On the uncertainty associated with detecting global and local mean sea level drifts on Sentinel-3A and Sentinel-3B altimetry missions - Author response to reviewers (2nd round)

Response to first reviewer (Graham Quartly)

I was a little disappointed that the authors did not use the opportunity offered by this resubmission to evaluate their approach using data consistent with what others will have by the time this is published i.e. with the correct USO correction for S3B. Fig. 4b of Quartly et al. (2020) shows the USO correction for S3B to change by 3mm over 2 years; given that this was originally applied with incorrect sign, one would infer a correct application would change the DelatGMSL by 3 mm/yr. A more thorough analysis could have been done by making appropriate use of the daily average correction (ftp://ftp.eumetsat.int/pub/EUM/out/RSP/lucasb/S3B.USO/S3B.cor_uso.daily.csv) to amend their 10-day gridded fields.

Response : We fully understand the point of view of the reviewer, however we would just like to remind that this study allowed us to detect and quantify the drift of the S3-B (and S3-A) GMSL in the framework of the S3-MPC project, and for this reason the USO correction was not yet available when the study was performed. For the sake of clarity, we believe it would be best to verify the stability of S3-B (and S3-A) corrected with this USO correction in a separate paper when the L2/L2P products are reprocessed and made available. If, however, this point is blocking the publication of the paper, a compromise may also be to provide this information in auxiliary material.

For me, the main plus of this paper is the robust statistical analysis to put uncertainty on the estimates of DeltaGMSL, and thus assign a probability that this is significantly different from zero. Indeed Figs. 2 & 3 could be usefully replaced with a table giving Mean trend, Uncertainty (1 sigma), Significance, rather than having some values in a figure and some in main text. I am not sure about their Eq. 4 -- can the authors please check that that is correct.

Response : Yes, you are right about the formula, which is now corrected to :

$$\hat{\beta} = N(\beta, (X^t X)^{-1}(X^t \Sigma X)(X^t X)^{-1})$$

For the figures vs table issue, we think that the figures make it easier to see the drifts and associated uncertainty, and whether they are significant or not by just looking at the intersection with 0. They also provide a means to quickly analyze the whole picture of missions intercomparisons, which is necessary to attribute the observed drifts to a specific mission for instance. We indeed provided trends, uncertainties, and using a gaussian distribution we calculated the confidence interval associated with trend / uncertainty, but this last statistic is only provided in the text. If the editor thinks it is necessary to add a table to sum up those statistics, we could add a table in the conclusion.

Seven of the given references are "grey literature" i.e. conference presentations or unrefereed reports. These should all have date when last accessed. Presuming Legeais et al. 2021 is published it should have volume and page no. Henry reference should start on a new line.

Response : OK, we've checked that the access was still working for the grey litterature references where we provided the link, and added the current date. The links to the presentations were also added for :

Ablain, M.: Estimating of Any Altimeter Mean Sea Level (MSL) drifts between 1993 and 2017 by Comparison with Tide-Gauges Measurements, 25 years of progress in altimetry radar symposium, 2018. https://drive.google.com/file/d/1Wt7nDLBOwtjGYtDPoO1ofFoisyuFv1yu/view?usp=sharing (last accessed June 10th 2022).

Poisson, J. C., Piras, F., Raynal, M., Cadier, E., Thibaut, P., Boy, F., Picot, N., Borde, F., Féménias, P., Dinardo, S., Recchia, L., and Scagliola, M.: SENTINEL-3A instrumental drift and its impacts on geophysical estimates, OSTST 2019, 2019. https://ostst.aviso.altimetry.fr/fileadmin/user_upload/2019/IPM_02_Poisson_OSTST2019_PTR_Drift.pdf (last accessed June 10th 2022).

In the case of Abain et al., it seems like the 25 years of progress in altimetry radar symposium, 2018 conference did not make presentations accessible through public links, so we put the presentation onto a google drive and generated the link for readers.

Legeais et al. 2021 was indeed published, but google scholar citations are not up to date, so I've added volume, page number, and DOI manually.

Henry et al. reference was indeed moved to a new line.

The paper details quite a bit the procedure and analysis for regional variation in DeltaGMSL and ends up showing that no region is appreciably different from the global value. Given that the authors have quite correctly minimised differences in corrections by using consistent atmospheric and tide models throughout, it would be helpful if they devoted a few sentences to which mechanisms could be responsible for regional variations and thus what this null result allows us to regard as understood.

Response : We have indeed detected a significant drift in the GMSL of S3A/S3B with respect to the Jason-3, Jason-2 SARAL/Altika mission, which we attributed to the altimetric parameters of these 2 missions (e.g. altimetric range, SWH). We performed the same type of analysis at regional scales to verify if this global drift could have a regional signature. At regional scales, the main sources of error can come from inhomogeneity in the calculation of the orbit between 2 missions when 2 satellites are not at the same altitude, for example because of the modeling of the gravity fields at the ITRF (see Couhert et al.; 2015; Prandi et al., 2021). If instrumental drifts of the altimeter are present, one could also expect to observe a spatial signature that depends on the wave amplitude for example. Given the larger uncertainties of the method at these regional scales, we did not indeed detect any regional drift around the observed global mean value of the S3A/S3B GMSL drive.
In order to follow your recommendation, we have specified in the introduction the regional signals that we could possibly observe.

Minor corrections
Abstract l.5 : possibly expand S3A and S3B on first use.
Abstract l.6-7 : Drift of S3A is compared with J3 then AL; whereas S3B is compared with AL then J3. Please reverse 2nd pair to make them consistent.
Introduction l.18 GSML should be GMSL
Introduction l.21 Suggest change "lower revisit rate" to "longer revisit period"
Introduction l.32 "Jason-3" occurs twice.
Introduction l.39 "GMSL.s" is a little ugly; clearer would be "GMSL estimates"
Section 3.1 l.34 Need to note that the 58.77-day alias is for Jason-3.
Section 4.4 l.6 "from -2 to +2"
Conclusions l.12 S3B is compared with AL then J3. Please reverse this pair to make them consistent with earlier S3A comparison

All those minor changes were implemented in the paper.

Section 3.1 l.27-28 This states that time correlated errors can be divided into those with timescales < 1 yr and those for 5-10 years. What about 1-5 years, why are those so explicitly ignored?

Response: In fact, two types of errors affect our approach: a) error due to measurements, and b) error due to internal ocean variability observed differently by two satellites that are not in the same orbit.

a) For the error due to measurements, as discussed in the paper, our study is based on Ablain et al. 2019 where the main sources of errors impacting the stability of the GMSL have already been identified. According to Ablain et al. 2019, the time-correlated errors were divided at the same time scales: 2 months and 1 year, 5 years , 10 years, etc... . Indeed, there are no descriptions in the literature of significant correlated altimeter errors at time scales between 1 and 5 years.

b) for the error due to internal ocean variability observed differently by two satellites is mainly observed for scales smaller than a few months (e.g. mesoscale) using and adapted averaging of the SLA grids (according to Henry et al. (2012))

We've modified this paragraph to make it clearer.