

Technical Memorandum

**SEVERE WEATHER CLIMATOLOGY OF
HUNTSVILLE WEATHER FORECAST OFFICE
COUNTY WARNING AREA**

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1.0 INTRODUCTION

1.1 Purpose

This memorandum was prepared to familiarize National Weather Service personnel with the severe weather climatology associated with the County Warning Area (CWA) of the Weather Forecast Office (WFO) in Huntsville (HUN), AL. This climatology is a historical account of tornado, wind, and hail data spanning the period from 1950-2001. The primary responsibility of any National Weather Service (NWS) office is to issue timely, accurate warnings and forecasts during hazardous weather events. A complete, detailed climatology of past severe weather events and knowledge of geographic characteristics of a CWA are critical to fulfilling this responsibility.



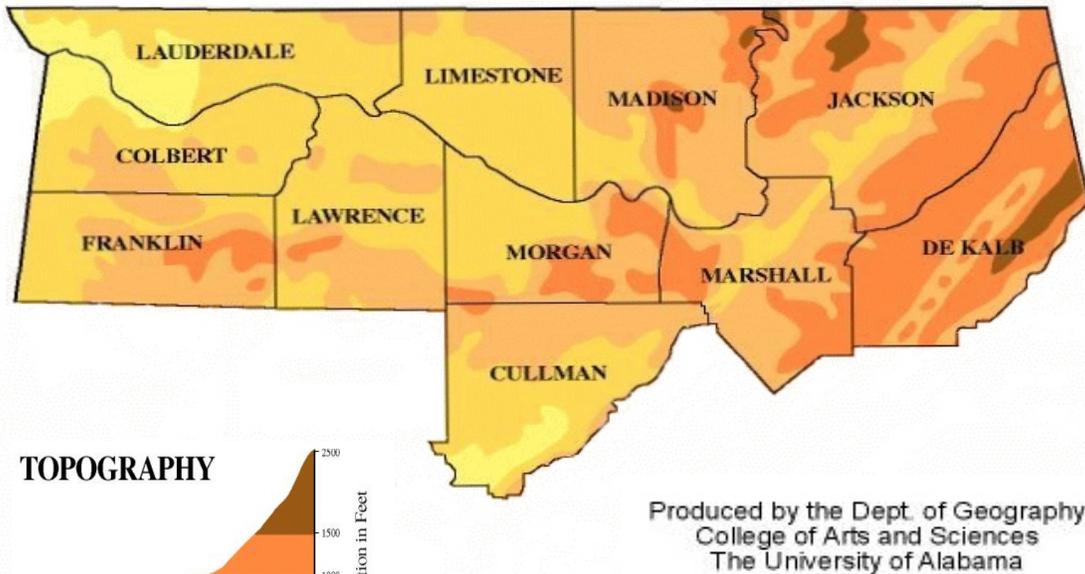
Figure 1. County Warning Area of WFO Huntsville, AL.

1.2 Description of CWA

The Huntsville CWA contains 11 counties in northern Alabama. These counties, depicted in Figure 1, include the rich agricultural areas of the Tennessee Valley and the southwest fringe of the Appalachian Mountain chain.

Figure 2. Elevation of Huntsville CWA.

As shown in Figure 2, elevations range from around 200 ft in the extreme western



section
ft. in
CWA

ns of Lauderdale and Colbert counties, to more than 1800
parts of DeKalb and Jackson counties. The majority of the
consists of elevations between 500 ft. and 800 ft. The
largest river in the CWA is the Tennessee River. The Tennessee River is the principal tributary
of the Ohio River. It is formed by the confluence of the Holston and French Broad rivers near
Knoxville, TN. The Tennessee River flows southwest from the Tennessee state line through the
middle of Jackson county and cuts through elevations in excess of 1500 ft. It then flows into
northern Marshall county, before turning northwest through extreme southwestern Madison
county and continuing west along the Limestone and Lauderdale county lines. The land area of
the Huntsville CWA is filled with many streams and smaller rivers which feed primarily into the
Tennessee River.

The eastern portion of the CWA includes Madison, Marshall, Jackson, and DeKalb
counties. These counties comprise the southwest edge of the Cumberland Plateau and the
Appalachian Mountains. Elevations are primarily greater than 750 ft., reaching near 2100 ft in
DeKalb county. This portion of the CWA contains three significant terrain features: the
Cumberland Plateau, covering most of northern Jackson county, Sand Mountain, a broad ridge
extending from Marshall county, through DeKalb county into Jackson county, and Lookout
Mountain, a high prominent ridge encompassing most of eastern DeKalb county. Sharp elevation
differences of 750-1000 ft. are common across the three easternmost counties of the CWA.

Franklin, Lawrence, Colbert, Limestone, and Lauderdale counties in the western portion of the Huntsville CWA are typically between 500 ft. and 750 ft. and consist of gently rolling hills or flat agricultural areas. Northwest Colbert county and southwest Lauderdale county range in elevation from 250 ft. to 500 ft. The elevations of the more mountainous areas in Franklin, Colbert, and southwest Lawrence counties increase to between 750 ft. and 1500 ft.

In the central portion of the CWA, Cullman and Morgan are primarily a mixture of mountainous terrain (between 750 ft. and 1500 ft.), gently rolling hills (between 500 ft. and 750 ft.), and the lower flood plains bordering the Tennessee River (250-500 ft.). This portion of the CWA also includes an area of very low elevations between 250 ft. and 500 ft. in southwest Cullman county.

