CNES/CLS AC STATUS

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

IDS AWG meeting, Toulouse 11 June 2018

CNES/CLS AC STATUS

❑ Status of the routine DORIS data processing

- **We processed DORIS2.2 and RINEX data until end of Dec. 2017**

- **New serie grgwd41**

ITRF2014 configuration

List of new additions:

• Introduction of Jason-3 and Sentinel-3A (RINEX data) in the GRG DORIS processing
• Switch to the ITRF/DPOD2014
• DORIS-only orbits processing and evaluation by SLR processing
• Strategy to mitigate the SAA impact for Jason-2 and Jason-3
  on the orbit (adjusting of frequency Polynomial on SAA station per pass)
  on the positioning (renaming of SAA stations)
• Remove the DORIS scale jump in 2012
  use the new position of the HY-2A CoM given by the Chinese Project
  make our own pre-processing when using Doris2.2 data

- **We provided GRG SINEX to IDS CC from July 2008 until end 2017**

- **We provided Sentinel3-A orbits to CPOD QWG since Sep. 2017**

Status of POD for Sentinel-3A and Jason-3 satellites

❑ Processing strategy

(we took the IERS conventions and the IDS recommendations)

Software	GINS/DYNAMO
DORIS data	RINEX 3.0 phase measurement converted to DOPPLER
Station Coordinates	ITRF2014 (DPOD2014)
Gravity Field	EIGEN-GRGS.RL03-v2.MEAN-FIELD with mean slope extrapolation
DORIS Troposphere	VMF1 + one gradient per station in North & East directions
Attitude Model	for Jason-3: nominal law likeTopex for Sentinel-3A: nominal law like Envisat
Surfaces Forces **&** **Estimated Parameters**	Box-wing model for solar radiation,drag, Albedo and IR Macromodel available at : *ftp://ftp.ids-doris.org/pub/ids/satellites/DORISSatelliteModels.pdf* Radiation pressure scale coefficient : 1 coef/day but strongly constrained to: 0.99 for Jason-3 and 1.0 for Sentinel-3A OPR empiricals: 2 coeff cos-sin /orbital period in normal direction and 2 coeff cos-sin /orbital period in tangential direction (per arc) Drag coefficients adjusted: 1 coef/4 hours for Sentinel-3A and 1 coef/half day for Jason-3
Time span processing	From April 2016 to August 2017 3.5-day arcs with a cut-off angle of 12°

Status of POD for Sentinel-3A and Jason-3 satellites

❑ POD Summary

DORIS RMS of fit and SLR external validation

OPR Acceleration Amplitude:

Along-track and Cross-track / Radiation pressure coefficient

SATELLITE	DORIS RMS (mm/s)	SLR RMS (cm)	OPR amplitude average (10^{-9} m/s^2)		Solar radiation coefficient
			Along-track	Cross-track	
Jason-3	0.35	1.8	1.3	2.6	0.99
Sentinel-3A	0.36	1.3	2.5	1.9	1.00

(from March 2016 to December 2017)

