Assessment of the AVISO Mean Seal Level indicator by comparison with in-situ measurements

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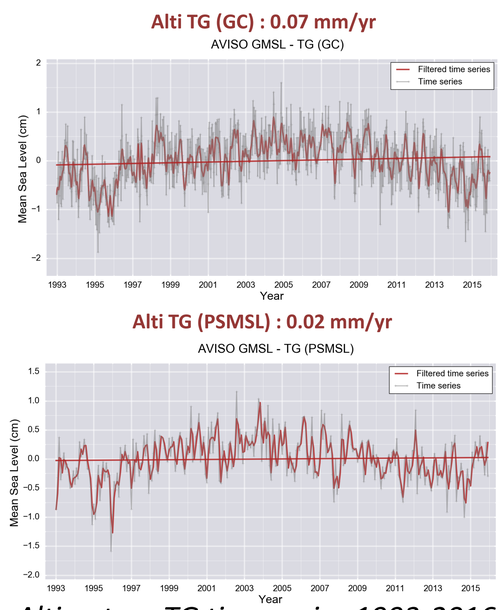
Overview

- Monitoring of the global mean sea level (GMSL) rise and its uncertainties is essential in the context of climate studies. Hence, calibration and validation of the altimeter sea level data are routinely performed by internal assessment and cross-comparison off altimeter data.
- The comparison with in-situ measurements provides an independent and complementary evaluation with respect to Tide Gauges (TG) as well as Temperature and Salinity profilers (TS) datasets.
- Comparison of altimetry data with in-situ measurements allows to :
  - Evaluate the potential improvement of new altimeter standards
  - Detect anomalies (e.g. drifts) in altimeter measurements
- Drifts detections require a precise assessment of the uncertainty budget both for TG and TS comparisons. Such an uncertainty analysis is detailed and potential altimeter drifts of Aviso MSL indicator are discussed.

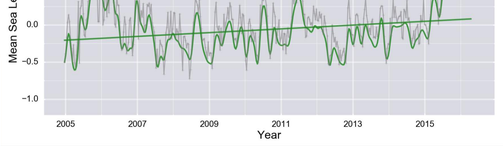
Altimetry / In Situ comparisons

- 2 tide gauges networks were used in the analysis : Gloss-Clivar and PSMSL
- Trend on AVISO GMSL over the 1993-2016 period :
  0.02 mm/y with PSMSL
  0.07 mm/yr with GC
- Positive drift over 1993-2002 :
  0.70 mm/yr with PSMSL
  0.75 mm/yr with GC
- Negative drift over 2005-2016 :
  -0.2 mm/yr with PSMSL
  -0.6 mm/yr with GC



Altimetry - TG time series 1993-2016. Top : GC, bottom : PSMSL

- Closure budget analyses : Comparison of the altimeter series with the sum of the steric and mass components:
  - Argo profilers referenced to 1900dbar
  - GRACE data, GRGS solution
- Positive drift over the [2005-2016] : **0.25 mm/yr** but reduced to **0.12 mm/yr** excluding 2015 and 2016 where anomaly in GRACE data are suspected (cf conclusions)

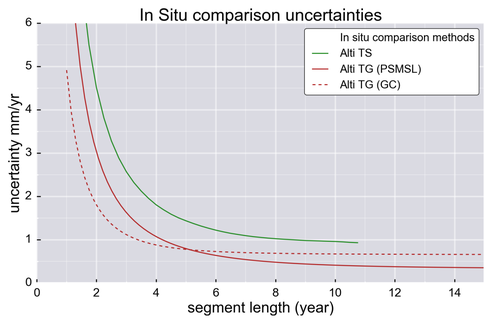


Altimetry - TS (Argo) – Mass (GRACE) time series over 2005-2016

Uncertainty budget

Novelty in this analysis is to account for constant as well as time dependent uncertainty sources

- This method allows to predict the uncertainty evolution according to the time series duration and different In Situ comparison methods



Evolution of uncertainty versus the period length for altimetry and In-situ comparisons (TG and TS)

