

# The Impact of Radio Occultation Data on Analysis of the Subtropical Anticyclone over Western Pacific Ocean

H. Liu, J. Anderson, B. Kuo, Y. Chen, and C. Snyder

NCAR

# Background

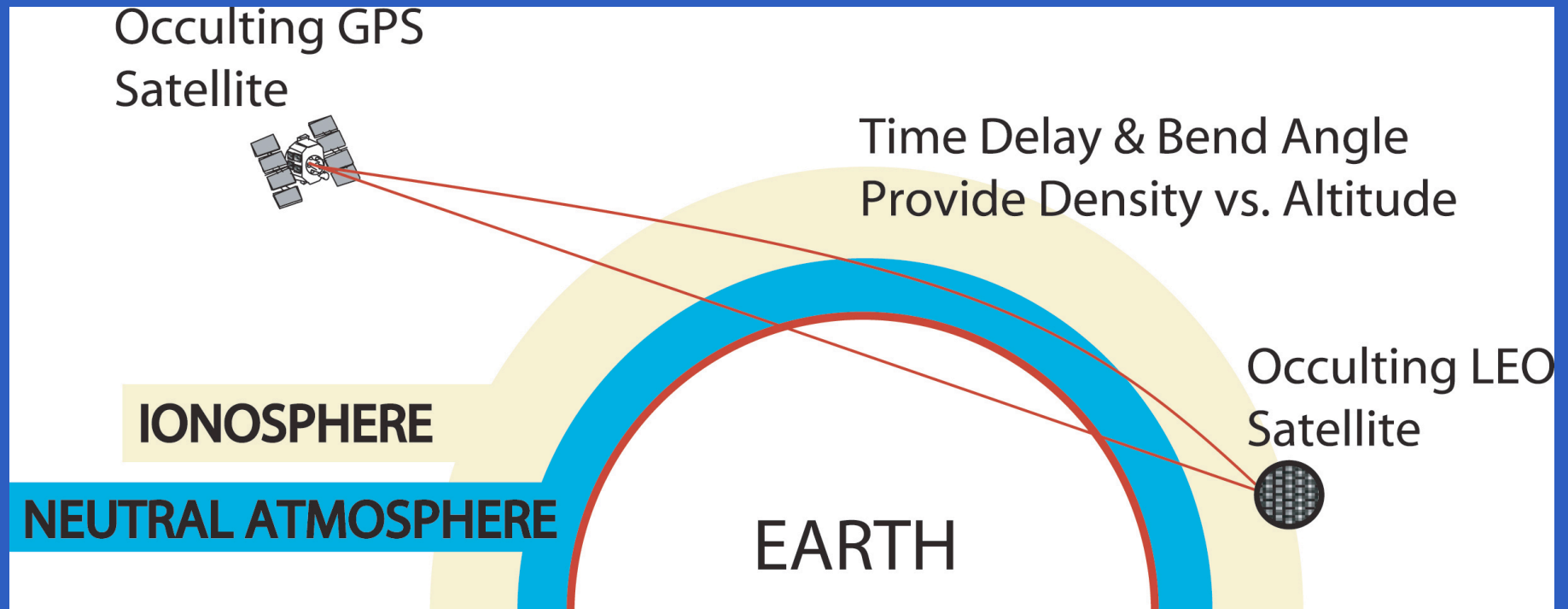
- The anticyclone is one of the key factors for the Asian summer monsoon
- It brings water vapor from Western Pacific
- controls the monsoon rainfall

# Observation concerns over Western Pacific

- Lack of good in-situ observations
- Remote down-looking data lacks vertical resolution  
(e.g., for moisture in the troposphere)
- Larger uncertainty in thick cloudy situations

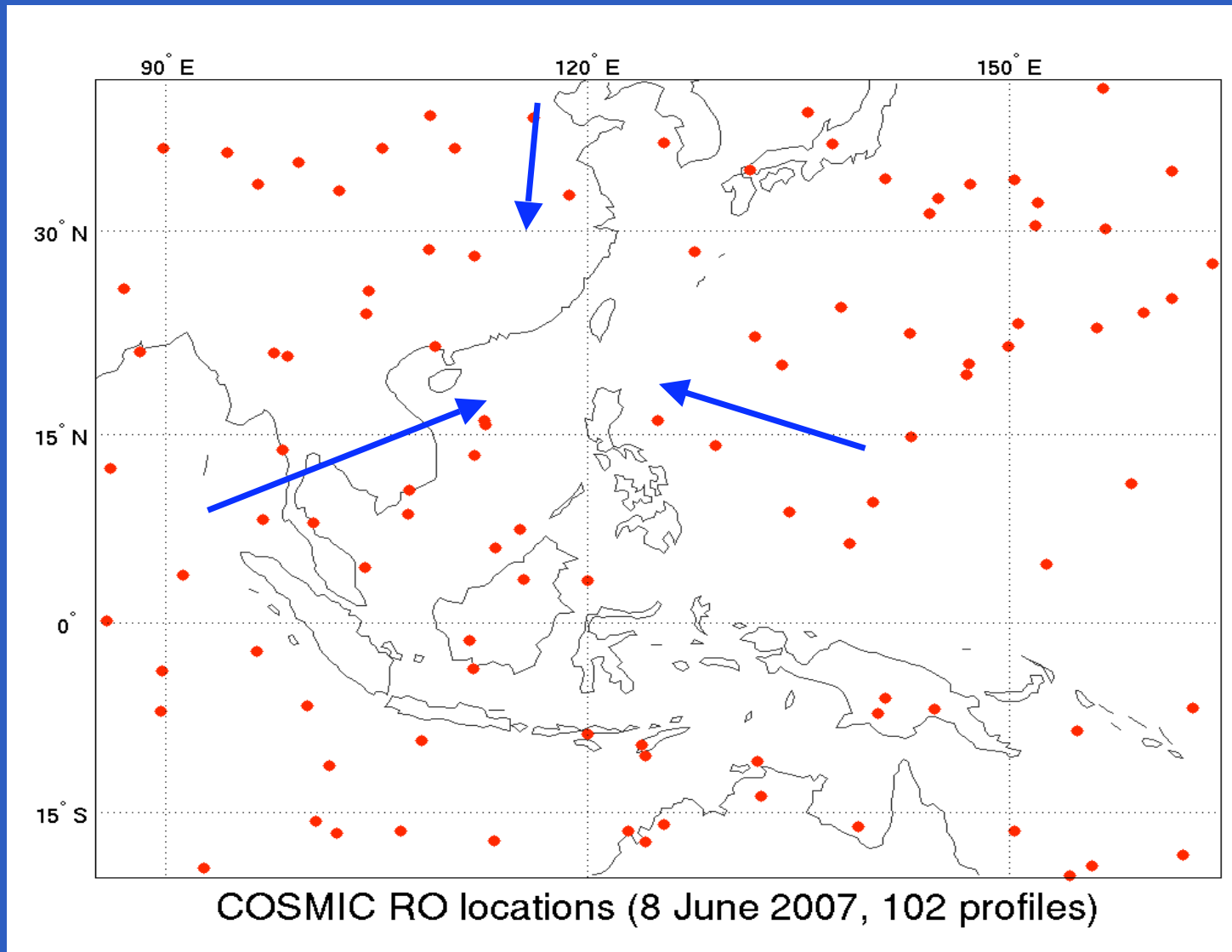
Analysis and forecast of the anticyclone is not satisfactory!

