

Climatological Data for July, 1909.  
 DISTRICT No. 8, TEXAS AND RIO GRANDE VALLEY.

BERNARD BUNNEMEYER, District Editor.

REPORT OF THE TEXAS HURRICANE OF JULY 21, 1909.

This disturbance was first observed on the morning of July 18, 1909, being then apparently central over western Cuba and moving in a northwesterly direction into the Gulf of Mexico. It remained in the Gulf for over three days steadily approaching the Texas coast at the rate of about 10 miles per hour. By 7 a. m. of July 21 it was central at a distance of perhaps 30 miles south southeast of Galveston, whence it moved inland over Brazoria and Wharton counties, breaking up on the following day in southwest Texas near the middle Rio Grande.

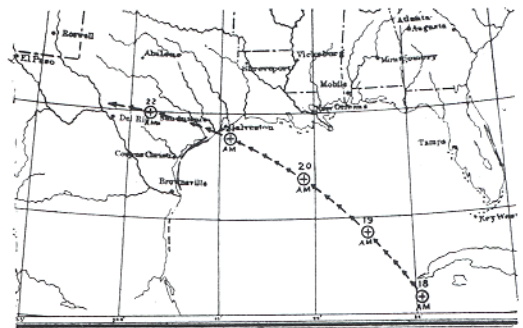


FIG. 1.—Path of Texas storm of July 18-22, 1909.

The path of the storm is shown on the accompanying fig. 1 from the day it was first announced to the day it finally dissipated. Warnings were issued daily from the Central Office of the Weather Bureau at Washington, D. C., and shipping and other interests at all Gulf and Atlantic ports were kept constantly informed of the progress of this disturbance. In consequence there were practically no marine disasters, but the damage on

land was unavoidably great. It is estimated that the total damage in Texas exceeded \$2,000,000.00, and 41 persons are reported to have lost their lives in this storm. Fig. 2 shows the storm-swept area, prepared from the best data available. The destructive force of the wind was greatest near the coast and diminished as the storm moved inland. The waves also did much damage. At Galveston the Gulf rose to a height of 10 feet above the normal, and to the westward it rose still higher, submerging the entire western portion of Galveston Island and many miles of the main land. At Velasco the tide was reported 3 feet higher than during the great Galveston storm of 1900. This is probably correct as the center of this storm passed over Velasco, while that of the 1900 storm passed over Galveston, or about 40 miles farther to the northeast. Press despatches gave accounts of many narrow escapes from a watery grave.

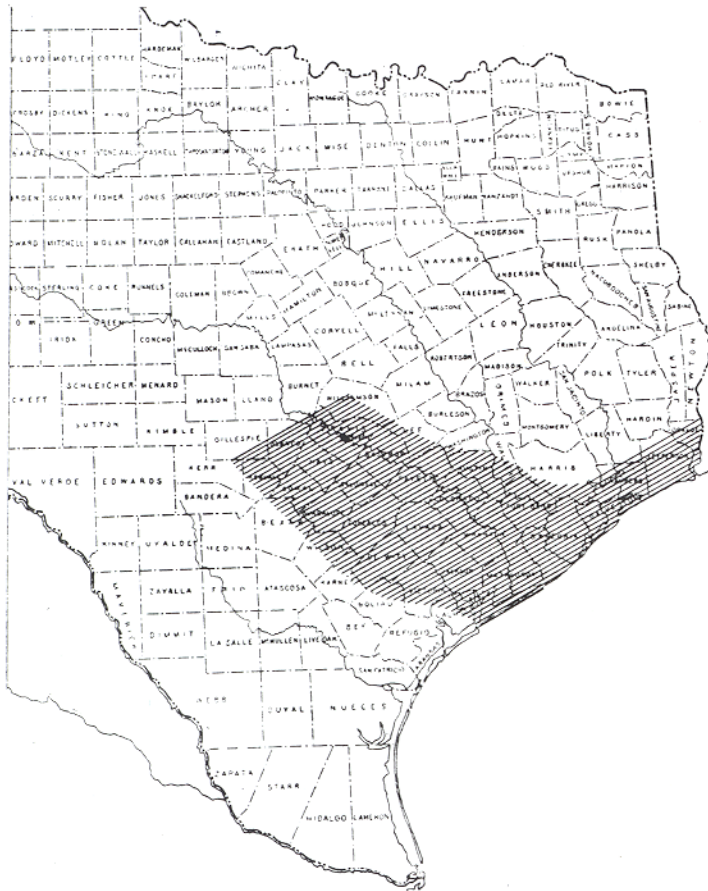


FIG. 2.—The limits of damage in the area visited by the Texas storm of July 21, 1909.

The storm was accompanied by heavy precipitation over the southern half of the State of Texas, except the lower Rio Grande Valley which received no moisture. At Hallettsville the rainfall from this storm amounted to 8.50 inches, and at Kerrville to 8.84 inches, which was the heaviest reported. Salt water was carried inland for many miles. At Bay City, which is about 20 miles from Matagorda Bay, the precipitation had a distinctly salty taste. There are no reports as to the occurrence of lightning and thunder, although a few claim to have seen faint flashes of lightning.

For several days preceding the approach of the hurricane the barometric pressure was above the normal over the eastern half of the country. From July 18 to 21 a well-defined area of high pressure advanced slowly southeastward over the Great Lakes and the Ohio Valley, while in Texas and neighboring States the weather had been for over two weeks, and was then, unusually warm. Assuming that storms follow a path in the

direction of least resistance, the cause of the course pursued by this disturbance can readily be understood from the weather conditions prevailing in the Gulf and Atlantic districts.

The lowest corrected barometric reading on the Gulf of Mexico, 29.08 inches, was observed on the S. S. *Paraguay* at 10 a. m., July 20. The lowest corrected reading on land, 29.00 inches, was observed at Bay City at 2.30 p. m., July 21. The maximum time at which the center of the storm appears to have passed a given point has been estimated at one hour. This would make the diameter of the center 10 miles, but it is probable that the diameter increased rapidly over land and was much smaller over the Gulf.

At the time of the storm the writer was on duty at Galveston, and from that place submitted the following immediate report to the Chief of the Weather Bureau:

The tropical storm of July 21, 1909, from a commercial as well as residential point of view has proven of the utmost importance to the city of Galveston. It was a very satisfactory test of the protection of the sea wall which was built after the destructive hurricane of 1900. Not a single life was lost within the protected area and the damage to property was only nominal, consisting principally of broken trees, fences and windows, and other minor losses. Outside of the sea wall everything exposed to the wind and waves was either destroyed or suffered severely. Among the property completely lost were two bathing pavilions, two fishing piers leading out from the sea wall, several structures near the beach beyond the western terminus of the sea wall, and two fishing piers on the jetties several miles east of Galveston. One other bathing pavilion was badly damaged.



FIG. 3.—Sea wall and pavilion at Galveston, Tex. The riprap at the bottom and the curved face of the wall break the force of the waves. The pavilion was destroyed by the storm of July 21, 1909.

The railroad bridge over the bay suffered to some extent, and traffic as well as telegraphic and telephonic communication was interrupted. Washouts occurred in several places. The total damage is estimated at \$100,000., and may possibly be greater.

The two fishing piers on the jetties were occupied on the day of the storm. The occupants of one of these piers were taken off before it was demolished; those of the other pier, consisting of 11 persons, went down with the structure, not, however, until after several heroic efforts had been made to save them. Seven of the 11 occupants were picked up alive on the following day by searching parties at a distance of 25 miles from the pier; three were picked up dead, and one is still unaccounted for and probably lost.

There was no damage to shipping, except that a few small boats were lost. The sloop *Ellen*, a fishing boat, was towed into port after the storm, with masts and rigging gone. Her captain, who was in a small boat at the time, was lost, struck by the boom during a gust of wind, as he was trying to board his sloop. He was probably instantly killed. The situation may be summed up as follows: Four persons dead and one person unaccounted for, property loss about \$100,000, nearly all of which occurred outside of the sea wall.

The first announcement of the approach of this storm was received at this office at 12:57 p. m., July 18, 1909, the advisory message coming from Washington through New Orleans. This was followed by further advisory messages received 1:05 p. m., July 19, and 9:45 a. m., July 20, the last message being to the effect that the disturbance was apparently over the central Gulf moving northward. Shipping interests and the public were kept thoroughly posted by telephone, bulletins, and the press, and I do not believe that on July 20 there was a single news-reading person in the city who was not aware of this storm. The weather was fine on July 19, and the sunset of that day was beautiful, showing in succession nearly all the colors of the rainbow over

the greater portion of the sky. The 20th, which was the day before the storm, opened clear. Toward noon a cirrus haze began to overspread the sky, which became slowly denser during the afternoon and gradually merged into alto-stratus clouds. By nightfall the sky was overcast, but later cleared, with clouds remaining in the eastern horizon. The wind was light until 7:00 p. m. when it shifted to the northeast, increasing in force and coming in mild gusts. At 8:40 p. m., the wind became north, but continued gusty. The highest velocity to midnight was 26 miles. There was a heavy sea swell and the Gulf was unusually high.

