

Assimilation impact of the FORMOSAT-7/COSMIC-2 GNSS radio occultation data with the CWB Global Forecast System

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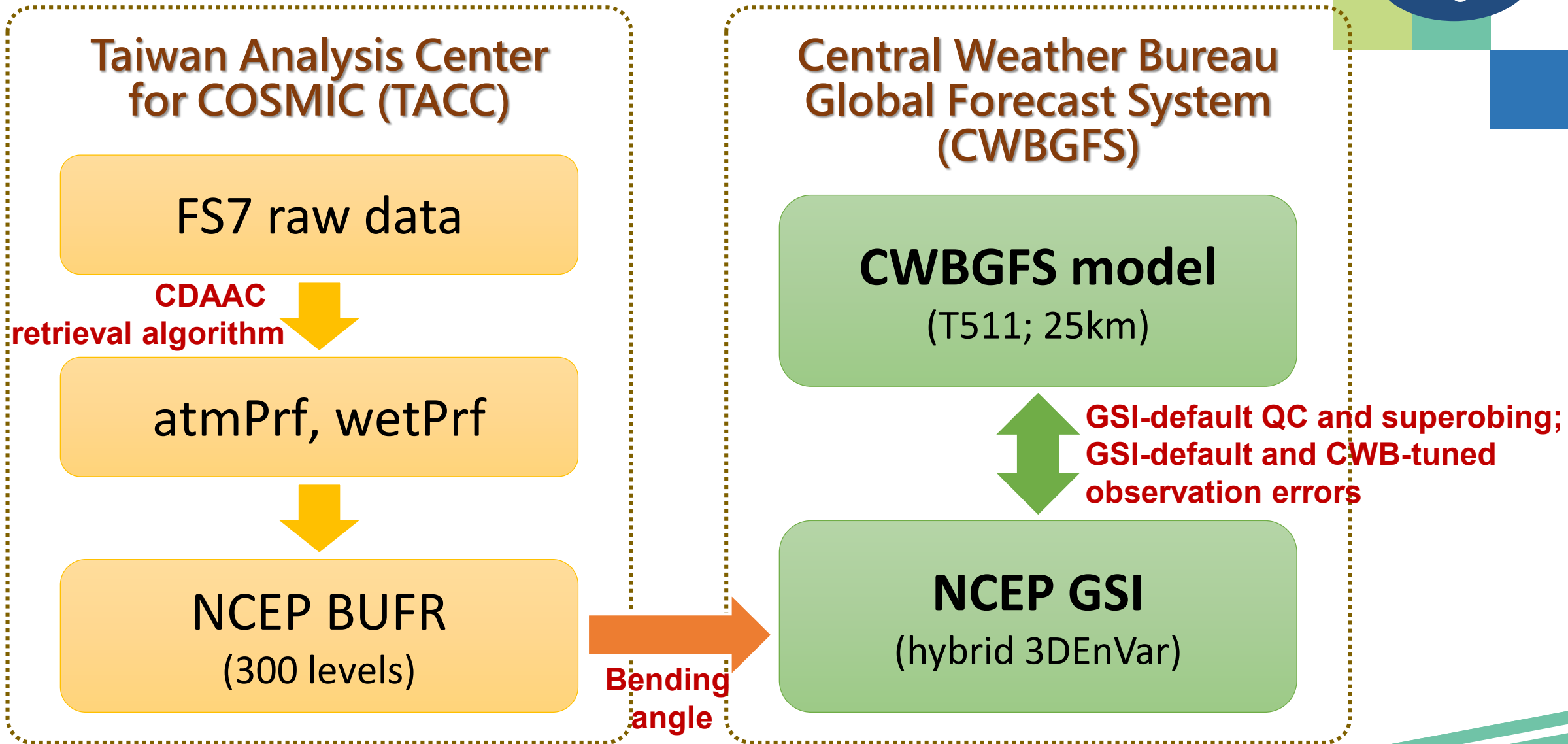
109年天氣分析與預報研討會

Outline



- The results from the parallel semi-operational experiment (August 2019 ~ February 2020)
 - Innovation statistics
 - Impact of the global forecast
 - EFSOI estimated data impact
- Impact of the low-level (< 4 km impact height) RO data
- Summary

