



## GRG AC status

Hugues Capdeville (CLS),  
Jean-Michel Lemoine (CNES),  
Adrien Mezerette (CLS)

CNES/CLS AC (GRG)

**IDS AWG**  
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# Status of CNES/CLS IDS Analysis Center

## ❑ Status of the routine DORIS data processing

We processed DORIS data until Dec. 2024 (Serie **grg56**) and provided to IDS Combination Center.

*SAA mitigation strategy on Sentinel-6A and HY-2C*

*The solutions HY-2C & 2D do not contribute to the scale determination of multi-satellite solution*

**we use the macromodel of Conrad et al. for Sentinel-6A**

**we use new GRGS TVG: CNES\_GRGS.RL05MF\_2024\_08.shc**

**we use DPOD2020\_V030 as apriori**

We also provided Sentinel3-A&B and Sentinel-6A orbits to CPOD QWG for the whole year 2024 in the same processing configuration.

## ❑ AC studies

***In progress:***

**Finalize the introduction of the SWOT satellite in the multi-satellite solution**

Develop a strategy to mitigate the impact of increased solar activity on POD and on multi-satellite solution

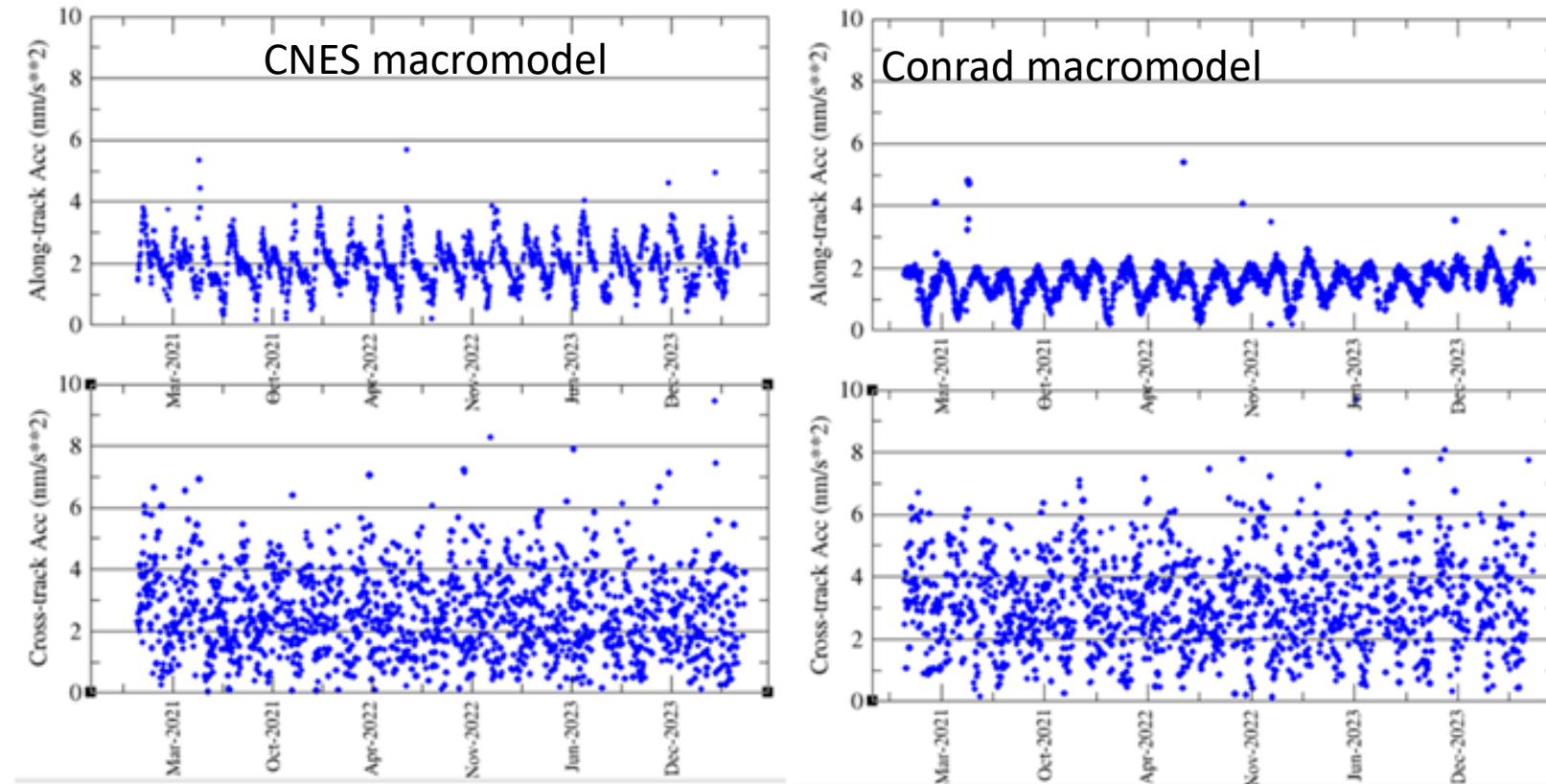
*(test recent atmospheric density models done, adjust more drag coefficient (from 1/4H to 1/1H))*

Analyzing the Impact of GPS Clock as the modelled DORIS USO on Station Position Estimation for Sentinel Satellites

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# Impact of the CONRAD model on POD and Geocenter

