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Assessment of Orbit Quality through the Sea Surface Height calculation - Yearly report 2017 - SALP activities

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Reference documents

DR1 SALP-RP-MA-EA-23080-CLS available on line at:
https://www.aviso.altimetry.fr/fileadmin/documents/calval/validation_report/annual_report_Orbit_2016.pdf

DR2 L2P products handbook available on line at::
https://www.aviso.altimetry.fr/fileadmin/documents/data/tools/hdbk_L2P_all_missions_except_S3.pdf

DR3 S3MPC.CLS.APR.002 - i1r0 - STM Annual Performance Report - Year 1

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1. Introduction

This document presents the synthesis report concerning analysis and development activities of Orbit validation using altimetry during year 2017. It is part of SALP contract n° 160182 (lot 1.6.2) supported by CNES at the CLS Space Oceanography Division.

2. Overview

For a long time, orbit has been the major error in **altimetry**. This is not anymore the case since the deployment of DORIS and GPS positioning system and several modelling improvements. Still, the errors associated to orbital errors remain particular because they still dominate for the **very large** temporal and geographical **scale (***Figure 1***)**. Typically, errors were shown to have a non-negligible impact on **climate scales studies** (*Ollivier et al. 2012, Couhert et al. 2014*). Thanks to the reduction of other errors and to the increasing capacity of validations diagnosis, orbit errors are also shown to contribute to **mesoscale** and basin scale.

In the frame of SALP contract, the quality of orbits used for altimetry missions is regularly analysed on POD side, (using intrinsic diagnosis such as tracking metrics, post fit residuals, laser performances…), but also through the assessment of orbit quality on the sea surface height estimation.

These studies have a double objective:

- For all nadir altimetry missions, the **quality of the orbit ephemerides** is crucial for the computation of the Sea Surface Height (SSH). Impacting mostly large scales, spatially and temporally, the errors attributed to the orbit are worse being quantified and analysed precisely.
- Conversely, to assess evolutions of the orbit computation, having an accurate knowledge of the impact on the SSH quality efficiently completes the intrinsic orbit based diagnosis. Indeed, it provides an **external reference** (the SSH) to **benchmark different orbit solutions** and to detect remaining weakness with a very fine precision.

To address different aspects of the quality (precision, long term stability…), the analyses rely on a **large panel of calval tools and skills**, these studies use **mono-mission** and **multi-missions** diagnosis as well as **in situ** database comparisons.

Past relevant studies already shown their usefulness:

- To **validate standards solutions**, in addition to intrinsic orbit based diagnosis
    - ➔ For instance, currently GDR-E standards validation vs GDR-D previous version
- To better **understand the orbit model** solutions
    - ➔ For instance, they enabled to detect (and solve) imprecision in the gravity field modelling in the orbit computation with an impact of 10 to 20% of the Mean Sea Level trend estimation depending on the missions
- To identify **weaknesses of some products**
    - ➔ For instance, they enabled to compare short time critical (STC 3 days)/no time critical (NTC, 1month) product quality.

These activities are performed since many years in collaboration with CLS and CNES and enable to contribute to international meetings and discussions (participations to the OSTST, ESA missions POD QWG, S3VT PI teams…).

This document sums up the different studies performed in this frame for year 2017.

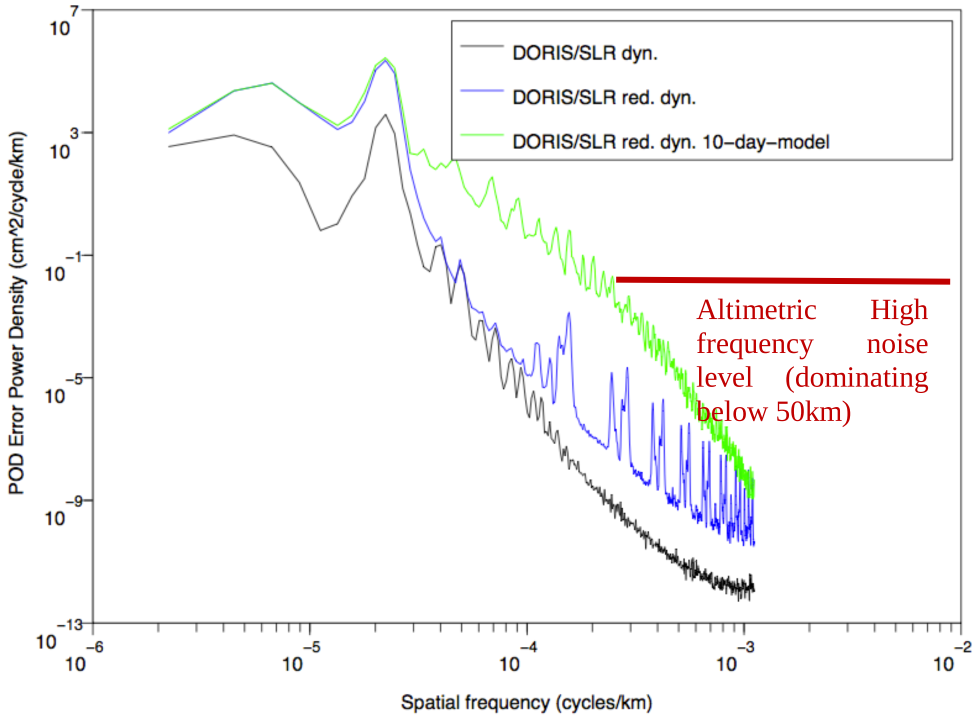

Figure 1 Spectral analysis of the radial differences between a degraded and a reference orbit solution (courtesy of CNES). The degraded orbit corresponds to ENVISAT DORIS-only orbit computed with the EIGEN-GL04S-Annual gravity field with the drift terms removed. The reference orbit is the DORIS/SLR reduced dynamic orbit with the most up-to-date gravity field model (10-day Grace solution). The radial difference between the degraded orbit and the reference orbit gives insight into the radial error.

The frame of these activities covers all the altimetric missions. It mainly focuses on CNES POD production but also integrates studies concerning other POD centres. *Table 1* sums up the official POD used for the SALP DUACS products (MOE = Medium/POD = Precise Orbit Ephemeris respectively for Near/Delayed Time production) as well as the techniques used for the POD definition. Since GDR-E standards, laser information is not anymore part of the solutions for it is used for validation purposes only on POD side.

