Update of the radiative transfer model to RTTOV-13 at JMA

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1 . Introduction

Various satellite radiance data are assimilated to obtain initial conditions for numerical weather prediction (NWP) models. Higher accuracy of radiative transfer model enables to utilize radiance data more appropriately. The radiative transfer model at the JMA's NWP systems (the global system, the meso-scale system and the local system) was updated from RTTOV-10.2 (Saunders et al. 2012, hereafter v10) to RTTOV-13.0 (Saunders et al. 2020, hereafter v13) in 2022. As the first step, the upgrade was limited to minimal changes such as follows:

- Update of RTTOV modules, MW and IR land surface emissivity atlases, MW scattering property files (from the mietable files to the hydrotable files)
- Conversion of v10 coefficient files in v13 format (still using v10.2 coefficients)

We are working on update to v13 coefficients. In this poster, we describe the impacts of assimilation with v13 coefficients for MW sounders (MWS) and imagers (MWI), and IR imagers in the global NWP system, and also present a preliminary investigation of hyperspectral sounder (HSS) coefficients with RTTOV-13.

2. Modification of quality control

Two changes of QC are conducted for update to v13 coefficients.

- Update of Static bias correction (ScanBC)
- Change of threshold of Cloud Liquid Water (CLW) for AMUS-A and ATMS from 100 g/m^2 to 120 g/m^2
  - Clouds are detected based on CLW (Weng, et al. 2002).
  - The threshold of CLW was reviewed because more CLW is calculated with the new ScanBC. If the threshold remain same, the used data decrease.

3. Observation System Experiments (OSE) for MWS, MWI, and IR imagers

CNTL: The JMA operational global system as of February 2023, using RTTOV-13 with v10 coefficients.
- Outer model: TL959L128 (20 km)
- Inner model: TL319L128 (55 km)
- 6-hr assimilation window with Hybrid 4D-Var

TEST: Same system configuration as CNTL, except using v13 coefficients for MW sounders and imagers, and IR imagers. Observation errors are same as CNTL.

Experimental Period: January and August 2020

Changes of STD of FG departure

STDs of FG departure are decreased for temperature from conventional observations, namely short-range forecast is neutral to improved. Accuracy of calculated brightness temperature for AMSU-A and ATMS is improved.

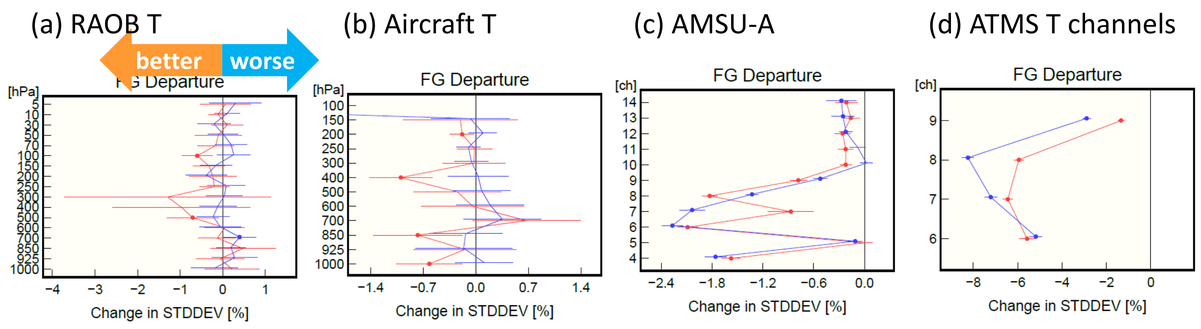


Figure 1. Changes in the STDV of FG departures for (a) temperature from RAOB (b) temperature from aircraft (c) AMSU-A (d) ATMS temperature channels for January (**blue line**) and August (**red line**) 2020.

Changes of Forecast Errors

Changes of forecast errors are almost neutral.

