

Assimilation of LEO-GEO Atmospheric Motion Vectors in GRAPES

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Introduction

Atmospheric Motion Vectors (AMVs) have mainly derived from geostationary satellites and polar-orbiting satellites. However, there is a gap between these two observation datasets in the latitudes zone from approximately 60° to 70° in both hemispheres. LEO-GEO atmospheric motion vectors (AMVs) are derived in order to generate AMVs in this gap by using composite satellite imagery from the combination of polar-orbiting and geostationary images. LEO-GEO AMVs have been produced by the Cooperative Institute for Meteorological Satellite Studies (CIMSS). This study investigates the impact of IR winds from LEO-GEO AMVs on GRAPES (Global/Regional Assimilation Prediction System) analyses and forecasts.

Data

- LEO-GEO AMVs datasets used in this study can get via FTP from the University of Wisconsin Space Science and Engineering Center (UW-SSEC)

Distribution of LEO-GEO AMV data

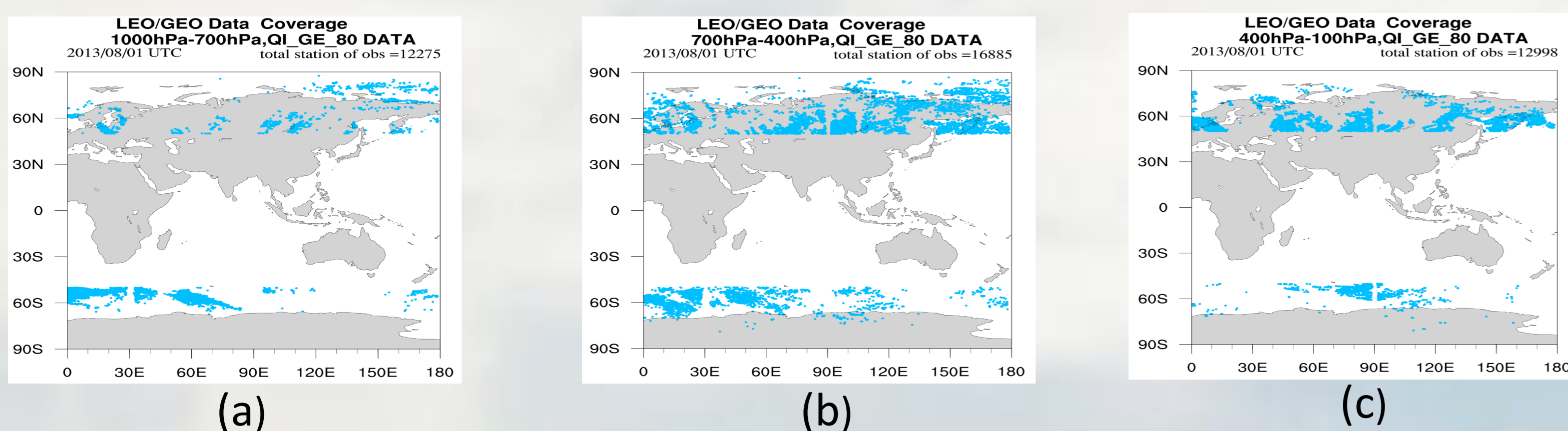


Fig.1 Example of LEO-GEO IR AMVs coverage at low (a: 1000-700hPa), mid (b: 700hPa-400hPa) and high (c: 400hPa-100hPa) on August 1st 2013 at 00UTC.

