Using EnKF radar data assimilation to analyze the impact of microphysical processes on the evolution of the 31 March 2016 Southeast-U.S. tornado outbreak during VORTEX-SE

*Daniel T Dawson II[1], Robin Lynn Tanamachi[1], Youngsun Jung[2,3], Jonathan Labriola[2,3], Bryan J Putnam[2,3], Ming Xue[2,3], Pamela Heinselman[4], Kent Knopfmeier[5], Edward R Mansell[4], Louis J Wicker[4]

1. Purdue University, 2. Center for Analysis and Prediction of Storms, 3. University of Oklahoma, 4. NOAA/National Severe Storms Laboratory, 5. Cooperative Institute for Mesoscale Meteorological Studies

Convective evolution in numerical models has been shown to be very sensitive to the parameterization of microphysical processes, yet the observations needed to verify these parameterizations remain exceptionally challenging to obtain. Ensemble Kalman filter (EnKF)-based analyses have proven to be very useful for analyzing storm-scale processes--including microphysical processes--especially when radar data are assimilated. With this approach, recent studies have been able to verify the ability of multi-moment bulk microphysics schemes to simulate certain microphysical structures and processes in severe convective storms through comparison with corresponding simulated polarimetric radar observations. In particular, hydrometeor size sorting has been shown to strongly affect the development of certain polarimetric signatures in supercell thunderstorms, but most studies have focused on relatively idealized environments with mostly qualitative comparisons with observations.

On March 31st, 2016, several severe thunderstorms, some of which produced tornadoes, developed over the southeast United States. Many of these storms--including one tornadic storm near Hartselle, Alabama--were observed by multiple instrumented platforms operating during the VORTEX-SE field program Intensive Operating Period (IOP) #3. The outbreak featured multiple rounds of relatively closely spaced supercells and convective line segments moving over the northern Alabama domain during afternoon and evening. The complex convective evolution of the outbreak represents a challenge for storm-scale numerical analyses and forecasts of the event. During the March 31st, 2016 IOP, multiple polarimetric radars were operating in the northern Alabama domain, and portable instruments equipped with Parsivel laser disdrometers (PIPS) were deployed within severe convective storms to provide direct measurements of the rain drop size distribution (DSD) along with measurements of temperature, relative humidity, pressure, and wind speed and direction.

In this study, these data are used to characterize the microphysical structure and evolution of the convective storms in the outbreak and to validate high-resolution storm-scale ensemble analyses and forecasts using the Advanced Regional Prediction System (ARPS) EnKF data assimilation system nested within the National Severe Storms Laboratory (NSSL) Experimental Warn-on-Forecast System for ensembles (NEWS-e). Preliminary results of experiments using the NSSL triple-moment bulk microphysics scheme and assimilating data from area WSR-88Ds and from VORTEX-SE radar platforms will be presented. The sensitivity of the model-predicted DSDs and polarimetric signatures with experiments in which size sorting of hydrometeors is alternately allowed/disallowed will be assessed. To quantify the sensitivity, a Parsivel simulator is used to sample the rain DSD as predicted by the scheme and then compared directly with the observed DSDs from the PIPS. Additionally, the Center for Analysis and Prediction of Storms (CAPS) Polarimetric Radar Simulator (PRS) is used to derive polarimetric radar observables from the model fields; these are compared with polarimetric observations from the various

radars.

Keywords: severe convective storms, radar data assimilation, microphysics, drop size distributions