

## ***Interactive comment on “The PMIP4 contribution to CMIP6 – Part 4: Scientific objectives and experimental design of the PMIP4-CMIP6 Last Glacial Maximum experiments and PMIP4 sensitivity experiments” by Masa Kageyama et al.***

**Anonymous Referee #2**

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This is a clearly written and scientifically well motivated paper describing the numerical experiments designed to mimic the effect of the last glacial maximum (LGM) on the climate system as a contribution to CMIP4. Much of the paper, appropriately so, reads like a technical guide to performing the simulations. This seemed to have been well done, but a meaningful evaluation would require an attempted implementation of this guide, to actually perform the experiments. This is not something I was in a position to do, nor do I have experience in directly configuring a model to perform numerical experiments with this degree of modification to the model; hence my ability to substantially review this, the most important part of the paper, is limited. However this perspective

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motivates one of my comments below.

1. The scientific backdrop, in the form of the four questions that place the LGM experiments in the context of CMIP6 was developed well, but more specificity and follow through would have strengthened it. For instance, on the climate sensitivity question wouldn't it be helpful to draw out more specifically the important role of tropical sea-surface temperatures, both with respect to some controversial aspects of the reconstructions (cf. Annan and Hargreaves, 2015 Quat. Sci. Rev.) and their perceived potential to rule out particularly high values of ECS (eg. Stevens et al., 2016, Earths Future). Scientifically the manuscript would be stronger, and the subsequent analysis would be easier, if time was spent articulating a few specific hypotheses as to how the PMIP simulations might contribute to better bounding climate sensitivity, or informing estimates on the bounds of forcing. Coming back to the questions at the end of the manuscript would also unify the presentation.
2. Very much related to the above, the manuscript needs a more thoughtfully prepared and substantive conclusions. At the moment it leads with platitudes such as "The LGM ... provides a demanding test of model reliability..." or 'will create an unprecedented data set'. The first point is false, the second says nothing. The LGM might very well test a group's ability to create a model that is adaptable to our understanding of two different climate states, and be no measure of its fidelity to predict the state of the system where the answer is not known ahead of time. Concentrating more on the specifics of the questions raised in section 2, and the hypotheses that can be drawn from them would strengthen the manuscript.
3. Given the complexity of the experiments, some checkpoint mechanism should be included. My suggestion is that after configuring the land-seas masks groups should be asked to publish in their documentation, but also simply check, their clear sky upward shortwave, either from the runs themselves or from a control

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period of a year or so. Here I imagine that the LMD group provides netcdf output of annually averaged clearsky reflected shortwave radiation, and numbers for its value over ice-free ocean, and over land/land ice sheets. The numbers, and plots should be given in the manuscript in the form of a figure and a table, and the full 2D fields should be provided as netCDF files for groups to compare to. The clearsky reflected shortwave radiation is not everything, but it is a good first indicator of the properties of the ice-sheets and (over the ocean) of the strength of the dust forcing. Having these in the same ballpark is an important check on the plausibility of the experiments, and avoids the problem of groups unwittingly using a very different and less plausible forcing. I also suggest checkpointing the bathymetry (page 11).

4. I suspect experience will show that the description of the procedures is insufficient to perform the experiments. Here I think a procedure for collecting such experiences to improve the technical documentation for setting up and running the experiments would be beneficial. I could imagine that this be handled in the form of a forum, but ideally this would be in some way connected to the manuscript, and/or lead to a revised procedural description after these experiences have been collected. I encourage the authors and editor to work together on a way to incorporate this feedback in the PMIP documentation.
5. The manuscript/protocol should be more demanding of the documentation (§10). For modelling groups to be considered within PMIP the PMIP community should set some standards of documentation. Point 2 above is an example of such a possible standard, but there are certainly more. Indeed having some more synthetic measures included as tables in each groups documentation will be very helpful for subsequent meta studies. A clear minimum standard of documentation should be demanded for the participating groups to be considered for entry into the PMIP community.

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6. The figure quality is poor. Figure 1 does not even present the units of what is being plotted and the caption is not complete. In other figures the projection is changed for no apparent reason and in some cases (Fig 2) apparently sub optimal. For instance why not polar projections for Fig 2. Fig 5 needs improvement as it is difficult to use quantitatively, and some homogenization of color scales is required. Earth is distorted in its aspect ratio for no apparent reason in Fig 6. Finally having the terminator at 190 deg (or centering the maps at 10 E better separates Asia from North America.

Additional, somewhat more minor points include

- P4.L11: 'carbone' should be 'carbon'
- P10: In the discussion of ice sheets, I find it hard to imagine that it would be possible to ascertain the effect of the differences being discussed. Is there experience to suggest otherwise?
- P10: The first time the variables 'sftxx' are introduced it might be helpful to explain their naming convention so as to better fix them in the reader's head.
- P10.L5: Wouldn't it be helpful to give some numbers to compare to. For instance downward insolation in JJA in NH and SH separately.
- P12.L19: 'illustrating the impacts ...' should be 'illustrates the impacts ...'
- P13.L15: The apparent un-availability of the river routing makes it appear that the experimental description is not complete. These files need to be included and their main differences from the present noted before the manuscript is published.
- P16: Please explain the rfp naming convention, i.e., realization, forcing, initialization, physics?

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