

LIFE HISTORY OF TROPICAL STORM IN LOUISIANA, SEPTEMBER 21 AND 22, 1920.

By ISAAC M. CLINE, Meteorologist.

[Weather Bureau, New Orleans, La., October 20, 1920.]

SYNOPSIS.

The tropical storm which appeared in the Caribbean Sea September 18, crossed the Gulf of Mexico during the 19th and 20th, and moved northward over Louisiana during the 21st and 22d, presents several features of unusual interest. It followed a course out of the ordinary for storms that move over Yucatan, and advanced with unusual rapidity. The storm was not of great intensity except near the center. We have more complete cloud, wind, and pressure records in the area traversed by this storm than have been available for study in any previous storm and these make its life history important in our search for knowledge of tropical storms. The lowest barometer reading after the storm passed inland was 28.99 inches at Houma, La. The depression began to decrease in intensity immediately afterwards. The observed tides were in conformity with the movement of the storm.¹ Warnings were distributed which were instrumental in saving lives and property. There was one death; and property damage was about \$1,450,000.

GENERAL METEOROLOGICAL CONDITIONS.

The special meteorological features preceding and attending this storm are given for New Orleans, La., Mobile, Ala., and Pensacola, Fla., stations to the right of the line over which the center of the storm advanced; and for Galveston, Houston, and Port Arthur, Tex., stations to the left of that line.

The clouds of the cirrus type at New Orleans, La., Mobile, Ala., and Pensacola, Fla., stations to the right of the line along which the center of the storm was advancing were from W. on the morning of the 19th, changing to SW. about noon and continuing from that direction while visible during the 20th and 21st, except that at Pensacola, Fla., at noon and 7 p. m. of the 21st they were again visible through the stratus clouds moving from the SE. As the storm receded and curved to the westward, they were reported as moving with the stratus from SE.

The clouds of the cirrus type appeared at Houston, Tex., to the left of the line along which the center of the storm was advancing on the morning of the 20th, coming from SSE.; they were from S. at noon, and SE. during the 21st and 22d.

The only cirrus clouds observed at Galveston, Tex., consisted of a very few fine wisps visible in the SE. about 8 a. m. at an elevation of about 10° with no apparent motion.

PRESSURE IN THE DIFFERENT PARTS OF THE STORM.

Excellent barometer records have been obtained from a number of places well distributed over the area traversed by the storm. The aneroid barometers have been checked with the Weather Bureau barometer and the largest difference was ± 0.07 of an inch. The proper corrections have been applied and it is believed that the observations represent the true conditions.

Complete barometer records covering the territory over which a cyclonic area has traveled are not usually found and they furnish interesting and valuable material for use in the study of a tropical storm moving into extratropical regions where the weather conditions at the time are practically the same as those that prevail in the tropics. The lowest pressure, 28.99, was reported from Houma, La., about 30 miles inland from the nearest coast line at 10:15 p. m. on September 21st; the next lowest was 29.09 at 11:20 p. m. at Morgan City, La., 10 miles to the north and 30 miles to the west of Houma. The next lowest was 29.13 at Bayou Goula, La., at 12:30 a. m. of the 22d, 80 miles from the coast. The topographical and physical features of the country for 50 miles from the coast are such that the hurricane, while traversing this area, retained the characteristics which it had in the open Gulf, and the wind and pressure conditions at Grand Isle, Morgan City, and Houma, represent the full intensity of the storm.

The cyclonic area commenced contracting and filling up on its outer rim soon after moving inland, as is shown by the comparison of the lowest pressure at Grand Isle and New Orleans, points about equidistant from the line over which the center of the storm advanced. At New Orleans, 50 miles farther along the line of advance than Grand Isle, the lowest barometer, 29.53, was 0.20 of an inch higher than at Grand Isle, 29.33. Near its center the storm did not diminish in intensity so rapidly. This is shown by the lowest barometer, 75 miles west and 20 miles farther north than New Orleans, at Bayou Goula, 29.13 inches. Bayou Goula is 50 miles farther along the line over which the center of the storm advanced than Houma, and the barometer near the center of the storm shows a rise of only 0.14 of an inch in this distance.

