Influence of agricultural management on nitrous oxide emissions: comparison of different modelling approaches

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Intensive agricultural land use is considered to be the major source of the anthropogenic contribution to the increase in atmospheric nitrous oxide (N\textsubscript{2}O) concentration during the last decades. Mathematical models help to understand interacting processes in the nitrogen cycle and state variables affecting N\textsubscript{2}O emissions. Most of the simulation models which have been used to estimate N\textsubscript{2}O emissions from soils under field conditions represent the underlying processes of denitrification or nitrification by first order rates without modelling the gaseous N\textsubscript{2}O transport process.

In the first part of the study we compare two modelling approaches of the modular nitrogen modelling system Expert-N for their ability to describe and quantify the seasonal variations of N\textsubscript{2}O fluxes in a potato-cropped soil. Model 1 assumes a fixed N\textsubscript{2}O:N\textsubscript{2} ratio for N\textsubscript{2}O production and neglects the transport of N\textsubscript{2}O in the soil profile, Model 2 explicitly considers a N\textsubscript{2}O transport and assumes a dynamic reduction of N\textsubscript{2}O to N\textsubscript{2}. Data for model evaluation arise from an experiment, where N\textsubscript{2}O fluxes were monitored over the vegetation period, using a closed chamber technique. Experimental results showed a variation of N and O\textsubscript{2} supplies between the ridge soil and inter-row soil of the potato plantation and a corresponding impact on N\textsubscript{2}O release to atmosphere. Thus, in the second part of the study we applied a multiregion modelling approach to get a spatially explicit modelling tool. In the multiregion approach a heterogeneous soil hydraulic regime is subdivided into finite, multiple, hydraulically interacting regions in the form of soil columns. Modelling results showed for the first part of the study that both modelling approaches were able to describe the observed seasonal dynamics of N\textsubscript{2}O emissions and events of high N\textsubscript{2}O emissions due to increased denitrification activity after heavy precipitation and fertiliser application. Extremely high emission rates from the inter-row soil of the potato plantation were underestimated by both models. The lower N\textsubscript{2}O release from the ridge soil was mainly due to a better aeration because of a lower soil bulk density and lower water contents caused by lateral run-off and root water uptake. This could be shown by the application of the multiregion approach in the second part of the study.