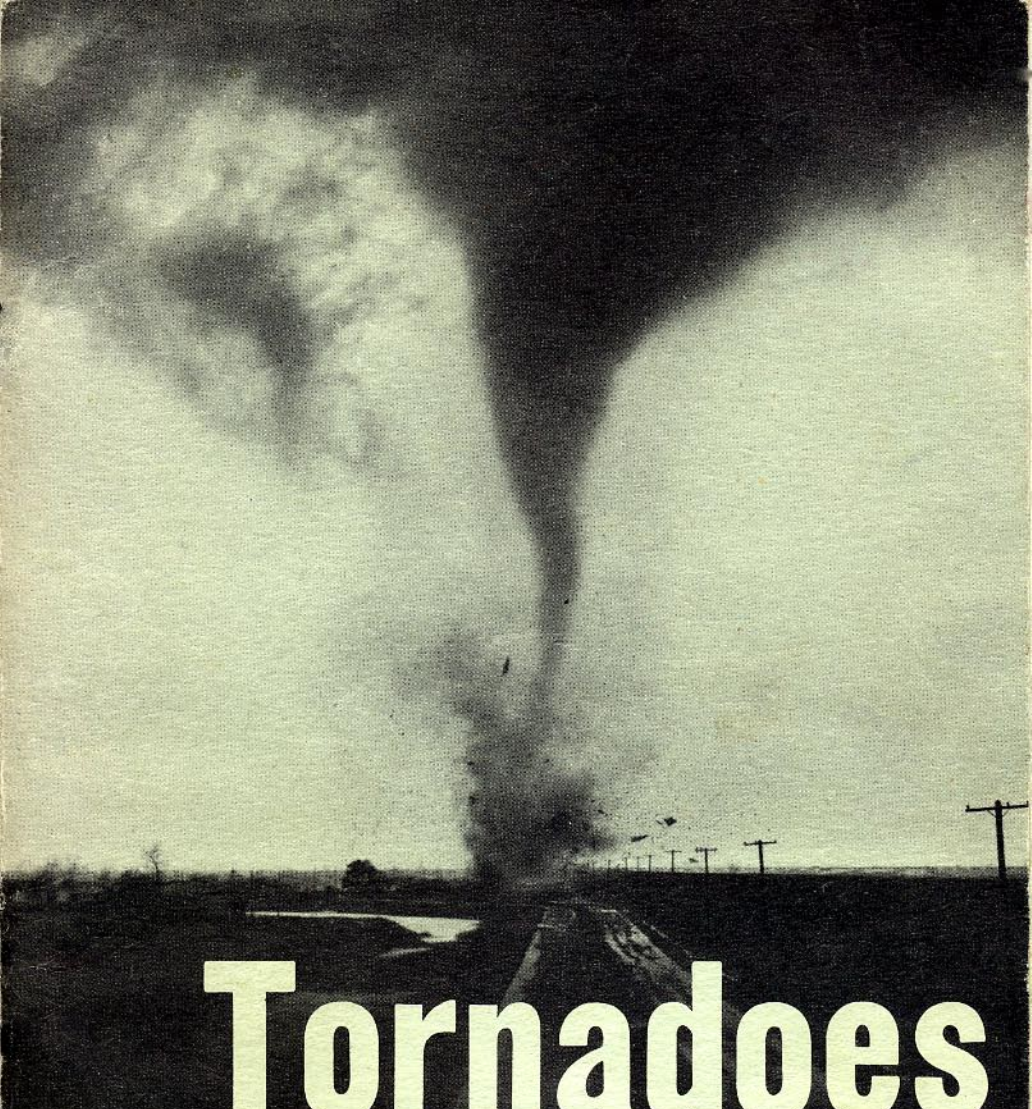

# Tornadoes

## and what to do about them

**PRICE**
**$1.50**

BY CECIL CARRIER
AND ROBERT G. BEEBE

ROBERT G. BEEBE, *instructor in meteorology,* University of Chicago two years.

*Forecaster,* U. S. W. B. and Panagra for 5 years.

*Research meteorologist,* U. S. W. B., 10 years, the last five of which was spent in tornado research.

*Meteorological consultant,* Midwest Weather Service.

Scientific journals have published about 25 technical papers.

CECIL C. CARRIER

*Education:*

Kansas State Teachers College, Pittsburg, Kans.; Indiana Central College, Indianapolis, Ind.; Wichita University, Wichita.

Majored in Mathematics and Physics.

Specialized meteorological training in Service.

Weather Officer in Air Force Weather Service.

18 years in Weather Business, 8½ years with Weather Bureau in Wichita, Kansas.

Recently received Seal of Approval from American Meteorological Society for Television weather shows.

# TORNADOES

## AND

## WHAT TO DO

## ABOUT THEM

*By Cecil Carrier*

*and*

*Robert G. Beebe*

**ACKNOWLEDGEMENTS**

We would like to express our gratitude to the U. S. Weather Bureau and to the late Snoden "Frosty Flora," author of "Tornado of the U. S." and, to all those who have worked toward making this booklet possible.

CECIL C. CARRIER

Cartoons by
BILL MILLER

Published by
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*Debris flies as this tornado strikes near Dallas, Tex., Apr. 2, 1957.*
PHOTO BY BILL BURKETT, DALLAS, TEXAS

# TORNADOES

## AND WHAT TO DO ABOUT THEM

The tornado is nature's most violent and destructive storm. Its spiraling winds of terrific velocity and explosive pressure reduction in the funnel itself, combine to cause almost unbelievable destruction. Despite its destructive nature a tornado covers a relatively small area.

The distinguishing characteristic of a tornado is the funnel-shaped cloud that is usually observed. Actually, tornadoes come in assorted sizes and shapes with some being only a few feet in diameter whereas, others have been described as a huge mass of turbulent dust and cloud of as much as a half mile across.

The destruction from a tornado is two-fold. The most important factor is the explosive effect of air pressure

*Tornado near Dawson, North Dakota – August 2, 1940. This was a tornado that, instead of having a funnel-shaped cloud, more nearly resembled a long rope. It killed two persons, injured twelve others, and wrecked seven homes and three public buildings in Dawson, North Dakota.* PHOTO BY F. J. BAUENDICK

*Tornado near Claremore, Oklahoma, April 27, 1942. This was the tornado which struck Pryor, Oklahoma, killing 52 persons, and caused a property loss of $2,000,000.* PHOTO BY MERLE BENNETT

within buildings. As a tornado passes over a building the normal air pressure is suddenly reduced. In doing so, the pressure between the inside and outside of the building explodes buildings outward, or at least roofs, windows, doors or sides of buildings, are blown or sucked outward. Larger buildings such as gymnasiums, auditoriums, supermarkets, etc., with broad roofs, are usually more susceptible to damage.

The exact amount of the pressure reduction from a tornado passing over a building is not known. However, there is one case on record where the pressure reduction amounted to nearly 2.5 inches of mercury and, this is about 8% of the atmosphere over most of Kansas. Put another way, this pressure reduction amounts to a difference of about 1 pound for every square inch of roof and wall in a building. Thus, the larger the building, the greater the total air pressure to blow it apart if a tornado passes over it.

The second damaging effect of tornadoes is the very strong wind in the funnel itself. Actually, the tornado wind speed has never been measured, but estimates by

*Ramona, Kansas — August 25, 1941 — one of two tornadoes that struck almost simultaneously, only two miles apart. They struck in open country, with damage amounting to only $70,000.*

PICTURE BY MRS. OMAR SHIELDS

tornado researchers range from 150 to 250 miles per hour. These are based upon engineering techniques plus studies of movies of tornadoes in action. Thus, while this is a strong wind, the wind alone cannot explain almost total destruction observed to accompany most tornadoes. So as a tornado approaches a house, the wind becomes very strong but, as the low pressure vortex gets close, the building may be destroyed by the explosive action, or at least structurally damaged. Then, as the circular winds return, the weakened structure suffers even more damage and parts of the building go flying off as debris.

Tornadoes may take many shapes and sizes. In a few cases at least, a funnel as such, was not visible as the tornado approached. Instead, it has been described as a gigantic roll or whirl of dust and cloud on the ground. Other tornadoes have assumed the typical funnel shape and some have been described as rope-like in appearance. It is important to remember that the visible part of the funnel does not have to reach the ground in order to cause damage. When this happens, the pressure within the funnel is simply not low enough to cause condensation all the way to the ground. (Or, the tornado may not have been going long enough to pick up enough dust for the entire funnel to reach the ground) for the visible funnel is composed of dust, and or condensed moisture or cloud. Funnels aloft, that are not reaching the ground, may or may not cause damage at the ground.

Sometimes tornadoes occur in groups with several occurring at the same time and from the same cloud. When this happens, there is often one large tornado with smaller ones developing suddenly near the larger one. Also, these smaller tornadoes seem to form and dissipate more quickly than the main tornado. So, if you see one tornado, be on the lookout for others nearby. Recent research has shown that the heaviest rain and largest hail usually occur just to the north of a tornado or the left of the track that it is following.

Some recent research has shown that at least some tornadoes follow a definite life cycle. The first indications are simply very black turbulent clouds with one part of the cloud seeming to approach the ground, but with no definite funnel apparent. At this time, it may cause a dust whirl at the ground, evidence of rotary motion from the cloud to the ground, although the funnel may not appear visibly to be reaching the ground. At this stage, the tornado may make several skips, with only minor and spotty damage. Later as the tornado increases in size, the funnel becomes visible all the way to the ground and, damage is continuous and extensive. Then, as the tornado becomes shaped more like a column, it is at the height of its intensity and there is no skipping or jumping — damage is extensive and continuous.

As the tornado approaches the end of its life cycle, it becomes more rope-like, or it is a very long, extremely narrow vortex and approaches the ground from an angle rather than the vortex being perpendicular to the ground. During this stage the tornado is still dangerous because the funnel may make rapid and erratic movements, and cover distances up to a half mile in seconds. Also, although the area of destructive winds is small at this point, it is still powerful enough to cause appreciable damage. It may well be that not all tornadoes follow this complete life cycle, but this has been true of those tornadoes in recent years where there were lots of photos or witnesses who were interviewed in detail.

