Natural baselines:
spatial variation of leaf optical properties in a boreal forest

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Nea Kuusinen, Lucas Toniolo Junior

OPTICS OF PHOTOSYNTHESIS LAB

Todays' topics

1/ Results from campaign from 2014. Spatial variation of leaf optics, complementary to Chao's temporal study

Spatial variation of leaf optical properties in a boreal forest is influenced by species and light environment. Jon Atherton* , Benat Olascoaga, Luis Alonso and Albert Porcar-Castell. Conditionally accepted, *Front. Plant Sci. - Functional Plant Ecology*

2/ FAST 2017 campaign summary so far (started last week!)

Fluorescence **A**cross **S**pace and **T**ime

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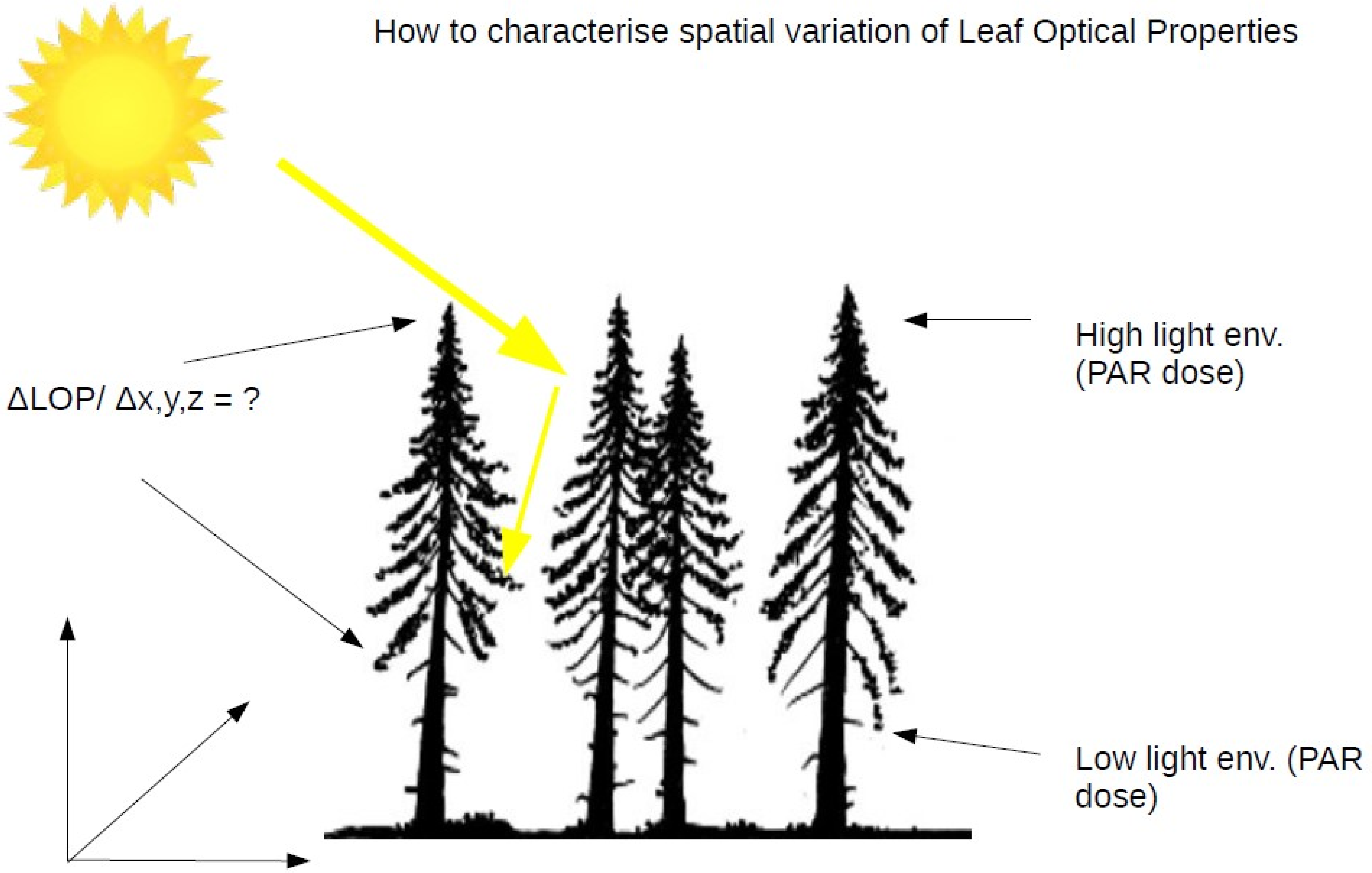
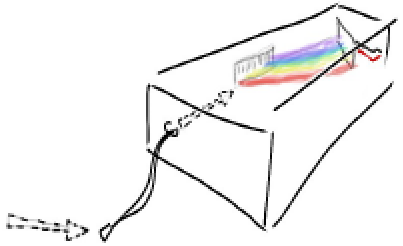
SPATIAL QUESTION DRIVING 2014 STUDY

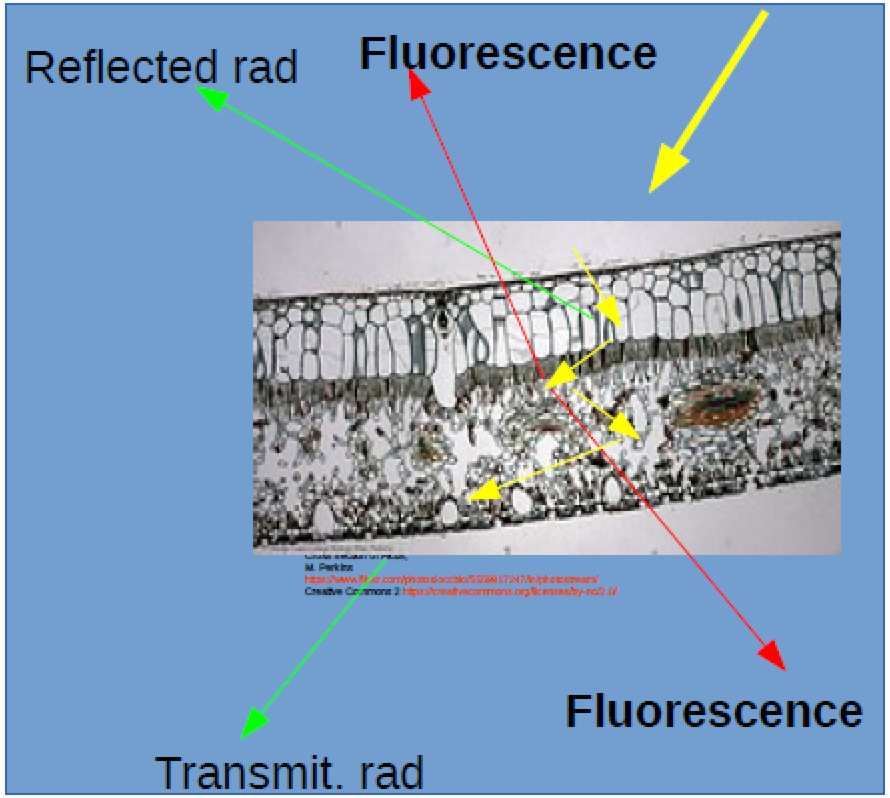
How to characterise spatial variation of Leaf Optical Properties



