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KANSAS TORNADOES.

By S. D. FLORA, Meteorologist.

[Dated: Weather Bureau, Topeka, Kans., Aug. 30, 1919.]

A tornado, frequently misnamed a cyclone, is the most spectacular of all storms known to inland America, and especially so in the prairie States, where the characteristic cloud can be plainly seen for miles. Its almost irresistible force is so terrifying and the damage and curious results of the enormous velocity of the whirling wind and sudden drop in pressure in the center of the vortex are so impressive that, once seen, they are never forgotten. Well-built houses explode and are carried away in small pieces, and stately shade trees that have sheltered families for generations are uprooted or have their limbs twisted off short as the whirling, writhing cloud descends from the sky and strikes them in its path, and yet perhaps a frail shanty within a few feet will escape without a board missing.

To the early settlers of Kansas, coming as they did from distant eastern States where such phenomena are almost unknown, these storms were one of the wonders of a new country to be told over and over to visitors and sent as special items of news to papers that gave them wide publicity. The result has been that the expression, "Kansas cyclone," has almost become an idiom of the language and the reputation of the State for visitations of these storms is greater than that of any other part of the country when, as a matter of fact, there is no reason to believe in the light of available data they are more numerous here, area considered, than in other States in this part of the country.

During the 33 years for which records of tornadoes in Kansas are available [1] 302 have been reported and of these only 9 per cent have occurred in the western third of the State, 41 per cent in the middle third, and 50 per cent in the eastern third. Just how far to the eastward this increase in frequency continues is a question that will require further investigation,[2] but it is interesting to see that the extreme western counties of the State enjoy comparative immunity and that it is possible western Missouri is more frequented by these storms than eastern Kansas.

Tornadoes have occurred in the State every month of the year, except January and December, but are most liable to occur in the late spring and early summer, since 50 per cent of the total number on record have been reported in May and June. Usually they come in the late afternoon, but they have been reported at practically all hours of the day.[1]

The meteorological conditions that precede a tornado are so well known that the term, "cyclone weather," has become a rather common expression in the State and refers to the oppressively warm, humid, or "sticky" weather that usually precedes them by several hours. A study of the weather maps indicates that these storms are most likely to form in the southeastern quadrant of a well-developed area of low pressure, but they have been reported in the northeastern and southwestern quadrants, so that hard and fast rules can not apply.

They may form after several hours of light wind or during a violent thunderstorm. Persons who have witnessed their formation usually report a great commotion in a threatening cloud or more commonly "two clouds came together." From this whirling mass the characteristic cloud descends until, in the case of the damaging storms, it touches the earth. Sometimes this cloud is really funnel shaped, more commonly it is described as resembling an elephant's trunk or a gigantic snake as it writhes and sways back and forth in its progress. Other observers have stated that it reminded them of a rope swinging back and forth from the clouds. Usually in case of a slender cloud the color is a milky white, except that near the ground it is dark from flying dust and débris. Clouds of larger diameter are generally of much darker shade.

It is not uncommon for two or more of these pendant clouds to be in evidence at the same time, sometimes in the formative stage, and as many as eight have been reported.[1] Often two will combine to form one of greater violence.

The noise of one of these storms as it approaches is terrific and has often been described as being "like that of a thousand railway trains crossing a trestle at the same time." It is probable the immense amount of destruction accomplished almost instantly as the whirling cloud passes over objects accounts for a great deal of this noise. Some observers have reported a peculiar humming noise like that of rapidly revolving machinery.

These storms cross the country at the rate of about 40 miles an hour, usually from the southwest, but there is no certainty about this. Occasionally one has been known to turn almost at right angles to its original course [2] and an instance has been reported where one moved back over the same path it had just traveled.[3]

[1] MONTHLY WEATHER REVIEW, December, 1915, 43: 615-617.
[2] The sparser population in western than in eastern Kansas may account in part for the difference in the numbers of tornados reported.—ED.

[1] Climatological Data, Kansas section, June, 1915.
[2] Climatological Data, Kansas section, April, 1916, and June, 1917.
[3] Climatological Data, Kansas section, June, 1919.

FIG. 1.—Tornado at Norton, Kans., June 24, 1909. (From copyrighted photograph by C. E. Reed.)

In an open country, which is characteristic of most o Kansas, a tornado cloud can be seen for miles and there is generally opportunity to take refuge when it occurs in the daytime. The most common and effective shelter is the far-famed "cyclone cellar," which is a cave near a residence, partially underground, with its top covered with soil and commonly used for dairy products and storing fruits and vegetables. Next in frequency of use for refuge is the southwest corner of the cellar or basement of a frame house. There are elements of danger in this, however, as, should the house be blown away, the cellar is likely to be partially filled with débris blown in with great violence. Instances have been reported where persons have survived by lying down in a ditch or shallow excavation, or simply on the lee side of a tree and locking the arms about it. In all these cases there is danger from flying pieces of timber or other objects with which the air is generally filled during such a storm; also a tree is likely to be uprooted if it is near the center of a storm path.

