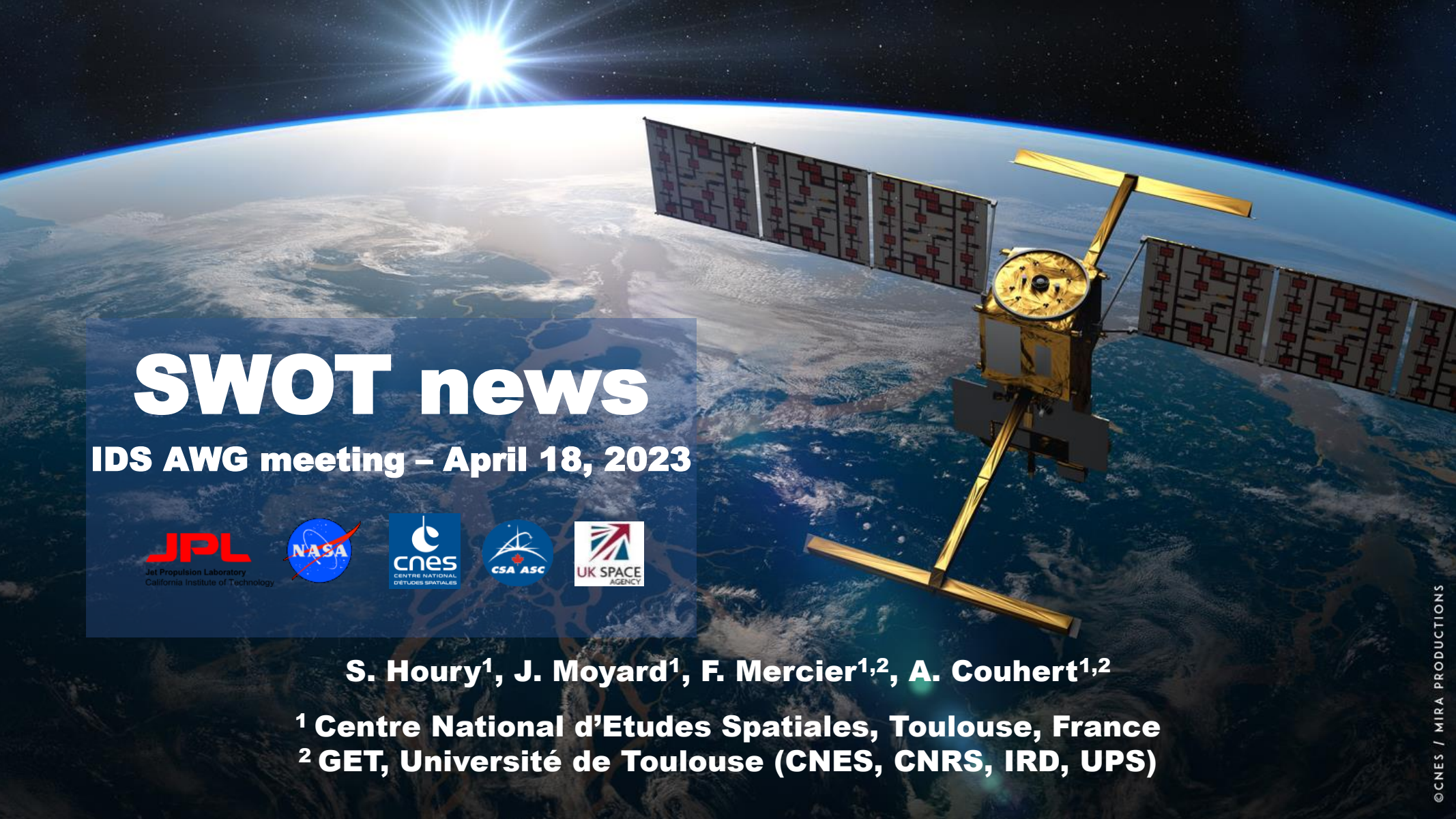

SWOT news

IDS AWG meeting – April 18, 2023

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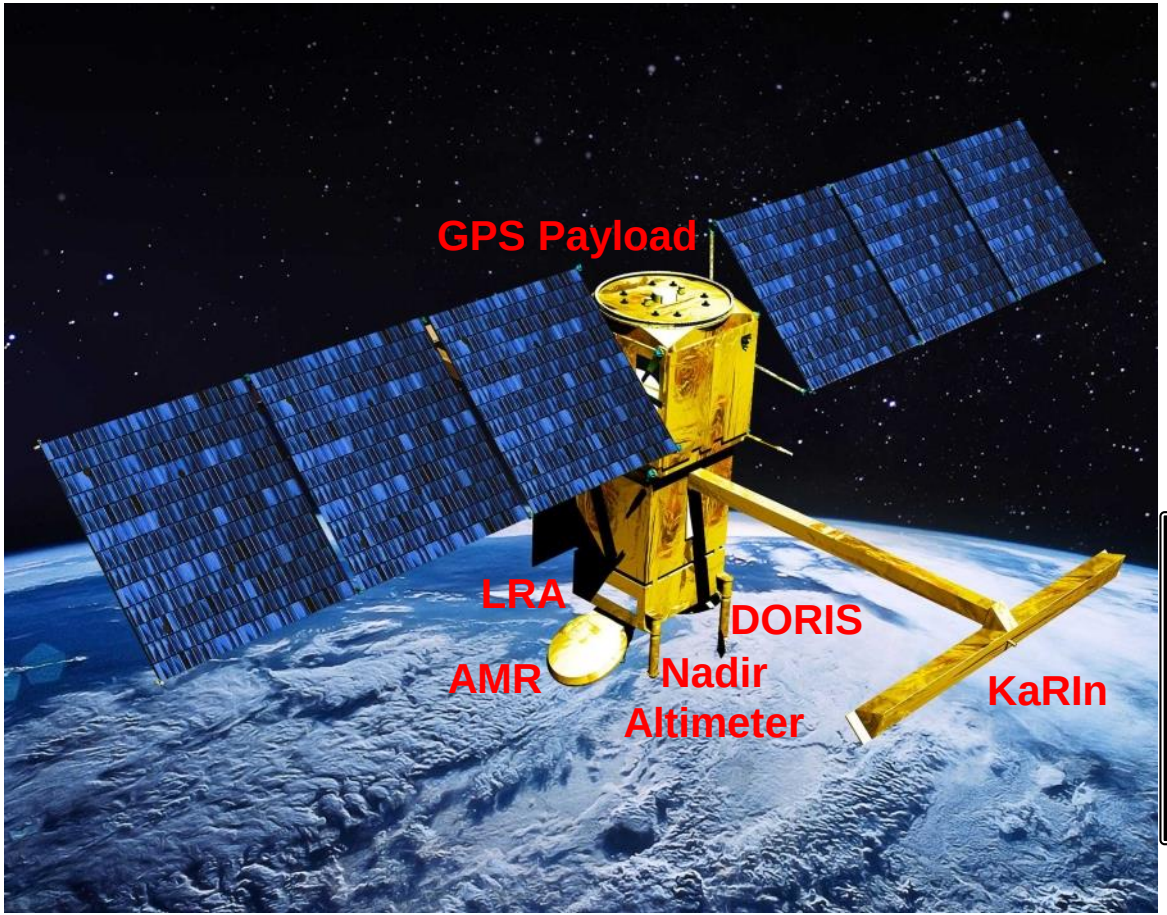
SWOT measurement system

Global survey of terrestrial surface water and how water bodies on Earth change over time.



Ka-band SAR interferometric system for heights and co-registered all-weather imagery

Calibration orbit:
857 km, 77.6° Incl., 1-day repeat.
Science orbit:
891 km, 77.6° Incl., 21-day repeat.

Conventional Jason-class altimeter for Nadir coverage, radiometer for wet-tropospheric delay, and DORIS/GPS/LRA for POD.

POD requirements

Lower than expected noise of KaRIn => POD error budget is even more critical.

Ocean SSH Long-Wavelength Budget & CBE

Ocean Error Component	Allocation [cm]	Height Error CBE [cm]	Comments
Ionosphere signal	0.5	0.2	Based on Jason heritage Ku/C ionospheric residual error after filtering
Dry troposphere residual	0.7	0.7	RMS after correction with models, based on Jason heritage
Wet Troposphere residual	1.2	0.76	Based on AMR and Wet tropo algorithm analysis. Includes sampling and retrieval error (0.53 cm), and instrument error (0.54 cm).
Radial Error	1.6	1.6	Jason heritage is ~ 1 cm. Analysis of CoM variation of F/S. Doris AIT result compliant with the need for POD algorithm performance.
Sea State Bias residual	2.0	2.0	Based on Jason heritage.
Altimeter noise	1.7	1.68	Based on Pos-3C AIT test results, including antenna phase center variation (variable part estimated from PL module analysis). AIT tests were performed at WC SNR (9,9 dB), better than 1,6 cm would be expected.
Total (RSS)	**3.4**	**3.24**	(No changes since SIR)