Quality Control and Statistics

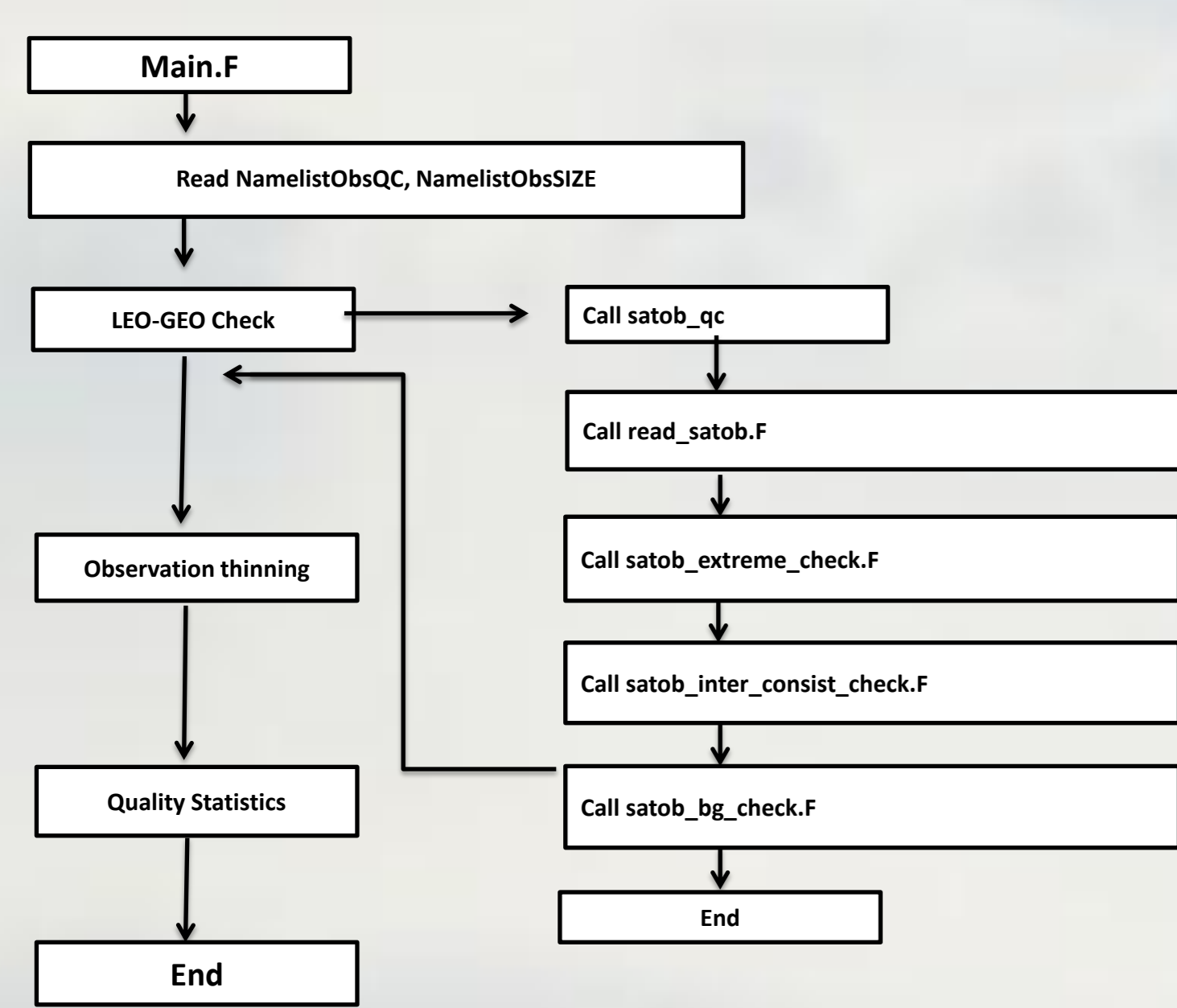