Mission	*GFO*	*TP*	*E1*	*E2*	*EN*	*C2*	*AL*	*J1*	*J2*	*J3*	*S3*
Duacs production center	*GSFC*		*REAPER (GFZ)*		*CNES*						*GMV/ CNES*
MOE CNES Technique	-	-	-	-	-	*DORIS*	*DORIS*				*DORIS*
POE CNES Technique	-	*DORIS(+SLR)*	-	-	*DORIS*	*DORIS*	*DORIS (AL)* *DORIS+GPS (J1, J2, J3)*				*DORIS +GPS*

Table 1 Altimetric missions considered in this frame and current orbit chosen in the DUACS Aviso products

For each mission, the studies rely on the performance of Sea Surface Height estimation, defined as the sum of several corrections whose standards are described below. Those standards consist in the L2P (enhanced, homogeneous calibrated and validated dataset) product definition (DR), described on line at the following address: https://www.aviso.altimetry.fr/fileadmin/documents/data/tools/hdbk_L2P_all_missions_except_S3.pdf

NTC L2P	ERS-1	ERS-2	T/P	EN	J1	J2	GFO	C2	AL	H2	J3
Orbit	Reaper [Rudenko et al., 2012]		GFSC STD15 until c 365,STD12 afterwards	GDR-D	GDR-E	GDR-E	GSFC	GDR-E	GDR-E	GDR-D	GDR-E
Sea State Bias	BM3 (Gaspar, Ogor, 1994)	Non parametric [Mertz et al., 2005] using c 70 to 80 with DELFT orbit and equivalent of GDR-B standards)	Non parametric SSB [N. Tran and al. 2010] (using c 1 to 111 with GDR-C standards and GDR-D orbit)	Non parametric SSB, [Tran, 2015]	SSB issued from GDR-E	Non Parametric SSB[Tran 2012]	Non parametric SSB [Tran et al., 2010]	Non parametric SSB from J1 with unbiased sig0	Non parametric SSB[Tran et al., 2014]	Non parametric SSB from J1	Non Parametric SSB [Tran 2012]
Ionosphere	Reaper [NIC09 model, Scharroo and smith, 2010]	NIC09 [Scharroo and smith, 2010] (c≤36), GIM [Iijima et al., 1999] (c≥37)	Dual-frequency altimeter range measurements (Topex) [Guibbaud et al., 2015], Doris (Poseidon)	Dual-frequency altimeter range measurement [Guibbaud et al., 2015] (c≤64)/GIM [Iijima et al., 1999] Corrected for 8mm bias (c≥65)	Dual-frequency altimeter range measurement [Guibbaud et al., 2015]	Dual-frequency altimeter range measurement [Guibbaud et al., 2015] Recomputed after SSB C-band update	GIM [Iijima et al., 1999]		GIM [Iijima et al., 1999]		Filtered dual-frequency altimeter range measurements [Guibbaud et al., 2015]
Wet troposphere	GNSS derived Path Delay [Fernandes et al., 2015]			Obligis et al., 2009	JMR issued from GDR-E	Neural Network correction (3 entries), Fréry et al. In preparation	From GFO radiometer	From ECMWF model	Neural Network correction (5 entries) Picard et al., In preparation	From ECMWF model	From J3-AMR radiometer
Dry troposphere	Model based on ERA-INTERIM		Modelbased on ERA-INTERIM	Model based on ECMWF Gaussian grids	Model based on ECMWF rectangular grids	Model based on ECMWF Gaussian grids	Model based on ECMWF rectangular grids	Model based on ECMWF Gaussian grids	Model based on ECMWF Gaussian grids	Model based on ECMWF Gaussian grids	Model based on ECMWF Gaussian grids
Combined atmospheric correction	MOG2D High frequencies forced with analysed ERA-INTERIM pressure and wind field + inverse barometer Low frequencies			MOG2D High frequencies forced with analysed ECMWF pressure and wind field [Carrere and Lyard, 2003; operational version used, current version is 3.2.0] + inverse barometer Low frequencies					MOG2D High frequencies forced with analysed ECMWF pressure and wind field [Carrere and Lyard, 2003; operational version used, current version is 3.2.0] + inverse barometer Low frequencies		MOG2D High frequencies forced with analysed ECMWF pressure and wind field [Carrere and Lyard, 2003; operational version used, current version is 3.2.0] + inverse barometer Low frequencies
Ocean tide	FES2014 [Carrère et al., 2015]										
Solid Earth tide	Elastic response to tidal potential [Cartwright and Tayler, 1971], [Cartwright and Edden, 1973]										
Pole tide	[DESAI, 2015]										
MSS	CNES-CLS-2015										

Table 2 Standards used for the SSH definition for each mission (reference frame: Reference corrections overview (in white same standards as L2 products, in green standards updated in L2P products)

3. Current CNES POE GDR-E orbits compared to the previous standards GDR-D

3.1. Calendar and standard components

Since end 2015 and during 2016, all orbit standards were upgraded from a GDR-D to GDR-E (including Jason-3 and Sentinel-3 also using GDR-E standards from the beginning of the mission), following the calendar below concerning the GDR products shifts:

Cryosat 2 : 2april 2015 (MOE on April 1st 2015)
4 april 2015 (POE)

Jason-2 : 26 may 2015 (MOE on May 25th 2015)
24 july 2015 (POE) – cycle 254

SARAL : 1 july 2015 (MOE du June 30th 2015)
4 august 2015 (POE) – arc 1 cycle 25

Hy-2A : February 2017

	POE-D (Reference)	POE-E
Gravity model	EIGEN+GRGS.RL02bis_MEAN-FIELD	EIGEN+GRGS.RL03-v2.MEAN-FIELD
Non tidal TVG	one annual, one semi-annual, one drift terms for each year up to deg/ord 50	one annual, one semi-annual, one bias and one drift terms for each year up to deg/ord 80
Surface forces	Radiation pressure model: thermo-optical coefficient from pre-launch box and wing model, with smoothed Earth shadow model	Radiation pressure model: calibrated semi-empirical solar radiation pressure model
DORIS	DORIS weight is reduced by a factor 10 before DORIS instrument change	SAA DORIS beacons weight is divided by 10 before DORIS instrument change
Orbit solution	Doris/Laser/GPS till cycle 169 Doris/Laser after cycle 169	Doris/GPS till cycle 169 Doris after cycle 169

Table 3 Standards used for the POD definition for each standard D and E (only for J1 concerning the DORIS beacons underweighting)

In the frame of these activities, the relative quality of both standards was analysed and summed up in a poster (Ollivier et al. OSTST 2016) as well as in DR1.

4. Quality of the current CNES POE orbits

To address the orbit quality, the main diagnoses used are of two kinds:

- Absolute diagnosis based on a direct estimation error of Sea Surface Height
- Relative diagnosis based on the comparison of two orbit standards, relatively to the estimation of two Sea Surface Height for which the orbital term is the only difference.

4.1. Geographic crossover analysis of each missions

One of the most relevant absolute diagnoses is the map of average difference of Sea Surface Height (SSH) at cross over points. It highlights the systematic discrepancies between coincident ascending and descending tracks separated by less than 10 days (insuring a good stability of ocean variability) and thus a potential error on the SSH estimation.

They rely on a statistical computation on points plotted on *Figure 2* where the time difference between ascending tracks is plotted and shown to be geometrically spread out differently from a mission to another. These diagnoses reveal cumulated errors on the SSH estimate but the very large scale ones are often relevant of orbital signatures.

