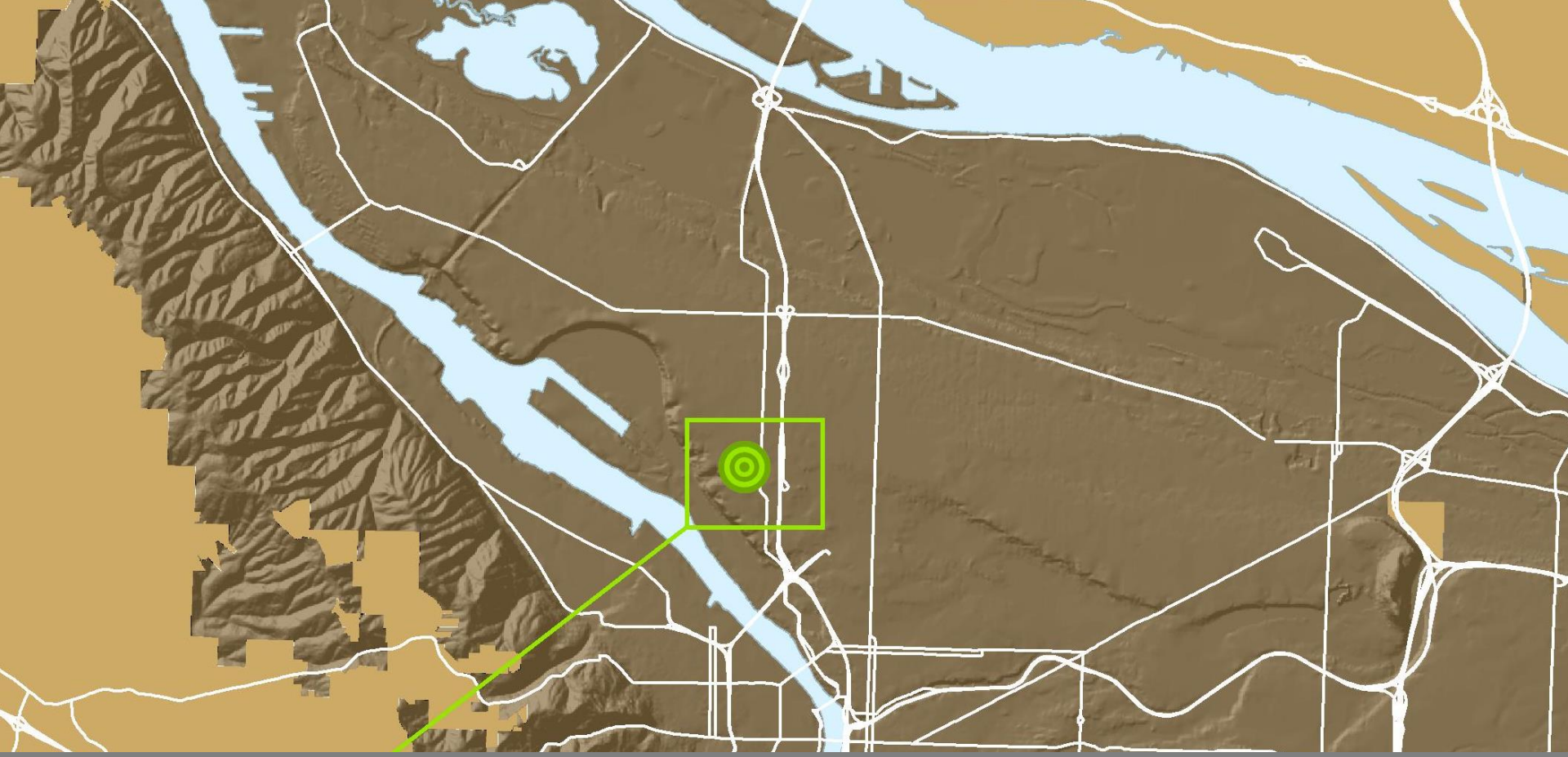
