P1.21 A TWELVE YEAR CLIMATOLOGICAL ANALYSIS OF SEVERE LOCAL STORMS OBSERVED BY THE OKLAHOMA MESONET

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1. INTRODUCTION

Organized severe weather is a common occurrence across Oklahoma. Prior research has shown that the region experiences a significant number of storms that produce strong winds, hail, and tornadoes which have a typical seasonal tendency (Kelly et al. 1985, Brooks et al. 2000). What is not well understood, however, is the geographic distribution and frequency of prolific severe report producing storms such as supercells and squall lines. A 12 year storm climatology is currently being developed for Oklahoma spanning 1994-2005 which includes storm tracks, initiation points, termination points, and duration of supercell and squall line storms. With the use of geographic information systems (GIS), a storm climatology is being developed into a geodatabase which will enable a powerful spatial analysis and future use of the dataset. Oklahoma Mesonet data will also be analyzed to help understand the associated meteorological surface conditions prior to and during storm occurrence.

2. CASES

Storm report data from the Storm Prediction Center's (SPC) storm report database were analyzed across Oklahoma for the period 1994-2005 to build a list of candidate events. Significant severe weather events were defined as any single convective day (1200 UTC – 1159 UTC) when (a) the total combined severe storm reports (hail and wind) was greater than or equal to 20 or (b) any tornado was reported in Oklahoma. The criteria were selected to yield mainly organized severe weather events.

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Using this approach more than 350 severe weather events were identified across Oklahoma through 2004. The distribution of events by month show the typical peak in severe weather activity in the springtime months of April, May, and June with a significant drop off in activity beginning in July (Fig. 1). On an annual timescale, there is notable variability in severe storm occurrence from year to year with 1999 being the most active of the study period (Fig. 2).

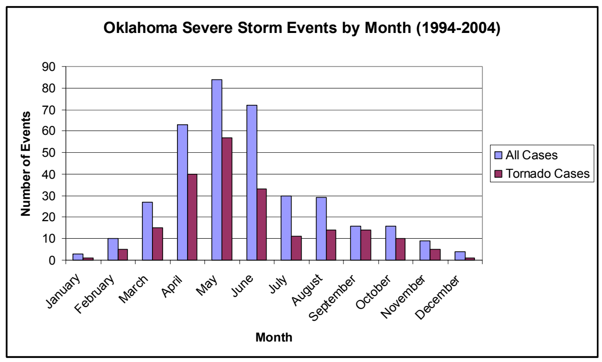

Figure 1. Monthly frequency of severe storm events across Oklahoma from 1994-2004 for all cases (blue) and cases associated with a tornado report (purple).

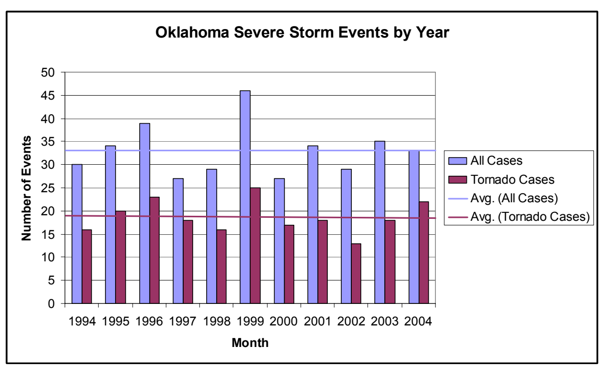

Figure 2. Annual frequency of severe storm events in Oklahoma from 1994 to 2004 for all cases (blue) and tornado cases (purple). The horizontal lines illustrate the average number of all cases (blue line) per year and the average number of tornado cases (purple line) per year.

3. METHODOLOGY

3.1 *Radar Data Acquisition*

To develop the storm climatology of supercells and squall lines from the cases found, NEXRAD Level-II and Level-III radar data were acquired from the National Climatic Data Center (NCDC) using the online data request (http://www.ncdc.noaa.gov/nexradinv/). Level-II data was used as a first choice for the cases while Level-III was acquired as a supplement or replacement for any missing Level-II data.

