

MONTHLY WEATHER REVIEW.

Editor: Prof. CLEVELAND ABBE. Assistant Editor: H. H. KIMBALL.

VOL. XXXI.

AUGUST, 1903.

No. 8

FORECASTS AND WARNINGS.

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

THE WEST INDIAN HURRICANE OF AUGUST 8-15, 1903.

The most important tropical storm that has appeared in North American waters since September, 1900, advanced from Barbados, West Indies, over the Caribbean Sea and the Gulf of Mexico from the 8th to the 15th.

The first indication of the presence of this storm to the eastward of Barbados was furnished by the morning telegraphic reports of the 8th. West Indian stations and Gulf and Atlantic coast shipping interests were at once notified that a disturbance probably of dangerous strength was approaching Barbados from the eastward and would move northwestward over the Windward Islands. Thereafter daily until the 14th, West Indian, Gulf, Atlantic stations, and shipping interests were advised of the apparent location and character and the probable course of the storm, and as it passed westward over the Caribbean Sea hurricane warnings were ordered at Gulf and southern Florida stations. The storm increased in strength as it advanced in a north of west course over the Caribbean Sea, and apparently attained its maximum intensity as it approached the Yucatan Channel.

Martinique appears to have been the only island of the Windward Group that suffered serious damage. The vortex of the storm passed over or near that island moving in a northwesterly direction during the night of the 8-9th, unroofing several hundred houses, destroying crops, and damaging a number of sailing vessels.

During the next two days the center of the storm was far

distant from any station of observation. Shipping interests and West Indian stations were, however, advised that while reports from that region were missing a disturbance of apparently marked energy was moving north of west over the Caribbean Sea near Santo Domingo. On the morning of the 11th the presence near Jamaica of a storm of great intensity was indicated and advices to that effect were issued with a warning that it was considered dangerous for vessels of all classes to sail for Gulf, Cuban, and South Atlantic ports.

Reports from Kingston, Jamaica, show that the first effects of the storm were felt on that island on the 10th, and that the main hurricane center reached the island on the morning of the 11th, causing a heavy loss of life and property. At Kingston the minimum barometer, 28.80 inches, as indicated by the barograph, occurred at 5:30 a. m. of the 11th, and at 6:15 a. m. the barometer had risen to 29.36 inches. The anemometer cups were disabled, but the maximum wind velocity at Kingston was estimated at 65 miles an hour. The principal sufferers were the owners of banana plantations whose losses were estimated at more than £500,000. The orange, pimento, and coffee crops suffered severely; the towns of Port Antonio and Port Maria were almost destroyed, and throughout the parishes of St. Mary, Portland, St. Andrew, St. Catherine, and St. Thomas the destruction to houses, property, and plantations was appalling. Kingston, with the exception of damage to houses and warehouses on the sea front, suffered less than any other place on the island.

But little information is available for determining the character and course of the storm after it passed Jamaica. Warnings were, however, issued that the storm was severe and likely to enter the Gulf of Mexico. Later advices show that the Cayman Islands were devastated on the evening of the 11th. Captain Hunter of the schooner *Gov. Blake* has furnished notes regarding the storm at Georgetown, Grand Cayman Island. According to his observations the 8th and 9th were clear and bright at Grand Cayman Island. The 10th was unusually warm with a north-northeast wind that freshened steadily. In the afternoon the weather became cloudy and a little rain fell in the evening. From 8 a. m. to 8 p. m., local time, the barometer fell from 29.80 to 29.70 inches. At 1 p. m. of the 11th the barometer read 29.50 inches, the wind was blowing about 30 miles an hour from the north-northeast, and the sky was covered with thick, black clouds from the same quarter. At 4 p. m. the wind was blowing about 45 miles an hour, and at 5 p. m., with the barometer at 29.30 inches, the wind was blowing in heavy gusts at 65 miles, and the clouds hung so low that they seemed to almost touch the tree tops. At 7 p. m. the roaring of the wind began, and at 8 p. m., with the barometer reading 29.00, the wind blew at 90 miles an hour in terrific gusts that churned up the water in the harbor of Georgetown and blew out to sea or capsized several vessels. At this time, 8 p. m., it was supposed that the worst of the storm had passed, but soon the barometer began to fall so rapidly that the needle of the aneroid could be seen to move. The barometer fell until 10 p. m. when it stood at 28.30 inches, with the wind blowing 110 to 120 miles an hour from east-northeast to east-southeast in gusts. About midnight it became almost calm for about thirty minutes, after which the wind came on fiercely from the southeast. At 1 a. m. of the 12th the barometer began to rise, and at 6 a. m. it read 29.30, and at noon 29.70. From midnight until 4 a. m. heavy rain continued in drops as large as gravel stones and with nearly the same abrasive effect. When the sun came out on the morning of the 12th a most desolate sight was presented. Every tree and plant on the island was either blown away or had its leaves and small branches stripped off, and crops were entirely destroyed. About 200 houses were blown down or unroofed, seven out of eight churches on the island were destroyed, vessels on the stocks were picked up and dashed to pieces, and of the 23 vessels in the harbor of Georgetown but one, the *Gov. Blake*, was saved. Most of the crews on board perished, but no one on shore was killed. The wind exhibited some curious freaks, totally demolishing some houses while others close by were not damaged.

Havana, Cuba, reports of the 12th indicated the approach of the storm center toward the southeastern part of the Gulf of Mexico, and advices to this effect were issued. On that date some destruction by high wind was caused to buildings and crops in the province of Pinar del Rio, Cuba.

Reports from Havana on the morning of the 13th appeared to locate the center of disturbance in the southeastern part of the Gulf of Mexico. A report received late in the day from Progreso, Yucatan, indicated that the center of the storm was near the northeast coast of Yucatan, and heavy sea swells were reported at Pensacola, Fla., and Fort Morgan, Ala. Reports from various sources indicate that the storm was very severe on the Yucatan coast and adjacent waters of the Gulf during the 13th. The captain of the steamship *Navarre* reports that he left Vera Cruz, Mexico, at 11 a. m., August 12, course 62° north, barometer 30.04, weather fine, and fresh breeze from east-northeast. At 1 a. m. of the 13th, when approaching The Triangle on the border of Campeachy Banks, the weather, though still fair, began to change, particularly in the north-northeast, where the sky was copper colored. The barometer had fallen to 29.88, with some heavy showers from the north-northeast, and a slight swell from the northeast.

At 5 a. m., in 21° 24' north, 94° west from Paris (91°

40' west from Greenwich), a squall from the northeast struck the vessel, the sea became heavy, the barometer had fallen to 29.76, the sky was overcast, and the wind increased in strength and shifted to north-northeast, to return to northeast at 11 a. m. At noon, in 21° 58' north, 90° 5' west from Greenwich, the weather had become stormy, the sea rougher and rougher, and by 2 p. m. the wind had increased to hurricane force from the northeast, the vessel was head on the waves, and the barometer had fallen to 29.61.

Between 3 and 6 p. m., when 15 miles south of the Alacranes, the hurricane was encountered in its full fury, the barometer reading 29.45, and the sea exceedingly rough. At 7 p. m. the worst of the storm had passed, the wind had shifted to the eastward, and the sea became less rough. At 8 p. m., in north 22° 25', west 89° 5' from Greenwich, the barometer had risen to 29.65, the wind had changed to east-northeast, and the sea had become calmer. At 11 p. m. the steamer resumed its usual speed, and continued on its course with fair weather.

Following a north of west course the vortex of the storm apparently reached the coast of Tamaulipas, Mexico, on the 15th, where it dissipated. Attending its passage many vessels were cast ashore on the coast of Yucatan, shipping and property were damaged from Yucatan to Tampico, and large tracts of the southern Gulf coast were submerged.

The approximate path of this hurricane from the 8th to the 15th is shown on Chart No. X.

When the fact is considered that, except during its passage over Jamaica, the hurricane center did not come within the region of telegraphic observation the difficulty experienced in defining its probable future course will be appreciated. With the ever present probability of a northward recurve of the storm, shipping interests were daily advised of the danger of sailing for southern waters that lay in its possible line of advance, and many disasters were doubtless averted by an observance of the warnings.

