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Impact of long term wetting on pore water chemistry in a peat bog in Ontario, Canada

Jonas Schaper (1), Christian Blodau (2), and Klaus Holger Knorr (1)

(1) Department of Hydrology, University of Bayreuth, Germany, (2) Department of Hydrology, Insitute for Landscape Ecology, University of Muenster, Germany

Peatlands of the northern hemisphere store a remarkable amount of carbon but also contribute to global methane emissions. As large areas in the boreal and subarctic zone are considered to undergo significant climate change it is necessary to understand how these ecosystems react to altered environmental conditions. Since not only temperatures but also precipitation is likely to increase in these regions, it is of particular interest to understand the impact of raised water tables and changing local hydrological flow patterns on peatlands' carbon cycle. We chose a pristine bog that was partly flooded by a reservoir lake created 60 years ago in Ontario, Canada. Water management in the reservoir resulted in seasonal flooding, shifting hydrological flow patterns and vegetation gradients. The impact of partial flooding on pore water chemistry and DIC and CH_4 concentrations were studied within surface peat layers. Samples were taken with pore water peepers along the vegetation- and flooding gradient. Turnover rates of DIC and methane were calculated from obtained concentration profiles and peat porosity under the assumption that transport is dominated by diffusion. Values of pH changed remarkably from 4 within the undisturbed bog part to almost 8 at the lake shore. Ca^{2+} and Mg^{2+} were the only ions that showed significant distribution patterns with readily increasing concentrations towards the lake water body. CH_4 and DIC concentrations also increased towards the lake and peaked in around 100 cm depth right at the shore with maximum concentrations being 2766 μmol L^{-1} for CH_4 and 7543 μmol L^{-1} for DIC, respectively. Turnover rates also increased towards the shore albeit some uncertainty lies in this finding as steady state condition required for calculations were probably not established and transport was not only dominated by diffusion. Maximum CH_4 production rates were modeled to be 36 nmol cm^{-3} d^{-1} and maximum DIC production was calculated to 64 nmol cm^{-3} d^{-1}. Ca^{2+} and Mg^{2+} concentration indicate lake water intrusion into the peat. Changes in pH are also probably due to lake water intrusion and altered plant communities. Vascular plant roots likely increased methanotrophy in subsurface layers but fuelled methanogenesis releasing labile carbon compounds in deeper layers. Modeling turnover rates gets exacerbated as other forms of gas transportation than diffusion prevail in vicinity to the lake. In addition to higher plant productivity lateral water flow is presumably the most important factor contributing to higher DIC and methane concentrations as it is thought to diminish the effect of end product inhibition in deeper peat layers towards the lake. We thus hypothesize that seasonal flooding not only affects ombrotrophic sites by nutrient inputs and subsequent changes in vegetation, but also due to altered hydrological flow patterns which will affect pore water chemistry and turnover rates by exchange of solutes and mineralization end products.