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Climate change modifies the diversity, structure and size of N2O-producing microbial communities in montane grassland soil

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It is well known that soils are important sources of nitrous oxide (N2O) with microbial nitrification and denitrification being key regulators of N2Oproduction and consumption. Climate change could modify these soil processes thereby affecting net exchange of soil N2O with the atmosphere. In this study, we examined the effects of simulated climatic change (warming, reduced summer precipitation and reduced winter snow cover) on in situ N2O fluxes and associated nitrifying and denitrifying microbial community size, composition and diversity in montane grassland soils. Climate change was simulated by translocation of 200 mini-lysimeters down an elevational gradient with a control transfer within the high altitude site from the pre-alpine grassland Terrestrial Environmental Observatory (TERENO).

Our results showed that simulated climate change promoted N2O fluxes in winter time due to the intensified frost and/or the thawing events favored by reduced snow cover but reduced N2O fluxes in dry summer period due to low soil WFPS (water filled pore space). Warming and lower precipitation increased the size of the nitrifying community but decreased the size of the denitrifying community. Denitrifying community composition, rather than nitrifying community composition, showed significant shifts in response to climatic changes, and soil moisture, temperature and soil ammonium concentrations were the most important factors influencing denitrifying community composition. Field N2O fluxes showed a strong positive correlation with the abundance of nitrite reductase genes (nirK+nirS) minus N2O reductase gene (nosZ). Furthermore, under climate change but not at recent climatic conditions, N2O fluxes were correlated with the abundance of ammonia oxidizing bacteria (AOB). Overall, our results illustrate that AOB and denitrifying communities of pre-alpine grassland soils can be quickly altered in a changing climate and that these changes have season-specific impacts on N2O fluxes.