Improving Analyses and Forecasts of the Asian Monsoon with GPS Radio Occultation Refractivity Observations

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Motivation

- Analysis and forecast of water vapor and wind over Asian Monsoon region, especially over oceans, have large uncertainty.
- GPS RO refractivity has information of water vapor in the middle and lower troposphere.
- See if GPS RO refractivity can improve analysis and forecast of water vapor, wind, and rainfall.

Assimilation Experiments

- WRF/DART at 36km resolution for June 1-14, 2007.
- *NoGPS run*:

  Assimilate radiosonde + satellite cloud winds +

  AIRS temperature (cloud-free).
- *GPS run*:

  Same as NoGPS run plus COSMIC RO refractivity.

- Ensemble means of analyses are compared.
- 24-hour forecasts from 00Z of each day are produced.

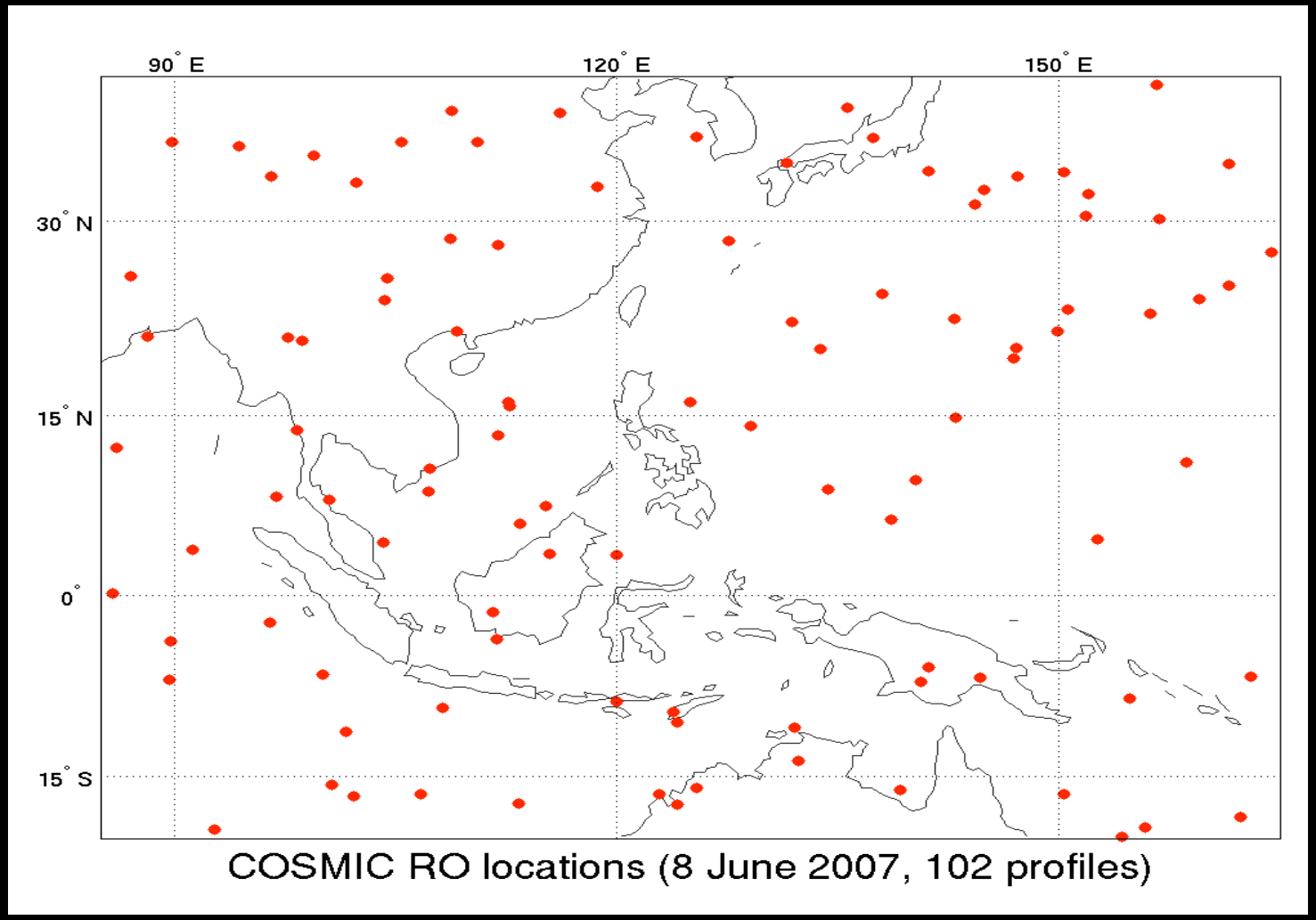
  (Total of 14 24-hour forecasts for the 2-week period)

Advantages of WRF/DART ensemble system

- Forecast error estimates from ensemble forecasts are flow dependent. This is crucial for forecasts at convective scale.
- Multivariate forecast error correlations (e.g., water vapor with other variables) are used to make analyses from GPS RO refractivity observations.

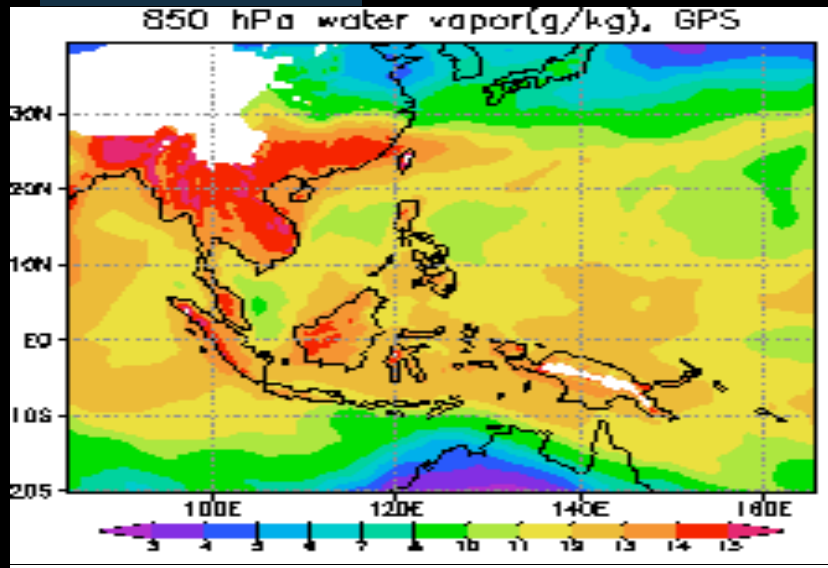
(for details, see www.image.ucar.edu/DAReS)

