TRACKING WATER LIMITATION IN PHOTOSYNTHESIS WITH SUN-INDUCED CHLOROPHYLL FLUORESCENCE

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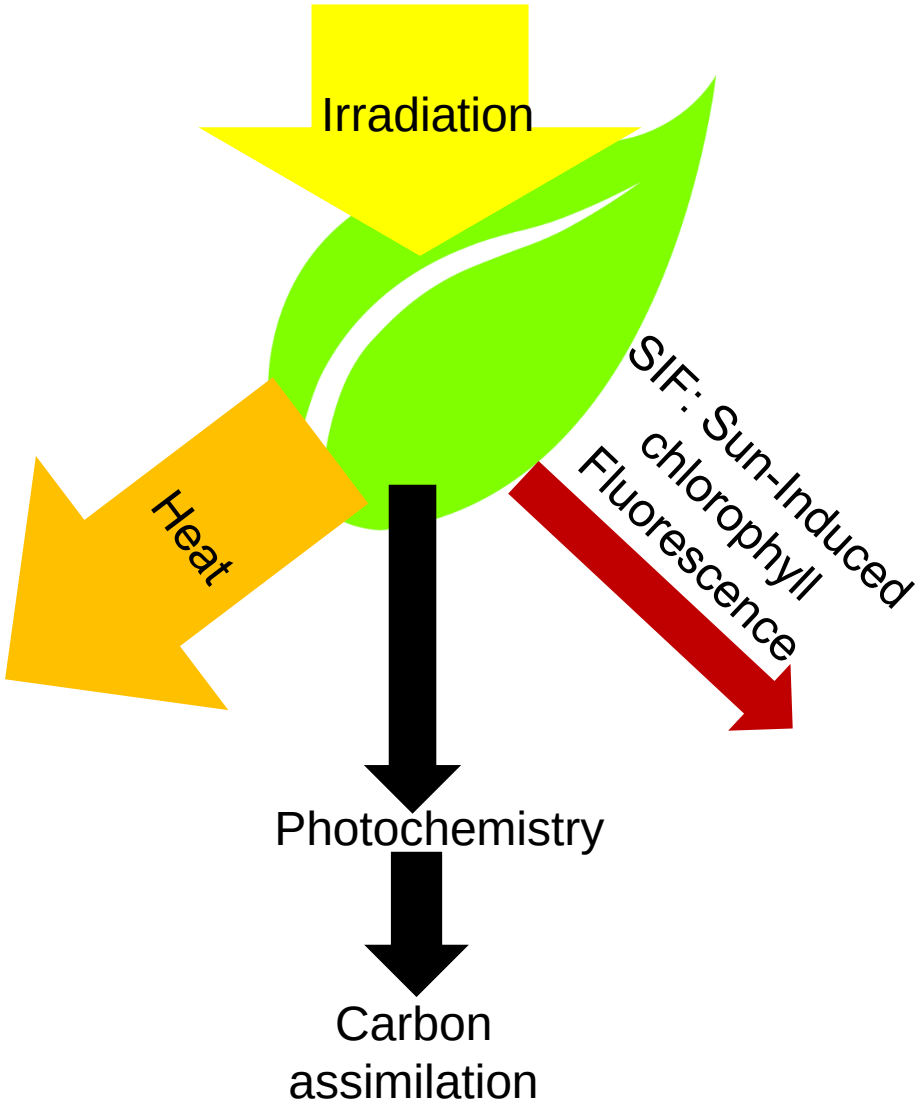
