Hyperspectral characterisation of arctic vegetation

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Land cover classification from spectral imagery

- One of the core methods in remote sensing
- Well established, with many available decision algorithms
- Spectral unmixing is attractive but limited by spectral diversity of the data
- Hyperspectral airborne and satellite data increasingly available

Spectral diagnostics and spectranomics

- Reflectance spectrum contains information about the characteristics of the target material (e.g. phenology, chlorosis…)
- Usefulness increases dramatically with higher spectral resolution

Hyperspectral data for subarctic vegetation remote sensing

- Primary motivation is study of the boreal forest-tundra interface
- Need a better understanding of the hyperspectral properties of tree, shrub, dwarf shrub, lichen and other types under ‘normal’ conditions
- Secondary motivation is ability to distinguish vegetation under anthropogenic stress

SLAP:
Spectral Library of Arctic Plants

- Collaboration between Geography Faculty, Moscow State University, Russian Federation, & Scott Polar Research Institute, University of Cambridge, UK

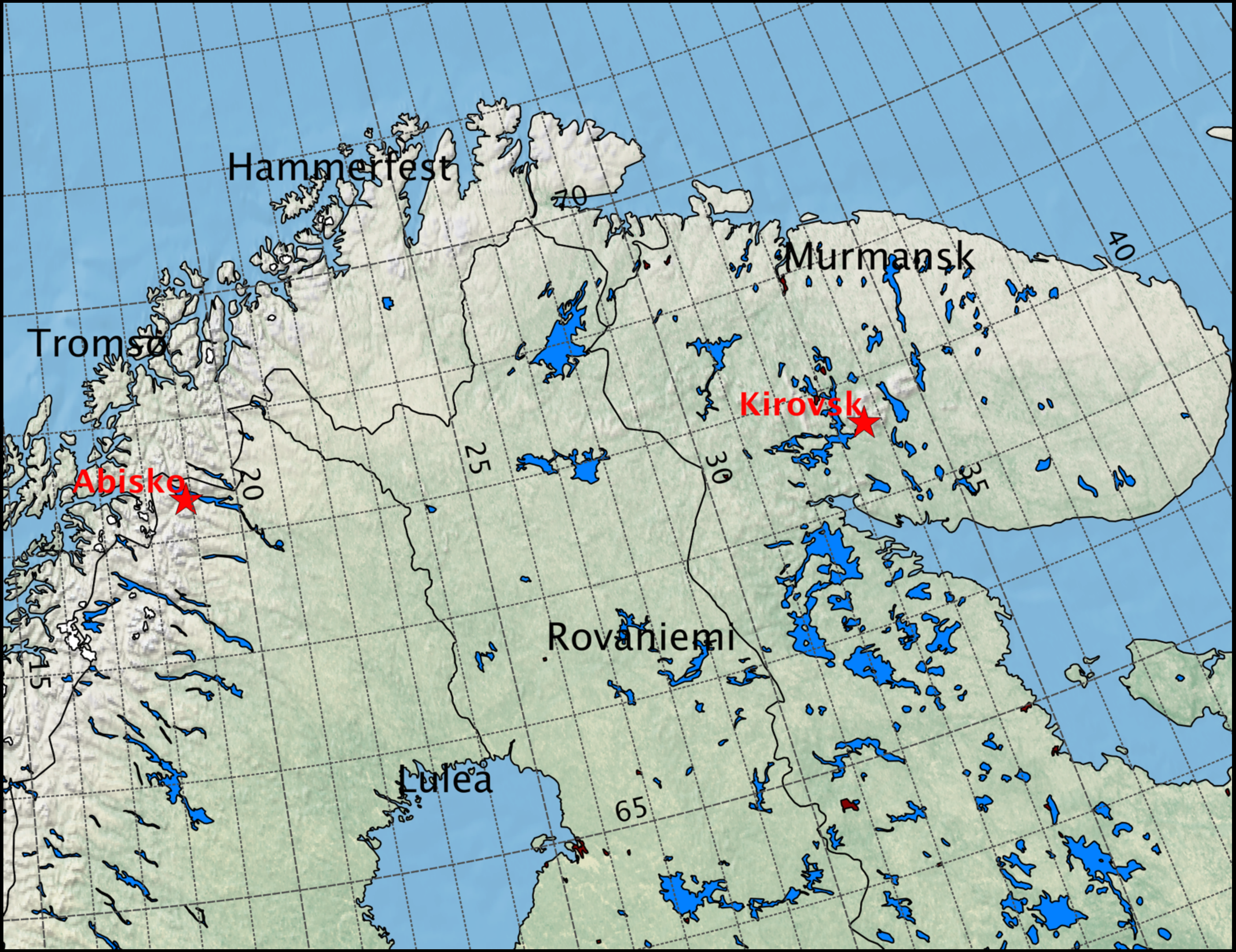
- Measurement activities in Abisko (Sweden) 2002 and Khibiny mountains (Russia) 2012-2014…

