

Interactive comment on “How did Marine Isotope Stage 3 and Last Glacial Maximum climates differ? Perspectives from equilibrium simulations” by C. J. Van Meerbeeck et al.

Anonymous Referee #2

Received and published: 1 December 2008

General comments: In this study, numerical modeling is used to compare the Last Glacial Maximum (LGM) and the Marine Isotope Stage (MIS) 3 climates, in order to shed light on the relevant differences between the two intervals with respect to the millennial-timescale variability. The authors combine ideas from modeling experiments performed in the frame of the Stage 3 project (Barron and Pollard, 2002; Pollard and Barron, 2003) and from so-called "water-hosing" experiments (testing the sensitivity to freshwater forcing). Compared to the Stage 3 studies, the analysis of differences in boundary conditions between LGM and MIS3 is extended to greenhouse gas and atmospheric dust forcings. The impact of changing the orbital forcing is also tested. In addition, having an interactive ocean component in the modeling setup allows investi-

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



gating the effect of shutting down the thermohaline circulation (THC) - a key factor in the millennial-timescale climate variability. Compared to most of the previous water-hosing experiments, the one presented here employs realistic MIS3 boundary conditions. I find this is an interesting work and should be published after minor revision.

Specific comments:

Page 1119, lines 12-18: "Barron and Pollard (2002) and Pollard and Barron (2003) ... could therefore not explain the mechanisms behind the oceanic circulation changes seen in data between stadials and interstadials." This was not quite the purpose of those studies. Cf. Barron and Pollard (2002), the Stage 3 modeling effort was devoted to investigating the impact of boundary conditions on the MIS3 climate and to producing MIS3 simulations that best fit the climate reconstructions. As a matter of fact, with respect to the millennial-timescale variability, this is the maximum one can do with equilibrium simulations: to identify the most important climate components and forcings, and propose configurations of parameters (boundary conditions) resulting in the best agreement possible between simulations and data. To really explain the mechanisms driving the switch between the cold and warm phases of the DO cycles, one probably needs, however, transient simulations. The same is true for addressing the frequency of DO events, so the reference to this issue should be removed from conclusions (bottom of page 1139). Also, lines 14-18 on page 1117 should be modified: "It is presently not clear, however, why DO events were much more frequent during MIS3 than during the following MIS 2 Therefore, we analyze in this paper some characteristic features of the MIS3 climate and compare them to the LGM climate ...". Instead of the comparison between MIS3 and 2, I believe it would be better to refer directly to the difference between LGM and MIS3: DO events have not occurred during full glacial, as well as during full interglacial conditions, but they have occurred during the transition between these extreme climate states. Therefore, the LGM (full glacial, no DO events) will be compared to MIS3, a part of the last glacial-interglacial transition period characterized by frequent DO oscillations.

S588

CPD

4, S587–S590, 2008

Interactive
Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



The relationship between DO/HE events and climate changes in continental domain should be considered with care. A great similarity exists, indeed, between rapid variations in North-Atlantic and Greenland records on one hand, and in many continental records on the other hand (see for ex. the compilation by Voelker et al., 2002). However, establishing a clear correlation between them is still "work in progress", one of the major difficulties being the accurate dating for the later. Note that the Stage 3 studies by Barron and Pollard, focusing on Europe, talk about "warm and cold MIS3 episodes", not about stadials and interstadials. Section 4.4 "Freshwater forcing required to mimic stadials": How was the 0.3Sv value chosen for the freshwater flux? Is it the minimum value for which the THC is shut down in the model?

At least in NW Europe, the (vegetation) model seems to seriously overestimate the LGM tree cover. A tree fraction of about 0.8 at LGM (if I get it right from Fig.5a) shows up there where a steppe-tundra environment would be expected, which doesn't leave much room for MIS-sta - LGM differences (Fig.5b). This lets to suppose that the simulated MIS-sta - MIS-int anomaly is even smaller - nevertheless, I think it would be interesting to show it, as it is done in figs. 3 and 4 for temperature, precipitation and geopotential heights. I agree that climate simulations for MIS3, as for any other period of time, should be performed with boundary conditions as realistic as possible. This is difficult to do in AGCM experiments, mainly because no global reconstruction of the sea-surface conditions exists for another glacial interval than the LGM, but transient EMIC (CLIMBER-2) experiments dedicated to MIS3, with evolving insolation, ice sheets and freshwater flux into the North Atlantic, have been published recently (e.g., Claussen et al., 2005, Jin et al., 2007) and deserve to be mentioned. In the last phrase in the conclusions (page 1140, lines 2-4: "With the results presented in this study, we know that insolation cannot be neglected..."), replacing "we know" by "we confirm once more" would be more appropriate - or the entire phrase could be removed, as the direct results of this study with respect to insolation are detailed in the last paragraph on page 1138.

Technical comments : P.1123, line 6: an additional 50-year interval P.1123, line 13: anomalies (not: anomaly) compared to LGM P.1129, line 3: remove "on our model" P.1132, line 20: MIS simulation of (not: on) Barron and Pollard P.1133, line 17: variations in orbital forcing or in the Scandinavian Ice Sheet size P.1133, line 20: temperature differences between the two (not: both) states P.1134, line 4: i.e. (not: i.c.) GHG P.1136, line 29: "As More alike": remove "As" P.1138, line 20: does (not: did) change substantially P.1139, line 4: between the two (not: both) states

Figure captions: Fig.1: ... insolation anomalies (not: anomaly) ... Fig.2: ... compared to present-day ones ... Fig.4: ... color (not: colour) scale Grey areas (not: area's) Fig.5: color (not: colour) scale Figs 8 and 10: between the two (not: both) states

Figures 3, 4 and 5 should be enlarged.

Also, please check consistency between the text and the reference list. At least one reference, Pollard and Barron (2003), does not appear in the list.

Interactive comment on Clim. Past Discuss., 4, 1115, 2008.

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)