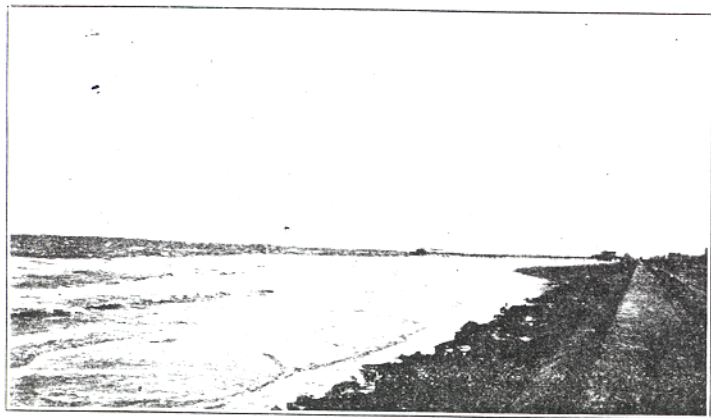


FIG. 4.—The sea wall at Galveston, Tex.; length, 19,594 feet; height, 17 feet above mean low tide; cost, \$1,295,275.

The wind continued north throughout the night and until 8:40 a. m., July 21, when it became northeast, gaining steadily in force with frequent violent gusts. Immediately after the morning observation, at 7:15 a. m., storm warnings were displayed, but the halyards parted at about 9:00 a. m. from the immense strain to which they were subjected. At 10:25 a. m. the wind shifted to the east, and at 10:50 a. m. attained a velocity of 68 miles per hour for five minutes. During this high velocity a gust of one minutes' duration occurred at the rate of 78 miles per hour. At 11:40 a. m. the wind became southeast and continued in that quadrant until after the storm. At 11:45 a. m., one of the wires connecting with the anemometer snapped at the binding post and for 12½ minutes there was a blank in the wind record. The anemometer, however, showed that during this period the wind traveled 14 miles. At about 12:35 p. m., there was a marked decrease in the violence of the wind and from this time on it lessened steadily but slowly. At 2:00 p. m. the wind record was again broken, but this time it was found to be due to the mechanism of the anemometer dial, and the extra anemometer was substituted, which cured the defective record.

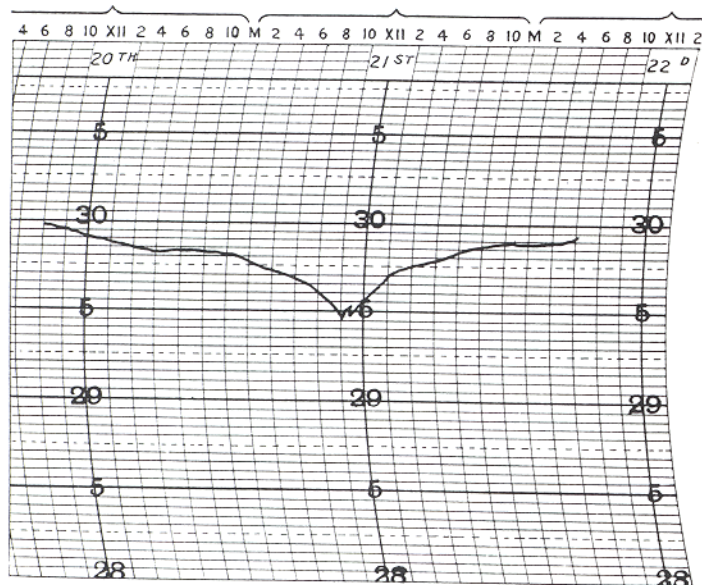


FIG. 5.—Barogram during the storm of July 21, 1909.

During the day the sky was covered with low stratus clouds and cloud which moved rapidly with the surface wind. Rain occurred from 5:17 a. m. to 5:28 a. m. and from 5:45 a. m. to 12:40 p. m., but most of the time it was a very light driving drizzle. The total precipitation for the day was 0.50 inch.

It is my opinion that much of this drizzle was spray driven in from the Gulf. It was subsequently found that nearly all trees and shrubbery, except palms, withered on the windward side, the leaves appearing scorched as by a fire and dropping off. It is believed that this phenomenon was caused by the action of salt water carried inland by the wind.

The action of the barometer is best shown by the barograph tracing, fig. 5.

A correction of 0.05 inch should be applied to this tracing. Half hourly barometer readings were, however, taken by Mr. H. H. Martin, with the following result:

| Time.       | Barometer reduced to sea level. | Time.       | Barometer reduced to sea level. |
|-------------|---------------------------------|-------------|---------------------------------|
| 7:00 a. m.  | 29.76                           | 11:00 a. m. | 29.58                           |
| 7:35 a. m.  | 29.74                           | 11:35 a. m. | 29.62                           |
| 8:00 a. m.  | 29.71                           | 12:00 noon  | 29.64                           |
| 8:35 a. m.  | 29.69                           | 12:30 p. m. | 29.68                           |
| 9:01 a. m.  | 29.65                           | 2:00 p. m.  | 29.75                           |
| 9:30 a. m.  | 29.64                           | 2:15 p. m.  | 29.80                           |
| 10:05 a. m. | 29.56                           | 2:45 p. m.  | 29.83                           |
| 10:30 a. m. | 29.57                           | 3:30 p. m.  | 29.83                           |
|             |                                 | 4:05 p. m.  | 29.86                           |

The lowest pressure was 29.557 inches at 10:05 a. m. From the direction of the wind, which was successively N., NE., E. and SE., it appears that the center of the storm passed south of Galveston. Press dispatches later had it that there were two storms at Velasco, Brazoria County, and at Bay City, Matagorda County, the first coming from the north and the second from the south. This indicates that the storm center moved inland over Velasco and Bay City, and that it passed about 25 miles south of Galveston.

The Gulf, it is estimated, rose to a height of nearly 10 feet above the normal and the entire western portion of Galveston Island was under water, drowning a large number of cattle and hogs. Volumes of water dashed over the sea wall and flooded successively the lower portions of the city. It was after 2:00 p. m. before this water finally disappeared through the drainage pipes.

The local office of the Weather Bureau was besieged by anxious inquirers during the entire day. From 4:00 a. m. until 7:00 a. m. Messrs. Scott and Martin answered all telephone calls, and after 7:00 a. m. Mr. W. P. Stewart was kept constantly busy at the telephone, advising people in the threatened sections to move into town to safer places, and that no assurance could be given until after the barometer should begin to rise. Thousands of people came down town and sought refuge in the county court house, public library, hotels and office buildings, the police and fire departments assisting in conveying them to safety. Our own office building was crowded from top to bottom. During the height of the storm the largest office window was blown in, the thermograph upset, and the station maximum thermometer broken.

Four special reports of the progress of the storm were sent to your office and one to New Orleans, but it is feared that some of them failed to reach their destination in time, as communication was cut off. Two messages, both sent from your office on July 21, did not reach this office until the following day.

The entire station force behaved admirably under trying circumstances.

The following are extracts from reports received, which throw much additional light upon the extent and severity of this tropical storm:

REPORT OF MR. W. F. BERG, MASTER OF THE S. S. PARAGUAY.

The following is a brief description of a hurricane which we encountered in the Gulf of Mexico during our last voyage from Sabine Pass, Tex., to Marcus Hook, Pa.

We left Sabine Pass on July 18, at 6 p. m. We had noticed storm signals set indicating that a storm was expected from the southeast. The weather was then clear, with a fresh southeast breeze and moderate sea. These conditions continued until shortly after noon of the following day, when the wind came from the northward. By 8 p. m., the wind had increased in force to a strong gale, with very high sea and cloudless skies. Our latitude at noon was 28° 27' north, longitude 91° 16' West. At midnight the skies had become overcast, the wind and sea remaining the same as at 8 p. m.

July 20, 8 a. m., the wind was still from the northward, blowing a strong gale, with frequent heavy squalls, heavy rain and a heavy cross sea. At 10 a. m., the wind died away altogether. The sky continued overcast, but much lighter than before, and the sea was very much confused although not very dangerous. At 11 a. m., the barometer read 29.10 inches (lowest) and the wind sprang up from the southward blowing full hurricane force, accompanied by very heavy rain, lasting until nearly 4 p. m. without a perceptible break. About 4 p. m. the weather became squally, the squalls gradually becoming less violent, with longer intervals until at midnight we were able to proceed on our course, the wind at that time being a strong southeast breeze with a clear sky and a rough sea.

