

Inversion of PROSAIL model from UAV-borne data

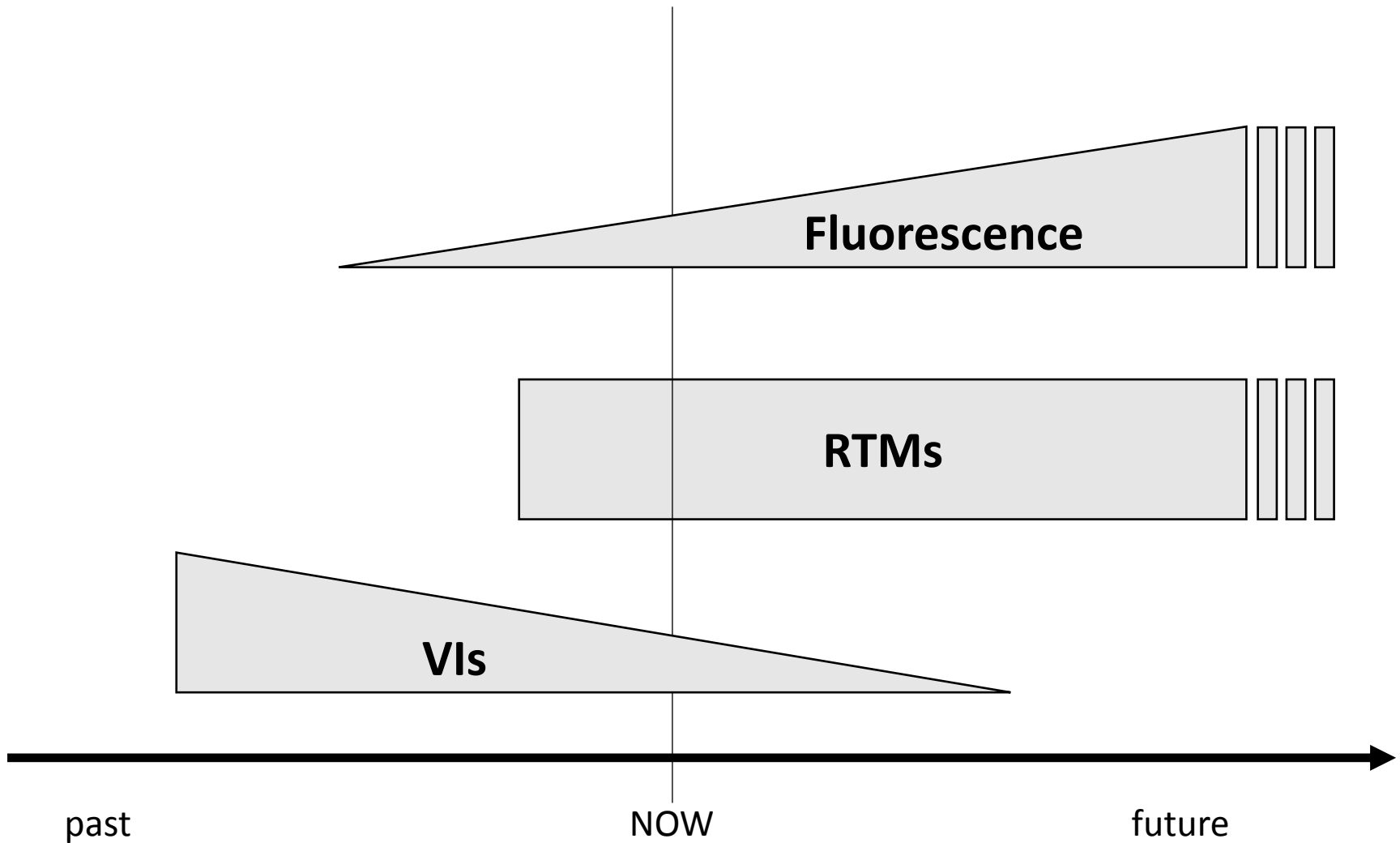
Enrico Tomelleri

&

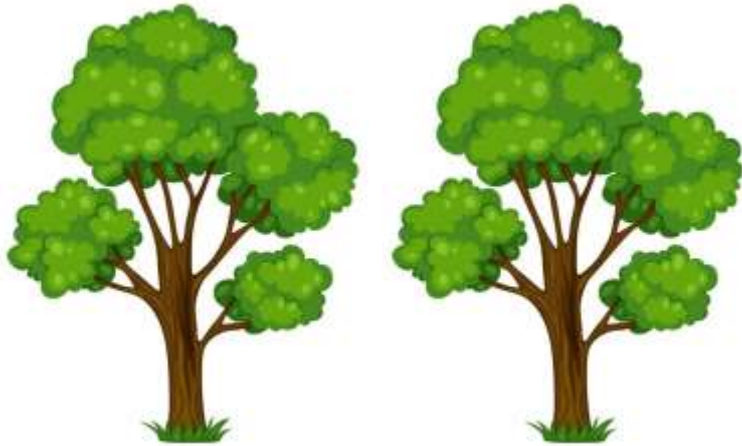
OPTIMISE WG2 community



Introduction



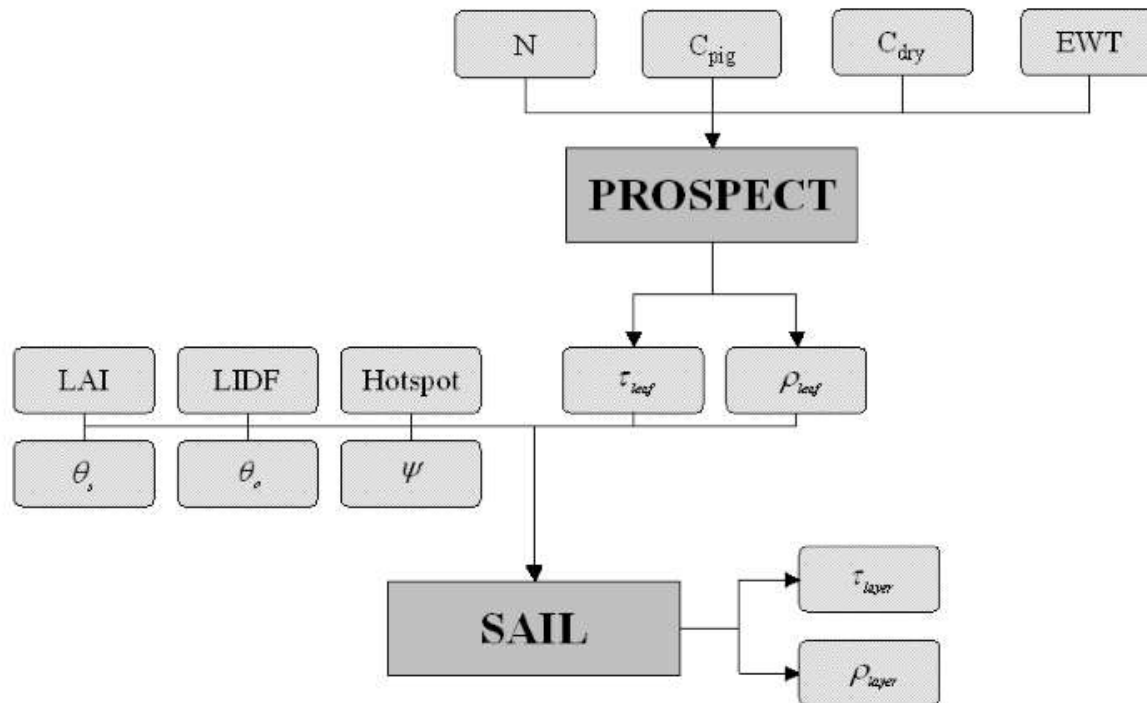
Rationale



Sampled area

Spatial resolution

PROSAIL



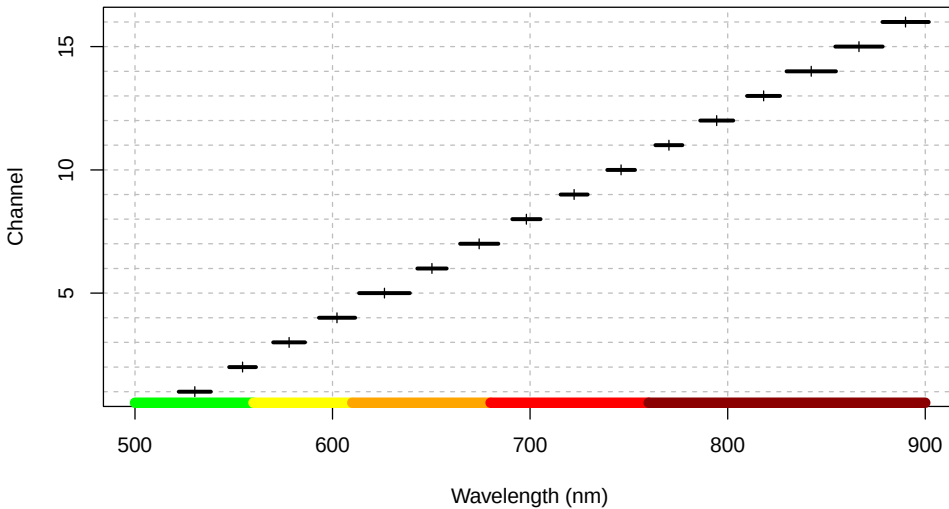
Input parameters

N	Leaf structure parameter
C _{pig}	Pigment concentration
EWT	Water content
LAI	Leaf Area Index
Hotspot	The hotspot parameter
θ _s	Solar zenith angle
