of the practice of insurance in the light of recorded experience of weather.

Local authorities have given little consideration to these matters, and individual farmers and others have trusted to their own reminiscences. It is, in fact, apparent that the balance of prosperity has been so large that it has not hitherto been felt necessary to pay much attention to the profits to be made out of the weather, or to economize the losses which it causes, but when the pinch of adversity comes, as it must come after the squandering of so much of the world's wealth in the war, the reduction of any risk by the use of organized knowledge is at least worthy of consideration. The stress of war is therefore a reason for organizing the study of weather, not a reason for postponing organization to a more prosperous season.

No one will deny that a careful record of the weather regularly compiled from day to day on a definite plan is, in the long run, a better basis of action than the longest stretch of personal reminiscences, just as a daily record of river level is better than an occasional mark on the parapet of a bridge. With the change of circumstances, from the comparative independence of the homestead to mutual dependence of town and country, and from the abundant prosperity of past years to the adversity that lies in front of us in the near future, the preservation of an adequate record of the events of weather for comparison with past times and with other localities has also changed from being a matter of scientific and personal curiosity to a necessity for the community. It is from that point of view that it should be regarded; the additional advantage that may accrue from scientific meteorological study is all to the good, but it is another matter.

The unanimity with which the health resorts have made provision for careful records of weather shows that a knowledge of the weather must be looked upon as a valuable asset, and it is equally so for any other locality. A contractor who undertakes work for a local authority must either know something about the weather or allow a wider margin for contingencies than is really necessary; the locality must either supply the information or provide the margin.

Hitherto the observations upon which we depend for supplying information about the weather in all parts of the British Isles have been largely those of country clergy and landowners; but the drain upon their resources, particularly in men, has begun to diminish the number of observations available. Already in Ireland the observations are altogether inadequate, and when, for example, questions are put as to the parts of the country where climatic conditions are favorable for afforestation, we can not give a satisfactory answer, because the localities have no record of their experience. Moreover, the distribution of observing stations depends not upon the present and future requirements of the public but upon the existence of a local volunteer.

It is submitted, therefore, that the local authorities should give serious consideration to the question of an adequate record of weather. The Meteorological Office has been active in collecting and organizing the meteorological information that was known to be available. This has given the impression that the office, as the creation of the central Government, ought itself to provide any observations that may be found necessary for any purpose whatever; but such an impression is quite erroneous. Out of 500 observatories and stations which contribute observations to the office for the benefit of the public, only 36 are maintained or subsidized out of office funds. A considerable number are maintained by local or statutory authorities and the remainder by private persons at their own expense. It is natural, and perhaps laudable, that in the matter of weather the city of Westminster should rely upon the Meteorological Office, instead of itself, for its memory; and it is not unreasonable that the office of works, in a dispute over a contract, should apply to the Office (unsuccessfully, I fear) for details of weather between Avonmouth and Bristol, and their relation to the average. But it would be absurd, for example, for the Council of the County of Warwick to rely upon London to know what weather had been experienced in Warwickshire; or for residents at Hindhead to live in ignorance of their own climatic conditions until the Government provides the information. The natural order is just the reverse; the Meteorological Office should naturally appeal to the localities to know what has transpired [happened] there, and it is a matter for surprise how many of the county councils, when appealed to, would be unable to say what the weather had been in their county since it was under their charge. The whole situation arises from the mistaken notion that to satisfy the condition of utility at all, knowledge must be useful here and now, and that nothing need be preserved for which the officials of to-day have no obvious and immediate use. It is the memory which goes back longest that is the most effective, and therefore most useful.

It ought, in fact, to be the function of the Meteorological Office to reduce, rather than to multiply, meteorological observations, by proper organization and by the suggestion of coordination, where coordination is economical. The following guiding principles seem to be applicable: For keeping its water supply and drainage properly under observation, every parish ought to have its raingage and the parish council might see to that. A district council might keep a regular record of temperature and weather as well, for its own district; while in every county there should be, for official purposes, a proper number, and no more, of fully equipped climatological stations which should be centers of information about the weather and its ways for all concerned.

THE TROPICAL HURRICANE OF SEPTEMBER 29, 1915, IN LOUISIANA.

By ISAAC M. CLINE, District Forecaster.

[Dated: Weather Bureau, New Orleans, La., Oct. 21, 1915.]

The most intense hurricane of which we have record in history of the Mexican Gulf coast, and probably in the United States, moved northward over southeastern Louisiana and southwestern Mississippi during September 29, 1915. The territory traversed by this hurricane, especially near its center, is well covered by cooperative observing stations, and the records of meteorological conditions from these stations furnish unusually interesting material for study in connection with hurricanes. We have very complete barometer readings from New Orleans, Burrwood, and Morgan City, La., and Bay St. Louis, Miss., and observations of weather conditions and changes in wind direction on and near the path of the center of the hurricane from the time it struck the Louisiana coast until it passed out of the State, a distance of about 150 miles.

We shall first consider the meteorological conditions and special features attending the hurricane, and then take up the issue and distribution of warnings by the Weather Bureau, the action taken to protect lives and property, and the value of the warnings.

GENERAL METEOROLOGICAL CONDITIONS.

Tuesday, September 28, 1915.—Early in the morning a few cirrus clouds were seen at New Orleans spreading over the sky, coming up from the south; by *10 a. m.* (90th mer. S. T.) the entire sky was covered with a cirrus veil, below which were about 4/10 strato-cumulus moving rapidly from the northeast. At *11 a. m.*, there was 4/10 cirro-stratus moving from the northeast and 2/10 cumulus coming from the east, the higher clouds were obscured. By NOON the cirrus had largely disappeared or were not visible, the strato-cumulus had decreased to about 2/10, and the sky was covered by cirro-stratus moving from the south. At *1 p. m.*, there was 1/10 cirrus and 3/10 cirro-stratus, all from the southwest, and 3/10 cumulus from the east. At *2 p. m.*, about 3/10 of the sky were covered by cirrus streamers coming up from the south and spreading to the north of the zenith; a few cirro-cumulus were moving from the south, and there was 3/10 strato-cumulus moving from the east. At *3 p. m.*, there was 4/10 cirrus and 3/10 cirro-stratus, all from the southwest, and there was 1/10 cumulus from the east. By SUNSET the cirrus veil had increased in thickness, merging into thin cirro-stratus and covering the entire sky, which at sunset was a faint brick-dust color, with a heavy bank of cumulus in the east. From sunset to *10 p. m.*, the sky was covered by a veil of high clouds as shown by observations of the stars, very few of the latter could be seen and those were of a peculiar copper tint. From 10 p. m. to MIDNIGHT the thickness of the clouds gradually increased.

Wednesday, September 29, 1915.—By 3 a. m. of the 29th the cloud cover had increased in thickness and was mainly strato-cumulus moving rapidly from the northeast; occasional heavy rain squalls occurred. By daybreak the clouds had increased in thickness, about 7/10 were typical nimbus and 3/10 strato-cumulus and scud moving rapidly from the northeast. This formation of clouds continued all day and into the night, with heavy rain most of the time and excessive [see p. 493, Table II] during the larger portion of the day. After the passage of the storm center the rainfall gradually decreased in intensity and the clouds decreased somewhat in thickness until at MIDNIGHT the rain ceased; but the sky was still covered with strato-cumulus clouds moving rapidly from the west.

Thursday, September 30, 1915.—From midnight until *7 a. m.* the clouds gradually decreased in density and the strato-cumulus gave way to alto-cumulus and cirro-stratus covering the entire sky. At *9 a. m.* the sky was entirely clear of clouds.

PRESSURE.

From September 22 to 25, the fluctuations of the barometer show nothing more than the ordinary normal diurnal changes. The faint rise in the barometer which is supposed to precede the gradual fall indicating the approach of a hurricane did not occur. A gradual fall in the barometer commenced on the morning of the 25th and the fall amounted to about 0.10 inch in 24 hours until noon of September 28 when the fall became more rapid. From 7 p. m. of the 28th to 7 a. m. of the 29th the barometer fell 0.18 inch.

During the 29th the barometer fell rapidly from 29.54 inches at 7 a. m. to 28.11 inches at 5:50 p. m., a fall of 1.43 inches in 10 hours and 50 minutes or slightly more than 0.13 inch per hour. From 3:10 p. m. to 5:50 p. m. the barometer fell 0.90 inch, or at the rate of more than 0.33 inch per hour. A trace of the barograph corrected and reduced to sea-level from observed readings of the mercurial barometer is reproduced in figure 5 on chart XLIII-114. Table 1 gives the readings of the mercurial barometer (reduced to sea-level) taken at 15-minute and 5-minute intervals. The readings were taken by Mr. Coberly and Mr. Harder, except that the 5-minute readings were all taken by Mr. Coberly and the instantaneous fluctuations as indicated by the movements of the barograph pen were noted by Mr. Harder, and I took the readings from 10:30 p. m., of the 29th until 12:30 a. m., of the 30th, and Mr. Coberly continued them until 7 a. m., of the 30th. The wind velocity and direction were taken from the triple-register and are given at the time of each barometer reading.

TABLE 1.—*Reduced pressure, barometer fluctuations, and wind velocity and direction at New Orleans, La., Sept. 29, 1915, 10 a. m. to Sept. 30, 6:55 a. m.*

