



Wir schaffen Wissen – heute für morgen

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Long-term effects of drought on tree-ring growth and tree ecophysiology in Pfynwald

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Objectives and Research Questions

- How does tree-ring growth of individuals between recently died and still living trees differ over the past ca. 100 years?
- How do carbon isotope values in tree rings differ between these groups?
- Are there different developments regarding climatic sensitivity and plant function?
- When did tree decline start and why?
- Can combination of tree-ring growth and carbon isotope derived water-use efficiency help answer to these questions?
- What is 10-year effect of irrigation on tree-ring growth and tree-ring carbon isotope response pattern?

Data and Methods



Dead trees



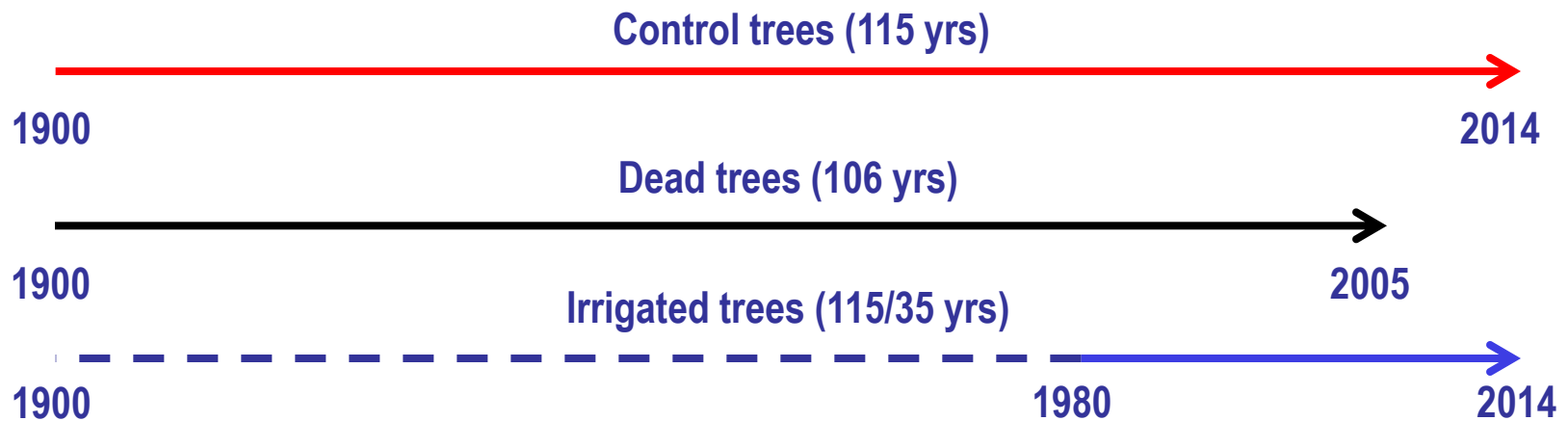
Control & Irrigated trees
(living)



TRW
measurements

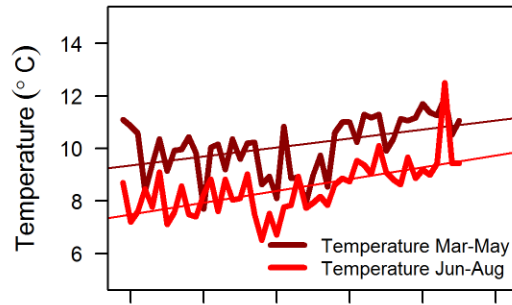
^{12}C	^{13}C
12.00000	13.00335
98.89%	1.11%
Stable	Stable

$\delta^{13}\text{C}$ isotope analysis

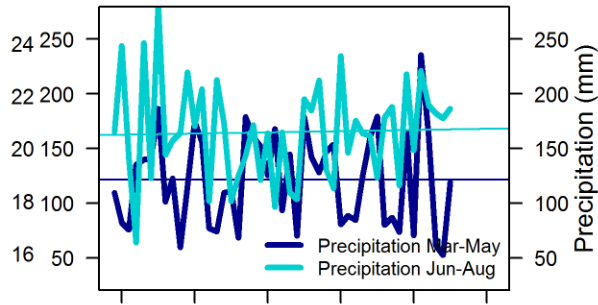


Climate data trends for Sion station (1959-2005)

