Dormancy-Track

Could initiation and progress of bud dormancy in temperate deciduous trees be tracked using water isotopes?

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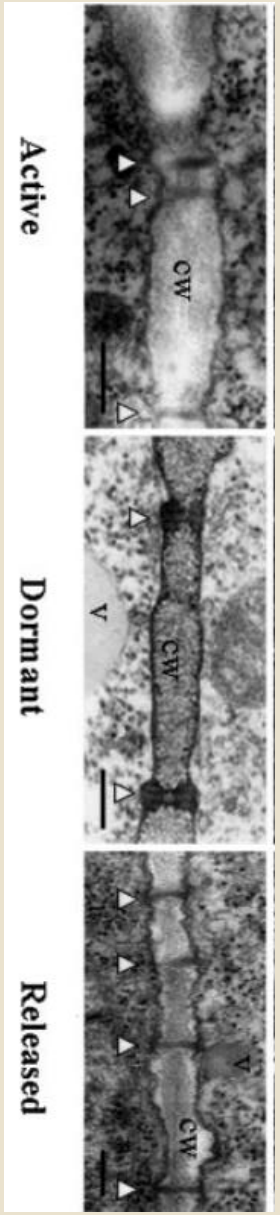
Background

- During autumn temperate deciduous trees cease growing and loose their leaves
- They enter a state of dormancy, where the hydraulic conductivity between twig and bud is restricted (Rinne, Kaikuranta et al. 2001)
- Callose and protein containing plugs (dormancy sphincter complex) contribute to this isolation (Rinne, Welling et al. 2011)
- Callose production and degradation is involved in many different biochemical processes (De Storme and Geelen 2014)
- **Is dormancy release one of them?**
- **Idea:**
  - Dormancy sphincter complex prevents symplastic water flow at highest dormancy depth.
  - Increasing chilling decreases dormancy depth by decreasing symplastic isolation



(Rinne, Kaikuranta et al. 2001)

