MEAN TRACK VERSUS GRIDDED MSS: THE PRICE OF A GEODETIC JASON-EOL

G.Dibarboure, P.Schaeffer, JF.Legeais, Y.Faugere, MI.Pujol, M.Ablain, CLS
N.Picot, E.Bronner, CNES
P.Femenias, ESA

1 - Abstract

The ageing of Jason1 and the risk to lose control of the satellite and the collision risk with TOPEX/Poseidon (still in orbit, and no longer manoeuvrable) initiated a collective reflexion on the so-called "Extension of Life phase" or EoL phase.

This work intends to quantify the additional error one should expect on along-track Sea Surface Height Anomalies. Formerly generated with the repeat track analysis and a precise Mean Profile, SLA will have to use the only proxy available for EoL: gridded MSS which are less accurate and coherent with instantaneous SSH and mission-specific errors.

2 – MSS error on SSHA ?

Basics : SLA = SSH - <SSH> (anomaly vs temporal reference) so SSH must be consistent with <SSH> (or we get error residuals in SLA)

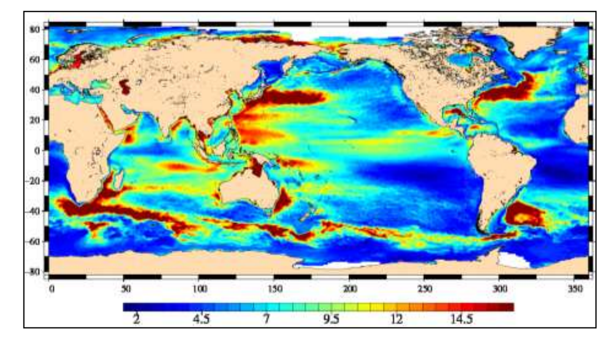
- ✓processing standards and geophysical corrections
- ✓satellite-specific geographically correlated errors (instrument or orbit) are removed by Mean Profiles

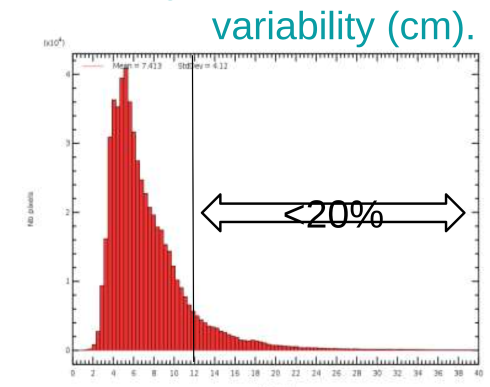
Any error on <SSH> translates into systematic SLA error. Amplified on multi-mission maps or assimilation because multiple missions contain the same error

- ✓ wavelengths (WL) equivalent to mesoscale create "artificial stationary eddies"
- ✓ shorter scales look like noise or correlated errors (50 to 100km)

Mean Profiles are not just time averages ➔ Large mesoscale structures removed from SSH with multi-mission maps to minimize <SSH> contamination from instantaneous variability (iterative process).

