Environmental Remote Sensing
GEOG 2021

Lecture 3

Spectral information in remote sensing

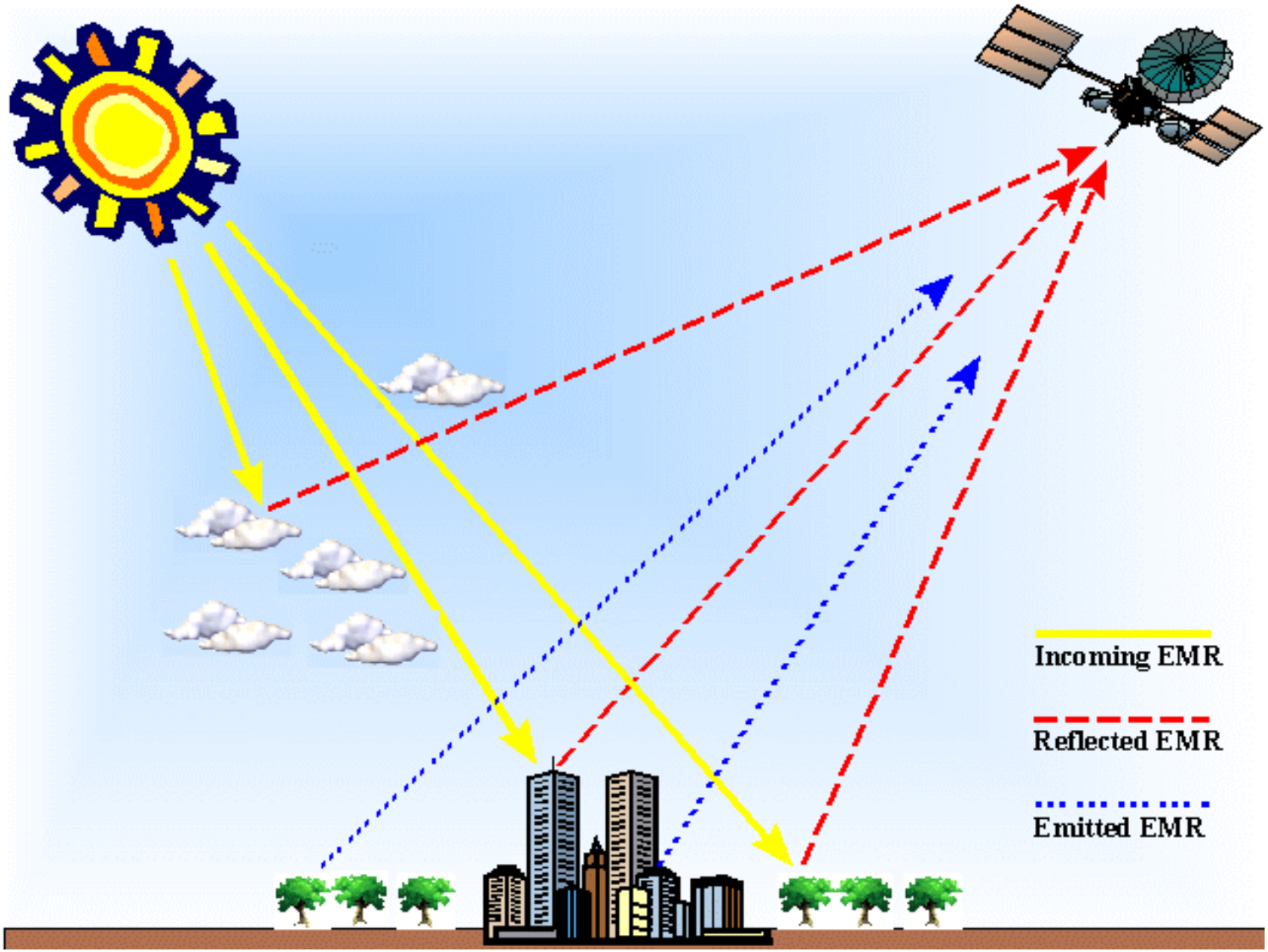
Aim

- Mechanisms of variations in reflectance - optical/ microwave
- Visualisation/analysis
- Enhancements/transforms
  - Getting info. from multispectral data

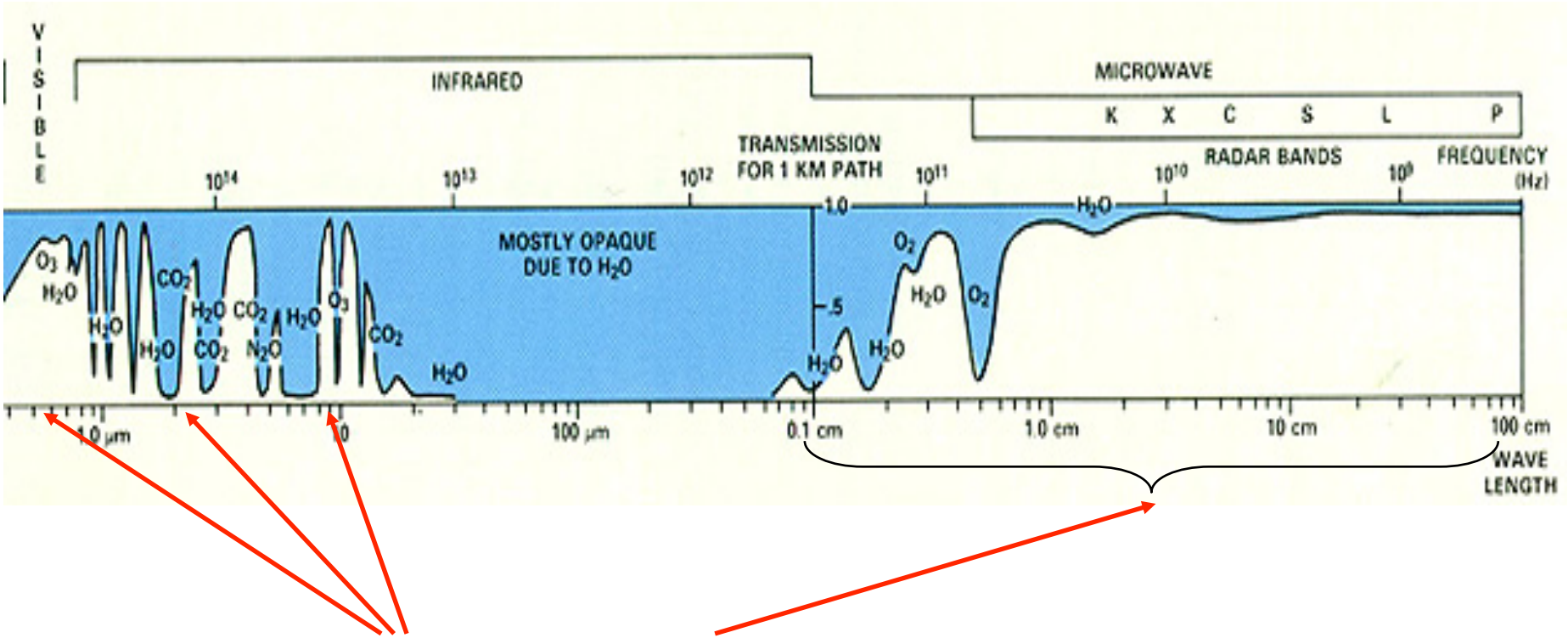
Reflectance

- Reflectance = output / input
  - (radiance)
  - measurement of surface complicated by atmosphere
- input solar radiation for *passive* optical
- input from spacecraft for *active* systems
  - RADAR
    - Strictly NOT reflectance - use related term backscatter