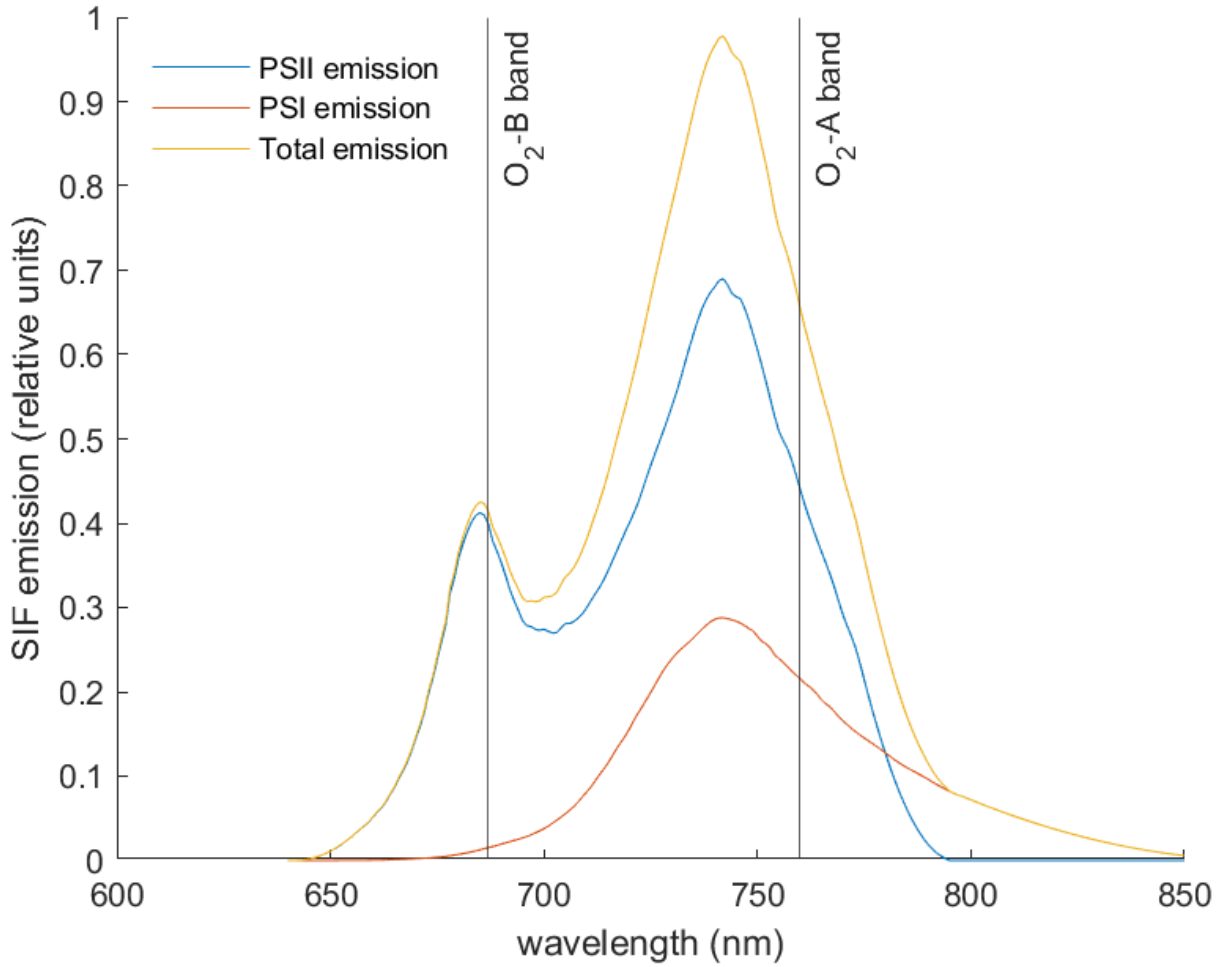
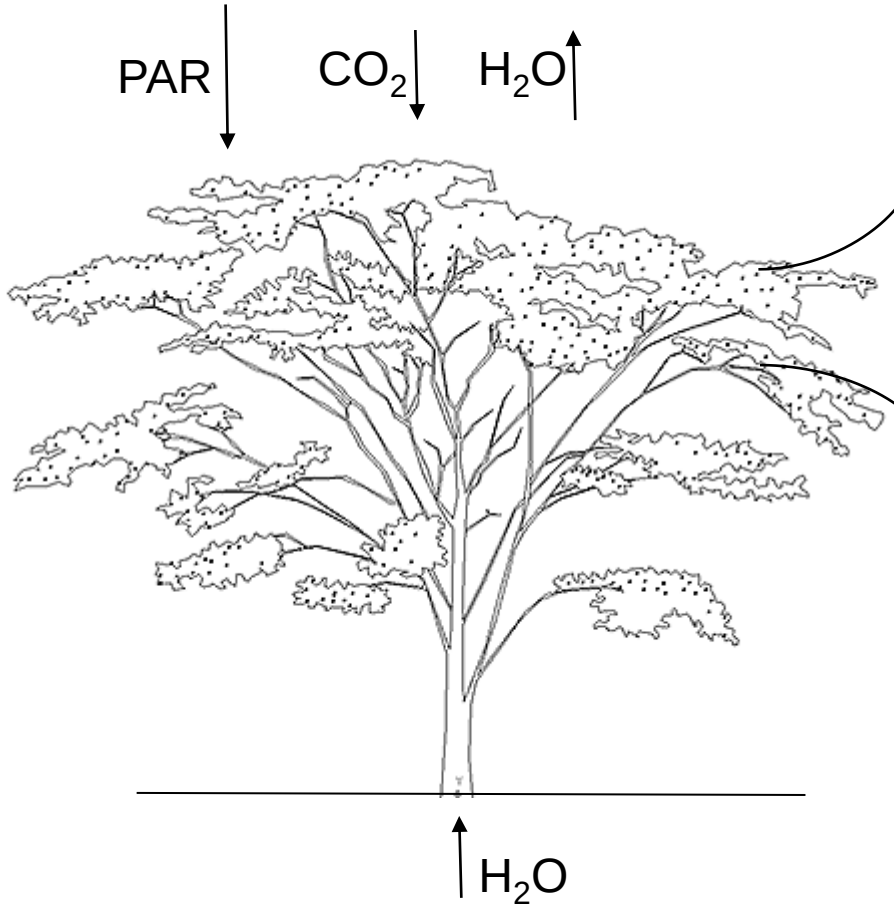
SIF: a remote sensing proxy for photosynthetic activity