1.3 Databases: Criteria, Sources, and Compilation

Three primary sources were used produce the databases analyzed in this study. These sources are listed below:

- Storm Prediction Center Databases (SPC)
- Significant Tornadoes: 1860-1991, by Thomas Grazulius
- *Storm Data* (Storm Data), published by National Climatic Data Center, Ashville, NC

In compiling this information, SPC data were considered correct when conflicting accounts were presented in different sources. Data from the Storm Prediction Center can be found at the SPC homepage (<http://www.spc.noaa.gov/>). SPC data were considered to be the correct data when conflicts arose because: 1) *Storm Data* lacked temporal resolution describing many events prior to 1980, 2) *Storm Data* did not classify each tornado event using an F-scale rating prior to 1980, and 3) All classifications of F-scale ratings were included in SPC data.

All events in these databases were the results of thunderstorms producing one of the following weather phenomena below:

- Confirmed tornado
- Confirmed winds of at least 50 knots (58 MPH) or damaging winds
- Confirmed hail at least three quarters of an inch in diameter

Tornado Database - The primary source for this tornado database was the Storm Prediction Center (SPC) tornado database from 1950 to 1995. This information was then supplemented with tornadoes documented in Significant Tornadoes from 1860 to 1949. Any additional tornadoes found in *Storm Data* publications were added. *Storm Data* and SPC both listed details of a tornado in county segments. These segments were merged to form one complete tornado path. Grazulius's Significant Tornadoes recorded the characteristics of a tornado's entire path.

Hail/Wind Databases - SPC databases were used to gather information on all hail and convective wind events from 1955 to 1995. The SPC databases were then supplemented by *Storm Data* for both types of events from 1996 to 2001.

1.4 Definitions

Several terms in this study are used during the following discussion of the HUN Severe weather climatology. The terms used are defined below.

1. Tornado Outbreak- An event in which a single, organized weather system produces 6 or more tornadoes. It ends when the beginning time of the last tornado in an outbreak is not followed by another tornado within a 6-hr period.
2. Tornado Day- Day in which a county in CWA experiences at least one tornado.
3. Weak Tornado- Tornado classified by Fujita's F-scale rating system as an F0 or F1 tornado.
4. Strong Tornado- Tornado classified by Fujita's F-scale rating system as an F2 or F3 tornado.
5. Violent Tornado- Tornado classified by Fujita's F-scale rating system as an F4 or F5 tornado.

2.0 STATISTICAL METHODOLOGY AND ANALYSIS

___All statistical observations were formulated through analysis of the three databases listed in Section 1.3. The databases were prepared in Paradox 9 format and then queried for analysis. For each database, characteristics of a particular type of severe weather event were analyzed in yearly, monthly, and hourly intervals.

2.1 Analysis of Strong and Violent Tornadoes

2.1.1 Distribution By Year

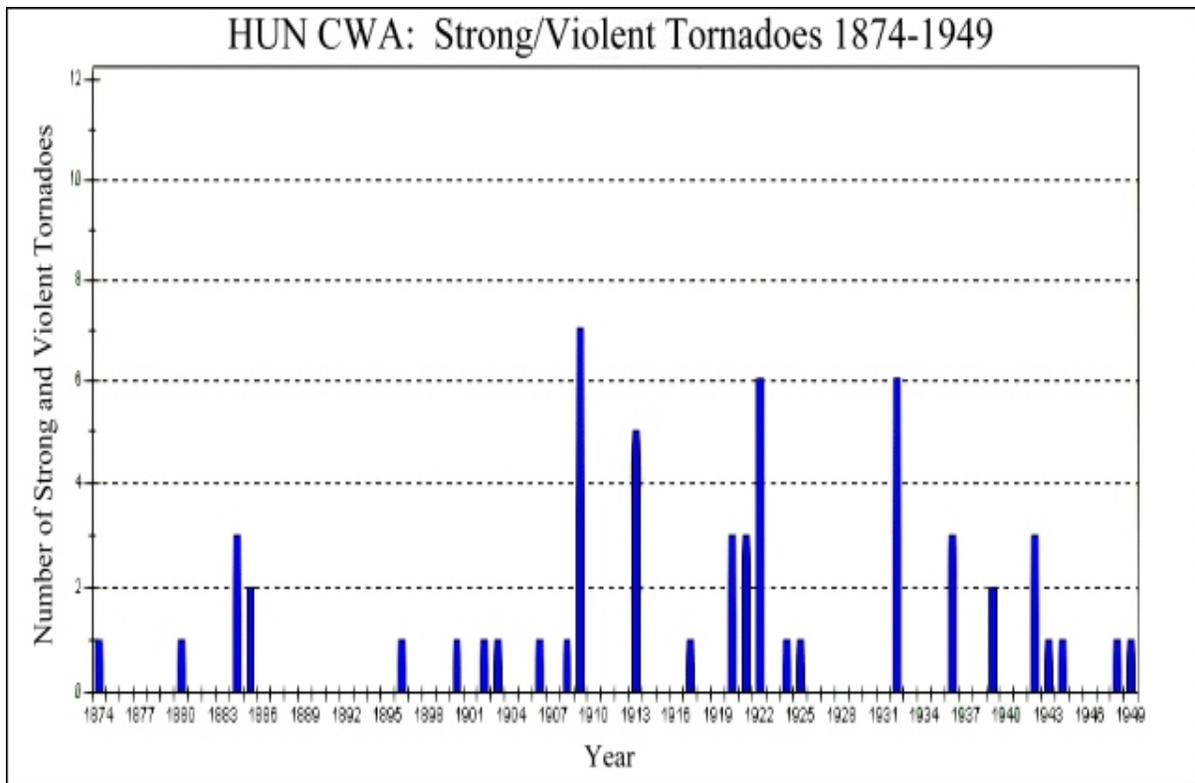
The distribution of strong/violent tornadoes in the Huntsville CWA is shown in Figures 3 and 4. From 1874 to 1949, the CWA averaged one strong/violent tornado a year. However, from 1950 to 2001, the yearly average frequency of strong/violent tornadic events increased to almost three per year. The events listed below likely had a positive impact on the increased number of confirmed strong/violent tornado events after 1949:

- The population of the CWA increased steadily from 486,348 in 1950 to 940,508 in 2000.
- The official NWS verification program for severe thunderstorm/tornado warnings commenced in 1980.

