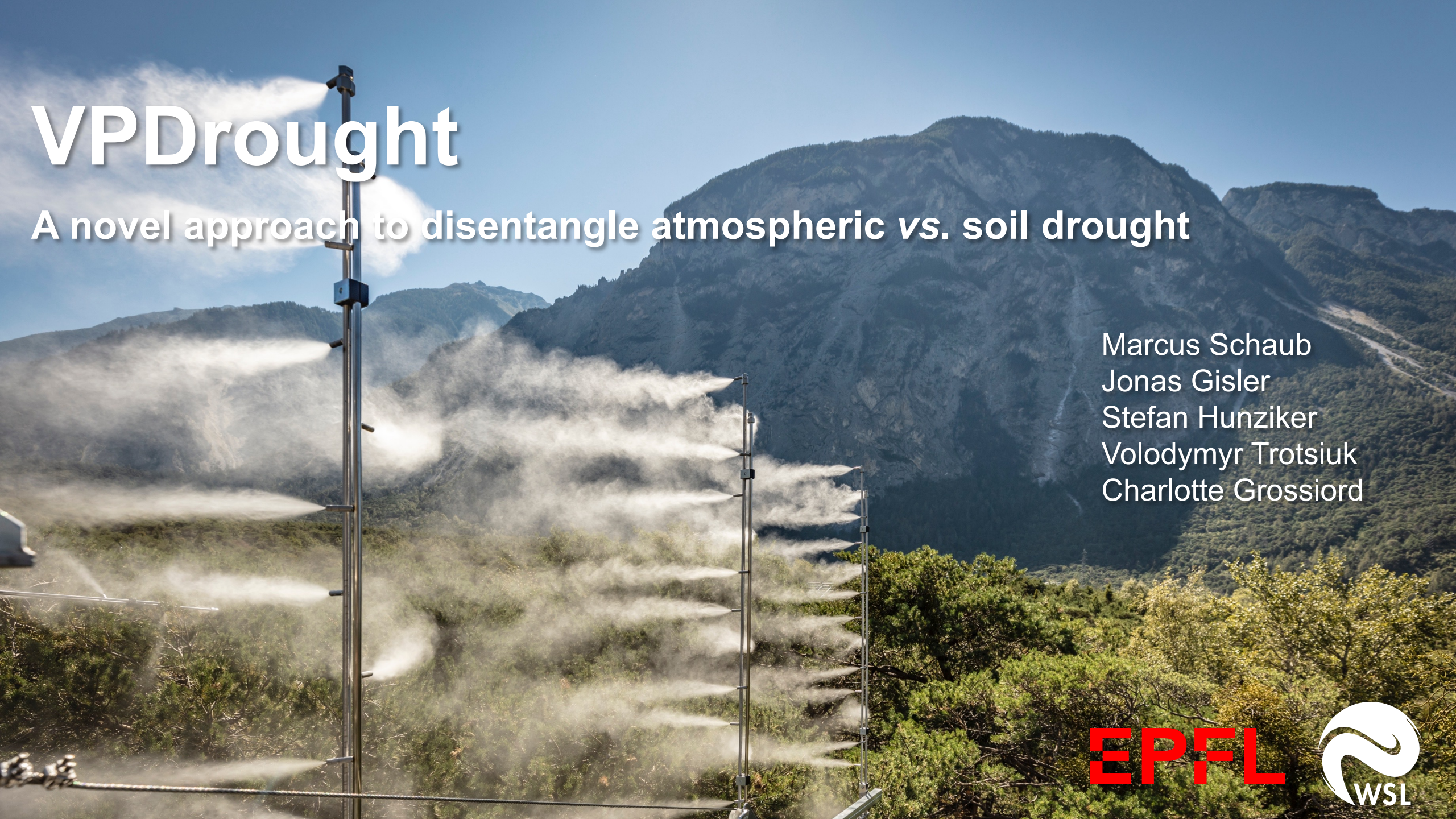


VPDrought

A novel approach to disentangle atmospheric *vs*. soil drought

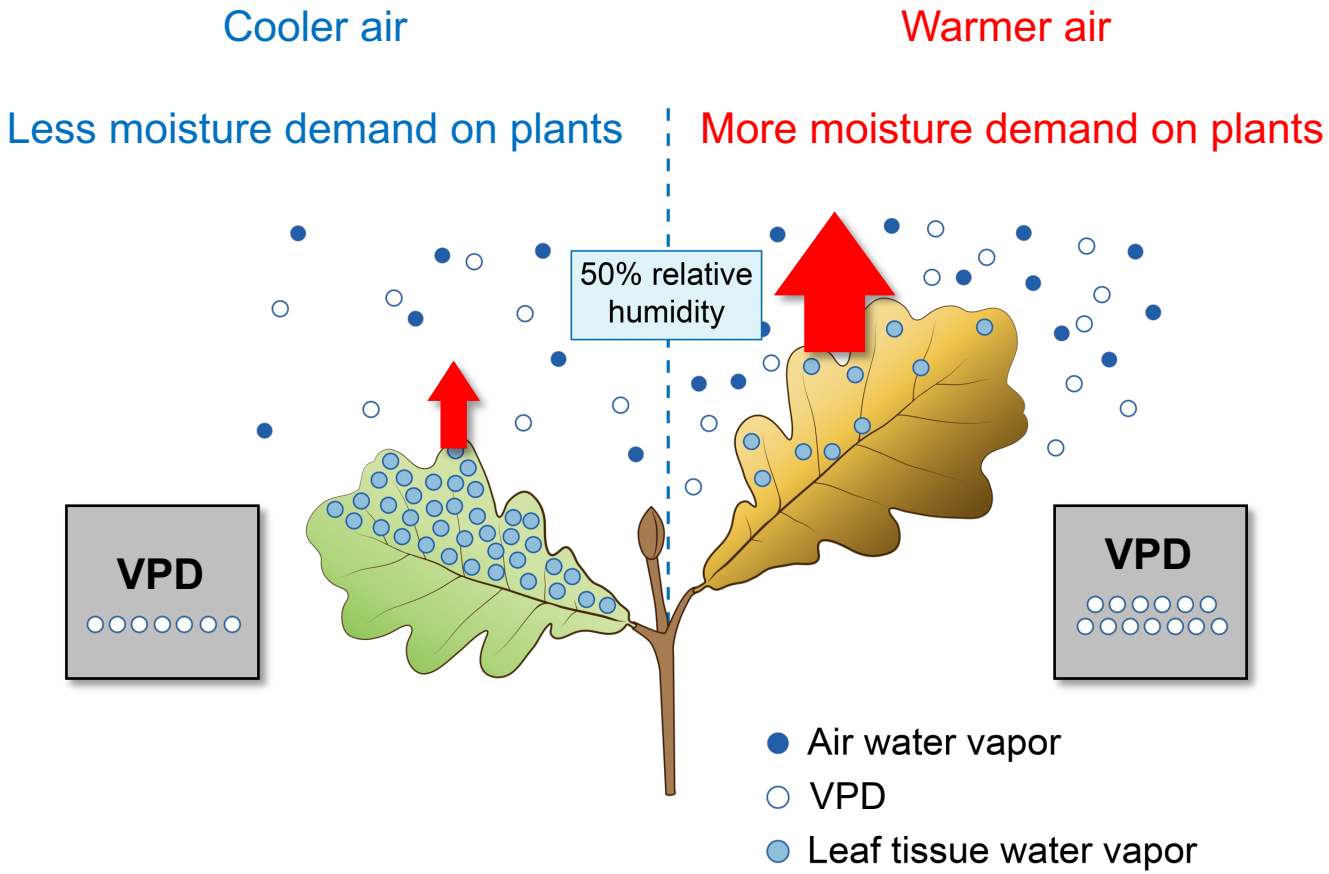
Marcus Schaub
Jonas Gisler
Stefan Hunziker
Volodymyr Trotsiuk