# GPS Radio Occultation Measurement



- Refractivity has density (water vapor and temperature) information
- Better vertical resolution (~100m near surface)
- Not contaminated by thick clouds and/or precipitation
- ~2500 soundings globally per day since Aug. 2006

# COSMIC GPS RO sounding locations (June 8, 2007)



# This study

We will examine impact of GPS RO data on:

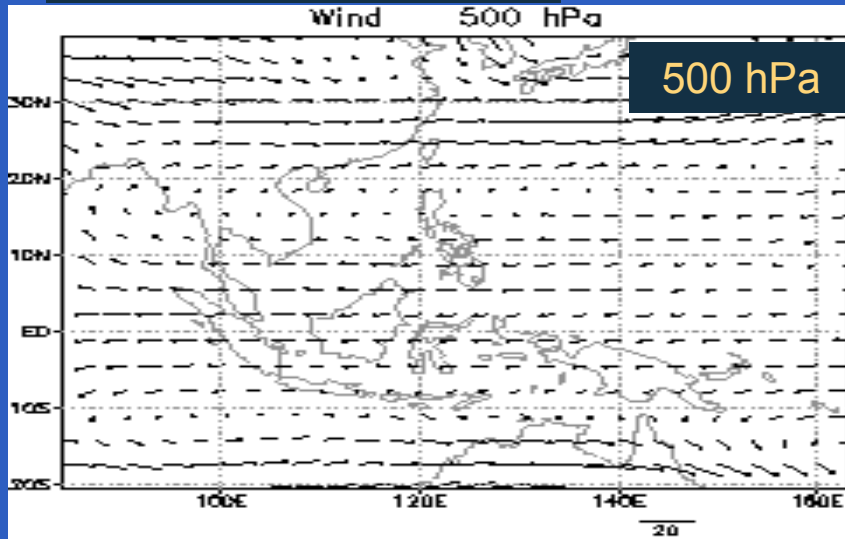
- Analysis of subtropical anti-cyclone over Western Pacific and associated water vapor flux
- Prediction of a heavy “Mei-Yu” rainfall over Taiwan,
- Analysis of the blocking highs in the mid-latitudes.

# Assimilation Experiments

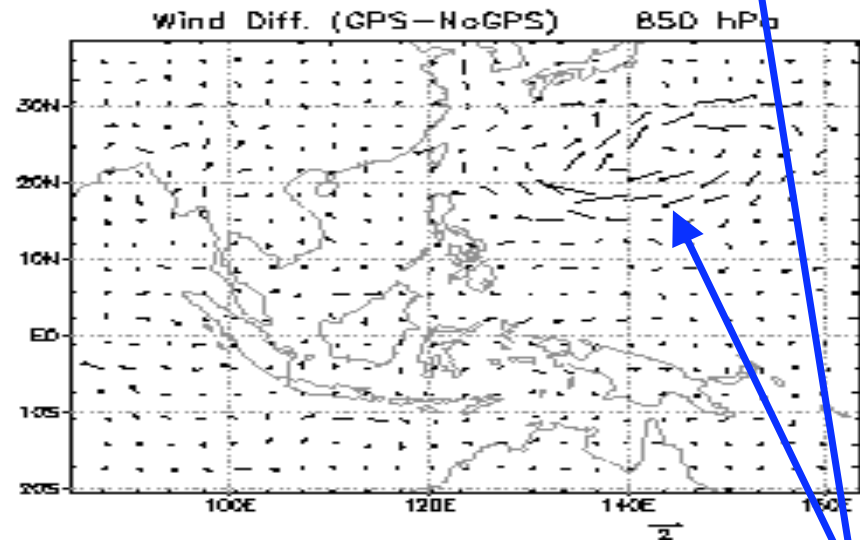
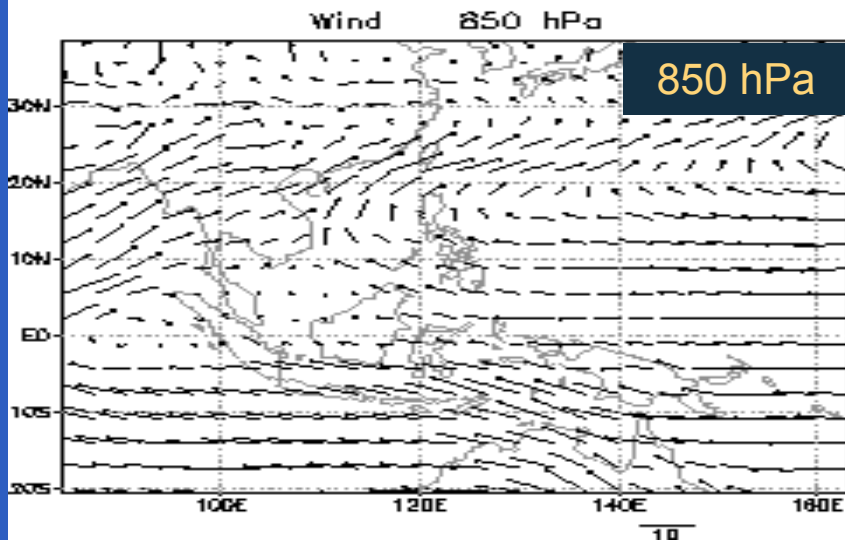
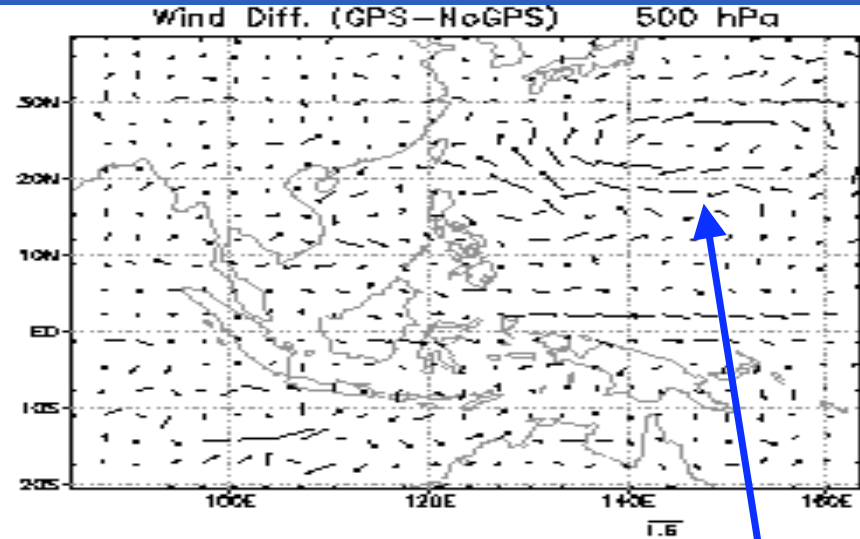
- DART/WRF ensemble data assimilation at 36km resolution continuously for June 1-14, 2007
- Analyses are produced 6-hourly
- *GPS run:*  
Assimilate radiosonde, satellite cloud-motion winds, cloud-free AIRS temperature + RO refractivity
- *NoGPS run:*  
The same as GPS run but without RO refractivity

