

## ***Interactive comment on “Pliocene Model Intercomparison (PlioMIP) Phase 2: scientific objectives and experimental design” by A. M. Haywood et al.***

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Our thanks to Chris Brierley for his comments on the Discussion paper.

Forcing factorization:

1. Forcing factorization experiments are very valuable in determining the significance of individual boundary condition changes to the overall simulated climatic response. If these boundary conditions are reasonable representations of the Pliocene world in which we wish to model, and that has been our strategy, then they can provide invaluable insights to the drivers of Pliocene warmth.

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2. We recognise that modelling groups will have limited time and resources. That is why in PlioMIP2 we have adopted a system to prioritise experiments. Core experiments are essential followed by Tier 1 and then Tier 2. Tier 2 being a lower priority than Tier 1 and Tier 1 being a lower priority than the Core. Only the Core is essential, Tier 1 and Tier 2 experiments are optional. We have also provided two options for those groups who wish to understand more about the drivers of climatological responses in their Pliocene simulation through enabling a non-linear (requiring 8 experiments) or just linear factorization (which requires only 4 experiments). Both options are open and we would not expect groups wishing to carry out both the non-linear as well as linear factorization.

3. The forcing factorization experiments may also be helpful to underpin emerging ideas for the second phase of the Pliocene Ice Sheet Model Intercomparison Project that may focus on driver for the intensification of Northern Hemisphere Glaciation.

Topography:

1. The reviewer is correct. There will be an equivalent paper to Dowsett et al. 2010 outlining the PRISM4 reconstruction in full. This intended to be published in Stratigraphy as Dowsett et al. 2010. We do not attempt to provide a full boundary condition description here and instead concentrate most on the description of the experimental design.

2. We agree that further clarification on the approach to forcing factorization experiments is needed and we will modify the text in Table 3 and provide a new figure in Supplementary material showing the conditions required over Antarctica and Greenland (areas where particular attention is required). This figure will be similar to Figure 3 presented in Lunt et al. (2012).

3. In terms of the approach to the land/sea mask a range of options is open to the modelling groups. They can implement the full suite of enhanced boundary conditions, the full suite of standard boundary conditions including required changes in gateways

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or if no changes to the land/sea mask are possible at all they can simply use their local modern land/sea mask adding changes in Pliocene topography (using the anomaly method). We do not impose which solution groups adopt and it will depend on the complexities of their models, time and resources. The key step is that each participating group documents their approach in their own paper in this special issue (as in the GMD PlioMIP Phase 1 special issue). Different approaches will facilitate an examination of the effect of different choices in terms of the land/sea mask, which is scientifically interesting in its own right.

Simulations:

Our thanks to the reviewer for his careful attention to the experiments proposed. We have looked at this again but with the changes listed below will still firmly believe that we have proposed the correct balance of experiments and that a significant re-organisation of our proposed experiments is unnecessary.

1. Regarding the quantity of simulations and what is optional and what is compulsory please refer to point 2 in the section on Factorization.
2. Yes if a group is intending to use the CMIP6 version of their model and run the Pliocene core simulation as a CMIP6 contribution the CMIP6 DECK experiments will also have to be performed by them or others within their group. Further details of the DECK experiments can be found in CMIP6 documentation. Our experimental design makes sure we have the essential runs to address the scientific questions we pose.
3. The choice of CO<sub>2</sub> sensitivity experiments (at 350 and 450 ppmv) is supported by the most recent reinterpretation of Boron isotope-based palaeo CO<sub>2</sub> estimates of Pliocene CO<sub>2</sub> variability (Gavin Foster personal communication to Alan Haywood, 2015).
4. First of all I would not take the past 4 past and past 4 future distinction in a very strict sense. It was a nice way to make a distinction between the different types of ex-

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periments proposed. Likewise the paper and indeed all of PlioMIP2 will not resolve the scientific and indeed somewhat philosophical debate surrounding the utility of palaeo to inform us about future climate change. Hopefully it can contribute though.

5. Regarding the experiments proposed under Pliocene4Future (P4F). We think there are two key questions under P4F and the experiments lean towards the exploration of Climate Sensitivity as well as model evaluation:

(a) Under model evaluation we have proposed a Pliocene 450 ppmv run but to make that objective crystal clear we should also add the Pliocene 350 run in P4F Tier 1 (model evaluation under plausible Pliocene CO2 scenarios).

(b) Climate sensitivity (emergent constraints and dependence of climate sensitivity to base state). James Annan's presentation on Pliocene climate sensitivity during the Past Earth Network Meeting this year demonstrates that the Pliocene is promising in terms of estimating Climate Sensitivity but is currently limited by the fact that the models did not have good CS calculations from the experiments performed. With the experiment proposed for PlioMIP2 we will be able to achieve more rigorous calculations of CS.

Looking again at the P4F science questions can be clarified by modifying the experiments in the P4F half to: Tier 1. Pliocene 350 and 450 (model evaluation) Tier 1 pre-industrial 560 (CS) Tier 2 Pliocene 280 and Pre-Industrial 400. (state dependence). With the core expts that will be enough to address question 2. The added advantage of this is that it reduces the number of runs needed overall by 1.

Line by line comments:

The comments in this section are very minor. But we will of course make the suggested small changes from this list that we feel are justified. One specific point does warrant particular mention is regarding the cross linking of the CP special issue with the PMIP4 special issue in GMD. Yes this remains a possibility and will be explored at both special

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issues develop.

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**CPD**

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