

Interactive comment on “Assessing Carbon Dioxide Removal Through Global and Regional Ocean Alkalinization under High and Low Emission Pathways” by Andrew Lenton et al.

Anonymous Referee #1

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I enjoyed reading this manuscript. The authors make a valuable contribution to an emerging field. Given that this is a relatively new area, this paper may set the normative approach to assessing and interpreting AOA model experiments. It would be useful if the authors took some time to explore the potential range of experiments (addition amounts, location of addition, against a wider range of emissions scenarios, overshoot/recover), what has already been addressed by previous work, and what is still left to do (potentially this could be tabulated?). Generally, this work is excellent and would encourage publication, with some minor edits/comments below.

Abstract: L19-21: Be specific, what changes are seen? In what parameter?

C1

L21-22: Not quite sure what that means.

L22-23 The change in saturation state is ambiguously describe, refer specifically to changes in omega.

L28 It's left a little open ended here, you could be more specific with the regional response. It is one of the more important findings from the experiment.

Introduction: Good introduction. Clearly explains why we need CDR and more specifically AOA. Also gives a description of ocean acidification and how AOA works.

L50: 'Including through coral bleaching' a little clunky, maybe remove 'through'

L54: Could you say something about the changing Revelle Factor, and the potential for AOA to impact this?

L148-150: simply states "impact" which could be a bit vague. Could go in further and state that they will be investigating the impact on the "carbon cycle, global surface warming (2m surface air temperature), and response and ocean acidification response to the 4 different AOA experiments under the high (RCP8.5) and low (RCP2.6) emissions scenarios." Which is stated in lines 207-210. Regarding my comment above, it is worth exploring the potential experiment space, magnitude of alkalinity addition, location, emission scenario, and the resulting impacts site specific/regional/global/ open ocean/coastal etc. What parts of this picture does your model/this paper deal with, what has already been done by others, and what is left to do? are other models needed?

Methods:

Model seems appropriate for the scope of this paper. Clear description of the experimental design which seems appropriate to answer the research question proposed in the introduction. Could explain what the model outputs are? Also should mention the testing for seasonality? (mentioned in lines 538-554)

L162-164: Do you expect this assumption to hold up under elevated alkalinity? Could

C2

the rain ratio change?

L204: Fair assumption, but it is worth pointing out that alkalinity manipulation could be from carbonate dissolution or NaOH addition which would not induce and impact from iron and silicate. You are testing the fundamental impact intrinsic to all of these methods of C sequestration. Results and discussion:

L208 – 209: the sentence doesn't make sense, a typo somewhere?

L215: Why have you chose this addition rate? Also, should alkalinity not be expressed in equivalents rather than moles (and throughout)?

L218-221: Fascinating, but why was the response different?

L232: "at" is missing

L239: I think 'an overall' is missing before 525 ppm in the brackets

L241: could you also give this as a % similar to how you did for RCP8.5

L251-254: This is really important...why was there an increase in export?... The 1% is an important outcome because it is the 'efficiency reduction' on the overall engineering system design.

Could tables 1-3 be summarised in one table? I think it would make things a little clearer.

Line 331: could be explained more clearly rather than just "due to the Revelle factor" (see previous comment)

L374: 'This reflects the fact that' should be rewritten 'This is caused by the subduction processes..' or something similar.

L396: 'Quite low', how low?

L445-447: But could you speculate as you have in the previous sentence? How much would export have to change to make a material difference?

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L507: This doesn't quite ring with your abstract, which suggests that ocean acidification would be mitigated. Would it not partially ameliorate the impacts?

L599: 'Interestingly' is used a bit too often, it gets a bit jarring.

Figures:

All Figures are clear. Slightly too many for this type of manuscript. Could some be moved to the supporting information? Figures 11-12 are not referred to in the text.

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