

Transregional  
Collaborative Research  
Centre TR32



# Spatial Fluorescence Patterns in a Heterogeneous Agriculture Landscape

Maria Matveeva, Patrick Rademske, Alexander Damm,  
Cosimo Brogi, Guido Waldhoff, and Uwe Rascher

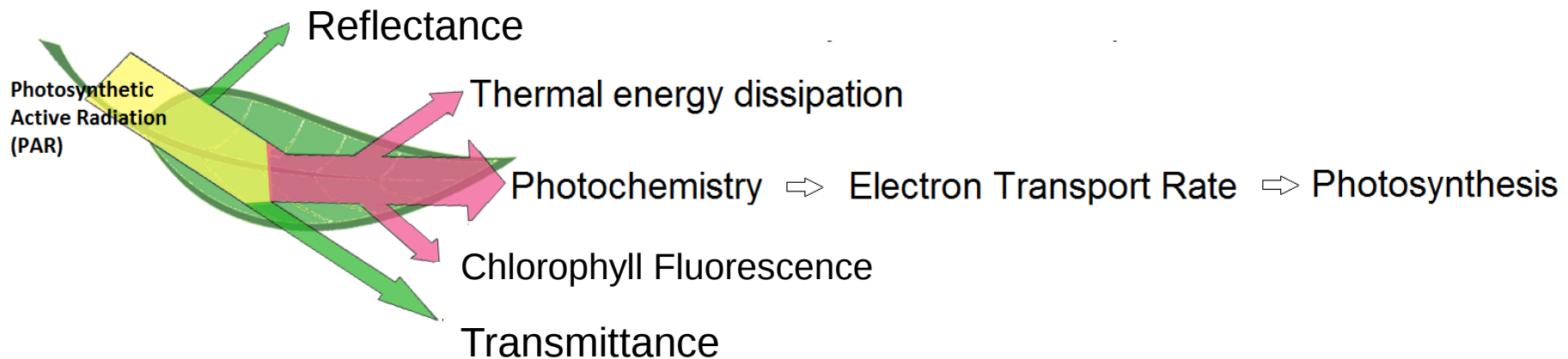
EARSeL 2017, 19-21 April 2017

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# Objectives of the work

Investigate the within- and between-species variability of red ( $F_{687}$ ) and far-red ( $F_{760}$ ) fluorescence and vegetation indices (VIs) on large areas

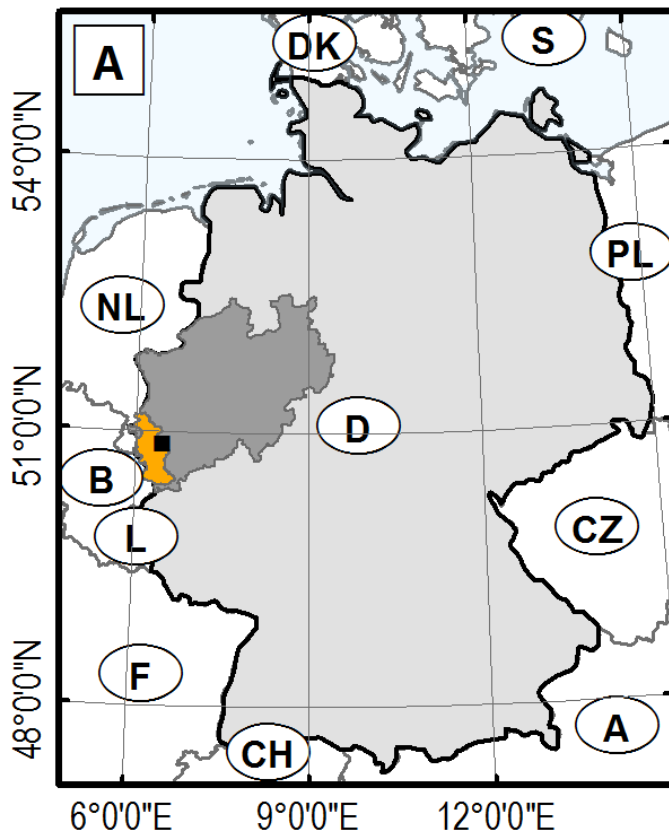
## Fluorescence



## Vegetation indices

Biophysical vegetation parameters, such as LAI, can be approximated from different VIs

Agricultural area in Rur  
catchment, NRW, Germany  
~15×15 km



## Airborne data: high-performance imaging spectrometer HyPlant



U. Rascher

Dedicated fluorescence spectrometer

Spectral ranges:

- 380–970 nm, FWHM 2.6-3.5 nm
- 970–2500 nm, FWHM 8.0-10.4 nm
- 670–780 nm, FWHM 0.2 nm

Spatial resolution of 3 meter per pixel

# Experiment

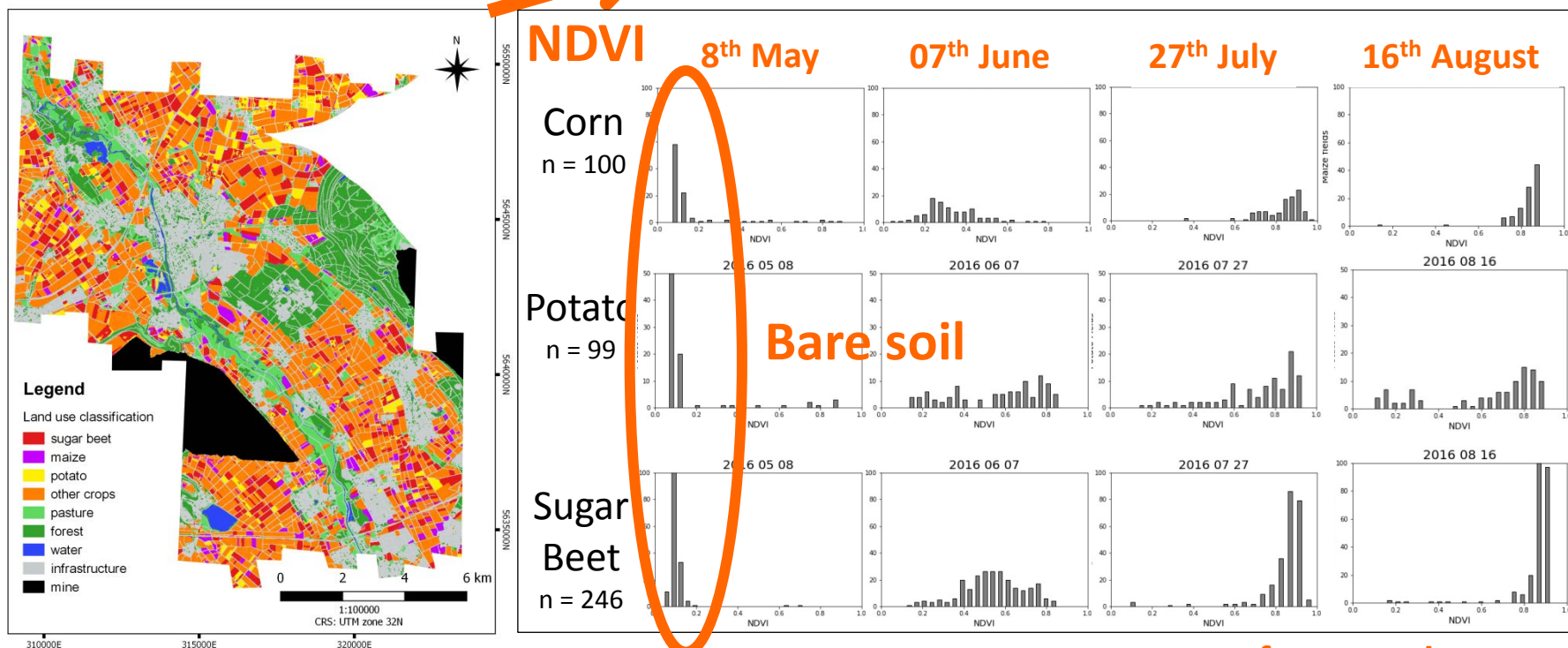
## Airborne data (19-20<sup>th</sup> July 2016)