- Methodological development is one goal

- Intention is to make spectra freely available online

- Other contributions will be welcomed

Field sites



Hammerfest
70
Murmansk
40
Tromsø
Kirovsk
Abisko
25
30
20
35
Rovaniemi
15
Lulea
65

Measurement configurations

- Remote measurements
  - goniometric
  - single geometry (nadir)

Acknowledgement:
Zurich FIGOS system

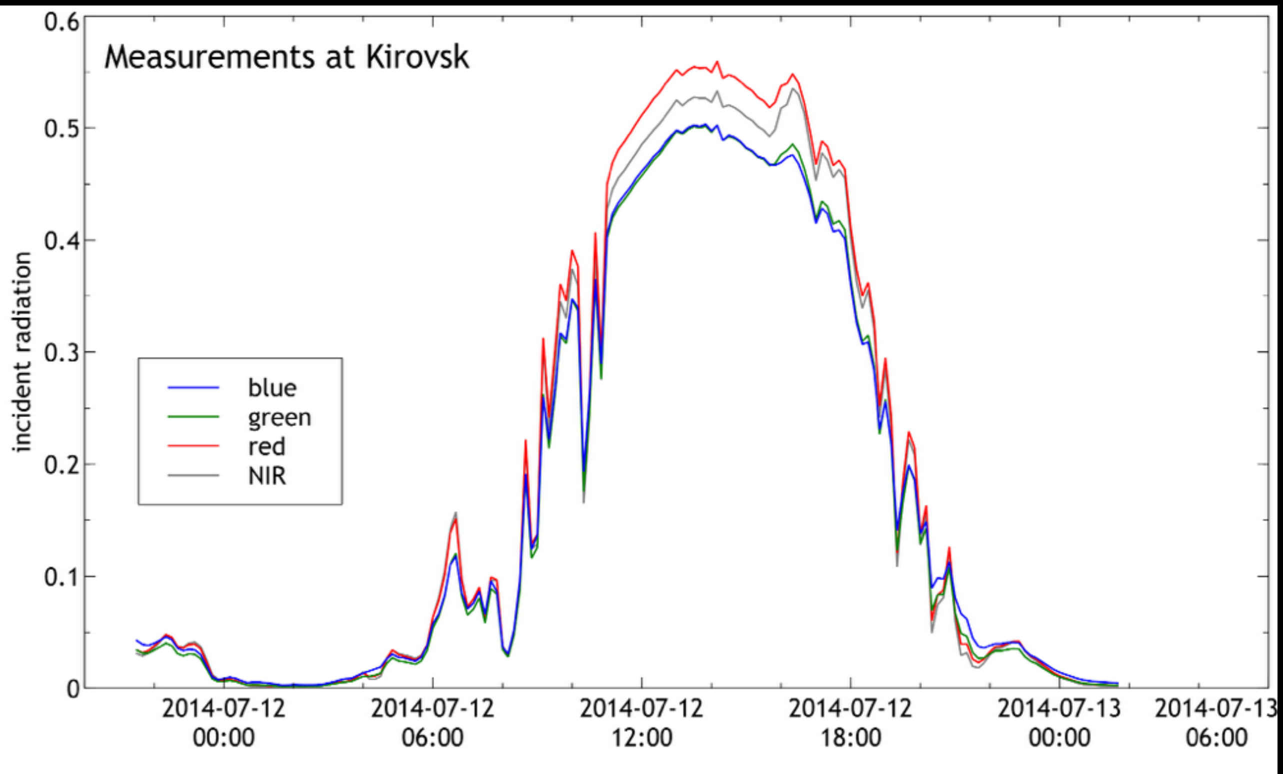
- Contact measurements
  - direct contact
  - leaf clip
  - integrating sphere

