REVIEW COMMENTS

0- OVERALL

I would like to address your approach towards apparent conductivities and electrical conductivity in general. First of all, as both properties are repeated quite often, I would suggest using the abbreviations EC (true) and ECa (apparent). Second, the difference between both is often unclear in the presented work. It can't be stressed enough that apparent electrical conductivity (ECa; as defined by McNeill (REFERENCE); 'apparent') shouldn't be compared to electrical conductivity (EC; a value of the half-space model; 'true'; retrieved after inversion of EMI data) of the subsurface (see also Figure 5). Also, the symbols used within the paper should elucidate this difference. At present, you use σ for both EC and ECa. I suggest using σ and σ_a, respectively, to avoid confusion and enhance the distinction between both.

Be consistent when using abbreviations, and stick to these once defined. You use the abbreviation EMI at the beginning, though later on use the full notation (e.g., L156, L162).

Some obvious questions arise during reading: (1) why use a reference line to calibrate the data where no sampling overlap exists between the two survey modes? (2) Why use a 3 layered inversion model for the EMI data when the ERI shows 2 layers? (3) Why is there no comparison of the inverted ERI data to the inverted EMI data?

(additionally: you could include an isosurface indicating the shape of the river? This is ultimately the goal of the presented work, i.e. retrieve the shape/morphology of the river.)

1- INTRODUCTION

L49-51: *EMI devices are increasingly used for a large number of near-surface geophysical applications, as a consequence of their ability to produce 2D images of the apparent electrical conductivity, σ, over a large surface.*

This is an example of my previous overall comment. 2D images of ECa (σ_a) are actually spatially lateral maps of the ECa; apparent. 2D cross-sections (inverted) of the EC (σ) are what is of interest in this article. I would suggest to rephrase this sentence, based on what you exactly mean with this.

L60-63: *This shift can be conveniently represented by a complex number, comprising quadrature and in-phase (respectively, real and imaginary) components, which can be inverted and then interpreted in terms of an apparent conductivity and an apparent depth of investigation (DOI).*

Should be: (respectively, imaginary and real). The quadrature (or imaginary) and in-phase (or real) components.

After inversion it is the EC (not ECa; example of overall comment)

I'm not really sure what you exactly mean with apparent DOI (I now only know that it is opposed to the real, L72). So I assume a specific DOI which you attribute to a certain setup independent of the soil model?

L67-70: *This interpretation relies on the fact that, for a given soil model, one specific apparent DOI is defined by three device setup parameters: (1) the offset between the transmitter and receiver magnetic dipole, (2) the orientation of the dipole pair, and (3) the frequency of the transmitter current oscillations.*

I think the fourth setup parameter: (4) instrument elevation or instrument operation height is of great importance and worth noting as well.

L78: The word 'typical' should be specified more. E.g., low, non-Ferro…

L80-84: *In a resistive or highly conductive environment, such as that presented in the present study, the McNeill equation is no longer valid, and EMI recordings, in particular their in-phase component, must be interpreted within the specific measurement context, taking all of the physical properties of the local environment into account.*

I suggest to list the physical properties (i.e., EC, mag. susc., diel. perm.) instead of mentioning 'all'.

2- DESCRIPTION OF THE STUDY AREA

What were the weather conditions when the measurements took place? Maybe worth to note, as they could have their influence as well (influence of watertable, moister content). In how many days or during which period was the survey conducted? This could have its influence on the results later on (see 2-layered vs 3-layered model).

An EMI survey is fast compared to an ERI survey and can be used to determine the location of the ERI survey. Was the EMI survey used to determine the location of the ERI survey to incorporate more lateral variations. If not, why not? In case of calibrating your signal, it is very important to cover as much as possible of the present variation.

L138: this → these

3- METHODOLOGY

Include instrument survey height here as well.

L154: …a reference transect <u>of</u> almost…

L166-167: *Three different offsets were used between the centers of the Tx and the Rx coils, namely: 1.48 m, 2.82 m and 4.49 m, each corresponding to a distinct DOI.*

I suppose you mean a distinct apparent DOI in this case? Based on each coil separation, without further knowledge of the soil model.

L170: The word attempting makes this sentence sound like you just tried something. Assuming this was done deliberately, I would use another word.

L195-199: *When compared to the analysis achieved using auger soundings, the electrical properties of the topsoil/loam formation appear to be merged with the clayey formation, with the exception of the western portion of the cross-section, which has significant sand and gravel content. This outcome could also be due to the finer spatial resolution of the ERI measurements (electrode spacing of 0.5 m).*

Based on the fact that later on a 3-layer model was used, I assume that the finer spatial resolution is given as the reason why there are only 2 distinct layers in the ERI profile? Maybe add a little information about the sensitivity distribution of the used ERI array setup? Is it justifiable to calibrate an assumed 3-layer profile with a 2-layered inverted ERI model? The inversion of ERI data is also an inversion with parameters and uncertainties. It is unfair to say that this model is 'true'.

