RESPONSES TO THE REVIEWERS

I. Responses to Reviewer 1 (in italics)

Review for: “Regional sea level budget over 2004-2022” by Marie Bouih, Anne Barnoud, Chunxue Yang, Andrea Storto, Alejandro Blazquez, William Llovel, Robin Fraudeau and Anny Cazenave (https://doi.org/10.5194/egusphere-2024-3945).

The paper and the figures have been significantly improved. However, additional adjustments could further improve the overall quality. The authors may wish to consider the following comments:

- Even though the estimation of trend uncertainties is not in the focus of this paper, the uncertainties are still crucial for the interpretation of the residual trends. Do you include formal fit errors in your trend estimats? For Figures 5 and 6, one could assume that the uncertainty of the CIGAR reanalysis is similar to the uncertainty of the whole ensemble and add this information to the corresponding plots.

Response

- As explained in the text (lines 344-346 of the previous revised version, the uncertainties of the residuals are based on the square root of the sum of squares of errors of each component. Uncertainties of altimetry is based on Prandi et al. (2021) while for the steric and manometric components, they are based on the dispersion of different products around their mean? This is also explained in the text (page 12 of the previous revised version).

- For CIGAR, we prefer not use the uncertainty of the whole ensemble because this may not be appropriate for a single reanalysis.

- Subsection 4 is a bit confusing and may need a revision. For comparisons between GRACE and altimetry, the GRACE data is commonly transferred to the centre of figure (e.g. https://doi.org/10.1029/2004GL020461). You question whether the altimeter data are actually given in the centre of figure and conclude that they appear to be. You also mention possible inconsistencies in the modelling of polar motion in GRACE and altimetry data. Could you add a few sentences to explain the possible inconsistencies in more detail?

Response

We agree with Reviewer 1 that the text was not clear enough. We replace the previous text (lines 429 to 434 of the previous revised version) by the following:

“Let’s remind that GRACE data are classically corrected for the geocenter motion when compared with altimetry data, in order to moveing GRACE observations from the centre of mass to the centre of figure of the reference system, in which the altimetry-based sea level is supposed to be also expressed after correcting the satellite orbits for the geocenter motion (Alexandre Couhert, personal communication).”

- The largest regional trend residuals occur in the North Atlantic, and the authors suggest that a spurious drift in the salinity measurements after 2015 may be responsible. This conclusion is not very well supported. Figure 7c shows that there is a residual drift throughout the whole time series rather than a drift starting in 2015. This should be discussed further.

Response

We also agree with Reviewer 1 that in Figure 7c, the residual time series presents a positive trend over almost the whole period (same for Figure 7d). But there is a clear shift as of 2015 that may be linked to the negative trend in the halosteric component (Figure 7a). We modified the text accordingly.

Specific comments:

Lines 143-145: Since the barystatic component is related to mass changes on land, the water should not be distributed evenly but according to the fingerprint-pattern. However, these are very small numbers.

Response

Text has been clarified

Lines 383-386 & lines 395-397: Now you mention signal of the large earthquakes I the GRACE mascons twice.

Response

Text has been clarified

Lines 429-430: Check sentence: The results confirm the referential of altimetry ?

Response

Text has been clarified (see above response to the general comment)

Lines 512-513/545: In fact, the residual trend patterns are similar, even though the manometric components do not agree. The dominant feature seems to be differences between the total and steric components that cannot be compensated by the rather small manometric component.

Response

We agree with the Reviewer's comment

Lines 561/562: wouldn't the circulation estimate be shifted due to the spurious salinity values?

Response

A sentence has been added

Supplement:

- Figure S1: could be improved by using same colorbar for trends as in figures 1 - 6, and the same color bar for all uncertainty-subplots

Response

We did that on purpose. Using the same color bar for all maps will lead to unreadable figures (some will be too flat, and for others, colors will be saturated)

- Figure S2, Table S1: It is difficult to relate the low degree spherical harmonics to the actual physical drivers. Do different versions of the low degree terms give different results?

Response

We are unsure about what Reviewer 1 means by "different versions of low degree terms" (different combinations? different mask?). Some physical drivers (geocenter motion, polar motion, GIA) particularly impact specific degrees. However, looking at the sea level budget residuals, i.e. at all sea level components, we are restricted to the oceanic domain and not the whole Earth, making this link less straightforward. The

use of low degrees here is meant to help identifying potential sources of spurious signals in the sea level budget residuals, hence we used combinations showing the impact of each degree on the residuals.

II. Responses to Reviewer 2 (in italics)

The authors have satisfactorily addressed the issues raised in my original review and I am happy to recommend publication at this point. There are a few minor typos that I have tried to list below. I also follow up on two previously raised points, for the consideration of the authors when creating a final version of the manuscript.

67/ My original comment on lines 66-70 did not request treatment of seasonal cycle budgets in the paper, as implied by the authors' response, but basically wanted to highlight the issue of equating "sea level budgets" with "sea level trend budgets". This issue is apparent all over the manuscript, starting with the title, which in my view would be clearer if it read "Regional sea level trend budgets over 2004-2022". The addition of "Focusing on trends" at the beginning of the revised paragraph on line 67 does address part of the issue, but I would suggest that the authors explicitly state somewhere that reference to "sea level budget" in the manuscript means specifically "trend budgets", or else use the latter expression where appropriate (especially in section titles).

Response
We added 'trend' everywhere in the manuscript

81/ "ocean basin-scales" or "the ocean basin-scale"

Response
Corrected

92/ "at the ocean basin-scale or smaller.

Response
Corrected

202/ "estimated to be"

Response
Corrected

278/ "steric effect from the"

Response
Corrected

335/ State explicitly what "dispersion" is and how it is calculated.

Response
We modified the text for clarity

415/ "in order to move"

Response
Corrected

545-546/ "similar. Figure 5 shows manometric

Response
Corrected

617-619/ As in my original comment, if we look at figure 7d, the residual is significantly different from zero. Thus, if I am reading figure 7d correctly, I think this sentence is somewhat misleading and would be better rephrased. If the authors wanted to go a little further, what I find interesting is that while the residual in figure 7d is mostly flat up until around 2015, it trends upward substantially after 2015, in fact

similar to what happens in the North Atlantic (figure 7c). Thus, the analyses suggest similar relevant issues with the regional trend budgets outside the North Atlantic, although only noticeable when multi-basin averages are used as in figure 7d.

Response
We modified the text as follows:
"Figure 7 well confirms the non-closure of the budget over the North Atlantic Ocean, with a significant positive residual trend, whereas in the remaining oceanic domain, no significant residual trend is noticed. Figure 7 (panel a) suggests that the North Atlantic residual trend is related to the observed decrease of the halosteric component as of 2015 of the North Atlantic."