CalVal Envisat

Envisat RA2/MWR ocean data validation.Yearly Report 2015

Preparation of the 2016 complete reprocessing

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LIST OF ACRONYMS

ECMWF	European Center for Medium range Weather Forecasts
GDR-A	Geophysical Data Record version A (before cycle 41 for Envisat mission)
GDR-B	Geophysical Data Record version B (after cycle 41 for Envisat mission)
GIM	Global Ionosphere Maps
IRI	Internationl Reference Ionosphere
MSL	Mean Sea Level
MWR	MicroWave Radiometer
POE	Precise Orbit Estimation
SLA	Sea Level Anomalies
SSB	Sea State Bias
USO	Ultra Stable Oscillator
PTR	Point Target Response

1. Introduction

This report is an overview of Envisat performance assessment and gathers analysis of Envisat dataset performed at CLS in 2015. Before the satellite loss, Envisat GDR data was routinely ingested in the Calval 1-Hz altimeter database maintained by the CLS Spatial Oceanography Division in the frame of the CNES Altimetry Ground Segment (SALP) and funded by ESA through F-PAC activities (SALP contract N° 104685 - lot1.2.A).

In spite of the loss of the satellite on the 8th of April 2012, CLS experts teams continue to improve the mean sea level computation, taking into account analysis of new standards carried out in passed years. In 2015 new standards have been analysed in terms of impacts at different scales. The continuation of this work allows to guarantee an optimal data quality level and to prepare the next reprocessing of the whole Envisat dataset.

The anticipation of the next complete reprocessing first concerns new standards in addition of the ones analysed in 2013/2014 (see [17],[18]), notably:
- The impact of **two ocean tides solutions**: GOT 4V10 and FES 2014 ocean tide solution was analysed this year;
- **Two Mean Sea Surface solutions** were proposed too, rapidly analysed in this report.

Regardless of the chosen standards, analyse of the valid dataset used for SSH comptation was refined and new solutions are proposed to better consider local behaviour of the ocean and then to improve the global quality of the altimetric data. Efforts were put on the **validation processs**, notably for remarkable areas, such as **coasts** and **high latitudes**, in order to better discriminate potential valid data on ocean.

Finally, the last part of this report reminds the use of **Envisat data in user services**, like ODES. The planned complete reprocessing campaign will for sure improve the Envisat global data quality and will provide to users refined ocean products.

2. New standards assessment and validation

2.1. Reminder: the context of the next reprocessing anticipation

The preparation of the next reprocessing campaign is split in two parts, one is covered by the ENVISAT ESL Phase F (see [46]) and is not presented here. The following figure 1 reminds the activities performed in 2014 and 2015, notably in terms of database upgrade.
The anticipation of the whole reprocessing campaign is possible through the maintain of the complete database, which needs to be constanly upgraded to better appreciate the impacts of the future standards.

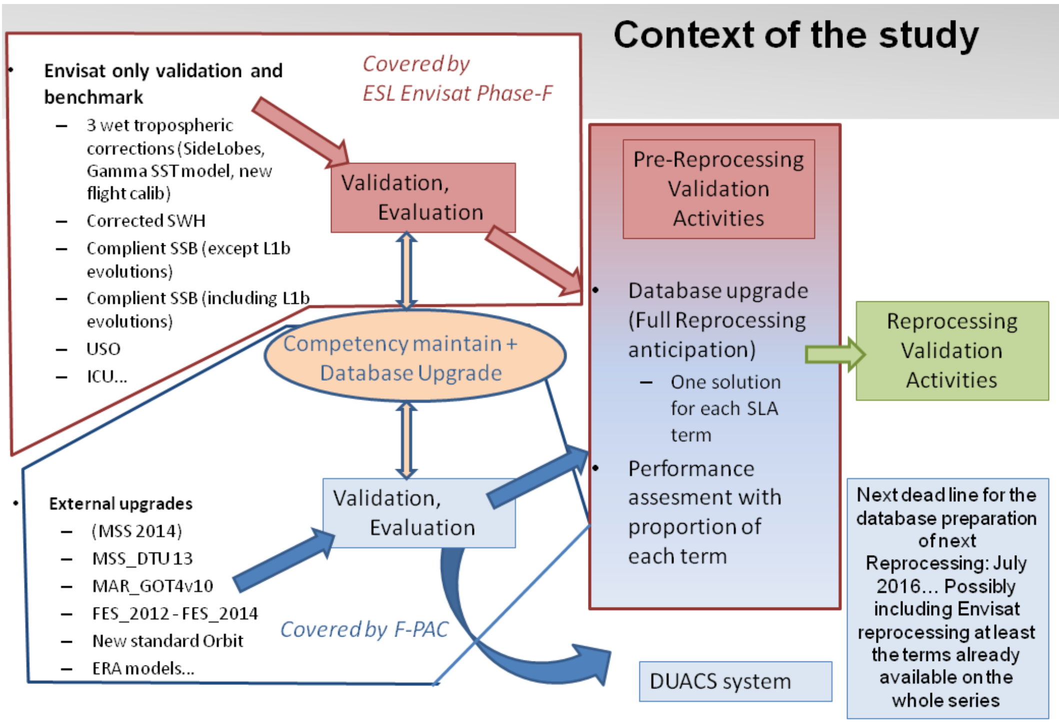
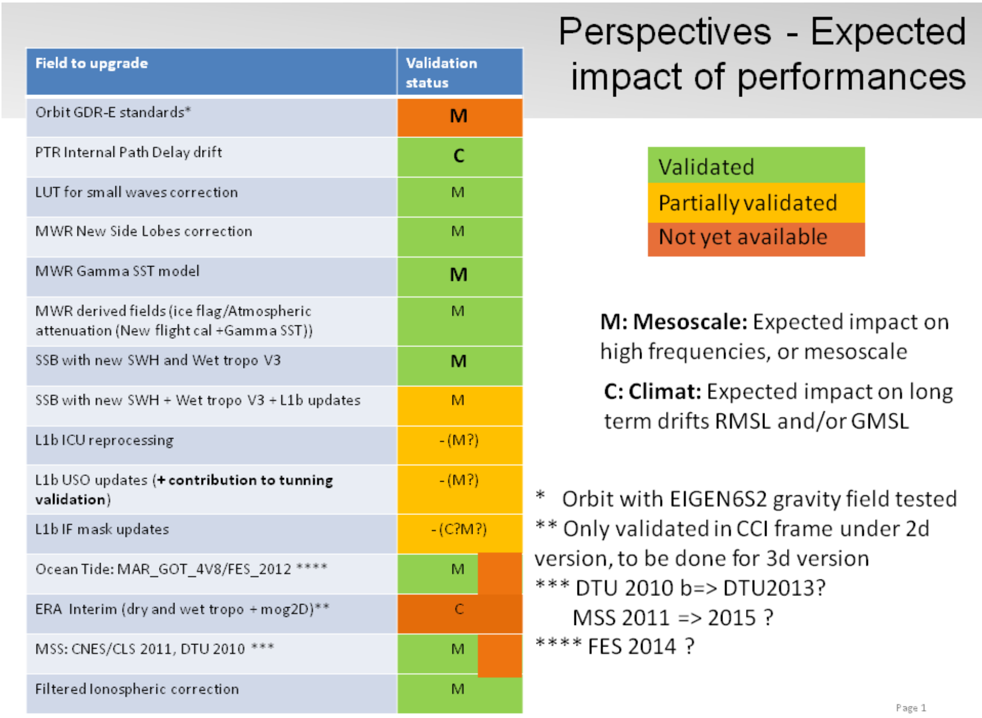


