

Reflectance Spectroscopy and Vegetation Indices

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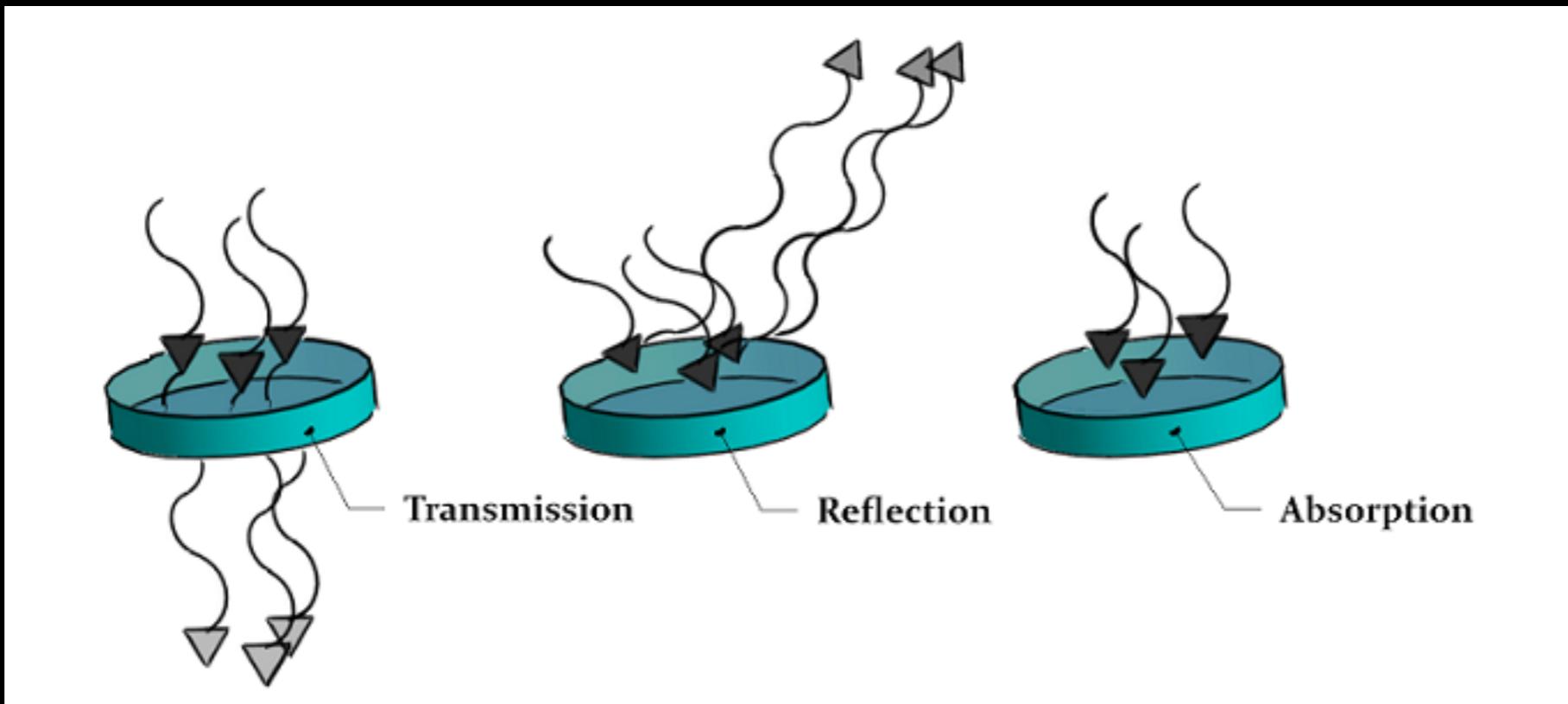
Reflectance-Calibrated Landsat Data from USGS

1. Go to earthexplorer.usgs.gov
2. Under “Search Criteria”, type in the place/time of the data
3. Under “Data Sets”, search for Landsat Surface Reflectance.

Note that you need to register.

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Reflectance



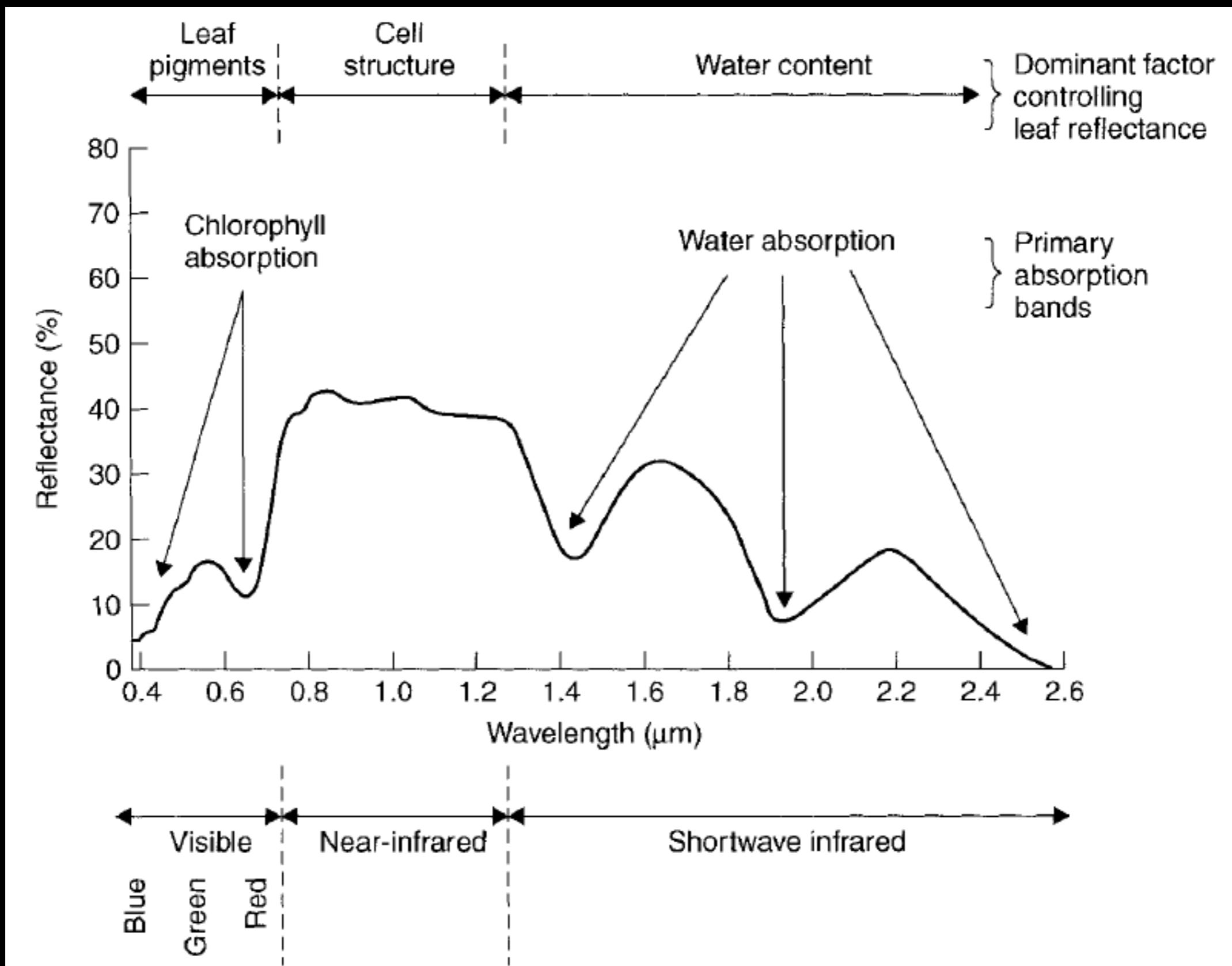
Incoming radiation = Transmission + Reflection + Absorption