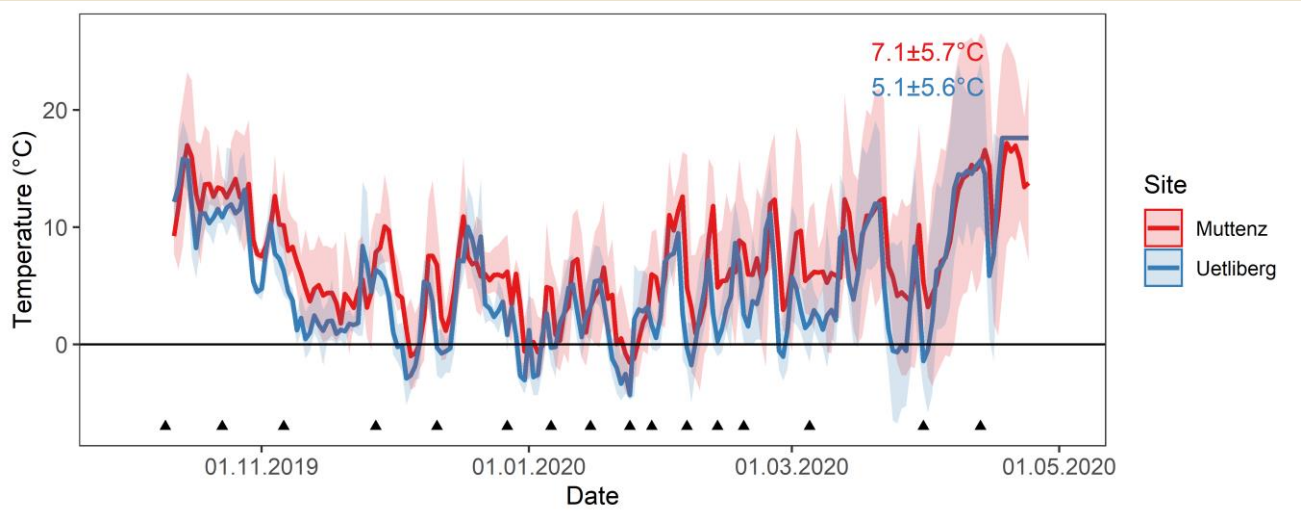
Aim

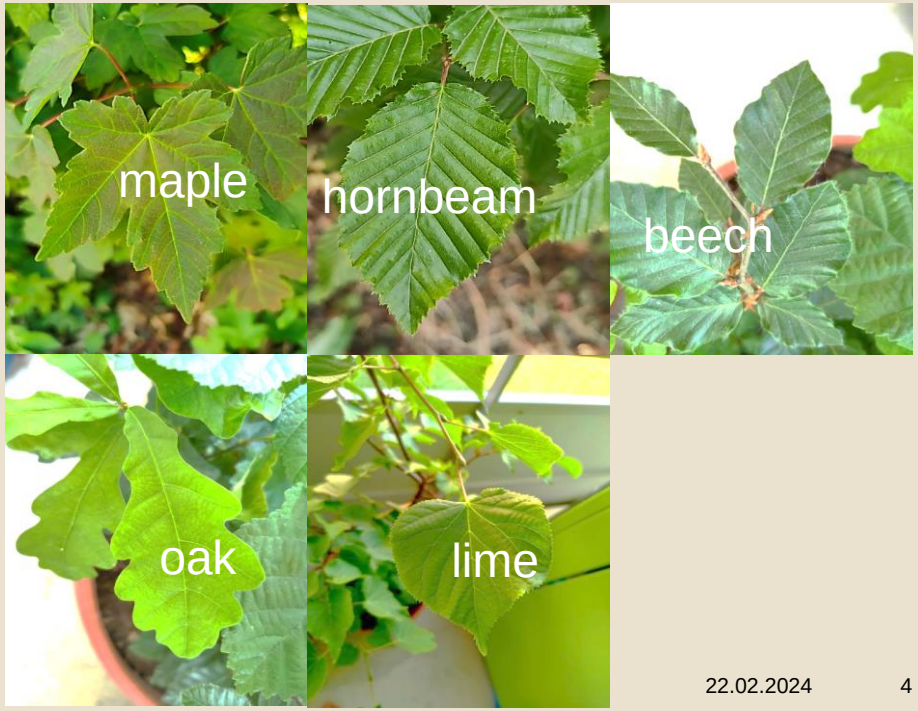
Tracking of symplastic isolation between twig and bud using water isotopes

1. Quantification of timepoint when buds become isolated from the rest of the plant and when the connection is restored
2. Is there a difference in the timing of dormancy induction and release between species?
3. Is water influx in buds correlated to dormancy depth?

Method

- 2 sites with a temperature difference of ~2°C
- 5 different species
- 5 individuals (replicates) per species and elevation
- ~15 sampling campaigns during winter 2019/2020 (biweekly, weekly)





