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Does nitrogen deposition affect plant-derived and microbial organic matter compounds differently?

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The IPCC report 2007 assesses soil nitrogen availability as a key factor in predicting future carbon sequestration by terrestrial ecosystems. However, various studies reported contrasting N effects on SOM dynamics, but the reasons for this are not well understood. One potential explanation is that decomposition processes of individual organic molecules respond differently to nitrogen. Compound-specific stable isotope analysis (CSIA) of C (and N) can be used to trace isotopically labeled molecules in soil. While such an isotopic label can be relatively easily obtained in arable soils via crop changes from C3 to C4 plants, this option does not exist for forests. Therefore, no data on molecular dynamics of forest soils and their response to changes in environmental conditions (increase in atmospheric CO_2 concentrations and in N deposition) exist so far.

Nonetheless, labeling of forest ecosystems is possible by fumigation with labeled CO_2, although only very few of these experiments are available worldwide.

In a new project, we will use archived soil samples from a CO_2 enrichment experiment in large open-top chambers. This experiment had been conducted in a factorial design to study interactions between CO_2 fumigation and N deposition on model forest ecosystems growing on two contrasting soils. The analysis of ^{13}C signatures in SOM fractions indicated a retarded mineralization of old SOM in fine particle size fractions. In this study, we will apply compound-specific isotope analysis to trace added CO_2 into plant and microbial biomarkers in soils. Thus, we will obtain systematic data on molecular dynamics in forest soils based on a ^{13}C labeling approach. In particular, we will test the hypothesis that decomposition of N-containing compounds (such as microbial amino sugars) does not respond to N additions, in contrast to decomposition of N-free compounds, such as lignin. The experimental design also enables us to address potential interactive effects of CO_2, N and soil type on concentrations both of plant biomarkers and of microbial biomarkers. A significant shift in the ratio between these biomarkers would be indicative of major changes in the carbon fluxes within the soil system. Localization of the labeled biomarkers in specific soil fractions will identify the soil compartments where important changes occur. This information may be used to test current hypotheses on organic matter stabilization mechanisms in soil. The project plan and first results will be presented.