

Response to the Reviewers Comments

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Manuscript title: A comparison of the climate and carbon cycle effects of carbon removal by Afforestation and an equivalent reduction in Fossil fuel emissions

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Anonymous Referee 3

Our responses to the reviewers' comments are in red.

General remarks

I would like to thank the authors for their work and efforts in improving the manuscript, it has improved greatly from the initial submission.

We thank the reviewer for the positive remarks on our work. We have addressed the comments of the reviewer in the revised manuscript as discussed below.

Comment 1

Introduction: This section has improved greatly and is more targeted and more readable than in the initial submission. My comments mostly focus on lines 53-70 where the authors discuss processes relevant to biophysical effects. Only albedo and evaporation are highlighted as important variables which is a rather limited view and neglects previous literature (eg Winckler et al. 2019 JGR; <https://doi.org/10.1029/2018JD030127>) that shows that changes in roughness are crucial to understand the effects of land cover changes. Even though I think it is justified to assess these impacts by analysing albedo and evaporation I think the other relevant processes should at least be acknowledged in this introduction.

Response to Comment 1

We thank the reviewer for this important comment. We agree with the reviewer that the effects of changes in surface roughness should be discussed in the introduction. We have added the following sentences to address this comment and cited the reference suggested by the reviewer:

“The biophysical effects of land cover change (such as afforestation/deforestation) refer to changes in land surface properties such as land surface albedo, surface roughness and evapotranspiration.” (Please see page 3, lines 53-55)

“Winckler et al., 2019a show that changes in surface roughness associated with land cover changes can have significant effect on surface temperatures.” (Please see page 3, lines 59-60)

Comment 2

Results and discussion: It is mentioned several times throughout the text that evapotranspiration decreases as a consequence of increased water use efficiency of trees however no literature is cited to support this claim and the authors do not appear to have assessed this hypothesis critically. As this argumentation is the main and only explanation of this change (which contradicts previous literature) it should be checked and explained better. Is it then assumed that the effects of water use efficiency are larger than the biophysical changes in roughness and evaporative capacity, which are generally deemed to cause an increase in evapotranspiration as a consequence of afforestation. I understand that these factors cannot explain a decrease but I find it strange that the lack of their role is not discussed nor explained anywhere in the manuscript.

Response to Comment 2

We thank the reviewer for this important comment. The decrease in evapotranspiration in our afforestation simulations is explained in a better way in the revised manuscript as follows, “In the AFFOREST case, evapotranspiration (averaged over 2471-2500) is smaller by 2.6%, 4.5% and 6.2% relative to the FIXED_AGR case in the SSP2-4.5, SSP3-7.0 and SSP5-8.5 scenarios, respectively (Figure 3c). In contrast, previous studies show that afforestation leads to an increase in evapotranspiration (Chen et al., 2012; Wang et al., 2014; Duveiller et al., 2018; Huang et al., 2018). This contradiction could be explained by the dominant effect of increase in water use efficiency of plants at elevated CO₂ levels over the effects from an increase in roughness length and an increase in the evaporative capacity of vegetation in our model simulations, resulting in a net reduction in transpiration (Cao et al., 2009, 2010; Gopalakrishnan et al., 2011). The effects of elevated atmospheric CO₂ on the transpiration fluxes are larger for trees compared to grasslands (Kirschbaum and McMillan, 2018).” (Please see page 8, lines 224-231)

Comment 3

line 390-391: how can you claim that results would be qualitatively similar in other studies with more complex models when similar studies exist but show strong differences in biophysics (eg cooling in tropics and evaporation increases see De Hertog et al. 2023 as an example; <https://doi.org/10.5194/egusphere-2023-253>). I suggest to soften this statement or to remove it.

Response to comment 3

The sentence is now changed in the revised manuscript as follows, “Despite the above limitations we believe that our results provide useful insights into the biophysical effects of afforestation in future climate scenarios.” (Please pages 12-13, lines 380-381)

Associate Editor Comments

General Remarks

Thank you for your revised manuscript and the detailed answers to the reviewer comments. Your manuscript has now been evaluated again by two reviewers. They both agree that the quality has much improved. One reviewer lists additional comments that need to be considered before your manuscript can be accepted for publication.

We are thankful to the associate editor for reviewing the document. We have addressed the comments of the associate editor in the revised manuscript as discussed below.

Comment 1

Abstract: please include some details about the setup of the (idealized) simulations.

Response to Comment 1

The following lines are added to the abstract describing the simulations, “We performed two major sets of idealized simulations in which fossil fuel emissions follow extended SSP scenarios (SSP2-4.5, 3-7.0, and 5-8.5), and equal amounts of carbon are removed by afforestation in one set and by a reduction in fossil fuel emissions in another set.” (Please see page 2, lines 18-20)

Comment 2

Section 3 is named 'Results', but reads more like Results and Discussion, as it includes also interpretation of the results and comparison to other studies. Also, the conclusion section is very long. A conclusion should bring short take-home messages but should not bring new elaborate interpretations. Please restructure sections 3 and 4 to improve this. So, either bring parts of the conclusion to the Results and Discussion section, or separate into 3. Results, 4. Discussion, 5. Conclusion. In the latter case, the data interpretation and discussion of results, should be included in section 4.

Response to Comment 2

We thank the editor for this comment by the editor. As suggested by the editor, we have now split the original section 4 into two sections (4. Discussion and 5. Conclusions). Section 4 discusses the data interpretation and results while section 5 briefly summaries the key conclusions.

