

Synergy between field spectrometry and eddy covariance data

Simon De Cannière, Quentin Beauclaire, Emeline Pirotte, Bernard Longdoz,
François Jonard



Drought is a recurring problem in Belgium!



Source: RTBF 2022

REGIONS HAINAUT

Sécheresse : les agriculteurs sont-ils dédommagés en cas de dégâts aux cultures ?

25 août 2022 à 11:53 • 2 min



Uitzonderlijk droog in Vlaanderen: "Situatie die zich normaal één keer om de vijftig jaar voordoet"

Daar is de lente, daar is de zon. Maar beter zou zijn: daar is de regen. Het is 'droog' tot 'uiterst droog' in Vlaanderen, en dat zo vroeg in het jaar. "Een situatie die zich normaal maar één keer om de vijftig jaar voordoet", zegt grondwaterprofessor Marijke Huysmans (VUB).

Source: HLN 2022



Source: BRF 2020

Frühling 2020 extrem trocken und sonnig

29.05.2020 07:30 29.05.2020 - 10:53

DOOR KLIMA WETTER

Au moins 166 communes wallonnes touchées par un phénomène de sécheresse exceptionnelle (vidéo)

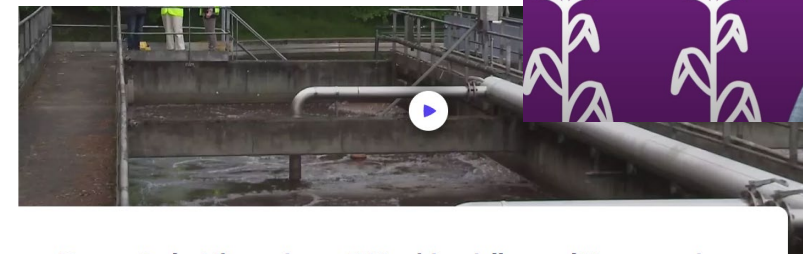
Des dédommagements sont espérés pour le début de l'année 2019 par le fond des calamités agricoles.



Source: Le soir 2018

Source: Karrewiet 2019

minder voedsel



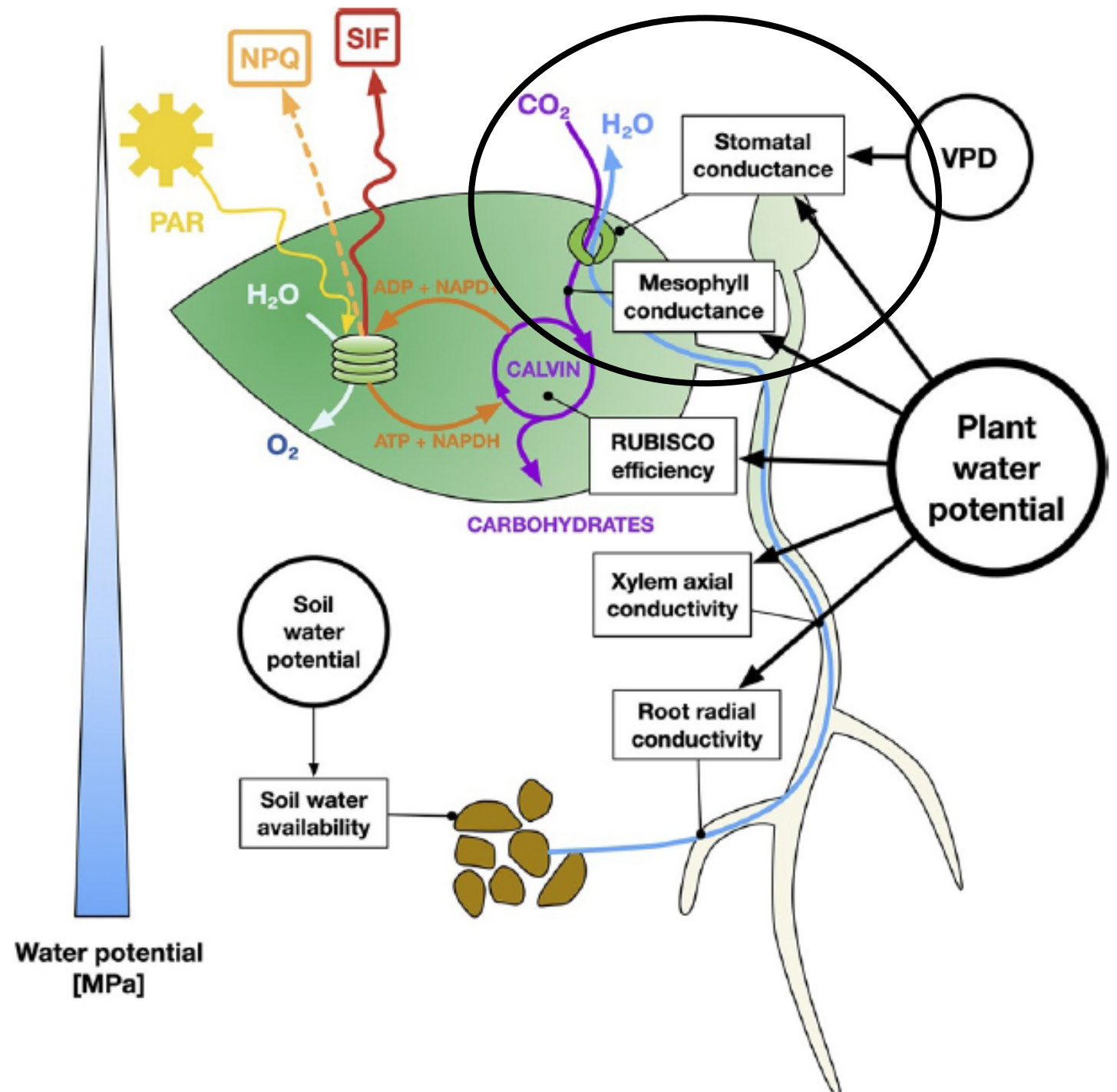
Droogte in Vlaanderen? Veel bedrijven zitten zonder plan B

