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Low temperature induced hydraulic constraints as a potential driver for the cold distribution limits of temperate trees

Günter Hoch
Department of Environmental Sciences
University of Basel

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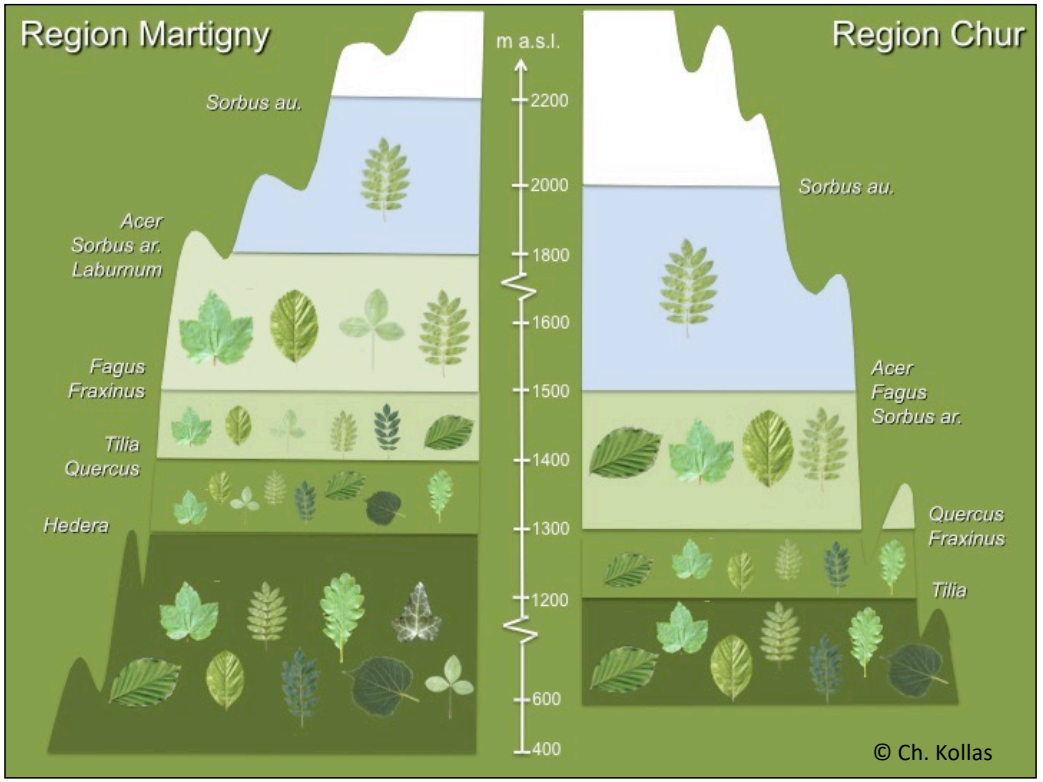
Cold limit of tree growth

Alpine treeline

Species-specific cold limits



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Cold limit of tree growth

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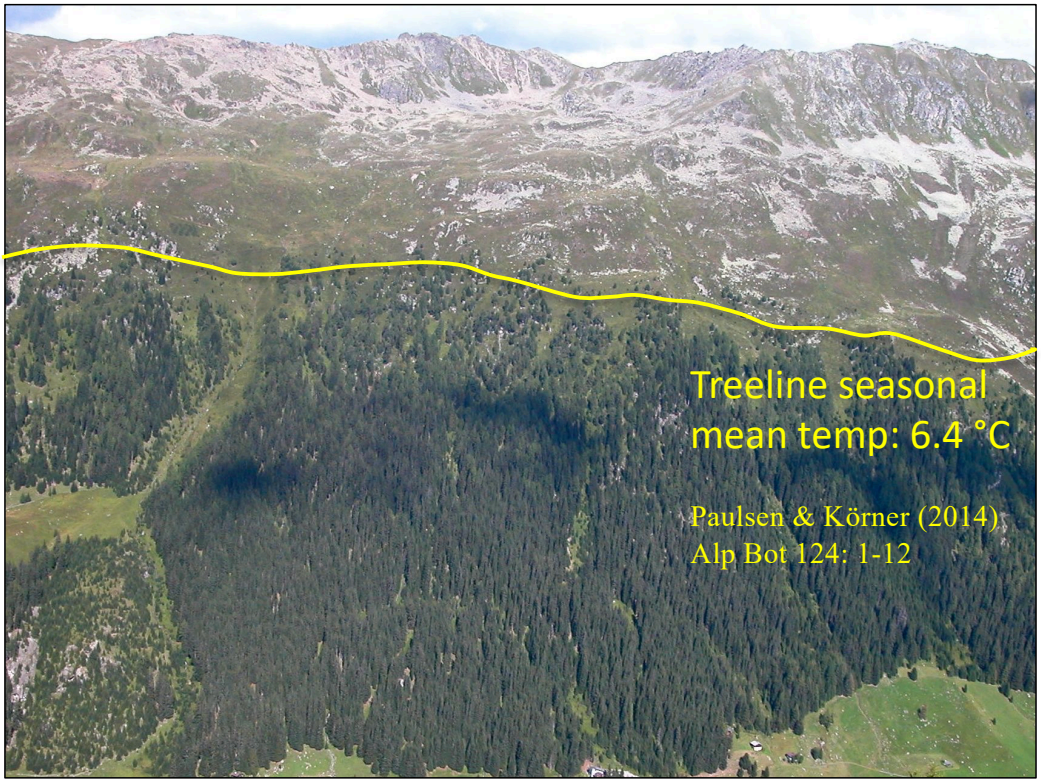
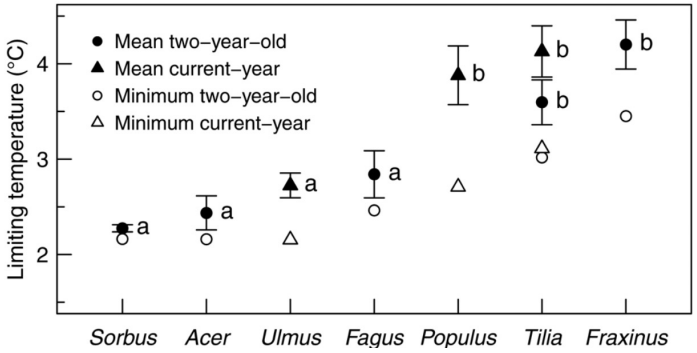
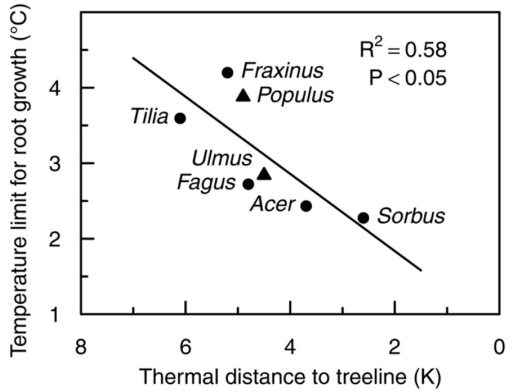


