A SEVERE WEATHER CLIMATOLOGY FOR THE WILMINGTON, NC WFO COUNTY WARNING AREA

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1. INTRODUCTION

The National Weather Service (NWS) Warning Forecast Office (WFO) located in Wilmington, NC has forecast and warning responsibility for fourteen counties spanning northeast South Carolina and southeast North Carolina (Fig. 1). Although the area may be better known for its vulnerability to land falling tropical cyclones, non-tropical severe thunderstorms are not uncommon. They often form as mid and upper-level tropospheric waves interact with the sea breeze front, the Piedmont trough, and the abundance of moisture provided by both the Atlantic Ocean and the Gulf of Mexico.

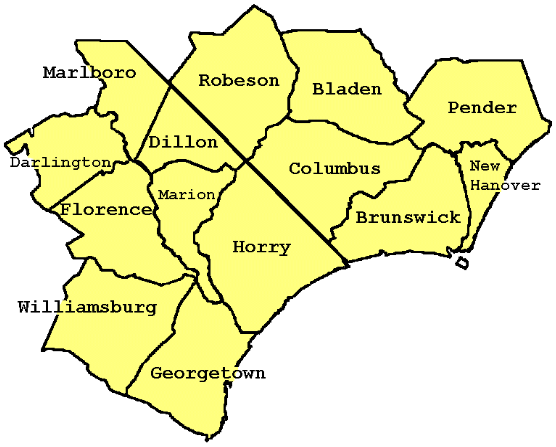

Figure 1. *The County Warning Area includes eight counties in northeast South Carolina and six counties in southeast North Carolina.*

2. DATA

By NWS definition, a severe local storm is one that is sufficiently intense to threaten life and/or property, including thunderstorms with large hail, damaging wind, or tornadoes (National Weather Service 1995).

The NWS Storm Prediction Center (SPC) in Norman, OK and the National Climatic Data Center (NCDC) in Asheville, NC provide online access to documented severe weather events across the United States. Each site provides tornado data from 1950 through 1995, and wind and hail data from 1955 through 1995. The NCDC site supplements this data with documented events through the present. Data for this study was supplemented with Local Storm Data publications and is current through December 31, 2000. All times are referenced to Eastern Standard Time.

3. COUNTY WARNING AREA TOPOGRAPHY AND DEMOGRAPHICS

The sandy soil of the central and eastern sections of the Carolinas is bounded by clay-laden soil to the west and the Atlantic Ocean to the east. On sunny days, the air mass over the sandy terrain heats up more quickly than its bordering air masses and results in the formation of a surface trough of low pressure (Fig. 2). Referred to as the *Piedmont trough*, this feature is often convectively active during the late spring and summer months (Koch et al. 1997).

Another feature which often provides the focus for thunderstorm development is the sea-breeze front (Fig. 3). Like the Piedmont

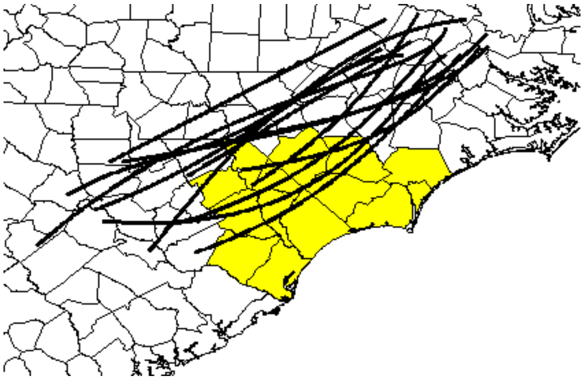

Figure 2. *The location of 13 Piedmont troughs that formed from May through September 1994 (adapted from Koch et al. 1997).*

trough, this boundary forms in response to differential heating. It can develop as early as mid-morning on hot spring and summer days, and defines the inland progression of the marine layer. On a typical day, the marine layer will penetrate across the coastal counties, but on occasion can progress inland 100 miles or more and blanket the entire county warning area (CWA) with more stable marine air.

