



Latest updates of the CNES/CLS IDS Analysis Center solutions

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Introduction of SWOT and Sentinel-6B in GRG processing chain

- **Latest additions:**

- Introduction of SWOT and Sentinel-6B in our processing chain
- Macromodel available at: <https://ids-doris.org/documents/BC/satellites/DORISatelliteModels.pdf>
- Updated DORIS Antenna Phase Center position for SWOT ($\Delta Z = 19.4$ mm @ 2GHz)

- Attitude:

Quaternions

Nominal attitude implemented

DORIS CoP position	SWOT (in mm)		
	X	Y	Z
UHF (400 MHz)	0.2 → -0.2	544.1 → 544.6	2611.7 → 2631.1
S (2 GHz)	0.2 → -0.2	544.1 → 544.6	2777.7 → 2797.1

- We have estimated the Radiation pressure scale coefficient:

For SWOT: 1.0

For Sentinel-6B: 1.02

Introduction of SWOT and Sentinel-6B in GRG processing chain

■ Results:

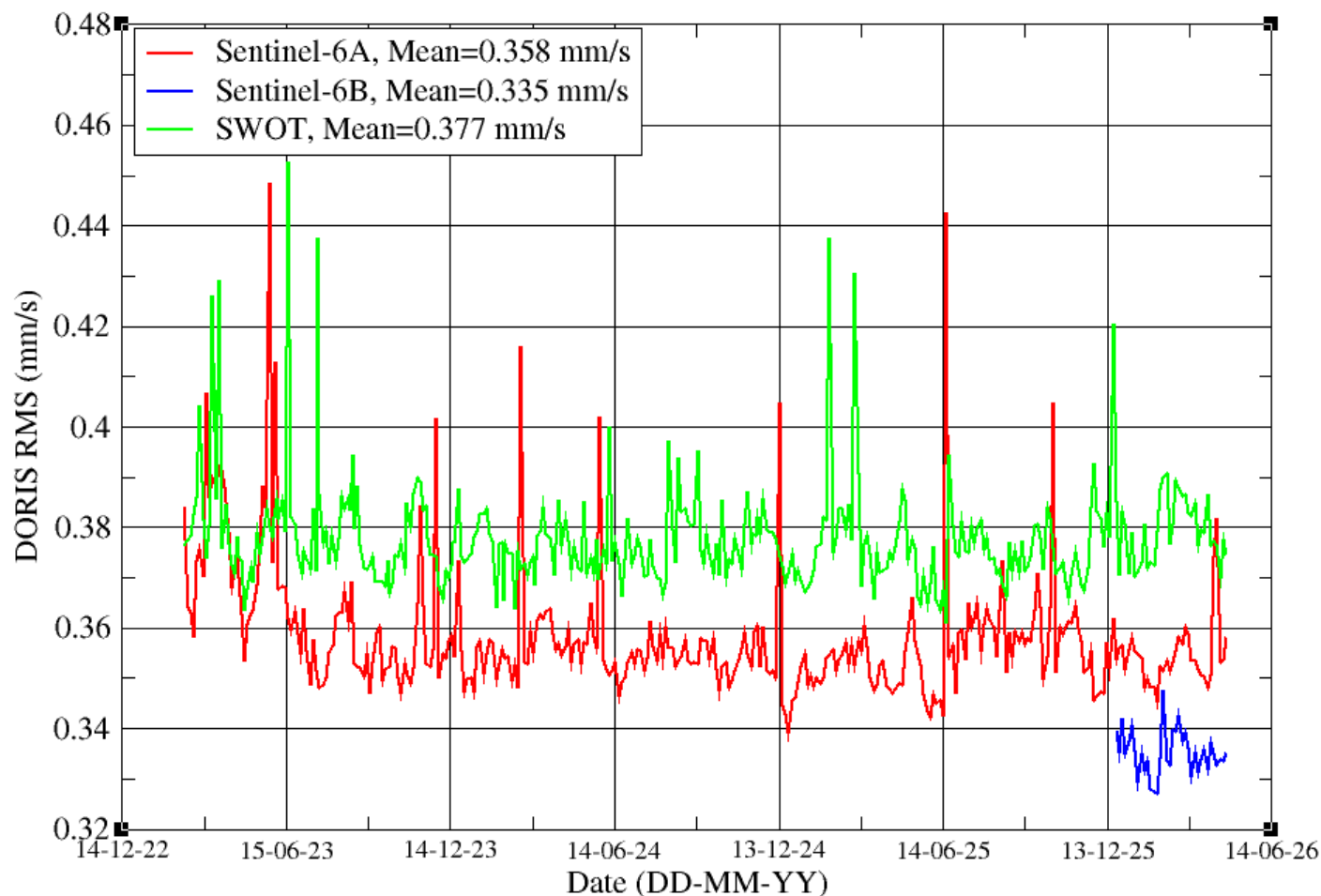
- DORIS data processing:
 - 165 weeks (from Feb. 2023 to Apr. 2026) for SWOT
 - 17 weeks (from Dec. 2025 to Apr. 2026) for Sentinel-6B
- POD results
 - DORIS residuals RMS and OPR empirical acceleration amplitudes comparisons to the CNES POD team (POE-F/G)
- Station position estimation
 - Evaluation of SWOT and Sentinel-6B single satellite solution by comparison to DPOD2020.v05
 - Impact of the integration of SWOT and Sentinel-6B on the multi-satellite solution

