

The TOPEX-A drift and impacts on GMSL time series

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Overview

The TOPEX/Poseidon satellite was a joint NASA-CNES mission launched in August 1992 carrying two radar altimeters. The mission provided, for 13 years, high accuracy sea surface height measurements. It was known since 1998 that the TOPEX-A instrument suffered from problems affecting significant wave heights estimates (Hayne and Handcock, 1998), but the Global Mean Sea Level (GMSL) estimate was assumed not to be affected. The TOPEX-A altimeter was nevertheless replaced in 1999 with the redundant onboard TOPEX-B instrument.

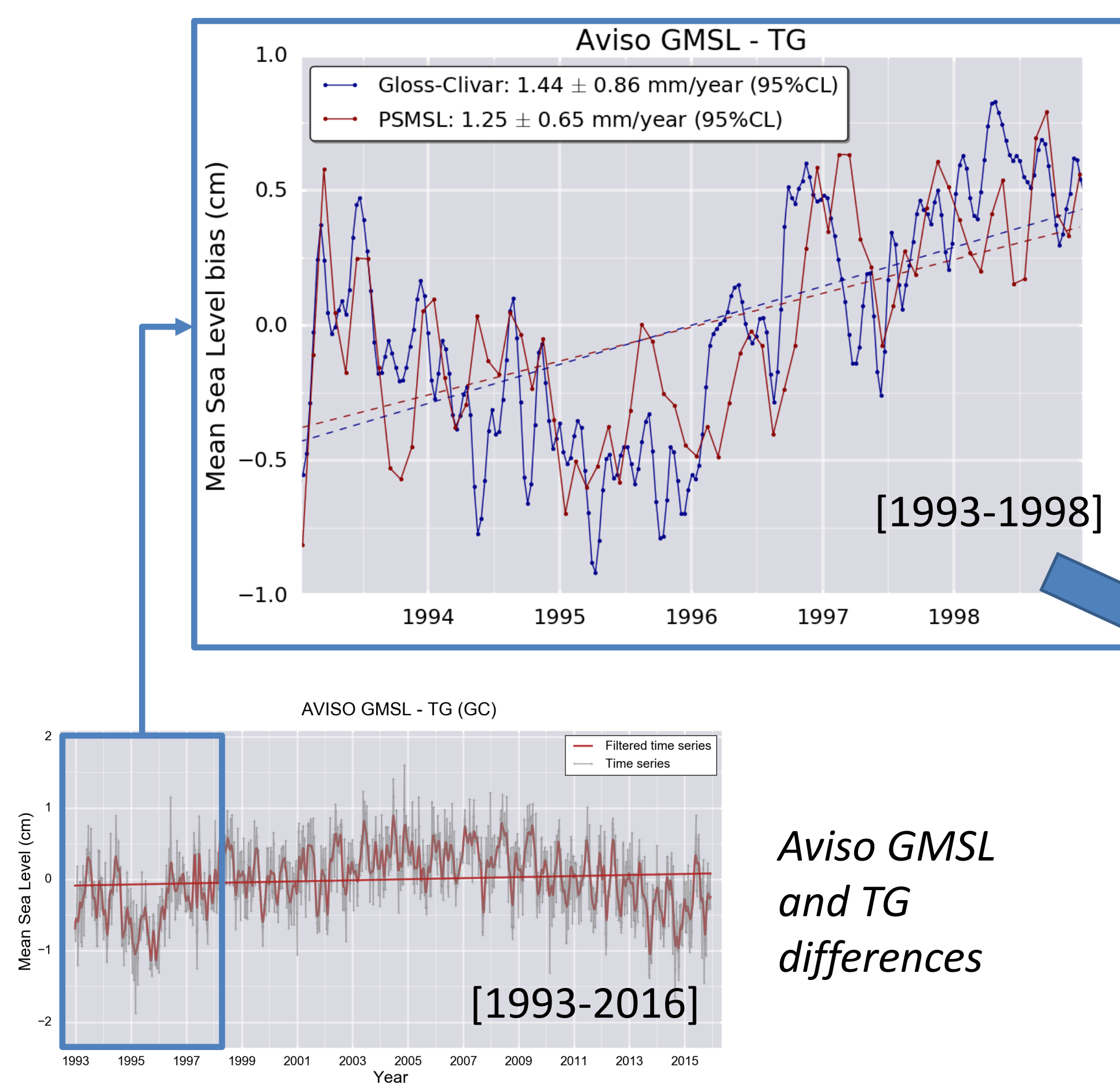
Several recent studies (Watson et al, 2015, Beckley et al, 2017, Cazenave et al, 2017) evidenced a significant drift of TOPEX-A GMSL. This poster aims at describing the TOPEX-A drift GMSL estimates and uncertainties through 3 independent approaches based on In Situ measurements and comparison with the on-board Poseidon altimeter.

