EGU21-5384
G2 - Reference Frames and Geodetic Observing Systems
G2.4 - Precise Orbit Determination for Geodesy and Earth Science
Tue, 27 Apr, 15:30–17:00

DORIS results on Precise Orbit Determination and on geocenter and scale solutions from CNES/CLS IDS Analysis Center contribution to the ITRF2020

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** IDS Combination Center

Outline

- ❑ Models and Standards Update
- ❑ Processing Strategy update
- ❑ POD results
  - OPR and DORIS RMS of fit
- ❑ Status of POD for DORIS satellites used for altimetry
  - DORIS RMS of fit
  - Comparison to external orbits
- ❑ Impact on the multi-satellite solution
- ❑ Ongoing and future work

Models/Standards update

❑ Models and standards recommended by IERS

Models/Standards		OLD	NEW
Earth rotation	**Mean pole**	IERS2010	Linear mean pole from updated IERS conventions
	Subdaily pole model	Previous IERS convention	Desai & Sibois from updated IERS conventions
Gravity model	**Time variable gravity field**	EIGEN-GRGS.RL03	EIGEN-GRGS.RL04
	Oceanic/Atmospheric gravity Dealiasing Products	No	AOD 1B RL06 (GFZ)
Ocean tides	**Station displacements (ocean loading)**	FES2012	FES2014b
	Gravitational attraction	FES2012	FES2014b
Phase Law		Alcatel, STAREC-B/C	**New Alcatel**, STAREC-B/C

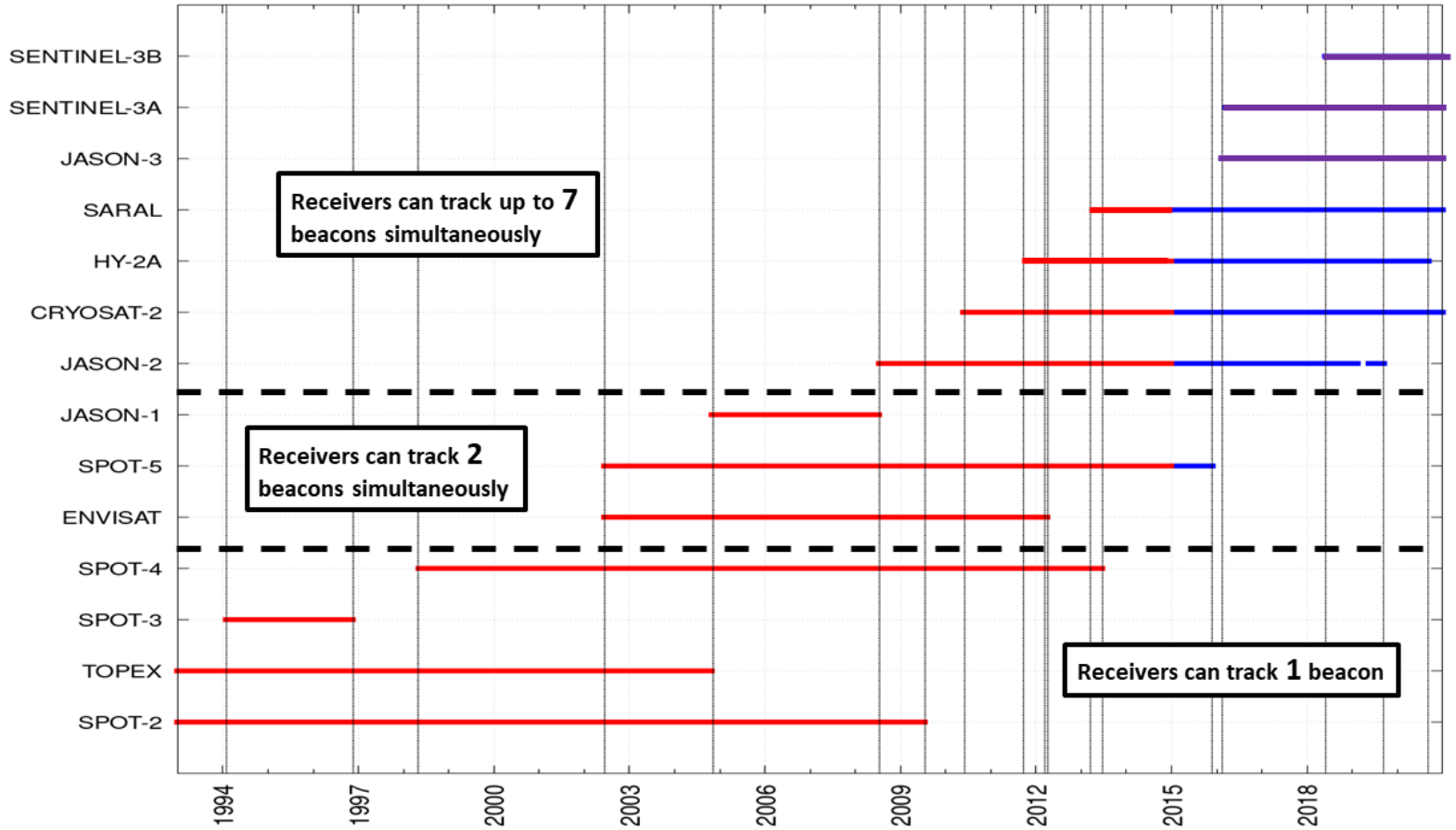
Processing strategy update

❑ Processing strategy (GINS/DYNAMO software)

Theme	OLD	NEW
Attitude modelling (Spacecraft + Solar array)	Attitude model for all satellites	Quaternions for Jason-1, Jason-2 and Jason-3
Coefficient Solar Radiation pressure Cr	Satellite dependent estimated and fixed	Satellite and time dependent Adjusted per arc (Not done for ITRF2020 but planned)
Estimated measurement parameters	One frequency bias per pass	One frequency bias **and drift for SAA stations per pass (for Jason-1, Jason-2 and Jason-3)**
Elevation cut-off and data downweighting	Cut-off 12° downweighting: $elev^2/400$ for elev < 20°	Cut-off 10°
Integration Step Size	60 sec	30 sec
SAA mitigation	Corrected data for Jason-1 and SPOT-5 Using SAA data from the most affected satellites only for POD (only for Jason-1)	Corrected data for Jason-1 and SPOT-5 Using SAA data from the most affected satellites only for POD (for Jason-1, **Jason-2&3, Sentinel-3A&B)**

Processing strategy update

❑Available DORIS data have been processed from 1993/01 to 2020/12 to contribute to the realization of the ITRF2020



ITRF2020= **ITRF2014** + **new missions (Jason-3, Sentinel-3A, Sentinel-3B)**

POD results

❑ DORIS RMS of fit and OPR Acceleration Amplitude / Radiation pressure coefficient

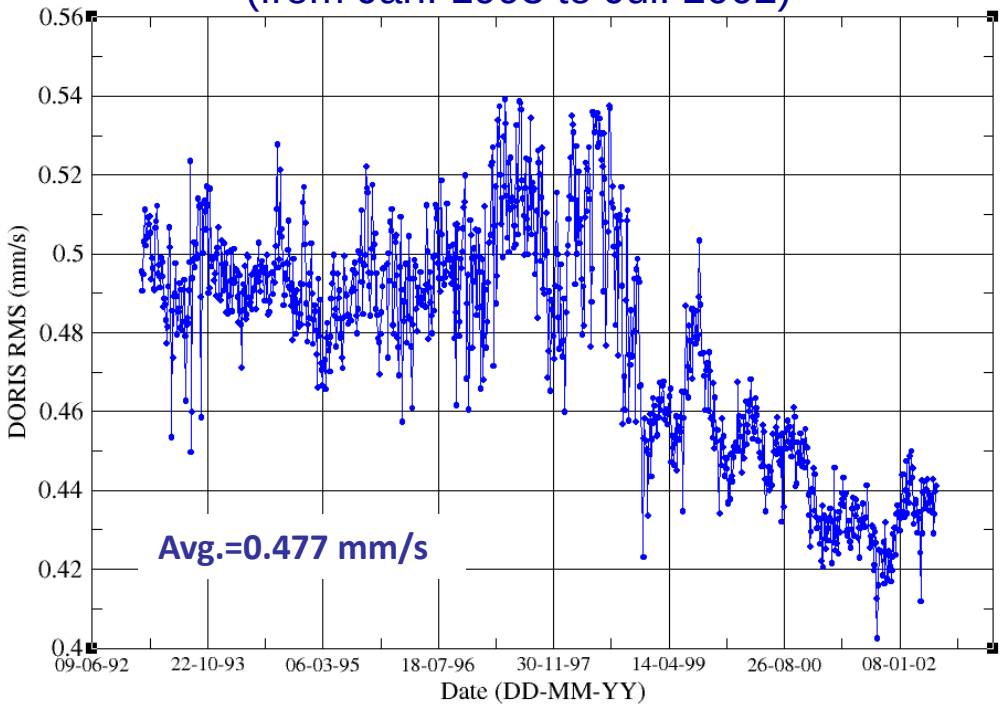
SATELLITE	DORIS RMS (mm/s)	OPR amplitude average (10^{-9} m/s^2)		Solar radiation coefficient Cr
		Along-track	Cross-track	
SPOT-2	0.42	1.8	3.6	1.07
SPOT-3	0.44	1.1	3.4	1.07
SPOT-4	0.42	1.4	2.9	1.16
TOPEX	0.46	1.5	5.8	1.03
JASON-1	0.32	2.1	2.9	0.94
SPOT-5	0.34	1.6	1.8	1.05
ENVISAT	0.39	1.0	2.0	1.05
JASON-2	0.32	4.0	2.1	0.97
CRYOSAT-2	0.35	2.9	2.6	1.0
HY2A	0.34	0.5	3.1	0.86
SARAL	0.34	1.4	2.4	1.0
JASON-3	0.36	0.9	2.2	0.99
SENTINEL-3A	0.37	2.3	1.4	1.0
SENTINEL-3B	0.38	1.4	1.5	1.0