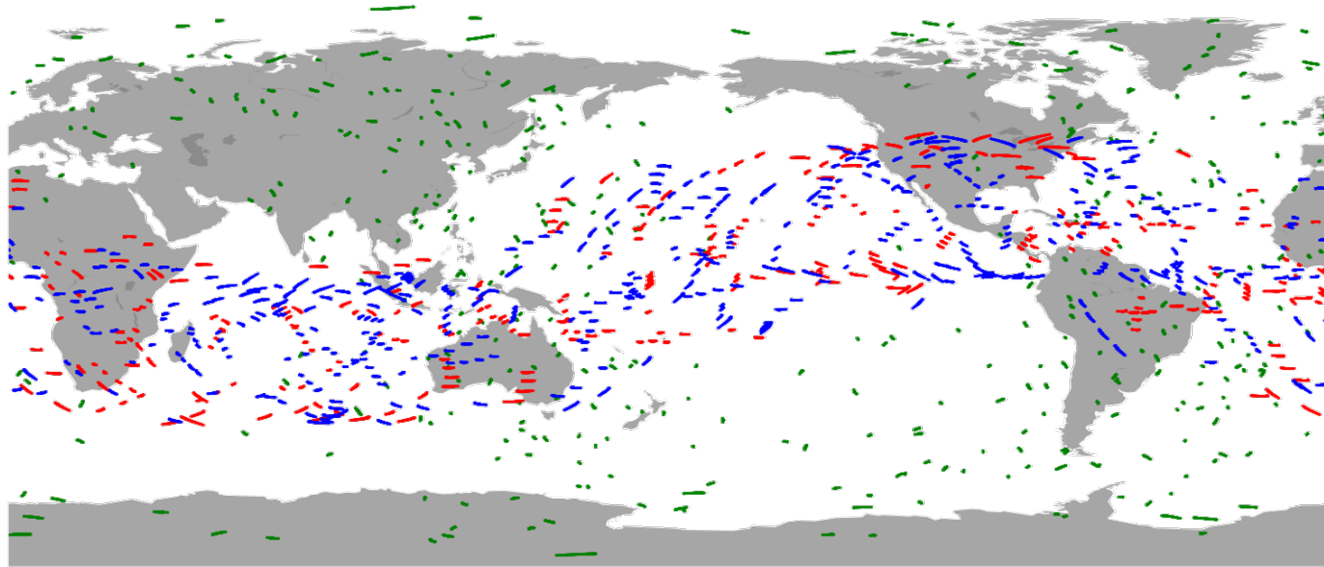
FORMOSAT-7/COSMIC-2 data for NWP at CWB



Data distribution status for NWP at CWBGFS

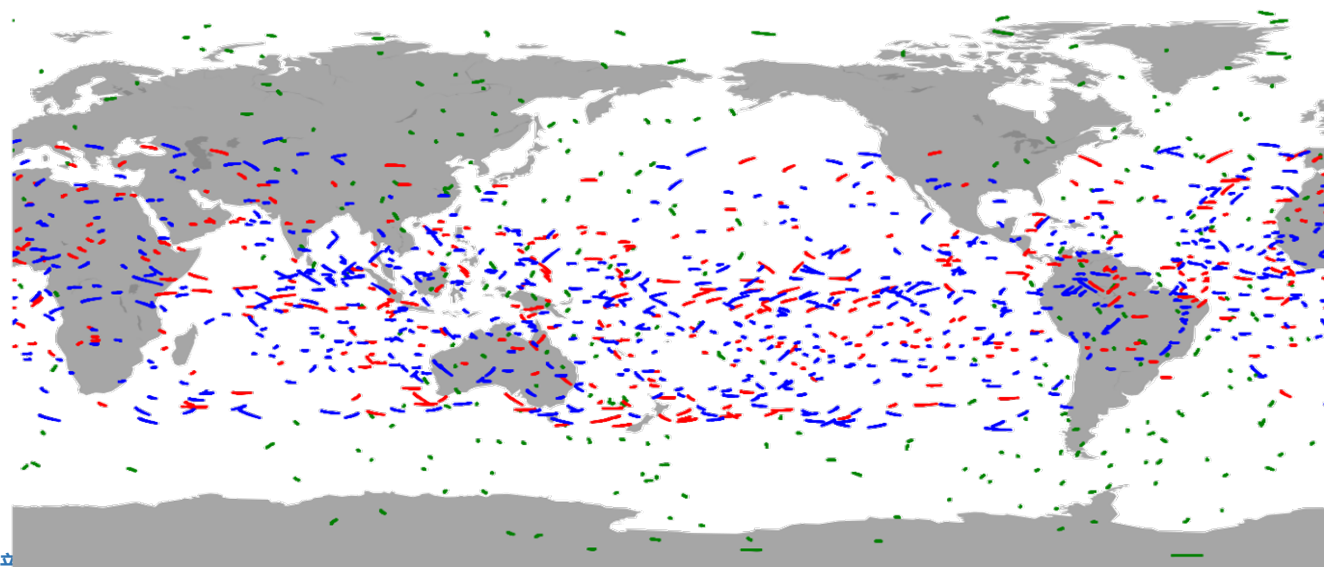


2019092412 GPS Radio Occultation Assimilated



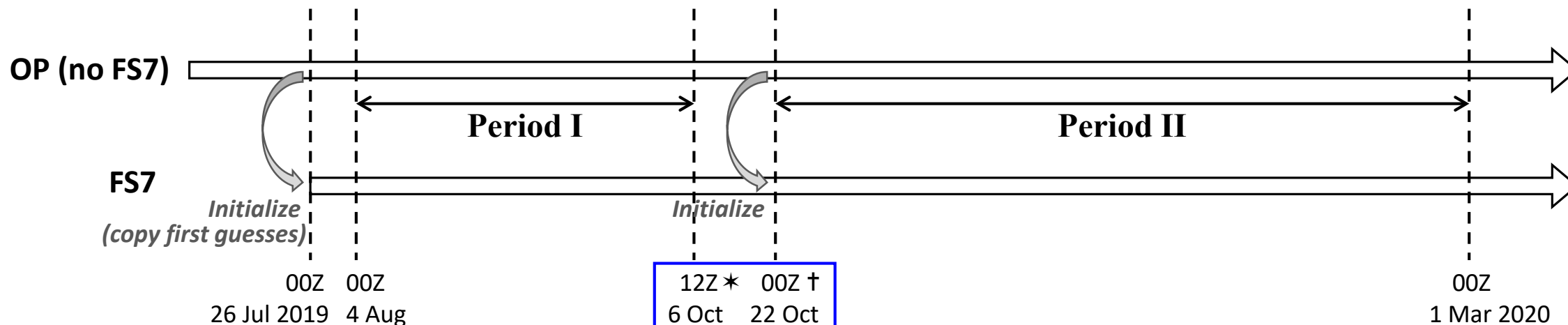
福衛七號 175,138(GPS、GLONSS)
102,238、72,900
其他衛星 81,163 ●

2020051012 GPS Radio Occultation Assimilated



福衛七號 241,970(GPS、GLONSS)
153,226、88,564
其他衛星 48,824 ●

CWBGFS operational (OP) and parallel semi-operational experiment (FS7)



* Adjust RO obs errors in FS7, reject <4 km impact height FS7 data
† Adjust RO obs errors in OP