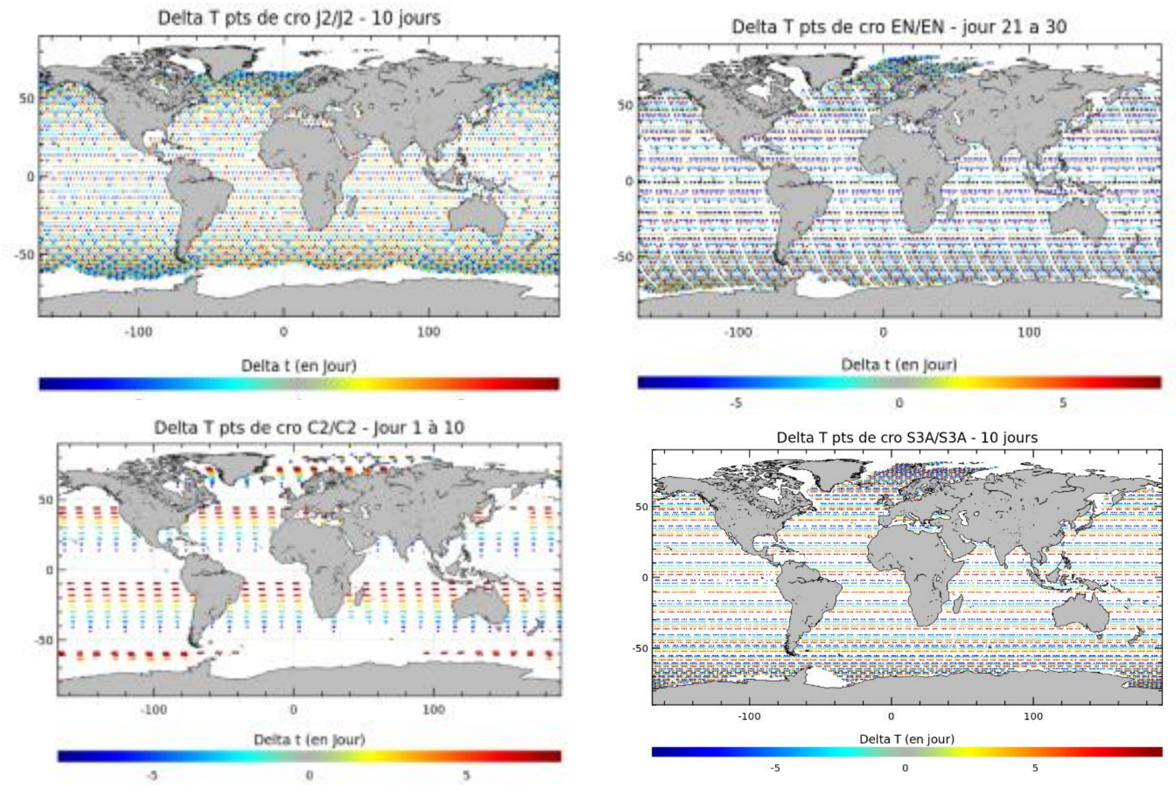

Figure 2 Delta time Asc-Dsc at Crossover point for J2 (or J1 or J3)/ C2/EN(or AL) and S3 , with 10days selection (current selection to limit the oceanic variability effect)

Figure 3 presents the signature of mean error at crossovers for all missions.

For Jason-2, the map is very homogeneous and clean. In average, all the differences are below +/-1cm.

For Jason-1, a slight pattern is visible near South America. This pattern, not visible on Jason-2 is due to the remaining South Atlantic Anomaly impact on DORIS instrument, cumulated to the lack of GPS in the solution at the end of the mission.The direct difference between Jason-1 and 2 is detailed in part 4.2.

For Envisat, the map is more inhomogeneous than the Jason's with patterns around +/-2cm. This effect is partly explained by several aspects: Envisat is sun-synchronous so the physical content of ascending and descending passes may present systematic differences (typically the impact of solar radiation pressure…). The blue color indicates that Ascending tracks are systematically below the Descending tracks.

For AltiKa, the map is also more inhomogeneous than the Jason's with patterns around +/-2cm. This effect is partly explained by several aspects: like Envisat, AltiKa is sun-synchronous so the physical content of ascending and descending passes may presents systematic differences to be investigated. The blue color indicates that Ascending tracks are systematically below the Descending tracks. This could be further investigated, potentially for other corrections than the orbit. Furthermore, the time series is shorter than for Jason1 and 2 so the effects are less averaged. The integrated effect should then tend to decrease as time goes.

For Cryosat-2, the striking effect is the double blind band situated around the equator and +/-[50]°Lat. This effect is due to the geometry of the orbit that avoids crossover points below 10 days in this area. Elsewhere, the map presents much larger patches than the Jason's series. Because the time series is smaller than the Jason-2's but also because of the geometry of the orbit introduces latitudinal dependency of the time discrepancy.

For Sentinel 3, the map is obtained by replacing SAR range by Pseudo LRM mode (see . Part6.2.1) in order to isolate the large scale errors not due to the orbit. Still, this map is the most inhomogeneous with patterns around +/-3cm. This effect is partly explained by several aspects: the time series is shorter than for all the other missions so the effects are less averaged. But when plotted over the same period, the errors are still higher than AltiKa's. The youth of the mission and the potential remaining errors on range does not enable to conclude directly that the discrepancies are due to the orbit only. Still, this should be further investigated.

