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

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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.

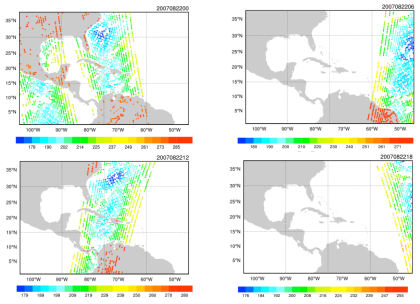

Figure 1 The horizontal distribution of the AMSU_A data from channel 1 of NOAA-15 on Aug. 22, 2007.

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.

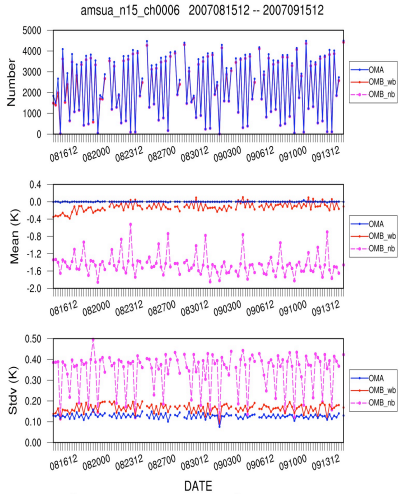

Figure 2 Time series of the number of observations, mean bias, and standard deviation of brightness temperature background with BC (red), without (pink) BC, and analysis increment (blue) for the CYC_AMSUA experiment.

Additional Tests on Bias Correction

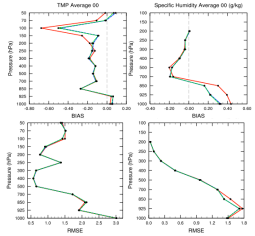

Figure 4 Vertical profiles of bias and rmse at the analysis time of temperature (left) and specific humidity (right) for AMSUA_angle (green, angle dependent VarBC in addition to air-mass VarBC), AMSUA_DC (blue, diurnal cycle included in air-mass VarBC), and CYC_AMSUA (red). Verification is against PrepBUFR observations for 1-week (2007081512-2007082212) testing period. Channels above the model top (10mb) are removed in AMSUA_angle and AMSUA_DC runs.

Forecast Verification

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

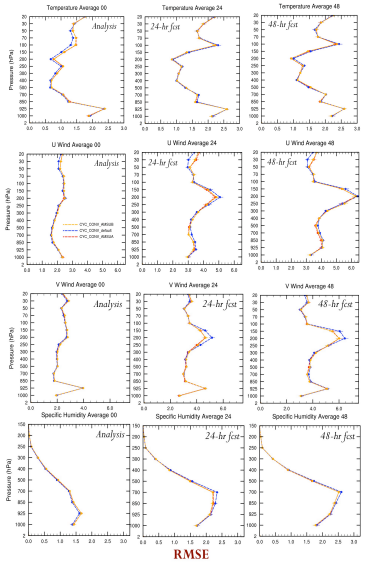

Figure 3 Vertical profiles of the rmse for the analysis (left), 24-hour forecast (middle), and 48-hour forecast (right) of temperature (upper), u-component wind (upper-middle), v-component wind (lower-middle), and specific humidity (lower) from CYC_CONV_default (blue), CYC_ AMSUA (red) and CYC_AMSUB (orange). Verification is against PrepBUFR sounding data and 95% confidence intervals.

Summary

- Verification against NCEP PrepBUFR data shows slightly 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.

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