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SEVERE WEATHER DURING THE LIFETIMES OF MCSS THAT AFFECT A LIMITED AREA OF THE GREAT PLAINS DURING THE MORNING HOURS

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1. INTRODUCTION

During the summer months mesoscale convective systems (MCS) often move through the Great Plains overnight, producing frequent severe weather, generally in the form of high winds and large hail. The majority dissipate during the late morning hours; however, a few MCSs remain steady or increase in intensity. The reason (or reasons) for the evolutionary behavior during the four hours or so before local noon is not well understood. Thus, MCS activity during this time of day creates a forecast problem. To address this problem, a research project is underway to investigate MCS activity that affects the county warning areas (CWA) of the Norman, Oklahoma and Dodge City, Kansas National Weather Service Forecast offices during the morning hours. The project includes a climatological study and investigation of environmental influences on the evolution of the MCSs. A similar project was carried out for 1996-2000 (Haynes 2002, Hane et al. 2003).

The climatological study included 182 systems during the warm season (June, July, and August) from 2001 to 2005. These systems affected one or both of the CWAs during the 0900-1700 UTC time period in the summer months. Each system lasted at least 3 hours and had a size greater than or equal to 100 km in the longest dimension. System intensity of at least 40 dBz (seen on the National Mosaic Reflectivity Images from the WSR-88D radar network) for at least one hour in the time period was also a requirement for inclusion in the study.

Systems were tracked and plotted from initiation to dissipation. The evolution of each system in the 2001-2005 period was assessed. It was found that about 86% either decreased in intensity or dissipated during the 1300-1700 UTC period. The remaining 14% either remained steady or increased in intensity during the 1300-1700 UTC period.

Most systems were initiated the previous afternoon or evening near terrain features in Colorado or New Mexico. This agrees with findings from the previous five-year climatology (1996-2000) that included 145 systems occurring during the warm season (Haynes 2002). Figure 3 shows a plot of initiation locations for the 10 summer period.

The majority of the systems were initiated on the previous day. The tendency for initiation to occur along ridges extending eastward from the Rocky Mountains (the Raton Mesa, the Palmer Divide, and the Cheyenne Ridge) is evident (Hane et al. 2005).

Severe weather reports were compiled for each system in the study. These reports were analyzed based on time of day, the type of severe weather, and broken down by year and month

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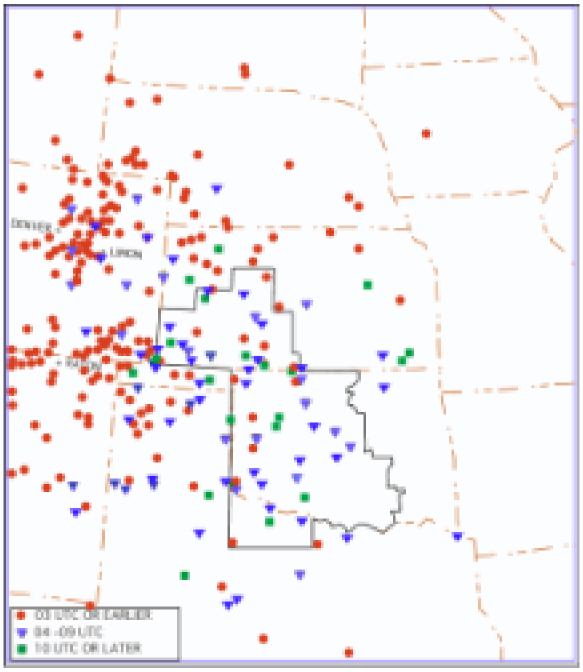

Figure1. Initiation locations of MCSs included in the 1996-2005 climatology. Red indicates initiation before 03 UTC; blue, 04-09 UTC; green, after 10 UTC. Black lines enclose county warning areas.

2. SEVERE WEATHER OCCURRENCES

2.1 Timing

Severe weather reports were compiled for each system during the entire system lifetime. The histogram below (Figure 2) shows the number of severe reports by type during each hour in 2001-2005 for a period within and surrounding the time range of interest (morning). The time in the figure starts at 19 UTC on the day before the system passed through Dodge City or Norman CWA and ends at the end of the day (2359 UTC) that passed through either CWA. This time range was chosen in order to include all of the severe reports associated with the MCSs in the study. It can be seen that the majority of the reports occurred on the pervious afternoon or evening for those MCSs (included according to the criteria listed in the introduction). In fact, about 80% of the storm reports were from systems in the 03 UTC or earlier initiation category.