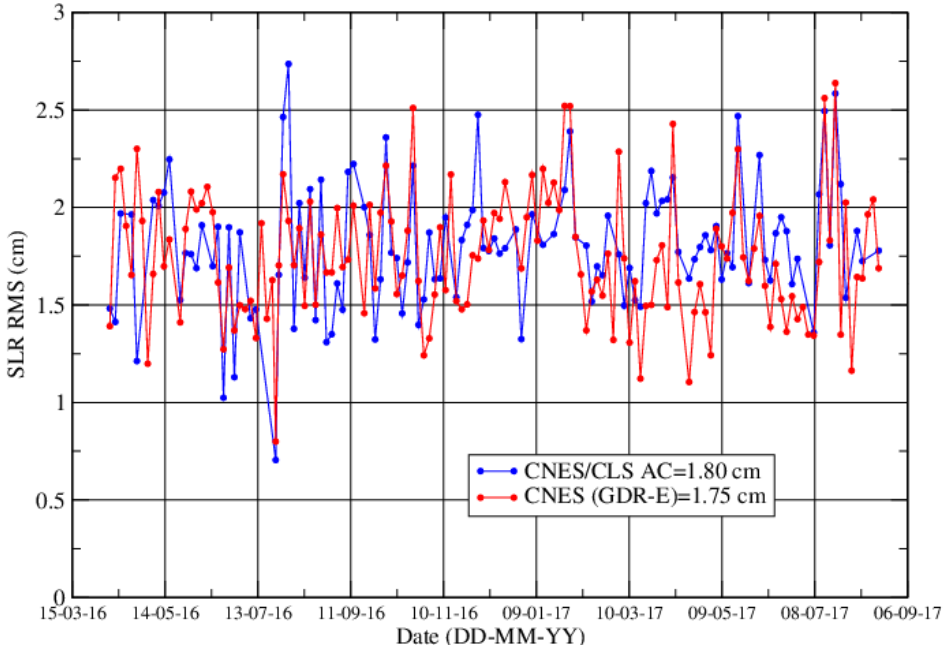
▪ *For the two directions, Along-track and Cross-track, the mean amplitudes are lower than 4x10^{-9} m/s^2, reflecting a satisfying level in the modeling of the satellite macromodels and the attitude law.*

Status of POD for Sentinel-3A and Jason-3 satellites

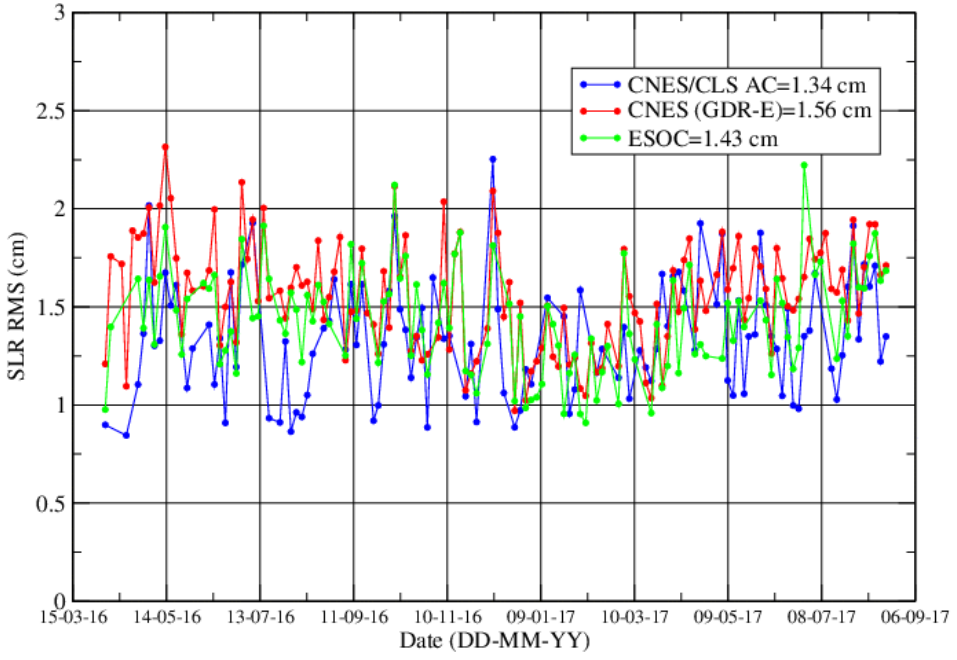
❑ Comparison to CNES (GDR-E) / ESOC orbits