Fig.2 The table of Quality Control for LEO-GEO

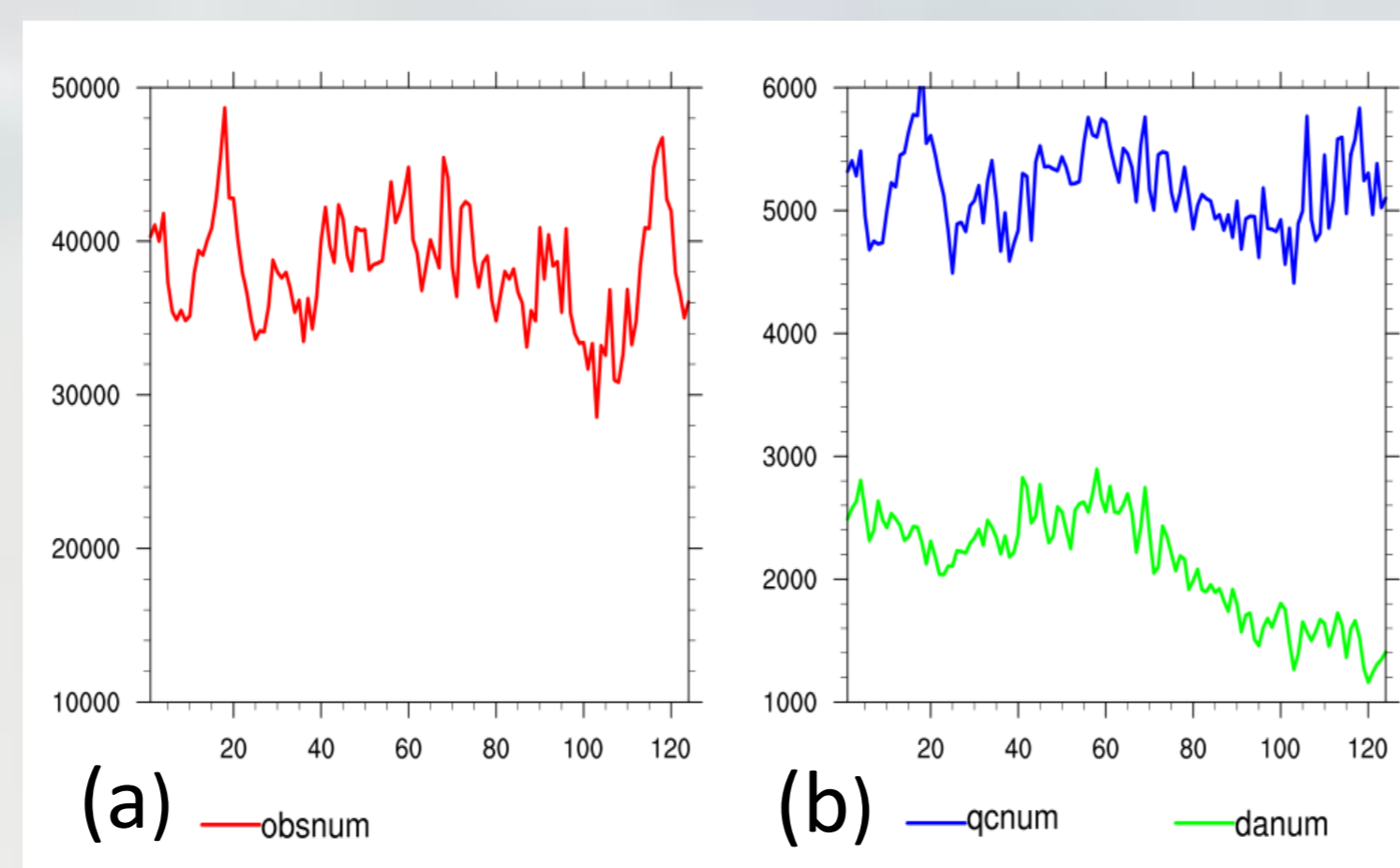
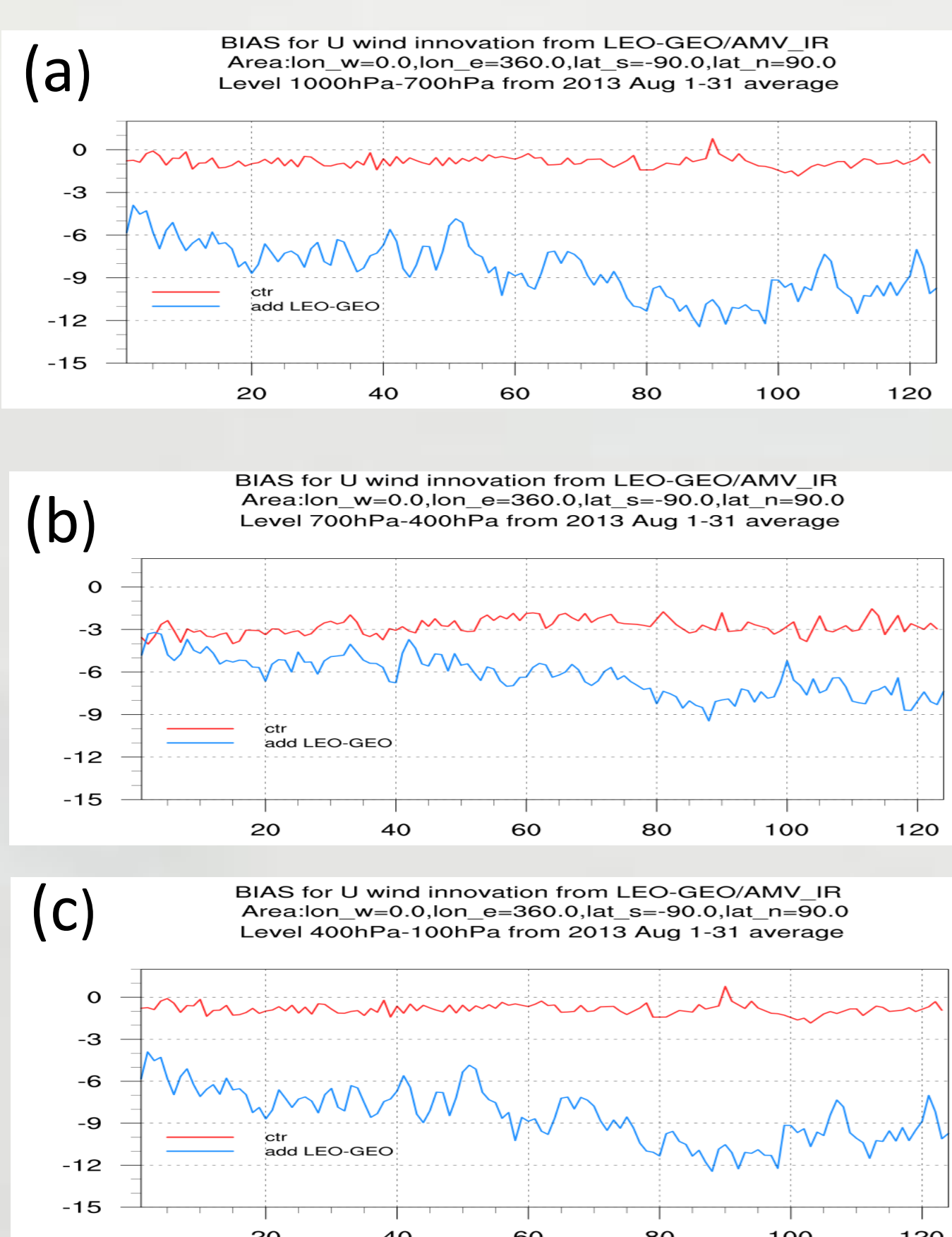