Effect of drought stress on SIF emission

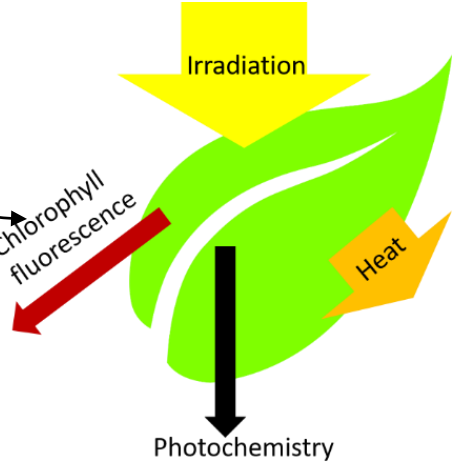


Stress changes leaf turgor pressure

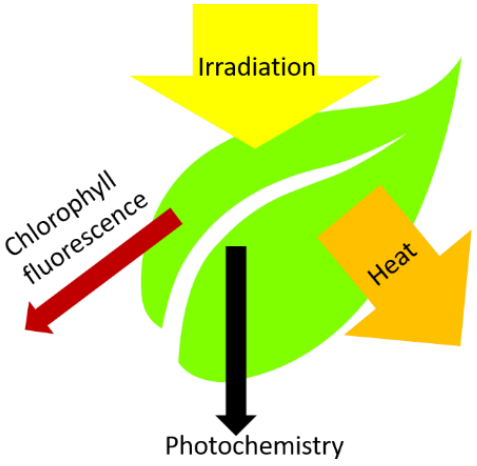
Unstressed

Stressed

Stress changes leaf biochemistry