COSMIC RO soundings (June 8 00-24Z, 2007)

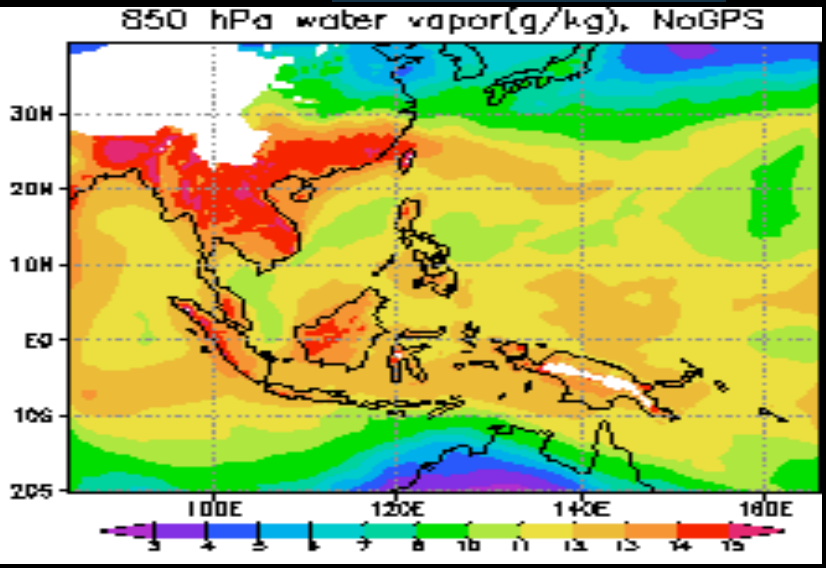


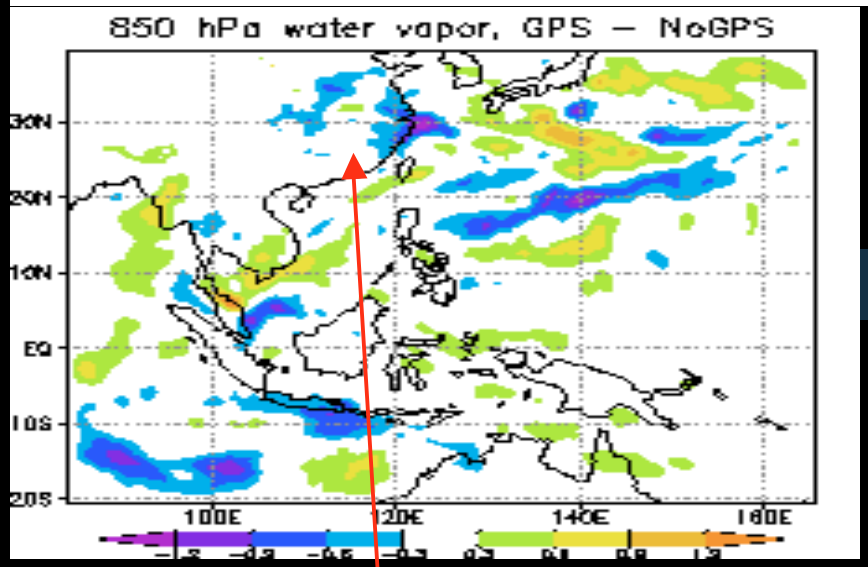
850 hPa Water Vapor Analysis (June 1-14, 2007)