# Effect of RO data on Wind Analysis

GPS Analysis June 1-14



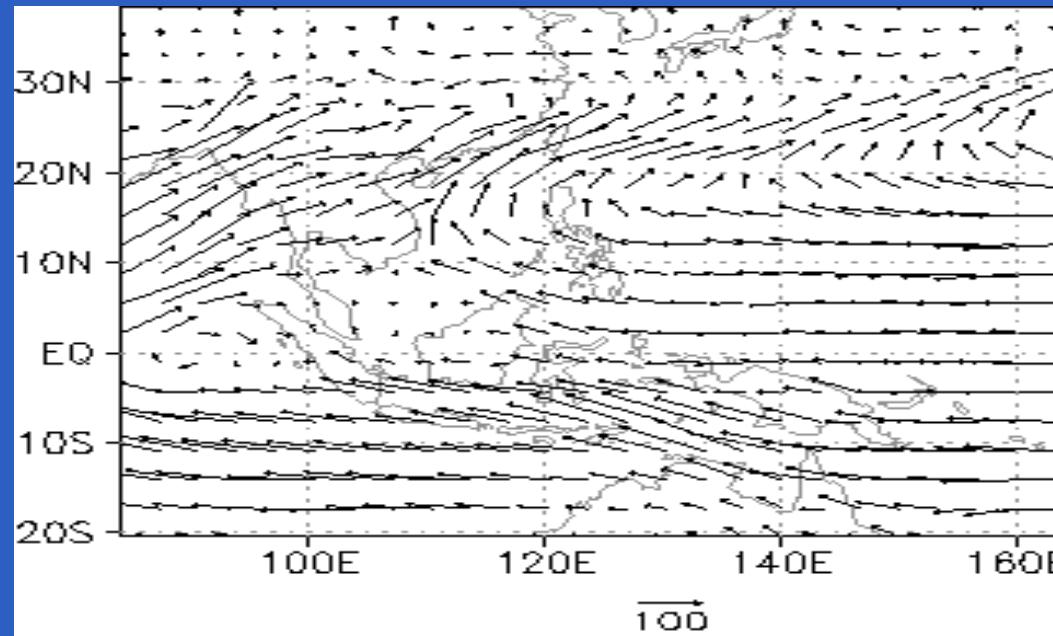
Difference of GPS - NoGPS



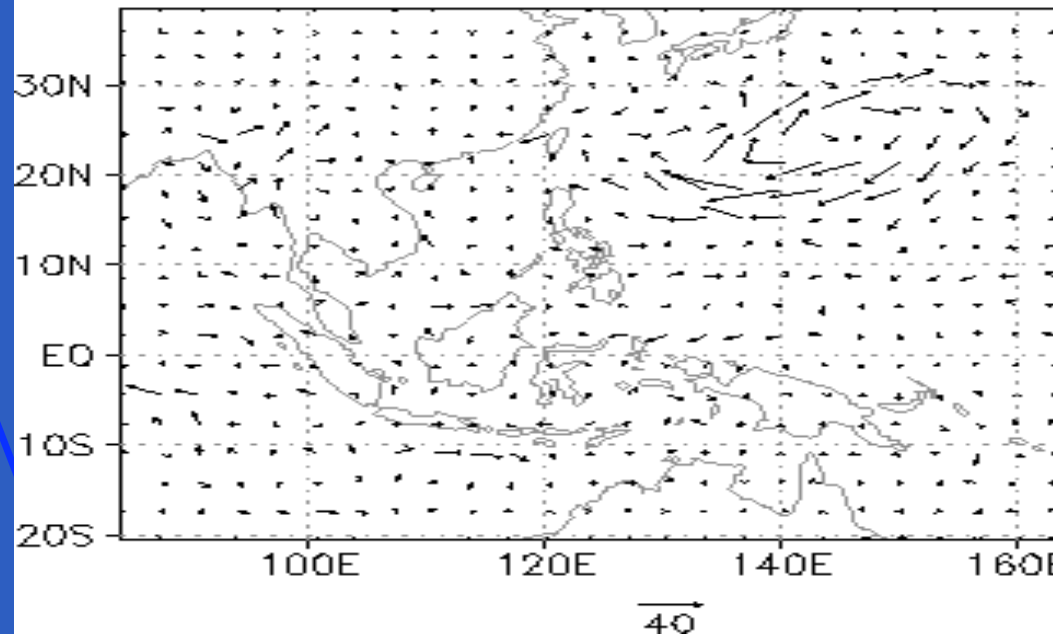
GPS RO data enhances the anti-cyclone over Western Pacific