- Top of Canopy (TOC) Reflectance
- Sun Induced Fluorescence

## Remote sensing data + ground measurements

- Land Use classification

Chosen crops: **corn, potato, sugar beet**



poster of Ivan Barbosa

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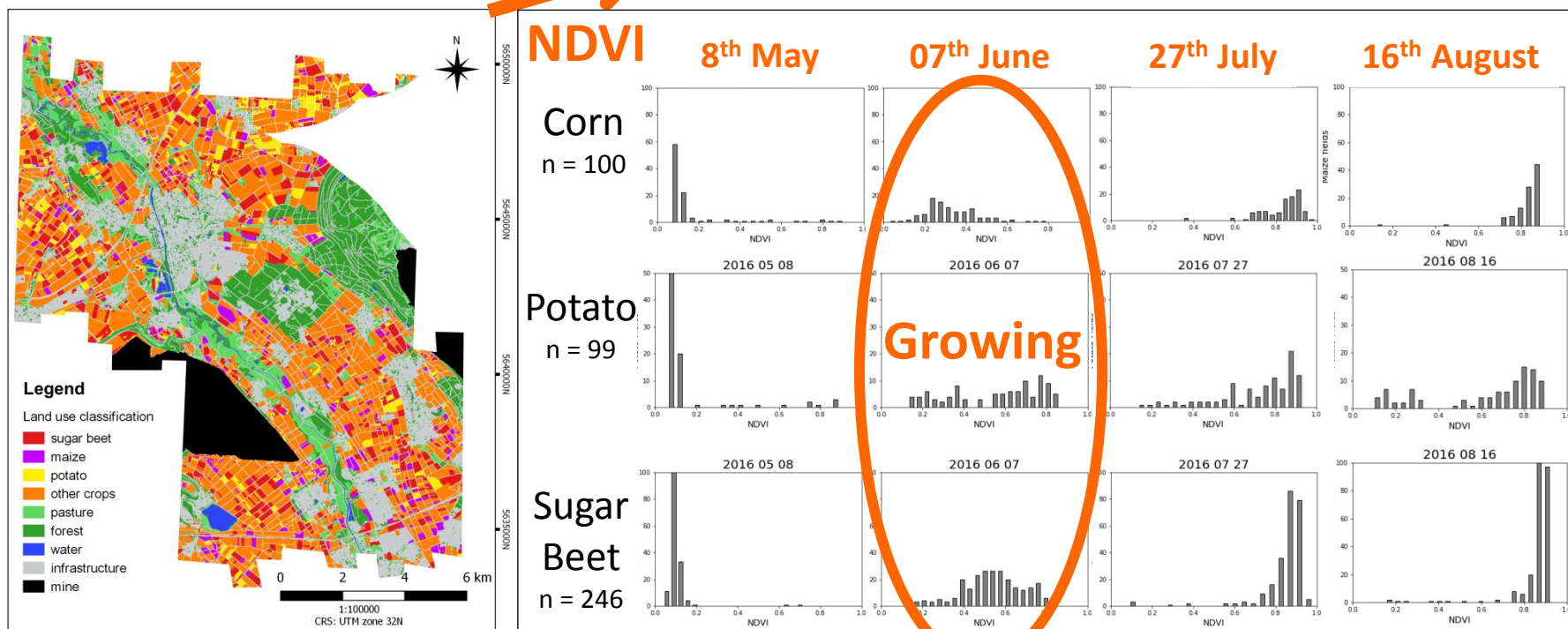
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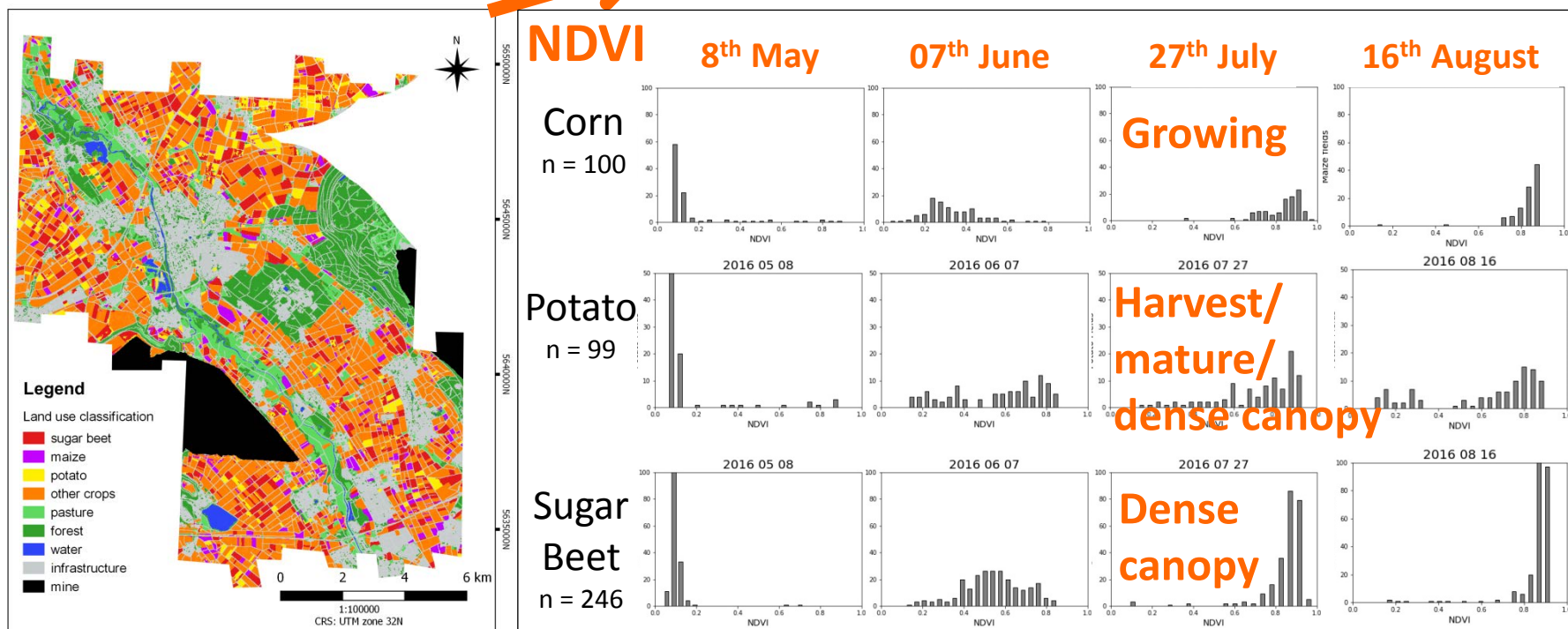
