Assimilation of Dual-Polarimetric Radar Observations with WRF 3DVAR and its Impact

Xuanli Li[a], John Mecikalski[a], Traci Fehnel[a], and Derek Posselt[b]

[a] *Department of Atmospheric Science, University of Alabama in Huntsville, Huntsville, AL, USA*
xuanli@nsstc.uah.edu , [b] *Atmospheric Science Department, University of Michigan, Ann Arbor, MI, USA*

Owing to the significant progresses in the high-resolution numerical modeling and data assimilation techniques, the numerical prediction of severe weather has been improved substantially. However, it remains a big challenge to predict accurately the evolution of convective events, especially on the storm scale and hence, storm-related quantitative precipitation forecast (QPF). Studies have shown that radar data assimilation can help with short-term prediction of convective weather by providing more accurate initial condition.

Dual-polarimetric (dual-pol) radar typically transmits both horizontally and vertically polarized radio wave pulses. From the two different reflected power returns, information on the type, shape, size, and orientation of cloud and precipitation microphysical particles are obtained, more accurate measurement of liquid and solid cloud and precipitation particles can be provided. The motivation for this research is centered around the upgrade of the current NWS WSR-88D radar network to include dual-pol capabilities, as started in 2011 and to be completed soon. The dual-pol radar network will cover the whole continental US, and therefore our research should have broad-reaching impacts. The assimilation of dual-pol radar data is however, challenging work as few guidelines have been provided on dual-pol radar data assimilation research. It is our goal to examine how to best use dual-pol radar data to improve forecast of severe storm and forecast initialization.

Our presentation will highlight our recent work on assimilating dual-pol radar data for real case storms. In our study, high-resolution Weather Research and Forecasting (WRF) model and its 3-Dimensional Variational (3DVAR) data assimilation system are used for real convective storms. Our recent research explores the use of the horizontal reflectivity (Z_{H}), differential reflectivity (Z_{DR}), specific differential phase (K_{DP}), and radial velocity (VR) data for initializing convective storms and snowfall events, with a significant focus being on an improved representation of ice hydrometeors. Our previous research indicated that the use of Z_{DR} can bring additional benefit into the hydrometeor fields than the use of Z_{H} only. Furthermore, the combination of K_{DP} and Z_{DR} data provide the best initialization for precipitation particles with warm-rain radar data assimilation. Our ongoing work includes the development of an ice microphysics processes scheme within the 3DVAR assimilation procedure. The ice processes can help to describe the ice particles more precisely at and above the melting layer.

In addition to forward model development, high-resolution (≤1 km) WRF model simulations and convective scale data assimilation experiments with WRF 3DVAR system will be discussed, emphasizing both warm rain and ice microphysical processes. Further details of the methodology of data assimilation, the influences of different dual-pol variables on model initial condition and on the short-term prediction of precipitation, and additional results from our ongoing work on the assimilation of dual-pol radar data, will also be presented at the symposium.