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Earth System Dynamics
Discussions

Interactive comment on "Different response of surface temperature and air temperature to deforestation in climate models" *by* Johannes Winckler et al.

Anonymous Referee #3

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General Comments

The research described in this article addresses an interesting topic – how deforestation affects various measures of temperature, as calculated by global climate models. Overall, I thought the results were well presented, but I had some issues with the way the paper was written, which led to some confusion on my part that required repeated re-reading. Some important ideas were glossed over (e.g., deforestation leading to reduced longwave forcing from above), and I had to infer (possibly incorrectly) some cause-and-effect mechanisms. This will require more interpretation of the results than is presented here.

Specific Comments

Page 2

Line 13: The 2 effects often associated with deforestation are albedo increases (which cool the surface) and a reduction in transpiration (which reduces the latent heat flux, forcing the sensible heat flux to rise and increasing the surface temperature). Is it the balance between these competing effects that depends on latitude, leading to cooling at some latitudes and warming at others?

Page 3

Line 24: I'm confused by the way the 'forest world' was created. I understand how forest was placed in areas where it existed in pre-industrial times (but currently does not). Figure 1, however, shows strong local effects in the Sahara and Gobi deserts. Was there any difference in the local forcing at these locations? A map of what the vegetation in the forest world looks like (along with the $\frac{3}{4}$ world) would be helpful.

Line 26: I'm not sure what 'three of four grid boxes' means. Were 3 out of every 4 forested ares randomly selected to be deforested, or was some kind of pattern used?

Page 6

Line 4: They write 'nonlocal effects strongly depend on the areal extent and spatial distribution of deforestation'. I'm assuming that the deforestation patterns differ among the different climate models, which is why it is impractical to compare nonlocal effects between the different GCMs, correct?

Line 25/26: I'm interpreting this as follows: deforestation leads to a global reduction in temperature and humidity (due to the increases in albedo and decreases in evapotranspiration?), and this leads to more longwave escaping to space and less coming from above. Is this correct, or do changes in cloud cover play a role? If the former, it should be stated more clearly.

Line 27: The pattern of nonlocal effects in Fig. 1 needs some explanation. Why are the eastern Pacific Ocean currents warmer? And why are the forested areas in the Amazon and equatorial Africa warmer? How are they affected by their neighboring, deforested areas? Is this also due to changes in longwave forcing?

Page 8

Line 4/5: Again, the idea here is that a local effect is propagated remotely by reducing humidity and allowing more IR to escape, correct? And if that is true, what is causing the nonlocal increases of the 3 temperature metrics in the Amazon and equatorial Africa? I'm assuming it is related to the dense forest in these areas, perhaps making the change due to deforestation more pronounced in these locations, but some explanation is needed.

Line 5: Now, it is stated that changes in atmospheric temperature and moisture are affecting longwave radiation. Is deforestation decreasing the global humidity, making the atmosphere more transparent to longwave?

Line 30-35: If 'atmospheric conditions are unstable', why do we not see convective overturning of the atmosphere? This would eliminate the vertical gradient seen in Fig. S3b. Also, how does reducing the roughness length increase instability?

I'm not quite following this explanation for the differences between Figs. S3a and S3b. First, Tsurf is shown to increase during the day and decrease at night. These are linked to changes in stability, and this leads to differences in the way T2m is calculated between night and day with Monin-Obukhov theory and Eq. 2. What is missing is an explanation of the changes in Tsurf, why they differ between day and night, and why the changes vary with latitude (Fig. 2). Are they related to changes in albedo, in evapotranspiration, or both? This seems to be the key driver for the local changes, and ultimately the nonlocal changes as well.

Additionally, invoking the parameterization in Eq. 2 as the explanation of why the T2m

values don't change as much as the Tsurf values is not really explaining why it is happening. Exactly what physical mechanism is causing the 2m temperature to vary less?

Finally, this explanation of differing responses between Tsurf and T2m in summer and during the day is ultimately the reason that these 2 variables look different in the annual averages in Fig. 1, correct? And the way that local changes in Tsurf vary with latitude in Fig. 1 are because the changes in Tmin at the surface dominate at high norther latitudes, while the changes in Tmax dominate elsewhere, correct?

Technical Corrections

Page 1

Line 5: The acronym MPI-ESM should be spelled out here.

Line 7: The phrase 'effects affect' is awkward, and should be revised.

Line 11: It was already established that the authors were using the MPI-ESM, so what is this 'inter-model comparison' they mention now? A sentence explaining that existing model data from multiple GCMs was examined for comparison to the MPI-ESM results is needed.

Page 3

Line 15: The 'wide range of climate models' needs more context. As in the abstract, a sentence explaining the idea should suffice.

Page 5

Line 27: The first sentence of Section 2.3 is confusing and should be rewritten. The phrase 'In order to. . ..other climate models,' is not needed, since it just states the same idea in the rest of the sentence.

Page 6

Line 6: Change ‘deforestation in the difference’ to ‘deforestation as the difference’.

Page 7

Figure 1: These are annual means, correct? If so, it should be in the caption.

Page 8

Line 23: The sentence ‘Similarly as in the case. . .’ should reference Fig. 2.

Page 11/12

Some information in the Discussions/Conclusions section was already included in the introduction.

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