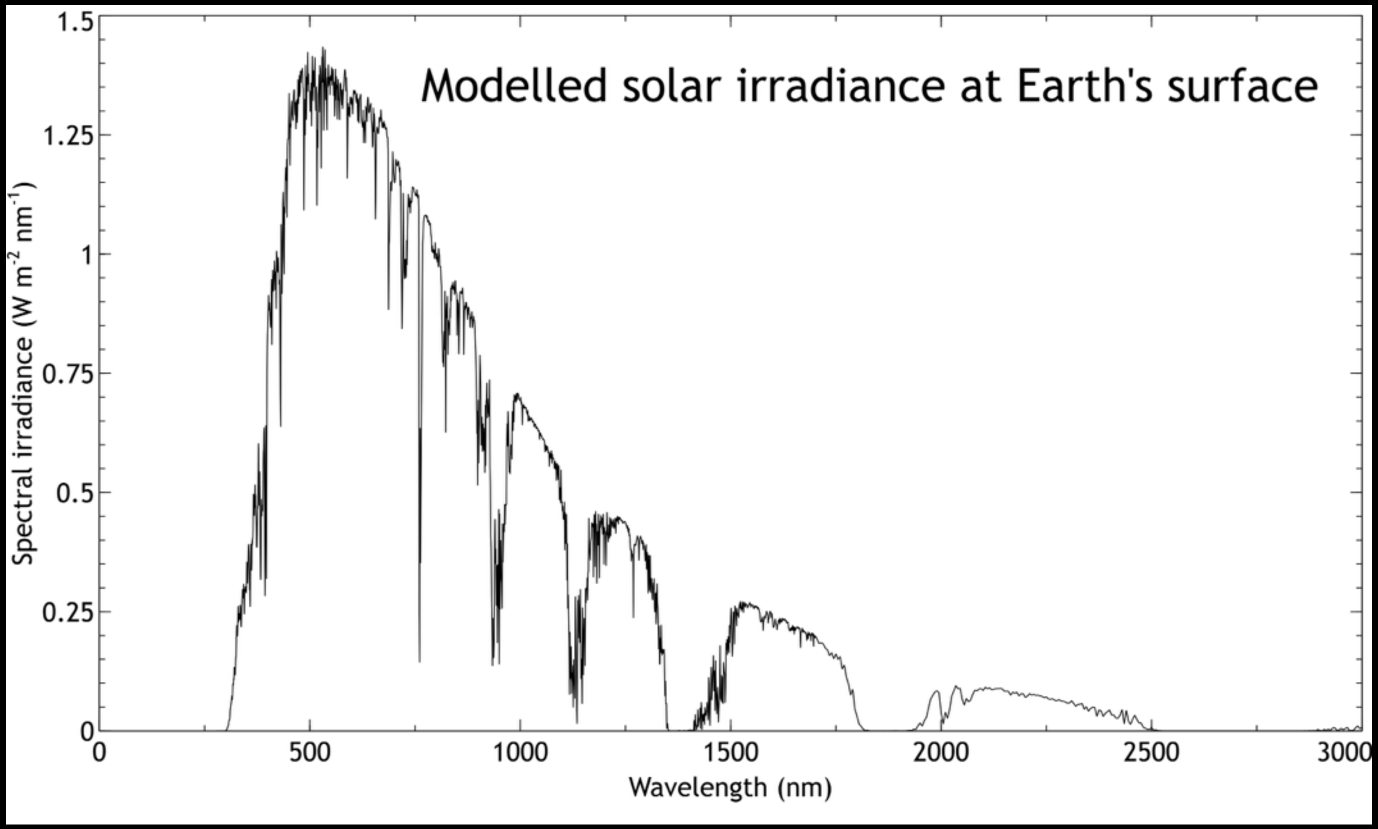
Acknowledgement:
ASD

Light sources

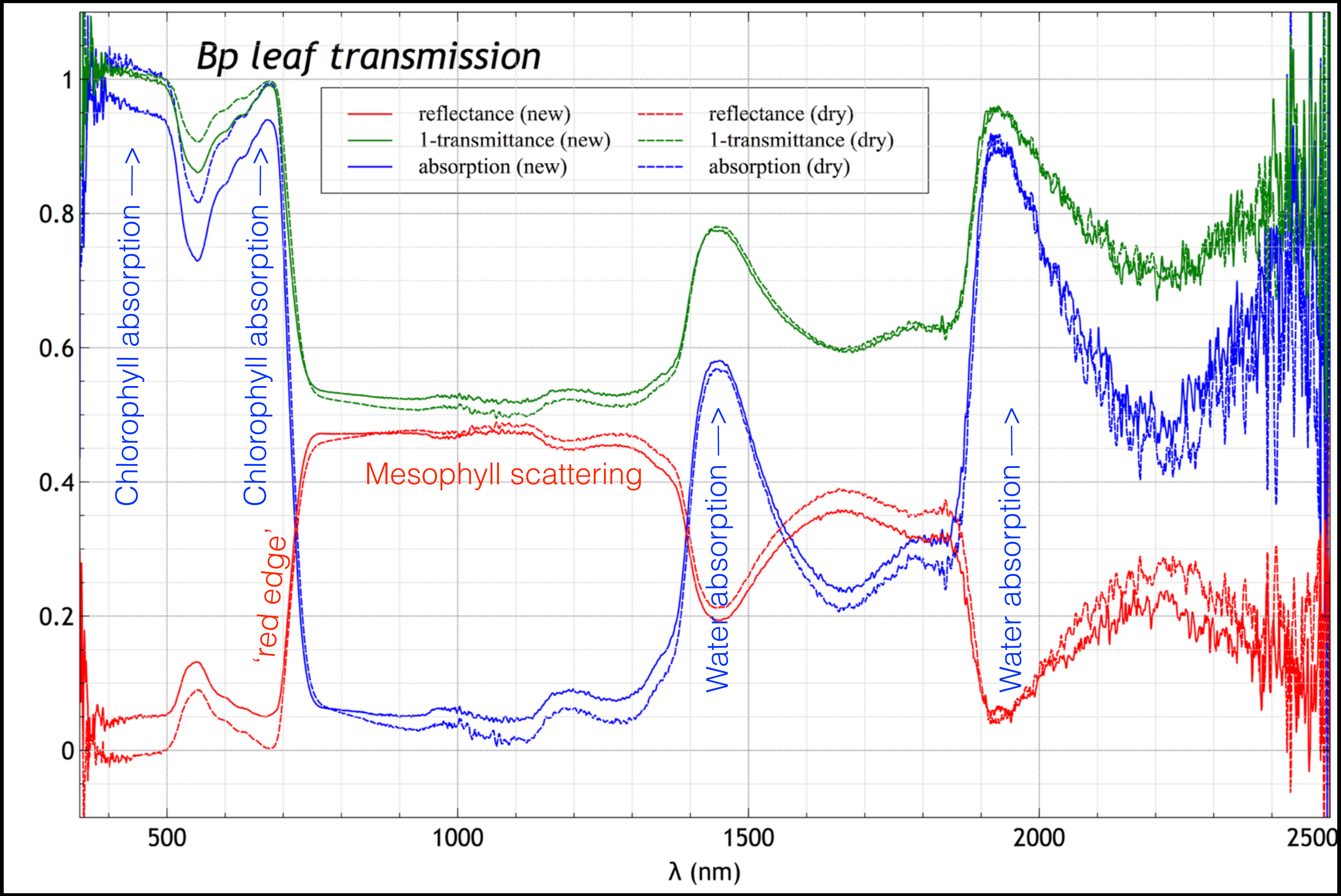
- Natural light
  - uncontrollable variation (weather)
  - some wavelengths unusable because of atmospheric absorption
- Artificial light (external or internal)
  - intensity of beam may damage biological samples