Species-specific cold limits

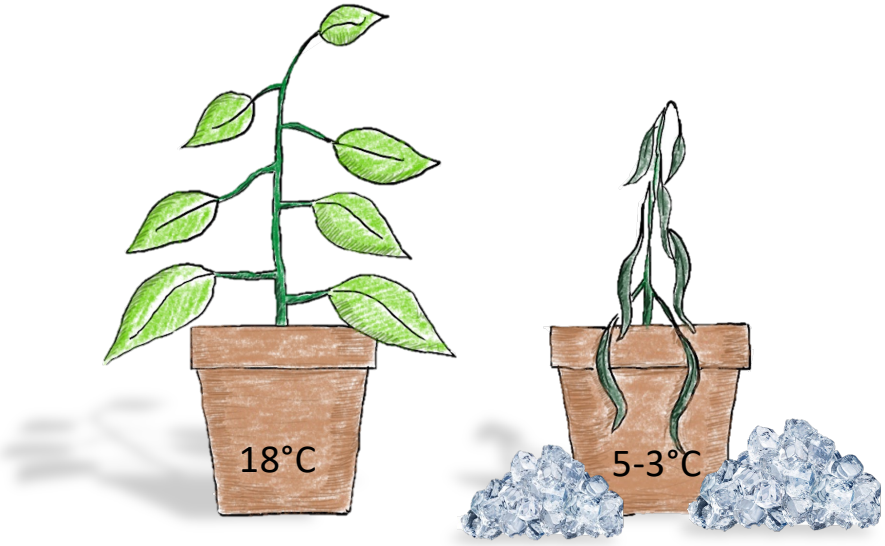




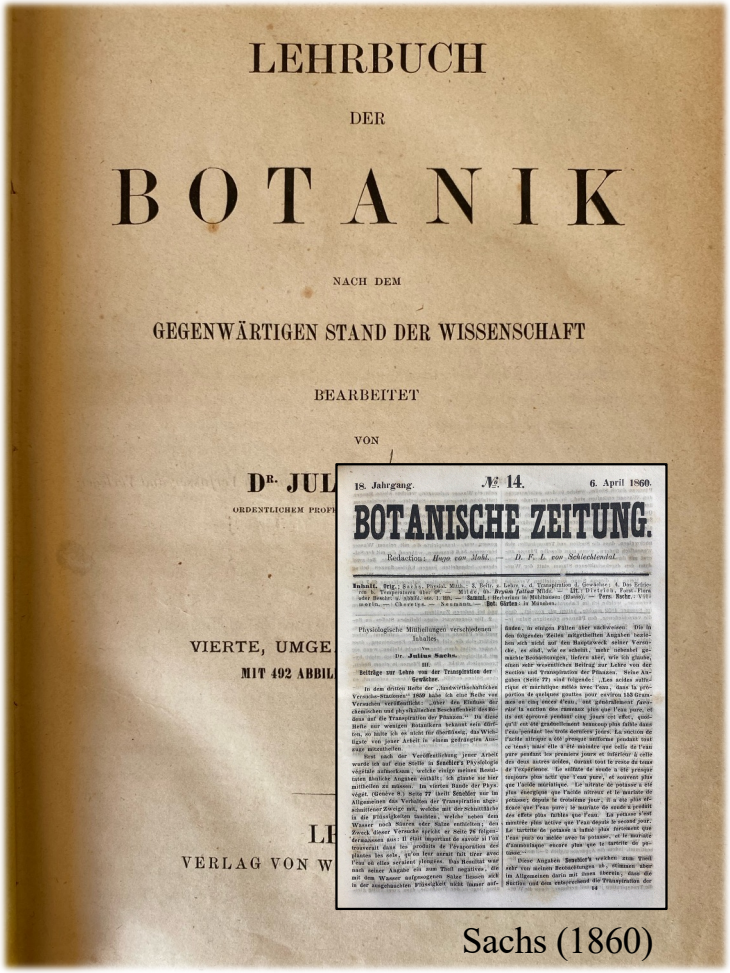
Schenker et al. (2014) Tree Physiol 34: 302-313

Hydraulic constraints from cold roots

Low, non-freezing root temperatures have negative effects on water relations of plants



Sachs (1874)



Sachs (1860)

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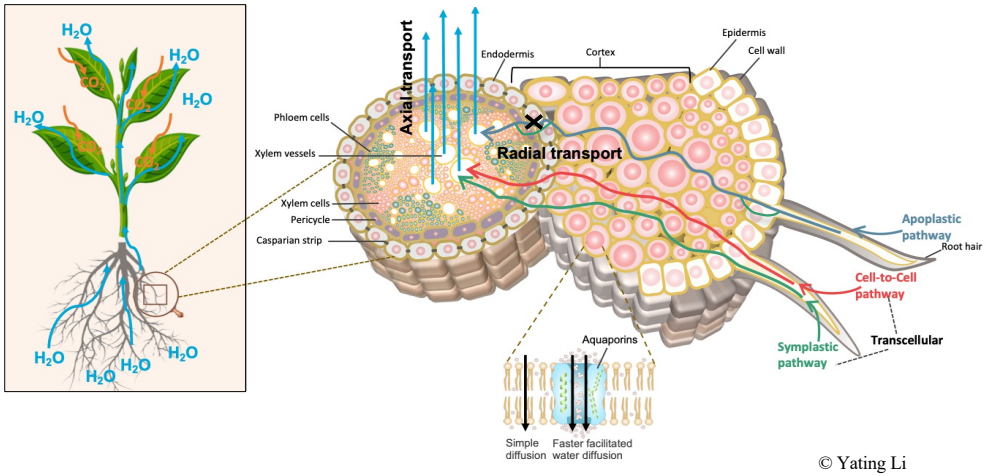
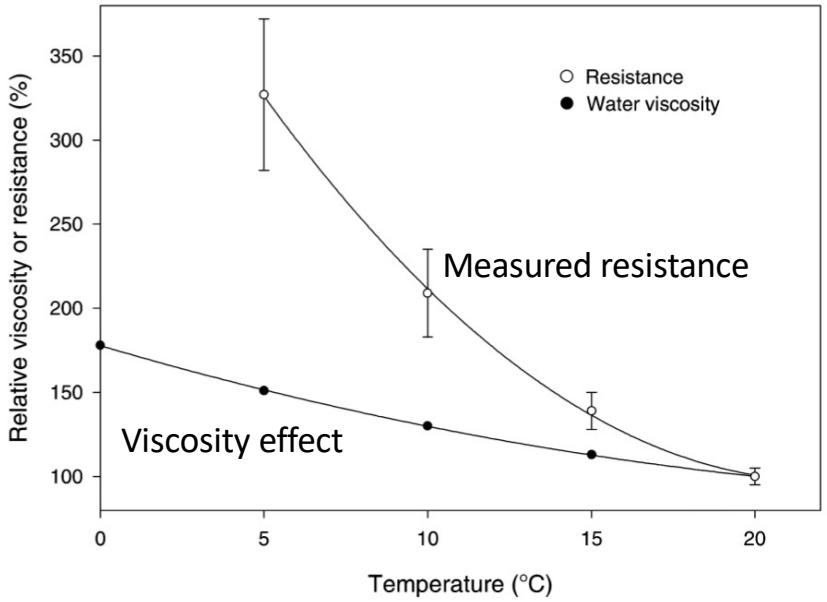
Hydraulic constraints from cold roots