Freshets occurred at intervals during the month in the streams of the lower Missouri Valley.

On the 4th storm warnings were ordered from New Haven, Conn., to Boston, Mass., and during the 5th a northeast gale caused damage to small vessels along the southern New England coast. From the 29th to 31st strong easterly winds prevailed on the middle Atlantic and southern New England coasts.

No serious damage by frost was reported during the month.

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From the cyclonic point of view this story requires the following explanatory note.

On the 11th at 5 p. m. the schooner *Governor Blake*, with Captain Hunter on board, parted her cable in Georgetown Harbor, and scudded to the south before the hurricane; and from the above account it will be seen that the *Governor Blake* got involved in the worst part of the storm, and was not thrown out, or left behind, until 1 a. m. on the 12th. She returned to Georgetown after a few days, having made several gallant rescues.

From other sources we learn that at Georgetown the hurricane raged with appalling violence from 9 to 11 o'clock, the wind veering from NE. to SE., so that the center must have passed a few miles to the south of the town at about 10 p. m.

Now the distance from Martinique to Kingston, Jamaica, is about 1095 miles; the distance from Kingston to Montego Bay is 83 miles; the distance from Montego Bay to Grand Cayman Island is 238 miles. As the center passed over Montego Bay at 9:30 a. m., we have the following velocities of the center along its course: from Martinique to Kingston, twenty miles an hour; from Kingston to Montego Bay, twenty-one miles an hour; and from Montego Bay to Grand Cayman Island, nineteen miles an hour. Hence, we shall assume that the center proceeded from Martinique to Grand Cayman Island at a uniform velocity of twenty miles an hour.

The accompanying chart, fig. 1, shows the position of the center of the hurricane at Greenwich, mean noon daily, from the 9th to the 12th, and the corresponding approximate local times.

THE WEST INDIAN HURRICANE OF AUGUST 11, 1903.

By MAXWELL HALL, Esq. Dated Montego Bay, Jamaica, August 14, 1905.¹

I. THE HISTORY OF THE HURRICANE BEFORE AUGUST 11.

The first intimations we had in Jamaica of this great storm came from the Weather Bureau at Washington, and the following notices were posted in Kingston by the local branch of that Bureau:

August 8, 11:30 a. m.—Washington Weather Bureau notifies evidence of a disturbance ESE. of Barbados, moving N. of W.

August 8, 4 p. m.—Central Bureau, Washington, notifies that the disturbance E. of Barbados will move NW. over the Windward Islands. It is probably of dangerous strength.

August 10, 4:15 p. m.—The following has been received from the Central Bureau in Washington: Disturbance apparent; marked strength; moving N. of W. over or near Santo Domingo. Reports from Santo Domingo missing.

But as a matter of fact the hurricane moved in a straight line from Martinique to Jamaica, and then over Cayman Islands and Yucatan to the coast of Mexico where it disappeared. The following extracts are taken from the account given by Professor Garriott in the United States MONTHLY WEATHER REVIEW for August, 1903:

¹ In editing this article the Editor has, with the author's permission, substituted "hurricane" for "cyclone" as the text applies specifically to the former.

II. THE PASSAGE OF THE HURRICANE OVER JAMAICA AUGUST 11.

We have now to consider the passage of the hurricane along almost the whole length of Jamaica, according to the following observations and notes arranged in order of time with respect to the passage of the center.

It may be here stated that the mean barometric pressure for August 11, is 29.928 inches; that all barometric pressures here given have been corrected for diurnal variation; that the readings of mercurial barometers have all been reduced to the Kew standards and to 32° F., sea level, and gravity at 45°, and that the readings of aneroid barometers have been corrected so as to make them agree with the mercurial barometers as nearly as possible.

The local reports are as follows:

(1) MORANT POINT LIGHT-HOUSE.

By Mr. W. H. BOORMAN.

At midnight the wind attained unusual force, which gradually increased until 4.30 a. m., August 11, when it became calm for about fifteen minutes, and then the wind changed to the SE.

From this we gather that the center passed a few miles south of the light-house, and that part of the calm area went over the place, so that the change of wind would have been from NNE. to SE. But there is something wrong about the time; it should have been 3:30 instead of 4:30. Indeed the nearest approach of the center to Port Antonio occurred at 4:30 a. m. and the point of nearest approach to Port Antonio was twenty miles WNW. of Morant Point. Mr. Boorman further wrote saying that he was entirely occupied in looking after the light, and this probably explains how the discrepancy occurs.

(2) HOPE GARDENS.

By Hon. WILLIAM FAWCETT.

1903.	Barometric pressure.
August 10, 5:30 p. m.	29.77 inches.
10, 9:15 p. m.	29.72
11, 3:15 a. m.	29.51
11, 4:40 a. m.	29.23
11, 4:55 a. m.	29.15
11, 5:08 a. m.	29.03
11, 5:20 a. m.	28.93
11, 5:23 a. m.	28.89
11, 5:35 a. m.	28.81
11, 5:48 a. m.	28.88

After this last observation the pressure continued to increase. The above pressures were deduced from the aneroid readings sent me by Mr. Fawcett by adding 0.22 inch for reduction to sea level and instrumental error combined.

The Hope Gardens were very near the northern edge of the central calm; the nearest approach occurred at 5:35 a. m., or thereabouts, and the lowest pressure was 28.81 inches.

(3) RICHINGS, NEAR KINGSTON.

By Mr. CHARLTON THOMPSON.

August, 1903.	Barometric pressure.	Wind.		Notes.
		From.	Force.	
	<i>Inches.</i>			
11, 6:15 p. m.	29.77			
11, 7:50 p. m.	29.77			
11, 9 p. m.	29.74			
11, 4:30 a. m.	29.22	n.	Heavy squalls.	
11, 4:50 a. m.	29.15	n.	Heavy squalls.	
11, 5:10 a. m.	29.10	n.	Hurricane	
11, 5:20 a. m.	29.01	nw.	Hurricane	The squalls were terrific.
11, 5:30 a. m.	28.92	nw.	Hurricane	
11, 5:55 a. m.	28.97	sw.	Hurricane	A lull of ten minutes.
11, 6:10 a. m.	29.17	s.	Hurricane	
11, 6:30 a. m.	29.34	s.	Heavy squalls.	The heaviest rain was from sw. and s.
11, 6:40 a. m.	29.39	s.	Moderating	
11, 7 a. m.	29.45	se.	Moderating	
11, 7:15 a. m.	29.50	se.	Moderating	
11, 7:45 a. m.	29.57	se.		
11, 8:20 a. m.	29.62	se.		

The barometric pressures were deduced from aneroid readings by subtracting 0.11 inch for instrumental error. Part of the calm area passed over Richings, and its nearest approach occurred at 5:35 a. m., which agrees with the time given by Mr. Fawcett. The lowest pressure was 28.92.

(4) KINGSTON.

By Mr. J. H. MILKE.

Date.	Time.	Barometric pressure.	Date.	Time.	Barometric pressure.
		<i>Inches.</i>			<i>Inches.</i>
August 10, 1903.	Noon	29.80	August 11, 1903	5 a. m.	29.53
Do	1 p. m.	29.80	Do	5:15 a. m.	29.26
Do	2 p. m.	29.81	Do	5:30 a. m.	29.21
Do	3 p. m.	29.80	Do	5:45 a. m.	29.11
Do	4 p. m.	20.79	Do	6 a. m.	29.01
Do	5 p. m.	29.77	Do	6:15 a. m.	28.95
Do	6 p. m.	29.76	Do	6:30 a. m.	28.93
Do	7 p. m.	29.76	Do	6:45 a. m.	28.93
Do	8 p. m.	29.75	Do	7 a. m.	28.93
Do	9 p. m.	29.74	Do	7:15 a. m.	29.04
Do	10 p. m.	29.73	Do	7:30 a. m.	29.14
Do	11 p. m.	29.73	Do	7:45 a. m.	29.23
Do	Midnight	29.73	Do	8 a. m.	29.33
August 11, 1903.	1 a. m.	29.72	Do	9 a. m.	29.47
Do	2 a. m.	29.70	Do	10 a. m.	29.54
Do	3 a. m.	29.66	Do	11 a. m.	29.66
Do	4 a. m.	29.63	Do	Noon	29.69

The above pressures were deduced from the tracings of the barograph report at Mr. Milke's store in Kings street, by adding 0.05 inch to the readings. It is an ink tracing; the line is rather thick, but the figures above can be relied on to 0.01 or so. The pen remained at the lowest reading, 28.93, longer than would seem proper considering that the place must have been near the southern edge of the calm; the tracing paper had not been carefully adjusted as to time.

