Initial assessment of FY-3A microwave temperature sounder radiance data in JMA's global data assimilation system

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Observations from microwave radiometers currently play an important role in data assimilation for Numerical Weather Prediction (NWP). Microwave observations contain information on atmospheric temperature and moisture under all weather conditions. The Advanced Microwave Sounding Unit- A (AMSU-A) is a temperature sounding instrument, and the assimilation of radiance data has a large positive impact on NWP. Accordingly, such data have been widely used at many NWP centers to produce initial conditions for prediction. These instruments are currently aboard NOAA (NOAA-15, 16, 18, and 19), Aqua and Metop satellites.

China's FY-3A satellite was launched in May 2008 and is also equipped with a microwave temperature sounding instrument (MWTS). The instrument's design is similar to that of AMSU-A. It uses four channels for atmospheric temperature sounding (MWTS channels 1, 2, 3 and 4 correspond to AMSU-A channels 3, 5, 7 and 9, respectively). In previous studies ([1], [2]), the quality of FY-3A MWTS radiance data was closely investigated and related issues were pointed out (i.e., pass-band shift of the central frequency and radiometer non-linearity). These studies proposed a method to correct such effects in the brightness temperature calibration process and in radiative transfer calculation. In our study, FY-3A MWTS radiance data after the calibration update by the National Satellite and Meteorological Center (NSMC) of the China Meteorological Administration (CMA) were used. For the fast radiative transfer model, RTTOV-10 [3] with a modified coefficient for FY-3A MWTS on the pass-band shift effect was utilized. In the initial assessment of FY-3A MWTS in JMA, the latest low-resolution version (TL319L60) of JMA's global data assimilation system was employed for the preliminary test. FY-3A MWTS data from July 20 to September 9, 2011, were obtained from the Fengyun Satellite Data Center (http://fy3.satellite.cma.gov.cn/arssen/) in non-real time for the assimilation experiment. FY-3A MWTS channels 2 and 3 were assimilated, and channel 1 was used to screen out cloud-contaminated data. The control run had the same configuration as JMA's operational global data assimilation system as of September 2011 except for the outer and inner model's horizontal resolution. In the test run, FY-3A MWTS data were incorporated into the control run.

The results of the quality check (O – B (Observed minus Background) departure statistics) in the JMA system indicated that the quality of FY-3A MWTS data is similar to or slightly better than that of AMSU-A (e. g., Metop and NOAA-18) [Figure 1]. In the data assimilation experiment, similar quality control and predictors of variational bias correction were applied for FY-3A MWTS. The thinning distance for MWTS was set as 160km, whereas that of AMSU-A was 250km.

From the data assimilation experiment, consistent temperature forecast improvements were confirmed in verification against radiosonde observation and initial field verification for the Southern Hemisphere [Figure 2]. The impacts for the Northern Hemisphere and the Tropics were almost neutral. The results obtained here were encouraging, and suggest that the improvement of temperature analysis with FY-3A MWTS data assimilation can lead to temperature forecast improvements like AMSU-A data assimilation.

To enable operational use of FY-3A/B MWTS data in JMA’s data assimilation system, it is necessary to obtain data in real time and to perform further investigation on the assimilation impact of FY-3A/B.

References

[1] Lu, Q., Bell, W., Bauer, P., Bormann, N. Peubey, C. 2011. An evaluation of FY-3A satellite data for numerical weather prediction. *Q. J. R. Meteorol. Soc.* **137**: 1298 – 1311. DOI:10.1002/qj.834.
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[3] Saunders, R. et al., 2012: RTTOV-10 Science and Validation Report. EUMETSAT, pp. 31