Photosynthetically-sensitive leaf optical properties and ways to summarise them

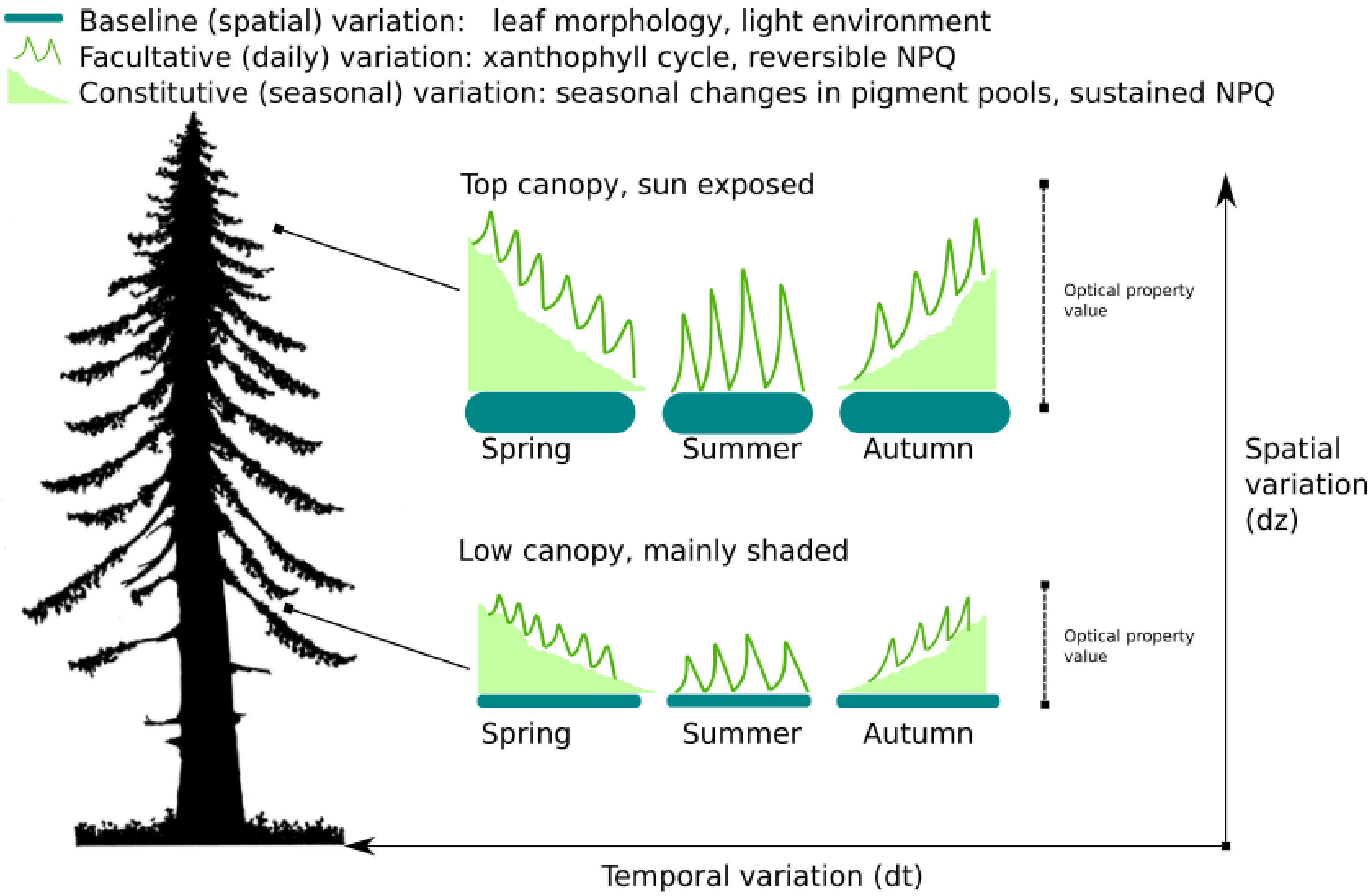
- Spectral fluorescence (band ratios)
- PRI *(carotenoids)*
- absorption/greenness ratios (*chlorop*