(5) VALE ROYAL, NEAR KINGSTON.

By Mr. J. R. SCOTLAND.

August, 1903.	Barometric pressure.	Wind.		Notes.
		From.	Force.	
	<i>Inches.</i>			
10, 5 p. m.	29.77			Barometer steady.
11, 3 a. m.	29.60	nw.	In gusts	
11, 3:30 a. m.	29.54	nw.	Strong	
11, 4 a. m.	29.51	nw.	Very strong	At 4 a. m. the cloud drift was: s.-cu. ne.; c.-s. e.; c. ese.
11, 4:30 a. m.	29.40	nw.	Heavy gusts	
11, 4:45 a. m.	29.35	nw.	Hurricane	
11, 5 a. m.	29.30	nw.	Hurricane	
11, 5:10 a. m.	29.24	nw.	70 miles per hour.	
11, 5:20 a. m.	29.21	nw.	70 miles per hour.	
11, 5:40 a. m.	28.97	nw.	70 miles per hour.	
11, 6 a. m.	28.97	nw.	Light	Lowest barometer. The lull was from 6 ^h to 6 ^h 15 ^m .
11, 6:05 a. m.	28.93	nw.	Calm	
11, 6:10 a. m.	29.04	sw.	Strong gusts	
11, 6:20 a. m.	29.17	sw.	Hurricane	
11, 6:30 a. m.	29.41	s.	Very strong	
11, 6:45 a. m.	29.43	se.	Strong	
11, 7:10 a. m.	29.50	se.	Strong	
11, 7:30 a. m.	29.55	se.	Strong	
11, 8 a. m.	29.59	se.	Strong	
11, 9 a. m.	29.66	se.	Brisk	
11, 10 a. m.	29.68	se.	Fresh	
11, 11 a. m.	29.70	se.	Fresh	

A mercurial barometer was used and the reading at 5 p. m. on August 10 was used to indicate the errors of the aneroids read near Kingston. The temperature that afternoon was as high as 95.5°. At 3 p. m. on the 10th the cloud drift was as follows: cirrus SE., cirro-stratus ESE., strato-cumulus NE.

(6) LINSTEAD.

By Mr. DUGALD CAMPBELL.

The place of observation was a mile north of the village. The storm began at 5:30 a. m., August 11, with the wind N. by E.; the wind gradually backed to NW. at 7 a. m.; there was a calm lasting about twelve minutes, and then the wind came from the SW. and S.; at 9 a. m. all was over.

(7) CHAPELTON.

By Mr. R. CRAIG.

One-tenth of an inch has been added to the readings of the aneroid (*L*) to bring them into accordance with other readings on the night of August 10.

August, 1903.	Aneroid.	Wind.
	<i>Inches.</i>	
10, 9 p. m.	29.08	light puffs.
11, 4 a. m.	29.05	nw.
11, 6 a. m.	29.05	w.
11, 7 a. m.	29.01	w. by s.
11, 7:40 a. m.	29.01	s. by w.
11, 8 a. m.	29.02	s.
11, 8:30 a. m.	29.03	s. by e.
11, 9 a. m.	29.03	se.
11, 10 a. m.	29.04	se.
11, 11 a. m.	29.05	se.

The wind was strongest from 7:40 to 8:30 a. m.

(8) LLANDOVERY.

By Mr. A. J. WEBB.

1903.	August 11,	Barometric pressure.
0 a. m.	29.87	inches.
6 a. m.	29.75	
6:50 a. m.	29.58	
7:05 a. m.	29.53	
7:14 a. m.	29.48	
8:15 a. m.	29.15	
8:35 a. m.	29.33	
10 a. m.	29.71	
Noon.	29.83	

An aneroid was used. Between 7:14 and 8:15 a. m. the storm was at its height, but a broken window prevented the readings being taken in that interval. If a curve be drawn representing the fall of pressure with the time, it will be found that the lowest reading was 29.2 a little before 8 a. m. The strongest wind was from the NE.

(9) HANBURY, NEAR SHOOTERS HILL, MANCHESTER.

By Mr. S. T. SCHARSCHMIDT.

August, 1903.	Barometric pressure.	Wind.		Notes.
		From.	Miles per hour.	
	<i>Inches.</i>			
10, 6 p. m.	29.80			
10, 10 p. m.	29.80			
11, 4 a. m.	29.69			
11, 5 a. m.	29.63			
11, 6 a. m.	29.56	wnw.	19	
11, 7 a. m.	29.43	w. by n.	77	
11, 8 a. m.	29.35	w. by n.	14	Lowest reading.
11, 9 a. m.	29.48	sw.	77	
11, 10 a. m.	29.56	s.	25	Between 10 p. m. and 11 p. m. two inches of rain fell.
11, 11 a. m.	29.64	sse.	10	
11, noon.	29.68			
11, 1 p. m.	29.69	se.	2	

The barometric pressure was deduced from the readings of an aneroid; 1.77 inches was added for reduction to sea level and instrumental error. The force of the wind was estimated by Beaufort's scale; the corresponding velocities are given.

(10) CHRISTIANA.

By Mr. T. C. GARRETT.

Wind and rain set in from the NE. at 11 p. m. on the 10th. At 5 a. m. on the 11th the wind was N. It gradually backed to NW. at 7 a. m. Then there was a lull for a quarter of an hour, when the wind recommenced from the W. At 8 a. m. the wind was SW., at 9 a. m. S., and finally SE. The strongest winds were from the N. and SW.

Fine cirrus bands were seen stretching N. and S. across the sky on the evening of the 10th.

(11) KEMPSHOT OBSERVATORY.

By Mr. A. MAXWELL HALL.

August, 1903.	Barometric pressure.	Wind.		Notes.
		From.	Force.	
	<i>Inches.</i>			
11, 5 a. m.	29.659	nw.		
11, 7:45 a. m.	29.434	nw.	Hurricane	
11, 8:15 a. m.	29.292	nw.	Hurricane	
11, 8:45 a. m.	29.097	ws.	Hurricane	
11, 10 a. m.	29.323	s.	Hurricane	Lull at 9:15 a. m.
11, 10:30 a. m.	29.415	s.		
11, 11 a. m.	29.522	s.		
11, 11:30 a. m.	29.579	se.		
11, noon.	29.650	se.		
11, 1 p. m.	29.705	se.		

The barometer used was a mercurial standard and the readings and the times may be regarded as thoroughly reliable, but the observer was quite inexperienced in cyclonic matters and paid more attention to the safety of the doors and windows of the houses than to the scientific part of the phenomenon, so that the very lowest readings were entirely omitted.

(12) BRANDON HILL, NEAR MONTEGO BAY.

By Mr. MAXWELL HALL.

August, 1903.	Barometric pressure.	Wind.		Notes.
		From.	Miles per hour.	
	<i>Inches.</i>			
10, 2 p. m.	29.874	ene.	15	Clear, very fine.
10, 4 p. m.	29.847	ene.	15	Clear, very fine.
10, 6 p. m.	29.837	ene.	3	Clear, a little cirrus se.
11, 6 a. m.	29.686	n. by e.	10	Rain, and scud flying fast overhead.
11, 7 a. m.	29.609	n. by e.	20	Heavy rain squalls.
11, 8 a. m.	29.520	nne.	50	Heavy rain squalls.
11, 8:15 a. m.	29.478	nne.	60	Heavy rain squalls.
11, 8:30 a. m.	29.427	nne.	60	Heavy rain squalls.
11, 8:45 a. m.	29.331	nne.	60	Very heavy squalls.
11, 9 a. m.	29.16	nne.	70	Very heavy squalls.
11, 9:15 a. m.	28.93	calm.	0	A break in the clouds; clouds ne. by n.
11, 9:30 a. m.	28.942	calm.	0	Plenty of light; clouds e. by s.
11, 9:37 a. m.	28.948	calm.	0	Clouds ssw.
11, 9:42 a. m.	28.991	ssw.	15	No rain.
11, 10 a. m.	29.173	s.	60	Wind steady; no rain.
11, 10:15 a. m.	29.273	s.	40	Wind steady; no rain.
11, 10:30 a. m.	29.359	s. by e.	10	Wind steady; no rain.
11, 11 a. m.	29.452	sse.	10	Rain.
11, noon.	29.602	se. by s.	10	Rain.
11, 1 p. m.	29.686	se. by s.	5	Light rain.

