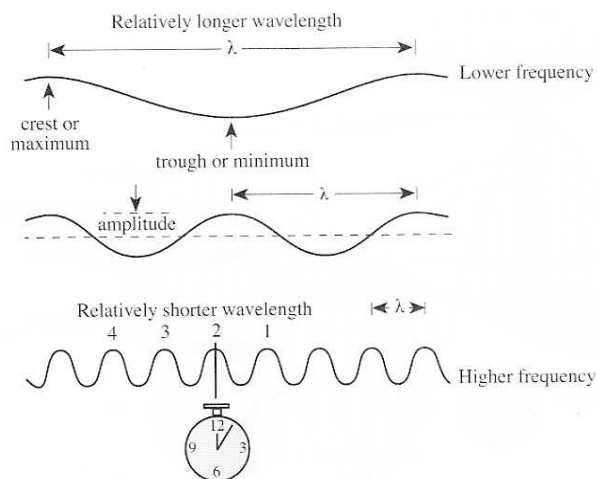
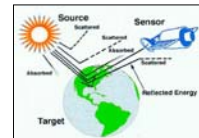
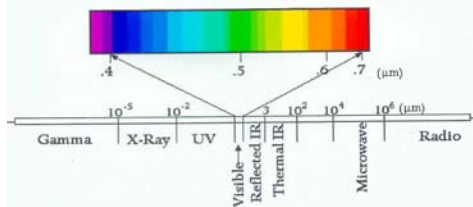
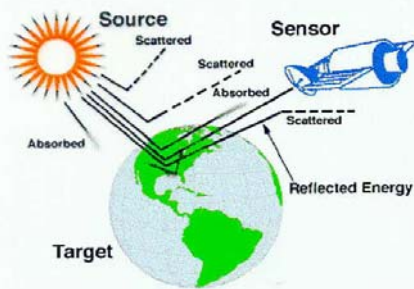
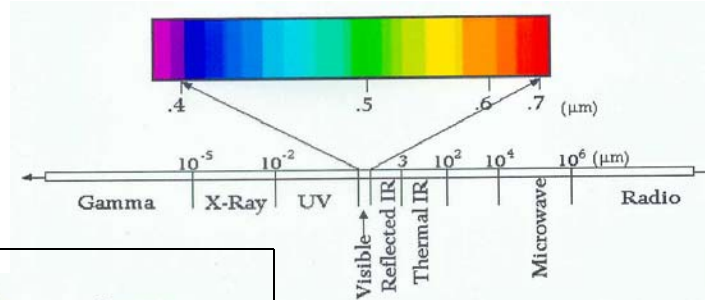
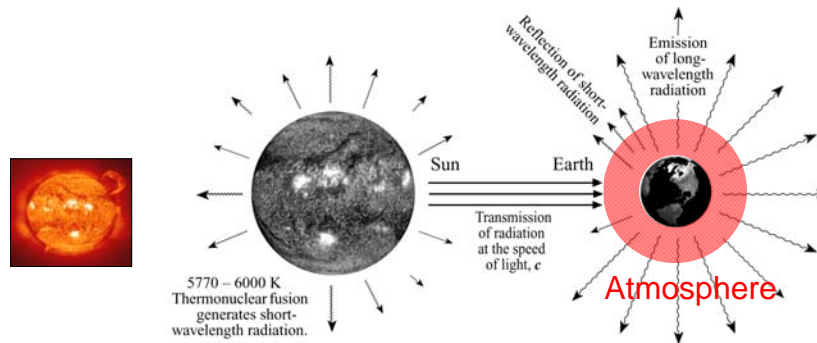


Electromagnetic Radiation (EMR) and Remote Sensing

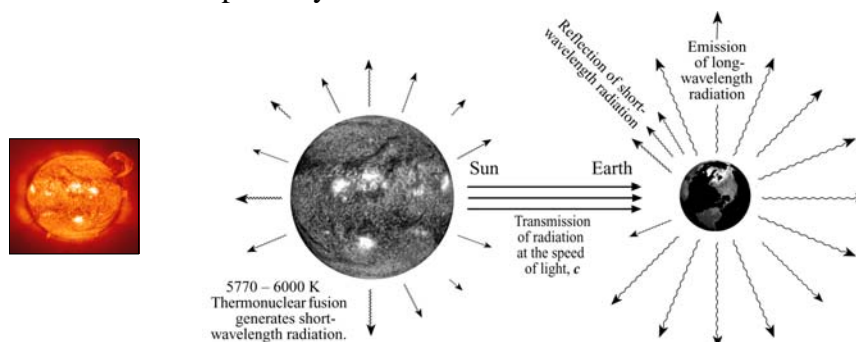




Anything missing in between?

