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# A novel fitting procedure for soil hydraulic properties with improved parameter uncertainty assessment

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Equations for soil hydraulic properties are used to numerically solve the Richards equation. Uncertainties in the parameters that compose these mathematical models propagate into simulation results and their quantification is important. Parameter fitting is usually done using measured data of conductivity (K), matric potential (h), and/or water content (q). Solvers that use derivatives in the fitting process estimate the parameter uncertainties based on the Hessian matrix and the covariance matrix. This procedure considers the uncertainties of the parameters have a normal distribution, and the precision of the parameter predictions are expressed as standard deviations and correlated by a correlation matrix. This approximation is acceptable when reliable data is available, but it is not true for scenarios with higher uncertainties in the original data. We developed a new method to fit the most commonly used models for the q, h, K relationships with a sigmoidal function for the q – h retention function. To approach the parameter uncertainty distribution to a normal distribution, a transformation is applied to the parameters and bootstrapping is used to generate the parameter uncertainty distribution. The transformation shows a better performance according to Shapiro–Wilk and D'Agostino's test. Another improvement was obtained by using two arbitrary points instead of $q_s$ and $q_r$ to anchor the retention function. When the two anchoring points are selected within the range of the measured data used for the regression, a lower uncertainty for the fitted parameters resulted. The choice of the anchoring points also impacted the correlation matrix.