Operational use of Suomi NPP ATMS radiance data in JMA's global NWP system

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1. Introduction

Since March 2017, microwave radiance data from the Advanced Technology Microwave Sounder (ATMS) of the Suomi National Polar-orbiting Partnership (NPP) spacecraft have been assimilated operationally into the global Numerical Weather Prediction (NWP) system run by the Japan Meteorological Agency (JMA). This report briefly describes related data quality control and the impacts of the assimilation.

2. Methods

The 22-channel ATMS is the successor to the Advanced Microwave Sounding Unit-A (AMSU-A) and Microwave Humidity Sounder (MHS) instruments. For the temperature-sounding channels (6 – 15) of this sounder, an ATOVS and AVHRR Pre-processing Package (AAPP) FFT-based filter is applied to achieve noise performance similar to that of AMSU-A. For ATMS data assimilation into the global NWP system, the approaches used for AMSU-A/MHS quality control (Okamoto et al. 2005) and variational bias correction (Sato 2007, Ishibashi 2009) in the system are applied. The thinning distance is set to 250 km for all ATMS channels. Edge data on field-of-view (FOV) numbers at 1, 2 and 95, 96 are not assimilated due to their anomalous biases. The RTTOV-10 fast radiative transfer model (Saunders et al. 2012) is used for assimilation.

Preliminary experiments involving the assimilation of ATMS tropospheric channels (6 – 9, 18 – 22) and stratospheric channels (10 – 15) were performed, with results showing a negative impact from the ATMS stratospheric channels that increased normalized standard deviations (STDV) of the first-guess (FG) departure from AMSU-A stratospheric channels (9 – 14) (Figure 1 (a), green line). As the cause of this impact remains unclear, ATMS tropospheric channels were selected for assimilation into the global NWP system.

3. Impacts on the NWP system

Observing system experiments covering periods of a month in each of boreal summer 2015 and winter 2015 – 2016 were performed to evaluate the impact of ATMS data assimilation into the global NWP system. The control experiment (CNTL) had the same configuration as the operational system as of December 2016. Data from ATMS tropospheric channels (6 – 9, 18 – 22) were added to the operational observation data set in the TEST experiment. Figure 1 shows changes in the normalized standard deviations of the FG departure. Although increased STDV was observed for AMSU-A tropospheric channels 6 and 7, results from the MHS, Advanced Microwave Scanning Radiometer 2 (AMSR2), Global Precipitation Measurement (GPM) Microwave Imager (GMI), Global Navigation Satellite System Radio Occultation (GNSS-RO) and radiosonde temperature observation indicated improved water vapor and temperature data in FG fields. Figure 2 shows the zonal means of root mean square error (RMSE)

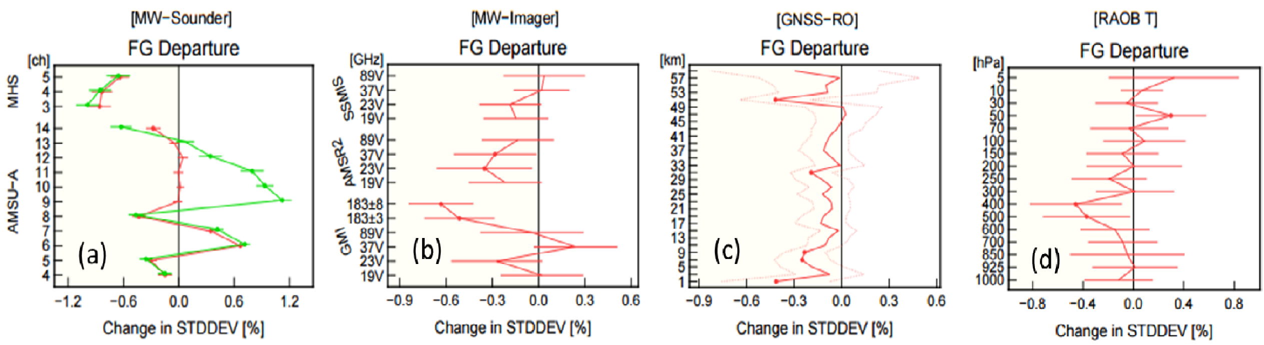

Figure 1: Normalized changes in the STDV of FG departures from (a) AMSU-A and MHS, (b) SSMIS, AMSR2 and GMI, (c) GNSS-RO bending angle and (d) radiosonde temperature observation in the boreal summer experiment. Negative values represent improvement. The horizontal axis indicates differences in normalized standard deviation. Error bars represent a 95% confidence interval, and dots represent statistically significant changes. In panel (a), the green line represents the results of a preliminary test in which stratospheric channels 10 – 15 were included in the assimilation.

differences for geopotential height on day 1 to day 3 forecasts in the boreal summer experiment. Clear positive impacts in the mid- and upper troposphere were observed, especially in the Southern Hemisphere. The assimilation of ATMS radiance data also brought improved tropical cyclone track predictions for the experiment periods (Figure 3).