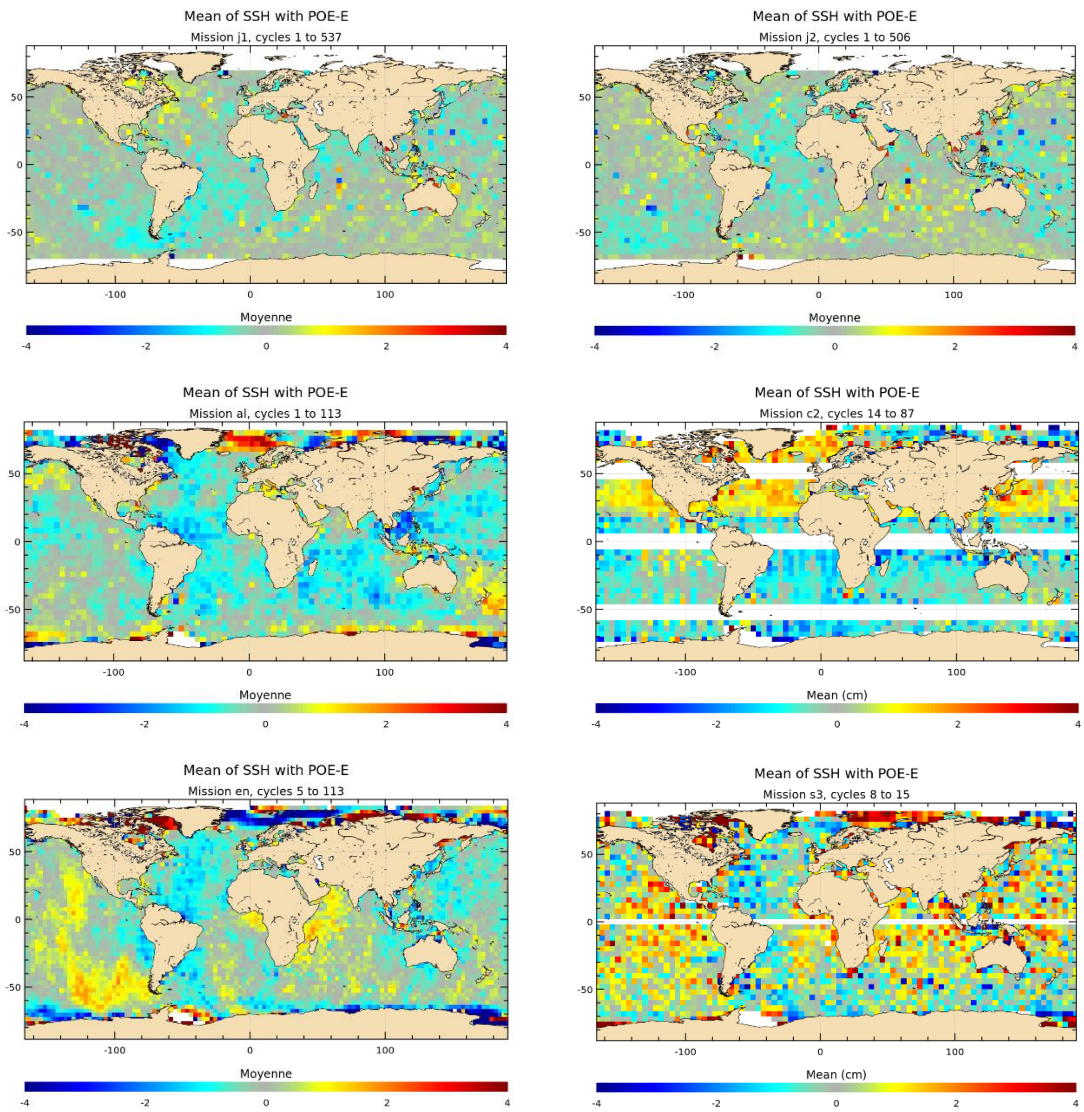

Figure 3 Map of the mean difference of Sea Surface Height at crossovers for all missions using CNES GDR-E standards (Jason1-Jason2-AltiKa-Cryosat2-Envisat-Sentinel3- using PLRM range)

4.2. Residual analysis of Jason-1 / Jason-2 consistency during tandem phase

Jason-1 and Jason-2 have the same altimetric system. During the tandem phase (cycles 1 to 20 of Jason-2), they are only separated by few seconds and their content is therefore totally comparable. On the *Figure 4*, the difference of Sea Surface Height is plotted along track and highlight centimetric discrepancies. These small differences are due to the orbit. Indeed, they are signatures of 2 factors:

- Jason-1 had lost its GPS payload for this period.

- The DORIS only orbit is affected by the DORIS onboard Ultra Stable Oscillator (USO) sensitivity to the radiation occurring in South Atlantic Anomaly region. Therefore, some of the DORIS beacons in the area were under-weighted in the orbit solution (Capdeville et al. 2006) to reduce the sensitivity to radiation effects.

In the GDR-E solution, this under-weighting was updated, in order to reduce the bias between both missions and to minimize a transition error on the Regional Mean Sea Level.

The resulting difference between both missions is very small but is featuring a clearer N/S bias.

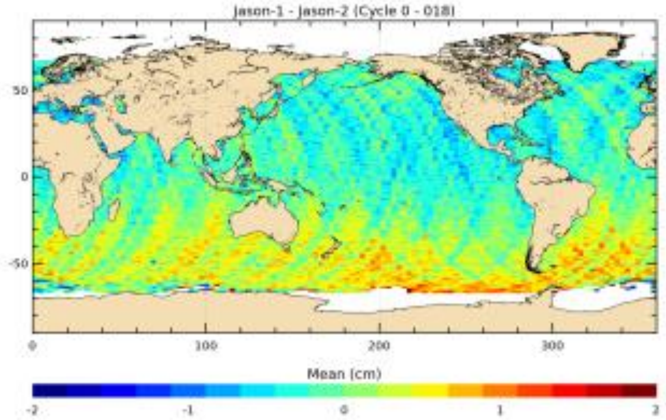

Figure 4 Orbit signature of the difference Jason-1-Jason-2 during tandem phase using CNES GDR-E POE standards

4.1. Temporal geographic crossover analysis of each missions

The stability of such ascending/descending discrepancies can be monitored thanks to *Figure 5* which highlights:

- For Jason-1 and Envisat, a slight inter-annual signal not directly explained up to now.
- For Sentinel 3 a rather strong bias placing the curve around 0.8cm above the others. This bias is further investigated in part 6.2 and significantly reduced when changing the tide model in the SSH computation.
- For all the missions, a periodic signal, equal to the draconitic (beta prime period ie period for which the sun and the orbital plan gets in the same configuration) period (depending on the mission) under investigation and probably linked to the beta angle of the mission (angle between the orbital plane and the solar rays).
  - For Jason-1, Jason-2 and Jason-3: 118 days, further investigated in Part 6.2.1
  - For the sun-synchronous Envisat, AltiKa and Sentinel 3: one year, further investigated in Part 6.2
  - For Cryosat-2: not exactly periodic but close to 1.5year

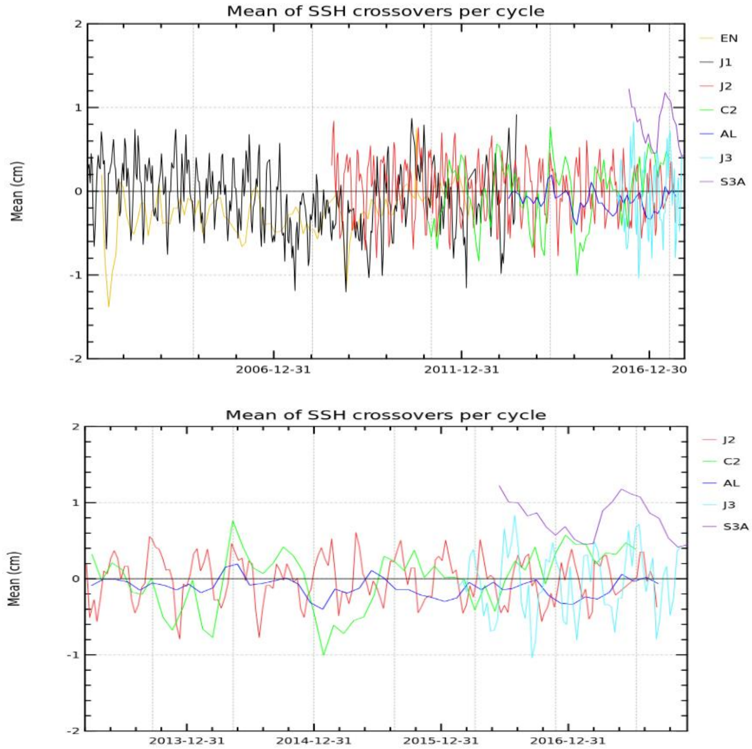

Figure 5 Monitoring of mean difference of Sea Surface Height at crossovers for all missions (top) for most recent missions (bottom) using CNES GDR-E standards

5. Quality of the CNES MOE orbits compared to the POE

Concerning the relative diagnosis based on the comparison of two orbit standards, comparisons can be performed between multiple solutions.