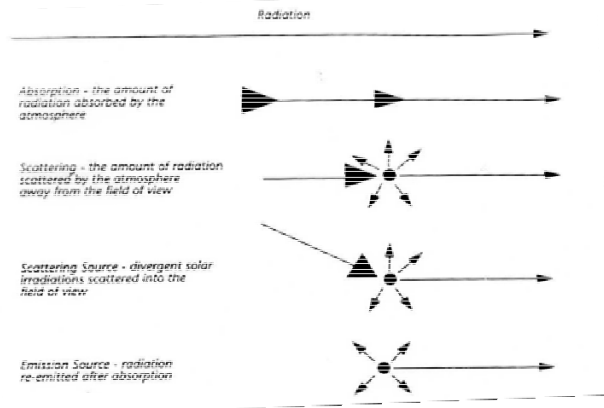
Electromagnetic Radiation (EMR)

- is radiated by atomic particles at the source (the Sun),
- propagates through the vacuum of space at the speed of light,
- interacts with the Earth's atmosphere,
- interacts with the Earth's surface,
- interacts with the Earth's atmosphere once again, and
- finally reaches the remote sensors where it interacts with various optical systems and detectors.



Atmospheric Scattering

When passing through the atmosphere, EMR interact with the suspended particles, such as aerosols, and clouds. Therefore scattering process happens. Three types of atmospheric scattering are important in remote sensing considerations.



Rayleigh (or molecular) Scattering:

Rayleigh scattering is primarily caused by oxygen and nitrogen molecules. The effective diameters are at least 0.1 times smaller than the affected wavelengths.

Rayleigh scattering is most influential at altitude above 4.5 km (pure atmosphere).

Rayleigh (or molecular) Scattering:

The amount of Rayleigh scattering is $1/\lambda^4$

As the result, invisible ultraviolet radiation is greatly affected by Rayleigh scattering.

Rayleigh scattering can be called small particle scattering.

In visible light, **blue** wavelength at 0.4 μm is scattered 5 times as the **red** wavelength at 0.6 μm .

This explains why the clear sky appears **blue**. The scattering made blue light reach our eyes from all parts of the sky.



Mie (or nonmolecular) Scattering:

Occurs when there are sufficient particles in the atmosphere that have mean diameters from 0.1 to 10 times larger than the wavelength under consideration.

Mie scattering can be called large particle scattering.

The important Mie scattering agents include water vapor and tiny particles of smoke, dust, etc. The influence of the Mie scattering is most affected in the lower 4.5 km of the atmosphere.

Mie scattering influences longer radiation wavelengths than Rayleigh scattering.

The wavelength of Mie scattering is between λ^4 to λ^0 .



Nonselective scattering:

Happened when the lower atmosphere contains suspended aerosols. The aerosols should have diameters at least 10 times larger than the wavelengths under consideration.

The important scattering agents include large particles of smoke, water vapor, water droplets, ice crystals in the clouds and fog.

Nonselective scattering has impacts on almost all spectral bands.

In visible wavelengths, water droplets and ice crystals scatter all wavelengths equally well so that the clouds in the sunlit sky looks white. Also large smog particles cause the color of sky to grey.

