A Little Goes a Long Way: 1˚C Warming Alters Microbial Metabolic Potential in a Permafrost Peatland

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Warming-induced permafrost thaw is resulting in the northward expansion of peatlands. These wetlands are a potent source of greenhouse gases, primarily methane, and their expanded area is predicted to contribute an additional 0.13–0.24 °C to global warming by 2100. However, it is unclear how the warming predicted to occur over the next several decades (e.g., 1–2 °C) will affect the activity and composition of the soil microorganisms that mediate methane production and oxidation in peatlands. The objectives of this study were to determine if the soil microbial community and its metabolic potential were affected by six years of 1–2 °C warming in a northern peatland near the permafrost boundary. We hypothesized that warming would alleviate a bottleneck in microbial respiration by accelerating the fermentation of organic compounds and increasing the mineralization of nutrients from organic matter. The experimental site was located on the northern side of the north Great Xing'an Mountains (52°95' N 122°86' E) in the discontinuous permafrost zone. Field warming of approximately 1–2 °C was achieved through use of open top chambers (OTCs) made of colorless, transparent plastic composite material that passively warmed the internal area. Cores were taken from inside six OTCs and paired reference samples were collected from a nearby area with similar vegetation. The taxonomic composition and functional potential of the soil microbial community was evaluated using metagenomic sequencing and measurements were made of dissolved organic carbon (DOC) and pH. The results showed the abundances of genes for methane production increased with warming, alongside the abundance of methanotrophs. Nitrate reducing and sulfur oxidizing bacteria were also significantly more abundant in the warmed treatment relative to ambient conditions, indicating that the redox potential was above the level typically associated with methanogenesis in some parts of the soil environment. DOC significantly increased with warming and was accompanied by a decrease in pH, suggesting an increase in decomposition. The findings supported the hypothesis that warming accelerated the mineralization of organic matter. The potential for methanogenesis increased with warming, as did the abundance of competitors (e.g., denitrifying and sulfur oxidizing bacteria) and methanotrophs. Together, the results indicate that the metabolic potential of the soil microbial community in a northern peatland was sensitive to six years of 1–2 °C warming.