Clim. Past Discuss., 6, C417–C419, 2010
www.clim-past-discuss.net/6/C417/2010/

Climate of the Past Discussions

Interactive comment on "A comprehensive, multi-process box-model approach to glacial-interglacial carbon cycling" *by* A. M. de Boer et al.

Anonymous Referee #2

Received and published: 9 July 2010

Review – A comprehensive, multi-process box-model approach to glacial-interglacial carbon cycling by de Boer, Watson, Edwards and Oliver.

In this manuscript, de Boer and colleagues use a box model of the ocean carbon cycle to investigate the role of ocean physics and biology in explaining atmospheric CO2 drawdown at the Last Glacial Maximum. To do so, they use an inverse approach, in which they solve the model equations for 107 random combinations of the model input parameters (describing the ocean circulation and the nutrient utilization) and hence explore the whole parameter space. They derive the most probable ocean state for the modern and glacial by comparing the model output (biological production, phosphate

concentrations, . . .) to available climatologies (e.g. PO4) and paleo-reconstruction (e.g. export production). To explain glacial observations, they propose that during glacial times AABW formation and high latitude mixing were reduced, and that nutrient utilization was increased in either the equatorial regions or the northern high attitudes.

The paper is well-written, the results are interesting and bring some new insights into how the interplay of ocean physics and biology contributes to atmospheric CO2 drawdown at the Last Glacial Maximum. Despite the fact that tens / hundreds of papers using box models to explain quaternary CO2 variations have been published, the contribution of this particular work is interesting mainly because of the methods that are applied. This is new because 1. the authors use new paleo-reconstructions of export production that have never been used to constrain past circulation in an inverse (simple) scheme, 2. they use an holistic inverse approach in which they cover the entire parameter space.

I have however some comments that I hope would help to improve the clarity of the manuscript.

My main concern is the lack of precision and remarks about the processes that are (or not) included in the model. My understanding is that some significant contributions to the glacial CO2 drawdown, ocean cooling and carbonate compensation for example, are not included. These processes are rather well-quantified and should be discussed in the manuscript because the targeted CO2 is not the same if the model does represent these processes. Also, the effect of iron fertilization has been quantified by a series of more "realistic" ocean carbon models (see Kohfeld and Ridgwell, 2009 in the SOLAS AGU Book for a discussion) : the outcome of the model output(change in nutrient utilization rate) could be compare to these previous estimations. In summary, I feel that the description of the models needs more details and that the results of the work need to be included into a wider context.

I have also a concern about the conclusions made about the role of the equatorial

regions. As stated by the authors themselves, the design of the box model preclude them to conclude on any importance of the EEP upwelling & biology in governing atm. CO2. I believe box models are not the appropriate tools to deal with the complex equatorial circulation.

I would also mention that the biology is seen in its simpler expression here. For example, even if nutrient utilization efficiency can change regionally, carbon and phosphorus are intrinsically linked in this model representation. One mechanism that could contribute to the glacial CO2 drawdown is a decoupling of C:P or C:N in the organic matter. This is worth being mentioned (see Tagliabue et al. 2009 CP)

Minor corrections: - p.869, l.2 : replace suggest by suggests. - p. 869 l.8 : “biology and the circulation”. I guess you mean circulation and mixing. - p869 l24: please indicate if the different mechanisms have been quantified (or not. . .). - p871 l25: Model description - p875 l26: add a parenthesis. - p 876 l4 : that is may by that it may - p881 l.2 : d15N and not d13N - p881 l.28 : reword.

Interactive comment on Clim. Past Discuss., 6, 867, 2010.