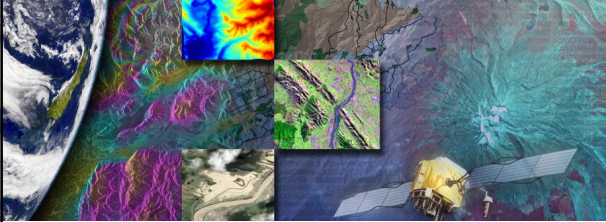


Lecture 3 – How does light give us information about environmental features



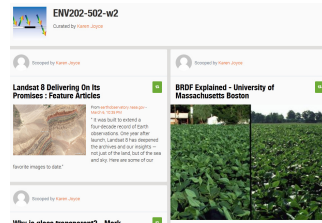
Dr Karen Joyce
School of Environmental and Life Sciences
Bldg Purple 12.3.09

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1

Revision

- Select a different scoop from last week
- Post the key points as a 'reaction' to <http://www.scoop.it/t/env202-502-w2> (need to sign in first)



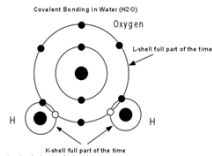
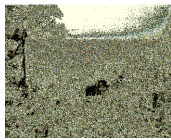
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2

Electromagnetic Radiation (EMR)



- What physical parameters are measured as the basis of remotely sensed images?
- Controls on variations in EMR reflected, absorbed or transmitted can be explained in the different portions of the EMR spectrum (bands):
 - At the physical level
 - At the atomic level
- Interactions at both scales are explained and quantified in radiative transfer theories
- These are equations which convert pixel values to biophysical parameters, and we use these to convert images to maps showing biophysical information.



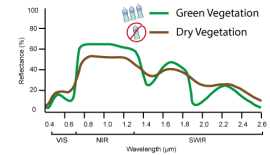
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Source: S. Phinn

3

Radiation Transfer and Interaction Pathways for Remote Sensing

- All remotely sensed data are a result of radiation interactions and transfers
- Radiative Transfer = Process of EMR being transferred through a medium



- Radiative Transfer Equations define how EMR is absorbed, reflected and transmitted as it passes through a medium
- The key to maximising the amount and accuracy of information extracted from remotely sensed data is understanding which radiation transfer and interaction processes to record and analyse
- How are these equations relevant to remotely sensed data?

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Source: S. Phinn

4

Radiative Transfer Equation for Data in an Image Pixel

Total irradiance (E_T) at the earth's surface:

$$E_T = E_0 T_{\theta_0} \cos \theta_0 + E_d$$

= [W/m².steradian]

Where,

- E_0 = top of atmosphere irradiance
- T_{θ_0} = transmissivity of atmosphere
- $\cos \theta_0$ = cosine of solar zenith angle
- E_d = diffuse irradiance
- R = reflectance or albedo

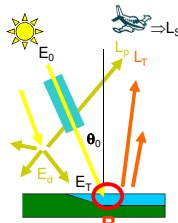
Radiance at the sensor (L_s):

$$L_T = 1/\pi \cdot R (E_0 T_{\theta_0} \cos \theta_0 + E_d)$$

Additive path radiance = L_p

Total radiance at sensor

$$L_s = L_T + L_p$$



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Source: S. Phinn

5

Your Job – Part 1

- Choose a topic
 - The Atmosphere
 - Water
 - Vegetation
 - Soils / rock
 - Benthic habitats



- Identify the physical, chemical, and biological components relevant to your topic
- Post to one of the following:
 - <http://padlet.com/wall/env202-502-atmos>
 - <http://padlet.com/wall/env202-502-water>
 - <http://padlet.com/wall/env202-502-veg>
 - <http://padlet.com/wall/env202-502-soil>
 - <http://padlet.com/wall/env202-502-benthic>