Mechanisms



Mechanisms



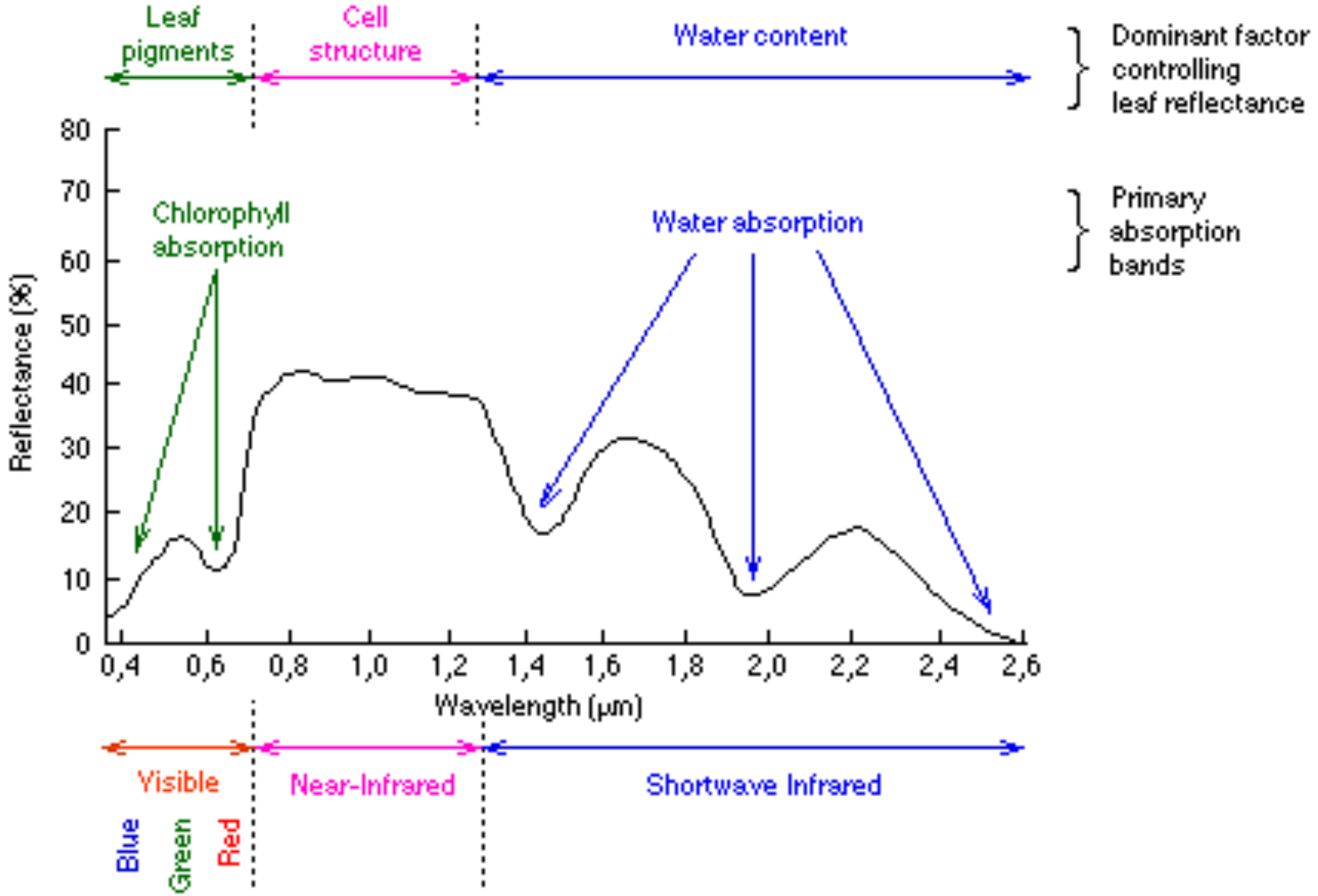
- Atmospheric “windows” – transmission high so can see through atmosphere
- Particularly microwave

Reflectance

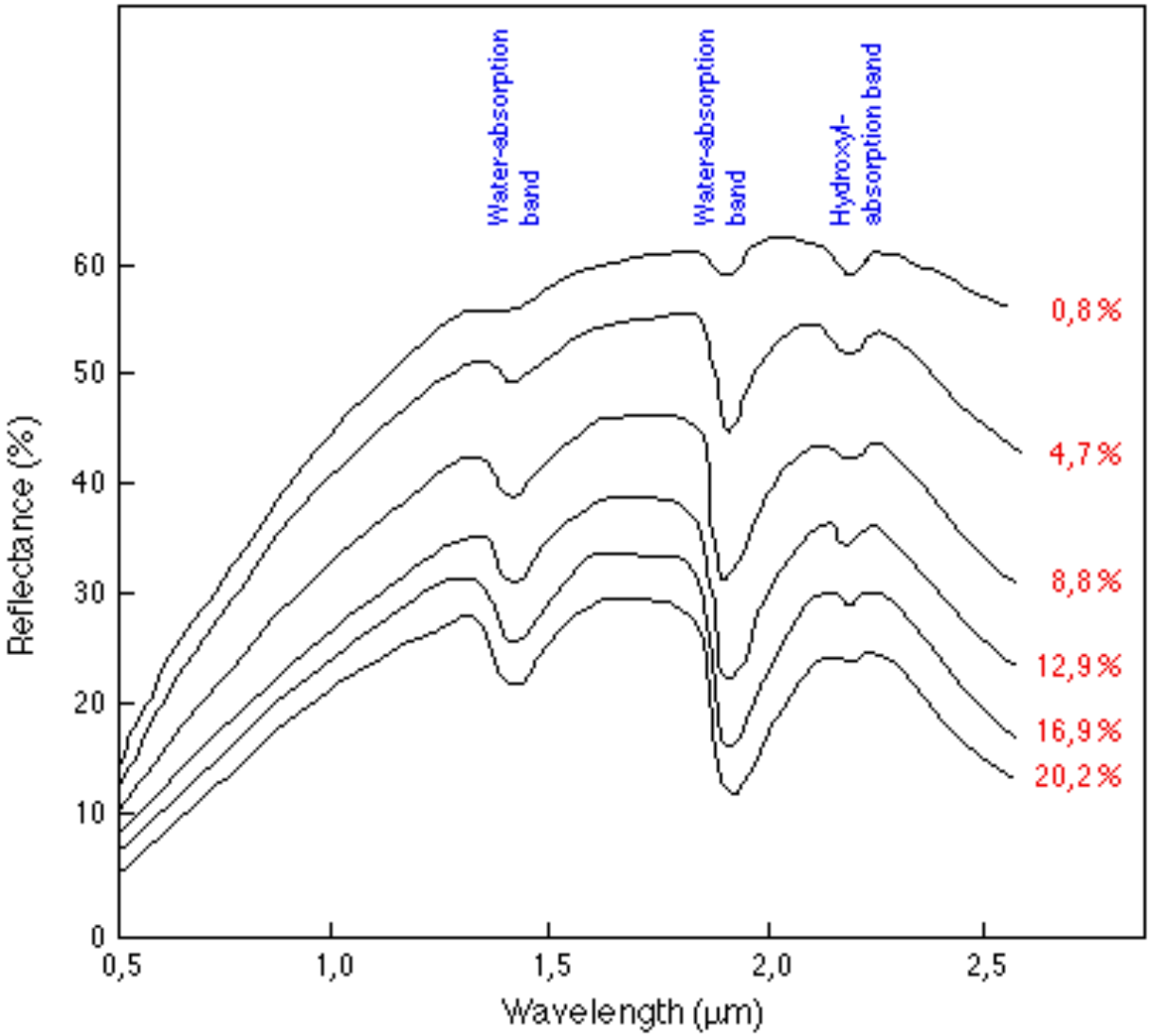
Causes of spectral (with wavelength) variation in reflectance?

- (bio)chemical & structural properties
  - chlorophyll concentration in vegetation
  - soil - minerals/ water/ organic matter

