Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC2
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Comment on gmd-2022-105

Anonymous Referee #2

Referee comment on "Impact of the numerical solution approach of a plant hydrodynamic model (v0.1) on vegetation dynamics" by Yilin Fang et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2022-105-RC2, 2022

The manuscript investigates how vertical resolution of soil-plant hydraulics and integration schemes influence a hydrodynamics-enabled biosphere model, FATES-HYDRO. The study conducted simulations by combining different numbers of top soil layers to create a gradient of different resolutions. They also use point-level simulations to explore the impacts of integration schemes.

Overall, I think the topic can be useful to the plant hydraulics and ecohydrological modeling community although I feel the design, interpretation, and presentation of the study can be further improved.

First, I think the underlying pathways of AGB changes under different resolutions are still elusive to me. Mixing top soil layers will surely influence hydraulic properties (as suggested by Fig. 4) but can also change the plant water accessibility right? I am not sure how FATES calculate the soil-to-root conductivity but I guess root biomass/area matters? How big an effect this can be, especially if the distribution of root biomass is exponential? Furthermore, does soil moisture influence AGB mainly by influencing growth or mortality, which ultimately drives equilibrium biomass? Would be helpful to plot the difference of (relative) growth/mortality if they are in the standard output

Second, I am not sure how much I can trust the XGBoost analysis especially since the out-of-sample accuracy is 67% (just a little different from random...). I guess including some variables on plants can help? (for example, average plant hydraulic traits within each grid cell?) In addition, using soil water potential rather than soil water might be better when looking at biomass differences...

Third, the AGB responses to the number of soil layers seem to be nonlinear and not necessarily monotonic in most of the 4 point-simulation sites (Fig.6). Why would this happen? Maybe some analysis of this point-level simulations can shed light upon large scale patterns.

Finally, I find the integration scheme analysis is simplistic and weak. For example, does a longer time step with explicit integration is computationally more efficient with a reasonable loss of accuracy? What would be the longest tolerable time step for plant hydraulics? How about other integration schemes such as Runge-Kutta? Such tests do not need to be long, I guess a few weeks worth of simulation is good enough so global simulations with different integration schemes might be possible.

A few minor comments:

Line 165-200, this section is not easy to read with many parameters and poorly formatted equations, and some typos (e.g. in eq. 8, the higher order term should be o(delta^2) instead of 0). Please consider having a full editorial check and improve the readability.

Line 250, negative delta_AGB --> overestimate reads very unintuitive. Please use experiment - reference simulations when calculating delta values.

Line 255, what is soil water saturation? Is it relative soil water?

Figures:

Fig1 and Fig2 can be combined together since they both talks about vertical soil columns

Fig. 5, what are X axes in panels (a) and (b)? # of trees?