Sun- and sky-light at Earth's surface

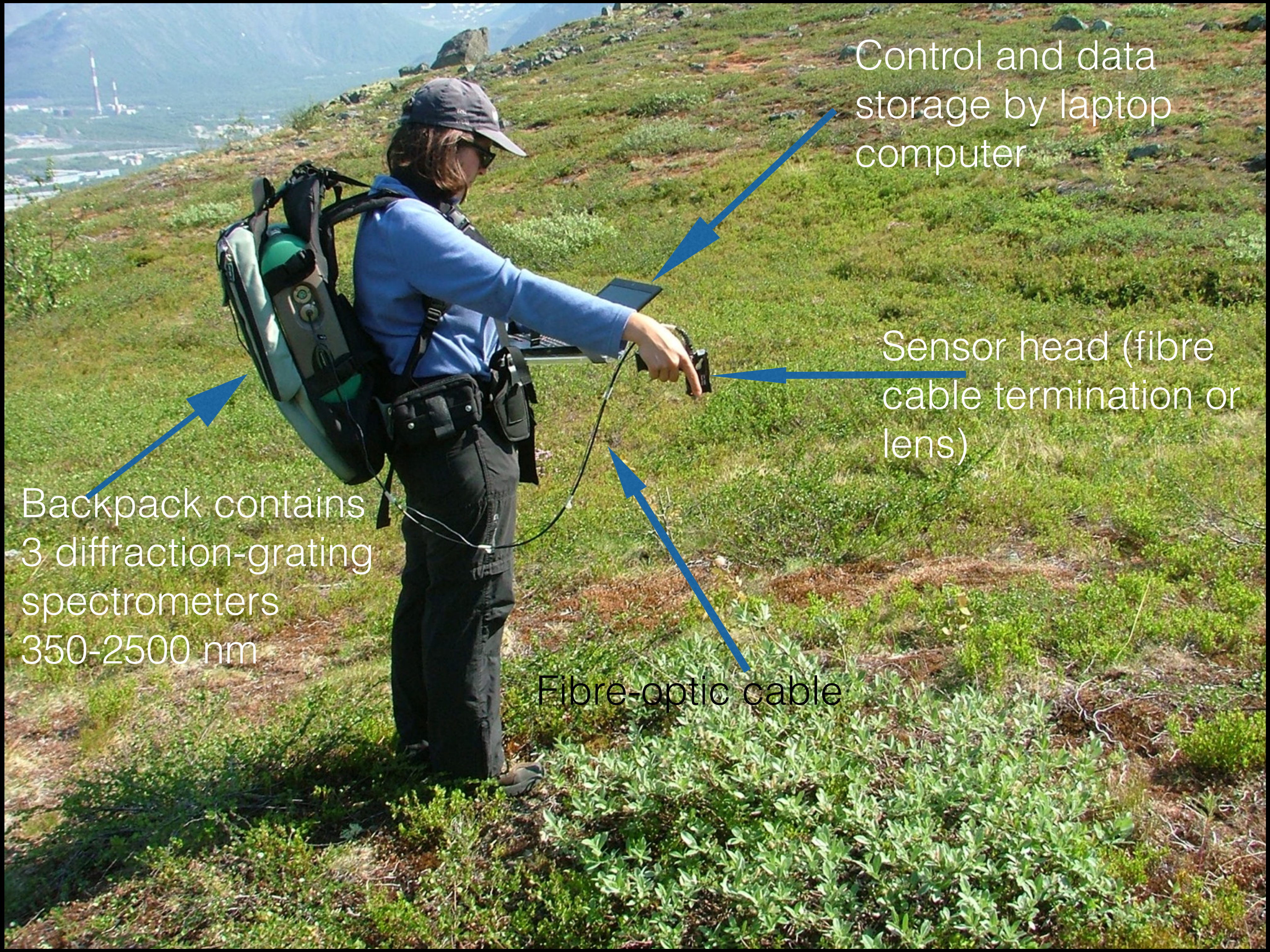




Typical optical properties of a leaf: *Betula pubescens*