CBE is near the requirement value. Measurement has a lot of heritage

Hydrology Height/Slope Error Budget & CBE

Hydrology Error Component	Height Error Alloc [cm]	Height Error CBE [cm]	Slope Error Alloc [urad]	Slope Error CBE [urad]	Basis of Estimate
Ionosphere signal	0.8	0.8	0.1	0.1	RMS of full signal for maximum solar activity using IONEX model
Dry troposphere Signal	0.7	0.7	0.1	0.1	RMS after correction with models, based on Jason heritage
Wet Troposphere Signal	4.0	1.0	1.5	1.5	Model-based correction.
Radial Error	1.62	1.6	0.5	0.02	Radial Error (incl. POD+CoM to Phase Center radial) RMS
KaRIn Random & Systematic Errors after Cross-Over	8.9	4.3	15.5	8.0	KaRIn roll-up, after cross-over correction
KaRIn Random	*(4.4)*	*(2.3)*	*(15.3)*	*(7.9)*	Based on measurement KaRIn test data & STOP analysis
KaRIn Cross & Along-track Systematic errors	*(7.55)*	*(3.6)*	*(1.7)*	*(0.9)*	Operational Calibration analysis of residual error and antenna cross track phase error for forward processing
High Frequency errors	*(1.15)*	*(0.1)*	*(0.5)*	*(<0.1)*	S/C disturbance analysis
(Unallocated margin, RSS)	*(1.23)*		*(1.75)*		
Motion errors	0.8	0.4	1.6	0.8	Based on analysis of river motion data
Unallocated margin (RSS)	0.65		6.6		
Total (RSS)	**10**	**4.8**	**17**	**8.2**	(was 5.1cm/8.6urad at SIR)
CBE Margin [%]		**52%**		**52%**	(was 49%/49% at SIR)

Specificities related to the POD of SWOT

Science data products:

- **L1_DORIS_RINEX, L1_GPSP_RINEX, swoman.txt, …**
- **SAT_COM: Satellite center of mass (CoM) product with position of CoM relative to spacecraft reference point:**
  - swomass.txt: History of mass and satellite CoM evolution (effect of propellant consumption and solar array rotations).
  - swoatt.txt: Epochs of yaw-flip events (every ~78 days).
- **ATTD_RECONST: Reconstructed attitude data product, providing spacecraft orientation from star tracker and gyro data (NetCDF).**
- **SWOT_SCC_HKTM-PARAM_SOLAR-PANEL_*.XML: Solar panel angles.**
- **MOE/POE: Medium-accuracy (< 36 hours) and Precise Orbit Ephemeris (< 28 days) products, providing satellite orbit position and velocity.**

Precision Orbit Ephemeris (POE) overview

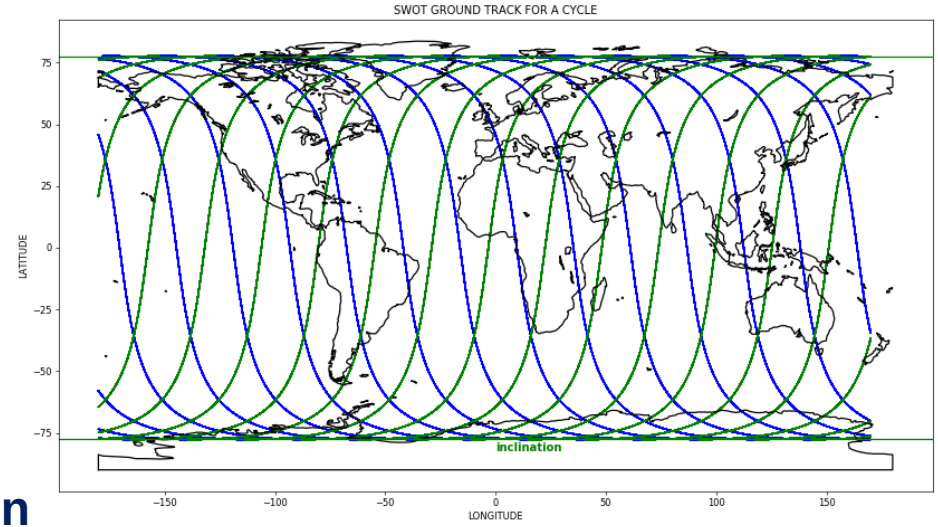
Time period for POD validation: January 15 – March 12, 2023.

Making use of all three tracking instruments:

- **CNES POE-F DORIS+GPS orbit solutions,**
- **SLR is saved for independent validations.**

Reduced-dynamic parameterization to account for residual measurements/dynamic modeling errors:

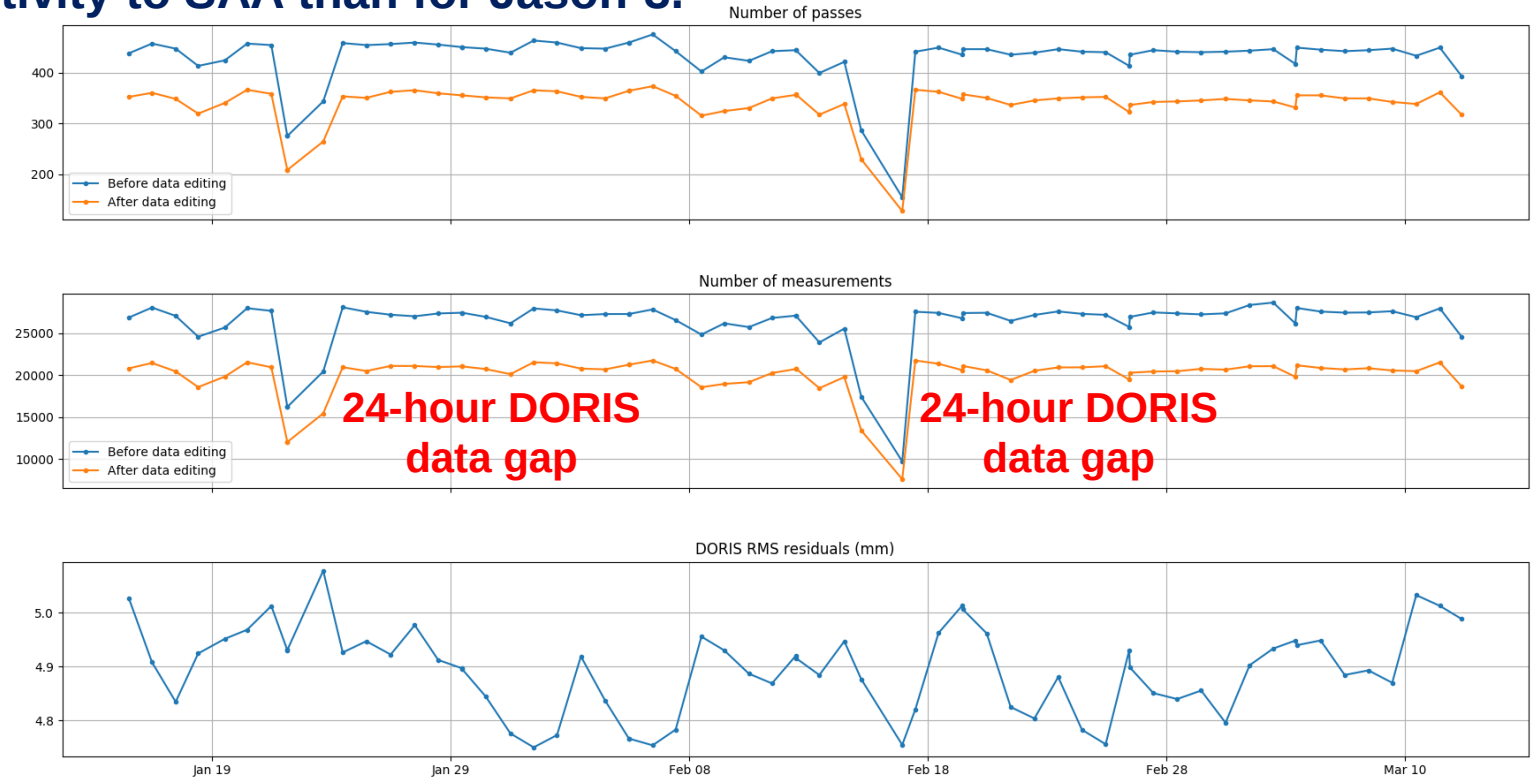
- **Solve for daily constant cross-track, 30-min constant along-track, 1/rev along/cross-track empirical accelerations every orbital revolution.**



Calibration orbit (1-day repeat cycle).

Performance of the tracking systems

RMS of daily DORIS Doppler post-fit residuals: ~4,8 – 5 mm suggesting a stronger sensitivity to SAA than for Jason-3.