Statistics on tornadoes probably have less meaning than is the case of any other meteorological phenomena. The average path length is sometimes given as from 10 to 40 miles but this is an average of many tornadoes with only a touchdown at one point whereas other paths have been over 300 miles. However, the path length most often reported is around 2 miles. The path width of destruction is often quoted as averaging 300 to 400 yards but, again, the extremes vary from only a few feet to swaths over a mile in width. The historical records on path length and width are somewhat unreliable for some observers consider a path length to be continuous when several tornadoes are observed, whereas other reporters consider the path length of each individual tornado. The path width, again, depends a lot upon the observer because some consider only the width of extreme destruction while others report the path width of scattered debris. Only seven tornadoes with paths of 200 miles or more have been reported in the nation since 1916. The longest reported was the Mattoon-Charleston, Ill., tornado of May 26, 1917, which traveled a distance of 293 miles. In Kansas records there have been 5 tornadoes that have traveled 100 miles or more.

Speed of forward movement of tornadoes also shows very large variations, with the average around 25 to 40 miles per hour. However, tornadoes have been known to stop, reverse direction or move forward as fast as 139 miles per hour.

The direction of movement is usually from the southwest, because that is the prevailing wind speed in the lower layers of the atmosphere during times of tornadoes. However, they have been known to move from any direction.

Many persons believe that tornadoes tend to follow, or avoid, riverbeds, hills, valleys, or other terrain effects. Actually, the statistics show the tornadoes pay no attention to either natural or man-made obstacles.

During the recent years, since the Weather Bureau and Air Force have been forecasting tornadoes, the records show that the number of reported tornadoes has increased several times. For example, from 1916 through 1950, there was an average of 149 tornadoes reported per year. Even in the earlier years, 1878-1887, there was an average of 146 reported per year. However, since 1953, the number of reported tornadoes is upwards of 500 each year, with over 800 being reported in 1955 and 1956. Thus, many persons believe that the number of tornadoes is really increasing. Statistical studies show that this is not really the case. Instead, most tornado researchers are convinced that it is a consequence of more reports — not more tornadoes.

For example, before tornadoes were forecast, people were not so conscious of them and those that occurred

*Blocks leveled, but a new building standing. As a study of utter destruction, this is the area where the "beast" proved superior to everything in its path.* PHOTO BY ROBERT ILLES, DALLAS, TEXAS

out in the open, or did little damage were not reported. Remember, very few tornadoes are actually seen by weather observers. Thus, the statistics compiled by the Weather Bureau are largely based upon those reports that actually get to the weather offices. Also, some of the bad tornadoes of recent years probably would not have been reported 20 years ago. For example, the tornado that did so much damage in Ruskin Heights on May 20, 1957 caused most of its destruction in an area that was farm land a few years ago. So, again, there are not more tornadoes, but instead, more tornadoes are being reported.

## WHERE

In all the world there is no place that is more favorable for tornado formation, per square mile, than central Kansas. Actually, tornadoes have been reported in other parts of the world — in Europe, Asia, Australia, and South America. Even so, for every tornado reported outside the United States during a year's time, there are at least a hundred in our own country. Tornadoes have been reported in every state except Hawaii but, again, they most often occur in the midwest and are least frequently observed west of the Continental Divide.

## WHEN

Tornadoes almost always occur with thunderstorms so the time of year when tornadoes are most likely coincides with those times when severe thunderstorms also are most likely. Thus, the areas of maximum tornado frequency change from the south and southeast during late winter and advance northwestward to Kansas by June and into the Dakotas by July and August. Then, as fall approaches, the area of maximum tornado occurrences retreats southward. But in Kansas where tornadoes occur most frequently, the peak season is from May through June. However, it is important to remember that they can occur during any month of the year. The time of day when tornadoes are mostly likely in Kansas is from 2 o'clock in the afternoon until midnight. Actually, tornadoes have occurred at all hours but are very rare between midnight and 2 o'clock in the afternoon. The reason for this is that tornadoes are believed to be caused by the

*Aerial view of Udall, Kansas, after the tornado of May 25, 1955.*
PHOTO BY JACK GATY, BEECH AIRCRAFT CORPORATION

*Somebody's dog and somebody's home near Udall, Kansas.*
PHOTO COURTESY KTVH NEWS

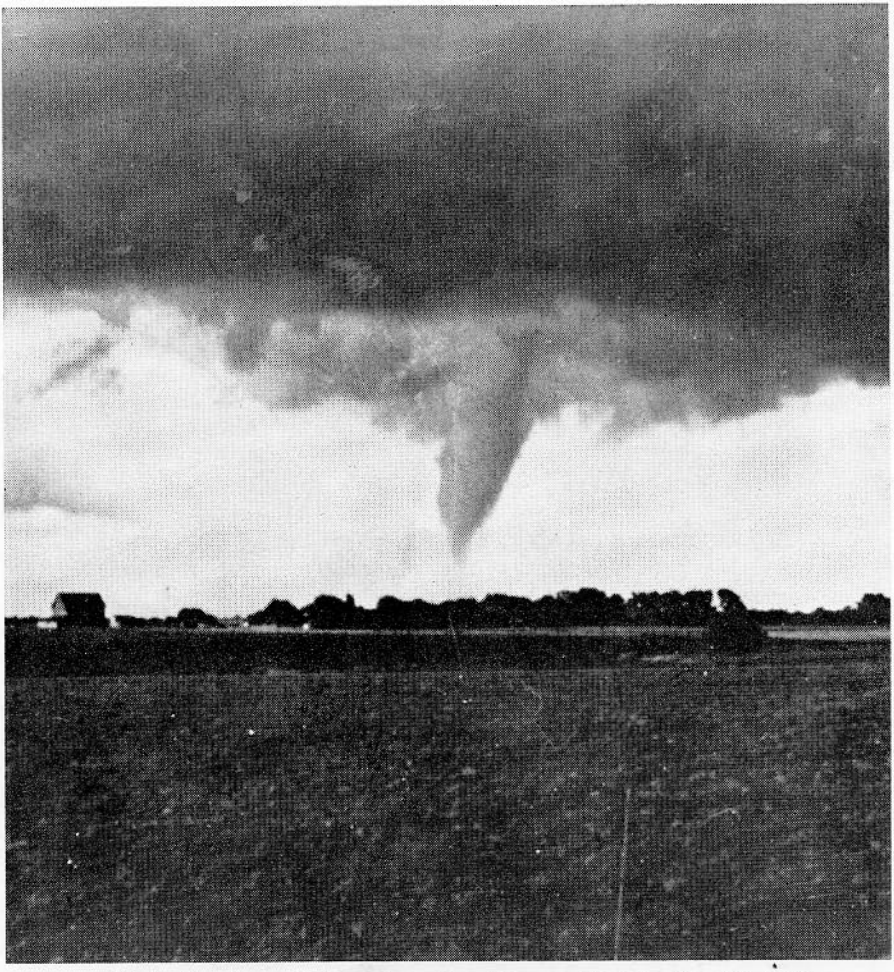
unstable atmosphere that causes severe thunderstorms.

One of the important factors in the formation of severe thunderstorms is the heating of the air next to the ground during the afternoon by the sun. Thus, when the sun has exerted its maximum influence on the afternoon temperature, thunderstorms form more easily. On the other hand, at night, the temperature usually drops so this tends to make the atmosphere more stable, especially after midnight, so that thunderstorms do not form as easily.

So, in summary, tornadoes in Kansas can form during any month and any hour, but are most frequent in the months of May through June and between 2 o'clock in the afternoon and midnight.

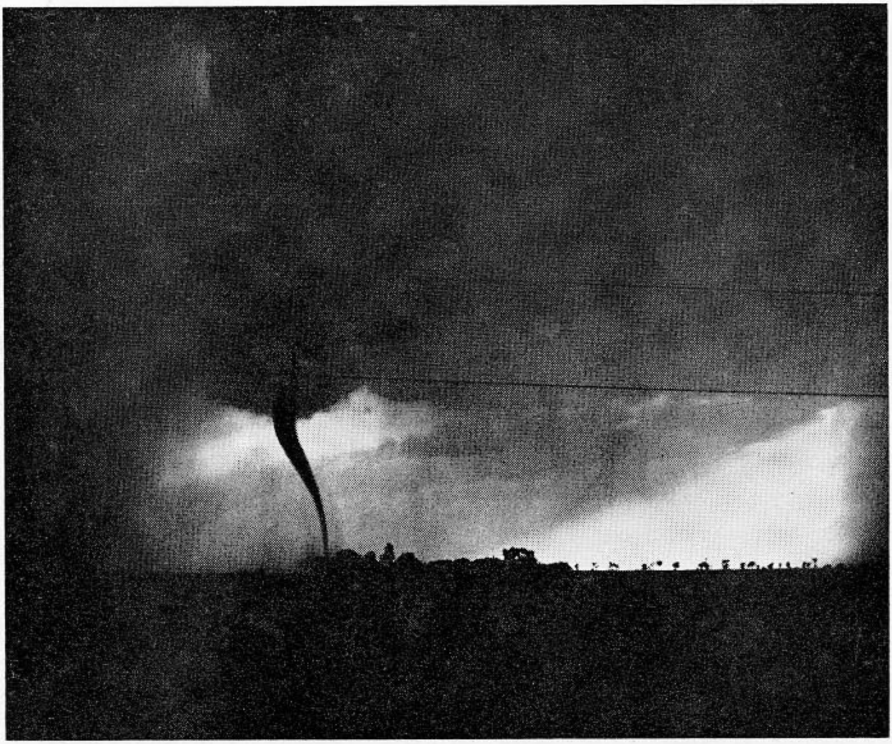
## WHAT CAUSES TORNADOES?

