IDS AWG
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GRG AC status and evaluation of the cnes_grgs_rl05 gravity model

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Status of CNES/CLS IDS Analysis Center

❑ Status of the routine DORIS data processing

We processed DORIS data until end 2022 (Serie grgwd42, ITRF2020 configuration) and provided to IDS Combination Center.
We provided Sentinel3-A&B and Sentinel-6MF orbits to CPOD QWG until end December 2022

❑ AC studies

Analyses of the CNES/CLS IDS AC single satellites solutions → some SAA stations impacted for HY-2A, Sentinel-6 and HY-2C solutions
We redelivered a new serie by applying SAA mitigation strategy for HY-2A, Sentinel-6MF and HY-2C from the beginning of the HY-2A mission (2011/10)
We did a POD evaluation of the ITRF2020 and DTRF2020P by comparison to DPOD2014
(Poster at EGU 2023 with G. Moreaux)

In progress:

Determination of quaternions (BUS+solar panel) files for HY-2C and HY-2D satellites
Evaluation of the cnes_grgs_rl05 gravity model
…

Evaluation of the GRGS gravity models

❑ **Processing strategy:**

DORIS data have been processed with GINS/DYNAMO software taking into account IERS conventions and IDS recommendations for ITRF2020

❑ **Gravity field used:**

RL04: cnes_grgs_rl04

EIGEN-GRGS.RL04.MEAN-FIELD.linear_mean_pole.zero_slope_extrapolation

RL05: cnes_grgs_rl05

potentiel/CNES_GRGS.RL05MF_combined_GRACE_SLR_DORIS.shc

❑ **DORIS data used:**

- TOPEX from 1993/01 to 2004/10 (~12 years)
- Jason-2 from 2008/07 to 2016/04 (~8 years)
- Cryosat-2 from 2014/12 to 2022/12 (~8 years)
- Saral from 2014/12 to 2022/12 (~8 years)
- Jason-3 from 2016/03 to 2022/12 (~7 years)
- Sentinel-6A from 2020/12 to 2022/12 (2 years)

POD Evaluation

❑ DORIS RMS of fit (mm/s) and comparison to external orbit POE-F

Reference orbit = POE-F

SATELLITE	DORIS RMS (mm/s) RL04 | RL05	GRG – POE-F RMS orbit difference (mm)		
		Radial RL04 | RL05	Cross-track RL04 | RL05	Along-track RL04 | RL05
TOPEX 1993/01 to 2004/10	0.477 | 0.477	12.6 | 12.3	78.1 | 77.1	48.2 | 46.1
Jason-2 2008/07 to 2016/04	0.322 | 0.322	7.64 | 7.45	18.7 | 18.6	23.4 | 22.4
Cryosat-2 2014/12 to 2022/12	0.361 | 0.361	6.74 | 6.32	14.2 | 14.2	16.3 | 16.1
Saral 2014/12 to 2022/12	0.342 | 0.342	7.07 | 5.96	13.3 | 13.3	17.7 | 15.2
Jason-3 2016/03 to 2022/12	0.364 | 0.364	7.72 | 7.03	26.3 | 26.4	25.2 | 22.7
Sentinel-6MF 2020/12 to 2022/12	0.367 | 0.367	8.53 | 7.02	26.9 | 27.1	26.2 | 22.8

- *DORIS RMS of fit:*

Same values with RL04 and RL05, no significant impact of gravity field.

- *Comparison to POE-F orbit:*

For radial component, the agreement is better with the new gravity field RL05.
For cross-track, no significant impact.
For along-track, the agreement is better with the new gravity field RL05.

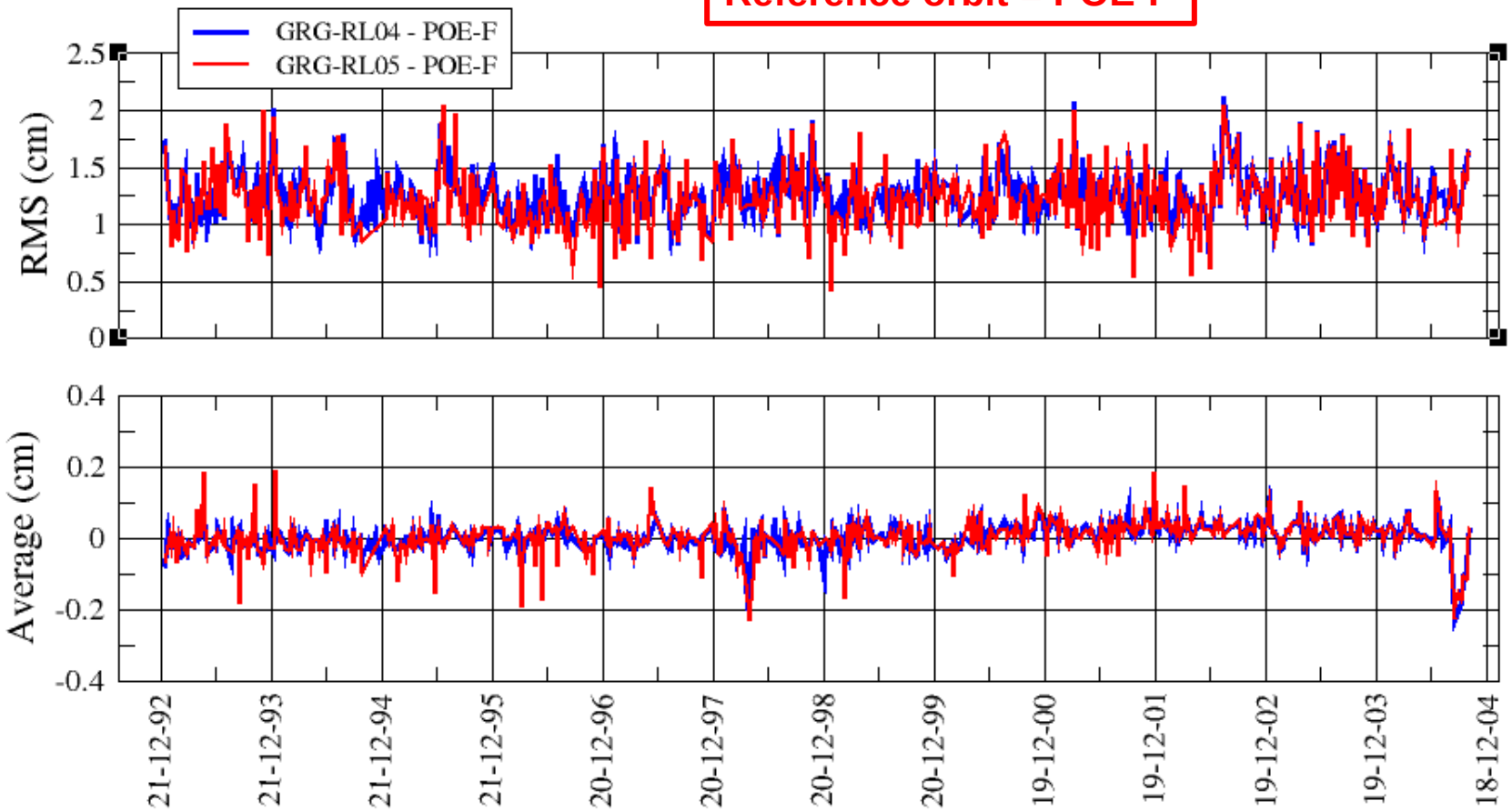
POD Evaluation

❑ Comparison to external orbit

Weekly RMS and Avg. Radial orbit differences (in cm)

- **Topex** (from 1993/01 to 2004/10)

Reference orbit = POE-F



- *For TOPEX, there is no significant impact.*

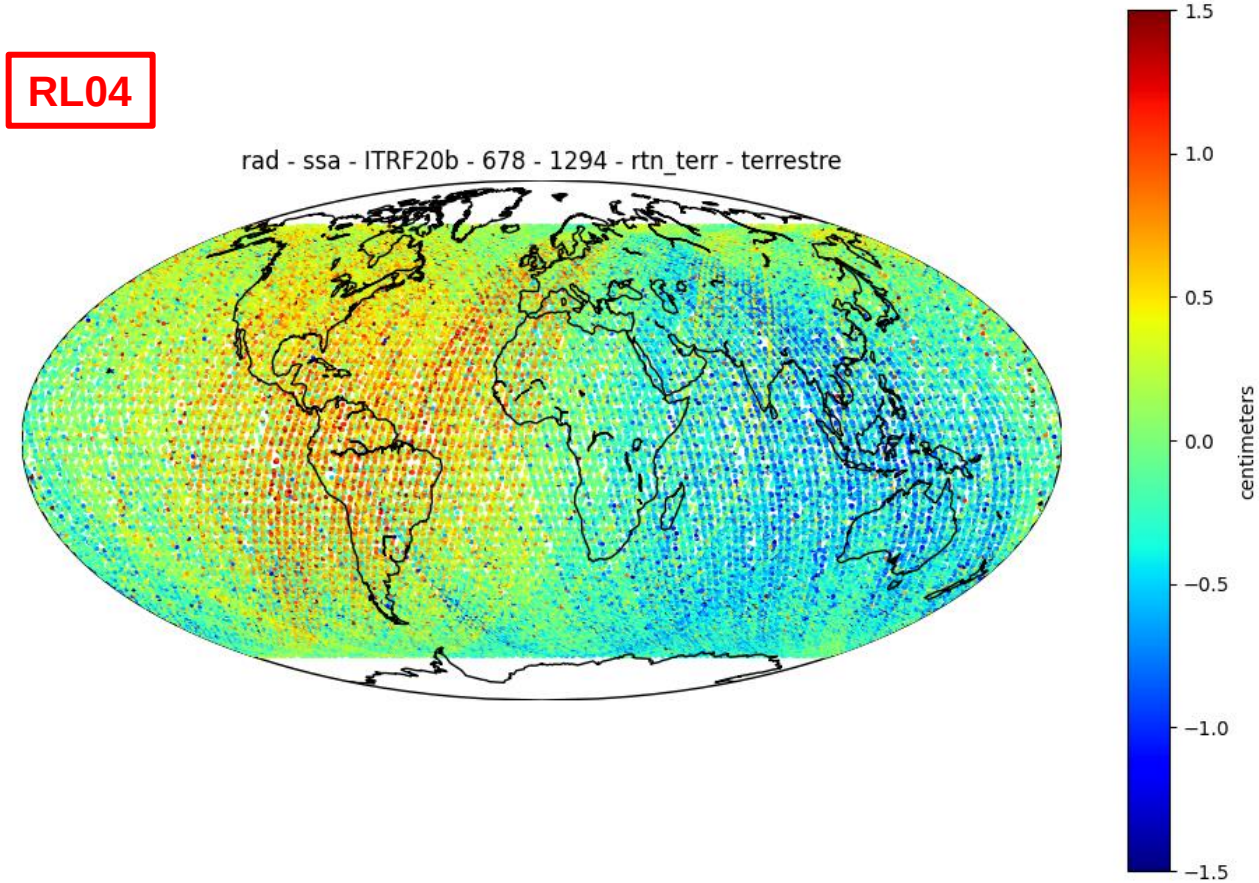
POD evaluation

❑ Comparison to external orbit: Geographically correlated radial differences (in cm)

