THE TROPICAL STORM OF JUNE 28, 1929

By W. P. DAY

Pressure had been low for several days previous to the 28th over the western portion of the Gulf of Mexico, but it was not until this date that any definite disturbance was more than suspected, a call for special observations being made on the morning of the 28th. A much delayed report from the steamship *Chester O. Swain* (the first vessel report in this region for several days) located the storm off the Texas coast and the following warning was immediately issued:

Hoist northeast storm warning 2 p. m. Galveston to Corpus Christi; disturbance of unknown but probably moderate intensity; central about latitude 27° N., longitude 95° 30′ W., apparently moving north-northwestward; will cause strong shifting winds probably gales at times on the Texas coast between Corpus Christi and Galveston.

The storm was of extremely small diameter, but of considerable intensity over a path about 20 miles in diameter from Port O'Connor to San Antonio. The lowest barometer reading probably was not below 29 inches, 29.12 being reported from Port O'Connor, 29.1 at Victoria, and 29.44 at San Antonio. Being of such small diameter, the storm did not last more than two or three hours at any one point, but estimated wind velocities as high as 80 miles per hour were reported. Corpus Christi and Galveston were only slightly affected.

Due to the difficulty in locating the storm, which was apparently in process of rapid development even as it struck the coast, adequate warnings were impossible for Port O'Connor and the southern portion of Matagorda Peninsula, the storm passing Port O'Connor at 4:30 p. m. The storm lasted from 4:30 to 6 p. m. at Port Lavaca and from 6:30 to 8 p. m. at Victoria.

THE TROPICAL CYCLONE OF SEPTEMBER 18–OCTOBER 4, 1929

By CHARLES L. MITCHELL

[Weather Bureau, Washington]

The early history of the September, 1929, tropical cyclone is rather obscure. A disturbed condition that apparently originated not far from the Cape Verde Islands about September 11 advanced steadily westward to the south of a strong area of high pressure that was centered near the Azores. From the few vessel reports that have been received by mail it appears that this disturbed condition was characterized by a rather slight decrease in pressure, some shift in winds from the normal northeasterly direction, and much cloudiness with frequent showers. This condition appears on the Northern Hemisphere weather maps not as a cyclonic circulation with closed isobars, but only as a northward loop in the isobars that progressed westward as a wave motion. By the 17th the pressure had decreased slightly over Porto Rico and the Virgin Islands and the wind had shifted to southwest, indicating the presence of a disturbance to the northeast of that region. On the morning of the 18th the wind at Turks Island had changed to light westerly, and reports from two vessels plying between New York and Porto Rico showed that a slight disturbance was advancing northwestward with center several hundred miles north of Porto Rico. So far as can be judged by vessel reports, this minor disturbance continued to move northwestward to a position off the coast of the South Atlantic States, where it dissipated on the 23d. Meanwhile pressure continued low north of Porto Rico and the Virgin Islands, and another cyclonic circulation was definitely established by the 20th, the center being about 300 miles north of Porto Rico. The first advisory warning was issued the evening of the 23d while the disturbance was still of slight intensity, and was centered about 250 miles north of Turks Island. Thereafter advisory warnings were issued at least twice daily until the hurricane center passed inland near Panama City, Fla., on September 30.

On the morning of the 24th the advisory stated that the disturbance was probably increasing in intensity. Upon receipt of 2 p. m. special observations from Nassau and several of the "out" islands, northwest storm warnings were ordered displayed at 5 p. m. Miami to Jupiter, Fla., and northeast warnings north of Jupiter to Charleston, S. C. In this warning it was stated that the disturbance would quite likely reach hurricane intensity within the ensuing 24 hours. At 11 a. m. of the 25th northwest storm warnings were extended south of Miami to Key West, because the morning report from Nassau indicated that the disturbance, which had previously been moving in a west-northwesterly direction, had turned toward the west and that its center would pass near Nassau later in the day. The noon report from Nassau showed quite clearly that the tropical disturbance was moving even south of west—a most unusual direction of movement for tropical cyclones, and especially in the Bahamas—as the barometer was falling rapidly and the wind had backed from west to southwest and had increased from 42 to 50 m. p. h. since 8 a. m. The northeast storm warnings were changed to hurricane at 2 p. m. Miami to Jupiter. At that time it appeared that the hurricane center would reach the southeast Florida coast near Miami the following morning. However, the hurricane was moving more slowly than it had been possible to know from the Nassau reports. A 2 a. m. special observation from Nassau, reporting a rising barometer, with the wind northwest 42 m. p. h., was received the morning of the 26th. This report was quite confusing and could not be verified. Inasmuch as no further reports were received from Nassau for several days and no information was received from vessels near the hurricane center, it was impossible to locate the exact center or direction of movement of the tropical cyclone during the 26th. The advisory warnings of that date, therefore, stated that the future course of the storm was uncertain but that no rapid movement in any direction was indicated during the next 24 hours. It was, indeed, unfortunate that observations were not received from at least two vessels known to have passed through or near the hurricane center. Again, during the 27th the forecaster had to rely entirely on the Cuban and southern Florida reports in attempting to locate the center. The following warning was issued at 9:30 p. m. of the 27th:

