NOAA Technical Memorandum
NWS ER-97

SEVERE WEATHER CLIMATOLOGY FOR THE COLUMBIA, SC WFO COUNTY WARNING AREA

Leonard C. Vaughan
National Weather Service Office
Columbia, South Carolina

Scientific Services Division
Eastern Region Headquarters
Bohemia, New York
September 2003

U.S. DEPARTMENT OF COMMERCE **National Oceanic and Atmospheric Administration** **National Weather Service**

NOAA TECHNICAL MEMORANDA
National Weather Service, Eastern Region Subseries

The National Weather Service Eastern Region (ER) Subseries provides an informal medium for the documentation and quick dissemination of results not appropriate, or not yet ready for formal publications. The series is used to report on work in progress, to describe technical procedures and practices, or to relate progress to a limited audience. These Technical Memoranda will report on investigations devoted primarily to regional and local problems of interest mainly to ER personnel, and usually will not be widely distributed.

Papers 1 to 22 are in the former series, ESSA Technical Memoranda, Eastern Region Technical Memoranda (ERTM); papers 23 to 37 are in the former series, ESSA Technical Memoranda, Weather Bureau Technical Memoranda (WBTM). Beginning with 38, the papers are now part of the series, NOAA Technical Memoranda NWS.

Papers 1 to 22 are available from the National Weather Service Eastern Region, Scientific Services Division, 630 Johnson Avenue, Bohemia, NY, 11716. Beginning with 23, the papers are available from the National Technical Information Service, U.S. Department of Commerce, Sills Bldg., 5285 Port Royal Road, Springfield, VA 22161. Prices vary for paper copy and for microfiche. Order by accession number shown in parentheses at end of each entry.

ESSA Technical Memoranda

ERTM 1 Local Uses of Vorticity Prognoses in Weather Prediction. Carlos R. Dunn. April 1965.
ERTM 2 Application of the Barotropic Vorticity Prognostic Field to the Surface Forecast Problem. Silvio G. Simplicio. July 1965.
ERTM 3 A Technique for Deriving an Objective Precipitation Forecast Scheme for Columbus, Ohio. Robert Kuessner. September 1965.
ERTM 4 Stepwise Procedures for Developing Objective Aids for Forecasting the Probability of Precipitation. Carlos R. Dunn. November 1965.
ERTM 5 A Comparative Verification of 300 mb. Winds and Temperatures Based on NMC Computer Products Before and After Manual Processing. Silvio G. Simplicio. March 1966.
ERTM 6 Evaluation of OFDEV Technical Note No. 17. Richard M. DeAngelis. March 1966.
ERTM 7 Verification of Probability of Forecasts at Hartford, Connecticut, for the Period 1963-1965. Robert B. Wassall. March 1966.
ERTM 8 Forest-Fire Pollution Episode in West Virginia, November 8-12, 1964. Robert O. Weedfall. April 1966.
ERTM 9 The Utilization of Radar in Meso-Scale Synoptic Analysis and Forecasting. Jerry D. Hill.March 1966.
ERTM 10 Preliminary Evaluation of Probability of Precipitation Experiment. Carlos R. Dunn. May 1966.
ERTM 11 Final Report. A Comparative Verification of 300 mb. Winds and Temperatures Based on NMC Computer Products Before and After Manual Processing. Silvio G.Simplicio. May 1966.
ERTM 12 Summary of Scientific Services Division Development Work in Sub-Synoptic Scale Analysis and Prediction - Fiscal Year 1966. Fred L. Zuckerberg. May 1966.
ERTM 13 A Survey of the Role of Non-Adiabatic Heating and Cooling in Relation of the Development of Mid-Latitude Synoptic Systems. Constantine Zois. July 1966.
ERTM 14 The Forecasting of Extratropical Onshore Gales at the Virginia Capes. Glen V. Sachse. August 1966.
ERTM 15 Solar Radiation and Clover Temperatures. Alex J. Kish. September 1966.
ERTM 16 The Effects of Dams, Reservoirs and Levees on River Forecasting. Richard M. Greening. September 1966.
ERTM 17 Use of Reflectivity Measurements and Reflectivity Profiles for Determining Severe Storms. Robert E. Hamilton. October 1966.
ERTM 18 Procedure for Developing a Nomograph for Use in Forecasting Phenological Events from Growing Degree Days. John C. Purvis and Milton Brown. December 1966.
ERTM 19 Snowfall Statistics for Williamsport, Pa. Jack Hummel. January 1967
ERTM 20 Forecasting Maturity Date of Snap Beans in South Carolina. Alex J. Kish. March 1967.
ERTM 21 New England Coastal Fog. Richard Fay. April 1967.
ERTM 22 Rainfall Probability at Five Stations Near Pickens, South Carolina, 1957-1963. John C. Purvis. April 1967.
WBTM ER 23 A Study of the Effect of Sea Surface Temperature on the Areal Distribution of Radar Detected Precipitation Over the South Carolina Coastal Waters. Edward Paquet. June 1967. (PB-180-612).
WBTM ER 24 An Example of Radar as a Tool in Forecasting Tidal Flooding. Edward P. Johnson. August 1967 (PB-180-613).
WBTM ER 25 Average Mixing Depths and Transport Wind Speeds over Eastern United States in 1965. Marvin E. Miller. August 1967. (PB-180-614).
WBTM ER 26 The Sleet Bright Band. Donald Marier. October 1967. (PB-180-615).
WBTM ER 27 A Study of Areas of Maximum Echo Tops in the Washington, D.C. Area During the Spring and Fall Months. Marie D. Fellechner. April 1968. (PB-179-339).
WBTM ER 28 Washington Metropolitan Area Precipitation and Temperature Patterns. C.A. Woollum and N.L. Canfield. June 1968. (PB-179-340).
WBTM ER 29 Climatological Regime of Rainfall Associated with Hurricanes after Landfall. Robert W. Schoner. June 1968. (PB-179-341).
WBTM ER 30 Monthly Precipitation - Amount Probabilities for Selected Stations in Virginia. M.H. Bailey. June 1968. (PB-179-342).
WBTM ER 31 A Study of the Areal Distribution of Radar Detected Precipitation at Charleston, S.C. S.K. Parrish and M.A. Lopez. October 1968. (PB-180-480).
WBTM ER 32 The Meteorological and Hydrological Aspects of the May 1968 New Jersey Floods. Albert S. Kachic and William Long. February 1969. (Revised July 1970). (PB-194-222).
WBTM ER 33 A Climatology of Weather that Affects Prescribed Burning Operations at Columbia, South Carolina. S.E. Wasserman and J.D. Kanupp. December 1968. (COM-71-00194).
WBTM ER 34 A Review of Use of Radar in Detection of Tornadoes and Hail. R.E. Hamilton. December 1969. (PB-188-315).
WBTM ER 35 Objective Forecasts of Precipitation Using PE Model Output. Stanley E. Wasserman. July 1970. (PB-193-378).
WBTM ER 36 Summary of Radar Echoes in 1967 Near Buffalo, N.Y. Richard K. Sheffield. September 1970. (COM-71-00310).
WBTM ER 37 Objective Mesoscale Temperature Forecasts. Joseph P. Sobel. September 1970. (COM-71-0074).

NOAA Technical Memoranda NWS

NWS ER 38 Use of Primitive Equation Model Output to Forecast Winter Precipitation in the Northeast Coastal Sections of the United States. Stanley E. Wasserman and Harvey Rosenblum. December 1970. (COM-71-00138).
NWS ER 39 A Preliminary Climatology of Air Quality in Ohio. Marvin E. Miller. January 1971. (COM-71-00204).
NWS ER 40 Use of Detailed Radar Intensity Data in Mesoscale Surface Analysis. Robert E. Hamilton. March 1971. (COM-71-00573).
NWS ER 41 A Relationship Between Snow Accumulation and Snow Intensity as Determined from Visibility. Stanley E. Wasserman and Daniel J. Monte. (COM-71-00763). January 1971.
NWS ER 42 A Case Study of Radar Determined Rainfall as Compared to Rain Gage Measurements. Martin Ross. July 1971. (COM-71-00897).
NWS ER 43 Snow Squalls in the Lee of Lake Erie and Lake Ontario. Jerry D. Hill. August 1971. (COM-72-00959).
NWS ER 44 Forecasting Precipitation Type at Greer, South Carolina. John C. Purvis. December 1971. (COM-72-10332).
NWS ER 45 Forecasting Type of Precipitation. Stanley E. Wasserman. January 1972. (COM-72-10316).