There are a number of factors which combine to cause tornadoes, but the relative role played by each is not well known to meteorologists today. If this were not the case, tornado forecasts could be far more precise in both time and space than is true today. One of the important factors associated with the formation of tornadoes is warm, moist air near the ground and it is this humid air that gives the tornado its life blood. Kansas residents are well aware



*Dissipating tornado funnel north of Lyons, Kansas, May 26, 1959. This is a pictorial example of why it is so hard to write a set of rules for identification and protection from tornadoes. This picture is the last one of four separate funnels to come out of the Mother Cloud; it stayed on the ground for about 1½ miles. There was no thunder, no lightning, no large line of severe thunderstorms, in fact, very little that would be normally classed as "tornado conditions." The one cloud was the only one in the sky, of any consequence, at the time. Mrs. Hoyt watched it spawn the four separate tornado funnels. Observers could see through the funnel, and could see debris whirling inside. Fortunately, all four funnels hit in open country and very little damage occurred. The funnels traveled a line from approximately 2½ miles northwest of Lyons, Kansas, to about five miles north of Lyons.* PHOTO BY BERT HOYT, LYONS, KANSAS that "tornado weather" is usually characterized as a sticky, sultry day, with southerly winds that are sometimes quite strong. Usually, before tornadoes occur, this warm humid air near the ground is only some 3,000 to 5,000 feet in depth and is capped by warmer, dry air above. Thus, there are really 2 layers of air, moving from different directions, of contrasting temperature and humidity. To the meteorologist this is recognized as a normally stable situation in which nothing but a few small clouds can occur. So, in order for clouds to break through this stable condition and form thunderstorms and tornadoes, it means that something rather unusual must be present to trigger the thunderstorms.

It is this triggering mechanism that is least understood by meteorologists, but it is believed that there are a number of them, sometimes acting alone and at other times in combination. One of the triggering mechanisms is the simple cold front where cold, or cool, air replaces warm air. This cold air simply lifts the warm air above it and, in doing so, forces the warm, humid air upward so that thunderstorms develop very rapidly. Another triggering



*This tornado picture was taken about seven miles northwest of Bassett, Kansas, 7:30 pm, June 15, 1959. It traveled about ten miles on the ground in open country and killed nineteen head of cattle.* PHOTO BY EARL EASTMAN, WICHITA, KANSAS

mechanism can be a combination of strong low level winds and the higher jet stream. There are, of course, other atmospheric processes which can be dominant, or at least helpful, as a triggering mechanism. In any case when the trigger mechanism acts, it tends to cause very rapid development of thunderstorms which can be severe enough to cause tornadoes.

However, since the cause of tornadoes today is not completely understood, tornado forecasts cannot now pinpoint the exact time and place of development. Instead, tornado forecasts are of relatively large areas wherein it is stated that tornadoes are possible, somewhere within a large area and over a several hour period.

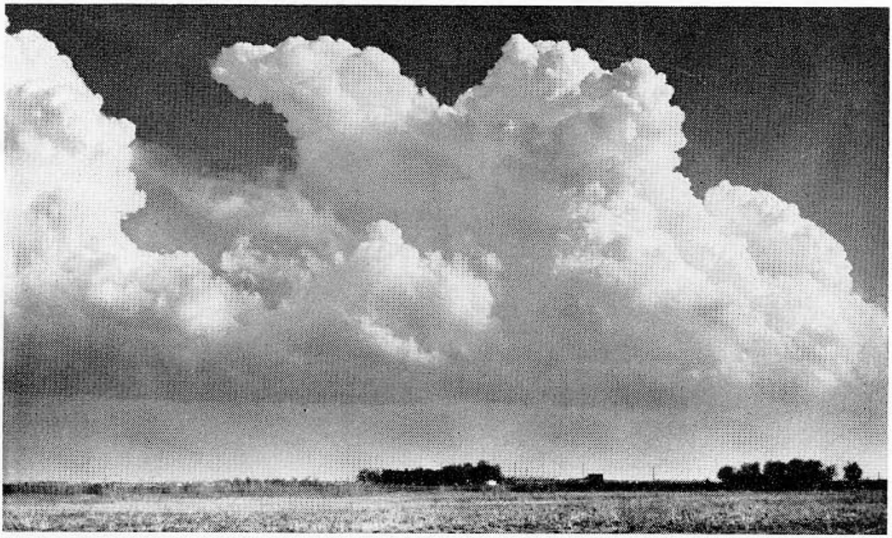
*The remains of a car and a tree after the Udall tornado.*
PHOTO COURTESY KTVH NEWS

*Destruction left by tornado that hit El Dorado, Kansas, on June 10, 1958.* PHOTO BY CHUCK DREILING, KTVH NEWS

## TORNADO FORECASTING HISTORY

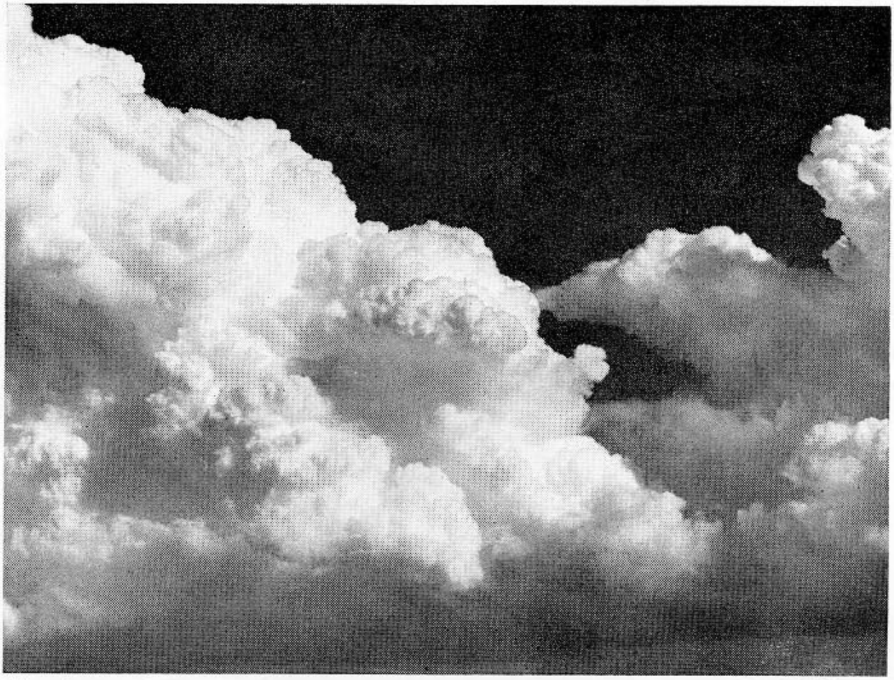
Attempts to forecast the development of tornadoes was first tried back in the 1880's by members of the U. S. Army Signal Service. Many detailed and extensive surveys were made of tornado occurrences and these related to the crude weather maps that were available in those days. Actually, the data that was compiled then is among the most complete available even today, since even complete books were written on a single tornado, and the details related to damage, movement, descriptions, and weather phenomenon associated with each tornado were considerable. Unfortunately, there seem to be no records of forecasts issued or of the methods used. After the Weather Bureau took over the National Weather Service, the station regulations in 1905 stated that forecasts of tornadoes are prohibited and this policy remained in effect until about 1938. How-

## TORNADO FORMS EAST OF WICHITA, KANSAS



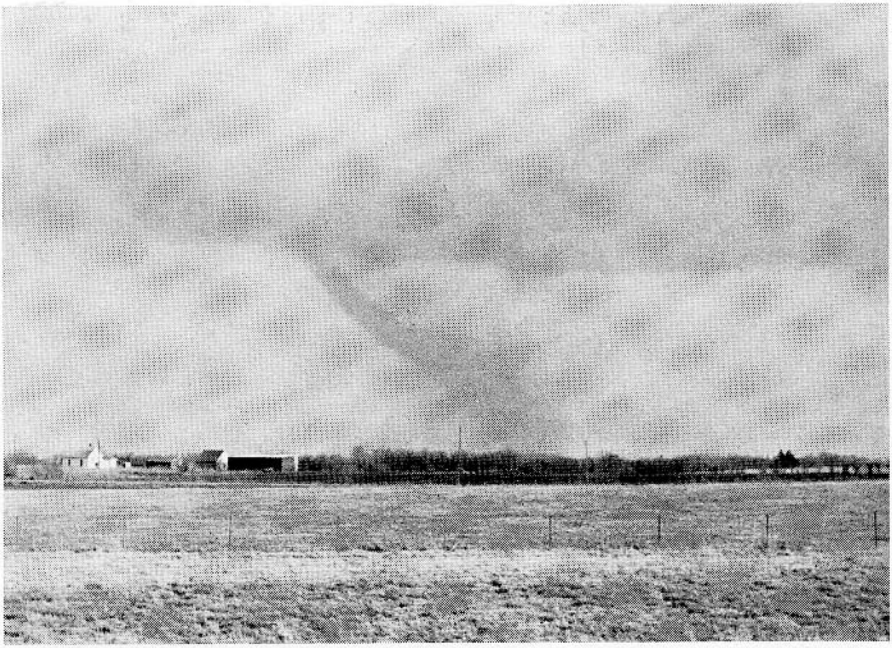
FAIR skies to TORNADO IN 45 MINUTES. Clouds started forming about 25 minutes before this picture was taken — **4:40 pm**

PHOTO BY HERB CLAGG, KTVH NEWS



15 minutes later clouds were continuing to develop rapidly — **4:50 pm**

PHOTO BY HERB CLAGG, KTVH NEWS



**5:00 pm** Tornado forming to ground —
PHOTO BY OSCAR F. BECKER, KANSAS TURNPIKE PATROL

**5:05 pm** Tornado in peak of its fury —
PHOTO BY JERRY WOHLER, KANSAS HIGHWAY PATROL

Tornado dissipated back into clouds just a few minutes after this picture was taken — **5:08 pm**

PHOTO BY JERRY WOHLER

It was only about 45 minutes from the time the clouds began to develop into a full active squall line, just to the East of Wichita on April 16, 1960, until this tornado had formed, hit and dissipated.

