Reply to Review of egusphere-2024-3200 from Anonymous Referee #2

We thank the anonymous referee #2 for the review. In the following, we respond to the comments in a point-to-point manner and the original comments from the reviewer are italicized and in blue fonts.

The paper by Yuan et al. presents the next step of the GIA modelling setup using CitcomS. While the method has been published previously (SLE solver in Zhong et al. and compressibility in A et al.), here they present a benchmark of the two combinations. The paper summarizes the applied methods very well. However, I felt sometimes a bit lost in the paper as you introduce a method/set-up and then something else is mentioned afterwards. You come back to the method/set-up at a later point. I would suggest splitting the paper in two parts: 1) introducing and benchmarking your model to simple harmonic loads (where no SLE is involved), and 2) the benchmark with the SLE and the ICE-6G_D ice model, which means that you introduce the SLE part after you have presented the first benchmark.

The SLE solver presented here has some important differences compared to that published previously (Zhong et al., 2022), see section 2.3 and lines 260-264. The sea level equation is an important part of CitcomSVE-3.0, and we think it is proper to describe it in the method section. However, we follow the suggestion to put section 3.2.1 into the supplement, making the paper easier to read.

A few other things could be done to convince the reader that your GIA modelling setup works:

- *Show a comparison of the geoid change in the benchmark with the SLE and ICE-6G_D.*
- *Compare your radial and horizontal displacement rates as well as geoid and RSL rates to the results by Peltier et al. (which you can find on his website).*

In this revision, we add the benchmark results for geoid change in both Table 3 and Fig. 3; see those in the revised manuscript.

In this paper, we compare the results from CitcomSVE-3.0 to our semi-analytical solutions because we can ensure that all the mathematical formulations used to define the GIA problem are essentially the same for those two codes. However, those formulations used by us are not exactly the same as those used in Peltier et al., 2015, for example, the formulations for polar wander and SLE. Although the slight differences in formulations may be insignificant for modeling results, it is not ideal to compare results from different formulations for benchmark purposes. So we did not compare our results with those of Peltier et al. However, we would like to point out that our RSL results for many different sites are in excellent agreement with those computed by Glenn Milne who is one of our collaborators for another project.

Minor comments:

L.73 - Huang et al. is not a coupled spectral-finite element method as it is purely based on the finite-element method. In addition, the method by Wu is also based on the finite-element method and only the potential calculations are done in the spherical harmonic domain. Not sure, if this should be then called coupled spectral-FE method. If I understand you correctly, you are doing the same by "coupling" the spherical harmonic domain with the FE method.

We revised this and put Huang et al. 2023 and Wu 2004 into the FE method group.

L.77 - "center of mass".

We corrected it.

L.144 - You mention that the Lamé parameters and viscosity can vary laterally and radially. Is this also true for the density? I couldn't find such a statement.

The density is horizontally homogeneous. We made it clear in line 124.

L.183 - "the applied potential, which is only relevant"

We revised this sentence in line 192.

L.185 - "on the unknown incremental"

We corrected it.

L.195-202 - Please move this paragraph somewhere else. It doesn't fit here.

We move this paragraph into lines 89-96.

L.212 - What "given threshold error tolerance" is implemented in CitcomSVE 2.1 & 3.0?

The tolerance is specified in the input file for CitcomSVE. In this work, we use 0.3%. We made it clear in line 213.

L.301 - Interesting approach. Please write it out in an equation how O(t) is calculated.

We add a section in the supplementary text to describe further our approach for calculating $O(t)$.

L.324 - Why do use the density and Lamé parameters from the mantle for the crust?

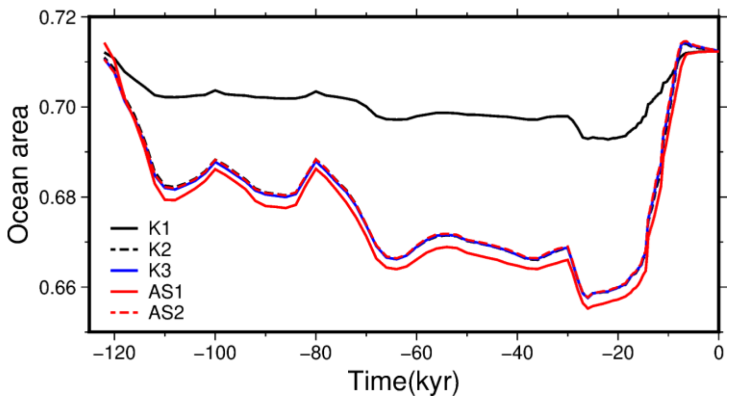
It will make benchmarks easier by having simple models that can be accurately represented by both analytical and numerical codes, to avoid the differences in results caused by model differences. The crustal layer in PREM is thin, and its density and Lamé parameters change rapidly in depth, which makes it difficult to be captured by numerical models, especially for low-resolution models. We have tested it with analytical code and found that this change of properties for this thin crustal layer does not affect the results significantly. For those reasons, we ignored this thin layer and treated it as the mantle material right below it for benchmark purpose.

Section 3.2.1 - You refer only to figures in the supplement. Either move the text to the supplement and summarize the results in the main article or move figures from the supplement to the main manuscript. I would prefer the former.

We adopted the suggestion and put this section into the supplement.

Section 3.2.1 - Just out of curisosity: Could you please plot K2 in Fig. S1 as well? So, the results of the 2nd iteration based on the approach by Kendall et al. No need to do this for the other figures.

We added K2 into Fig. S1. Note that K2, K3 and AS2 almost overlap with each other.



L.419 - In the abstract you say ICE-6G_D, but here it is ICE-6G now. Please use the same and correct abbreviations throughout the text.

We changed it to ICE-6G_D throughout the paper.

L.546 - Please use more representative names for your model types, e.g. GIA_R1 could be GIA_135 to indicate that this model has a resolution of 135 km and the reader doesn't have to go back and check what R1 was referring to.

Although model resolutions for R1, R2, and R3 were described here within a paragraph, it is easier to find the model resolutions from Table 3, which contains information about horizontal, vertical, and time resolutions for all models. Since those models (R1, R2, R3...) also differ in vertical resolution, we are afraid that using GIA_135 as the name may mislead readers to think that the vertical resolutions are same for those models. Since we only have three different spatial resolutions (R1, R2, and R3), and they are ordered with increasing resolution, this naming convention makes it clear that R1 has the lowest spatial resolution, whereas R3 has the highest spatial resolution. Considering those reasons, we prefer this kind of naming convention.

Table 3 - I find it difficult to compare the CPU hours when you use different amounts of cores. Please unify this to see the direct difference.

We added a new row as core-hours (i.e., "number of CPUs" multiples runtime) in Table 3.

Fig.S2/S3 - Use the same abbreviations for both figures.

We modified the legend in Fig. S3 to make the abbreviations consistent with other figures.

Figures – Copernicus recommends the authors to use colorblind-friendly colors/colormaps, which is stated on the GMD website (https://www.geoscientific-model-development.net/submission.html#figurestables). This includes avoiding the parallel usage of red and green as well as the avoiding jet and rainbow colormaps. The link above provides examples where you can find suitable colormaps and find colors for your line plots that are suitable.

Thanks for pointing out the colormap issues. We modified Fig. 1 and Fig.4 to avoid the parallel usage of red and green, and modified Fig. 3 and Fig. 5 for another colormap.