Methane emissions throughout the year in arctic tundra, northern Alaska

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Methane (CH_4), a greenhouse gas of concern, is largely emitted from tundra environments. We have been continuously measuring the air space in soils and the atmosphere as gradient-based surface-atmosphere fluxes for arctic tundra at Toolik Field Station, northern Alaska (68° 38' N) for two years (starting in October 2014).

Despite a constant atmospheric CH_4 concentration, measurements within the soil profile showed high variability in air withdrawn from different locations. One soil profile indicated a CH_4 sink (i.e., CH_4 oxidation) during fall, but oxidation ceased during the coldest months with concentrations similar to the atmospheric measurements. A second soil profile 5 m away showed production of CH_4 (i.e., methanogenesis) with concentrations two-times higher than atmospheric levels, even during mid-winter when soil temperatures were below –15 °C.

At the landscape level, however, CH_4 showed consistent emissions including during the arctic winter. On average, we measured a net source of CH_4 in fall, winter, and spring, with emissions averaging 13.3, 14.9, and 17.9 mg m^{-2} d^{-1}, respectively. This was in contrast with literature data showing little or no CH_4 emission in winter. Our summer 2015 data coverage was not complete, which did not allow comparison with the coldest seasons. Footprint analysis, performed around the tundra gradient tower, showed that the highest CH_4 emissions were from wetland areas of our study site; the upland areas, however, contributed for the lowest CH_4 emissions. Our results indicated a high spatial variability, but emissions were largely dominant on a large scale throughout the year.