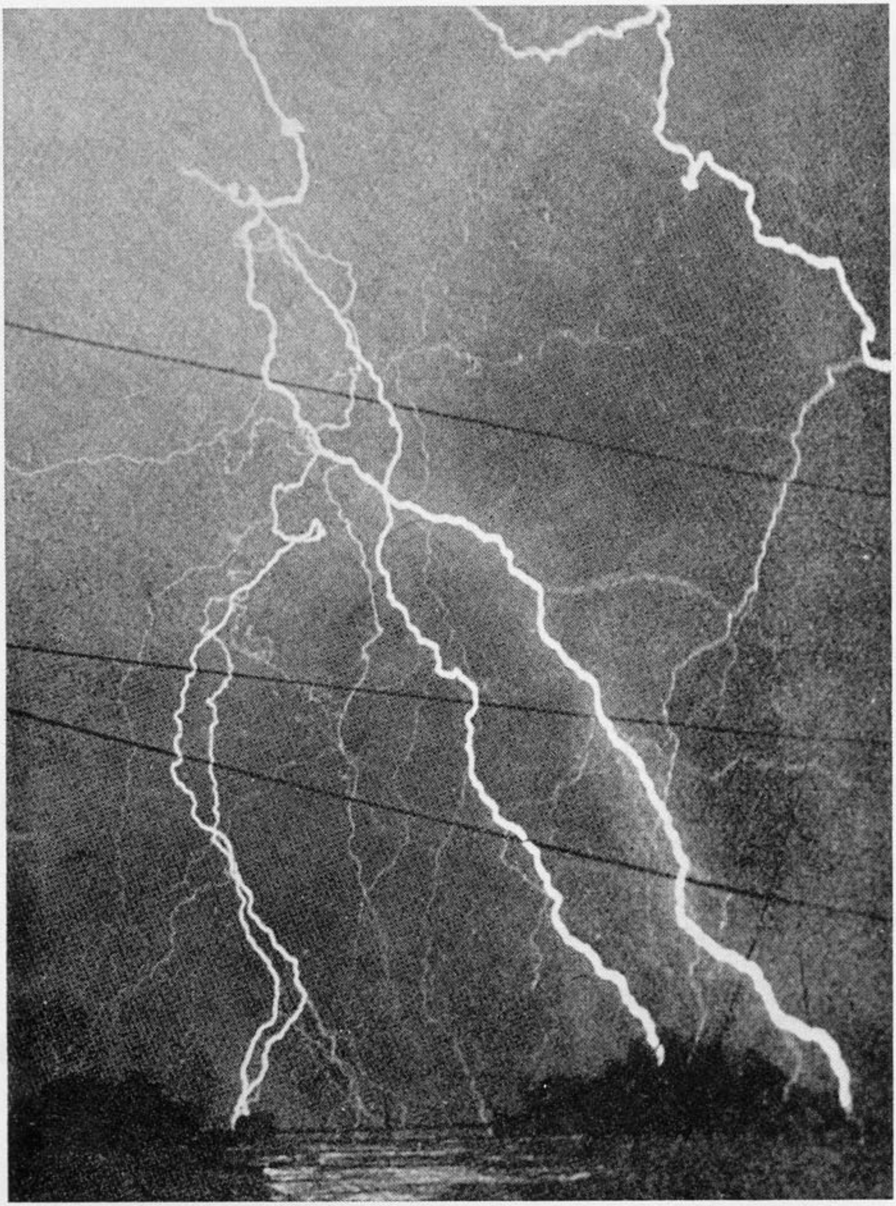
ever, because of the limited knowledge of the cause of tornadoes, very few, if any were issued.

Beginning in the 1920's, the surface weather observations were augmented by a few kite and airplane observations of pressure, temperature, and humidity at levels above the ground. Thus, observations in 3 dimensions afforded meteorologists an opportunity to study, at least on a limited scope, the air mass in which tornadoes form. From these observations in the 1920's, it was learned that the atmosphere was stratified in the lower layers before tornadoes formed, with a layer of warm, dry air just above a ground layer of very humid air. However, progress was slow because of the great distance between observations.

In the 1930's the radiosonde was developed. This is an instrument that not only can measure temperature, humidity, and pressure, but it is sent aloft on a balloon, reaches as high as 20 miles above the ground and sends back radio signals of the measurements. This instrument was later improved so that wind direction and speed could be obtained. As experience was gained in using these radiosondes, more stations were installed throughout the United States, indeed over most of the world.

In 1948, 2 tornadoes within a week struck Tinker Air Force Base near Oklahoma City. Two Air Force meterologists, E. J. Fawbush and R. C. Miller, who were very much interested in the tornado forecasting problem, did some further research and came up with some tornado forecasting rules. They initiated a program of tornado forecasting for the Air Force and a similar program was adopted by the Weather Bureau in 1952. The SELS Center (Severe Local Storms Center) was moved to Kansas City in 1954 and this group is now largely responsible for tornado and severe thunderstorm forecasts for the entire United States.

*Fort Riley, Kansas – May 15, 1943. Taken near Camp Funston, camera pointed toward the northwest. This vortex cloud struck the C.R.T.C. five to ten minutes after the first vortex cloud passed over and caused the great destruction at the same place.*
PHOTO BY SGT. A. E. TINKER, MANHATTAN, KANSAS



*Lightning such as this gives the visible evidence of electrical potential in thunderstorms that leads to the research on sferics to spot severe weather.*

## TORNADO FORECASTS

When a forecast of tornadoes is issued for an area it means that tornadoes are possible somewhere in this large area during a period of time, usually about 6 hours. This does not mean that tornadoes are probable — ONLY THAT THEY ARE POSSIBLE. The areas are usually quite large, being about 150 miles wide and 200 miles long. The usual specific description of a tornado forecast area goes something like this ". . . . one or two tornadoes are possible from 2 o'clock this afternoon until 8 o'clock this evening along and 60 miles either side of a line from 30 miles southwest of Topeka to 40 miles south of Dodge City."

This description of the tornado forecast area is often confusing to the listener who immediately wonders where he is relative to the forecast. Since tornadoes pay no attention to political or geographical boundaries such as state lines, county lines, etc., it is difficult for the forecaster to lay out his prediction along more readily understood boundaries. Actually, after the forecast is issued from Kansas City, the Weather Bureau office with a responsibility to given counties often reissues the forecast in terms of counties to be affected. However, in most cases, it gets to the public as issued from Kansas City.

A forecast of tornadoes is based upon the assumption that unusually severe thunderstorms are expected and usually these thunderstorms are expected to be along a line known to the meteorologist as a squall line. Squall lines usually move to the East so the tornado forecast area, known as a +box+ to the forecaster, is longest along a west-east axis. Also, low pressure centers that are often associated with tornado outbreaks usually move to the northeast. This is why most of the lines given in the tornado forecast are orientated in this way. Also, the forecaster expects the severe weather to begin in the western part of the area given and move to the East or Northeast. This is why the "All-Clear" is sometimes given to the western part of a tornado forecast area before the eastern part. However, tornadoes have formed to the west of a squall line, or to the east of it. Because of this uncertainty, the entire area is usually left alone until the forecast has expired or thunderstorm activity no longer exists.

The verification of tornado forecast areas by the SELS Center in Kansas City over past years shows that, of all those issued, tornadoes actually occurred in about one third of these. Also, many tornadoes have occurred that were not forecast. However, it is important to remember that most of the really damaging tornadoes in recent years have been in tornado forecast areas. This means that the chance of an important tornado occurring that is not forecast is small. At the same time, it must be realized that most localities in a tornado forecast area will never have one. Thus, the tornado forecast should be looked upon as kind of advisory to the public to be on the lookout themselves, or to keep radios or TV sets on for further advisories.

When a tornado has actually been reported, the Weather Bureau may issue a "tornado warning" and this is quite different from a forecast. The warning means that a tornado has been sighted whereas a forecast means only that tornadoes are possible. In the case of a warning, the location, intensity, and direction of movement are often given, but there are relatively few warnings as compared with forecasts.

## WHAT TO WATCH FOR

There are a number of things that one should keep in mind in connection with tornado forecasts. First of all, being within a tornado forecast area need be of no particular concern, at least from a statistical viewpoint, because more people are killed by automobiles each year than over the last 40 years by tornadoes. Or, put another way, an individual takes more chances with his life by getting into his car for a little drive over the week-end than by ignoring all tornado forecasts during a given year.

However, it is not our purpose here to depreciate the importance of tornado forecasts, instead, the objective is to put them in their proper perspective. Remember that tornadoes are almost always associated with thunderstorms so that unless you hear thunder or see lightning, there is little danger of a tornado. Also, tornadoes of any appreciable size seem to make a distinctive roar that can be heard some distance away. For this reason, many tornado researchers feel that, if one is especially attentive, it is safe to wait until the roar is heard before seeking shelter. However, the danger here is that there definitely isn't much time, so that prompt action is necessary.

Many times, tornadoes are forecast on the basis of a trigger action developing which never does. In such cases skies remain nearly clear so, again, until clouds are heavy and thunderstorms are occurring, the danger of a tornado in your area is small indeed. The important thing for individuals to remember is that it is not yet possible to predict the beginning of individual tornadoes. Thus, the significance of tornado forecasts, is, in part at least, to alert persons in these areas that tornadoes are possible and to be on the alert for storm clouds. In one sense, the individual is on his own to be on the alert.