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6

Vegetation Radiative Transfer

- Light interactions with vegetation are controlled at several scales
- Within leaf:
 - Photosynthetic processes
 - Photosynthetic + non-photosynthetic pigments
 - Water content
 - Self-defense/regulatory mechanisms
 - Leaf internal and external structures

7

Vegetation Scales

- Leaf
 - Internal (structure, chemistry, processes)
 - Form/morphology
 - Orientation
 - Coating
- Canopy
 - Density and arrangement of leaves
 - Crown form and layering
- Stand
 - Structural properties
 - Topography/microclimate
 - Biomass
- Community

8

Water Radiation Transfer and Interactions

- Water-interactions:
 - Air-Water interface + atmosphere
 - Water column
 - Substrate features (sediment, benthic flora and fauna)
- Water-column:
 - Absorption and Scattering
 - Suspended and Dissolved matter
- Key controls:
 - Surface roughness
 - Organic matter
 - Inorganic Matter
 - Depth
 - Substrate type

9

Mineral and Soil Radiation Transfer

- Minerals
 - Similar controls on interactions as atmospheric gases
 - Atomic level interactions of light with different minerals is unique due to their structure
 - Results in distinctive mineral absorption spectra
 - Source of minerals data: <http://minerals.gps.caltech.edu/>
- Soils
 - Mineral content (e.g. iron oxide)
 - Organic content (e.g. leaf litter)
 - Roughness / texture (sand, silt, clay)
 - Moisture content

