Long-term irrigation in a drought-prone pine forest accelerates carbon cycling and leads to vertical redistribution of SOC

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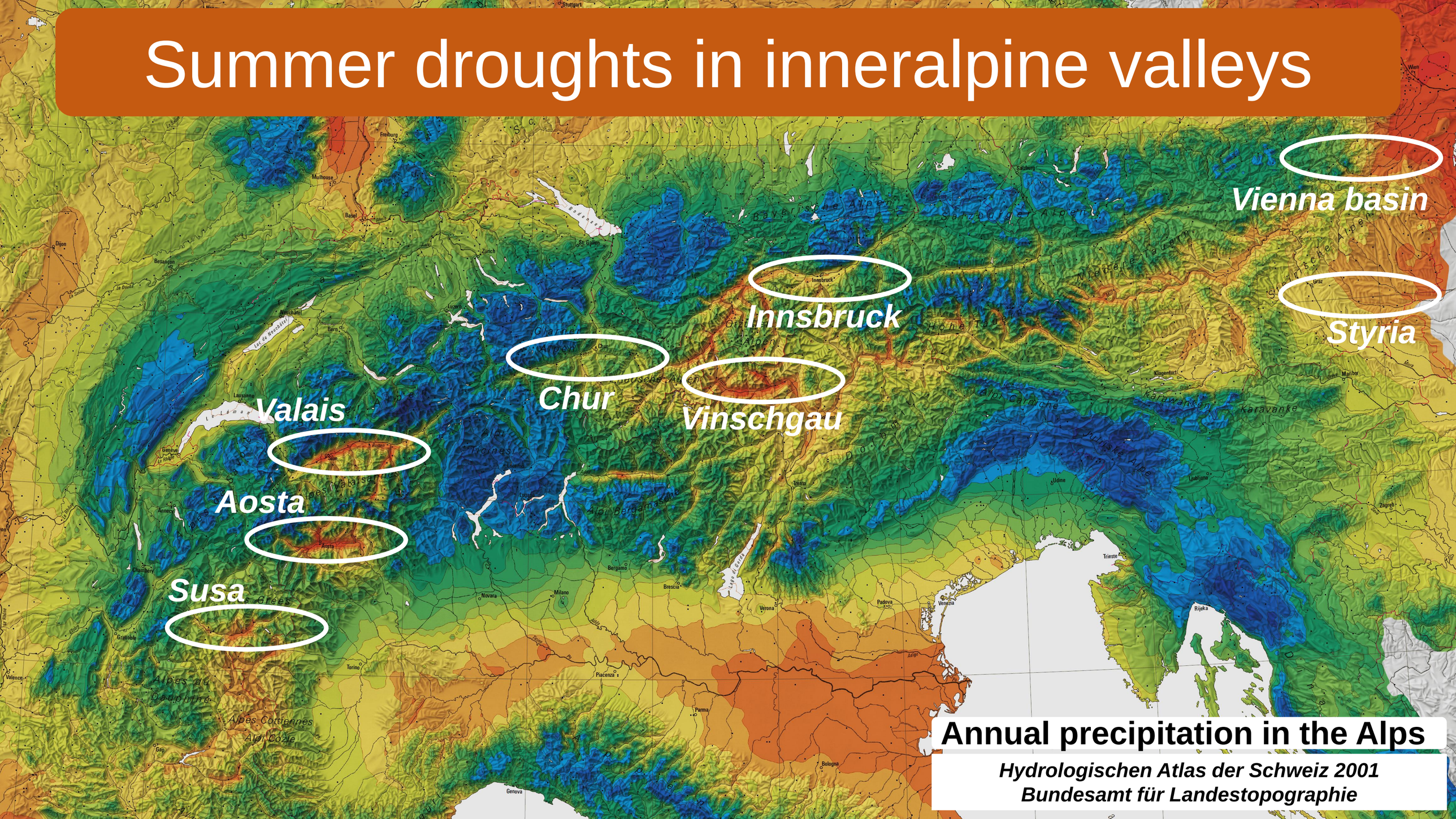
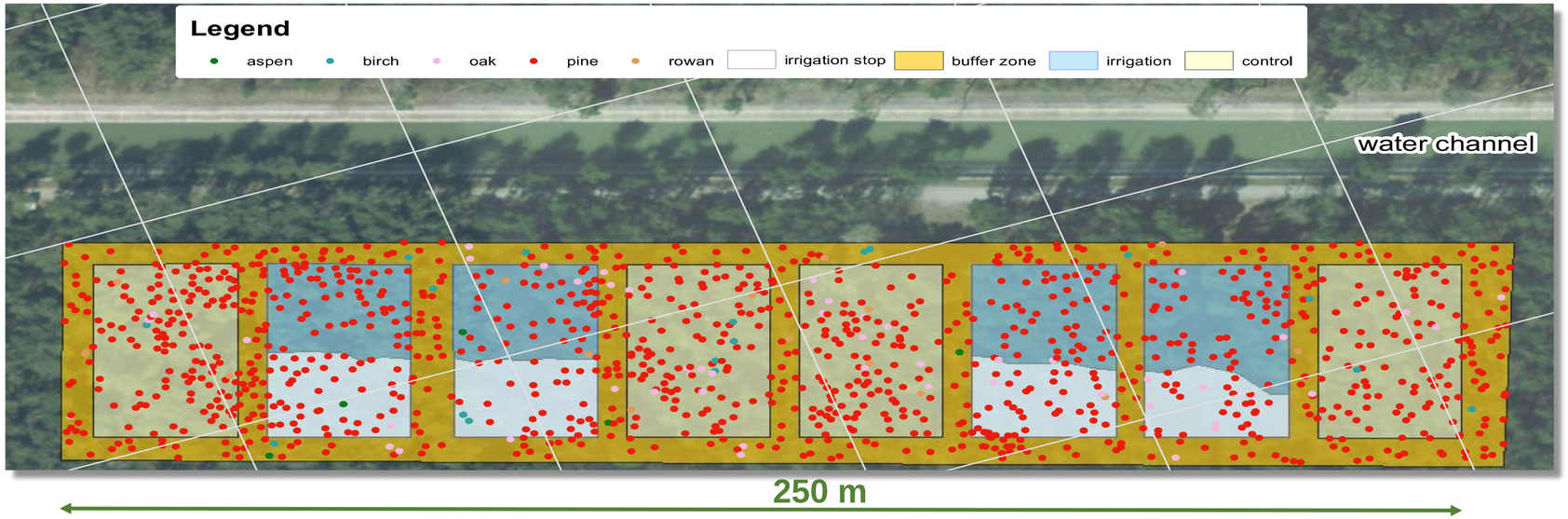
Summer droughts in inneralpine valleys