3.2 *Radar Data Analysis and Storm Criteria*

Two main software packages were used to analyze radar data for the 12 year climatology. For Level-II data a program entitled GRLevel2 (available at http://www.grlevelx.com/) was used to both view and track supercells and squalls lines. Level-III data was viewed and analyzed via NCDC's online Java NEXRAD viewer (available at http://www.ncdc.noaa.gov/oa/radar/jnx/jnv.jnlp).

Several criteria were developed to identify supercell storms and squall lines for the climatology. Supercells were required to contain a mesocyclone and persist for 30 minutes or more. Radar features discussed in Moller et al. (1994) such as deviant motion, hook echoes, or bounded weak echo regions (BWER) were used to assist in supercell identification and tracking. In addition, initiation was based on the first occurrence of a 40 dBz echo and termination was based on loss of all supercell characteristics. Supercells were tracked following the region within the forward flank just north of the storm inflow. Fig. 3 illustrates an example of supercell tracking for a selected event from 1994.

The criteria for squall lines was taken similarly to Bluestein et al. (1985) and Klimowski et al. (2003). For this study squall lines were required to have a linear organization, have a length to width ratio of at least 5:1, be 50 km in length, and persist for greater than 30 minutes. Initiation was taken to be the first time at which all the criteria were met and termination was the time at which 1 or more criteria failed. Squall lines were tracked using both the centroid of the line as well as the two end points. Fig. 4 shows an example of squall line tracking as displayed in ArcMap.

3.3 Compiling the GIS Database

GIS was used extensively in conjunction with radar data to develop a database of supercell and squall line tracks for the state of Oklahoma from 1994-2005. Using the radar programs, 17 separate attributes were recorded and imported into a ArcMap shapefile. Upon the completion of each year's worth of storm tracks, shapefiles will be consolidated and transferred into a feature class. A geodatabase will then be constructed using all of the feature classes developed for each year.

4. GIS ANALYSIS

A detailed GIS analysis of supercell and squall line tracks is currently being created for the more than 350 severe weather events between 1994 and 2005 across Oklahoma. When completed, cumulative graphics of all supercell tracks and squall line tracks will be available. In addition, further analyses will be possible such as cumulative initiation points, termination points, and storm track durations.

Using attribute data combined with GIS tools such as querying and overlays, numerous conclusions will be drawn regarding the spatial and temporal characteristics of storms across Oklahoma. For instance, all initiation points of supercells for the 12 year period will be possible by performing a simple 'Query by attribute' search. Different temporal characteristics could be found by further reducing the search to specific years or to cumulative months (e.g. initiation points during all months of May during the 12 year period). For example, Fig. 6 shows supercell tracking points from January 1, 1994 through July 1, 1994 with all initiation points highlighted. During this short time period, supercell storms tended to initiate in central and west central Oklahoma. A similar, yet much more robust analysis will be possible once all events have been analyzed. Using this completed storm climatology geodatabase, one will be able to determine preferred zones where supercell storms and squall lines initiated, terminated, and tracked on time scales ranging from 12 years to specific weeks.

5. FUTURE GOALS AND RESEARCH

Current research goals include completing the climatology of supercell and squall line tracks for the 1994-2005 time period. Furthermore, a ArcGIS geodatabase will be compiled from all of the storm track data. Various GIS analyses will be conducted to determine the spatial and temporal characteristics of severe weather across Oklahoma. Seasonal and annual variability will also be determined.

In addition, Oklahoma Mesonet data will be analyzed for selected cases to better understand the surface conditions that existed prior to and during the occurrence of severe weather. Current ideas include analyzing surface wind data associated with supercell events to determine the relationship between winds backing with time and storms producing tornadoes.