10

Aquatic Vegetation - Coral

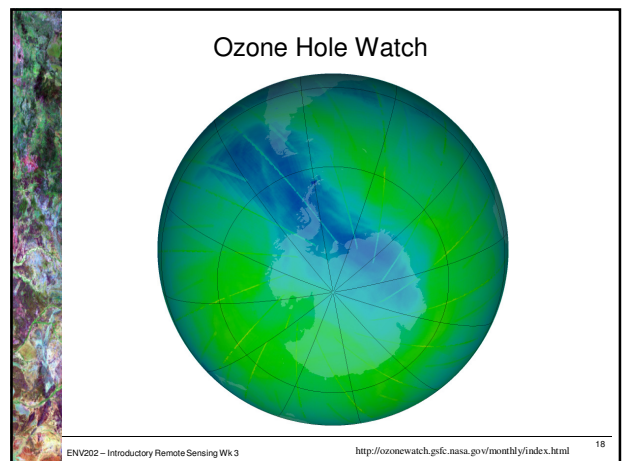
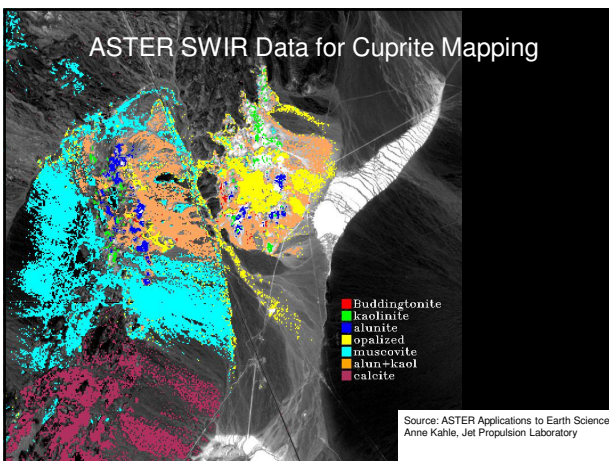
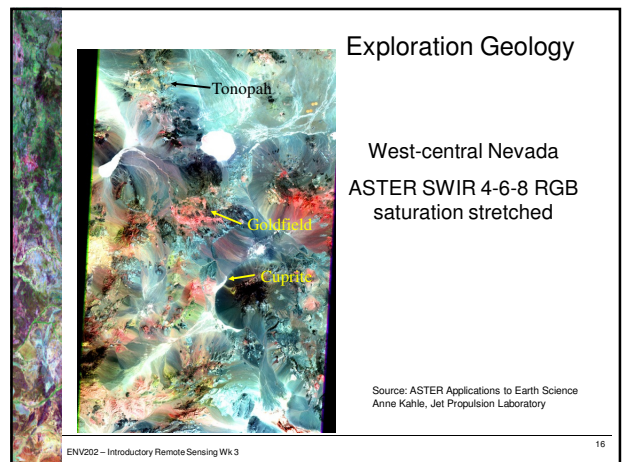
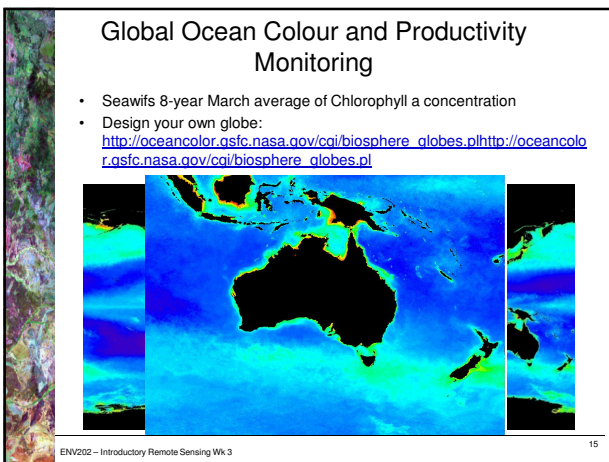
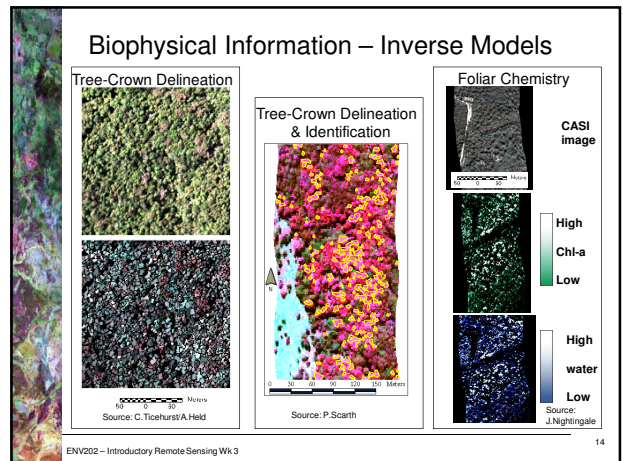
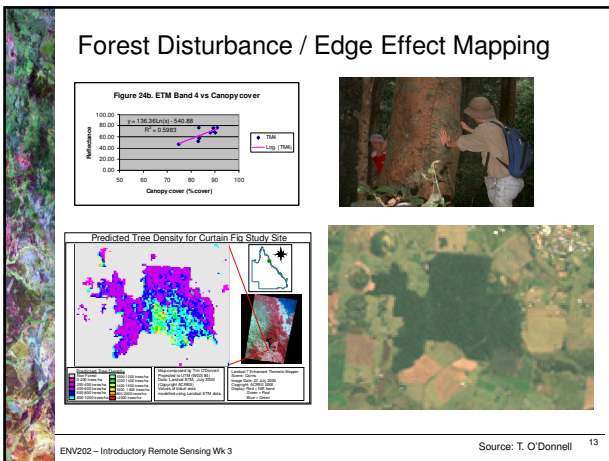
Graph source A: Hochberg, E. J., M. J. Atkinson and S. Andréfouët (2003). "Spectral reflectance of coral reef bottom-types worldwide and implications for coral reef remote sensing." *Remote Sensing of Environment* 85(2): 159 - 173.

