General comment to the reviewer: Thank you for taking the time to thoroughly read our manuscript and for your constructive comments, which have greatly improved the clarity and accessibility of our manuscript. Your original comments are highlighted in red and our responses are in black. When text is copied directly from the revised paper the words are italicized.

This paper seems a mine of parameters for land surface process models and resources for generating the parameters. My feeling is that the author(s) made a reasonable effort for conducting this research, and further, this paper should be published in GMD as soon as possible because I believe this paper would be of extreme value for developers and users of the land surface process and terrestrial ecosystem dynamics models.

Thank you for recognizing the value of our research, and again for reading our paper thoroughly.

However, there are some small flaws in the present manuscript, and so before this paper is accepted, the author(s) must revise the manuscript according to the followings: When an abbreviation/a symbol appears for the first time, write it out in full spelling: What is TFS (P1L33, P6L20), WD, LMA, NL and PL (P6L21)?

We have ensured that all acronyms are defined the first time they are used in the manuscript.

I suggest in Introduction section, you should state the temporal (apparently, hourly scale) and spatial (apparently single-plot/stand scale) scale of the model. This might be "readers-friendly".

We added two sentences in the revised introduction (P4 L4-8) to clarify this point: *In this paper, we develop a continuous porous media approach intended for application at specific sites in the tropics to explore dynamics of water fluxes from hourly to seasonal timescales and at spatial scales ranging from individual trees to the stand-level scale. This intermediate-scale approach is a model testbed meant to inform implementations of plant hydraulics in coarse-scale forest ecosystem models.*

Prior to this insertion in the Introduction, we also clarified the scale of the various modeling approaches that are discussed (coarse-scale ecosystem models and fine-scale hydraulics models; see P3 L14 and P3 L27).

Further, you elaborated a plant hydraulic submodel in this research. As you note, solving Richards Equation is tough and needs heavy computation resourse. I do not think such plant hydraulic models are suitable for large-scale and long-term vegetation dynamics models. Thus, I also suggest in the Introduction section you should explicitly state why you elaborated the hydraulic models ("because such models can describe detailed plant water relations" is not enough) and future strategy of applications of the hydraulic models.

We have expanded the section outlining the various approaches to doing plant hydraulics (P3 L27-P5L8), in order to highlight why we elaborated (what we have now termed) the "continuous porous media" approach:

a range of approaches exist for modeling plant hydraulics at fine scales (i.e., individual trees), all involve an extension of Darcy's law (Darcy, 1856) from the soil domain to include plants as well. Darcy's law states that water flux anywhere in the soil-plant continuum is proportional to the product of soil or plant hydraulic conductivity and a gradient in water potential. In order for these models to capture drought response, hydraulic conductivity within the soil-plant continuum must dynamically respond to changes in moisture. Three main approaches are distinguished in terms of how they represent the impact of declines in water potential on tissue water content and xylem hydraulic conductivity. A first class of models is the simplest and simulates moisture sensitivity of soil-root conductance but not xylem hydraulic conductance (Jarvis et al., 1981; Williams et al., 1996; Ogée et al., 2003; Alton et al., 2009; Bonan et al., 2014). This approach has proven useful for modeling the effects experimental drought in tropical forests (Williams et al., 1998; Fisher et al., 2006; Fisher et al., 2007), but it remains unclear whether this approach misattributes drought effects occurring within trees to the soil; therefore a second class of models implements variable xylem conductivity with xylem water potential (Williams et al., 2001; Hickler et al., 2006; Domec et al., 2012; Duursma and Medlyn, 2012; Xu et al., 2016). To simplify computational load, these two approaches do not explicitly track dynamic changes in the volume of plant water storage. Instead, a constant ratio of change in stored water per unit change in water potential, or stem hydraulic capacitance, is assumed, which may overestimate the buffering capacity of tree stored water under extreme drought conditions when small relative declines in stored water induce very large declines in water potential. An additional consequence of the design of these models is the inability to represent the bidirectional flow of water at the root-soil interface. Reverse flow of water from roots into soil is an important process in root hydraulic distribution (Oliveira et al., 2005), and may also mediate time to desiccation under drought (North and Nobel, 1997).

