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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Soil dielectric characterization at L-band microwave frequencies during freeze-thaw transitions" *by* Alex Mavrovic et al.

Anonymous Referee #2

Received and published: 28 July 2020

General comments:

The manuscript by Mavrovic et al. conducted permittivity measurements of different soil types with various soil water content using OECP and HydraProbe at frequency of L-band and 50MHz, respectively. Two experiments, fast freeze/thaw transition and slow freeze/thaw transition, were designed. Two soil dielectric model, TD GRMDM and Zhang's model, were driven by the known inputs to simulate the real and imaginary part of soil permittivity. By comparing permittivity measurements between OECP and HydraProbe during freeze/thaw cycles, they demonstrated there are differences of permittivity characteristic between L-band and MHz instruments and suggested the

necessities to make proper calibration. By comparing the permittivity measurements and model simulations, they reported the observable discrepancies and highlighted the need for soil dielectric models to take into account the hysteresis effect. Such work is under the research topic to evaluate satellite microwave data products from the in situ permittivity measurements (MHz frequency).

The topic of this manuscript is of interest to the readers of HESS and the measurements can be potentially of importance to the microwave related researches. However, in its current form, the uncertainties regarding the measurements are not detail, which make it hard to judge the validity of the comparison of OECP and HydraProbe measurements. The difference between OECP and HydraProbe measurements is not only from the frequency dependence of permittivity, but also can come from the fact that they are not measuring the same volume of soil samples. As the temperature range of this experiment is large, the temperature dependence of OECP and HydraProbe measurements matters. In addition, the presentation of results is with inaccuracies and can be further explained. Given the current form of the manuscript, I cannot recommend its publication. I expect it suitable for publication in HESS with convinced presentation of measurements and results. Please see below my specific comments.

Specific comments:

Title, Abstract: I can not see any details about the description of soil dielectric characterization in the Abstract. Please consider either adjust the title or adding the relevant text in Abstract.

1 Introduction

Line 71: "The high uncertainties in soil permittivity models result from the difficulty in gathering in situ permittivity. . ." as from my understanding, the uncertainties in soil permittivity models can come from the parameters is not well defined by the in situ permittivity measurements. please clarify this sentence.

2 Theoretical background

Line 104 & 130: Section numbers are incorrect.

Line 124: please explain the temperature dependence of OECP measurements. As OECP undergoes a large variation of temperature (e.g., -10°C to 10°C), how does OECP perform under such conditions? At which temperature OECP is calibrated? Please make a clarification.

Sect. 2.2 please consider presenting the equations used for TD GRMDM and Zhang's model, maybe can put in the appendix. As later you proposed a modification of Zhang's model to consider the hysteresis effect, It is better to present the equations and clear introduce how you make modifications.

Line 193: what is HPP?

3 Data and methods

Sect. 3.1.2 Slow freeze/thaw transition Please explain the purpose for this experiment. Please describe the temperature settings and add information about the measuring interval of OECP and HP measurements.

3.2 Studied soil types

Maybe I have misunderstandings here. How many soil samples were collected and then used in this experiment? Are these soil samples for each site with the same moisture content?

Line 221: When is the experiment conducted?

4 Results

In this section, Figures 5-8 are presented. While only a general description was presented. Lacking of the characteristic of soil dielectric, the difference among Figures 5-8, the difference between fast and slow freeze/thaw transition measurements.

Line 242: please explain "Although hysteresis should be expected because of the latent heat of fusion of water".

Line 246: "with offsets depending on the soil type" please consider presenting the results more detail.

Line 267-268: "both models overestimated the soil permittivity of thawed samples with high water content according to the results of this study." please explain such overestimation.

5 Discussion

Line 295: please consider presenting the equations of the modified version of Zhang's model.

Line 296: "consider ice fraction above 0°C" is the artefact or the real conditions? Please make explanations.

Line 300: please specify what is "the hypothesis".

Line 316: please explain how you implement a double "threshold"

6 Conclusions

In the current form, conclusion appears not informative compare to the Abstract. Please consider making modifications, adding more information.

Technical comments:

Line 95: considering change into "Section 2.2 gives an overview of two soil permittivity models"

Figure 4: please add the plotting scale to indicate the dimensions.

Figure 10: how is it reproduced? Please indicate the equations, the used parameters.

Figure 11: where are (a) and (b) on the figures?

Tables: Please consider using the consistent format

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