



Increased nitrogen deposition did not affect the composition and turnover of plant and microbial biomarkers in forest soil density fractions

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Increased atmospheric nitrogen (N) deposition and elevated CO₂ concentrations affect many forests and their ecosystem functions, including organic matter cycling in soils, the largest carbon pool of terrestrial ecosystems. However, it is still not clear how, and what the underlying mechanisms are. Specific molecules of plant and microbial origin (biomarkers) might respond differently to N deposition, depending on their internal N content. Microbial cell-wall-constituents with high-N content like amino sugars are reliable biomarkers to distinguish between fungal- and bacterial-derived organic residues. Individual lipids are plant-specific biomarkers that lack N in their molecular structure. Here, we tested the effects of elevated CO₂ and increased N deposition on the dynamics of plant and microbial biomarkers by studying their composition and turnover in forest soil density fractions. Furthermore, we tested the hypothesis that these biomarkers respond differently to increased N deposition, depending on their internal N content.

We used soil samples from a 4-year elevated CO₂ and N deposition experiment in model forest ecosystems (open-top chambers), that were fumigated with ambient and ¹³C-depleted CO₂ and treated with two levels of ¹⁵N-labeled fertilizer. Bulk soil was separated into free light fraction, occluded light fraction and heavy fraction by density fractionation and ultrasonic dispersion. The heavy fraction was further particle-size fractionated with 20 μm as a cut-off. We determined carbon and N concentrations and their isotopic compositions (δ¹³C, δ¹⁵N) within bulk soil and density fractions. Therein, we extracted and quantified individual amino sugars and lipids and conducted compound-specific stable-isotope-analysis using GC- and LC-IRMS.

Results show that amino sugars were mainly stabilized in association with soil minerals. Especially bacterial amino sugars were preferentially associated with soil minerals, exemplified by a consistent decrease from fungal- to bacterial-derived amino sugars from light (plant-like) to heavy (mineral) soil fractions. Other than expected, elevated CO₂ and increased nitrogen deposition did not affect the distribution of amino sugars within and between soil fractions. One explanation could be that the four years of the experiment were too short to reach a new equilibrium of fungi and bacteria.

For the first time we were able to determine isotope ratios of individual amino sugars in soil density fractions from a natural abundance field experiment. Our results show that, in the presence of soil minerals amino sugars turn over slower than in light, physically unprotected fractions. Surprisingly, fungal amino sugars turn over at the same rate than total organic carbon, while bacterial amino sugars turn over slower. Furthermore, nitrogen deposition did not affect the turnover of individual amino sugars in soil density fractions, indicating that microbial community distribution was not affected after four years of increased nitrogen deposition. This is in contradiction to the often observed reduction of fungal biomass after nitrogen additions.

Data from the lipid analysis (plant biomarkers) are still under investigation and will be presented in conjunction with the results for amino sugars (microbial biomarkers).