We hebben een normale winter gehad met gewone temperaturen en een

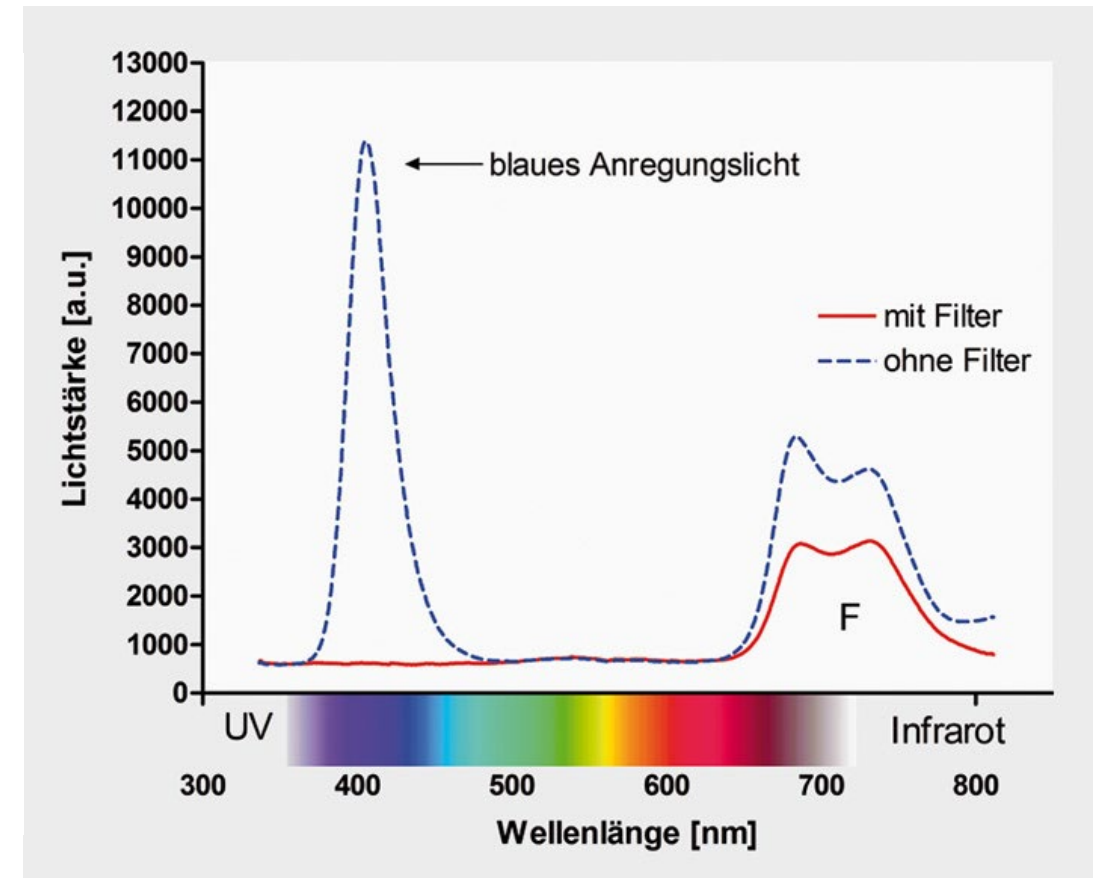
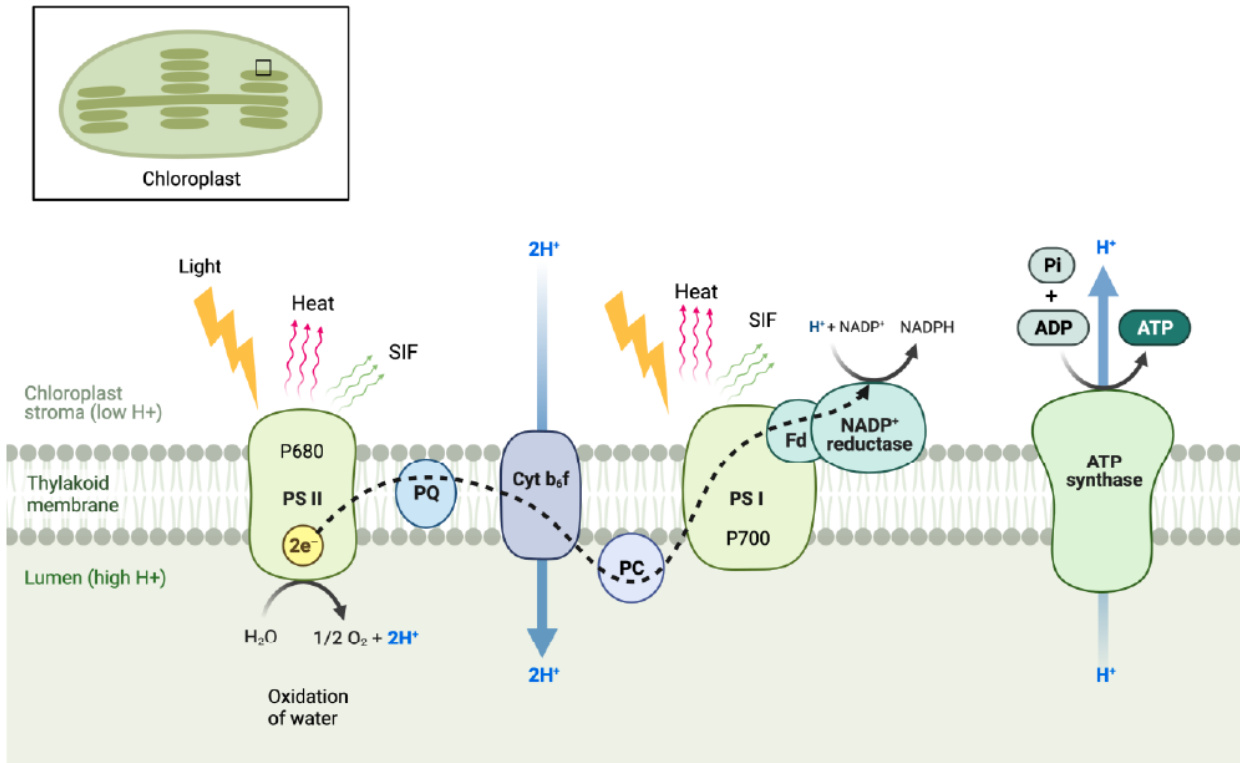
Source: vrt 2019

