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Assimilation of precipitation-affected microwave radiances in a cloud-resolving WRF ensemble data assimilation system

sara zhang (1), dusanka zupanski (2), milija zupanski (2), arthur hou (1), and samson cheung (3)
(1) NASA Goddard Space Flight Center, Greenbelt, MD, United States (sara.q.zhang@nasa.gov), (2) Colorado State university, Fort Collins, CO, United States, (3) University of California, Davis, CA, United States

In the last decade the progress in satellite precipitation estimation and the advance in precipitation assimilation techniques proved to have positive impact on the quality of atmospheric analyses and forecasts. Direct assimilation of rain-affected radiances presents new challenge to optimal utilization of satellite precipitation observations. Currently operational and research experiences in using precipitation observations have focused on a global model resolution with prescribed static forecast error statistics, while a high-resolution with cloud-resolving physics and flow-dependent forecast error information are needed for applications such as for downscaling precipitation information from rain-affected radiances and for improving hydrological forecasts.

To address some of these challenges, a WRF ensemble data assimilation system (WRF-EDAS) at cloud-resolving scales has been developed jointly by NASA/GSFC and Colorado State University. The high-resolution WRF-EDAS is designed to assimilate precipitation-affected radiances in addition to the NOAA/NCEP operational data stream of in-situ data and clear-sky satellite observations. The ensemble data assimilation technique opens a new pathway to provide dynamically updated background error covariance, and to utilize full nonlinear microphysics and radiative transfer model in precipitation observation operators. The high resolution of nested domain WRF model first guess allows more realistic representation of precipitation distribution in the field of view (FOV) of microwave radiance observations in low and medium range of frequencies. We present experimental results of assimilating AMSR-E microwave radiances in case studies of summer storm events over land. The assimilation of precipitation-affected radiances from multiple channels of AMSR-E has shown positive impact on the downscaled precipitation analysis and short term forecast of microphysical variables. The sensitivity of precipitation analyses to the uncertainties associated with beam-filling and the vertical distribution of hydrometeors are investigated to formulate bias corrections and to guide observation error specification tuning.