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# Environmental factors influencing trace house gas production in permafrost-affected soils

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The permafrost-carbon feedback has been identified as a major feedback mechanism to climate change. Soil organic matter (SOM) decomposition in the active layer and thawing permafrost is an important source of atmospheric carbon dioxide ($CO_2$) and methane ($CH_4$). Decomposability and potential $CO_2$ and $CH_4$ production are connected to the quality of SOM. SOM quality varies with vegetation composition, soil type, and soil depth. The regulating factors affecting SOM decomposition in permafrost landscapes are not well understood. Here, we incubated permafrost-affected soils from a polygonal tundra landscape in the Lena Delta, Northeast Siberia, to examine the influence of soil depth, oxygen availability, incubation temperature, and fresh organic matter addition on trace gas production.

$CO_2$ production was always highest in topsoil (0 – 10 cm). Subsoil (10 – 50 cm) and permafrost (50 – 90 cm) carbon did not differ significantly in their decomposability. Under anaerobic conditions, less SOM was decomposed than under aerobic conditions. However, in the absence of oxygen, $CH_4$ can also be formed, which has a substantially higher warming potential than $CO_2$. But, within the four-month incubation period (approximate period of thaw), methanogenesis played only a minor role with $CH_4$ contributing 1-30% to the total anaerobic carbon release.

Temperature and fresh organic matter addition had a positive effect on SOM decomposition. Across a temperature gradient (1, 4, 8°C) aerobic decomposition in topsoil was less sensitive to temperature than in subsoil or permafrost. The addition of labile plant organic matter (13C-labelled Carex aquatilis, a dominant species in the region) significantly increased overall $CO_2$ production across different depths and temperatures. Partitioning the total amount of $CO_2$ in samples amended with Carex material into SOM-derived $CO_2$ and Carex-derived $CO_2$, however, revealed that most of the additional $CO_2$ could be assigned to the organic carbon from the amendment. A significant increase in SOM-derived $CO_2$ (positive priming) was only evident in permafrost samples. Here, the relative priming effect was significantly stronger at lower temperatures.