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The role of plant functional groups in methane dynamics in a boreal fen under pristine and water level drawdown conditions

T. Riutta (1), E.-S. Tuittila (2), and J. Laine (3)

(1) School of Geography and the Environment, University of Oxford, Oxford, United Kingdom (terhi.riutta@ouce.ox.ac.uk), (2) School of Forest Sciences, University of Eastern Finland, Joensuu, Finland (eeva-stiina.tuittila@uef.fi), (3) Finnish Forest Research Institute, Parkano, Finland (jukka.laine@metla.fi)

Vegetation and hydrology are important controlling factors in peatland methane dynamics. Vegetation structures (i.e. species composition, physiognomy, density) and productivity are strongly interlinked with moisture conditions (water table level variation), and the methane flux is a result of the vegetation-water table interaction, rather than a direct effect of water table or vegetation. Therefore, observational studies in pristine peatlands have a limited ability to separate the effects of these factors. This study aimed to experimentally quantify the role of the fen ecosystem components — sedges, dwarf shrubs, *Sphagnum* mosses, and the underlying peat — in methane fluxes in control and experimental water table drawdown conditions and to separate the plant-mediated effects from the effect of altered water table level on methane fluxes.

We carried out the experiment in a boreal nutrient-poor fen using two treatments: a vegetation component removal treatment with four levels and a water level treatment with two levels (control and a 15 cm water level draw down). We measured methane fluxes during four growing seasons using a static chamber technique. The first year was a calibration season preceding the water level drawdown treatment. Based on the vegetation removal treatments, plant-mediated fluxes comprised 75% of the total cumulative growing season methane flux (7.8 ± 0.83 g CH_4 m^{-2} from June to September) in the control water level conditions. Sedge and *Sphagnum* moss mediated fluxes accounted for 48% and 27% of the total flux, respectively. The presence of dwarf shrubs, on the other hand, had a slightly attenuating effect on the fluxes. In water level drawdown conditions, fluxes were significantly lowered (cumulative growing season flux 0.12 ± 0.10 g CH_4 m^{-2}) and the presence / absence of the plant groups had hardly any effect on the fluxes. There was a tight, positive relationship between net ecosystem production and methane flux in the control conditions but not in the water level drawdown conditions, where the methane fluxes showed very little spatial or temporal variation. In conclusion, water level acts as a switch; only after passing through the water level control does the vegetation regulate the fluxes. The results are relevant for assessing the response of peatland fluxes in changing climatic conditions, as water level drawdown is the major projected impact of climate change on northern peatlands.