WEATHER ON THE ATLANTIC AND PACIFIC OCEANS

NORTH ATLANTIC OCEAN

By F. A. YOUNG

The weather over the North Atlantic during August presented few unusual features over the extratropical regions where approximately normal conditions prevailed.

There were two tropical disturbances during the month; the first was in the vicinity of Turks Island on the morning of the 5th and following the usual northwesterly path, struck the southeast coast of Florida on the 7th. On the 5th and 6th this disturbance was of a comparatively moderate nature, but on the 7th winds of hurricane force were reported by vessels near the center. The disturbance continued in its northwestward course until near the thirtieth parallel and eighty-third meridian on the 9th, when it began to recurve, and moving over the land, passed out to sea near the Virginia Capes on the morning of the 12th, with moderate to strong gales along the coast between Hatteras and New York.

The second disturbance was central near Jamaica on the 11th, and on that day strong easterly gales were encountered in the northerly quadrants as shown on Chart XII, and also by the report from the American S. S. *Bogota* in table. This disturbance decreased in intensity as it moved in a north-northwesterly direction, and was accompanied by comparatively moderate winds on the three succeeding days. On the 13th the center was off the southwest coast of Florida and on the 14th near Apalachicola. From this point it began to recurve slightly toward the east and gradually filled in as it moved over the land.

WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

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The outstanding feature of the weather during September was the tropical hurricane that prevailed during the second decade of the month. This storm may be classed as one of the most severe on record and is fully described elsewhere in the REVIEW. A map of the track is also shown and Charts VIII to XV, which cover the period from the 11th to the 19th, give an idea of the extent and intensity of the hurricane, as well as of the conditions which prevailed over the northern portion of the ocean.

The number of days with gales was considerably above the normal over the eastern section of the steamer lanes, as they were reported on 6 days in the squares between 45° to 50° N., and 20° to 30° W. West of the 40th meridian, gales of extra-tropical origin occurred on from 1 to 3 days.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, 8 a. m. (seventy-fifth meridian). North Atlantic Ocean, September, 1928*

Stations	Average pressure	Departure [1]	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.73	[2]	30.36	27th	29.16	1st.
Belle Isle, Newfoundland	29.88	−0.02	30.14	20th	29.64	29th.
Halifax, Nova Scotia	30.07	+0.06	30.50	20th	29.76	22d.
Nantucket	30.05	+0.01	30.36	6th	29.70	26th.
Hatteras	30.01	−0.02	30.20	5th [3]	29.30	19th.
Key West	29.93	−0.04	30.10	1st	29.58	17th.
New Orleans	29.98	−0.01	30.10	9th	29.82	18th.
Cape Gracias, Nicaragua	29.84	−0.04	29.94	1st	29.76	16th. [3]
Turks Island	30.02	+0.05	30.10	1st [3]	29.86	14th. [4]
Bermuda	30.14	+0.09	30.34	6th	29.84	23d.
Horta, Azores	30.10	−0.06	30.44	9th	29.58	25th.
Lerwick, Shetland Islands	29.97	+0.13	30.34	15th	29.72	6th.
Valencia, Ireland	30.08	+0.09	30.48	15th	29.54	28th.
London	30.12	+0.12	30.35	15th	29.61	28th.

[1] From normals shown on Hydrographic Office Pilot Chart, based on observations at Greenwich mean noon, 7 a. m., seventy-fifth meridian.
[2] No normal available.
[3] On other dates.
[4] Probably lower on 15th, which is missing.

The number of days with fog was apparently above normal along the New England coast, about normal over the middle sections of the steamer lanes, and somewhat below over the Grand Banks and off the European coast. From the 2d until the 5th a tropical disturbance of moderate intensity moved slowly westward over the Caribbean Sea. The American S. S. *San Benito* on the evening of the 4th ran into a severe squall off Cape San Antonio, accompanied by heavy rain and suddenly shiftings winds of a maximum force of 8, though the barometer readings varied but little during the night. The American S. S. *Norma*, in 20° 30′ N., 81° 07′ W., near midnight of the 3d, encountered a heavy ESE. to SE. squall of force 8 to 10, with a rough cross sea.

On the 5th a LOW was central about 10 degrees east of Belle Isle that afterwards developed into by far the most severe storm of the month in northern waters. On the 6th the steamer lanes between the fifteenth and forty-fifth meridians were swept by heavy gales, with a maximum force of 12, as shown by storm reports in table from the American S. S. *Tulsa*. By the 7th this disturbance had decreased considerably both in intensity and extent, although on that date moderate to strong gales were encountered between the twenty-fifth meridian and the Irish coast.

On the evening of the 9th a moderate depression was central near 27° N., 51° W., that moved slowly north accompanied by moderate winds until the morning of the 11th. By that date this LOW was near 40° N., 45° W., and had deepened considerably, with winds of force 7 near the center at the time of observation.

Chart VIII, for the 12th, shows the position of the tropical hurricane on that date and also that of the northern disturbance, just referred to, central near 43° N., 37° W. The latter LOW moved steadily northward and, as shown on Chart XII, was by the 16th near the coast of Iceland.

From the 17th to 19th conditions over the steamer lanes were comparatively quiet, but by the 20th a well-developed LOW of limited extent was central near 47° N., 40° W., accompanied by moderate northwesterly gales. On the 21st and 22d the center of this LOW was from 300 to 500 miles north of the Azores, and on both of these dates moderate gales were reported by vessels in the vicinity of these islands as well as in the eastern sections of the steamer lanes.

From the 22d to the 24th a depression was over the western portion of the Gulf of Mexico, although up to the time of writing no vessel reports have been received indicating a wind force higher than 6 in that region.

From the 24th to 30th moderate to strong gales were reported from the steamer lanes east of the thirtieth meridian, although the storm area varied considerably from day to day, reaching its greatest intensity on the 28th and 29th.

From the 25th to 29th there was also a comparatively slight disturbance in the vicinity of Newfoundland and Nova Scotia, with a maximum wind force of 9 at Belle Isle on the 26th.

