MSS_CNES_CLS_2015
Presentation & assessment

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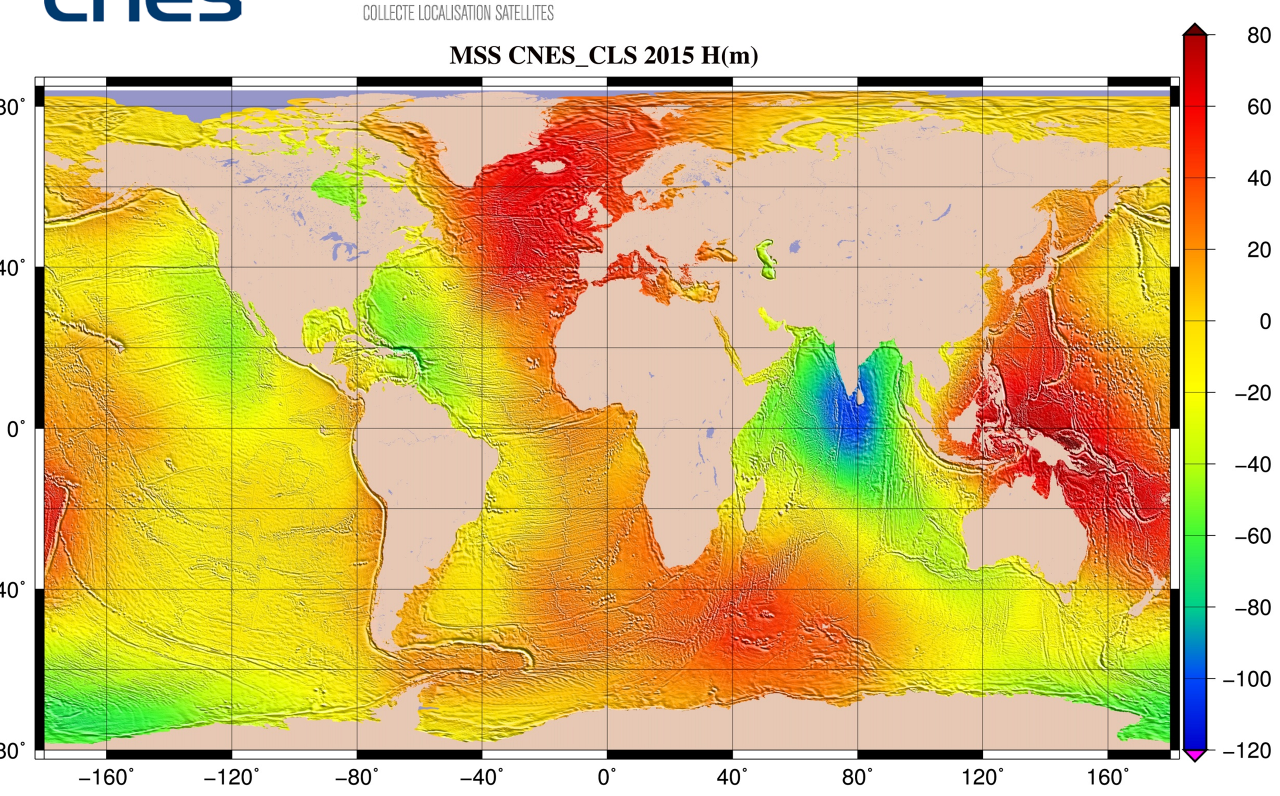


Fig 1:Mean Sea Surface CNES_CLS 2015. Heights are in meter above T/P ellipsoid.

MSS Characteristics	
Spatial coverage	Global (84°N to 80°S)
Spatial resolution	1 minute (~1.8km /eq)
Reference period	1993 – 2013 (20 years)
Reference ellipsoid	T/P
Dataset	Mean Profiles:T/P-J1-J2, E2-En, GFO, TPn-J1n Geodetic Missions: ERS-1, CryoSat, J1
Noise budget	Taking into account : white noise, long wavelengths bias, uncertainties of oceanic variability.