Figure 1: *Organization of activities in preparation of the next reprocessing campaign*

Validation were performed on outputs provided by experts (isardSAT, CLS) and can remain different from the results obtained after the operationnal implementation. Nonetheless, anticipated updates were validated one by one on a chosen period, and compared at least to the version V2.1 corresponding to the last reprocessing campaign. This methodology avoids a double complete reprocessing performed on L2 data but ensure to detect problems or suspicious behaviours before the beginning of the official reprocessing campaign.

2.2. Standards analysed and expected impacts

For the evolutions in the frame of the SALP activities, validation of the cumulated effects is performed on the whole dataset when updated data are available. This validation consists in the analyse of the impact on SSH, using the new standards compared to the one used in Duacs products. Figure 2 summarize all the updaded standards and the validation level at this time. Expected impacts are here mentioned.



Field to upgrade	Validation status
Orbit GDR-E standards*	M
PTR Internal Path Delay drift	C
LUT for small waves correction	M
MWR New Side Lobes correction	M
MWR Gamma SST model	M
MWR derived fields (ice flag/Atmospheric attenuation (New flight cal +Gamma SST))	M
SSB with new SWH and Wet tropo V3	M
SSB with new SWH + Wet tropo V3 + L1b updates	M
L1b ICU reprocessing	-(M?)
L1b USO updates (+ contribution to tunning validation)	-(M?)
L1b IF mask updates	-(C?M?)
Ocean Tide: MAR_GOT_4V8/FES_2012 ****	M
ERA Interim (dry and wet tropo + mog2D)**	C
MSS: CNES/CLS 2011, DTU 2010 ***	M
Filtered Ionospheric correction	M

Figure 2: *Updated standards for the next reprocessing campaign and expected impacts.*

As previously explained, L1B updates are partially validated (in orange). Orbit in GDR-E standard is not yet available, even if an orbit solution with the EIGEN6S2 gravity field was already tested (see [17]).

For ocean tides and Mean Sea Surface solutions, updateed standards are yet available, and performences are described in the following part. The analysed standard are:
- GOT 4V10 and FES 2014 ocean tide corrections are compared to the one used in the 2014 reprocessing campaign (GOT 4V8 solution);
- Mean Sea Surface: CNES/CLS 2015 and DTU 2013 solutions are compared to the CNES/CLS 2011 Mean Sea Surface solution used in V2.1 dataset.

2.2.1. Ocean tides updates

2.2.1.1. GOT 4V10

GOT 4V10 solution is here compared with GOT 4V8 previously used for the last complete reprocessing campaign. The evolutions taken into account in the 4V10 model concern the load and ocean tides for semi-diurnal wave S2. All the other files remain the same. On mean difference between 4V10 and 4V8 versions, an very small annual signal is visible, around 0.15mm in amplitude. An impact of the change of Envisat orbit is observed on this amplitude. In terms of performances at

mesoscale, we note a global reduction of variance of SSH at crossovers, reaching a mean diminution of $0.2cm^2$ for open ocean dataset (bathymetry under $-1000m$, latitudes under 50 deg and oceanic variability under $20cm$).
Reduction is global, and remarkable for Hudson Bay area. We note a slight degradation on south latitudes, as visible on figure 3.

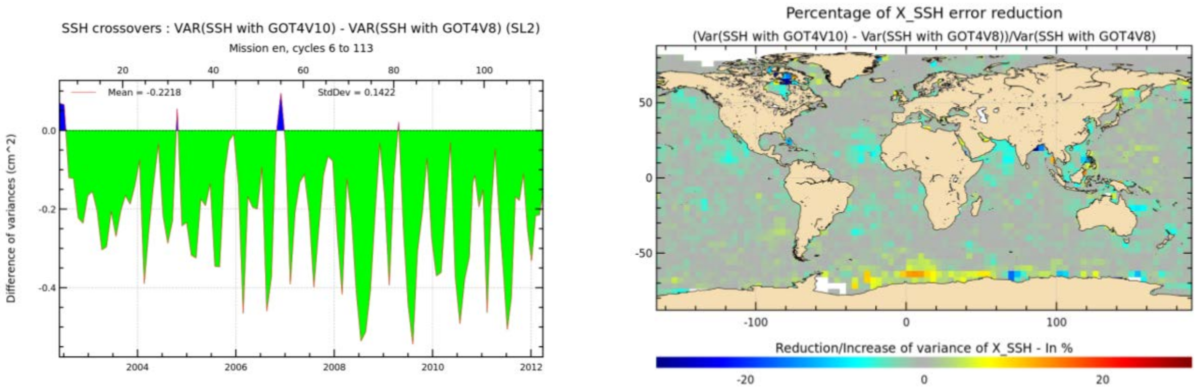


Figure 3: *Difference of variance of SSH at crossovers, due to GOT 4V10 against GOT 4V8 ocean tide solution.*

No impact is visible on global Mean Sea Level, very weak impact for the regions cited above.

2.2.1.2. FES 2014

The following analysis deals with the FES 2014 ocean tide solution, here compared to GOT 4V8 correction, which is the version used for the last reprocessing campaign. Figure 4 presents the evolution of the variance of SSH at crossovers, using the new FES solution against GOT solution. We note a global reduction of variance, along the Envisat serie and globally on the map. Note that this comparison is presented here for open ocean (bathymetry under $-1000m$, latitudes under 50 deg and oceanic variability under $20cm$).
The reduction of variance of SSH at crossovers is particularly marked for high latitudes, which represents a good improvement for Envisat dataset.