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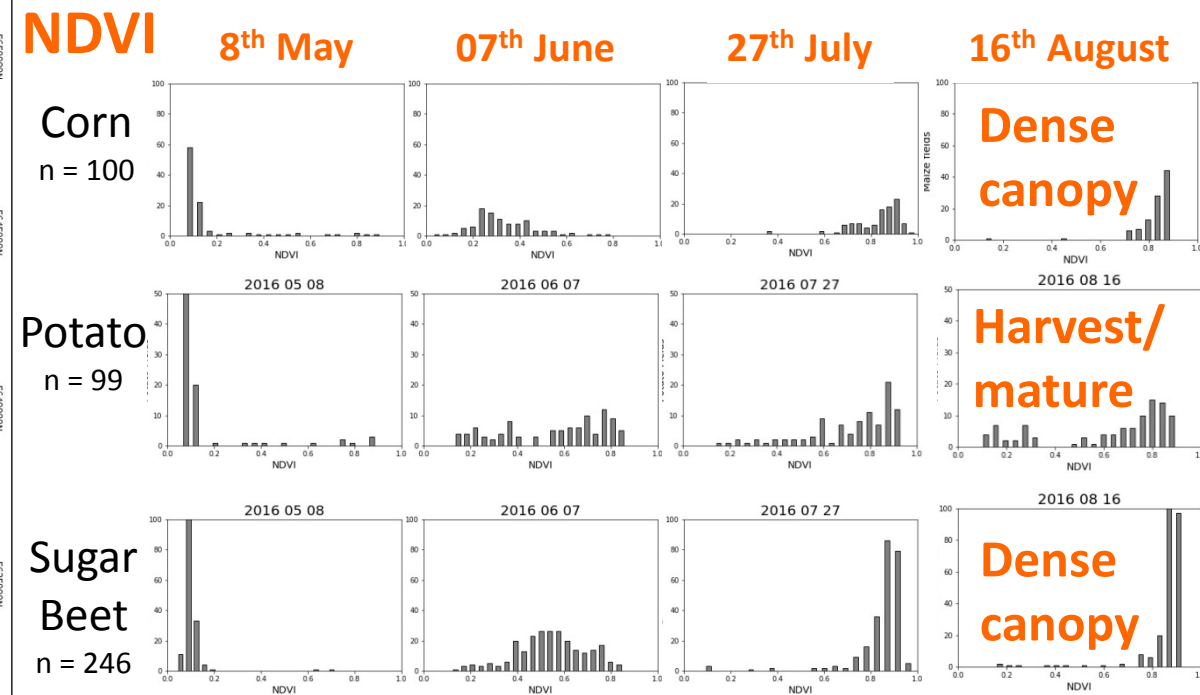
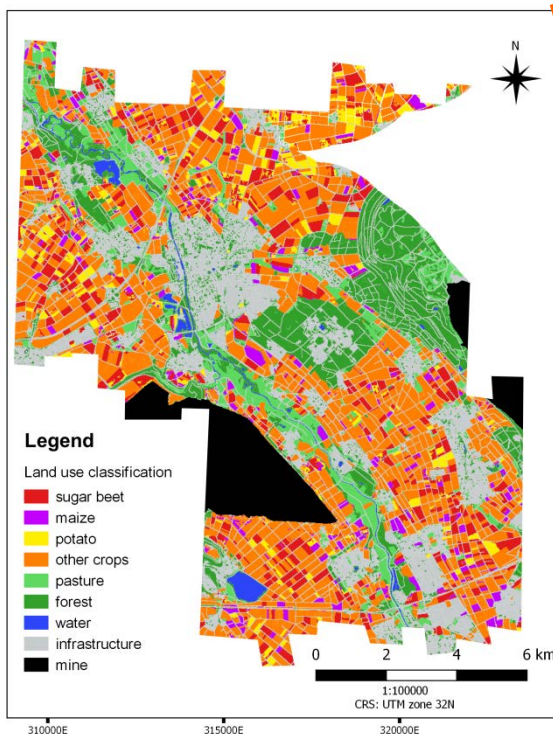
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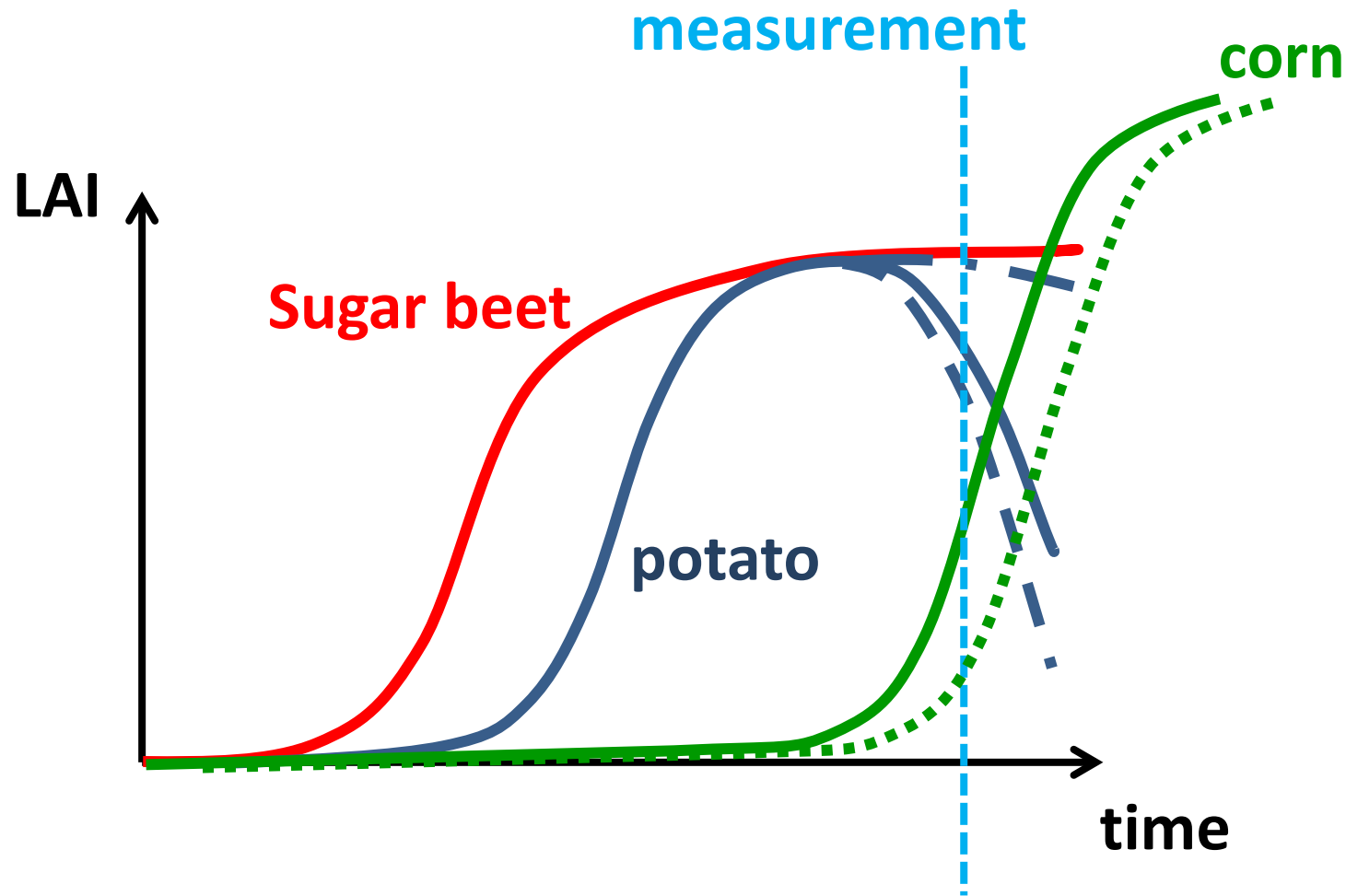
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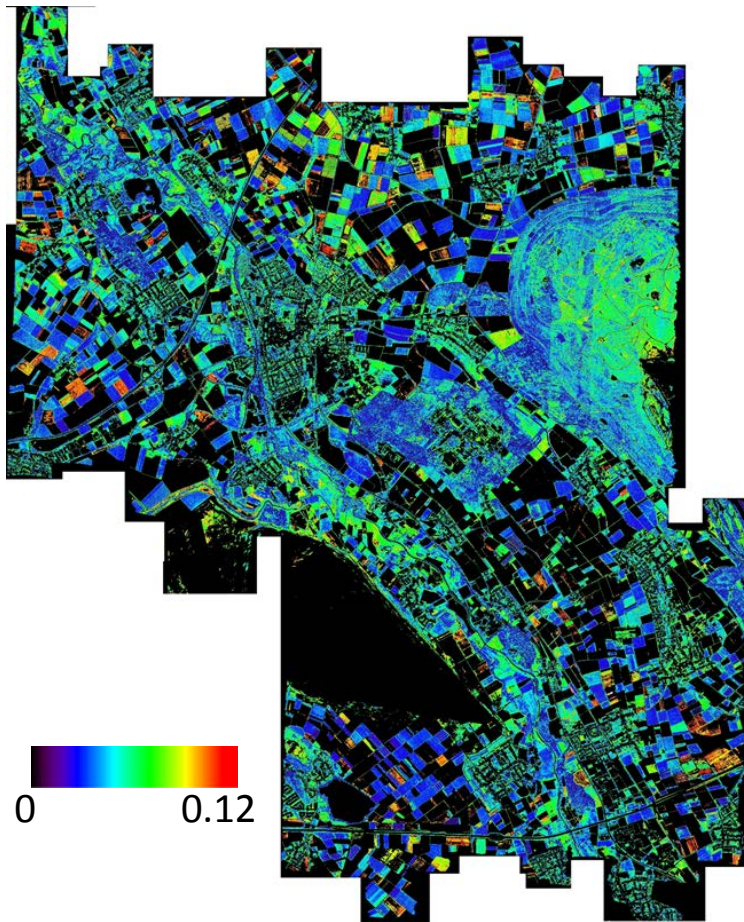
poster of Ivan Barbosa