Time. (90th M. S. T.)	Pressure.	Wind.		Fluctuations in pressure.	Observers.
		Velocity.	Direction.		
1915. Sept. 29.					
A. M.	*Inches.*	*Mi./hr.*		*Inches.*	
10:00	29.40	37	ne.	.....	Coberly & Harder.
10:30	29.33	48	ne.	0.02	Do.
11:00	29.30	38	ne.	.....	Do.
11:15	29.25	43	ne.	Slight.	Do.
11:30	29.24	53	ne.	0.01	Do.
11:45	29.19	34	ne.	.....	Do.
12:00, noon	29.18	46	ne.	0.05	Do.
P. M.					
12:15	29.15	48	ne.	0.03	Do.
12:30	29.14	49	ne.	0.01	Do.
12:45	29.13	46	ne.	0.01	Do.
1:00	29.10	54	e.	0.02	Do.
1:15	29.09	50	e.	0.01	Do.
1:30	29.08	49	e.	0.01	Do.
1:45	29.06	44	e.	Steady.	Do.
2:00	29.05	44	ne.	0.01	Do.
2:15	29.01	50	e.	0.02	Do.
2:30	28.98	50	e.	0.02	Do.
2:45	28.94	54	e.	0.03	Do.
3:00	28.93	53	e.	0.02	Do.
3:15	28.90	52	e.	0.01	Do.
3:30	28.87	54	e.	Steady.	Do.
3:45	28.81	48	e.	Steady.	Do.
4:00	28.76	52	e.	0.02	Do.
4:15	28.68	63	se.	0.03	Do.
4:30	28.56	60	se.	Steady.	Do.
4:45	28.53	66	se.	0.03	Do.
4:55	28.44	72	e.	0.02	Coberly.
5:00	28.39	72	e.	0.03	Do.
5:05	28.37	76	se.	0.03	Do.
5:10	28.34	86	se.	0.02	Do.
5:15	28.28	75	se.	0.02	Do.
5:20	28.23	70	se.	0.03	Do.
5:25	28.17	70	se.	0.02	Do.
5:30	28.16	52	se.	0.02	Do.
5:35	28.15	44	se.	Steady.	Do.
5:40	28.13	42	se.	0.02	Do.
5:50	28.11	46	se.	0.03	Do.
5:55	28.13	44	se.	0.05	Do.
6:00	28.14	50	s.	Steady.	Do.
6:05	28.15	50	se.	Steady.	Do.
6:10	28.14	60	se.	0.05	Do.
6:15	28.15	44	se.	Steady.	Do.
6:20	28.17	46	se.	Steady.	Do.
6:25	28.17	48	s.	Steady.	Do.
6:30	28.17	42	se.	0.02	Do.
6:35	28.19	33	s.	0.02	Do.
6:40	28.19	34	s.	0.02	Do.
6:45	28.23	31	sw.	Steady.	Do.
6:50	28.26	32	sw.	Steady.	Do.
6:55	28.28	36	sw.	Steady.	Do.
7:00	28.31	31	sw.	Steady.	Do.
7:05	28.33	33	Variable.	Steady.	Do.
7:10	28.35	39	sw.	Steady.	Do.
7:15	28.39	39	sw.	Steady.	Do.
7:20	28.41	38	s.	Steady.	Do.
7:25	28.44	38	sw.	Steady.	Do.
7:40	28.54	29	sw.	.....	Do.

TABLE 1.—*Reduced pressure, barometer fluctuations, and wind velocity and direction at New Orleans, La., Sept. 29, 1915, 10 a. m. to Sept. 30, 6:55 a. m.*—Continued.

Time. (90th M. S. T.)	Pressure.	Wind.		Fluctuations in pressure.	Observers.
		Velocity.	Direction.		
1915. Sept. 29.					
P. M.	*Inches.*	*Mi./hr.*		*Inches.*	
7:55	28.63	29	sw.	.....	Coberly.
8:10	28.70	26	sw.	.....	Do.
8:25	28.77	26	sw.	.....	Do.
8:40	28.82	26	sw.	.....	Do.
8:55	28.86	23	sw.	.....	Do.
9:10	28.91	24	sw.	.....	Do.
9:25	28.95	24	sw.	.....	Do.
9:40	28.97	22	sw.	.....	Do.
9:55	29.01	23	sw.	.....	Do.
10:10	29.04	21	sw.	.....	Do.
10:25	29.06	25	sw.	.....	I. M. Cline.
10:40	29.09	28	sw.	.....	Do.
10:55	29.13	29	sw.	.....	Do.
11:10	29.14	28	sw.	.....	Do.
11:25	29.15	30	sw.	.....	Do.
11:40	29.16	28	sw.	.....	Do.
11:55	29.17	35	sw.	.....	Do.
Sept. 30.					
A. M.					
12:10	29.20	36	sw.	.....	Do.
12:25	29.22	29	sw.	.....	Do.
12:40	29.22	27	sw.	.....	Coberly.
12:55	29.25	27	sw.	.....	Do.
1:10	29.27	29	sw.	.....	Do.
1:25	29.28	29	sw.	.....	Do.
1:40	29.30	30	sw.	.....	Do.
1:55	29.32	26	sw.	.....	Do.
2:10	29.33	27	sw.	.....	Do.
2:25	29.35	30	sw.	.....	Do.
2:40	29.37	24	sw.	.....	Do.
2:55	29.38	31	sw.	.....	Do.
3:10	29.40	26	sw.	.....	Do.
3:25	29.41	23	sw.	.....	Do.
3:40	29.42	25	sw.	.....	Do.
3:55	29.43	23	sw.	.....	Do.
4:10	29.45	25	sw.	.....	Do.
4:25	29.46	23	sw.	.....	Do.
4:40	29.49	21	sw.	.....	Do.
4:55	29.49	23	sw.	.....	Do.
5:10	29.51	20	sw.	.....	Do.
5:25	29.52	19	sw.	.....	Do.
5:40	29.53	17	sw.	.....	Do.
5:55	29.54	16	sw.	.....	Do.
6:10	29.55	17	sw.	.....	Do.
6:25	29.57	18	sw.	.....	Do.
6:40	29.57	16	sw.	.....	Do.
6:55	29.58	16	sw.	.....	Do.

Barometer and wind observations taken aboard the Honduran steamship *Ceiba* were furnished by Capt. Ernest E. B. Drake, and are given in Table 2, the barometer used being the ship's aneroid, Weather Bureau No. 6224.

TABLE 2.—*Observations on the* Ceiba, *3 miles NE. of the Weather Bureau, New Orleans.*

Time.	Pressure.			Wind direction and force.
	Observed.	Correction.	Corrected.	
Sept. 29.				
A. M.	*Inches.*	*Inches.*	*Inches.*	
4:00	29.71	−0.11	29.60	
6:00	29.64	−0.11	29.53	Fresh to strong east, with frequent heavy squalls and continuous rain.
8:00	29.64	−0.11	29.53	
10:00	29.52	−0.11	29.41	
12:00 noon	29.31	−0.11	29.20	
P. M.				
2:00	29.07	−0.11	28.96	ene. 7.
3:00	28.95	−0.11	28.84	e. by n. 7 to 8.
4:00	28.87	−0.11	28.76	e. 8.
5:00	28.41	−0.11	28.30	e. by s. 9 to 10.
6:00	28.15	−0.11	28.04	ese. 11.
6:40	28.125	−0.11	28.01	se. by e. 11.
7:00	28.22	−0.11	28.11	se. 11 to 10.
8:00	28.55	−0.11	28.44	sse. 10.
10:00	28.92	−0.11	28.81	s., moderating rapidly and rain clearing.
12:00	29.13	−0.11	29.02	ssw.

The above observations were taken at the ship's mooring about 3 miles northeast of the local office, Weather Bureau, and the distance from the center of the hurricane is about the same as that of the local office, Weather Bureau. It is noted that this barometer fell a little more rapidly than the Weather Bureau barometer.

Barometer readings at Burrwood, La., on the east bank at the mouth of the southwest pass of the Mississippi River, have been furnished by Mr. George E. Henderson, special meteorological observer, Weather Bureau, as follows:

TABLE 3.—*Barometer readings at Burrwood, La., and on the dredge* New Orleans.

Time (90th M. S. T.).	U. S. dredge New Orleans, aneroid.	Burrwood, La., mercurial barometer.	Time.	U. S. dredge New Orleans, aneroid.	Burrwood, La., mercurial barometer.
Sept. 29.			*Sept. 29.*		
A. M.	*Inches.*	*Inches.*	A. M.	*Inches.*	*Inches.*
2:00	29.66	.....	9:45	29.00	.....
3:00	.....	29.42	10:00	29.04	.....
3:30	.....	29.38	12:00, noon	29.05	.....
4:00	29.56	29.38			
4:30	.....	29.33	P. M.		
5:00	.....	29.30	2:00	29.09	.....
5:30	.....	29.27	4:00	29.17	.....
6:00	29.27	29.23	6:00	29.23	.....
6:30	.....	29.21	7:00	29.31	.....
7:00	.....	29.18	8:00	29.37	.....
7:30	.....	29.13	9:20	29.52	.....
8:00	29.18	29.09	10:00	29.54	.....
8:30	.....	29.00	12:00, midnight	29.58	.....

Mr. Henderson and his family, with others in Burrwood, went aboard the U. S. dredge *Benyaurd*, deeming that safer than to remain ashore. This explains why the readings of the mercurial barometer were discontinued after 8:30 a. m. of the 29th.

It is observed that the aneroid barometer on the U. S. dredge *New Orleans* (see Table 3) read 0.24 inch too high at 2 a. m. of the 29th, that it fell more rapidly than the mercurial barometer until 6 a. m., when it was only 0.06 of an inch above the mercurial, but that at 8 a. m. the aneroid showed a more sluggish fall and was 0.09 of an inch higher than the mercurial. The passage of this storm has furnished some interesting features in connection with the ordinary aneroid barometers. Some aneroids which have been checked with the mercurial barometer in this office and found very accurate at ordinary pressures read much too low and others read too high during the passage of the hurricane. The Weather Bureau barometer at Burrwood shows a pressure of 29.00 inches at 8:30 a. m. on September 29, while the aneroid shows the lowest during the storm as 29.00 inches at 9:45 a. m. At New Orleans the barometer fell 0.33 inch during the hour just preceding the occurrence of the lowest pressure, but New Orleans was much nearer the center of the hurricane than Burrwood, and this explains why the fall in pressure was not so great at Burrwood as at New Orleans. Judging from the actions of the aneroid barometer on the U. S. dredge *New Orleans*, it is apparently safe to assume that the lowest barometer at Burrwood was about 28.80 inches. The relation of Burrwood to the center of the hurricane will be taken up later.

The barometer readings given in Table 4 were made at Morgan City, La. (67 miles west of New Orleans), and furnished by Mr. R. A. Squires, of Morgan's Louisiana & Texas Railroad & Steamship Co.

TABLE 4.—*Readings of aneroid barometer at Morgan City, La.*

[Correction, perhaps +0.02 inch.]

Time (90th M. S. T.).	Aneroid barometer.	Time.	Aneroid barometer.
Sept. 29.		*Sept. 29.*	
A. M.	*Inches.*	P. M.	*Inches.*
4:30	29.58	3:00	29.06
7:00	29.56	4:00	29.05
8:00	29.53	5:30	29.10
9:00	29.50	8:00	29.18
10:00	29.43	9:00	29.24
11:00	29.38	10:00	29.31
12:00, noon	29.30	*Sept. 30.*	
P. M.		A. M.	
1:00	29.20	3:00	29.50
2:00	29.10		

Mr. Squires reports that the wind blew hardest from a direction 2 to 4 points west of north about 4 p. m. to 4:30 p. m., and went to the west about 8:30 p. m. His barometer reads, at ordinary pressures, 0.02 inch lower than the Weather Bureau barometer at New Orleans.

The following barometer readings were taken at Bay St. Louis, Miss., and furnished by Prof. Florian Schaffter, of New Orleans, who was spending the summer at that place:

TABLE 5.—*Readings of an aneroid barometer at Bay St. Louis, Miss., by F. Schaffter.*

[Correction, see text.]