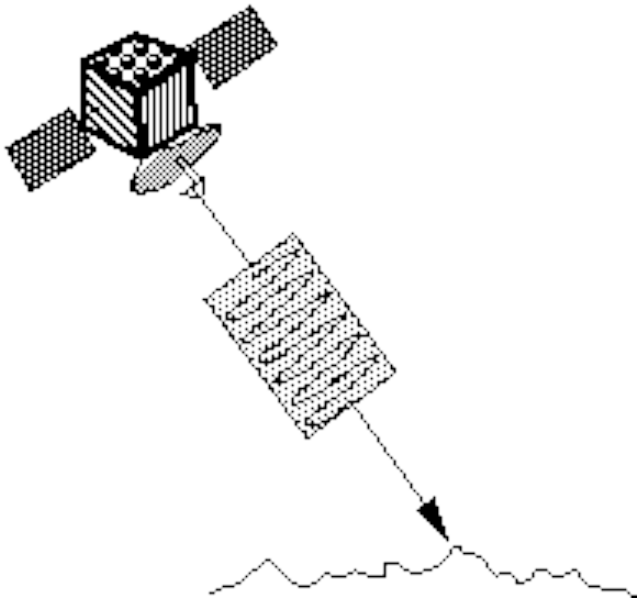
Optical Mechanisms: vegetation



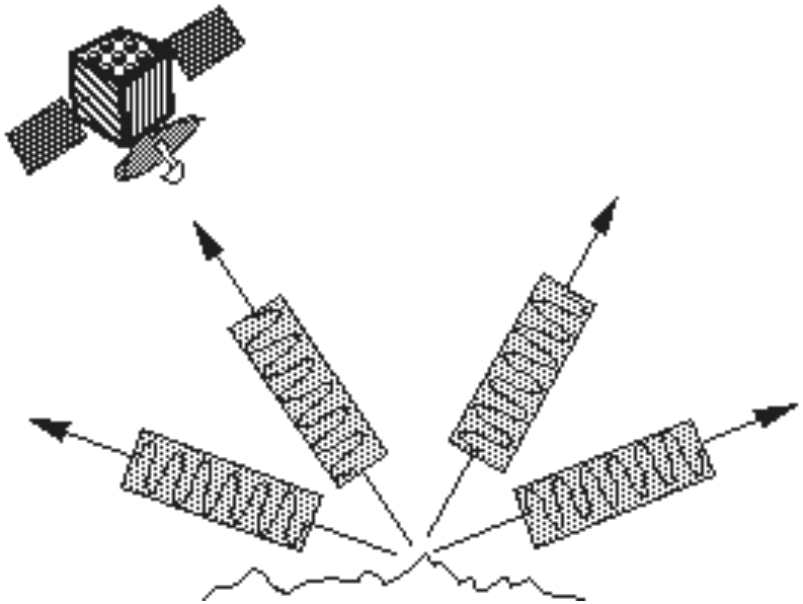
Optical Mechanisms: soil



RADAR Mechanisms



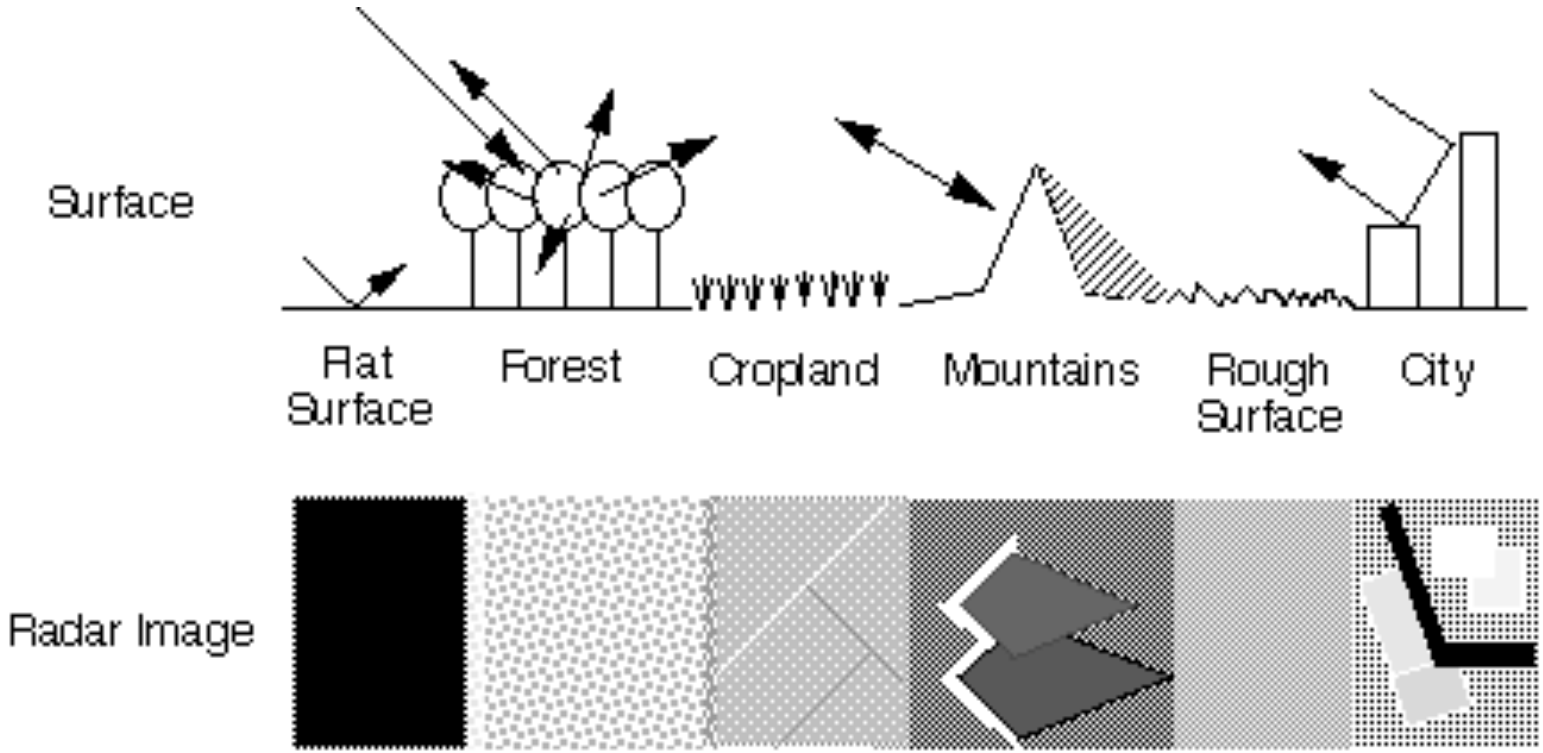
Transmit



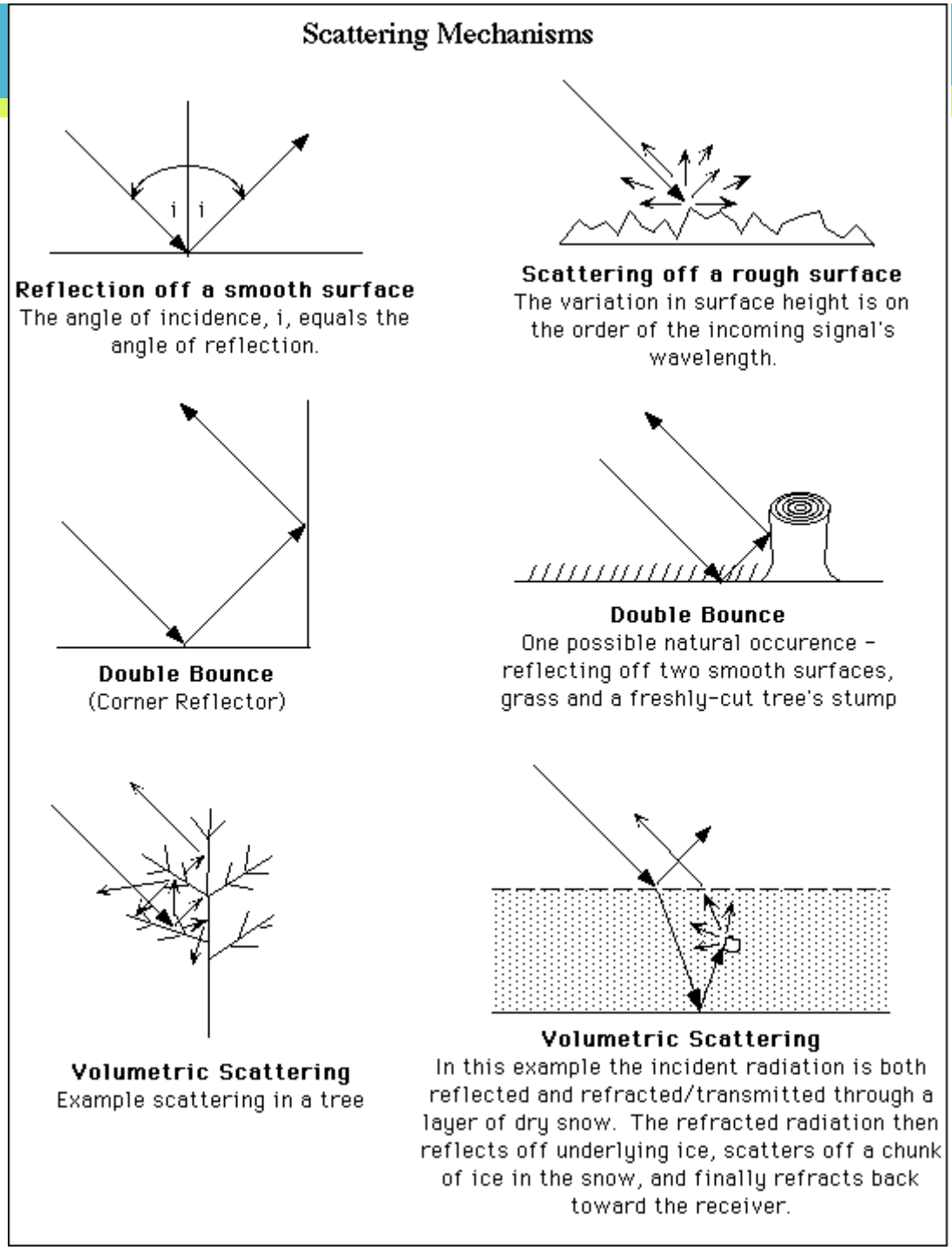
Receive

See: http://southport.jpl.nasa.gov/education.html

RADAR Mechanisms



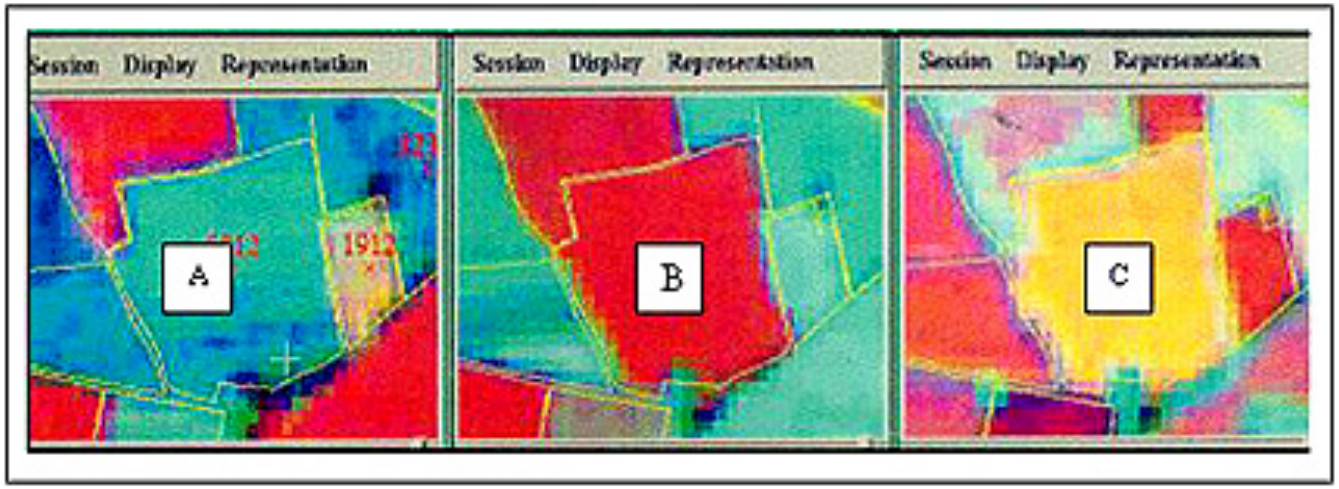
RADAR Mechanisms



Vegetation amount

consider

- change in canopy cover over time (dynamics)
- varying proportions of soil / vegetation (canopy cover)