## □ OPR Acceleration Amplitude for Sentinel-6A

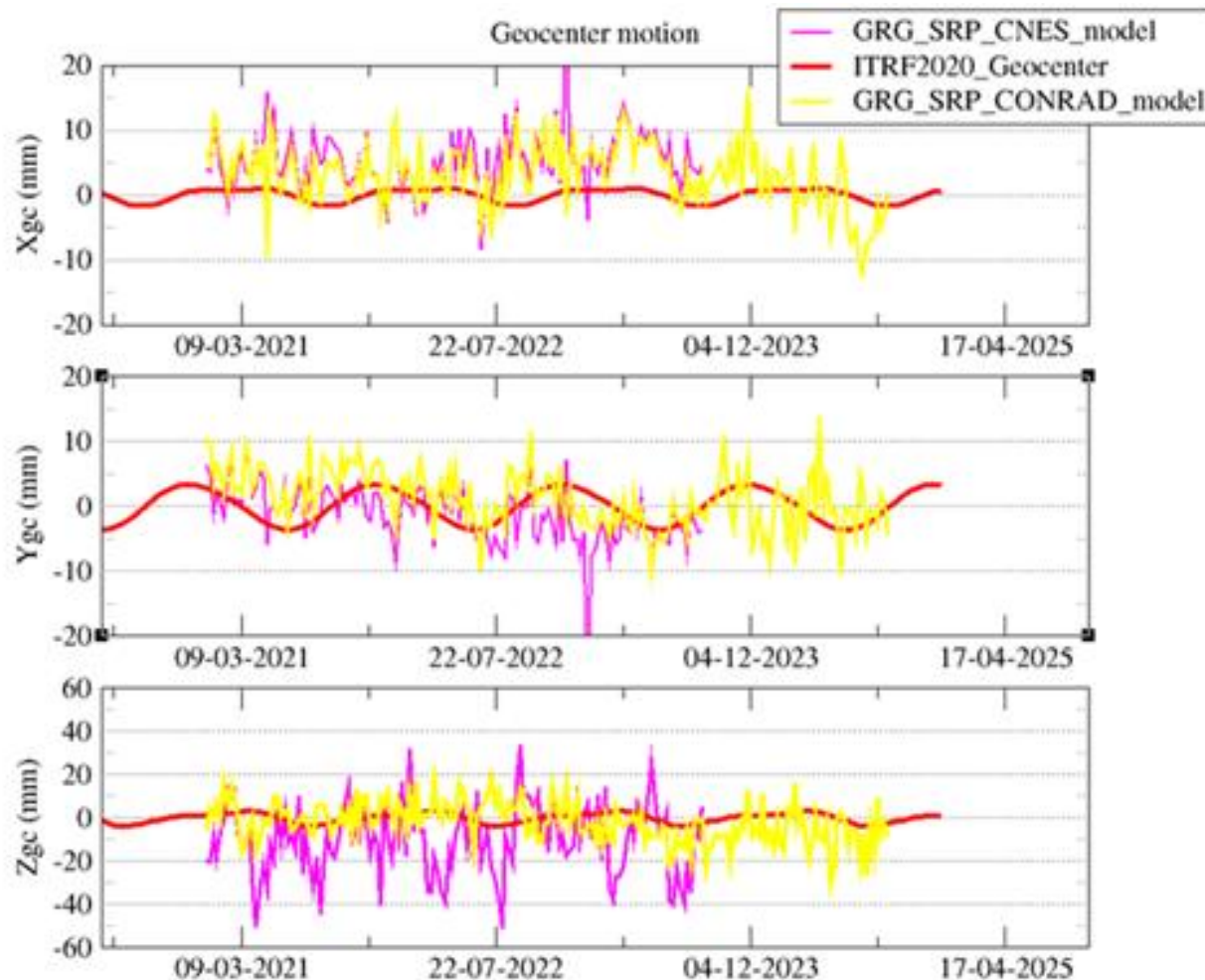


- **CNES 6-plate macromodel** (from the document DorisSatelliteModels.pdf): Cr estimated at 1.06
- **Conrad 12-plate macromodel, tuned with GNSS data by Alex Conrad et al. from JPL.** Cr estimated 1.02

▪ **The Conrad macromodel allows for reducing the OPR tangential amplitude**

# Impact of the CONRAD model on POD and Geocenter

## □ Geocenter from S6A single satellite solution (comparison of each solution DPOD2020.v030)



- In magenta S6A single satellite solution obtained with CNES macromodel
- In yellow S6A single satellite solution obtained with Conrad model
- In red the Geocenter model from ITRF2020 of Z. Altamimi.

**The Conrad macromodel helps reduce the signature at the 59-day period (half the draconitic period of Sentinel-6A) on the z geocenter component.**

# Introduction of SWOT in GRG processing chain

- **Latest additions:**

Macromodel available at: <https://ids-doris.org/documents/BC/satellites/DORISSatelliteModels.pdf>

Attitude:

- Quaternions

- Nominal attitude implemented

We have estimated the Radiation pressure scale coefficient: 0.98.

- **First results:**

We processed SWOT DORIS data from February 2023 to December 2024.