Comparison with tide gauges (TG)

No linear drift is detected over [1993-1998] period :

- 1.4 ± 0.86 mm/yr with Gloss-Clivar network
- 1.3 ± 0.65 mm/yr with PSMSL network (within a 95% confidence interval)

with a minimal value in 1995 and drift of approx. 3.1 mm/yr over [1995-1998] period corresponding to the TOPEX-A ageing.



Aviso GMSL and TG differences

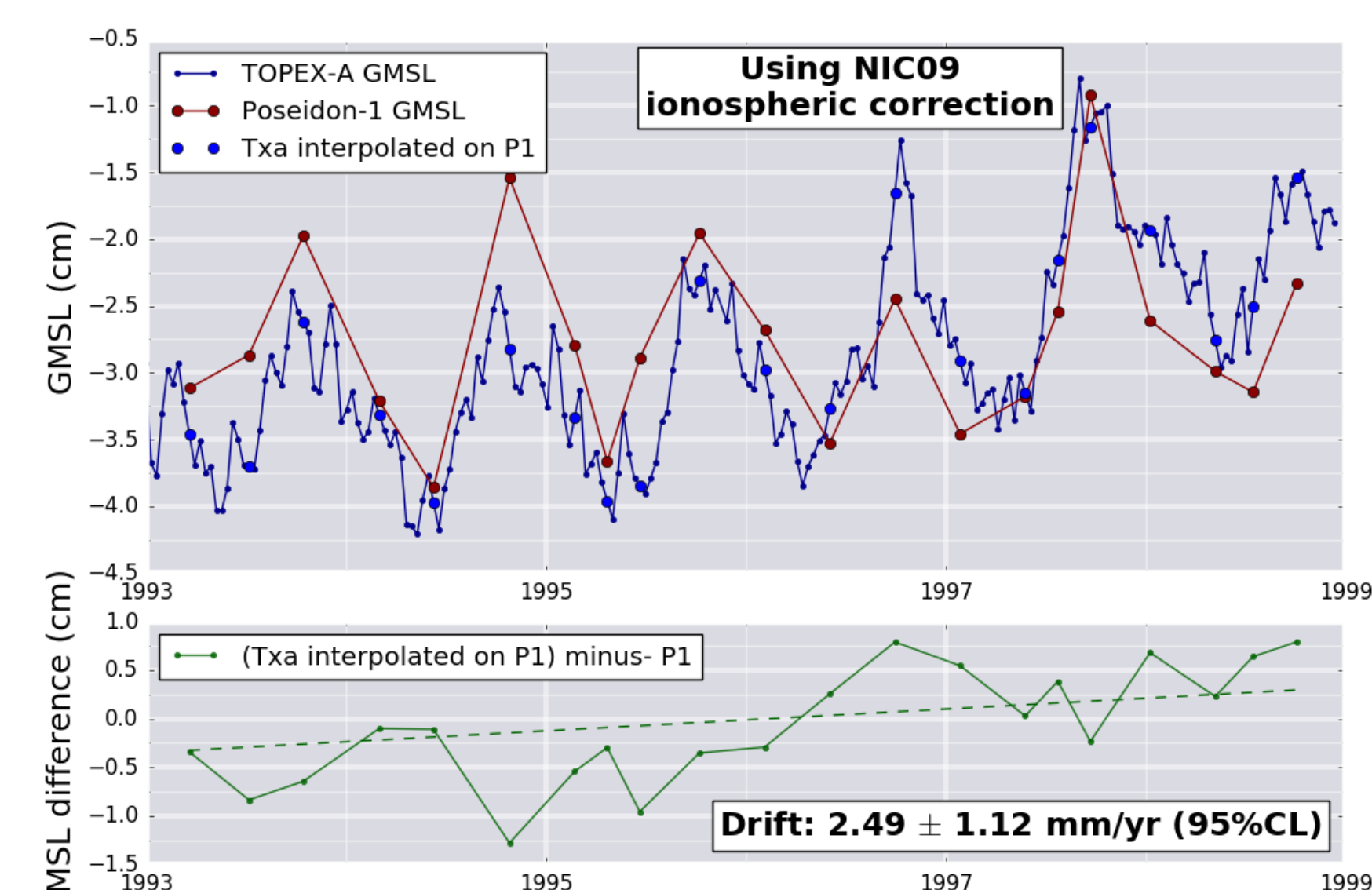
Comparison with Poseidon

The on-board Poseidon altimeter working intermittently (about 1 in 12 cycles) with Topex-A/B altimeters can be used to measure the TOPEX-A drift (Zawadzki et al., OSTST 2016).

Using the same ionospheric correction model (NIC09) for Poseidon and Topex-A, the TOPEX-A drift is estimated at :

- 2.5 ± 1.1 mm/yr (within a 95% confidence interval).

As with TG, a stronger drift is observed over [1995,1998] period 3.3 mm/yr (not statistically significant)

