Estimating impacts of non-vascular vegetation on global biogeochemical cycles from the geological past to the future

Research proposal for the German Research Foundation (DFG) – Summary

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Non-vascular vegetation, such as lichens and bryophytes, have been suggested to contribute significantly to global biogeochemical cycles, e.g. via productivity and nitrogen fixation. They may protect permafrost soil against future warming, and they probably caused global glaciations in the geological past, by enhancing chemical weathering and thereby reducing atmospheric CO_2.

However, quantitative knowledge on non-vascular effects is still incomplete, which mainly concerns the response to future climate change, the role for ecosystem carbon and nutrient budgets, and impacts on climate throughout Earth's history. Current process-based models of non-vascular vegetation are not sufficient to represent these processes.

For this reason, we will create a new version of the established lichen and bryophyte model LiBry, which will include the limiting effect of nutrient availability on productivity under CO_2-fertilisation. We will provide a first global estimate of future productivity under climate change and also quantify non-vascular effects on future permafrost soil temperature and biological nitrogen fixation.

Additionally to the new LiBry, we will develop a weathering model, which will, in combination with LiBry, explicitly simulate effects of non-vascular vegetation on biotic enhancement of chemical weathering. Subsequently, we will apply the weathering model to several periods in the Paleozoic and the Proterozoic, and quantify the impacts of early non-vascular vegetation on past climate and atmospheric composition.

Development of the new LiBry will be performed by the applicant, while the model of chemical weathering will be developed by a PhD student. Collaborators will perform experiments, which will complement our work and which will enable future model application to regional and local scales.

Combining our work with the global land surface model JSBACH, where LiBry is already integrated, will facilitate research on interactions with vascular vegetation, fire, and future carbon balance of peatlands. Our estimates will be useful to constrain simulations of paleoclimate and past atmospheric composition. Potsdam University is selected as the host institution due to its focus on vegetation modelling, Earth sciences, ecology and evolution, as well as the nearby research institutions GFZ, AWI, and PIK.