Continuing the Global Mean Sea Level reference record with Jason-CS / Sentinel-6

L. Zawadzki[1], M. Ablain[1], G. Dibarboure[2]

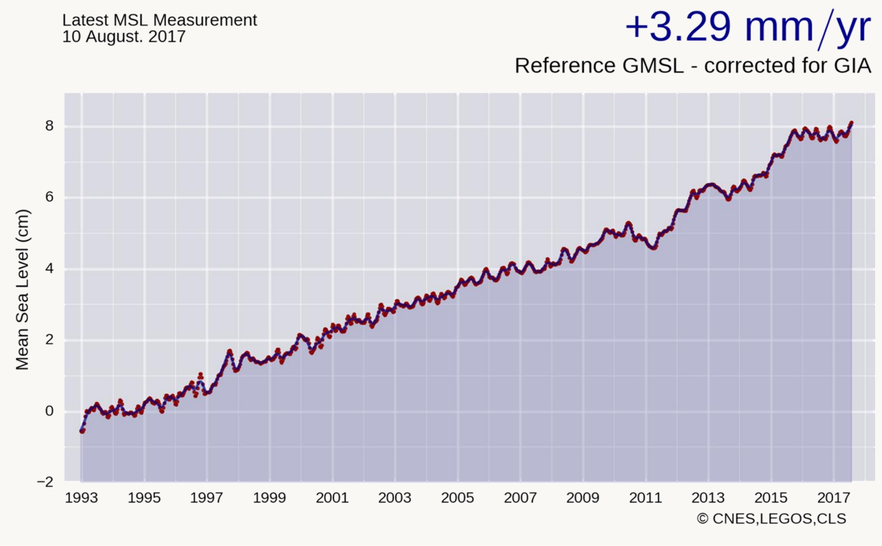
1. CLS, Toulouse, France
2. CNES, Toulouse, France

Impact of Sea Level Bias Uncertainties on the Global MSL Trend

Thanks to satellite altimetry, the Mean Sea Level (MSL) continuous record is maintained since January 1993 using TOPEX/Poseidon data followed on the same orbit by Jason-1, Jason-2 and Jason-3 records.

Estimated uncertainty on the Global MSL continuous record trend over 15-20 years:
- (Ablain et al, 2009): 0.6 mm.yr^{-1}
- (Leuliette et al, 2012): 0.8 mm.yr^{-1}

Climate users requirements (UR) on Global MSL trend uncertainty: 0.3 mm.yr^{-1} over 10 years



In order to extend the current MSL continuous record, Sentinel-6:Jason-CS altimetric mission will be the natural successor of Jason-3: on the same orbit with a calibration phase (also called verification phase).

In Zawadzki & Ablain, 2016, we showed the importance of calibration phases to derive a continuous and accurate MSL with respect to the GCOS requirements. These results are applicable to the transition between Jason-3 and Sentinel-6, or Jason-3 and Sentinel-3a, see table below.

	Jason-3 / Sentinel-6	Jason-3 / Sentinel-3a
Relative Bias Uncertainty	1 mm	2.5 mm
Corresponding uncertainty on trend over 10 years	0.15 mm.yr^{-1}	0.4 mm.yr^{-1}

However, these uncertainties are obviously correlated with the method used to estimate the inter-mission relative bias.
The objective here is to develop a work plan in preparation to Sentinel-6/Jason-CS launch:

Questions:
- What would be the MSL trend uncertainty induced by the premature loss of Jason-3?
- How can we improve the accuracy of the methods to estimate the relative biases? Would a multi-mission approach –using Jason-3 and Sentinel-3 (a/b) be accurate?

MSL trend uncertainty induced by premature loss of Jason-3

In the eventuallity of a premature loss of Jason-3, the orbit change of Jason-2 leaves us with few options. The best one is probably to use Sentinel-3a/b as a temporary replacement pending Jason-CS launch.

In Zawadzki & Ablain, 2016, we showed how the successive inter-mission relative bias uncertainties affect the MSL trend uncertainty in time. This uncertainty is indeed function of the length of the period,

The following figure represents an abacus predicting the MSL trend uncertainty if we were to switch temporarily from Jason-3 to Sentinel-3a and back to Jason-CS between 2016 and 2020 with the current relative bias estimation method. The uncertainties are very significant w.r.t GCOS requirements.