The freakish occurrences that result from these storms will tax the credulity of a person who has never seen them. Undoubtedly there is the usual tendency to exaggerate them, but after examining the wreckage a person is inclined to believe almost any story that is told. The often-recited instances of straws being blown with such violence they are left sticking in the bark and even in the wood of a tree or fence post have to be seen in order to be appreciated. Chickens are sometimes stripped of their feathers and left alive, though more often they are killed, if near enough the vortex of the cloud for that to happen. An instance has been related on creditable authority of a dresser being smashed to kindling and its mirror carried some distance and set down against a fence without being cracked; also of a window sash being blown from a railway depot, which was demolished, and laid down on an adjoining lawn with a heavy iron scale weight on it without the glass being broken. A glass jar of fruit from a shelf in this same depot was blown a considerable distance and picked up later in perfect condition. The writer has known of an instance where a well-built schoolhouse was torn into small pieces and large elm trees about it uprooted, yet a small coal shed among the trees and a short distance from the schoolhouse escaped with only one board missing. It is interesting to note that several people who had vainly tried to get into the schoolhouse for shelter from the storm had taken refuge in this coal shed and escaped uninjured. One of the remarkable features noted in reading over the accounts of these storms is the number of almost miraculous escapes. Unexplainable and almost unbelievable occurrences similar to the above that have come to the attention of the writer might be repeated at great length.

Tornado paths seem to be almost entirely independent of the topography of a country, popular opinion to the contrary notwithstanding. It is often said of a town which has never been visited by one that it owes its immunity to being in a valley, but the tornado of June 5, 1917,[1] crossed the Kansas River Valley a few miles above Topeka, mowing down trees on the steep slope of the high bluff as it descended into the south side of the valley and demolishing the little town of Elmont, which is on the lee side of a high bluff in the valley of Halfcreek.

Lightning is sometimes erroneously said never to strike twice in the same place, but this is certainly not true of a tornado. The little town of Codell, in Rooks County, Kans., in the western part of the State, was struck by a tornado on May 25 for three years in succession, each storm coming at approximately the same hour of the day.[1]

It is not at all unusual to find persons in Kansas who have been eyewitnesses of tornadoes, but photographs of the cloud are exceedingly rare. Usually one is so absorbed in watching the unusual sight or in getting to a place of safety that a camera is not thought of until it is too late. The views accompanying this article were collected by the writer in connection with an investigation of these storms in Kansas that has extended over a period of 12 years and the sources from which they have been received leave no doubt as to their authenticity.

[1] Climatological Data, Kansas section, July, 1917.

NOTE ON TORNADOES.*

In a "Note on Tornadoes," Lieut. J. Logie, aimed at showing that no convection currents are capable of producing tornadoes of the intensity claimed for some of these storms. The author computed the difference of temperature between the air in the center of the tornado and that outside. For a tornado having a pressure reduction of 50 millibars at the surface the mean temperature difference was found to be 23° A if the tornado extended to 5 km. (16,000 feet), 10° A if it extended to 10 km., and 5° A if it extended to 15 km. From the known values of the lapse rate of saturated air, it follows that under conditions of maximum instability a saturated ascending current not less than 8 km. high might produce a tornado of this intensity. Since such instability rarely occurs, and in addition ascending currents of saturated air are usually everywhere penetrated by descending masses of cooler air, even a tornado of this intensity is unlikely to be so produced in natural conditions.—*Symons's Metl. Mag., July, 1919, p. 67.*

A LOCAL STORM AT ABERDEEN PROVING GROUND, MD., JULY 6, 1919.

By OTTO NEUMER.

The hot spell of early July came to a close at Aberdeen, Md., with a thunderstorm marked by heavy rainfall, and high winds which wrecked a Handley-Page aeroplane standing on the aviation field. The maximum temperature for the 3d was 93°F.; the 4th, 94°F.; and the 5th, 94°F. The minima were successively 59°F, 66°F, 69°F., and 72°F., the last being in the night of the 5th and 6th. During the 5th and 6th of July, the surface winds were southeast, very warm and moist. At 2:15 p. m. (75th meridian time) of the 5th there was a west wind at an altitude of 3,000 meters. On Sunday morning, the 6th, the surface wind was southeast, but veered rapidly with altitude until at 1,700 meters it was coming from the west. These west winds aloft were probably potentially colder than those at the surface, and in passing over the warm southerly winds formed a decided temperature gradient.

Cumulus clouds developed on the morning of the 6th, and early in the afternoon covered about half the sky. The sun became obscured at 2:25. At 3:30 p. m. the wind suddenly veered from south to west, backing to southwest at 4:40 p. m. and rising from 8.5 to 30 miles per hour. At the same time the sky became overcast with heavy stratus clouds. Rain began falling at 4:43, the temperature suddenly dropped from 82°F. to 65°F., and

[1] Climatological Data, Kansas section, July, 1919.
* Roy. Meterological Soc., June 18, 1919.

[To face p. 448.]

FIG. 2.—Tornado cloud at Solomon, Kans.

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FIG. 3.—Tornado cloud at Minneapolis, Kans., 1900. (Camera pointing to northeast.)

FIG. 4.—Tornado cloud at Ellis, Kans., June, 1915. (The color of the cloud as printed is deceptive. The original photograph shows it was quite dark.)

FIG. 5.—Tornado cloud at Mullinville, Kans., June 11, 1915.

FIG. 6.—Tornado cloud at Hoyt, Kans., April 19, 1916.

FIG. 7.—Tornado cloud at Lebanon, Kans., Oct. 9, 1913. (Photographed by Earl V. Bower.)

FIG. 8.—Tornado cloud at Lebanon, Kans., Oct. 9, 1913. (Photographed by Earl V. Bower.)

[To face p. 448.]

FIG. 9.—Tornado cloud at Lebanon, Kans., Oct. 9, 1913. (Photographed by Earl V. Bower.)