(CONTINUED ON INSIDE REAR COVER)

NOAA Technical Memorandum NWS ER-97

SEVERE WEATHER CLIMATOLOGY FOR THE COLUMBIA, SC WFO COUNTY WARNING AREA

Leonard C. Vaughan

National Weather Service Office
Columbia, SC

Scientific Services Division
Eastern Region Headquarters
Bohemia, New York
September 2003

United States
Department of Commerce
Donald Evans
Secretary

National Oceanic and
Atmospheric Administration
Conrad C. Lautenbaucher, Jr.
Under Secretary and Administrator

National Weather Service
John J. Kelly, Jr.
Assistant Administrator

TABLE OF CONTENTS

1. INTRODUCTION

The National Weather Service (NWS) Warning Forecast Office (WFO) located in Columbia, South Carolina has forecast and warning responsibility for 23 counties (Fig. 1). These counties cover an area of central South Carolina known as the Midlands, and a portion of east-central Georgia known as the Central Savannah River Area. This part of the southeastern United States can often have a very active severe weather season. The combination of abundant low-level moisture from both the Atlantic Ocean and the Gulf of Mexico along with frontal boundaries that interact with this moisture often set the stage for strong to severe thunderstorm development.

2. DATA

The data included for this study were from 1950 to 2001. Data for this paper were collected from the National Climatic Data Center (NCDC) Storm Events database. This database contains documented severe weather events from 1993 to the present. Although the months of June and July of 1993 are missing from this database, additional data were used from the NWS Storm Prediction Center (SPC), which includes tornadoes from 1950 to 1992, thunderstorm winds from 1959 to 1992 and hail from 1959 to 1992. During this period there were 2710 documented severe weather events across the county warning area (CWA) (Fig. 2). All of the times that are referenced throughout the paper are referenced to Eastern Standard Time.

3. TOPOGRAPHY AND DEMOGRAPHICS OF THE COUNTY WARNING AREA

The topography of the CWA varies greatly across the Midlands and Central Savannah River Area. The western portion of the CWA is much like the Piedmont region that borders the area to the west, which is made up of rolling land composed of clay-laden soil. The central portion of the CWA contains the sand hills that run from southwest to northeast across the area. The eastern portion of the CWA shifts from slightly rolling to flat land where it transitions to the Coastal Plain and is composed mostly of sand and clay soil.

The CWA encompasses more than 13,000 square miles (Fig. 3) with a population greater than 1,500,000 people (Fig. 4). The average population density across the area is 120 people per square mile (Fig. 5). The area contains many river basins and several large man-made lake systems.

4. TORNADO CLIMATOLOGY

4.1 Magnitude

Tornadoes are classified by intensity based on the extent of the damage and associated wind speed. This is done according to the Fujita scale (Table 1), which rates tornadoes from F0, least destructive, to F5, most destructive. Of the 278 tornadoes that were documented during the 51 year period from 1950 to 2001, there were no F5 tornadoes, 6 F4 tornadoes (2%), 18 F3 tornadoes (7%), 53 F2 tornadoes (19%), 103 F1 tornadoes (37%), and 98 F0 tornadoes (35%) (Fig. 6).

4.2 Monthly Frequency

During the period from 1950 to 2001, 278 tornado occurrences were recorded. A graph of these occurrences by month (Fig. 7), shows there are 3 peak periods for activity during the year. The first peak appears during the months of March, April and May. This corresponds to the historical severe weather season that is experienced across the southeastern United States. The most active month was May with 41 recorded occurrences. A secondary peak occurs during the months of July and August. This is most likely related to tropical phenomena such as hurricanes, tropical storms, and tropical depressions that have traveled close to or across portions of the CWA. There is a third peak that occurs during the month of November. This is most likely related to systems developing across the southeastern U.S. due to the warm and moist air still in place across the region and the intrusion of colder and drier air from Canada. Of the 24 tornadoes that were reported as Severe (F3) or

Devastating (F4), 13 (54%) of them occurred during the peak period from March through May.

4.3 Hourly Frequency

The hourly distribution of tornado occurrences (Fig. 8), shows that the majority of tornadoes occur from noon through 8 PM. The peak occurs between 2 PM and 6 PM. There is also a minor secondary peak that occurs late at night between 10 PM and 2 AM. Of the 24 tornadoes that were reported as Severe (F3) or Devastating (F4), 17 (71%) of them occurred during the peak period of 4 PM to 8 PM (Fig. 9).

4.4 Associated with Tropical Systems

Tornadoes associated with tropical systems have a large impact on the occurrence of tornadic activity during the months of July through September. Many of the tornado events recorded during this period likely originated from either the remnants of a tropical system, tropical storm, or hurricane. The graph depicting tornado events by month (Fig. 7), shows a secondary peak in the months of July and August. This peak is strongly influenced by the tornado outbreak associated with the remnants of Tropical Storm Beryl on August 16, 1994. This outbreak produced 15 tornadoes across the CWA, the largest outbreak during the period from 1950-2001. This one event accounted for 60% of the tornadoes recorded during the month of August for the 51 year period. During the months of July, August and September of the 51 year period, 63 tornadoes occurred, and 28 (44%) of those were related to tropical systems. During the middle to late Summer period, the wind fields across the southeast are typically weak and lack the vertical wind shear structure needed to support tornadic activity. Tropical systems often provide this necessary component, as they track in proximity to the CWA.

5. HAIL CLIMATOLOGY

5.1 Monthly Frequency

The occurrence of severe hail (hail with a diameter of 3/4 of an inch or greater) can take place anytime of the year. However, the data (Fig. 10) shows that there is a distinct season that begins in March and continues through July, with a peak during the month of May. During the month of May there were 210 (28%) severe hail events. During the peak period from April through June there were 530 (71%) events. The occurrence of hail is very infrequent in the Fall and early Winter. During the period from September through December there were only 31 (4%) events. Convective activity, in general, is historically low during this period across the CWA.

5.2 Hourly Frequency

The hourly distribution of severe hail events (Fig. 11) shows that most events tend to occur during the afternoon and evening hours. This corresponds well with the diurnal cycle of thunderstorm activity during the convective season. The most active period occurs from noon through 8 PM, with the peak occurring between 2 PM to 6 PM. During the period from noon through 8 PM there were 603 (80%) events. The peak period from 2 PM through 6 PM there were 385 (51%) events. The occurrence of hail is very infrequent during the overnight hours. During the overnight period from 2 AM to 8 AM, there were 13 (2%) hail events.

6. SEVERE THUNDERSTORM WIND CLIMATOLOGY

6.1 Monthly Frequency

The occurrence of severe thunderstorms winds (winds of 50 knots or greater) is most common between the months of May and August (Fig. 12) with a peak during the month of June. During the peak period from May to August there were 1,106 (66%) severe thunderstorm wind events that occurred during the 51 year period. The occurrence of severe thunderstorm winds decreased dramatically in the Fall and early Winter. There were only 126 (8%) events from October through December. Again, this corresponds well to the historical convective season across the CWA.

6.2 Hourly Frequency

As was the case with severe hail, the hourly distribution of thunderstorm winds corresponds to the diurnal cycle of convective activity. The most active period (Fig. 13) exists from noon through 10 PM with a peak period from 2 PM to 6 PM. During the peak period, 828 (49%) severe wind events occurred.

