Assimilation of AIRS Radiances in Regional Model and Its Impact on Typhoon Forecast

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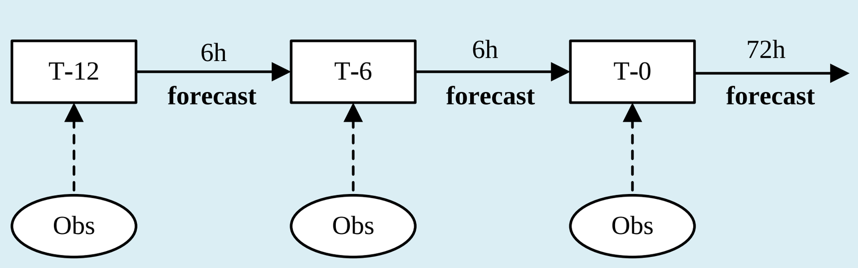
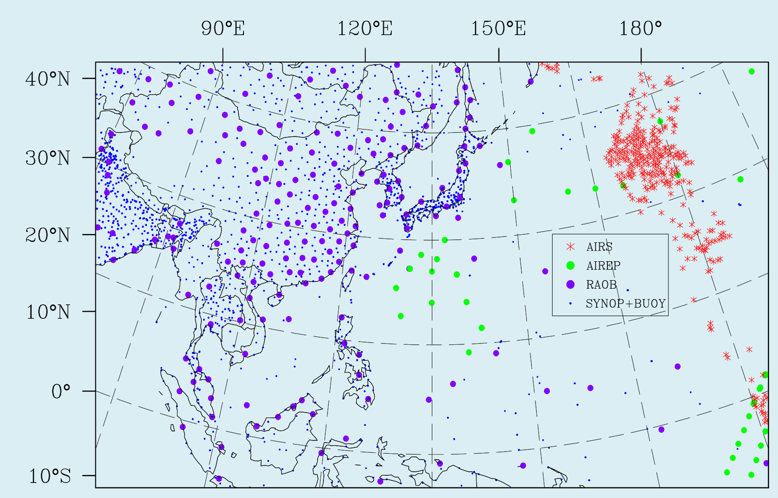
1. Introduction

- Increase of extreme severe weather, such as typhoon and rainstorm; Development of high resolution regional model;
- **Hyperspectral infrared radiance** data can provide high resolution of temperature and humidity profiles;
- Special issues in regional data assimilation: the initial and boundary conditions from the global model; **model top** of regional model; regional background error covariance (**B matrix**); the highly variable at each assimilation cycle for the number of observations; impact of limited data volume on the current method of **bias correction**;

2. Model and Assimilation

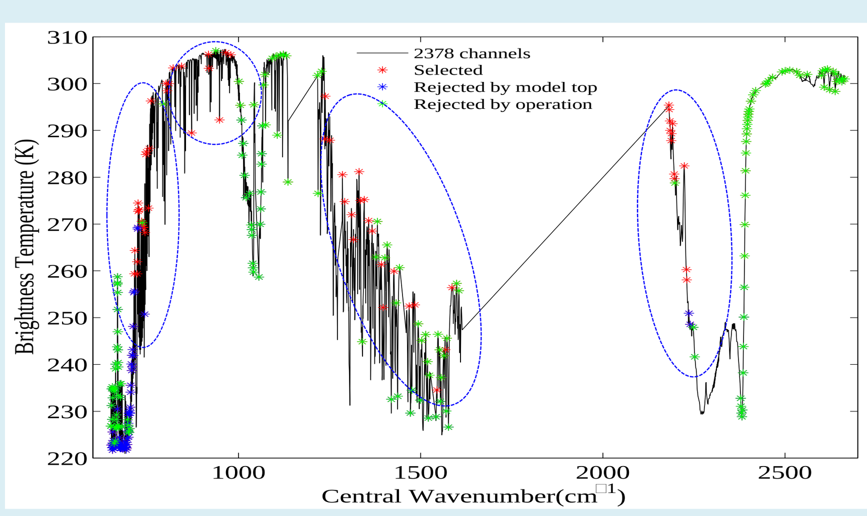
- Weather Research and Forecasting (**WRF**); Gridpoint Statistical Interpolation (**GSI**); Community Radiative Transfer Model (**CRTM**)
- Model horizontal resolution: 12 km; Domain size: 917 by 550 by 50; model top: 10 hPa
- Data: all conventional data and **AIRS**.