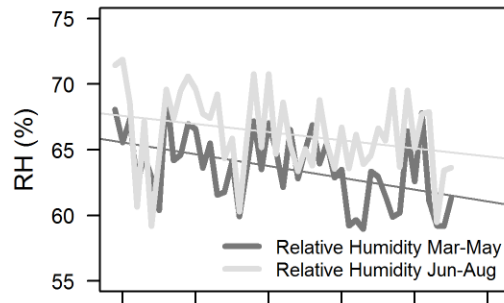
Temperature



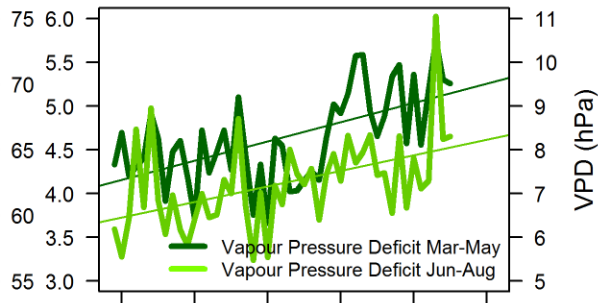
Precipitation



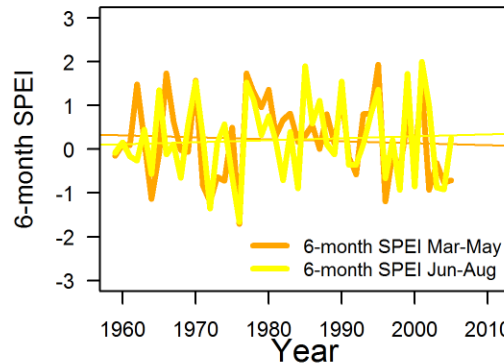
Relative Humidity



