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Does nitrogen deposition affect the turnover of plant- and microbially-derived organic matter compounds differently?

Marco Griepentrog (1), Alexander Heim (1,4), Frank Hagedorn (2), Rienk H. Smittenberg (1,3), and Michael W. I. Schmidt (1)

(1) Department of Geography, University of Zurich, Zurich, Switzerland (marco.griepentrog@geo.uzh.ch), (2) Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), Birmensdorf, Switzerland, (3) Geological Institute, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland, (4) Klaus Büchel Anstalt, Mauren, Principality of Liechtenstein

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 N, depending on their internal N content. According to this hypothesis, decomposition of compounds with high N content, like microbial amino sugars, would not respond to N additions, in contrast to compounds with low N content like plant-derived lignin. A significant shift in the ratio between these biomarkers would be indicative of major changes in the C fluxes within the soil system. Localization of isotopically labeled biomarkers in soil density fractions will identify the soil compartments where important changes occur. This information may also be used to test current hypotheses on organic matter stabilization mechanisms in soil.

We use soil samples from a four year CO_2 enrichment and N deposition experiment with model forest ecosystems (open-top chambers with beech / spruce) on two soil types (acidic loam / calcareous sand). The ecosystems have been fumigated with two levels of ^{13}C-labeled CO_2 (370 / 570 μmol mol^{-1}) and treated with two levels of ^{15}N-labeled fertilizer (0.7 g / 7 g NH_4NO_3-N m^{-2} yr^{-1}). We will apply compound-specific stable isotope analysis to trace added CO_2 into plant- and microbially-derived molecular markers (lignin / amino sugars) within soil density fractions (free / occluded light and heavy fraction).

In a methodological evaluation we first tested which density cut-off and ultrasonic dispersion energy yielded the maximum organic matter in the light fraction. Results indicate that a density cut-off at 1.6 g cm^{-3} optimally separates light from heavy fractions. At higher density C concentrations decrease while mass increases, suggesting incorporation of mineral material into the light fractions. An ultrasonic energy input of 250 J ml^{-1} seems to be adequate to release light fractions occluded within soil aggregates since no changes in C concentration and mass recovery occur at higher dispersion energy.

Additionally we did a literature survey of 28 studies using combinations of density fractionation and ultrasonic dispersion to separate occluded fractions. A wide range of dispersion energies (22 – 1700 J ml^{-1}) with a median of 240 J ml^{-1} and a mean of 299 $\pm$ 40 J ml^{-1} were used. Interestingly only 15 studies reported calibration of the ultrasonic equipment used and almost none of them discussed why they used specific densities or ultrasonic energy for separation of occluded material.

Besides density fractionation results, we will present first data on molecular markers together with initial interpretations.