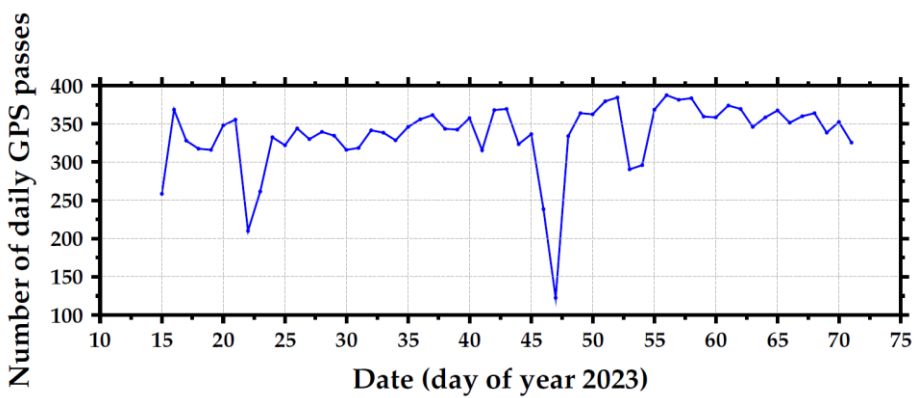
Performance of the tracking systems

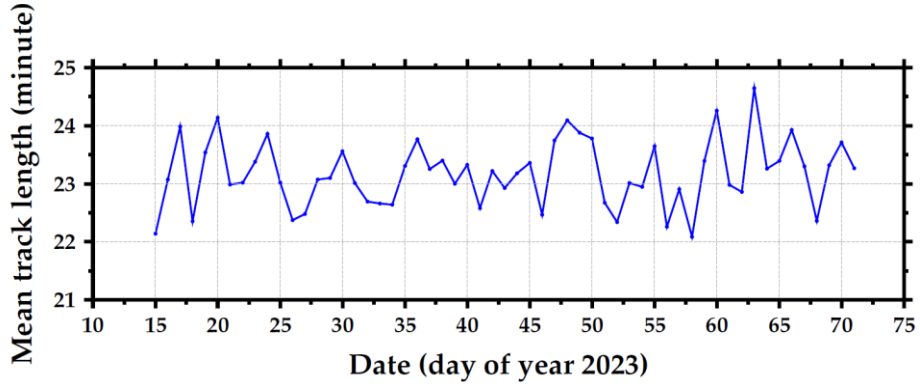
Valid GPS data used in the POE-F solution:

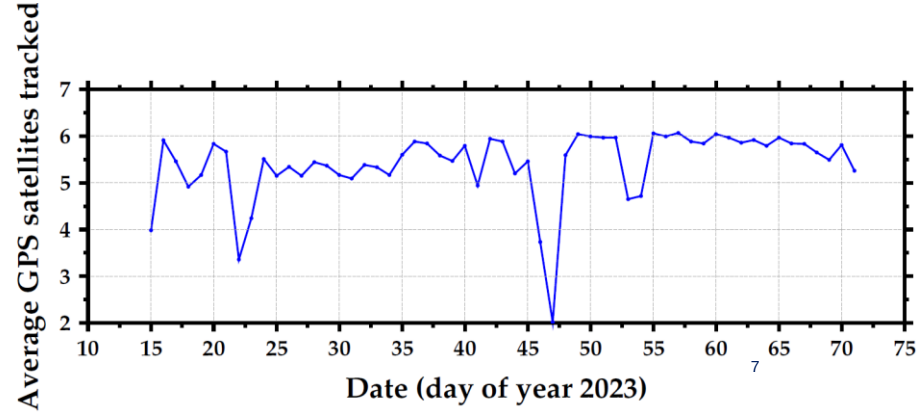
⇒ **Number of passes comparable to Jason-3.**

