

Interactive comment on “Meeting climate targets by direct CO₂ injections: What price would the ocean have to pay?” by Fabian Reith et al.

Anonymous Referee #1

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In this study, the authors used an Earth system model of intermediate complexity, UVic, to investigate the effect of direct CO₂ injection on atmospheric CO₂, temperature, and ocean acidification. Under the reference CO₂ emission scenario of RCP4.5, CO₂ is injected directly in the form of dissolved inorganic carbon into deep sea sites around 3000m to limit global warming below 1.5 K. Three injection strategies are designed and simulated: 1) once global mean warming exceeds 1.5K, all further emission are injected into the deep ocean; 2) inject CO₂ into the deep ocean in an amount to keep global mean warming below 1.5K; 3) inject CO₂ into the deep ocean in an amount such that atmospheric CO₂ follows the concentration pathway of RCP 2.6. In all injection scenarios, substantial amount of CO₂ outgassing is found, indicating that a significant amount of carbon leakage needs to be re-injected to achieve the mitigation goals. With

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respect to the biogeochemical effects, it is found that CO₂ injection into the deep ocean mitigate surface acidification, but at the cost of more acidified water in the deep ocean, in particular in the vicinity of the injection sites. This study is well-defined and the analysis is comprehensive and in-depth. This study makes a useful contribution to the assessment of climate and environmental effect of direct CO₂ injection.

I have a few suggestion that the authors may want to take into consideration:

- 1) The mitigation scenario of RCP 4.5 is used as the reference scenario for all injection experiments. It would be illustrative to demonstrate the effect of direct CO₂ injection under higher emission scenarios (i.e., RCP 8.5). To achieve the same mitigation goals, deep ocean would be much more acidified, and presumably, more CO₂ would be out-gassed from the deep ocean.
- 2) In terms of deep ocean acidification, the authors may want to look at the evolution of aragonite (calcite) saturation horizon.
- 3) What is the role of land carbon cycle here? How much of the outgassed CO₂ can be attributed to (or compensated by) the terrestrial CO₂ flux? Can the land carbon cycle feedback be quantified by turning on/off the UVic land carbon component?

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