θ _o	Observer zenith angle
ψ	The difference in azimuth between sun and observer

Output parameters

τ _{leaf}	Transmittance of the leaf
ρ _{leaf}	Reflectance of the leaf
τ _{canopy}	Transmittance of the canopy
ρ _{canopy}	Reflectance of the canopy

Instrument



FPI

500-900nm

FOW 36,5°

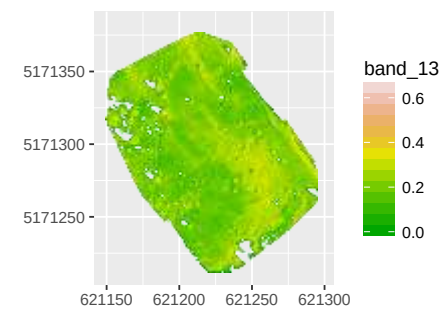
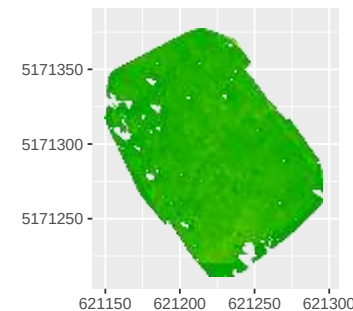
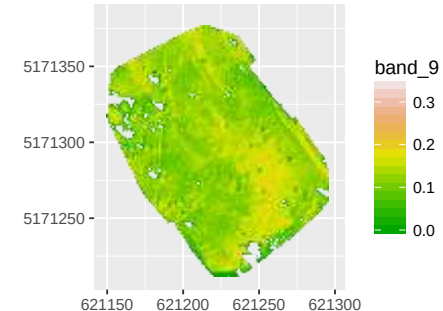
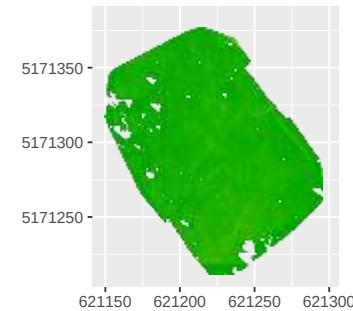
Spectral resolution >10nm FWHM