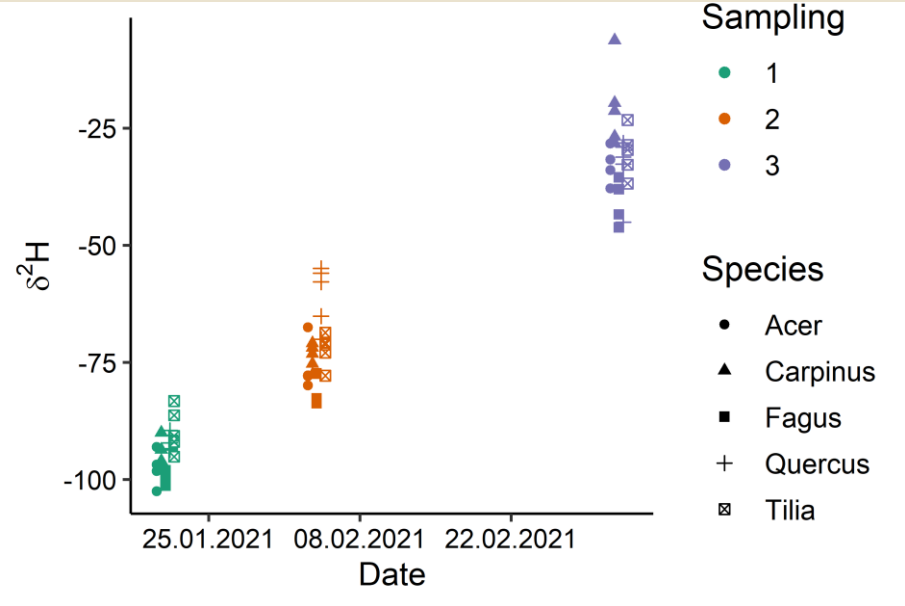
Method

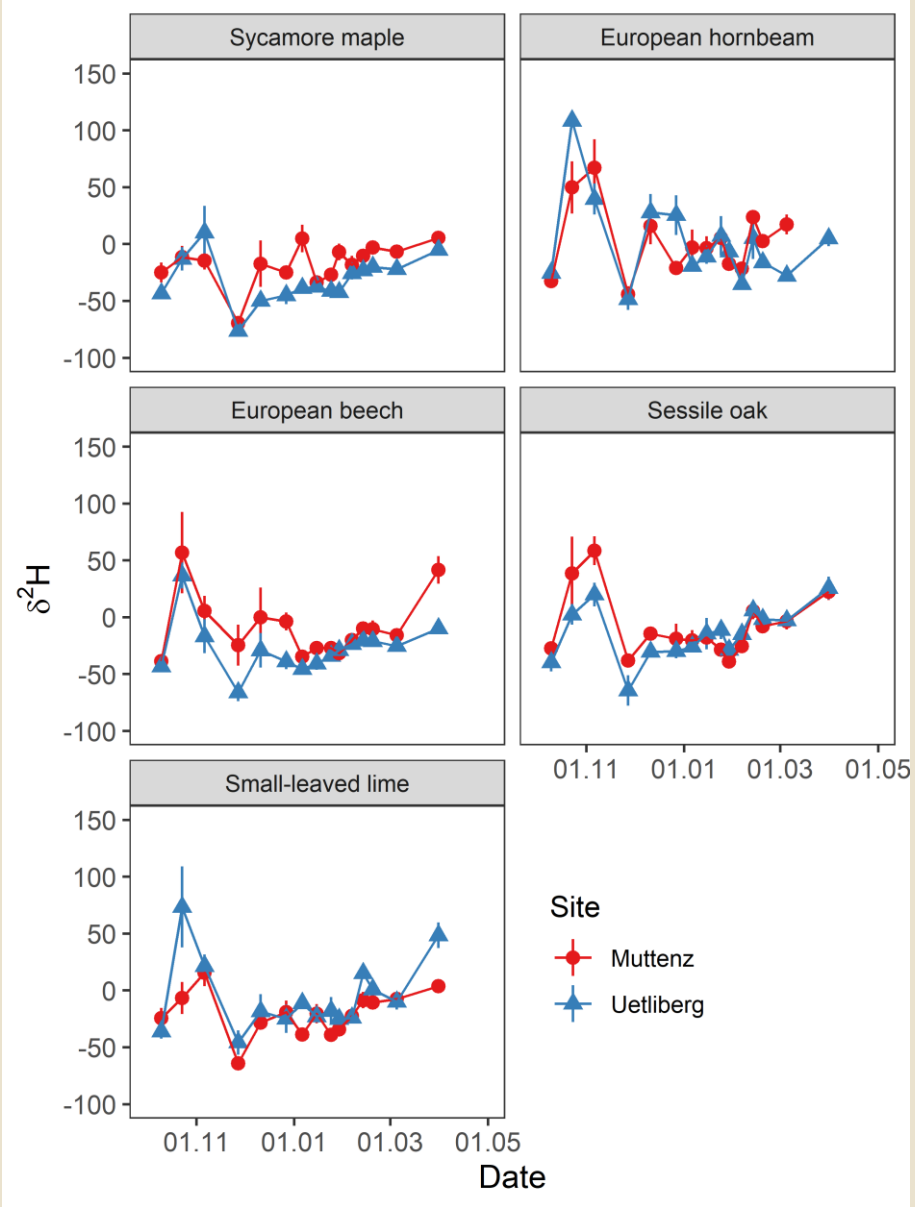
- Sampling of 2 twigs per individual and campaign
- Recutting of **twig 1** before placing into deionized water (for dormancy depth)
- Recutting of **twig 2** in about ten pieces (~8 cm long) each containing one single bud at the uppermost part (for water uptake)
- Placement of **twig 2** pieces into labelled water (δ^2H~2000‰) for at forcing conditions for 24 h