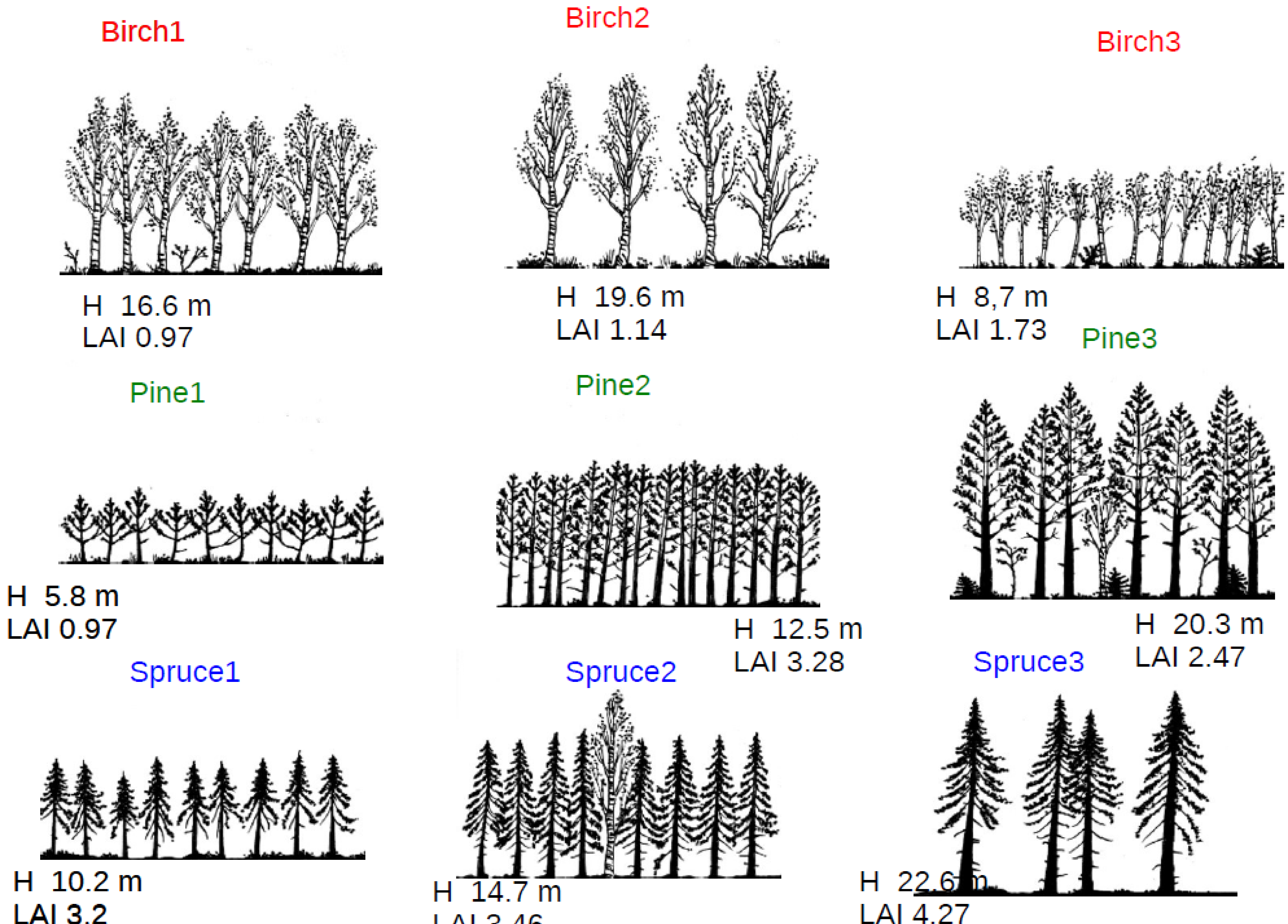




For more info on fluorescence, see our review .Porcar-Castell A, et al 2014, J Exp Bot

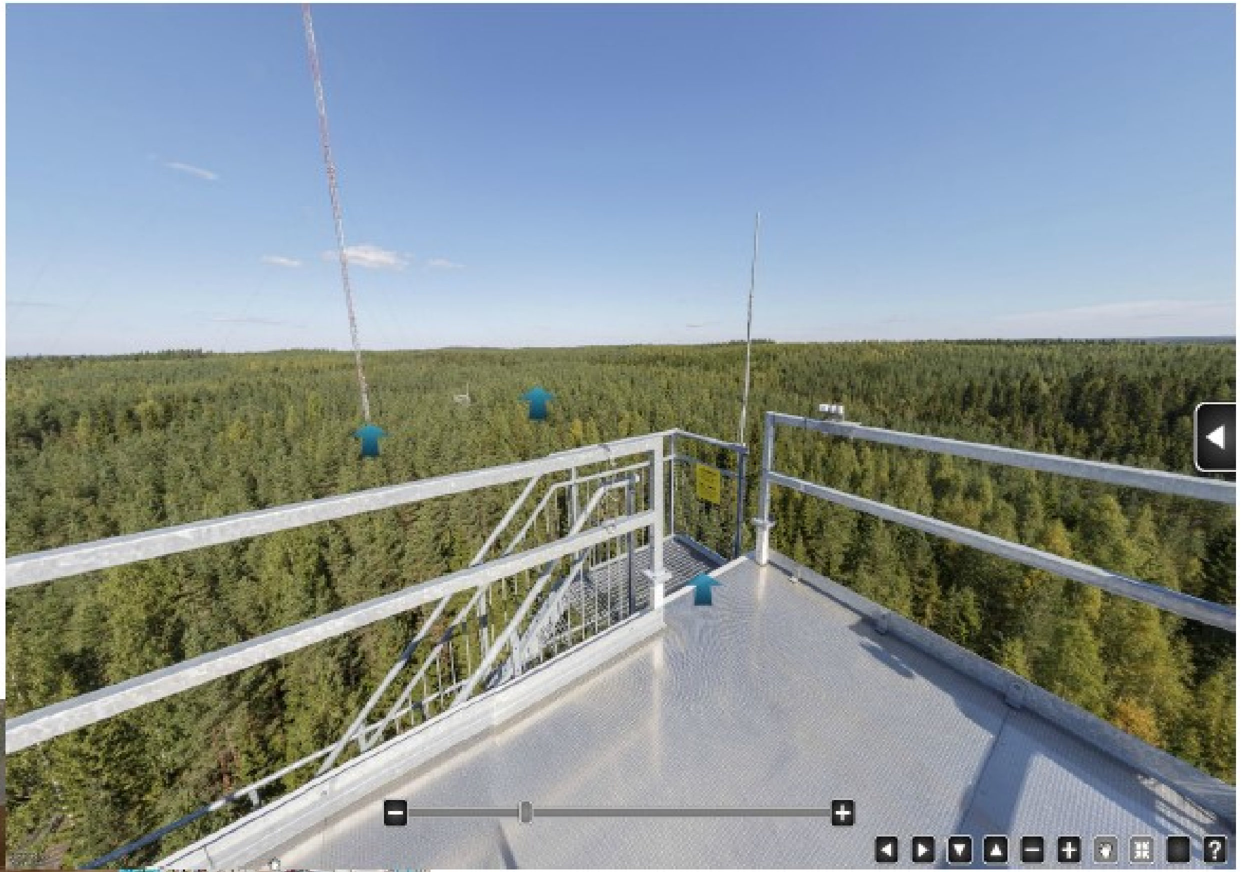
A new concept: **Natural Baselines**




Birch1
H 16.6 m
LAI 0.97
Birch2
H 19.6 m
LAI 1.14
Birch3
H 8,7 m
LAI 1.73
Pine1
H 5.8 m
LAI 0.97
Pine2
H 12.5 m
LAI 3.28
Pine3
H 20.3 m
LAI 2.47
Spruce1
H 10.2 m
LAI 3.2
Spruce2
H 14.7 m
LAI 3.46
Spruce3
H 22.6 m
LAI 4.27