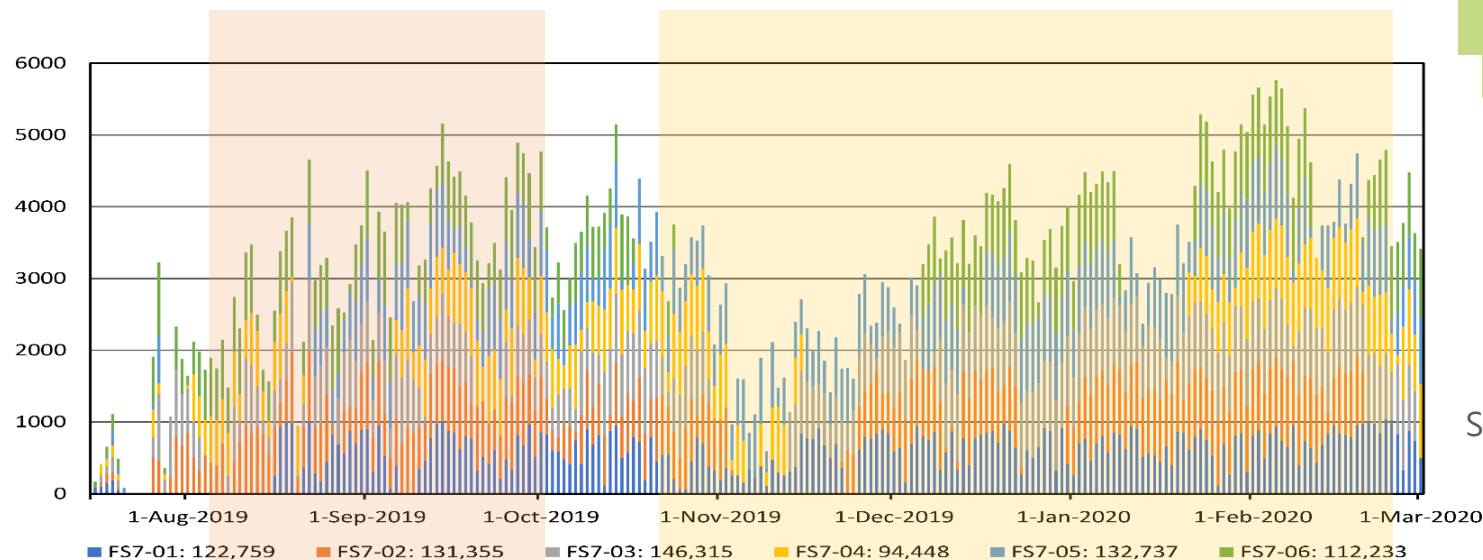
[A2-15]

- The estimation and sensitivity of GNSS-RO bending angle observation errors in the GSI hybrid data assimilation system (黃子茂)

Daily data count and assimilation impact

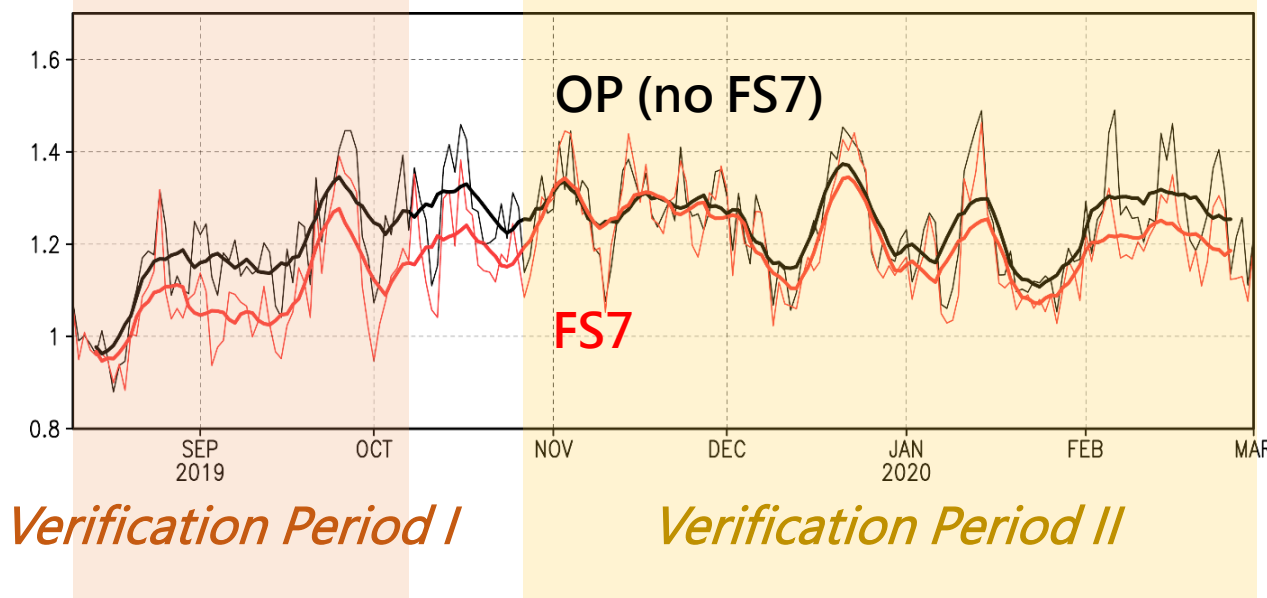


Daily counts of FS7/C2 RO profiles



Supplied by TACC

5-day forecast errors of tropical 500-hPa temperature (lower is better)



