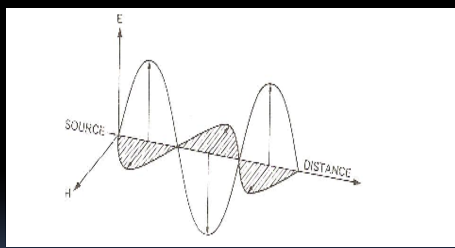
ELECTROMAGNETIC RADIATION

Introduction

- Interpretation of remote sensing imagery depends on a sound undestanding of electromanetic radiation and its interaction with surfaces and the atmospfere

Electromagnetic Spectrum

- Electromagnetic radiation consists of an Electrical field (E) and magnetic field (H).
- The electric and magnetic are oriented at right angles to one other , and vary along an axis perpendicular to the axis of propagation



- **Electromagnetic energy display 3 properties :**

1. **Wavelenght**

Units of Length Used in Remote Sensing

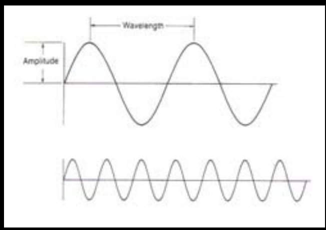
Unit	Distance
Kilometer (Km)	1.000 m
Meter (m)	
Centimeter (Cm)	10^{-2} m
Milimeter (mm)	10^{-3} m
Micrometer (µm)	10^{-6} m
Nanometer (nm)	10^{-9} m
Angstrom unit (A)	10^{-10} m

2. Frequency

Frequency Used in Remote sensing

Unit	Frequency (cycles per second)
Hertz (Hz)	1
Kilohertz (kHz)	10^{3}
Megahertz (MHz)	10^{6}
Gigahertz (GHz)	10^{9}

3. Amplitudo



Kecepatan energi elektromagnet

$$c = \lambda v$$

c = kecepatan elektomagnetik (299.893 km/s)
λ = panjang gelombang
v = frekuensi

Principal Divisions of the Electromagnetic Spectrum

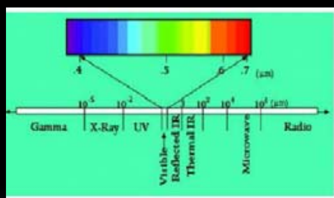
Division	Limits
Gamma rays	< 0,03 nm
X-rays	0,03 – 300 nm
Ultraviolet radiation	0,3 -0,38 µm
Visible light	0,38 – 0,72 µm
Infrared radiation	
Near infrared	0,72 – 1,3 µm
Mid infrared	1,3 – 3,00 µm
Far infrared	7,0 – 1.000 µm
Microwave radiation	1 mm – 30 cm
Radio	≥ 30 cm

Ultraviolet Spectrum

Ultraviolet means '*beyond the violet*'

For practical purpose, radiaton of significance for remote sensing can be said to begin with ultaviolet region, a zone of short-wavelenght radiation that lies between the X-ray region and the limit of human vision.

Visible spectrum



- B : 0,4 – 0,5 µm
- G : 0,5 – 0,6 µm
- R : 0,6 – 0,7 µm

Additive primaries

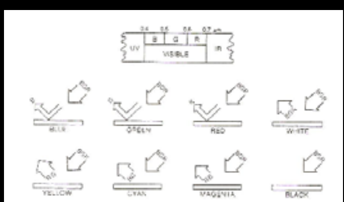


FIGURE 2.4. Colors.

- Infrared Spectrum
- Microwave Energy

Radiation Laws

Q = *hv*

Q : radiant energy
h : konstanta Planck (6,626 x10-34 J.s
v : frequency

Stefan Boltzmann law

$$W = \sigma T^4$$

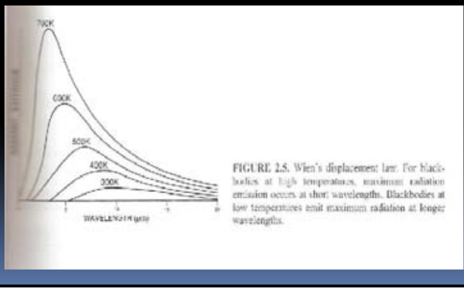
W : emitted radiation
σ : Constant Stefan Boltzmann (5,669 x 10^{-8} W/m²K^{-4})
T : Temperatur (K)

- Wien's displacement law

  λ = 2,897.8/T

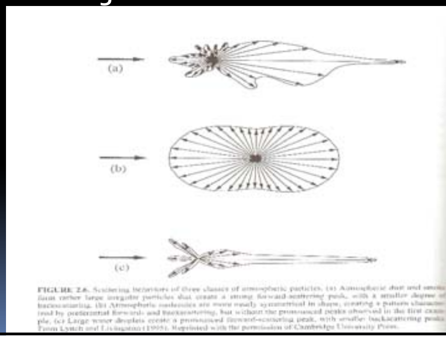
  λ = wavelenght

  T = temperature

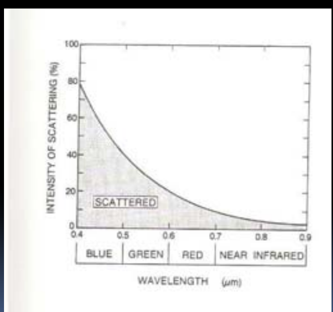


Interaction with the atmosphere

1. Scattering



Rayleigh scattering



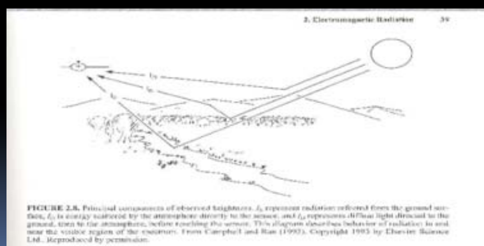
- I = Is + Io + Id

I : effects of scattering

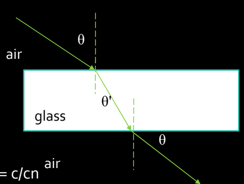
Is : radiation refrected from the ground surface

