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Assessing the regulation of processes and fluxes of N_2 and N_2O production from arable soil as prerequisite for model evaluation

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N_2O production and consumption via denitrification in soil is largely controlled by the availability of substrates, gas diffusivity, and temperature. Gas diffusion in soil controls denitrification and its N_2O to N_2 product ratio since it affects two major proximal denitrification factors, i.e. the concentrations of O_2 and of N_2O, and is governed by the structure and the state of water saturation of the pore system. At a given O_2 consumption rate decreasing diffusivity causes an enhanced anaerobic soil volume where denitrification can occur. Gas diffusivity is generally quantified as bulk diffusion coefficients that represent the lineal diffusive gas flux through the soil matrix. However, the spatial distribution of respiratory O_2 consumption and denitrification - and hence the local concentration of O_2 and N_2O - is highly non-homogeneous. Biogeochemical models have been extensively used to predict soil N_2O dynamics, but until there is very little work on their validation based on experimental data on processes including N_2O reduction to N_2.

Objectives of the present study were to supply data sets suitable to evaluate denitrification models and to elucidate the regulation of N_2O production and reduction processes.

Repacked soil cores were amended with nitrate and organic litter as substrates for heterotrophic denitrification and incubated in an automated mesocosm system under aerobic as well as anaerobic conditions for 9 weeks. The soil moisture as a control parameter of the gas diffusivity in the soil pore system as well as the incubation temperature were altered periodically. An N_2 depleted incubation atmosphere and the ^{15}N labeled soil nitrate pool allowed quantification of the N_2 production in the soil and the nitrate-derived fraction of emitted N_2O by IRMS, and fluxes of N_2O and CO_2 were monitored via gas chromatography. Data will be used to evaluate denitrification dynamics of the models DailyDaycent and Coup (Grozs et al., 2018, this session).

Results showed that litter strongly enhanced N_2+N_2O fluxes and the nitrate-derived N_2O fraction but lowered the N_2O/(N_2+N_2O) ratio of dentrification. Moreover, all flux parameters clearly responded to irrigation, fertilization, temperature and O_2 concentration, showing that results are promising to evaluate models under a broad range of conditions.

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