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Hydrology and Earth System Sciences Discussions

Interactive comment on "Polymer tensiometers with ceramic cones: performance in drying soils and comparison with water-filled tensiometers and time domain reflectometry" *by* M. J. van der Ploeg et al.

A. Tarantino (Referee)

tarantin@ing.unitn.it

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GENERAL COMMENTS

The paper first presents an improvement of the POT recently developed by the authors. By minimizing the polymer chamber depth and maximizing the ceramic area in contact with the polymer, the authors were able to reduce the response time associated with temperature changes and rewetting. These results are summarized in Table 3 and are

certainly of interest.

The major part of the paper (from Fig. 2 to Fig. 8) is, however, devoted to the comparison between water potential measured using the POT with the measurement using conventional water-filled tensiometer (CT) or inferred from TDR and laboratory water retention curve.

Unfortunately, most of the conclusions drawn by the authors are difficult to check. The axis scale of the various plots presented by the authors makes it difficult to appreciate differences between TDR, CT, and POT measurements. In addition, the procedure used to infer water potential from TDR measurement should be discussed in more detail. Error in water potential derived from TDR measurement is associated with both the accuracy of the water retention fitting and the accuracy of the TDR water content measurement. These points are not satisfactorily addressed in the paper.

The experimental results presented by the authors are potentially very interesting. Comparison of POT with TDR and CT measurement is expected to demonstrate the performance of POT, which is a very promising instrument for long-term measurement of high suction in the field. I would encourage the authors to submit a revised version of the paper according to the specific comments detailed below.

SPECIFIC COMMENTS

1) Page 4355, lines 19-24 The authors should illustrate the procedure adopted to determine the water retention curve. It is not clear whether i) the soil cores were first saturated and then placed in the pressure plate/hanging column to determine the entire main drainage curve or ii) the soil cores were directly placed in the pressure plate/hanging column and suction was then determined on soil cores having the same water content as in the box. In case i) Was the soil saturated still in the sampler? Was the soil placed in the pressure plate together with the sampler? Was any pressure applied to the sample to improve contact with the ceramic plate? Was shrinkage observed upon the application of progressively increasing suction and, if so, how total

volume was determined? What was the scattering in the bulk density (standard deviation) of the samples retrieved from the boxes? To determine the effective degree of saturation Se, did the authors use an average bulk density or they used the bulk density determined on each specific soil core? In case ii), how water content was controlled, considering that conventional pressure plates do not allow the control of water content? Was any external pressure applied to the sample to improve contact with the ceramic plate? How total volume and, hence, bulk density was determined? What was the scattering in the bulk density (average and standard deviation) of the soil cores?

2) Page 4355, lines 29 The authors used Equation (2) to fit the 'gravimetric' measurement. However, Equation (2) is written in terms of 'volumetric' water content (see page 4356, line 4 and Table 4). Volumetric water content and gravimetric water content are equivalent only at constant porosity, i.e. if the soil does not shrink upon drying and samples all have the same bulk density. However, no information is provided about shrinkage upon drying (particularly for the loam EB2). In addition, the bulk density of the soil cores in EB1 seems rather scattered as inferred from the saturated water contents in Table 4. This point is of importance as laboratory water retention data seem to have been obtained in terms of gravimetric water content (page 4355-line 20 and 22, page 4357-line 23) whereas TDR measurement refers to volumetric water content. To elucidate these points, the authors should plot water retention data in terms of both gravimetric and volumetric water content. This would allow the reader to check the dispersion of water retention data, the effect of bulk dry density, and the accuracy of the VG fitting. It would also make it possible to verify the continuity between pressure plate and hanging water column data.

3) Page 5357-lines 24-26, page 4358-line 23, Figure 4 and Figure 6 The comparison with between POT and CT should be presented with the vertical axis scale in the range form -0.1 MPa to 0.1 MPa because differences between POT and CT measurement in Fig. 4 and Fig. 6 cannot be appreciated with the vertical axis in the range from -2.5 MPa to 0.5 MPa.