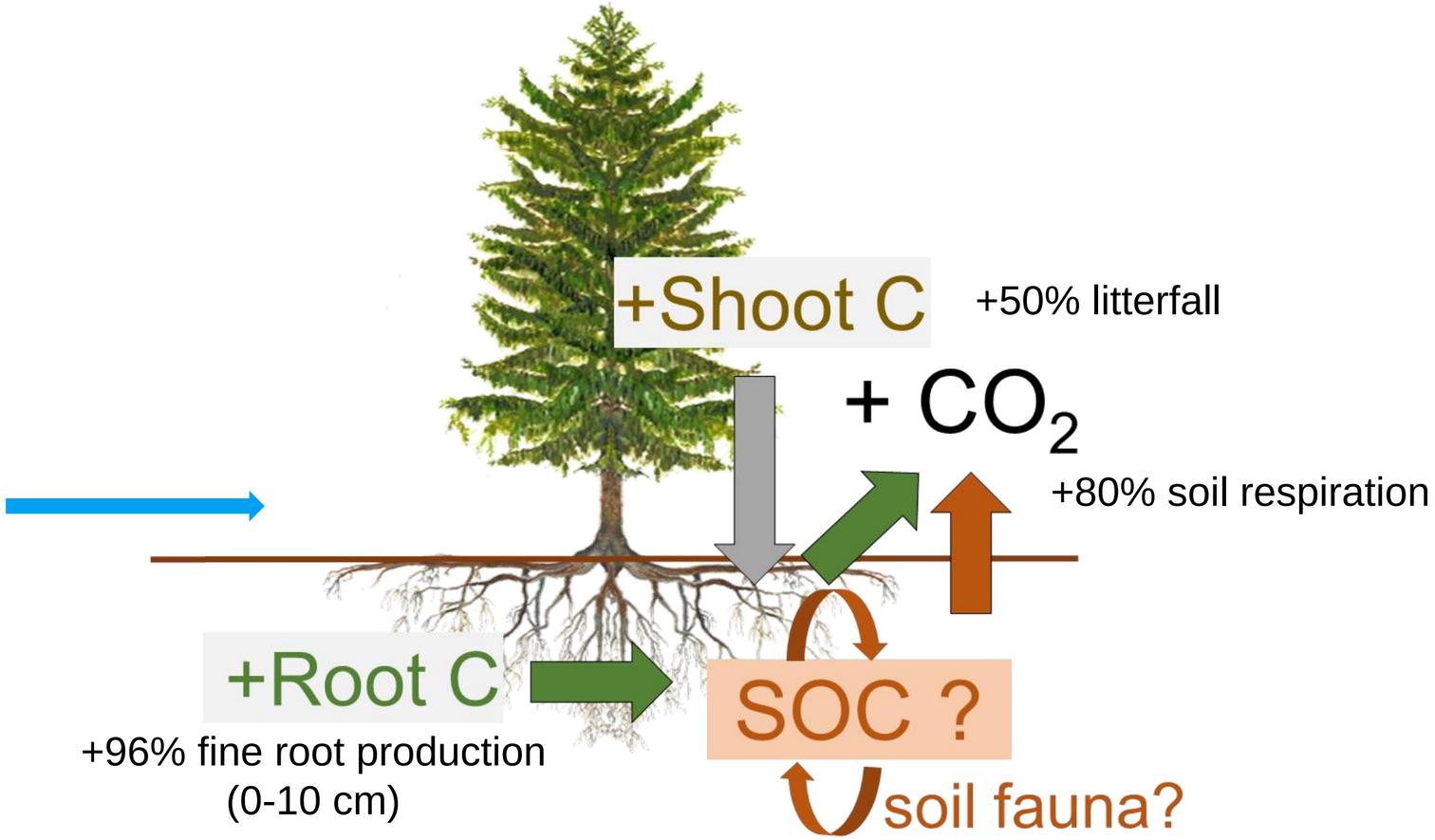
Pfynwald long-term irrigation experiment