Note.—American S. S. *Stanley*, Capt. C. H. Longbottom; observer, J. P. Hays. From Port Said to New York.

September 17, 12.50 p. m., ship's time. In 39° 25′ N., 63° 25′ W., a whirlpool about 500 feet in diameter passed vessel about 1 mile to the northward. Whirlpool was traveling to the eastward at about 20 knots and was churning up the water and sending up a column to a height of about 40 feet. Whirlpool seemed to be caused by an eddy of wind coming from a low dark nimbus cloud directly above it, with which it seemed to keep pace. It did not appear to be a waterspout in process of formation, as nothing but a fine spray was carried into the air. Barometer 30.12 inches. Dry-bulb, 91°, wet, 82°, water 80°.

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THE WEST INDIAN HURRICANE OF SEPTEMBER 10–20, 1928

By CHARLES L. MITCHELL

[Weather Bureau, Washington, October 31, 1928]

On the morning of September 10 the S. S. *Commack*, in latitude 17° N., longitude 48° 15′ W., reported a barometer reading of 29.94 inches with wind from the northeast, force 7. This was the first information received relative to one of the greatest hurricanes of record, although this hurricane undoubtedly formed near the Cape Verde Islands. Incidentally this report was received from a vessel about 600 miles east of the longitude of Bridgetown, Barbados, this being the most easterly vessel report concerning a tropical cyclone ever received by radio. At 2 p. m. the same date the S. S. *Clearwater*, in latitude 14° N., longitude 51° W., reported a barometer reading of 29.90 inches with wind from the northwest, force 5, and a pressure fall of 0.10 inch in 2 hours. At 8 p. m. of the same date the S. S. *Clarissa* in latitude 13° N., longitude 51° W., reported a barometer reading of 29.84 inches with wind from the west, force 6. The reports from these three vessels definitely established the fact that a tropical cyclone of unknown intensity was moving almost directly westward, being central at 8 p. m. nearly 600 miles east-northeast of Bridgetown. The following morning a report from the S. S. *Inanda*, in latitude 17° N., longitude 56° W., was received, the barometer reading 29.86 inches with wind from the northeast, force 10. By 8 p. m. pressure had begun to fall in the Lesser Antilles and the wind at Bridgetown, Barbados, had backed from northeast to northwest. The advisory warning issued that evening stated that the center of the tropical disturbance would likely pass over the Lesser Antilles north of Martinique on Wednesday (12th).

At 8 a. m. of the 12th the barometer at Roseau, Dominica, read 29.44 inches and the wind was 24 m. p. h. from the northwest. The path of the hurricane from Dominica to western Ontario, where it merged with an extratropical cyclone on September 20, is shown in Figure 1.

A report received by mail from Pte. á Pitre, Guadeloupe, shows that the center of the hurricane passed close to that place about noon of the 12th with a barometer reading of 27.76 inches (copy of barograph trace in fig. 2). No reports of damage accompanied the barometric data. However, press dispatches from Paris, France, indicate that great destruction was wrought by the hurricane in Guadeloupe, which is a French possession. The English islands of St. Kitts and Montserrat also suffered heavy losses. About 11 a. m. of the 13th the hurricane center passed near the S. S. *Matura*, in latitude 17° 35′ N., longitude 65° 10′ W., a short distance southwest of St. Croix, Virgin Islands, a barograph trace received by mail showing a minimum pressure of about 27.50 inches. A wind velocity of 90 m. p. h. was reported from St. Thomas, 50 miles north of the center, and the island of St. Croix

FIG. 1.—Track of hurricane, September 12–20, 1928

suffered heavily in loss of life and in damage to property and crops.

The hurricane crossed Porto Rico during the 13th, causing the loss of many lives and widespread destruction to crops and property. The report of the official in

charge of the Weather Bureau office at San Juan will be found immediately following this article.

After leaving Porto Rico, the direction of movement of the hurricane changed from west-northwest to nearly northwest, maintaining the latter course continuously at a rate of about 14.5 miles per hour until after it passed inland over the east Florida coast near West Palm Beach. There was little damage in the island of Haiti, although the center moved near, and almost parallel to, the northeast coast. This absence of reports of damage is not so remarkable, inasmuch as winds of hurricance force are seldom experienced more than a comparatively few miles to the south and west of the center of a hurricane. This is due to the fact that the pressure gradient is not so steep in these directions, except perhaps for a few miles from the center, as it is to the north and northeast of the center, where an area of high pressure usually lies.

Advisory warnings of the approximate location and direction of movement of the hurricane were issued twice daily beginning with the 11th. Repeatedly, these advisories stated that the storm was a dangerous one and that vessels in and near its path should observe the greatest caution. As a result, few vessels ventured within the danger zone and little damage and little loss of life at sea have been reported.

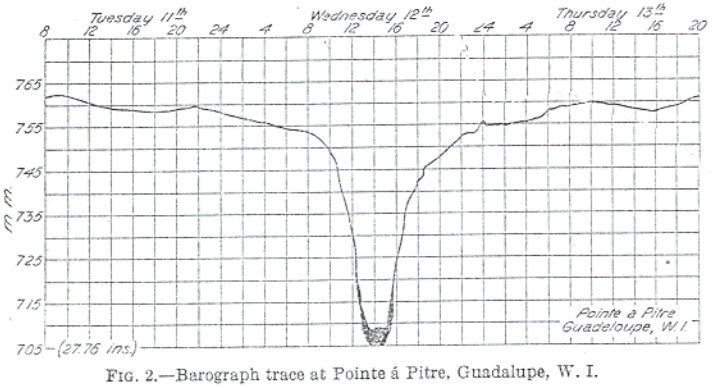

FIG. 2.—Barograph trace at Pointe á Pitre, Guadalupe, W. I.

