Simulation of N_2O and NO emissions from soils on plot and landscape scales using biogeochemical models

K. Butterbach-Bahl, C. Werner, M. Kahl and R. Kiese

Institute for Meteorology and Climate Research, Atmospheric Environmental Research (IMK-IFU), Karlsruhe Research Centre

Soils are on a global scale the dominating source of the greenhouse gas N_2O. The observed increase of atmospheric N_2O concentrations is largely due to the increased use of N fertilizer and to the perturbation of the regional and global N cycles and, thus, to increased N_2O emissions from terrestrial ecosystems. Although this is already well known for more than two decades, our knowledge on sources of N_2O on regional and global scales is still restricted and highly uncertain, since N_2O emissions are extremely variable in space and time and are often event based. In the recent past process based biogeochemical models were developed which allow to mimic the complex interactions of biological and physico-chemical processes involved in ecosystem C and N cycling and associated N_2O production, consumption and emission. These models have intensively been applied to various field sites with different landuses such as e.g. tropical forests in Australia, temperate forests in Germany or a series of agricultural sites in China and US, thereby showing their capability as well as their restrictions when simulating N_2O emissions. These applications revealed that the optimisation of parameters e.g. based on field and laboratory studies and the assessment of parametric uncertainty is still a major challenge for the development of biogeochemical models. To address this problem we applied Bayesian calibration techniques in order to improve predictions and to assess model uncertainty. Finally we linked the biogeochemical models DNDC and Forest DNDC to detailed GIS databases to assess regional hot spots of N_2O emissions from various landuses on regional (Europe/ Australia) and global scales. Our simulation results confirm that e.g. tropical rainforest on a global scale or intensively fertilised arable land, as can be found e.g. in the Po region of Italy, are indeed major sources for atmospheric N_2O, largely overriding background N_2O emissions from a series of natural, non N deposition influenced ecosystems.