- Dry pine forest, Valais, Switzerland (MAP = 576 mmm)

- 4 plots: Irrigated since 2003 (+600 mm yr^{-1}, May-October)
  → *Removal of water limitation*
- 4 plots: Dry (control)

Effects of water limitation on SOM cycling



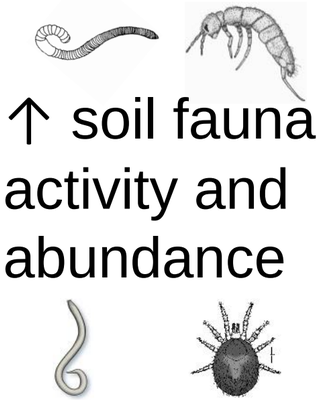
Brunner et al., 2019
Hartmann et al., 2017

Objectives

What is the impact of water limitation on **SOC storage**?
And what is the role of **soil fauna**?

Hypothesis

Irrigated forest

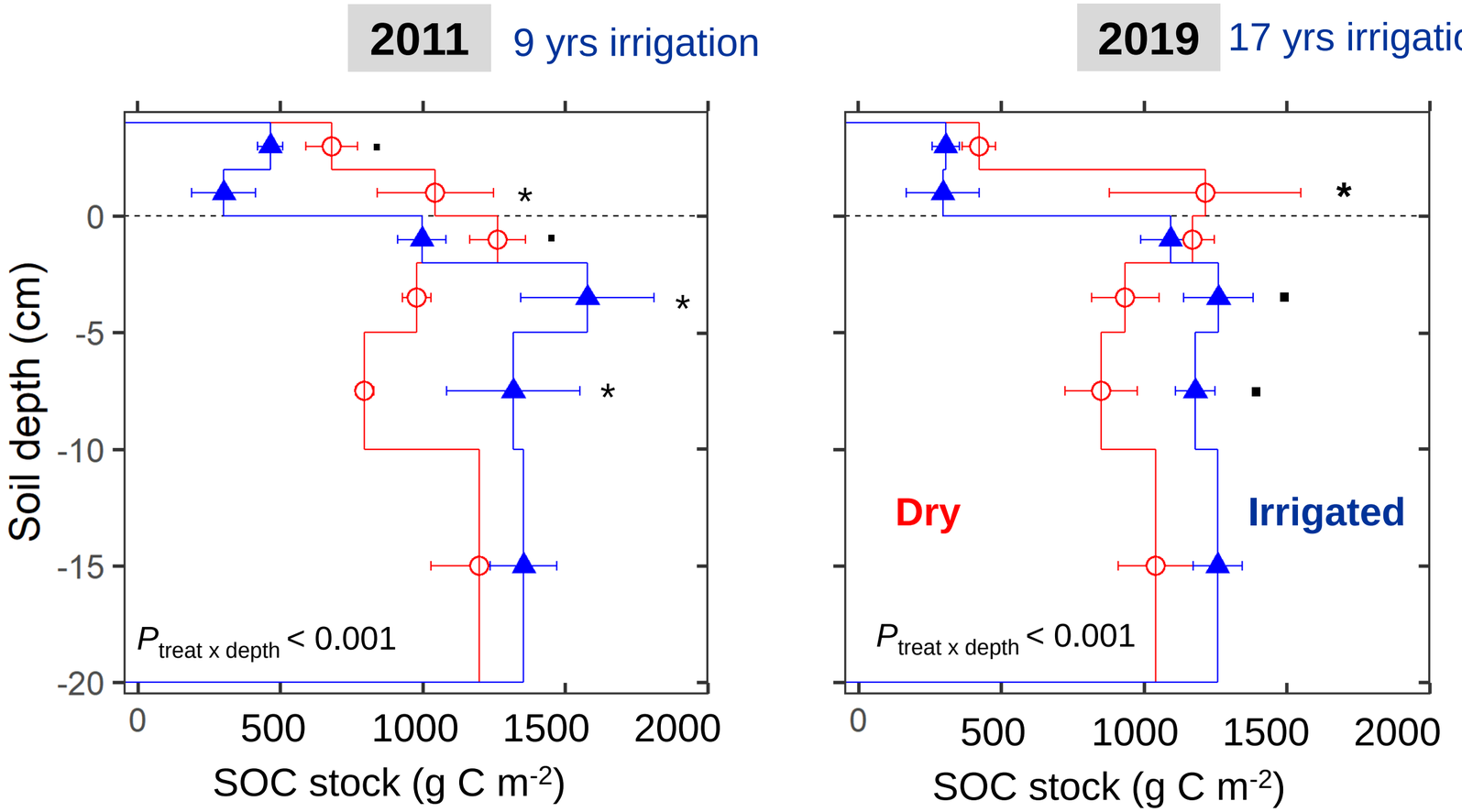


↑ soil fauna activity and abundance

↑SOC cycling
↑ litter translocation

↑ C stocks in mineral soil?

