

Manuscript « Regional sea level budget over 2004-2022 »

Responses to the Reviewer 2 Comments (*in italics*)

30 March 2025

II. Reviewer 2

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 authors investigate the regional closure of 20-year sea level trend budget based on altimetry (total), ARGO (steric), GRACE/Reanalysis (manometric) sea level datasets and GRD fingerprints. The paper focuses on the differences between various manometric datasets. It examines the influence of the GRACE processing on the regional sea level budget and emphasises the need to apply the geocenter correction. The largest regional trend discrepancies occur in the North Atlantic, and the authors suggest that a spurious drift in the salinity measurements may be responsible.

The paper deals with a relevant topic and is well written. The introduction provides a good overview of the topic and cites the relevant literature. Equations could help to make it easier to find out which components were taken into account for which data sets to calculate the residual trends. The figures are clear and informative, however, some of them seem to be in the paper twice. If possible, the datasets and the corresponding versions should be cited unambiguously (e.g. doi for altimetry).

Unfortunately, none of the manometric components studies provides a sufficient closure of the regional trend budget. Possible causes for the differences between the datasets should be discussed in more detail. A discussion of the uncertainties of the trend estimates is missing for all data sets. With regard to the North Atlantic, the explanation for not closing the trend budget should be better justified. The figures suggest rather decadal variability between the gyres than consistent long-term drifts in the entire area.

Response

We have added maps of trend uncertainties for the sea level data, components and residuals, and now focus on the regions where the residual signal is above the noise.

We also performed an EOF analysis of the gridded residual time series (the corresponding figure has been added in the SI). It is reproduced below (using GRACE SH solution for the manometric component):

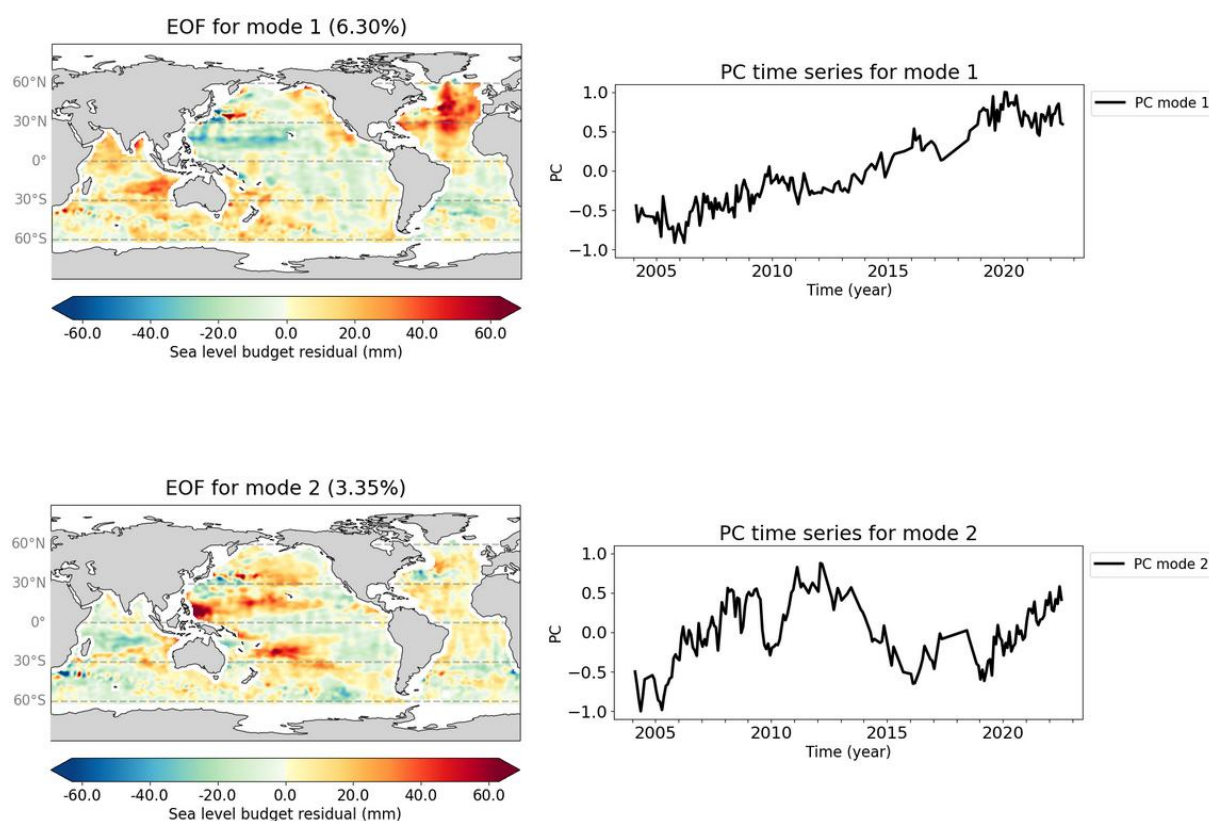


Figure S3: Modes 1 and 2 of the EOF decomposition over 2004-2022 of the gridded residual time series (with the GRACE SH manometric component). The left panels are the spatial maps while the right panels are the associated principal components (PC).

