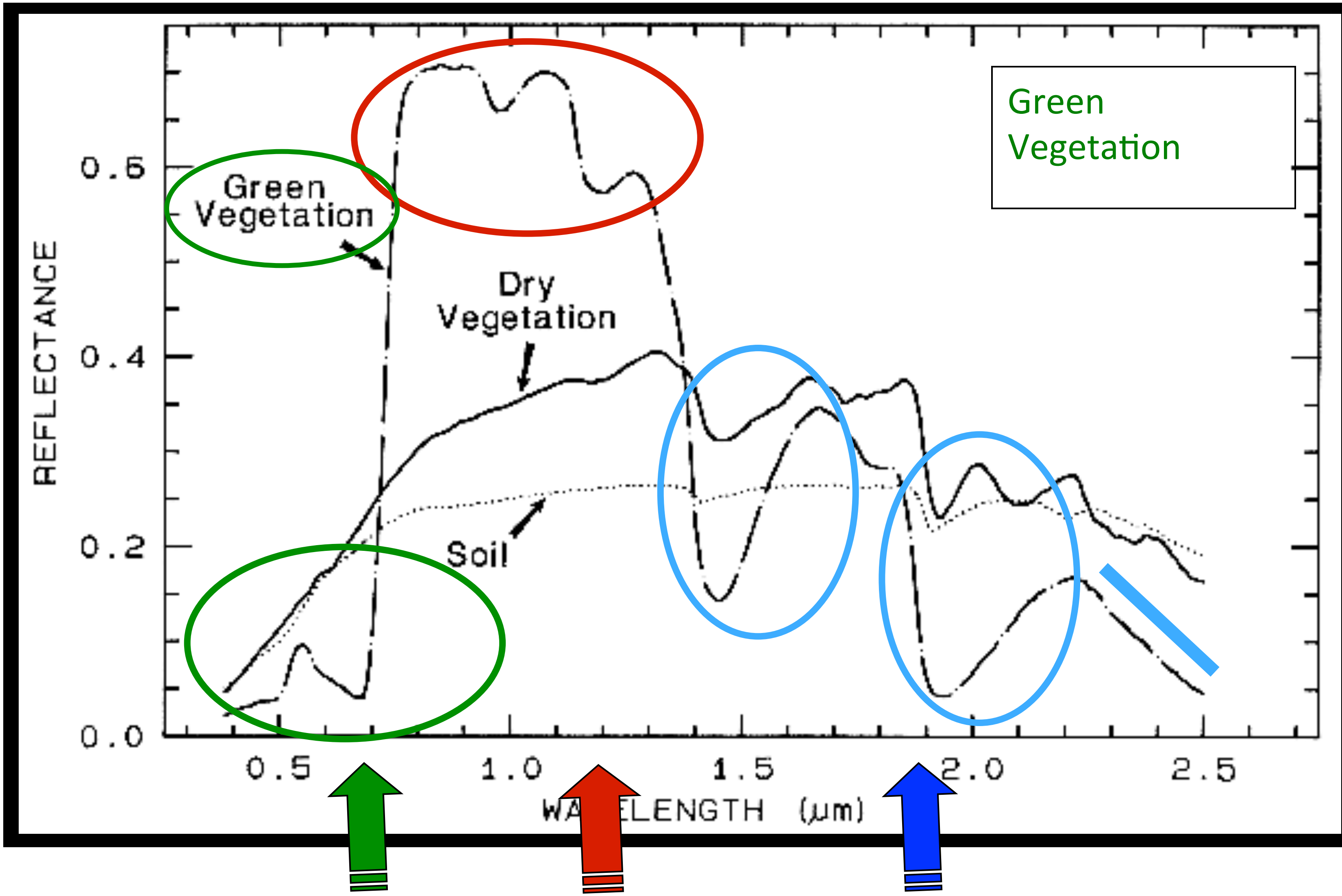
Spectra of common Earth-surface materials

