

# InSitu isotope measurements of water and isotope fractionation in trees

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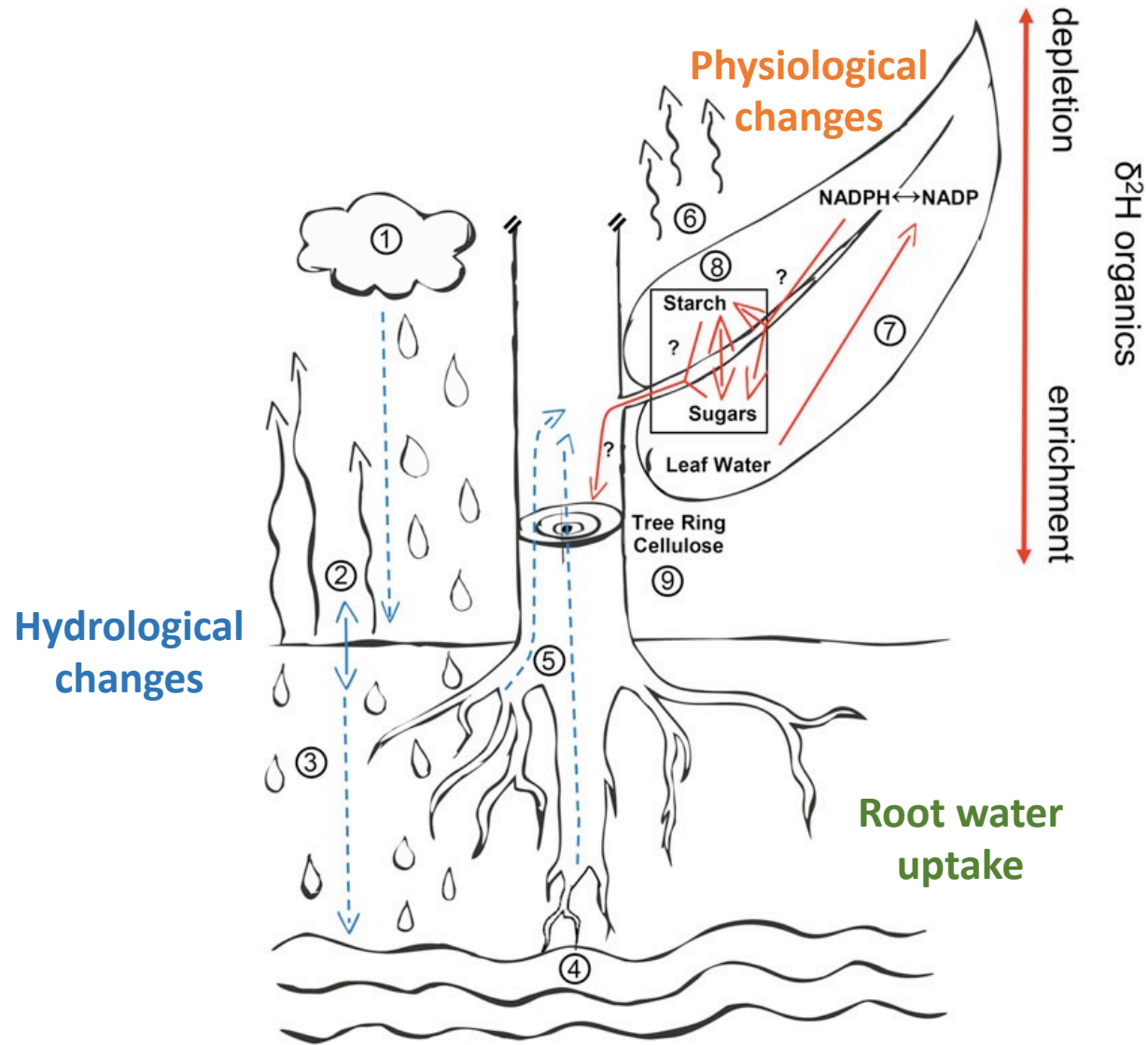
Funding

 **cost**  
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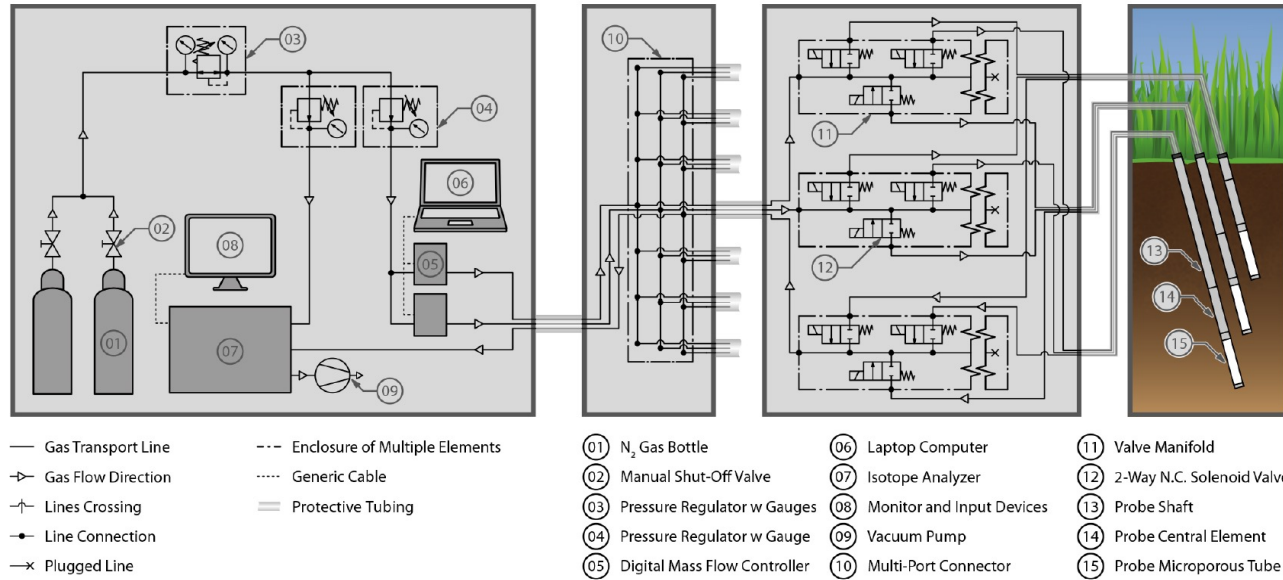
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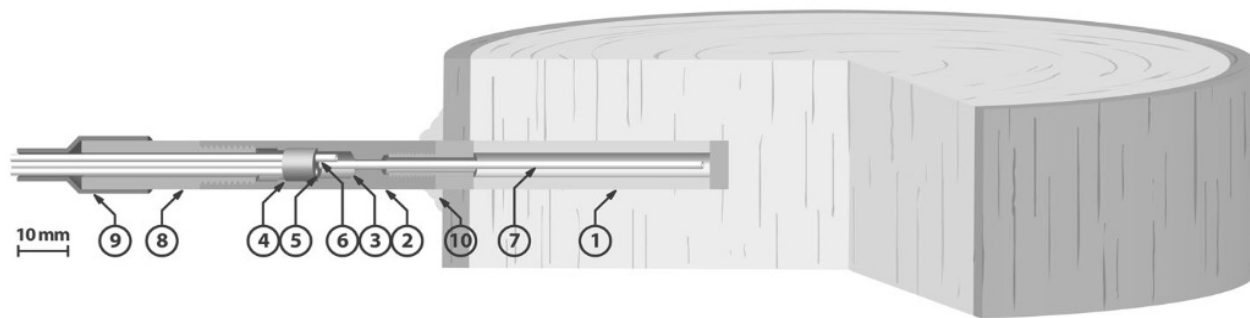
# Stable isotope as a proxy for understanding environmental changes



