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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Reflection tomography of time-lapse GPR data for studying dynamic unsaturated flow phenomena" *by* Adam R. Mangel et al.

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I have found the paper interesting. And as such, with an application to the attempt of estimating moisture content from multi-offset GPR data, is largely novel. Yet, I have found it to a large extent disappointing that the authors seem to give too much credit to their own past work, and neglect a large body of literature considering multi-offset GPR processing, that dates back at least a couple of decases. Even more serious, is the lack of proper reference to wave migration methods that are state of the art in industrial seismic processing, and are yet presented herewith as if they are novel, or at least rediscovered by the authors. The reference list is poor in both respects, but particularly with concern to migration algorithms (only Stork 1992 is mentioned, that dates back some 25 years, and later Yilmaz and Doherty, 2001). I encourage the authors

to widen the literature review and put their work, not without merits, in the correct perspective. See below some suggestions for references to be put in the correct context, particulary in terms of GPR applications (but not only). From a technical viewpoint, I am a bit puzzled by the error estimates for water content estimates that is 5-10% in vol/vol (is it saturation or moisture content?) – as compared to 5-15% from soil probes (again, same question). I feel this error is far too high to make the estimates useful (if it is moisture content as I read it!). Note that in cross-hole GPR usually a 2-3% error in volumetric moisture content is generally accepted as realistic. Finally, as much as I like GPR, it should be clearly stated in the introduction that GPR can only be used in relatively resistive soil conditions. This is generally omitted when presenting GPR applications, yet in many practical situations the soil conductivity is high enough to force us to shift to ERT or EMI for soil moisture content estimates. References Forte E. and M. Pipan, 2016, Review of multi-offset GPR applications: Data acquisition, processing and analysis, Signal Processing, doi: 10.1016/j.sigpro.2016.04.011 Jaumann S. and K. Roth, 2018, Soil hydraulic material properties and layered architecture from time-lapse GPR, Hydrol. Earth Syst. Sci., 22, 2551–2573, doi: 10.5194/hess-22-2551-2018 Lambot, S., Antoine, M., Van den Bosch, I., Slob, E., and Vanclooster, M.: Electromagnetic inversion of GPR signals and subsequent hydrodynamic inversion to estimate effective vadose zone hydraulic properties, Vadose Zone J., 3, 1072–1081, https://doi.org/10.2113/3.4.1072, 2004. Lambot, S., Slob, E., Rhebergen, J., Lopera, O., Jadoon, K. Z., and Vereecken, H.: Remote estimation of the hydraulic properties of a sand using full-waveform integrated hydrogeophysical inversion of time-lapse, off-ground GPR data, Vadose Zone J., 8, 743–754, https://doi.org/10.2136/vzj2008.0058, 2009. Leparoux D., D. Gibert, P. Côte, 2001, Adaptation of prestack migration to multiâĂŘoffset groundâĂŘpenetrating radar (GPR) data, Geophysical prospecting, 49(3), 374-386, doi: 10.1046/j.1365-2478.2001.00258.x Klenk, P., Jaumann, S., and Roth, K.: Quantitative high-resolution observations of soil water dynamics in a complicated architecture using time-lapse ground-penetrating radar, Hydrol. Earth Syst. Sci., 19, 1125–1139, doi: 10.5194/hess-19-1125-2015, 2015.

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