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Hydrology and Earth System Sciences Discussions

Interactive comment on "Efficient reconstruction of dispersive dielectric profiles using time domain reflectometry (TDR)" *by* P. Leidenberger et al.

P. Leidenberger et al.

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The authors acknowledge the paper's detailed study by referee C. Hübner and thank him. The paper will be revised on the basis of these comments. We answer the comments of [Hübner(2005)] as follows:

1. ***referee:*** *In chapter 2 Methods and chapter 6 Appendix transmission line parameters of two and three rod probes are given. The calculations are based on an approximation. I suggest to compare this approximation with more exact values, e.g. based on finite element software calculations. There is no need to rely only on an approximation when there is widely available software to calculate transmission line parameters with better accuracy.*
authors: We agree with the reviewer that our model is an approximation that can be improved with an additional numerical step. Indeed, looking at Eq. (16) to (21) we recognize that the geometry of the transmission line can be encapsulated into

a single parameter, which must be calculated numerically, however. These calculations are currently under way and will be included in the revision.
referee: *Using the parameters of table 3, eq. 16 and eq. 18 the resulting speed of propagation in air is about 3% lower than the expected speed of light. Please check eq. 19 and eq. 21 with the parameters of table 4. The calculation of the speed of light with this formulas gives erroneous results.*
authors: Equation (16) and Eq. (18) are derived for a three rod probe and Table 3 refers to a two rod probe. Equation (19) and Eq. (21) are derived for a two rod probe and Table 4 refers to a three rod probe. Nevertheless there is a deviation of the speed of light, calculated with the mentioned formulas and the associated tables, cf. comment of schlaeger2005b and respective reply.

2. ***referee:*** *One of the most important aspects for the practical use of a reconstruction algorithm is the required computation time. Please provide additional information about computer resources required for typical reconstruction problems. This is essential for assessing the practical value of the presented algorithm.*
authors: The reconstructed profiles shown in the paper are computed on a personal computer (2GHz clock) within a few hours. The actual computation time depends strongly on the measurement configuration, e.g. probe length, TDR rise time, dispersive character, upper and lower limits for the reconstructed parameters.

   The rather massive computational effort results from the requirement to employ a globally optimizing algorithm since this type of problem is often vulnerable to local minima [Rahmat-Samii and Michielssen(1999)]. We chose a genetic algorithm which is known to be very robust albeit rather slow. Algorithmic improvements are easily accomplished, for instance by using hybrid approaches, but they were deemed essential for this prove-of-concept study.

3. ***referee:*** *Chapter 3.1 und 3.2 are called "Validation", but examples of TDR traces are shown only and no comparison with independent calculation methods is*

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made. So, what is meant here by validation ?
authors: In Chap. 3.1 and 3.2 we demonstrate the effects of different termination conditions and dispersive dielectric media on calculated TDR traces. These examples demonstrate the effect of the different model for probe termination. In a revised version of the paper we plan to include measured traces in the validation section as well.

4. ***referee:*** *In chapter 3.3. reconstruction examples are shown. I suggest presenting more convincing examples with larger variation of permittivity and pronounced multiple reflections. Most of the examples only show a very slight variation of permittivity. This is not a very challenging task for a reconstruction algorithm. Synthetic profiles with large permittivity and conductivity variations would be better to assess stability and performance of the algorithm. If possible include independent reference measurements to compare the results with the true water content (e.g. from gravimetric measurements)?*
authors: We follow this suggestion and will include TDR traces exhibiting larger dielectric variations in a revised version of the paper.

   We would like to point out here, that we do not only reconstruct one single value of permittivity per spatial slice but reconstruct the parameters of the Debye model, describing dispersive dielectric behavior. We consider this to be a significant feature of our reconstruction algorithm.

References

[Hübner(2005)] Hübner, C.: Interactive comment on “Efficient reconstruction of dispersive dielectric profiles using the time domain reflectometry (TDR)" by P. Lei-

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denberger et al., Hydrology and Earth System Sciences Discussions (HESSD), 2, S751–S752, 2005.

[Rahmat-Samii and Michielssen(1999)] Rahmat-Samii, Y. and Michielssen, E.: Electromagnetic Optimization by Genetic Algorithms, Wiley Series in Microwave and Optical Engineering, John Wiley & Sons, 1999.

[Schläger(2005)] Schläger, S.: Interactive comment on “Efficient reconstruction of dispersive dielectric profiles using the time domain reflectometry (TDR)" by P. Leidenberger et al., Hydrology and Earth System Sciences Discussions (HESSD), 2, S800–S803, 2005.

Interactive comment on Hydrology and Earth System Sciences Discussions, 2, 1449, 2005.