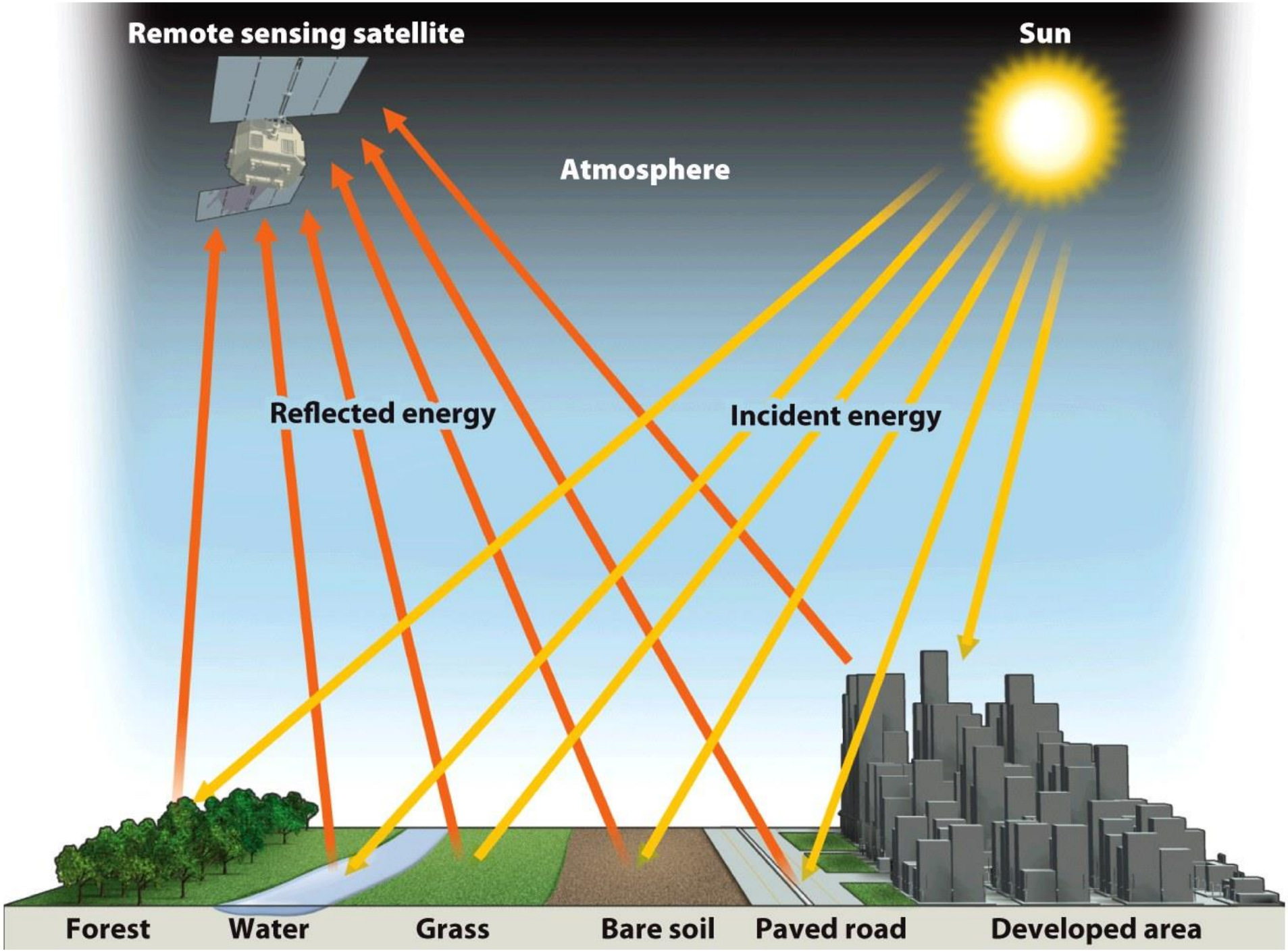