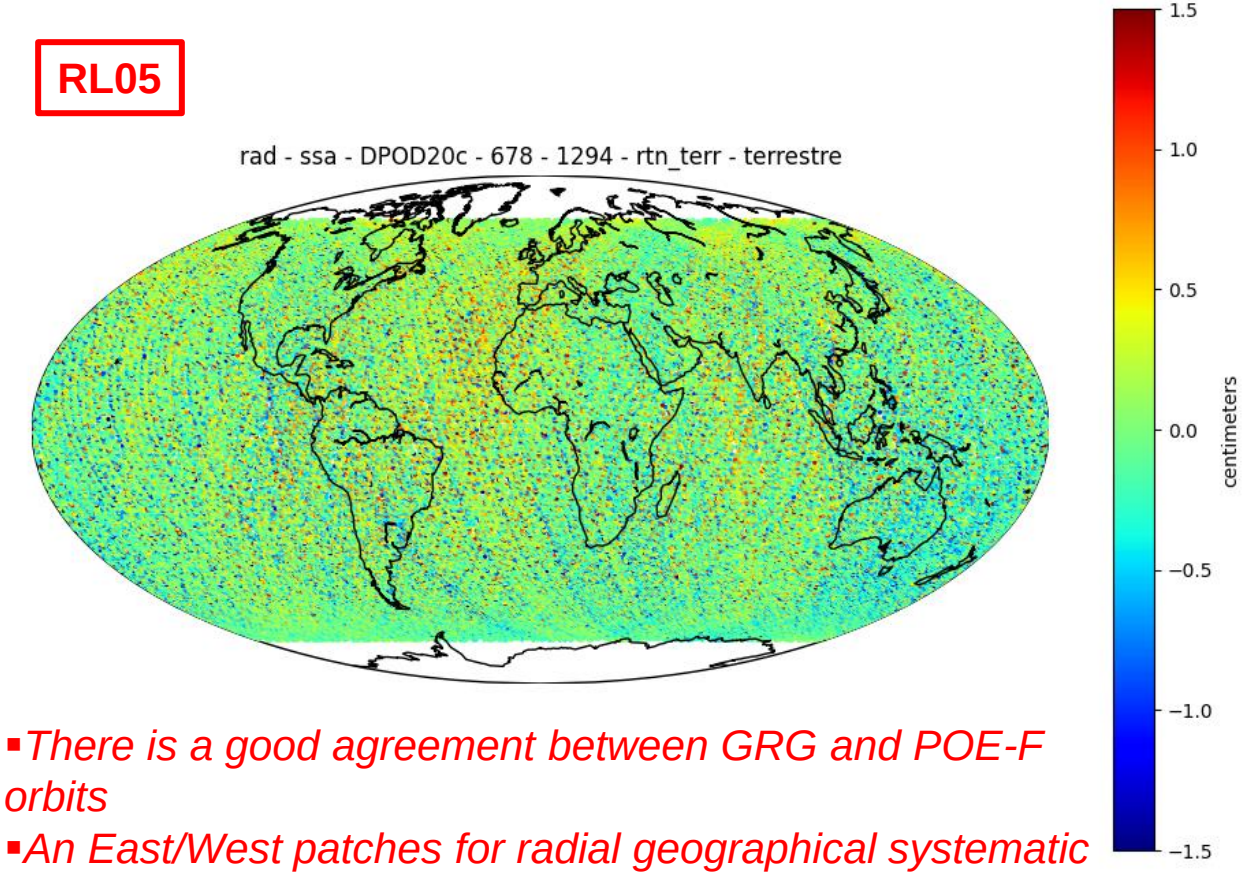
- **TOPEX** (from 1993/01 to 2004/10)

Reference orbit = POE-F

RL04



RL05



- *There is a good agreement between GRG and POE-F orbits*
- *An East/West patches for radial geographical systematic differences vanishes with RL05.*

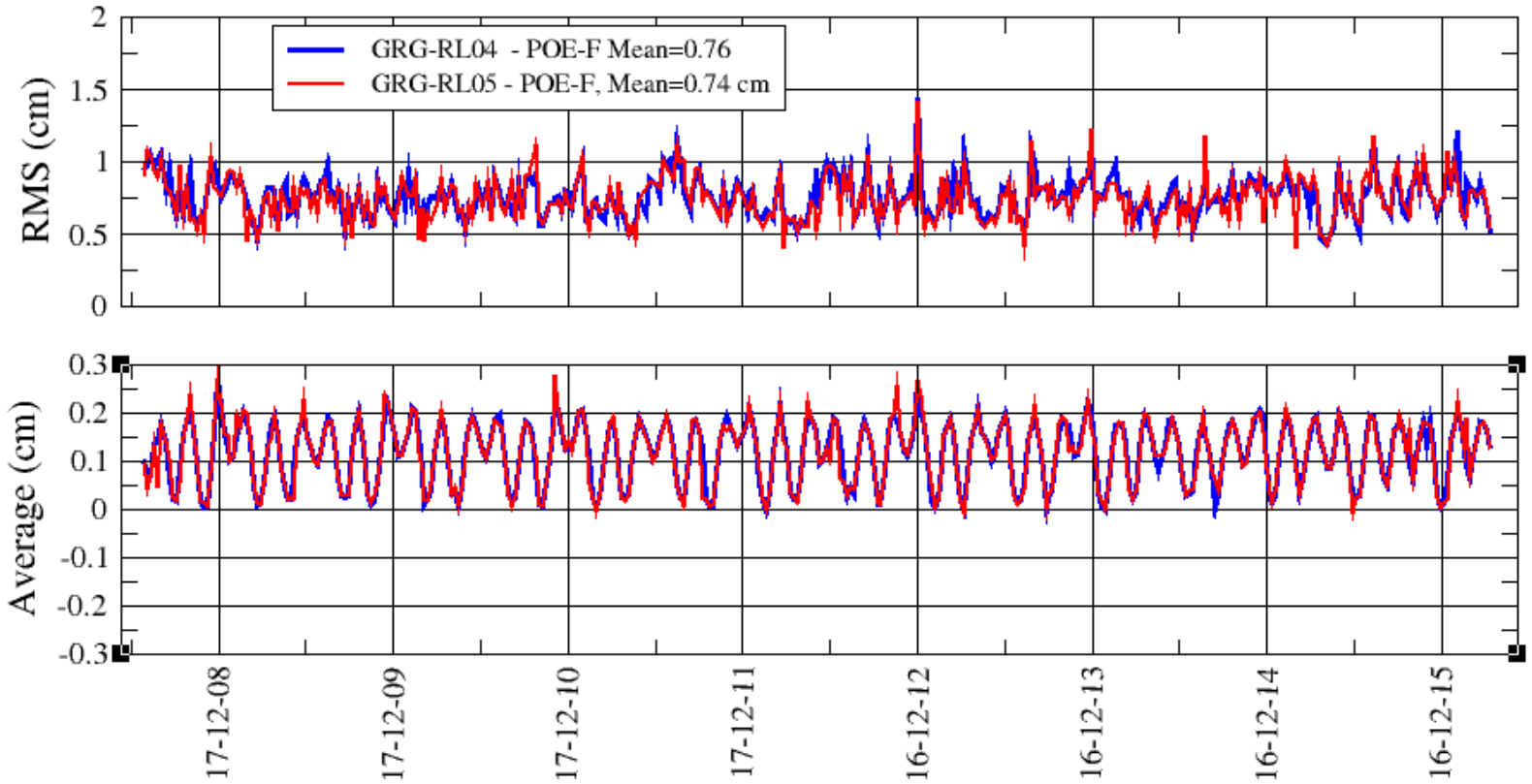
POD Evaluation

❑ Comparison to external orbit

Weekly RMS and Avg. Radial orbit differences (in cm)

- **Jason-2** (from 2008/07 to 2016/04)