Independent SLR RMS of fit

Jason-3



Sentinel-3A



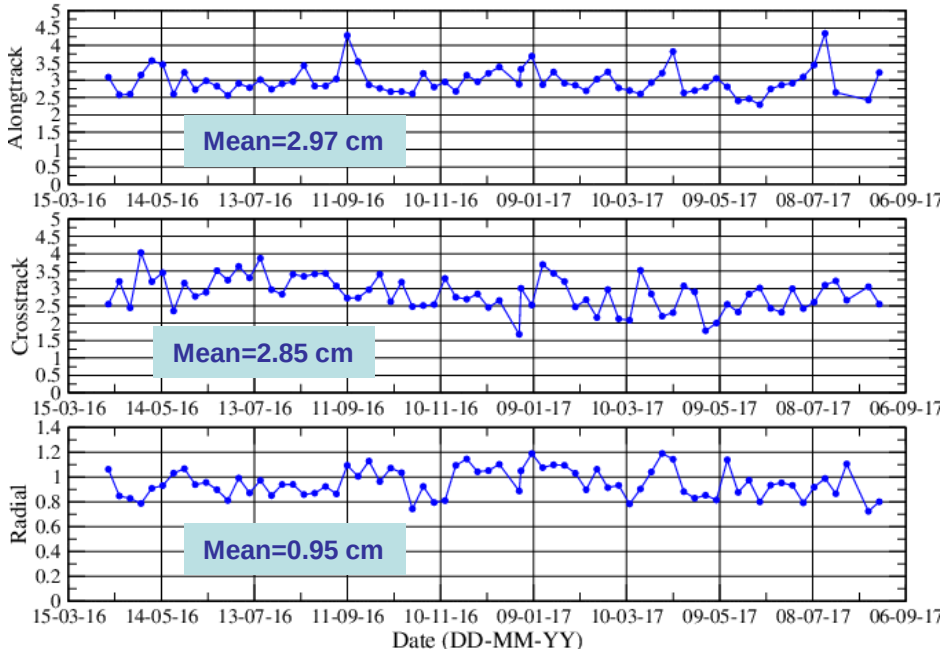
- *The SLR RMS residuals on Jason-3 and Sentinel-3A orbits are at a good level.*
- *The level is comparable to the others orbits evaluated, CNES-GDR-E and ESOC.*

Status of POD for Sentinel-3A and Jason-3 satellites

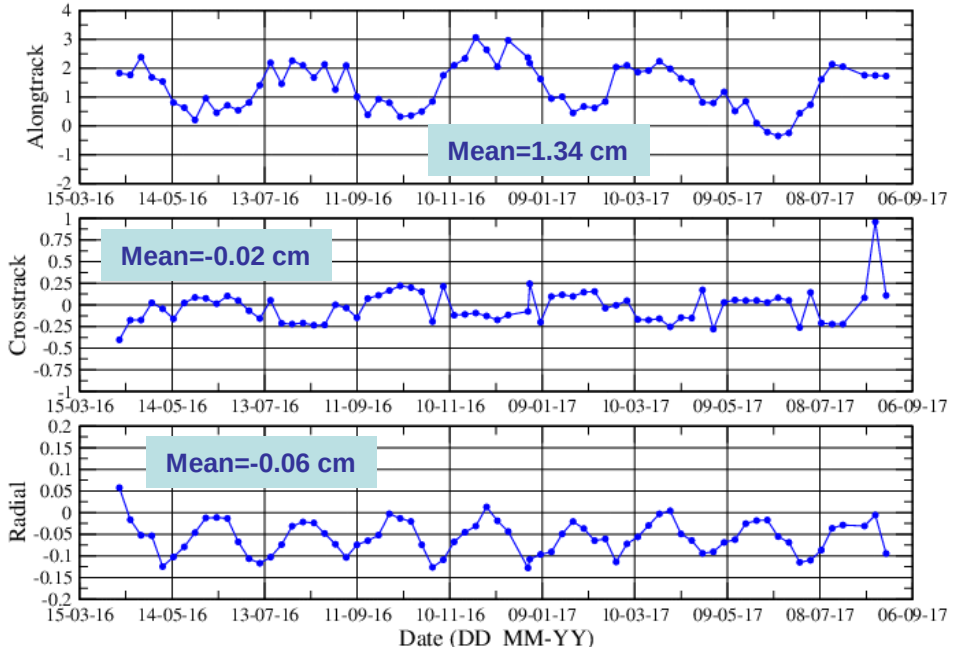
❑ Comparison to CNES (GDR) orbits

Jason-3 orbit differences

RMS of orbit differences (in cm)



