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Archaeal Ammonia Oxidizers and Total Production of N2O and CH4 in Arctic Polar Desert Soils

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Ammonia-oxidizing Archaea are abundant in Arctic desert soils and appear to be responsible for the majority of ammonia oxidation activity in these cold and dry ecosystems. We used DNA microarrays to characterize the microbial community consisting of ammonia-oxidizing Archaea and methane-oxidizing Bacteria in three polar deserts from Ellesmere Island, Canada. Patterns of net greenhouse gas production, including production and consumption of CO_2, CH4, and N2O were compared with community relative richness and abundance in a structural equation model that tested causal hypotheses relating edaphic factors to the biological community and net gas production.
We extracted and amplified DNA sequences from soils collected at three polar deserts on Ellesmere Island in the Canadian high Arctic, and characterized the community structure using DNA microarrays. The functional genes Archaeal AmoA and pMMO were used to compare patterns of biological community structure to the observed patterns of net greenhouse gas production from those soils, as measured in situ. Edaphic factors including water content, bulk density, pH, and nutrient levels such as nitrate, ammonia, and extractable organic carbon were also measured for each soil sample, resulting in a highly multivariate dataset.
Both concentration and net production of the three greenhouse gases were correlated, suggesting underlying causal factors. Edaphic factors such as soil moisture and pH had important, direct effects on the community composition of both functional groups of microorganisms, and pH further had a direct effect on N2O production. The structural relationship between the examined microbial communities and net production of both N2O and CH4 was strong and consistent between varying model structures and matrices, providing high confidence that this model relationship accurately reflects processes occurring in Arctic desert soils.