

Geosci. Model Dev. Discuss., referee comment RC1
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Comment on gmd-2022-125

Anonymous Referee #1

Referee comment on "GCAM-CDR v1.0: enhancing the representation of carbon dioxide removal technologies and policies in an integrated assessment model" by David R. Morrow et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2022-125-RC1>, 2022

This manuscript describes the model GCAM-CDR 1.0, which includes a broader portfolio of CDR options as well as dedicated CDR policies. The authors show, that for identical input files the model behavior resembles GCAM 5.4. However, the additional policies introduced in GCAM-CDR 1.0 will lead to substantially different outcomes. The implementation of a broader CDR portfolio is useful and timely, and goes beyond what other models have included so far, e.g. by including ocean liming. The explicit policies will also allow for useful analyses which can make timely contributions to current debates. The paper is concise and well written, and I recommend publication in Geoscientific Model Development.

However, I have some open questions that need to be addressed before publication:

As a general comment, it would be very useful to report also costs of the different technologies described in the manuscript.

P4 I98-105: The approach for CDR to compete with a placeholder technology to limit growth is unclear. How is the placeholder technology modelled? How is ensured that this technology is competitive, but doesn't have or produce energy or money? Why is this approach chosen, and not a direct constraint modelling the actual constraints?

P4 high-heat DAC: why can only be gas used to generate the high temperatures and not H₂? Is there a justification for taking the lower estimates of energy requirements from Realmonte?

P4 low-heat DAC: Is there a justification for taking the lower estimates of energy requirements from Realmonte? Why can the low-temperature heat not be provided via electricity as well, e.g. heat pumps? From the conclusion I take that the availability of waste heat is a limitation for this technology. This doesn't seem plausible and could be solved by allowing for other heat sources, which would of course increase the costs for deployment beyond the availability of waste heat.

P4 TEW: According to Strefler et al., 1 t basalt binds 0.3 tCO₂. If I understand the numbers in the SI correctly, here 1 t C is assumed, which would be a factor of 10 off.

P5 ocean liming: Again, the numbers seem to be on the optimistic side of the range given in Renforth et al. Also, it doesn't seem plausible that the availability of cargo ships limits the capacity of ocean liming. Building dedicated ships would certainly be possible, though this would increase costs.

P6 I192: Depending on the climate target, this seems implausible. Why would there be separate targets for DAC and BECCS, if the main output provided at least by DAC (i.e. CDR) could also be fulfilled via BECCS?

P6 I202ff: This mechanism is confusing. CDR options like DAC are constrained mainly by energy supply, which could be increased, driving prices up. So if DAC is always paid at market rates, how is the demand limited?

P7 I215: The energy could also be provided by bioenergy technologies without CCS. What is the incentive for using BECCS instead?

P7 I226: Why is the default case to have BECCS separated from the CDR market?

P7 I246ff: This is an arbitrary choice. CDR could also be distributed according to the economic efficient solution, or according to other equity schemes. Please explain the reasoning behind this choice.

P12 I342: I don't see why bioliquids should not be used as feedstock. It requires a proper accounting of the lifetime of these feedstocks, but then also the use of fossil fuels does as this would also lead to emissions.

P13 I365: Why 15% per year? This is an arbitrary choice, please explain the reason behind this number.

I also have some minor comments listed below.

P2 I68: I assume you mean GCAM-CDR here and not GCAM 5.4

P7 I232: typo in "revenues".