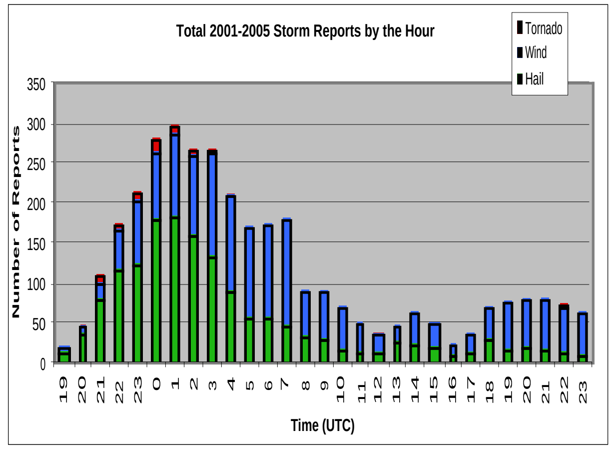

Figure 2. Severe reports by type each hour during the lifetimes of MCSs that affect the focus area during the morning hours

Systems were classified into two evolutionary categories: a 'decreasing' category consisting of 156 systems that dissipated or decreased in intensity during the 1300-1700 UTC time period and a 'non-decreasing' category consisting of 26 systems that remained steady or increased in intensity during the 1300-1700 UTC time period. The temporal distribution of severe reports was significantly different for the two modes of late morning MCS evolution. Figure 3a shows the storm reports for the decreasing systems and Figure 3b shows the storm reports for the non-decreasing systems. The decreasing systems had a maximum during the previous evening then taper off overnight into the morning. On the other hand, the non-decreasing systems had only a few reports from the previous day and overnight hours and a maximum in the afternoon hours following the period of interest. The latter afternoon occurrences imply that forecasting the evolution of systems in late morning has great importance. It should also be noted that not all of the systems that decreased in late morning dissipated shortly thereafter, since there were a significant number of severe reports in that afternoon (Fig.3a).

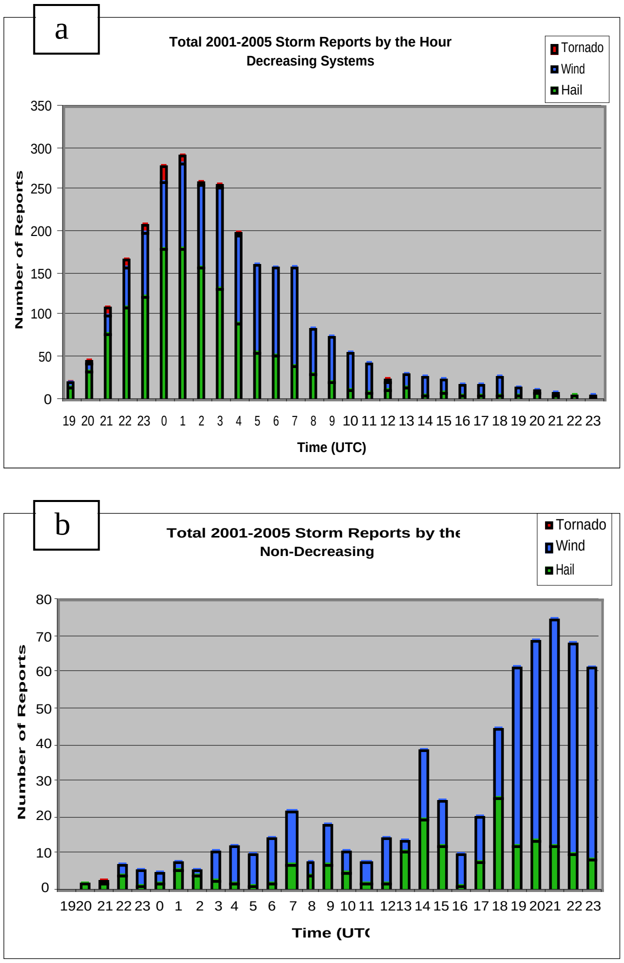

Figure 3. Severe reports by type each hour during the lifetimes of MCSs: (a)decreasing systems (b)non-decreasing systems.

