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Partitioning of the forest floor CO_2 fluxes reveals the belowground interaction between different plant species

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Soil CO_2 emissions originate from heterotrophic respiration i.e. the decomposition of soil organic matter and autotrophic respiration from plant roots. The different sources also interact since trees are known to allocate carbon to symbiotic mycorrhizal fungi and other root-associated organisms. The sacrifice is beneficial because mycorrhiza can boost the decomposition of soil organic matter and in that way release soil nutrients for tree use. It is also proposed that ericoid- and ectomycorrhizal fungi associated with roots of different plants (dwarf shrubs and trees) have links between each other.

We established a trenching experiment at the SMEAR II (Station for measuring ecosystem-atmosphere relations) in southern Finland in late 2012 with the intention to partition the different sources of CO_2 at forest floor. The site is middle-aged Scots pine stand (Pinus sylvestris) and soil is Haplic Podsol with soil depth of 0.5-0.7 m and intermediate fertility. In trenching method, roots are cut around a plot (1m*1m), which is isolated from the surrounding soil with impermeable fabric. We used two different mesh fabrics with pore sizes 1 μm (allows only access of water and small molecules) and 50 μm (allows the ingrowth of fungal hyphae, incl. mycorrhiza) to separate the plots from the neighbouring soil and prevent the ingrowth of tree roots. In order to study the connection between understory plant and tree roots, and their mycorrhizas, we applied three different ground vegetation treatments: one with intact ground vegetation, one with only dwarf shrubs (herbs and mosses removed) and one where all ground vegetation (shrubs, herbs and mosses) was cut.

Soil CO_2 emissions were regularly measured from all treatments at one-month intervals throughout the growing seasons 2013-2015. We used manual chambers and CO_2 emissions were measured on permanently installed collars on each plot. Soil temperature and moisture were also measured at each plot. Trenching creates extra dead tree roots inside the plots. We used litterbags and the distribution of root size classes to estimate the decomposition rate of those roots.

After root-exclusion, CO_2 emissions decreased by almost 70% when all the ground vegetation was removed. The CO_2 emissions increased with increasing ground vegetation in the trenched plots whereas in control plots, the ground vegetation did not have a clear effect on the emissions. The emissions developed differently when all other plants, except ericoid shrubs were removed. During the first two years after tree-root exclusion, emissions at these plots were approx. 50% compared to the control, irrespective of the presence of the mycorrhizal hyphae. However, soil respiration increased notably in the third year, if fungal connection between ericoid mycorrhizal dwarf shrubs and ectomycorrhizal trees was allowed. In the presentation, I will show the results from all treatments and the connections between the different soil CO_2 flux components discuss the reasons behind the observations.