5.1. Multimission impact of orbit standard updates on the SSH performance

As presented in the EUMETSAT meeting in Toulouse in September 2016, a comparison was performed to estimate the relative quality of MOE (3days delay product) compared to POE solution (1month delay product).

These diagnoses reveal cumulated errors on the SSH estimate but the very large scale ones are often relevant of orbital signatures.

Here, *Figure 6* shows that (for J2 example) the MOE presents a negative systematism between ascending and descending tracks (-1.5cm) and a +/-2cm 120day signal, much reduced at the transition between GDR-C and GDR-D orbits (mainly thanks to the better gravity field modelling) With the POE the quality is globally better, with no clear systematism (mainly thanks to the GPS addition in the solution).

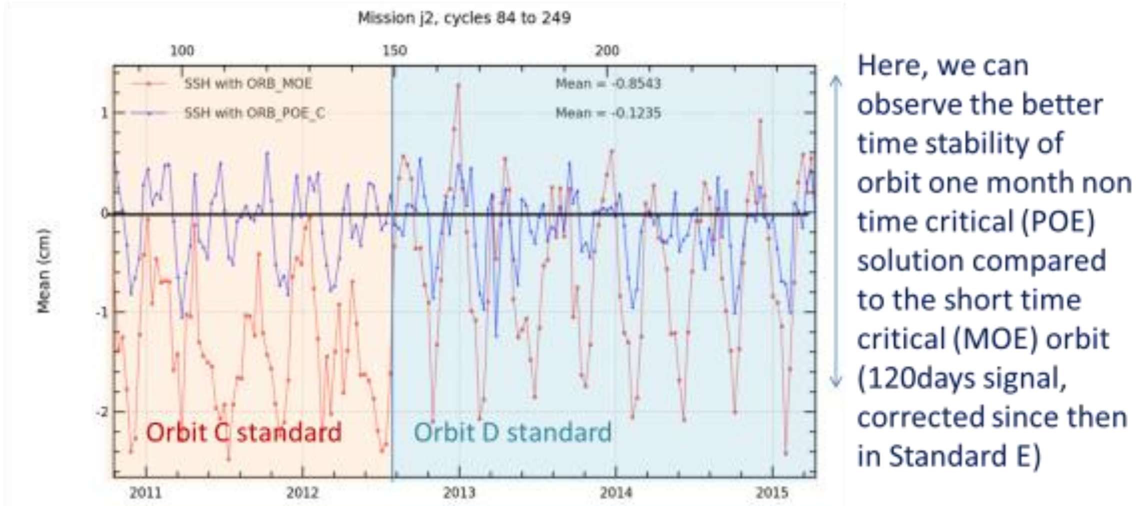

Figure 6 Monitoring of mean difference of Sea Surface Height at crossovers for all missions using CNES GDR-C and D standards for MOE compared to GDR-D POE standards

The variance gain at crossovers also indicates (*Figure 7*) that the MOE is slightly degraded compared to the POE but in a much lower way with GDR-D standards than with GDR-C.

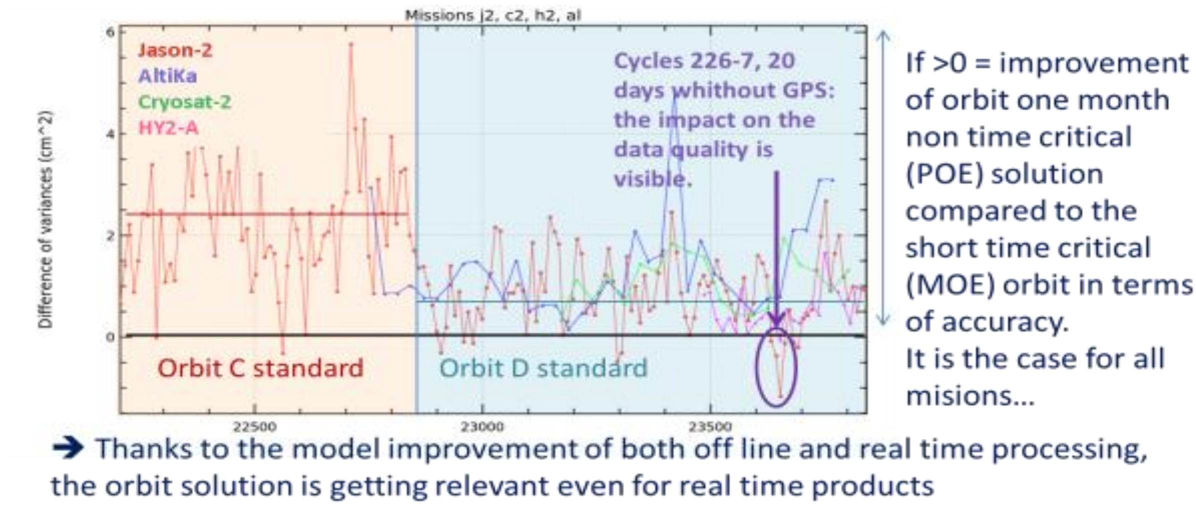

Figure 7 Monitoring of variance difference of Sea Surface Height at crossovers for all missions using CNES GDR-C and D standards for MOE compared to GDR-D POE standards

These diagnosis of MOE/POE comparisons can regularly be updated and contribute to the discussion of potential faster products delivery in the OSTST community. They will be updated in 2018 using the new GDR-E/F standards for all missions.

5.2. MOE and POE orbit quality and impact on the SSH performance for J3 and S3

For the most recent mission J3 and S3, two different behaviours were noticed:

First, concerning the standard deviation at crossovers:

- for Jason-3, (see *Figure 8* right) the performances of IGDR (MOE) and GDR (POE) are very close with a non-significant difference on this diagnostic.

- unlikely, for Sentinel-3, (see *Figure 8* left and in DR3) the STC (MOE) performance is 5% lower than the NTC (or STC using the POE). A more recent version is in preparation on POD centre side to improve MOE solution on this aspect, was presented at OSTST 2017 and the impact on SSH performances will be analysed further in 2018.

