Quantify Errors and Uncertainties in Altimetry Data

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❑ **Objectives:** Establish the link between Altimetry experts and applications (MSL, mesoscale, etc)
- New insights about errors in the altimeter system
⇒ From experts to applications
- User needs and requirements in terms of errors, including formalism of errors
⇒From applications to experts

❑ Splinter divided into 3 parts :

1) Mea Sea Level applications
2) Ocean circulation & mesoscale
3) Analysis and formalism of errors

1) Mean Sea Level

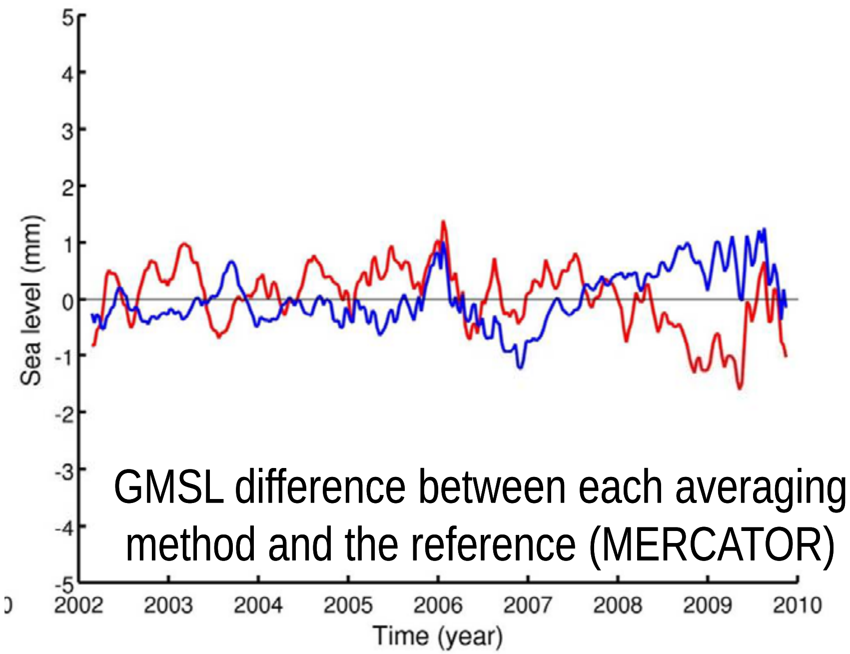
❑An issue raised at last OSTST was "**to enhance the GMSL intercomparison between several groups in order to better understand GMSL differences**" => 2 presentations to answer this question

❑ Henry et al. (oral) :

⇒ impact of methodology is significant: averaging, gridding, weighting

⇒ CU / AVISO, differences on the order of 0.1 mm/yr for the GMSL, and reach 0.3 mm/yr in tropical and high latitudes bands