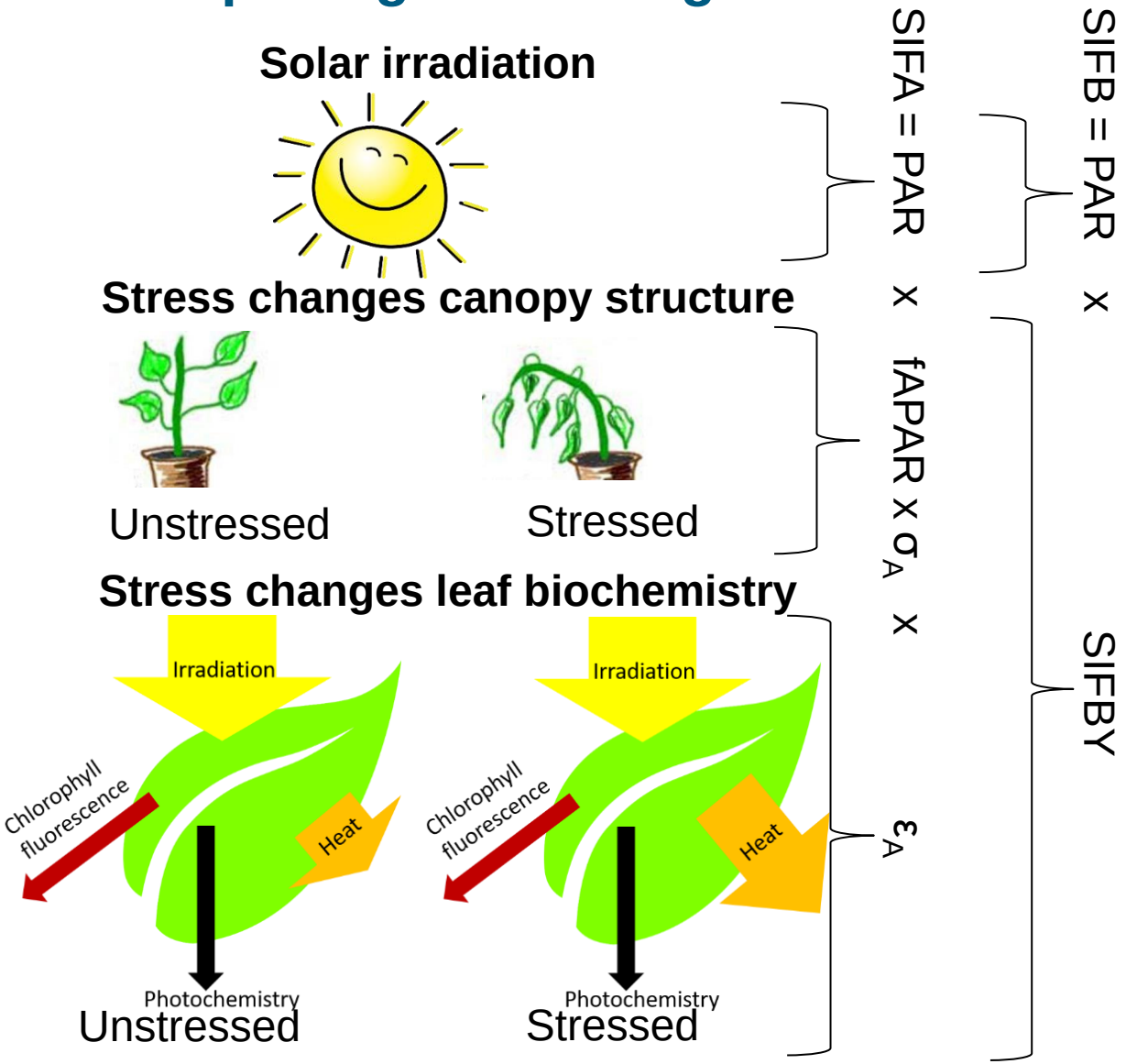


Unstressed



Stressed

Decomposing the SIF signal



PAR: photosynthetically active radiation

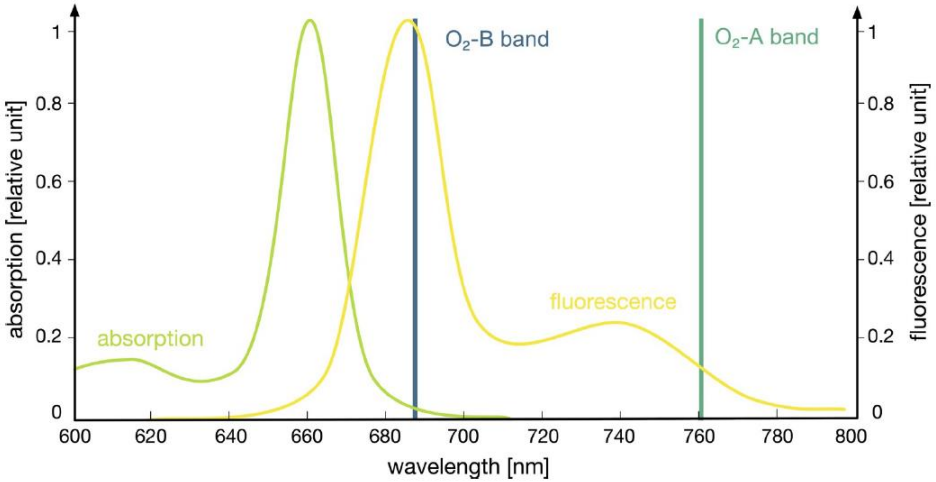
fAPAR: fraction of absorbed photosynthetically active radiation