SATELLITE	Inclination (degree)	Altitude (km)
Sentinel-6B	66.04	1336
SWOT	77	891

Introduction of SWOT and Sentinel-6B in GRG processing chain

POD Results

□ DORIS residual RMS



- **SWOT and Sentinel-6A** (from Feb. 2023 to Apr. 2026)
- **Sentinel-6B** (from Dec. 2025 to Apr. 2026)

▪ *The DORIS RMS residuals for SWOT are higher, at a level comparable to Sentinel-3A and 3B.*

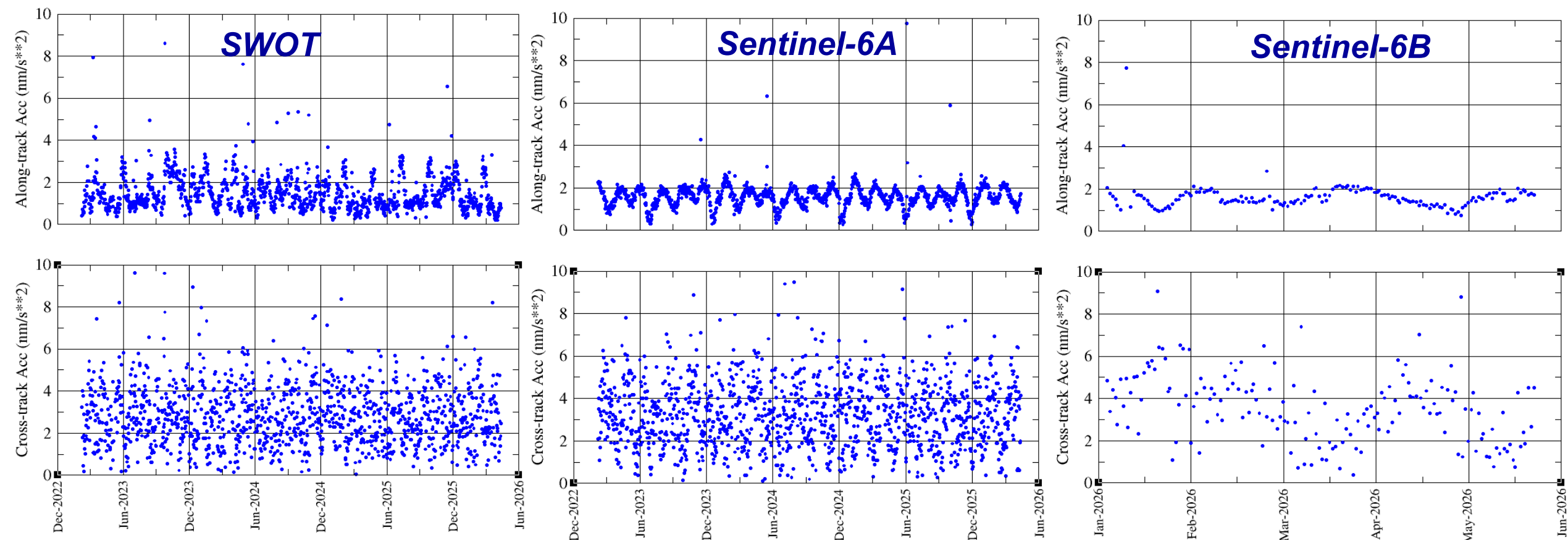
▪ *The DORIS RMS residuals for Sentinel-6B are lower, at a level comparable to Saral.*