- Cutting of buds of **twig 2** 2 mm above the base of the bud
- Water extraction for isotope analysis and determination of water content

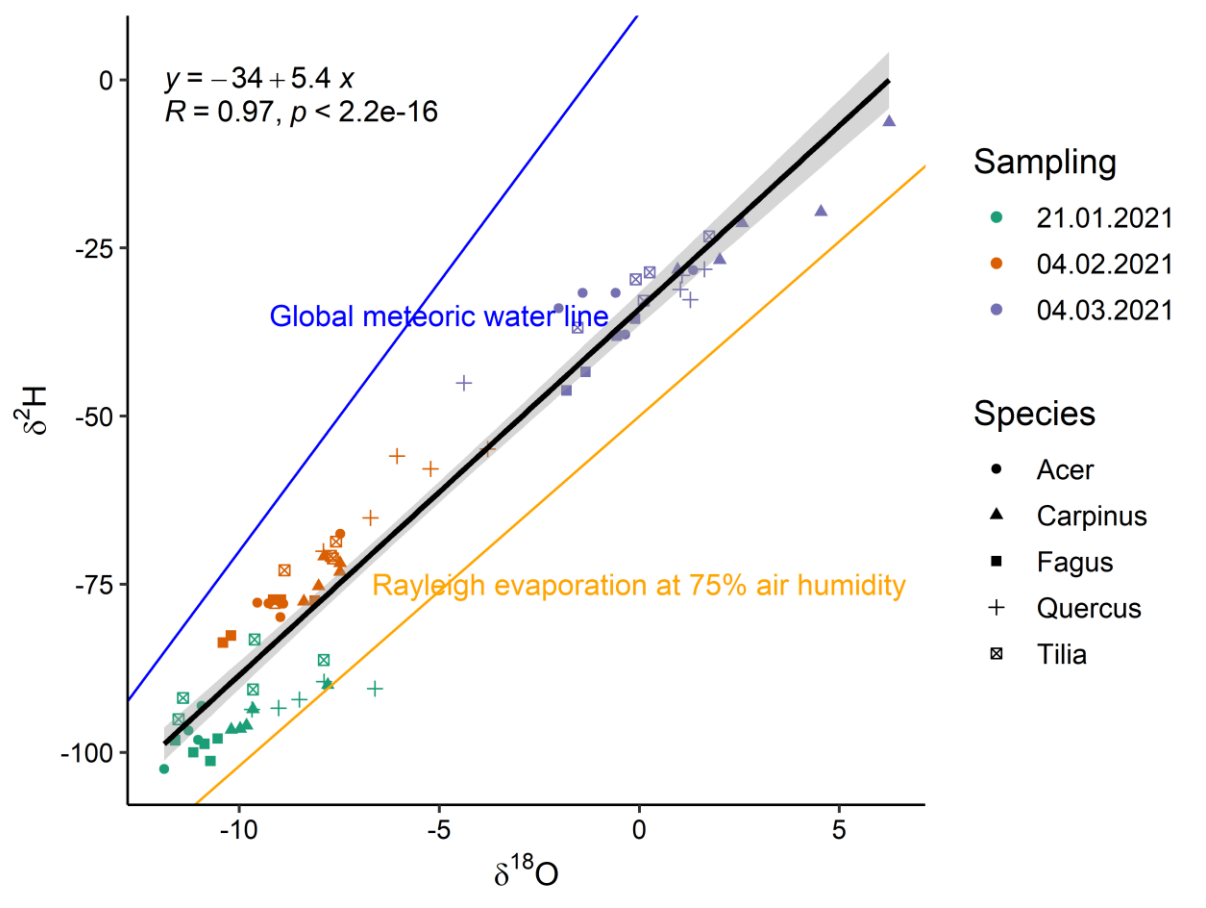
Method

- How to calculate water flow from twig into bud from δ^2H?
- **Naive assumption:** Bud-water δ^2H stays the same for the entire winter dormancy.
- **Reality:** Bud-water δ^2H changes over time





