First contact:
Rohianuu Moua
Corresponding author:
Rohianuu Moua
Handling editor:
Marnik Vanclooster

Answers to Revision required 15 may 2023

20 July 2023
Editor decision: Reconsider after major revisions (further review by editor and referees)
by Marnik Vanclooster

Public justification (visible to the public if the article is accepted and published): In their revised manuscript, the authors have made an effort to address the comments provided by the reviewers. While the revisions made are commendable, they primarily focus on minor improvements rather than addressing the major revisions suggested by the reviewers. The authors state in the abstract that the originality of their work lies in suggesting a statistical parameter estimation approach using Markov Chain Monte Carlo (MCMC) to obtain direct estimates of parameter uncertainties. However, it should be noted that parameter uncertainty estimation in inverse problems is a well-established theory and not fundamentally original. The true originality of this work lies primarily in the investigation of specific boundary conditions, as mentioned in the previous review. Unfortunately, the authors did not incorporate additional analyses with different soil types or other boundary conditions as suggested by both reviewers.

Answer

In the revised version of the manuscript, we have now overcome this weakness of our study. We have applied the methodology to several types of sand, also considering different depths of the water table and various pressure heads at the top surface. These modifications are described from lines 501 to 521, also throughout table 4 and an additional figure (n°9). Our conclusions have been extended to add the main findings (L555 - 562)

Despite these limitations, the manuscript has several strengths. The authors have effectively clarified and corrected various points, resulting in a well-written paper. The numerical experiment presented, which involves the retrieval of unsaturated soil hydraulic properties from ground-penetrating radar (GPR) travel times, is technically sound and of interest to the scientific community.
In the previous review, a summary of the manuscript, highlighting its main aspects was provided. The authors analyze the retrieval of unsaturated soil hydraulic properties using GPR travel times associated with the wetting front and fixed reflectors during an infiltration event. They employ a 1D solution of Richard's equation to simulate the hydrodynamics, with specific boundary conditions consisting of a 10 cm pressure head (Dirichlet) and a 1 m deep water table. The analysis focuses on a single soil type, resembling sand, and considers the radar system as a point at the soil surface, neglecting radar-antenna system interactions.

Answer

Details have already been provided concerning the porous media considered and the boundary conditions (see L501-521 / 555-562). For radar-antenna system interaction, we have chosen to work on travel times to avoid such kind of problems (calibration of antenna amplitude, etc.).

The applicability and the portability of the procedure to other users is insured by the easiness of the protocol. And we remind that the specific geometry has been taken into account with the distance between TX and RX. Explanations have been included in the revised version on lines 229-239.

Sensitivity analyses and parameter estimation using the MCMC Bayesian approach demonstrate the informative nature of travel time data for estimating soil hydraulic properties, revealing different parameter sensitivities and corresponding uncertainties. Although the manuscript is well written and presented, its novelty remains limited compared to the existing state of the art. It primarily serves as a case study with specific boundary conditions, making its interest predominantly centered around these conditions and corresponding analyses.

Answer

Our approach consists in characterizing a soil using an infiltrometry test, which generally does not combine hydraulic and geophysical measurements. To reinforce the scope of the methodology, we have now considered several types of sand (whose van Genuchten hydrodynamic parameters correspond to those of an experimental site) and have also tested the impact of the the water table depth and the height of the ponding water applied.

Furthermore, the lack of modeling for the radar system and its interactions with the medium restricts the practical applicability of the conclusions. To enhance the paper, the authors should delve deeper into the physical interpretation of the results and thoroughly review the literature related to their topic (e.g., not cited Jadoon et al., WRR, 2008, amongst several other key publications), drawing connections between their observations and the existing body of knowledge.

Answer

Additional simulations have been performed to better support the conclusions reached and show that the methodology is effective. References have been added to improve the state of the art (Jadoon et al. 2008, Tran et al. 2014) and the interpretation of results has also been refined (L363-364 / 392-397).

Report #1

In their revised manuscript, the authors have made an effort to address the comments provided by both myself and another reviewer. While the revisions made are commendable, they primarily focus on minor improvements rather than addressing the major revisions suggested by the reviewers. The authors state in the abstract that the originality of their work lies in suggesting a statistical parameter estimation approach using Markov Chain Monte Carlo (MCMC) to obtain direct estimates of parameter uncertainties. However, it should be noted that parameter uncertainty estimation in inverse problems is a well-established theory and not fundamentally original.

The true originality of this work lies primarily in the investigation of specific boundary conditions, as mentioned in my previous review. Unfortunately, the authors did not incorporate additional analyses with different soil types or other boundary conditions as suggested by both reviewers. As a result, the outcomes of their analyses are of limited general interest.

Despite these limitations, the manuscript has several strengths. The authors have effectively clarified and corrected various points, resulting in a well-written paper. The numerical experiment presented, which involves the retrieval of unsaturated soil hydraulic properties from ground-penetrating radar (GPR) travel times, is technically sound and of interest to the scientific community.

In my previous review, I provided a summary of the manuscript, highlighting its main aspects. The authors analyze the retrieval of unsaturated soil hydraulic properties using GPR travel times associated with the wetting front and fixed reflectors during an infiltration event. They employ a 1D solution of Richard's equation to simulate the hydrodynamics, with specific boundary conditions consisting of a 10 cm pressure head (Dirichlet) and a 1 m deep water table. The analysis focuses on a single soil type, resembling sand, and considers the radar system as a point at the soil surface, neglecting radar-antenna system interactions. Sensitivity analyses and parameter estimation using the MCMC Bayesian approach demonstrate the informative nature of travel time data for estimating soil hydraulic properties, revealing different parameter sensitivities and corresponding uncertainties.

Although the manuscript is well written and presented, its novelty remains limited compared to the existing state of the art. It primarily serves as a case study with specific boundary conditions, making its interest predominantly centered around these conditions and corresponding analyses. Furthermore, the lack of modeling for the radar system and its interactions with the medium restricts the practical applicability of the conclusions. To enhance the paper, the authors should delve deeper into the physical interpretation of the results and thoroughly review the literature related to their topic (e.g., not cited Jadoon et al., WRR, 2008, amongst several other key publications), drawing connections between their observations and the existing body of knowledge.

Answer

We thank the referee for his very constructive comments. We are well aware that certain points are prohibitive for publication in the egusphere journal, so we have addressed all your comments and improved the quality of our study.

So, following the initial improvements made, we have addressed the various shortcomings as follows. New simulations have now been carried out, considering several types of soil, studying the impact of the depth of the water table on parameter estimation, and also applying different water heights of surface water to be infiltrated from the infiltrometer device. Consequently, interpretations of our results have been enhanced to go deeper in the physics (L364-365 / 393-398). The reviewer can check the modifications in the revised manuscript from lines 501 to 521, also throughout table 4 and an additional figure (n°9). Our conclusions have been extended to add the main findings (L555 - 562). Finally, we also added the mentioned references to better draw the connection with existing literature on the subject and to reinforce the state of the art which had already been improved in the previous feedback.