SATELLITE	Inclination (degree)	Altitude (km)
Sentinel-6A	66.04	1336
Sentinel-6B	66.04	1336
SWOT	77	891

Introduction of SWOT and Sentinel-6B in GRG processing chain

POD Results

□ OPR Acceleration Amplitude



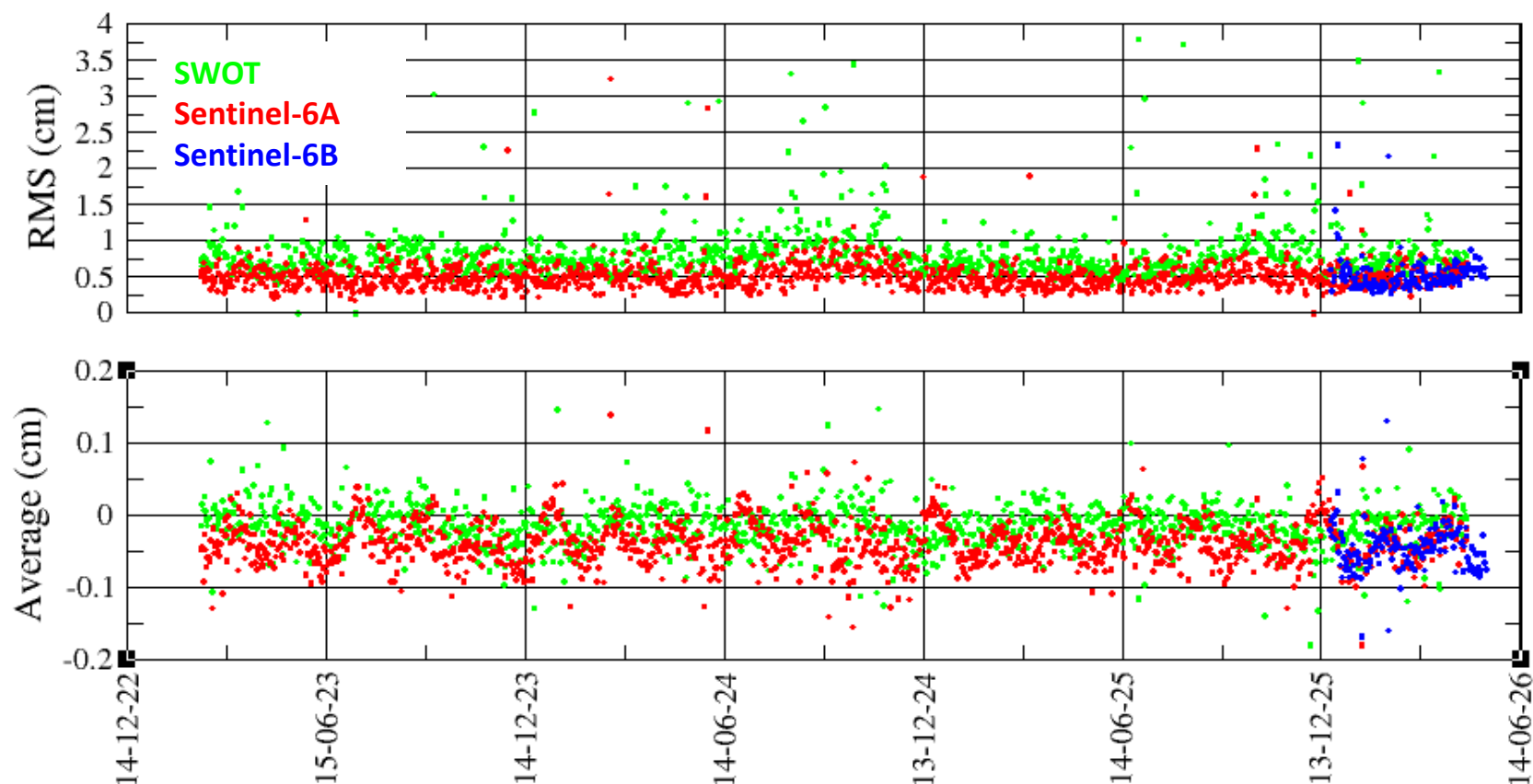
- For SWOT and Sentinel-6B, the OPR acceleration amplitudes are consistent in both directions (along-track and cross-track)
- A draconitic signature is observed for Sentinel-6B, similarly to Sentinel-6A.