# InSitu isotope measurements of water or get to know where the water comes from – live!



An online probing and analyzing system for water isotopologues in the soil and the xylem



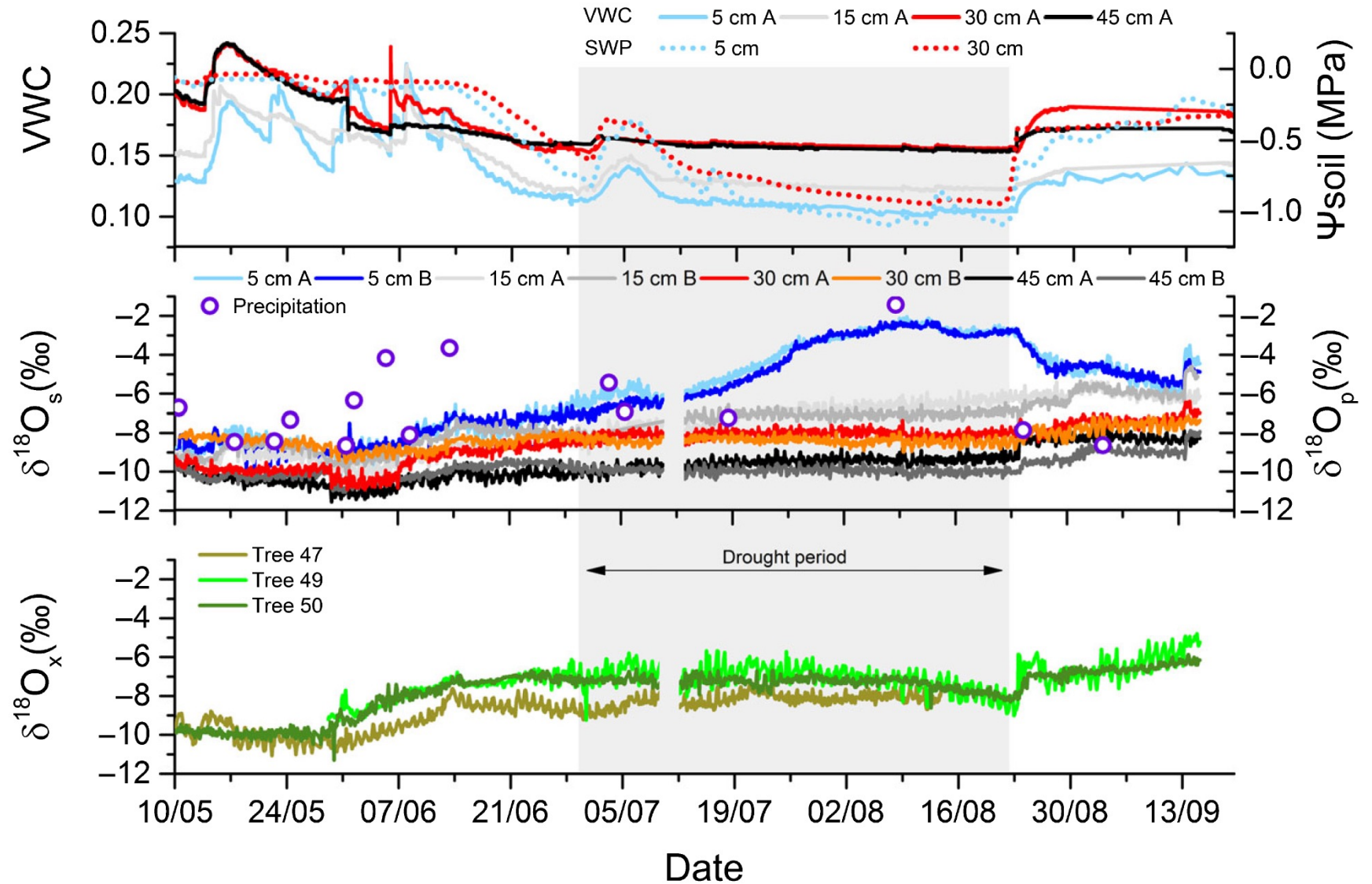
# InSitu isotope measurements of water or get to know where the water comes from – live!



