Estimating a drift in TOPEX-A Global Mean Sea Level using Poseidon-1 measurements

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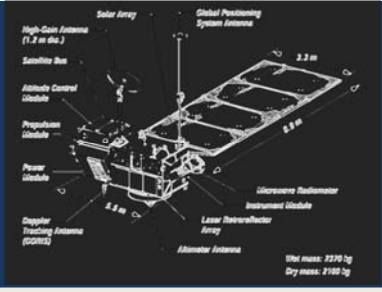

Context

➢ The degradation of the TOPEX side-A altimeter over the years, but also the unstability of TMR (Stum 1998) induces a significant Global Mean Sea Level drift.

➢ Despite empirical corrections [Scharroo et al., 2004], this results in a major source of uncertainty in the continuous Global Mean Sea Level (GMSL) record error budget [Ablain et al., 2009]

➢ Comparisons to Tidal Gauges (TG) show a drift between 1.5 and 2.0 ± 0.7 $mm.yr^{-1}$ [Mitchum et al., 1998 ; Watson et al., 2015 ; Prandi @ OSTST 2015]

➢ Poseidon-1 is technically very close to Poseidon-2/3/4 and the data quality – to our knowledge – should be equivalent

➢ In the context of TOPEX reprocessing, characterizing the TOPEX-A drift is necessary and of major interest for the climate community.

Can we estimate TOPEX-A drift based on Poseidon-1 measurements

What would be the impact of correcting this drift on the Sea Level rise acceleration

Stability of Poseidon-1

➢ Poseidon-1 (P1) Point Target Response (PTR) is very stable over the mission life: drift below 0.6 $mm.yr^{-1}$ (cf. Fig. 1).

➢ It is perfectly accounted for in the ground processing,.

➢ All other instrumental variables (filter, PTR power) show a very good stability as well

Poseidon-1 stability is perfect

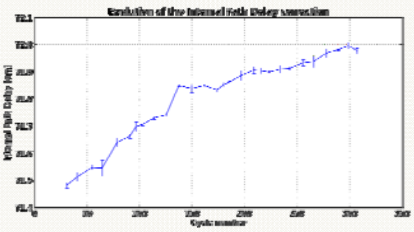

Fig. 1: Stability of the internal path delay correction in raw Poseidon-1 data (before ground processing)

Methodology

1. TOPEX-A (Txa) GMSL record is interpolated on P1 cycles.
2. Txa drift is estimated as the trend of the difference between Txa interpolated and P1 GMSL records.

➢ Over the TOPEX-A period (cycles 20-234), 22 cycles of P1 are available (1 out of 10)

Question: Are there enough Poseidon-1 cycles recorded to estimate TOPEX-A drift ?

➢ We simulated Txa and P1 GMSL records (with Jason-1). A drift has been artificially introduced in simulated Txa and succesfully retrieved.

There are enough Poseidon-1 cycles to estimate the drift in TOPEX-A GMSL record

Application to TOPEX / Poseidon data

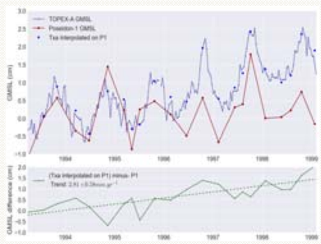

Fig. 2: Application of methodology to TOPEX-A/Poseidon-1 data. Upper panel: GMSL records. Lower panel: Difference between the interpolated TOPEX-A and Poseidon-1 records

Results suggest there is a **2.8 ± 0.6 $mm.yr^{-1}$ drift in TOPEX-A GMSL record w.r.t Poseidon-1 measurements**

➢ Consistent, though larger, with [Watson et al, 2015] which estimated the drift between 1.5 and 2.0 ± 0.4 $mm.yr^{-1}$.

Impact on the reference GMSL record acceleration

➢ The impact of correcting this 2.8 $mm.yr^{-1}$ drift in the reference continuous GMSL record (TOPEX/Poseidon + Jason-1 + Jason-2) is quantified Fig. 3 and Fig. 5.

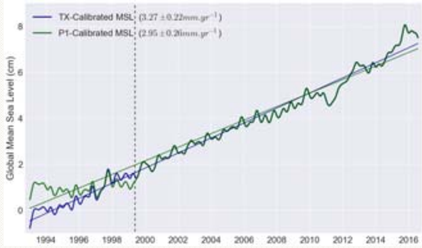

Fig. 3: Impact of a 2.8 mm.yr-1 correction in TOPEX-A on the reference GMSL record (seasonnal cycle removed)

➢ Significant impact on GMSL trend over 1993-2016: **-0.3 $mm.yr^{-1}$**

➢ [Shepherd et al., 2012], [Haigh et al., 2014]: **an acceleration over the last two decades should have arisen in the GMSL record.**

➢ [Fasullo et al., 2016]: "the 1991 **eruption of Mt Pinatubo to likely have masked the acceleration that would have otherwise occurred**", cf. Fig. 4

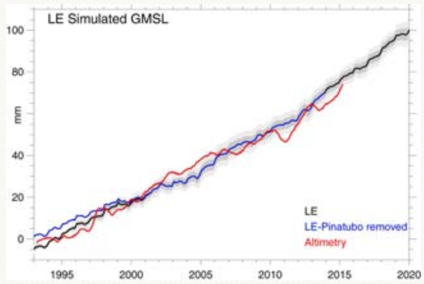

Fig. 4 (from Fasullo et al., 2016): Sea level rise associated with ocean heat storage and the sum of all contributions estimated from Large Ensemble budgets and cryospheric contributions

The present study suggests the acceleration over the past two decades is occuring: **0.07 $mm.yr^{-2}$**.

➢ Using a smaller 1.5 $mm.yr^{-1}$ correction for Txa drift ([Watson et al., 2015]), the acceleration would be 0.04 $mm.yr^{-2}$

Combined to the effect of the 1991 Mt Pinatubo eruption, this study suggests GMSL, hence climate change, is in fact significantly accelerating.

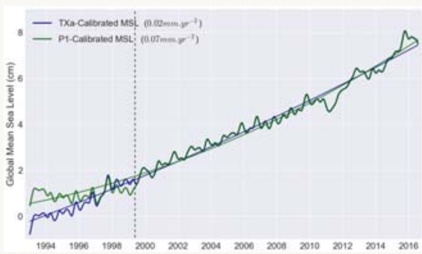

Fig. 5: Impact of a 2.8 mm.yr-1 correction in TOPEX-A on the acceleration in the reference GMSL record (seasonnal cycle removed)

Outlooks

➢ Using the Poseidon-1 GMSL record to correct TOPEX-A drift is promising but may benefit from the ongoing reprocessing with MLE4 retracker.

➢ The drift correction must be thoroughly validated, e.g. using the tidal gauges network. However, given the scarce repartition and accuracy of TG stations over this period, the validation remains challenging, **cf Poster Prandi et al. @OSTST 2016**

➢ The significant impact on the GMSL acceleration must be understood and validated

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OST/ST meeting, Oct 31st- Nov 4th, 2016

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