7. CONCLUSION

By studying the climatology of severe weather that occurs across the Midlands of South Carolina and the Central Savannah River area of Georgia, the staff at WFO CAE will be better prepared to anticipate when events are likely to occur. An awareness of the spatial and temporal distribution of past severe weather events can aid forecasters in evaluating severe weather potential and assist local management in assigning staffing and forecaster duties throughout the year. In addition, this climatology will also provide valuable information that can be used in our local outreach efforts.

ACKNOWLEDGMENTS

The author would like to thank Mike Cammarata, Science Operations Officer, of WFO Columbia, SC for his valuable input, patience and review. The author would also like to thank Ron Jones, former Data Acquisition Program Manager, of WFO Columbia, SC for his graphical expertise and Steve Naglic, Warning Coordination Meteorologist, of WFO Columbia, SC for the acquisition of local storm data.

REFERENCES

Fujita, T.T., 1987: *U.S. Tornadoes Part 1. 70-Year Statistics*. Satellite and Mesometeorology Research Project, 120 pp.

National Climatic Data Center, 1993: Tropical Cyclones Of The North Atlantic Ocean, 1871-1992. *Historical Climatology Series*, **6**, No. 2, 193 pp.

National Weather Service, 2002: *National Weather Service Instruction*, 10-511. [Available online at: http://www.nws.noaa.gov/directives/010/pd01005011b.pdf]

Purvis, John C., 1980: South Carolina Hurricanes, 1950-1979. The South Carolina Emergency Preparedness Division Office of The Adjutant General, 25 pp.

Figures

Figure 1. Map of WFO Columbia, SC County Warning Area.

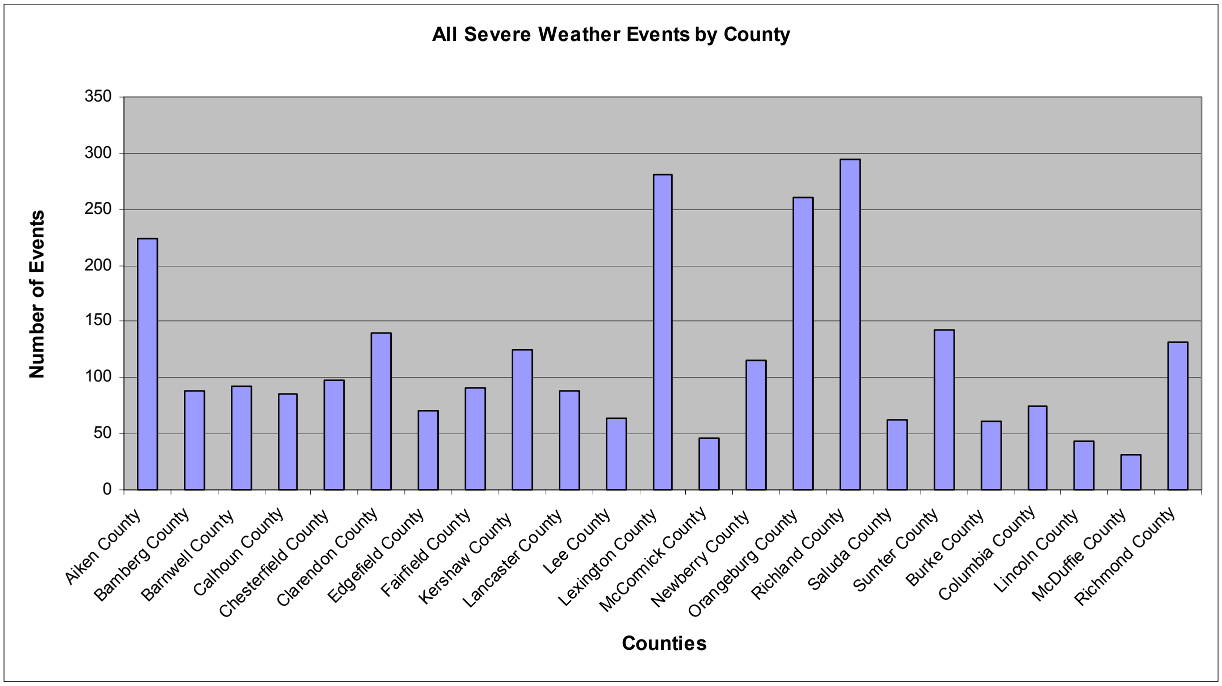

Figure 2. Total number of severe weather events by county from 1950 through 2001.

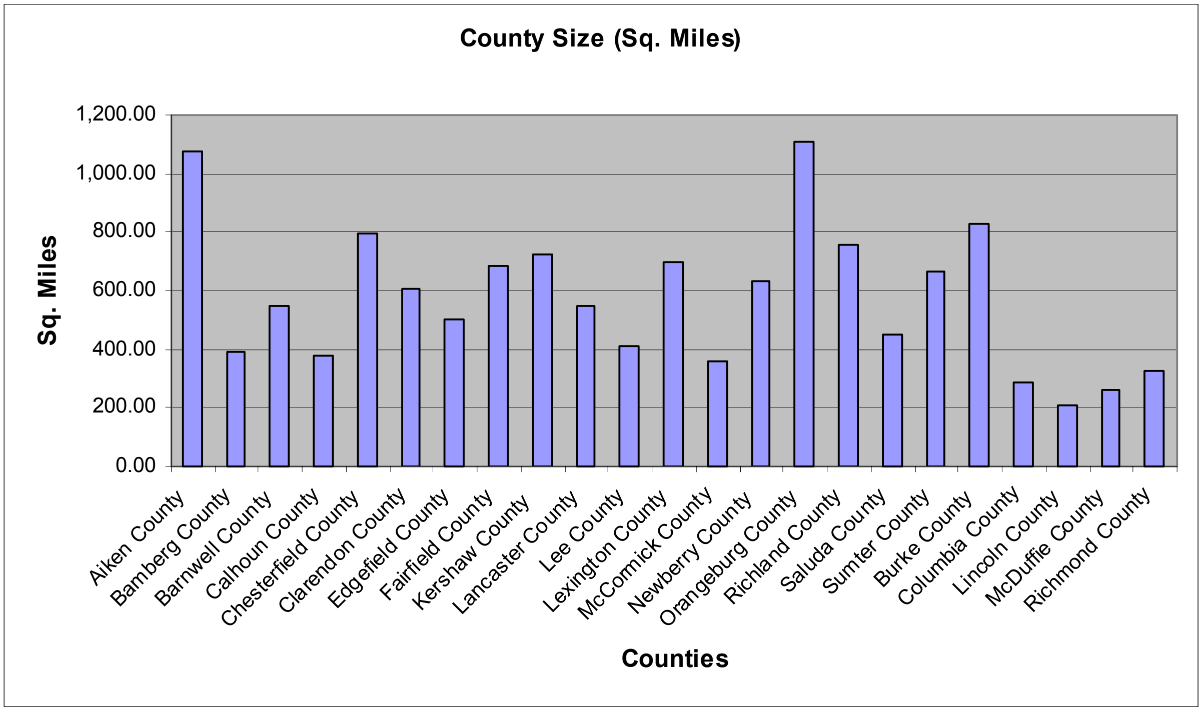

Figure 3. County size in square miles.