The temporary switch to Sentinel-3a between Jason-3 and Sentinel-6/Jason-CS would lead to a trend uncertainty of the 30-year MSL record (1993-2023) of 0.28-0.32 mm.yr^{-1}. By comparison to the reference scenario (direct transition from Jason-3 to Sentinel-6/Jason-CS), this represents an additional trend uncertainty of 0.09 to 0.13 mm.yr^{-1}

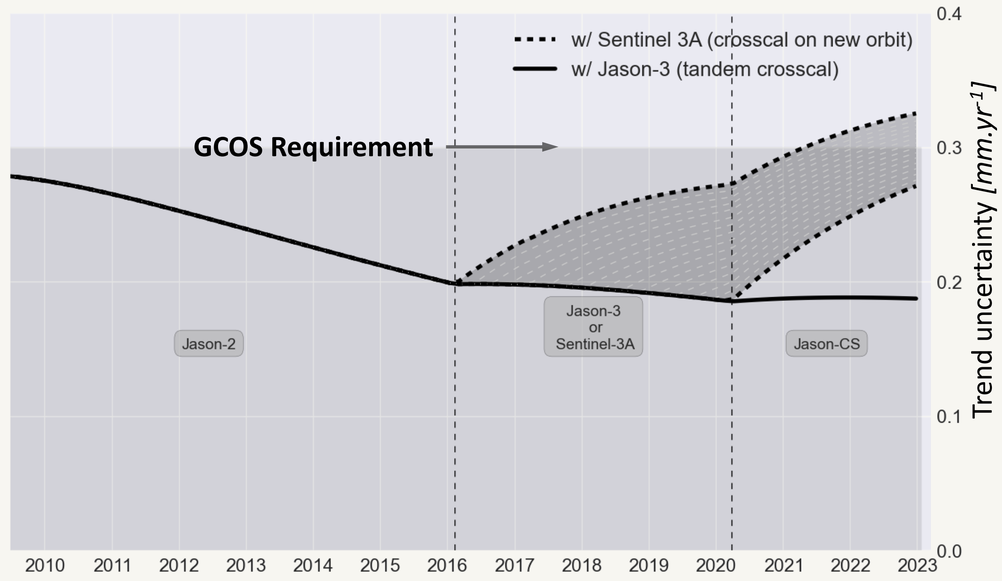


*Fig 1. For each time step **t**, uncertainty on the trend of the continuous MSL record for the period 1993-**t** induced by the successive intermission relative bias uncertainties. Zoom on 2010-2023.*

Improvement of intermission relative bias estimation

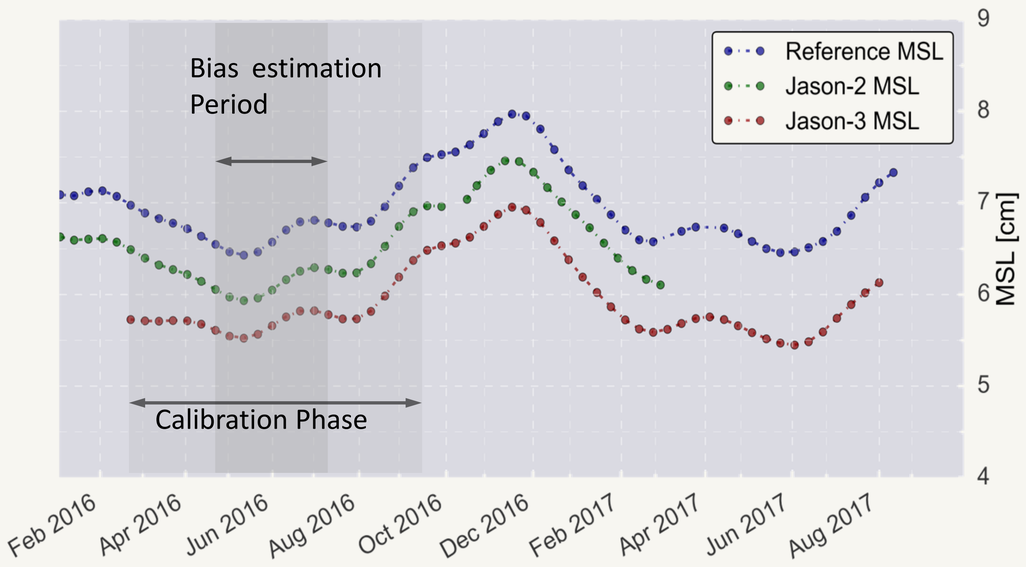


Fig 2: Estimation of Jason-2/Jason-3 MSL relative bias over the calibration phase

The current method is straightforward: the bias is estimated over 10 cycles of the verification phase, if any, see Fig 2,

This document presents a workplan in 2018 to design and evaluate new methodologies, especially when there is no calibration phase :
- Using crossovers analyses
- Using part or all of the available satellite constellation
- Removing the mesoscale before estimating the bias thanks to L4 altimeter products

The objective of these different approaches is to reduce the effect of ocean variability on the bias accuracy

Methods could be tested with simulated scenarii (to be defined) but also could be useful to improve the TOPEX-A/TOPEX-B MSL relative global bias.

The question of regional bias is also of great interest for regional MSL trend sestimation (not described in this poster), and should be evaluated by these new methododologies.

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