¹ See MONTHLY WEATHER REVIEW, March, 1920, 48: 127-146.

The lowest barometer at points on either side of the cyclonic area occurred when the center of the storm passed nearest such places and the time of their occurrence coincided with the time that the center of the storm crossed a line passing through such places at right angles to the line along which the center of the storm was advancing at that time.

If, on either side of the storm center, the times of the occurrence of the lowest barometer at two or more stations parallel with a line crossing the line of advance of the storm center are available, the exact direction in which the cyclonic area was advancing at that time can be determined. In this connection see figure 1, which gives the lowest barometer readings and the times of their occurrence in this storm.

WINDS.

Moderate gales occurred at New Orleans and Burrwood, the only regular Weather Bureau stations with self-recording instruments directly in the hurricane proper.

Parishes. Reports from cooperative observers cover this storm fully. Extracts from the reports of cooperative observers are given below.

Where the correspondent in a parish reports "No storm" or "No damage" that fact has been stated in the parish on figure 1, and the direction in which the wind shifted as the storm advanced is also shown. This chart furnishes information of special interest. The changes in the wind in the right and left hand segments of the cyclone show the exact path of the hurricane center during its progress for 100 miles after its center reached the coast. No damaging winds occurred to the left of the line along which the center of the storm advanced.

At Morgan City the wind changed from northeast to northwest at 10:30 p. m., then calmed down and shortly afterwards came up light from the southwest. The lowest barometer occurred at 11:30 p. m., during the period in the lull in the wind. This indicates that the center of the storm passed nearly over Morgan City, and that the exact center of the storm passed to the right of that place. No severe winds occurred at Morgan City, but a few miles to the right of that place the wind was of hurricane force.

At New Roads in Point Coupee Parish the wind shifted from northeast to southwest at 3 a. m., which indicates that the center of the storm passed over that place at that time.

North of Iberville Parish, no winds out of the ordinary were reported either to the right or left of the line along which the center advanced until Caldwell and Lincoln Parishes were reached, where the disturbance again showed increasing intensity.

PRECIPITATION.

Conditions were such that no precipitation occurred in the region visited by the storm prior to the morning of the 22d except that caused by the tropical cyclone, and we had excellent opportunity for the study of precipitation in the various parts of the cyclonic area as it moved inland. Light precipitation was reported from the eastern portion of east Texas on the morning of the 21st, but only a trace at most stations; however, 1 inch at Hitchcock and 1.20 at Beaumont were reported. Light precipitation was reported from only a few stations in southern Louisiana on the morning of the 21st, but by 7 p. m. of the 21st the rain area had extended northward to Vicksburg, Miss., and Shreveport, La., and had extended eastward to Apalachicola, Fla., but had not extended northeastward as far as Mobile, Ala., or Pensacola, Fla. By the morning of the 22d the rain area had extended northwestward over northeast Texas and into eastern Oklahoma in front of the direction in which the storm was advancing, while to the eastward of the center precipitation had extended into southwestern Alabama, over southern and central Mississippi, and into southern Arkansas. The precipitation was heaviest on the Mississippi coast about 90 to 135 miles to the right of the center of the storm; here a few stations report 5 to 7 inches. Over southeastern Louisiana and southern Mississippi, to the right of the line over which the center of the storm advanced, 100 to 150 miles inland, the precipitation was generally 2 to 5 inches. In southern Louisiana, to the left of the line over which the center of the storm advanced, the precipitation slightly exceeded 1 inch. Over the interior of Louisiana, after the storm had become extratropical, the rainfall on both sides of the storm ranged generally between 1 and 2 inches, but no station received as much as 2 inches.

