

# ***Interactive comment on “Global climate response to idealized deforestation in CMIP6 models” by Lena Boysen et al.***

**Lena Boysen et al.**

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Dear Referee,

thank you for providing us with this constructive review.

Referee comments: This study reports on the multi-model LUMIP deforestation experiment. The authors show that controlled, large-scale, global deforestation may contribute global geophysical cooling of near-surface temperatures and global geochemical warming. The geo-physical effects vary latitudinally and by model, generally with warming in the tropics and cooling elsewhere, while the geochemical effects are estimated offline as warming everywhere. The geochemical effects generally are greater than the geophysical effects, leading to net warming, although a potential CO<sub>2</sub>-

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enhanced land sink is not included here. Land carbon losses are driven by vegetation loss. Some novel metrics for assessing and potentially estimating the effects of deforestation are also presented. I appreciate the tremendous effort the authors have put into this study to advance our understanding of the effects of land cover change on the earth system. I have a few main comments, followed by some brief detailed comments.

Reply: Thank you for your acknowledgement of our work and your valuable feedback to our manuscript. In the following I will address your points and how we want to improve the manuscript.

1. Improving the abstract: What are the take home messages? There are a lot of different analyses, and only one aspect is highlighted in the abstract. The abstract includes some key numbers, and at least the potential net warming statement of large scale deforestation. While this in itself is a key finding (with the associated caveat of constant CO<sub>2</sub>), there are a few other notable results to highlight. Missing are the policy/scenario implications related to time/fraction of emergence for climate vs carbon. And the potential for rough estimates of response via the sensitivity metrics (which are analogous to climate sensitivity of models). I understand that there are some limitations to the sensitivity metrics and the time of emergence estimates, but based on S13 and S18 (plus the rest of the carbon figures), it seems safe to say that the climate signals have relatively long time frames while carbon signals have relatively short time frames. However, the climate signal emergence is further complicated by observations that show large, immediate meteorological distinctions between forest and grassland. The sensitivity metrics support the temperature and carbon results, and are potentially useful to the community.

Reply: Thank you for pointing this obvious finding out! We will follow your suggestions and make the abstract stronger and more significant by including these results.

2. Swap figures: In relation to comment (1) above, switching some of the regular and supplemental figures would make the paper stronger. For example, figures S22

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(carbon sensitivity to deforestation) and S18 (ToE and FoE) are more relevant to the carbon points than figures 9-10, which are explanatory. Also, figure S3 is much clearer and easier to understand than figure 3, and follows the text better (you can add Tas to fig S3).

Reply: We agree that some of the figures have the potential to be shown in the main text. However, we would like to keep the number of figures as it is now and the decision for one or the other figure is difficult. We would like to keep the GPP and carbon time series figures in the main text as they show fundamental results. The decision for the surface energy balance decomposition figure has also more sides to it. We argue that the model-wise comparison in the manuscript offers an easier access to the model's performance to simulate Tsurf. On the other hand, a component-wise presentation provides a better inter-model comparison which might be more valuable to the reader. We therefore agree to swap Figures 3 and S3.

3. Temperature definitions: The descriptions of Tsurf-model and Tas are not complete, which makes it difficult to properly assess the temperature comparisons. While Tsurf is clearly a radiative temperature, is Tsurf-model a radiative temperature for all the models? Tsurf in some models is a canopy air temperature, at a height dictated by the displacement height and aerodynamic roughness. The 2m air temperature is often the air temperature 2m above this "Tsurf." It is important to be clear as to what and where these temperatures actually are, as shown by some of your references.

Reply: Thank you for this inquiry. We will add more specifications to the method and results section on where surface temperature is calculated in the models and what this implies.

4. MIROC: MIROC does not seem to meet the deforestation harmonization requirements, and its plots don't seem to add to the understanding of the issue. In fact, a lot of extra text is dedicated to explaining why MIROC is different from the others. It would be cleaner if it were not included.

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Reply: We would like to keep MIROC in the analysis. We list the caveats of each model's execution of the experiment and highlight if this is the reason for an observed result. This in itself is a demonstration of the difficulties in carrying out harmonized land-use and land cover change-related studies with many participating models. We think that it is still interesting how strong regrowth in this model is and how small the biogeophysical responses are despite a clear disturbance. Furthermore, MIROC simulates interesting carbon dynamics and should therefore be accounted for. We argue that it would be more inclusive to leave MIROC in all analyses than to keep it in only some relevant ones (e.g. the carbon analysis).

We will add 'We nevertheless analyse results from MIROC to not only demonstrate the effect these different technical realizations of one scenario can have but to also to draw conclusions for improvements in this model.'

5) Some supplemental figures are cited out of order.

Reply: We will fix that. Thank you for your close observation.

Thank you for your further comments to improve the readability and understanding of our study. We will take them into account during the revision and you can find them in the supplement.

With kind regards, Lena Boysen & co-authors

Please also note the supplement to this comment:

<https://bg.copernicus.org/preprints/bg-2020-229/bg-2020-229-AC4-supplement.pdf>

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