$$I = Transmittance + Reflectance + Absorbance$$

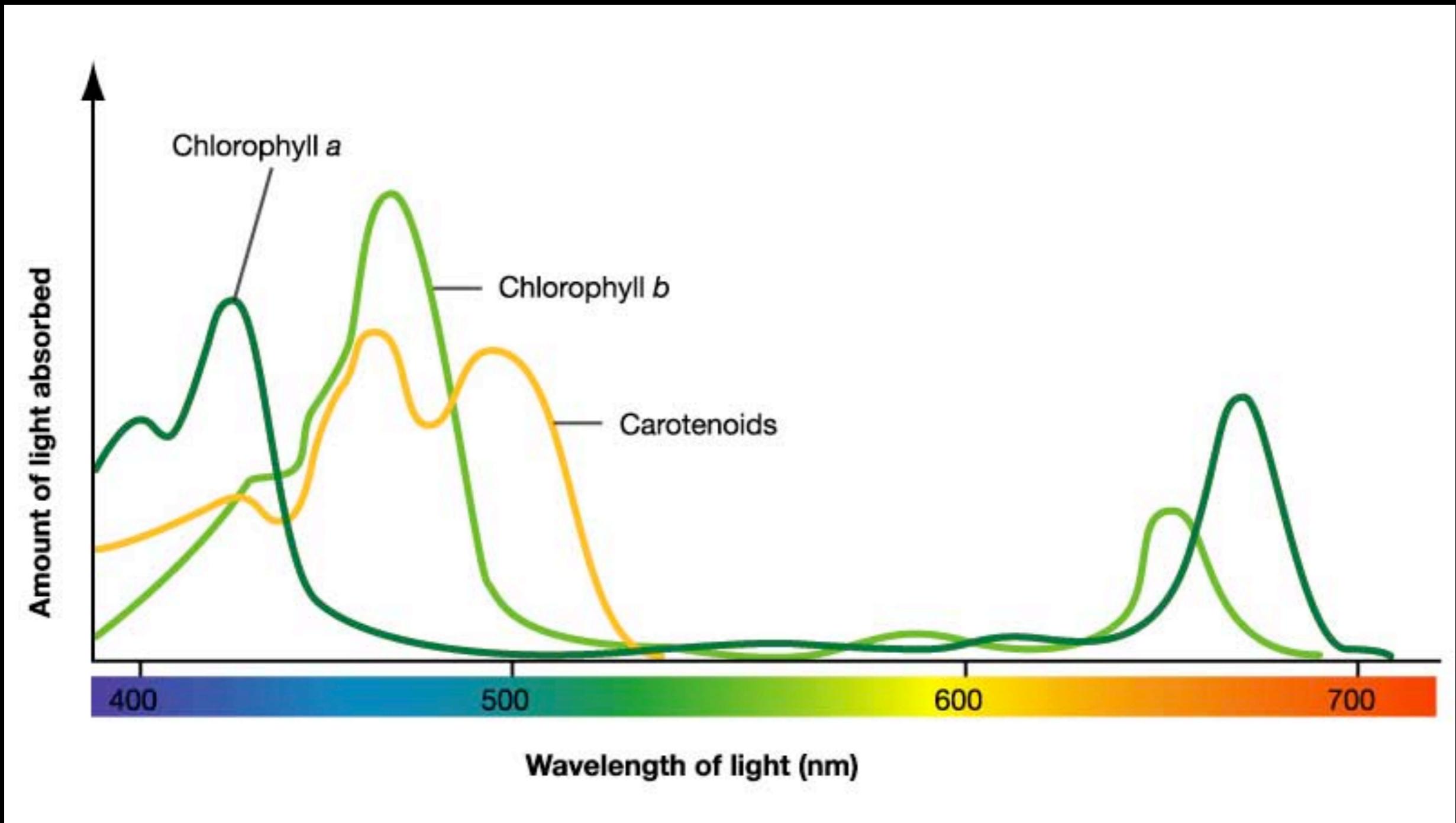


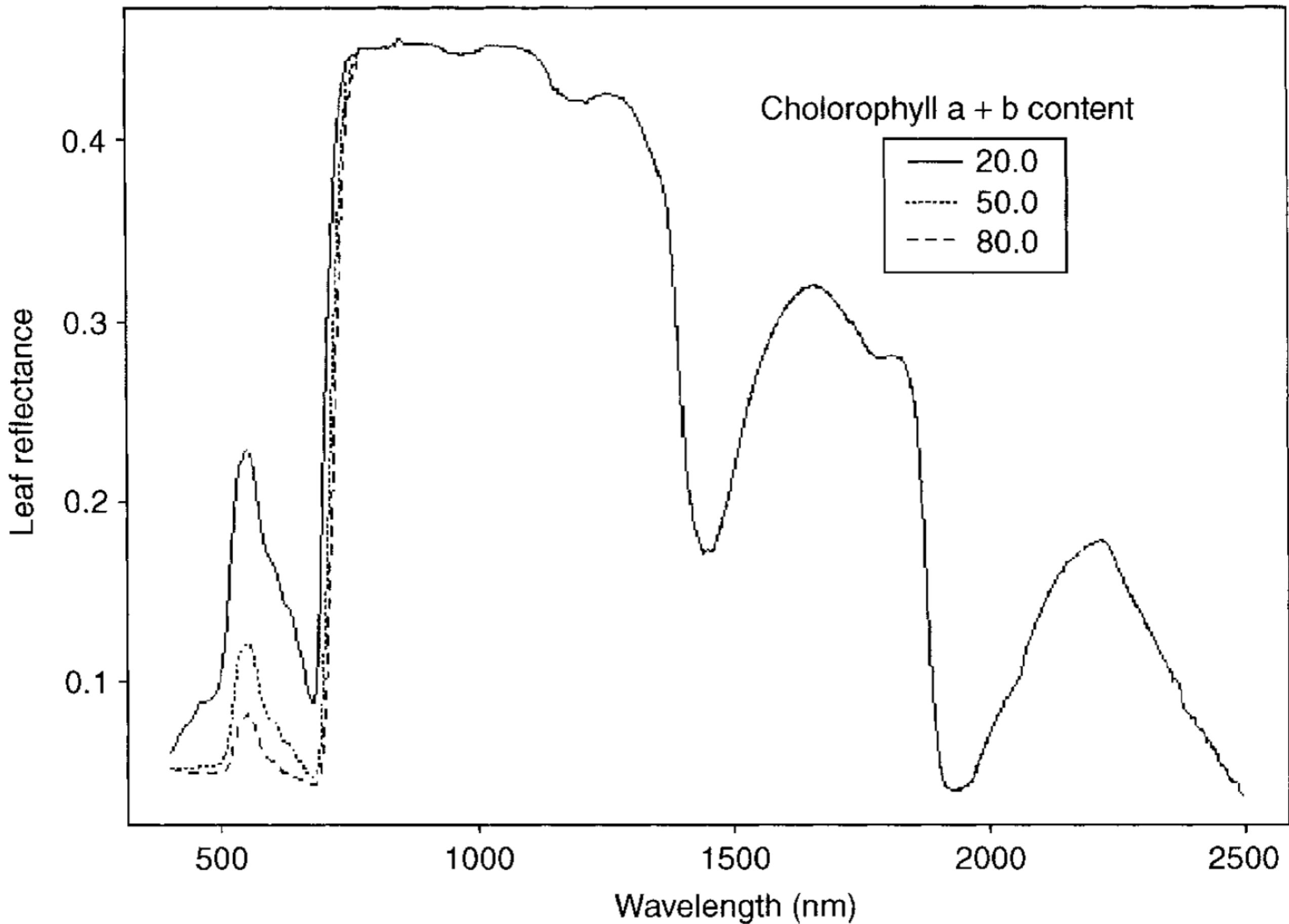
Richard Mosse

Leaf spectra



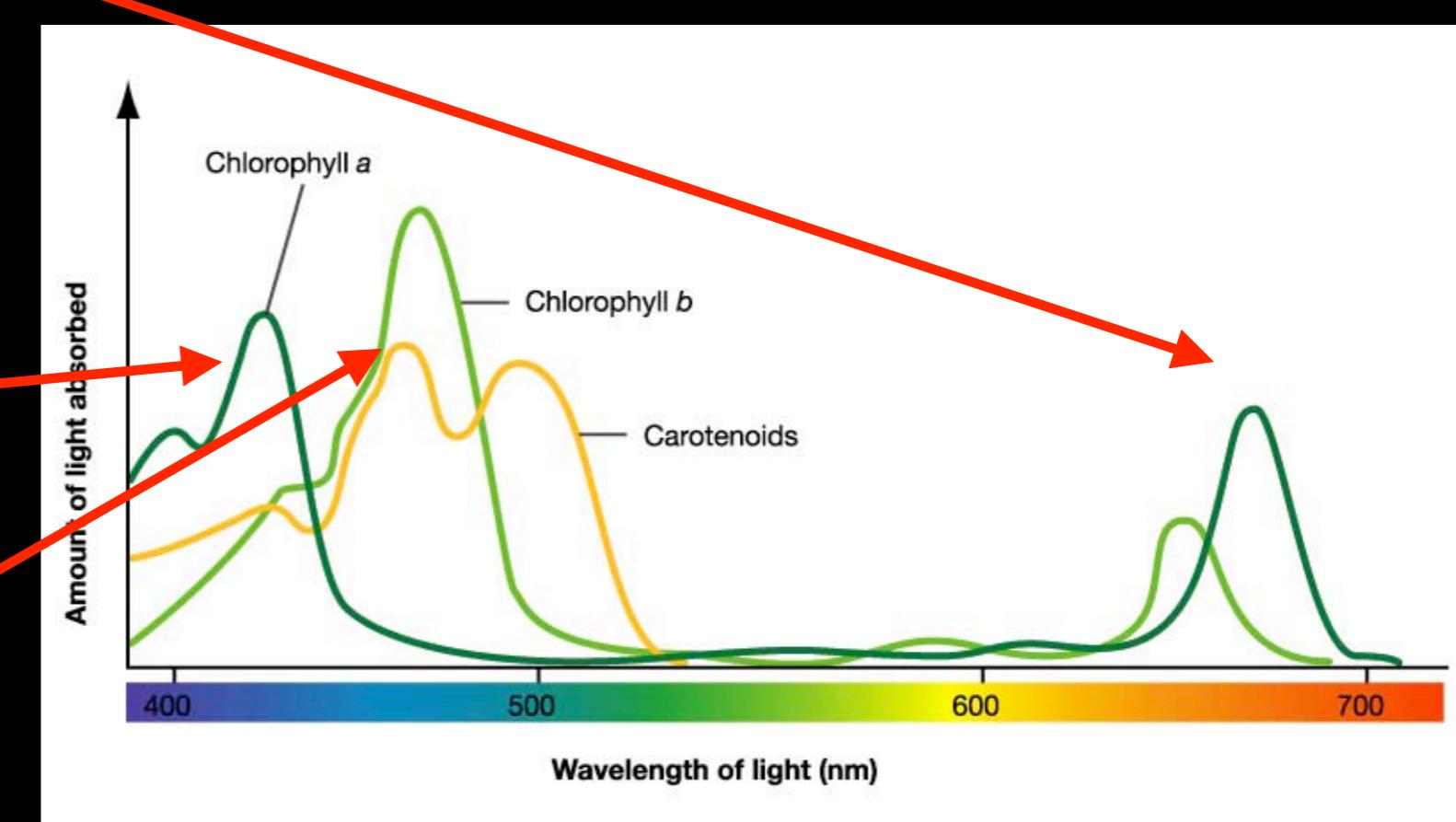
Pigment absorption



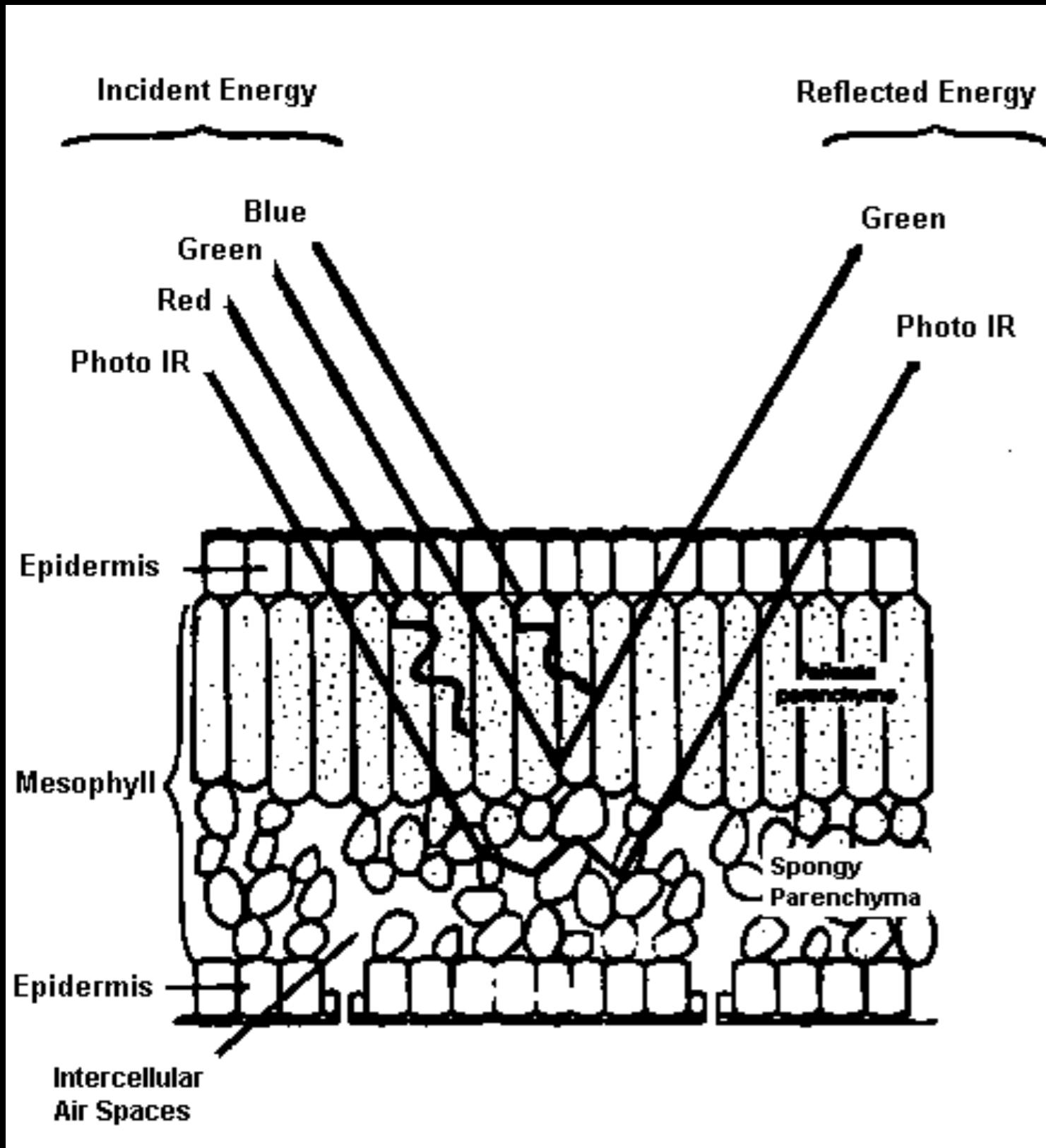


MODIS bands and Chlorophyll

Band	Wavelength (nm)	Resolution (m)	Primary Use
1	620-672	250m	Land/Cloud/Aerosols
2	841-890	250m	Boundaries
3	459-479	500m	
4	545-565	500m	
5	1230-1250	500m	Land/Cloud/Aerosols
6	1628-1652	500m	Properties
7	2105-2155	500m	
8	405-420	1000m	Ocean Color/
9	438-448	1000m	Phytoplankton/
10	483-493	1000m	Biogeochemistry
11	526-536	1000m	
12	546-556	1000m	
13	662-672	1000m	
14	673-683	1000m	
15	743-753	1000m	
16	862-877	1000m	
17	890-920	1000m	Atmospheric
18	931-941	1000m	Water Vapor
19	915-965	1000m	



