Modelling to understand measurements and scaling of observations

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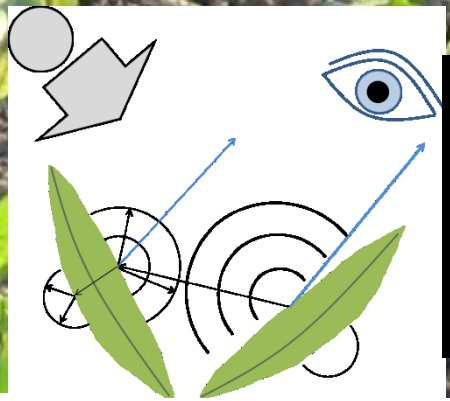

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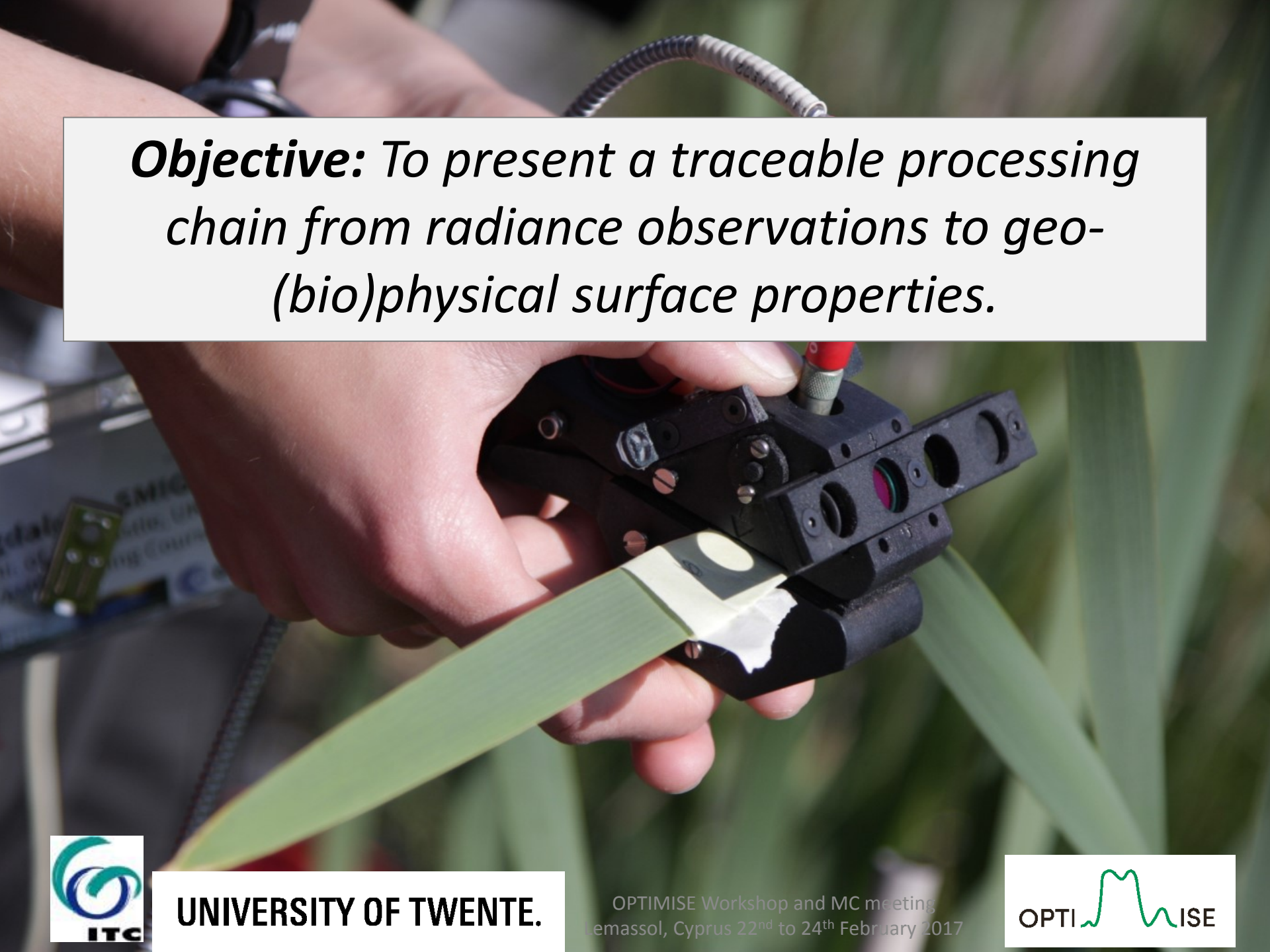
Remote Sensing of Fluorescence, Photosynthesis and Vegetation Status ESA-ESRIN, 24-26 Jan 2017



Objective: *To present a traceable processing chain from radiance observations to geo-(bio)physical surface properties.*