ASD Fieldspec Pro

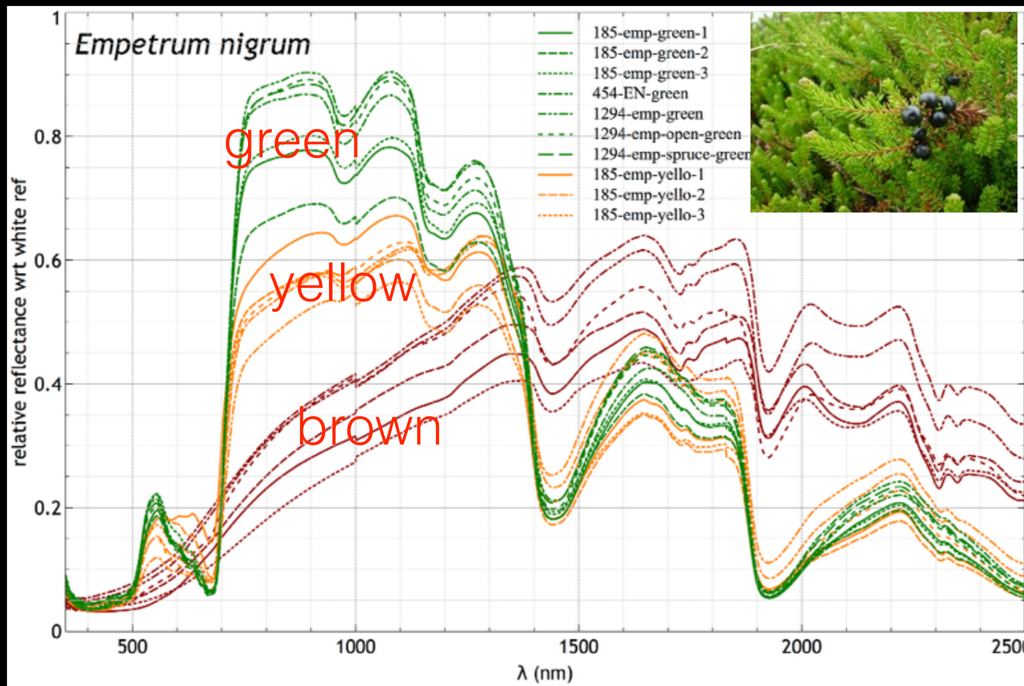



Sample

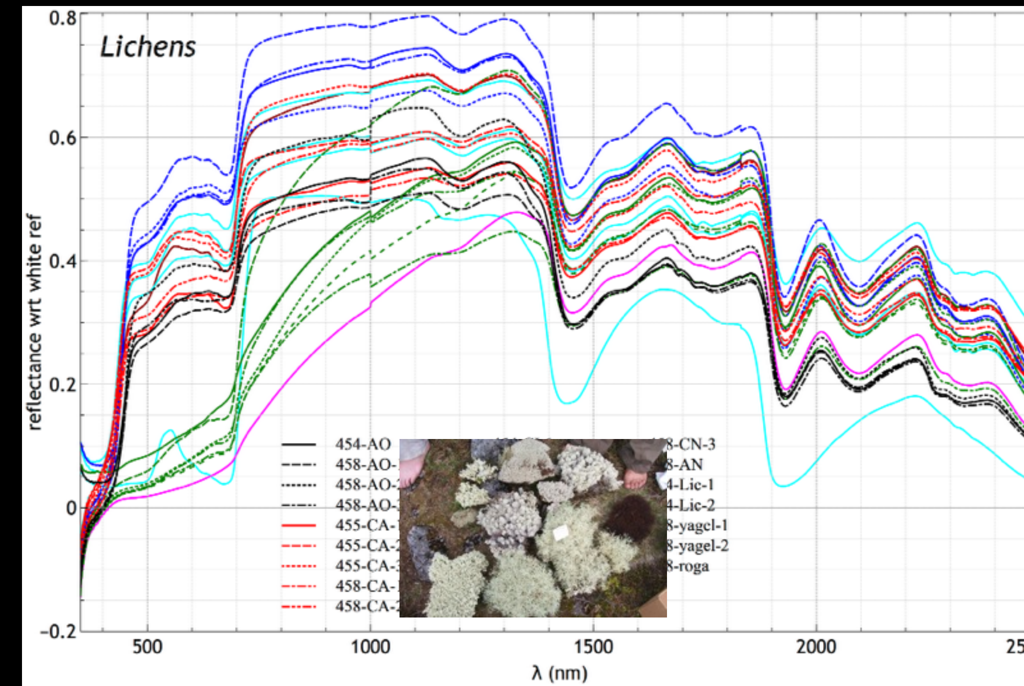

Reference
(spectralon panel)