Irrigation leads to a vertical SOC redistribution



Organic layer

~0.8-1 kg C m^{-2}

Mineral soil

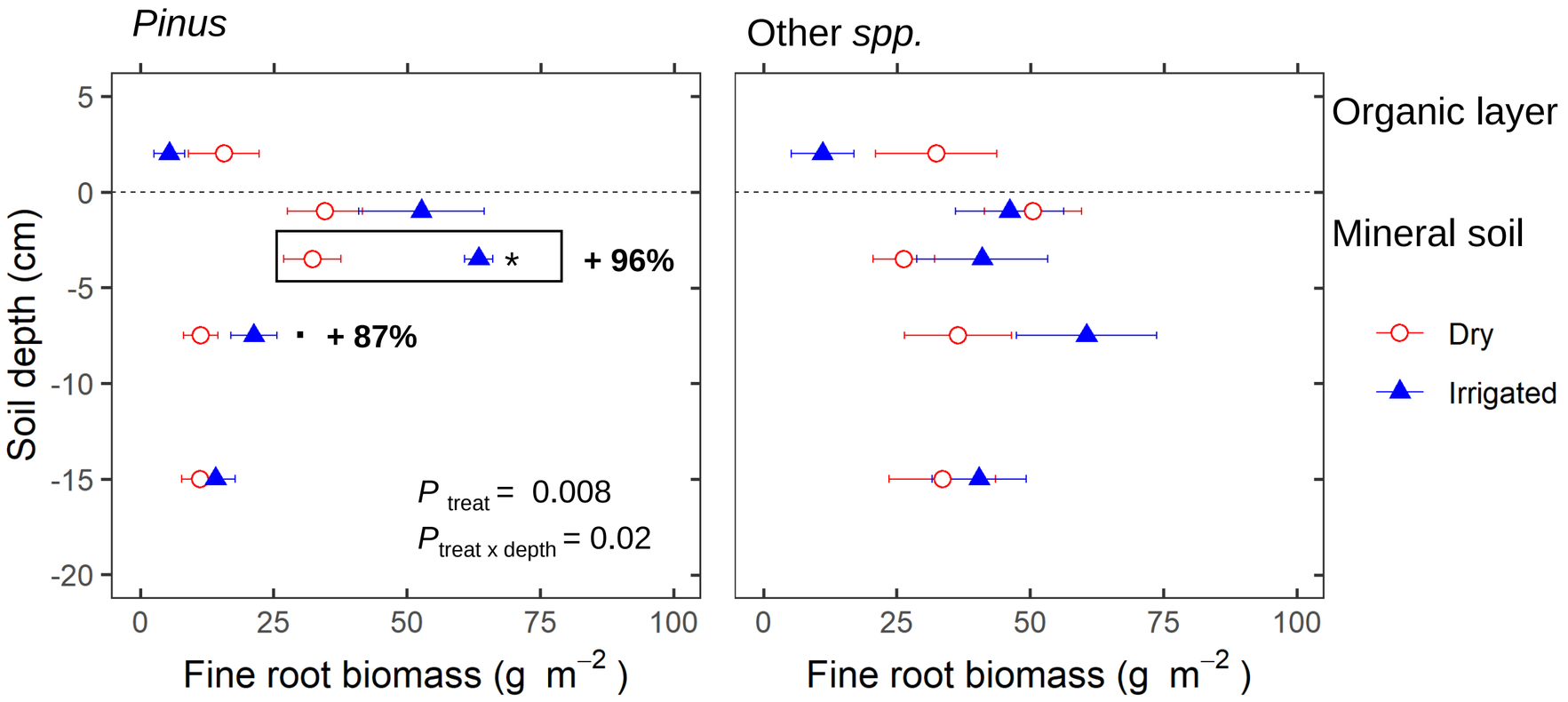
DOC leaching
Roots
Soil fauna

n = 4 plots per treatment, with 4 soil pits per plot

Guidi et al., in prep

Pine fine root biomass increases under irrigation

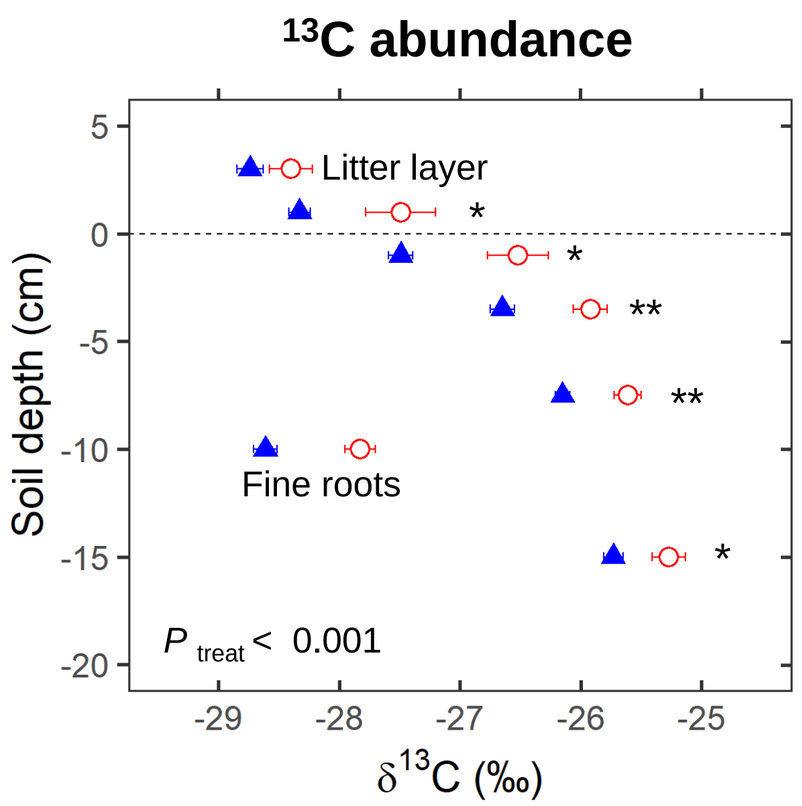
2019 17 yrs irrigation: + 25% total fine root biomass

