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Soil organic matter decomposition and temperature sensitivity after forest fire in permafrost regions in Canada

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On the Northern Hemisphere, 24% of soils are underlain by permafrost. These soils contain 50% of the global soil carbon pool. The Northern Hemisphere is also the region which is predicted to be most affected by climate warming and this causes uncertainties over the future of the permafrost. It has been estimated that 25% of permafrost might thaw by 2100, exposing previously frozen carbon pools to decomposition. In addition, global warming is expected to cause increase in the frequency of wild fires, which further increase permafrost melting by removing the insulating organic surface layer. The amount of released soil carbon from permafrost soils after forest fire is affected by degradability and temperature sensitivity of the soil organic matter, as well as soil depth and the stage of succession. Yet the common effect of these factors remains unclear.

We studied how soil respiration and its temperature sensitivity (Q10) vary in different depths and within time by taking soil samples from different fire chronosequence areas (burned 3, 25, 46 and 100 years ago) from permafrost region in Northern Canada (Yukon and Northwest Territories, along Dempster Highway). The samples from three different depths (5, 10 and 30 cm) were incubated in four different temperatures (1, 7, 13 and 19°C) over 24h. Our results showed that the CO_2 fluxes followed the stages of succession, with recently burned sites having lowest rates. The organic matter at 5 cm depth proved to be more labile and temperature sensitive than in deeper depths. The Q10 values, however, did not differ between sites, excluding 30 cm at the most recently burned site that had a significantly higher Q10 value than the other sites. The results implicate that heterotrophic soil respiration decreases on permafrost regions during the first stages after forest fire. At the same time the temperature sensitivity in deeper soil layers may increase.