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The contribution of ectomycorrhizal fungi to litter decomposition may imply synergistic controls of above- and belowground vegetation on soil CO₂ emissions

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The stimulation of vegetation productivity in response to rising atmospheric CO₂ concentrations can potentially compensate climate change feedbacks. Vegetation and soil C storage will be however limited by nutrient availability, the allocation of C resources of vegetation into aboveground biomass versus roots and on the feedbacks with soil microorganisms. Plants can modulate the amount of carbon that is allocated to above- versus belowground in response to changing atmospheric CO₂ concentrations, with a consequent alteration of productivity and of the litter and rhizosphere inputs to the soil. Recent studies have highlighted the crucial role of mycorrhizal fungi on the response of vegetation productivity to rising CO₂ concentrations. We hypothesize that mycorrhiza can also play a key role on litter decomposition for N acquisition, therefore affecting CO₂ emissions and the amount C sequestered into the soil.

In order to test this hypothesis, different levels of litter addition were implemented on trenched (root exclusion) and non-trenched plots (with roots) in a temperate deciduous forest of ectomycorrhiza-associated species (beech and oak). Soil CO₂ fluxes were continuously measured at high temporal resolution with automatic chambers, whereas the spatial and seasonal variability was determined using portable chambers. The composition of saprotrophic and symbiotic fungal communities were determined in each treatment after 2 years, as well as the changes in soil C and N stocks.

Soil CO₂ effluxes showed a synergistic interaction between the increased litter inputs and the presence of roots, where the carbon mineralized in response to litter addition was much higher in the non-trenched plots. DNI sequencing of fungal communities confirmed that trenching succeeded in suppressing virtually all ectomycorrhizas. Litter manipulation (exclusion, control, doubled addition) showed a linear relationship with ectomycorrhizal (ECM) strains of divergent exploration types, where the litter exclusion treatment was dominated by ECM of short exploration types and long exploration ECM types dominate at double litter. These results together suggest that long exploration types of ECM may contribute to litter decomposition for N and/or other nutrients, thus enhancing CO₂ fluxes and N acquisition by plants. Therefore, the association of plants with ectomycorrhizal fungi not only may determine the productivity responses to rising atmospheric CO₂ concentrations, but also the rates of litter decomposition and N cycling.