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Validating soil denitrification models based on laboratory N_2 and N_2O fluxes and underlying processes derived by stable isotope approaches

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Robust denitrification data suitable to validate soil N2 fluxes in denitrification models are scarce due to methodical limitations and the extreme spatio-temporal heterogeneity of denitrification in soils.

Numerical models have become essential tools to predict denitrification at different scales. Model performance could either be tested for total gaseous flux ($NO + N_2O + N_2$), individual denitrification products (e.g. N_2O and/or NO) or for the effect of denitrification factors (e.g. C-availability, respiration, diffusivity, anaerobic volume, etc.). While there are numerous examples for validating N_2O fluxes, there are neither robust field data of N_2 fluxes nor sufficiently resolved measurements of control factors used as state variables in the models. To the best of our knowledge there has been only one published validation of modelled soil N_2 flux by now, using a laboratory data set to validate an ecosystem model. Hence there is a need for validation data at both, the mesocosm and the field scale including validation of individual denitrification controls.

Here we present the concept for collecting model validation data which is be part of the DFG-research unit "Denitrification in Agricultural Soils: Integrated Control and Modelling at Various Scales (DASIM)" starting this year. We will use novel approaches including analysis of stable isotopes, microbial communities, pores structure and organic matter fractions to provide denitrification data sets comprising as much detail on activity and regulation as possible as a basis to validate existing and calibrate new denitrification models that are applied and/or developed by DASIM subprojects.

The basic idea is to simulate "field-like" conditions as far as possible in an automated mesocosm system without plants in order to mimic processes in the soil parts not significantly influenced by the rhizosphere (rhizosphere soils are studied by other DASIM projects). Hence, to allow model testing in a wide range of conditions, denitrification control factors will be varied in the initial settings (pore volume, plant residues, mineral N, pH) but also over time, where moisture, temperature, and mineral N will be manipulated according to typical time patterns in the field. This will be realized by including precipitation events, fertilization (via irrigation), drainage (via water potential) and temperature in the course of incubations. Moreover, oxygen concentration will be varied to simulate anaerobic events.

These data will be used to calibrate the newly to develop DASIM models as well as existing denitrification models. One goal of DASIM is to create a public data base as a joint basis for model testing by denitrification modellers. Therefore we invite contributions of suitable data-sets from the scientific community. Requirements will be briefly outlined.