The following barometer readings were taken during the disturbance:

|                          | Inches. |                         | Inches. |
|--------------------------|---------|-------------------------|---------|
| July 19, 4:00 p. m.....  | 30.08   | July 20, 2:30 p. m..... | 29.55   |
| July 19, 8:00 p. m.....  | 29.98   | July 20, 3:00 p. m..... | 29.61   |
| July 19, Midnight.....   | 29.92   | July 20, 3:30 p. m..... | 29.66   |
| July 20, 4:00 a. m.....  | 29.81   | July 20, 4:00 p. m..... | 29.70   |
| July 20, 8:00 a. m.....  | 29.43   | July 20, 4:30 p. m..... | 29.70   |
| July 20, 10:00 a. m..... | 29.10   | July 20, 5:00 p. m..... | 29.65   |
| July 20, 12 Noon.....    | 29.13   | July 20, 5:30 p. m..... | 29.66   |
| July 20, 12:30 p. m..... | 29.30   | July 20, 5:50 p. m..... | 29.78   |
| July 20, 1:00 p. m.....  | 29.36   | July 20, 6:50 p. m..... | 29.83   |
| July 20, 1:30 p. m.....  | 29.44   | July 20, 7:10 p. m..... | 29.88   |
| July 20, 2:00 p. m.....  | 29.50   | July 20, 8:50 p. m..... | 29.90   |

The foregoing readings were taken from an aneroid barometer, which was compared with a standard barometer at Philadelphia, Pa., and found to read 0.02 inch too high.

#### REPORT OF THE STORM AT ANGLETON AND VELASCO, BY MR. W. P. STEWART.

On the way to Velasco the effects of this storm were first seen at Danbury, Tex., a village about 20 miles north of Velasco. At this place two buildings had been blown down.

At Angleton, a town of 800 inhabitants, about 15 miles north-northwest of Velasco, about one-half the houses had been destroyed, many of them substantial brick structures. Of the buildings left standing nearly all had been more or less damaged. The debris was strewn toward the north-northwest. I was informed that high northerly wind prevailed during the forenoon of July 21. It shifted to the southeast and south about 12:30 p. m. and immediately attained hurricane force. There was some clearing of the sky as the center passed, but only a slight lull in the wind. Rebuilding is being pushed rapidly at this place.

On the way from Angleton to Velasco the wrecks of many farm buildings were seen. Apparently the newer houses were left standing. In the timber along the Brazos River Valley many trees were uprooted or broken off. Those at the bottom were from the northeast, those on top from the southeast or south. Corn stalks and other light debris invariably lay from the south, showing that the last blow was from that direction.

At Velasco, which had been a town of 600 people, apparently one-half of the town was destroyed. Here the wind was nearly as strong from the north as from the south. The storm-warning tower of the Weather Bureau was wrecked before the wind shifted to the south. There was a calm of about 45 minutes at the center, and for a few minutes the sun came out. The wind shifted to south about 12:30 p. m. Of the buildings left standing a large number leans toward the north. It is said that at Velasco the tide was 3 feet higher than during the great storm in 1900. It is evident that the earlier estimate that the storm center passed about 25 miles south of Galveston was approximately correct.

#### REPORT OF MR. R. B. LOGGINS, COLUMBIA, TEX.

On July 21 we had two storms at this place with a lull between them lasting from one-half to three-quarters of an hour—long enough for us to come from our retreat to the house, serve dinner and eat. These storms came from directly opposite directions, the former from a little west of north, and the latter, which was the more severe, from a little east of south. Both were severe. The former prostrated shade trees and fences, and unroofed houses, and the latter tore down whatever was left. There was no loss of life in this community. One negro woman on my place was hurt, but not seriously. All tenant and outhouses were destroyed, but the dwelling was left standing, though wet and somewhat knocked out.

#### REPORT OF MRS. MARY A. STEVENS, BRAZORIA, TEX.

The storm in the morning was northwest by north. After 10 a. m. it increased suddenly in violence. About noon there was a lull for almost one hour; then the return wind struck fast and fierce—seemingly worse than in 1900—decidedly worse than in the morning. It lasted until 4 p. m. During the afternoon the wind blew mainly from the south and southwest. At 10:30 a. m., the rain gage blew over and the amount of rainfall has been estimated.

#### REPORT OF MR. E. C. QUEREAU, BAY CITY, TEX.

I forward you a few data on the recent West Indian hurricane as observed by me at Bay City, Tex. I have a compensated aneroid barometer of English make and noted that it registered 30.2 inches at 8 a. m. My barometer has not been compared with a mercurial for a long time, but by watching the isobars on the weather maps, I judge that it reads about 0.2 too high. However, I will give you actual readings.

At about 12 m. of the 21st, it had fallen to 29.5 inches, with a strong wind blowing from the north. At 1 p. m. it read 29.3 inches, and the wind shifted to north of west. At 2:30 p. m. it read 29.2 inches, the lowest point reached, with wind from the west, increasing to a terrific gale, which was estimated at from 70 to 75 miles per hour. The barometer remained at 29.2 inches until about 3:30 p. m., when it began to rise slowly. The wind shifted to southwest and later to south, but did not slacken perceptibly for half an hour after the barometer began to rise. By 5:30 p. m. the wind

had died out and the barometer returned to 30.2 inches. The rainfall was excessive during the storm. A tub I put out was blown away, and there were very few things that were not blown away. A neighbor had a pail in a tree which was filled (about 12 inches). The country here is very flat, but water filled the roads and fields until the ground was out of sight under several inches of water. Evidently the center of the storm passed east of Bay City, but probably not far. Destruction to buildings was very great in this city and east of the Colorado River, but there was not much damage west of that river.

A friend from Rock Island, near Eagle Lake, reported that the wind there started in from the north when there was a lull for nearly an hour. It then shifted to the south and was very destructive. Evidently the center of the storm passed over that place.

#### REPORT OF MR. C. R. SWISSELM, BAY CITY, TEX.

The morning of July 21 dawned cloudy, with light rain and very little wind. About 9:30 or 10:00 a. m., the wind became stronger and at noon commenced to tear down awnings and signboards. About 1:30 p. m., our hotel, which was a large frame building, began to rock and we moved to a small brick building across the street and remained there for probably one half hour, when the wall of the opera house next door gave way and fell through the roof of our shelter, but the wooden ceiling held the brick long enough to allow us to escape. We then moved to another brick building immediately adjoining, but left it in about five minutes, because its roof blew off. We then retreated to the building which contained the post-office. The walls of this building held, but all its windows were blown in. The storm ceased about 6:30 p. m. The damage was all done between noon and 6 p. m.

I was slightly confused in the points of the compass, but to the best of my knowledge the wind began from the northwest and gradually shifted to the west, south, and southeast. There was no lull during the storm. The velocity of the wind was estimated by several people at about 110 miles per hour, and that is also my estimate. The wind was strong enough to pick up pieces of wood 6 inches in diameter and 3 feet long and hurl them through the air. It rained incessantly, but there was no lightning or thunder, and the water that fell had a distinct taste of salt and stung the eyes. The wind came in gusts and in several instances knocked holes in brick walls, but left the walls standing. Several buildings had the front blown in and the rear blown out.

The warehouse and cotton gin district was completely wiped out. Many residences were blown off their foundation, but were otherwise not seriously damaged. The frame buildings seemed to suffer less than the brick. There was scarcely a frame house left standing between Bay City and Wharton. The town of Van Vleck had only three houses left standing and they were badly damaged.

#### REPORT OF MR. F. P. LUND, MIDFIELDS, TEX.

The center of the storm passed over El Campo, Tex., where there was a lull in the wind from about 4:20 p. m. to 4:40 p. m., when the wind blew from a nearly opposite direction.

At Midfields, the wind commenced to blow from the north and gradually shifted to the southwest.

My aneroid barometer read 30.24 inches in the morning and by 1 p. m. had fallen to 29.53. At two o'clock it read 29.33 and remained stationary until 3 p. m., when it rose to 29.45. At four o'clock, it again fell to 29.33, but by 5 p. m. had risen to 29.45 and continued to rise until it read 30.24 inches.

NOTE:—The aneroid barometer used by Mr. Lund in his observations seems to read from 0.2 to 0.3 inch too high.

#### REPORT OF DR. J. E. LAY, HALLETTSVILLE, TEX.

The storm of July 21 was the worst ever known in this community. I have been a resident here since 1850 and nothing like it has been known in my experience. I have measured the rainfall since 1872 and have never known more than 6 inches to fall in one storm, but on this occasion there fell 8.5 inches before it ceased. The wind must have blown at least 55 or 60 miles per hour. The velocity is only estimated as I have no anemometer, but taking into consideration the damage done to crops, outhouses, windmills and other things in general, it must have reached or exceeded that velocity.

From the despatches from Galveston, the storm center must have struck the coast between that city and Corpus Christi and if it did, it must have been deflected inland and to the northward. I judge so from the course the wind took at this place which evidently shows that the storm center passed east of us between this place and Houston.

On the 20th the barometer began to fall, the temperature being about 100°. Press despatches showed that a storm was in the east Gulf and I feared it would come this way for the whole of Texas was a seething furnace with the barometer comparatively low. I stated these facts to my friends and my prediction was correct.

About 3 p. m. of the 21st, the wind freshened from a northerly direction with an already cloudy sky, and continued to gain in velocity. The barometer continued to fall and by 5 p. m., the storm was upon us increasing in force until about 8:30 p. m., when the barometer ceased to fall, remained

stationary for a few minutes, and then began to rise with great rapidity. After this the wind slowly abated and by 9:30 p. m. had shifted, by way of west and south, to the southeast where it died away. From the course the wind took, I suppose the center passed east and toward the interior, northward of us.