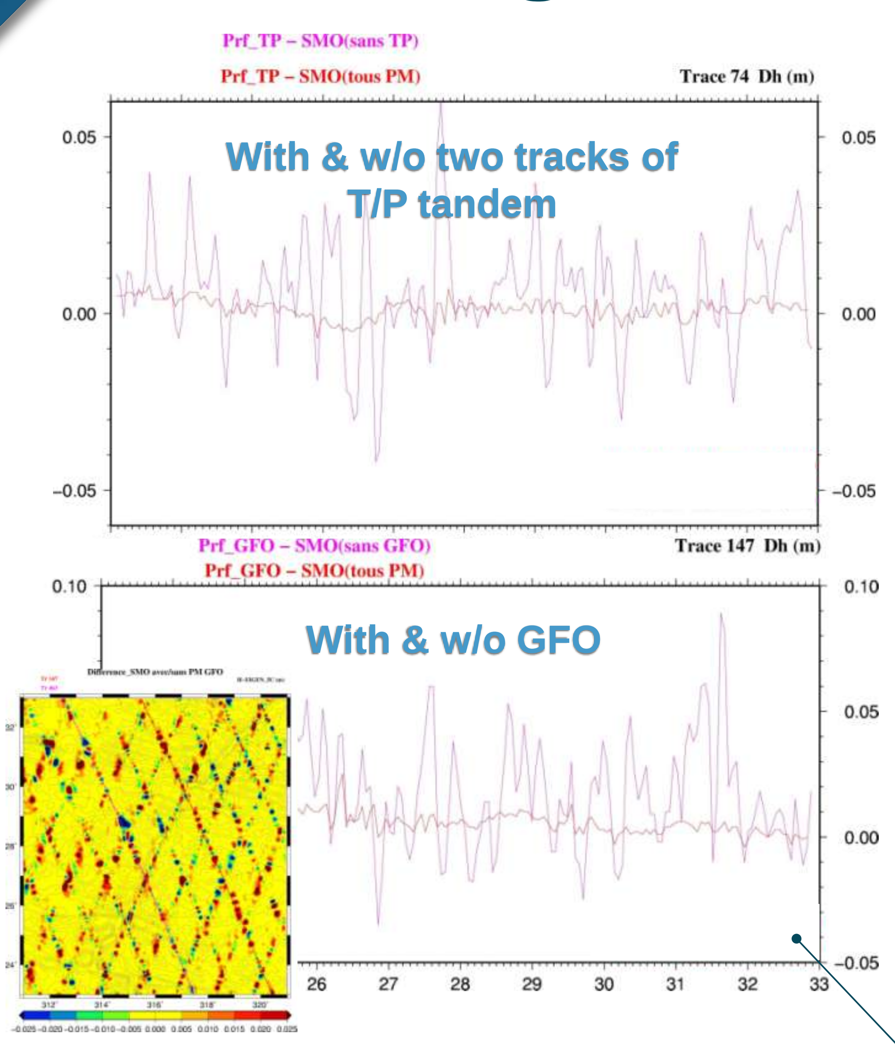
Gridded MSS are maps built from HR Mean Profiles and geodetic data (ERS, GEOSAT)



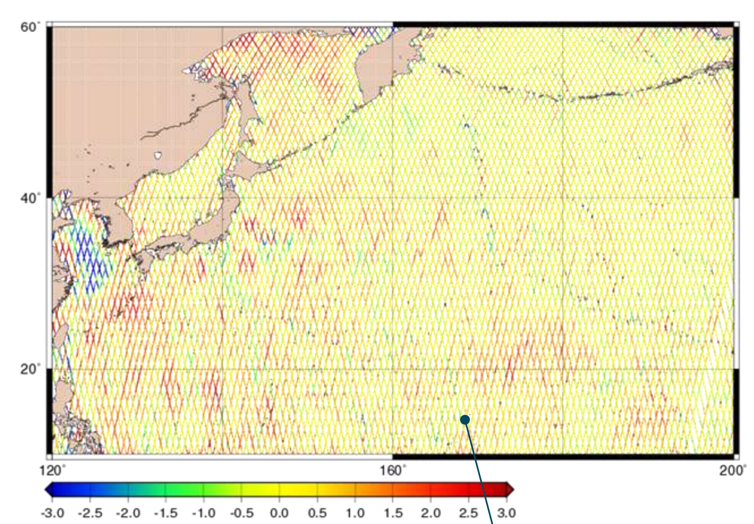


Map and histogram of the ocean variability (cm).

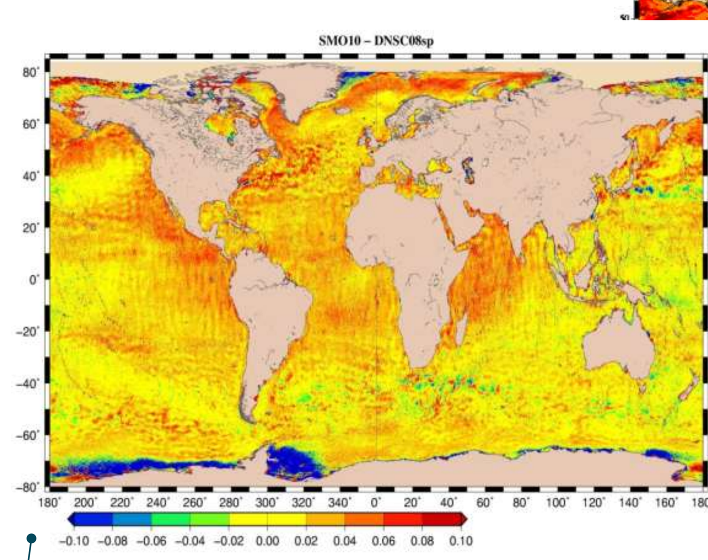
3 – Origin and estimates of error sources



