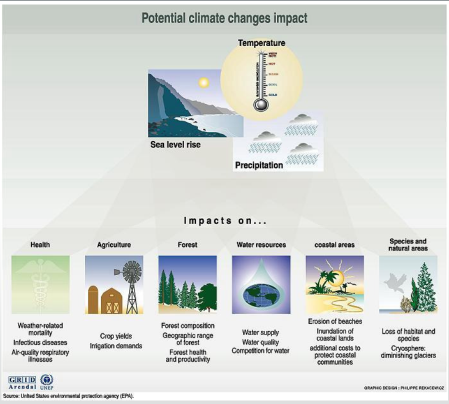
GEOG6039: Introduction to GIS and Remote Sensing

Lecture 10: Summary Session

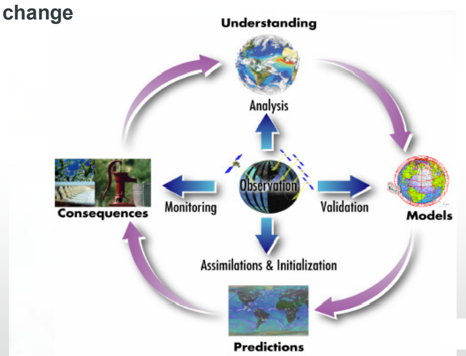
Lectures 1 and 2

- Introductions and definitions
  - RS is obtaining information at a distance from a target
    - Spatial, spectral, temporal etc.
  - Measure reflected/emitted/backscattered EMR and INFER biophysical properties from them
  - Range of platforms and applications, sensors, types of remote sensing (active/passive)
- Why use RS?
  - Global coverage (potentially), repeatable.....
  - Can view inaccessible regions
  - Many applications

Impacts of climate change



Role of Remote sensing in climate change



Lecture 1 : History of Remote Sensing

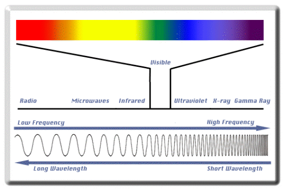
1858 Gasper Felix Tournachon "Nadar" takes photograph of village of Petit Bicetre in France from a balloon

After the war the technology was in place to begin large scale aerial surveys

Ref: Campbell (2002), Chapter 1: History and Scope of RS

Lectures 1 and 2

- Introduction to the EM Spectrum
  - Continuous λ
  - ...UV, Visible, Near infrared, Shortwave infrared, thermal, microwave, radio..
  - Shorter λ (higher f) = higher energy
  - Longer λ (lower f) = lower energy

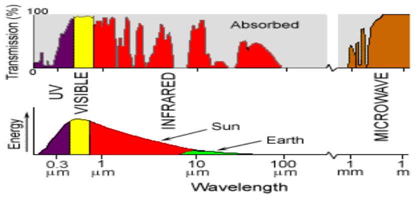


Lecture 3

- Energy interactions with the atmosphere
- How is EMR modified by the atmosphere?
  - Scattering
    - Rayleigh
      - Upper atmosphere, caused by small particles (e.g. N and CO_2) wavelength dependent)
    - Mie
      - Lower atmosphere, caused by particles roughly equal to the scattered recitation e.g. aerosols, wavelength dependent)
    - Non-selective
      - Lower atmosphere, caused by large particles, NOT wavelength dependent.
  - Absorption (O_3, CO_2, H_2O)

Lecture 3

Atmospheric windows



If you want to look at the surface

- Look in atmospheric windows where transmission is high

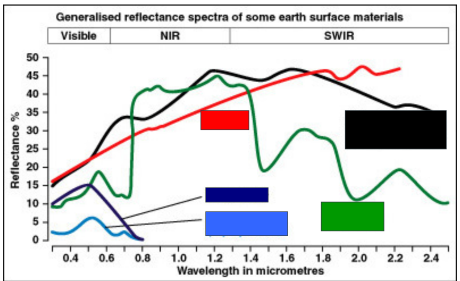
- V. Important when selecting instrument channels
  - Note atmosphere nearly transparent in µwave i.e. can see through clouds!
  - Big advantage of µwave RS