▪ *For the two directions, Along-track and Cross-track, the mean amplitudes are lower than $4x10^{-9}$ m/s^2, reflecting a satisfying level in the modeling of the satellite macromodels and the attitude law.*

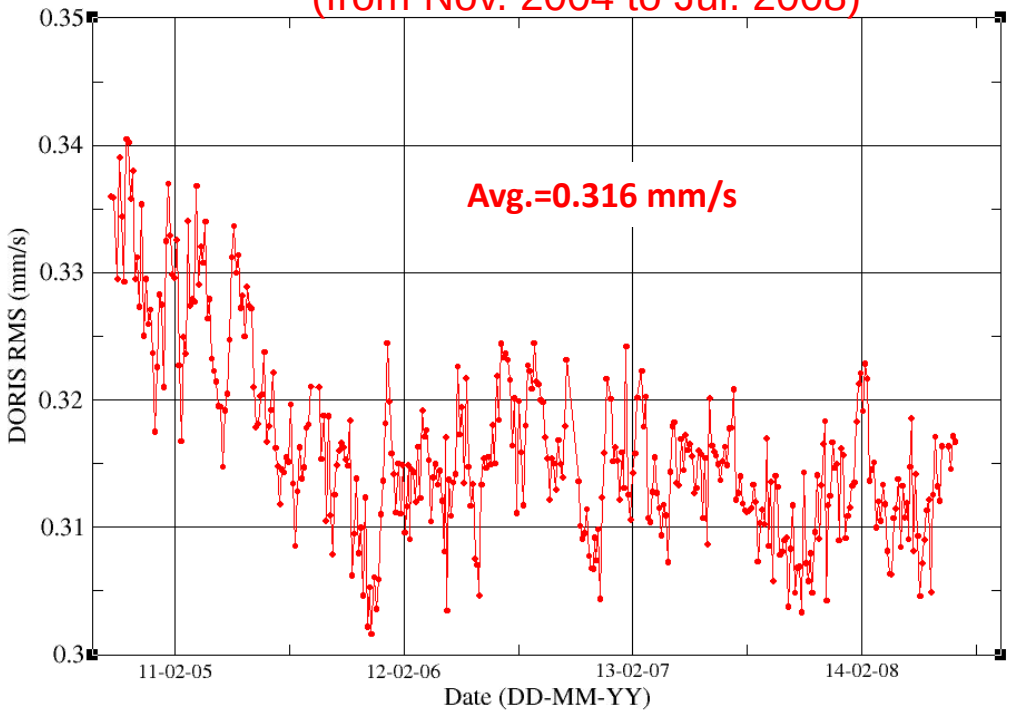
Status of POD for DORIS satellites used for altimetry

❑ DORIS RMS of fit

TOPEX
(from Jan. 1993 to Jul. 2002)



Jason-1
(from Nov. 2004 to Jul. 2008)

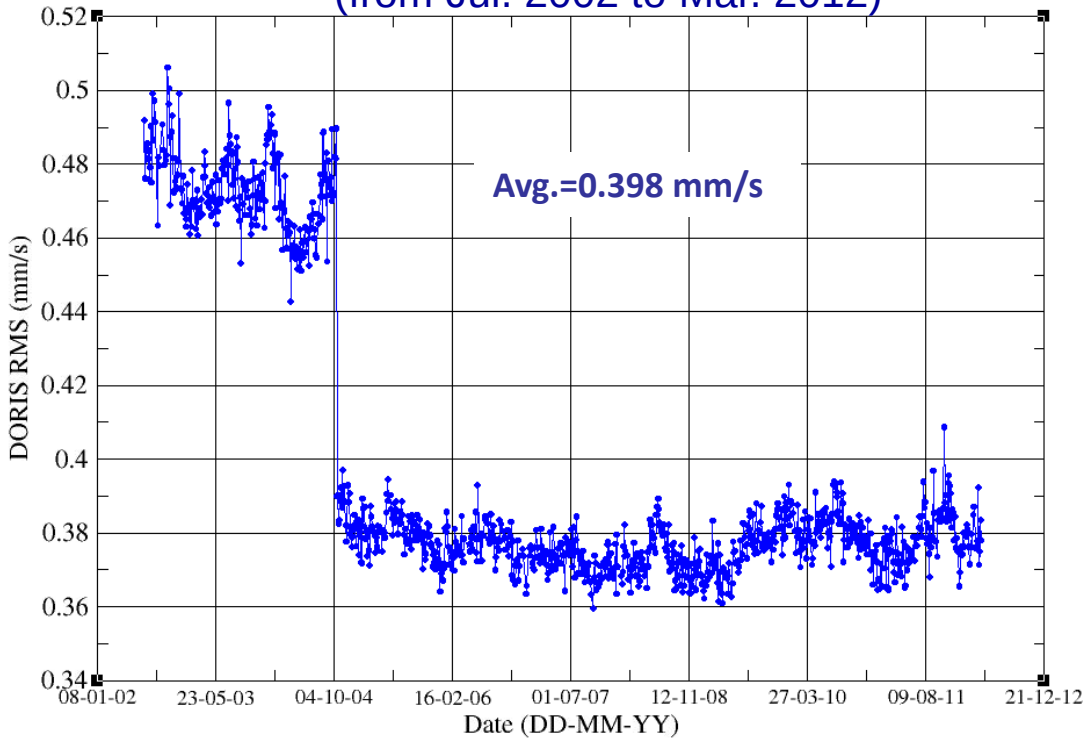


- *For TOPEX satellite, there are 2 level of DORIS RMS residuals respectively for the 2 DORIS USO (change from Nominal DORIS instrument to Backup in Dec. 1998).*
- *There is a ~59 days periodic signal for both satellites (draconitic period, β' angle).*

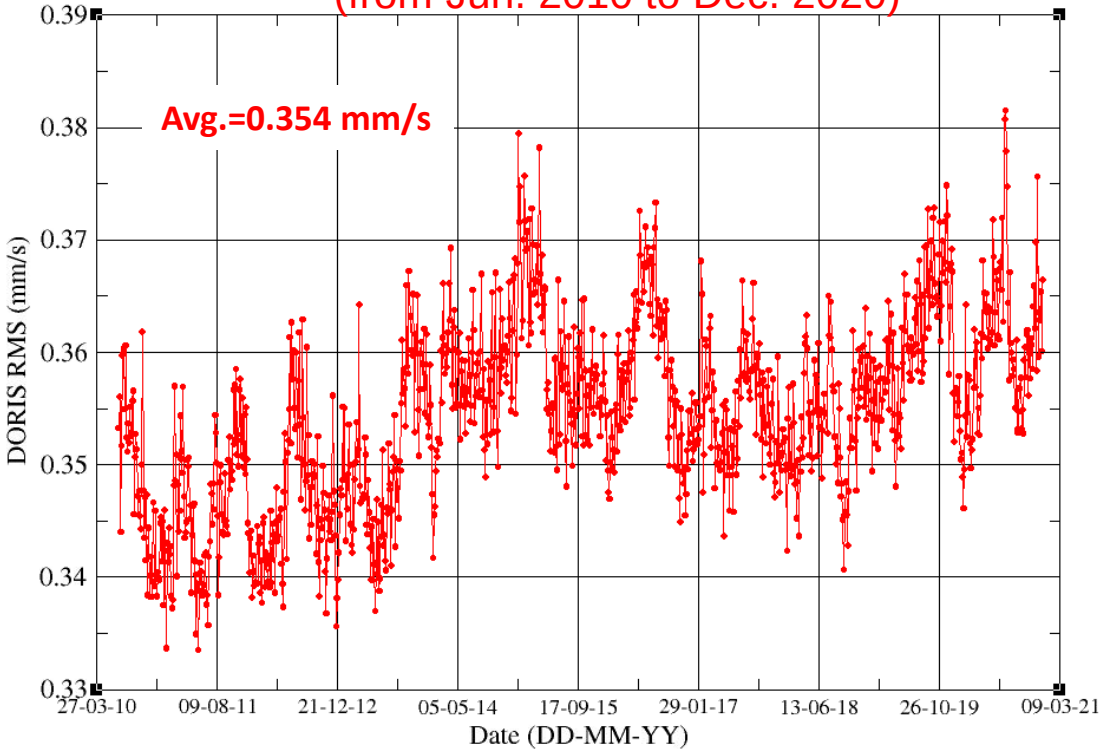
Status of POD for DORIS satellites used for altimetry

❑ DORIS RMS of fit

ENVISAT
(from Jul. 2002 to Mar. 2012)



Cryosat-2
(from Jun. 2010 to Dec. 2020)