σ_A: fraction of energy leaving the canopy

ε_A: fraction of energy re-emitted as fluorescence

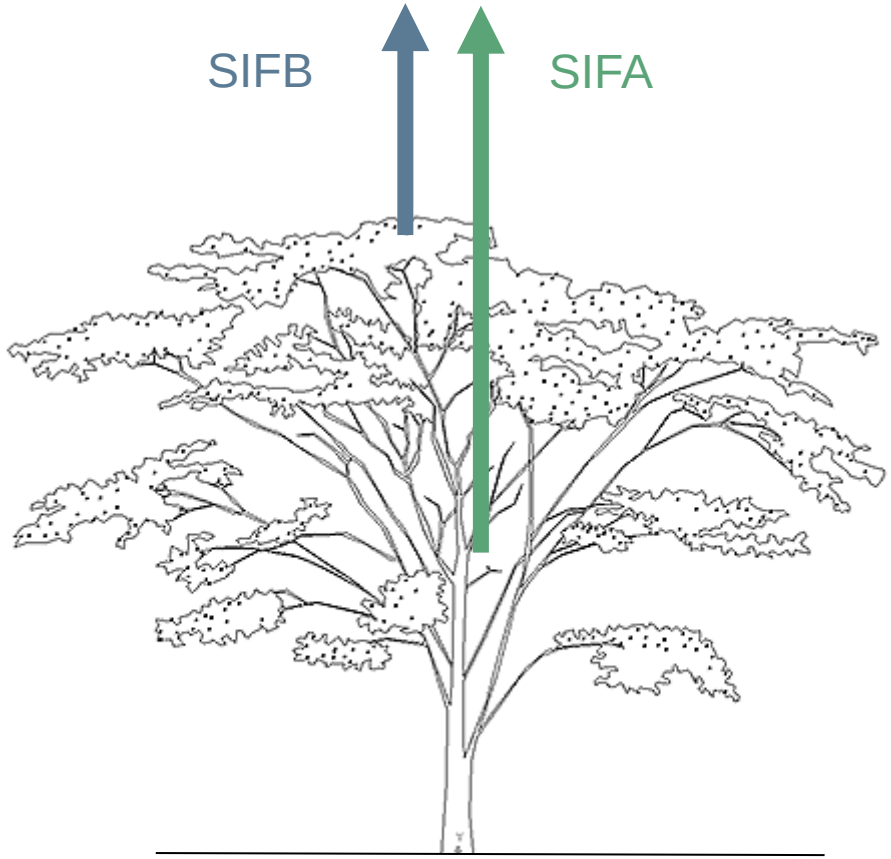
SIF properties differ along the fluorescent spectrum

