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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Water movement through plant roots: Exact solutions of the water flow equation in roots with varying hydraulic properties" *by* Félicien Meunier et al.

Anonymous Referee #1

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General comments This paper propose new solutions of water flow through plants roots by extending the solution with a constant root hydraulic conductance from Landberg and Fowkes (1978) to linear and exponential variations of hydraulic conductance (radial and /or axial) along the root. These solutions are further extended when hydraulic conductance variations along the root can be decomposed into piecewise linear/exponential variations. Examples of applications are given for hydraulic conductance variations estimated from experiments, which differ from a constant conductance or to illustrate effect of tissue maturation (on root conductance) or how root effective conductance could be maximized. The paper is interesting in pointing to the differences between a uniform conductance along a root and a variable (exponential or

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piecewise linear) conductance variation, which is more biologically realistic and which rise, for the latter, to a more regular, less abrupt variation of xylem suction or radial flux along the root. This is not necessarily new, as general solutions to water flow equation with any conductance variation (including those shown in the paper) in roots have been solved numerically since at least 2 decades, but the authors clearly show here the difference and non-equivalence between constant and variable root. The added value of getting analytical solutions could be better stressed, even if numerical solutions are available, in the sense that such analytical solutions can be used to verify the numerical resolution and to get a generalization of the hydric behavior, with the main influencing parameters of the solution, to a branched root system and/or with varying soil water potential. That's the way followed by Landsberger and Fowkes (1978) who broadened the reach of their solution of the single root flow. This also the case of Ariyaratna (1990) who developed afterwards a solution equivalent to the equation A2 (linearly varying kx; Ariyaratna R 1990, An extension to the Landsberg and Fowkes' model, Master of Science thesis, Texas Tech University). Unfortunately, the authors don't show that in this paper, restricting to the single root, uniform soil case. It would be worth to present how their results could be extended, more precisely than what it is stated in conclusion (P19 –L 28-30 or P 3 L8). From another point of view, my feeling is that the authors don't really come back to real life and the biology (in the examples), but rest on comparisons between calculations. That stems in part from the fact that only the single root case is addressed, and not a root system. However, for example trying to compare types of uptake pattern with root growth (as in section 3.3) with real behavior of plant would be interesting; Looking at the implication of the optimal radii as presented section 3.4 would make the calculation more interesting. Indeed, for example, an optimal radius of exponential root that would be 0.11 cm would lead to a root length of $\sim$ 1 cm. Is it the kind of roots that is observed in reality? Concerning the derivation of solution, some of them could be rechecked and possibly verified with numerical integration (see detailed comments). As to the form of the document, the paper is rather well written but I would suggest reconsidering

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the use of some expressions. The use of “root branches” is misleading as we expect an investigation of a branched root system, which is not the case. I would rather suggest using “single root” or simply “a root” throughout the paper. I’d rather use also a “segment of root” homogeneously within the document. The axial conductance is denominated here “intrinsic axial conductance”. Generally “intrinsic” refer to the transfer property of a porous medium independently of the flowing fluid. It’s not the case here, as conductance is referred to water and “intrinsic” could be dropped in the text. Concerning the title I would be more explicit and suggest: “Exact solutions of the water flow equation in roots with linearly or exponentially varying hydraulic properties”. (see also detailed comments) Detailled comments See the annotated manuscript in attached file P2 L13 ref. Martre et al. 2000 is for leaves, better cite works by McCully and coll. (for maize roots).

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/hess-2016-633/hess-2016-633-RC1-supplement.pdf

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