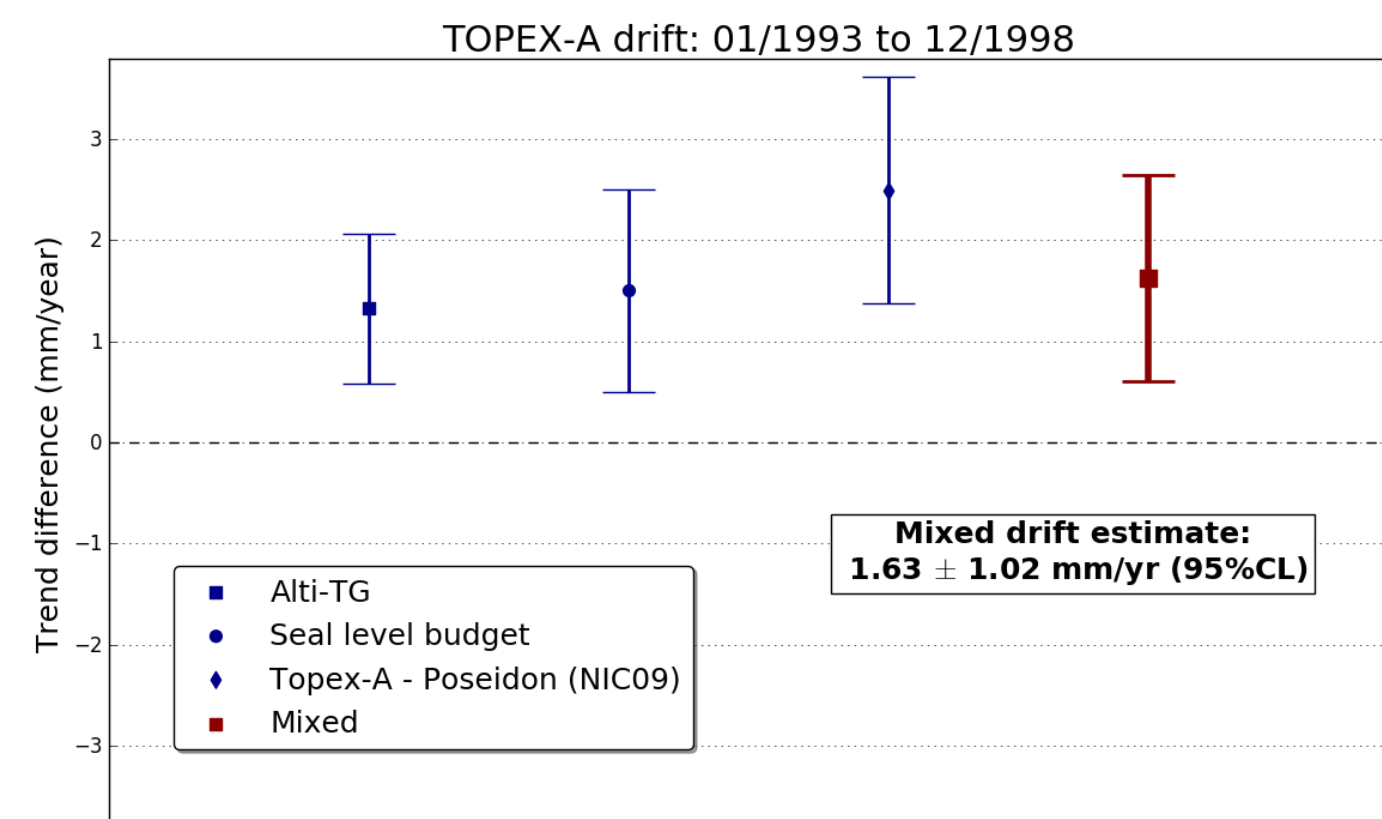


Top: GMSL times series for TOPEX-A (blue) and Poseidon-1 (red); Bottom : GMSL differences TOPEX minus Poseidon- 1 (green)

Merged drift estimate

The average drift and mean uncertainty can be derived from these 3 independent method with the following mathematic formalism:

$$a = \frac{\sum_i a_i^2}{\sum_i \frac{1}{\delta_i^2}}$$
$$\delta = \sqrt{\frac{\sum_i (a_i - a)^2 + \delta_i^2}{\sum_i \frac{1}{\delta_i^2}}}$$