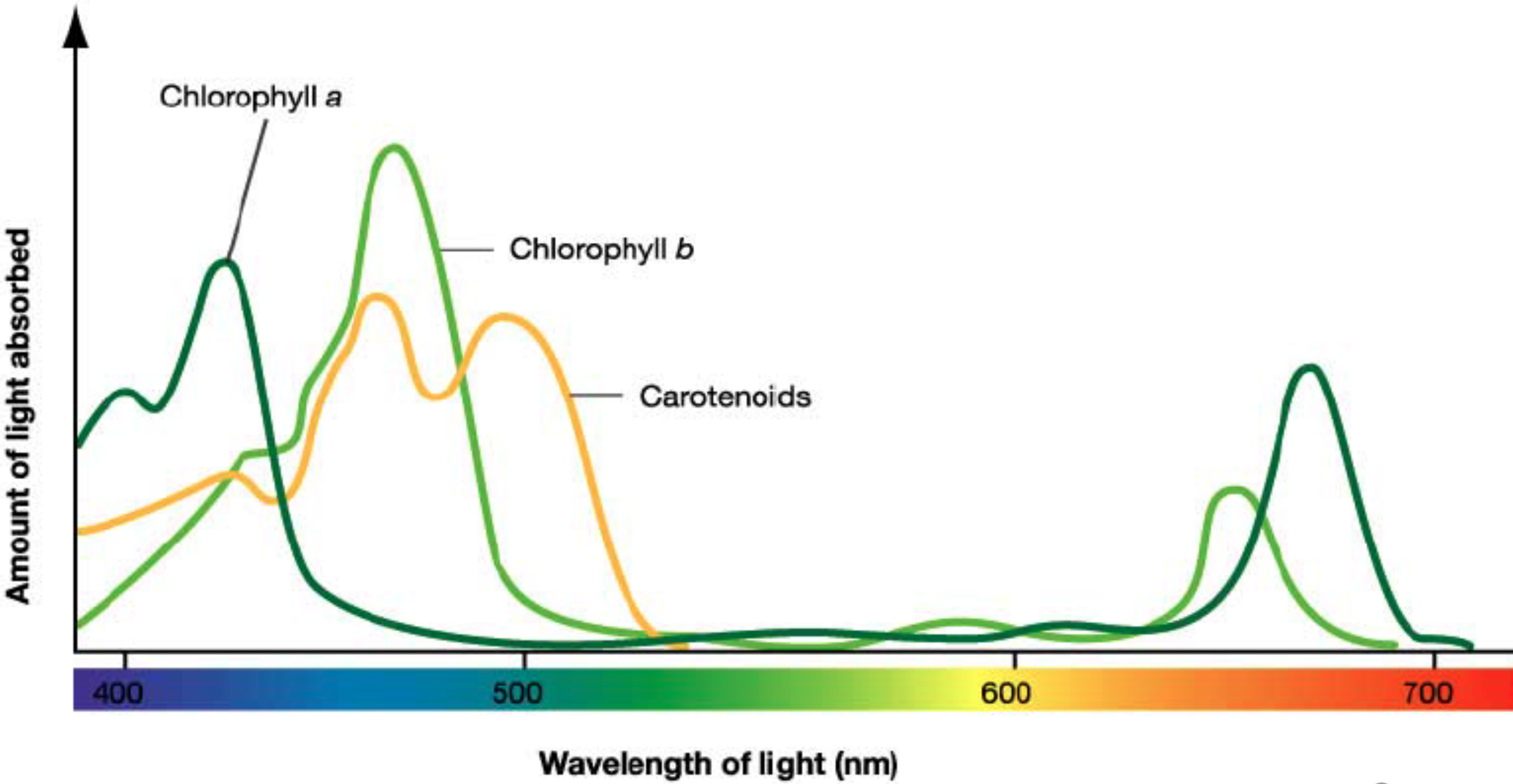


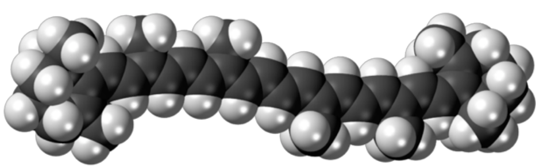
Chlorophyll absorption

Cellular scattering

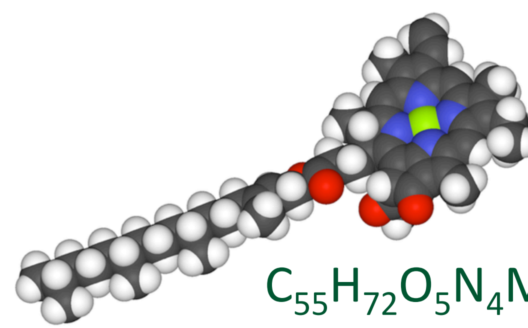
Water absorption

Plant Pigments



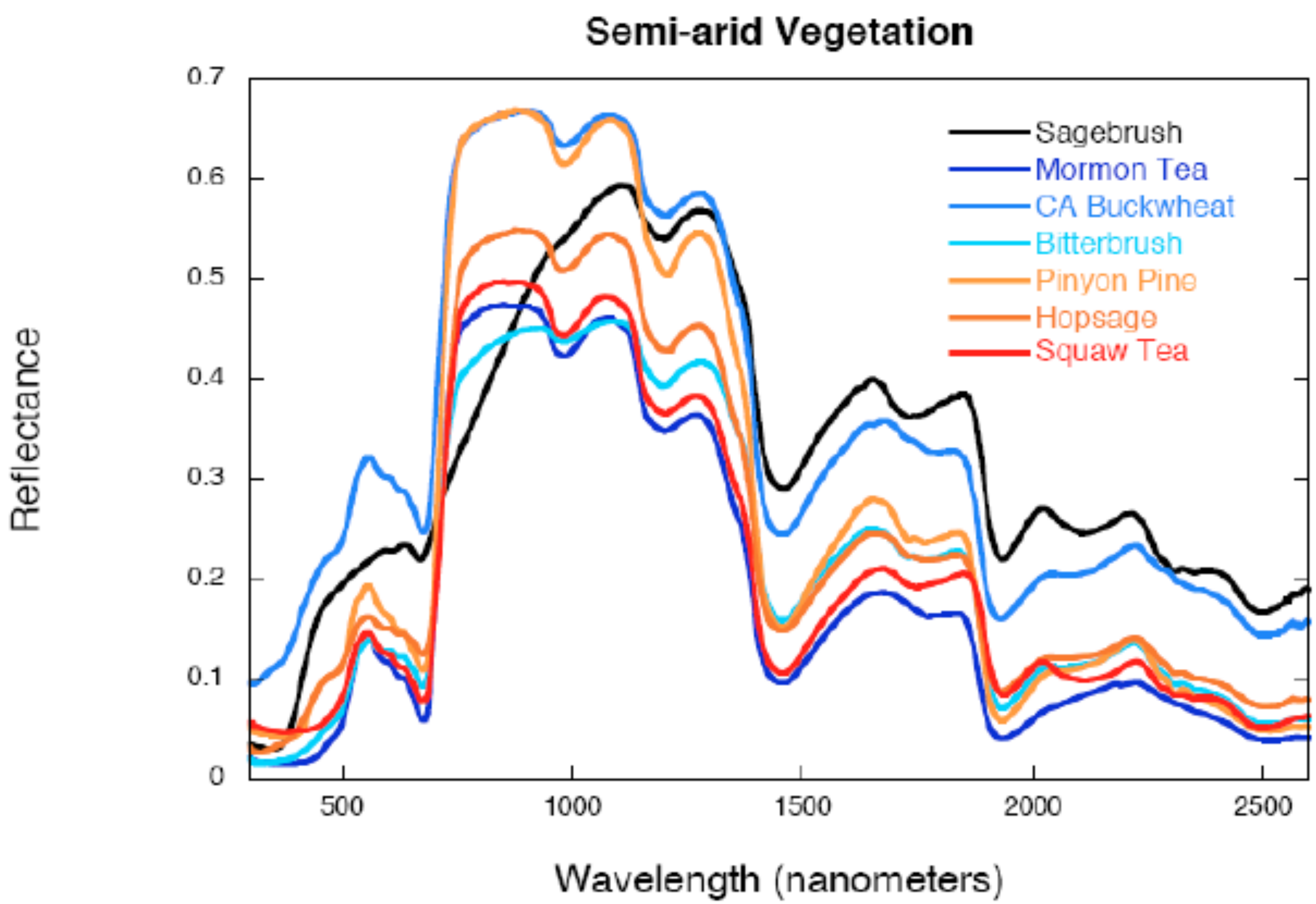


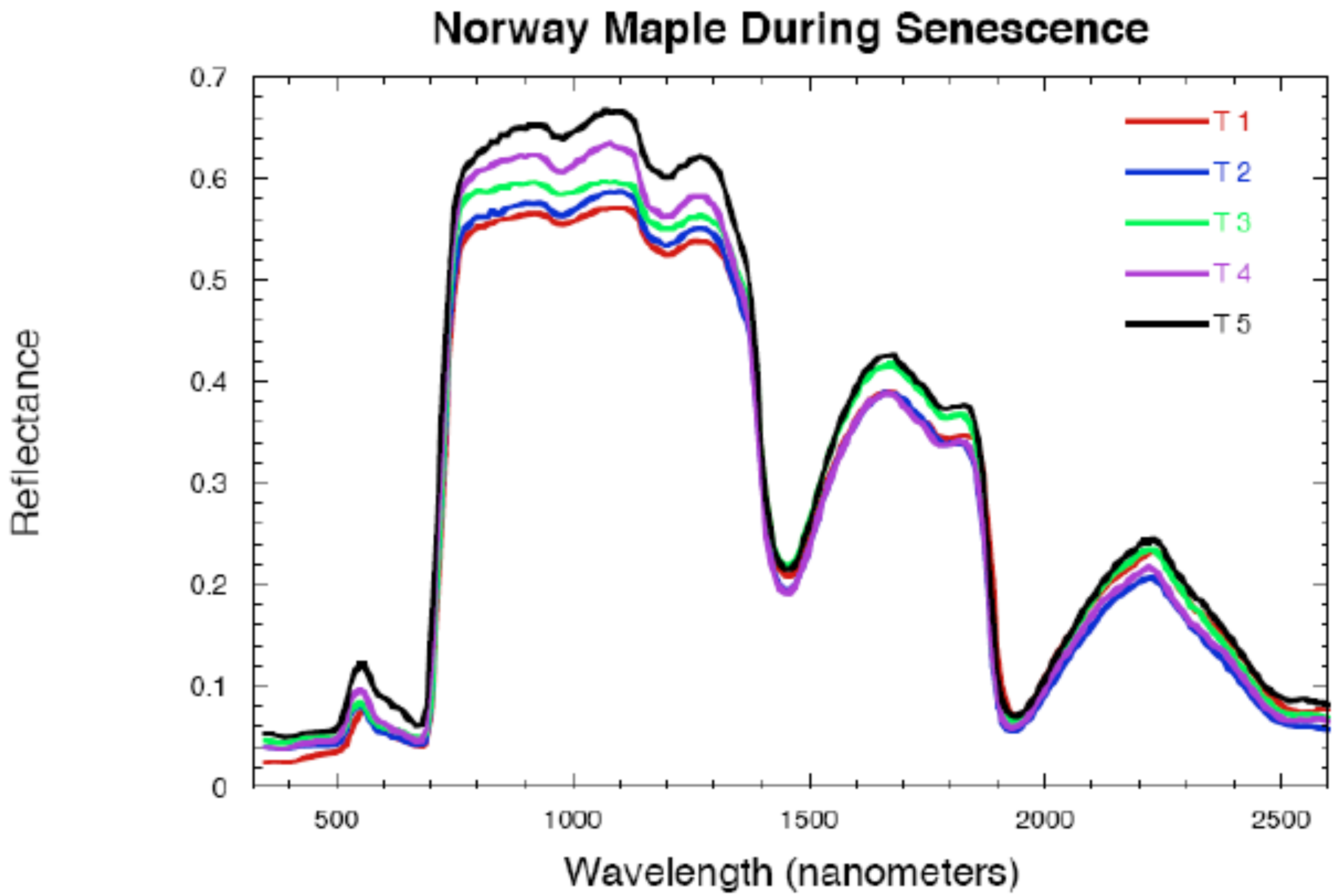
$C_{40}H_{56}$



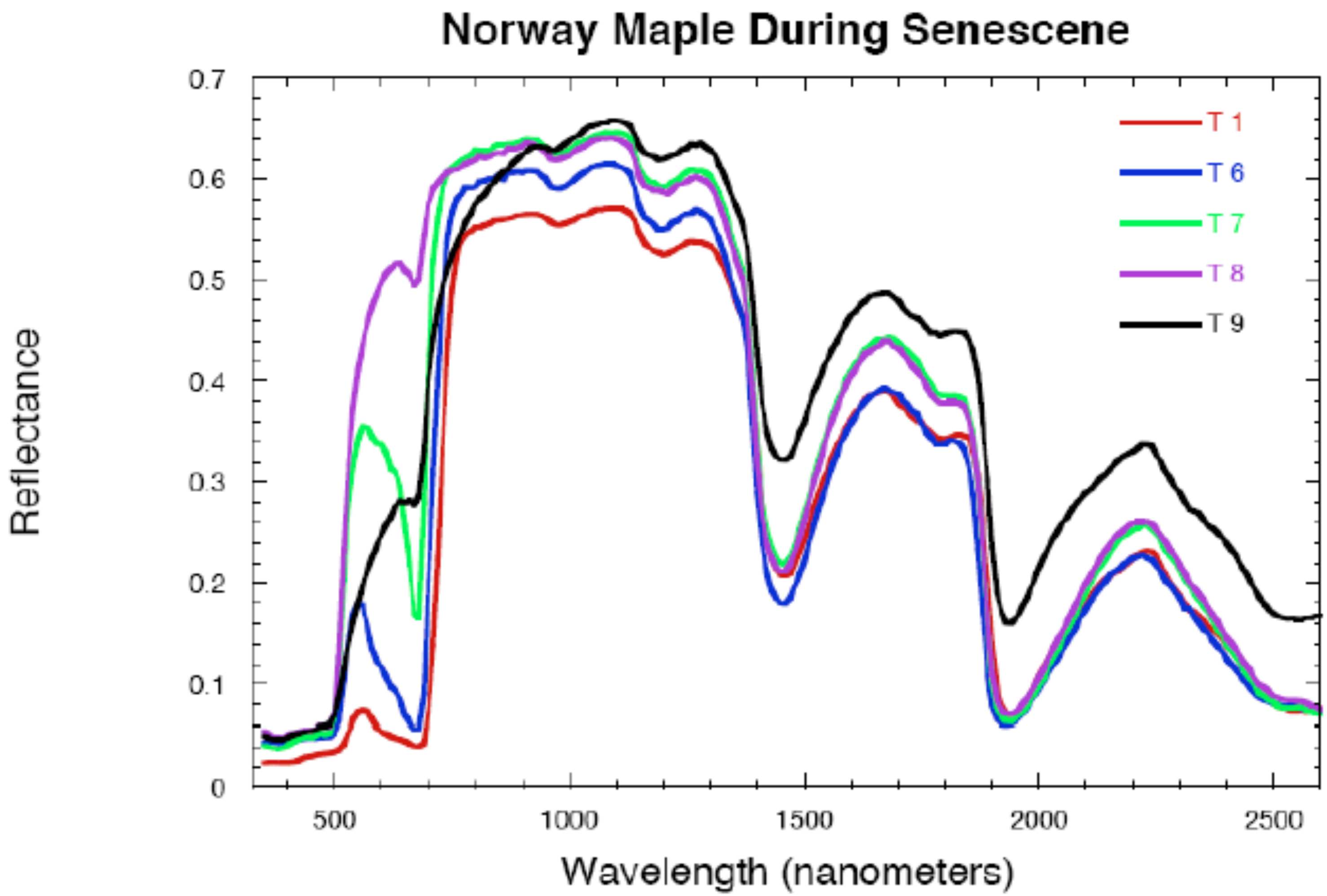
$C_{55}H_{72}O_5N_4Mg$

Variations from one species to another

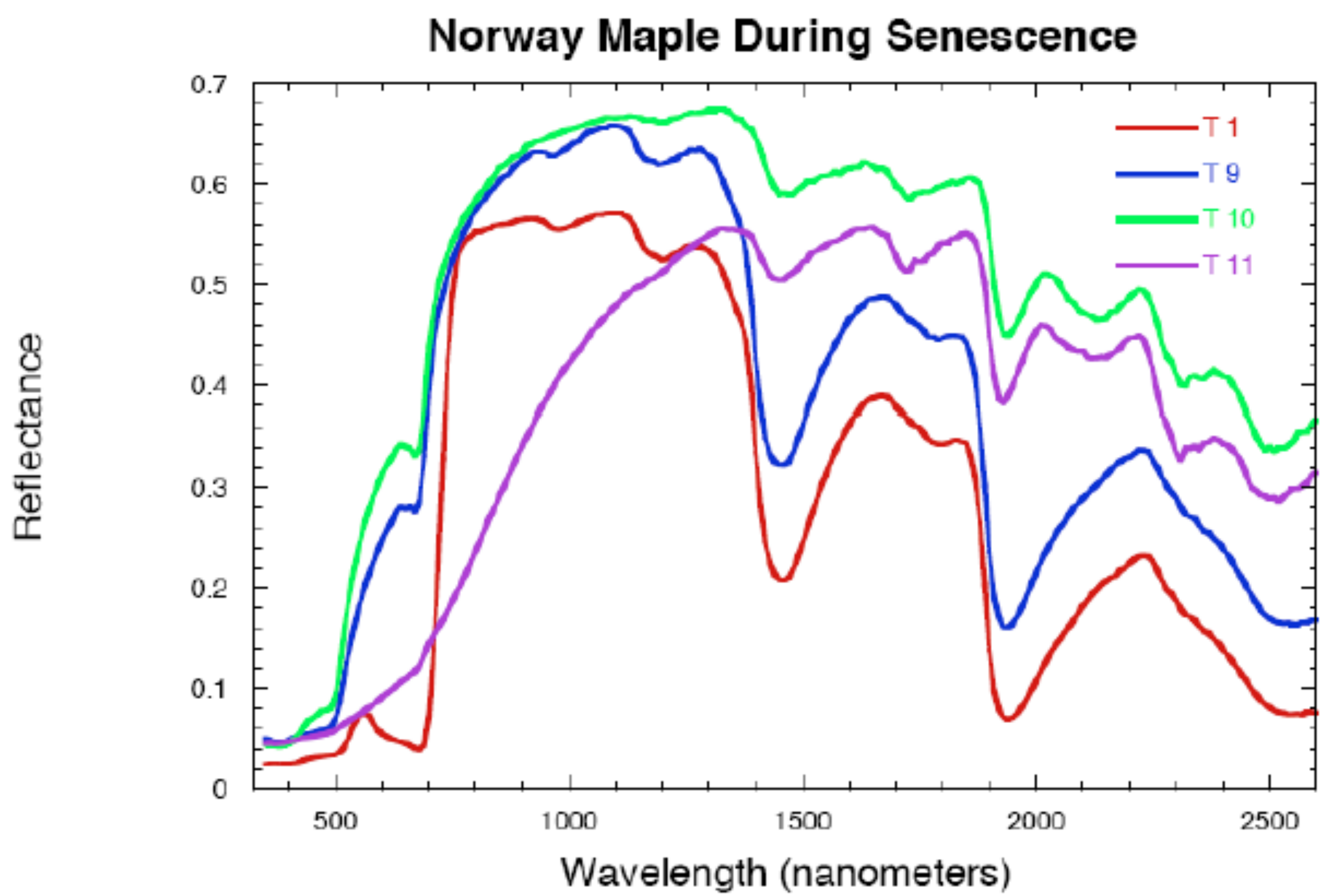




Norway Maple During Senescence
Reflectance
Wavelength (nanometers)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
500
