



EGUsphere, referee comment RC2

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Comments on the paper "SURFER v1.0: A flexible and simple model linking emissions to sea level rise"

Anonymous Referee #2

Referee comment on "SURFER v2.0: a flexible and simple model linking anthropogenic CO₂ emissions and solar radiation modification to ocean acidification and sea level rise" by Marina Martínez Montero et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-135-RC2>, 2022

This paper presents a new simple and fast modelling tool (SURFER) that allow assessing carbon emission evolution and solar radiation management long-term impacts on sea-level rise and ocean acidification. The paper describes the tool, presents example of calibration and associated model results for a few set of experiments. Although I find this work interesting and I believe that SURFER could indeed be useful for the community, this paper does not really demonstrate why SURFER should be used and, in my opinion, somehow lacks of maturity in its present version. Please find below few suggestions/comments that I believe may help improving the manuscript.

Main comments:

Framing and motivation:

- I think it would be good to make clearer what SURFER fills as a gap; because EMICs and ESMs can also be used for long runs (as shown in the paper actually), but I understand that they don't allow estimating SLR and ocean acidification. Is that right?
- Most of the introduction moves around the fact that such simple models are useful to explore impact of policy analyses, cost-benefit analyses, etc... for long-term concerns that are mostly omitted. These omissions may in turn lead to wrong decisions. In the conclusion, one can read "[...] it is well-suited for long-sighted multi-objective policy analyses: With this model we can not only assess the short and long-term effects of anthropogenic emissions, but also put future technologies into the mix, such as carbon dioxide removal and solar radiation management." Although I find such motivation for developing that sort of model indeed appropriate, I don't believe that results shown in the paper demonstrate this. My suggestion would thus to really perform some policy analyses-like case studies to make this more concrete and support the motivation of the paper. Otherwise, the introduction should rather focus on what the model provides as outputs and how this fills more direct needs.

- Ocean acidification is another very important output that should be better emphasized in the title too, not just SLR.

Model design & description:

- The model provides SLR estimates due to Greenland and Antarctic melting components but omit first order components such as glaciers, ice caps and thermal expansion. I'd suggest either to upgrade the model to allow accounting for those non-negligible contributions or otherwise to clarify that the model provides "SLR due to ice-sheets melting".
- In the model, the carbon cycle processes that rule carbon fluxes between the atmosphere and ocean rely on chemical & physical processes that are well known and constrained. For the land reservoir though, this appears to be derived from EMICs and ESM simulations and ends up to be model dependent. In this regard, I think it would be good to estimate or comment on how sensitive are the SURFER results to such a parameterization. Is there no other way or can we put additional constraints to lower the influence of external model results?
- In my opinion, the ice-sheet module would deserve some more explanation on how the equations on ice volume are derived and to what the different terms refer to – note that I have basically no knowledge on ice-sheet modelling and physics. Details could be provided in a supplementary material.

Model validation & comparison

- Section 3 shows some qualitative comparison with CMIP5 and CMIP6 results for some variables but in my opinion, it would be worth to perform a more systematic comparison with CMIP5 & CMIP6 outputs. These data that are easily accessible. Such an analysis would make the models comparison and SURFER performances assessment more convincing.
- The Greenland ice-sheet contribution to SLR strongly departs from the other study to which the results are compared (Van Breedam et al., 2020). This suggests a strong sensitivity of the model results to the calibration phase. In this regard, I think that some illustration of the sensitivity to some parameters (e.g. from Table 3 or Table 4) could be very relevant. Moreover, this appears to be easily achievable because the model is particularly fast. From a more general point of view, I think the strength of the SURFER model is that it is very efficient to run long period. One could imagine using such a tool to propagate uncertainty on parameters or boundary conditions.

Specific comments:

- L201: Planetary boundary => this is an important point and could be very use as a

motivation in the introduction I believe.

- Section 2.2: providing units would be useful to better follow the equations.
- Eq 32: it would be good to describe all terms in the text below.
- Section 2.3: see the main comments, but more details in a supplementary material would be welcome here.
- L289: why reasonable value? compared to what ? Please clarify.