ENERGY INTERACTIONS IN THE ATMOSPHERE

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The atmosphere has different effects on the EM transfer at different wavelength. These effects are caused primarily by the atmospheric scattering and absorption.

1) **Scattering:** Scattering of electromagnetic radiation is caused by the interaction of radiation with matter resulting in the reradiation of part of the energy to other directions not along the path of the incident radiation. Scattering effectively removes energy from the incident beam. Unlike absorption, this energy is not lost, but is redistributed to other directions. Both the gaseous and aerosol components of the atmosphere cause scattering in the atmosphere.

Scattering by gaseous molecules

The law of scattering by air molecules was discovered by Rayleigh in 1871, and hence this scattering is named Rayleigh Scattering. Rayleigh scattering occurs when the size of the particle responsible for the scattering event is much smaller than the wavelength of the radiation. The scattered light intensity is inversely proportional to the fourth power of the wavelength. Hence, blue light is scattered more than red light. This phenomenon explains why the sky is blue and why the setting sun is red.

Scattering by Aerosols

Scattering by aerosol particles depends on the shapes, sizes and the materials of the particles. If the size of the particle is similar to or larger than the radiation wavelength, the scattering is named Mie Scattering. The scattering intensity and its angular distribution may be calculated numerically for a spherical particle. However, for irregular particles, the calculation can become very complicated.

When the scattering of all wavelengths of electromagnetic radiation equally in the atmosphere, usually caused by particles which are much larger than the energy wavelengths is called non-selective scattering. Cloud appears white due to non-scattering.

2) **Absorption:** Atmosphere selectively absorbs energy in different wavelengths with different intensity.

The atmosphere is composed of N_2 (78%), O_2 (21%), CO_2, H_2O, CO, SO_2, etc. Since different chemical element has a different spectral property, regions with different intensity. As a result, the atmosphere has the combined absorption features of various atmospheric gases. Following figure shows the major absorption wavelengths by CO_2, H_2O, O_2, O_3 in the atmosphere.

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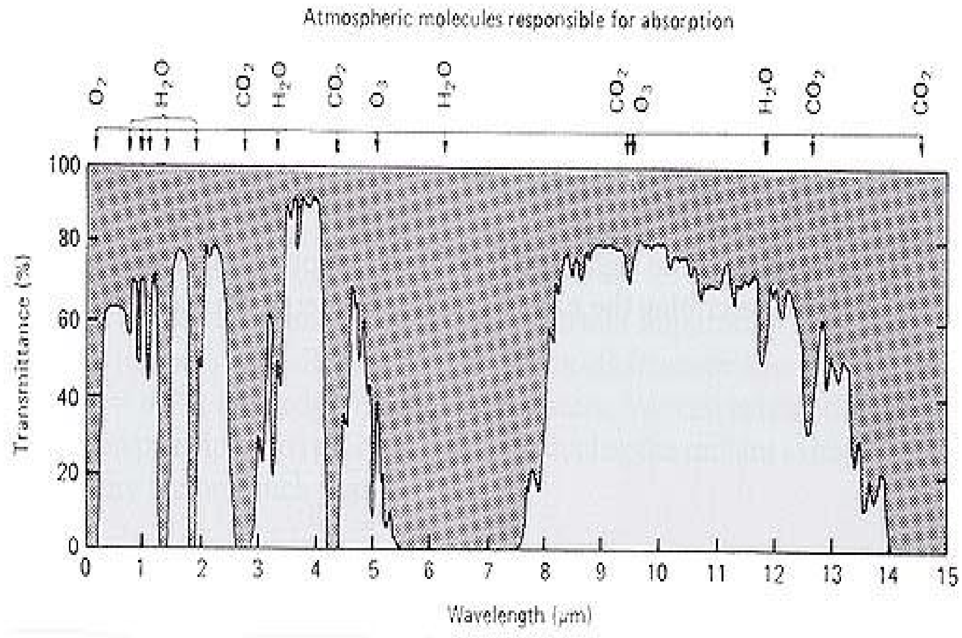

Figure: Major absorption wavelengths by CO_2, H_2O, O_2, O_3 in the atmosphere

(Source: Lillesand and Kiefer, 1994)

3) **Transmission:** The remaining amount of energy after being absorbed and scattered by the atmosphere is transmitted.

Atmospheric Window: The wavelength ranges in which the atmosphere is transparent are called atmospheric windows. Remote sensing projects must be conducted in wavelengths that occur within atmospheric windows.

Atmospheric absorption reduces the number of spectral regions that we can work with in observing the Earth. It affects our decision in selecting and designing sensor. We have to consider

1) The spectral sensitivity of sensors available;

2) The presence and absence of atmospheric windows;

3) The source, magnitude, and spectral composition of the energy available in these ranges.