GPS



NoGPS



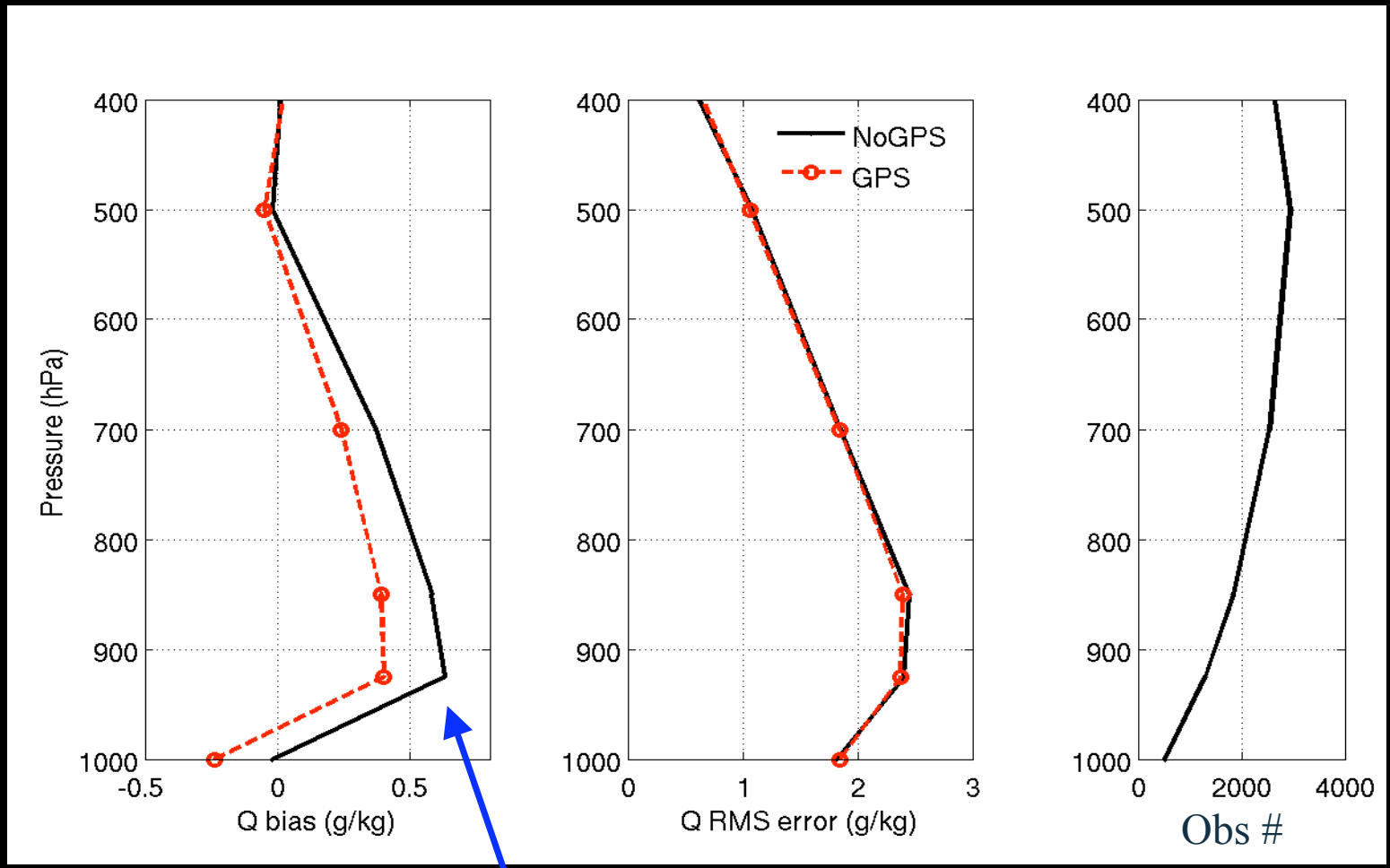


GPS - NoGPS

Key point: Water vapor is reduced over China

Bias and RMS error of water vapor Analysis

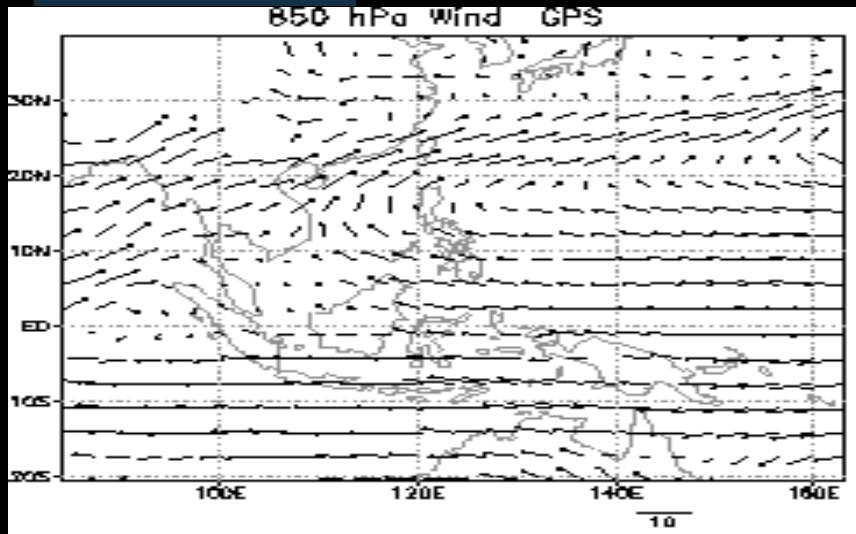
Relative to radiosondes over China



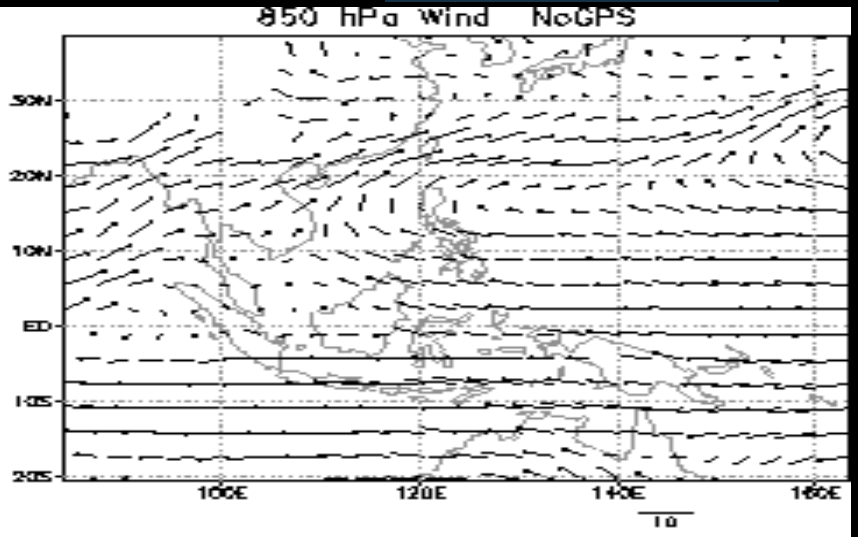
A wet bias in the lower troposphere is reduced.

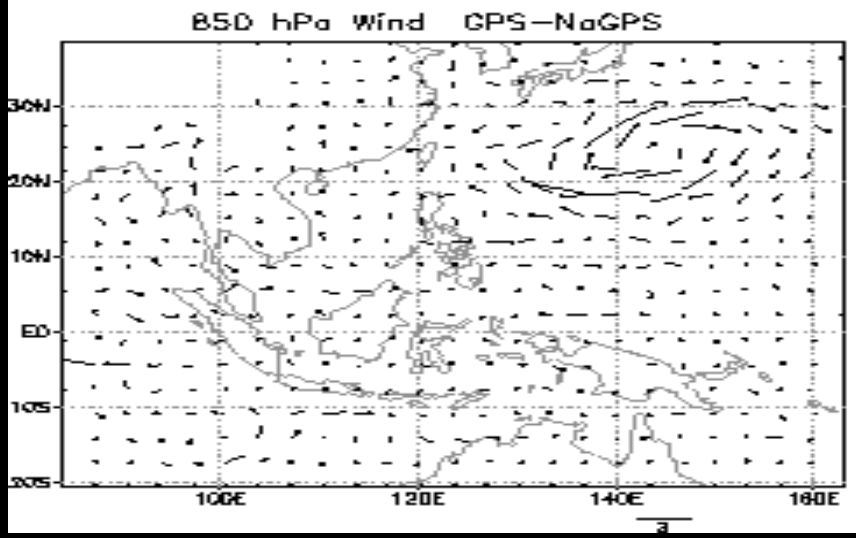
850 hPa Wind Analysis (June 1-14, 2007)