A convenient way to address these issues is in a third class of models (hereafter the "continuous porous media approach"), which simply extend the modeled mass balance of water from the soil domain into the plant by relating simulated changes in water content to water potential (and vice versa) everywhere within the plant-soil continuum (Edwards et al., 1986; Arbogast et al., 1993; Sperry et al., 1998; Kumagai, 2001; Bohrer et al., 2005; Mackay et al., 2015; Mirfenderesgi et al., 2016). While more computationally complex, the continuous porous media approach offers two main advantages in addition to addressing the issue of plant water storage and bidirectional root flow. First, the coupled plant-soil system is represented by a single mass balance equation, such that root water uptake or loss simply emerges from the solution of this equation, and needs not be ascribed post-hoc as is the case in the first two approaches. Second, this approach relies on an explicit description of the relationship between water content and water potential in plant xylem (the "pressure-volume", or PV curve), analogous to the water retention curves used in soil physics. As we will show, there is a wealth of information on PV hydraulic traits for leaves, and to a lesser degree, stems in tropical forests. Implementing PV curves in the model greatly increases the scope of data with which the model can be parameterized. In this paper, we develop a continuous porous media approach intended for application at specific sites in the tropics to explore dynamics of water fluxes from hourly to seasonal timescales and at spatial scales ranging from individual trees to the stand-level scale. This intermediate-scale approach is *a model testbed meant to inform implementations of plant hydraulics in coarse-scale forest ecosystem models.*

Concerning to P3L10, you need to read: Kumagai, T., Porporato, A. (2012) Drought-induced mortality of a Bornean tropical rainforest amplified by climate change. Journal of Geophysical Research -Biogeosciences, 117, G02032, doi:10.1029/2011JG001835.

We found this paper particularly relevant (thank you!) and have cited it in the place you suggested. We anticipate returning to this paper when considering deriving mortality functions from our plant hydraulics model.

Concerning to P4L3-7, you need to mention this pioneer paper: Kumagai, T. (2001) Modeling water transportation and storage in sapwood -model development and validation. Agricultural and Forest Meteorology, 109, 105-115. And "Arbogast et al., 1993" should be inserted in the former array of references P4L6-7.

This citation has now been included.

Fugure 1: Subfigures involved in Fig 1 are incomprehensible and seem unnecessary because they have no explanation. Provide them with appropriate explanations if you want them to be involved in Fig 1.

The figure caption has now been updated to explain the various other sub-panels in this figure:

Left sub-panel: inputs are plot observations of the tree size distribution and distributions of each of four plant functional traits (WD, LMA, N_L, P_L). Middle bottom: the perfect plasticity approximation (PPA) orders trees by decreasing crown area. Middle top: TFS assigns physiological traits, such as $V_{c,max}$, to each tree based on functional traits. Middle: the PPA is used to estimate light environments of each tree, which influence fast timescale (hourly) biophysics of crown light interception, photosynthesis, and stomatal conductance. Assimilated carbon is allocated to leaves, stems, and fine roots daily. Top right (hydrodynamics): Soil-root-stem-canopy water fluxes interact with fast-timescale TFS biophysics by taking transpiration as a boundary condition and passing back the 'fraction of maximum conductance' (FMC_{gs}) for downregulating the next timestep's stomatal conductance based on leaf water potential. Top right (size- and trait-scaling): Hydraulic traits in leaves, stem, and roots are assigned based on each tree's height and trait values according to empirical equations and allometric theory described in this paper. Bottom right: TFS predicts a distribution of individual tree net primary productivities. See Supplement Fig S1.1 for the structure of the plant hydraulics model.

P8L18: ">=" should be "ï˝C ¸s".

Assuming the pdf conversion of your comment meant to say "≥", we updated the symbol accordingly

P10L13: "(-)" should be omitted or changed to "(unitless)".

Done.

P10L14: “-1” should be superscripts, and “FMC” should be “FMCx”.

Done.

P10L15: “1” should not be italic.

Done.

P10L23: Why is “relative to” italic?

These italics have been removed

P11L13: Remove “derive”.

Done.

P14L13: Insert “statistical” between “All” and “analyses”. “R” should be “R software” and “(R core team 2015)” is not enough information.

“statistical” was inserted and “R” was changed to “R language,” but we left the citation the same, as this is the suggested format for citing the R statistical program.

P14L14-15: You should not state this text “In all : : :: : : ’****’.” here. You should refer to statistical significance at each figure’s caption (Figs 2-6, and 8).

This sentence has been deleted and the reference to statistical significance remains in the figure captions.

3.2 Model setup: Give more detailed throughfall exclusion experiment (TFE) or remove all statements on the TFE in the manuscript (I will explain later).

We have removed all analyses and references to the TFE per your suggestion (further explanation given below)

P18L4: 50% reduction of what?

Removed.

Captions of Figures 2 and 10: Give full spellings of the abbreviations such as LMA, WD, and so forth.

Done.

Figures 5, 6 and 8: Legends of symbols are needed.

Done.

Caption of Figure 6: Al:As needs to be italic and subscripts.

Done.

Caption of Figure 8: “ks,max,x” needs brackets.

Done.

4.2.1 Impact of plant…: Add further and more detailed explanation on why transpiration rate was higher in dry season than in wet season for both TFSs and why transpiration rate in dry season was inhibited with v.1-Hydro.

