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Biogeosciences Discussions

Interactive comment on "Phytoplankton calcifiers control nitrate cycling and the pace of transition in warming icehouse and cooling greenhouse climates" *by* Karin F. Kvale et al.

Anonymous Referee #2

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Review of manuscript: "Phytoplankton calcifieres control nitrate cycling and the pace of transition in warming icehouse and cooling greenhouse climates" by Karin F. Kvale, Katherine E. Turner, Angela Landolfi, and Kathrin J. Meissner

In their manuscript the authors address the question which role phytoplankton calcifieres might play during rapid climate transitions on centennial time scales in affecting oceanic tracer distributions and the marine biogeochemical cycles. Therefore they have employed an Earth system model of intermediate complexity (UVic) which was recently upgraded by implementing coccolithophorides and biogenic calcite as a fully prognostic tracer, which also accounts for the mineral ballast effect. By ramping at-

mospheric pCO2 levels up (RU) and down (RD) between 285 and 1257 ppm in their experiments, the model was driven from icehouse to greenhouse conditions and vice versa. The main result of the study is the discovery of a mitigation effect of PIC ballast on several biogeochemical tracers. As an example, in the RU scenario which runs the model from a low CO2 icehouse to high CO2 greenhouse conditions, an increasing ballast effect due to enhanced PIC production mitigates changes in export fluxes and prevents the development of augmented oxygen minimum zones (OMZ). The paper is interesting, well organized and clearly written. Therefore, subject to minor revisions, I can recommend publication in Biogeosciences.

General comment: As mentioned in the manuscript, and in contrast to earlier studies, recent literature points towards elevated coccolithophoride production rates under rising temperatures and ocean acidification. However, this is not necessarily the case for biogenic calcification. Keeping temperature, alkalinity and nutrient concentrations fixed, increasing CO2 concentrations will lead to diminished calcification rates in many of the coccolithophoride species (see Bach et al., 2015). As a result, reduced calcification rates under high CO2 conditions could counteract the overall stimulating effects on coccolithophorides and weaken the PIC ballasting effect, which then could even lead to a spread of OMZs, as found by Hofmann and Schellnhuber (2009). To my knowledge, UVic does not account for a pH-value (or Omega) dependent calcification rate. Therefore, I would appreciate a short paragraph in the manuscript clarifying this issue.

Minor comments: page 2 line 3 : The sentence "... marine carbon export production is well-established Balch (recently summarized by 2018)" should be rewritten as : ".. marine carbon export production is well-established (recently summarized by Balch, 2018)"

page 7 lines 2 and 3: " ... suboxic (defined here as below 5 mmol O2)"; did you mean 5 mmol/m3 O2 ?

pages 18 and 20: The labels on axis of figures 1 and 3 are rather small, please enlarge.

Page 12 lines 18-21: In the sentence starting with: “The MIXED model shows a slight decline in NPP ...” refers to figure A2, which shows plankton biomass but no NPP. Please correct this mismatch or rephrase the sentence.

Reference:

Bach, L.T., et al. A unifying concept of coccolithophore sensitivity to changing carbonate chemistry embedded in an eco- logical framework. Prog. Oceanogr. (2015), http://dx.doi.org/10.1016/j.pocean.2015.04.012

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