Clim. Past Discuss.,
doi:10.5194/cp-2016-109-RC1, 2017

Climate of the Past Discussions
Open Access
EGU

Interactive comment on "The influence of ice sheets on the climate during the past 38 million years" *by* Lennert B. Stap et al.

Anonymous Referee #1

Received and published: 19 January 2017

General comments:

The authors present results of model simulations of the past 38 million years using a simple zonally averaged energy balance model coupled to a 1D ice sheet model. The presented results contribute to our understanding of climate - ice sheet interactions on very long timescales and therefore the paper represents a valuable contribution to this research field. The use of a relatively simple model is justified by the very long transient simulations which would be too computationally expensive to perform with more complex models. However, in order for the paper to be suitable for publication in Climate of the Past, some minor issues listed below should be addressed.

The model is described only very briefly in the Methodology section. I'm aware that the model is described in more detail in previous publications, but it would be useful to the

Printer-friendly version

Discussion paper

reader who is not familiar with the model if some more details would be given (e.g. the resolution of the ice sheet model is not even mentioned in the text). How is the model initialized? Additionally, the way the CO2 concentration is derived in the model and applied as forcing is crucial for the simulations performed and should be described in the paper. I would suggest to at least include the equations for δ18O and CO2.

The description of the experiments used to show the hysteresis behavior of the model is spread over several sections of the paper, which is very confusing to the reader. First it is mentioned in the Methodology section that using different δ18O stacks gives very different results but no reason for that is given until section 3. Then at the end of Section 2 (Page 4, lines 7-15) the hysteresis experiments are described, but it is difficult to understand why these experiments are needed before knowing what the problem is (which is only outlined in Section 3). I would suggest collecting all of this in one section describing the difference between 5Myr and 38Myr simulations, the experiment setup for diagnosing the reason for the differences, the hysteresis behavior and the retuning procedure.

I'm not aware of any other modeling study showing a hysteresis behavior that is caused by the atmosphere model or ocean model when excluding overturning, so it would be interesting to know what is causing this. Because of the relatively short time scale of atmospheric processes, it seems difficult to imagine that the climate model keeps memory of the initial conditions over multimillenial time scales. Could the authors elaborate on this? Are the different hysteresis branches really stable equilibria of the model? Also, does this hysteresis behavior depend on the forcing rate (50 ppm/50 kyr)? What are the initial conditions for these experiments?

The model-derived atmospheric CO2 could be compared with available proxy data (e.g. Beerling and Royer, 2011).

It would be interesting to see also the sea level evolution (maybe also the ice volume evolution separately for NH and Antarctica) and possibly global temperature evolution,

Printer-friendly version

Discussion paper

also to make it easier for the reader to interpret Figures 4 and 5.

Figure 3 is very hard to read, especially Figure 3b. Maybe Figure 3b could be split in 3 different plots?

The following sentence in the abstract (Lines 8-9) is not clear, at least not until one has read the rest of the paper: 'Firstly, we investigate the relation between global temperature and CO2, which changes once the model run has experienced high CO2 concentrations.'

Interactive comment on Clim. Past Discuss., doi:10.5194/cp-2016-109, 2016.