- The density of the storm spotter network increased after the opening of the Weather Service Office in Huntsville, AL in 1958.
- Public awareness/education of tornadic and severe thunderstorm phenomena increased steadily with time. (hail, microbursts, etc.)

As can be seen in Figures 3 and 4, there is no discernable pattern in the distribution of strong/violent tornadoes from 1874 to 2001. The most active years were 1973 and 1974, highlighted by the 11 strong/violent tornadoes which occurred during the infamous Super outbreak of April 3, 1974. This outbreak produced all 3 of the F5 tornado events experienced in the Huntsville CWA and was responsible for 504 injuries and 47 (53%) deaths documented from 1950 to 2001 in this study. Other especially active years included 1909, 1913, 1922, 1932, 1957, 1958, and 1985.

Figure 3. Distribution of strong/violent tornadoes from 1874 to 1949.



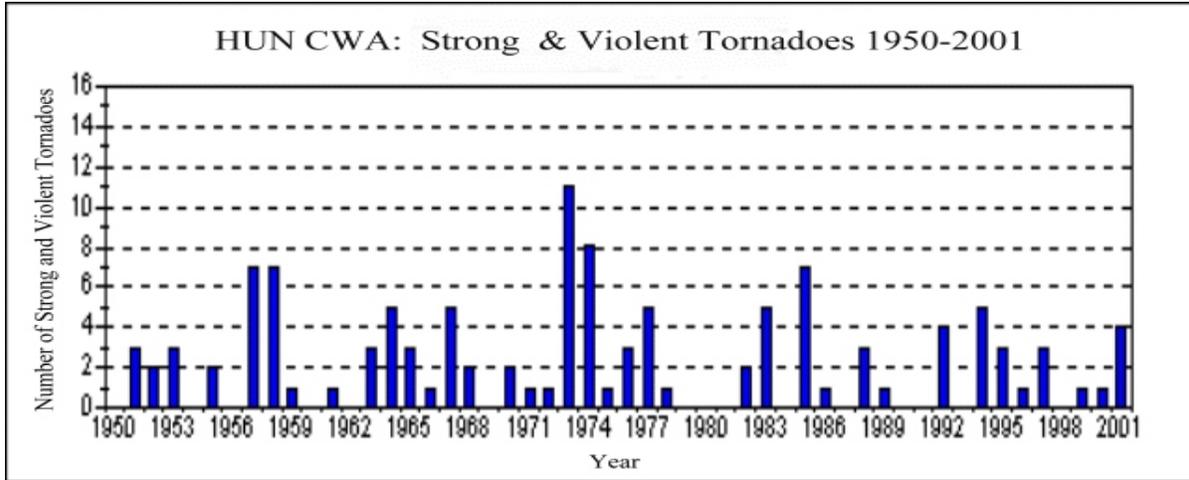


Figure 4. Distribution of strong/violent tornadoes from 1950 to 2001.

2.2 Analysis of all confirmed tornadoes in the Huntsville CWA

2.2.1 Distribution By Year

There is no source that officially documents weak tornadoes prior to 1950. After 1950, scientific advances in the classification of tornado events, spurred by Professor Theodore Fujita, led to improved documentation and more accurate reporting of tornado events. During this period, weak (especially F1 and F0) tornadoes began to be identified and documented correctly. In order to present a more accurate climatology of tornado events in the CWA, the database from 1950 to 2001 was used. Many factors such as those listed in 2.1.1 lend validity to an analysis of this period. The distribution of all confirmed tornadoes in the Huntsville CWA between 1950 and 2001 is shown in Figure 5.

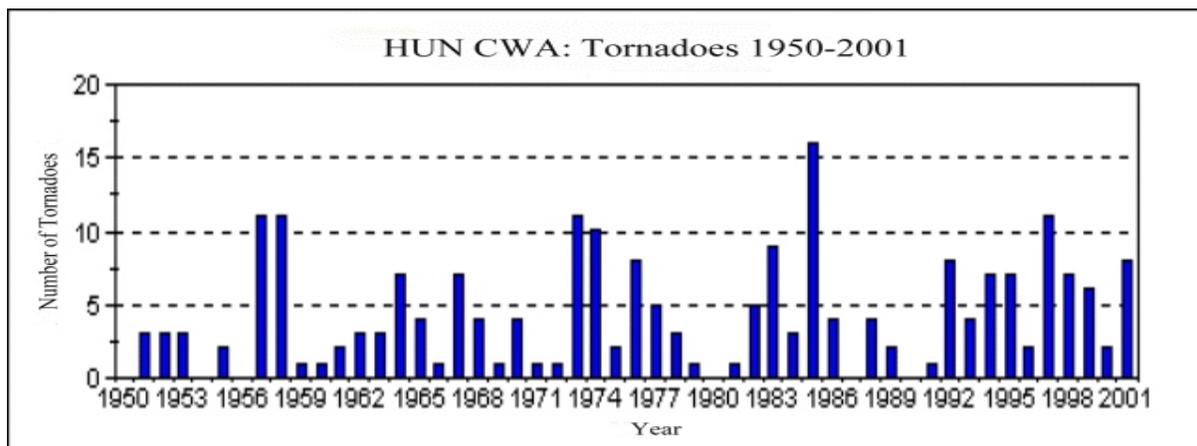


Figure 5. Distribution of tornadoes in CWA from 1950 to 2001.

No discernable pattern is noted when analyzing Figure 5, although several years of peak tornadic activity are evident. The CWA averages more than 4 tornadoes per year and slightly more than 2 tornado days per year. The most active year for tornadic activity occurred in 1985 with 16 tornadic events. This maximum was caused by the interaction of Hurricane Danny with a frontal boundary over the southeast U.S. Since 1950, tornado outbreaks in the CWA have occurred on the following dates: 04/05/1958, 04/03/1974, 03/20/1976, 08/16/1985, 11/22/1992, and 11/24/2001.