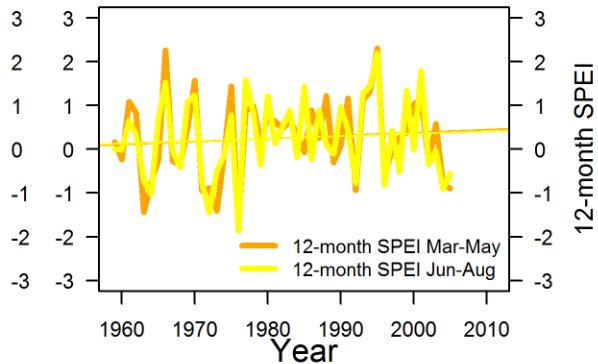
Vapour Pressure Deficit



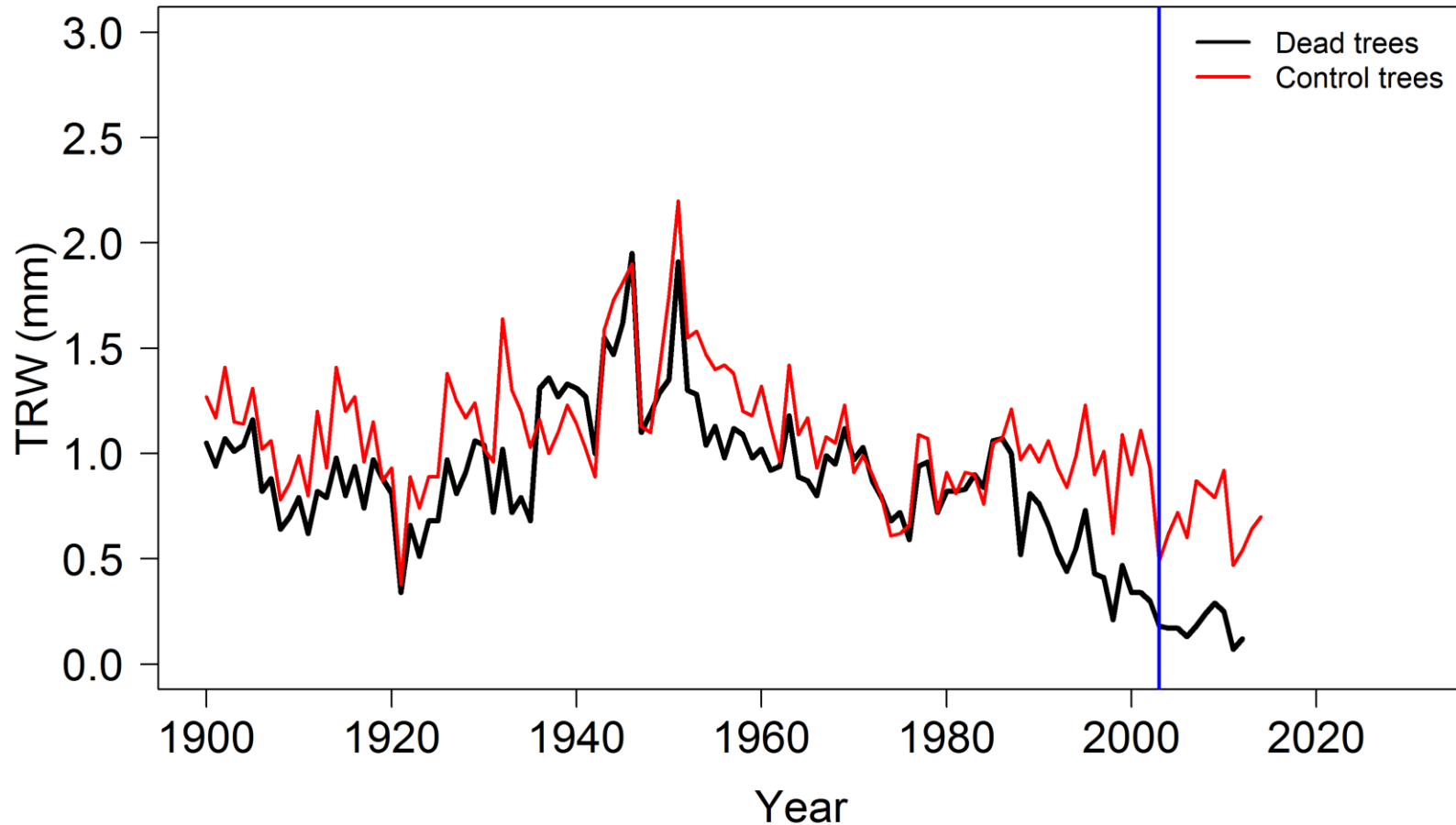
Drought Index



Drought Index

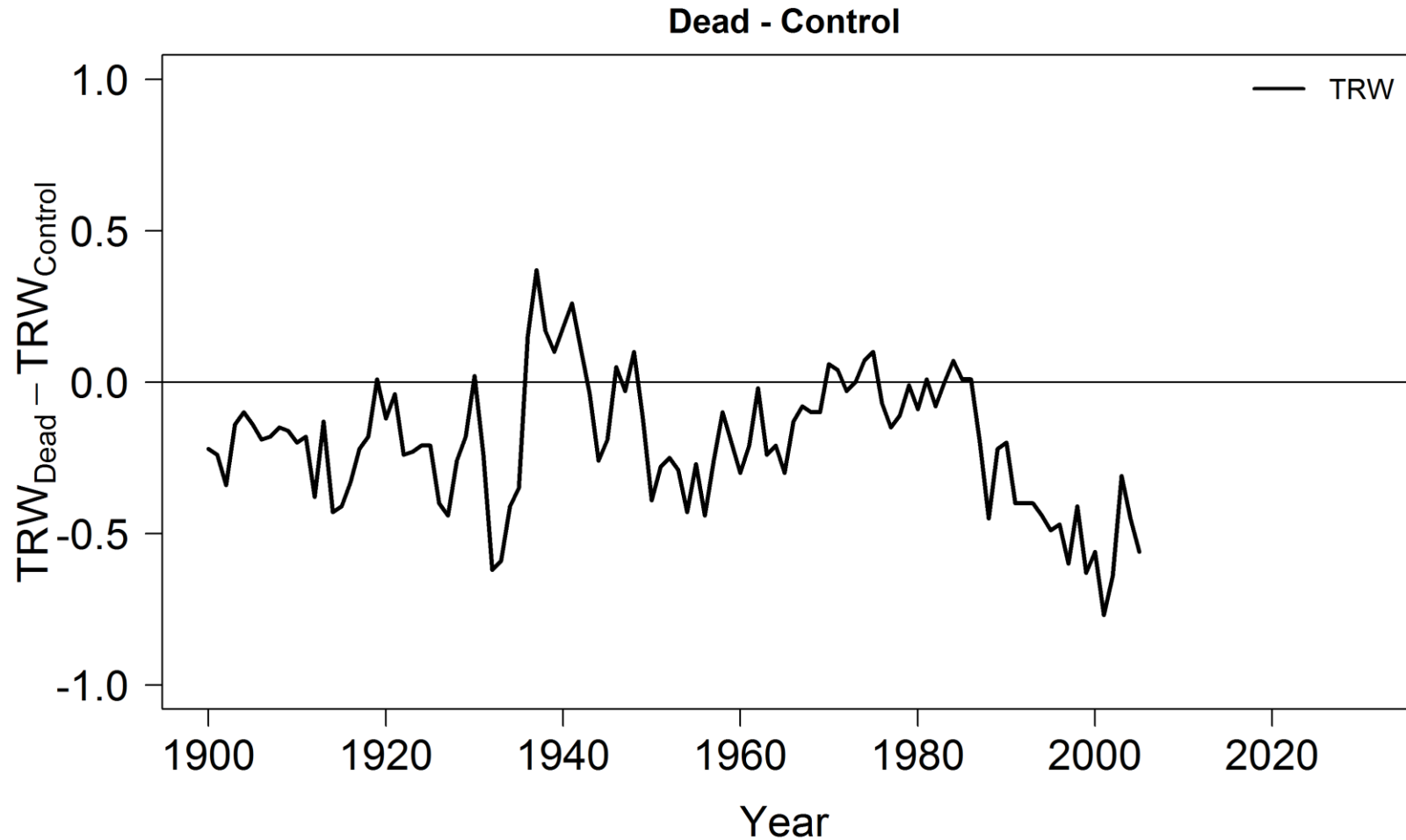