Many people have in recent years made the statement that there is no longer any reason for being concerned about a tornado because, with the warnings that are issued you would have a 15-minute notice of a tornado approaching. Nothing could be any further from the truth. All the work being done on the forecasts, observer networks, and warning systems is being done in the hope that some warning *might* be given to the public. Some people have used this as a false sense of security. Neither the Weather Bureau nor any public disseminating concern can guarantee you will be warned of a tornado heading your way. That is still basically your own responsibility. Here is why, with the forecasts of tornado possibility, being as yet, far from pin-point accuracy and with the length of time the tornado funnel is active (most often quoted about 2 miles and a few

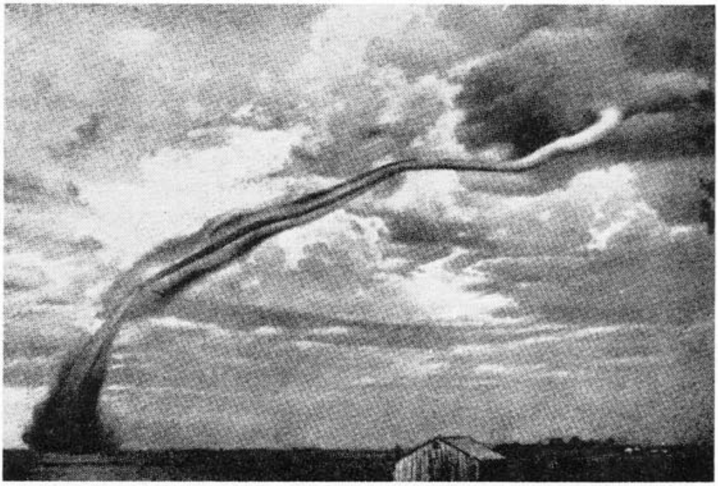
minutes), you can see the chance of giving a sufficient warning to any particular spot is very, very remote. This is why, in my opinion, in some cases the hysteria created by misuse and overemphasizing forecasts, warnings, and information could be worse than ignoring them.

## OBSERVER NETWORKS

Many cities, especially with a Weather Bureau, set up observer networks before the tornado season begins. These observers are given some training as to what a tornado really looks like and are located around the city, sometimes many miles away. It becomes their responsibility to call the Weather Bureau, or other designated officials, with reports of actual tornadoes. When they do sight a tornado, this information is immediately sent to radio and TV stations, and usually a tornado warning is sounded. This plan is one of the best in alerting cities to the danger of a tornado but, even here, there are many problems. Often, the tornado may touch down only for a few seconds or minutes and be gone. Or, a tornado may form between observers especially since there is often heavy rain in the vicinity of tornadoes. Also, in recent years during a tornado forecast period, many persons see cloud formations that appear to them like funnels so they call the Weather Bureau or radio or TV stations with the report. This is especially true after a city has had a devastating tornado and people become unusually conscious of tornadoes. So, again, during a tornado forecast or warning period, individuals are on their own to a large extent.

We have found a lot of the fear of tornadoes has come from not knowing what they are, what they look like, where and how they might occur, and how to provide protection from them. We hope, we have done a little in this booklet to help that situation.

As you know the best protection from storms is a well-built and maintained storm shelter. A tornado shelter should be large enough and comfortable enough so your family could spend several hours in it if necessary. The ideal would be one large enough for a family room, den, library or similar room so that when concern over the weather develops life can go on almost as usual. A shelter built solely as a refuge in a last minute emergency would certainly protect you from the tornado but the anxiety of when to get into it would be a constant concern.



*This classical photograph of a tornado was taken by Miss Lucille Handberg near Jasper, Minnesota. From "THE ELEMENTS RAGE," by Frank W. Lane.*

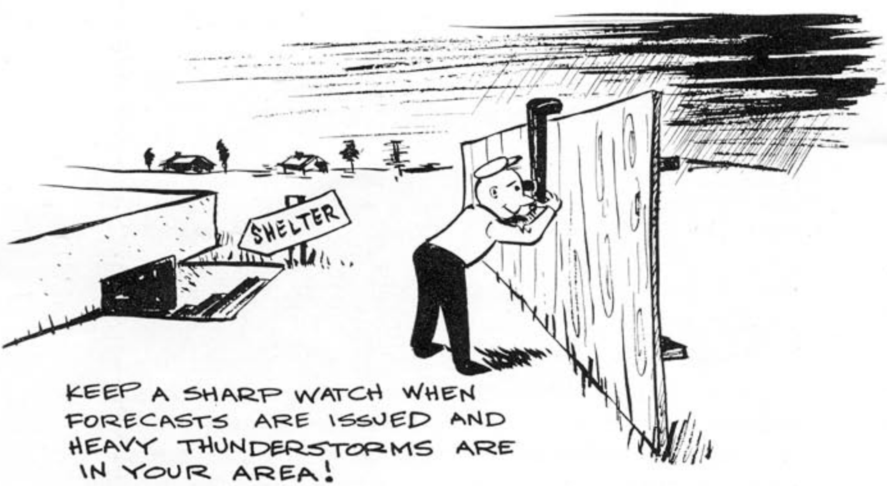
## TORNADO WARNING DEVICES

Because many persons have a fear of tornadoes, it is easy to sell almost any kind of a gadget that supposedly will give some kind of a warning that a tornado is approaching. Unfortunately, there is no known instrument today that is at all dependable. One device that has been widely sold in recent years is based upon the pressure reaching a certain low value and then it sounds like an alarm or buzzer. This device is basically an aneroid barometer with a switch to turn on a buzzer when the pressure reaches the pre-set value. In this case, the gadget must be near the center of the tornado vortex itself before the buzzer will sound. In other words, the buzzer will sound, but only after the tornado has reached its full destructive force. Therefore, it is not an alarm or warning in any sense.

Other instruments have been sold on the basis of sferics, or atmospheric static reaching a given high value. This is really a small radio with a device to count the frequency of static. But again, this is not an alarm because many tornadoes occur without the amount of static required to set off this alarm while the given amount of static often occurs without tornadoes. So, again, this gadget is worthless as a tornado alarm.

## RADAR

During the past few years, radars have been installed at many weather stations and by radio and TV stations throughout the Midwest. Following each installation, there is usually quite a lot of publicity as to how these instruments will aid in forecasting severe weather and tornadoes. While radar is one of the most useful observational instruments used in weather observing today, it cannot see a tornado. Actually, the observations, or echoes,



that show up on a radar scope are simply reflections of objects in the air such as raindrops or hailstones. There are no known cases wherein radar has picked up debris, although this certainly seems possible.

The big advantage of radar is that it can exactly locate rain and hail areas, and subsequent observations show the speed and path of movement. Also, the intensity of the rain or hail can be determined from the radar scope, by an experienced operator. Much research has been carried out regarding the identification of tornadoes and hail by radar. Indeed, there are a few cases on record of a "hook" in connection with a tornado but it must be remembered that over the years of radar observations and tornado occurrences, that many, many tornadoes have occurred without the "hooked echo" and there have been many hooks without tornadoes. Thus it is clear that radar itself cannot now see tornadoes. Even so, most tornado researchers believe that the more intense the thunderstorm, the more likely it is to cause a tornado, and radar is an excellent tool for determining the intensity of the thunderstorm. So, while radar is a wonderful tool in the observing and predicting of severe storms, in itself it cannot either see or predict tornado formation or occurrence.

## SFERICS

During recent years, there has been considerable research on the electrical characteristics of thunderstorms that cause hail, tornadoes and damaging winds. It has been found that, in many cases, the more severe storms and tornadoes have had an unusual amount of lightning associated with them. Also, means have been developed to count the frequency of these electrical discharges which most of you know as static on your radio. Actually, the eye does not see the many discharges that take place in a single lightning stroke. This determination of the frequency of the electrical discharges and the direction from which they come is known as sferics.

It has been found that this research has been encouraging but much further work remains to be done before it can be classed as a useful tool in tornado forecasting or even in the determination of a tornado that has already formed. The problem is that many tornadoes occur without high sferics counts and many high sferics counts are not associated with tornadoes. Recent work wherein the sferics data are combined with radar reports show some encouragement, but today sferics is still in the experimental stage.

## RESEARCH

Tornado research has increased many times during the past decade. This work is being carried on by the Weather Bureau, the Air Force, the Navy plus many other governmental agencies, a number of universities and by private weather services, usually under government contracts. In 1956 the Weather Bureau initiated a project called the Tornado Research Airplane Project. The objective of this was to send an instrumented airplane into areas where tornadoes were forecast, and well before they were expected to develop, to measure pressure, humidity, temperature and the characteristics of the electrical field.

This was, of course, a relatively small project and some very interesting results were found. Consequently, this project has now expanded with help from a number of governmental agencies who are concerned with this problem and during the 1960 tornado season, at least 4 instrumentated airplanes will be flying tornado forecast areas to compile data for research. Since so much data are being gathered, it is expected that considerable time will be required for the analysis of the data so that sensational results are unlikely for the immediate future. Even so, this project holds a lot of promise for increasing the meteorologist's understanding of how tornadoes form.

There are many other projects now being carried on relative to the tornado problem. Several researchers have studied series photos or movies of tornadoes to estimate wind speeds, the life cycle and other poorly understood facts about tornadoes. Others are working on the association of unusual pressure changes before, during and after tornadoes. Many suggestions have been made regarding possible control of tornadoes and, of course, this would be highly desirable. However, it seems quite unlikely that means of control will be found until the meteorologist understands what causes them in the first place.

*This funnel was photographed near Rockwell, Texas, April 30, 1947. This is a classic example of the "funnel" shaped vortex of the tornado.*

## SUGGESTIONS FOR CONSTRUCTING A TORNADO CELLAR

The safest place to be when a tornado strikes is in an underground room, commonly called a storm cellar. In rural areas where tornadoes are relatively frequent, many householders have built an underground shelter which serves the double purpose of providing shelter from tornadoes and storing vegetables. Increased attention is also being given to the construction of family type underground emergency shelters in city areas. The cellars are sometimes connected to the basement or the first floor of a house by means of a tunnel with a door at each end. Many storm cellars are either built in the side of an earth bank, or are partly underground and covered with earth.