GPS



NoGPS



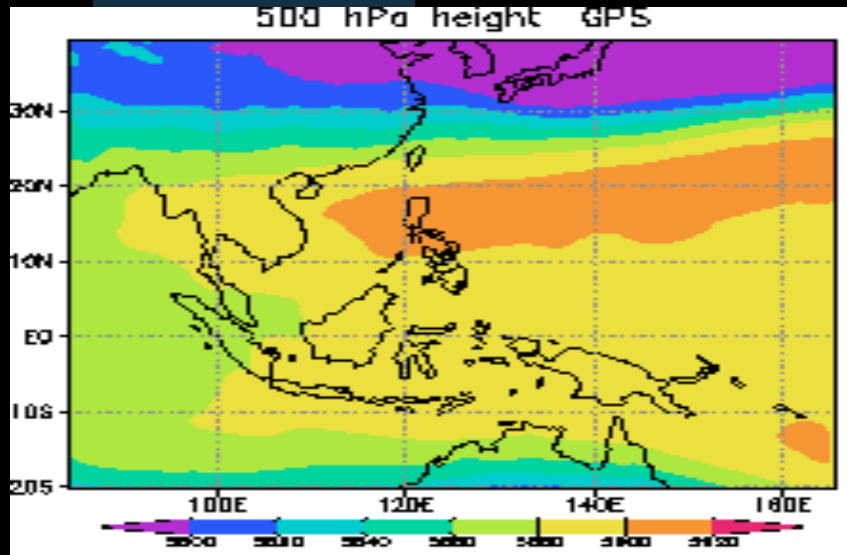


GPS - NoGPS

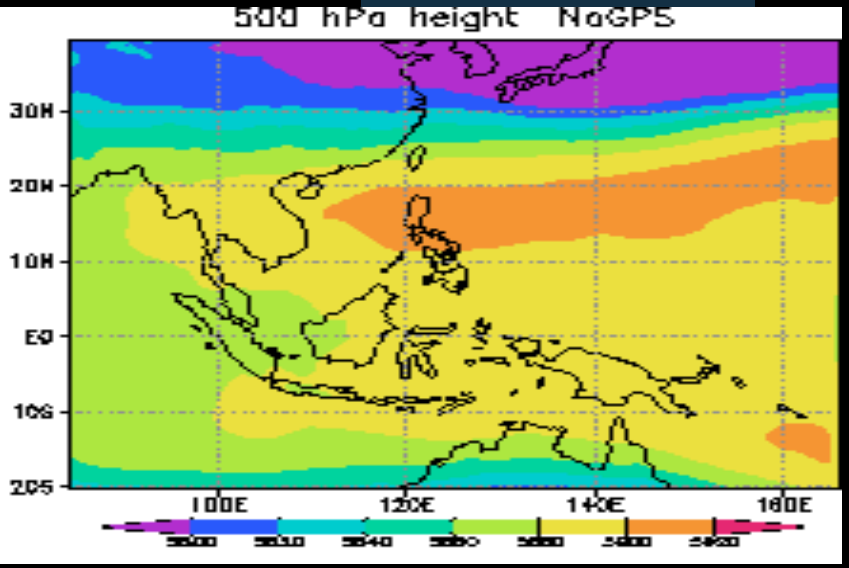
RO data enhances the anti-cyclonic circulation over Pacific