Reference orbit = POE-F



- *For Jason-2, there is no significant impact.*

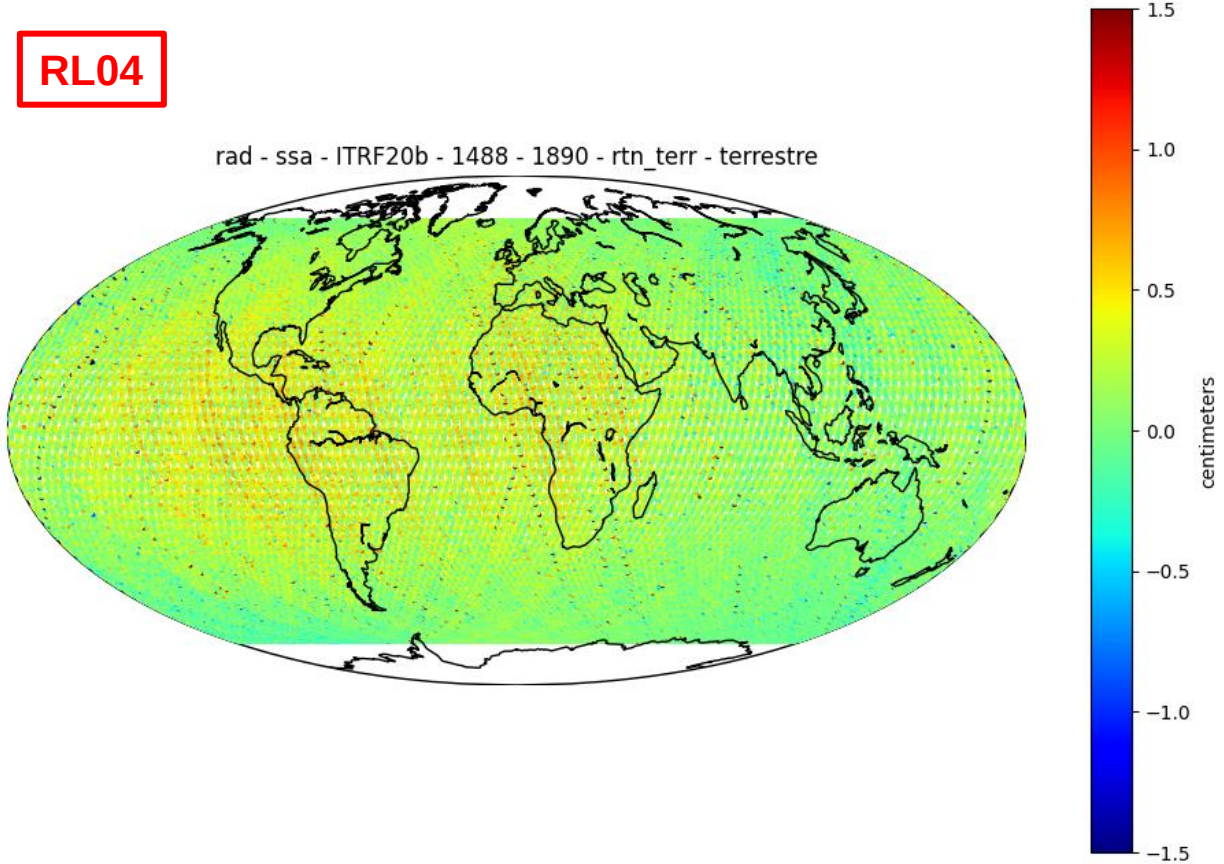
POD evaluation

❑ Comparison to external orbit: Geographically correlated radial differences (in cm)

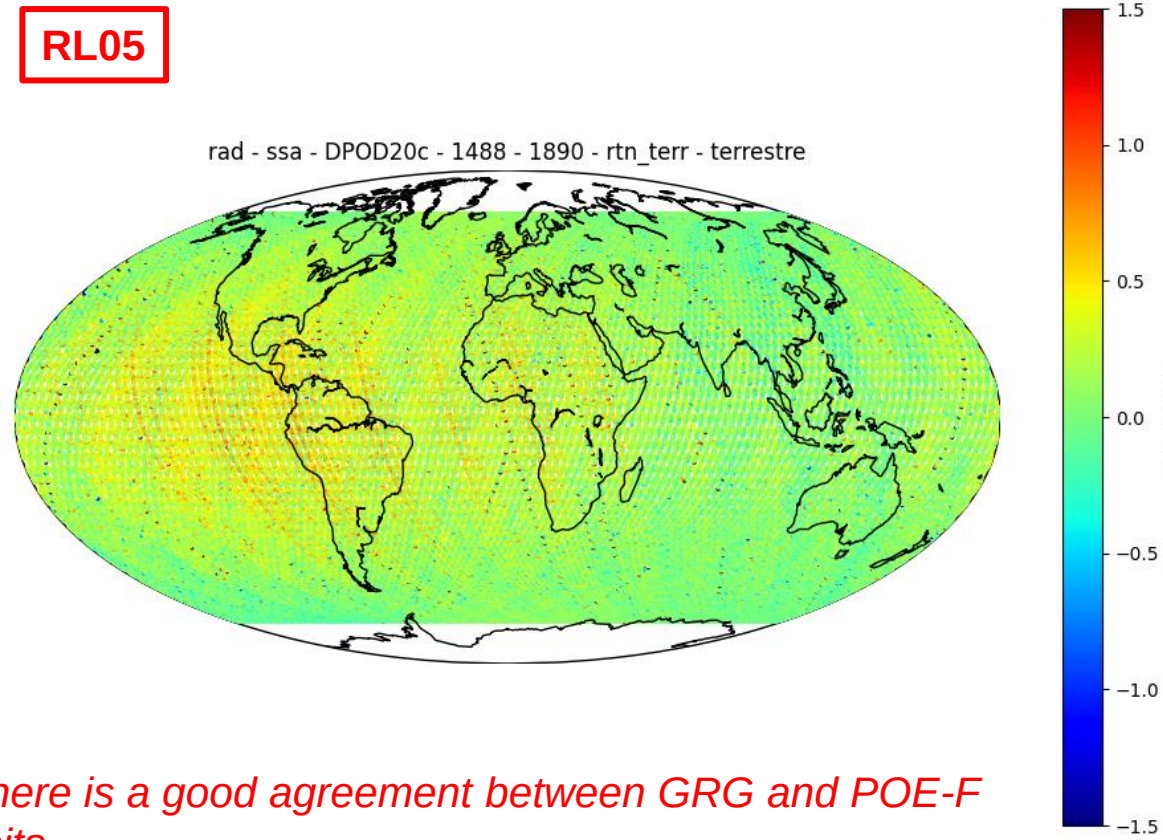
- **Jason-2** (from 2008/07 to 2016/04)

Reference orbit = POE-F

RL04



RL05



- *There is a good agreement between GRG and POE-F orbits*

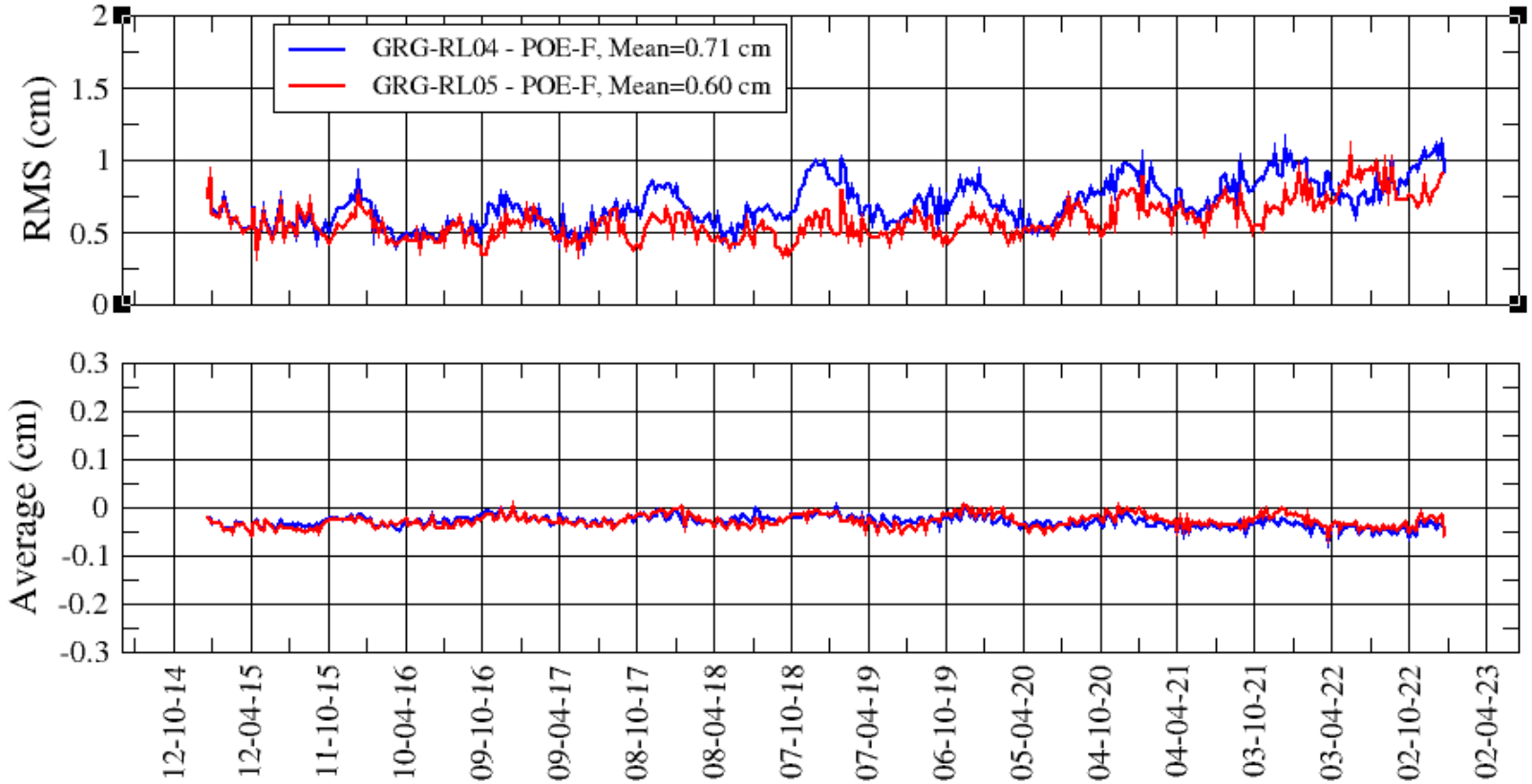
POD Evaluation

❑ Comparison to external orbit

Weekly RMS and Avg. Radial orbit differences (in cm)

- **Saral** (from 2014/12 to 2022/12)