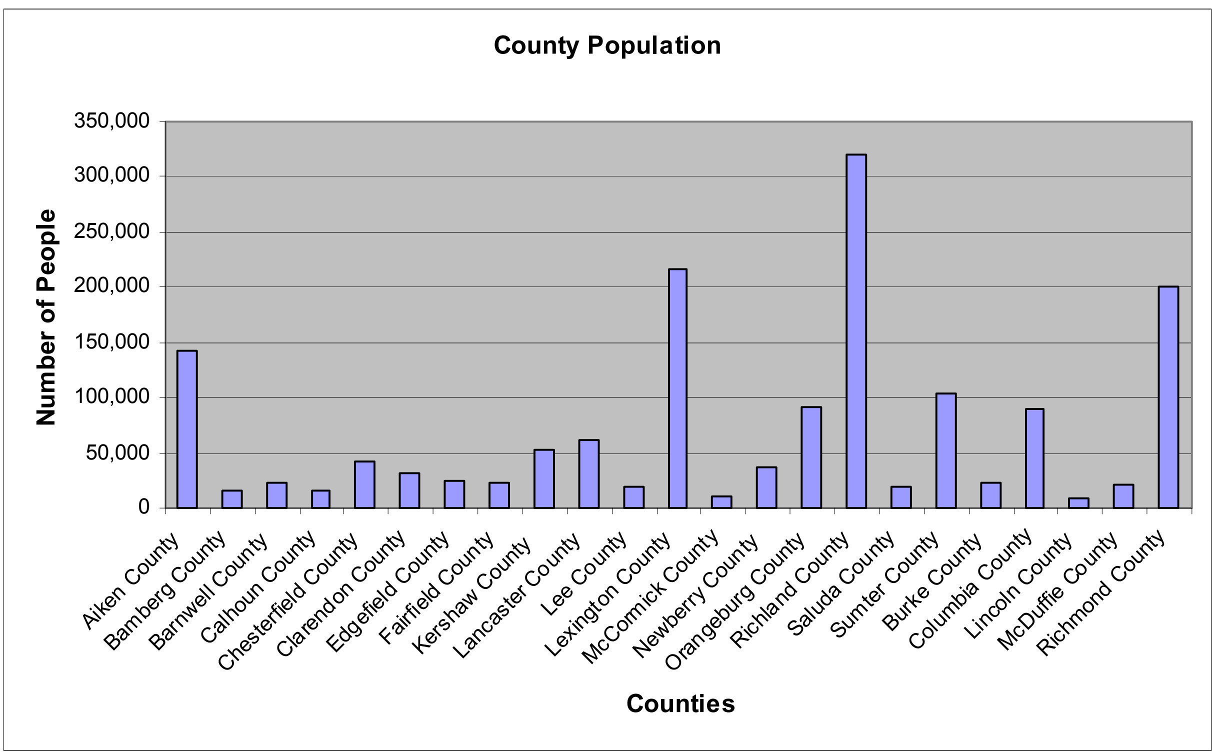

Figure 4. County population based on 2000 Census Data.

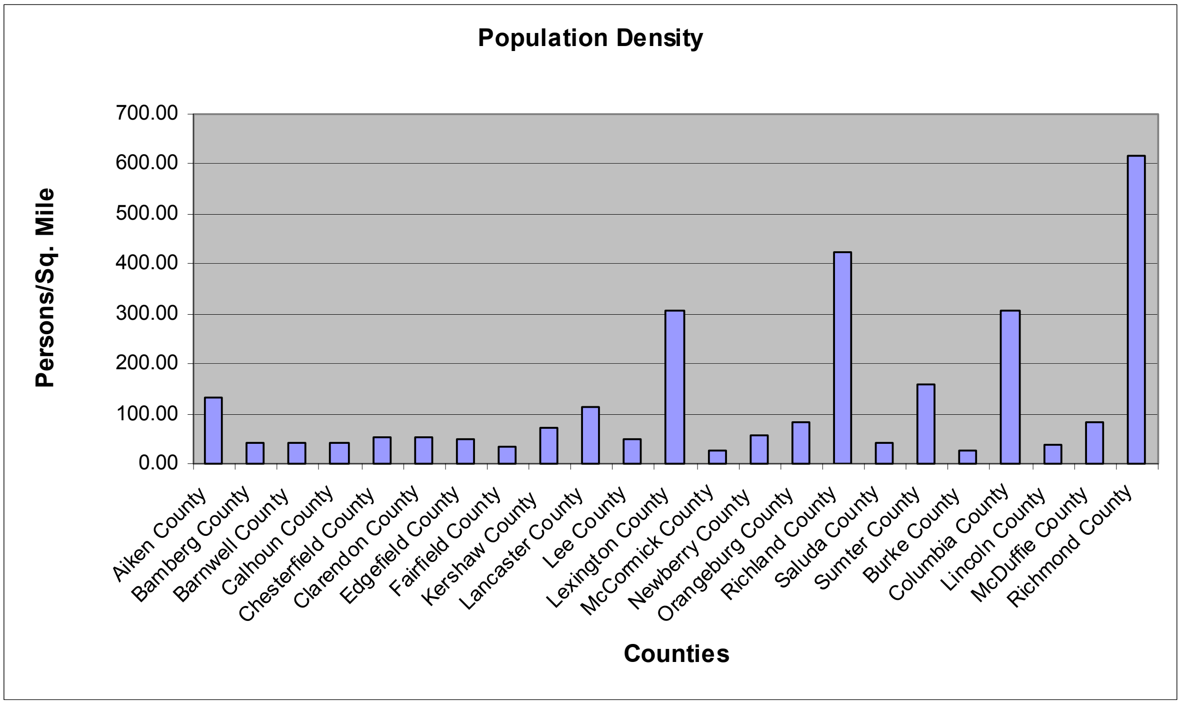

Figure 5. County population density (persons per square mile) based on 2000 Census Data.

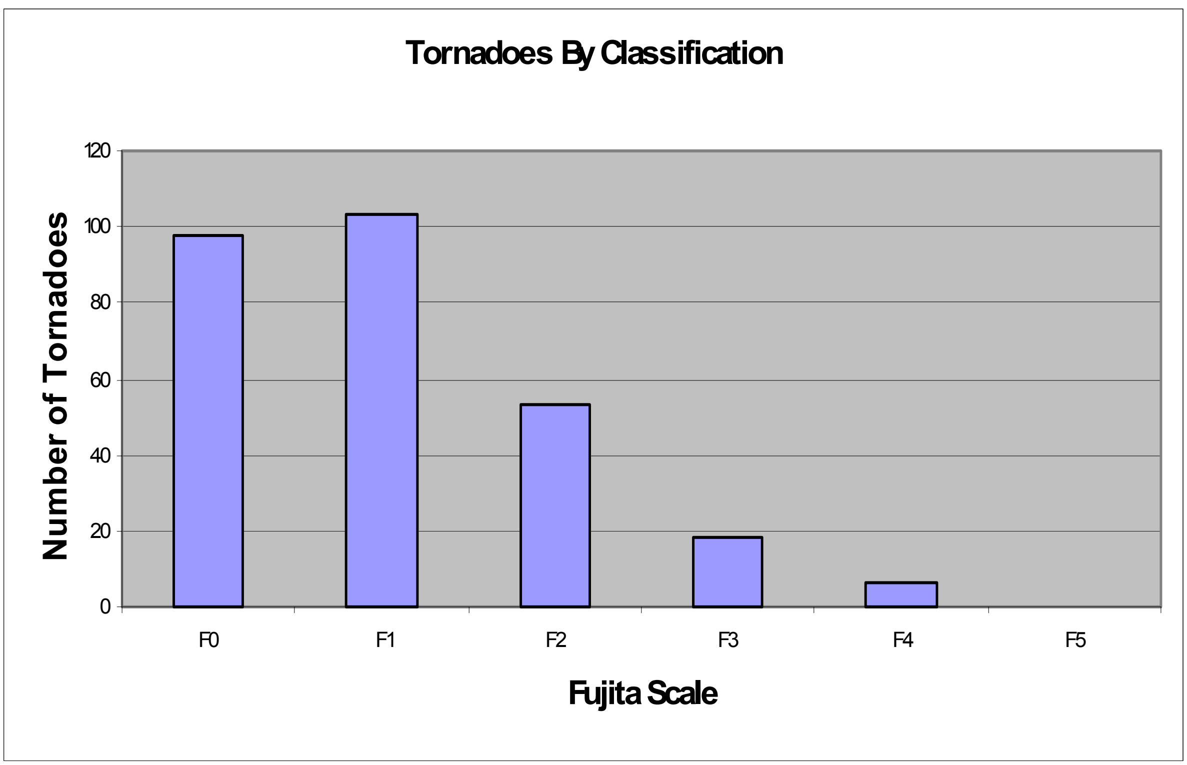

Figure 6. Distribution of Tornadoes by the Fujita Scale (F0-F5) (1950-2001).

