Treibhausgasemissionen im Klimawandel - Greenhouse Gas Emissions and Climate Change

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Fertilized grasslands are a major source of the potent greenhouse gas N_2O, exceeding other land use types such as croplands, wetlands and forests. This lecture addresses effects of climate change on the emission of radiatively active trace gases (N_2O, NO, NO_2, NH_3 and CH_4) and the underlying soil microbial and physical processes.

We hypothesize that 1) a rise in temperature is likely to increase NxOy emissions to a larger extent than CO_2 emissions, because of multiplying effects of a series of underlying processes, which are all temperature sensitive; 2) elevated atmospheric CO_2 concentrations may counteract the temperature effect; 3) drought slows down the N-cycle and rewetting leads to pulses of N-release, which result in enhanced N-trace gas emission rates; 4) during drought the NO/N_2O ratio and the N_2O/N_2 ratio will increase.

In order to catch both hot spots and hot moments of soil trace gas fluxes one can combine manual, semi-automated and fully automated field measurements with controlled laboratory incubations of intact soil cores. The results can be fit into a non-linear multiple regression model for the prediction of GHG emissions from the soil. Predictions from lab incubations can be validated against field measurements. Nitrogen losses via N_2 and the $N_2O:N_2$ ratio can be assessed in a specially designed laboratory incubation system.

Plot-scale GHG budgets for the different treatments can be obtained by combining results from non-CO_2 GHG emissions, soil respiration, and biomass production. Similarly, a N-budget including N-leaching and N_2-fixation results could be estimated. The processes of nitrification, denitrification and nitrifier denitrification and their contribution to N-gas emission can be studied. Our laboratory model parameterization results feeds into ecosystem modelling of climate change effects.

The novelty of the Gumpenstein Experiment and the envisaged investigation approach lies in (i) the assessment of non-linear and non-additive effects of climate change on the N-budget as well as the GHG budget. Hereby the response surface approach enables us to distinguish linear from non-linear response functions of soil trace gas fluxes and to single out contrasting effects of temperature, elevated CO_2, nutrient supply and drought. (ii) Trace gas measurements combine technologies for non-reactive as well as reactive N-species and could include experiments on N_2-fluxes, which is unique and closes an important gap of knowledge within the N-cycle.

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