1000
1500
2000
2500
T 1
T 2
T 3
T 4
T 5

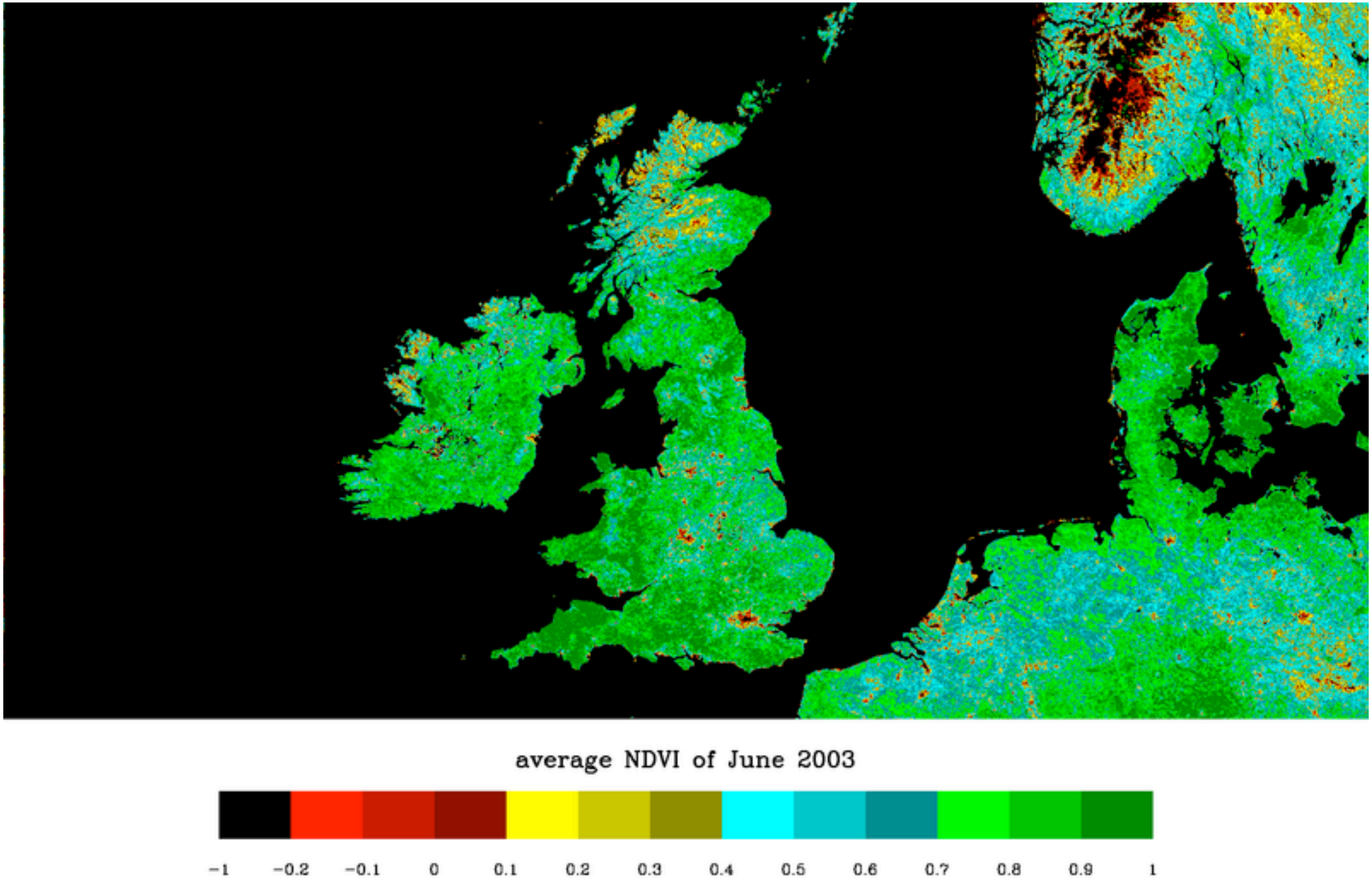


Norway Maple During Senescene
Reflectance
Wavelength (nanometers)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
500
1000
1500
2000
2500
T 1
T 6
T 7
T 8
T 9


Norway Maple During Senescence
Reflectance
Wavelength (nanometers)
T 1
T 9
T 10
T 11
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
500
1000
1500
2000
2500

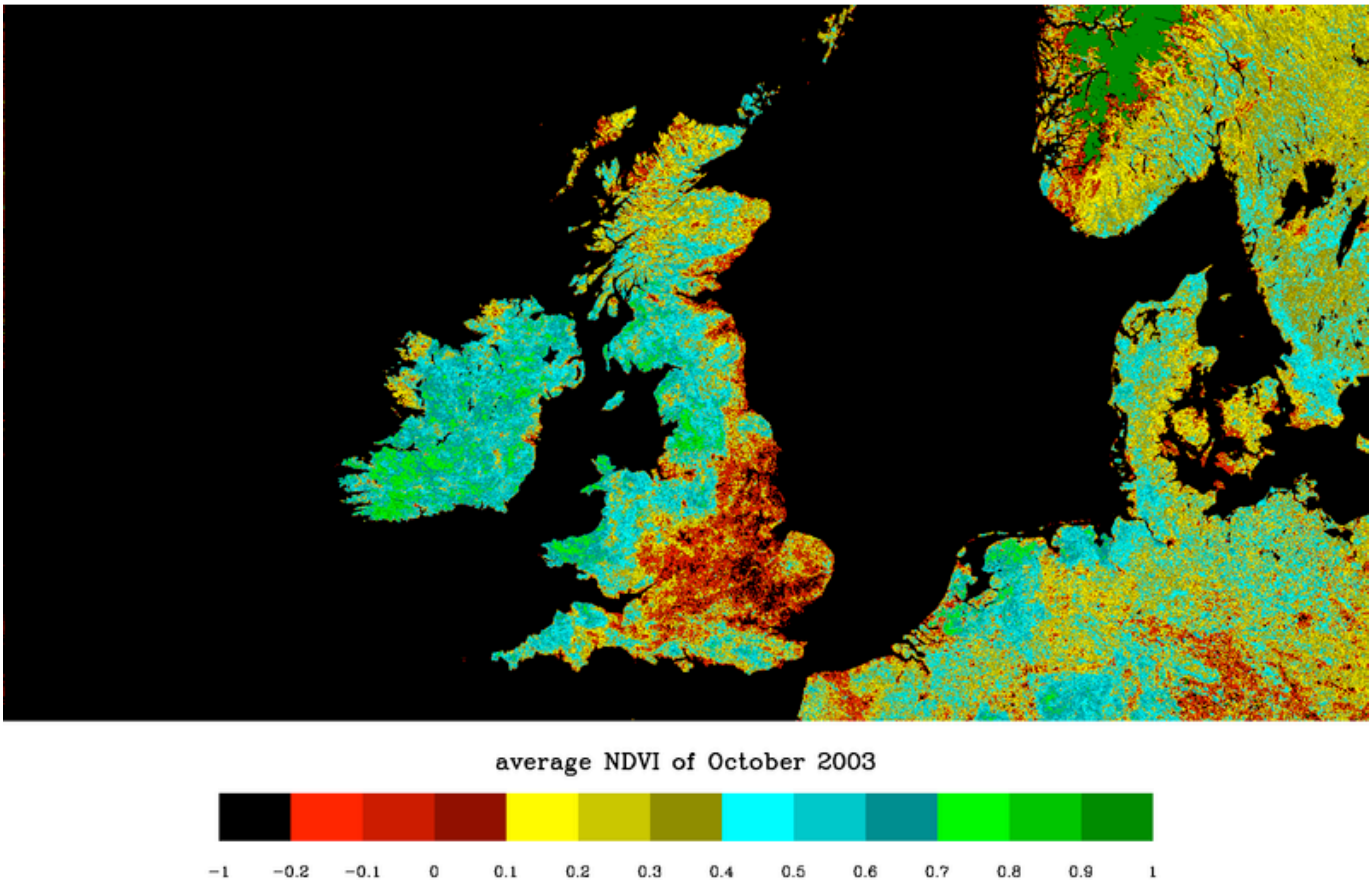
Normalized Difference Vegetation Index

$$\mathrm{NDVI} = \frac{(\mathrm{NIR} - \mathrm{VIS})}{(\mathrm{NIR} + \mathrm{VIS})}$$