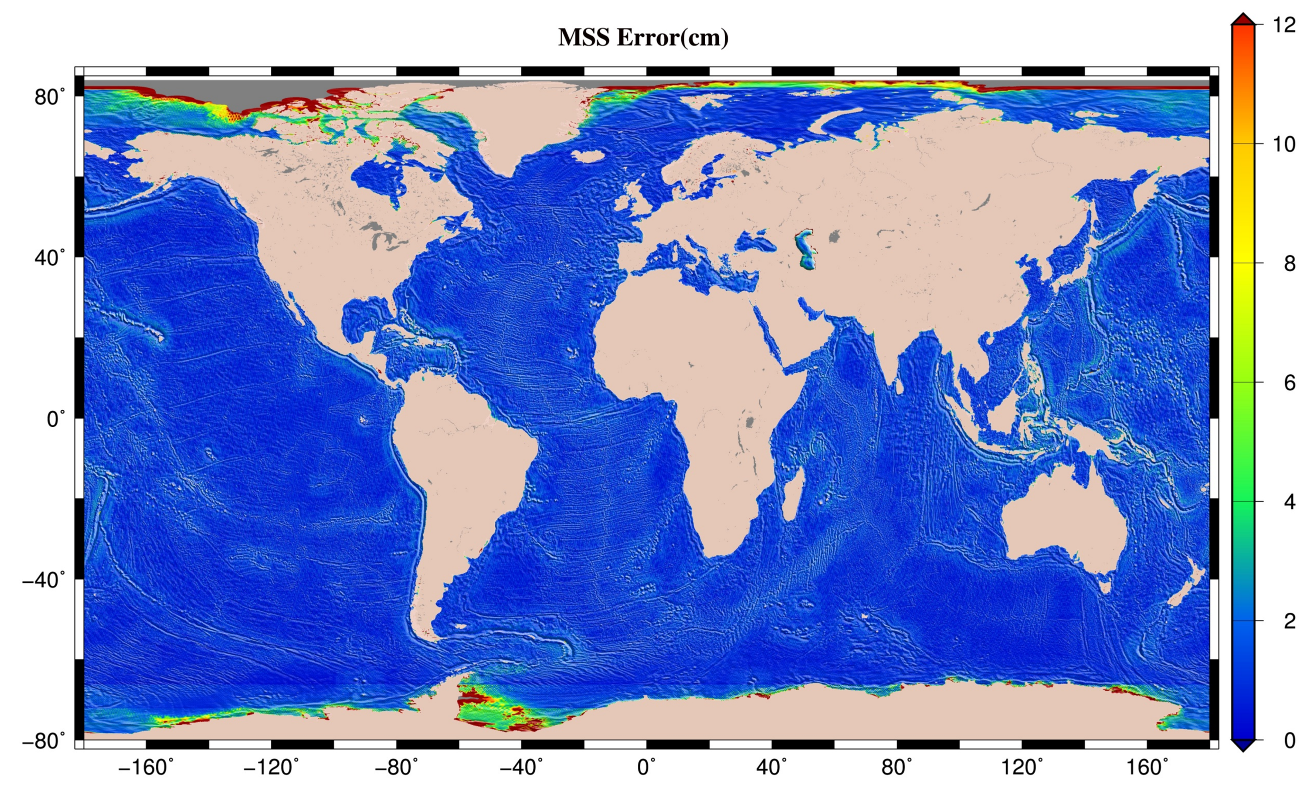


Fig 2: calibrated error in centimeter.

Mapping Method

The method is based on a optimal interpolation (details are given in Schaeffer et al. 2012. The CNES_CLS11 Global Mean Sea Surface Computed from 16 Years of Satellite Altimeter Data, Marine Geodesy, 35:sup1, 3-19).

$$\theta_{est}(\vec{r}_0) = \sum_{i=1}^{N}\sum_{j=1}^{N} A_{ij}^{-1} C_{xj} \Phi_{obs,i}$$

Where:
- θ_{est} is the estimation of the MSS(λ,φ),
- Φ_{obs} are the altimetric data,
- $C_{i,j}$ is the covariance/correlation function between observations and the position to be estimated,
- $A_{i,j}$ is the covariance matrix between observations and their noises budget . This budget includes three terms which are a white noise, a noise related to the ocean variability and a long wavelength bias.

