Impact of the Local Spectral Width of GPS RO Bending Angles from COSMIC on Typhoon Track Forecast

Ming-En Hsieh[1], Yu-Chun Chen[1], Hui Liu[2], Ling-Feng Hsiao[1], Lung-Yao Chang[1], Ching-Yuang Huang[1, 3]
[1] Taiwan Typhoon and Flood Research Institute [2] University Corporation for Atmospheric Research [3]National Central University

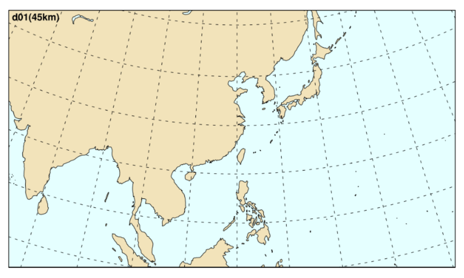
Introduction

- Global Positioning System (GPS) radio occultation (RO) data are beneficial for numerical weather prediction (NWP) due to the advantage of high vertical resolution, global coverage, all-weather sensing.
- The width of the local spectrum (LSW) of wave optics (WO) transformed signal represents the uncertainty of bending angles retrieved by WO and can be utilized to improve the assimilation of GPS RO data.

Model

Typhoon WRF (TWRF) Model

- Designed for typhoon forecast in the neighborhood of Taiwan (Hsiao et al. 2012)
- Fixed domain with $\Delta x = \Delta y = 45$ km, 45 vertical levels with model top at 30 hPa
- Using WRF-3DVAR and two 6-h update cycles (partial cycling) and then 72-h forecast
- GPS RO operator: local refractivity



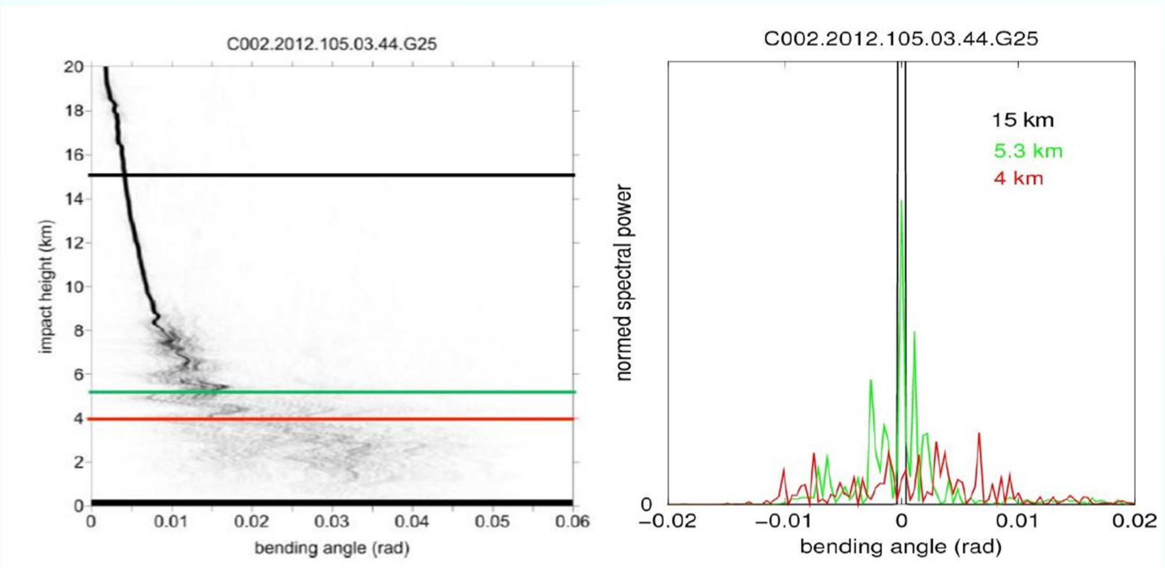
The 45-km domain (222 x 128) of TWRF.