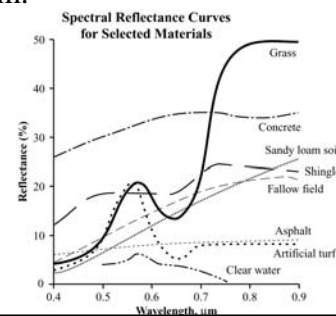
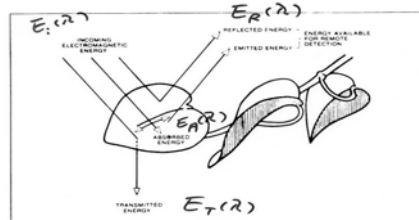


Spectral Reflectance Properties

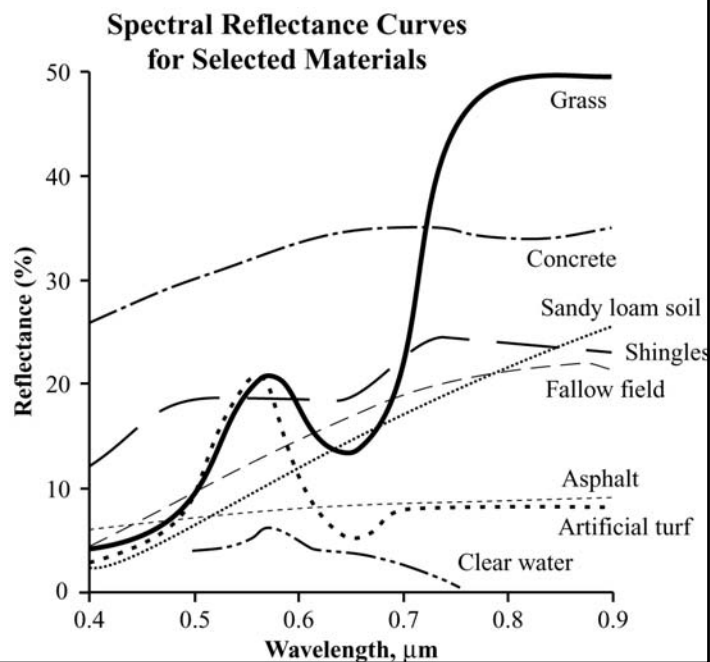
How much of EMR will be reflected depends on the nature of the materials and which portion of the EMR is being measured.

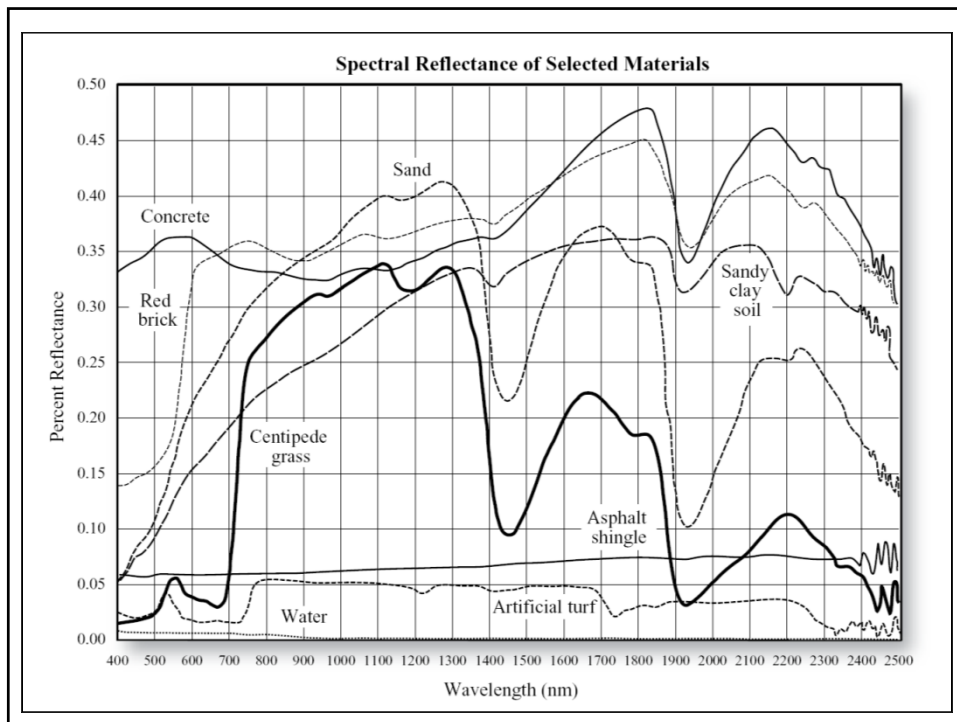
The nature of this reflected component over a range of wavelengths is called **spectral response patterns**.

Spectral patterns are descriptions of the degree to which energy is reflected in different regions of the spectrum.



