Title :	**Parallel Groups Session 4, Working Group 6** **Closing the N budget: denitrification and leaching**	
Time :	08:30 – 10:30, 16th March 2006	
Venue :	Hotel am Badersee, Grainau, Germany	
Chair/ **Rapporteur :** **Attendees :**	Lex Bouwman (LB) Per Ambus (PA)	RIVM RISOE

Topics suggested for discussion in WG6:

- *Given the fact that in level 3 sites only leaching and not denitrification is determined, how can we validate models?*
- *How well do current models simulate ammonia fluxes?*
- *How well do current models calculate crop N uptake or removal by animals in grasslands?*
- *How well do current models simulate denitrification and leaching fluxes?*
- *Should further attempts be made to include denitrification measurements? Methods?*
- *Is determination of potential denitrification helpful?*

Current status

In a brief introduction to the topic LB emphasized the current inability to model denitrification di-nitrogen losses from agricultural systems despite the importance of this pathway for agricultural N budgets. Large uncertainties still exists in assessment of agricultural N_2 losses caused mainly by differences between measurement techniques and lack of long-term observations (Hofstra and Bouwman, 2005).

As the main product from soil denitrification is di-nitrogen gas it is generally agreed that quantification of this process is experimentally difficult. Current methodologies including isotope tracer applications, acetylene block or replacement of N_2 in confined mesocosms suffers from significant drawbacks. Obviously on the one hand this lack of applicable measurement techniques makes building of robust denitrification-models a challenging task, but on the other hand even more important. As an example, presented by PA, the gap in the N-budget of an Austrian forest ecosystem (Zechmeister, pers. comm.) was closed by application of the biogeochemical process-oriented PnET-N-DNDC model (Stange et al., 2000)

Our current ability to predict dominant N-loss strengths in agricultural systems at the plot-scale was summarized by Changsheng Li who gave an overview of the process-based DNDC-model (Li, 2000). From this presentation it appeared that magnitudes of plant uptake and NH_3 volatilization are modelled relatively well. The model prediction of NO_3^- leaching is less accurate, and needs to be improved. Losses of N_2 from denitrification are poorly predicted by DNDC. Particularly with respect to this pathway, the model needs substantial improvement. One reason for the weakness of the model in this context is the lack of available, long-term studies on denitrification losses at field-plot scales.

Keith Smith advocated a hybridized process-based and empirical model for the prediction of gaseous losses from agriculture (Smith et al., 2003). In this model, important driving parameters for soil denitrification and nitrous oxide production (WFPS; T) is predicted from metrological input data and a simple exponential relationship predicts the N-gas losses. The model works fine with N_2O-loss observations, however, the model has not yet been developed and verified for total denitrification N-gas losses.

The introductory presentations as well as the discussion during the WG6 session addressed primarily issues concerning GHG and denitrification gas losses with less weight on leaching losses. A number of important issues concerning current knowledge gaps and priorities for future activities were identified by the WG6 group. In addition to the general considerations, discussions were also aiming to identify efforts needed to be taken within the NitroEurope project in order to optimize utilization and impact of planned activities.

Future emphasis

Important that experimentalists and modellers within NitroEurope communicate carefully to exchange information. It appears that efforts to measure denitrification are implemented in mere subtasks within C1 and C2 of NitroEurope. Efforts to transfer this information to modellers should be prioritized e.g. by arrangements of thematic workshops.

Further development of the simple empirical modelling approaches (K. Smith) as an effort to predict N-gas losses at regional scales. Determination of general relationships between total N-gas loss and $N/(N_2+N_2O)$ ratios vs. soil physical conditions (moisture tensions and T) at regional scales characterized by distinct soil textures. Such relationships could be useful e.g. to determine lower and upper boundaries for total N-gas losses within certain regions.

Assimilation/sequestration of organic N in soils and litter layer. Current estimates indicate a gap of 60 Tg in the global N budget as indicated by A. Mosier in his keynote presentation. Assuming a C:N ratio in the range of 20-30 obviously also significant amounts of C may be sequestered into the terrestrial biosphere with this poorly described process. One approach to address this pathway could be to implement long, term tracer-based experiment including ^{15}N applications at field-plot scales. This approach may be useful to achieve a more comprehensive understanding of N-cycling particularly in low-input systems (P. Boeckx and O. Cleemput). Long-term tracer experiments with observations on tracer and total N concentrations in soil organic and inorganic N-pools should be combined with application of empirical models to describe N-cycle pathways and magnitudes. Such models are currently available in the literature (e.g. DUMAZ; Mary et al., 1998).

There is a need to increase experimental scales and assess N-losses at for example the entire watershed basis (A. Mosier). It is important to encounter all N-sinks/-sources not only at the field scale, but also at larger scales. A significant transfer of leached organic and inorganic N may lead to secondary emissions in bordering ecosystems (riparian zones; streams; estuarine areas). Within NitroEurope this approach could be strengthened e.g. by inclusion of key data from other studies across Europe.

Generally and within NitroEurope there is a need to focus more on leaching and assimilation of organic N compounds in addition to inorganic N addressed in many studies (B. Rees).

There is a need to further improve the process oriented model PnET-N-DNDC (R. Kiese). Predictions of emissions of oxidized N-gases across European forest and grassland ecosystems were relatively satisfactory, however, the model is unable to model all systems.

There was some discussion on the usefulness of measuring potential denitrification as a proxy for ambient denitrification activity. Potential denitrification is relatively easy to determine, however, different protocols are found in the literature. As a consequence of the often observed pronounced spatial as well as temporal variability prediction of denitrification N-gas losses from the potential proxy may be associated with substantial errors. The denitrification model NEMIS (Henault and Germon, 2000) predicts denitrification from soil physical parameters and potential denitrification, however, the model is sensitive to soil moisture fluctuations impeding upscaling opportunities.

Key references

Henault, C. and Germon, J.C. 2000 NEMIS, a predictive model of denitrification on the field scale. Eur. J. Soil Sci. 51: 257-270.

Hofstra, N. and Bouwman, A.F. 2005 Denitrification in agricultural soils: Summarizing published data and estimating global annual rates. Nutr. Cycl. Agroecosys. 72: 267-278.

Li, C.S. 2000 Modeling trace gas emissions from agricultural ecosystems. Nutr. Cycl. Agroecosys. 58: 259-276.

Mary, B., Recous, S., Robin, D., 1998. A model for calculating nitrogen fluxes in soil using N-15 tracing. Soil Biol. Biochem. 30: 1963-1979.

Smith, K.A., Ball, T., Conen, F., Dobbie, K.E., Massheder, J. and Rey, A. 2003 Exchange of greenhouse gases between soil and atmosphere: interactions of soil physical factors and biological processes. Eur. J. Soil Sci. 54: 779-791.

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