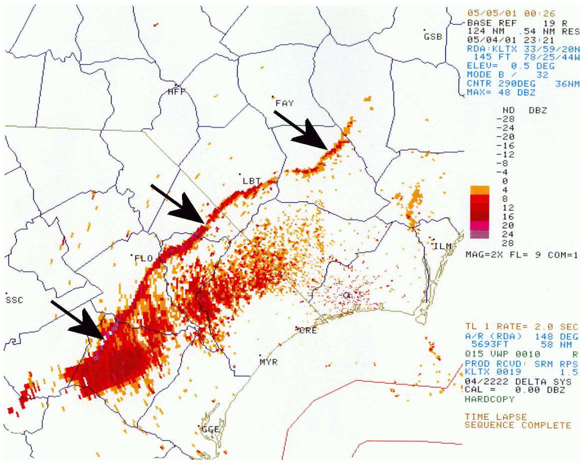

Figure 3. *Example of the sea-breeze front indicated in KLTX WSR-88D reflectivity at 2321 UTC 4 May 2001.*

These phenomena do not, in themselves, determine the severity of thunderstorms. However they do have a significant impact in defining the areas that are more or less likely to experience convection.

Population density variations across the CWA likely bias local severe weather climatology statistics. Figure 4 shows that counties with lower population densities often report less severe weather, possibly because many events are not witnessed firsthand and therefore go unreported.

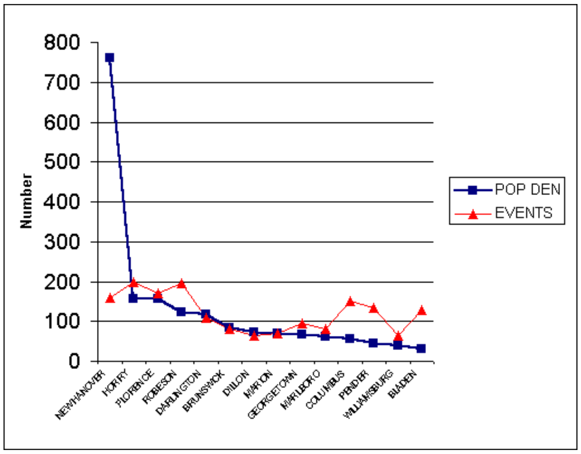

Figure 4. *County population density (persons per square mile) based on 1999 Census Bureau estimates, and number of documented severe weather events from 1950-2000.*

Although one may expect more severe weather events to occur in larger counties, statistics do not always show this correlation (Fig. 5). For example, Horry county is the largest county in terms of square miles, and also reported the most severe weather. However Williamsburg county, the fourth largest, reported the least. This may be attributed to the fact that Horry county is the most densely populated county and Williamsburg county is among the least.

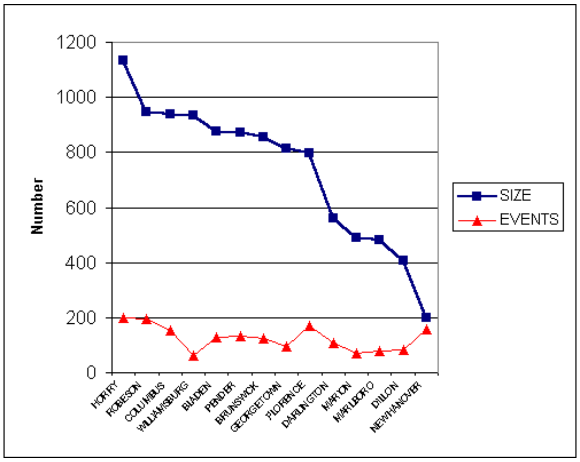

Figure 5. *County size (in square miles) and number of documented severe weather events from 1950-2000.*

4. TORNADO CLIMATOLOGY

a) Monthly frequency

The monthly distribution of tornadoes shows that the CWA experiences three different tornado seasons within a year (Fig. 6). An increasing trend begins in January and peaks in June, with the sharpest increase in activity from February to March. Of the tornadoes on record from 1950-2000, 50% occurred from March through June.

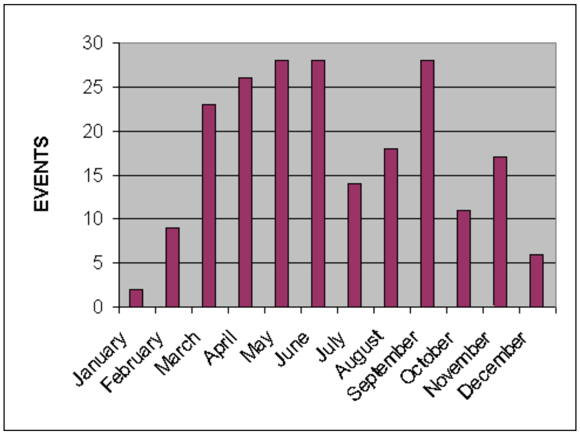

Figure 6. *The monthly distribution of tornadoes (1950-2000).*

Secondary peaks occurred in September and November. The November maximum is known nationally as the second "tornado season" (Grazulis 1993). The September peak is unique to coastal regions of the United States from Texas to Virginia, and coincides with the peak in tropical cyclone season.

b) Hourly frequency

Diurnal trends over the course of a year show an increase in activity after 10 AM. Mid to late afternoon is the most active part of the day with a peak between 4-5 PM. Thirty-nine percent of events occurred between 2-5 PM (Fig. 7).