⇒ binning for AVISO and weighting for CU are to be improved

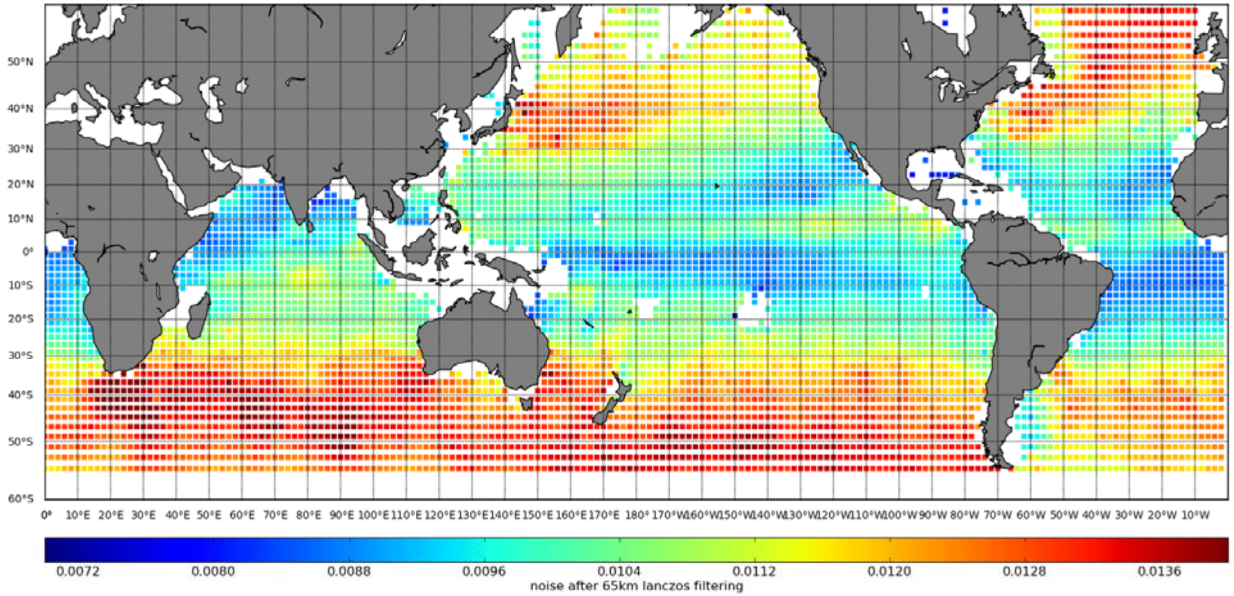


❑ Masters et al. (poster) : impact of altimeter standards is low on Jason-1/Jason-2 but remains significant on TOPEX (due to instabilities on altimeter parameter).

2) Ocean circulation & mesoscale

- Dufau et al. : spatial spectral analysis of SSH to characterize small scales observability by intersect of slope and noise level

⇒This study provides a map of SLA observation errors (instead of a constant value) for data assimilation systems