Virtual Hyytiälä

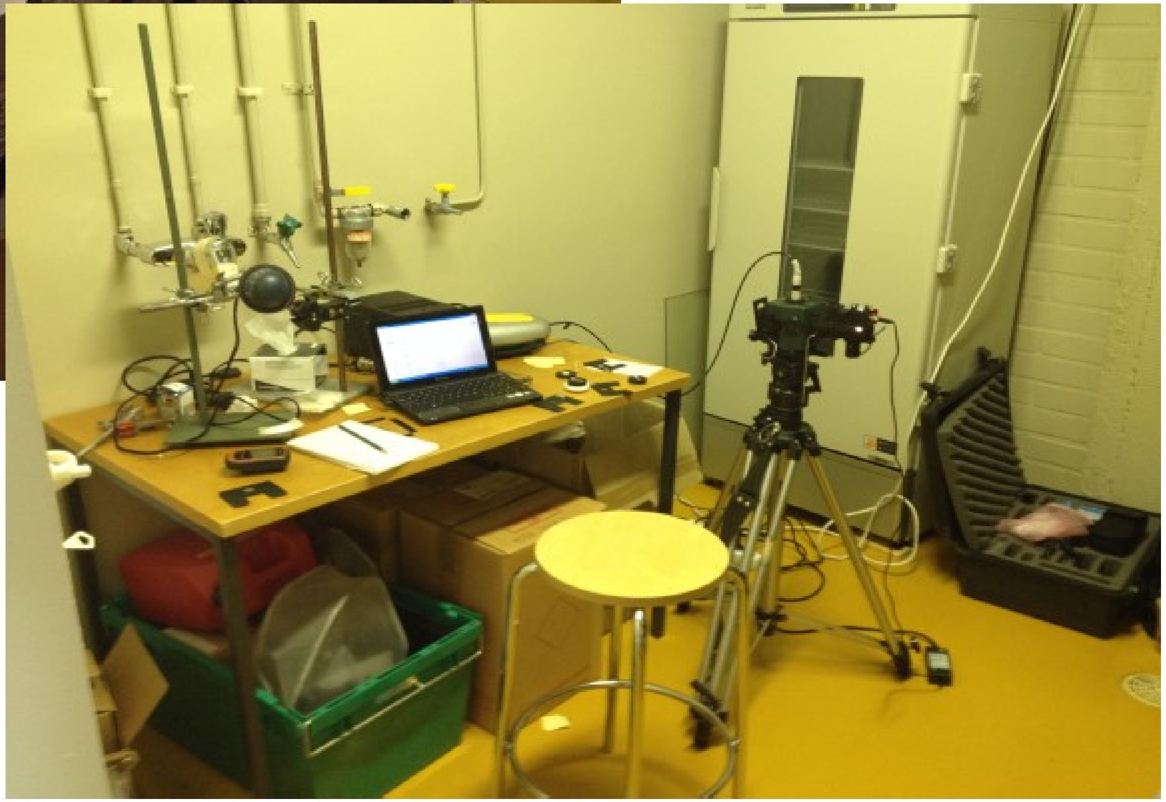
- SMEARII measurment station
- Optics of Photosyn. Field work is mainly here e.g. 2014 campaign and FAST2017
- Long and distinguished history of measurements in atmos. Chem and ecophy. Increasing RS facilities



http://www.helsinki.fi/hyytiala/virtuaalihyytiala/virtuaalihyde.html

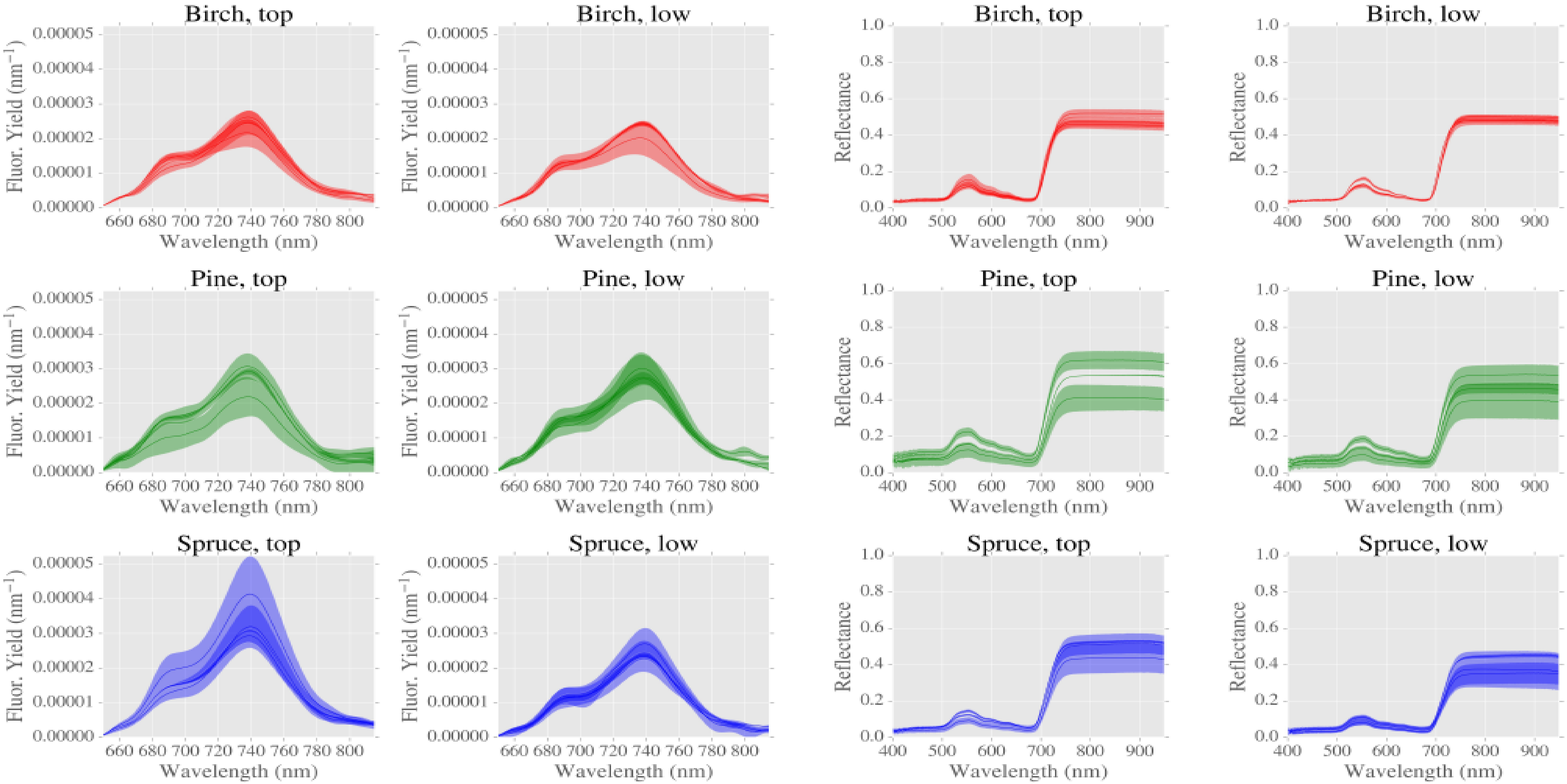
Measuring natural optical baselines: summer 2014 campaign