The last figure 5 presents comparisons with other ocean tide solutions: 2012 FES version, GOT 4V10 and DTU 2010 solutions. The reduction of variance of SSH at crossovers is observed in the three comparisons, and marked on high latitudes notably against GOT solution. The impact on coastal areas is remarkable, notably compared to the previous FES solution. The reduction of variance is significative for some open ocean areas too, such as North Australia for example.
Note that this encouraging results are similar for Jason's missions and Altika (see [26] for the complete validation results)

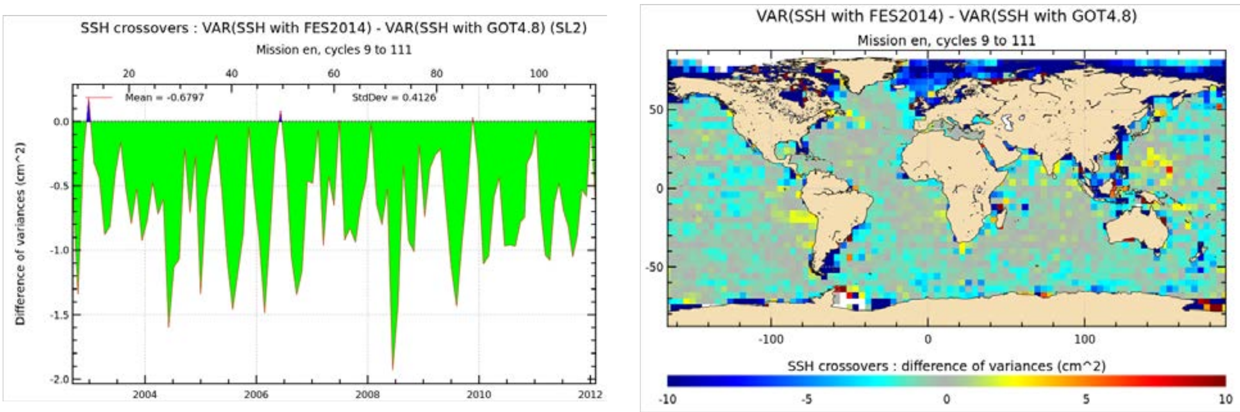


Figure 4: *Difference of variance of SSH at crossovers, due to FES 2014 against GOT 4V8 ocean tide solution.*

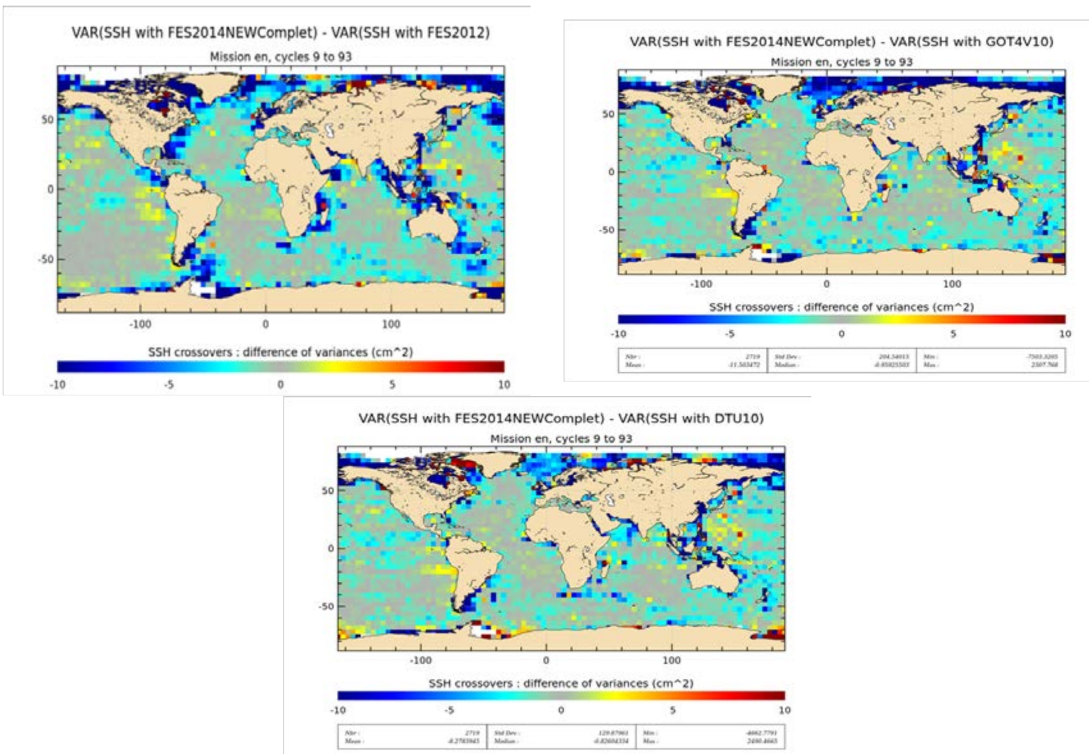


Figure 5: *Impact of FES 2014 ocean tide solution at crossovers, against* ***Left:*** *FES 2012 solution* ***Right:*** *GOT 4V10 solution* ***Bottom:*** *DTU10 solution*

2.2.2. Mean Sea Surface updates

As presented in 2, two updated solutions of Mean Sea Surface will be provided in the next reprocessed products:
- CNES/CLS solution: if available and validated, the 2015 version would be used;
- DTU solution: in the same idea, 2013 solution could be used.

For OSTST 2015, an analyse of Mean Sea Surface solutions was specially performed on Altika during the mispointing scenario (cycle 17), which represented an unexpected experiment of error estimations notably far for a repetitive ground track position. This analyse compares three solutions of Mean Sea Surface (2011 and 2015 CNES/CLS solutions, and 2013 DTU) over this special period and for nominal altimeter behaviour too.

The complete results are available in Annex or at http://meetings.aviso.altimetry.fr/fileadmin/user_upload/tx_ausyclsseminar/files/OSTST2015/GEO-04-Pujol_OSTST2015.pdf.

3. Editing improvement for Duacs multimissions process: coastal data

In SLA multimission products, some residual errors were noticed near coasts resulting in a pollution of multimissions maps. These values were attributed to drifting missions. The corresponding SLA seemed to be erroneous and the causes were not clearly defined. Oceanic tide model could be in cause, but Mean Sea Surface definition seemed to be a great source of error too.
As a consequence a palliative but drastic solution is currently used in DUACS products: data providing by drifting missions under 20km from coasts are not used in SLA multimission maps generation.
This solution is not really satisfactory, a significant number of data is not considered whereas SLA could be valid and usable for multimissions analysis and products generation.