What were the weather conditions when the measurements took place? Maybe worth to note, as they could have their influence as well?

L205-208: I would suggest to rephrase in a more comprehensive way.

L227-232: *During the field data acquisition we faced several difficulties that prevent us to do a CMD profile exactly on the reference profile. Actually, the EMI data used for the calibration have been taken from the mapped data closest to the reference profile. This has led to several positioning and alignment errors : 1) the EMI data do not exactly cross the reference profile, 2) the EMI data are irregularly spaced along the ERI profile, and 3) the orientation of the CMD device was not exactly the same, for each measurement retained for the calibration.*

I don't really get why you draw a reference profile on a location where you can't perform a CMD survey. This is the core of the calibration process.

Also add the fact that (4) the height above the surface is changing constantly (as you are wearing the instrument?) for each measurement.

The changing orientation has a great impact on the calibration as other sensitivity distributions are constantly used to attain the results.

You are naming these errors that are included in the process but do not really assess how to contribute to the results. What is their impact, is this not too big?

L244: Once calibration <u>is</u> done…

L252-265: *Step (3) does not guarantee that estimated interfaces will match the ERT interfaces 1) if the fixed/chosen resistivities are not correct, or 2) if EMI does not integrate the ground in the same way as the ERI in case of strong anisotropy, which seems not to be the case here, since a good match is obtained. The correlation coefficients are comprised between 0.5 and 0.7. Such values can be explained by several sources of errors in the estimation of the EMI apparent conductivities along the reference profile: 1) the differences in the location between the EMI measurements used for the calibration and the ERI profile, 2) the fact that the one dimensional model used for the EMI modeling is extracted from the* *inversed 2D resistivity section, 3) the difference of sensitivity between the ERI and EMI data. The regressions indicate the need of a stronger correction for the VCP configuration than for the HCP configuration. The scaling correction decreases as a function of offset, particularly for the HCP, which can be explained by the fact that small offsets are more sensitive to positioning and orientation errors, as well as natural near-surface variabilities.*

Based on the correlation coefficients it is hard to say that a good match is obtained. The correlation isn't that high (i.e. it does indicate anisotropy). This is also visible in the VCP configuration, which is more influenced (compared to the HCP conf.) by the anisotropy (also due to the 1 m instrument operation height). The VCP configuration has a highly concentrated sensitivity close to the instrument compared to the HCP which reaches this high sensitivity (in 1D) at a lower point (more spread compared to the VCP). This results in an increasing correlation for bigger coil separations (due to a smaller relative impact on the response of the present anisotropy).

L271-273: *Consequently, a three-layer model seems reasonably justified all over the site during the inversion process to represent the studied area: a resistive topsoil, a conductive clayey filling, and a resistive sand/gravel layer.*

Is it justifiable to use a 3-layered model for the inversion after you calibrated the EMI data using a '2-layered' model, i.e. the inverted ERI results? Shouldn't the ERI spacing be adjusted such that the small top layer can be detected? (Like in the western part). Maybe discuss the characteristics of the sensitivity distribution of the ERI array setup?

L844-286: Maybe use the abbreviation SRMR (or SRSR?) to indicate the standardized root-mean-squared residual and then also in the formula (L286): SRMR = …

4- EMI INVERSION RESULTS AND DISCUSSION

Overall, I think there should be an increased focus on explaining why something is occurring and on the validation of the inversion.

I think it would be an asset to show the 2D slices of the inverted EMI data on the location of the reference ERI profile. This could provide a means of comparing the inversion results of both techniques.

L333-335: *The combined HCP&VCP data inversion naturally leads to the occurrence of higher values of data residual, than in the case of the individual HCP or VCP inversions.*

Why is this the case? Because, at least theoretically, you add extra information into the inversion process. Is this the best approach? Should they be inverted together? Or both separately and use them in a complementary way?

5- CONCLUSION

Overall, the limitations of the presented technique can be stressed more, as they are obviously present.

L343-345: *In order to correct the sensitivity issues arising from EMI measurements, a calibration procedure was implemented, based on the use of a linear correction with ERI inversion results and auger soundings.*

These aren't sensitivity issues, but drift and factory calibration issues.

L360-362: This is unnecessary to mention, it is more a future practical goal based on specific information regarding the institutional framework of the research. Research programs have to be mentioned in acknowledgements, not in the body of the paper.