MSL closure budget

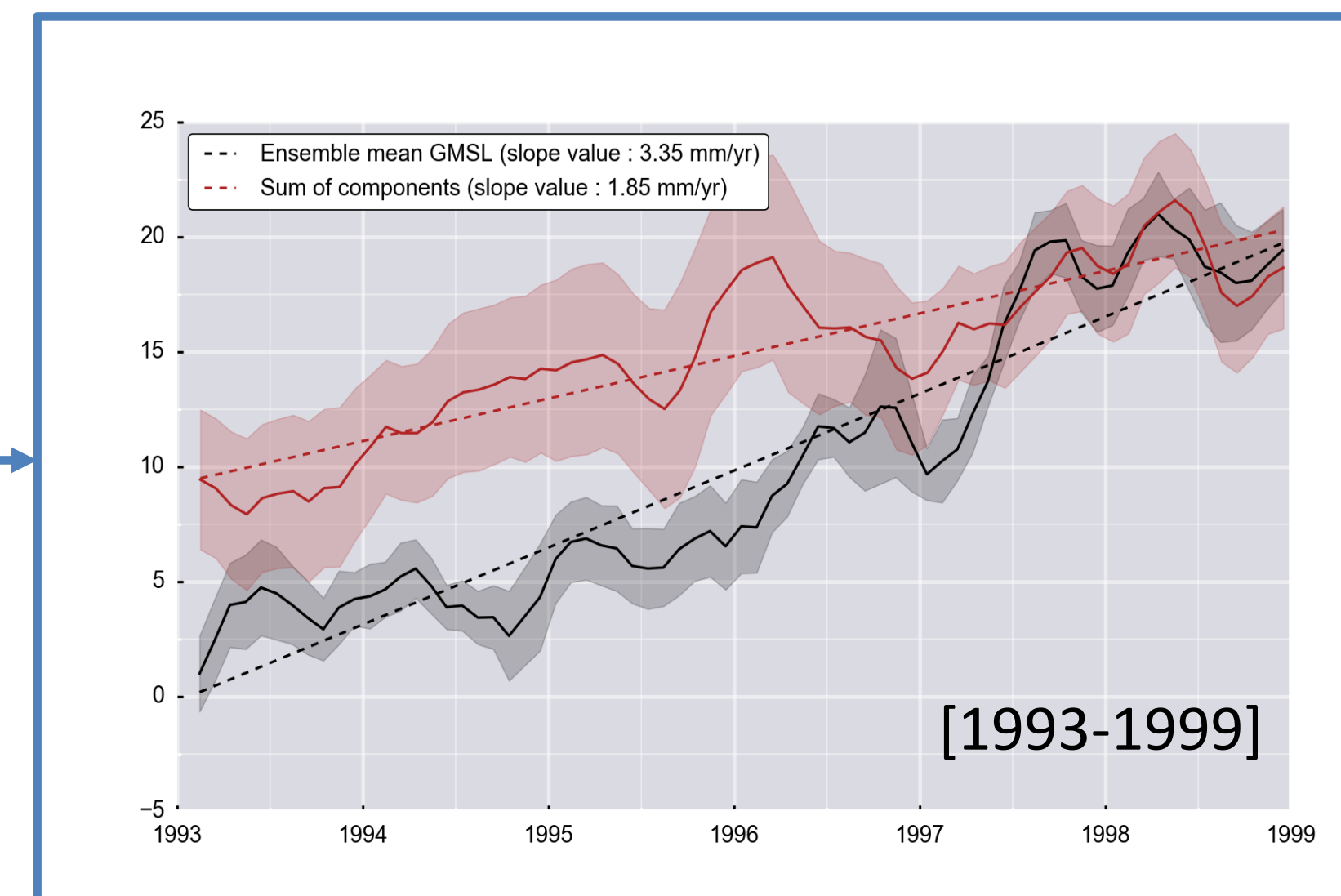
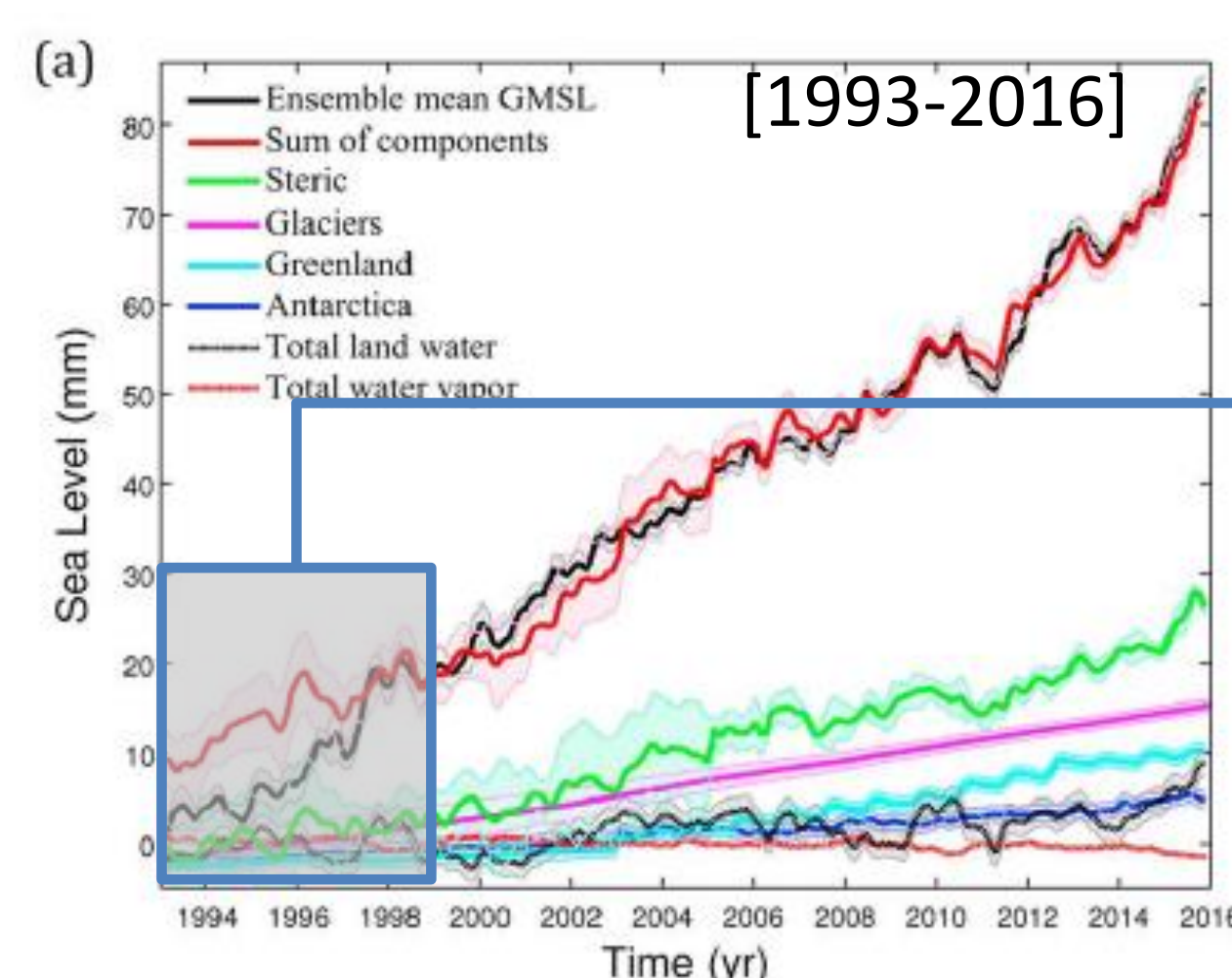
Closure budget analysis consists in comparing the sea level rise as measured by altimetry missions with the sum of the steric and mass components.