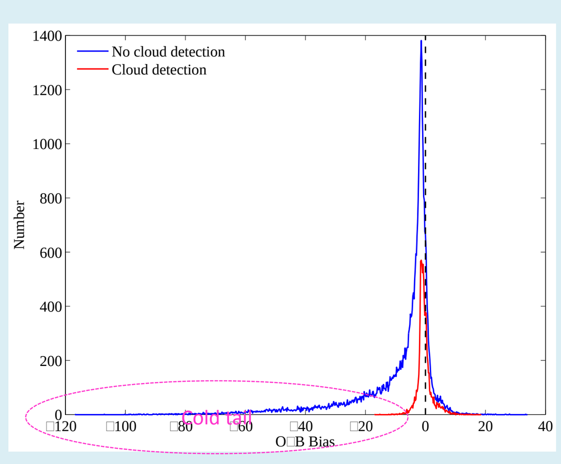
3. Quality control

Channel selection

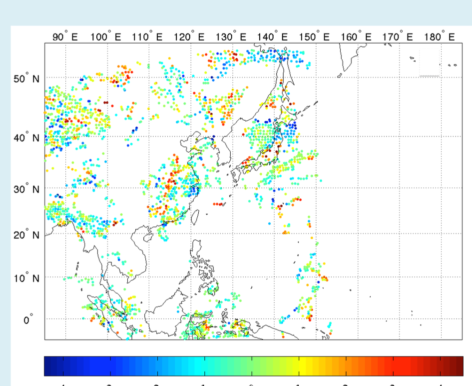


AIRS channel peak around or above model top were rejected based on sensitivity analysis (McCarty, 2009) **61** channels assimilated: 18 temperature; 11 windows; 20 water vapor; 12 shortwave