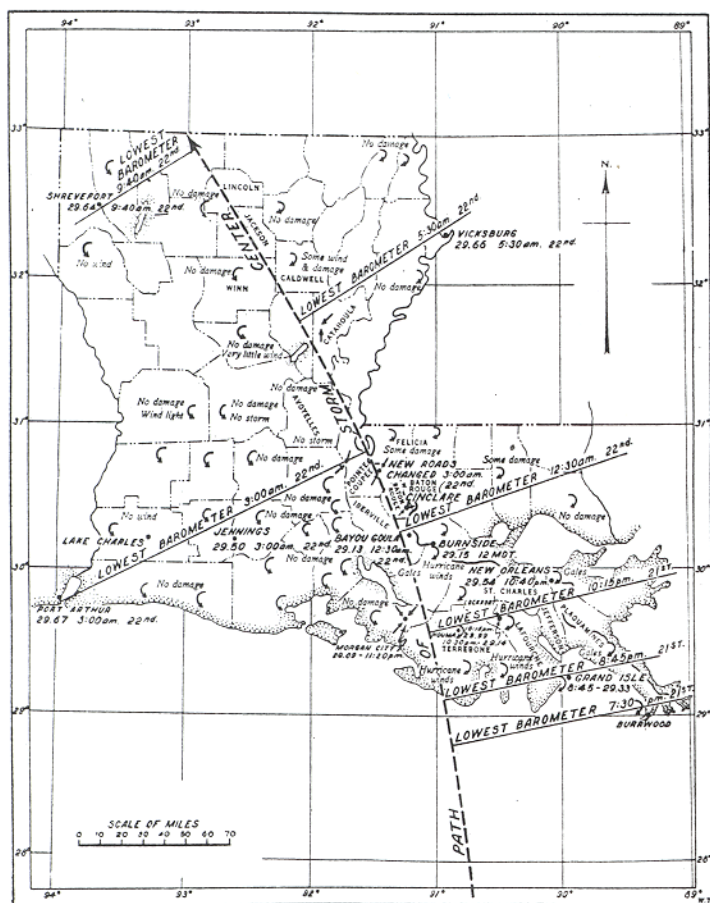


FIG. 1.—Wind changes and path of hurricane. Time of occurrence and lowest barometer in different parts of the cyclonic area, and connecting lines intersecting path of storm at right angles.

Gales occurred to the right of the cyclone as far as Pensacola, Fla., and Mobile, Ala., but the wind velocities at these two places can not be attributed altogether to the tropical storm, as their winds, both in direction and velocity, were controlled more by the anticyclonic area over the East Gulf and Atlantic States than by the cyclonic area over Louisiana.

Hurricane winds occurred in Jefferson, Lafourche, Terrebonne, and St. Charles Parishes and destructive gales occurred in St. John, Ascension, and Iberville

Elsewhere the amounts of precipitation were mostly light. The distribution of rainfall in relation to the center of the storm is shown in figure 2.

Lightning was not observed and no thunder was heard during the storm nor immediately after it. Lightning was observed in the south at 10 a. m. September 22, which was after the storm had moved well inland. The observer at Galveston reported a moderate thunder storm from the southeast in the very early morning of the 21st. Moreover, it is a striking fact that neither has lightning been seen nor thunder heard during the actual passage of a tropical storm over this region. The tropical cyclone, it appears, is not attended by frequent vivid lightning and heavy thunder, as is the case with extratropical cyclones occurring at the same season of the year.

