Combined transient method for determining soil hydraulic properties in a wide pressure head range

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Introduction

Multistep-outflow and evaporation experiments are two standard methods for the simultaneous determination of the water retention and hydraulic conductivity functions in the laboratory. Both methods provide information in partly different pressure head ranges. Very good agreement of the soil hydraulic properties obtained from these two methods in their overlapping measuring range was found (Schelle et al., submitted). In this study we combine the extended multistep-outflow method (XMSO, Iden and Durner, 2010) and the simplified evaporation method (EVA, Peters and Durner, 2008) to attain reliable information about the soil hydraulic properties in a wide range of pressure heads, including the saturated conductivity.

Results

We show data from the combined experiments for two undisturbed sandy loam samples. Inverse simulations matched the measured pressure heads inside the 7.2 cm high soil samples, cumulative outflow data from the XMSO experiment, and retention and hydraulic conductivity data from the EVA experiment very well. Estimated soil hydraulic properties obtained from the combined evaluation are shown for the van Genuchten-Mualem model (VGM) and the free-form algorithm (FF, Iden and Durner, 2007).

Materials and Methods

(Phase 1) Saturated percolation in an initially saturated soil column with ponding ⇒ (Phase 2) Drainage by a step wise decrease in pressure head at the lower boundary ⇒ (Phase 3) Equilibration phase ⇒ (Phase 4) Evaporation.

Conclusions

- The combined method yields reliable information about the soil hydraulic properties at saturation (Phase 1), in the wet range (Phase 2) and in the medium dry range (Phase 4).
- Soil hydraulic functions at the overlap of experimental phases (2) and (4) match very well.
- Inverse simulation of the XMSO process including evaporation data into the objective function yields precise hydraulic properties from saturation down to pressure heads of −1000 cm.

References

Schelle, H., S. C. Iden, A. Peters and W. Durner (in review): Analysis of the agreement of soil hydraulic properties obtained from multistep-outflow and evaporation methods, VZJ.