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Hydrology and Earth System Sciences Discussions

Interactive comment on "Assessment of shallow subsurface characterization with non-invasive geophysical methods at the intermediate hill-slope scale" *by* S. Popp et al.

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The authors have completed a thoughtful field investigation that has produced what promises to be a valuable data set.

Unfortunately, I don't think that their analyses are sufficient to justify their conclusions. I have the following specific concerns regarding the work, as presented.

The authors have adopted a very simple model of EMI depth sensitivity. This interpretation, which can be attributed to McNeil (I did not see this attribution in the text, although it is in the reference list), is based on simplifying assumptions that may not apply. We have published a more complete analysis (see Callegary publications) which should

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be considered, especially for the PR measure used here. In particular, the vertical and lateral sensitivities of the two orientations are quite different and can depend on the water content. With appropriate discussion of the limitations, I like the PR approach for this effort.

Related to the previous point, the authors have not made sufficient effort to consider the impacts of the differing support volumes of the EMI and gamma methods. I believe that this reduces the value of their data set.

The authors should be aware of the work of Qing et al., Robinson et al., and Franz et al., all of whom have shown large scale applications of EMI for hydrologic mapping. Qing actually mapped a larger area than was considered in this study. I think that rather than claim uniqueness of the study based on difficulty of access or scale of measurement, the authors may want to highlight their cluster-based analysis.

The authors visited the site twice, assuming that the water content changed. But, there are no data presented to assess whether the water content was different. Rather, readers are shown cluster maps based on a correlation made under the later condition and asked to accept that they show texture/water content from time lapse measurements. The addition of confirmatory water content measurements under different conditions seems critical to publishing this work. Similarly, the authors claim that the gamma response is due to water content variations, but there appears to be a lack of data to support this critical conclusion. (Could this be tested by measuring on site under dry conditions, then sequentially adding water?)

The authors should be careful of using terms like '10% of seasonal variation in soil moisture'. Does this mean a variation of 0.1 in water content? Or, does it refer to 10% variation in the water content value?

The strongest part of the paper is the cluster analysis. The authors appear to have selected a useful approach and used this approach appropriately and thoughtfully.

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The authors are also too loose with conclusions like 'spatial pattern at the hillslope scale similar to those of ECa'. A quantifiable measure of similarity should be used here. Too often, it seemed that the similarity was overstated. This is particularly true when considering Figure 8. To me, it appears that the clusters are not able to discriminate among the ECv and ECh values. This suggests that the clustering is dominated by the gamma data. Even these data, when artificial fill sites are removed, does not seem to separate clusters well. I was left feeing that the conclusions were overreaching and not sufficiently supported by the data or the analyses.

I would encourage the authors to take one more trip to the field and follow the procedures of their second field trip. Perhaps they could conduct some other field calibrations and investigations of instrument sensitivity at the same time. I understand that this represents a major effort. But, without the addition of confirmatory data under both conditions, the conclusions are unfounded.

Three-Dimensional Sensitivity Distribution and Sample Volume of Low-Induction-Number Electromagnetic-Induction Instruments Author(s): Callegary James B.; Ferre Ty P. A.; Groom R. W. Source: SOIL SCIENCE SOCIETY OF AMERICA JOURNAL Volume: 76 Issue: 1 Pages: 85-91 DOI: 10.2136/sssaj2011.0003 Published: JAN 2012

Vertical spatial sensitivity and exploration depth of low-induction-number electromagnetic-induction instruments Author(s): Callegary James B.; Ferre Ty P. A.; Groom R. W. Source: VADOSE ZONE JOURNAL Volume: 6 Issue: 1 Pages: 158-167 DOI: 10.2136/vzj2006.0120 Published: FEB 2007

Repeated Electromagnetic Induction Surveys for Determining Subsurface Hydrologic Dynamics in an Agricultural Landscape Author(s): Zhu Qing; Lin Henry; Doolittle James Source: SOIL SCIENCE SOCIETY OF AMERICA JOURNAL Volume: 74 Issue: 5 Pages: 1750-1762 DOI: 10.2136/sssaj2010.0055 Published:SEP-OCT 2010

Imaging of hill-slope soil moisture wetting patterns in a semi-arid oak savanna catchment using time-lapse electromagnetic induction Author(s): Robinson David A.; Abdu

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Hiruy; Lebron Inma; et al. Source: JOURNAL OF HYDROLOGY Volume: 416 Pages: 39-49 DOI: 10.1016/j.jhydrol.2011.11.034 Published: JAN 24 2012

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 2511, 2012.