EGUsphere, referee comment RC1
https://doi.org/10.5194/egusphere-2022-683-RC1, 2022
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Comment on egusphere-2022-683

Anonymous Referee #1

Referee comment on "Limits and CO_2 equilibration of near-coast alkalinity enhancement" by Jing He and Michael D. Tyka, EGUsphere, https://doi.org/10.5194/egusphere-2022-683-RC1, 2022

General comments:

In "limits and CO_2 equilibration of near-coast alkalinity enhancement" the author's set out to assess the suitability of coastal locations for the application of near-coast OAE by determining the ability of a location to 1) sustain a flux of alkalinity at a set pH and omega aragonite saturation, 2) assess the interference distance between locations, 3) assess the amount of atmospheric CO_2 which is theoretically absorbed per unit of alkalinity added and 4) assess how quickly seawater returns to equilibrium in respect to atmospheric CO_2. The author's used their assessment to make a conclusion as to whether near-coastal OAE is a suitable method of carbon dioxide removal (is it capable of removing atmospheric CO_2 on a gigaton scale without causing severe perturbations to seawater chemistry). The Author's achieved this through the use of a global circulation model and found that the amount of alkalinity which can be added to any given area and its subsequent efficiency/uptake of atmospheric CO_2 are highly dependent on the characteristics of that location.

Overall, I enjoyed this manuscript. I found it easy to read although the manuscript tackled a significant issue of marine CDR. I am not fully equipped to make significant comments as to the model and methods used to implement it here. As such I will focus my comments elsewhere in this article. However, from my understanding the model used was of a satisfactory nature, the author's explained its use well and appear to have conducted several further investigations based on their initial models. The figures used were clear and added to the reader's understanding of the manuscript, however, I felt at times the captions were longer than necessary and I refer to this below. I have some fairly minor comments, listed below which I hope will add to the manuscript.

Technical & specific comments:

- Line 7: " the steady-state OAE rate" is this referring to the rate at which OAE

equilibrates with atmospheric CO_2? If so possibly consider "the rate at which OAE reaches a steady state…" as this was a difficult sentence to decipher.

- Line 9: "…currents allow the…" consider: "currents allow for the…"
- Line 10: "We found that within…" consider " We found that with…"
- Line 20-21: I found this to be a rather harsh concluding sentence, particularly for an abstract. Furthermore, there was no explanation of how much alkalinity is lost, particularly when in theory we should be able to avoid this loss through our selection of locations (I appreciate that you discuss this sufficiently in your manuscript, however for those readers who only read the abstract this may be misleading). I would recommend briefly expanding on this loss of alkalinity to the deep (e.g. potential for this to occur, the ability for us to avoid this etc.) and moving it up in the abstract so that it is not the concluding sentence.
- Line 29: "On long geological timescales" this reads oddly and is stating the obvious, I recommend deleting the adjective "long".
- Line 50: Although a relevant study please consider referencing (Guo et al., 2022) https://doi.org/10.5194/bg-19-3683-2022 instead as this study directly looked at the effects of nickel on phytoplankton.
- Line 51-52: This seems like an appropriate point to mention the energy costs associated with grinding and therefore benefits to coastal applications using coarser minerals.
- Line 70: I think it is important to also state the subsequent drop in CO_2 associated with increasing pH as it is not currently clear which variable is impacting organisms (e.g. phytoplankton). Furthermore, although a relevant article, Bach et al. (2019) did not conduct any first-hand research into the ecological effects of OAE. I would recommend including the citation (Subhas et al., 2022) or another ecological study on the effects of OAE to bolster this statement.
- Line 72: The manuscript by Moras et al., 2021 is now published and as such should be referenced as (Moras et al., 2022) https://doi.org/10.5194/bg-19-3537-2022 . I would also recommend adding the citation Hartmann et al., 2022 as done in line 46. This could be said for other sections where Moras et al., 2022 is cited and the inclusion of Hartman et al., 2022 is appropriate.
- Line 75: delete capital S in "Some"
- Line 83: brackets around "2015" and full stop after et al. not "et al,"
- Line 84: "imagining the distribution of…" imagining is an odd word to have here, consider "simulating".
- Line 102: again, citing (Guo et al., 2022) https://doi.org/10.5194/bg-19-3683-2022 would be beneficial.
- Line 104: I think it is important to distinguish the fact that an increase in alkalinity does not necessarily increase DIC. Increases in alkalinity increase the ability of the ocean to sequester CO_2 however whether DIC increases or not is dependent on the in-gassing of CO_2 from the atmosphere (or alternative method of CO_2 injection). I appreciate this is commonly inferred but I believe it is important to highlight this fact so that readers are not under any false impressions about OAE. I recommend deleting "(and subsequent increases in DIC)" or editing this sentence to reflect the above statement.
- Line 117-118: "Finally, the effectiveness and timescale of CO_2 uptake due to an OAE deployment in a given region is of interest we can define the uptake efficiency ηCO_2 as" this sentence is difficult to read. Consider something along the lines of: "Finally, to assess the effectiveness and timescale of CO_2 uptake due to an OAE deployment in a given region of interest we can define the uptake efficiency ηCO_2
- Line 213: I have one concern/question over the pulse injections of alkalinity. Did these consider the potential for alkalinity to precipitate out at depth? I understand the need to model the potential for high alkalinity/low CO_2 water parcels to return to the surface ocean. However, I am concerned that the modelling of such potentially long timescale processes may lead to over/underestimating the return of high alkalinity/low CO_2 water parcels to the surface ocean, as it is possible for alkalinity to be removed at depth through precipitation.

