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Biogeosciences Discussions

# *Interactive comment on* "Variable tree rooting strategies improve tropical productivity and evapotranspiration in a dynamic global vegetation model" *by* Boris Sakschewski et al.

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The article by Sakschewski et al introduces a scheme for modelling variable rooting depths into the LPJmL4.0 DGVM. This is the version of LPJ dealing with managed lands (ML). Otherwise, it shares much with the original LPJ (as opposed to the individual based and gap variants). I agree the problem identified is potentially very significant: previously this and other DGVMS have used a fixed rooting depth, which may limit the ability of modelled vegetation to adjust to different water environments. The new scheme is assessed by comparing model outputs (including NPP, max rooting depth, ET, NEE, and cover) to various datasets and products for South America, mostly



at large (regional or larger) spatial scales. The new model is compared to two other versions of LPJ - the base version and the new model but with variable rooting effectively disabled. The authors claim that overall the variable rooting scheme improves the models ability to capture observed dynamics and distributions in the different datasets.

I like many aspects of this paper. In particular I appreciate the approach of carefully examining the behaviour of the model across a range of climate scenarios,

Overall I think this paper and model variant have great potential. The new scheme is clever and I have little to critique in its design. The various analyses do suggest the new model is providing a better match to available data. But I am yet to be convinced this improved match is for the reasons the authors claim (better handling of soil water & rooting).

The biggest concern I have is that despite all the results presented, these mostly for aggregate outputs at largish spatial scales. Almost no evidence is presented to show the effect of the new scheme on the actual water balance in the soil. Moreover, we don't even know how water is modelled in the different versions. Sure, the soil and root depth is changed, but what does this mean for water balance at different soil depths? Surely this is key to assessing why the model behaves differently. This is important, as the changes in rooting will also change the way carbon is allocated within the model (e.g. deeper roots divert carbon away from leaves). Are the model improvements due to changes in hydraulics, or changes in carbon allocated between leaves and roots?

Second, I feel the authors need to come up with a stronger story and reduced set of results. The paper is currently very long and dense. The authors have made many comparisons using a variety of datasets. Consequently, there is a large number of figures (15) and tables (8). This makes it hard for us to know where to put our attention.

Finally, more work is needed to make the different results accessible and easy to interpret. I found that each figure required a fair bit of work to interpret what is going on. Some simple changes could make it much easier for the reader, then we could spend less time deciphering your results and more time thinking about the science! As examples,

- In Fig 1: confusing caption. Simplify labels in legend.

- In Fig 6: label panels with dataset name, so that we don't need to refer to legend as much

- In Fig 9, uses different colours in the map and traces, otherwise these are easily confused. Label each subplot with site name.

- In Fig 12, put labels on the columns (evergreen, deciduous) and rows (models), so that we can easily see what the different panels are without constantly referring to the caption.

Some minor issues

- Some line breaks between paragraphs would make the text much easier to read

- Eq 8: I've looked over this a few times and wonder if the n_est_tree at the end should be removed?

- ln 413 – It didn't make much sense to me to compare your results to a modelled product of rooting depth.

- I found the talk of offspring, saplings, and "growth" throughout the paper a bit misleading. My understanding of this version of LPJ is that each patch has a single functional type which has a density 'n' of average sized individuals. When new offspring are recruited, they don't grow from seed to adult, but rather enter fully formed at the average size (this occurs by increasing n, the number of individuals). The only time the individuals seemingly grow from small to large plants, is when starting from bare soil, i.e. during spin up. Yet, often the paper gave the impression that individuals could be born and grow.

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