Reference orbit = POE-F



- *For Saral, the agreement is better with RL05.*

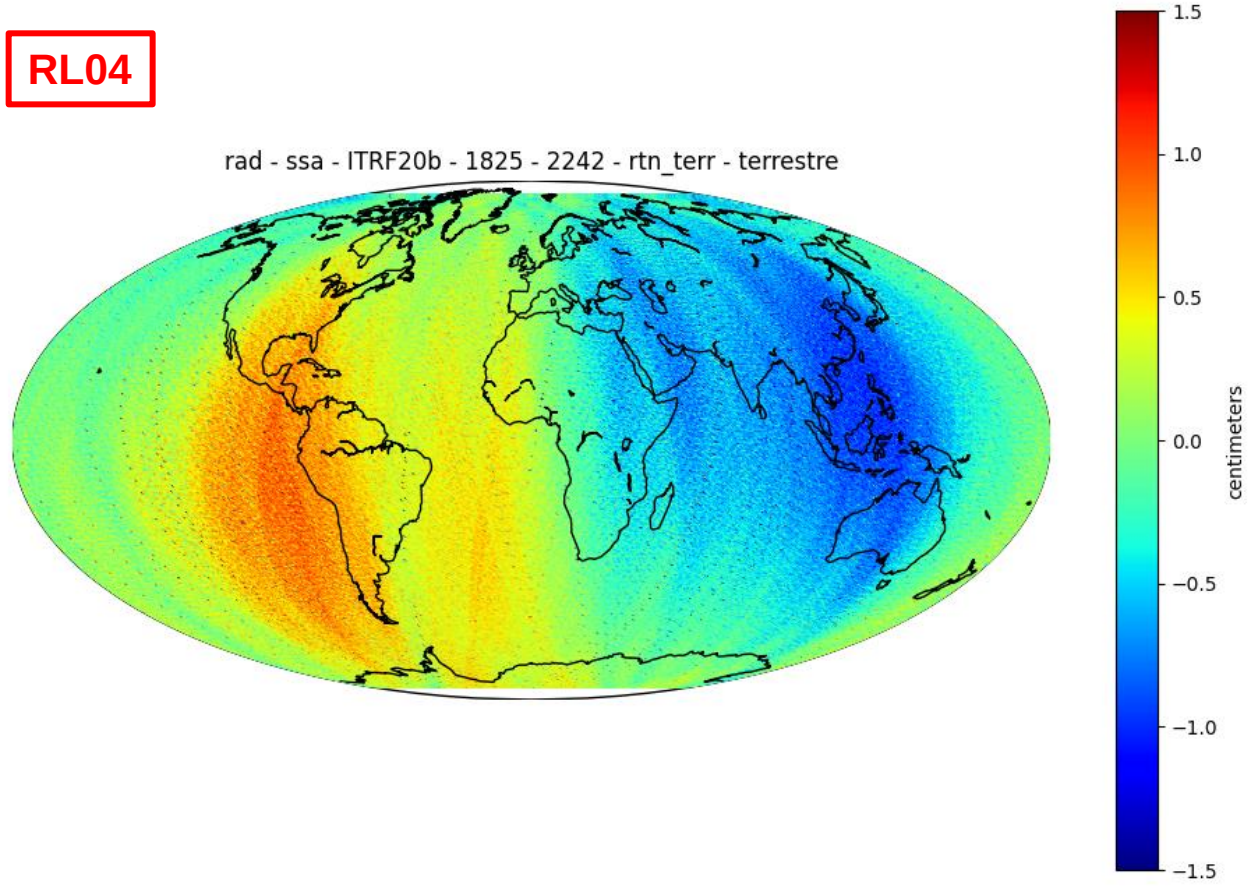
POD evaluation

❑ Comparison to external orbit: Geographically correlated radial differences (in cm)

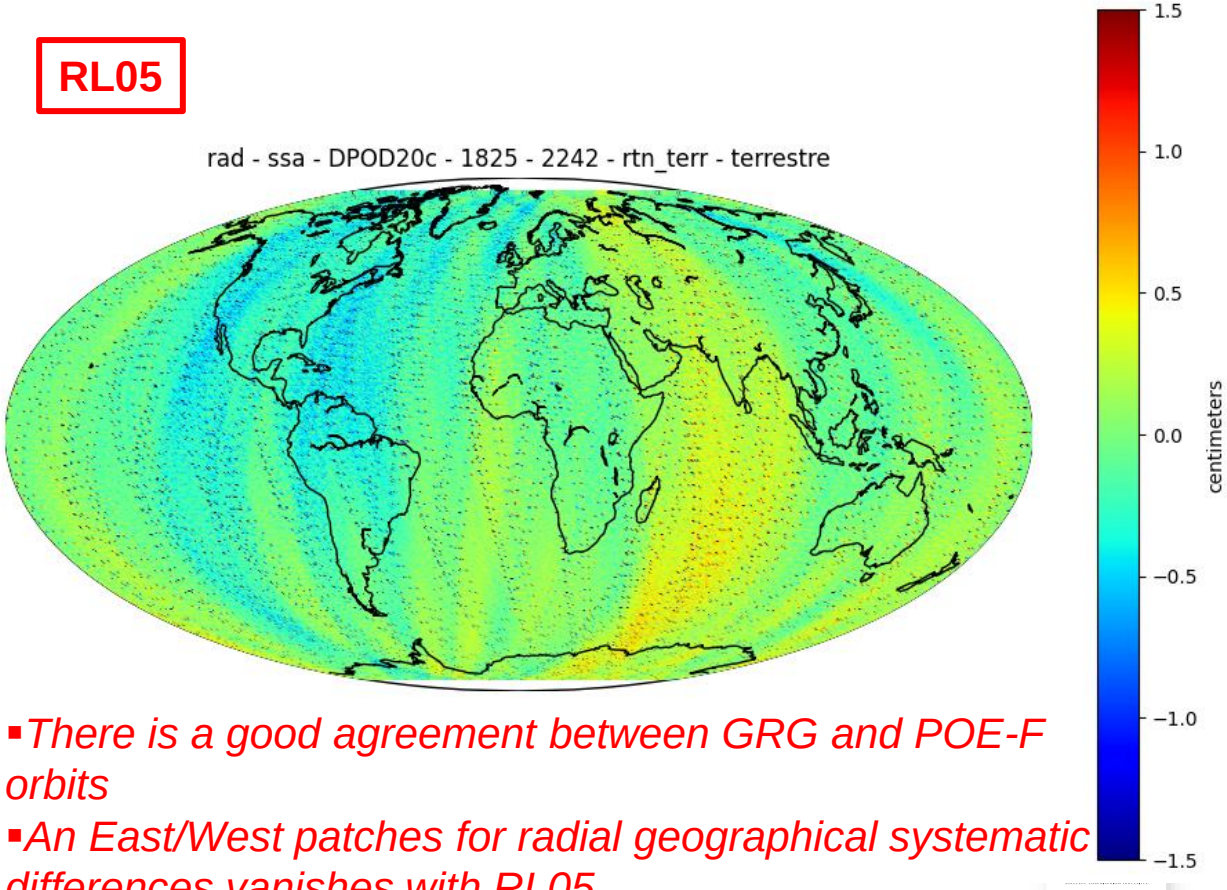
- **Saral** (from 2014/12 to 2022/12)

Reference orbit = POE-F

RL04



RL05



- *There is a good agreement between GRG and POE-F orbits*
- *An East/West patches for radial geographical systematic differences vanishes with RL05.*

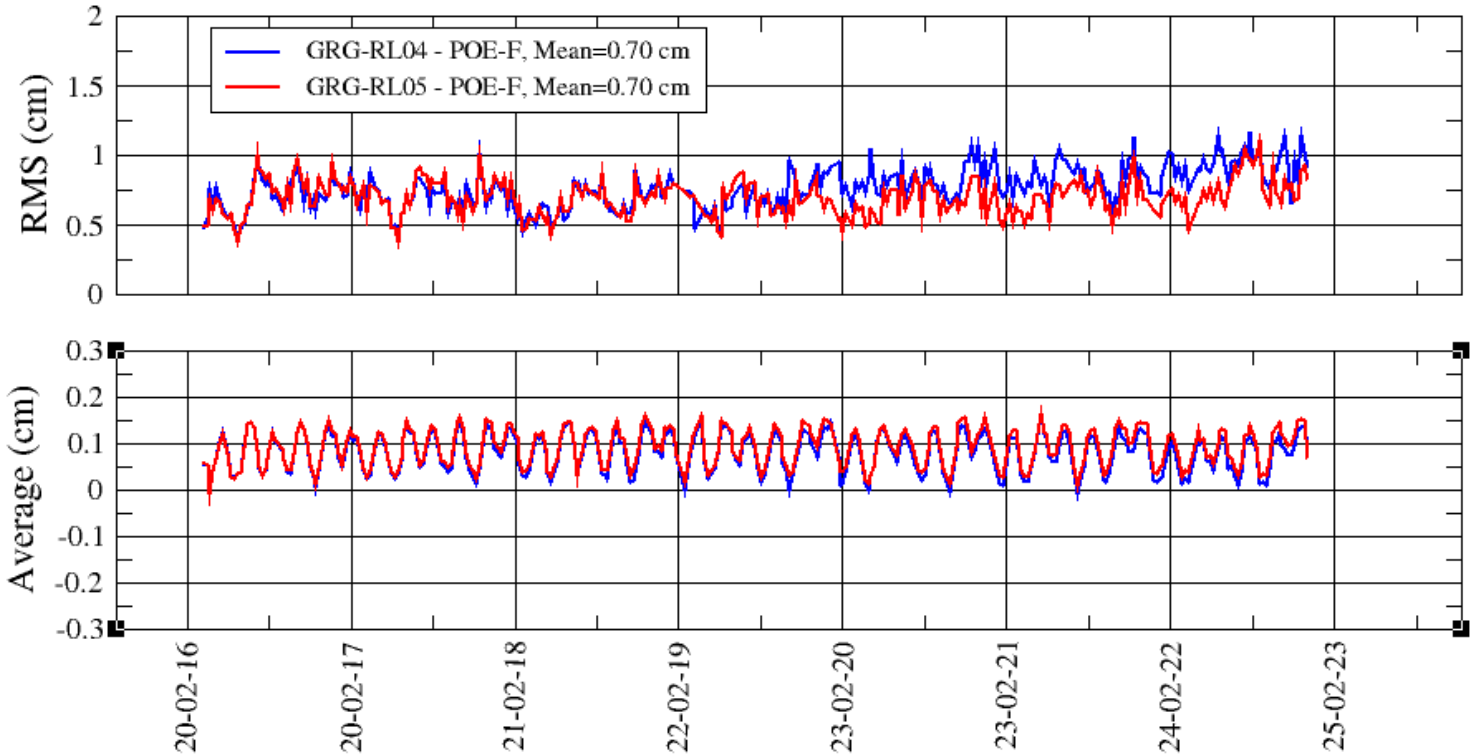
POD Evaluation

❑ Comparison to external orbit

Weekly RMS and Avg. Radial orbit differences (in cm)

- **Jason-3** (from 2016/03 to 2022/12)

Reference orbit = POE-F



- *For Jason-3*
  The agreement is better with RL05.