Typical
spectral
reflectance
curves in the
region
0.4 – 0.9 μm.





Spectral Signature

Every natural and artificial object reflects and emits EMR over a range of wavelengths in its own chemical composition and physical state.

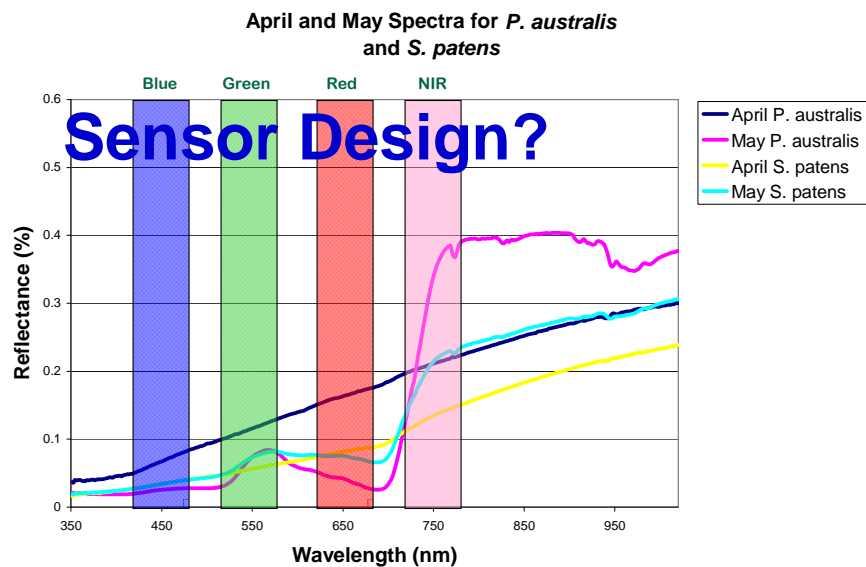
The distinctive reflectance and emission properties of objects are called **spectral signature**.

Within some limited wavelength region, a particular object will usually exhibit a diagnostic spectral response patterns that differs from other objects.

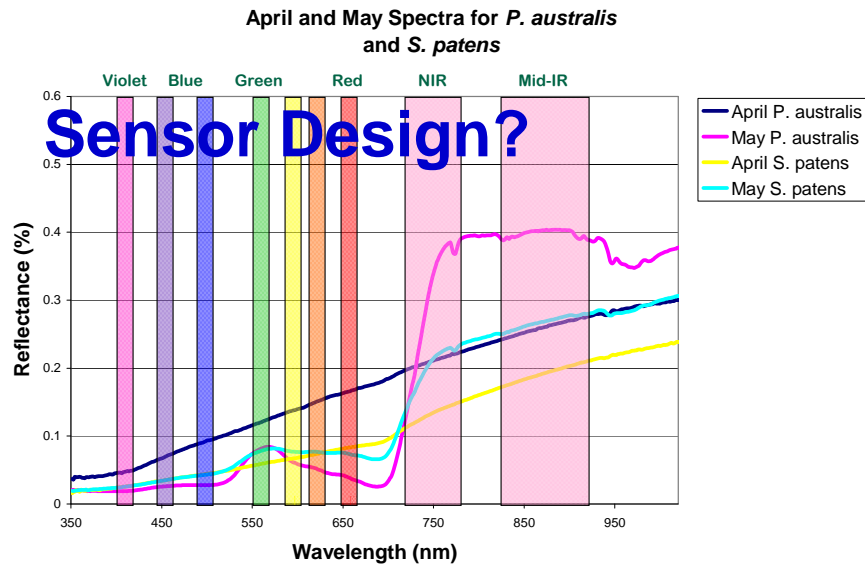
It is hoped that each material on the earth would have a distinctive spectral response patterns that would allow it to be reliably detected by visual and digital means.

Finding distinctive spectral response patterns is the key to most procedures for remote sensing image interpretation.