European beech



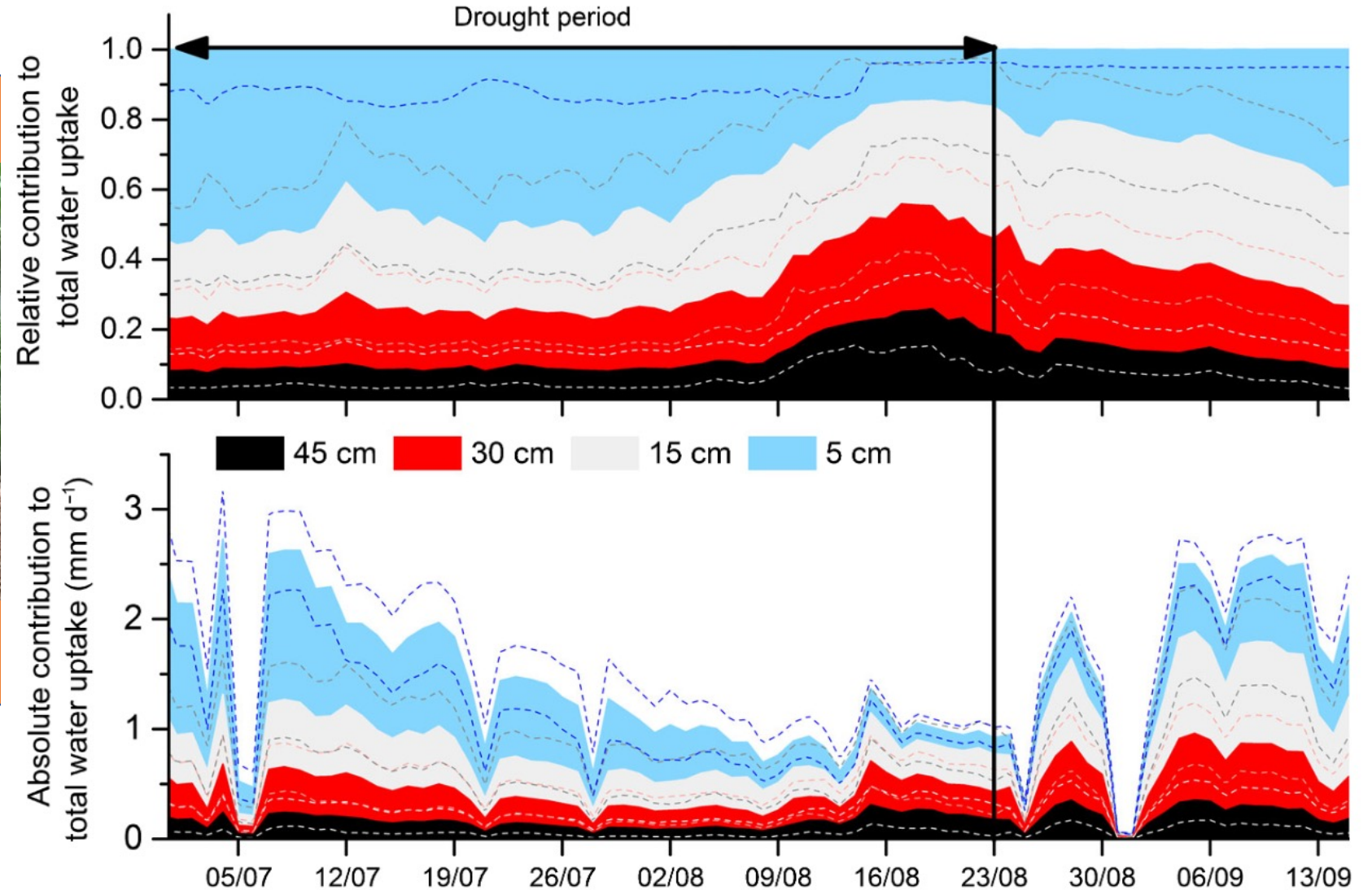
Gessler *et al.* 2022



# InSitu isotope measurements of water or get to know where the water comes from – live!



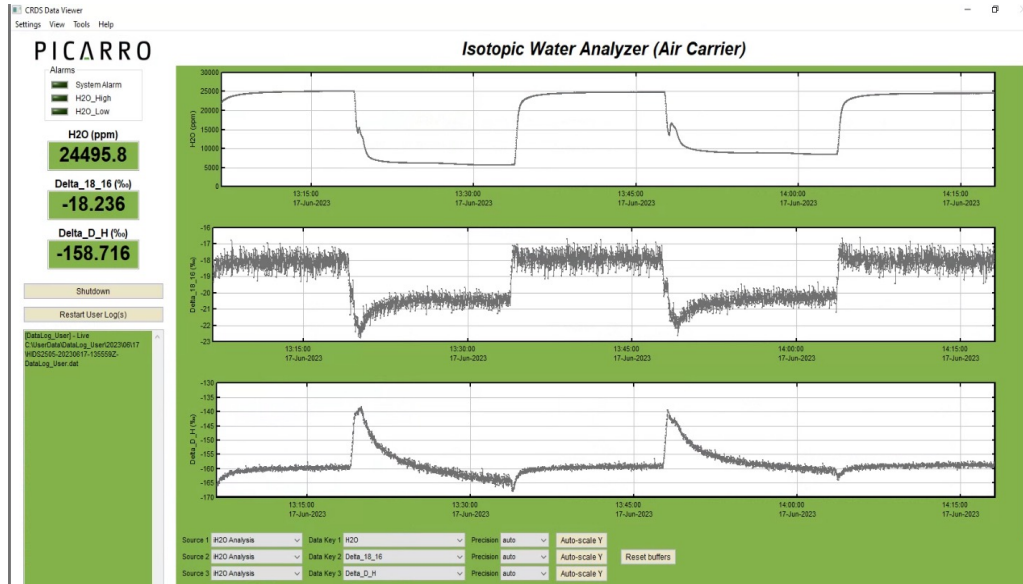
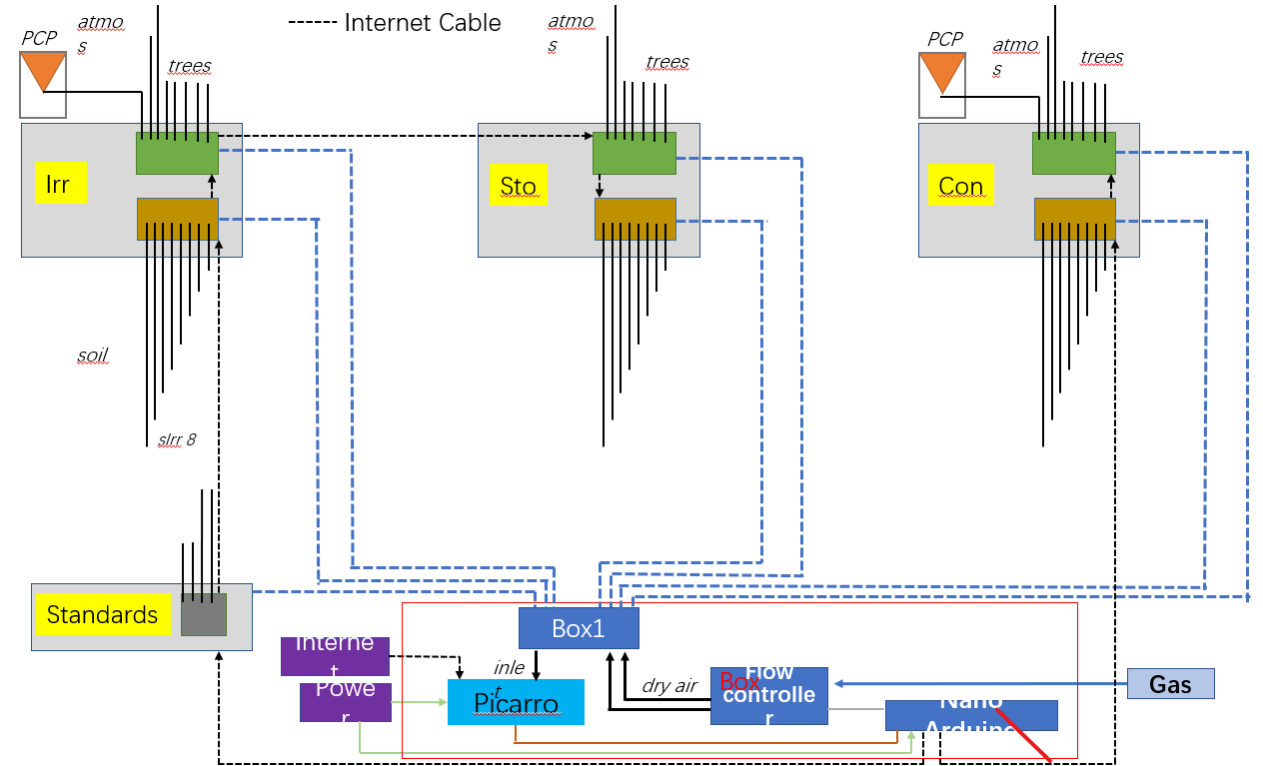
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# InSitu isotope measurements of water Pfynwald