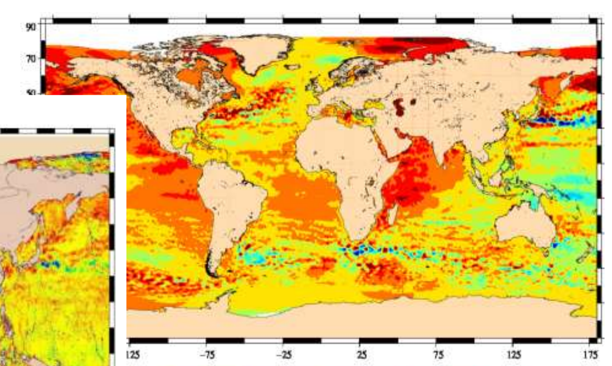
Error G: Along-track difference (m) between the MPs and two gridded MSS computed with (red) or without (pink) two tracks of T/P tandem (top figure) and the full GFO dataset (bottom figure). Differences are limited to WL<100km by the gridding process (solution constrained by other repetitive datasets).



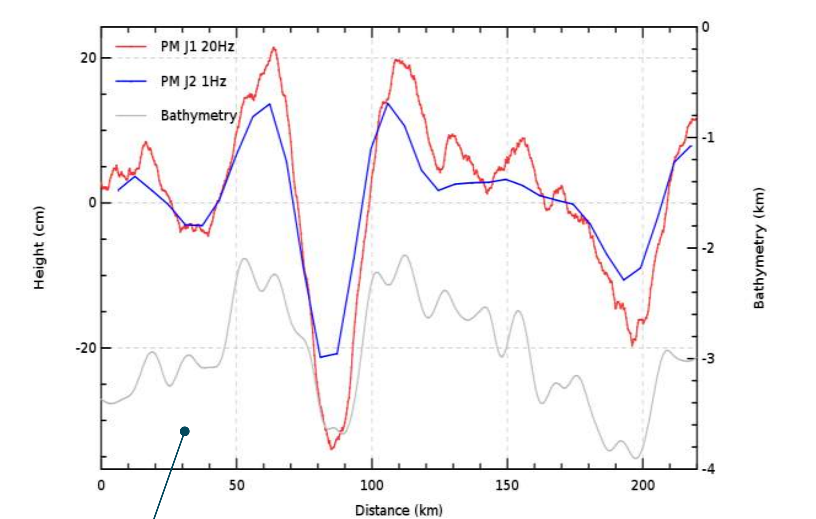
Error E1: Residuals (cm) between the CNES/CLS 2010 MSS and the ERS/ENVISAT mean track (data actually used in the MSS gridding).



Error B: Differences between DNSC08 & CLS/ CNES10 primarily due to interannual discrepancies



Error B: Difference (cm) between a 93-99 average and a 12 year average (from DUACS maps)



Error F: Comparison between a low resolution 1Hz mean track (blue) and a 20Hz mean track (red) over bathymetric features (gray) in the Atlantic. High-pass filtered (50km). Computed over 11 cycles after minimization of ocean variability.

SLA Error

=		stemming from	1 Error if not corrected	2 Current status in DUACS Profiles
Mean Profile Error	A	Uncorrected mesoscale variability error	6mo-1year : 5 to 7cm min (WL: 20-50km) 3-5years: <3.5cm 7-15years: <1cm (WL: 100-200km)	Non-existent. Instantaneous ocean varibility is removed before the time average, average computed over 10+ years on all tracks).
	B	Interannual variability error	<5cm (WL: >5000km) <5-8cm in wb currents (WL: 200-500km)	Non-existent as re-referenced on a common period and cross-calibrated on the reference mission (both SSH and [illegible]
	C	Obsolete altimetry standards	>3.8cm (2001, all WL) 3.5cm (2001 standards, WL>50km) >1 to 3cm (GDR-B)	GDR-C or equivalent used for all missions. Remaining error not well-defined.
	D	Cross-track geoid gradient	>2.5 cm if cross-track geoid gradient correction is not used	CTGG applied <1cm between CTGG methods

