

## ***Interactive comment on “Sensitivity of atmospheric CO<sub>2</sub> to regional variability in particulate organic matter remineralization depths” by Jamie D. Wilson et al.***

### **Anonymous Referee #3**

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This paper presents a novel approach to answering an important open question. The precise pattern of spatial variability in how organic carbon is remineralised is still debated, so the authors approach the issue instead from the perspective of “where are the most sensitive regions?”, with sensitivity defined as changes in atmospheric CO<sub>2</sub> through the proxy of preformed phosphate. This is a nice piece of work and I’m happy to recommend publication. I make some suggestions below, largely relating to clarity on technical points.

- While I understand why the two model scenarios (restoring or fixed export) are presented as end-members, the fixed export run nevertheless takes its export from a

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restoring run. It is true that output from the run giving the closest fit to observations is used as baseline but it should still be acknowledged that the 'end-members' are far from independent models.

- The description of tracking preformed phosphate needs more detail. The decomposition described in Appendix B gets phosphate away from surface only – it still needs to be tracked in the interior. How is this done?
- The authors should show the scatter plot of predicted vs observed values for the relationship described in page 5 lines 12-13 as it is fundamental to the manuscript. It should show predicted and observed changes in PO<sub>4</sub> as this is the predicted field.
- Fig 6 and section 3.2 – there is a sound argument for geometric mean so just show geometric mean and give the argument in the methods. It is not necessary to show arithmetic mean results in Fig 6a
- As a more informative second panel for Fig 6 show the same as current 6b but with regression taken out to show variability due to regional variability more clearly. The authors should also acknowledge in the text that the random sampling leads to under-sampling of highest and lowest global b values.
- How independent in structure are the 3 models used for the PO<sub>4</sub> vs pCO<sub>2</sub> relation?
- Fig A1 should be in the main body of the paper
- Consistency needed in terminology: in Subantarctic (text) and subpolar (fig)
- Remineralisation depth is defined (page 2, lines 8-9) assuming exponential profile (decrease by 63%) - but models use Martin curve
- Does the misfit function used to carry out the comparison to WOA (page 4, lines 22-23) take volume into account?
- Explain the maximin Matlab option for hypercube sampling in Matlab (page 4, line 31)

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- page 4 line 25: not sure that “reference” is appropriate
- Fig 3 caption needs rewording. All values are positive.
- The authors’ definition of the Subantarctic boundary makes it a little difficult to compare results to Kwon’s paper where the Southern Ocean was defined as south of 40S. Given that the Kwon paper provides such strong motivation for this manuscript this deserves comment.
- Page 6, lines 4-6: It should be explicitly acknowledged that there is a rather weak relationship between export and sensitivity for the restoring runs (Fig 4b)
- Use notation that distinguishes regional and global means of PO<sub>4</sub>\_pre
- Both constant export and nutrient restoring should be shown in Fig 5.
- Page 7, Line 3: “sensitivity”
- Page 8, lines 28-30: “As such, the global mean change in potential future and past changes in remineralisation depth may be larger than the uncertainty associated with spatial variability.” B changes discussed less than current observed range” The changes being discussed here are substantially smaller than the current range of observed values. Even if, as this paper argues, the global ocean may not be overly sensitive to spatial variation in b, it is worth noting that the current uncertainty in a global value of b still has very large uncertainty partly because of the confounding effect of under-sampled spatial variability.
- Page 10, line 21: Which sea ice field is used?
- Page 11, line 5: 1-v not 1-kappa
- Appendix A: state that the bottom of the second grid box in the vertical is at 120m (presumably)?

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