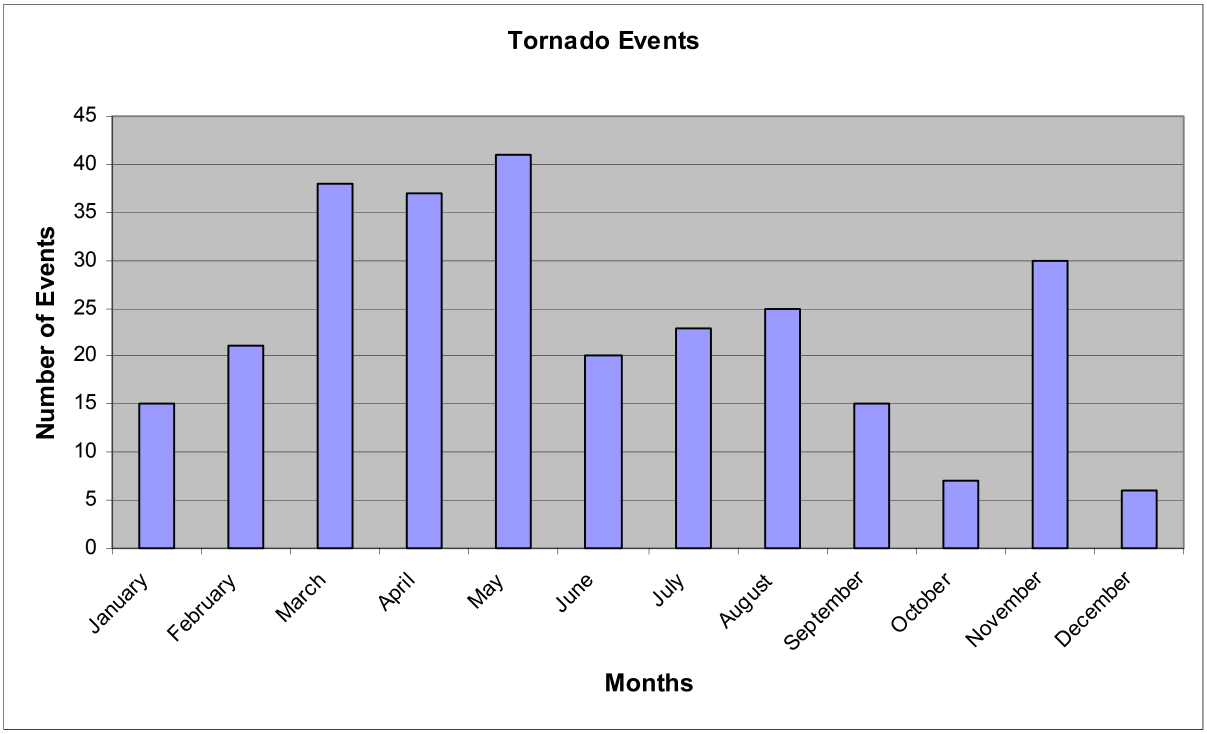

Figure 7. The distribution of tornado events by month (1950-2001).

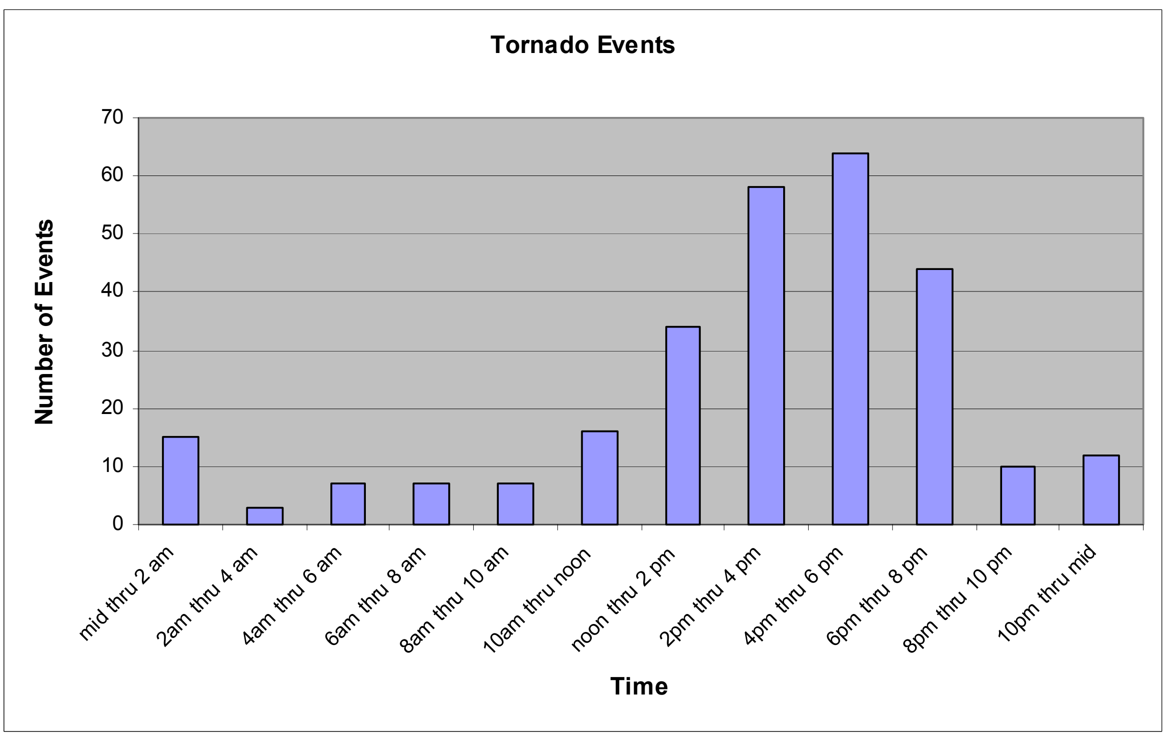

Figure 8. The distribution of tornado events by hours (1950-2001).

