

Interactive comment on “Climate change and ocean acidification impacts on lower trophic levels and the export of organic carbon to the deep ocean” by A. Yool et al.

Anonymous Referee #1

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The manuscript by Yool, Popova, Bernie, and Anderson presents global ocean ecosystem simulations for the 21st century under two different atmospheric carbon dioxide concentration pathways. The paper documents significant decreases in ocean productivity in response to a more stratified ocean that limits the convective supply of nutrients into the euphotic zone. The paper also documents significant decreases in the supply of organic material to seafloor communities in response to the decreased ballasting effect of calcium carbonate itself a response to ocean acidification.

The paper is well written and the results are presented clearly. However, the appendix needs to be carefully proofread. Appendix A.1 that is supposed to describe the model's state variables is missing. On pages 3489 and 3490 the "d" in the derivative is missing
C2079

in the denominator. Also, why do some equations use the "partial" symbol and others use the "d"? Finally, none of the equations are correct without adding to the time-tendency terms the effect of the tracer-flux convergence due to advection and diffusion.

The following comments are added in the hope that they might help improve the manuscript:

1) Given the importance of changes in stratification to the results presented in the paper it would be useful for the reader to be able to see in section 3.1 plots that compare some measure of the model's pycnocline, nutricline and mixed layer depths to their counterparts for the real ocean.

2) In section 3.2 is it possible to diagnose the relative importance of the different effects that contribute to the expansion of suboxic waters. In particular how much of the reduction is due to the reduced O₂ solubility due to warmer waters? How much is due to the reduced ventilation as a result of increased stratification? How much is due to the shallower remineralization in response to the decrease in ballasting? To what extent does the reduction in productivity compensate for the other effects?

3) For some of the figures, the differences between 1990s and 2090s are subtle and it would be nice if the paper showed the percent difference using a blue-white-red colormap.

Other minor comments:

page 3468 line 21: delete "change"

line 24: delete "are"

page 3470 lines 5-6 "with particular declines in the equatorial Pacific and, particularly, the North Atlantic" could be rewritten more clearly as

"particularly in the equatorial Pacific and North Atlantic."

line 10 change "region" to "regional"

line 26 change "Switching from nutrients," to "In contrast to nutrient concentrations,"

page 3471 line 26-27 "This is most marked in the Atlantic (−27.5 %) and the Arctic (−31.7 %) oceans." It is not clear what the numbers in parenthesis mean.

page 3472 lines 8-14 what is the cause of the shallower remineralization?

page 3474 line 7: add the word "In" at the beginning of the sentence.

line 17: "...change in Table 2 that of CaCO₃ production" should be "change in Table 2 being that of CaCO₃ production", i.e. add the word "being"

page 3477 line 2: change "unfavorable" to "declining", the meaning of unfavorable is ambiguous

line 11: It is not clear what "(68 % → 64 %)" is referring to, presumably it is referring to the production above the mixed layer but this isn't clear.

line 15 and 16 "In parallel, the volume of suboxic ocean waters increased by 13 %." It would be nice to see how the model's volume of the suboxic waters compares to observations.

Interactive comment on Biogeosciences Discuss., 10, 3455, 2013.