Knowing this palliative solution, an effort was made in 2014 to define a new solution which allows to refine the validation of SLA near coasts.
This solution consists in an iterative filtering of SLA data directly after the classical editing process. For drifting missions, this solution adds therefore a step in the global editing process and allows to determine a SLA which is valid very close to shore.
After the classic editing process a median filter is applied on the whole dataset of valid SLA, using a window of 60 points (400km). This filtering method give a specific validity flag for each SLA data. After this filtering step, this specific flag is taken into account in the band of 30km near coasts.

SLA is therefore considered as valid if:

- beyond 30km from coasts, SLA value is validated by the classical editing process;
- below 30km from coasts, SLA value is validated:
  - by the classical editing process AND
  - by the iterative median filter (statistics in 3σ) directly applied after the classical editing process.

The optimal distance to be used could be adapted depending on the application needs.
The iterative process allows to give robustness to statistics and the filtering parametrization allows to remove only the spurious values of SLA very close to shores.

Figure 6 presents for cycle 112 the current solution used for Envisat in Duacs production system (on the left) and the new solution proposed for a better consideration of SLA near coasts for drifting phase (on the right). The zoom is made on Egean Sea because of the multitude of islands in this area.

We easily sea the gain of data very close to coasts. These SLA data are now considered as valid and can be used in multimission process.

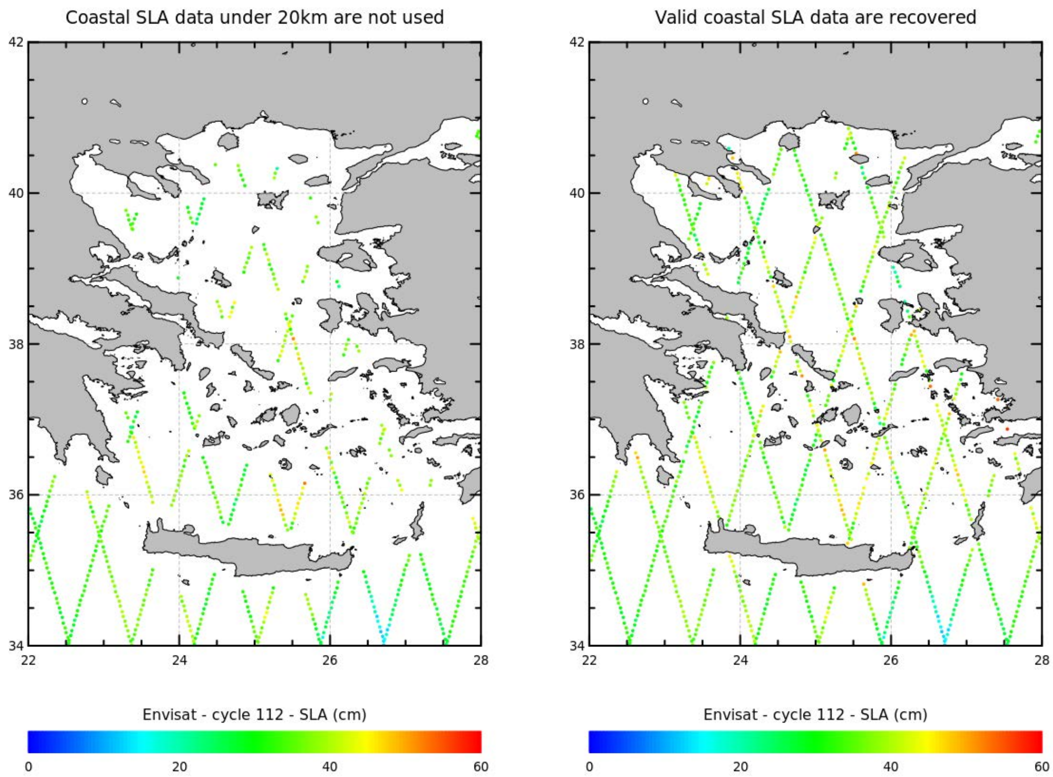


Figure 6: *Envisat cycle 112,* ***Left:*** *Data under 20km are removed for drifting missions - Current DUACS solution* ***Right:*** *Data near coasts are recovered with filtering solution directly applied on Sea Level Anomaly (result of filtering is here considered under 30km)*

4. High latitudes analysis

4.1. Ice data detection improvement

Ice and land data discrimination is one of the first step of altimetric data validation process. For altimetric missions carrying on a radiometer, ice detection is based on differences between wet tropospheric correction, computed with the instrument data, and the ECMWF model and a defined threshold. This approach, combined with a sufficient number of elementary data, give us an estimation of the presence of ice for a given localization.
But the data flagged as ice with this method cand be polluted by error near coasts, increasing the difference between radiometer and model data. As a consequence, a non negligible data number near coasts are detected as ice for latitudes under 60 deg, which seems not acceptable. An improvement of the solution, based on a simple filtering method combined with the OSI SAF data, was analysed for Altika this year in the frame of Peachi activities.
Here this complete solution is not presented but could represent a very good improvement for the next reprocessing campaign too. The following part shows how the external reference can be used on current method, which is a first step to improve the ocean dataset consideration. The idea is to compare the result of the ice limit defined by the classical CalVal algorithm with an external reference.

4.1.1. The OSI SAF project

To build a dynamic mask of ice where the iterative filtering method can be applied, external data are used. These data are provided by EUMETSAT and take part of OSI (Ocean and Sea Ice) project. Available data are gathered under the label SAFs (Satellite Application Facilities). This project is based on a cooperation between several institutes (MET Norway (Norway), DMI (Denmark), Ifremer (France), KNMI (Netherlands)) and hosted by Meteo-France. Several type of products are provided: Sea Surface Temperature, wind product,ice, ... in global or regional standards, for several resolutions, and in different file formats (Netcdf CF, Grib, ...). For more information, see http://www.osi-saf.org/.

4.1.2. Ice data from OSI SAF

To refine the ice area, ice concentration data are here analysed. These data, combining satellite data from different sensors, give users a global information of probability of ice. Ice concentration data, given in percentage, are gathered in Netcdf files, one per hemisphere and per day. Each Netcdf file is defined in polar stereographic projection, with a resolution of 10km. These data are available since 2005. Figure 7 presents the map of ice concentration for cycle 43 (December 2005).