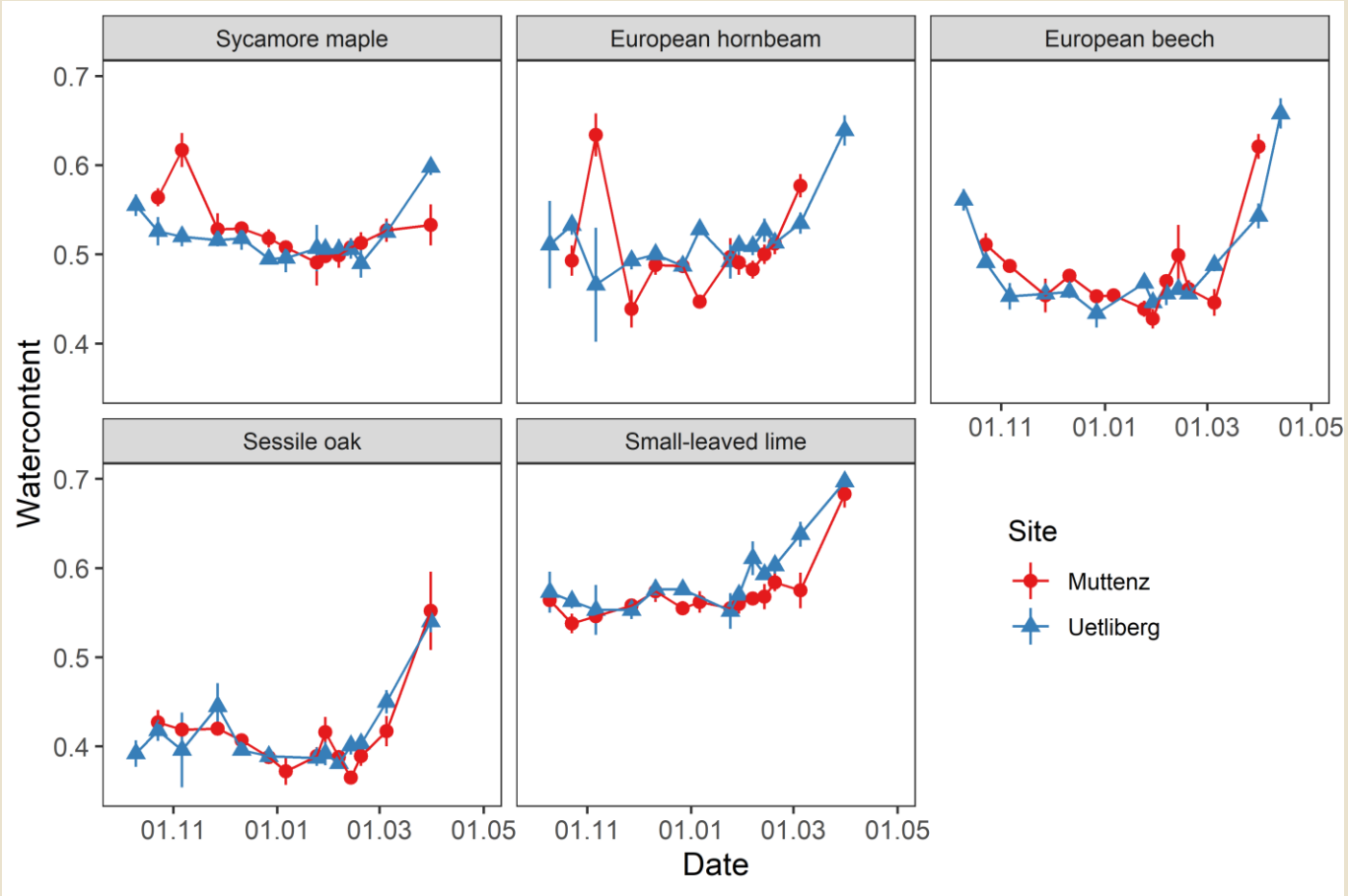
How to take into account fluctuations in bud-water δ^2H?



- Calculation of natural δ^2H using $\delta^{18}O$
- **Expectation:** the relationship between bud-water δ^2H and $\delta^{18}O$ could be explained by the global meteoric water line
- **But:** Water isotopic composition of the water inside the bud equals rayleight evaporation at 75% air humidity
- Do buds loose water by evaporation during winter?