Experimental Design

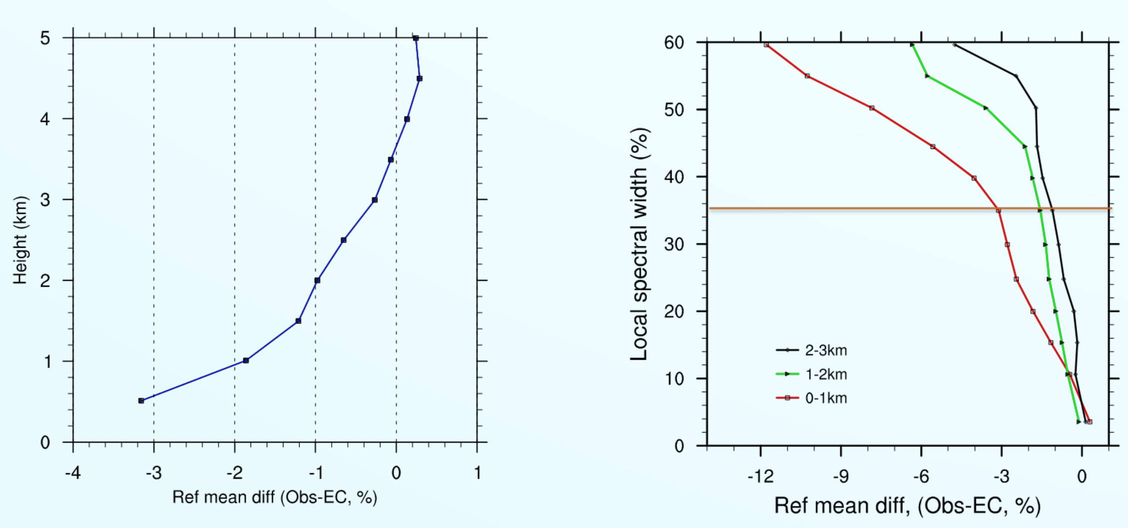
- I.C. & B.C. : NCEP GFS $0.5° \times 0.5°$ analysis
- Observation: GTS; COSMIC GPS RO data (wetPrf)
- Periods : Typhoon Sinlaku, Hagupit, Jangmi (09.08 18Z - 09.28 00Z) in 2008

Local Spectral Width

- The LSW is large in the lower troposphere.
- It causes larger retrieval uncertainty and larger biases against global analyses.



An example of retrieval uncertainty of the bending angle.



Mean difference between ECMWF 12-h forecasted and observed refractivity in the tropical in April, 2012.

Quality Control by LSW

- Replace the QC conditions in WRFDA by rejecting those RO data with LSW/2 lower than 35% at height below 3 km.

Dynamical Obs. Error by LSW

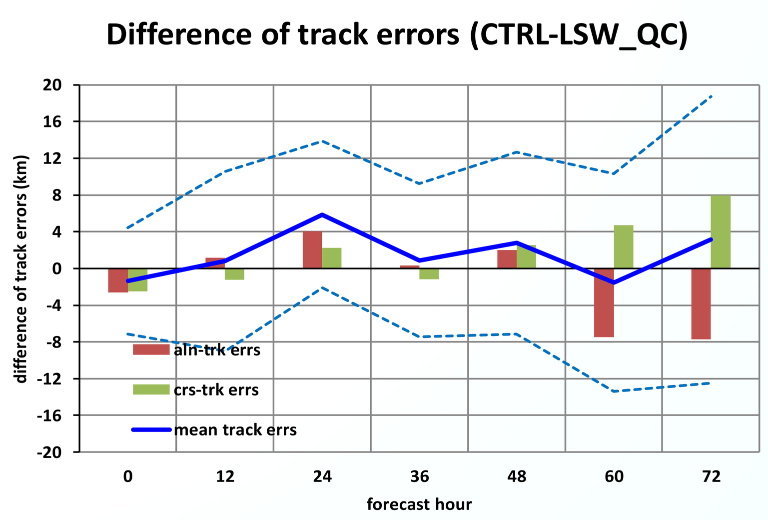
- Good correlation between observation error and LSW.
- Use linear regression formulas at height below 6 km.

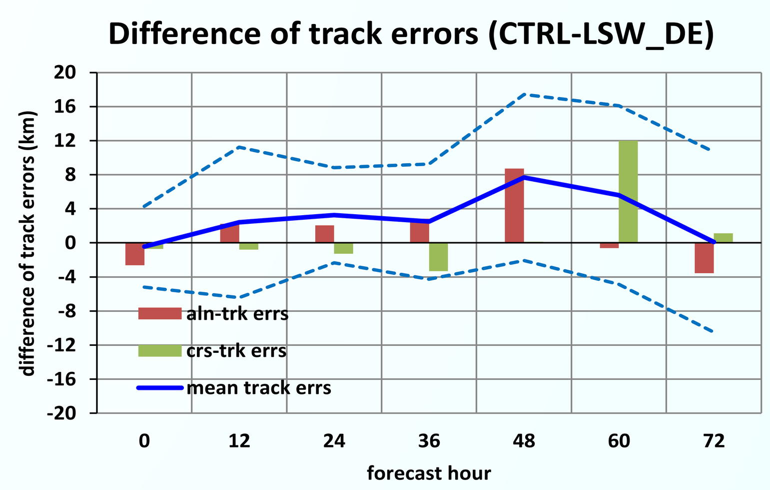
RO N error = *coef1* × LSW/2 + *coef2*

Height (km)	Coef1	Coef2
1	0.15	0.53
2	0.12	0.58
3	0.14	0.50
4	0.17	0.38
5	0.20	0.38
6	0.25	0.37