POD results

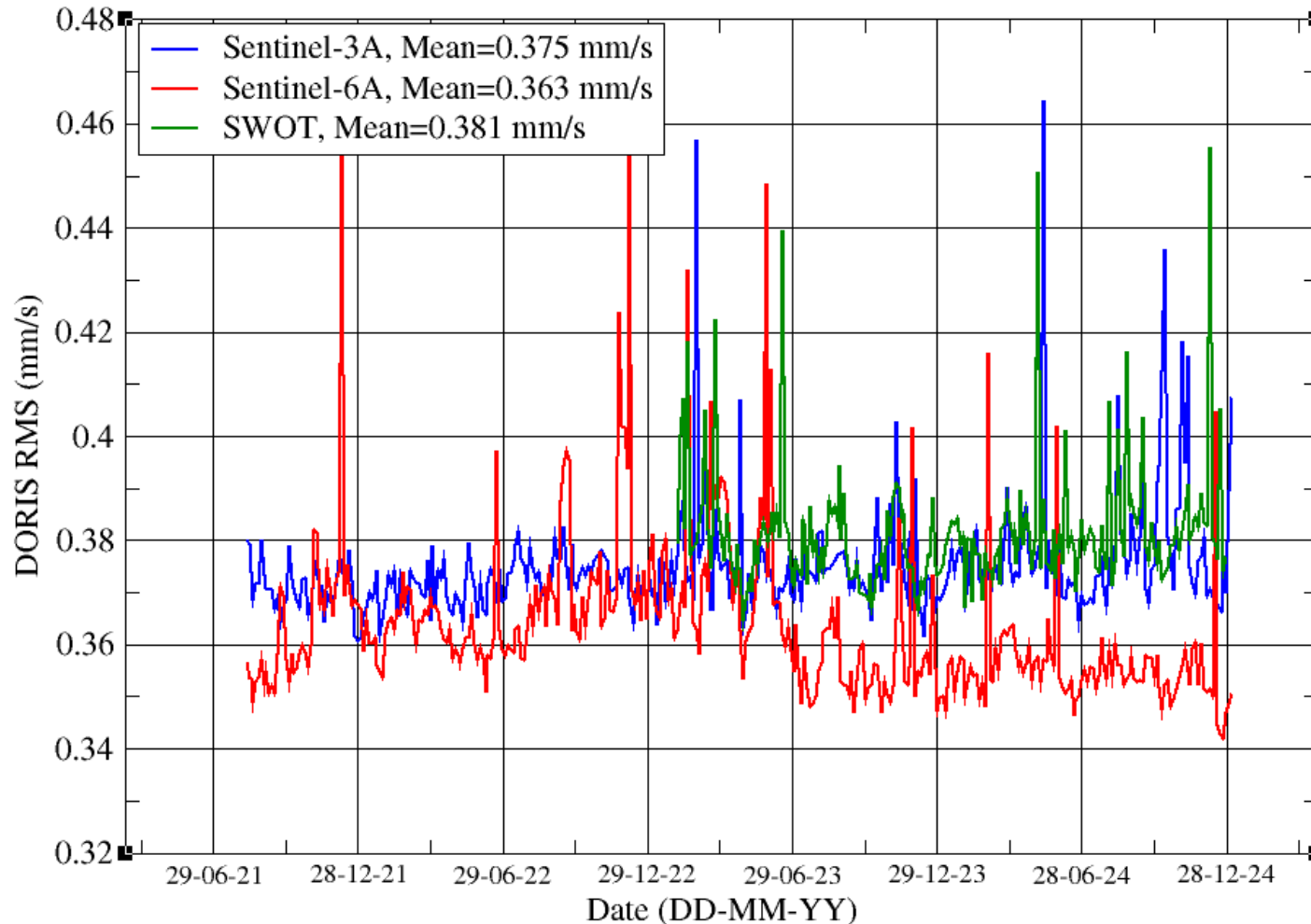
- orbit residuals and OPR empirical acceleration amplitudes

- comparisons to the CNES POD team orbit POE-F

Evaluation of SWOT single satellite solution by comparison to DPOD2020.v03

# Introduction of SWOT in GRG processing chain

## □ DORIS RMS of fit

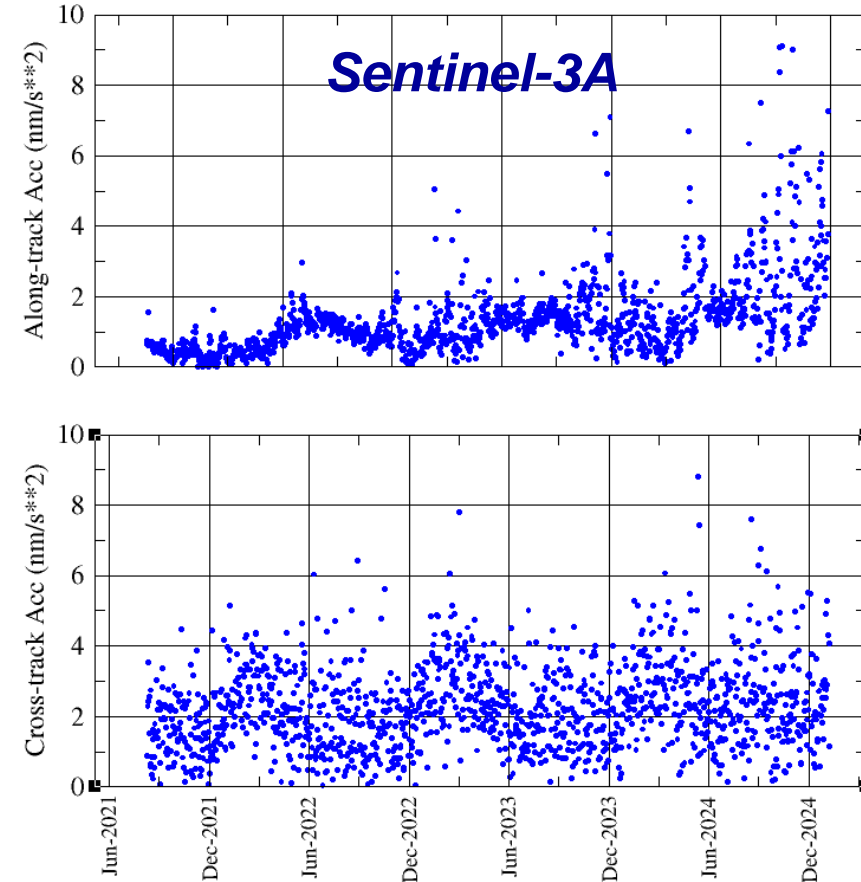
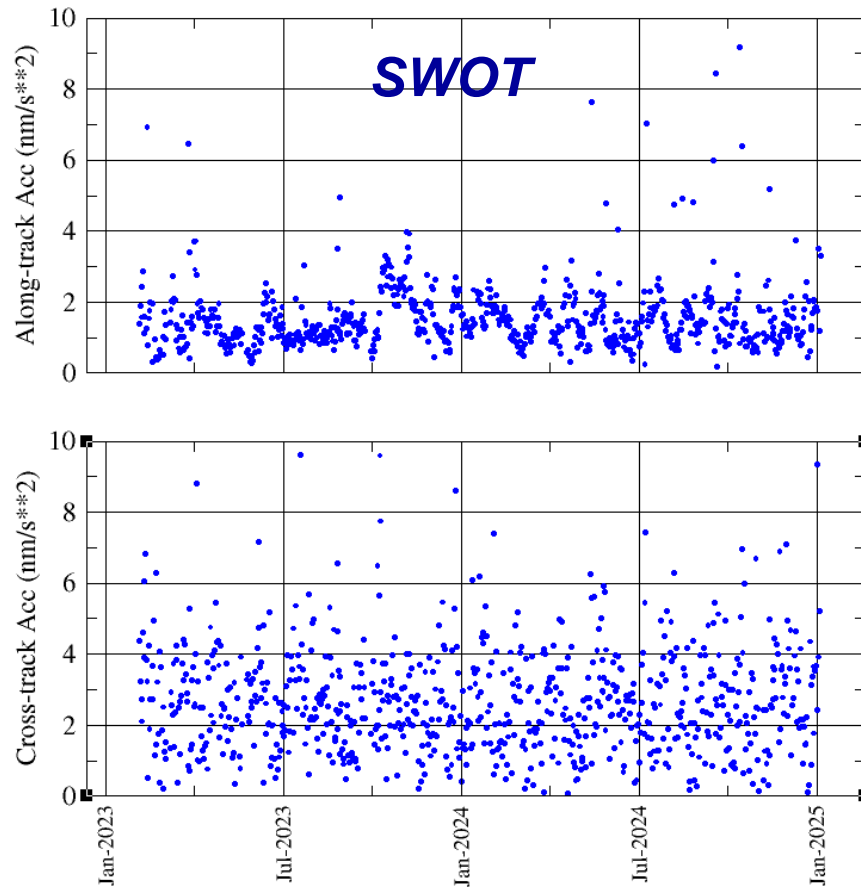