> Storm central about 100 miles southeast of Miami, apparently moving very slowly westward, attended by strong shifting gales and probably winds of hurricane force near center. Caution advised vessels Florida Straits and off southeast Florida coast. Wind will likely reach gale force greater part area Jupiter to Key West within next 12 hours, and residents still on exposed keys or islands should seek places of safety.

The morning reports of the 28th indicated that the hurricane was advancing westward through the Florida Straits with center almost due south of Miami. The northeast storm warnings south of Miami to Key West were changed to hurricane at 9 a. m., and northeast storm warnings were displayed north of Key West to Tampa. At 8 p. m. the center was about halfway between Key West and Fort Myers and advancing northwestward over the Gulf of Mexico. Northeast storm warnings were therefore ordered displayed at 9:30 p. m. north of Tampa to Pensacola. The following morning the hurricane center was about 100 miles west of Fort Myers and moving northwestward about 10 miles per hour, and northeast storm warnings were extended to the mouth of the Mississippi River at 10 a. m. During the afternoon of the 29th the following warning was issued:

> Change to hurricane warnings 5 p. m. Apalachicola to Pensacola. Tropical storm still moving northwestward about 10 miles per hour, and its center will likely cross the coast line between Apalachicola and the Mississippi coast some time Monday, attended by winds of hurricane force near center.

The next morning the Apalachicola report was missing on account of disrupted wire communication, but the Pensacola report indicated that the center was about 75 miles southeast of that place and still moving northwestward 10 to 12 miles per hour. Hurricane warnings were extended along the Alabama and Mississippi coasts at 9 a. m. Later reports showed that the center was slightly farther east than indicated by the Pensacola report, and during the day and early part of the following night it curved sharply toward the northeast, passing inland near Panama City at midnight. The storm moved rapidly northeastward, reaching the lower St. Lawrence Valley the morning of October 4, after which it moved eastward across the Atlantic Ocean, reaching the British Isles the morning of the 8th. After this date it merged with another extensive disturbance that was advancing eastward farther to the north.

The path of this tropical cyclone (see Chart III, Monthly Weather Review for September, 1929) was one

of the most erratic and abnormal during the last 50 years, with an exceedingly slow rate of movement during the period September 24–28. On the 24th it was centered some distance northeast of Nassau, and during the 28th it passed through the Florida Straits. During the 3½-day period ending at 8 a. m. of the 28th the storm center moved only about 300 miles, or less than 4 miles an hour, and the greater part of this time its course was toward the southwest, the center on the 28th being 80 or 90 miles farther south than on the 24th. Its rate of movement over the water previous to the 24th and after the morning of the 28th was approximately 10 miles an hour.

During most of September the winds in the altocumulus and cirrus cloud levels were light and variable over the United States, and this condition no doubt existed over the Bahamas region, especially during the 24th to 28th. As a rule, during September the Atlantic high-pressure area much of the time extends westward from Bermuda to the South Atlantic States, but this condition seldom prevailed during September, 1929. This accounts, in a large measure, for the slower air drift toward the west in the region of the Bahamas. Moreover, an air mass moving quite slowly in any given direction will change its direction of movement under the influence of very slight changes in pressure distribution. It is difficult or impossible to detect such slight changes in pressure distribution during September 24–28, but the fact that the tropical cyclone moved toward the southwest during most of this period shows quite clearly that some minor change in pressure distribution, and consequently change in direction of air movement occurred in the higher levels that controlled the movement of the cyclone.