Do not over tighten with
Plant Probe


ThinkPad
Fragile
FieldSpec 3
Hi-Res

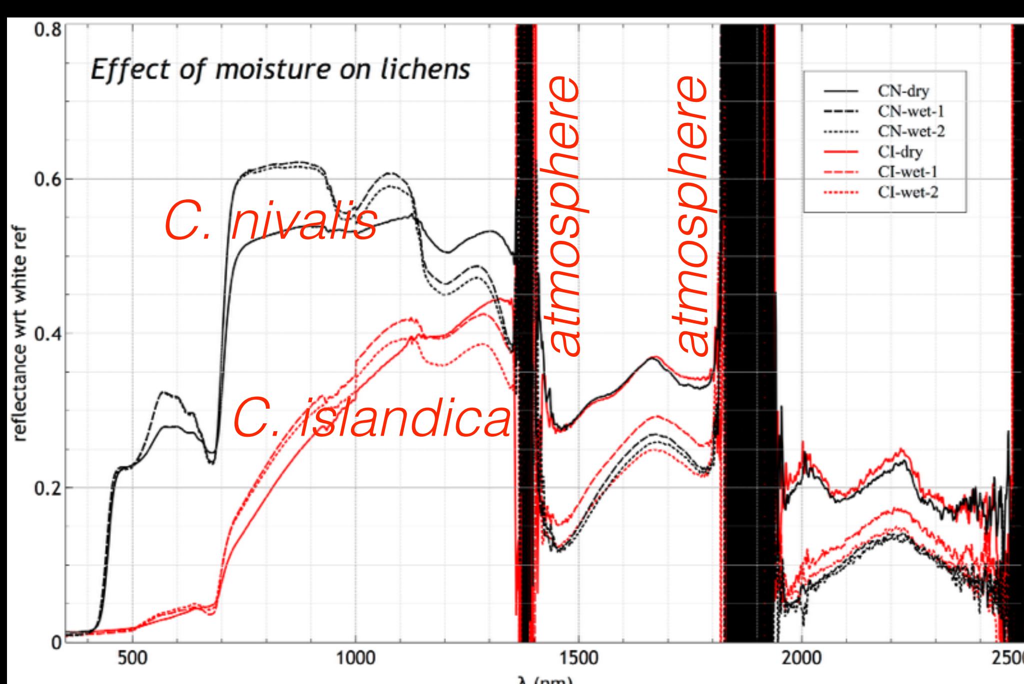


Single species: intrinsic variability

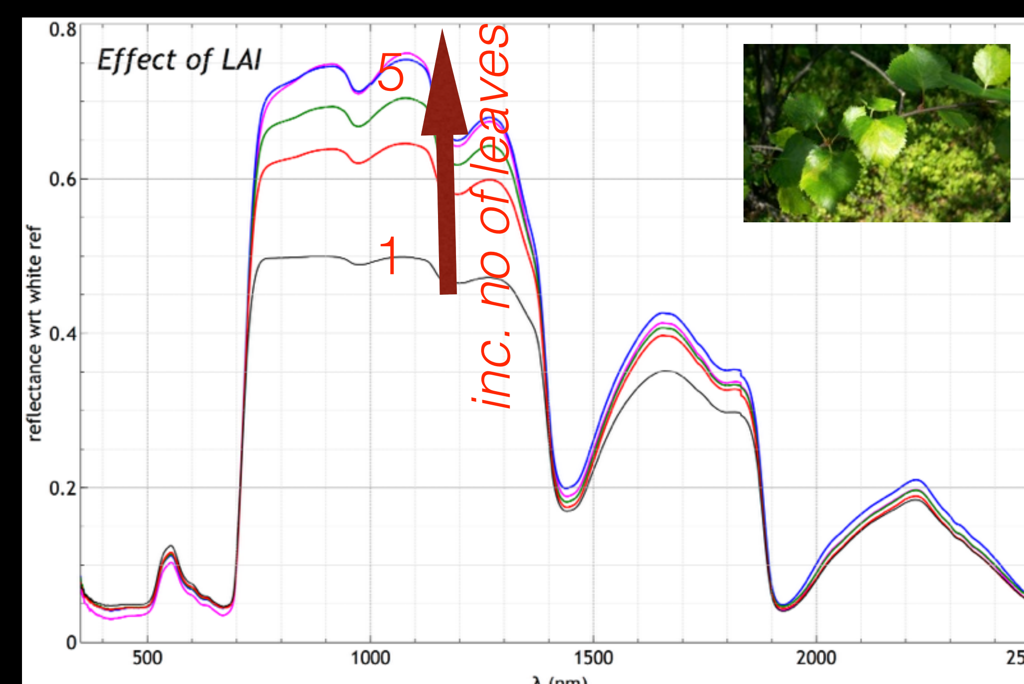


Variation within functional type

Environmental conditions
(& sunlight as illuminant)



