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Using tension infiltrometry and reflectometry to determine soil hydraulic properties

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The estimation of soil hydraulic properties, i.e. the soil water retention and unsaturated hydraulic conductivity, is a fundamental step for quantifying water and solute movement in the vadose zone. Many laboratory and field methods exist to determine the soil hydraulic properties, but most are expensive and cumbersome. Among the advantages of tension disc infiltrometry are the relatively low price of the instrument, the minimal disturbance of the soil, and the replicability of the measurements. The hydraulic conductivity can only be measured at or near soil saturation, which makes it particularly suitable to study the effects of macropores on infiltration. Tension infiltrometers are therefore routinely used to evaluate the behaviour of hydraulic conductivity as influenced by soil tillage, irrigation amount and water quality, surface slope, and surface crusting. The most popular methods are based on the quasi-analytical solution by Wooding for steady infiltration from a circular source. Recently, some authors analyzed transient tension infiltrometer data in the frame of an inverse solution to estimate the parameters of the well-known Mualem-van Genuchten soil hydraulic functions. They obtained encouraging results for different soils in field and laboratory experiments by using an objective function that includes multiple tension cumulative infiltration data and the final soil water content. Other studies used the time-domain reflectometry (TDR) in conjunction with cumulative infiltration to inversely optimize hydraulic parameters. In a laboratory experiment, the inclusion of transient water content in the objective function improved the identificability of soil hydraulic parameters with diagonally placed TDR probes. However, prediction of water retention curve was never satisfactory, except when independent soil water characteristic data were included in the objective function. In the present study, we attempt to validate and improve the conjunctive use of tension infiltrometer and TDR measurements for es-

timating the hydraulic properties from field experiments. To evaluate the usefulness of soil water content data obtained by TDR, the HYDRUS-2D code was used to generate synthetic data for several hypothetical soils and a sensitivity analysis was then performed to optimize, for each soil, the position of TDR probes for estimating the hydraulic parameters. Some field experiments were then analyzed by using Hydrus-2D in the numerical approach to solve Richards' equation and to estimate hydraulic parameters by comparing different combination of measurement data sets included in the objective function and estimated parameters. Our first results have confirmed the usefulness to include in the objective function water contents measured from diagonally buried TDR probes which allow the sampling of the wetted soil shortly after the start of the infiltration process.