Done. Revised text reads as follows, first on the seasonal differences (P22 L22-27):
The large increase in simulated transpiration in the dry season for both TFS v.1 and TFS v.1-Hydro (Fig. 9e-f) is driven by the comparatively large increase in incoming solar radiation, and hence absorbed radiation, due to a reduction in cloud cover (Fig 9a-d) (Carswell, 2002; Fisher et al., 2007). At the level of individual tree crowns, canopy position is the dominant control over the amount of absorbed PAR (compare different colored lines in Fig 9a-d).

and on why dry season transpiration was inhibited with v.1-Hydro (P23 L1-4):
The effect of including plant hydraulics in TFS v.1-Hydro was to limit late morning and afternoon transpiration via the depletion of stored water within the canopy and tree stem, which caused midday declines in leaf water potential (see Fig 10) and induced hydraulic limitation to water flux via the FMC_{gs} *term (see Eqn 8).*

Figure 11: Mention clearly which type of TFS was used for this simulation in the caption. Further, you have to note that this analysis in Fig 11 cannot be any validation for the model because there was no difference in both observations and computations between control and 50%TFE. I recommend to omit all statements on both the TFE observations and computations (further recommendation and explanation later).

Done. As explained below and per your suggestion, all analyses and references to TFE have been removed.

Figure 13 and 4.3.3 Fidelity of modeled …: Did you mean the simple soil bucket models of both TFSs v1 and v1-Hydro could not reproduce the temporal variation in soil moisture for the Control and the 50%TFE? If so, this is very critical problem because simulations of plant water relations such as stomatal behavior, sapflow, root water uptake and so forth must be conducted on the premises that the soil moisture environment is appropriately reproduced. In this case, I think discussion on simulation of TFE would ruin this paper. So, in this case, I suggest omitting all statements about TFE in this paper. Note that without the TFE, the value of this paper would not change. If you are successful in reproducing soil moisture environment for both the Control and the TFE, show the time variations in modeled and simulated soil moisture and give more detailed and analytical explanation about why both TFSs v1 and v1-Hydro could not capture the observed reduction in transpiration under the TFE.

We agree on your suggestion to remove the TFE parts of this paper, because the current bucket soil hydrology is not amenable to simulating drought. We also revised a couple sentences (P8 L1-4) highlighting this current belowground structural deficiency for future development:

The present scheme does not consider the vertical distribution of soil water or roots. We anticipate this to be a key component for future model development when we incorporate this scheme into host models with variable soil depths.

P25L24-25: How thinking plant hydraulic submodels important leads to developing ESM? Please give a concrete explanation.

We have added a clause to the final sentence of this paragraph to this effect (P26 L26-27):

Finally, the model makes substantial improvements to TFS v.1 in terms of simulated transpiration rates (Fig 13a, b), highlighting how plant hydraulics mediate the biosphere-atmosphere exchange of carbon and water.

P29L3: (If the models failed to reproduce the soil moisture environment) I guess "not vertically discretize the soil water or root distribution" is not big problem. This is simply problem caused by failures in mass balance equations because the models could not capture the soil moisture depletion induced from 50% rainwater reduction.

The inability of the model to reproduce soil drought conditions is not related to the failure of the model to do soil water mass balance; all precipitation and evaporation is accounted for via changes in the total stored water in the system. Rather, it is a direct consequence of using a soil depth of 4 meters at this site and allowing roots to exploit this entire bucket. This soil bucket does not sufficiently deplete under the simulated drought conditions (in default TFS v.1 nor in TFS v1.-Hydro) because it represents an average soil moisture over the entire 4-meter domain. In contrast, a vertically stratified water balance model that accurately reproduces observed TFE soil moisture response at this site would, according to the observations (see Rowland et al. 2015 Extended Data Figure 2), have the largest a large TFE effect in shallow layers where most roots would be concentrated (see Fisher et al. 2007 Figure 6).

Conclusion: You should confess this paper's current model is too complex to incorporate it to coarse-scale DGVMs.

Done, although future work will need to identify where simplification is necessary and where complexity is still needed. The final sentence of the paper (P33 L5-8) highlights this:

Likely some degree of simplification of the present approach will be required upon implementation in ESMs; nonetheless we expect that inclusion of trait-driven plant hydraulics *schemes will lead to reduced uncertainty in the future state of tropical forests under climate change.*

References

Fisher, R. A., Williams, M., da Costa, A. L., Malhi, Y., da Costa, R. F., Almeida, S., and Meir, P.: The response of an Eastern Amazonian rain forest to drought stress: results and modelling analyses from a throughfall exclusion experiment, Global Change Biology, 13, 2361-2378, 2007.

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