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Effects of experimental drought and rewetting of a northern temperate fen soil as assessed by δ^{13}C and thermodynamics

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Due to climate change induced effects, the impact of drought and rewetting effects on peatland ecosystems is discussed. The relevance of such ‘events’ versus climate change ‘trends’ is not well known. We studied the impact of experimental drought and rewetting in intact monoliths from a temperate fen. Over a period of ~300 days we incubated one vegetated (DW-V) and one defoliated mesocosm (DW-D), inducing a drought from days 100-150 and subsequent rapid rewetting. One additional vegetated mesocosm (H-V) was kept at permanently high water table. CO_2 and CH_4 turnover were calculated from concentration profiles, diffusive transport and mass balances. CH_4 emission was monitored using static chamber measurements. Results were compared to changes in carbon isotopic signature in CO_2 and CH_4 and in thermodynamic calculations of the energy yield for the two major methanogenic pathways. A ^{13}C labeling experiment provided insight into the relevance of freshly assimilated carbon for total turnover.

Drying out two mesocosms effectively retarded methane production after rewetting for days to weeks but promoted methanotrophic activity in the aerated peat of these treatments. CO_2/CH_4 ratios were thus greater in the drying/rewetting treatments and no methane was emitted from these treatments. Based on isotope and flux budgets aerobic soil respiration contributed 32-96 % in the high water table treatment, while contributing 86-99 % in the variable water table treatments. Drying and rewetting

did, however, not lead to a shift in methanogenic pathways as assessed by stable carbon isotope analysis of CH_4 and CO_2. There was also no prominent change in thermodynamic energy yields before and shortly after the water table manipulation. Results from isotope analysis and thermodynamic calculations of methanogenic pathways were in apparent contradiction, however, the first supporting hydrogenotrophic, and the latter acetoclastic methanogenesis. This was probably caused by underestimation of hydrogen concentrations due to heterogeneity and microorganism clusters. The study furthermore demonstrated the importance of fresh plant derived carbon inputs, supporting high turnover in the rooted zone and even providing suitable conditions for methanogenic activity above the water table in the capillary fringe. Regarding more frequent drying and rewetting events, the study did not reveal prominent effects on the short term. Long term effects may, however, not be excluded, especially as the vegetation had an important impact on near surface turnover and vegetation changes may be expected to affect also the carbon balance.