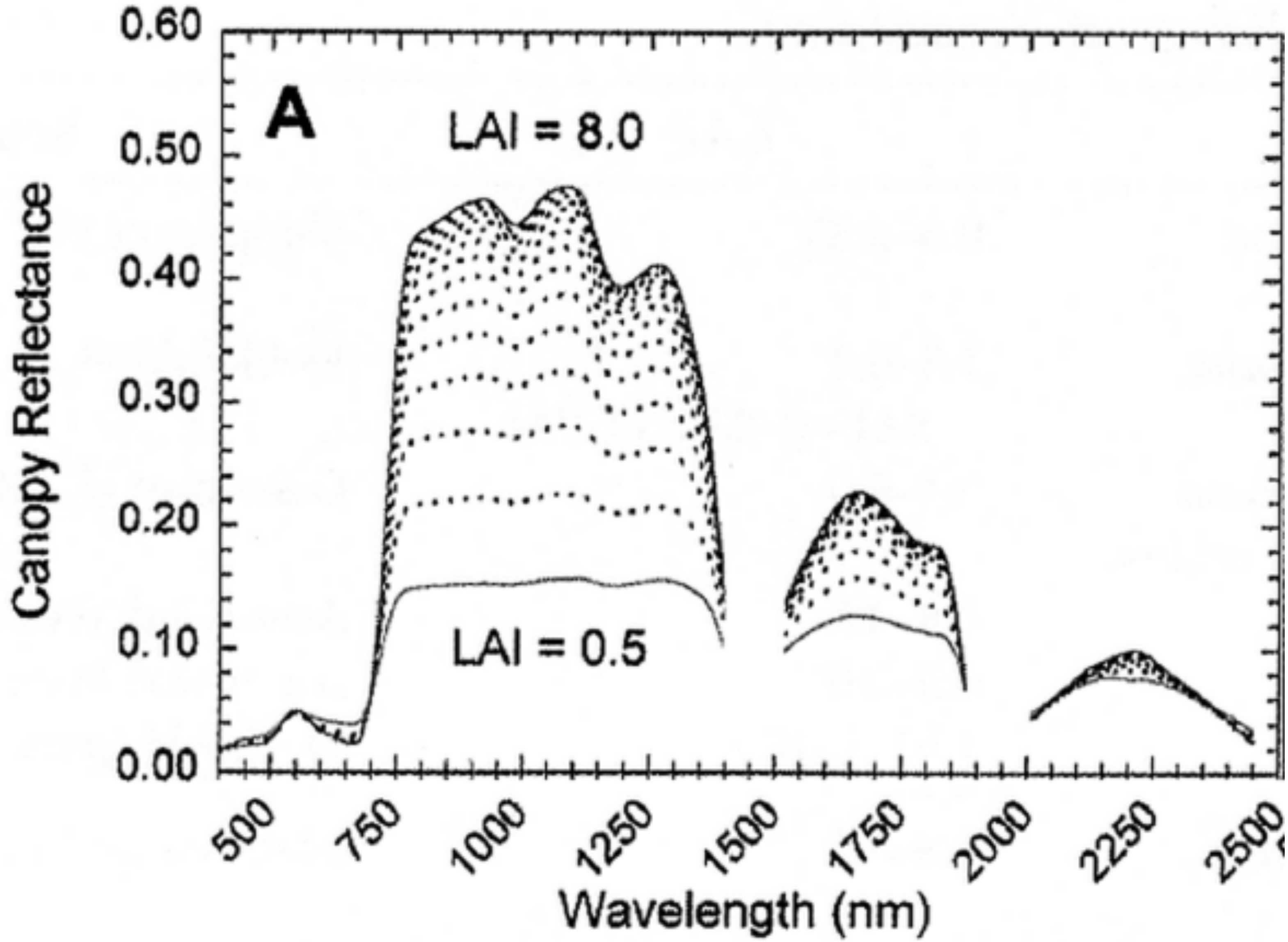
Normalized Difference Vegetation Index

$$\mathrm{NDVI} = \frac{(\mathrm{NIR} - \mathrm{VIS})}{(\mathrm{NIR} + \mathrm{VIS})}$$



Thicker canopy = *more* reflective

(at wavelengths where absorption is minimal)



Thicker canopy = *more* reflective

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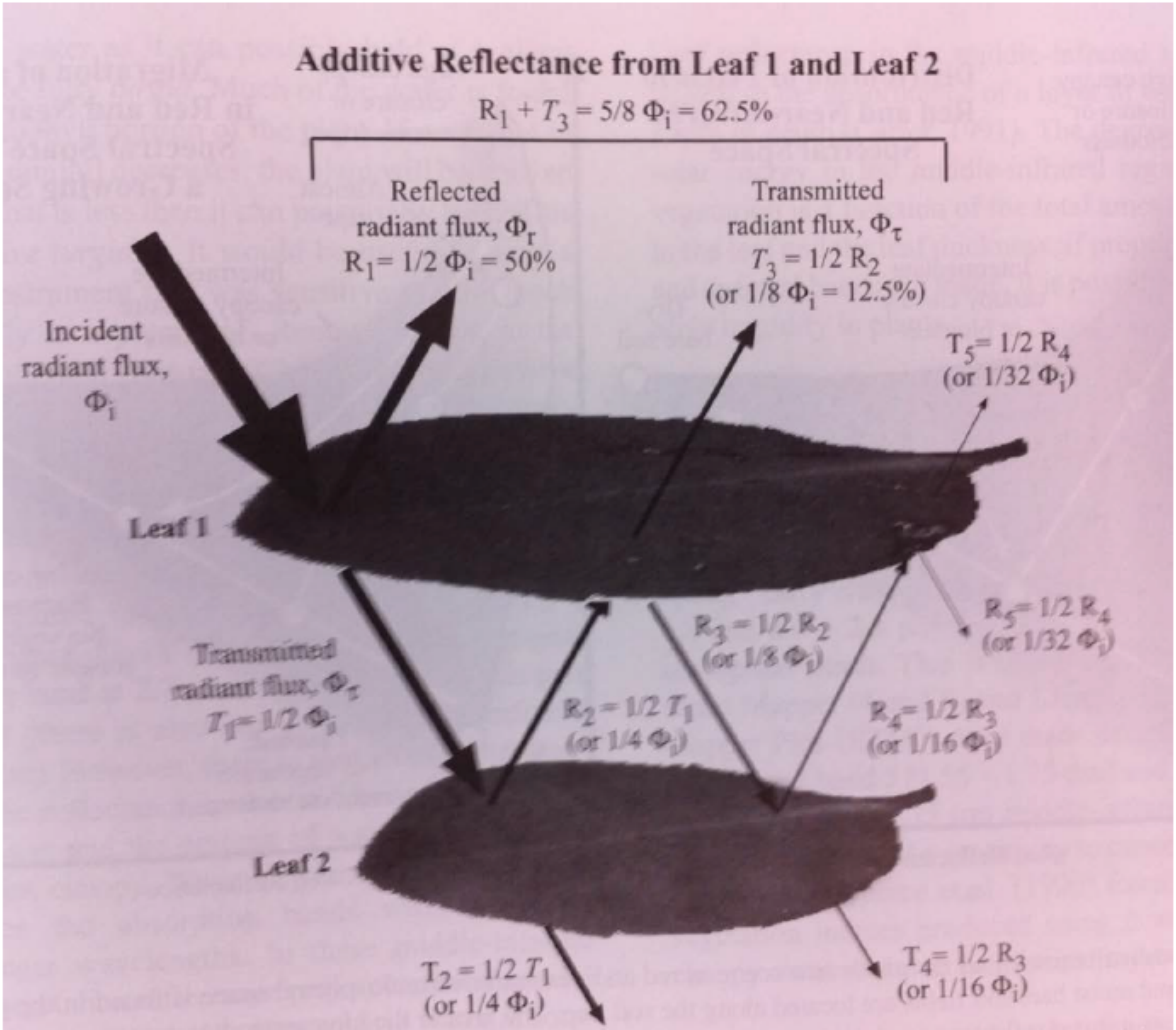
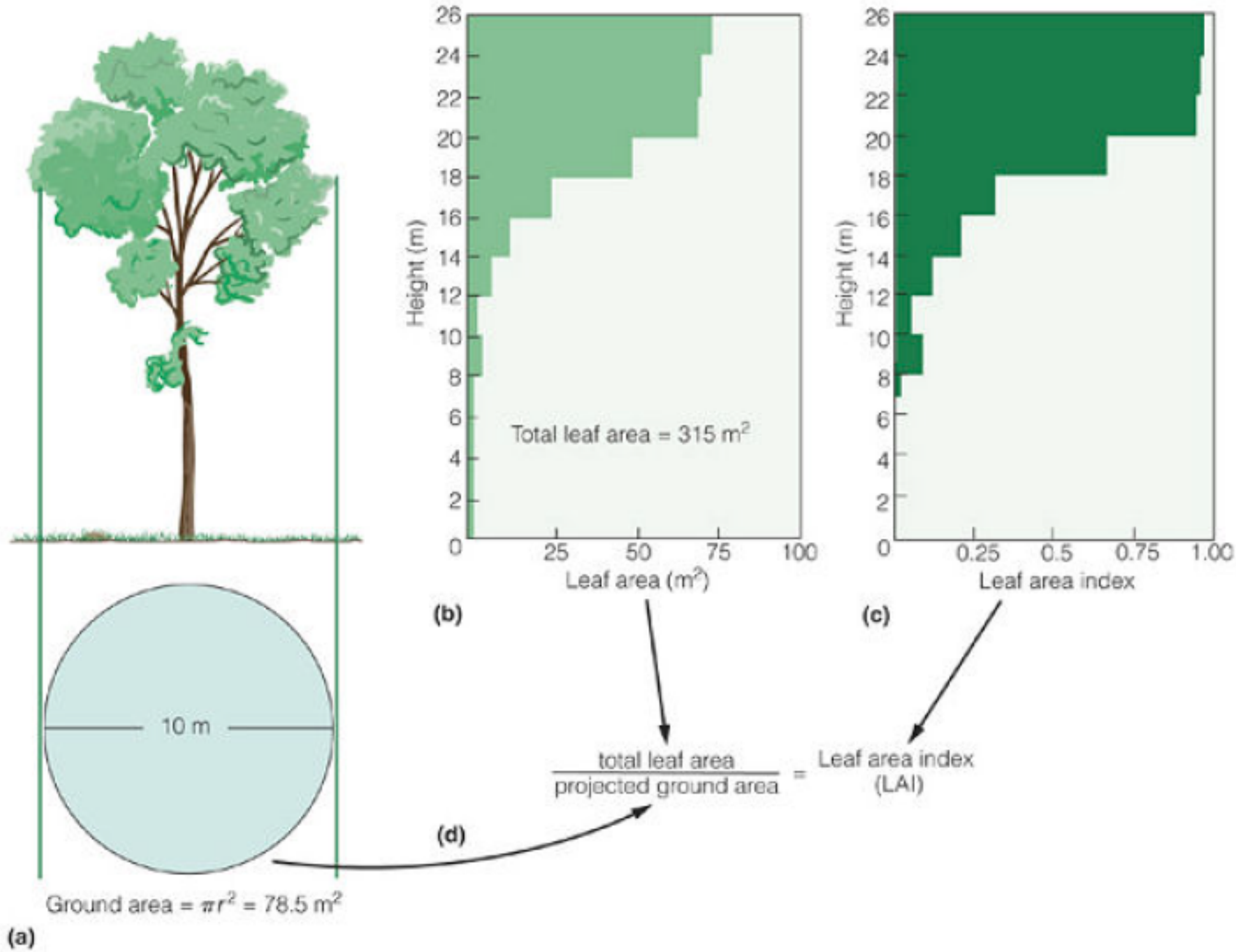
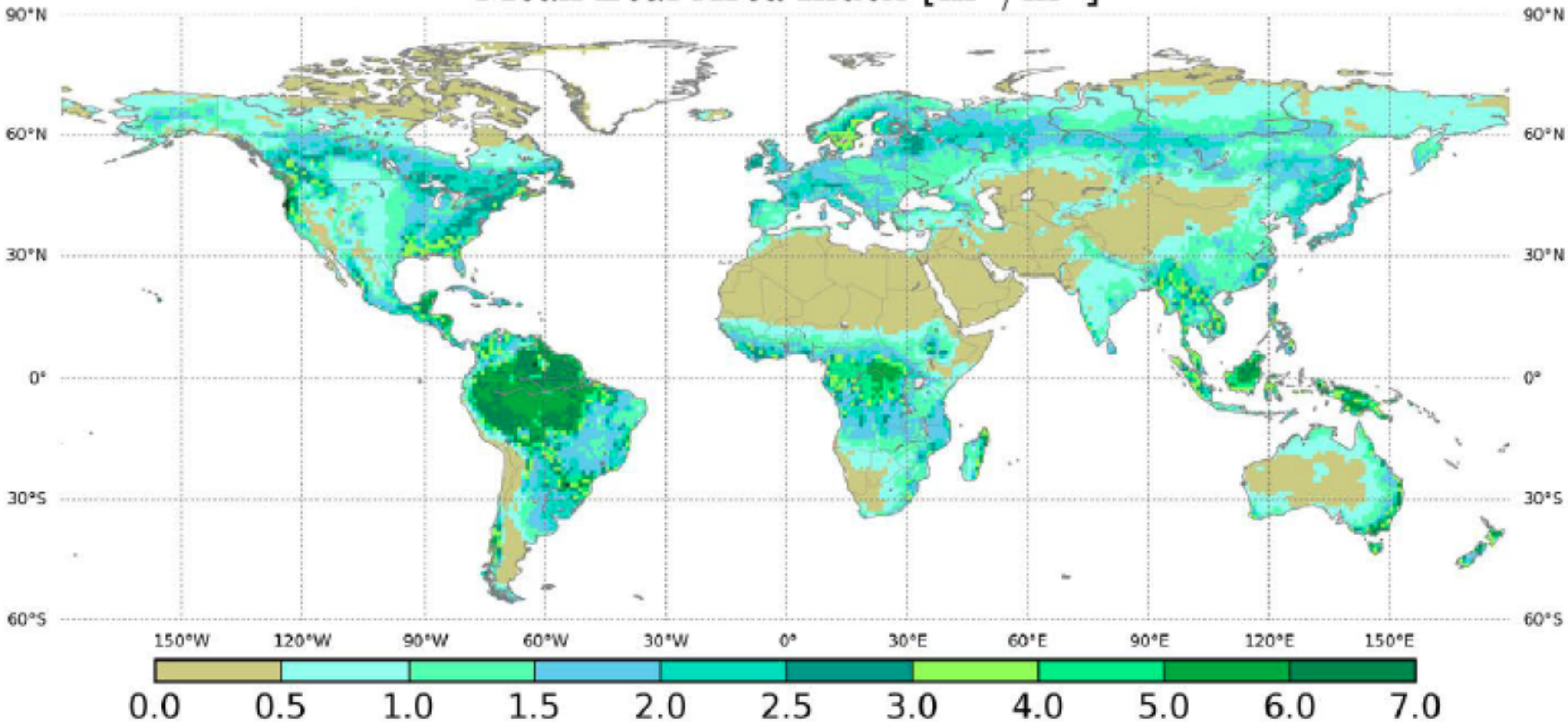


