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Biogeosciences Discussions

Interactive comment on "The influence of the ocean circulation state on ocean carbon storage and CO_2 drawdown potential in an Earth system model" *by* Malin Ödalen et al.

Anonymous Referee #2

Received and published: 20 June 2017

Ödalen et al. explore the partitioning of carbon in the ocean under different circulation and mixing scenarios using a model of intermediate complexity. The authors describe the possible change in atmospheric pCO2 in terms of the "drawdown potential" of each scenario. Changes in saturation and soft tissue pump carbon appear to have the largest effects on the total carbon inventory, though the carbonate and disequilibrium pumps are not entirely negligible.

This is an important topic for the community and addresses a standing question in paleoclimatology. The model and methods used are well established and credulous. However, prior to publication, this paper requires significant editing. In places, the lan-

guage is quite informal and should be revised (e.g. p. 19, lines 24-25: "...but does not seem to have been picked up in the model intercomparison community..."). Additional comments are given below.

General comments:

- I assume that you don't have preformed nutrients (O2, PO4, DIC) written out in the model output? If you do, this eliminates the problem with O2dis, as you can calculate O2sat and then calculate the remineralised O2 and hence Csoft explicitly. Additionally, preformed O2 and PO4 would be much more useful in the parameterisation for Alkpre.

- Is it possible to change the circulation in the model in the Southern Ocean and not in the Atlantic or vice versa? The bipolar seesaw could theoretically induce changes in Cdis in the Southern Hemisphere but not in the Northern Hemisphere.

- If it's not too cumbersome, perhaps consider using descriptive abbreviations for the different SEs

Specific comments:

- p. 3, lines 4-5: Could you specify the order of magnitude of the change in CO2?

- p. 3, line 35: It's also important to note that these studies don't even have Cres due to infinitely fast gas exchange

- p. 4, lines 3-5: I don't find this paragraph necessary

- p. 4, lines 28-29: I don't believe that this is correct, as the pumps can have opposing effects. It should be specified that the net effect of all of the pumps must be to redistribute carbon from the surface to the deep ocean.

- p. 5, line 17: I think what you mean is that alkalinity is not set (or affected) by gas exchange, but referring to an "expected" value of Cpre is a little misleading.

- p. 5, lines 31-32: Please include Martin (1990), Paleoceanography, as this is one of

the central references for increased soft tissue pump efficiency during glacials.

- p. 7, lines 5-6: “and has a level of detail for the carbon system that made it particularly suitable for this study.” This is very general; please specify why it is appropriate for this study (and/or why less complex models are not).

- p. 8, line 25: When referring to Cdis, it would be useful to cite Ito and Follows (2013), GBC.

- p. 10, lines 14-24: Another important reference is Ito et al. (2004), GRL.

- Section 3.3: Do you use the same parameterisation for preformed alkalinity in all simulations? Please specify the errors in Cres in the surface field.

- p. 12, lines 17-22: Again, please specify the size of the error introduced by making this approximation.

- p. 14, lines 6-7: Isn’t this relationship true per definition of Csoft?

- p. 15, lines 29-31: Please describe here the importance of the temperature limit on the calculation of Csat, if this is on a comparable order of magnitude.

- p. 17, lines 13-14: Have you done experiments to specifically examined he role of sea ice in determining Cdis? Quantitative results would be very interesting!

- p. 17, line 15: Only 0.01%? This seems to be at odds with Fig. 2.

- p. 18, line 15: Changes in the solubility due to ocean temperature changes don’t seem “indirect”

- p. 19, lines 31-32: Ito and Follows (2013), GBC also uses the same scheme to look specifically at this; please include this.

- p. 20, lines 23-24: Please specify what you mean by “an LGM-like circulation” and add appropriate citations

- p. 22, line 27: Please cite the statement that “there may have been more, not less,

preformed nutrients in the deep ocean during the last glacial”

- p. 24, line 6: please specify if you mean the soft tissue pump and/or the carbonate pump

- Fig. 8: Perhaps difference sections would be more useful?

- Fig. 9: It would be more illustrative to zoom in with the colourbar

- Figures: Please make the font size larger, particularly in Fig. 7-10

- Table 3: Please give units for DC; why not include DCcarb?

Technical corrections:

- p. 2, line 2: “and” should be “an”

- p. 2, line 20: “constraining;” should be “constraining:”

- p. 4, line 11: “patwhay” should be “pathway”

- p. 5, line 4: “HCO3-“ should be properly formatted

- p. 5, line 31: “eg.” should be “e.g.”

- p. 9, line 28: Full stop missing at end of sentence

- p. 10, line 1: “DE:s” should be “SEs”

- p. 10, line 5: “Eqs. 6-7” should be “Eqs. (6)-(7)”

- p. 14, line 24: “SE:s” should be “SEs”

- p. 14, line 25: “SE:s” should be “SEs;” there is an extra parenthesis

- p. 14, line 27: “SE:a” should be “SEs”

- p. 14, line 33: “SE:a” should be “SEs”

- p. 15, line 13: “SE:s” and “SE:a” should be “SEs”

- p. 15, line 21: extra full stop in “Fig. 2 b.”

- p. 15, line 32: space missing in “andDCsat”

- p. 16, line 9: “SE:s” should be “SEs”

- p. 18, line 4: “SE:s” should be “SEs”

- p. 18, line 18: “SE:a” should be “SEs”

- p. 19, line 12: “particularily” should be “particularly”

- p. 20, line 11: “SE:s” should be “SEs”

- p. 20, line 24: “simulation” should probably be “circulation”

- p. 22, line 15: Comma after “that” should be removed

- p. 22, line 28: Citation should be in parentheses

- p. 23, line 1: the space in the website should be removed

- p. 24, line 3: “c.f.” should be “cf.”

- Fig. 1 caption: “the SE:s” should be “the SEs”

- many references are formatted Author (year) where they should be (Author, year), e.g. p. 2, lines 4 and 16

- bibliography: check that CO2 is written with a subscript; remove “n/a” from page numbers

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