Summer fluxes of methane from tree stems in boreal forest are influenced by soil water content.

Machacova, K.[1,*], Halmeenmäki, E.[2], Pihlatie, M.[2,3], Pavelka, M.[1], Dušek, J.[1], Urban, O.[1]

[1]*Global Change Research Centre, Bělidla 986/4a, 603 00 Brno, CZ*
[2]*Department of Physics, University of Helsinki, P.O. Box 48, 00014, FI*
[3]*Department of Food and Environmental Sciences, University of Helsinki, P.O. Box 56, 00014, FI*
**author for correspondence; email: machacova.k@czechglobe.cz*

Boreal forests comprise almost one third of the global forest area, and according to results of soil flux measurements they are a significant natural sink of important greenhouse gas methane (CH_4). However, the boreal tree species have been excluded from the calculation of the CH_4 balance of boreal forest ecosystems, although it is known that this gas can be emitted from aboveground plant surfaces.

Our objectives were therefore i) to determine whether and to which extent mature silver birch (*Betula pendula*), Scots pine (*Pinus sylvestris*) and Norway spruce (*Picea abies*), typical representatives of boreal forests, emit CH_4 from their stems, and ii) to estimate whether soil water content affects the CH_4 exchange from trees and forest floor. The measurements were performed in June and July 2014 in the boreal forest surrounding the SMEAR II station in Hyytiälä, Finland. Fluxes of CH_4 from stems and forest floor were simultaneously measured using static chamber systems and quantified by gas chromatographic analyses.

Our study shows that the boreal tree species emit CH_4 from their stems under natural field conditions. Under high soil volumetric water content (0.92 ± 0.01 m^3 m^{-3}), birch was the strongest emitter of CH_4 (9.5 μg CH_4 m^{-2} h^{-1}, medians) among the tree species studied; the forest floor emitted CH_4 at rate of 37 μg CH_4 m^{-2} h^{-1}. The CH_4 emissions from stems of birch and pine decreased with decreasing soil water content; similarly to forest floor, which turned to sink for CH_4 (-44 μg CH_4 m^{-2} h^{-1}) under low soil water content (0.37 ± 0.02 m^3 m^{-3}). On the other hand, the CH_4 emissions from spruce stems showed an opposite trend regarding to soil water content thus being the strongest emitter of CH_4 (0.55 μg CH_4 m^{-2} h^{-1}) under low soil water content. After scaling up to landscape level, the estimated average CH_4 emission from pine, spruce and birch trees under low soil water content was equivalent to 0.0−0.4% of the forest floor uptake. Under high soil water content, birch contributed with up to 5% to the forest floor emissions, thus constituting a significant part of CH_4 flux in the boreal forest.

Acknowledgement
This research was financially supported by the project ENVIMET (CZ.1.07/2.3.00/20.0246), EU FP7 project ExpeER (Experimentation in Ecosystem Research, Grant Agreement no. 262060), Emil Aaltonen Foundation, The Academy of Finland Centre of Excellence (projects 1118615 and 272041), and Helsinki University Centre for Environment, HENVI. We would like to thank Stanislav Stellner, Jiří Mikula and Marek Jakubík for technical support.