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Effects of elevated CO_2 on soil organic matter turnover and plant nitrogen uptake: First results from a dual labeling mesocosm experiment

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The response of plant growth to elevated concentrations of CO_2 (eCO_2) is often constrained by plant nitrogen (N) uptake. To overcome potential N limitation, plants may invest photosynthetically fixed carbon (C) into N acquiring strategies, including fine root biomass, root exudation, or C allocation to mycorrhizal fungi. In turn, these strategies may affect the decomposition of soil organic matter, leading to uncertainties in net effects of eCO_2 on C storage.

To gain more insight into these plant-soil C-N-interactions, we combined C and N stable isotope labeling in a mesocosm experiment. Saplings of *Fagus sylvatica* L. were exposed to a $^{13}CO_2$ enriched atmosphere at near ambient (380 ppm) or elevated (550 ppm) CO_2 concentrations for four months of the vegetation period in 2016. Aboveground and belowground net CO_2 fluxes were measured separately and the ^{13}C label enabled partitioning of total soil CO_2 efflux into old, soil derived and new, plant-derived C. We used ingrowth cores to assess effects of eCO_2on belowground C allocation and plant N uptake in more detail and in particular we evaluated the relative importance of ectomycorrhizal associations. In the soil of each sapling, ingrowth cores with different mesh sizes allowed fine roots or only mycorrhizal hyphae to penetrate. In one type of ingrowth core each, we incorporated fine root litter that was enriched in ^{15}N. Additionally, total N uptake was estimated by using ^{15}N enriched saplings and unlabeled control plants.

We found that eCO_2 increased aboveground net CO_2 exchange rates by 19% and total soil respiration by 11%. The eCO_2 effect for GPP and also for NPP was positive (+23% and +11%, respectively). By combining gaseous C fluxes with data on new and old C stocks in bulk soil and plants through destructive harvesting in late autumn 2016, we will be able to infer net effects of eCO_2 on the fate of C in these mesocosms. Biomass allocation patterns can reveal physiological responses to high C availability under potentially constrained N availability. Together with data on biomass production within the ingrowth cores these results elucidate mechanisms affecting soil C storage and plant N uptake under eCO_2.