Cloud detection



Histogram of O-B;Looks symmetrically

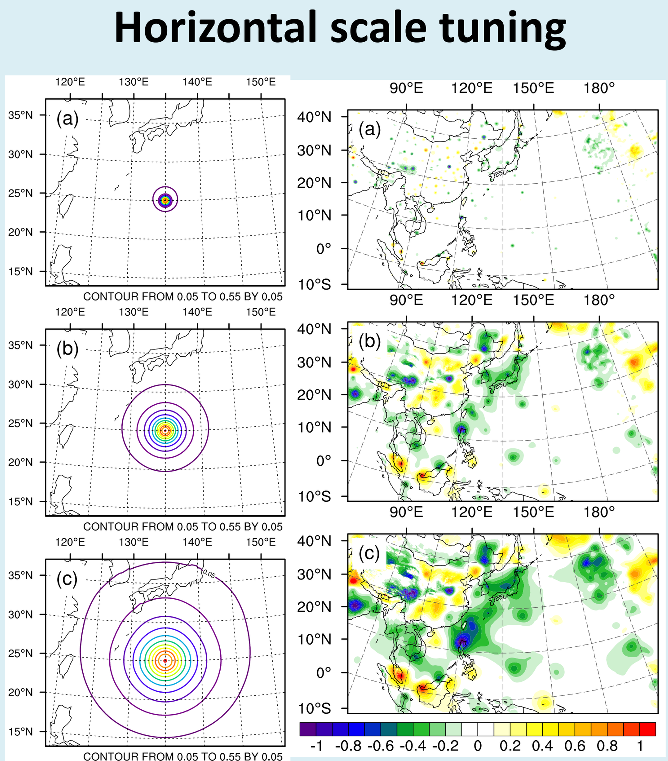


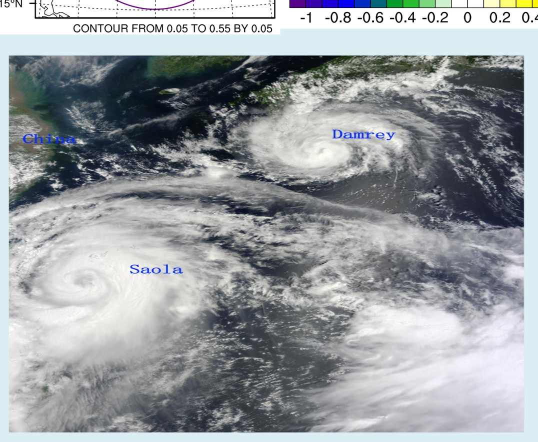
Distribution after quality control

4. B matrix tuning

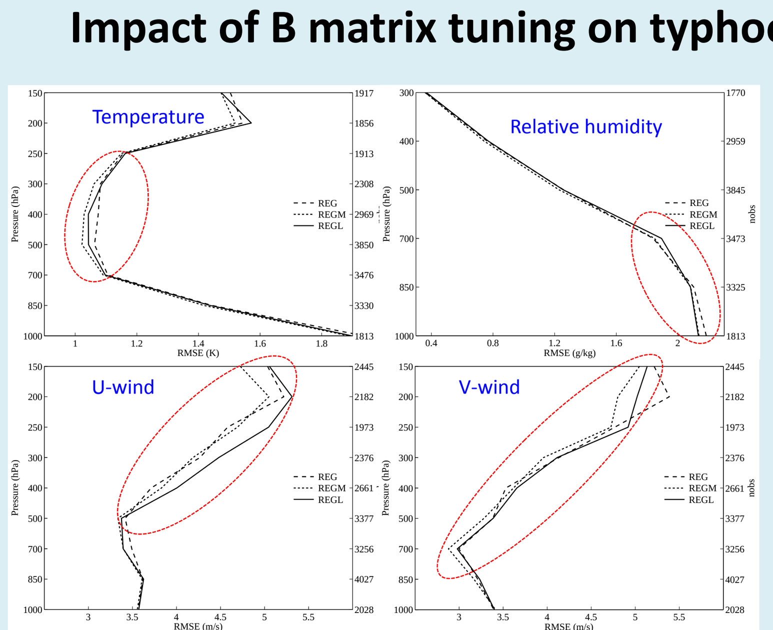
B matrix: Spread out information from observations; Controls % of innovation that makes up the analysis; Maintain dynamically consistent increments between model variables. Estimated from **NMC method**.

Horizontal scale tuning

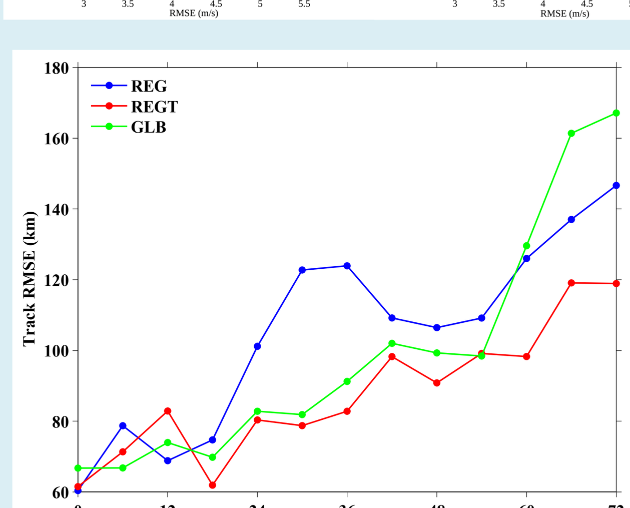




Impact of B matrix tuning on typhoon forecast



RMSE profiles between 24 h forecast and radiosonde observations for one week; About 3000 radiosonde data used to evaluation per level on average.