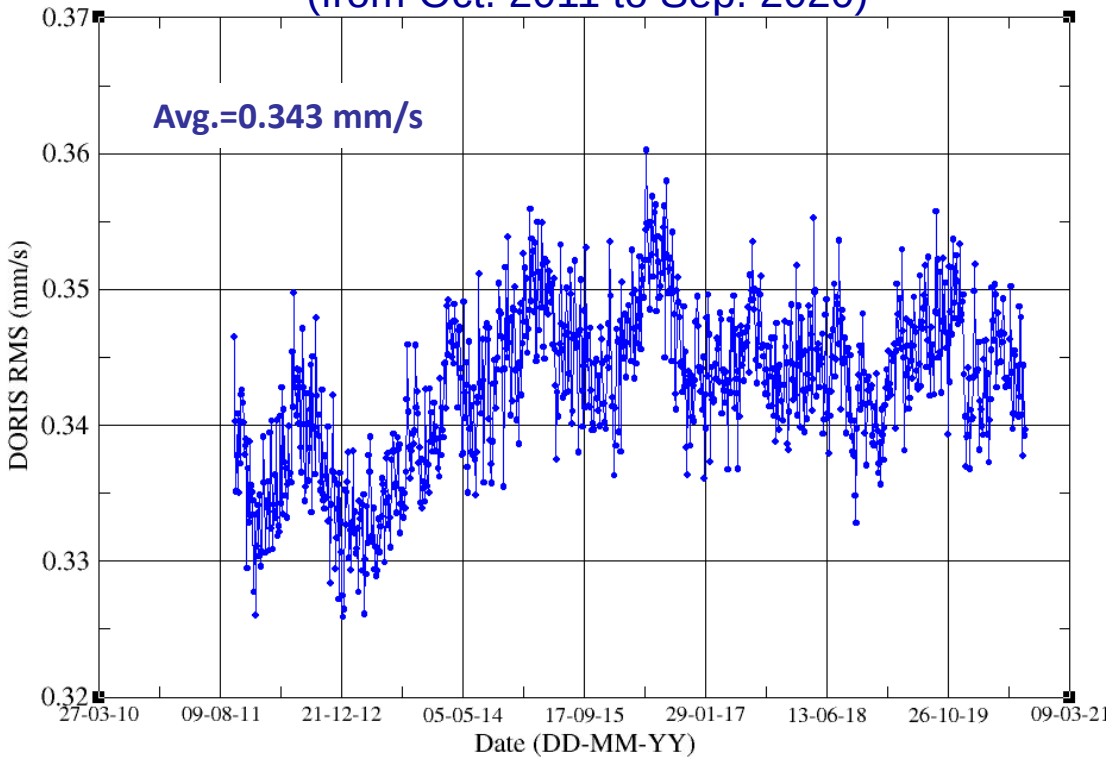


- *For ENVISAT, there are 2 level of DORIS RMS residuals reflecting the change from DORIS nominal chain to DORIS redundant chain in Jun. 2004.*
- *For Cryosat-2, there is a ~240 days periodic signal (draconitic period).*

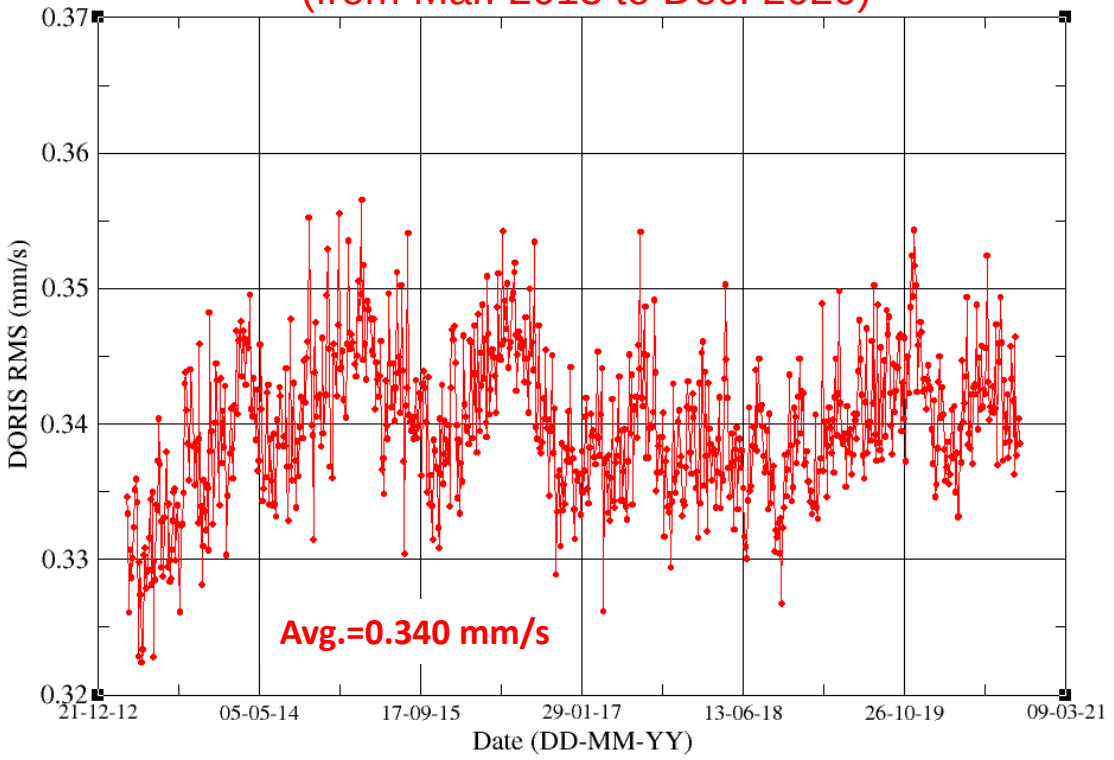
Status of POD for DORIS satellites used for altimetry

❑ DORIS RMS of fit

HY2-A
(from Oct. 2011 to Sep. 2020)



SARAL
(from Mar. 2013 to Dec. 2020)

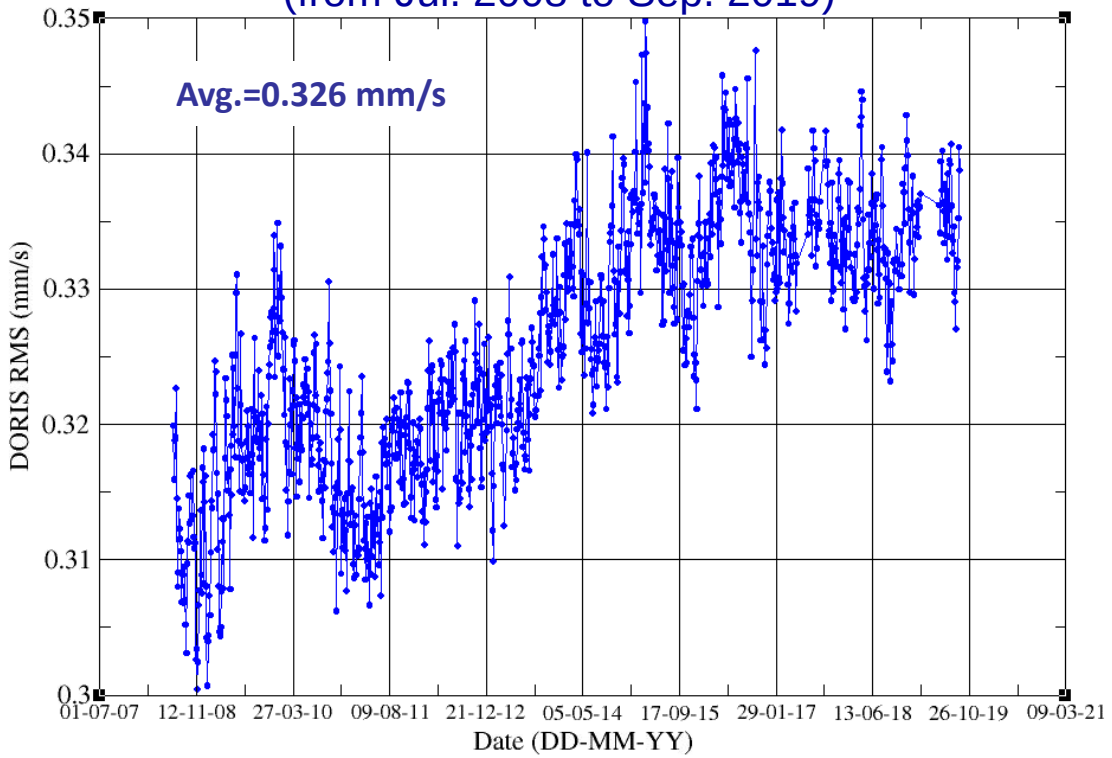


- *For both satellites, there is an annual periodic signal (draconitic period).*
- *A similar signature for both satellites which could be linked to solar activity.*