Remote Sensing – Part II

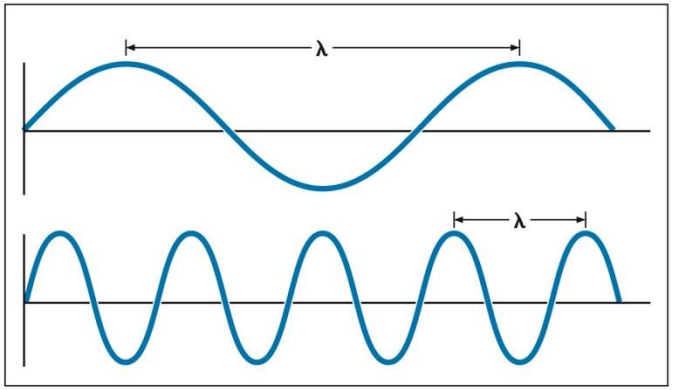
Maps & Geospatial Concepts| Fall 2015

Light Energy


Remote sensing satellite
Sun
Atmosphere
Reflected energy
Incident energy
Forest
Water
Grass
Bare soil
Paved road
Developed area

Light Energy

- Energy being radiated as waves, all at different wavelengths
- **Wavelength.** The distance between two waves
  - Long wavelengths = low frequency
  - Short wavelengths = high frequency

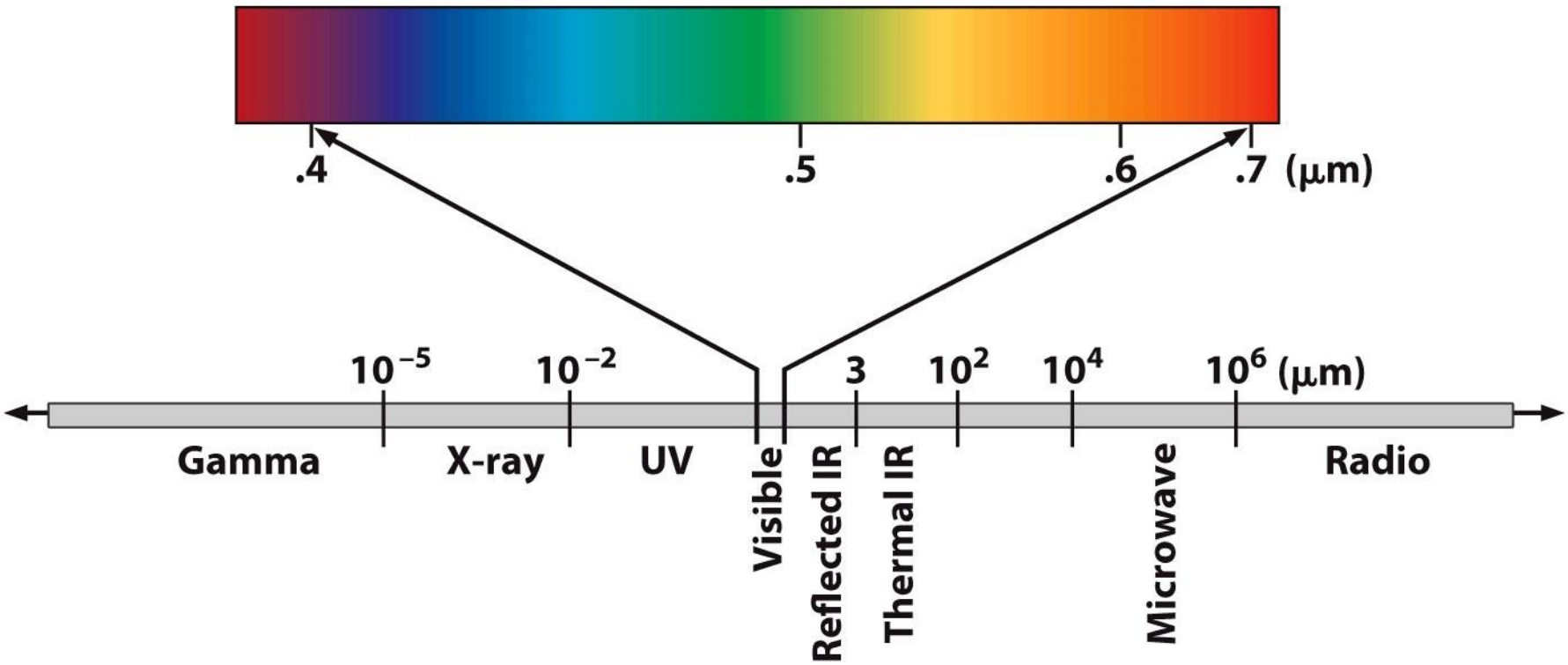


Light Energy

- Frequency x wavelength = speed of light
- Energy moves at a constant speed – speed of light (c) – 300 million m/sec

Light Energy

- **Electromagnetic Spectrum.** Properties of light energy in relation to wavelength



Light Energy

- Micrometers. One-millionth of a meter
- Nanometer. One-billionth of a meter

Light Energy

- **Visible Light Spectrum.** the portion of the electromagnetic spectrum with wavelengths between 0.4 an 0.7 micrometers
  - Shorter wavelengths = blue
  - Medium wavelengths = green
  - Long wavelengths = red
- Each represents a band of energy measured by a remote sensing device

Light Energy

- Gamma
- X-Ray
- Ultraviolet (UV)
- Near Infrared (NIR), 0.7 – 1.3 micrometers
- Middle Infrared (MIR), 1.3 – 3.0 micrometers
- Thermal Infrared (TIR), 3 – 14.0 micrometers