Photosynthesis is
at intersection of
water and carbon
cycles

- Plants pump up water from soil to do photosynthesis
- Drought stress increases leaf resistance, slowing down photosynthesis
- Subsequent change in the light reactions of photosynthesis



SIF is a signal from the heart of photosynthesis



Burkart 2014

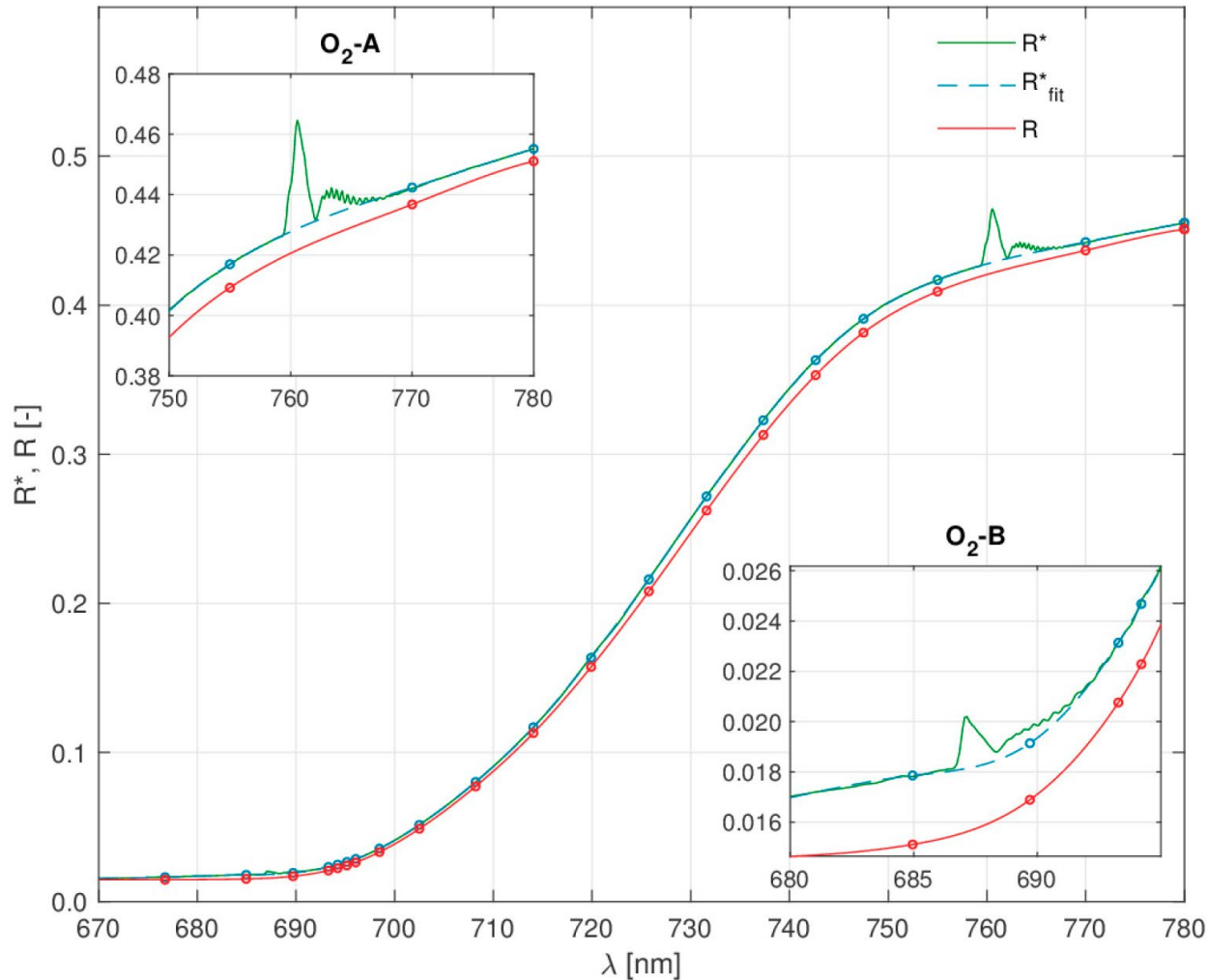
SIF is a signal from the heart of photosynthesis