Dead trees started to decline already in mid 80s



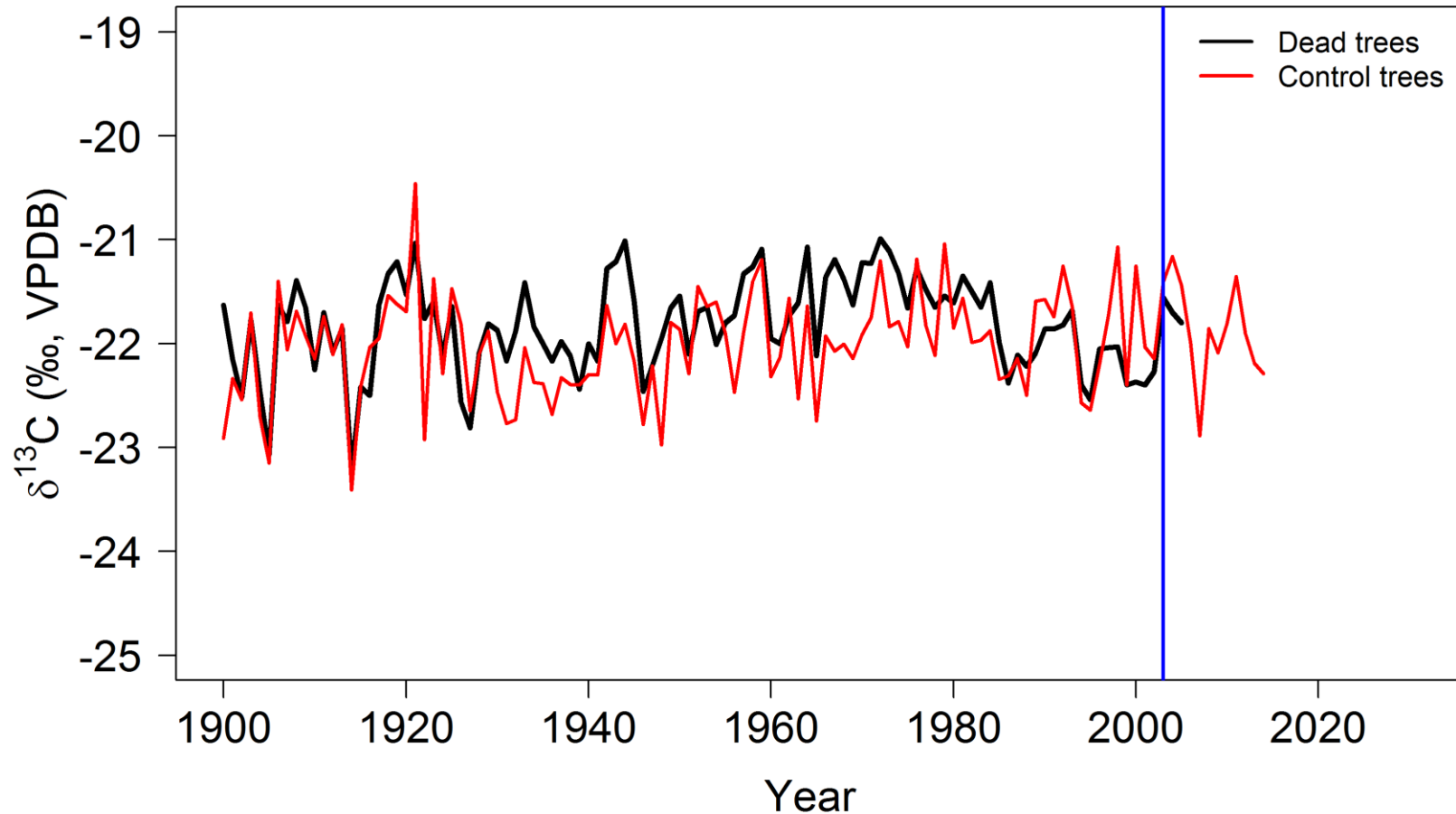
Raw Tree-Ring Width (TRW) Data from Pfywald: 1900-2014