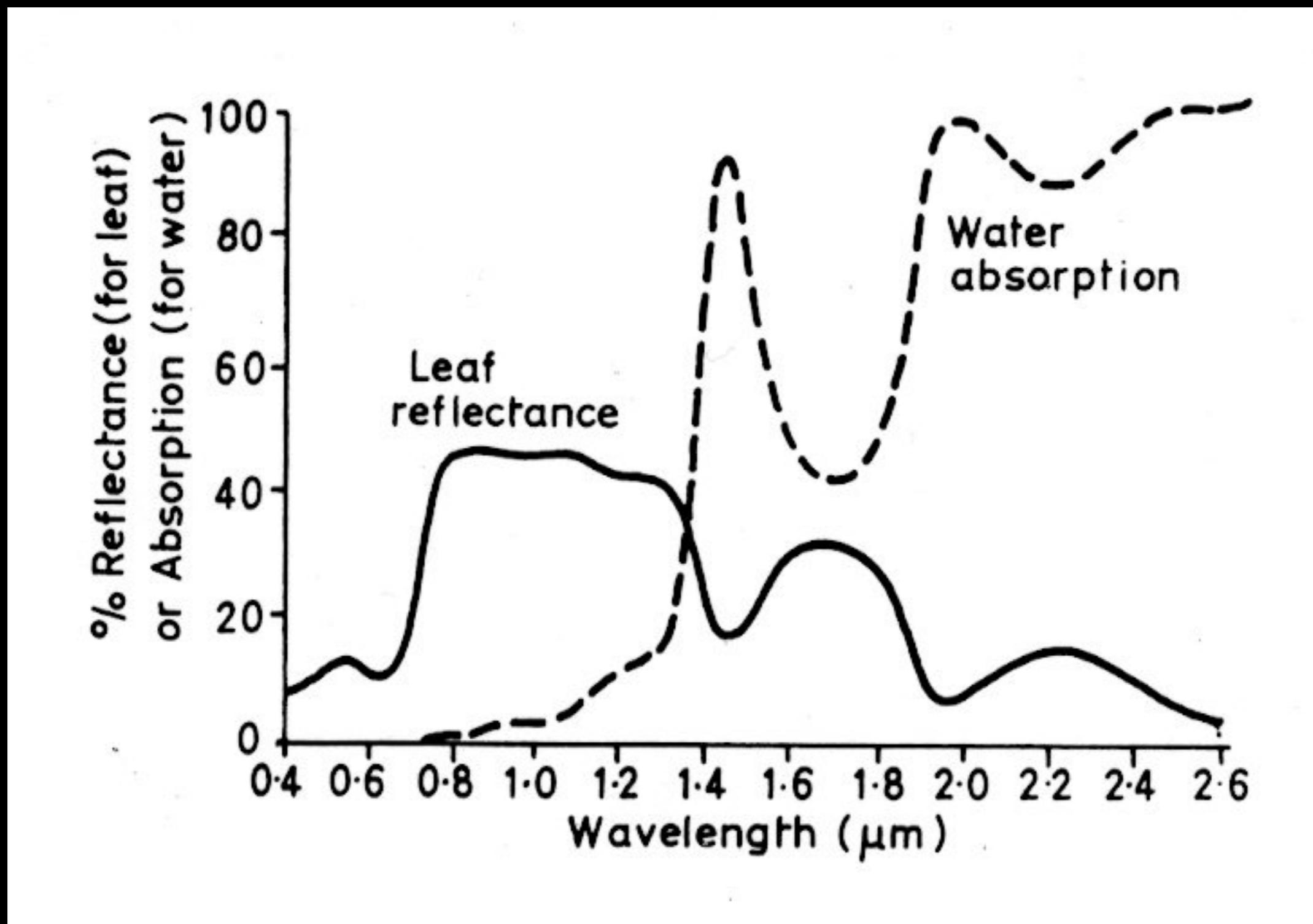
Leaf structure



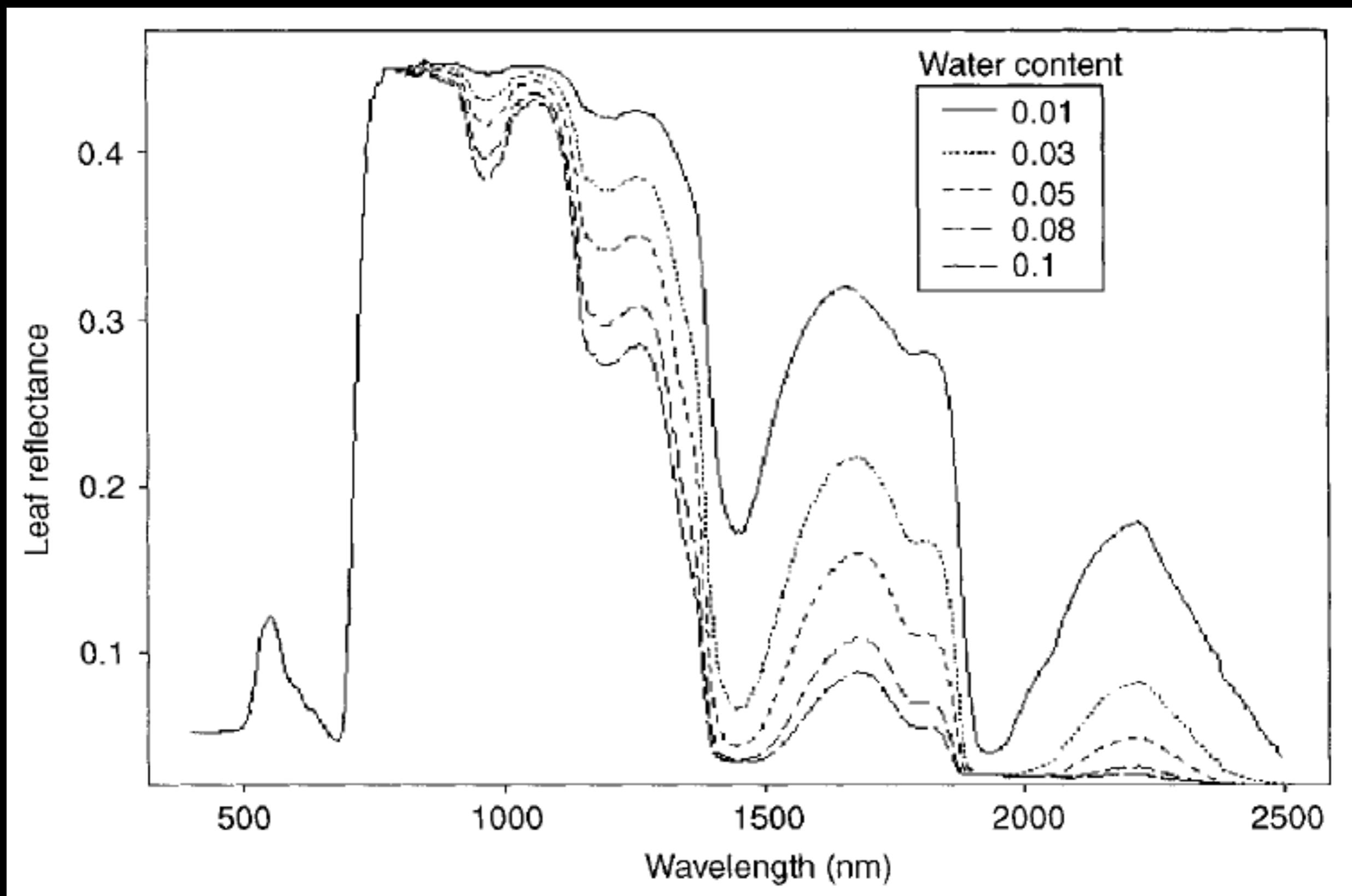
Pigments absorb visible EMR

Spongy mesophyll cells reflect NIR

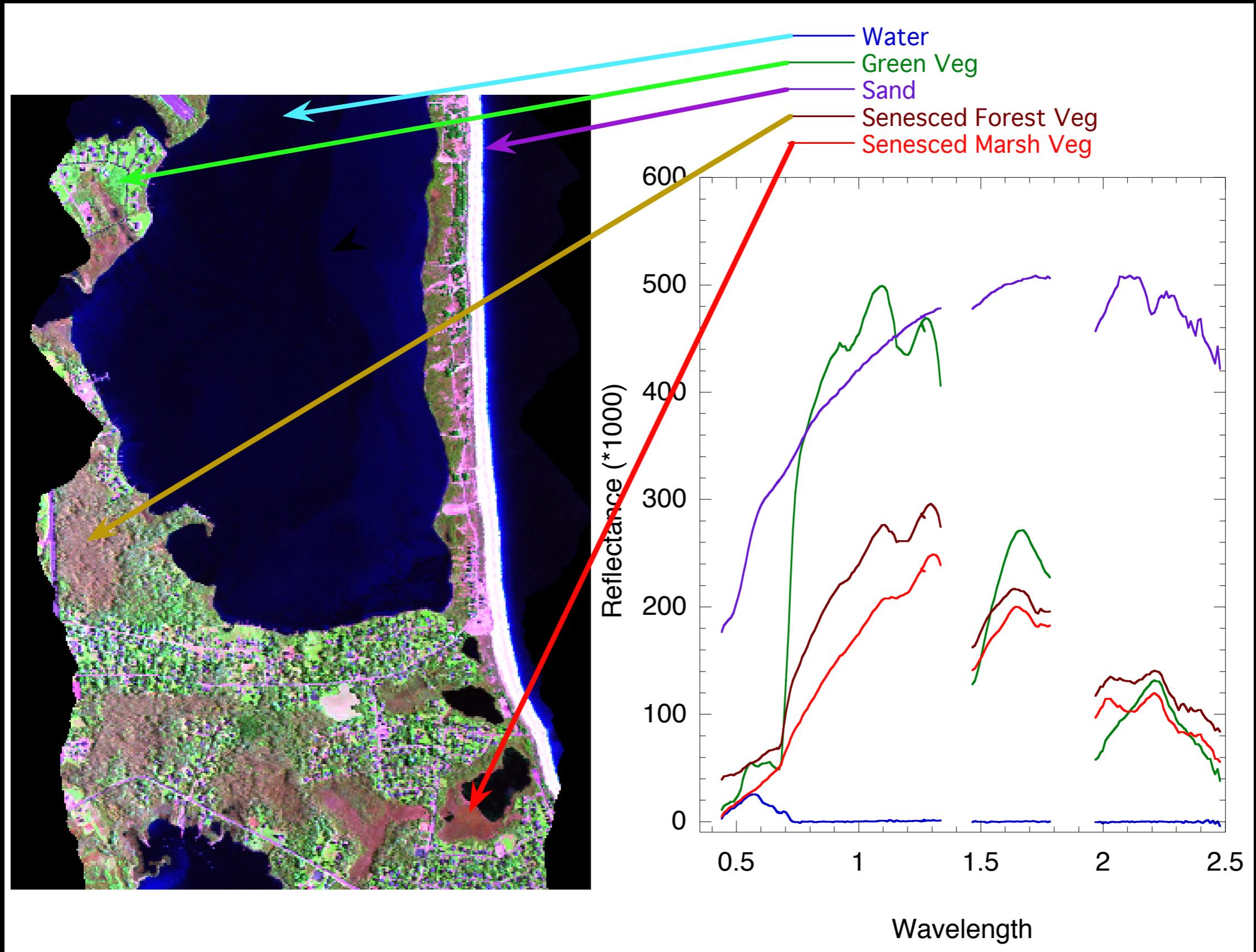
Water absorption



The shape of the spectra tell the water concentration



Spectra taken from satellite



Other chemical components

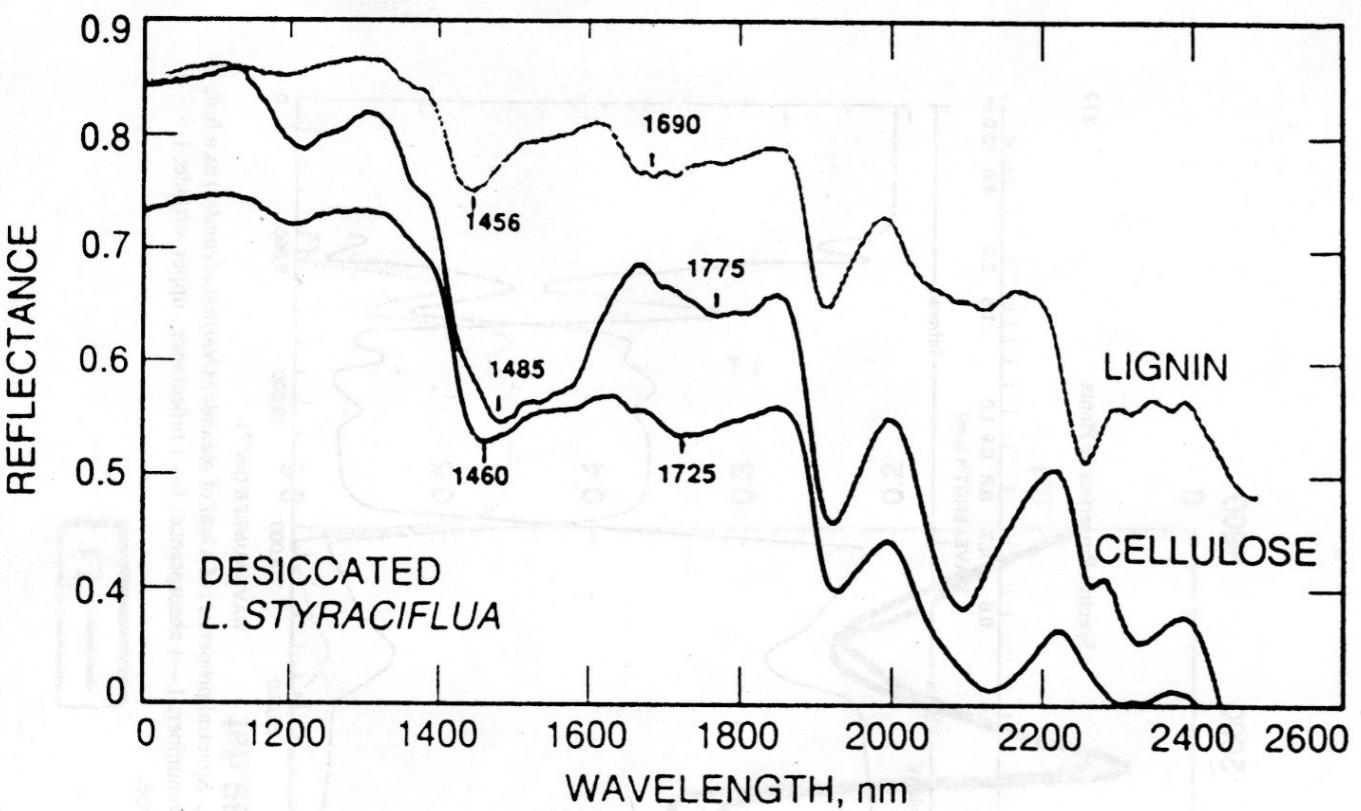
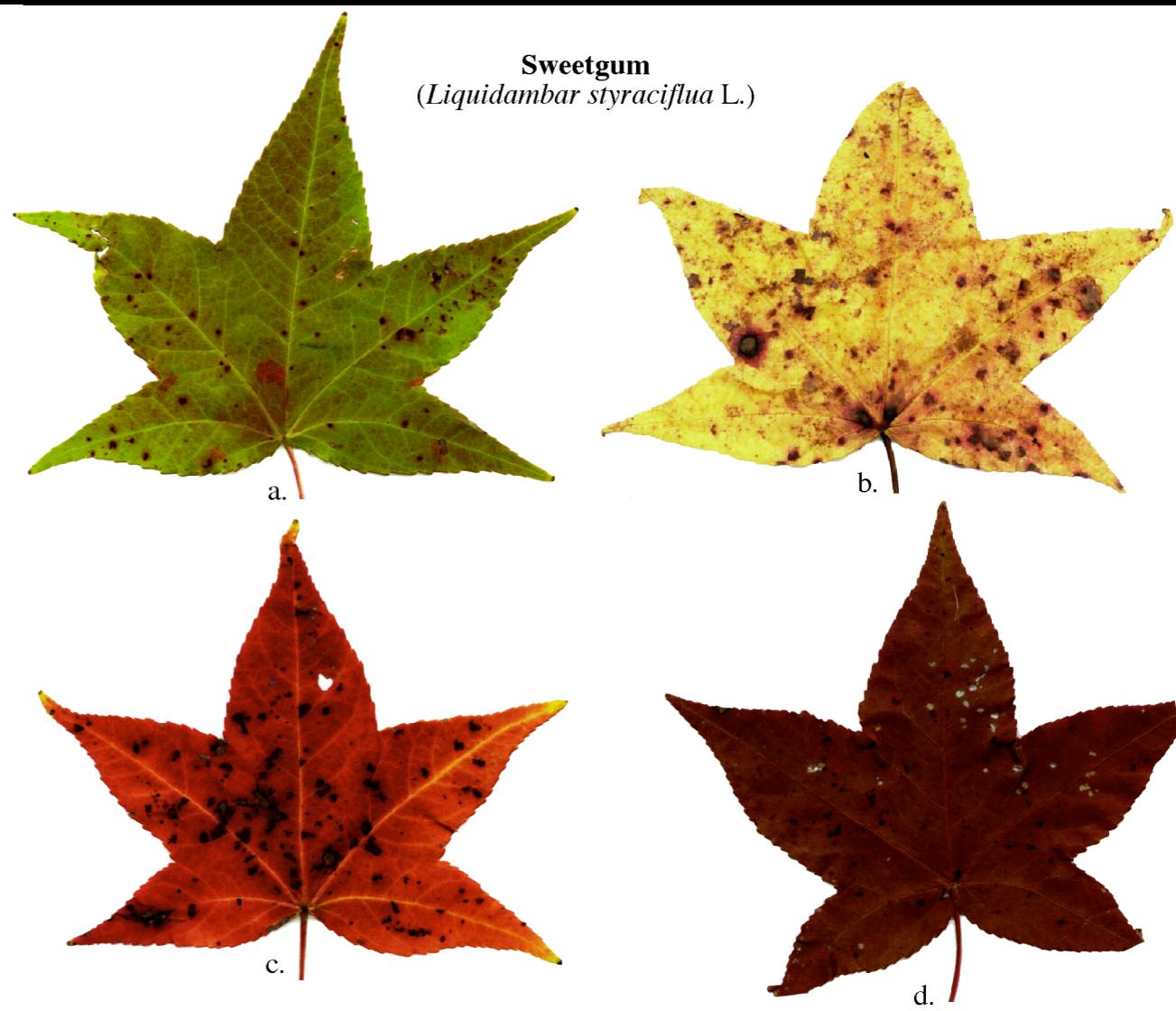
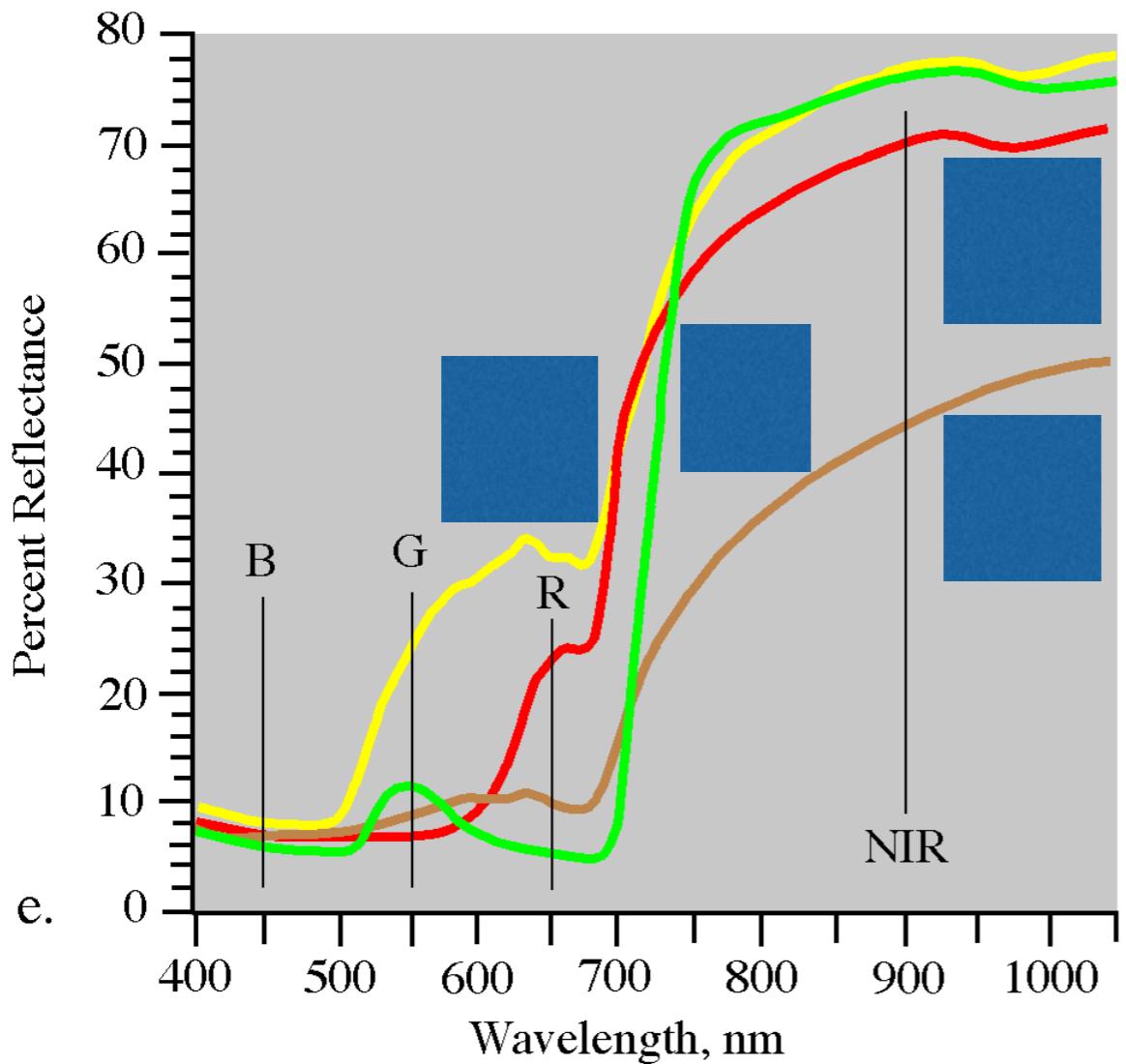


