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Development of an ensemble-based data assimilation algorithm for high-resolution dynamically balanced precipitation analysis

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Precipitation process plays key role in the global and regional hydrological cycles. Assimilation of precipitation observations into weather prediction models posts special challenges: the observation operator involves nonlinear and coupled physical processes, and cloud-resolving scales are needed to simulate realistic cloud and precipitation sensitive radiance comparable with satellite data. Ensemble data assimilation methods are promising for assimilation of this type of observations, thanks to statistical approaches based on ensemble model forecasts to represent the link between precipitation observations and state variables.

We present here the development of an ensemble-based data assimilation system to meet the challenges and enhance scientific applications of the Global Precipitation Measurement (GPM) Mission led by NASA and JAXA. The system utilizes a high-resolution Weather Research and Forecasting (WRF) model with multiple nests and the Maximum Likelihood Ensemble Filter (MLEF). The WRF model employs the sophisticated cloud-resolving microphysical schemes of the Goddard Cumulus Ensemble (GCE) model. The Goddard Satellite Data Simulation Unit (SDSU) is also incorporated into the observation operator for assimilation of cloud/precipitation sensitive radiance. The goal is to use ensemble data assimilation technique to produce high-resolution dynamically balanced precipitation analysis. Because of the use of ensembles of forecast models, the resulting precipitation analyses are dynamically balanced with other model variables, such as temperature, pressure, wind and humidity, therefore the data impact is more extendable into future forecasts. This is important for weather, climate and hydrological forecast applications. The ensemble data assimilation also provides uncertainty estimates of the precipitation analyses. Finally, we will discuss potential application of the ensemble data assimilation at cloud-resolving scales to retrieve precipitation from microwave rain-sensitive radiances.