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Coupling biological processes and gaseous transport in models describing GHG emission from soils

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The precise coupling of gaseous transport and biochemistry in models describing the emission of greenhouse gases (GHG) from soil is necessary because CH4 and N2O can be both produced and consumed in soil. Eventual fluxes to the atmosphere depends on the position of reaction sites and the escape pathways for these gases. The CO_2 production rate depends in turn on the efficiency of oxygen transport in the soil. Basing on models published in literature and our own experience the main principles leading to the best simulation results can be summarized as: 1) keeping a balanced level of detail in coupled model systems describing biochemical reactions and transport; 2) reduction of unnecessary complexity by means of using the most essential relationships elucidated by comprehensive statistical model testing; 3) consideration of all transport mechanisms in relation to prevailing ecological conditions. We will show examples of the successful application of coupled model systems for the prediction of three main GHG: CO_2, N2O and CH4 as well as results of application of our model MICNIT designed for the simulation of CO_2 and N2O emission and microbial C and N turnover in soil.
We conclude that coupled gas transport and decomposition models lack the latest findings in modelling microbial growth in soil. So, models including an explicit description of microbial growth, i.e. growth rate and efficiency, humification ratios and their relationship with N availability (Blagodatsky, Richter, 1998; Moorhead and Sinsabaugh, 2006; Eliasson, and Ågren, 2011) need to be coupled with well-developed soil physics models with appropriate description of transport processes.

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