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Effects of functional traits of bryophyte layer on water cycling and energy balance in boreal and arctic ecosystems

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In boreal and arctic ecosystems, mosses and lichens (bryophytes) form ground cover that stretches from upland forests to peatlands, bryophytes being a ubiquitous component of plant communities. Bryophyte cover has an influence on the nutrient, carbon and water cycling as well as the energy balance at the Earth's surface.

A bryophyte model has been developed that describes energy and water balance in the ground floor layer. It has been further developed from APES (Atmosphere-Plant Exchange Simulator), a 1-dimensional multilayer, multispecies soil-vegetation-atmosphere transfer model with a separate bryophyte layer at the forest floor. APES has been previously introduced by Launiainen et al. (2015. Ecol. Mod.). One aim of the model development is to pinpoint the most important functional traits of the bryophyte layer in order to implement bryophyte layer in regional and global scale models.

To study effects of moss layer on microclimate and soil energy balance and hydrology, the model describes biophysical interactions between soil layers, forest floor cover, vegetation and the atmosphere. In the revised bryophyte component, the description of optical properties, hydraulic and thermal conductivity, moss-air transport has been improved from the original APES implementation.

To assess model performance, parameter uncertainty, and to identify key functional traits of the moss layer in varying environmental conditions (e.g. in different microclimates and varying soil conditions), global sensitivity analyses (Morris screening and Sobol' method) were conducted. The results of the sensitivity analyses can be used as a roadmap to identify knowledge gaps associated with parameters, assess overall performance of the model, and to study interactions between model components in a quantitative manner.

Future work includes a more detailed description of the photosynthesis and respiration processes of the bryophyte layer in order to study feedback mechanisms in carbon balance.