Author’s response to comments

Author's responses to a few comments of Reviewer #1 are not satisfactory. Please check comments below.

1) For improvement, first, they should fit their new model into a broader field of mechanistic plant hydraulic models. They mentioned some previous work such as SPA model and Xu et al. (2016) but it’s still not very clear how they were motivated, how the new model was built on, and what are the strengths and weaknesses of their new model compared with other similar plant hydraulic models. They had some discussion starting from Line 547, but adding more details would be great.
- I expect that uniqueness and motivation should be rephrased, not by simply adding Table 1. We need to know what are the contribution of this study to the community better.
- The reviewer's comments on Line 353 are also related to this response.
[Response] Thanks for pointing this out. I specify the novelty of our hydraulic model with the tree mortality scheme. The earlier hydraulic models like SPA and Xu et al (2016) indeed proposed the simulation framework of water flow and water potential following Darcy’s law, however, a full segmentation of the hydraulic system including water flow and water storage change of leaves, stem, and root are still not completely solved yet (i.e. root part was missing in Xu et al., 2016). Our hydraulic architecture refines the segmentation of plant hydraulics of leaves, stem and root, separately, of which the hydraulic conductance varies with water potential value following sigmoidal relationship. Meanwhile, the water capacitance is considered as well to account for the variation in water storage. The hydraulic models like SPA and Xu et al (2016), lack either the full segmentation or the consideration of contribution of each water storage pool (SPA model only used canopy capacitance). Our model also extends one step further to link the hydraulic failure measured by percentage loss of conductance to tree mortality rate via an empirical model composed of two parameters: drought exposure threshold (number of continuous days under water stress), and tree mortality fraction upon each tree mortality event. This tree mortality sub model accounts for the cumulative drought effects, which can adapt to different drought strengths and drought frequencies. Therefore, our hydraulic model with tree mortality scheme improves the hydraulic segmentation simulation and also paves a new way of linking hydraulic failure to tree mortality. Please see line 615–627 in the new clean version for our revision.

2) Second, one of the key limitations of the usage of such plant hydraulic models is numerous parameters, as shown in Table 1 in this paper. The authors focused on one site simulation with well-recorded plants’ traits. However some topics such as how sensitive and uncertain these parameters are, and how to parameterize the model at the regional and global scales might be interesting to add to the discussion. The authors may find this paper relevant to their discussion:
- I expect that authors mention the uncertainties due to parameter values and their impacts on regional and global simulation or real quantification based on more simulations with wide ranges of parameter values. Please it does not seem relevant to simply mention methodological ways how to quantify parameter uncertainties.

[Response] Thanks for pointing this out. Here we focus on the tree mortality sub-model to clarify the parameter uncertainties issue. Regarding our tree mortality empirical sub-model, the two parameters, drought exposure threshold and tree mortality fraction upon each stress event, are related to each other given a target tree mortality rate. We derive a parameter space composed of these two empirical parameters in the tree mortality scheme that can produce similar tree mortality rate for cohort #20 in Caxiuana TFE experiment in 2005 (cohort #20 is taken as an example here). That is to say, higher drought exposure threshold should be combined with a higher tree mortality rate in each event, and vice versa (Figure R1). Specifying a higher drought exposure threshold, such a parameterization scheme would underestimate the impact of drought with high intensity but short period since higher drought exposure threshold would lead to less frequent tree mortality events detection in model perspective.

After the derivation of a parameter space, we did a regional simulation focusing on the 2005 drought in western Amazon using parameters specified in the main text (named as default simulation). To reduce the computation load, we just use the percentage loss of conductance output in the default simulation to calculate the number of tree mortality events with varying drought exposure threshold in order to test the range of parameters values. Figure R2 shows that the tree mortality rate (cohort #20) below 20% can become lower if the model was fed with a higher drought exposure threshold (DT=25 or 30). And the tree mortality rate below 20% tends to be higher with a lower drought exposure threshold (DT=10). Although all these parameters combinations can produce a similar tree mortality phenomenon (cohort #20) for Caxiuana TFE setup in 2005, they will perform differently regarding drought with different intensities and durations regionally. Therefore, more experiment data manifesting the tree tolerance should be well included to constrain the drought exposure threshold uncertainties in our model framework. Please see line 694-713 in the new clean version for our revision.

