Assimilation of INSAT-3D Thermal Infrared Window Imager Observation using Particle Filter

Prashant Kumar* and Munn V. Shukla
Atmospheric and Oceanic Sciences Group, Space Applications Centre, ISRO, Ahmedabad, India

Abstract

A big challenge in the satellite data assimilation is the effective use of InfraRed (IR) window channel radiances in the high-resolution weather model. A hybrid data-assimilation method is used in this study for very severe cyclonic storm "Vardah," in which three-dimensional variational method is used to assimilate control observations, and particle filter method is used to assimilate Indian geostationary satellite INSAT-3D data. In the context of imperfect weather model, various particles (or ensembles) are prepared with different combinations of model physics. To implement particle filter, INSAT-3D thermal IR window channel 1 (TIR-1; center wavelength 11 μm) measured brightness temperature (BT) and cloud mask product are used to assign appropriate weights to different particles to reduce model uncertainties. This step is followed by resampling step in which new particles are generated from high weight particles using stochastic kinetic-energy backscatter scheme method and dynamical variables are perturbed into the model physics. Results suggest that simulated TIR-1 BT analysis and forecasts from WPF (with INSAT-3D data using particle filter experiments) are closer to INSAT-3D measured TIR-1 BT in comparison to WCNT (without INSAT-3D data using particle filter) experiments. Furthermore, approximately 10% to 50% improvements are found in mean track error forecasts in WPF experiments. An improvement of ~10% is noticed in cyclone center position in analysis. Prediction of storm intensity is also improved after assimilation. Results also suggest that vertical structure of WPF simulated humidity, temperature, wind speed, and surface pressure is improved over WCNT runs.

Reference:

Kumar, P., & Shukla, M. V. (2019). Assimilating INSAT-3D thermal infrared window imager observation with the particle filter: A case study for Vardah Cyclone. Journal of Geophysical Research: Atmospheres,124. https://doi.org/10.1029/2018JD028827