<u>Revision to: "Low sensitivity of three terrestrial biosphere models to soil texture over the South-American tropics"</u>

In this study, the authors perform a sensitivity analysis to different soil texture properties (from the global SoilGrids250m dataset) on the carbon cycle in three Terrestrial Biosphere Models (TBMs), namely LPJ-GUESS, ED2 and ORCHIDEEv2.2. They evaluated the aboveground biomass spatial distribution, ecosystem Gross Primary Productivity (GPP), soil carbon content and drought stress simulated by the three models over the Amazon rainforest region, using model default pedotransfer functions. They found that the model outputs were mainly insensitive to soil texture change, showing the poor representation of the soil-vegetation coupling in the TBMs.

Overall I find the topic very interesting and important to produce accurate simulations in the land surface models. There are some points that I think need to be improved/clarified in the manuscript to be suited for a publication.

**Major comments:**

1. I think the soil texture is also connected to the land use / land cover over a region. Even more, the root depth plays a key role in the water uptake and therefore in GPP and ET processes. Given that the Amazon basin has gone through deforestation activity for more than three decades, it is important to take into account the land cover, the root depth and the soil texture to have a realistic effect in the change in biomass.

2. I think the change in soil clay should be carried out with a recalibration of other land surface-related parameters in the TBMs to have an accurate representation of land surface processes. Maybe the low sensitivity observed in the simulations is in part related to this non parameter recalibration?

**Minor comments:**

1. I suggest in the introduction to include also relevant literature in regards with Amazon deforestation. I think deforestation and subsequent land cover change has an effect in soil texture variability that is worth to mention.

2. The authors cite literature about ORCHIDEE and ED2, but not about LPJ-GUESS. I suggest to include recent work done with this model.

3. Line 96 → Please specify sensitivity of what property/variable from the three TBMs to soil texture?

4. Line 96-98 → Please rephrase this idea "which occupy different positions along the vegetation representation abstraction continuum". Perhaps do the authors mean something like the three models have different levels of complexity?

5. Line 107 → Could you please explain your reasons to select the cohort mode over the other two options and the related implications?

6. Line 108 → I believe the acronym "PFT" has not been properly introduced nor explained so far.

7. Line 110 → Which meteorological drivers? And where do you get this input data from?

8. Line 117 → "Soil moisture in the top two layers (20 cm) is available for surface evaporation". Does this mean that deeper soil moisture (>20 cm) is not available for evapotranspiration processes? I believe this is not an accurate representation of the soil water uptake by the Amazon rainforest (see doi: 10.1038/372666a0). How can this affect the interpretation of your results?

9. Line 117 → "Only two larger percolation layers are defined". Larger than what?

10. Lines 121-122 → About the soil water content per grid cell, how does it change in time? Do you give soil moisture as input data to the model to compute the water content at filed capacity and at wilting point?

11. Lines 133-134 → I suggest to remove this information or move it to the introduction, as I do not see its relevance for the methods nor for the results.

12. Line 137 → Similar to my previous comment, where do you get the meteorological forcing from?

13. Lines 152-153 → "Simulated sites are characterised by vertically uniform soil texture and hence hydraulic properties over the entire soil column". Did you mean: Simulated sites are characterised by vertically uniform soil texture and hence _uniform_ hydraulic properties over the entire soil column?

14. Lines 15-156 → I am confused here. If this model can use the vertically integrated soil water from the deepest soil layer (which I believe is 8 m depth based on line 148), how can you compare the results obtained from this model (ED2) with those obtained from the previous

model (LPJ-GUESS) that only uses water available from the first 20 cm of the soil column? Also, the third model (ORCHIDEE v2.2) has 2 m depth soil profile, so the same question would apply for the results from the third model.

15. Line 162 → For <u>a</u> given vegetation

16. Line 164 → I see that here you define for the first time the acronym PFT, but it was used several times before.

17. Line 166 → A reference for *Richards equation* would be good here.

18. Line 185 → With "current PFT distribution" do you mean a global ESA-CCI land cover map from 2015? From 2021? From 2022?

