

Interactive comment on “Quantitative high-resolution observations of soil water dynamics in a complicated architecture with time-lapse Ground-Penetrating Radar” by P. Klenk et al.

Anonymous Referee #2

Received and published: 19 December 2014

This manuscript uses high-resolution time-lapse ground penetrating radar (GPR) measurements to study soil water content dynamics at a test bed with a complicated subsurface architecture. Modelling of GPR wave propagation is used to better understand the observed GPR data. In particular, the authors aim to evaluate the accuracy of the average soil water content by using the bottom reflection from the test bed and to evaluate the feasibility of monitoring the dynamic shape of the capillary fringe reflection. Overall, the quality of the writing is sufficient, although careful editing could further improve the paper. Please find below a set of general and specific comments that I think

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need to be addressed. If these major revisions have been addressed properly, I can recommend the paper for publication.

GENERAL COMMENTS

1. I feel that the introduction can be significantly improved. Although it provides an overview of what has been achieved, it does not really become clear what is missing in previous work, and how the present study addresses this. Although it is perhaps a matter of taste, I would also like to see the formulation of a clear aim in the last part of the introduction. As the introduction is written now, it gives the impression that this manuscript makes a small contribution here and there but only in an incremental manner. It also seems that the main message of this manuscript is close to that of Dagenbach et al. (2013). The authors should make it much clearer how this paper is different from their previous paper that also dealt with the shape of the capillary fringe reflection. Finally, it may be worth to motivate why looking at the capillary fringe reflection is interesting. In many instances in the field we do not clearly see this reflection because shallow groundwater is not likely to occur in soils amenable to GPR.

2. Along the same lines as outlined above, I found that it is also not so clear from the presentation of the results what the main findings are. What have we learned from this study, and how can this bring us forward with GPR?

2. In the abstract, you talk about assessing the accuracy of GPR measurement in the testbed using the bottom reflection. In the relevant sections, you talk about precision. The latter is correct for what you do. Nevertheless, I think a mass recovery calculation should be attempted, and this would at least give the global accuracy. Throughout the manuscript you should evaluate the use of precision and accuracy, which are obviously not the same.

SPECIFIC COMMENTS

Page 12367, Line 9. Please evaluate the use of acknowledged throughout the

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manuscript. I feel that you use it in an inappropriate manner on several occasions. Here 'recognized' seems more appropriate.

Page 12367, Line 6. Something is missing here. It is not the radar that needs quantification.

Page 12367, Line 19. It is not so clear to me why you try to introduce a contrast here between what has been achieved with full-wave inversion and what you are doing. Could you provide a better motivation?

Page 12369, Line 2. Although the cited work indeed assumed horizontal layering, I do not think that the methods are fundamentally limited to layered media. Therefore, I find this not a very strong argument.

Page 12371, Line 17. Figures should be referred to in the presented order. Here, you jump from figure 1 to figure 4.

Page 12371, Line 25. Not clear what you mean with infiltration curtain here and also later in the manuscript.

Page 12371, Line 22. I propose to only discuss the GPR measurements that will be analyzed later in the manuscript. No need to mention here what other GPR measurements were made simultaneously.

Page 12373, Line 17. David Robinson did some really nice work on the determination of the solid phase dielectric permittivity. I propose that this paper is a better citation: Robinson, D.A. 2004. Measurement of the solid dielectric permittivity of clay minerals and granular samples using a time domain reflectometry immersion method. *Vadose Zone J.* 3:705–713.

Page 12374, Line 9. Simplify presentation here? I do not see a real need to introduce the soil matric potential here.

Page 12374, Line 9. This is true for static equilibrium only.

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Page 12375, Line 10-25. Is it necessary to introduce the van Genuchten model here? For me, it is sufficient to say that previous work by Dagenbach et al. (2013) has shown that the Brooks-Corey model better represents the capillary fringe and thus the GPR reflection.

Page 12379, Line 15. It should be made clearer here how this is different from previous work. If the shape of the capillary front reflection contains so much information (as previously shown in my opinion), then why not try to back out the hydraulic properties? This would show the advantage of full-waveform modelling for coupled inversion approaches, which has not been previously reported and could have big implications.

Page 12380, Line 4. If it is porosity only, I would expect that the permittivity difference is largest at saturation. Could you clarify your argumentation here? Is it not the effect of different porosity on the other soil hydraulic parameters that we are seeing here?

Page 12380, Line 12. Why misinterpreted? Since the porosity is different, I think that this is a different material.

Page 12383, Line 20-29. This is difficult to follow. Perhaps the reader should be guided better here, and the relevant features should be indicated in the figure.

Interactive comment on *Hydrol. Earth Syst. Sci. Discuss.*, 11, 12365, 2014.

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