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Spatial variability of stable carbon isotope composition and concentrations of CH4 in surface air and water saturated peat profiles of a North Karelian natural mire complex

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The application of stable isotopes is a tool to identify the pathway by which CH4 in peatlands is formed, since CH4 produced by acetate cleavage is not as depleted in 13C as CH4 produced from CO2 reduction with H2. Whereas seasonal and vertical changes in isotopic composition of CH4 in peat profiles have been studied in details, there is a lack of information about the spatial variation of CH4 isotopic signatures on a microscale level.

Here, our goal was to identify the C sources for CH4 emissions from a typical minerotrophic-oligotrophic low sedge pine peatland in East Finland. We used stable C isotopic characteristics (d13C) of CH4 to differentiate between types of methanogenesis in continuously water-saturated layers under three different microsites (hummocks, lawns and hollows) of ombrogenic and minerogenic parts of the peatland, and attempted to follow the CH4 pathways throughout the peat profile to the atmosphere.

CH4 concentrations increased with depth in all microsites except for ombrogenic hollows. The highest CH4 concentrations were detected on depths of 1.5 m for hummocks and hollows and 2 m for lawns in the minerogenic area. In the ombrogenic area of the peatland only hummocks had elevated CH4 concentrations at depth of 2 m. CH4 concentrations in the air above the microsites were 2-3 folds lower and increased in the order hummocks>lawns>hollows. d13C values decreased with depth on all microsites indicating higher contribution of CO2 reduction vs. acetate cleavage pathways of methanogenesis. However, the d13C-CH4 enrichment in upper peat horizons and in the atmosphere may occur not solely due to the type of methanogenesis but to CH4 transport and oxidation. The latter two presumably comprised 40-60% of the d13C-CH4 enrichment on lawns and hollows, and up to the 70% on hummocks. Thus, CO2 reduction vs. acetate cleavage pathway contributed more to total methanogenesis in situ: (i) with depth (deeper than 1 m), (ii) on minerogenic vs. ombrogenic parts of the studied peatland, (iii) in lawns and hollows vs. hummocks. However, additional isotopic characteristics of CH4 and CO2 are needed to reveal the pathways of methane in upper peat horizons and the peatland's surface/atmosphere boundary.