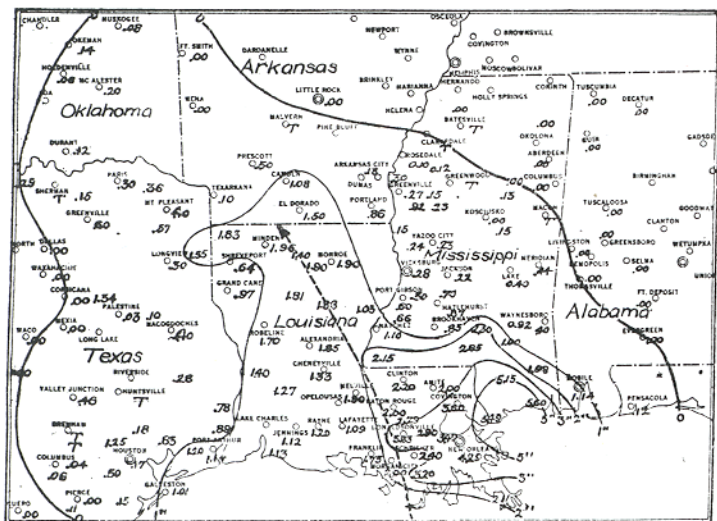


FIG. 2.—Distribution of precipitation. At all stations where the names are given the amounts are up to 7 a. m., Sept. 22; at places without names, the amounts are up to 7 p. m. of the 22d, the hour at which they make their measurements.

TIDES.

The tides which occurred followed the predicted tides at Galveston and the interpolated tides based on Galveston for Corpus Christi, Tex., and Burrwood, La., and Fort Morgan, Ala., and those for Port Arthur, Tex., based on Key West, very closely, from noon of September 19 to 2 p. m. on the 20th, when the tides began rising above the predicted tides at both Galveston and Port Arthur, Tex. The rise of the tide above the predicted tide at Corpus Christi did not set in until 6 a. m. of the 21st. The tide at Burrwood, La., showed a slight increase above the predicted tide at 2 p. m. of the 20th, but no material rise above the predicted tide occurred except on the Texas coast up to 12 noon of the 21st, which indicates that the storm was moving toward the Texas coast during the 20th. After noon of the 21st the tide at Galveston showed a tendency to return to the predicted tide, and at Port Arthur and Corpus Christi, Tex., the tide did not rise farther above the predicted tide. The tide at Burrwood and Fort Morgan commenced rising slowly but steadily above the predicted tide about 2 p. m. of the 21st and it continued rising as the storm approached, the storm tide at Burrwood being 1 foot at 7 p. m., 1.8 feet at 8 p. m., and 2 feet at 10 p. m., in excess of the predicted tide. Burrwood was 90 miles to the right of the line over which the center of the storm was advancing. At Grand Isle, La., 60 miles to the right of the line over which the center of the storm was

advancing, the storm tide had become so pronounced at 4 p. m. (just two hours after the well-defined rise set in at Burrwood) that the officer in charge at the Coast Guard station at Grand Isle called all the inhabitants on the island into the station, which was constructed for use as a place of refuge in case of a hurricane.

Burrwood is the only available tide-reporting station within 100 miles of the point where the center of the storm moved inland. The storm tide occurred on low tide. If the storm had come in during the morning the tide would have been higher by more than 1 foot. As the storm moved inland over Louisiana, the waves and swells banked a tide of 5 to 6 feet along the Louisiana coast in Lake Borgne and on the coast of Mississippi Sound, which overflowed the tracks of the Louisville & Nashville Railroad. The rise in the tide above the predicted tide on the Texas coast during the afternoon of the 20th and forenoon of the 21st shows that during the 20th, the storm was moving toward that part of the coast. The cessation of the rises in the tide on the Texas coast about noon of the 21st, and the steady rise that commenced on the Louisiana and Mississippi coasts soon after

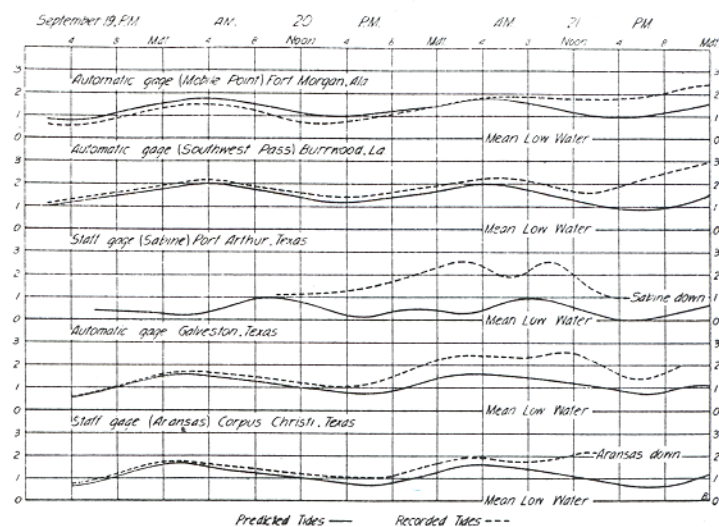


FIG. 3.—Tidegraphs, September, 1920. Predicted tides for Burrwood (Southwest Pass), La.; Fort Morgan (Mobile Point), Ala.; and Corpus Christi (Aransas), Tex., are calculated from the standard port, Galveston; and Port Arthur (Sabine), Tex., from Key West.

noon of the 21st, show that the storm changed its course in about latitude 25° and longitude 90° (the position the storm occupied when Supervising Forecaster Bowie issued his warning at 10 p. m. of the 20th) during the night of the 20th and the early morning of the 21st from the Northwest and took up a course just a little west of north toward Atchafalaya Bay, La. The increased rise in the tide at Burrwood, with the position of the storm as above noted, shows that the swells that came out of the right-hand rear quadrant of this storm and caused the rise in the tide on the east Louisiana coast traveled with a speed of about 30 miles per hour. The center of the storm reached the coast about seven hours after the rise in the tide commenced, and this indicates that the center of the storm advanced during the 21st with an average speed of nearly 15 miles per hour before its center reached the Louisiana coast.

As late as 5 p. m., September 21, the greatest fall in the barometer was on the east Texas and west Louisiana coasts, but at this time and for three hours previous, the only continued rise in the tide above the predicted tides was on the east Louisiana coast and on the Mississippi Sound coast. The barometer continued to fall on the

east Texas coast and in southwest Louisiana until 3 a. m. of the 21st, seven hours after the center of the storm had moved inland, but no additional storm tide occurred on the Texas coast after noon of the 21st, eight hours before the storm moved inland 400 miles to the eastward from Galveston, Tex. The tides during the approach of the storm are shown on figure 3.

PATH AND MOVEMENT OF STORM.

The storm moved inland over the central and east Louisiana and the Mississippi coasts. The center of the cyclonic area advanced northward in Louisiana along a line running close to longitude 91° , and the calm area of the center passed partly over Morgan City, La., and thence northward over the interior into Iberville Parish near Bayou Goula. Records of the lowest barometer and the times of their occurrence during the passage of the storm were made at an exceptionally large number of points in the area traversed by the storm and from these the speed with which the cyclonic area advanced has been determined. Near the center, the lowest barometer at Houma occurred at 10:15 p. m., and at Burnside and Bayou Goula, the lowest occurred at 12 midnight of the 21st and 12:30 a. m. of the 22d, respectively; the distance from Houma to these places is 50 miles, and two hours' time intervened between the time of the lowest barometer at Houma and its occurrence at Burnside and Bayou Goula, which shows the storm advanced with a speed of 25 miles per hour, an unusually rapid movement for a tropical cyclone in this region. New Orleans and Grand Isle, 50 miles apart, are on a line nearly parallel to the line over which the center of the storm advanced. Two hours intervened between the time of the occurrence of the lowest barometer at Grand Isle and its occurrence at New Orleans, which confirms a progressive movement of 25 miles per hour, twice the average speed traveled by tropical storms in this latitude and 10 miles per hour greater than the speed of any of these storms which have come under the writer's observation during the last 30 years. The path along which the center of this storm advanced is definitely located both by the direction in which the winds changed from north to south and also by the lowest barometer readings.