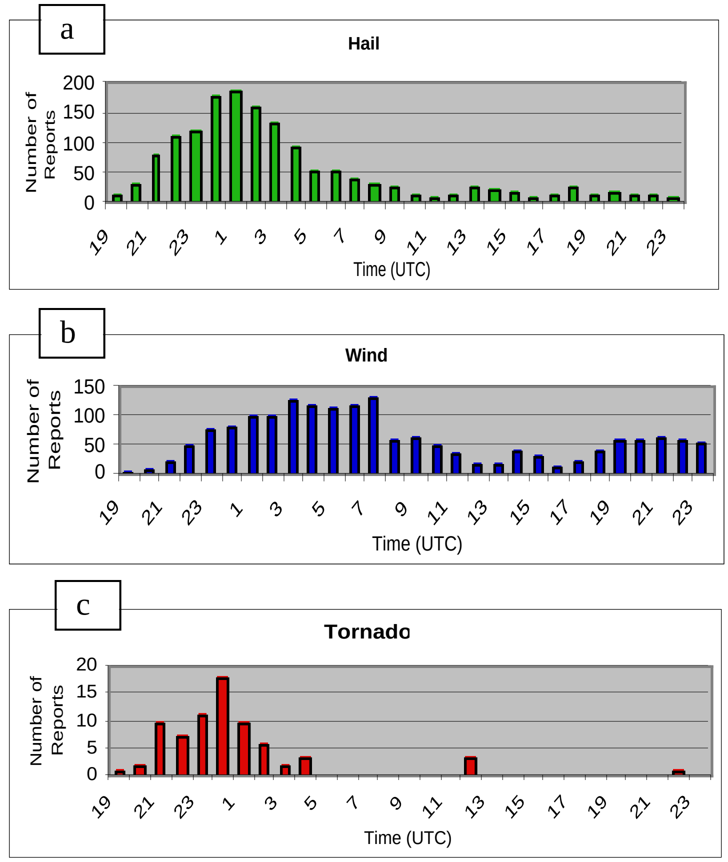

Figure 4. Storm reports by hour for (a) Hail, (b) Wind, and (c) Tornadoes.

2.2 Types of severe weather

Severe weather occurrences with the 182 MCSs that occurred in the 2001-2005 period were investigated based upon archived information from the NOAA/Storm Prediction Center. It was found that 128 of the 182 cases (70%) had some form of severe weather during their existence. A total of 3434 reports were logged with these systems. Damaging wind reports were the most numerous with 52% followed by large hail with 46%. Tornado occurrences were infrequent and generally occurred soon after storm initiation on the pervious day. The distribution of hail, wind and tornado reports over the time period are shown in Figure 4.

The hail distribution has a maximum in the early evening on the previous day. It is not surprising to find the majority of the hail reports around the time period of peak heating for the day. When considering hail reports that occurred at 10 UTC or later, 78% were from storms that initiated after 03 UTC. The non-decreasing systems accounted for 61% of the hail reports that occurred after 10 UTC. The distribution of wind reports was spread over the time period. One broad maximum occurred in the evening of the previous day, and another smaller maximum (after the morning time period) occurred primarily (70%) with non-decreasing systems. Of the reports that occurred after 10 UTC 68% were wind reports. The only tornadoes that occurred later in the systems lifecycle (after 05 UTC) were from two systems that increased in intensity in the 0900-1700 UTC time period.

2.3 Monthly and Yearly Trends in the Storm Reports.

Trends in the reports varied by year. Severe reports in 2001 predominantly occurred during the month of June, whereas the majority of the reports in

2002 occurred during the month of August. In 2003 reports are split between June and August, with a few more in June. Severe reports in 2004 predominantly occurred during the month of June which was followed by July and then August. In 2005 the most reports occurring during the month of July, followed by June. For the period 2001-2003 June had the most severe weather reports, followed by August, with relatively few reports in July. July in 2004 and 2005 however, were very active with 57% of all the July systems occurring in these two years, accounting for 88% of the severe reports in July.

Although the systems that occurred in 2004 were only 27% of all the systems in the period, they accounted for 47% of all the severe storm reports. 2005 had the second largest amount of reports but only accounts for about 20% of all the reports. During 2002 18% of all the reports occurred. The remaining 15% are from 2001 and 2003 combined. It is interesting that 2002 had almost twice as many reports as 2003 because 2002 had few systems. This is likely due to the occurrence of a few highly severe systems in 2002.

3. FUTURE WORK

Cases from the 2001-2005 period will be added to the environmental influence portions of this project (cases from 1996-2000 period). A large number of environmental variables will calculated for the purpose of comparison with the character of MCS evolution. The additional cases will be especially valuable in identifying environmental influences, as it will significantly increase the sample size and include a time period when RUC low-level wind analyses are more accurate. The ultimate goal of this project is to provide a tool for operational forecasters that will help provide more accurate short-term forecasts of MCSs. It should be clear from the results shown here that late morning MCS evolution is an important factor in forecasting severe weather. Once results are further refined, testing of tools produced by this project will be undertaken in an operational setting.

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