Based on these findings, ATMS radiance data have been assimilated into JMA's global NWP system since 29 March 2017.

References

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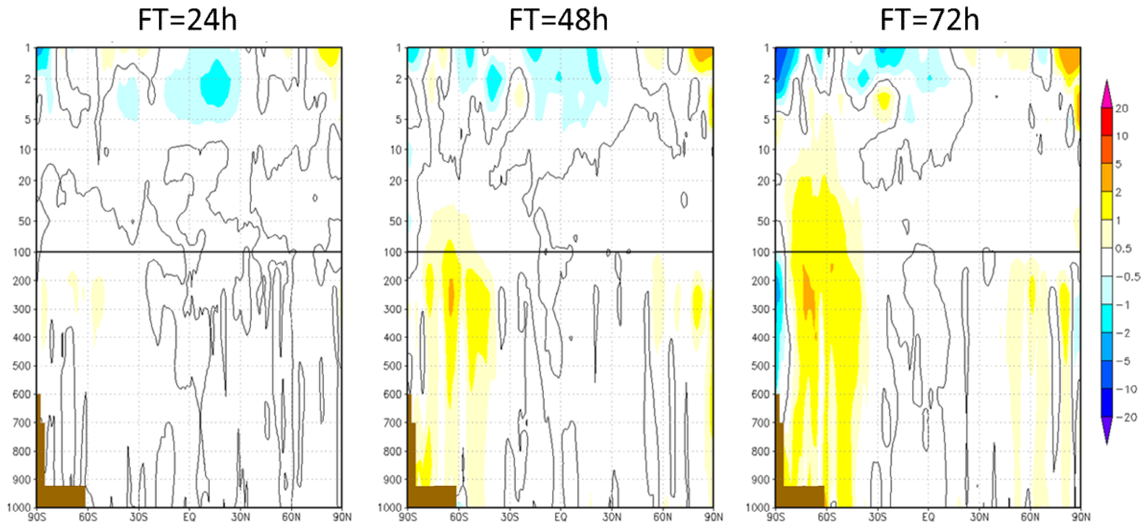

Figure 2: Zonal mean of RMSE differences between CNTL (without ATMS) and TEST (with ATMS) for forecasting of geopotential height in August 2015. Positive values indicate forecast error reductions. Verification is against the experiment's own analysis.

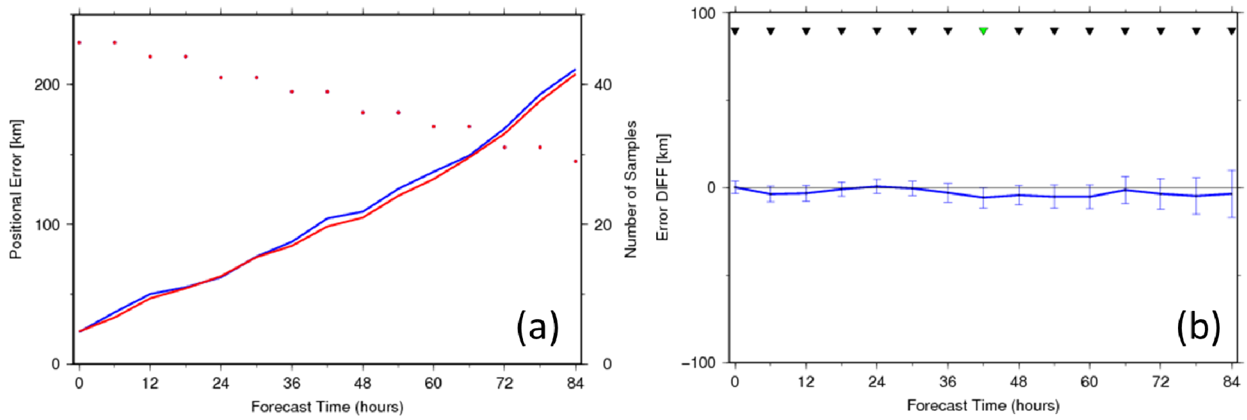

Figure 3: (a) Average of typhoon track forecast errors for August 2015. The red and blue lines represent positional errors of TEST (with ATMS) and CNTL (without ATMS), respectively. Red dots indicate the number of cases included in the statistics. Forecasts were verified against best-track data from Regional Specialized Meteorological Centre (RSMC) Tokyo – Typhoon Center analysis. The horizontal axis indicates forecast time. (b) Difference in typhoon position errors between TEST and CNTL. Negative values indicate error reductions, and error bars represent a 95% confidence interval. The triangles at the top indicate the statistical significance differences, with green indicating significance.