Comparison of methods for determining unsaturated hydraulic conductivity in the wet range to evaluate the sensitivity of wetting front detectors

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Abstract

The design of passive lysimeters or wetting front detectors determines the tensions at which they collect a water sample from an unsaturated soil. When deployed in the field to help manage irrigation, it is necessary to know the minimum flux of water that can be sampled by a passive lysimeter and how this relates to the drainage flux at field capacity. This requires a good estimate of the unsaturated hydraulic conductivity characteristic, $K(h)$, in the wet range (< 10 kPa). We compared various field, laboratory and theoretical approaches for obtaining the $K(h)$ function and compared these to a reference $K(h)$ function derived by applying inverse modelling approaches to field drainage experimental data. The Van Genuchten model and three of the pedotransfer models produced $K(h)$ functions with a root mean square error of less than 5% compared to the reference, and appear to be simple methods of obtaining a reasonable estimate of unsaturated hydraulic conductivity. However, despite the goodness of fit, there can be a 10-fold difference in conductivity at a given tension < 10 kPa estimated from the different methods. Moreover, water content at field capacity depends entirely on whether field capacity is defined as time elapsed after saturation, a set tension or a minimum flux.

Keywords: inverse modelling, instantaneous profile method, pedotransfer functions, wetting front detector, field capacity, HYDRUS-2D