Time (90th M. S. T.).	Aneroid barometer.	Time.	Aneroid barometer.
Sept. 29.		*Sept. 29.*	
A. M.	*Inches.*	P. M.	*Inches.*
10:30	29.60	8:00	29.12
11:30	29.48	11:00	29.18
P. M.		*Sept. 30.*	
3:00	29.34	A. M.	
6:00	29.14	1:45	29.26
		8:00	29.52

Prof. Schaffter says that the lowest barometer occurred at 8:00 p. m. of the 29th and is represented by the reading given. The aneroid barometer he used is a good one, and at ordinary pressures it reads the same as the Weather Bureau mercurial barometer at New Orleans. I am of the opinion that a mercurial barometer at Bay St. Louis would have shown a pressure of about 28.90 inches. The actual readings given by the aneroid show a barometric gradient of 1 inch in 50 miles. Bay St. Louis, Miss., is east of and a little north of New Orleans.

The following table gives aneroid barometer readings during the hurricane, September 29, 1915, which were made in New Orleans at Stanley Thomas hall, Tulane University of Louisiana, by Prof. W. B. Gregory and Mr. N. C. Curtis:

TABLE 6.—*Readings of an aneroid barometer at Tulane University, Sept. 29, 1915.*

Time (90th M. S. T.).	Aneroid barometer.	Time.	Aneroid barometer.
A. M.	*Inches.*	P. M.	*Inches.*
8:30	29.60	2:15	29.10
9:05	29.55	2:30	29.05
9:30	29.52	2:35	29.02
10:30	29.45	2:40	29.01
10:50	29.38	2:45	29.00
11:00	29.40	3:00	28.97
11:15	29.36	3:10	28.95
11:30	29.30	3:15	28.93
12:00, noon	29.30	3:30	28.90
12:40	29.23	4:00	28.76
P. M.		4:30	28.65
1:00	29.20	4:45	28.35
1:20	29.17	5:15	28.25
1:45	29.14	5:30	28.10
		6:00	28.10

Tulane University is 7 miles west of the local office, Weather Bureau, and 1 mile north of the sugar experiment station; the grounds of Tulane University and Loyola University are adjacent, hence these records will be of value in connection with the wind directions reported from the sugar experiment station and from Loyola University.

WINDS.

The wind gradually increased during the afternoon and night of *September 28*, the prevailing direction being from the east and oscillating between northeast and southeast; the most frequent oscillations were toward the northeast. From midnight to 2:45 a. m. *of the 29th;* the wind was blowing steadily from the northeast with a velocity of from 17 to 18 miles per hour. From 2:45 to 8 a. m. the prevailing direction was east, oscillating occasionally between northeast and southeast; when the wind changed from northeast to east the velocity increased to 25 miles per hour, and a maximum velocity of 34 miles per hour occurred for a period of five minutes at 3:50 a. m. At 8 a. m. the wind backed to northeast and continued from that direction until 1:10 p. m.; from 1:10 p. m. to 4:15 p. m. the prevailing direction was east, oscillating at frequent intervals to the southeast; from 4:15 p. m. to 5:20 p. m. the prevailing direction was southeast, but there were intervals of three to five minutes with the direction from the east. From 5:20 p. m. to 6:30 p. m. the wind was steady from the southeast. The wind shifted from southeast to south at 6:35 p. m. and to southwest at 6:45 p. m., continuing from that direction during the night. The velocity now subsided rapidly, falling below 30 mis./hr. during the hour ending at 9 p. m.; however, maximum velocities of 32 to 36 miles were recorded in each hour from 11 p. m. of the 29th to 3 a. m. of the 30th.

TABLE 7.—*Wind velocities and directions at weather bureau, New Orleans, La., Sept. 29, 1915.*

Time.	Direction.	Mean velocity.	Maximum 5-min. velocity.
		Mis./hr.	*Mis./hr.*
Midnight (28)–2:45 a. m.	NE.	17 to 18	
3:50 a. m.	E.		34
2:45–8 a. m.	E.; ne., se.	25	
7–8 a. m.	E.	32	39
8–9 a. m.	NE.	35	43
9–10 a. m.	NE.	37	45
10–11 a. m.	NE.	42	48
11–noon	NE.	40	53
Noon–1 p. m.	NE.	48	54
1:10 p. m.	e.		
1–2 p. m.	E.; se.	49	54
2–3 p. m.	E.	50	56
3–4 p. m.	E.	50	54
4:15 p. m.	SE.		
4–5 p. m.	SE.	60	72
5–6 p. m.	SE.	62	[1] 86
6:35 p. m.	S.		
6:45 p. m.	SW.		
6–7 p. m.	SE., SW.	41	53
7–8 p. m.	SW.		

[1] E-SE.

The wind velocity was 50 mis./hr. or higher for four hours and was 60 or above for two hours, the maximum velocity, 86 mis./hr., was 20 miles in excess of the highest velocity, 66 miles, previously recorded at New Orleans. The wind attained the greatest velocity when it shifted from east to southeast. The wind subsided rapidly after 3 a. m. *September 30*, and died out almost completely between 5 p. m. and 8 p. m. The wind backed to the west at 8:45 a. m., and to the northwest at 1 p. m., September 30. The wind, when at its height, was not steady but

came in a rapid succession of gusts of a few seconds duration, which may be likened to pulsations. The extreme velocity of 130 miles per hour, from the southeast, occurred at 4:58 p. m., while the maximum velocity for five minutes, 86 miles per hour, occurred from 5:11 to 5:16 p. m. The velocity in the pulsating gusts of a few seconds duration was, at times, undoubtedly much greater than the extreme velocity for a whole single mile.

The wind velocity 50 miles distant from the center was evidently much greater than it was at New Orleans. At Burrwood, La., 100 miles south of New Orleans and located at the mouth of the southwest pass of the Mississippi delta, unprecedented high winds for this section of the country were recorded and the velocity exceeded any winds previously recorded on the Gulf coast. In fact, this was the most intense hurricane known to the recorded history of this part of the country. [The automatic record of the anemometer at Burrwood is unusually perfect and distinct, notably so when one considers the abnormally high winds it records; much credit is due G. E. Henderson, the observer, for having maintained his instrument in such perfect condition and for securing such a record.] The wind directions and velocities at Burrwood during September 29 are given below in Table 8.

TABLE 8.—*Wind velocities and directions recorded by the Weather Bureau self-recorder at Burrwood, La., Sept. 29, 1915.*

Time. (90th M. S. T.)	Direction.	Velocity.		
		Mean.	Maximum, 5 minutes.	Extreme, 1 mile.
		Miles/hr.	*Miles/hr.*	*Miles/hr.*
4:45 a. m.–7:20 p. m.		70+		
6 a. m.	ene.			
7 a. m.–6:35 p. m.		80+		
8 a. m.	e. by n.			
10 a. m.	e. by s.			
Noon	ese.			
2 p. m.	se. by s.			
3–4 p. m.		108		
3:31–3:50 p. m.		116		
3:40–3:45 p. m.			124	
3:45 p. m.				140
4–5 p. m.		106		
5–6 p. m.		96		
6 p. m.	sw., s.			

At 6 p. m. of the 29th the wind went to southwest and was southwest or south the remainder of the night; by noon of the 30th it had settled into the southwest. Along the Gulf Coast, from Burrwood eastward to Rigolets, the wind velocity was probably about the same as at Burrwood. From Rigolets the wind probably decreased in velocity toward the center of the hurricane, and there was a rapid decline in the velocity to the eastward of the Rigolets.

Extracts from reports by cooperative observers.

The following extracts from special reports of Weather Bureau cooperative observers at stations in the area covered by the hurricane, furnish valuable material relative to wind changes with the progress of the hurricane. From these and other available material we can determine the exact route over which the center of the hurricane traveled. They also furnish valuable data concerning the conditions of the weather at the center of the hurricane, such as the "eye of the storm," calms, etc. The extracts are given in geographical order commencing on the Gulf coast and thence northward with the progressive movement of the hurricane.

Houma, La.—The wind blew from the northeast on September 29 until between 10 a. m., and 11 a. m., when it began blowing alternately north and northeast, with intermittent periods nearly calm. About 4 p. m. there was a lull, after which the wind blew its hardest from the northwest, finally falling off in that quarter between 11 p. m. and midnight; the wind went from northeast to north, northwest, and west.—*F. X. Zeringer.*

Lockport, La.—The wind began to increase Tuesday night (28th) shortly after dark, but its intensity was not noticed particularly until about 9 a. m. Wednesday, the 29th. During this time it was blowing from the northeast and continued from this quarter with increasing intensity until between 4:30 p. m. and 5 p. m., when it dropped very quickly to a moderate velocity. This lasted for about half to three quarters of an hour when it again began to blow hard from the northwest, or perhaps a little west of northwest. I did not notice any gradual change in the direction from the northeast to northwest, if there was any. There was no period of calm, my observation being that it had changed from a moderate and decreasing northeast wind to an increasing northwest gale. It was also my opinion that our greatest velocity was from the northwest, but lasted only for a very short period. Trees that had withstood the northeast wind snapped off with the northwest wind. By 8 p. m. the wind began to be more moderate.—*Frank H. Adams.*

Avoca Island near Morgan City, La.—After blowing northeast for some hours after the storm began on the morning of the 29th, the wind backed up north by northeast and blew as we estimate at the rate of about 50 miles per hour. It then backed farther and gradually to the north, and I should say blew directly from the north during the highest of the gale, or from about 4 p. m. to 6 p. m. During the night the wind shifted to the west by the way of northwest. We were afraid of a tidal wave here, and the writer noted particularly your wind forecast and saw your predictions verified.—*Eugene A. Pharr.*

Morgan City, La.—The wind was from the northeast the morning of the 29th and continued to increase from that direction until 1 p. m., when it shifted to north-northwest and still increased in velocity until 4:30 p. m., when it blew hardest. From this time until 8 p. m., the wind decreased and backed to the west. There was no period of calm.—*V. E. Kinsey.*

Sugar Experiment Station, New Orleans, La. (7 miles west of local office, Weather Bureau).—During the early hours of the morning of the 29th the wind direction was very uncertain, but as the gale increased it blew more or less north-northeast; toward evening, from about 4 p. m. to 5:30 p. m., the wind had reached its greatest velocity, and it seemed to come directly from the northeast. At 4:50 p. m. it did its worst damage to the station. All during the day there were lulls for a few seconds and then renewed gusts of wind and rain.