Light Energy & Atmosphere

- **Atmospheric Windows.** The wavelengths of electromagnetic energy that passes through the Earth's atmosphere
- **Scattering.** Light is scattered by particles in the atmosphere
  - Rayleigh. Caused by particles smaller than the wavelength being scattered (molecules)
  - Mie. Caused by particles the same size as the wavelength being scattered (dust or smoke)
  - Nonselective. Caused by particles larger than the wavelength being scattered (water or clouds)

Light Energy hits the Ground

- **Transmittance.** When the light passes through the target (glass)
- **Absorption.** When light energy is trapped by the target (blacktop)
  - When something appears one color (i.e. Red), all other colors are absorbed by the object
- **Reflected.** When light energy is reflected by the target

Light Energy hits the Ground

- **Incident Energy.** The total amount of energy that interacts with the target object
  - Incident Energy = Reflected + Absorbed + Transmitted
- **Spectral Reflectance.** Percentage of the total incident energy that is reflected off a target object
  - Spectral reflectance = (Reflected/Incident)x100

Spectral Reflectance

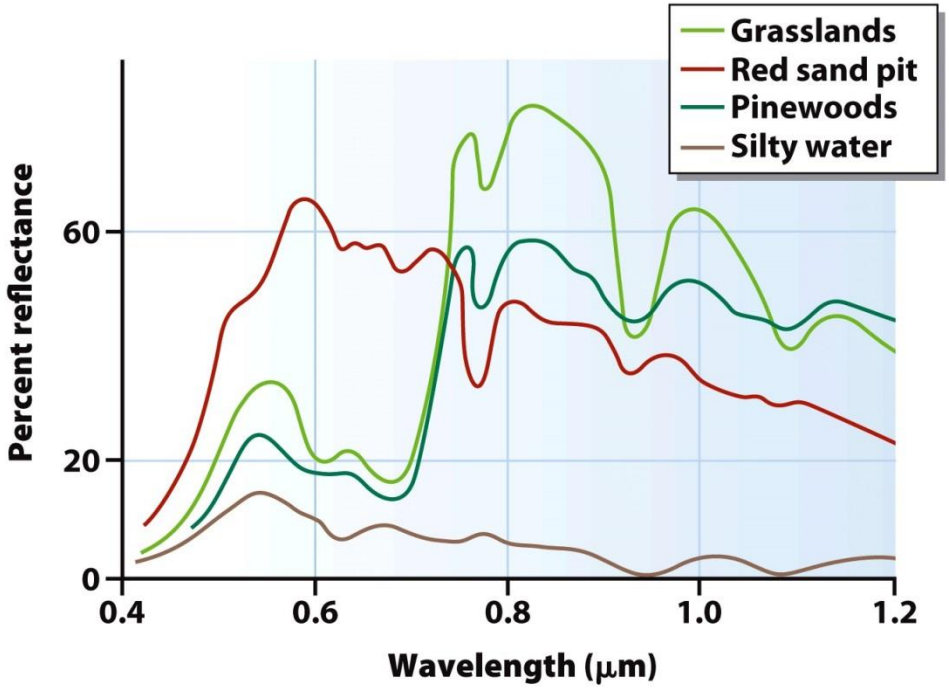
How is all this related to remote sensing?

Spectral Reflectance

- All objects on Earth reflect energy wavelengths differently
- Some things reflect energy differently depending on the conditions (spring/summer v. fall/winter)