SIFB is affected by reabsorption

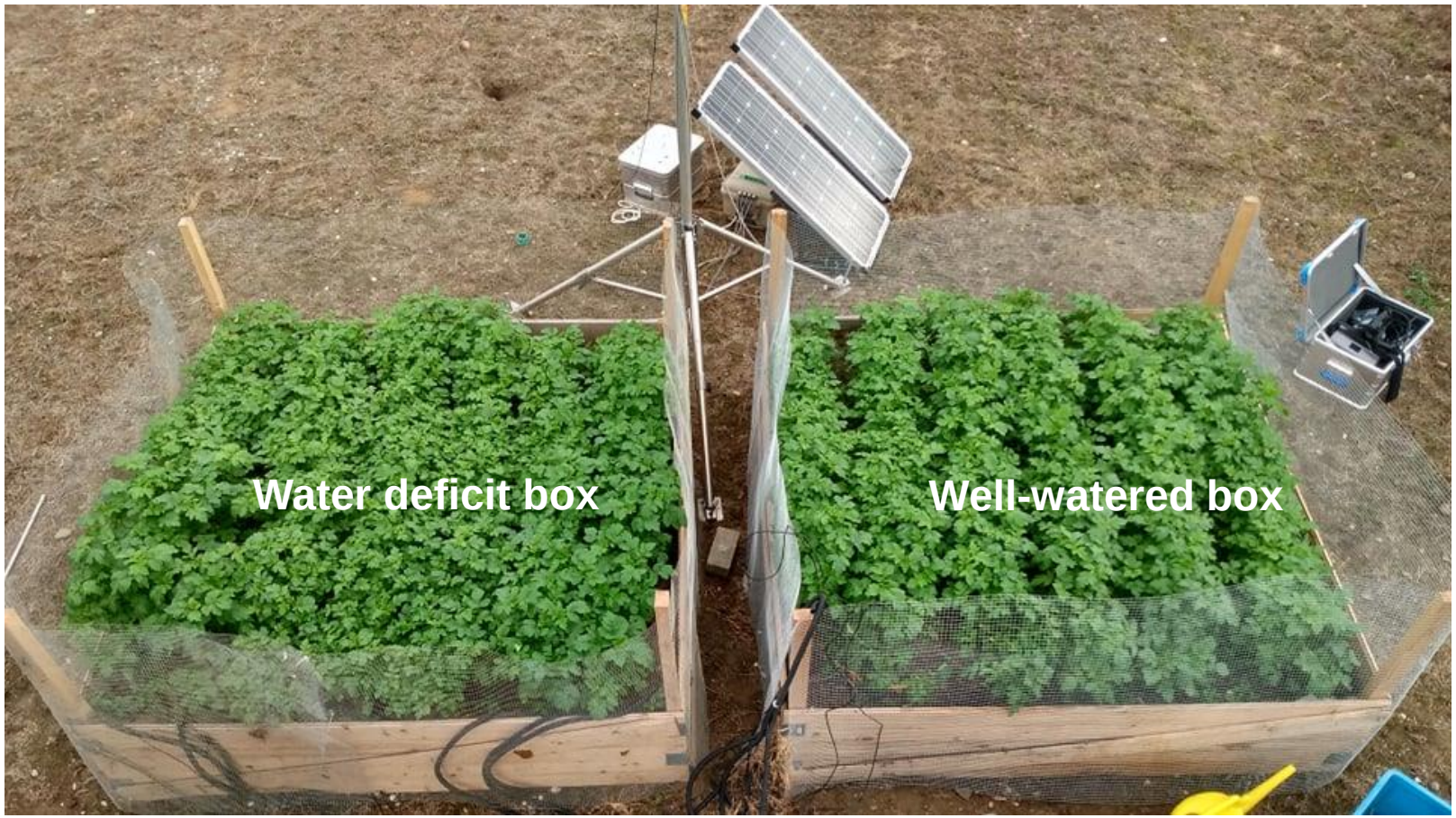


Taken from Jonard et al., 2020

SIFA and SIFB have different origins



Experimental setup



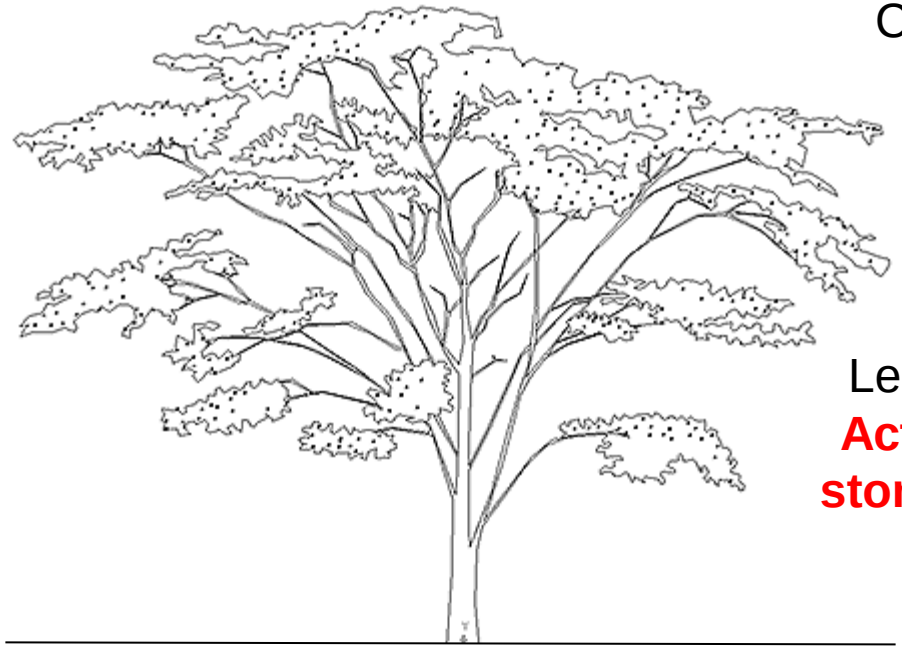
SIF emission and reflectance measured with spectrometer