During the entire storm, the rain fell in torrents putting the water courses up very high. The damage to crops is very great, but can not be accurately estimated at this time.

With the tempest howling, the rain beating through every place thought to be secure, the trees crashing and now and then torn up by the roots that had held them secure against every storm for a hundred years or more, and

total darkness prevailing, this was the most awful night I have ever experienced. The most consoling thought is that there was no loss of life.

REPORT OF JULIUS LAUX, FLATONIA, TEX.

During the storm of July 21, both my thermometer shelter and raingage were blown over, but I am glad to say were not damaged, although I lost my rainfall record. The storm was very severe. Considerable damage was done to shade trees and store buildings, but very little to dwellings. A number of outhouses and barns was blown down. Some private rain gages which heretofore agreed closely with mine showed 5.75 inches of precipitation.

## WEATHER, FORECASTS, AND WARNINGS FOR THE MONTH.

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

July closed with a barometric depression over the Caribbean Sea within which two disturbances of slight intensity appeared. One of the disturbances moved northward between Santo Domingo and Porto Rico and thence to the Atlantic coast of the United States, attended along the middle Atlantic seaboard by heavy rains on the 4th and 5th, and the other passed over the Gulf of Mexico to the Texas coast with moderate to heavy rains in the middle and west Gulf coastal districts from the 4th to 8th. The rains that attended the Gulf disturbance verified a special forecast issued Thursday, July 29, in which the statement was made that rains would fall in middle and west portions of the cotton belt, where rain was needed, by the middle of the following week. The rains set in as scattered showers about the middle of the week referred to and became more general Friday and Saturday, and the precipitation for the latter half of the week aggregated about or slightly more than the normal weekly rainfall.

tion as definite in character as conditions warranted and with the appearance of the disturbance near Yucatan were advised that it was considered unsafe for vessels over central and western portions of the Gulf of Mexico. The westward advance of the storm center over the Mexican coast line and thence into the mountainous interior rather than along a normal northerly course can not be accounted for. By reason of the anomalous path it pursued, expected rough weather over the northwestern portion of the Gulf was not experienced and there was a less extensive distribution of general rains over the Southern States than was anticipated in a special forecast that was issued August 10.

On the 16th a disturbance appeared east of the Virgin Islands, W. I., moved rapidly thence on a northwest course, and apparently recurved during the 17th and 18th to the south and east of Bermuda. On the latter date another disturbance appeared off the Carolina coast and moved northward and then northeastward over the Atlantic without being severely felt at coast stations. Preceding the northward advance of this storm a disturbance that moved from the Lake region to the middle Atlantic coast caused excessive rains on the New Jersey and New York coasts, the precipitation at New York City for the twenty-four hours ending at 8 a. m. of the 17th being 5.04 inches. During the prevalence of the stormy conditions above referred to in eastern and southern waters a period of heat that for duration and intensity had been unequaled since 1901 prevailed in the Western States, and more particularly from the Great Plains over the lower Missouri and middle Mississippi valleys. The heat in the West was broken the night of the 17th and during the 18th, without the usual accompaniment of rain and relief from the intense heat was had in the Southwestern States on the 19th.

Morning reports of the 18th indicated the presence of a disturbance to the eastward of the Island of Dominica, W. I. By 2 p. m. the center of the disturbance had advanced to a position south and east of St. Kitts and probably near Guadaloupe. West Indian ports were advised that the storm would move north of west and probably pass near the Virgin Islands and Porto Rico. By the morning of the 19th the storm center was south of and near Porto Rico and moving in a north of west direction. Afternoon reports of the 19th indicated that the center of the disturbance was approaching Santo Domingo and advices were issued to the effect that the storm would continue a west-northwest course toward the Bahama Islands. By the morning of the 20th the center had advanced over Santo Domingo and was apparently north of Port au Prince, Haiti and by the following morning it had apparently recurved over the Atlantic beyond the region of observation.

Closely following this disturbance came a storm that showed marked intensity during its passage over the Caribbean Sea and the Gulf of Mexico and occasioned an enormous loss of life and property in northeastern sections of Mexico. This storm, or hurricane, appeared east-northeast of Barbados on the 20th and advices were then issued that it would probably move on a westerly course. By the morning of the 21st the center had advanced to the vicinity of Martinique, from which position it moved westward and on the morning of the 22d was central south of and apparently near Porto Rico. Vessel interests were advised as follows:

Hurricane of marked intensity near and south of Porto Rico moving westward. Dangerous for vessels over western West Indian waters during next several days.

On the 23d there appeared to be two cyclonic centers, one moving on a north of west course over the Windward Passage and another, a secondary or "twin" storm, south of Haiti. The

On the 9th reports from Yucatan and the Mexican Gulf coast indicated the presence of a disturbance of marked intensity near or west of the northern point of Yucatan or in the Gulf of Campeche. By the following morning the center of the disturbance had apparently moved westward toward the Mexican coast in the vicinity of Tampico after which it appeared to pass inland north of Tampico and dissipate in heavy rains in the mountain districts during the 10th and 11th. During the presence of this storm over the western portion of the Gulf of Mexico, far from stations of observation, its course could not be determined. Shipping interests were however given informa-

former evidently dissipated over the southern Bahamas or passed northward over the ocean without acquiring marked intensity and the other moved westward to a position off the southern coast of central Cuba by the 24th and reached the Yucatan Channel on the 25th. On the 23d the storm caused great loss of property on the Mole St. Nicholas, Haiti, many houses being wrecked by high easterly gales and by waves that rolled in from the bay. Some damage was also caused to banana fields on the north side of Jamaica. Advices issued on the 23d noted the presence of the more southern storm and stated that the northern disturbance would move west-northwest in the region of the Bahamas; also that rough water would be experienced in Cuban waters and probably as far south as Jamaica. During the 24th the southern provinces of Cuba were visited by heavy winds and rains that caused considerable property damage and in the afternoon a wind velocity of 60 miles an hour from the northeast was reported at Havana. On that date advices were issued that the storm would move west-northwest toward the southeastern portion of the Gulf of Mexico and vessels were cautioned to avoid those waters.

On the 25th the steamship *Cartago* was obliged to heave-to thirteen hours in the Yucatan Channel with wind blowing at an estimated velocity of 100 miles an hour, beginning in the morning from the northeast and shifting shortly after noon to east by southeast and continuing from that quarter during the afternoon. The position of the *Cartago* in the channel, twenty-five miles off the Yucatan coast, with hurricane winds, and high seas that dashed over the ship, and a current from the Gulf running in an opposite direction, was one of extreme peril. Damage, however, was of a minor character. The morning of the 26th the captain sent an account of the storm by wireless to New Orleans, via Burrwood, La. This was the first instance of a storm experience at sea that was transmitted in season to be utilized in current forecast work. The distance between the ship and the receiving station was about 500 miles.

Following a west-northwest course from the Yucatan Channel the hurricane center reached a position in the Gulf off and probably southeast of the mouth of the Rio Grande River by the morning of the 27th and moved thence inland near the mouth of the Rio Grande, attended by excessive rains that caused an enormous loss of life and property by flood in north-eastern districts of Mexico. The following extracts from a report by J. L. Cline, Weather Bureau Observer at Corpus Christi, Tex., indicates the character of the wind and seas that were experienced on the southern Texas coast that was covered by the north, or dangerous, semicircle of the hurricane:

The barometer fell slightly during the afternoon and night of the 26th. On the 27th it was comparatively low and oscillating and reached the lowest reading, 29.73 inches, at 4:30 p. m. The wind was from the northeast, occasionally shifting to east, and thunderstorms came from the southeast. The wind reached a maximum velocity of 66 miles from the east at 2:28 p. m., and 48 miles an hour from the east was reached at 2:53 a. m. of the 28th. The wind subsided during the evening and night of the 28th. Unusually high tides and rough seas prevailed on the 27th and 28th. Low lands on Harbor, St. Joseph, Mustang, Padre, and other islands along the Gulf coast south and east of Corpus Christi from St. Joseph Island south to the mouth of the Rio Grande were inundated. The water in Corpus Christi and Neuces bays was higher than for many years and reached a maximum height about 8:30 a. m. of the 28th. The water covered low lying portions of Corpus Christi, and even where the land is comparatively high along the bay front in central and northern portions of the city, waves would occasionally dash over the bank. A number of wharves and piers were damaged. All low lands or "flats" north and northwest of the city, bordering on Neuces Bay, were submerged to a depth of 1 to 3 feet. The water receded slowly during the 29th. People living on the low islands along the Gulf state that the warnings of the Bureau were timely and enabled them to reach points of safety. This accounts for the fact that no lives were lost on the Texas coast during the passage of this tropical storm.

A special, dated August 30, from Point Isabel, Tex., to the Corpus Christi Herald reads as follows:

The people who were at Tarpon Beach are loud in their praises of the United States Weather Bureau, and say that had it not been for the warn-

ings sent out by the Bureau that everyone of them might have been drowned. As it was, they received warnings in time to seek safety in the quarantine station, where they all remained until the storm was over.