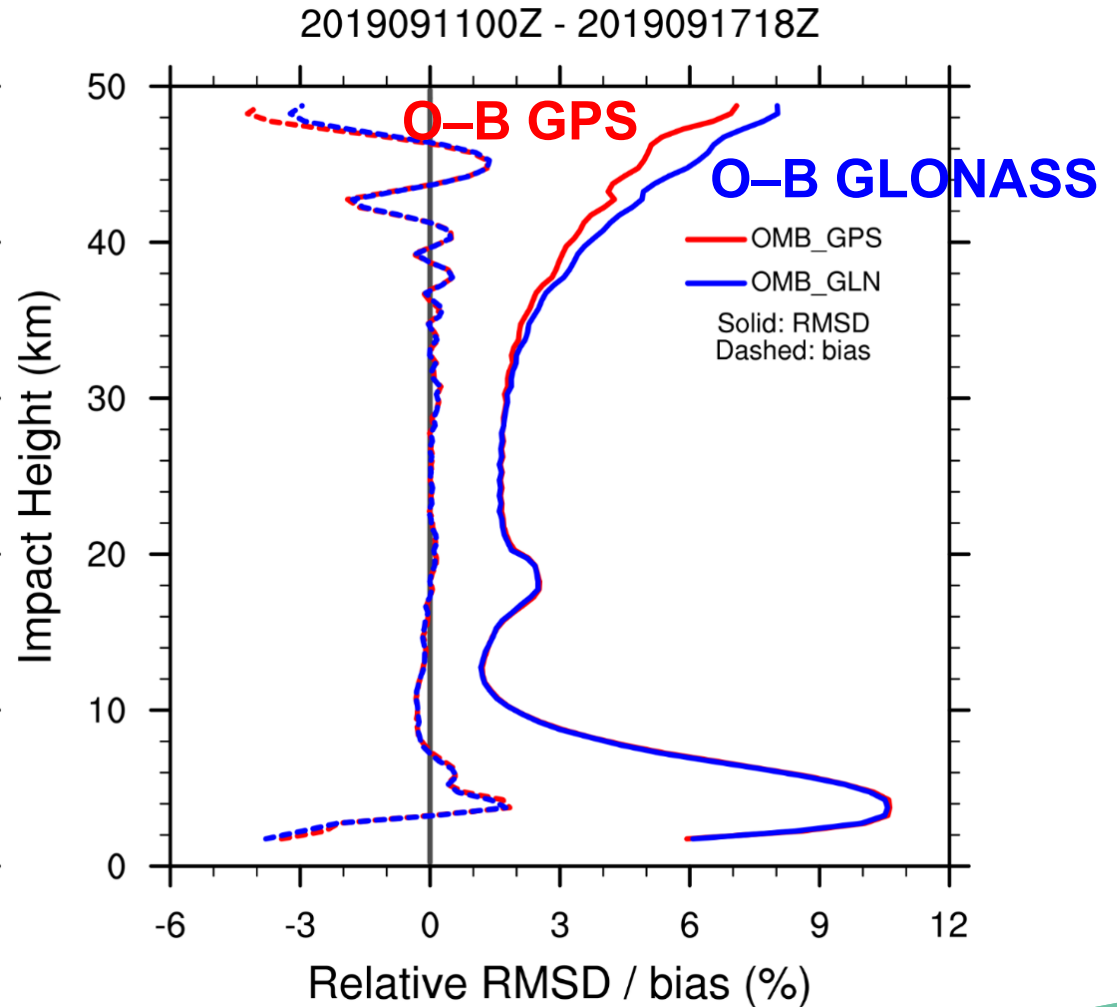
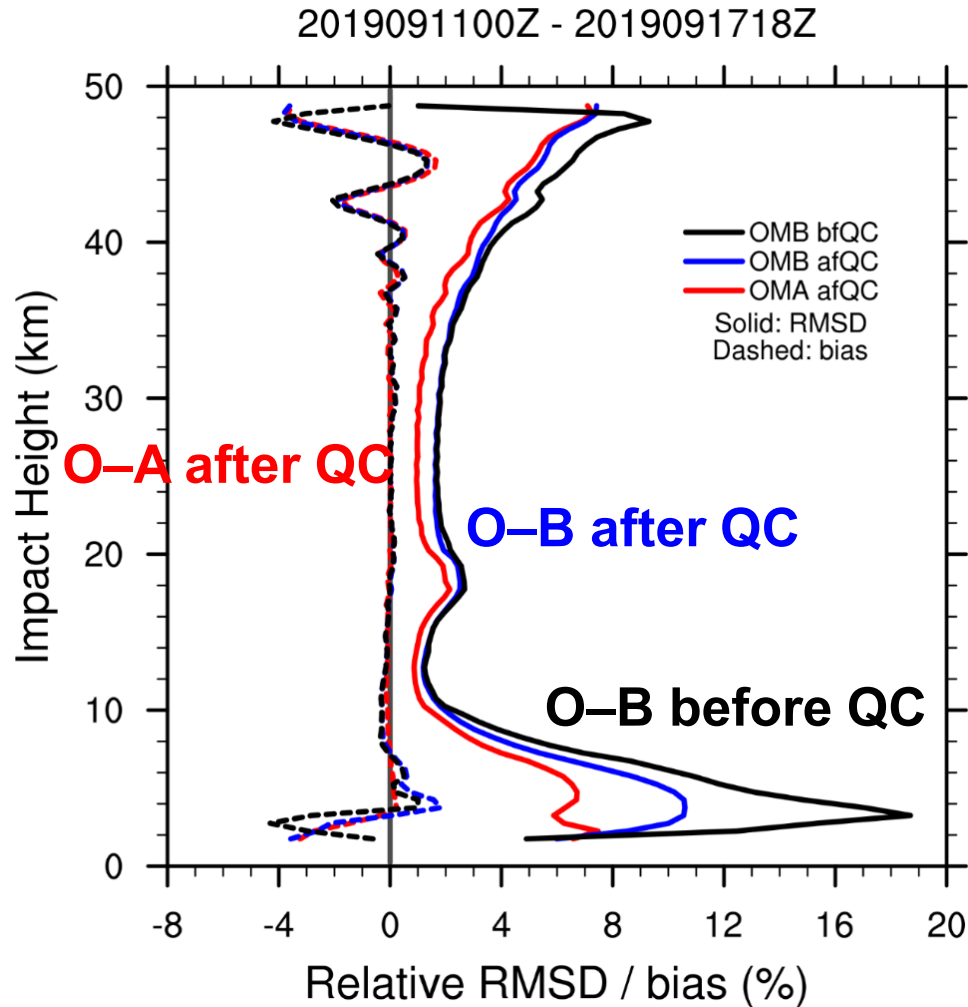
Verified against the NCEP analysis

Innovation statistics (O-B, O-A; bending angle)



ALL

GPS vs. GLONASS



Impact to the global forecast

— verified against the NCEP analysis

Significant positive impact in tropics; neutral-to-positive impacts in other regions

With two different observation error settings (Periods I and II), similar positive impacts are obtained.



