Hydrology and Earth System Sciences Discussions

Interactive
Comment

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.

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We thank Dr. Tarantino for his time dedicated to this paper, and his constructive comments that helped to improve it. We made the reply pointwise, based on the points raised by the reviewer.

1. Undisturbed soil cores (see Grossman and Reinsch 2002 p. 207, and Dirksen 1999 p18-20) that were taken were weighed to determine the moisture content they

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had in the evaporation container. We placed the undisturbed samples carefully on the sandbox apparatus and then saturated them from below by gradually increasing the matric potential at the bottom of the sample from -150 cm to 0 cm. This is a standardized routine (see Dirksen 1999 p 21 and Romano et al. 2002 p694 Fig. 3.3.2-5), and pressure is generally not prescribed as the very wet soil could easily deform. The very fine sand of the sandbox apparatus is quite plastic for positive pressure heads (as is the case when the matric potential is zero at the surface), which helps establish good contact. For the pressure plate method (Dane and Hopmans 2002 p. 688) a disturbed saturated soil sample was used and poured into a ring that was placed on the ceramic plate (Dirksen 1999 p22). Thus, pressure was not necessary to ensure firm contact. After the first saturation of the evaporation box we observed soil setting leading to a reduction of 2.5% of soil volume in the vertical direction. No shrinkage was observed during the evaporation experiments and determination of water retention curve. The average bulk density was 1490 kg m^{-3} with a standard deviation (SD) of 77 kg m^{-3} for the sand and 1376 (SD 60 kg m^{-3}) for the loam. To calculate the volumetric moisture content we used the bulk density determined on each specific soil core. We have included specific information in the revised manuscript, but rely on the provided references for the details of the methods we used, to avoid duplication of material published previously.

2. From the gravimetric water content we calculated the volumetric water content, according to a standard procedure described by Topp and Ferré (2002). We included this information in the current manuscript.

3. We included extra figures (Fig. 4 in the revised manuscript) with the scale ranging from 0.5 to -0.5 MPa, and kept the original ones to illustrate the measurement range of the polymer tensiometers.

4. The matric potential in individual pendular rings and dead-end pores is determined by the radius of curvature at the air-water interface. A change in water content (by evaporation/condensation) results in a change in matric potential in the water pockets.

If the radius of curvature of individual water pockets changes only little with the distance between water pockets (which is the case if the water pockets are in equilibrium with the local vapor pressure and the water vapor can efficiently diffuse; both conditions are realistic at the centimeter scale in a dry soil) a phase average matric potential can be defined and measured on a larger scale than that of the individual water pockets. This matric potential is not valid to calculate a Darcian flux; a matric potential gradient only leads to a flux in the vapor phase and not in the water phase. The question remains at which matric potential the water phase becomes discontinuous. Within the vadose zone community the concept of a discontinuous water phase and the questionability of a Darcian flux is not widely accepted. Based on our experiments we can indeed conclude that is difficult to compare the POT with the TDR at low moisture contents. It illustrates the importance of measuring soil matric potentials in the field directly. Considering the second concern: We have determined a TDR apparent permittivity-water content calibration curve, which is mentioned in the discussion paper on page 4355, lines 8-11. In principle we agree with Dr. Tarantino's remark considering the improvement of the TDR's accuracy by TDR wave analysis, but we found this approach not practically feasible in our experiment due to measurement interval and the duration of the experiment (over 10,000 waveforms were observed). In our opinion, the modification suggested by Dr. Tarantino, although sensible, would still not have sufficiently increased the accuracy of TDR in the dry range.

5. When rewetting the soil with tap water, the dried out ceramic was rewetted with water containing salts from the tap water. Subsequently, the polymer tensiometers were placed back in a water bath containing demineralized water. The salts in the ceramic then diffused out of the ceramic, leading to a pressure drop in the polymer solution . This effect resulted in an average pressure drop of 0.041 MPa, ranging from 0.020 to 0.052 MPa. We have included this in the manuscript and recommend to keep solutions in the experiments and the water bath as similar as possible.

6. Beyond the air-entry value of the ceramic the ceramic acts as an unsaturated porous

medium. In this case, a matric potential change leads to a water flux into or out of the ceramic. We agree with the reviewer that deviations may be due to a time lag caused by this flux, and have included this in the manuscript.

7. We tried several ways to clarify Fig 7 (Fig. 8 in the revised manuscript), and found that plotting the low water content range separately worked best. We have plotted the fitting curves as continuous lines, as requested by Dr. Tarantino. The combined POT TDR data points may appear as a line as a result of the number of data points (over 10,000 for EB1). We included those plots in the revision.

8. Figure 7 (Fig. 8 in the revised manuscript) was modified in line with comment 7. In the low matric potential range the differences are well visible in Fig. 8 (Fig. 10 in the revised manuscript). Changing to a log-scale would not be very helpful in our opinion, since it would diminish the readability in the dry range, which is the most interesting. We have plotted the fitting curves as continuous lines, as requested by Dr. Tarantino. The combined POT TDR data points may appear as a line as a result of the number of data points (over 6000 for EB2).

9. We do not agree with the Dr. Tarantino regarding this point. We have calibrated the TDR as mentioned in point 6. The experimental procedures have been described in standard literature as mentioned in point 1. We have clarified our experimental procedures as mentioned by Dr. Tarantino in point 1 as much as we could without repeating the already published literature on these methods.

10. We replaced it.

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