Authors' Responses

Reviewer Comments in black, authors' responses in red

RC1:
The study investigates temperature overshoot in a novel "current commitments" scenario that achieves large-scale negative emissions (of 3 different levels) in the 22nd century and beyond. These scenarios would overshoot the 1.5C threshold for over 300 years. On top of these baseline scenarios the study implements SRM to keep temperatures to 1.5 C. They find, rather unsurprisingly, that in a scenario that exceeds 1.5C for centuries if SRM is deployed to keep temperatures below 1.5C then it would be deployed for centuries.

There is very little that this study would add to the literature. The study's core finding is obvious, and the specific numerical value arrived at is determined by the scenario assumptions made by the authors and the one model that is applied. Furthermore, beyond showing the scenario(s) that the authors have created, the study has only 2 results: the length of time that SRM is deployed and the time-evolution of the cumulative carbon flux due to SRM. In my judgment there is not a sufficient depth of analysis or novelty in this work for it to be publishable in its current form.

Beyond the limited depth of analysis and lack of novelty, the results of this study are determined by the scenario assumptions made by the authors and by the insufficiently described ensemble of MAGICC6 model variants. While the scenario is fairly well described and quite reasonable, it is only 1 scenario (with 3 different CDR endings). There would be much more to analyse and discuss if a wider range of more and less ambitious scenarios were presented. The ensemble of MAGICC6 variants determines the results but there is insufficient description of how this ensemble is generated, nor is the reader given a quantitative assessment of its ECS and carbon cycle characteristics relative to more complex models or expert judgments.

In my judgment there is not a sufficient depth of analysis or novelty in this work for it to be publishable in its current form.

We thank reviewer 1 (R1) for taking the time to comment on our study. The main issues pointed out by the reviewer are the insufficient depth of analysis, the lack of novelty and the limited number of scenarios.

In the revised paper we have addressed all these issues. We have greatly increased the number of scenarios. Instead of using one stylized scenario with 3 different magnitudes of CDR we are looking at all scenarios in the IPCC AR6 WG3 database

that are aligned with 2030-NDCs and have decreasing or stagnating CO2 emissions in the last 5 years of the 21st century. This amounts to 355 scenarios with a wide range of 2100 warming outcomes, climate policy and CDR assumptions. We run each scenario with all 600 ensemble members of MAGICC7, resulting in 213 000 scenario realisations.

MAGIC V7.5.3 comes with several major updates in atmospheric chemistry and carbon cycle components compared to MAGICC6 and is IPCC AR6 consistent. We included a more thorough analysis of the ensemble members and the range of climate sensitivity they cover. An additional co-author was brought on board with additional MAGICC and scenario development expertise.

Regarding the lack of novelty, we want to point out that to our knowledge this dataset is now the largest set of overshoot scenarios available for investigating SRM peak-shaving, and similar findings have not been presented elsewhere. Due to the more diverse range of scenarios and assumptions included, we were able to not only analyse potential deployment length but to also explore what this length is dependent on and how much of this is under human control.

We hope that with these major revisions we were able to address all of the reviewer's core concerns.