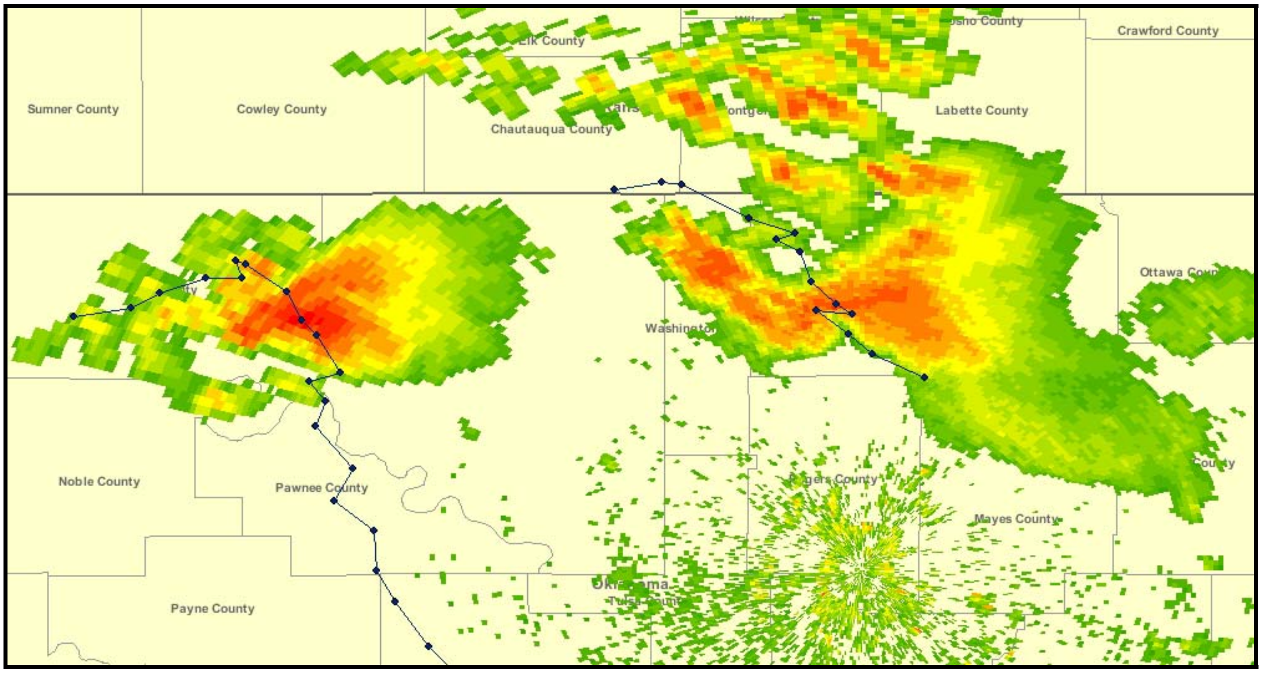

Figure 3. KINX radar base reflectivity from 00:12:55 UTC on 5/7/1994 overlaid with storm tracks and points in ArcMap.