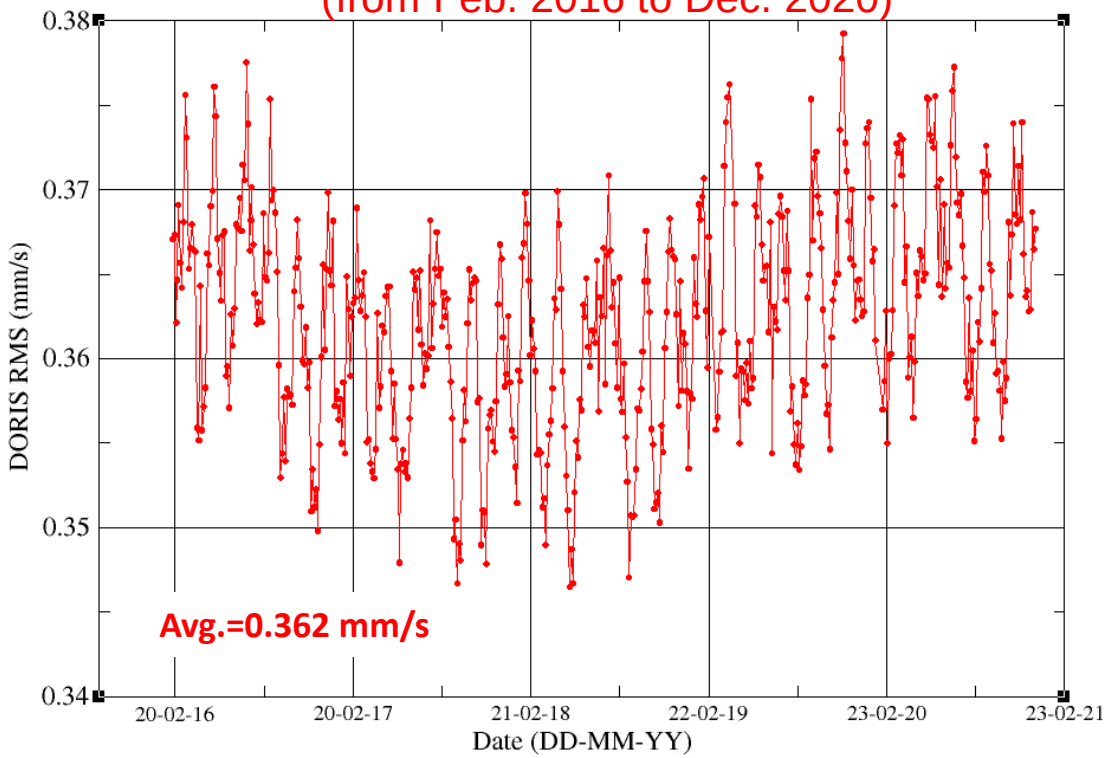
Status of POD for DORIS satellites used for altimetry

❑ DORIS RMS of fit

Jason-2
(from Jul. 2008 to Sep. 2019)



Jason-3
(from Feb. 2016 to Dec. 2020)

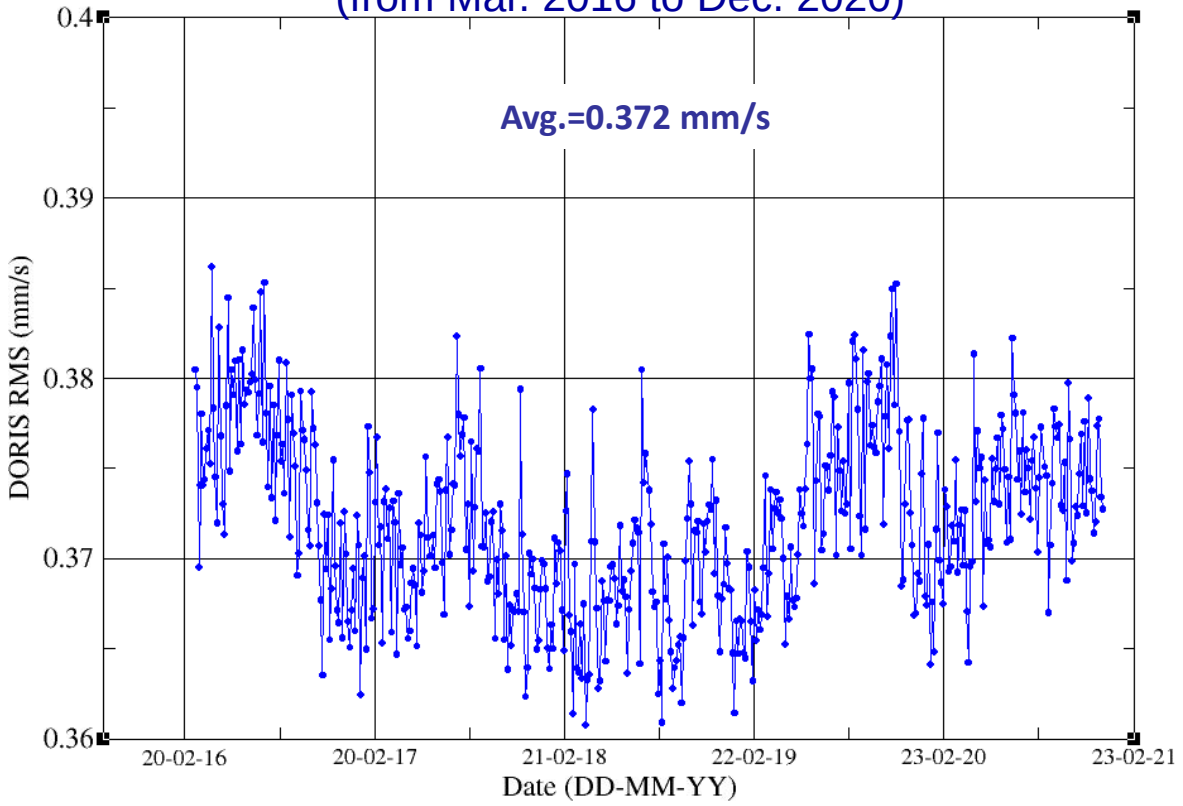


- *For Jason-3, the level of DORIS RMS residuals is slightly higher compared to Jason-2, explained by its higher sensitivity to the South Atlantic Anomaly (SAA).*
- *There is a ~59 days periodic signal for both satellites (draconitic period).*

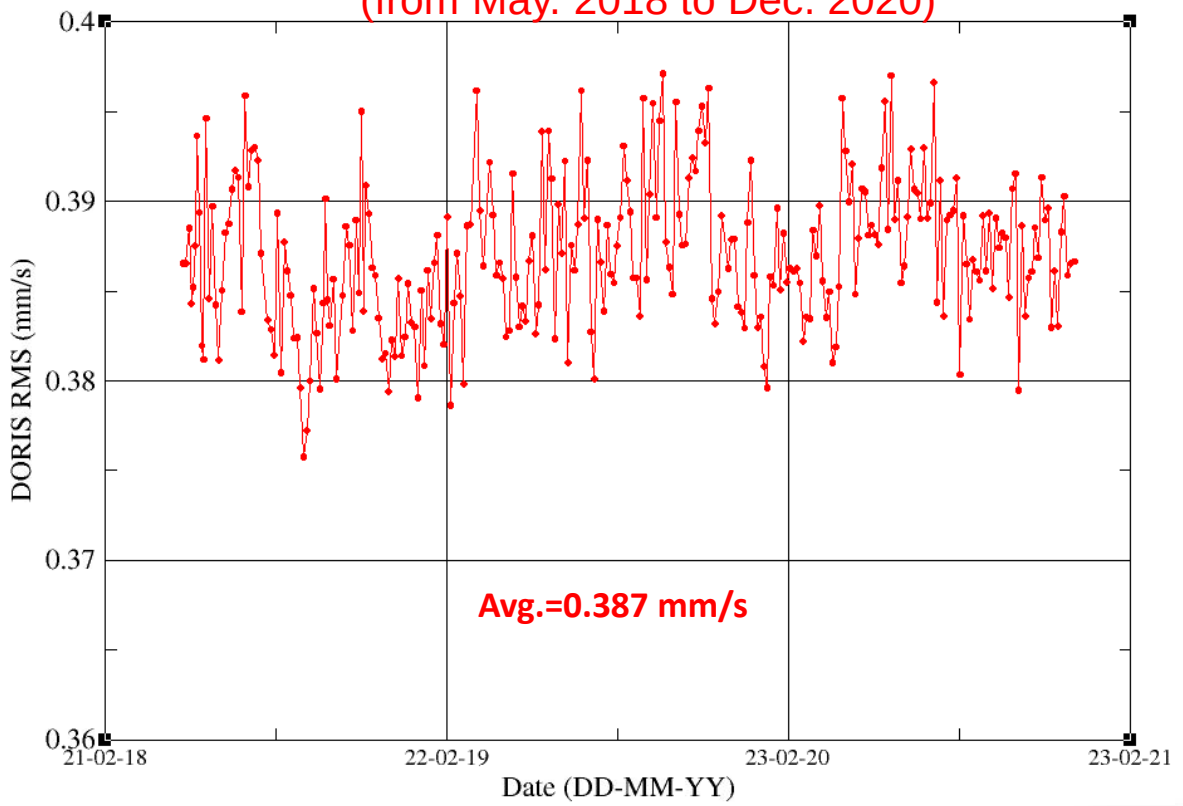
Status of POD for DORIS satellites used for altimetry

❑ DORIS RMS of fit

Sentinel-3A
(from Mar. 2016 to Dec. 2020)



Sentinel-3B
(from May. 2018 to Dec. 2020)



- *The level of DORIS RMS residuals is slightly higher for Sentinel-3B which could be explained by its higher sensitivity to the SAA.*
- *There is a ~40 days periodic signal for both satellites.*

