REVEALING SOURCES OF BIOLOGICAL METHANE PRODUCTION IN BOREAL UPLAND FORESTS

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BACKGROUND

Boreal upland forests are considered as a sink for the greenhouse gas methane (CH₄) due to methanotrophic microbes that oxidize CH₄ in soils. Recently, several studies have confirmed that emissions of CH₄ from vegetation can occasionally overcome the sink strength of the soil, and the forest ecosystems may then act as a source of CH₄. However, the origin and the production mechanisms of CH₄ emitted from trees still remain controversial. Our aim was to assess whether methane producing microbes (methanogens) in different compartments of the forest could account for CH₄ emissions within a boreal forest.

CH4 FLUX MEASUREMENTS

CH₄ flux measurements were conducted in southern Finland, in an ICOS forest site surrounding the SMEAR II station (Fig. 1). Above canopy measurements were conducted with flux gradient method from the 127 m tall mast (Fig. 1a and b). Forest floor CH₄ flux was measured by static chamber method with 54 soil chamber collars (Fig. 1a and c). The tree stem CH₄ emission rates were measured from three plots with different mean soil volumetric water content from three pine, spruce and birch trees (Fig. 1a and d).

Based on the above canopy measurements, boreal forest canopies acted as an occasional source of CH₄ in 2012-2014 (Fig. 2).

METHANOGENS

To detect the abundance of methanogens, samples of the most prevalent plant and tree species, soil and decaying wood were taken in June 2014 and 2015. Five replicate samples from each material were divided into different compartments: shoots, stem and roots, or upper and lower layer of soil. Samples were freeze-dried and ground and DNA was extracted. qPCR analysis of the mcrA-gene was performed to quantify the methanogenic community.

From the paludified wet sites of the forest floor, high number of mcrA gene copies were detected (Fig. 5). Few mcrA gene copies were also detected from decayed wood and some parts of the understory vegetation (Fig. 5). No mcrA gene copies were detected from humus and litter.

CONCLUSIONS

Our results demonstrate that boreal forests can occasionally act as a source of CH₄. Emissions were detected above the forest canopy, from the forest floor and tree stems. Also, our preliminary results from the qPCR analysis reveal that wet sites of the forest floor encompass high number of mcrA gene copies, and that mcrA gene can also be detected from some parts of the understory vegetation. No methanogens were, however, detected from living wood of the trees, indicating that the stem emissions do not result from in-situ microbial production. More research is still needed to confirm the role of methanogens to the CH₄ flux dynamics in boreal upland forests.