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Assimilation of GOES satellite-based convective initiation and cloud growth observations into the Rapid Refresh and HRRR systems to improve aviation forecast guidance

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Latent heating profiles derived from GOES satellite-based cloud-top cooling rates are being assimilated into a retrospective version of the Rapid Refresh system (RAP) being run at the Global Systems Division. Assimilation of these data may help reduce the time lag for convection initiation (CI) in both the RAP model forecasts and in 3-km High Resolution Rapid Refresh (HRRR) model runs that are initialized off of the RAP model grids. These data may also improve both the location and organization of developing convective storm clusters, especially in the nested HRRR runs. These types of improvements are critical for providing better convective storm guidance around busy hub airports and aviation corridor routes, especially in the highly congested Ohio Valley – Northeast – Mid-Atlantic region. Additional work is focusing on assimilating GOES-R CI algorithm cloud-top cooling-based latent heating profiles directly into the HRRR model. Because of the small-scale nature of the convective phenomena depicted in the cloud-top cooling rate data (on the order of 1-4 km scale), direct assimilation of these data in the HRRR may be more effective than assimilation in the RAP.

The RAP is an hourly assimilation system developed at NOAA/ESRL and was implemented at NCEP as a NOAA operational model in May 2012. The 3-km HRRR runs hourly out to 15 hours as a nest within the ESRL real-time experimental RAP. The RAP and HRRR both use the WRF ARW model core, and the Gridpoint Statistical Interpolation (GSI) is used within an hourly cycle to assimilate a wide variety of observations (including radar data) to initialize the RAP. Within this modeling framework, the cloud-top cooling rate-based latent heating profiles are applied as prescribed heating during the diabatic forward model integration part of the RAP digital filter initialization (DFI). No digital filtering is applied on the 3-km HRRR grid, but similar forward model integration with prescribed heating is used to assimilate information from radar reflectivity, lightning flash density and the satellite based cloud-top cooling rate data. In the current HRRR configuration, 4 15-min cycles of latent heating are applied during a pre-forecast hour of integration. This is followed by a final application of GSI at 3-km to fit the latest conventional observation data.

At the conference, results from a 5-day retrospective period (July 5-10, 2012) will be shown, focusing on assessment of data impact for both the RAP and HRRR, as well as the sensitivity to various assimilation parameters, including assumed heating strength. Emphasis will be given to documenting the forecast impacts for aviation applications in the Eastern U.S.