Spectral Response Curve



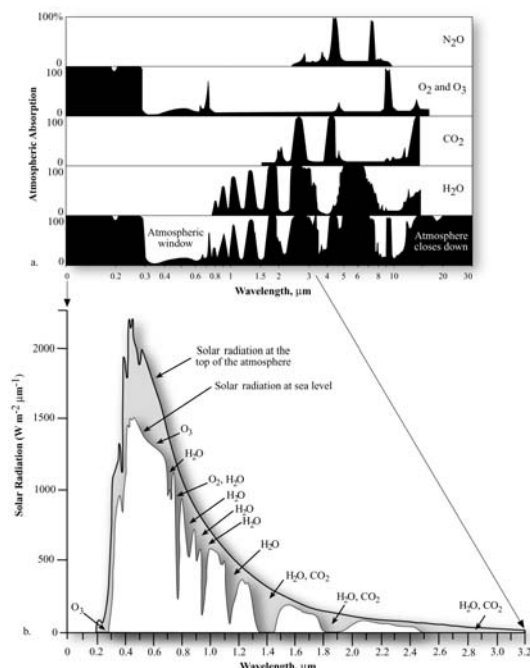
Spectral Response Curves

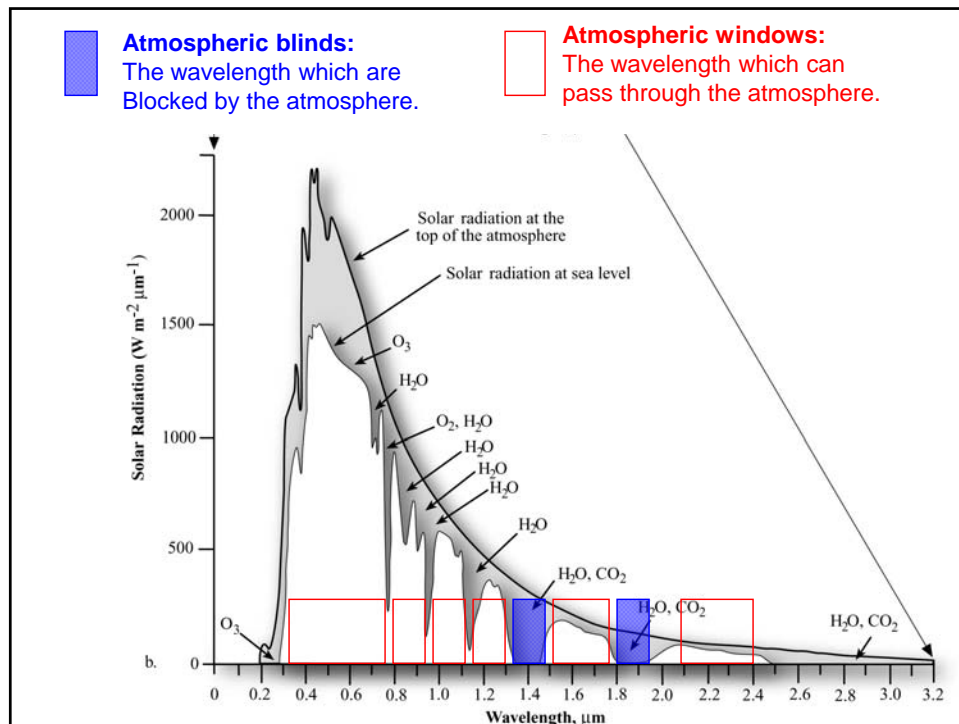


The atmosphere essentially “closes down” in certain portions of the spectrum while “atmospheric windows” exist in other regions that transmit incident energy effectively to the ground.

It is within these windows that remote sensing systems must function.

The combined effects of atmospheric absorption, scattering, and reflectance reduce the amount of solar irradiance reaching the Earth’s surface.





EMR

- The foundation of remote sensing technology is based on the measurement and interpretation of the patterns of EMR.
- EMR is a dynamic form of energy. EMR transmit cross space in the wave form and in the speed of light.
- The whole range of EMR is called spectrum.
- EMR is characterized by wavelength and frequency. Different wavelengths or frequencies indicates different portion of EMR.
- EMR interact with atmosphere. The atmosphere causes significant absorption and/or scattering of the wavelength, such as Rayleigh (molecular) scattering, Mie (non-molecular) scattering, and non-selective scattering.
- EMR also interact with the surface materials in the form of absorption, reflection, and transmission.
- Consider the reasons of interaction between EMR and the atmosphere, atmospheric windows will have to be used for remote sensor design and ground information detection.