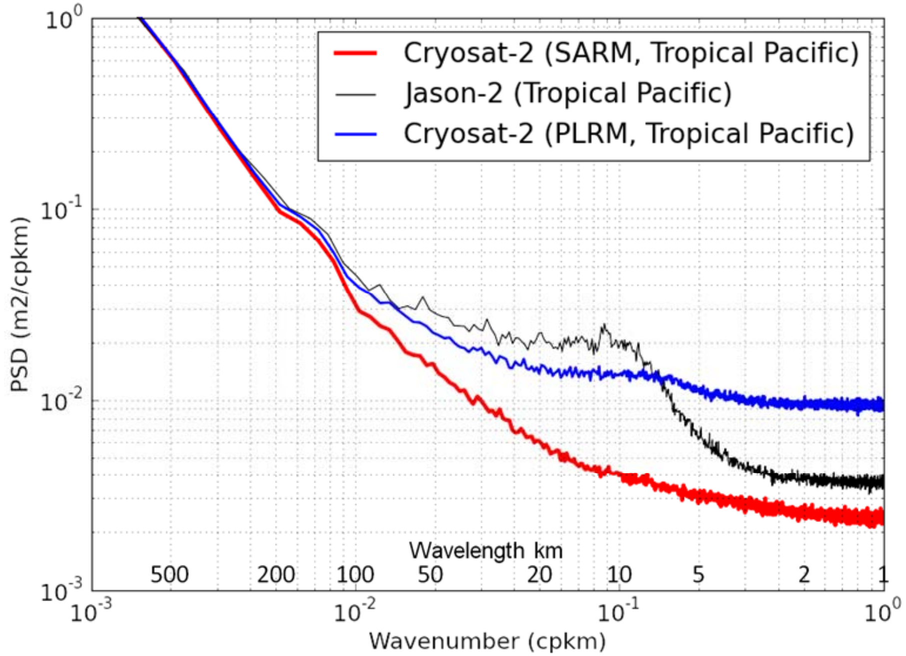


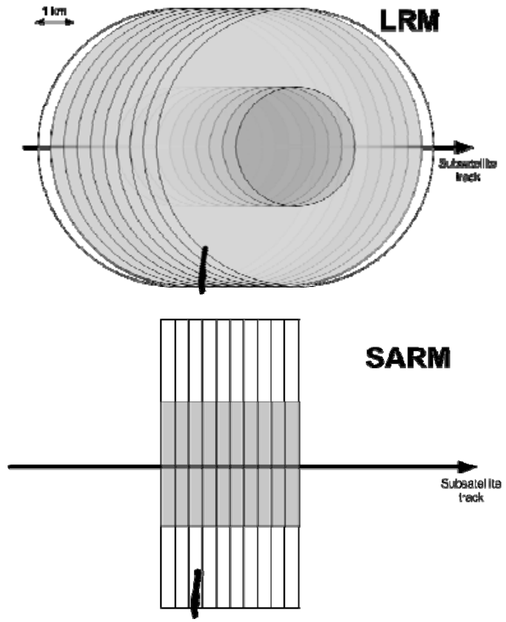
⇒Ideally, should be estimated for each season to follow error (and slope?) temporal change.

3) Analysis and formalism of errors

❑ Thibaut et al: New insight of short wavelength error characterisation

⇒Hump on all the LRM altimeter spectra (10-60+ km), not in along-track SARM
⇒Due to the waveform contamination by the heterogeneity of the sea surface (depends on the footprint size)





❑ Decontamination will require to revisit the editing of 20 Hz altimeter measurements potentially using wavelet analysis
⇒The challenge is to find a trade-off between data coverage and data quality which depends on application

3) Analysis and formalism of errors

- O. Andersen et al., performed an exhaustive cross-comparison of several ocean tidal models in terms of performances

⇒ First time an assessment of tidal currents available from (selected) models performed by comparing against tidal velocities estimated from current meters located in the deep ocean and from acoustic tomography

- G. Jacob et al, sampling errors in the decomposition of vertical modes from current meter data estimated using an eddy-resolving ocean circulation model with embedded tides

=> Few tidal current observations , tentative to estimate barotropic / barocilinic tidal velocities from current meters observations

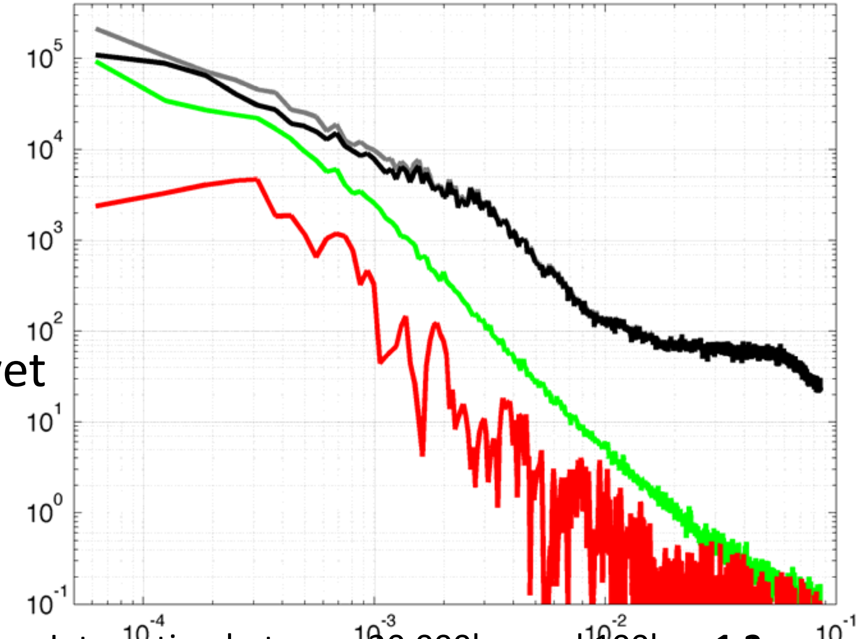
⇒The ability to estimate the barotropic velocity is affected by the number and distribution of the current meters and the internal tide variability

3) Analysis and formalism of errors

- C. Ubelmann et al., have presented a new method to improve the characterisation of the high frequency errors separating the wavelengths

$$\sigma^2(E) = \langle H_C, C \rangle = \frac{1}{2}\left(\sigma^2(C) + \sigma^2(H_C) - \sigma^2(H_{NC})\right)$$

