ICYESS2013-52-1
Interdisciplinary Conference of Young Earth System Scientists
Hamburg, Germany, 22 – 25 September 2013

Estimating Impacts of Lichens and Mosses on Global Biogeochemical Cycles

P. Porada (1), B. Weber (2), W. Elbert (2), U. Pöschl (2), and A. Kleidon (1)

(1) MPI Biogeochemistry Jena, Jena, Germany (pporad@bgc-jena.mpg.de), (2) Max Planck Institute for Chemistry, P.O. Box 3060, 55020 Mainz, Germany

Lichens and mosses may have a significant effect on global biogeochemical cycles. Several studies suggest that they are important contributors to terrestrial nitrogen fixation and that they enhance surface weathering rates. Their potential effect on global weathering rates might have influenced climate throughout Earth's history. Most of these studies, however, are either conceptual or rely on upscaling of regional estimates to obtain global numbers. Here, we use a different method which allows us to quantify the impacts of lichens and mosses on biogeochemical cycles at the global scale. We focus on three processes, namely nitrogen fixation, phosphorus uptake and chemical weathering. Our estimates have the form of potential rates, which means that we quantify the amount of nitrogen and phosphorus needed by lichens and mosses to approximate their actual uptake of these elements. Furthermore, we use potential phosphorus uptake on bare ground in combination with the phosphorus content of rocks to estimate chemical weathering by the organisms, assuming that they release weathering agents to obtain phosphorus. The requirements of lichens and mosses for nitrogen and phosphorus are derived by multiplying their net carbon uptake by their nutrient content, also accounting for resorption and leaching of nutrients. The carbon uptake is calculated by a process-based simulation model. For medium scenarios of nutrient content, resorption and leaching the predicted requirement for nitrogen ranges from 3.5 to 34 Tg/yr and for phosphorus it ranges from 0.46 to 4.6 Tg/yr. Estimates of chemical weathering are between 0.058 and 1.1 (km^3 rock)/yr. These values seem to have a realistic order of magnitude. There are, however, not enough observational data available to make a definitive assessment of the estimates. Nevertheless, the results support the notion that lichens and mosses have the potential to play an important role for biogeochemical cycles.

Different factors contribute to the uncertainty in our estimates: The value of net carbon uptake, the nutrient content of lichens and mosses and the values of resorption and leaching. Uncertainty in carbon uptake is due to high functional variability of lichens and mosses, leading to broad ranges of possible model parameter values. A part of this uncertainty can be reduced by generating many random "strategies" in the model which differ in these parameter values. These "strategies" represent the functional variability of real lichens and moss species. By determining which "strategies" are able to survive in a given climate, the range of possible values can be narrowed. Another method for reduction of uncertainty is to find relationships between different parameters of the model. This reduces the number of independent parameters. The uncertainty in the values of nutrient content, resorption and leaching is analysed by setting upper and lower bounds for these factors. We then discuss possibilities to reduce this uncertainty by establishing relations between nutrient content, resorption and leaching and other properties of lichens and mosses.