Image dimension 1010 x 1010 pixels

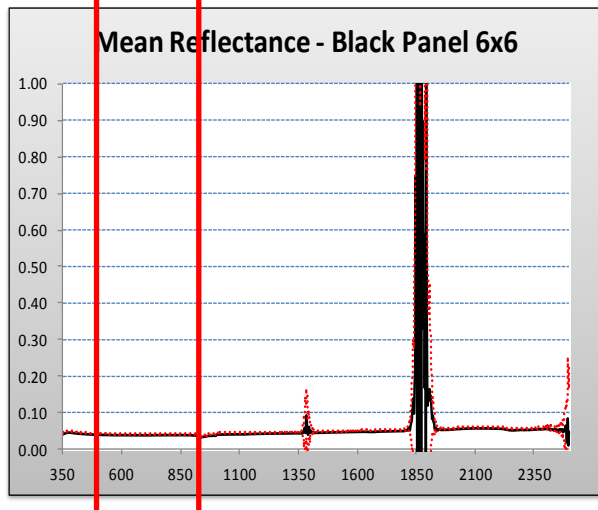
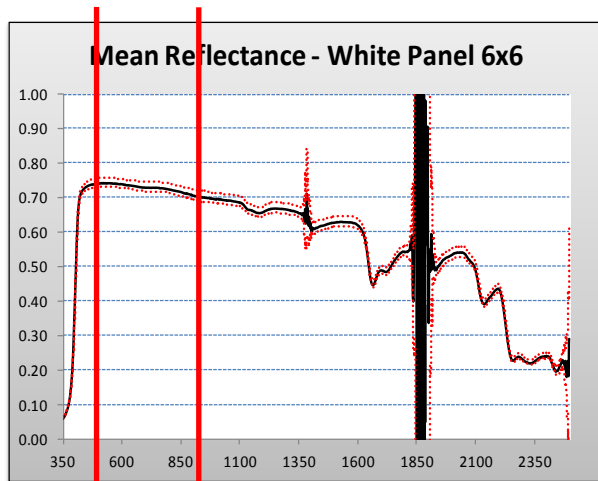
Format: multi-tiff,

Ground reference: textile material (Odissey)

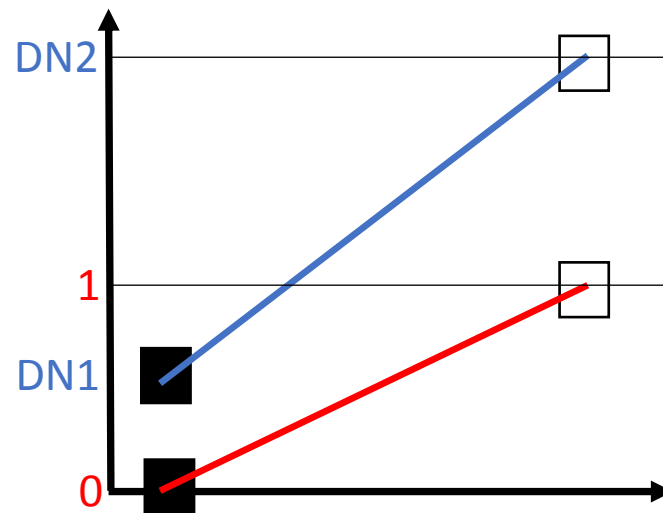
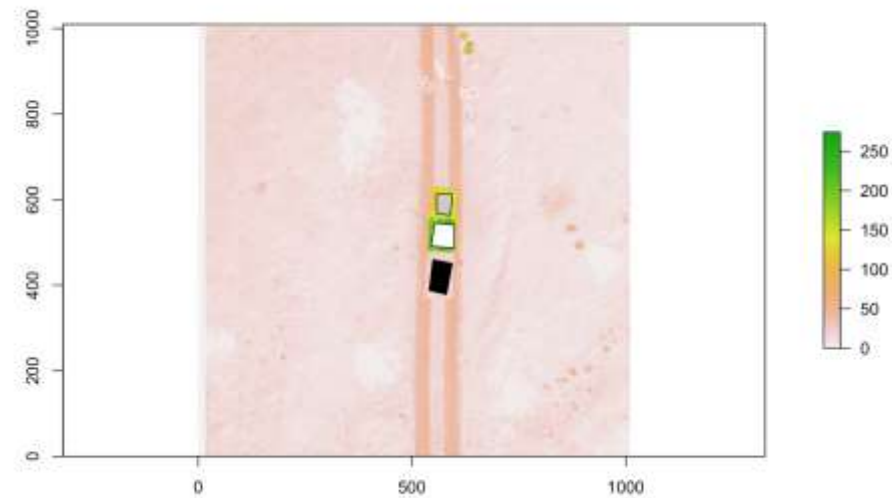
Geodata: internal GPS/GCP



