

Biogeosciences Discuss., referee comment RC3  
<https://doi.org/10.5194/bg-2022-227-RC3>, 2023  
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## Comment on bg-2022-227

Anonymous Referee #3

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Referee comment on "A comparison of the climate and carbon cycle effects of carbon removal by Afforestation and an equivalent reduction in Fossil fuel emissions" by Koramanghat Unnikrishnan Jayakrishnan and Govindasamy Bala, Biogeosciences Discuss., <https://doi.org/10.5194/bg-2022-227-RC3>, 2023

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### general comments

The manuscript compares the climate effects of a world with high land based mitigation (afforestation) and one the same carbon removed for 3 different SSP scenarios. They use the University of Victoria Earth System Climate Model and make the comparison for a variety of variables related to the carbon cycle, surface energy cycle and ocean. In general the research is novel and is executed in a thorough way and answers interesting questions. However, at this point the manuscript somewhat lacks a critical discussion and doesn't relate nor compares the outcomes of this study to previous literature as much as it should. I think the manuscript can improve greatly by including for example a discussion section which can elevate the results and compare them to previous literature.

### specific comments

- The comparison between the afforestation simulation (AFFOREST) and the reduced emission simulation (REDUCED\_FF) is interesting, the way I see it in the REDUCED\_FF simulation you account for the carbon effects of afforestation but neglect the biogeophysical effects, thus the difference between both simulations allows to quantify the biogeophysical effects of afforestation. It would be interesting to compare these effects in temperature to previous studies both observational (Duveiller et al., 2018; Alkama and Cescatti, 2016) but also modelling studies with more complex Earth System Models that quantify the biogeophysical effects (a.o. Boysen et al., 2020; Winckler et al., 2019; Portmann et al., 2022). This way you could assess how well the UVIC model represents biogeophysical effects or whether there are potentially biases (a comparison can only be qualitative of course as the amounts of afforestation differ across studies).
- In the analysis of the temperature response you mainly focus on albedo as an explaining variable, this is warranted as the effects are mostly cooling however

previous research as mentioned in my comment above found that afforestation might also cause a local cooling effect due to changes in turbulent heat fluxes. It might be interesting to check some of the other energy balance components in order to understand whether these effects are absent in the model or whether the temperature response is simply dominated by the global warming as a consequence of the albedo effects.

- The description of the model is too limited and should be elaborated as at this point it is not clear what important processes for afforestation are resolved and which not. You should elaborate this description (or add a more detailed section in the supplements) with a larger focus on the land surface scheme (e.g. list of PFT's).
- Line 186-188: you explain that the albedo increases initially in all simulations, but you never explain why this happens or what process is behind it. I assume it is the remaining natural vegetation reaching their climax as the model employs a dynamic vegetation model but it would be good to clarify that here.
- Line 238: this is still the section regarding temperature effects it is a bit strange that in the summary of this section you mention ocean acidification, I would remove this.
- The results have clear narrative and important conclusions which are clear and well founded, however the article would benefit from including more similar literature in a discussion chapter in order to facilitate the understanding and critical review of results which can also help draw out future research suggestions. At this point in time I lack this greatly as there is a lot of work out there on the effects of afforestation on climate and carbon (see eg Pongratz et al. 2022), it would also be good to check if some studies have assessed the ocean effects of afforestation (I am not aware of any literature regarding this so I cannot suggest any). This comparison to literature can help highlight strengths and limitations from the approach used in this study.

#### technical corrections

- This is in part my opinion but I don't think you need lat lon labels in a global spatial plot, just the ticks suffice for the readability of the plot and in general it just gets cluttered more by adding all those labels, however this is just an opinion so if you want to stick with the plots you have now that's fine too.
- Line 213 : Sect. 3.1 ii) one bracket should be removed after ii
- Line 262: Figure22 should be Figure S22

#### References:

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- Boysen, Lena R., et al. "Global climate response to idealized deforestation in CMIP6 models." *Biogeosciences*22 (2020): 5615-5638.
- Winckler, Johannes, et al. "Nonlocal effects dominate the global mean surface

temperature response to the biogeophysical effects of deforestation." *Geophysical Research Letters* 2 (2019): 745-755.

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