Solar Radiation

Solar Radiation in the earth's atmosphere has two main effects:

- heating
- energy input for deviations from equilibrium

Most chemical processes in the atmosphere are started by energy input from the sun; the consequences are determined by kinetics.

Energy of photons:

$$E = h\nu = hc / \lambda$$

h = Planck's constant, c = velocity of light
L=Lohschmidt's number

Convenient units:

$$E(\text{per mole}) = Lh\nu$$
$$= Lhc / \lambda$$
$$= \frac{119625}{\lambda} \frac{\text{KJ}}{\text{mol}}$$

$\Rightarrow$ extreme red (800nm) $\approx$ 150KJ/mol
extreme blue (400nm) $\approx$ 300 KJ/mol

$\Rightarrow$ visible light can produce electronic transitions up to photolysis of loosely bound chemical species

- scattering by air molecules (Rayleigh scattering)
- scattering by aerosols and clouds (Mie scattering)

⇒ The photon flux in the atmosphere is a strong function of wavelength, height, solar elevation and atmospheric constitution

Radiation in the Atmosphere

Source: sun, black body radiation of approx. 6000 K, cooler in the UV, warmer in the IR, strong absorptions in the solar atmosphere (Fraunhofer lines)

In the earth's atmosphere, there is

- strong absorption by O_2, O, N_2, and O_3 in the UV and many other absorbers in the IR (H_2O, CO_2, CH_4, ...)

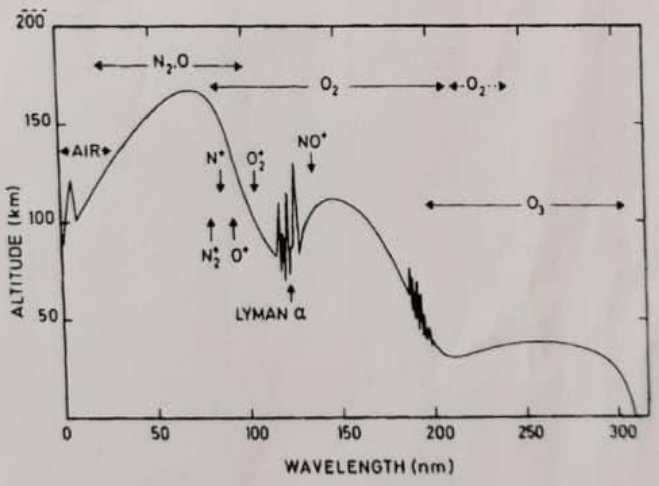

Fig. 4.3. Depth of penetration of solar radiation as a function of wavelength. Altitudes correspond to an attenuation of 1/e. The principle absorbers and ionization limits are indicated.

Absorption of Light

When photons are absorbed by a molecule, they change the energy states of

- the electrons
- the vibration
- the rotation

In general, energy levels of atoms or molecules are discrete, and the energy of the absorbed photon must fit the difference in energy

$$\nu = \Delta E / h$$

(**Resonance Condition**).

The **Intensity of a Transition** is determined by

- electronic transition moment, computed from the wavefunctions and transition dipole
- population of the upper and lower states

To avoid computation of the transition moment, often **Selection Rules** are given ($\Delta S=0$ or $\Delta L=\pm 1$ in atoms) to decide which transitions are allowed, and which forbidden.