Lecture 4

- Energy interactions with surface features
- What happens when energy meets a surface?
  - Absorbed, reflected or scattered
  - Which depends on the type of matter and the wavelength of the energy
  - Wavelengths where absorption takes place are called absorption features
  - Spectral signatures

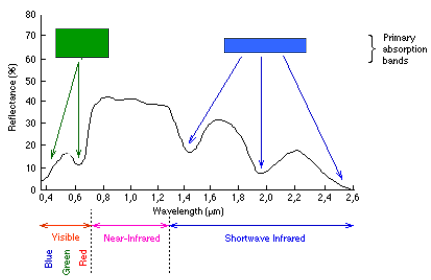
Lectures 4

- Spectral Information

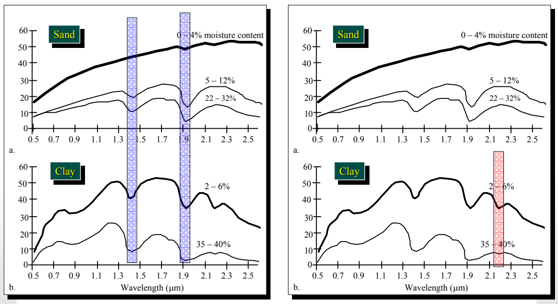


Lecture 4

- Vegetation



Lectures 4



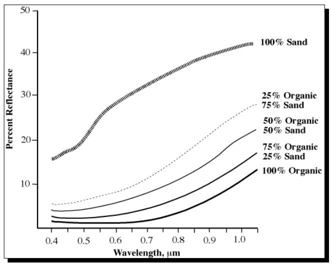
Moisture

Clay or sand? Hydroxyl band

Lecture 10

Lectures 4

- Soil



Organic content – Darker soils, lower reflectance

Summary

Lecture 10

Lectures 5

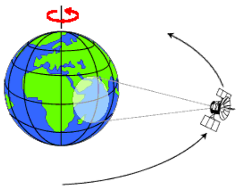
- Sensors and sensor systems
- Platforms
  - Airborne
  - Space-borne
- Orbits
  - Geo-stationary
  - Sun synchronous near-Polar orbiting

Summary

Lecture 10

Lecture 5

- Geostationary – High orbit e.g. communications
- The satellite orbits the earth at exactly the same speed as the earth turns and at the same latitude, specifically zero, the latitude of the equator. A satellite orbiting in a geostationary orbit appears to be hovering in the same spot in the sky, and is directly over the same patch of ground at all times.

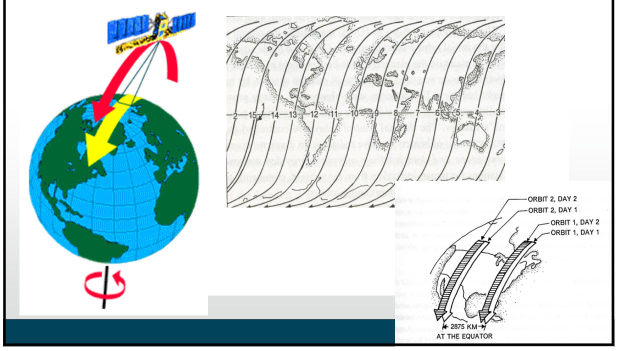


Summary

Lecture 10

Lecture 5

Near-Polar – Lower orbit e.g. Earth observation



Summary

Lecture 10

Lecture 5

Resolution

- Spatial resolution
  - Ability to separate objects spatially (function of optics and orbit)
- Spectral resolution
  - Location, width and sensitivity of chosen λ bands (function of detector)
- Temporal resolution
  - Time between observations (function of orbit and swath width)
- Radiometric resolution
  - Precision of observations (determined by detector sensitivity)

Summary

Lecture 10

Lecture 5

Low v High Resolution?

