Authors' Response to Reviewer 4

General Comment.

The authors offer a new perspective on regional sea level budget (SLB) closure by focusing on two machine learning (ML) algorithms. They show how self organizing maps (SOM) and d-MAPS allow to identify spatially coherent regions and (i) close the SLB in most of those regions and (ii) further reduce the uncertainties otherwise present when using the gridded data alone. Importantly, by focusing on two ML tools they are able to demonstrate the robustness of their conclusions under the models architecture considered. This is a good, well written paper and it further demonstrate the benefit of focusing on coherent patterns rather than gridded data. I recommend publication after some minor revisions.

Response:

Dear Reviewer,

Thank you for your feedback and positive review. We have addressed all the issues item by item as follows.

Kind regards,

Carolina Camargo, on behalf of the authors

Comment 1

Section 2.1. Is terrestrial water storage included in the sea level budget? If not, can the authors give an explanation on why it was not considered?

Response: Yes, the terrestrial water storage is included in the sea-level budget, in the GRD component. We added a sentence to Section 2.1 to clarify which terms are included in the GRD component:

For the GRD component, we use the estimates from Camargo et al. (2022), which includes the geocentric sea level response to changes on the Antarctic and Greenland ice sheets, glaciers and terrestrial water storage.

Comment 2

Figure 1. In a recent paper, Wang et al. (2021) closed the sea level budget at tide gauges locations. In Figure 1 of Wang et al. (2021), the authors show different components of sea level (SL) ranging from stereodynamic SL to GIA, Glaciers etc. Can the authors explain possible differences between their Figure 1 and the one in Wang et al. (2021). In any case the authors should at least cite that work.

Response: Thank you for your comment. The first and main difference between our estimates and the ones from Wang et al. (2021) is the time period: Figure 1 of Wang et al. (2021) shows trends from 1958-2015, and our Figure 1 from 1993-2016. This will result in different global mean trends and patterns shown in the figures. For example, their sterodynamic trend has a global mean trend of 0.7 mm/yr, while we have 1.55 mm/yr for the steric component. Another difference is in the data sets they use for their estimates, for example they use the average of three global mean thermosteric data sets, while we use the ensemble mean of fifteen regional steric data sets (including both the salinity and temperature effects). Finally, their barystatic-GRD fingerprints show relative sea-level change, since they are comparing it with tide gauges, while we use absolute sea-level change fingerprints. Nevertheless, we agree that the work of Wang et al. (2021) should be acknowledged in our manuscript. We have added a reference to their work in the introduction:

The sea-level budget has also been analysed for individual coastline stretches characterized by coherent variability (Dangendorf et al., 2021; Frederikse et al., 2016; Frederikse et al., 2017; Rietbroek et al., 2016), and at individual tide gauges (Wang et al., 2021).

Comment 3

It would be clearer if SOM and d-Maps are introduced in two different subsections or paragraphs (Section 2.3.1 and 2.3.2)

Response: Thank you for your suggestion. We added subsections to the paragraphs introducing SOM and d-Maps.

Comment 4

I understand that in both SOM and d-Maps, domains are identified after removing the seasonal cycle and trends. This is reasonable. It is my understanding though that after the domain identification step, the time series considered in each domain are averaged time series with seasonality and trends included. Is this correct? This should be clearly stated in the manuscript and it is missing at the moment (my bad in case I missed it).

Response: Indeed, after the domain identification, for the budget analysis the time series include seasonality and trends. To clarify it, we added this information in Section 2.3:

We pre-process the input data by removing the global mean trend, seasonality and by applying a spatial Gaussian filter of 300km half-width to remove small scale variability. Note that, after the domains identification, for the budget analysis, global mean trend, seasonality and small scale variability are included in the time series.

and also in Section 2.2:

Note that, unlike for the identification of the domains (Section 2.3), the time series used to estimate trends and uncertainties include seasonality and global mean trends.

Comment 5

Section 4.1. The budget is closed in 77/92 d-Maps domains. I wonder if the remaining 15 domains where the budget is not closed are mainly found in the Southern Ocean. In that region I see lots of very small regions which could be just noise. If that is the case I suggest the author to add this in the paper.

Response: Not all of those regions are in the Southern Ocean, as shown in the Figure below. Most of them are small regions, in which probably the non-closure of the budget is related to noise. Other regions might be due to the dynamic influence (e.g., in the Malvinas Confluence zone), or because they are regions covering continental shelves and close to the coast. We have added this information to Section 5.

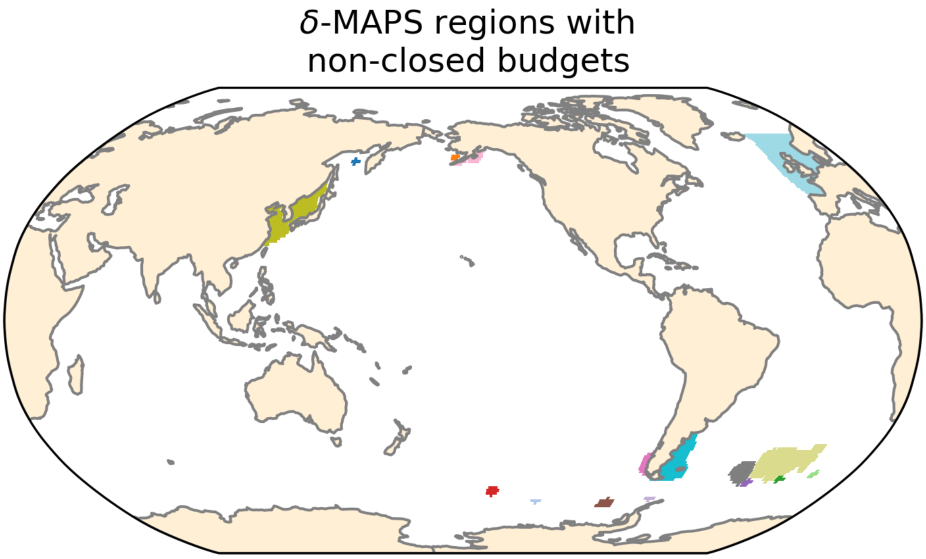

Figure 1: δ-MAPS regions in which the sea-level budget is not closed.

Comment 6

Figure 4. "Sea level budget trends (mm/yr) for (a) d-MAPS ad (b) SOM" I think it should be the opposite: Sea level budget trends (mm/yr) for (a) SOM and (b) d-MAPS.

Response: Thank you for pointing this out, indeed it should be (a) for SOM and (b) for d-MAPS. We have corrected it accordingly.

References

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