Geophysical Research Abstracts
Vol. 18, EGU2016-5790, 2016
EGU General Assembly 2016

Linking biological soil crust diversity to ecological functions

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Biological soil crusts (BSCs) are an association of different microorganisms and soil particles in the top millimeters of the soil. They are formed by algae, cyanobacteria, microfungi, bacteria, bryophytes and lichens in various compositions. Our aim was to determine and compare the biodiversity of all occurring organisms in biogeographically different habitats, ranging from polar (both Arctic and Antarctic), subpolar (Scandinavia), temperate (Germany) to dry regions (Chile). The combination of microscopy and molecular techniques (next-generation sequencing) revealed highly diverse crust communities, whose composition clustered by region and correlates with habitat characteristics such as water content. The BSC biodiversity was then linked to the ecological function of the crusts. The functional role of the BSCs in the biogeochemical cycles of carbon, nitrogen and phosphorous is evaluated using an array of state of the art soil chemistry methods including Py-FIMS (pyrolysis field ionization mass spectrometry) and XANES (x-ray absorbance near edge structure). Total P as well as P fractions were quantified in all BSCs, adjacent soil underneath and comparable nearby soil of BSC-free areas revealing a remarkable accumulation of total phosphorous and a distinct pattern of P fractions in the crust. Further, we observed an indication of a different P-speciation composition in the crust compared with BSC-free soil. The data allow answering the question whether BSCs act as sink or source for these compounds, and how biodiversity controls the biogeochemical function of BSCs.