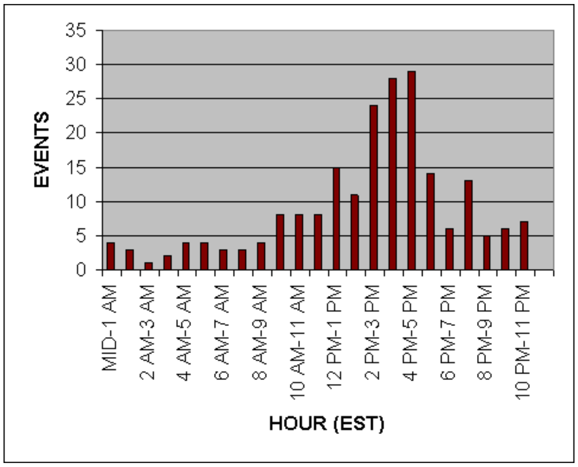

Figure 7. *The hourly distribution of all tornadoes (1950-2000).*

When viewed separately, the three tornado seasons reveal differing diurnal trends. During the March-June season, activity increases after 10 AM, peaks between 4-5 PM, and drops off sharply after 5 PM (Fig. 8). Only 2% of these tornadoes occurred between 11 PM and 7 AM. The October-November activity peaked between 2-5 PM, with 64% of events within this time range (Fig. 9). August and September events were more evenly distributed. Sixty-five percent occurred between noon and 10 PM (Fig. 10).

