Assimilation of space based GPS occultation data for JMA GSM

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1 Introduction

A data assimilation (DA) system of space-based GPS radio occultation data has been developed for JMA Global Spectral Model (GSM). This scheme will be implemented to GSM soon. The GPS data have high potential to improve the initial field of the GSM because of their global distribution with high vertical resolution. As of February 2007, we receive CHAMP (CHAllenging Mini-satellite Payload) data from GFZ[2] through the Internet (Wickert et al. 2000).

2 Methods

There are various data forms for GPS data assimilation, such as assimilating excess path length, bending angle, refractivity, and retrieved temperature and specific humidity. Among them, refractivity data assimilation was examined for operational use at JMA, because it is one of the most cost-effective methods. The data were used with height from 5km to 35km where small biases were found. A procedure to correct observation biases is based on a linear regression approach and their regression coefficients are estimated by Kalman filter in every analysis. The predictors for the bias correction are latitude, height, and refractivity. Fig.1 shows cross section of observation innovation (O-B), and Fig.2 shows the amount of bias correction. Observation errors were determined as a function of height in five latitudinal bands independently.

3 Assimilation experiments

Observation system experiment for the GPS refractivity data (TEST) was conducted for August 2004 and January 2005, and it was compared with the control experiment (CNTL) with the global 4D-Var analysis system to asses the impacts of GPS refractivity assimilation. Tables 1 and 2 show mean improvement rates[3] of RMS forecast errors against initial field for the August experiment and January experiment, respectively. They show positive impacts by assimilating CHAMP data in almost all areas. Typhoon track forecast errors are also slightly reduced after FT=60 (not shown).

4 Acknowledgements

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3 Mean improvement rate $= \sum_{i=1}^{9} \frac{-(RMS_{test} - RMS_{cntl})}{RMS_{cntl}} \times 100$

i corresponds to nine forecast hours of 24,48,72,96,120,144,168,192 and 216.

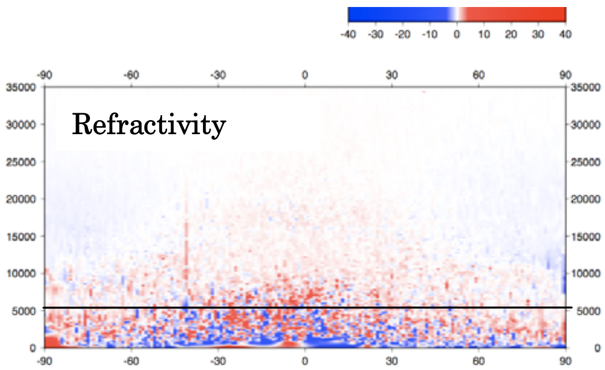

Fig.1 Cross section of observation innovation (O-B) before bias correction. Vertical axis means altitude (km) and horizontal axis means latitude. An investigation period is on July 20 to September 9, 2004.

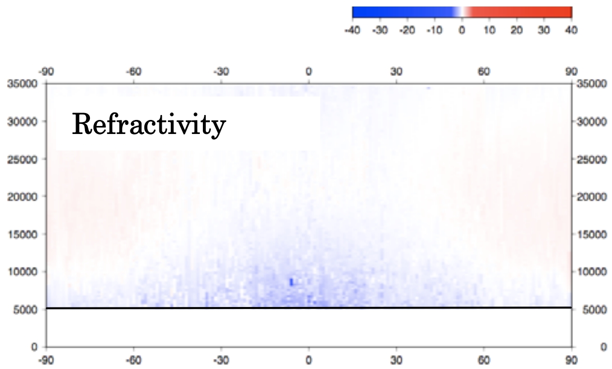

Fig.2 Amount of bias correction of refractivity. The data were used with height from 5km to 35km.

Table 1 August experiment : Improvement rate of RMS forecast errors against initial fields in the various elements in the August experiment. Yellow means improvement more than 0.1%, white means neutral and gray means deterioration more than 0.1%.

Global

GL	Z	T	Wind
300	0.68	0.27	0.29
500	0.84	0.33	0.42
850	0.61	0.34	0.32
Psea	0.46		

Northern Hemisphere

NH	Z	T	Wind
300	1.00	-0.01	0.36
500	1.02	0.55	0.34
850	0.69	0.60	0.24
Psea	0.44		

Tropics

TR	Z	T	Wind
300	0.23	0.76	0.15
500	0.19	0.31	0.41
850	0.02	0.65	0.05
Psea	0.04		

Southern Hemisphere

SH	Z	T	Wind
300	0.55	0.38	0.27
500	0.77	0.24	0.45
850	0.59	0.18	0.44
Psea	0.48		

Table 2 January experiment : Same as Table 1, but for January.

Global

GL	Z	T	Wind
300	0.43	0.12	0.13
500	0.42	0.43	0.20
850	0.34	0.26	0.10
Psea	0.36		

Northern Hemisphere

NH	Z	T	Wind
300	0.64	0.09	0.27
500	0.54	0.61	0.34
850	0.58	0.53	0.26
Psea	0.61		

Tropics

TR	Z	T	Wind
300	-0.25	0.44	0.14
500	0.04	0.41	0.17
850	-0.01	0.08	0.07
Psea	0.14		

Southern Hemisphere

SH	Z	T	Wind
300	0.28	0.11	0.01
500	0.35	0.18	0.06
850	0.20	-0.05	-0.03
Psea	0.15		

Reference

Wickert, J., C. Reigber, G. Beyerle, R. Konig, C. Marquardt, T. Schmidt, L. Grunwaldt, R. Galas, T. K. Meehan, W. G. Melbourne, and K. Hoche, 2000: Atmosphere sounding by GPS radio occultation: First results from CHAMP. *Geophys. Res.* , **28**, 3263-3266.