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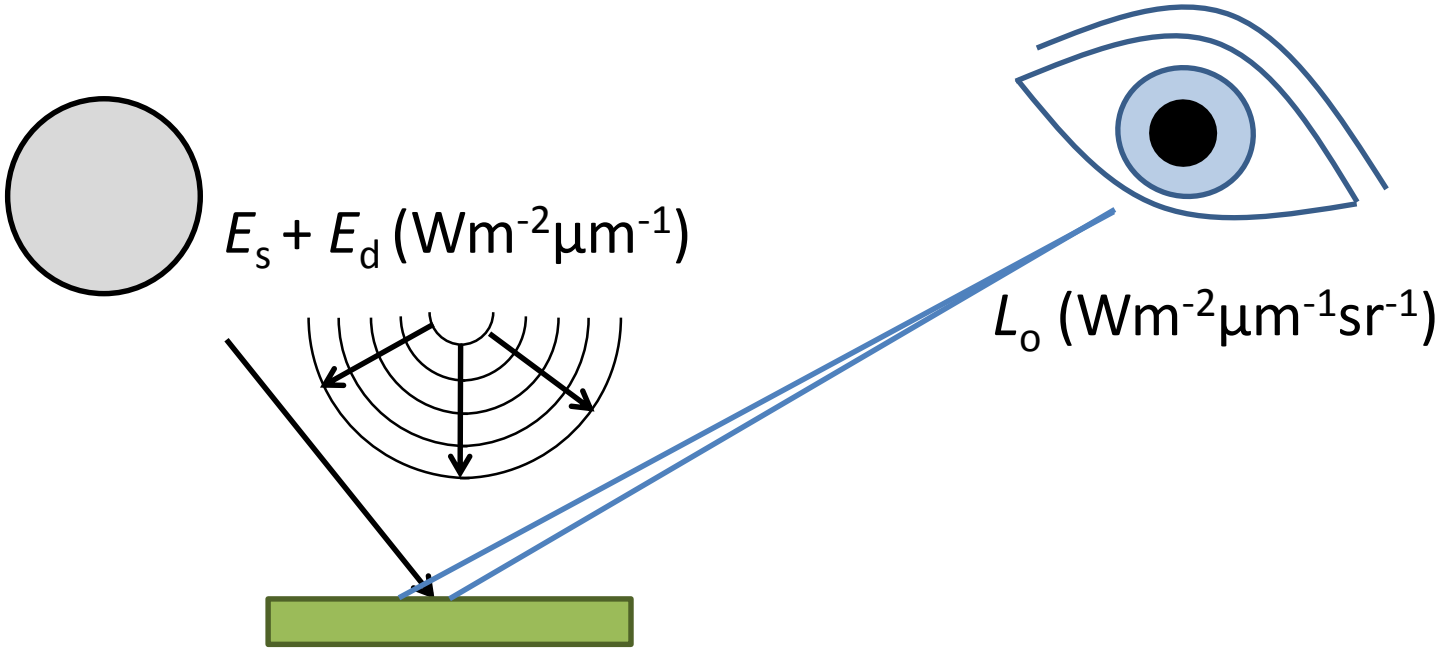
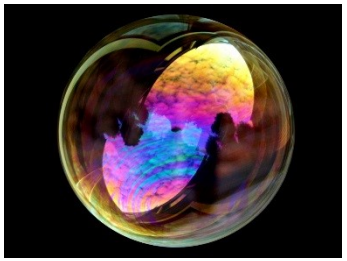