Empirical line calibration

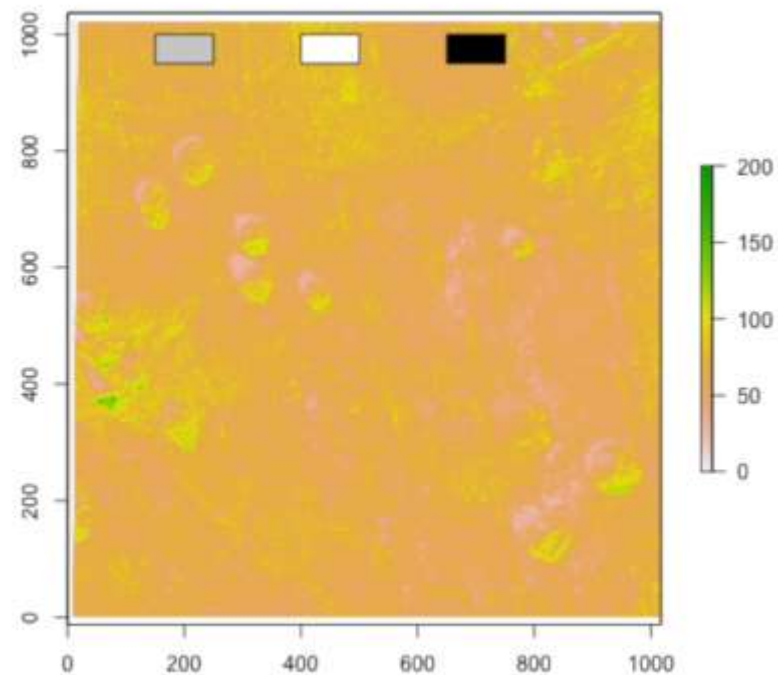
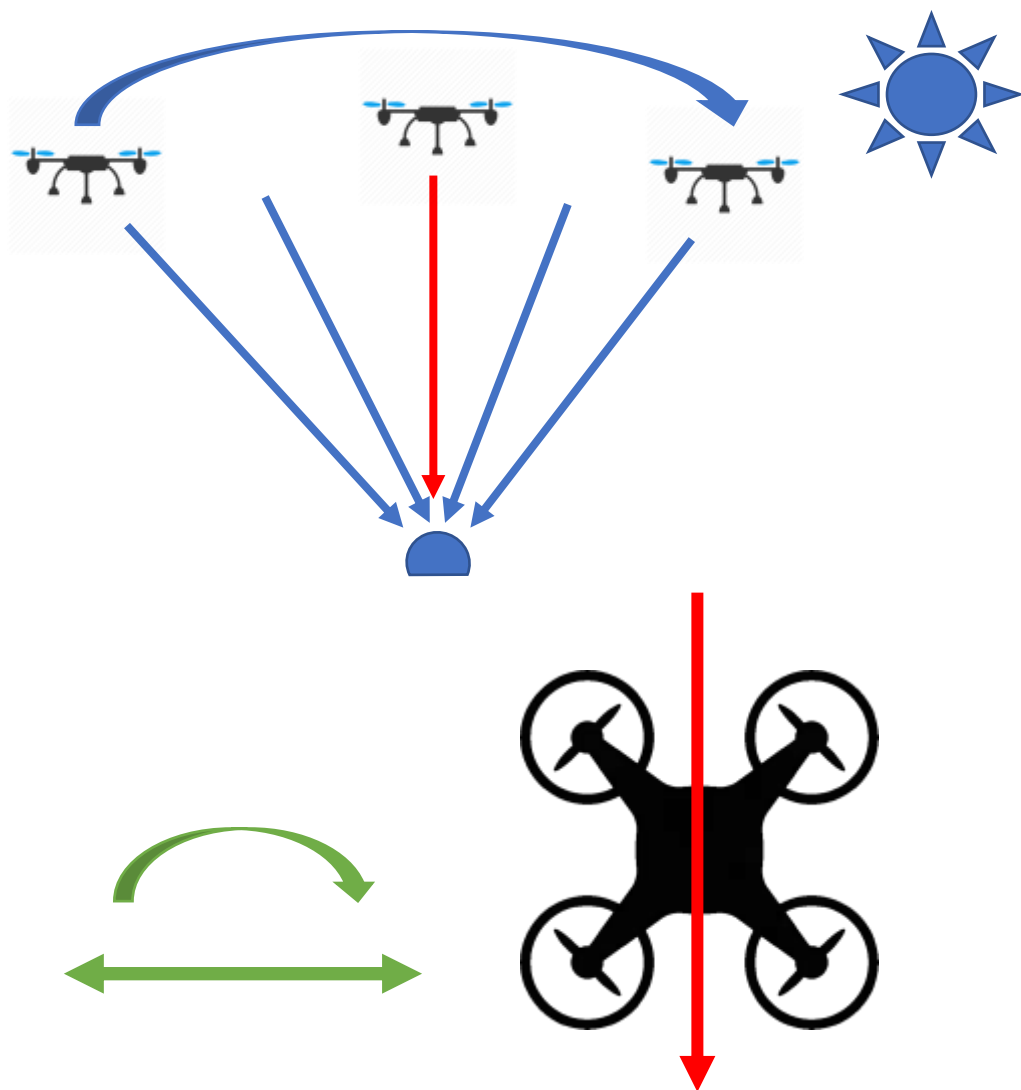


Range:
500 to 900 nm
white panel
0.728 (sd 0.011)
black panel
0.038 (sd 0.001).