Introduction of SWOT and Sentinel-6B in GRG processing chain

POD Results

Comparison to external orbit (POE-F for SWOT and POE-G for Sentinel-6A and -6B)

Daily Average and RMS radial orbit differences (in cm)



▪ For the 3 satellites, there is a good agreement in RMS between the GRG and CNES orbits (< 1 cm RMS).

▪ The average radial difference is nil for SWOT and negative by a few mm for Sentinel-6A and -6B

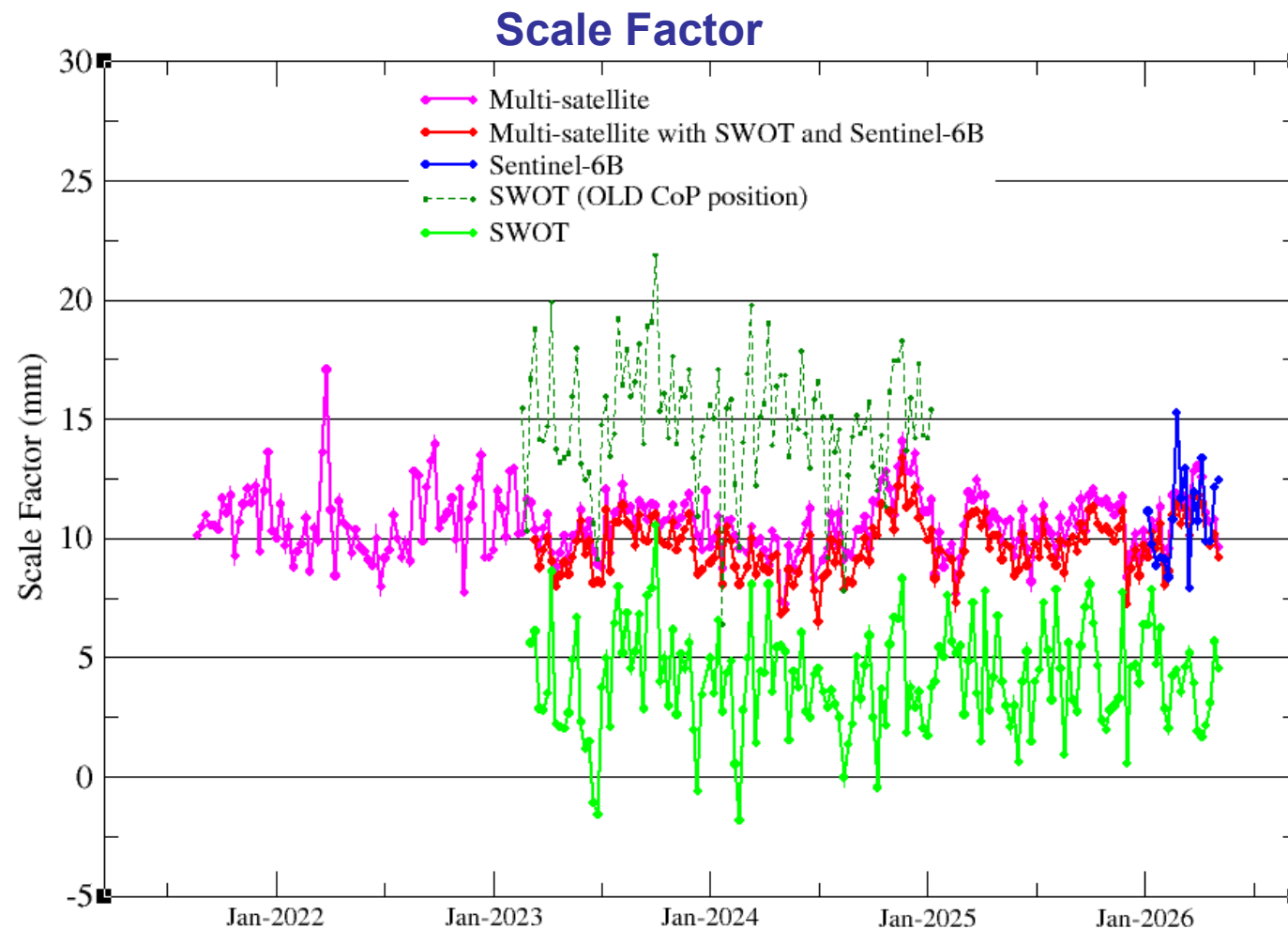
▪ A draconitic signature is observed in the mean orbit differences for Sentinel-6B, similarly to Sentinel-6A.

Orbit Comparison to POE			
Mean of daily RMS (cm))	Radial	Along-track	Cross-track
SWOT	0.86	2.45	2.19
Sentinel-6A	0.52	1.95	2.34
Sentinel-6B	0.57	1.97	1.95