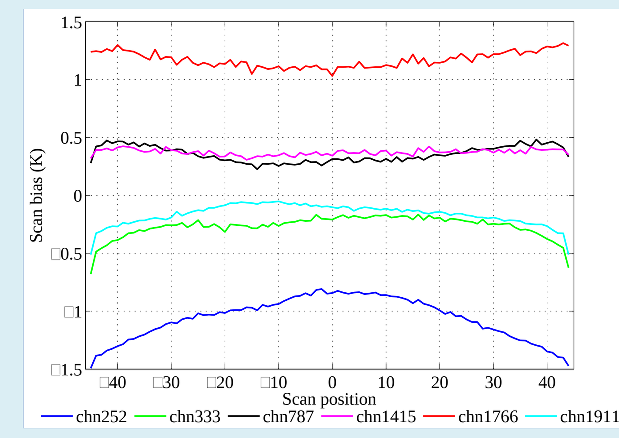


Tuned B matrix improve track forecast, compared with un-tuned B and global B

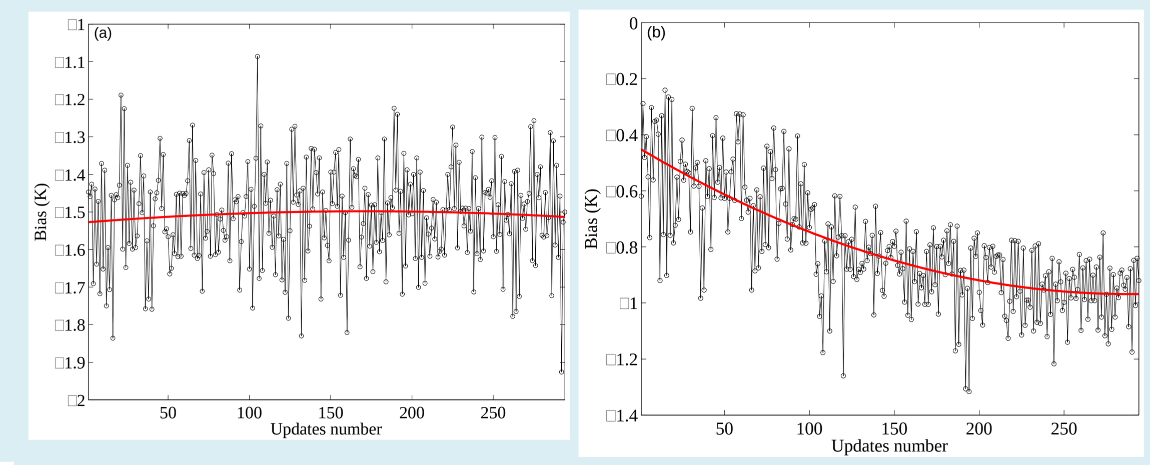
5. Bias correction

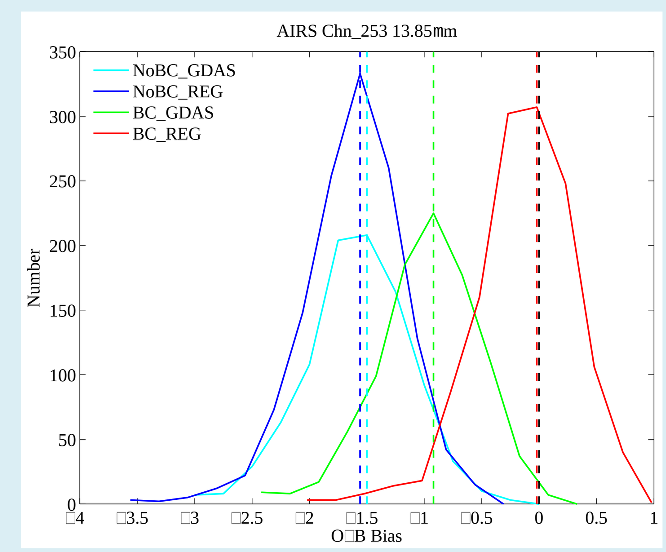
- Sources: calibration, radiative transfer model and short term forecast
- Characteristics: varies with time, airmass, scan position, satellite orbit
- Variation Bias Correction (Auglìgné, 2007): Scan angle bias + Airmass bias
- One month local spin-up to update scan bias and airmass coefficients