TRW in dead trees was most of the time lower



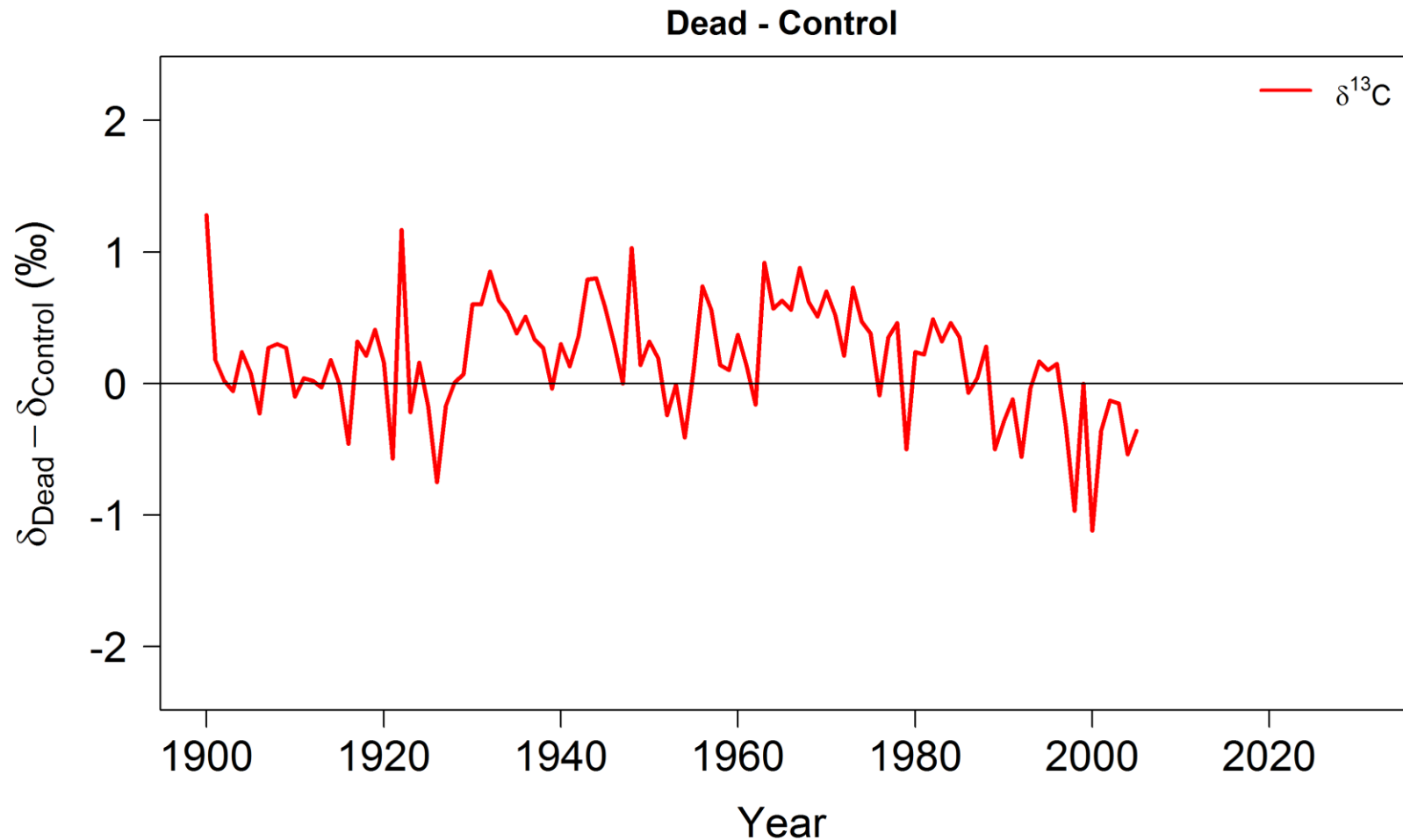
1900-1979: mean = - 0.16 mm.; SE = 0.02 mm