A=Bare soil

B=Full cover

C=Senescence

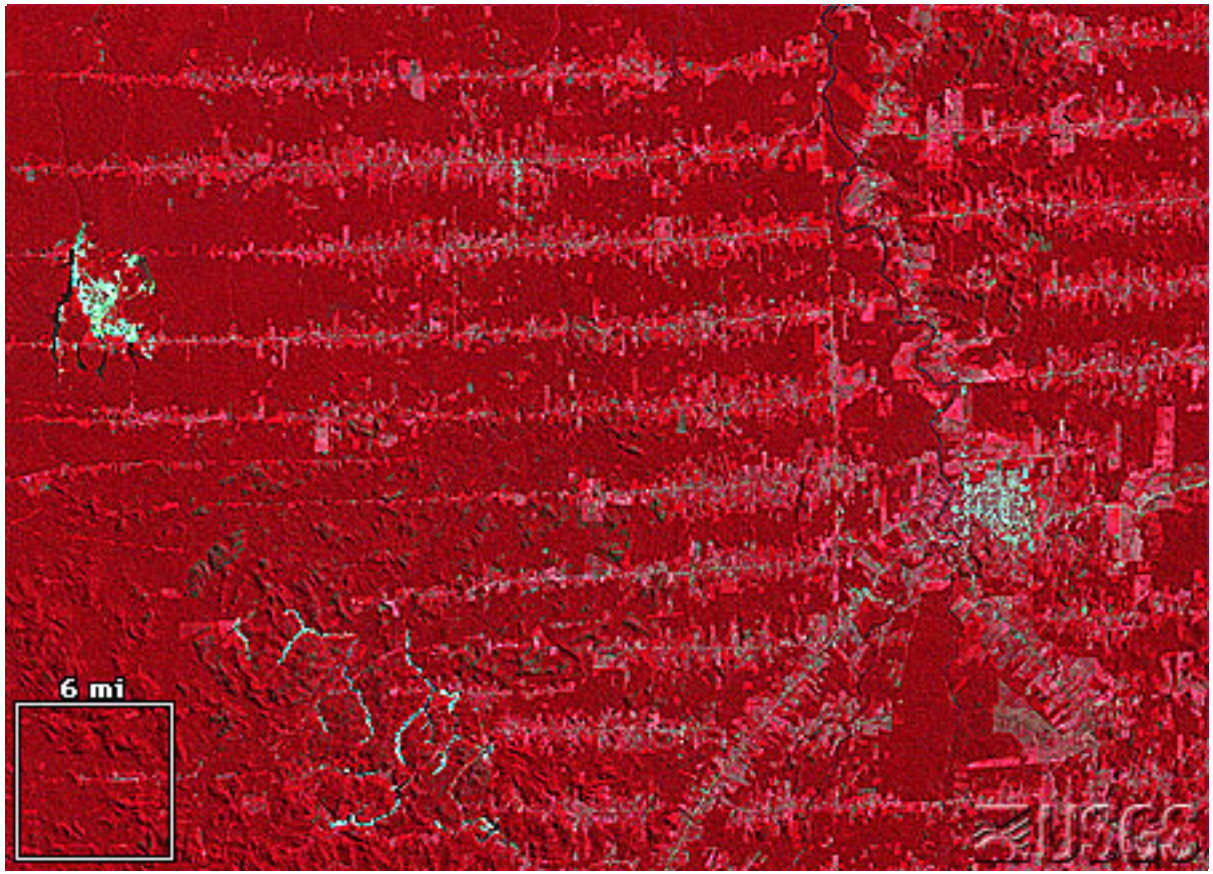
Vegetation amount & dynamics

Change detection

Rondonia 1975

Rondonia 1986

Rondonia 1992



http://earth.jsc.nasa.gov/lores.cgi?PHOTO=STS046-078-026

http://www.yale.edu/ceo/DataArchive/brazil.html

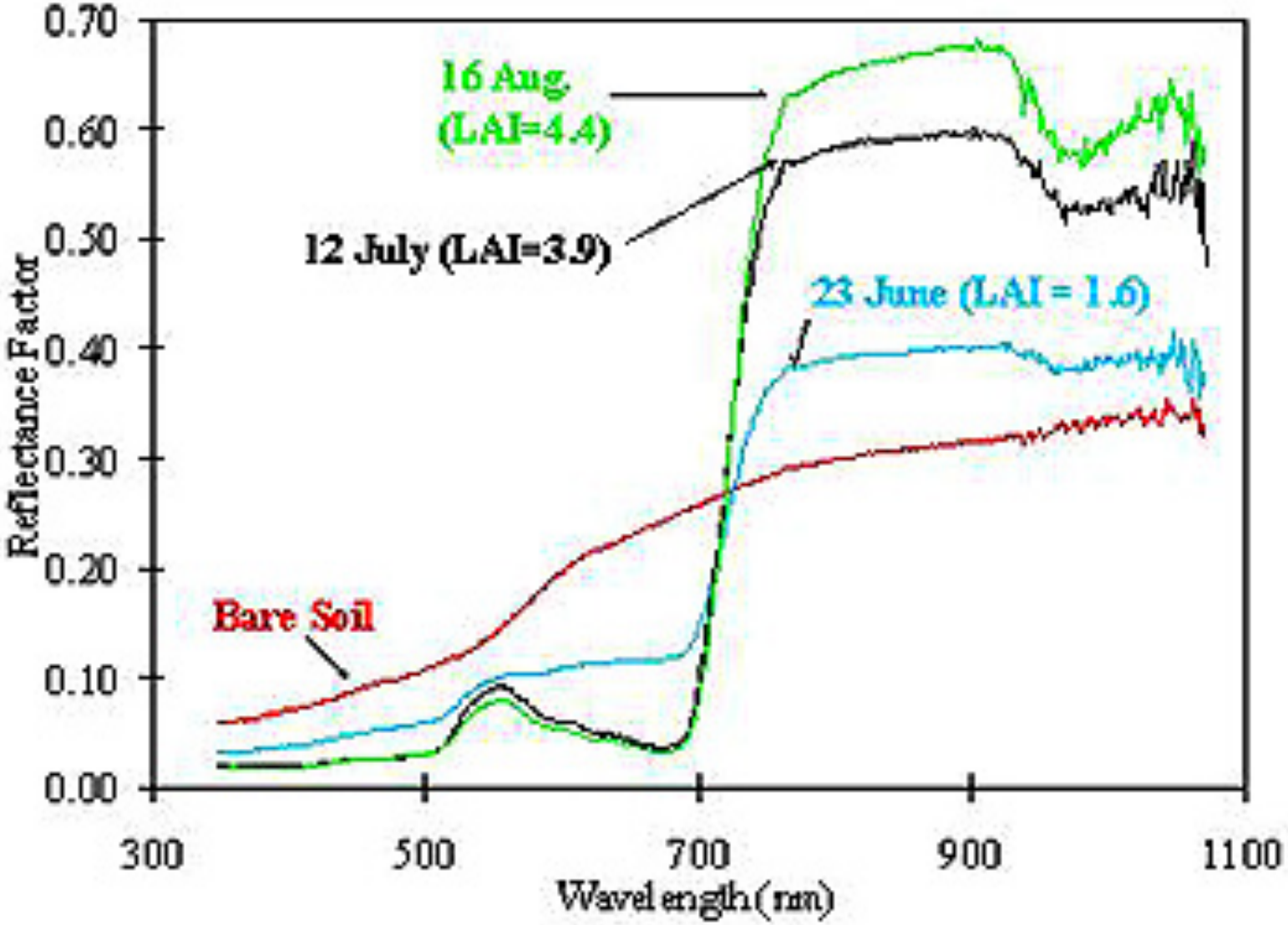
Uses of (spectral) information

consider properties as continuous

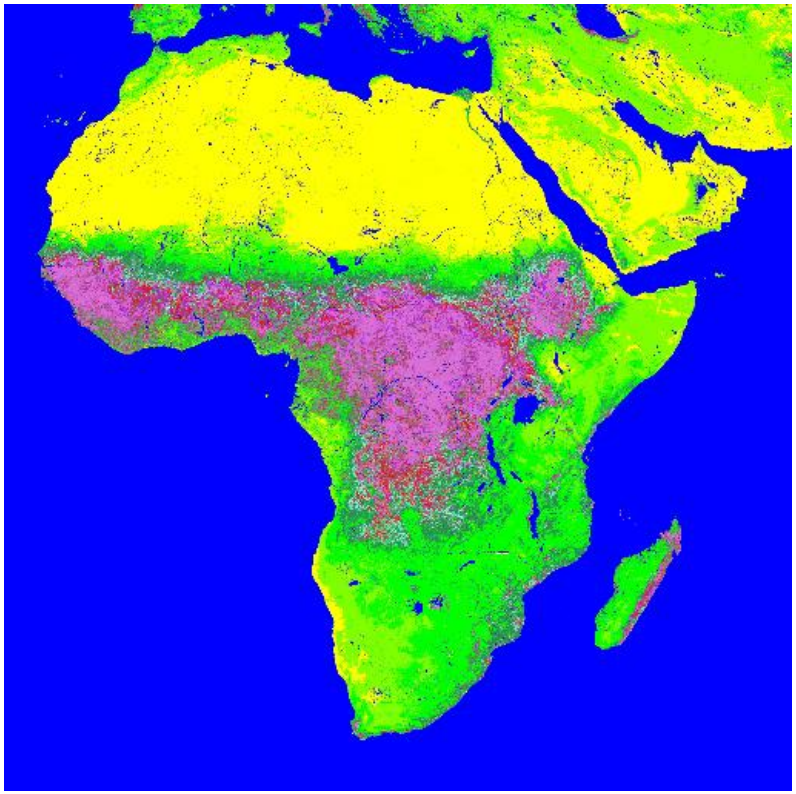
- e.g. mapping leaf area index or canopy cover

