Charleston vessels and cargoes valued at nearly \$1,000,000, remained in port.

Two storms of unusual severity crossed the upper lakes, one on the 17th and 18th, and the other on the 25th and 26th; on the lower Lakes the severest storm of the month occurred on the 26th and 27th.

No wind storms of marked severity occurred on the Pacific coast during October, 1898.

THE WEST INDIAN HURRICANE OF SEPTEMBER 29-OCTOBER 2.

The Weather Bureau West Indian reports of September 28, 1898, indicated the formation of a cyclonic storm in the neighborhood of Puerto Rico, and during September 29 the circulation of the winds, the character and movement of the clouds, and the action of the barometer showed that the central area of the disturbance had moved to a position off the northern coast of Santo Domingo. During September 30 the center moved north of west over the old Bahamas Channel and began to recurve northward. Conforming to one of the laws of cyclonic disturbances the storm-center deepened during the recurve, and by the morning of October 1 its influence had extended to the Florida coast. Advisory messages were sent to south Atlantic ports at 9:50 a. m., giving the position of the storm and stating that high north to northeast winds would prevail along those coasts. Special noon and 3 p. m. observations showed that the center of disturbance was approaching our southeastern coasts. Storm northeast signals were ordered from Key West to Norfolk, and the following warning was communicated to the Bureau of Navigation, Navy Department, Washington, the New York and Philadelphia Maritime Exchanges, and generally to Atlantic coast and east Gulf maritime interests:

Storm approaching the Florida coast near Jupiter. Dangerous shift-

ing gales indicated for Florida coasts, and northeast gales as far north as Norfolk.

By the evening of October 1 the storm center had moved to a position about 150 miles to the northeastward of Jupiter and was apparently moving in a northwesterly direction. During the night of October 1 the storm was deflected to a more westerly course by an extensive area of high barometer which occupied the Atlantic coast districts to the northward of its position, and, following a law previously referred to, it increased in intensity, until, by the morning of October 2, when it was central off the coast northeast of Jacksonville, Fla., it had acquired hurricane strength. Immediately following the receipt of the morning reports on October 2, the following message was telegraphed to all south Atlantic ports and to the Navy Department, the maritime exchanges, and all interests, both marine and land, which were subject to injury by hurricanes:

Hurricane off the northeast point of Florida will move north and cause northeast hurricane winds on the South Atlantic coast this afternoon, and to-night on the Middle Atlantic coast.

Advisory messages were sent to middle and east Gulf coasts, and all authorized means were used to disseminate throughout the threatened districts information regarding the hurricane. The storm center crossed the coast line about midway between Jacksonville and Savannah, in the neighborhood of 11 a. m. of October 2, and the character of its action during that day is indicated by the following reports:

A. J. Mitchell, section director, Weather Bureau, Jacksonville, Fla.:

The barometer fell rapidly during the day and night of October 1, and reached a minimum of 29.07 at 11 a. m. of the 2d. The storm center appeared to pass north and east of Jacksonville, probably 50 to 60 miles distant. The maximum wind velocity, 60 miles an hour, occurred about 11:10 a. m., 2d. Information signals were hoisted at 1 p. m., of the 1st, and northeast storm signals were displayed at 4 p. m. of the 1st, and at 7 a. m. of 2d hurricane signals were hoisted. As the storm approached from the southeast no serious damage was done to coast districts south of Mayport; at Mayport and Pablo flood damages amounted to several thousand dollars. In Jacksonville damages will not exceed \$5,000, the small loss being due, in a great measure, to the timely warnings of the Bureau, and also to the fact that the highest winds were from a westerly direction. The coast district from Mayport to Fernandina suffered heavily, in fact Fernandina was nearly destroyed. Great damage was caused on the coast near and south of Everet. On the south Georgia coast the wind was from the northeast, and the sea flooded level lands, destroying crops and stock and imperiling lives. From Savannah to St. Augustine all telegraph lines were prostrated and many miles of railroad track washed away. At Fernandina boats at anchor foundered or were blown into the marshes. A conservative estimate of the damage in Florida by this storm is \$500,000.

It is a pleasure to report that the Bureau effectively reduced the losses of both property and life by warnings. Vessels that would have sailed Saturday from the several Florida ports numbered ten or more, and, as they were sailing craft, they would have suffered the fate of those caught at sea. The value of the vessels and cargoes detained was \$380,000, and the crews numbered 56.