Removing Oceanic Variability
Objective Analysis of SLA

All SSH (ERM & GM) were corrected from the oceanic variability (SLA). A particular attention was paid concerning Geodetic Missions for which time averaging is not possible. SLA are the result of a space-time optimal interpolation (Le Traon, P.-Y., and G. Dibarboure. 2004. An illustration of the contribution of the TOPEX/Poseidon-Jason-1 tandem mission to mesoscale variability studies. Mar. Geod. 27:3–13).
The method developed allows us to reduce drastically the effect of oceanic variability and moreover to homogenize the mean oceanic content with an arbitrary period. Figure 3 show the impact of this method applied on Cryosat-2 data.

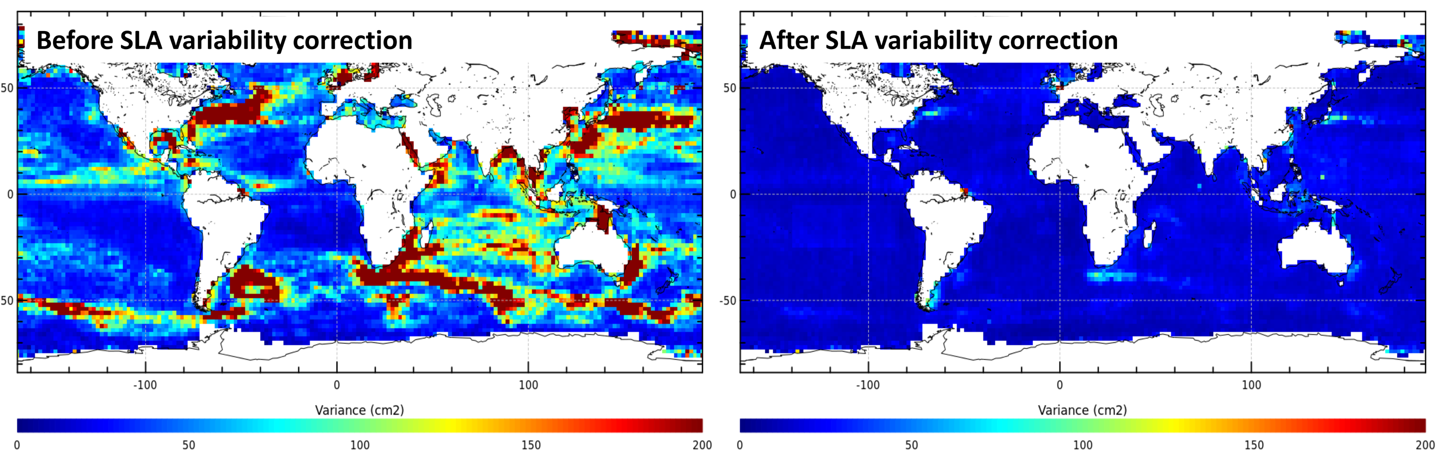


Fig 3: Variance of Cryosat-2 SLA before and after dynamical SLA variability correction.

SSH along geodetic tracks was corrected from ocean surface variability in order to retrieve the seasonal and interannual SSH component. This correction is however limited when considering wavelengths < ~200km.