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		stemming from	1 MSS computed before 2008	2 Recent MSS (CLS/CNES & DNSC)
MSS Error	E	Correlated error averaging (discrepancy between missions ? mix of errors)	**Difference between cross-calibrated MPs and MSS actually using them** : 1-3 cm (WL > 100km)	
	F	Map smoothing (scales which cannot be resolved away from known tracks, degrading along-track content)	**Worst case (local difference between EGM08 and recent MSS, high-pass filter, located on bathymetry gradients)** <3 to 5 cm (WL : 10 to 30km + noise) 1 to 2 cm (WL : mesoscale)	
	G		**Small scales(difference between MSS computed with and w/o specific TP or GFO tracks):** 1.6 to 2.5cm (WL: <100km)	
	H	Omision error	**Larger scales (SSHA increase during on new track if tandem data are not used, difference between CLS01 and CLS10 in ERS diamonds)** 3 to 7 cm (WL: all) 1.5 cm (WL: 50 to 500km)	**Best case (SSHA increase during T/P drift using DNSC or CLS/CNES)** 0.8 to 1.2 cm (WL: 100 to 500km) **Worst case (different behaviour of CLS and DNSC when compared to a common EGM08):** <3 to 5 cm (WL < 75km)
	I	Mesoscale variability from geodetic data not properly removed before absorption in MSS		

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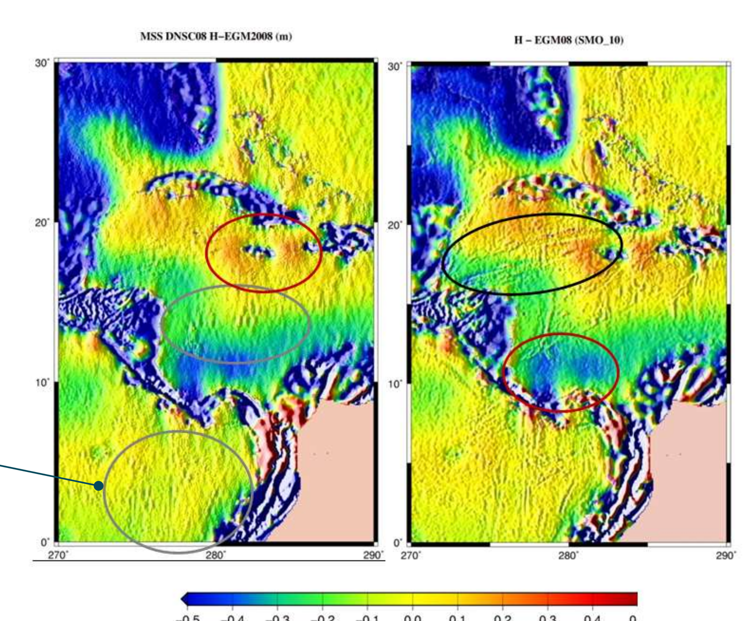
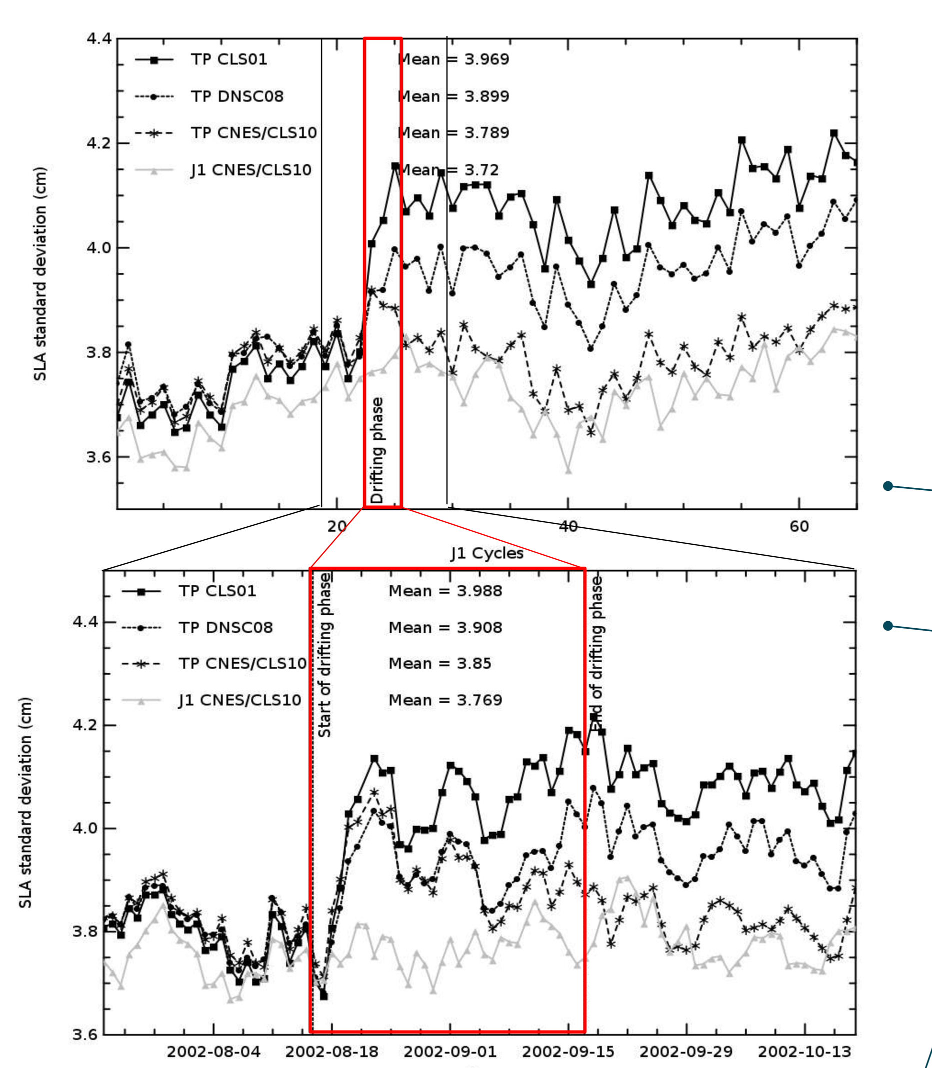
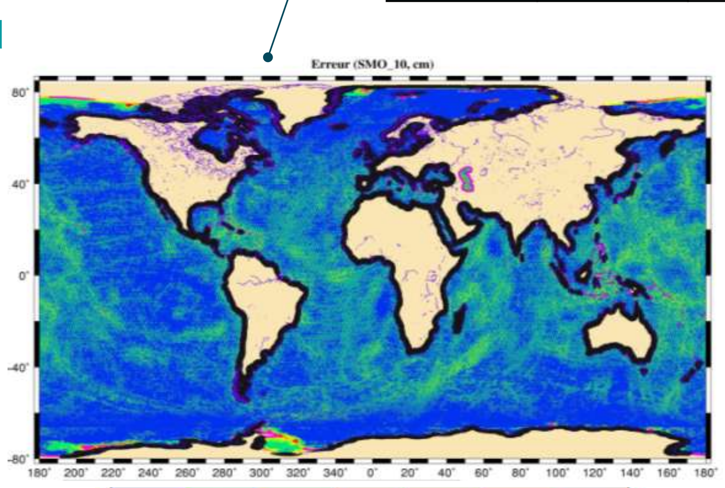
		stemming from	1 Error on SSHA from mean profile	2 Error on SSHA from gridded MSS
Dynamic SLA Error	J	Discrepancy between SSH and <SSH> (standards, processing...)	Non-existent as MPs are computed with each standard change. Otherwise 50% of the variance reduction from new altimetry standards upgrades is lost using obsolete time reference	**Worst case : 2-year average of Jason/ENVISAT difference, low pass filtered to remove variability** <2 to 3 cm (WL : 300 to 2000km)