Loyola University, New Orleans, La. (1 mile north of the Sugar Experiment Station).—From early morning until about 5:15 to 5:30 p. m., the wind seemed to be steady from the northeast. From 5:30 p. m., until about 6:30 p. m., or perhaps a little later, there was almost a perfect lull, at least it seemed so by comparison with the tremendous disturbance preceding. At the time between 6:30 p. m. and 7 p. m. the wind veered around until it blew strong from a southerly direction, it being difficult to say whether it was from the south, southeast, or southwest.—*Anton L. Kunkel, S. J.*

Reserve, La.—During the recent hurricane the wind shifted from northeast to east, predominating from the northeast. The storm started here about 10 a. m., and blew steadily from the northeast until about 6 p. m., then from that hour it shifted from northeast to east until about midnight; after midnight it turned to the west for quite a time. During the storm there was no period of calm, but the wind blew in gusts most of the time.—*Edward Godchaux.*

St. Gabriel, La.—The wind began from the northeast about 7 a. m. of the 29th, and gradually increased until 9:30 p. m., when it shifted to the northwest and subsided.—*Capt. John B. Murphy.*

Donaldsonville, La.—The direction of the wind in the hurricane of September 29 was northeast from the time of observation at 7 a. m. until 5:30 p. m., when there was a period of calm, after which the wind shifted to north, keeping that direction until 8:45 p. m., when it backed to northwest.—*Alfred J. Landry.*

Cinclare, La.—The wind on September 29 was from the northeast until about 5 p. m., when it shifted to the north and remained from that direction until it subsided. The wind was high from noon until 11 p. m. There was no noticeable period of calm.—*A. W. Wallace.*

Covington, La.—High east wind began on the morning of the 29th: about 6 p. m. the wind increased in velocity and commenced from a southeasterly direction. The velocity increased from 7 p. m. until 10 p. m., when it blew hardest. After the wind shifted to southeast there were lulls of a short duration, then the wind would blow with greater fury than ever.—*Mrs. M. C. Buquoi.*

Baton Rouge, La.—On the morning of September 29 there was a light northeast wind, which increased in velocity as the day passed, and between 5 p. m. and 6 p. m. it shifted to northwest, and about 7:30 p. m. the wind was highest.—*Elmo M. Bott.*

Hammond, La.—The wind started in blowing from the northeast in the morning and gradually increased in velocity as night approached. About 5 p. m. it lulled slightly, but then began to blow harder until about 7 p. m., when it came out of the north, and about this time the storm seemed to reach its maximum.—*C. C. Carr.*

Amite, La.—The winds came alternately high and light from the same direction, northeast. There were high winds from the northwest also.—*Miss Lulu M. Wentz.*

SPECIAL FEATURES SHOWN BY THE WINDS.

An interesting feature brought out by the foregoing reports on the winds in this hurricane is that in the eastern or right-hand segment of the hurricane the highest velocities are invariably reported to have occurred with the change from easterly to southeasterly winds, being as a rule from the southeast, and probably coincident with the passage of the hurricane center. The records at New Orleans and Burrwood show this positively. In the western or left-hand segment, the highest velocities are reported to have occurred at some point between north and northwest, and with a change of the winds towards the west. The highest winds in the right hand segment came from the opposite quadrant from that in which they occurred in the left-hand segment, being almost from directly opposite directions.

At New Orleans with the change in direction from southeast to south the wind velocity fell off to 50 per cent of what it had been with the same barometric gradient when the direction was from the northeast to southeast. A similar decrease in velocity is reported to have taken place in the western or left-hand segment of the hurricane when the wind shifted from northwest to west and southwest. The progressive movement of the hurricane being about 12 miles per hour (see path and movement of hurricane center) accounts for part of this, viz: The progressive movement would increase the gradient wind by 12 miles per hour in the front segment, and diminish the gradient wind by the same amount in the rear segment, which together would give an apparent difference in velocity, making it 24 miles greater in the front segment than in the rear segment of the cyclonic area. This leaves a falling off in the wind velocity in the rear segment below that in the front segment when compared to barometric gradients of something like 10 miles per hour, which is not explained by the progressive velocity of the cyclonic area.

PRECIPITATION.

Light precipitation began at 2:35 a. m., on the 29th, and with the exception of a heavy shower for a few minutes about 3:40 a. m., soon after the wind veered from northeast to east, very little precipitation occurred prior to 7 a. m., during which time the wind was from the east. Soon after 7 a. m., the wind backed to the northeast and the precipitation increased until 12 noon, 1.59 inches being recorded in the hour ended at 12 noon. The precipitation became lighter again after the wind veered to the east at 1:10 p. m., and it diminished until the fall during the hour ending at 3 p. m., was only 0.30 inch. As the wind veered toward the southeast the precipitation became heavier again and during the hour ended at 5 p. m., also the hour in which the complete change from east to southeast occurred, the precipitation amounted to 1.05 inches. The precipitation then diminished and almost ceased about half an hour before the wind veered from southeast to south at 6:35 p. m., or rather it ceased during the hour in which the change to south was taking place. A light misting rain, however, continued until 11:30 p. m. The total precipitation during the passage of the hurricane amounted to 8.20 inches. A notable feature in connection with the precipitation was the increase in precipitation just prior to the time that the wind shifted from northeast to east near the middle of the day, the falling off in the amount of precipitation both during the early morning hours and again in the afternoon hours during the time the wind was from the east, the increase in the amount of precipitation again as the wind was shifting from the east to southeast, and that the precipitation almost ceased when the wind veered from southeast to south.

The distribution of the precipitation in the area covered by the cyclonic movement of the atmosphere is of special interest. The heaviest precipitation occurred near the center and within a distance of 25 miles to the east of the center, but heavy precipitation occurred over a large area in the eastern segment of the storm, while to the west of the path of the center of the storm the precipitation diminished rapidly and 50 miles to the west of the path of the center of the storm the precipitation was negligible. The distribution of precipitation in relation to the center of the hurricane is shown in figure 7 (XLIII–114).

LIGHTNING AND THUNDER.

The flashes of lightning, supposed to be a special feature in a tropical hurricane, were not present in this one. There was an absence of lightning and thunder, which calls for special comment. About 3 a. m. of September 29 faint sheet lightning was observed a few times in the

northeast, and twice low, distant thunder was heard, but after that time and during the passage of the hurricane the total absence of lightning was commented on in the office. About 9:30 p. m., September 29, four hours after the center of the hurricane had passed, Mr. A. V. Hall, of the Times-Picayune, reported he had observed a peculiar lightning in the southwest a few times. Mr. Hall described it as a light flaring up in sheets not unlike the fire coming out of the mouths of serpents as represented in imaginary illustrations.

NOTE.—In the hurricane of September 8, 1900, at Galveston, Tex., I do not remember to what extent lightning was visible during the day, but certain incidents were revealed by lightning at night which I can never forget. It was sheet lightning to the southeast that revealed to me out of the darkness after the wrecking of my home my brother and my two oldest children floating on wreckage. The lightning enabled me to pick up a strange child about 4 years old floating on the débris of a wrecked house, and occasional flares of lightning enabled us to see buildings, which we would soon hear being ground down and destroyed by the waves and wreckage on which we were floating. This lightning occurred while the wind was from the southeast and ceased quite a while before we landed at 11:30 p. m. In my report on the hurricane of September 8, 1900, I did not go into details relative to meteorological conditions, and I give this here in order to put it of record.

TEMPERATURE.

As the hurricane approached during the night of the 28th, the temperature fell suddenly about 3:40 a. m. of the 29th from 81°F. to 75°, but this occurred with the first heavy shower of rain preceding the hurricane, and the temperature always shows a sudden and decided drop with a heavy shower of rain. After 3:40 a. m. the temperature fell gradually 1 or 2 degrees until noon of the 29th, fluctuating considerably. During the afternoon of the 29th, the sudden fluctuations disappeared, and there were gradual rises or falls of 2 or 3 degrees, the falls occurring with sudden downpours of precipitation and the rises when these would slacken. Temperature conditions during the hurricane were not unlike those found in ordinary heavy rainstorms.

PATH AND MOVEMENT OF HURRICANE CENTER.

The pressure and wind records at New Orleans, Burrwood, and Morgan City, La., Bay St. Louis, Miss., and other places, especially the fact that the barometer remained nearly stationery at Burrwood from 9:45 a. m., the time of the occurrence of the lowest barometer, until 2 p. m. of the 29th, more than four hours, taken along with the wind reports from surrounding stations, indicates that the storm center struck the Louisiana coast about halfway between the mouth of the Mississippi River and Atchafalaya Bay, the center being then about 50 miles west of Burrwood and recurving slowly toward the northeast. The slight change in pressure conditions at Mobile and Pensacola from 8 p. m. of the 28th to 8 a. m. of the 29th also shows that the storm recurved over southeastern Louisiana, and was probably moving toward the northwest up to the time that its northern segment struck the marshes of southeastern Louisiana. The storm center passed near and east of La Rose and Lockport on Bayou Lafourche, where the wind backed suddenly without an intermediate direction from northeast to northwest during the afternoon of the 29th. At Thibodaux, in the northwestern part of Lafourche Parish, the wind backed more gradually from northeast to northwest and west. The prevailing wind at New Orleans being northeast from 8 a. m. until 1 p. m., five hours, east from 1 p. m. until 4 p. m., three hours, southeast from 4 p. m. until 7 p. m., three hours, then southerly the remainder of the day, indicates that the storm curved to the northeastward around New Orleans.

The lowest pressure at Morgan City, La., 67 miles west of New Orleans, was 29.05 inches and the lowest at Bay St. Louis, Miss., 50 miles east of New Orleans, was 29.12 inches. The gradient between Bay St. Louis and New Orleans, when applied from Morgan City eastward to the path of the center of the hurricane, would bring the 28.11 inches isobar on the west side of the center to within about 25 miles of the local office, Weather Bureau, New Orleans. This would place the center of the hurricane about 12 miles to the west of the New Orleans office. This is also in harmony with the reports of changes in wind direction at the sugar experiment station and Loyola University, just 7 miles west of the local office, Weather Bureau, where the wind was reported by two trained independent observers, 1 mile apart, as shifting from northeast to southeast without any intermediate direction. Further, a complete calm, with the wind shifting from northeast to southeast without any intermediate direction was reported by Mr. C. E. Heckathorn, observer, Weather Bureau, as occurring at his residence from 5:30 to 6 p. m., 1 mile farther west than the above stations, indicates that the eastern limit of the imaginary center, or calm area of the hurricane, passed about 8 miles west of the local office, Weather Bureau, and that the diameter of the comparatively calm area was about 8 miles. The barometer reading at New Orleans probably represented as low a barometer as occurred at any point, even in the center of the hurricane. At Tulane University the barometer at 20 feet altitude was 28.10 inches for 30 minutes and another barometer nearby read 28.09 at 5:42 p. m.

