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Vertical profiles of trapped greenhouse gases in Alaskan permafrost active layers before the spring thaw

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Seasonally frozen ground over permafrost is important in controlling annual greenhouse gas exchange between permafrost and atmosphere. Soil microbes decompose soil carbon and generate carbon dioxide and methane when they become activated. However, the actual greenhouse gas emission follows various efflux pathways. For example, seasonal freezing of the top soil layers can either restrain or press the gas emission from deeper layers. It has been reported that abrupt release of methane during spring is attributable to the emission of trapped gases that had failed to be released instantly after formation (1, 2). In order to examine the seasonally trapped greenhouse gases, we drilled five Alaskan permafrost cores before spring thaw; one from coastal tundra, two from typical boreal forests, one from area where fire occurred, and one from peat accumulated sites. Vertical profiles of carbon dioxide and methane concentrations were obtained with 5-10 cm depth intervals. We found methane peaks from two cores, indicating inhibition of methane efflux. We also analyzed organic carbon, nitrogen and water contents and compared them with the greenhouse gas profiles. We are continuing analysis for the soil temperature profiles of the sampling boreholes because the detailed temperature information might be related to microbial activity, and can be used as indirect indicators of soil water freezing and latent heat influences at some active layer depth (zero curtain effects). All the high-resolution analyses for subsurface environments may help to improve understanding greenhouse gas emission from permafrost regions.

1. Mastepanov M, et al. (2008) Large tundra methane burst during onset of freezing. Nature 456(7222):628-630.
2. Song C, et al. (2012) Large methane emission upon spring thaw from natural wetlands in the northern permafrost region. Environmental Research Letters 7(3):034009.