

A Case Study of FY-4A Atmospheric Motion Vectors in GRAPES

Xiaomin Wan, Wei Han

Numerical Weather Prediction Center, China Meteorological Administration, Beijing, China

Contact: wanxm@cma.gov.cn

Introduction

FY-4A was launched on 11 Dec 2016. With the improvements in the image navigation and calibration system, the accuracy of AMVs derived from FY-4A is expected to be improved.

In this study, by comparing with NCEP FNL data, the quality of FY-4A infrared AMVs was better than FY-4A water vapor AMVs. Based on GRAPES_RAFS, three numerical experiments were conducted to examine the impacts of FY-4A AMVs on analysis and forecast for Severe Typhoon Hato on 00 UTC 23 August, 2017. The results showed some encouraging results, especially after assimilated FY-4A WV AMVs, which had neutral to positive impact on wind and height analysis field. Furthermore, due to the improvement of the initial fields for the model prediction, the performance of the precipitation forecast was improved.

Data

- FY-4A AMVs is 3-hour intervals, provided by CMA's National Satellite Meteorological Center (NSMC)
- There is no Quality Indicator for FY-4A AMVs yet.

FY-4A AMVs

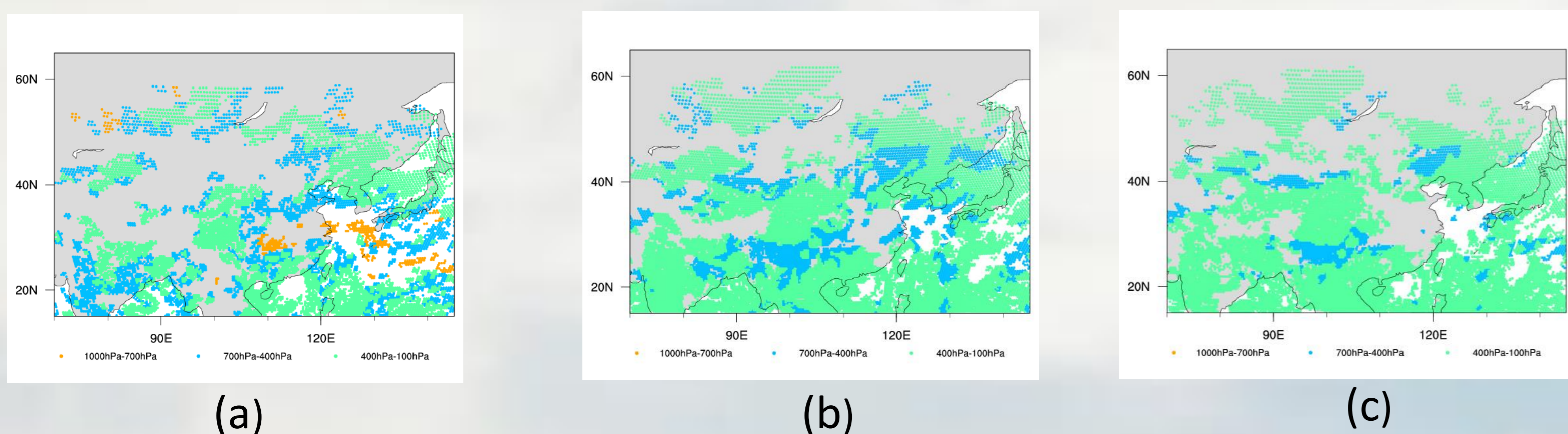


Fig.1 Data coverage plots for FY-4A AMVs at 00 UTC on 23 August 2017 (yellow dots:1000 hPa-700 hPa, blue dots:700hPa-400 hPa, green dots:400 hPa-100 hPa) (a) IR channel, (b) WV channel at low level, (c) WV channel at high level