Introduction of SWOT and Sentinel-6B in GRG processing chain

Station position estimation

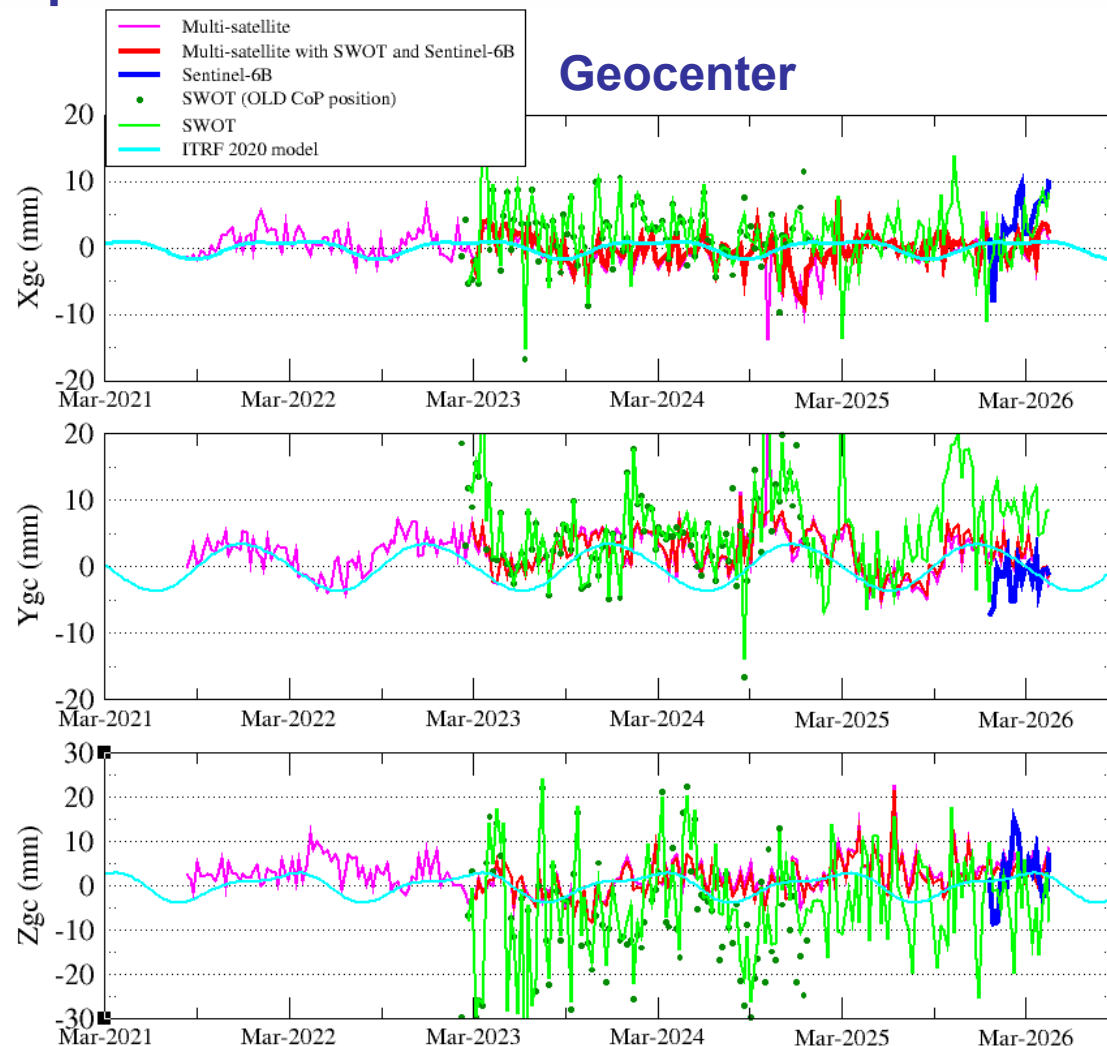
❑ Comparison of each solution to DPOD2020.v030 (computed by CATREF)



- *In green: SWOT single satellite solution, and in dark green with the old CoP values*
- *In blue: Sentinel-6B solution, closer to the multi-satellite solution*
- *In magenta: multi-satellite solution*
- *In red: multi-satellite solution including SWOT and Sentinel-6B*
- *Including SWOT slightly reduces the scale factor.*

Introduction of SWOT and Sentinel-6B in GRG processing chain

Station position estimation



Introduction of SWOT and Sentinel-6B in GRG processing chain

South Atlantic Anomaly impact on the orbit

□ DORIS RMS of fit (in mm/s) of SAA station from GRG processing

Mean over 165 weeks (from Feb. 2023 to Apr. 2026) for Saral, Sentinel-6A and SWOT

Mean over 17 weeks (from Dec. 2025 to Apr. 2026) for Sentinel-6B

Station	Saral	Sentinel-6A	Sentinel-6B	SWOT
All	0.338	0.358	0.335	0.378
Cachoeira	0.425	0.449	No data	0.489
Arequipa	0.310	0.371	0.371	0.419
San Juan	0.371	0.390	0.381	0.449
Kourou	0.416	0.449	0.430	0.467
Ascension	0.371	0.414	0.392	0.419
Yarragadee	0.312	0.333	0.321	0.353
Wettzell	0.320	0.328	0.308	0.358

▪ Previous studies have shown that Saral is only weakly affected by the SAA.