- **SWOT** (from Feb. 2023 to Dec. 2024)
- **Sentinel-3A & 6A** (from Aug. 2021 to Dec. 2024)

▪ *The DORIS RMS residuals for SWOT and Sentinel-3A are at the same level.*

# Introduction of SWOT in GRG processing chain

## □ OPR Acceleration Amplitude



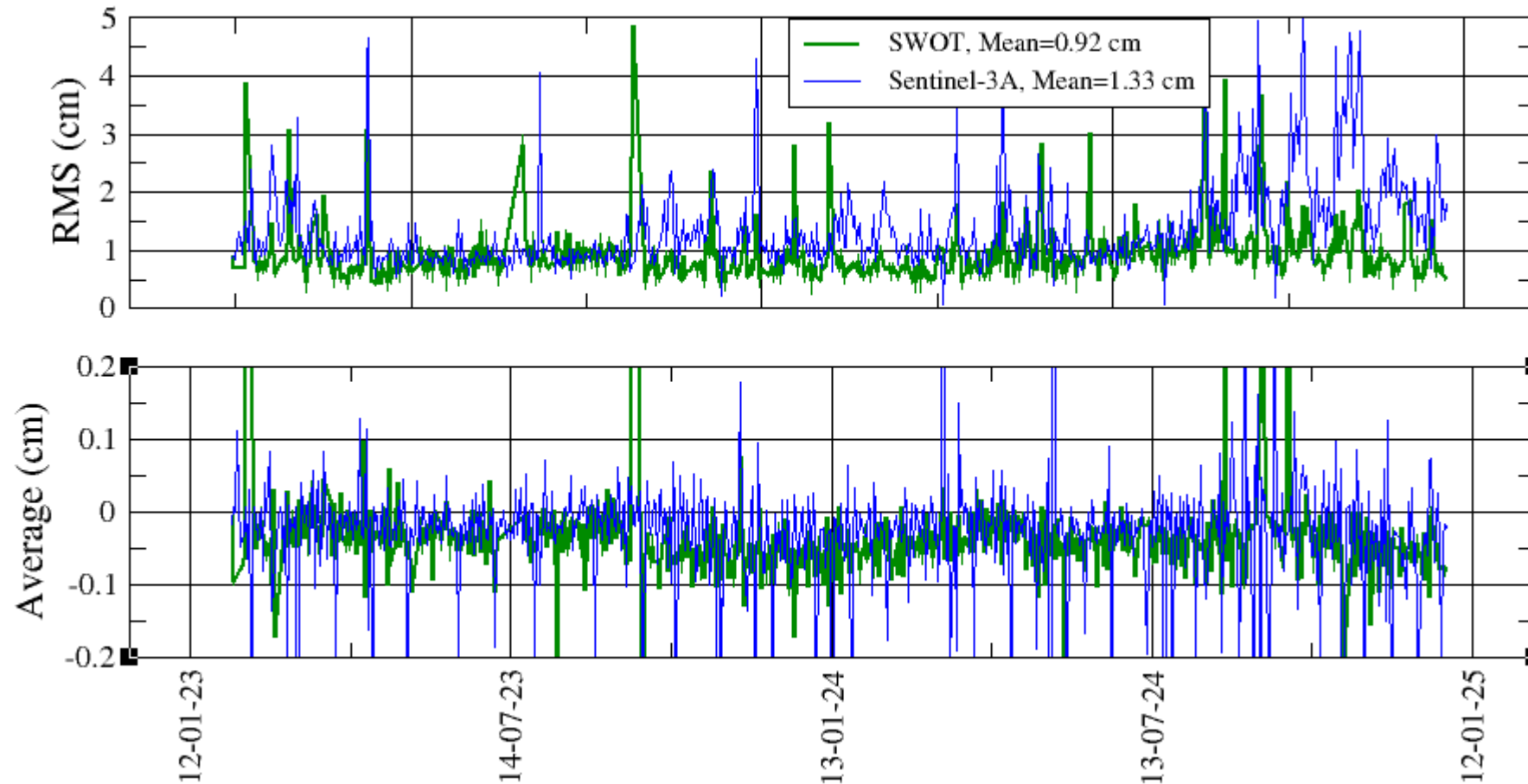
- As for Sentinel-3A, for SWOT, the level of the OPR amplitude is correct for the two directions, Along-track and Cross-track.
- For Sentinel-3A, there is a degradation in the along-track amplitude from early 2023 (as the solar flux increases).