Charlotte Grossiord

EPFL

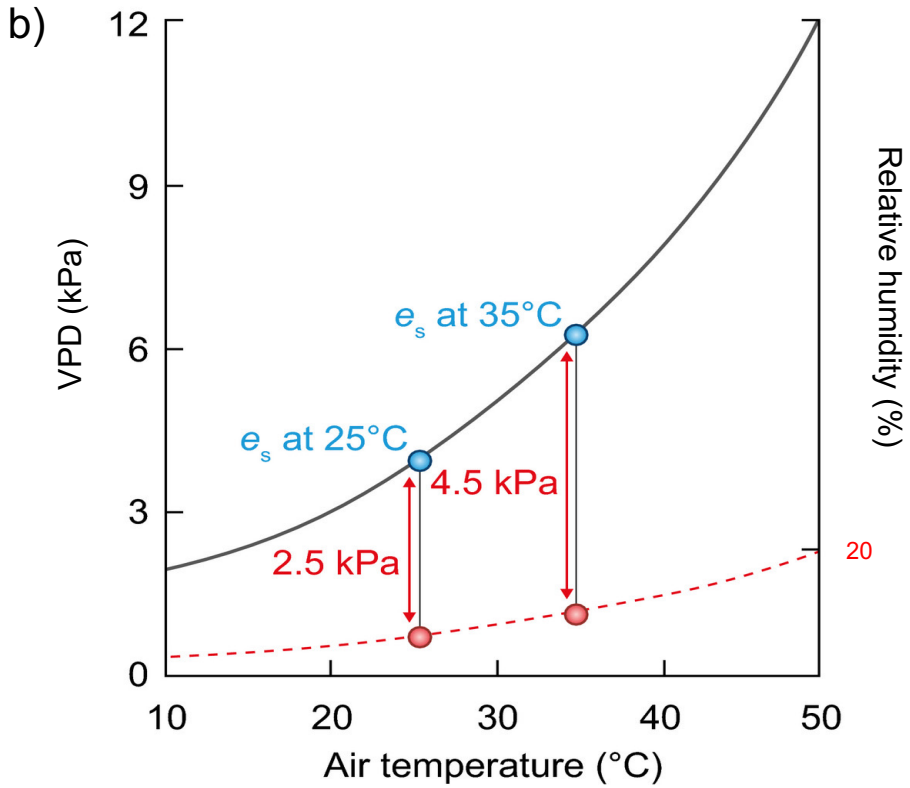
WSL

Vapor pressure deficit (VPD)

$$VPD = e_s - e_a = (611\exp(17.27 \times \mathbf{T} / 237.3 + \mathbf{T})) - (\mathbf{RH} \times e_s/100)$$