Scan angle bias correction

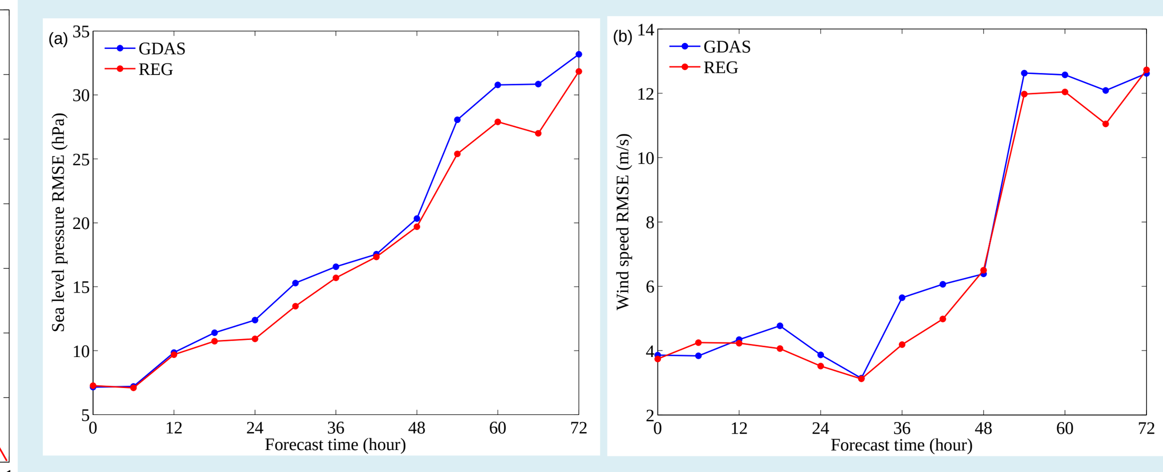


Time series change: Time dependence





Histogram of O-F before and after BC Compared with coefficients

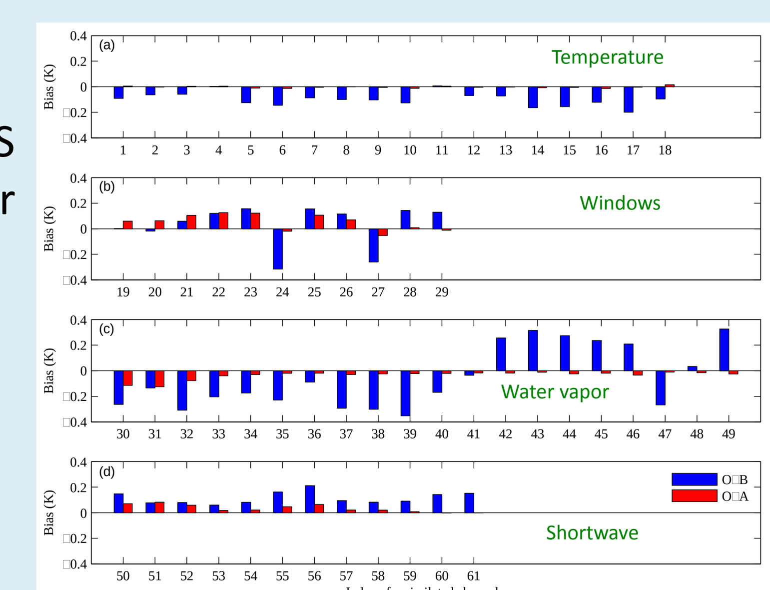


RMSE comparisons of typhoon Saola's 72 h intensity forecast when different bias correction coefficients were applied

6. Impact of AIRS radiances assimilation on typhoon forecast

O-B/O-A analysis

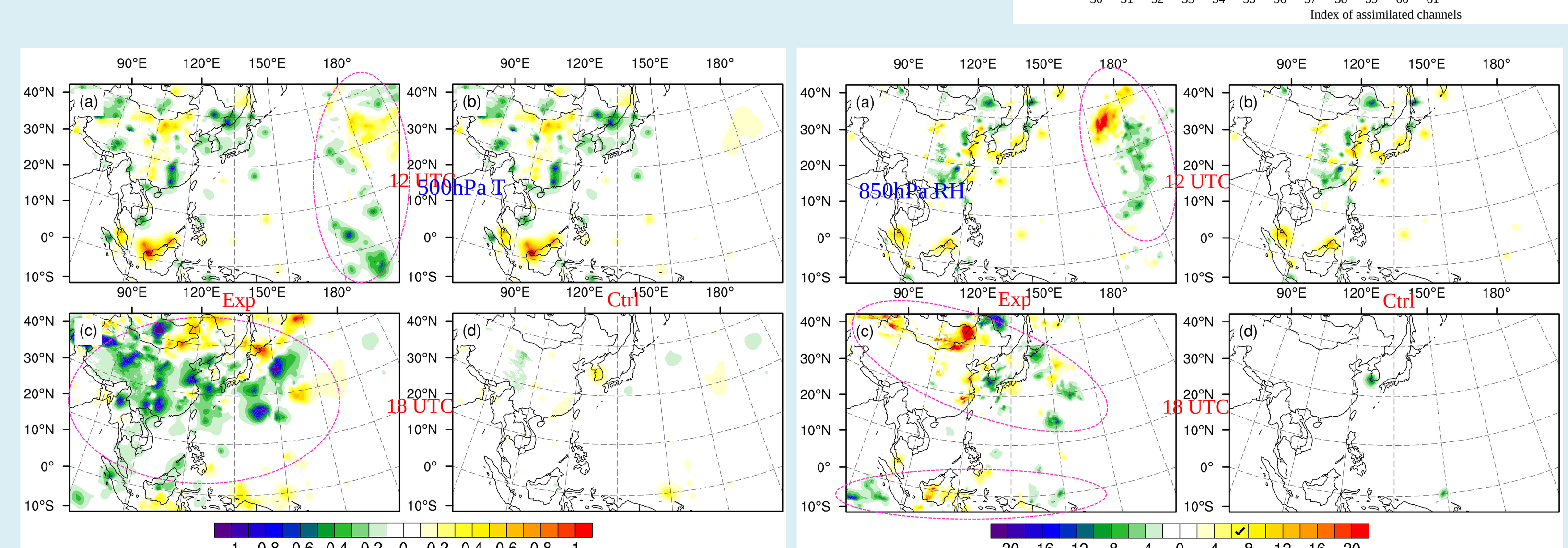
Bias comparisons of O-B and O-A for all 61 AIRS channels assimilated O-A are close to zero after assimilation for temperature and moisture channels