Difficulty for the TOPEX period : use of steric sea level products with incomplete coverage and presenting large dispersion among them + estimate mass by accounting for all contributions to sea level changes (glaciers, atmospheric, land water ...)

Dieng et al. 2017 compared the ensemble mean of several GMSL products with the sum of the steric and mass contributions over the 01/1993 - 12/1998 period and found a drift of :

1.5 ± 1 mm/yr (within a 95% confidence interval)

Left: MSL closure budget overall the altimetry era with contribution of each components ; Right: focus on TOPEX-A period for GMSL and Steric + Mass components.

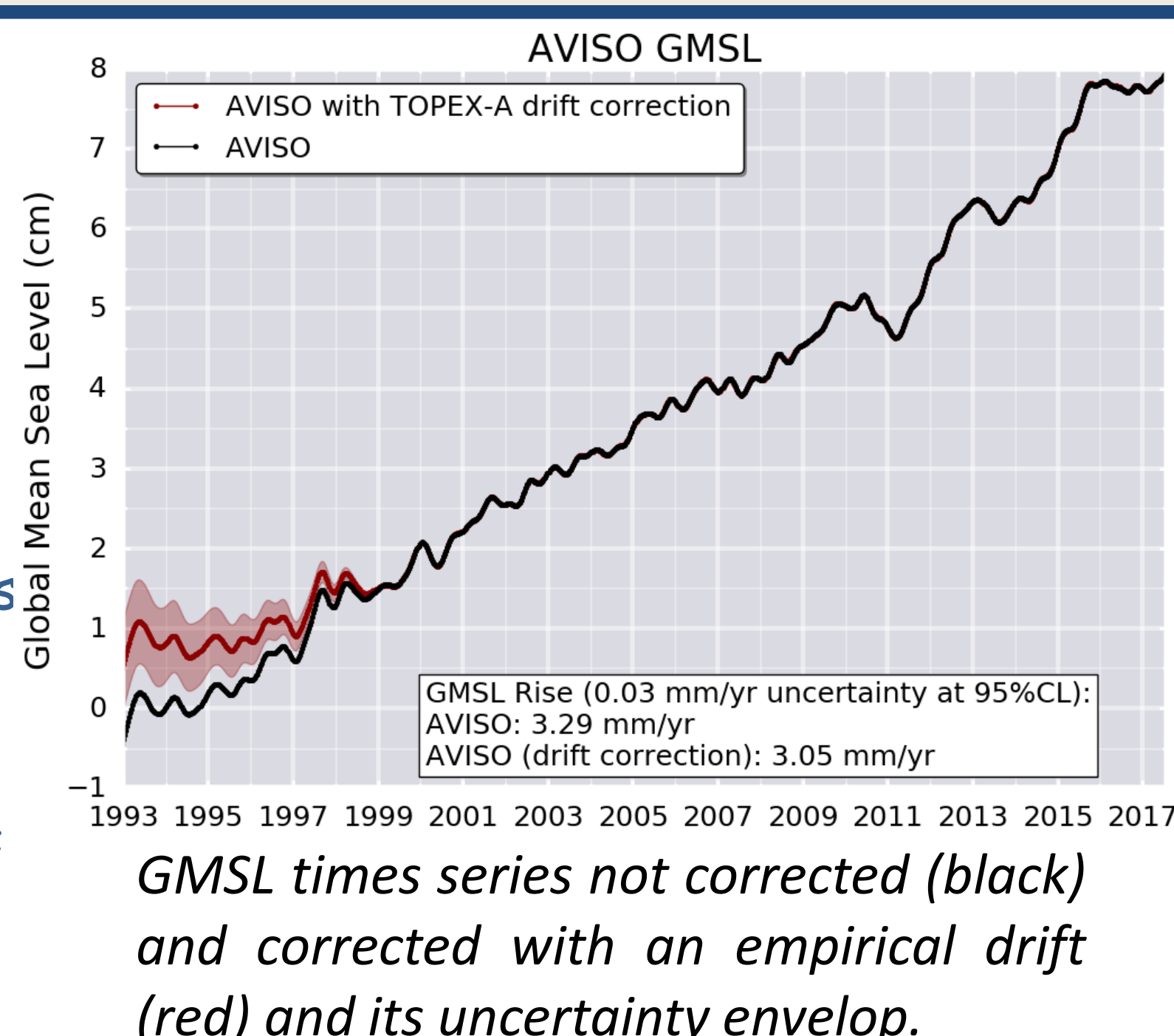


Outlook

- TOPEX-A drift is evidenced with 3 independent method leading to an average estimation of : 1.6 mm/yr \pm 1mm/yr (95% confidence interval) \Rightarrow with a stronger drift over [1995-1998] period.

- Impact on the GMSL trend over the 25-year period is low but significant : -0.25 mm/yr \pm 0.16 mm/yr (95% confidence interval)

\Rightarrow It highlights a potential acceleration of MSL evolution of 0.07 mm/yr² (Fasullo et al., 2016)



GMSL times series not corrected (black) and corrected with an empirical drift (red) and its uncertainty envelop.

Given the importance of TOPEX-A drift on GMSL evolution, TOPEX-A data should be corrected:

- 1) By using the next TOPEX reprocessing expected in 2018 ?
- 2) By not using Wallops coefficient correction on TOPEX-A altimeter range as recommended by (Beckley et al 2017) ?
- 3) By applying an empirical correction derived from in-situ (tide-gauge) comparisons ?
- 4) Other approach as removing the TOPEX-A period for the GMSL calculation ?

An OSTST recommendation is required