On the morning of the 14th when the hurricane was central off the northeastern coast of Haiti, the advisory warning stated that the hurricane center would pass near Turks Islands, British West Indies, during the following night. At midnight the barometer at Grand Turk read 28.50 inches and the wind was 120 m. p. h. from the northeast. The following is from a letter received from George S. Frith, of Grand Turk:

Permit me to write and thank you for your very kind advices regarding this and past hurricanes. Without your reports and warnings I do not know, and can not even form the remotest idea, of what would happen to these islands. The hurricane that raged here all Friday night beats all that I know of. The center apparently passed about 9 miles south of our island, which is Grand Turk, and I fear that the Caicos Islands have suffered severely, no reports having been received from there up to the present moment (Sept. 16). No one but those who have passed through one can imagine what it is to witness one of these hurricanes. Two schooners are ashore and a total loss, but with crews saved. They were both consigned to our house and were loading fishery salt for Canadian ports.

The special observer of the Weather Bureau at Grand Turk reports that a sloop, recently built, and on her way to Grand Turk for measurement and registration, was lost, together with 18 lives, at Ambergris Cay.

It was evident the morning of 15th that the hurricane center would pass near Nassau, Sunday (16th) forenoon, and warnings were issued to that effect. Saturday night's advisory read, in part, as follows:

* * * This hurricane is of wide extent and is attended by dangerous and destructive winds. Its center will likely pass near or slightly north of Nassau, Sunday morning. Storm warnings are now displayed from Miami to Titusville, Fla. Winds of hurricane force are probable as far west as longitude 79 degrees (60 miles off the southeast coast of Florida) by Sunday noon. Recurve of hurricane's path not yet indicated.

In addition, the warnings sent to Miami and West Palm Beach stated that "every precaution should be taken (to-night) in case hurricane warnings should be found necessary Sunday on the east Florida coast." A thorough distribution of this information was ordered.

The German steamer *August Leonhardt* en route from New York to Puerto Colombia, was hove to in latitude 23° 10′ N., longitude 74° 10′ W., when the center of the hurricane passed over it about 3 p. m. of the 15th, the lowest barometer reading being 27.80 inches. Just previous to the arrival of the center the wind was north-northeast force 12 (and more). After the barometer had remained stationary and the wind had calmed down for a short time, the hurricane started again at 3:10 p. m., this time blowing from the south-southeast, according to the report of Second Officer R. Sievers, "with an undescribable force. The force of the wind, if more or less, could only be judged by the noise made by the storm, which reminded me of the New York subway going full speed passing switches. Rain and spray were carried away horizontally and our whistle started to blow loudly due to the force of the wind pressing the wire. The foam and spray went up to the masthead (40 meters above the water), this being proved by our antenna and insulators which we had to take down in order to clean off the salt. Hatch tarpaulins, boat ventilators, covers, etc., were torn to pieces and carried away. It is impossible to describe the sea and swell. Spray, rain, and foam was so dense that we could not see our forecastle head."

Continuing in a practically straight course from Porto Rico to Lake Okeechobee, Fla., the center of the hurricane passed near but slightly north of Nassau, Bahamas, on the morning of the 16th. The following excerpt is from the report of Mr. D. Salter, Meteorological Recorder at Nassau:

* * * At 10 p. m. (15th) the corrected barometer reading was 29.50 inches, with overcast sky, and wind northeast 40 miles and freshing rapidly. At midnight the barometer had fallen to 29.35 inches and was still dropping rapidly, overcast sky, and wind northeast 55 miles. At 1:30 a. m. of the 16th the barometer was 29.22 inches, wind northeast 65 miles and increasing, accompanied by rain. Two a. m. saw the barometer down to 29.00 inches and falling every minute, wind still northeast 75 miles, with rain. The 4 a. m. barometer was 28.25 inches, with wind shifting to northwest by west 100 miles. The recording speed register ceased to function at 3:30 a. m., owing to the anemometer cups blowing away while recording 96 miles wind speed. At 5 a. m. the barometer reached its lowest point, 28.08 inches, wind southwest estimated velocity 110 to 120 m. p. h., and heavy rain. By 6 a. m. the barometer had risen to 28.50 inches and a considerable fall in the wind speed had taken place, although still blowing from the southwest, with heavy gusts, accompanied by rain. * * * The total rainfall during the passing of the disturbance amounted to exactly 9 inches.

* * * Although considerable damage was done to property and to a lesser extent to crops, no loss of life occurred, probably owing to the precaution taken as a result of the numerous early warnings received by wireless telegraphy and made public.

The following warning was issued the morning of the 16th:

Hoist hurricane warnings 10:30 a. m. Miami to Daytona, Fla. * * * No report this morning from Nassau. Indications are that hurricane center will reach the Florida coast near Jupiter early to-night. Emergency. Advise all interests. This hurricane is of wide extent and great severity. Every precaution should be taken against destructive winds and high tides on Florida east coast, especially West Palm Beach to Daytona.

Later in the day storm warnings, which had previously been displayed, were changed to hurricane warnings on the west coast from Punta Rassa to Cedar Keys, and on the 17th north of Cedar Keys to Apalachicola, and north along the east Florida coast as far as Jacksonville.

The center of the hurricane reached the coast in the Palm Beach section about 7:00 p. m. of the 16th. A copy of a barograph trace furnished by the American Telephone and Telegraph Company and which was made in their office at West Palm Beach is reproduced in Figure 3. The corrected sea-level reading is 27.43 inches, 0.18 inch lower than at Miami during the hurricane of September 18, 1926, and is the lowest pressure ever recorded in the United States during a hurricane.

The hurricane moved northwestward over the Florida Peninsula, its center passing over Lake Okeechobee during the early night of the 16th and near and slightly east of Bartow about 7:00 a. m. of the 17th. Its course changed to north-northwest after leaving the Bartow section, and, after passing between Ocala and Cedar Keys it turned toward the north-northeast, passing a short distance west of Jacksonville about 1:00 a. m. of the 18th.