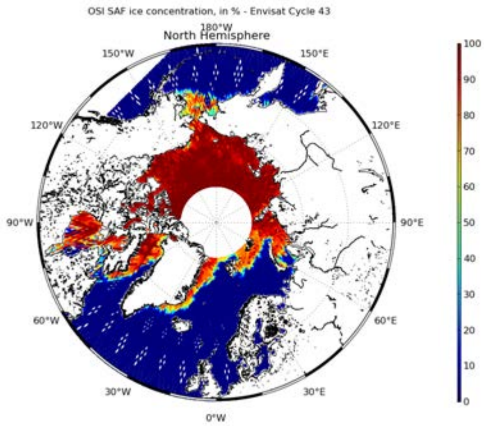


Figure 7: *Ice concentration, in %, for December 2005. Tracks effect is associated to the geometry of the orbit (35 days of data on the maps).*

4.1.3. Combination with Envisat current ice flag

Figure 8 presents the current data detected as ice for cycle 43 (December 2005). We easily see the over-editing of ice data nears coasts, notably in North of Europe. We can imagine that there is effectivelly no ice along these coasts.

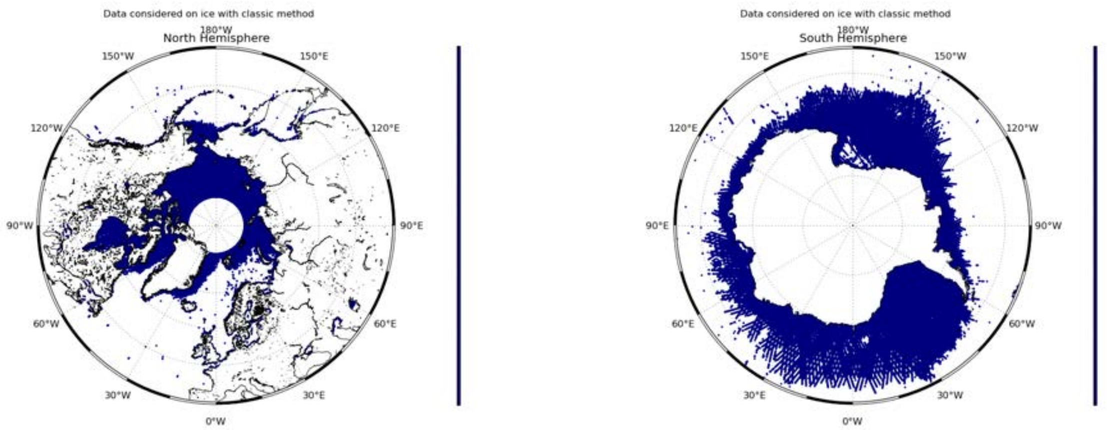


Figure 8: *Data detected as ice by current algorithm (threshold on difference of radiometer-model wet tropospheric correction)*

Comparing figure 7 and 8, we can easily say that the current method is too restrictive and rejects potential ocean data.
Then, the idea is to apply the current method only if OSI SAF ice concentration is positive; if for 1Hz data, ice concentration is null, then we consider that the data is on ocean, without other check.
If ice concentration is positive the value of current ice flag is taken into account as a additional information.
This allow to deduce a new ice flag, presented in figure 9. Ice limit seems more realistic.

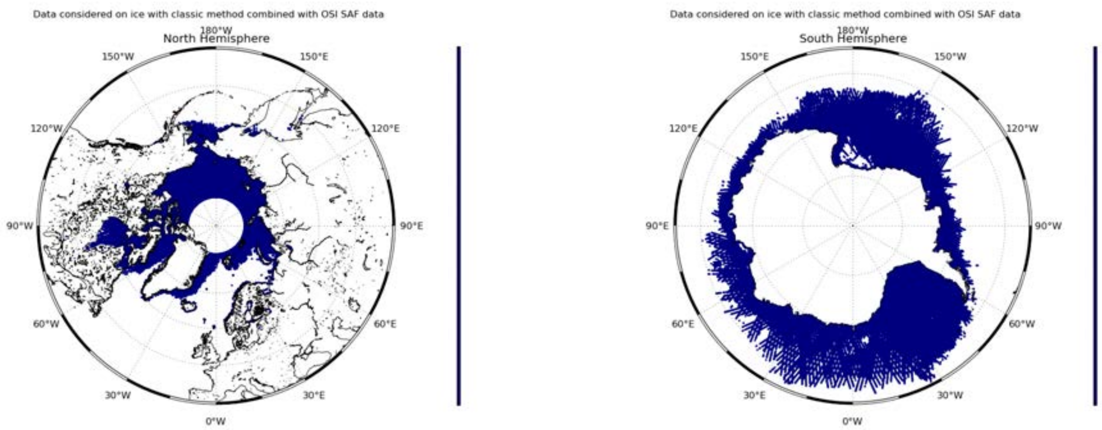


Figure 9: *Data detected as ice by current algorithm associated to OSI SAF data*

4.2. Analyse of Sea Surface Height at high latitudes

4.2.1. Impact of the ice detection method on altimetric parameters

To extend the analysis of ice detection improvement, we focused on the impact of the method described in 4.1.3. on altimetric data at high latitudes. The figure 10 presents the impact of the OSI SAF data consideration on the radiometer wet tropospheric correction at high latitudes. The standard deviation of the difference between two versions is here presented: the "5 parameters" solution (proposed for the next reprocessing campaign) and the V2.1b solution (see [18]). We easily see that suspicious valid values visible on the left are removed by ice concentration data consideration.

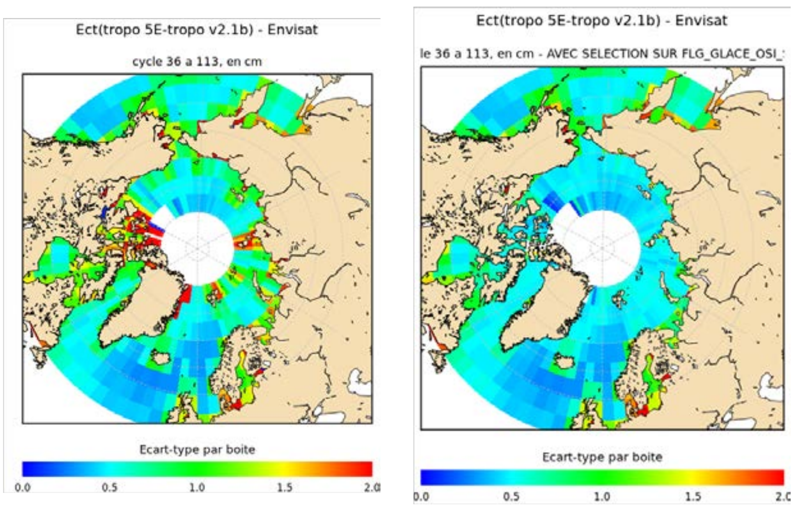


Figure 10: *Standard deviation of radiometer wet tropospheric correction, computed by box - Valid data on ocean -* ***Left:*** *Using ice flag* ***Right:*** *Using ice flag and ice concentration mask*