Messages received during the 27th from the Point Isabel Life-Saving Station on Brazos Island, at the mouth of the Rio Grande River indicated the character of the storm at that point. The first message was sent in the morning and stated that the crew of the station had saved everybody at Tarpon Beach. A later message, received by the Superintendent of the Ninth District Life-Saving Service at Galveston was as follows:

This vicinity struck by a violent hurricane. Keeper and crew compelled to abandon station. Stopped at Tarpon Beach and rescued all people in surf boats and brought them over to Point Isabel. Station in a dangerous condition. Keeper and crew still at Isabel. Heavy weather.

In reply to a message from the Superintendent for further information the Keeper reported about 9 p. m. as follows:

People and crew left the station at daylight, at which time seas were breaking against the station and over Tarpon Beach. Rescued everybody. Unable to return to station this day. Station has not been sighted on account of hurricane since crew left. Hurricane still blowing and sea raging.

The value of advices and warnings issued in connection with this storm may be inferred from the fact that reports fail to show the loss of a single vessel along or near its course, that extended from the eastern islands of the West Indies to the western course of the Gulf of Mexico; neither do reports indicate that any vessel that cleared from United States or West Indian ports ran into the hurricane.

From the 27th to 30th a shallow barometric depression advanced from the Caribbean Sea south of Haiti northwestward to the Florida Peninsula and at the close of the month was central off the northeast Florida coast. This was the last of a series of barometric depressions of greater or less intensity that appeared over the tropical and subtropical regions of the Atlantic and Gulf of Mexico during June, July, and August and moved thence westward or northwestward. During the closing days of August pressure conditions over the Caribbean Sea resumed a normal aspect, and the first summer high barometer area of any considerable magnitude advanced from the British Northwest Territory to the Atlantic seaboard attended by temperature falls of 20°, or more, over the interior where temperature had been almost uninterruptedly high during July and August.

## SPECIAL REPORT ON THE HURRICANE OF SEPTEMBER 20-21, 1909, ON THE LOUISIANA AND MISSISSIPPI COASTS.

The hurricane which moved northward over Louisiana and Mississippi, September 20-21, 1909, was of the greatest geographic extent and probably the most severe storm that has been experienced on the central Gulf coast.

## WEATHER CONDITIONS AT NEW ORLEANS PRECEDING AND DURING THE HURRICANE.

*September 18.*—The pressure was quite uniform, ranging from 29.91 to 29.97 inches. The wind was light with the prevailing direction northeast until 5 p. m., and east, except for a short interval, from that hour until midnight. The temperature averaged 4° above the normal and ranged from 76° to 88°. The day was partly cloudy with cirrus and cirro-stratus clouds moving from east or northeast during the greater part of the day, but occasionally from the north. Polar bands tinged with pink were observed at 7 p. m.

*September 19.*—Very little change in pressure conditions took place until the afternoon when the barometer began falling slowly; at 10 p. m. a more rapid fall set in. The temperature averaged 3° above the normal and ranged from 77° to 85°. The wind was steady from the northeast during the twenty-four hours, the velocity increased steadily from a light wind in the morning until noon, after which it blew generally at a rate of 18 to 20 miles per hour, the maximum velocity being at the rate of 28 miles per hour from the northeast at 12.55 p. m. Cirro-stratus clouds prevailed during the forenoon with some cumulus and alto-stratus during the afternoon. Rain fell at intervals commencing at 4:55 p. m. About sunset the clouds were tinged with a brilliant carmine glow lasting from 5:50 to 6:30 p. m., being most pronounced at 6:10 p. m.

*September 20.*—The barometer fell at a steady and uniform rate from 29.80 at midnight of the 19th to 29.63 at 10 a. m., after which the decrease in pressure was more pronounced and was at a uniform rate of nearly one-tenth of an inch in two hours until 7 p. m. when the lowest reading, 29.23 inches, was recorded. The lowest temperature during the day, 74°, occurred at 1 p. m., and the highest recorded during the twenty-four hours was 79°. The wind was from the northeast until 8 a. m., coming in sudden gusts ranging in velocity from 22 to 42 miles per hour, a rate of more than 30 miles per hour being recorded in some five-minute period of every hour after 1 a. m. From 8 to 9 a. m., the wind blew from all directions, not continuously from any one direction during a period of five minutes; during this hour the wind lulled and the velocity was uniformly about 16 miles per hour. From 9 to 10 a. m., the wind blew steadily from the northeast and the velocity nearly doubled over that of the preceding hour with a maximum at the rate of 40 miles per hour at 9:53 a. m. From 10 a. m. until noon the wind was variable blowing from all directions not remaining from any one direction during a period of more than five minutes. The wind lulled again during this time and the velocity ranged from 12 to 24 miles per hour. From 12 noon until 3 p. m. the wind oscillated between northeast and southeast, being mostly east, and the hourly wind velocity ranged from 25 to 33 miles per hour, the maximum for five minute periods being for each hour at the rate of 31, 37, and 40 miles, respectively. From 3 to 4 p. m., the wind was mostly from the east, but occasionally from



the southeast with increasing velocity, the total movement for the hour being 39 miles with a five-minute maximum at the rate of 46 miles per hour. From 4 until 5:20 p. m., the wind veered toward the southeast after which it remained steady from the southeast until 10:45 p. m., when it veered to the south. The wind velocity increased as the wind settled into the southeast, with an hourly movement from 4 to 5 p. m. of 45 miles, and for a five-minute period it was at the rate of 58 miles per hour; from 5 to 6 p. m. the hourly movement was 49 miles and the maximum for five minutes was at the rate of 62 miles per hour; from 6 to 7 p. m., the hourly movement was 55 miles and the maximum for five minutes was at the rate of 66 miles, this being 6 miles greater than the highest wind previously recorded at New Orleans. After 7 p. m. the wind subsided slowly, but storm velocities occurred at intervals until about midnight. The wind was freaky, blowing at all times during the day in sudden powerful gusts or blasts limited to narrow areas and requiring but a few seconds of time in passing a given place. These sudden gusts or blasts were of much greater velocity than the highest five-minute record. Low, heavy clouds, from which rain fell incessantly, moved rapidly from the northeast during the forenoon and from the east and southeast during the afternoon. The rainfall was heaviest from 12 noon to 1 p. m., when 1 inch fell, there being no other hour during the day with one-third that amount.

September 21 was clear and pleasant, with light wind from the south.

#### EFFECTS OF THE HURRICANE.

The center of the hurricane moved inland between the mouth of the Mississippi and the Atchafalaya rivers, as forecast by the Weather Bureau. The wind at Morgan City backed from the northwest, by the west, to the south, while at New Orleans it veered from the northeast, by the east, to the south. The center of the disturbance moved northward over eastern Louisiana, passing about halfway between New Orleans and Morgan City. Excessively high tides occurred in the eastern segment of the hurricane, flooding all the lowlands on the middle Gulf coast to a depth ranging from 2 to 10 feet. At New Orleans the back water in the river, as a result of the storm tide, was 4 feet on the afternoon of the 20th. The storm winds carried the water from the Gulf of Mexico northward, east of the Mississippi River over Breton Sound, eastern Plaquemines, St. Bernard, and Orleans parishes into Lake Pontchartrain, giving the highest tide water ever known in those sections. Reports from the north shore of Lake Pontchartrain indicate that the tide had risen 4 feet up to 7 p. m. on the 20th, when it remained stationary for nearly an hour. From 8 to 10 p. m. there was a storm wave of 3 feet, making a total tide in that section of 7 feet. The water commenced receding about midnight. A break in the protection levee on Bayou St. John near the Dumaine Street Bridge allowed the water from Lake Pontchartrain to flow through and flood a large area, in the western portion of New Orleans, to a depth ranging from 1 to 2 feet. The highest storm tide occurred between the mouth of the Mississippi River and the Mississippi Sound, about 50 miles east of the storm center. The occurrence of the highest tide in this part of the storm and so far from the center was, no doubt, due to the fact that the storm was moving northwest until it reached the Louisiana coast, and then curved more to the northward. Reports from Grand Isle, which was near the center of the storm, indicate a tide of about 4 feet in that section as the highest water on that island was but 2 feet. From the Atchafalaya River westward, the northerly winds held the tides down; however, the winds were high and dangerous as far west as Galveston, Tex.

Much damage resulted from the storm along the middle Gulf coast, and for some distance inland. At New Orleans five persons were killed either by falling chimneys or coming in contact with live wires broken by the wind, and the property

damage is estimated at about \$1,000,000, the greater part of which was along the river front, mainly from the sinking of barges loaded with coal. Small craft were torn from their moorings in harbors and suffered much damage.