No detailed report of damage along the east Florida coast has been received. The following is the report, in part, of the official in charge of the Weather Bureau office at Miami:

* * * The damage at Miami was negligible, being confined principally to a few plate-glass windows and to awnings. Hollywood and Fort Lauderdale escaped with only slight structural damage to buildings, the most serious losses being from water damage, resulting from broken windows and leaking roofs. A few thousand dollars will cover the losses at both places.

From Pompano north to Jupiter, especially at Delray, Lake Worth, Palm Beach, West Palm Beach, and Kelsey City, there was serious structural and water damage, the losses being greatest at Palm Beach and West Palm Beach. There has been no authentic statement as to the total losses, but they amount to several million dollars.

In the Lake Okeechobee region, the great loss of life and the damage to property were caused by the overflowing of the lake along the southeast shore, principally at Belle Glade, Pahokee, and South Bay. The small houses in those localities were washed away or inundated, and approximately 2,000 persons were drowned. In addition to the immediate losses caused by the storm, practically the entire Everglades region south of Lake Okeechobee has been flooded, making it impossible for growers to prepare the land for the usual early winter crops. This condition represents one of the largest items in the list of losses resulting from the storm.

One of the noteworthy features in connection with the storm was the absence of serious structural damage to substantial buildings. This was also particularly noticeable after the Miami hurricane of September 18, 1926. These two hurricanes, both of major intensity, have shown that buildings properly constructed will not suffer serious structural damage from hurricanes, and that the use of storm shutters will prevent practically any damage to such buildings. This statement applies to frame buildings as well as to those constructed of steel, concrete, brick, or stone.

The hurricane center was of great diameter, the lull attending the passage of the center occurring over a path 25 miles or more in width, while in the Miami hurricane of 1926 the diameter of the center was about 13 miles.

* * * The information that the storm would likely pass inland near Jupiter, moving northwestward (toward Okeechobee) was telephoned to the lake region by this office and by Miami firms having interests along the south shore of the lake. Mr. Frank Schuster, who was located at South Bay, near Belle Glade, visited this office several days after the storm and stated that he had warning in sufficient time to enable him to make many automobile trips in the vicinity of South Bay for the purpose of collecting the white residents and moving them to a large barge. With the assistance of other men, he saved the lives of 211 men, women, and children.

The hurricane apparently reached Lake Okeechobee with little diminution in intensity. Complete barometric and wind data during the storm were furnished by Mr. B. A. Bourne, who is in charge of the breeding work at the Bureau of Plant Industry's sugar cane breeding station located on the shore of Lake Okeechobee about one-half mile northward from Canal Point. The barometer fell rapidly with a corresponding increase in the wind velocity after noon of the 16th. At 5:00 p. m. the barometer was 29.17 inches and the wind 40 m. p. h. from the north; at 7:48 p. m., the barometer was 28.54 inches and the wind 60 m. p. h. from the northwest; and at 8:15 p. m. the anemometer cups blew away after the velocity reached 75 m. p. h. from the northwest, the barometer at this time reading 28.25 inches. By 9:00 p. m. the barometer had fallen to 27.87 inches with an estimated wind velocity of 150 m. p. h. from the northwest. There was a dead calm between 9:30 and 10:00 p. m. when the center passed over the station, the lowest barometer reading being 27.82 inches at 9:45 p. m. Shortly after 10:00 p. m. the barometer began to rise and the wind immediately came with hurricane force from the southeast, reaching an estimated velocity of

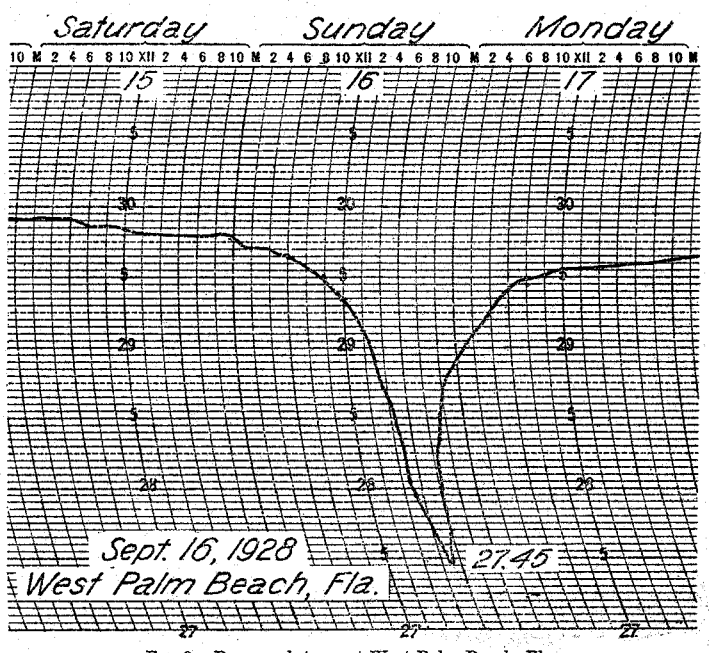

FIG. 3.—Barograph trace at West Palm Beach, Fla.

160 m. p. h. about 10:45 p. m. The wind force decreased rapidly after 11:00 p. m.

The following, relative to the progress of the hurricane over Florida, is quoted from the report of the section director of the Weather Bureau at Jacksonville:

* * * Whole gale to hurricane velocities prevailed over the southeast coast and inland from Miami to the south-central and central portions of the peninsula during the night of the 16th, and whole gale to hurricane velocities over much of the interior of the peninsula during the 17th; and gales on the 18th as the storm center moved north-northeastward from the vicinity of Lake, Polk, and Sumter counties near the point of recurve. An appreciable diminution in velocity obtained about the time of recurve, it seems, although sharp, fitful gales, characteristic of hurricanes, featured the storm throughout its course.