TG

- Vertical Land Motion $\propto N^{-1/2}$
- N : number of selected tide gauges, depends on the period
- Collocation errors
- Noise $\propto t^{-3/2}$
- residual annual + semi annual signals $\propto t^{-2}$

TS

- Mass solution uncertainty : empirical determination using various solutions
- Deep steric uncertainty 0.1 mm/yr
- GIA uncertainty : 0.3 mm/yr

- Uncertainty for a 10 year analysis for **TG** :
  0.41 mm/yr [95% confidence interval] for PSMSL
  0.67 mm/yr [95% confidence interval] for GC
- And for **TS** + Mass : **0.96 mm/yr [95% confidence interval]**

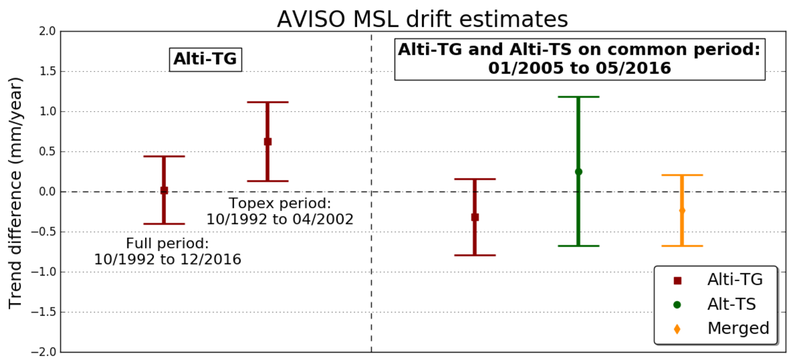
Interpretation and conclusions

Focus on the overall altimetry period

No significant drift over all the altimetry period [1993-2016] detected with **TG** gauges (merged PSMSL and Gloss-Clivar estimates) with a low uncertainty :
0.4 mm/yr (95% confidence level).

Focus on the first altimetry decade

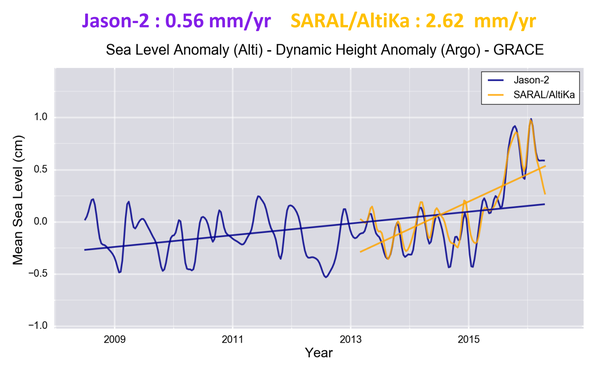
- However, the drift detected with **TG** over the [1993,2002] period, corresponding to TOPEX mission used as reference in AVISO GMSL is significant :
  - Close to +0.6 +/- 0.5 mm/yr
  - The well-known TOPEX-A drift is responsible for the positive Alti- **TG** drift on the 1992/1999 period (see poster by Ablain et al.)



Drift estimation of AVISO GMSL with respect to InSitu measurements and associated uncertainties

Focus on the second altimetry decade

- A smaller drift is observed with **TG** over the [2005, 2016] period, corresponding to Jason-1/Jason-2 missions used as reference in AVISO GMSL :
  -0.3 +/- 0.5 (95% confidence level)
- Uncertainty is higher than drift, thus it is not possible to affirm this drift is due altimetry error.
- No significant drift over the [2005-2014] period is detected with **TS** :
  0.12 +/- 0.96 mm/yr (95% confidence level)
- Year 2015 and 2016 are excluded due to additional errors not yet understood (large positive drift) :
  - Not due to altimeter data : Jason-2 and SARAL/AltiKa are in agreement
  - Possible explanations to be confirmed : problems on GRACE data due satellite ageing (e.g. data gaps)



Comparison of the Alti-TS-Mass residuals for Jason-2 and SARAL/AltiKa

References

- AVISO: http://www.aviso.altimetry.fr
- Legeais et al. 2016 , Ocean Science 12 (3) 647-662
- Valladeau et al. 2012 , Marine, Geodesy 35 (sup1) 42-60

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