2.2.2 Distribution by Month

The monthly distribution of tornadoes from 1950 to 2001 is shown in Figure 6. This graph depicts 3 peak periods of tornadic activity in the CWA: April-May, August, and November. The August maximum observed in Figure 6 is heavily biased by the Hurricane Danny outbreak on 08/16/1985, which produced 12 (85.7% of the total for the month) tornadoes. Figure 7 depicts two periods of peak tornado activity: the spring months of March, April, and May, and the fall month of November. During these months, atmospheric conditions are favorable for tornado formation and development. These two periods are separated by an extended lull in activity from June through October. The exceptions during this quiet period are usually due to hurricane activity, as with Danny in August of 1985.

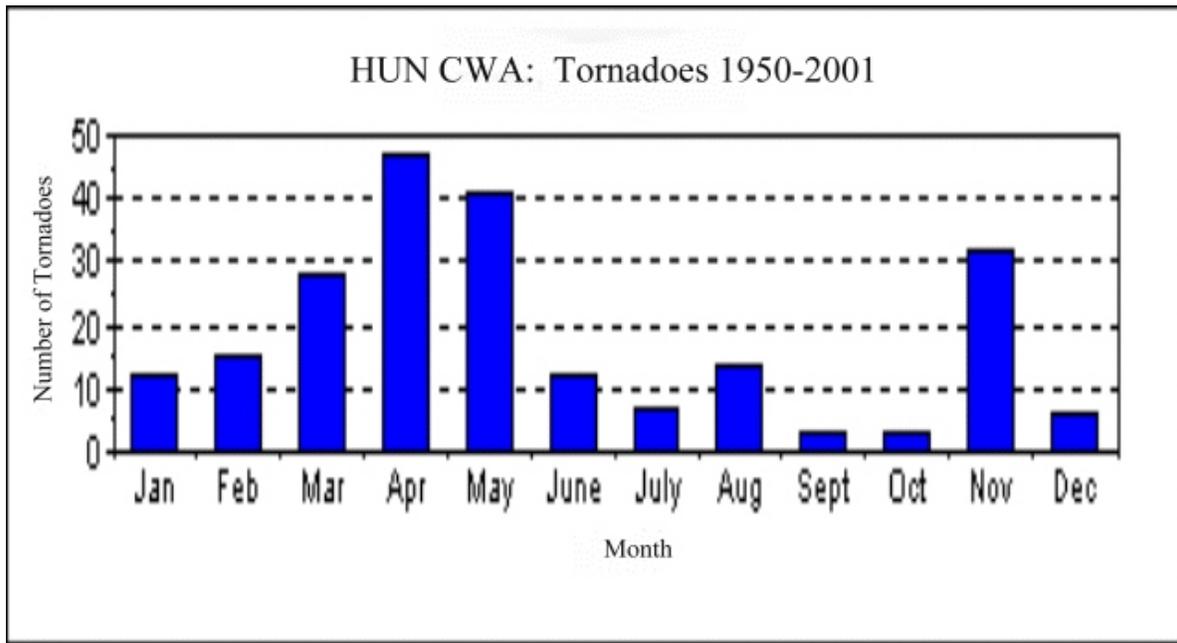


Figure 6. Monthly distribution of tornado events in the CWA from 1950 to 2001.

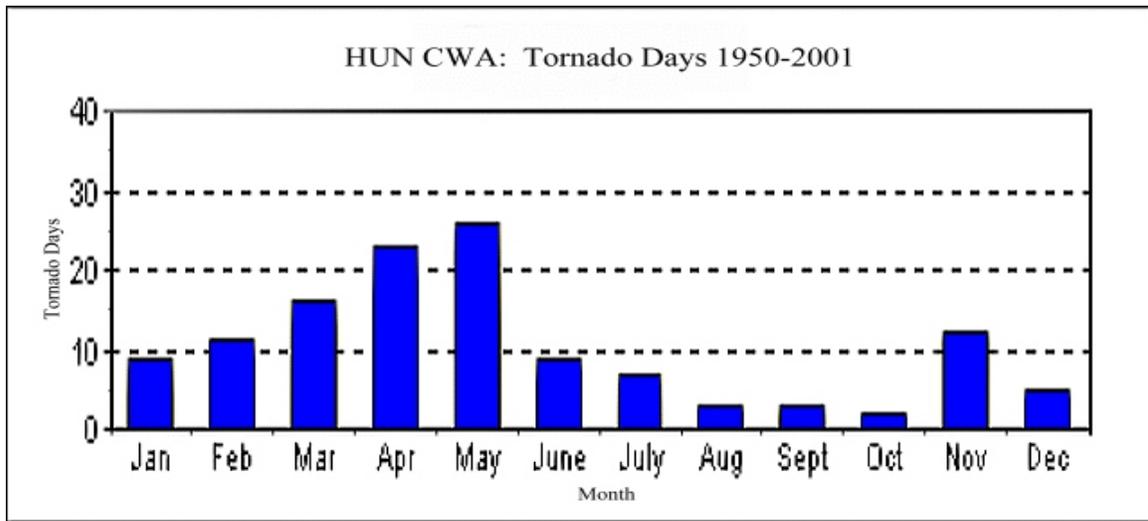


Figure 7. Monthly distribution of tornado days from 1950 to 2001.