Radial root water transport



© Yating Li

Populus tremuloides



Wan et al. (2001) Tree Phys 21: 691-696

At low root temperatures:

- **Increased water viscosity**
- **Restricted biomembran permeability for water**
- **Decreased activity of aquaporins**

Cold root effects for trees

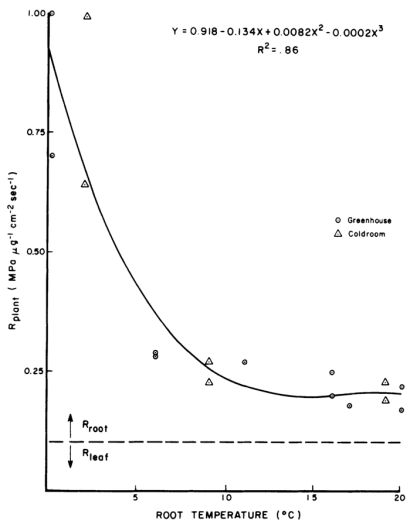
Plant Physiol. (1980) 65, 635–640
0032-0889/80/65/0635/06/$00.50/0

Soil Temperature Influences on Root Resistance of *Pinus contorta* Seedlings[1]

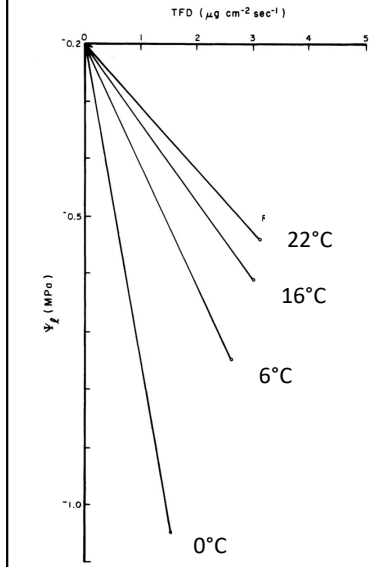
Received for publication June 8, 1979 and in revised form October 31, 1979

STEVEN W. RUNNING AND C. PATRICK REID
Department of Forest and Wood Sciences, Colorado State University, Fort Collins, Colorado 80523

Plant resistance



Leaf water potential



Running & Reid (1980) Plant. Physiol. 65

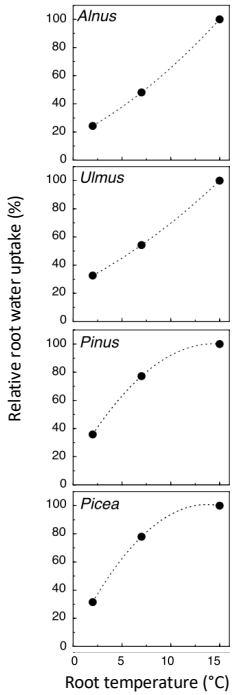
Tree Physiology 42, 1311–1324
https://doi.org/10.1093/treephys/tpac005

Research paper

Negative effects of low root temperatures on water and carbon relations in temperate tree seedlings assessed by dual isotopic labelling

Wenna Wang[1,2] and Günter Hoch[1,3]

Root water uptake



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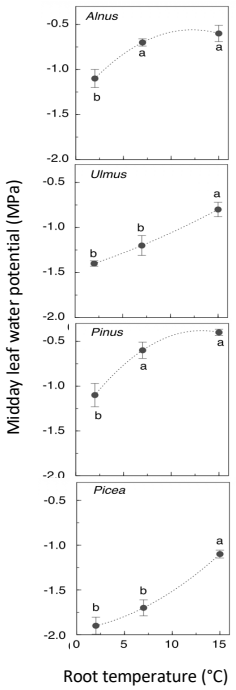

Wang & Hoch (2022) Tree Physiol 42

Cold root effects for trees

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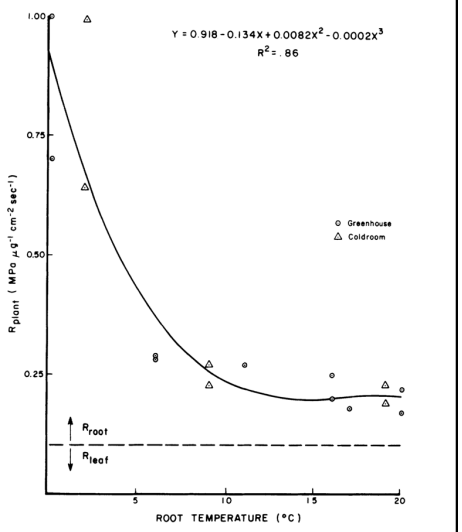

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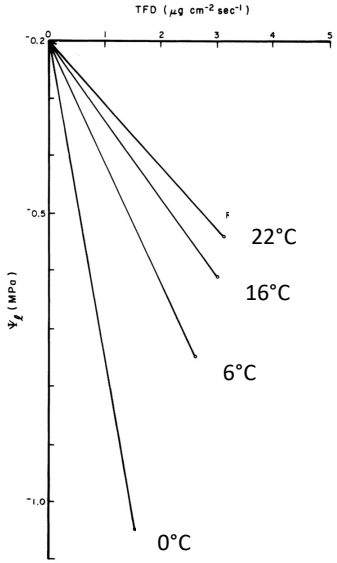
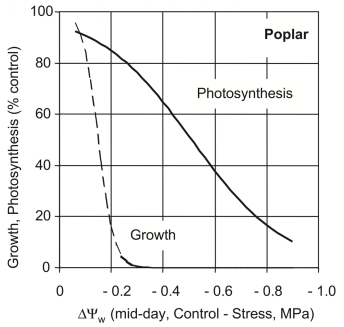
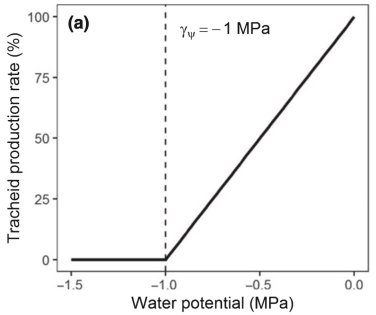


Running & Reid (1980) Plant. Physiol. 65



Muller et al. (2011) J. Exp. Bot. 62



Cabon et al. (2020) New Phytol. 226

Cold roots induce drought-like stress in trees.