Leaf Area Index (LAI):

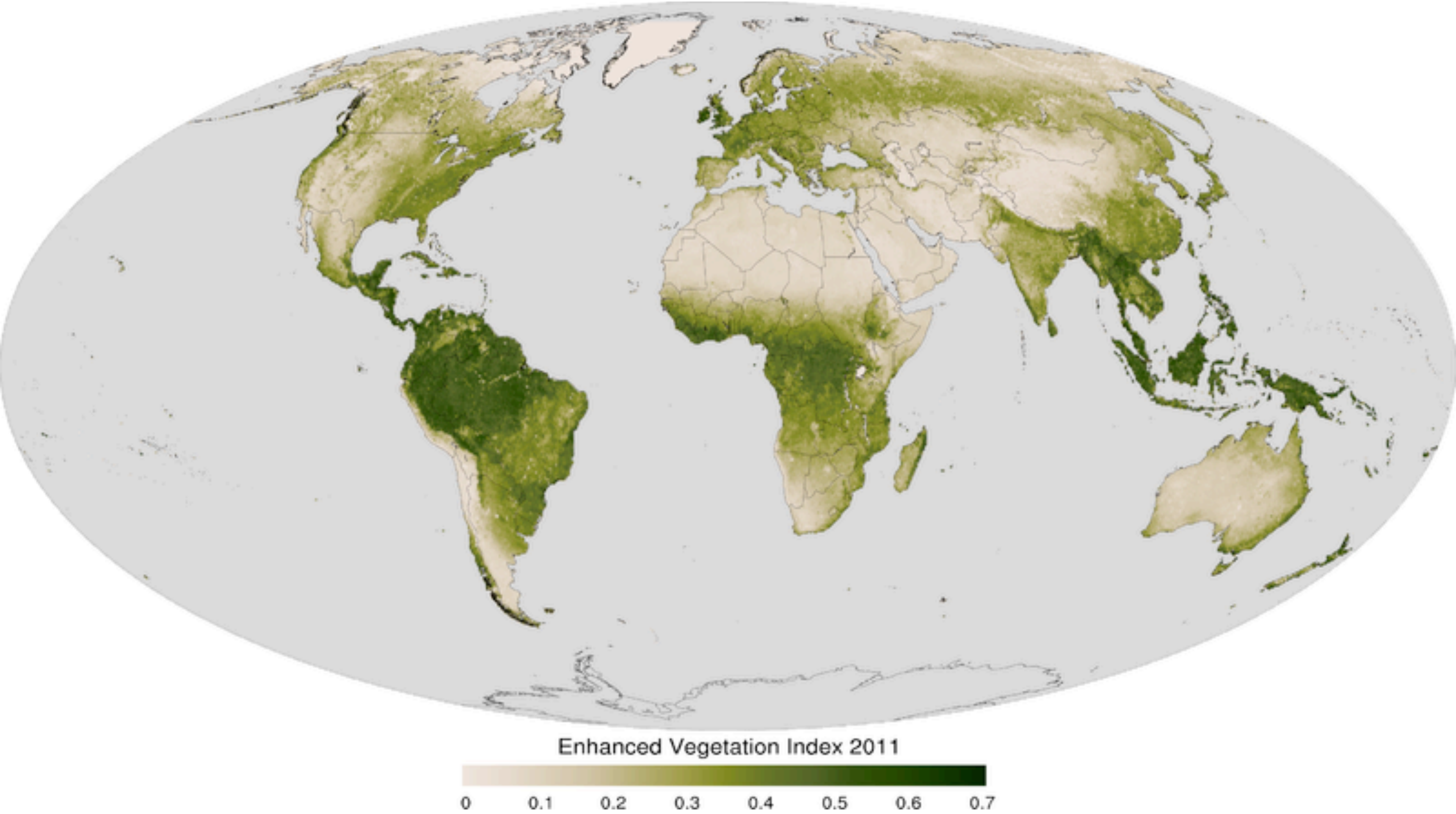
the one-sided green leaf area per unit ground surface area



