Assimilation of COSMIC GPS-RO data for the JMA Global Spectral Model

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1 Introduction

The Japan Meteorological Agency (JMA) started the assimilation of GPS radio occultation (GPS-RO) refractivity data from the COSMIC mission for the operational Global Spectral Model (GSM) on November 1, 2010. COSMIC data have been provided since February 8, 2010, via the Internet as it was possible to acquire them earlier than through GTS. This paper presents the assimilation configurations and pre-operational test results.

2 Bias correction for assimilation of GPS-RO data

GPS-RO refractivity data exhibit systematic biases in the troposphere against first-guess fields from GSM forecasts. Figure 1 shows the refractivity departures (O-B) between GPS-RO and the first guess with the same specifications as operation before bias correction. It was found that one of the reasons for such biases was that, rather than the virtual temperature, the temperature with piled-up height corresponding to GPS observations was used with reference to the refractivity of the first guess. Figure 2 shows the same situation as Fig. 1, but with virtual temperature for piled-up height. Figure 3 also shows the same situation as Fig. 1, but after bias correction, and Fig. 4 shows the same situation as Figure 2, but after bias correction.

Biases are corrected using linear regression equations. The regression coefficients are estimated with the Kalman filter for every analysis, and the predictors for bias correction are latitude, height and refractivity. The bias-corrected refractivity data are assimilated into the height range of 7 – 30 km. Observation errors and bias correction coefficients are defined independently in five latitudinal bands (90 – 60°S, 60 – 20°S, 20°S – 20°N, 20 – 60°N, 60 – 90°N), and observation errors are also defined as a function of height.

3 Assimilation experiments and results

Observation system experiments for COSMIC GPS-RO refractivity data were conducted in September 2009 and January 2009 as pre-operational tests. The control experiment (CNTL) had the same configuration as the operational GSM, and the COSMIC data were also assimilated in the test experiment (TEST). Figures 5 and 6 show differences in the zonal mean RMS errors between CNTL and TEST in 72-hour geo-potential height forecasts against their own initial fields for September 2009 and January 2009, respectively. The red areas are those where the root mean square (RMS) errors are smaller in TEST than in CNTL, which indicates forecast improvement from the assimilation of COSMIC GPS-RO data. Such improvement in the 72-hour forecast period is seen in most regions except around the Antarctic in the January experiment, although no such clear improvement is observed in the September experiment.

4. Acknowledgements

We would like to thank UCAR and NSPO for their provision of the COSMIC data used in this work.

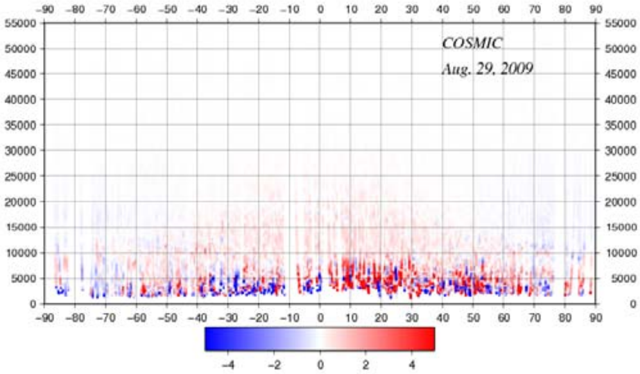

Fig. 1: COSMIC GPS-RO refractivity departures (O-B) between GPS-RO and the first guess. The vertical axis shows the height (m), and the horizontal axis shows the latitude (degrees). Red indicates positive departures, and blue indicates negative departures.

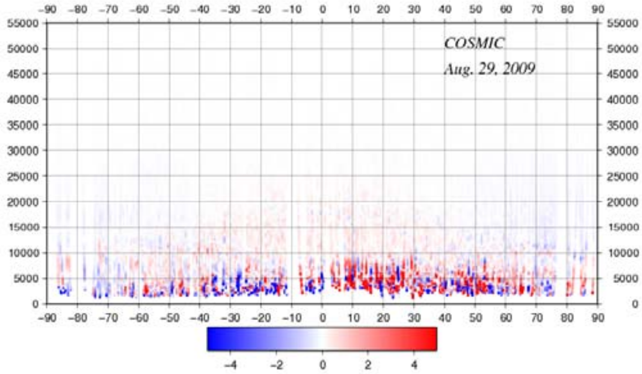

Fig. 2: As per Fig. 1, but with virtual temperature for piled-up height corresponding to GPS observation with reference to the refractivity of the first guess