Reduced plant water potentials might lead to turgor-driven limitations of below and aboveground tree growth.

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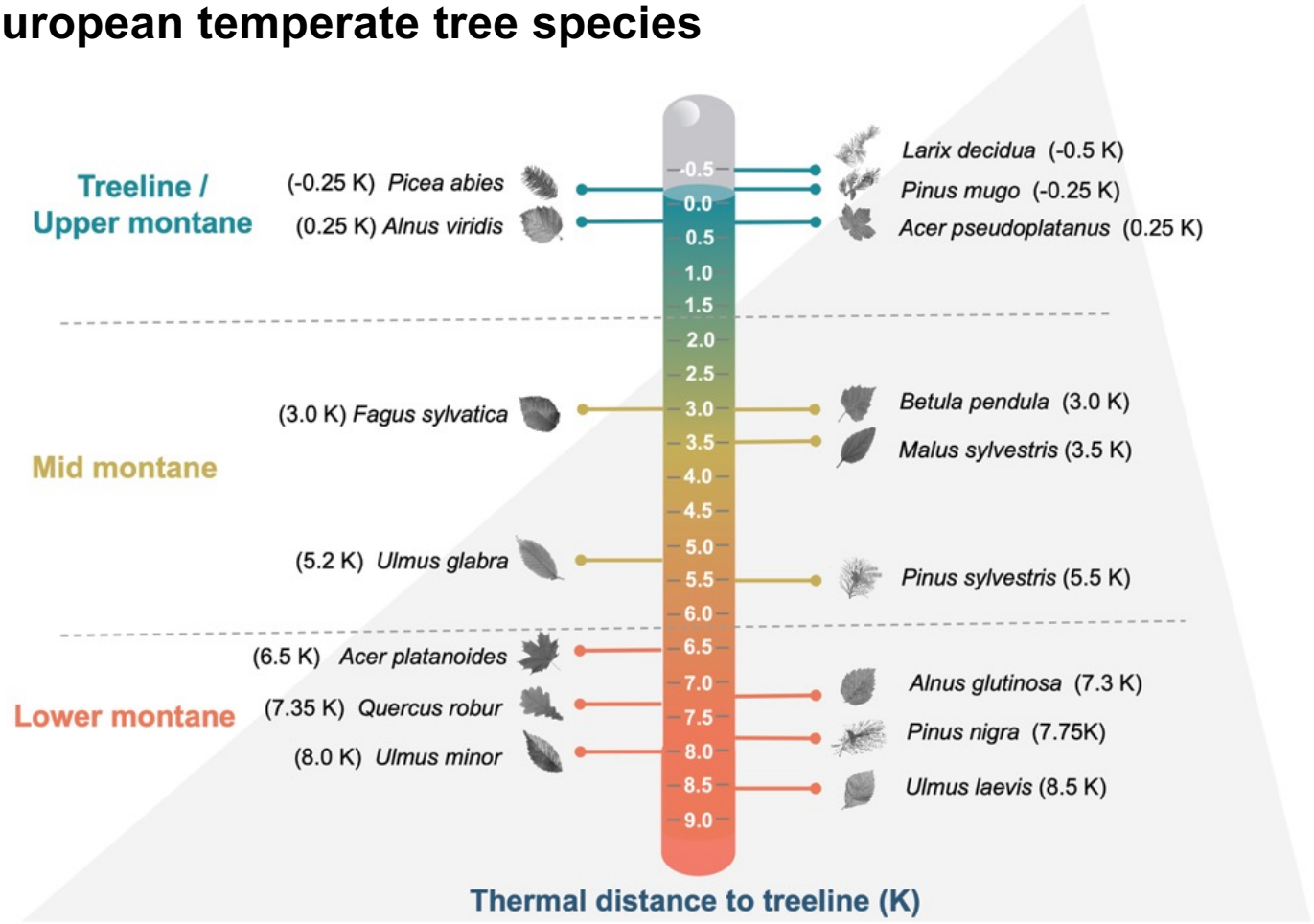
Species-specific sensitivity

