

STATE OF ILLINOIS
WILLIAM G. STRATTON, *Governor*



Tornadoes in Illinois

by

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TORNADOES IN ILLINOIS

by S. A. Changnon Jr. and G. E. Stout

SUMMARY

This report discusses some of the climatological facts concerning tornadoes occurring in Illinois. Its purpose is to investigate the frequency of tornadoes in Illinois and to evaluate the resulting loss in lives and damage to property.

The tornado climatology of all states is reviewed for comparison with Illinois. The states are ranked according to number of tornadoes and deaths and damage caused by tornadoes.

Tornadoes in Illinois are investigated in relation to their occurrence by area, by hour, and by season. They are also discussed according to their severity and to their physical characteristics.

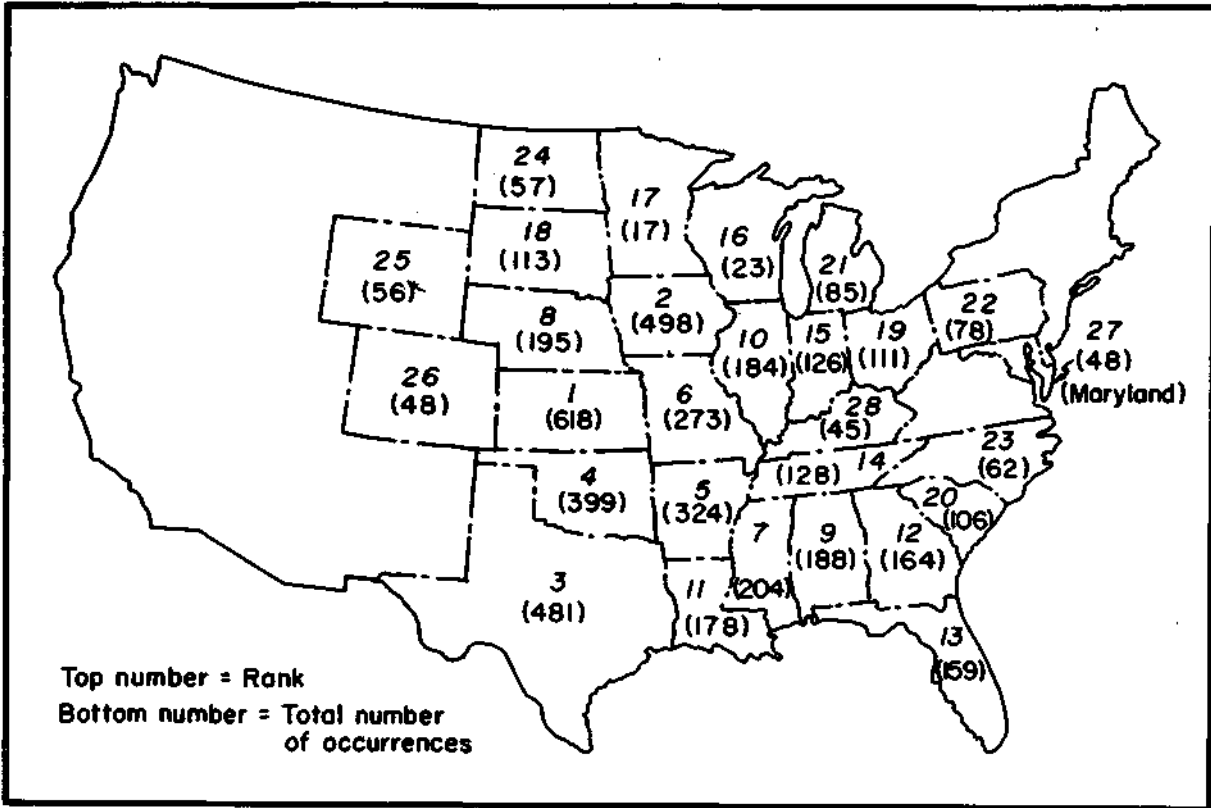


FIGURE 1 TORNADO OCCURRENCE RANKING ON NATIONAL BASIS AND NUMBER REPORTED PER STATE, 1916-1950

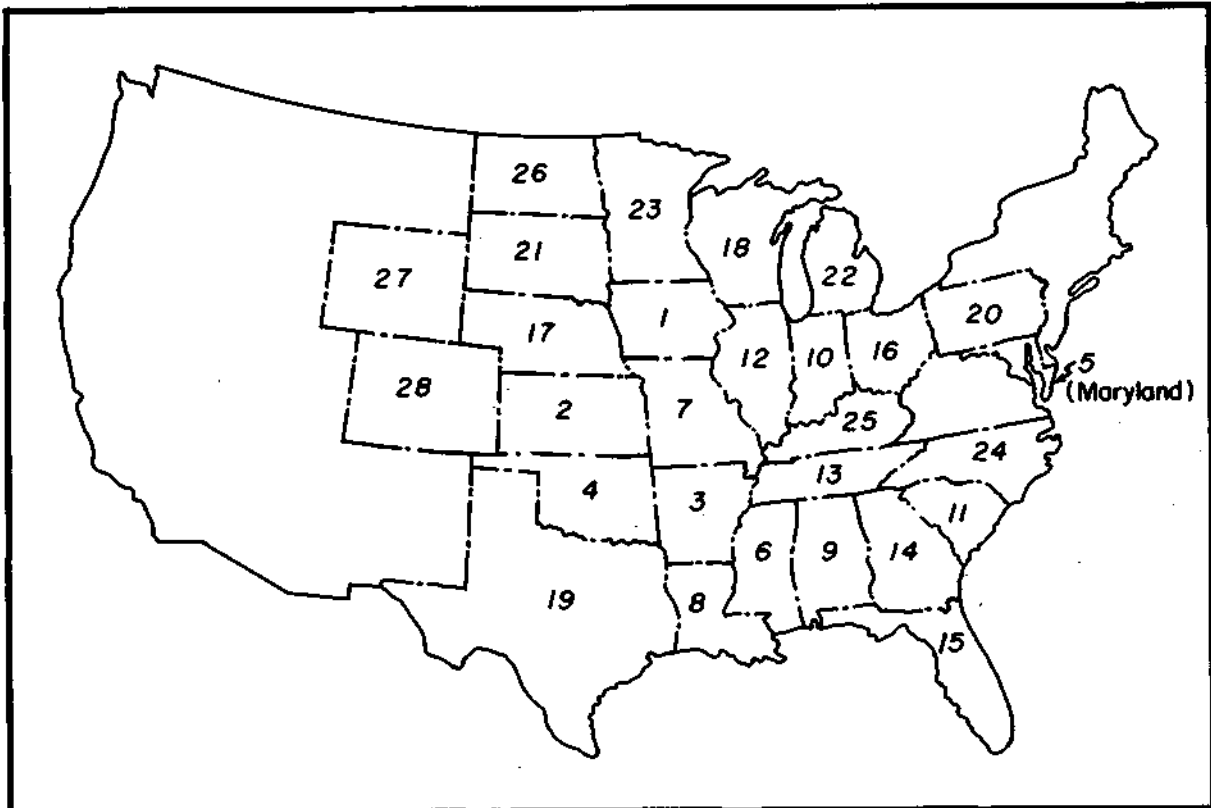


FIGURE 2 STATE RANKING BY TORNADO OCCURRENCE, ADJUSTED FOR AREA, 1916-1950

NATIONAL TORNADO STATISTICS RELATED TO ILLINOIS

Introduction

Statistics concerning tornadoes that have occurred in the United States are compared by states to analyze the consequence of tornadoes in Illinois. Because states are political entities of unequal size and shape, they do not serve as an ideal geographic unit for a comparison of this kind. However, tornado statistics have been accumulated by states, and therefore, this basis of comparison is most convenient.

Frequency of Occurrence by States

Illinois ranks tenth in the United States in number of tornadoes. From 1916 through 1950, the U. S. Weather Bureau recorded 184 tornadoes occurring in Illinois.⁽¹⁾ In Figure 1, the number of tornadoes occurring in various states and the rank of each state according to the number of tornadoes are indicated. Kansas, Iowa, and Texas rank first, second, and third, respectively.

A high percentage of tornadoes has been observed in the central Great Plains region in an area extending north from the Gulf of Mexico to the Great Lakes and from the Rocky Mountains to the Appalachians. This area is referred to hereafter in this report as the central tornado belt.

Frequency of Occurrence by Area

Figure 2 shows the ranking by states when the number of tornadoes is adjusted for the square miles within the political boundary of each state. In this evaluation, Illinois assumes the twelfth rank in the United States. Iowa, Kansas, and Arkansas are ranked first, second, and third, respectively.