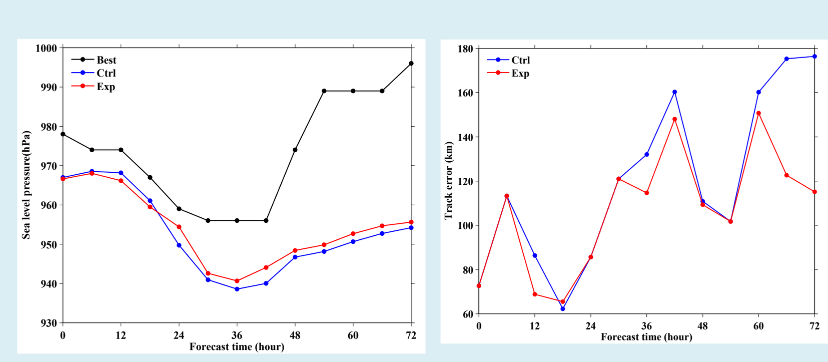


Analysis Increment

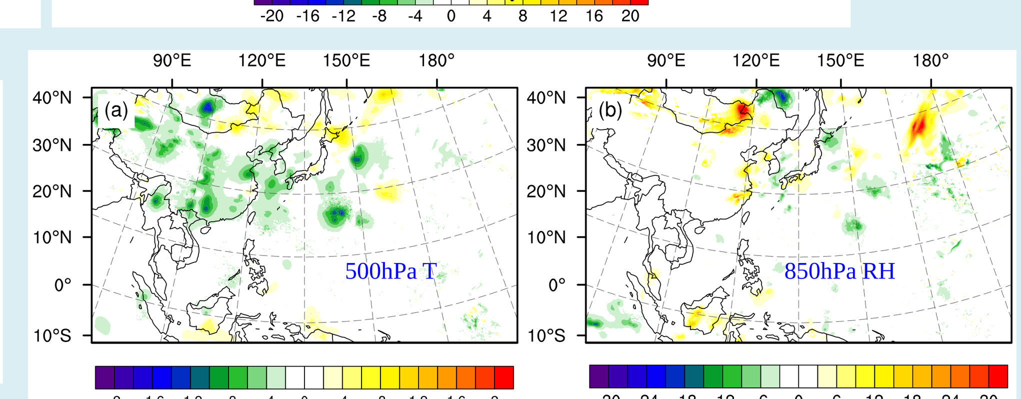
Control Run (**Ctrl**): all conventional observations

Experiment Run (**Exp**): Control Run + AIRS





Comparisons of 72h track and intensity forecast for Ctrl and Exp experiment with the best observations from JTWC



（a）Temperature at 500 hPa: Cold

（b）Relative humidity at 850 hPa: Dry

Exp analysis minus Ctrl analysis

7. Summary

- Limited Area NWP carried out using community models
- Assimilation of AIRS radiances through quality control, B matrix tuning and bias correction
- Positive impact for clear sky AIRS assimilation both on typhoon track and intensity forecast

Reference: Y. Liu, H. Huang, W. Gao, A. Lim, et al, Tuning of background error statistics through sensitivity experiments and its impact on typhoon forecast, *Journal of Applied Remote Sensing*, 2015(9):096051.