Mean of orbit differences (in cm)



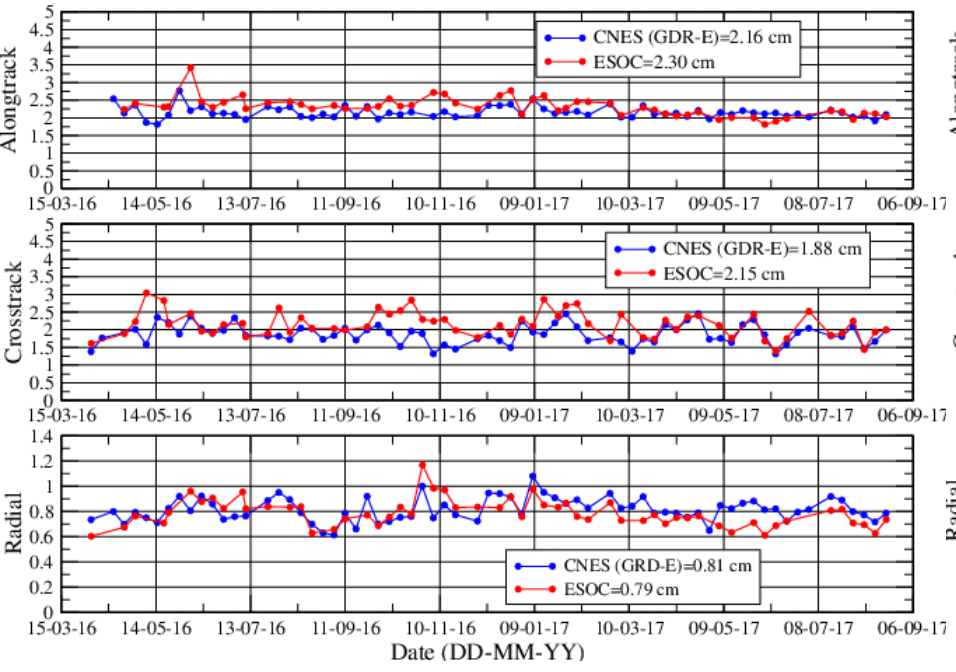
- *There is a good agreement between the orbits calculated with GINS and ZOOM (GDR-E) but there is an along-track bias (~ 1.34 cm) which could be explained by the difference in time tagging.*
- *For Jason-3, there is also a 60 days periodic signal in the radial component.*