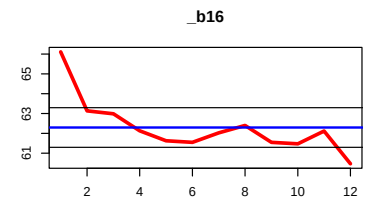
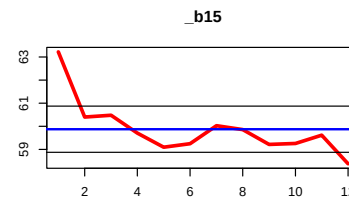
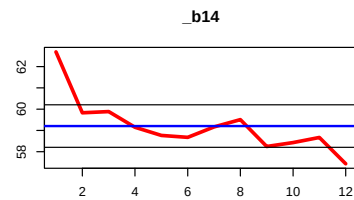
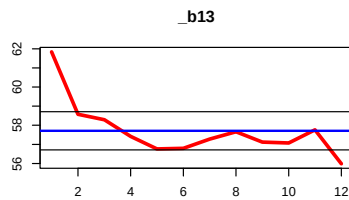
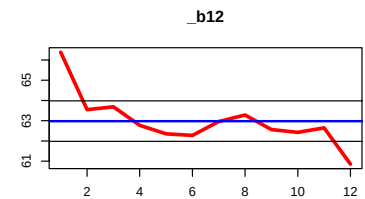
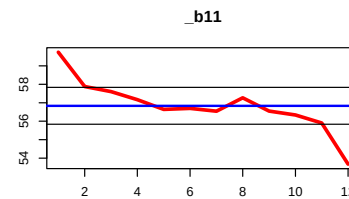
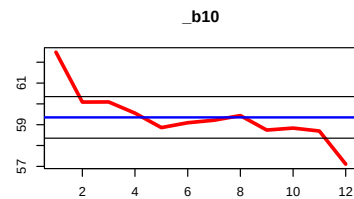
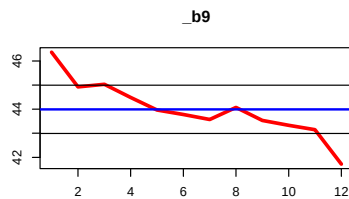
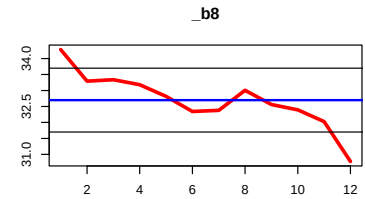
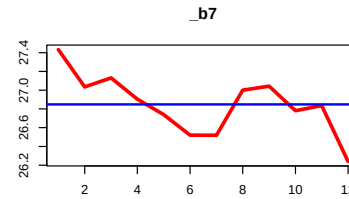
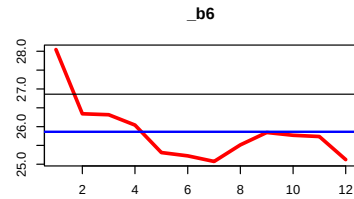
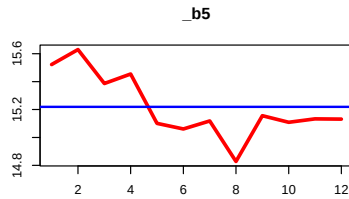
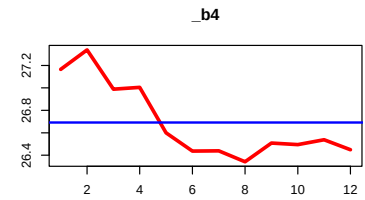
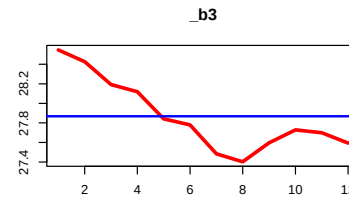
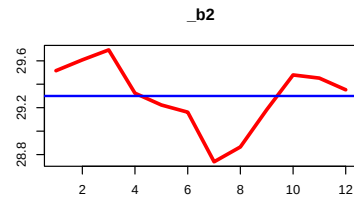
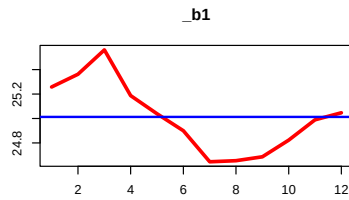


