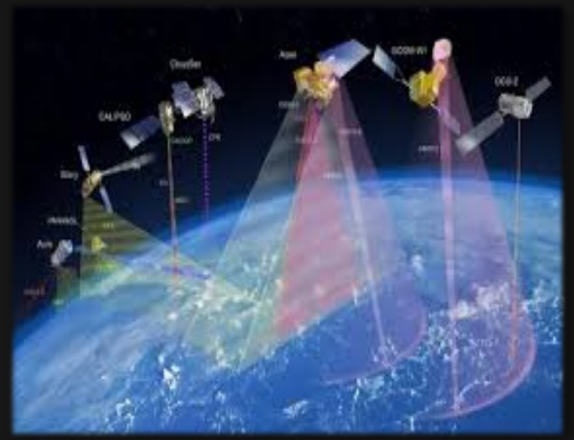
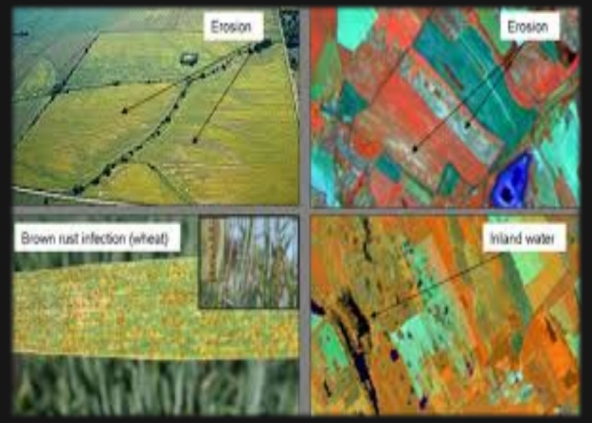
Introduction to Remote Sensing





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Remote sensing ?

- “is the measurement or acquisition of information of some property of an object or phenomena by a recording device that is not in physical or intimate contact with the object or phenomena under study”

- “is the art and science of obtaining information about an object without being in direct contact with the object” (Jensen 2000).

Transmitting Information

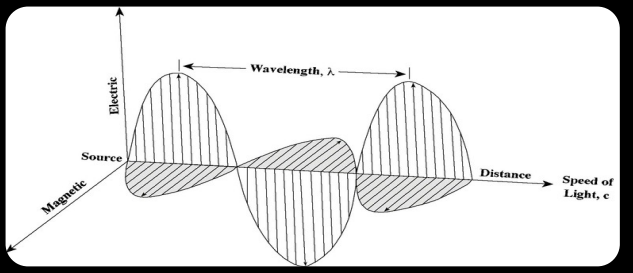
- For carrying information we use energy
- Energy transmitted through Wave Form
- Electro Magnetic Radiation carries energy

Five Senses

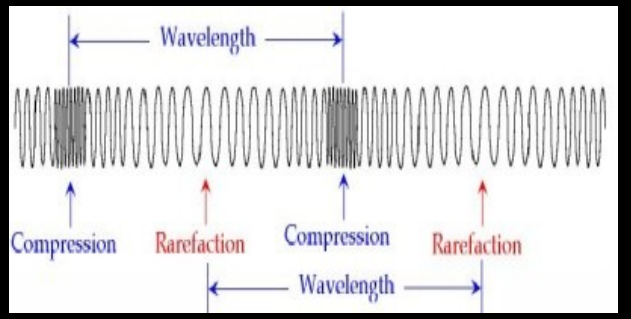
Seeing 	**Hearing** 
Tasting 	**Touching** 
Smelling 	**My Five Senses are Swell!**

How sense transmit ?

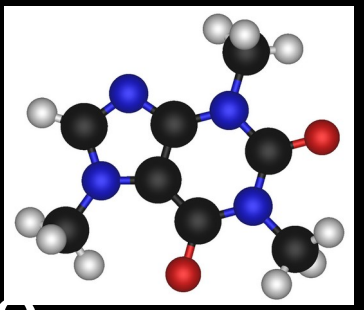
Electromagnetic Wave



Sound wave/Mechanical Wave

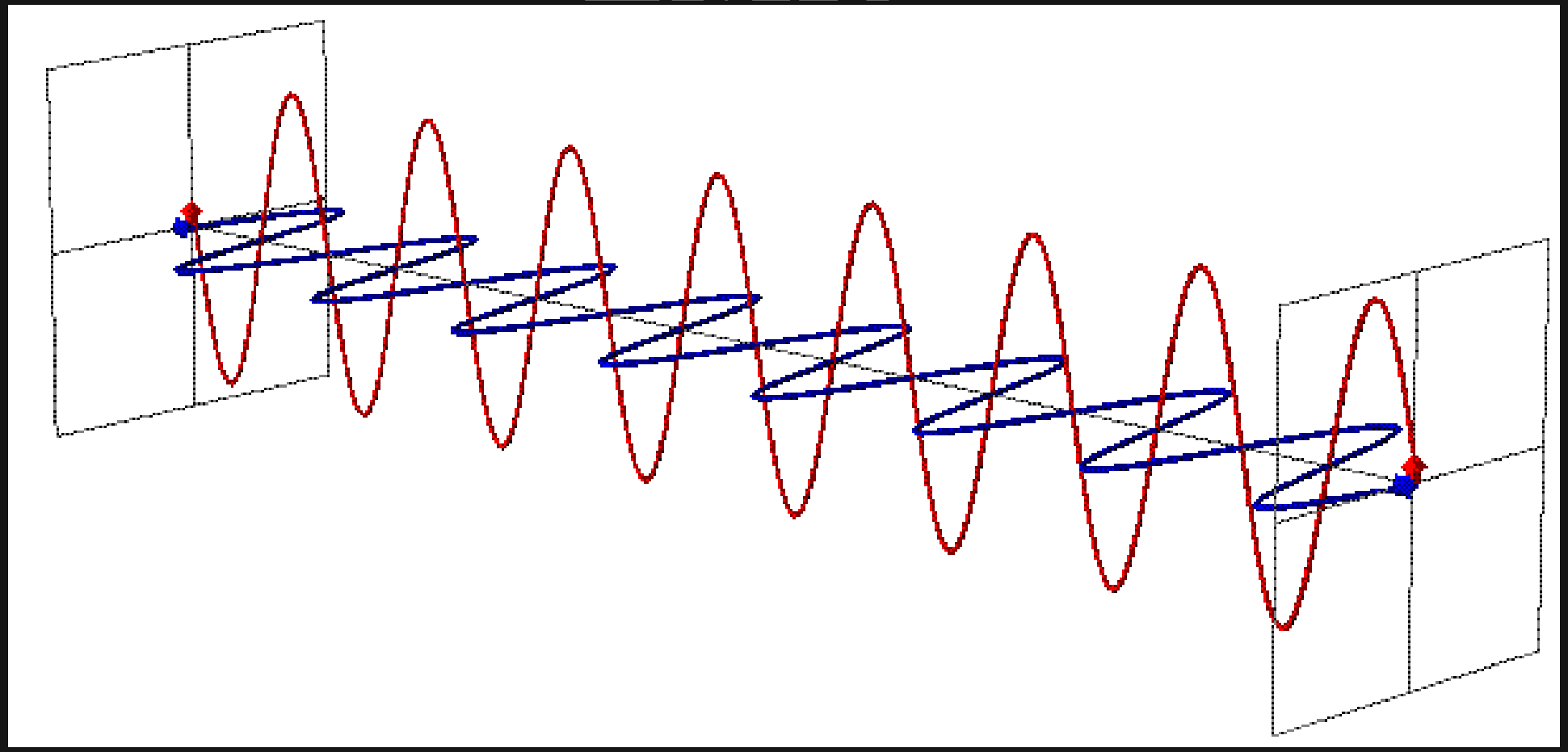


Molecules



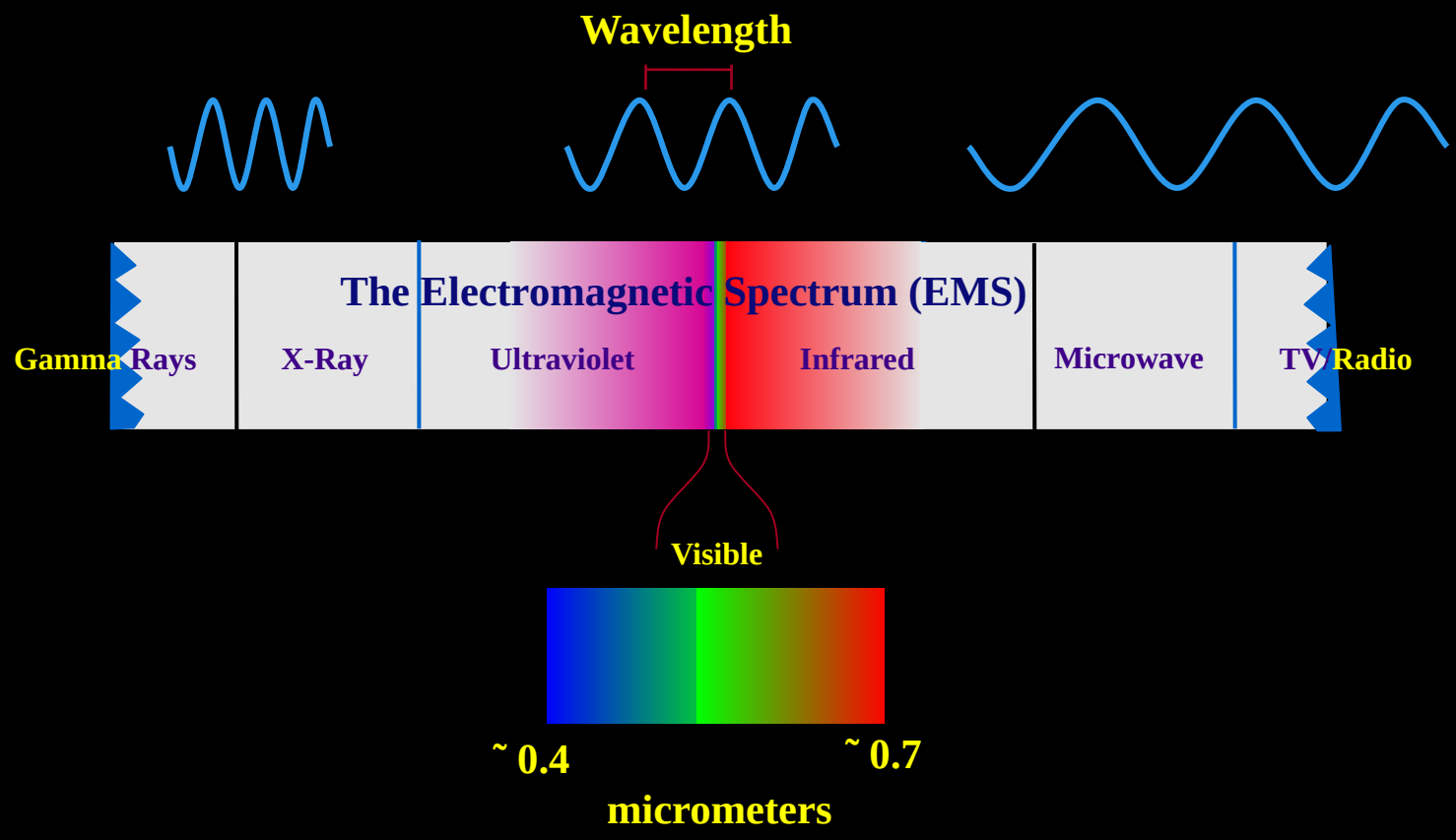
All are basically called Remote sensing (?)