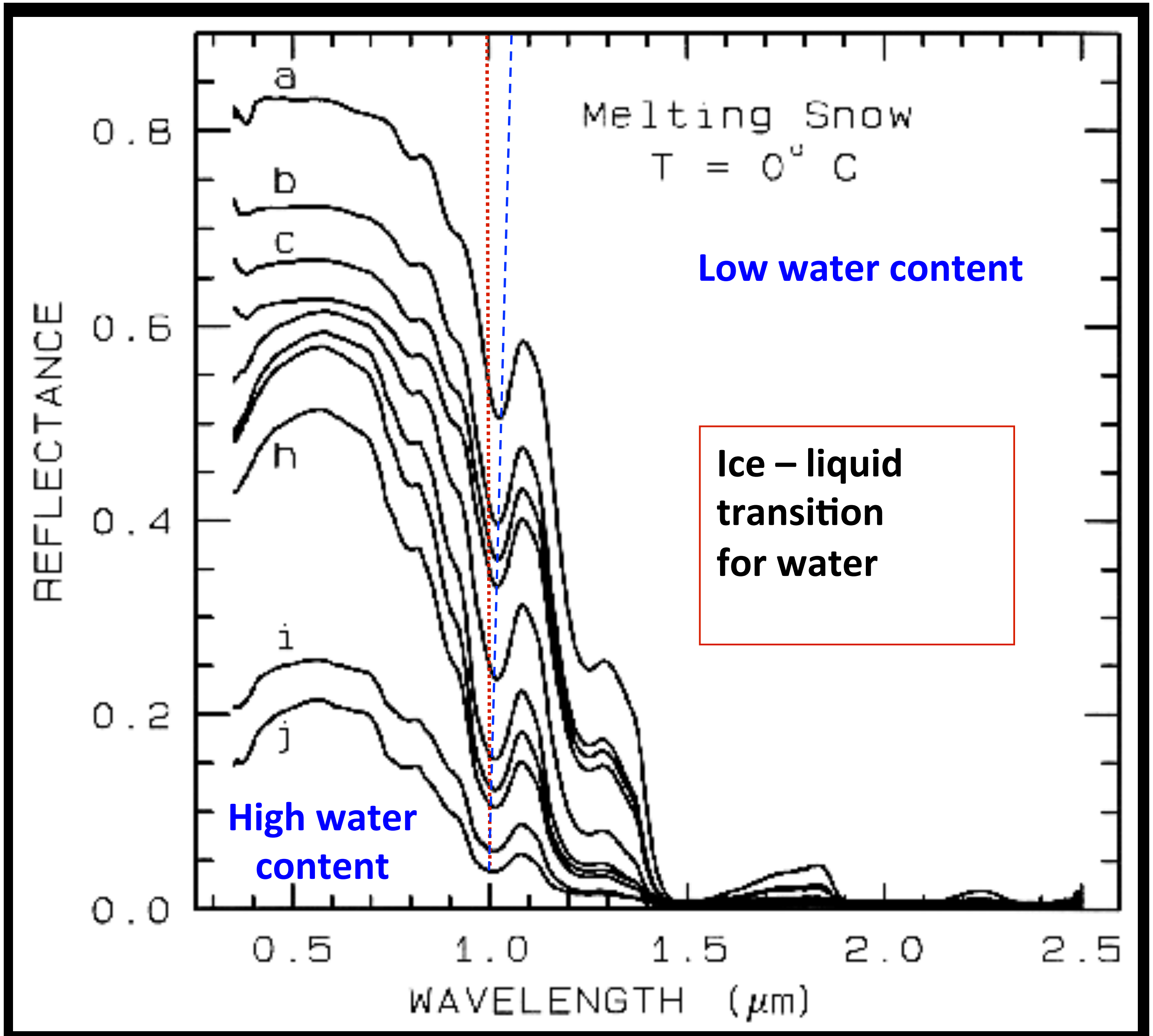
Mean Leaf Area Index $[m^2/m^2]$



$$EVI = G \times \frac{(NIR - RED)}{(NIR + C1 \times RED - C2 \times Blue + L)}$$



Phase affects spectra



Bands don't broaden much as ice turns to water

Band centers shift subtly

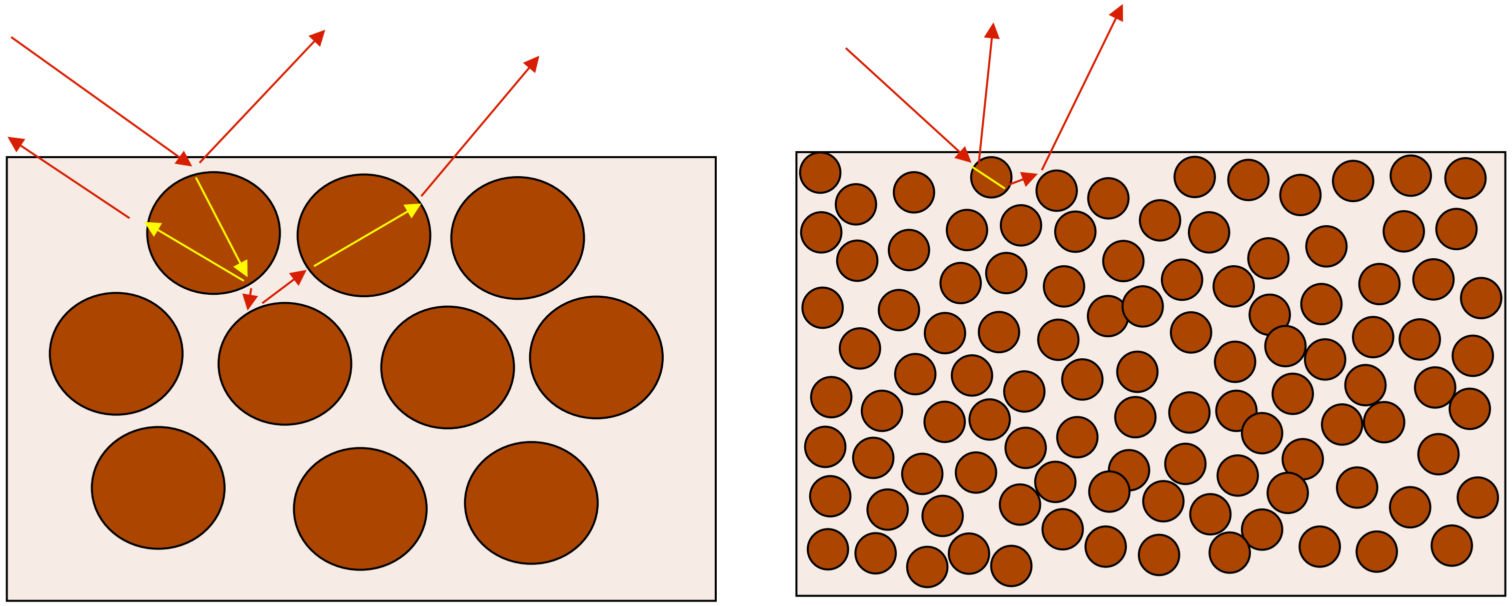
Amount of absorption increases with optical length z in Beer's law (e^{-kz}) – there are no grain interfaces in water.