A velocity of 100 m. p. h. (or more) seemingly occurred at West Palm Beach, Palm Beach, and Lake Worth. * * * The following velocities occurred at regular Weather Bureau stations: Jacksonville, 48 E. extreme velocity, 56; Miami, 60 W., extreme velocity 78; Key West, 39 W.; Fort Myers, 51 NW., and Tampa, 31 N. Apalachicola and Pensacola were not materially affected by the storm.

The lowest barometer readings at regular stations were as follows: Jacksonville, 28.90; Miami, 28.97; Tampa, 28.98; Fort Myers, 29.14, and Key West, 29.48 inches. The lowest unofficial reading reported north of Lake Okeechobee was 28.54 inches at Bartow.

* * * After September 10, twice daily, warnings were received culminating in the display of hurricane warnings on both coasts. All warnings were correct and timely, and their distribu-

tion effective and valuable. The history of this hurricane is a melancholy one, associated as it is with the tragic ending of nearly 2,000 lives on Lake Okeechobee, whose waters attained a height of 10 to 15 feet as they were forced southward and impinged on the shallow rim of the lake. The damage to property, greatest at Lake Worth and the beaches, approximated millions. The total property loss at West Palm Beach, Palm Beach, and other places in Florida affected and relieved by the Red Cross is given as $25,000,000, which seems high.

On October 28 Red Cross officials announced their official casualty estimate, placing the number of dead at 1,836, and of injured at 1,870 for the entire storm area in Florida. The detailed casualty list is as follows: West Palm Beach area (from Jupiter to Delray Beach), 26 dead, 1,437 injured; Broward County, one dead, 51 injured; Palm Beach County, 1,700 dead, 265 injured; Okeechobee County, 25 dead, none injured; other territory, 84 dead, 67 injured. A total of 10,172 families had registered with the Red Cross applying for aid up to October 28, about two-thirds of this number being in Palm Beach County.

After leaving Florida the storm decreased steadily in intensity as it moved close to the Georgia and South Carolina coasts and passed into North Carolina the night of the 18th–19th. On the 19th its course again changed to north and later toward the north-northwest, diminishing greatly in intensity and merging with another disturbance over Ontario during the 20th. No material damage has been reported from the Coast States north of Florida.

SAN FELIPE [1]—THE HURRICANE OF SEPTEMBER 13, 1928, AT SAN JUAN, P. R.

By OLIVER L. FASSIG, IN CHARGE

[Weather Bureau Office, San Juan, P. R.]

On Tuesday morning, September 11, a message was received from the Weather Bureau Office in Washington announcing a tropical disturbance in latitude 15° N. and longitude 50° W. There was no evidence of a disturbance on the morning map of the 11th. At 3 p. m. upon receipt of special reports, changes in wind direction at St. Lucia and Barbados were signs of an approaching tropical disturbance. At the same time a radio report to Barbados from the S. S. *Inanda* was intercepted by the Ensenada radio station indicating that a storm of considerable intensity was raging over the Atlantic about 300 miles east of the Leeward Islands. These were the first indications of the approach of a storm toward Porto Rico. The vessel report was incomplete making it impossible to locate the center of the storm accurately. At the time of the evening observations of the 11th the lowest barometer reading was 29.76 inches at Barbados.

At 8 a. m. of the 12th a well-formed cyclonic disturbance was evidently centered to the east of Dominica, which reported a northwest wind of 20 miles per hour and a barometer of 29.50 inches. At 1 p. m. of the 12th the lowest barometer was 29.32 inches with a west wind of 40 miles per hour, at Dominica.

As September storms usually move in a west-northwest direction at an average speed of 12 to 13 miles per hour, the San Juan radio broadcast of Tuesday evening stated that the storm would move west-northwest and that the center would probably pass south of the Island of Porto Rico Wednesday night or Thursday morning. This information was broadcast from the naval radio station at San Juan every 2 hours from 8 p. m. Tuesday night. The warning was telegraphed to the 75 police districts of Porto Rico and otherwise given general distribution over the island. Observations from the Lesser Antilles on Wednesday morning still indicated that the vortex of the storm would pass at some distance south of Porto Rico. Information contained in the 6 p. m. observations of Wednesday the 12th indicated that the storm was centered farther northward than was anticipated and that the center would probably pass directly over the Virgin Islands and Porto Rico. This information was given prompt distribution throughout the island. At the same time hurricane warnings were ordered up at St. Thomas and at 12 ports along the coast of Porto Rico.

The storm broke over the southeastern portion of the Island early Thursday morning with the center near Guayama and passed across the island in a west-northwest direction, leaving between Aguadilla and Isabela. The storm center moved across the island in about 8 hours at the rate of 13 miles per hour. The barometer, as the center passed to the south of San Juan at 2:30 p. m., registered the very low reading of 28.75 inches (28.81 inches reduced to sea-level). (See fig. 1). At Humacao on the east coast of Porto Rico a reading of 28.04 inches was recorded at 1:50 p. m. Ponce reported 28.27 inches at 4:30 p. m.; Arecibo on the north coast 28.75 inches at 3:30 p. m.; Isabela on the northwest coast 27.80 inches at 9 p. m.; Mayaguez on the west coast 28.60 inches at 8 p. m. Guayama on the southeast coast reported the lowest barometer (27.50 inches) at 2.30 p. m. (27.65 inches reduced to sea-level). Guayama, Cayey, and Aibonito reported a period of calm or light winds lasting 20 to 30 minutes, indicating that the storm center passed over these towns.

The steamship *Matura* of the Trinidad Line reported a barometer of 27.50 inches (sea-level) about 10 miles south of the island of St. Croix. As a reading of 27.72 inches was reported at West Palm Beach, Fla., it would seem that the intensity of the storm remained about the same from the Lesser Antilles to Florida—a distance of about 1,700 miles. The storm center apparently kept its initial course west-northwest until it reached Florida, with an average progressive movement of 13 miles per hour, when the path turned to the northwest over Florida, then northward and northeastward across New York State on the 20th.