Frequency of "Outstanding" Tornadoes

In a publication concerning tornadoes in the United States⁽¹⁾ the Weather Bureau lists 131 "outstanding" tornadoes that occurred in the 75-year period from 1875 to 1950. "Outstanding" tornadoes are defined as those which resulted in the loss of more than one life and/or property damage greater than \$ 100,000. Twelve of these 131 tornadoes occurred within Illinois. Only Missouri and Arkansas, each with 14, had a greater number of outstanding tornadoes than Illinois during this 75-year period. The Illinois tornadoes are listed in Table 1.

State Comparisons by Deaths and Damages

The consequence of tornadoes in the central tornado belt is further realized by comparing by states the deaths and property damage resulting from tornadoes. Illinois has a record of 914 deaths resulting from tornadoes for the 35-year period from 1916 through 1950⁽²⁾ This total ranks Illinois first in the United States in number of deaths resulting from tornadoes. In relation to property damage associated with tornadoes during this period, Illinois, with \$48,705,680 damage, ranks second to Oklahoma. These two factors signify the seriousness of tornadoes occurring in Illinois. Although Illinois ranks only tenth nationally in incidence of tornadoes, it ranks first in number of deaths and second in amount of damage.

The principal reason for the high death and property damage factors is the density of population. Of the 10 states in which the greatest number of tornadoes in the United States have occurred, Illinois ranks highest in the ratio of persons per square mile. The density creates a

TABLE 1
SOME OUTSTANDING ILLINOIS TORNADOES, 1875-1950

Date	Place	Lives Lost	Injured	Property Damage
1876, May 6	Chicago	0	0	\$ 250,000
1877, June 4	Mt. Carmel	16	100	400,000
1888, Feb. 19	Mt. Vernon	18	54	400,000
1898, May 18	Northwestern Ill. (a)	47	Unknown	700,000
1912, April 21	Southern, Ill. (b)	18	0	1,000,000
1917, May 26	Mattoon-Charleston	101	638	2,500,000
1920, March 28	Elgin-Wilmette-Clearing	28	300	3,000,000
1922, April 17	Eastern Ill. (c)	7	Unknown	295,000
1925, March 18	Southern Ill.	606	1011	13,303,000
1928, Sept. 14	Rockford	14	0	1,200,000
1935, March 25	Massac County	1	34	300,000
1948, March 19	Gillespie-Bunker Hill	33	449	3,765,000

(a) Crossed portions of Iowa, Illinois and Wisconsin, deaths and property damages are totals for three states.

(b) Near Carbondale.

(c) Crossed portions of Illinois, Indiana, and Ohio.

greater possibility of fatality per tornado occurrence. Illinois has three times as many persons per square mile as any other state in the central tornado belt. Moreover, this high population ratio is not due to the population of the Chicago metropolitan area. After subtracting the population of the Chicago area from the state population, Illinois still ranks first in the ratio of persons per square mile in the central tornado belt.

Among the central tornado belt states Illinois also ranks first in the number and size of urban concentrations. Seventy-four per cent of the Illinois population is classified as urban. Therefore tornadoes occurring in Illinois, where there are concentrated areas of population and high-value property, are likely to be more destructive than in rural and sparsely-populated regions. For instance, a severe tornado could move over a long path through many parts of the central tornado belt without killing a person, while a tornado with a life history of 15 minutes and a narrow path could kill hundreds and cause extreme property damage in many parts of Illinois. It can be concluded that Illinois is more vulnerable to deaths and destruction by tornadoes than other states in the tornado belt.

Course of Maximum Activity in Tornado Belt

The seasonal distribution of tornado occurrences in Illinois is closely related to the over-all seasonal distribution occurring in the central tornado belt. The center of maximum tornado activity during the year moves northward from the Gulf States in the late winter to Iowa in the summer and returns southward in the fall.⁽¹⁾ The greatest frequency in January is recorded in Louisiana, Alabama, and Mississippi. In February the center of activity begins to move northward with increased activity in Arkansas. A rather wide-spread area of maximum tornado occurrence follows in March throughout Arkansas, Missouri, Alabama, Tennessee, Mississippi, and Illinois. During April and May the center of activity moves northwestward into Oklahoma, Kansas, Missouri, and Iowa. The center of activity begins to reverse during June and lies within the area of Kansas, Nebraska, and Iowa. The number of tornadoes occurring in the United States decreases during July, August, and September with Iowa remaining as the center of activity. With a reduced number of tornadoes occurring in November, the center of maximum activity moves southward to the Arkansas, Louisiana and Mississippi area, where it remains through December.

