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Biogeosciences Discussions

Interactive comment on "Response of Export Production and Dissolved Oxygen Concentrations to pCO_2 and Temperature Stabilization Scenarios" *by* T. Beaty et al.

Anonymous Referee #1

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GENERAL ASSESMENT

This manuscript presents the results of a modelling exercise to forecast the global distribution of dissolved oxygen (DO) in the oceans under different CO2 radiative forcing scenarios. It focuses specifically on the expected expansion of the currently existing and forthcoming oxygen minimum zones (OMZ). I have contrasting feelings with this work. On the one side, despite I'm not a modeller, I can appreciate the broad scientific interest of the study and the modelling and interpretation effort done by the authors. On the other side, the fact that the model does not forecast the changes in formation rates of the water masses and, therefore, the ventilation of the ocean interior, is a major weakness of the study. I know that the authors are aware of this limitation and

briefly discuss their implications but, to my understanding, they have omitted the most important process driving the extension of the OMZs.

DETAILLED COMMENTS

Page 1, line 18. As far as I understood, the model does not evaluate only the response to changes in CO2 radiative forcing but to CO2 dissolution in the surface ocean too.

Page 2, lines 2 & 3. Unit of dissolved oxygen concentration are incorrect. They should be μmol L–1 to be consistent with the units reported in the manuscript. Furthermore, when dissolved oxygen concentrations are reported in μmol L–1 this means that two samples with the same amount of dissolved oxygen but different temperature will have a different concentration of dissolved oxygen unless you are reporting the concentrations at a fixed temperature. Is this the case? If not, it would be better to report the concentrations in μmol kg–1, as use to be done in oceanography.

Page 2, line 3. Do you refer to ocean area or you mean ocean volume? I think that in this context ocean volume would be more appropriate. This is applicable to all the times that you refer to ocean area throughout the manuscript.

Page 2, lines 18-21. The description of the factors controlling the distribution of dissolved oxygen in the ocean is incomplete. On the one side, apart from the exchange of dissolved oxygen between the sea surface and the atmosphere, which depend on the solubility of this gas in seawater, the formation of central, intermediate and deep water masses is essential to understand the ventilation of the ocean interior. On the other side, only one element of the organic carbon biological pump is considered: the downward flux of particulate organic carbon. At least, the contribution of dissolved organic carbon (which represents 20% of the organic carbon biological pump) should be mentioned.

Page 2, lines 23–26. It is not just solubility and variations in the biological pump, but ventilation of the ocean interior, i.e. water mass formation rates.

Page 4, lines 26-28. As indicated above, this is only part of the story of the organic matter biological pump. Dissolved and suspended (slow sinking) organic matter is missed despite they can represent about 20% of the downward flux.

Page 5, 16-19. How the increase of temperature of the deep ocean in response to CO2 radiative forcing is modelled without affecting the water mass formation rates and the ventilation time of the ocean interior?

Page 6, lines 7-9. You mean temperature change of the SURFACE ocean, isn't it?

Page 8, line 22 - page 9, line 5. No figure or table is shown; therefore, the reader has just to believe what the authors describe.

Page 9, lines 15-20. A figure should support this description (as supplementary material for example).

Page 9, lines 23 - page 10, Line 19. A figure should support the description of cases other than 4X (as supplementary material for example).

Page 10, line 22 - page 11, Line 6. A figure should support the description of cases other than 4X (as supplementary material for example).

Page 11, lines 18-22. A supplementary figure should support this description

Page 12, lines 11-15. A supplementary figure should support this description

Page 12, lines 16-18. The sentence is confusing. Figure 6 do not show that such an increase by > 300 μmol L–1 in the deep sea and by > 200 μmol μmol L–1 in the intermediate water masses occur. Maybe this is the maximum increases that you detect, but if you use the symbol ">" it looks like this is the minimum increase.

Page 12, lines 29-30. So, what is the significance of all these effort when one of the major drivers of the distribution of dissolved oxygen in the ocean interior is not taken into account?

Page 13, first paragraph. A few sentences should be written about the effect of no considering dissolved organic matter in the transport of organic matter to the ocean interior.

Table 1. Please, define sCO2.

Figure 2. Dissolved oxygen units are missing in the caption.

Figure 3. Dissolved oxygen units are missing in the caption.

Figure 5. Please, add a map of the transect as in Figure 6 and 8. The caption does not indicate which variable are you showing.

Figure 7. To which scenario does panel (d) refers?

Figure 8. "Lost OF OXYGEN due to. . ."; units are not correct: they should be μmol/m3/y I guess.

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