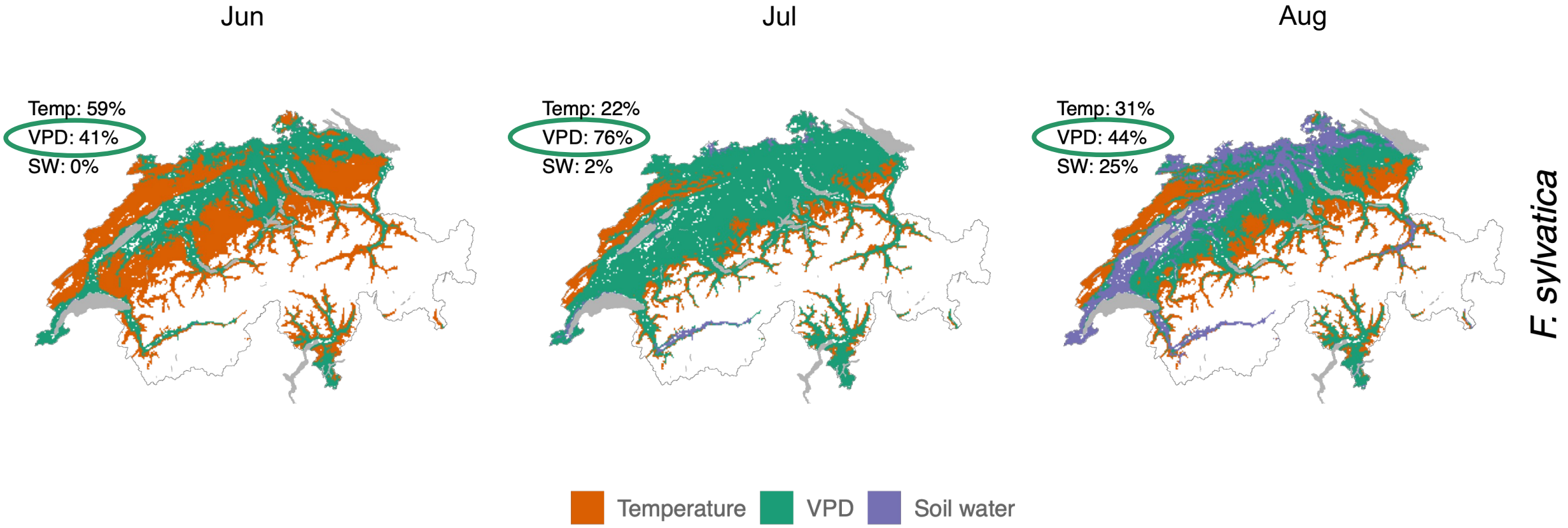


USGCRP, 2018



Grossiord *et al*. (2020) *New Phytologist*

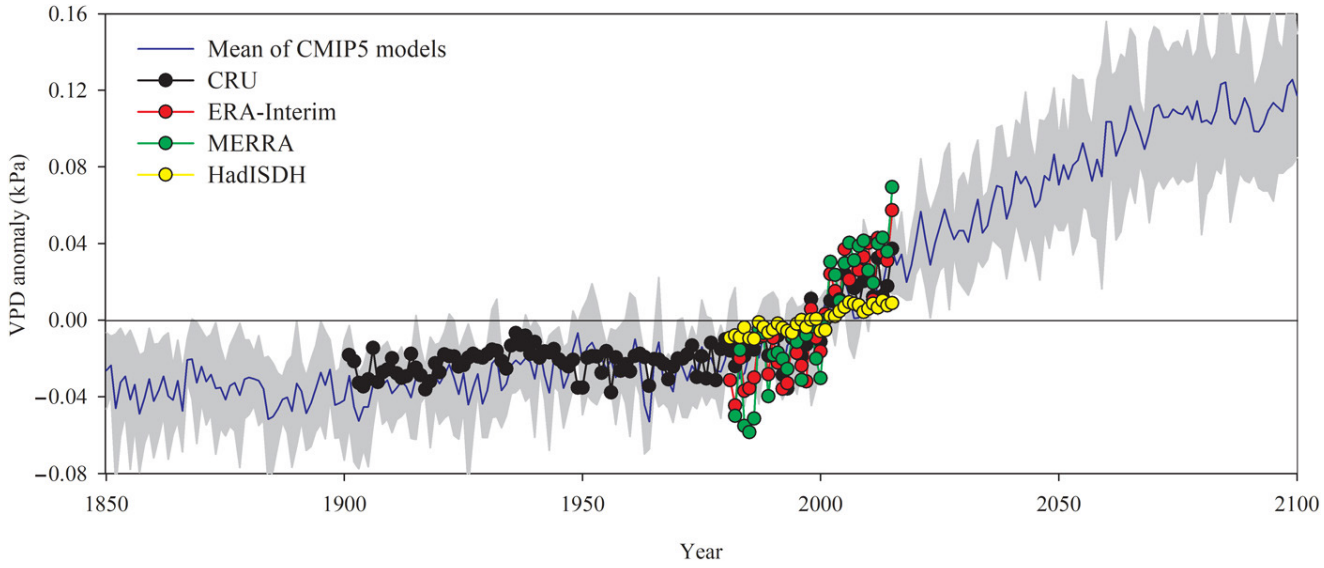
Tree growth constraints by T, VPD and SWC in 1991-2018