Io : energy scattered by the atmosphere directly to the sensor

Id : difuse light directed to the ground, then to atmosphere , before reaching the sensor



2. Refraction



Indeks bias

n = c/cn air

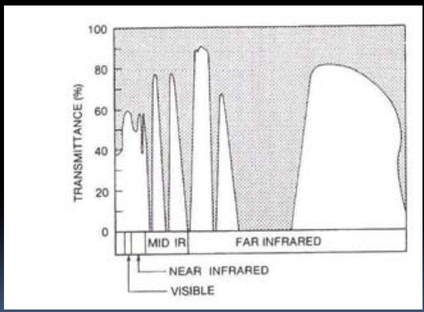
Hukum Snell

n sin θ = n' sin θ'

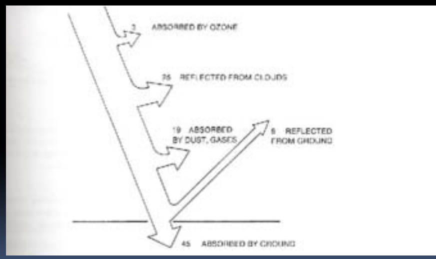
3. **Absorption** occurs when the atmosphere prevents, or strongly attenuates, transmission of radiation or its energy trough the atmosphere

Atmospheric windows

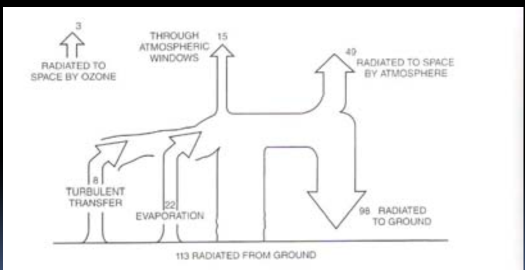
- The Earth's atmosphere is by no means completely transparen to electromagnetic radiation because these gases together form important barrier s to transmission of electromagnetic radiation through the atmosphere.
- Those wavelenght that are relatively easily transmitted through the atmosphere are referred to as *asmopheric windows*



Incoming solar radiation



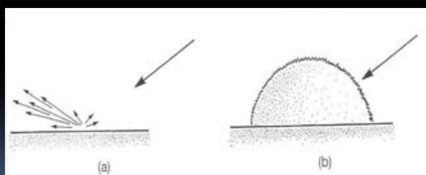
Outgoing terresterial radiation



Interaction with Surface

- Reflection

  Reflection occurs when a ray of light is redericted as it strikes a nontransparent surface



Specular reflection Diffuse reflection

- Transmission

  Transmission of radiation occurs when radiation passed through a substance without significant attenuation.
- Fluorescence

  Fluorescence occurs when an object illuminated with radiation at a different wavelenght.

Spectral properties of Object

- A fundamental premise in remote sensing is that we can learn about object s and features the Earth's surface by studying radiation reflected or emitted by these feature, using cameras and remote sensing intruments, we can observe the brigtnesses of objects over a range of wavelenght, so that there are numerous points of comparison between brightnesses of separate objects

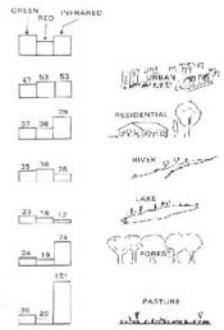
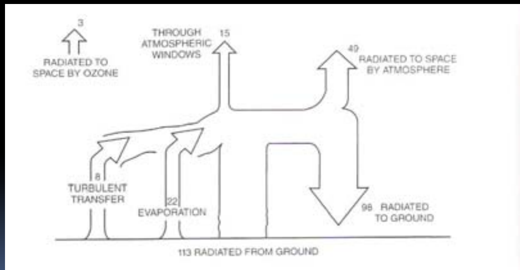


FIGURE 2.19. Spectral signatures



Three models for Remote sensing

50 I. FOUNDATIONS

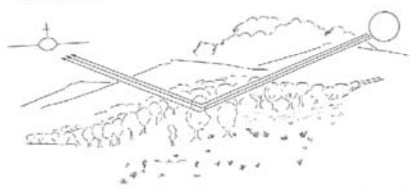


FIGURE 2.20. Remote sensing using reflected solar radiation. The sensor detects solar radiation that has been reflected from features at the Earth's surface. (See Figure 2.12.)

FIGURE 2.21. Remote sensing using emitted terrestrial radiation. The sensor records solar radiation that has been absorbed by the Earth, and then reemitted as thermal infrared radiation. (See Figures 2.12 and 2.13.)

FIGURE 2.22. Active remote sensing. The sensor illuminates the terrain with its own energy, then records the reflected energy as it has been altered by the Earth's surface.