# Introduction of SWOT in GRG processing chain

## Comparison to external orbit POE-F

(from Feb. 2023 to Dec. 2024)

### Daily Average and RMS radial orbit differences (in cm)

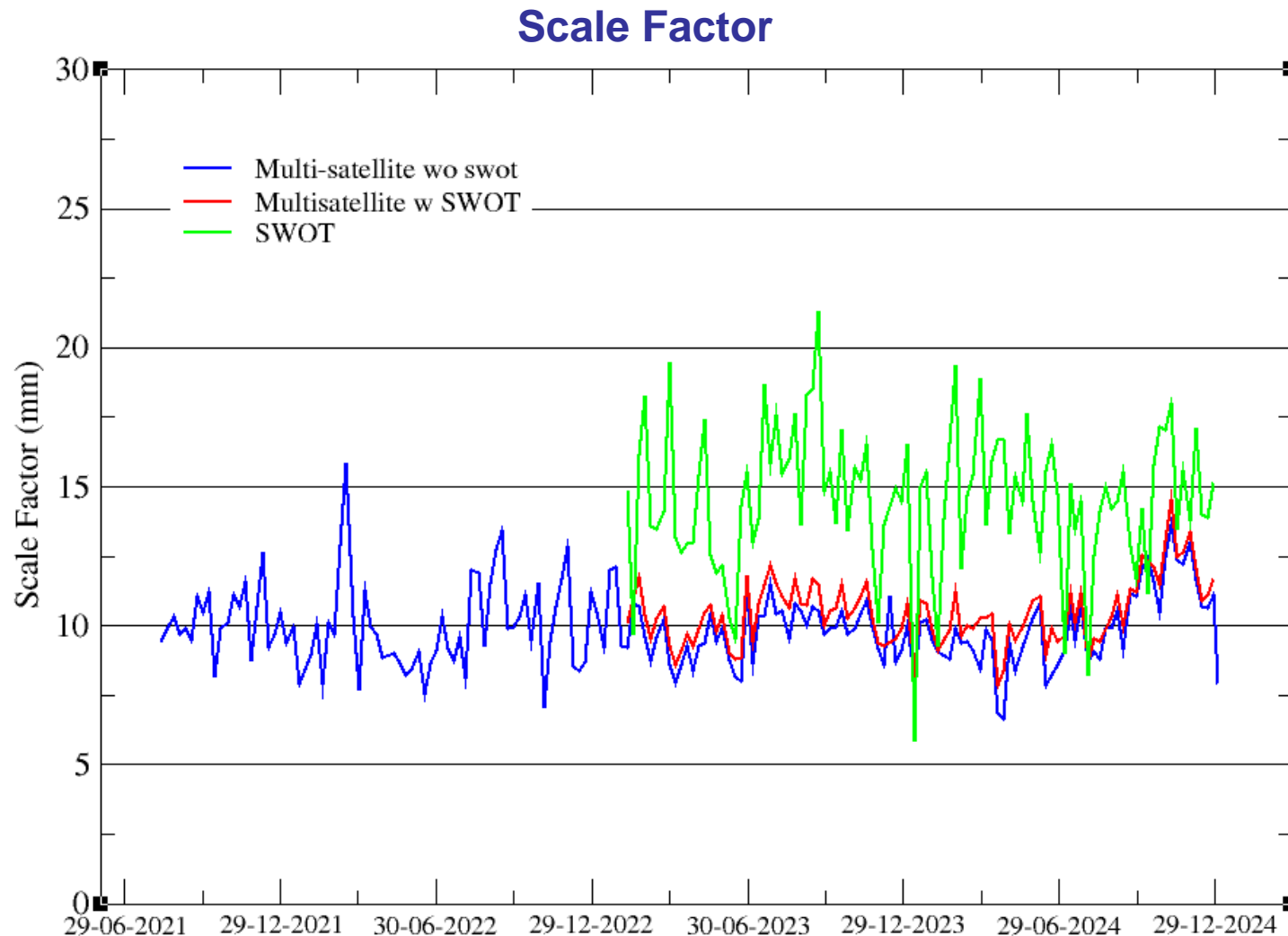


- For SWOT, there is a good agreement between GRG orbit and CNES orbit (< 1cm RMS).
- For Sentinel-3A, there is a more significant degradation at the end of 2024 (as the solar flux increases).



