Biogeosciences Discussions

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Comment on bg-2022-38

Anonymous Referee #1

Referee comment on "Assessment of negative and positive CO_2 emissions on global warming metrics using large ensemble Earth system model simulations" by Negar Vakilifard et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2022-38-RC1, 2022

General Comments

This contribution assesses the benefits of negative emissions / CO2 removal technologies deployment for future climate states using an ensemble of intermediate complexity earth system model results. The authors use effective transient climate response to cumulative CO_2 emissions (eTCRE) and zero emissions commitment (ZEC) as metrics to quantify these impacts. The authors find that thermal dependance and airborne fraction of CO2 contribute almost equally to the uncertainty in eTCRE, which is in contrast with recent analysis of the CMIP6 ensemble. Additionally, the authors find that negative emissions deployment can help avoid continued warming after net-zero emissions are reached. The manuscript is clear and well-written and the analysis appears free of errors. However I have several recommendations aimed at increasing the impact and clarity of this work, which are detailed below.

Specific Comments

The authors use the RCP 4.5 medium-level mitigation scenario as a benchmark to assess the future climate response to negative CO2 emissions. However much of the discussion of prospective large-scale negative emissions deployment in the recent literature focuses on their use towards limiting end-of-century warming to well-below 2 C, more consistent with RCP 2.6 or RCP 1.9. Although even the "medium" mitigation scenario may seem optimistic relative to the present real-world trajectory, using one or both of these forcing scenarios representing even deeper levels of mitigation could increase the impact of this work. I recommend the authors run similar analysis on one or both of these deeper mitigation scenarios, even as a sensitivity case. This could allow the modeling community,

policymakers, and other stakeholders insight into what a "best case" scenario might look like in terms of transient climate response and committed warming.

In the final paragraph of the conclusions section the authors refer to the need for negative emissions technologies that have naturally long storage times. In the main body of the manuscript it would be helpful to describe exactly what types of carbon removal technologies are represented in the models used to develop the ensemble. Long-lived and permanent storage such as direct air capture or enhanced rock weathering referred to in the conclusions? Or biospheric such as afforestation? Or is the representation of negative emissions agnostic as to the source in the models? Any biospheric contribution to the negative emissions and potential feedbacks or the limitations in representing them should be identified in the discussion around land carbon.

Technical Corrections

The authors should be more precise in differentiating point source carbon capture from carbon capture from the atmosphere for negative emissions. Throughout the manuscript the more generic "carbon capture" or "carbon capture and storage" is used. While readers might infer from context that this is referring to negative emissions, this term should be clearly defined at every use to avoid the possibility of misinterpretation.