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Climate of the Past Discussions

Interactive comment on "Linking glacial and future climates through an ensemble of GCM simulations" *by* J. C. Hargreaves et al.

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The long-debated question of how to constrain climate sensitivity with palaeodata (especially LGM) was recently brought back to the scene since "ensemble of experiments" are available for statistical analyses. Hargreaves et al. have already nicely contributed to the question, and here is another useful, informative paper.

The question examined here is the correlation between LGM minus Present with 2xCO2 minus present temperature changes, at the regional and local scales. The authors calculate correlation coefficients between zonal mean and global temperature changes, or zonal mean LGM and zonal mean 2xCO2, something that neither MD06 nor Crucifix 2006 could do because they lacked a sufficient number of experiments.

The price paid here is, most likely, a lack of structural differences between the ensemble members, a point correctly emphasized by the authors, though.

The asymmetry (even in the regional details) LGMGHG vs CO2 is a particularly useful result. It supports Crucifix's conclusion about the non-linearity of the cloud response in the tropics. Note that Crucifix shows that 3 models (including MIROC) out of a sample of four cool less at the LGM than expected from the 2xCO2 experiment. MIROC3.2 may therefore not be anomalous, as the authors suspect.

It is also quite impressive to see how much the resulting ensemble is compatible with palaeoclimate data evidence (page 959). Considered together with Crucifix 2006, this point raises the question of the apparent difficulty to formulate climate models that frankly contradict LGM data. Any comment ?

About this, the authors claim that "the drier climate at the LGM resulted in a decreased water vapour feedback". There is certainly a decrease in water-vapour content, but it is not obvious how this reduces the strength and uncertainty on the cloud feedback, given that even the modern distribution of clouds is very imperfectly represented by state-of-the-art climate models.

If Figure 3 provided a robust estimate of the mean and uncertainty on the LGM / 2xCO2 temperature ratio, it would be possible to combine it to the LGM data uncertainty to estimate the confidence interval of climate sensitivity. It is up to the authors to see whether this step can reasonably be crossed, given that the lack of structural differences between the ensemble members probably leads to overestimate the correlation coefficient between LGM and CO2 temperature changes. Likewise, would a 0.6 correlation between LGM and CO2 temperature changes in Antarctica be sufficient to effectively constrain global warming ? The authors response is certainly positive, but it might be worth substantiating this point by rough ("first order") mathematical arguments.

Finally, it is not entirely clear why the authors produced three 40-member ensembles, rather than one big 120-member ensembles.

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After these comments, I am only left with a few editorial suggestions.

(1) Page 953 : "... especially when considered in combination with other lines of evidence..." : The authors should be more explicit

(2) Page 955 : give full meaning of "T2"

(3) Page 956 : "model error": This is probably what Annan and Hargreaves, QJRMS 2002, call "uncertainty on the model error", and what Rougier calls "discrepancy". It might be worth briefly clarifying this point for the audience of Climate of the Past.

(4) Page 958 : "similarly reasonable" : replace by "equally reasonable" (?)

Interactive comment on Clim. Past Discuss., 2, 951, 2006.