2.2.3 Monthly Deaths & Injuries Due to Tornadoes

From 1950 to 2001, 220 tornadic events were confirmed in the CWA. These tornadic events were responsible for 99 deaths. The monthly distribution of these deaths is shown in Figure 8. Historically, the spring season is the deadliest period in the CWA. The months of March through May account for 115 (52%) of these tornadic events and 68 deaths. April is the most deadly and active single month of tornado activity in the CWA, accounting for 47 events (21%) and 56 deaths (56%) from 1950 to 2001. May ranks second in tornadic activity with 40 (18%) tornado events, but only 3 (3%) of the deaths. By comparison, November ranks third in tornado activity (15%), but it ranks second in deaths (21.2%). The injuries due to tornadoes during this time period mirror the patterns seen in deaths, as seen in Figure 9.

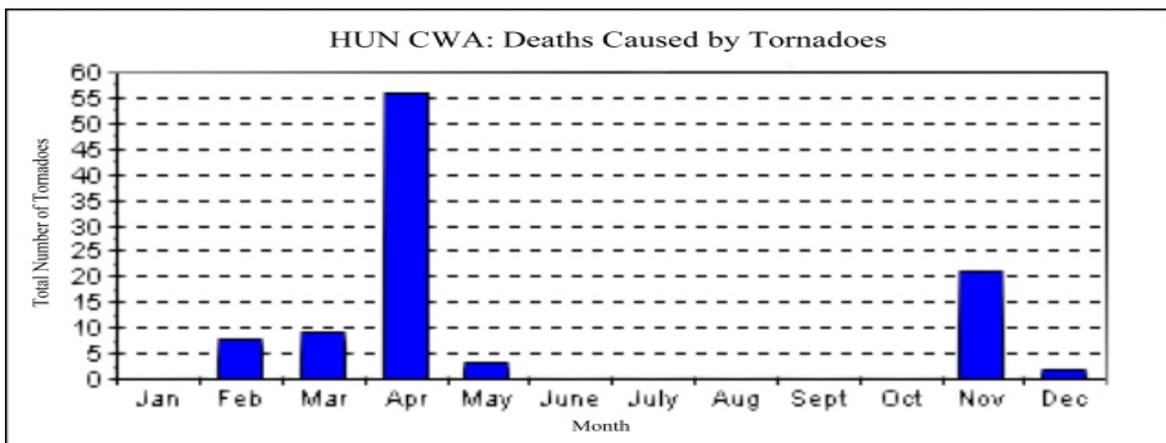


Figure 8. Deaths caused by tornadoes in Huntsville CWA.

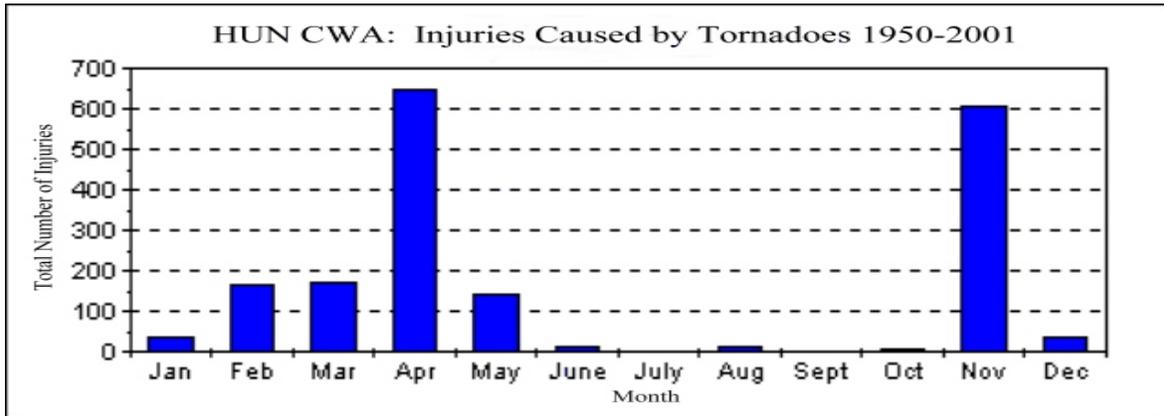


Figure 9. Injuries caused by tornadoes in Huntsville CWA.

2.2.4 Tornadoes By Hour

The hourly distribution of tornadoes is depicted in Figure 10. One hundred and seventy seven (80.5%) of the 220 tornadoes in the CWA occurred between 1100 CST (11 AM) and 0001 CST (12:01 AM). The two most notable peak periods of activity occur in the early afternoon and evening hours. The highest level of activity is between 1600 CST (4 PM) and 1901 CST (7:01 PM). A second high level of activity is seen between 1200 CST (Noon) and 1501 CST (3:01 PM). A third (much lower) peak in tornadic activity occurs between 0800 CST (8 AM) and 1001 CST (10:01 AM). The most tornadoes during any single hour in the CWA occur between 1600 CST (4 PM) and 1701 CST (5:01 PM).

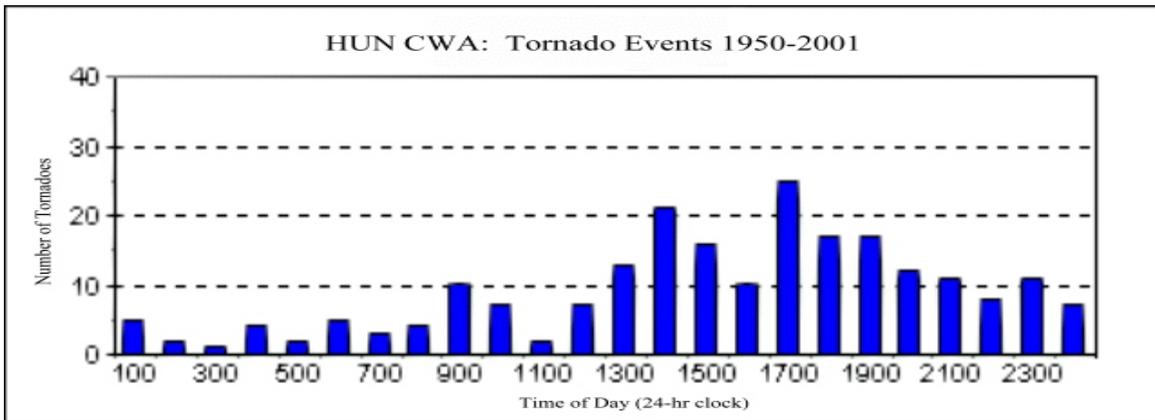


Figure 10. Hourly distribution of tornado events.