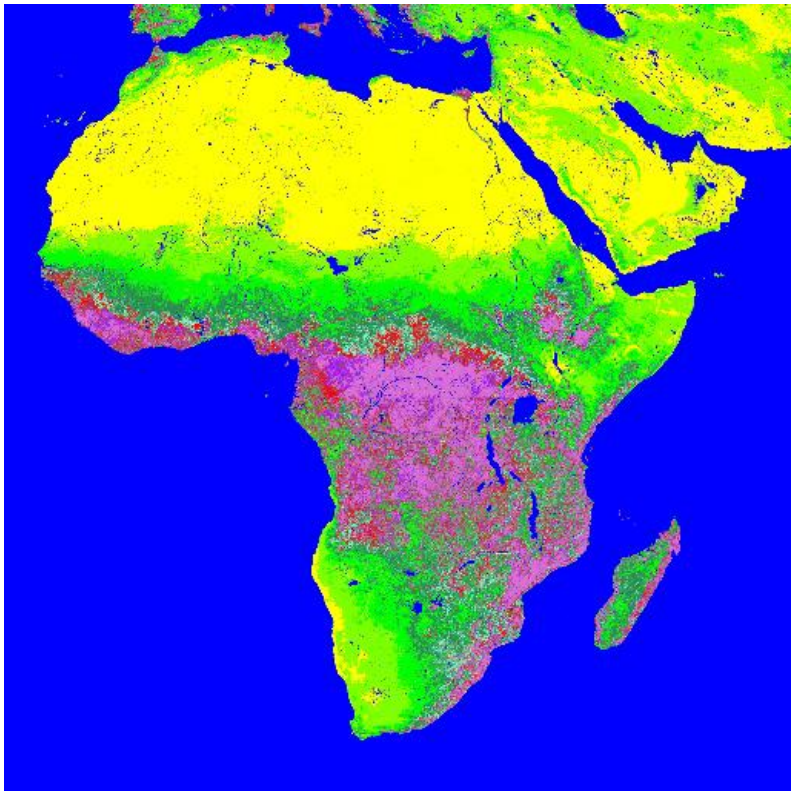
or discrete variable

- e.g. spectrum representative of cover type (classification)
- Vegetation reflectance LOW in visible, HIGH in near-infrared (NIR)


0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Reflectance Factor
16 Aug. (LAI=4.4)
12 July (LAI=3.9)
23 June (LAI = 1.6)
Bare Soil
300
500
700
900
1100
Wavelength (nm)

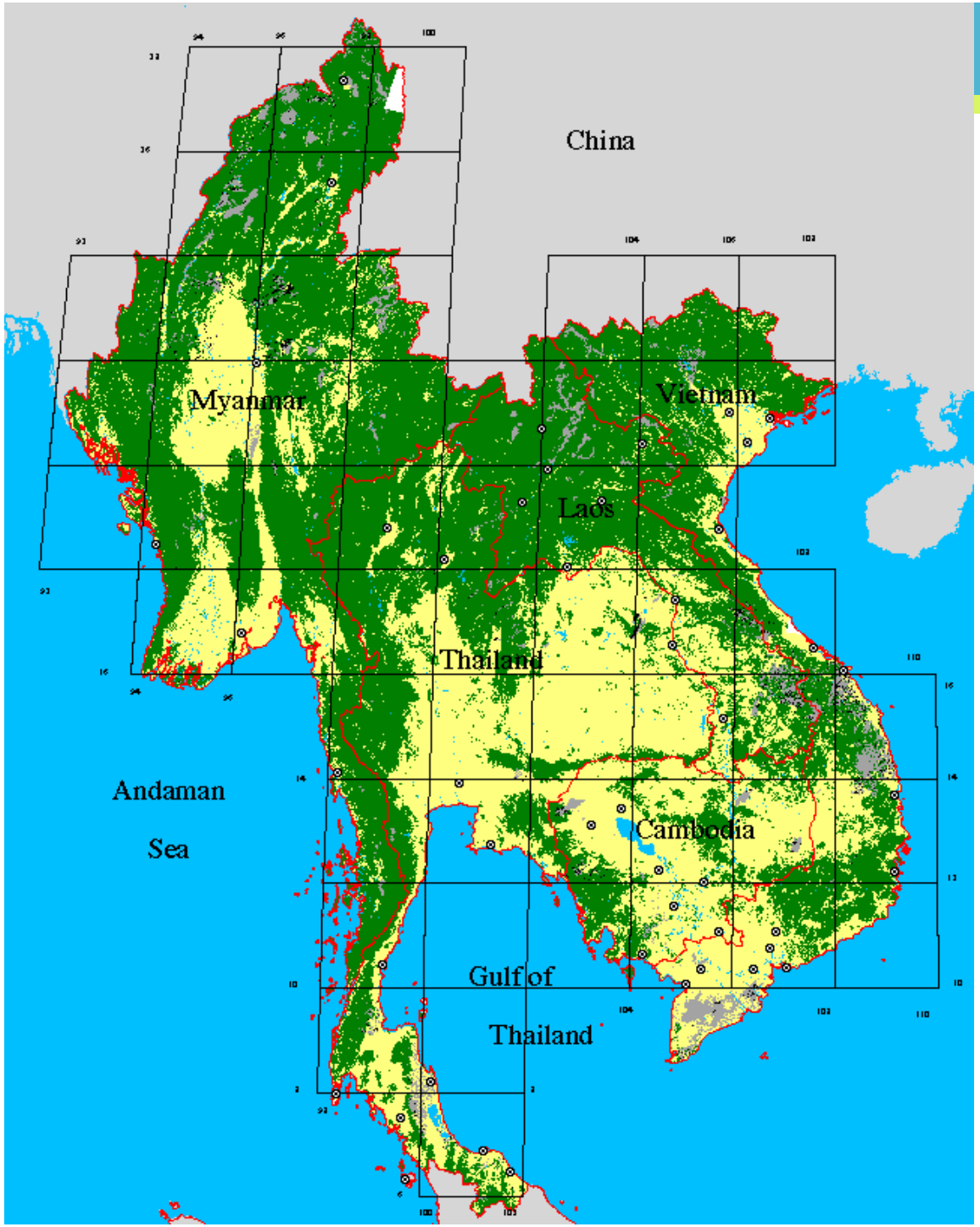
Leaf Area Index (LAI)





MODIS LAI over Africa: September 2000 (left), December 2000 (right)

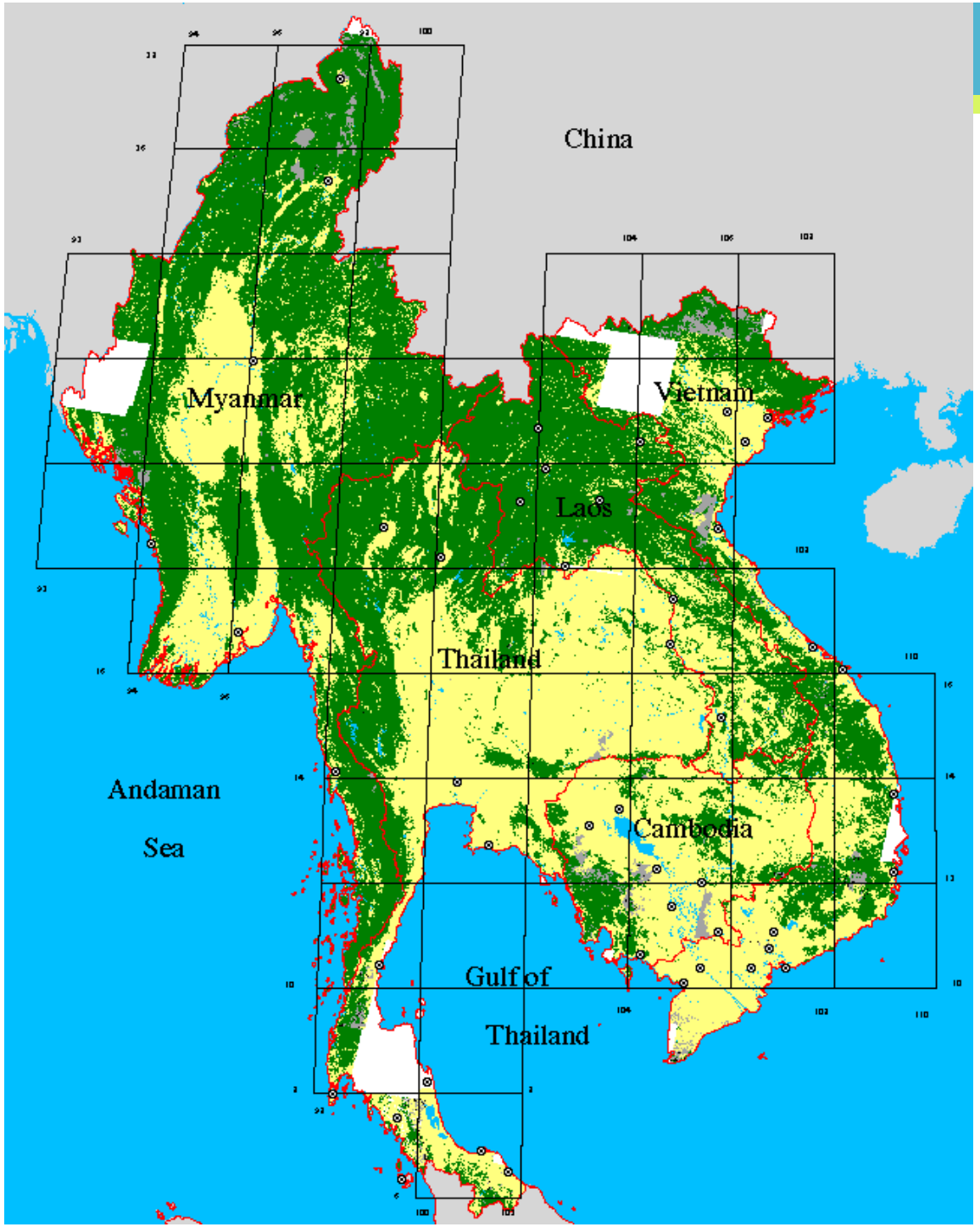
See: http://edcdaac.usgs.gov/modis/dataprod.html & http://earthobservatory.nasa.gov/Newsroom/NasaNews/2001/200112206806.html