SIF can be visualized lab conditions

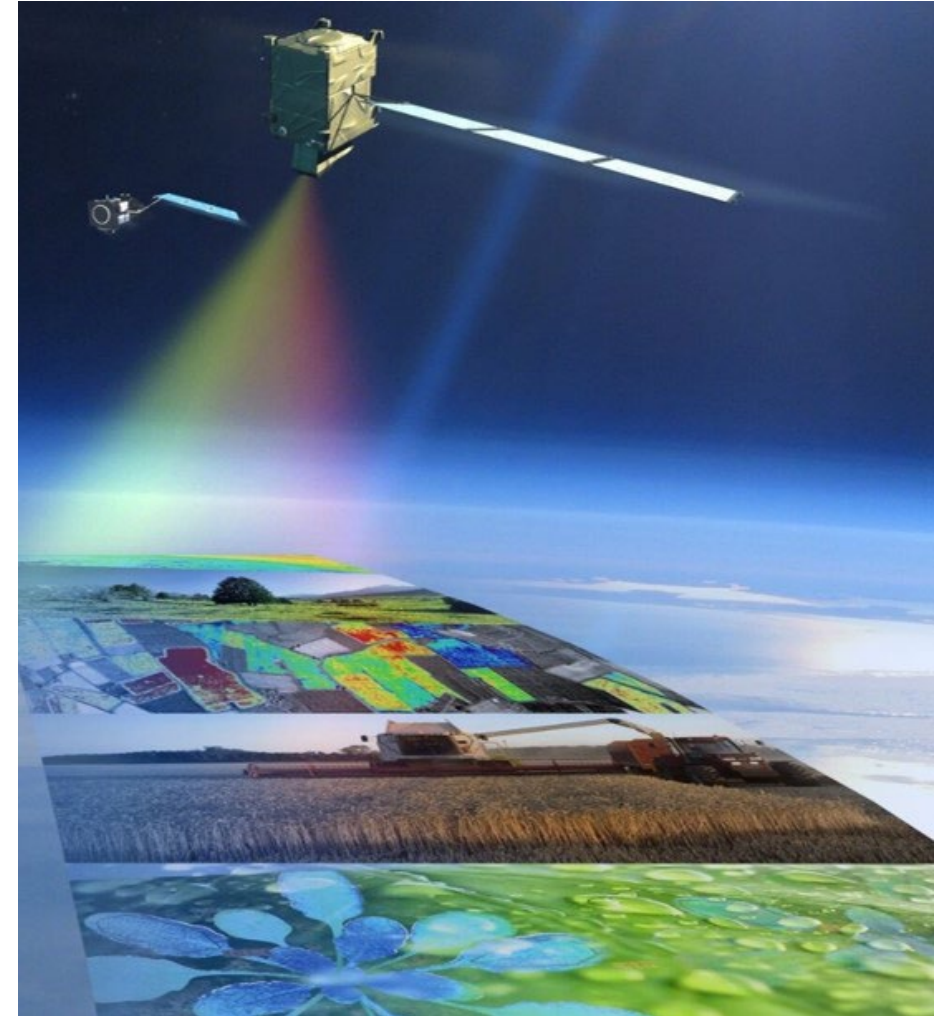


Photos by Andreas Burkart

Advances in spectrometry enable SIF retrievals



Cogliati et al., 2019



Artist's Imprission of
Fluorescence EXplorer satellite

ICOS infrastructure is ideal for interpretation of SIF

Light reactions: monitored with