Leaf transparency



Classes of vegetation

Type	**measurement status**
trees	*Betula pubescens* well represented; some *Salix* and *Picea.* Information on leaf transparency.
dwarf shrubs	8 species well represented but leaf transparency not studied yet
fruticose lichens	10 species well studied (some published). Moisture effects studies and found significant.
mosses	Limited investigation.
graminoids	Limited investigation.

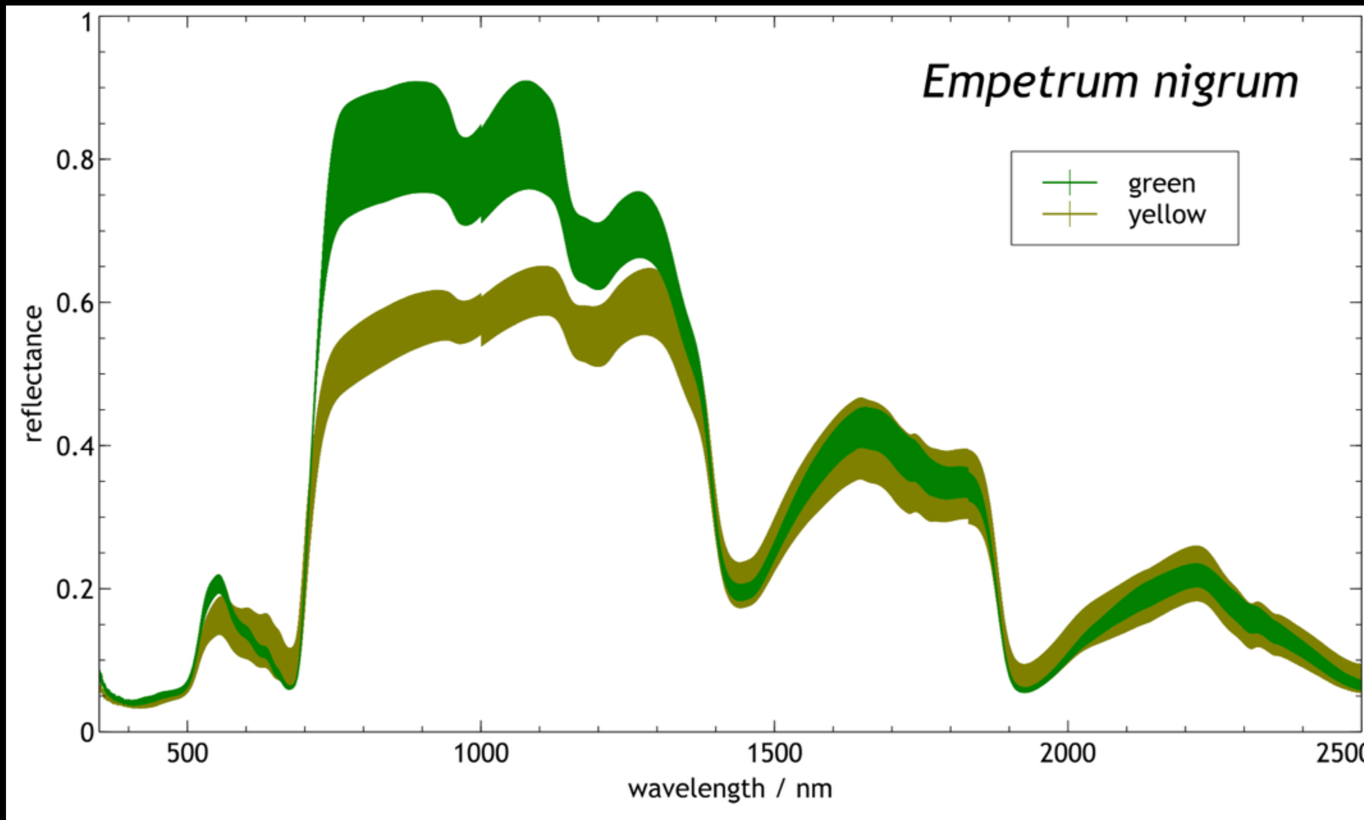
Some investigation of abiotic surfaces (sand, different rock substrates etc)

Towards a protocol for non-goniometric measurements of plants…

- Can samples be harvested before measurement?
  - leaf pigments decay quickly…
- Optimum procedure for lichens (and do we need to worry about transparency?)
- Monitoring of light levels?
  - time interval between successive reference calibrations?
- Surrounding obstructions
  - how much of the sky needs to be visible?
- Single leaf *v* leaf stack
  - should we mimic actual LAI, characterise individual leaves, or…?
- Exposure to intense artificial light
  - drying, even burning, can be an issue
- How to group and combine spectra