There is a 59 days periodic signal in the radial component. Probably due to the use of a different solar radiation pressure model (direct solar).

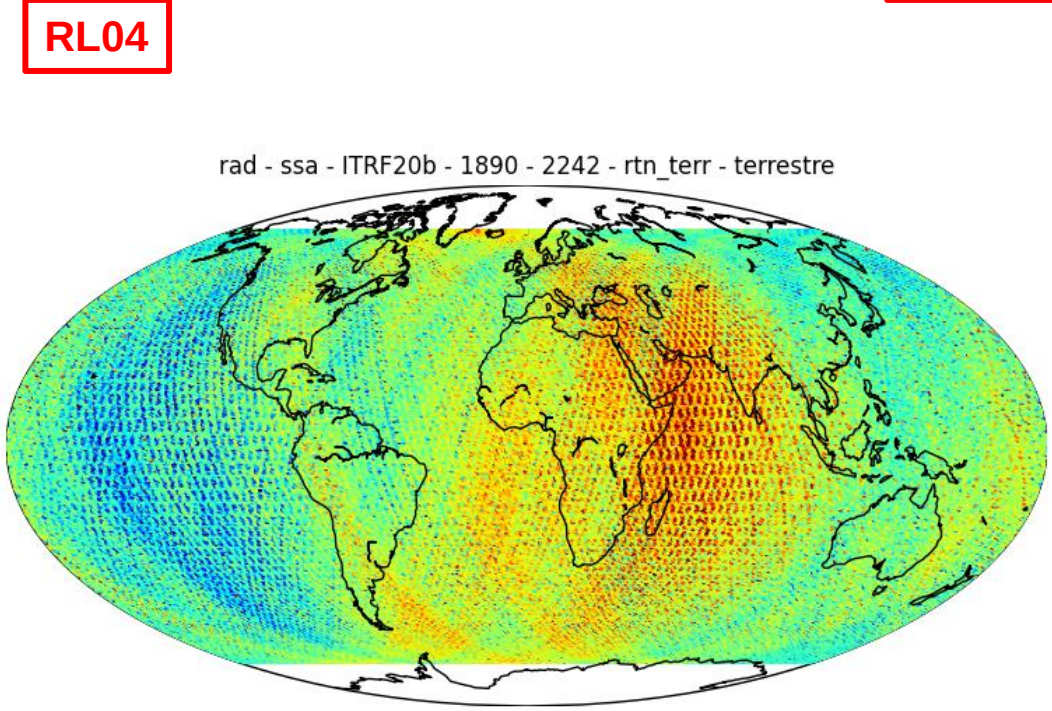
POD evaluation

❑ Comparison to external orbit: Geographically correlated radial differences (in cm)

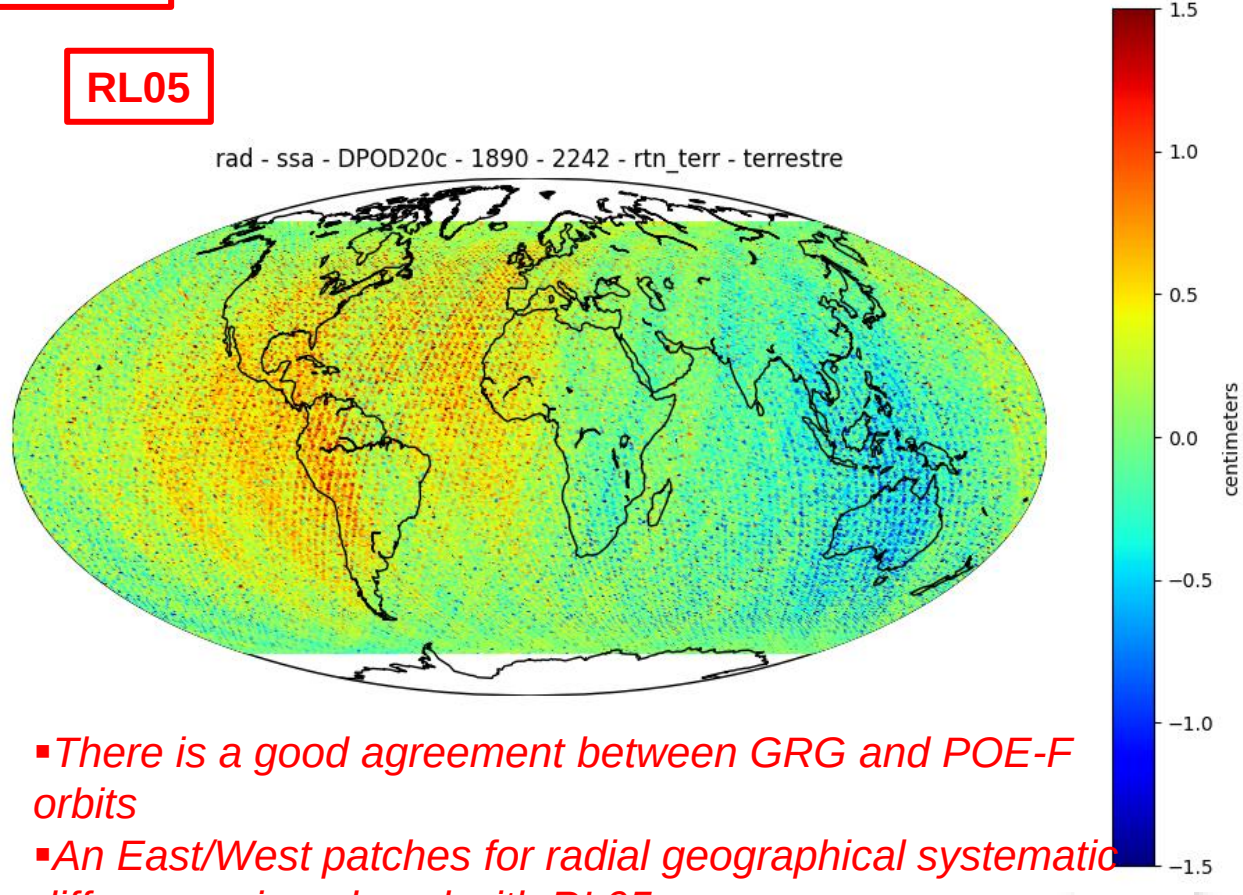
- **Jason-3** (from 2016/03 to 2022/12)

Reference orbit = POE-F

RL04



RL05



- *There is a good agreement between GRG and POE-F orbits*
- *An East/West patches for radial geographical systematic differences is reduced with RL05.*

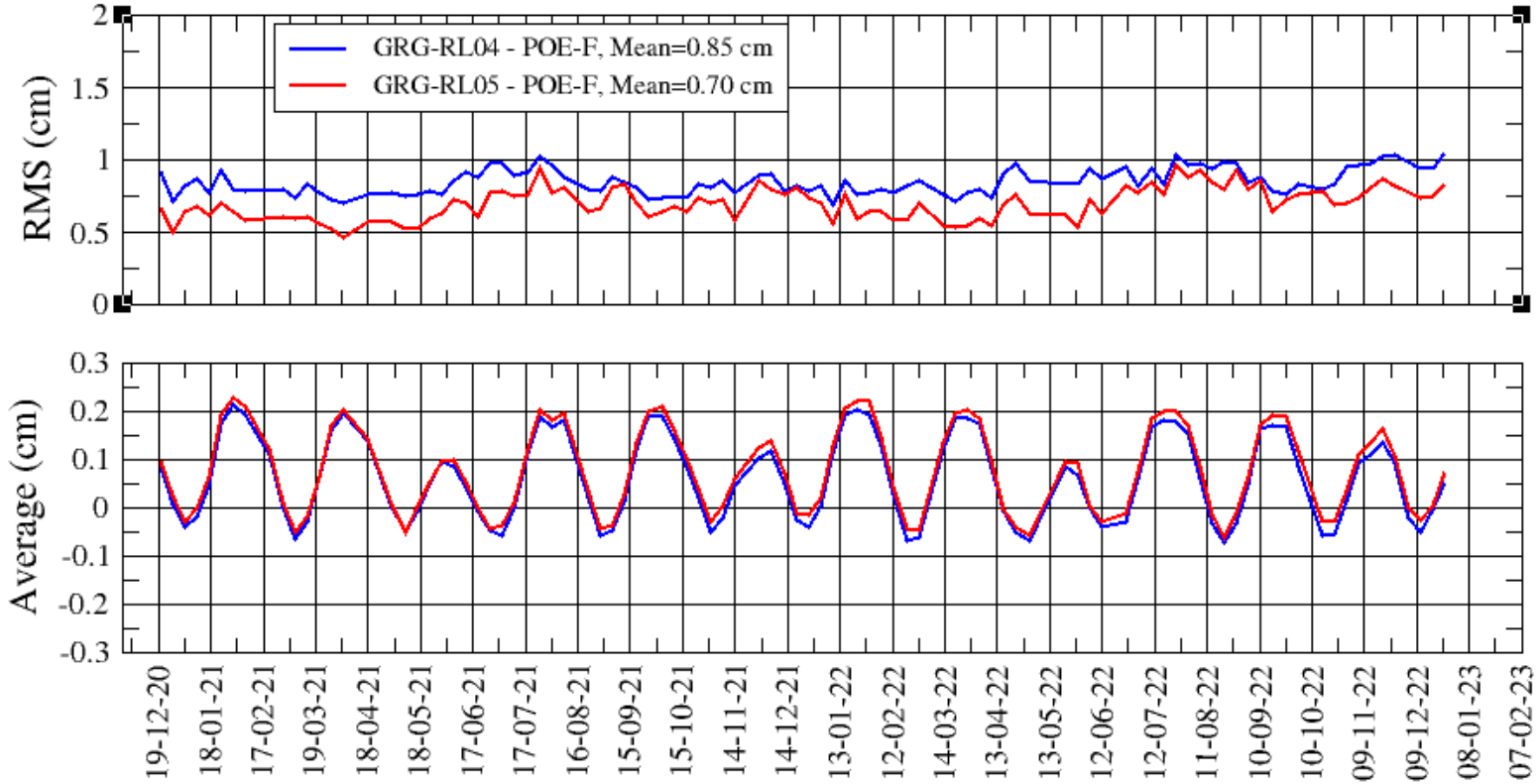
POD Evaluation

❑ Comparison to external orbit

Weekly RMS and Avg. Radial orbit differences (in cm)

- **Sentinel-6** (from 2020/12 to 2022/12)

Reference orbit = POE-F



- *For Sentienl-6*
  The agreement is better with RL05.