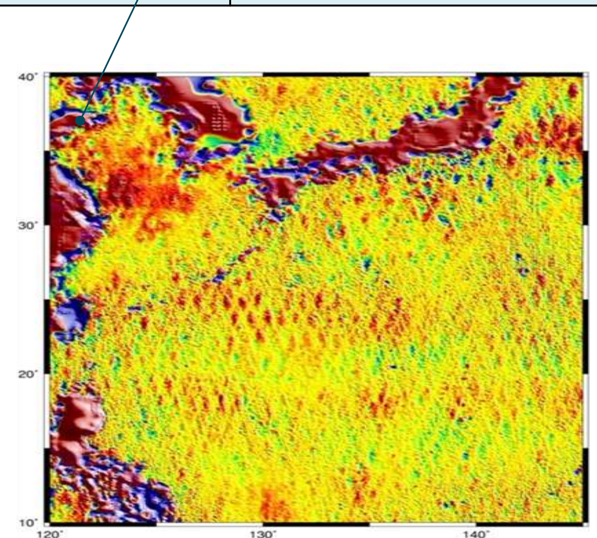
Error E+F+I. Differences (m) between DNSC08 (left) or CNES/CLS2010 (right) and EGM08. Trackiness altimetry signatures (gray circles), and sharp and coherent small scale geoid features (black circle). The 3 to 7cm differences in 100 to 500km structures (e.g. red circle) is not entirely explained by inter-annual residuals