Status of POD for Sentinel-3A and Jason-3 satellites

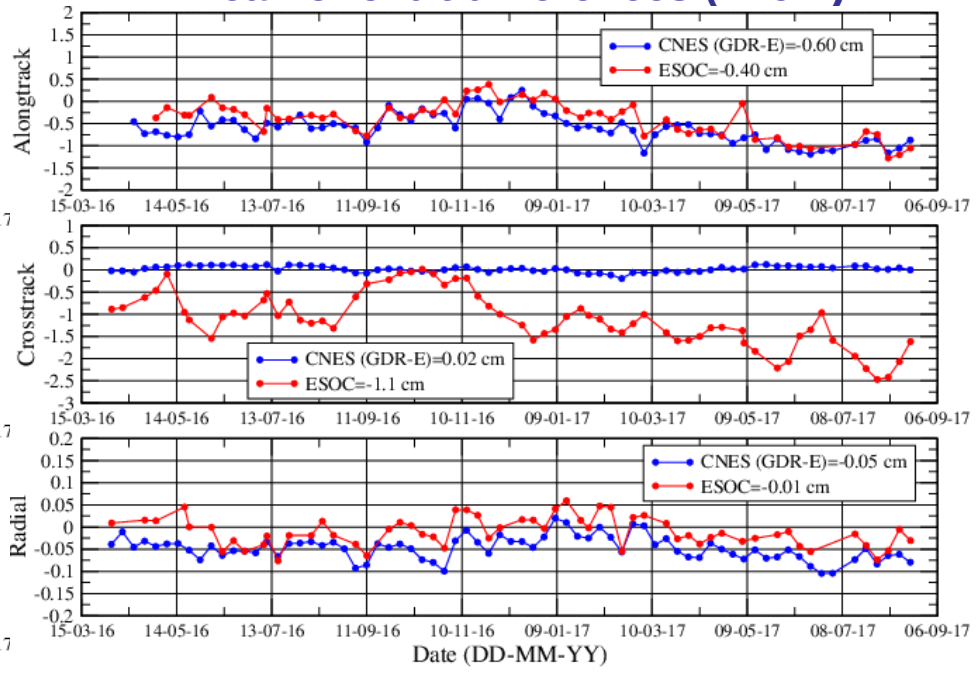
❑ Comparison to CNES (GDR) / ESOC orbits

Sentinel-3A orbit differences

RMS of orbit differences (in cm)



Mean of orbit differences (in cm)