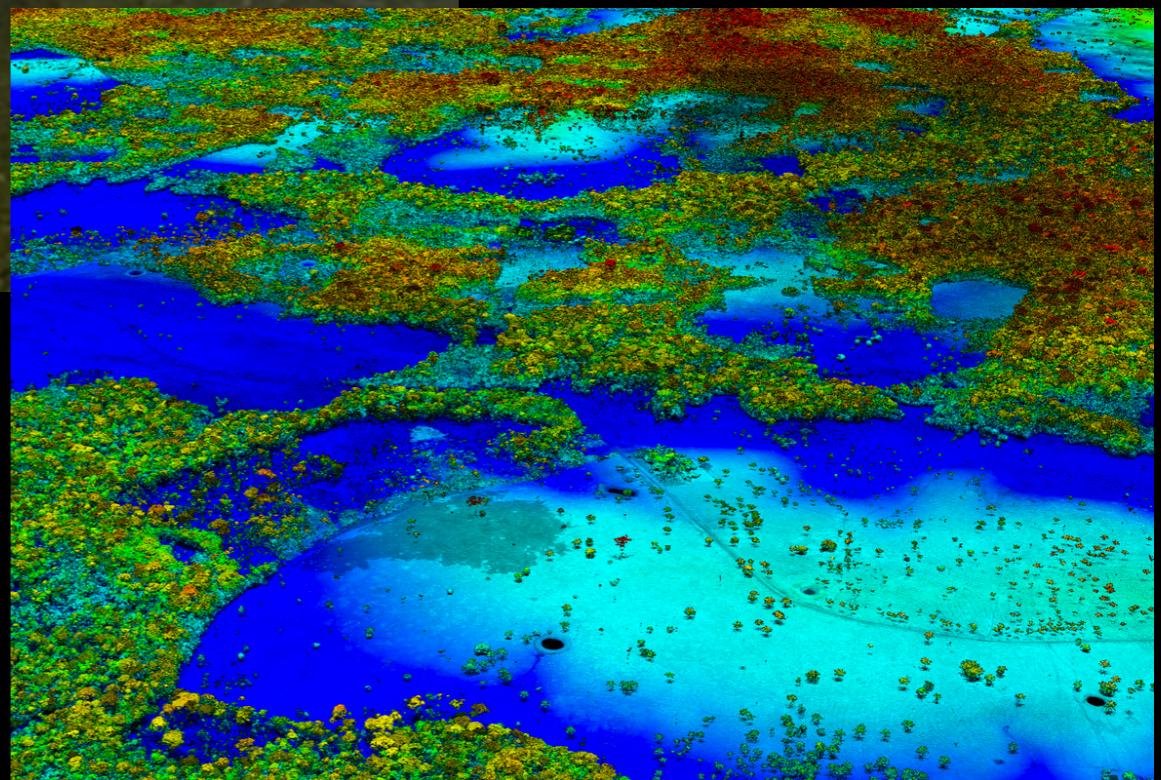
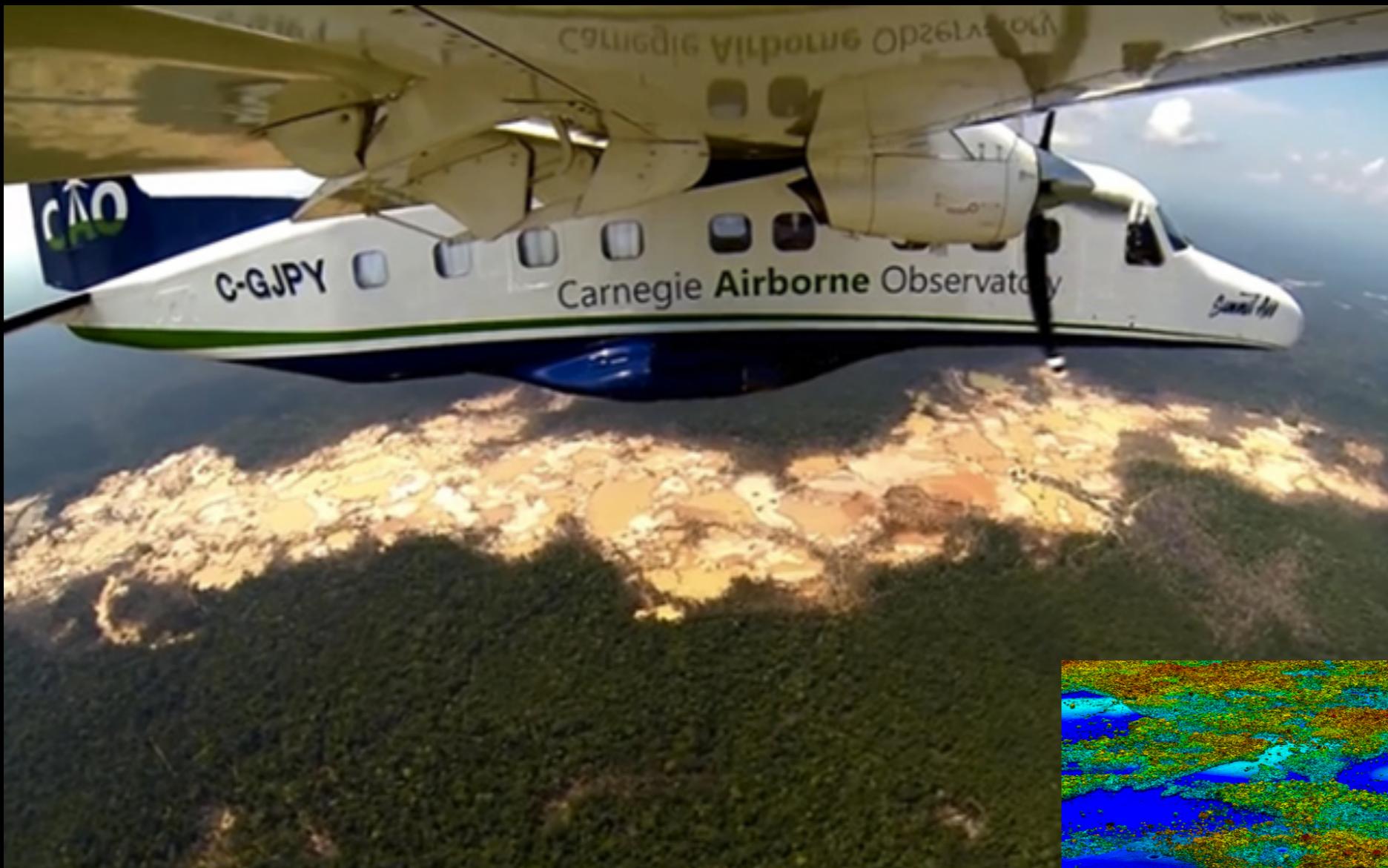
Figure 1. Reflectances of lignin, cellulose, and desiccated *L. styraciflua*.



Changes in leaf spectra



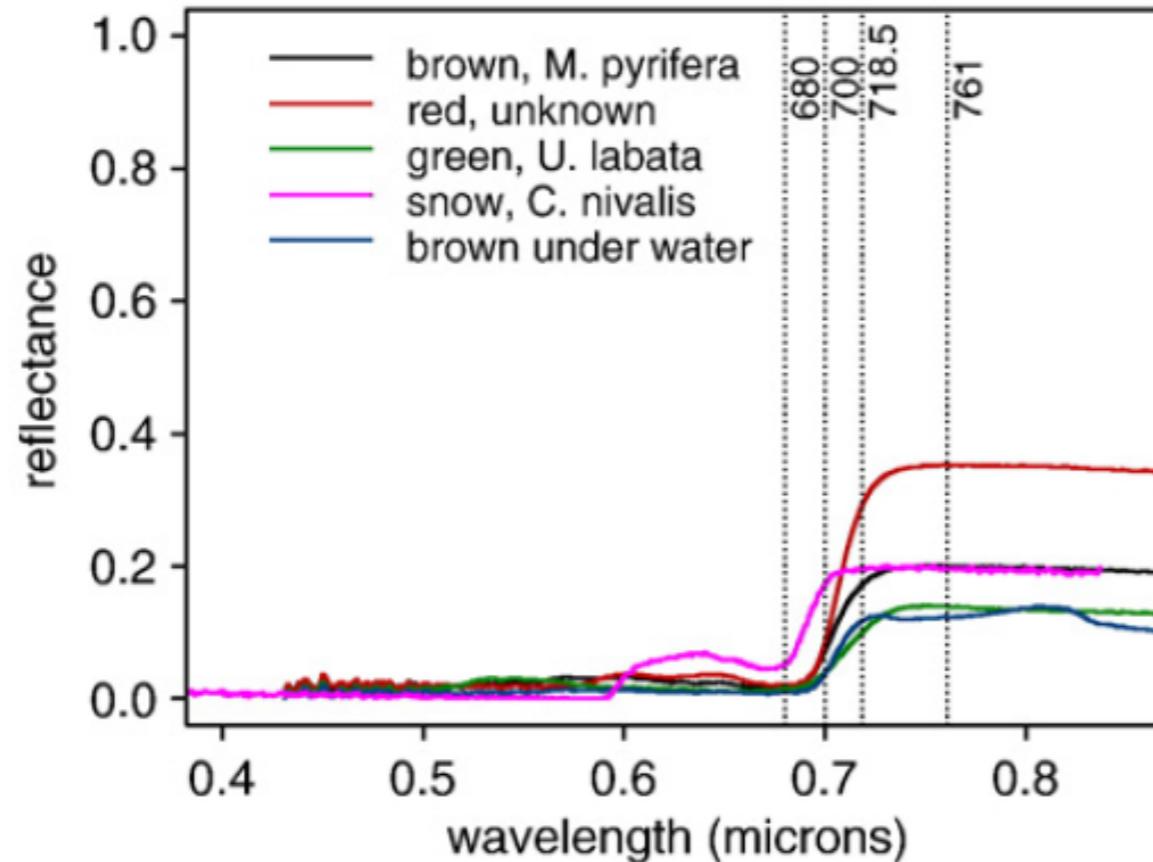
Carnegie Airborne Observatory (CAO)



Algae and Bacteria

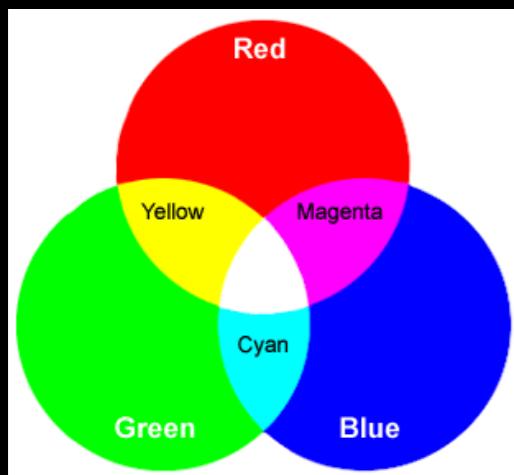
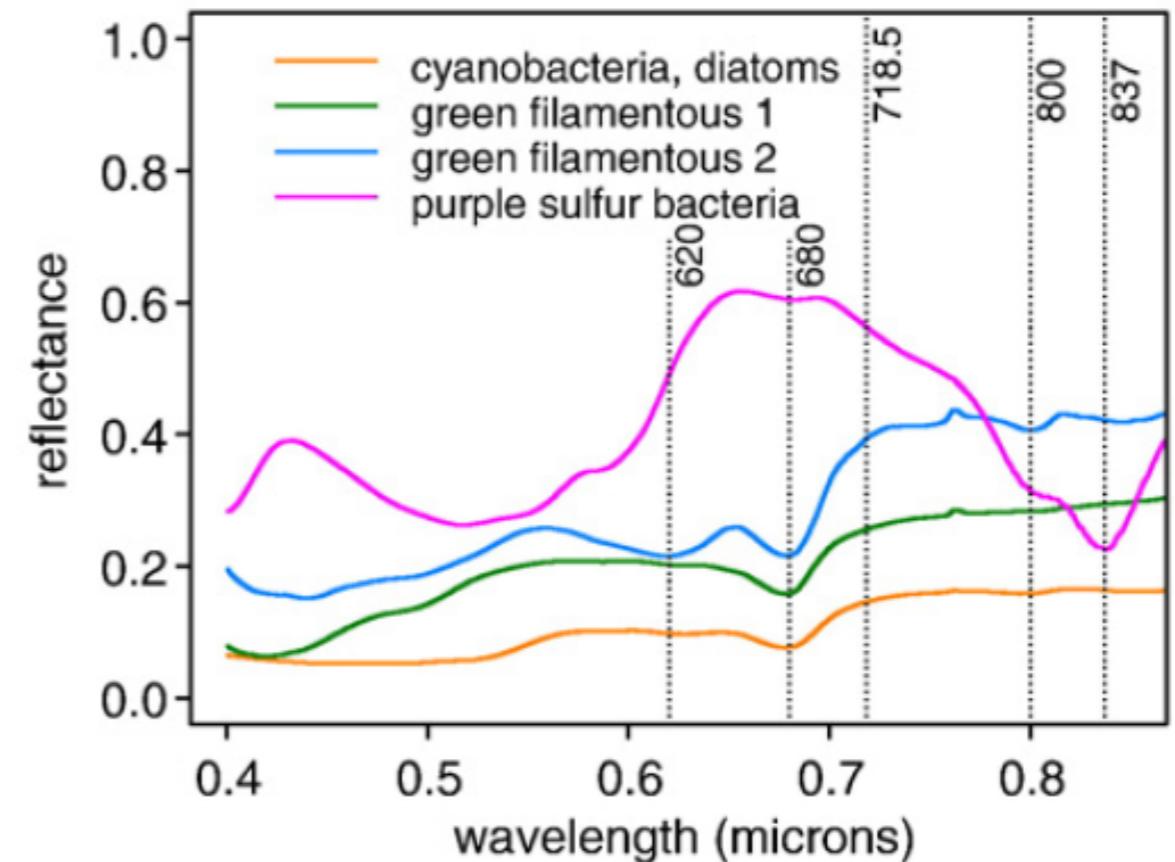
(e)

ALGAE

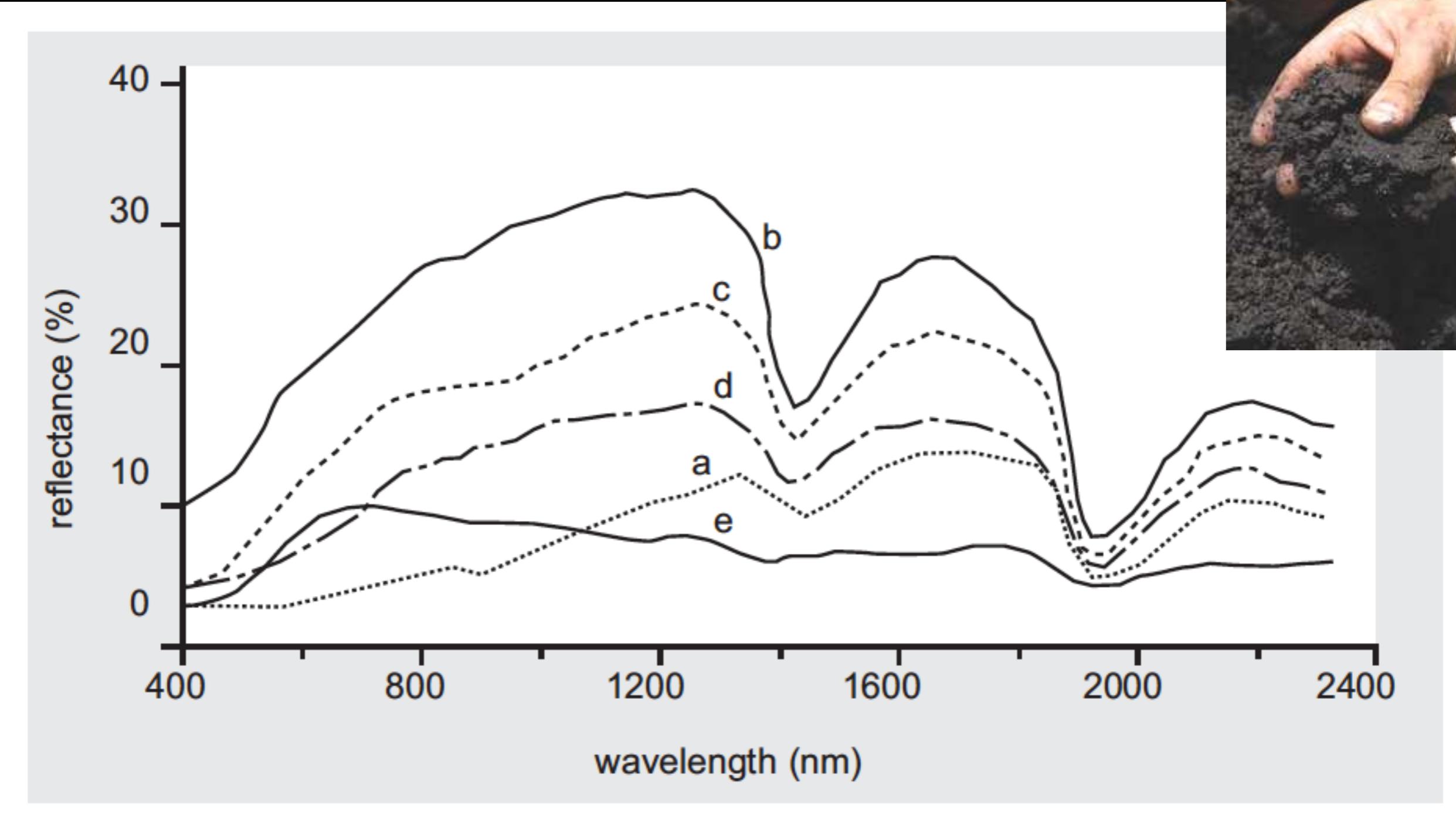


(f)