There is a 59 days periodic signal in the radial component. Probably due to the use of a different solar radiation pressure model (direct solar).

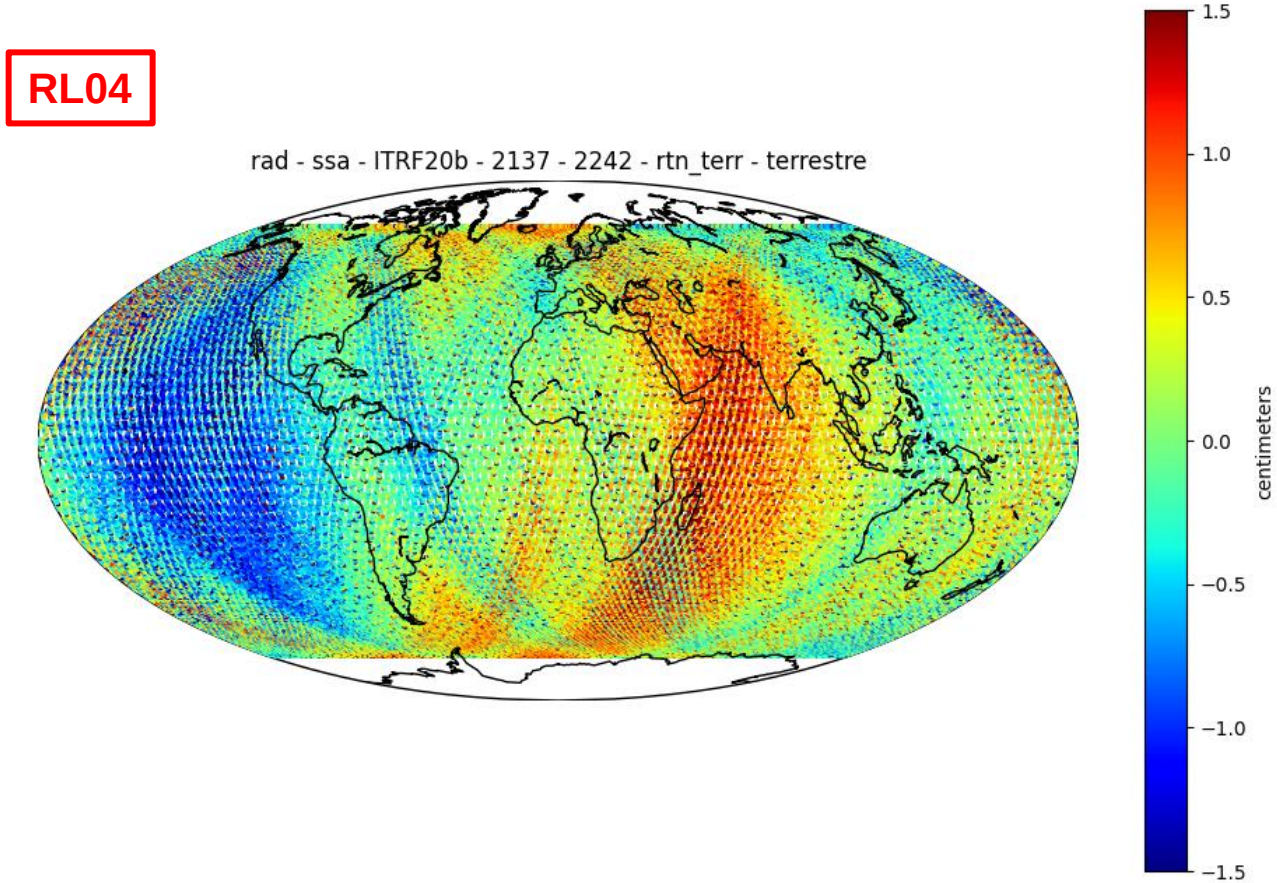
POD evaluation

❑ Comparison to external orbit: Geographically correlated radial differences (in cm)

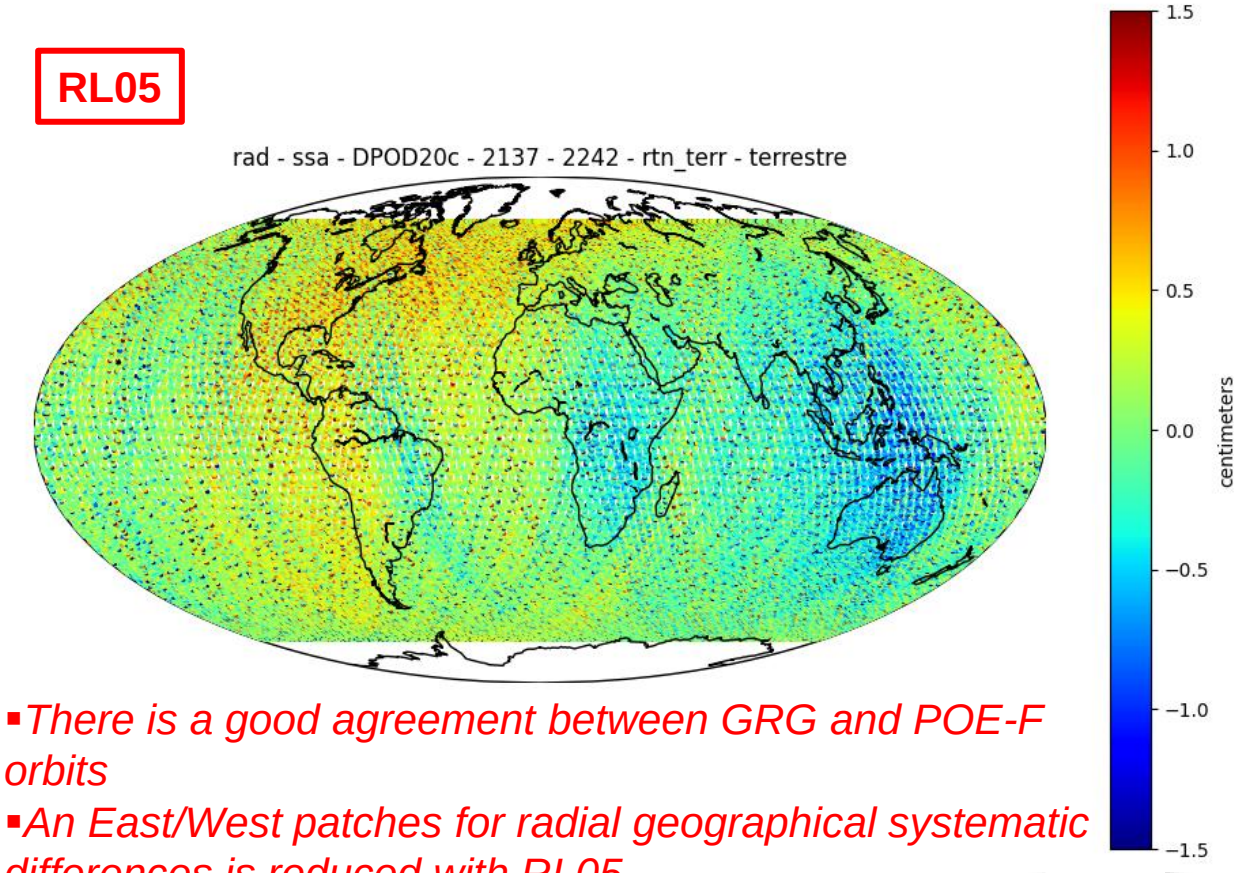
- **Sentinel-6MF** (from 2020/12 to 2022/12)

