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Anaerobic soil volume as a major controlling factor for soil denitrification and respiration

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Gas diffusion in soil is a key variable to control denitrification and its N2O to N2 product ratio since it affects two major proximal denitrification factors, i.e. the concentrations of O_2 and of N2O. Gas diffusivity 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 N2O - is highly non-homogeneous.

Knowledge of the anaerobic soil volume fraction (ansvf) has been proposed as a key control on denitrification, and has subsequently been used in many denitrification models. The ansvf has previously been quantified by direct measurement of O_2 distribution in individual soil aggregates using microsensors. The measured ansvf corresponded to modelled values based on measured aggregate diffusivity and respiration, but was not yet correlated with measured denitrification rates.

In the present ongoing study, we are incubating soil cores amended with nitrate and organic litter in an automated mesocosm system under aerobic as well as anaerobic conditions. An N2 depleted incubation atmosphere and the 15N labeled soil nitrate pool facilitate quantification of the N2 production in the soil by IRMS, and fluxes of N2O and CO_2 are monitored via gas chromatography. The ansvf and the measured denitrification and respiration rates will then be used for model validation.

During the session we will present first results of this study.