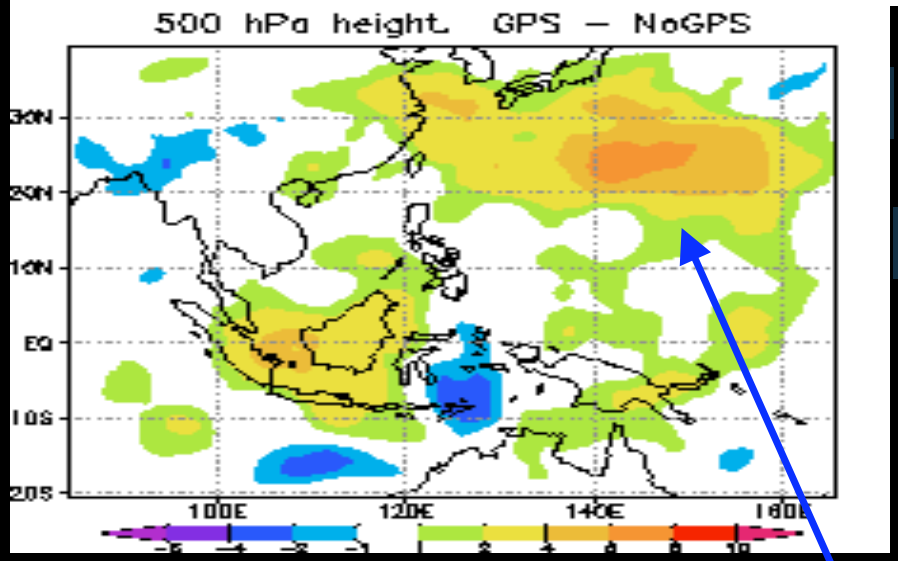
500 hPa height Analysis

GPS



NoGPS



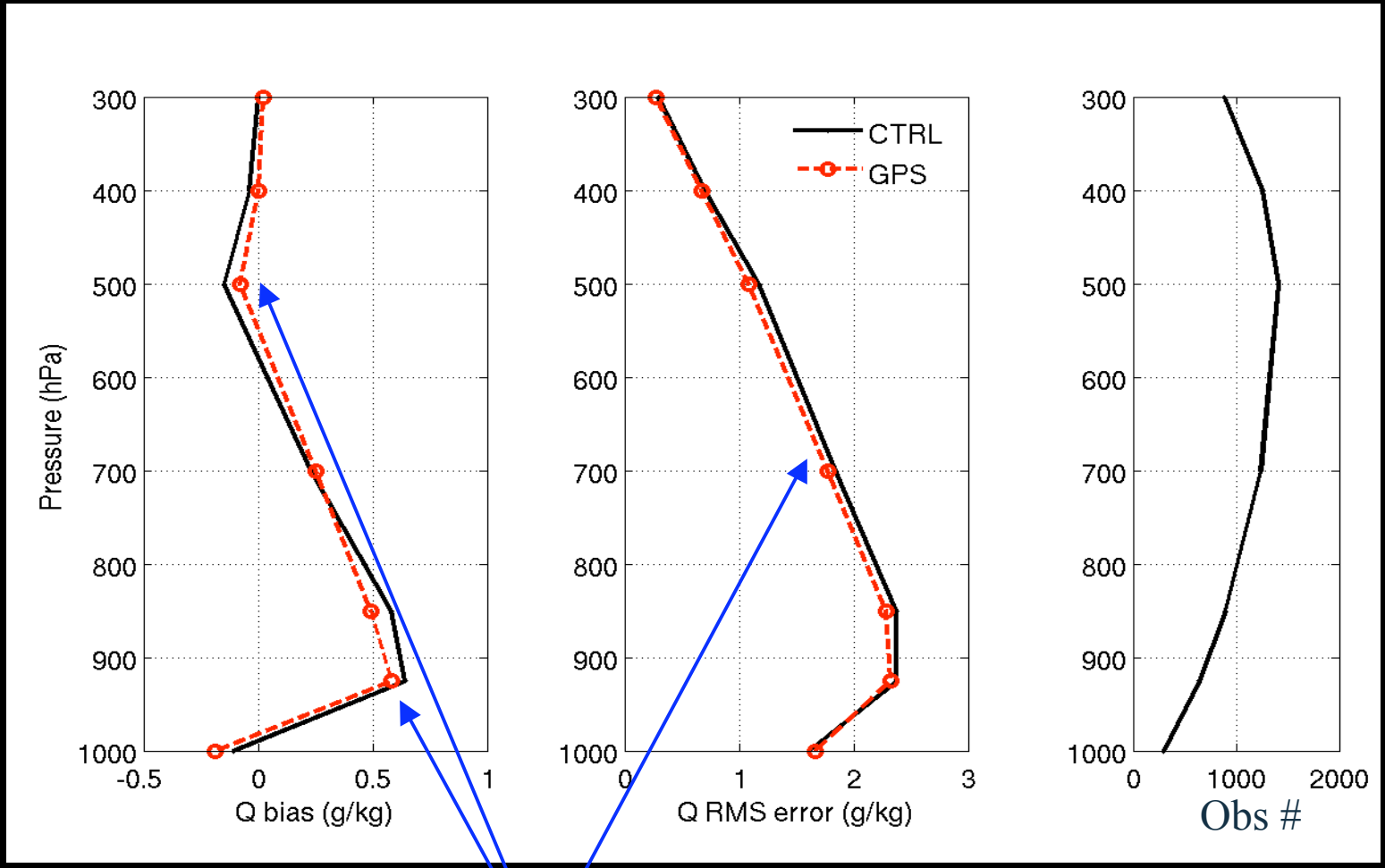


GPS - NoGPS

RO data enhances the subtropical high over Western Pacific

Errors of 24-hour Forecasts of water vapor (June 1-14)

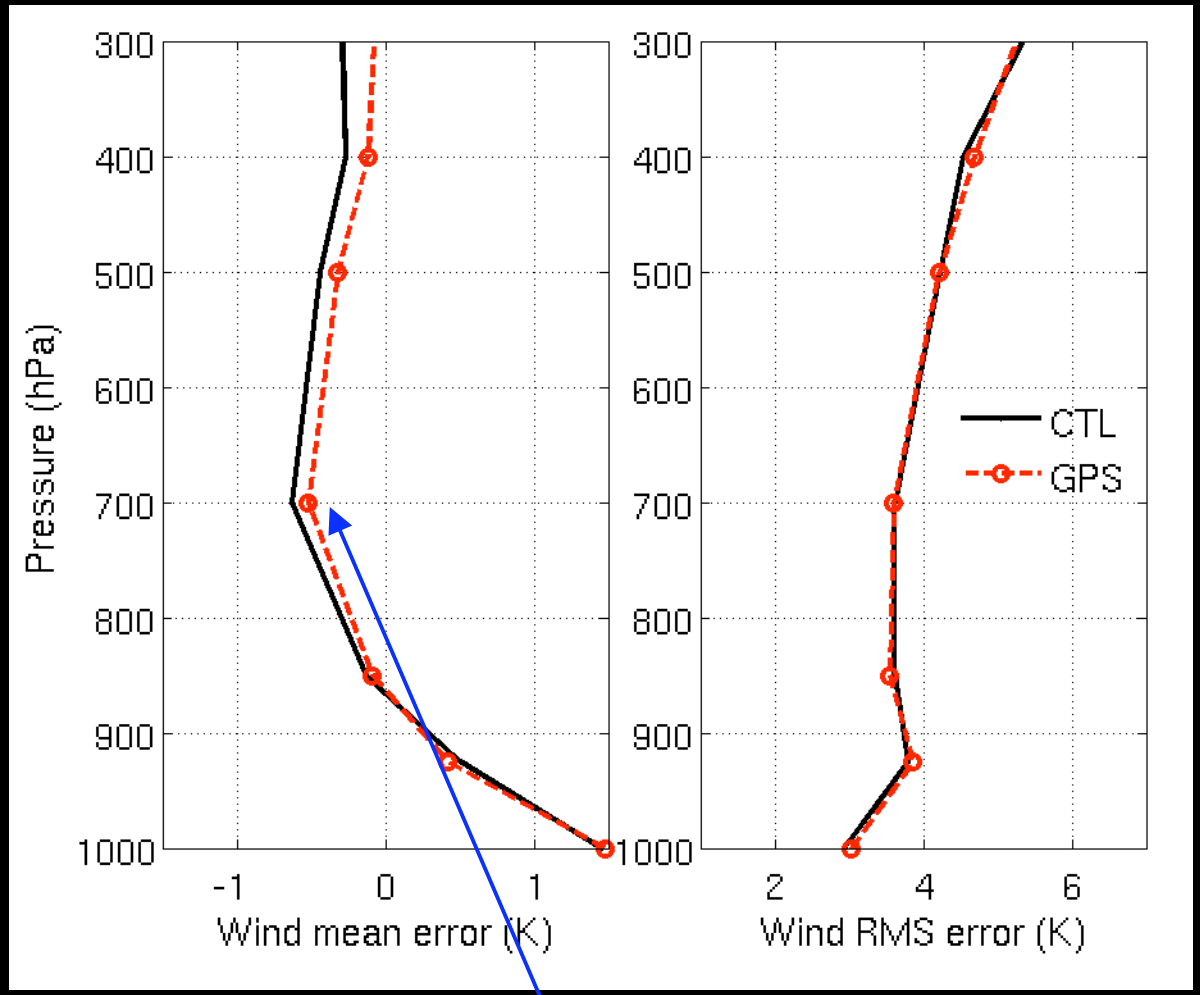
Relative to radiosondes over China



Wet biases and RMS error are reduced.