Results: Bud-Water content during Winter

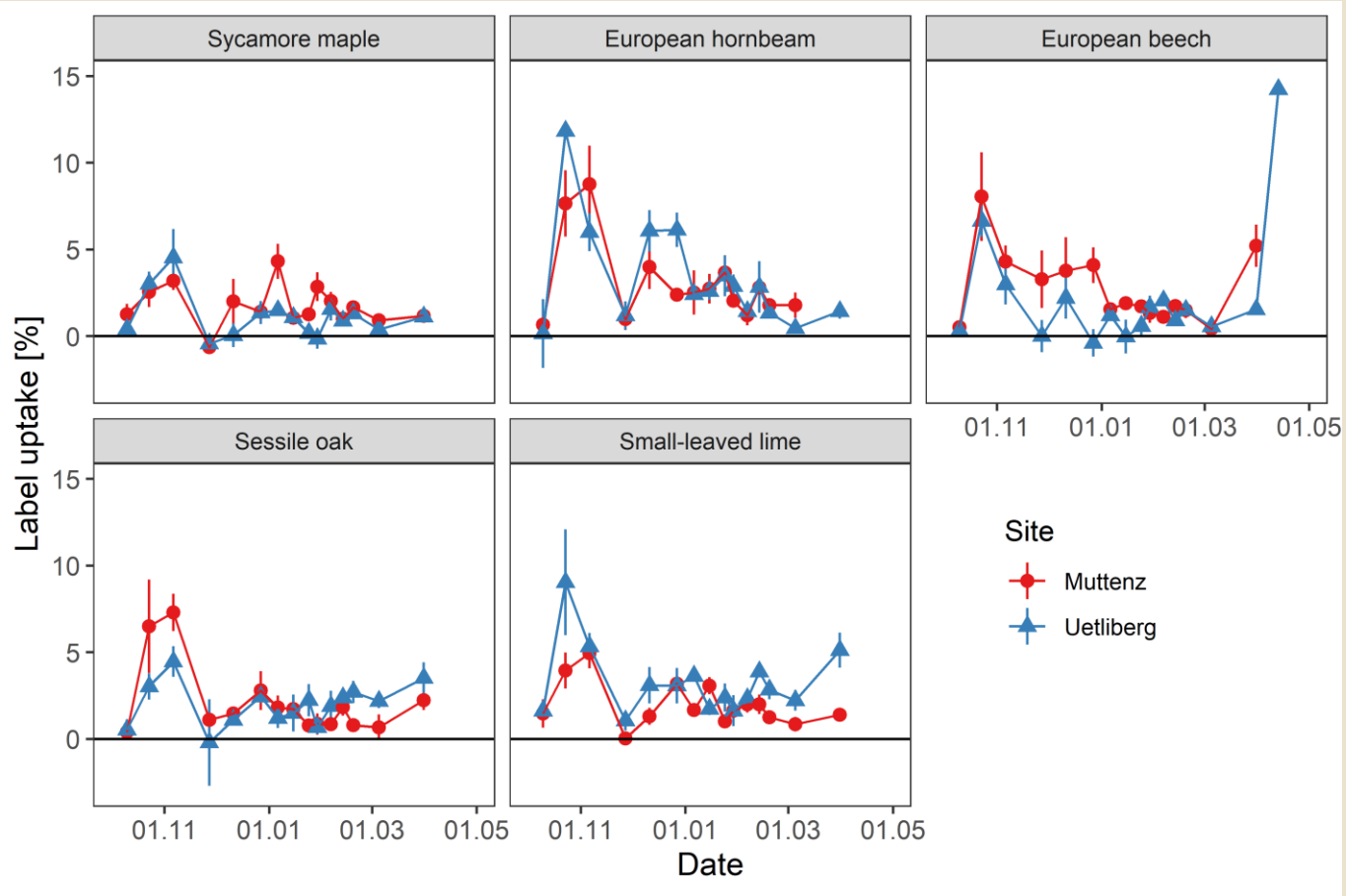
- **Bud-watercontent** during winter dormancy **depends** on **species**
- **Change** in bud-watercontent during winter **depends** on **species**
- Higher symplastic isolation during winter for beech compared to lime?



