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Discussions

Interactive comment on "The electrical self-potential method is a non-intrusive snow-hydrological sensor" *by* S. S. Thompson et al.

Anonymous Referee #1

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I read this paper with great interest, in that the measurement of meltwater fluxes and liquid water content with a non-invasive tool could be hugely helpful to the snow hydrology community. While my gut feeling is that the measurements described here are of value, the presentation is confusing and needs a bit of work to be accessible. With some edits, this could be a really nice paper.

One significant issue is that it was somewhat unclear what is being measured/modeled. It kind of seems like magic: one measurement (passive voltage) tells us about both water content and meltwater flux? As written, it is unclear to me how these are parsed, exactly.

Another point without clarity just comes from language: The word "model" is thrown around, but a qualifier is needed: there is no numerical model presented here, but rather equation fitting. Some clarification is needed early in the paper and throughout. I kept waiting for an integrated, physically-based model to appear.

My biggest problem with this paper is the sensitivity analysis. As conducted, it appears that all the variables were varied independently, which suggests no feedback between them. Is this true? If so, that should be explained. If not, a more robust sensitivity analysis should be considered. Also, why are there only data for one day in the results? It would have been instructive to see the melt/freeze cycle over 24 hours. As is, I don't know how to interpret the meaningfulness of the estimated values.

Lastly, more is needed to explain why it correct to assume that the properties of snow and meltwater are temporally invariant, and how important that is to the analyses here. This would be a great line of discussion for a conclusions section. The paper just kind of dies off with a list of possible future needs, without a clear indication of how to step forward on these, or without a clear wrap up of the work that has been done. A conclusions section would be really valuable to this paper, especially since the abstract itself is quite poor. It is much too vague, and don't focus on quantitative results of study.

More minor issues are below:

P3 L1: uncertainty in what? L20: remove semicolonâĂŤinappropriate use and not needed

L 23: Don't we know that the answer to Q1 is "yes" based on previous work? Maybe we specific about what processes/parameters instead.

L26: "hydrological implications" of what?

P4 L6: This equation has been around long before Kulessa et al. 2012. Another ref should be used here if one is needed.

L19. Why would h_0 and ψ_0 have negligible magnitudes?

P5 L1: What is the meaning of this saturation exponent? This appears to just be an empirical fitting factor.

L3-6: This sentence is so awkwardly written that I'm not sure what is happening. What "experimental concept"? That simulates what in situ? And "all" attributes? What are these?

L20: How is meltwater bulk discharge measured? (I later see, on P6 line 8. Move up.)

L24: Awkward wording: "Execution followed the potential amplitude method"

P6 L19: What is 0.4m? The depth of the snow pack? Not clear how measurements were made...at 0.4 m depth?

L22-23. First sentence here is awkward.

L24. Magnitude of what?

L27. What is an "even day"?

P7 L3. This is fluid electrical conductivity, right?

L14. Most of these measurements seem to have no consistent pattern. Perhaps tie up this paragraph by noting what actually had value to the model.

L 17. I have trouble believing there are no surface undulations in any field setting. How was this confirmed? If snow covered, how is it even known? Or do you mean surface of the snow?

P8 L3-16. It's really great that the authors have listed the assumption of their model here. However, some of these seem really constraining and also hard to validate. Somewhere in this paper, the implications of having some of these assumptions wrong seems important to believing the results. Another thought of the conclusions section.

L20. How is cross-sectional area measured? Is this just the area of the snow pack? If so, does the ground below the snow have no impact?

L21. Isn't the dielectric permittivity of water around 80 (unitless)? What is the value given here? Also, this is permeability of the snow, correct?

P9. In general, readers shouldn't have to look at another paper to understand the one we're reading. Bring in the equations/figures from the other paper if needed to tell the story here.

L21. What "indeed agrees"? The pH and EC data with themselves? That's what the sentence implies as written. Confusing.

L 23. I don't like the word "modeled" here for putting numbers into an equation. So despite the huge variability in the measured parameters, the moisture content only values by 1-3%? How is that possible in the linear equation I assume is being used (Eq 3,5)?

L27. Period missing.

P 11 L21. Is there no feedback between the tested variables? Again, I'm surprised by the small variability in parameters of interest given the huge uncertainties in measurements. Somehow, this needs to be explained so that it's accessible to your readers.

P 12 L1. Definition of how snow pack is measured should be moved way up to when first mentioned.

L8. 's is missing after the citation.

L11. So what is the benefit of SP if other measurements are needed to confirm? To more full explore in space or time? Some information is needed here to help the reader. I also don't still understand how water content and flux are distinguished from a single data set.

Table 1. Somewhere in the text, more description of uncertainty vs sensitivity as defined here is needed.

Figure 4. I'm confused. Why isn't there a range of estimated Sw here? Isn't each

parameter being varied from a min to max value such that there should be a range of outcomes?