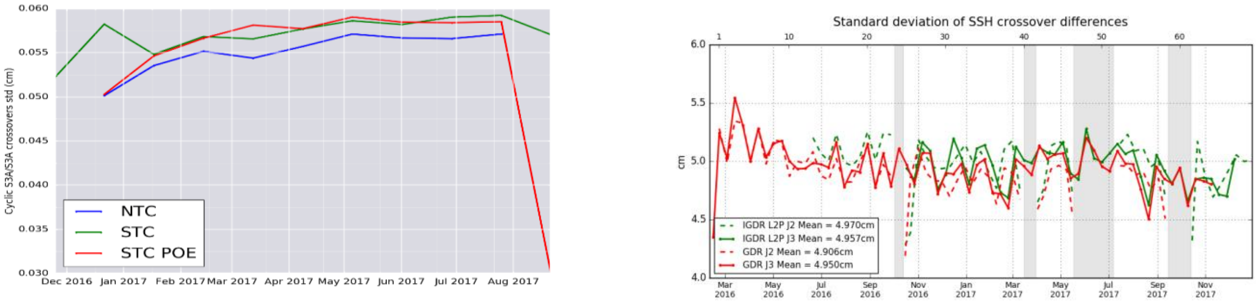

Figure 8 Monitoring of standard deviation of Sea Surface Height difference at crossovers for using CNES GDR-E standards for MOE compared to POE for Sentinel-3 (left) and Jason-2 and 3 (right)

Second, concerning the average difference at crossovers:

- for Jason-3, (see *Figure 9*) the performances of IGDR (using MOE) was surprisingly more homogeneous, and stable than the GDR (using POE standards). Part of this observation was explained by a small anomaly identified on POE in the assimilation of GPS data in the model outside from the yaw flips periods (see DR2). It will be solved in the future GDR-F solution. But another analysis enabled to identify a second order dependency between orbit error and tidal models in the SSH computation. This is explained in part 6.2.1

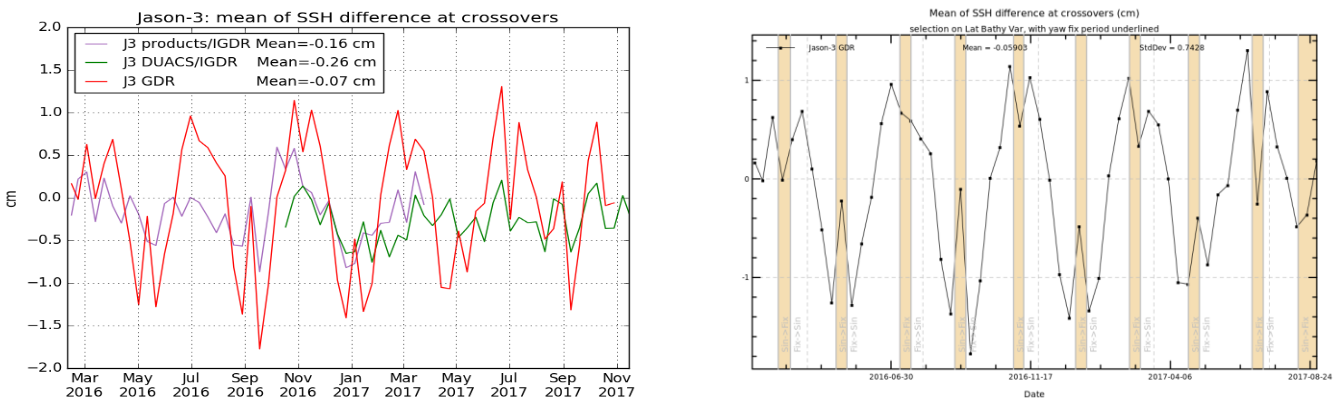

Figure 9 Monitoring of mean difference of Sea Surface Height at crossovers for Jason-3 using CNES GDR-E standards for MOE compared to POE standards (left). Yaw fixe periods highlighted in gold (right).

6. Particular investigations on CNES study orbits

6.1. Impact on orbits of the geocenter position change

New **GDR-E** standards are reaching a very good quality (cf. OSTST 2015 and above). Thanks to GRACE-based models, gravity field errors are now much reduced. Smaller and smaller errors –considered as negligible before- are now observable. This highlighted the fact that **changing the geocenter position can induce millimetric variations on the orbits (order of magnitude of the precision required for climate studies).** A sensitivity study was performed this year to analyse this point.

GPS constellation reference network is aligned to ITRF origin, thus the geocenter position estimation from GPS constellation is not possible in the current solution. Hence, this study is performed on **pure DORIS orbit solutions**. Besides, a **dynamic model** is used in order to focus on the Z impact (unlike reduced dynamic which effect was shown to be mixed in X, Y and Z directions, see A. Couhert's talk available on Aviso web site).

	Geocenter model	Technics	Mission
POE-E standard	Ries model = annual motion (no drift) of the LASER reference geocenter	DORIS + GPS Reduced dynamics model	Jason-2
DORIS Dyn Ries	Ries model = annual motion (no drift) of the LASER reference geocenter	DORIS Dynamic model	Jason-2

Table 4 Discrepancies between the official POE and the tests Standards used for the study

The impact of choosing a bi technique reduced dynamic orbit or a pure DORIS using dynamic modelling is quantified. No global trend differences are noticed but large scale effects very variable in time appear (*Figure 10*).

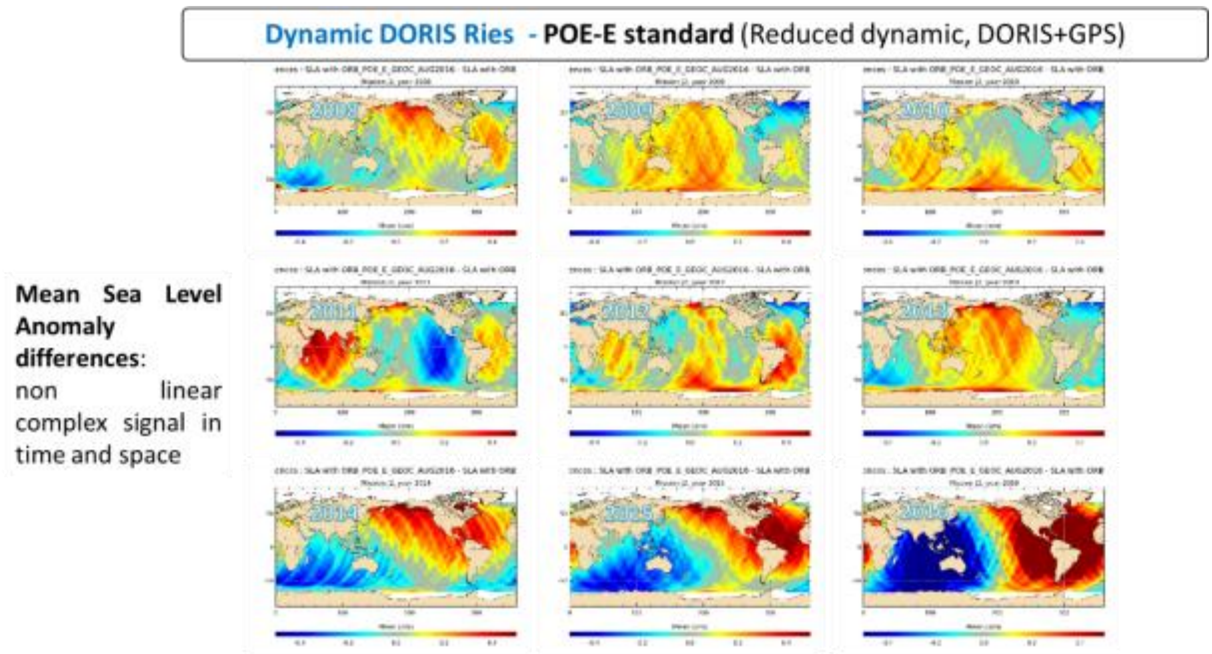

Figure 10: Difference between a pure DORIS dyn Ries (dynamics and using DORIS) and POE_E standards (Reduced dynamics and using DORIS+ GPS)

Following last year impact analysis, investigations have been carried on to expand the conclusions to the impact of such choice on the climatic scales and errors in the closure budget exercise.

