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Climate of the Past Discussions

Interactive comment on "Global climate simulations at 3000 year intervals for the last 21 000 years with the GENMOM coupled atmosphere–ocean model" *by* J. R. Alder and S. W. Hostetler

Anonymous Referee #2

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General comments:

This paper describes a sequence of time slice experiments with an AOGCM very similar in the conceptual design to Kutzbach and Guetter (1986). Although I find arrangement of the article reasonable for the purpose of introducing the simulation results to the community (that is the presentation of the simulated climates states and their evaluation against independent proxy data and models (PMIP3)), the potpourri of figures and textual descriptions is not a good source for someone who tries to learn about the dynamics of the past climatic changes, in particular. The brevity in which the dy-

namics of the emerging differences in precipitation, sea ice and ocean circulations are discussed, makes it hard to give constructive or critical detailed comments. But in the end, the paper serves well for its main purpose: The description of what the time-sliced equilibrium simulations indicate as differences between pre-industrial and past climate states.

In summary, the paper has no major research flaws or logical errors, and it thus will require only a few changes.

Specific comments:

Introduction:

p.2928 line 20-23: this part of the text could be moved into the previous paragraph, together with the rest of the PMIP model simulation descriptions (add in line 4).

Methods:

p.2930: line 15-16: It is unclear what is meant with 'permanent sea ice': 'perennial sea ice'?

p.2930: Question: was the doubling CO2 sensitivity estimated from a present-day climate state?

It is interesting to see that despite the lower climate sensitivity the LGM to Holocene temperature trend is in the same order of magnitude as the reconstructions suggest (see my later comment in under the Summary Section).

p. 2930: line 27: Unclear what 'which' stands for the PD or PI temperature: '[. . .], which is 1.97 C cooler than observations [. . .]'. Only afterwards it becomes clear that it must be the PD simulation.

p.2930: last paragraph and p.2931 first paragraph: What does it mean that the NH temperature trend is of the right magnitude compared with observations, if the model has a low climate sensitivity in the CO2 doubling experiment?

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p. 2932: paragraph 1: One could consider adding Renssen et al., GRL, (2005), Notaro et al, GRL, (2006) to the references.

p.2932-2933, last paragraph: It is okay to choose one calendar definition over the other, however, are the insolation curves in Figure 1, the mid-month values of Berger and Loutre (1991), or are these the also now fixed-calendar seasonal averages? This issue should be resolved in the Figure 1 caption. (See also Chen et al., Clim. Dyn. (2010)).

Results:

p.2934: line 21-23: It is unclear what is the location and direction component of the pressure gradient? North-South gradient towards the equator or towards the Mediterranean?

p.2934: last paragraph (line 25 +): Does he difference pattern also suggests a slight north-south shift in the pressure systems (in particular together with the later discussed rainfall it could make sense)?

Section 3.2 p. 2935 l.10-28: The recent paper by Liu et al. in PNAS (2014) should be taken into account in discussing the differences in the global mean temperature trends of the Holocene.

p.2936 l.12: south of the FIS: by that is meant the region which extends into the central Asian continent, right?

p.2936 l. 24: write 'precessional shift of perihelion, and by changes in obliquity'

p.2937 l. 17: Please start the new sentence with the season '[. . .] warming over America. During summer, GENMOM simulates [. . .] consistent with [. . .]'

Section 3.3:

page 2938: l. 10-14: This is an example where the compression of complex information is dangerous. What is seen in precipitation anomalies in the model is associated

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through a ‘short-cut’ chain of causal relations. How certain is it that the described ‘quasi-global’ precipitation pattern is caused only by the ice-sheet /sea-ice changes and not through tropical SST changes in response to orbital and GHG forcing (locally)?

p.2941 last paragraph: It should be made clear in the beginning that NH sea ice area extent is controlled by bathymetry (land-sea-area changes). Area changes are in response to external forcing are thus biased.

p.2942 first paragraph l. 4-5: It would be better to write ‘not affected by land-sea area changes with global sea level rise’ (in this model at least; ice-shelf changes could indeed change the ocean area for sea ice)

p.2944 first paragraph: Please take into consideration the recent study by Marson et al, Clim. Past, (2014) (doi:201410.5194/cp-10-1723-2014)

Section 4.2

p.2946: line 25-26: I am confused by the use of the word ‘regionally coherent pattern’ and ‘contrasting areas of warming’. Is a coherent pattern a pattern with only positive (or negative) anomalies, whereas ‘contrasting areas’ show both positive and negative anomalies? Could it be labeled as ‘regionally incoherent pattern’? Or does the use of words suggest an inconsistency with a reference pattern (e.g. the pattern reconstructed by proxies)?

Section 5: Summary:

p.2948 l.21-27: Climate sensitivity was found to be on the low end for doubling CO2. If the LGM cooling is now consistent and in the middle range of the estimated LGM cooling, I wonder would that indicate a higher climate sensitivity during the LGM (a result suggesting a ‘state-dependent’ climate sensitivity?) or is it suggesting that the cooling contribution from ice-sheets (here an external forcing) is overestimated / or proxies may underestimate the global cooling contribution (e.g. they may not sample appropriately the NH ice-sheet regions). Or is the climate sensitivity and LGM cooling

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altogether consistent within the margin of uncertainties?

References:

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Liu, Z., Wang, Y., Gallimore, R., Notaro, M., & Prentice, I. C. (2006). On the cause of abrupt vegetation collapse in North Africa during the Holocene: Climate variability vs. vegetation feedback. Geophysical Research Letters, 33(22), L22709. doi:10.1029/2006GL028062

Marson, J. M., Wainer, I., Mata, M. M., & Liu, Z. (2014). The impacts of deglacial meltwater forcing on the South Atlantic Ocean deep circulation since the Last Glacial Maximum. Climate of the Past, 10(5), 1723–1734. doi:10.5194/cp-10-1723-2014

Renssen, H., Goosse, H., Fichefet, T., Brovkin, V., Driesschaert, E., & Wolk, F. (2004). Simulating the Holocene climate evolution at northern high latitudes using a coupled atmosphere-sea ice-ocean-vegetation model.

Interactive comment on Clim. Past Discuss., 10, 2925, 2014.