See: http://www.bsrsi.msu.edu/rfrc/stats/seasia7385.html

Forest cover 1973

Forest Cover
- Forest
- Non-Forest
- Water
- Cloud
- Cloud Shadow



Forest cover 1985

Forest Cover
Forest
Non-Forest
Water
Cloud
Cloud Shadow

visualisation/analysis

- spectral curves
  - spectral features, e.g., 'red edge’
- scatter plot
  - two (/three) channels of information
- colour composites
  - three channels of information
- enhancements
  - e.g. NDVI

visualisation/analysis

- spectral curves
  - reflectance (absorptance) features
  - information on type and concentration of absorbing materials (minerals, pigments)
    - e.g., 'red edge':

      increase Chlorophyll concentration leads to increase in spectral location of 'feature'

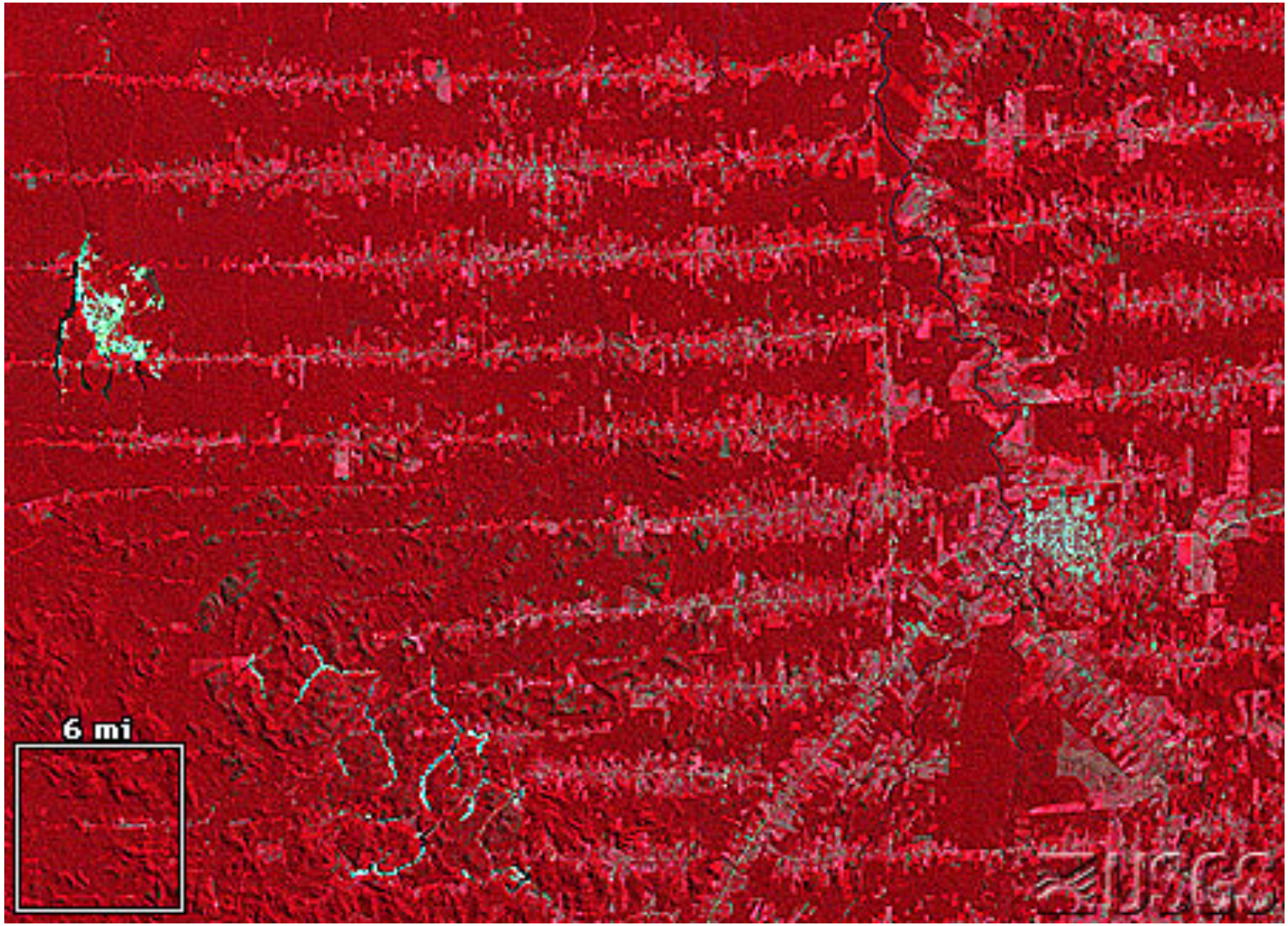
      e.g., tracking of red edge through model fitting or differentiation

visualisation/analysis

- Colour Composites
- choose three channels of information
  - not limited to RGB
  - use standard composites e.g. false colour composite (FCC)
    - learn interpretation
    - Vegetation refl. high in NIR, display on red channel, so more veg == more red, soil blue

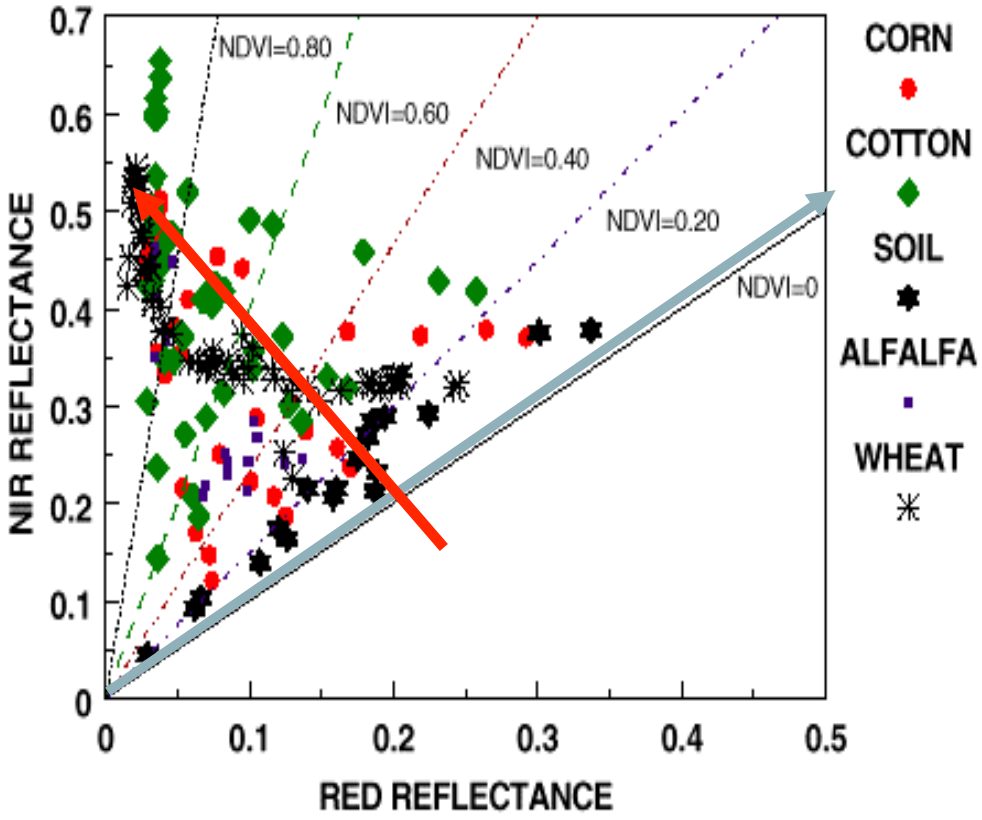
visualisation/analysis

Std FCC - Rondonia

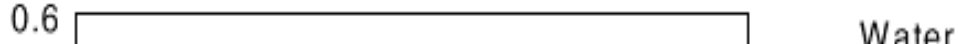


Vegetation Indices

– reexamine red/nir space features



Cloud of reflectance points in NIR-red waveband space for agricultural crops observed throughout the growing season.



