Title:
Warming effects on greenhouse gas fluxes and the microbiome of alpine soils

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Abstract (300 words maximum): :
Alpine ecosystems are particularly sensitive to climate change. At higher elevations, these systems are barren (vegetation-free) with seasonal snow cover. Despite the significant percentage of area that these regions cover, they remain understudied. In these sites, microorganisms constitute most of the biodiversity and are the main drivers of biological processes. However, their role in the climatic processes of these environments remains unresolved.
In this project, warming experiments were set up on a high-altitude soil under intermittent snow cover and sampling was performed during the summer and autumn seasons of 2023 and 2024. CH_4 and CO_2 gas fluxes were measured in situ and soil samples were also collected. A combination of metagenomics and metaproteomics will serve to survey the microbiome and its functional activity. This multimodal approach aims to answer whether these barrens are net carbon sinks, what microbial activity drives the gas fluxes and which environmental factors regulate these processes.
Our results show for the first time that these ecosystems are net CH_4 sinks and CO_2 sources, with average daily fluxes of -0.193 ppb and +0.107 ppm respectively. A warming of 1.5°C is enough to exacerbate the methane sink (48% more uptake) and a modest increase in CO_2 emissions (2% bigger release, considering all seasons). Gas fluxes also showed strong seasonality, The CH_4 sink effect decreased by 42.8% during summer 2024 compared to Autumn 2023. Meanwhile the release of CO_2 only increased 2.8% during the same period of time. Furthermore, the sub-sites subject to experimental warming displayed even greater CH_4 flux seasonality with a 60.57% weaker sink effect during summer 2024 compared to Autumn 2023. Integrating the gas flux data and the -omics derived information will provide critical context to explain these gas fluxes and unprecedented understanding of the climatic processes in this alpine environment.