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New insights into isotope uptake and allocation processes from a 13C and 18O-labeling study in a Swiss pine forest.

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The isotope and thus the information transfer of climatic signals from photosynthetic active leaves towards potential sinks such as tree-rings under different environmental and hydrological conditions is still not fully understood. $13CO_2$-pulse-labeling experiments allow for assessing carbon allocation from sinks to sources, however, much less is known about the signal transfer of oxygen isotopes. Here, we applied a newly developed 18O-pulse-labeling technique in combination with $13CO_2$-labeling to compare the C- and O-signal uptake and allocation from leaves into twigs under different soil moisture conditions. The study was performed in a pine (Pinus sylvestris) forest in Switzerland (Pfynwald, Valais), where a long-term irrigation experiment is conducted since 15 years. One branch per tree (ca. 1 m length) of control (natural dry) and irrigated pine trees, as well as detached mistletoes (as a side aspect), were enclosed in chambers with light-permeable foil in the morning. 18O-enriched water was applied via spraying (i.e. leaf wetting) until relative humidity (RH) in the chamber was fully saturated. Subsequently, the chamber was closed and $13CO_2$ gas injected. Labeling conditions were held constant and exposure was stopped after 4 h at midday. Subsequently, samples of needles, mistletoe leaves, twig phloem and xylem were taken over 192 h (8 days) for extraction and isotope analysis of water and water soluble compounds (i.e. photosynthetic assimilates). We found that the soil water conditions did not influence the 18O-label uptake into water and assimilates of needles and twigs under high RH. However, the 13C-label incorporation into needle and twig assimilates was higher in irrigated trees than in control trees. Our observation suggests that the RH response of the processes controlling the C- and O-signal uptake may differ. We will discuss our results in relationship with measurements of leaf gas-exchange and non-structural carbohydrates. Further, we will explore the C- and O-signal allocation from needles into twigs and compare the photosynthetic activity between the parasitic mistletoes and the host trees. Our study gives therefore new insights into isotope uptake and allocation processes in trees under changing climatic conditions.