Scorecards –

Green/Red :
FS7 is better/worse
than OP

RMSE

Bias

▲	Better at 99.9% significance level
▲	Better at 99% significance level
▲	Better at 95% significance level
□	Not statistically significant
▼	Worse at 95% significance level
▼	Worse at 99% significance level
▼	Worse at 99.9% significance level
□	Not applicable

Period I **Tropics**

		Globe				N. Hemisphere				S. Hemisphere				Tropics						
		Day 1	Day 3	Day 5	Day 7	Day 1	Day 3	Day 5	Day 7	Day 1	Day 3	Day 5	Day 7	Day 1	Day 3	Day 5	Day 7			
Anomaly Correlation	Height	250hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		500hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		700hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		1000hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
	Vector Wind	250hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		500hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		700hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		850hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
	Temp	250hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		500hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		700hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		850hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲

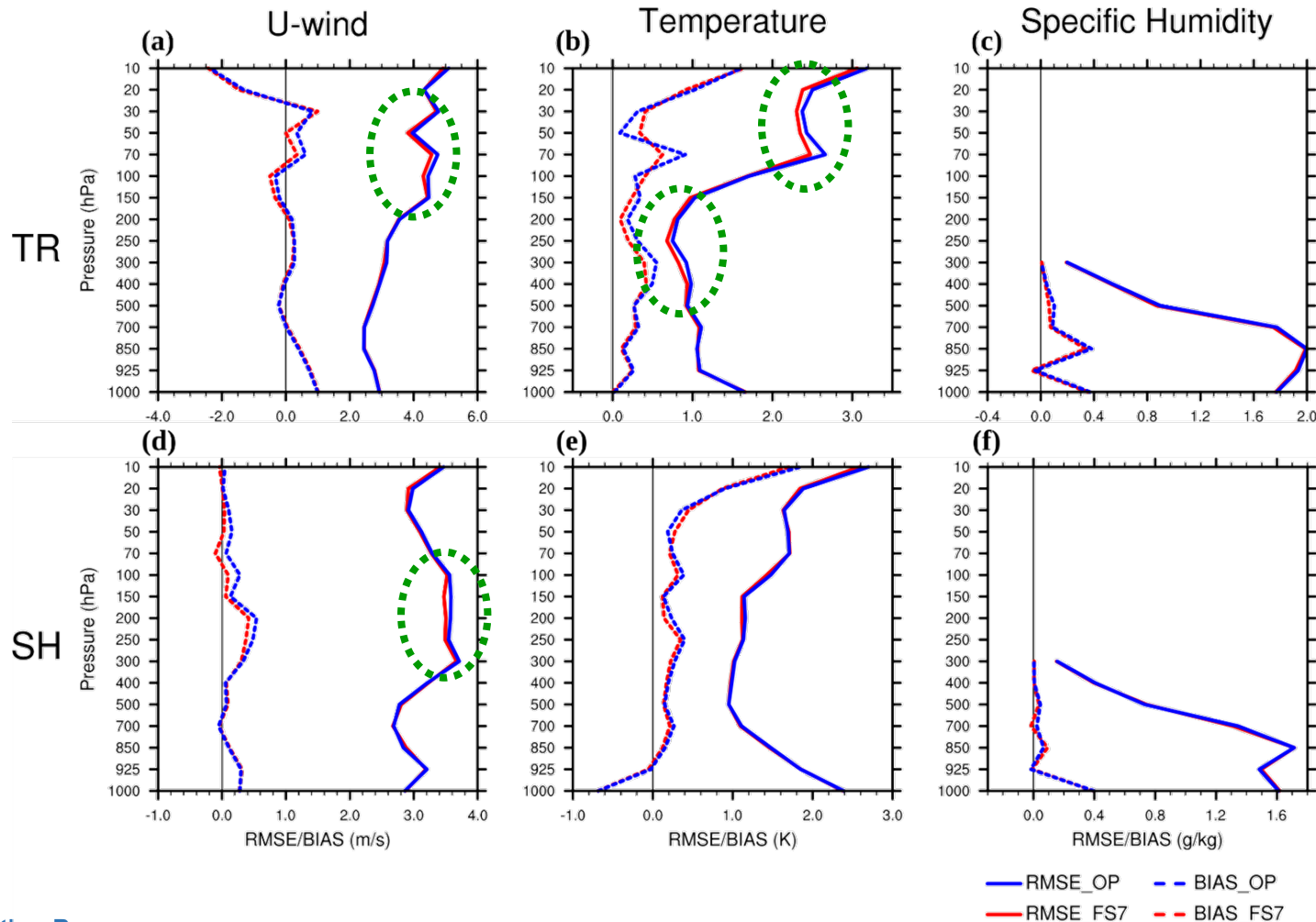
Period II **Tropics**

		Globe				N. Hemisphere				S. Hemisphere				Tropics						
		Day 1	Day 3	Day 5	Day 7	Day 1	Day 3	Day 5	Day 7	Day 1	Day 3	Day 5	Day 7	Day 1	Day 3	Day 5	Day 7			
Anomaly Correlation	Height	250hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		500hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		700hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		1000hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
	Vector Wind	250hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		500hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		700hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		850hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
	Temp	250hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		500hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		700hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		850hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲

Impact to the global forecast

— verified against radiosonde observations

Clear positive impacts of the fit to tropical radiosonde temperature over the lower stratosphere and upper troposphere; For winds, positive impacts are seen near the jet level.

