

## ***Interactive comment on “Glacial climate sensitivity to different states of the Atlantic Meridional Overturning Circulation: results from the IPSL model” by M. Kageyama et al.***

**Anonymous Referee #1**

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This is a well written paper on the changes in climate that are associated with a reduced/collapsed AMOC in a glacial background state. It is based on three simulations with the IPSL coupled AO-GCM (glacial control, reduced AMOC and collapsed AMOC) and contains excellent literature reviews on 1) paleodata showing millennial-scale variations that have been connected to AMOC abrupt events and 2) earlier modelling experiments, mostly with a modern or pre-industrial background state. Although the paper reads well, it suffers from a lack of focus and too much detail. I would suggest to concentrate on the climatic response to AMOC changes, to evaluate that response against data, which is not done (surprisingly) in the present manuscript, and to summarize where the present results from glacial experiments differ from earlier

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modern/pre-industrial experiments. The paper would improve considerably from these (mainly editorial) changes and would then be acceptable for publication in CP.

Main points of criticism

- 1) Lack of focus, too much detail. A few suggestions to improve this: Sections 3-6 describe the model response in very much detail. This could be condensed, let some Figures speak for themselves. Section 4.1 (Figs 8-10) could be summarized in a few sentences (no Figs). Only show the right-hand-sides of Figs 11-12, could even be combined in one Fig. Evaporation (Fig. 14) is the end result of many different processes in the coupled atmosphere-ocean system: not clear what we learn here. Section 6: it is distracting to discuss a feedback on the AMOC collapse here (why one only and not others?) – should go out.
- 2) An evaluation of the simulated large-scale patterns of response against available paleodata, which are already discussed in the introduction, is warranted in the conclusion section. Do the present results support the hypothesis that AMOC variations are the underlying cause of the millennial events seen in the data?
- 3) The authors motivate their present work partly from the lack of similar model experiments with a glacial background state. This is a good point. However, they do not discuss to what extent the present results differ from earlier results with a modern/pre-industrial background state (i.e. should we really do these experiments against a glacial state)? If the response is similar for glacial and modern states, that would be an interesting conclusion too. It should be possible to evaluate this, based on the published literature. There are some references missing with respect to pulse experiments conducted with a glacial background state (Bitz et al., 2007; Weber and Drijfhout, 2007; Hu et al., 2008).

Smaller points

- 1) Introduction: at many points it is stated that AMOC changes CAUSE climatic

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changes (stadials and interstadials) around the Atlantic and elsewhere. This is stated too strongly and I would avoid such (cause and effect) terminology. For example, section 1.1 would more appropriately be titled 'paleorecords of millennial-scale changes in climate', as this is what we see in the data. We do not know a-priori that this reflects the climatic sensitivity to the AMOC state. Rather, this is a hypothesis to be tested with the modelling experiments (see also main point 2 above).

2) Section 2: the three different experiments are not very well defined. Please be more precise.

#### References

Bitz, C.M., J.C.H. Chiang, W. Cheng and J.J. Barsugli, 2007. Rates of thermohaline recovery from freshwater pulses in modern, Last Glacial Maximum, and greenhouse warming climates, *Geophys. Res. Lett.*, 34, L07708, doi:10.1029/2006GL029237.

Hu, A., B. L. Otto-Bliesner, G. A. Meehl, W. Han, C. Morrill, E. Brady, B. P. Briegleb, 2008: Response of thermohaline circulation to freshwater forcing under present day and LGM conditions. *J. Climate*, 21, 2239-2258.

Weber, S.L., and S.S. Drijfhout, 2007. Stability of the Atlantic Meridional Overturning Circulation in the Last Glacial Maximum climate, *Geophys. Res. Letters*, 34, L22706, doi:10.1029/2007GL031437.

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