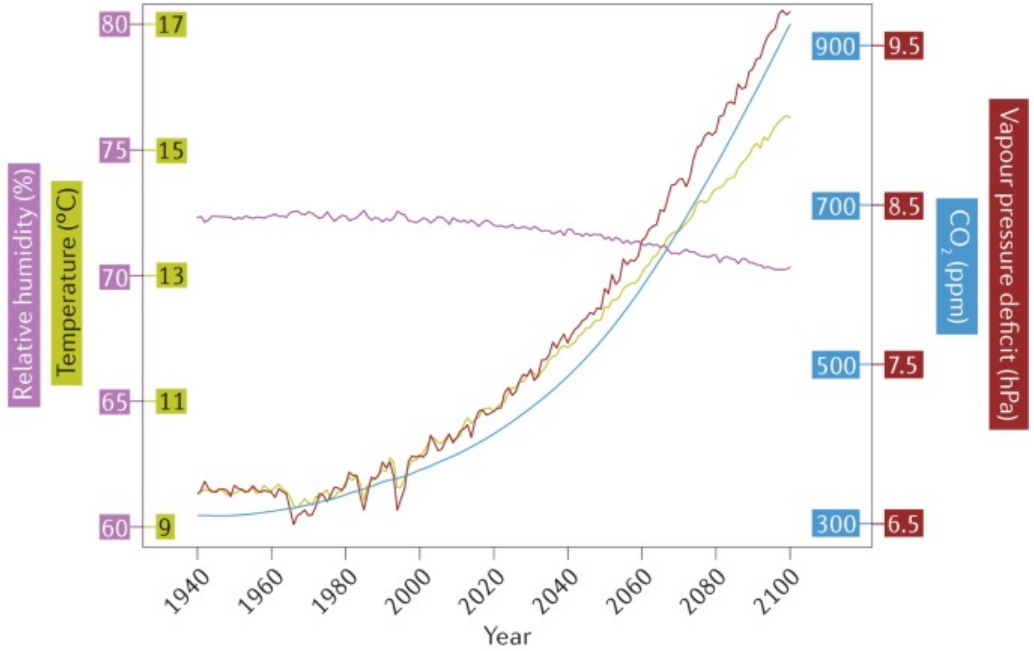
Trotsiuk *et al.* (2021) *Journal of Ecology*

Future VPD …

Yuan *et al*. (2019) *Science*
Global mean VPD anomalies – relative to 1982-2015 – of vegetated area over the growing season.



McDowell *et al.* (2022) *Nature*
Average simulated CO_2, T, RH and VPD from 1940 – 2100.



Swiss National Science Foundation

WSL

VPDrought

- 2022 Funding
- 2023 Permissions & test system
- 2024-2029
- Multiple stresses (VPD x SWC)
- 20-30% VPD reduction

➢ Processes and ecosystem understanding

➢ Long-term experimental research platform Pfynwald

"How do changes in atmospheric vs. soil drought affect Pinus sylvestris from molecular to ecosystem level?"

Marcus Schaub & Charlotte Grossiord

SWISS FOREST LAB

UNI BASEL

EPFL

ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich

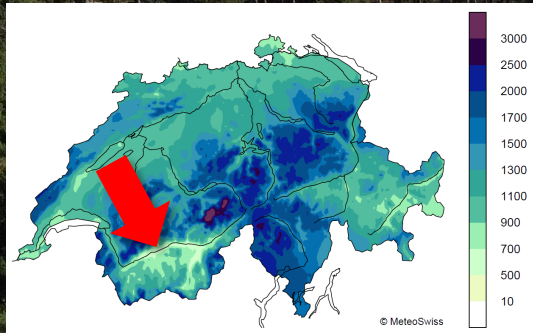
PFYN-FINGES NATURPARK WALLIS PARC NATUREL VALAIS

Forst Region Leuk

FMV

The Long-term Irrigation Experiment Pfynwald

- Natural, even aged, xeric Scots pine forest in the Rhone Valley
- 876 *Pinus sylvestris* trees / ha
- Natural precipitation < 600 mm/year (driest region in CH)
- Since 2003 irrigation (+ 600 mm/year)
- Since 2014 irrigation-stop on 1/3 of each irrigated plot
- 30 individual tree- & ecosystem-level traits (Bose *et al*. 2021)



