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Decoupling of respiratory components of Scots pine forest floor using stable carbon isotopes in intensely dry conditions

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Climate is expected to warm and drought episodes may become common events during the growing seasons. The studies on the survival of northern conifers have indicated that Scots pine (*Pinus sylvestris* L.) will benefit from the changes in the climate. Still, belowground carbon processes, such as exchange of carbon between plants and soil, remain poorly understood due to their complex nature. Changes in climate, for example the frequency of drought episodes, may have unpredictable effects on these processes. In this study we investigated the effect of drought on tree root activity by measuring CO_2 emissions at the forest floor.

The CO_2 emissions at the forest floor originate, not only from tree roots, but also from the activity of root-associated fungi in symbiosis with tree roots (i.e. mycorrhizas), and from non-symbiotic microbes decomposing soil organic matter (i.e. heterotrophic respiration). In order to study the individual processes under the field conditions, these components should be separated. This has been challenging, as these processes are tightly connected and affected by similar environmental drivers. The CO_2 flux components have differences in isotopic composition, i.e. specific δ^{13}C values in their CO_2 emissions (e.g. soil respiration is usually slightly heavier in ^{13}C than plant-associated respiration), and those differences could be used in partitioning the sum of all respiratory components at the forest floor.

The aim was to test the applicability of the stable carbon isotopes in the decoupling of the different respiratory fluxes in drought conditions with Scots pine. For the purpose, we carried out a controlled drought experiment in a greenhouse in the Viikki campus (60˚13'N) of the University of Helsinki, and studied seasonal dynamics and the contribution of different components of forest floor respiration to overall CO_2 emissions in a middle-aged Scots pine forest in the SMEARII (61˚51'N) field station in southern Finland.

In the greenhouse experiment, Scots pine saplings were divided into three different treatments: control trees with continuous watering, trees without watering and trees that were first exposed to severe drought before continuous watering. We excavated and incubated soil and root samples regularly during the drying and re-wetting to study the effect of moisture deficiency on the respiration and its δ^{13}C, in order to obtain the isotope signal of the end-members of the isotope mixing model.

In the field, forest floor CO_2 emissions were measured on plots with and without living tree roots (root exclusion via trenching method) throughout one growing season with an extended dry period. The ground vegetation was removed from all the plots. In addition to the trenching experiment, tree roots were dug from the soil and incubated in order to measure tree root respiration and δ^{13}C of respiration.

In the greenhouse experiment, soil respiration was more sensitive to soil moisture than root respiration. After removing the effect of the ambient temperature on soil respiration, soil and root moisture were clearly connected to the soil and root respiration, respectively. In the presentation, I will show the results of the experiments and discuss the reasons behind the observations.