2.2.5 Hourly Deaths Due to Tornadoes

Deaths due to tornadoes (Fig.11) are distributed mainly during two peak time frames.

The greatest number of deaths in the CWA occur between 1600 CST (4 PM) and 1901 CST (7:01 PM) and account for 71.7% of all tornado deaths. A second peak in fatalities is present between 0300 CST (3 AM) and 0601 CST (6:01 AM). This period accounts for 15.2% of all deaths due to tornadoes in the CWA. In summary, most deaths occur in the CWA either in the late afternoon/early evening hours or near daybreak.

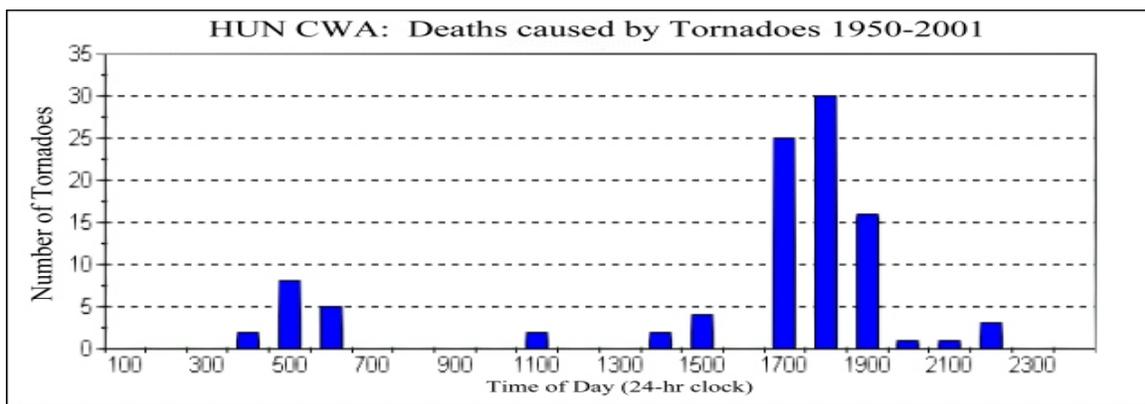


Figure 11. Deaths caused by tornadoes in the HUN CWA.

2.2.6 Tornadoes and Tornado Deaths/Injuries By F-scale

Most confirmed tornadoes in the HUN CWA can be categorized as weak. Tornado events classified in the F0-F2 range constitute 178 (81%) of all tornado occurrences in the CWA from 1950-2001. F2 tornadoes are the most prevalent F-scale classification in the HUN CWA, constituting 35% (77) of all events. F1 tornadoes are a close second, accounting for 69 (32%) events. F3, F4, and F5 tornado occurrences from 1950 to 2001 account for 19% (42) of all tornado events. F3, F4, and F5 tornadoes were responsible for 94% of all deaths and 86% of all injuries caused by tornadoes in the Huntsville CWA. F4 and F5 tornadoes constituted only 5% (11) of all tornadoes that affected the Huntsville CWA from 1950 to 2001. These violent tornadoes were the cause of 79% of all deaths and 69% of all injuries caused by tornadoes. Although F3, F4, and F5 tornadoes are relatively uncommon, these tornadoes account for most of the deaths/injuries caused by tornadoes in the CWA.

2.3 Hail Events in Huntsville CWA

2.3.1 Hail By Year

The yearly distribution of hail events in the Huntsville CWA is shown in Figure 12.

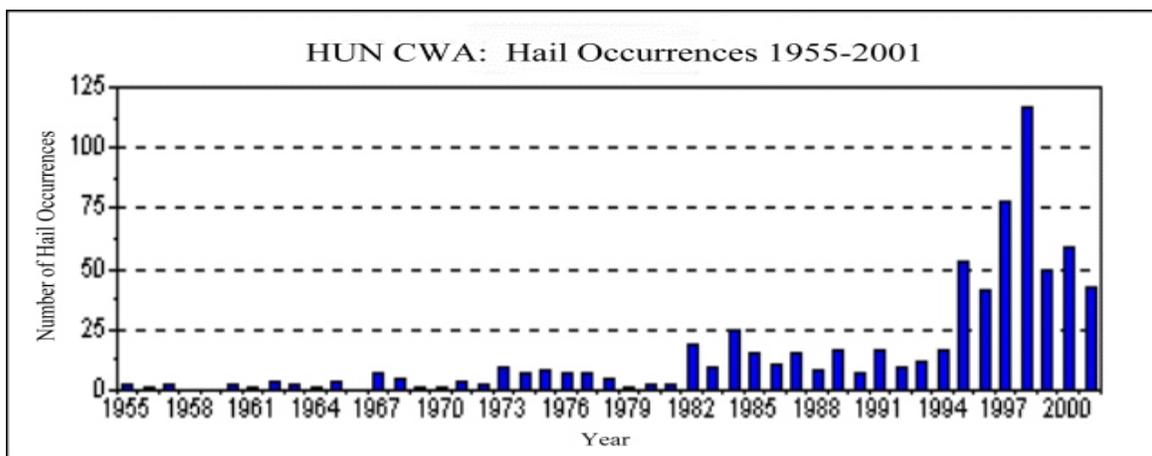


Figure 12. Number of hail events per year in CWA.