The barometer used was a mercurial standard. The very heavy squalls were estimated up to 80 miles an hour. The calm lasted 27 minutes, from 9:15 to 9:42 a. m. The readings at 9 and 9:15 a. m. were taken with an aneroid, as it was too dark to read the standard in the closed veranda. The temperature in the open veranda was 79° at 6 a. m. and again at 11 a. m.; it fell to 76° in the closed veranda at 9 a. m.

(13) SAVANNA LA MAR.

By Mr. J. F. BRENNAN.

August, 1903.	Barometric pressure.	Wind.		Clouds.		Notes.
		From.	Miles per hour.	Kind.	From.	
	<i>Inches.</i>					
10, 7 a. m.	29.89	ne.	12	1 cirrus.	ne.	Squally.
10, 10 p. m.	29.82	ne.	12	10 nimbus.	?	Rain.
11, 7 a. m.	29.70	ne.	12	10 cumulo-nimbus.	nne.	Squally.
11, 8 a. m.	29.59	ne.	12	10 nimbus.	n. by e.	Rain.
11, 9:30 a. m.	29.46	nnw.	20	10 cumulo-nimbus.	nw.	Rain.
11, 10:30 a. m.	29.47	sw.	20	10 cumulo-nimbus.	sw.	Rain.
11, 11 a. m.	29.52	ssw.	30	10 cumulo-nimbus.	ssw.	Rain.
11, 11:30 a. m.	29.57	se.	35	10 cumulo-nimbus.	se.	Rain.
11, noon.	29.64	se.	35	10 cumulo-nimbus.	se.	Rain.
11, 12:30 p. m.	29.67	se.	29	10 cumulo-nimbus.	se.	Rain.
11, 1 p. m.	29.68	ese.	30	10 cumulo-nimbus.	se.	Rain.
11, 5 p. m.	29.76	se.	30	10 cumulo-nimbus.	se.	No rain.
11, 7 p. m.	29.79	se.	20	10 cumulo-nimbus.	se.	Squally.

The barometric pressures were deduced from aneroid readings. The velocity of the wind was estimated.

III. GENERAL RESULTS OF THIS STUDY.

From the backing of the wind at Richings and at Vale Royal it appears that the center must have passed a little north of these places: also a little north of Linstead, Chapelton, and Christiana, south of Llandovery, but central over Brandon Hill, Montego Bay. A straight line from near the Morant Point light-house to Montego Bay satisfies these conditions, as shown in the accompanying chart, fig. 2.

From the observations made at Brandon Hill it appears that the worst part of the storm lasted for two hours, from 8 to 10 a. m., and hence the computed diameter of the destructive area of the hurricane was not more than 40 miles. If, therefore, we draw two lines on the chart parallel to the course of the center, twenty miles north and south of the course respectively, the area of destruction will be bounded by these lines.

We now see why the south coast of Jamaica from Old Harbor to Savanna la Mar did not suffer; it was outside the limit.

Again, Montego Bay was fairly sheltered from the northerly and southerly winds, so that the town was not injured; and Lucea was sheltered from the northwesterly and southerly winds and also escaped; but all along the north coast from Manchioneal to Falmouth the wind was tremendous, and there was considerable loss of life among the falling trees and houses. In many low-lying places the wind drove the sea ashore: and there is reason to suppose that had the center been moving slowly instead of at the high rate of twenty miles an hour, there would have been appalling loss of life from the invading sea.

At Kingston and Port Royal the storm began between 2 and 3 a. m. with the wind, it is said, from the NE.; about 5 a. m. it shifted to the W.; at 5:30 a. m. there was a lull; the barometer began to rise, and the wind worked round to the SE. Port Royal did not greatly suffer; and the chief damage in Kingston was confined to the telegraph poles and wires. The Daily Gleaner gave the following account of the appearance of the city at 6 a. m. :

At 6 o'clock Kingston presented a woful spectacle. The streets were utterly deserted. In some quarters there was not a sign of life. But on every hand stood out the evidences of the night's terrible visitation. Huge trees, landmarks of a score of years many of them, lay across the streets and lanes. Roofs of houses, broken windows, and fallen wires appeared in every thoroughfare. Right away up Orange street every telephone pole was down. Like so many broken masts they lay across the street, their net-work of wires in a tangled mass, all within reach of the hand. In some places the telephone, electric light, and tramway wires were mixed in inextricable confusion. All over the city it was the same. Streets and lanes were blocked by broken trees, fallen telephone poles, and other débris.

At Port Antonio the wind had been from the N. during the 10th, and it increased in violence until 3 a. m. on the 11th, when it blew a hurricane which lasted till 5:30 a. m. The wind was very violent; all the small and poorly built houses collapsed as a matter of course; several solidly built buildings, such as the hospital and the Tichfield School, were more or less destroyed, and of the five or six steamers in the harbor four or five were driven ashore. It may be inferred that full hurricane force was reached from the statement that trees were not merely blown down; they were uplifted with their roots and hurled along.

There was no lull. The nearest approach of the center to Port Antonio was fifteen miles, and according to the observation made at Brandon Hill the diameter of the calm area must have been about ten miles, so that at the nearest approach Port Antonio must have been ten miles from the northern edge of the calm area. No doubt the wind veered to NE. when the hurricane was strongest, and then to E. and SE.; but I have no note on this subject.

At Manchioneal the wind was equally strong. It com-

menced from the N., then veered NE., E., and SE., when it was said that "nothing could stand before its fury." The small town was destroyed. The houses, with very few exceptions, were either blown down or washed away by the waves, which came 100 yards ashore, and there was considerable loss of life.

Returning westward, Port Maria also suffered greatly. On the 10th the wind was from the N., and as night came on the wind increased. At 4:30 a. m. on the 11th the hurricane struck the town, and at 6:30 a. m. it was at its height. The sea rose, and in an incredibly short time it had swept over the entire eastern portion of Main street, across the Warner swamp land into Warner street, a thing unparalleled in the history of this ancient town.

At Falmouth the advance of the sea was so rapid that the correspondent of the Gleaner called it a "tidal wave," meaning, no doubt, one of those terrible waves due to earthquake shocks which often devastate the shores of countries liable to earthquakes. He writes:

The whole seaboard was devastated both by the hurricane and the tidal wave, which rose some twenty feet and rushed with a deafening roar up the streets, carrying fishing canoes and other small craft more than one hundred yards up the streets.

From inquiry made on the spot it appears that the sea rose somewhat rapidly and then rushed ashore, so much so, that Inspector Toole had great difficulty in removing his family from his quarters in the old barracks, which as the sea rose he considered untenable, but there was no such "tidal wave" as described above.

A very large number of poorly built houses were destroyed, a great deal of damage was done to more substantial houses, and as many as fifteen sloops were driven ashore or sunk.

The wind veered from NW. around by N. to E. and SE.; the storm was at its height between 8 and 9 a. m.; the nearest approach of the center was seven miles, so that Falmouth was just outside the northern edge of the central calm, and of course there was no lull.

From these few and brief descriptions of the storm at different places some idea may be formed of the enormous amount of damage done within the storm area; all the large plantations of cocoa palms along the north side and at the east end were destroyed; all banana cultivations, wherever situated, were ruined for a time; and throughout the length and breadth of the island a large proportion of fruit, pimento, and coffee trees were damaged or destroyed.

