

Interactive comment on “Unrepresented model errors – effect on estimated soil hydraulic material properties” by Stefan Jaumann and Kurt Roth

Anonymous Referee #1

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This paper deals with the use of inverse modelling of soil water content and soil pressure measurements for estimating effective hydraulic parameters. Data are obtained from the ASSESS test site, which is an advanced experimental facility with well-known but complex soil layering and well-controlled boundary conditions. In particular, the effect of unrepresented model errors is investigated, and more importantly procedures are proposed to account for these model errors within the inversion process. The representation errors that are considered include uncertain sensor positions, uncertainty in boundary conditions, local heterogeneity, and dimensionality of the model (here: 1D vs. 2D). For the selected boundary condition (multi-step drainage and imbibition from below), it is found that small representation errors in sensor position can significantly affect the inverted material properties.

I am strongly supportive of the idea of this study. Many studies typically stop after a

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single inverse modelling run. Sometimes the residuals are inspected, but very rarely the results of inverse modelling are used to improve the model concept or the system representation. This study explores several representation errors, and the results seem to indicate that reasonably small changes in system representation can significantly improve the data fit and the properties of the residuals. However, I have a few general concerns and specific comments that I would like to see addressed. Addressing these comments likely involves moderate to major revisions. In addition, grammar and spelling should be improved in the revised version.

GENERAL COMMENTS 1. The introduction is rather unambitious and does not do full justice to the content of the manuscript. The authors decided to include a second introduction in section 4.3 where the structural error analysis is introduced. I strongly encourage bringing the idea of structural error analysis in the beginning of the manuscript to better prepare the reader for what is coming. The general stance of this extended introduction could be: Analysis of inverse modelling results to improve models. As already indicated above, I think there are too few studies that pursue this idea.

2. A general concern with the chosen approach is that the same data are used for inverse modelling and evaluation of the results. Would it not be much stronger when the inversely estimated parameters are tested on an independent dataset? Are such independent datasets available for the ASSESS test site? In the current manuscript, improvements in data fit are reported, but this is fully expected because the amount of parameters was increased at the same time.

3. A short discussion about the transferability of the results to other soil types would also be useful for the readers. Of course, gradients in water content are steep in ASSESS and this may significantly impact the importance of accurate sensor positioning. Would the same insights be obtained when the ASSESS test would have consisted of different loam soils? Please comment.

4. The authors decided to not take the classical structure of Introduction, Materials and

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Methods, Results and Discussion, Conclusions. For me, the alternative structure is not really working. For example, part of the results are presented in section 4.3 where the used methods have not yet been clearly explained. Although I may be purist in this matter, I would say that this paper would benefit from an organization following the classical scheme.

SPECIFIC COMMENTS Page 1, Line 1. Abstract should be a single paragraph. In addition, it is customary to provide the scope of the manuscript with an opening statement. Here, the authors immediately jump to the aims of the study.

Page 1, Line 19. Is direct determination really expensive? I would prefer time-consuming here.

Page 2, Line 19. Huisman et al. (2010) considered a soil layer on top of the dike material.

Page 2, Line 21. I would like to see more information about the TDR system that was used. Did the authors rely on automatic waveform analysis, or was this done manually to obtain more accurate results?

Page 2, footnotes. I find it very unusual that the authors use footnotes. Is this possible and common in HESS? In any case, it seemed to me that much of the information provided in the footnotes could have easily been integrated in the main text. Please reduce the amount of footnotes to a minimum.

Page 4, Line 14. One-sentence paragraphs should be avoided.

Page 6, Line 19. I am not so convinced that a separate section on the implementation is a good idea. In particular, I do not really like the three very short subsections that now follow. It makes the text unpleasant to read.

Page 9, Line 5. I could not follow your implementation of small-scale heterogeneity. Are you using heterogeneous parameters fields throughout the domain, or is this heterogeneity only introduced locally? Please clarify.

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Page 10, line 12. I know this as global-local approach.

Page 10, line 21. Not sure that standard deviation is appropriate here? Is this not the expected standard deviation of the residuals (e.g. measurement error).

Figure 7. This figure did not make things clearer for me. Consider deleting.

Page 12, Line 5. The start of this section seems out of place. For me, this clearly belongs to the general introduction (see general comments).

Page 13, Line 20-32. Perhaps I am a purist, but for me this is a result and this is not a good position in the paper to discuss a result. I would bring this later.

Figure 9. It would be good to show measured and modelled data in at least one figure. Here, a third column could be added to the left in addition to the residuals.

Page 15, Line 5. Avoid repetitions. This has already been described four lines ago.

Figure 10. This figure is too complicated. I am not sure how to read it. I am particularly unsure about the green.

Page 19, Line 32. It is not so clear how you reached this conclusion. Perhaps this needs to be emphasized better when discussing the results.

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