LOCATION OF STORM CELLAR. The storm cellar should be near the southwest corner of the residence, when possible, but not so close that falling walls could block the exit. If there is a nearby rise of ground, the cellar can be dug into it to the depth required to make use of the rise for protection. Entrance to the cellar should face northeast and the cellar should not be connected in any way with house drains, cesspools, or sewer and gas pipes. In digging the shelter, a shelf about three feet wide can be left along the walls to be used as a bench or as a substitute for a cot.

SIZE OF STORM CELLAR. The size depends on the number of persons to be accommodated and the storage needs. From a safety standpoint, a structure seven feet high with a 6′ by 8′ floor will take care of eight people for a short time and provide a limited amount of storage space. An 8′ by 10′ floor is more suitable when vegetable bins are to be placed along one of the walls.

MATERIAL. Reinforced concrete has sufficient advantage to compensate for the cost. Split logs or 2-inch planks treated with creosote and covered with tar paper may also be used for walls and roof. Cinder block, hollow tile, or brick may also be used for walls. The roof should be covered with a 3-foot mound of well-pounded dirt, sloped to divert surface water. This gives greater protection and helps keep out cold and heat. The door should be of heavy construction, hinged to open inward so the hinge pins can be removed if the door becomes blocked. The door can be held closed by a heavy crossbar. A secondary exterior door at the top of the steps will help keep heavy rain out of the cellar and insulate the interior.

DRAINAGE. The floor should slope to a drainage outlet, such as a tile drain, if the bottom of the cellar is sufficiently above the surrounding area. If not, a dry well can be dug. An outside drain is better because it will aid ventilation.

VENTILATION. A vertical ventilating shaft about one foot square can extend from near the floor level through the ceiling. This can be converted into an emergency escape hatch if the opening through the ceiling and above is made two feet square and the one-foot shaft below is made easily removable. If desired, a loading chute two feet square can be installed through which vegetables can be received for storage. The chute will also provide more ventilation and can be used as an extra escape hatch. Heavy wood slat gratings on the floor will also improve the circulation of air.

STORED EQUIPMENT. Emergency equipment, such as a pick, shovel, lantern, hammer, and screwdriver can be stored in the cellar and greased to prevent rusting. These tools will more than pay for themselves if all escapes become blocked.

Many people have credited storm cellars with saving their lives during tornadoes. There is no better place for protection when a tornado is seen, or when a warning is heard that a tornado is approaching.

## TORNADO SAFETY RULES

## TO KNOW WHAT TO DO WHEN A WARNING IS RECEIVED, OR A TORNADO IS OBSERVED, MAY MEAN THE DIFFERENCE BETWEEN LIFE AND DEATH!!

### I.

There is no universal protection against tornadoes except caves or underground excavations. When time permits, go to a tornado cellar, cave, or underground excavation which should have an air outlet to help equalize the air pressure. It should be kept fit for use, free from water, gas, or debris; and preferably equipped with pick and shovel.

### II. If you are in open country:

1. Move at right angles to the tornado's path. Tornadoes usually move ahead at about 25 to 40 miles per hour.
2. If there is no time to escape, lie flat in the nearest depression such as a ditch or ravine.

### III. If in a city or town:

1. Seek inside shelter, preferably in a strongly reinforced building. STAY AWAY FROM WINDOWS!
2. In homes: The southwest corner of the basement usually offers greatest safety, particuarly in frame houses. People in houses without basements should find other shelter, preferably in a storm cellar, athough a depression, such as a ditch or ravine, can offer some protection. If time permits, electricity and fuel lines should be shut off. Doors and windows on the north and east sides of the house may be opened to help reduce damage to the building.

3. Standing against the inside wall on a lower floor of an office building offers some protection.

### IV. If in schools:

1. In city areas: If school building is of strongly reinforced construction, stay inside, away from windows, remain near an inside wall on the lower floors when possible. AVOID AUDITORIUMS AND GYMNASIUMS with large, poorly-supported roofs!
2. In rural schools that do not have strongly reinforced construction, remove children and teachers to a ravine or ditch if storm shelter is not available.

### V. If in factories and industrial plants:

On receiving a tornado warning, a lookout should be posted to keep safety officials advised of the tornado's approach. Advance preparation should be made for shutting off electrical circuits and fuel lines if the tornado approaches the plant. Workers should be moved to sections of the plant offering the greatest protection.

### VI.

Keep calm! It will not help to get excited. People have been killed by running out into streets and by turning back into the path of a tornado. Even though a warning is issued, chances of a tornado striking one's home or location are very slight. Tornadoes cover such a small zone, as a rule, that relatively only a few places in a warned area are directly affected. You should know about tornadoes though, "just in case."

### VII.

Keep tuned to your radio or television station for latest tornado advisory information. Do not call the Weather Bureau, except to report a tornado, as your individual request may tie up telephone lines urgently needed to receive special reports or to relay advisories to radio and television stations for dissemination to thousands in the critical area.

*United States Department of Commerce — Weather Bureau*

# OUTSTANDING TORNADOES OF RECORD IN KANSAS . . .

Following is a list of Kansas tornadoes with one or more of the following characteristics – traveled a path of 50 miles or longer, killed 10 or more persons, or caused damage estimated at 50 thousand dollars or greater.

**Tornadoes in Kansas Outstanding in Length, Number of Lives Lost and Damage:**

| Date | Counties | Length of Path | Lives Lost | Number Injured | Estimated Damage |
|---|---|---|---|---|---|
| 1887, Apr. 21 | Linn | .... | 20 | 237 | ......... |
| 1892, Mar. 31 | Butler | .... | 17 | ... | $ 18,000 |
| 1892, May 27 | Harper and Sumner | .... | 16 | ... | 300,000 |
| 1896, May 17 | Washington, Marshall, Nemaha and Brown | .... | 25 | ... | 300,000 |
| 1905, May 8 | Ellsworth and Marquette | .... | 29 | 23 | 100,000 |
| 1915, Nov. 10 | Barton | 1000 ft | 11 | ... | 1,000,000 |
| 1917, May 25 | Elk, Woodson, Greenwood and Allen | 58 mi | 1 | ... | 50,000 |
| 1917, May 25 | Sedgwick, Harvey, Butler and Marion | 65 mi | 12 | ... | 600,000 |
| 1917, June 5 | Wabaunsee, Shawnee, Jackson and Jefferson | 50 mi | 9 | ... | 500,000 |
| 1918, Feb. 27 | Elk, Greenwood, Woodson, Allen, Bourbon and Linn | 100 mi | 0 | ... | 200,000 |
| 1924, June 9 | Montgomery, Labette and Cherokee | 50 mi | 1 | ... | ......... |
| 1924, July 13 | Butler | 23 mi | 1 | ... | ......... |
| 1927, May 7 | Comanche, Barber, Kingman, Reno and McPherson | 118 mi | .. | ... | ......... |
| 1929, Apr. 20 | Wilson, Neosho and Bourbon | 65 mi | .. | ... | 100,000 |
| 1929, Apr. 20 | Greenwood, Woodson, |  | .. | ... | 100,000 |
|  | Coffey and Anderson | 70 mi | .. | ... | 75,000 |
| 1930, May 5 | Saline, Dickinson, Clay and Riley | 50 mi | .. | ... | 100,000 |
| 1932, June 4 | Morton and Stanton | 50 mi | .. | ... | 35,000 |
| 1941, Apr. 12 | Greeley, Wallace, Sherman and Cheyenne | 150 mi | .. | ... | 100,000 |
| 1941, June 8 | Gove | 50 mi | .. | ... | 50,000 |
| 1942, Apr. 29 | Decatur | 20 mi | 16 | ... | 100,000 |
| 1942, May 2 | Wilson, Neosho, Allen and Linn | 88 mi | 3 | ... | 220,000 |
| 1942, May 10 | Haskell, Gray and Ford | 48 mi | .. | ... | 80,000 |
| 1947, Apr. 9 | Meade and Ford | 35 mi | .. | ... | 225,000 |
| 1947, Apr. 9 | Barber and Kingman | 40 mi | .. | ... | 200,000 |
| 1949, Jan. 3 | Wilson and Neosho | .... | .. | ... | 120,000 |
| 1951, June 6 | Pratt | 34 mi | .. | ... | 25,000 |
| 1951, June 20 | Wichita, Scott and Lane | 50 mi | .. | ... | 30,000 |
| 1951, June 26, 27 | Gove and Trego | .... | 5 | 100 | 2,080,000 |
| 1952, June 21 | Leavenworth and Wyandotte | 50 mi | .. | ... | 25,000 |
| 1953, May 10 | Chase, Morris, Logan and Wabaunsee | 45 mi | .. | ... | 10,000 |
| 1954, May 31 | Neosho and Bourbon | 50 mi | .. | ... | 66,000 |
| 1955, May 25 | Sumner and Cowley | 45 mi | 80 | 270 | 2,225,000 |
| 1955, June 4 | Osborne, Smith, Jewell and Republic | 70 mi | .. | ... | 200,000 |

| Date | Counties | Length of Path | Lives Lost | Number Injured | Estimated Damage |
|---|---|---|---|---|---|
| 1955, June 4 | Ford, Edwards and Pawnee | 50 mi | .. | ... | 250,000 |
| 1956, Apr. 2 | Cowley to Coffey | 75 mi | 2 | 27 | ......... |
| 1956, Apr. 2, 3 | Harvey to Atchison | 150 mi | .. | 8 | 1,000,000 |
| 1956, Oct. 29 | Russell, Lincoln and Mitchell | 25 mi | .. | 2 | 50,000 |
| 1957, May 20 | Sherman and Rawlins | 100 mi | .. | ... | ......... |
| 1957, May 20 | Cloud, Republic and Washington | 60 mi | .. | ... | 50,000 to 500,000 |
| 1957, May 20 | Franklin, Miami and Johnson | 57 mi | 7 | 31 | 500,000 to 5,000,000 |
| 1958, June 10 | Butler | 8 mi | 15 | 50 | 3,000,000 |

