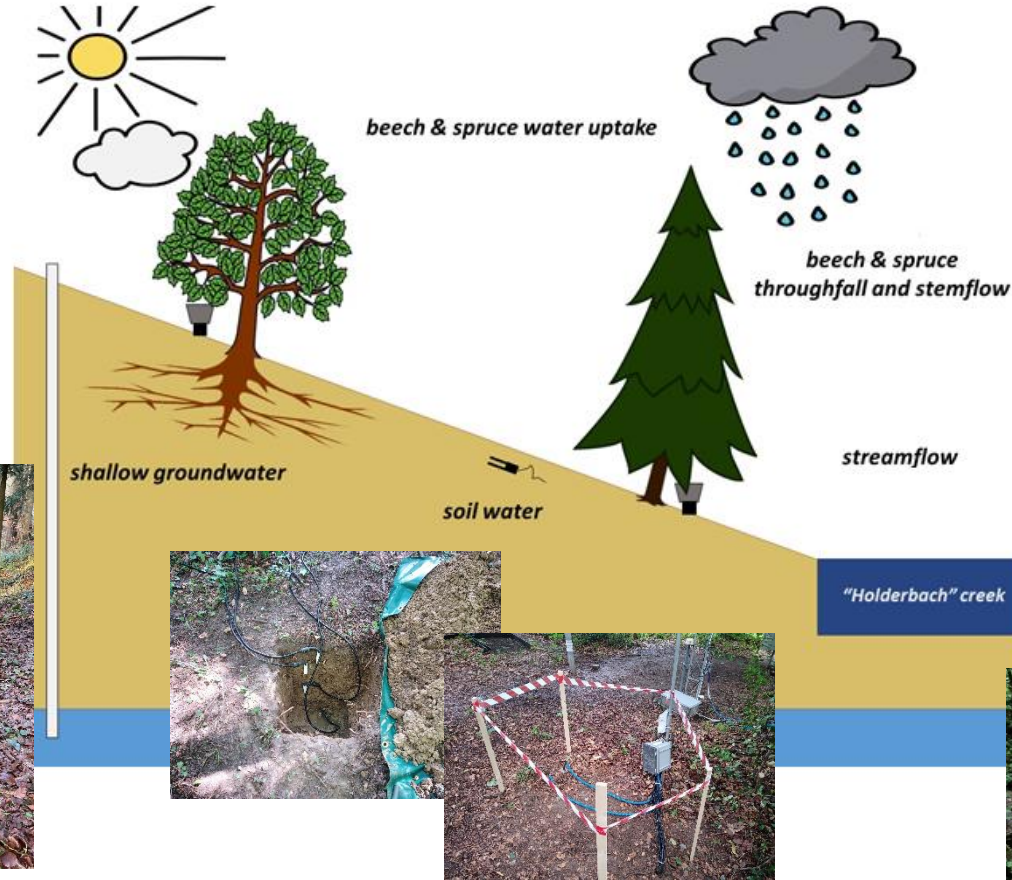
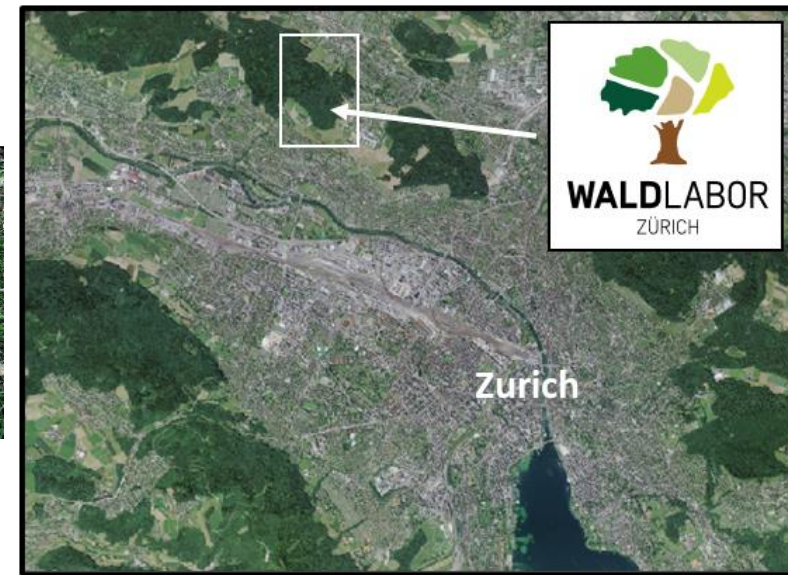




Water dynamics across the soil-plant-atmosphere continuum

Dr. Marius G. Floriancic – ETH Zürich

“WaldLab” Ecohydrology Site



- 0.3 km² catchment
- beech & spruce mixed forest
- 5 years stable water isotopes
~ 1800 water samples / year

<https://hyd.ifu.ethz.ch/ecohydlab/waldlab.html>

<https://hyd.ifu.ethz.ch/ecohydlab/waldlab.html>

TreeNet Site since 2022 – “Hoenggerberg – Waldlabor”

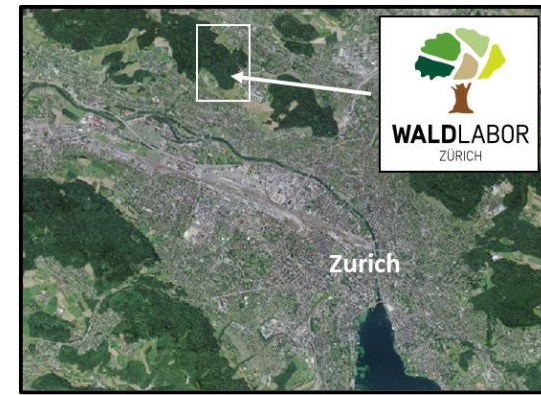
- currently 5 beech (*Fagus sylvatica*) & 5 spruce (*Picea abies* (L.) H. Karst.)

and dendrometers at beech & spruce roots (shallow & deep roots)

- to be extended in 2025 to: (sponsored by Moët Hennessy)

major oaks (*Quercus robur*, *Quercus petraea*)

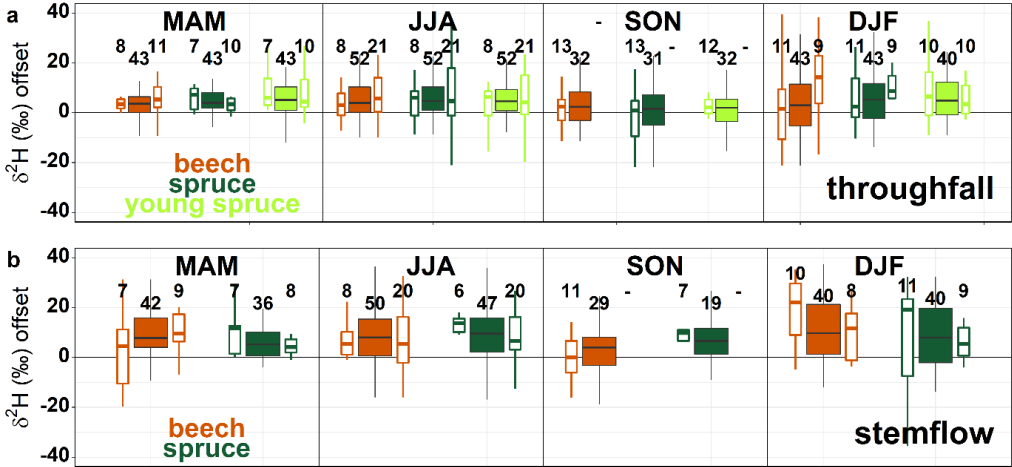
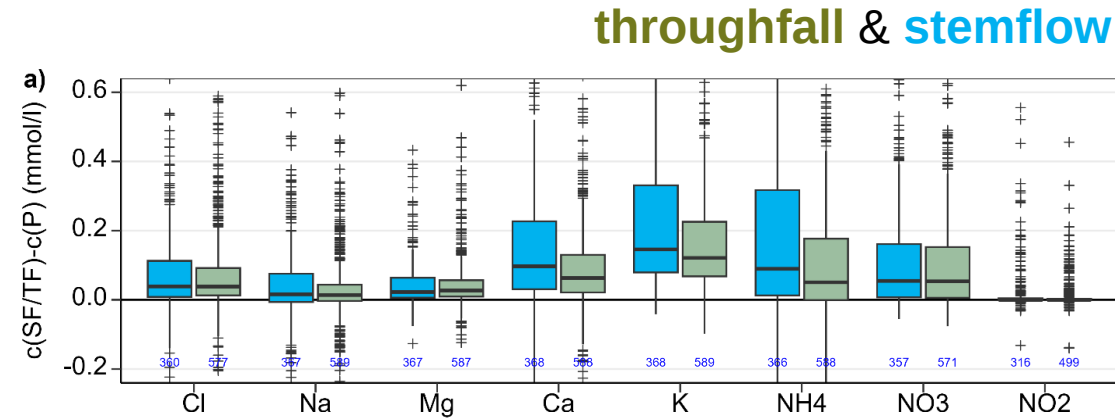
oak afforestation (*Quercus petraea*, *Quercus pubescens*, *Quercus x streimii*, *Quercus cerris*)



1) Forest trees modulate magnitude & chemistry of incoming precipitation

dry deposition, enrichment, leaching
& fog deposition

enrichment, exchange & selection



Hydrological Processes

RESEARCH ARTICLE | [Open Access](#) |

Quantification of enrichment processes in throughfall and stemflow in a mixed temperate forest

Maria H. Grundmann, Peter Molnar, Marius G. Floriancic

First published: 08 July 2024 | <https://doi.org/10.1002/hyp.15224>

Hydrological Processes

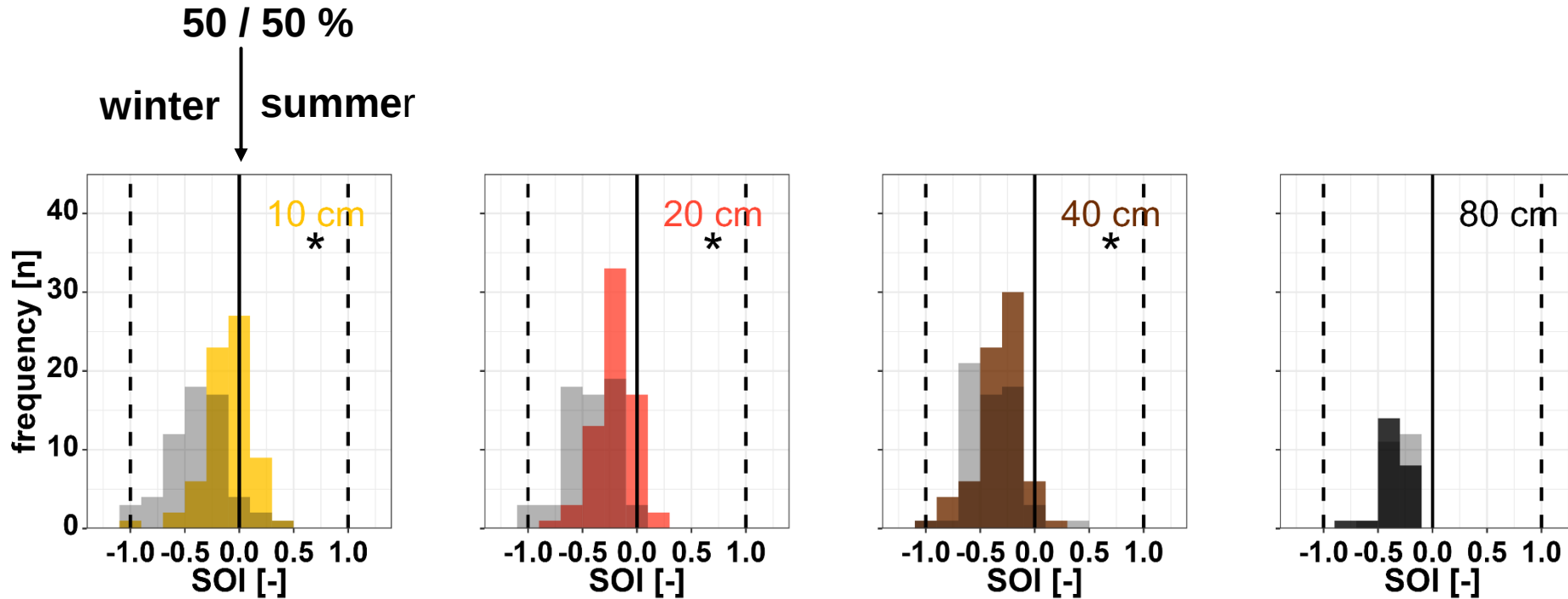
RESEARCH ARTICLE | [Open Access](#) |

Isotopic offsets in throughfall and stemflow may have small effects on estimates of winter precipitation fractions

Marius G. Floriancic, James W. Kirchner

First published: 03 March 2024 | <https://doi.org/10.1002/hyp.15095>

2) Winter precipitation dominates soil & xylem waters



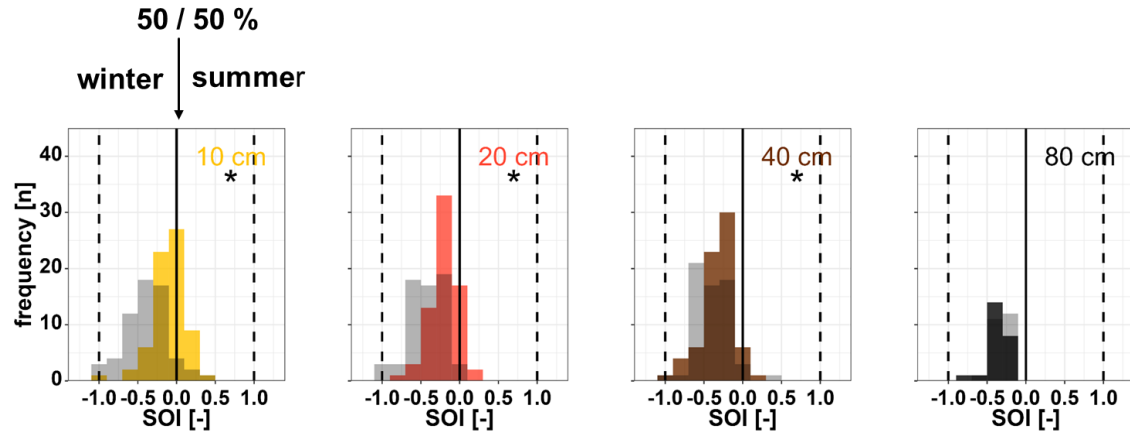
soil water in summer (May – Oct)

soil water in winter (Nov – Apr)

most soil storage refill occurs in winter

in summer → only little precipitation reaches the soil

2) Winter precipitation dominates soil & xylem waters



most soil storage refill occurs in winter

in summer → only little precipitation reaches the soil

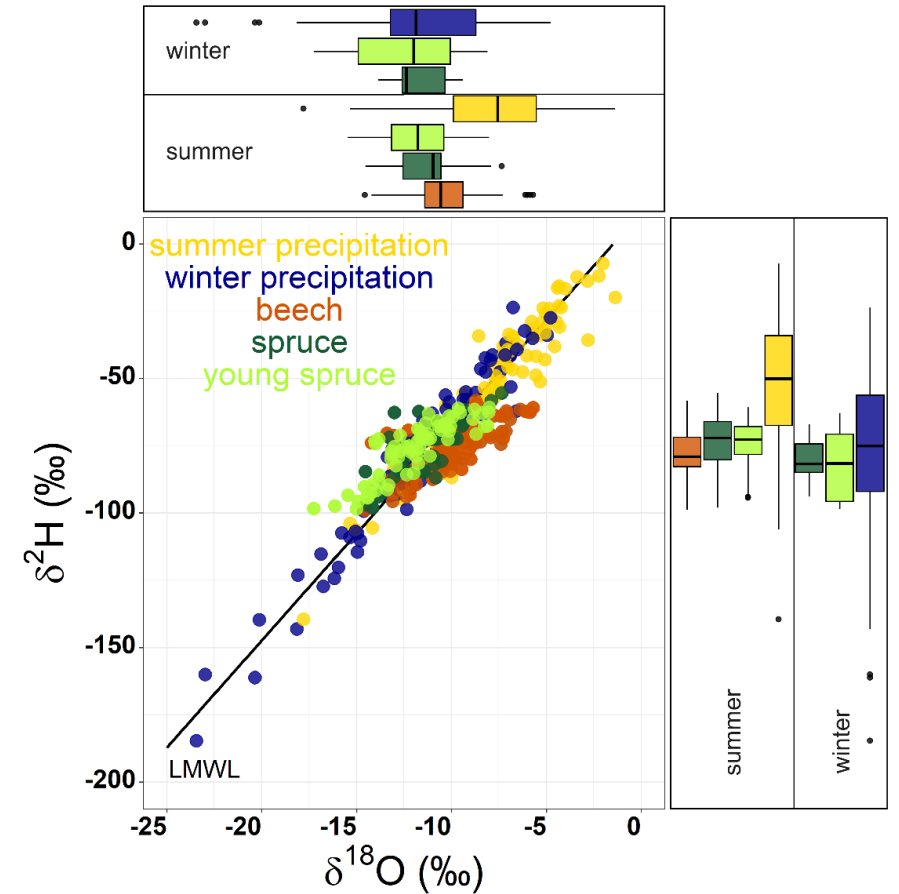


RESEARCH ARTICLE | [Open Access](#) | [CC](#) [BY](#) [NC](#) [ND](#)

Isotopic evidence for seasonal water sources in tree xylem and forest soils

Marius G. Floriancic [✉](#) Scott T. Allen, James W. Kirchner

First published: 17 April 2024 | <https://doi.org/10.1002/eco.2641> | Citations: 1



tree transpiration is dominated
by **winter precipitation**

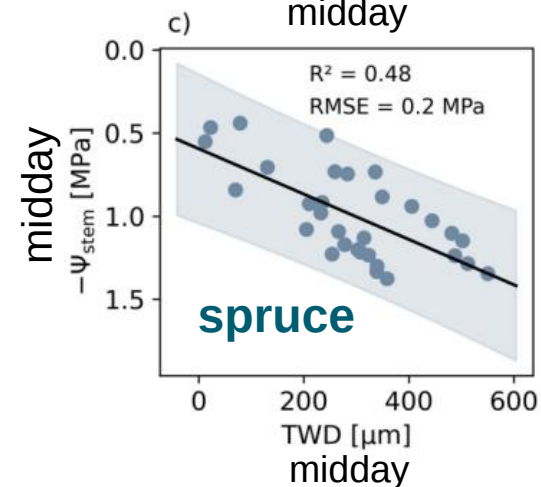
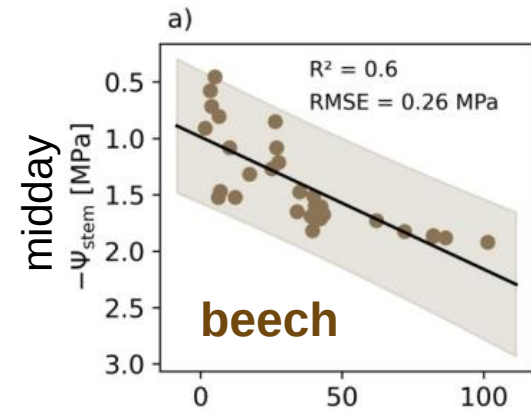
3) Plant water storage capacities in spruce & beech

“water retention curve” of plant tissue

Tree water deficit **TWD** ~ Plant water content



Plant water potential Ψ_{stem}



Martinetti et al. (in review), TP

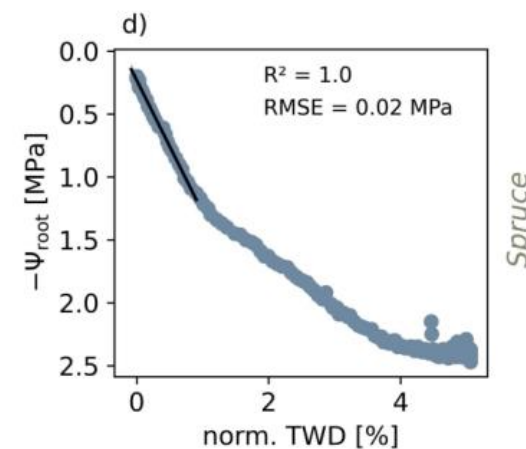
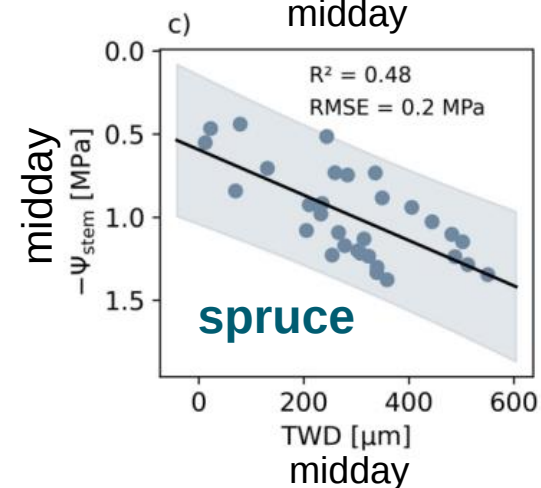
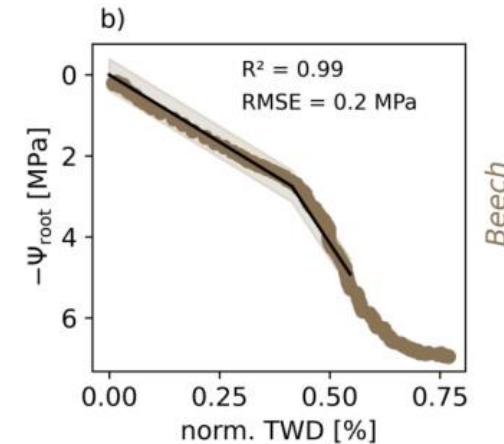
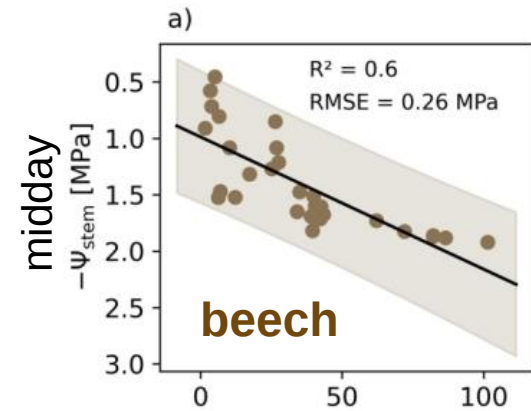
3) Plant water storage capacities in spruce & beech

“water retention curve” of plant tissue

Tree water deficit **TWD** ~ Plant water content



Plant water potential Ψ_{stem}



beech & spruce roots for laboratory experiments:

- saturated
- installed dendrometers & psychrometers
- observing root drying

Martinetti et al. (in review), TP

3) Plant water storage capacities in spruce & beech

Tree water deficit **TWD** ~ Plant water content

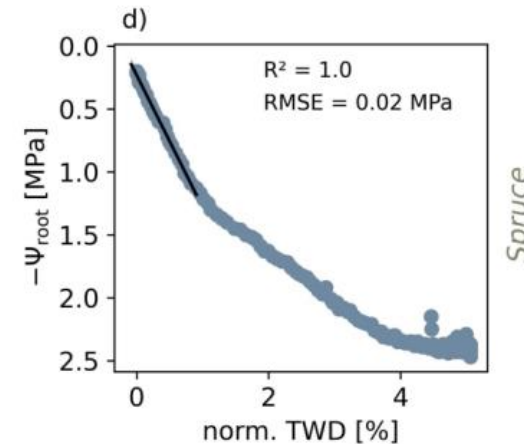
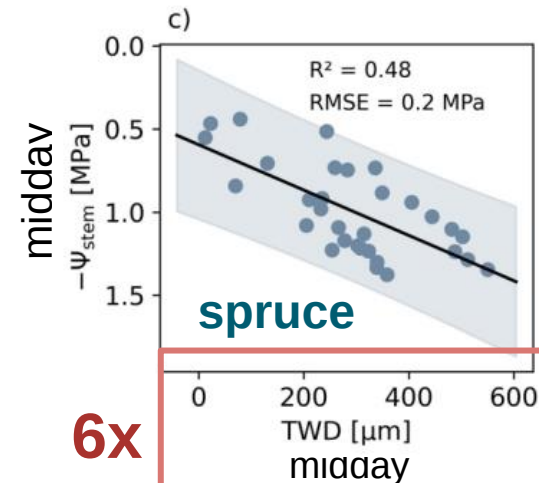
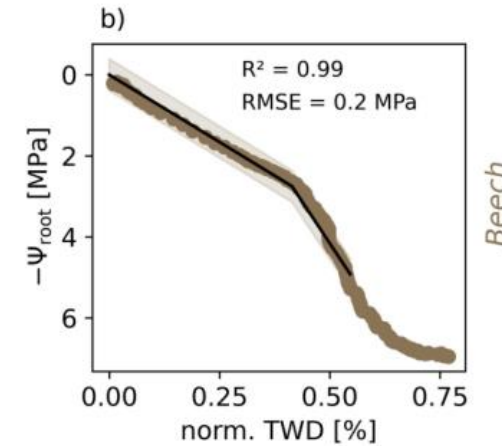
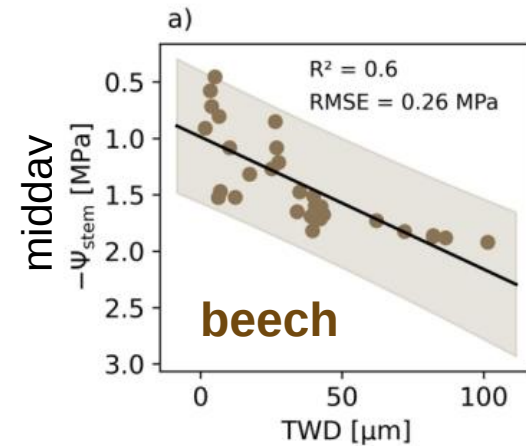


Plant water potential Ψ_{stem}



spruce has much higher water storage capacities

→ more storage in tissue, earlier stomata closing

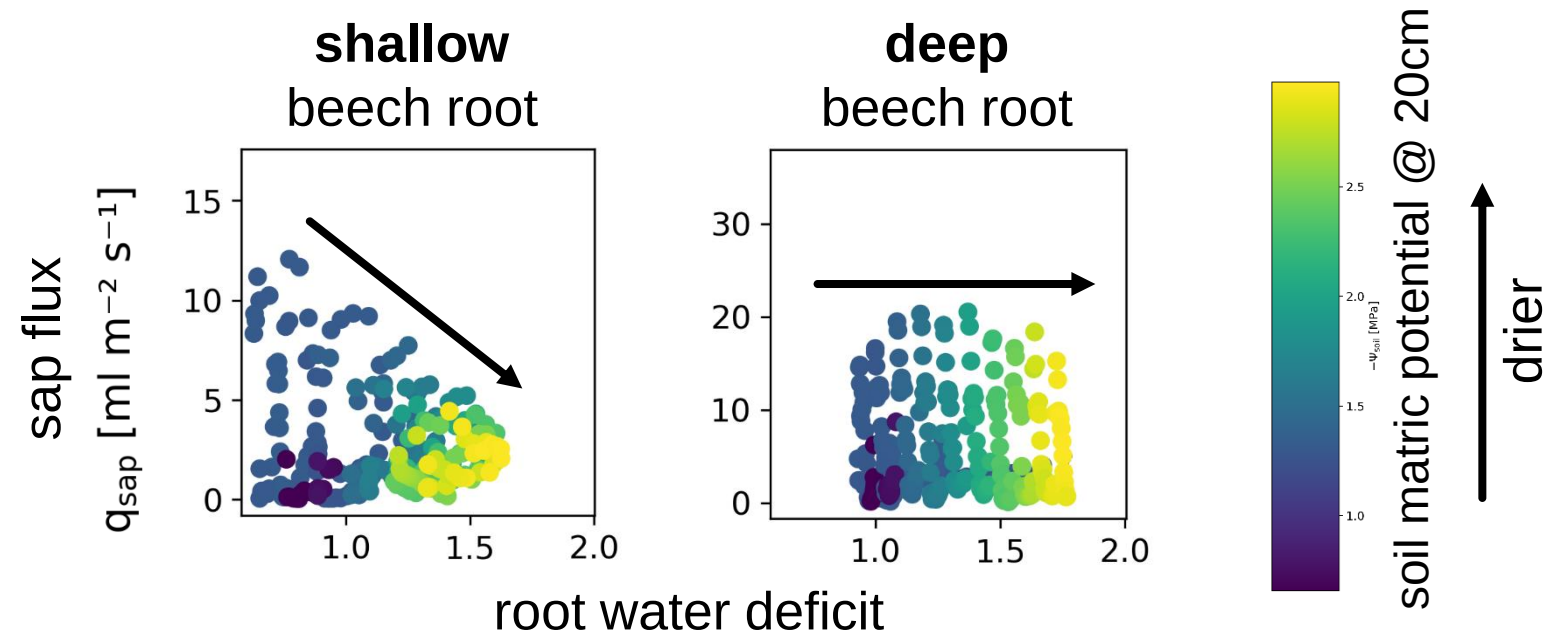


Martinetti et al. (in review), TP

Deeper roots support transpiration during dry periods



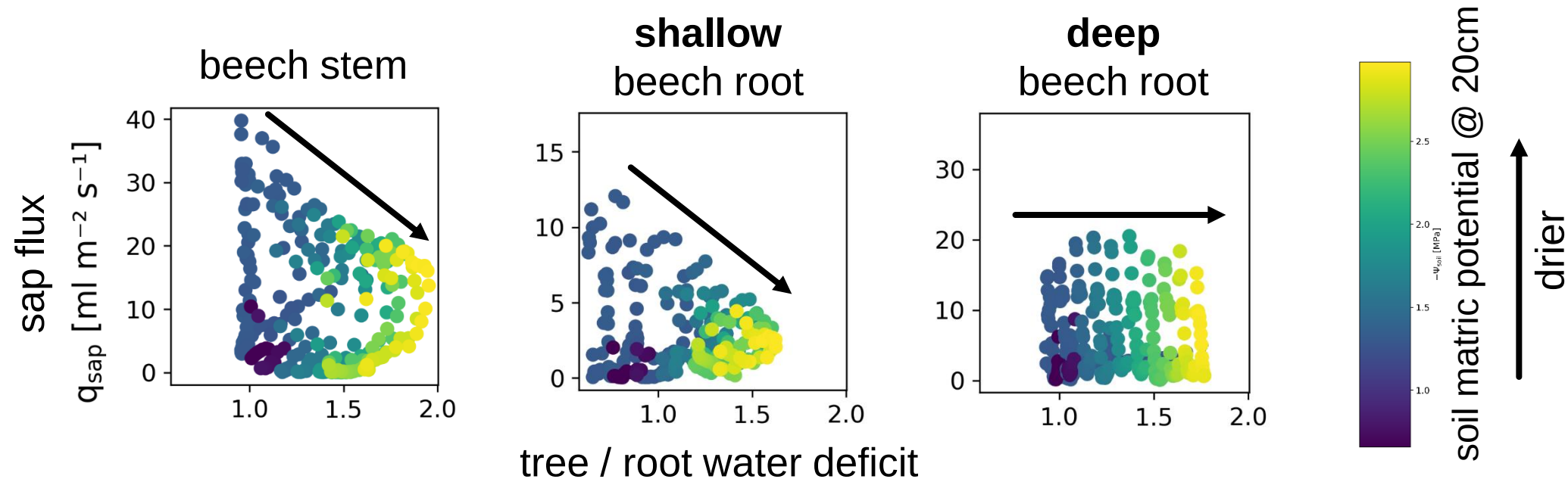
*Martinetti et al.
(in review), TP*



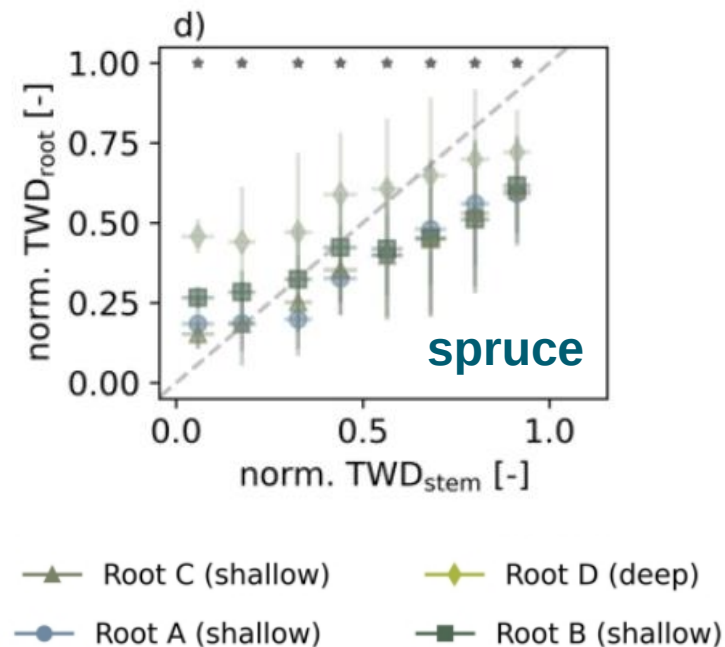
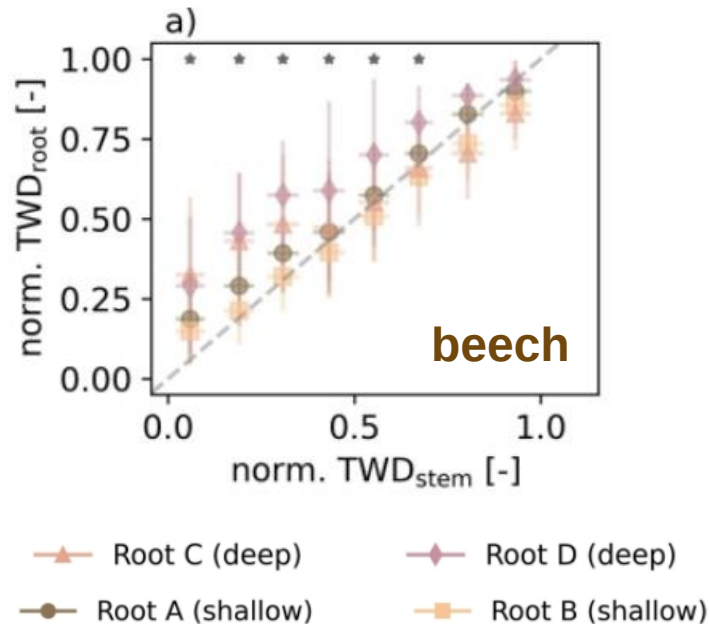
... but deeper roots only can not sustain full tree transpiration



*Martinetti et al.
(in review), TP*



Higher stem water storage in spruce compared to beech



spruce has much higher water storage capacities
→ more storage in tissue, earlier stomata closing



Martinetti et al. (in review), TP

Conclusions & Outlook

- Stable water **isotopes** reveal **which waters** move through **soils & tree xylem**
i.e., seasonality, water uptake depths, age of soil water & transpiration
- **Water flux data** reveal the **response** of trees to **water limitations** along the plant
i.e., TWD in different parts of the tree, internal storage, hydraulic bottlenecks
- **Combine** information on **tree response** and **water age** in the soil-plant-atmosphere continuum



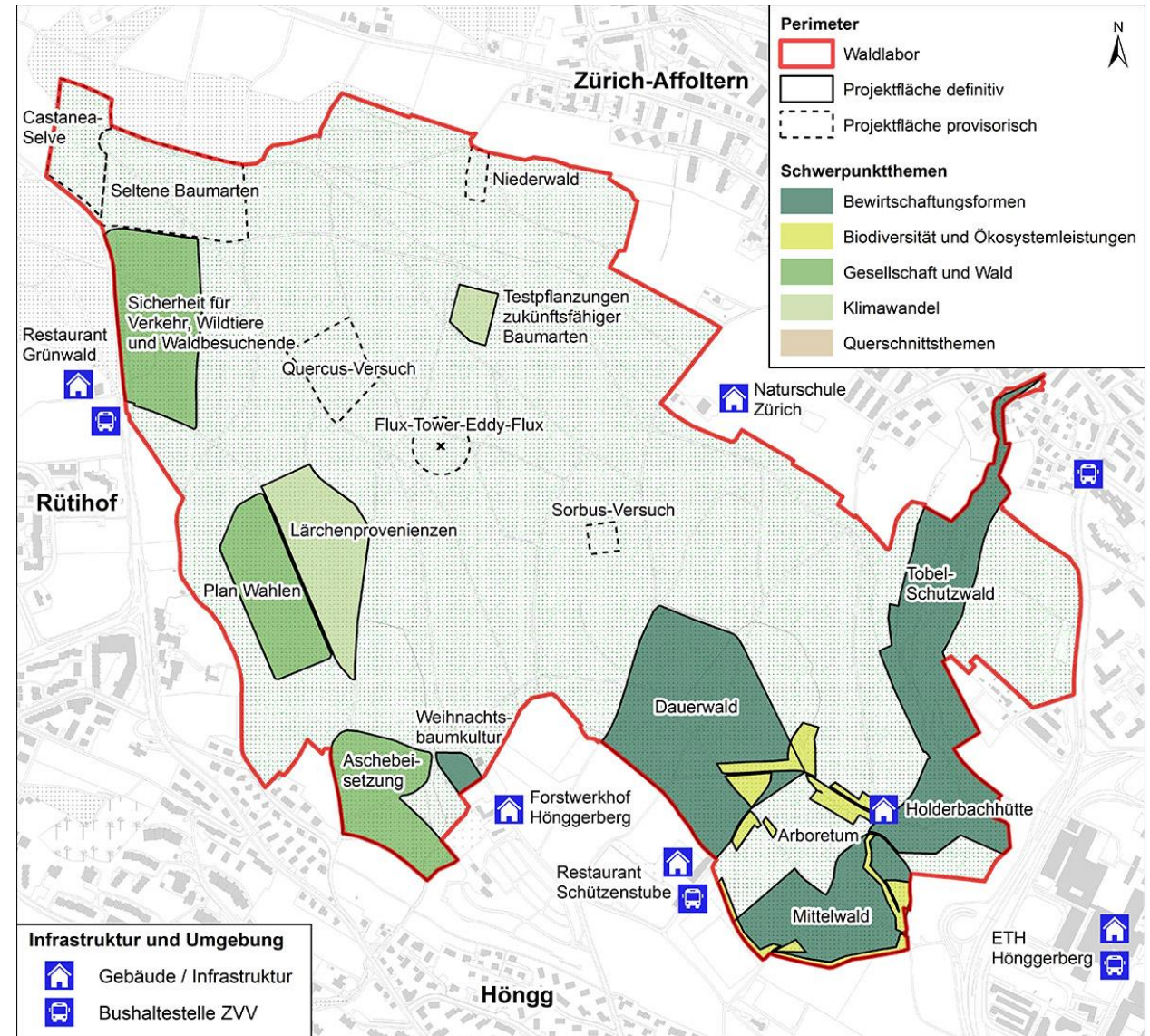
Outlook – Waldlabor Zürich

<https://www.waldlabor.ch/>

Currently developing a detailed observation concept

If you are interested, have ideas or plans please reach out!

florancic@ifu.baug.ethz.ch



Recent “WaldLab” Publications:

Floriancic MG, Allen S and Kirchner JW; (2024) [Young and new water fractions in soil and hillslope waters](https://doi.org/10.5194/hess-28-4295-2024). Hydrology & Earth System Sciences; <https://doi.org/10.5194/hess-28-4295-2024>

Grundmann MH, Molnar P and **Floriancic MG**; (2024) [Quantification of enrichment processes in throughfall and stemflow in a mixed temperate forest](https://doi.org/10.1002/hyp.15224). Hydrological Processes; <https://doi.org/10.1002/hyp.15224>

Floriancic MG, Allen S and Kirchner JW; (2024) [Isotopic evidence for seasonal water sources in tree xylem and forest soils](https://doi.org/10.1002/eco.2641). Ecohydrology; <https://doi.org/10.1002/eco.2641>

Floriancic MG and Kirchner JW; (2024) [Isotopic offsets in throughfall and stemflow may have small effects on estimates of winter precipitation fractions](https://doi.org/10.1002/hyp.15095). Hydrological Processes; <https://doi.org/10.1002/hyp.15095>

Bernhard F, **Floriancic MG**, Treydte K, Gessler A, Kirchner JW and Meusburger K; (2024) [Tree- and stand-scale variability of xylem water stable isotope signatures in mature beech, oak and spruce](https://doi.org/10.1002/eco.2614). Ecohydrology; <https://doi.org/10.1002/eco.2614>

Floriancic MG, Allen S, Meier R, Truniger L, Kirchner JW and Molnar P; (2022) [Potential for significant precipitation cycling by forest-floor litter and deadwood](https://doi.org/10.1002/eco.2493). Ecohydrology; <https://doi.org/10.1002/eco.2493>



***Thank you
for your attention!***

