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Estimating sphagnum peat hydraulic properties from laboratory evaporation experiments

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In ombrotrophic peatlands, the equilibrium between the production and decay of organic matter is principally controlled by the moisture state and its oxic/anoxic conditions in the vadose zone. In order to predict a peatland's fate, it is necessary to describe the hydraulic processes with models correctly. However, no suitable systematic and mechanistic model exists to date. This knowledge gap is attributed to the complexity of peatland ecosystem processes. The reasons for this probably include spatial and temporal heterogeneities, swelling and shrinkage phenomena, hydrophobicity and difficulties in representative sampling. For a valid description of the non-linear processes involved, peat soil hydraulic properties play an intricate part. Their determination requires taking the characteristics mentioned into considered. Our research aims to quantify these characteristics and, eventually, to establish a model in order to numerically simulate the water fluxes in the unsaturated zone.

We started with laboratory measurements with which we determined peat soil hydraulic properties. Our study is based on an ombrotrophic peatland site in the Harz Mountains (Germany). Samples were taken over the entire unsaturated part of a Histosol profile. Before the laboratory experiments, samples were frozen, cut to shape and subsequently fully saturated in a vacuum. We used the same sample specimen for the saturated hydraulic conductivity and the simplified evaporation method. Results show that the hydraulic properties rapidly change in the upper-most layers with a step-like change over a small distance, close to the permanently saturated zone. We also show that the swelling and shrinkage is considerable, which means that traditional concepts based on the rigidity of the porous media are not applicable. Furthermore, the results indicate that the frequently used van Genuchten model cannot describe our data very well.