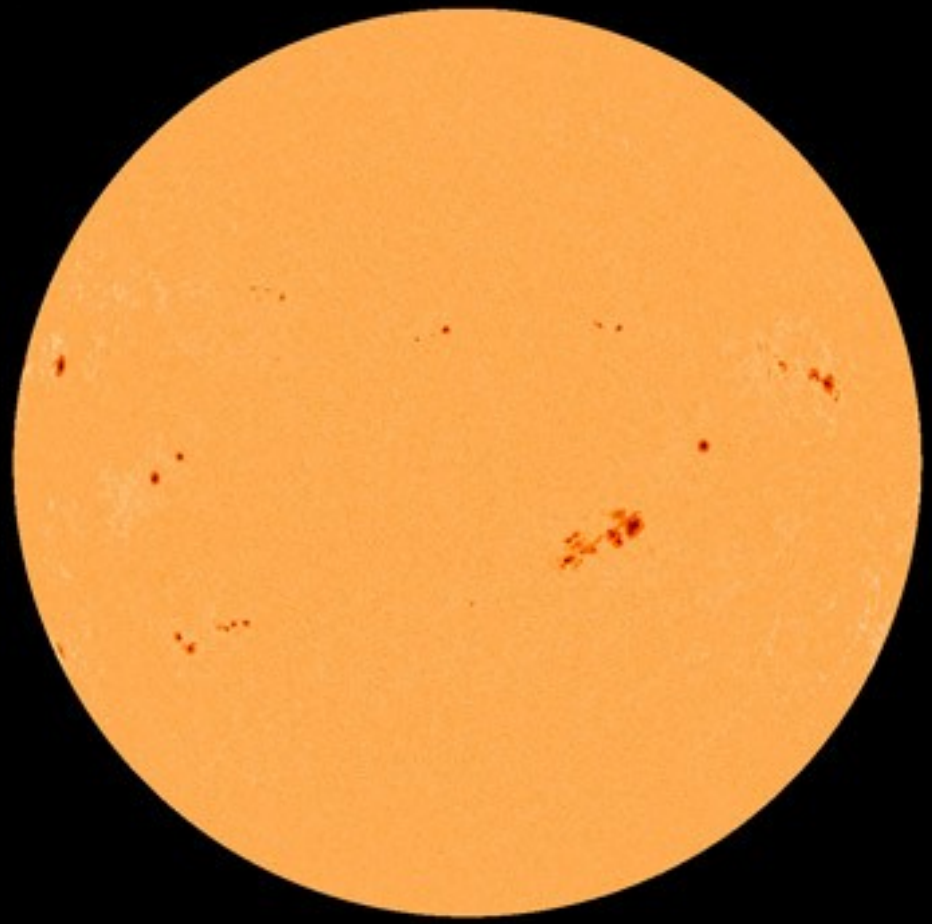
EMR

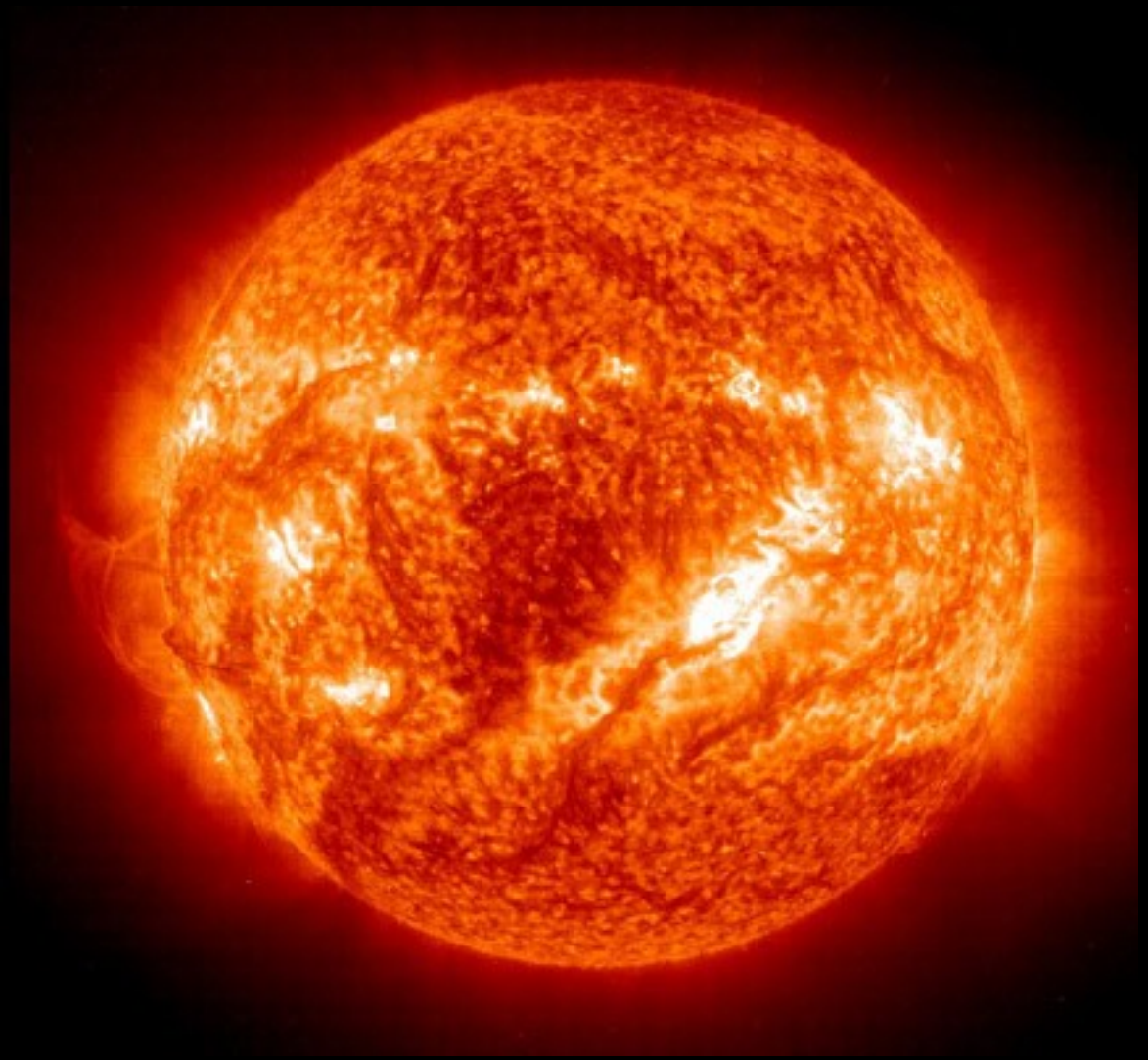


Measuring EMR

- EMR can be classified according to the length of the wave







Great lines by B. C. Bose

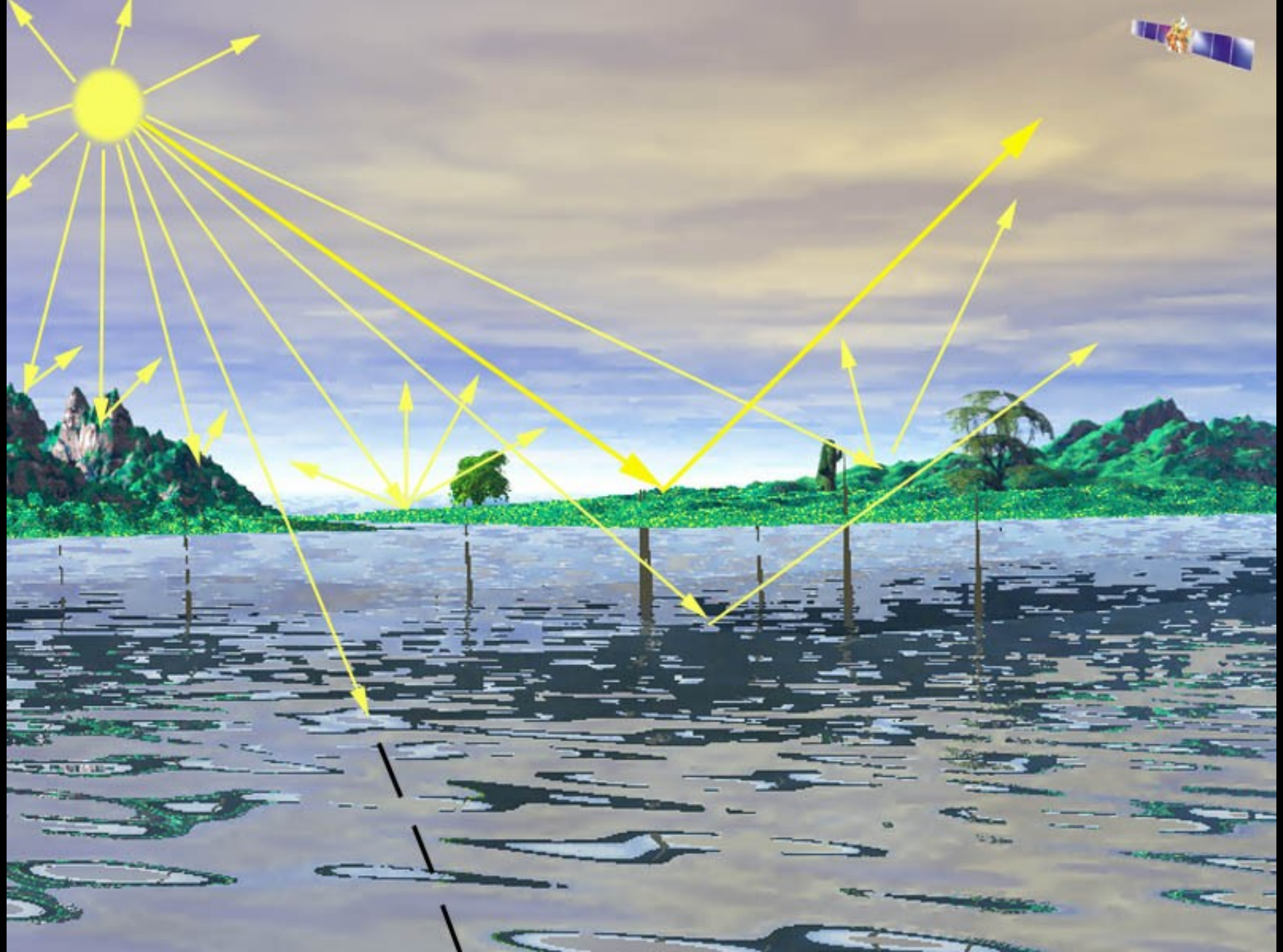
“Change cannot be given to you every time. You must bring the change”

Who is B. C. Bose?

He is a **citybus** conductor.

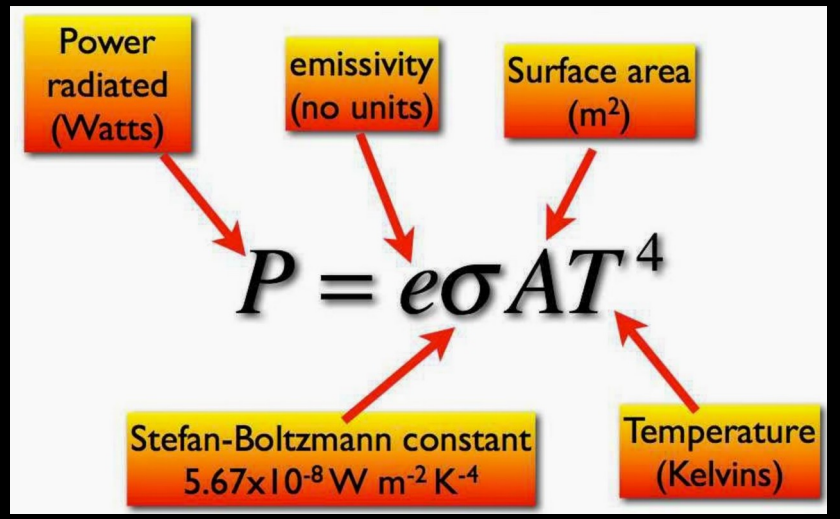
Now read again and explain

“Change cannot be given to you every time. You must bring the change”



Stephen Boltzmann Law

The total radiant heat power emitted from a surface is proportional to the fourth power of its absolute temperature.



Where ‘P’ is in Watts, emissivity (e) has no units, Area (A) m^2 and Temperature (T) is in Kelvin.

Stephen Boltzmann Law

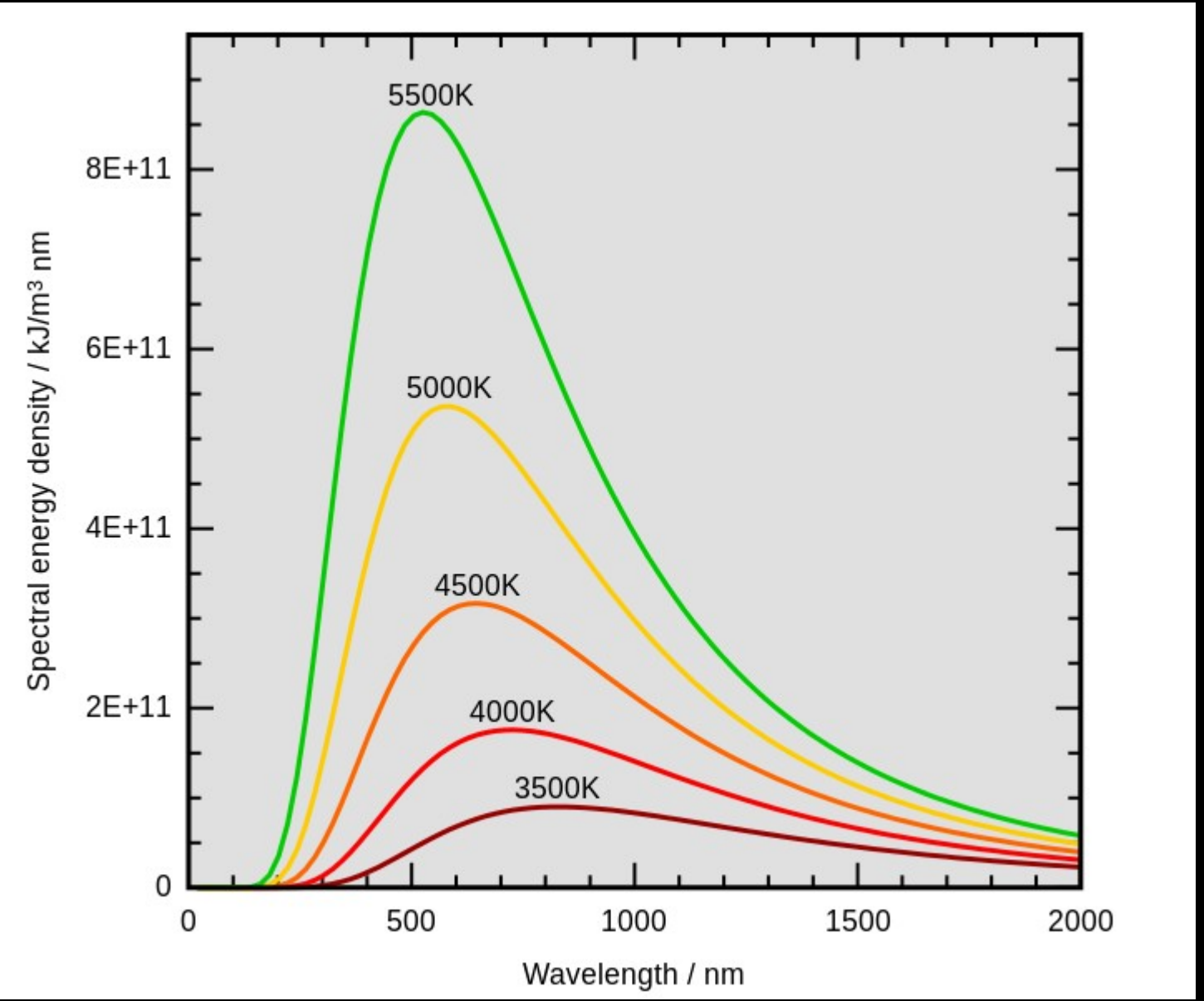
The **total emitted radiation** ($M\lambda$) from a blackbody is proportional to the fourth power of its **absolute temperature**.

$$M\lambda = \sigma T^4$$

where σ is the Stefan-Boltzmann constant, 5.6697×10^{-8} W m^{-2} K^{-4}.

Thus, the amount of energy emitted by an object is a function of its temperature.

Black body radiation



Wien's Displacement Law

$$\lambda_{max} = k / T$$

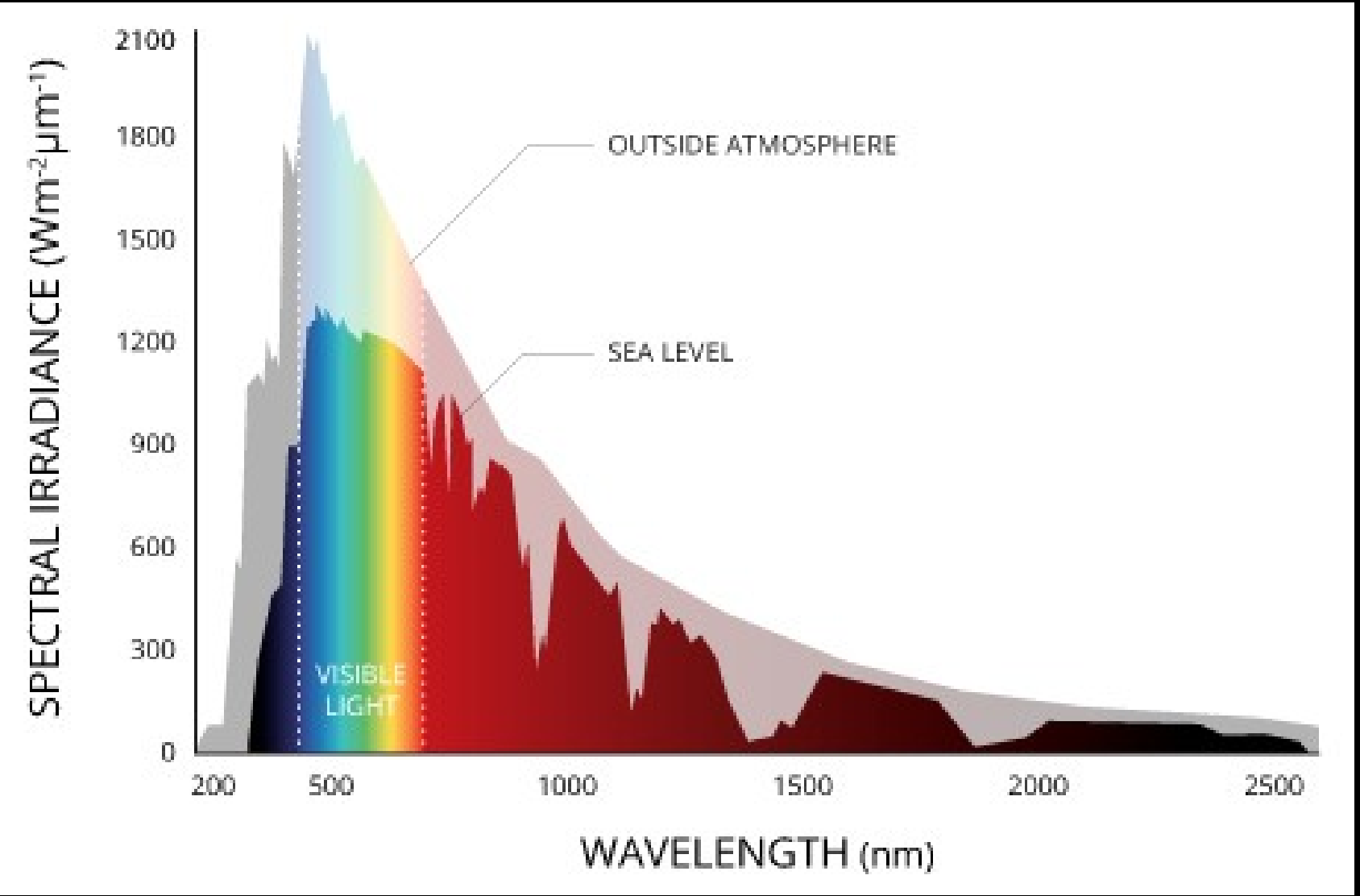
where k is 2898 μm ˚K, and T is in degrees Kelvin.

The Sun approximates a 6,000 k blackbody, therefore its dominant wavelength is:

$$2898\ \mu m\ ^{\circ}K\ /\ 6000\ ^{\circ}K = 0.483\ \mu m$$

The Earth approximates a 300 ˚K (27 ˚C) blackbody and has a dominant wavelength at approximately 9.7 μm.

