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Interactive comment on "Quantifying the impact of ocean acidification on our future climate" *by* R. J. Matear and A. Lenton

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Reviewer 2 (C7980)

I think the manuscript is well suited for BG. It is well written and illustrated (although some figures are too small and the labels cannot be easily read; e.g. Figs. 5,6, 8,9). The conclusions are supported by evidence presented. Thus I recommend this paper can be published with minor revisions.

We thank the reviewer for his positive comments on the paper, We anticipate when the final manuscript is typeset they will scaled as required.

Specific comments: The authors results are obviously dependent on the model used. E.g. the model uses a simple fixed vertical profile of POC flux and remineralization.

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Discussion Paper

Other models have used slighly more complex formulations for the vertical POC flux. E.g. Schmittner et al. (2008) use a fixed sinking speed and a remineralization rate that is temperature dependent. This leads to faster and shallower remineralization as the upper ocean warms. This also leads to an increased rain ratio. Schmittner et al. have speculated that this effect may counter the effect of OA on CaCO3 production and rain ratio. A more recent paper, which should be cited, Pinsonneault et al. (2012 Biogeosciences 9, 2351pp) shows that this is indeed the case. Due to the fixed POC flux profile used this effect is not included in the author's model but it may well play a role in more complex models and/or the real ocean. So I think it would be appropriate to discuss this.

We have included the suggested papers along with a discussion of how using a temperature dependent remineralization with fixed sinking rate may alter the response. However, we emphasize that the simulation with a modified POC profile was an attempt to assess the potential of changing the depth of POC remineralization on oceanic carbon uptake along the lines that Schmittner et al (2008). While the chosen POC remineralization is simple, the sensitivity simulations showed that changes in POC remineralization do not significant change the carbon uptake over then next 100 years.

Schmittner et al. (2008) also showed that while ocean biogeochemical changes are not important for atmospheric CO2 and climate until 2100 they can be important on longertime scales. This may be another point the authors want to mention in this paper.

Our conclusions are based on simulations to 2100 however, for longer time periods this may not be true and we have added this point to the discussion section of the paper along with the suggested reference.

Comments in paper

pg 17684 - changed to H+

pg 176865 - made suggested deletion

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pg 176866 – Comment - warming, on the other hand, has been argued to increase CaCO3 production and the rain ratio (Schmittner et al. 2008; Pinsonneault et al. 2012 Biogeosciences 9, 2351pp) In our REF simulation the PIC:POC export ratio is kept constant and we cite the suggested papers to aid in motivating this formulation. We now state that such a formulation implies an increase in calcium carbonate production with ocean warming. Since our REF simulation has this affect the sensitivity experiments incorporate only affects that reduce the calcium carbonate production. At the point in the paper where the comment is listed, we are discussing the impact of rising CO2 on biogeochemical processes, hence we do not include the reviewer's comment here but added it to the section when we discuss the behaviour of the REF simulation

pg 17691- agree warming could increase POC remineralization and this comment was added to the paper with a citation to Rivkin et al., 2001

pg 17693 and 4 - more comprehensive model data comparison.

We have added the suggested figures for surface phosphate and thickness of suboxic water.

We have added the DIC, ALK, DO, Phosphate and AOU assessment to the Taylor diagram and Table 3, and zonally averaged sections of DIC and Alkalinity are given in appendix A ,along with global averaged profiles of these variables. We like the idea of quantifying the model-data misfit with the Taylor diagram diagnostics because provides an easy number for other model simulations to compare to.

To the text we have also added that: the phosphate and AOU sections were recently assessed in Duteil et al 2012; and Duteil et al 2013 where the model did reasonable job of representing these fields.

For CFCs and C14 we did not add these figures because in the paper there was not much discussion of the ocean circulation. However, we now briefly comment on how previous published work using a simulation that was near identical to the REF simula-

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tion did reproduce CFCs and natural C14 observations (Matsumoto et al., 2004).

17695 – We confirm that the impact is due to increased stratification and now state this.

17696 - REMIN+ shows no increase in the Southern Ocean (Fig. 8 d). I think "REMIN+" should be changed to "COMB".

The figure labels are correct but the text is wrong and REMIN+ was changed COMB.

We agree the simulation is only looking at transient effects and a further comment on the long-term response has been added in the discussion with the suggested references.

pg 17698 - Added the suggested figure (anoxic water vs observations) to the paper and discuss it when assessing the model simulation (see. pg 17693 and 4 responses).

Cited references

Duteil, O., Koeve, W., Aumont, O., Bianchi, D., Bopp, L., Galbraith, E. D., Matear, R. J., Moore, J. K., Sarmiento, J. L. and Segschneider, J.: Preformed and regenerated phosphate in ocean general circulation models: can right total concentrations be wrong?, Biogeosciences, 9(1), 1–11, doi:10.5194/bg-9-1-2012, 2012.

Duteil, O., Koeve, W., Oschlies, A., Bianchi, D., Galbraith, E., Kriest, I. and Matear, R. J.: A novel estimate of ocean oxygen utilisation points to a reduced rate of respiration in the ocean interior, Biogeosciences, 10(11), 7723–7738, doi:10.5194/bg-10-7723-2013, 2013.

Matsumoto, K., Sarmiento, J. L., Key, R. M., Aumont, O., Bullister, J. L., Caldeira, K., Campin, J. M., Doney, S. C., Drange, H., Dutay, J. C., Follows, M. J., Gao, Y., Gnanadesikan, A., Gruber, N., Ishida, A., Joos, F., Lindsay, K., Maier-Reimer, E., Marshall, J. C., Matear, R. J., Monfray, P., Mouchet, A., Najjar, R., Plattner, G. K., Schlitzer, R., Slater, R., Swathi, P. S., Totterdell, I. J., Weirig, M. F., Yamanaka, Y., Yool,

A. and Orr, J. C.: Evaluation of ocean carbon cycle models with data-based metrics, Geophys. Res. Lett, 31(L07303), doi:10.1029/2003GL018970, 2004.

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/10/C9265/2014/bgd-10-C9265-2014-supplement.pdf

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Interactive comment on Biogeosciences Discuss., 10, 17683, 2013.