CLIMATOLOGY OF TORNADES IN ILLINOIS

Introduction

The frequency, location, time of occurrence, direction of movement, seasonal variation, and other meteorological characteristics related to tornadoes in Illinois were investigated. To accomplish this investigation, a 25-year period of detailed tornado records from 1927 through 1952^(3,4) was selected for analysis. In a climatological consideration of Illinois tornadoes, it is important to understand that occasionally tornadoes occur in different locations in the state on the same day, which are called "tornado days". These are not recurrences of the same tornado. During this 25-year period under study, Illinois had 88 tornado days, with a total of 140 tornadoes occurring. Of the 140 tornadoes, 79 occurred on days with combinations of 2, 3, 4, 6, or 9 per day. On One occasion during this 25-year period, nine tornadoes occurred on the same day in nine different locations in Illinois.

Seasonal Frequency

In an attempt to classify the tornado frequency by seasons of the year, three 4-month groups

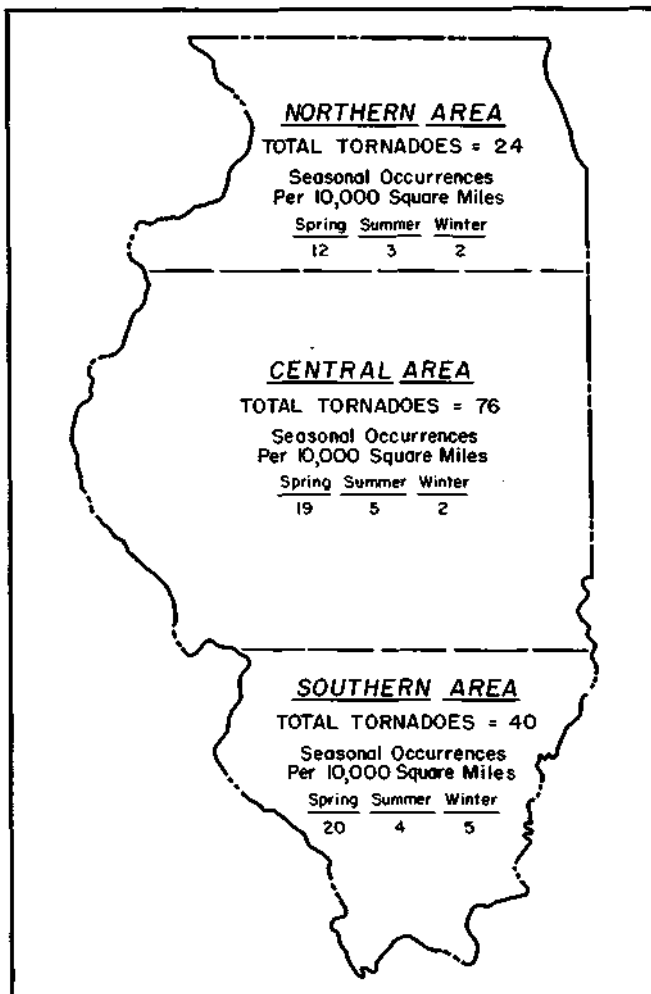


FIGURE 3 AREAL AND SEASONAL TORNADE OCCURRENCES IN ILLINOIS, 1927-1952

were selected. A 3-season grouping was selected because the annual frequency pattern of tornadoes in the state presents a definite 3-cycle pattern of occurrence. The three seasons selected were spring (March through June) summer-fall (July through October), and winter (November through February).

The spring season had 101 of the 140 tornadoes or 72 per cent of the total. The summer-fall season had 24 tornadoes or 17 per cent, while the winter season had the smallest number, 15 tornadoes, or 11 per cent of the total.

The leading month for occurrences was March with 31, followed by May (29), April (23), June (18), and July (8). No tornadoes occurred in February, and October had only three.

Location Frequency

Two methods were employed to study the locations of tornadoes occurring in Illinois. In the first method the state was divided into three sections: the southern area, by an approximate east-west line from Alton through Effingham; the northern area, by an approximate east-west line from Moline to Kankakee; and the central area, which lies between the foregoing boundaries. These boundaries were selected to fit general climatological boundaries used by the U. S. Weather Bureau.¹³ Tornado occurrences in each section were then determined. The second method used consisted of computing the number of tornadoes per county area so that a tornado occurrence isogram map could be derived.