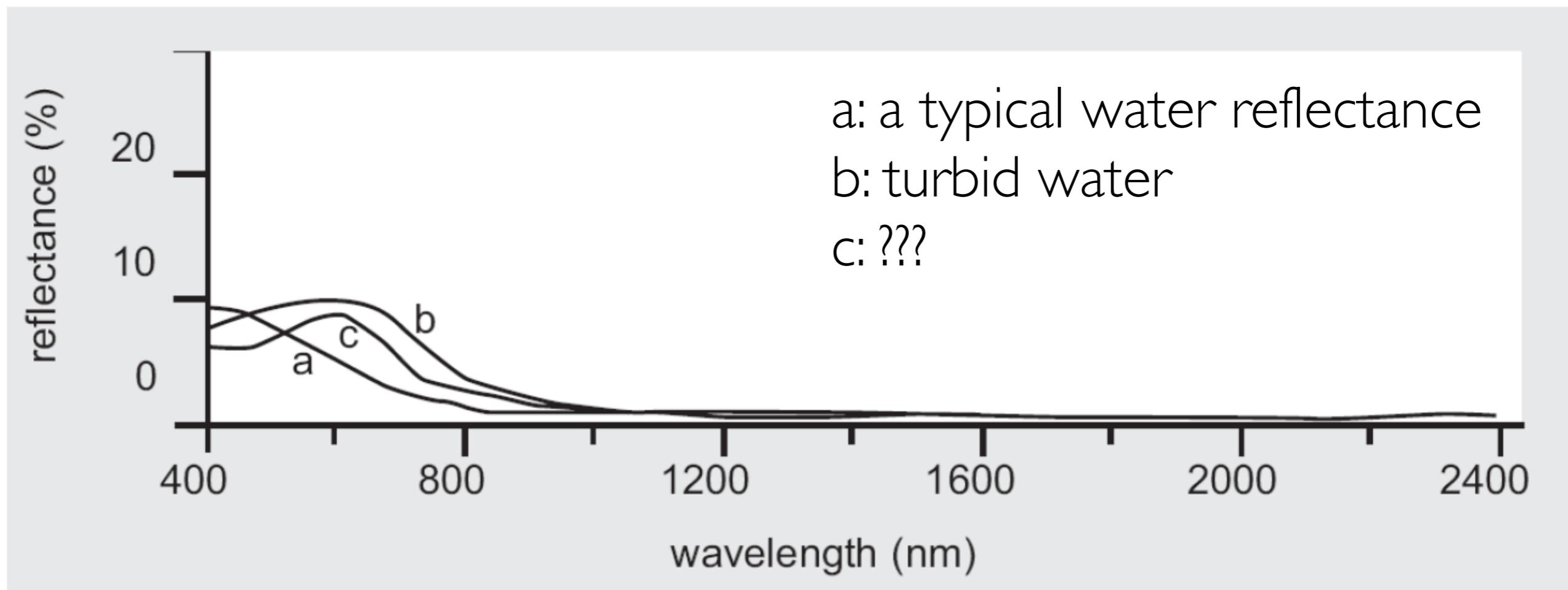
BACTERIA



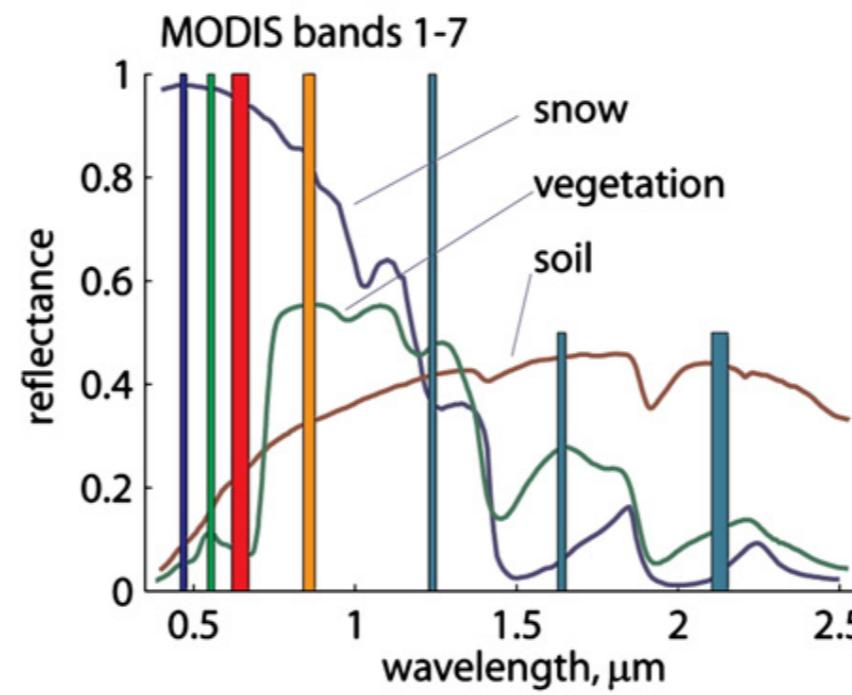
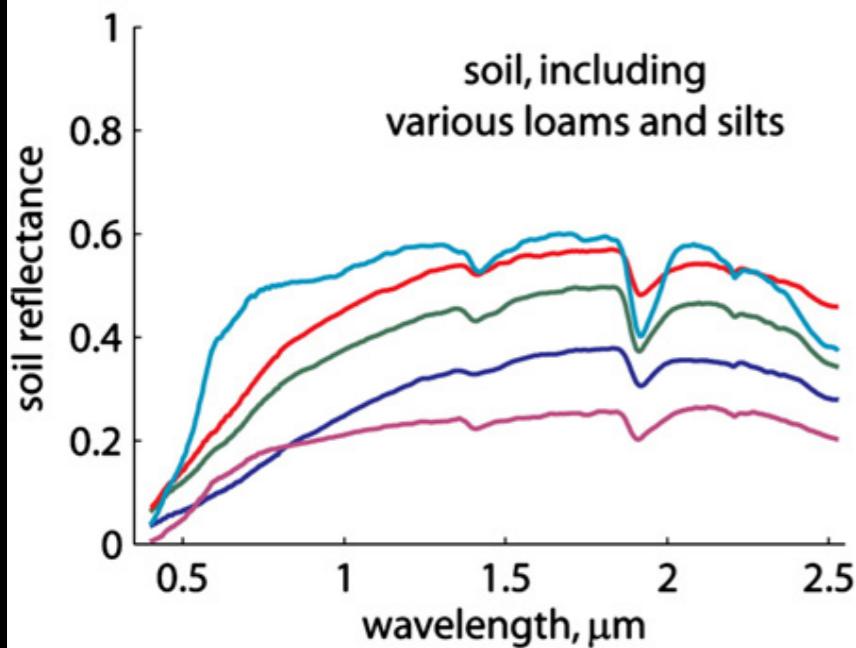
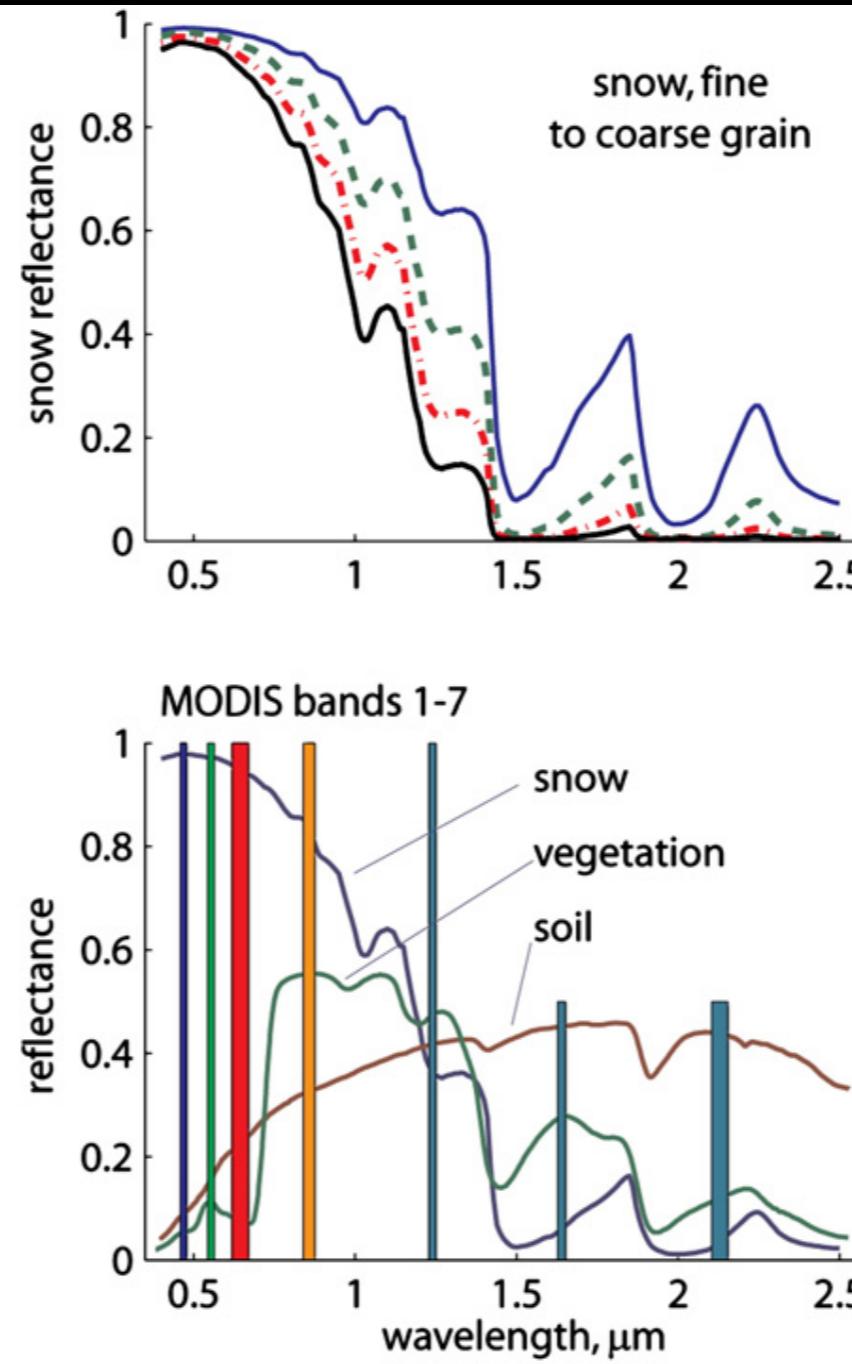
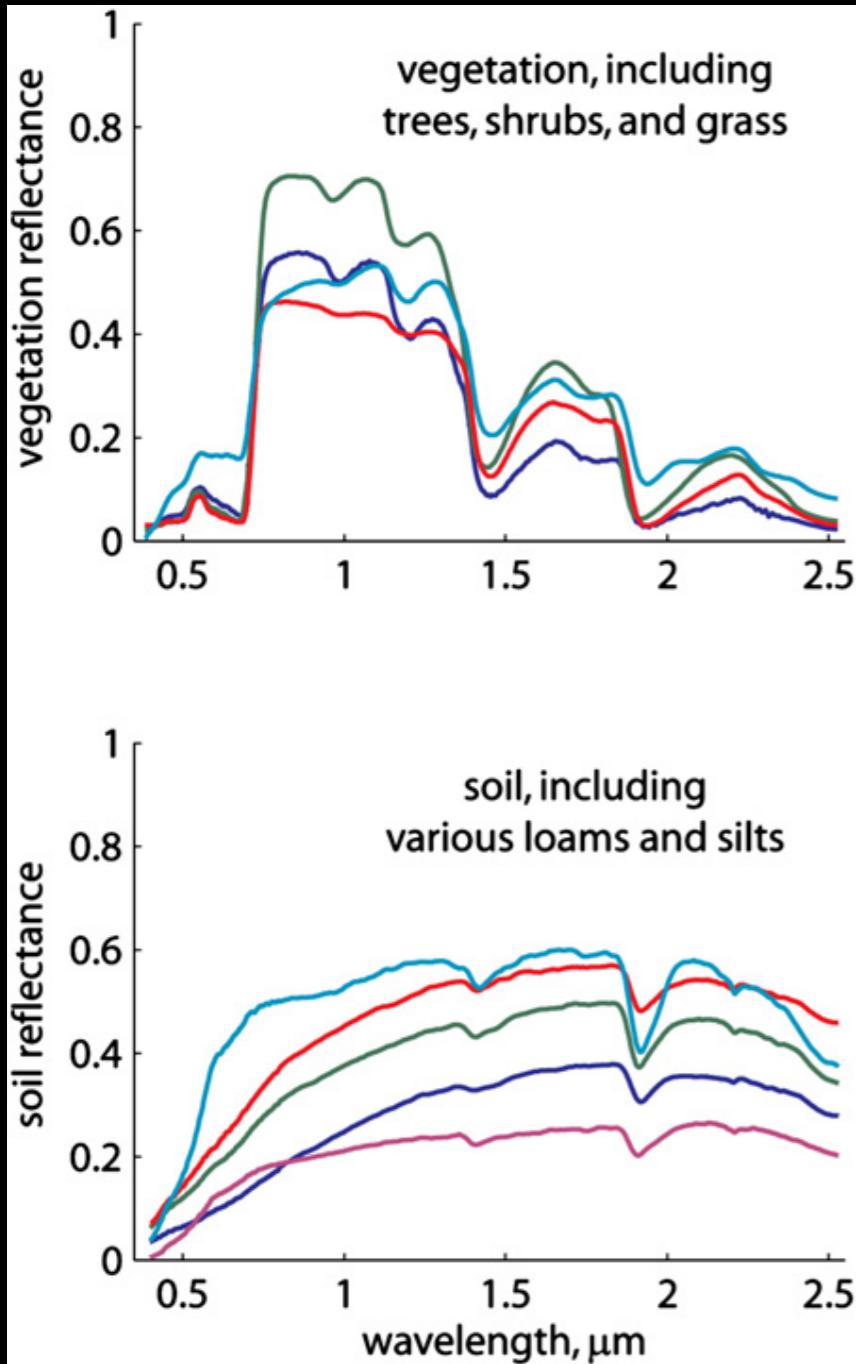
Soil and mineral spectra



Water spectra



Spectra and MODIS bands

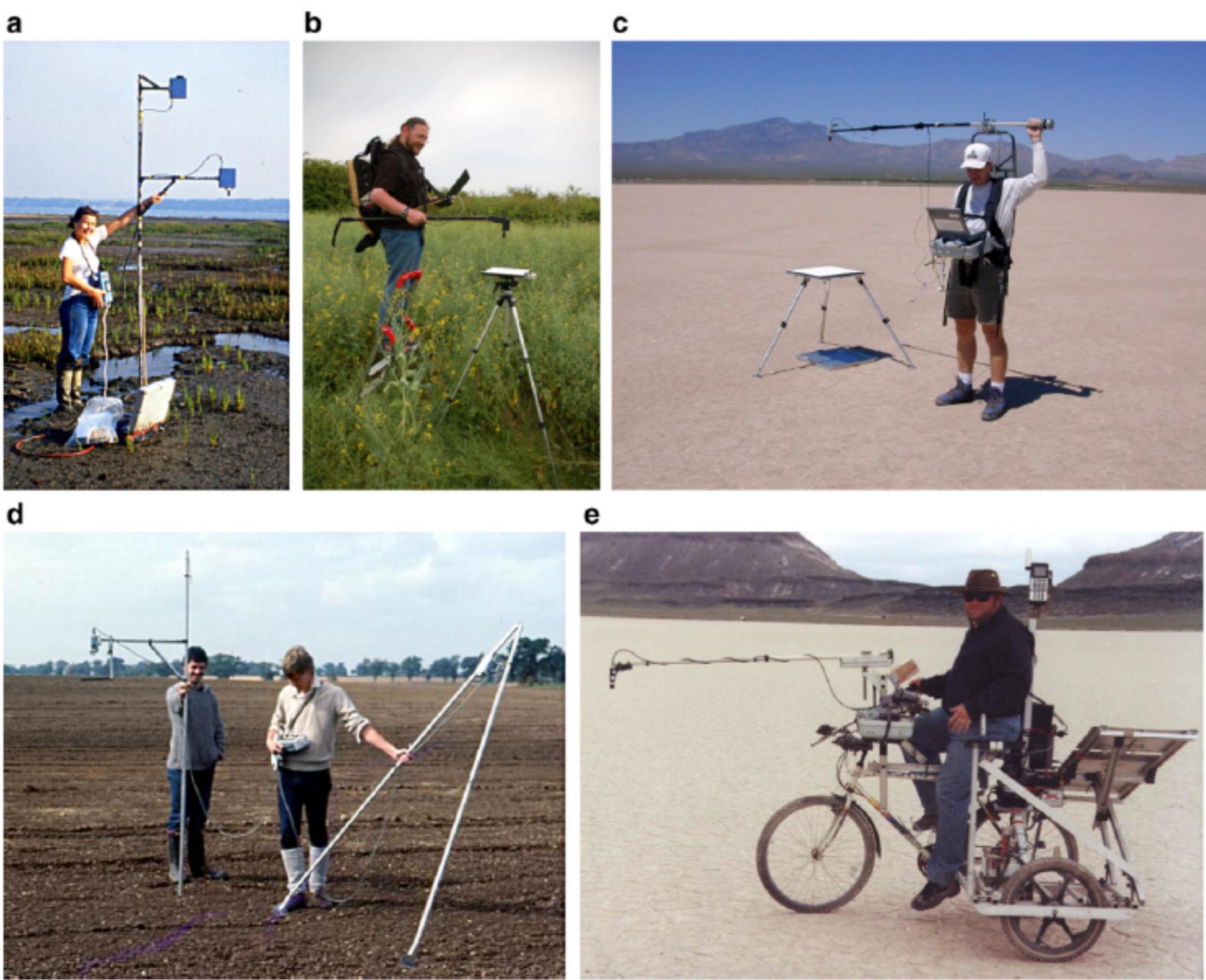


1. The shape and magnitude of the reflectance spectra can tell us the type and the concentration of the material.
2. Water in the atmosphere absorb solar radiation at 1.45 μm and 1.9 μm , and we cannot use these wavelengths to monitor the Earth's surface.

