

Bias of the ^{15}N gas flux method in the field due to subsoil diffusion of ^{15}N labelled denitrification products according to experimental data and gas diffusion modelling

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Common methods for measuring soil denitrification in situ include monitoring the accumulation of ^{15}N labelled N_2 and N_2O evolved from ^{15}N labelled soil nitrate pool in soil surface chambers. Gas diffusion is considered to be the main accumulation process. Because accumulation of the gases decreases concentration gradients between soil and chamber over time, gas production rates are underestimated if calculated from chamber concentrations. Moreover, concentration gradients to the non-labelled subsoil exist, inevitably causing downward diffusion of ^{15}N labelled denitrification products. A numerical 3-D model for simulating gas diffusion in soil was used in order to determine the significance of this source of error. Results show that subsoil diffusion of ^{15}N labelled N_2 and N_2O – and thus potential underestimation of denitrification derived from chamber fluxes - increases with cover closure time as well as with increasing diffusivity. Simulations based on the range of typical gas diffusivities of unsaturated soils show that the fraction of subsoil diffusion after chamber closure for 1 hour is always significant with values up to >30 % of total production of ^{15}N labelled N_2 and N_2O . Field experiments with arable loess soil for measuring denitrification with the ^{15}N gas flux method were conducted. We compared surface fluxes of ^{15}N and $^{15}\text{N}_2\text{O}$ from ^{15}N -labelled microplots confined by aluminum cylinders using the closed chamber method, when the cylinders were open or closed at the bottom, finding $26 \pm 15\%$ higher surface fluxes when closed. The ability of the model to predict the time pattern of gas accumulation was evaluated by comparing measured and simulated values.