$$\pi L_o = (r_{so}E_s + r_{do}E_d)$$

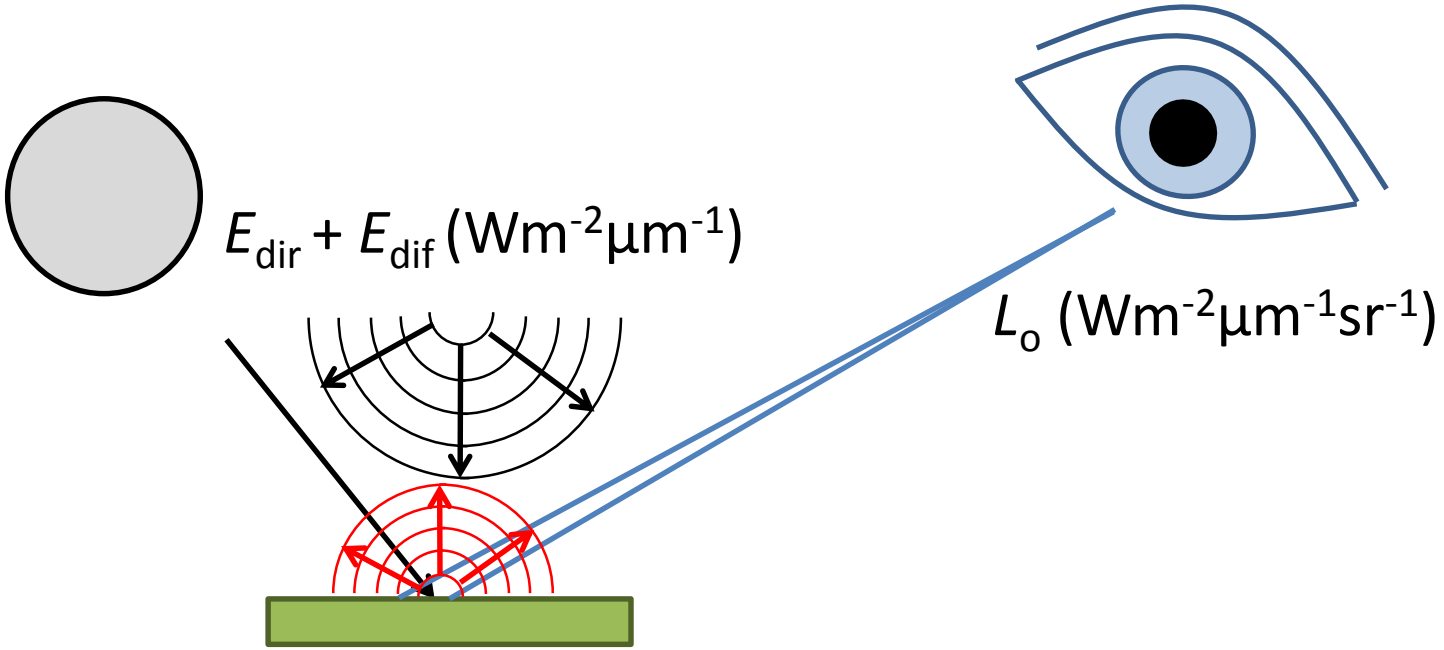
- Spectral signatures of pigments, water, etc.
- Refraction and geometry of objects



Observation models: *Radiative transfer models that describe the relations between the physical and biochemical properties of objects and the observed radiation*

$$[\pi L_o, r_{so}, r_{do}] = f(X)$$

$$\pi L_o = (r_{so} E_s + r_{do} E_d)$$



Chlorophyll fluorescence (0.65-0.80 µm)
Thermal emitted irradiance (2.5-50 µm)

$$\pi L_o = r_{so}E_s + r_{do}E_d + \pi F_o + \pi B_o(T)$$

$$\pi L_o = r_{so}E_s + r_{do}E_d + \pi F_o + \pi B_o(T)$$

$$\pi L_o = f(X)$$

Retrieval

$$X = f^{-1}(\pi L_o)$$

Leaves
- Absorption spectra (*K*) of Chemicals (*C*): $\sum K_i C_i$
- Refraction index
- Leaf thickness

Canopy
- Leaf density (or area)
- Leaf orientations
- Soil background
- Stems and branches

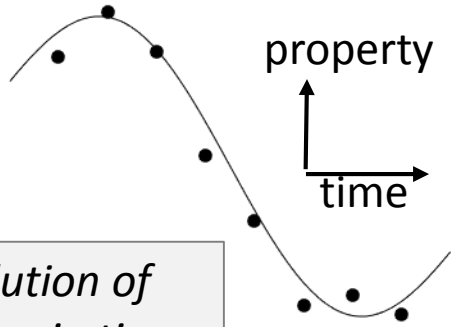
Soil
- Brightness

Sensitivity

wavelength

$$\frac{\delta L_o}{\delta X} = \begin{bmatrix} \frac{\delta L_{o,\lambda 1}}{\delta X_1} & \cdots & \\ \vdots & \ddots & \vdots \\ & \cdots & \frac{\delta L_{o,\lambda n}}{\delta X_m} \end{bmatrix}$$

X



Retrieval

$$X = f^{-1}(\pi L_o)$$

Process models: *describe the evolution of geo-(bio)physical surface properties in time*

Process model

$$P = f_2(X, E_s + E_d, M)$$

Environmental conditions (function of time)

- Temperature
- Humidity
- Air pressure (and partical CO_2 pressure)
- Soil moisture

'Invisible' vegetation parameters

- Photosynthetic pathway
- Carboxylation capacity (Rubisco)

- Chloroplast movement
- De-epoxydation
- Stomatal opening
- Photosynthesis
- Transpiration

Scale	Observation model	Process model
Leaf	Fluspect	Biochemical
Canopy	RTMo (0.40-2.50 µm) RTMf (0.64-0.85 µm) RTMt (2.5-50 µm)	Energy Balance Routine