MSS_CNES_CLS_2015 assessment

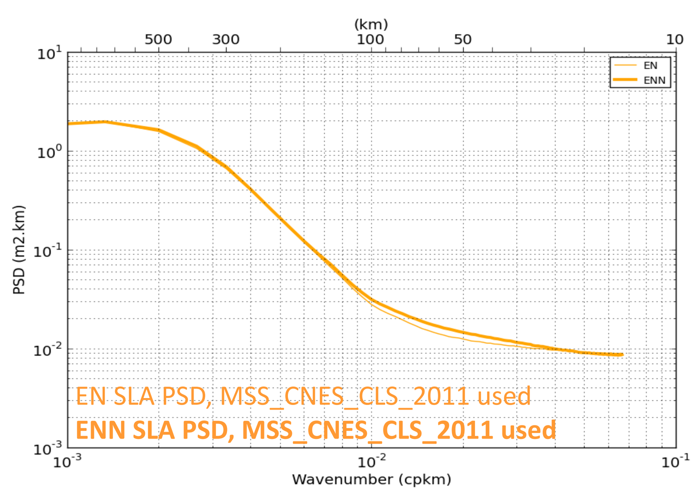
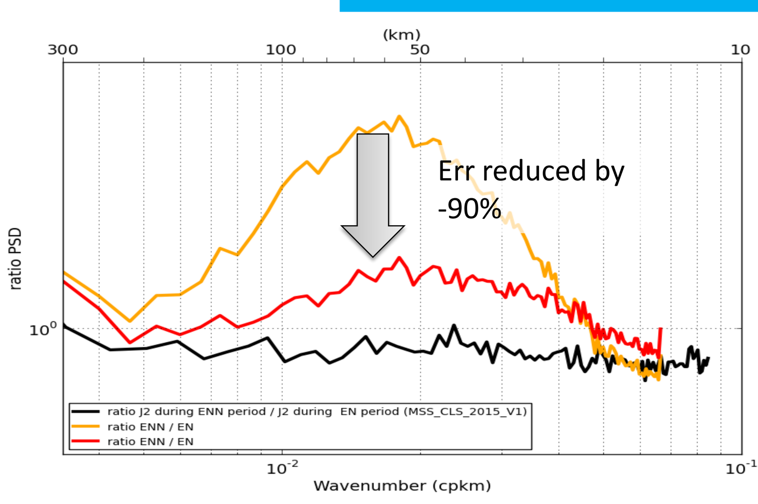


Fig 2: SLA PSD and SLAPSD ratio. Comparison of SLA along Envisat repetitive tracks (EN) and geodetic tracks (ENN). SLA PSD ratio along Jason-2 tracks is used as reference ratio.



ENN / EN SLA PSD ratio, MSS_CNES_CLS_2011 used
ENN/EN SLA PSD ratio, MSS_CNES_CLS_2015 used
J2 / J2 PSD ratio, MSS_CNES_CLS_2011 used

Comparison of SLA PSD along repetitive tracks and geodetic tracks positions reveled **omission errors on MSS_CNES_CLS_2011 for wavelength < ~200km.**
Reduction of the MSS error along Envisat geodetic tracks (not used for MSS_CNES_CLS computation).
- Maximal error reduction near wavelength 60km.
- Mean MSS Error reduction on the [0, 200km] wavelength range : -90% (-0.83 cm rms)

Results confirmed along independent HY-2A tracks

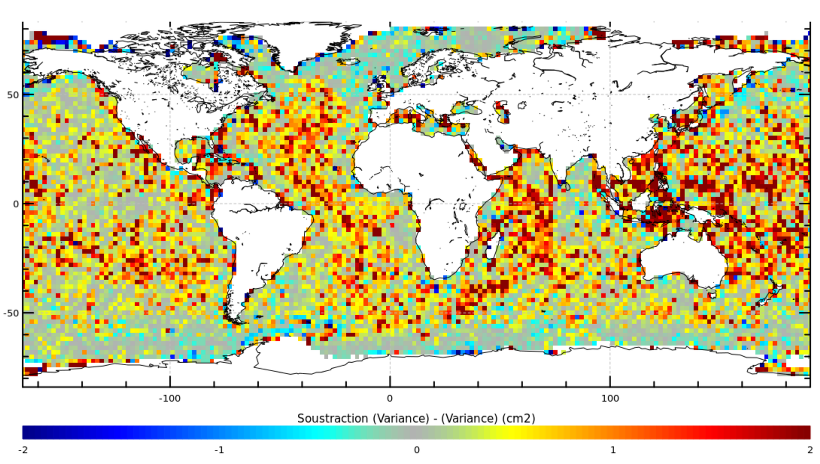


Fig 3a: Difference of the variance of the SLA selected on wavelength < 250km along HY-2A tracks when MSS_CNES_CLS_2011 and MSS_CNES_CLS_2015 is used. Statistics computed over year 2015.

