

Towards improved estimation of the unsaturated soil hydraulic conductivity in the near saturated range by a fully automated, pressure controlled unit gradient experiment.

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Determination of soil hydraulic properties has always been an important part of soil physical research and model applications. While several experiments are available to measure the water retention of soil samples, the determination of the unsaturated hydraulic conductivity is often more complicated, bound to strong assumption and time consuming.

Although, the application of unit gradient experiments is recommended since the middle of the last century, as one method towards a (assumption free) direct measurement of the unsaturated hydraulic conductivity, data from unit gradient experiments is seldom to never reported in literature.

We developed and build a fully automated, pressure controlled, unit gradient experiment, which allows a precise determination of the unsaturated soil hydraulic conductivity $K(h)$ and water retention $VWC(h)$, especially in the highly dynamic near saturated range. The measurement apparatus applies the concept of hanging water columns and imposes the required soil water pressure by dual porous plates. This concepts allows the simultaneous and direct measurement of water retention and hydraulic conductivity. Moreover, this approach results in a technically less demanding experiment than related flux controlled experiments, and virtually any flux can be measured. Thus, both soil properties can be measured in mm resolution, for wetting and drying processes, between saturation and field capacity for all soil types.

Our results show, that it is important to establish separate measurements of the unsaturated hydraulic conductivity in the near saturated range, as the shape of the retention function and hydraulic conductivity curve do not necessarily match. Consequently, the prediction of the hydraulic conductivity curve from measurements of the water retention behavior in combination with a value for the saturated hydraulic conductivity can be misleading. Thus, separate parameterizations of the individual functions might be necessary and are possible with this approach. Furthermore, the apparatus allows a convenient quantification of temperature effects on both hydraulic properties and first results demonstrate impressively the important role of temperature on hydraulic conductivity, which is notoriously underestimated.