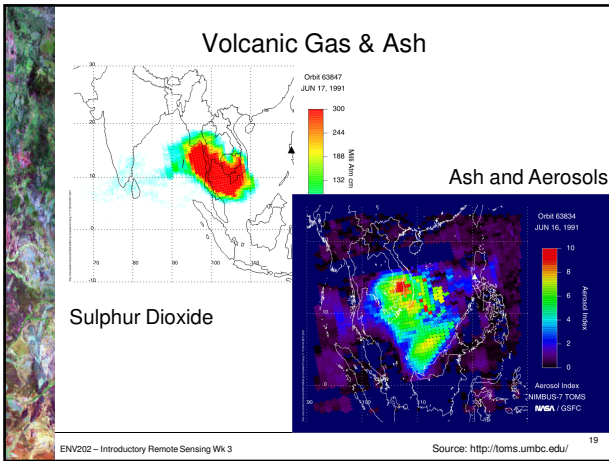
11

Your Job – Part 2

- Choose a different topic
 - The Atmosphere
 - Water
 - Vegetation
 - Soils / rock
 - Benthic habitats
- Identify the potential remote sensing applications
- Post to one of the following:
 - <http://padlet.com/wall/env202-502-atmos>
 - <http://padlet.com/wall/env202-502-water>
 - <http://padlet.com/wall/env202-502-veg>
 - <http://padlet.com/wall/env202-502-soil>
 - <http://padlet.com/wall/env202-502-benthic>

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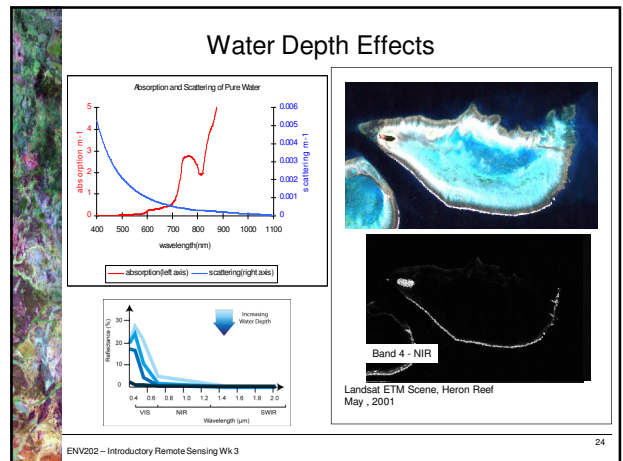
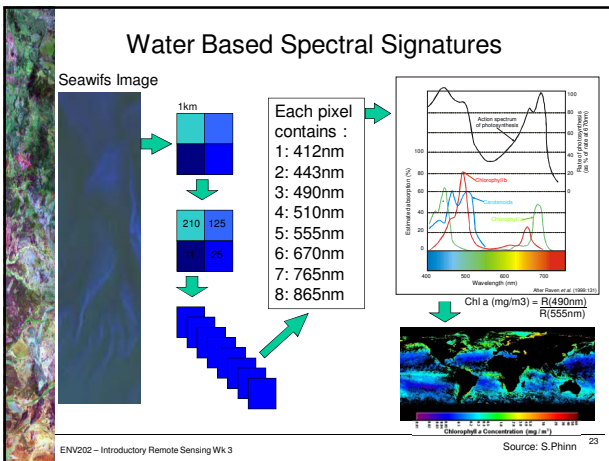
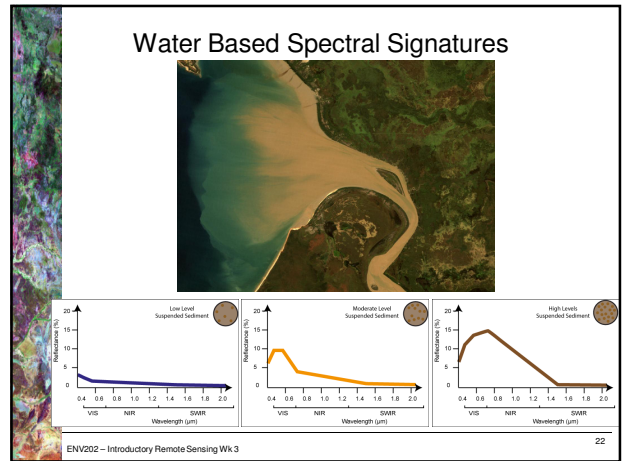
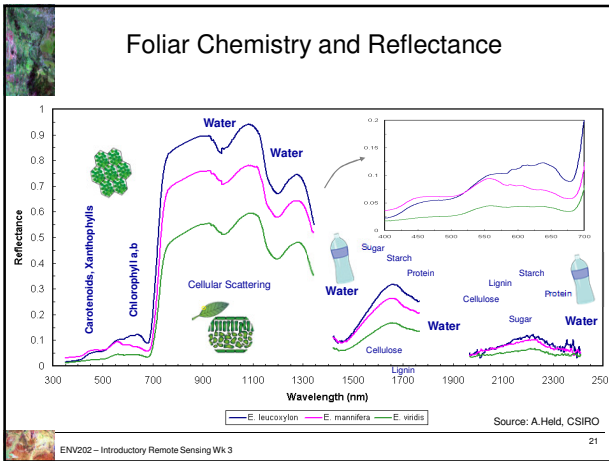




