Detailed point-by-point response

Overall, this reviewer found that the manuscript has improved and the authors have addressed many concerns. There are some minor things that this reviewer would like some clarification on. Additionally there are some technical corrections that the authors need to address as well. Primarily around the use of defined terms, figure corrections, etc. Please be extremely thorough with edits around formatting and how you decide to use your defined variables. This review is based on the manuscript version with changes shown, so some of these comments may not be relevant and already addressed.

We thank the reviewer for taking the time to re-read the manuscript and to provide feedback on the manuscript and appreciate their thoughful and diligent comments. We hope we have adressed them thoroughly and ask the reviwer to get back in case something is not clear or unsatisfactory answered.

Specific Comments:

1. L26 Pan et al. 2024 might be a good reference as an update: Pan, Y., Birdsey, R. A., Phillips, O. L., Houghton, R. A., Fang, J., Kauppi, P. E., Keith, H., Kurz, W. A., Ito, A., Lewis, S. L., Nabuurs, G.-J., Shvidenko, A., Hashimoto, S., Lerink, B., Schepaschenko, D., Castanho, A., & Murdiyarso, D. (2024). The enduring world forest carbon sink. Nature, 631(8021), 563–569. https://doi.org/10.1038/s41586-024-07602-x

   Yes, that's a good point. Included!

2. L93 maybe include resolution for the study here as well? I see that it's in L112, but one of the first things that popped into my head was the question of how big are the grid cells.

   Agreed, we included the resolution in L93.

3. L134-137 Could the authors please plot out the map of the the ecoregions alongside the evergreen needleleaf fraction map to show clearly how the study/model areas are defined? Could be added to the supplement. On all maps maybe have some clear way to distinguish the study area because otherwise the maps such as figure 2 make it look like everything is bare soil even though the grey is slightly different than the background grey.

   We adapted the color key of bare soil in Figure 2, to be better distinguishable from the base map. We also added the WWF boreal ecoregion to our Figure 3B for reference. If the reviewer is interested further, here is an interactive map of all the ecoregions: https://ecoregions.appspot.com/.

4. Figure 1 setpup → setup, really nice figure!

   Corrected. Thanks for the feedback, really appreciated!

5. L152-160: some formatting issues, where equation showing up after Table 1. I like the inclusion of the equations. Maybe reference the equations in the description. This is also the area where this reader got confused with the terms and how they are used throughout the manuscript.

   We expanded on the definitions given here to hopefully clear out confusing use of these variables throughout the manuscript (see later comments). We also corrected some formatting issues in the process and made sure the table was not inserted right before th equation (though we assume this will be subject to final layout changes).

6. "To express which percentage of vegetation FPC(excluding bare soil) consists of which PFT". Is soil specific in the model of land where vegetation can grow or is just land fraction/cover? Could the authors consider changing soil to land as a general term and then specify bare soil as you have already done to make a clearer distinction. For example "FPC describes the fraction of (soil → land), covered by a specific PFT. If FPC is smaller than one, vegetation does not cover the (soil → land) completely, and the bare soil fraction is calculated as 1 - FPCV ".

   This might be due to the fact that we use a soil map to define our grid and I am therefore thinking of the landsurface as 'soil' but 'land' sounds not correct to me here. I would understand this to refer to larger geographic areas and not the per-gridcell level. But I am happy to change it, if the reviewer feels strongly about this.

7. L163-165: What instances are IBS and TeBS combined? Region based?

   We combined this for Figure 3. It's a good point, I made it explicit in the text.

8. L180 is bare soil 1-FPCv and not X^V

   The difference between FPC_V and X^V is that FPC_V can be larger than one, while X^V and X^{Soil} are normalized between 0 and 1 (due to being fractions). Equation 4 says that X^{Soil} is 0 if $FPC_V > 1$ (no bare soil), or $1 - FPC_V$ if $FPC_V < 1$, so make sure it is a fraction. Now thinking about it, X^V really is a synonym for FPC_V that is only defined if $FPC_V < 1$. We removed X^V throughout the text and used FPC_V to avoid confusion here.

9. L187 Is the heading 2.4.3 still there?

   One reviewer requested less subsections, so I merged 2.4.2 and 2.4.3. The current headings are: 2.4.2. Biophysical land-surface properties and 2.4.3. Attribution of drivers

10. Table B1 units for FPC $m^2\,m^2$?

    Yes, thank you. Corrected.

11. L216 Is it FPCv or X^v? What exactly is X^v without the Xi^v

    See answer to 8. I also added some information to the paragraph to hopefully make it clearer.

12. L220 Potentially change units for AGC to kg C m^-2.

    Yes, it should be kg C m^-2.

13. Figure 2 2070-2100. Is there really that much bare soil fraction? Can the authors explain this further?

    In the model, yes. One aspect is that these are averages over the whole study area and parts of the study area are very high latitudes with very sparse vegetation. Another thing to keep in mind is that these fractions are resolved in 'real space' whereas remote sensing data classifies on a pixel basis e.g. 50 % forest cover is classified as a forested pixel in the ABoVE framework. Thus vegetation cover fractions tend to be higher in remote sensing. We have another study where we compare and validate this in more detail, unfortunately it is not published yet.

    It is of course possible that our simulated bare soil fraction is indeed to high. This would especially have an impact on the albedo calculations. I added a sentence to the discussion there to make this clear.

14. L253 "of total FPCv" I think if the authors define terms that it would be best to use them or consider ways to simplify the terms.

    Total FPC includes soil fraction, so FPC_V would not be correct here. I made it clearer in the text, which variable I am refering to where and also references the Equations that are now Eq. 1 - 4, previously Eq. 1.

15. L269 "X^v -¿ FPCv?" declines?

    I think this also stems from the confusion due to FPC_V and χ^V being synonyms if $FPC_V < 1$, as is the case for averages over the landscape (that refers to Figure 2a and Figure 3). I initially used χ^V here for consistency but I agree that I might have achieved to be more confusing instead. I changed it here to FPC_V. See also answer to 8.

16. L270 Figure 3b

    We added 'Figure', thanks for spotting that.

17. L281 Figure ?? formatting issue.

    Yes, thank you. Corrected.

18. L296 is X^v this seems like the authors are trying to state that FPCv increases?

    See Comment 17.

19. Figure 3, B5, and B6 are awesome and interesting to think about. For easier comparison these figures should be kept on the same scale.

    Thanks, I am happy to hear that. Good point, I set the y-limits to be consistent across plots. (I hope this is what you mean?)

20. Figure 4 no pink lines or stippling

    Unfortunately I do not understand this comment Are you saying the pink lines and the stippling should not be there or that you do not see it? Would it be possible to clarify?

Thank you again for taking the time and apologies we were not able to adress the last comment.