Investigating the Impact of pre-GPM Microwave Precipitation Observations in the Goddard WRF Ensemble Data Assimilation System

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In recent decades, the availability of satellite observations has greatly increased, in particular passive microwave observations on precipitation processes. Because rainfall has large variability and short predictability time, frequent and broad data coverage is crucial to assimilation of precipitation data to improve precipitation analyses and forecasts in NWP system. Indeed, the forthcoming GPM (Global Precipitation Measurement) program will provide more than fifteen overpasses per day in the mid-latitudes thanks to a constellation of observing systems. The assimilation of precipitation-affected radiances into numerical forecast models has shown promising potential in improving atmospheric analyses and forecasts. In the meantime it also raises new challenges to data assimilation systems. In order to effectively use these observations, a data assimilation system needs to have a forecast error covariance capturing temporal and spatial variability of precipitation and clouds, an observation operator adequately representing non-linear microphysics and radiative transfer in presence of clouds and precipitation.

We present a data impact study on the assimilation of microwave radiance observations in precipitating areas using Goddard WRF ensemble data assimilation system (Goddard WRF-EDAS). A series of assimilation experiments are carried out using a pre-GPM constellation in a WRF 9 km grid-spacing domain in Western Europe (SSMIS/DMSP-F16, -F17, -F18; AMSR-E/AQUA; MHS/NOAA-18, -19 and Metop-A). A case study of storms, which occurred over France in September 2010, is used to illustrate the analysis sensitivity to precipitation-affected observation errors and the flow-dependent background error covariance of hydrometeors. A bias correction scheme is developed based on the statistics of radiance innovations in rainy areas. Observation system experiments (OSE) are configured as a control and a set of experiments using pre-GPM precipitation data with varied frequency of data coverage in different lengths of assimilation window. Results show that the assimilation of multiple-instrument radiances in precipitating areas has a positive impact on the accumulated rain forecasts verified by ground-based radar rain estimates.