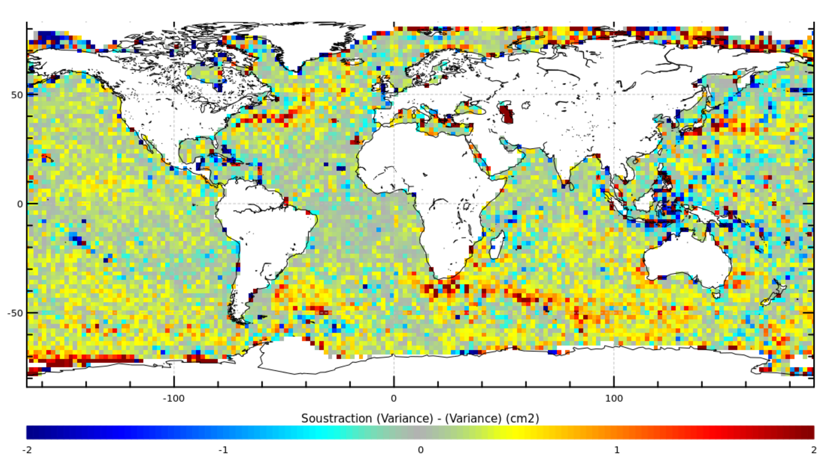


Fig 3b: same as Fig3a, but comparing SLA variance using MSS_CNES_DTU15 and MSS_CNES_CLS_2015.

SLA variance along HY-2A tracks confirmed the reduction of the MSS errors at wavelengths < ~250km with MSS_CNES_CLS_2015 (note that HY-2A measurements are independent from all the MSS solutions).
- SLA Variance reduction along geodetic structures when comparing MSS_CNES_CLS_2015 with MSS_CNES_CLS_2011: up to XX cm² at wavelengths [0, 250km]
- The comparison between MSS_CNES_CLS_2015 and MSS_DTU15 underlines
  - Nearly the same capability of retrieving geodetic structures in both the MSS solutions.
  - Local SLA variance increase with MSS_CNES_CLS_2015 highlight some structures more accurately retrieved in MSS_DTU15.
  - A global SLA variance reduction at wavelengths [0, 250km] when using MSS_CNES_CLS_2015 rather than MSS_DTU15: more important commission errors in MSS_DTU15:
    - Mean reduction of ~0.4cm² → It is the signature of the noise signal observed on MSS_DTU15.
    - Max reduction in dynamic areas : up to 2 cm² → Ocean variability less accurately corrected in MSS_DTU15

Costal areas are better retrieved with MSS_CNES_CLS_2015.
Evolution as a function of the distance to the coast of the mean SLA variability along the HY-2A tracks shows the evolution of the quality of the different MSS solutions near the coast .
- Main differences observed in the [0, 30km] band near the coast

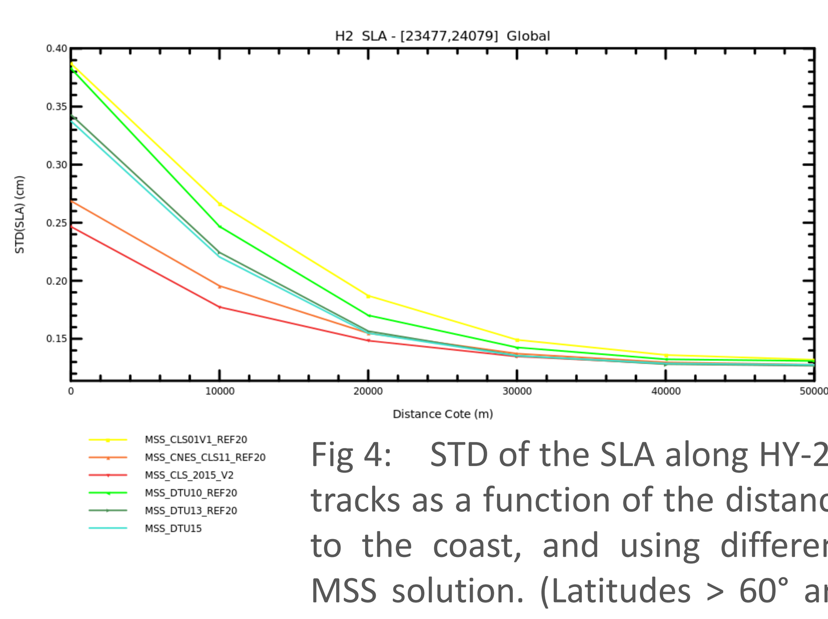


Fig 4: STD of the SLA along HY-2A tracks as a function of the distance to the coast, and using different MSS solution. (Latitudes > 60° are excluded

