Geophysical Research Abstracts
Vol. 19, EGU2017-10083, 2017
EGU General Assembly 2017

Spatial variation in below ground carbon cycling in a pristine peatland, driven by present and past vegetation

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Peat carbon cycling is controlled by both large scale factors, such as climate and hydrological setting, and small scale factors, such as microtopography, vegetation, litter quality, and rooting depth. These small scale factors commonly vary within peatlands, causing variation in the carbon balance at different locations within the same site. Understanding the relationship between small scale carbon cycling and vegetation helps us to assess the variation of carbon dynamics of peatlands, because vegetation composition acts as an integrator of factors such as microtopography, hydrology, and nutrient level. Variation in vegetation illustrates spatial variation of these underlying factors. Furthermore, the presence of certain plant species affects carbon cycling directly through litter quality or aeration through root tissues. In order to understand these within-site variations in terms of carbon cycling, we investigated carbon accumulation, decomposition, and biogeochemistry of pore waters along a transect of peat cores with changing vegetation and water levels in an ombrotrophic peatland in southern Patagonia. The transect ran from a Sphagnum magellanicum dominated spot with relatively high water table, to intermediately wet spots with mixed Sphagnum/shrubs vegetation, or dominated by Cyperaceae, eventually to a more elevated and drier spot dominated by cushion plants (mainly Astelia pumila). There were large differences in peat accumulation rates and peat densities, with faster peat growth and lower densities under Sphagnum, but overall carbon accumulation rates were quite similar in the various microenvironments. At most plots C/N ratios decreased with depth, concurrent with increasing humification index derived from FT-IR spectra. But under cushion plants this relation was opposite: more humification with depth, but also C/N ratios increases. This reflected the differing source material at depth under the cushion plants, and that the cushion plant peat layers were formed on top of Sphagnum peat. The divergent source material throughout a peat core makes it difficult to use C/N ratios to indicate peat decomposition rates. Although the low peat density and higher C/N ratios indicate that overall carbon turnover is slow at Sphagnum plots, pore water methane concentrations were elevated. At cushion plant plots, however, higher redox potentials exist until greater depths due to aerenchymous roots, inhibiting methane production and release. Our results demonstrate that large variation exists within pristine bogs, in terms of decomposition patterns, organic matter quality, and carbon turnover pathways, corresponding to variation in surface moisture levels and vegetation. Furthermore, variation in carbon cycling properties are maintained in buried peat layers and reflect more the organic material of that layer, than the current surface carbon dynamics.