▪ Cachoeira and Kourou show high RMS values for all satellites.

▪ The global DORIS RMS for Sentinel-6B is at the same level as for Saral, with slightly higher values at SAA stations.

▪ The global DORIS RMS for SWOT is higher, especially for SAA stations.

□ → Two stations outside the SAA region

Introduction of SWOT and Sentinel-6B in GRG processing chain

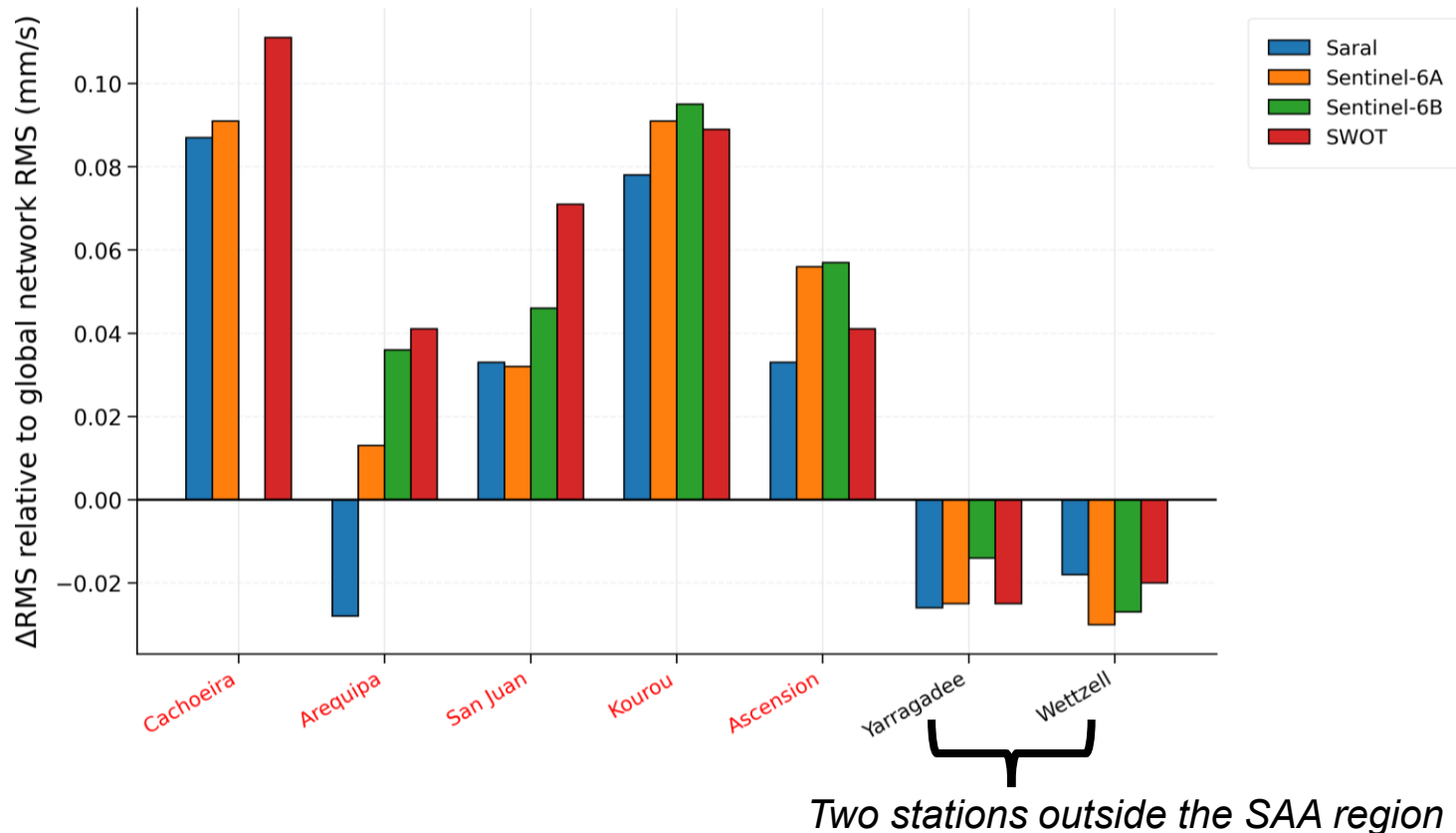
SAA impact on the orbit

□ DORIS RMS of fit (in mm/s) of SAA station from GRG processing

Mean over 165 weeks (from Feb. 2023 to Apr. 2026) for Saral, Sentinel-6A and SWOT

Mean over 17 weeks (from Dec. 2025 to Apr. 2026) for Sentinel-6B

For each satellite and station, we compute the DORIS RMS relative to the global network RMS



- Previous studies have shown that Saral is only weakly affected by the SAA.
- Cachoeira and Kourou show high Δ RMS values for all satellites.
- Δ RMS values for Sentinel-6B are higher at SAA stations compared to Saral and Sentinel-6A.
- Δ RMS values for SWOT are higher at SAA stations, except for Ascension, which lies outside the SAA region at SWOT altitude.

Introduction of SWOT and Sentinel-6B in GRG processing chain

SAA Impact on the station position estimation

□ Single satellite Solution compared to DPOD2020.V5 (computed by CATREF)

Mean over 165 weeks (from Feb. 2023 to Apr. 2026) for Saral, Sentinel-6A and SWOT

Mean over 17 weeks (from Dec. 2025 to Apr. 2026) for Sentinel-6B

Station	Saral (in mm)			Sentinel-6A (in mm)			Sentinel-6B (in mm)			SWOT (in mm)		
