Geophysical Research Abstracts
Vol. 16, EGU2014-4293-2, 2014
EGU General Assembly 2014

Variability of matric potential measurements in evaporation experiments and its influence on the derived hydraulic properties

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The simplified evaporation method according to Schindler (1980) is an attractive method for determining hydraulic properties (retention curve and the unsaturated hydraulic conductivity) of a soil sample. In this method, a saturated sample is subject to evaporation, and the temporal course of matric potentials in the core is related to its water content loss by evaporation. Measurement and analysis are automated in the form of the commercially available product HYPROP© (UMS GmbH, Munich). The method and its implementation in the HYPROP system have shown to give accurate and reliable results with a minimum of effort and time required. In the HYPROP system, matric potentials are recorded in two planes of a soil sample by vertically installed tensiometers. The aim of this study was to experimentally investigate how representative and robust the matric potential readings at individual horizontal locations within a depth layer are, and how possible differences in matric potentials at different positions within a depth layer affect the calculated hydraulic soil properties. An additional aim was to verify whether vertically installed tensiometers give identical results to the traditionally horizontally installed tensiometers.

The investigations took place in a system called BIG-HYPROP. In principle, it follows the same setup as the standard HYPROP system, but differs with respect to the soil sample size and the number of tensiometers. Whereas standard HYPROP cores are 5 cm high and 8 cm wide (250 cm^3), BIG-HYPROP cores have a diameter of 24.5 cm and a height of 10 cm (4714 cm^3). Five pairs of tensiometers were positioned in depths of 2.5 cm and 7.5 cm, three of them aligned vertically, and two horizontally. Additionally, temperature was measured at the bottom and in the depths 2 cm, 4 cm, 6 cm, 8 cm as well as directly at the surface.

The scatter of the measured matric potentials during stage-1 evaporation was found to be very small (cv <3%). For sand, the scattering significantly increased during the transition from stage-1 to stage-2 evaporation (t = 30 h), reaching its maximum at the end of the measurement (cv = 6% to 8%). Despite differences in the tensiometer readings, the calculated hydraulic functions are very similar and associated only with very small uncertainties. The horizontally and vertically aligned tensiometers showed no systematic differences. We conclude that matric potentials measured with individual tensiometers can be reliably regarded as representative for the measurement plane. The increasing scattering of the upper tensiometers during stage-2 evaporation had a negligible effect on the identified hydraulic functions. The orientation of the tensiometers had no influence on the measured values.