As stated previously, the disturbance was of little intensity until after the morning of September 24. The steamship *Gulf Bird* was near the center in latitude 26° 30′ N., longitude 74° 20′ W., and reported a barometer reading of 29.66 inches and wind southwest 22 m. p. h. The steamship *Potomac* passed near the hurricane center on the 25th about 15 miles west of Abaco Island and reported a barometer reading of 27.30 inches (uncorrected). At Nassau the lowest pressure was 27.64 inches (unofficial) between 8 p. m. and midnight of the same date. The next report received from near the center was 28.09 inches on the steamship *Bessemer* in latitude 25° N., longitude 80′ W., at 8 a. m. of the 28th. The center passed over Long Key, the barometer falling to 28.18 inches at 9:30 a. m. of the 28th. The lowest pressure at Miami was 29.41 inches at 12:30 p. m. and at Key West 29.21 inches at 3:30 p. m. of the 28th. At Everglades, Fla., it was 28.95 inches at 5 p. m. and at Boca Grande 29.18 inches at 1 a. m. of the 29th. There were no reporting vessels near the center as it moved northwestward over the Gulf of Mexico, but apparently there was a slight decrease in the intensity of the hurricane before it passed inland near Panama City, west of Apalachicola, Fla. The lowest barometer reading at Panama City was 28.80 inches at midnight of the 30th. Apalachicola reported a minimum of 29.06 inches at midnight and Pensacola 29.19 inches at 2:40 p. m. There were in reality two minima at Apalachicola, the first, 29.23 inches, occurring at 3:30 a. m. of the 30th, while the hurricane center was still advancing toward the northwest. As the center continued to move in that direction for several hours thereafter, the barometer at Apalachicola rose slowly until 10 a. m., when it reached 29.39 inches. Shortly thereafter the hurricane recurved sharply toward the northeast and its center passed closer to Apalachicola than previously, resulting in the lowest pressure at midnight. The storm decreased very slowly in intensity as it passed over northwestern Florida and southern Georgia, Thomasville, Ga., reporting a pressure of 29.12 inches at 8 a. m. of October 1. After the 1st there was very little change in intensity until it reached the lower St. Lawrence Valley during the 4th, the nearest station to the center at each observation reporting between 29.30 and 29.36 inches.

The following maximum wind velocities were reported during the progress of the storm: Miami, 56 E. on September 28; Key West, 66 W., 28th; Fort Myers, 59 NE., 28th; Tampa, 33 E., 29th; Apalachicola, 59 S., 30th; Pensacola, 70 NE., 30th; and Jacksonville, 61 SW., October 1. No accurate information has been received regarding the force of wind in the Bahamas region, but it must have exceeded 100 m. p. h. near the hurricane center. The estimated velocity at Key Largo was (during gusts) about 150 m. p. h. There was a 10-minute lull as the hurricane center passed over this key. This hurricane was more severe than the 1926 hurricane at Key Largo. At Everglades the estimated velocity was 90–100 m. p. h. No estimate has been made of the maximum wind velocity at Panama City, where the center of the hurricane passed inland.

LOSS OF LIFE AND PROPERTY DAMAGE

The only report yet received relative to the hurricane in the Bahamas is the following Associated Press report, dated September 28:

> Severest hurricane struck Nassau from west 1:30 p. m., Wednesday (September 25), preceded by 24-hour gale from west in early stages. Rose very high, flooding road and carrying away sea wall and houses. After seven hours' blow from west and southwest the center was over Nassau. Lull four hours. Resumed midnight, blowing harder than before from the southeast and east. Damage done. Continued all Thursday (26th). Barometer at height of storm 27.64, abated Friday (27th). Still strong winds blowing. Damage to private property enormous. Few houses escaped, many unroofed, especially in colored quarter. Stores, churches, and shipping affected very severely. Mail steamer *Princess Montagu* blown out of harbor and stranded on Tony Rock. Rescued passengers and crew to-day. Mail vessel *Ena K.* safe in harbor. Many lives lost and casualties numerous. Impossible to estimate yet. No news from "out" islands. Feared some suffered severely. No communication yet.

