

Reply to comments by anonymous referee #2

We would like to thank anonymous referee #2 for his/her time and effort in reviewing our manuscript (cp-2020-05). The comments raised in the review are highly appreciated and have helped us to further improve our manuscript. In the following, we respond to comments raised in the review.

GENERAL COMMENTS

1. The title seems to be not so consistent with the introduction. From the title, I think the changes in orbit forcing and PlioMIP's boundary conditions are all the main topic, even the orbit forcing (basically orbit forcing is one of the PlioMIP's boundary conditions) is more important. However, from the introduction, only the last 5 lines (line 27-31 in page 3) you mention the orbit forcing. And you only did one orbit forcing experiment, that gives me a feeling whether it's necessary to put the orbit forcing in this paper. Maybe only analyzing the impact of the changes in PlioMIP's boundary conditions to mid-Pliocene climate could be better.

The scope of this paper extends beyond comparing PlioMIP1&2 simulations, as we took the initiative to compare with another orbit which is not specified within the framework of PlioMIP. Hence, we show that a change of orbit can impact the results of PlioMIP2. We believe that the results on the alternative orbit, that provides a regionally and seasonally warmer but equally plausible climate in the context of the mid-Pliocene, are valuable additions to our contribution to PlioMIP2. Consequently, we suggest to keep these as a part of the manuscript. In particular, we see that the North Atlantic Ocean is warmer in K1 than in KM5c, and we aim at testing to which extent the model-data agreement is influenced by the choice of the orbit. Hence, we propose that the sensitivity study based on one specific warmer orbit highlights the temperature variability across the mid-Pliocene, and potentially may be a starting point towards future model-data comparisons that are based on other time-slices than KM5c. We agree that the introduction section might not convey this information concisely, so we have elaborated more on the orbital forcing in the introduction section.

2. Additionally, I think precipitation and temperature are two basic climate variables. Adding some analysis of the precipitation could be better.

The main idea going into this study was to infer the major driver of the mid-Pliocene warmth, hence the sensitivity studies by changing different boundary conditions and analyzing SAT and SST. According to suggestions of both reviewers, we have added some precipitation analyses showing the difference between PlioMIP1 and PlioMIP2 core simulations in supplement 1.

SPECIFIC COMMENTS

1. Page 2, line 25: delete "and the Pleistocene-Pliocene". You only study the mid-Pliocene period, never investigate anything during the Pleistocene-Pliocene period.

~~Pleistocene-Pliocene~~ deleted.

2. Page 5, line 6-8: the sentence "that is useful.....that is based.....", there are two "that is".

We have reformulated the sentence.

From

Thus, the KM5c time-slice has been selected, partly on the basis of strong similarity of the orbit at that time to the modern orbital configuration, that is useful towards interpreting paleoenvironments in the context of future warming (Haywood et al., 2016) that is based on anthropogenic activity and will obviously be set in a near-modern orbital configuration.

To

Thus, the KM5c time-slice has been selected, partly on the basis of strong similarity of the orbit at that time to the modern orbital configuration. This is useful towards interpreting paleoenvironments in the context of future warming (Haywood et al., 2016) that is based on anthropogenic activity and will obviously be set in a near-modern orbital configuration.

3. Page 5, line 19-21: I think there are three major components, not four.

The ocean biogeochemistry model HAMOCC is an important component of the COSMOS. We agree that writing it in another sentence different from that which lists ECHAM, MPI-OM and JSBACH may confuse readers, so we have included it accordingly.

4. Consistency: the authors use “PI” instead of “pre-Industrial”, but not all. I think except the first one, the others all use PI could be better. In figure 2, 3, 4, 5 and the main body, the temperature’s unit is K; but in figure 6, 8, it is degree C. Maybe all use degree C could be better.

- We have changed all “pre-industrial” to “PI” except the first one.

- Temperature unit K has been changed to degree Celsius to ensure consistency.

5. Some paragraphs are really too long (e.g. the first paragraph in SAT, the third paragraph in discussion), it’s really hard for readers to follow (at least for me). I suggest the authors to divide those long paragraphs into two or three shorter paragraphs.

We agree that the paragraphs are too long and might be hard for readers to follow, we have re-arranged the result section to address the effect of the relative contribution of boundary conditions as outlined in the by RC1. Long paragraph have also been shortened to make it more comprehensible.

6. Page 17, line 27-29, the sentence “The difference in CO₂ between PlioMIP1 and PlioMIP2 simulations does not change the general impression of large scale mPWP climate patterns, but produces warmer oceans especially in high latitudes of the Northern Hemisphere” is not so clear. I don’t know which one produces the warmer oceans, the PlioMIP1 or PlioMIP2?

Modified to enable clarity.

“The difference in CO₂ between PlioMIP1 and PlioMIP2 simulations does not change the general impression of large scale mPWP climate patterns, but produces warmer oceans in PlioMIP2 especially in high latitudes of the Northern Hemisphere”

7. What's the "sea ice compactness" mean? In the results, the authors use "sea ice extent and compactness", but in the discussion, "sea ice extent and compactness" and "sea ice extent and thickness" are all used. Does that mean "compactness" equal to "thickness"?

The analyzed model variable is sea ice compactness. It is the fraction of sea ice cover to sea ice free ocean surface at any grid cell. We have changed "sea ice compactness" to the more widely used "sea ice concentration".

8. As a reader, I think the discussion is not so clear and logically organized.

In the discussion section, long paragraphs have either been shortened or splitted into more comprehensible paragraphs.

TECHNICAL CORRECTIONS

page 9, line 17, use "Hemisphere, we find" instead of "Hemisphere we find";

Fixed

page 11, line30, use "Figure 11f, h" instead of "Figure 11f and 11h";

Fixed

page 12, line 1, use "(see Figure 12b, d)" instead of "(Figure 12b and 12d";

Fixed

page 12, line 8, use "(compare Figure 12b, d, f, h with 11f)" instead of "(compare Figure 12b,d,f,h with 11f)";

Fixed

page 18, line 24, use " Salzmann et al., 2013), further" instead of " Salzmann et al., 2013),further".

Fixed

There are a lot these kind of mistakes, please check the whole paper carefully.

We thank the reviewer for pointing these mistakes out. The whole paper has been carefully checked and all the missing spaces, commas and brackets have been fixed.