Solar Radiation

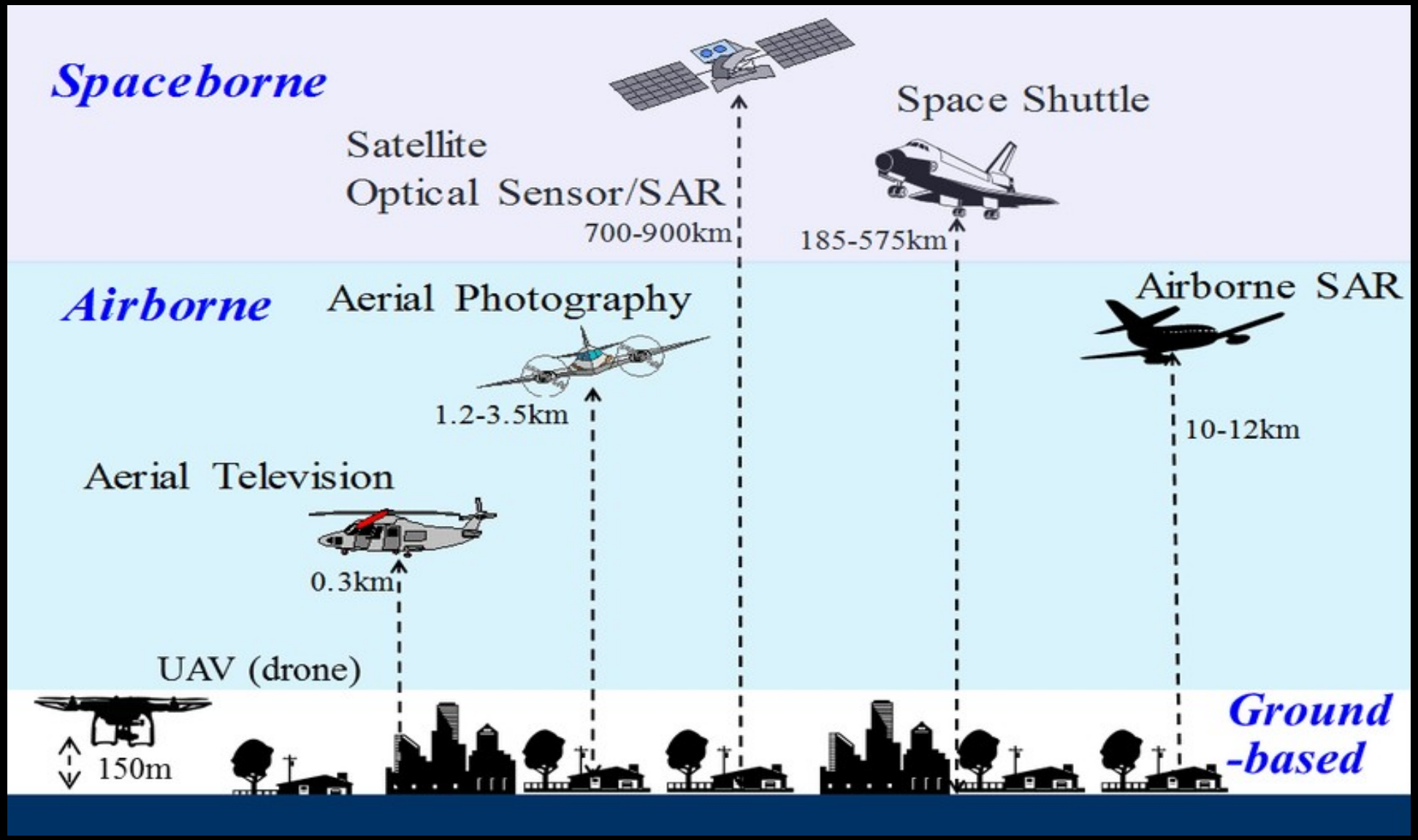


*Most of the solar radiation that reaches Earth is made up of **visible and infrared light**. Only a small amount of ultraviolet radiation reaches the surface.*

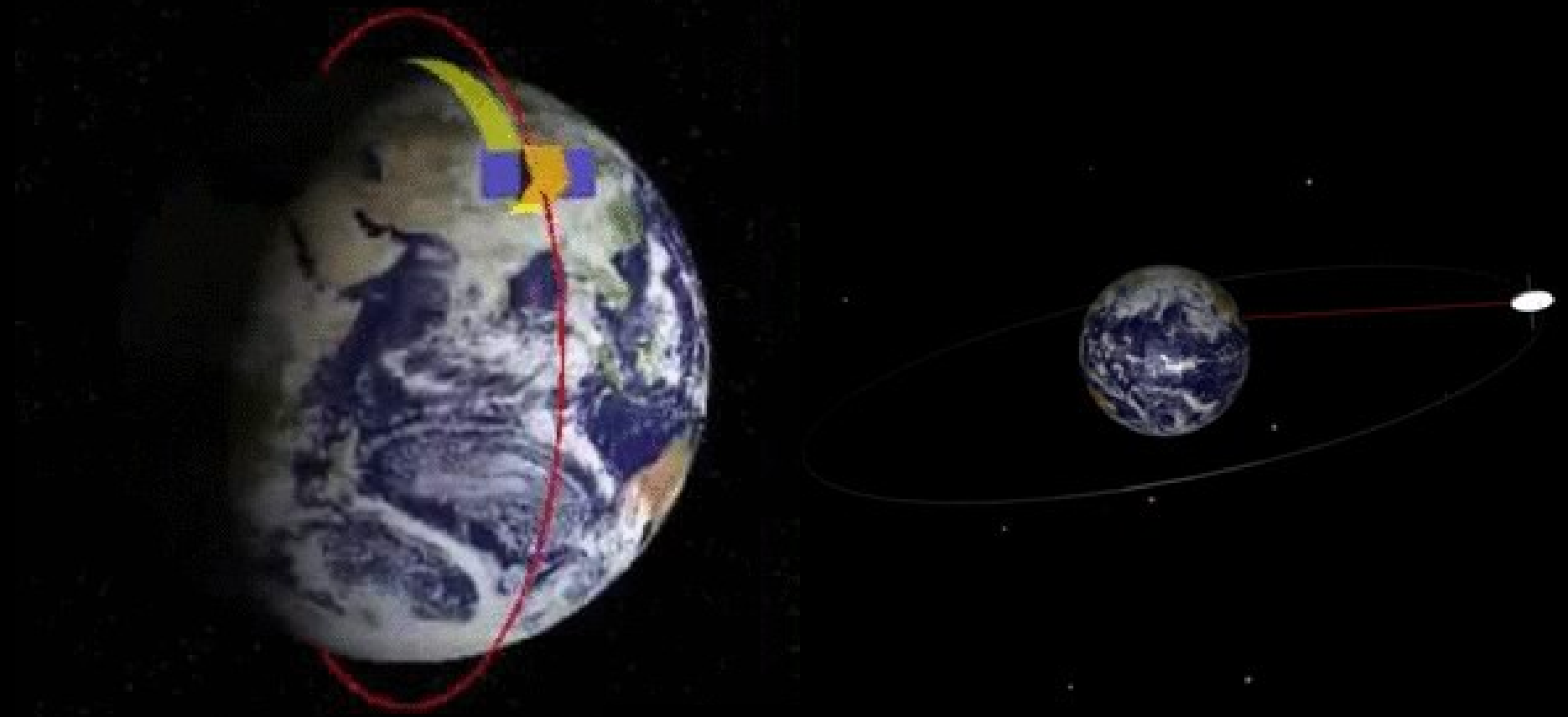
Platform:

- The vehicles or carriers for remote sensors are called the **platforms.**
- Selection of a platform is determined by the altitude that determines the ground resolution.
- 3 types of platform:
  - Ground Based Platforms
  - Airborne Platforms
  - Spaceborne Platforms

Remote Sensing Platform



Satellite Orbit



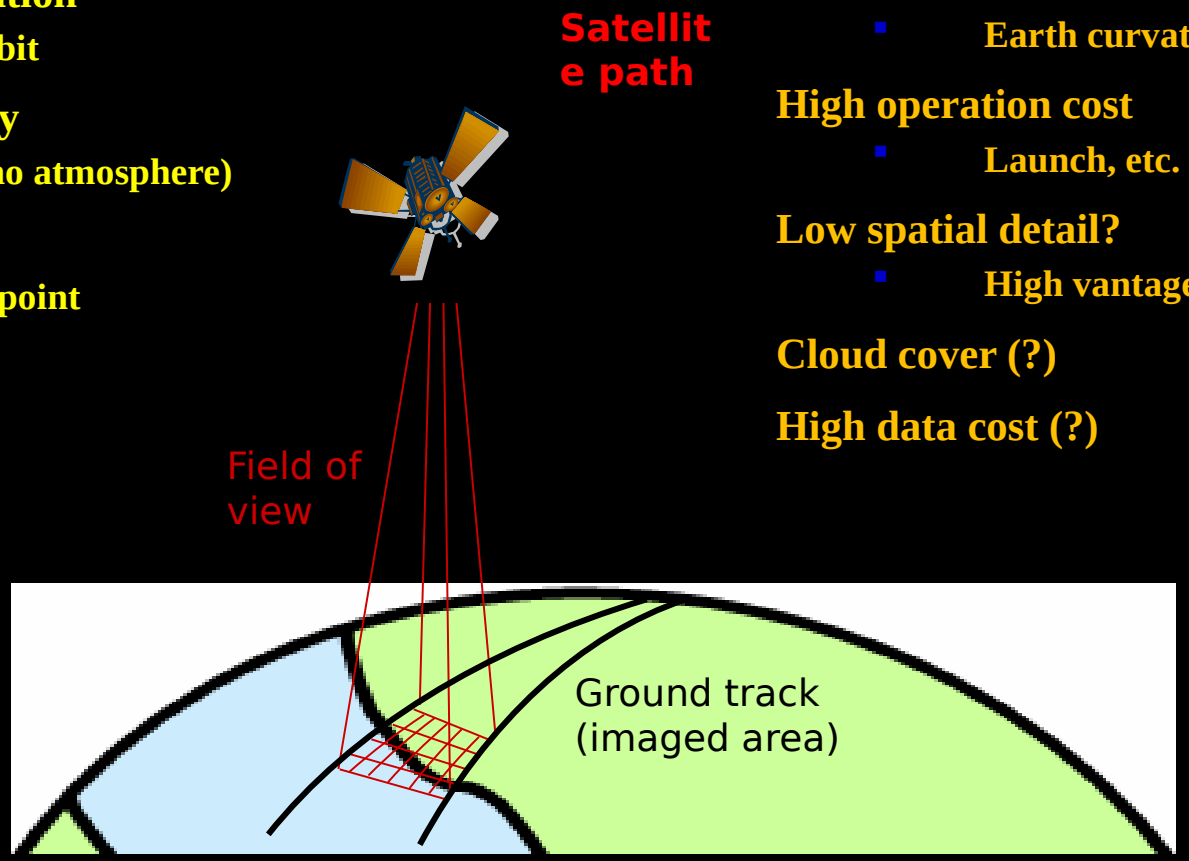
Satellite platforms

Advantages

Continuous data acquisition
- **Permanent orbit**

High geometric accuracy
- **Stable orbit (no atmosphere)**

Wide area of coverage
- **High vantage point**



Disadvantages

Geometric distortion
- **Earth curvature**

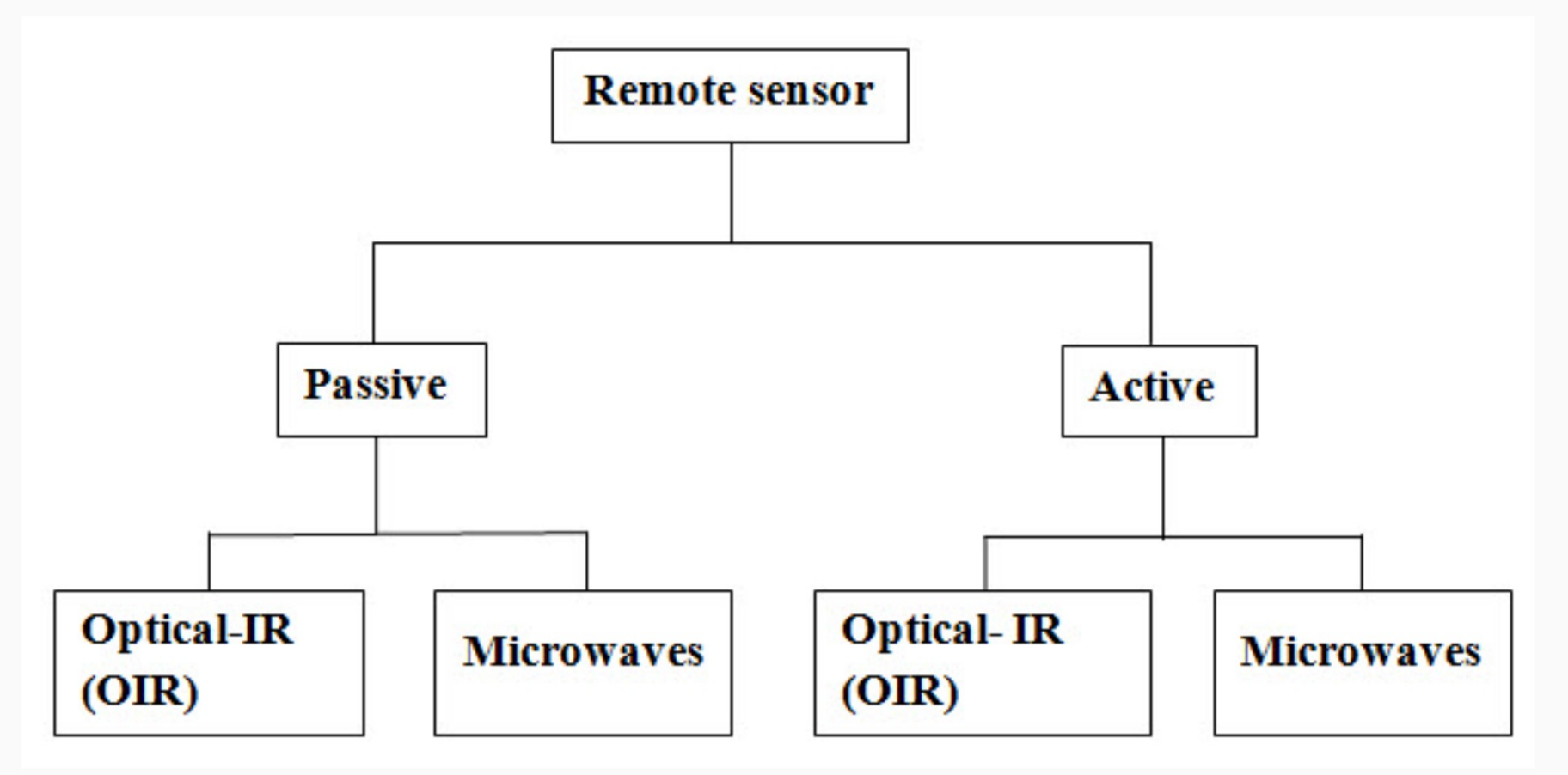
High operation cost
- **Launch, etc.**

Low spatial detail?
- **High vantage point**

Cloud cover (?)

High data cost (?)

Sensors


Remote sensor
Passive
Active
Optical-IR (OIR)
Microwaves
Optical- IR (OIR)
Microwaves

Passive Sensing

✓ Passive remote sensing **depends on natural energy (sunrays) bounced by the target**.

- **Spectrometer** distinguishes and analyzes spectral bands.
- **Radiometer** determines the power of radiation emitted by the object in particular band ranges (visible, IR, microwave).
- **Spectroradiometer** finds out the power of radiation in several band ranges.
- **Hyperspectral radiometer** operates with hundreds of narrow spectral bands within visible, NIR and MIR regions.
- **Imaging radiometer** scans the object or a surface to reproduce the image.
- **Sounder** senses the atmospheric conditions vertically.
- **Accelerometer** detects changes in speed per unit of time (e.g., linear or rotational).

Active Sensing

- ✓ D**irects its signal to the object and then checks the response – the received quantity**.
- ✓ Active remote sensing techniques differ by what they transmit (light or waves) and what they determine (e.g., distance, height, atmospheric conditions, etc.).

- **Radar** is a sensor assisting in ranging with radio signals.
- **Lidar** determines distance with light. The target location and distance are understood by multiplying the time by the speed of light.
- **Laser altimeter** measures elevation with lidar.
- **Ranging instruments** estimate the range either with one or two identical devices on different platforms sending signals to each other.
- **Sounder** studies weather conditions vertically by emitting impulses, in case it falls to the active category.
- **Scatterometer** is a specific device to measure bounced (backscattered) radiation.

Field of View (FOV)/ Instantaneous Field of View (IFOV)

- The Field Of View (FOV) is the actual observable area of an optical system like the human eye or a camera.
- Instantaneous Field of View (IFOV) is the measure of the spatial resolution of a remote sensing imaging system. Defined as the angle subtended by a single detector element on the axis of the optical system.