“Odyssey64” (Kayospruce Ltd.)
data source: UNIMIB

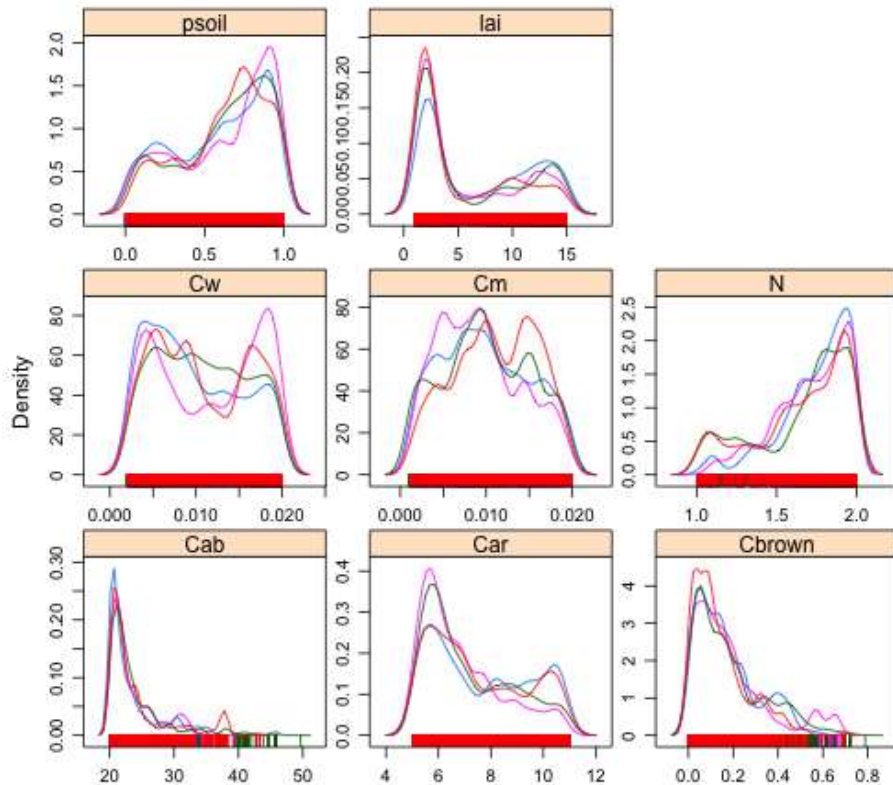
Directional reflectance



Directional reflectance



Equifinality



Problem dimensionality reduction

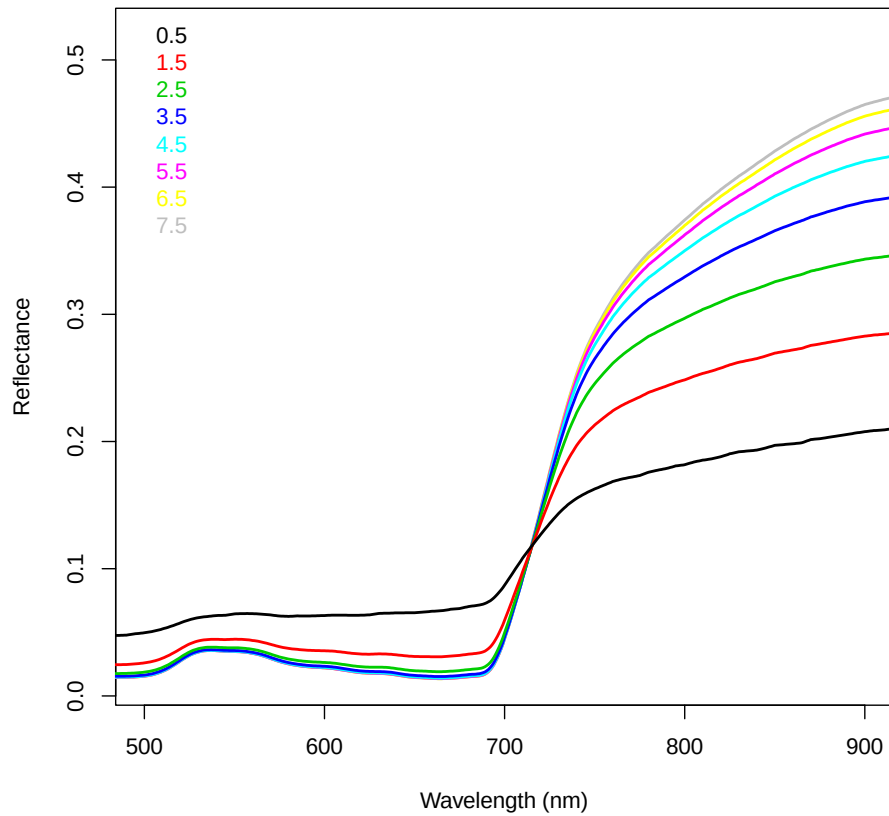


Constrain prior ranges
and select parameters of interest

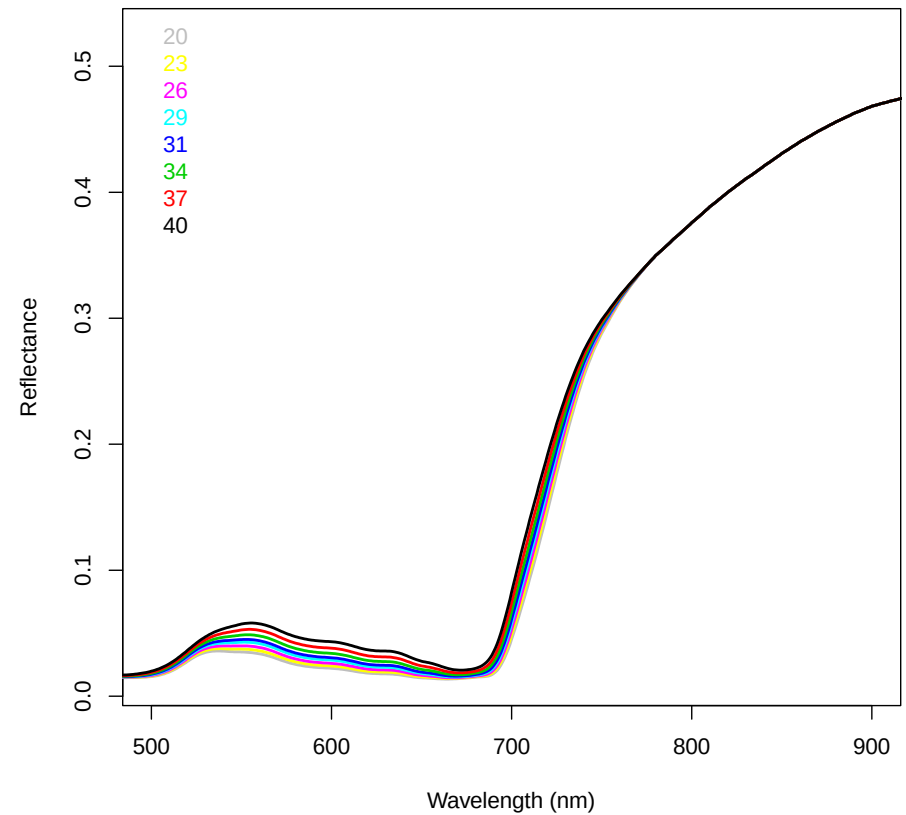
Equifinality



LAI



Cab

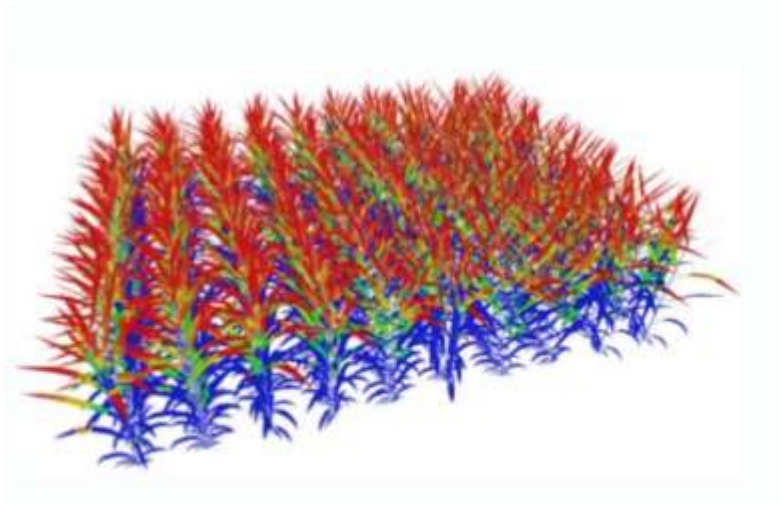


Meta-model

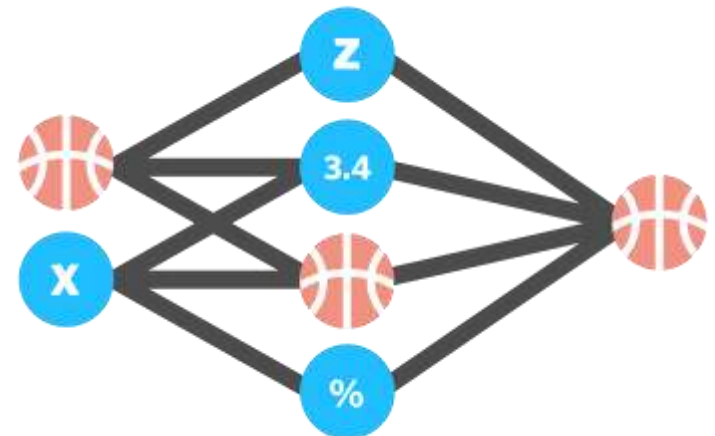


**meta-models are surrogate statistical models
that approximate the functioning of a process-based model**