## U. S. DEPARTMENT OF COMMERCE WEATHER BUREAU

**Some Outstanding Tornadoes, Dates, Number Deaths, Number Injured and Estimated Property Damage 1875 - 1955**

| Date | Place | Time of Occurrence | Lives Lost | Injured | Estimated Damage |
|---|---|---|---|---|---|
| 1876, May 6 | Chicago, Ill. | 5:10 pm | .. | ... | $250,000 |
| 1877, June 4 | Mt. Carmel, Ill. | 4:30 pm | 16 | 100 | 400,000 |
| 1877, July 7 | Pensaukee, Wis. | .... | 8 | many | 300,000 |
| 1878, June 1 | Richmond, Mo. | 4:05 pm | .. | ... | 100,000 |
| 1878, Aug. 9 | Wallingford, Conn. | 5:45 pm | 30 | 70 | 250,000 |
| 1878, Oct. 8 | Monticello, Ia. | 5:30 pm | .. | ... | 100,000 |
| 1879, Apr. 14 | Collinsville, Ill. | 2:35 pm | 1 | 7 | 50,000 |
| 1879, Apr. 16 | Walterboro, S. C. | 3:45 pm | 11 | ... | 200,000 |
| 1879, May 29, 30 | Kansas, Missouri, Nebraska, Iowa | aft'no'n-evening | 30 | 50 | no estimate |
| 1879, June 10 | Delphos, Kans. | evening | 2 | 14 | 100,000 |
| 1880, Apr. 18 | Fayetteville, Ark. | .... | 2 | 25 | 100,000 |
| 1880, Apr. 18 | Licking, Mo. | .... | 1 | 17 | 50,000 |
| 1880, Apr. 18 | Marshfield, Mo. | .... | 65 | 200 | 110,000 |
| 1880, Apr. 25 | Macon, Miss. | 8:30 pm | 22 | 72 | 100,000 |
| 1881, Apr. 12 | Hernando, Miss. | 2:00 pm | 10 | ... | 50,000 |
| 1881, July 15 | New Ulm, Minn. | 4:45 pm | 6 | 53 | 400,000 |
| 1881, Sept. 24 | Quincy, Ill. | 5:00 pm | .. | ... | 100,000 |
| 1882, Apr. 5 | Stafford, Kans. | 4:00 pm | 1 | sev'al | 100,000 |
| 1882, Apr. 18 | Brownsville, Mo. | .... | 11 | 150 | 180,000 |
| 1882, May 8 | Mt. Ida, Ark. | .... | 2 | sev'l | 150,000 |
| 1882, June 17 | Grinnell, Iowa | 8:45 pm | 130 | 300 | 1,000,000 |
| 1883, Apr. 22 | Copiah Co., Miss. | 1:10 pm | 42 | 100 | 470,000 |
| 1883, May 13 | Kansas City, Mo. | .... | .. | ... | 300,000 |
| 1883, May 18 | Orongo, Mo. | .... | 6 | 33 | 75,000 |
| 1883, May 18 | Racine, Wis. | .... | 25 | 100 | 200,000 |
| 1883, Aug. 21 | Rochester, Minn. | 6:36 pm | 31 | ... | 200,000 |
| 1883, Nov. 5 | Springfield, Mo. | .... | sev'l | ... | consid'ble |
| 1884, Feb. 19 | Bird's Point, Mo. | .... | .. | ... | 80,000 |
| 1884, Feb. 19 | Ala., Ga., N.C., S.C. | aft'no'n | 420 | 1,000 | 3,000,000 |
| 1884, Apr. 1 | Oakville, Ind. | .... | 4 | 50 | 75,000 |
| 1884, Apr. 27 | Jamestown, Ohio | .... | 6 | ... | 200,000 |
| 1884, July 21 | Dell Rapids, S.D. | .... | .. | ... | 100,000 |
| 1884, Aug. 28 | Huron, S.D. | 3:00 pm | 6 | ... | consid'ble |
| 1884, Sept. 9 | Minn., Wis. | 5:00 pm | 6 | 75 | 4,000,000 |
| 1884, Sept. 28 | Shongo, N.Y. | 6:20 pm | 2 | 20 | 80,000 |
| 1885, Aug. 3 | Camden, N.Y. | .... | 6 | 100 | 500,000 |
| 1885, Sept. 8 | Washington, N.H., Ohio | .... | 6 | 100 | 500,000 |
| 1886, Apr. 14 | St. Cloud, Sauk Rapids, Minn. | 4:00 pm | 74 | 136 | 500,000 |
| 1886, May 12 | Attica, Ind. | .... | .. | 12 | 200,000 |

| Date | Place | Time of Occurrence | Lives Lost | Injured | Estimated Damage |
|---|---|---|---|---|---|
| 1887, Apr. 15 | St. Clairsville & Martin's Ferry, Ohio | .... | .. | ... | 250,000 |
| 1887, Apr. 21 | Prescott, Kans. | 5:30 pm | 20 | 237 | 1,000,000 |
| 1887, Apr. 22 | Mt. Carmel, Ill. | 6:00 pm | 2 | sev'l | 50,000 |
| 1887, Apr. 22 | Clarksville, Ark. | .... | 20 | 75 | 150,000 |
| 1887, June 16 | Grand Forks, N.D. | .... | 4 | ... | 150,000 |
| 1888, Feb. 19 | Mt. Vernon, Ill. | .... | 18 | 54 | 400,000 |
| 1889, Jan. 9 | Brooklyn, N.Y. | .... | .. | ... | 500,000 |
| 1889, Jan. 9 | Reading, Pa. | .... | 40 | ... | 77,500 |
| 1890, Mar. 27 | Louisville, Ky. | 7:57 pm | 78 | ... | 4,000,000 |
| 1890, May 10 | Akron, Ohio | .... | .. | ... | No es'm'te |
| 1890, July 26 | Lawrence, Mass. | .... | 8 | ... | No es'm'te |
| 1891, May 20 | Centralia and Mexico, Mo. | 3:00 pm | 4 | 35 | 71,000 |
| 1892, May 27 | Harper, Kans. | 7:40 pm | 4 | ... | 371,000 |
| 1893, Apr. 25 | Cleveland Co., Okla. | 5:30 pm | 30 | many | 25,000 |
| 1893, Apr. 28 | Cisco, Eastland Co., Tex. | 10:00 pm | 23 | ... | 400,000 |
| 1894, Oct. 2 | Little Rock, Ark. | 7:20 pm | 4 | 26 | 508,600 |
| 1895, July 13 | Cherry Hill, N.J. | 3:45 pm | 4 | 50 | 93,000 |
| 1895, July 5 | Baxter Springs, Kans. | .... | 5 | 10 | 120,000 |
| 1896, May 12, 15 | Denton and Grayson, Tex. | .... | 76 | ... | 231,000 |
| 1896, May 27 | St. Louis, Mo. | .... | 306 | ... | 12,904,000 |
| 1897, Mar. 30 | Chandler, Okla. | 5:30 pm | 14 | 40 | 100,000 |
| 1898, May 18 | Ia., Wis., Ill. | 3:20 pm | 47 | many | 700,000 |
| 1899, June 12 | New Richmond, Wis. | .... | many | ... | No es'm'te |
| 1900, Nov. 20 | Ark., Miss., Tenn. | aft'no'n-evening | 73 | many | 500,000 |
| 1901, Aug. 24 | Bayonne, Jersey City, Hoboken, N.J. | aft'no'n | .. | ... | 150,000 |
| 1902, Mar. 28 | Calhoun Co., Miss. Franklin Co., Ala. | 1:30-3:45 pm | 2 | ... | consid'ble |
| 1903, June 1 | Gainesville, Ga. | 12:45 pm | 98 | 190 | 1,000,000 |
| 1904, Aug. 20 | Minneapolis-St. Paul, Minn. | 8:00 pm | 14 | ... | 1,500,000 |
| 1905, May 10 | Snyder, Okla. | 6:45-8:45 pm | 87 | 49 | 20,000 |
| 1906, Mar. 2 | Meridian, Miss. | 6:30 pm | 23 | ... | 400,000 |
| 1907, Apr. 5 | Alexandria, La.-S. Miss. | 1:00 am | 20 | ... | 200,000 |
| 1908, Apr. 24 | Lamar Co.,-Wayne Co., Miss. | 3:00 pm | 100 | 649 | 880,000 |
| 1909, Mar. 8 | Dallas-Monroe Co., Ark. | 5:00-7:10 pm | 64 | 671 | 635,000 |
| 1910, May 29, 30 | Charleston, W. Va. (tornadic character) | night | 1 | ... | 100,000 |
| 1911, Apr. 12 | Brown, Waubaunsee, Douglas, Cherokee Co., Kans. | .... | 5 | 61 | 855,000 |
| 1912, Apr. 21 | Illinois | 4:30 pm | 18 | ... | 1,000,000 |
| 1913, Mar. 23 | Terre Haute, Ind. | .... | 21 | ... | 1,000,000 |
| 1913, Mar. 23 | Omaha, Nebr. | .... | 95 | ... | 3,500,000 |
| 1914, Aug. 21 | Wilkes-Barre, Pa. | .... | 7 | 50 | consid'ble |
| 1915, June 17 | Pottawatomie, Coffey, Bourbon Co., Kans. | 4:00-9:00 pm | 5 | 8 | 98,000 |
| 1916, Apr. 19 | S.E. Kans.-Vernon Co., Mo. | 3:00-5:00 pm | 12 | 168 | 1,235,000 |
| 1916, June 5 | Ark. (series of tornadoes) | 1:00 pm | 83 | 400 | consid'ble |
| 1917, Mar. 23 | New Albany, Ind. | 3:08 pm | 45 | ... | 2,000,000 |