Reference orbit = POE-F

RL04



RL05

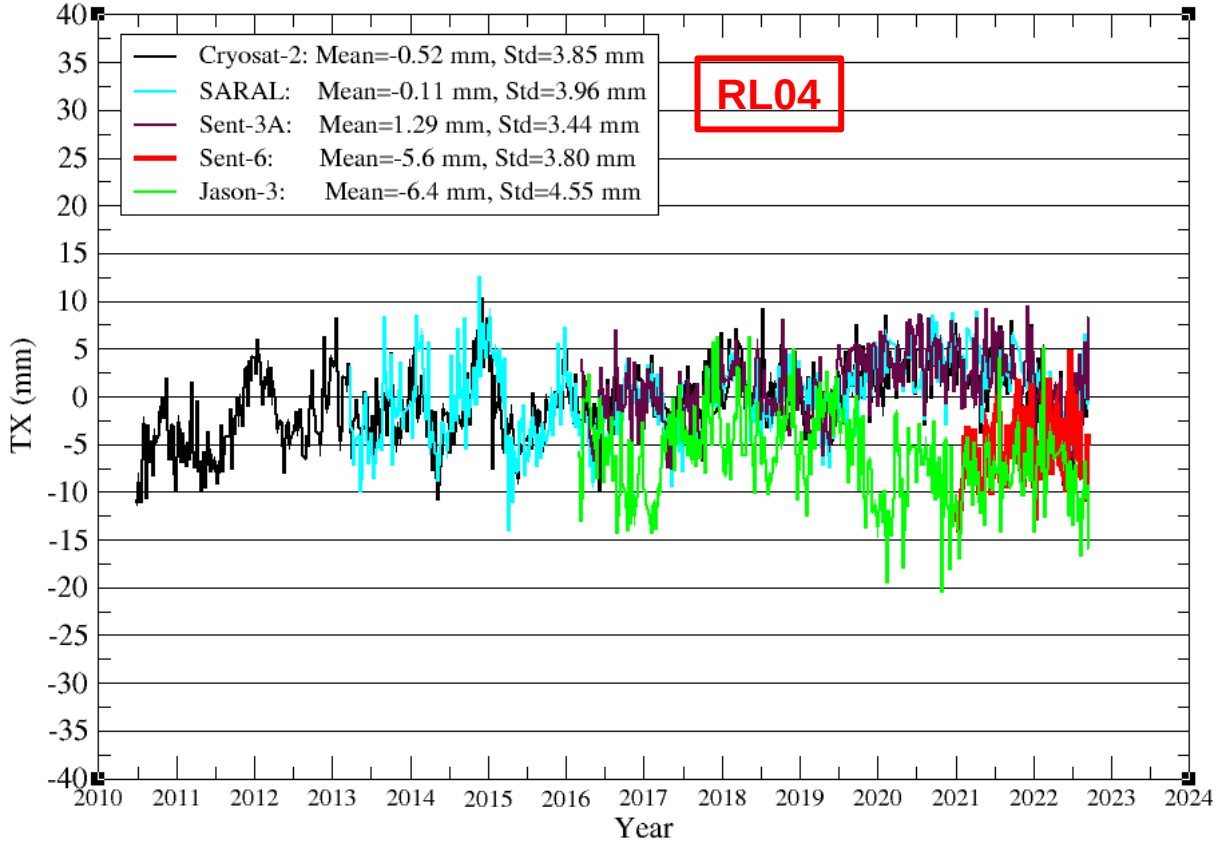


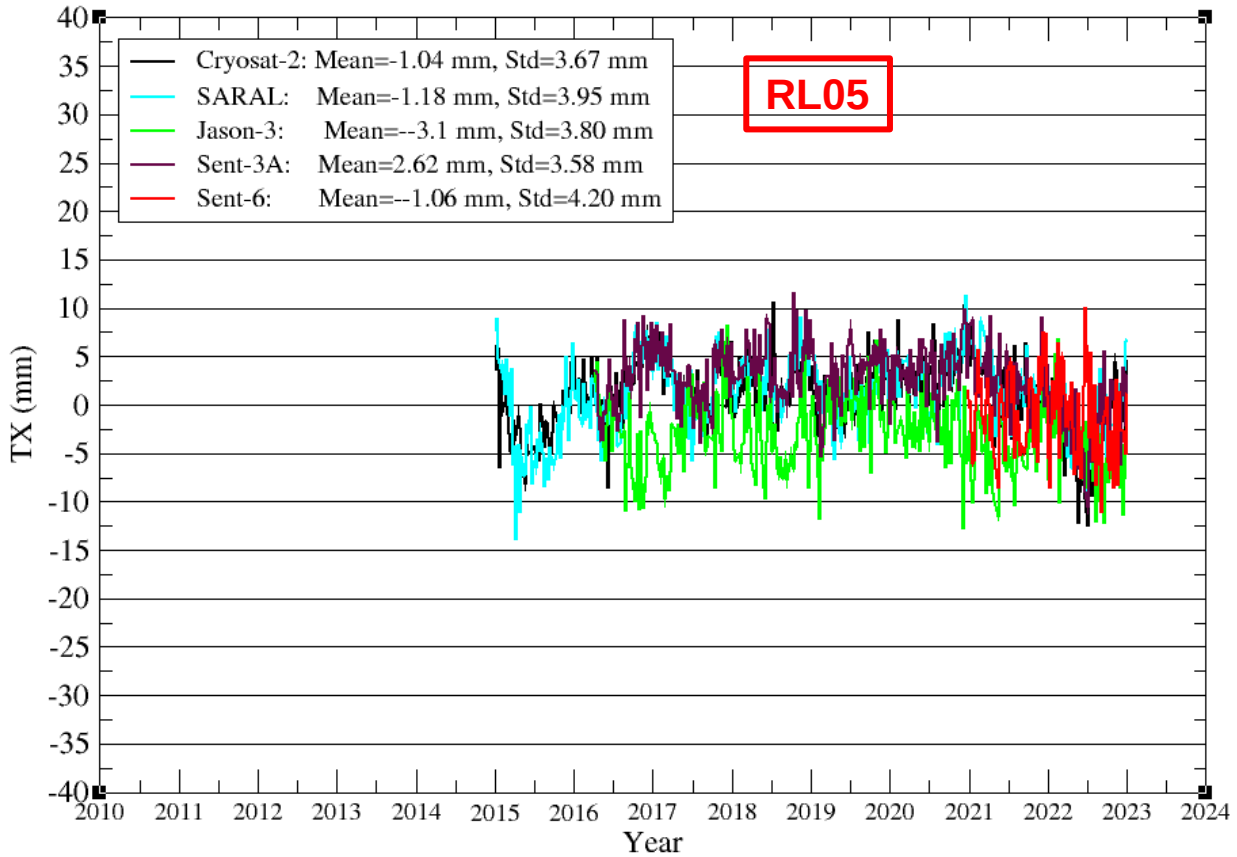
- *There is a good agreement between GRG and POE-F orbits*
- *An East/West patches for radial geographical systematic differences is reduced with RL05.*