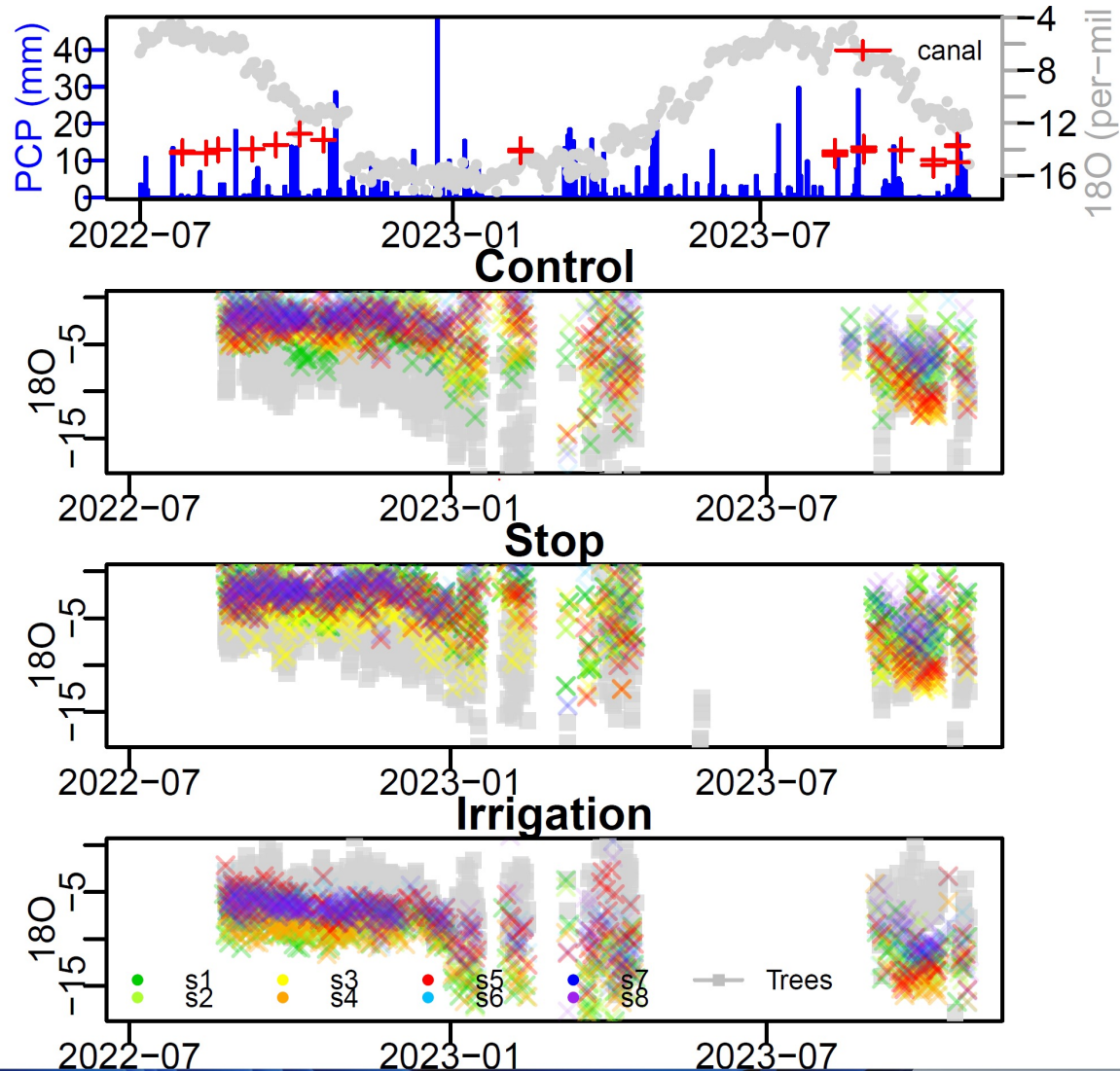
# InSitu isotope measurements of water Pfynwald - Set-up



**Treatments:** control, irrigation, stop-irrigation, 4 standards  
**Each plot:** 5 trees, 8 soil depth (max. 2 m), and atmosphere  
**Traits:** Soil water content and matrix potential, soil and stem temperature,.....and more  
**Years:** 2022, 2023

# InSitu isotope measurements of water

## Pfynwald – Soil water isotopes

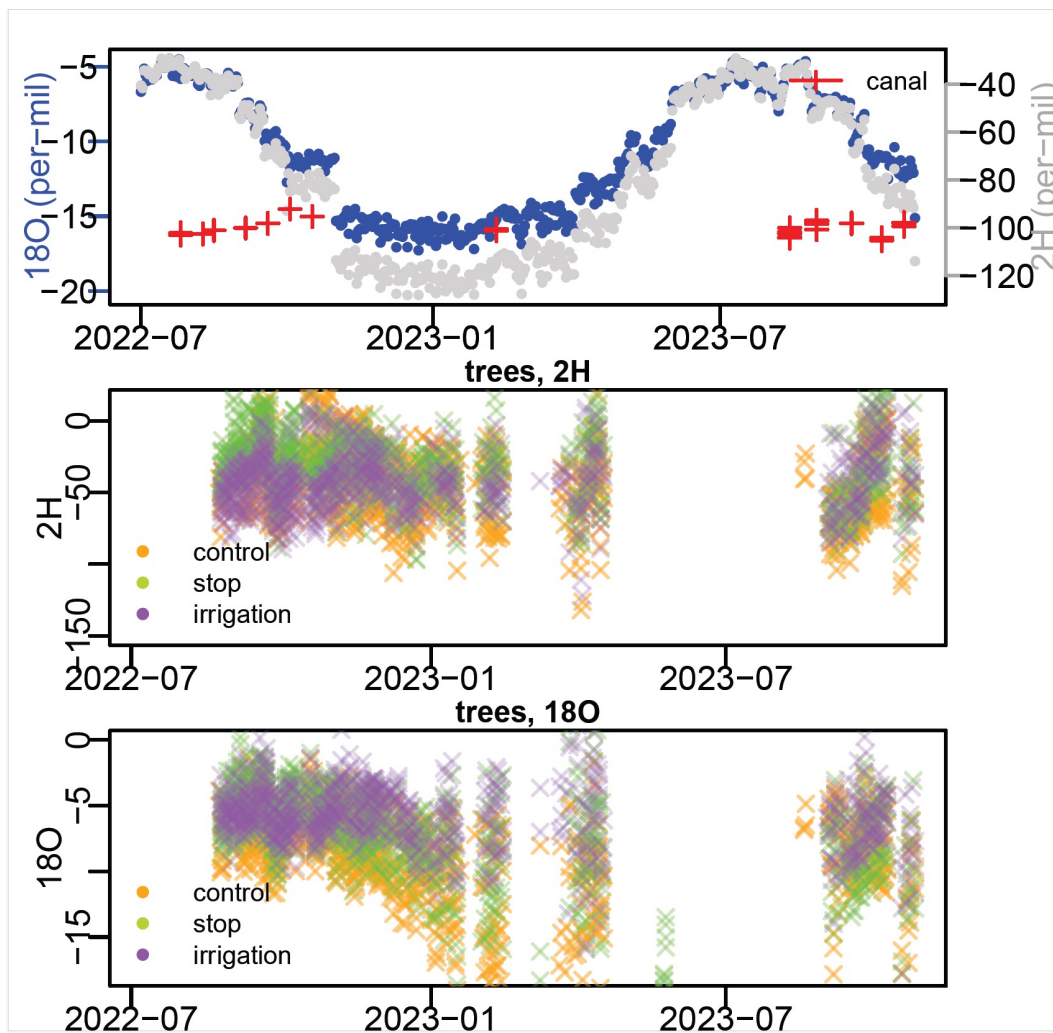


### Preliminary data of soil water

- Irrigation water is isotopically depleted compared to summer precipitation signal
  - Irrigation effect visible in the irrigation treatment
- Control and stop-irrigation show similar isotope pattern



