Climate of the Past Discussions

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Comment on cp-2021-112

Anonymous Referee #2

Referee comment on "Local oceanic CO_2 outgassing triggered by terrestrial carbon fluxes during deglacial flooding" by Thomas Extier et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2021-112-RC2, 2021

Review of "Oceanic CO_2 outgassing triggered by terrestrial organic carbon fluxes during deglacial flooding" by Thomas Extier et al.

Thomas Extier and colleagues present a new implementation of terrestrial organic carbon fluxes between the land and ocean as land is flooded and becomes ocean or vice versa in the MPI-ESM as well as results from a deglacial simulation.
I was very pleased to see this process being implemented in an Earth system model (ESM) and support the publication of the well written article with a clear documentation of the implementation and am looking forward to see further applications.
Nevertheless, I would like to add a few comments.

1) Introduction:
Maybe expand the section on glacial-interglacial CO_2 variations (p.2, ll.39-49). In the context of the current study, recent estimates of total changes in land carbon storage between the last glacial maximum (LGM) and preindustrial (PI) might be of interest (e.g. Müller and Joos, 2020 BG; Jeltsch-Thömmes et al., 2019 CP).
Further, many studies have invoked processes other than physical changes in the ocean (see e.g. Menviel et al., 2012 QSR or Sigman et al., 2010 Nature for a review, and many others) to explain glacial-interglacial CO_2 variations.

2) Prescribed atmospheric CO_2 concentration:
At the end of section 2.1 the authors note that all atmospheric concentrations are prescribed in the simulations.
One of the goals of glacial-interglacial simulations with ESMs is to simulate the change in atmospheric CO_2 concentration, i.e. the ~90 ppm increase since the LGM. While making sure to have the correct atmospheric inventory, prescribing atm. CO_2 comes with drawbacks. For example, without other changes this would lead to a smaller LGM DIC inventory as the atmosphere would act as a sink until equilibrium is reached with the ocean. The authors circumvent this by initializing the spinup simulations with higher alkalinity concentrations. Is there a specific reason for not letting atm. CO_2 evolve freely over the course of the simulation? I don't think, though, this would change the findings of

the study, as the effect of terrestrial organic carbon fluxes is diagnosed from the difference of two runs, but would like to see at least a short discussion of this choice. Are changes in tracer concentrations as a result of lower sea-level considered here as well?

3) Simulated terrestrial carbon inventory
In general, I was a bit surprised to read that the effect of terrestrial organic carbon fluxes as a result of flooding are rather small and am wondering whether this might link to the size of the simulated terrestrial carbon inventory and thus the amount of carbon available in flooded gridcells.
On page 10, l.232-233 the authors state that the terrestrial carbon inventory increased from 922.9 GtC to 1302.7 GtC between 21-15 kaBP and amounts to 1563.6 GtC in 12 kaBP. I am no expert on land modeling, but in a recent paper Müller and Joos (2020, BG) simulate total terrestrial carbon at the LGM at about 2000 GtC, which increases to about 2500 GtC in 12 kaBP. This is almost twice the amount shown in this study. Also, Ganopolski and Brovkin (2017, CP) simulate a larger terrestrial carbon inventory. Is the assumption correct that a higher terrestrial carbon pool would also increase the terrestrial organic carbon flux during flooding? If yes, this might be a point to be included in the discussion of uncertainties of the findings.
In the same paragraph (p.10, ll.235-237) include Müller and Joos, 2020 BG into the estimates of terrestrial carbon evolution.
Are peatlands included in the land component of the model?
Are there other uncertainties that would be good to be discussed (other than C:N:P ratios)?

Minor comments:

- make sure text in figures is readable (size), for example legends in Fig. 11 are very small

- p.5, ll.129-130: either 'presented a new development' or 'presented new developments'

- p.11, Fig. 4: why not compare 21 ka model with 21 ka reconstruction?

References:

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