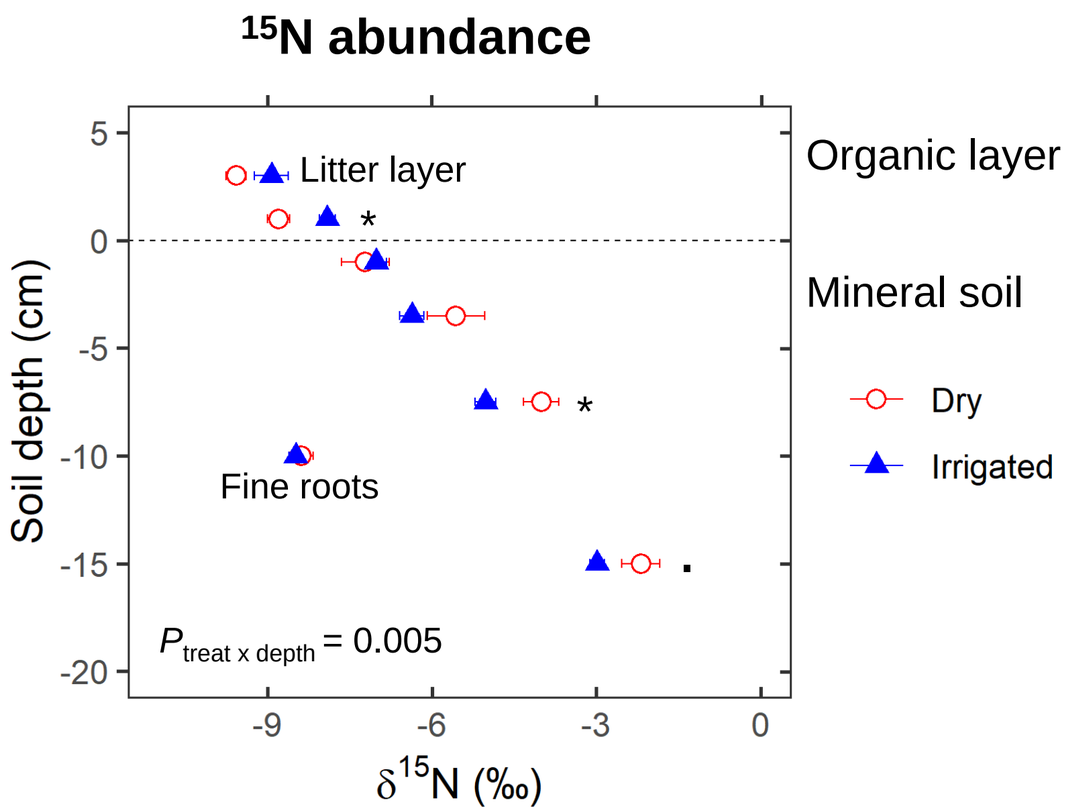


Guidi et al., in prep

Irrigation changes isotopic SOM composition

2019 17 yrs irrigation





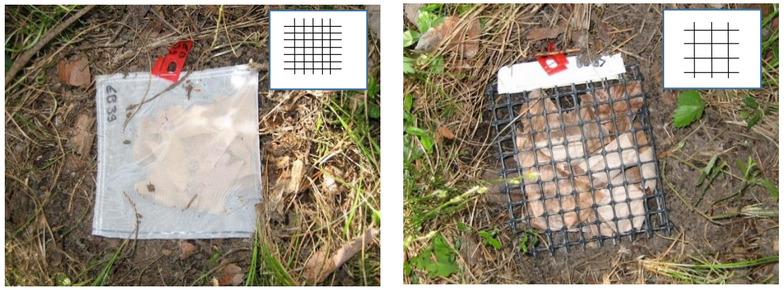
Guidi et al., in prep

Irrigation accelerates faunal-mediated litter decomposition

2014 **May → October**

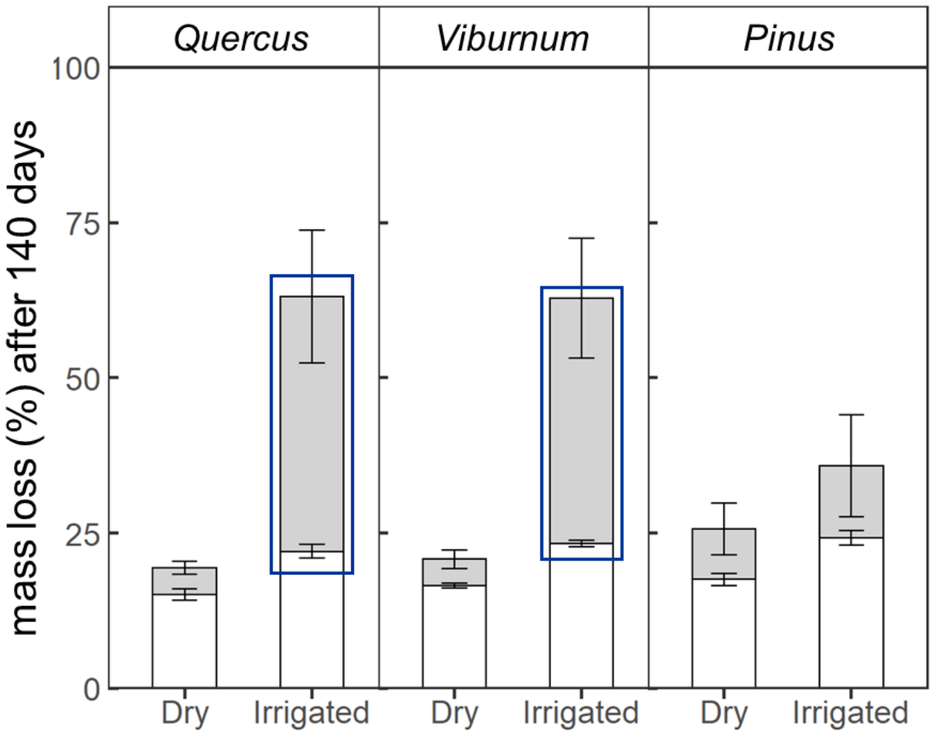
Species *Quercus, Viburnum, Pinus*

Micro *vs*. Macrofauna



Irrigation

Master thesis M. Vogel, 2015



Macro- and mesofauna

Microfauna and microbes