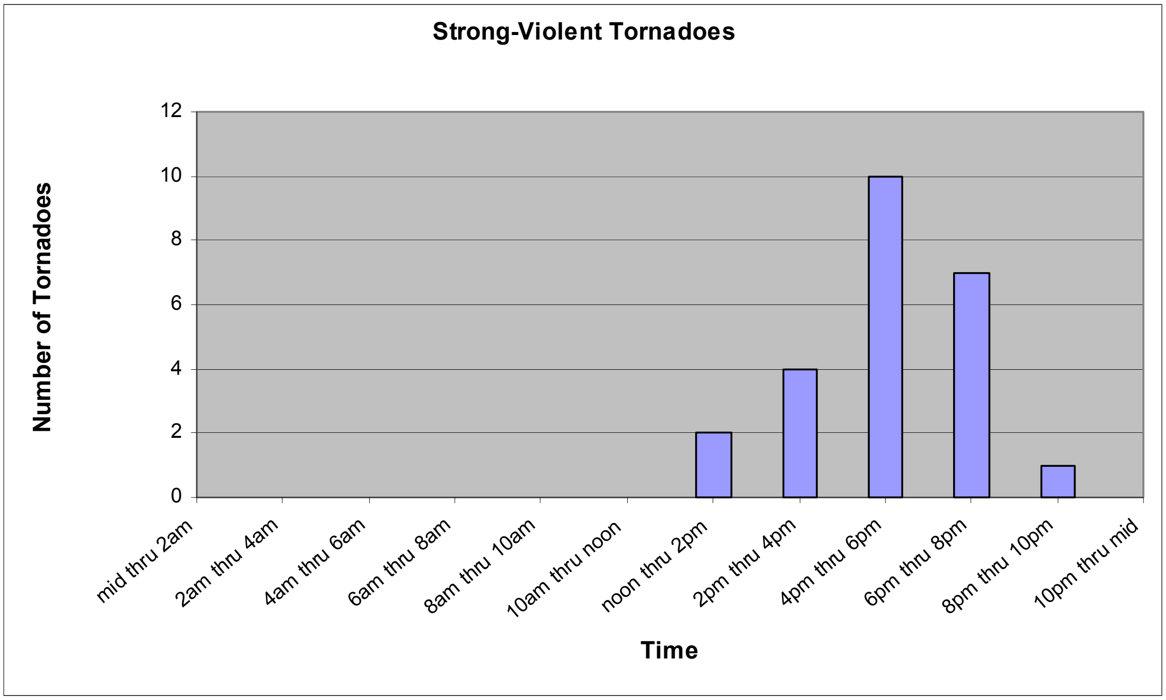

Figure 9. Distribution of strong-violent tornadoes (F3-F5) (1950-2001).

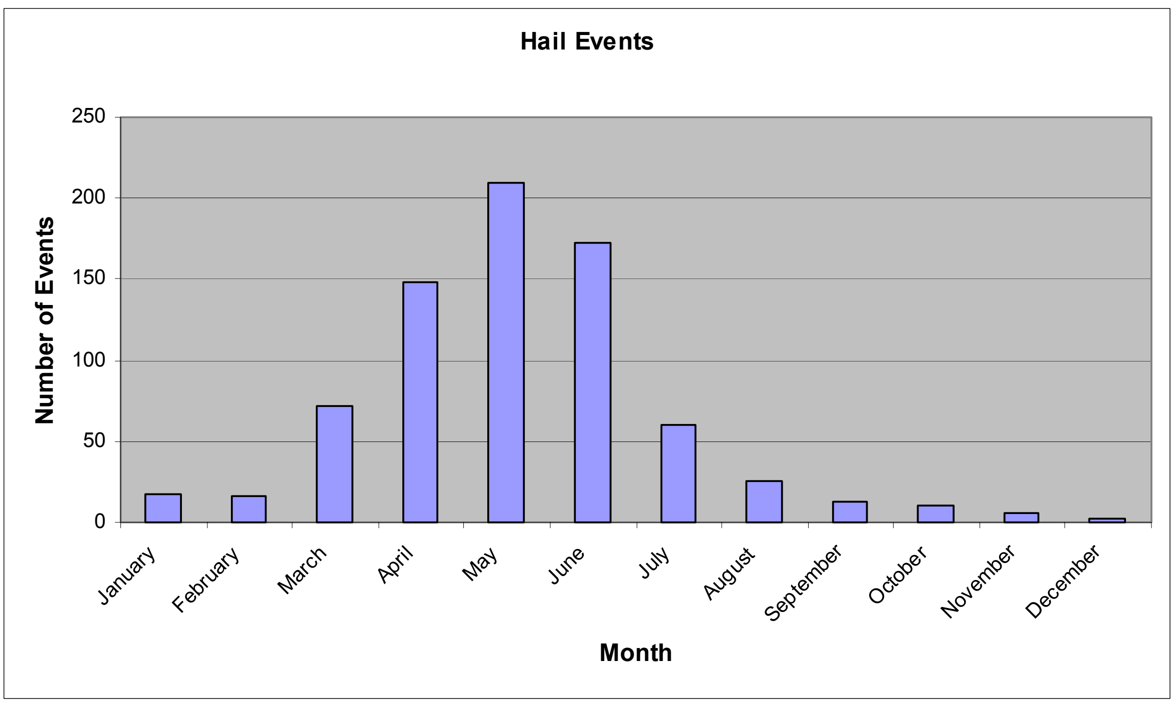

Figure 10. The distribution of hail events by month (1950-2001).

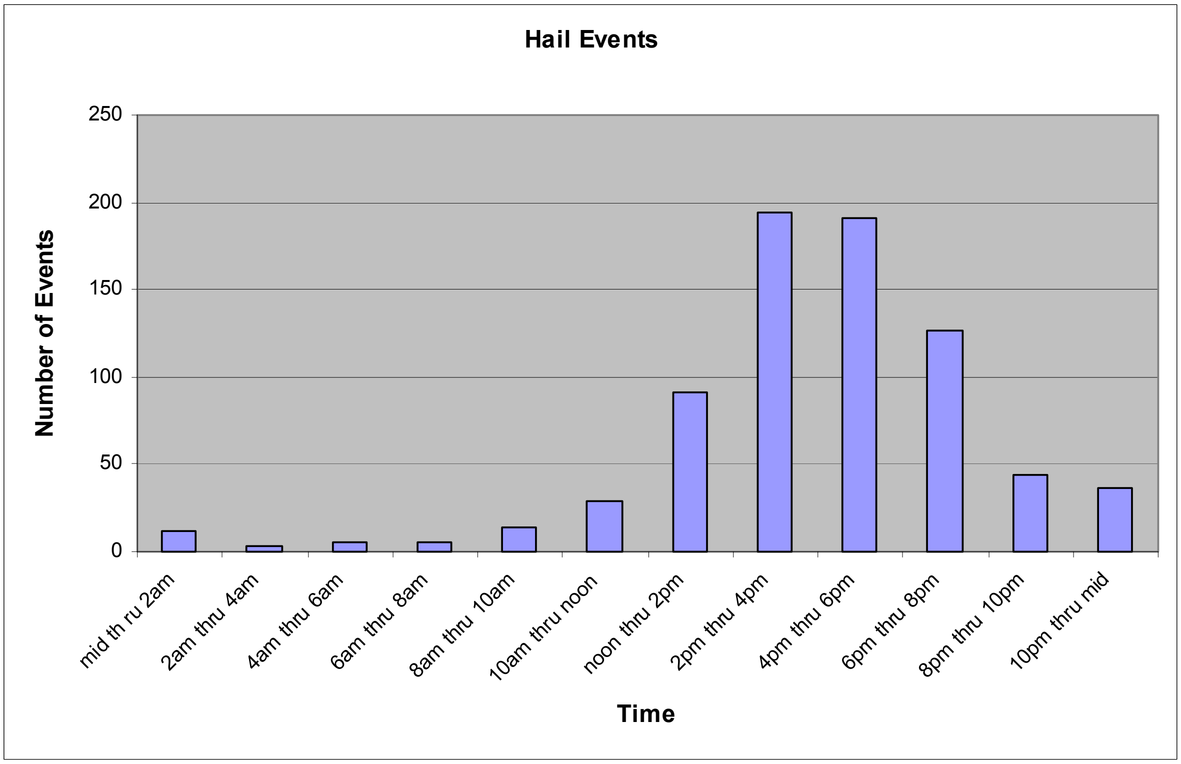

Figure 11. The distribution of hail events by hour (1950-2001).