Results: Label-uptake during winter

- **High** label **uptake** at the **beginning** of winter dormancy and at the **end**
- **No progressive restoration** of **symplastic isolation** during winter

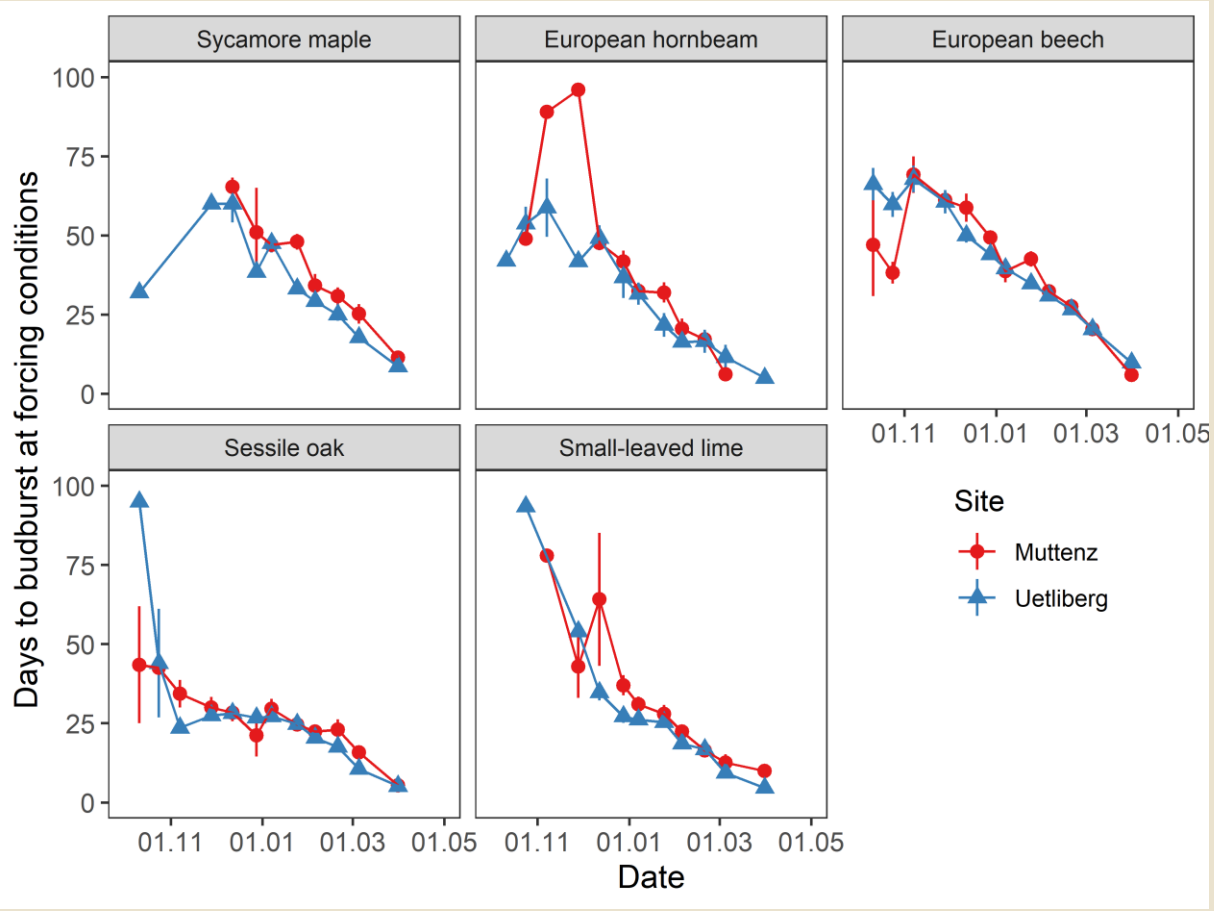
Is air temperature the most important driver for the symplastic isolation during winter for all species?



Results: Label-uptake and dormancy depth

- Dormancy depth decreases with increasing chilling for all species
- **But:** No relationship between label-uptake and dormancy depth
- Quantity of **water flow** between twig and bud is **not a good indicator** of **dormancy depth**

What is the plant biological mechanism of chilling and chilling accumulation?