# Introduction of SWOT in GRG processing chain

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

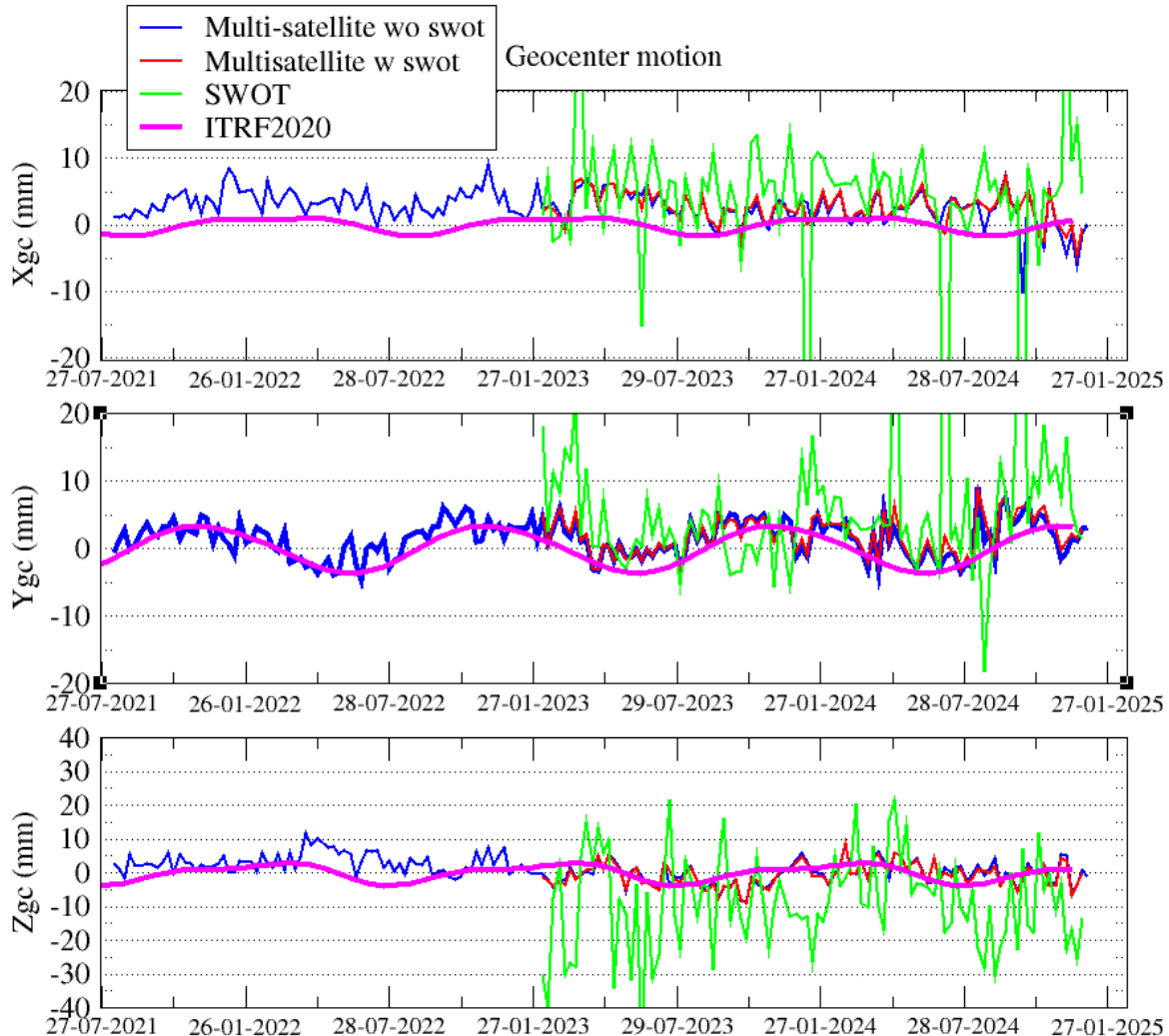


- In green SWOT single satellite solution*
- In blue: Multi-satellite solution wo SWOT*
- In red: Multi-satellite solution w SWOT*
- The contribution of SWOT causes an increase in the multi-satellite scale*

# Introduction of SWOT in GRG processing chain

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

### Origin



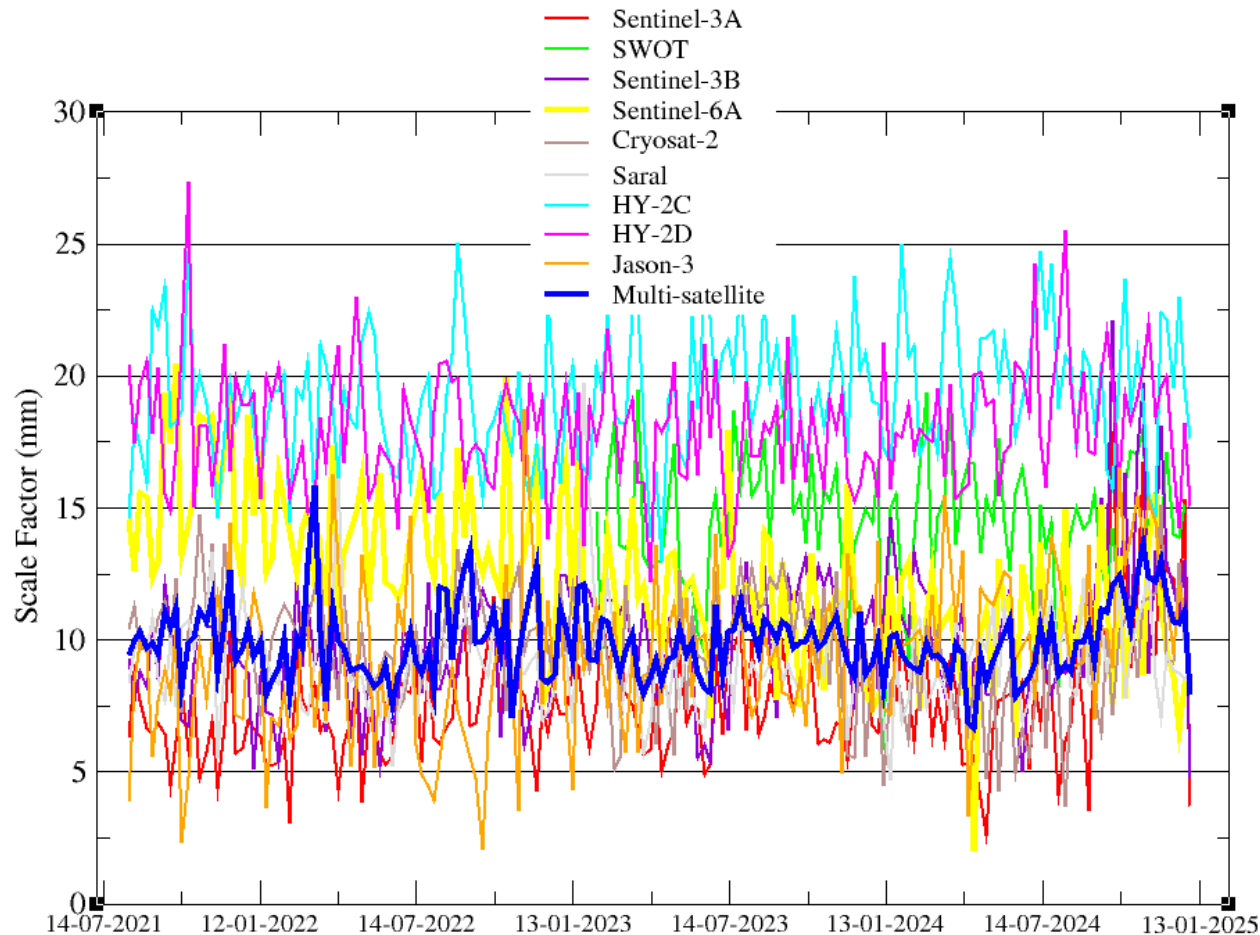
- *In green: SWOT single satellite solution. The discrepancy is higher*
- *In blue: Multi-satellite solution wo SWOT*
- *In red: Multi-satellite solution w SWOT*
- *In magenta: the Geocenter model from ITRF2020 (by Z. Altamimi)*
  
