

Interactive comment on “The importance of paleoclimate modelling for improving predictions of future climate change” by J. C. Hargreaves and J. D. Annan

M. Crucifix (Referee)

michel.crucifix@uclouvain.be

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1 Summary

The authors present four ensembles of experiments of at least 36 members each, covering pre-industrial, $\sqrt{2}$ times CO₂, mid-Holocene and LGM. All experiments are performed with the MIROC3.2 AGCM (slab ocean) but with different combinations of parameters. Linear correlations between different climate measures with climate sensitivity allow them to comment on the potential utility of PMIP-type experiments to constrain global and zonal future climate changes.

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2 Overall appreciation

The scope of the paper is well defined, the exposition is clear and conclusions are sound. This being said the approach is quite empirical : little effort is made to explain the results in terms of physical mechanisms. The authors have probably preferred to stay on clear statistical inferences, rather than speculate on climate mechanisms that could not be verified without an immense work of model output analysis. This choice is perfectly defensible.

The problem with this paper is that the statistical inference is a bit too rough. As the authors correctly appreciated statistical significance is the key in such studies, but they have here chosen to ignore that climate is correlated across zonal bands and months. As a consequence, the statistical significance of their results is overestimated.

Consider for example the positive correlation between D6ka precipitation over monsoon regions, with D2xCO₂ precip. In passing, let us observe that the strongest correlations occur during the winter months, that is outside the monsoon season. Precip in Asia is seen to be slightly “significant” over 5 months out of 12, distributed over winter and autumn. This seems much, but the probability of a “false positive” would probably not be negligible if the covariance structure of the ensemble across months was properly taken into account. A similar comment could be made for latitudes about the Figure 6.

3 Specific suggestions

Here are a few suggestions to get better value out of the huge work of experiment preparation, submission and post-processing delivered by the authors:

- Be more technical to assess the significance of the extra information brought by

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a palaeoclimate experiment. For example : page 2065 “In this case, we do also find significant correlation between the CTRL and DLGM temperatures, meaning here that we do not have evidence that the correlations are testing independent aspects of the model”. This is an interesting remark, but why not try to formalise this, by comparing two- and three-variate linear prediction models, and control whether LGM does improve the predictions of the 2xCO₂ response, for example by means of an information criteria like BIC?

- One way to mitigate the correlation structure across months and latitudes is to consider orthogonal or quasi-orthogonal response modes, like global mean, polar amplification, . . .
- The various figures do not make a very convincing case of the potential of mid-Holocene experiments to constrain the future climate response, except perhaps for temperature at high latitudes. Of course this is not easy to admit given the effort undertaken by the palaeoclimate community to reconstruct the climate of that time with models and data. The attempts by the authors to 'save' the mid-Holocene in the discussion section is legitimate and has value, but unless they make a more convincing statistic case the discussion might remain at odd with what actually appears in the figures.

I recommend a revision of the manuscript along those lines. Only a very small number of misprints were spotted and can be corrected at proof stage, and I have otherwise no specific editorial comment.

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