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Carbon dioxide and methane exchange of a patterned subarctic fen during two contrasting growing seasons

Lauri Heiskanen[1], Juha-Pekka Tuovinen[1], Aleksi Räsänen[2], Tarmo Virtanen[2], Sari Juutinen[2], Annalea Lohila[1], Timo Penttilä[3], Maiju Linkosalmi[1], Juha Mikola[2], Tuomas Laurila[1], and Mika Aurela[1]

[1]Finnish Meteorological Institute, Climate research programme, Helsinki, Finland (lauri.heiskanen@fmi.fi)
[2]Ecosystems and Environment Research Programme, Faculty of Biological and Environmental Sciences, University of Helsinki, Finland
[3]Natural Resources Institute Finland (LUKE), Helsinki, Finland

Abstract

Northern mires have sequestered substantial amounts of atmospheric carbon since the last glacial period forming one of the largest carbon pools in the biosphere (Hugelius et al., 2020). Current global warming is causing the subarctic and arctic regions warm rapidly, two to three times as fast as the rest of the world (Masson-Delmotte et al., 2018), which will affect the carbon balance of these mires.

In Kaamanen, northern Finland, we studied carbon dioxide (CO_2) and methane (CH_4) exchange between patterned mesotrophic fen and the atmosphere, both on ecosystem and plant community level. The ecosystem level measurements were conducted by utilizing eddy covariance method, while the fluxes on plant community scale were measured with flux chambers. The studied fen can be described as a mosaic of strings and flarks (or hummocks and hollows, respectively). The microtopography of the string-flark continuum form four main plant community types with varying water table conditions and vegetation composition. The measurements took place in 2017–2018. The two years in question were contrasting in their meteorological and environmental conditions. The 2017 growing season had average temperature, but high precipitation sum, while 2018 growing season was warm and dry. In July 2018 a north-western Europe-wide heatwave caused a month-long drought period at the site. Compared to 2017, the annual carbon balance of the Kaamanen fen was affected by earlier onset of photosynthesis in spring and the drought event during summer 2018.

We found that the annual carbon balance of the fen did not differ markedly between the studied years, even though the meteorological and environmental conditions did. The earlier onset of growing season in 2018 strengthened the CO_2 sink of the ecosystem, but this gain was counterbalanced by the later drought period. Additionally, we found strong spatial variation in CO_2 and CH_4 dynamics between the main plant communities. Most of the variation in ecosystem level carbon exchange could be explained by the variation in water table level, soil temperature and vegetation characteristics, which were also the environmental factors that varied between the

plant community types.

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