- Trade off coverage v detail (and data volume)
- Spatial Resolution?
  - Low spatial resolution can cover wide areas
  - High res gives more detail BUT may be too much data (and less energy per pixel)
- Spectral Resolution?
  - Broad bands – less spectral detail BUT greater energy per band
  - Dictated by sensor application e.g. VIS, SWIR, thermal etc.

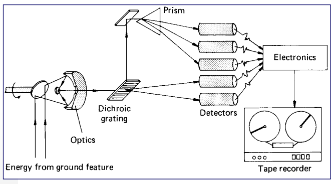
Summary

Lecture 5 and 6

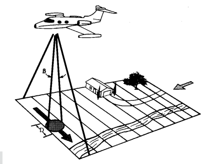
- Sensors and sensor systems
- Sensors
  - Multispectral scanners
  - Hyperspectral scanners
  - Along Track (push broom)
  - Across Track (whisk broom)

Lectures 5 and 6

- Across Track Scanner (whisk broom)

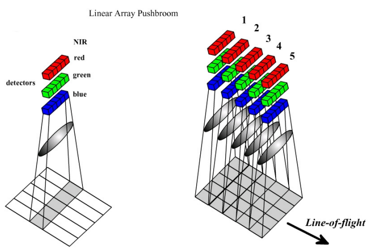


Example : Landsat



Lecture 5 and 6

- Along Track Scanner (Pushbroom)



Example : SPOT

Lecture 6

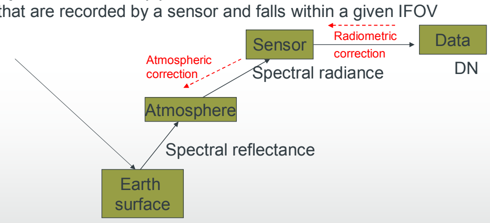
Major Remote Sensing Systems

- Landsat
- SPOT
- AVHRR
- ENVISAT
- Terra and Aqua
- Spectral, spatial, temporal resolutions!

Lecture 7

Radiometric calibration

Spectral radiance (L) are measures that describe the amount of light that are recorded by a sensor and falls within a given IFOV



Spectral radiance *independent* of sensor

DN *depends* on sensor

Lecture 7

How do we get spectral radiance at sensor?