16 European temperate tree species

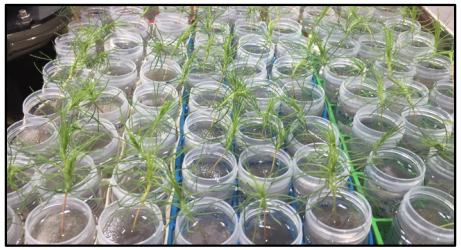


PhD thesis Yating Li

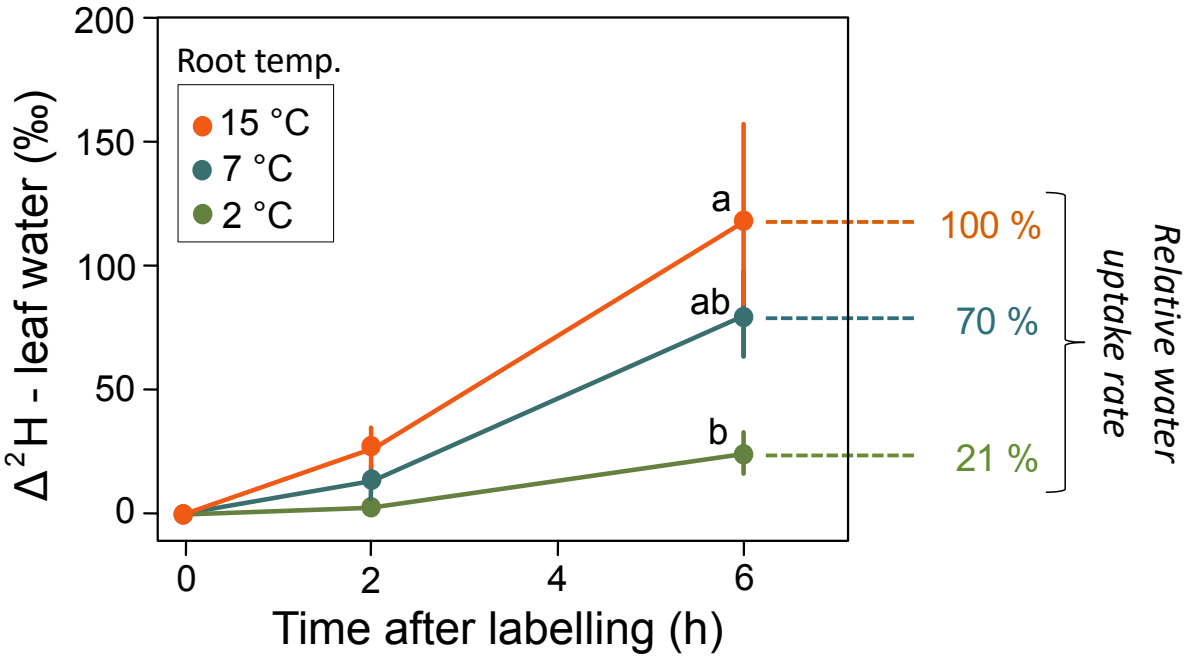
University of Basel

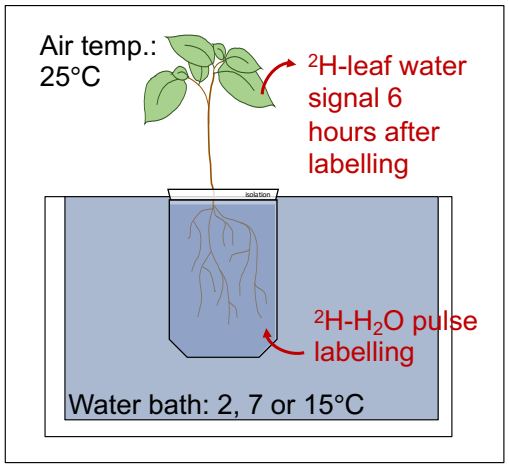
Species-specific sensitivity





PhD thesis Yating Li





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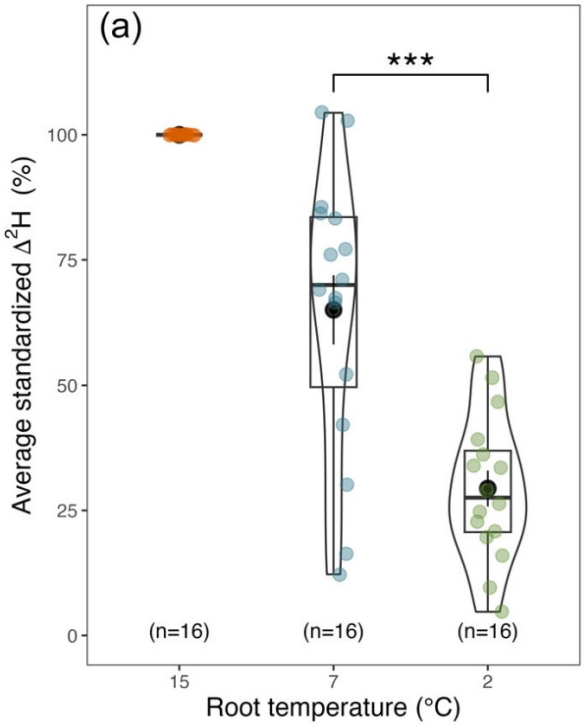
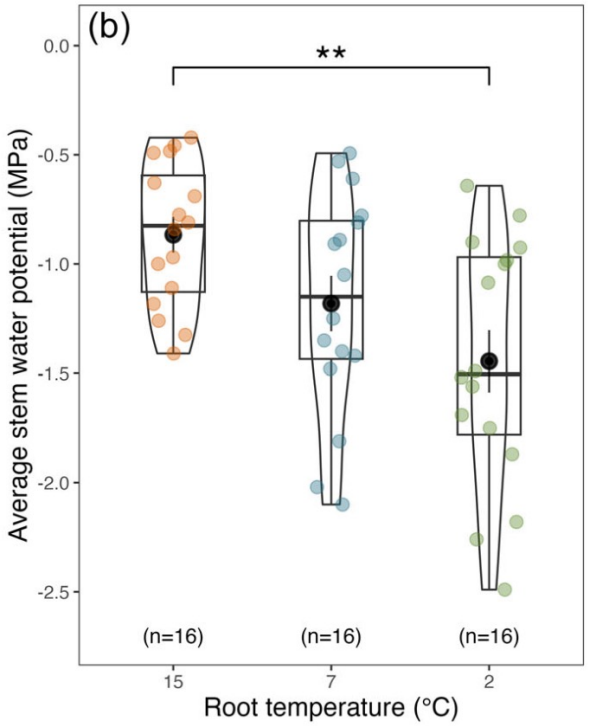
Species-specific sensitivity