Retrieval chain

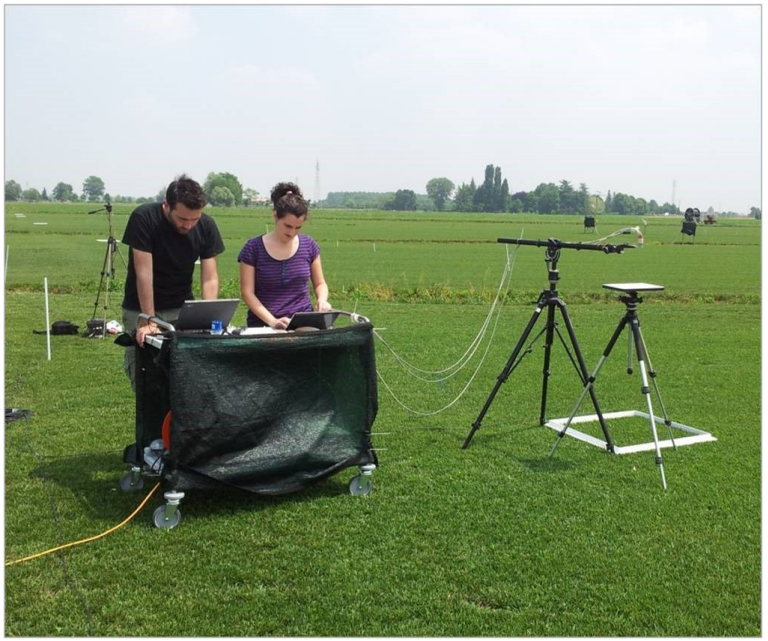
Step 1: $X = f_1^{-1}(\pi L_o)$

Step 2: $P = f_2(X, E(t), M(t))$

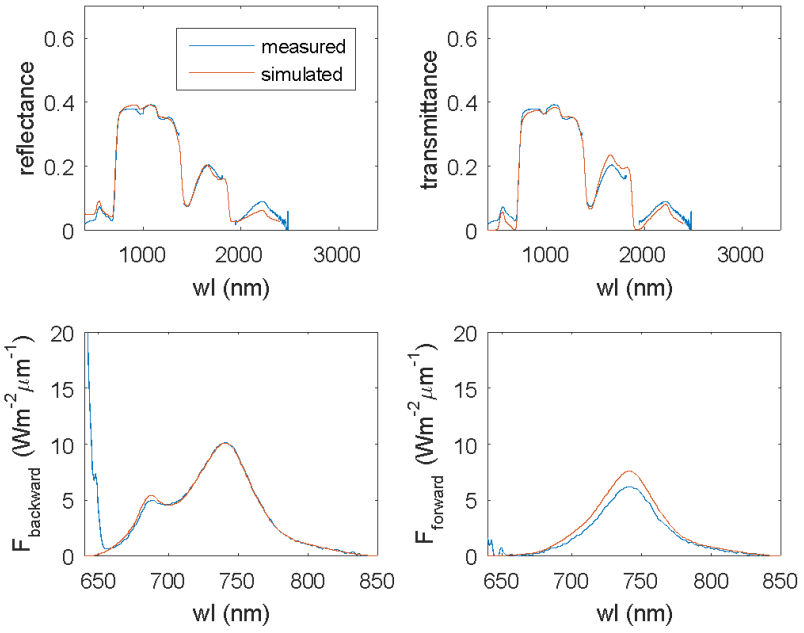
Examples

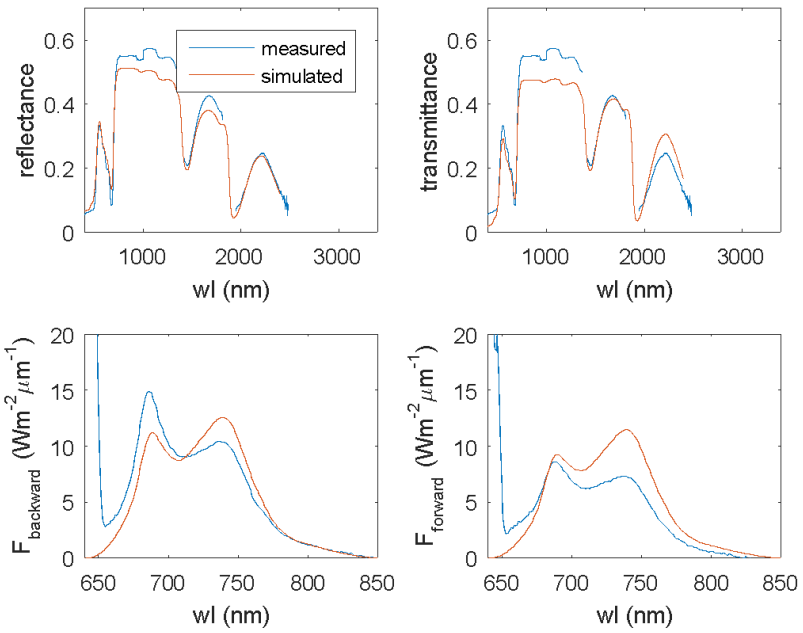
Soyflex, Udine

FLEX-EU, Latisana



SoyFlex leaf properties