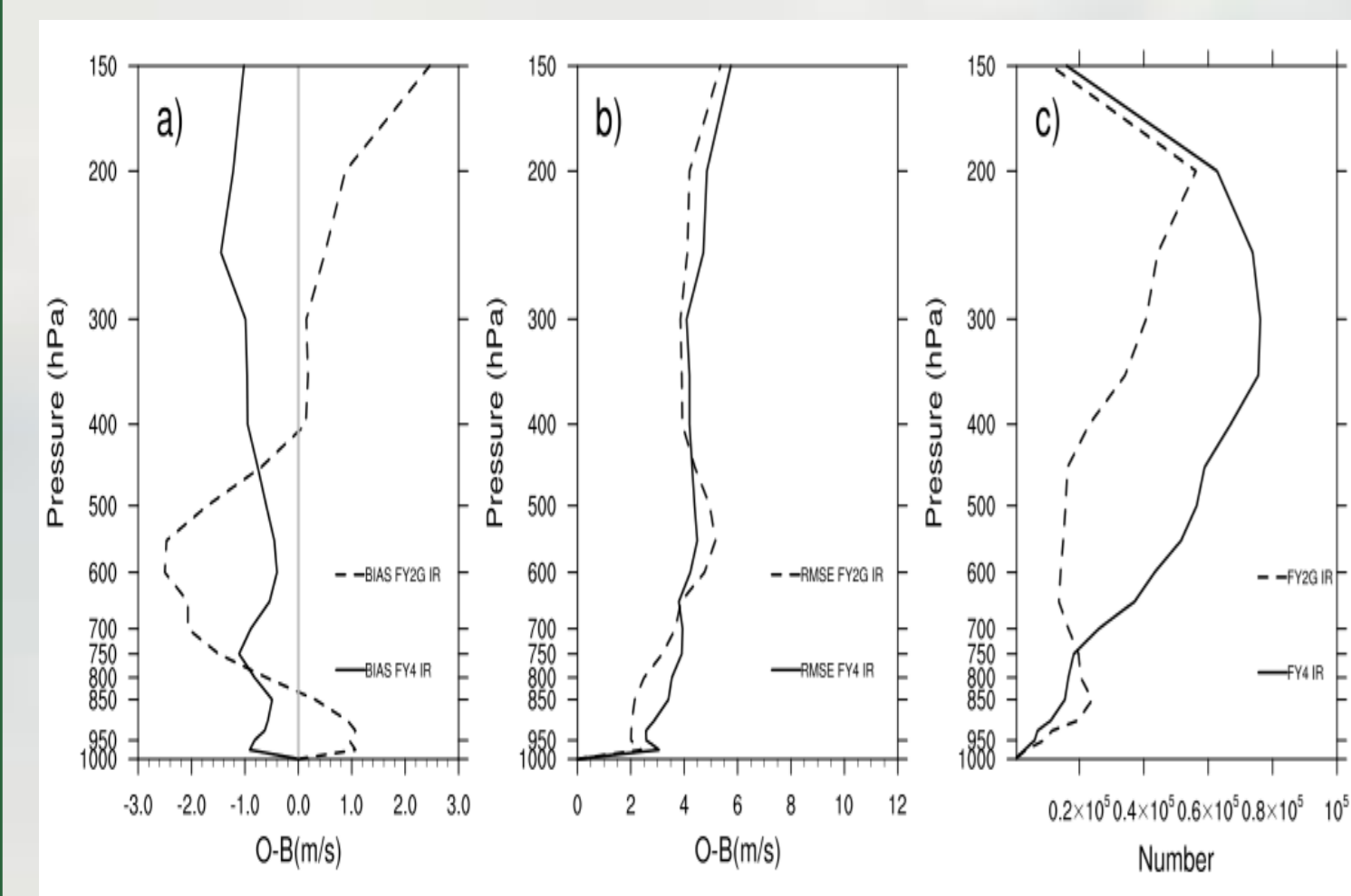


Fig.2 U wind Bias, RMSE and the number of FY-4A and FY-2G AMVs at vertical profile in August 2017 (solid lines: FY-4A IR, dash lines: FY-2G IR) (a) Bias, (b) RMSE, (c) the number

The quality of FY-4A IR AMVs was better than FY-2G IR AMVs at middle level, and the bias of FY-4A WV AMVs became larger at high level.

