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# A Process-based Model of Global Lichen Productivity

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Lichens and biotic crusts are abundant in most ecosystems of the world. They are the main autotrophic organisms in many deserts and at high altitudes and they can also be found in large amounts as epiphytes in some forests, especially in the boreal zone. They are characterised by a great variety of physiological properties, such as growth form, productivity or color. Due to the vast land surface areas covered by lichens, they may contribute significantly to the global terrestrial net carbon uptake. Furthermore, they potentially play an important role with respect to nutrient cycles in some ecosystems and they have the ability to enhance weathering at the surface on which they grow. A possible way to quantify these processes at the global scale is presented here in form of a process-based lichen model. This approach is based on the concepts used in many dynamical vegetation models and extends these methods to account for the specific properties of lichens. Hence, processes such as photosynthesis, respiration and water exchange are implemented as well as important trade-offs like photosynthetic capacity versus respiratory load and water content versus $CO_2$ conductivity. The great physiological variability of lichens is incorporated directly into the model through ranges of possible parameter values, which are randomly sampled. In this way, many artificial lichen "species" are created and climate then acts as a filter to determine the species which are able to survive permanently. By averaging over the surviving "species", the model predicts lichen productivity as a function of climate input data such as temperature, radiation and precipitation at the global scale. Consequently, the contribution of lichens to the global carbon balance can be quantified. Moreover, global patterns of lichen biodiversity and other properties can be illustrated. The model can be extended to account for the nutrient dynamics of lichens, such as nitrogen fixation and the acquisition and retention of phosphorus. Furthermore, the impact of lichens and biotic crusts on the infiltrability of the soil surface and exudation of organic compounds to the substrate on which they grow can be represented. In this way, the influence of lichens on weathering rates at the land surface can be estimated. Thus, the model presented here can be seen as a first step to quantify the impact of lichens on global biogeochemical cycles.