Rainfall.—The rainfall of the 13th and 14th was the heaviest ever recorded in Porto Rico during the past 30 years. Unfortunately reports from the special observers of the Weather Bureau showed a high percentage of overturned rain gages. In addition, the great velocity of the winds made it impossible to register more than 50 to 75 per cent of the amounts which actually fell. Along the coast the rainfall was generally below 10 inches. In the regions of greatest normal rainfall—the vicinity of Adjuntas in the Central Cordillera and in the Luquillo Mountains the amounts exceeded 25 inches. The approximate distribution of rainfall is shown in Figure 3. Adjuntas, in the central mountain region, reported the phenomenal fall of 29.60 inches, a record which will have to be examined more carefully before being finally accepted. At San Juan the rain gage was overturned before the height of the storm was reached and probably only 50 per cent of the total amount which fell was recorded. It is estimated that the amount should be approximately 10 inches.

[1] It is customary in Porto Rico to name a hurricane after the particular saint's day on which it happens to occur.—*Editor.*

Winds.—At 11:44 a. m. of the 13th the anemometer at the office of the United States Weather Bureau in San Juan lost one of its cups—just after recording a maximum velocity (the greatest velocity in 5 minutes) of 150 miles per hour, and an extreme velocity (the highest velocity in 1 minute) of 160 miles. These velocities probably exceed all official records of the Weather Bureau for similar storms. San Juan was about 30 miles from the storm center when these velocities were recorded. Estimates of 200 miles per hour near the center of the storm appear to be not much overdrawn. At San Juan the storm increased in intensity for 3 hours after the record of 150 miles was made. Most of the damage to property on the Weather Bureau Reservation occurred

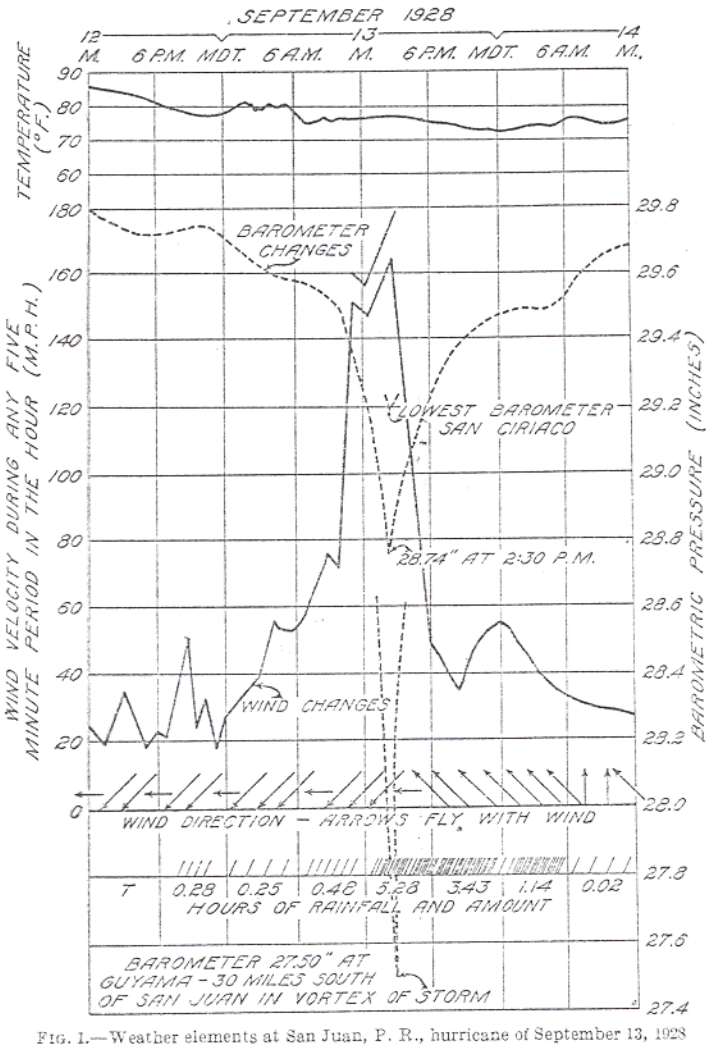

FIG. 1.—Weather elements at San Juan, P. R., hurricane of September 13, 1928

between 2:30 and 3:30 p. m. The balloon shed collapsed at 2:30 p. m. The residence of the official in charge began to lose portions of the roof about the same time and the entire roof and the ceilings were carried away by 3:30 p. m. With only two cups the anemometer still recorded about 75 miles per hour. The second cup disappeared at 12:47 p. m. The arms and the shaft of the anemometer with one cup still attached were blown away at 1:33 p. m.; these parts were later found at San Antonio docks, a distance of a third of a mile to the southwest of the weather bureau wind tower.

The nearest approach to the intensity of San Felipe was San Ciriaco on the 8th of August, 1899. The paths of these two storms across Porto Rico were almost identical. The highest velocity of the wind recorded at San Juan during San Ciriaco was 75 miles per hour on a 4-cup anemometer. The 3-cup anemometer in service at San Juan during the recent storm registers 30 per cent less than the 4-cup variety at velocities in excess of 100 miles. In other words, the 4-cup anemometer formerly used at Weather Bureau stations would have registered not less than 190 miles at San Juan on the 13th at the time the anemometer lost 1 cup.