# Changes in greenness with time

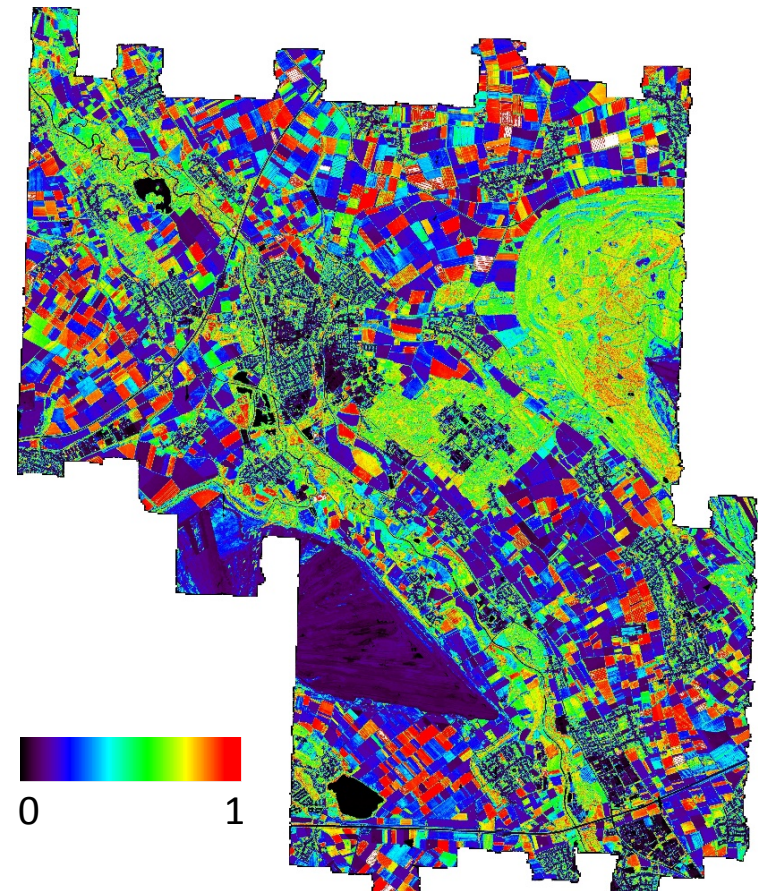


# Examples of VIs and fluorescence maps

## PRI



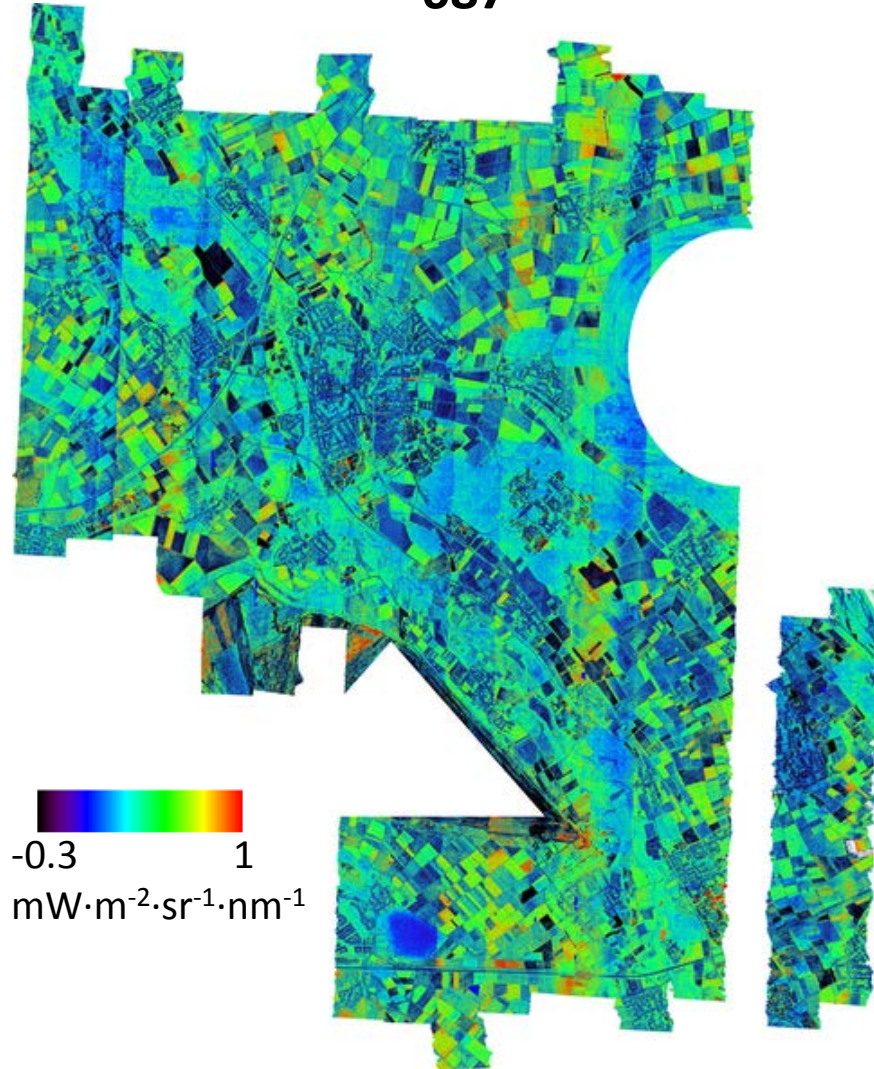
## EVI



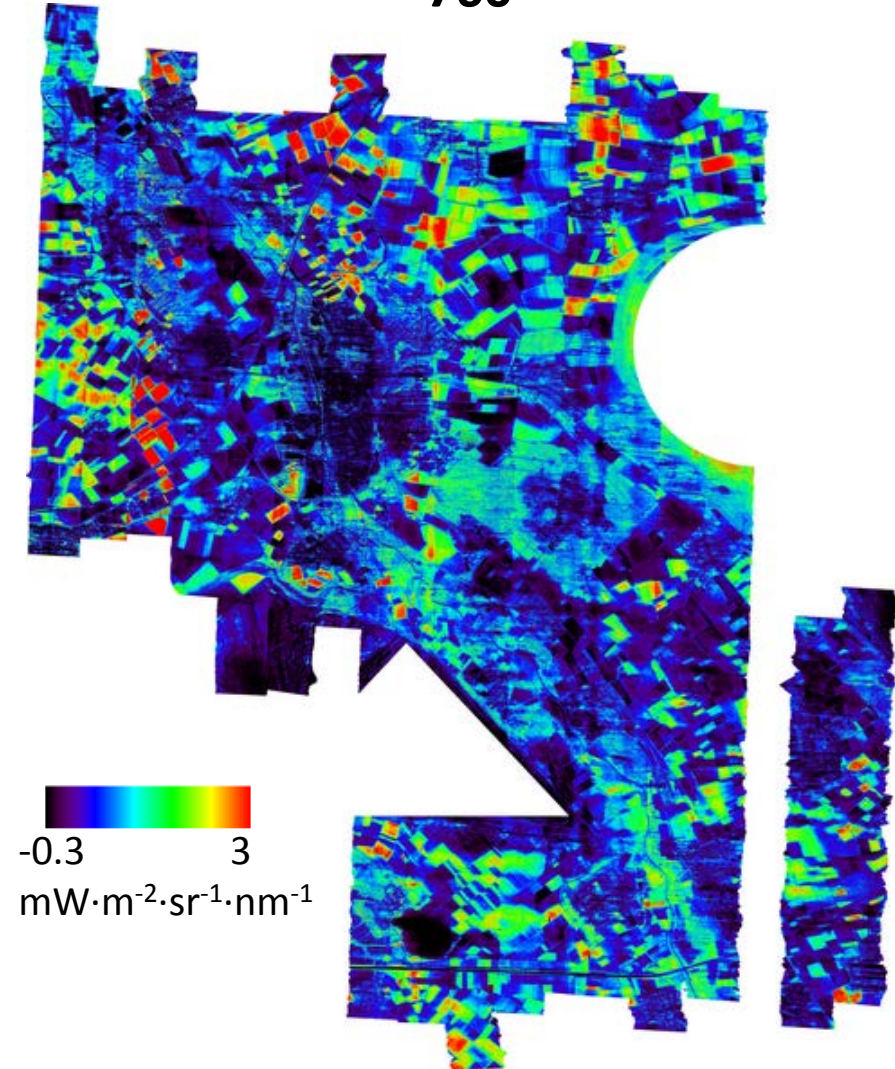
(All not-vegetated pixels are masked out)

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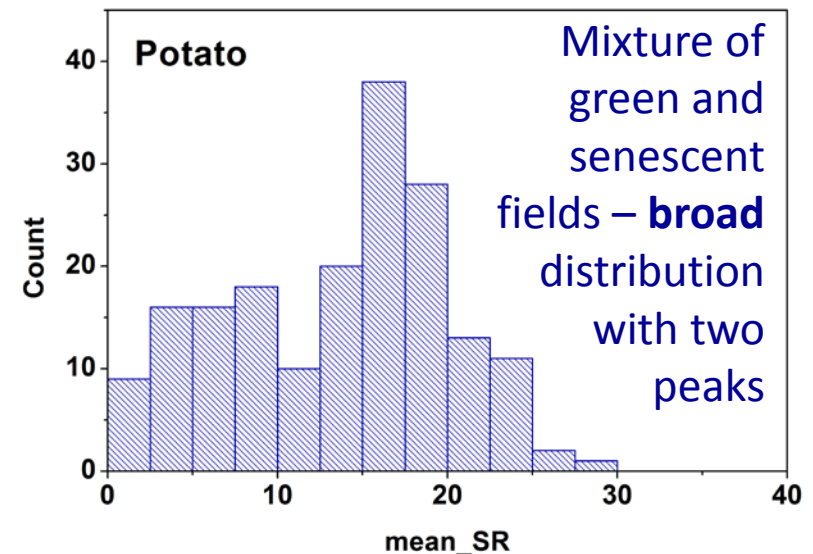
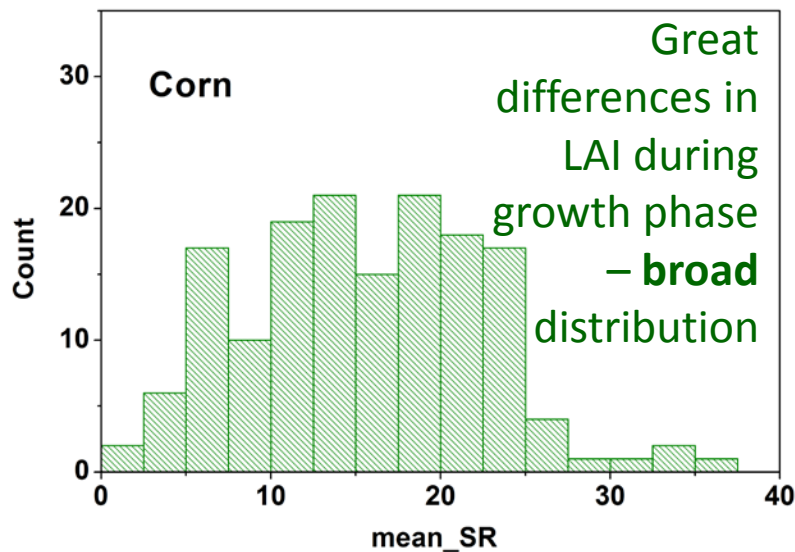
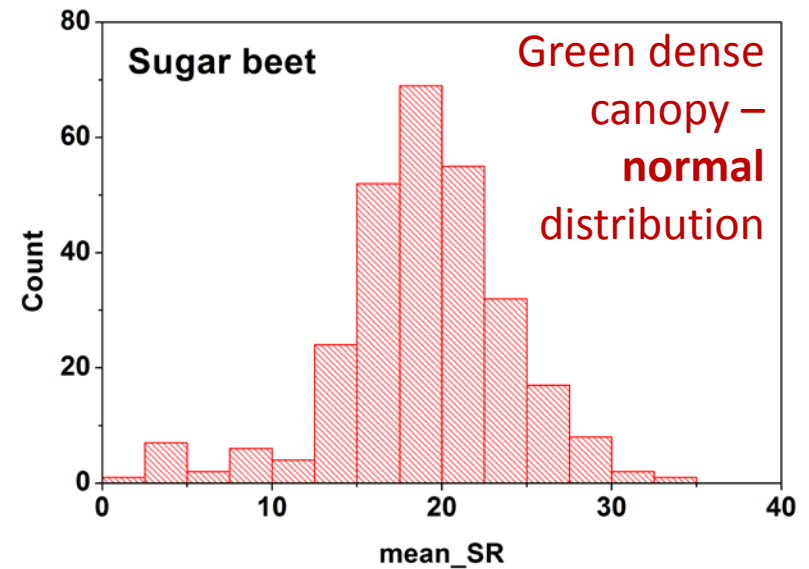
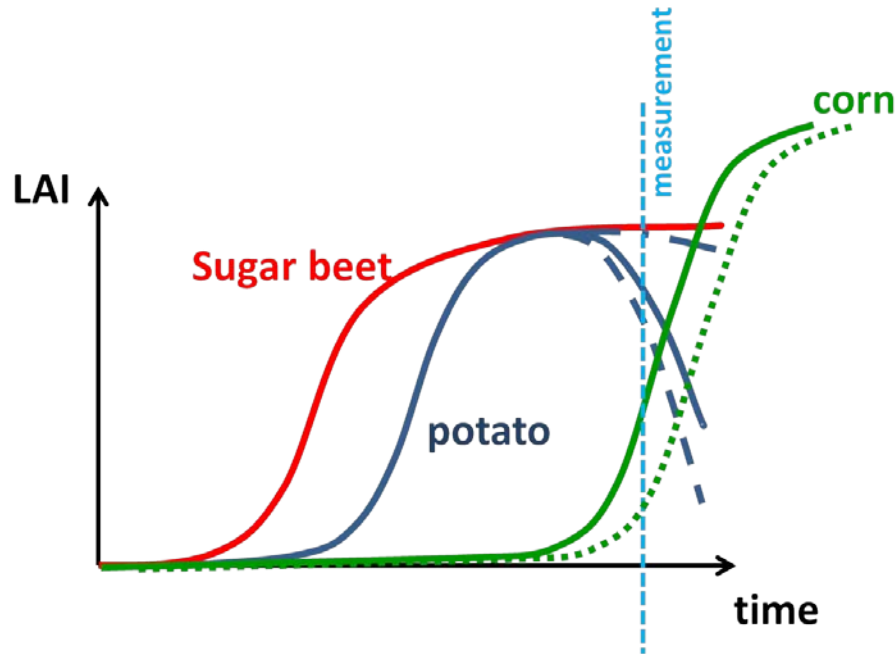
**F<sub>687</sub>**



