

Geosci. Model Dev. Discuss., referee comment RC2
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Comment on gmd-2021-362

Anonymous Referee #2

Referee comment on "Forest fluxes and mortality response to drought: model description (ORCHIDEE-CAN-NHA r7236) and evaluation at the Caxiuana drought experiment" by Yitong Yao et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-362-RC2>, 2022

This paper describes the implementation of a hydraulics scheme into the land surface model ORCHIDEE and its evaluation against the Caixuana drought experiment. In general, this is a nice piece of work, but the presentation could be quite significantly improved.

One important point is the need to show how the model simulations have changed since the new routines were added. The figures only show output from the new version of the model. To assess the value of the added subroutines, the paper needs to show output from previous versions of the model for comparison. There is some in the supplementary, but there is insufficient quantitative assessment of how each version of the model performs. The R values for sap flow are lower in the new model version than the previous one, suggesting a degradation of model performance. The comparison of GPP with previous models is qualitative only. It would be valuable to add some statistics to compare performance of different model versions.

There were quite a few questions about the model description.

It would be of great value to go through the symbols used and try to make them consistent, instead of using a mixture of abbreviations and symbols. It is confusing to have WD the wood density, ρ_{root} the root density, WC the amount of water per unit volume of sapwood, and root_{wc} the amount of water per gram root biomass. Try to come up with a more systematic set of symbols. In particular, avoid abbreviations instead of symbols (e.g. use D rather than dbh) and avoid using variable names from code such as `circ_class_mor` or `counterPLC50`. Give these symbols. Also use capitals consistently, e.g. Cleaf, Cstem and Croot should all have capital "C".

Ensure to give all units clearly in text and ensure they are consistent. For example, is capacitance in units of mmol (line 203) or mmol m⁻² MPa⁻¹ (line 207) or in kg m⁻³ MPa⁻¹

(Table A1)? I suggest checking over all of the equations thoroughly to ensure units are correct throughout the text.

Eqn 4: $msap,max = vstem *WC$

V_{stem} is the volume of a cylinder of diameter DBH and height h (eqn 6) so overestimates volume of a stem. How is the stem form factor corrected for? How is this then converted to sapwood?

WC is defined as the mass of water per unit sapwood volume in $mol\ m^{-3}$. It should be defined as the maximum mass of water, or the mass of water when water potential = 0. Clarify, is this per unit sapwood volume or per unit stem volume?

Figure 2 does not seem important or relevant enough to include as a main figure. It just shows the form of the sigmoidal relationship for different parameter values. The different values are not used in the paper, however, so it's not clear why this wide range of parameter values are shown.

What happens when the canopy is wet? I note that in Figure 4, the canopy evaporation is a tiny fraction of ET, which seems very unlikely for this wet, high-LAI forest. These numbers need a reality check.

I found the representation of T_{demand} (eqn 23) to be remarkably simple – one would normally expect a land surface model such as Orchidee to have a more complex representation of T , including a boundary layer conductance and some scaling of g_s to the canopy. Is the canopy transpiration the same as T_{demand} ?

Does this value of g_s affect assimilation? How has the assimilation (and GPP) calculation changed?

Be more specific about how water potentials are found.

Line 270: we decrease leaf water potential until the difference between leaf water supply and demand is "close to zero" – How does this algorithm work? How close is tolerable?

Line 294 and line 304: we "try to solve" Why only "try" ? How is the water potential found,

and what happens if one can't be found?

Give some indication of how parameter values are chosen. The table does list references, but it is not clear how values are chosen from the references.

It's unfortunately not acceptable to refer to other papers that are still in review. The Joetzer et al. (in review) paper was not accepted in Biogeosciences in 2018.

<https://bg.copernicus.org/preprints/bg-2018-308/>

The fact it has not yet appeared raises some questions. This paper does rely quite heavily on that one, so it seems essential that that paper be accepted before this one can be. There may of course be some extenuating circumstances.

Section 2.1.6 is quite disconnected from the rest of the model implementation and it is not clear what has changed here from previous versions of the model.

It would be valuable to add more interpretation of the outputs of the model in terms of underlying assumptions. For example, it's noted that leaf water potentials are lower in the taller trees. The effect of height should be about $-0.1\text{MPa} / 10\text{m}$. Once this is accounted for there are similar LWPs across cohorts, which is somewhat surprising given that cohorts have different rooting depth and see different soil moisture. There also doesn't appear to be a lot of difference in the PLC by cohort (Figure 9). The discussion later talks about the larger mortality rates in large trees, but it's not clear how this arises from the model structure. It would be useful to talk through how this works in the text.

It does also seem odd that the lower soil layers dry out much more than the upper soil layers. It seems that the plants are preferentially using water from lower in the soil profile. Again, it would be useful to talk through what the model is doing in terms of water uptake.

Smaller points:

Line 200 mentions "the first time-step" but is that just the very first half hour of a ten year simulation or is it every day? If water potentials are assumed the same in the first time step, what value do they take?

Please justify eqns 14 and 15.

Line 246: Please give correct units for J. (mmol m⁻² s⁻¹ ?)

Please include values and units for the parameters in eqn 24.

Line 349, "morality" should be "mortality"

Figure 3, how is sapflow extracted from the model? Is it the same as "T" in Figure 4 and "Tsupply" in Figure S4, or are these different outputs?

Please give full figure captions for the supplementary material. What is shown in Figure S1, exactly? What do the grey bands represent? Are the values given on a half-hourly or daily basis, and if daily, how are they averaged? Do the gs values differ by cohort?

What are the values shown in Figure S2? Were the data from Lin et al. filtered to show just high-PAR values? Are the observational values in fact comparable with the modelled values?

What are the measured and modelled values shown in Figure S8? How are the modelled values averaged over the cohorts? Where are the obs measured, and what is the uncertainty?

I did go looking at the code repository but it's very large and not clear where the new code resides. It would be useful to indicate which subroutines were modified / added in this version of the code.