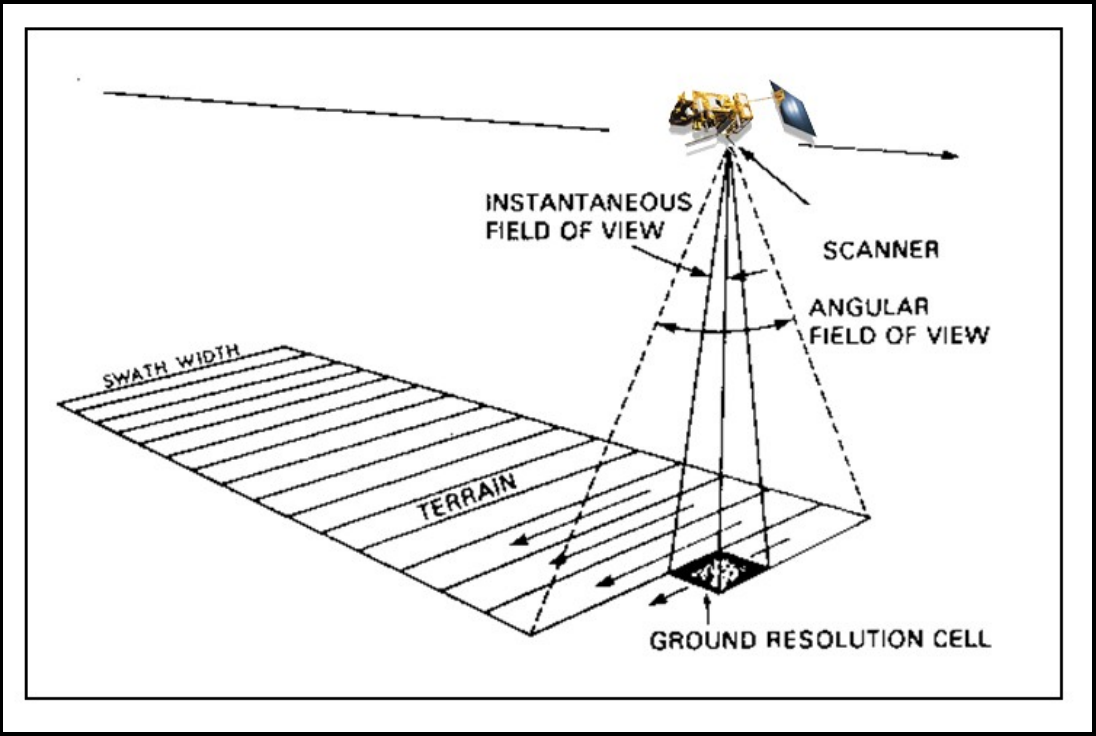
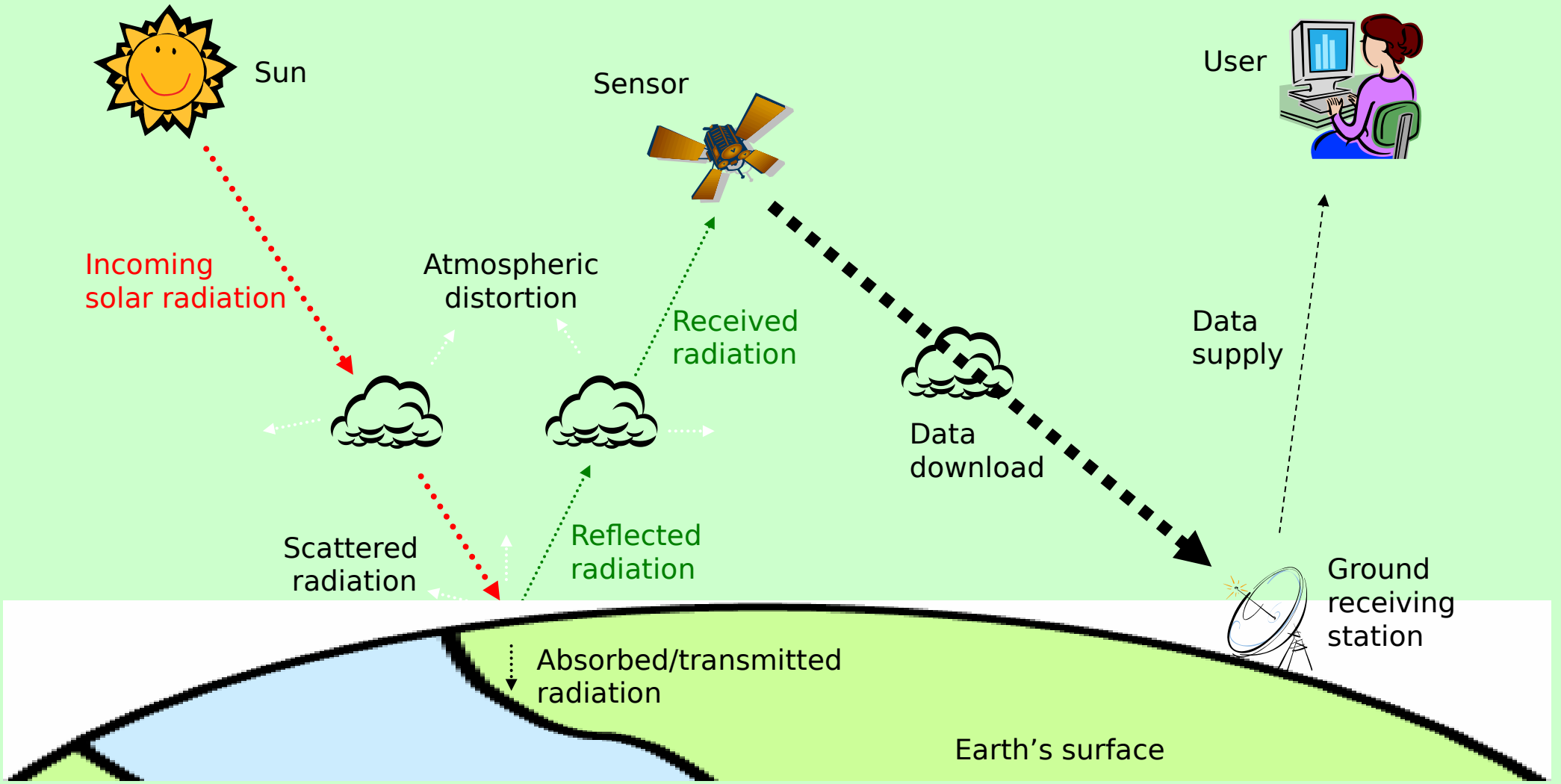
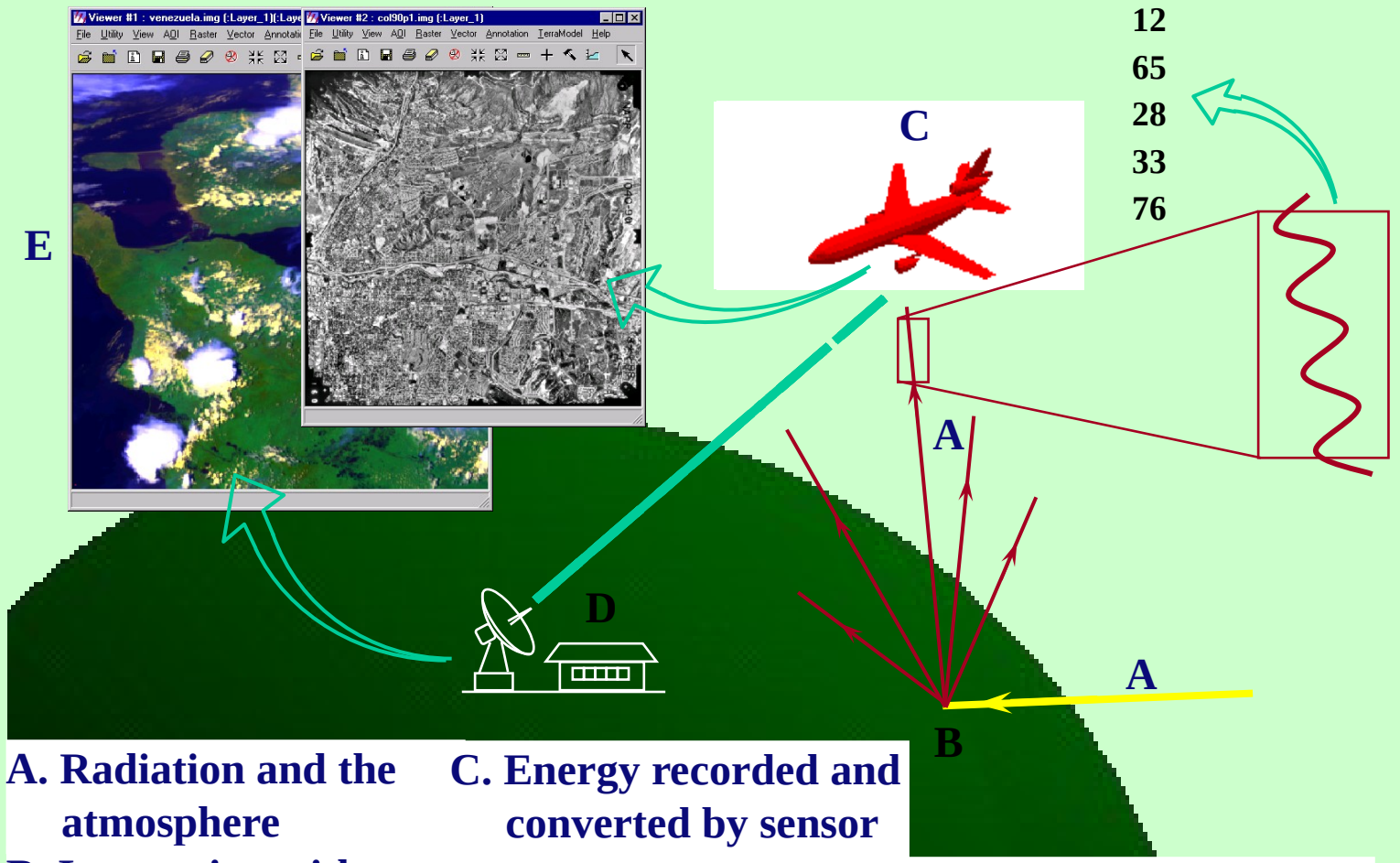


Image acquisition



The process of remote sensing



A. Radiation and the atmosphere

B. Interaction with target

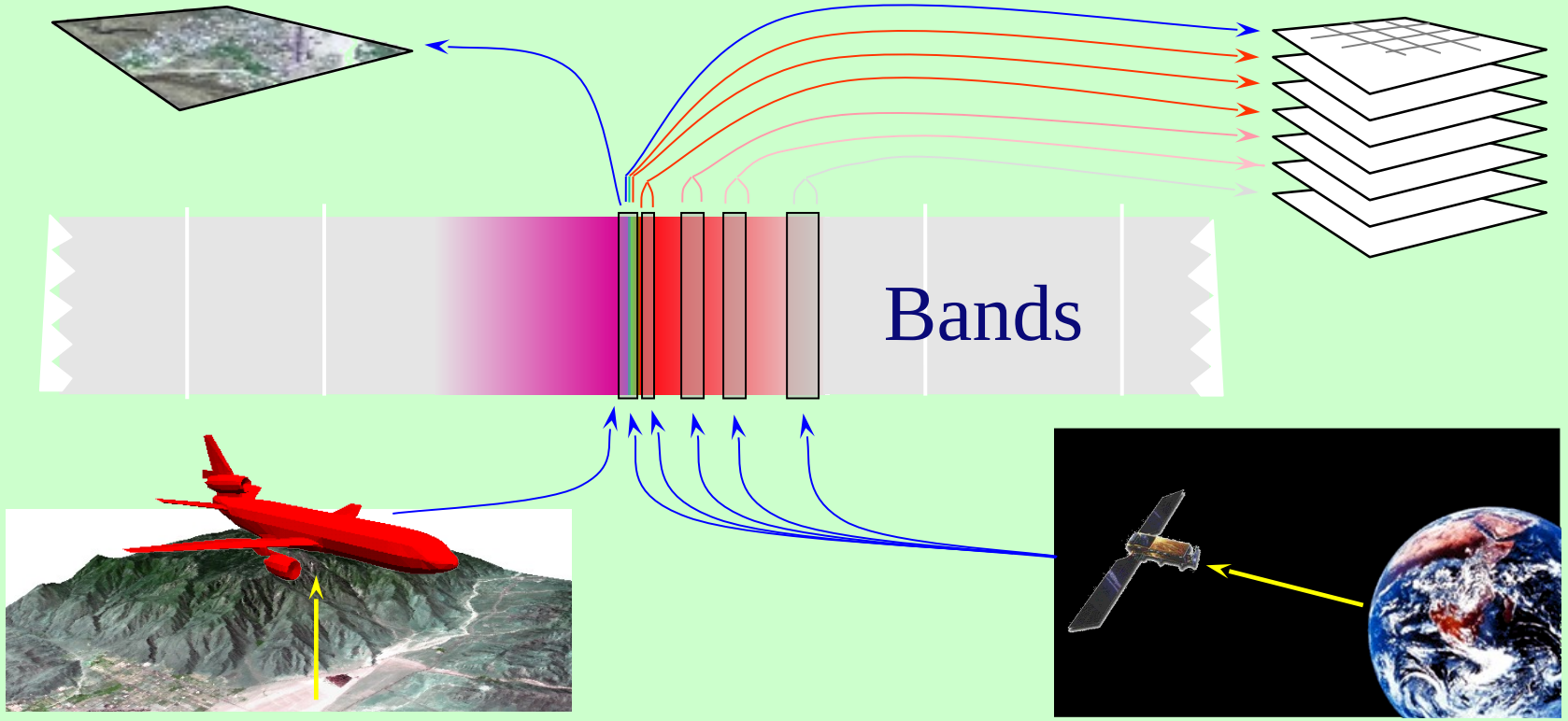
C. Energy recorded and converted by sensor

D. Reception and processing

E. Interpretation and analysis

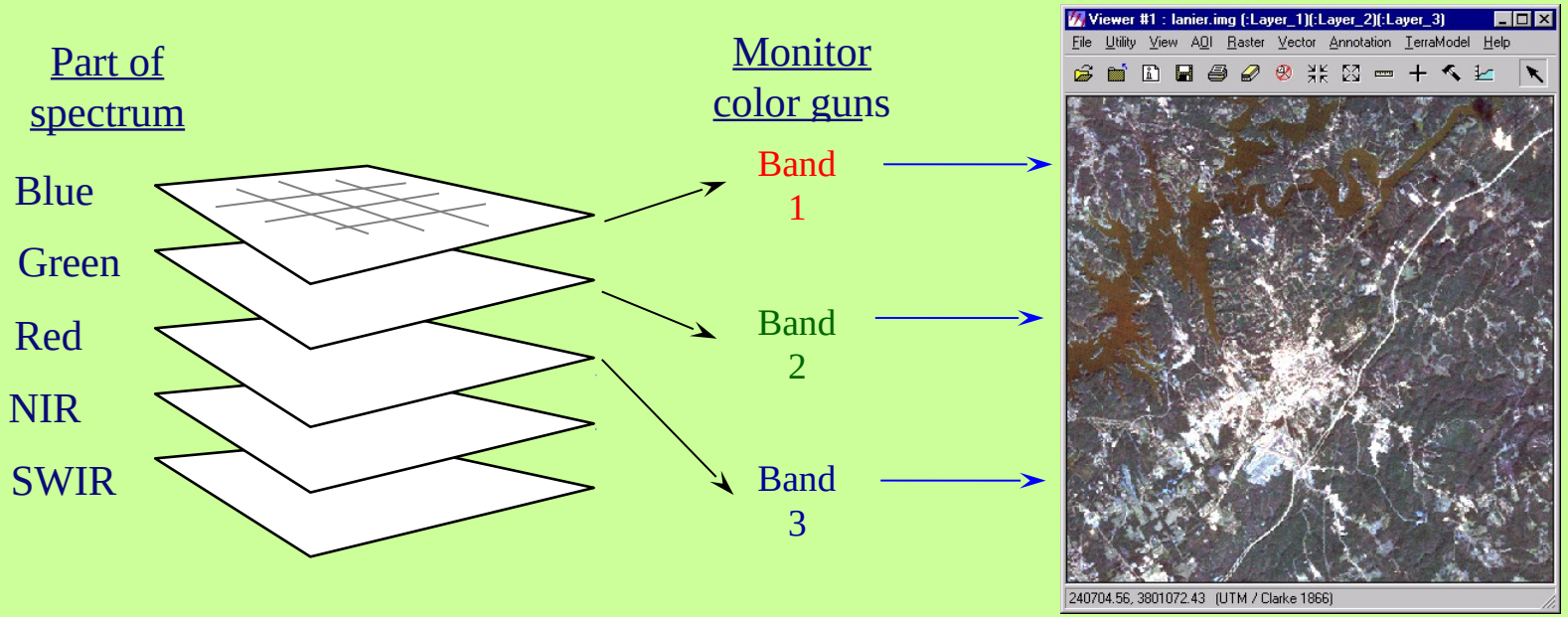
Measuring Light: Bands

- Human eyes only ‘measure’ visible light
- Sensors can measure other portions of EMS