RTM



Machine learning



Approach



- Area of interest selected, campaign 8.2015
- Fixed sun geometry
- LAI: 0.3-8 / Cab 20-40 $\mu\text{g}/\text{cm}^2$
- LUT: 100000 PROSAIL forward runs, random noise added
- random forest algorithm trained (Breiman, L. 2001)
multiple trees grown
- **FPI (16 bands 500-900nm) data aggregated to 0.5m,
shadows removed**
- LAI, Cab predicted

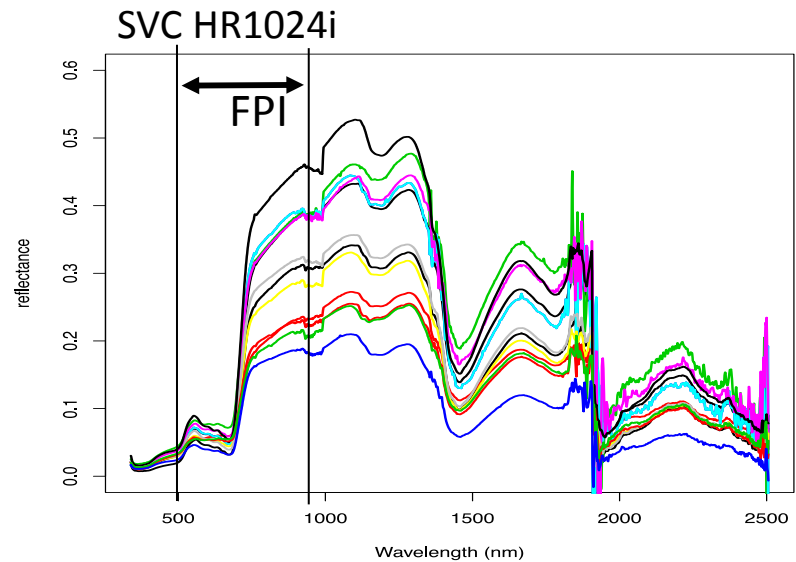
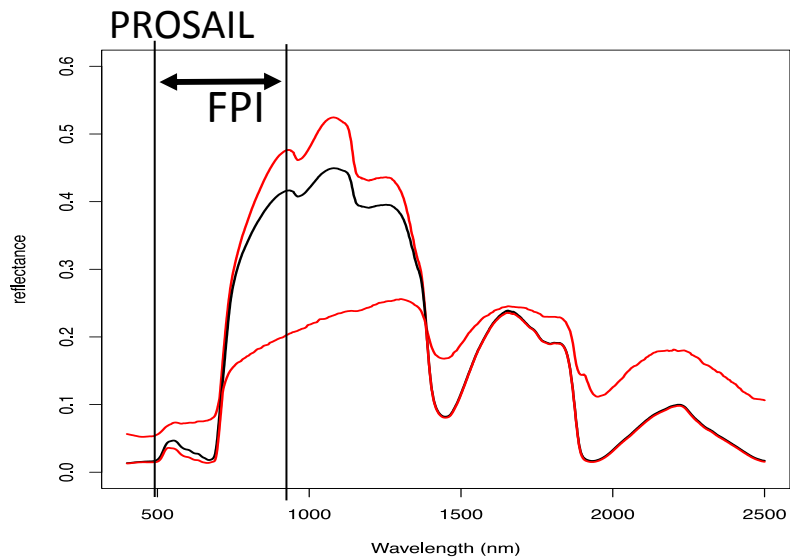
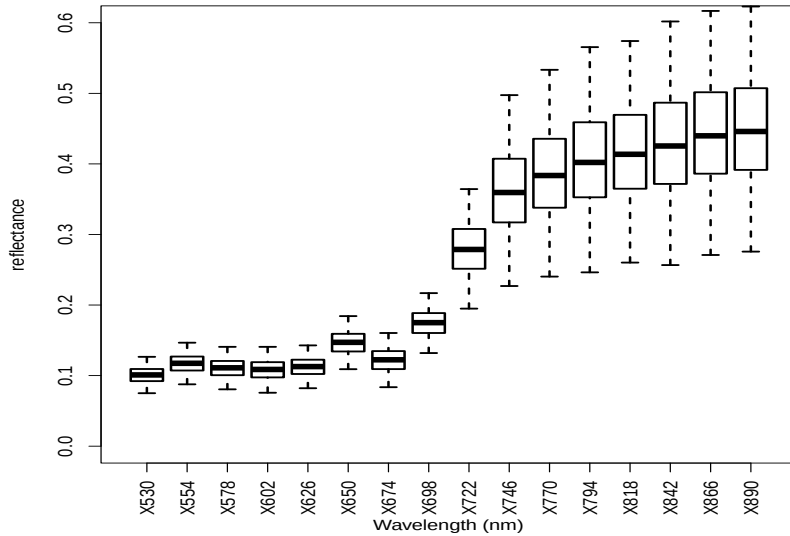
The Area of Interest



