ought not to be encouraged to get more experience by taking the offensive with a line squall, but may learn something of its wiles by getting set down on a good field well in advance of the roll cloud of the squall and making sure of some shelter. Once passed the squall will be followed by the weather of the other side which is not uniformly good but often marked by bumpy, rough, colder air, with numerous snow or rain squalls, scudding clouds and varying visibility which finally ease up when the colder change attains full possession of the territory.

EVAPORATION FROM RAIN GAGES

551.573 : 551.508.7

By HARRY G. CARTER

[Weather Bureau Office, Lincoln, Nebr.]

To determine the amount of water that would evaporate from a rain-gage measurements were made at Lincoln from May 1 to September 30, 1928. A standard 8-inch gage with receiving funnel and measuring tube in place was used in making the measurements. The water was placed in the measuring tube, the depth ranging from 5 to more than 10 inches (measuring 0.50 inch to more than 1 inch on a regular measuring stick). Readings were made at the time of the regular 7 a. m. and 7 p. m. observations.

The measurements were not in any way intended to determine the exact amount of evaporation from a free-water surface, but merely to give an indication of the amount of water that would evaporate from a rain gage during the interval between the ending of a rain and the measuring of the water.

The results of the measurements indicated that the daily evaporation averaged nearly 0.02 inch each 24 hours during May and approximately 0.01 inch each 24 hours during June, July, August, and September. Measurements also indicated that practically two-thirds of the evaporation occurred during the 12 hours between 7 p. m. and 7 a. m. Whether this was the actual condition or due to the crude method of measuring evaporation with a measuring stick with relatively large units, is questionable. But every month showed the greatest evaporation during the night.

Table 1 shows the average evaporation for the two 12-hour periods for each month during which measurements were made.

Since practically all the cooperative observers, at least in Nebraska, measure rainfall but once each day, usually late in the afternoon or early evening, it would seem that there is a possibility that between 0.01 and 0.02 inch of water would evaporate from the gage before the rain was measured, particularly so when the rain fell a short time after observation and the water stood in the gage 15 to 20 hours before being measured.

TABLE 1.—*Evaporation from a rain gage at Lincoln, Nebr., from May to September, 1928*

	May	June	July	Aug.	Sept.
Average evaporation:	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
For the 12 hours, 7 a. m. to 7 p. m.	.005	.003	.002	.003	.004
For the 12 hours, 7 p. m. to 7 a. m.	.012	.006	.007	.006	.008
For the 24 hours, 7 a. m. to 7 a. m.	.017	.009	.009	.009	.012
Average percentage of total evaporation:	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
For the 12 hours, 7 a. m. to 7 p. m.	29	33	22	33	33
For the 12 hours, 7 p. m. to 7 a. m.	71	67	78	67	67

During the months when precipitation is practically all in the form of rain, say from the 1st of April to the last of September, there are, on an average, between 45 and 55 rainy days in Nebraska. Since approximately two-thirds of these rains fall during the night hours and the water is not measured until late the next afternoon, it would seem that there would be a loss of water by evaporation amounting to between 0.30 and 0.60 inch during the six months.

From the above it would appear that cooperative observers should be encouraged to measure rainfall after each fall, or if this is impracticable, as it would be in many cases, to make measurements both morning and evening, keeping in mind that the amount to be entered on the daily record should be the amount that fell during the 24 hours ending at the hour of observation

COAST FOGS AND RADIOBEACONS

551.575

By WILLIS E. HURD

[Weather Bureau, Washington]

Recently in connection with a study of fog at sea, made at the central office of the Weather Bureau, there arose an informal discussion with the Lighthouse Service as to whether, fog being present at a given lighthouse, say on the southern New England coast, one might reasonably determine upon the probabilities of simultaneous fog occurrence at another lighthouse a considerable number of miles distant.

While there are many instances of fog obscuring in an unbroken sheet a long stretch of sea off the coast, more frequently such surface condensation is of a spotted character, depending upon the local contour of, and amount of sea envelopment by, the adjacent land; neighboring conditions of atmospheric pressure; the direction and steadiness, or variability, and force of the wind; the differences in temperature between adjacent water surfaces, or between that surface and the overlying air, etc. In almost any case there is great difficulty attending the successful forecasting of sea fogs.

Apart from the purely meteorological probabilities involved, it is interesting to note that various light stations incidental to their position finding signals by radiobeacon, are giving special information as to fog and thick weather whenever it exists in their vicinity.

In the Lighthouse Service Bulletin of the Department of Commerce for March 1, 1929, appears the following item bearing upon this subject:

FOG INFORMATION BROADCAST FOR SHIPPING

In addition to their primary purpose of providing signals on which ships can take accurate bearings by radio, the radiobeacon system incidentally broadcasts valuable information as to fog and low-visibility conditions along the coast.

These signals are operated during fog or low visibility and are silent in clear weather, excepting for certain regular time schedule operating periods, which are published for each station. Therefore, a navigator has a ready means throughout the 24 hours of ascertaining the visibility conditions on any part of the coast by listening in for a desired radiobeacon at any time other than its scheduled period.

As the radiobeacon signals may usually be heard at distances of 200 to 300 miles, this should often furnish useful or valuable information both to vessels approaching from seaward and to those bound along the coast. The radiobeacon system is now sufficiently extended that the signals overlap along the entire coast, and the signals from the 37 radiobeacons on the Atlantic, Gulf, and Pacific coasts now spread out over a sea area of over a million square miles.