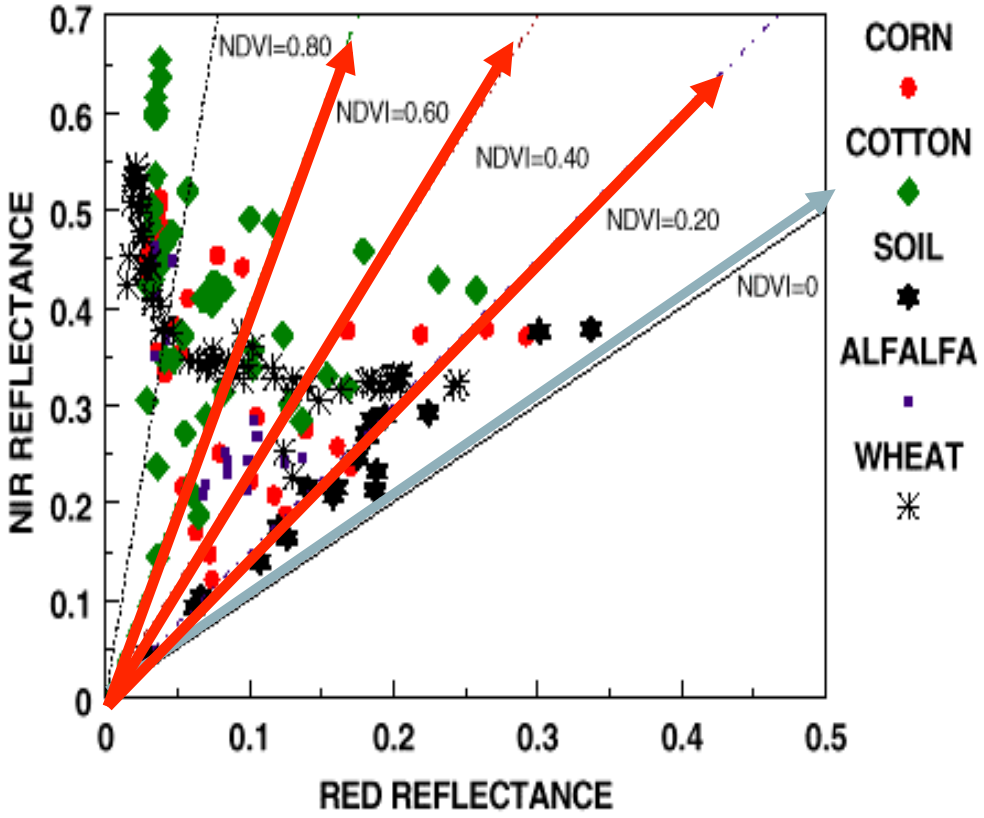
Enhancements

Vegetation Index (VI) approach

- define function of the two channels to ***enhance response to vegetation*** & minimise response to extraneous factors (soil)
- maintain (linear?) relationship with desrired quantity (e.g., canopy coverage, LAI)
- Main categories:
  - ratio indices (angular measure)
  - perpendicular indices (parallel lines)

Enhancements

Vegetation Indices



Cloud of reflectance points in NIR-red waveband space for agricultural crops observed throughout the growing season.

Enhancements

Vegetation Indices

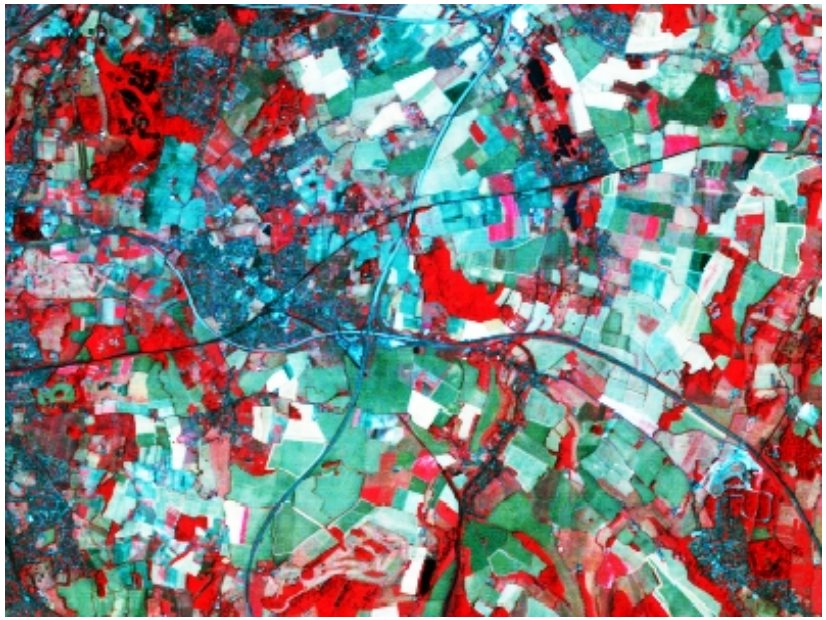
- Ratio Vegetation Index
  - RVI = NIR/Red
- Normalised Difference Vegetation Index
  - NDVI = (NIR-Red)/(NIR+Red)

Enhancements

Vegetation Indices

RATIO

INDICES



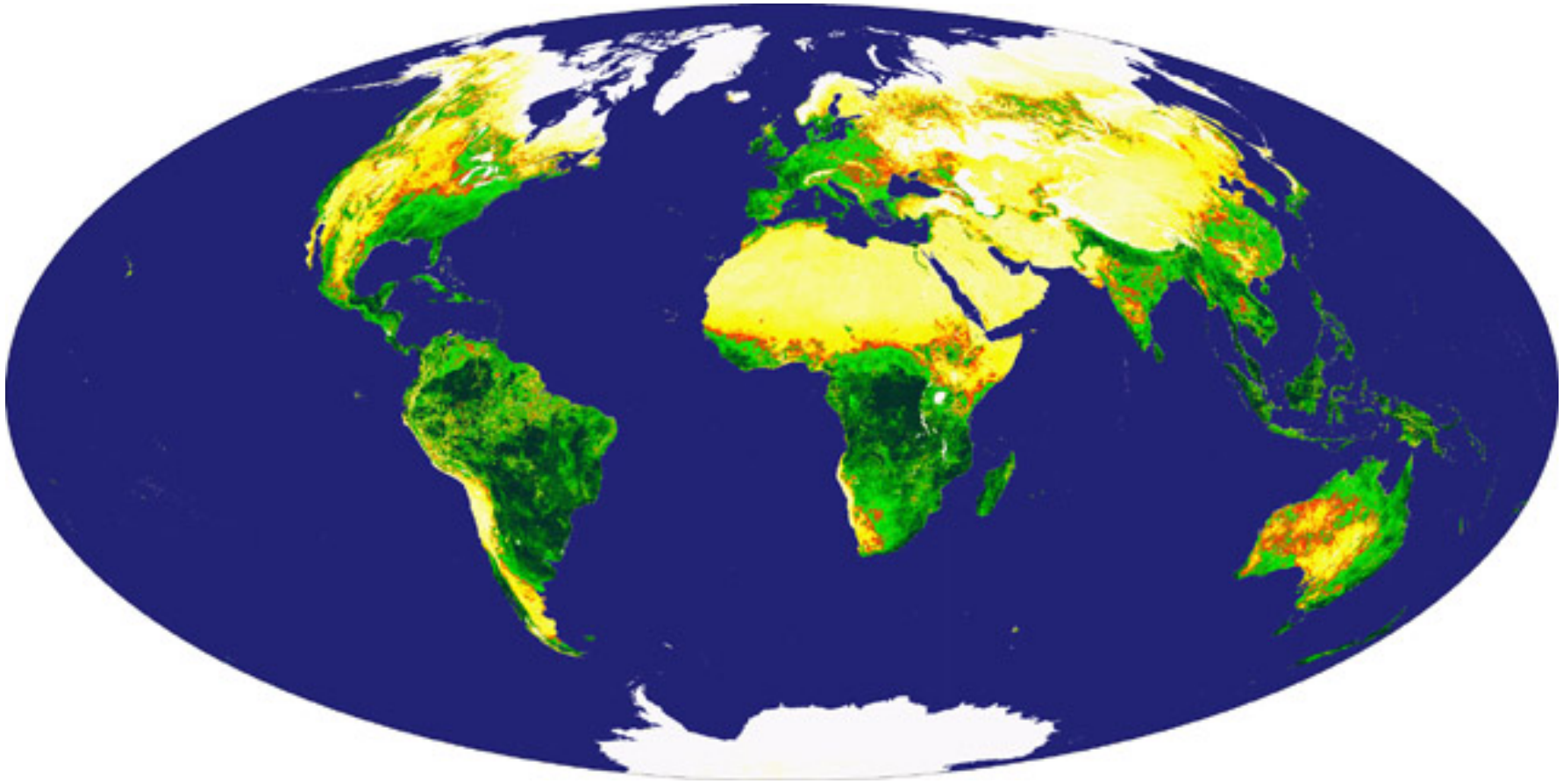
FCC (veg is red)

