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Investigating Greenhouse Gas Fluxes in Tundra Soils in situ in the Field and Under Controlled Laboratory Conditions

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Arctic tundra soils contain significant amounts of organic carbon that can potentially release greenhouse gases such as methane (CH_4) and carbon dioxide (CO_2), particularly during freeze-thaw cycles. As the atmospheric lifetime and radiative forcing of each of these species differs, it is important to understand the mechanisms by which carbon release may preferentially be in favour of one species over the other.

We present 2 years of *in situ* observations of CH_4 and CO_2 soil concentrations in the Arctic tundra at Toolik Field Station in northern Alaska by diffusive gas wells. Field observations show a consistent production of CO_2 in all six gas wells, including throughout the arctic winter at soil temperatures below - 15°C. Field observations showed both net oxidation of CH_4 and production of CO_2 in tundra soils within close proximity. A critical observation was that the production of CH_4 continued throughout the arctic winter, but oxidation of CH_4 ceased during the coldest period, suggesting different temperature sensitivities of the two processes leading to changes in net ecosystem CH_4 production.

To further investigate temperature sensitivities for tundra CO_2 and CH_4 dynamics, we conducted controlled laboratory incubations studies using flux chambers whereby temperatures were shifted incrementally between -10 ˚C and 5 ˚C. Initial results show cessation all oxidation and production of greenhouse gases (GHG) below -1 ˚C, in contrast to field measurements that showed activity to continue under much colder temperatures. Net CH_4 fluxes altered with soil type and temperature, whereby O and A horizon soils showed net oxidation above 2 ˚C when thawing, yet the net oxidation flux continued below 1 ˚C during freezing. B horizon soil showed net CH_4 production above -1 ˚C when thawing, yet this flux stopped at 1 ˚C when freezing. These results show different temperature sensitivity of GHG production and oxidation in different soil horizons as well as differences between thawing and freezing processes.