Coordinates: 46.68° N, 10.59° E
Elevation: 1550 m a.s.l. SW
Average temperature 6.5°C
annual precipitation to 550 mm



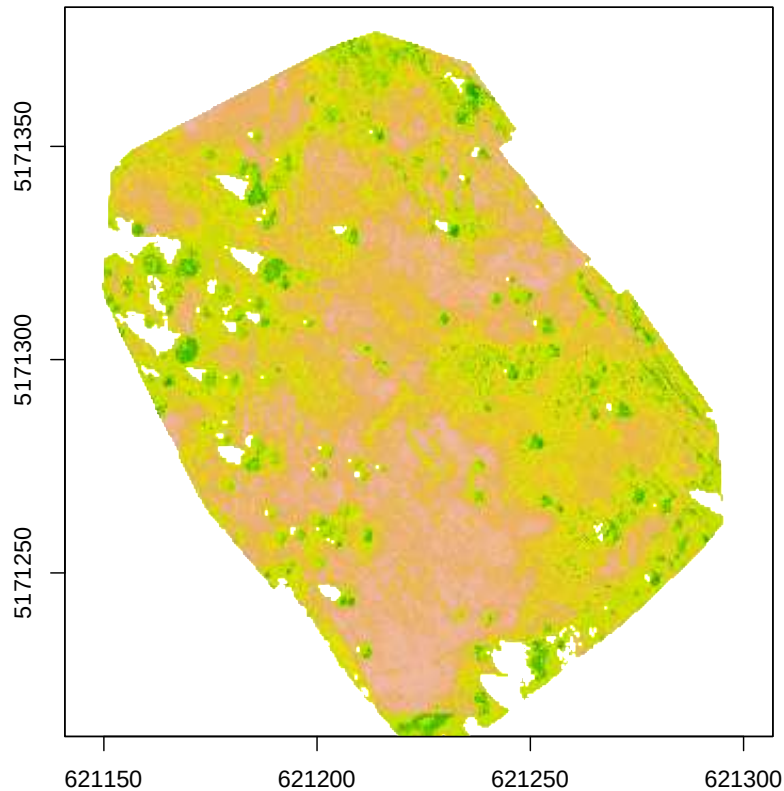
Acquired spectra



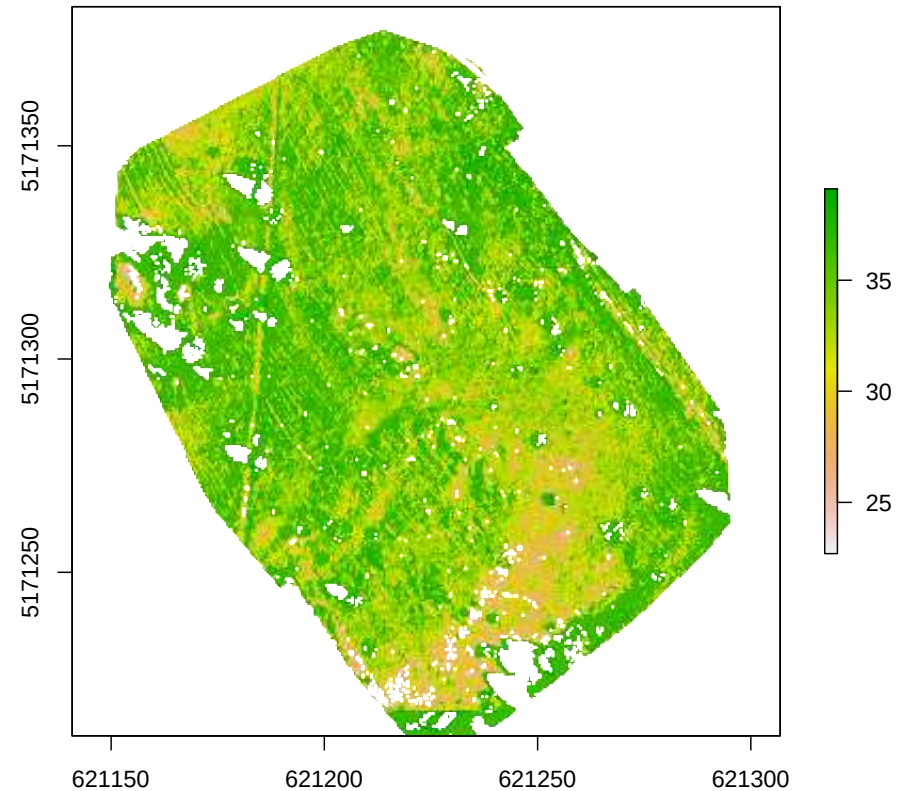
Retrieved traits



LAI (m^2/m^2)



Cab $\mu\text{g}/\text{cm}^2$



measured range 0.79-2.89 m^2/m^2

Concluding remarks



- There is need for documented approaches in UAV sampling designs
- UAV imagery requires a lot of computing time for model inversions
- Meta-models can speed-up modelling experiments
- Equifinality should be addressed with well constrained priors (field measurements!)
- Mapping of ecosystem traits from UAV borne data is very promising especially for small scale vegetation dynamics