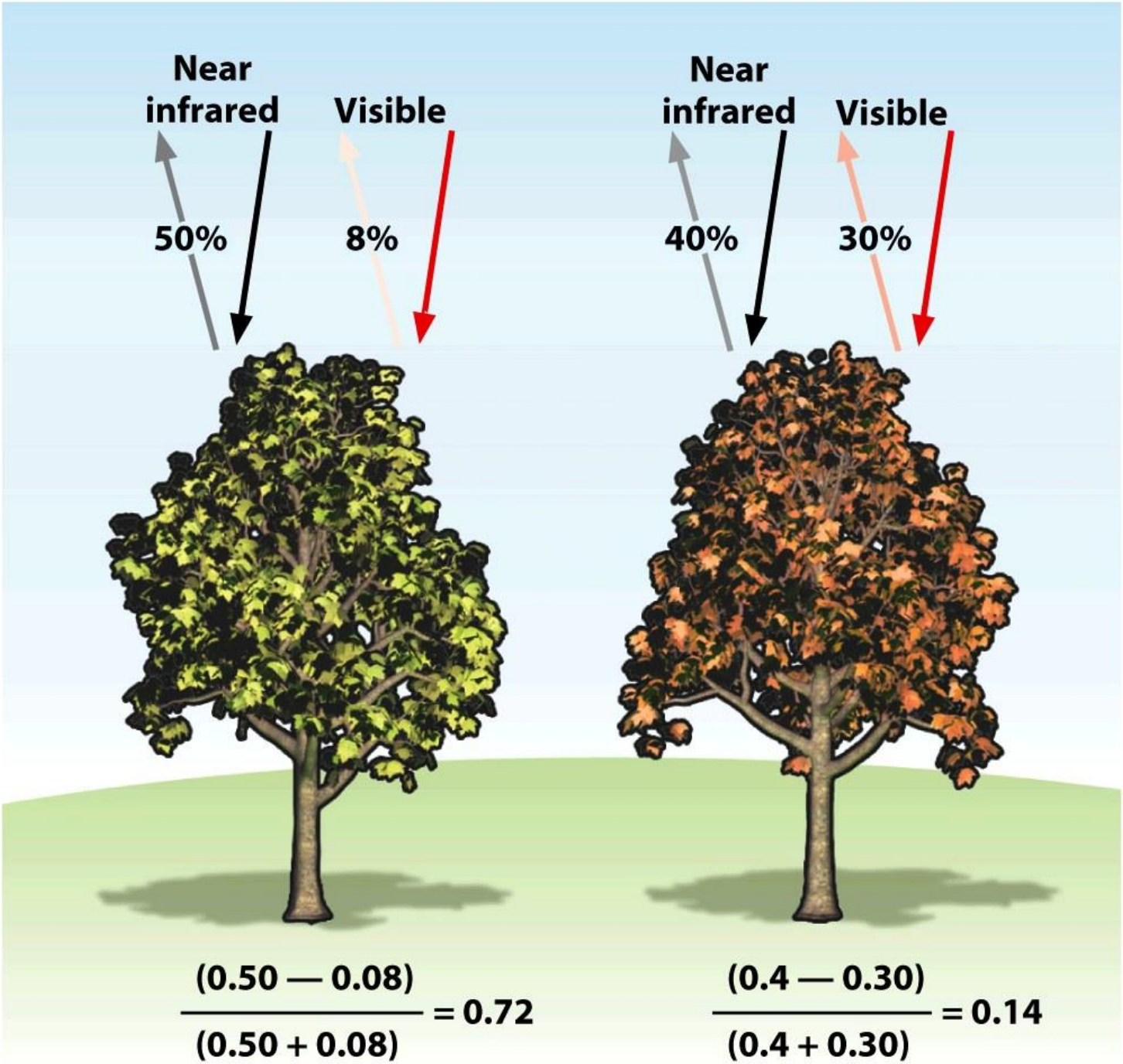
Spectral Reflectance

- **Spectral Signature.** Unique identifier for an object, created by charting out the percentage of reflected energy per wavelength, against the value for that wavelength



Normalized Difference Vegetation Index (NDVI)

- Measures the healthiness of vegetated areas
- Health veg absorbs blue & red light energy to fuel photosynthesis & create chlorophyll
- A plant with more chlorophyll will reflect more NIR energy than an unhealthy plant
- NDVI = (NIR - Red)/(NIR + Red)
- Ranges from -1(low) to +1(high)