⇒ **Expected shorter mean track length with its lower altitude.**

⇒ **Average number of GPS satellites tracked between Jason-2 and Jason-3.**

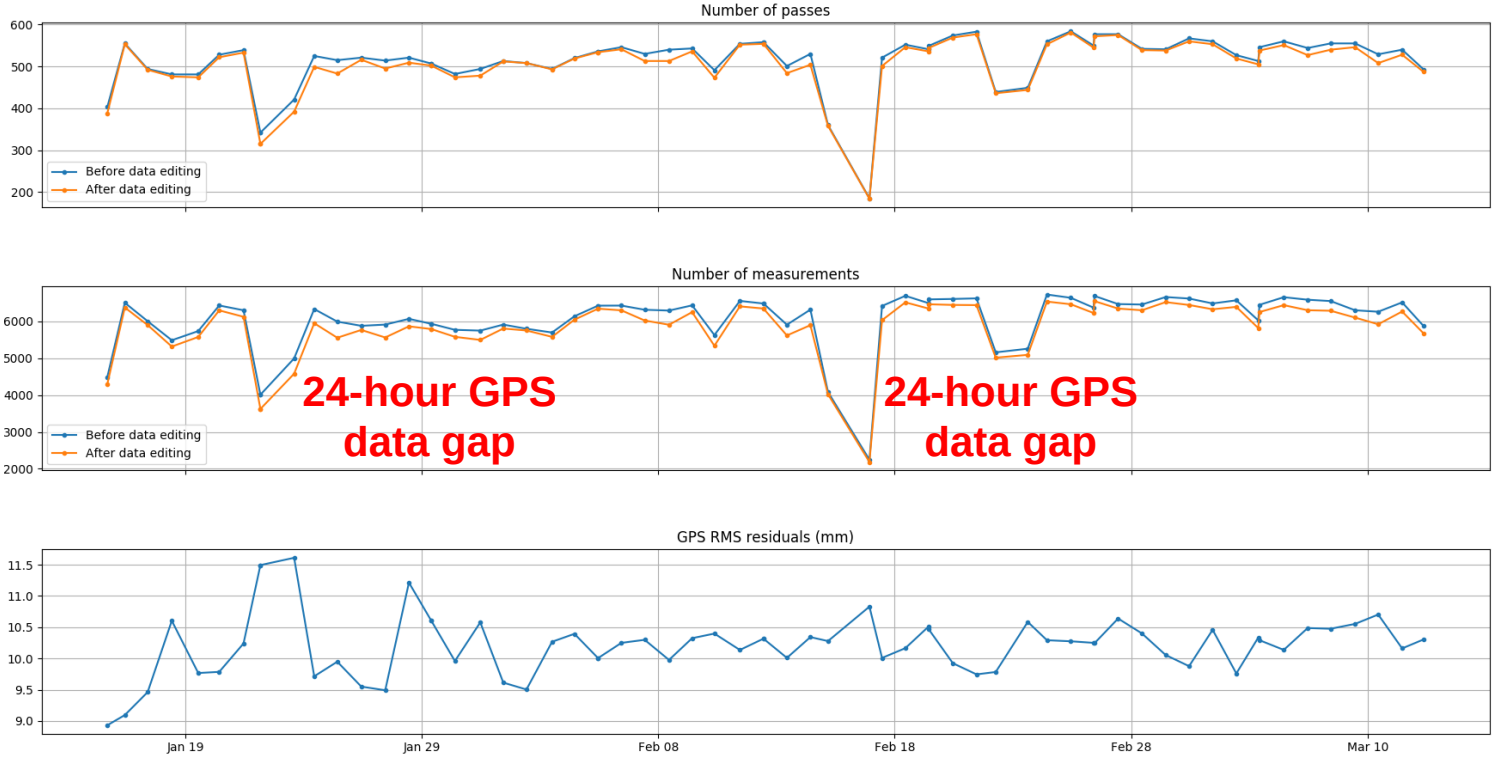






Performance of the tracking systems

RMS of daily GPS phase (LC) post-fit residuals: Slightly higher than for Jason-3 but with a pre-flight phase map (solar array perturbations).



