Universität Basel

Research Project

Microhabitat effects on N2O emissions from semiterrestrial soils

Third-party funded project

Project title Microhabitat effects on N2O emissions from semiterrestrial soils
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The potential to emit greenhouse gases such as nitrous oxide (N2O) greatly affects the climate regulation function of ecosystems. However, the generally high spatial and temporal variability of N2O emissions from soils makes their prediction difficult. Semiterrestrial soils such as floodplain soils (fluvisols) and gleysols that have developed and stand under the variable influence of groundwater, are potential hot spots of N2O emissions. Anticipating a higher frequency of drying-re-wetting cycles and flooding events as a consequence of predicted future climate change, the importance of these soil types as terrestrial N2O sources is likely to increase in the upcoming decades. Research so far has shown that N2O production and consumption in soils are strongly linked to micro habitat formation, including microsites in soil aggregates, the rhizosphere or locations where relatively easily degradable soil organic matter has been accumulated. Furthermore, cycles of drying and re-wetting appear to be particularly conducive to the formation of respective hot moments. We therefore argue that in order to develop indicators for the 2O emission potential" of soils we need to systematically assess the relative importance of the different microhabitat effects under drying and re-wetting conditions.

In this project, we plan to apply such an approach to relatively N-rich soils from near-natural ecosystems, including two fluvisols from a restored river floodplain and a forest gleysol. In controlled laboratory experiments in microcosms, the topsoil layers of the selected soils will be manipulated through various combinations of " and moisture" treatments. In the " treatments the effects of aggregate size and type (coarsly sieved soil, micro aggregates only, earthworm scats), rhizosphere processes (plants growing in coarsly sieved soil or micro aggregates) and organic matter accumulations (leaf litter mixed into coarsly sieved soil or micro aggregates) are tested. The moisture" treatments include two wetting – drying - re-wetting cycles. In one of the treatments, wetting consists of increasing soil moisture by rainwater to unsaturated conditions that are optimum for denitrification, in the other treatment soil is saturated by groundwater. Data are obtained on three levels. Firstly, by monitoring the N2O efflux from the microcosms during the treatments, the temporal variability of net N2O production, in particular the occurrence of hot moments, is assessed. Secondly, additional data obtained during specific phases within a treatment cycle, in particular during hot moments of N2O emissions, shall provide further insight into production, consumption and source processes of emitted N2O. To this end, we plan to measure gross N2O production, to assess N2O source partitioning, and to quantify soil N transformation rates, substrate and C availability. Thirdly, during the same selected phases, we plan to characterize the nitrifying and denitrifying soil microbial communities. For gross N2O production and source partitioning, innovative isotopic tracer methods – headspace pool dilution and substrate 15N enrichment, respectively - will be adapted. In addition, the feasibility of deducing the main N2O producing N transformation process from the natural abundance isotopic ratio of N in emitted N2O, and/or the site preference of the enriched N will be tested.

The results of this experimental project are expected to increase our understanding of how environmental heterogeneity at a small scale affects the occurrence of high N2O emissions. On a qualitative basis, this should help to develop soil and plant/soil indicators for the N2O emission potential of soils. On a quantitative basis, the results from this study may be used to improve biogeochemical models predicting N2O emissions in natural and near-natural ecosystems under current and future climate.

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