# InSitu isotope measurements of water Pfynwald



## Preliminary data of tree water

- Treatment differences visible
- Treatment effect slightly varies with element (O vs H)

## Next Steps

- Quality control and calibration of data
- Ecological evaluation of, e.g. root water uptake



# Comparing different Methods to analyze Tree Water uptake Dynamics

## Main research questions

- 1) How do different methods influence isotope-based reconstructions of tree water uptake
- 2) How is tree water uptake influenced by soil water availability and irrigation legacy effects



Maurus N. Villiger & Elham Freund





# Comparing different Methods to analyze Tree Water uptake Dynamics

## Methods used to extract water

- Scholander Pressure Bomb (SPB)
- Cryogenic Vacuum Distillation (CVD)
  - InSitu measurements



Scholander Pressure Bomb



Cryogenic Vacuum Distillation



# Comparing different Methods to analyze Tree Water uptake Dynamics

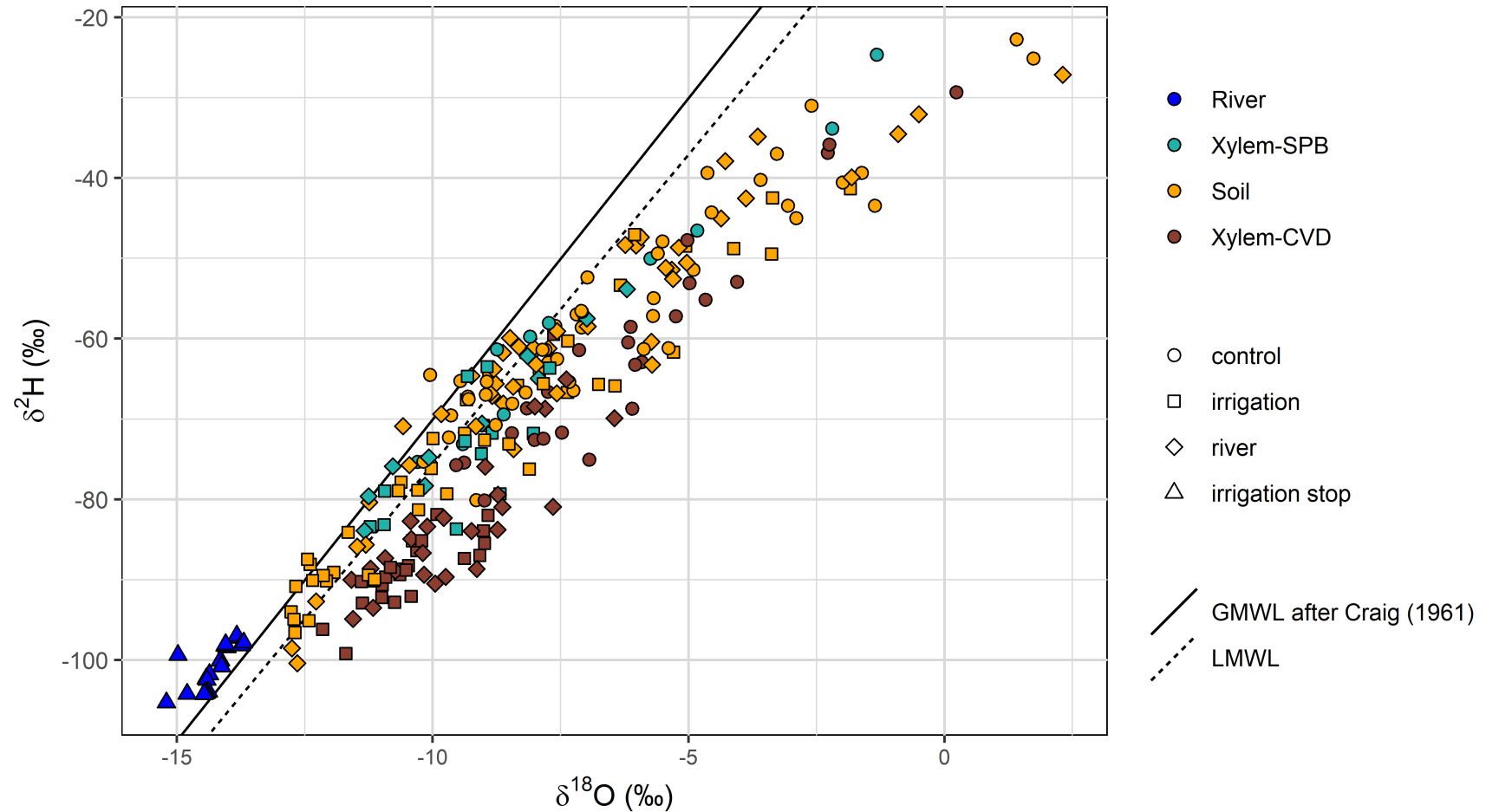
## Sampling at InSitu Plots

5 Campaigns from August to October 2023

- Twig xylem samples for each treatment and each method from 5 different trees
- Soil samples from up to 50 cm depth, 3 per plot