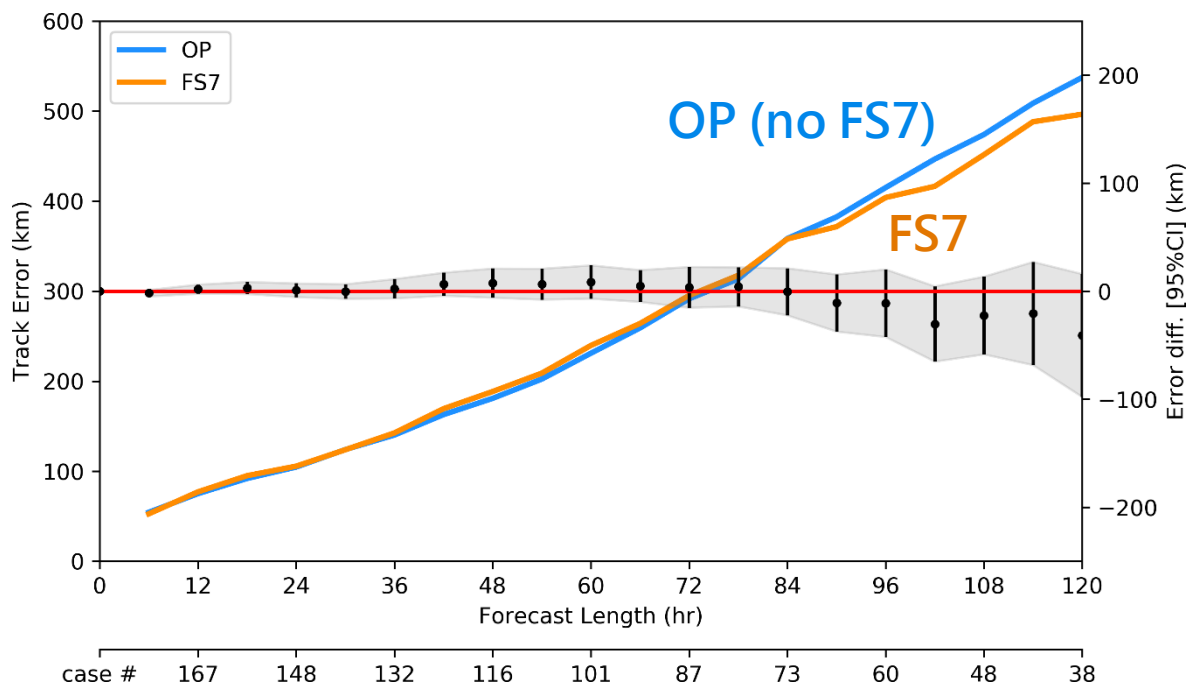


Impact to typhoon track forecast

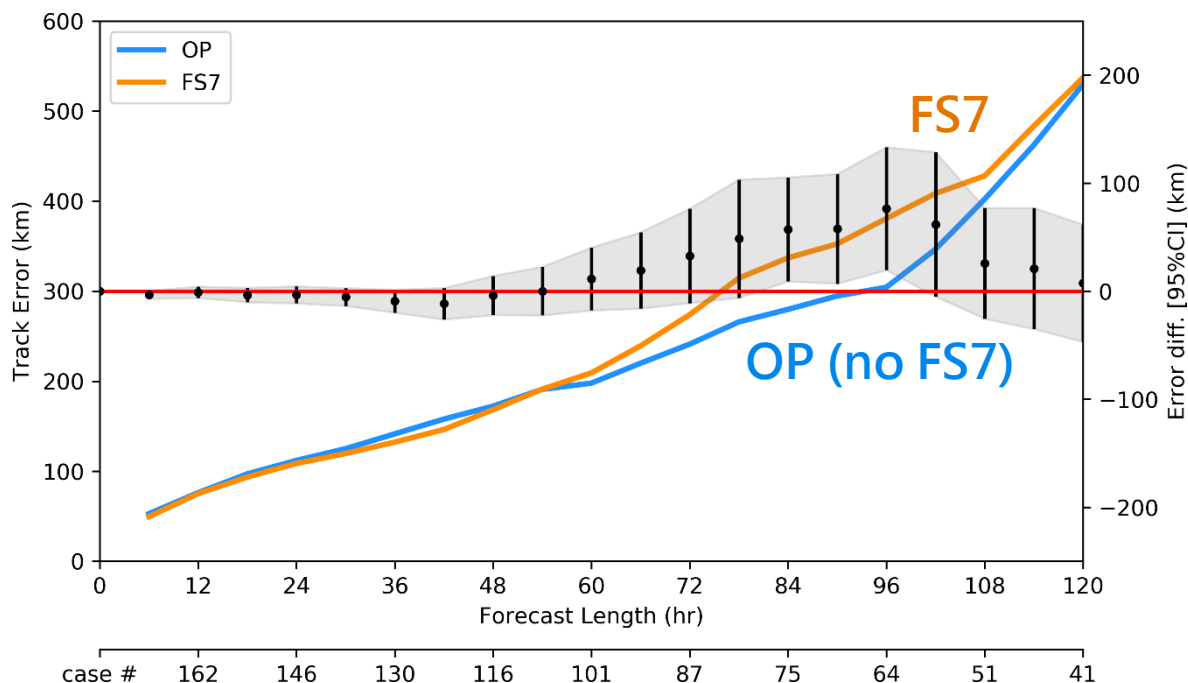


Mixed results, statistically insignificant at most of forecast times

Average track forecast errors – *Period I* (10 typhoons)