Supporting data

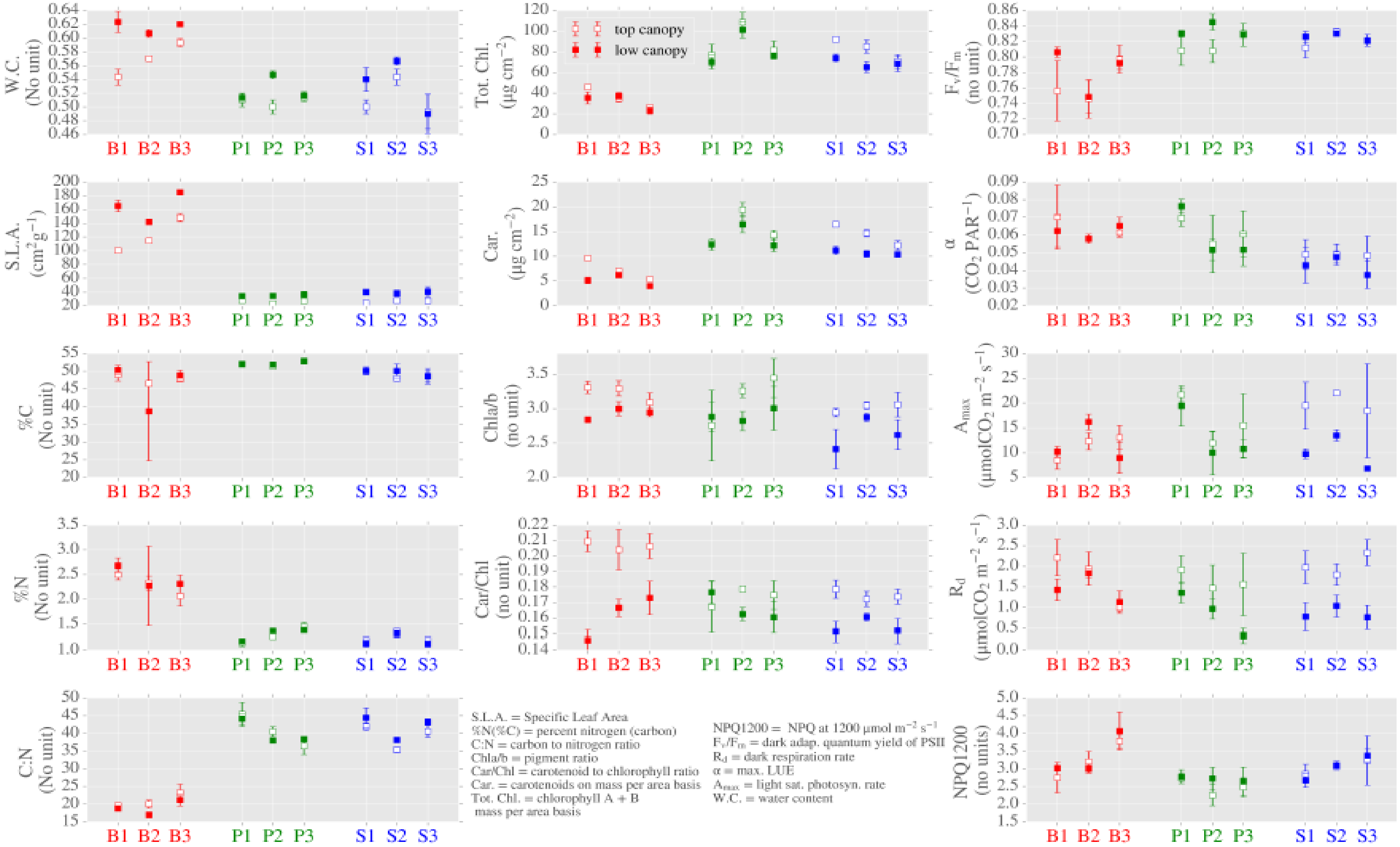


Optical measurements

Spectral fluorescence and reflectance across species and Light environment



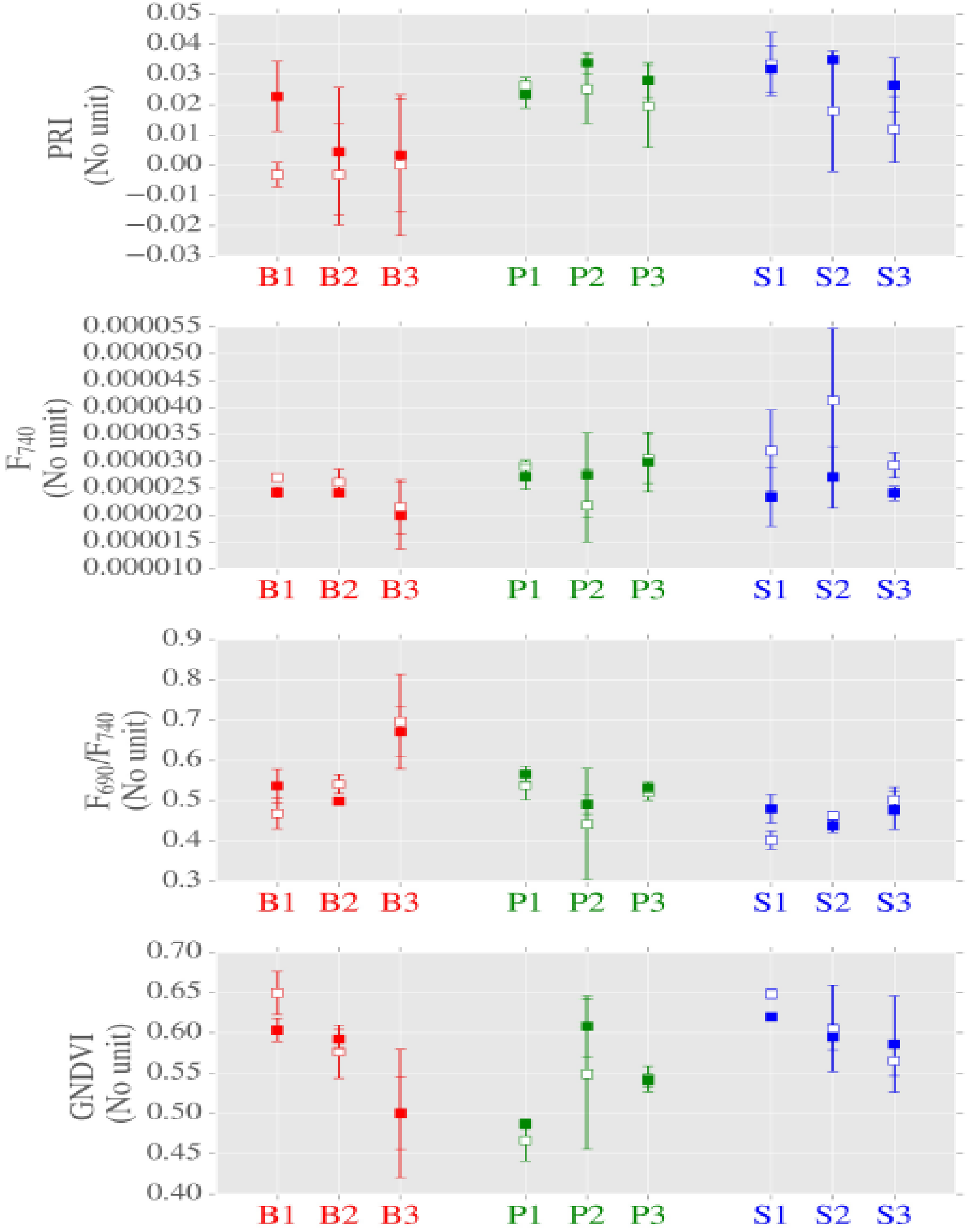
Supporting data



S.L.A. = Specific Leaf Area
%N(%C) = percent nitrogen (carbon)
C:N = carbon to nitrogen ratio
Chla/b = pigment ratio
Car/Chl = carotenoid to chlorophyll ratio
Car. = carotenoids on mass per area basis
Tot. Chl. = chlorophyll A + B mass per area basis