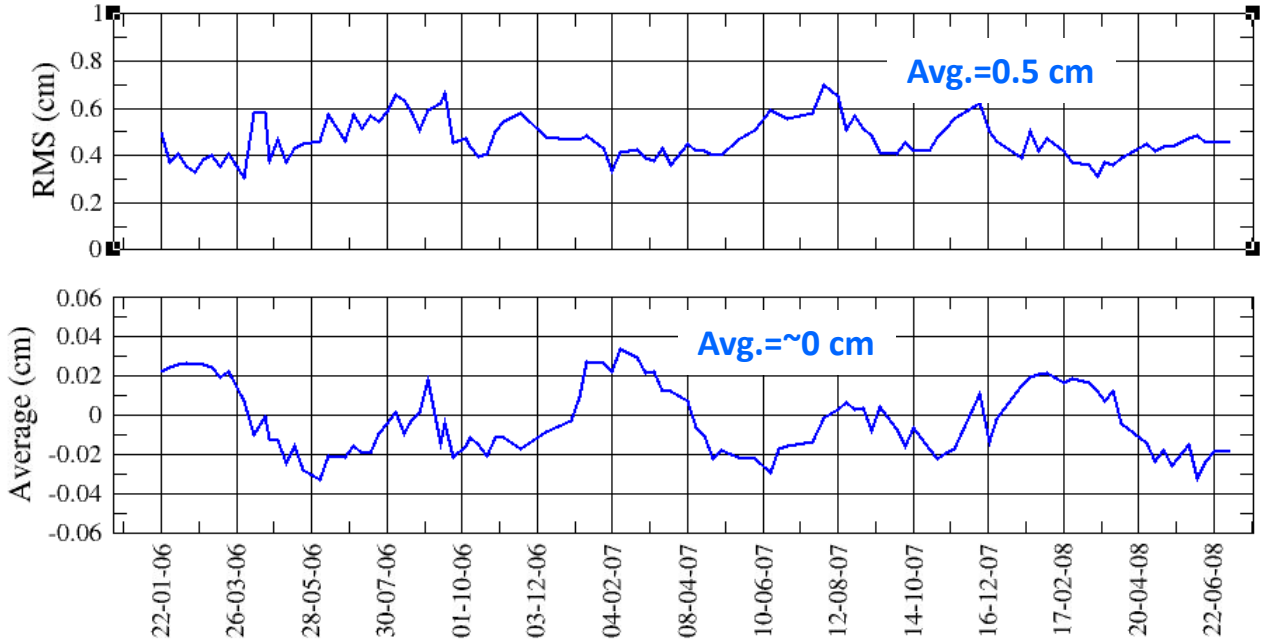
Status of POD for DORIS satellites used for altimetry

❑ Comparison to CNES (POE-F) orbit

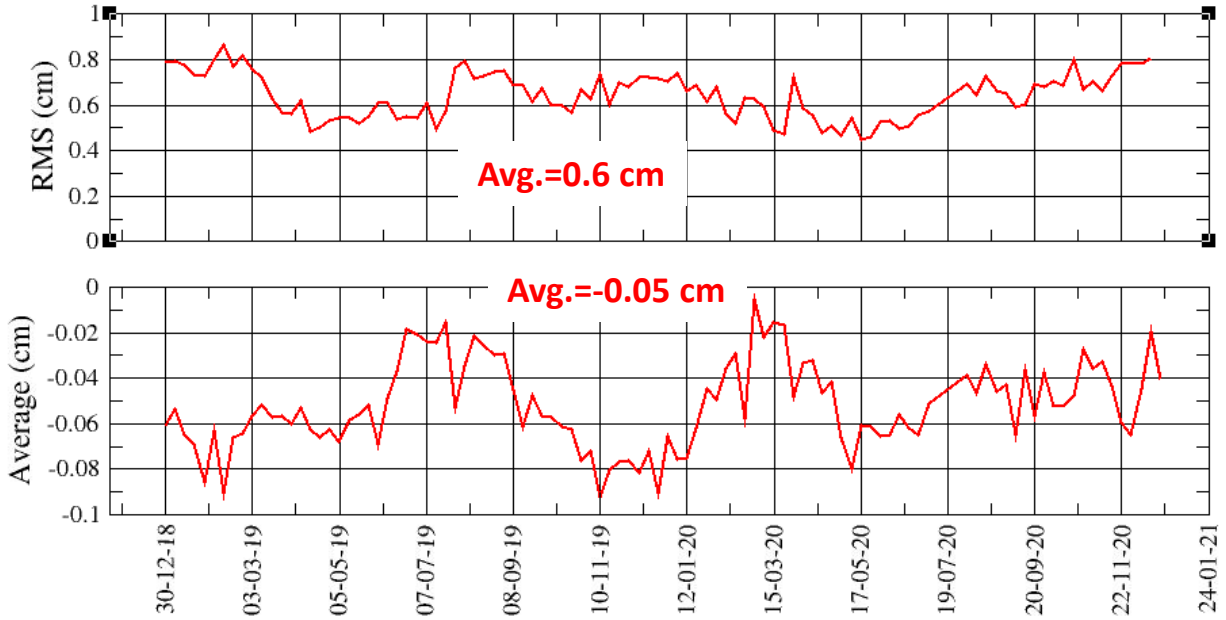
RMS and Avg. Radial orbit differences (in cm)

Reference orbit = GRG orbit

ENVISAT
(from Jan. 2006 to Jun. 2008)



Cryosat-2
(from Jan. 2019 to Dec. 2020)



- *There is a good agreement between GRG orbit and external orbit CNES-POE-F (< 1 cm RMS).*
- *For ENVISAT, there is a semi-annual periodic signal.*
- *For Cryosat-2, there is a ~240 days periodic signal (draconitic period).*

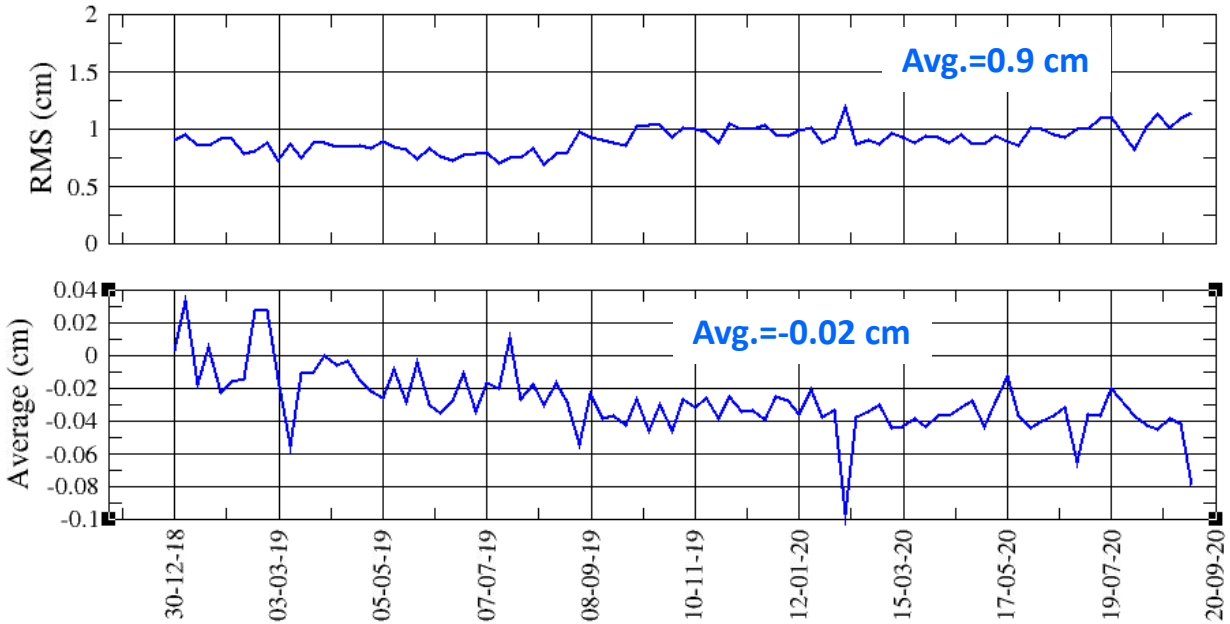
Status of POD for DORIS satellites used for altimetry

❑ Comparison to CNES (POE-F) orbit

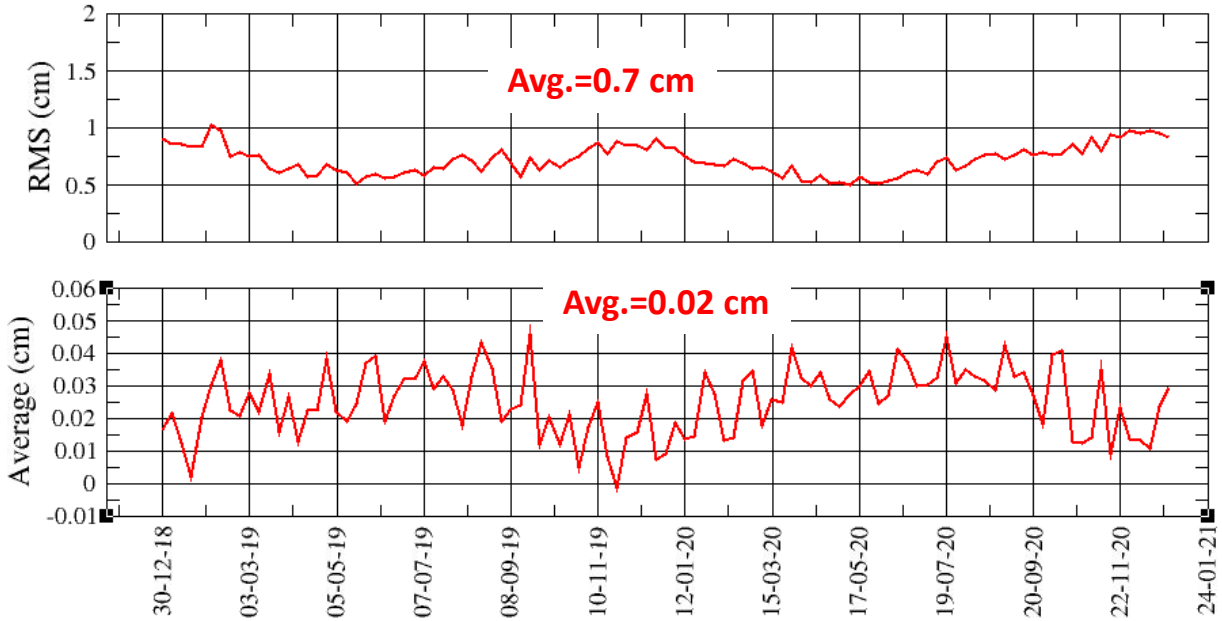
RMS and Avg. Radial orbit differences (in cm)