More than half the coal fleet along the Mississippi River was sunk. The railroads suffered severe damage. The Louisville and Nashville Railroad lost 25 miles of track, and the bridges at Rigolets and at Bay St. Louis were partly destroyed. The Illinois Central Railroad lost 8 miles of double track and several bridges. Other roads suffered to some extent, but no reports of the extent of their damage has been received. Telephone and telegraph wires in all directions were prostrated, there being but one wire left in operation out of New Orleans, a telephone line to Hattiesburg, Miss. The wireless towers were all blown down. The Western Union Telegraph Company opened a wire by the way of Dallas, Tex., on the 22d and this was followed by other wires on the 23d and 24th, and on the 25th a good telegraph service was restored. The damage suffered by the railroad, telegraph, and telephone companies will probably exceed \$1,000,000. Many towns for some distances inland suffered heavy damage. Agricultural interests in Louisiana suffered less than was at first anticipated, and the damage to crops will probably not far exceed \$1,000,000. The total damage in Louisiana and Mississippi is estimated at about \$5,000,000. Nearly 200 persons are known to have perished in Terrebonne Parish and about 50 deaths occurred as a result of the storm in other portions of Louisiana and Mississippi. The exact loss of life will never be known, but a conservative estimate places the total number of deaths at about 350. Nearly 4,000 people were rendered homeless, the bulk of these being in Terrebonne Parish. The coast region of Terrebonne Parish is cut up by numerous bayous, and 2,000 or 3,000 fishermen live along these sluggish streams. Houma is the nearest telephone exchange, and people living several miles south of that place are without rapid means of communication and could not be reached by warnings.

When it is taken into consideration that dangerous winds occurred from Tampa, Fla., on the east to Galveston, Tex., on the west, over a long stretch of low coast, and at New Orleans the wind velocity exceeded all previous storms the small loss of life is phenomenal when compared with that resulting from previous storms in this section. It is a notable fact that no loss of life resulted from drowning in the neighborhood of the storm-warning display stations of the Weather Bureau, which establishes the fact that the warnings were effectual in the saving of life. Four-fifths of the deaths that resulted from the storm occurred in a portion of Terrebonne Parish that could not be reached with the warnings, and many of the remaining number resulted indirectly from the storm in a manner that no warnings could have prevented their occurrence. Under the guidance of the warnings of the Weather Bureau, all of the small craft that could be reached had sought harbors and prepared to weather the storm. The coal fleet anchored along the banks of the Mississippi kept up steam commencing Saturday night and they were advised Sunday, in conversation over the telephone, to keep in readiness for the storm. About half the fleet was sunk, but the remaining half was saved as a direct result of the action taken on the advice of the Bureau. No loss of life occurred on the high seas, because all the craft not strong enough to weather severe storms heeded the warnings and remained in port. The only casualty reported was that of the steamer *Utstein*, which was stranded in 7 feet of water just west of the Ship Shoal lighthouse. The *Utstein* was bound from Spanish Honduras for New Orleans with a cargo of fruit. None of the crew was lost. There was some loss of life on small craft that had sought refuge in the bays and bayous, but these people had sought what they deemed safe harbors. It is not possible to estimate to what extent lives and property were saved as a result of the warnings, but judging from action taken

it can safely be said that the number of lives and the amount of property saved greatly exceed the losses.

COMMENTS ON WORK OF WEATHER BUREAU.

The following comments on the warnings have been received:

The Daily Picayune, New Orleans, La., September 22, 1909, says:

It must be said to the credit of the Weather Bureau that the excellent work done has proven of incalculable benefit to life and property by the issuance of timely warnings of the storm. On Wednesday of last week the Weather Bureau began to give out bulletins as to the location of the tropical hurricane and its probable trend, and this warning note never ceased from day to day until the crucial moment, Monday morning, when the definite warning was issued, telling about the very near approach of the disturbance threatening south Louisiana and probably having some sinister design upon the city of New Orleans. The storm reached this city about the time forecasted by the Weather Bureau, and it lasted until nearly midnight Monday.

In commenting editorially on the storm, the Daily Picayune of September 25, 1909, says:

The admirable arrangements made by the weather service insures ample warning of the approach of these West Indian storms, but there is little that can be done to protect property from their ravages. That the timely warn-

ings save many lives is, however, undoubted, and were the people who live in exposed stretches of the coast to pay greater attention to these warnings the loss of life would be still more reduced. Sailors who go to sea carefully note the weather predictions and are guided thereby, whereas the people living on the low-lying coast, who have actually more to fear than the sailors, usually pay less heed to the storm predictions.

The following extracts from letters received convey the general tenor of public feeling toward the work performed by the Bureau:

MORGAN CITY, LA., *September 24, 1909.*

The storm warnings were timely and were the means of saving life and property. Boatmen who were prepared to sail were advised and took timely warning, thus being able to save their property.

(Signed) M. COGUENHEM.

NEW ORLEANS, LA., *September 22, 1909.*

We write to express our appreciation for the excellent and courteous service which your office furnished to us during the uncertain hours of the recent storm. We feel that your office was solely instrumental in saving to New Orleans, through advices sent out by you in advance, many lives and thousands of dollars worth of property.

We can doubly assure you that many people in New Orleans were given encouragement throughout the height of the storm by information given out during its fury.

(Signed) CASTELL & TREFNEY.

## WEATHER, FORECASTS, AND WARNINGS FOR THE MONTH.

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

After more than two months of low and fluctuating barometric pressure over the tropical Atlantic and Gulf of Mexico, and attendant stagnated and unusually warm and dry weather over the interior of the United States, September opened with a resumption of average atmospheric pressure in the South and a more active movement of barometric areas over the North American Continent. The continental changes were indicated by the following special forecast that was issued August 29:

The week beginning Monday, August 30, will be one of moderate temperature generally in districts east of the Rocky Mountains. Rain will set in over the great corn growing States about the middle of the week and the rain area will move eastward to the Atlantic States by the close of the week. The rains will be followed by a period of cool weather for the season in middle and northern sections of the country.

velocity of 60 miles an hour from the northeast and a twenty-four-hour rainfall of 7.88 inches was reported. Reports indicate that the storm damage in Pinar del Rio Province aggregated about \$1,000,000. From a position off the western extremity of Cuba the storm center moved northwestward over the Gulf of Mexico and reached a point near the mouth of the Mississippi River on the morning of the 20th.

Advices issued from the 12th to 14th were based upon observations taken at considerable distances from the center of the disturbance and were necessarily limited to statements regarding its apparent location and probable course. Advices of the 15th stated that the disturbance was west of Jamaica and that it would probably move northwestward to the Yucatan Channel. On the following day, the 16th, Atlantic and Gulf shipping interests and ports were notified that the hurricane center was apparently moving slowly toward the west Cuban coast or the Yucatan Channel, and on the 17th the following was telegraphed:

Hurricane center has reached Pinar del Rio Province, Cuba, and apparently moving northward. Shipping in south Atlantic and east Gulf ports or due to sail for southeast coast waters advised to remain in port.

By the 18th the course of the storm was more clearly indicated and advices stated that the center of the hurricane was apparently advancing toward the central Gulf of Mexico. On this date storm warnings were ordered for the western Florida, Alabama, Mississippi, and eastern Louisiana coasts. On the 19th the storm warnings were extended to the northern Texas coast; middle Gulf ports were advised that the center of the tropical hurricane was apparently approaching the Louisiana coast and hurricane warnings were ordered for the Louisiana coast. Advices of the morning of the 20th stated that the hurricane center was near the mouth of the Mississippi River and would move northward over Louisiana.

At the regular 8 a. m., seventy-fifth meridian time, observation of the 20th the report from Burrwood, La., a Weather Bureau station at the mouth of the Mississippi, was missing and New Orleans, about 70 miles to the northwestward of the storm's vortex, was the nearest point from which a report was received. At that place the barometer was 29.68 inches, wind northeast and blowing at a rate of 36 miles an hour and a rainfall during the preceding twelve hours of 0.94 inch. It was calculated at that time that barometric pressure at the center of the storm was about 29 inches. The barometer fell steadily at New Orleans and at 8 p. m. read 29.22 inches, with wind from the southeast and blowing 48 miles an hour, with an extreme recorded velocity of 68 miles and a rainfall of 2.86 inches during the preceding twelve hours. The center of the storm was then west and probably within 50 miles of New Orleans.

At 3 a. m. of the 21st barometric pressure at Vicksburg, Miss., was 29.06 inches. By 8 a. m. of the 21st the center had advanced to a position over southeastern Arkansas, with lowest reported barometer 29.34 inches at Little Rock where the wind was from the north and an extreme velocity of 40 miles an hour had been recorded. Moving thence northward the center of disturbance reached west-central Illinois by 8 p. m., with pressure 29.40 inches at Springfield, Ill. By that time the storm had merged with a barometric depression that had moved eastward over the Plains States, and by the morning of the 22d a trough of low barometer extended from Lake Superior to the Rio Grande Valley, with lowest pressure 29.50 inches at Sault Sainte Marie, Mich. During the succeeding forty-eight hours the barometric trough moved eastward to the Atlantic coast attended by general rains that were heavy in localities and followed by an extensive area of high barometer and cool weather that carried the frost line to the northern portions of the middle Gulf States.