The storm retained hurricane intensity until Ascension and Iberville Parishes were reached. It diminished in intensity with marked rapidity and advanced more slowly on reaching the bluff lands of Baton Rouge and Feliciana Parishes and the heavily timbered regions along the Atchafalaya and lower Red Rivers in Pointe Coupee and Avoyelles Parishes. The winds north of Iberville Parish were not dangerous to any extent either to the right or left of the line over which the center of the storm had been advancing and no well defined changes in the wind by way of east or west to south were noted between Iberville Parish and Caldwell Parish, to the northward. The wind at Cinclare, west Baton Rouge Parish, shifted from north directly to the south; at New Roads, Pointe Coupee Parish, it shifted from north directly to southwest. At Mansfield, Catahoula Parish, the wind blew first from the north then from the south. Strong winds occurred during the forenoon of the 22d, 150 miles to the northward from Pointe Coupee Parish, in the region of Caldwell, Jackson, and Lincoln Parishes, and the storm advanced more rapidly after passing the bluff and timbered regions.

The lowest barometer at Galveston and Port Arthur, Tex., and Lake Charles and Jennings, La., occurred at 3:40 a. m. to 3 a. m., respectively, on the 22d, which is six to eight hours after the center of the storm had moved to the northward of those latitudes. This continued fall in the pressure so far to the west of, and in the rear of, the location of the center of the storm at midnight of the 21st, indicates that the storm, when it lost its intensity on reaching the bluff and timbered lands was crowded to the westward by the eastern high pressure area and then formed a general, but weak low pressure area, extratropical in nature, covering Louisiana with its center over Caldwell and Winn Parishes, as appeared on the weather map at 7 a. m., September 22. The storm at that hour showed a well defined but weak cyclonic circulation over Louisiana; it advanced toward the northwest and was centered at 7 p. m. of the 22d a short distance to the northeast of Fort Smith, Ark.

WARNING SERVICE.

Warnings announcing the development of a tropical disturbance over the western Caribbean Sea were received on the night of September 18, and advisory warnings were received regularly thereafter until the passage of the hurricane inland. These warnings gave the location of the disturbance and its probable direction of movement and were distributed by telegraph to all coast stations and radiographed to ships at sea and published in the daily papers.

The exceptionally rapid progressive movement of the disturbance across the Gulf of Mexico was announced by the Supervising Forecaster on the 20th when he ordered warnings as follows:

WASHINGTON, D. C., *September 20, 1920.*

Hoist northeast storm warnings 10 p. m., New Orleans to Port Lavaca, Tex., and northwest storm warnings Corpus Christi section to Brownsville. Tropical storm apparently centered in latitude 25° , longitude 90° , of considerable intensity and moving northwest. Advise all interests to be on the alert.

BOWIE.

Hurricane warnings were ordered displayed from Morgan City, La., to Corpus Christi, Tex., at 10 a. m. on the 21st and were extended eastward along the Gulf coast to Pensacola, Fla., at 9 p. m. on that date.

An extraordinary distribution of warnings was commenced at once on receipt of the orders to hoist hurricane warnings. A motor boat was chartered and sent from Lake Arthur to Cameron, La., and intermediate points. The warnings were sent to all telephone exchanges in the threatened areas and Mr. C. A. Stair, District Superintendent, instructed the managers to give the warnings the widest possible distribution by telephone.

The telegraph companies instructed their managers to give the warnings the widest possible distribution in the interests of their customers.

Railroad superintendents sent the warnings to their station agents with instructions to advise all interests to take every precaution against high winds and high tides. In New Orleans the police and fire departments were used in advising the public of the approach of the storm.

DAMAGE FROM STORM.

The display of hurricane warnings at Morgan City, La., on the morning of the 21st caused persons living near the Gulf coast and along the bayous in the area covered by the storm warning to move to interior towns.

Storm tides and waves are the agents of greatest destruction in tropical storms and as this storm came in at low tide the damage along the coast was not so great as it would have been if the storm had moved inland in the forenoon.