During the storm of San Ciriaco on August 8th, 1899, it was estimated that fully 3,000 lives were lost during the progress of the storm across the Island of Porto Rico. Most of these fatalities were caused by floods. Loss of life during the recent storm of San Felipe will not exceed 300, due mostly to the fact that the approach of the storm was announced in time to take necessary precautions against loss of life. The lowest barometer reading recorded in 1899 was 27.75 inches at Guayama. The lowest recorded during the recent storm was 27.65 inches at Guayama. The center of the storm passed over the northern portion of the French Island of Guadeloupe in the Lesser Antilles—moved west-northwestward, passing about 10 miles to the south of St. Croix in the Virgin Islands. It entered Porto Rico along the southeast coast and left it on the northwest coast—passed to the north of Santo Domingo and Haiti—doing very little

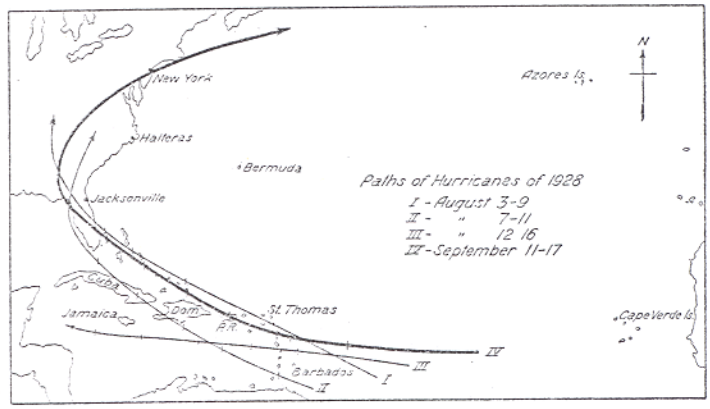

FIG. 2.—Path of hurricanes of 1928

damage in these islands; passed to the south of Turks Islands and Nassau in the Bahamas and entered Florida at West Palm Beach on the morning of the 16th. The French island of Guadeloupe reported heavy loss of life and great property damage. The English islands of St. Kitts and Montserrat, a short distance to the north of the path of the storm also suffered heavy losses. The lowest barometer at St. Thomas, Virgin Islands, 50 miles north of the path, was 29.30 inches, with a maximum wind velocity of 90 miles per hour at 10 a. m. of the 13th. The Island of St. Croix, Virgin Islands, within 10 miles of the center, suffered heavily in loss of life and damage to property and crops.

Area of winds of hurricane force.—Guayama, on the southeast coast of Porto Rico, was in the vortex of the storm at 2:30 p. m. of the 13th. Winds of hurricane force prevailed from 4 a. m. to 10 p. m., a period of 18 hours—assuming a progressive movement of 13 miles per hour for the storm, the area of winds of hurricane force east and west, would be 234 miles. At San Juan, 30 miles to the north of the vortex, hurricane winds prevailed from 4 a. m. to 4 p. m., or 12 hours.

Winds of hurricane force were experienced throughout the island to the north of the path; to the south some portions of the coast were apparently free from hurricane winds. The north-south extent of hurricane winds is

a matter of conjecture in the absence of vessel reports either to the north or south of Porto Rico during the storm. A fact worthy of notice is that few vessel reports were received at any time during the progress of the storm, indicating that timely warnings held vessels in port or kept them away from the zone of danger. In San Juan harbor several vessels delayed sailing for 24 to 48 hours. In spite of the great intensity and great extent of the storm no reports of loss of vessels in the vicinity of Porto Rico have been reported.

