Recent updates on the use of GNSS RO data in JMA's Operational Global Data Assimilation System

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1. Introduction

Global Navigation Satellite System (GNSS) Radio Occultation (RO) observation is a very important component of the global observing system because it provides atmospheric vertical profile information and can be assimilated into numerical weather prediction (NWP) systems. The Japan Meteorological Agency (JMA) began assimilation of RO refractivity data into its global NWP system in March 2007, resulting in the improvement of analysis and forecast fields in the Southern Hemisphere and elsewhere. However, due to the well-documented degradation of retrieval precision, refractivity profiles cannot be assimilated at levels higher than 30 km. As the assimilation of bending angle profiles helps to avoid such assimilation height limitations, a new configuration for bending angle data assimilation was developed and tested. It was incorporated into the global NWP system on March 18, 2014.

2. Updates and related impacts

In the new configuration for bending angle assimilation, changes are applied to RO data preprocessing. By way of example, bending angle profiles above 30 km are not excluded, and vertical data thinning is removed because the vertical correlation of observation errors in bending angle profiles is small (Rennie 2010).

A one-dimensional observation operator provided as part of the Radio Occultation Processing Package (ROPP) was introduced for bending angle data assimilation. ROPP is developed and maintained by the Radio Occultation Meteorology Satellite Application Facility (ROM-SAF).

Observing system experiments were performed for the two months of August 2013 and January 2014 to identify the impact of RO data assimilation in the global NWP system. The experiment on bending angle assimilation (BANGLE) corresponding to the current operational configuration included the above-mentioned changes, and the experiment on refractivity assimilation (REFRAC) was identical to BANGLE except that refractivity data were assimilated with the previous operational configuration in place of bending angle data. The experiment which removed RO data assimilation from BANGLE (NO RO) was also conducted.

Figures 1 and 2 show the mean error and root mean square error of background (six-hour forecast) fit to radiosonde temperature measurements in the Northern Hemisphere for BANGLE, REFRAC and NO RO. It is clear that in both BANGLE and REFRAC, there was a reduction of large biases relative to radiosonde observations that appeared in the upper troposphere and stratosphere in the case of NO RO.

Figure 3 shows a time-series representation of the global averaged O-B (Observation before bias correction minus Background) for Metop-B/AMSU-A channel 13 during the initial 32 days of BANGLE, REFRAC and NO RO. The O-B of BANGLE was smaller than those of REFRAC and NO RO in all cases. As the weighting function for AMSU-A channel 13 peaks near 5 hPa, the background of BANGLE near 5 hPa was improved by assimilating RO profiles above 30 km.

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References

Rennie, M. P., 2010: The impact of GPS radio occultation assimilation at the Met Office. *Quart. J. Roy. Meteor. Soc.,* 136, 116 – 131.

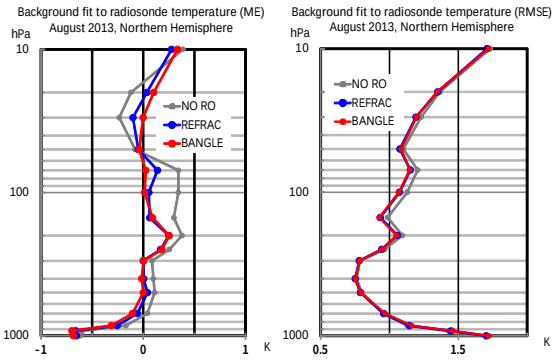

Figure 1: Mean error and root mean square error of background (six-hour forecast) fit to radiosonde temperature measurements in the Northern Hemisphere for bending angle assimilation (BANGLE; red line), refractivity assimilation (REFRAC; blue line) and removal of RO data assimilation (NO RO; gray line) experiments conducted in August 2013

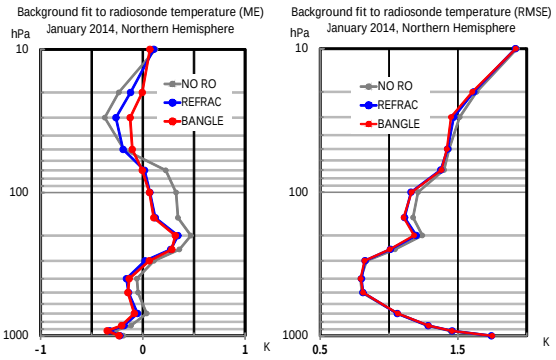

Figure 2: As per Figure 1, but for January 2014

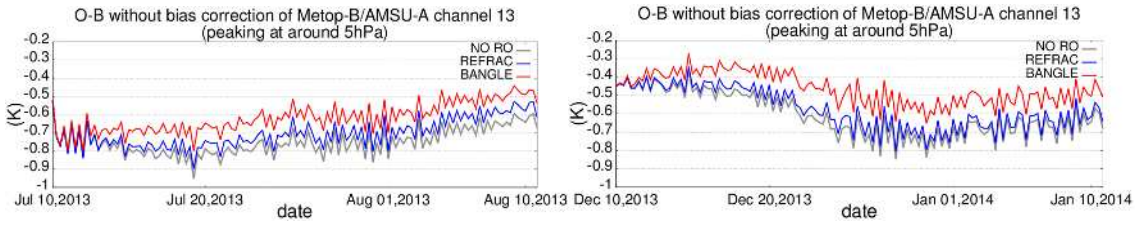

Figure 3: Time-series representation of global averaged O-B (Observation before bias correction minus Background) for Metop-B/AMSU-A channel 13 during the initial 32 days of bending angle assimilation (BANGLE; red), refractivity assimilation (REFRAC; blue) and removal of RO data assimilation (NO RO; gray) experiments. The monitoring periods were from July 10 2013 to August 10 2013 (left) and from December 10 2013 to January 10 2014 (right).