This is a particle size effect

Particle size affects spectra

Coarse particles – spectra dominated by absorption inside grains

Fine particles – spectra dominated by surface reflection



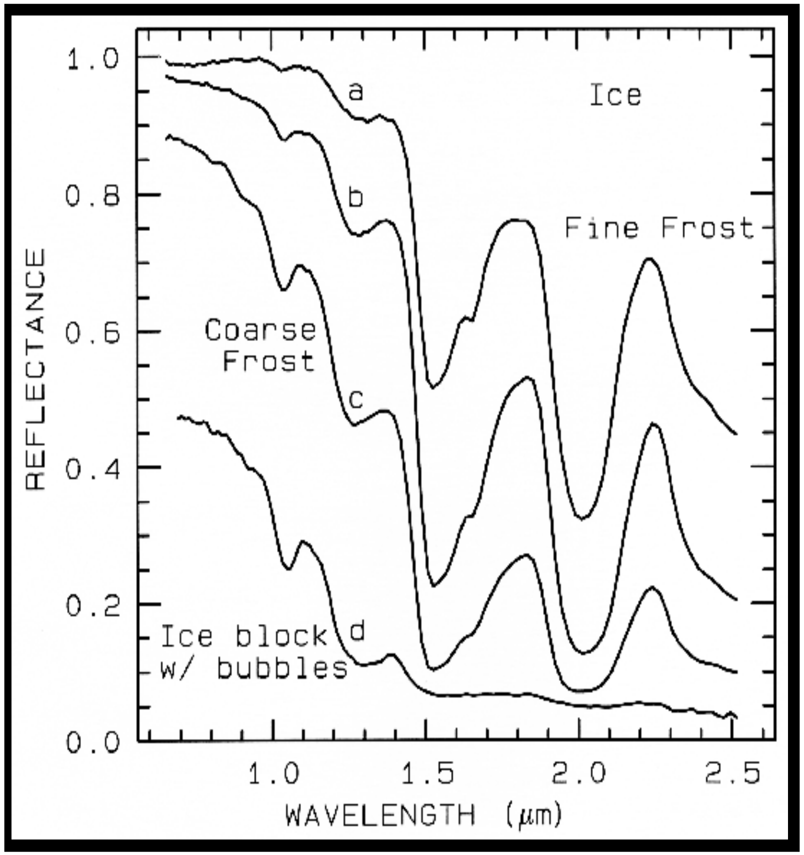
Low surface/volume ratio

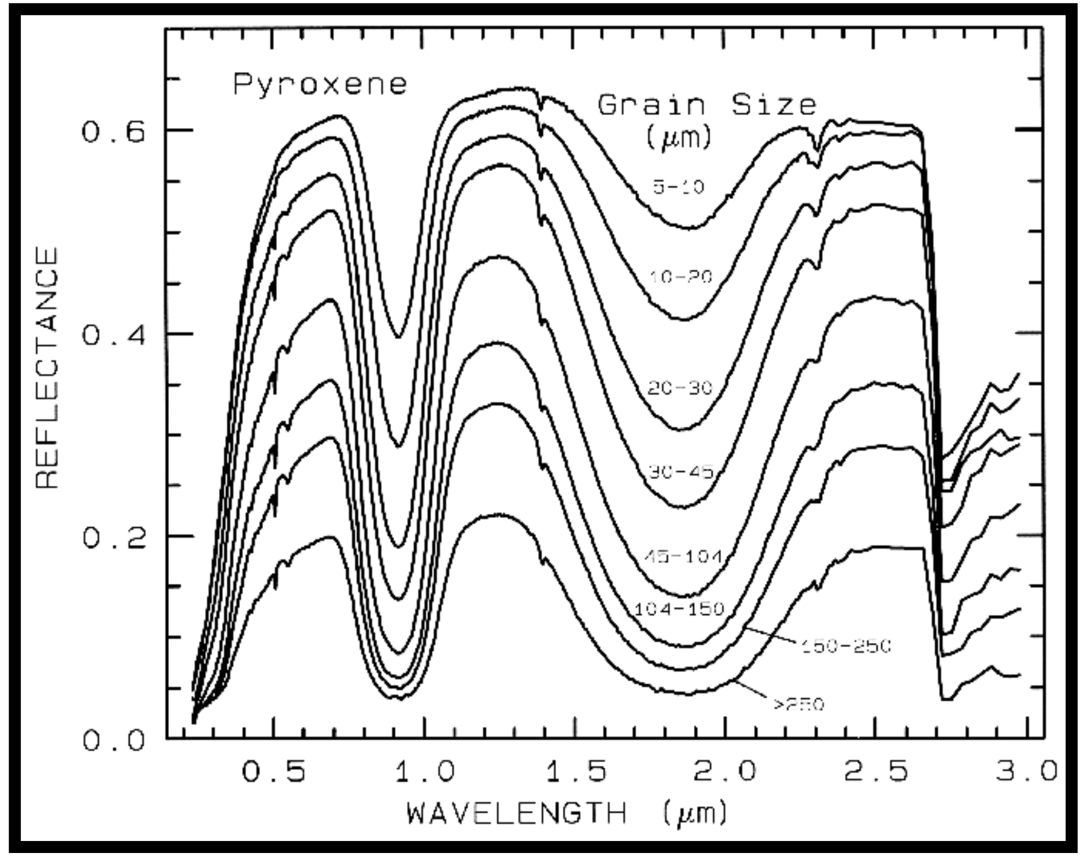
High surface/volume ratio

Average optical path is long

Path is shorter

Particle size affects spectra



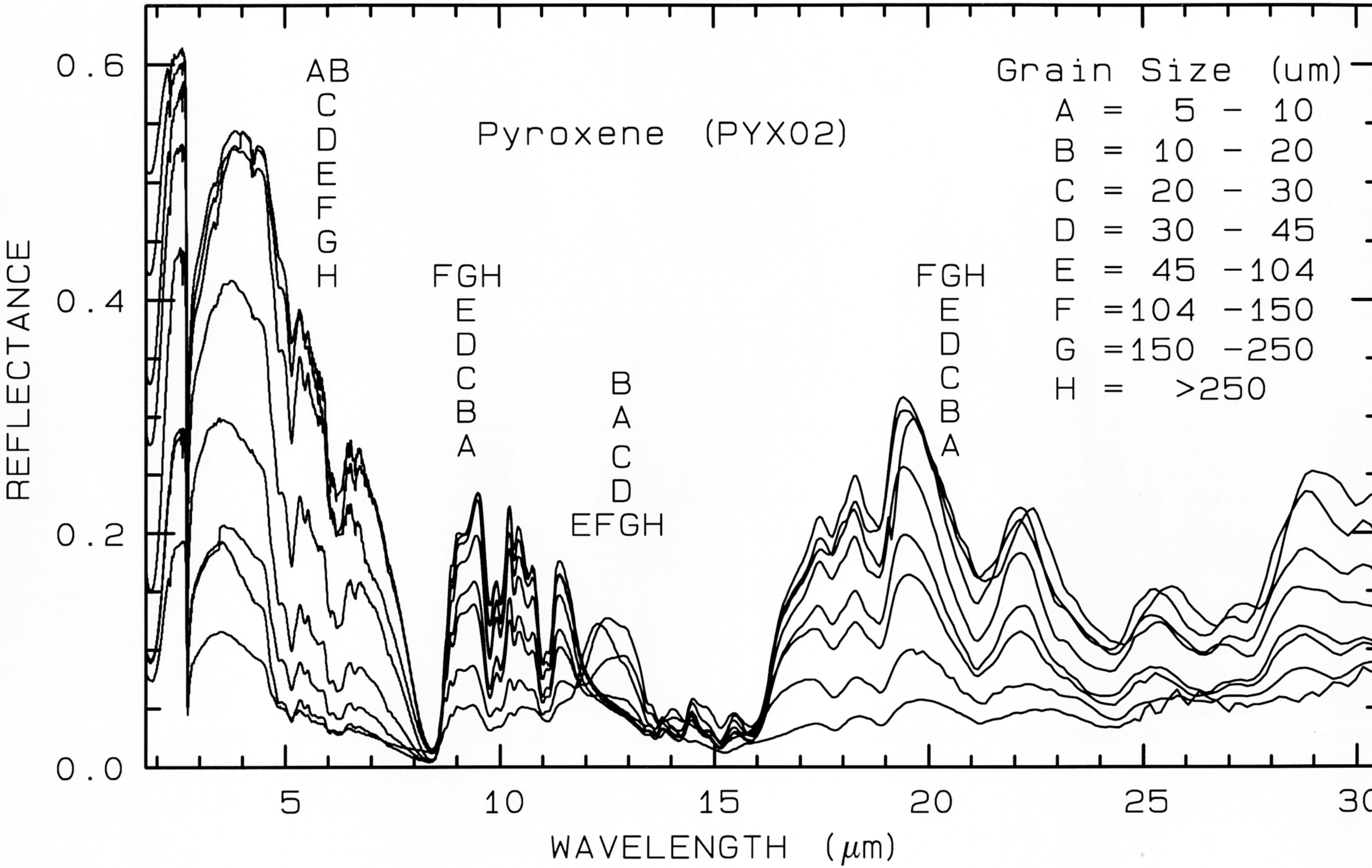


H_2O

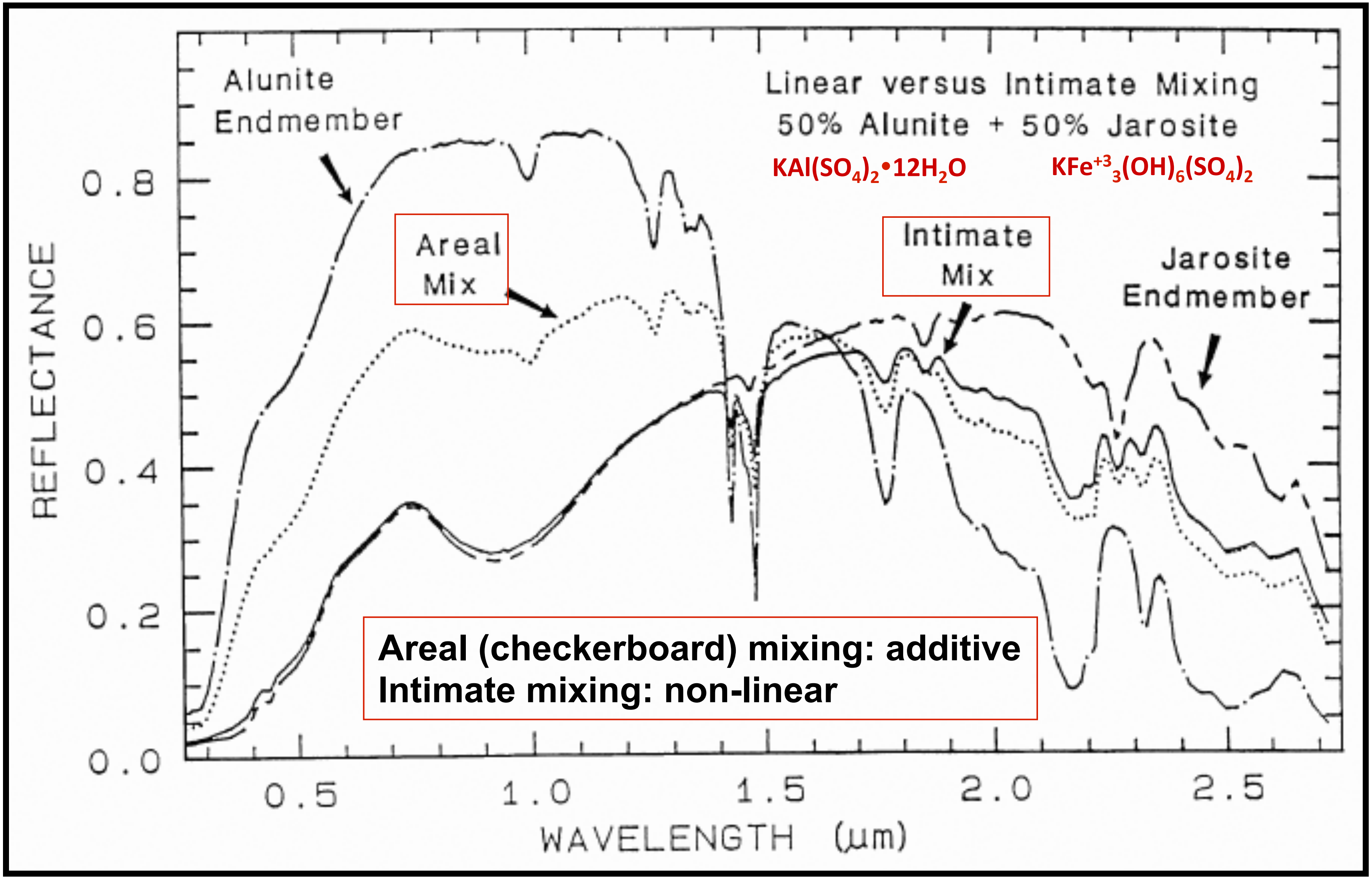
Pyroxene

$XY(Si,Al)_2O_6$

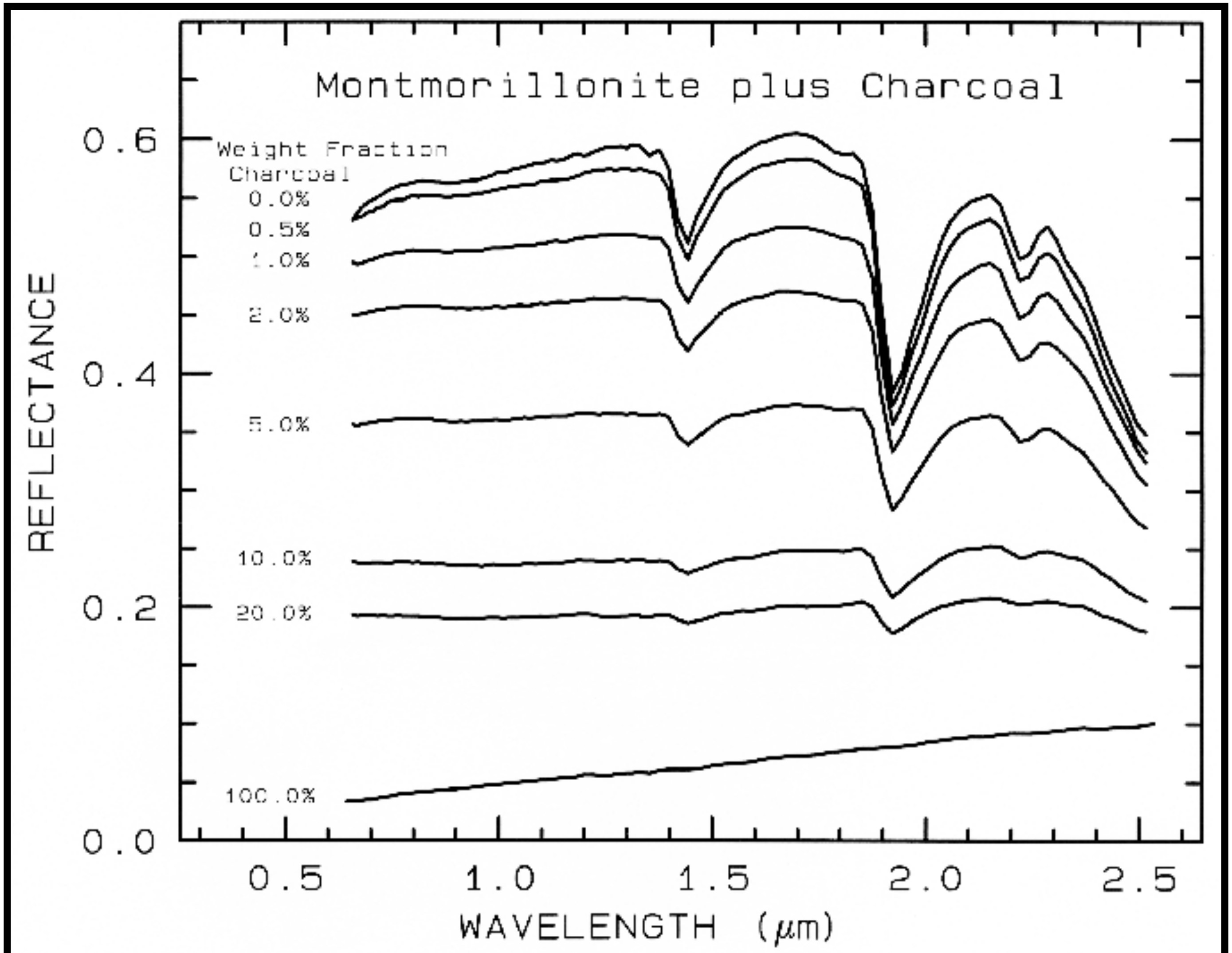
…and not always in a simple way



Spatial resolution also affects spectra (by mixing)



