Inverse estimation of unsaturated hydraulic properties using evaporation measurement techniques in sandy soil

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Abstract

Estimation of unsaturated soil hydraulic properties (USHP) is beneficial to evaluate the movement of flow and pollutant/solute transport in vadose zone. However, it is a difficult and time consuming task in soil physics. Therefore, the inverse estimation techniques have been adopted by several researchers to avoid such complexities. In this study, Campbell (CB) and van Genuchten (VG) models were selected as popular hydraulic models to describe the USHP. A Labouratory experiment was carried out for Toyoura standard sandy soil to measure the transient evaporation. Subsequently, the transient evaporation was calculated with considering the water and vapor flow. The inverse estimation with combining the Genetic Algorithm (GA) as an optimization tool was used and the optimum model parameters were obtained by fitting the calculated evaporation curve to the measured data. To verify the best model to estimate the USHP, saturation distribution profile of the soil sample at the steady state was used. It was found that the drawn curve by VG equation was relatively compatible with the measured evaporation data as well as the saturation data. Further, the experimentally measured soil suction pressure (ϕ) and hydraulic conductivity (k) data as a function of volumetric water content (θ) could be fit well with the estimated USHP curves by VG model equations. Based on these observations, it is clear that this method of USHP estimation is a reliable method and can be used easily for the model selection process of unsaturated soils.

Keywords: Inverse estimation, Genetic algorithm, Hydraulic models, Toyoura standard sandy soil, Saturation distribution

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