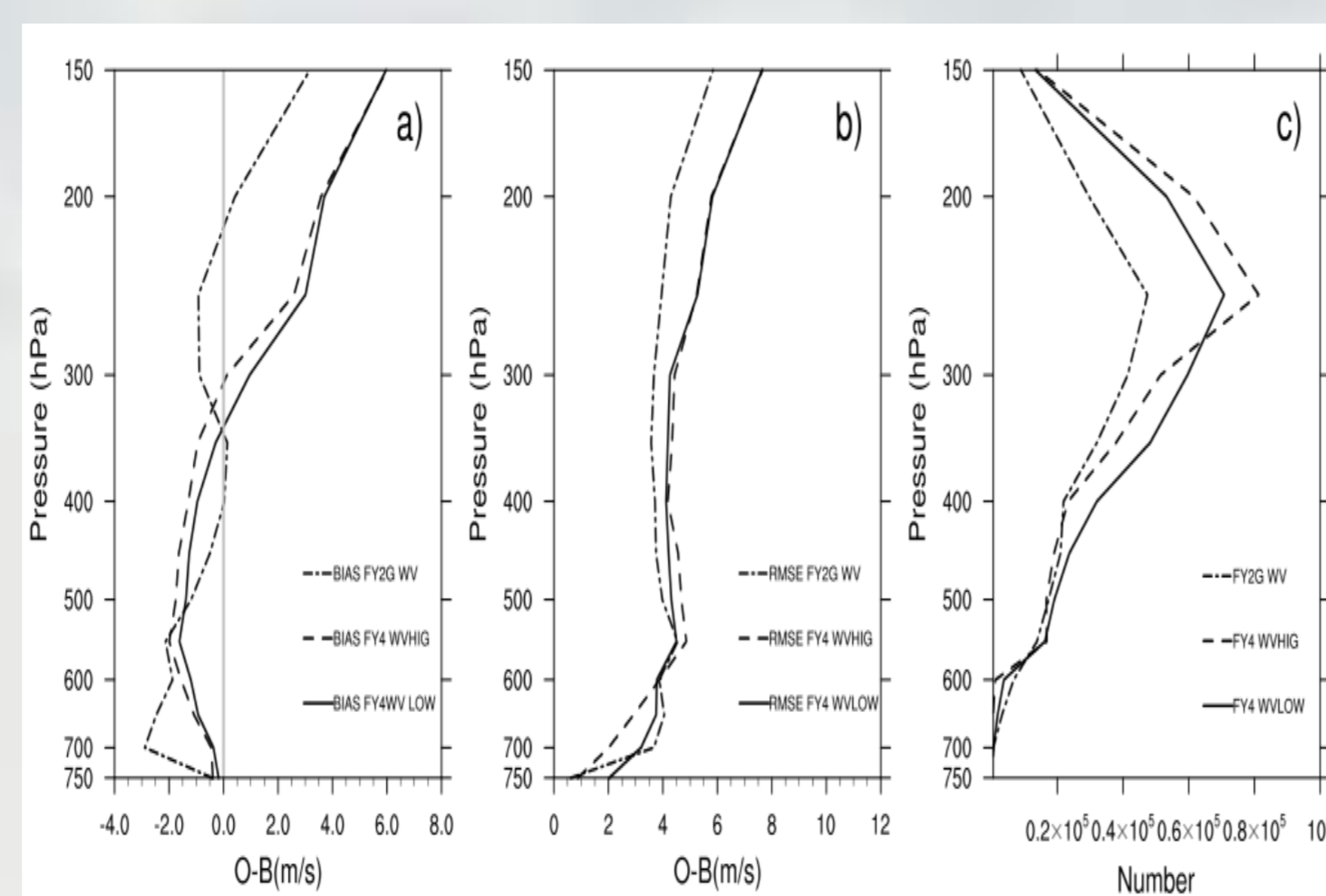


Fig.3 Same as Fig.2, but for FY-4A and FY-2G WV AMVs (solid lines: FY-4A WV channel at low level, dash lines: FY-4A WV channel at high level, dot dash line: FY-2G WV channel)

Assimilation and Forecast Impact on GRAPES

Case: Severe Typhoon Hato landed on Guangdong coast line

Model: GRPAES_RAFS (Rapid Analysis and Forecast System)

Initial Time: Aug. 23,2017 at 00 UTC

Resolution:10 km

Exp.	Observation	FY-4A IR AMVs	FY-4A WV AMVs
Exp.1	conventional observation +AIREP+GNSS/MET		
Exp.2	conventional observation +AIREP +GNSS/MET + FY-4A IR AMVs	8460	
Exp.3	conventional observation +AIREP +GNSS/MET + FY-4A AMVs	8460	7444