16 tree species

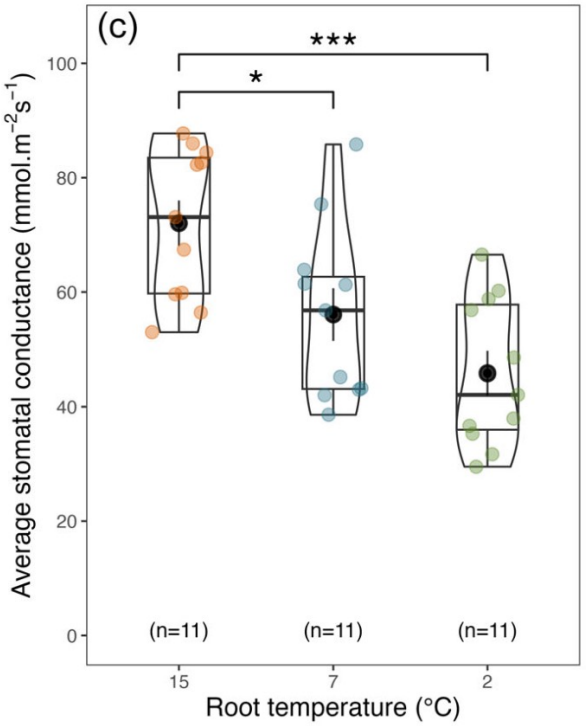
Water uptake



Mid-day water potential



Stomatal conductance



Li & Hoch (2024) Plant Cell Env 47:2192-2205

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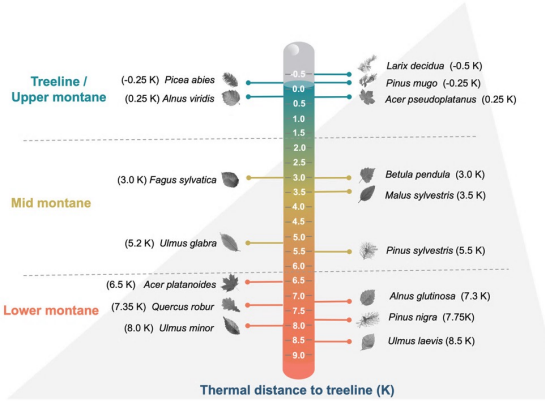
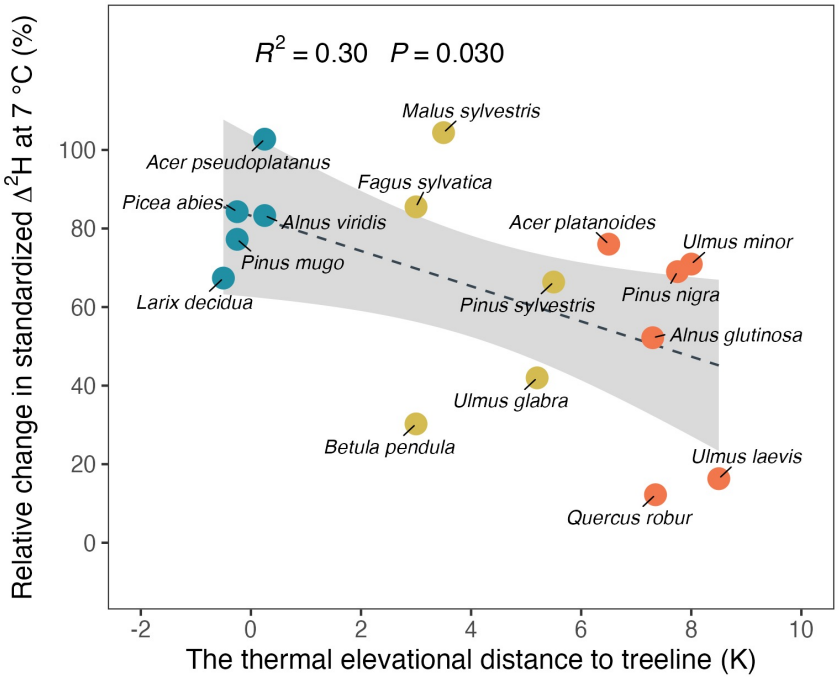
Species-specific sensitivity

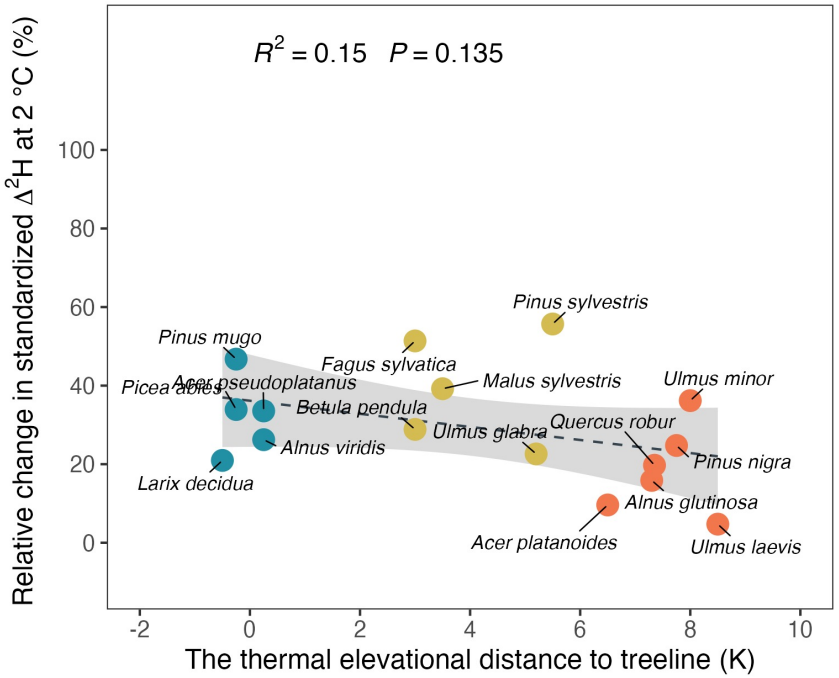


Root water uptake relative to 15 °C

7 °C



2 °C



Li & Hoch (2024) Plant Cell Env 47:2192-2205

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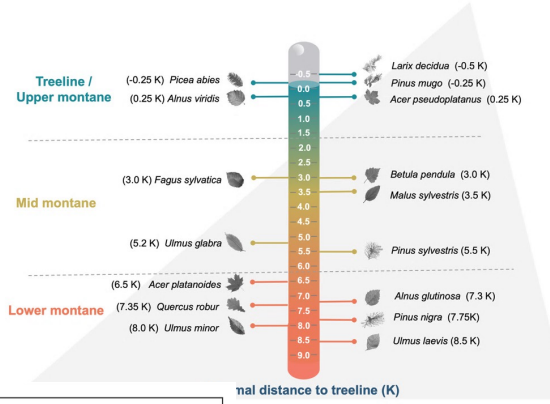
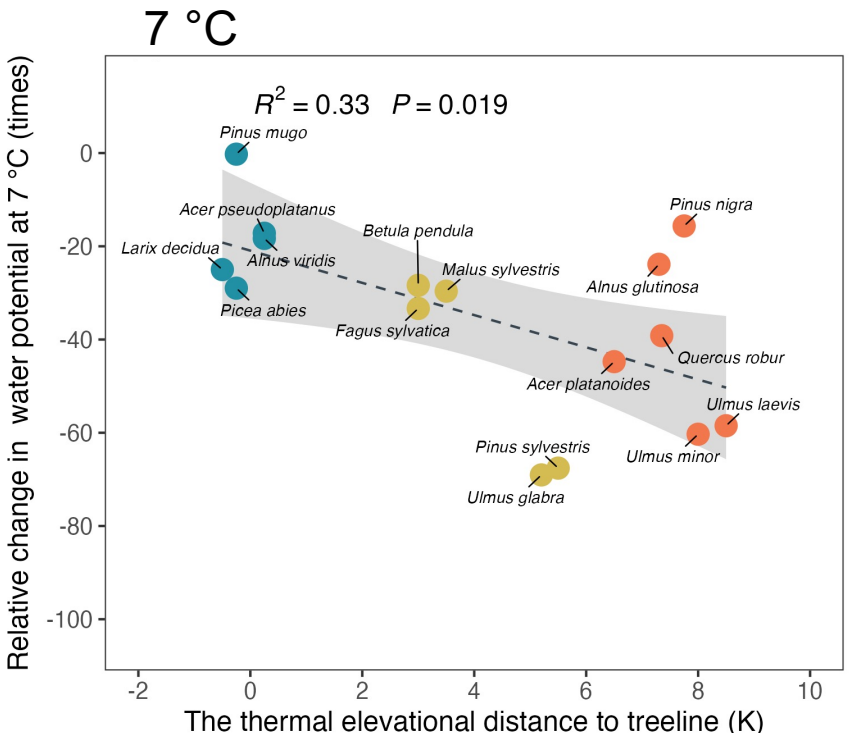
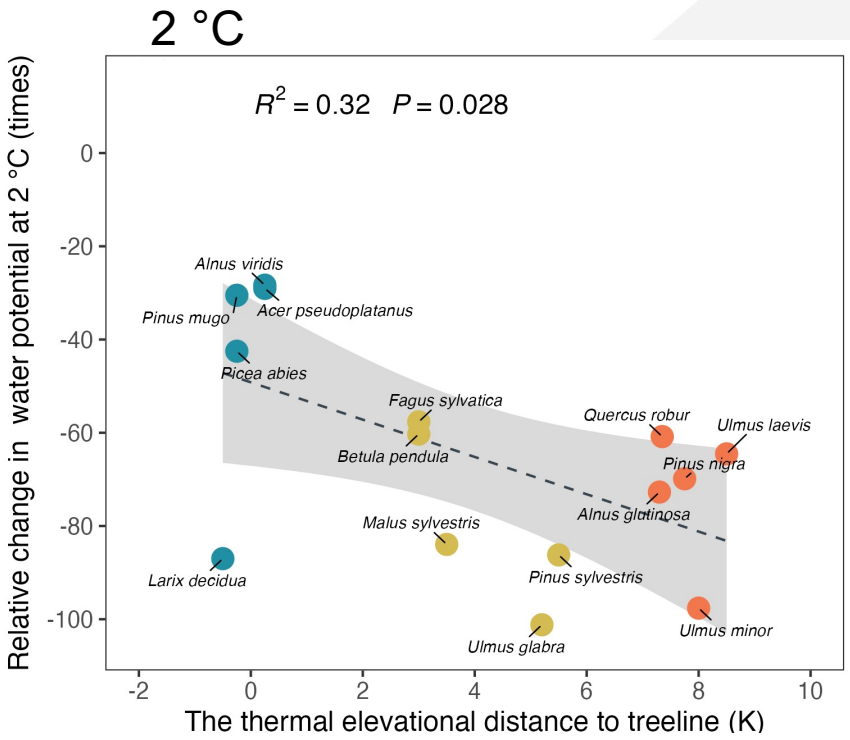
Species-specific sensitivity



