Testing and Evaluation of Radiance Data Assimilation Using the WRF-GSI System

Chunhua Zhou¹,², K. M. Newman¹,², H. Shao, X. Y. Huang¹,² and M. Hu¹,³,⁴

¹Developmental Testbed Center (DTC); ²National Center for Atmospheric Research (NCAR);
³NOAA/ESRL/Global Systems Division; ⁴CIRES/University of Colorado

Introduction

The Gridpoint Statistical Interpolation (GSI) is a three dimensional variational (3D-Var) data assimilation system that is being developed at NCEP/EMC, NOAA/GSD, NASA/GMAO, and NCAR/MMM. At DTC, the testing and evaluation efforts on the end-to-end system of WRF and GSI in regional applications are being conducted, in order to determine the capability and robustness of the GSI coupled with WRF ARW in regional applications, as well as to evaluate the impact of a variety of existing and proposed operational data types.

In this work, the GSI and WRF v3.2 were used to assess the impact of assimilating AMSUA and AMSUB radiance data in the AFWA T8 domain for the time period of August 15th to September 15th, 2007. Monthly runs with 6-hourly cycling and 48 hours forecast were made for both AMSUA and AMSUB, in addition to the conventional data. Additional tests are performed to investigate the impact of diurnal cycle in air-mass bias correction and angle-dependent bias correction. Verification using Model Evaluation Tools (MET) are performed against NCEP PrepBUFR data.

Experiment Design

- CYC_CONV_default: GSI and ARW 6 hour cycling runs assimilating conventional PrepBUFR data, 15km horizontal resolution, 57 levels.
- CYC_AMSUA: Same as CYC_CONV_default, except AMSUA radiance data were assimilated as additional data.
- CYC_AMSUB: Same as CYC_CONV_default, except both AMSUA and AMSUB radiance data were assimilated as additional data.

Radiance Data Coverage

AMSUA and AMSUB radiance data are assimilated with a 3 hours time window, in addition to the NCEP PrepBUFR data. An example is shown below for the data coverage of AMSUA within AFWA T8 domain.

Bias Correction

For the CYC_AMSUA and CYC_AMSUB runs, a variational Bias Correction (BC) within GSI was used. The following figure presents the time series of the number of observations, mean bias, and standard deviation of the brightness temperature background with and without BC. Significant reduction in bias and standard deviation after the GSI bias correction can be seen at this channel.

Forecast Verification

MET verification was performed against PrepBUFR sounding observations for the monthly CYC_AMSUA and CYC_AMSUB runs.

Additional Tests on Bias Correction

Additional runs were made, including diurnal cycle in Variational BC and adding AMSUB data in addition to AMSUA data. Significant reduction in bias and standard deviation after the GSI bias correction can be seen at this channel.

Summary

- Verification against NCEP PrepBUFR data shows slight SS positive impact in the humidity and wind forecasts from AMSUA radiance data compared to the run with conventional data only.
- Adding AMSUB radiance data in addition to AMSUA shows no SS improvement or degradation over conventional and AMSUA radiance data alone.
- Additional weekly runs suggested that removing channels above the current model top and including diurnal cycles in Variational BC give smaller bias and rmse for the temperature and specific humidity at analysis time. Extended runs with tuned satellite bias coefficients might be useful in further evaluating the impacts.

Acknowledgments: This work is sponsored by the Air Force Weather Agency.