Plot design

2003 — 2014 — 2024 — 2029

Soil Treatments

- Control
- Irrigation
- Drought
- Irrigation-Stop

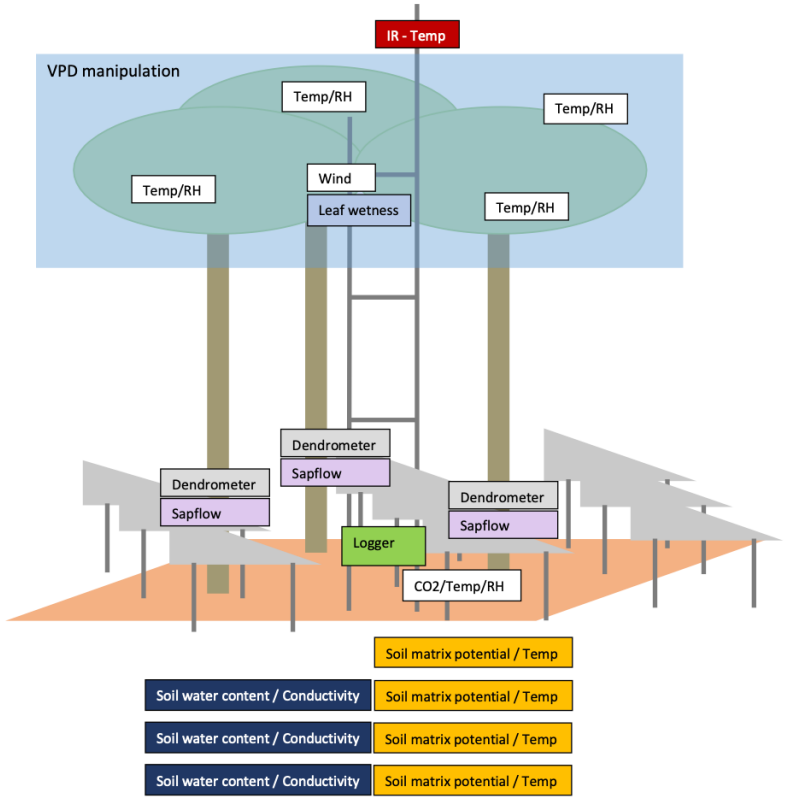
Atmospheric Treatments

- Control
- Reduced VPD

Infrastructure

- 18 Measurement scaffolds
- 6 VPD manipulation scaffolds
- 6 Rainout shelters

Treatment combinations



Example: Drought & Reduced VPD

Replicates: 3 scaffolds x 3 trees

Atmosphere / Soil	Control	Reduced VPD
Drought		
Control		
Irrigation-Stop		
Irrigation		

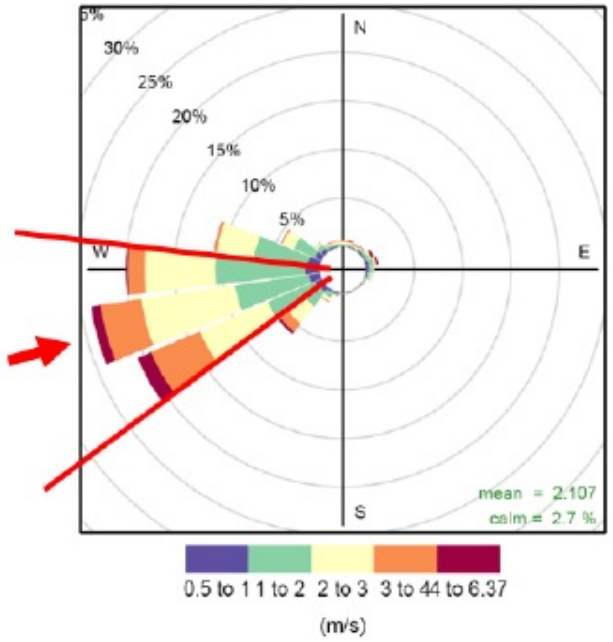
System control

- **VPD = f(T, RH)**
- **Stable wind conditions**
  Wind direction: 285° +/- 50°
  Wind speed: <0.1 m/s