The record of the tide gage at Port Royal is very interesting; by comparing the height of the water on the 11th with the corresponding heights on the 10th and 12th,³ we get the results given in the following table:

		Inches.
August 11,	0 a. m., water level	1 below mean.
	1 a. m., water level	7½ below mean.
	2 a. m., water level	4 below mean.
	3 a. m., water level	1 below mean.
	4 a. m., water level	6½ above mean.
	5 a. m., water level	11½ above mean.
	6 a. m., water level	13½ above mean.
	7 a. m., water level	9 above mean.
	8 a. m., water level	5½ above mean.
	9 a. m., water level	6 above mean.
	10 a. m., water level	6½ above mean.
	11 a. m., water level	4 above mean.

It then fell to the mean again as before midnight.

It, therefore, appears that an advancing hurricane produces a wave in the height of the level of the sea; the height first falls when the hurricane is 80 or 100 miles away, and then rises, the greatest rise taking place at the time of nearest approach of the center; in this particular instance, the fall below mean was seven inches and the rise above mean thirteen inches.

Now, during the evening and night of August 10, the wind

²At Fort de France, Martinique, it also lasted two hours.

³To eliminate the small tidal effect.

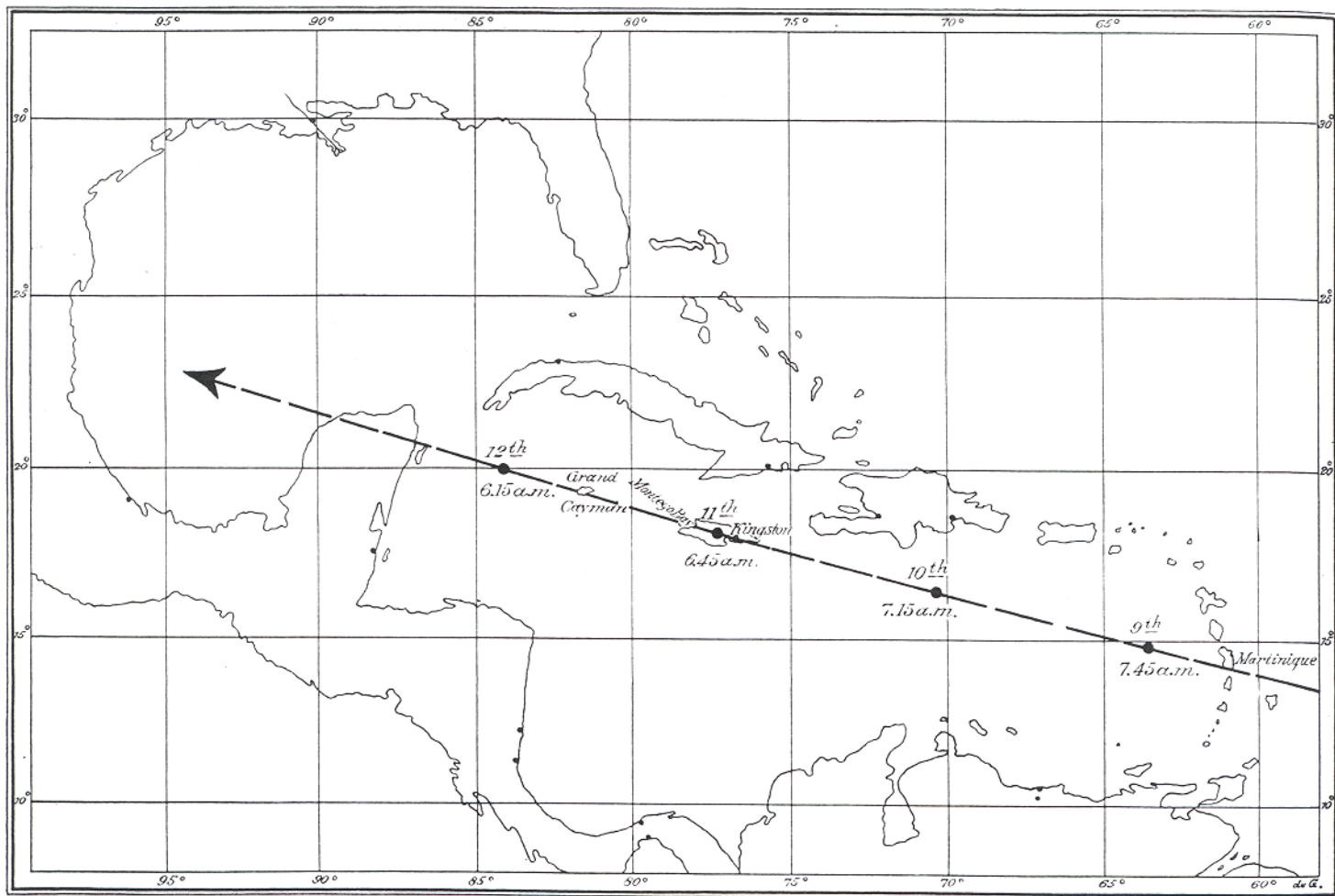


FIG. 1.—Position of the center of the hurricane from August 9 to 12, 1903, at Greenwich mean noon, with the approximate local times.

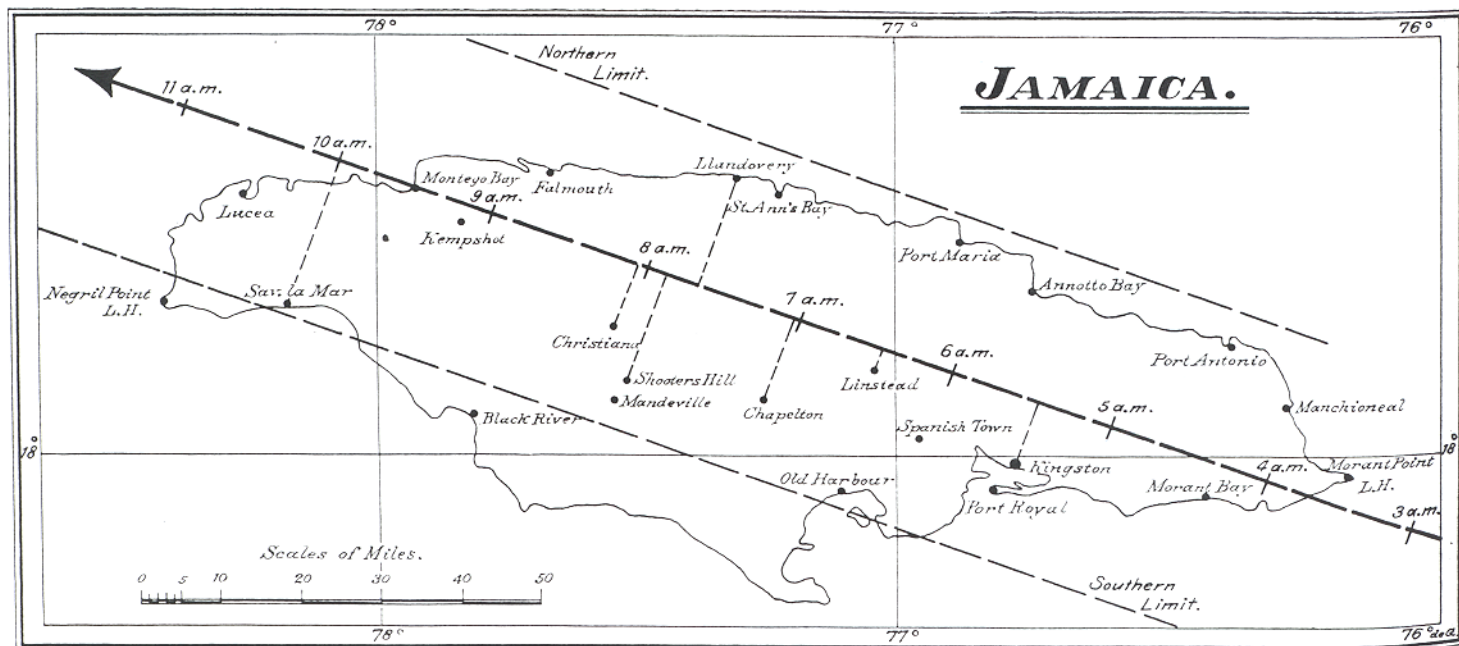


FIG. 2.—Positions of the center of the hurricane on August 11, 1903, for each hour of Kingston mean time.

set in from the N. at Manchioneal, Port Antonio, Port Maria, Falmouth, and no doubt at many other places on the north side of the island: this direction is in accordance with the cyclonic theory, but at Christiana, Montego Bay, and Savanna la Mar, the wind was NE.; so that the wind at these places had not yet felt the influence of the cyclonic center. Up to 11 p. m. on the 10th the wind was NE. at Christiana, when the center was 180 miles away, and we do not know when it backed to N.; if this was at 1 a. m., the center would have been 140 miles away.⁴

Now, as the wind had been N. nearly all day at Port Antonio, when the course of the center was much farther away, it is quite clear that the winds at places on the northern shore were far more susceptible to cyclonic influence than at places like Christiana, Montego Bay, and Savanna la Mar, where ranges of hills and forests interfered with the surface current; any local system of storm warning should embody this fact.