- *There is no impact on the geocenter when SWOT is added to the multi-satellite.*

# Scale from GRG solutions

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

SATELLITE	Inclination (degree)	Altitude (km)
Cryosat-2	92	717
Saral	98.65	750
Jason-3	66.04	1336
Sentinel-3A	98.65	814
Sentinel-3B	98.65	814
Sentinel-6	66.04	1336
HY-2C	66	971
HY-2D	66	971
SWOT	77	891

Scale Factor from grg solutions



- *Highest scale levels:*
  - 1) *HY-2C and HY-2D*
  - 2) *SWOT*
  - 3) *Sentinel-6A (Drift), SAA?*
  
- *Lowest scale levels:*

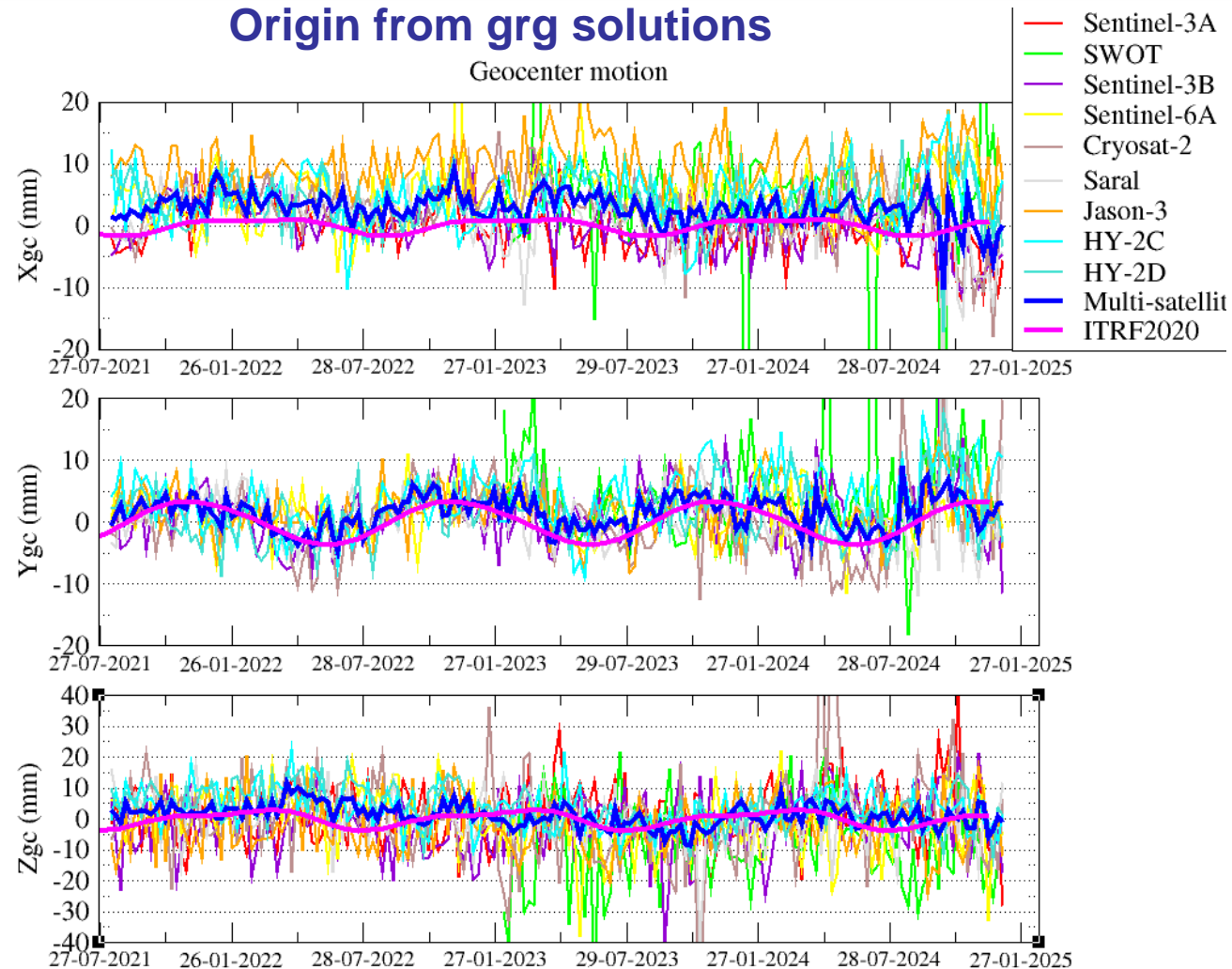
*Sentinel-3A, 3B, Cryosat-2, Saral and Jason-3*

*But slight increase at the end of 2024.*
  
- *In blue: Multi-satellite solution wo SWOT in which HY-2C and HY-2D solutions do not contribute to the scale.*

