Impacts of assimilating ABI and AHI water vapor channel radiances in GFS-T1534 with GSI

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ABSTRACT

NCMRWF is routinely carrying out GFS-T1534 model analysis, which IMD uses for operational forecasts. The present GFS-T1534 model with hybrid 4D EnsVar assimilation system at NCMRWF is a robust system that monitors the quality of satellite radiances and based on assimilation statistics decisions are taken as to which channels have to be assimilated. This assimilation system is operational at NCMRWF from 2018 onwards. Recently with the availability of Advanced Baseline Imager (ABI) and Advanced Himawari Imager (AHI) radiances from GOES-16 and GOES-17 satellites, the current assimilation system has been upgraded to include the ABI and AHI clear-sky radiances. This study emphasizes the added benefit of assimilating the ABI and AHI radiances in the present assimilation system at NCMRWF. The impact of assimilating radiances from ABI and AHI is investigated using radiances from water vapor channels. The quality of ABI and AHI radiances for each channel is assessed by comparing with the model background. Assimilation experiment shows that assimilation of ABI and AHI water vapor radiance improved the model forecasts in all regions (Northern Hemisphere, Southern Hemisphere, and Tropics) and at different pressure levels in comparison to the control experiment. A significant reduction in RMSE is noticed for variables such as wind vectors, temperature, and geopotential heights at most of the levels. This study reveals that assimilation of ABI and AHI data from water vapor channels show a marginal positive impact on forecast skill in comparison to the Control experiment.

INTRODUCTION

- Assimilation of infrared radiances from geostationary instruments have shown significant positive impact in global numerical weather forecasting (wang et al., 2018).
- Advanced Baseline Imager (ABI) and Advanced Himawari Imager (AHI) are a newest generation of the geostationary visible and infrared imager onboard GOES-16 and Himawari-8 satellites, which has 16 channels, out of which 10 IR channels (i.e., 7-16) are important for NWP models (Zhuge & Zou, 2016; Zhuge et al., 2017).
- Ma et al., 2017 assimilated AHI radiances into NCEP GFS and found positive impact on the upper tropospheric water vapor.
- In the present study, the impact of assimilating the WV channels of ABI and AHI brightness temperatures on the NGFS-T1534 model forecasts are investigated

METHODOLOGY

- The impact of assimilating ABI and AHI radiances on the model forecasts are assessed by conducting the two model experiments during 24 Sep 2020 to 15 Oct 2020
  1. **CNTL:** The conventional observations from land surface, marine surface, radiosonde, satellite-derived winds and aircraft observations and satellite radiances are assimilated
  2. **ABIWV :** The same observations as in CNTL along with ABI and AHI brightness temperatures
- Three infrared Water Vapor (WV) channels of ABI and AHI instruments onboard GOES-16 and Himawari-8 satellites are assimilated in NGFS-T1534, which are sensitive to the middle to upper tropospheric humidity. The spatial coverage of ABI and AHI are shown in Fig. 1.

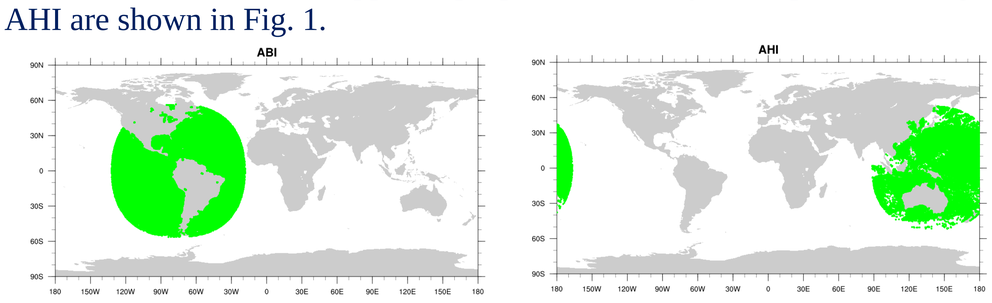

Fig.1: Spatial coverage of ABI and AHI

- ABI has three WV channels (i.e., channels 8, 9 & 10) centered at 6.25, 6.95 and 7.35 µm and the weighting function peaks of these channels are located near 370, 420 and 560 hPa, respectively.
- AHI has three WV channels 8-10 (6.2, 6.9, and 7.3 µm) that are sensitive to middle and upper tropospheric humidity.
- GSI version 14.1.7 has been modified to include ABI and AHI radiances. Community Radiative Transfer Model version 2.2.3 is employed in the GSI as the observation operator to assimilate ABI and AHI radiances.