Reference orbit = GRG orbit

HY-2A
(from Jan. 2019 to Sep. 2020)



SARAL
(from Jan. 2019 to Dec. 2020)



- *There is a good agreement between GRG orbit and external orbit CNES-POE-F (< 1 cm RMS).*
- *For SARAL, there is an annual periodic signal.*

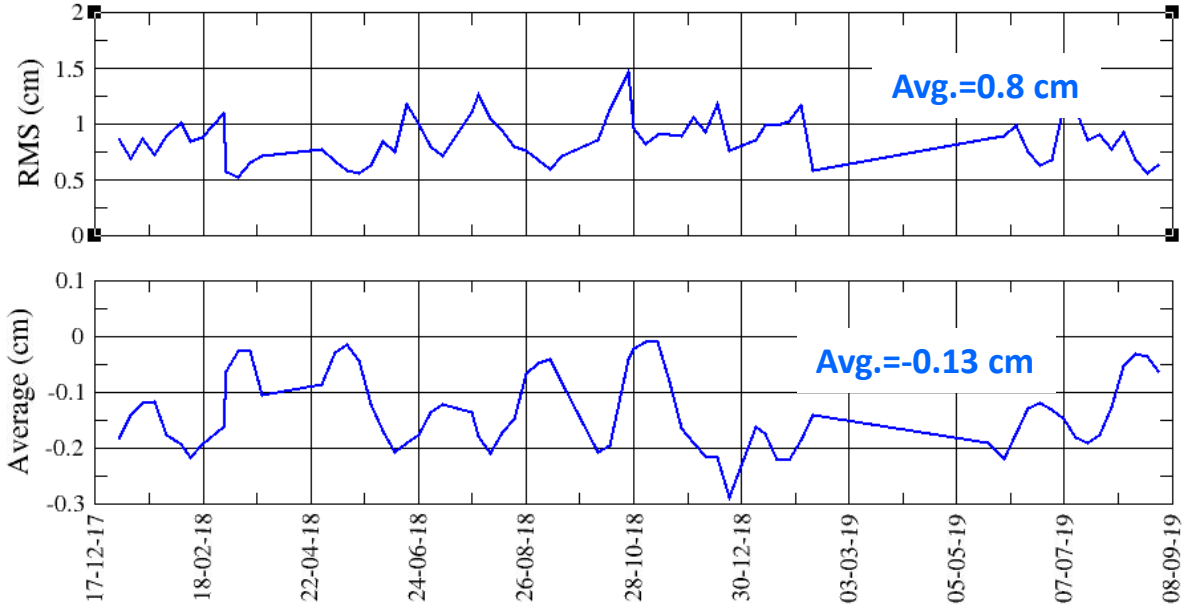
Status of POD for DORIS satellites used for altimetry

❑ Comparison to CNES (POE-F) orbit

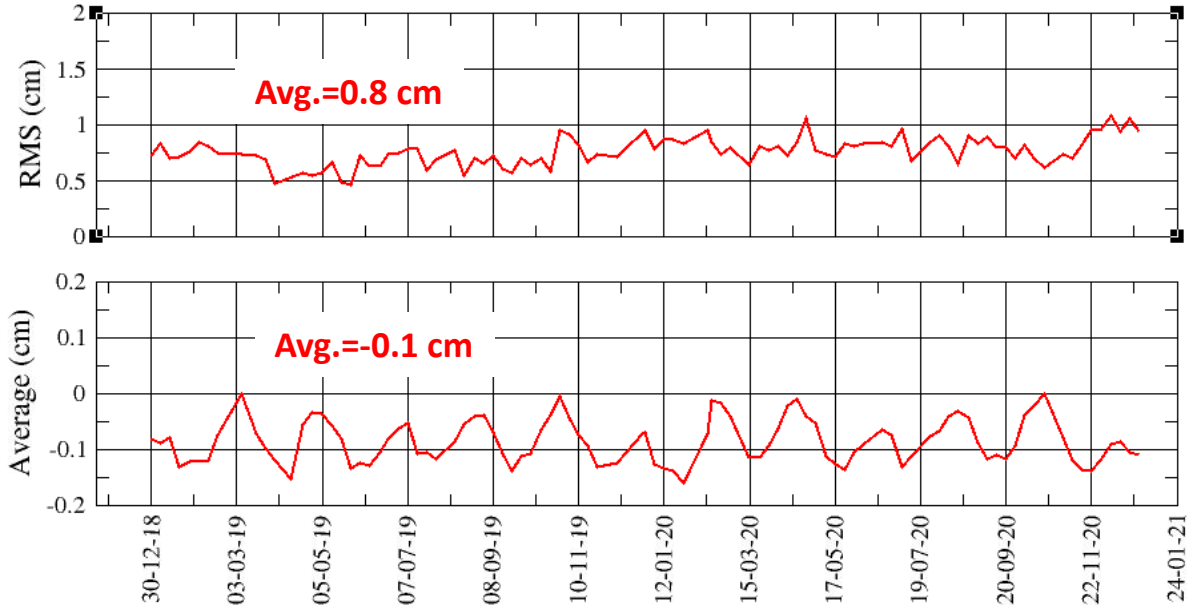
RMS and Avg. Radial orbit differences (in cm)

Reference orbit = GRG orbit

Jason-2
(from Jan. 2018 to Sep. 2019)



Jason-3
(from Jan. 2019 to Dec. 2020)



- *There is a good agreement between GRG orbit and external orbit CNES-POE-F (~0.8 cm RMS).*
- *There is a 59 days periodic signal in the radial component and small bias (~-0.1 cm).*

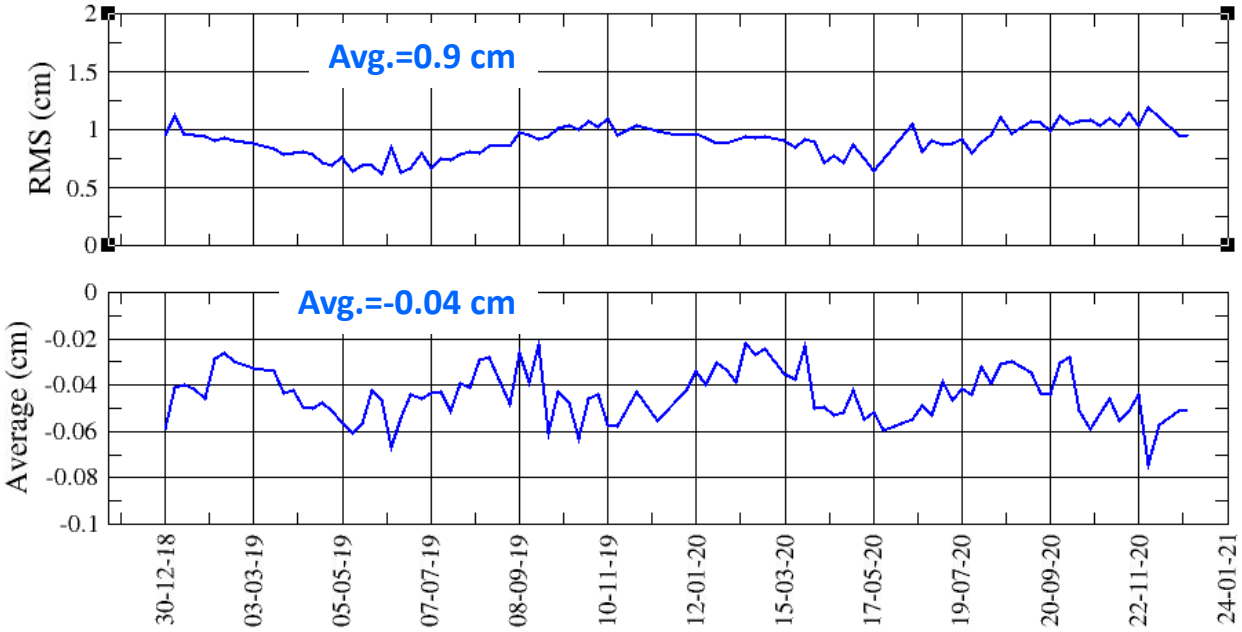
Status of POD for DORIS satellites used for altimetry

❑ Comparison to CNES (POE-F) orbit

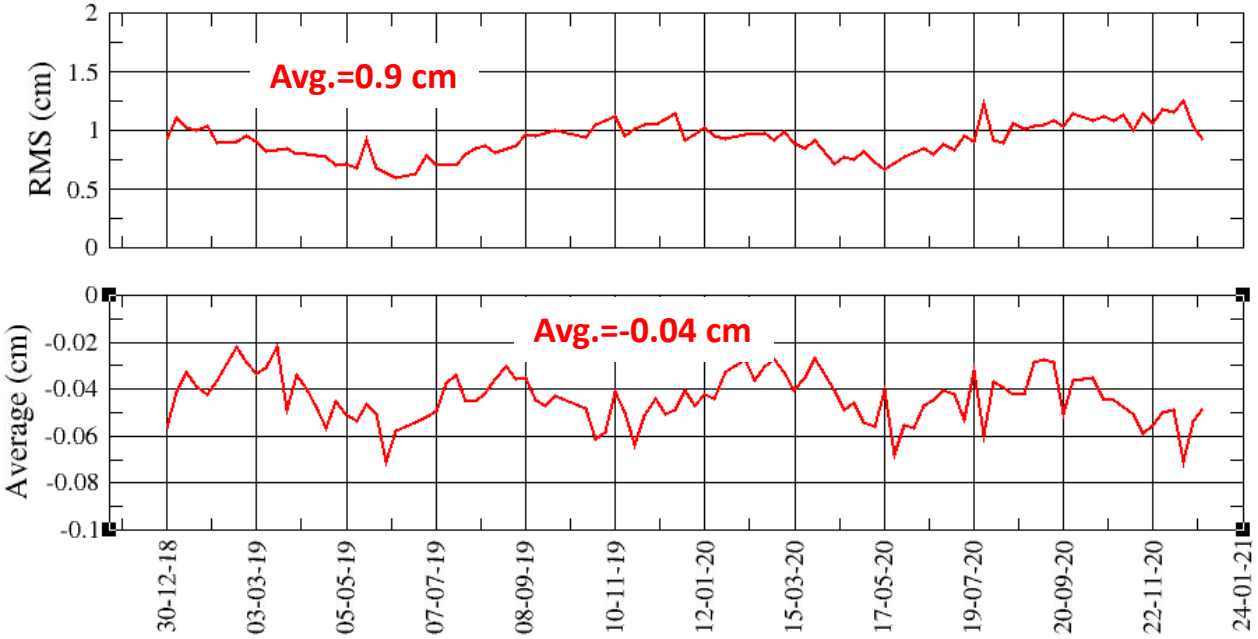
RMS and Avg. Radial orbit differences (in cm)