Origin and scale from single satellite solutions

- **Comparison of each solution to DPOD2014_057 (computed by CATREF)**

TX from single satellite solutions



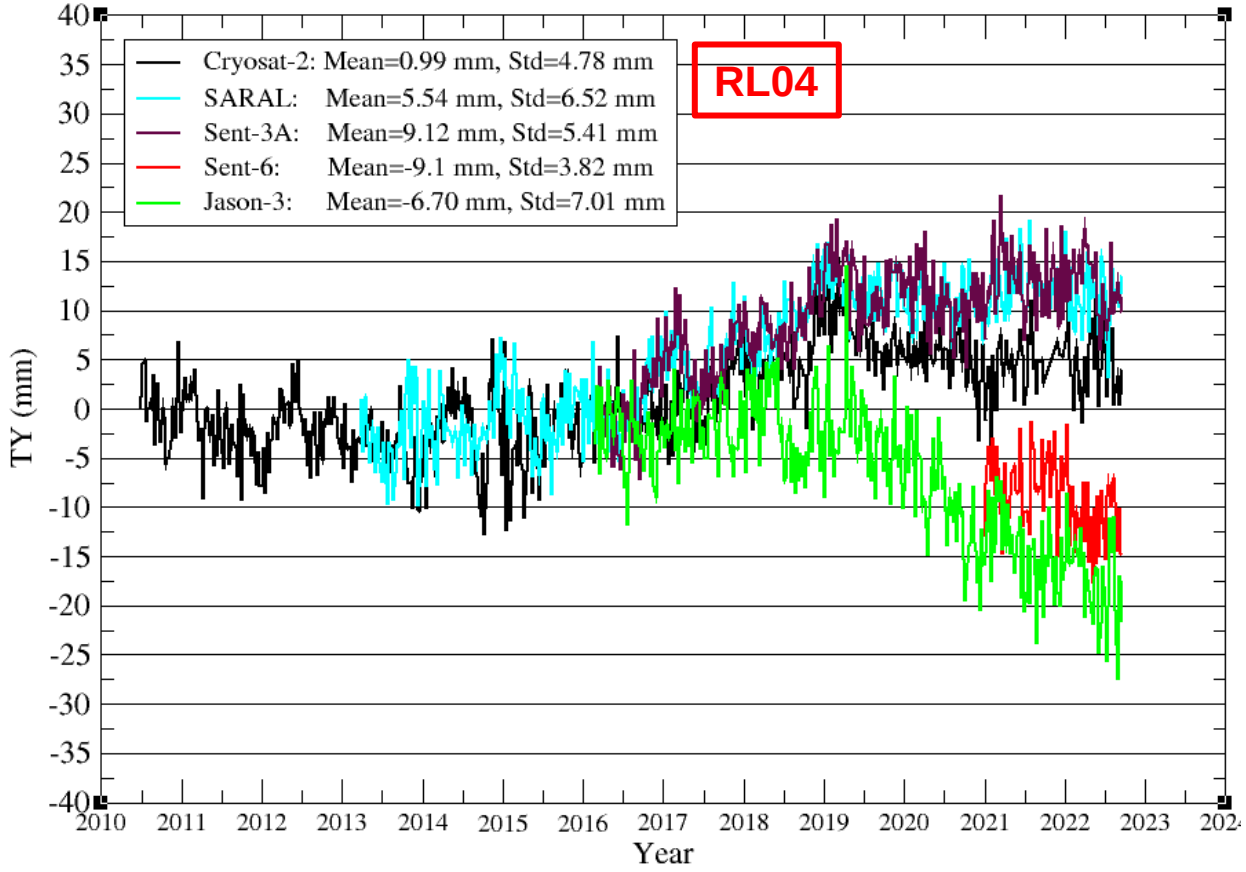


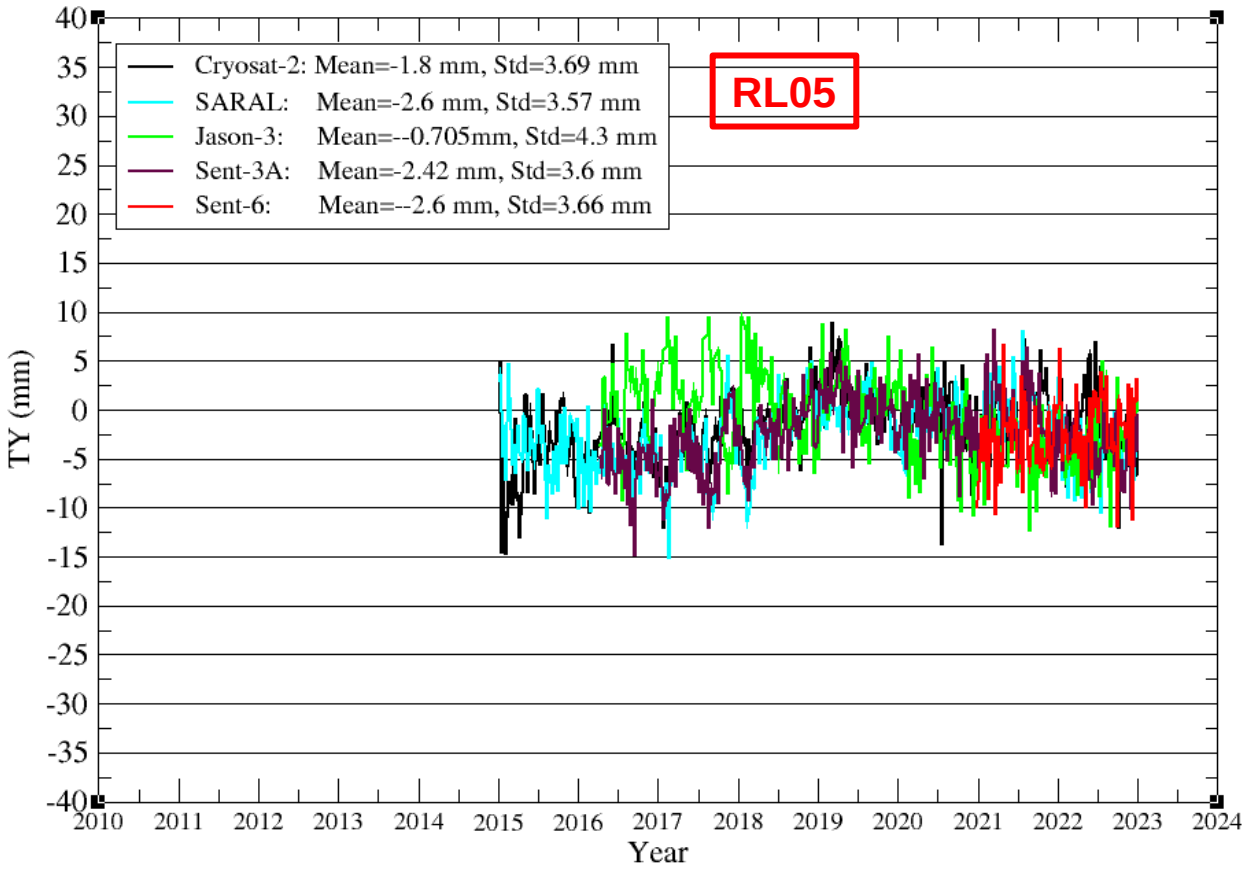
- *With RL04, Jason-3 and Sentinel-6 TX have a behavior different compared to other satellites (different altitude and inclination).*
- *With RL05, the agreement with other satellites is better.*

Origin and scale from single satellite solutions

❑ Comparison of each solution to DPOD2014_057 (computed by CATREF)

TY from single satellite solutions



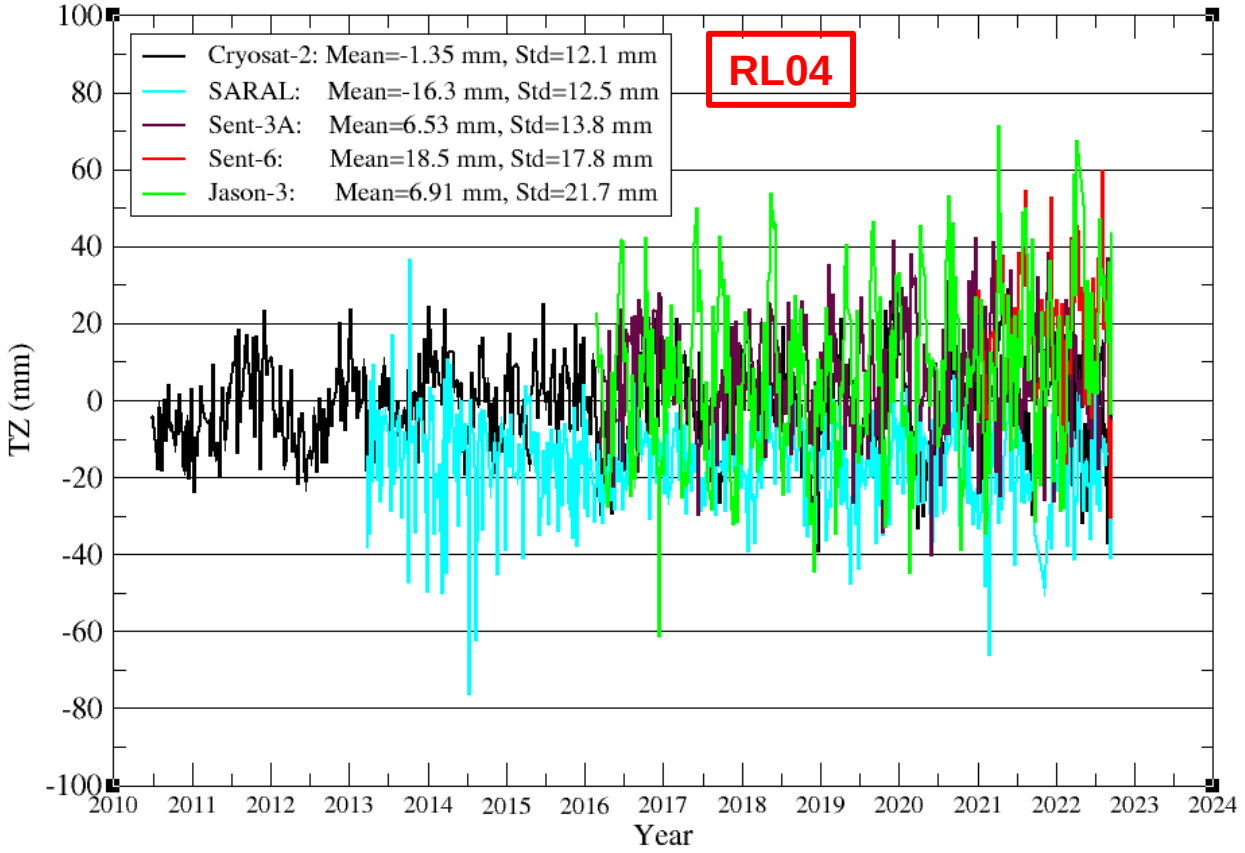


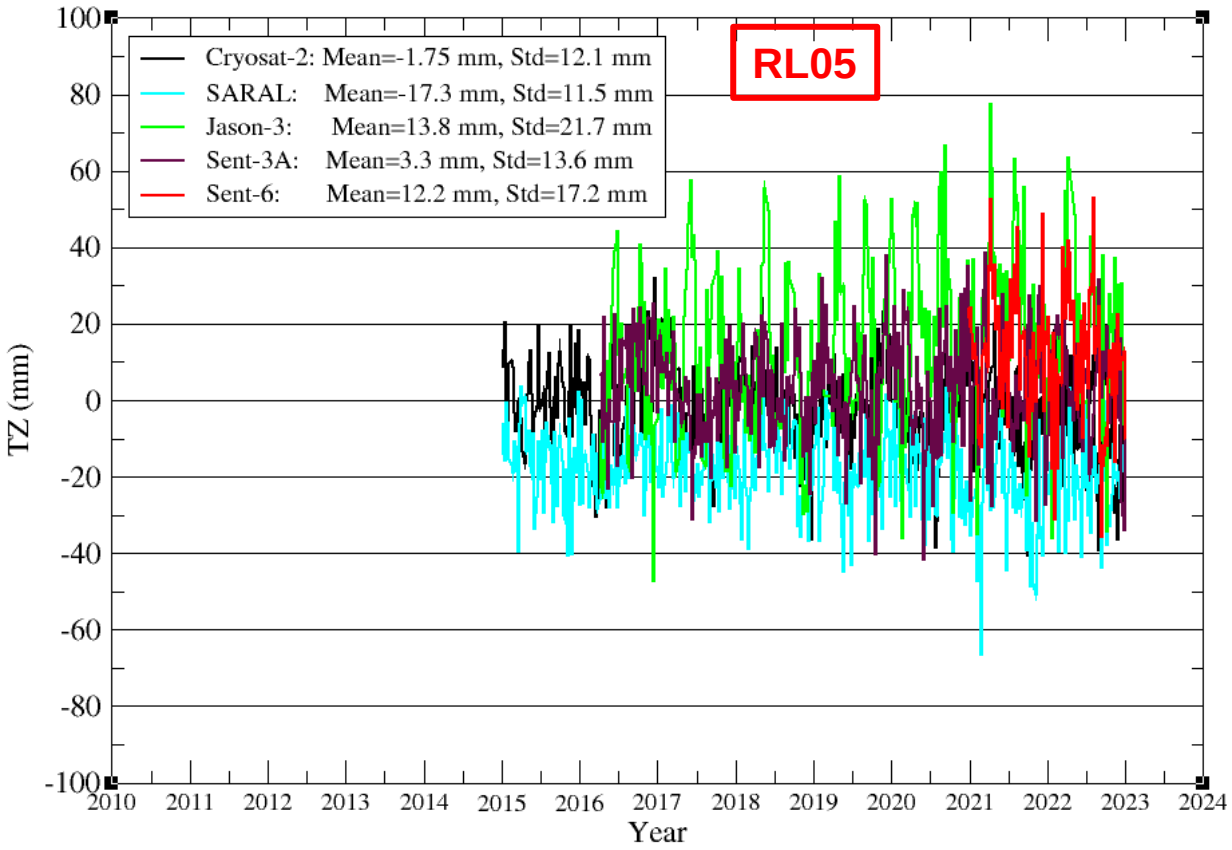
- *With RL04, Jason-3 and Sentinel-6 TX have a behavior different compared to other satellites (different altitude and inclination).*
- *With RL05, the agreement with other satellites is better.*

Origin and scale from single satellite solutions

- **Comparison of each solution to DPOD2014_057 (computed by CATREF)**

TZ from single satellite solutions





- *No significant impact on Tz.*

Conclusions and future work

- *The new GRGS gravity field RL05 improves:*
  - *The agreement between POE-F and GRG orbit*
  - *The agreement of translations Tx and Ty*

- *Future work*
  - *Continue to analyze Origin and Scale factor from single satellite solutions*
  - *There is good agreement between GRG orbit and external orbit but there is still room for improvement*
  - *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*
  - *Introduction of SWOT in our processing chain*
  - *To mitigate SAA effect Introduction of GPS epochwise estimated onboard clocks*
    - *Possible with Sentinel-3A, Sentinel-3B and Sentinel-6MF.*

Jalabert et al., 2018. Analysis of South Atlantic Anomaly perturbations on Sentinel-3A Ultra Stable Oscillator. Impact on DORIS phase measurement and DORIS station positioning, Adv. Space Res.
Štěpánek et al., U., 2020. Inclusion of GPS clock estimates for satellites Sentinel-3A/3B in DORIS geodetic solutions, J. Geod.