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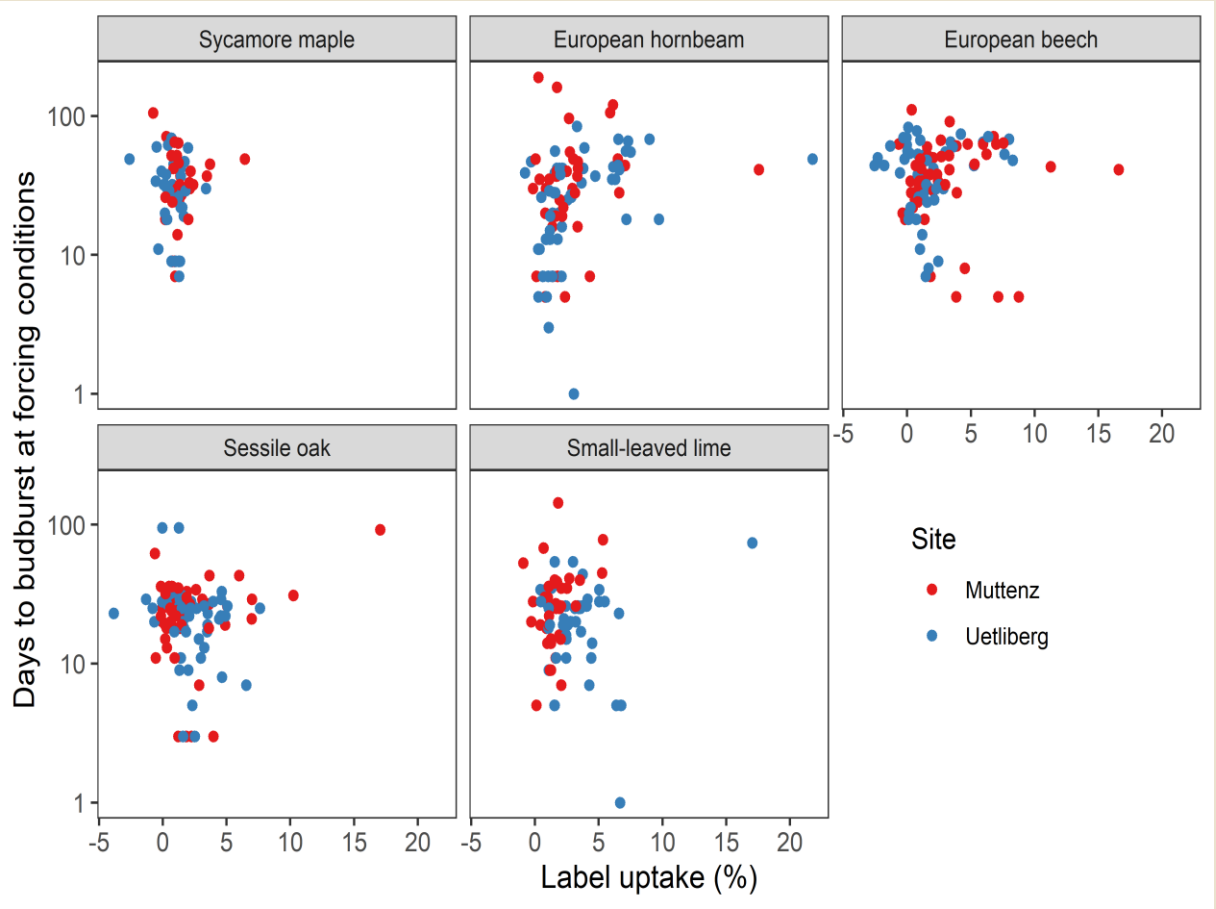

Conclusion and outlook

Objectives:

1. Quantification of timepoint when buds become isolated from the rest of the plant and when the connection is restored 
2. Is there a difference in the timing of dormancy induction and release between species? 
3. Is water influx in buds correlated to dormancy depth? 

But how can we determine dormancy depth from molecular measurements?

- **Idea 1:** Exploring the ABA signaling pathway: (See poster S7.P9 of Bénédicte Wenden et al.)
- **Idea 2:** Explore mechanisms driving frost hardiness: (See Kovaleski, A. P. 2022)