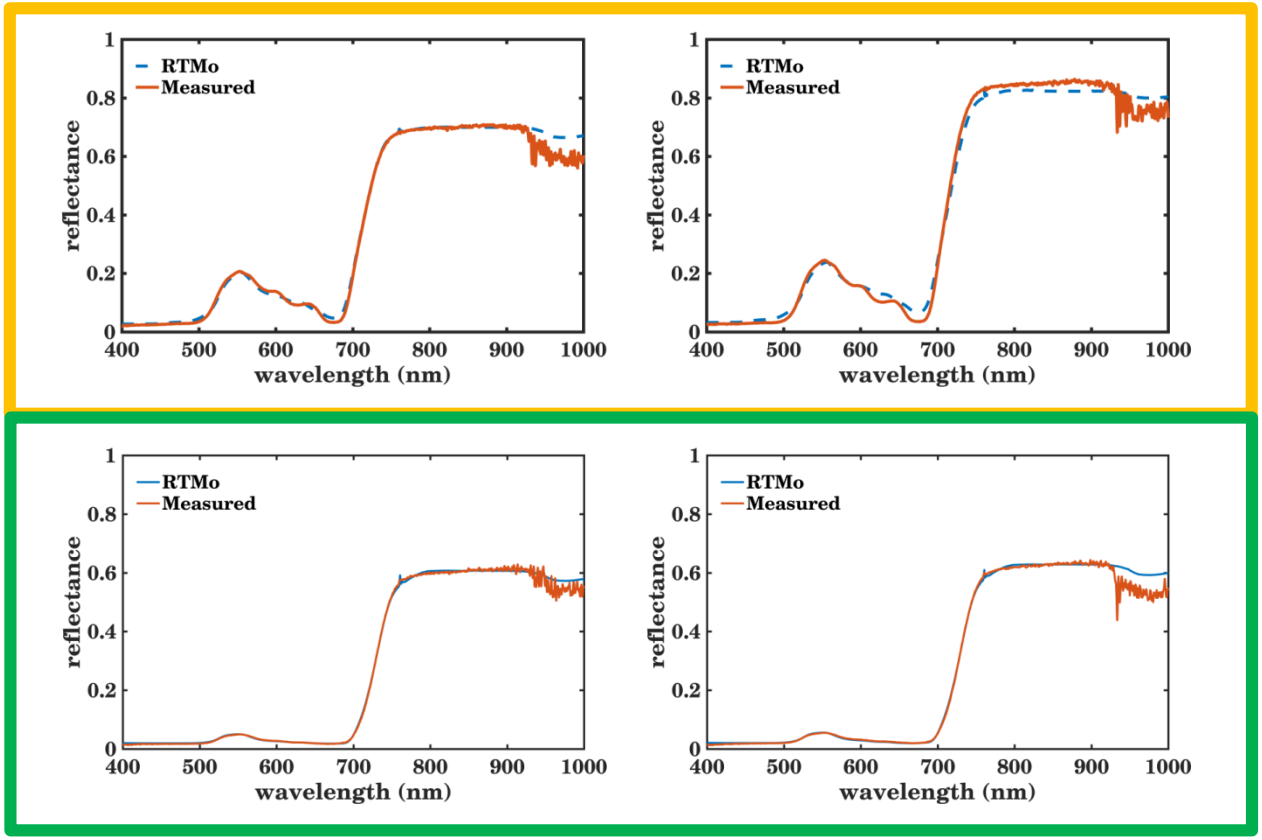




SoyFlex canopy properties (1)

Canopy level measurements with the MSS -> HR4000 (400-1000 nm)

-Cab
-Cca
-Cw
-Cs
-Cm
-N
-LAI
-LIDFa, LIDFb

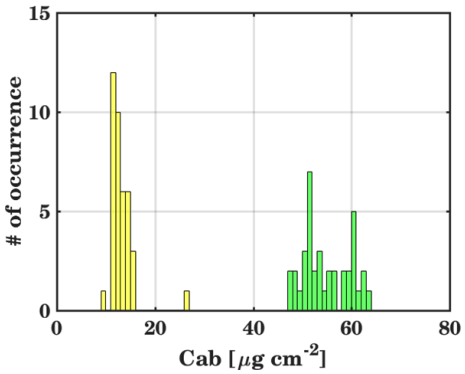


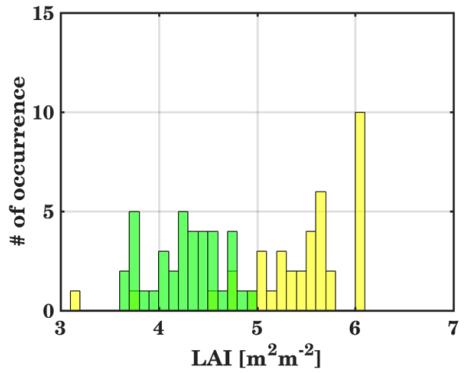
SoyFlex canopy properties (2)