Average track forecast errors – *Period II* (8 typhoons)



EFSOI estimated data impact

— comparison to other data assimilated in the CWBGFS system

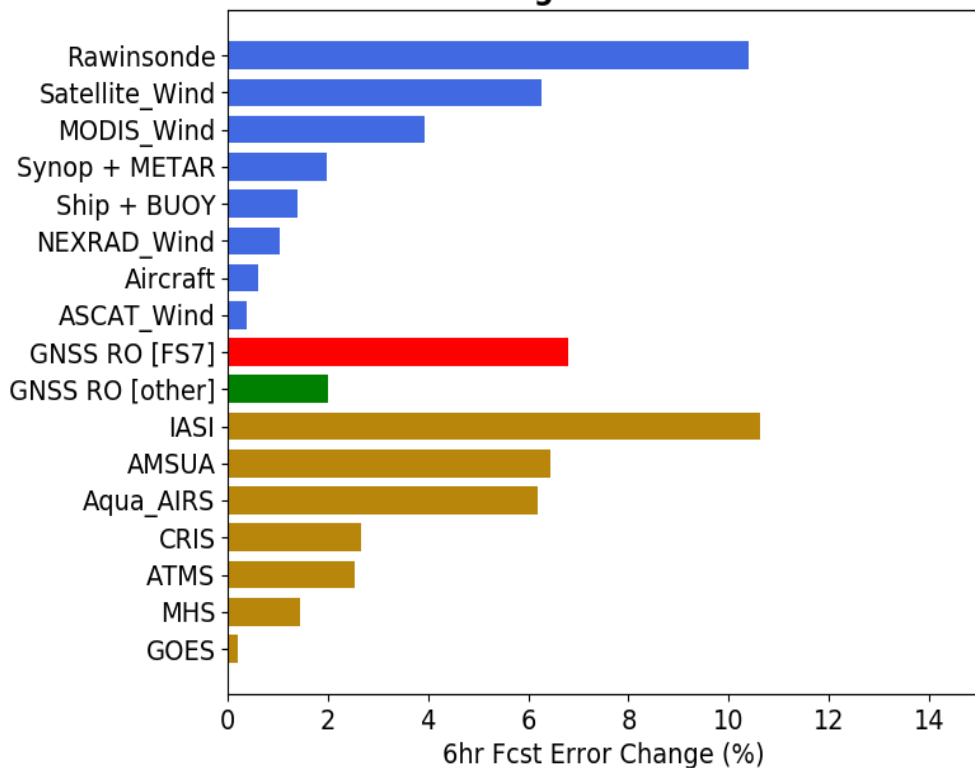


FS7/C2 GNSS RO data contributes to about 6~8% of the total impact of all assimilated data.

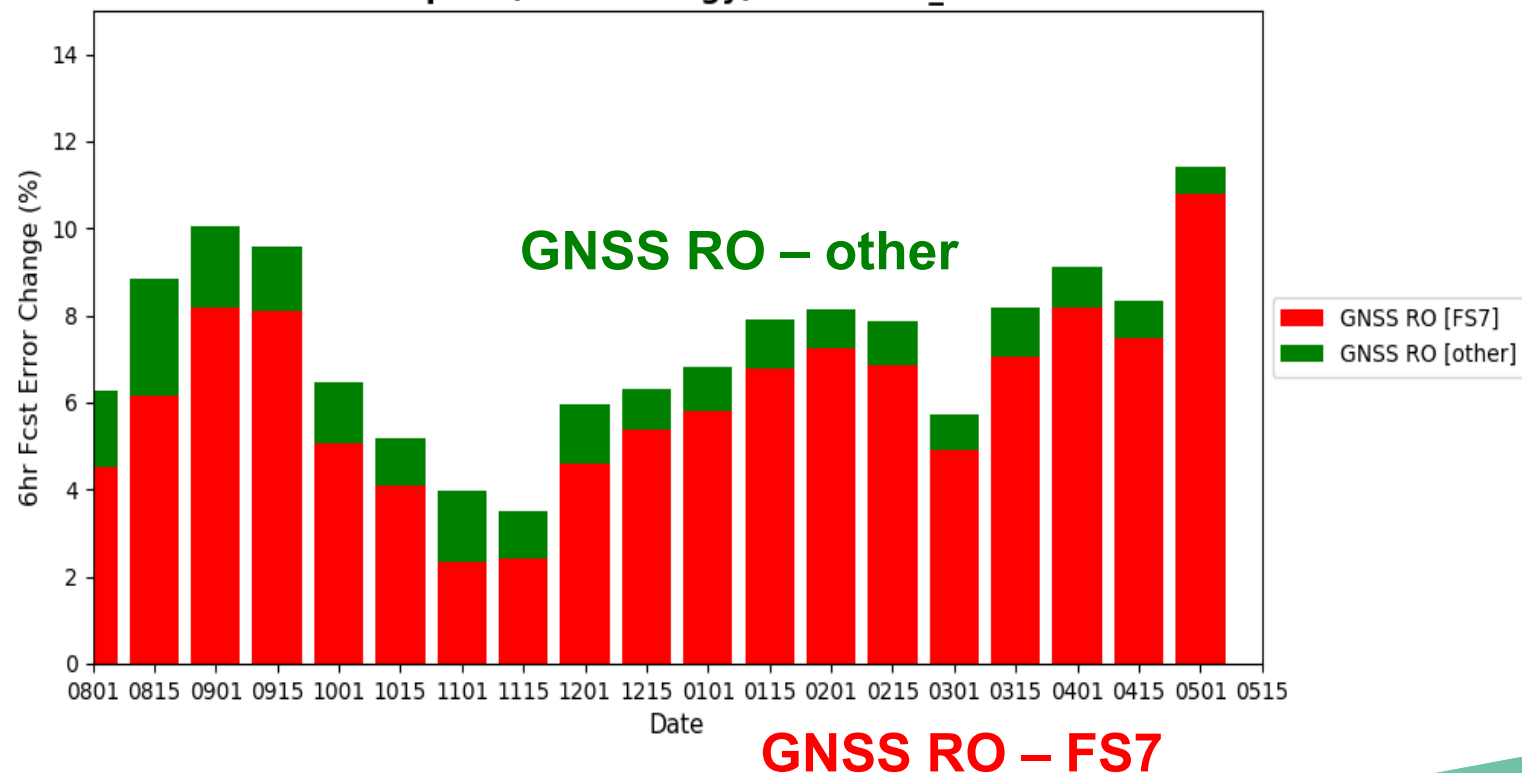
Period I

Aug 2019 – May 2020 (each 1/2-month interval)

