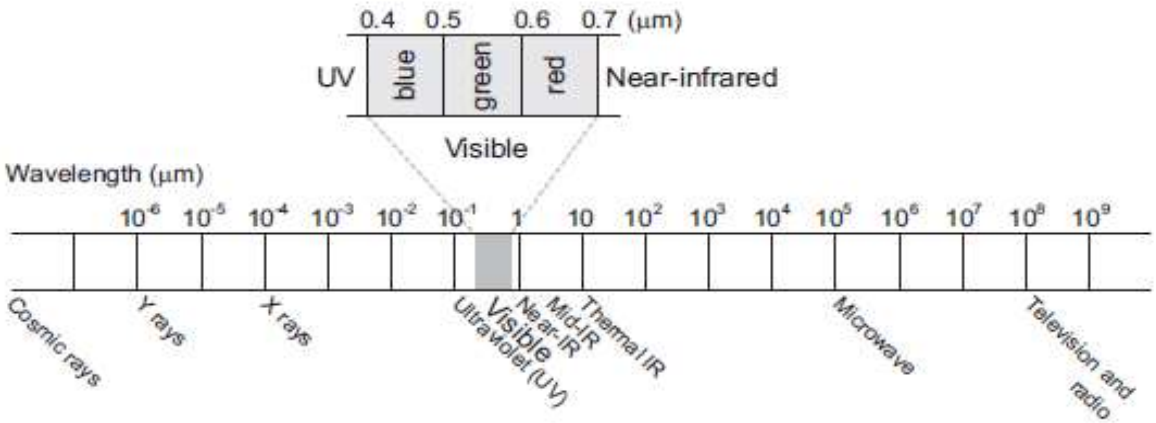
Electromagnetic spectrum

All matter with a temperature above absolute zero (K) radiates electromagnetic waves of various wavelengths. The total range of wavelengths is commonly referred to as the electromagnetic spectrum below. It extends from gamma rays to radio waves.



Remote sensing operates in several regions of the electromagnetic spectrum.

a) **optical part of the EM spectrum**.

Refers to that part of the EM spectrum in which optical phenomena of reflection and refraction can be used to focus the radiation.

The optical range extends from X-rays (0.02 μm) through the visible part of the EM spectrum up to and including far-infrared (1000 μm).

b) **The ultraviolet (UV) portion of the spectrum.**

has the shortest wavelengths that are of practical use for remote sensing. This radiation is beyond the violet portion of the visible

wavelengths. Some of the Earth's surface materials, in particular rocks and minerals, emit or fluoresce visible light when illuminated with UV radiation.

c) **The microwave range.**

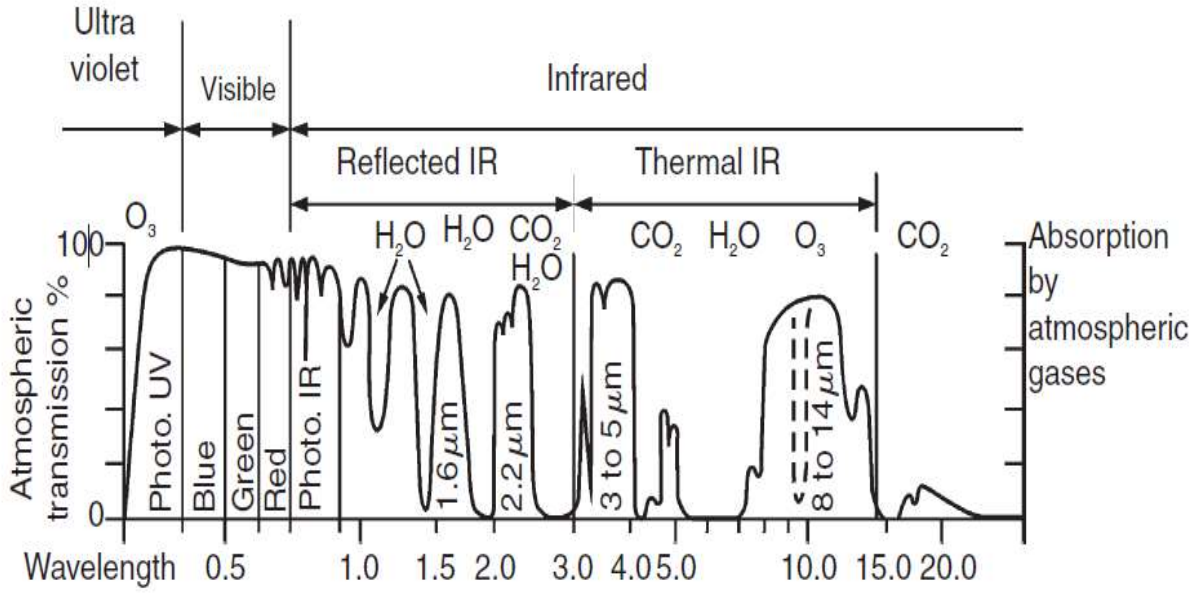
Covers wavelengths from 1 mm to 1 m.

The visible region of the spectrum Figure before is commonly called 'light'. It occupies a relatively small portion in the EM spectrum. It is important to note that this is the only portion of the spectrum that we can associate with the concept of colour. Blue, green and red are known as the primary colours or wavelengths of the visible spectrum.

The longer wavelengths used for remote sensing are in the thermal infrared and microwave regions. Thermal infrared gives information about surface temperature. Surface temperature can be related, for example, to the mineral composition of rocks or the condition of vegetation. Microwaves can provide information on surface roughness and the properties of the surface such as water content.

Absorption and transmission

Electromagnetic energy travelling through the atmosphere is partly absorbed by various molecules. The most efficient absorbers of solar radiation in the atmosphere are ozone (O_3), water vapour (H_2O) and carbon dioxide (CO_2). Figure below gives a schematic representation of the atmospheric transmission in the 0–22 μm wavelength region.



From this figure it may be seen that about half of the spectrum between 0–22 μm is not useful for remote sensing of the Earth's surface, simply because none of the corresponding energy can penetrate the atmosphere. Only the wavelength regions outside the main absorption bands of the atmospheric gases can be used for

remote sensing. These regions are referred to as the atmospheric transmission windows and include:

• A window in the visible and reflected infrared region, between 0.4–2 μm. This is the window where the optical remote sensors operate.

• Three windows in the thermal infrared region, namely two narrow windows around 3 and 5 μm, and a third, relatively broad, window extending from approximately 8 to 14 μm.