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

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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!
• 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)

RO data Enhances flux from Western Pacific toward Asia

GPS Analysis
June 1-14

Difference of GPS - NoGPS
Effect of RO data on Northward Water Vapor Flux

(Vertical Cross Section Along 20N, June 1-14)
Effect of RO data on Water Vapor at 850 hPa (1-14 June)

PV 850 mb

GPS Analysis

NoGPS Analysis

Difference of GPS - NoGPS

Stronger Northward flux
Validation of Water Vapor 6-h Forecast over land

Bias, rms error relative to radiosondes

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

![Graph showing comparison between RO excess RMS error (m) and height (km) for No-GPS and GPS scenarios.](image)
“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**
(> +20mm/day)

OBS
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