The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC2
https://doi.org/10.5194/tc-2022-60-RC2, 2022

Comment on tc-2022-60

Anonymous Referee #2

Referee comment on "Exploring the capabilities of electrical resistivity tomography to study subsea permafrost" by Mauricio Arboleda-Zapata et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2022-60-RC2, 2022

In this paper, the authors test the applicability of ERT to characterize subsea permafrost. To achieve that goal, they further developed a novel inversion approach that has been discussed in detail in a previous paper. This paper is well structured, clearly written, and very well presented. Although it is applied to a subsea permafrost here, the developed methodology can easily be transferred to other problems.

Reading over the paper, I think what is missing is a thorough comparison to conventional, i.e. smoothness-constraint, ERT inversion. Since there is no ground-truth available, the authors cannot show that their approach provides superior accuracy in determining the IBPT. So the reader is somewhat left wondering why this additional computational effort is actually needed. Couldn't you achieve similar results by using "standard" processing schemes? To address this, I would suggest adding the results of a smoothness-constraint inversion to Fig. 2 and 7, which I believe will show the benefit of your inversion method clearly, and will highlight that the additional computational effort yields a more robust recovery of the subsurface structure.

Another more fundamental comment refers to the spatial heterogeneity of the water resistivity you are trying to image. You describe the two field sites as places with different flow pattern feeding freshwater into the coastal system. I believe that this is likely causing spatial heterogeneity in the water resistivity going from the coast further into the sea. Yet, in your inversion approach, you only address the variation in the thickness of the sea-water layer, but not its resistivity. Why are you not addressing this? Is it because the variability in rho_w is small enough that it does not affect the inversion (if so, can you show that?), or is there another reason for not addressing it?

Other than these two comments, please find below a few more detail comments:

Line 38: Although I generally agree, you may want to check out the work by Wagner et al., who show an approach to get quantitative values of ice content from joint inversion of ERT and seismic data.

Line 66: Might be better to stick with resistivity here, rather than changing to conductivity.

Figure 1 (d) & (h): What do you mean by sounding number here? Does this refer to the measurements per level? Is there really a need for this last panel? In the test you only refer to this plot to highlight the higher noise level, but I think you can also that comparing (c) and (g).

Line 160-161: Judging from c, it looks like levels 6 to 9 in general are noisier than the shallower ones.

Line 188: To improve clarity, it might be worth adding here how you describe thd geometry of the interface. Are you using a specific function with x numbers of parameters, or do you have a layer thickness for each sounding location?

Line 264: Is this an arbitrary number for the number of points of the interface, or where does it come from?

Line 265: I'm not entirely sure I follow how you get to 36? Five nodes for two interfaces should be 10 parameters describing the tickness, and then you need a resistivity for the water column, unfrozen sediments and frozen sediments.

Line 330: This argumentation is a bit weak. Only because you have some sensitivity does not necessarily mean that you can resolve subsurface structures and that you can interpret the inverted models.

Line 335-336: These areas seem a little suspicious to me. Why do you first get almost no sensitivity, and then a comparable high value. This does not seem to agree with the expected sensitivity pattern.

Line 359: Why did you chose different PSO parameters for the two different sites? To compare the results, wouldn't it be better to use the same set of parameters?

5.2.3 Sensitivity analysis: Having a sensitivity study for each site feels a bit repetitive. Perhaps merging the two sensitivity studies would make sense?

Line 464 - 468: I may have missed that, but where do you show that in the 2D case. As I understand, you invert for rho_w and z_w only.