

This paper presents an interesting method to image non-invasively water flow in soils. I am not familiar with this method and not aware of its applications in soil science. Large parts of the section in which the method was presented were hard to understand for me and I assume that this will be similar for many readers of HESS. I think the authors should improve this. The readability of the paper could also be improved drastically by proof-reading by a native English speaker.

The result of the inversion is an image of normalized dielectric permittivity. I have two main questions about normalized dielectric permittivity. The first is about the reference that is used to normalize the dielectric permittivity. As I understood it, the authors use the dielectric permittivity of water. But, since the dielectric permittivity of wet soil is considerably smaller than that of water, I do not understand how the authors come to a normalized dielectric permittivity of wet soil that is equal to 0.9. Therefore, I guess that the authors did not normalize to the dielectric permittivity of water but to the dielectric permittivity of water saturated soil. But, this is not as it is written in the text. The second question is related to the derivation of the normalized dielectric permittivity. As I understood it, the authors invert normalized measured capacitances. However, this must be related to a few assumptions and approximations. In general, inversion of a normalized measurement signal does not lead to a normalized output variable. I think the authors should make these assumptions explicit or explain why these assumptions hold true.

Detailed comments:

In the introduction part, it is suggested that the listed techniques provide data with temporal resolution but do not provide 3-D spatial data. I think that this is not generally true. There are also a few examples where ERT tomography (Daily et al., 1992; LaBrecque and Yang, 2001; Zhou et al., 2002) was used to monitor 3-D infiltration.

p1370: In Eq 2, $Q_{i,j}$ is defined and in the other equations, only Q_j is used.

p1371 ln 13: 'because the relation between the interrogating field and the permittivity ... are dependent on each other' I do not understand this sentence. If there is a relationship, then I would say that it is trivial that the interrogating field and the permittivity are dependent.

p1371: I am not familiar with 'soft fields' and 'soft tomography'. The authors could maybe explain this a little bit

p1371 ln 29: sensitivity mode $\rightarrow$ sensitivity model?

p1373, Eq. 9: The authors use a normalized capacitance. This normalized capacitance is then inverted to obtain normalized permittivities. In several tomographic methods, the measurement signal is inverted to an image and the image is subsequently normalized. I think there are some underlying assumptions or approximations here. I propose that the authors explain this.

p1376: 'When the soil is saturated, the permittivity will not be as high as the permittivity of pure water. Therefore the value of the mean normalized capacitance ... will not reach the pure water value.' I do not understand the reasoning and argumentation here. The dielectric permittivity of a wet soil is smaller than 90% of the permittivity of water. Dielectric mixing models have been developed to relate the dielectric permittivity of wet soil to the volumetric water content and the dielectric permittivity of water and soil particles (Roth et al., 1990). Or has the permittivity been normalized to the permittivity of the wet soil?

p1376 and Figure 8: Except for the value of the relative permittivities, the results shown in figure 8 seem to be plausible. But, similar to other tomographic methods, I guess in this method there will also be some issues about smoothing or the introduction of artefacts. For instance, the pure water infiltration experiment in the empty column shows some of these artefacts. In this experiment, the water front should be flat and sharp and there shouldn't be increases in water content above the wetting front. Figure 6 illustrates that the inversion does not fully obey these criteria. Therefore, I think that some discussion about artefacts in Figure 8 would be useful. For instance, to what extent do the distributions represent real heterogeneities of the water distribution in the column and to what extent are artefacts displayed?

References

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