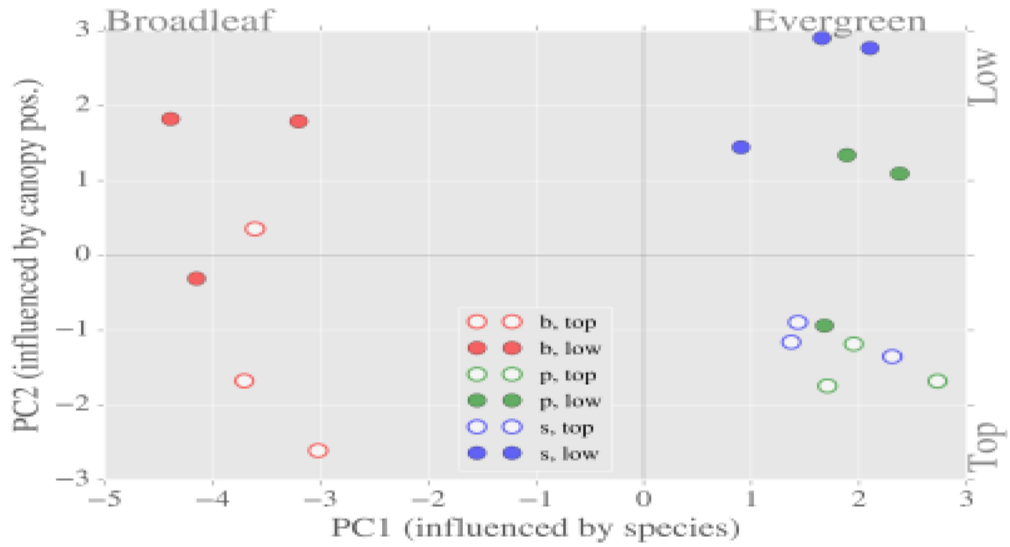
NPQ1200 = NPQ at 1200 μmol m^{-2} s^{-1}
F_v/F_m = dark adap. quantum yield of PSII
R_d = dark respiration rate
α = max. LUE
A_{max} = light sat. photosyn. rate
W.C. = water content

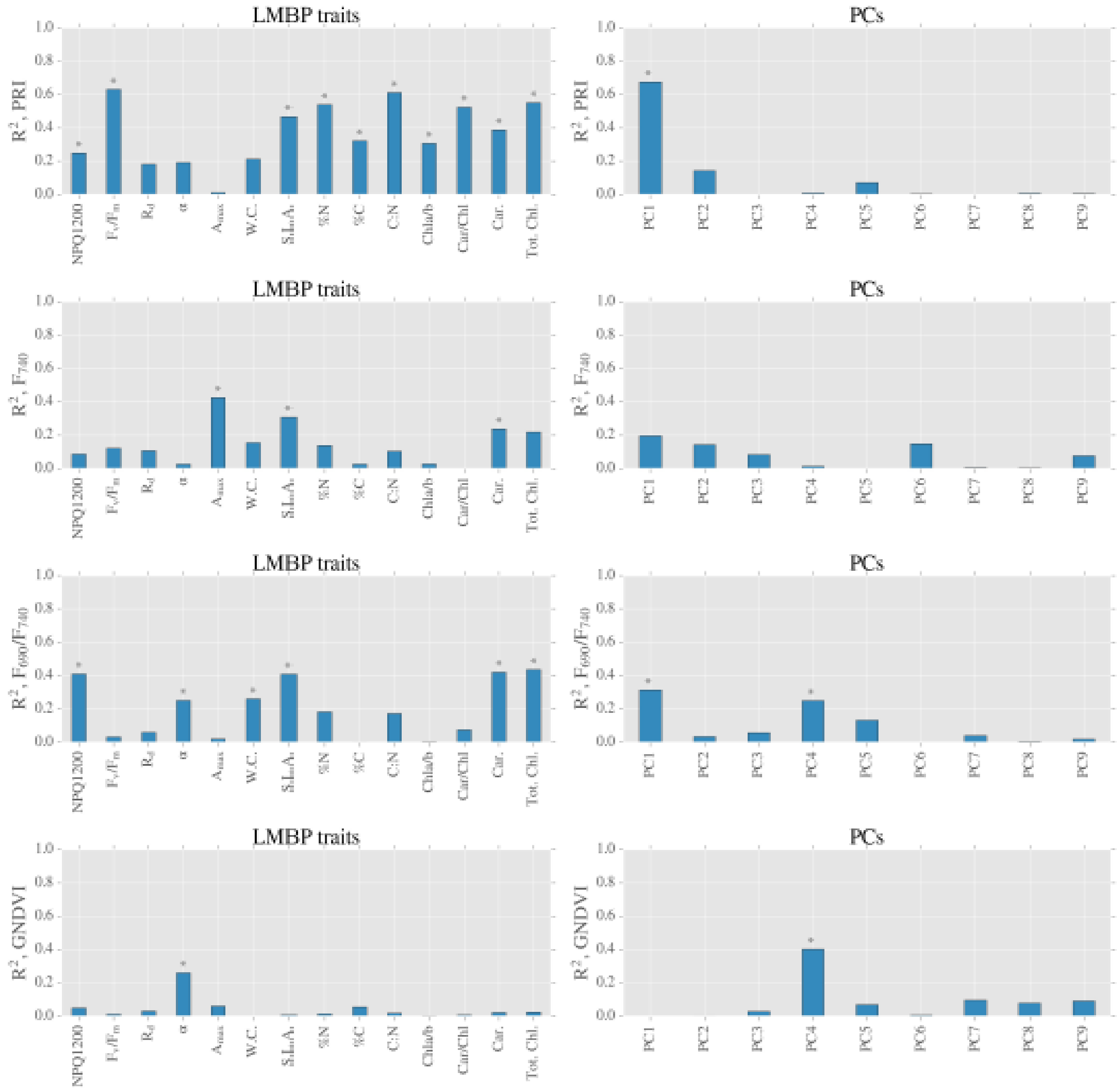
Leaf optical properties → spectral indices
(under low light)