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4.2.2. Refined analysis of SSH variance at crossovers

The variance of SSH at crossovers conventionally gives an estimate of the overall altimeter system performance. This allows to only consider mesoscale effects and to better quantifiate the impact of geophysical corrections on sea level measurements.
In 2015 a refined analysis was performed to better understand this diagnosis specially at high latitudes, a region where great and unexplained variance differences can be observed.
This analysis concerns the comparison of two solutions or radiometer wet tropospheric corrections: the V2.1B and the '5 parameters' solutions, proposed for the next reprocessing campaign (see [18] and [46]).
The analysis presented here concerns the methodology and not the scientific results observed using one or the other of the solutions.

To better understand and interpret the diagnosis of difference of SSH variance at crossovers, we start from the theory; the difference of variance of SSH can be broken into two terms:

- the difference of variance of the corrections we have to compare ...
- and a term of covariance

Then, literally, we can write (applied on V2.1B/5E rad. wet tropospheric solutions):

$$Var(SSH_{new}) - Var(SSH_{ref}) = Var(5E\ wet\ tropo\ corr.) - Var(V2.1B\ wet\ tropo\ corr.)$$
$$+Covar(SSH_{not\ corrected\ from\ wet\ tropo.}, 5E\ wet\ tropo\ corr. - V2.1B\ wet\ tropo\ corr.)$$

where SSH_{new} *is the SSH computed with the 5E MWR wet tropo. corr.*
and SSH_{ref} *is the SSH computed with the V2.1b MWR wet tropo. corr.*

The difference of SSH variance at crossovers is plotted on Figure 11 in polar projection, for the same valid dataset for the two SSHs.
We observe (11,center) that the variance of radiometer wet tropospheric corrections, V2.1b and 5E, are very similar for the very high latitudes, where a degradation of variance of SSH is observed on the left. This can indicate that the radiometer correction is not responsible for this degradation. Furthermore, wet tropospheric corrections in theses areas are very low.
If we look at the polar map on the right, representing the term of covariance, we note a remarkable behaviour of this term particularly in these very high latitudes areas. As a new result, the covariance can be high in this zone, which is not really intuitive. And we know that the difference of wet tropo. corrections in these zones is limited to a few centimeters.

As a consequence, for very high latitudes areas, we observe a covariance term more important than the variance difference of the corrections themselves. This phenomenon is now demonstrated and must be taken into account in SSH quality analysis at crossovers.
This phenomenon has never been formally established before this refined analysis on Envisat. Being aware of this term of covariance could be a good complement to refine the analyse of this diagnosis and could help us to draw conclusions.

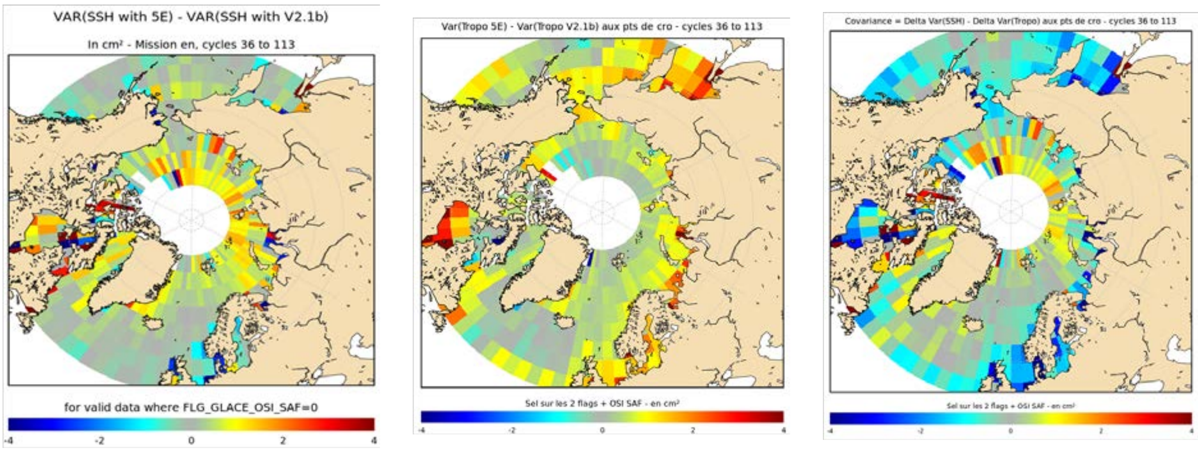


Figure 11: ***Left:*** *Difference of variance of SSH at crossovers - two standards of radiometer wet tropospheric correction used* ***Center:*** *the first term of the variance formula: the difference of variance of the radiometer wet tropospheric corrections themselves* ***Right:*** *the second term of the SSH variance formula: the covariance*

4.3. Conslusion and prospects

Use of an external reference such as OSI SAF ice concentration data allows to better determine valid ocean dataset, which is decisive for the SSH computation and its quality estimation. The use of an external reference has already been analysed for other missions, such as Cryosat-2 and Altika, with very good results. This method represents a good solution to homogenize altimetric data validation too, which can improve multi-missions cross-comparisons.
Removing suspicious values at high latitudes allows to refine analysis of residual information in these areas. Analyse of potential covariance and correlations between SSH terms represents a source of improvement for the global SSH quality analysis.

5. Wide range of use for Envisat enhanced data

Historically, Delayed Time corrected SSH products (DT CorSSH) are available for users on Aviso+ web site (http://www.aviso.altimetry.fr/fr/donnees/produits/produits-hauteur-de-mer/global/corssh.html), for the non-operationnal and in-flight missions.
For Envisat, the whole serie reprocessed in 2011 is available with associated geophysical corrections in Netcdf format (Netcdf 3). Users can obtain one Netcdf file per track for cycle 6 to 113. For more details on the Delayed Time CorSSH products, please see http://www.aviso.altimetry.fr/fileadmin/documents/data/tools/hdbk_dt_corssh.pdf.

Since 2014, these products are available via ODES service (Online Data Extraction Service,http://odes.altimetry.cnes.fr/), for Envisat and for other altimetric missions too.