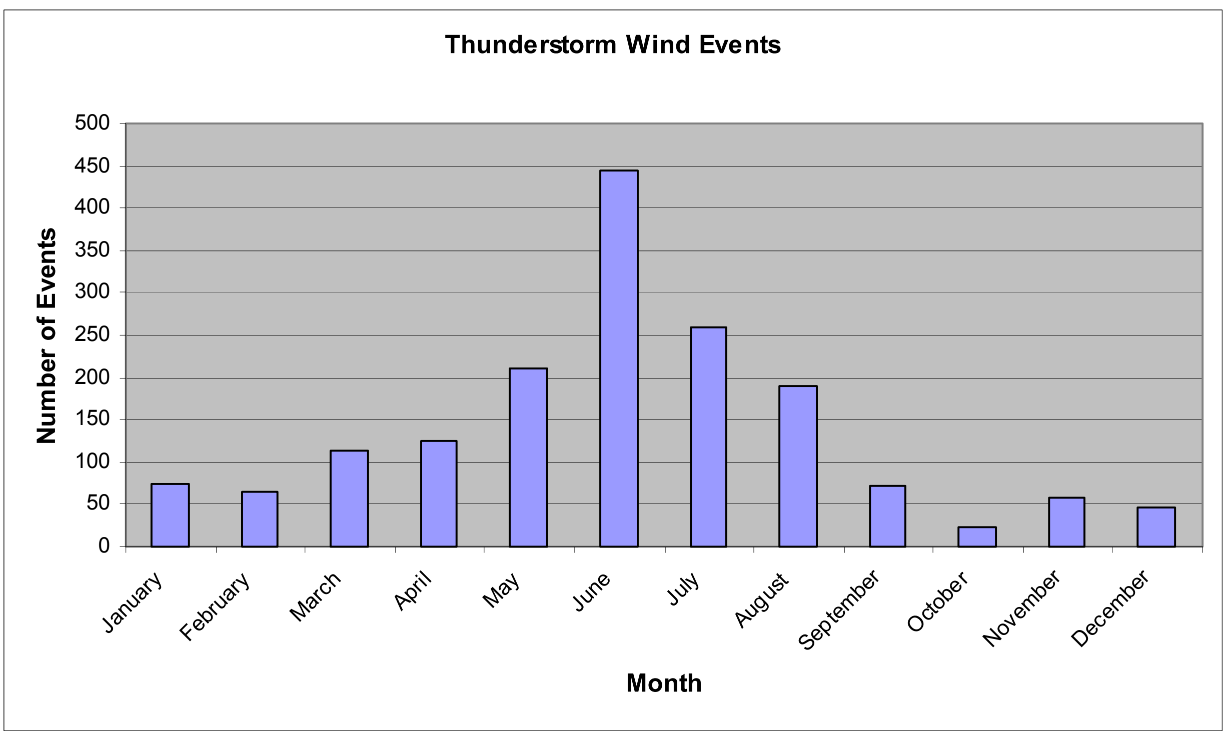

Figure 12. The distribution of severe thunderstorm winds by month (1950-2001).

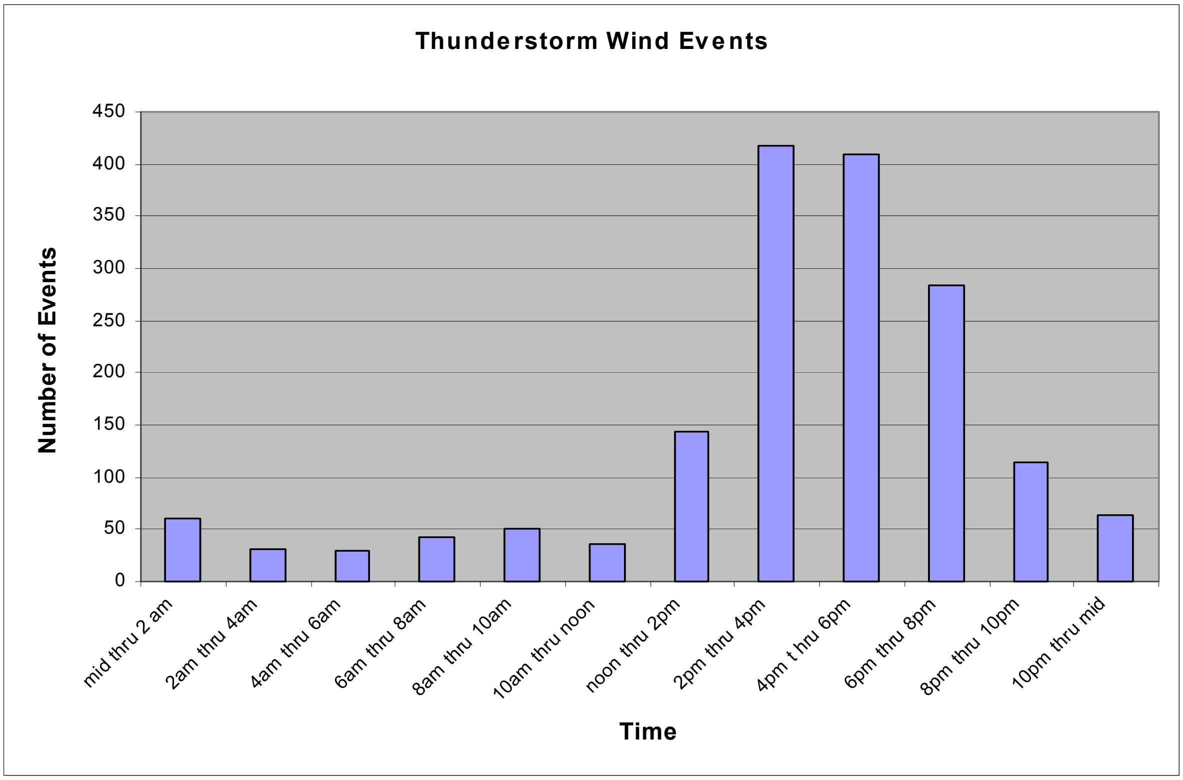

Figure 13. Distribution of severe thunderstorm winds by hour (1950-2001).

Table 1. The Fujita Scale:

Scale	**Wind Speed**	**Tornado Character**
0	40-72 mph	Gale Tornado (weak)
1	73-112 mph	Moderate Tornado (weak)
2	113-157 mph	Significant Tornado (strong)
3	158-206 mph	Severe Tornado (strong)
4	207-260 mph	Devastating Tornado (violent)
5	261-318 mph	Incredible Tornado (violent)