Frequency by Area

By use of the first method to divide the state into sections (Fig. 3), the central Illinois area was found to predominate with 76 tornadoes which was approximately 56 per cent of the total. The southern section ranked second with 40 tornadoes or 28 per cent, with the northern area having the fewest number, 24, or 16 per cent of the total.

To determine more accurately the occurrence of tornadoes within each area, the frequency of tornadoes was compared to square miles per area in each of the three state areas. The results, as shown in Table 2, indicate that southern and central Illinois are about equal in frequency of tornadoes per unit area.

Frequency by County

By use of the number of tornado occurrences in each county, a more detailed description of the areal distribution of tornadoes in Illinois was obtained. From this occurrence data by counties, an isogram map was constructed (Fig. 4) to indicate tornado frequency from 1927 through 1952. This map indicates that a belt of maximum tornado occurrence extends from the East St. Louis-Alton area northeast through the Springfield area, and from there eastward through the Champaign-Danville area. To the west, north, and southeast

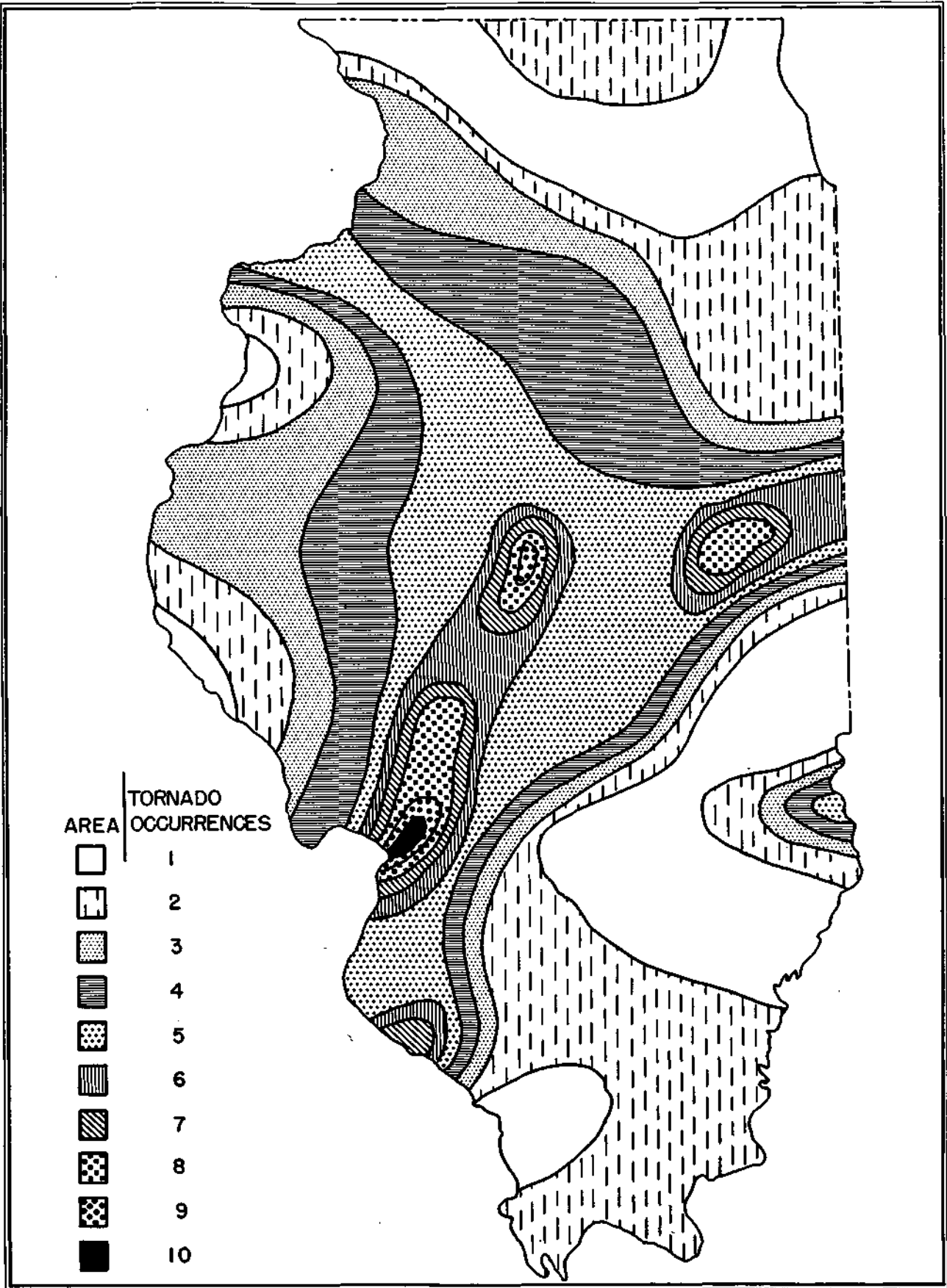


FIGURE 4 TORNADO FREQUENCY IN ILLINOIS, 1927-1952

TABLE 2

NUMBER OF TORNADOES OCCURRING PER 10,000 SQUARE MILE
UNITS IN THREE STATE AREAS, 1927-1952

State Areas	Total Tornadoes	Spring	Summer	Winter
Northern	17	12	3	2
Central	27	19	5	3
Southern	30	20	4	6

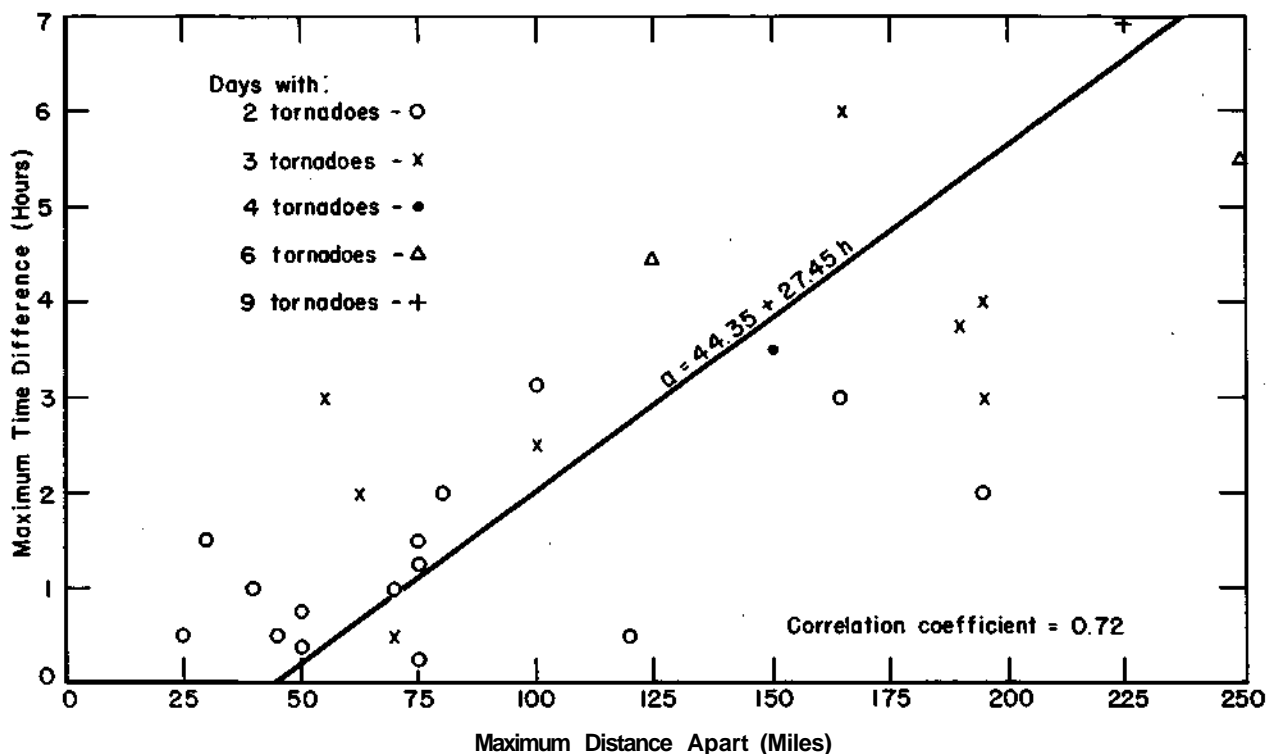


FIGURE 5 RELATION OF MAXIMUM TIME AND SPACE DIFFERENCES BETWEEN TORNADO OCCURRENCES
ON DAYS OF TWO OR MORE TORNADOES, 1927-1952

of this high frequency belt, the occurrence frequency decreases rapidly.