The next Envisat reprocessing campaign will allow to update these products and to propose to user the last corrections to refine the computation of Sea Surface Height.

Finally Envisat data will take part of the CMEMM's reprocessing campaign, planned in 2018. Historical database will therefore be updated with part of the chosen standards defined in 2015 for the next Envisat reprocessing campaign.

6. Conclusion

This report gathers results of analysis performed in 2015 to continue to improve the quality of the Envisat whole dataset. The major aim of this year was to continue to actively prepare the next complete reprocessing campaign, planned in 2016.

The list of standards used for the next reprocessing campaign was established and almost finalised. New solutions would be interesting such as 2015 CNES/CLS or 2015 DTU Mean Sea Surface solutions, not yet available. Some standards were finely analysed, with the support of CLS experts teams. The expected improvement are substantial, on global point of view but for remarkable areas such as high latitudes or coastal zones, which is very encouraging for the global quality of the next Envisat reprocessed dataset.

New solutions for editing have been analysed this year to better define the valid dataset for ocean sea level computation. Multi missions analyses have been performed this year, which will for sure benefit to Envisat dataset, notably for coastal dataset optimization.
An important evolution of this year concerns high latitudes consideration too, with the use of ice concentration external data, which have never been used previously for valid dataset determination. The idea is to efficiently refine the ocean/ice limit to maximize the potential dataset usable in Sea Level Anomaly determination.

The next reprocessing campaign is now planned in a near future. The multiple validations performed these last 2 years allow to be very confident in the quality of the next Envisat dataset. For the sake of dataset optimisation, new data treatments are proposed for Envisat but for other altimetric missions too. This allows to analyse particular behaviours observable on an altimetric mission and to propose answers which can have a benefical effect on other missions.

7. Annex

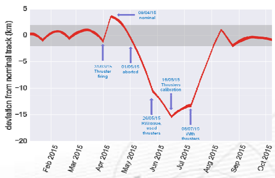
7.1. The recent drift of SARAL: an unexpected MSS experiment

The recent drift of SARAL:
an unexpected MSS experiment

M.-I. Pujol, Y. Faugere, G. Dibarboure, P Schaeffer,
Amandine Guillot, N. Picot

Objectives

Main objective: Take advantage of the recent drift of SARAL, up to 10km from its nominal ground track due to the temporary stop of its orbit housekeeping to refine the estimation of the MSS errors far from the repetitive ground track positions & evolution of this errors with ground track position distance



Additional objective: discuss crucial importance and processing issues using geodetic missions for MSS computation

Methodology

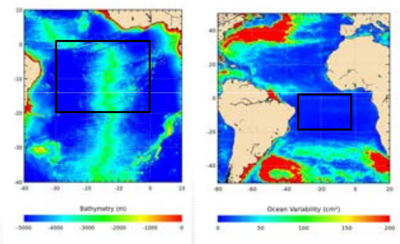
➢Analyze of the SLA variance along the tracks of different altimeters

- AL : on its nominal ground-track position (Jan-Mar 2015)
- AL opportunity during the drift of the ground-track position (May-Jul 2015)
  =>not ingested in MSS, independent dataset
- J2 used as reference (Assume MSS error minimal along J2 repetitive ground tracks)

➢Analysis of the temporal evolution of the SLA variance
- Focus on a low variability area with high MSS gradients
- Focus on wavelength < 200 km only

➢Spectral Analysis

Methodology



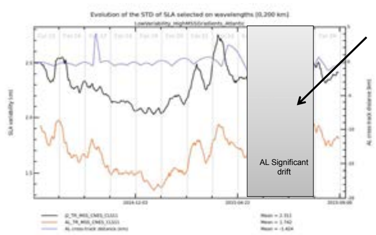
Methodology

→ Comparison of 3 different MSS:

MSS_CNES_CLS_2011	MSS_CNES_CLS_2015	MSS_DTU13
▪ Referenced on [1993, 2012] Period; ocean variability removed	▪ Referenced on [1993, 2012] Period ; ocean variability removed	▪ Referenced on [1993, 2012] Period
▪ Uses Mean Profiles for large and small scales information : TP/J1/J2 ; E2/EN ; G2 ; TPN/J1N	▪ Uses Mean Profiles for large and small scales information : TP/J1/J2 ; E2/EN ; G2 ; TPN/J1N	▪ Uses Mean Profiles for large scales (> ~250km) information : TP/J1/J2 ; E2/EN ; G2 ; TPN/J1N
▪ geodesic mission used : ERS-1	▪ geodesic mission used : ERS-1; J1G, C2[2011,2014]	▪ Use geodetic mission for small scales (< ~250km) information : Geosat ; ERS-1; J1G ; C2[2012]

Variance analysis

MSS_CNES_CLS11 used



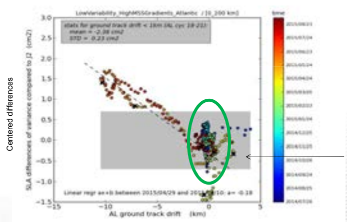
▪ Short Wavelength (< 200km) SLA variability increase along Al tracks during the ground-track drift

▪Not observed along J2 tracks

Variance analysis

MSS_CNES_CLS11 used

(SLA variance along AL tracks – SLA variance along J2 tracks) as a function on the Al ground-track drift



Variability differences between J2 and AL : -2.38 ±0.23 cm²

Induced by :

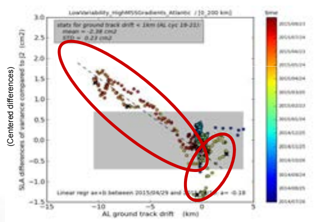
- Different 1Hz noise errors for the two altimeters (bias removed on the plot)
- Ocean surface variability differently sampled

→ we use the variability of the differences to define the error of the methodology : Error Bar = 3σ

Variance analysis

MSS_CNES_CLS11 used

(SLA variance along AL tracks – SLA variance along J2 tracks) as a fct on the Al ground-track drift



MSS error evolution with AL ground-track position:

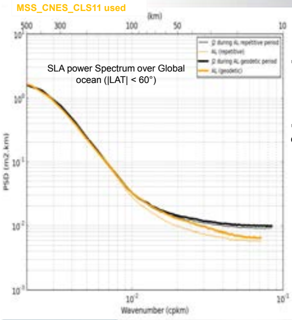
→**Err = 4.2 mm rms / km**

→ Mixed with ocean variability between 0-4 km

→ **Err significant for ground-track distance > 5km** (low variability & high MSS gradients area)