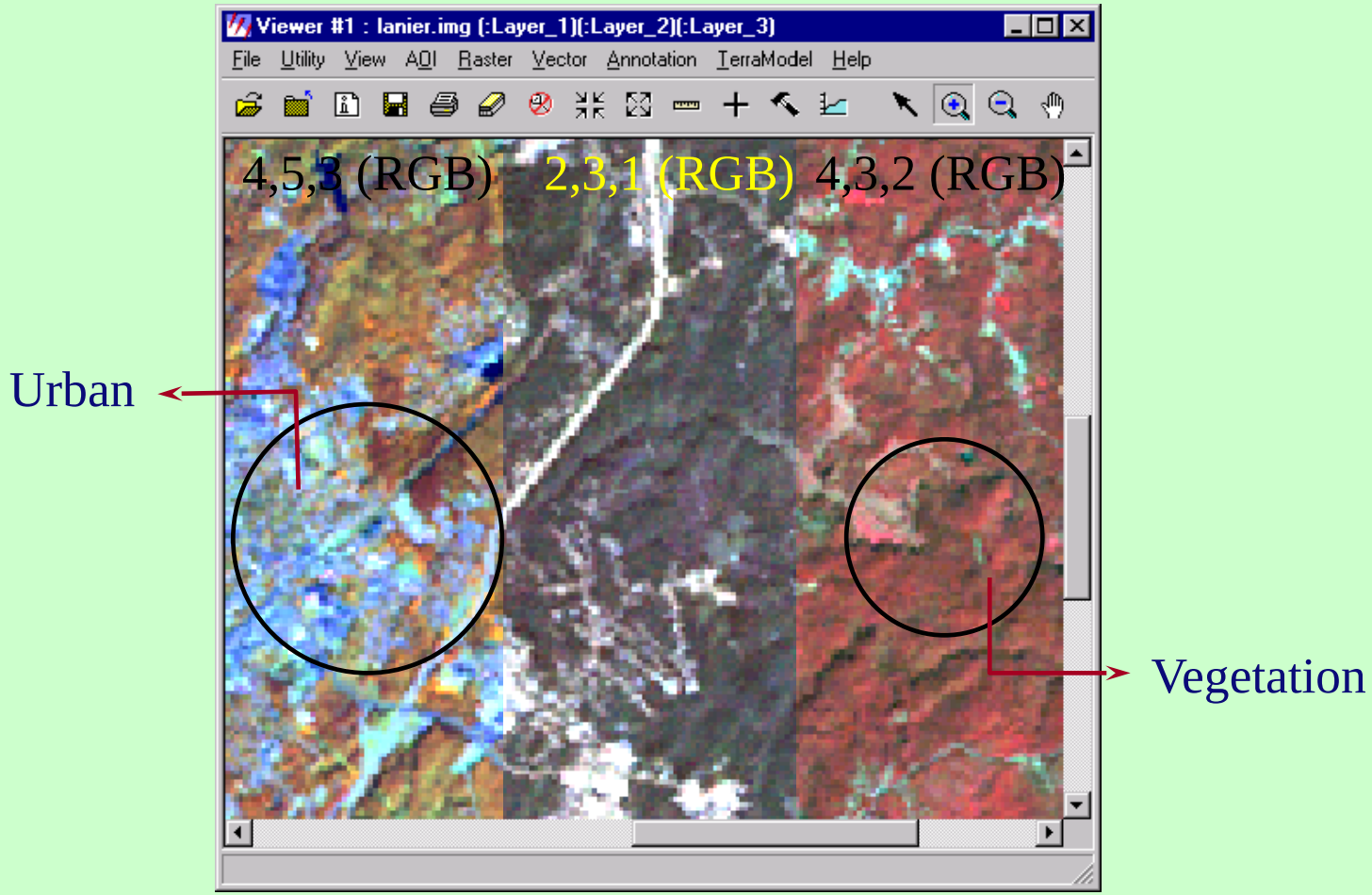
Viewing images

- Three bands are viewable simultaneously

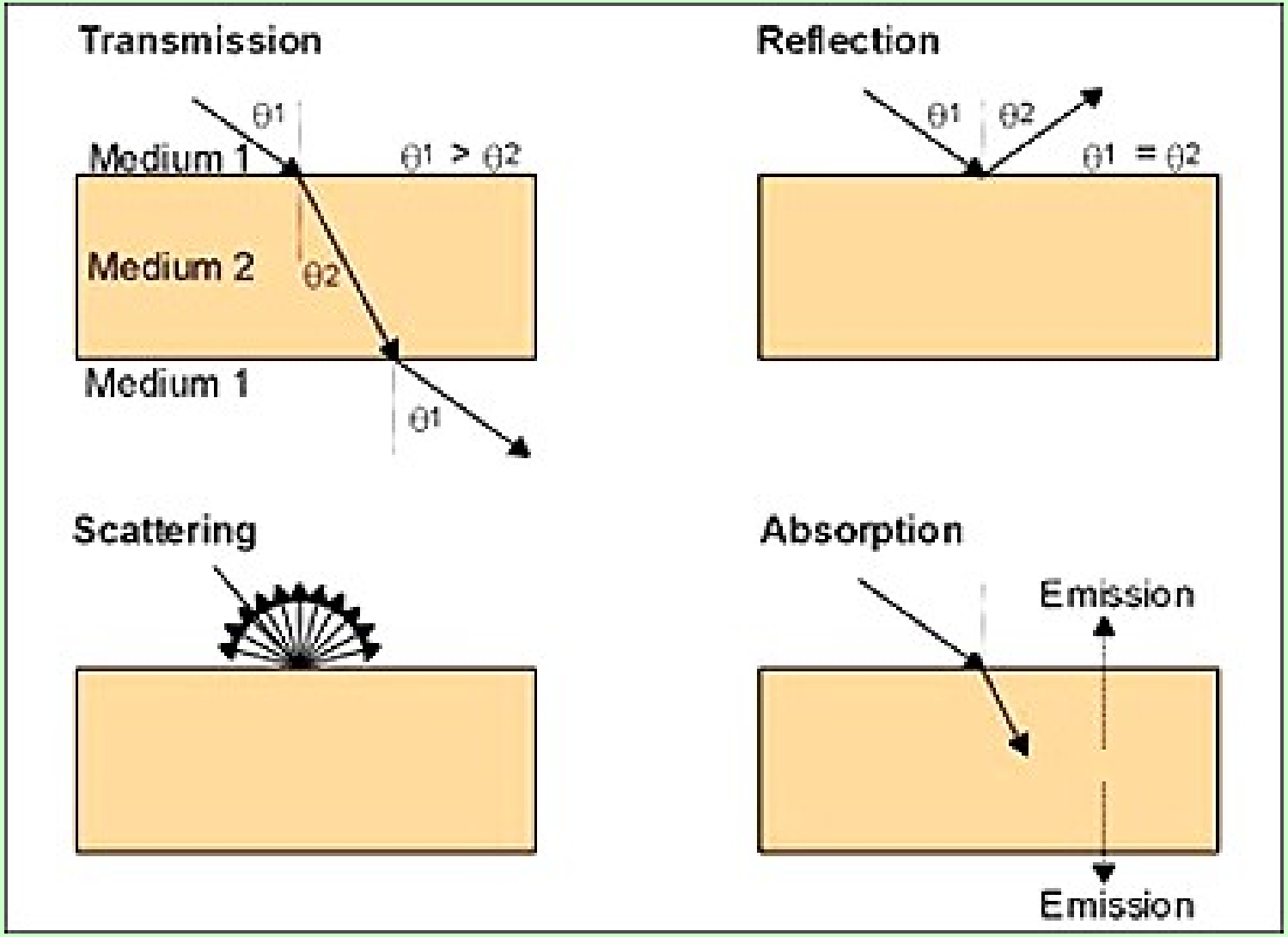


Band Combinations

- Features can become more obvious

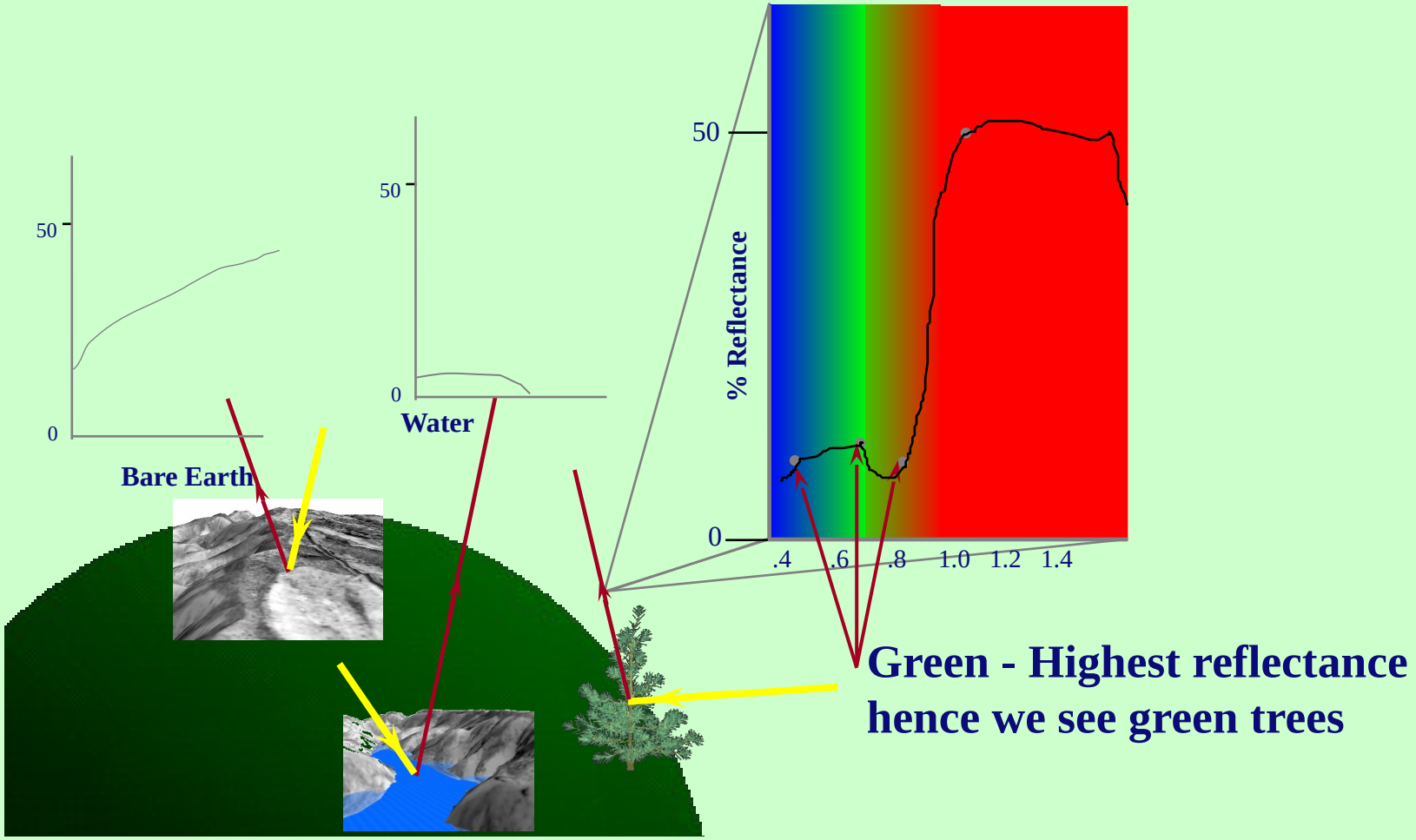


Energy interactions with matter

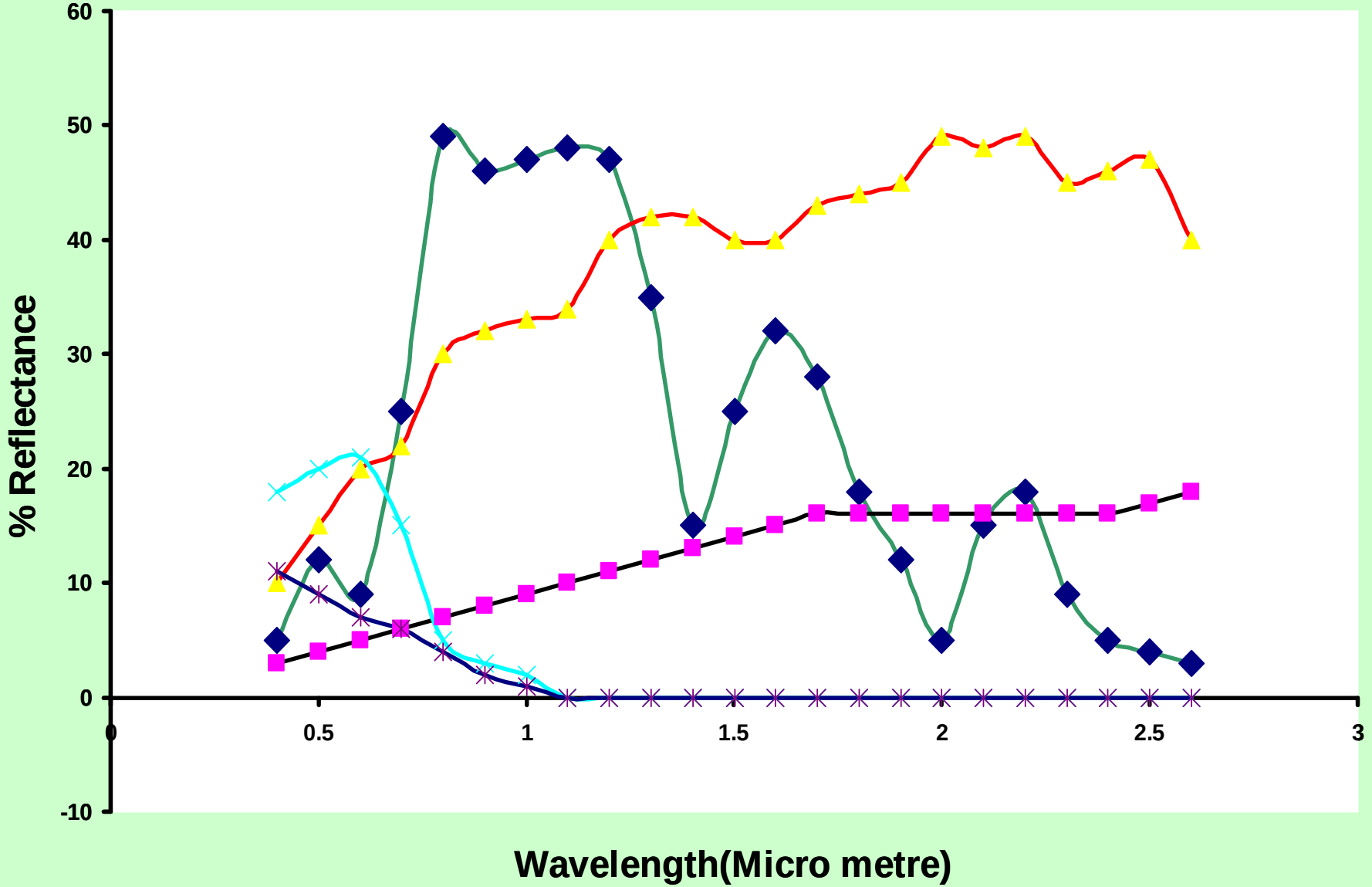


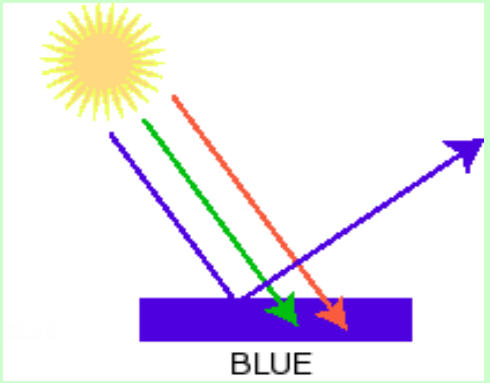
Spectral Signatures

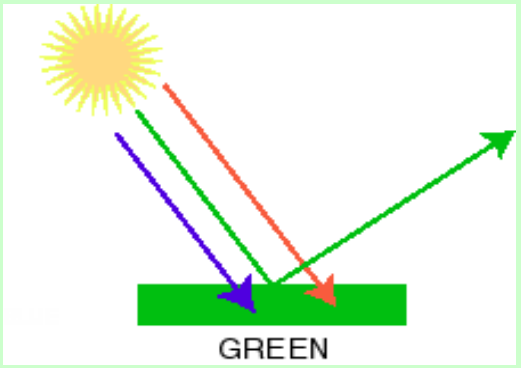
- Signal received by sensor depends on land cover