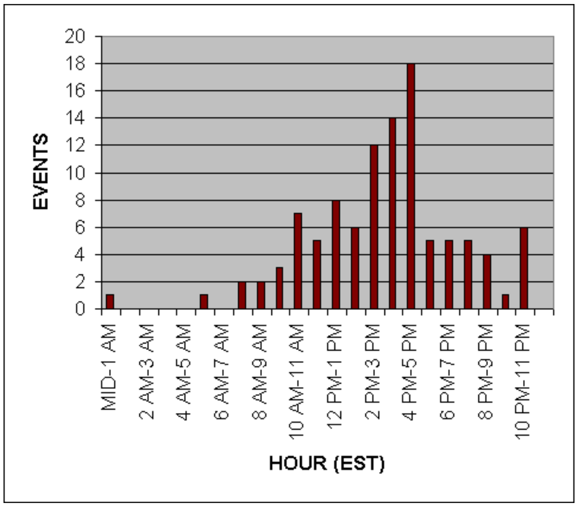

Figure 8. *The hourly distribution of March-June tornadoes (1950-2000).*

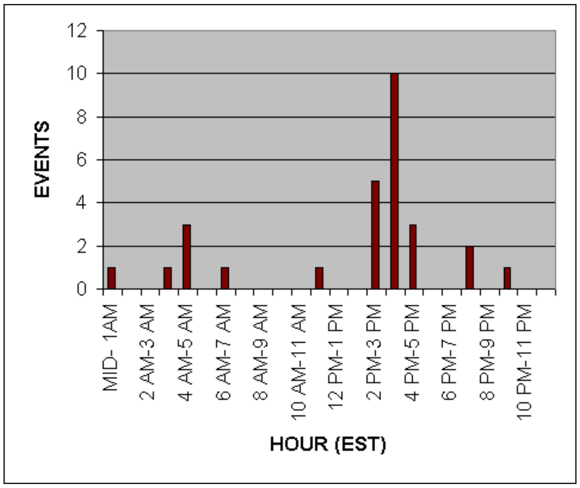

Figure 9. *The hourly distribution of October-November tornadoes (1950-2000).*

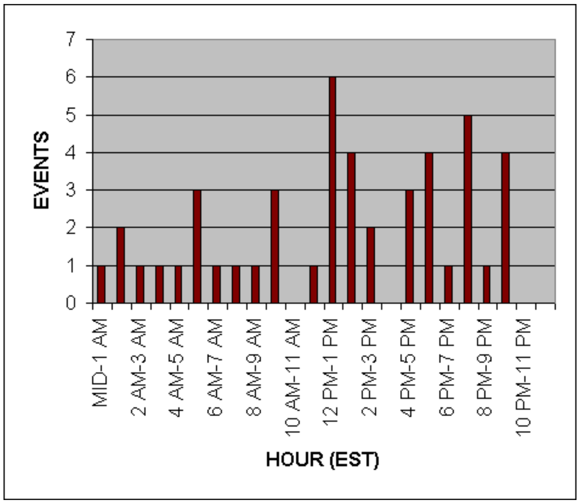

Figure 10. *The hourly distribution of August-September tornadoes (1950-2000).*

Late night and early morning tornadoes were more common during August and September than during other months, with one-third having occurred between midnight and 10 AM. A reason may be that tropical cyclone (TC) tornado activity is closely associated with the enhanced wind fields and vertical shear near the center of tropical cyclones, and landfall can occur at any hour. Studies have shown that TC tornado activity peaks during the 24 hours following landfall (Hill et al. 1966; Nolan and Gray 1974; Gentry 1983). Unfortunately the data available for this study does not distinguish tropical tornadoes from non-tropical ones.

c) Magnitude

The Fujita Scale (Table 1) attempts to classify tornado intensity based on the extent of the associated wind damage (Fujita 1981). Most tornadoes which occurred in the CWA were classified as weak. Of the 216 tornadoes which were rated according to the Fujita Scale, 75% were ranked as either F0 or F1 (Fig. 11). There have been 6 known occurrences of F4 tornadoes in the CWA between 1950-2000, however no documented tornadoes have produced F5 damage.

Table 1. The Fujita Scale

Scale	Wind Speed	
0	40-72 mph	Weak
1	73-112 “	Weak
2	113-157 “	Strong
3	158-206 “	Strong
4	207-260 “	Violent
5	261-318 “	Violent

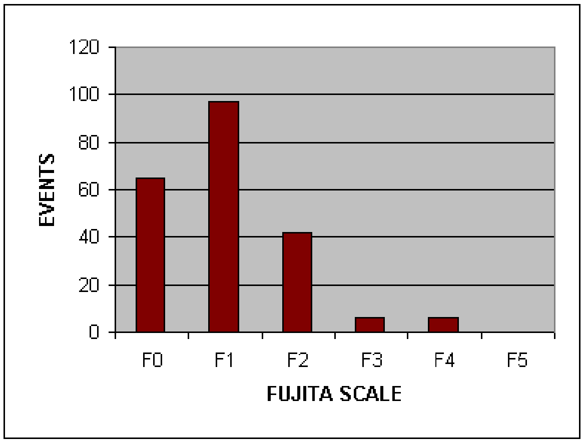

Figure 11. *Tornado distribution by F-Scale (1950-2000).*

5. HAIL CLIMATOLOGY

a) Monthly frequency

The monthly distribution of severe hail events shows a prominent peak during the month of May, and very little activity during the late fall and winter months (Fig. 12). Sixty-five percent occurred from April-June, and 94% occurred from March-August. Since 1955, only three cases of severe hail have been recorded between the months of October and January, with no reports in October or December.

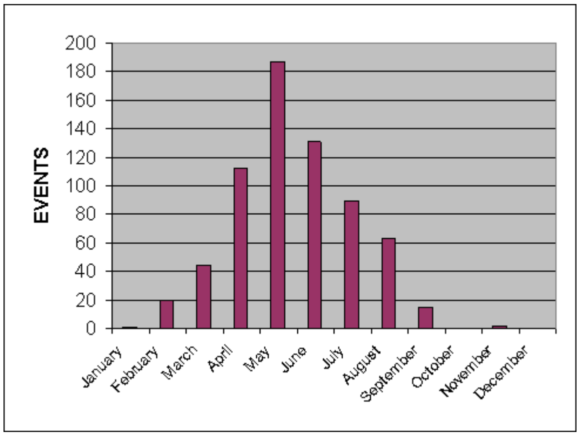

Figure 12. *The monthly distribution of severe hail events (1955-2000).*

b) Hourly frequency

Severe hail has been documented during every hour of the day, with the exception of 3-4 AM (Fig. 13). Eighty-four percent of the events occurred between 11 AM-8 PM, with diurnal trends indicating a prominent peak between 2-4 PM. Only 5% of the cases occurred between midnight and 10 AM.

