Review of revised manuscript HESS-2012-248, Three-dimensional monitoring of soil water content in a maize field using electrical resistivity tomography by L. Beff et al.

Comments

Judging based on the provided responses ('hessd-9-C4547-2012-supplement.pdf'), the authors have carefully addressed the comments I had had for the first manuscript version and have modified the manuscript accordingly when necessary. I now have only some minor remarks which should be addressed before publication (see below).

In the following, my original comments are shown in black, the authors' replies are shown in blue and new remarks are shown in green.

p8543, l11: "a constant value of 50 for lambda was chosen.." Explain why you chose 50 and not another value.
To choose the value of lambda, we realized several inversion tests with lambda going from 10 to 100. The value of 50 for lambda was the result of a compromise between the inversion quality (rrms and chi2) and the smoothness level of the images. High values of lambda overly smoothed the image and could not fit data appropriately (relatively high rrms and chi2). Low values of lambda fitted the data better but produced too much small-scaled anomalies that were not necessary.
You should explain in the manuscript on which basis you decided which lambda was giving the best results, i.e. how you judged the trade-off between rrms/chi2 and smoothness. Since you quantitatively compare ERT and TDR data, the TDR data should not be used to make this judgment.

Section regarding ERT sensitivity and added in the corrected document
2 Material and methods
2.4 Electrical Resistivity Tomography
2.4.3 ERT inversion
[…]
ERT spatial resolution is a complex function of numerous factors, e.g., electrode layout, measurement schedule, data quality, imaging algorithm, electrical conductivity distribution (Kemna et al., 2002). To **determine** ERT spatial resolution, an indirect approach based on the sensitivity could be used (Binley and Kemna 2005, Kemna et al., 2002).
"Determine" should not be used in this context because sensitivity is not equivalent to resolution albeit it may be used as a proxy to investigate the resolution.

The resolution is supposed to be low in model regions where sensitivity of the measurements is poor (Binley and Kemna 2005). In this study, we used the coverage which is like an overall or cumulative sensitivity. In analogy to linear tomography problems, it is the sum of all (absolute values of the) sensitivities for a given model parameter (Gunther, 2004). Because the cell sizes were not equal for all model parameters, we weighted the coverage by dividing it for each cell j by its size, η_j (in m3). The coverage, cov_j (in log (m-3)), was calculated for each cell j of inverted resistivity as showed in Eq. 7. The obtained coverage was then normalized and logarithmized for the figures.

$$\mathrm{cov}_j = \frac{\sum_{i=1}^{N} \left| \dfrac{\partial f_i(\boldsymbol{m})}{\partial m_j} \right|}{\eta_j} \qquad (7)$$

[..]

3 Results and discussion
3.3 Processes inducing SWC distribution
3.3.1 SWC spatial variability

Figure 1 presents the normalized logarithmic coverage of the 3D ERT inversion model, calculated with Eq. 7. To visualize the normalized logarithmic coverage distribution, one vertical section passing by three ERT electrodes sticks (y = 0.05 m (Figure 1 a)) and two horizontal sections (z = -0.15m (Figure 1 b) and -1.42m (Figure 1c)) **were realized**.

Maybe better: ".. were chosen as representative examples." (?)

We observed that coverage decreases with the distance from the electrodes and that the staggered position of the ERT electrodes did not deform the coverage distribution. Moreover, with the contribution of combined surface and stick electrodes, the coverage stayed relatively high in the whole soil volume (Figure 1 a) and deep stick electrodes increased the coverage **till** the bottom of the considered soil volume.

Better ".. down to .." instead of "till"

However, the coverage stayed the lowest in the bottom of the soil volume. But with TDR measurements, we showed that the SWC variability is also lower with depth (Figs. 7 and 8). Huge resolution is therefore not so important in the deep soil horizon. **Moreover with the TDR and ERT SWC comparison, we proved that the there was no major problem in the resolution. Indeed, if the coverage was too low, the inverted ERT measurements would badly predicted the hydrological processes as showed by Nguyen et al. (2009).**