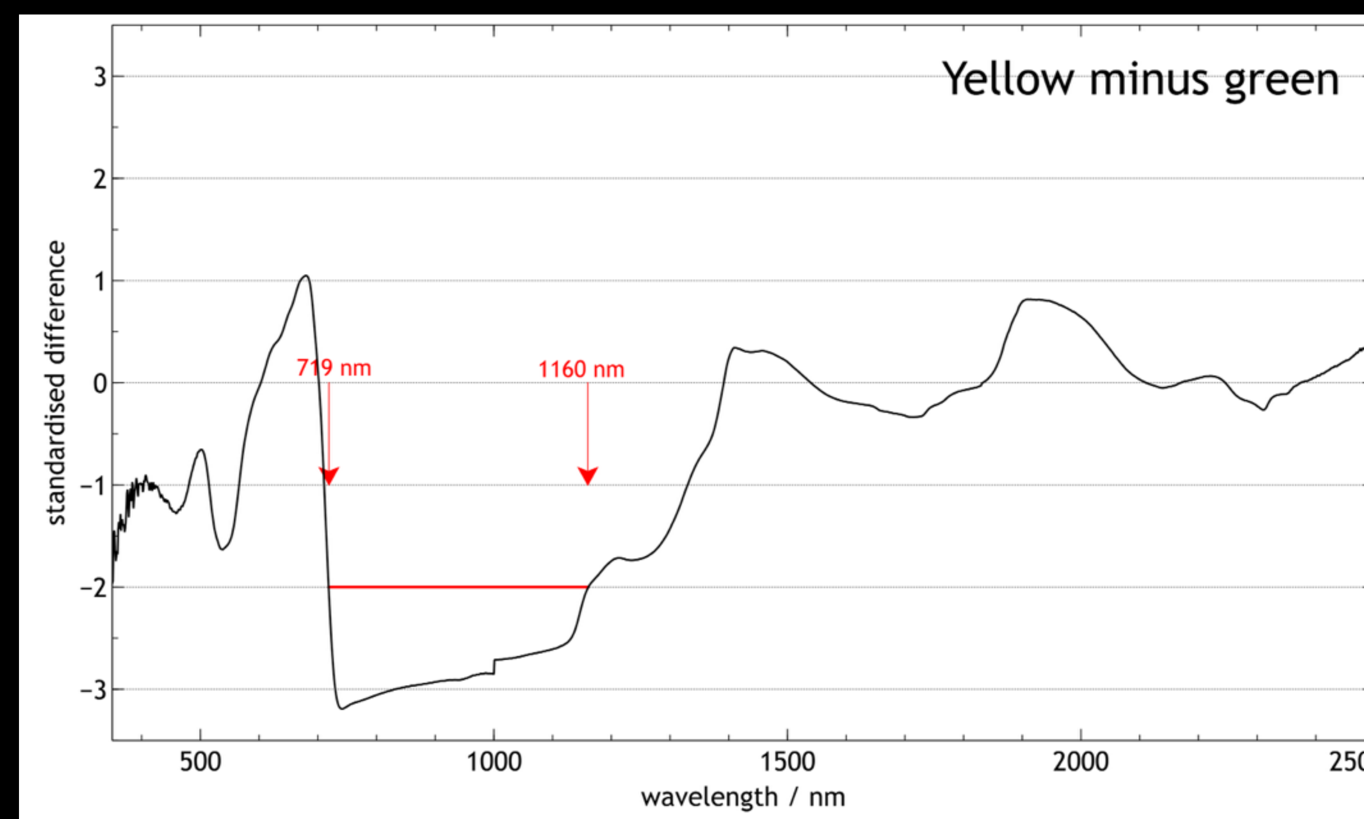
Comparing spectra

- Need to establish difference/similarity between spectra in order to decide whether they can be grouped/combined
- Usual methods involve deriving some single measure of difference such as mean difference, spectral angle etc.
- But these fail to distinguish between spectra that are *somewhat* different over a wide range of wavelengths and *very* different over a small range of wavelengths - which may be a more useful way of comparing them.



- Spectra of mature and senescent *E. nigrum* are 'mostly similar' except in the NIR
- Calculate mean and standard deviation of their difference
- Standardised difference is their ratio

- Absolute value of standardised difference exceeds 2.0 for the range 719-1160 nm
- Quote the spectral difference as 1160-719=441 nm
- Method allows for atmospheric absorption bands to be ignored in a straightforward way



International collaboration on definition of protocols and standards, collection of spectra?

- Discussion with Birgit Heim (AWI Potsdam) in July
- Possibility to create international group (so far, UK, Russia, Germany, Australia…)
- I would like to collect contact details of those potentially interested in participating


More information on SLAP and requests for data contributions coming soon!
Thank you for your attention