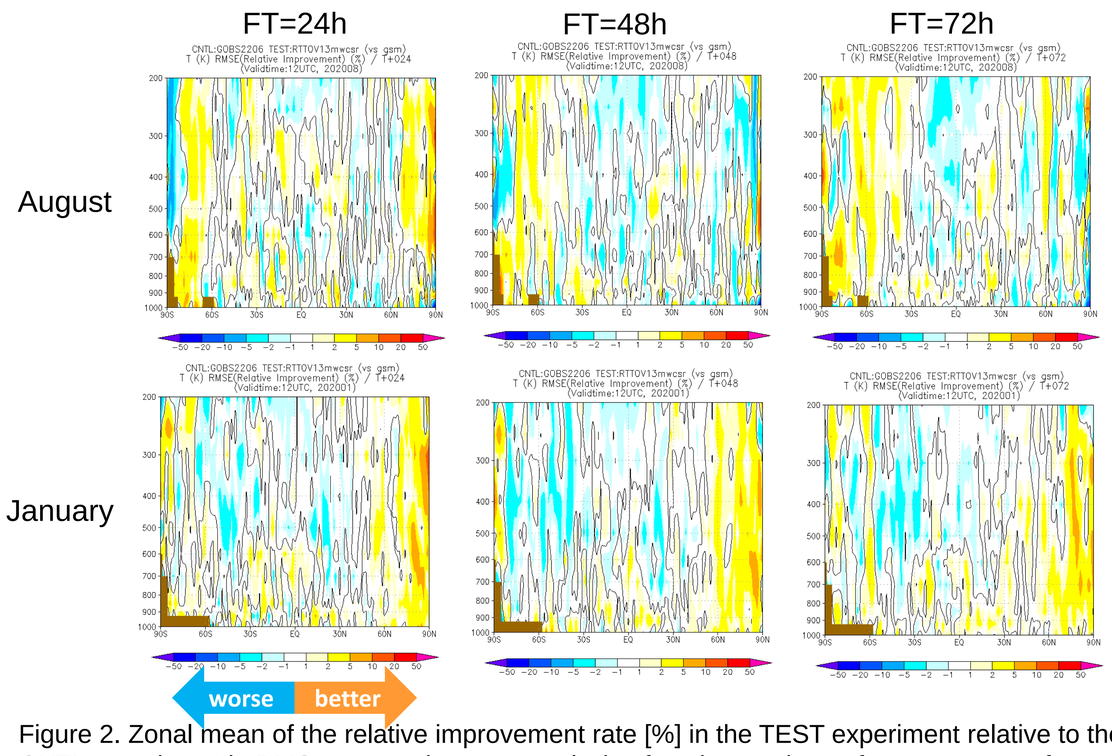
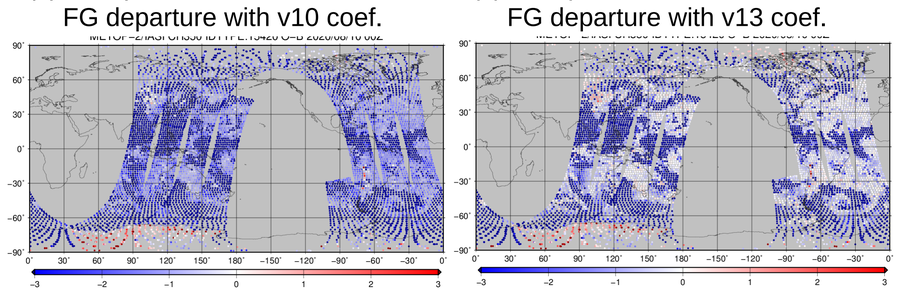


Figure 2. Zonal mean of the relative improvement rate [%] in the TEST experiment relative to the CNTL experiment in RMS error against own analysis of each experiment for *temperature forecast*. Warm colors indicate forecast error reduction.

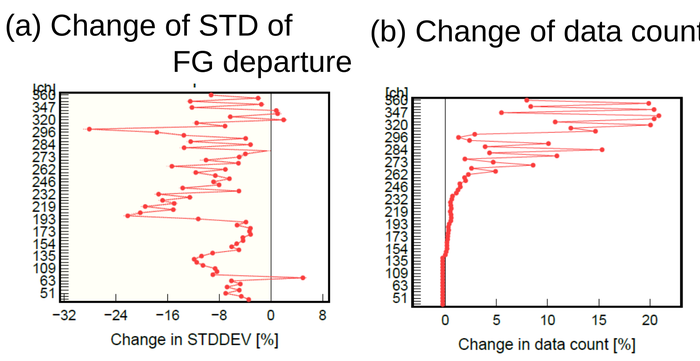
4. Preliminary investigation for HSS

In order to investigate impacts of v13 coefficients for HSS, the FG departures using v10 and v13 are compared without data assimilation cycles (the first guess is used from CNTL).



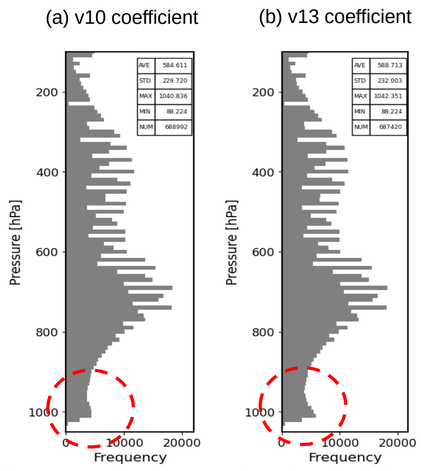
FG departure before bias correction become closer to zero for v13 coefficients in clear area .

Figure 3. comparison of map for Metop-A/IASI ch 350 (wavenumver: 735.25cm^{-1}) FG departure before bias correction with v10 and v13 coefficients.



Calculation accuracy of brightness temperature is improved for HSS and data counts increase at channels which are sensitive to the lower troposphere.

Figure 4 . Changes in (a) the STDV of FG departures and (b) data count for Metop-A/IASI for August 2020



Cloud screening in quality control for HSS is based on whether estimated cloud top (Eyre and Menzel 1989) is higher than sensitive level for each channel. Estimated cloud top with v13 coefficient is lower than that with v10 coefficient. This is because data counts increase at channels which are sensitive to the lower troposphere.

If the estimated cloud top is lower than actual height of cloud, accuracy of analysis may degraded by assimilating observational data with cloud contamination under clear-sky assumption. We plan to verify the cloud top height with v13 coefficient using other products to confirm the accuracy.

Figure 5. Histogram of estimated cloud top for Metop-A/IASI with (a) v10 and (b) v13 coefficients for August 2020

5. Summary and Future Plans

Summary

We evaluated impacts of update from v10 to v13 coefficients.

- Impact of update for MWS, MWI, and IR imagers coefficients
  - The short-range forecasts are improved. Improvements in the forecast are not clear.
- Preliminary investigation for update of HSS coefficients
  - the calculated brightness temperature is improved, and a number of used data increases at the channels which are sensitive to the lower troposphere.
  - The estimated cloud top height with v13 coefficients is lower than that with v10 coefficients.

Future Plans

- We plan to verify the estimated cloud top height for HSS using other products to confirm the accuracy and investigate the impact of v13 coefficients for HSS in data assimilation.
- We will update to v13 coefficients at the JMA's operational NWP systems.