With regard to the NE. winds at Kingston and Port Royal at the commencement of the storm, it may be said that the wind at Kingston generally does show some irregularity as a hurricane approaches, due, I believe, to the Port Royal and Blue Mountain ranges, which rise to an average elevation of 5000 feet at a distance of not more than ten miles from Kingston, and protect the city and the harbor from all strong northerly winds.

The next point for consideration is the fact that the wind was much stronger on the north than on the south side of the island at the same distance from the center and within the storm area. It has been already noticed that the open sea allowed light winds to be readily affected by the cyclone at a great distance, but we are now considering the strength of the wind when near its full force.

Thus, at 6 a. m., there should have been a SSW. wind at Port Royal fully equal to any experienced on the north side of the island, which was not the case; and again at Savanna la Mar the wind never rose above 35 miles an hour. How is this to be accounted for?

The cyclonic theory no doubt presents many difficulties. Take, for instance, the motion of the calm area at the center: this is not produced by combining the motions of translation and rotation, for in that case the lowest pressure would not coincide with the calm area, which it invariably does. In the chart of this hurricane we could easily find a line south of the central line, where the wind was blowing from WNW. at twenty miles an hour; combining this with the velocity of the center toward the WNW. of twenty miles an hour, there would be a belt of calm far removed to the south from the belt of lowest pressure: but this was not the case.

Let C be the center of a cyclone, and let A and B be the positions of portions of the moving air in front and in rear of C , respectively:

$A, C, B:$

then we are to suppose that C was once at B , and that it will shortly be at A , and that the area of lowest pressure has proceeded from B to A with a wave-like motion, without thrusting the air in front of it or dragging it behind.

Dr. W. N. Shaw, Secretary of the Meteorological Committee of the Royal Society, has shown that if each portion of air within a cyclone simply moves at any instant in accordance with its position and distance from the center at that instant, then the effect of the motion of the center is to make the air (in such a cyclone as we are now considering) sweep in from the north to the central line and then turn sharply around the center, W., S., and SE., while the air south of the central line hardly approaches or even moves away from the center.

Consequently the mountain ranges referred to above and the ranges all along the middle of the island may have great effect

in diminishing the strength of W., S., and SW. winds at places south of the central line, especially when the motion of the center is large.

⁴Corresponding to a fall below mean pressure of 0.17 inch.

MONTHLY WEATHER REVIEW.

Editor: Prof. CLEVELAND ABBE.

VOL. XXXI.

SEPTEMBER, 1903.

No. 9

FORECASTS AND WARNINGS.

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

Two storms of marked intensity advanced from the subtropical region north of the West Indies to the Atlantic coast of the United States during the second decade of the month.

The regular morning reports of the 10th indicated the presence of a disturbance over the eastern Bahamas. By the evening of the 10th the center of disturbance had advanced to the vicinity of Nassau, New Providence Island, Bahamas, where a minimum barometer reading of 29.20 inches was reported at 7 p. m. Between 6 and 7 p. m. the wind at Nassau increased from an easterly direction to 60 miles an hour, when the anemometer cups blew away. The wind then went to southerly and reached an estimated velocity of 90 miles an hour. On New Providence Island the fruit crop was destroyed and much damage was caused to small buildings. At Cat Cay, Bahamas, a minimum barometer reading of 28.82 inches was reported.

During the 11th the hurricane center approached the southern Florida coast. At Jupiter the barometer fell from 29.88, at 8 a. m., to 29.63, at 6 p. m., and the wind increased from the northeast to a velocity of 78 miles an hour at 6:45 p. m. For one minute the wind blew at a rate of 84 miles an hour. At 11 p. m. the direction of the wind changed to east and the velocity began to decrease. At 1 a. m. of the 12th the wind veered to southeast and increased to 60 miles an hour, and at 7 a. m. the gale ended. The center of the storm passed about 50 miles south of Jupiter, and the greatest amount of damage

on the east Florida coast was caused in that region. The northern limit of destructive winds on the east coast was about 30 miles north of Jupiter. In the vicinity of Jupiter the losses were confined principally to pineapple sheds. From West Palm Beach to Miami the property loss amounted to about \$100,000. Nine lives were lost in the stranding and breaking up of the British steamer *Inchulva* at Delray. The vessel and cargo are said to have been valued at \$350,000. An oil barge was lost by a tug and blown on the beach at the lower end of Lake Worth; it was afterwards hauled off and the loss was estimated at \$5000. The schooner *Martha T. Thomas*, loaded with lumber, was blown ashore near Jupiter, and if the efforts that were being made to save the cargo were successful the loss did not exceed \$15,000.

During the 12th the storm center moved northwestward over the southern part of the Florida Peninsula and passed into the Gulf of Mexico. At Tampa the barometer fell from 29.68 at 8 a. m. to 29.42 at 1 p. m., and from 10:15 a. m. until after 2 p. m. the average wind velocity was about 40 miles an hour, with squalls at a rate of 50 to 60 miles an hour. In Tampa, buildings were destroyed or damaged to the extent of about \$200,000, and in the surrounding country great havoc was caused to orange groves.

The center of disturbance crossed the extreme northeast part of the Gulf of Mexico during the 13th, and at 8 p. m. was located east of Pensacola. At St. Andrews the barometer

is reported as having fallen from 29.80 at 7 a. m. to 29.08 at 4:15 p. m., with northeast wind that increased in gusts to about 60 miles an hour. From 4:15 to 4:45 p. m. the barometer was stationary, and then rose slowly with wind going to southwest. The wind had been west from 3:30 to 4:45 p. m., and at 4 p. m. reached an estimated velocity of 75 to 80 miles an hour. The wind continued strong from the southwest until the morning of the 14th.

During the 15th and 16th this storm practically dissipated over the east Gulf and South Atlantic States.

The warnings and advices issued in connection with this storm permitted all possible precautions to save exposed property, and comparatively little damage was caused to vessels.

Mr. C. E. Garner, President of the Jacksonville Board of Trade, has written as follows regarding the warnings:

I wish to express my appreciation of the timely warnings given by the Weather Bureau both at this point and at Tampa during the recent West Indian hurricane. They were especially valuable at Tampa, as I have steamers operating from that point to Manatee River and Terre Cela Bay points, and the notice we had from the Weather Bureau prevented our leaving port on Saturday the 12th. The observer at Tampa kept us fully advised as to the situation there, and his warnings to vessels not to leave port, in my judgment, prevented serious disasters. I think it is very fortunate for the agricultural and shipping interests of this State that we have such an efficient service of the Weather Bureau, and that the service is in the hands of such capable and accommodating officials.

The Tampa Evening Herald of September 15 comments editorially regarding the storm, and says, in part:

Too much credit for the saving effected can not be given to the Weather Bureau, and it is the intention of this article to direct public attention seriously toward one of the most valuable of the Government branches in this city.

The Weather Bureau observer at Jacksonville, Fla., reports that there is no doubt but that a large amount of property and a number of lives were saved by the timely display of the storm warnings. Ten vessels, the approximate value of which was one-quarter of a million dollars, remained in port at Jacksonville during the displays, and three vessels, valued at \$135,000, at Fernandina. Sponge and fishing vessels, valued at nearly \$200,000 and employing hundreds of men, remained in ports along the Florida coast, and the display of warnings undoubtedly saved many of these vessels and their crews. The observers at Tampa and Pensacola gave the widest possible distribution to the warnings and state that they were, as usual, well heeded.