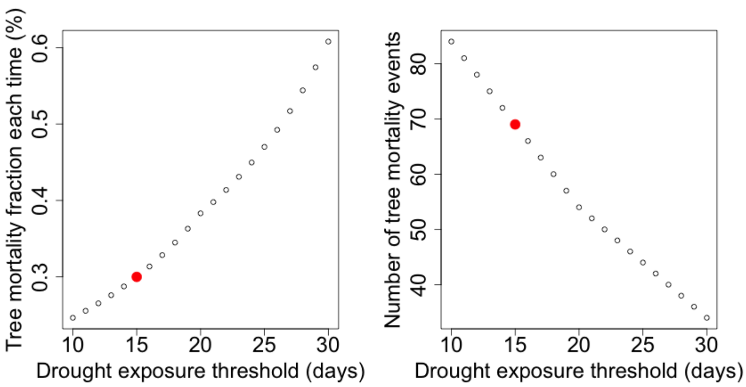

Figure R1 The combination of different drought exposure threshold and tree mortality fraction upon each event. Here, the drought exposure threshold from 10 to 30 days is shown as an example here. Higher drought exposure threshold would lead to less frequent tree mortality events. The red point denotes the parameter we used in the main text for the Caxiuana experiment.

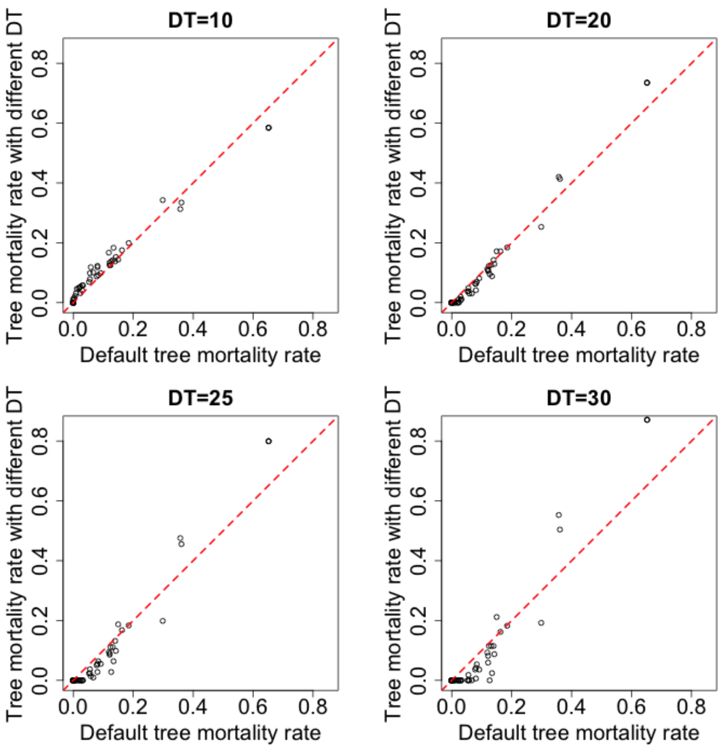

Figure R2 The effect of varying drought exposure threshold (DT) on tree mortality estimation. 'Default tree mortality rate' is calculated by the DT used in the main text. 'Tree mortality rate with different DT' is calculated by the DT labeled on top of each panel. Each point represents one pixel in western Amazon. The red dashed line is 1:1 line. When points distribute on top of the 1:1 line, the tree mortality rate calculated by another DT is higher than the default one. Cohort #20 is used here as an example.