The diameter of the hurricane proper—that is, between points where the pressure was 29.50 inches on the outer rim (this pressure is taken as the outer rim because this hurricane occurred within an area of low pressure of unusually large extent)—may safely be placed at between 250 and 300 miles. The time required for the passage at New Orleans from the front isobar of 29.50 to the rear isobar of 29.50 inches was about 24 hours, which would make the progressive movement of the hurricane about 12 miles per hour. Mobile, Ala., 150 miles east of New Orleans, was on the outer rim of the hurricane proper. The lowest barometer reading reported from the Mobile station was 29.50 inches, and it is assumed that a similar pressure would have been noted about 150 miles west of New Orleans. No observer reports a breaking away of clouds in the center, "the eye," of the storm.

Figure 6 (XLIII–114) gives the directions in which the winds changed at several stations in southeastern Louisiana during the progress of the hurricane, and shows as accurately as possible, from the information available, the path traversed by the center of the hurricane.

TIDE CONDITIONS.

No extraordinary tide conditions appeared during September 28, the day preceding the hurricane, and as late as the morning of the 29th men who had been advised on the afternoon of the 28th to go to their families on the Mississippi coast returned to New Orleans on an early train Wednesday morning and telephoned me that they had left everything comparatively quiet on the Gulf coast and they had noticed no extraordinary tide on the trip to New Orleans. On my advice they attempted

to return to their families by the first train at 11 a. m., but an unusually rapid rise in the tide had submerged the tracks of the Louisville & Nashville Railroad at Rigolets, and the train was annulled. The tide continued to rise as the hurricane advanced and during the afternoon of the 29th covered all low lying lands south of New Orleans and east nearly to Bay St. Louis and around Lake Ponchartrain to the north. The tide and swells topped the levees along the Mississippi River below New Orleans and in places the tide was reported to be as much as 15 to 20 feet above sea level. It was undoubtedly the highest tide of record in this section. At the junction of Harveys Canal with the Mississippi River, just above New Orleans, and 100 miles from the Gulf, the tide was 6 feet in the river. Swells rolled up the river during the hurricane 10 to 12 feet above the high tide. The water was carried into Lake Ponchartrain by the storm, overflowed the protection levees, and flooded a large area in the western part of New Orleans. Over that portion of the city lying between the Old Basin Canal and Broadway and from Claiborne Avenue out to Lake Ponchartrain, the water driven in by the storm ranged from 1 to 8 feet in depth. After the passage of the storm center the tide receded rapidly, except in New Orleans where the water had to be removed by the drainage system and remained for three or four days.

It is evident that the tide came up with the hurricane, because, considering the northeast winds blowing, there were no extraordinary tide conditions, even as late as the morning of the 29th. The long swell on the ocean usually reported as preceding hurricanes had not been observed up to that time. The only noticeable conditions indicating the advance of the hurricane and its probable course was a wind-blown rise of 1 foot in the Mississippi River at New Orleans, and a fall of 0.5 foot in the Atchafalaya River at Morgan City. Had it not been for the fall in the tide at Morgan City there would have been nothing in tide conditions along the coast to attract attention, with the character of winds prevailing.

WARNING SERVICE AND ACTION TAKEN TO PROTECT LIFE AND PROPERTY.

Warnings announcing the appearance of the hurricane in the eastern portion of the Caribbean Sea were received at New Orleans on September 23, and advisory warnings were received daily thereafter until the passage of the hurricane. These warnings gave the location of the storm and its probable direction of movement, and were telegraphed to all coast stations, radiographed to ships at sea, telephoned to ship agents, and published in the daily papers.

September 28 the following warning was distributed by telegraph to all display stations on the Louisiana coast, radiographed to ships at sea, and was widely distributed by telephone and mail:

Hoist northeast storm warning, Louisiana coast, 8:30 a. m. Tropical disturbance will cause increasing northeast winds and probably moderate gales along the Louisiana coast this afternoon and to-night.

(Signed) CLINE.

Warnings for moderate gales were sent with the forecasts at 8:20 a. m. to all telephone exchanges in southern Louisiana. At 9:50 a. m. the following advisory warning was received from the central office, and was distributed by telegraph to all display stations on the coast, radiographed to ships at sea, and telephoned to all interests likely to be affected:

Advisory storm warning. Tropical storm attended by dangerous winds centered this morning over Gulf of Mexico in apparently latitude 24° and longitude 87° and moving northward toward the mouth of the Mississippi River. Its influence will be felt late to-night and Wednesday on the middle Gulf coast.

(Signed) BOWIE.

About 1:30 p. m. the following message was received:

BERWICK, LA., *September 28, 1915.*

Dr. I. M. CLINE,
Weather Bureau, New Orleans, La.

This company has men and boats on the Gulf and we would appreciate advice sent us direct at our expense if storm should head this way.

(Signed) LOUISIANA OYSTER & FISH CO.

The following reply was sent at once:

Hurricane centered about 300 miles off mouth of Mississippi River apparently moving northward. Consider it advisable to call in men and boats. Effects of storm will be felt on middle Gulf coast by Wednesday morning.

(Signed) CLINE.

At 2:40 p. m. the following hurricane warning was received from the central office, Washington, D. C.:

Hoist hurricane warnings 3 p. m., New Orleans to Pensacola. Tropical storm centered near latitude 26° and longitude 88°, moving northward. Dangerous winds late to-night and Wednesday. Center of storm will probably strike coast near or immediately east of the mouth of the Mississippi River. Advise all interests.

(Signed) BOWIE.

An extraordinary distribution of warnings was commenced at once and the following injunction was given those to whom it was sent: "Please reach persons in exposed localities." It was telegraphed to all special storm warning display stations on the middle Gulf coast; was telephoned at Government expense to the telephone exchanges in the threatened area in Louisiana. Mr. T. Barton Baird, district manager of the Cumberland Telephone & Telegraph Co., was called up, the warning read to him, and a list of the telephone exchanges to which the warning had been sent; by our request he instructed the managers at the several exchanges to give the warnings the greatest possible distribution and to endeavor to reach persons in exposed localities. Similar action was taken by Mr. W. A. Porteous, manager of the Western Union Telegraph Co.; Mr. N. E. Church, manager of the Postal Telegraph Co.; Mr. Charles Marshall, superintendent of the Louisville & Nashville Railroad; and by Mr. Isidore Fisher, at Fishers Landing on Harveys Canal, who sent the warning by boat at Government expense down through the Barataria section to Grand Isle. Mr. J. R. Reynolds, superintendent of police, New Orleans, was requested to post the warnings at each police station, and to notify the people on the police rounds that a hurricane with dangerous winds would prevail Wednesday; to advise the people to exercise every precaution against danger; and to reach persons in exposed localities. The fire-alarm department, at my request, sent the warning to all their stations with similar instructions. The commanding officers at Jackson Barracks and at the naval station took similar action. An assistant at the Weather Bureau office telephone, with a list of shipping and others who receive such warnings, called up the chief operator at the telephone exchange and had a special operator assigned to switching from one number to another so that we could get the warning to the greatest number in the shortest time.

The pressure conditions around the Gulf coast Tuesday morning, September 28, and cloud conditions and movements during the day were such that public interests were advised that afternoon that the hurricane would probably be more severe than that of 1909, the most severe storm in the previous history of New Orleans.

Capt. Galbraith, manager of the Western Union branch in the New Orleans local office, Weather Bureau, reported for duty shortly before 7 a. m., September 29. I informed him that wire trouble would soon be experienced and requested him to take such precautions as would enable us to collect reports and get out forecasts and warnings and distribute them early. The following warning, based on pressure and weather conditions along the Gulf coast and on tide conditions at New Orleans and Morgan City, La., was issued at once:

Advisory warning Louisiana coast, 8:20 a. m. Tropical disturbance will move northward over southeast Louisiana. Center will probably pass between New Orleans and Atchafalaya Bay. Easterly gales probably reaching hurricane force in eastern Louisiana and strong northerly winds to moderate gales on west Louisiana coast to-day and to-night. High tides.

(Signed) CLINE.

This warning was given the widest possible distribution by telephone, telegraph, and railroad offices throughout the threatened area and also by mail in New Orleans. Warnings for easterly gales and probably hurricane winds were telephoned to all eastern Louisiana, and for northerly to westerly gales to all western Louisiana. We had just finished distributing forecasts and warnings by telegraph and telephone at 9 a. m. when serious wire trouble set in.

All persons asking were advised to remain at home and stay indoors; the principals of several schools were also advised.

This advice and the distribution of the warnings through the police and fire-alarm departments kept people at home or in their offices and stores and reduced the number of people on the streets during the storm to a minimum, and this unquestionably prevented much loss of life in New Orleans.

When the barometer fell below 28.25 inches and continued falling so rapidly, I began wondering what the result would be. It was a great relief to us when the barograph pen stopped at *a reduced barometer reading of 28.11* inches and then began to rise. Every minute during the afternoon of the 29th I had told people coming into the office and over the telephone, that the worst was not over; but after 5:50 p. m., they could be told that the center had passed although dangerous winds would continue for a few hours. Telephone calls came so fast that when we wished to send a message we could not get central and had to go to another telephone. Some one was on the line before we could hang up and lift off the receiver. The strain of anxiety on the part of the public was the greatest I have ever witnessed.

The Daily States, September 30, 1915, in commenting on the storm says:

When the fierce blasts, which in the morning hours came from the northeast, shifted east, then south, and finally, about 10 p. m. southwest, were at their most terrifying height in the late afternoon, hundreds of persons, women, children, and men fought their way through the swirling, blinding mist of rain and flying fragments of roofs and cornices to the substantial stone and marble post-office building in Camp Street, in the top story of which the Weather Bureau is located. Here they felt safer and could get some first-hand information as to what to expect. Among them were some 20 women who lived in the Christian Women's Exchange, the roof of which had already been damaged.

When night came and word still came from the Weather Bureau that, though the center of the storm had passed about 6 o'clock, all danger was not yet over, more than 300 women, children, and men decided to remain in the building all night. Toward midnight, exhausted with anxiety, many of them laid (!) down on the stone floor of the post-office corridor, their heads pillowed on mail sacks supplied them by Assistant Postmaster George V. Fuchs, and snatched such sleep as they might under these hard conditions.

Not until daylight did they leave for their homes.

From many office buildings and stores down town telephone messages came into the Weather Bureau at nightfall asking whether it was safe for other crowds of men and women gathered in them to venture into the streets to go home, but in every case the bureau advised that they remain where they were until daylight on account of darkness and fallen wires.

About 11 a. m., September 29, the chief clerk to the superintendent of the New Orleans & Northeastern Railroad called and asked advice about taking trains over the fourteen miles of trestle and abutments across Lake Ponchartrain. They were advised to suspend trains as the storm would increase in severity during the afternoon. The wind subsided slightly between 1 p. m. and 2 p. m., and the officials of the railroad, being anxious to keep up their train schedules, called again and asked if it would not be safe for them to keep their trains moving. I told them positively that higher winds would occur than had been recorded and that in my opinion there would be winds which would blow trains off the trestle, and they then issued orders for the trains coming in to New Orleans to stop at Slidell on the other side of the lake and they canceled all outgoing trains.

