5.15 ASSIMILATION OF ZDR COLUMNS FOR IMPROVING THE SPINUP AND FORECAST OF CONVECTIVE STORMS IN STORM-SCALE MODELS

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A primary motivation for assimilating radar reflectivity data is the reduction of spin-up time for modeled convection. Cloud analysis techniques, which seek to induce and sustain convective updrafts by inserting temperature and moisture increments and hydrometeor mixing ratios into the model analysis from simple relations with reflectivity, are commonly used to assimilate radar into storm-scale models. Polarimetric radar data provide additional insight into the microphysical and dynamic structure of convection beyond that of reflectivity alone. Many distinct polarimetric signatures have been discovered. In particular, the radar meteorology community has known for decades that convective updrafts cause, and are typically co-located with, differential reflectivity (ZDR) columns – vertical protrusions of enhanced ZDR above the environmental 0°C level. Despite these benefits, limited work has been done thus far to assimilate dual-polarization radar data into numerical weather prediction model.

This study performs proof-of-concept experiments that explore the utility of assimilating ZDR columns to improve storm-scale model analyses and forecasts of convection for real data cases. Using the Advanced Regional Prediction System (ARPS), we modify the existing cloud analysis routine to adjust model temperature and moisture state variables in regions of detected ZDR columns as proxies for convective updrafts, and compare the resultant cycled analyses and forecasts with those from the original reflectivity-based cloud analysis formulation. Results indicate both qualitative and quantitative improvements from assimilating ZDR columns. These improvements include more coherent and fewer spurious updrafts, forecast updraft helicity swaths that better match radar-derived rotation tracks, more realistic forecast reflectivity fields, and improved equitable threat scores and reduced bias. These findings support the use of dual-polarization radar signatures to improve storm-scale model analyses and forecasts and warrant further study.