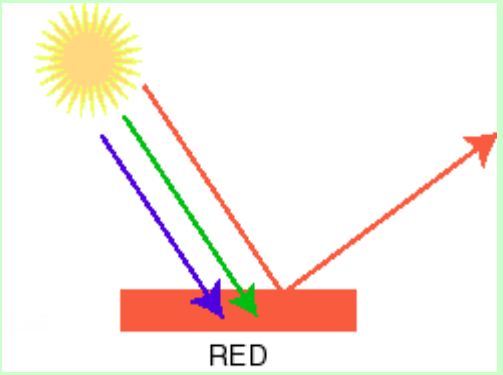


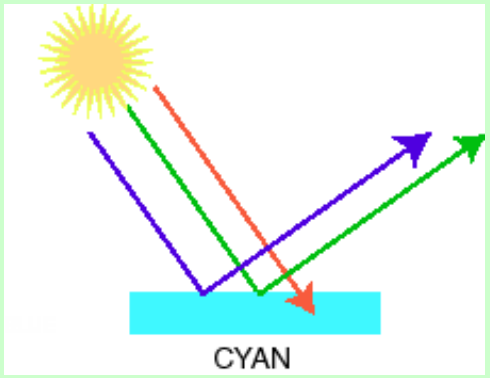
Spectal reflectance of major land covers

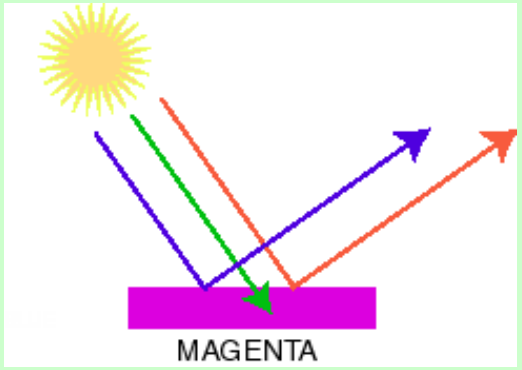


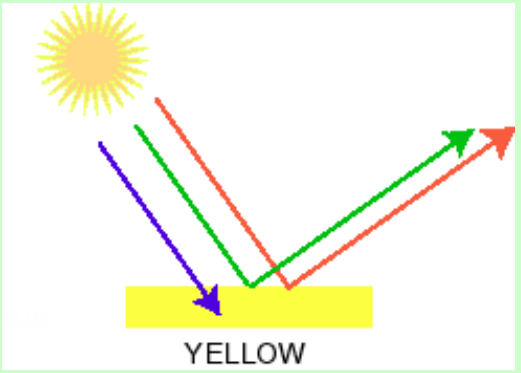

BLUE

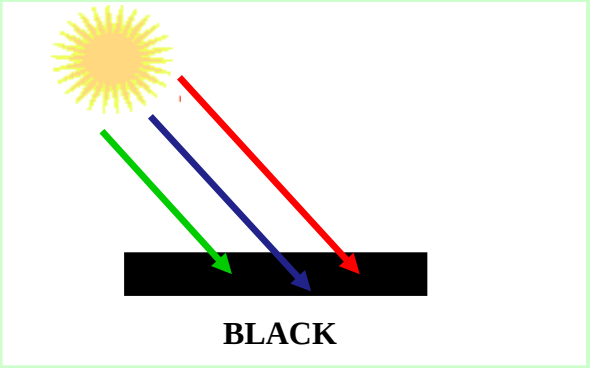

GREEN

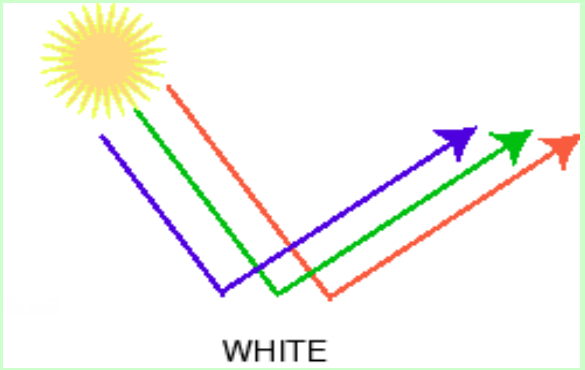

RED

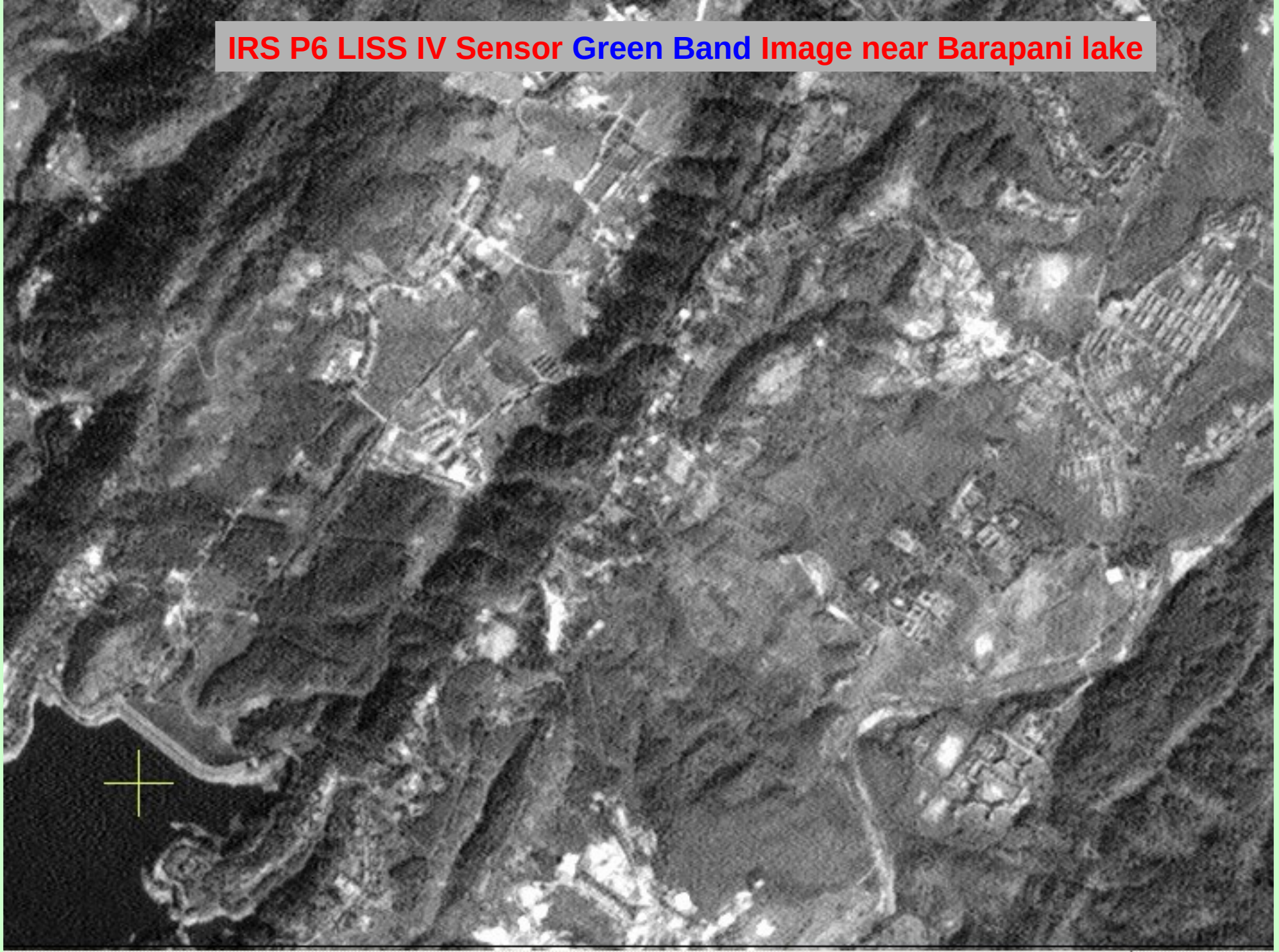

CYAN


MAGENTA

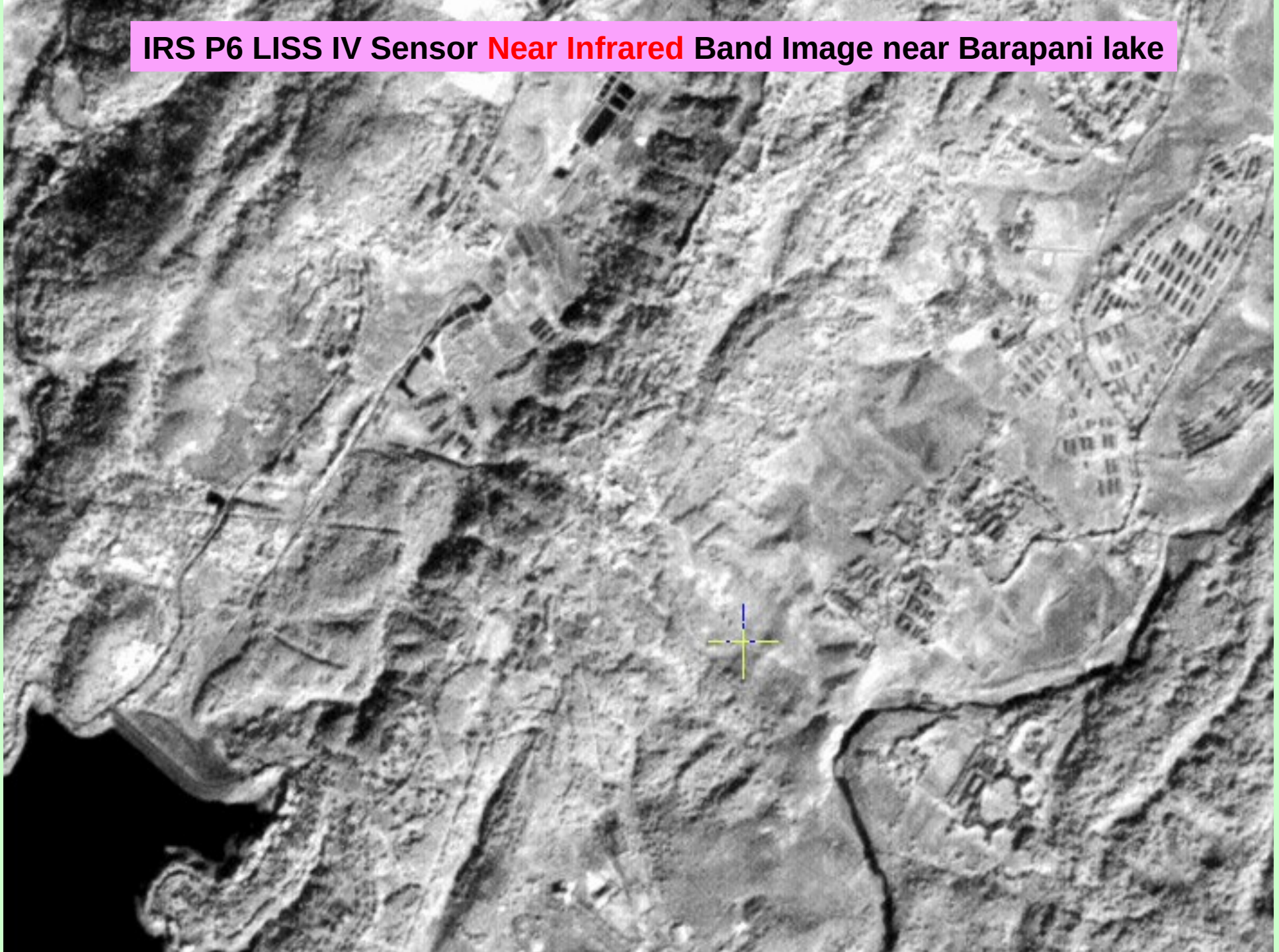

YELLOW


BLACK


WHITE


IRS P6 LISS IV Sensor Green Band Image near Barapani lake


IRS P6 LISS IV Sensor Red Band Image near Barapani lake


IRS P6 LISS IV Sensor Near Infrared Band Image near Barapani lake

Resolution

- All remote sensing systems have four types of resolution:
  - Spatial
  - Spectral
  - Temporal
  - Radiometric

Spatial resolution

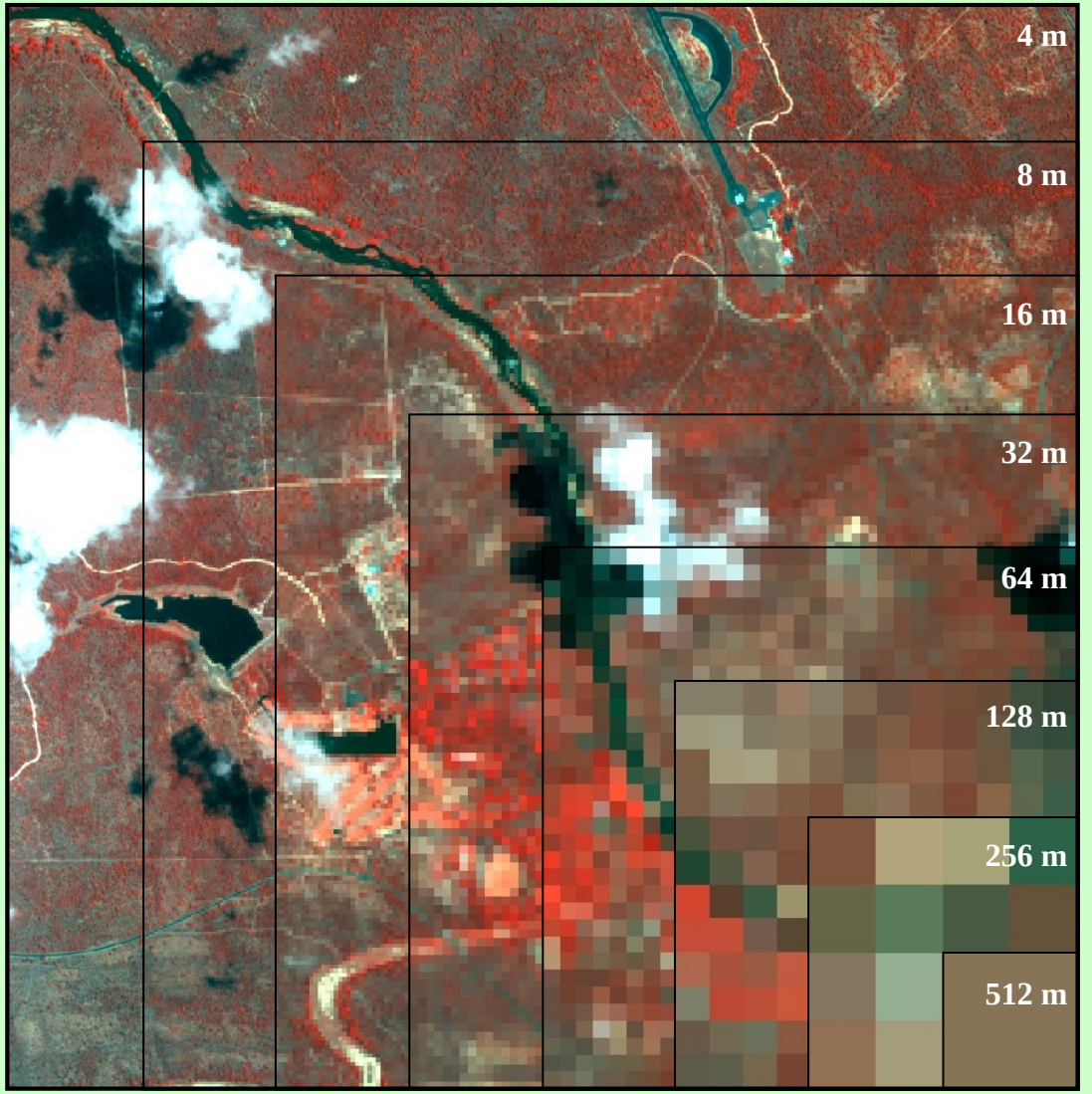
In simple terms, spatial resolution means ‘pixel size’

The concept is simple…

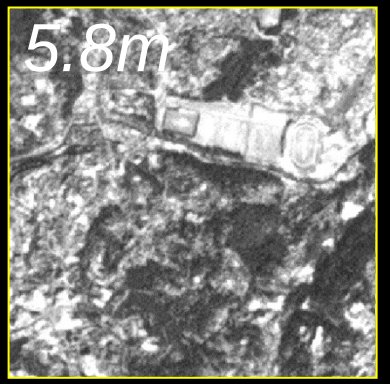
Fine spatial resolution image =
- fine spatial detail
- small feature identification