sun-induced chlorophyll fluorescence (SIF)



Carbon assimilation: monitored
with eddy covariance (EC) tower



ATP, NAD(P)H

ADP, NADP⁺

SIF and EC measurements
go together as bread and
butter

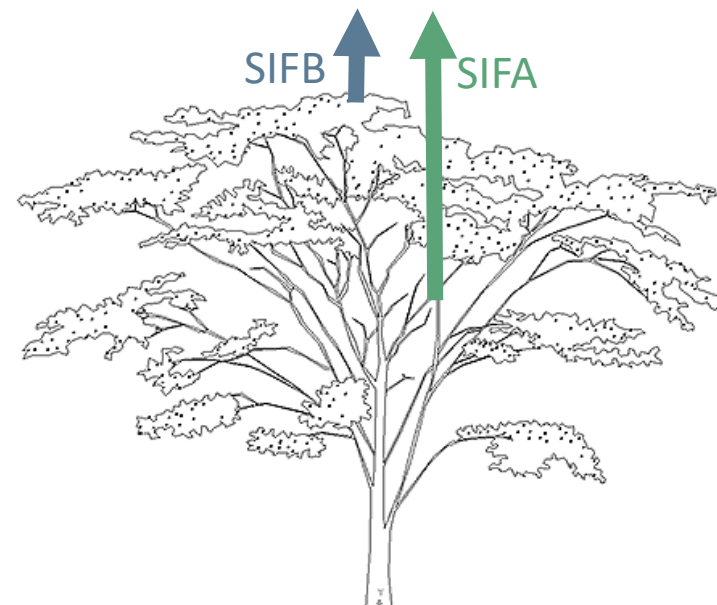
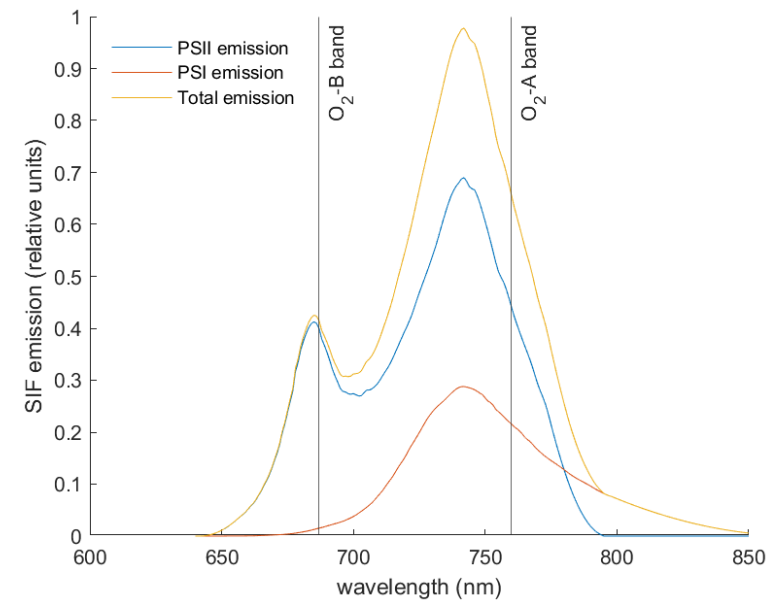
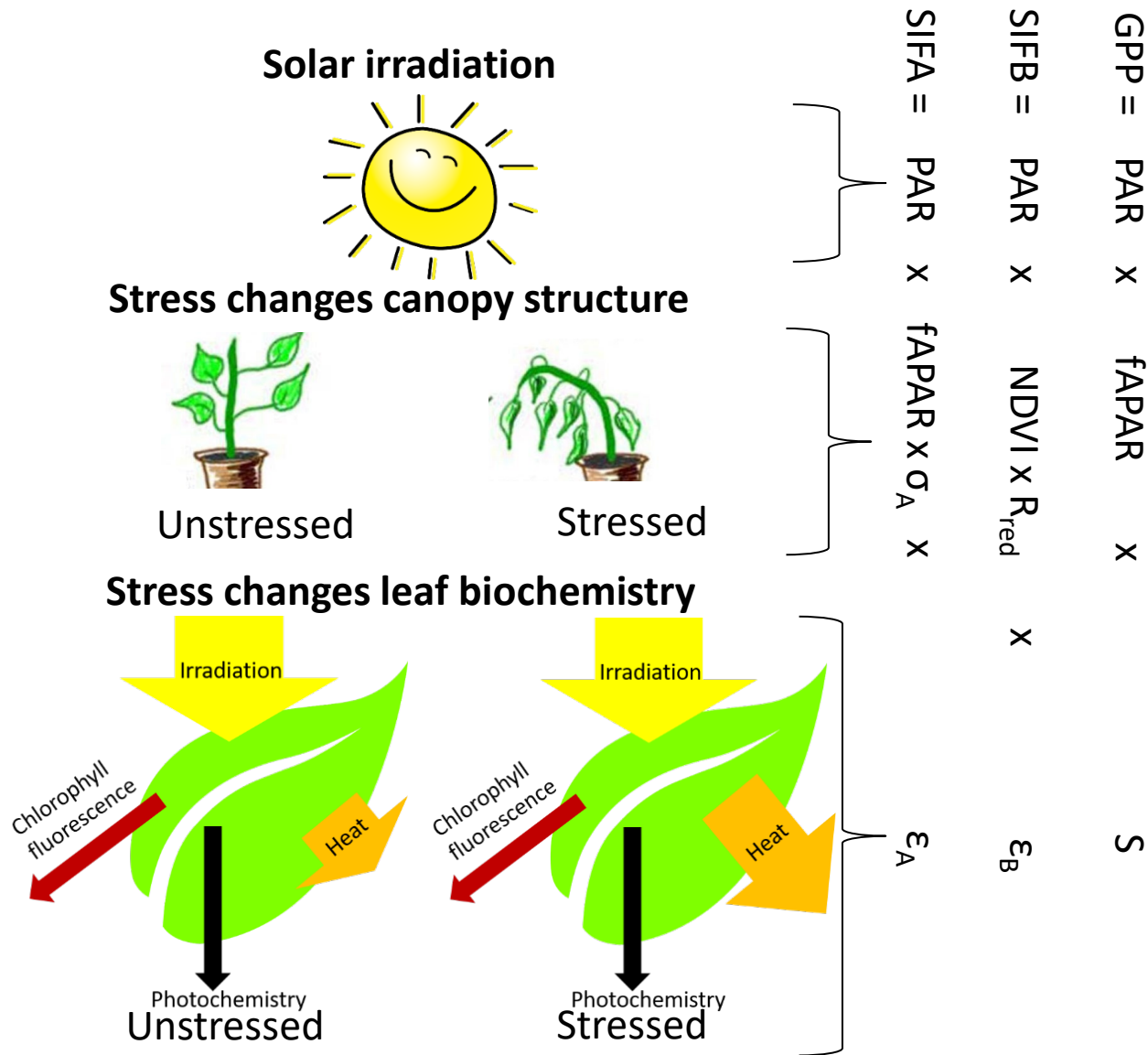
Field Experiment over Lonzée

