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Climate of the Past Discussions

Interactive comment on "Proposing a mechanistic understanding of changes in atmospheric CO_2 during the last 740 000 years" *by* P. Köhler and H. Fischer

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The referee raised various questions to which we like to answer in the following:

1. The $CaCO_3$ dynamics might be too simplistic, especially concerning a possible time delay proposed by other studies. This topic was brought up by all referees and we extended our study by various additional simulation and an extended discussion on this subject. The details on the investigation of the time delayed response of the sediment were discussed in the response letter to the comments of referee #2.

2. Another concern around $CaCO_3$ was the possibility that changing $CaCO_3$ fluxes

to the seafloor might drive the model to a new lysocline depth, which is prevented by our approach. The revision of our model (as explained in details in another response letter) covers now no prescribed changes in the lysocline anymore.

3. It was asked for a more explicit description on how nutrient supply and productivity was handled in the model. We expanded the model description accordingly. This is one of several points raised by the referee, in which the answer to the concern is described in detail in a previous article [Köhler et al.(2005)]. We agree with the referee on the principle, that each article has to stand for its on, and should be self-explainable. Nevertheless, we like to add, that nowadays models which are used in a series of articles are very often described once in detail, and referred to that original description thereafter.

4. The referee asked for an explanation why a reduction in North Atlantic Deep Water (NADW) leads to a decrease in CO_2 in our model, while other models seems to gain also opposing effects. We extended in the description of our results on this topic. Briefly, a main difference between our and other studies might be the complexity of the models. In GCMs or models of intermediate complexity changes in ocean circulation have consequences not only for the strength of the water fluxes, but also for heat transport and thus temperature, salinity, nutrient concentration and probably sea ice formation. In our model changes in ocean circulation is decoupled from changes in temperature as the later is also prescribed externally. Thus, the effects of a change in NADW on atmospheric CO_2 is solely that part based on circulation changes. This difference and a detailed interpretation why CO_2 is reduced for reduced NADW is now included in the revised manuscript.

5. It was stated that our assumptions were lacking a rational support why they were chosen here. Especially changes in Southern Ocean ventilation and iron fertilisation were questioned. On the other hand the referee mentioned our previous article [Köhler et al.(2005)] as a more thoughtful analysis and nothing new can

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be learnt from the present manuscript. These two arguments somehow represents nicely the difficulties in building a work upon previous studies. To the first one (no support for our assumptions) we again have to say: It is all written in [Köhler et al.(2005)]. One reason for not including it in here again was, not to bore the reader with a repetition of already previously stated things, which brings us to the second point. It is true, it is difficult to excite the reader on the same topic twice. Everything which was written before is still valid, thus, we have to deal with the same problem and still support the same approach to find an answer. However, what is new here and what should be exciting about this manuscript is besides the revision of the carbonate compensation mechanism the different time scale, i.e. the dynamics of CO_2 during different terminations which all differ individually. It was not obvious for us at the very beginning, that our approach based on knowledge gained for Termination I would give us reasonable results for longer times, for other terminations and for glaciations as well. We understand this as support for our assumptions and our model design.

References

[Köhler et al.(2005)] Köhler, P., Fischer, H., Munhoven, G., and Zeebe, R. E.: Quantitative interpretation of atmospheric carbon records over the last glacial termination, Global Biogeochemical Cycles, 19, GB4020, doi: 10.1029/2004GB002345, 2005.

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