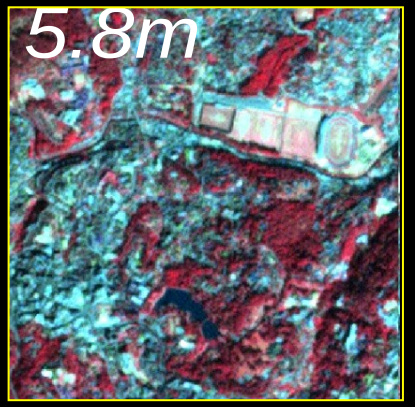
Coarse spatial resolution image =
- coarse spatial detail
- large feature identification

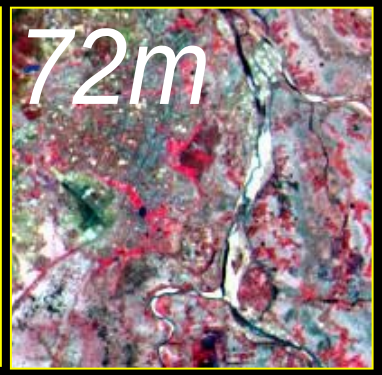
As spatial resolution is degraded progressively, features become increasingly blurred and harder to identify

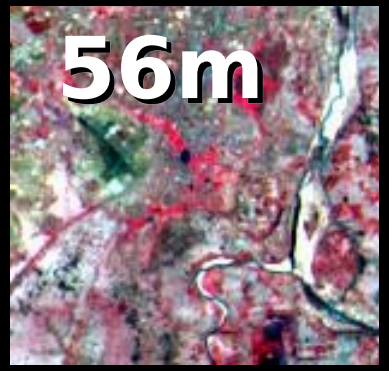


INDIAN IMAGING CAPABILITY





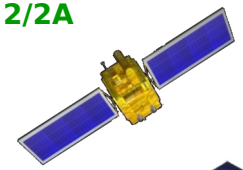


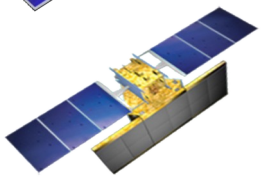


SATELLITES

LAND & WATER

RESOURCESAT-2/2A





RISAT-1 & EOS #

HIGH RESOLUTION

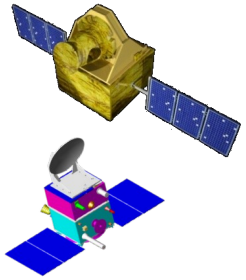
Cartosat 2 and 3

RISAT-2

CARTOSAT-1

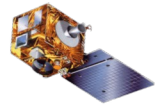
OCEAN

OCEANSAT-2



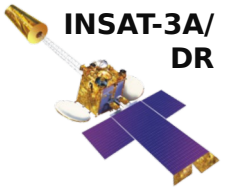
SARAL, ScatSat

WEATHER; CLIMATE

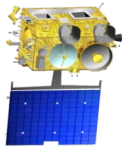


KALPANA -1

INSAT-3A/ DR



MEGHA-TROPIQUES

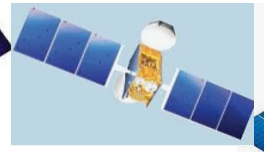


INSAT-3D/DR

COMMUNICATION

GSAT 8

GSAT 10



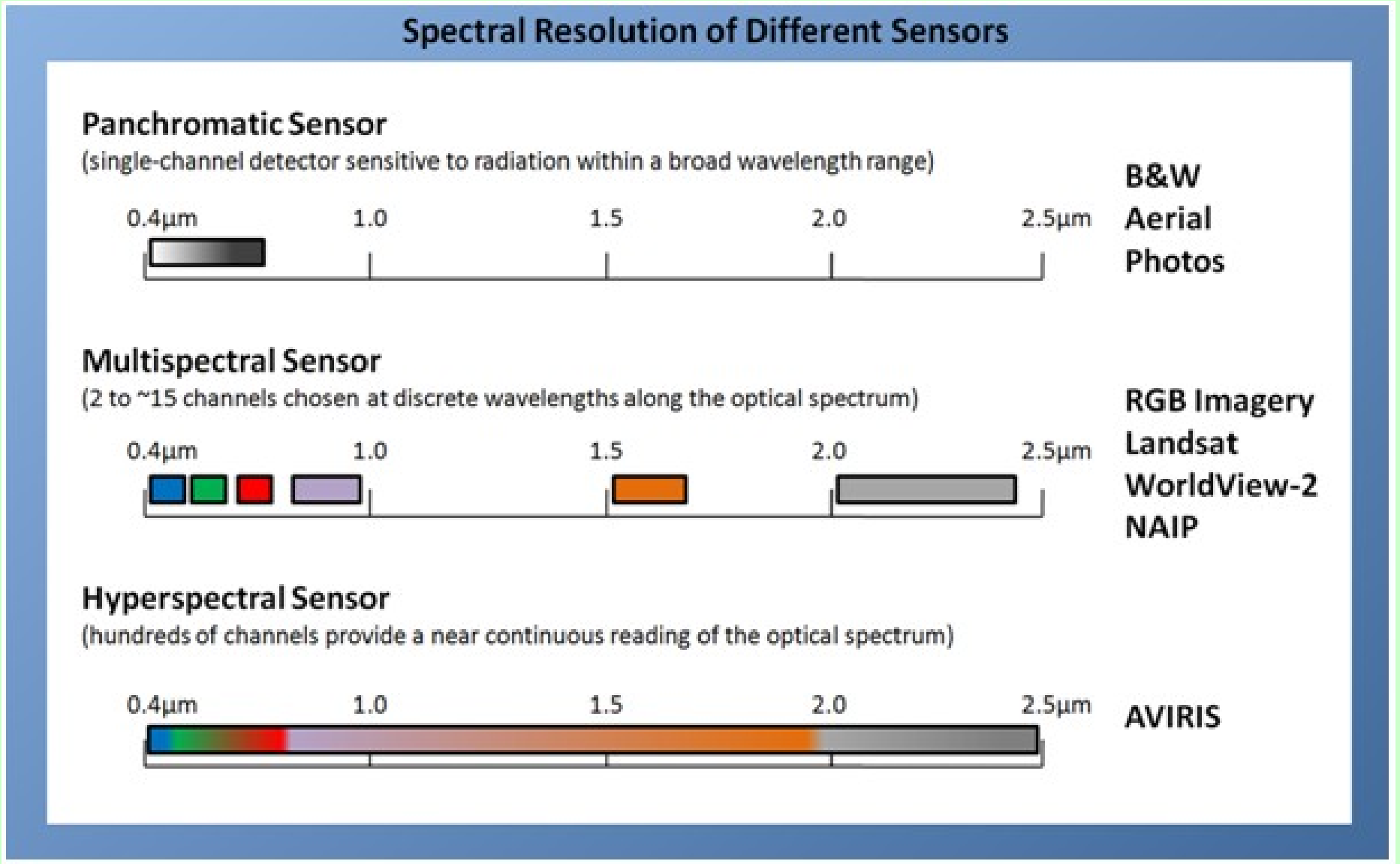
GSAT 17

GSAT 18

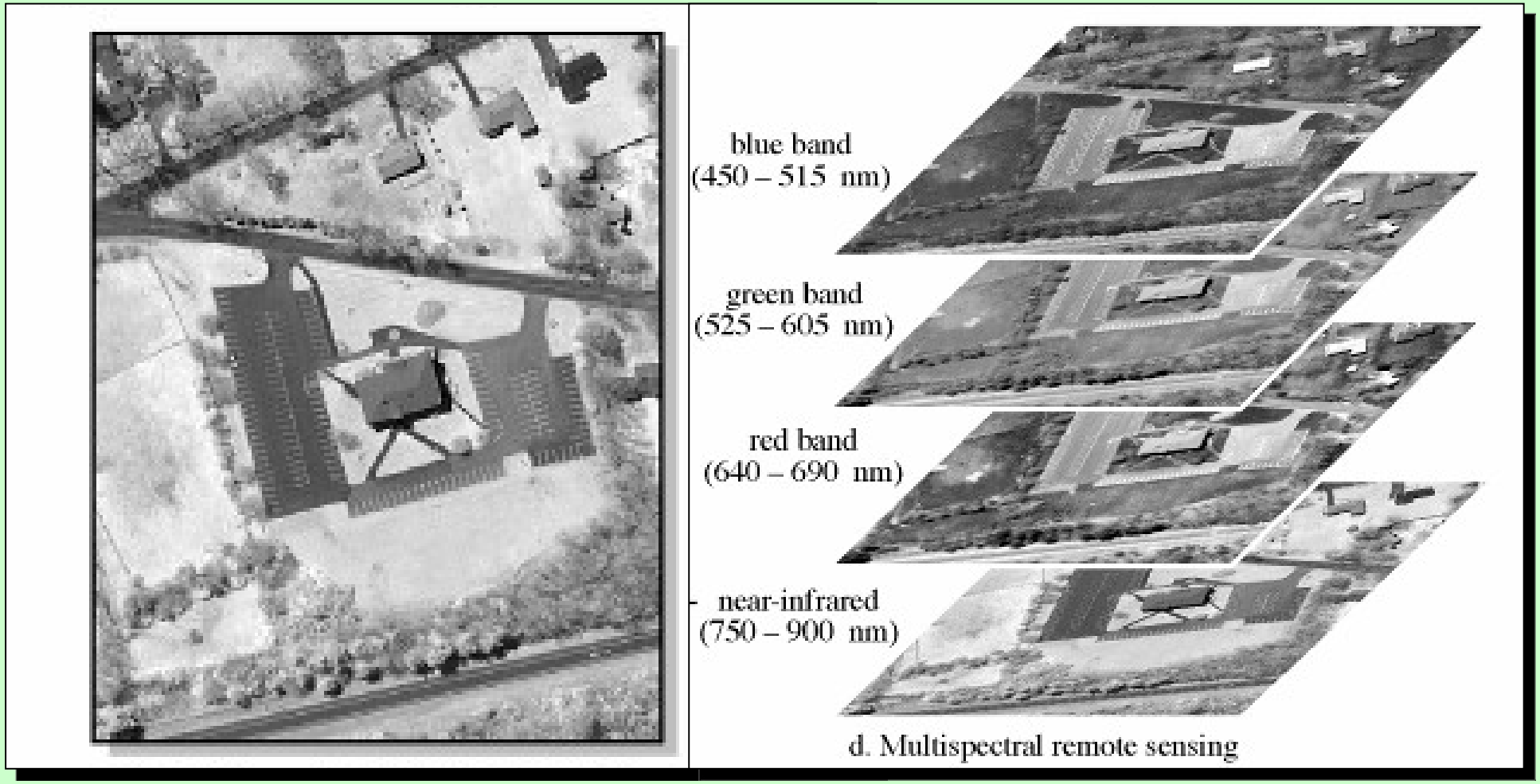
GSAT 29

NAVIGAITION

Spectral Resolution



Spectral Resolution

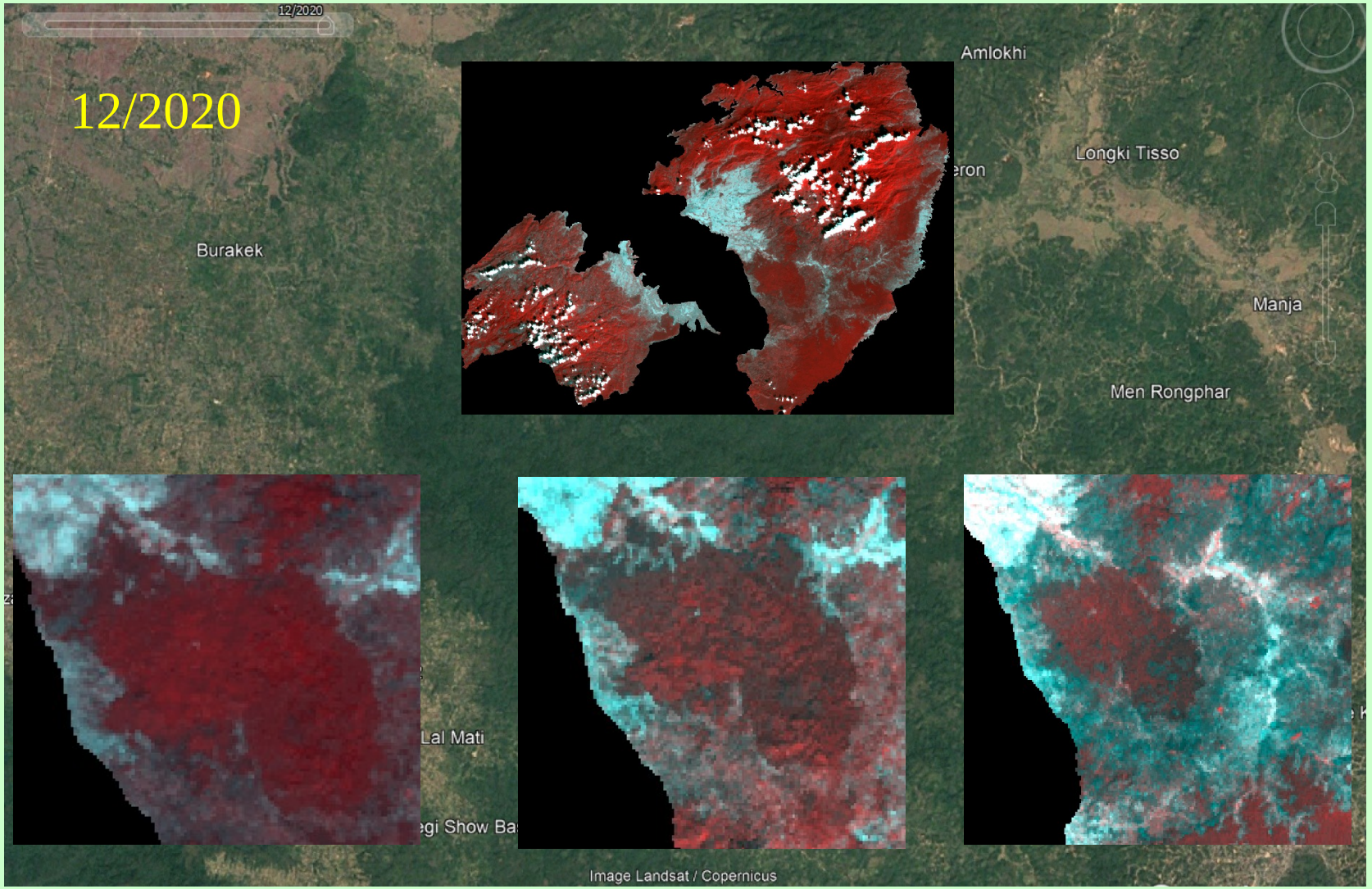


Source: Jensen (2000)

Temporal Resolution

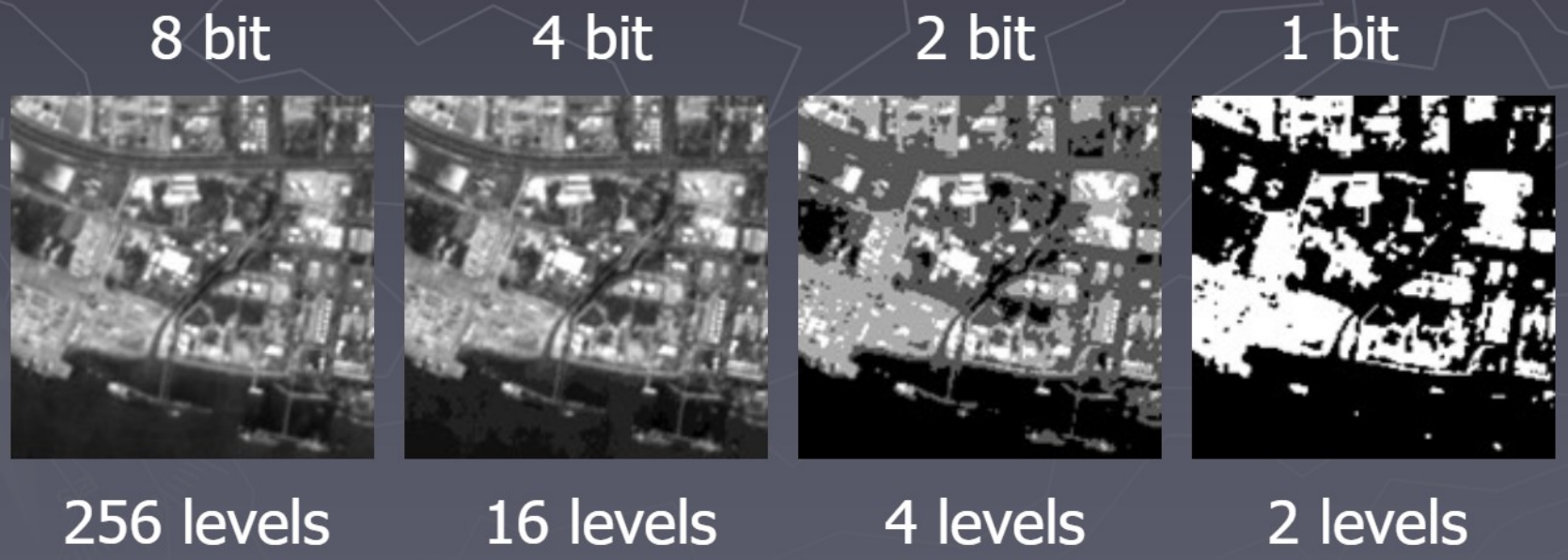
Frequency at which a sensor records imagery of a particular area (revisit capability). Useful for mapping land-cover changes and conducting time series studies.