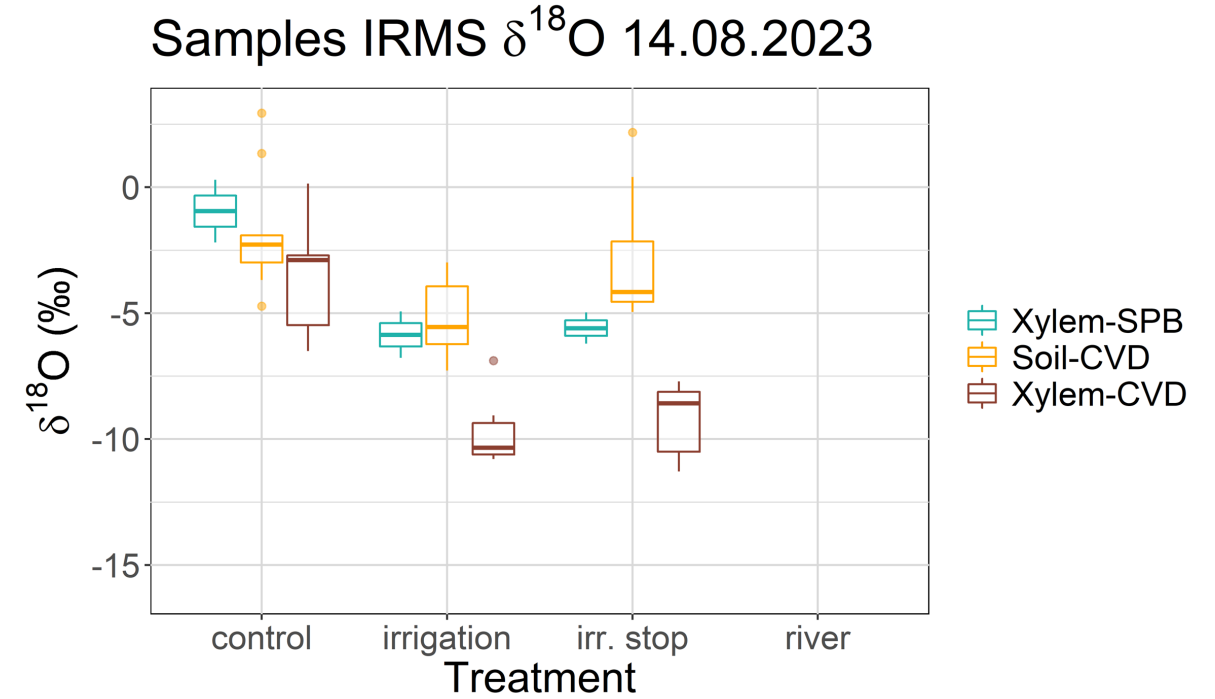
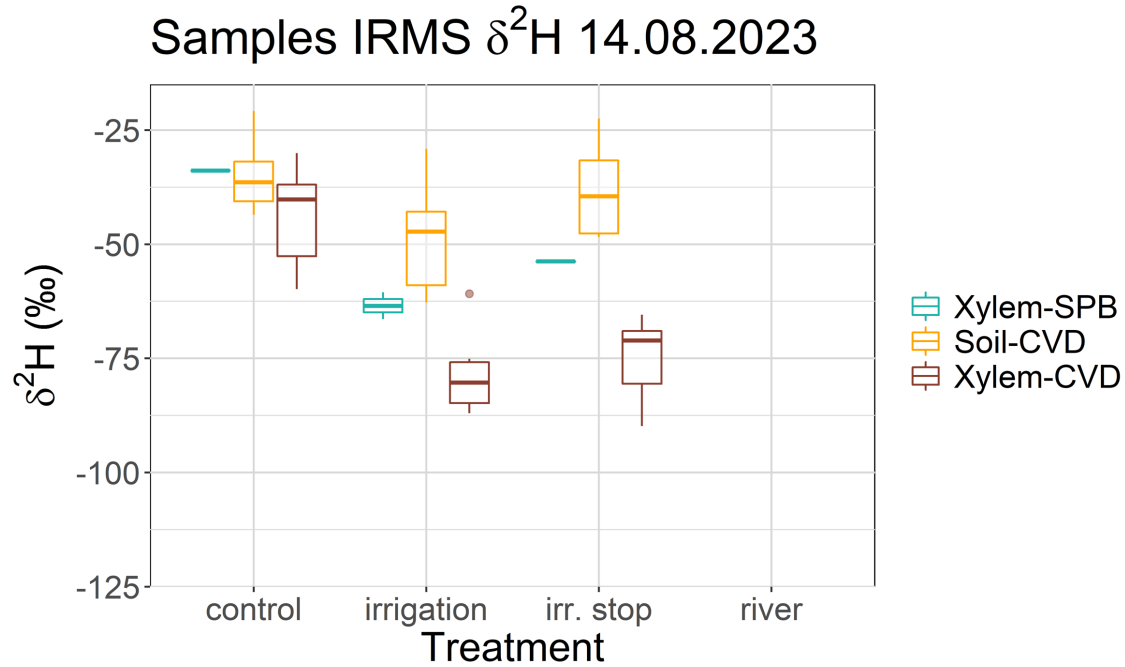


Samples  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$  vs. Global Meteoric Water Line





# Comparing different Methods to analyze Tree Water uptake Dynamics



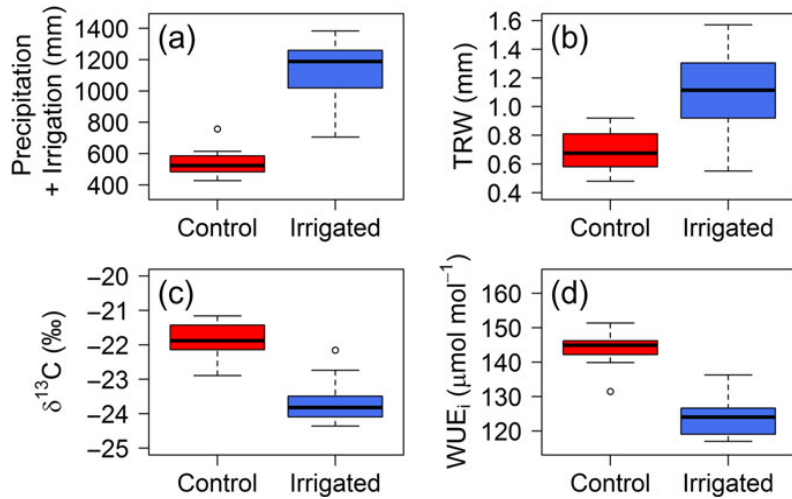
## First results

- Xylem water isotopes vary with methods (CVD vs SPB)
- Soil water availability induces changes in isotopes of soil and xylem water
- Intermediate isotope signals in stop-irrigated trees indicate an irrigation legacy effect

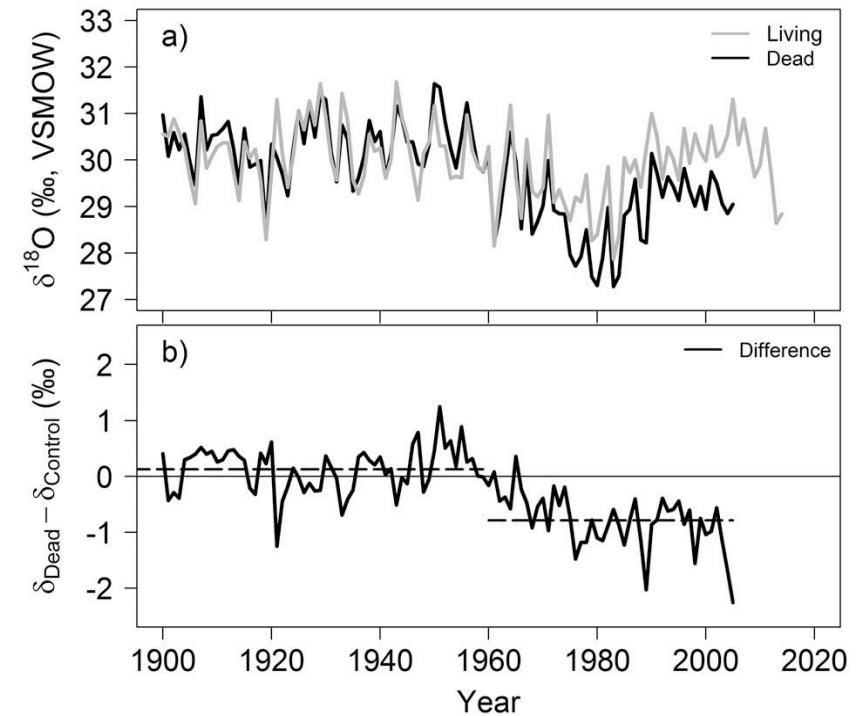
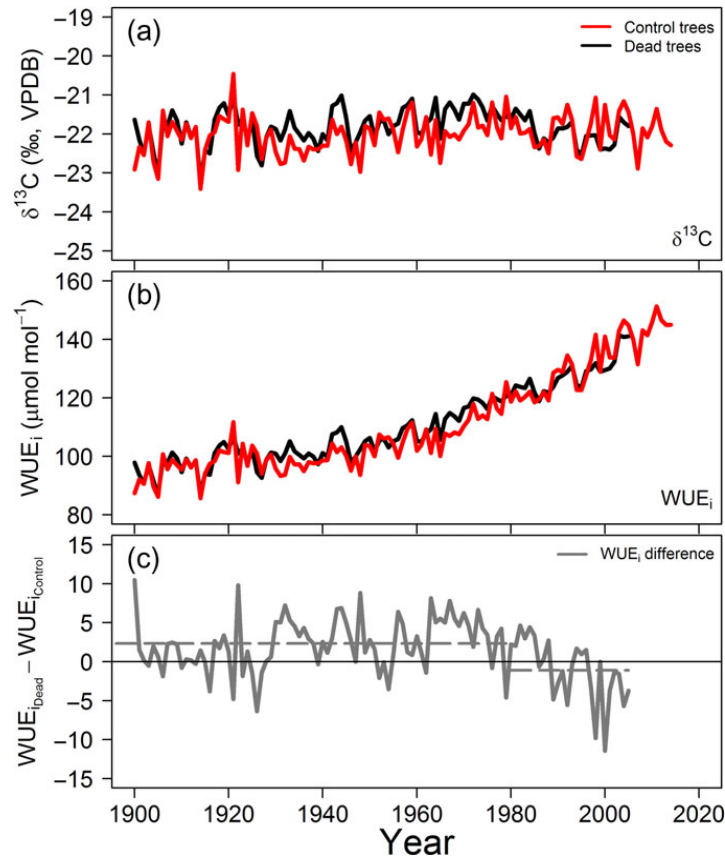
# Isotope fractionation

