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Turnover of organic matter in forest soils under increased N deposition

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Soils contain the largest fraction of the terrestrial carbon pool. However, if soils act as a carbon source or sink under the ongoing climate change is still uncertain. For instant, recent studies are controversial whether anthropogenic induced N deposition into forest ecosystems accelerates, suppresses or does not affect soil organic matter decomposition. Several studies have indicated a substrate specific N effect on soil organic matter decay. While increased N deposition seems to inhibit the degradation of lignin and its derivatives, it might accelerate the decomposition of labile litter components. Besides CO2 release, N addition may also alter the leaching of dissolved organic carbon, which is likely an important process of carbon transport within the soil profile. So far, only a few studies have surveyed the dissolved organic carbon production under increased N deposition.

To gain more insight into potentially varying effects of N addition on different substrates in a forest soil, we performed a labeled litter experiment in a productive beech forest in Switzerland. At the end of November 2007 we replaced native litter with 13C labeled beech leaves (-40.7‰) and beech wood (-38.4‰), which enabled us to trace the fate of 13C in CO2 as well as in leached dissolved organic carbon. To simulate an increased N deposition, we added a NH4NO3-solution (+60 kg N ha-1y-1) biweekly and during one year.

Our results suggest that the initial stage of leaf litter decomposition was completed after three winter month despite of a mean air temperature of only 0.6°C. In this initial stage, N addition intensified microbial CO2-release by up to 25%. However, N addition had the opposite effect afterwards with strongly reduced litter respiration on the N treatment sites (-28%). Since N addition reduced carbon loss from the leaf layer by 15% on average, we suppose a corresponding surplus of the carbon input into the soil compared to the control sites. In contrast to the leaf layer, we did not observe any significant N effects on wood and soil organic matter decomposition.

Only 5.6% of the DOC leached from the litter layer was recovered in the DOC of the mineral soil at 5cm depth, indicating that most of litter-derived DOC was retained in the mineral soil. Altogether, N addition reduced DOC production by 30%, which possibly was a result of suppressed lignin degradation.