

Reviewer #2 (<https://doi.org/10.5194/egusphere-2024-1802-RC2>)

Review of "Benefits of a second tandem flight phase between two successive satellite altimetry missions for assessing the instrumental stability" by Ablain et al.

This paper describes a potential second tandem flight phase and the benefits this would bring to the calibration of two reference altimeters.

While the topic is of interest, the paper is often too brief in describing what has been done, and the reader needs to look for the cited references in order to understand the methodology (and sometimes even those references don't give the information we're after). For example, in section "5.1 Uncertainty budgets of other validation methods" the authors say "the altimeter measurements are not performed exactly at the same time and location". There is no information about the maximum allowed differences in space and time between altimeter and tide gauge data, or between 2 altimeters, so the reader is unable to assess how this comparison is done. The cited references do not give this information either, or I have been unable to find them (one of the references, Ablain et al 2018, is not complete in the list of references and I have been unable to find it).

For the sake of clarity, we have merged Sections 2 and 3, which provide a sequential explanation of each step in the proposed methodology for calculating the uncertainty of the 2-tandem phase method. This restructuring is intended to facilitate a better understanding of the methodology.

Although not the main focus of this study, the methodology for deriving the uncertainty of comparison methods between altimetry and tide gauges, or between 2 altimetry missions outside a tandem phase, is also based on the same methodology as the 2-tandem phase method, with the provision of a specific uncertainty budget. By clarifying the methodology for the 2-tandem phase method (new section 2), we also aim to shed light on the other comparison methods. We have also clarified the text and mentioned the typical time differences and distance differences.

We have also completed the reference "Ablain et al., 2018" has been updated providing the access to the file: https://www.geomatlab.tuc.gr/fileadmin/users_data/geomatlab/international_review_workshop_2018/presentations/01_Monday/Session_01/06_S1_23_Ablain_et_al.pdf

The manuscript also contains various vague statements or definitions, in particular when using the word "uncertainty" throughout the manuscript. It should be clear at

each moment of the paper which uncertainty are they talking about (example, the title of section 2 "Method to quantify the uncertainty of the 2-tandem phase method", which uncertainty? As it is phrased, it sounds like the uncertainty that the 2-tandem phase takes place or not...). Also, there are 2 "method" in the same sentence. The term "estimated" should also go with uncertainty in many parts of the manuscript.

Corrected: The title of this section has been updated to “Methodology for estimating uncertainty in the 2-tandem phase method” to clearly indicate that it refers to the process of estimating the uncertainty associated with this method, not uncertainty regarding the occurrence of the second tandem phase itself. Additionally, the introduction of this section has been revised to further clarify this distinction.

The use of the term “uncertainty” throughout the manuscript has been carefully reviewed. We ensure that throughout the manuscript, the types of uncertainties and their associated sources (e.g., instrumental noise, geophysical corrections, etc.) are consistently defined and referenced.

I'll specify my comments in order of appearance:

Line 39, but general comment: please check the parentheses of your citations, they are often wrong ("identified and characterised by (Ablain et al., 2019b; Guérou et al., 2023; Prandi et al., 2021).") should be "identified and characterised by Ablain et al. (2019b), Guérou et al. (2023) and Prandi et al. (2021)."

We have corrected in the paper the parentheses of our citations.

line 81: "drifts in the seal level data record". Strange wording, it is not the sea level that drifts (it changes, and it is not that change the authors are after) but the satellite sensors' accuracies.

Indeed, the sentence was wrong, we are looking for drift errors. This has been corrected.

Line 116: "This uncertainty budget enumerates the various sources of uncertainty", please enumerate which ones. Line 117: "standard deviation associated with errors": which errors are you talking about here?

The main sources of errors in the stability of the sea level data record have been detailed in the introduction. They are attributed to short-term time-correlated errors, long-term time-correlated errors and offset between two successive reference missions. The sentence has been clarified in the updated document.

Line 120 Σ_{TP} should be Σ_{tp}

Corrected

Equations (and text), please put matrices in bold characters, especially Σ since it is used later as the summation symbol.

Corrected

Line 136 The equation there is given without describing each of its components, and what the components i of the correction are.

We have detailed each component of the equation and added a description.

Line 128: "relative errors observed during the two tandem phases". No information is given about these "relative errors", which errors and how are they estimated/calculated. Also, in line 134 it says "we can study the uncertainty of the 2-tandem phase method without having yet executed the second tandem phase" so the use of "observed" in the first sentence is a bit misleading.

- **We have merged sections 2 and 3, presenting a sequential explanation of each step of the methodology proposed to calculate the uncertainty of the 2-tandem phase method. This reorganization aims to facilitate a clearer understanding of the methodology.**
- **In section 2.2, we have added detailed information on the calculation of error covariance matrices based on the work of Ablain et al., 2019. We have clarified the construction of the covariance matrix during the second tandem phase**

Line 142: the choice of 1 degree in latitude and 3 degree in longitude has been used elsewhere, but some explanation about this choice should be provided.