4) Page 4358-lines 1-3 and lines 19-23, and Figure 4 and Figure 5 The water retention curve of the sand at matric potentials higher than 0.1 MPa is characterized by very low water contents where the water is likely to be discontinuous in the pore space. Inferring matric potential from these very low water contents is therefore highly questionable. Moreover, the water contents at matric potentials higher than 0.1 MPa are all close to the residual value (Fig. 5) and the water retention curve is almost vertical (Figure 7). It is therefore almost obvious that matric potentials inferred from water contents in this range are very unstable. Another concern is associated with the accuracy of TDR measurement, which is typically 0.01-0.02 m3/m3, i.e. of the same order of magnitude of the water content measured (Fig. 5). To measure water contents using TDR with accuracy lower than 0.01 m3/m3, special attention should have been devoted to the TDR apparent permittivity-water content calibration curve and to the interpretation of the TDR reflection waveform to extract the probe travel time. However, no information was given in the paper about the procedure used to infer water content from the TDR reflection waveform. Concerning Figure 4, I think the authors should indeed focus on the low matric potential range (0-0.1 MPa). Again, the comparison between POT and TDR should be presented with the vertical axis scale in the range from -0.1 MPa to 0.1 MPa.

5) Page 4358-lines 1-3 and Figure 4 It is not clear whether the POT measurements shown in Fig. 4 have been corrected for time decay of osmotic pressure. Measurements after 10-Nov-2004 seem to suggest that no correction was made because a constant decrease in matric potential is observed. Please, address this point and, anyway, plot POT data already corrected for the purpose of comparing POT with TDR and CT.

6) Page 4359, line 17 Beyond the air-entry value of the ceramic, deviations are significant and not 'little' as stated by the authors. If one ideally prolongs the matric potential versus time curves beyond the air-entry value, it will be found that errors may be of the order of 1 MPa. I would conclude that POTs cannot measure matric potential beyond

the air-entry suction of the ceramic. About the deviations in POT measurement beyond the air-entry suction of the ceramic, I am not fully convinced by the explanation provided by the authors. When the ceramic desaturates, its diffusivity significantly decreases because the time derivative of the ceramic water content becomes greater than zero and the hydraulic conductivity decreases). Deviations observed by the authors may simply be due to a time lag in the equalization of water pressure in the tensiometer chamber.

7) Page 4359, lines 24-25 and Figure 7 and 8 Data in Figure 7 should be plotted by either focusing on the low matric potential range (0 to 0.1 MPa) or the low water content range (<0.05 m3/m3). The figure presented by the authors is very difficult to interpret.

8) Page 4360, lies 22-23, Figure 7 and 8 The conclusion drawn by the authors are difficult to check. Data in Figure 7 should be plotted in a log-log scale to appreciate TDR and POT data at low water contents and low matric potential. Data in Figure 8 should be plotted in terms of log(psi) to appreciate differences in the low matric potential range. In both figures, experimental data should be plotted as symbols and fitting curves as continuous lines. In the figures presented by the authors, it is difficult to differentiate between data and fitting curves.

9) Page 4360, lies 22-23, Figure 7 and 8 Differences in the WRCs recorded in the laboratory on soil cores and in the boxes using POT and TDR data may arise from the different techniques used to measure either the matric potential or the water content. There is no information on the procedure used to infer water content from TDR travel time and there was apparently no calibration of TDR measurement (comparison between water content derived from TDR and that determined in the oven). There is also little information on the experimental procedure used to measure/apply matric potential in the pressure plate (if and how contact was ensured between the ceramic plate and the sample, how the porosity of the sample was estimated/measured to derive the volumetric water content, how long the sample was left in the pressure plate, if and how equalization was checked). If this information is not reported, it will be very difficult to critically analyze the differences observed in Figure 7 and 8, apart from generic consid-

erations. The paper entirely focuses on the comparison of experimental data and the right emphasis should be placed on the experimental procedures, which significantly affect water potential and water content measurement. The information given on page 4355, lines 19-24 is insufficient.

TECHNICAL CORRECTIONS

10) page 4350, line 3 Replace 'Water-filled tensiometer' with 'CONVENTIONAL water-filled tensiometer'

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 4349, 2009.