# Effect of RO data on Water Vapor Flux Analysis (850 hPa)



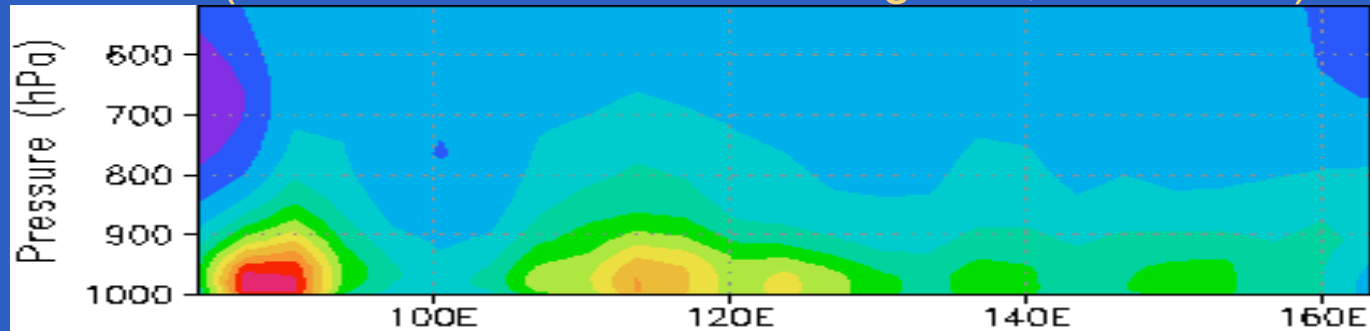
GPS Analysis  
June 1-14



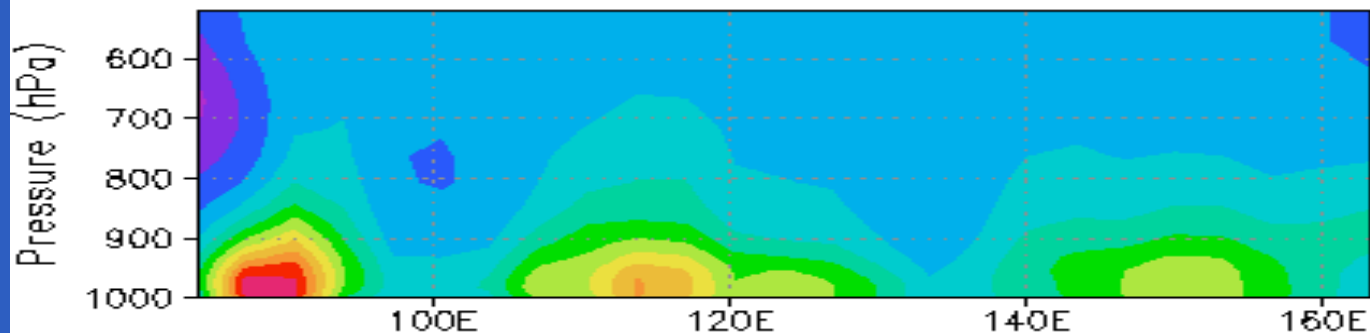
Difference of  
GPS - NoGPS

RO data Enhances  
flux from Western  
Pacific toward Asia

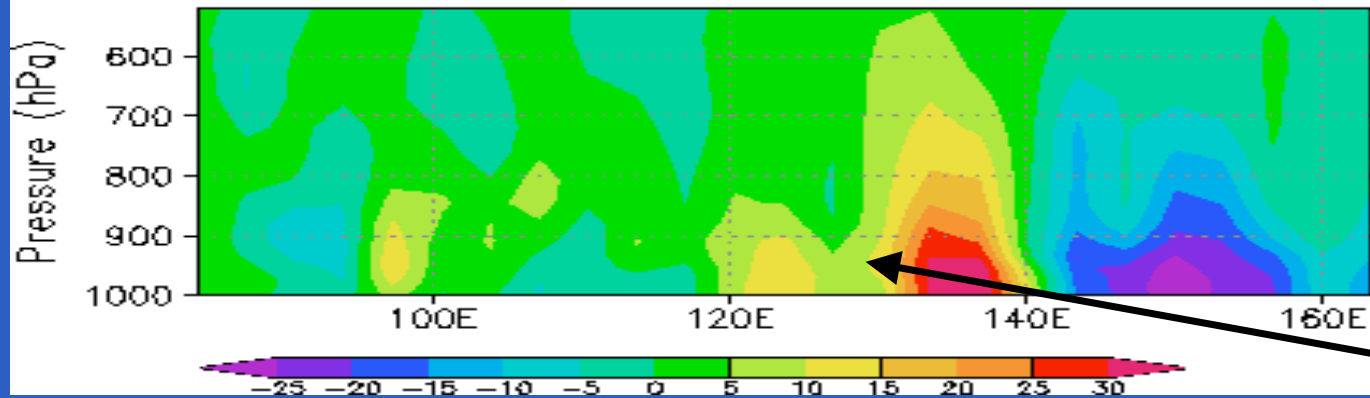
# Effect of RO data on Northward Water Vapor Flux (Vertical Cross Section Along 20N, June 1-14)