The origin of the severe storm that visited the middle Atlantic coast on the 16th is obscure; it is probable, however, that it advanced northwestward from the subtropical region south of Bermuda. Evening reports of the 15th showed the presence of a disturbance off the North Carolina coast, but did not clearly indicate its intensity and subsequent course. Advancing northward during the night of the 15th, the disturbance was central near the southern New Jersey coast on the morning of the 16th. During the 16th the center of disturbance moved northward along the New Jersey coast and divided, one part apparently passing up the Connecticut Valley and the other northwestward over New York. During this day recorded wind velocities of more than 60 miles an hour occurred along the New Jersey, New York, and southern New England coasts. Although the area of this storm was small, it caused the loss of a number of lives and considerable destruction of property and crops. On account of high winds along the middle and north Atlantic coasts, storm warnings that were ordered on the morning of the 16th were continued during the 17th.

During the 28th a severe storm recurved northeastward over Bermuda. At 8 a. m. the barometer at Hamilton was 29.82 inches with a moderate east wind and rain. At 10:40 a. m. 29.60 inches, and at 12:20 p. m. 29.20 inches. At 2:20 p. m. a reading of 29.18 inches was reported, with barometer rising

rapidly. The wind, that had been increasing from northeast shifting to east, backed about 2 p. m. to northwest. The wind is reported to have attained hurricane force, uprooting trees, damaging houses, and destroying crops. The storm probably approached Bermuda from the east or southeast, or possibly it developed in the southern end of a trough of low barometric pressure that passed eastward from the middle and north Atlantic coasts of the United States during the night of the 27th. Its recurve northward near Bermuda was made on the eastern edge of an area of high barometric pressure that extended eastward from the Atlantic coast during the 28th. Moving northeastward from Bermuda this disturbance apparently united with an extensive area of low barometer that covered the British Isles during the closing days of September and the first week of October.

During the 10th and 11th a severe storm prevailed over the British Isles, the North Sea, and adjoining continental coasts, wrecking many vessels. During the 12th and 13th this storm passed eastward over continental Europe. From the 19th to the 21st a storm advanced from the ocean between the Azores and the coast of Portugal to the west coasts of the British Isles, where high but diminishing winds prevailed during the next two days.

The first storm of the month on the Great Lakes advanced from Kansas to the St. Lawrence Valley during the 9th and 10th. A storm that caused high winds over the western Lake region moved from Colorado to Manitoba during the 11th and 12th. A disturbance of moderate strength occupied the eastern Lake region during the 16th and 17th, and a storm of marked intensity moved eastward over the Great Lakes during the 25th, 26th, and 27th.

No severe general storms crossed the Pacific coast. On the 12th, 13th, and 23d high northwest winds occurred at coast points near San Francisco, Cal.

The month opened with prevailing dry weather in the interior of the Gulf and South Atlantic States, Tennessee, and Kentucky. On the 9th rain relieved to some extent the drought conditions in central Texas, and rains from the 13th to 15th broke the dry period in the eastern part of the cotton belt.

Frost occurred in the Northwestern States on the 4th and 5th, and in northwestern Ohio on the 6th. From the 14th to the 16th frost was reported in the corn belt as far south as northern Kansas, extreme northwestern Missouri, southern Iowa, and northern Illinois, and injury to corn, mostly in the lowlands, was reported in the Dakotas, Nebraska, and Minnesota. The occurrence of frost was, in each instance, announced in the forecasts.

Snow fell on the Continental Divide, Colorado, on the 7th, and at Butte, Mont., on the 8th. On the 15th heavy snow was reported in Wyoming.

During the second decade of the month flood stages were reached in the upper Mississippi River and tributaries.

came with a sudden rush from that direction, and the wind blew with great force until 6 a. m. of the 15th. I can not estimate the velocity of the wind, but it was very high; I had to hold myself on the boat by clinging to a stanchion with both arms, and the wheelman had to stand in front of the wheel so that the wind would blow him against the wheel and not away from it.

During the 15th the storm gradually moderated, and on the 16th the hatches, which had been closed for three days, were opened and 270 dead cattle were removed from a cargo of 613. It was by far the worst storm I ever encountered, and I have been a sailor all my life.

Abstract of log of steamship Jason.

Date.	Barometer.		Remarks.
	<i>Mm.</i>	<i>Inches.</i>	
1903.			
Aug. 13, 2 p. m.	762.0	30.00	Fine weather; light breeze from ene.; left Tampico.
4 p. m.	762.2	30.01	Fine weather; light breeze from ene.
8 p. m.	762.0	30.00	Do.
14, 12 midnight.	762.0	30.00	Fine weather; fresh breeze from ene.
4 a. m.	760.0	29.92	Cloudy; strong breeze nne.
5 a. m.	760.0	29.92	Do.
6 a. m.	759.8	29.91	Heavy rain; wind north, blowing up suddenly to storm.
7 a. m.	759.5	29.90	Heavy rain; wind north; storm; heavy sea.
8 a. m.	759.0	29.88	Do.
9 a. m.	758.0	29.84	Heavy rain; wind north, increasing to hurricane; heavy sea; warm and oppressive.
10 a. m.	757.0	29.80	Do.
11 a. m.	756.0	29.76	Do.
12 m.	755.0	29.72	Heavy rain; wind north, hurricane; heavy sea; warm and oppressive.
1 p. m.	752.5	29.63	Do.
2 p. m.	751.0	29.57	Do.
3 p. m.	750.0	29.53	Do.
4 p. m.	749.0	29.49	Do.
5 p. m.	747.0	29.41	Do.
6 p. m.	745.0	29.33	Do.
7 p. m.	744.0	29.31	Do.
8 p. m.	743.5	29.27	Do.
8:30 p. m.	742.8	29.24	Do.
9 p. m.	743.6	29.25	Dead calm.
10 p. m.	744.5	29.31	Hurricane.
15, 12 midnight.	745.0	29.33	Do.
4 a. m.	750.0	29.53	Do.
8 a. m.	759.0	29.88	Storm.
12 m.	761.5	29.98	Strong gale.

At 9 p. m. of the 14th a great calm, and then the wind turned from north through east to south. At 9:20 the cyclone came with a sudden rush from south, glass rising. Wind blew with terrible force right up to 6 a. m. of the 15th; after that time it went slowly down to storm, strong gale, and fresh breeze at 12 midnight of August 15-16. The sea was very rough at the time and there were heavy rain squalls all the time. During the hurricane the temperature of the air was about 31° Celsius, and before the hurricane it was not more than 27°-29° in the middle of the day. Sunday morning, the 16th, the wind was fresh breeze from east and the sea very moderate.

HURRICANE IN THE GULF OF MEXICO.

By Capt. J. ELLIGERS, jr.

Mr. W. C. Devereaux, Assistant Observer, Havana, Cuba, forwards the following report by Capt. J. Elligers, jr., captain of the Norwegian steamship *Jason*, with reference to the hurricane of August 14 and 15. The exact location of the vessel is not known, other than as given in the extract from Captain Elligers's report:

We received a telegram at Tampico on August 11 from the United States Weather Bureau, stating that a hurricane was approaching the Mexican coast, but, as the following day did not show any signs of the approach of the storm and as our boat was new and well loaded, we sailed with a cargo of cattle at 2 p. m. of the 13th, direct for Havana. The weather was clear, with a light breeze from the east-northeast and a normal barometer. After midnight of the 13th the wind increased to a brisk breeze from the north-northeast. At 6 a. m. of the 14th, when we were about 150 miles east of Tampico, a gale suddenly blew up from the north, with heavy rain, the barometer began to fall rapidly, and the sea became very rough. The wind continued from the north with terrible force until 9 p. m. of that day, but seemed to be strongest between 12 noon and 4 p. m.; the rain fell in torrents, the air was sticky and much warmer than on the preceding day, and the sea was very rough. The barometer reached the lowest point at 8:30 p. m., one reading 29.24 and the other reading 29.13 (they were together before the storm). From 9 to 9:20 p. m. there was a dead calm; the rain had stopped, but the sea was terrible; the only thing I can compare it to is the boiling water in a mammoth kettle. At 9:20 p. m. the wind turned to south, through east, and the storm

THE HURRICANE SEASON.

By ENRIQUE DEL MONTE, Chief of Central Station, Havana, Cuba.

