Reply to comment of Anonymous Review #3.

Reviewer comments are displayed in italics, our responses in roman font.

Reviewer comment:

This MS provides the introduction to a new Best Practices Guide for research on ocean alkalinity enhancement (OAE), giving the background to the development of that document. It gives the climate policy context for ocean-based methods for carbon dioxide removal, with specific focus on OAE. It is well-structured and clearly written, covering the main science issues and knowledge gaps that are to be later discussed in greater detail.
The only significant gap would seem to be (brief) consideration of the current status of OAE governance, primarily from a regulatory perspective at international level – since this was considered to be a very high constraint on the OAE feasibility by IPCC (Bindoff et al., 2019; Fig 5.23). The authors may consider such issues to be out of scope for the guide; however, that would not seem to be the case, since substantive subsequent content is indicated ("The guide also discusses the legal context in which research occurs"; line 179).
The nature of decision-making at UN bodies is relevant here. Since formal decisions are based on consensus and agreement, a cautionary approach is the most usual outcome – as is evident by decisions to date by the Convention on Biological Diversity (CBD) and the London Convention/London Protocol (LC/LP) on 'marine geoengineering' in general and ocean fertilization in particular. A major concern by CBD and LC/LP parties is the risk of adverse transboundary effects, with the actions of one nation state negatively affecting another; such effects may be unlikely for OAE, nevertheless, they could occur even if OAE deployments are limited to territorial waters. For climate-scale OAE, there would also need to be international agreement on carbon accounting within the UNFCCC framework, a topic that is likely to be highly contentious (and therefore taking a very long time to resolve). .
It is relevant that the LC/LP has recently identified OAE as an approach requiring further attention: https://www.imo.org/en/MediaCentre/PressBriefings/pages/Marine-geoengineering.aspx. GESAMP (2019) could also usefully be cited in the context of governance issues.

RESPONSE: We thank the reviewer for flagging these issues. We agree that they require consideration and have addressed them extensively later in the guide (in the chapter on "Legal Considerations" of the OAE guide 23). We proposed to add further discussion of the governance issues in the introduction (see our response to reviewer 1) and then refer readers to the chapter on Legal Considerations. We now also refer to the GESAMP 2019 report.

A few minor comments:

- *Line 59: "several Gt CO2 per year globally". It would be helpful to be more specific regarding the amount of residual emissions that are included in IPCC scenarios (presumably 2-3 Gt pa, on the basis of "close to 20%").*

  done: We have modified the sentence to read:
  'between 10% and 20% of today's emissions, i.e. about 6 to 12 Gt CO_2e per year globally), where CO_2e includes the CO_2 equivalents of non-CO_2 GHGs that are estimated to contribute half to two thirds of the residual emissions (Buck et al.,

2023).'

- *Line 65: Change "current global CDR deployment" to "current CO2 removal" (since this is 'unintentional' rather than purposeful CDR).*

  done

- *Line 108: After "macrophytes", insert "(e.g. seaweed)"; that is more understandable.*

  done

- *Line 114: "with high (> Gt CO2 yr-1 scale) theoretical sequestration". It would be more informative if actual estimates of maximum CO2 removal can be given here, by several authors; e.g.: "between 3 -30 Gt CO2 yr-1 theoretical sequestration (Kohler et al. 2013; Renforth & Henderson, 2017; Feng et al 2017").*

  We thank the reviewer for pointing this out! We have accordingly changed the text to: 'with high theoretical sequestration potential in the range of 3 to 30 Gt CO_2 yr^{-1} (Köhler et al., 2013; Renforth and Henderson, 2017; Feng et al., 2017)'

- *Line 140: What is meant by "at the expense of imperfect CDR"? Explain – or delete.*

  We wanted to say that addition of alkalinity without equilibration with atmospheric CO2, i.e. imperfect CDR, reduces acidification more than alkalinity addition with CO2 equilibration. However, as even complete equilibration of added alkalinity with atmospheric CO2 will lead to a small increase in pH and thus a small reduction of acidification, we decided to delete the phrase.

- *Line 185-6: "We have to widen the space of options… climate targets" seems rather wordy - and too prescriptive. Simplification and linkage with previous sentence is suggested: "… is urgently needed, to enable society to define and design appropriate actions to reach agreed climate goals".*

  done, much appreciated.

EXTRA REFERENCES CITED ABOVE

Bindoff, N.L. et al (2019) Changing Ocean, Marine Ecosystems, and Dependent Communities. Chapter 5 in: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [eds H.-O. Pörtner et al]. Cambridge University Press.

Feng EY et al (2017). Model-based assessment of the CO2 sequestration potential of coastal ocean alkalinization. Earth's Future, 5(12): 1252-1266.

Köhler P et al (2013) impact of open ocean dissolution of olivine on atmospheric CO2, surface ocean pH and marine biology. Environmental Research Letters, 8(1): 014009.

GESAMP (2019) High level review of a wide range of proposed marine geoengineering techniques". (Boyd, P.W. and Vivian, C.M.G., eds.). (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UN Environment/ UNDP/ISA Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud. GESAMP WG 41, Reports & Studies Series.