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Microbial uptake of biogenic volatile organic compounds released from thawing permafrost

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Non-methane biogenic volatile organic compound (BVOC) emissions are one of the greatest uncertainties in our understanding of the climate system, and the scientific interest in this area has increased accordingly during the last decades. The focus of BVOC studies has been on vegetation emissions, but microorganisms themselves and decomposition of organic material also lead to significant BVOC production.

Arctic areas are currently experiencing considerable climate warming, and the consequently thawing of permafrost soils expose vast amounts of organic material to decomposition. This event will undoubtedly have serious consequences for methane and carbon dioxide emissions, but the decomposition processes also present a potential source of BVOCs. However it may be that microorganisms in the uppermost active soil layers can utilize BVOCs as a carbon source similarly to methane. Our aim was to assess the following questions: 1) Are BVOCs released from the thawing permafrost, and what is the quantity and quality of the emissions? 2) Are the microorganisms in cold Arctic soils able to consume BVOCs rising from beneath thawing permafrost soil, and in that way hinder the BVOCs from reaching the atmosphere?

In laboratory experiments measuring BVOC emissions, on a proton transfer reaction time of flight mass spectrometer (PTR-TOF-MS), in permafrost and active layer soils we elucidated the capacity of Arctic soils to serve as a sink and source for BVOCs. Thawing permafrost soils proved to be a significant source of a large range of BVOCs. However active layer soils proved to be an equally good sink, taking up the BVOCs released from the permafrost. Additional studies with 14C-labeled compounds were used to determine the ability of the soil microorganisms to mineralize a series of the most abundant BVOCs released from the permafrost