Reported hail events are very sparse from 1955 through 1980. Prior to 1980, less than 10 hail events were confirmed each year. Even during the active year of the Super Outbreak of 1974, only 7 confirmed hail events were reported. From 1955 to 1981, the CWA averaged 3 hail events, and from 1982 to 1994 it averaged nearly 14 hail events per year. The number of events increased in the early 1980's after the National Weather Service officially began their severe weather verification program, and jumped rapidly after the NWS modernization progressed in the early 1990's. After 1994, the CWA averaged almost 63 confirmed hail reports each year. There is no gradual shift which would lend credibility to the climatological accuracy of the entire hail database. In order to gain as much insight as possible to hail events due to severe convective storms, the hail database was only analyzed from 1982 to 2001. This period accounts for 621 (88%) of the 706 confirmed hail reports from the entire period from 1955 to 2001.

2.3.2 Hail Events By Month (1982 to 2001)

As seen in Figure 13, the primary months for hail activity are March through June, with the month of May containing the most events. This is indicative of the combination of a lower freezing layer height, higher CAPE, and a stronger flow of moisture interacting with cold air masses. The number of hail events in the CWA trends downward from June through December, followed by a secondary peak in the month of January. The secondary jump in tornadic activity seen in Figure 6 in November is not reflected in the hail events database.

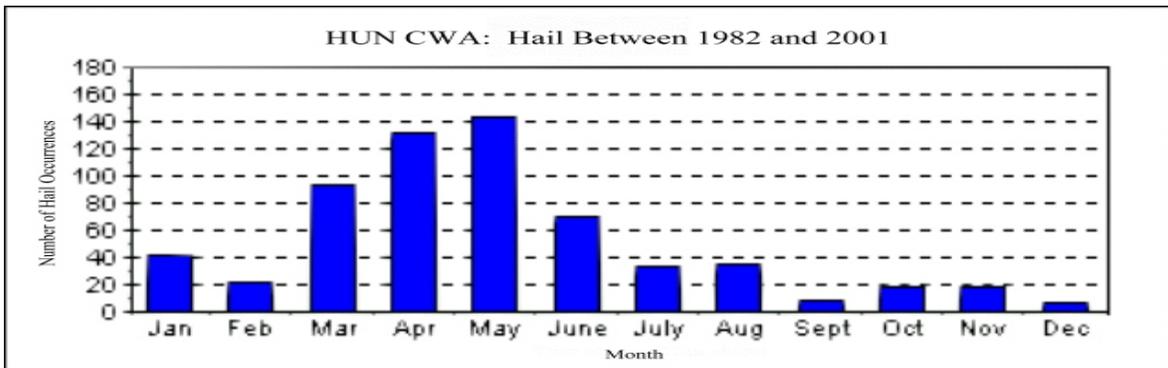


Figure 13. Monthly distribution of hail events.

2.3.3 Hail By Hour (1982 to 2001)

The hourly distribution of hail events during this period is shown in Figure 14. The confirmed hail events primarily occur between 1300 CST (1 PM) and 2101 CST (9:01 PM) and account for 458 (74%) of the 621 events during this period. A significant jump in activity occurs after 1300 CST (1 PM) with a peak level of activity between 1600 CST (4 PM) and 1701 CST (5 PM). This corresponds well with the time of maximum daytime heating and maximum CAPE values. The frequency of events decreases steadily after 2000 CST (8 PM), reaching a minimum near daybreak.

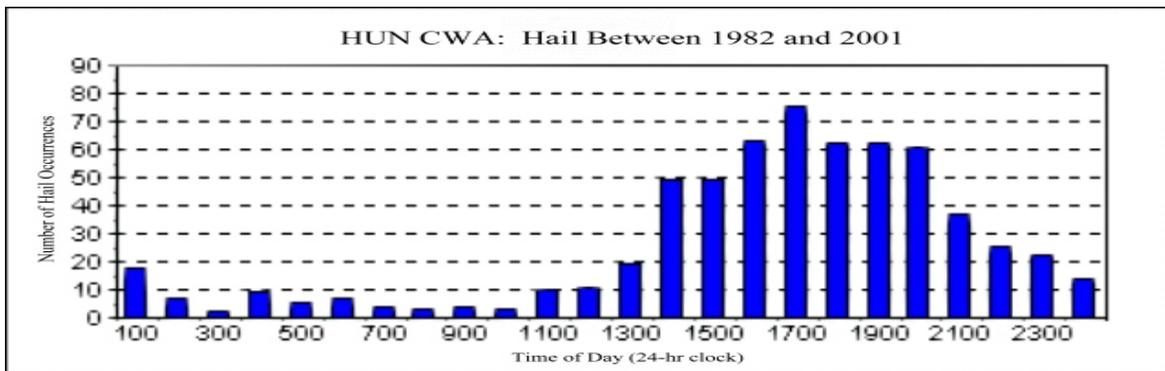


Figure 14. Hourly distribution of hail events.

2.2.4 Wind Events Due to Severe Convective Storms

2.4.1 Distribution By Year (1955 to 2001)

A total of 1317 wind events affected the CWA from 1955 to 2001. The distribution of wind events during this period is shown in Figure 15. Between 1955 and 1962, the CWA averaged 2.75 confirmed wind events per year, and reports were very sporadic in comparison to

later years. From 1963 to 1981, the number of confirmed wind events in the CWA increased significantly, averaging 12.5 events per year. After the beginning of the NWS verification program in 1980, the number of confirmed wind reports continued to increase. During the period from 1982 to 2001, the CWA averaged 52.9 events per year. Unlike the hail database, wind events were not nearly as sparsely distributed prior to 1980. However, there is a distinct difference in the average number of confirmed wind events after 1982, as shown in Figure 15. Therefore, the wind database from 1982 to 2001 was used in the following analysis.

