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The Cryosphere Discussions

Interactive comment on "Two-dimensional Inversion of wideband spectral data from the Capacitively Coupled Resistivity method – First Applications in periglacial environments" *by* Jan Mudler et al.

Anonymous Referee #1

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Two-dimensional inversion of wideband spectral data from the capacitively coupled resistivity method – First application in the periglacial environment.

By Mudler et al.,

Major

The manuscript describes the new development in the capacitively coupled method which was developed for low-frequency measurements. Authors modified the method by including Cole to Cole parameterization. However, for someone not deeply familiar

with these methods it hard to follow the manuscript. It was very unclear from reading an abstract: Why is it important to modify low frequency method in first place? What do low frequency methods provide? Why it is important to extend them to wider frequency range? Which additional rate of frequencies does this new modification cover? What type of information do we get by inverting CCR data?

Similarly, in the introduction, authors jump on explaining how by having electrical resistivity and dielectric permittivity is not enough. I suggest to start with explaining why doing ERT measurements is important in the first place? What type of subsurface information do we obtain by using these ERT? Then move to explaining why it is not enough and that having permittivity provides and additional information that is useful for interpretation of subsurface conditions. It is not clear, which subsurface conditions authors are referring to?

First paragraph ends with statement that determination of the ice content is possible with ERT. Is that the overall goal of this work?

P2L10 Why is it usable on the extremely hard surface? Need to better explain it. From the description, I not sure what type subsurface information CCR provides.

P2L30. OK, the aim of the study is test the application of the newly developed method on the identification of the ground ice.

Shilthorn From the description of the subsurface I conclude that it is a rock. What type of ground ice can exist in the solid rock? Does that rock has fractures that filled with ice? What about ice that might be formed at the ground surface? Does that ice layer is important and was taken into account?

Lake site Lake was frozen. Is there any information of the ground subsurface? Is it frozen? How deep is the seasonal frost layer? Any information on the percentage of ice within the ground?

P6. L10. There some GRP measurements in permafrost regions that estimate ALT

and soil moisture, and could be used to calculate ice content (e.g. Chen et al., 2016 and Jafarov et al., 2017).

P6.L15 What is relatively high? Do you mean ice lenses wise or massive ice?

P6.L15-22 lit review and can be moved to the introduction.

P7.L25-30 Does that mean that inversion depends on one parameter (c)?

P8.L23. Figure 4 inversion done with and without determination of height. Where are those two on the plot? I do not see two curves (one for h0 another for hinv)? The legend should be adjusted correspondingly. X-axis, is f an actual frequency or logarithm?

Figure 6. It is not clear which of the Tromso data correspond to the lake ice and which to the ground ice?

P12.L16 Why authors decided to use AarhusInv code and not BERT for example? How well does AarhusInv compares to other existing codes? Is this code an open source? If it is, then it would nice to provide a link for the modification implemented in the code.

Why did authors choose χ metric? Is that commonly acceptable fitness metric? Why not RMSE or Taylor diagram?

P20.L17 'reasonably consistent' ... Is that possible to quantify it (what is the correlation)?

Overall, I have been struggling throughout this paper to understand the purpose of this study. What is an ultimate goal of doing this? Is it to get a better measurement of the ground ice? If yes. Are there any ground truth data? How these inversion can be compared with in-situ data?

Suggestions: In this current version of the manuscript, methods, results, and literature review are all mixed up together. Think how you can better organize/separate them. Starting from the bigger picture, like knowing ground ice is extremely important for many reasons... In particular, for better understanding of the permafrost thawing rates

and consequences. Then introduce the method. Provide a literature review on the existing methods and models. Justify the usage of the current model and talk about how important the current improvements are in terms of better quantifying of the ground ice. In addition, in the description of the site location, it would be extremely useful to know subsurface characteristics/properties. Are there fractures in the rock? How much do you know about subsurface ground ice at the lake station? Comparing inversely derived ground ice with actual ground ice will be extremely useful.

The current version is a good methodological paper and missing emphasis on how this work is important and how it is contributing the current state of science. Addressing these two missing issues will make this paper suitable for the journal like Cryosphere.

References

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