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Comparison between destructive and *in situ* monitoring methods of determination of soil pore water isotopic compositions for addressing ecohydrological questions

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Analysis of stable isotopes of water (^{2}H and ^{18}O) has shown to be useful for tracing processes at the soil-plant-atmosphere interface. Since the development of laser based spectroscopy the spatial and temporal resolutions and representativeness of isotopic measurements have significantly improved. But sample collection still remains challenging. As yet, plant and soil material is most commonly sampled destructively and water is extracted cryogenically under vacuum. However, recent results indicate that cryogenically extracted water is influenced by soil properties and might not be representative for mixing processes in the soil at different temporal scales.

In this study, we installed a prior tested sampling technique based on polypropylene tubing that enables continuous *in situ* monitoring of the isotopic composition of soil pore water vapor in a grassland in Southern Germany. We set up rainout shelters to induce water limited conditions and applied two artificial isotopically labeled rain pulses, each followed by a period of drought. Spatial and temporal dynamics of the isotopic composition of soil pore water vapor within the soil profiles were measured *in situ* on three replicates. Additionally, isotopic composition of the transpiration of two grassland species was monitored *in situ* with leaf cuvette measurements. Our observations were cross-validated with isotopic composition of destructively sampled soil and leaf water, which was extracted via cryogenic vacuum extraction.

The comparison of the different methods illustrates the usefulness of *in situ* non-destructive sampling to investigate spatio-temporal processes at the soil-vegetation-atmosphere interface. The possibility to measure repeatedly at identical soil locations and at daily resolution with high accuracy, allowed us to discern temporal dynamics of the water isotopic composition from lateral soil heterogeneity. The isotope labeling approach facilitated spatio-temporal differentiation between different soil layers. Comparing transpiration isotopic composition revealed destructive sampling to be afflicted with high uncertainties of input-parameter estimates when deriving transpiration isotopic composition from bulk leaf water.

Our study contributes to recent developments of more accurate sampling techniques in ecohydrological research. It highlights the necessity to enhance our understanding of the relevance of hydrological processes on temporal scales and calls for wider application of coupled soil and transpiration measurements at high temporal resolution.