

Authors' Responses

Reviewer Comments in black, authors' responses in red

RC3:

General Comments:

They key point of the article is an important one: under a realistically pessimistic continuation of the new "business as usual" and feasible CDR rates, keeping warming below 1.5°C would require centuries of SRM before CDR could clean up the carbon mess. While I agree with **RC1** that this point is obvious to experts, this does not mean that the obvious should go unstated! (**RC2** somewhat agrees but finished by saying "this has been discussed before", without citing any specific examples.) I find the discussion in the literature unsatisfying and, at worst, deliberating misleading in a way that portrays SRM as less problematic than it really is.

We are thankful to hear that R3 thinks that our study represents a valuable contribution to the SRM discussion and fully agree with the state of published literature on this issue.

However, I did find much the paper to be much longer than it needed to be; many paragraphs are unnecessary distractions from the key point. I also agree with **RC1** and **RC2** that the authors are trying to pass the scenarios as much too sophisticated or realistic. In contrast to **RC1** and **RC2**, however, I would instead encourage the authors to dramatically simplify their scenario and methods and submit it as a short "perspective", either in Earth System Dynamics or elsewhere. For example, they could use idealized emissions scenarios that are constant positive emissions → linear decrease with prescribed slope → constant negative emissions; these scenarios would be characterized by just 3 constants (the year emissions reductions begin; the emissions reductions rate; the CDR level) and the authors could briefly explore how these parameters affect the SRM timescale and how they relate to various scenarios discussed in the literature (including the somewhat realistically-pessimistic scenario they described here). While I do not think this article merits publication in Earth System Dynamics as is, I think that a revised article that is entirely (and only) about SRM timescale could merit publication.

We want to thank the reviewer for the suggestion to submit the study as a "perspective". We eventually decided to go down a different route by greatly expanding the analysis to include many more scenarios to fully counter the impression that results from our single scenario design could be generalised. More

specifically, we increased the number of scenarios to 355, spanning a wide range of 2100 warming outcomes, climate policy and CDR assumptions.

We hope that with these substantial revisions and expanded methodological setup, you will agree that the article is suitable for a publication in ESD.

Specific Comments:

I do not think the carbon cycle discussion merits inclusion in the article. The feedback is tiny compared to cumulative emissions and CDR, probably very model specific, and is not at all explained in terms of underlying processes.

We removed the carbon cycle discussion in the revised manuscript.

RC2 mentioned that Drake et al. 2021 model scenarios with tradeoffs between mitigation, CDR, and SRM. Belaia et al. 2021 do as well (<https://www.worldscientific.com/doi/full/10.1142/S2010007821500081>). Neither *explicitly* state a timescale over which CDR has to be maintained, but it is obviously multiple centuries from their plots.

Given the discussion of climate changes on long timescale, it may be worth mentioning idealized scenario modelling that includes Sea Level Rise, e.g. Montero et al. (<https://egusphere.copernicus.org/preprints/2022/egusphere-2022-135/>).

Line 102: It should be explained where the 2.2 Wm^{-2} value comes from.

Line 109: Is the 0.12 Wm^{-2} relative to some long-time mean? What does this number signify?

Thank you for these specific comments, we have taken them into consideration for our new manuscript.