Occurrence Relations on Days of Two or More Tornadoes

Inasmuch as over 56 per cent of all tornadoes between 1927 and 1952 occurred in combinations of two or more on one day, the time and location relationships of these tornado occurrences were investigated. Twenty-seven days had two or more occurrences; and March, with 8 days, was the predominant month. The maximum time between occurrences on any day was seven hours, and the greatest distance between occurrences was 250 miles. The maximum time difference of occurrences for each day and the associated maximum distance between these occurrences for all 27 cases were graphically plotted and are shown in Figure 5. A linear equation was developed because the plotted points indicated the existence of a direct relation between the maximum distance and the maximum time difference. A correlation coefficient of 0.72 was obtained from these data which substantiated the apparent relation-

ship that the greater the distance, the greater the time difference between occurrences. In general, tornadoes on days with two occurrences occurred closer together in both space and time than did the tornadoes on days with 3, 4, 6, or 9 occurrences.

On March 30, 1938 nine separate tornadoes occurred in south-central Illinois in an area bounded on the north by an east-west line from Quincy to Rantoul and on the south by an east-west line from Chester to Mt. Carmel. Over \$1,356,000 damage was incurred, 15 lives were lost, and 91 persons were injured. The longest path of the nine tornadoes was 115 miles (Kellerville to Eureka) and the shortest path was one mile (near Edinburg).

Hourly Frequency

The diurnal tornado frequency was next ascertained.^(3,4) Figure 6 indicates that the period from 0400 through 0800 is the minimum occurrence period, with continuing low frequency until approximately 1500. The maximum period of

occurrences is from 1500 to 1900, followed by a gradual decrease until 2300. After 2300 the frequency diminishes rapidly until 0400 the following day. Therefore, the maximum period of occurrence is from 1500 through 1900 when 57 per cent of all Illinois tornadoes occur. During the summer-fall and winter seasons tornado occurrences tend to be much more evenly distributed throughout the day than during the spring season.

Direction of Movement of Tornadoes

The average direction of tornado movement in Illinois is similar to that occurring throughout the tornado belt⁽¹⁾. Approximately 60 per cent of the tornadoes move from the southwest to the northeast, with 34 per cent from other westerly directions ranging from the south, clockwise through the northwest. The remaining 6 per cent occurs from the north and northeast. These average directions of tornado movement hold true for any location in the state.

Destructive Tornadoes in Illinois

For the purpose of analyzing the severity of the 140 tornadoes occurring in Illinois from 1927 through 1952, a revised classification of tornado severity was chosen. A severe or destructive tornado was considered one that had caused greater than \$ 50,000 damage and/or at least one death. The "destructive" classification differs from the U. S. Weather Bureau definition of an

"outstanding" tornado by having a minimum material damage limit of \$ 50,000 rather than \$ 100,000. Close examination of damage costs from the 140 tornadoes indicated that they generally fell into two groups, which were either in a negligible bracket of \$ 10,000 or less, or were in a higher bracket of \$50,000 or more. Therefore, the \$50,000 minimum limit seemed more suitable to a tornado severity definition for Illinois, that is at best, very arbitrary.

By using this definition for classifying tornadoes, 52 of the 140 tornadoes belong in the "destructive" category. Of the 52 destructive storms, 39 occurred during the spring season, or almost 40 per cent of all Illinois spring tornadoes were destructive. Five destructive storms occurred during the summer-fall season; this is 21 per cent of the total tornadoes recorded during that season. Eight "destructive" tornadoes occurred during the winter season, or over 50 per cent of the 15 recorded winter occurrences.

The average path width of the 52 destructive tornadoes in Illinois was 600 yards with an average length of 27 miles. According to the Weather Bureau, the average width of tornado paths throughout the United States is about 400 yards with an average length of approximately 16 miles.⁽¹⁾ The shortest path length of any destructive tornado was one mile and the maximum length was 163 miles. The narrowest path width of any destructive tornado was 34 yards and the widest path width was 4 miles.