Mode 1 is dominated by a strong residual trend in the North Atlantic. Its spatial map is very similar to the residual map. Mode 2 shows a low frequency oscillation of period around 11 years on which are superimposed shorter fluctuations related to ENSO.

Specific comments:

Lines 78-92:

The usage of the expressions regional, basin-scale, sub-basin scale and local scale is confusing and could even be inconsistent

Response

These terms were introduced to distinguish between the different spatial scales

Lines 141-143: Shouldn't the barystatic component distribute according to the GRD fingerprints?

Response

The barystatic term is spatially quasi uniform. It was removed for the regional budget assessment.

Line 180: Could you provide numbers for the small regional GIA & contemporary GRD trends?

Response

Added

Line 190-200: Please specify the data version (doi?). Some of the given information is abundant since it is not used (Topex side A drift, total sea level uncertainties)

Response

Added

Lines 217: Could you provide numbers for the regional deep steric contributions?

Response

Added

Lines 265-: Could you specify the differences between the manometric data from ocean reanalysis? What is the uncertainty and why did you choose these models?

Response

Added

Line 271: Are all reanalyses based on ARGO data? Is it known how the salinity drift is handled in the individual reanalyses?

Response

This is indeed a key issue. We added the following text:

“One may wonder whether the salinity drift observed in some Argo floats as of 2015 is impacting the CIGAR reanalysis since, unlike altimetry data, T/S data are assimilated during the reanalysis integration, thus non-linearly interacting with dynamical processes. The treatment of the salinity drift simply consisted in rejecting data that Argo had flagged for rejection in the delayed mode. But this may not fully guarantee that all bad salinity data have been discarded. However, to compute the reanalysis-

based manometric component, the local steric contribution is removed. Thus any effect of the Argo salinity drift should be minimized.”

Lines 304-305: Figure 1 suggests that the spatial filtering of altimetry and mascon datasets is not consistent.

Response

The same filtering is indeed applied. However due to the lower resolution of GRACE data compared to altimetry, the GRACE-based manometric map looks smoother.

Lines 306-308: Are there systematic differences between the trends for these two periods?

Response

No there are no significant trend differences. But adding 3 years is interesting since it shows that the trends do not change, hence do not reflect short term fluctuations.

Figure 2: Is there a difference to figure 1b and 1e?

Response

Figure 2 has been deleted since it was redundant with Figure 1

Line 340-345, Couldn't there be problems with the degree 2 terms of the GRACE-processing as well?

Response

There is a consensus within the GRACE community to use such values.

Lines 370-390: I would suspect that the ARGO-data, as well as the ocean reanalysis, are referenced to the centre of figure. Even though the altimeter orbits were calculated relative to the centre of mass they may have been transferred to the centre of figure somewhere on their way to the level 4 Copernicus sea level grids.

Response

Normally, all data are expressed in the center of figure reference frame but for the altimetry data, the way the geocenter correction is performed may still be an issue (Alexandre Couhert, personal communication)

Figure 4: Trends differ quite a lot. What is the uncertainty of individual trend estimates?

Response

There is no information on individual reanalysis uncertainty. Only dispersion around the ensemble mean can be estimated.

Line 458: You decide to focus on the CIGAR model, but the results for CIGAR are not included in Table 2.

Response

This has been added

Lines 511-515: The halosteric component seems to be on the decline after 2015/2016 and to be anticorrelated with the thermosteric component. You might want to consider the budget for the subtropical and the subpolar gyre separately.

Response

We leave this for a future work that will focus on the North Atlantic

Why should the effects of a spurious drift in salinity measurements only be effective in the North Atlantic?

Response

Because it is in this region that most instrumental drifts have been detected

Figure 9: If you suspect that the PC1/EOF1 of the halosteric signal is dominated by the North Atlantic signal, why do you perform a global EOF-analysis?

Response

The figure has been deleted