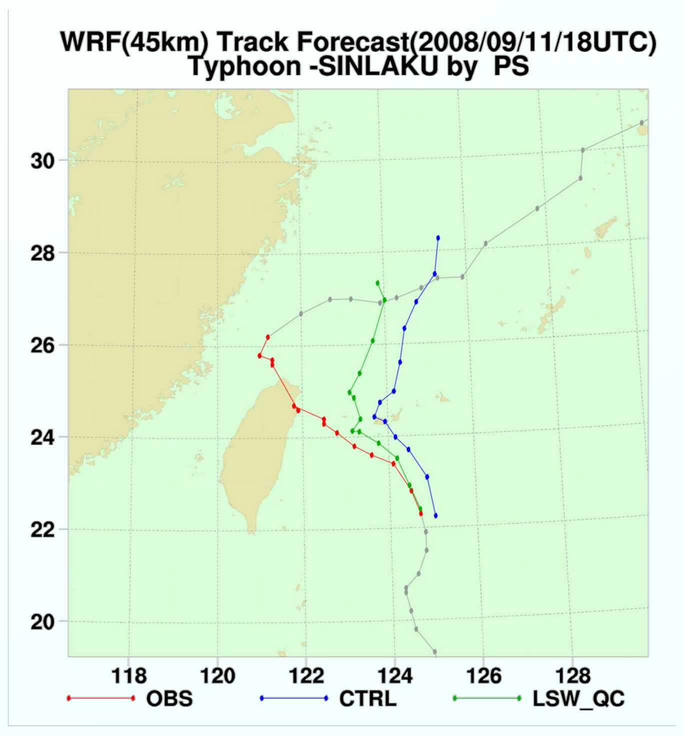
Results

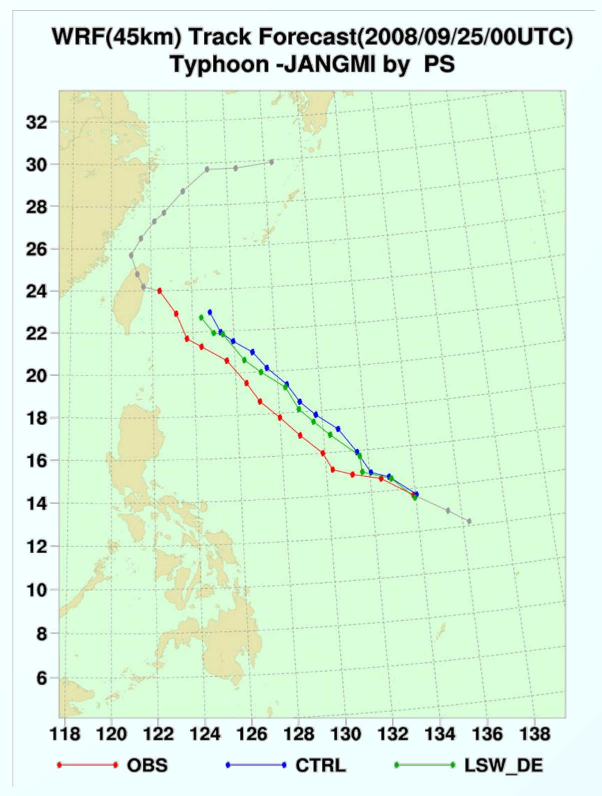
- Mean track error difference from CONTROL run





- Examples





Reference

Chen, Y.-C., M.-E. Hsieh, L.-F. Hsiao, Y.-H. Kuo, M.-J. Yang, C.-Y. Huang, and C.-S. Lee, 2015: Systematic evaluation of the impacts of GPSRO data on the prediction of typhoons over the northwestern Pacific in 2008–2010, *Atmos. Meas. Tech.*, 8, 2531-2542.

Hsiao, L.-F., D.-S. Chen, Y.-H. Kuo, Y.-R. Guo, T.-C. Yeh, J.-S. Hong, C.-T. Fong, and C.-S. Lee, 2012: Application of WRF 3DVAR to operational typhoon prediction in Taiwan: impact of outer loop and partial cycling approaches, *Wea. Forecasting*, 27, 1249-1263.

Kuo, Y.-H., H. Liu, S. Sokolovskiy, Z. Zeng, and B. Ruston, 2014: A physically based data QC procedure and its impact on the assimilation of GPS RO observations in the tropical lower troposphere, "Eighth FormoSat-3/COSMIC Data Users' Workshop," Boulder, CO, USA, Sept. 30-Oct. 2, 2014.

Schreiner, W., S. Sokolovskiy, D. Hunt, C. Rocken, and Y.-H. Kuo, 2011: Analysis of GPS radio occultation data from the FORMOSAT-3/COSMIC and Metop/GRAS missions at CDAAC, *Atmos. Meas. Tech.*, 4, 2255-2272.