# Origin from single satellite solutions

## Comparison of each solution to DPOD2020 (computed by CATREF)

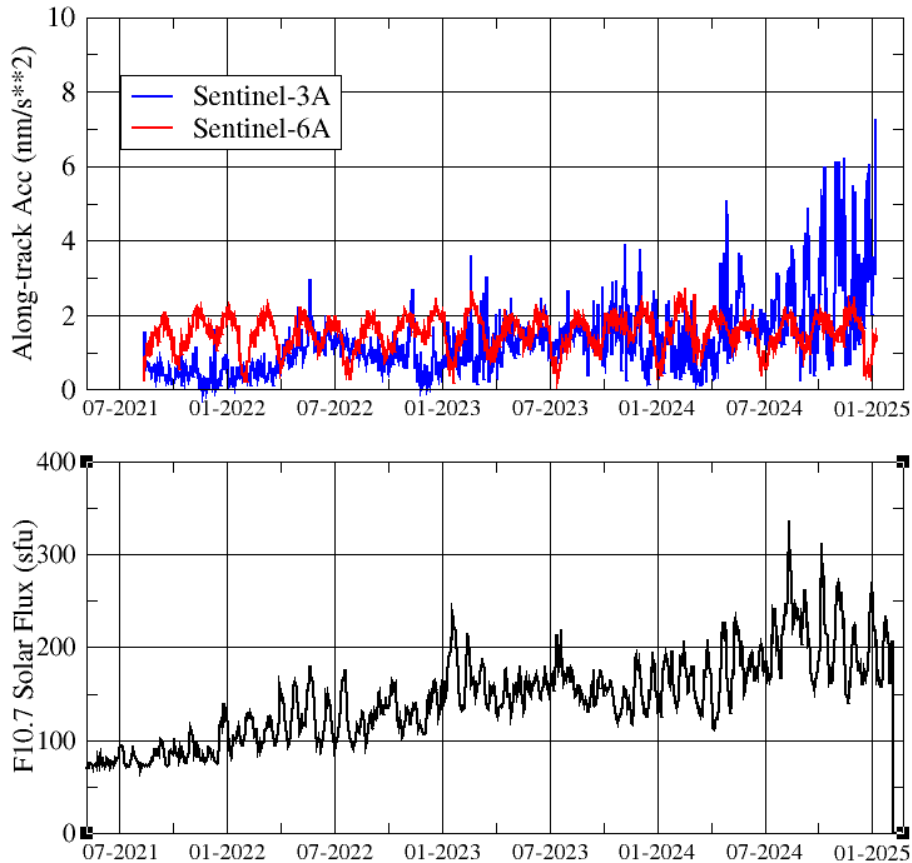
SATELLITE	Inclination (degree)	Altitude (km)
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Sentinel-6	66.04	1336
HY-2C	66	971
HY-2D	66	971
SWOT	77	891



- *T<sub>x</sub>: good agreement between the multi-satellite solution and geocenter solution from Z Altamimi. Degradation end 2024. There is a bias for Jason-3, and for HY-2C&2D, SWOT.*
- *T<sub>y</sub>: there is a good agreement between the single satellite solutions. Good agreement between the multi-satellite solution and geocenter solution from Z Altamimi.*
- *T<sub>z</sub>: correct agreement between the multi-satellite solution and geocenter solution from Z Altamimi. But the single satellites are quite scattered.*

# Impact of increased solar activity on POD

## OPR Acceleration Amplitude (along-track)

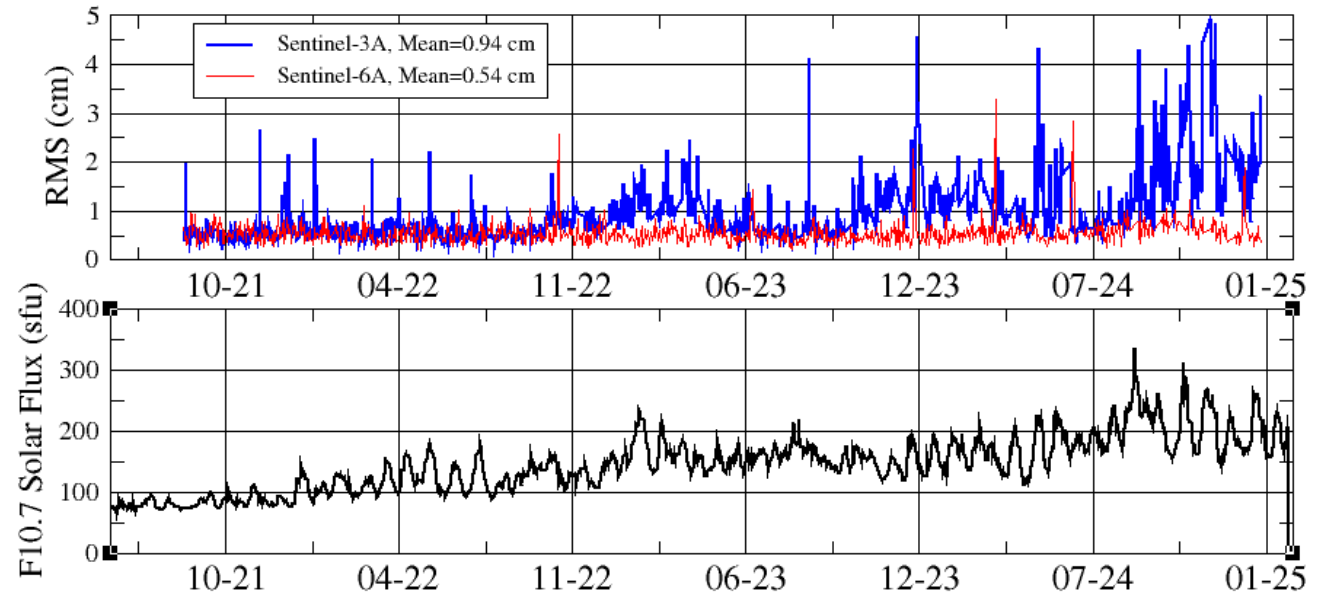


- For Sentinel-3A, there is a degradation in the along-track amplitude from early 2023 as the solar flux increases. No impact for Sentinel-6A which has a higher altitude.

## Comparison to JPL orbit

### Daily RMS orbit differences (in cm)

(from Aug. 2021 Dec. 2024)



- For Sentinel-3A, the agreement between GRG orbit and JPL orbit deteriorates as the solar flux increases.
- For Sentinel-6A, the agreement between GRG orbit and external orbit is similar over the entire period (~0.6 cm RMS), even when the solar flux is higher.

# Future work

- *Continue to analyze Origin and Scale factor from single satellite and multi-satellite solutions*
- *We plan to continue the evaluation of GRG orbits:*
  - by comparisons to internal orbits with GNSS*
  - by comparison to external orbits*
  - by Independent SLR RMS of fit*
  - by Altimeter crossover Cycles*
- *Develop a strategy to mitigate the impact of the increased solar activity*
- *Finalize the introduction of SWOT in our processing chain*
- *Contribution to the IDS Working Group:*

*Analyzing the Impact of GPS Clock as the modelled DORIS USO on Station Position Estimation for Sentinel Satellites (Presentation scheduled at the EGU)*
- *Preparation for the GENESIS mission: Tri-technique (SLR+GNSS+DORIS) combination for LEO single satellites as Sentinel-6A, 3A&B, Jason-3 ..*
- *...*