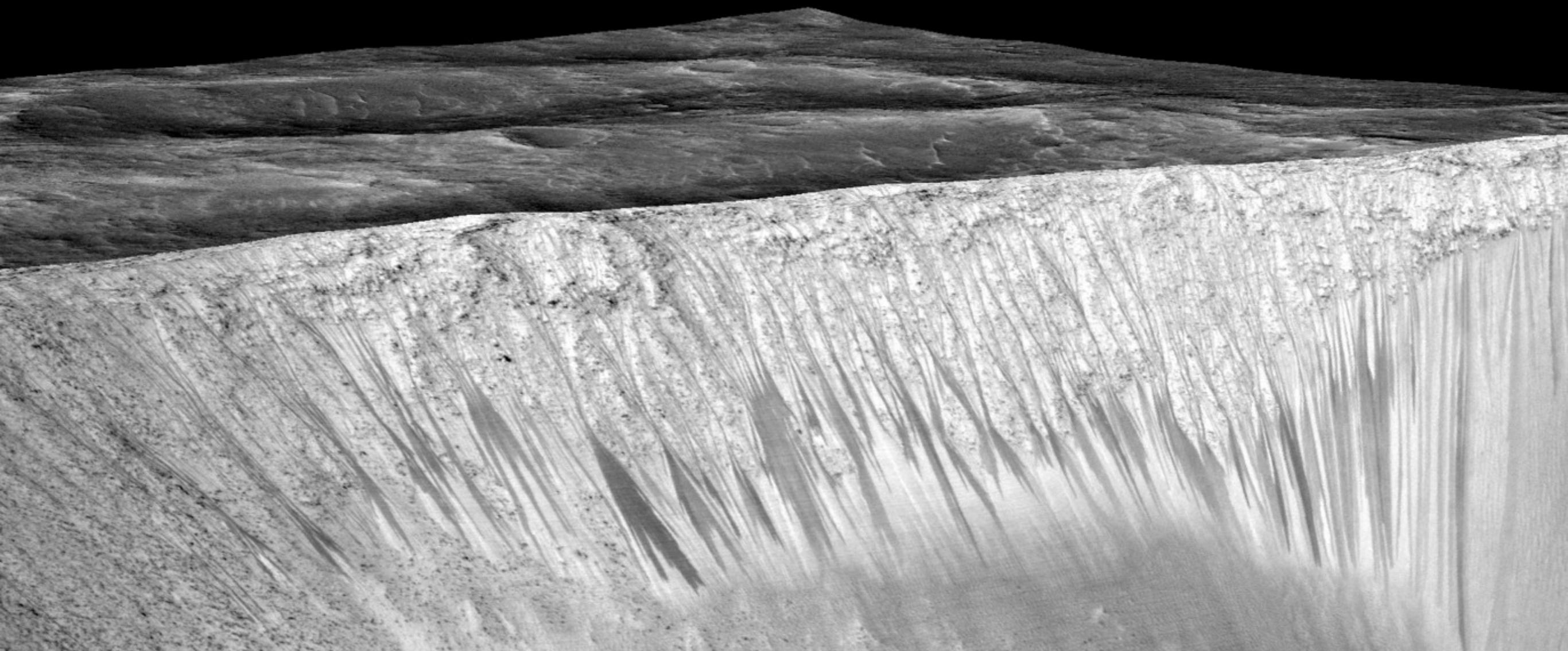
Field measurements of spectra



Field measurements of spectra



Was there water on Mars?



Reflectance Spectroscopy helps finding brine water on Mars

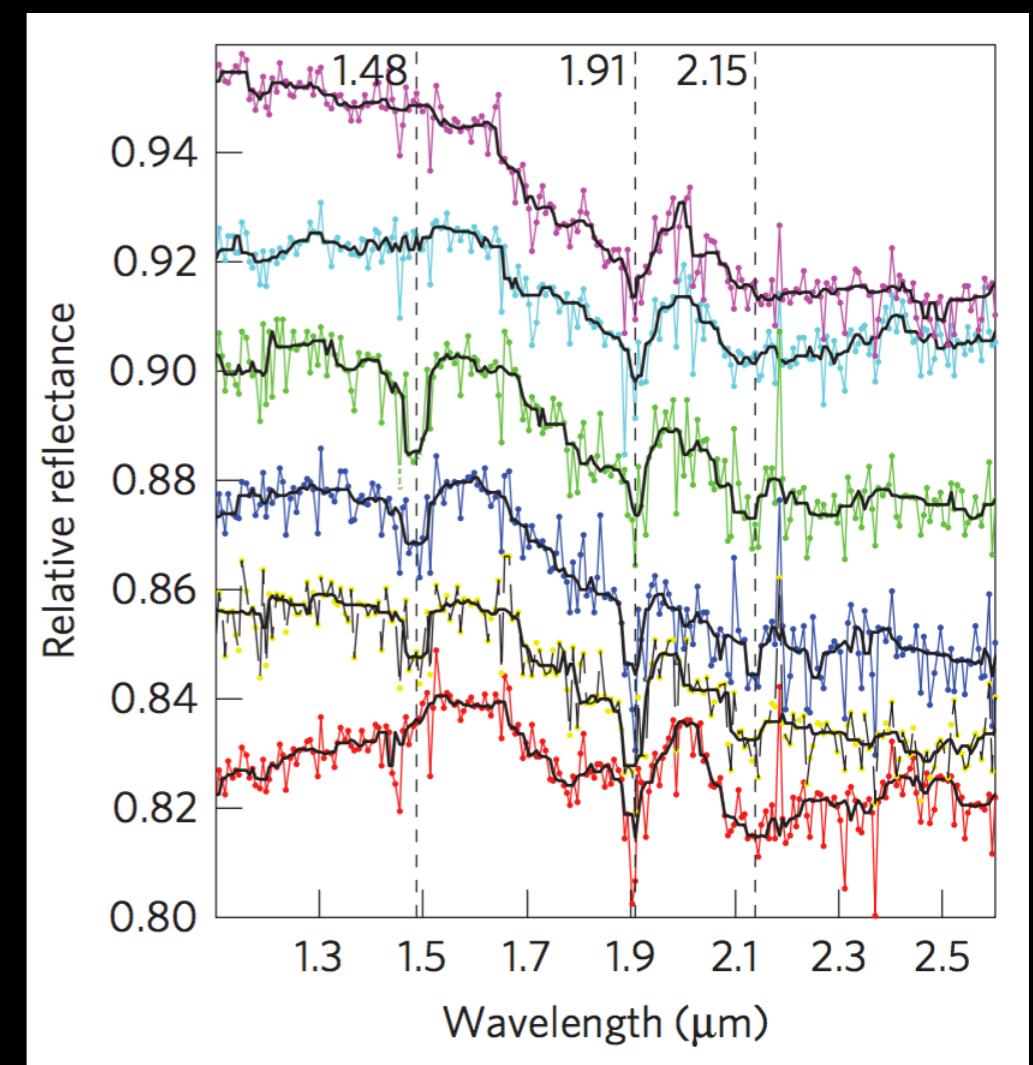
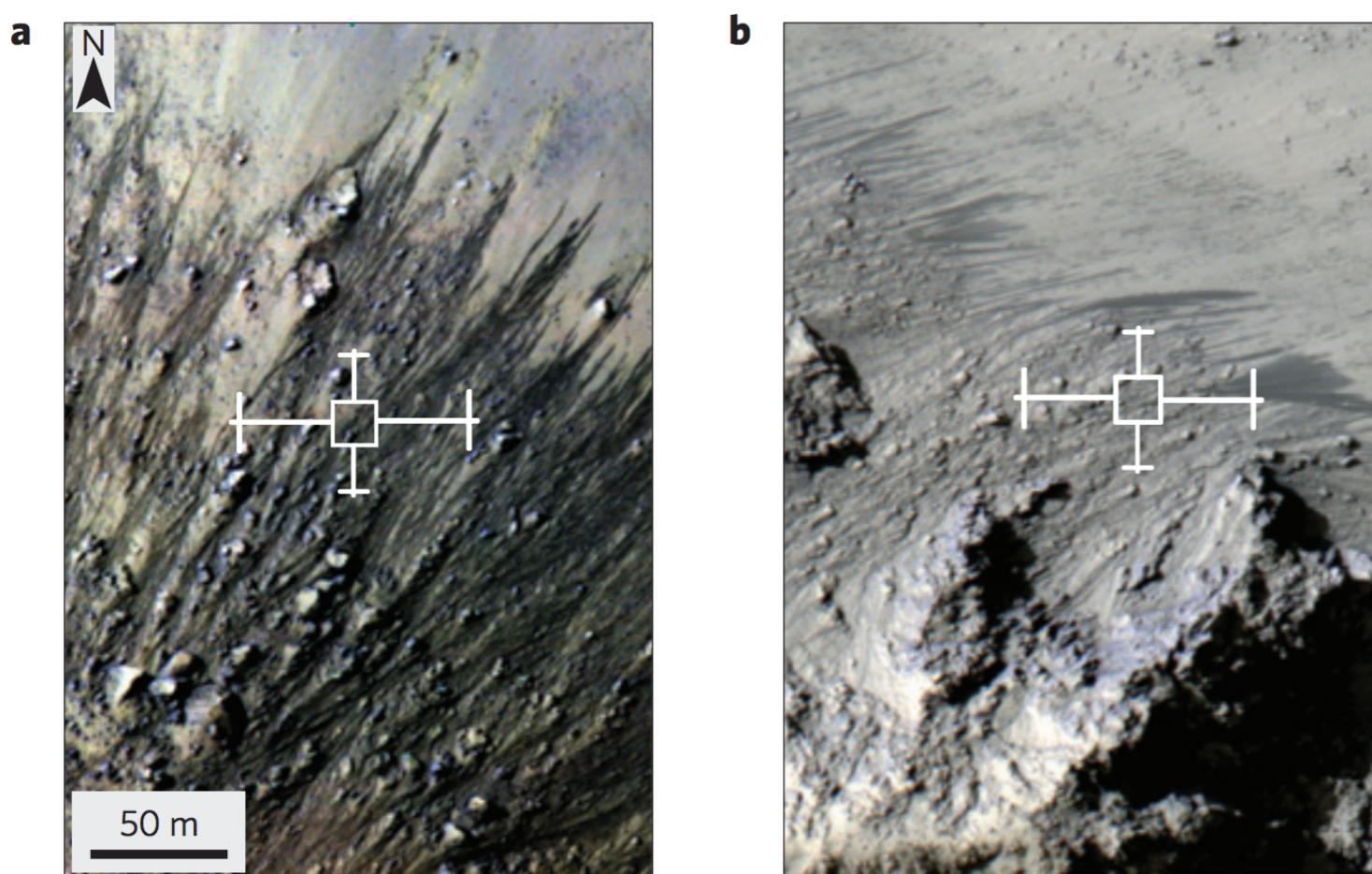
nature
geoscience

LETTERS

PUBLISHED ONLINE: 28 SEPTEMBER 2015 | DOI: 10.1038/NGEO2546

Spectral evidence for hydrated salts in recurring slope lineae on Mars

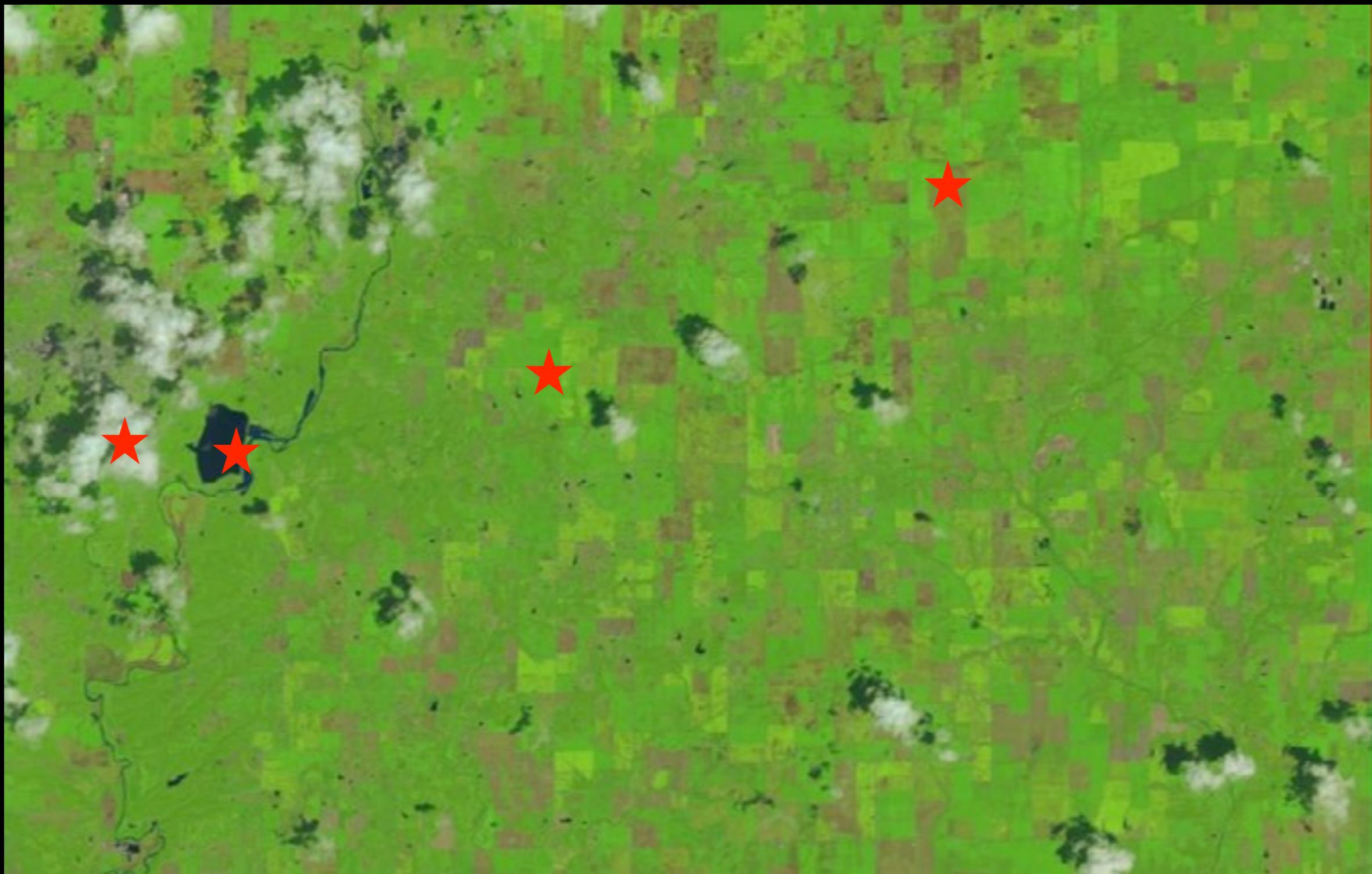
Lujendra Ojha^{1*}, Mary Beth Wilhelm^{1,2}, Scott L. Murchie³, Alfred S. McEwen⁴, James J. Wray¹, Jennifer Hanley⁵, Marion Massé⁶ and Matt Chojnacki⁴