H. B. Boyer, Observer, Weather Bureau, Savannah, Ga.:

The most of the damage sustained in the vicinity of Savannah was caused by the backing up of the water by the southeast hurricane winds blowing against the Gulf Stream. Cotton warehouses and naval stores yards were flooded to a depth of several feet, and merchandise stored under sheds was damaged by heavy rain. It is impossible to make an estimate of the loss along the city wharves, but it was quite heavy. About 5,000 barrels of rosin were floated and badly scattered, and it is estimated that 60,000 bushels of rice, valued at about \$60,000 were washed away. The conditions along the Ogeechee were fully as bad as along the Savannah, Mr. W. G. Morrill, who represents three-fourths of the rice planting interests in this section, stating that his losses from the two storms (August 30-31 and October 1-2) amounted to \$350,000, which represents value of life and live stock destroyed. He also states that 97 negroes were drowned upon the plantation which he represents.

Hutchinsons Island, opposite Savannah, was completely overflowed to a depth of 4 to 8 feet, the salt water stretching back over the rice plantations in South Carolina to the pine ridges, about 3 miles to the northeast of Savannah. All the lowland to the eastward of Savannah was submerged.

At Thunderbolt, about 6 miles from Savannah, and on the Wilmington River, one life was lost. Small sailing craft were sunk or blown into the marshes, and wharves were damaged; the property loss being estimated at \$3,000 to \$5,000. At the Isle of Hope the water rose 15 feet, washing away bath-houses and boat-houses. Down the Savannah River wharves and oil houses were washed away. At Quarantine station the wharves were badly damaged, and the British steamer *Syanara*, and the schooners *Fannie L. Childs* and *Milville*, and the Italian bark *Franklyn* were blown ashore. The loss to wharves and tramway was \$3,500. At Tybee Island Mr. Lovell's house was blown away, and at the fort about 24 feet of sand piled up inside the works. The Tybee railroad was badly washed. At Warsaw the barracks were washed out, and a depth of 4 feet of water was reported in the magazine. The Sea Islands off the Carolina coasts escaped severe injury, although the tide was very high and the wind heavy. At Beaufort the water came up into the streets. At Port Royal, S. C., the damage was slight. At the naval station considerable sand was washed into the dry dock. The greatest loss was sustained south of Savannah and nearer the storm center. Great havoc was caused at Brunswick, where a conservative estimate places the losses at \$500,000. Nearly every business house and warehouse in the city was flooded. At noon, on the 2d, the principal residence and business thoroughfares were 4 to 8 feet under water. Nearly all docks suffered from lifting; one to two hundred thousand feet of lumber and hundreds of barrels of naval stores were washed away, and five vessels were washed ashore. At New Town, records kept by the family of Egbert Dart, show that not since 1812 has such a flood been known in that section.

Campbell Island, 12 miles from Darien, on the Attahama, was swept by water, and all of its inhabitants, except three, were drowned—not less than 20 and perhaps 50. At Darien there were 31 persons drowned and 1 killed, and the loss to rice, stock, lumber, vessels, etc., aggregated \$350,000. The height of the tidal wave at that place was about 13 feet above mean high water mark, inland, and 18 feet at Sapels Light-house.

The property damaged at Brunswick, Darien, and the surrounding country, is estimated at \$1,000,000, and the loss in the State is incalculable.

At Savannah the information signal was ordered at 10:20 a. m. of October 1, and storm northeast signals at 4:30 p. m. Every effort was made to disseminate the warnings. The storm winds began 2:30 a. m. of September 2, and continued until 11:50 p. m. of that date, with a maximum velocity of 60 miles per hour from the northeast at 11:30 a. m. No damage was sustained by the shipping in port. The Savannah Morning News of October 3 remarked as follows in connection with the work of the Weather Bureau: "To these (Weather Bureau) warnings the safety of the shipping in the harbor was due. * * * Every precaution had been taken to warn shipping circles and considerable damage was averted by the advice from the Capital."

Mr. Boyer cites many highly commendatory statements by representatives of the maritime and business interests of Savannah and vicinity, wherein a saving of many thousands of dollars is shown to have resulted from precautionary measures, which were based upon advices received from the Weather Bureau.

L. N. Jesunofsky, Local Forecast Official, Charleston, S. C.:

The order to hoist storm northeast signals was received 6:07 p. m. 1st, and the information the accompanying message contained regarding the approaching storm was given the widest distribution. Very little damage was caused in Charleston and vicinity, although damage was caused to sailing craft and a number of persons were drowned along the South Carolina coast.

Mariners were all warned on Saturday, the day preceding the storm, that navigation would be dangerous within the following forty-eight hours, and vessels and cargoes to the value of nearly \$1,000,000 were detained in port, and many tugs, schooners, barks, brigs, and steam vessels were taken up the Ashley and Cooper rivers late Saturday and early Sunday to avoid the high seas. Rice planters lost heavily from the high tides, and the sea-island cotton growers had their crops injured by sea spray.

After the 2d the storm passed inland and lost force rapidly.