The steamship *Wisconsin Bridge* went aground during the hurricane near Hole-in-the-wall Light on the southeastern tip of Abaco Island, and the tanker *Potomac* broke in two on Andros Island. With the exception of the fishing schooner *Mercia Montgomery*, which sailed from Apalachicola on September 18 carrying a crew of eight men, and was never heard from again, no other marine disasters of consequence have been reported.

The loss of life in Florida due to the storm was confined to a negro woman at Marathon, a negro child near Wewahitchka, and a man who lived near the beach at Panama City, who, although warned, refused to go to a place of safety.

Property damage was quite small in Florida. No damage of consequence was done on the southeast coast north of the keys, except at Fort Lauderdale, where a tornado (see account on p. 420, this review) that developed (probably as a waterspout?) over the ocean moved northwestward across the city and did approximately $100,000 damage. Tornadoes were also reported at Miami, Stuart, and Boca Ratone, but with no serious damage. While tornadoes in connection with tropical cyclones are of rare occurrence, it is noteworthy that the tornadoes referred to occurred in the right rear quarter of the tropical cyclone, as is usually the case when they occur

in connection with extratropical cyclones, although the Florida tornadoes occurred to the northeast of the cyclone center and those accompanying extratropical cyclones usually occur southeast of the center. In both cases the tornadoes move parallel to the path of the cyclones.

The greatest damage in the Florida Keys seems to have taken place on the northward side of the center—the upper Matecombe Key, the southern portion of Key Largo, and the Cape Sable and Ten Thousand Island areas. On the mainland south of Florida City, about 12 miles of the railway roadbed will have to be replaced. The damage at Key West was confined to the swamping of small fishing boats in the upper harbor, and temporary interruption of lighting and telephone service. A few thousand dollars will cover the loss.

While the wind attained a velocity of about 100 m. p. h. at Everglades and about 75 m. p. h. at Punta Rassa, very little damage has been reported from the southwest Florida coast. However, in Lee county there was an estimated damage of 20 to 30 per cent to oranges and 50 per cent damage to grapefruit. There was no damage of consequence north of Punta Rassa to and beyond Cedar Keys. In the vicinity of Apalachicola preventable damage due to the storm was comparatively small, but there was considerable damage to property that could not be well protected. The greatest damage occurred when high tides and heavy seas carried away practically every wharf along the water front and damaged all of the fish and oyster houses and canning plants. Some stock in stores in the lower sections was damaged by high water. The high tide and heavy seas did considerable damage to the new Gulf Coast Highway west of Apalachicola. Damage to the business and residential sections was of a minor nature although widespread.

Although the hurricane center passed inland at Panama City, the damage reported was remarkably small for a storm of this character. All wharves and several fish houses were destroyed in the Panama City area and the total monetary damage is estimated at between $100,000 and $150,000. At intermediate places between Panama City and Pensacola the damage was small. Satsuma orange groves and pine trees that had been turpentined in and near the path of the hurricane center suffered considerably. At Pensacola the damage was very small, the total being estimated at about $60,000.

THE SEPTEMBER 28, 1929, TORNADO IN FORT LAUDERDALE, FLA.[1]

By GEORGE B. HILLS

Beginning with the afternoon of the 27th of September, a hurricane, which was then nearing the Florida coast, evidenced itself through generally increasing winds and falling barometer. By 4 p. m. of the 28th the wind was blowing from a point south of east at a probable consistent velocity approximating 60 miles per hour and with gusts of greater velocity, temporary decreases, and continuous rain of varying intensity.

At about 4.40 p. m. I was in the back of my mother's house and I noticed that it was suddenly becoming very dark. Within probably two or three minutes the light was so poor that the reading of a newspaper in an inside room would have been difficult. The darkness was accompanied by a rapid and almost complete cessation of all wind.

I called my mother and went with her out onto a screened back porch, which afforded a relatively open view to the southeast, the south, and the southwest. (Her home is located east and slightly south of the main business section of the city.) I immediately saw a low cloud mass in the southeast, black with a golden or yellowish cast, which was approaching rapidly in a northwesterly direction. Within probably a few seconds it had approached to within approximately 600 feet of us and by that time its roar might be compared to the noise of several freight trains being slammed about close at hand. At that point the entire side and roof of a house flew up into the air at least 100 to 125 feet in height and then broke up into small pieces; other débris filled the air, and in a few seconds more the storm had passed on to the northwest and out of sight. Excepting that the flying débris was apparently moving in all directions, no rotating movement was observed. The heavy rains and poor light would have made any such observations difficult. The light quickly returned to normal with the passing of the disturbance.