NWS	ER 46	An Objective Method of Forecasting Summertime Thunderstorms. John F. Townsend and Russell J. Younkin. May 1972. (COM-72-10765).
NWS	ER 47	An Objective Method of Preparing Cloud Cover Forecasts. James R. Sims. August 1972. (COM-72-11382).
NWS	ER 48	Accuracy of Automated Temperature Forecasts for Philadelphia as Related to Sky Condition and Wind Direction. Robert B. Wassall. September 1972. (COM-72-11473).
NWS	ER 49	A Procedure for Improving National Meteorological Center Objective Precipitation Forecasts. Joseph A. Ronco, Jr. November 1972. (COM-73-10132).
NWS	ER 50	PEATMOS Probability of Precipitation Forecasts as an Aid in Predicting Precipitation Amounts. Stanley E. Wasserman. December 1972. (COM-73-10243).
NWS	ER 51	Frequency and Intensity of Freezing Rain/Drizzle in Ohio. Marvin E. Miller. February 1973. (COM-73-10570).
NWS	ER 52	Forecast and Warning Utilization of Radar Remote Facsimile Data. Robert E. Hamilton. July 1973. (COM-73-11275).
NWS	ER 53	Summary of 1969 and 1970 Public Severe Thunderstorm and Tornado Watches Within the National Weather Service, Eastern Region. Marvin E. Miller and Lewis H. Ramey. October 1973. (COM-74-10160)
NWS	ER 54	A Procedure for Improving National Meteorological Center Objective Precipitation Forecasts - Winter Season. Joseph A. Ronco, Jr. November 1973. (COM-74-10200).
NWS	ER 55	Cause and Prediction of Beach Erosion. Stanley E. Wasserman and David B. Gilhousen. December 1973.(COM-74-10036).
NWS	ER 56	Biometeorological Factors Affecting the Development and Spread of Planet Diseases. V.J. Valli. July 1974. (COM-74-11625/AS).
NWS	ER 57	Heavy Fall and Winter Rain In The Carolina Mountains. David B. Gilhousen. October 1974. (COM-74-11761/AS).
NWS	ER 58	An Analysis of Forecasters' Propensities In Maximum/Minimum Temperature Forecasts. I. Randy Racer. November 1974. COM-75-10063/AS).
NWS	ER 59	Digital Radar Data and its Application in Flash Flood Potential. David D. Sisk. March 1975. (COM-75-10582/AS).
NWS	ER 60	Use of Radar Information in Determining Flash Flood Potential. Stanley E. Wasserman. December 1975. (PB250071/AS).
NWS	ER 61	Improving Short-Range Precipitation Guidance During the Summer Months. David B. Gilhousen. March 1976. (PB256427).
NWS	ER 62	Locally Heavy Snow Downwind from Cooling Towers. Reese E. Otts. December 1976. (PB263390/AS).
NWS	ER 63	Snow in West Virginia. Marvin E. Miller. January 1977. (PB265419/AS).
NWS	ER 64	Wind Forecasting for the Monongahela National Forest. Donald E. Risher. August 1977. (PB272138/AS).
NWS	ER 65	A Procedure for Spraying Spruce Budworms in Maine during Stable Wind Conditions. Monte Glovinsky. May 1980. (PB80-203243).
NWS	ER 66	Contributing Factors to the 1980-81 Water Supply Drought, Northeast U.S. Solomon G. Summer. June 1981. (PB82-172974).
NWS	ER 67	A Computer Calculation and Display System for SLOSH Hurricane Surge Model Data. John F. Townsend. May 1984. (PB84-198753).
NWS	ER 68	A Comparison Among Various Thermodynamic Parameters for the Prediction of Convective Activity. Hugh M. Stone. April 1985. (PB85-206217/AS).
NWS	ER 69	A Comparison Among Various Thermodynamic Parameters for the Prediction of Convective Activity, Part II. Hugh M. Stone. December 1985. (PB86-142353/AS).
NWS	ER 70	Hurricane Gloria's Potential Storm Surge. Anthony G. Gigi and David A. Wert. July 1986. (PB86-226644/AS).
NWS	ER 71	Washington Metropolitan Wind Study 1981-1986. Clarence Burke, Jr. and Carl C. Ewald. February 1987. (PB87-151908/AS).
NWS	ER 72	Mesoscale Forecasting Topics. Hugh M. Stone. March 1987. (PB87-180246/AS).
NWS	ER 73	A Procedure for Improving First Period Model Output Statistics Precipitation Forecasts. Antonio J. Lacroix and Joseph A. Ronco. Jr. April 1987. (PB87-180238/AS).
NWS	ER 74	The Climatology of Lake Erie's South Shoreline. John Kwiatkowski. June 1987. (PB87-205514/AS).
NWS	ER 75	Wind Shear as a Predictor of Severe Weather for the Eastern United States. Hugh M. Stone. January 1988. (PB88-157144).
NWS	ER 76	Is There A Temperature Relationship Between Autumn and the Following Winter? Anthony Gigi. February 1988. (PB88-173224).
NWS	ER 77	River Stage Data for South Carolina. Clara Cillentine. April 1988. (PB88-201991/AS).
NWS	ER 78	National Weather Service Philadelphia Forecast Office 1987 NOAA Weather Radio Survey & Questionnaire. Robert P. Wanton. October 1988. (PB89-111785/AS).
NWS	ER 79	An Examination of NGM Low Level Temperature. Joseph A. Ronco, Jr. November 1988. (PB89- 122543/AS).
NWS	ER 80	Relationship of Wind Shear, Buoyancy, and Radar Tops to Severe Weather 1988. Hugh M. Stone. November 1988. (PB89-1222419/AS).
NWS	ER 81	Relation of Wind Field and Buoyancy to Rainfall Inferred from Radar. Hugh M. Stone. April 1989. (PB89-208326/AS).
NWS	ER 82	Second National Winter Weather Workshop, 26-30 Sept. 1988: Postprints. Laurence G. Lee. June 1989.(PB90-147414/AS).
NWS	ER 83	A Historical Account of Tropical Cyclones that Have Impacted North Carolina Since 1586. James D. Stevenson. July 1990. (PB90-259201).
NWS	ER 84	A Seasonal Analysis of the Performance of the Probability of Precipitation Type Guidance System. George J. Maglaras and Barry S. Goldsmith. September 1990. (PB93-160802)
NWS	ER 85	The Use of ADAP to Examine Warm and Quasi-Stationary Frontal Events in the Northeastern United States. David R. Vallee. July 1991. (PB91-225037)
NWS	ER 86	Rhode Island Hurricanes and Tropical Storms A Fifty-Six Year Summary 1936-0991. David R. Vallee. March 1993. (PB93-162006)
NWS	ER 87	Post-print Volume, Third National Heavy Precipitation Workshop, 16-20 Nov. 1992. April 1993. (PB93-186625)
NWS	ER 88	A Synoptic and Mesoscale Examination of the Northern New England Winter Storm of 29-30 January 1990. Robert A. Marine and Steven J. Capriola. July 1994. (PB94-209426)
NWS	ER 89	An Initial Comparison of Manual and Automated Surface Observing System Observations at the Atlantic City, New Jersey, International Airport. James C. Hayes and Stephan C. Kuhl. January 1995.
NWS	ER 90	Numerical Simulation Studies of the Mesoscale Environment Conducive to the Raleigh Tornado. Michael L. Kaplan, Robert A. Rozumalski, Ronald P. Weglarz, Yuh-Lang Lin , Steven Businger, and Rodney F. Gonski. November 1995.
NWS	ER 91	A Climatology of Non-convective High Wind Events in Western New York State. Thomas A. Niziol and Thomas J. Paone. April 2000.
NWS	ER 92	Tropical Cyclones Affecting North Carolina Since 1586 - An Historical Perspective. James E. Hudgins. April 2000.
NWS	ER 93	A Severe Weather Climatology for the Wilmington, NC WFO County Warning Area. Carl R., Morgan. October 2001.
NWS	ER 94	Surface-based Rain, Wind, and Pressure Fields in Tropical Cyclones over North Carolina since 1989. Joel Cline. June 2002.
NWS	ER 95	A Severe Weather Climatology for the Charleston, South Carolina, WFO County Warning Area. Stephen Brueske, Lauren Plourd, Matthen Volkmer. July 2002.
NWS	ER 96	A Severe Weather Climatology for the WFO Wakefield, VA County Warning Area. Brian T. Cullen. May 2003. (PB2003-105462)
NWS	ER 97	Severe Weather Climatology for the Columbia, SC WFO County Warning Area. Leonard C. Vaughan. September 2003.

NOAA SCIENTIFIC AND TECHNICAL PUBLICATIONS

The National Oceanic and Atmospheric Administration was established as part of the Department of Commerce on October 3, 1970. The mission responsibilities of NOAA are to assess the socioeconomic impact of natural and technological changes in the environment and to monitor and predict the state of the solid Earth, the oceans and their living resources, the atmosphere, and the space environment of the Earth.

The major components of NOAA regularly produce various types of scientific and technical information in the following kinds of publications:

PROFESSIONAL PAPERS--Important definitive research results, major techniques, and special investigations.

CONTRACT AND GRANT REPORTS--Reports prepared by contractors or grantees under NOAA sponsorship.

ATLAS--Presentation of analyzed data generally in the form of maps showing distribution of rainfall, chemical and physical conditions of oceans and atmosphere, distribution of fishes and marine mammals, ionospheric conditions, etc.

TECHNICAL SERVICE PUBLICATIONS--Reports containing data, observations, instructions, etc. A partial listing includes data serials; prediction and outlook periodicals; technical manuals, training papers, planning reports, and information serials; and miscellaneous technical publications.

TECHNICAL REPORTS--Journal quality with extensive details, mathematical developments, or data listings.

TECHNICAL MEMORANDUMS--Reports of preliminary, partial, or negative research or technology results, interim instructions, and the like.

Information on availability of NOAA publications can be obtained from:

NATIONAL TECHNICAL INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
5285 PORT ROYAL ROAD
SPRINGFIELD, VA 22161