Nitrous Oxide (N2O) emissions in a continuum plot-groundwater-wetland-river in a farming catchment area

1 Scope of the study
Nitrous oxide (N2O) has an important role in the atmosphere; it is a greenhouse gas with a 296 times larger global warming potential than carbon dioxide over a 100 year time period (IPCC, 2001). Soil contribution of global emission of N2O is 70% (Conrad and Smith 1999) with a major contribution of agricultural soils, responsible for 67% of anthropogenic N2O emissions (UNFCCC, 2003).

The purpose of this study was to analyze environmental factors (texture and organic matter content of soil, crop management and fertilization application) in a continuum from an agricultural plateau to the riparian zone, in order to quantify emissions of N2O (IPCC 2006).

2 Study site: The Orgeval sub-basin

The study site is a north-westward falling slope reaching the Avenelles River with an average inclination of 2.2%.

3 N2O emissions by soils

Material & Methods

Nitrous oxide (N2O) gas emission is measured with the "closed chamber technique" with 5 sampling plots at each site.

N2O concentrations in the gas sample are analyzed using a gas chromatograph (GC) coupled with an electron capture detector (ECD).

N2O fluxes are determined by measuring N2O concentration increases in the chamber headspaces and calculating the slope of linear regression of N2O concentrations in function of time.

Soil and air temperatures are measured around each chamber as well as soil moisture and organic matter content.

4 NO3 and N2O in groundwater and rivers

Nitrate and N2O in groundwaterwaters

Nitrate and N2O in rivers

Sampling strategy & Experiment protocol

Dissolved NO3 and nitrate in the groundwater and rivers are sampled with a submersible pump. Dissolved nitrous oxide is analyzed following desorption, with a gas chromatograph (FID) and an electron capture detector (ECD).

Nitrate is measured on filtered water (GF/F 0.45 µm of porosity) with an autoanalyzer (Quaas), after cadmium reduction into nitrate with the sulphuric oxide method.

Dissolved N2O in groundwater and rivers always above saturation with very high concentrations in groundwater

N2O concentration gradient along the slope with highest concentrations in upper portion (more marked for N2O). In 2008, nitrate concentrations is in the same order in groundwater and rivers.

Two key periods for highest concentrations of nitrate and dissolving N2O spring (2008 & 2009) after fertilization and fall after first high post-summer rainfall.

5 Soil potential denitrification: a lab study

Denitrification potentials are variable in function of depth, about 2 µgN/g dry soil/h.

N2O emission potentials are much higher in surface, about 0.12 µgN/g dry soil/h.

Results: % N2O production

N2O emission potentials about 10% of surface denitrification potential.

... in relation with a higher organic matter content

Acknowledgments

This study has permitted to show that landscape position affects N2O emissions as well as soil characteristics like WFPS.

Values from 6 to 10 gN/gN2O ha−1 day−1 for croplands are well in the range of those found in other regions of the world (Bouwman, 1996; Garine et al., 2001). Laboratory experiments show that N2O production is potentially higher at the surface, so that besides being emitted N2O could reach the groundwater by infiltration. During the water transfer from aquifer to surface water, N2O could be further reduced or emitted.

N2O concentrations in groundwaters are clearly higher than concentrations found in rivers and huge compared with that of the saturation, with a clear gradient along the slope. Soils appear to be a real source of N2O for the river water.

References