Error Characterization of the radiometer wet troposphere correction (red curve)



Integration between 20,000km and 100km: **1.2 cm**

- First attempts, and method to be tuned/improved

⇒Possibilities of doing regional analysis, providing maps of errors, …

Conclusions

❑ From last OSTST, improvements have been performed on the altimeter error characterization

⇒ Huge work to better understand the Global MSL differences between each group

⇒ New insights of the altimeter error at short wavelength scales (Hump)

⇒ Better characterization of orbit and geophysical corrections errors (tidal models, atmospheric corrections, wet troposphere corrections,…)

⇒ Improvement of the error formulation (separating wavelengths)

❑ For the future (next OSTST):

⇒To enhance the link with users, requirements about error characterization (e.g. : model assimilation)

⇒ to continue to characterize the altimetry errors depending on wavelengths and frequencies and to provide a synthetic error budget of altimetry data for each altimeter standards (e.g : wet tropo, instrumental processing, ….)

Estimates of GDRD Orbits Error Budget (> 365-day)
by A. Couhert & L. Cerri (POD Splinter)

Error Source	Global	Regional
Tracking Systems (GPS, DORIS, SLR)	/	Annual term: SLR range biases oscillations from *3* to *9 mm* Long-term evolution: SLR range biases drift (5-10 years) < *2 mm/y*
Reference Frame	Annual term: North/South oscillations < *8 mm* Long-term evolution: Z-drift (10 years) < *0.3 mm/y* GMSL long-term evolution: Drifts (10 years) < *0.05 mm/y*	Long-term evolution: - Jason2 (5 years) < *0.6 mm/y* at extreme latitudes - Jason1 (10 years) < *0.3 mm/y* at extreme latitudes
Time Variable Gravity (TVG)	GMSL long-term evolution: Jason-1 (10 years) < *0.10 mm/y* GMSL interannual variation: - ENVISAT (5 years) < *0.15 mm/y* - Jason-1 ~900-day variability < *0.10 mm*	Annual term: East/West patterns < *4 mm* Long-term evolution: East/West patterns < *2 mm/y* Interannual variations: ENVISAT (5 years) < *3 mm/y*

Agenda

- Applications:
  - MSL:
    - **Leuliette et al.** (canceled): What do errors between altimeters tell us about the length of the Jason-3/Jason-CS calibration phase?
    - **Henry et al.** : Effect of the processing methodology on satellite altimetry based global MSL rise over the Jason-1 operating period
    - *Ablain et al. (Poster) : Why altimetry errors at climate scales are larger in the first decade (1993-202)?*
    - *Master et al. (Poster): Bumps and wiggles: making sense of Sea Level climate Record variability*
    - *Thao et al. (Poster): Assessment of long term errors of wet tropospheric corrections for altimetry missions: a Mean Sea Level issue*
  - Ocean circulation, mesoscale:
    - **Dufau et al.** : Reducing altimetry small scale errors to access (sub) mesoscale dynamics: dream or reality?
    - **Richman, et al.** : Sampling errors in the decomposition of vertical modes from current meter data estimated using an eddy-resolving ocean circulation model with embedded tides
    - *Hela et al. (Poster): Analysis of fine scale coastal process in the Gulf of Lion*

Agenda

- Analysis and formalism of errors:
  - **Thibaut et al.** : Investigating short wavelength correlated errors on low resolution mode altimetry
  - **Ubelmann et al**. : Wavenumber spectrum of estimated uncertainty in Jason-2 sea surface height measurement
  - **Stammer et al.** : Accuracy Assessment of Global Ocean Tide Models
  - *Carrere et al. (Poster): Comparisons to in situ data and estimation of errors in the Dynamic Atmospheric Correction*
  - *Garcia et al. (Poster) : Retracking Jason-1 Altimeter Waveforms for Marine Gravity Recovery*
  - *Scharffenberg et al. (Poster): Asymmetries between along- and across-track velocity spectra from tandem-mission altimetry*