Your Job – Part 3

- Choose a different topic
 - The Atmosphere
 - Water
 - Vegetation
 - Soils / rock
 - Benthic habitats
- Identify the relevant wavelengths and interactions
- Post to one of the following:
 - <http://padlet.com/wall/env202-502-atmos>
 - <http://padlet.com/wall/env202-502-water>
 - <http://padlet.com/wall/env202-502-veg>
 - <http://padlet.com/wall/env202-502-soil>
 - <http://padlet.com/wall/env202-502-benthic>

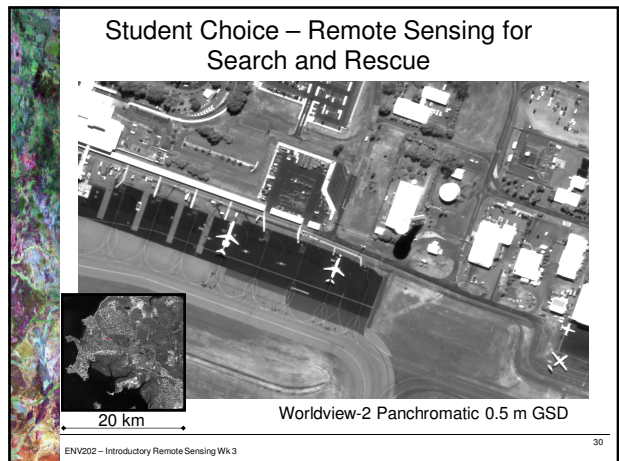
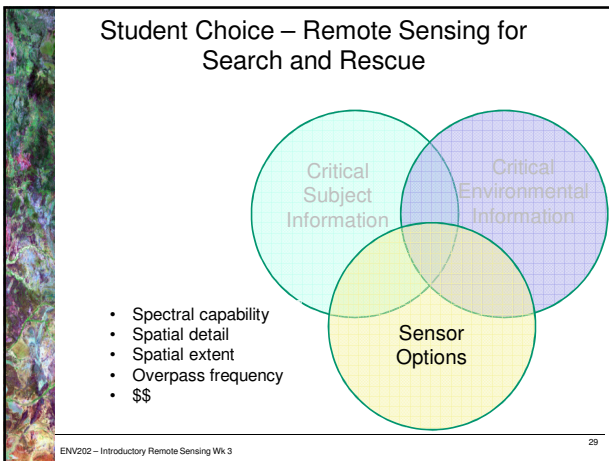
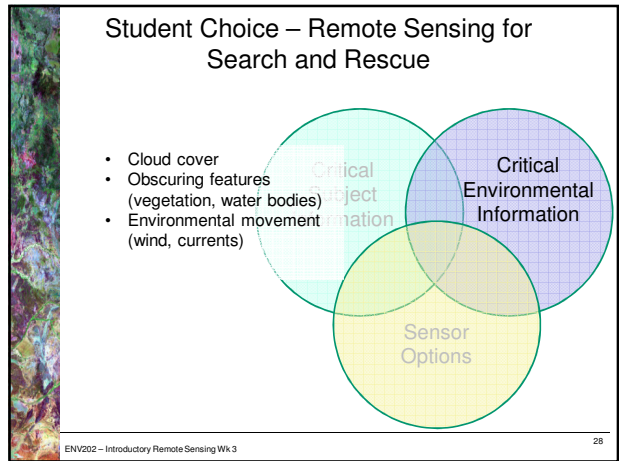
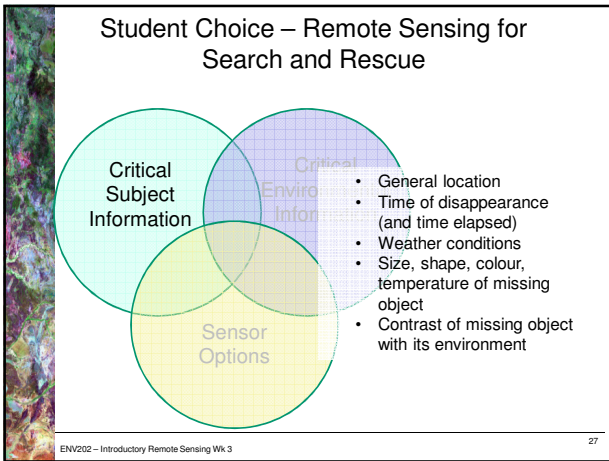
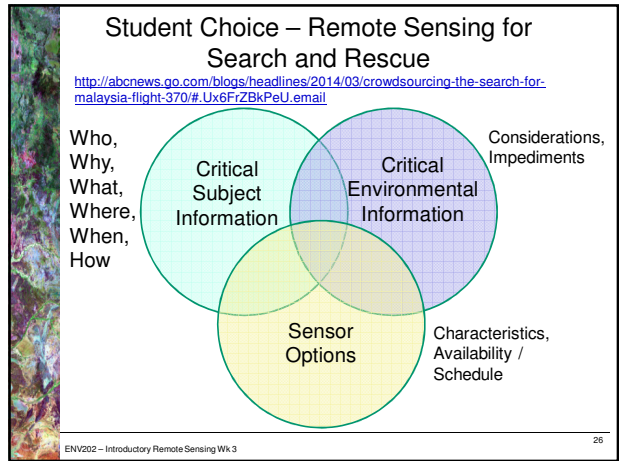
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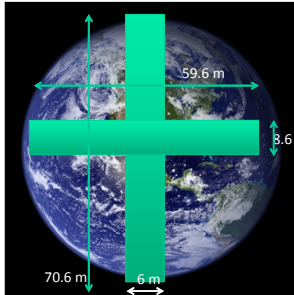
Controls on EMR Interactions

Factor	Spectral Signature Variation
Atmospheric Conditions	Presence or absence of water vapour in the atmosphere Presence or absence of gases, smoke and dust particles in the atmosphere
Stage of growth (for vegetation)	Changing appearance depending upon the stages of growth Changes in health or varying nutrients availability Incidence of diseases
Reflective and emissive properties	Variation in spatial properties (e.g. density of plants, pattern of distribution) Variation in thermal properties
Site environmental Conditions	Variation in moisture availability Variation in site fertility
Viewing Condition	Variation in sun angles Variation in sensor viewing angle Variation in altitude of the viewing platform

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Student Choice – Remote Sensing for Search and Rescue



Total area earth = 510,072,000km²
Total area MCG = 20,000m²

Total area plane = 934 m²
Size of relative equivalent feature = ??

Diameter of the object to find within the MCG = 0.2 mm!

Could you find a grain of cous cous in the MCG?