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TITLE: Laboratory evaporation experiments in undisturbed peat columns for determining peat soil hydraulic properties

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ABSTRACT BODY: Knowledge about hydraulic properties of organic soils is crucial for the interpretation of the hydrological situation in peatlands. This in turn is the basis for designing optimal rewetting strategies, for assessing the current and future climatic water balance and for quantifying greenhouse gas emissions of CO2, CH4 and N2O, which are strongly controlled by the depth of the peat water table.
In contrast to mineral soils, the hydraulic properties of organic soils differ in several aspects. Due to the high amount of organic components, strong heterogeneity, and shrinkage and swelling of peat, accompanied by changing soil volume and bulk density, the applicability of standard hydraulic functions developed for mineral soils for describing peat soil moisture dynamics is often questioned.
Hence, the objective of this study was to investigate the applicability of the commonly applied van Genuchten-Mualem (VGM) parameterization and to evaluate model errors for various peat types. Laboratory column experiments with undisturbed peat soils (diameter: 30 cm, height: 20 cm) from 5 different peatlands in Germany were conducted.
In numerical simulations using HYDRUS-1D the experimental data were used for an inverse estimation of the soil hydraulic parameters. Using the VGM parameterization, the model errors between observed and measured pressure heads were quantified with a root mean square error (RMSE) of 20 – 65 cm. The RMSE increased for soils with higher organic carbon content and higher porosity. Optimizing the VGM 'tortuosity' parameter (τ) instead of fixing it to its default of 0.5 strongly reduced the RMSE, especially for the soils that showed high pressure head gradients during the experiment.
Due to the fact, that very negative pressure heads in peatlands occur rarely, we reduced the range of pressured heads in the inversion to a 'field-relevant' range from 0 to -200 cm which strongly reduced the RMSE to 6 - 12 cm and makes the VGM parameterization applicable for all investigated peat soils. For the field-relevant scale, especially for very wet conditions, we demonstrate the importance of macro-pores by using a simple macro-pore approach, with only 1 additional parameter, i.e. the macro-pore fraction, which strongly reduced the RMSE down to 1 – 7 cm. Since τ has not been identified as an important parameter for the field-relevant range, only 5 parameters were optimized in this approach. This keeps the derivation of the parameters manageable and thus provides a model that is applicable to practical issues.

KEYWORDS: 1875 HYDROLOGY Vadose zone, 1847 HYDROLOGY Modeling.

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Additional Details

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