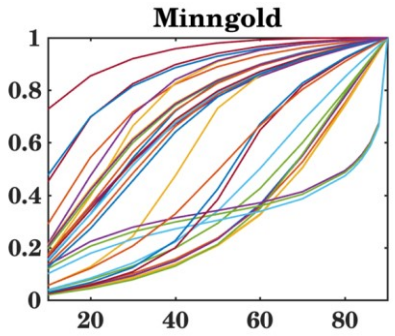
Canopy level measurements with the MSS -> HR4000 (400-1000 nm)

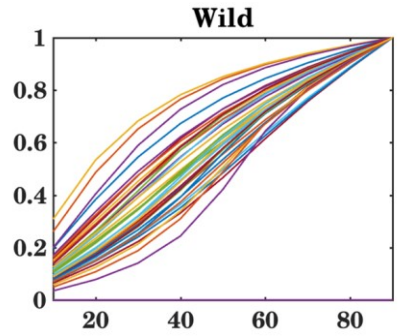
22 July 2016, 39 samples for each variety

-Cab
-Cca
-Cw
-Cs
-Cm
-N
-LAI
-LIDFa, LIDFb



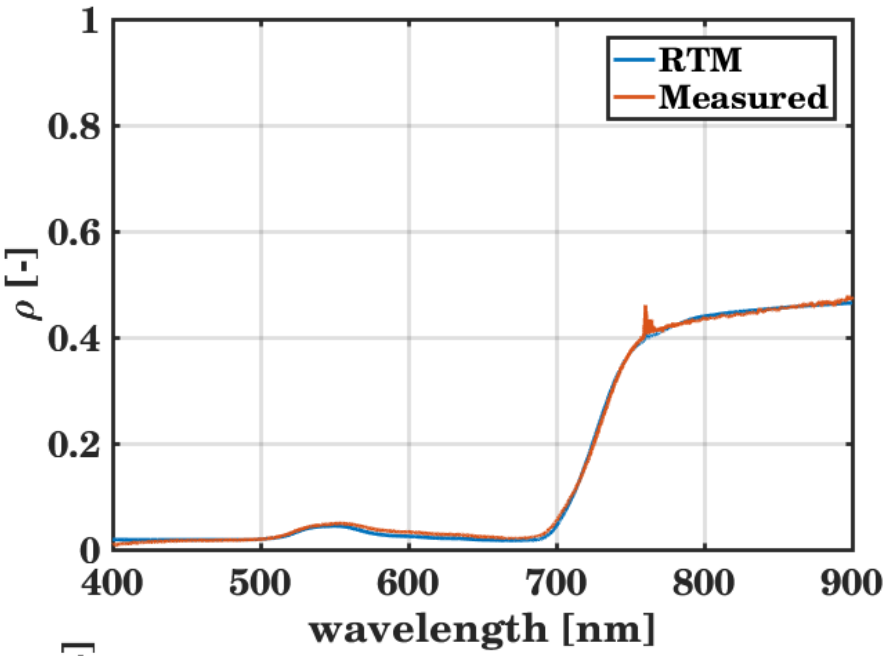


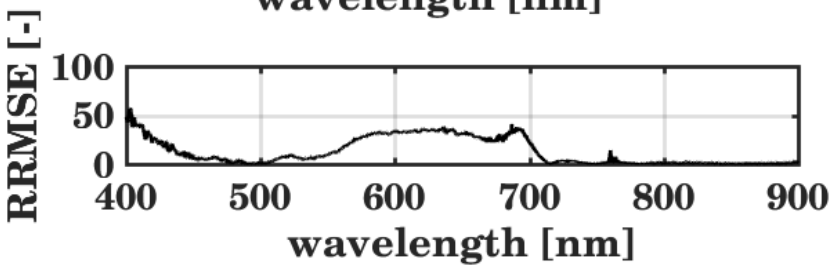


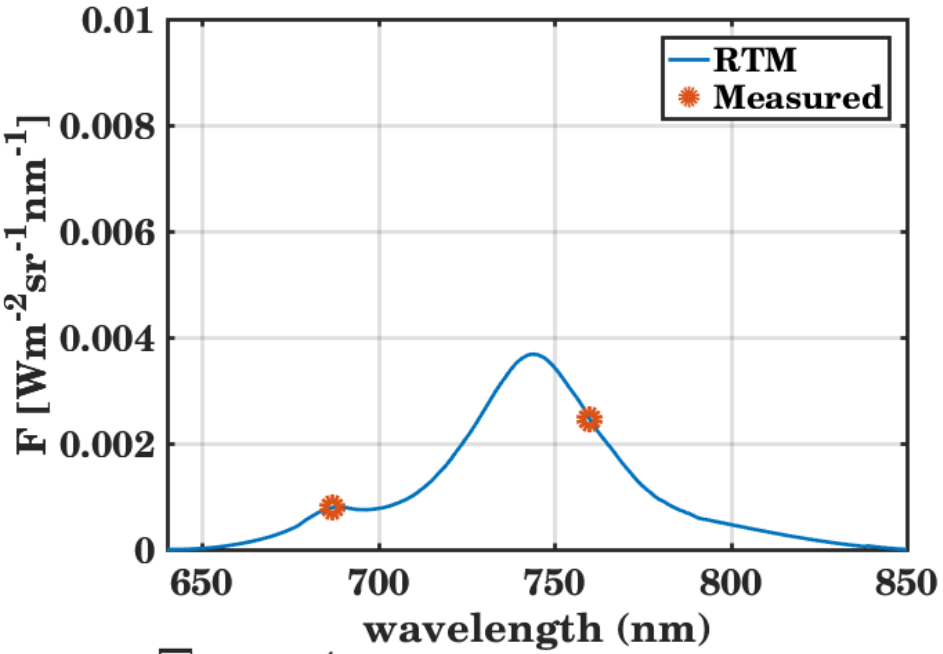