Table 1 Summary of the three experiments

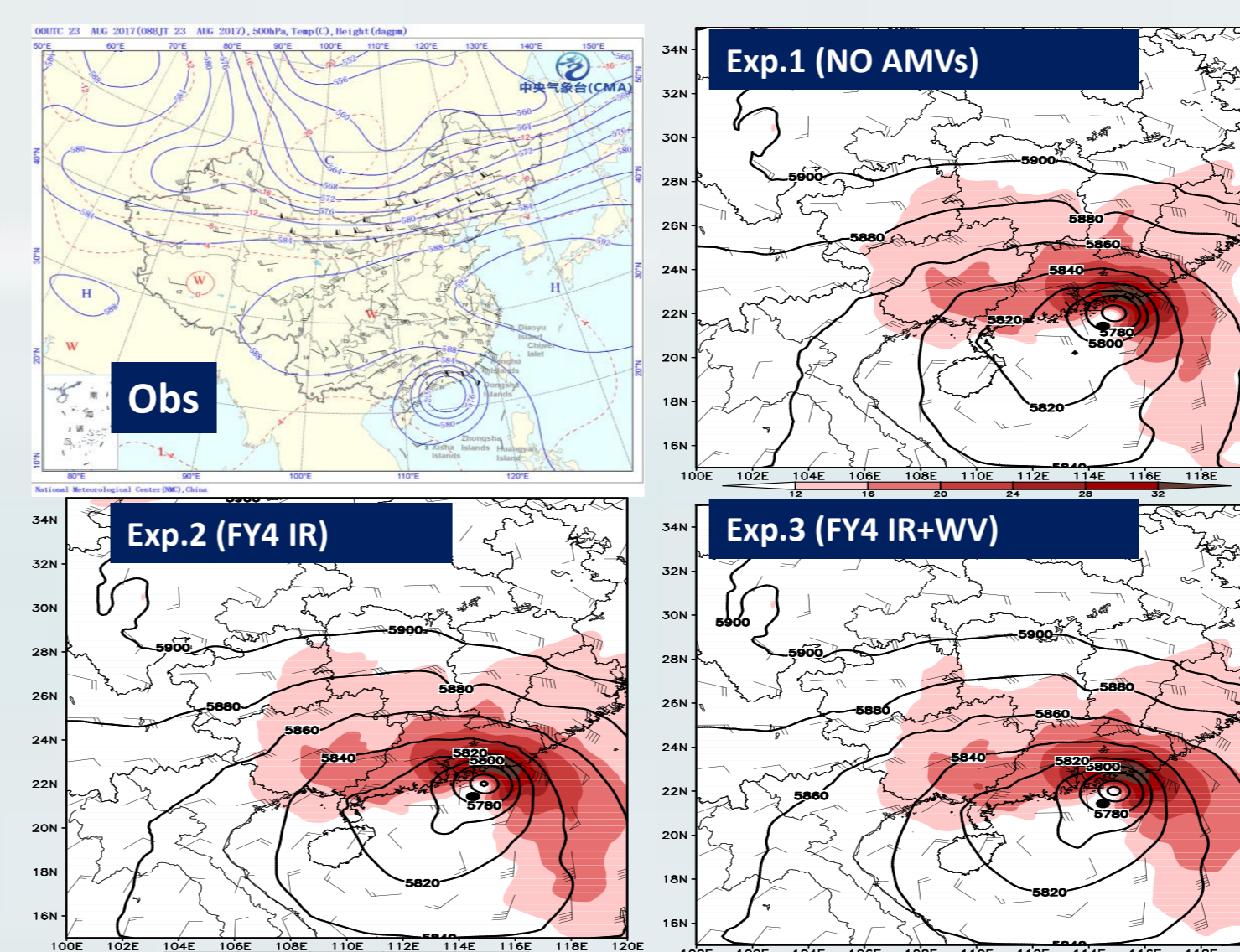


Fig.4 500 hPa geopotential height field (contour, unit: gpm), wind field (vector) and wind velocity analysis field (shadow, unit: m/s) at 00 UTC on 23 August 2017 (the black dot represents the position of the typhoon)

