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Soil hydraulic properties of sphagnum moss and peat

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The moisture state of the vadose zone (acrotelm) of ombrotrophic peatlands decisively determines whether carbon is contained in soil organic matter or released to the atmosphere. As the pore space is variably saturated with water throughout the year, oxygen diffusion, heat, and solute transport and thus the redox state are a function of water content over time. For prediction purposes, the hydrological processes must be epitomised in computer models which establish a link between the terrestrial water cycle and the carbon cycle. This requires a proper representation of effective soil hydraulic properties which are a mandatory input to the Richards equation, the standard model for variably-saturated flow processes in porous media.

By applying the Richards equation to peatlands, one assumes that the acrotelm can be conceptualised as a rigid porous material. To test this approximation and select the most adequate set of soil hydraulic property functions, we conducted a series of specifically designed laboratory evaporation experiments on sphagnum moss and decomposed sphagnum peat. Sampling was carried out in five centimeter depth increments of an ombrotrophic bog profile in the Harz mountains. We selected sphagnum moss as it is a predominant plant species colonising bogs of the Boreal.

Inverse modelling was used to test the adequacy of different parameterizations of soil hydraulic property functions. We used pressure head data measured by two tensiometers in the objective function to identify soil hydraulic properties. The Richards equation was used as process model. We critically assess the applicability of the van Genuchten/Mualem model, which finds frequent application in peatland hydrology, and discuss alternatives which account for (1) multimodal pore size distributions, (2) physical plausibility towards the dry end, (3) capillary and non-capillary storage and flow, and (4) isothermal flow of water vapour. Finally, our results indicate that applying the Richards equation to water flow under evaporation conditions to sphagnum moss and sphagnum peat is a feasible approximation.