Better understanding of soil nitrogen dynamics via in situ ^{15}N labelling and numerical data analysis

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Knowledge of the factors that determine nitrogen (N) retention by terrestrial ecosystems is crucial to assess the impact of changes in anthropogenic N emissions and climatic conditions on future N cycling and losses. Retention of N has been demonstrated for a wide range of forest ecosystems, including forests in Europe and NE America that are exposed to chronically enhanced N deposition. Soils have been reported to be the main N sink in forests, but it is still unclear which factors determine this N retention capacity. Therefore, we examined the possible effects of forest type and tree species on soil N cycling. The quality and quantity of soil organic matter in forests largely depends on the tree species composition, and soil N dynamics have been shown to vary among tree species as well. As most soil N transformations are carried out by heterotrophic microorganisms that depend on the supply of available organic C, with chemoautotrophic nitrifiers using inorganic C as exceptions, soil organic matter chemistry is thought to be at least partially responsible for varying soil N dynamics.

A better understanding of N cycling in forest soils requires the quantification of gross N transformation rates, which are typically determined by ^{15}N pool dilution experiments. However, soils are often mixed before incubation, so that the results obtained may not be valid under field conditions. Even when intact cores are studied in situ, the soil-root system is disturbed by inserting cylinders before adding ^{15}N. Here we present a ^{15}N soil labelling approach in which soil temperature, water and gas exchange, and plant root and mycorrhizal activity remain under field conditions throughout the 8-day experiment. Gross N transformation rates were quantified with a ^{15}N tracing model and numerical data analysis (Müller et al., 2007). Compared to the commonly used analytical equations, this optimization technique allows gaining more insight in simultaneously occurring soil N transformations, including processes such as heterotrophic nitrification and dissimilatory nitrate reduction to ammonium (Huygens et al., 2008; Rütting et al., 2008). The application of this innovative experimental and modelling approach will be illustrated by the difference in gross N dynamics for adjacent deciduous and coniferous temperate forest soils located in a region with high N deposition.

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