GPS Analysis



NoGPS Analysis



Difference of  
GPS - NoGPS

Stronger  
Northward flux

# Effect of RO data on Water Vapor at 850 hPa (1-14 June)

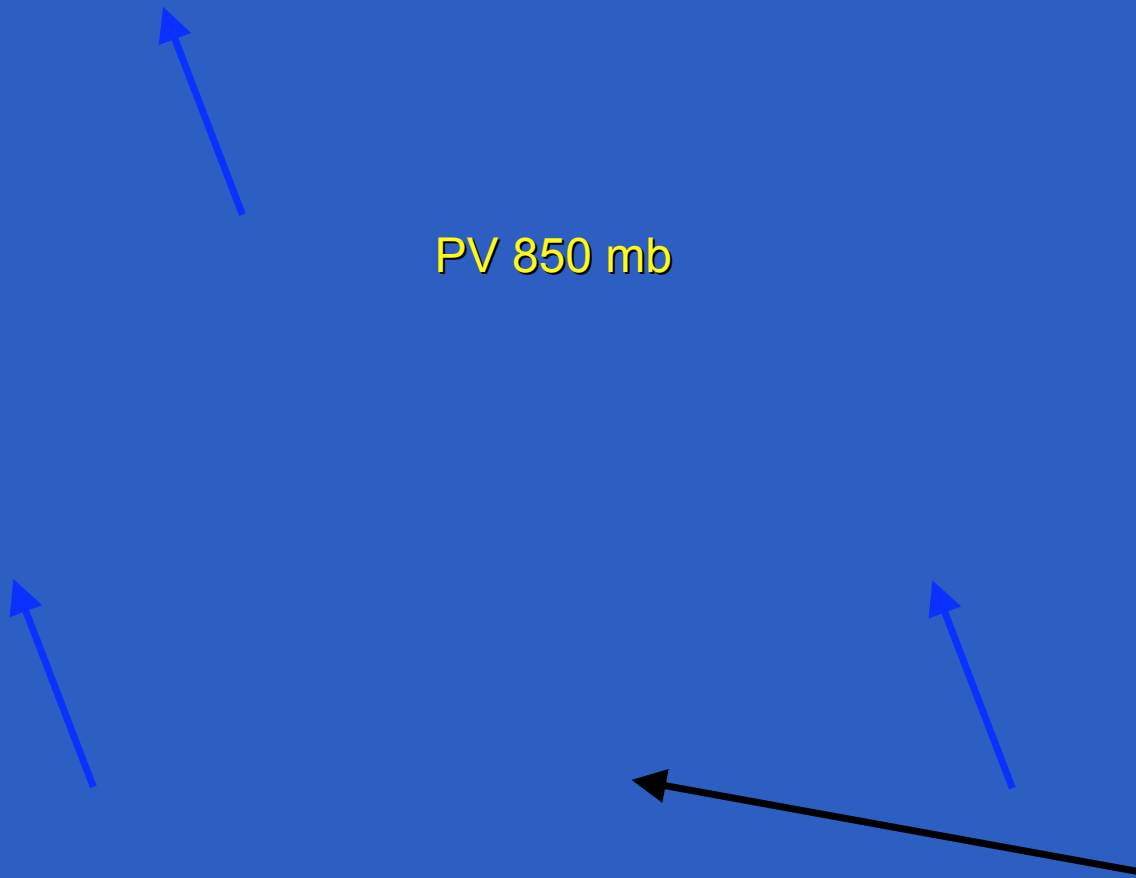
GPS Analysis

NoGPS  
Analysis

PV 850 mb

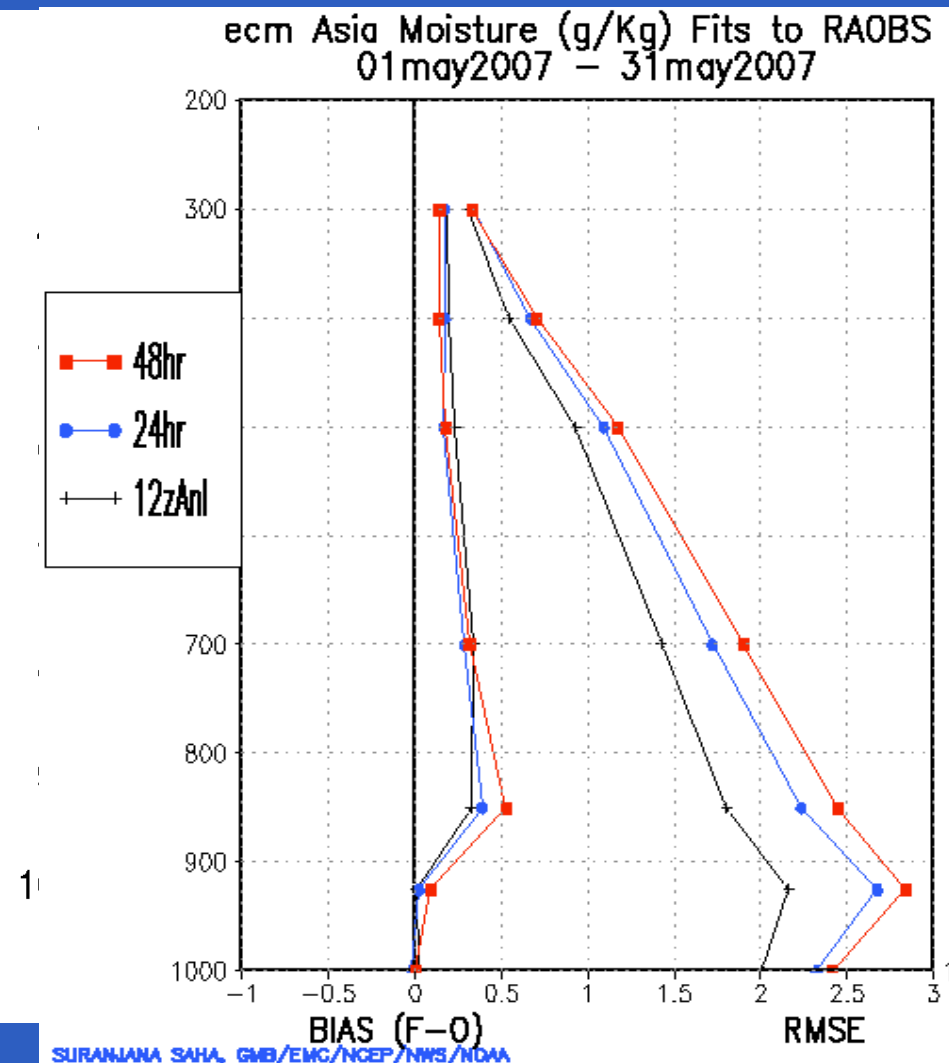
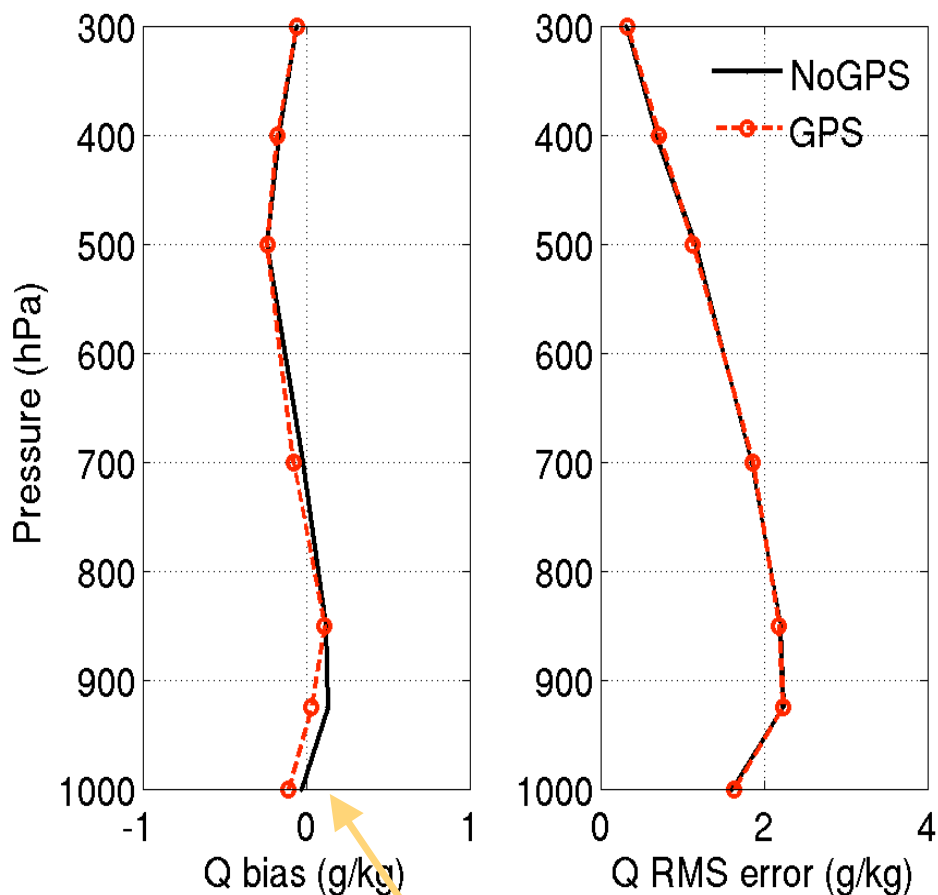
Difference of  
GPS - NoGPS