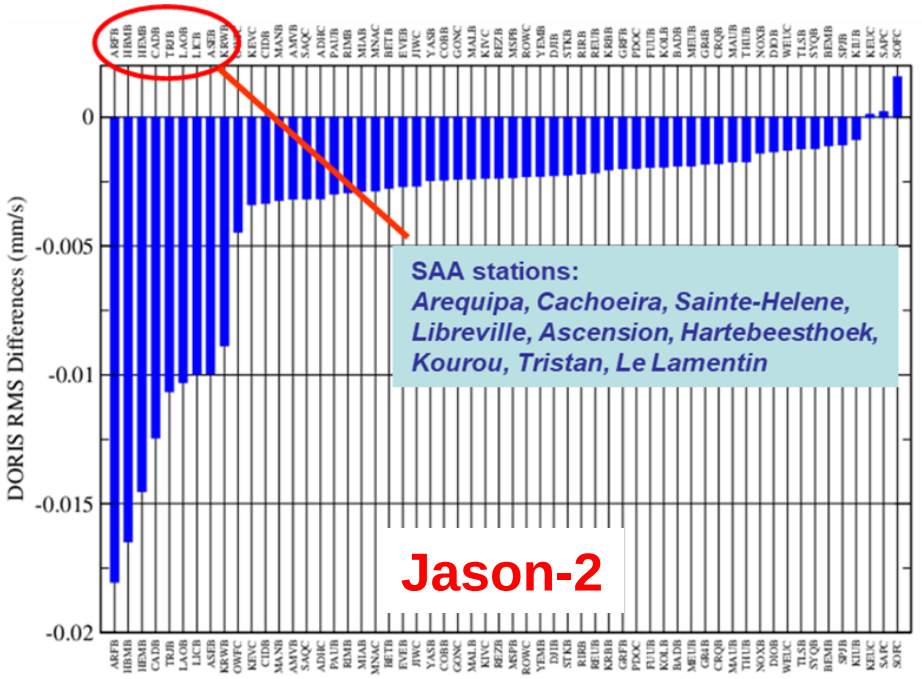


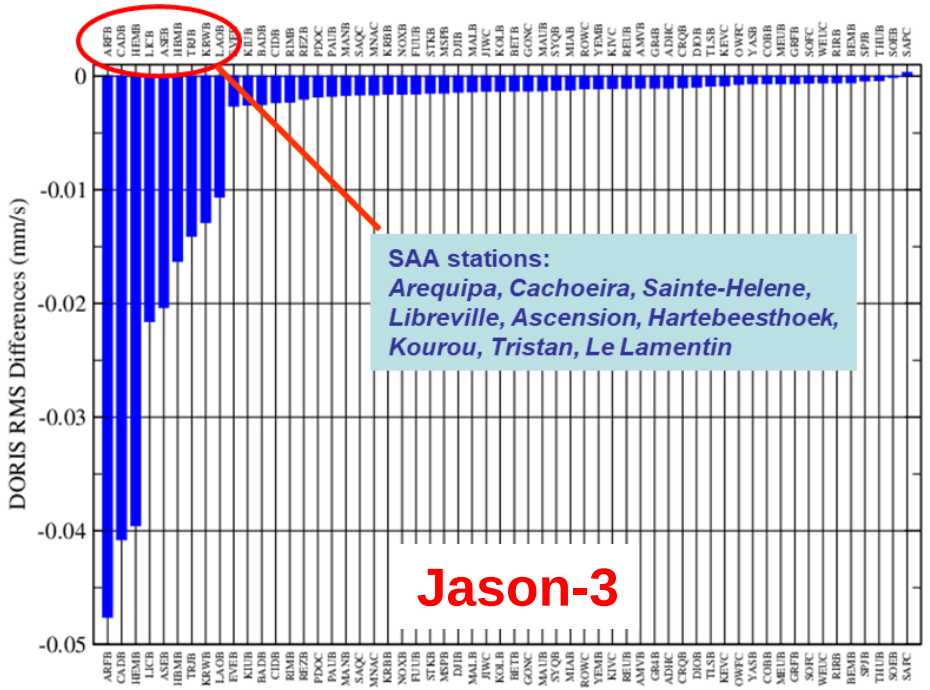
- *For Sentinel-3A, the agreement is better but there is also an along-track bias (~ 6 mm).*
- *The comparison to ESOC orbit gives better results except for crosstrack component with a bias of 1.1 cm.*

Strategy to mitigate the SAA effect

- **Estimation of the beacon frequency Polynomial on SAA station per pass**
  - **Impact on the precise orbit**

Classical processing: one Frequency Bias adjusted per pass.
With strategy: Frequency Polynomial (degree 4) adjusted per pass.





- *The DORIS residuals are lower when we apply the strategy of polynomial adjusting frequency per pass for SAA stations.*
- *The impact is significant for SAA stations and the number of measurements is higher.*

Strategy to mitigate the SAA effect

❑ Strategy to add single satellite solution affected by the SAA in the multi-satellite solution

For Jason-1, the method we implemented, tested and adopted for ITRF2014 is: before combining Jason-1 solution to the other single satellite solutions, we rename the SAA stations (and all their adjusted parameters) so these SAA stations from Jason-1 do not contribute to the realization of the combined solution.

Multi-satellite Solution compared to DPOD2014

We computed weekly multi-satellite solutions from 2010 to August 2017 (8,5 years).

We provided 3 solutions:

- **Solution of reference REF: Envisat + Spot4 + Spot5 + Cryosat-2 + HY-2A + Saral + Sentinel-3A**
- **Solution 1: REF + Jason-2 + Jason-3**
- **Solution 2: REF + Jason-2 SMS + Jason-3 SMS**

With SMS = SAA Mitigation Strategy: Renaming + (Polynomial adjusting)

Station	Solution 1 (in cm)			Solution 2 (in cm)		
	North	East	Up	North	East	Up
Cachoeira	0.9	-0.2	2.2	0.3	0.2	0.7
Arequipa	-0.5	1.1	2.3	0.0	0.3	0.4
Kourou	-0.4	0.1	0.2	-0.2	0.06	0.04
Ascension	0.1	-0.5	2.0	0.1	-0.1	0.5
Saint Helene	1.4	-0.4	1.6	0.5	-0.2	0.4
Le Lamentin	-0.1	-0.3	-1.1	0.0	-0.1	-0.2
Libreville	-1.0	-0.3	1.1	-0.02	-0.06	0.2
Yarragadee	*0.1*	*-0.1*	*0.06*	*0.1*	*-0.1*	*0.07*

- *The IDS solution provided for the ITRF2014 was worsened by the Jason-2 solution for the SAA stations.*
- *The strategy brings an improvement in the station position estimation for the SAA stations, especially for the vertical component.*

Correction of the DORIS scale factor jump in 2012

❑ Correction of the HY-2A high scale

The high scale level of HY-2A increased the scale of the DORIS solution.

