Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2018-238-RC1, 2018

Hydrology and Earth System Sciences
Discussions
Open Access
EGU

Interactive comment on "Small scale characterization of vine plant root water uptake via 3D electrical resistivity tomography and Mise-à-la-Masse method" *by* Benjamin Mary et al.

Anonymous Referee #1

Received and published: 6 July 2018

This article describes how electrical resistivity tomography and Mise-à-la-Masse method can be used in conjunction to map root activity or root zone. Indeed, it is a very interesting approach applied to soil-root research for the first time. The authors provides a nice introduction of non-invasive methods of soil root system and then discuss MALM inversion procedure and provide very interesting results indeed. For instance, they are able to map the root extension or root active zone.

In the introduction, it would be nice to also refer the paper Werban et al. (2008) who did interesting ERT study on lupine roots and showed that rooted soil differs from bare soil in terms of pedophysical model.

Printer-friendly version

Discussion paper

In P2L27, authors rightly mentions that understanding of contributions from individual root segment on bulk electrical conductivity is limited. I would suggest to refer a recent modeling paper that tries to address exactly this same issue: (Rao et al.: A mechanistic model for electrical conduction in soil–root continuum: a virtual rhizotron study, Biogeosciences Discuss., https://doi.org/10.5194/bg-2018-280, in review, 2018.). In fact, similar modeling study with explicit representation of root structure in the MALM forward modeling should be done as a follow up work to understand better how this approach can be made more robust. Authors could suggest this in the conclusion section.

In P3L29, authors mentions that current injected in stem is most likely to exit the root system only at fine root locations. It would be nice to justify this assumption by providing more information on range of resistance in inner layer of root, outer bark structure as well as fine roots. For instance, current can also exit from woody root radially, if bark layer is anisotropic and offers radially much lower resistance, allowing current to exit even before they reach finer roots. For example, Anderson and Highinbotham (1976) showed that for maize roots, they measured electrical resistance in axial and radial directions of both inner and outer layers of root. They show that radially resistance is much lower for the roots. It would be nice to see, if the above mentioned scenario is discussed in this paragraph and if MALM could be applied to, for instance maize root or non-woody roots or instead can we predict anisotropy in root structure using this approach? However in P11L20, authors also rightly point out that more research is needed to know exactly where current exits the root. In this context, I suggest to discuss the electrical anisotropy of root tissues in the same paragraph and mention how MALM would possibly perform for a highly anisotropic root system. First root is electrically anisotropic at microscopic scale (few centimeter) and also macroscopically the root architecture and soil water uptake pattern induce anisotropy in electrical conductivity. But using MALM to study anisotropy of root structures can itself be an independent study but the authors can suggest that research can take place in this direction using the techniques mentioned in the paper.

Printer-friendly version

Discussion paper

Section 2.3.2 wasn't completely clear to me. For example, I had difficulty in understanding the lines 22 to 24 in P7. May be resentencing these lines can bring more information. Although, I get the overall idea of using Eq.[1] and [2] to find secondary current source location in underground, I believe sections 2.3.2 and 2.3.3 still needs some improvement in terms of explanation. For example, the no. of nodes in the mesh and the no. of electrodes are the vector size of Dm and Df, which determines the matrix size of F1 and F2. The values used in the paper can be specified along with computational time it took to do MALM inversion (if it was lengthy process). The term Ns in Eq. [2] is not clearly mentioned and its corresponding value of choice. Is Ns = no. of nodes in the mesh? What authors call sources in these sections are nothing but regions where current (injected by real source in stem) exits the root system (below ground) due to electrical conductivity/ electric potential gradient and hence these are not active sources, so I would suggest to use more physically more meaningful term such as secondary source or passive source to really distinguish it from primary or active source of current that is injected in tree stem. Calling them just source might be misleading (in my opinion).

In general, the explanation for MALM inversion procedure in the paper is not adequate. Efforts could be taken to make it a bit more clear for novice readers. For example, authors mentions MALM inversion as ill-posed, so what kind of regularization, did authors use to make solution stable ?

Secondly, I would suggest some minor suggestions which would, in my opinion, improve the readability of the paper.

âĂć I suggest to use the word non-invasive throughout the journal to have uniformity and the word non-intrusive in P2L8 can be changed to non-invasive. âĂć In P2L18, abbreviation FTSW is not defined. âĂć There is a unwanted comma in (Amato et al. 2009;,) at P2L22. âĂć In P4L20, stating resistivity is complex number for alternating current may not be so appropriate,in my opinion, as compared to saying resistivity is complex number for polarizing medium having resistance and capacitance parts. Even

for DC current, for example capacitor discharging, we can associate this effect into complex resistivity or impedance. âĂć In L26P6, why is the term micro ERT used, if it is same as 3D ERT which is used throughout, I would remove the term micro to avoid confusion or add it everywhere. âĂć I would add figure indices a), b), c), and d) in Figure A.1 P14 âĂć I would add figure indices a),b),c) along with xlabel,ylabel and SI units of quantities presented in the Figure A.2, P15. âĂć I would add figure indices a) and b) in Figure 2 P23. Also in the left figure, I would put surface electrodes in different color or marker to differentiate it with borehole labels. Once can also change the angle of the tilt in the left figure so that all 4 pillars of boreholes are visible without overlapping. Also size of left figure can be increased by making both the figures as column instead of side-by side row figures. âĂć The underlined term Regularization in Figure 3, P24 seems to be unconnected to flowchart. Rather it should be used inside the blocks where it is used. âĂć Add units to axis labels in Figure 4b P25. The green dot or circle in Fig 4c is not described in caption. Also electrode numbers are not visible. I would also specify electrode numbers corresponding to Borehole1, Borehole2, Borehole3 and Borehole4, so that Figure 4d can be easily compared with Figure 2 a (left) to know the location of these boreholes. âĂć Again green circle in Figure 5 b in P26 needs to be described in caption below. Size of electrode label can be increased for readability. âĂć In Figure 6 b P27, x-axis limits can be reduced from maybe 80 to 150 and adding vertical grids will make the quantitative inspection of variations in soil resistivity, relatively easy. Also size of Figure 6c can be increased. âĂć Figure indices a),b),c), and d) needs to be added in Figure 7, P28. The color contrast between Borehole1 and Borehole 2 is low in bottom figures. âĂć Figure index a) and b) are missing in Figure 9 at P30. âĂć In P6L26, suddenly author uses the new term micro ERT which can be confusing since previously 3D ERT is used. I would suggest to either use micro ERT throughout or use 3D ERT everywhere. âĂć In P7L13, MATLAB version and the name of the optimization function could be mentioned for repeatability reasons. âĂć I would suggest mentioning the units of Dm and Df in Eq 1 and 2. For example, in P7L7, authors can mention Dm is the measured voltage instead of measured data

to be more precise. Also, the word “forwarded” in the same line can be changed to forward voltage data.

I conclude by saying that this paper indeed brings new knowledge in the field of non-invasive imaging of soil-root system and is definitely relevant for publication in HESS. However, I recommend publication after addressing the above listed comments and suggestions.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2018-238, 2018.

Printer-friendly version

Discussion paper