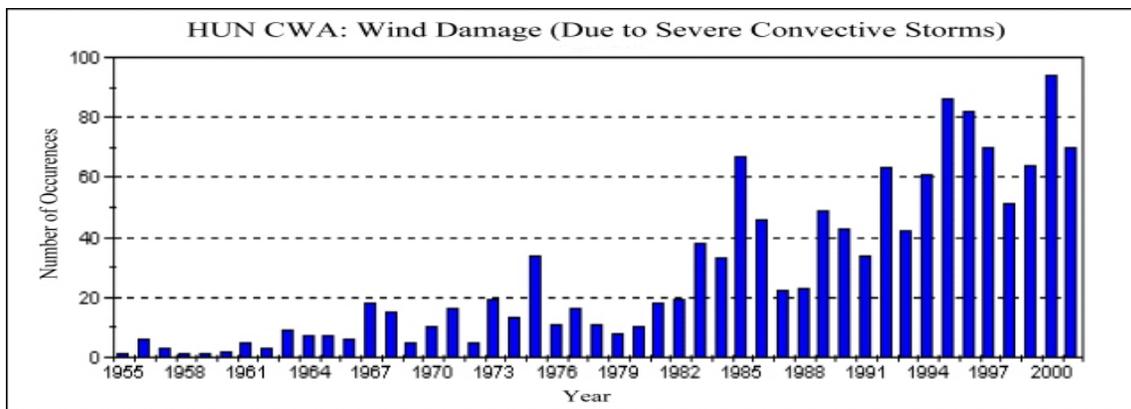


Figure 15. Yearly distribution of wind events from 1955 to 2001 (Due to convective storms).

2.4.2 Distribution By Month 1982 to 2001

As seen in Figure 16 (pg. 13), there are two noticeable peaks in the monthly distribution of wind events in the CWA, which occur during the late winter/spring and summer months. The peak seen in February through May is usually caused by squall line and supercell thunderstorms associated with stronger upper level dynamics. The greater of the two peaks in June through July is primarily caused by microbursts produced by pulse severe thunderstorms. The peak period of wind events in the CWA spans a five month period from February through August. This is in contrast to the sharper peaks noted in the tornado and hail databases shown earlier.

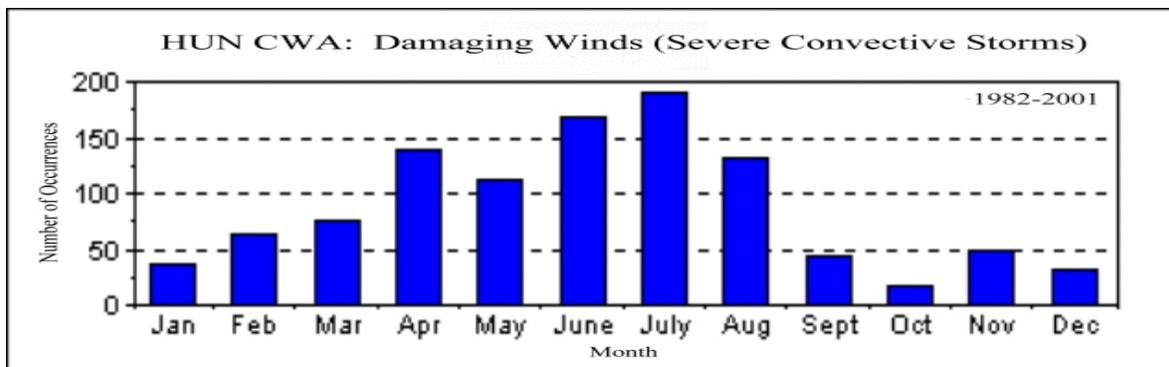


Figure 16. Monthly distribution of wind events (Due to Convective Storms) from 1982 to 2001.

2.4.3 Distribution By Hour 1982 to 2001

_____The hourly distribution of wind events in Figure 17 displays one broad peak period of activity during the afternoon/early evening hours, reaching a maximum between 1600 CST (4 PM) and 1701 (5:01 PM). Approximately 79% of all convective wind events in the CWA occur between 1100 CST (11 AM) and 2101 CST (9:01 PM). The number of wind events drops off dramatically after 2100 CST (9 PM), reaching a minimum near daybreak.

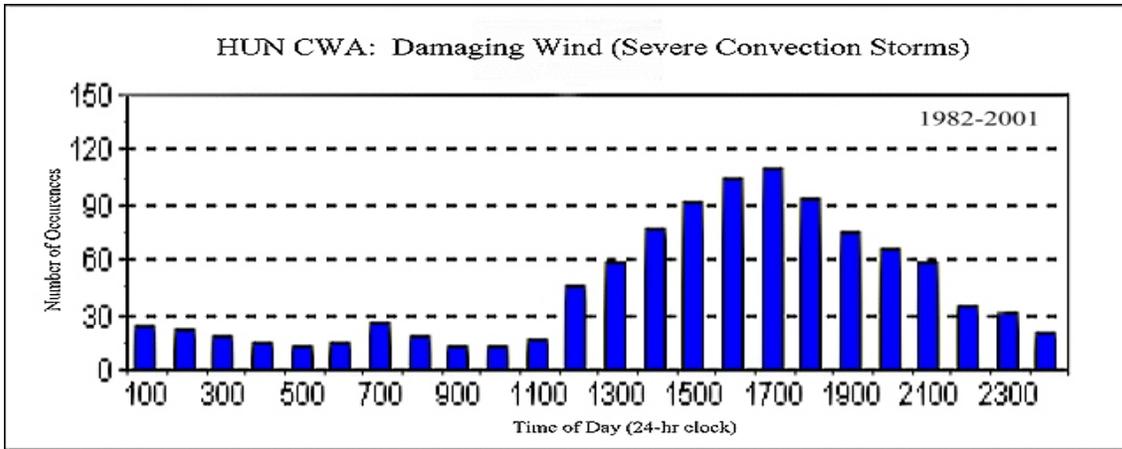


Figure 17. Hourly distribution of wind events from 1982 to 2001 (Due to Convective Storms).

3.0 ACKNOWLEDGMENTS

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