

Biogeosciences Discuss., referee comment RC2
<https://doi.org/10.5194/bg-2022-38-RC2>, 2022
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Comment on bg-2022-38

Anonymous Referee #2

Referee comment on "Impact of negative and positive CO₂ emissions on global warming metrics using an ensemble of Earth system model simulations" by Negar Vakilifard et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2022-38-RC2>, 2022

Review of: Assessment of negative and positive CO₂ emissions on global warming metrics using large ensemble Earth system model simulations

Vakilifard et al.

Overall Assessment:

The study uses an intermediate complexity Earth system model to assess eTCRE, ZEC and the effect of net negative emissions on these metrics. In addition the study uses the theoretical framework of Williams et al., 2016 to decompose TCRE into components. Although the perturbed parameter model set-up is a promising method, the experiment design is baffling and thus the wider meaning of the results is very unclear. Additionally the paper focuses on far too many metrics leading to a manuscript that is exceptionally long but without discernible purpose or meaningful conclusions. I recommend that the paper undergo major revisions.

General Comments:

(1) The authors need to explain where the 82 (86?) variants of GENIE come from. There is a reference to Foley et al., 2016) which presumably first derived the model set-up but a paper of this length should be self-contained and explain to the reader which parameters are being perturbed and how the variants represent uncertainty in the climate system.

(2) The experiment design does not make much sense. The design is an example of a half-idealized experiment, as the non-CO₂ forcings are frozen at 2020 values but there is no explanation as to why this is done. Why not follow the real RCP 4.5 pathway? There are times when half-idealized experiments do make sense but their purpose needs to be clear which is absent here. Also why use RCP 4.5 instead of SSP 4.5? What is gained by starting the experiments in 850 CE instead of 1850 CE? The relevance model simulations would be easier to interpret if either real scenarios or idealized experiments were conducted.

(3) Following from the strange experiment design the computation of eTCRE if not comparable to other models and the computation of ZEC is incorrect. eTCRE by its nature varies by the pathway of non-CO2 forcing agents. Here the effect of these agents is frozen in 2020, meaning that eTCRE cannot be compared to eTCRE computed by other models for RCP 4.5.

ZEC is defined as the Zero Emissions Commitment and can be defined as CO2-only ZEC, or ZEC for other forcing agents independently or in combination (e.g. Matthews & Zickfeld 2012). Here none of these protocols is followed and you attempt to compute ZEC for zero CO2 emissions while holding the non-CO2 forcings constant. Thus the metric you compute is not ZEC, nor can it be compared to ZEC derived from other model simulations.

(4) While the decomposition of eTCRE into components is fine it is unclear what this analysis adds to our understanding of eTCRE. The paper essentially does the decomposition explains the results but does not assess how the 28 perturbed parameters are controlling the evolution of these components.

Specific Comments:

Line 2: K EgC^{-1} is the preferred unit. Having Celsius and carbon together is confusing.

Line 180: Does this mean that 4 of the model variants crashed?

Figure 2: Grey lines for each variant with a mean value would be easier to look at.

Figure 3: The release of carbon from sediments seems really high.

Line 224: Does Genie have any other heat sinks? Estimate is wrong word, makes it seem like energy is not being conserved by the model.

Figure 10: Needs work. Different line styles for the percentiles would improve legibility.

References:

Matthews, H. Damon, and Kirsten Zickfeld. "Climate response to zeroed emissions of

greenhouse gases and aerosols." *Nature Climate Change* 2.5 (2012): 338-341.