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Production and transport of gases in the soil: from 1-D soil gas profiles towards 2- and 3-D representations of soil gas processes

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Most studies implicitly use a 1 dimensional simplification of soil processes with a dominating vertical profile, e.g in soil physical and chemical properties. In many cases, this is a useful and sufficient representation of the realty which helps to answer research questions in an efficient way. Yet, in some cases, a 2 D or 3 D analysis of the processes is necessary to avoid misinterpretation of experimental results, e.g. modeling the impact of chamber deployment time during the measurement of gas fluxes (von Fischer et al. 2009) or trenching experiments (Jassal et al. 2006).

We developed a new method to determine the 2 D patterns of the soil gas diffusion coefficient D_S/D_0 in situ, using simultaneously several inert tracer gases. Soil gas transport was modelled inversely using the Finite Element Modeling program COMSOL. In combination with measurements of target gases such as CO_2, CH_4 and N_2O, this allowed us for modelling the 2-D patterns of transport and production of CO_2, CH_4 and N_2O in the soil. We observed how methane oxidation and soil respiration zones shifted within the soil profile while the gas fluxes at the surface remain rather stable during a 3 week campaign. The soil was a net sink for N_2O, yet, in the subsoil local (weak) source of N_2O lead to horizontal fluxes of N_2O.

We are testing the 3 D approach in the lab on defined substrates and objects to quantify the spatial resolution and reliability of the method. In a next step, we want to test the method in the field and study the ventilation and soil gas fluxes of an ant nest in 3D.

References:

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