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N2O and N2 emissions from contrasting soil environments – interactive effects of soil nitrogen, hydrology and microbial communities

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Reactive nitrogen (N) in the environment has doubled relative to the natural global N cycle with consequences for biogeochemical cycling of soil N. Also, climate change is expected to alter precipitation patterns and increase soil temperatures which in Arctic environments may accelerate permafrost thawing. The combination of changes in the soil N cycle and hydrological regimes may alter microbial transformations of soil N with unknown impacts on N2O and N2 emissions from temperate and Arctic soils.
We present the first results of soil N2O and N2 emissions, chemistry and microbial communities over soil hydrological gradients (upslope, intermediate and wet) across a global N deposition gradient. The global gradient covered an N-limited high Arctic tundra (Zackenberg-ZA), a pacific temperate rain forest (Vancouver Island-VI) and an N saturated forest in Austria (Klausenleopoldsdorf-KL). The N2O and N2 emissions were measured from intact cores at field moisture in a He-atmosphere system. Extractable NH4+ and NO_3-, organic and microbial C and N and potential enzyme-activities were determined on soil samples. Soil genomic DNA was subjected to MiSeq-based tag-encoded 16S rRNA and ITS gene amplicon sequencing for the bacterial and fungal community structure.
Similar soil moisture levels were observed for the upslope, intermediate and wet locations at ZA, VI and KL, respectively. Extractable NO_3- was highest at the N rich KL and lowest at ZA and showed no trend with soil moisture similar to NH4+. At ZA and VI soil NH4+ was higher than NO_3- indicating a tighter N cycling. N2O emissions increased with soil moisture at all sites. The N2O emissions for the wet locations ranked similarly to NO_3- with the largest response to soil moisture at KL. N2 emissions were remarkably similar across the sites and increased with soil wetness. Microbial C and N also increased with soil moisture and were overall lowest at the N rich KL site. The potential activity of protease enzyme was site dependent indicating different capacities for N turnover of the microbial community. These findings indicate a positive feedback between increased soil N and wetter soils that promotes N2O relative to N2. These interactions may be site specific due to differential functional diversity of the soil microbial community. Future characterization of the community structure will shed light on the link between the role of microbial groups related to soil N cycling pathways and the resultant partitioning of N2O and N2 emissions in these contrasting environments.