Errors of 24-hour Forecasts of wind speed (June 1-14)

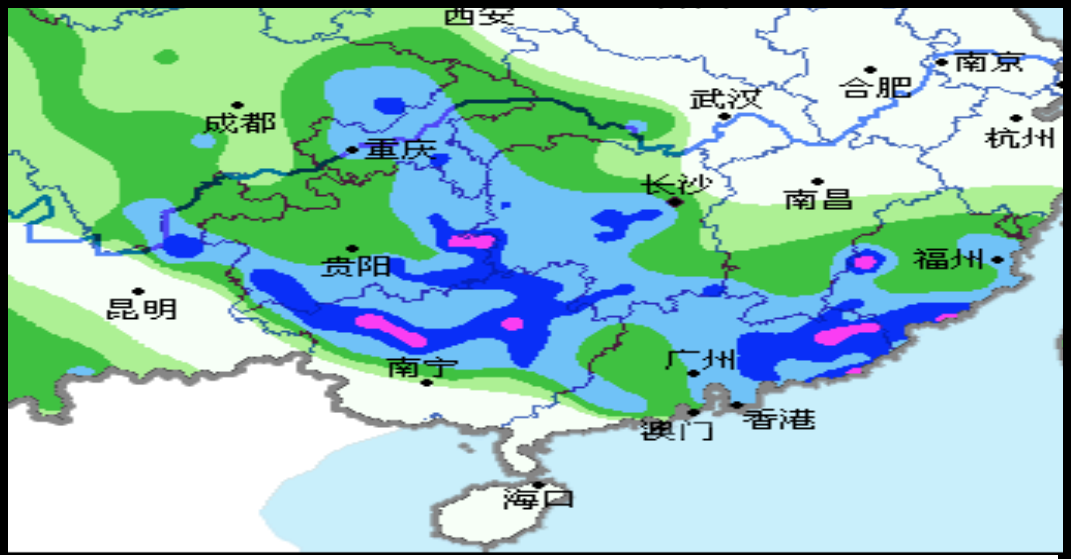
Relative to radiosonde over China



The wind speed bias is reduced.

