Hydrology and Earth System Sciences Discussions

Interactive comment on "A simple three-dimensional macroscopic root water uptake model based on the hydraulic architecture approach" *by* V. Couvreur et al.

Anonymous Referee #2

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In this paper, a model for root water uptake is developed that is based on a number of simplifying assumptions. To assess its performance, this model is compared with one that accounts for the hydraulic architecture. The treatise is quite attractive in separating root architecture and compensation aspects, for a simple root zone architecture. This part is easy and transparent to follow, i.e., has educational value. What I also find very appealing in the presentation, is that several major assumptions are made, and these are accentuated in the methodology section to determine a way to test these assumptions. The testing is done in a transparent and well thought through way: (i) has the simple root architecture meaning for complex root systems, (ii) are axial resistances

small enough to be neglected in the compensation term, and (iii) can soil-root interface potentials be averaged in a soil element. For testing, the simpler implicit model is compared with a more complex one. To test the assumptions, several tests were devised. Forcing uniform conditions (soil water potential; no changes in root architecture), it was ascertained that two macroscopic properties (SSD and Krs) were indeed constant. This appears to be the case irrespective potential and transpiration demand. Testing of assumption (iii) was done by confirming that for the complex HA, the compensation φ depends linearly on the vector of soil water potentials as predicted by the equation that follows from making that assumption, and this is indeed the case and the macroscopic Kcomp is quite constant. At this point, however, I still wonder how the implicit model results were obtained: it is not clear to me, how the simplified root architecture was derived from the complex one. The paper demonstrates that a simple root architecture model can be compatible with a more complex one, that has significantly larger computation times. This is a profound advantage, obviously. For me, the attractiveness of the paper is in coming up with a nice way to deal with compensation, and the emerging macroscopic parameters mentioned in section 5.3. A revision, as far as I am concerned, should focus on elucidating how the simple (implicit) model is exactly dealt with. Since the implicit model still has many adaptable parameters, it should not be such a surprise that it can mimick an even more complex one. If that can be done, and I am quite convinced that the authors can clarify things for me easily, I believe that this paper is quite a step forward with regard to root water uptake modelling as is usually done at this moment. The introduction to the used models is a bit compact, to my taste, and I expect that quite some readers will wonder about some of the used definitions. Collar water potential being one of them. I wonder why the new model is called 'implicit'. In numerical work, this term is usually reserved to solving the equations. What is a catenary process, I had to look up, I admit. Considering the comparison of the two model approaches in the introduction, one wonders how well the HA modeling is a priori parameterized. For instance, are the resistances & conductances for the two models related with each other, and how? For the presentation, I propose

that eq. 2 & 3 are also moved to the appendix. As it is now, only for Qr,1 the result is in the main text for no obvious reason. Furthermore, the reading is unnecessarily complex if you refer to a term (φ), used in the rest of the paper, without telling 'which second term you mean'. Just replace (2) by the expression involving φ, , and some function f(R) and refer for details to the appendix. Three interesting features are observed in relation with eq. 2, 3, and the appendix. I wonder why they are so interesting. As presented, the impression is given that (first) being a sum of two terms multiplied with a dimensionless factor is interesting. As such, it is not. The interesting thing might be that the expressions concern an easily separable Tact, compensatory term and a reference uptake fraction. It is obvious, after recognizing the compensatory term, that is is zero if soil water potential is uniform. That the sum of dimensionless factors is one for the entire root architecture is not surprising or interesting, but a consequence of what it is: a relative uptake rate for each of the pathways of water uptake (if soil water potential is uniform). In short, I think that this discussion of p. 4948 and 4949 should be turned around: (1) analytical solutions can be given for the simple architecture of figure 1, (2) these solutions can be cast in the general form Qr=(Tact+φi).(/f(R)), (3) where we recognize a compensatory and a reference uptake fraction term, (4) the first one zero at uniform soil potential and the second one summing up to unity. Whereas RWU is a well known acronym for root water uptake, the newly introduced vector SUD is not. I would call this vector a 'uptake fraction', because it is a fraction, and I would not give it the symbol SUD (which is more as a computer code identifier), which later could be interpreted as multiplying S, U and D: I would give it a real symbol, as you do also in the other equations. E.g. fU. I admit that it is a matter of taste. I believe that (9) has been derived under the constraint that $\alpha \approx 1$ although line 5-6 p. 4953 says differently, but if correct (otherwise, I am lost somewhere), to avoid ambiguity, this should be mentioned in line 7 of p. 4951, or, alternatively, line7 should not start a new paragraph. The potential difference of line 8 should be better explained, i.e., to what this flux refers (the index j is not sufficient). The authors are of course free to call their conductance (line 8) a compensatory conductance, but I doubt that this gives much understanding

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to the readers. Their case is presented 'too economically' to my taste. Lines 13-15 are obsolete, if the constraint made regarding α is presented better. Again, p. 4952, line12, interesting features are announced. The second feature is indeed interesting, i.e., it draws the public to some old work, as I am unaware of that publication adn the term Thevenin equivalent resistance. The first feature is not so surprising to me and I propose that the various terms in 10 are renamed SUDj, for brevity. p.4953: line 10: for a very special root system, is that what you want to say? Since now the soil element becomes more important (than in the introduction), it is now time to define exactly what you mean. Line 14-18: I find your way of formulating this quite difficult to follow. This can be said more straightforwardly. The text is ambiguous for me. Why is information transferred from the soil grid to the root architecture? Basically your aim is to go from architecture to soil grid, right?! What is the root node? Concerning eq. 12: as I understand it, Q is determined by (9). The delta factor is only 1 for one value of k, for each i value, but for each k value, more than one i can give a delta that is 1. Please indicate so. Now, all RWU together (all k) should not be larger than the transpiration demand. How is that ascertained? Please delete eq (13): it is trivial. p. 4954: you should rephrase line 9-11:...is the value of... should become ..., which we call... The approximation that you make: how big is the error that you make, for the considered examples later in the paper? p.4955: explain line 1-2. What do you mean with 'not explicitly into account', but 'sensitive'. Further, I wonder whether you really wish to use the word 'verify' in line 21. I suggest that you use a more neutral term. Typo's/English: P4944 line 3: delete much; line 17: contrasted? P4949 line 14-15: is increased of??? P4950 line 7: replace 'it' by 'this' P4952 line 7: delete 'out of' and replace 'we could find a link between' by 'links'; Line 22: replace 'that' by 'the'. P4953: 'which would reduce the number of parameters ... to two. P4954 line 1: value, not values P4957 line 8: their existence: wrong terminology! Line 10: please phrase this in a more meaningful way.

Comma's should be inserted at many places.