Later investigations indicated that the disturbance had struck and moved along a path approximately three-quarters of a mile in length, beginning at the outer fringe of the residential section southeast of the business center of the city and moving northwesterly across the business center and through a negro section to the northwest.

The path of the disturbance varied from approximately 150 to 300 feet in width, and within its path it damaged or completely wrecked the frame houses, garages, trees, and other obstacles that it encountered. At the stormward side of the business section of the city it struck the exposed rear of a 4-story reinforced concrete and tile hotel from which it ripped the greater portion of the flat roof and the parapet walls above the top floor level. I saw two pieces of débris which I would judge weighed from 100 to 125 pounds, and which were identified as having come from the hotel structure, lying from 300 to 500 feet farther along the storm path.

Across the street from the hotel the storm struck fairly against a 10-story reinforced concrete office building, where the damage was limited to the breaking out of the large majority of glass windows on the east or stormward side. Apparently rising up over the building, the storm again struck the ground a few hundred feet beyond, completely blowing away all excepting the floor of the Railway Express Co. office and loading platform alongside the Florida East Coast Railway tracks. Two trunks and a dog belonging to a friend of mine, which were in the express company office at the time, had not been located the following day.

Continuing for perhaps a quarter of a mile before it apparently rose and disappeared, the storm destroyed most of a 2-story store building above the level of the second floor, and seriously damaged or destroyed a large storage warehouse and lumber yard, mill-working establishment, and several lightly built negro houses.

The entire damage along the path of the storm probably occurred within a minute's time and represented the only damage incurred in the city during the entire period of the hurricane.

[1] Scattered evidence has come to hand at various times that seems to indicate the occurrence of tornadic storms within well developed tropical cyclones. The editor is glad, therefore, to be able to present first-hand evidence of the occurrence of a tornado within a fully developed tropical cyclone. The tornado did not have the destructive violence that is associated with storms of like character in the interior of the continent, and its direction of movement, although contrary to that of most tornadoes, was in the same direction as that of the tropical cyclone.—EDITOR.

The outer limit of the tornado's path was sharply defined. A typical example was found in the instance of a house which we own, the corner of which was located 18 feet from the corner of a similarly constructed adjoining house. Our house was completely undamaged, while the adjacent house was completely destroyed.

Another example was found in the instance of a lightly built cottage with a slightly supported open porch, located immediately across the street from the lumber yard and mill-working establishment referred to above. While the latter was very badly damaged, the flimsy cottage across the street was not harmed in any way.

The captain of a large dredge anchored at Port Everglades, a few miles southeast of Fort Lauderdale, advised me that the tornado in coming in from the ocean passed between his dredge and a large barge anchored some 400 feet to the north without striking either. He advised me that he saw no evidence of a waterspout in connection with the tornado.

Mr. E. A. Pynchon, a civil engineer and shipyard owner of Fort Lauderdale, was watching a recording barometer in Flippen's hardware store when the storm center passed within some 300 or 400 feet of that building. He states that the needle dropped abruptly nine points, quivered at the low point for a few moments, and then rose abruptly to the original reading. The graph record indicated a vertical line drop and rise of five points.

The passing of the tornado apparently marked the peak and end of the hurricane disturbance at Fort Lauderdale. Within 30 minutes after its passing a decrease in the intensity of the hurricane winds was definitely noticeable, and within two hours the wind velocity was probably down to 30 miles an hour or less. Thunder and lightning had developed in the east by that time, and the storm decreased continuously thereafter. The recording barometer indicated a steadily increasing pressure after the passage of the tornado.

ADDITIONAL EVIDENCE

Following is an excerpt from the report of the cooperative observer at Fort Lauderdale:

> I did not see the tornado, but heard the noise, but as the hurricane was causing so much noise did not notice that of the tornado. My daughters were sitting in the bedroom on northeast side of the house, and came running to the porch and wanted to known what the air was filled with that was going past on the north side of my house. Some who saw the tornado speak of it as a "ball of fire." The tornado went through the city bouncing like a ball; places in its path would not be touched, then it would strike some building and tear it into pieces.

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