Hydrol. Earth Syst. Sci. Discuss., 10, C1534–C1536, 2013
www.hydrol-earth-syst-sci-discuss.net/10/C1534/2013/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Temporal stability of soil moisture patterns measured by proximal ground-penetrating radar" *by* J. Minet et al.

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Received and published: 8 May 2013

We thank the referee for its constructive comments, especially as he noticed that the two methods for determining time-stable areas could actually not be quantitatively compared. Most of the major points raised by Wei Hu were also pointed out by H Bogena. Please find below a quick response to the major comments of the paper. A detailled review will be prepared soon.

1) About the trade-off between GPR uncertainties and spatial resolution

We strongly concur with the comment of the referee stating that the opportunity of using GPR for soil moisture mapping depends on the trade-off between spatial resolution

and measurement accuracy. This trade-off is function of the relative importance of the measurement uncertainty w.r.t. the spatial variability, under the constraint of a maximal uncertainty that can be accepted. In our context, we think that the trade-off is mainly in favor of the GPR method w.r.t. to the reference method, as the uncertainties in soil moisture using GPR is much smaller than the observed soil moisture variability. We support that an indirect measurement method can be better suited for mapping if it provides much larger amount of data than an accurate but cumbersome method with a few measurement points. This is actually one of the principle of the digital soil mapping approach.

In the paper, we will emphasize this in 2.2 (Comparison with soil core sampling measurements) and the influence of soil moisture to depth characterization will be better discussed, because this is a large part of the uncertainties from the GPR that were underestimated.

2) About the uncommensurability of the two methods

H. Bogena made a similar remark on this point. We agree that the second method (intersection of time- stable areas) is poorly generic and could actually not be closely compared with the first method. Indeed, the tolerance of the second method highly depends on the number of acquisitions, while the tolerance of the first method not. The choice of the soil moisture threshold is also highly arbitrary, except if we keep in mind the opportunity to use this method to install permanent sensors. The first method should be preferred rather than the second one, although straight-forward and particularly suited for continuous mapping methods, which is bringing a new conclusion to the paper.

We will strongly clarify the description of the second method in he Materials and methods. The two methods were no more directly compared, as they are actually uncommensurable as you raised, except at the level of the geographical delineation they provide.

3) About the wheel compaction

As written in the paper (3.2 Line effect), the repeated passes of the ATV have compacted the soil underthe wheel tracks, resulting in (1) a change in the volumetric soil moisture by the modification of the soil bulk density and (2) the possibility of deviation of flow paths. Nevertheless, it is worth noting that the spacing between ATV's wheels is about 1 m width so that the major part of the footprint below the GPR antenna was not directly affected by the compaction.

This important issue was already raised in the paper, but we will advance this reason in the paper to explain the larger errors in the last two acquisitions.

4) About the few number of acquisitions

The small number of acquisitions and the limited time frame on which the study was conducted is probably the weakest point of this study. That is why this is explicitly stated in the abstract and the conclusions. It is also closely linked with the lower applicability of the intersection method (second method) with a larger number of acquisitions.

We will insist on that in the revised version of the paper.

5) About the low penetration depth.

This is indeed a major concern with the radar remote sensing of soil moisture instruments. Note that the GPR is using lower frequencies (200-800 MHz) than the lowest frequency-satellites (L-band, $\sim$ 1300 MHz) and have thus a deeper characterization depth. Nevertheless, it is widely accepted in the remote sensing community that it is more valuable to use remotely-sensed data in a change detection approach, e.g., by investigating the time stability of a spatial pattern, rather than using remotely-sensed data as absolute measurements.

We will also insist on that in the revised version of the paper.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 4063, 2013.