In-situ stable water isotope probes allow for high-frequency monitoring of soil and xylem water isotope signatures.
This helps to observe fast changes in tree species-specific water uptake patterns.

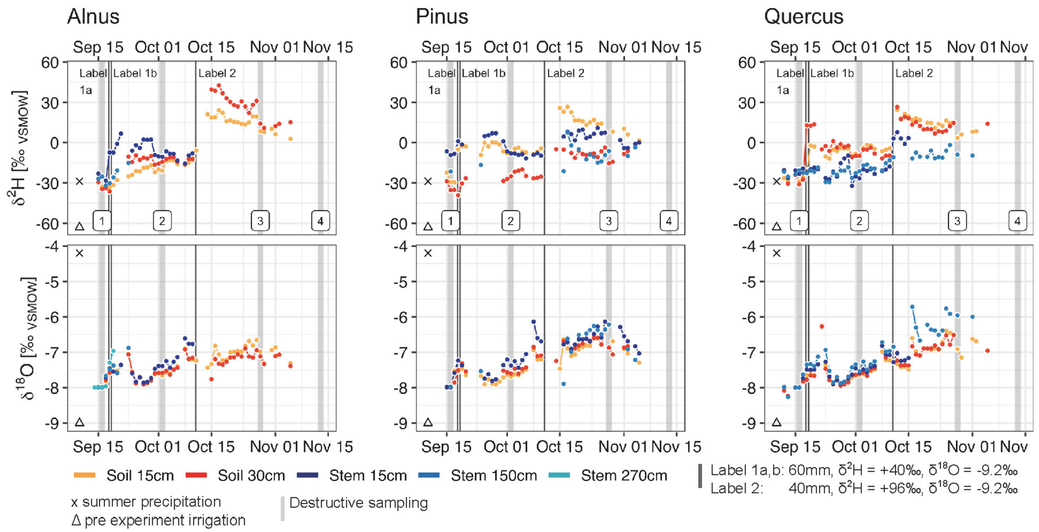

Fig. 1: Isotopic variation (δ^2H and $\delta^{18}O$) over the course of the experiment

Monitoring tree species-specific water uptake strategies via continuous in-situ stable water isotope measurements

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METHODS

- Three 20 year-old trees: pinus, alnus, quercus
- Planted into clayey silt
- Isotope labeling with deuterated water as irrigation water (three campaigns) (Fig. 1)

Equipment:

- In-situ porous-membrane isotope probes in soils and tree xylem
- Soil moisture and temperature probes
- Soil matric potential probes
- Sapflow sensors
- Portable photosynthesis system (LI-COR)
- Climate station

Comparison with destructive samples:

- 4 samplings: Soils (2 depths), tree xylem (2 heights) per pot
- Destructive extraction: cryogenic vacuum extraction and vapour equilibration (bag) method

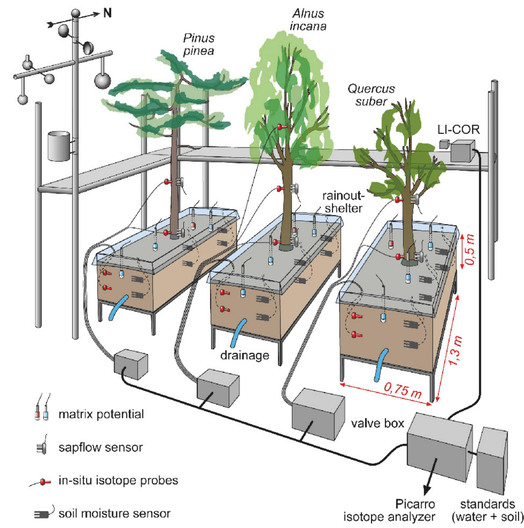

Fig. 2: Overview of experimental setup

RESULTS

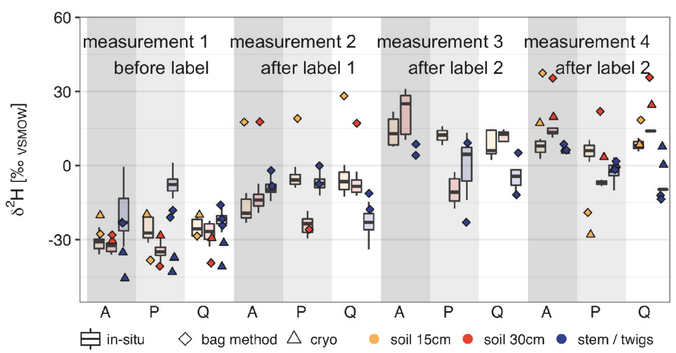

Fig. 3: Comparison of destructive (cryogenic extraction and vapour equilibration (bag) method) with continuous in-situ measurements for the three tree species (Alnus, Pinus, Quercus)

Tree-specific isotope label water uptake (Fig.1):

Alnus:

Distinct response in xylem and soil (30cm) δ^2H values after 1 day for both labelings; Soil isotopic signature more responsive in 30cm than in 15cm

Pinus:

Distinct reaction in xylem δ^2H values (15cm) after 1 day; Similar isotopic dynamics but higher δ^2H values in 15cm than in 30cm soil depth

Quercus:

Slower response in tree xylem δ^2H signatures, but quick response in the soil

In-situ vs. destructive sampling:

Destructive samples show a wider isotopic spread but were mostly consistent with in-situ measurements, especially before the labeling.

For the most part, soil δ^2H values of the destructive methods were more positive than the values obtained from the in-situ measurements.

We observed difference in the performance of the methods depending on the tree species.

CONCLUSION

- In-situ isotope measurements are a powerful tool to trace ecohydrological fluxes.
- In-situ isotope measurements compared reasonably well to isotope values obtained via destructive sampling but offer less invasive measurements in much higher temporal resolution.
- We observed very heterogeneous isotopic behavior in soils and trees under controlled conditions.
- All tree species showed quick responses to the isotopic labeling.