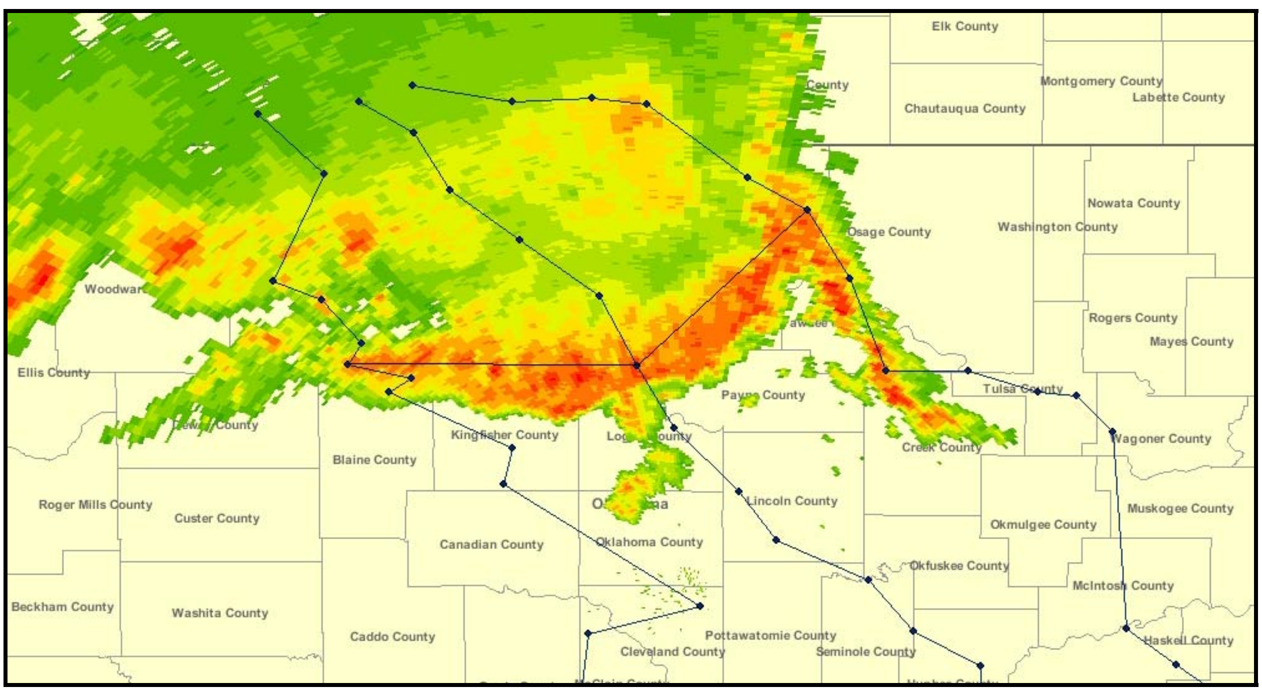

Figure 4. KTLX radar base reflectivity from 08:34:35 UTC on 5/29/1994 overlaid with storm points and tracks. The center line denotes the track of the centroid of the squall line while the lines on either side represent the endpoint tracks of the squall line.

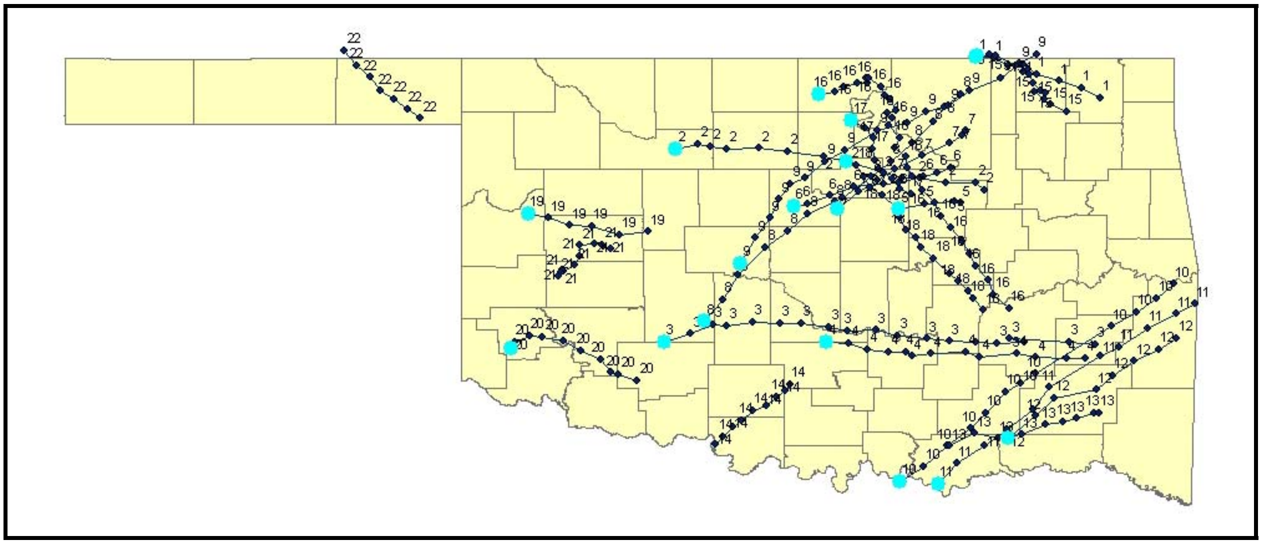

Figure 5. Supercell points and tracks (dark blue) from January 1, 1994 though July 1, 1994. The numbers denote the supercell ID while the turquoise points highlight all supercell initiation points. Storms without initiation points either entered from outside the state or initiated prior to available radar data.

6. REFERENCES

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