Stronger  
Northward flux



# Validation of Water Vapor 6-h Forecast over land

## Bias, rms error relative to radiosondes

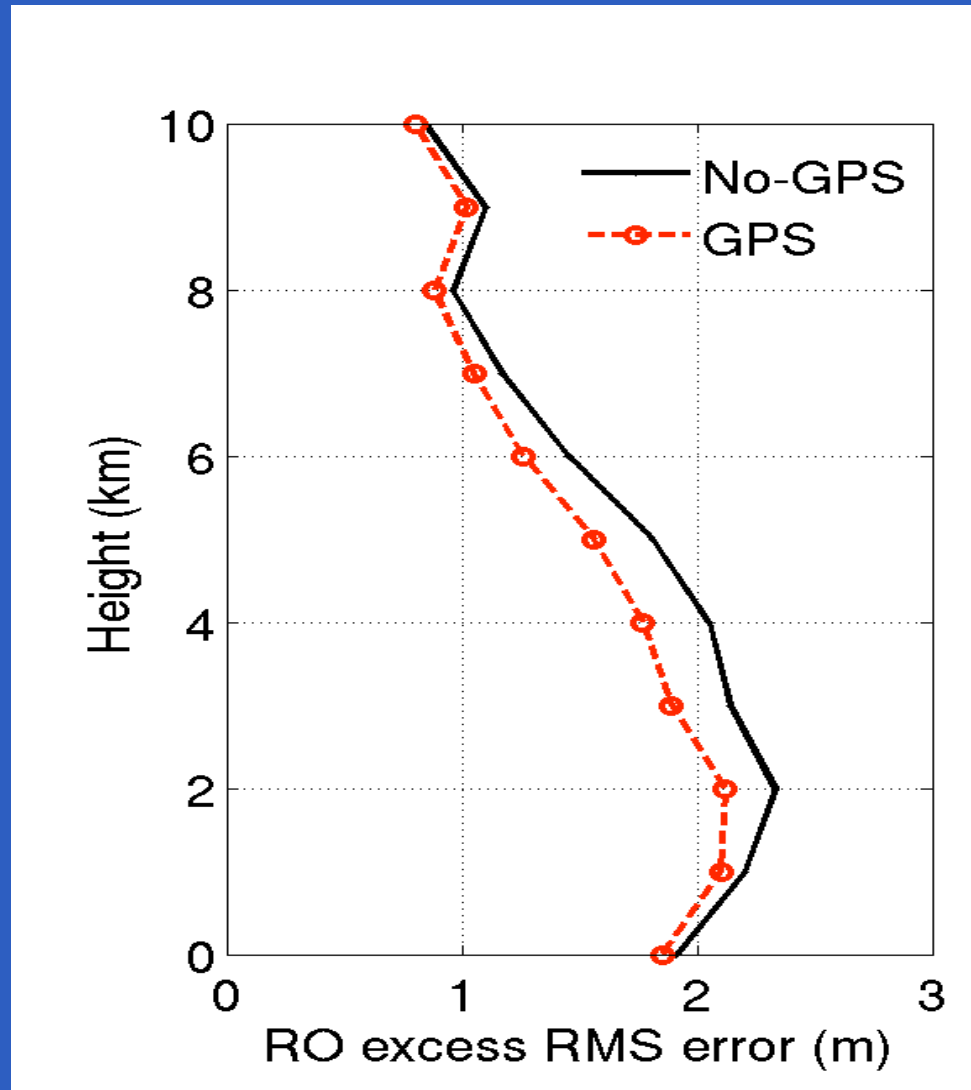


SURANJANA SAHA, GMB/EMC/NCEP/NWS/NDMA

The bias is even smaller than ECMWF & NCEP analyses