Installed Field Spectrometer FLoX next to ICOS station in Lonzée on February 24, 2022

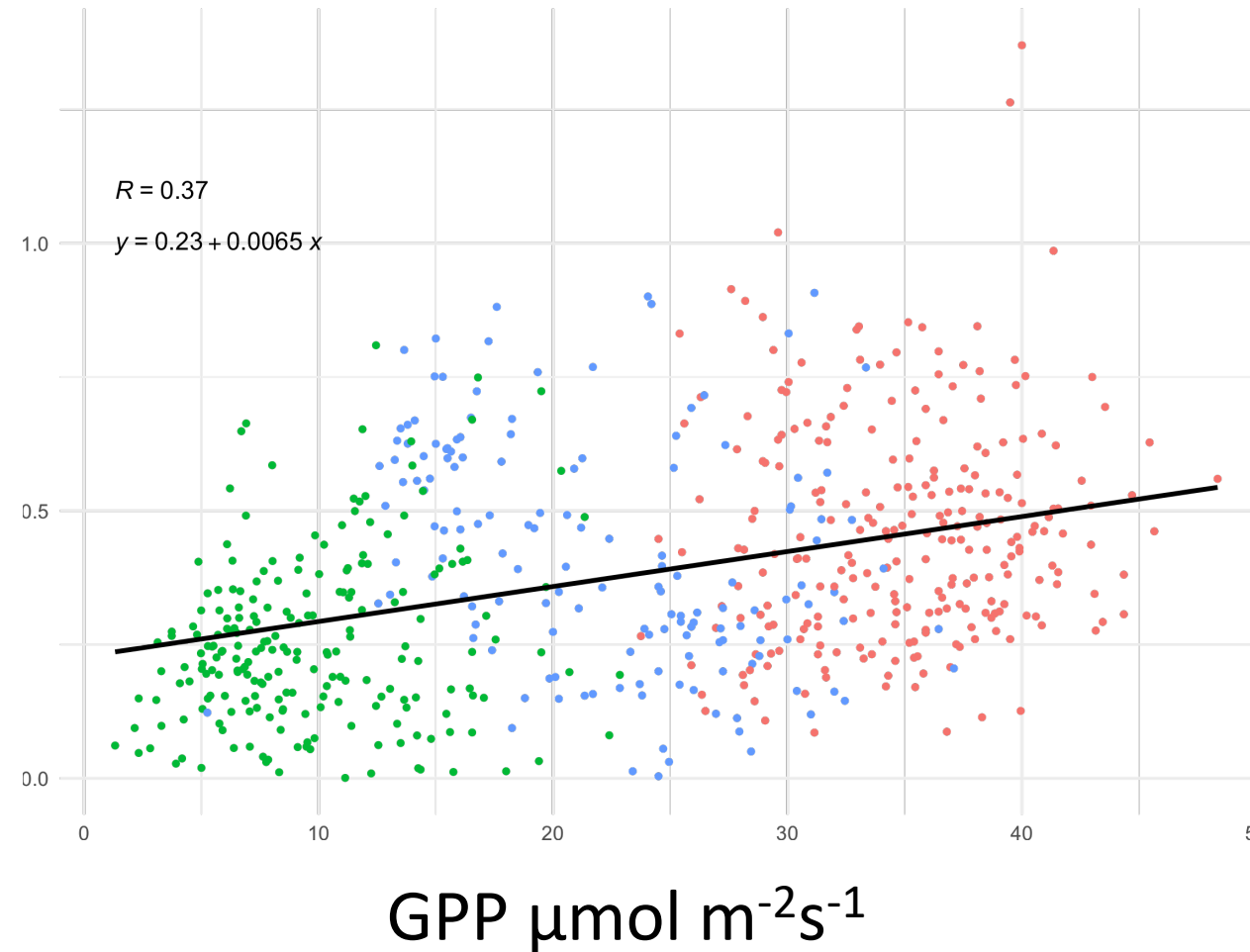
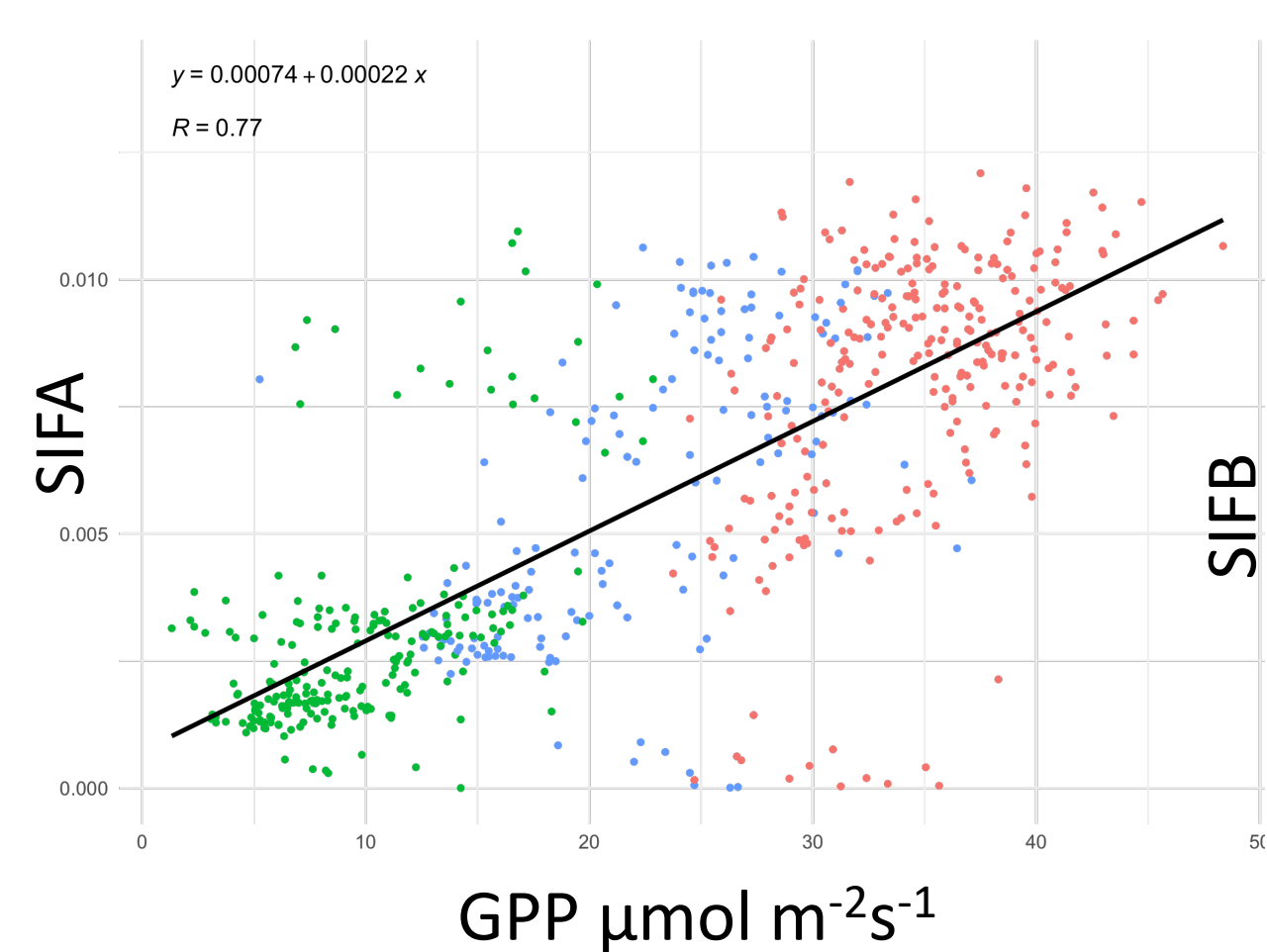
Measure SIF alongside Carbon and Water Fluxes over the Lonzée site during growing season



