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Exploring the impact of live roots on the soil COS flux

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Partitioning the measured net ecosystem carbon dioxide (CO_2) exchange into gross primary productivity (GPP) and ecosystem respiration remains a challenge, which is usually tackled by disentangling the net ecosystem CO_2 exchange using various methods. A relatively new approach uses the trace gas carbonyl sulfide (COS) to estimate GPP. This is possible because of the very similar pathways CO_2 and COS take into and within leaves, allowing researchers to use COS uptake as a proxy for the CO_2 uptake in plants. In order to assess the viability of COS as a GPP proxy, COS sources and sinks in ecosystems have to be quantified. One of the biggest unknowns in this regard is the contribution of the soil.

In our study we looked at the effects of live roots on the soil COS-exchange, a topic that has not yet been explored in the literature. While in the last couple of years different working groups measured soil samples in the lab, no study to date looked at the impact of live roots on the soil COS flux. We hypothesized that live roots will change the COS flux by changing microbial community composition and activity via root exudates. In order to investigate the root contribution of a live plant we had to build an experimental setup that would allow us to only measure the belowground plant parts and the soil, while at the same time keep the whole plant alive. The plants used in this study were young beech trees (~2 years) and the soil was commonly used potting soil, in order to ensure a mostly homogeneous substrate for the trees. The measurements were spread out over one year to cover the different phenological stages of the trees, from no leaves in winter to new and mature leaves in spring and summer, respectively, to senescent leaves in autumn. Growth lamps were used to supply the aboveground parts of the plants with light during the day.

Most pots, with and without plants, emitted COS during the course of the experiment. COS and CO_2 emissions increased in pots with roots compared to the control pots, but the increase in CO_2 emissions was much stronger compared to the increase in the COS flux, which lead to consistently higher COS/CO_2 emission ratios in the control pots, which contained potting soil only. A diurnal pattern was visible in all the measurements with the largest emissions for COS and CO_2 occurring in the afternoon, when soil temperatures were the highest. Comparing the measurements over the whole experiment a clear difference in the COS/CO_2 ratio could be observed between the measurements without leaves in February compared to the measurements with leaves in summer and autumn, indicating a dynamic effect of live roots on the soil COS exchange.