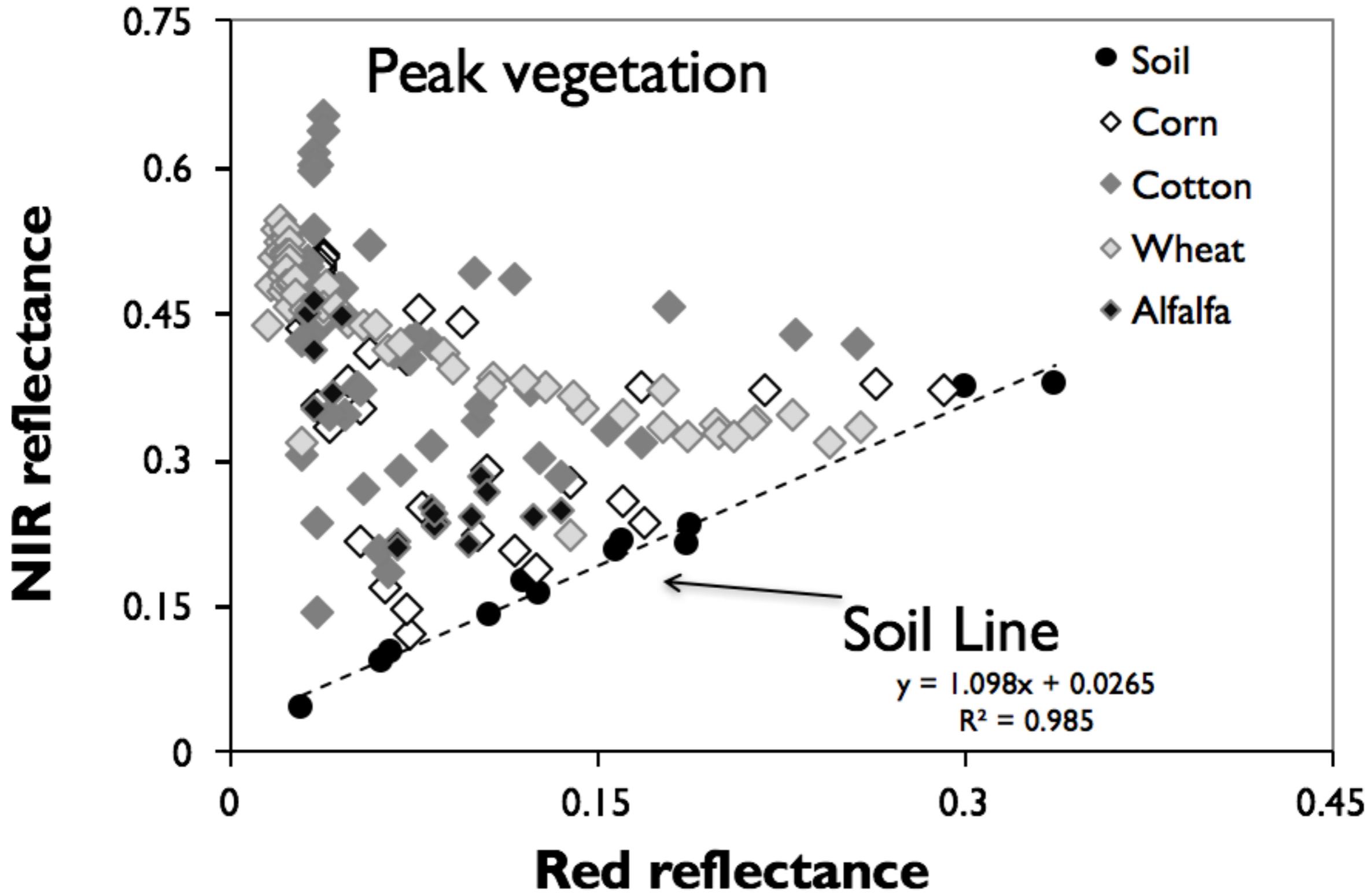
Vegetation indices (VIs)

- VIs are spectral transformation of two or more spectral bands in order to enhance the signature from vegetation.
- They indicate the “greenness”, which is mostly a function of leaf area index and chlorophyll concentration.
- Advantages compared with using the full spectra: 1) requires less sophisticated instrument; 2) Less data need to be transferred.
- Disadvantage: cannot detect subtle changes in vegetation spectra.

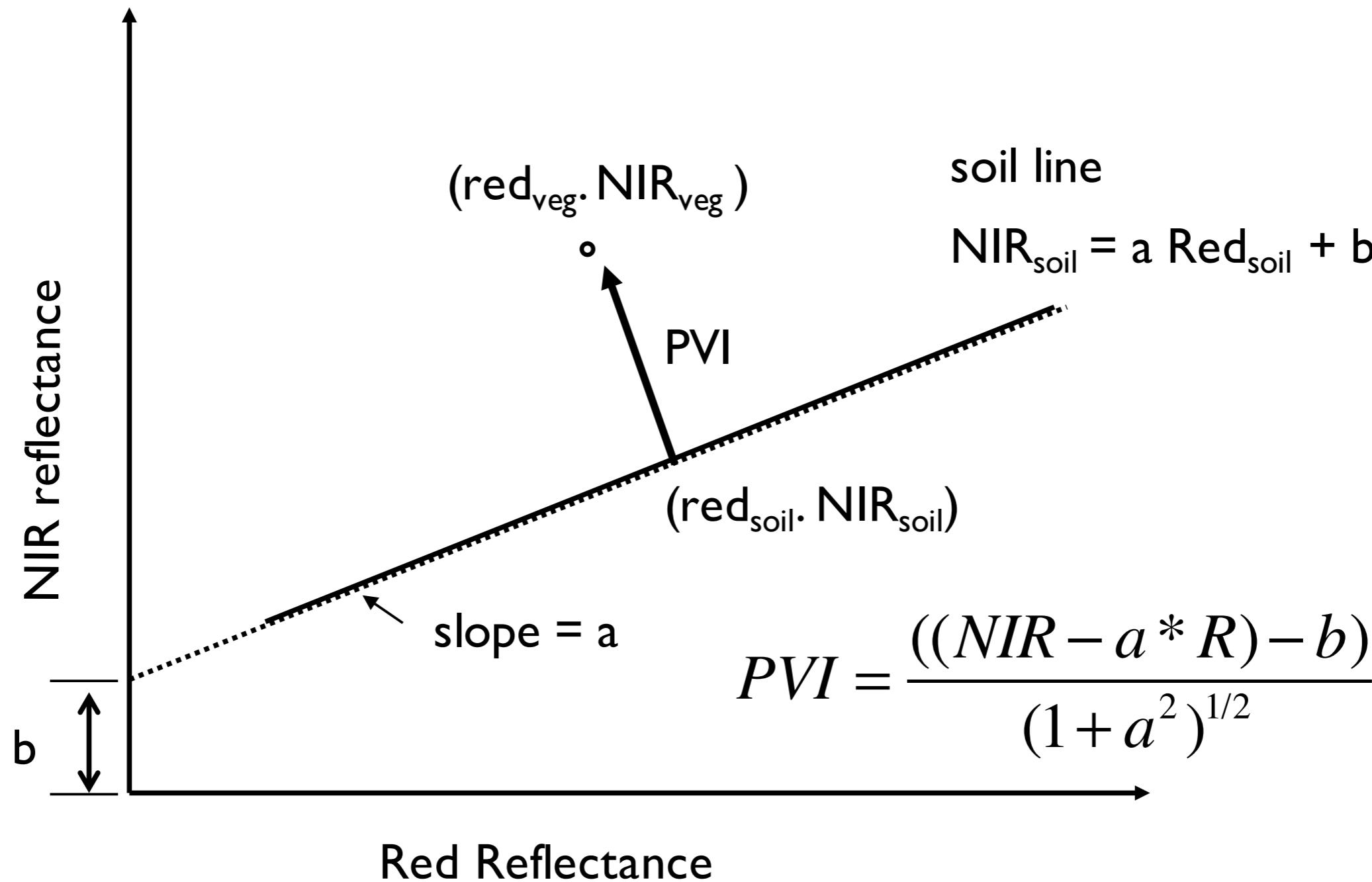
Pick a few objects and plot them on the
NIR-R space



Soil line



Perpendicular Vegetation Index (PVI) and Difference Vegetation Index (DVI)

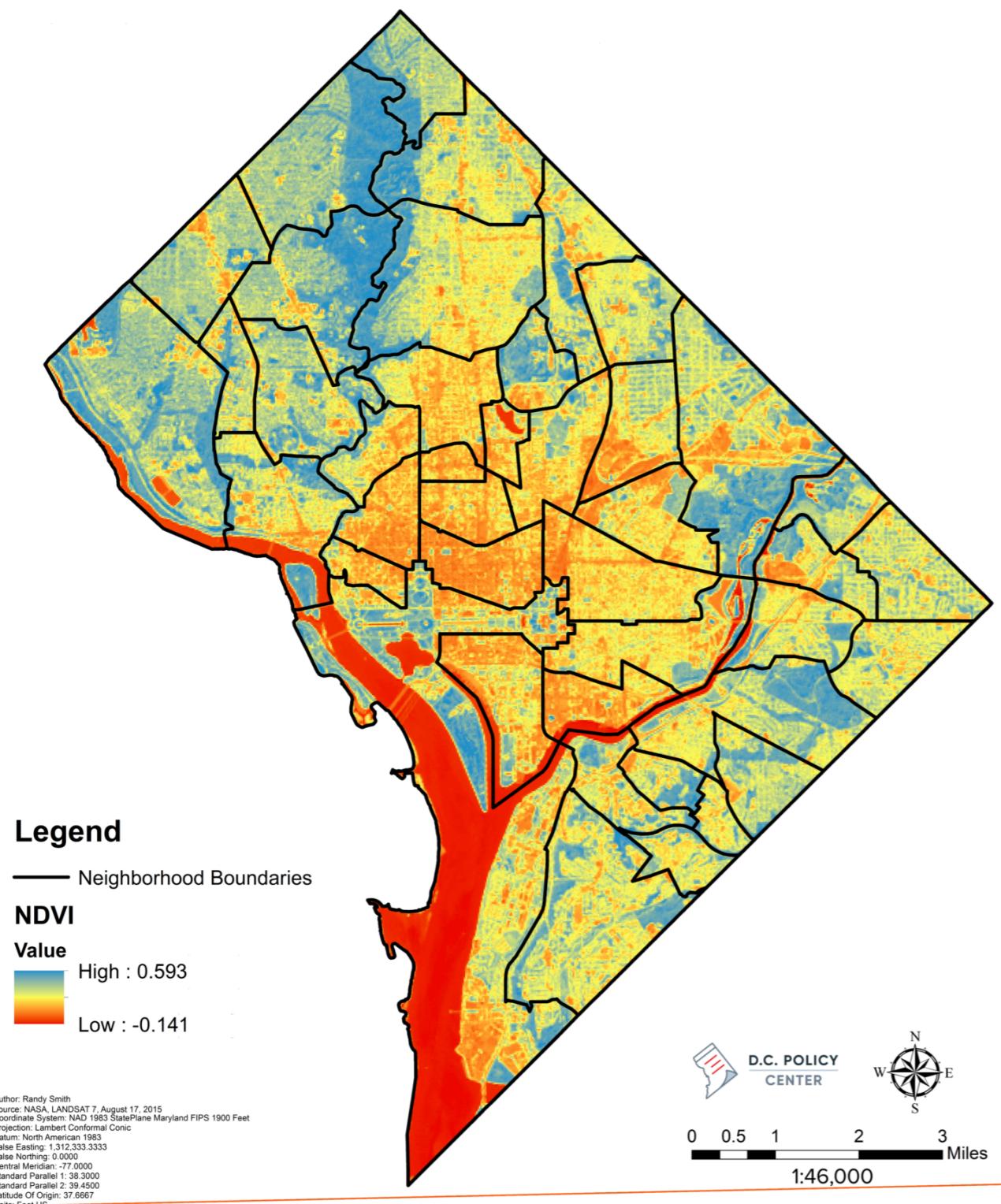


Most commonly used VIs

- Simple Ratio (SR): $SR = NIR/R;$
- Normalized Difference Vegetation Index (NDVI): $NDVI = (NIR-R)/(NIR+R);$
- Derive the relationship between NDVI and SR.
- NDVI is designed as an indicator of the amount of green leaves.

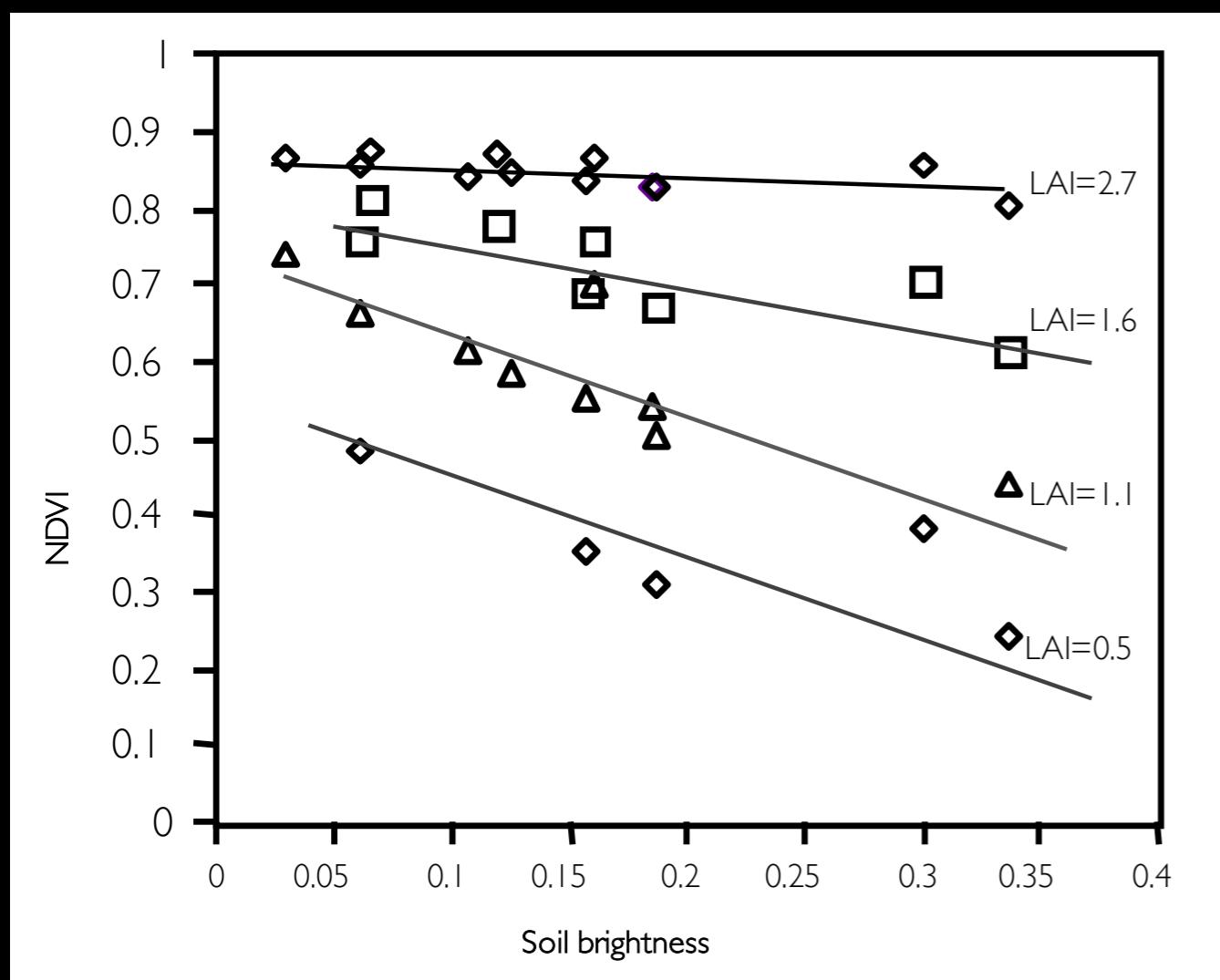
Where are the trees?

