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Microhabitat Effects on N2O Emissions from Floodplain Soils under Controlled Conditions

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Semi-terrestrial soils such as floodplain soils are considered to be potential hotspots of nitrous oxide (N2O) emissions. The quantitative assessment of N2O release from these hot spots under field conditions, and of the microbial pathways that underlie net N2O production (ammonium oxidation, nitrifier-denitrification, and denitrification) is challenging in the environment because of the high spatial and temporal variability. The production and consumption of N2O appears to be linked to the presence or absence of micro-niches, providing specific conditions that may be favorable to either of the microbial pathways that produce or consume N2O. The availability of oxygen, reactive organic carbon, and dissolved nitrogen substrates likely play key roles with regards to the net production of N2O. Previous field studies demonstrated, for example, that flooding can trigger "hot moments" of enhanced N2O emission through a close coupling of niches with high and low oxygen availabilities. Such microhabitat effects likely depend on soil aggregate formation, plant soil interactions in the rhizosphere and the degradation of organic matter accumulations. In order to assess how these factors can modulate N2O production and consumption under simulated flooding/drying conditions, we have set up a mesocosm experiment with model soils comprising various mixtures of N-rich floodplain soil aggregates (4000 - 250 μm representing large aggregates, or <250 μm representing small aggregates) and inert matrix material (glass beads of 150 - 250 μm size, or quartz sand of 2000 – 3200 μm size, respectively). Soils containing the different aggregate size groups were either planted with willow (Salix viminalis L.), mixed with leaf litter or left untreated. At several time points before, during and after a simulated flood event, we measure the net efflux rate of N2O. In addition, soil water content, redox potential as well as carbon and nitrogen substrate availability are monitored. In order to gain insight into the sources of, and biogeochemical controls on N2O production, we will measure the bulk isotopic signature of the produced N2O as well as its intramolecular 15N site preference. Changes in soil microbial communities, potentially controlling the balance between N2O production and consumption under different microhabitat conditions will be assessed using high-throughput DNA sequencing and q-PCR of key functional genes. Our study helps to increase our limited understanding of how microhabitats affect the occurrence of high N2O emissions from floodplain soils.