Assessment of GOES-R ABI Level 1B Radiances for NWP Applications

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Abstract

This proposal addresses the first two research priorities A1 and A2 in the topic area of "Improving Operational Environmental Prediction". For direct assimilation of Geostationary Operational Environmental Satellite-R (GOES-R) Level 1B (L1B) radiances in National Centers for Environmental Prediction (NCEP) 3D-Var Grid Statistical Interpolation (GSI) data assimilation systems for improved global and regional numerical weather forecasts. The Community Radiative Transfer Model (CRTM) serves as a forward observation operator in the NCEP GSI systems. Some significant improvements have recently made to CRTM in order to better simulate Himawari-8 Advanced Himawari Imager (AHI) observations. The improvements include updates of spectral response function (SRF) data base, surface reflectivity and emissivity, and cloud scattering lookup tables. It was found the fast transmittance model in the currently released CRTM was parameterized with an outdated AHI SRF and thus the bias (O-B) at AHI thermal channels can be larger than 1.0 K. Through collaborating with Japan Meteorological Agency (JMA), we have obtained the latest AHI SRF and updated the CRTM fast transmittance model. Under clear atmospheric conditions, AHI biases at all the infrared channels over ocean and land are less than 0.8 K and 1.2 K, respectively after SRF updates. We will further evaluate the CRTM performance through uses of the GOES-R Advanced Baseline Imager (ABI) post-launch test (PLT) data and field campaign data and ensure a timely update of the CRTM ABI transmittance model and other components. In addition, we will generate the CRTM fast transmittance models for GOES-S/U/T ABI based on the prelaunch established SRF data bases.

For cloudy radiance assimilation in numerical weather prediction (NWP) models, CRTM simulations require cloud optical properties including single scattering albedo and phase matrix. A new ice cloud scattering data base was recently developed from the MODIS (Moderate Resolution Imaging Spectroradiometer) Collection 6, in which ice particles are represented as severely roughened hexagonal ice column aggregates with a gamma size distribution. Comparisons of brightness temperatures between CRTM simulations covering the infrared wavelengths and satellite observations show that the new ice cloud optical property look-up table (LUT) substantially enhances the performance of the CRTM under ice cloud conditions. This new data base will be used for ABI cloudy radiance assimilation as well.

Numerical data assimilation experiments will be conducted in 2018 and 2019 hurricane seasons to show the added values of ABI to the current baseline data streams for hurricane and coastal precipitation forecasts. The forecast experiments will be conducted through a refined GSI system in which research findings are incorporated. For the Hurricane Weather Research and Forecast (HWRF) runs, we will use the general warm-start with HWRF 6-hour forecasts as background fields. The GOES-R ABI radiance data assimilation will be carried out in three HWRF domains with different data thinning strategies over non-

overlapping regions. Assimilation of satellite data from all instruments will be carried out within the outermost domain to allow a better prediction of hurricane environmental flow features whereas uses of ABI data over the middle and inner domains will realize the full benefit of high-resolution GOES-R ABI data for improving severe weather forecasts. Benefits of GOES-R ABI data assimilation for improved quantitative precipitation forecasts (QPFs) will also be explored for coastal storms near the Gulf of coast and other areas.