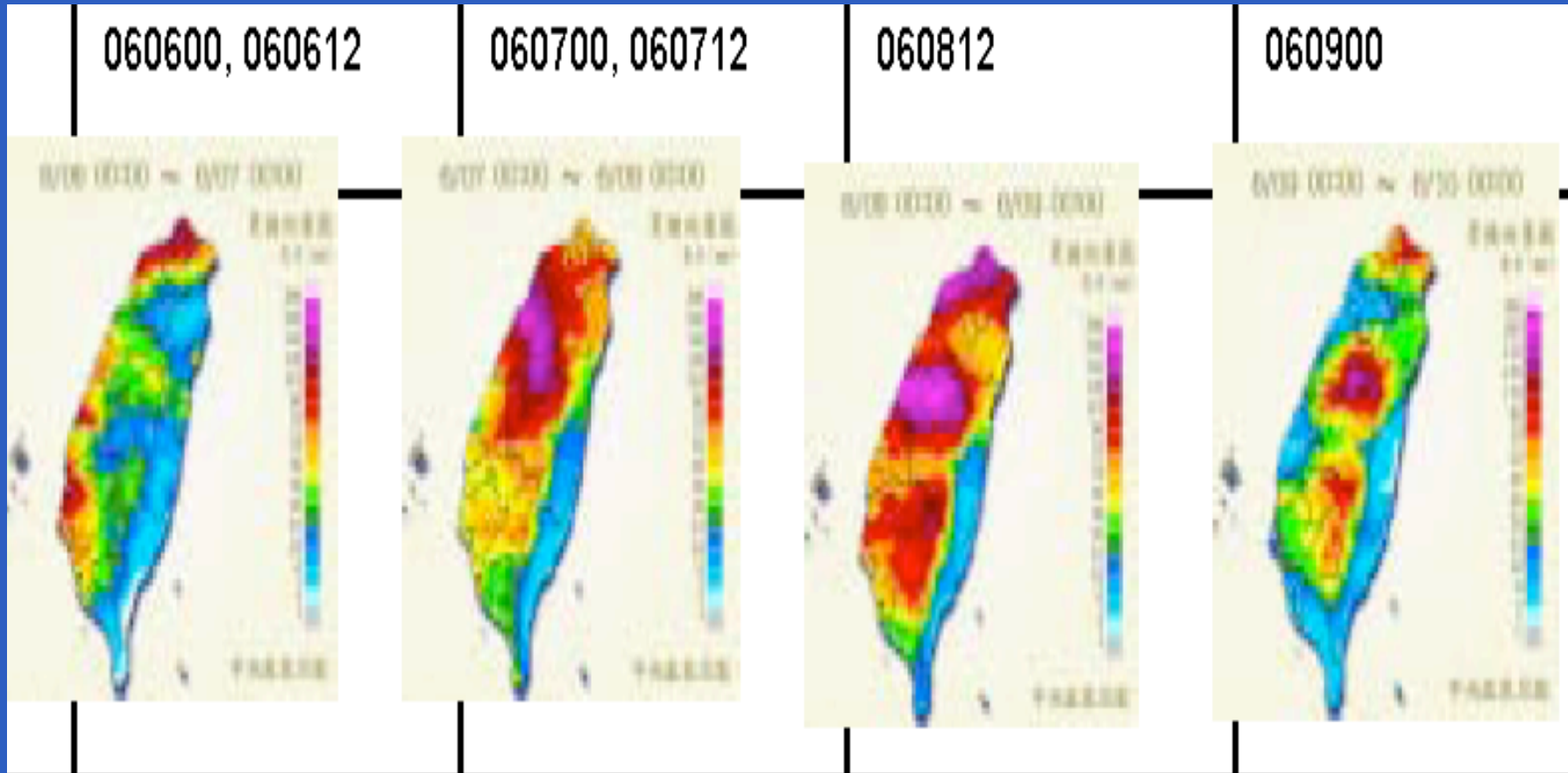
# Validation of 6-hour Forecast by RO Data

RMS error relative to RO soundings over **ocean and land**



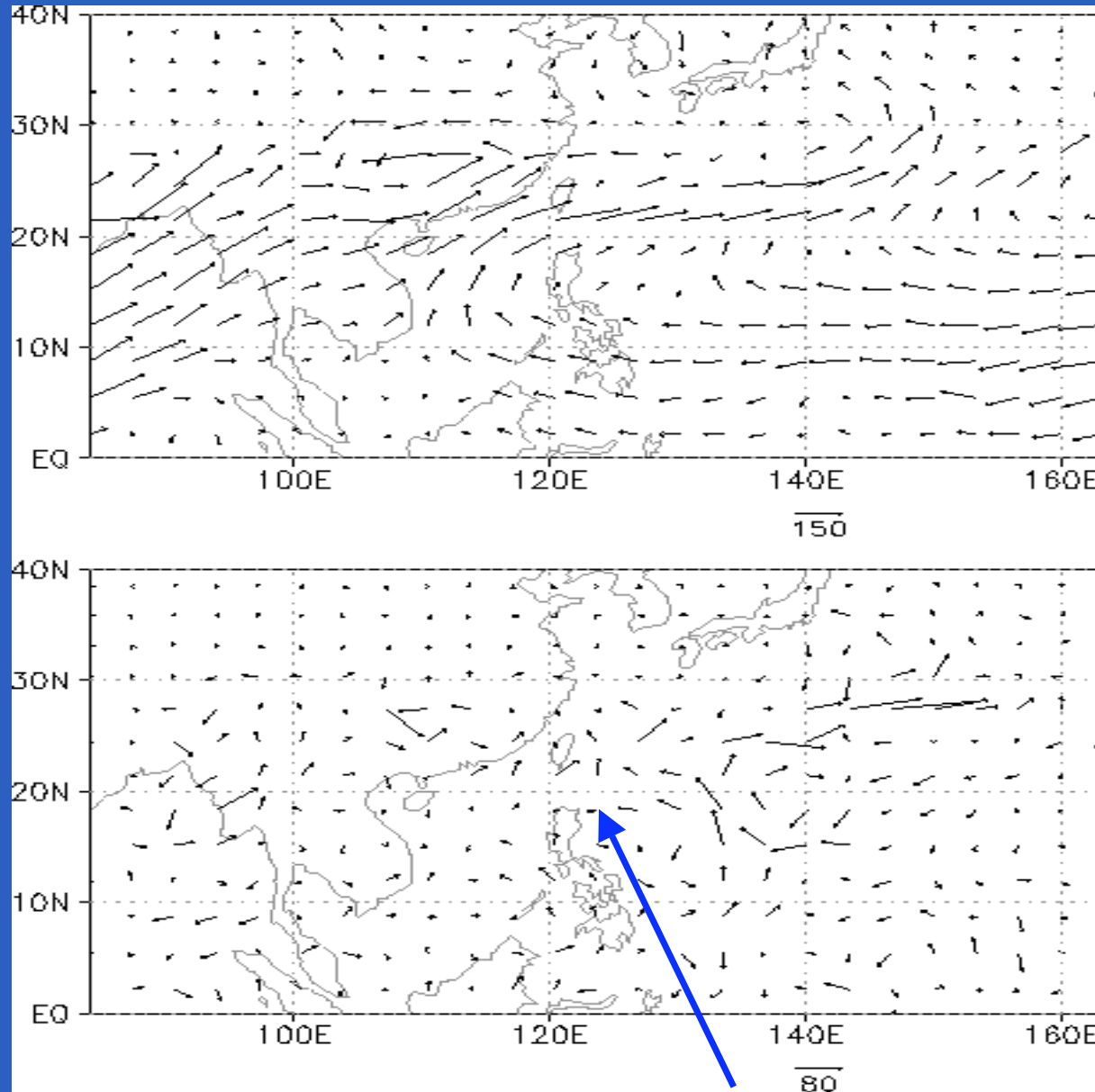
# “Mei-Yu” rainfall Case over Taiwan (June 6-9, 2007)