Special observations were telegraphed to the central office every two hours during the hurricane, up to and including 3 p. m. At 5 p. m. all wires out of the city had gone down. Efforts were made to communicate with the Naval radio station in Algiers, the Tropical radio station, and the Marconi station, but all were cut off or out of commission, and New Orleans was absolutely cut off from the outside world. About 10 p. m. of the 29th Mr. Israels, manager of the Associated Press, telephoned that the Marconi Co. had rigged up a temporary wireless station on the American steamship *Excelsior* at the foot of Saint Ann Street, and that they would relay important matter through the American steamship *Creole*, at anchor near the mouth of the river, to Mobile, where it would be put on the land lines. A message to the Chief of the Weather Bureau, giving the regular 8 p. m. observation of the 29th and a brief report on the hurricane was thus sent from New Orelans about 11 p. m. of the 29th. [This message was received at Washington during the afternoon of the 30th]. The regular observations were sent and special reports were transmitted to the chief of the bureau daily through the above channels until October 2, when wire service was established by the Western Union Telegraph Co. into the local office of the Weather Bureau.

The warnings reached every locality in the threatened area, as is shown by press reports and other reports from the storm area, except that the water became so rough that the boat chartered could not make the trip to Grand Isle; however, the previous notices relative to the movements of the storm reached Grand Isle.

People in exposed localities, with a few exceptions, acted promptly on receipt of the warning and sought places where they thought they would be secure. Grand Isle and the Barataria Bay section is practically devastated, nearly all buildings having been destroyed, and all live stock drowned. However, only 23 lives were lost in all this vast region, and 14 of these resulted from the capsizing of boats. At Burrwood the inhabitants went aboard the United States dredge *Benyuard;* fishing boats and other small craft sought refuge in bays and bayous, where they felt secure, but the storm tide of 15 to 20 feet carried many of them from their moorings and left them high and dry on the prairies or far out in the marshes. Weather Bureau warnings held at least 25 ocean-going steamers in the river and at the wharves from the 24th

to 30th. Without definite advice regarding the hurricane the effects on shipping in port would have been disastrous. Vessels which went to sea on the 23d to 26th received the warnings and steered to the westward of the hurricane; no report of an ocean-going vessel being lost has been received.

DAMAGE AND LOSS OF HUMAN LIFE.

The damage to property and the loss of human life were remarkably small when the intensity of the hurricane is taken into consideration. In New Orelans several buildings were totally destroyed and nearly every building suffered injury to some extent, amounting in some cases to several thousand dollars. Four small steamers, or tugs, were sunk in the harbor and several steamers broke from their moorings and were blown ashore. A great many small craft which had sought refuge in the bays and bayous were blown ashore and left by the tide on dry land; several coal barges loaded with coal were sunk. The destruction of buildings was very great in the country surrounding New Orleans. At Leeville on the lower Lafourche, of the 100 houses in the village, only one was left standing, but no one was killed. At Golden Meadow and from that point to Cut Off, 100 houses were demolished, but no lives reported lost. At several places on the Mississippi River below New Orleans and on Lake Ponchartrain 90 per cent of the buildings were completely destroyed.

I have checked the deaths closely and 275 will cover the entire loss of life resulting from this unprecedented hurricane. The loss of life at Rigolets resulted from an absolute disregard of specific warnings and advice to come to New Orleans. Mr. John T. Meehan, of the Times-Picayune, was in the local office, Weather Bureau, when we issued the specific warning at 8:20 a. m., September 29, giving the path which the hurricane would follow and advising that hurricane winds and high tides would prevail over southeastern Louisiana that day and night. He asked me what the result would be at Rigolets, stating that he knew some people there, and I told him he had better telephone them at once, which he did. He spoke with Manuel, the keeper of the club, through his wife, gave him the warning and told him to have everybody come to New Orleans on the next train, which was due to pass that place about 10 a. m. Manuel replied that the train would not stop for them, and Mr. Meehan told him that if the train would not come to a stop for flagging to put a cross tie on the track. The keeper said, "They will put me in jail," to which Mr. Meehan replied, "You would be better off in jail than where you are now and for God's sake stop that train at all hazards and come to New Orleans." It has since been learned that Manuel flagged the train and it stopped, but the people were not there to get aboard, the rising tide was jeopardizing the passengers on the train, which could not wait until the people could be collected from the houses. Manuel returned to his companions and when the storm was over his lifeless body, with 23 others of those who were in the club, were found strewn over the marshes. Mr. Meehan, who went to the Rigolets the morning after the hurricane, with a rescue party, assisted in looking after the burial of the keeper, Manuel, and his companions.

Mr. J. B. Fasterling, Buras, La., president of the Plaquemines police jury, under date of October 1, says:

It is yet impossible to estimate the number of those who perished, but the death rate has been remarkably low considering the force of the storm. There were 2 feet more water than in the 1903 gale.

The Times-Picayune, October 3, says:

It generally is agreed that the death toll paid the hurricane has been remarkably low along the lower river compared to what the might of the gale led all to anticipate.

The damage done by the hurricane on the middle Gulf coast will probably exceed $13,000,000, and approximately may be distributed as follows: In the city of New Orleans the damage has been heavy. The damage to municipal property has been appraised at nearly $500,000. As late as October 13, more than two weeks after the hurricane, the Dealers and Contractors Exchange stated that a survey of the city indicated that 25,000 houses were then in a leaky condition as a result of the hurricane. The total damage to property in New Orleans may be safely estimated as at least ten times the amount of damage suffered by the public buildings belonging to the municipality, and on this basis the damage to property in New Orleans is placed at about $5,000,000; to shipping and coal interests on the river, $1,750,000; in the country outside of New Orleans, to buildings, railroads, small craft, crops, and telegraph and telephone systems about $6,500,000.

VALUE OF WARNINGS IN SAVING LIFE AND PROPERTY.

Much of the success obtained through the warnings in saving human life and property was brought about by the specific statements given on the morning of Tuesday the 28th as to where the hurricane would strike the Gulf coast, and the forecasting Wednesday morning at 8:20 a. m. of the exact course its center would follow, with the character of winds and tides which would prevail, and by the firm and convincing manner in which the people were told what to expect and what to do. We expressed no doubts, but told the people specifically what to expect and advised them without hesitation what action to take. The admonition "Please reach persons in exposed localities," given to every manager of a telegraph and railroad station on the middle Gulf coast, and all telephone stations in southeastern Louisiana and others, with the hurricane warning on the 28th, impressed the people with the seriousness of the impending crisis, and stirred the public to prompt and decisive action to protect life and property such as was never exercised previously. The fact that only 275 lives were lost in all that vast stretch of 300 miles of coast line, including the most populous center in the South, tells the story of the value of the service rendered the people of this section.

The Times-Picayune, Thursday, September 30, 1915, says:

The intensity of the storm, while it did considerable damage in New Orleans and vicinity, proved the worthiness of Dr. I. M. Cline, the district forecaster of the United States Weather Bureau. Never before, perhaps, in the history of the Weather Bureau, have such general warnings been disseminated as were sent out by the local bureau in reference to the disturbance that passed New Orleans Wednesday evening. At 7 o'clock Wednesday morning Dr. Cline said the wind would attain a velocity of 65 miles an hour, or more. At 2 o'clock in the afternoon, when a velocity of 62 miles an hour had been recorded, and when most persons believed the worst had passed, Dr. Cline said the worst was yet to come. He then predicted that the maximum intensity of the storm would be reached here "between 5 and 6 o'clock." As a matter of actual record, the maximum was at 5:30, when a wind velocity of 86 miles an hour for 10 minutes was recorded, and when, for a period of about 20 seconds a velocity of 130 miles was reached.

There may have been much life loss along the coast, but such a catastrophe can not be charged to the Weather Bureau, for the warnings of the approach of the hurricane were sent broadcast before the high winds ever reached the Louisiana coast.

Tuesday afternoon Dr. Cline expressed the belief that the storm would be more intense than that which wrought such damage at New Orleans and along the coast in September, 1909. His prediction came true, although there were many persons in the city who were skeptical

concerning this prediction until the winds actually had recorded a new velocity record for the city.

The New Orleans Item, October 13, 1915, says:

About 20 years ago a West Indian hurricane, far lighter in force and stress than the recent storm, struck the Gulf coast. Over 2,000 lives were lost and many millions in property.

Ten days ago another West Indian hurricane came with tremendously increased intensity. But the loss in life in all the vast stretch of marsh and bayou and sea line is only 275. The property damage is infinitely less.

There is one specific reason for this difference in results: Increased efficiency in the Weather Bureau and an increased and extended service rendered possible by enlarged personnel and extended range of observations.

The News and Courier (Charleston, S. C., Oct. 1, 1915) published the following comment on the Weather Bureau's services:

WEATHER BUREAU MAKES GOOD AGAIN.

For the third time this season [fall of 1915] the United States Weather Bureau has been put to the test and for the third time it has proved its worth. Three great tropical storms have swept upon the shores of this country out of the southern waters where these tempests are brewed. But for the Weather Bureau's good work it is certain that each of these storms would have blotted out thousands of lives along the coasts of the Gulf States.

The News and Courier has already made acknowledgment of its realization of how fine the bureau's work has been. Now that for the third time this year the bureau has been put to the test and has met it admirably, a further acknowledgment is due. Seldom, if ever before, has the bureau been confronted with more important problems than those which it has met and solved this year, and this latest demonstration of its efficiency should not be allowed to pass without remark.

CONDENSATION UPON AND EVAPORATION FROM A SNOW SURFACE.[1]

By B. ROLF.

[*Reprinted from* Science Abstracts, Sec. A, Sept. 25, 1915, § 1203.]

The following experiments were carried out in Swedish Lapland. Four shallow zinc trays, each about 600 square centimeters in area and 3 centimeters in depth, containing snow, were exposed in the open upon the snow-covered ground in such a way that their rims were level with the general surface of the snow. The trays were carefully filled with snow before each experiment and weighed. They were again weighed after an exposure of 24 hours in winter, or 12, 6, 3, or even 2 hours in summer. The difference in weight gives the gain or loss by condensation or evaporation. The experiments were carried out uninterruptedly from December, 1905, to July, 1906, but most of the results could not be used, being vitiated by disturbing causes. Of these, drifting snow was the principal in winter, and absorption of solar radiation by the trays was common in summer, producing an excess of melting and evaporation. The results of the experiments which were finally accepted as trustworthy are printed in full. In winter, and up to the beginning of June, the ground was completely covered with snow, but afterwards numerous bare patches were rapidly developed, and by the middle of July the snow had disappeared. Before June, water vapor therefore passed between the air and a snow surface; afterwards humid soil enters also into the process.

