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The role of trait variation of non-vascular vegetation for their impact on biogeochemical cycles

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Non-vascular vegetation, such as lichens, mosses, or terrestrial algae and cyanobacteria, carry out key functions in various ecosystems world-wide.
These functions include effects on hydrological processes, net exchange of CO2, and the nutrient budget of ecosystems. The impact of the organisms on ecosystem functions, however, is not uniform, but it may strongly depend on the distribution of traits in individual non-vascular communities. Hence, to estimate large scale effects of non-vascular vegetation on biogeochemical cycles, it is crucial to predict their spatially and temporally dynamic community composition with respect to key traits.

The few currently available large-scale estimates do not examine systematically the role of traits for the biogeochemical effects of non-vascular vegetation, A better assessment of the patterns of key eco-physiological traits is, however, urgently needed, since climate change will likely substantially affect non-vascular community composition and, consequently, ecosystem functions.

Here, I will present a process-based modeling approach which provides quantitative estimates on the trait distributions of non-vascular vegetation communities, and relates these to biogeochemical functions. The so-called LiBry model has been extensively applied to simulate effects of non-vascular organisms on global biogeochemical cycles, focusing on cycles of carbon, water, and nitrogen. The model is, however, applicable at site scale as it accounts for key ecophysiological processes which control the carbon balance and the growth of an individual organism. By simulating at each location a large number of individuals which differ broadly with regard to 12 key physiological trait values, the model explicitly represents physiological diversity of non-vascular communities. The long-term carbon balance of each individual is then used as the criterion for relative success in the process of natural selection, shaping the trait distribution of communities at different locations. In this way, effects of environmental conditions on trait distributions and their consequences for ecosystem functions of non-vascular vegetation can be represented in a quantitative way.

I will provide an overview on large-scale biogeochemical impacts of non-vascular vegetation, derived by the LiBry model. In particular, I will show examples of how patterns in key traits, and also dynamic changes in community mean trait values, affect the biogeochemical functions of the organisms.