Stem water potential relative to 15 °C





Li & Hoch (2024) Plant Cell Env 47:2192-2205

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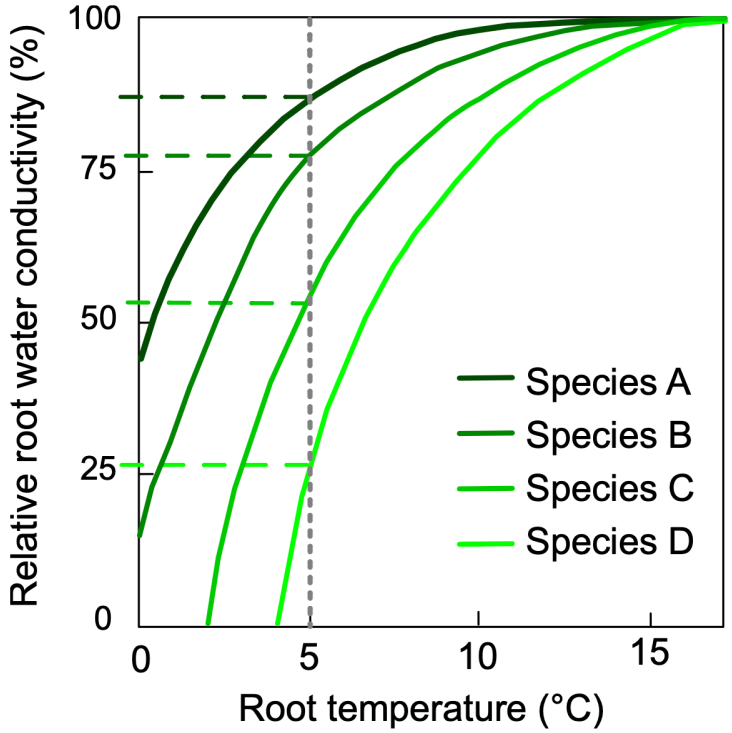
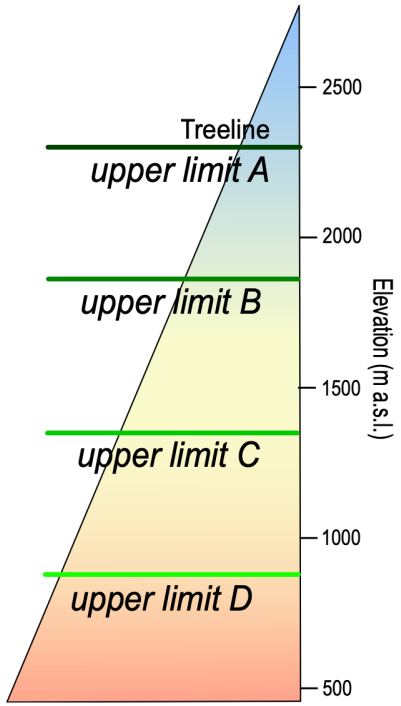
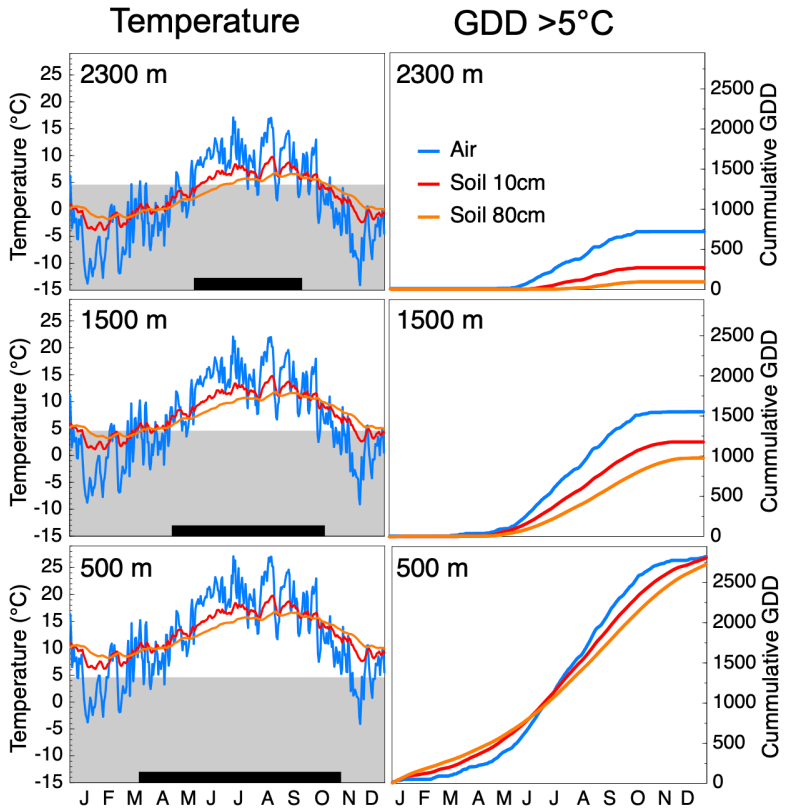
Conceptual summary