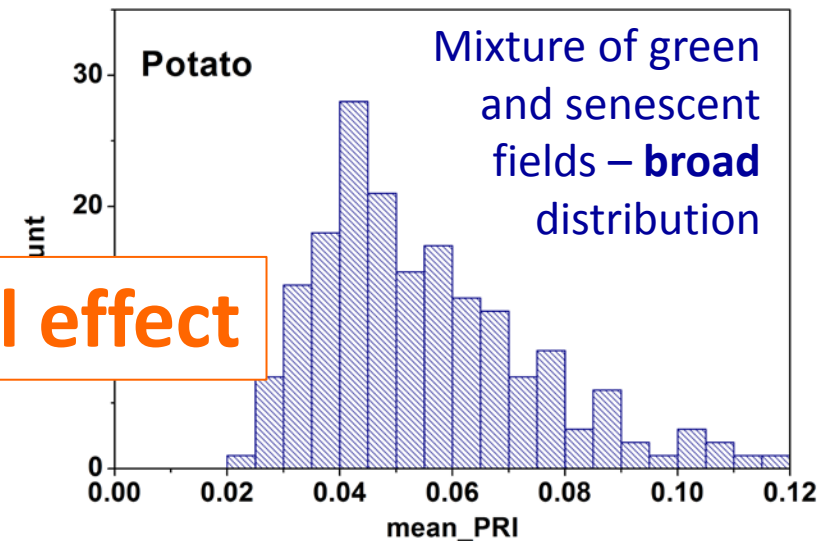
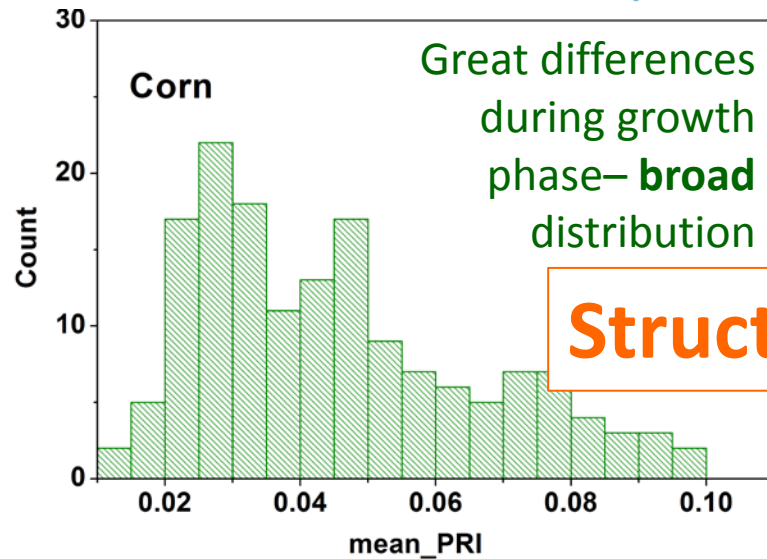
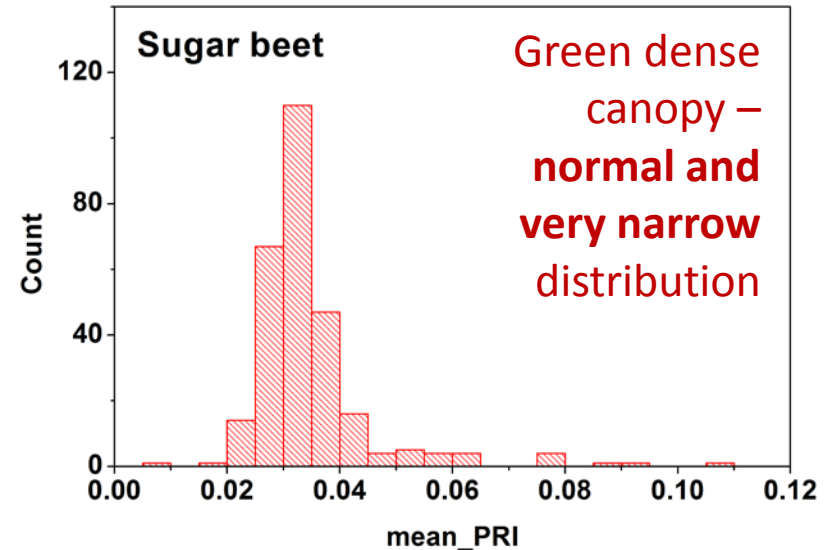
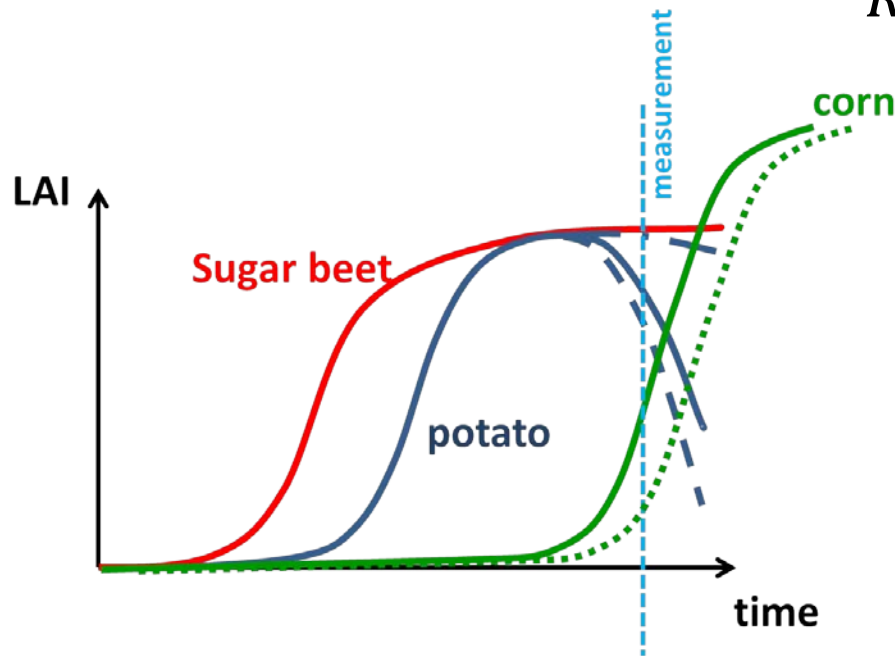
**F<sub>760</sub>**



