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The propagation of a soil $H_2^{18}O$ labeling through the atmosphere-plant-soil system under drought using $H_2^{18}O$ and $C^{18}OO$ as two independent proxies

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Above- and belowground processes in plants are tightly coupled via carbon and water flows through the atmosphere-plant-soil system. While recent studies elucidated the influence of drought on the carbon flow through plant and soil using ^{13}C, much less is known about the propagation of ^{18}O. Therefore, this study aimed to examine the timing and intensity of ^{18}O enrichment in soil and shoot CO_2 and H_2O vapor fluxes of European beech saplings (*Fagus sylvatica* L.) after applying ^{18}O-labeled water to the soil.

A custom-made chamber system, separating shoot from soil compartments, allowed independent measurements of shoot and soil related processes in a controlled climate chamber environment. Gas-exchange of oxygen stable isotopes in CO_2 and H_2O-vapor served as the main tool for investigation and was monitored in real-time using laser spectroscopy. This is the first study measuring concurrently and continuously the enrichment of ^{18}O in CO_2 and H_2O in shoot- and soil gas-exchange after applying ^{18}O-labeled water to the soil.

Photosynthesis (A) and stomatal conductance (g_s) of drought-stressed plants showed an immediate coinciding small increase to the $H_2^{18}O$ irrigation event after only $\sim$30 min. This rapid information transfer, however, was not accompanied by the arrival of ^{18}O labeled water molecules within the shoot. The actual label induced ^{18}O enrichment in transpired water and CO_2 occurred not until $\sim$4h after labeling. Further, the timing of the enrichment of ^{18}O in the transpirational flux was similar in both treatments, thus pointing to similar transport rates. However, drought reduced the ^{18}O exchange rate between H_2O and CO_2at the shoot level, likely caused by a smaller leaf CO_2retroflux. Moreover, ^{18}O exchange between H_2O and CO_2 occurred also in the soil. However, the there was no difference observed between the treatments.