↑ 10x macro- and mesofauna mediated litter mass loss

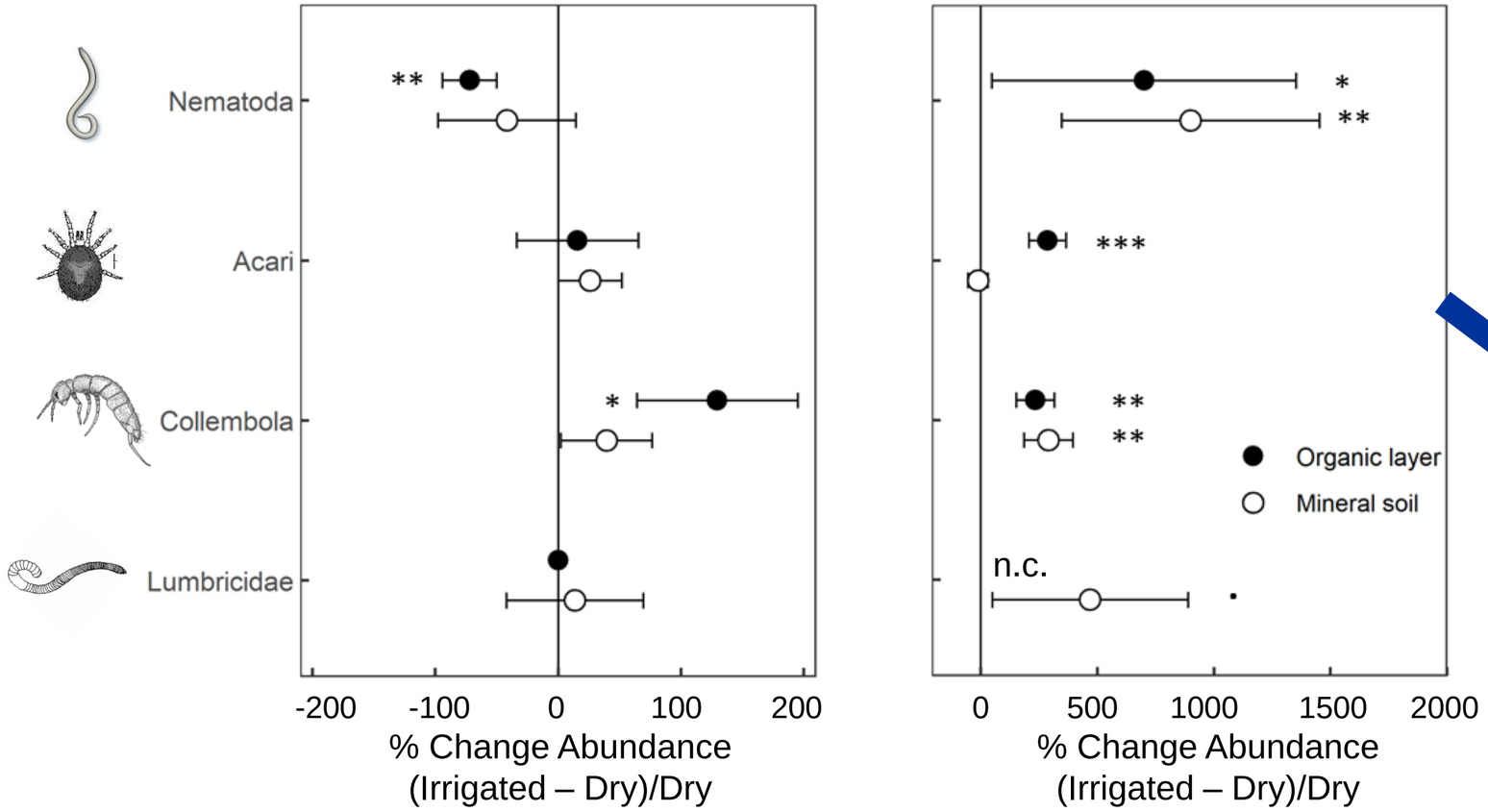
Guidi et al., in prep

Soil fauna abundance is highly sensitive to the removal of water limitation

2015

May before start of irrigation

July during irrigation period



2-10x increase in the abundance of the main decomposer organisms

Gravimetric SWC

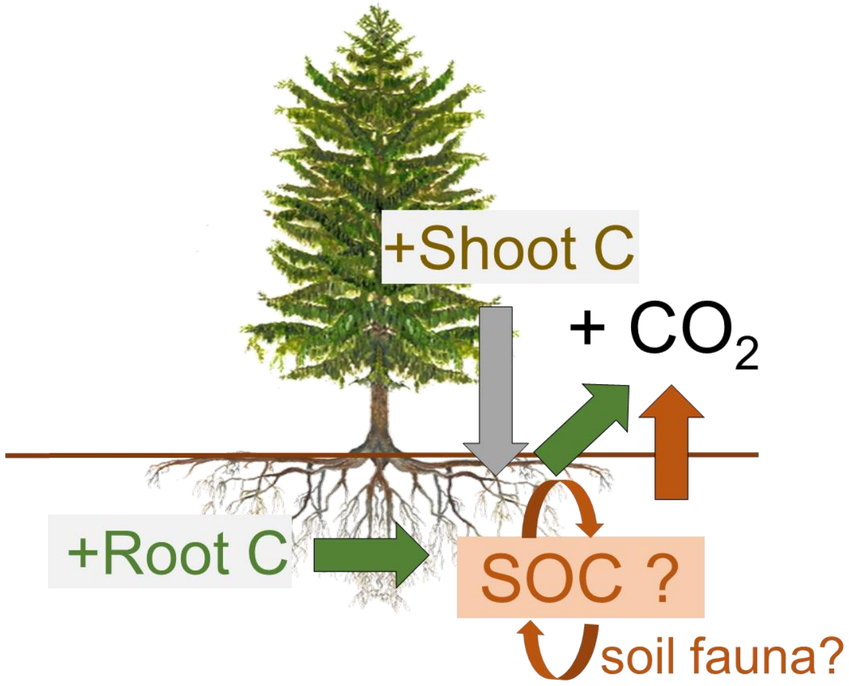
50% Dry
59% Irrigated

15% Dry
31% Irrigated

Guidi et al., in prep

Bachelor thesis T. Stucky, 2015

Take-home messages



Under long-term irrigation:

Redistribution of SOC:
C losses from organic layers, C gain in mineral soil

↑Soil fauna abundance and activity after removal of water limitation

Under naturally dry conditions:

↓ faunal-mediated litter C translocation from organic layers to mineral soil

↓ belowground C to microbes
(Gao et al., 2021, Hartmann et al., 2017)

THANK YOU! QUESTIONS?

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