Geoscientific Instrumentation Methods and Data Systems Discussions

Geosci. Instrum. Method. Data Syst. Discuss., referee comment RC2
https://doi.org/10.5194/gi-2022-8-RC2, 2022

Comment on gi-2022-8

Steven Evett (Referee)

Referee comment on "Calculation of soil water content using dielectric-permittivity-based sensors – benefits of soil-specific calibration" by Bartosz M. Zawilski et al., Geosci. Instrum. Method. Data Syst. Discuss., https://doi.org/10.5194/gi-2022-8-RC2, 2022

Review of gi-2022-08: Calculation of soil water content using dielectric permittivity

measurements; benefits of soil-specific calibration

Overall:

This paper was very difficult to read and understand. The English is somewhat fractured and word choice is sometimes inappropriate. I have added notes in several places in the first part of the manuscript PDF to help improve the text in this respect. I hope those guidelines will be followed for the rest of the text.

The authors could make some word changes that would be helpful:

- Change “probe” and “probes” to “sensor” and “sensors”. These are soil water sensors. A probe does not necessarily involve a sensor.
- Change “measurement” to “sensing”, “measure” to “sense” and so on. The sensors involved do not measure soil water content and they do not measure dielectric permittivity. They measure frequency and deduce permittivity and water content from that measurement – they are thus soil water content sensors.
- Write “capacitance” not “capacity”.

The graphs are not easy to understand because the colored symbols are too small, and too similar in color in some instances. Please use different symbols for the different depths and use black and white, not colors. Colors are particularly difficult for the color blind.

The authors took samples from pits in soils containing smectitic/montmoronillitic clays and from pits in soils containing kaolinitic clays. This is potentially quite interesting because it is known that these clay types have much different cation exchange capacities (charge densities) and act quite differently with regard to FDR sensors. Unfortunately, only results from one clay type are shown and the expected comparison is never shown.

In the Conclusion:

The outcome that errors were larger for smaller water contents and smaller for larger water contents should be compared to results of others. All other studies of which I am aware show larger error at larger water contents and relatively small error in dry soils. The authors found the opposite, and we need to understand why it happened. Was this a computational error?

The authors write that, “Once soil-specific calibration is done, FDR probes, and certainly other dielectric permittivity measurement-based probes, are accurate and may serve for SWC measurement.” In general, this conclusion does not follow from the results given. The results given are for only one pit and one clay type. The authors should use the

calibration equation for data from the other pits and show how well the calibration stands up when used for another pit and location with the same clay type. Then show how different the results are when the calibration is used for the other clay type (kaolinitic).

Specific comments:

Please see the annotated PDF file of the manuscript for all specific comments. A few will be given here.

Lines 48-49: This is not true. The FDR sensors obey Gauss' law and thus are affected by capacitance. The TDR sensors obey Maxwell's equations and capacitance is not involved. Importantly, Gauss' law includes the complex permittivity, the bulk electrical conductivity, and a geometric factor that strongly affects capacitance. Maxwell's equations do not involve a geometric factor.

Lines 49-50: This is incorrectly written. The TDR method is a broad band method with central frequency in the 1 GHz range but the fast rise time pulse used in TDR methods is not emitted at frequencies of 1 GHz or even close to that.

Lines 53-54: Again, incorrectly stated. An FDR sensor measures frequencies, which are affected by the capacitance of the soil-sensor system. According to Gauss' law, the capacitance is related to both the dielectric permittivity and the bulk electrical conductivity of the soil.

Line 68: The clay soil for which the authors showed results could be termed ionic but it is important to understand that not all clay soils are ionic (highly charged). The kaolinitic clays have small charge and act more like sands with regard to their ionic and dielectric properties. Therefore, it is important for the authors to not state "For clayey soil...." but to make their statements specific to the soil with which they are working.

Lines 77-92: This is an odd way to begin a Materials and Methods section. This list of equipment could be given in a table, which would then be cited in the text explaining the method.

Line 80: What is the meaning of "cloche" in the caption for figure 1 here? Would another word be more meaningful? A cloche is defined as a bell or dome-shaped cover. I do not see a cloche here.

Lines 107-109: This soil sampling procedure is not very convincing. What precautions were made to prevent soil compression during sampling? Was the surface of the soil inside the tube compared with the surface of the soil in the pit wall outside the tube to determine if compression had occurred? What characteristics of the sampler design would have minimized compressive forces? It would be informative to see a cross-sectional drawing of the soil sampler with dimensions.

Line 117: What does “analogic probe tension” mean? Should it be "analog sensor voltage"? What are the units of voltage in the figure? Are these millivolts? Please give the units of voltage in the figure.

Line 119: Was there really only one reference digital TDR sensor used? Were there no replicates?

Line 126: Which clayey soil was used for this? This is important. The results obtained with a kaolinitic clay would be different from those obtained with a smectitic or montmorillonitic clay. I see no reason to believe that the result (calibration) shown in Figure 3 is universally transferrable among soils with different clay types and quantities. The calibration should be used with data from other soil pits to show if it is transferrable.

Lines 190=191: What does "with SWC (in ð□□□3/ð□□□3) increasing from 7% to 35%" mean? The SWC is in units of m3/m3. What does 7% to 35% mean?

Lines 197-198: Please put the description of calculating the relative error and equation 3 at the beginning of the paragraph before Figure 6 is cited. Doing so will help the reader understand what is being discussed in the text.

Please also note the supplement to this comment:
https://gi.copernicus.org/preprints/gi-2022-8/gi-2022-8-RC2-supplement.pdf