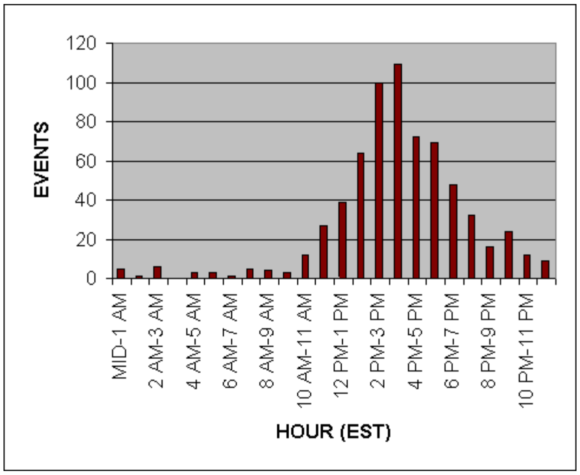

Figure 13. *The hourly distribution of severe hail events (1955-2000).*

6. WIND CLIMATOLOGY

a) Monthly frequency

The monthly distribution of severe wind events shows the most active period being May-August, during which 70% of all events occurred (Fig. 14).

b) Hourly frequency

The hourly distribution of severe wind shows that 74% of documented events occurred between noon and 8 PM (Fig.15). Outside of this time, events were evenly distributed with no secondary maximums evident. During the three most active months, this diurnal trend becomes even more apparent. From May-August, 84% of documented events occurred between noon and 8 PM (Fig. 16).

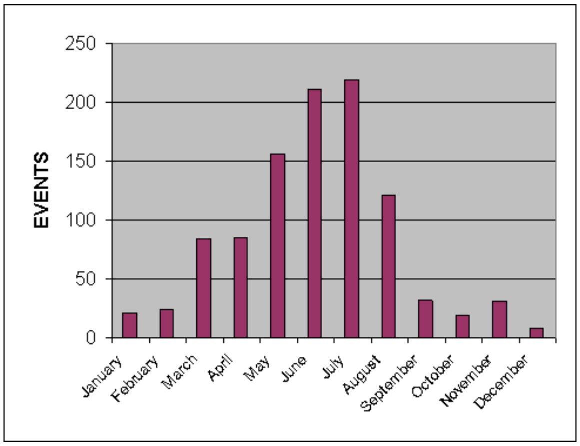

Figure 14. *The monthly distribution of severe wind events (1955-2000).*

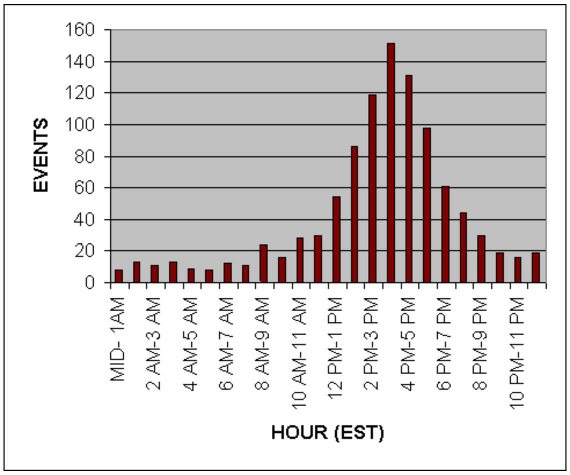

Figure 15. *The hourly distribution of all severe wind events (1955-2000).*

7. CONCLUSIONS

Becoming familiar with the monthly, hourly, and county-by-county distribution of local severe weather events will help the staff of WFO Wilmington, NC improve severe weather forecasts and warnings. Knowing the peak months and hours for severe weather will result in heightened awareness of the operational staff, and will allow the local management to make better-informed long-term staffing decisions. In addition, this climatology will aid the local Public Outreach Team by helping identify those counties which stand to benefit the most from increased outreach efforts. Also, more data should be collected to develop a more detailed study of tropical cyclone tornadoes.

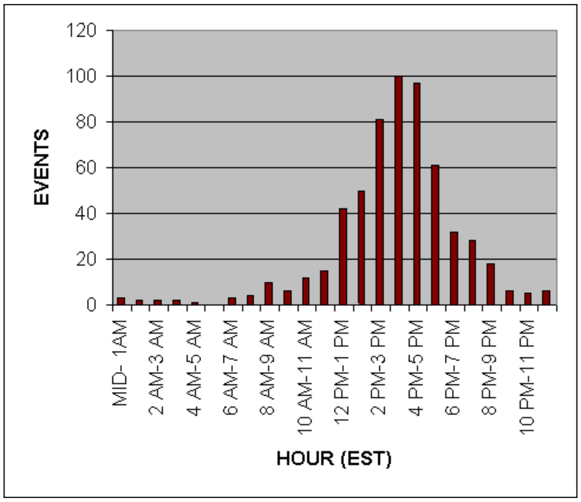

Figure 16. *The hourly distribution of May-July severe wind events (1955-2000).*

8. ACKNOWLEDGMENTS

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