The work was presented at OSTST 2017 and is available on aviso at the following address: https://meetings.aviso.altimetry.fr/?id=95&no_cache=1&tx_ausyclsseminar_pi2%5BobjAbstracte%5D=2198.

6.2. Orbit errors and large scales signatures of the SSH standards

6.2.1. Jason2 and Jason-3

The effect of standards on the average SSH difference at crossovers is usually dominated by orbit errors.

Yet, the combination of a tide solution having assimilated a given orbit has significant impacts on this diagnosis.

Below is the summary of a study presented in the Jason-3 yearly report and addressing the opposite effect of changing the tides on Jason-2 and Jason-3. The average at crossover is less homogeneous for J3 using FES2014 whereas it is more homogeneous for Jason-2.

This effect highlights the importance of the standards chosen as the reference to address orbit quality issues.

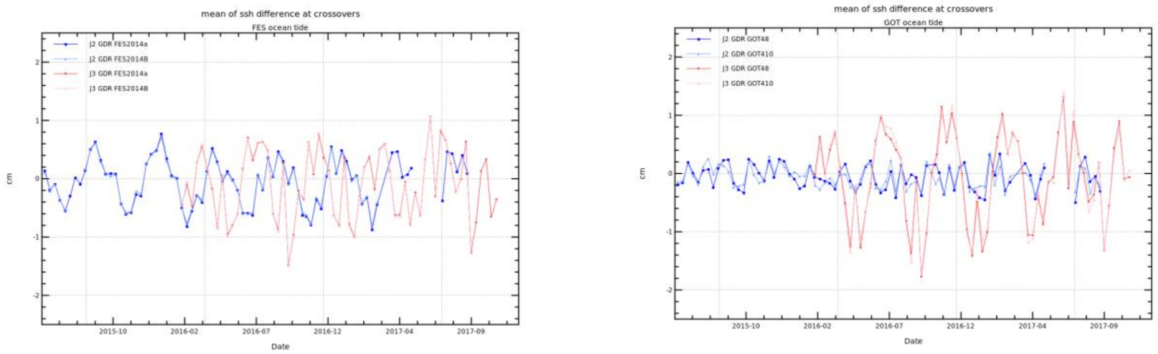

Figure 11 Monitoring of Jason-2 (bleu) and Jason-3 (red) mean of SSH difference at crossover using different ocean tide solutions FES2014 (left) or GOT (bottom right)

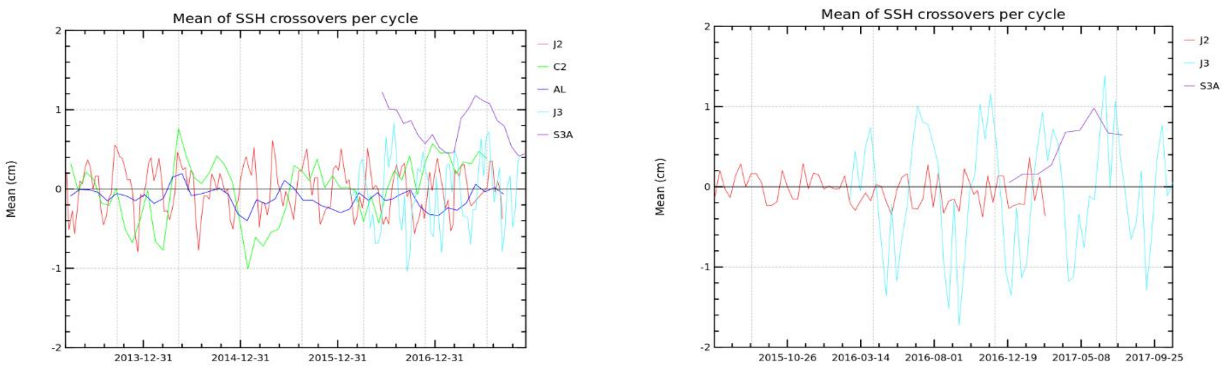

Figure 12 Monitoring of mean difference of Sea Surface Height at crossovers for most recent missions using CNES GDR-E standards. Including the impact of the tide solution GOT4v10 (right) or FES 2014 (left) model

6.2.2. Sentinel-3

Figure 3 and *Figure 5* show metrics concerning the statistics at crossovers using the L2P standards. For Sentinel-3 mission, this implies that the range used comes from its nominal SAR doppler processing of the waveforms. This choice is driven by the fact that SAR data give much better skills in mapping the mesoscale ocean activities. Yet, larger scale errors are induced, understood and on the point to be corrected in the products. The large patterns observed are not linked to orbital errors but rather to SAR processing sensitivity to wave movements.

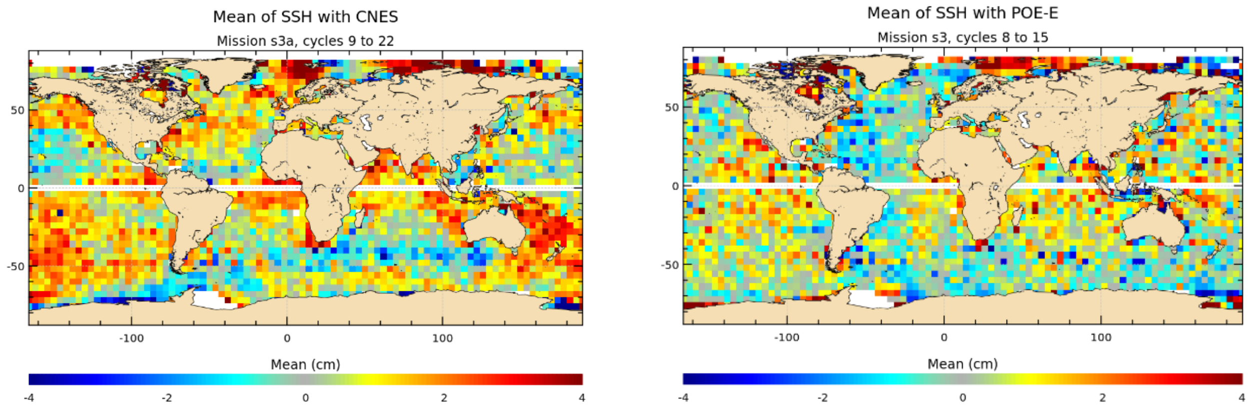

Figure 13 Map of the mean difference of Sea Surface Height at crossovers for all missions using CNES GDR-E standards for Sentinel3-(left) using the SAR mode, available in the L2P products, and (right) using the PLRM range mode

The impact of changing such field in the SSH computation (LRM instead of SAR) also has a small impact on data. but it does not decrease the systematic bias observed between ascending and descending passes (see *Figure 14*).

Unlikely, and as observed for Jason-2/Jason-3, changing the tide model has an impact on the average at crossover. The oscillation between 4mm and 1.2cm using FES 2014 model (dotted curve) is reduced between 0 and 1cm when using GOT 4v10. (More information can be found in the Sentinel-3 yearly report DR3). For this mission, the signature of the tide impact is not at the same period but this indirect effect will certainly be of interest for future investigations.