## THE TROPICAL STORM OF SEPTEMBER 12-21.

During the first decade of the month pressure continued abnormally high over the Azores region and, except on the 6th and 7th, was high over and near the British Isles. This distribution of pressure, by increasing the strength of the northeast trade winds, promoted in the tropical regions of the southwestern Atlantic conditions favorable to the development of cyclonic disturbances. The barometer began to fall over the Lesser Antilles September 10, and from the 12th to 14th a depression of apparent slight intensity moved westward over the Caribbean Sea. On the morning of the latter date two centers of cyclonic action appeared, one north and the other south of the Island of Jamaica. By the following morning the northern depression had apparently dissipated and the one to the southward of Jamaica had increased in intensity and was moving northwestward toward the Yucatan Channel where it arrived the morning of the 17th. At that time the barometer at Pinar del Rio, Cuba, read 29.44 inches, the wind had attained a

A full report on the effects of the above mentioned hurricane in the vicinity of New Orleans has been prepared by I. M. Cline, Official in Charge of the Weather Bureau office at that place, and appears in the summary of District No. 7, page 623.

At Mobile many vessels ran up the river about 12 miles for shelter and a number of those that remained at Mobile were sunk or damaged. The loss to shipping was estimated at \$3,000. The damage to property in Mobile, mostly by high water, was estimated at \$5,000. The estimated value of merchandise and goods that were saved by removal from wharfs and lower floors in stores was \$400,000. At small towns on the Alabama coast the damage by wind and high tides was estimated at \$6,000. At Coden the water in the town was about 3 feet deep. At points on the Mississippi coast the tides reached heights of 8 to 12 feet. The loss at Scranton was about \$11,000 and at Biloxi about \$43,000. At Gulfport and vicinity the damage by wind was about \$7,000 and by tides about \$150,000. The damage by wind at Pass Christian, Bay St. Louis and vicinity was about \$20,000, and by high tides, including railroad losses, about \$800,000. At these points the storm was considered the severest ever experienced. About 200 bath houses and 20 modern residences on the beach were demolished and many others damaged. Four large and six small fishing schooners were wrecked and numerous small boats were beached. Only three lives were lost on the Alabama and Mississippi coasts. The warnings that were sent along these coasts are said to have been instrumental in saving lives and much property.

The damage in Pensacola Bay, that was confined largely to small craft, wharfs, bath houses, etc., was estimated at \$4,000. Warned of the approaching storm, many families left their homes along the bay shore and found safer quarters. Parties in the bathing pavilions on Santa Rosa Island were brought to the city. Steamers in the harbor kept up steam and small vessels and some of the fishing fleet anchored across the bay.

Following the passage over the continent of the tropical disturbance barometric pressure continued low over the Greater Antilles and the Florida Peninsula during the balance of the month. From the 21st to 24th an extensive area of high barometer moved from the north Pacific coast over the Lake region and central valleys, where it remained nearly stationary until the 27th, with heavy frost in the upper Lake region and upper Mississippi Valley the morning of the 27th, after which it settled southward over the Gulf States, with light frost in Tennessee the morning of the 29th.

A notable feature of the third decade of September was the prevalence over the Azores of exceptionally low barometric pressure. At Horta, Fayal, the barometer began to fall rapidly on the 25th, reached 29.40 inches on the 27th and rose very slowly to 29.50 inches by the morning of the 30th, with maximum reported wind velocity 52 miles an hour from the southwest on the 30th. The pressures thus noted were in the southern quadrants of a low barometer area that was central over the mid-Atlantic north of the Azores. The center of this low area evidently moved northward toward Iceland where a pressure of 28.78 inches was reported October 2.

## WEATHER, FORECASTS, AND WARNINGS FOR THE MONTH.

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

During the first decade of October the weather was fair and cool over the eastern portion of the United States and light frost occurred at intervals during that period in the Middle Atlantic and New England States.

From the 3d to the 10th a barometric disturbance advanced from Alaska to the Great Lakes where it deepened and remained nearly stationary until the 15th when the center moved eastward over the St. Lawrence Valley and Canadian Maritime Provinces. This disturbance was attended by rain in middle and northern sections of the country from the Pacific to the Atlantic, by gales over the Great Lakes, and on the 14th by severe local storms in Tennessee, northern Alabama, and northern Georgia. It was followed by snow from the upper Mississippi Valley over the Lake region and the interior of New York and New England. The area of high barometer that followed the disturbance carried the frost line over the interior of the east Gulf and South Atlantic States. Reports indicate that the high barometer area extended far to the southward and caused a sweep of cold air over the central states of Mexico that was destructive to crops. It is probable that the action of the tropical storm described as the Key West hurricane contributed to the flow of cold air currents over Mexico.

## THE KEY WEST HURRICANE OF OCTOBER 11, 1909.

One of the general laws of cyclonic movement in the West Indies, announced by the late Father Viñes, implies that hurricane tracks are traced farther and farther to the westward as the season advances.

So ancient is belief in this rule that the ecclesiastic authority, from time immemorial, wisely ordained that priests in Porto Rico should recite in the mass the prayer, 'Ad repellendat tempestates,' during the months of August and September, but not in October, and in Cuba it should be recited in September and October, but not in August. All of which proves that the ecclesiastical authority knew by experience that the cyclones of October were very much to be feared in Cuba, but not those of August, and that in Porto Rico, on the contrary, the hurricanes of August are disastrous, while those of October are rare.—Viñes.

Weather Bureau records verify the general law referred to. They also show that during the principal hurricane months these storms are liable to appear in any part of the region between the tenth and twenty-fifth parallels of latitude and east of the eightieth meridian and to recurve northward in any part of the area that is bounded by the sixty-fifth and ninety-fifth meridians. It is evident, therefore, that averages of tracks can be given but little weight in forecasting the course of individual hurricanes.

The hurricane season of 1909 presented marked departures from the general law of cyclonic movement. The storms of the early portion of the season reached the west coast of the Gulf of Mexico, and as the season advanced the tracks were traced farther and farther to the eastward. Of the six hurricanes that appeared but two recurved to the northward, one over Louisiana in September and the other over extreme western Cuba and Key West in October, and no storms of marked intensity occurred over Porto Rico and the Lesser Antilles. The sixth important storm of the season in tropical waters moved from the western Caribbean Sea over the lower Gulf of Mexico from October 22 to 24.

Indications of a storm development over the south-central Caribbean Sea were noted as early as October 2. The character and the probable course of the storm could not, however, be determined until October 6. Beginning that date and continuing daily until the 9th shipping interests and coast ports were advised regarding its movement and increasing intensity, and vessels bound for western Cuban waters were advised to exercise caution. Attending the presence of the storm over the western Caribbean Sea on October 9 a tidal wave swept from

the Gulf of Mexico over low-lying islands and sea coasts along the Yucatan Peninsula, drowning, it is reported, a large number of persons, mostly fishermen and their families. On the 10th storm warnings were ordered on the southern Florida coast, and at 6 a. m. of the 11th storm warnings were changed to hurricane at Sand Key and Key West, Fla. Following this action, Florida Weather Bureau stations were telegraphed as follows:

Hurricane now central near Key West promises to be destructive to life and property over a large portion of the Florida Peninsula. You are authorized to incur any necessary expense and to adopt every reasonable measure to disseminate warnings to the islands, coast cities, and even the interior of the State.

The pressure distribution at 8 a. m. of the 11th is shown on fig. 1.

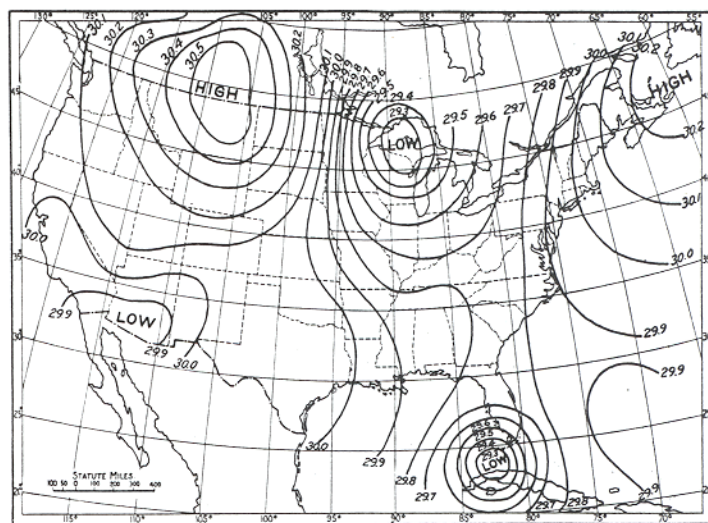


FIG. 1.—Isobars over the United States, 8 a. m., seventy-fifth meridian time, October 11, 1909.

Later in the morning the following special bulletin was telegraphed Atlantic and Gulf Weather Bureau stations and furnished the public press:

The West Indian storm that has been moving westward over the Caribbean Sea during the last week has developed into a hurricane of marked intensity and at 8 a. m. Monday morning was central west of Key West, Fla. At Sand Key the wind was 60 miles from the east. At 10 a. m. the pressure at Key West was 28.94 inches with a wind velocity of 56 miles from the east and a very high sea swell. Storm warnings were ordered Sunday afternoon from Key West to Mobile and changed to hurricane warnings early Monday morning. Hurricane warnings were also ordered on the Atlantic coast as far north as Charleston. The center of the storm will probably move northward over Florida to-night and Tuesday and be felt Tuesday off the entire south Atlantic coast. All shipping in the affected area has been warned to seek refuge immediately. Hourly observations will be taken and all ports kept advised of the direction of the storm.