Reference orbit = GRG orbit

Sentinel-3A
(from Jan. 2019 to Dec. 2020)



Sentinel-3B
(from Jan. 2019 to Dec. 2020)



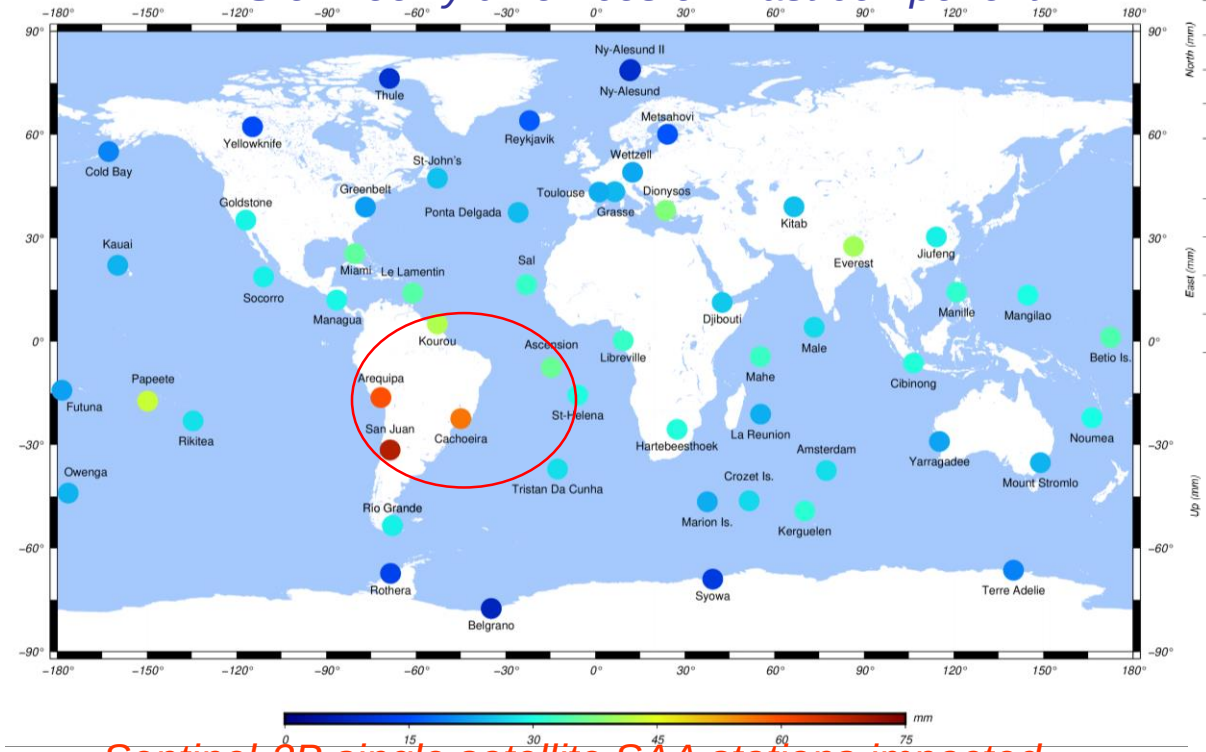
- *There is a good agreement between GRG orbit and CNES-POE-F (< 1 cm RMS).*
- *There is a small bias (~-0.04 cm) and a semi-annual periodic signal.*

Impact on the multisatellite solution

❑ SAA strategy is also applied for Sentinel-3A&B satellites

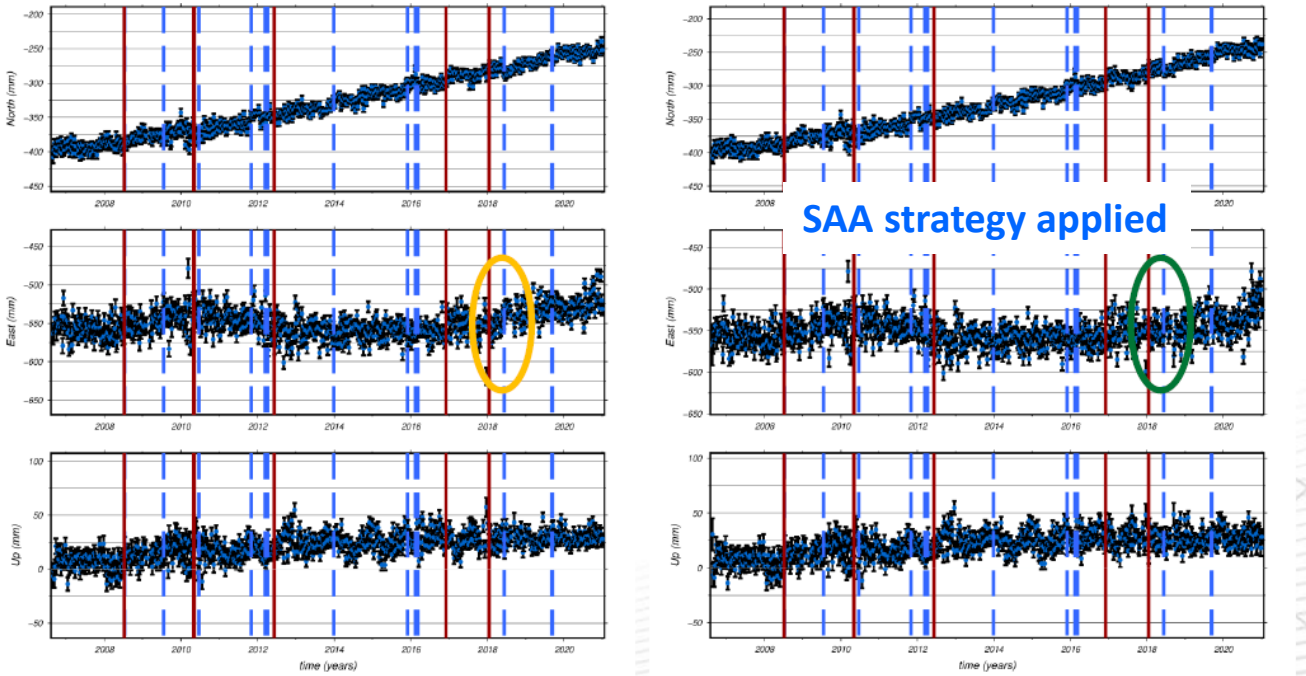
SAA strategy: not using SAA data from the most affected satellites on the station positioning

- *Single satellites solutions differences:*
  Sentinel-3B - Saral
  WRMS of weekly differnces on East component



- *Sentinel-3B single satellite SAA stations impacted.*

- *Multisatellite solution when SAA strategy is applied for Sentinel-3A&B*
  Impact on Arequipa station



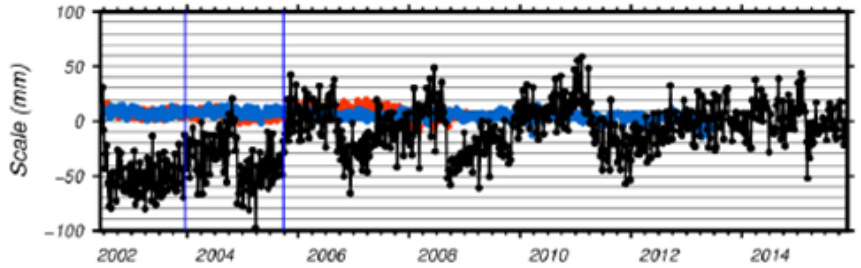
- *Improvement in East component.*

Impact on the multisatellite solution

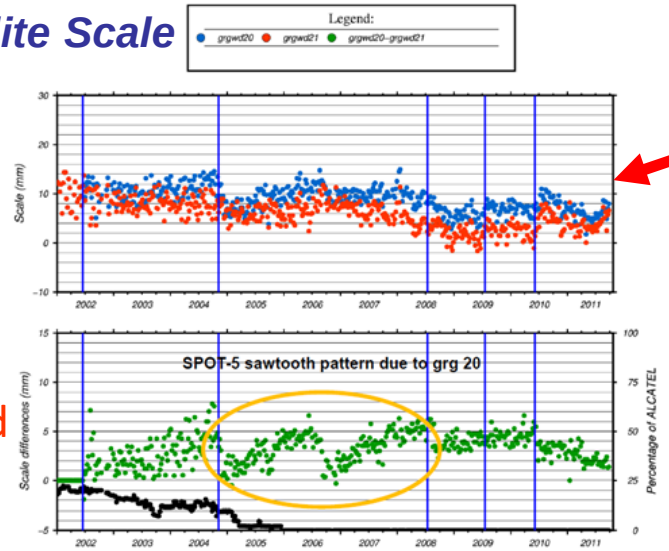
❑ Impact on the multisatellite solution when SPOT-5 does not contribute to the scale