Navigators have been availing themselves of this source of weather information, and it has been particularly mentioned in reports recently received from Commodore Hartley, formerly of the *Leviathan*, and Captain Williamson, of the *Kentuckian*. In one case Ambrose radiobeacon was used when passing Nantucket Lightship to judge of conditions at the entrance to New York, and in the other Blunts Reef radiobeacon was used by a coastwise vessel to ascertain conditions ahead of it.

551.515 (781)

TORNADOES IN KANSAS

By S. D. FLORA

Tornadoes are more numerous in May and June than any other time of the year in the Middle West, according to records of the United States Weather Bureau. In Kansas 53 per cent of the 177 tornadoes that have struck the State since 1913 have occurred either in May or June. The only months entirely free from them in the State in that time are January and December.

In the 13 years ending with 1928 more tornadoes occurred in Kansas than in any other State, as shown by a summary of the Weather Bureau record obtained through its network of almost 5,000 stations. When relative areas of States is considered, however, it is found that both Iowa and Arkansas have experienced more tornadoes in that period than Kansas. Actual damage by these violent windstorms has been immensely greater in Missouri than in either Kansas, Iowa, or Arkansas. Illinois, Indiana, and Ohio have also had a bigger tornado loss than the Sunflower State, largely due to the same cause.

The year 1928 set a new high mark for tornado frequency in Kansas, with a total of 26 recorded against a 15-year average of slightly less than 12. Kansas tornado losses for the period totaled $9,547,150 and 102 persons were killed, according to official estimates. This may seem high in the aggregate, but it is less than two-fifths of the property loss of the St. Louis tornado on September 29, 1927, and the fatality list is not a sixth as great as that of the tri-State tornado that struck Murphysboro, Ill., March 18, 1925.

One reason why Kansas tornado losses have been small, comparatively speaking, is that tornadoes in that State seldom travel more than 25 miles before they break up. In the Mississippi Valley some of them travel 50 to 150 miles. In Kansas a great many tornadoes pass over prairie country, where buildings are few and far apart, and finally draw up into the clouds with no more damage than a few out buildings wrecked and telephone lines and wind mills blown down. Kansas people in one respect, at least, are more fortunate than their eastern cousins. In most sections of the State the funnel shaped cloud can be seen approaching for several miles and there is a chance for a run to shelter in basements or "cyclone cellars." The latter, which are merely outdoor caves, are common sights near farm houses in central and western Kansas, where they are used for storage of vegetables and dairy products. Many a Kansas farmer and his family have emerged unhurt from a handy "cyclone cellar" after a tornado has passed over and house and barn have been swept away by the wind.

Only three Kansas tornadoes have been in the million-dollar class. One that struck Great Bend November 10, 1915, killed 11 persons and destroyed property to the estimated extent of $1,000,000. Another struck in the oil fields of Butler County July 13, 1924, tore up Augusta, played havoc with oil rigs, and caused a total loss of $2,000,000 and one person killed. The Hutchinson tornado of May 7, 1927, left its trail in five Kansas counties, Comanche, Barker, Kingman, Reno, and McPherson, killed 10 persons, and destroyed property to the extent of $1,300,000.

Tornadoes are undoubtedly more numerous than most persons realize. St. Louis has had two violent ones, on May 27, 1896, and again on September 29, 1927. Omaha had two that caused great destruction; the Easter storm of March 23, 1913, and another April 6, 1919. St. Joseph has seen four tornadoes in the past 14 years: One April 2, 1913; one March 3, 1923; one June 24, 1924; and the last on May 24, 1927. The Kansas Cities have two tornadoes in their history. The first struck Kansas City, Mo., May 11, 1886, and the last reached the western suburbs of Kansas City, Kans., July 16, 1927. Topeka has seen two tornadoes in recent years, but both were in its suburbs and caused very little damage. A violent tornado on June 5, 1917, registration day, missed Topeka by only a few miles. Four destructive tornadoes formed within a radius of 80 miles of Sioux City, Iowa, on September 13, 1928, and one of them, headed almost directly for the city, ended only 5 miles from the suburbs.

Science has devised no way of predicting when or where a tornado will strike or exactly what path it will travel once it starts. Weather Bureau officials recognize certain conditions that are favorable—sultry, "sticky" afternoons following mornings that are oppressive, especially in May and June, with an area of low atmospheric pressure shown on the weather map to the northwest—but the Weather Bureau makes no predictions of tornadoes. Even when conditions are apparently most favorable tornadoes may not occur at all and when they do appear there is no certainty in regard to what locality or even what State they will strike. Also, no successful effort has ever been made to warn cities of the approach of a tornado when it is traveling in their general direction. Wire service is always disrupted by such a storm and radio would be worthless on account of disablement of a sending station in the storm path. The tornado that struck Hutchinson, Kansas, May 7, 1927, had been traveling in a sweeping curve that carried it in a general direction toward that city for five hours before it finally struck. It narrowly missed one county seat and several small towns on the way and was seen by hundreds of persons, yet Hutchinson had absolutely no warning of its approach.

Personal safety when a tornado is approaching is either a matter of luck or the exercise of swift judgment. Ac-