Carbon isotope values in dead and control trees



$\delta^{13}\text{C}$ Data from Pfywald (mean of 5 trees per group): 1900-2014

Slightly higher WUE for dead trees before mid 80s



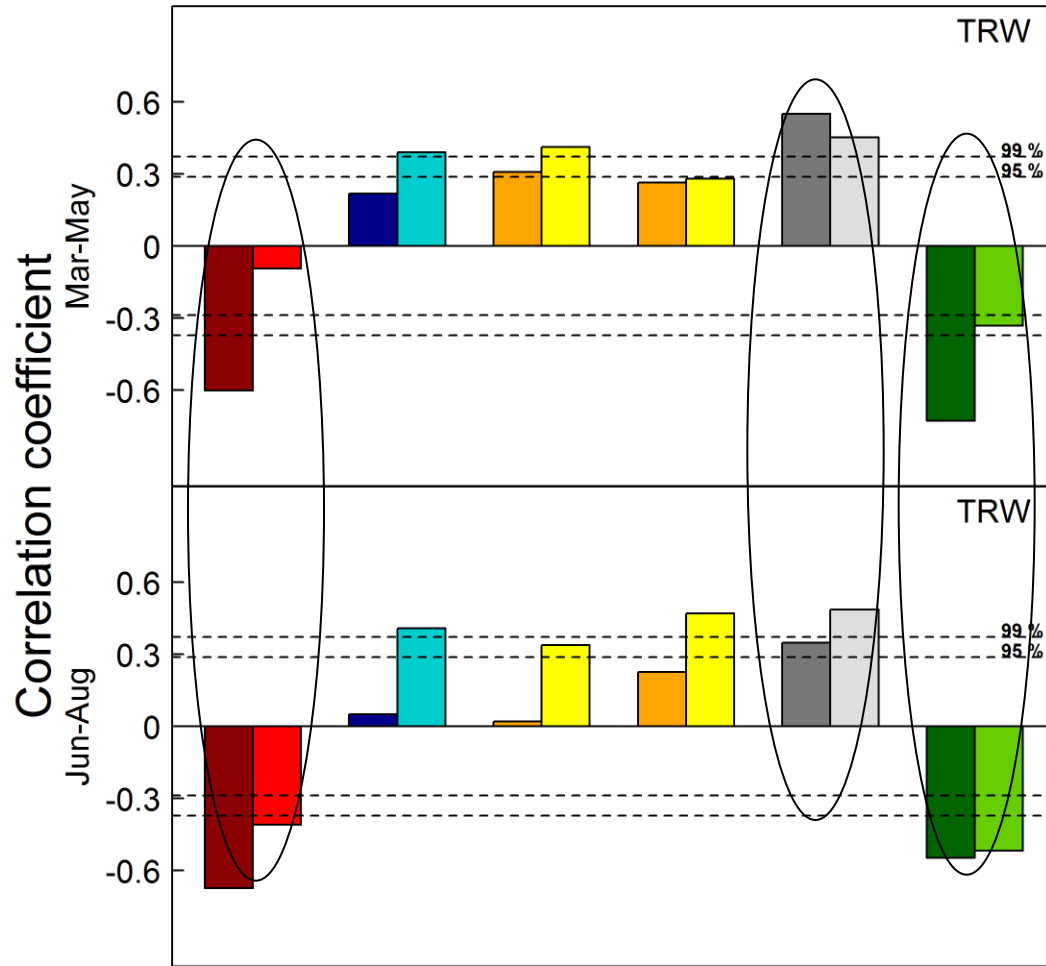
1900-1979: mean = 0.27 ‰; SE = 0.04 ‰

Strong tree-ring growth response for dead trees

1960-2003

Mar-May

Jun-Aug



Dead trees

Control trees

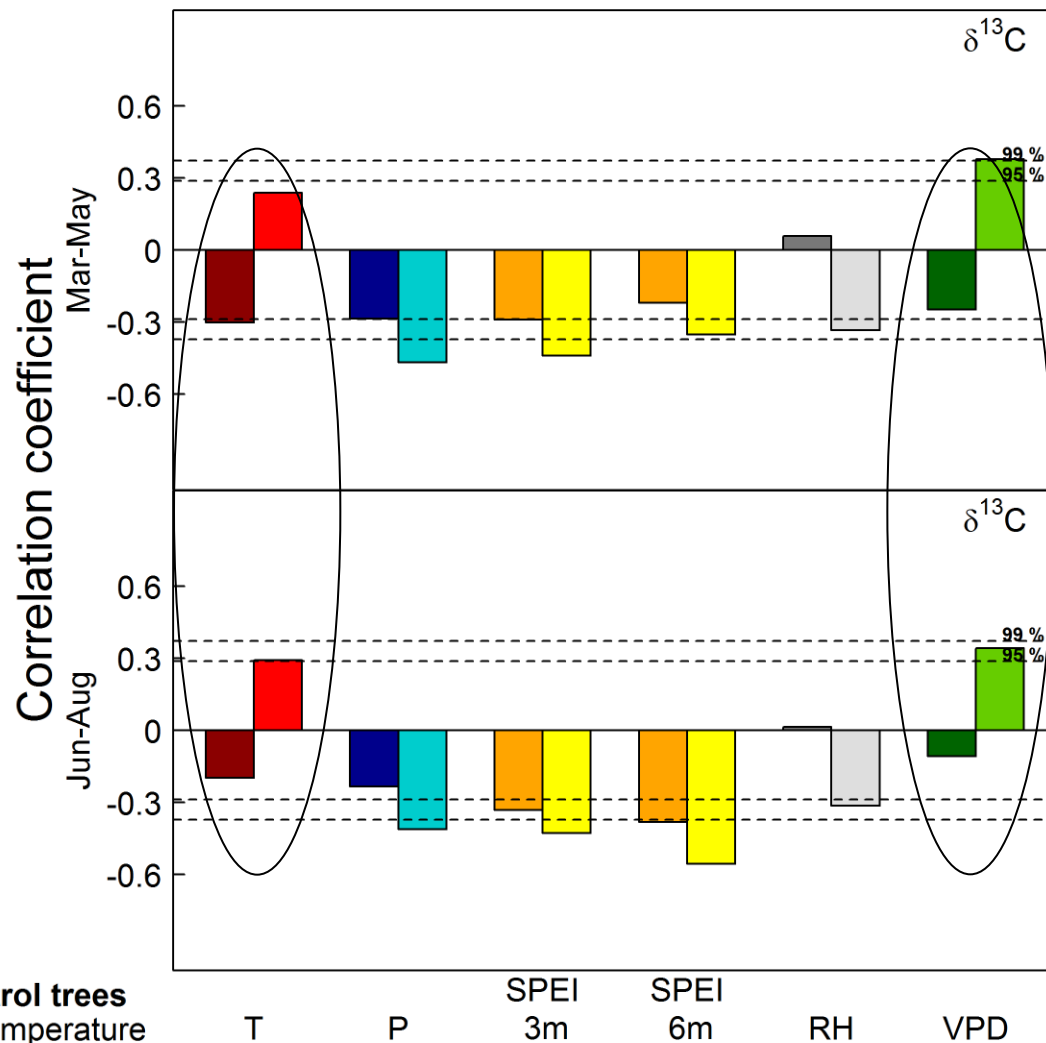
- Temperature
- Precipitation
- 3-month SPEI
- 6-month SPEI
- RH
- VPD