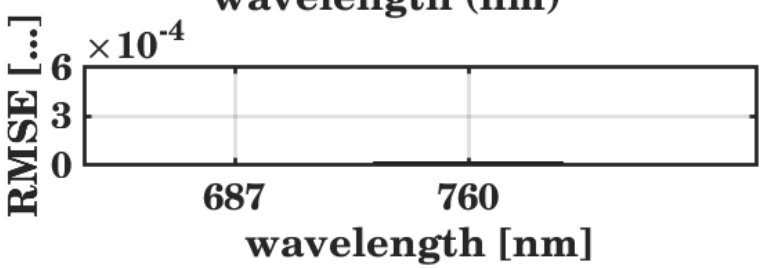
Latisana canopy retrievals

STSM by Marco Celesti

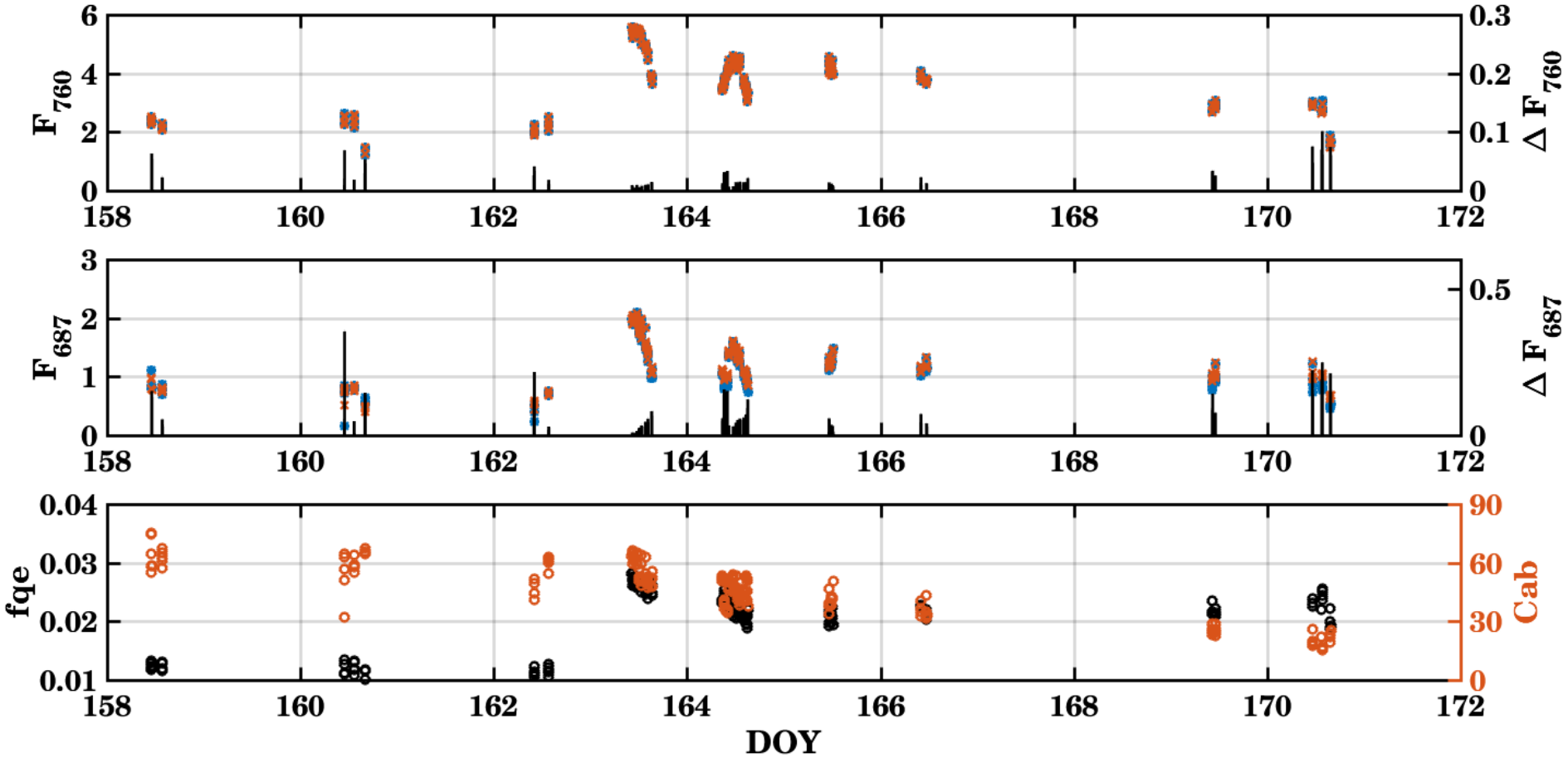








Latisana canopy retrievals (2)

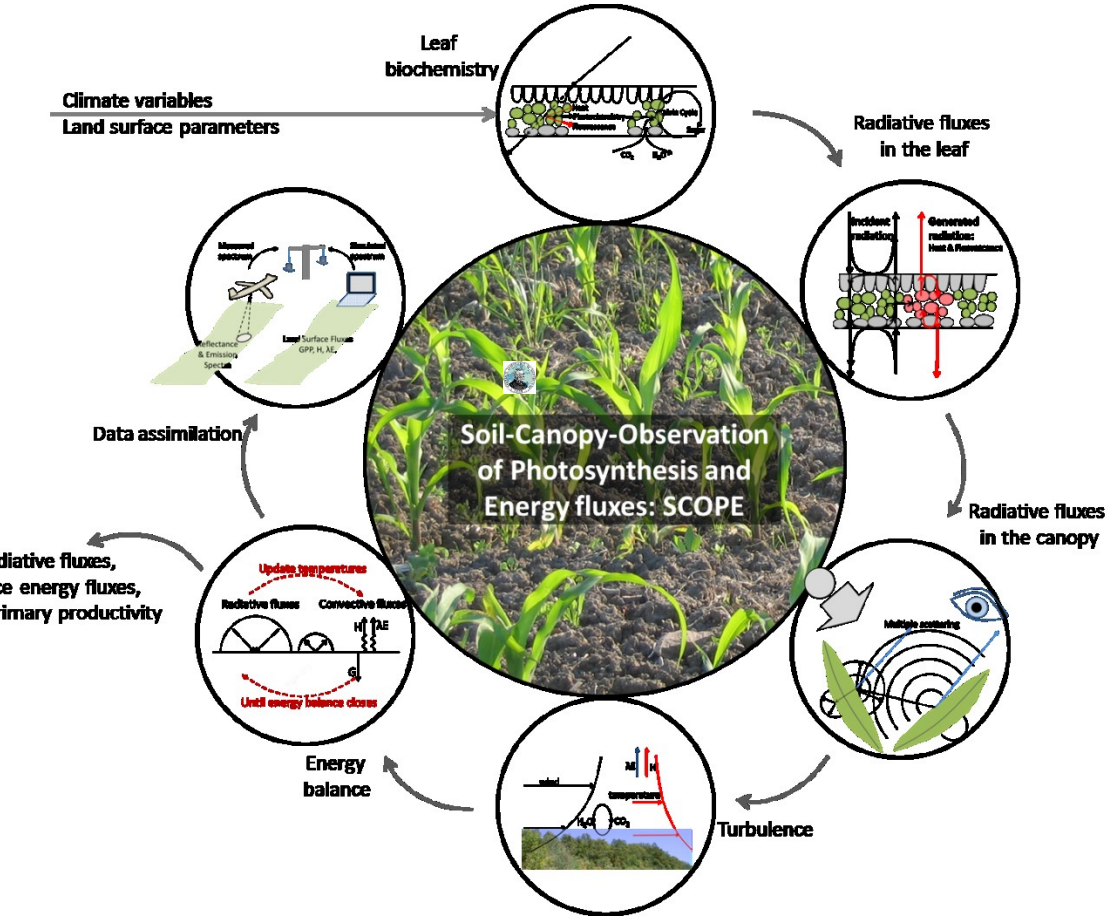


Session 6, tomorrow 12:20,

Peiqi Yang

“Response of C3 and C4 Crops to a Heat Wave detected by using Airborne Reflectance and Chlorophyll Fluorescence Measurements”

Online course: send e-mail to c.vandertol@utwente.nl


Leaf biochemistry
Climate variables
Land surface parameters
Radiative fluxes in the leaf
Soil-Canopy-Observation of Photosynthesis and Energy fluxes: SCOPE
Data assimilation
Radiative fluxes in the canopy
Radiative fluxes, Surface energy fluxes, Gross primary productivity
Energy balance
Turbulence