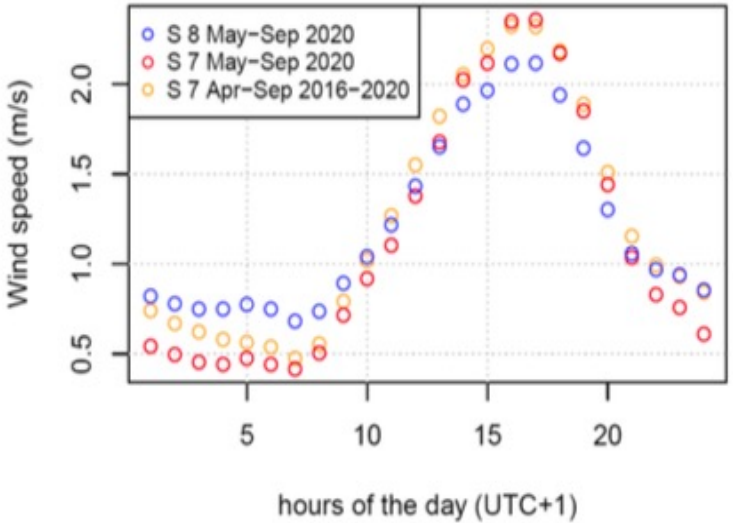
➢ **Continuous adjustment of system**

- **Capacity**: 1.5 – 10 L/m²/h
- **Dimension:** 5 x 10 m nozzle field

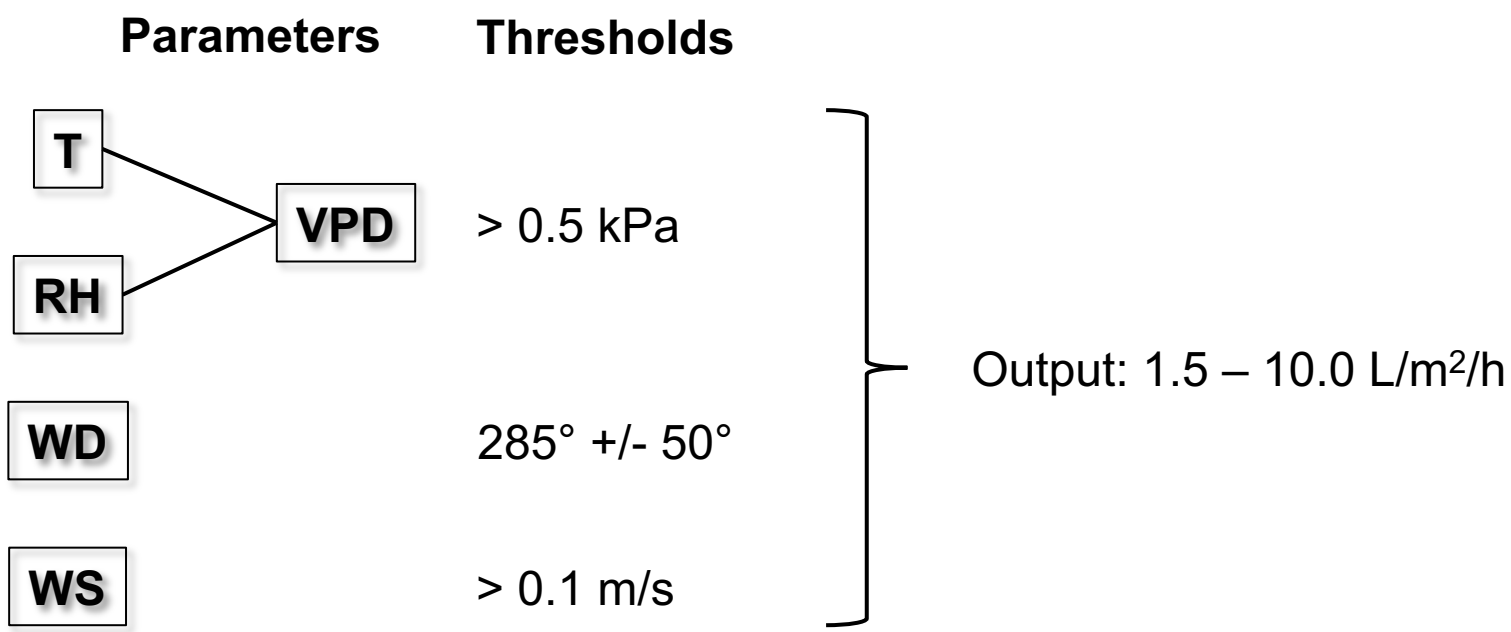
Wind direction at 15-16 UTC+1



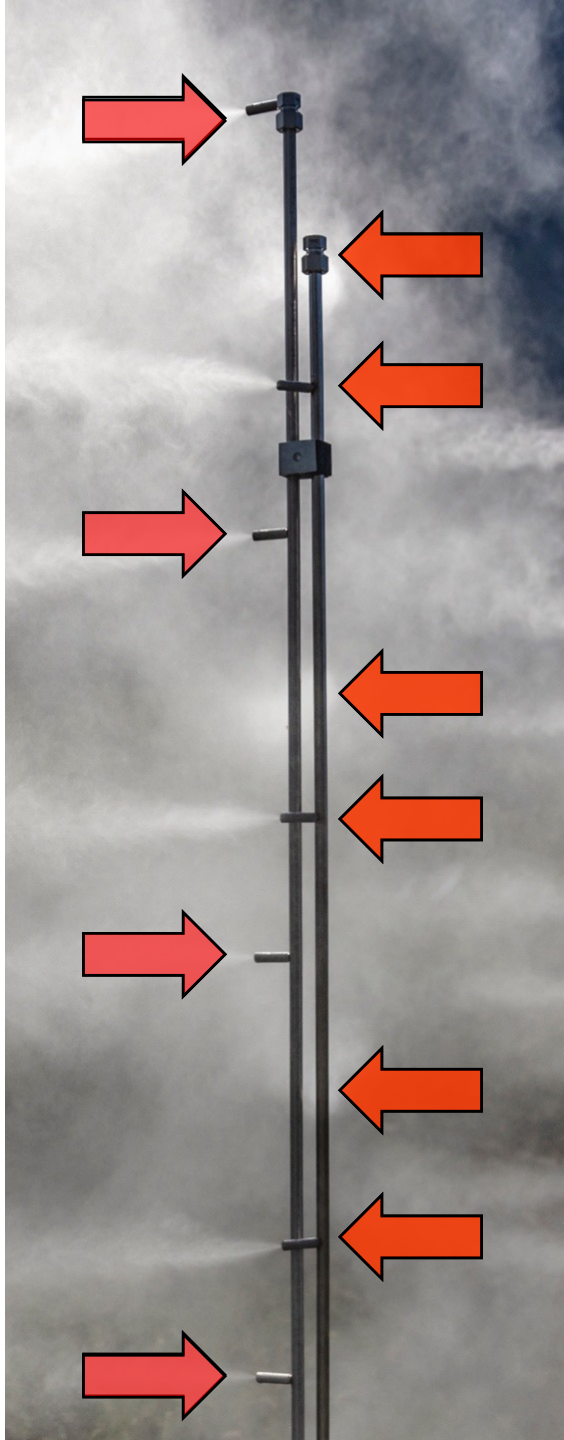
Diurnal wind speed



System control parameters



Level	Circle	Pressure (bar)	Output (l/m²)
1	1	70 – 150	1.5 – 3.5
2	2	70 – 150	3.6 – 6.5
3	2 & 1	70 – 150	6.6 – 10.0