Spectrometer pivots between boxes

Soil moisture and meteorological data assess stress conditions

Key variables to assess drought stress and drought reaction

Evaporative demand: **VPD**



Canopy structure: **FCVI**,
leaf water potential

Leaf biochemistry: ε_F,
Active fluorescence,
stomatal conductance

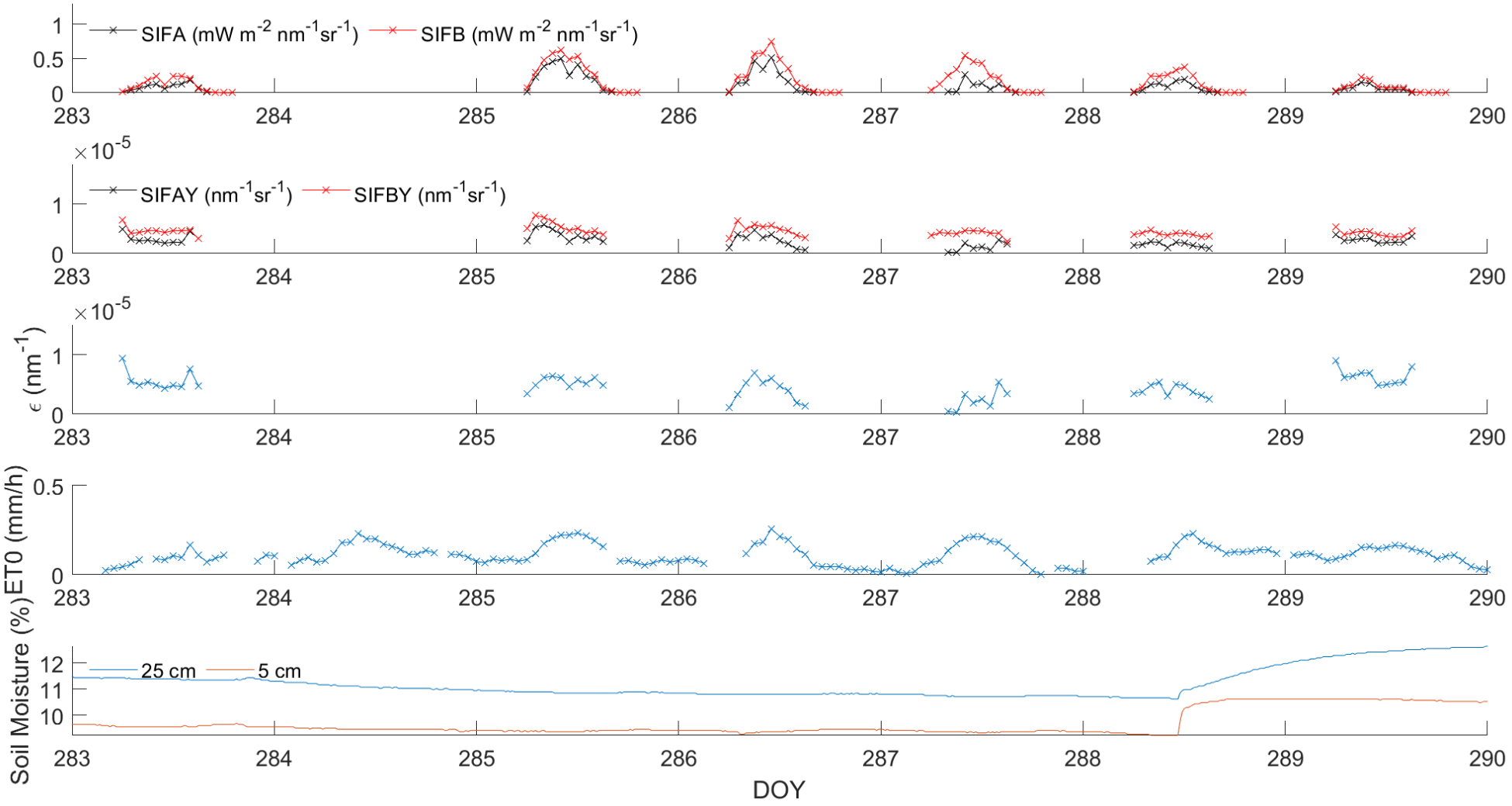
Water availability
Soil water potential
Soil water content