or the reconstruction of environmental and physiological signals

2003-2014



Studies of isotope fractionation in Pfywwald



# Hydrogen isotope values of tree lignin methoxy groups as a proxy to assess source water variations

Short-Term Scientific Mission grant provided by EU Cost-Action WATSON



**Anna Wieland**  
(University of Heidelberg)

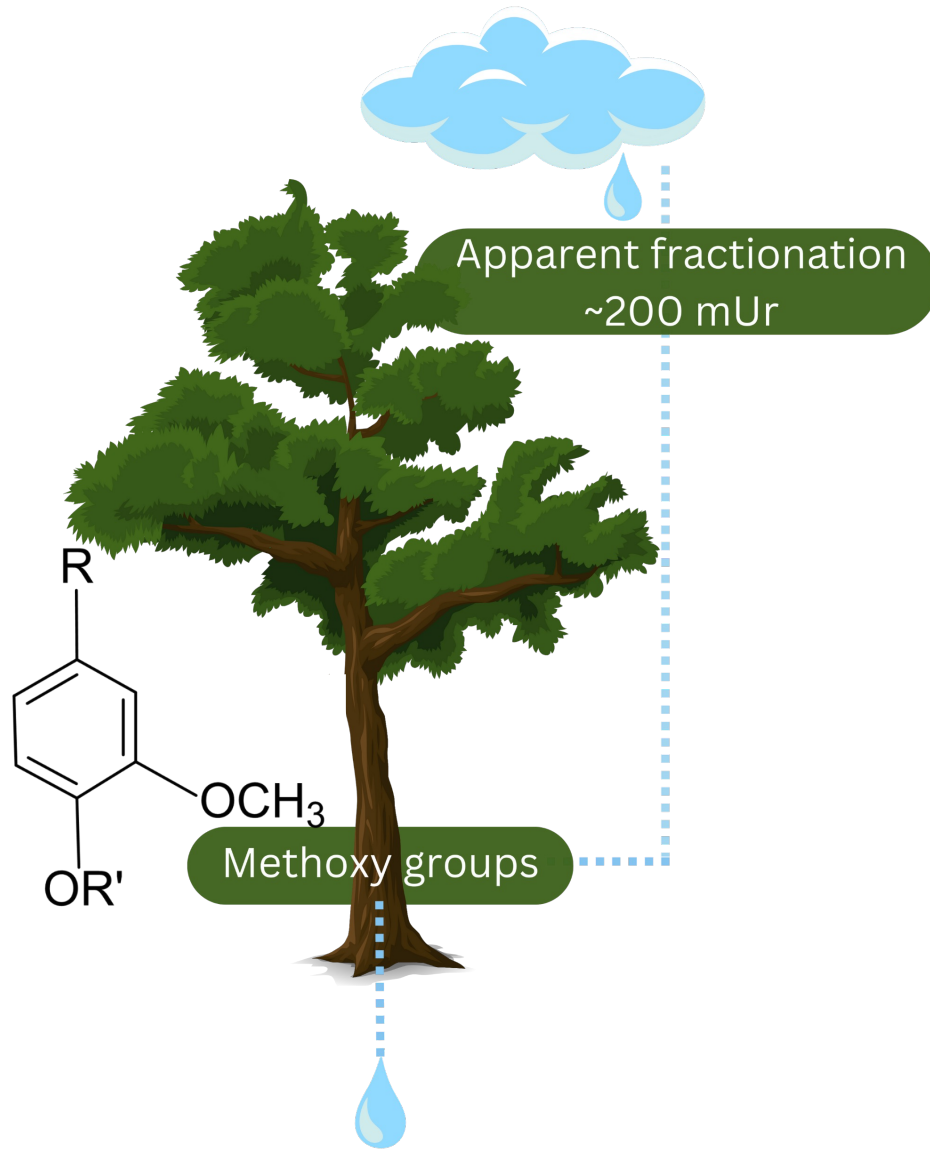
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**Marco Lehmann**