Fig.3 The comparison of the observation number of LEO-GEO IR winds (the red line), the number of LEO-GEO IR winds after quality control (b: the blue line) and the number of LEO-GEO IR winds assimilated in GRAPES (b: the green line)

Assimilation and Forecast impact on GRAPES



Exp.1	Assimilated conventional observation +AIREP +AMVs
Exp.2	Assimilated conventional observation +AIREP +AMVs + LEO-GEO AMVs

Table 1 The two data assimilation experiments

In this study, GRAPES is the operational NWP system of the China Meteorological Administration (CMA). The resolution is 0.5° × 0.5°. The experiment period is from 00 UTC 1 August to 18 UTC 31 August 2013. The assimilation window is 6h.

Fig.4 Mean O-B U wind bias between Exp.1 (red line) and Exp.2 (blue line) at low (a: 1000-700hPa), mid (b: 700hPa-400hPa) and high (c: 400hPa-100hPa) from 00UTC 1 August to 18UTC 31 August 2013 (LEO-GEO observation minus GRAPES model background)

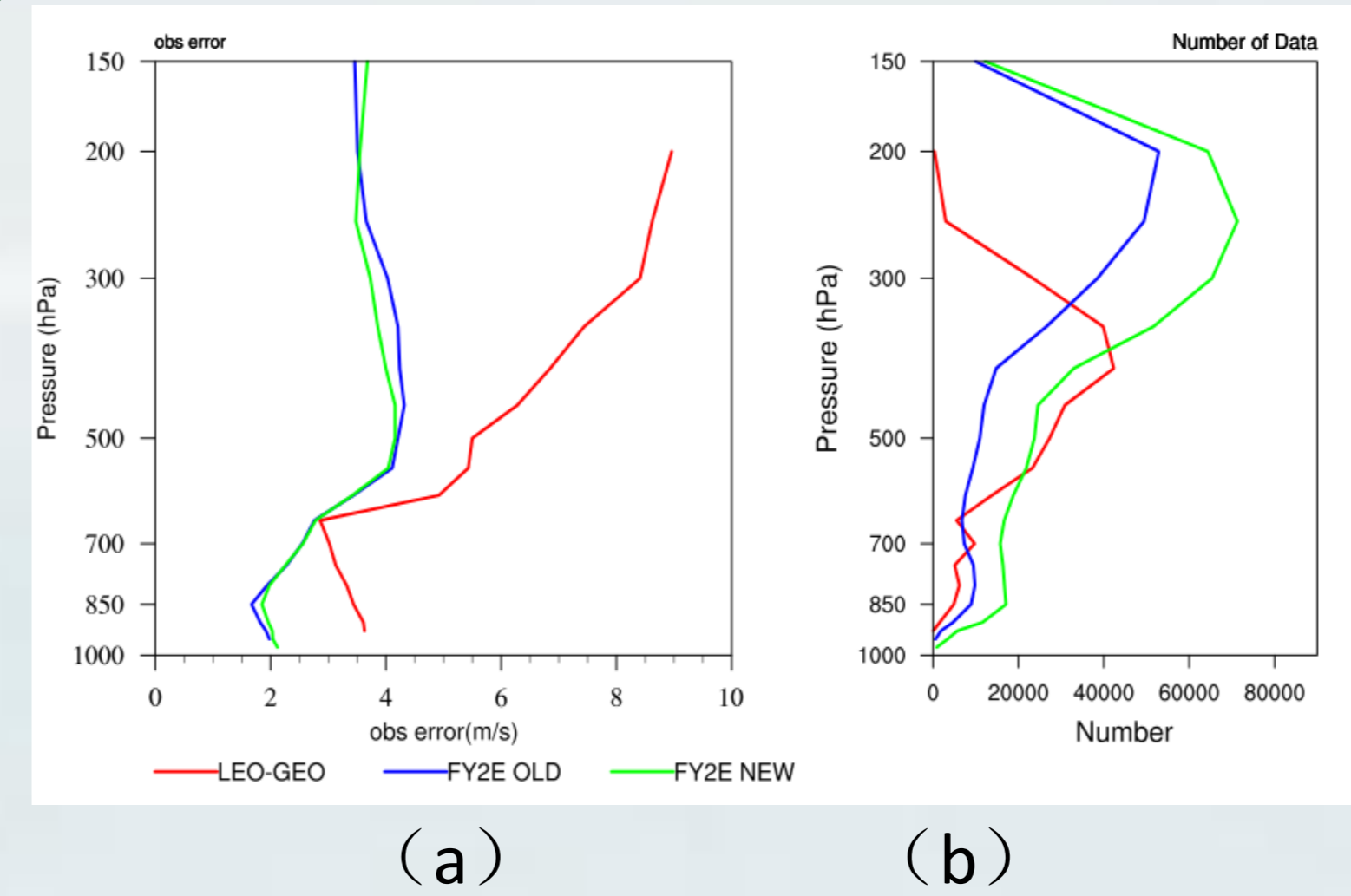


Fig.5 Vertical profile of mean observation error for LEO-GEO AMVs and FY2E AMVs. The red line is for LEO-GEO AMVs, the blue line is for FY2E AMVs (before improved) and the green line is for FY2E (reprocessed).