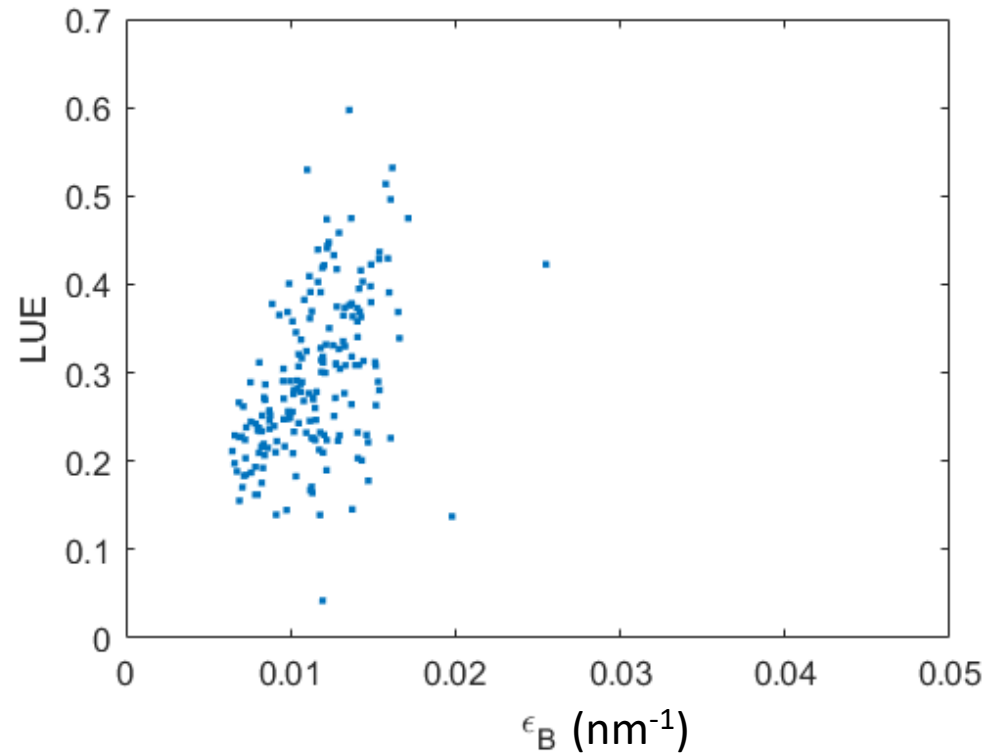
Effect SIFs on emission



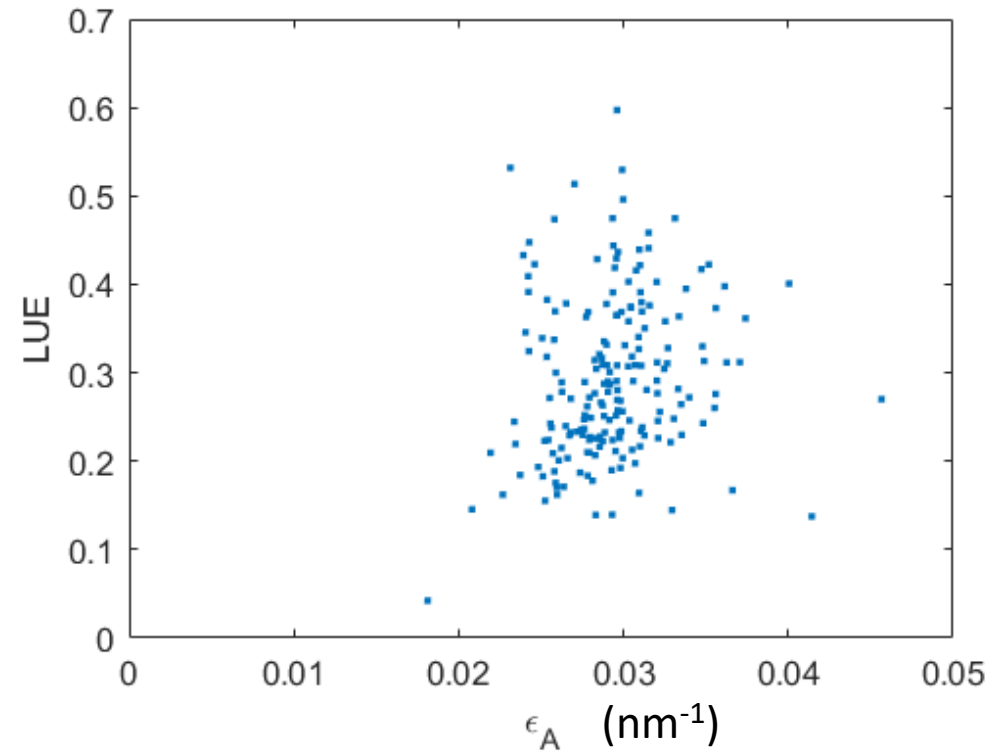
Traditional approach: link SIF to GPP



ICOS-FloX combination helps physiological interpretation of SIF signal

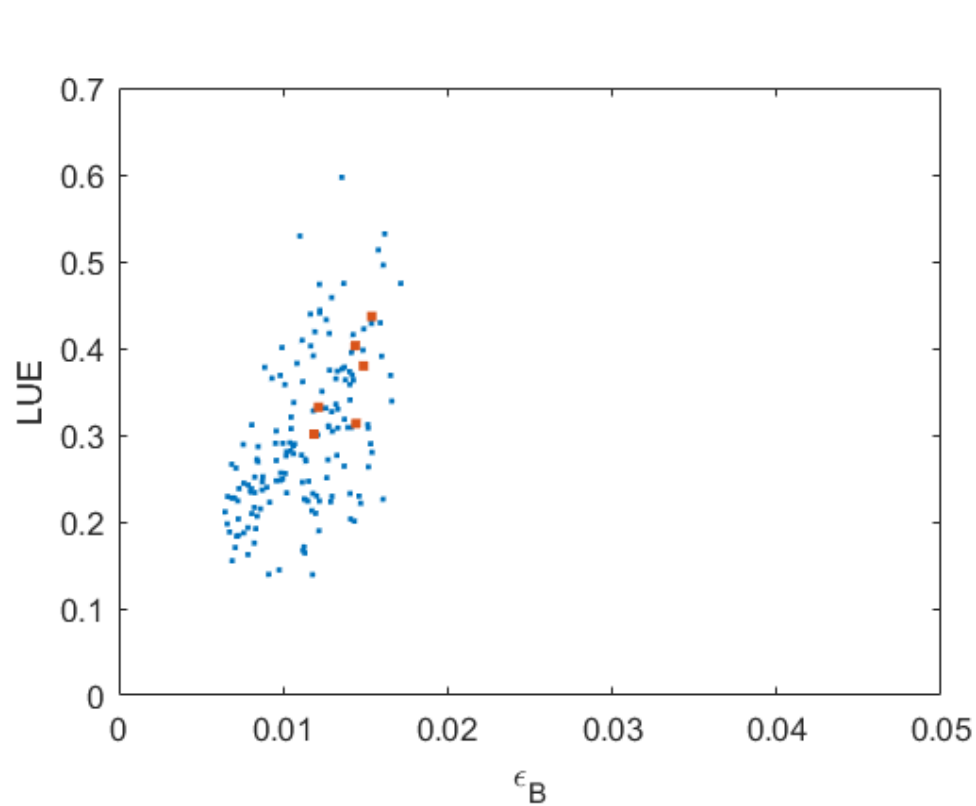


$R^2=0.98$

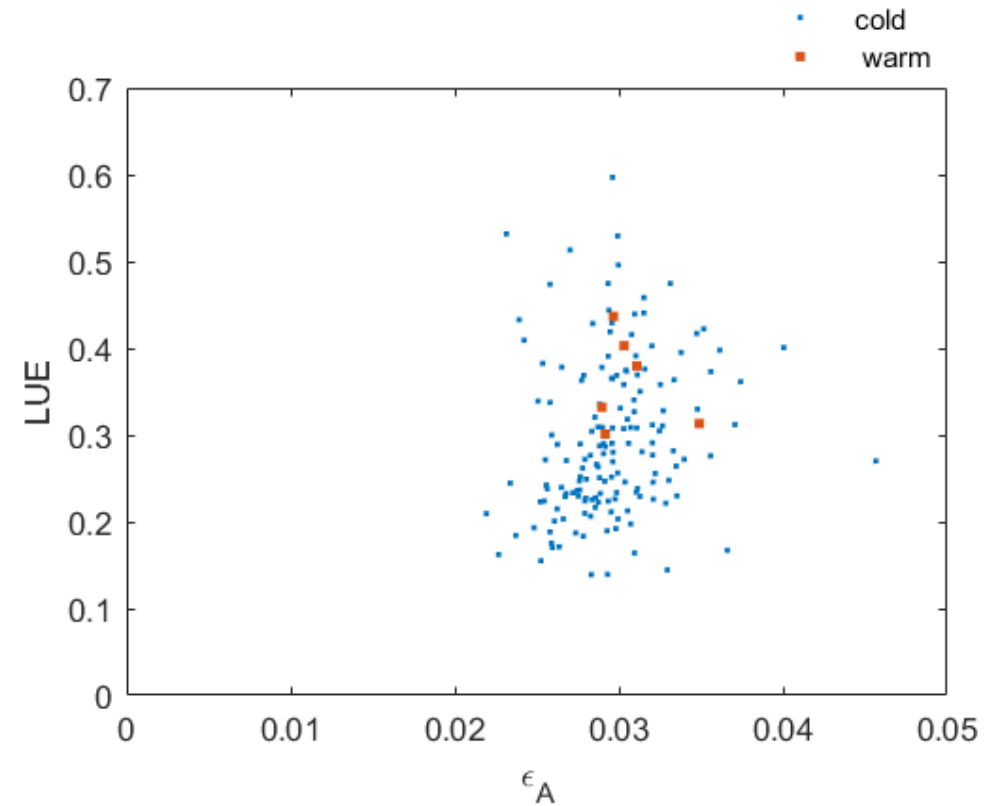


$R^2=0.97$

Effect VPD on shape fluorescence curve

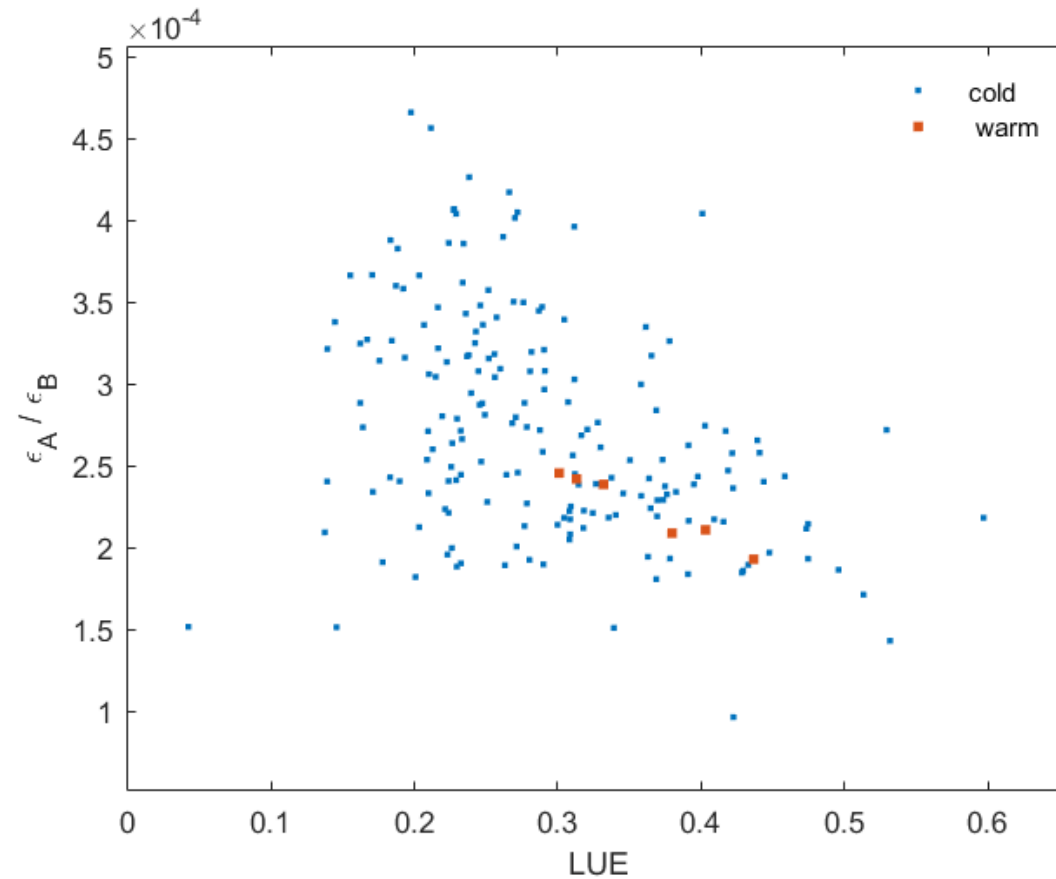


Positive Slope $\epsilon_B - \text{LUE}$
 $R^2 = 0.5$



Negative Slope $\epsilon_A - \text{LUE}$
 $R^2 = 0.06$

SIF ratio as a potential LUE proxy?



Negative slope
 $R^2 = 0.95$

Conclusion

- Sun-induced chlorophyll fluorescence is an emerging signal, sensitive to photosynthesis
- ICOS infrastructure has been a cornerstone in experiments for SIF interpretation
- SIF can be normalized unto a physiological signal
- Ratio of SIF bands has potential to be used as proxy for LUE