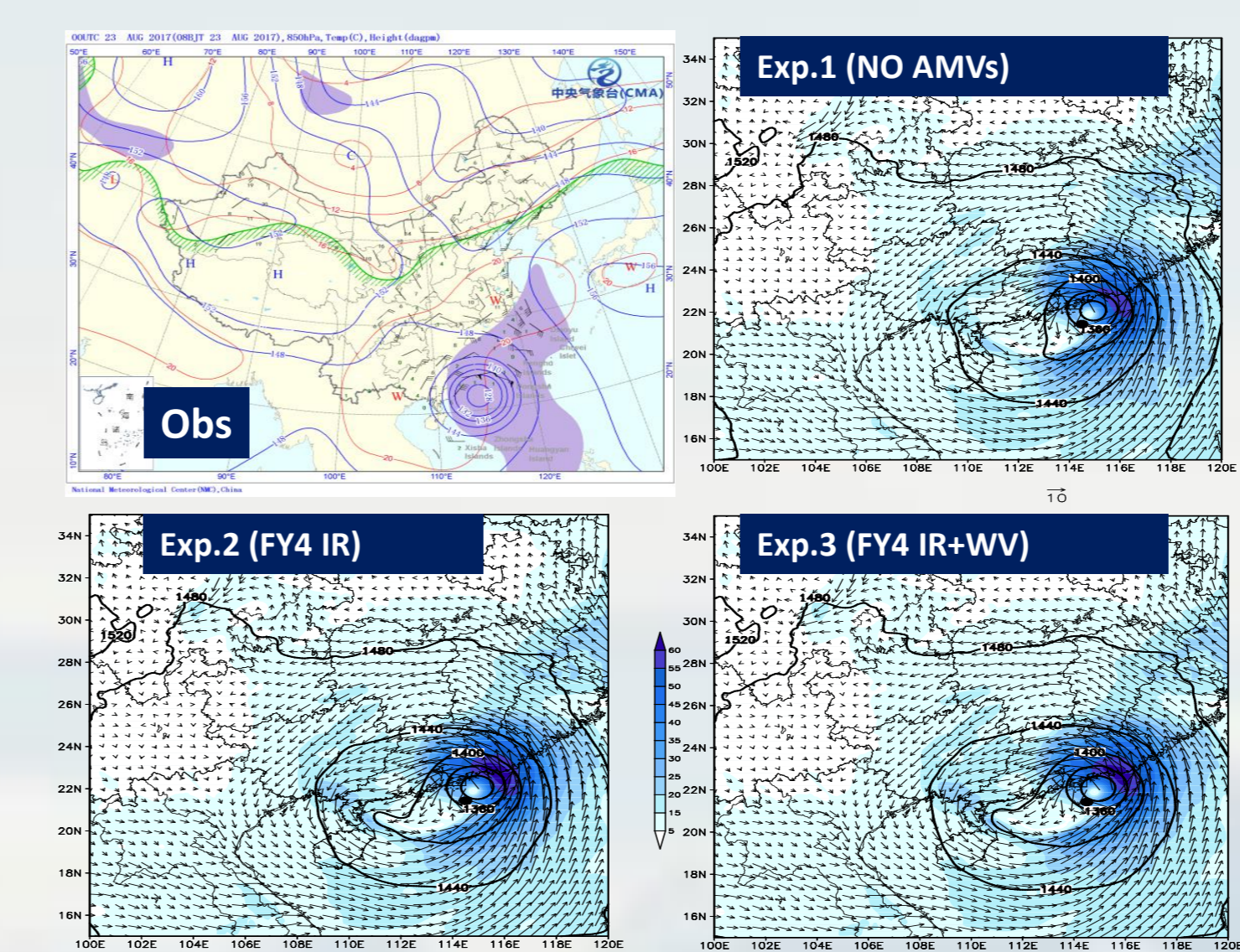


Fig.5 850 hPa geopotential height field (contour, unit: gpm), wind field (vector, unit: m/s) and vapor transportation [the shadows, unit: g/ (cm-hPa-s)] at 00 UTC on 23 August 2017 (the black dot represents the position of the typhoon)