| Date | Place | Time of Occurrence | Lives Lost | Injured | Estimated Damage |
|---|---|---|---|---|---|
| 1917, May 26 | Mattoon-Charleston, Ill. | 12:00 noon | 101 | 638 | 2,500,000 |
| 1917, May 26 | Lake Co., Tenn.-Fulton, Hickman, Carlisle & Graves Co., Ky. | 4:00-9:00 pm | 70 | ... | 2,000,000 |
| 1918, Aug. 21 | Tyler, Minn. | 9:20 pm | 36 | ... | 1,000,000 |
| 1919, June 22 | Fergus Falls, Minn. | 4:45 pm | 59 | ... | 3,500,000 |
| 1920, Mar. 28 | Chicago, Ill. & vicin. | 12:05 pm | 28 | ... | 3,000,000 |
| 1920, Mar. 28 | Ala.-Ga. | .... | 50 | ... | 1,400,000 |
| 1920, Apr. 20 | Oktibbeha Co., Miss. Franklin Co., Ala. | 9:00 am | 87 | ... | 1,500,000 |
| 1920, May 2 | Rogers, Mayes, Cherokee, Okla. | 6:00-8:35 pm | 64 | ... | 175,000 |
| 1921, Apr. 15 | Cass Co., Tex.-Miller, Hempstead, Pike Co., Ark. | 4:00 pm | 61 | ... | 1,300,000 |
| 1922, Apr. 17 | Ill., Ind., Ohio | 3:30-8:00 pm | 16 | 53 | 900,000 |
| 1922, May 4 | Austin, Tex. | 4:00 pm | 12 | 50 | 500,500 |
| 1923, Apr. 4 | Alexandria-Pineville, La. | 6:00 pm | 14 | ... | 750,000 |
| 1924, Apr. 30 | Ga.-S.C. | 6:00-8:00 am | 10 | ... | 2,202,000 |
| 1924, Apr. 30 | Central S.C. | 7:30 am | 67 | ... | 1,000,000 |
| 1924, June 28 | Lorain-Sandusky, O. | 4:35 pm | 85 | ... | 12,000,000 |
| 1925, Mar. 18 | Mo., Ill., Ind. | 1:00-4:00 pm | 689 | 1,980 | 16,500,000 |
| 1926, Nov. 9 | LaPlata, Cedarville, Md. | 2:35-3:15 pm | 17 | ... | 100,000 |
| 1926, Nov. 25 | Belleville to Portland, Ark. | 4:30-9:30 pm | 53 | ... | 627,000 |
| 1927, Apr. 12 | Rock Springs, Tex. | .... | 74 | ... | 1,230,000 |
| 1927, May 9 | Randolph Co., Ark.-Poplar Bluff, Mo. | 2:05 pm | 92 | ... | 2,287,000 |
| 1927, Sept. 29 | St. Louis, Mo. | .... | 72 | ... | 22,000,000 |
| 1928, June 16 | Jackson Co., Okla. | 6:15 pm | 4 | 52 | 1,500,000 |
| 1928, Sept. 14 | Rockford, Ill. | 3:22 pm | 14 | ... | 1,200,000 |
| 1929, Apr. 5 | Minn.-Wis. | 5:30 pm | 6 | ... | 1,010,000 |
| 1929, Apr. 25 | S.E. to Central Ga. | 4:00 pm | 40 | ... | 850,000 |
| 1930, May 6 | Hill & Ellis Co., Tex. | 3:30 pm | 41 | ... | 2,100,000 |
| 1930, June 13 | Minn.-Wis. | 5:00 pm | 6 | ... | 1,100,000 |
| 1931, Jan. 5 | Caswell & Warren Co. N.C. | 4:00 pm | 6 | sev'l | 45,000 |
| 1931, Dec. 12, 13 | Columbia & Quachita Co., Ark. | 11:45 pm-12:30 am | 1 | ... | 1,250,000 |
| 1932, Mar. 21 | Ala. (series of tornadoes) | 3:15-7:00 pm | 268 | 1,874 | 5,000,000 |
| 1933, Mar. 14 | Nashville, Tenn. | 7:30 pm | 15 | scores | 2,200,000 |
| 1933, May 1 | Webster-Bienville Parishes, La. | 4:00 pm | 23 | 400 | 1,250,000 |
| 1934, Oct. 23 | Maryville, Mo. | 5:15 pm | 5 | 12 | 900,000 |
| 1935, Mar. 25 | Massac Co., Ill. | 3:40 pm | 1 | 34 | 300,000 |
| 1935, Apr. 6 | Wilkinson-Amite Co., Miss. | 7:30 pm | 11 | 75 | 190,000 |
| 1936, Apr. 2 | Cordele, Ga. | 7:30 pm | 23 | 500 | 3,000,000 |
| 1936, Apr. 5 | Tupelo, Miss. | 8:55 pm | 216 | 700 | 3,500,000 |
| 1936, Apr. 6 | Gainesville, Ga. | 8:27 am | 203 | 934 | 13,000,000 |
| 1937, Feb. 20 | S. Central Mo. | 4:00-5:00 pm | .. | 13 | 190,000 |

| Date | Place | Time of Occurrence | Lives Lost | Injured | Estimated Damage |
|---|---|---|---|---|---|
| 1937, Mar. 25 | Fayette & Clark Co., Ky. | 6:00 pm | 5 | 23 | 150,000 |
| 1938, Sept. 29 | Charleston, S.C. | 6:45 am | 32 | 150 | 2,000,000 |
| 1939, Apr. 16 | Drew Co., Ark. | 3:10 pm | 27 | 62 | 20,000 |
| 1939, June 18 | Hennepin & Anoka Co., Minn. | 3:10 pm | 9 | 222 | 1,200,000 |
| 1940, Feb. 10 | Dougherty Co., Ga. | 4:20 am | 18 | 397 | 3,200,000 |
| 1941, June 9 | Lamb, Swisher, Donley Co., Tex. | 4:00 am | 4 | 33 | 510,000 |
| 1941, Oct. 26 | Dardenelle to Hamburg, Ark. | 11:15 pm | 19 | 95 | 200,000 |
| 1942, Mar. 16 | Cen. to N.E. Miss. | 4:00 pm | 75 | 525 | 1,375,000 |
| 1942, Apr. 27 | Rogers & Mayes Co., Okla. | 3:45 pm | 52 | 181 | 2,000,000 |
| 1943, Apr. 27 | Akron-Cleveland, O. | 7:30 pm | 3 | 214 | 3,475,000 |
| 1944, June 23 | Ravenna, Ohio, Pa., W. Va. to Cumberland, Md. | 6:00-9:30 pm | 150 | 867 | 4,150,000 |
| 1945, Apr. 12 | Okla.-Ark. | 3:25-6:00 pm | 102 | 689 | 3,962,000 |
| 1946, Jan. 4 | N.E. Texas | 2:10-9:00 pm | 30 | 335 | 2,650,000 |
| 1947, Apr. 9 | Texas, Okla. & Kans. | 6:00-10:00 pm | 169 | 983 | 9,772,750 |
| 1948, Mar. 19 | Bunker Hill & Gillespie, Ill. | 6:38-7:35 am | 33 | 449 | 3,765,000 |
| 1948, Mar. 20 | Oklahoma City, Will Rogers & Tinker Flds. | 10:00 & 6:00 pm | 0 | 9 | 16,350,000 |
| 1948, Mar. 26 | Terre Haute to Redkey, Ind. | 5:00 pm | 20 | 200 | 3,000,000 |
| 1949, Jan. 3 | La. & Ark. | 3:00-6:00 pm | 58 | 439 | 1,457,920 |
| 1949, May 15 | Amarillo, Tex. | 6:30 pm | 6 | 83 | 4,779,000 |
| 1949, May 21 | Cape, Girardeau, Mo. | 6:55-7:00 pm | 23 | 130 | 3,500,000 |
| 1950, July 19 | Van Wert & Allen Co., Ohio | aft'no'n | 0 | 30 | 2,000,000 |
| 1951, June 26, 27 | Gove & Trego Co., Kans. | 11:10 pm-12:30 am | 5 | 100 | 2,080,000 |
| 1951, July 20 | Hennepin Co., Minn. | 9:00-9:30 pm | 5 | scores | 6,000,000 |
| 1952, Feb. 29 | Fayetteville, Tenn. | 4:30 pm | 2 | 150 | 3,000,000 |
| 1952, Mar. 21, 22 | Ark., Mo., Tenn. (series of tornadoes) | 3:00 pm-12:00 pm | 208 | 1,154 | 14,000,000 |
| 1952, Apr. 4 | Louisiana (3 tornadoes) | 2:00 am-3:30 am | 4 | 46 | 1,062,000 |
| 1953, Apr. 18 | Columbus, Ga. | 6:15 pm | 2 | 198 | 15,000,000 |
| 1953, Apr. 30 | Warner Robbins, Ga. | 5:15 pm | 18 | 300 | 15,000,000 |
| 1953, May 11 | Waco, Texas | 4:10 pm | 114 | 597 | 41,200,000 |
| 1953, June 8 | Flint to Lakeport, Mich. | 8:30-10:30 pm | 116 | 867 | 19,000,000 |
| 1953, June 8 | Northern Ohio | 7:00-11:00 pm | 17 | 400 | 20,000,000 |
| 1953, June 9 | Central & Eastern Mass. | 3:25-5:00 pm | 90 | 1,288 | 52,200,000 |
| 1953, Dec. 5 | Vicksburg, Miss. | 5:35 pm | 38 | 230 | 25,000,000 |
| 1954, Mar. 13 | Taylor, Crawford and Bibb Counties, Ga. | 10:00-11:35 pm | 5 | 75 | 3,000,000 |
| 1954, Mar. 13 | Ft. Mitchell, Ala.-Ft. Benning, Ga. | 8:40-9:45 pm | 2 | 20 | 6,000,000 |
| 1954, June 1 | Cottle Co., Texas | 7:30 pm | 1 | 14 | 2,611,500 |
| 1955, May 25 | Blackwell, Okla. | 9:30 pm | 20 | 280 | 8,015,000 |
| 1955, May 25 | Udall, Kan. | 10:30 pm | 80 | 270 | 2,225,000 |