Analysis of altimetry errors using in-situ measurements: Tide gauges and Argo profiles

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To date, the global assessment of altimeter data can be performed through:

- internal assessment of altimeter data (comparison of instrumental corrections with global models, calculation of SSH at crossovers)
- cross-calibration between altimeter missions
- comparison with in-situ measurements which are used as external and independent sources of comparison to better assess the multiple system performances

In this way, altimetry is compared to tide gauges and Argo floats data in the frame of the SALP project (CNES).

Objectives:

1. Detect global and regional altimeter MSL drifts or anomalies
2. Estimate the impact of new altimeter standards on SSH estimation
Overview

- Datasets and methodology reminder,
- Global altimetry drifts,
- Evaluation of new standards
### Datasets and methodology

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<th>tide gauges</th>
<th>Argo floats</th>
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<td>Relative SSH time series from</td>
<td>• Argo T/S profiles from Coriolis GDAC database,</td>
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<td>• GLOSS/CLIVAR</td>
<td>• Ocean mass fields from GRACE</td>
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<td>Extraction of the most correlated altimetry time series</td>
<td>Interpolating altimetry at the position of each Argo profile</td>
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- • Long time series available, • Dependent on tide gauges distribution, • No open ocean
- • Available from 2002 onwards, • global ocean evenly sampled
Global altimeter drifts

• Latest results from Jason-1, Jason-2 and Envisat
Global altimetry drifts, Jason-1 & Jason-2

- Jason-1 and Jason-2 GMSL drifts:
  - 0.7 mm/yr using RWT
  - reduced to 0.2 mm/yr when MWT and homogeneous standards are used,
  - => Jason-1 and Jason-2 see the same GMSL evolution, see S. Philipps presentation

- Comparison to TG data shows that,
  - over the Jason-1 period, no significant drift is observed,
  - there is a 0.8 mm/yr difference between Jason-1 and Jason-2 mean TG differences over 2008/2012 (0.0 mm/yr vs -0.8 mm/yr),
  - this difference is reduced to 0.4 mm/yr when using MWT, and no significant drift of Jason-2 is observed.
Global altimetry drifts, Jason-1 and Envisat

- Envisat and Jason-1 GMSL trends differ by 1.0 mm/yr over 2004/2012,
- A similar value is observed on alti-TG differences,
- and on altimetry - (Argo+GRACE) differences,

The combination of different types of in-situ data allow to detect and indicate the MSL drift of Envisat with respect to Jason-1 over the period 2004-2012.
Evaluation of new standards

- Jason-1 orbit solution,
- wet tropospheric correction on Topex/Poséidon,
- Assessment of ESA’s CCI sea level dataset
Orbits assessment on Jason-1

• Jason-1 GDR-D orbits: calculated with underweighting of DORIS stations in the SAA
  • North/South bias between Jason-1 and Jason-2 over the verification phase,

• Test of a new Jason-1 orbit with no underweighting:
  • North/South bias is reduced,

• But Jason-1 regional trends are modified!
Orbits assessment on Jason-1

• Comparison between Jason-1 altimetry and T/S profiles
• separating North /South hemisphere (for $|\text{lat}| > 20^\circ$)

Using PondJA1

- under-weighting: $\Delta = 0.6 \text{ mm/yr}$
- no under-weighting: $\Delta = 0.2 \text{ mm/yr}$

The new orbit solution

• improves consistency between Jason-1 and Jason-2,
• improves Jason-1 consistency with Argo data
• New tropospheric correction (UoP) for all missions,
• Induces SL trend changes in the Indian Ocean over the Topex period,

We use Argo and TG data to assess the performance of this new correction with respect to the composite wet tropospheric correction.
• impact on the variance of the altimetry – insitu differences:
  • TG: variance of the differences reduced by 4 cm²
  • Argo: variance of the differences reduced by 1 cm²,

• Argo floats also suggest that the Indian Ocean MSL drift is more consistent with the GPD wet tropospheric correction

Using GPD tropospheric correction on Topex
• reduces regional Alti-Argo trend differences between basins
• improves consistency between altimetry and in-situ data
• Comparing two multi-satellite gridded products
  • SSALTO/DUACS Upd (see Y. Faugere’s talk)
  • ESA’s Sea Level Climate Change Initiative product (see M. Ablain’s talk)
    • climate-oriented,
    • monthly grids
• With respect to in-situ data (TG and Argo) used as reference,

• Small differences between the datasets considering GMSL:
  • in-situ not useful at global average scale,
  • separation of temporal and spatial scales,
Exploring differences between CCI and DUACS

- In situ data provide a very valuable external data source to compare altimetry datasets, even high level (L4) merged products
- considering different time and space scales allows to identify significant signals
Conclusions

- **In-situ data are:**
  - a tool to assess global MSL drifts and jumps
  - an external dataset to evaluate altimeter standards,
    - for mono-mission studies,
    - and for multi-mission gridded datasets,

- **And,**
  - different time/space signals can be usefully investigated

- **Yet,**
  - some processing questions are still open,
    - GIA induced signals,
    - altimetry processing,
    - need for a comprehensive uncertainty estimation,
Conclusions

• knowledge gained comparing past and present satellite altimetry and in-situ should be applied to present and future missions;
  • CryoSat 2
  • SARAL/AltiKa,
  • Jason-3
  • Sentinel 3
  • Jason-CS
  • …

• eventually, we are trying to ensure the reliability of global and regional MSL estimates
Thank you for your attention