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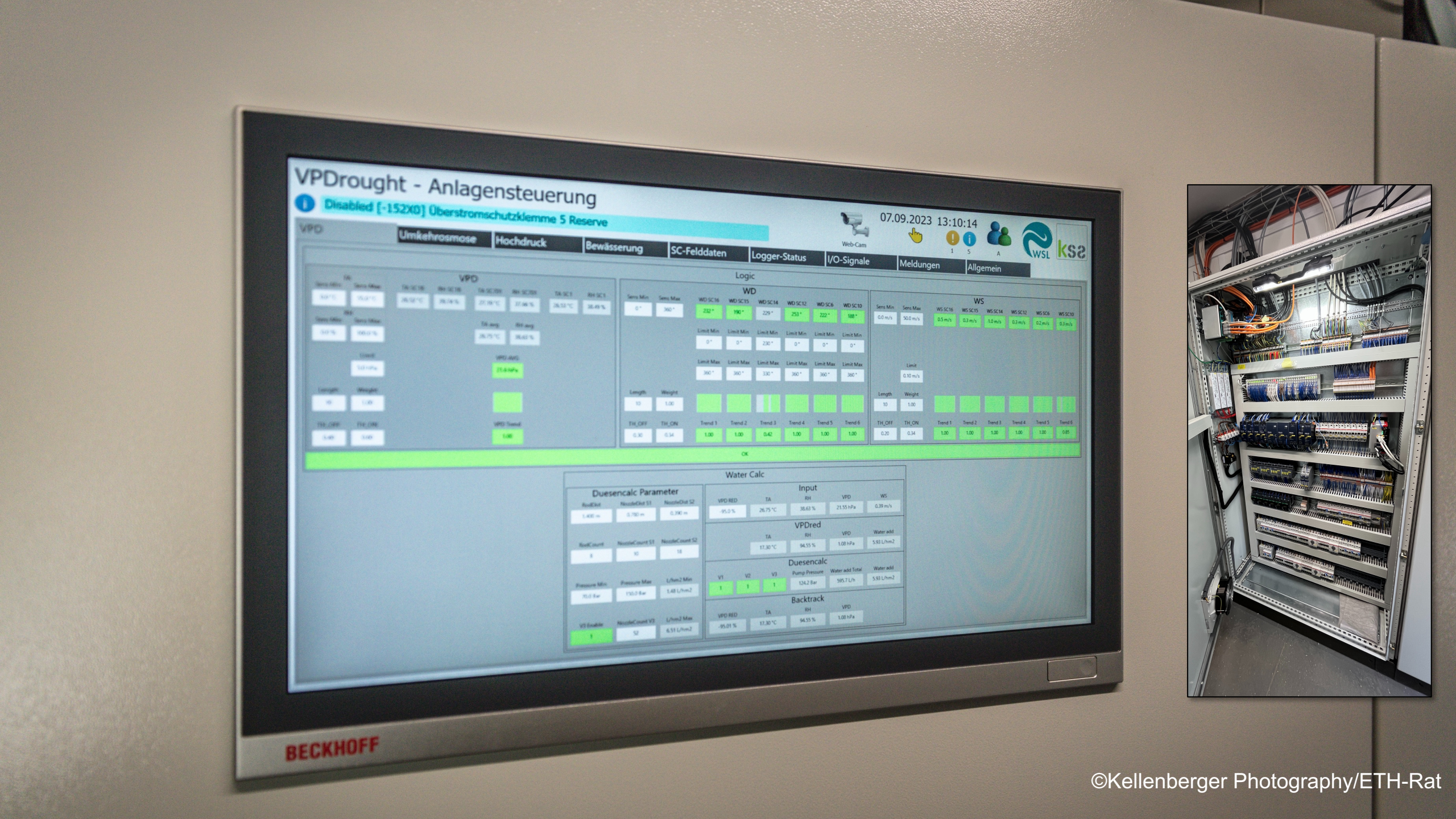
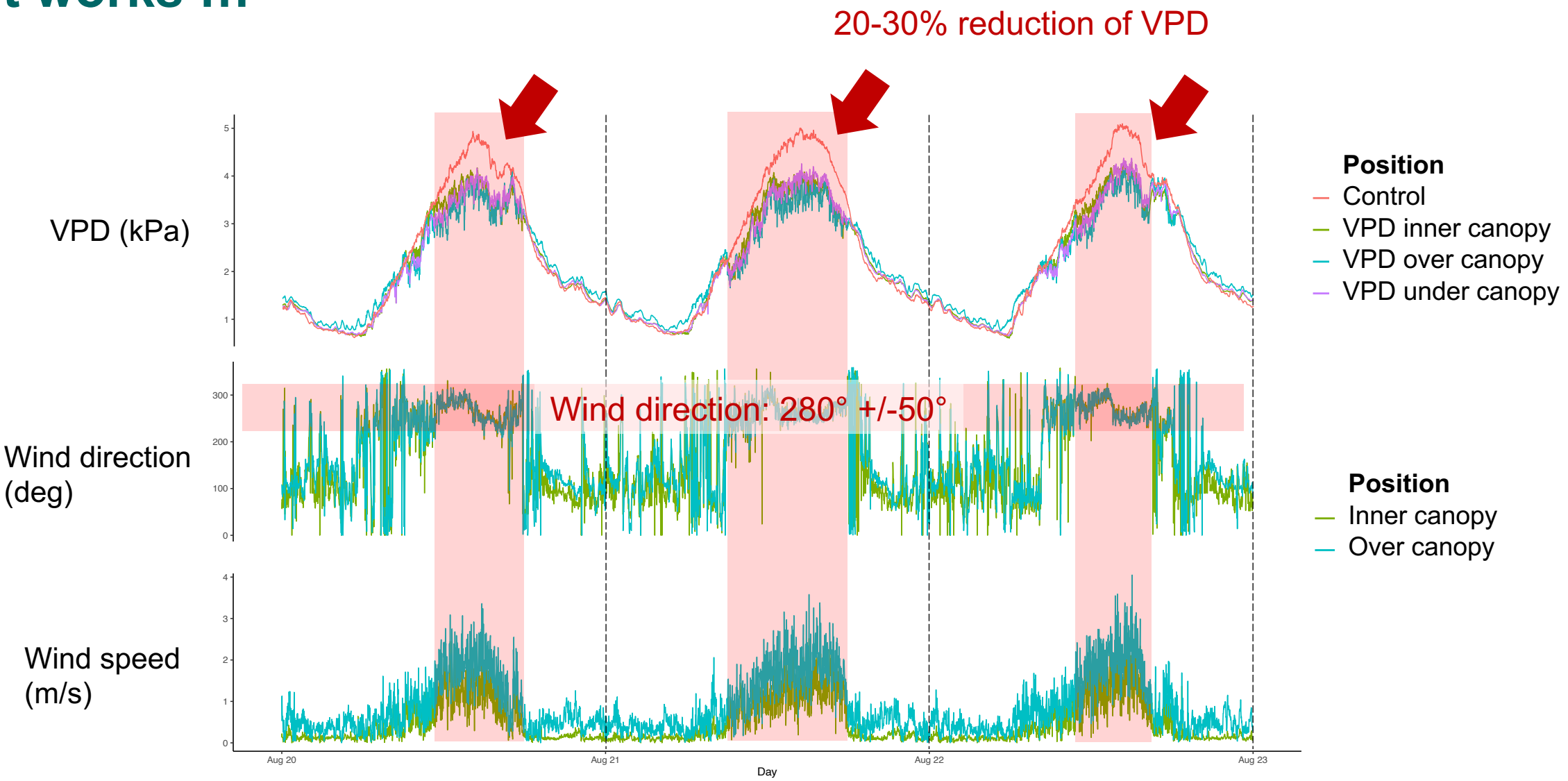