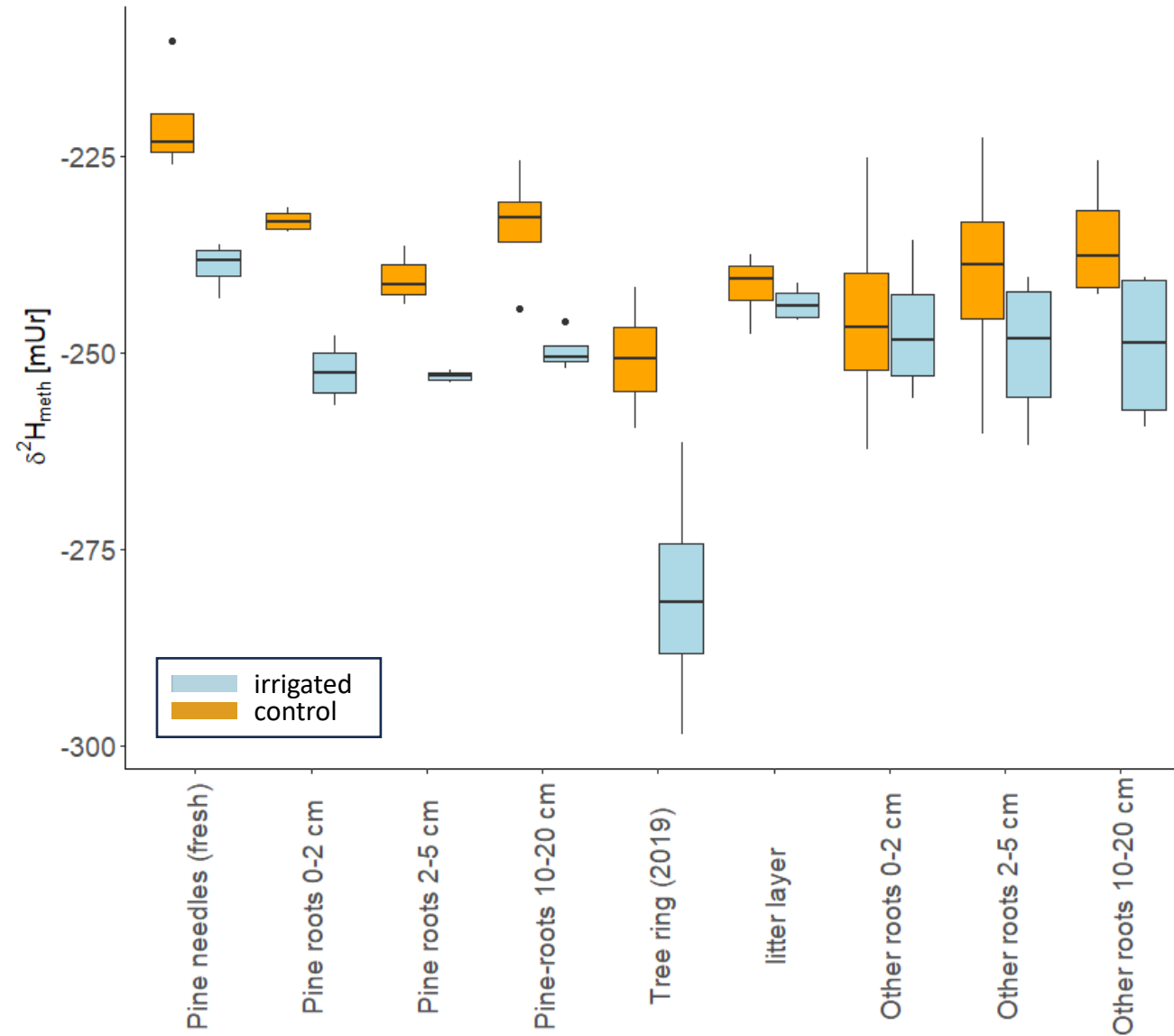
# Lignin Methoxy groups as a tree source water isotope proxy



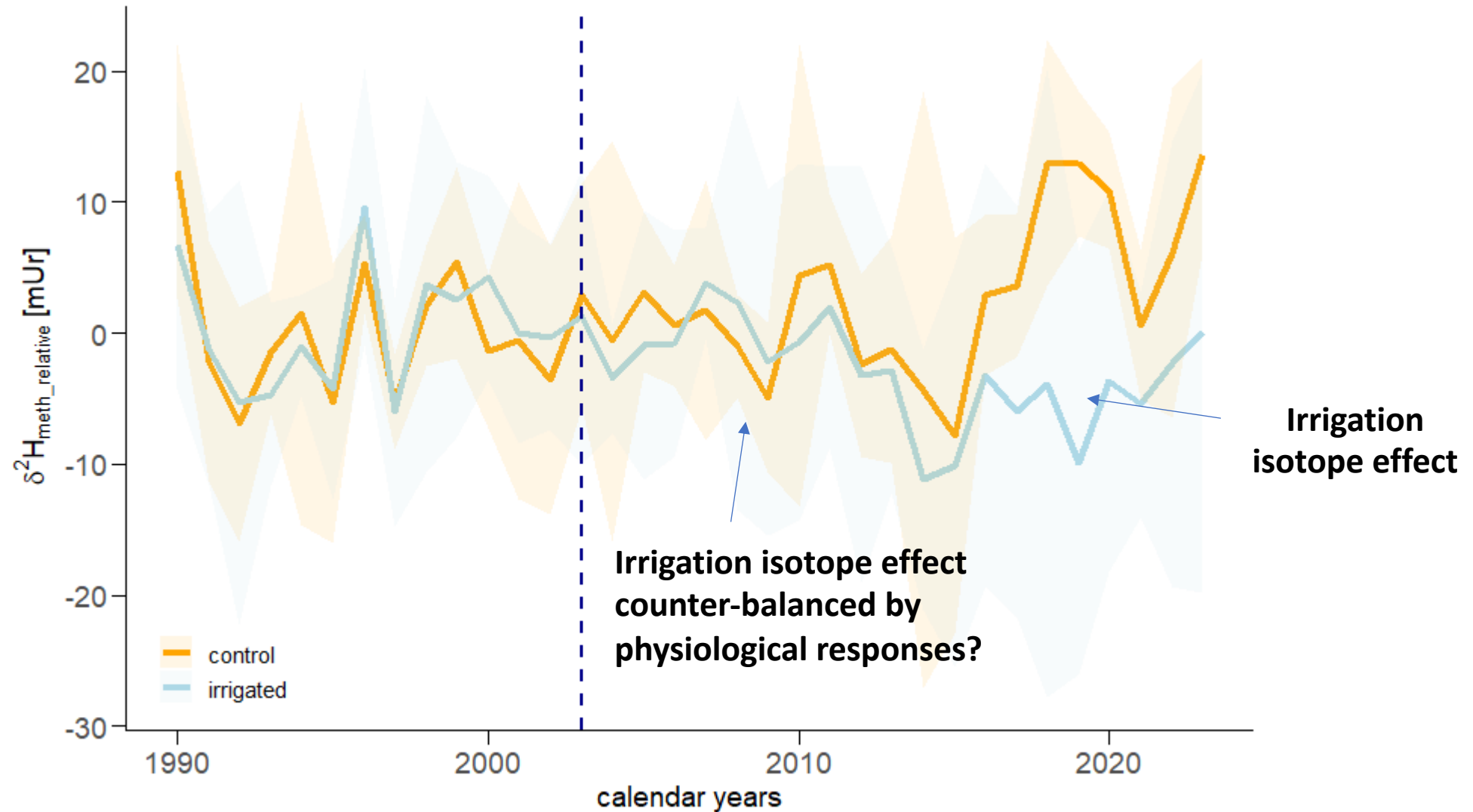
- Relative **constant isotope fractionation** between  $\delta^2\text{H}$  values of precipitation and lignin methoxy groups
- $\delta^2\text{H}$  values of lignin methoxy groups in plants may function as **proxy for source water isotopes** and thus e.g. root water uptake depth
- Pfywald **irrigation water is isotopically depleted** compared to growing season precipitation.
- Do we see the isotopic effect caused by irrigation in  $\delta^2\text{H}$  values of lignin methoxy groups of pine trees?



# Lignin Methoxy groups as a tree source water isotope proxy



# Lignin Methoxy groups as a tree source water isotope proxy



$\delta^2\text{H}_{\text{meth\_relative}}$ : standardised to 1990-2002 (pre-irrigation period)

# InSitu measurements and Isotope fractionation

## VPDdrought

- Studying **root water uptake** with new In-Situ setup?
- Studying **isotope fractionations** through measuring C, O, H isotopes in leaves (i.e. assimilates) and tree rings (i.e. cellulose, lignin methoxy groups)?
- Studying the **influence of water vapor and soil water** on O, H isotopes in plant material at natural abundances and through labelling?
- Studying **foliar nutrient uptake** through performing N isotope labelling and/or spraying nutrient solutions?
- **Regular sampling** of plant tissue for stable isotope analysis during VPDdrought?
- **Placeholder for your idea**