RESULTS

- Scorecard is prepared over three regions (Northern hemisphere, southern hemisphere and Tropics) for RMSE and Bias between CNTL and ABIWV experiments (Figure 2).
- Significant reduction in RMSE is noticed over tropics followed by southern hemisphere and northern hemisphere almost for all pressure levels. Among the analyzed variables geo-potential height shows remarkable improvement.
- Improvement in Bias is found in middle to upper troposphere over all of the three regions for geo-potential height and temperature.

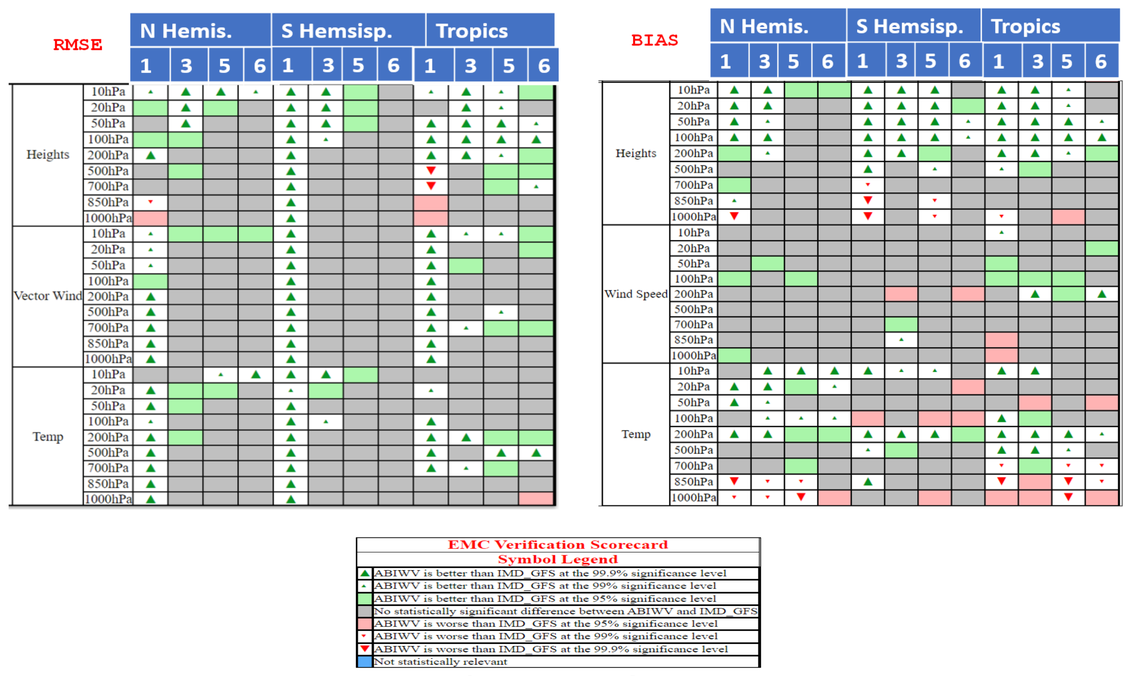

Fig.2: Verification scorecard

- The analysis of anomaly correlation is shown slight improvement in ABIWV experiment compared CNTL. The anomaly correlation for tropics is shown in Fig. 3.

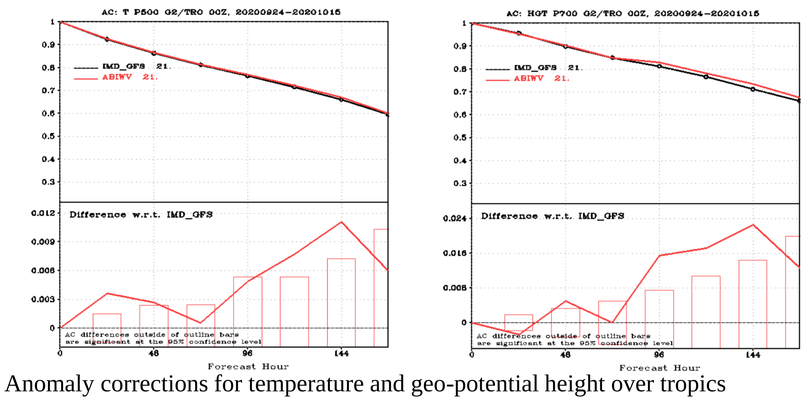

Fig.3: Anomaly corrections for temperature and geo-potential height over tropics

SUMMARY

ABI and AHI water vapor radiances assimilation into the NGFS-T1534 shows positive impact on the model forecasts, which is evident from the analysis of RMSE, bias and anomaly correlation of wind vectors, temperature and geo-potential height.

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