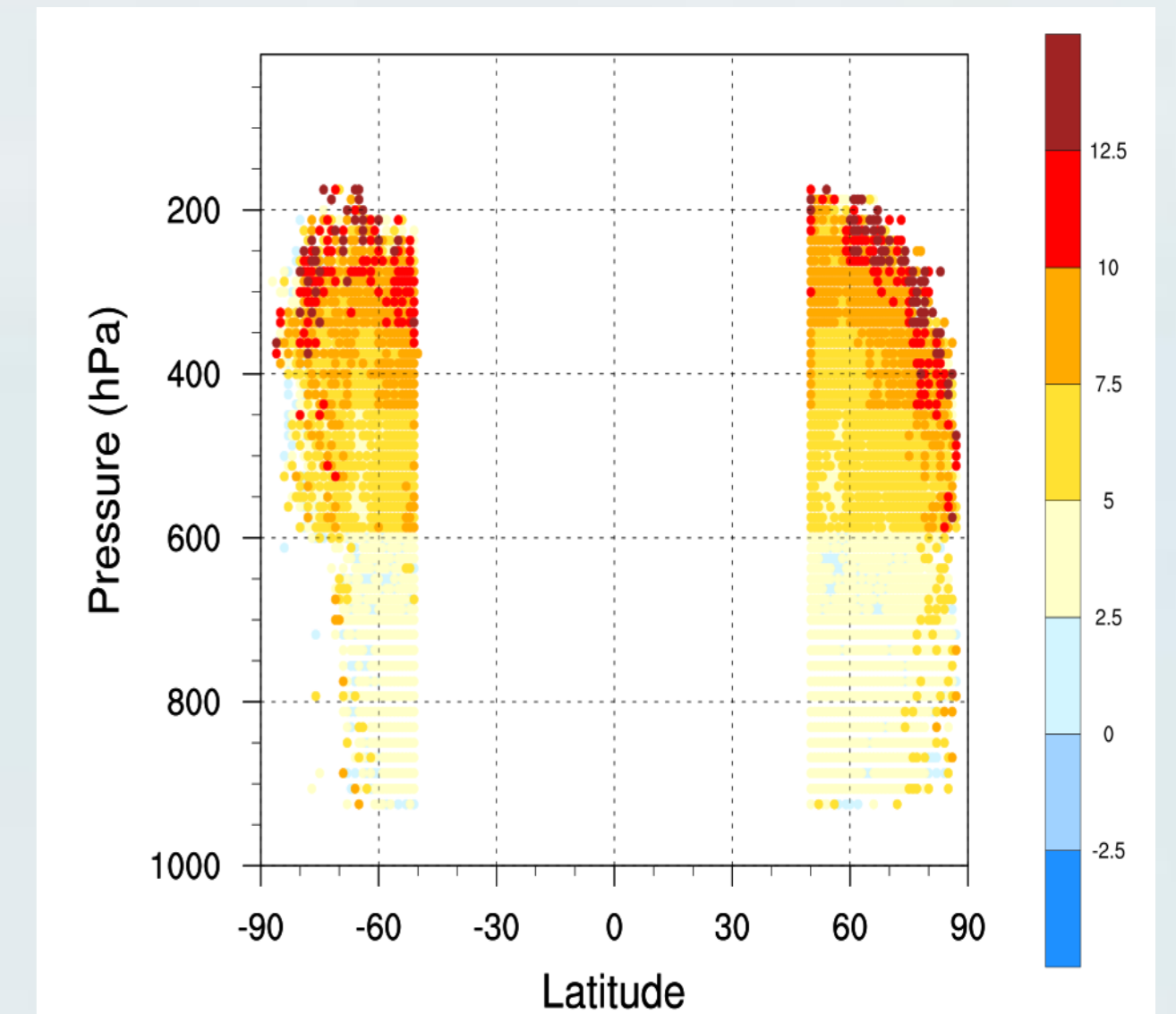


Fig.6 Vertical profile of mean observation error for LEO-GEO AMVs as a function of height and latitude for August 2013

$$(\epsilon^{obs})^2 = d_b^{obs} \cdot d_a^{obs}$$

The observation error of LEO-GEO AMVs is obtained according to the statistical result of Desroziers, which is a function of O-B and O-A.

Fig.5 and Fig.6 show the observation error of LEO-GEO AMVs is larger than 4 m/s, compared with FY2E AMVs, however the observation error reduces from about 900hPa to 700hPa.