# Distribution of Simple Ratio ( $SR = \frac{R_{<800>}}{R_{<680>}}$ )

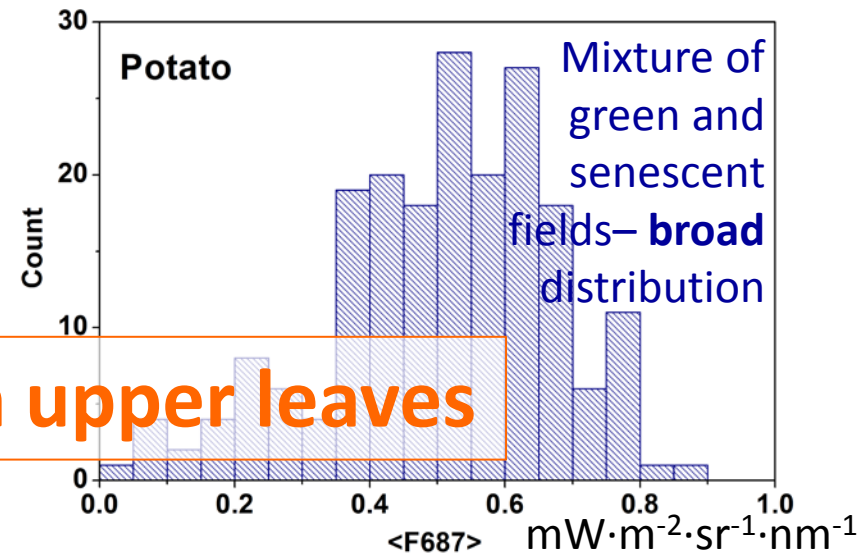
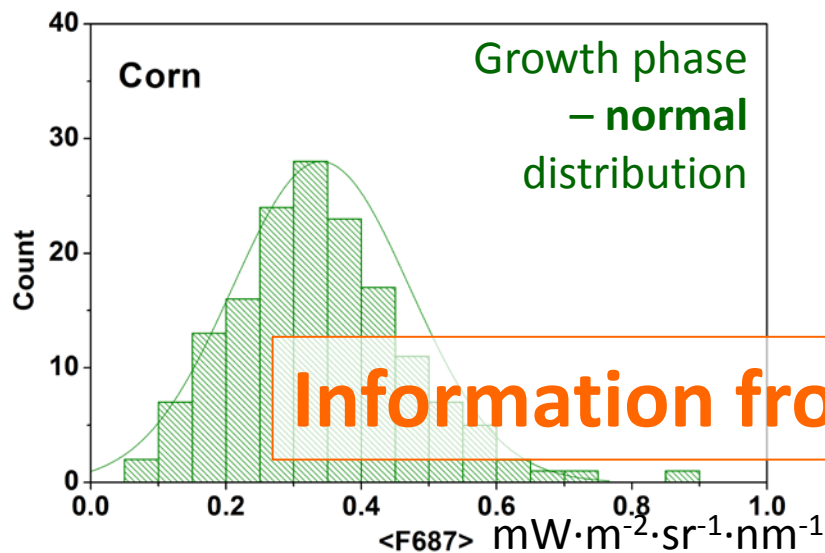
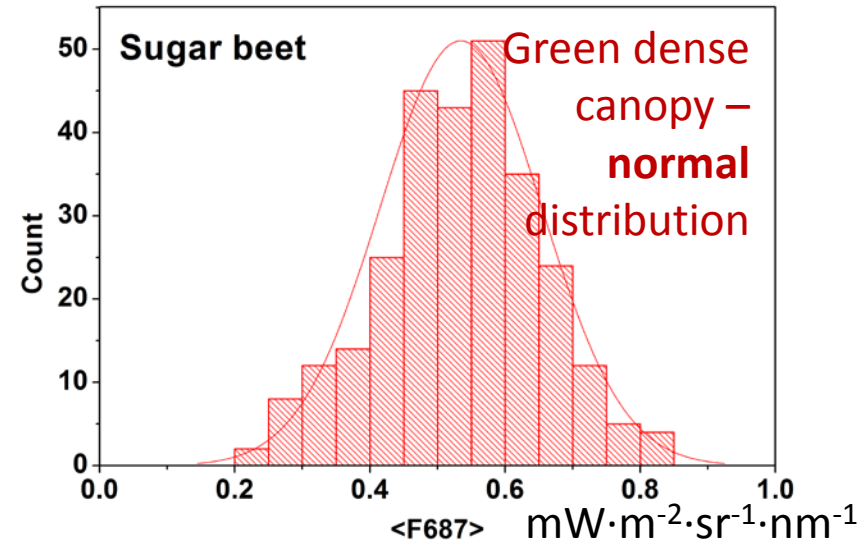
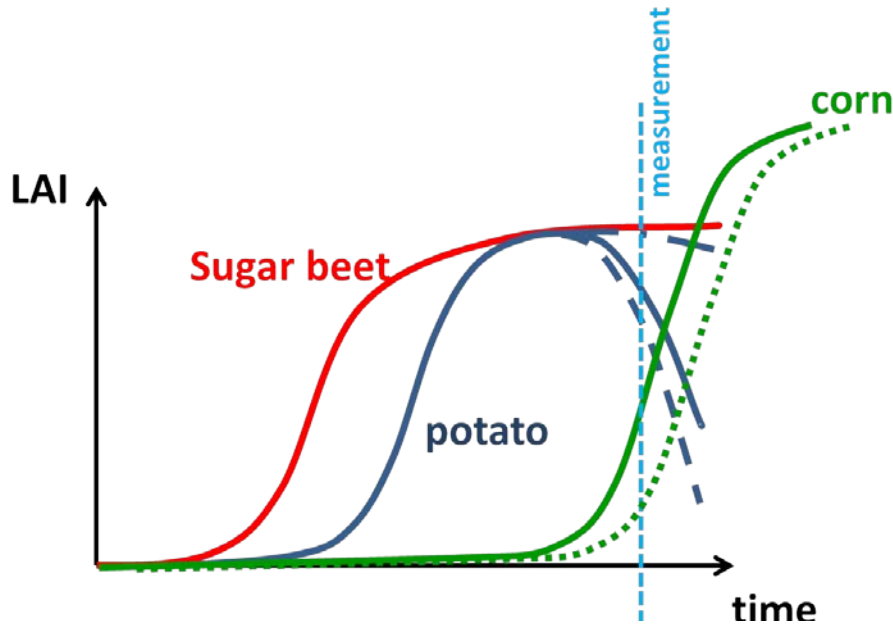