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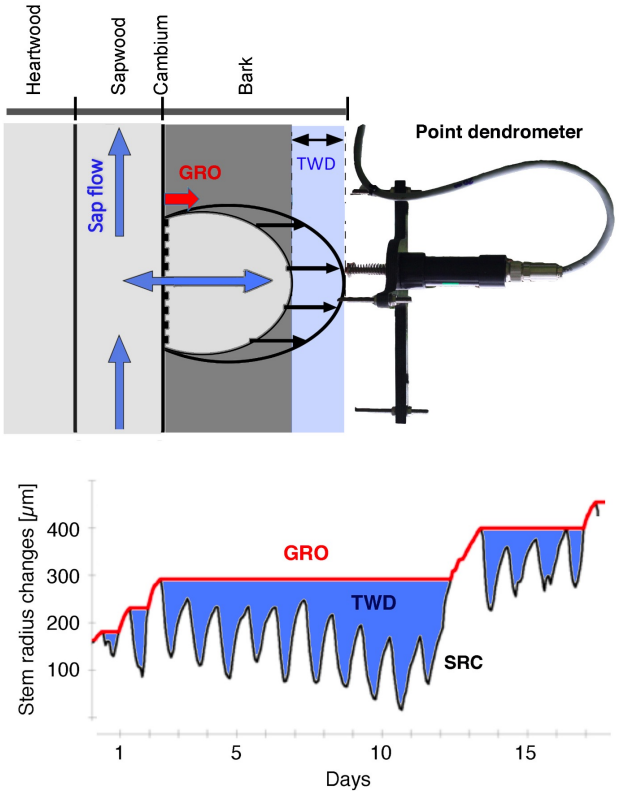
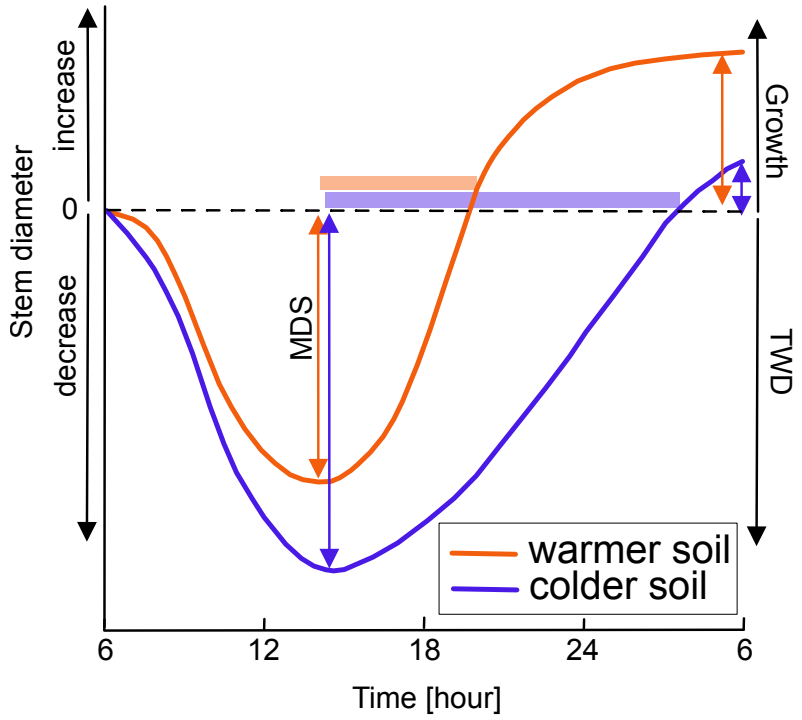
Measure cold root effects in mature trees?

Point dendrometer measurements of TWD and growth





Zweifel et al. (2021) Frontiers Forest Global Change 4

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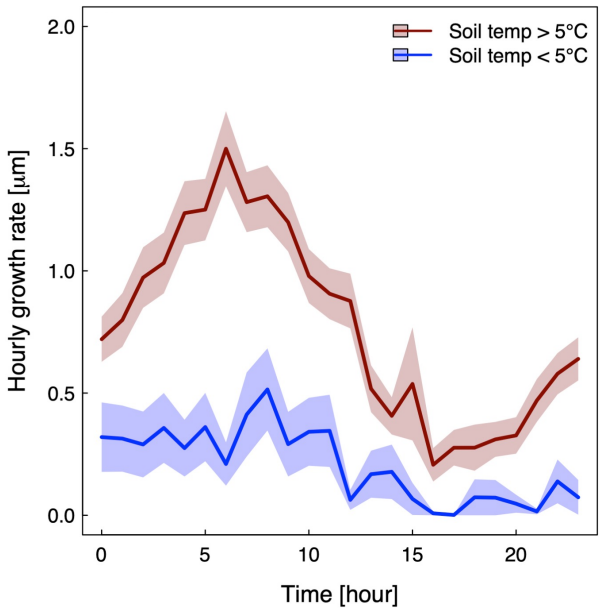
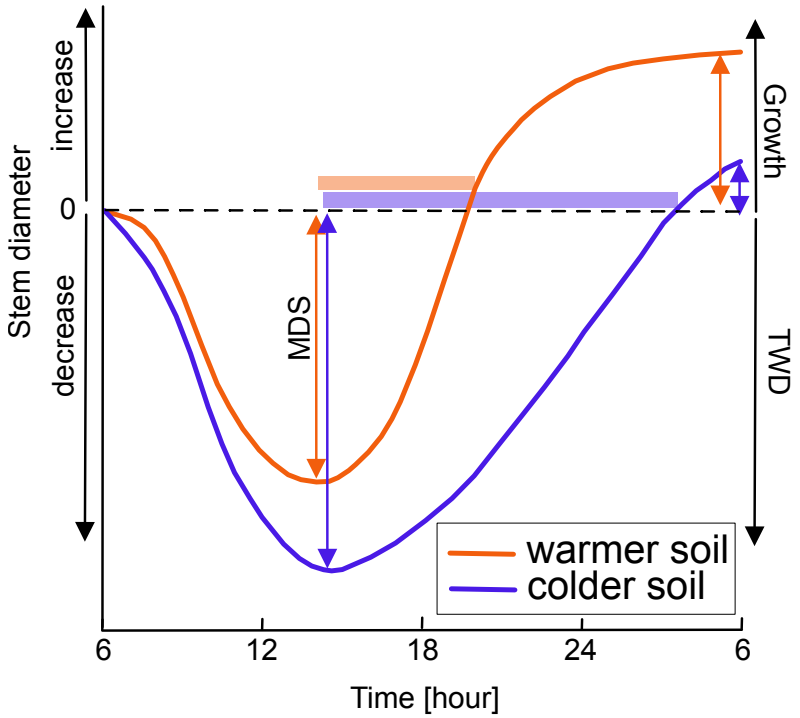
Measure cold root effects in mature trees?

TreeNet site Davos

Selected days in May and June 2018 – 2023
with similar air temperatures and VPD



S. Etzold (unpubl.)



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Chinese Scholarship Council

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