Our manuscript titled "The geometry of sea-level change across a mid-Pliocene glacial cycle" received two largely positive reviews that listed several suggestions for improvement. In the material below, we respond to the second comment. The reviewer comments appear in blue, and our responses are in black, with text quoted from the manuscript indented.

Reviewer #2 (Anonymous):

Thank you for the insight on our manuscript, our response to the following comments will be in bold.

In this manuscript, the Authors set up a GIA model for the deglaciation during the Mid-Pliocene Warm Period in order to explore the fingerprints of sea level change and, more specifically, their regional deviations from GMSL. In my opinion, this is an original and interesting contribution, the approach is technically sound and the manuscript is very well written, so I definitely support its publication. I have just a few comments for the Authors, which I hope will be useful to further improve the manuscript.

We thank the reviewer for these positive comments and their constructive review.

Lines 100-110: The definition of GMSL is a key point for this analysis, as the Authors remark in the paper. The definition that is adopted here (GMSLp) essentially takes into account only the ocean volume change in regions which were not covered by grounded ice at the beginning of the melt, in contrast with the more standard definition (GMSLs) which takes into account all the meltwater input. I think that it would be useful to better discuss the implications of the two definitions, and why GMSLp is the best choice for the present analysis.

We agree that our manuscript does not sufficiently motivate our adoption of the global mean sea level definition $GMSL_P$ – over other possible choices - in the normalization of the sea level calculations and we will revise the manuscript to address this issue. There are several important points to make in this regard:

- As long as a fully gravitationally self-consistent sea level theory is adopted (e.g., Kendall et al., 2005) the choice of GMSL definition will not impact the patterns evident in Fig. 4, only the numbers associated with the scale bar on that figure. Thus, the main aim of the paper – to explore "geometries of sea-level change" remains robust.
- However, in considering how geological observations at some sites relate to GMSL, the definition adopted for GMSL matters.
- Why do we believe that $GMSL_P$ is the most appropriate definition? In some sense, the strongest argument for this choice is evident in Fig. 4, where all the normalized sea level predictions lie very close to unity (1.0) on the equator. That is, in the far field of ice sheets one would expect that calculations over a long time window (in our case, from 3.295 Ma to 3.155 Ma) should be close to the global mean. This argument accords with the results in Pan et al. (2021) who showed that the outflux of water from exposed marine based sectors – which is included in the definition of $GMSL_P$ - tends to compensate for ice age (deformational and gravitational) dynamics. We can put this another way. If we had instead

adopted $GMSL_S$ as our definition then, for example, the normalized plot for the West Antarctic scenario in Fig. 4 would have a value close to 0.6 ($GMSL_P/GMSL_S = 2.74/4.87$).

- In the revised manuscript we will justify our choice of $GMSL_P$ more fully. In addition, we will add to the Discussion section a sub-section in which we more carefully compare this choice with other possible definitions for global mean sea level, including not only $GMSL_S$ (which uniformly spreads total ice volume change over the global oceans) but also a definition based on uniformly spreading ice above floatation at 3.295 Ma over the ocean.

Lines 169-171: Do the ice sheets have a constant thickness and a variable area?

The ice sheets do not have a constant thickness. As per the model output from Berends et al. (2019) the ice sheets are tied to modeled Pliocene topography, and therefore have varying thicknesses and geographic extents through the MIS M2 to KM3 period. This can be seen in Fig. 3 where the ice geometries show both variable geographic extents (that contour to the continent and change as ice melts) as well as variable thicknesses across the ice sheet extent (most notable in the marine-based sectors).

Lines 226-231: How the 24 models are generated? The lithospheric thickness and UM/LM viscosities are randomly sampled in the given ranges or the ranges are scanned uniformly for each of the three parameters?

The 24 models were combinations of the following lithospheric thicknesses (72, 96 and 125 km), and upper (0.2, 0.5 and 0.8 Pa s) lower mantle viscosities (5, 10, and 20 Pa s). Three models with lithospheric thickness of 96 km and upper mantle viscosity of 0.8 Pa s were not included. All earth models are within the range of models inferred from studies of GIA datasets (Mitrovica and Forte, 2004; Lambeck et al., 2014). We will update the text to include this and add the three model runs that were not included.

Lines 291-297: it is not clear how the melt scenarios shown in Fig 7 are identified; a few more details would be useful to fully understand this analysis.

We agree with the reviewer that the rationale for these melt scenarios is vague. These five scenarios were chosen to represent (a) commonly accepted sources of Pliocene ice sheet melt, as well as (b) scenarios that encompass melt from only the Northern Hemisphere ice sheets, (c) ice sheet contributions excluding East Antarctica (b and d), and (e) a scenario that includes melt from all ice sheets. We will update the text to reflect this explanation, but we will also emphasize that these choices were simply chosen to highlight possible departures of site-specific observations from global mean sea level.

Line 139: perhaps “3.89” should be “2.89”?

This will be corrected.

Lines 165-168 (and elsewhere): values of $\delta^{18}O$ are sometimes given without units and sometimes with units of ‰; the notation should be made uniform.

This will be corrected.

Figures 4 and 6: the three dots marking the positions of the sites discussed in the text are barely visible; I suggest using a larger and/or different symbol. Also, it could be useful to add in one of panels of Fig 4 three labels to help the reader identify the three locations.

This will be corrected.

Figure 5: the black circle in the box-and-whisker plot is hardly visible, also in this case I suggest using a larger/different symbol. Also the black line corresponding to the median is hard to see in the case of Enewetak Atoll.

This will be corrected.