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Where does the water come from? Variations in soil water uptake depth in a beech forest during the 2018 drought

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Water uptake under variable soil water supply is highly critical for the functioning of trees and the services provided by forests. Current climate projections predict an increasing variability of precipitation and thus a higher frequency of droughts alternating with extreme precipitation events. Reduced water availability is the most critical driver for tree mortality and impairment of trees' functions. Under variable water supply, both the ability of a plant species to utilize remaining water under drought and to immediately capitalize on soil rewetting from subsequent rainfall events will be crucial for its survival and competitiveness. High uncertainty still exists regarding the ecohydrological belowground interactions at the soil–root interface on short to seasonal time scales.

To overcome previous limitations, we carried out high-resolution *in situ* observations of $\delta^{18}O$ in soil and xylem water to track the water uptake of beech trees based on the approaches of Volkmann et al. (2016a & b) in the hot dry summer 2018. We set up a laser isotope system to continuously probe the $\delta^{18}O$ signature in the water vapor in equilibrium with the soil water at different soil depths and with the xylem of beech trees in a forest in Switzerland and applied a Bayesian isotope mixing model (BIMM) to resolve the origin of the water taken up. Moreover, we installed xylem flow sensors, dendrometers and soil moisture sensors in the trees.

Mid of June the drought period started with extended phases of high temperature and only infrequent precipitation. At the same time, soil water content sharply decreased, especially in the upper soil layers and transpiration as well as radial growth started to decline, and this pattern became more pronounced until the end of August. In the soil water, strong ^{18}O enrichment in the upper 5 cm and slighter enrichment in 15 cm developed during this period. The BIMM results indicated that tree xylem water was made up by > 80% of shallow soil water (0-15 cm) at the onset of the drought and that this contribution continuously dropped to < 20% by the end of August, when deeper soil water and groundwater became more important. End of August, intensive rainfall events along with decreasing temperatures terminated the drought period when shallow soil water pools became partially replenished, and transpiration increased again. Within days, the contribution of shallow soil water to tree xylem water increased and reached a share of > 70% a

couple of weeks after the end of the drought. With the *in situ* method applied here, real-time information of the plasticity of soil water use becomes available and we can l trace the effect of drought and drought release on root activity of trees in different soil depths.

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