# Distribution of PRI ( $PRI = \frac{R_{<570>} - R_{<531>}}{R_{<570>} + R_{<531>}}$ )



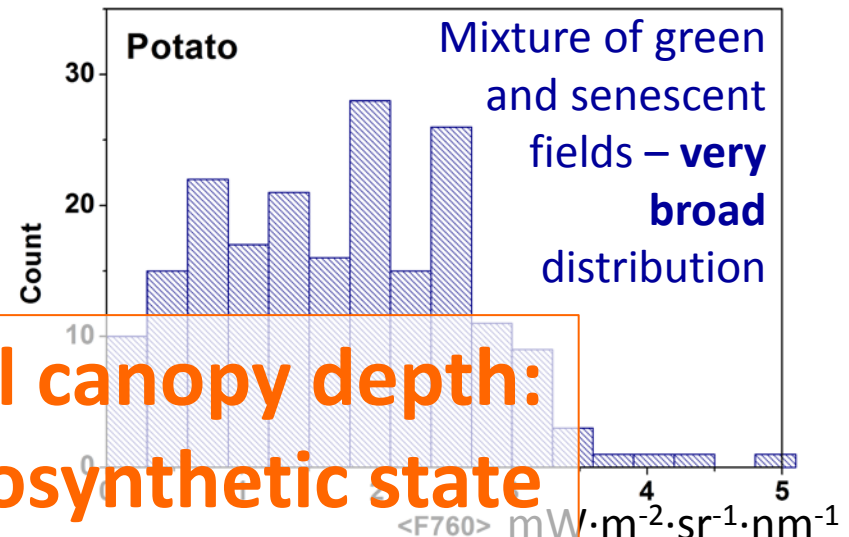
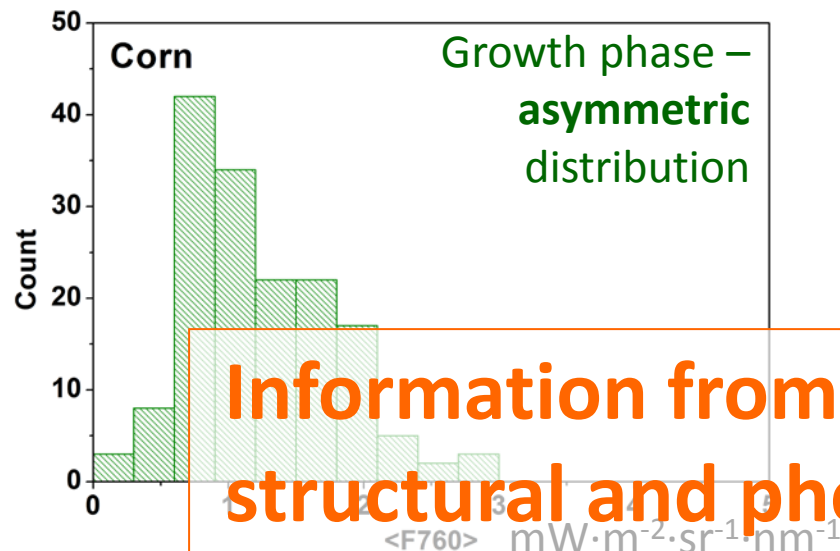
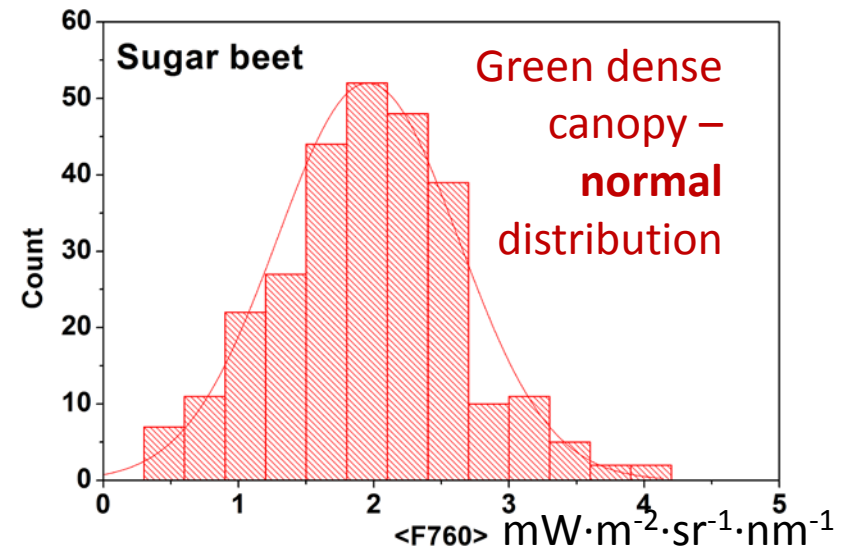
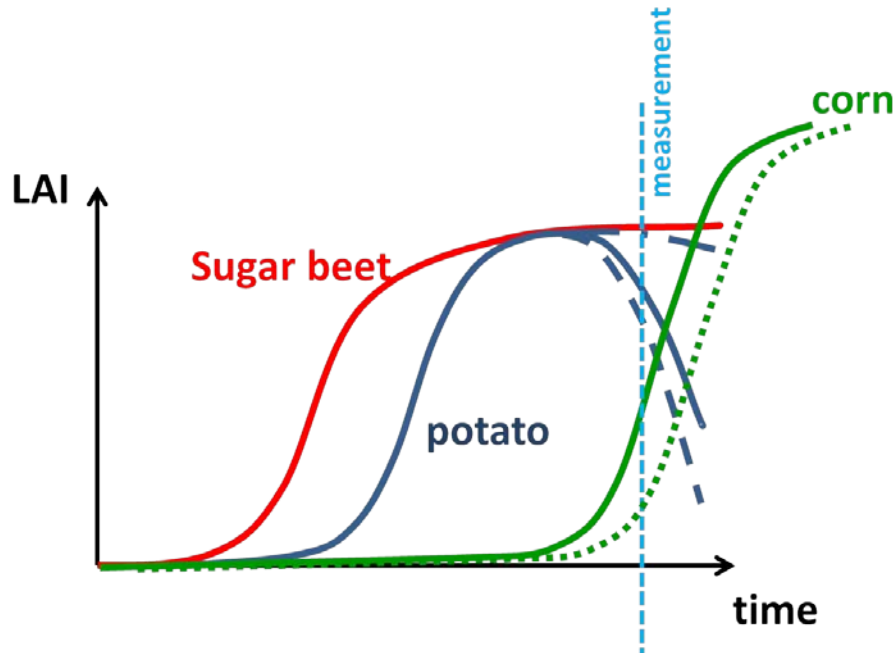
**Structural effect**

# Distribution of red fluorescence $F_{687}$



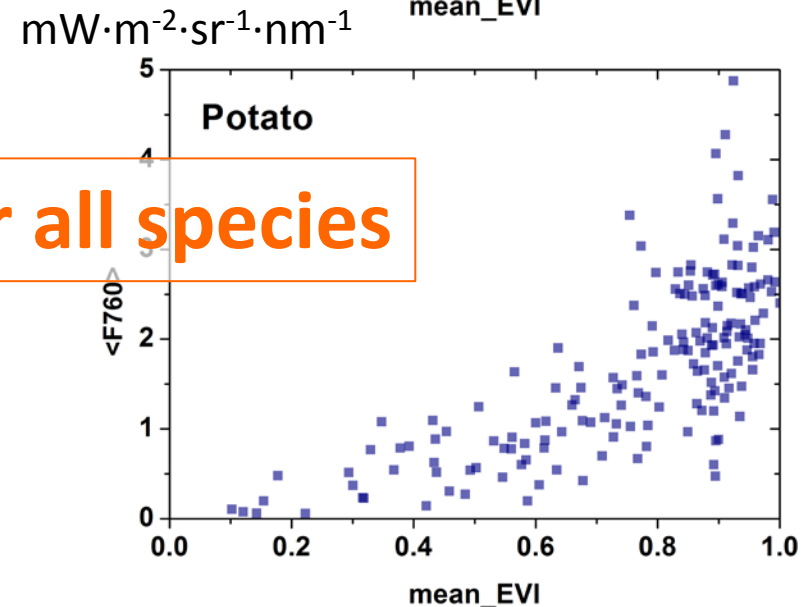
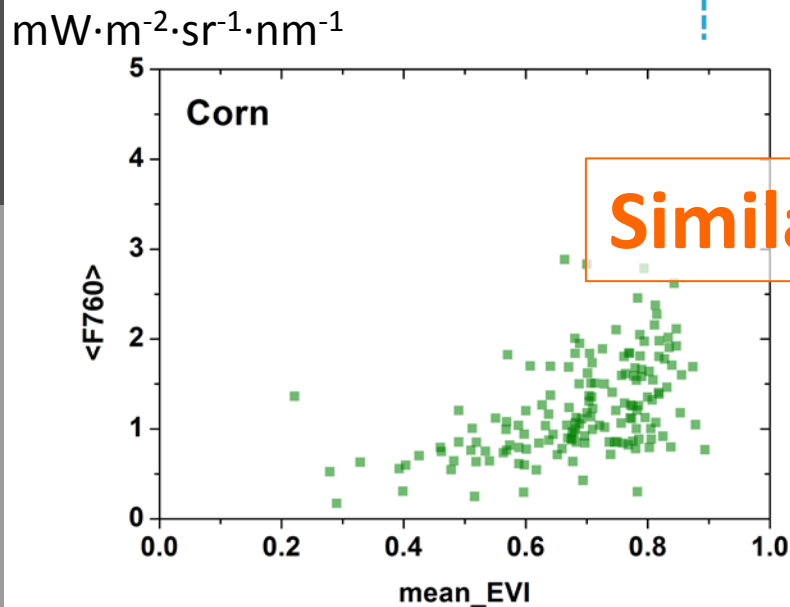
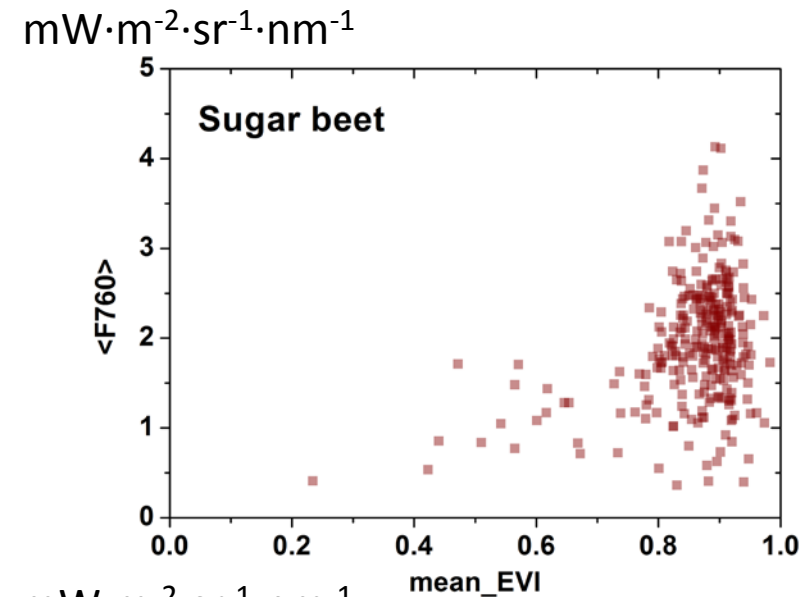
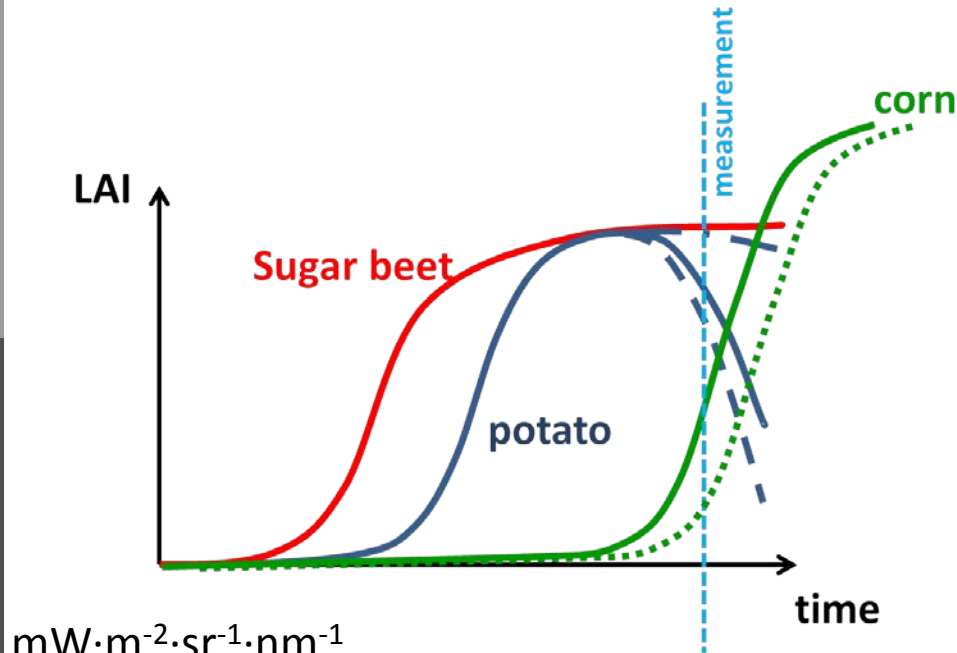
**Information from upper leaves**