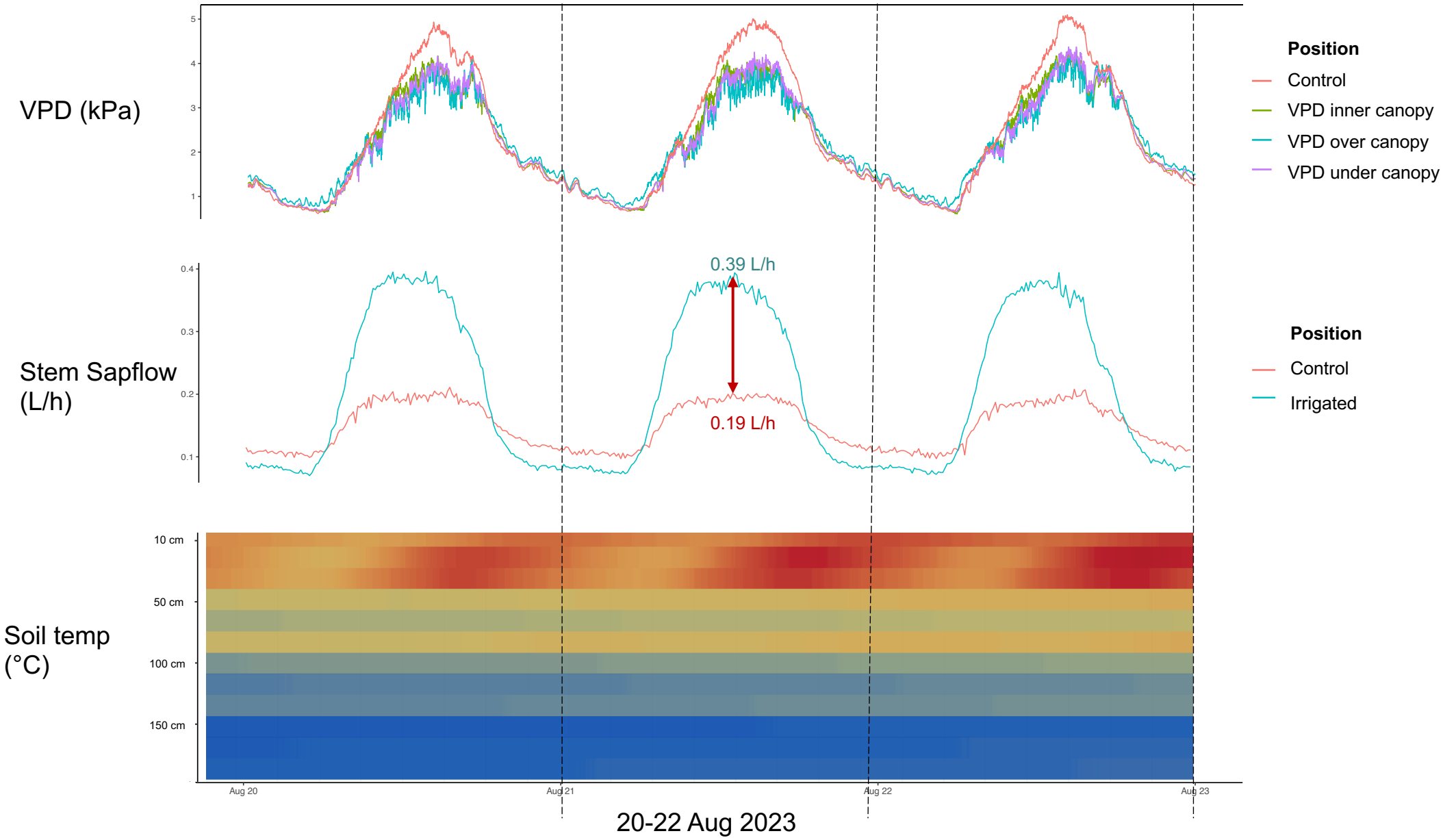


It works …



20-22 Aug 2023

… the soil-plant–atmosphere-continuum

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