Spectral analysis

MSS_CNES_CLS11 used

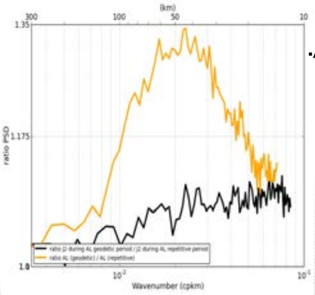


- **AL and J2 SLA Spectra for two period:**
  - Before the drift (AL_Repeat)
  - during the drifting phase(AL_Geo)

- **Increased AL energy during the drift** not observed with J2
  - → characterize MSS error increase when the ground track is far from its nominal position
  - → omission error: few geoid signal information at 50km scales due to the poor geodetic coverage before 2010

Spectral analysis

MSS_CNES_CLS11 used



- **AL and J2 Ratio Spectra**
  - AL(AL_Geo) / AL(AL_Repeat)
  - **J2(AL_Geo) / J2(AL_Repeat)**

- **Max impact between 20-200km**:
  + 30% additional errors at 50km
  ~+10% (i.e. 0.95 cm rms) for wavelengths 20-200km

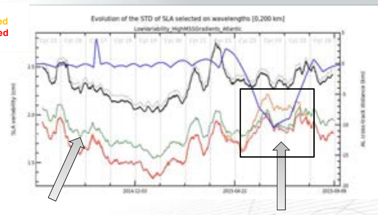
CLS

What's about the latest MSS ?

CLS

Variance analysis

MSS_CNES_CLS11 used
MSS_CNES_CLS15 used
MSS_DTU13 used

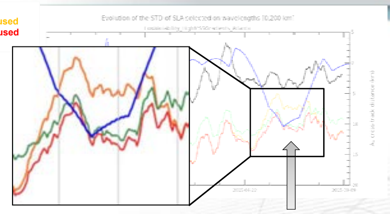


Along repetitive AL tracks
MSS_DTU13 variance globally higher than for MSS_CNES_CLSxx : +0.75 cm rms

Along drifting AL track
Strong improvement with **MSS_DTU13** and **MSS_CNES_CLS15** during AL drift thanks to the use of geodetic mission Ja1G and C2

Variance analysis

MSS_CNES_CLS11 used
MSS_CNES_CLS15 used
MSS_DTU13 used

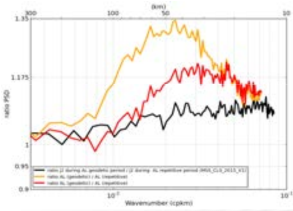


MSS_DTU13 error globally higher than for MSS_CNES_CLS11 along repetitive AL tracks : +0.75 cm rms

Small error increase using **MSS_DTU13** and **MSS_CNES_CLS15** during AL drift thanks to the use of geodetic mission Ja1G and C2

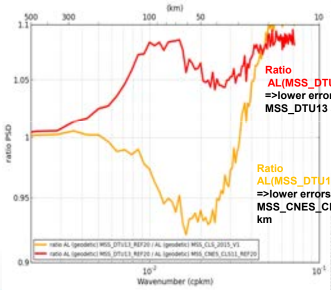
Spectral analysis

MSS_CNES_CLS11 used
MSS_CNES_CLS15 used



- **AL and J2 Geo/Repeat Ratio Spectra**
  - **J2(AL_Geo) / J2(AL_Repeat)**
  - **AL(AL_Geo) / AL(AL_Repeat) with MSS_CNES_CLS11**
  - **AL(AL_Geo) / AL(AL_Repeat) with MSS_CNES_CLS15**
- MSS Error reduced by 90% (noises errors excluded)

Spectral analysis



- **AL Ratio Spectra during the geodetic period with several MSS**

Ratio AL(MSS_DTU13) /AL(MSS_CNES_CLS15)
=>lower errors for MSS_CNES_CLS15 vs MSS_DTU13 at wavelengths <200km

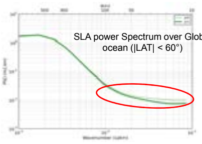
Ratio AL(MSS_DTU13)/AL(MSS_CNES_CLS11):
=>lower errors for MSS_DTU13 vs MSS_CNES_CLS15 at wavelengths 200-30 km

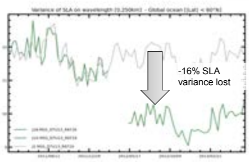
What's about Ja1 Geodesic mission?

MSS_DTU13 used

J1G Vs J1N analysis

SLA analysis along J1N & J1G tracks: **data ingested in the latest MSS estimation**



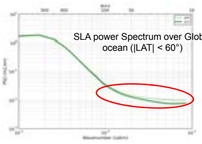


MSS_DTU13:
▪ Loss of SLA variance for wavelength <250km]: -16% (~-1.4 cm rms)
➔ Commission errors suspected: part of the ocean variability and measurement short wavelengths errors observed with J1G are introduced in the MSS

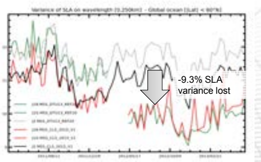
MSS_CNES_CLS15 used
MSS_DTU13 used

J1G Vs J1N analysis

SLA analysis along J1N & J1G tracks: **data ingested in the latest MSS estimation**



MSS_CNES_CLS15:
▪ Loss of SLA varianece for wavelength <250km]: -9.3% (-1 cm rms)



MSS_DTU13:
▪ Loss of SLA variance for wavelength <250km]: -16% (~-1.4 cm rms)
➔ Commission errors suspected: part of the ocean variability and measurement short wavelengths errors observed with J1G are introduced in the MSS

Conclusions

❑Altika drift gives us the great opportunity to characterize the MSS error increase according to the distance to the repetitive ground-track positions
=> MSS_CNES_CLS11 : **increase of the MSS Err according repetitive ground-track distance : +4.2 mm rms/km**

❑**Strong improvement with recent MSS**
=>MSS_CNES_CLS15 (vs MSS_CNES_CLS11): omission error reduced by ~90% for scales 200-40km
=>Geodetic missions used in these recent solutions **largely contribute to improve the MSS precision** outside of the repetitive ground-track
=>Need of geodetic mission, with good performance at small scales to improve the small scales of the MSS: **=>Recommendation for a drifting Altika phase**

❑**Inclusion of geodetic missions in MSS is crucial but the ocean variability remains an issue for those data**
=>MSS_CNES_CLS15 & MSS_DTU13: significant loss of signal at wavelengths < 250km : commission errors signature

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