COMET OUTREACH PROGRAM FINAL REPORT

University: University of Oklahoma / Cooperative Institute for Mesoscale Meteorological Studies

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Cooperative Project Title: Development of a Tool to Aid in Forecasting the Evolution of Late-Morning MCS Activity

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SECTION 1. SUMMARY OF PROJECT OBJECTIVES

Included in the cooperative project are the following objectives: (1) extend an existing climatological study of mesoscale convective systems (MCSs) that affect the county warning areas of Norman, OK and Dodge City, KS WFOs during the late morning to include the summer months of 2001-2005; (2) assess the environmental influences on the evolution of these systems by extracting data from archived Rapid Update Cycle (RUC) analyses in locations ahead of each of these MCSs; (3) carry out discriminant analysis or other analytical methods to determine the parameters that most influence evolution; and (4) develop a tool based upon these results that will be useful in many forecast offices around the nation in forecasting the evolution of these morning systems.

SECTION 2: PROJECT ACCOMPLISHMENTS AND FINDINGS

Therese Thompson, a student selected to work on the project, completed the identification of about 180 MCSs that occurred during the summers of 2001-2005 that met the criteria for inclusion in the study, using the NCDC hourly WSR-88D mosaic archive. The tracks of all these systems were plotted and saved as image files, and the character of the system (linear versus cluster) noted. Severe weather occurrences associated with included MCSs have been compiled based on an archive from the NOAA/Storm Prediction Center. The speed and direction of motion of each system were determined and recorded. The evolutionary character of each system during the late morning was also determined, and also noted were locations (latitude and longitude) ahead of each system for input into software that produces soundings from RUC analysis gridded data. . An archive of RUC analyses was accessed and soundings extracted at

different locations and times ahead of each observed system. From these soundings various quantities were calculated including measures of stability, wind shear, flux of moisture toward the system, and other derived variables.

A second effort involved the documentation of severe weather occurrences with these systems. This included an accounting of different types of severe weather (damaging wind, large hail, and tornadoes) throughout the life cycle of each system. An important finding was that with those systems that survive the late morning (a time when the majority of these systems dissipate) a significant amount of severe weather occurs during the following afternoon. Thus, the forecasting of late morning system evolution takes on significant importance. This work was summarized in a Severe Storms Conference paper.

University participants carried out analysis of environmental factors that influence the evolution of these systems based upon cases in the 1999-2000 period. Discriminant analysis identified a number of three-variable combinations that appear to strongly influence the character of the evolution of these systems during this time of day. Among the promising environmental variables are CAPE, lifted index, relative inflow of moisture into the system in surface-based layers, upper level meridional wind speed, a quantity relate to upper level wind shear, system direction, and system speed. At this writing, data from the 2001-2005 period is undergoing the same type analysis. This much larger sample size of cases will be evaluated to confirm and enhance the combinations of environmental variables that are promising candidates for incorporation into an operational forecast tool.

Software in the NWS office is being adapted to provide a tool to aid forecasters in forecasting the evolution of morning mesoscale convective systems. A series of three to four maps will be produced for use by forecasters that will show areas most likely to support the maintenance of existing systems. This tool will be evaluated during the summer of 2007.

SECTION 3. BENEFITS AND LESSONS LEARNED: OPERATIONAL PARTNER PERSPECTIVE

NWS participants benefited by acquiring a new tool to forecast the evolution of early morning convective systems in the Great Plains. These systems bring significant amounts of severe weather and rainfall during the summer months. Because of the substantial impact of these systems and the fact that they often occur in environments weakly forced at the synoptic scale and often not well forecast by the large-scale numerical models, any means to discriminate their evolution is valuable.

NWS participants also benefited by improving their understanding of the research process and by skills acquired to develop AWIPS software used in the course of the project.

SECTION 4. BENEFITS AND LESSONS LEARNED: UNIVERSITY PARTNER PERSPECTIVE

University participants have benefited from new knowledge concerning the behavior of mesoscale convective systems during the late morning hours. The initiation locations of systems affecting the county warning areas of Dodge City and Norman lie mostly to the west and northwest of these areas. A large fraction of these systems are initiated during the previous afternoon along ridges that extend eastward from the Rocky Mountains. About 75-80 % of systems decreased in intensity or dissipated during the late morning. Environmental variables that most strongly influence evolution are CAPE/lifted index, north-south wind component at upper levels (350 hPa), an upper level shear variable, relative inflow of moisture to systems, system direction of motion, and system speed. It was learned that systems that survive the late morning are often severe the following afternoon. The student involved in the project benefited from learning how to access various data streams, and gaining knowledge of the structure and evolution of MCSs and how they relate to severe weather.

SECTION 5. PUBLICATIONS AND PRESENTATIONS

Hane, C. E., D. L. Andra, Jr., K. Trammell, and F. H. Carr, 2005: Development of a tool to aid in forecasting the evolution of Great Plains MCSs during late morning hours. AIRMASS 2005 Conf., Wichita, KS, CD-ROM.

Hane, C. E., D. L. Andra, Jr., J. A. Haynes, T. E. Thompson, and F. H. Carr, 2005: On the importance of environmental factors in influencing the evolution of morning Great Plains MCS activity during the warm season. Eleventh Conf. on Mesoscale Processes, Albuquerque, NM, Amer. Meteor. Soc.

Thompson, T. E., C. E. Hane, D. L. Andra, Jr., and F. H. Carr, 2006: Severe weather during the lifetimes of MCSs that affect a limited area of the Great Plains during the morning hours. 23rd Conf. on Severe Local Storms, St. Louis, Amer. Meteor. Soc., P4.1 on CD.

Hane, C. E., J. A. Haynes, D. L. Andra, and F. H. Carr, 2007: The evolution of morning convective systems over the U. S. Great Plains during the warm season. Part II: A climatology and the influence of environmental factors. Mon. Wea. Rev. (in press).

Hane, C. E., T. E. Thompson, D. L. Andra, Jr., and F. H. Carr. 2008: The evolution of morning convective systems over the U. S. Great Plains during the warm season. Part III: An update on the effect of environmental factors. Mon. Wea. Rev. (in preparation).

SECTION 6. SUMMARY OF UNIVERSITY/OPERATIONAL INTERACTIONS AND ROLES

The role of university participants was to carry out a climatological study of MCSs that affect the county warning areas of the Dodge City and Norman NWS offices during summer late morning hours, to analyze environmental data for each of these systems in order to determine the variables that most strongly influence evolution during that time of the day, to document severe weather occurrences in each case, to convey results to others through oral presentations and scientific papers, and to work with the Norman WFO to develop a tool that might aid in forecasting the evolution of these systems.

The role of the NWS participants was to facilitate interaction between WFO forecasters and researchers, and to implement the study's resulting forecast parameters in the WFO Norman operational AWIPS (Advanced Weather Interactive Processing System). Interaction with NWS staff occurred through a seminar arranged at WFO Norman, sharing of research papers and posters by the Norman WFO SOO, and finally a series of meetings to discuss the forecast parameters with WFO staff involved in transferring the research parameters to an operational setting. The WFO SOO, ITO (Information Technology Officer), and forecaster focal point for the Advanced Weather Interactive Processing System (AWIPS) worked together to implement an AWIPS software implementation for the research that will allow WFO forecasters to easily incorporate the research into their forecasts using a variety of gridded data sets in real time. The AWIPS software implementation for the MCS project can easily be shared with any interested WFO due to the portable nature of the implementation within AWIPS.