REVEALING SOURCES OF CH_4 IN A BOREAL UPLAND FOREST

E. Halmeenmäki[1*], O. Peltola[1], M. Santalahti[1,2], J. Heinonsalo[2], H. Fritze[3], M. Pihlatie[1], K. Machacova[4]

1) Division of Atmospheric Sciences, Department of Physics, University of Helsinki, Finland
2) Department of Food and Environmental Sciences, University of Helsinki, Finland
3) Natural Resources Institute Finland, Vantaa, Finland
4) Global Change Research Centre, Brno, Czech Republic
* email: elisa.halmeenmaki@helsinki.fi

Traditionally, boreal upland forests are considered as important sinks for the greenhouse gas methane (CH_4) due to CH_4 oxidizing bacteria (methanotrophs) in the soil. However, recent evidence suggests that boreal forest ecosystems may act as occasional sources of CH_4. Furthermore, over the last decade there has been growing evidence that vegetation can act as a significant source of CH_4, although the mechanisms of the emissions are still mostly unknown. Moreover, methanogens have been discovered from the roots and mycorrhizae of boreal tree seedlings, indicating that CH_4 can also be produced in the rhizosphere of upland forest soils. Thus, CH_4 emissions detected from above the canopy in boreal forests (Peltola et al., 2012) might originate from production below ground and transport via the trees to the atmosphere. Contradictions in sources and sinks of CH_4 within boreal forests, and the unknowns in CH_4 production processes underline the importance of larger scale research of CH_4 flux in boreal forests.

We studied CH_4 flux from forest floor and above the canopy at SMEAR II station in Hyytiälä (61° 51' N, 24°17' E; 181 m above sea level) in 2013–2014. The aim was to reveal sources of CH_4 production in boreal upland forest ecosystems and to estimate the contribution of the tree and forest floor emissions to the ecosystem scale CH_4 flux. The ecosystem scale CH_4 flux was calculated with a concentration gradient method from CH_4 concentrations measured at the main mast of SMEAR II station (Peltola *et al.* 2012). The forest floor CH_4 fluxes were measured with 54 soil chambers covering the main source area of the ecosystem scale CH_4 flux. The manual chamber measurements were performed from May to September on average every three weeks in 2013 and every second week in 2014. In addition, we conducted a laboratory experiment of studying the CH_4 exchange of aboveground and below ground parts of bilberry (*Vaccinium myrtillus*), lingonberry (*Vaccinium vitis-idaea*), heather (*Calluna vulgaris*), and Scots pine (*Pinus sylvestris*) grown in microcosms. Additionally, we analysed methanogens by qPCR from vegetation and soil, from both the field and the laboratory experiment. For the field site, methanogens were quantified from various plant species, and also from humus soil, peat, and decayed woody tissue.

The results of the soil chamber measurements demonstrated that occasional and considerable CH_4 emissions occurred from the forest floor, mainly during May–July. In May and July 2013 the forest floor was on average a source of CH_4, while during other periods the forest floor acted on average as a sink of CH_4. The largest emissions originated from two moist areas of the forest where the water table was often at the surface. Occasional CH_4 emissions were also measured above the forest canopy, particularly during the spring and late summer 2014. However, the emissions from the forest floor do not entirely explain the emissions at the ecosystem level. The laboratory experiment suggests that roots of the studied plant species consume CH_4 compared to bare humus soil, while the shoots of heather and Scots pine emitted CH_4. Reasons for the shoot CH_4 emissions remain unclear; however, further analysis of the role of methanogens within the plant-soil systems may reveal whether CH_4 production could be of microbial origin.

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