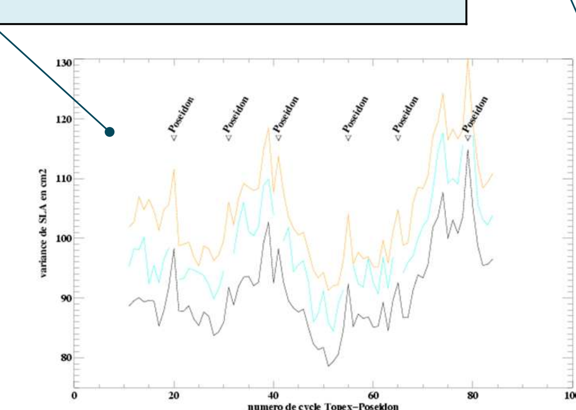
Error H+I: Along-track SSHA std (cm) from T/P and Jason (pass-band filtered from 50km to 500km), before, during and after the orbit change . Old and new gridded MSS are compared.



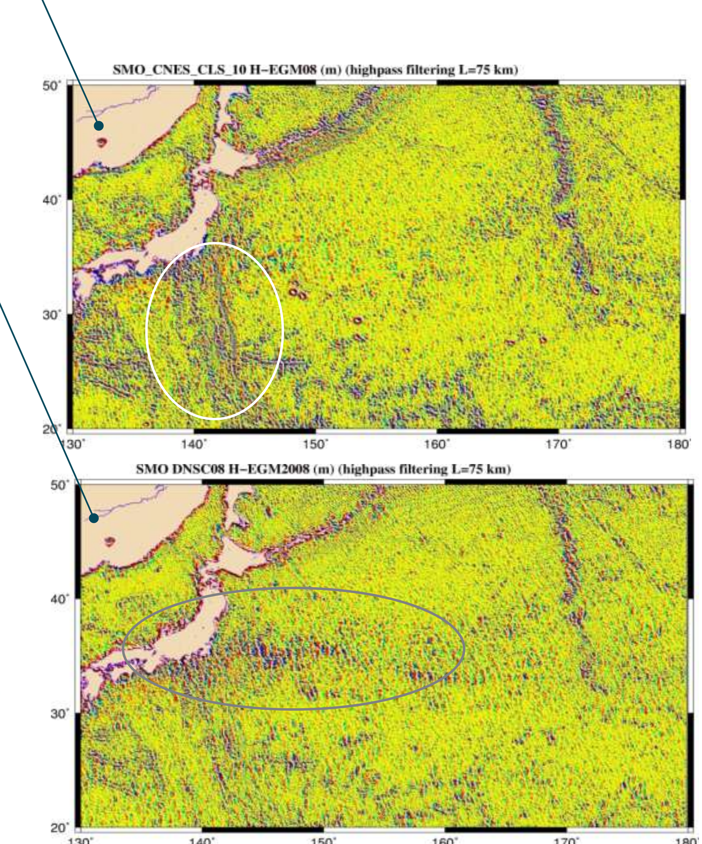
MSS Error (theoretical): Formal mapping error (cm)of the CLS/CNES gridding process (OI)



Error I+H: difference (m) between CLS01 and CNES/CLS10. Red diamonds located between ERS/ENVISAT tracks come from an improved minimization of mesoscale in geodetic data



Error J1: Unit cm². SSHA variance when GDR-B standards are applied both on the SSH and on the mean profile (black), applied only on the SSH with a 2004 mean profile (cyan) and applied neither on SSH nor on mean profile (orange). Dataset used: first 2 years of T/P.



Error F+H2+I2: Difference between DNSC08 (top) or CNES/CLS 2010 (bottom) & EGM08 after high-pass filtering (75km). Mesoscale variability residuals (gray circle) and sharper MSS gradients from bathymetry (white circle).

4 – Summary and Conclusions

Optimistic estimates taking self-consistent CLS/CNES datasets and only the omission error range from 1cm (100 to 500km) to 2.5 cm (shorter scales), and pessimistic estimates (distribution of MSS once interannual signal is removed) would be 3 to 5cm. A 3cm average estimate would coherent with theoretical formal errors. Moreover, gridded MSS cannot cancel out static mission-specific errors observed by Cal/Val (1-2cm after cross-calibration).

As an illustration, at least 50% of the globe would be affected by an error equal to 50% of the local signal variability, and only 20% of the oceans would have an error inferior to 25% of the variability. Modern MSS are much better than pre-Jason2 surfaces, but they are still not on par with repetitive altimetry. Could Cryosat-2 geodetic data change this?

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