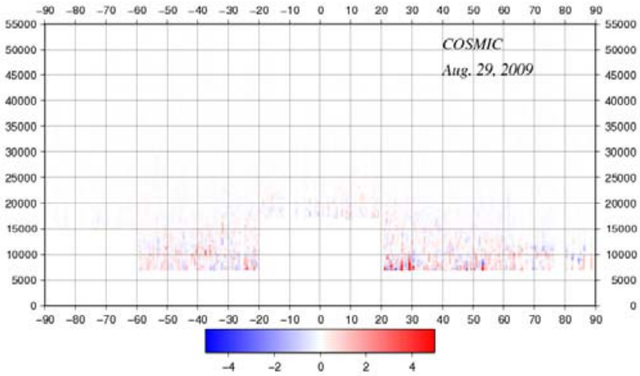

Fig. 3: As per Fig. 1, but after bias correction and quality control

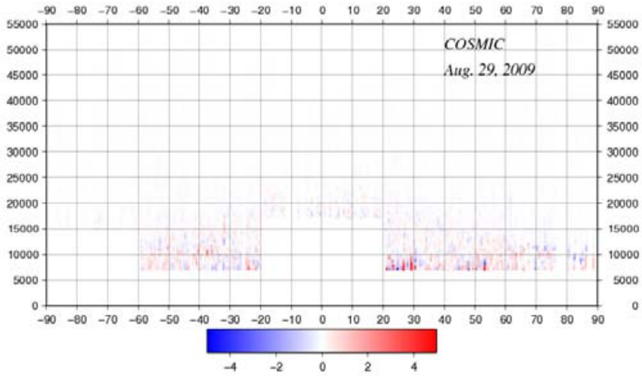

Fig. 4: As per Fig. 2, but after bias correction and quality control

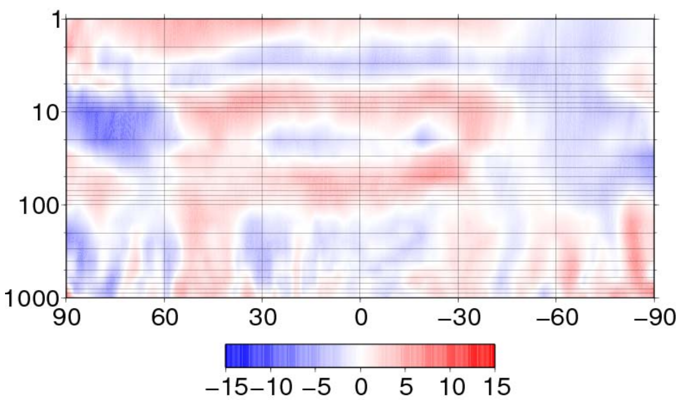

Fig. 5: Differences in zonal mean RMS errors between CNTL and TEST in 72-hour geo-potential height forecasts for September 2009. The vertical axis shows pressure (hPa), and the horizontal axis shows latitude (degrees). Red indicates improvement from the assimilation of COSMIC GPS-RO data, and blue shows deterioration.

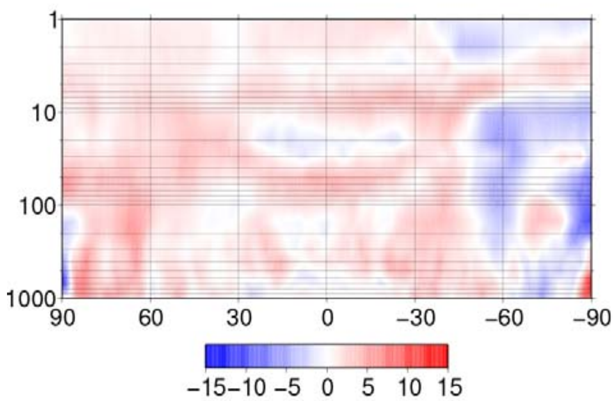

Fig. 6: As per Fig. 5, but for January 2009