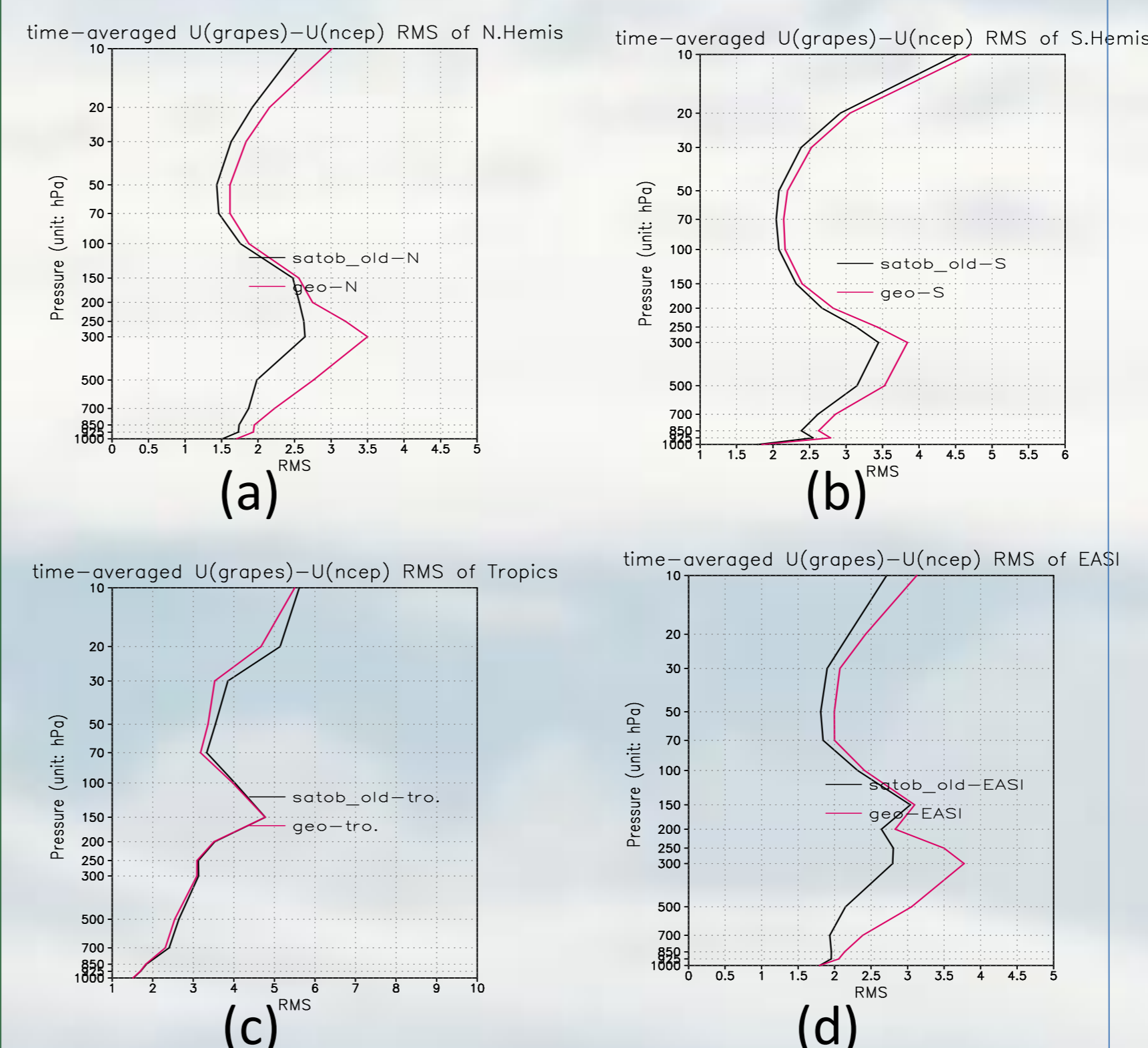


Fig.7 RMSE of U winds analysis between GRAPES and NCEP (GRAPES minus NCEP) in the Northern Hemisphere (a), in the Southern Hemisphere (b), in the Tropics (c) and in the East Asia (d) for the control (black line) and the LEO-GEO (red line) experiment for August 2013.