Advices were issued during the day in which the northeast course of the storm was given and the statement was made that there was apparently no further danger in the Gulf of Mexico. On the following morning the advices stated that the storm had passed northeastward beyond the region of observation.

At 6 a. m. of the 11th the hurricane was central west-southwest of Habana and over or near the western portion of the Province of Pinar del Rio and its advance over that province was preceded and attended by torrential rain and winds of hurricane force. At Habana the storm raged for several hours sinking or stranding small craft in the harbor, prostrating trees, and flooding the streets with water. The following notes by Mr. Dague, Observer Weather Bureau, are descriptive of the action of the storm at Sand Key:

The office was abandoned at 8:30 a. m., and the barograph and supplies were carried to the light-house. At 8:45 a. m. the signal tower fell and the sidewalk was carried away. A little later the outhouses were washed away. When the station was abandoned the barometer had begun to fall rapidly and the wind had reached a velocity of 75 miles an hour. At 9:15 a. m. the anemometer cups were blown away. At this time the wind was estimated at 100 miles an hour with gusts that exceeded that velocity. Heavy rain obliterated objects more than 50 feet distant. At 9:30 all trees had been blown down, the atmosphere appeared like a white mist and water was beginning to cover the island. Five minutes later heavy seas swept over the island. At 10 a. m. the entire island was covered with water to a depth of about 4 feet and all sand was washed from the island. At 10:30 the Weather Bureau building went over and was immediately washed out to sea.

A heavy swell from the southeast prevailed during the storm. The barometer fell rapidly from 4 until 11:30 a. m. when the minimum reading, 28.37 inches, was registered. A rapid rise then set in that continued until 6 p. m. at which time the weather had moderated. Excessively heavy rain fell until 1 p. m., when it began to decrease and ended at 2 p. m. After the wind had backed to the northwest the swell from the southeast opposed it and caused the water to spray from the top of the swells through the air with the wind. Two windows in the top of the light-house were broken during the most violent part of the storm and the openings caused a draught through the tower that made it impossible to open the door at the bottom of the tower.

The following report has been made by the Weather Bureau observer at Key West, Fla.:

From 9 p. m. of the 10th to 6 a. m. of the 11th the barometer fell steadily to 29.52 inches. From 6 to 11:40 a. m. of the 11th the barometer fell to 28.50 inches, the lowest reading ever recorded at this station. At 11:40 a. m. the wind shifted from northeast to northwest and in thirty minutes the barometer rose one-half an inch. At 7 p. m. it had risen to 29.61 inches. The wind increased from 2:30 until 8:50 a. m. and from the latter hour it continued at hurricane force until 1:05 p. m., with maximum velocity 83 miles from the northeast between 10:05 and 10:10 a. m. and an extreme velocity at a rate of 94 miles an hour at 10:07 a. m. From 4 to 11:45 a. m. 8.02 inches of rain fell and between 8:45 and 11 a. m. there was a downpour of 6.13 inches. At 9:30 a. m. the waves had covered the Weather Bureau grounds and considerable spray had fallen in the gage, making it necessary to discard stick measurements.

The estimated storm damage in the city was close to \$1,000,000. About 400 buildings collapsed or were blown down. In the northern section of the city, where the tide rose through the streets and houses, the water and the wind carried frame buildings across lots and many other buildings were lifted by the water. Along the water front 300 boats, large and small, were destroyed. It seems almost miraculous that only one life was lost during the storm.

Ample warnings of the storm were furnished by the Weather Bureau from the 8th to 11th. At 5 p. m. of the 10th northeast storm warnings were hoisted and advices were bulletined and telephoned throughout the city. At 6 a. m. of the 11th hurricane warnings were hoisted and the following was telephoned and bulletined to all local interests and sent to the Florida East Coast Railroad:

"Take every precaution immediately to secure life and property. Hurricane close."

During July, 1909, when a temporary telephone line was built by the Florida East Coast Railroad the official in charge of this office made arrangements with engineers on the extension work to telephone all storm warnings and weather reports. By this means they were in direct communication with the office day and night.

The Key West Citizen of October 12 states:

"Warnings had been issued by the Weather Bureau and the time of the climax was predicted almost exactly by the Official in Charge, who stated it would reach its worst about noon."

Editorially the same paper states on October 16:

"When during the storm most persons abandoned their business the Weather Bureau force stuck to their posts and kept the public informed of the progress of the storm."

After leaving Key West the hurricane swept the Florida Peninsula south of Miami, as shown by fig. 2. On the extension of the Florida East Coast Railroad, about 3,000 workmen were withdrawn from dangerous points. Vice-president J. P. Beckwith, of the road states:

Positively not a life was lost in the storm. Very little damage was done to the right of way or work on the extension. The road will be open to traffic within a few days to Knights Key. Warning by the Weather Bureau enabled us to fully protect all employes and equipment.

Mr. A. J. Mitchell, Weather Bureau Observer at Jacksonville, Fla., reports as follows:

The correctness of the warning and the effectiveness of its distribution are indicated in the small loss of life, about one dozen, along the lines of the projected railroad. Those who were drowned paid the penalty of remaining

aboard a tugboat, which sank, instead of seeking shelter, as others did. With about 3,000 laborers scattered many miles over the low islands of the sea along the proposed route of the Florida East Coast Railroad the fact that the loss of life was so small is an eloquent tribute to the wisdom of the railroad officials in obeying implicitly the information given out by the Weather Bureau. In 1906 many hundreds of laborers were drowned during a tropical storm as a consequence of ignoring warnings. While many tugboats, lighters, and other auxiliary equipment were saved, the losses of the railroad company will reach hundreds of thousands of dollars, and it is conceded by the company and by the public press that hundreds of lives were saved through the warnings issued in connection with the storm of October 11, 1909.

About Miami, Fla., the principal damage was to the citrus fruit crops that were blown from the trees in immense quantities. At Nassau, Bahamas, the storm was felt the night of the 11th when the barometer fell to 29.37 inches and the wind reached a velocity of 50 miles an hour from the southwest. After crossing the northern Bahamas the storm area expanded with a rapid loss of intensity.

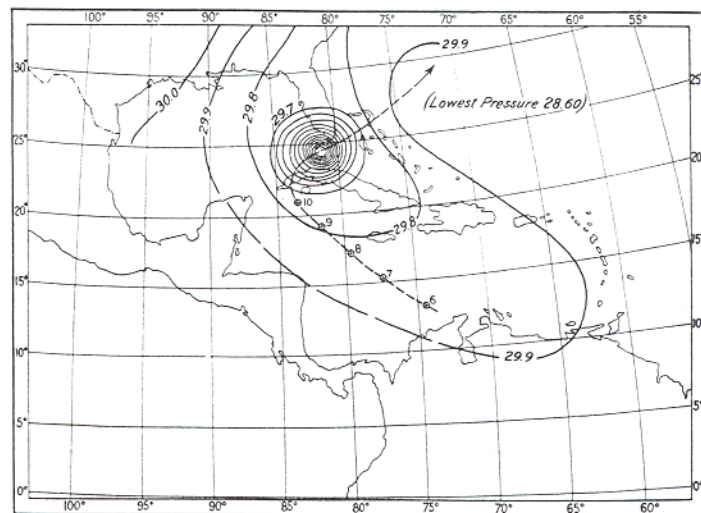


FIG. 2.—Isobars over the United States at noon, seventy-fifth meridian time, October 11, 1909.

While a summary of available information regarding this storm shows that protective measures employed upon the receipt of the warnings reduced losses of life and property to a minimum, it appears certain that many fishermen, spongers, and others in small boats, and dwellers on the low-lying islands or keys that fringe the coast of the southern Florida Peninsula that were outside the zone of communication were lost.

From the 19th to 22d a disturbance moved from the north Pacific coast to the St. Lawrence Valley, with rain on the middle and north Pacific coast and in the middle and northern States east of the Rocky Mountains. Attending the movement of the storm center eastward over the northern Lake region a tornado occurred the afternoon of the 21st about 25 miles south of Erie, Pa. A disturbance that advanced from the middle Rocky Mountain region to the Canadian Maritime Provinces from the 21st to 25th, was followed by a cool wave that caused heavy frost in the east Gulf and South Atlantic States.

From the 22d to 24th a storm passed from the western Caribbean Sea over the lower portion of the Gulf of Mexico attended by excessive and persistent rains that caused destructive floods in the State of Tabasco, Mexico. During the closing days of October a cold wave of unprecedented severity for the season was reported in the valleys near Mexico City.

From the 23d to 27th a disturbance moved from the British Northwest Territory to the St. Lawrence Valley, and on the 28th a disturbance appeared over the British Northwest that at the close of the month extended in a trough of low pressure, from Lake Superior southwestward, with lowest barometer over eastern Kansas.