Sensitivity of Assimilating GOES Cloud Water Path Retrievals to Model Cloud Microphysics

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Assimilating retrieved cloud properties from satellite data into storm-scale models has to date received limited attention in the research community despite its potential to provide a wide array of information to a model analysis. Retrievals currently available include cloud water path (CWP), which represents the amount of cloud water and cloud ice present in an integrated column and cloud top (base) heights. Retrieval algorithms have been developed to derive these products from operational GOES Imager data with a spatial resolution of up to 4 km at 15 minute intervals.

Jones et al. (2013) developed a new forward operator designed to assimilate CWP retrievals through the Data Assimilation Research Testbed (DART) software using an Ensemble Kalman Filter (EnKF) approach. The new CWP forward operator combines the satellite cloud height information with the WRF generated cloud hydrometeor variables to determine where in the atmospheric column and how much to adjust the CWP to match the observation. Testing of this forward operator within a convection allowing model using a case study occurring on 10 May 2010 in Oklahoma and Kansas showed positive impacts on both the location of ongoing convection in the model and in the reduction of spurious convection generated by the model when no satellite data was assimilated.

Since CWP is directly related to the cloud hydrometeor variables in the model analysis, it follows that the assimilation will be highly sensitive to the cloud microphysics scheme selected. To test this hypothesis, experiments using idealized convection in addition to real data are conducted for a variety of cloud microphysics schemes. In both cases, the more advanced schemes tended to perform better compared to more traditional schemes. In particular, the concentrations of frozen hydrometeors (ice, snow, graupel, and hail) were particularly sensitive to the scheme used by an experiment. These results emphasize the importance of using the right cloud microphysics scheme when assimilating cloud property retrievals or any other satellite data within cloudy regions.

Future GOES-R retrievals will improve both the spatial and temporal resolution as well as provide more detailed information on multiple cloud layers and liquid vs. frozen cloud phases. As a result, the positive impacts found when using both simulated and real retrievals based on current data should only increase as GOES-R data becomes available in the future.

References

Jones, T. A., D. J. Stensrud, P. Minnis, and R. Palikonda, 2013a: Evaluation of a forward operator to assimilate cloud water path into WRF-DART. *Mon. Wea. Rev*. In Press (online).