Unexpected $\delta^{13}\text{C}$ response of dead trees – loss of gas-exchange control?

1960-2003

Mar-May

Jun-Aug



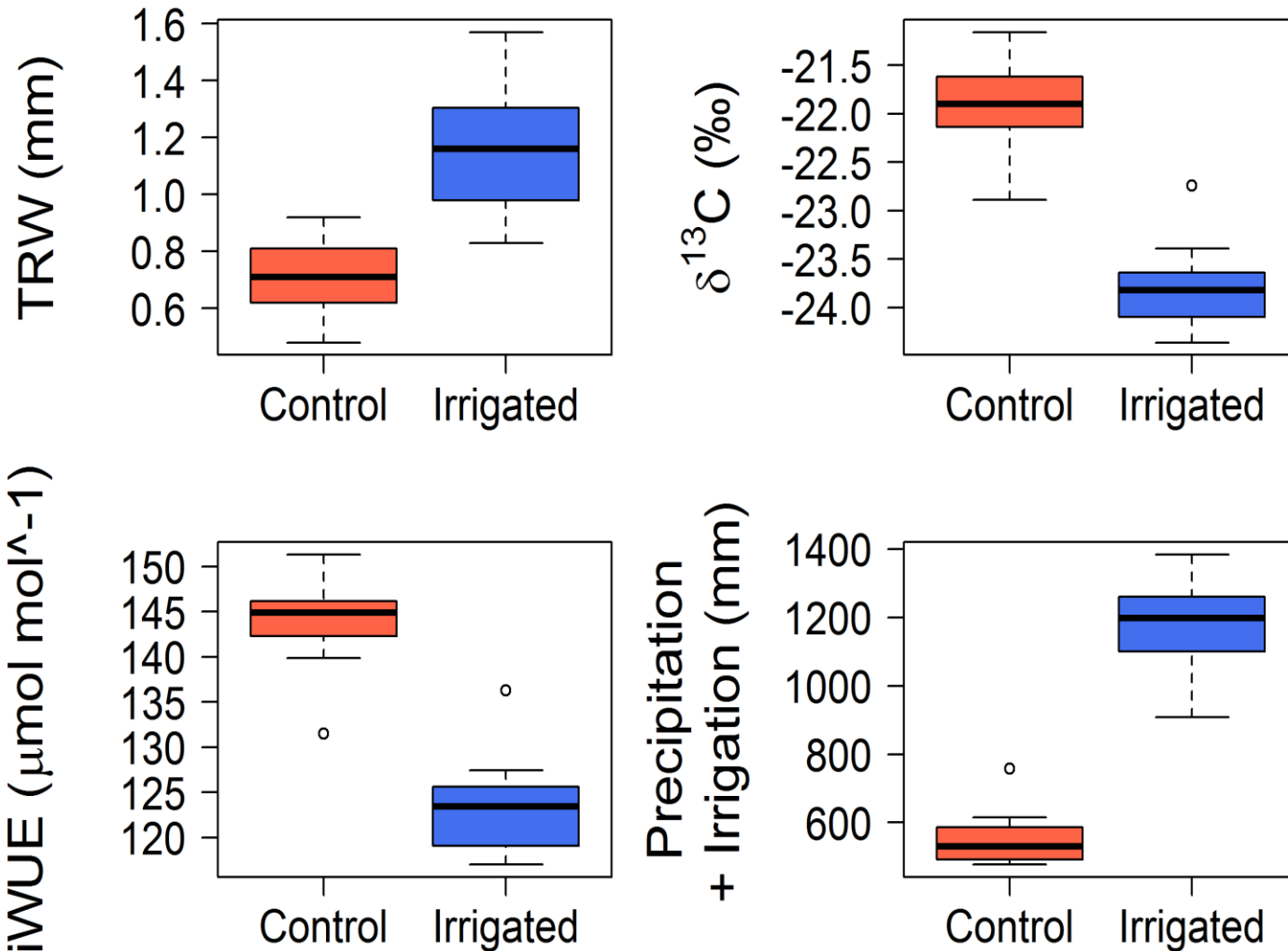
Dead trees

Control trees

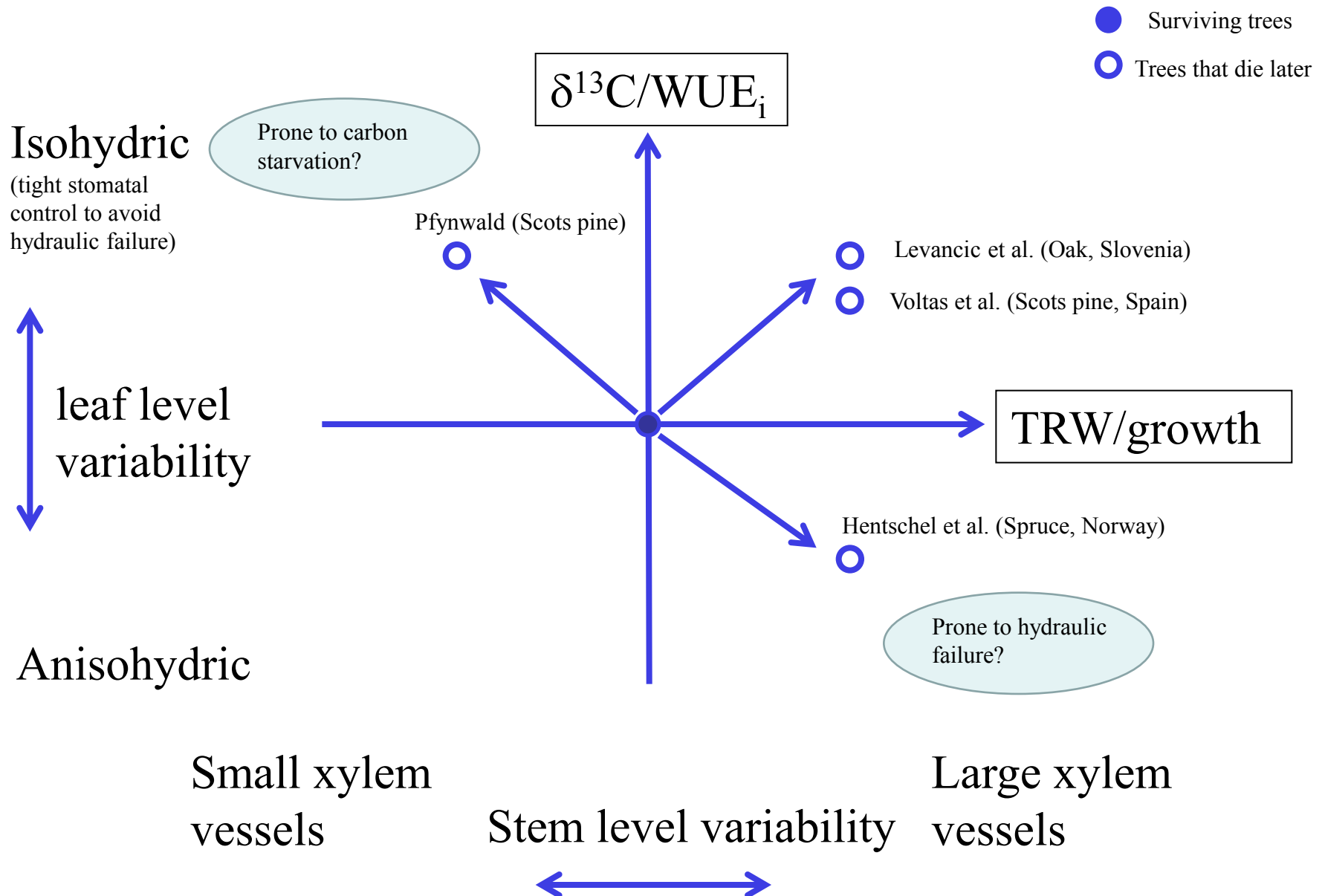
- Temperature
- Precipitation
- 3-month SPEI
- 6-month SPEI
- RH
- VPD

- Temperature
- Precipitation
- 3-month SPEI
- 6-month SPEI
- RH
- VPD

2004-2014



Conceptual framework (for the early life phase of trees)



- Tree-growth was initially lower and WUE higher for dead trees in the early life phase than for living indicating a very conservative water use strategy
- Distinct deviation in tree-ring growth between two groups occurred in the mid-80s when also temperature and VPD started to increase
- Different response in $\delta^{13}\text{C}$ to temperature and VPD than normally expected for dead trees and lower WUE in the late life phase might indicate loss of gas-exchange control
- Decline and possibly eventual mortality was a long-term process for dead trees most likely due to continuous weakening
- Irrigation strongly improves tree-ring growth and plant function

Thank you for your attention!