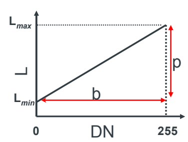
Y=mX+c

L= slope*DN+ intercept

Slope= $\frac{p}{b} = \frac{(L_{max} - L_{min})}{255}$

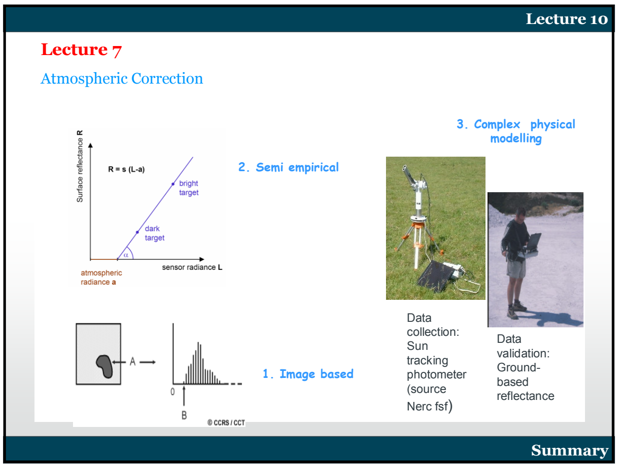
Intercept= L_{min}

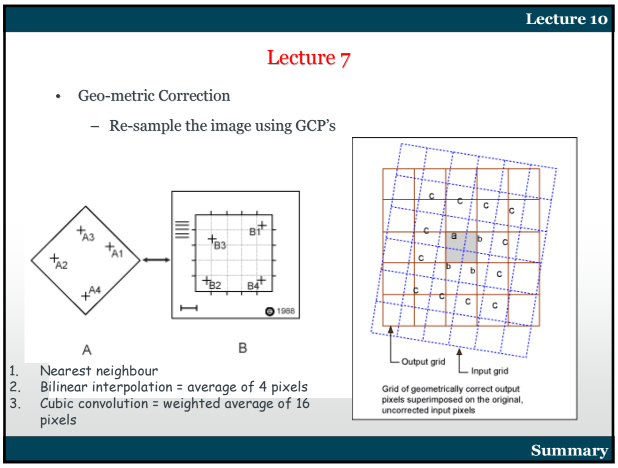
$L = \frac{(L_{max} - L_{min})}{255} * DN + L_{min}$

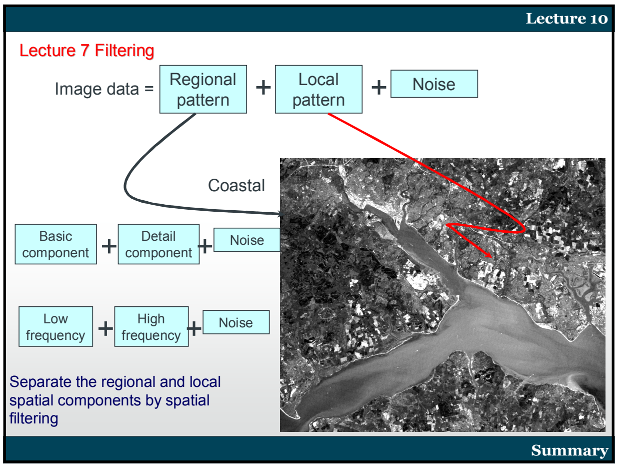


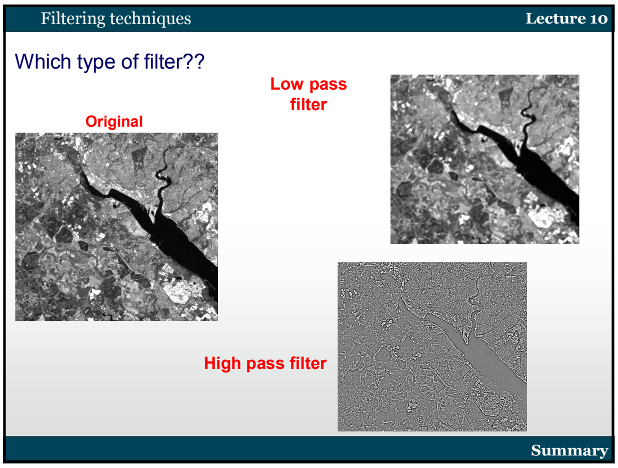
L_{min} is spectral radiance corresponding to a DN of 0

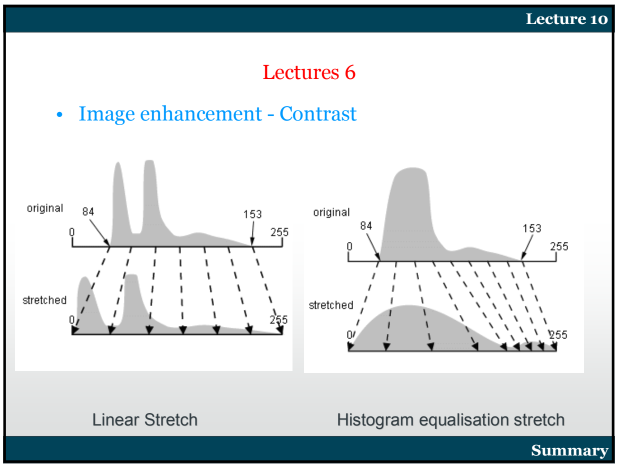
L_{max} is minimum radiance required to generate maximum DN (255)