Significant improvement of the MSS_CNES_CLS solution in Arctic region :
- Comparison of the SLA variance along Envisat tracks during the important melting ice that occurred in 2007 shows a significant reduction of the errors previously observed with MSS_CNES_CLS_11 in the Laptev Sea.
- Results obtained with MSS_CNES_CLS_2015 are comparable to results obtained with MSS_DTU15.

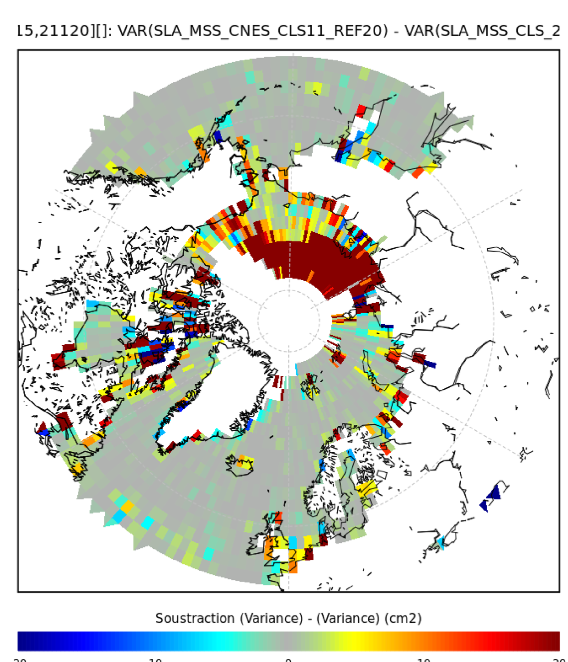


Fig 5a: Difference of the variance of the SLA along Envisat tracks when MSS_CNES_CLS_2011 and MSS_CNES_CLS_2015 is used. Statistics computed over [July, October 2007.

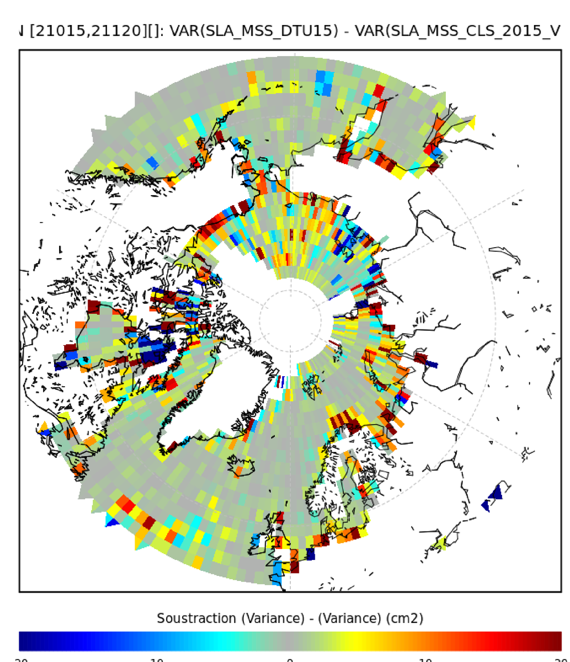


Fig 5b: same as Fig5a, but comparing SLA variance using MSS_CNES_DTU15 and MSS_CNES_CLS_2015.

Perspectives

Key issues for the next MSS generation:
- MSS reference period & correction of the ocean surface variability for wavelengths < ~200km.
- Coastal areas
- Sea ice contaminated areas

Recommendations:
- Accurate along-track MSS estimation along repetitive tracks : need repetitive track over long period; new repetitive tracks ?
- MSS estimation strongly benefits from geodetic missions. Reduction of the ocean variability along theses tracks is however primordial → need geodetic missions, with different temporal period coverage.
- integration of a very high density of altimeter measurement ?