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Manipulation experiments to infer the age and tracer composition of hydrologic fluxes

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Several ecohydrological problems such as when and where precipitation becomes the source of plant uptake are usually tackled through stable isotope measurements. Our ability to go after these questions is often limited by field conditions that cannot be controlled, but targeted manipulation experiments can go beyond some of these limitations by imposing known boundary conditions and allowing the experimental closure of the isotope balance. This contribution presents examples from existing experiments that aim to understand which water, in terms of age and tracer composition, is uptaken by vegetation or drained to deeper soil horizons. In particular, we illustrate the Spike II experiment, which was carried out on a large vegetated lysimeter within the EPFL campus (CH) in 2018. This experiment featured the application of 40 mm of isotopically-enriched water on top of the lysimeter and its tracking for 40 days through the soil water, the lysimeter bottom drainage and the plant xylem. A total of more than 900 water samples were collected to reconstruct the “story” of the labeled precipitation. The detailed results from such controlled experiments represent a fundamental “ground truth” for our understanding of root water uptake patterns in large and diverse landscapes.