It is found that when snow covers the ground the condensation, C, can be connected with the duration of exposure in hours, t, the maximum vapor pressure at the temperature of the snow layer, f, and the actual vapor-pressure of the surrounding air, F, by the formula

$$C = at + b(F-f)t,$$

where a and b are constants which are determined from the observations by the method of least squares. A negative value of C indicates an evaporation instead of a condensation. In winter a is practically zero, and the formula is

$$C = +0.0174(F-f)t.$$

In spring, when the air temperature is above 0° C., and the snow still covers the ground, f is the saturation of vapor-pressure at 0°C., and is therefore constant (4.6 mm. of mercury). The formula becomes

$$C = -0.0010t + 0.0168(F-4.6)t.$$

The cases when the ground is only partially covered could not be expressed by a similar formula, but it was found that by grouping the experiments according to time of day, values of a and b could be computed for each group and these values showed a marked diurnal variation. Thus in the morning a was $+0.009$; it reached a maximum of $+0.020$ in the afternoon, and fell off again in the evening and night. The constant b also showed a maximum during the day hours of about $+0.029$ and a minimum during the night of $+0.016$. The errors resulting from the use of these formulas are small in comparison with the amount of condensation or evaporation.—*R. Corless.*

[1] *See* Ark. f. Mat., astron., och fysik, Stockholm, 1914, 9; 35. p. 1-19.

RELATION BETWEEN MONTHLY VALUES OF ATMOSPHERIC PRESSURE VARIATION AND SIMULTANEOUS MONTHLY VALUES OF TEMPERATURE VARIATION AND HUMIDITY, AND GEOGRAPHICAL LATITUDE.[1]

By N. EKHOLM.

[*Reprinted from* Science Abstracts, Sec. A, Sept. 25, 1915, § 1202.]

Köppen has considered the relation between pressure variation and the latitude of the observing station, the "deflecting force of the earth's rotation," and the friction between air and earth; but as the energy of all atmospheric motions can ultimately be expressed in terms of temperature and humidity, the author endeavors to discover a relation between pressure variation on the one hand and temperature variation, humidity, and latitude of observing station on the other. Hann had already found that temperature variations alone can not account for the observed pressure variations.

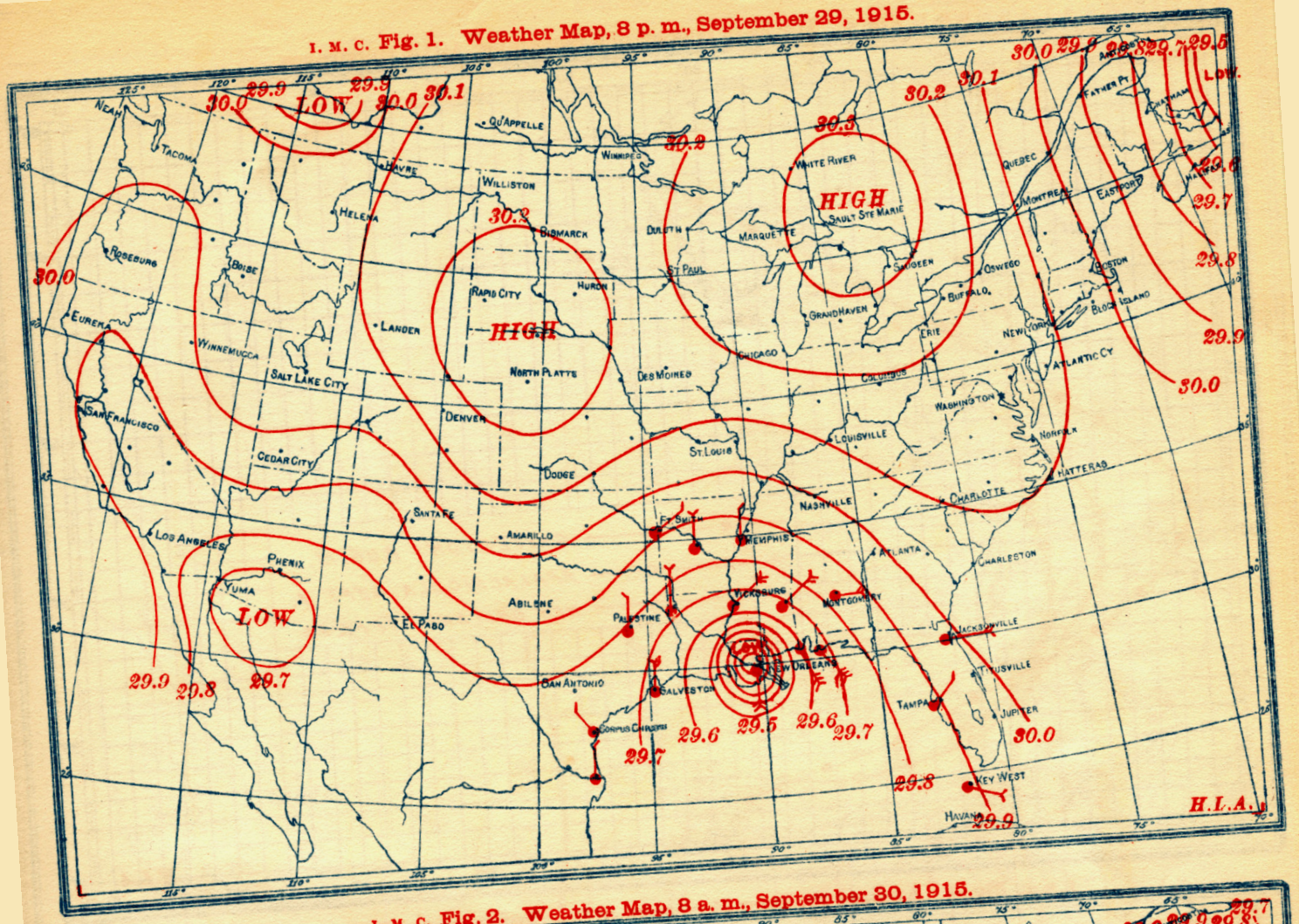
The investigation refers to the three winter months, December to February only, and the data used are monthly values from 23 stations between latitudes 50° N. and 70° N. If L is mean monthly pressure variation, W the simultaneous temperature variation, and F the simultaneous mean vapor pressure for a station of which the latitude is ϕ, it is found that the equation

$$L = 8.73 \sin^2\phi\, F + 1.07 \sin^2\phi\, W$$

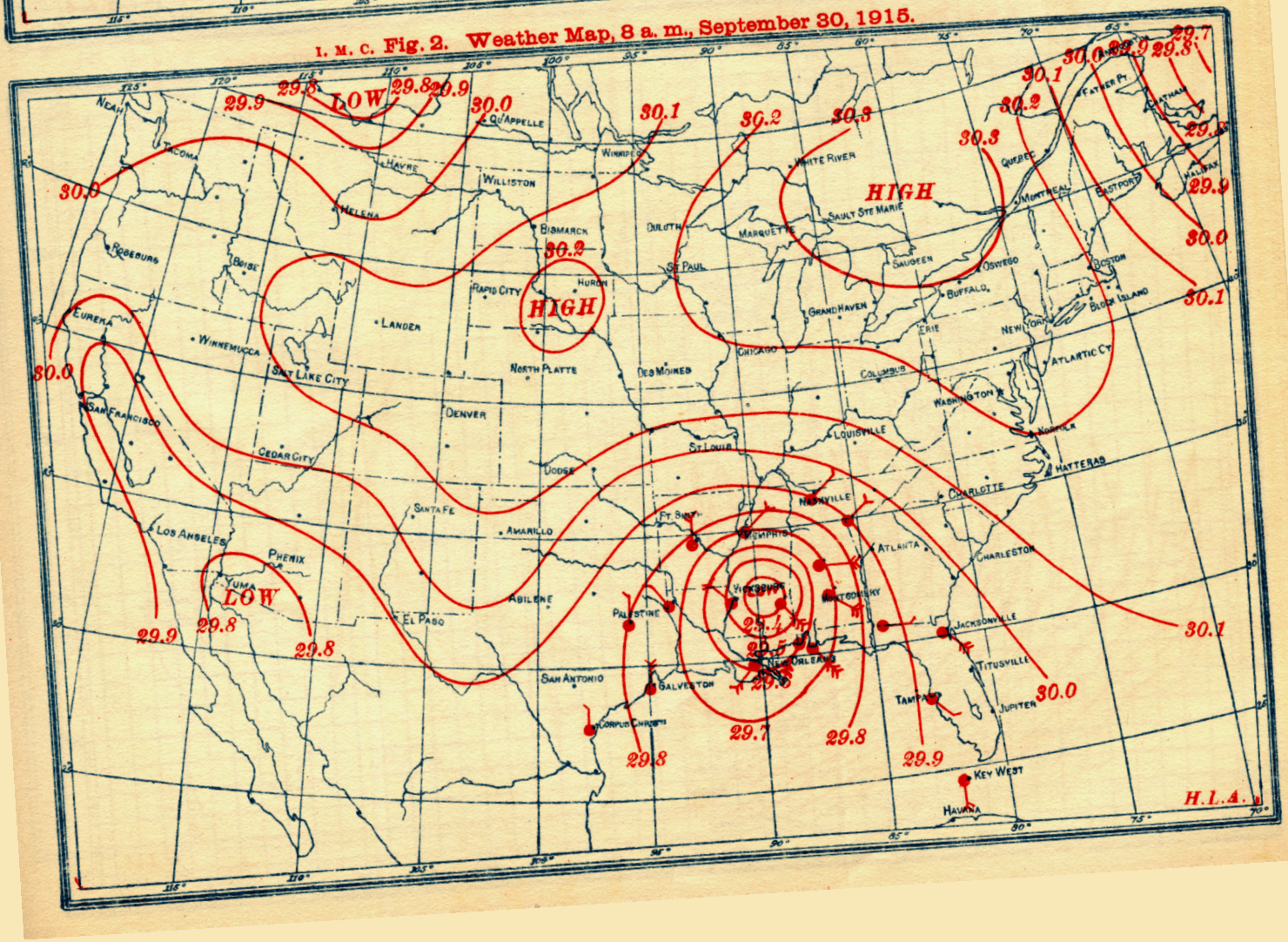
expresses with considerable accuracy the dependence of L upon ϕ and W. The equation applies both to continental stations where F is small and W is large, and to maritime stations where F is large and W is small. Thus the values of the two terms on the right-hand side of the equation for the two stations Iakutsk (Siberia) and Valencia (southwestern Ireland) are respectively 0.88, 28.01, and 34.86, 8.69. The computed values of L are therefore 28.9 and 43.5, which differ from the actual values by 1.4 and 2.1.—*R. Corless.*

[1] See Ark. f. Mat., astron. och fysik, Stockholm, 1914, 10; 3. p. 1-111.