NDVI (veg is bright)

Global NDVI from MODIS in 2000

RATIO

INDICES

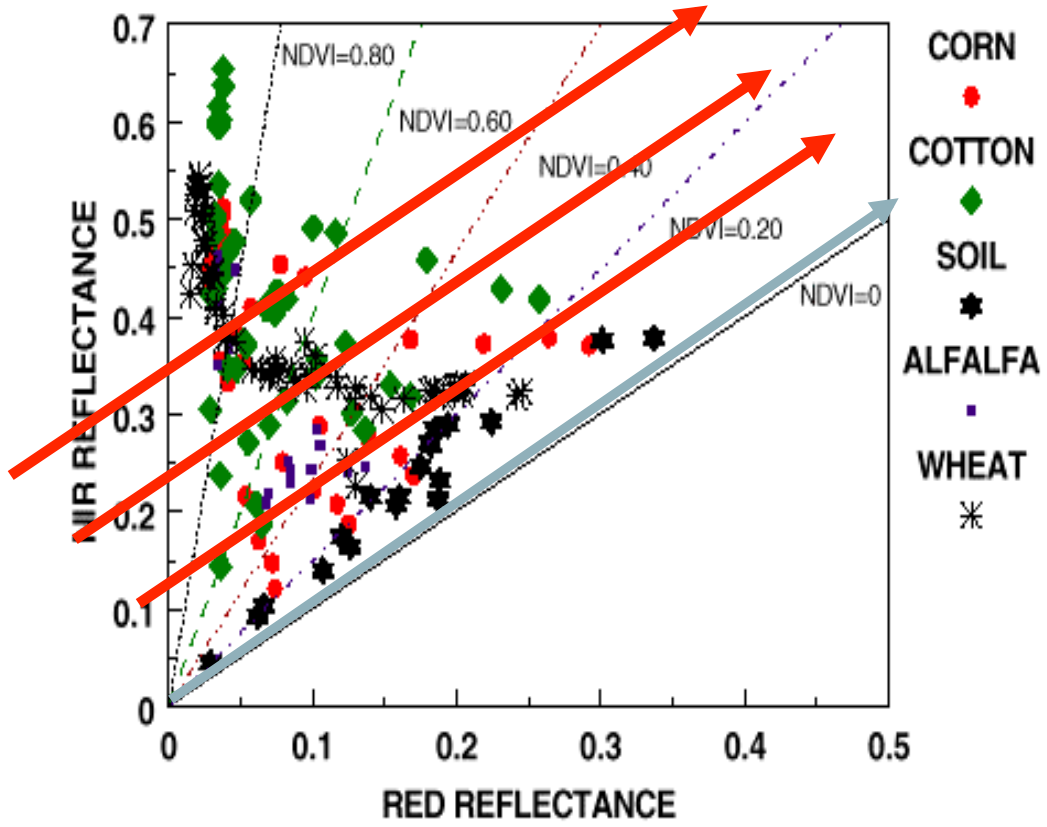


See: http://visibleearth.nasa.gov/view_rec.php?id=106

Enhancements

Vegetation Indices

PERPENDICULAR INDICES



Cloud of reflectance points in NIR-red waveband space for agricultural crops observed throughout the growing season.

Enhancements

Vegetation Indices

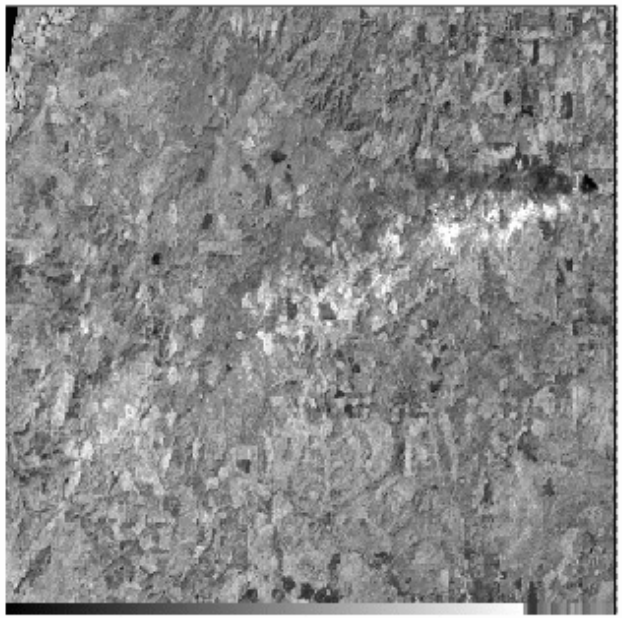
PERPENDICULAR

INDICES

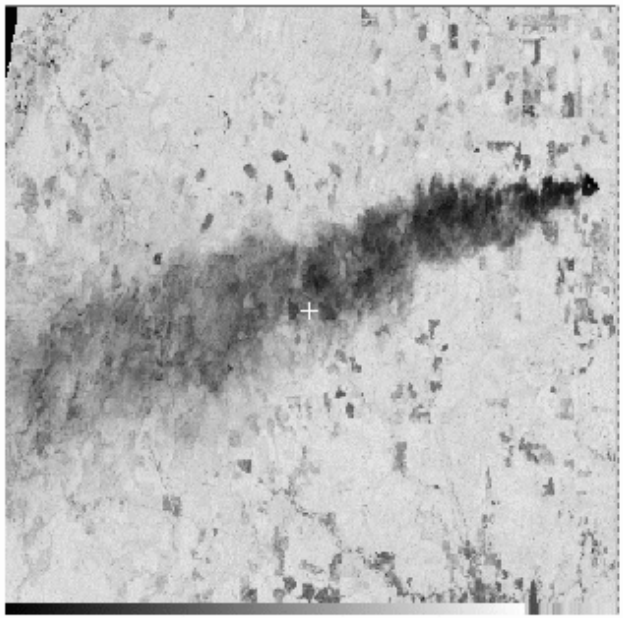
- Perpendicular Vegetation Index
  - PVI
- Soil Adjusted Vegetation Index
  - SAVI

PERPENDICULAR INDICES

a SARVI2



b NDVI



c

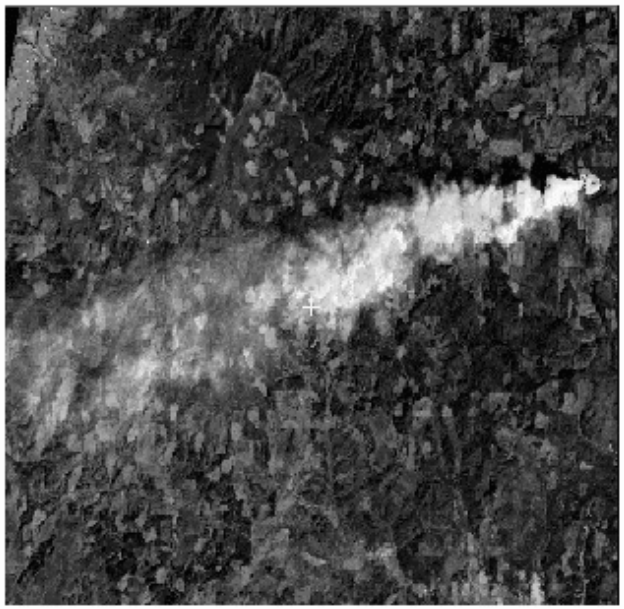


Illustration of the smoke correcting properties of the SARVI2 (a) along with the NDVI (b) and a color composite (c). (Oregon coastal forest, LANDSAT 5, August 29,1993; 983x660 30 m pixels; atmospherically corrected with the dark object subtraction (DOS) technique)

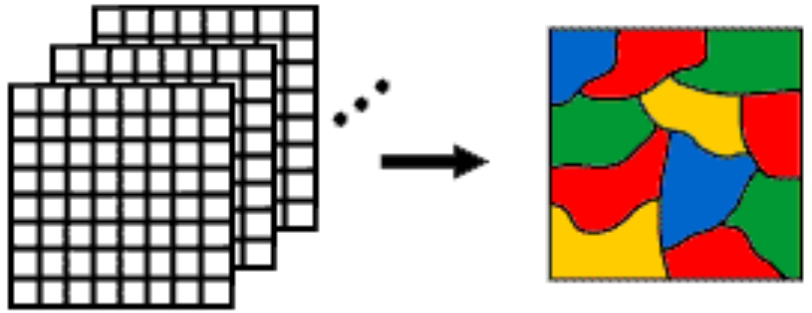
And others ...

Multispectral image classification quick intro

- categorising data
- data abstraction / simplification
- data interpretation
- mapping
  - for land cover mapping
  - use land cover class as a surrogate for other information of interest (ie assign relevant information/characteristics to a land cover class)

Multispectral image classification

- Very widely used method of extracting thematic information
- Use multispectral (and other) information
- Separate different land cover classes based on spectral response, texture, ….
- i.e. separability in “feature space”



Summary

- Scattering/reflectance mechanisms
- monitoring vegetation amount
- visualisation/analysis
  - spectral plots, scatter plots
- enhancement
  - VIs

Pseudocolour: Thermal imaging (~10-12μm)

Standard greyscale image

Pseuduocolour image

From http://www.ir55.com/infrared_IR_camera.html