Geophysical Research Abstracts
Vol. 13, EGU2011-2578, 2011
EGU General Assembly 2011

Nitrous oxide emissions along an agricultural landscape: direct measurements and modeling

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Agricultural practices widely contribute to the increase in atmospheric nitrous oxide (N2O) concentration and are the major source of N2O which account for 24% of the global annual emission (IPCC, 2007). Although nitrification and denitrification are respectively aerobic and anaerobic processes, both can occur simultaneously at aerobic and anaerobic microsites within the soil and therefore depend on soil characteristics and management.

Nitrous oxide emissions from soils are known to be highly discontinuous in space and time, variable in amplitude which makes the estimation of emissions and their prediction particularly difficult. Besides their control by various factors, such as climate, soil conditions and management (content of NO3- and NH4+, soil water content, presence of degradable organic material…), the role of topography is less known although it can play an important role on N2O emissions (Izaurralde et al., 2004).

Our study has shown that landscape position clearly affects cumulative N2O emissions over the year, highest emissions being observed on the low topographical positions. Using models, the estimation of N2O fluxes have been done with greater accuracy than using simple approaches such as the IPCC methodology. However, choosing or proposing a model is not straightforward and several aspects must be taken into account.

Beyond the quality of prediction, the robustness and the easy-to-use of a model strongly depend on the number and the nature of parameters which have to be determined. The interest of using complex process-based models, requiring a priori knowledge of the processes, is that they can be use for exploring scenarios. On the contrary, the simple and empirical models do not allow such an exploration. We have here explored and compared different simple ways of modeling N2O emissions, from purely statistical models (multiple regression, decision tree) to a process-based approach in the form of the NOE2 model (Hénault et al., 2005; Bessou et al., 2010).

The comparison of these different approaches is done with the constraint of using the same set of control variables and keeping the same number of fitted parameter. Even if statistical models yielded unbiased estimations, they showed difficulties in capturing the variability of emissions which was provided by the NOE2 process-based model with only two fitted parameters, e.g. a better agreement with the high post-fertilization fluxes.

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