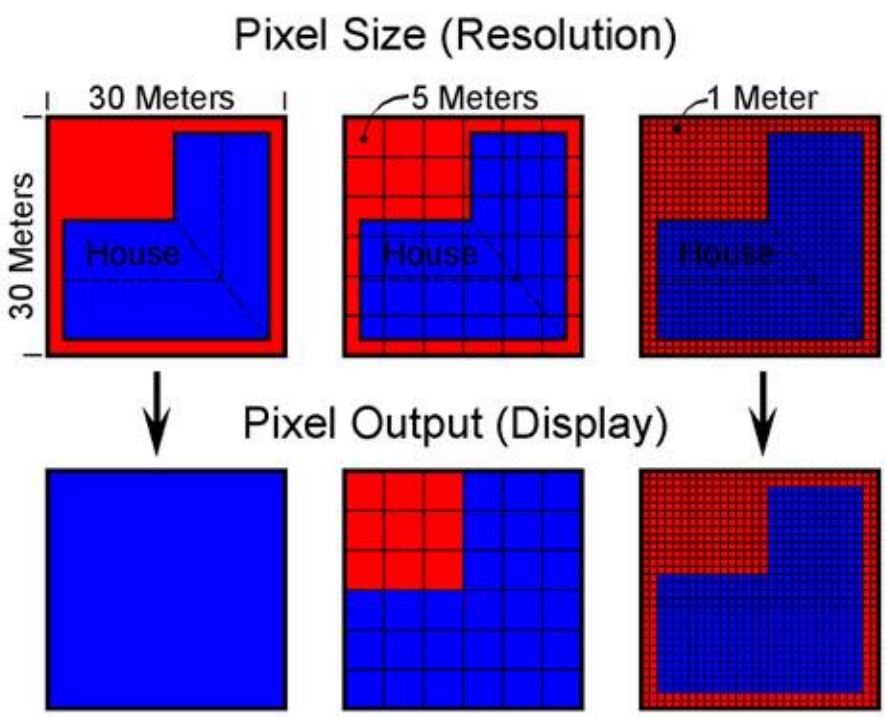

Near infrared
Visible
50%
8%
Near infrared
Visible
40%
30%
$\frac{(0.50 - 0.08)}{(0.50 + 0.08)} = 0.72$
$\frac{(0.4 - 0.30)}{(0.4 + 0.30)} = 0.14$

Digital Images

post data collection

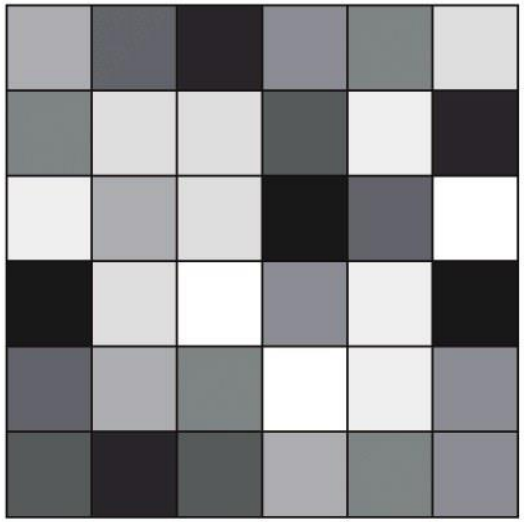
Spatial Resolution

- The size of the area on the ground being represented by each pixel in the image (i.e. 30m, 10m, 1cm)

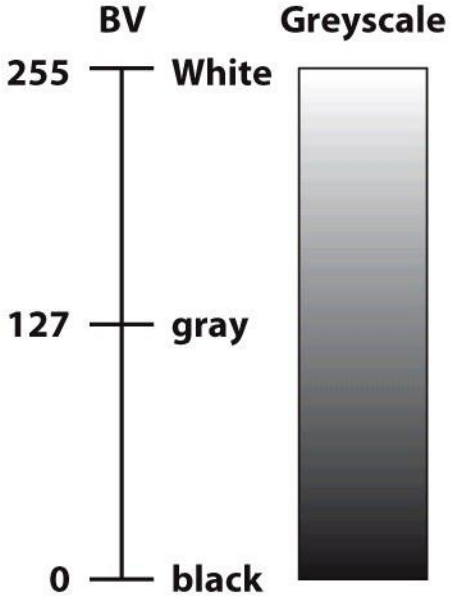


Brightness Value

- The energy measured at a single pixel based on the amount of radiance measured – one for each wavelength.



170	85	17	136	119	221
119	255	221	68	238	17
238	170	221	0	85	255
0	221	255	136	238	0
85	170	119	255	238	136
68	17	68	170	119	136



Brightness Value

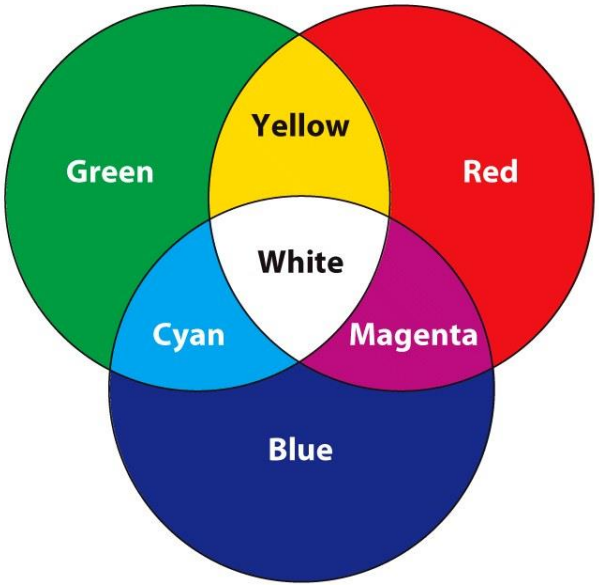
- Scaled to fit a range of values specified by the sensor from low (little radiance) to high (a lot of radiance)
  - 8-bit sensor records values between 0-255
  - 0 = black, 255 = white
  - Allows all wavelengths to be visible on the computer screen

