

Geosci. Model Dev. Discuss., referee comment RC1
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Review on gmd-2021-270

Anonymous Referee #1

Referee comment on "Tree Hydrodynamic Modelling of Soil Plant Atmosphere Continuum (SPAC-3Hpy)" by Marcela Silva et al., Geosci. Model Dev. Discuss.,
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The study describes the development of a new SPAC model. The study is of great relevance to hydrology ecohydrology and ecosystem modelling and clearly within the scope of the journal. The model couples the partial differential equations that describe water flow in the soils, and plants.

- My main concern regarding the paper is its novelty. The authors should more clearly illustrate the new features of the present model that have not been previously reported. For example, the plant water transport is very similar to FETCH2, the whole model set-up very similar to Huang, C-W et al., 2017 New phytologist (already cited in the paper). The authors should more clearly present the main novelties of the present model. I am not saying that the model is not novel, but rather the novelty needs to be better described in the manuscript.
- Regarding the model implementation itself, it is great to see comparisons between analytical solutions and previous numerical solutions for model confirmation.
- Regarding the complexity of the model, my main comment is that the model formulation seems incomplete for a SPAC model, as it mostly neglects the atmospheric component. I would expect a SPAC model to be forced with meteorological variables. At the current state tree transpiration is provided as a boundary condition, instead of being computed prognostically. The authors can consider expanding the model to have this capability.
- To my understanding, the model in its current form, can only simulate a single dry-down period as no infiltration is implemented. This is something that the authors might want to include in the model as it cannot be currently used for continuous long term simulations.
- A finite difference method was used to solve the Richards' equation for both soils and plants. This numerical formulation does not guarantee mass conservation. As a sanity check I would advise the authors to report the total water mass conservation. Given the accuracy of the model in recovering the analytical solution, I am confident that any discrepancy is negligible but worth reporting nevertheless.
- A discussion point that might need to be better addressed is the added benefit of the vertically distributed, computationally expensive solution. Many ecosystem models lump tree hydraulics with a small number of resistances (commonly soil to root, root to leaf and leaf to atmosphere) or a combination of a small number of resistors and

capacitors (e.g., ED2 model - Trugman, Anna T., et al. "Leveraging plant hydraulics to yield predictive and dynamic plant leaf allocation in vegetation models with climate change." *Global change biology*12 (2019): 4008-4021.). This approach is definitely more computationally parsimonious, and less data demanding as all plant hydraulic traits are lumped. A discussion of pros/cons would benefit the paper.

Minor comments

- In page 3 lines 64 and 73, I would advise the authors to rephrase the term "lumped" as it might lead to confusion as the model is at least in 1D distributed.
- Looking at the Python code, I noticed that object orientation was hardly ever used, that would be great for a modular model design that can be used to "plug-in" additional modules in the future (e.g., radiative transfer schemes, photosynthesis, phloem transport etc). The authors might consider in the future reconstruction of the code.