Biogeosciences Discussions

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Comment on bg-2022-243

Anonymous Referee #1

Referee comment on "Tropical Dry Forest Response to Nutrient Fertilization: A Model Validation and Sensitivity Analysis" by Shuyue Li et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2022-243-RC1, 2023

General comments

This study integrated a representation of phosphorus-dependent relative allocation to root tissues into the ED2 model. The model was simulated at a site in a tropical dry forest in Costa Rica for +N, +P, and +NP fertilization treatments. Modelled results were compared to empirical observations. The model was then simulated over 30 years to examine the influence of the new process representation over a longer time scale. The comparison between a model and empirical observations of experimental manipulations of nutrient input is very useful for model development. However, it was unclear whether the process that was represented in this study (increasing allocation to fine roots with increasing soil P) is prevalent in systems outside of this site, what its underlying mechanisms are, and how it relates to other central processes (such as the relationships between allocation to fine roots and soil nitrogen or water). Furthermore, the statistics used to establish the results were unclear.

Specific comments

- The premise of this study needs to be better established. What is the mechanism underlying increasing allocation to fine roots with increasing soil P? Does this response occur in other ecosystems or are the only observations from the Costa Rica site? The introduction gave several examples of how different ecosystems and different individuals within a given ecosystem respond differently to N and P fertilization. Are there any patterns that emerge across ecosystems? If this response is specific to a single or a small number of sites, why should it be represented in TBMs? Have empirical studies indicated that this is important for larger C fluxes? This is somewhat touched on

in the Discussion but its prevalence was not clear.

- How do other factors interact to determine relative allocation to roots? Water and nitrogen should play important roles as well. Is it valid to only focus on P (especially given that the results suggest that it is increased water uptake that seemed to drive AGB)? Additionally, I would assume that the role of other plant mechanisms to increase P uptake would be important as well, such as phosphatase synthesis and arbuscular mycorrhizae. These are likely intricately linked to fine root biomass in real ecosystems. While these do not necessarily need to be examined or modelled, they should be at least recognized in the experimental setup and discussion. Additionally, flexible stoichiometry could be important. How have other models approached these phenomena?
- It was not made clear which PFT was being studied in these experiments. Were there multiple PFTs? Given that this is a dry tropical forest, do deciduousness and phenology play a role here? How could these results differ between tropical dry forests and tropical moist forests? Have similar experiments been conducted in tropical moist forests?
- Using different statistical analyses for leaf, wood, and root due to patterns that emerged from the observation-based data may not be the best approach. It would be a more direct comparison to use the same statistical analyses for each tissue because the biases in the empirical observations may not be present in the model outputs. Figure 4 is a central figure but it is unclear whether it shows only the control treatment or an average across treatments. Regardless, this analysis should be conducted for each fertilization treatment independently given that the premise of the study is that fertilization treatment influences relative allocation. Furthermore, are the temporal trends important here given that the same amount of fertilizer was applied each year and the experiment was only 3 years long? Given that the primary focus is the difference between tissues rather than the difference between years, it may make more sense to aggregate across years for each tissue / treatment.
- Is a 2 year spinup sufficient? Shouldn't the spinup be run until an equilibrium is established?

Technical correction

Line 81 "While models have rarely be validated on these time scales" I would argue that models are often evaluated over the past several decades (1960s to present).

Production units should be kg m-2 yr-1.

Table 3 is challenging to interpret. Could this be transformed into a figure?

Include other parameterizations in Figure 5 (additional panels).

Include other treatments in Figure 8 (additional panels).

Figure 6: Clarify if this is averaged across treatments or if this is the control treatment only.