# Distribution of far-red fluorescence $F_{760}$



**Information from all canopy depth:  
structural and photosynthetic state**

# Correlation of $F_{760}$ and EVI

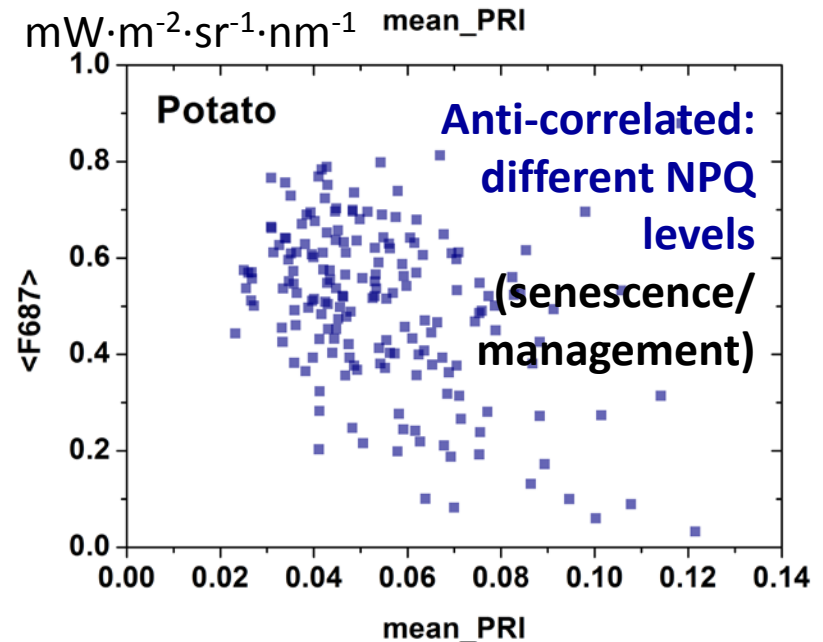
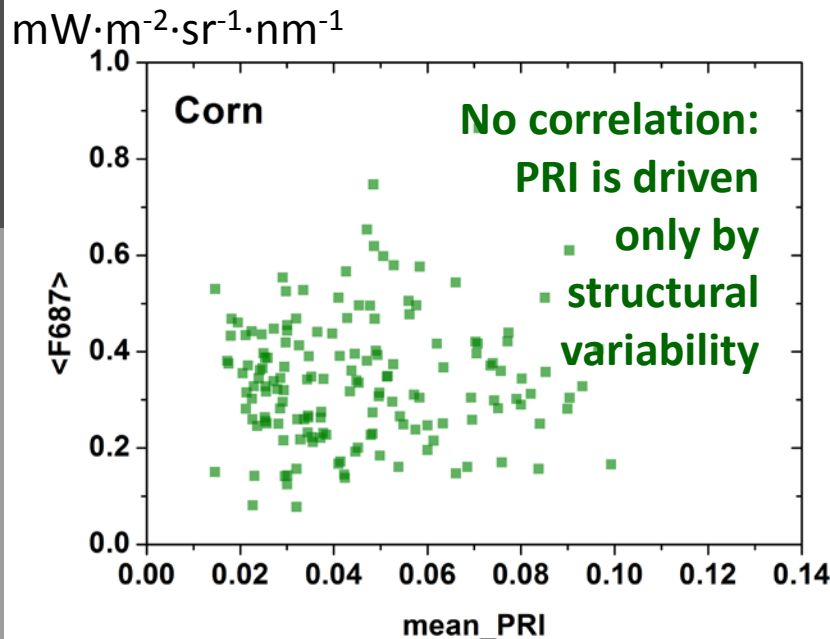
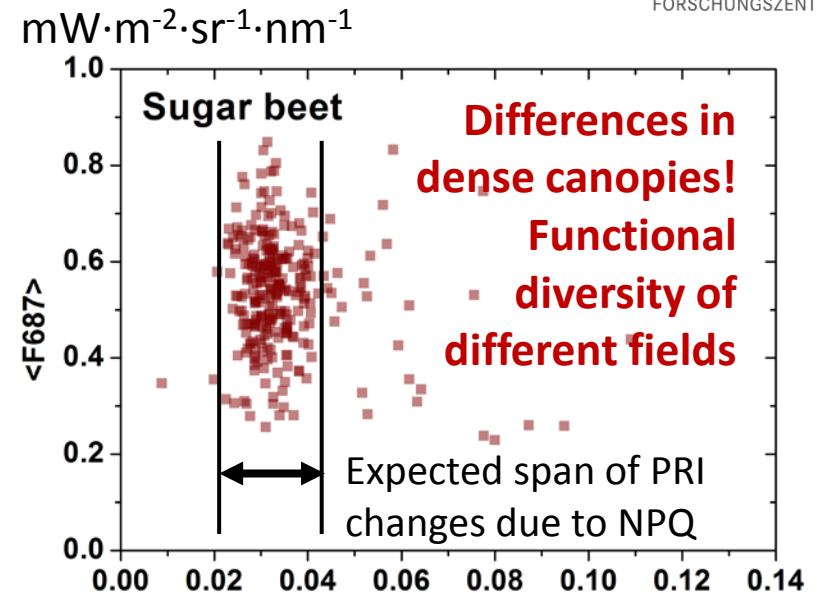


**Similar for all species**

# Correlation of $F_{687}$ and PRI

- $F_{687}$  is a proxy for photochemical efficiency
- PRI is a proxy for NPQ

Hence they should be anti-correlated



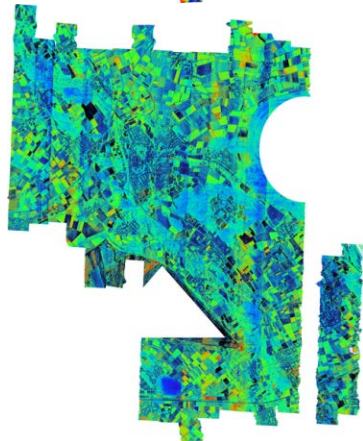
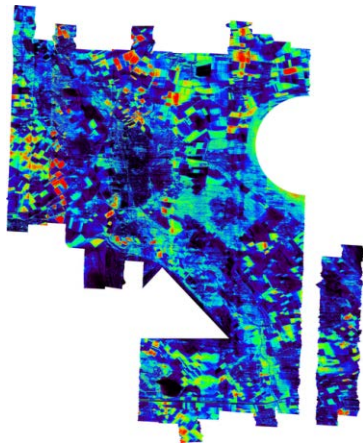
# Functional diversity of different fields



Sugar beet fields  
3 days before overflight



Effect of soil water holding capacity on canopy:  
Field 1 – normal  
Field 2 – drought stressed



- The heterogeneity of fluorescence (F) and vegetation indices (VIs) between fields was evaluated
- The **variability** of  $F_{687}$  and  $F_{760}$ , PRI and SR for green dense canopy is normally distributed
- **Broader distributions are caused by structural effects** (growing canopies) or **canopy senescence**
- The **correlation between  $F_{760}$  and EVI** was confirmed, with  $F_{760}$  still showing variability in dense canopies
- **When PRI is driven by NPQ, PRI and  $F_{687}$  are anti-correlated** and show functional diversity of different fields

- Project TR32 for financial support and great scientific network
- People organizing and performing the campaign: A. Schickling, P. Rademske, U. Rascher
- Data processing: A. Damm and P. Rademske
- Land Use data: C. Brogi and G. Waldhoff
- Ground soil moisture measurements: W. Korres and team

**Thank you very much for your attention!**