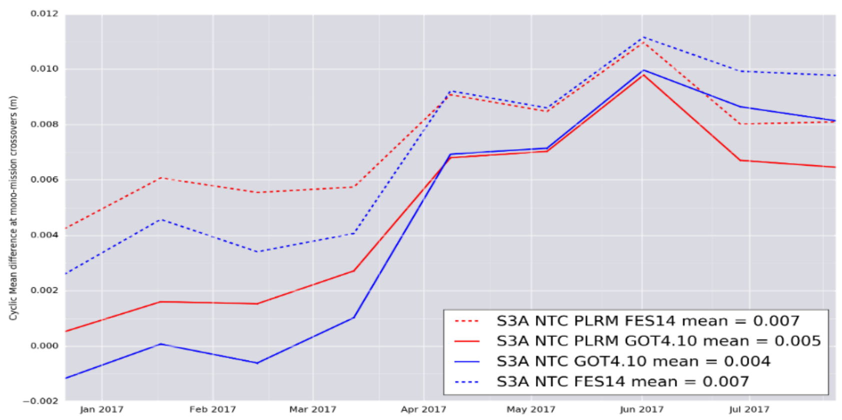

Figure 14 Monitoring of mean difference of Sea Surface Height at crossovers for Sentinel3-(blue) using the SAR mode, available in the L2P products, and (red) using the PLRM range mode. Including impact of the tide solution GOT4v10 (plain curve) or FES 2014 (dotted curves) model

6.3. Quality of the CNES POE orbits compared to other production centres

6.3.1. Orbits quality from different POD centres for Sentinel 3

In order to further investigate the quality of Sentinel-3 orbit, and complementarily to the intrinsic diagnosis (see parts above), a comparison to ESA orbit production centre was performed.

The study was realized over the common period (three months) of both datasets, and, because of the low number of cycles statistics have to be considered with precaution.

Maps of mean differences at crossovers show very similar patterns for both centres (*Figure 15*).The variance at crossovers are also very similar (difference of variance on the right), with a very slight reduction of variance (better performance of SSH restitution) for CNES POE.

The absence of notable anomalies enables to conclude that the quality of both orbits are very similar.

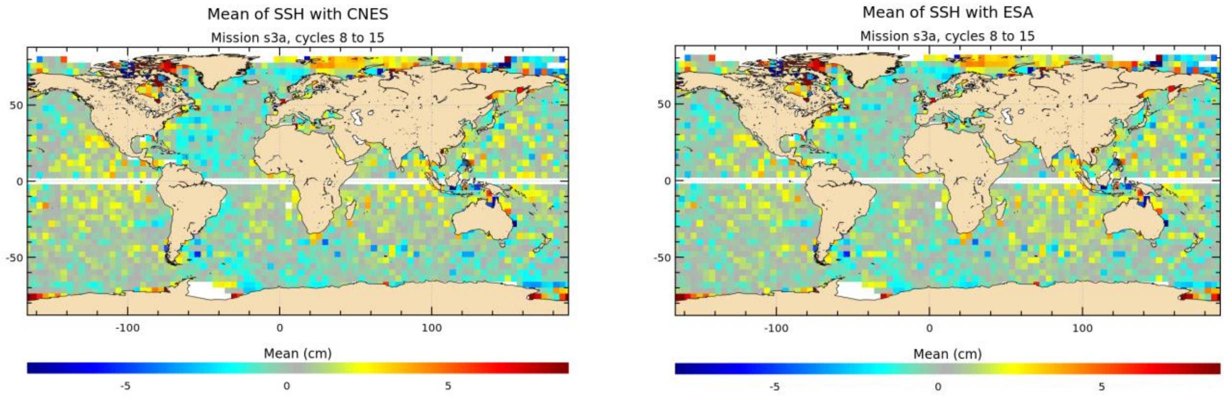

Figure 15: Map of the mean Sea Surface Height for Sentinel 3A mission using CNES standards (left) GMV (right)

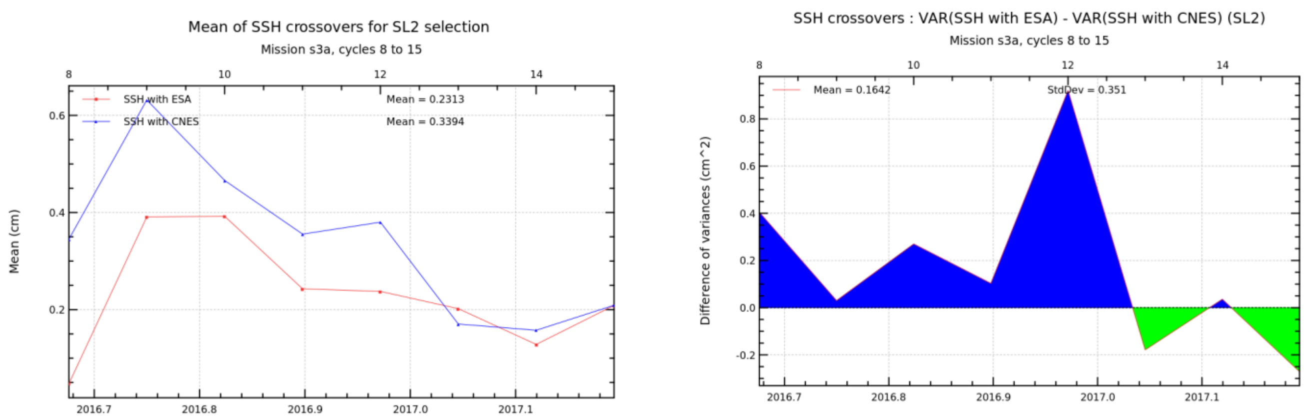

Figure 16: Monitoring of average (left) and difference of Variance of Sea Surface Height (right) for Sentinel 3A mission between CNES GWV standards function of latitude

7. Conclusion

In this document, we analyse and compare the missions' behaviours from an absolute point of view and compare orbits solutions in order to validate a new standard or to determine the best solution among others.

On the Jason-1/2 time series, climate studies could be carried on, through the analysis of impact on orbit solution in the sea level budget in earth energy balance. A paper is in prep.

The first analysis on the new Sentinel3 mission were extended on a longer time series, confirming the discrepancies between MOE and PO. ➔ an improving evolution is planned on the MOE production, early 2018 to reduce the differences between JPL GPS solutions and CNES solutions (see Last year report [DR1]). This will be analysed thoroughly.

On Jason-3, as well the time series became large enough to be analysed. POE issues concerning the GPS managing outside from the yaw periods was observed and is planned to be solved in the future products standards.

Furthermore, this year, sensitivity of the correlation between orbit standards and tidal models was highlighted. Indeed, depending on the orbit used in the SSH assimilated to build tide models, the mean SSH difference at crossovers are very different. These "second order" impact will be further investigated during 2018.

Appendix A - **List of acronyms**

TBC	To be confirmed
TBD	To be defined
AD	Applicable Document
RD	Reference Document