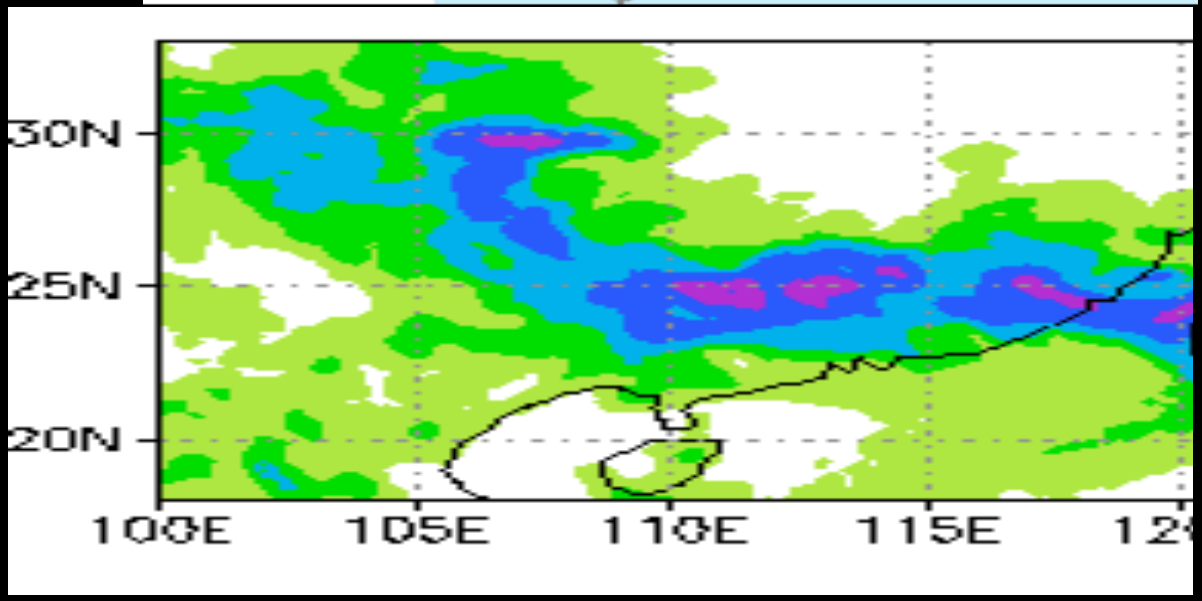
A Heavy rainfall Case over China

Accumulated gauge precipitation



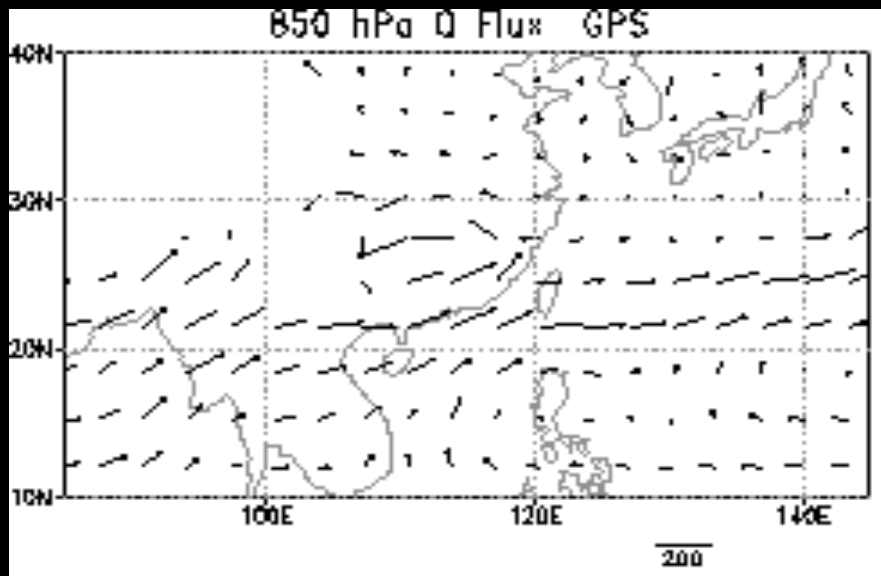
Observation

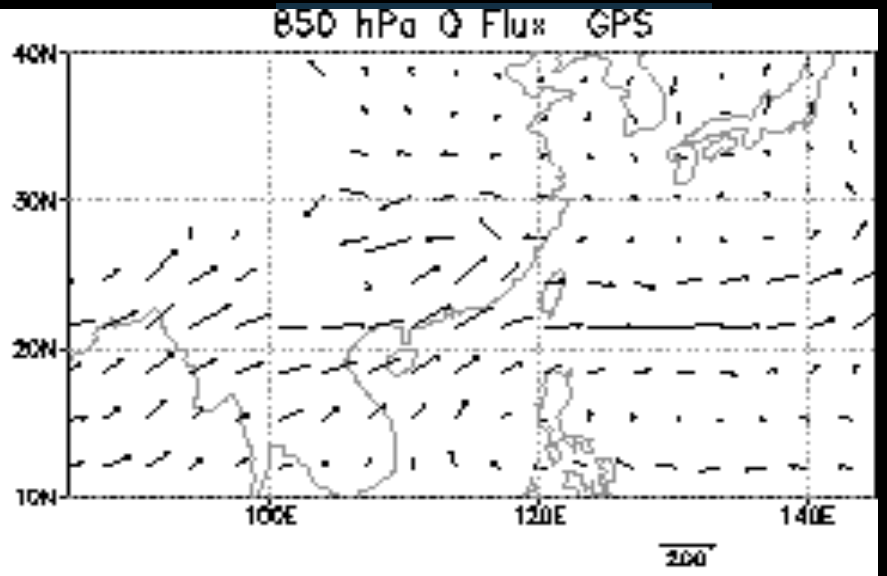
June 8-9 00Z, 2007

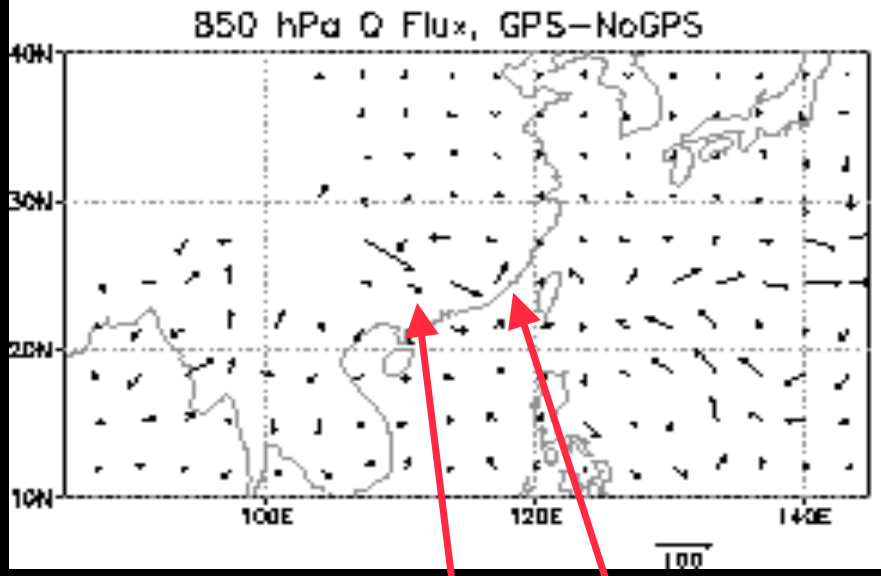


NoGPS Forecast

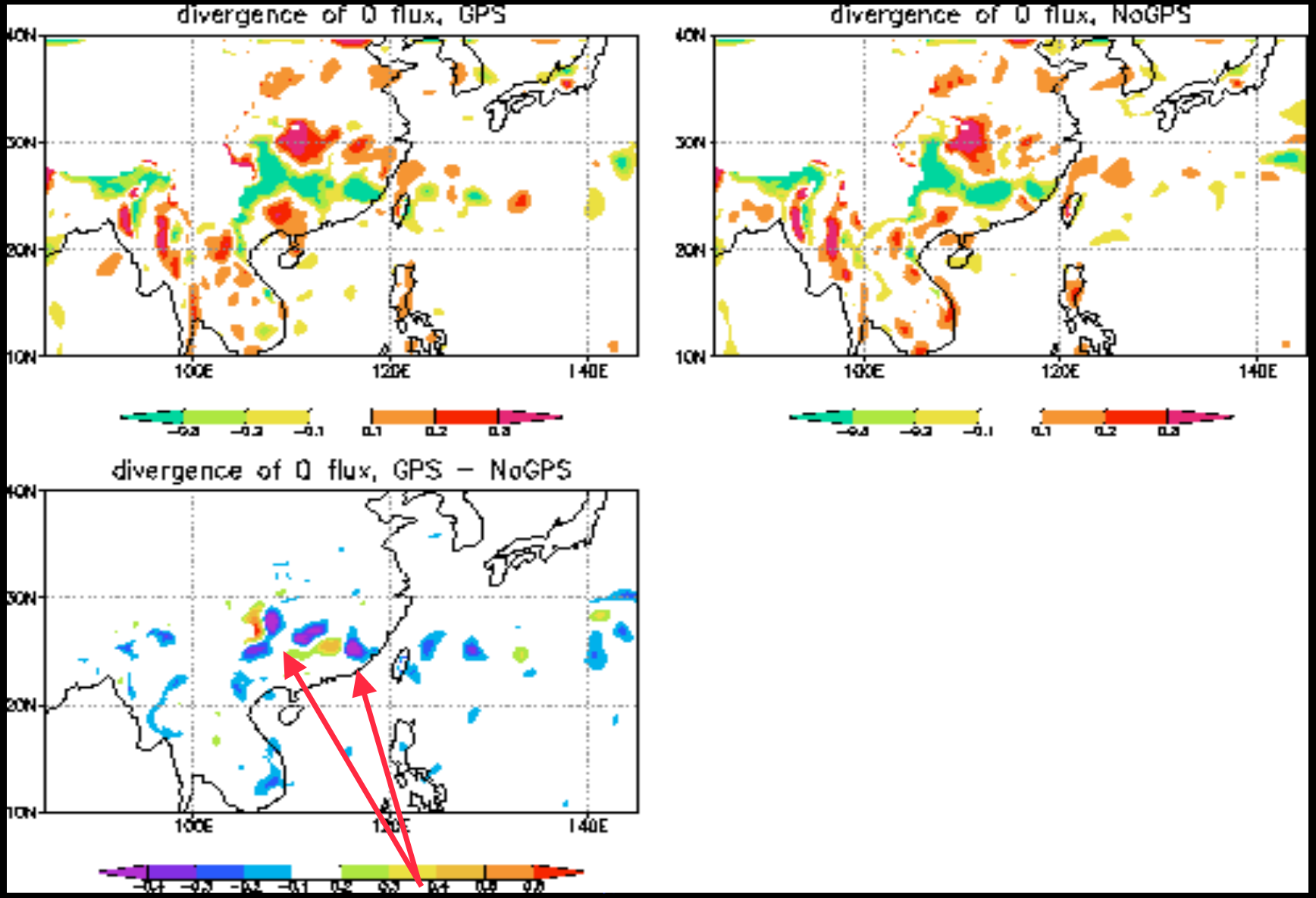
Analysis of 850 hPa moisture flux (June 8 00Z)