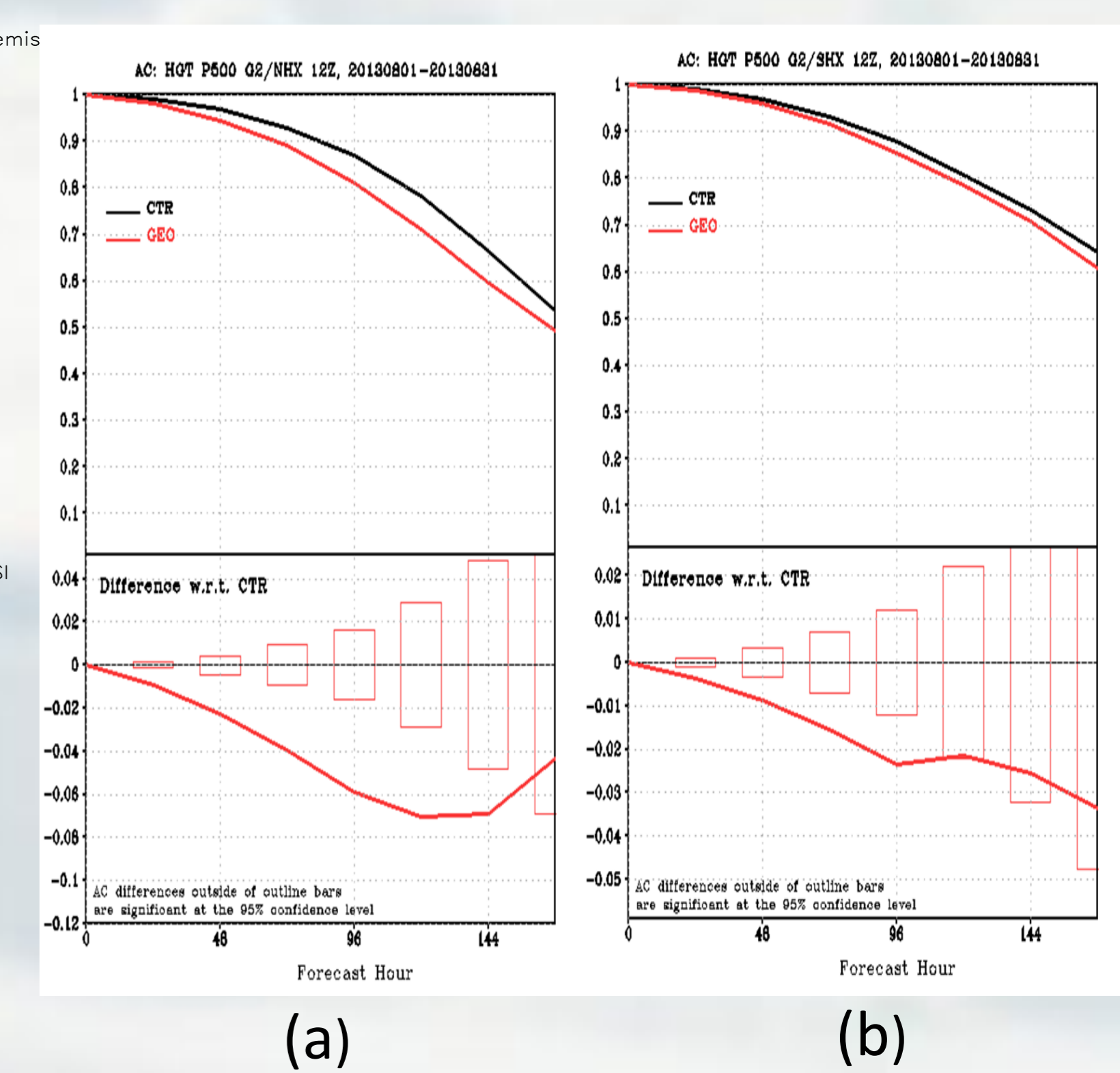


Fig.8 Anomaly correlation coefficient (ACC) for the 500hPa height for the 7-day forecast in the Northern Hemisphere (a), in the Southern Hemisphere (b). The black line denotes the control experiment, and the red line denotes the LEO-GEO assimilation experiment.

Fig.7 shows the comparison of the RMSE of U wind between the GRAPES analysis and the NCEP analysis in the NH, SH, Tropics and East Asia areas. No matter in which area, the LEO-GEO data have a negative impact on the analysis. Another indication of the negative impact of LEO-GEO data on GRAPES in Fig.8, which shows the anomaly correlation coefficient of the 500hPa height for 7-day forecast as a function of time. Regardless of the SH and NH areas, the negative effect of LEO-GEO experiment in the ACC is evident compared to the control run.

Discussions

It is of great value to apply LEO-GEO AMVs efficiently with the purpose of the improving the initial fields and numerical forecasts. However, the above results demonstrate that the assimilated of LEO-GEO AMVs in GRAPES has a negative impact on the analyses and forecasts at all ranges. It is also noted that LEO-GEO AMVs error is large, especially above 500hPa. Because in GRAPES we have the same observation error standards for different AMVs, more researches are needed about investigation of the error characteristics of LEO-GEO AMVs and development of the new QC method for LEO-GEO AMVs.

Acknowledgement

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Reference

Desroziers G, Berre L, Chapnik B, et al. Diagnosis of observation, background and analysis-error statistics in observation space[J]. Quarterly Journal of the Royal Meteorological Society, 2005, 131(613):3385-3396.
Lazzara M A, Dworak R, Santek D A, et al. High-Latitude Atmospheric Motion Vectors from Composite Satellite Data[J]. Journal of Applied Meteorology & Climatology, 2014, 53(2):534-547.