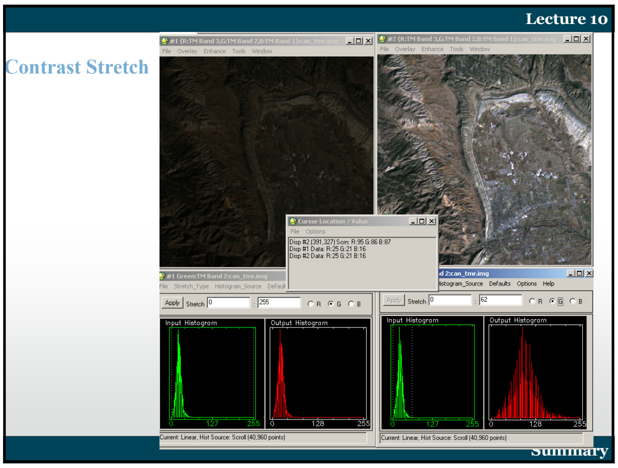

Lecture 10
Lecture 7
Atmospheric Correction
3. Complex physical modelling
2. Semi empirical
R = s (L-a)
bright target
dark target
Surface reflectance R
sensor radiance L
atmospheric radiance a
1. Image based
Data collection: Sun tracking photometer (source Nerc fsf)
Data validation: Ground-based reflectance
Summary


Lecture 10
Lecture 7
Geo-metric Correction
Re-sample the image using GCP's
A3
A1
A2
A4
B1
B3
B2
B4
A
B
Output grid
Input grid
Grid of geometrically correct output pixels superimposed on the original, uncorrected input pixels
1. Nearest neighbour
2. Bilinear interpolation = average of 4 pixels
3. Cubic convolution = weighted average of 16 pixels
Summary


Lecture 10
Lecture 7 Filtering
Image data = Regional pattern + Local pattern + Noise
Coastal
Basic component + Detail component + Noise
Low frequency + High frequency + Noise
Separate the regional and local spatial components by spatial filtering
Summary


Filtering techniques
Lecture 10
Which type of filter??
Low pass filter
Original
High pass filter
Summary

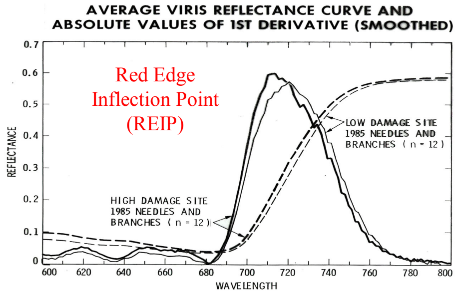

Lecture 10
Lectures 6
Image enhancement - Contrast
original
84
153
0
255
stretched
0
255
Linear Stretch
Histogram equalisation stretch
Summary


Lecture 10
Contrast Stretch
Input Histogram
Output Histogram
Summary

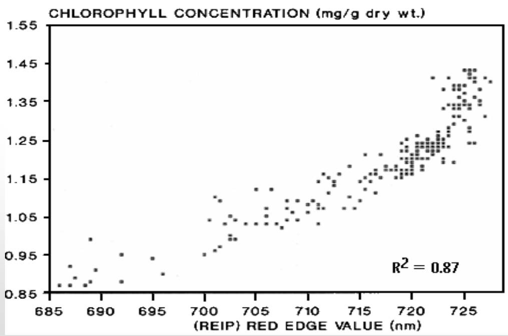
Lecture 7

- Image Ratios/Vegetation Indices
  - NDVI
  - MSI
  - SR….
    - Can help identify subtle spectral differences
    - Simple to understand/implement

REIP



Relationship Between Chlorophyll Concentration and REIP Values (Taken From Moss and Rock, 1991)



Lectures 8 and 9

Image classification

- Unsupervised classification
  - Computer based approach
  - Interpret spectral classes to make useful information
  - ISODATA, K-Means
- Supervised Classification
  - Analyst based approach
  - Supervised Classification Stages
  - Training, Classification
  - Force spectral classes into specific information classes
  - Parallelepiped, min-distance to mean, max-likelihood