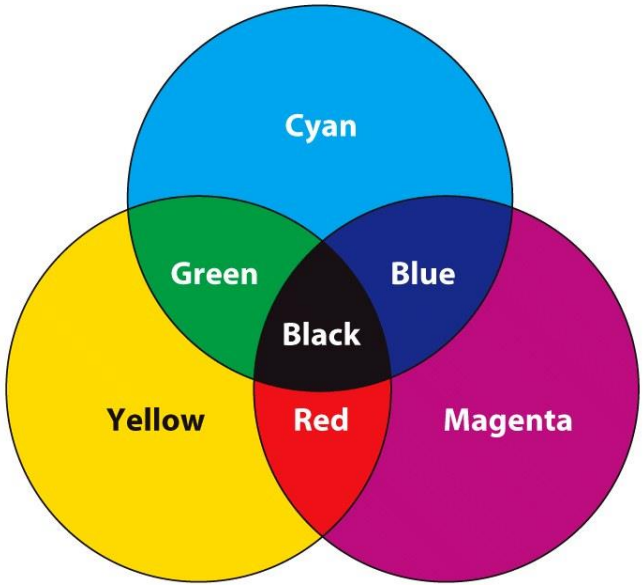
Brightness Value

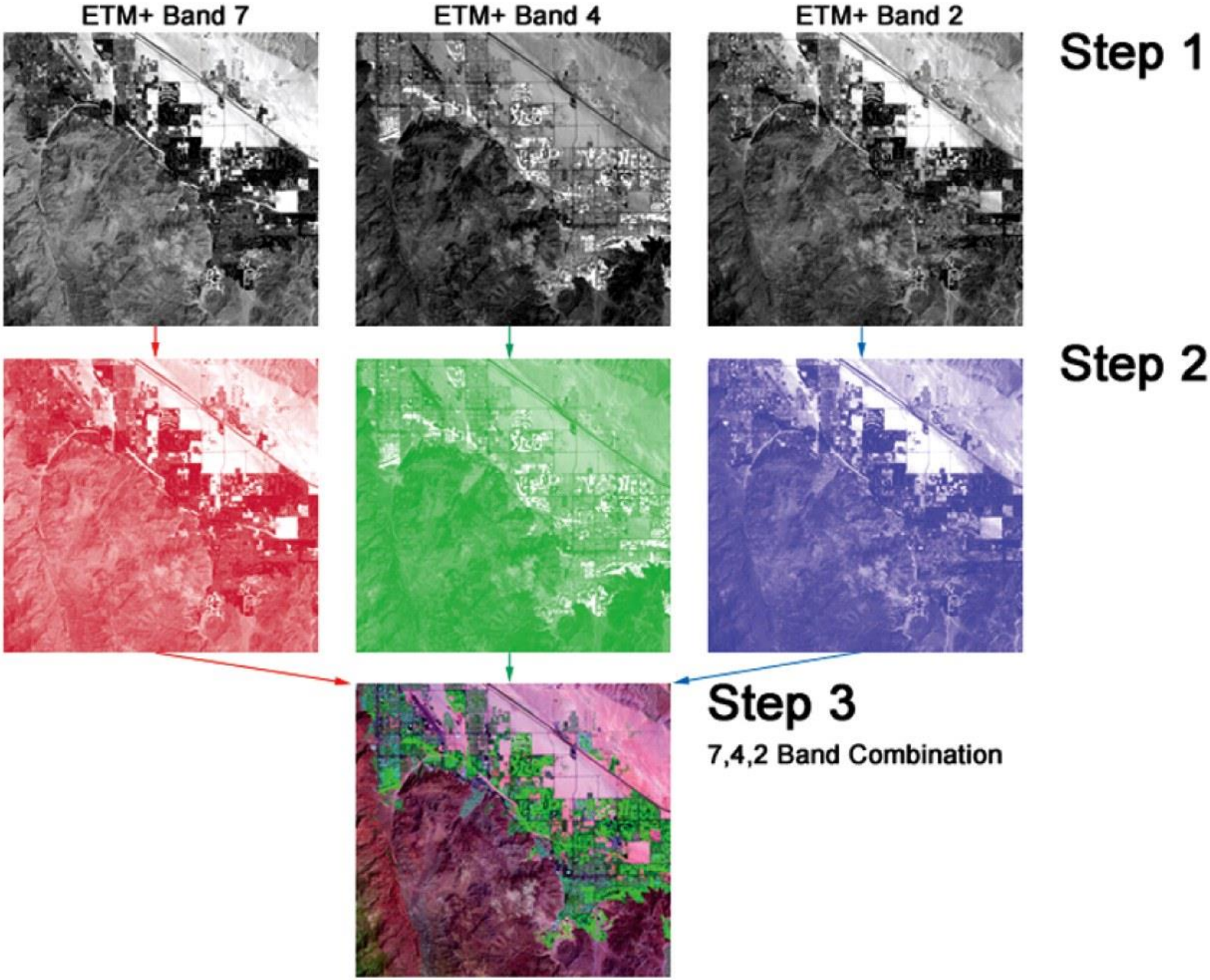
- **Panchromatic.** Sensor collects the multiple wavelengths as one band, displaying the imagery in black & white
- **Multispectral.** Sensor collects multiple wavelengths simultaneously (2-36 bands), displaying imagery in various colors
- **Hyperspectral.** Sensor collects over 200 bands of the electromagnetic spectrum simultaneously, displaying imagery in various colors