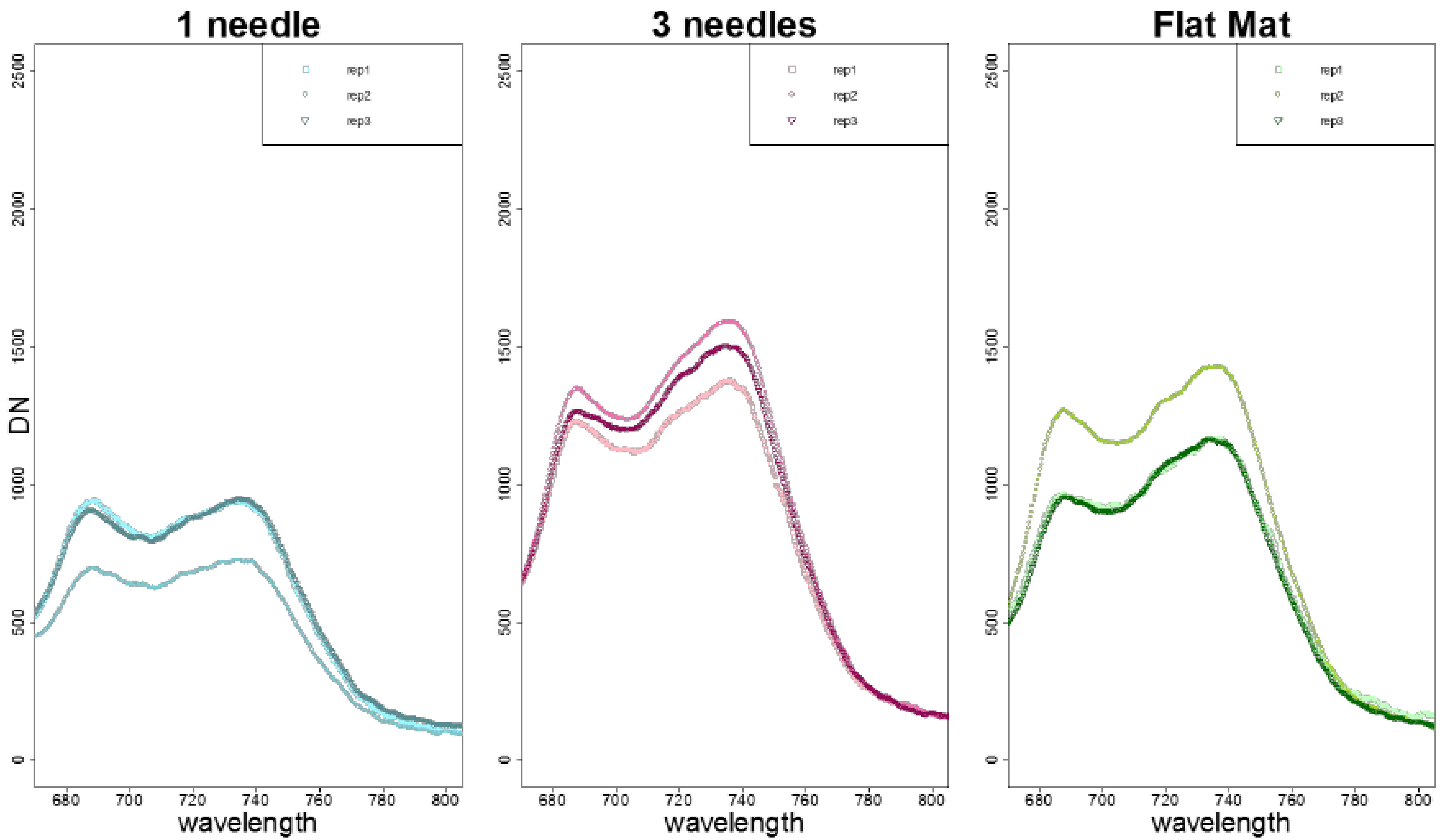
Correlation matrix – Highlight F and PRI

Principal Component Analysis





Needle spectra fluorescence: a warning!

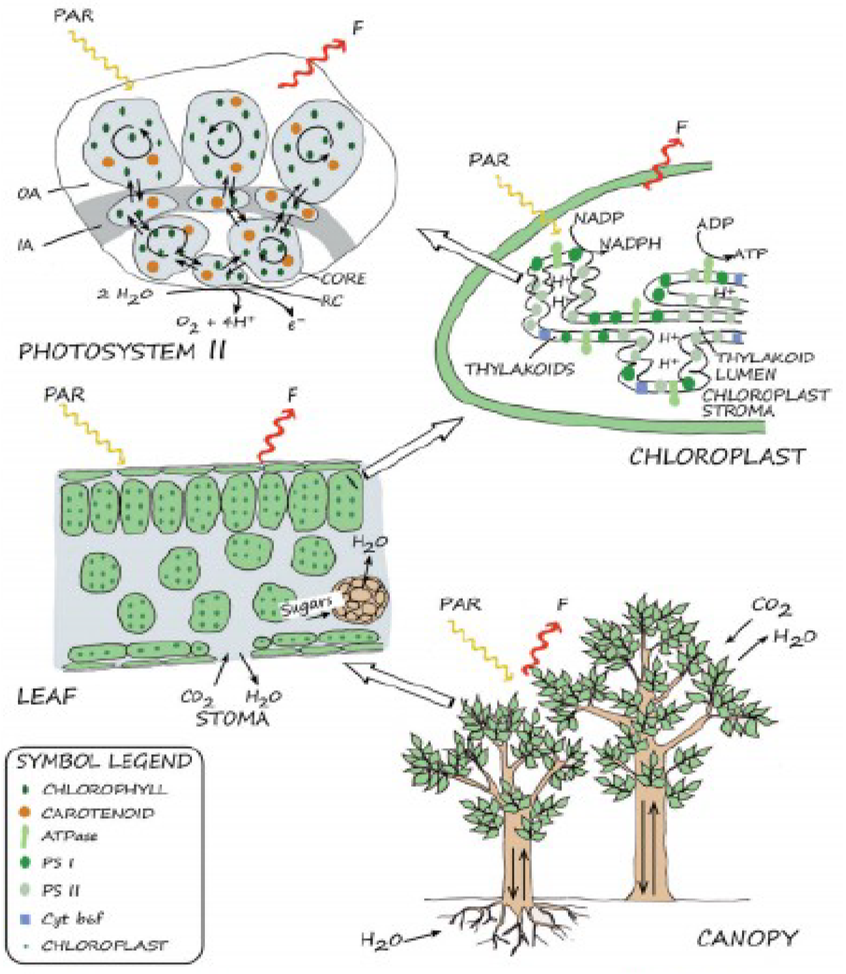


Rajewicz, A new protocol to measure ambient and 77 K chlorophyll fluorescence spectra, in prep.