Damage was confined mainly to railroad, telegraph, and telephone systems, the losses sustained by these interests being estimated at \$750,000. The tides and waves washed out the Louisville & Nashville Railroad bridge at Chef Menteur and damaged the roadbed in other places to such an extent that it was about ten days before train service could be resumed. The telephone company reported 2,500 telephones out of commission in New Orleans and a little more than one third of the long distance system was put out of commission. The telegraph service west and north was badly crippled. The telephone and telegraph services were restored promptly. Damage to rice and sugar cane was confined mainly to Terrebonne, Lafourche, Plaquemine, and Jefferson Parishes. The total damage to crops is estimated at about \$700,000. Only one death was reported and that as a result of an electric wire which had been broken down by the wind at New Orleans.

The fact that not a sea-going vessel was lost in the storm and only one life is reported lost shows the great value of the warnings and the effectiveness of their distribution.

NOTE.—Full reports of cloud observations, barometer readings, and remarks of cooperative observers can be seen on the original manuscript on file in the Central Office of the Weather Bureau, Washington, D. C.

TROPICAL STORM, SEPT. 29-30, 1920.

By ALEXANDER J. MITCHELL, Meteorologist.

[Weather Bureau, Jacksonville, Fla.]

The existence of the tropical storm of September 29-30, was first announced by the Central Office on September 27. (See pp. 544-545, below.) At the time reports from coast stations were rather indefinite, except that the wind direction may have been an affirmative factor.

Minus pressure changes became more significant on the 28th, and on the 29th they were conclusive as to the future direction of the disturbance. The rainfall increased on the lower coast of the section on the 28th, becoming heavy and general in the west-central portion of the peninsula on the 29th, on which date minus pressure changes were confined to South Atlantic districts and the immediate Gulf coast from Louisiana eastward. The western anticyclone, but feebly felt in the west Gulf States on the 28th, had, by the 29th, increased in magnitude and was rapidly pushing east and south, thus adding celerity to the northeast movement of the disturbance, as was indicated by the forecaster in his early advisory messages regarding the probable course of the storm.

The configuration of the isohyets and the 24-hour rainfall show the approximate path of the storm to have been from near Cedar Keys on the Gulf coast, whence it approached during the night of the 29-30th, thence northeast to the Atlantic seaboard. The 24-hour rainfall along the path of the storm ranged from 5 inches at Cedar Keys, Levy County, to 8 inches at Lake City, Columbia County. Local observers reported "high winds," "storm," or "gales."

The storm was very severe when deep into the Gulf, as indicated by reports from masters of vessels, but it

was probably losing energy as it approached the coast, as the minimum central pressure was not below 29.47 inches at any Florida station. Gales occurred, however, from Key West northward during the night of the 29th and early on the 30th. And considerable damage was done along the west coast from about Fort Myers northward to St. Marks. High tides, salt spray, and high winds inundated low lands on the immediate coast, and heavy rains flooded fields more inland, where truck and fruit suffered to a considerable extent. As the result of a prostrated wire one person was killed at St. Petersburg. A yacht was sunk at Fort Myers, and a number of vessels were wrecked or dismantled in the Gulf, among which was the American steamer *Speedwell*, en route British Honduras to New Orleans.

In view of the existence of the strong anticyclone which was rather exceptional for these low latitudes so early in the season, resulting in the breaking of minimum temperature records, is it altogether unorthodox to suspect an interdependence between the two phenomena? At least a relationship more than casual or incidental? Did the tropical storm, as reflected in the wide area over which a great displacement took place, accentuate the upbuilding of the "high"? Its counterpart, the cold wave, is not altogether the result of translation from high to low latitudes, but it arises, in a great measure, probably, as the result of outward radiation from the barren regions, of higher latitudes. Most of the great anticyclones, as they sweep south and east, incidentally develop lows which, as well developed entities, frequently play a vital part in the ultimate effects of cold waves.