19. Line 194 → What do you mean with "the most default"? Is it that you varied only few parameters from Table 1?

20. Lines 206-207 → I do not understand the sentence. Perhaps do you mean that you average either (*i*) the last ten years of the historical period (2006-2016) or (*ii*) the last year of the historical period (2016)?

21. Lines 215-217 → The information of where to find the code is already in section Data and code availability, therefore, I suggest to remove it from the methods section.

22. I think Section 2 should be reorganized in a more straightforward way for understanding. For instance, you could start with a first subsection that contains a description of the study area (coordinates, land use/land cover, climatology, etc.). A second subsection could be the models' description. A third subsection could be a brief description of all datasets used in the study. In a fourth subsection you could integrate the simulation protocol, the soil scenarios and the model parameterization. And a fifth subsection could be the analyses.

23. Figure 1B is not really showing *the difference* between the intra-grid cell and the inter-grid cell variability but both in the same plot. I would suggest either to rephrase this part of the caption (to something like *inter (black) and intra (red) grid cell variability...*), or to really plot just one line that shows the difference between the two lines. Moreover, why does the legend include sd (mean) for the inter-grid cell variability and mean (sd) for the intra grid cell variability? What is "sd"? I presume is standard deviation, but the acronym is not defined.

24. Caption from Figure 1C. I suggest to remove the last sentence ("showing a clear shift toward larger clay contents in the Max. clay scenario"), as this should not be part of the caption, but part from the main text describing the results.

25. Lines 238-239 → The sentence "The three soil scenarios were built on this intra-gridcell variability in soil texture...within each gridcell" is not part of the results but part of the methods. You should move this to the methods section.

26. Line 245 → Perhaps do you mean supplementary Figure S2?

27. Figure 2 and Figure S2 → I strongly recommend the authors to change these Figures. Instead of plotting the mean values of each model in the second row of the Figures, you could plot (for each model) the difference between the model output and the reference data. It perhaps will be interesting to see in which specific regions there is better/worse performance of the models. The way the Figures are displayed right now makes it very hard to compare overestimation/underestimation of the models in regards with the reference data. Moreover, why is Figure S2 in supplementary if its results are as important as the results from Figure 2?

28. Line 264 → The first sentence does not specify differences in what.

29. Line 266 → Which correlation coefficient did you compute? The methods section does not mention any correlation analysis, so this came as a surprise in the results section.

30. Line 266-271 → Can you please explain how can we infer these numbers from Figure 3? Or is this information not shown in the Figures and you computed it elsewhere?

31. Line 272 → Please indicate the location of these gridcells and the reasons to select them.

32. Line 277 → You mention here Soil moisture index. Is it the same of soil drought stress index? If so, you should refer to it in the same way throughout the document.

33. Line 278 → After the sentence "aboveground biomass" add: (supplementary Figure S3).

34. Line 284 → Did you perform any significance test to say this? If not, you should write "We observed some substantial impacts..."

35. Line 290 → Change from "most important" to "the most important".

36. Figure 6 → Could you provide the $R^2$ for the goodness of fit and the slope of the fitted line? Also, I strongly recommend to change the markers for the scenarios, it is really hard to differentiate one from the other.

37. Line 304 → I would omit the cross-reference here of Figure 1 as I do not see a strong reason to use it in the context of the sentence.

38. Lines 315-316 –> Explicitly indicate that the supplementary Figure S6 is from Poggio et al. 2021. Perhaps something like: see supplementary Figure S6 from Poggio et al. 2021.

39. Figure S5 → Explicitly indicate in the caption that $K_{sat}$ is saturated hydraulic conductivity.

40. Overall, I think that the discussion section should not present cross references to Figures. All the Figures (both from the main text and from the supplementary material) should be properly described in the results section and the main message derived from them can be included in the discussion. Specially, Figure S5 is mentioned for the first time in the discussion, so please move it to the results section.