The map below shows the Normalized Difference Vegetation Index (NDVI) in Washington, D.C. Areas in blue have the highest score, and have greater vegetation coverage. Areas in red have the lowest score, with no vegetation coverage.

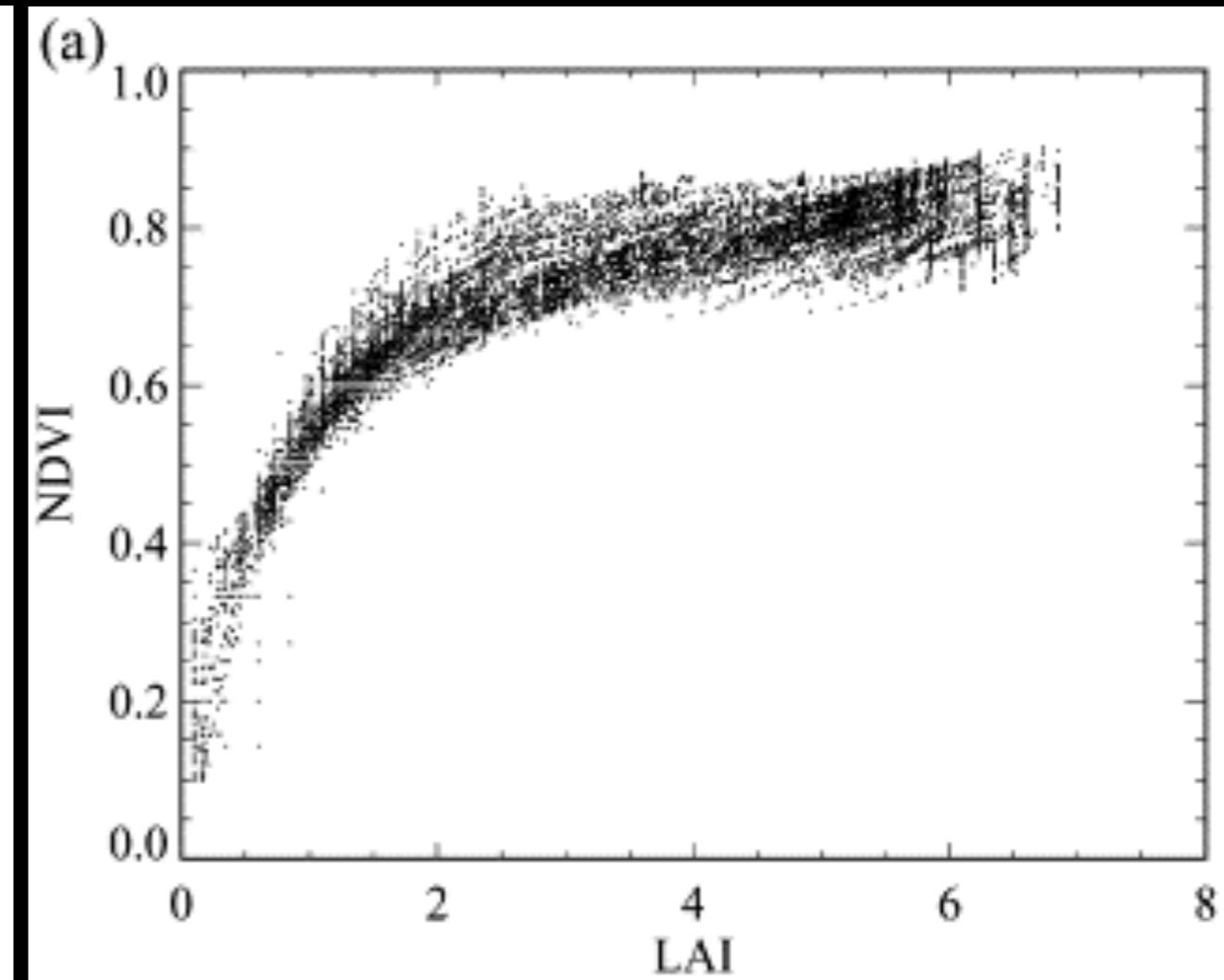


- Blue: high NDVI, more green leaves
- Red: low NDVI, what does it mean?

The caveat of NDVI



Low leaf area conditions
soil background effect



High leaf area conditions
Saturation

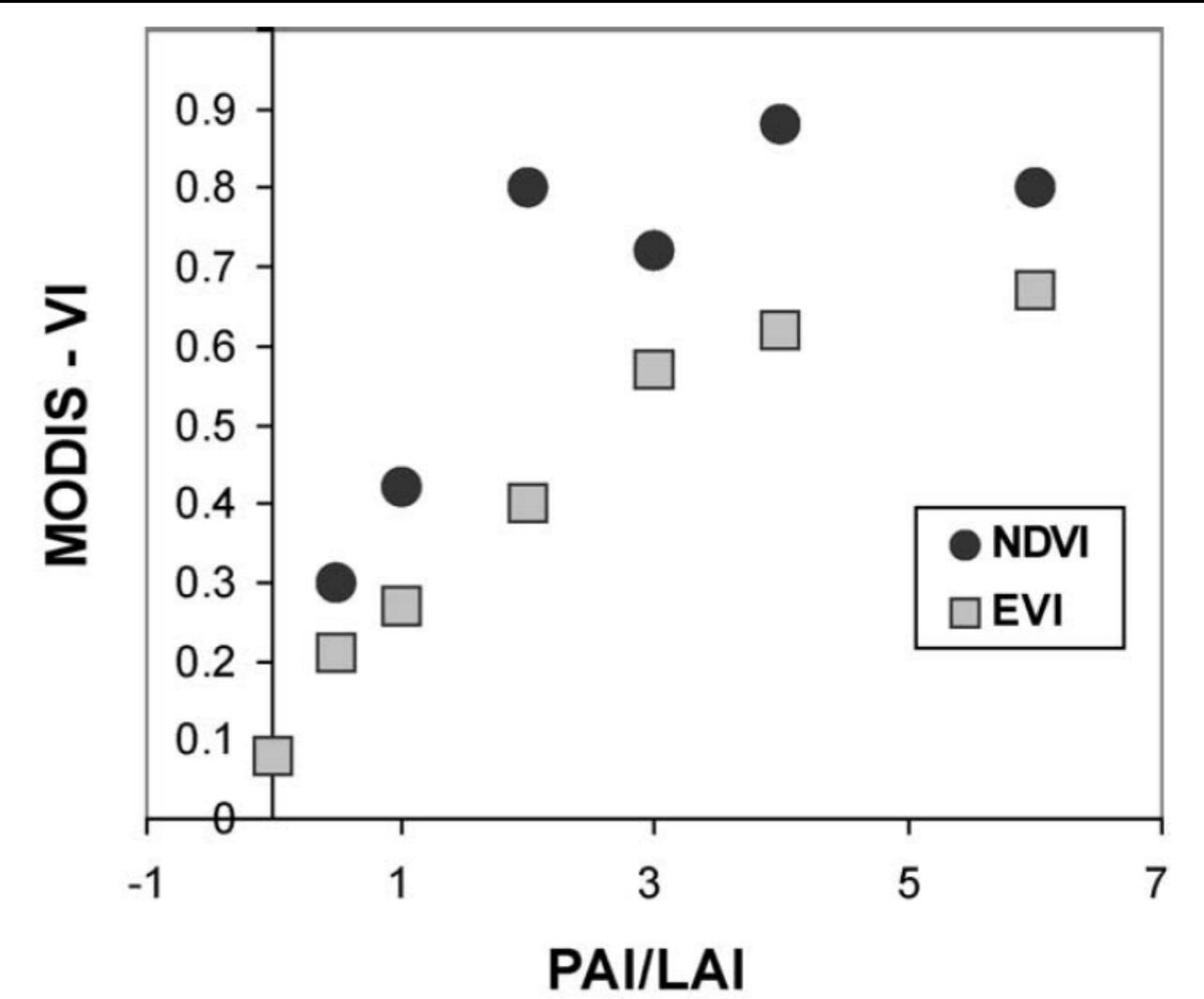
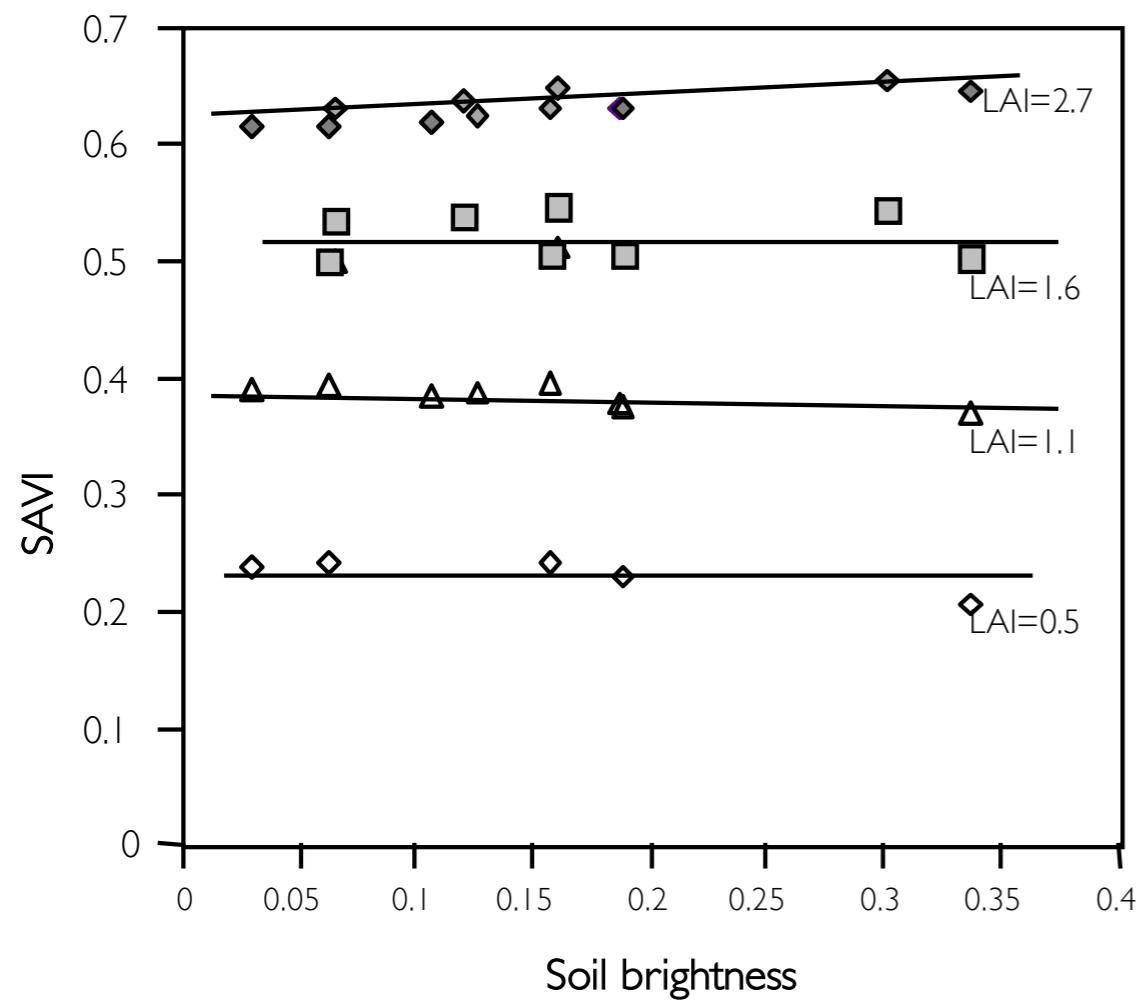
Soil-Adjusted Vegetation Index and Enhanced Vegetation Index

$$SAVI = \frac{(1 + L)(NIR - R)}{(NIR - R + L)}$$

$$EVI = 2.5 \frac{NIR - R}{NIR + 6R - 7.5B + 1}$$

- $L = 0.5$
- Reflectance from NIR (Near Infrared); R(Red); and B(Blue).
- Can SAVI/EVI solve the problems with NDVI?

SAVI&EVI are better “greenness” indicators



Low leaf area conditions

Eliminates soil background effect

High leaf area conditions

Less saturation

EVI vs. NDVI

250m, 16-days composite, Sept. 29-Oct. 14, 2000



EVI



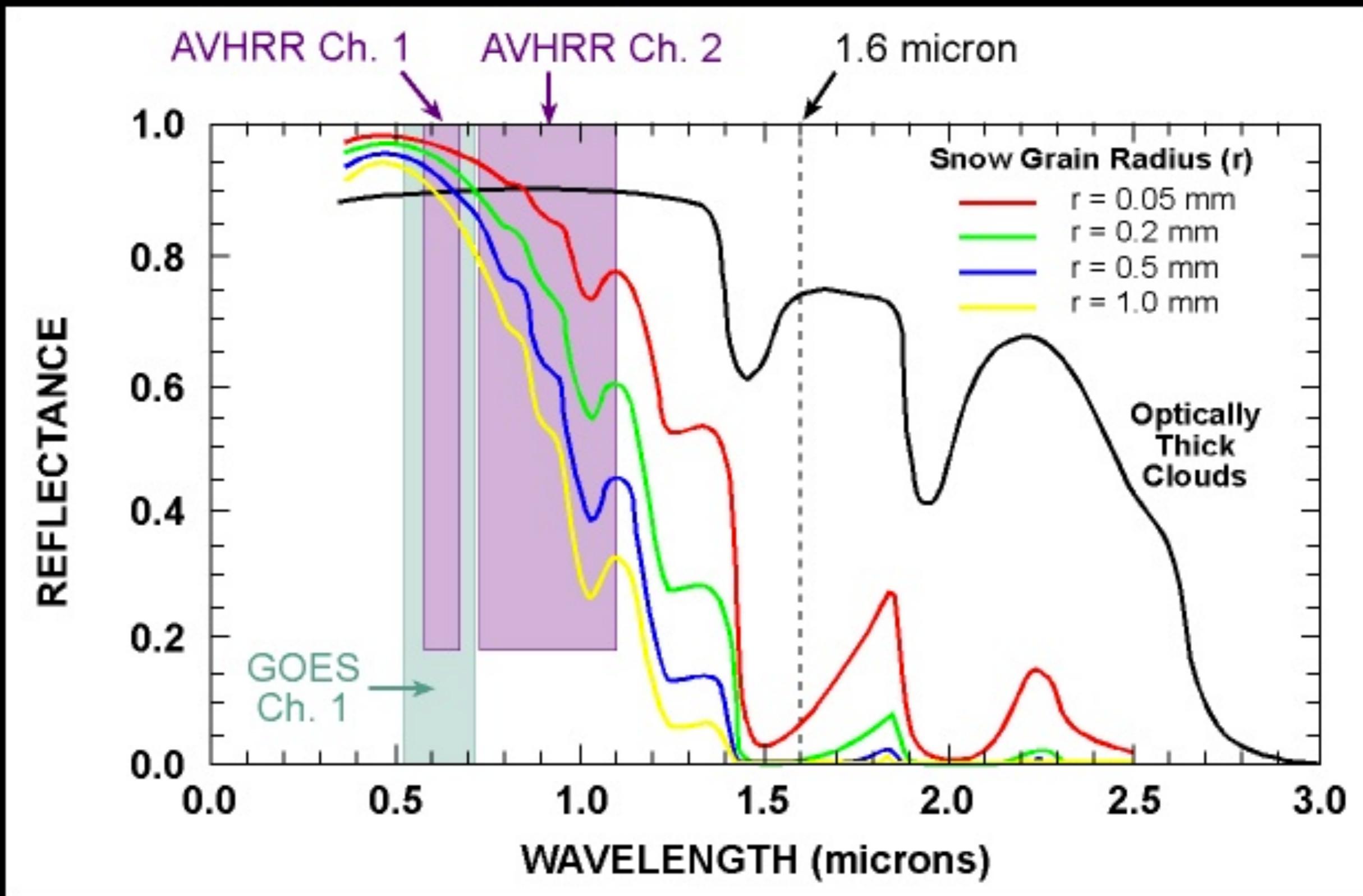
NDVI

Make your own index!



* Suomi NPP VIIRS 0.64 um refl Wed 18:06Z 29-Jan-14

Make your own snow index!



Make your own index!



* Suomi NPP VIIRS 0.64 um refl. Wed 18:06Z 29-Jan-14