Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2018-280-AC1, 2018

Interactive comment on "A mechanistic model for electrical conduction in soil–root continuum: a virtual rhizotron study" *by* Sathyanarayan Rao et al.

Sathyanarayan Rao et al.

sathyanarayan.rao@uclouvain.be

Received and published: 14 September 2018

The reviewer provides a nice and a brief summary of what we did in the first paragraph and we thank you for the efforts in doing so. Thanks for the complement "the manuscript is interesting and the work done is technically sound". We appreciate and thank the reviewer for providing his comments in general. Regarding other comments, our responses are below:

Reviewer comment:

"Despite the above in my view, important aspects that were omitted (discuss below),

weakening the work and limits its applicability. Furthermore, the lack of experimental data to support the model is missing."

Response: We fully agree with the limitation of this work as pointed out by the referee, especially the lack of experimental data. We discussed them in details in the manuscript. We definitely believe that the next step is to compare the model with experimental data. However, to our opinion, : (1) the manuscript is already long enough; (2) the development and results provided by a process-based model themselves reveal interesting features that deserve publication per se.

Reviewer Comment: "1. As the author's notes (e.g., L429-443) at the field scale, a 3D model might be needed. This is important because (a) the soil/root volume ratio might be different from the presented 2D case, and (b) the 3D electrical field are expected to differ (perhaps significantly) from the 2D field in the presence of the complex root structure (how this will impact anisotropy?). A 3D analysis seems to be necessary in this case, even if on a simpler root system. In addition, it is important to report the volume of roots in the soil and to compare it to normal field conditions."

Response:

Our goal here was to illustrate the effect of roots on ERT results and hence we chose a simple geometry of rhizotron, which is essentially a 2D. In addition, this design will be used in future experimental research, which also justifies our choice. We agree that results presented here might change quantitatively when modeled in 3D and such analysis will be included in future works, however, qualitatively, the results would not change much in our opinion, especially in terms of ERT reconstruction. In addition, we added lines at L222 in the attached draft to report the density of roots in the electrical forward modeling at different times: "The total root length per unit volume in the RSWMS simulation was 0.06, 0.22, 0.66, 1.1, and 1.61 cm/cm3 at day 5,10,15,18 and 22, respectively. In the typical field, the root density is around 1cm/cm3."

Reviewer Comment:

“2. The authors assume that the electrical conductivity of the pore water is constant, this is, in my view, not adequate. Without considering any complex processes (e.g., L434), the mere fact that the roots take water and leave salts means that the water conductivity around the root is high. How this is affecting the authors’ analysis is not clear, but because the bulk electrical conductivity and the water conductivity are strongly coupled, it might be significant (authors are advised to consult Rhoades et al., 1976).”

Response:

We did not assume that the plant takes up water and leaves salts. We rather assumed that the solute was taken proportionally to water uptake, which leads to no change of solute concentration in pores. We agree with the reviewer, that including complex processes such as root exudation and active solute uptake or exclusion might change the conductivity data of forward map. Note however, that in the field this is not always visible in experiments (see for instance Beff et al., 2013). In addition, this is a function of the type of nutrient, the uptake flux, the plant genotype etc. It would additionally require a finer grid able to deal with solute gradient much below the cm scale. This is very interesting but would deserve another study focused on that topic. Moreover, field data’s often shows monotonically increasing electrical conductivity with water content meaning there is negligible effect of salt accumulation near roots. If salt accumulation near roots were non-negligible, it would perhaps create a cloud of points with no clear petro-physical trend.

Reviewer Comment:

“3. The authors conducted a real experiment with a plant at the rhizotron scale. Taking real ERT measurements at the same opportunity could immensely improve the manuscript and contribute to the validation of the numerical model. In addition to the above: - It is worthwhile to compare forward modeling with and without roots, and not only the results of the inversion. This comparison could provide an estimation of the

root contribution to water content independently of the applied inversion algorithm.”

Response:

The light transmission experiment to extract root system on a rhizotron in this paper was not equipped to do ERT experiment at that time. Also, installing ERT electrodes on a rhizotron with a plant is a significant effort (and a challenge to avoid the electrode wiring showing up on the light transmission image). We agree with the reviewer that validation of numerical model is necessary but we leave it for a further paper. This paper is first needed to (1) present and introduce the concepts of our model, (2) realize a sensitivity analysis of the important factors affecting ERT measurements and to (3) provide to the scientific community a tool to optimize electrode configuration for real experiments.

Reviewer Comment: “In line 58, it seems authors do not distinguish between two terms, apparent conductivity and bulk conductivity.”

Response:

The word apparent is deleted in line 58.

Attached supplement "review 2 version.pdf" highlights the changes made for reviewer 2 comments in green while for reviewer 1 comments, it is in red.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2018-280/bg-2018-280-AC1-supplement.pdf

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2018-280, 2018.