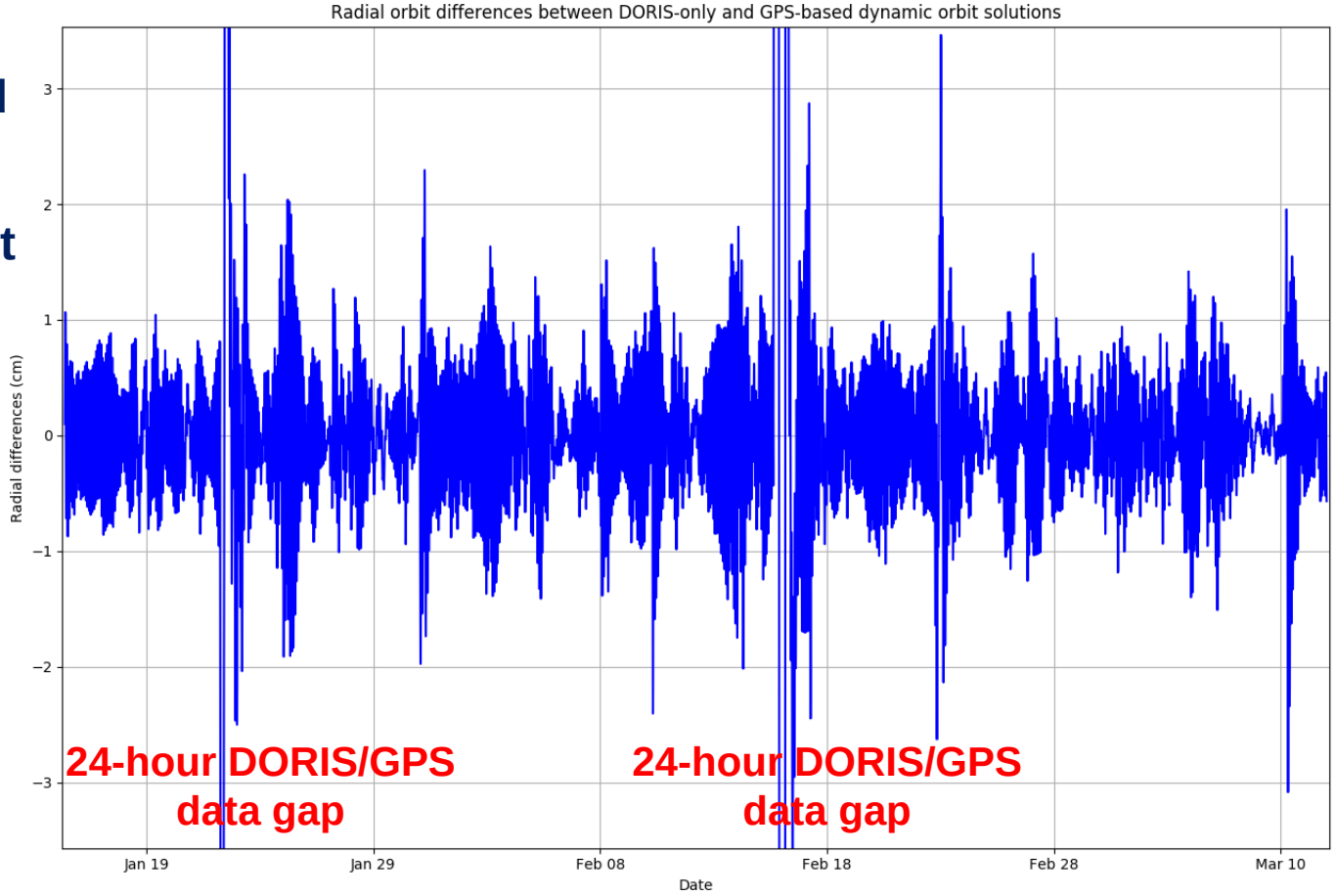
Internal orbit comparison

DORIS-only w.r.t. GPS-based dynamic orbit solutions:

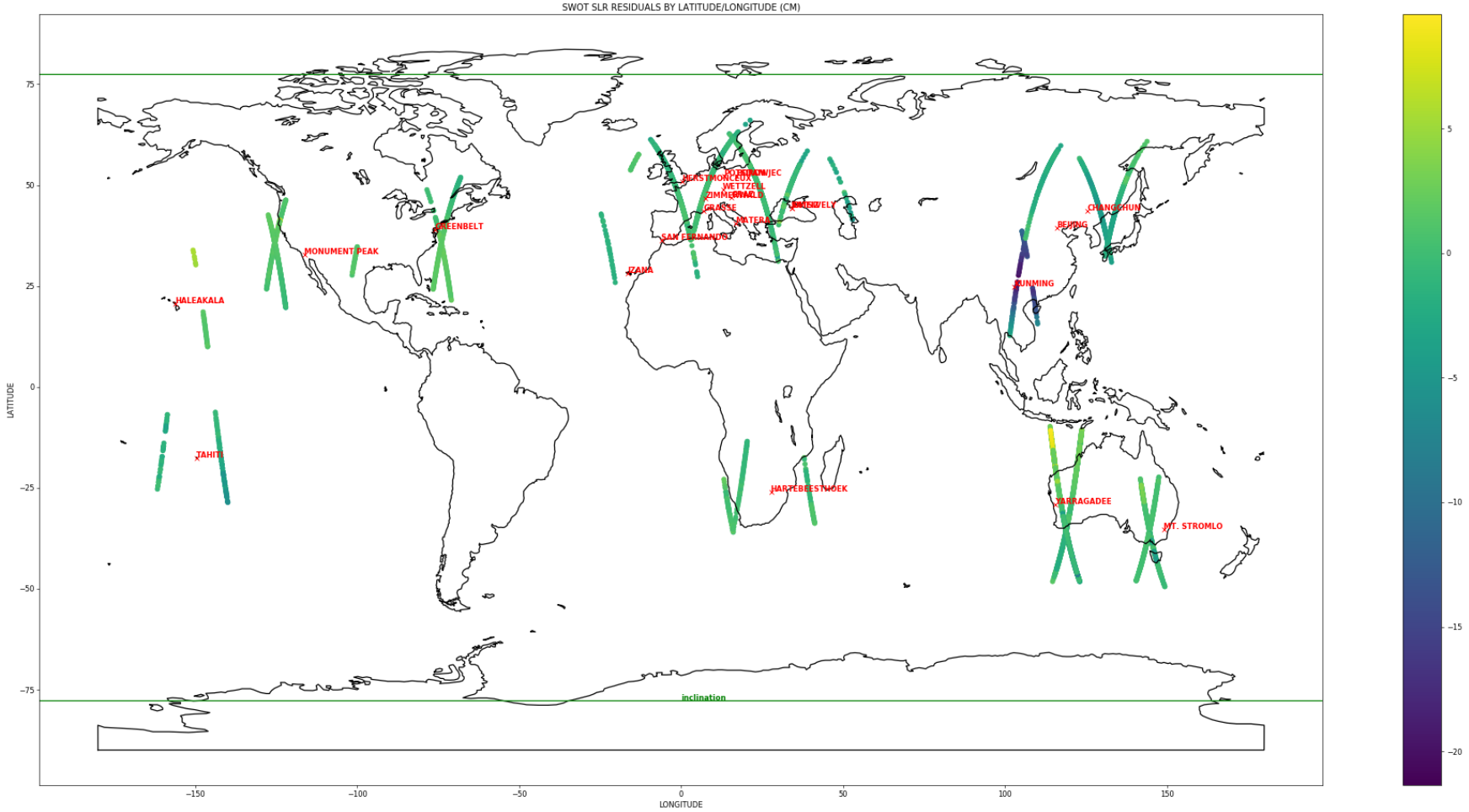
⇒ **Sub-centimeter agreement in the radial direction: ~5 mm RMS.**