Conclusions

- Light environment influences PRI; however species probably more important. Scaling implications.
- Fs (yield) at longer wavelengths also sensitive to light environment
- Fs (yield) related to Amax at fixed light (NPQ)

Fluorescence **A**cross **S**pace and **T**ime (FAST) campaign



Porcar-Castell et al, 2014, Journal of Experimental Botany,65 (15)

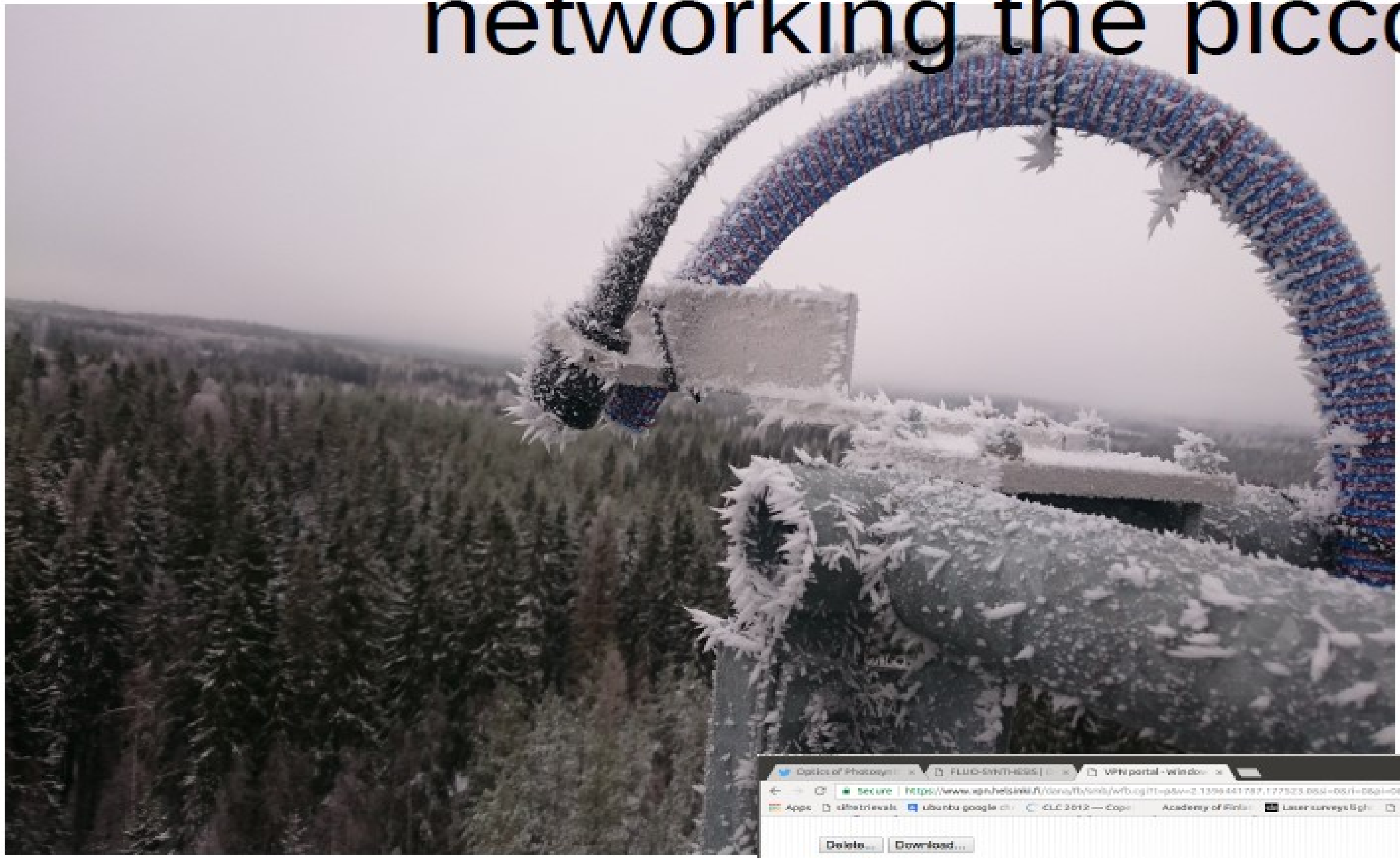
- started last week until July
- molecular –> satellite scale
- how does chlorophyll a fluorescence scale spatially but also temporally

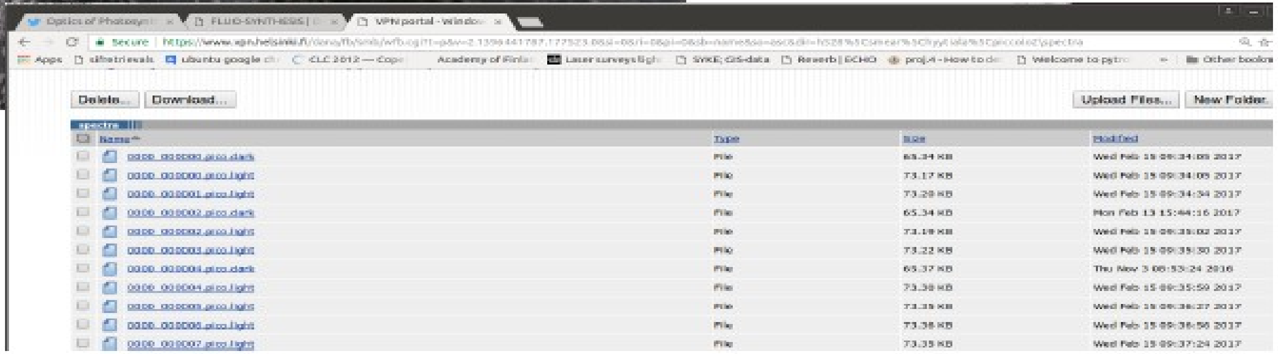
Table 2. Partners by Theme/Scale

Institute Theme/Scale ->	MOLECULAR	LEAF	CANOPY	ECOSYSTEM	LANDSCAPE
1. OPL, Optics of Photosynthesis Laboratory, Forest Sciences, U. Helsinki	X	X	X	X	X
2. FGI, Remote Sensing and Photogrammetry, Finnish Geospatial Institute				X	X
3. Aro's Lab, U. Turku + Finnish Centre of Excellence in Molecular Biology of Primary Producers	X	X			
4. **EPL**, Ecosystem processes Lab, U. Helsinki + Finnish Centre of Excellence (FCoE) in Atmospheric Science		X	X	X	X
5. Korpela, Forest Sciences, U. Helsinki			X	X	
6. CanSEE Lab Department of Biosciences, U. Helsinki	X	X	X	X	
7. FMI, Finnish Meteorological Institute				X	X
8. Mottus' Lab, Department of Geography, U. Helsinki			X	X	
9. Ihalainen's Lab. Nanoscience Center	X	X			
10. NERC **FSF**, Field Spectroscopy Facility, U. Edinburgh			X	X	X
11. Plazaola's Lab, Plant Physiology and Ecology, University of the Basque Country	X	X			
12. Global Ecology Unit, **CREAF**, Autonomous University of Barcelona		X	X	X	X
13. LEO, Laboratory of Earth Observation, U. Valencia			X	X	X
14. LSCE, Paris				X	X
15. IRSTEA, Paris		X			
16. Forschungzentrum, **Jülich**		X	X	X	X
17. Helmholtz Centre Potsdam German Centre for Geosciences (**GFZ**)				X	X
18. University of **Twente**		X	X	X	
19. University of **Milano-Biccoca**			X	X	
20. European Academy of Bolzen, **EURAC**			X	X	X
21. NASA **JPL**/Caltech		X	X	X	X
22. Berry's Lab/Carnegie Institution for Science	X	X	X	X	X

Plus some more e.g. carbonyl sulphide groups

FAST campaign prep, installing and networking the piccolo





FAST campaign, under-story treatment

Thankyou!

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