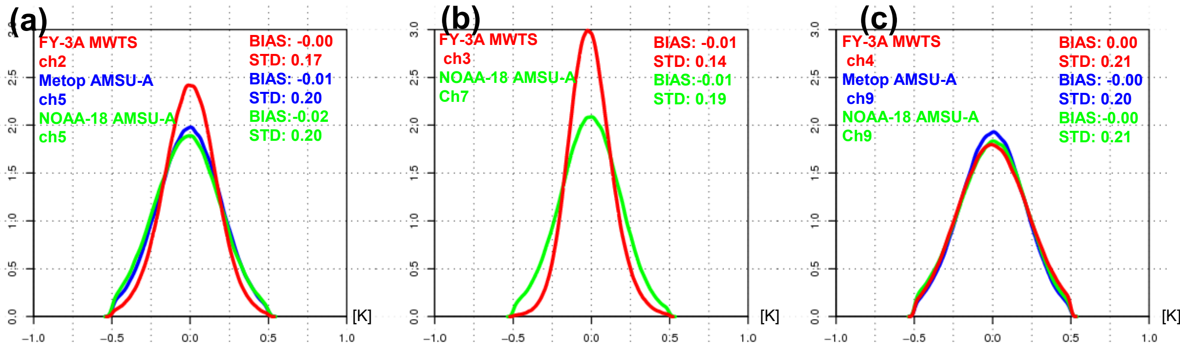
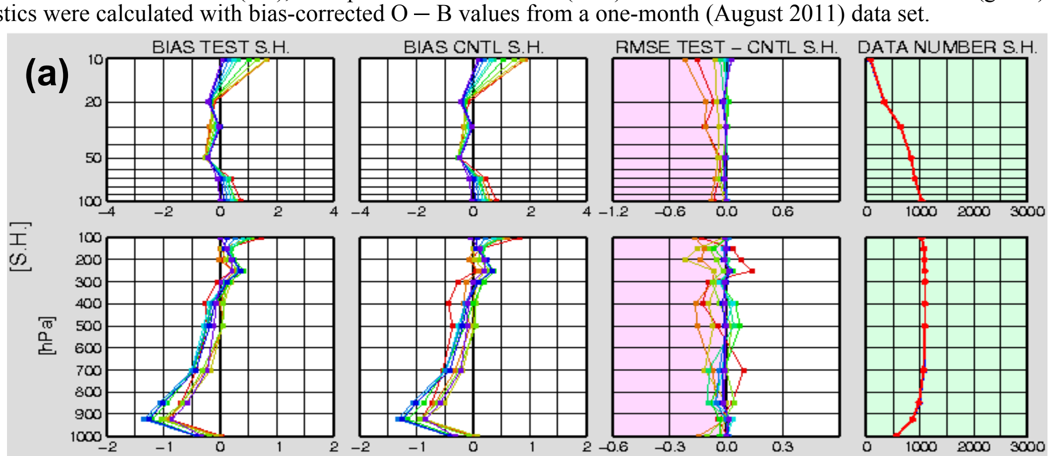


Figure 1 Comparison of O − B departure normalized histograms (a) FY-3A MWTS channel 2 (red), Metop AMSU-A channel 5 (blue) and NOAA-18 AMSU-A (green), (b) FY-3A MWTS channel 3 (red), NOAA-18 AMSU-A channel 7 (green); and (c) FY-3A MWTS channel 4 (red), Metop AMSU-A channel 9 (blue) and NOAA-18 AMSU-A channel 9 (green). The statistics were calculated with bias-corrected O − B values from a one-month (August 2011) data set.



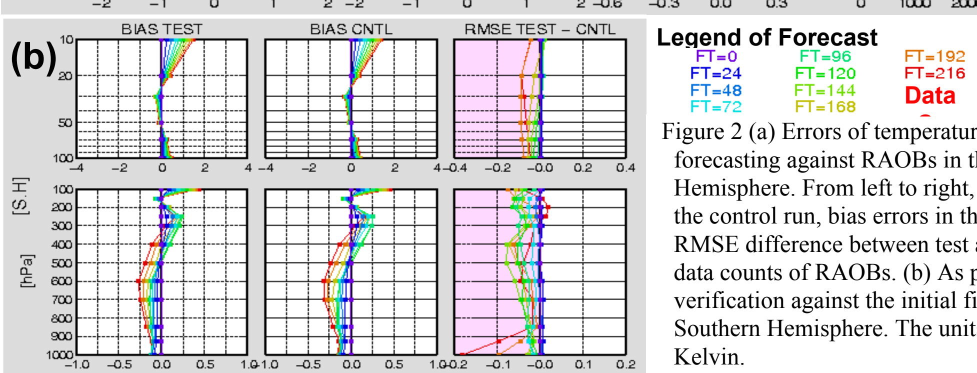


Figure 2 (a) Errors of temperature analysis and forecasting against RAOBs in the Southern Hemisphere. From left to right, bias errors in the control run, bias errors in the test run, RMSE difference between test and control, and data counts of RAOBs. (b) As per (a), but for verification against the initial field in the Southern Hemisphere. The units of error are Kelvin.