Clim. Past Discuss., 6, C866–C868, 2010
www.clim-past-discuss.net/6/C866/2010/

Climate of the Past Discussions

Interactive comment on "A new interpretation of the two-step $\delta^{18}\vec{O}$ signal at the Eocene-Oligocene boundary" *by* M. Tigchelaar et al.

M. Tigchelaar et al.

mtigch@hawaii.edu

Received and published: 13 October 2010

We thank the referee for his thorough reading of the manuscript and the constructive and positive comments. We fully agree, that the model is conceptual and caution should be applied when directly comparing the model results with proxy data. We will make this more clear in the revised manuscript. Please find below our detailed answers to the comments.

1. **Modes of circulation:** It is true, that a switch from NPP to TH would cause a similar deep sea temperature change, and some aspects of the NPP state may fit better with proxy data for the Eocene than the modeled SP state. The reason why we chose for the SPP state as Eocene reference was that several studies

suggest that deep water formation in the North Atlantic has started around or after the E-O transition, while before the Southern Ocean may have been the only deep-water source. The initiation of North Atlantic deep water formation has also tectonic reasons: The North Atlantic was very narrow and small, and it has been suggested that deep water could form there only when the Greenland-Scotland ridge subsided most likely in the early Oligocene ((Davies et al. , 2001; Miller and Tucholke , 1983)). See also response to Dr. Coxall's comments.

2. **Eocene climate:** We agree.

3. **CO_2:** This is a good point that the referee makes here. We will revise the manuscript in such a way that it becomes more clear that the model that we are using is a conceptual model and that the data are highly uncertain, so that one-on-one comparisons are not very useful. The section on increasing the melting temperature might still be of use to illustrate that model results can roughly be improved and that the model allows for spontaneous transitions under certain parameter settings.

4. **Sea ice:** In the Gildor and Tziperman (2001) model the sea ice albedo is 0.65 and the ocean albedo is 0.07. The contrast between the two is thus indeed large, but both values are not unrealistic. As already noted in the article, a too high sensitivity when the ocean fraction exceeds $\sim$80% is not only a problem in the Gildor and Tziperman (2001) model, but many others as well (Gildor and Tziperman, 2001; Ingram et al., 1989). Since the Southern polar land fraction during the Eocene was 21% we were left with two options: increase the land fraction artificially or disable the sea ice module. Because (i) sea ice is thought not to have been important in the Eocene (Huber and Sloan, 2001) and (ii) we expected the land fractions to be an important factor in determining the MOC configuration, we decided to disable the sea ice module. The effect of including sea ice while increasing the land fraction artificially was not tested; excluding sea

CPD
6, C866–C868, 2010

ice was therefore not an attempt to make our results look better.
Removing sea ice from the schematic in Fig. 1b is a good suggestion. We will take care of this in the revised manuscript.

References

Davies, R. and Cartwright, J. and Pike, J. and Line, C: Early Oligocene initiation of North Atlantic deep water formation, Nature, 410, 917–920, 2001.

Gildor, H. and Tziperman, E.: A sea ice climate switch mechanism for the 100-kyr glacial cycles, J. Geophys. Res., 106, 9117–9133, 2001.

Huber, M. and Sloan, L. C.: Heat transport, deep waters, and thermal gradients: coupled simulation of an Eocene greenhouse climate, Geophys. Res. Lett., 28, 3481–3484, 2001.

Ingram, W. J., Wilson, C. A. , and Mitchell, J. F. B.: Modeling climate change: an assessment of sea ice and surface albedo feedbacks, J. Geophys. Res., 94(D6), 8609–8622, 1989.

Miller, K. G. and Tucholke, B. E: Development of Cenozoic abyssalciruclation south of the Greenland-Scotland Ridge, In: Structure and development ofthe Greenland-Scotland Ridge (ed. M. H. P. Bott, J. Thiede, S. Saxov and M. Talwani),pp. 549–589. New York: Plenum Press. (1983)

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper