Max Planck Institute for Biogeochemistry

TRUSTEE training
training on Remote Sensing for Ecosystem modelling

Nutrient induced changes in Sun-Induced Fluorescence in a Mediterranean grassland

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Thanks to the co-authors

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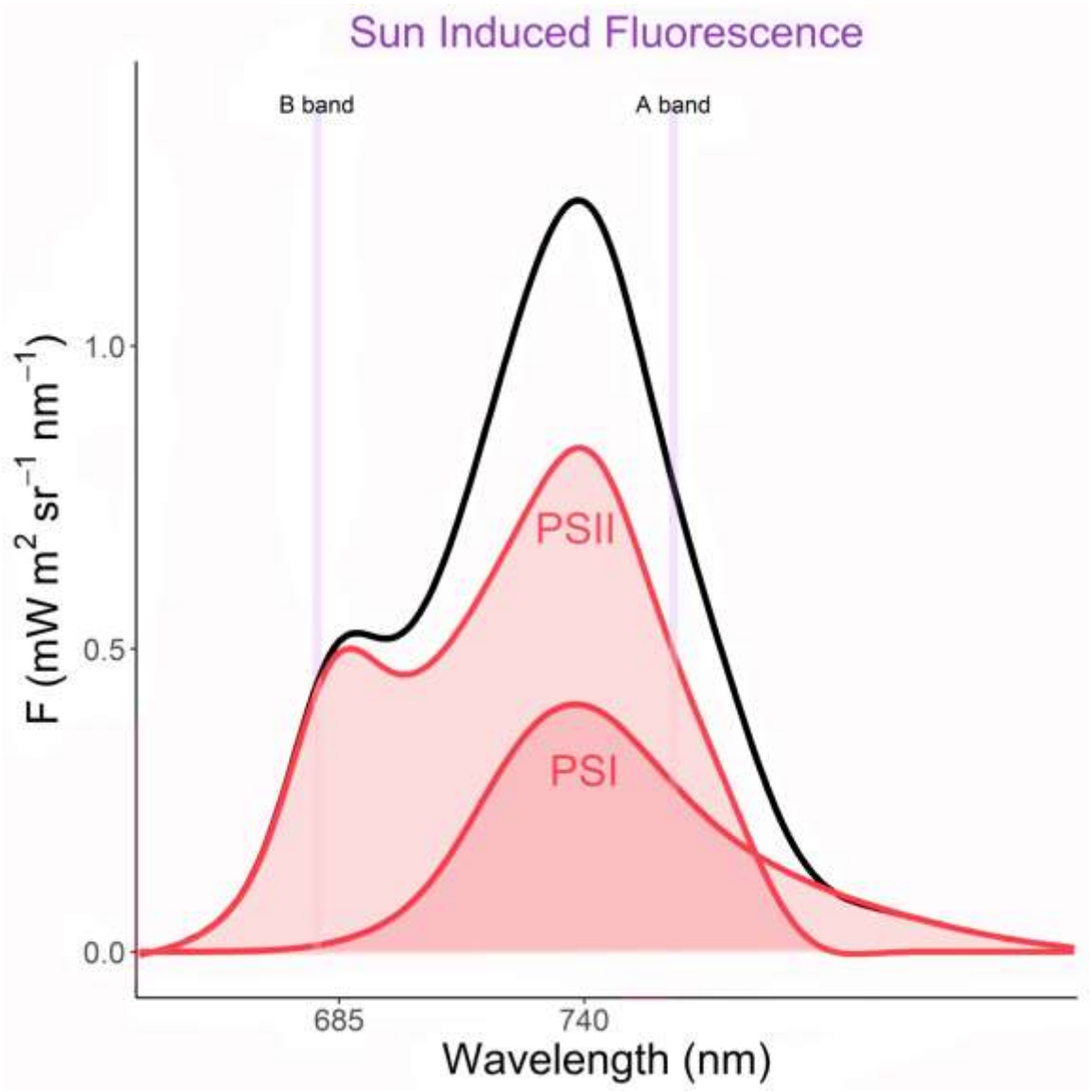
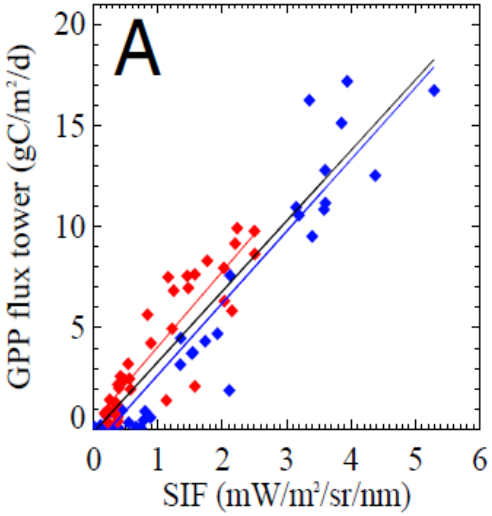
- Oscar Perez-Priego
- Christiaan van der Tol
- Tarek S. El-Madany
- Tommaso Julitta
- Micol Rossini
- Anatoly Gitelson
- Markus Reichstein
- Mirco Migliavacca

Sun-Induced Fluorescence (SIF)



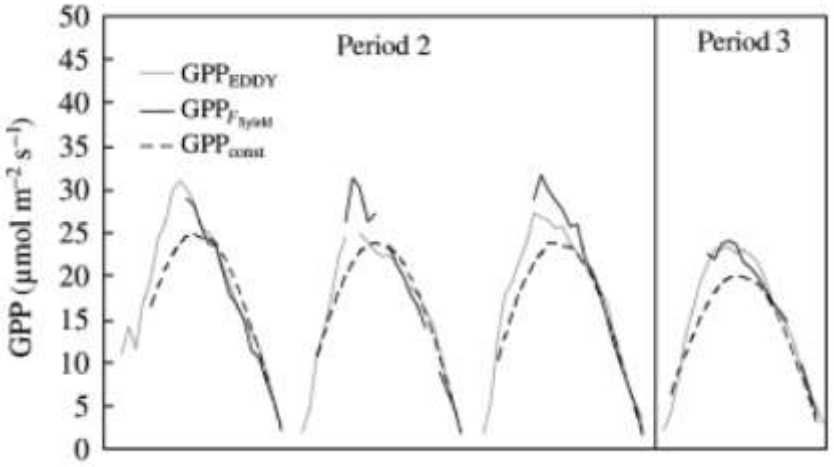
GPP – SIF

Global scale



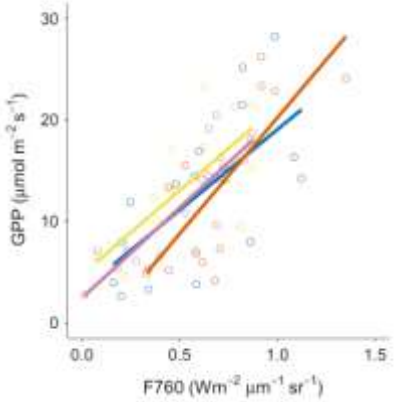
Guanter et al. 2014

Ecosystem scale



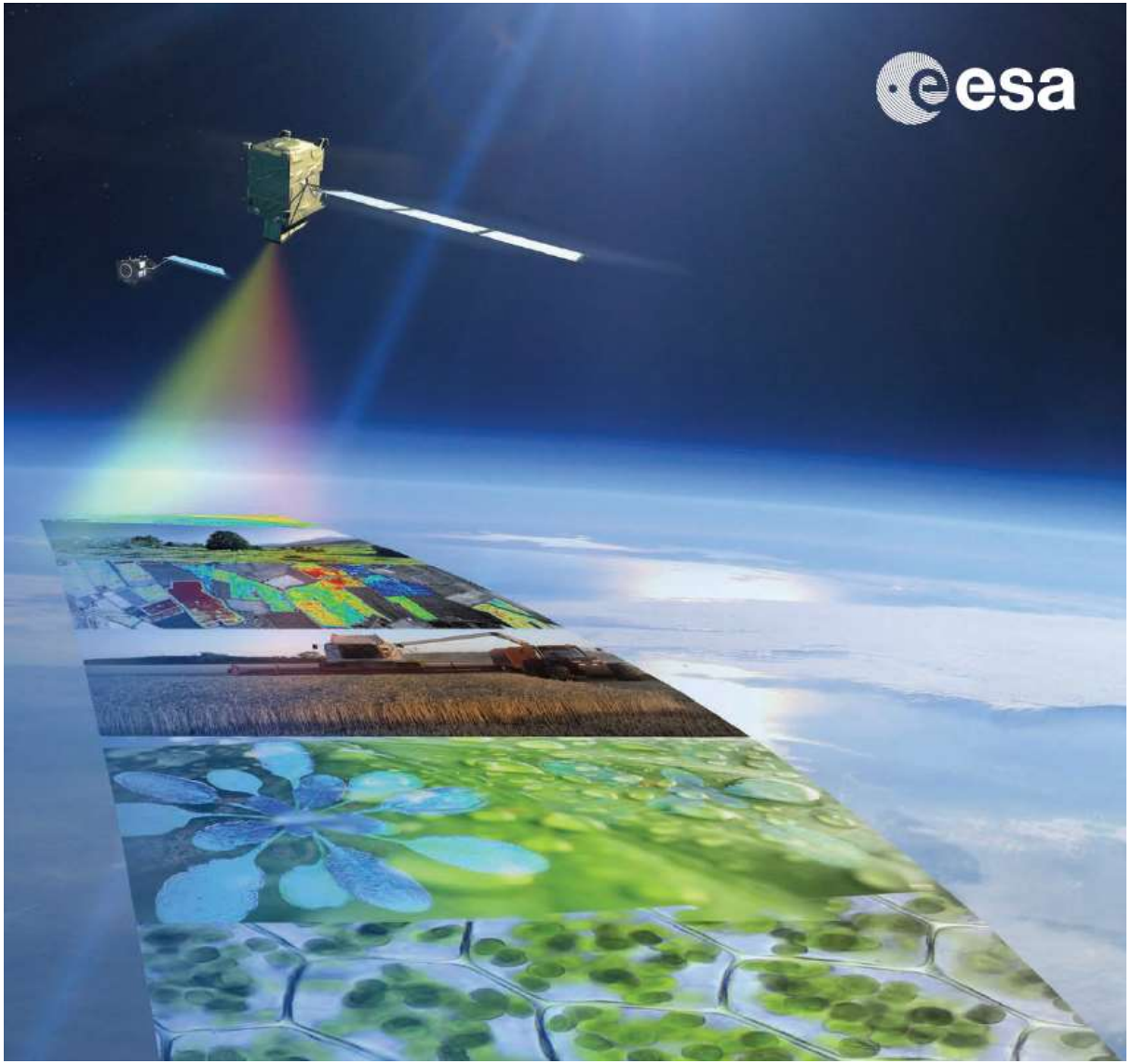
Damm et al. 2010

Local scale



$$GPP \approx F_{760} \times \frac{LUE_p}{Fesc * LUE_f}$$

FLEX 2022

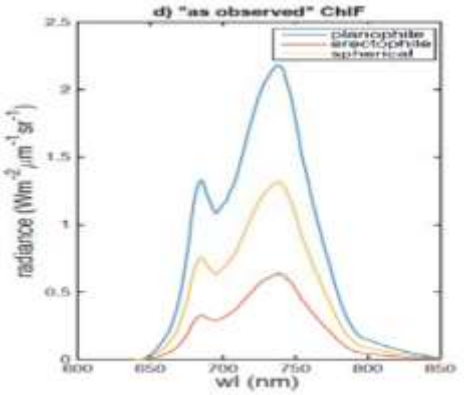


Problem statement

$$GPP \approx F_{760} \times \frac{LUE_p}{Fesc * LUE_f}$$

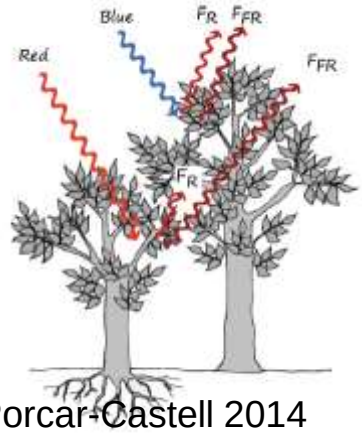
- **LUEp**, **LUEf** and **Fesc** are hard to measure or parametrize

- *Fesc* very useful because allow to obtain SIF emitted at leaf level
  - SIF emission should carry more physiological information



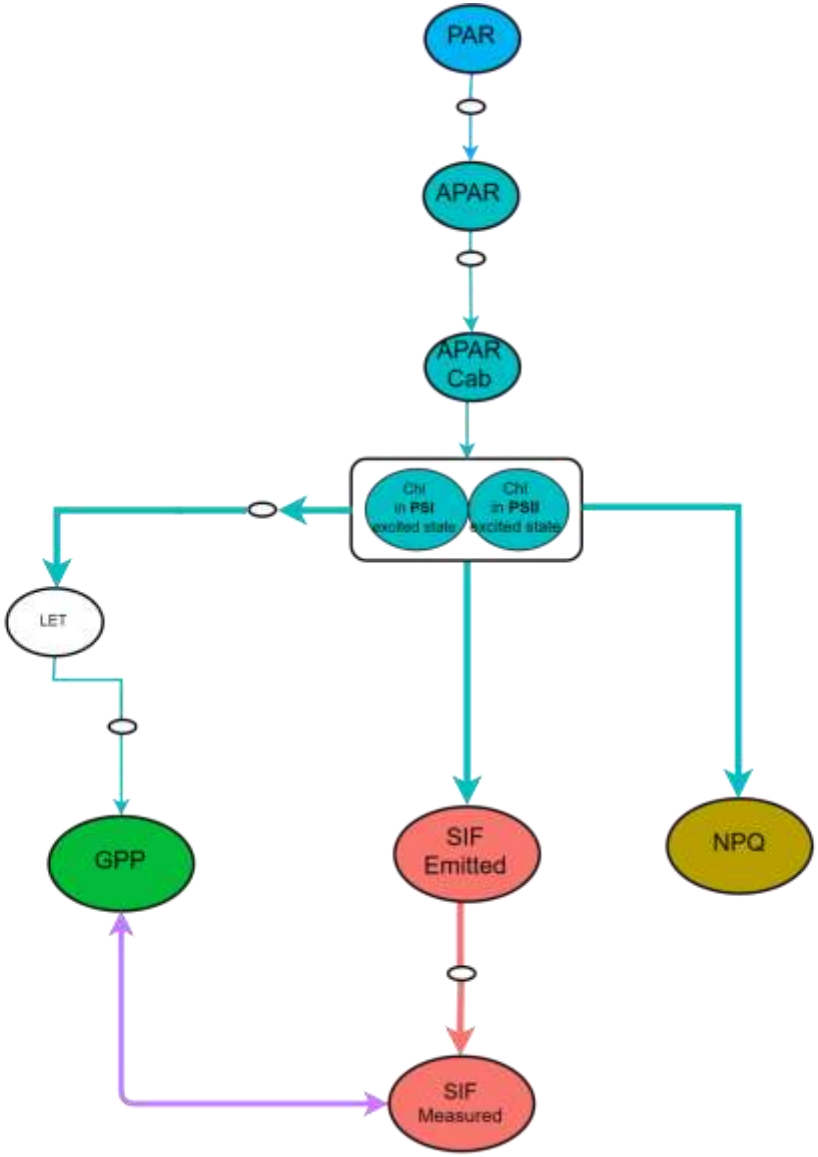
Migliavacca 2017

- Not clear how successful this approach is at predicting GPP under *high spatial variability*



Porcar-Castell 2014

Theoretical framework; complexity behind LUE eq.



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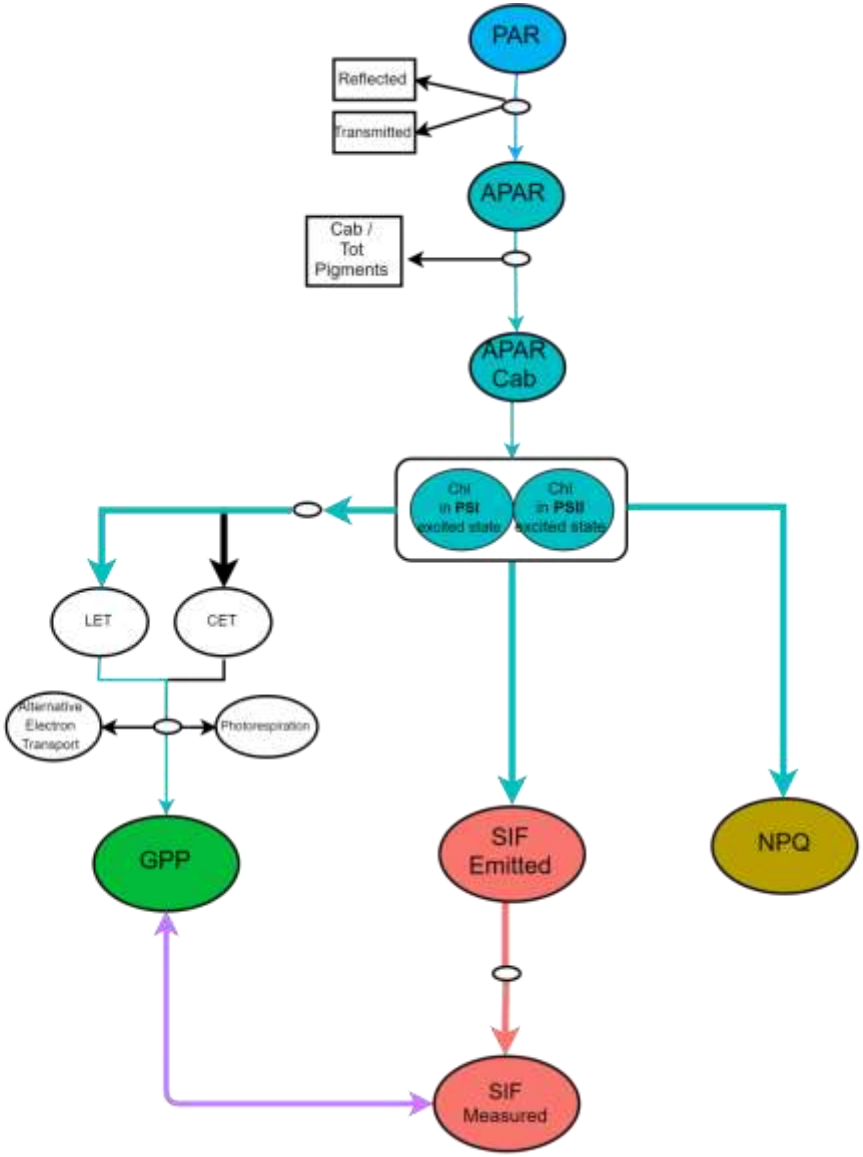

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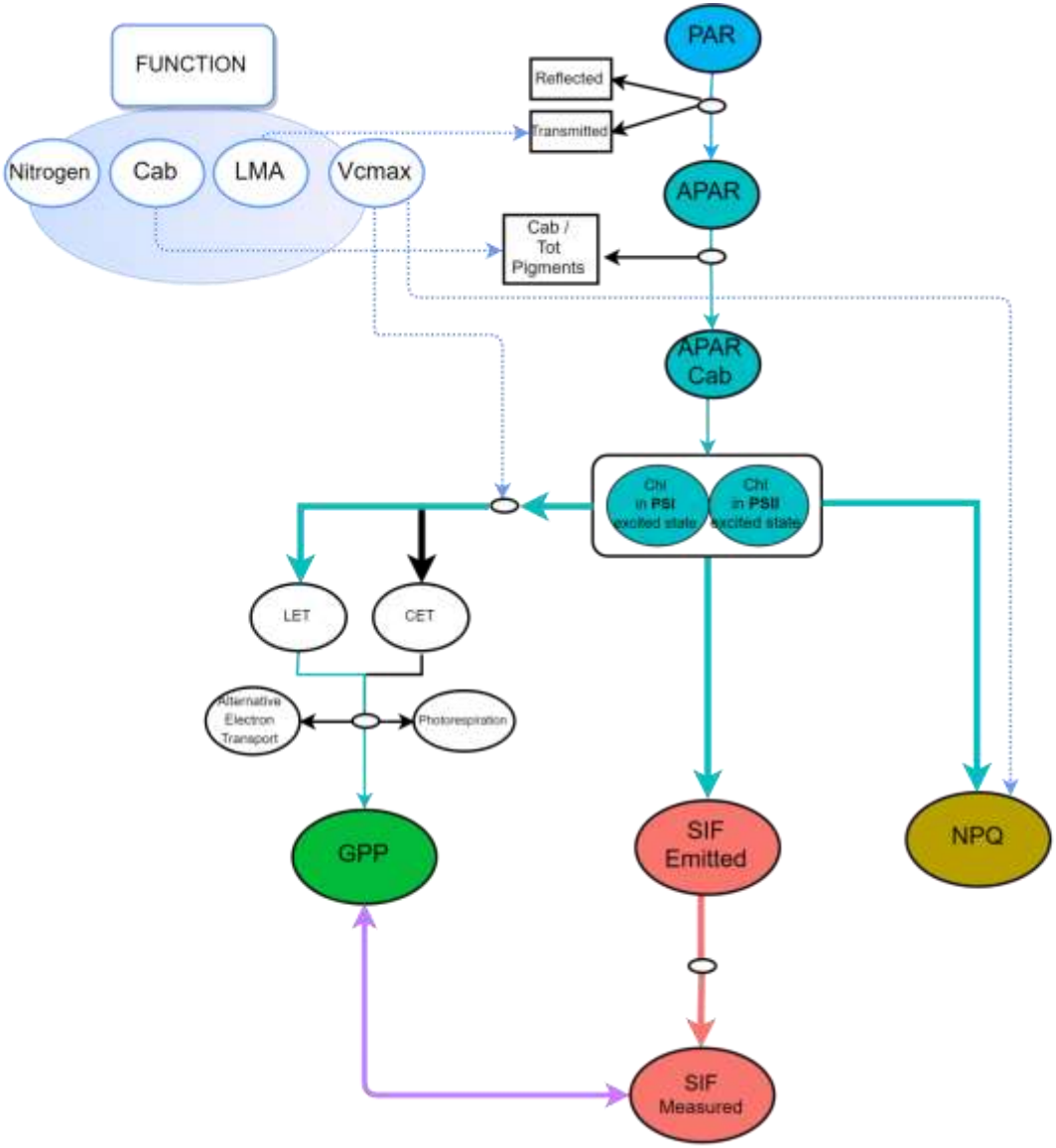

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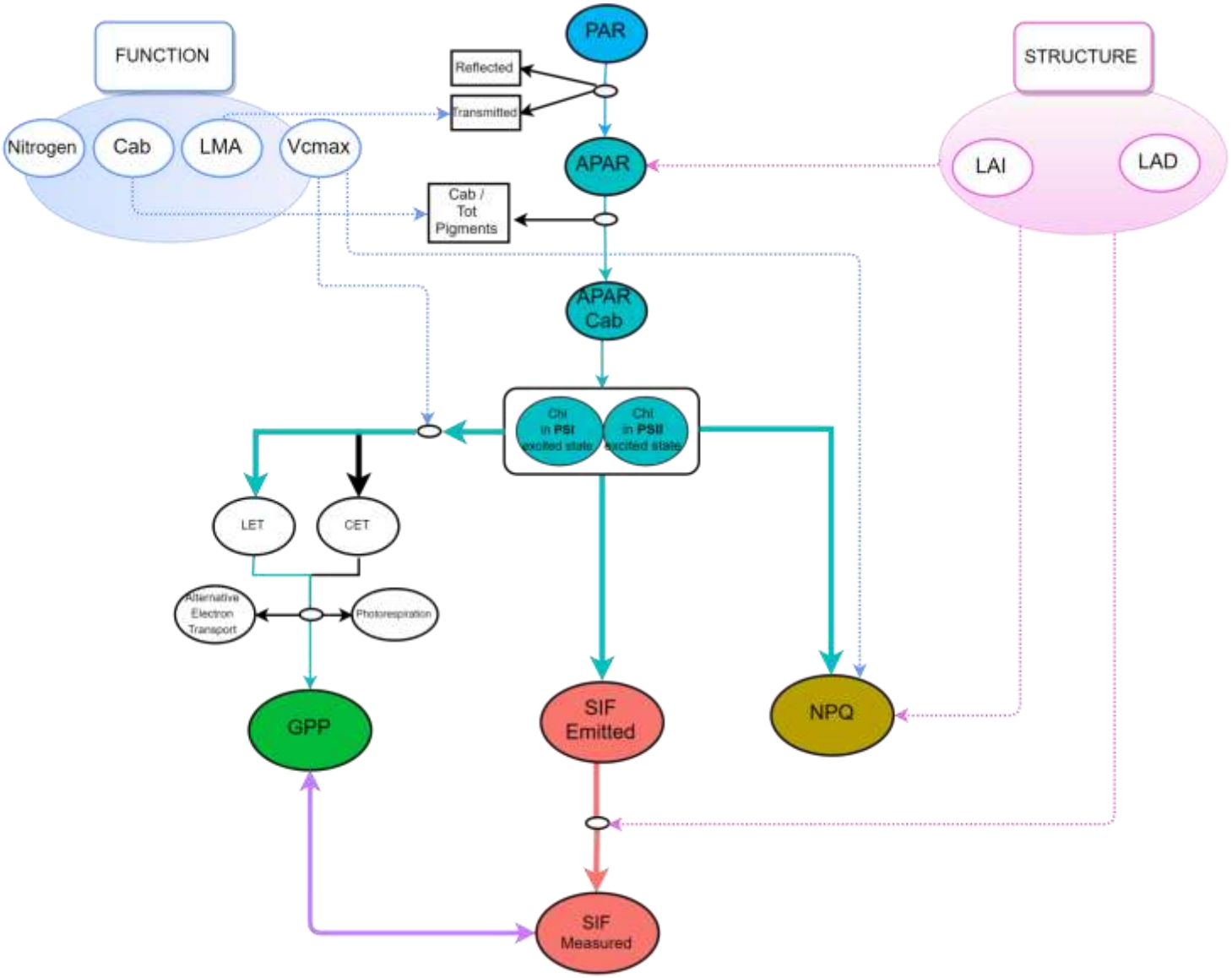

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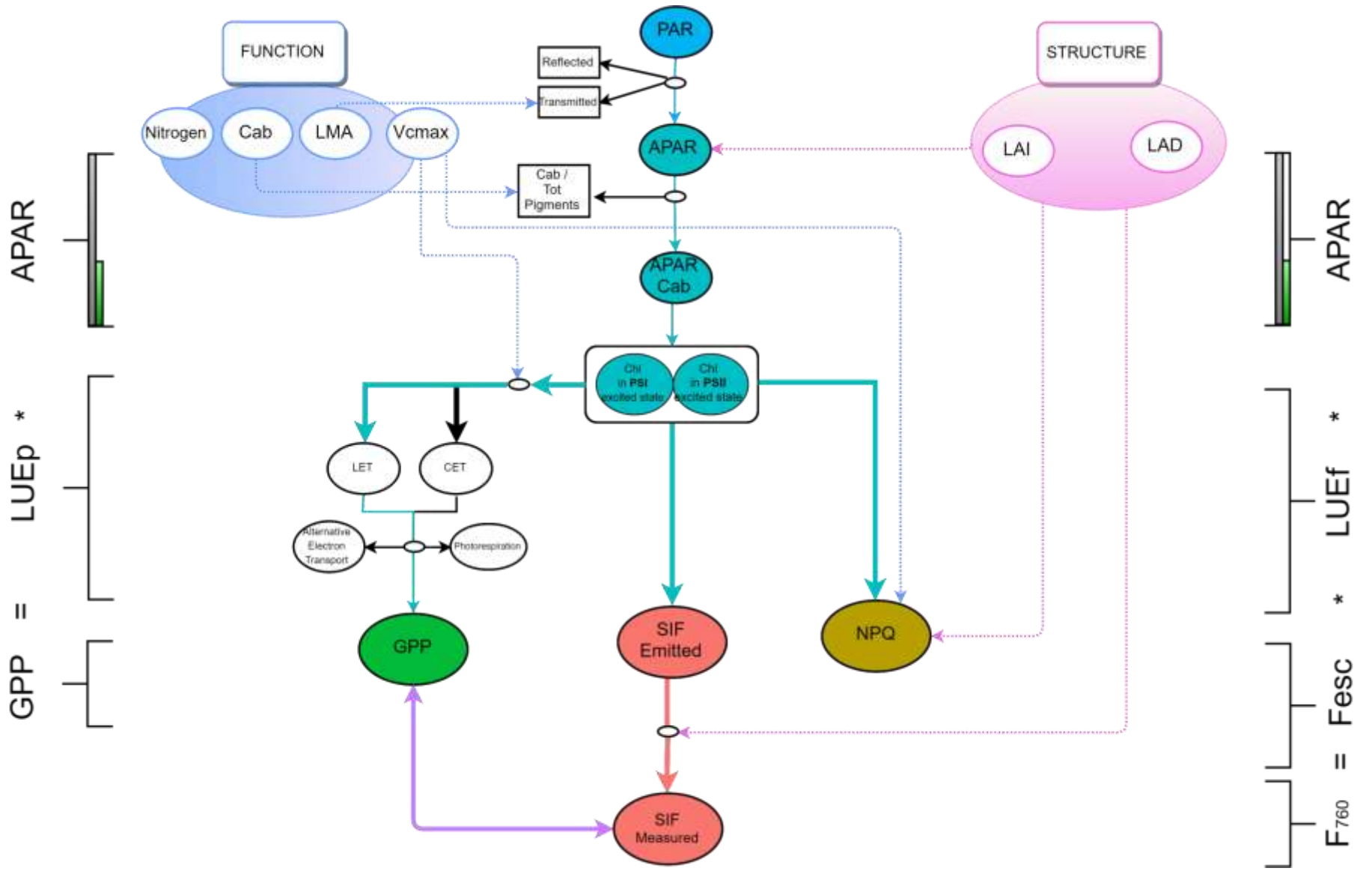
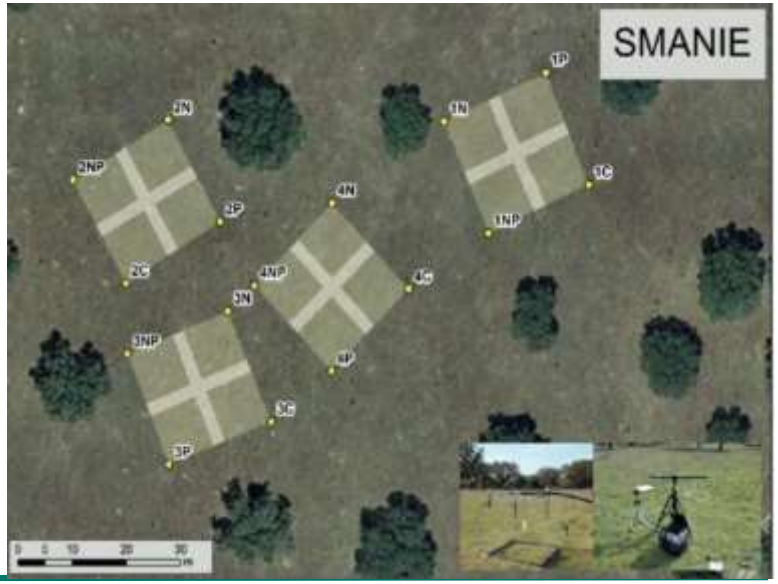


Objectives

Evaluation of the *effect* of fertilization on GPP- SIF dynamics

Evaluation of the *processes* that link GPP and SIF

Majadas, Spain – Nutrient manipulation

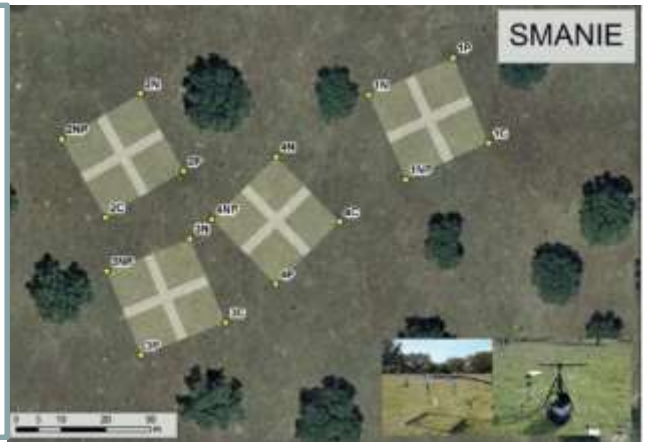


Methods

$$Fesc = \frac{F760_{observed}}{F760_{emitted}\ /\pi}$$

SCOPE model

- GPP from chambers
- Water fluxes
- Hyperspectral measurements
- SIF
- Leaf traits (N, Cab)
- Structural traits (LAI, LAD)
- Plant abundance



Validation with measured GPP and SIF

SCOPE model → **Fluorescence emission** → **Fesc and LUEf**

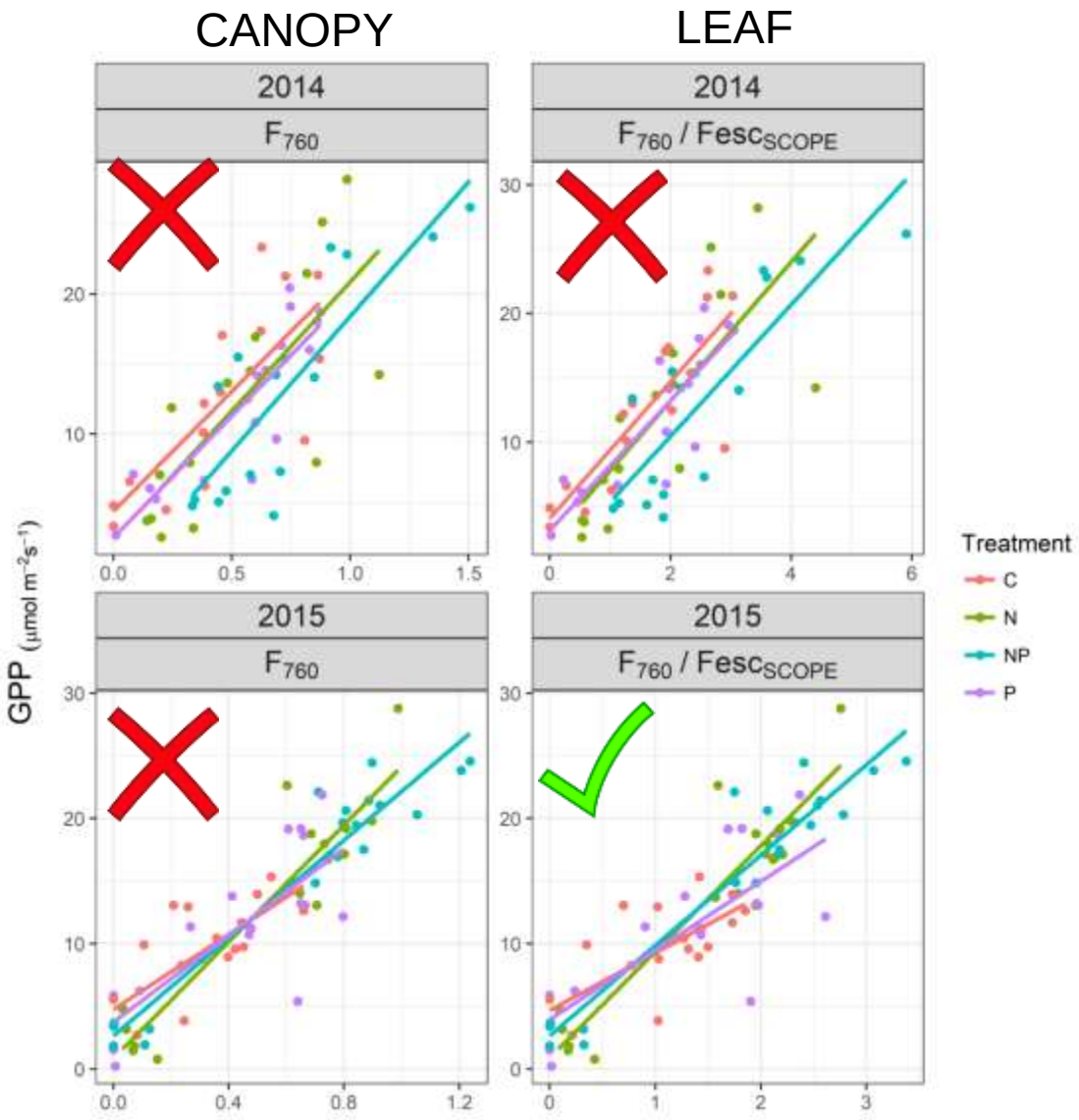
Methods

- **Relative importance analysis** to identify predictors of terms of LUE

- Use this knowledge to **reconstruct the theoretical framework in an *empirical way***

- **Path analysis** to statistically analyze the theoretical framework proposed

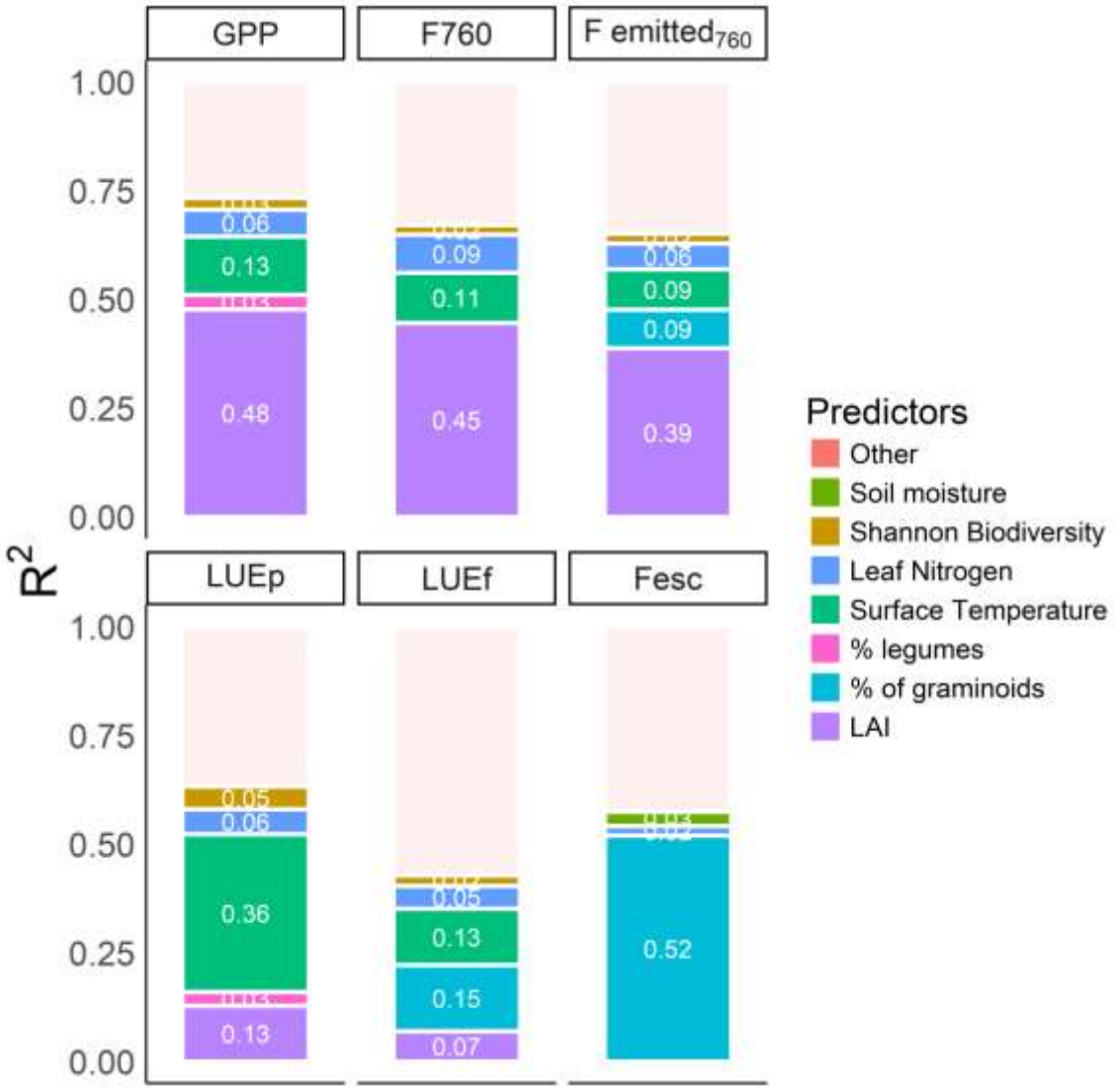
Effect of fertilization on SIF emission



Is there an interaction between Nitrogen treatment and SIF when predicting GPP?

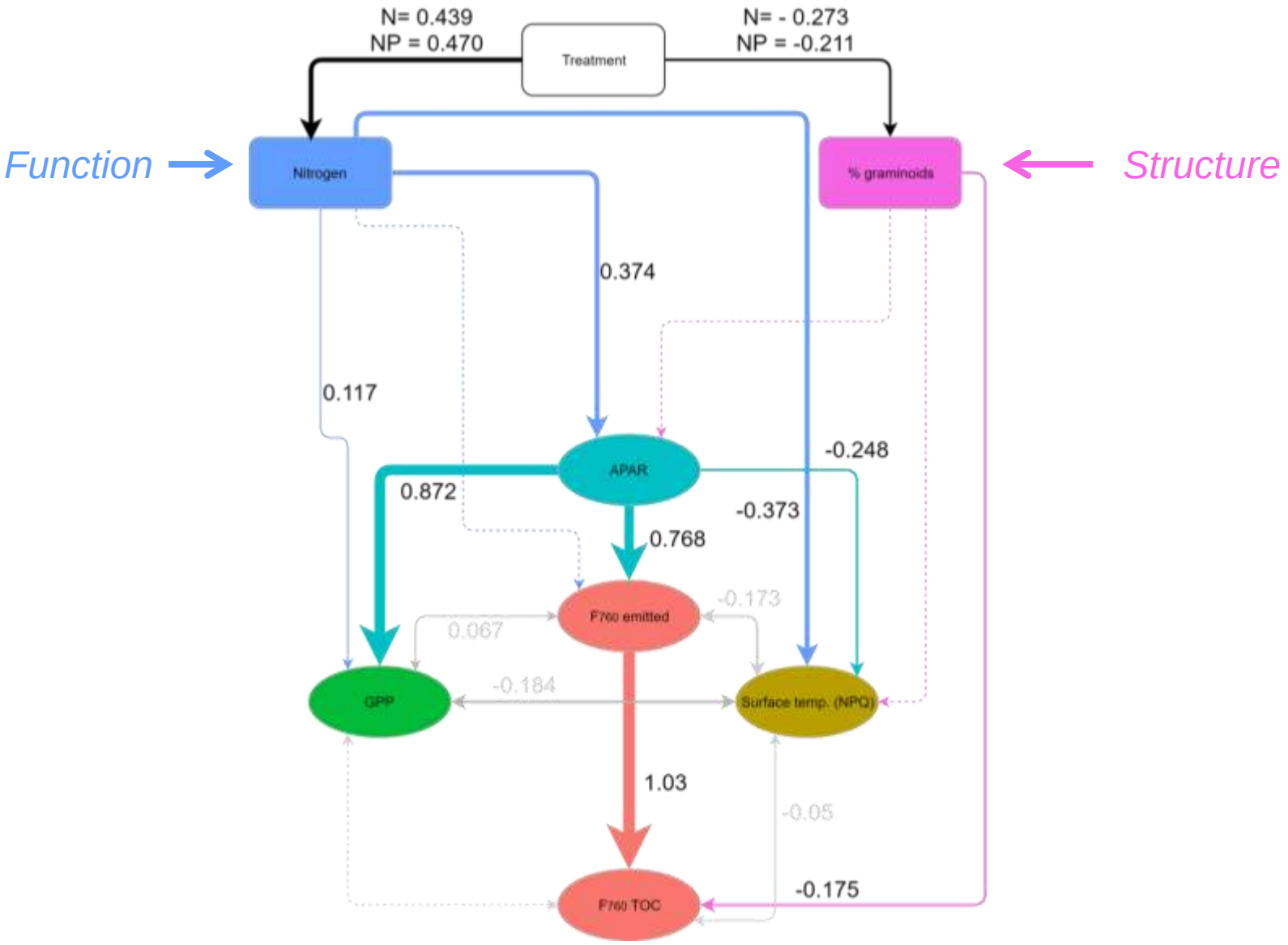
- Treatment effect is captured at the emission level, but *canopy structure compensates*

Relative importance analysis (lmg)



- GPP and F760 share the same predictors
- Fesc is mainly a function of plant type ← LAI

Path analysis



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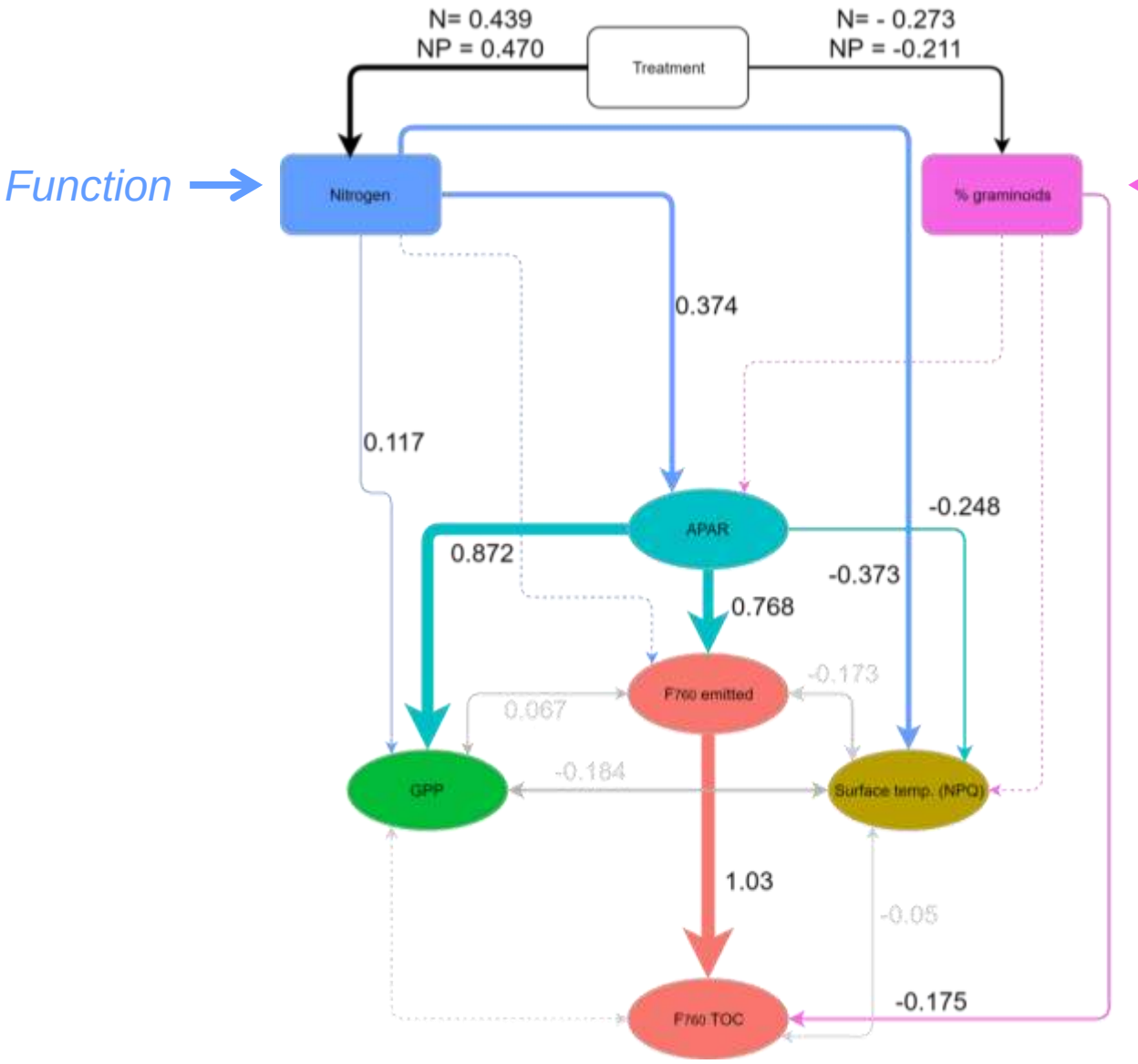
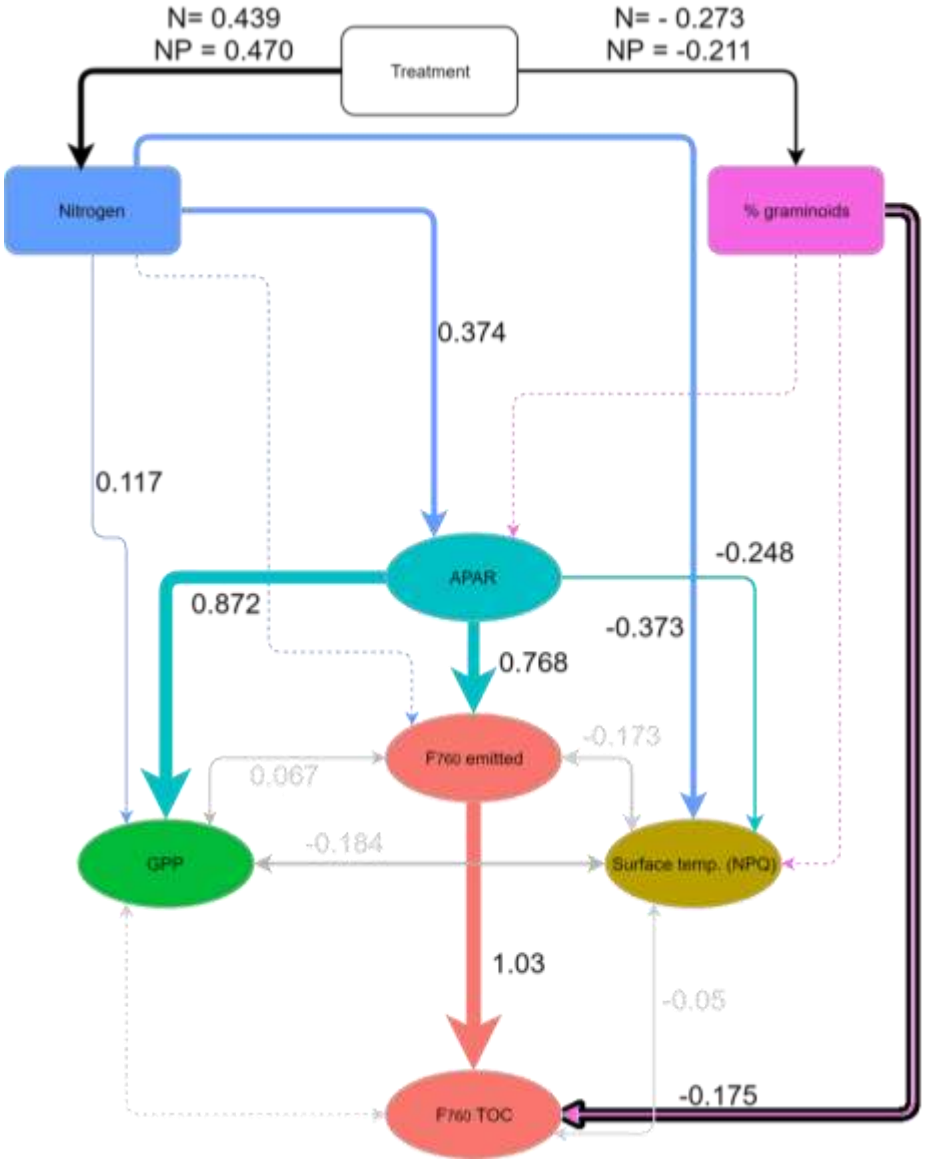