Accumulated gauge precipitation from Pilot SoWMEX



Heavy rainfall > 200mm/day on June 7 & 8, 2007

# Effect of RO data on 850 hPa Water Vapor Flux Analysis



GPS Analysis

June 8-9, 2007

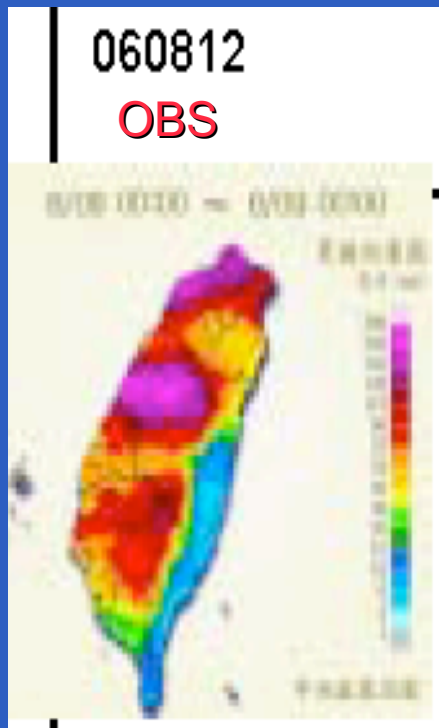
Time series??

Difference of  
GPS - NoGPS

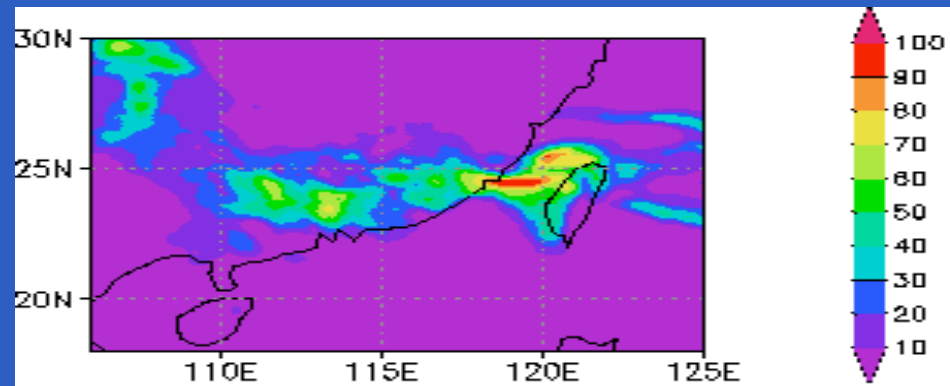
GPS RO shows enhanced flux from South & East to Taiwan

# Effect of RO data on 24-hour Prediction of Rainfall (12km grids)

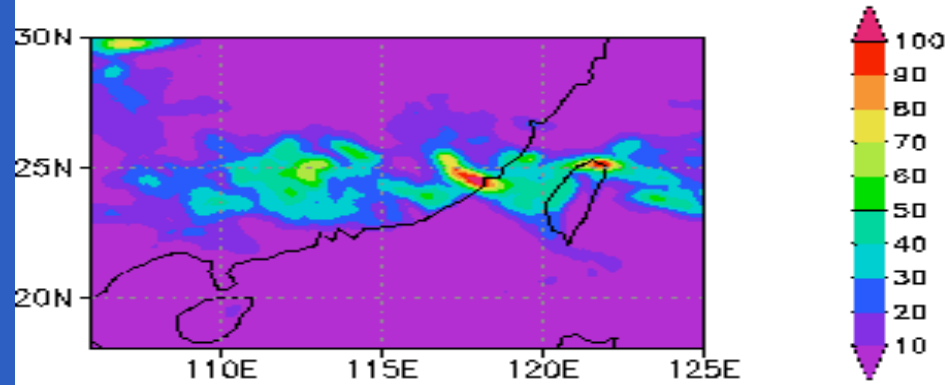
(00Z 8 - 00Z 9 June, 2007, unit: mm)



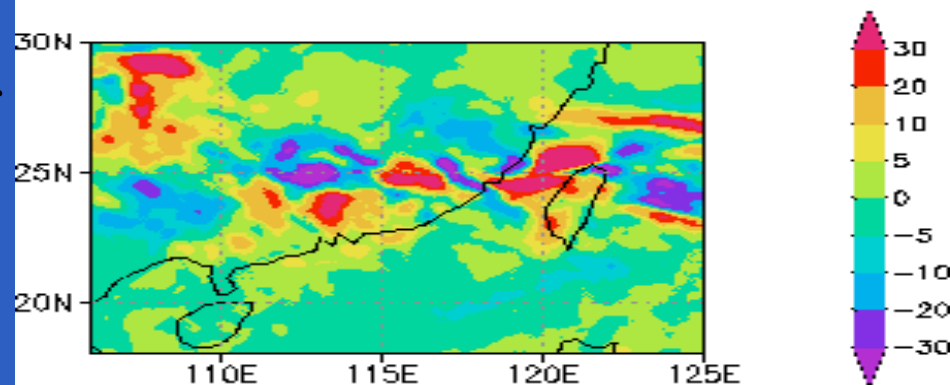
RO data increases forecast rainfall over Taiwan consistent with the SoWMEX observations



GPS Forecast  
(heavier rain)



NoGPS Forecast  
(underestimated)



Difference of  
GPS - NoGPS  
( $> +20\text{mm/day}$ )



# Conclusions

Assimilation of RO data has significant impact on :

- Analysis of the anti-cyclone and water vapor flux over the Western Pacific
- Prediction of the heavy “Mei-Yu” rainfall over southern part of Taiwan and nearby ocean