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Sensitivity of soil water content simulation to different methods of soil hydraulic parameter characterization as initial input values

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Soil hydraulic parameters, which can be derived from in situ and/or laboratory experiments, are key input parameters for modeling water flow in the vadose zone. In this study, we measured soil hydraulic properties with typical laboratory measurements and field tension infiltration experiments using Wooding's analytical solution and inverse optimization along the vertical direction within two typical podzol profiles with sand texture in a potato field. The objective was to identify proper sets of hydraulic parameters and to evaluate their relevance on hydrological model performance for irrigation management purposes. Tension disc infiltration experiments were carried out at five different depths for both profiles at consecutive negative pressure heads of 12, 6, 3 and 0.1 cm. At the same locations and depths undisturbed samples were taken to determine the water retention curve with hanging water column and pressure extractors and lab saturated hydraulic conductivity with the constant head method. Both approaches allowed to determine the Mualem-van Genuchten (MVG) hydraulic parameters (residual water content θr, saturated water content θs,, shape parameters α and n, and field or lab saturated hydraulic conductivity Kfs and Kls). Results demonstrated horizontal differences and vertical variability of hydraulic properties. Inverse optimization resulted in excellent matches between observed and fitted infiltration rates in combination with final water content at the end of the experiment, θf, using Hydrus 2D/3D. It also resulted in close correspondence of [U+F061] and Kfs with those from Logsdon and Jaynes' (1993) solution of Wooding's equation. The MVG parameters Kfs and α estimated from the inverse solution (θr set to zero), were relatively similar to values from Wooding's solution which were used as initial value and the estimated θs corresponded to (effective) field saturated water content θf. We found the Gardner parameter αG to be related to the optimized van Genuchten parameters αvG and n as αG $\approx$ αvG n. The laboratory measurement of Kls yielded 2 – 30 times higher values than the field method Kfs from top to subsoil layers, while there was a significant correlation between both Ks values (r = 0.75). We found significant differences of MVG parameters θs, n and α values between laboratory and field measurements, but again a significant correlation was observed between laboratory and field MVG parameters Ks, n, θs (r$\geq$0.59). Assessment of the parameter relevance in 1-D model simulations, illustrated a better simulation performance when using laboratory data set from middle to deeper depths (30 to 60 cm). In contrast, field experiment parameter sets, which were achieved in a fast and simple way (less time consuming and labor intensive), resulted in slightly better soil-water content simulation performance in the topsoil (10 and 20 cm) where the plant roots are concentrated. Generally, in view of precision agriculture, field measurements and inverse optimization approaches are preferred to determine soil hydraulic properties. But based on the results, it is not possible to judge whether laboratory or field methods should be preferred and what is the most appropriate data set to predict soil water fluctuations in a complete soil profile.