When we used the new position of the CoM given by the Chinese Project, the HY2A scale is significantly reduced.

❑ Scale variations due to the use of Doris2.2 data

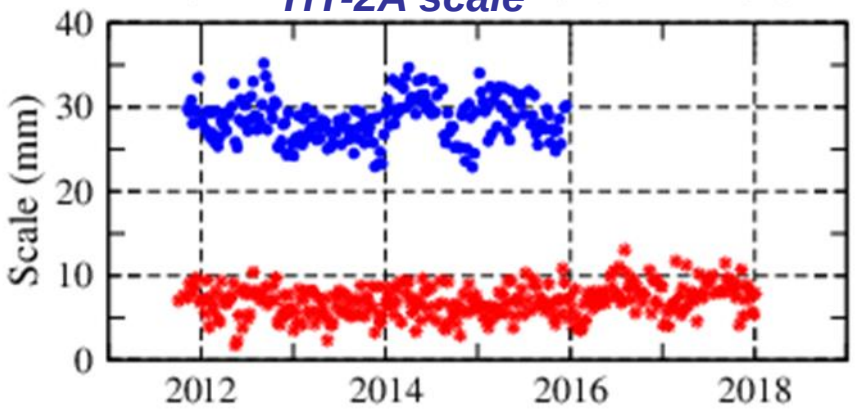
Impact of using only the data considered to be good in CNES pre-processing:

The increase of the scale factor for Jason-2 and Cryosat-2 was fully explained by the change of tropospheric model used by CNES in its POD processing (GDR standards): from CNET (GDR-C) to GPT/GMF (GRD-D).

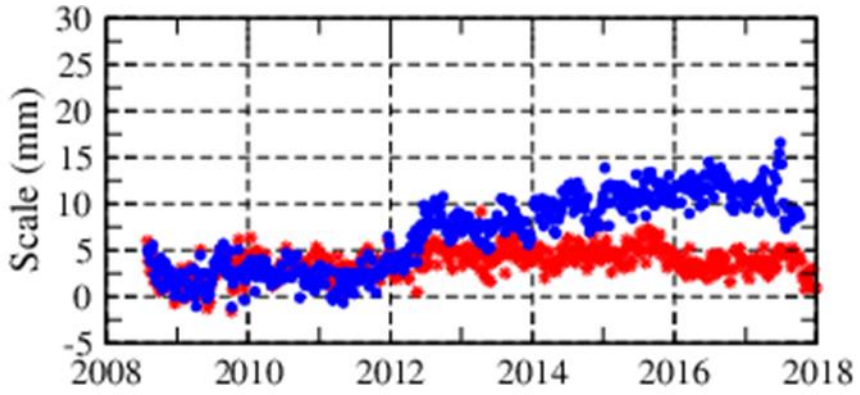
The larger number of data, especially at low elevation, was the cause of the change we observe in the scale factor.

When we did our own pre-processing when using all doris2.2 data and the scale jump is removed

