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Online measurements of nitrous oxide and methane in the soil profile of a pre-alpine grassland subject to extreme climatic manipulations

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Soils are known to take up and emit nitrous oxide (N_2O) and methane (CH_4) in different microsites within the soil profile. Understanding the production and consumption rates in different soil layers, as well as the transport processes between those layers, will contribute to a better mechanistic understanding of the exchange of these greenhouse gases between the soil surface and the atmosphere.

In the frame of a manipulation experiment in a pre-alpine grassland in Austria, we have combined "traditional" static chamber measurements with online monitoring of concentrations of N_2O and CH_4 at 5 different soil depths (from 0 to 36 cm) with permeable tubes connected to a laser-based gas monitor.

During our observation period, the grassland soils acted as a N_2O source and a CH_4 sink, respectively, as determined by the chamber measurements. We observed an almost linear increase of soil N_2O concentrations and a linear decrease of soil CH_4 concentrations with depth, suggesting that the whole soil profile (up to 36 cm depth) significantly emitted N_2O and took up CH_4. N_2O concentrations at 36 cm depth were variable, ranging from 700 to 2200 ppb. CH_4 concentrations at this depth were very low, usually < 500 ppb, with some single observations $<$ 100 ppb.

Simulated drought likely reduced the N_2O production along the whole soil profile, with overall lower N_2O concentrations, which resulted in lower N_2O emissions from the soil into the atmosphere in the drought treatment compared to the control. With regard to CH_4, our results suggest that lower soil water content provoked by the drought promoted higher diffusion rates of atmospheric CH_4 into deeper layers of the soil profile, which in turn stimulated a larger CH_4 uptake rate in the drought treatment.

We will further compare our soil flux estimations as inferred from both chamber measurements and soil concentrations in order to evaluate the feasibility of soil profile measurements to estimate N_2O and CH_4 exchange rates from soils, and will evaluate the specific role and temporal dynamics of the different soil layers in the production and consumption of those greenhouse gases.