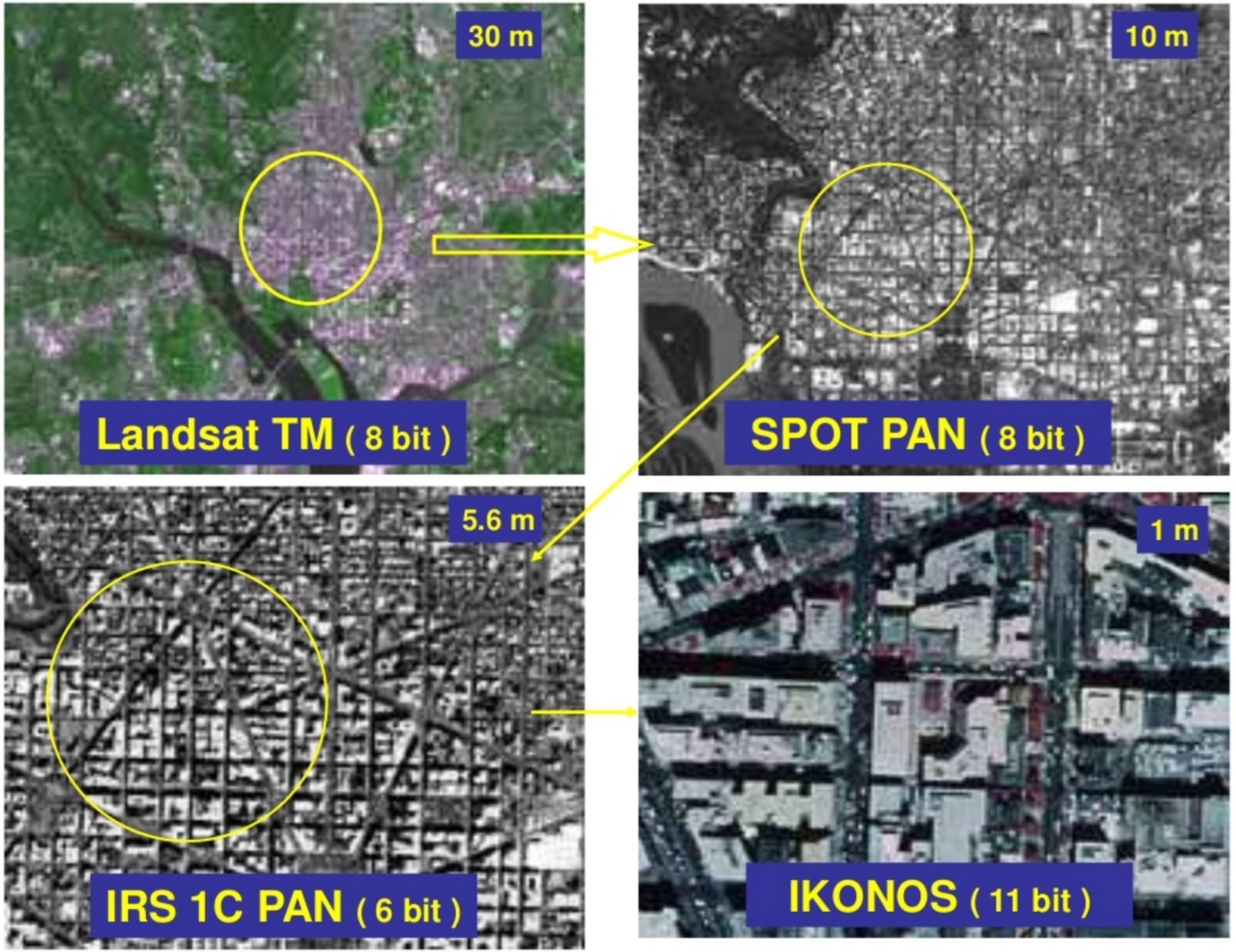
Date 1 Date 2 Date 3 Date 4


12/2020
12/2020
Amlokhi
Longki Tisso
Burakek
Manja
Men Rongphar
Lal Mati
Image Landsat / Copernicus

Radiometric Resolution

- The sensitivity of a detector to differences in signal strength as it records the radiant flux reflected or emitted from the terrain




30 m
Landsat TM (8 bit)
10 m
SPOT PAN (8 bit)
5.6 m
IRS 1C PAN (6 bit)
1 m
IKONOS (11 bit)

Atmospheric Scattering

There are three (3) types of scattering which take place:

1. Rayleigh scattering
2. Mie scattering
3. Non-selective scattering

Rayleigh Scattering

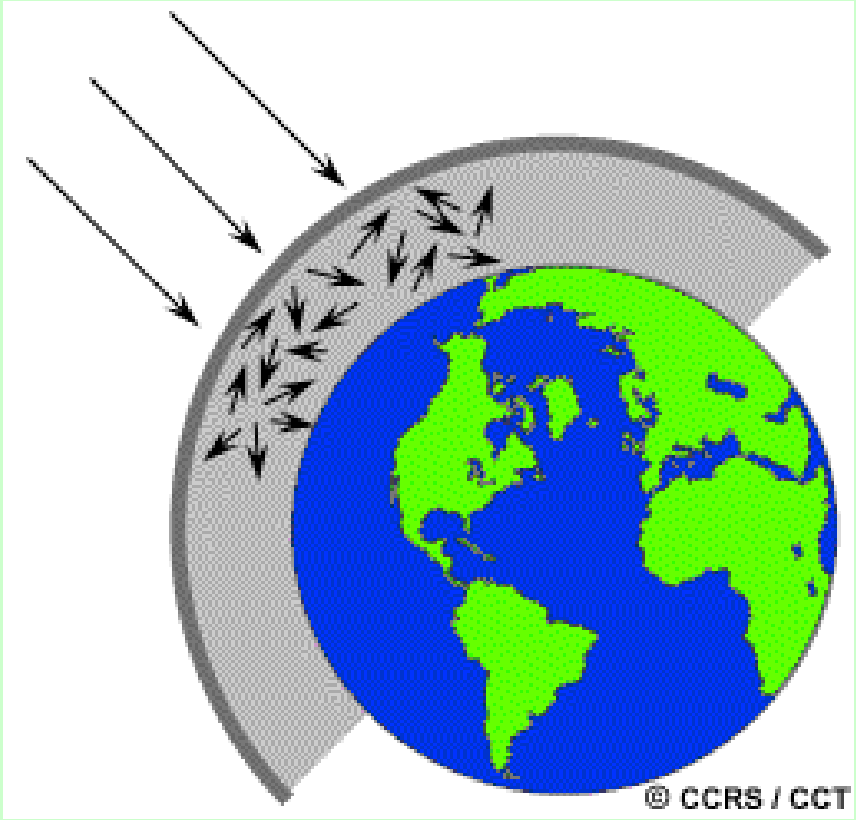
Rayleigh scattering occurs when particles are ***very small compared to the wavelength*** of the radiation, e.g. small specks of dust or nitrogen and oxygen molecules.

Rayleigh scattering causes shorter wavelengths of energy to be scattered much more than longer wavelengths. This is the ***dominant scattering mechanism in the upper atmosphere***.

The amount of scattering is inversely related to the fourth power of the radiation's wavelength.

For example, blue light (0.4 μm) is scattered 16 times more than near-infrared light (0.8 μm).

The blue sky
The Red Sun rise & Sun set



Mie Scattering

Mie scattering occurs when the particles are just about ***the same size as the wavelength*** of the radiation.

Dust, pollen, smoke and water vapour are common causes of Mie scattering which tends to ***affect longer wavelengths*** than those affected by Rayleigh scattering.

Mie scattering occurs ***mostly in the lower portions of the atmosphere*** where larger particles are more abundant, and dominates when cloud conditions are overcast.

Nonselective Scattering

This occurs when the particles are ***much larger than the wavelength*** of the radiation.

Water droplets and large dust particles can cause this type of scattering.

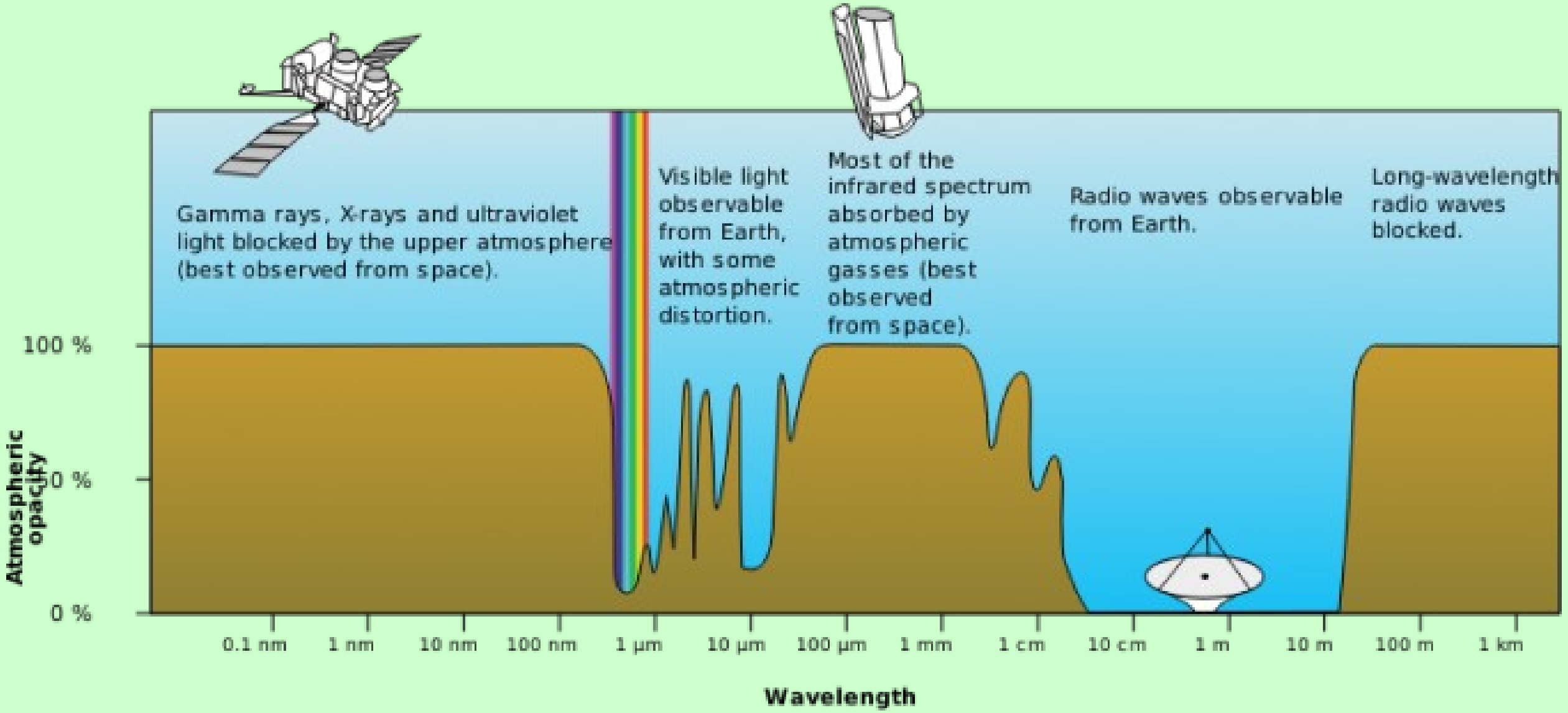
Nonselective scattering gets its name from the fact that ***all wavelengths are scattered about equally***.

This type of scattering causes fog and clouds to appear white to our eyes because blue, green, and red light are all scattered in approximately equal quantities (blue+green+red light = white light).

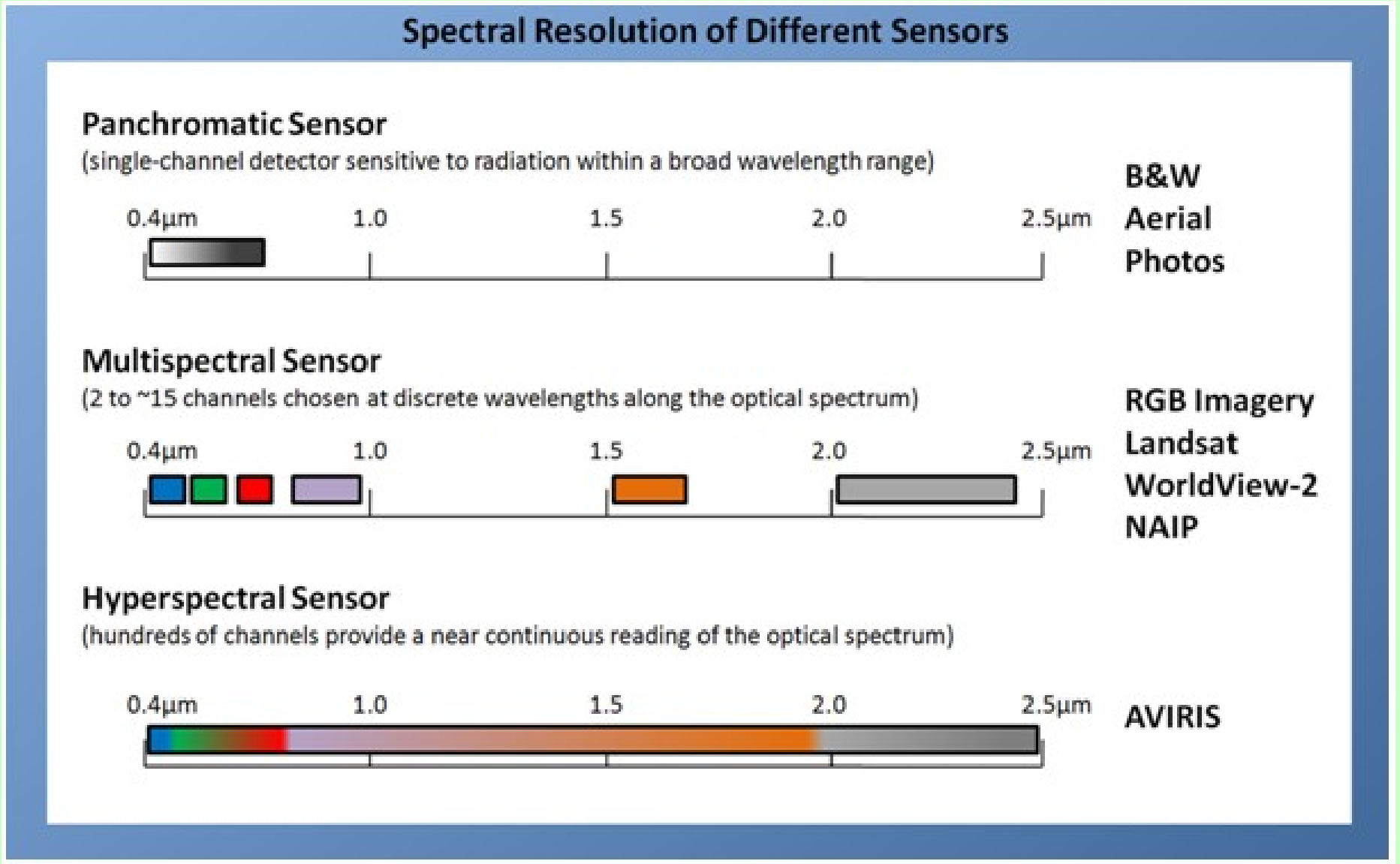
Atmospheric Window

- One important practical consequence of the interaction of electromagnetic radiation with matter and of the detailed composition of our atmosphere is that ***only light in certain wavelength regions can penetrate the atmosphere well***.
- Because gases absorb electromagnetic energy in very specific regions of the spectrum, they influence where (in the spectrum) we can "look" for remote sensing purposes

Atmospheric windows



Spectral Resolution



Thank you