The 1° latitude per 3° longitude choice has been made following recommendation by Henry et al. (2014) to optimise the effect of sea level variability observed by reference altimeter missions in the GMSL. A sentence to clarify this has been added to the manuscript.

Line 145. Explain the GMSL AVISO method briefly

The AVISO method have been detailed and added to Section 2.1.1

Line 154 (and figure 2). A 2-month periodic signal is mentioned in panel f. The attribution to POD is given without reasoning, and in fact POD uncertainties are part of the uncertainty budget you are trying to assess, so why removing it?

During the tandem phase, we observed a periodic signal in the GMSL differences between J3 and S6-MF. This signal, occurring over a two-month period, is attributed to differences in the Precise Orbit Determination (POD) calculations used for each satellite.

Recent research by Cadier et al. (submitted) has identified the source of this periodic signal as β' (beta-prime) dependencies within the CNES POD solution employed for S6MF. Their work demonstrates that using the JPL POD solution significantly reduces this 60-day error signal (see figure below from Cadier et al.).

While systematic GMSL differences arising from POD variations can occur during tandem phases, these discrepancies are typically resolved a few years after the tandem phase ends. This correction is achieved through adjustments to the POD calculations by POD experts, as has been the case for all tandem phases involving Topex/Poseidon, Jason-1, Jason-2, and Jason-3. Therefore, we consider the uncertainty due to POD discrepancies to be negligible in this study.

The paper offers now a more comprehensive justification for the aforementioned observation regarding the POD differences and the contribution of POD uncertainty.

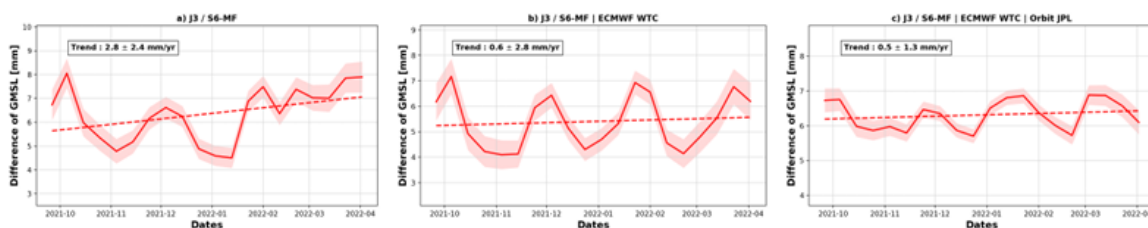


Fig. 26. GMSL differences between J3 and S6-MF LR NR over the side B tandem phase using the radiometer and CNES orbits (a), model and CNES orbits (b), model and JPL orbits (c)

Also, you say that the data without this 2-month signal is the dashed line in figure 2f, but for me this line shows a much more evident periodic signal. Further down the text it is mentioned that "the autocorrelation of each GMSL difference does not show an **obvious** time dependency", and that the "the GMSL differences are fully decorrelated beyond one month" which is expected since I guess this has been done after removing this 2-month signal?

The dashed line is the difference before removing the periodic signal. It has been clarified in the text and added on the figure caption. The autocorrelation plot has been done after removing the signal for Jason-3 and Sentinel-6A.

Line 176 "The standard deviation is assigned to the uncertainty budget for the 1-month correlated error (see Tab. 2), homogeneously to the global scale." Sentence not complete?

Corrected

line 193: 10.16 mm yr⁻¹ sounds huge

Corrected

Line 229: provide details about the uncertainty budgets and what are the maximum Δ_t and $\Delta_{x,y}$ used to compare 2 altimeters and an altimeter to tide gauge data

We do not think it is the aim of this paper to provide too much detail on the uncertainty budget of other comparison methods (we have already provided the uncertainty table). However, the text has been significantly improved and we also provide the typical figures for the time difference and spatial difference.

Line 246 You repeat that you are doing two additional methods (line 246-248)

Corrected

line 324 Incomplete reference (pages, journal?)

Corrected : we have provided the accessthe file: https://www.geomatlab.tuc.gr/fileadmin/users_data/geomatlab/international_review_workshop_2018/presentations/01_Monday/Session_01/06_S1_23_Ablain_et_al.pdf

Figure 1. Line blue is the "relative sea level drift" Again, I think this wording is confusing.

Corrected: it has been replaced by "Relative sea level differences drift"

Figure 2. central figures should have a reduced y-axis to see better the variability. Same for bottom panels.

Corrected

Indicate what the dashed line is in 2f.

Corrected

Figures 3, 4 and 5: the symbols are quite small and difficult to tell apart (especially in figures 3 and 4). The legend contains "uncertainty at 68%" but it is not shown in the figures. The vertical and horizontal lines within the figures seem to be added rather randomly, and in figure 4 there is an extra vertical dashed line that is not explained

Corrected

The symbols have been enlarged. The “uncertainty at 68%” is to give information on the uncertainty plotted in the figure. The vertical and horizontal lines are the grid of the plot, they have been removed for clarity in figure 3 and 4. The extra vertical dashed line is the adopted scenario for the second tandem phase and is mentioned in the legend. The colour is set to blue to better distinguish it.