Geosci. Model Dev. Discuss., 5, C174–C178, 2012
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Geoscientific Model Development Discussions

GMDD

5, C174–C178, 2012

Interactive Comment

Interactive comment on "MAESPA: a model to study interactions between water limitation, environmental drivers and vegetation function at tree and stand levels, with an example application to [CO_2] × drought interactions" *by* R. A. Duursma and B.E. Medlyn

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Received and published: 16 April 2012

We welcome the positive assessment by the reviewer. As detailed below, the main objection to our implementation is inaccurate : the MAESPA model does calculate the leaf water potential for each tree separately, as well as for each grid point within each tree. The manuscript was very unclear on this point, which we will amend in the revision

We thank the reviewer for careful reading of the equations, which did contain a few errors. However, none of these errors appear in the model code, only in our incorrectly transcribed equations. We respond to each of the reviewer's comments in detail below.

Reviewer: "The modeling framework proposed in this paper, to couple MAESTRA with a soil water balance model, represents an important improvement, but due to its simplicity, some strengths of the MAESTRA model are lost: for example, a unique leaf water potential is computed for all trees (and for all leaves within a tree) although it is well known that big trees, due to higher exposition to winds, light, and to air with higher VPD, and also due to increased path length resistances to water transport, etc, have generally much lower leaf water potential than small trees. Then, some of the advantages provided by the 3D representation of the canopy are lost in MAESPA due to the 1D framework for the iterative computation of leaf water potential and water uptake by roots. If I had to couple MAESTRA with a water-budget submodel, I would try to compute leaf water potential iteratively for each tree, although I agree that this would be very computer intensive..., and also would be quite challenging (due to the lack of information on root length density, etc , at the tree level)."

Response : Actually, MAESPA calculates the leaf water potential (LWP) at each grid point in each of the target trees, the same as stomatal conductance and photosynthesis (see Figure 1, and description in the section 'Radiative transfer'). As such, much variation in LWP is calculated within crowns (due to shading effects on transpiration rate), and between trees (effects of shading, plus the possibility to specify the leaf-specific hydraulic conductance per tree). In the revision, we will highlight this, as the current manuscript is unclear about it.

However, it is true that the soil water balance is computed in a 1D column, and rooting density is a stand-average, rather than a tree-level input (because of the impossibility of parameterizing and properly testing a model that would have those properties vary from tree to tree).

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Reviewer: “Page 465: f(D) (or f(L)) was omitted in Equation 2;”

Response: This error does not appear in our uploaded manuscript, only after conversion to the GMD format (Eq 2 should be multiplied by f(D)).

Reviewer: Page 466 Line 4: PSIf is defined as: “the PSIL at which fPSIL is 0.5”. This is wrong ...”

Response The reviewer is correct that our definition of PSIf was incorrect, we will fix this in the revision (note, this does not affect the actual model or parameterization).

Reviewer :” In Equations 12, 13, 24, PSIR-PSIS should be replaced by PSIS - PSIR, because during the day PSIR is normally more negative than PSIs. In some cases (e.g. in cases of hydraulic lift at night), PSIR may happen to be less negative than PSIs resulting in a water flux from the roots to the soil in dry soil layers, but this (hydraulic redistribution) does not seem to be considered by the model: I think the authors should mention this point in the discussion.”

Response : It is correct that the equation should be PSIS – PSIR, this error does not appear in the model, only in our manuscript. It is also true that we do not consider hydraulic lift, and we will mention this in the Discussion.

Reviewer : Page 470, Line 23, it is said that Rlg is small compared to Rrad. Then it could vanish from the denominator of Eq. 12, and indeed it no more considered in other Equations (e.g. Eq. 24). But on page 470, Line 24, it is also said that Rsr is small compared to Rrad. Then, Rsr should also vanish from the denominator of Eq. 12. But in spite of neglecting Rsr in Equations 23 and 24, the authors eliminated Rrad. This is not consistent. Probably Line 24, Page 470 you should replace “Rsr is small compared to Rrad” by “Rrad is small compared to Rsr”. “

Response : We will clarify this section of the manuscript, because the current description is not entirely clear. As we state on page 471 (line 4-7), ‘Note that we do include Rsr in the calculations of the overall resistance of the soil-to-leaf pathway (see section

Hydraulics of the soil-to-leaf pathway), 5 but omit it here to simplify the fractional uptake of water from different soil layers.'. As such, we omit Rsr from Eq 13 (which is based on Taylor and Keppler) to calculate fractional water uptake, but again consider this resistance later, in Eqns 23 and 24, when we calculate the root-weighted soil water potential. This simplification is possible because Rrad does not vary between soil layers (and therefore is inherent in the plant resistance). We will point out in the revision why the current implementation was chosen, rather than the original SPA submodel.

Reviewer: " Equation 14 is wrong: (ea-es) should be replaced by (es-ea): soil evaporation occurs when the water vapour pressure in the soil pore spaces is higher than in the air, not the opposite. "

Response : We followed the convention by the SPA model, that soil evaporation is a negative flux (because it leaves the soil space), however, we made no mention of this (and is a very confusing definition anyway). We will revise the equation as suggested.

Reviewer : "Page 474, Line 14, the soil-to-root resistance is expressed in mol/m2/s. This may be the unit for a conductance but not for a resistance. In Eq. 22, Lv is in m/m3, Hs in m, and Ks in mol/m/s/MPa. Then the unit for Rsr should be MPa s m2/mol, as correctly given in Appendix A."

Response: This is an error, will fix in the revision. Again, this is an error in the manuscript, not the model.

Reviewer: "Equation 23 is wrong: in the denominator, "Rsr/LT" should be replaced by "Rsr*LT":"

Response : The reviewer is correct; we will fix this mistake in the revision (but note that this error does not appear in the model code, only in the manuscript).

Reviewer: 'Equation 27 is wrong and this can be seen from the Units. If Kth is in W/m/K and (Ts2-Ts1) in K, then Qc would be in W/m. The right unit for Qc is W/m2. Then (Ts2-Ts1) should be divided by the depth difference (m) between soil layer 1 and 2."

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Response: We erroneously omitted the depth of the layer in the equation (but it does appear in the model code).

Reviewer : " Page 479, Ligne 11: "We used a hypothetical stand with total leaf area index of 3m2 môĂĂĂ2". However, in Table 2, Tree leaf area = 35 m2 and stand density is 1100 tree/ha, then LAI=35*1100/10000=3.85 m2/m2, not 3 m2/m2."

Response : Will fix in the revision.

Reviewer : "Page 485: 'Although many studies...' "

Response : The uncoupling of growth from photosynthesis might be an additional mechanism by which trees do not always conform to the expected [CO2] x drought interaction. We will add this to the discussion, and the citations provided by the reviewer.

Reviewer : "Page 486, Lines 18-19, replace "Fig 5b" by "Fig 6b" and 'Fig 5c" by "Fig 6c". For Fig 5 (and other Figs) replace "AT(Ratio eCa/aCa)" by "Ratio AT(eCa)/AT(aCa)"'.

Response : Will fix.

Reviewer : "Tables 2 and 3: - sf is not unitless: since PSIf is expressed in MPa, the unit for sf should be MPa-1 - At which reference temperature are given Jmax and Vcmax?"

Response The reviewer is correct about the units, and Vcmax / Jmax are given at the standard reference T of 25degC (will mention this in the revision).

Reviewer "Some parameter values such as Rmin are not given. "

Response : Will add the value of Rmin, and check if other parameters are missing.

Interactive comment on Geosci. Model Dev. Discuss., 5, 459, 2012.