- Results heading: The text under the heading “Results” appears to be more of a discussion which also includes the results. Consider changing the heading to “results/discussion” or “discussion” (depending on the journal requirements).
- Figure 1 caption, line 3: “The variation of sustainable alkalinity flux in different parts of the coastal strip is apparent” I don’t think this is necessary for the figure caption, consider moving it to the main body of the text/ incorporating it into the discussion in lines 289-298.
- Figure 1e and 1f: x-axis labels? Are they simply the number of grid points? I recommend adding at least one x-axis and labels (if both use the same x-axis) to assist the reader.
- Figure 1 caption: “...the total global total...” consider changing to “...the total global injection...”
- Figure 1 caption: “the addition rate and pH change stabilize after 5 years” Again I don’t think this is necessary. I recommend moving this to the discussion.
- Line 315: consider changing “...can both be found...” to “...can be found, both on the outside and inside of the injection strip”
- Figure 2 caption: again, I would recommend moving the descriptive parts of the figure caption into the main body of the text e.g. sentences “in general regions…” as well as “ widening strips allow more…”. Much of this is already in the text and is therefore repetitive.
- Figure 2B: the axis labels here are odd, consider editing it so that the y-axis labels line up with each other. E.g., 40 is on the same vertical line as 400 etc.
- Figure 2b caption: change “a large range of injection capacities is observed” to “a large range of injection capacities are observed”
- Figure 3; figures seem to be mislabelled. Figure 3c should be 3b I believe. If not please change these around so they are in order (figure 3a, 3b then 3c).
- Figure 3 caption: much of the caption is already present in the text, consider deleting the descriptive sections last 2-3 sentences).
- Figure 3: Consider labelling the figures as; "figure a.i" as done for figure 5.
- Line 329: should this be “figure 2C”, not “figure 3C”, also note the text highlighting the locations could be included in the figure 2 caption and then referred to in the text simply as “…the regions depicted in figure 2c…” without the need to relist the countries.
- Figure 5 caption: “…for the same 3 locations shown in A” should this be “…shown in i”?
- Line 359-60: Is this in reference to a figure? If so please state the figure.
- Line 381: “be” is repeated, delete
- Line 392: it isn’t clear why this is apparent, if it is based on the figure or from a reference, please clarify this in the sentence.

Supplementary

- figure caption s1, line4: “the total global total injection” change to “the total global injection rate…”
- figure s4 caption: consider including the general locations of these maps.
- Figure s5: again, consider adding some general locations. Stating additional specific areas suggests that they have been chosen at random. Consider specifying if these areas were selected at random or why these areas were chosen.