HY-2A scale



Multi-satellite scale

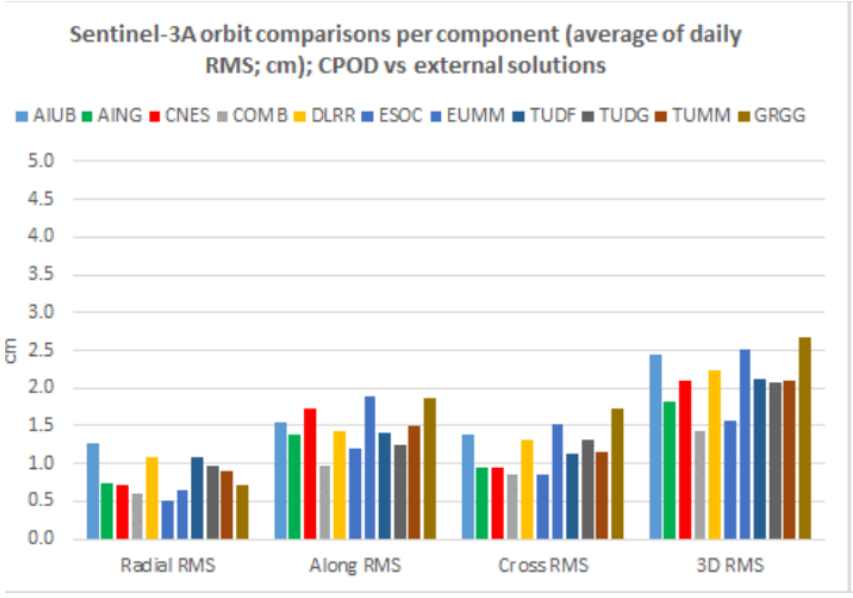


Sentinel-3A - GRG DORIS-only orbits

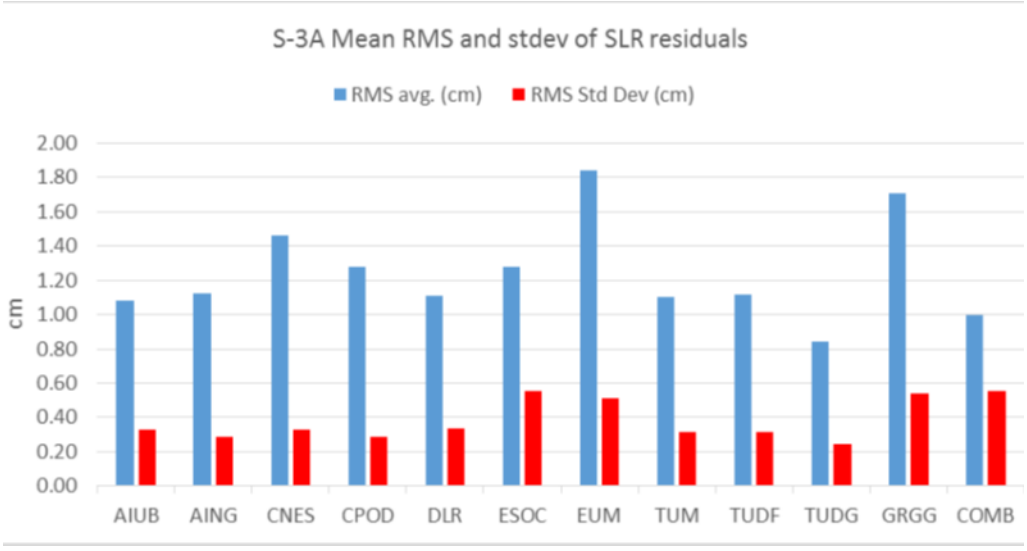
❑ Comparison to QWG GPS-only orbits

Results from GMV (J. Fernandez)
Sentinel-3A orbit differences
SLR evaluation of orbits

RMS of orbit differences (in cm)
Reference orbit: CPOD



Independent SLR RMS of fit



- *The quality of Sentinel-3A DORIS-only is at the same level than GPS-only orbits, in particular in radial direction*

PERSPECTIVES

- Geocenter and Scale factor from single satellite solutions (in progress)
- Using quaternions for the s/c body and solar array for Jason-2 and Jason-3 (spectral analysis)
- POD from GPS Sentinel-3A RINEX data
- Introduction of Sentinel-3B in the GRG processing chain
- Preparation to the next ITRF:
  implementation of models recommended by IERS as
  linear mean pole model
  FES2014, …