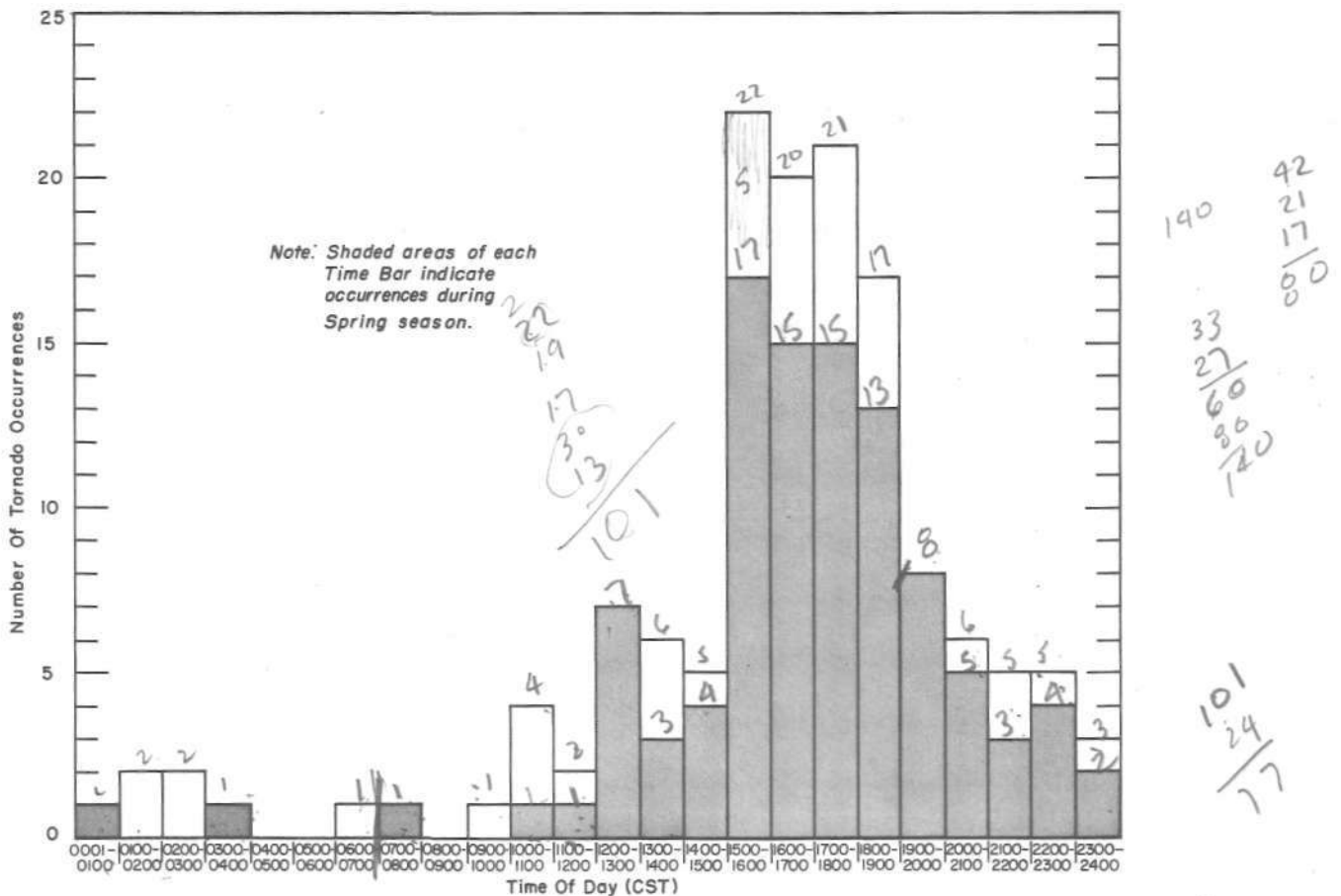


FIGURE 6 DISTRIBUTION OF ILLINOIS TORNADO OCCURRENCES BY TIME OF DAY, 1927-1952

Roughly 3/4

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$$\begin{array}{r} 27 \\ \hline 34 \end{array}$$

$$\begin{array}{r} 140 \\ 34 \\ \hline 106 \end{array}$$

$$\begin{array}{r} 106 \\ \hline 140 \end{array}$$

*approx 75% of all
Tornadoes occur during daylight hours.*

*Runy Spring,
7670*

$$\frac{77}{101}$$

$$\frac{29}{39}$$