Explicitly representing the drivers and processes of GPP - SIF

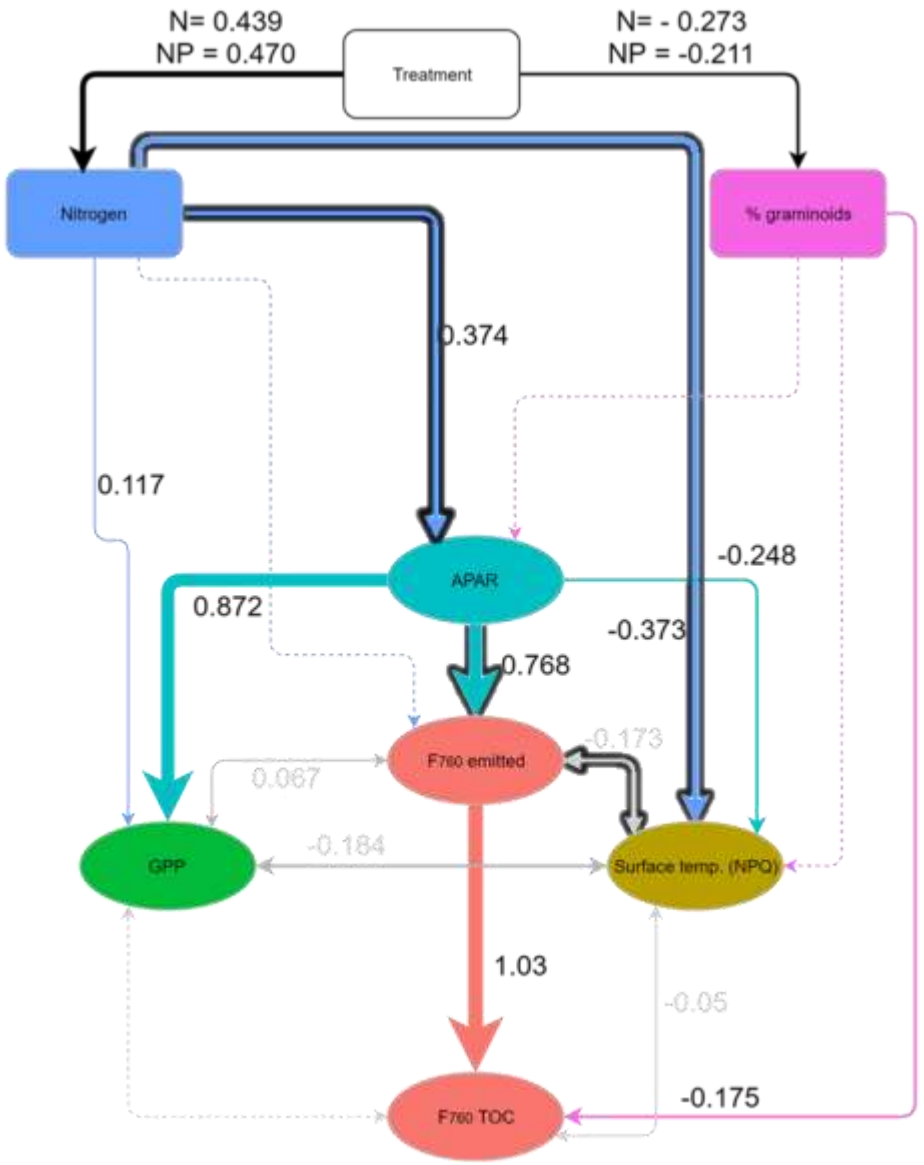
Path analysis



Explicitly representing the drivers and processes of GPP - SIF

- ***Structure*** **does affect F760,** in a direct way

Path analysis



Explicitly representing the drivers and processes of GPP - SIF

- ***Structure*** **does affect F760,** in a direct way
- ***Function*** **does influence** F760 emitted in a indirect way
  - Effect mediated by APAR and NPQ

Conclusions and next steps

Treatment

SIF emission carries out more **physiological information** and responds to treatment

Processes

Nitrogen fertilization affects both structural and functional traits, →SIF emission

Changes in **Leaf N affect more indirectly SIF emission**

Towards empirical Fesc descriptions

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