Response to reviewer 2 of the paper entitled
"Different response of surface temperature and air temperature to deforestation in climate models"
Ref.: esd-2018-66

We would thank the reviewer for the time he/she devoted on reviewing the manuscript, and for his/her helpful comments.

Below are the reviewers comments (***bold italic font***) and our responses to each point (normal font). All line numbers that we provide in our responses refer to the revised version of the manuscript in which track changes are not shown.
The original manuscript contained one paper (Winckler et al., 2018) that had not been accepted yet. This manuscript has now been accepted (doi: 10.1029/2018gl080211) and can be made available to the reviewers.

In this paper, the authors evaluate how the land cover change response differs for surface temperature relative to air temperature in observations and models. This paper provides important clarification in terms of how these two different temperatures respond to land cover change with observations indicating that changes in surface temperature are roughly twice as strong as they are for air temperature. Models show a varying amount of agreement with the observations. The assessment of local versus nonlocal responses is less developed and is less likely to be the 'final word' on this topic, but I believe the nonlocal results are still worthy of publication. The paper is generally well-written (though it could use another full edit) and the figures are clear. I recommend the paper for publication pending minor revisions as outlined below:

We are happy that the reviewer thinks our results are worthy of publication.

1. ***Definition of local: The authors use the term local to refer to responses to deforestation within the same grid cell where the deforestation occurs and nonlocal changes to situations where deforestation has effects that extend beyond the deforested region. This is a reasonable definition, but it's worth noting that several recent studies have looked at even more local responses by examining the sub-grid responses within a grid cell (e.g., forested vs cropland). Perhaps it would be helpful to note the difference in definition and to cite a few of these studies (e.g., Malyshev et al., 2015, Schulz et al., 2016, Meier et al., 2018).***

   It is indeed important to clarify differences to these previous studies. In the last paragraph of section 2.1, we now cite these studies and shortly discuss differences in the definitions of local effects.

2. ***P.1, Line 17: Not sure I agree with the statement 'Much less considered are the climate changes'. Researchers have been investigating the climate impacts of deforestation for decades.***

   We corrected the respective text. Now: 'In addition, changes in forest cover can cause a warming or cooling,...'

3. ***P.2, Line 34: For clarification, consider changing: 'the local effects have to be isolated from the climate model results' to 'the local effects need to be disaggregated from the nonlocal effects when analyzing climate model results.'***

   We changed the text accordingly (with 'separated' instead of 'disaggregated').

4. ***P.3, Line 26. Can you provide a rationale for the method of removing forest in 3 out of 4 grid cells? Why not 2 out of 4 or 1 out of 4 or 5 out of 6? Would be helpful to be able to refer to the deforestation map, either as a figure in the main text or as supplemental material.***

   We now acknowledge (last paragraph of section 2.1) that the choice of 3 of 4 grid cells is to some extent arbitrary, but the local effects within a grid cell are largely insensitive to this choice (Winckler et al., 2017a). We now provide the deforestation map in Fig. S1.

5. ***P.5, Line 24. It's not totally clear to me how T2m is derived from S2m using eqn. 1. Equation 1 describes how to calculate Szaero, not S2m.***

   We now state that $z_{aero} = 2\text{m} + d + z_0$ has to be used in equation 1 in order to derive T2m.

6. ***P.5, Line 22: Change 'Different functions gamma are used' to 'Different functions for gamma are used'. Line 27: An extra 'and' in this line.***

   Thanks, corrected.

7. ***P.6, Line 26: This sentence confused me at first because I had forgotten about the way the global-deforestation run was done (i.e., with 3 out of 4 gridcells deforested). Please clarify. Seems possible that what you mean is actually 'large-scale' deforestation rather than global-scale.***

   We changed 'global-scale' to 'large-scale'.

8. ***Figure 1. Seems like some level of significance is needed here or at the very least selection of a color scale that doesn't imply a near-global signal from deforestation (i.e., colors everywhere).***

   We added stippling to indicate where results are not significant at a 5% level according to a student t-test accounting for lag-1 auto-correlation (Zwiers and von Storch, 1995).

9. ***P.11, line 5: Should probably note that CCSM4, CESM1-CAM5 and NorESM1 all share the same land model, CLM4).***

   I added this remark, thanks.

10. ***P. 11, line 17. I don't think this is an assumption, this is a result of your analysis. There is no 'assumption' that Tatm does not respond to deforestation.***

    I changed the phrasing, thanks.

11. ***12. P.12, line 26: Personally, I don't think the comment about carbon cycle feedbacks and the fact that they are non-local is necessary. First, this is stating the obvious. Second, this paper is about biogeophysical impacts.***

    This statement may be obvious for experts on deforestation effects in climate models, but possibly not for the broad audience of ESD. We would like to keep this statement to make non-experts aware that the biogeophysical effects (for which dT seems to differ especially for the local effects) are only

one part of the deforestation effects, and that the other part, the carbon effects, can be expected to act essentially nonlocally.

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Meier, R., Davin, E. L., Lejeune, Q., Hauser, M., Li, Y., Martens, B., et al. (2018). Evaluating and improving the Community Land Model's sensitivity to land cover. Bio- geosciences, 15(15), 4731-4757. https://doi.org/10.5194/bg-15-4731-2018
Schultz, N.M., X. Lee, P.J. Lawrence, D.M. Lawrence, L. Zhao, 2016: Assessing the use of subgrid land model output to study impacts of land cover change. JGR., 121, 6133-6147, DOI: 10.1002/2016JD025094.

References

Bright, R., Cherubini, F., and Str\omman, A. H. (2012). Climate impacts of bioenergy: Inclusion of carbon cycle and albedo dynamics in life cycle impact assessment. *Environmental Impact Assessment Review*.

Schultz, N. M., Lawrence, P. J., and Lee, X. (2017). Global satellite data highlights the diurnal asymmetry of the surface temperature response to deforestation. *Journal of Geophysical Research: Biogeosciences*, 122(4):903–917.

Winckler, J., Reick, C. H., Lejeune, Q., and Pongratz, J. (2018). Nonlocal effects dominate the global mean surface temperature response to the biogeophysical effects of deforestation. *Geophysical Research Letters*.

Winckler, J., Reick, C. H., and Pongratz, J. (2017a). Robust identification of local biogeophysical effects of land-cover change in a global climate model. *Journal of Climate*, 30(3):1159–1176.

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Zwiers, F. W. and von Storch, H. (1995). Taking serial correlation into account in tests of the mean. *Journal of Climate*, 8(2):336–351.