Color Composite

- Generated by displaying brightness values of one band to red, one to blue, and one to green.
  - Displayed color is a combination of three brightness values, from three wavelengths



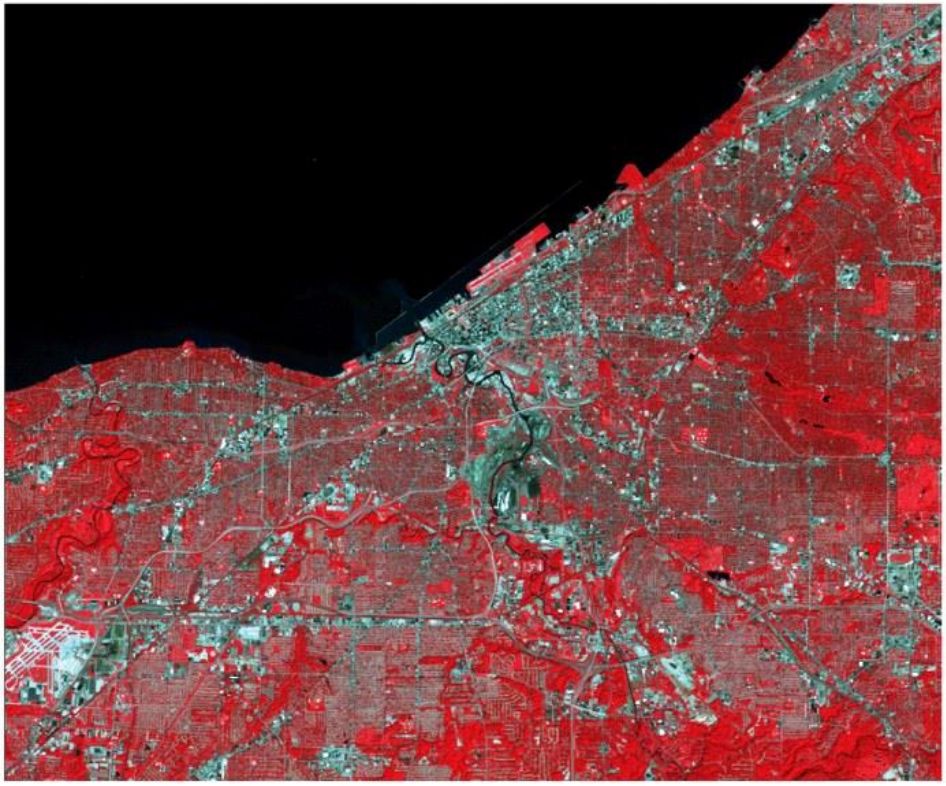



ETM+ Band 7
ETM+ Band 4
ETM+ Band 2
Step 1
Step 2
Step 3
7,4,2 Band Combination

Color Composite

- True Color.
  - Red band = red
  - Green band = green
  - Blue band = blue
- False Color.
  - Any deviation from the true color composite
- Standard False Color.
  - NIR band = Red
  - Red band = Green
  - Green band = Blue

(a) True Color Composite



(b) False Color Composite