⇒ **Along-track bias: ~9 mm.**

⇒ **Cross-track bias: ~5 mm.**



Distribution of tracking SLR stations (high latitudes are blind)



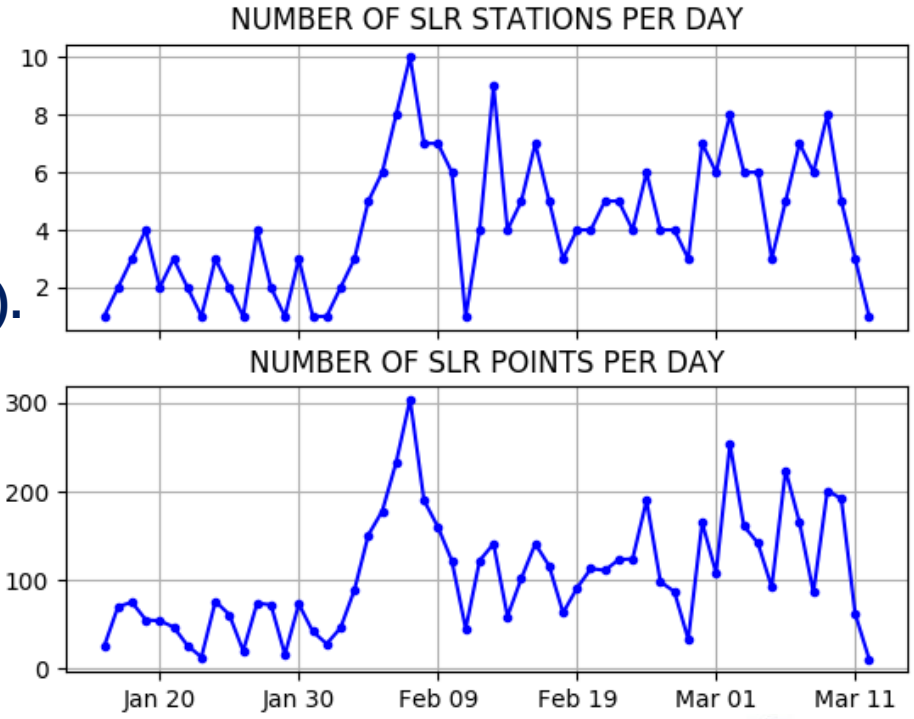
SLR availability

Tracking network:

- **~5 stations routinely track SWOT every day (21 in total).**
- **The top three stations with most tracking of SWOT are Yarragadee (Australia), Changchun (China), Mt. Stromlo (Australia).**

Normal points:

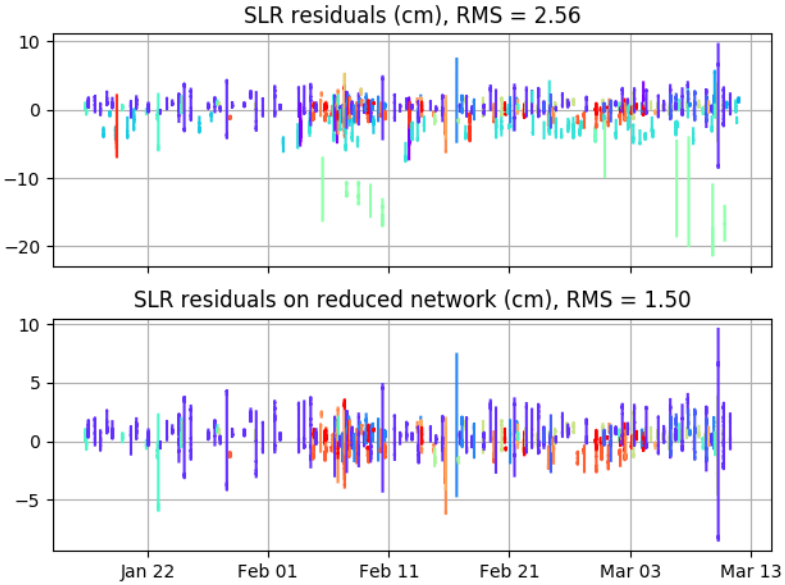
- **~110 daily SLR normal points for SWOT (200-300 for Sentinel-6 MF/Jason-3).**



Independent orbit validation owing to SLR observations

Subset of highest quality ILRS stations already validating radial POD accuracies of < 1.5 cm (RMS):

- 8834 (0.9 cm), 7501-7825 (1.0 cm), 7839 (1.3 cm), 7105-7841 (1.4 cm), 7110 (1.5 cm), 7824 (1.6 cm), 7840 (1.7 cm), 7090 (1.8 cm).



RMS of SLR residuals vs. time (left) & elevation angle (right).