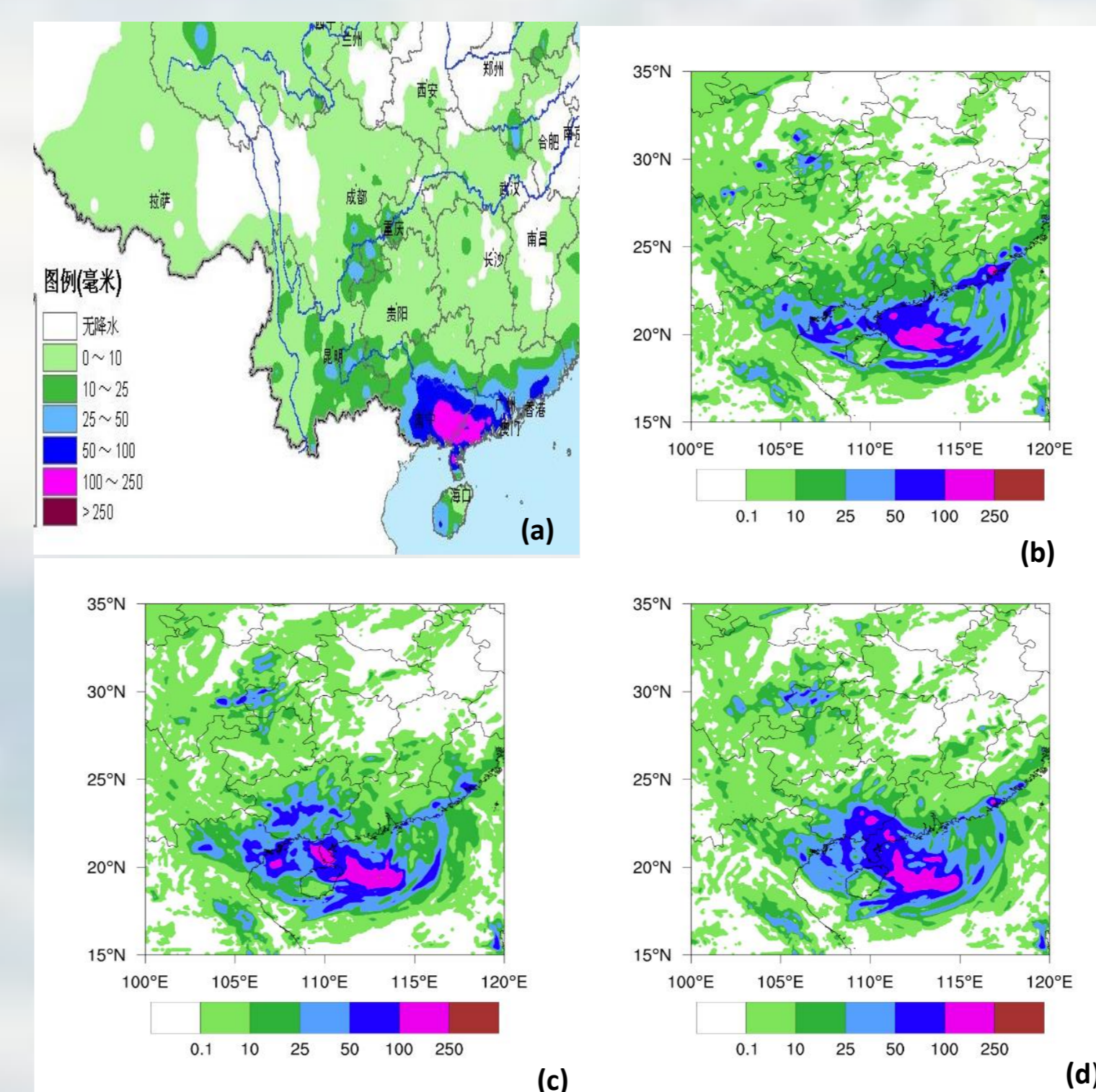


Fig.6 24-hour precipitation at 00 UTC on 23 August 2017 (unit: mm) (a) observed precipitation, (b) rain forecast of Exp.1, (c) rain forecast of Exp.2, (d) rain forecast of Exp.3

Fig.6 shows the rainfall forecast performance of location and intensity of strong rainfall center over the South China was improved after assimilated FY-4A AMVs, and Exp.3 showed better rain forecast than Exp.2.

The verification results shows the Equitable Threaten Score (ETS) of Exp.3 is improved for all five graded and is higher than Exp.2. Meanwhile, the bias of model forecast of Exp.3 is lower than Exp.2 (Fig.7).

