Assimilation of Metop-A and GRACE-A GPS-RO data for JMA's GSM

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1 Introduction

The Japan Meteorological Agency (JMA) started the assimilation of Global Positioning System (GPS) Radio Occultation (RO) data on November 30, 2009 for its operational global model. The assimilated data are obtained from Metop-A/GRAS through the GTS, and GRACE-A/BlackJack data are received via the Internet (Wickert et al., 2005).

2 Methods

We assimilate refractivity instead of bending angle to save on computational cost, and limited data for altitudes from 7 km to 30 km are assimilated. As refractivity data have a bias against the first guess in the troposphere and lower stratosphere, a bias correction procedure is implemented based on a linear regression approach. The regression coefficients are estimated using a Kalman filter for each analysis. The predictors for the bias correction are latitude, height and refractivity; Figure 1 shows that of a cross section of observation innovation (O-B), and Fig. 2 shows that of observation innovation (O-B) after bias correction. Observation errors and bias correction coefficients were defined in five latitudinal bands (90 – 60°S, 60 – 20°S, 20°S – 20°N, 20 – 60°N and 60 – 90°N) independently, and observation errors were defined as a function of height.

3 Assimilation experiments in the low-resolution model

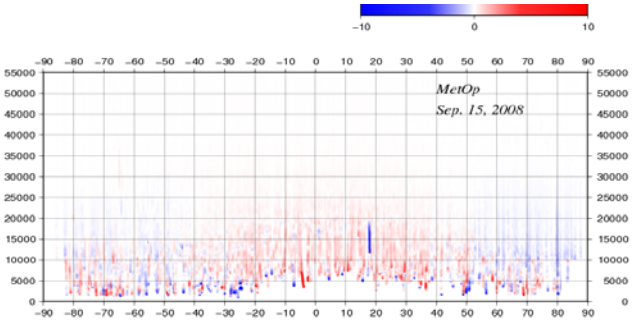
Observation system experiments for GPS refractivity data were conducted for the periods of September 2008 and January 2009 to assess the impact of GPS refractivity assimilation. The control experiment (CNTL) had the same configuration as the operational global model, and GPS-RO data were added in the test experiment (TEST). Figures 3 and 4 show the differences (CNTL-TEST) in the RMS errors of 72-hour temperature forecasting at 50 hPa against their own initial fields. Positive values indicate that the RMS error in TEST is smaller than that in CNTL. In the Southern Hemisphere of the September experiment and in the Northern Hemisphere of the January experiment, red areas are dominant relative to blue areas. As the mean TEST RMS errors are smaller than those for CNTL, it can be concluded that GPS-RO data assimilation had a positive impact.

4 Summary

As GPS RO data contain systematic biases against the first guess of JMA's global model, bias-corrected GPS-RO data were assimilated in the experiments. As improvement of the analysis field was confirmed, JMA started to use Metop-A and GRACE-A GPS-RO data on November 30, 2009 in actual operation.

4 Acknowledgements

We would like to thank GFZ for providing GRACE-A/BlackJack data and EUMETSAT for providing Metop-A/GRAS data.



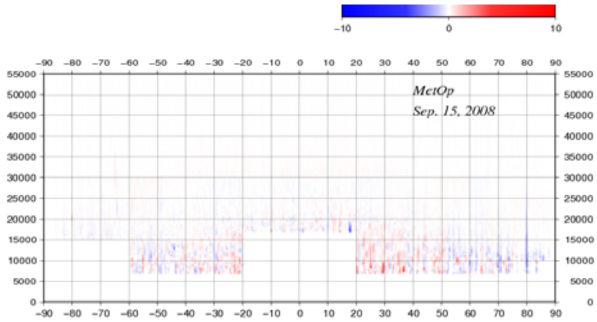
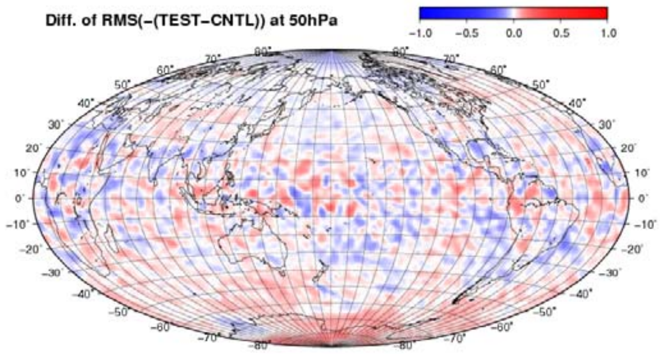


Fig. 1: Cross section of observation innovation (O-B) before bias correction. The vertical axis shows altitude (m), and the horizontal axis represents latitude as of September 15, 2008.

Fig. 2: Cross section of observation innovation (O-B) after bias correction and QC. Data for heights from 7 km to 30 km are used



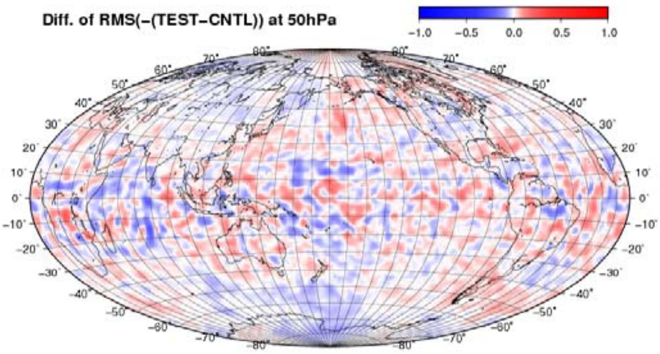


Fig. 3: Distribution map for 50-hPa RMS forecast error differences (CNTL-TEST) of temperature against the initial fields for the September experiment at FT = 72. Red areas represent improvement, and blue ones indicate deterioration.

Fig. 4: As per Fig. 3, but for the January experiment.

References

Wickert, J., G. Beyerle, R. König, S. Heise, L. Grunwaldt, G. Michalak, C. Reigber, T. Schmidt, 2005: GPS radio occultation with CHAMP and GRACE: A first look at a new and promising satellite configuration for global atmospheric sounding. *Annales Geophysicae*, **23**, *3*, pp. 653-658.