GRG SPOT-5 Scale (black curve)

Sawtooth pattern for SPOT-5 scale

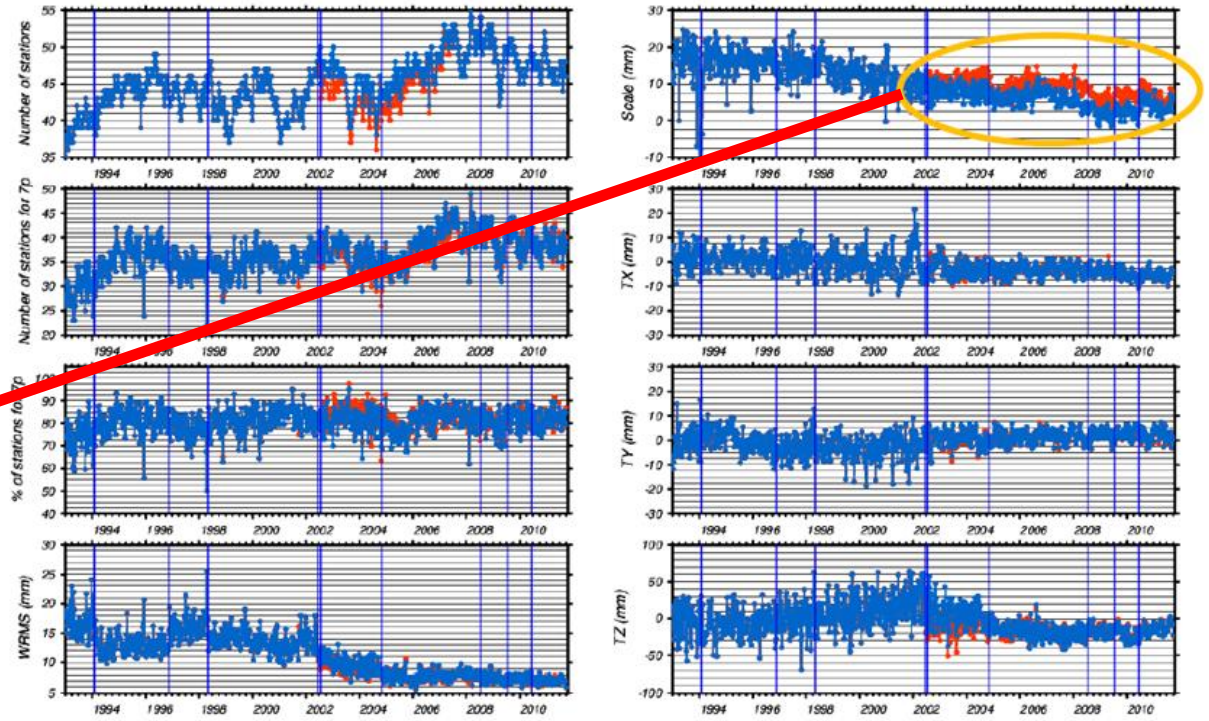


Multisatellite Scale



Green=Blue -Red

Multisatellite solution when SPOT-5 does not contribute to the scale (in red)

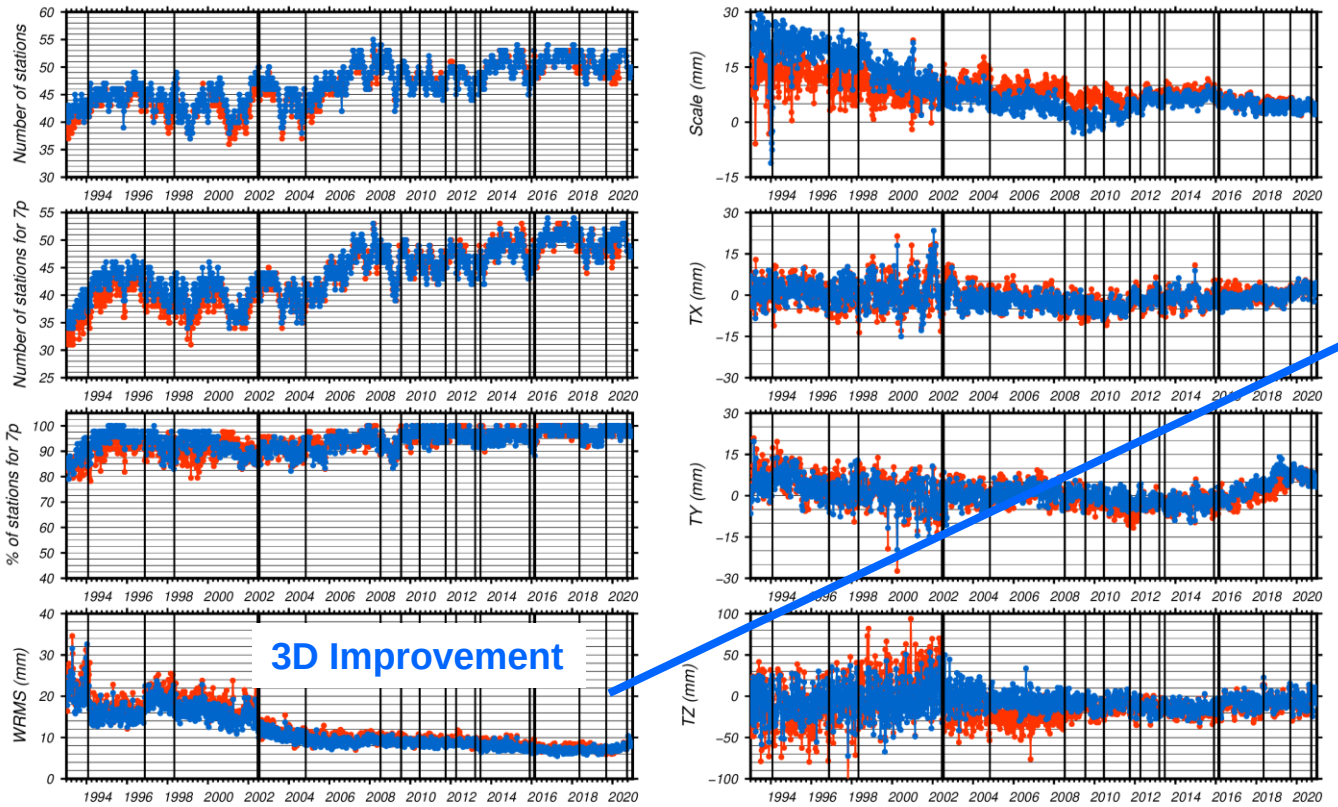


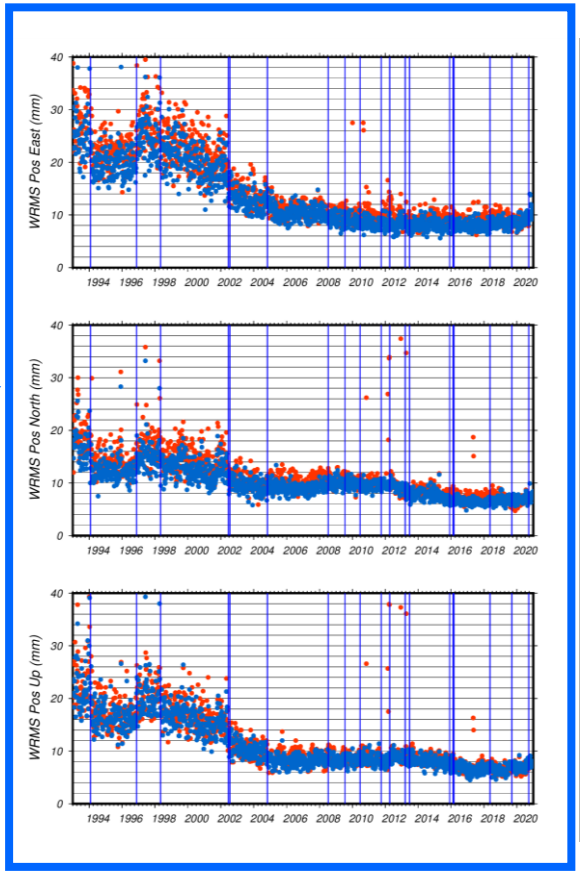
▪*Improvement of the multisatellite scale when SPOT-5 does not contribute to the scale estimation.*

Impact on the multisatellite solution

❑ GRG multisatellite solution (weekly) compared to DPOD2014v5

GRG ITRF2014 like (in red) vs GRG ITRF2020 (in blue)





- *Improvement in East and North component.*

See also presentation of Moreaux & al :
The IDS Contribution to the ITRF2020: Realization and Evaluation (EGU21-2315)

Ongoing and future work

❑ Ongoing work

- *Continue discussions with other ACs to improve the IDS solutions (comparison of single satellite solutions)*
- *Continue to evaluate GRG orbits:*
  - *by comparisons to GRG orbits with GNSS*
  - *by comparison to other external orbits*
  - *by Independent SLR RMS of fit*
  - *by Altimeter crossover Cycles*
- *Implement HY-2C and Sentinel-6 in our processing chain*

❑ Future work

- *Write a paper on the ITRF2020 reprocessing*
- *Improve satellite macromodels from analyzing ITRF2020 reprocessing*
- *Use quaternions for Sentinel-3A&B and Cryosat-2*
- *…*