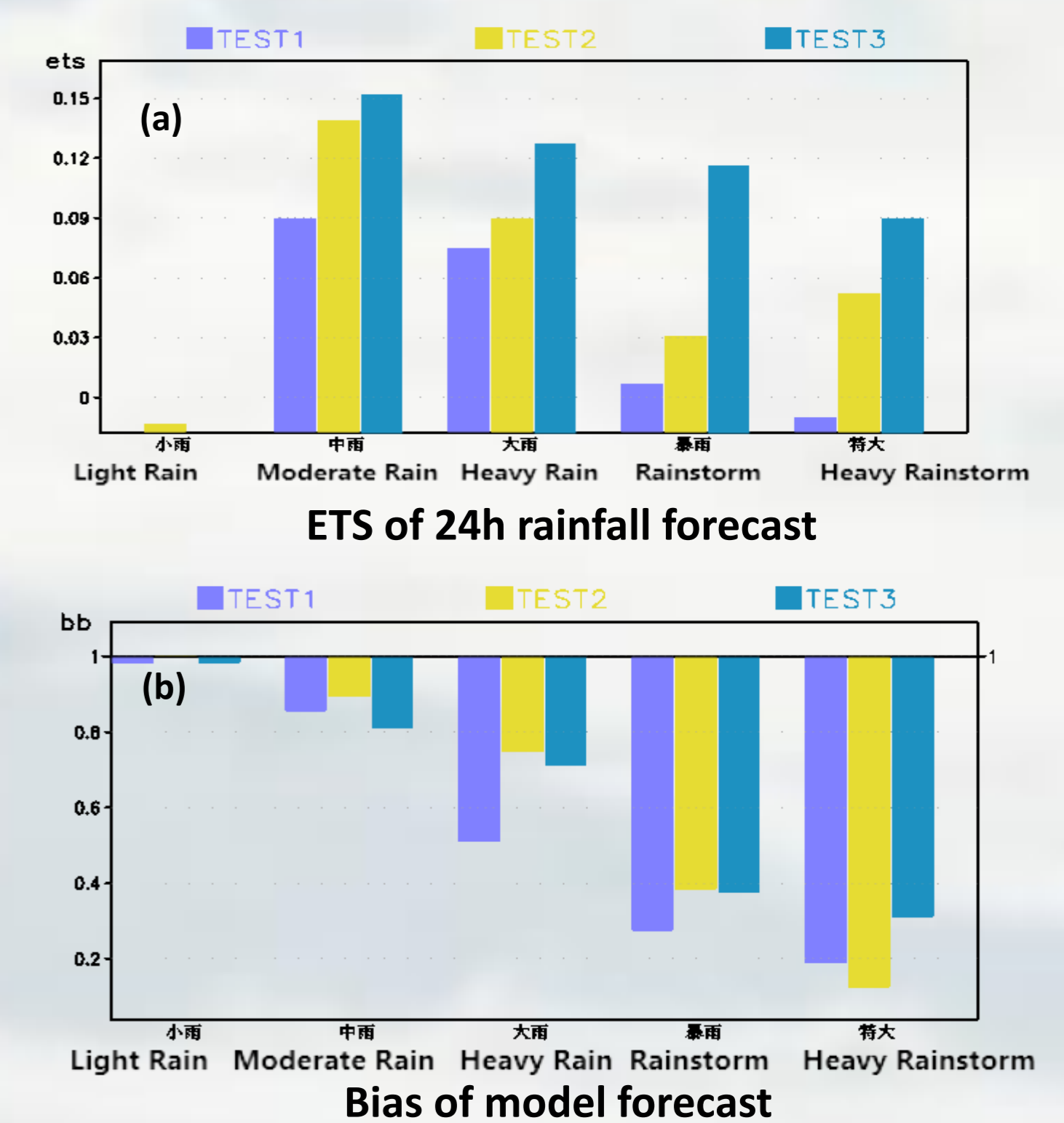


Fig.7 Verification of 24-hour rainfall forecast of the South China (purple: Exp.1, yellow: Exp.2, blue: Exp.3)

Discussions

It is of great value to apply FY-4A AMVs efficiently with the purpose of improving the initial fields and numerical forecasts. A case study shows the FY-4A AMVs in GRAPES_RAFS can improve the environmental flow analyses that may be influencing the typhoon tracks and intensity. For the 24-hour rainfall forecast of the South China, the forecast of location and intensity of strong rainfall center has also been improved especially after using FY-4A WV AMVs. However, there is no Quality Indicator for FY-4A AMVs yet, and further research is needed for the quality of FY-4A AMVs. In future, CMA will continue investigating the impact of FY-4A AMVs in GRAPES.

Acknowledgement

Thanks Dr Xiaohu Zhang for providing FY-4A AMVs data.

Reference

Zhang Zhiqing, Lu Feng, Fang xiang et al.2017.Application and Development of FY-4 Meteorological Satellite [J]. Aerospace Shanghai, 34(4):8-19.
Dong Yaohai.2016.FY-4A meteorological satellite and its application prospect [J].Aerospace Shanghai, 33(2):1-8.