Geophysical Research Abstracts, Vol. 8, 05724, 2006
SRef-ID: 1607-7962/gra/EGU06-A-05724

Improvements in modeling of N_2O exchange between soil and atmosphere: biological processes and gaseous diffusion

S.A. Blagodatsky (1), A.A. Revetnev (1), R. Kiese (2) and K. Butterbach-Bahl (2)

(1) Institute of Physicochemical and Biological Problems in Soil Science, Pushchino, Russia,
(2) Research Center Karlsruhe GmbH, IMK-IFU, Garmisch-Partenkirchen, Germany
(sblag@itaec.ru / Fax: +7-0967-330595)

For the precise description of CO_2 and N trace gas exchange between soils and atmosphere in process-oriented models it is essential to explicitly describe microbial dynamics as well as water and gas transfer in soils. This task can be better solved using advanced mathematical and programming tools such as numerical integration of differential equations describing microbial transformations or gas diffusion. Currently most of soil organic matter models use finite difference methods and fixed time steps for calculations. In this case optimal minimum time step chosen for one soil/ecosystem with definite properties may not be suitable for other cases. Calculations with very small time steps (appropriate for any case) demand very high computer performance and can easily exceed any time limits. So, application of the more advanced techniques is desirable during elaboration of complex ecosystem models simulating microbiological processes and gas exchange between soil and atmosphere.

The aim of our investigations was to check whether the implementation of numerical methods for integration of the gas diffusion equations such as 4^{th} order Runge-Kutta method will improve the consistency of model output for soils with different physico-chemical properties (density, porosity, microbial activity).

In this study we tested a new version of the soil biochemistry sub-module in the DNDC model (Li et al., 2000). This model simulates *inter alia*:

– mineralization of plant residues and soil humus (decomposition, ammonification),

– dynamics of soil microbial biomass (C and N),

– denitrification, with explicit description of production and consumption of intermediates

– autotrophic nitrification and nitrifier denitrification, with description of growth of nitrifiers

– heterotrophic nitrification

– dynamical change in proportion between anaerobic and aerobic parts of soil as well as transport of gaseous and soluble substrates between these two parts and through soil profile (anaerobic balloon concept).

Our work shows, how model outputs (N_2O, NO and CO_2 emission rates) depends on chosen prerequisites and algorithms of calculation. Trial model runs demonstrate that fixed calculation time-step and fixed height of soil layer were optimal for one soil (sandy loam with standard properties) but fail in another case (real example of forest site). Application of advanced numerical method for calculation helps in overcoming this drawback and allows tuning user-defined parameter values applied in detailed microbial processes description.

Li, C., Aber, J.D., Stange, F., Butterbach-Bahl, K., Papen, H. (2000) A process-oriented model of N_2O and NO emissions from forest soils: 1. model development. *J. Geophys. Res.* **105,** 4369-4384