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Spatial and temporal variation of ^{13}C -signature of methane emitted by a temperate mire ecosystem

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The net methane emission of any mire ecosystem results from a combination of biological and physical processes, including methane production by archaea, methane consumption by bacteria, and transport of methane from peat to the atmosphere. The complexity of spatial and temporal behavior of methane emission is connected to these.

^{13}C -signature of emitted methane offers us a further constraint to evaluate our hypothesis on the processes leading to the variation of methane emission rates. For example, assuming the spatial variation in methane emission rate at microtopographic scale is due to variation in trophic status or variation in methane consumption, will lead to differences in the relation of methane emission rate and its ^{13}C -signature, expressed as $\delta^{13}\text{C}$.

We have measured the methane emission rates and $\delta^{13}\text{C}$ of emitted methane by six automated chambers at a poor fen ecosystem over two growing seasons. The measurements were conducted at Mycklemossen mire (58°21'N 12°10'E, 80m a.s.l.), Sweden, during 2019-2020. In addition, we measured atmospheric surface layer methane mixing ratios and $\delta^{13}\text{C}$ to obtain larger scale ^{13}C -signatures by the nocturnal boundary-layer accumulation (NBL) approach. All $\delta^{13}\text{C}$ -signatures were derived using the Keeling-plot approach.

The collected data shows spatial differences of up to 10-15 ‰ in 10-day averages of $\delta^{13}\text{C}$ -signatures between different chamber locations. Temporal variations of 10-day average $\delta^{13}\text{C}$ -signatures from most chamber locations reached over 5 ‰, while the temporal variation of NBL derived $\delta^{13}\text{C}$ -signature was slightly lower.

The observed spatial variation in the $\delta^{13}\text{C}$ -signature was somewhat systematic, indicating, especially in the middle of the summers, the main control of spatial variation of methane emission to be the trophic status. The temporal changes, measured at different locations, indicate spatial differences in the temporal dynamics at the microtopographic scale. The temporal behavior of larger scale NBL $\delta^{13}\text{C}$ -signature does not fully correspond to the behavior of the chamber derived average $\delta^{13}\text{C}$ -signature.