[Translation of a circular letter from the Central Meteorological Station of the Republic of Cuba, dated July 23, 1903.]

It is well known to all that the hurricane or cyclone season of the Antilles embraces a period variable from one year to another, and that the period of duration also varies with regard to its beginning and its ending, although the date of the latter is subject to more regularity than that of the former.

In fact in some years the cyclonic activity manifests itself in June (and even in May, as it happened in 1889), and continues until the end of October; in other years it begins in July and even in August, but terminates in October. This does not mean that every year there will be hurricanes which pass more or less near to us. Some years are recorded in which there has not been any real cyclonic activity, although this is rarely the case; thus during the past year there were no storms that properly deserved the name of hurricanes.

Up to this date the cyclonic activity has not commenced this year, nor does the upper current of the atmosphere appear to indicate that its beginning is near, although conditions may afterwards vary with relative rapidity and may almost unexpectedly inaugurate the hurricane season.

But whatever may be the date at which cyclonic activity begins, tropical hurricanes in their progress are subject to the two following empiric laws:

1. The place of formation of a hurricane is variable, being intimately connected with the time of the year in which storms originate.

2. The hurricane once formed advances in a route or trajectory that varies both with the different periods of the cyclonic activity and with geographical latitudes.

The practical generalization of the two laws we have just mentioned is due to the sagacity and perseverance of one of the highest authorities of modern times in matters relating to hurricanes of the Antilles (we allude to the deceased Father

Viñes). It is clear that there should be such laws, and in fact they are known to all who devote themselves to this study. But it is the duty of the official scientific center, of which we are now in charge, to keep all advised, and in particular seamen who navigate the hurricane region as to the practical utility of the two laws of cyclonic formation and translation which we have just enunciated.

In this matter we believe that nothing can be lost, but, on the contrary, much can be gained by repeating at this time what has long been known to many, but also perhaps unknown to some.

With respect to the first law we derive the following practical conclusions:

1. The hurricanes in August are formed generally to the eastward, very near the Cape Verde Islands. At first they move westward and a little northward, and in the neighborhood of the Windward Islands, pursue a west-northwest direction. The recurve is generally effected by these hurricanes within a zone between the meridians of New Orleans and Puerto Plata, and between 29° to 33° of north latitude.

2. The hurricanes of September originate between Barbados and St. Thomas. The recurve is generally effected between the meridians of Cape Masi (74° W.) and the State of Texas, and between the 27° and 29° of north latitude.

3. The hurricanes of the first decade of October sometimes form in the Windward Islands, or in the eastern part of the Caribbean Sea. These recurve between 23° and 26° of north latitude, in a zone limited by the meridians of Matanzas (82° W.) and Cape Catoche (88° W.). They come very close to Cuba and pass through the western provinces, or the Yucatan Channel.

Consequently the hurricanes described in the three preceding paragraphs always come to Cuba from a great distance and give us plenty of time to take the precautions necessary to diminish their ravages. It is the duty of the observers in the extreme Windward Islands to discover them and announce their formation to us. The Weather Bureau of the United States is in an excellent position to perform this service, inasmuch as during the hurricane season it keeps up, at a heavy expense, five regular stations which communicate by cable twice a day to Washington the state of the weather in the central region of storm formation.

Should any cyclones occur this year during August, September, and the early part of October, the five Weather Bureau observers just referred to will first report them, as they form what may be called pickets or outposts. During these months they will have hard work. As for ourselves we have only to be attentive and wait for the first information from them, as the Republic of Cuba does not yet possess meteorological stations outside of the island. On the other hand, however, from the date of first advice until the end of the hurricane season, the task of discovering cyclones falls altogether upon the observers who are in our zone, as the storms always originate in the vicinity of the Island of Cuba.

4. The hurricanes of the second decade of October commonly originate to the southeast of Havana, some, however, form in the neighborhood of Central America. The recurve is generally made between 20° and 23° north latitude, and in the second branch of their paths they cross the western provinces between Matanzas and Pinar del Rio.

5. The cyclones of the third decade of October originate very near to Central America. They recurve very far to the south, and in the second branch cross the western part of the island of Cuba with great and increasing velocity. These are the hurricanes that demand most attention and care, since although discovered a long time in advance yet we may within a few hours find ourselves in the very center of the storm.

Passing now to the practical generalization of the second of the laws cited at the beginning of this article, or that relative to the routes or normal trajectories of hurricanes, according to the different divisions of the period of cyclonic activity, we deem it better and more profitable to reproduce exactly the paragraphs devoted to this matter by Father Viñes in his last and celebrated work on tropical hurricanes.¹

The law that I have just expounded (that of general routes or trajectories) indicates to seamen the most dangerous zones during the hurricane months and which zones they should endeavor to avoid as much as possible; or if they must pass through them, should try to ascertain, if possible, whether the course is clear of danger or not. If they must navigate the zones described, they should be on the watch for the first indications of a cyclone, in order to take the necessary precautions in time. Leaving the application of this law to the prudence of the mariner, as circumstances may dictate and their courses permit, I will mention several practical cases that may arise.

Sailing vessels making a voyage between South American ports and Havana in the month of August may do so through the Caribbean Sea without danger. In July and September it is also advantageous to sail through the Caribbean Sea, provided they sail in low latitudes; near the Yucatan Channel they must proceed with great care. In the month of October it is very dangerous to make the voyage via the Caribbean Sea, but it may be made to the northward of Porto Rico without probable danger until quite close to Havana.

The voyage from Havana to Spain by steamer through the new channel is not dangerous if made with care. Upon leaving Havana, through telegrams received from the Windward Islands and observations made in the island of Cuba, the captain of the ship may, in the greater number of cases, be kept informed of the best date and be assured of safety while passing through the channel. Once to the north of it, he should work to the east, sailing south of the Bermudas, and within forty-eight hours after leaving Havana he will have crossed the zone frequented by the August hurricanes and will have entered the anticyclone of the Atlantic, with the advantage that if any cyclone should reach him during his voyage, it will pass at some distance to the north, and he can utilize its winds for his voyage. The navigator may object that he will thereby lose time, but he would probably lose much more if he should meet a cyclone. There was a distinguished captain in the Lopez Line who always took this course, and he never regretted it.

Steamers that leave Havana in August for New York, and vice versa, should utilize the Gulf Stream by keeping toward the eastward or right of the current on the northward journey; and on leaving New York for Havana they should not try to avoid the current by nearing the coast of the Gulf of Charleston, but sail easterly, or on the right of the stream. This offers two advantages, the first is that they avoid the part of the route most frequented by August hurricanes, and the second is that they escape being caught between the path of the cyclone and the coast, as happened with the horrible shipwreck of the *City of Vera Cruz*. By sailing away from the stream in an easterly direction navigators have an open sea, and when a hurricane threatens them, if they see that it is going to recurve to the Gulf of Charleston, they may tack under advantageous conditions. If they see that it is recurving farther to the eastward, they can continue their voyage by following the channel, thus utilizing the winds of the cyclone.

The September hurricanes in a voyage to Spain are even easier to avoid, because they either recurve on the coast of Texas, or else recurve in Florida or its vicinity, and these can be avoided, provided that upon leaving Havana the captain knows that he has time to enter the channel without danger.

The voyage from Havana to Porto Rico and vice versa, in September, and especially at the beginning of that month, is very dangerous, because it is exactly in the path of the hurricanes. This voyage should be avoided as much as possible.

The captains of vessels leaving Santiago de Cuba for the United States in August and September, and having to enter the hurricane zone, should not sail without first ascertaining whether there are any indications of a cyclone to windward. Several ships have been saved from great damage by taking this precaution.

Finally, if the master of a sailing vessel navigating in the Gulf of Mexico in the month of October, finds himself in the eastern part of the Gulf, and detects indications of the proximity of a cyclone, he should at once head to the southwest, and if in the vicinity of the Yucatan Channel, he should sail toward the Gulf of Campeche, because these cyclones generally recurve before they pass the meridian of Cape Catoche or that of New Orleans.

¹ See B. Viñes Investigation of the Cyclonic Circulation and the Translatory Movement of West Indian Hurricanes. Weather Bureau, Washington, 1898.