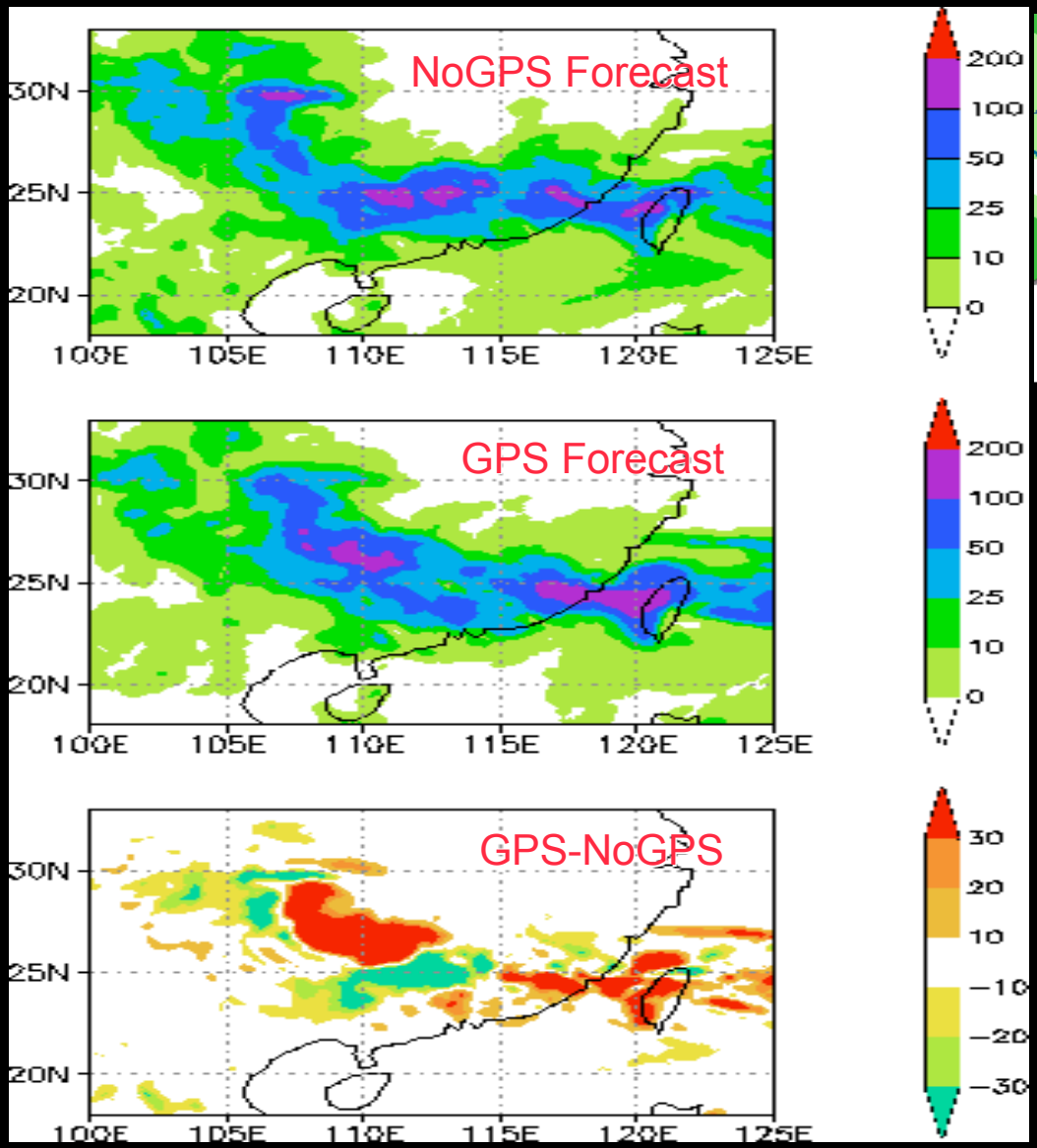
Analysis of 850 hPa moisture convergence (June 8 00Z)

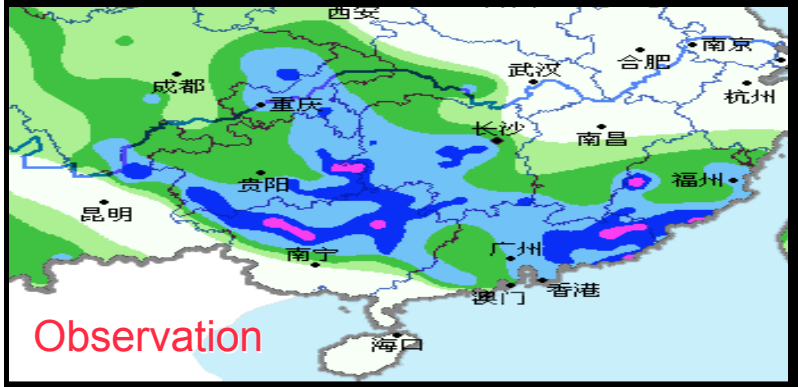


GPS run shows increased water vapor convergence

Forecast of 24-hour Cumulative Rainfall, 0800Z - 0900Z

(unit: mm/24h)





Conclusions

The COSMIC RO data:

- Reduced bias of water vapor and wind analyses and forecasts.
- Better simulated the subtropical high over western Pacific.
- Improved prediction of a heavy rainfall event over China.