Remote sensing based variable

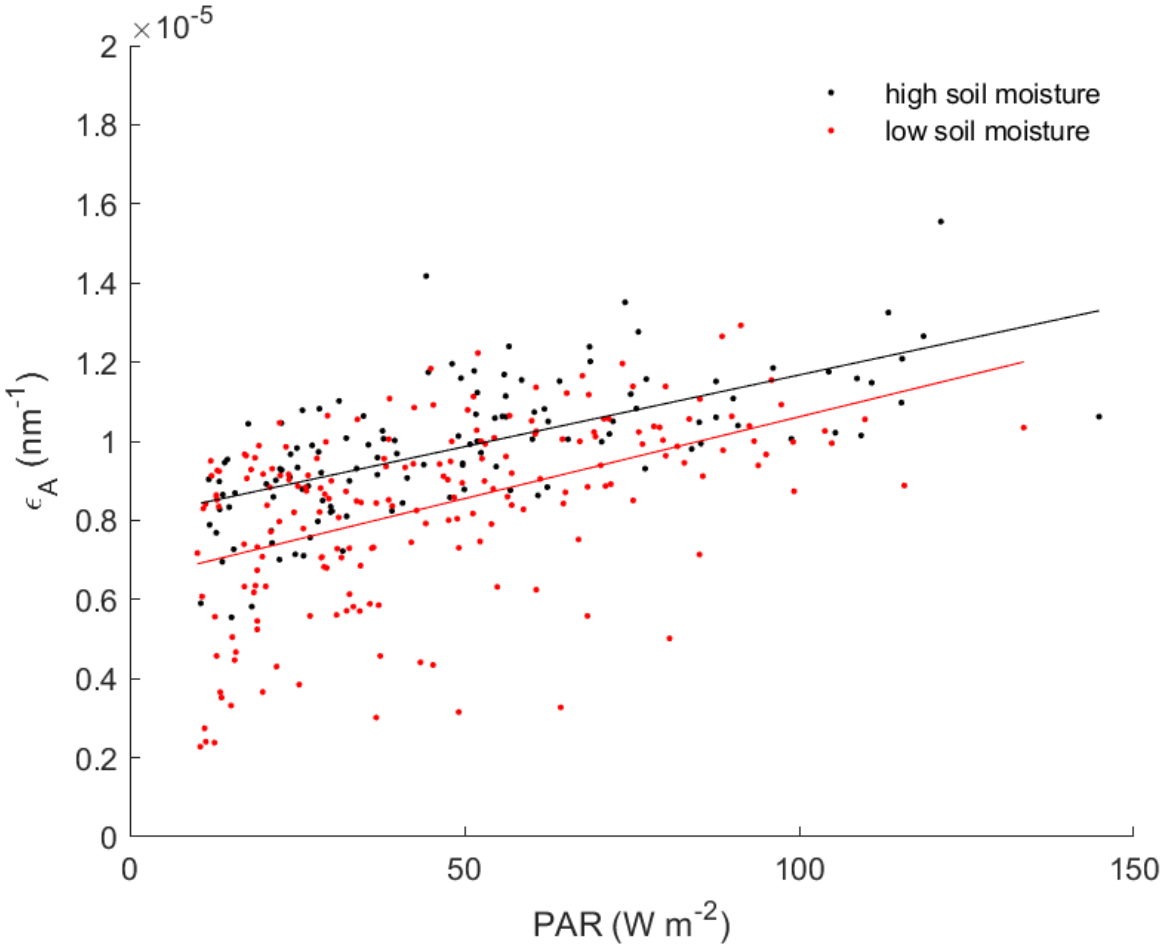
Point measurement

Continuous measurement

Prolonged stress decreases biochemical component of SIFA emission



Drought stress decreases ε_A



$$\epsilon_A = 3.6 \cdot 10^{-8} \cdot \mathrm{PAR} + 8.049 \cdot 10^{-6}$$

$$R^2 = 0.423$$

$$\epsilon_A = 4.1 \cdot 10^{-8} \cdot \mathrm{PAR} + 6.48 \cdot 10^{-6}$$

$$R^2 = 0.244$$

Take-home message

SIF contains a structural and biochemical component

- SIFA reacts to soil moisture and VPD
- Reaction is mainly driven by leaf biochemistry
- SIFB does not show clear reaction to stress