Intimate mixing can be highly non-linear

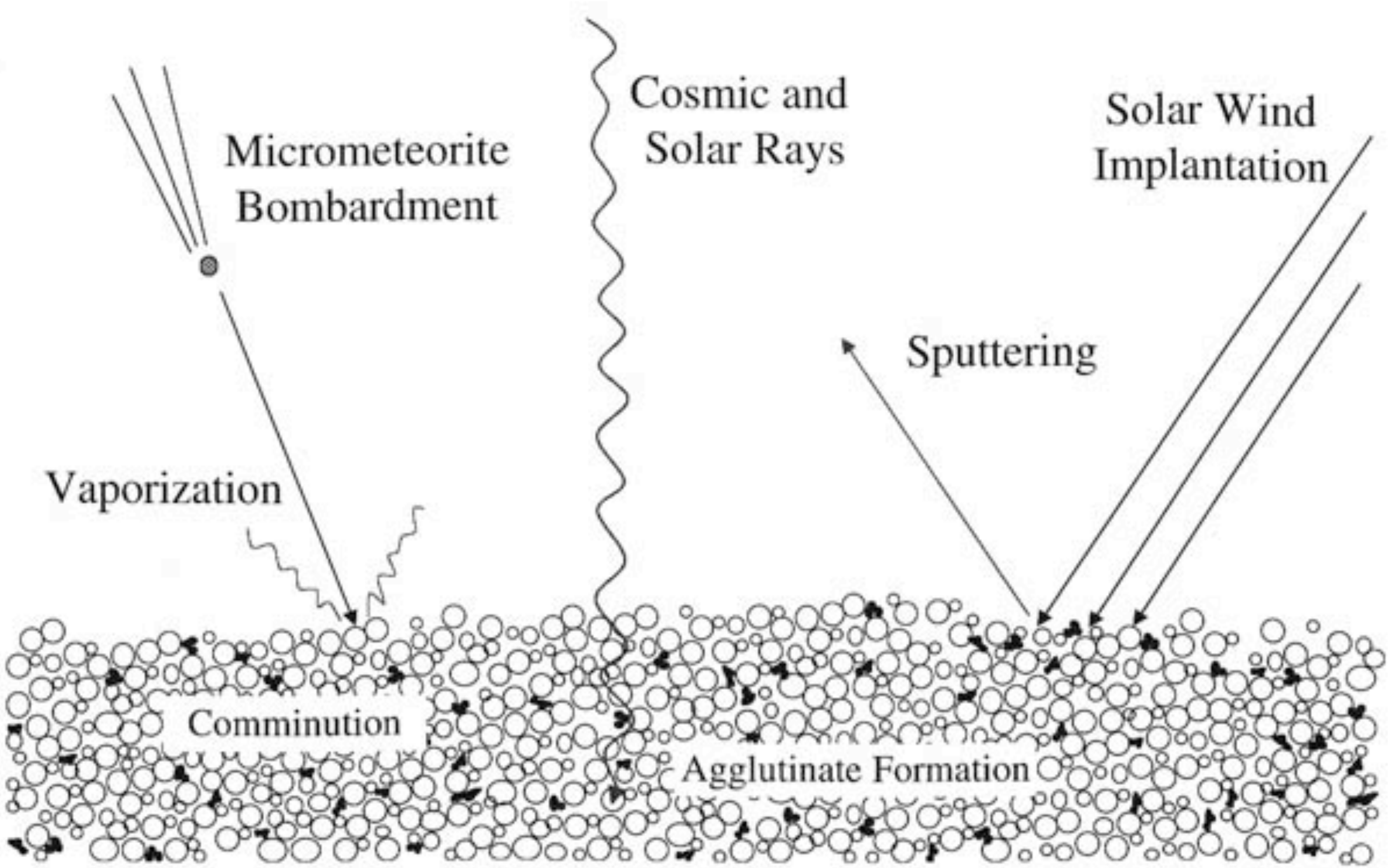


Adding highly absorptive charcoal greatly reduces the optical path length ("z" in Beer's Law: e^{-kz})

A small amount has a large effect

Larger amounts have diminishing effect

Space weathering

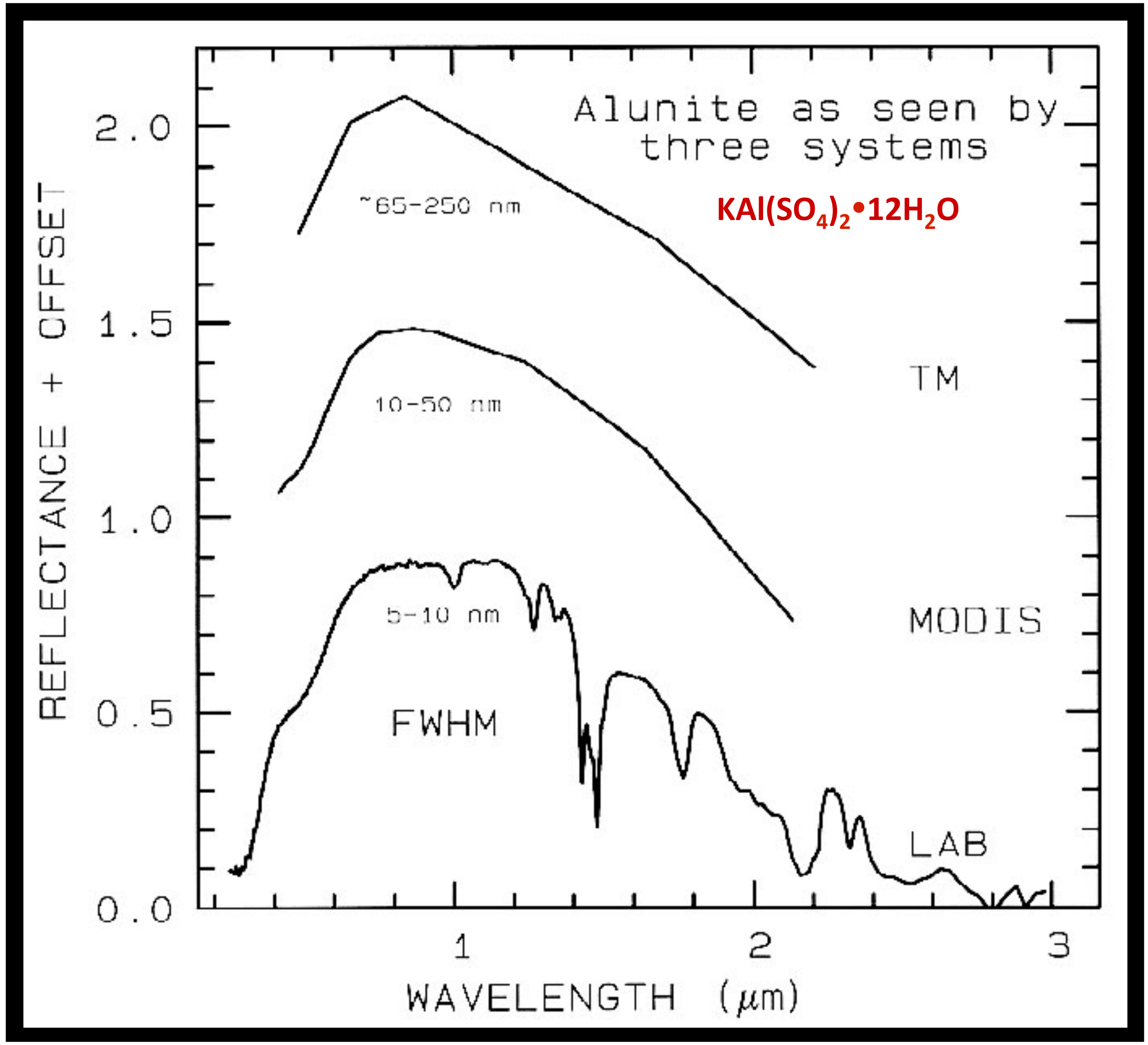


Nanophase iron reddens, darkens, weakens absorption bands

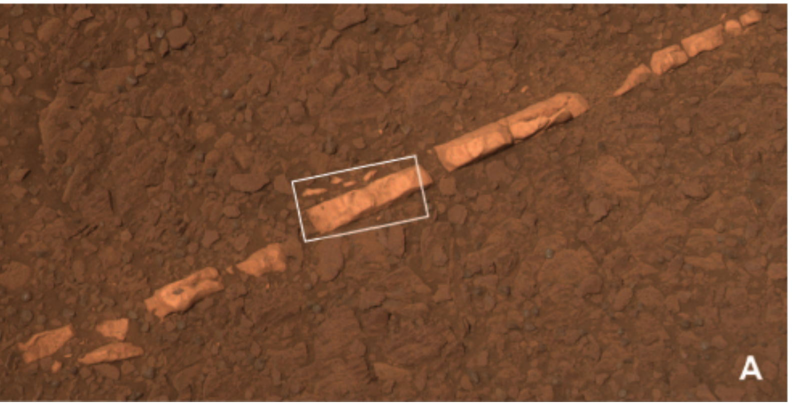
Spectral resolution:

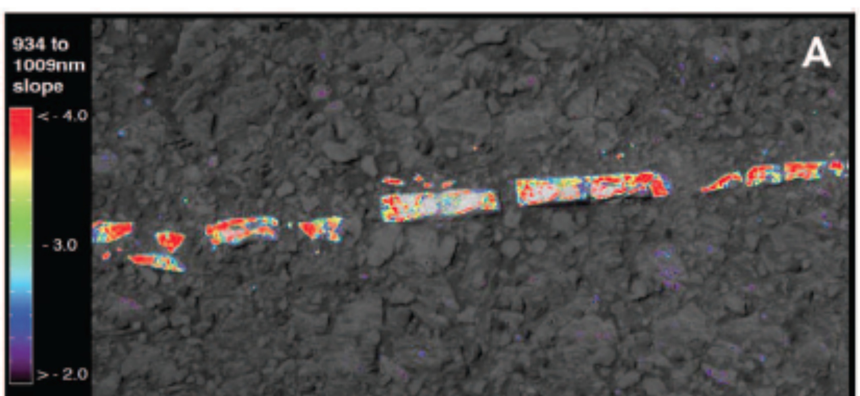
multispectral remote sensing vs. imaging spectroscopy

Imaging spectroscopy is more likely to resolve absorption bands



The challenge of multispectral data





Many distinct minerals look similar!