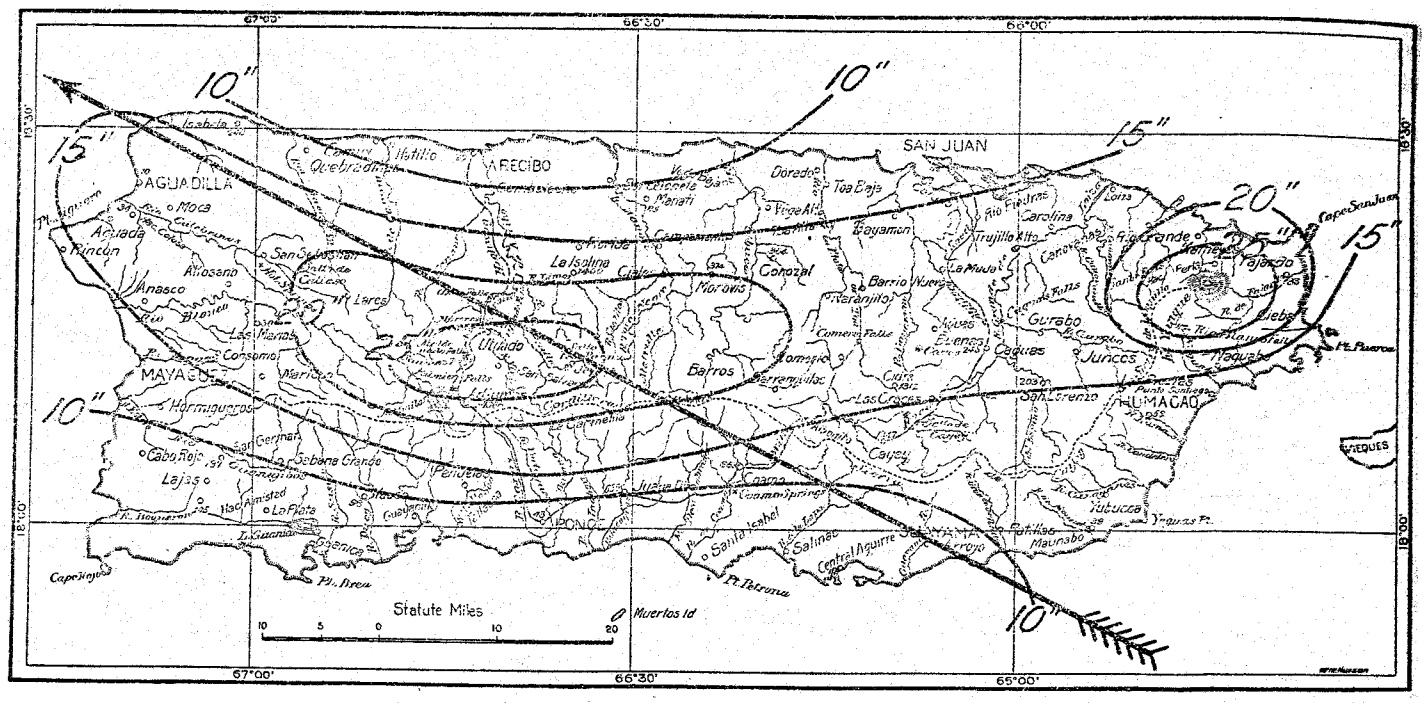

FIG. 3.—Rainfall distribution in Porto Rico hurricane, September 13, 1928

Storm damages in Porto Rico.—As stated above the loss of life during the storm will approximate 300. Several hundred thousand people were rendered homeless. Some towns near the center of the storm were practically leveled. The principal crops of the island are sugar, tobacco, coffee, and citrus fruits. Sugar and tobacco interests lost heavily but are generally controlled by large corporations able to take care of themselves. The heaviest property losses were sustained by the coffee growers who had in sight one of the largest and best crops in recent years. In addition to the loss of the crop the shade trees, requiring years to replace, were largely destroyed. The citrus fruit growers lost their entire crop but most of the trees were saved. Property and crop losses are estimated at approximately $50,000,000.

Storms of 1928.—The storm of September 13th was the fourth to pass across the West Indies during the present hurricane season. All of these came into view to the eastward of the Windward Islands. Three of them struck Florida, inflicting a heavy toll of life and great property losses. Reports of the wreckage of the storm of September 13th (San Felipe) will probably confirm statements made that it was the most destructive storm on record in the West Indies. The extremely low readings of the barometer (27.50 inches) and the unparalleled intensity of the winds experienced will substantiate the claims.

San Ciriaco and San Felipe losses compared.—

	San Ciriaco Aug. 8, 1899	San Felipe Sept. 13, 1928
Loss of life in Porto Rico	3,000	300
Lowest barometer reported at Guayama—inches	27.75	27.65
Lowest barometer at San Juan—do	29.23	28.81
Duration of hurricane winds at San Juan—hours	3	12
Maximum velocity of wind at San Juan—m. p. h.	75	+150
Advance warnings of storm—hours	[1] 18	36
Property losses	$20,000,000	$50,000,000

Historic storms of Porto Rico.—Hurricanes of the past 100 years which are most frequently referred to because of their violence:

Santa Ana	July 26, 1825.
Los Angeles	August 2, 1837.
Santa Elena	August 18, 1851.
San Narciso	October 29, 1867.
San Felipe (I)	September 13, 1876.
San Ciriaco	August 8, 1899.
The 2nd San Felipe	September 13, 1928.

[1] Owing to lack of facilities for prompt distribution of the warning to the rural population, the storm struck them unannounced.

WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

NORTH ATLANTIC OCEAN

By F. A. YOUNG

The weather conditions were exceptionally severe over the middle and eastern sections of the North Atlantic. West of the fiftieth meridian the number of days with gales was somewhat below the normal and along the American coast moderate conditions prevailed with the exception of a few disturbances that will be referred to later.

Charts VIII to XII show the conditions from the 11th to 15th, inclusive, during the flight of the German airship *Graf Zeppelin*, which left Germany on the 11th for the United States.

The number of days with fog, judging from reports received, was considerably below the normal over the Grand Banks, the greater part of the steamer lanes and off the European coast, while not far from normal along the American coast between Hatteras and Newfoundland.

On the 1st a disturbance was central near 41° N., 51° W., that moved rapidly eastward, reaching its greatest extent and intensity on the 3d when near 52° N., 30° W. On that date the storm area extended over the northern steamer lanes from the fifteenth to the fortieth meridians and vessels in the southwesterly quadrants reported northwesterly gales of force 11 and 12 at the time of observation. By the 4th this disturbance had diminished somewhat in force, although whole westerly gales still prevailed over a considerable area; by the 5th it was off the west coast of Ireland, with moderate conditions near the center, although southerly gales were reported from the vicinity of the Azores. On the 5th there was a second LOW central near 45° N., 45° W., that also became dangerous as it traveled eastward, and from the 6th until the 11th a succession of severe gales prevailed over portions of the middle and eastern sections of the steamer lanes.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, 8 a. m. (seventy-fifth meridian), North Atlantic Ocean, October, 1928*

Stations	Average pressure	Departure [1]	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.61	([2])	30.08	29th	29.10	16th.
Belle Isle, Newfoundland	29.77	−0.10	30.20	28th	29.16	15th.
Halifax, Nova Scotia	30.07	+0.07	30.58	31st	29.48	25th.
Nantucket	30.12	+0.10	30.54	31st	29.52	24th.
Hatteras	30.16	+0.13	30.44	30th	29.74	24th.
Key West	30.00	+0.02	30.14	26th [3]	29.92	1st.[3]
New Orleans	30.08	+0.07	30.30	26th	29.90	1st.[3]
Cape Gracias, Nicaragua	29.86	−0.04	29.90	20th [3]	29.78	24th.
Turks Island	30.02	+0.07	30.08	26th [3]	29.96	4th.[3]
Bermuda	[4] 30.18	+0.16	30.36	28th	29.88	1st.
Horta, Azores	30.28	+0.16	30.56	25th	29.92	3d.
Lerwick, Shetland Islands	29.63	−0.16	30.20	3d [3]	28.46	20th.
Valencia, Ireland	29.74	−0.17	30.29	1st	29.11	26th.
London	29.85	−0.06	30.30	3d	29.28	27th.

[1] From normals shown on Hydrographic Office Pilot Chart, based on observations at Greenwich mean noon or 7 a. m. seventy-fifth meridian.
[2] No normal available.
[3] And on other dates.
[4] Average of 27 observations.

On the 10th a disturbance of tropical origin was somewhere in the vicinity of 22° N., 37° W., as indicated by the storm report from the Dutch S. S. *Prins Frederik Hendrik*. Unfortunately, this is an unfrequented part of the ocean and so few reports have been received that it has been difficult to trace its track accurately until the 14th, the position on that date being shown on Chart XI. It was on the 14th that the American tanker *David C. Reid* foundered, her approximate position being given in an SOS as 37° N., 38° W., apparently not far from the center of the disturbance just referred to.