

Interactive comment on “Horizontal soil water potential heterogeneity: simplifying approaches for crop water dynamics models” by V. Couvreur et al.

Anonymous Referee #2

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The authors address the crucial issue of upscaling Root Water Uptake (RWU) variables and parameters for crop water dynamic simulations. They start from a high-resolution 3D root architecture hydraulic simulation (based on the model by Couvreur et al., 2012) and upscale the results to 2-D and 1-D simulations. In order to simplify horizontal soil water flow the authors test two different assumptions: the first approach consists in assuming homogeneous Soil Water Potentials (SWP) in the upscaled soil elements while, in the second approach, an analytical solution for constant rate horizontal flow around roots is used. The authors evaluate the methodologies for different plant types (maize and wheat) and for different transpiration rates and soil characteristics (silt loam

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and sandy loam).

General Comments:

The article is well written and of interest to the audience of this journal. The results are well presented and provide useful information for future modeling studies on RWU. I suggest only minor changes that may improve the overall quality of the manuscript.

Specific comments:

First of all I agree with referee de Jong van Lier on the issue of plant collar-leaves water potentials. Assuming that they are identical implies to assume zero collar-leaves resistance and it is necessary to add a discussion on the implications of such an assumption. In addition, the authors neglect the cavitation processes that may occur in the plant xylem even though they have been shown to play an important role in regulating plant transpiration (e.g. Domec et al 2012). If the authors decide to follow the referee's comment and implement the collar to leaf resistance by an extra term, they should also consider introducing a "vulnerability function" to account for cavitation (e.g. Daly et al. 2004).

Secondly, since the study addresses the issue of upscaling but focuses on the plant scale only, it would be interesting to add a discussion on the implications of these results to larger scales (e.g. field or watershed). In other words, what happens in terms of model predictions when the model grid is in the order of 10 m instead of 10 cm? And what about the overlapping of root systems? I personally think that the manuscript would benefit from a discussion on these topics.

Technical corrections:

- P. 1207, line 1: typo "for OF soil-plant" (remove OF);
- Eq. 1: in the case of 3D flow, hydraulic conductivity K is a tensor [3x3], please clarify;
- P. 1208, line 1: "the time", remove THE;

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- P 1208, line 2: “total SWP”, here you refer for the first time to “total” SWP, please explain;
- P 1208, line 19: “M soil elements”, do you account for all the soil elements or only the soil occupied by roots? Obviously it depends on how SSF is defined but this is not clear here;
- P. 1212, line 2: “[Gx1]”, is this the size of the vector? Not clear
- P. 1216, line 7: “R-SWMS”, please add a reference (e.g. Javaux et al., 2008)
- P. 1218, line 11: top and bottom boundary conditions are explained, what about the edges of the domain?
- P. 1218, Eq. 19: Tpot is calculated on the basis of potential EvapoTranspiration ETref by the FAO methods. However, ETref accounts for both plant transpiration and soil evaporation. The latter should not be accounted for in the RWU term. Can you please discuss this point?
- P. 1219, line 24: the authors refer to “eight scenarios” but Table 1 and Fig. 4 illustrates 6 scenarios, please be consistent;
- P. 1220, line 23: consider to move the sentence “Equations . . . Appendix C” somewhere else in the text. Not sure it is related to the “Comparison with Ref scenarios” section;
- P. 1224, lines 20-23: consider changing “days” and “nights” with “daytime” and “night-time”;
- P. 1225, line 13: “Values . . . by soil”, I don’t understand this sentence, please clarify;
- P. 1225, line 21: Typo “IN the same time”, correct with “AT”;
- P. 1228, line 17: Typo, “while OF psi_sr is still” remove “OF”;
- P. 1229, line20: “equal to minus infinity”, why? Add reference to an equation to clarify

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this point;

- P. 1229, line 26: “when the model was further coupled to Richards Eq.”, it was not clear that the model was not coupled before, please add comments in Section 3.2;

- P. 1230, line 1: “These could ... 10^{-7} d^{-1} ”. Remove this sentence, the value of the time step doesn't provide any information if the numerical solver, the convergence criteria, etc are not explained.

- Fig. 4: Add the label and units to the X- and Z-axis. I guess the scale is in cm but it has to be clear.

- Fig. 5: Consider to use different symbols in panel a) and b). Is the X-axis in panel c) and d) a log-scale? Clarify

References

V. Couvreur, J. Vanderborght, and M. Javaux, A simple three-dimensional macroscopic root water uptake model based on the hydraulic architecture approach, *Hydrol. Earth Syst. Sci.* 16 (2012) 2957–2971, doi:10.5194/hess-16-2957-2012.

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