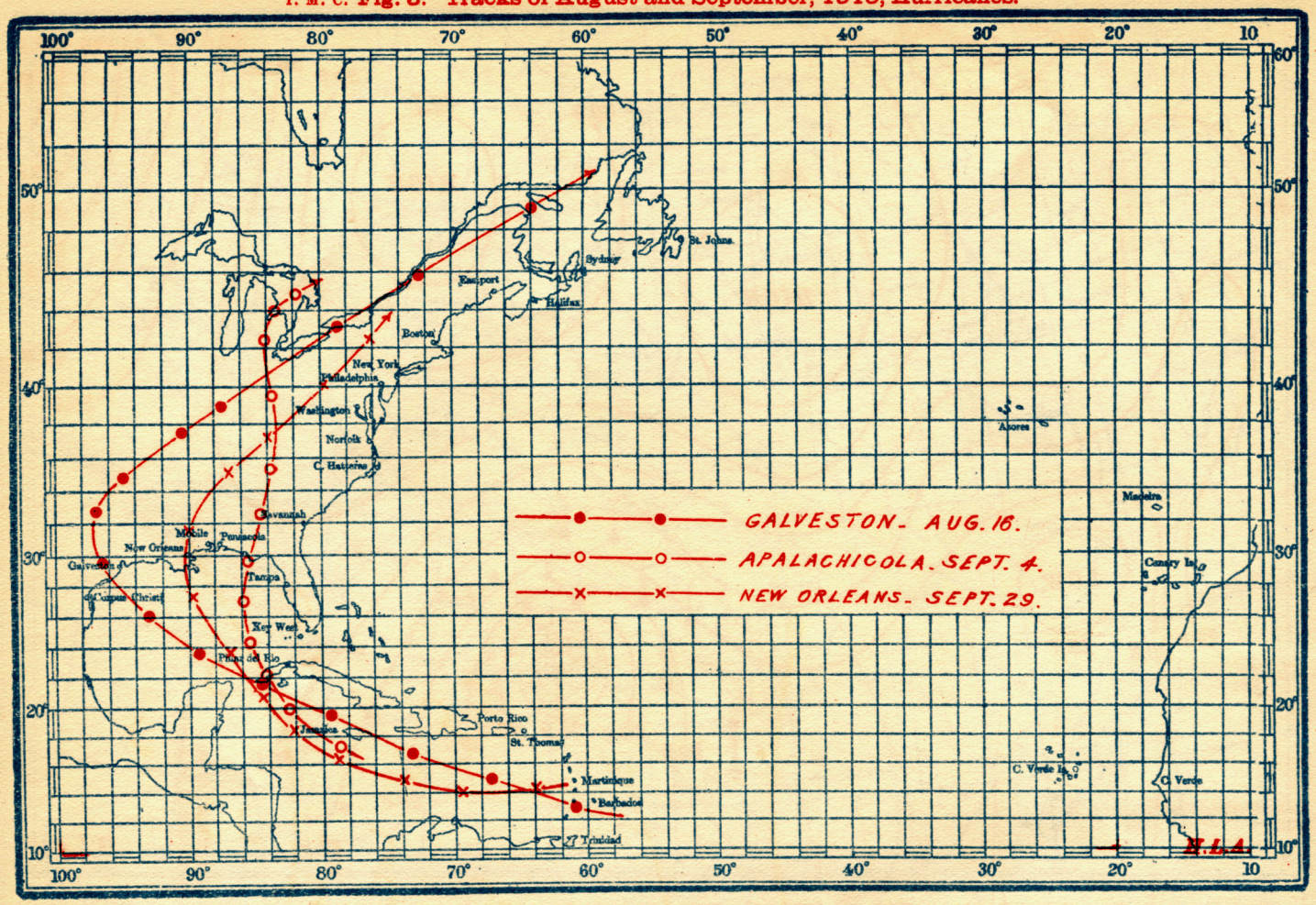
I. M. C. Fig. 1. Weather Map, 8 p. m., September 29, 1915.



I. M. C. Fig. 2. Weather Map, 8 a. m., September 30, 1915.



I. M. C. **Fig. 3. Tracks of August and September, 1915, Hurricanes.**



I. M. C. **Fig. 4. Average 24-Hour Movement of Hurricanes during September.**

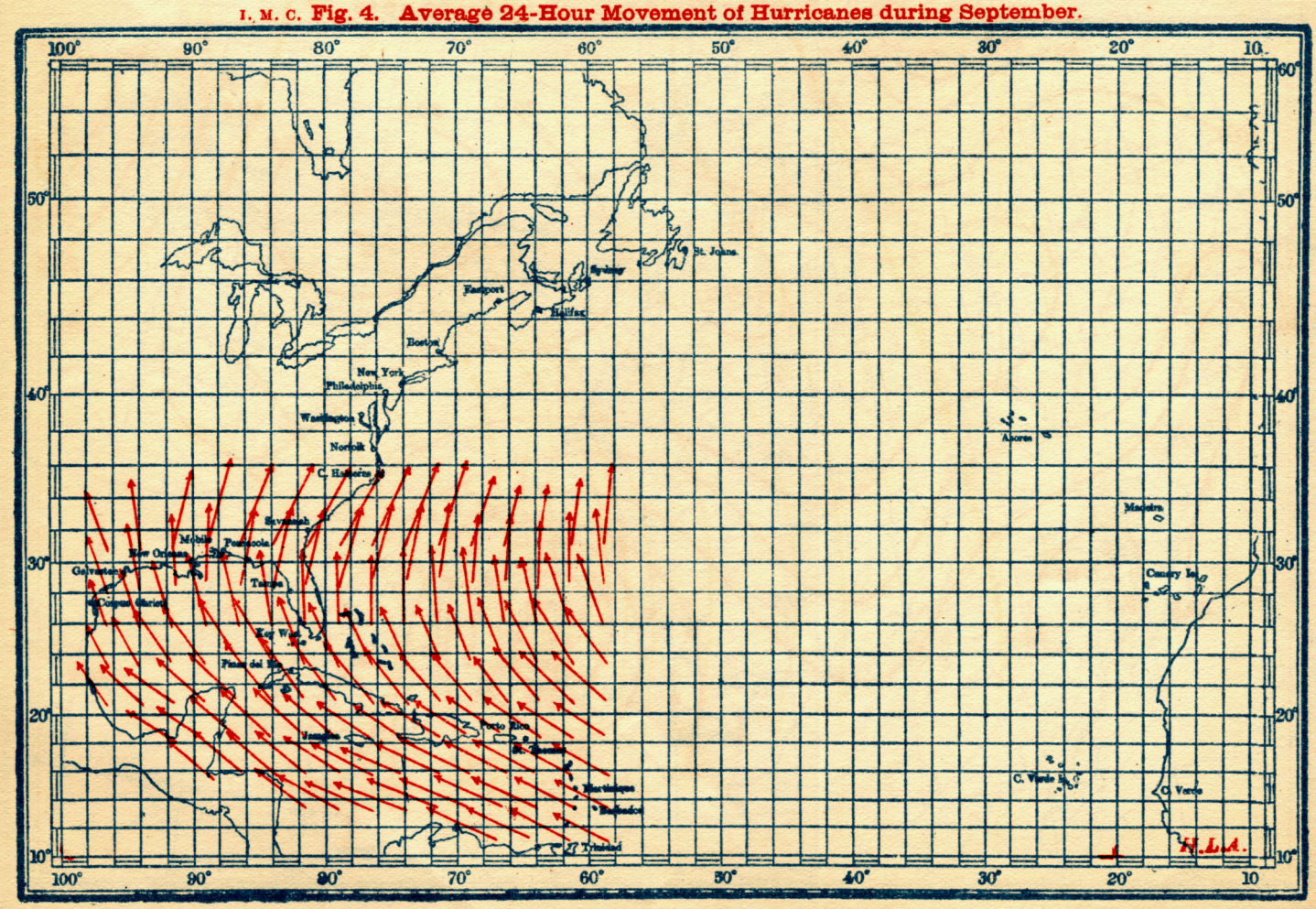


Fig. 5.

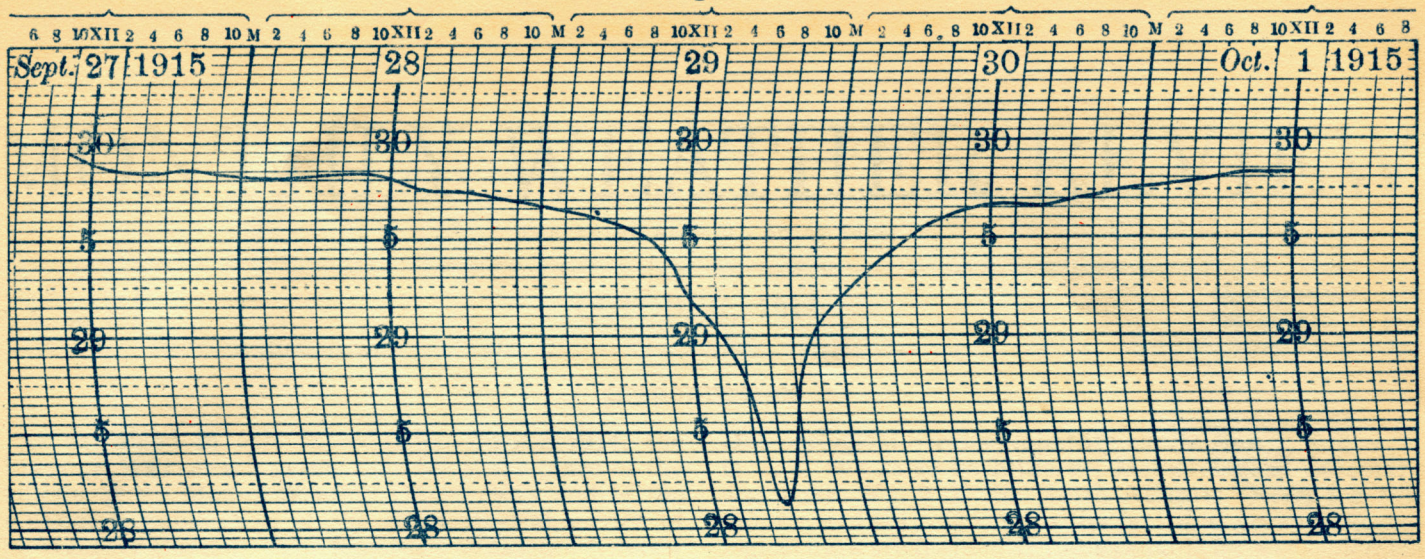


Fig. 6.

Fig. 7.

I. M. C. Fig. 5. Barogram at New Orleans, La. Fig. 6. Wind changes along the hurricane track.

I. M. C. Fig. 7. Rainfall either side of the hurricane.