	North	East	Up	North	East	Up	North	East	Up	North	East	Up
Cachoeira	-1.6	14.1	-18.1	-8.6	50.4	17.8	No	No	No	-36.8	81.2	77.1
Arequipa	-4.1	-3.1	-0.6	-7.3	52.8	-28.6	-10.7	-10.4	14.9	-1.0	67.6	1.0
Kourou	3.3	-5.1	-2.0	-0.6	-10.1	-30.7	-0.5	-23.1	-17.3	1.4	-56.1	3.7
Ascension	3.8	0.8	-2.9	-7.2	16.3	16.0	-3.4	-29.2	29.9	5.8	-9.1	6.2
Saint Helene	3.5	9.6	-1.3	4.5	-17.1	5.1	26.8	1.9	-4.7	6.5	26.2	1.1
Yarragadee	-2.1	3.6	1.2	-2.8	-4.8	-0.7	-0.2	-8.1	6,7	-0.2	4.5	1.8
Wettzell	-0.9	6.8	-3.4	-4.9	-3.8	9.8	1.9	-9.1	-0.3	-2.2	3.2	-1.0

- The SAA impact is larger for Sentinel-6A, Sentinel-6B and SWOT. Their solutions exhibit significant biases (>10 mm) in at least one NEU component at SAA stations.

Future work

- *We plan to continue:*
 - *analyzing origin and scale factor from single-satellite and multi-satellite solutions*
 - *the evaluation of GRG orbits:*
 - *through comparisons with internal GNSS-based orbits*
 - *through comparisons with external orbits*
 - *using independent SLR RMS of fit*
 - *using altimeter crossover cycles*
 - *to develop a strategy to mitigate the impact of increased solar activity*
 - *to work on DORIS zenith tropospheric delay (see Vikash Kumar presentation)*
 - *to contribute to the IDS Working Group on “Integrated Clock Correction Strategies for DORIS”*
 - *the preparation for the GENESIS mission: tri-technique (SLR + GNSS + DORIS) combination for LEO satellites (e.g. Sentinel-6A, Sentinel-3A & 3B, Jason-3)...*