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

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Introduction

Global Navigation Satellite System (GNSS) Radio Occultation (RO) has proven to be a very important element in the global data observing system, as the measurement is an important source of atmospheric profile information for assimilation into the NWP system. The Japan Meteorological Agency (JMA) has assimilated bending angle data into its global NWP systems by introducing the Radio Occultation Processing Package (ROPP) (Culverwell et al. 2015). This paper reports on recent updates in the usage of GNSS RO data.

Updates

The relevant revisions have been evaluated and tested in the pre-processing of RO data for incorporation into the operational global assimilation system. The major updates are as follows:

- New bending angle threshold in gross error checking for the tropics
- New handling of RO quality flags (16-bit in BUFR)
- Setting of the lower altitude limit in data selection
- ROPP update from version 6 to version 8

Gross error checking is part of quality control performed before analysis based on the departure of observation and the first guess (known as the FG departure). Observations for which the absolute value of the FG departure exceeds the relevant threshold are rejected. The previous threshold was 1.5 times the observation error globally. This was stringent for the tropics because the number of bending angle observations passed through the gross error checking in the tropics was smaller than those for other areas due to the relatively large errors of tropic first guesses. The current threshold value is three times the observation error for the tropics.

Quality flagging involves 16 items of quality information added by the data processing center of each satellite. Before this update, only one item showing the quality of bending angle processing was referenced in quality control. In this update, profile quality was added as extra information to support quality control via quality flags.

In previous operation, there was no lower limit of altitude for usage. However, Metop observations exhibited a bias at altitudes below 8 km (von Engeln et al. 2009). The bias of other satellites was less severe, but was observed below 2 km. Accordingly, the lower limit of altitude for usage was set as 8 km for Metop and 2 km for other satellites.

The ROPP processing program developed by ROM SAF (the Radio Occultation Meteorology Satellite Application Facility) includes the source code for RO data assimilation. ROPP version 6 was introduced when we started to assimilate bending angle instead of refractivity in March 2014. As the new source code for

assimilation of bending angle data was added in ROPP version 8, we updated to the version 8.

Impacts on analysis

Observation system experiments for the new assimilation configuration were performed for August 2015 and January 2016. The control experiment had the same configuration as the previous operational global system, and the test experiment included the above-mentioned updates. Among the four changes, the most significant was that implemented for the bending angle threshold in gross error checking for the tropics. Figure 1 shows normalized changes in the standard deviation of the FG departure of radiosonde observation. As the reduced bending angle threshold in gross error checking increased the number of RO observations used for the tropics, the first guess profiles of radiosonde temperature were improved in the area. As a result, the first guess profiles of zonal wind were also improved.

Summary and future tasks

The usage of RO data in operational global analysis was updated on July 25 2017. After the update, the number of observation data used was increased for the upper troposphere and the stratosphere, and improved analysis of temperature and wind were confirmed there.

The above updates included the setting of a lower altitude limit below which the usage of observation data is halted. However, a November 2016 EUMETSAT update of RO data processing for Metop improved the quality of the Metop bending angle below the lower limit. In future work, data usage should be updated via careful monitoring of changes in data quality.

References

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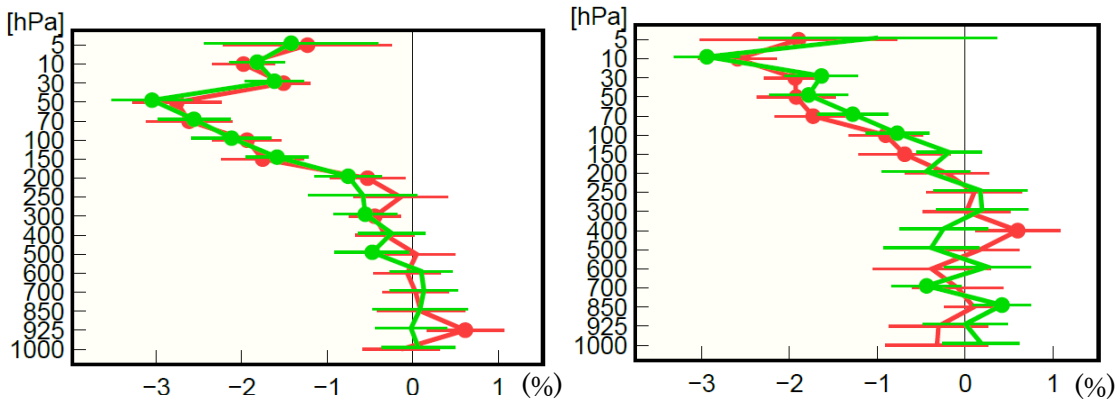

Figure 1: Normalized changes in the standard deviation of first-guess departures from radiosonde temperature (left) and zonal wind (right) in the tropics based on the experiments of August 2015 (red) and January 2016 (green). Negative values represent improvement. The horizontal axis indicates normalized standard deviation differences, error bars represent a 95% confidence interval, and dots represent statistical significance.