Average Total EFSOI



Total Impact (Moist energy) in 201908_202005

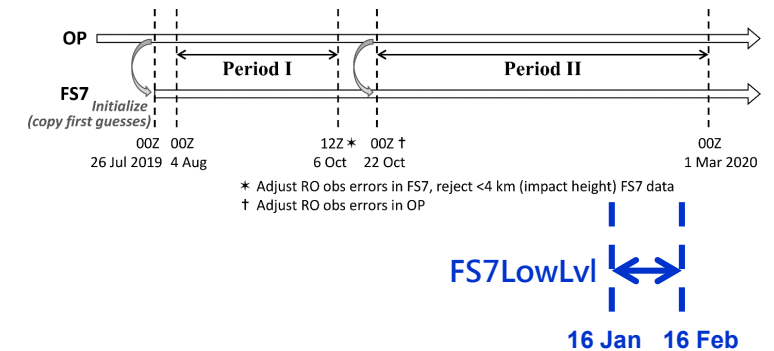


Impact of the low-level height threshold

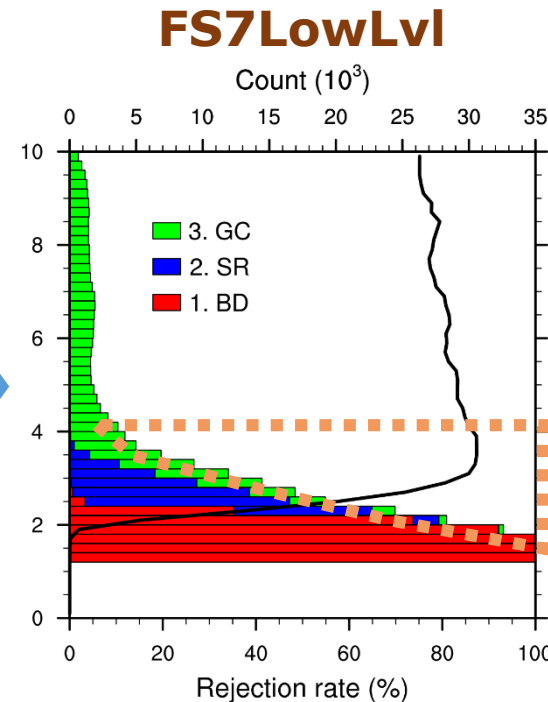
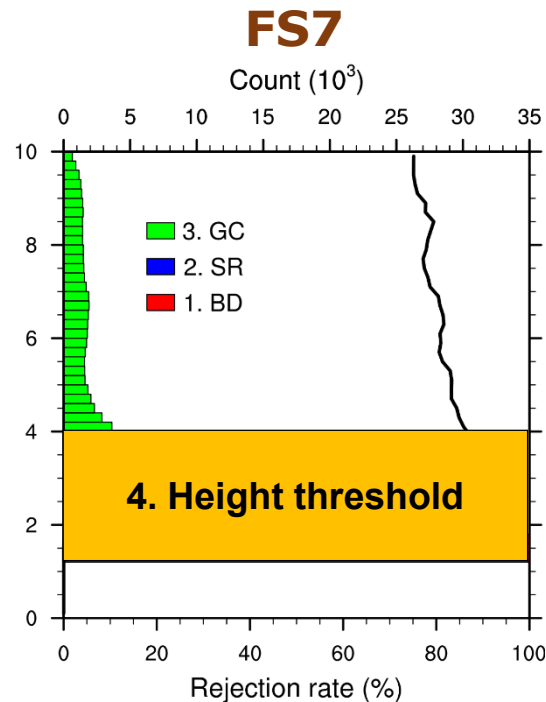


An additional experiment is conducted for a one-month period within Period II. (16 January to 16 February 2020)

Experiment name	Obs errors for RO data	Low-level height threshold QC for FS7/C2 RO data
FS7	CWB estimated	4 km (impact height)
FS7LowLvl	CWB estimated	No



QC rejection rates of FS7/C2 data



- 3. GC: Gross error check
- 2. SR: Super-refraction check
- 1. BD: Out-of-model-boundary check

Summary



- Results from the parallel semi-operational experiment (~7 months) with CWBGFS / GSI:
 - O-B, O-A characteristics similar to other existing RO data (both GPS and GLONASS).
 - Significant positive impact in all variables in tropics.
 - Neutral-to-positive impacts in other regions.
 - Mixed results for the typhoon track forecasts (but is understandable).
 - The EFSOI estimated impact of FS7/C2 RO data is impressive (6~8 % of the total assimilation impact).
- Use of the low-level RO data:
 - It seems not necessary to impose a strict height threshold for low-level FS7/C2 data. The default QC built in GSI can already function well.
- The FS7/C2 RO data have been operationally used in CWBGFS since 15 September 2020.
- Lien, G.Y. et al, 2020: Assimilation impact of early FORMOSAT-7/COSMIC-2 GNSS radio occultation data with Taiwan's CWB Global Forecast System. Submitted to



Innovation statistics - FS7 vs. FS3

LAT: -50 to 50 FS7: 13669862 FS3: 660190