I do not agree. The spatial resolution does not lead to biased ERT measurements (or 'badly predicted hydrological processes'). Bias is instead introduced by the asymmetries between the electrode layout and the distribution of the bulk electrical resistivity. To my knowledge there is not yet any publication avalaible on this topic. Studies were this effect is partly discussed are
"Koestel J.K., Kasteel R., Kemna A., Esser O., Javaux M., Binley A., Vereecken H. (2009) Imaging Brilliant Blue Stained Soil by Means of Electrical Resistivity Tomography. Vadose Zone Journal 8:963-975. DOI: 10.2136/vzj2008.0180."
and
"Koestel J.K., Vanderborght J., Javaux M., Kemna A., Binley A., Vereecken H. (2009) Noninvasive 3-D transport characterization in a sandy soil using ERT: 1. Investigating the validity of ERT-derived transport parameters. Vadose Zone Journal 8:711-722. DOI: 10.2136/vzj2008.0027."
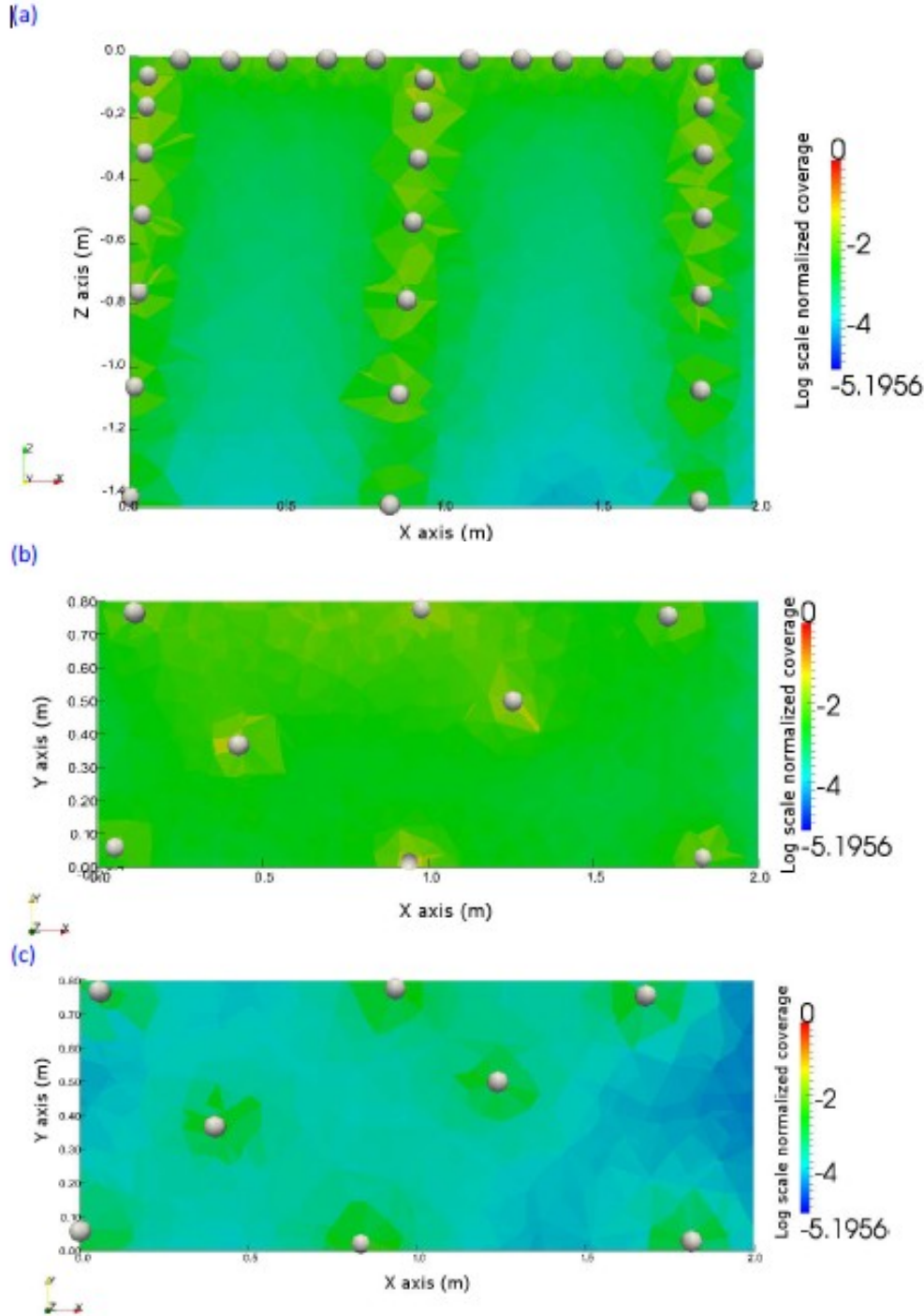
[..]

Figure 1: Normalized coverage sections at y = 0.05m (a), z = -0.15 m (b) and z = -1.42m (c) of the 3D ERT inversion model. The coverage was calculated using Eq. 7. The white balls represent the electrodes present in the considered sections.

These figures are in principal appropriate to illustrate the how resolution and accuracy are expected to decline with distance to the electrodes. However, the color scheme of creates the impression that the coverage was approximately homogeneous in the shown cross-sections which is not true. The green colors cover two orders of magnitudes. The coverage appears to be never larger than -1. The authors

should adapt the color scheme as such that its upper bound starts at -1 instead of 0 and that the yellow colors are expanded on expense of the green colors.