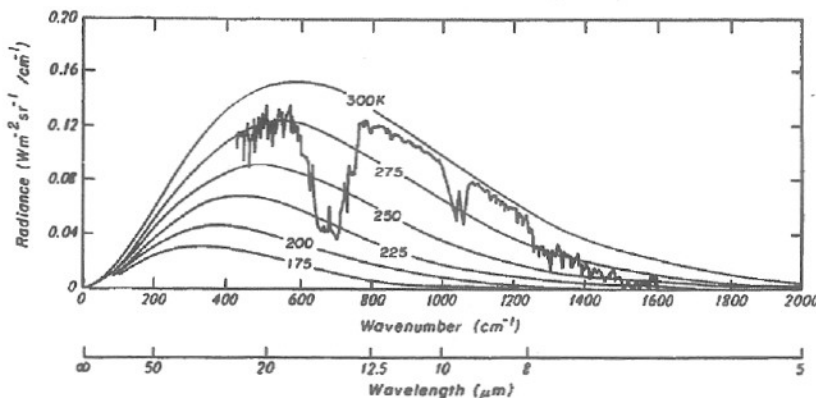
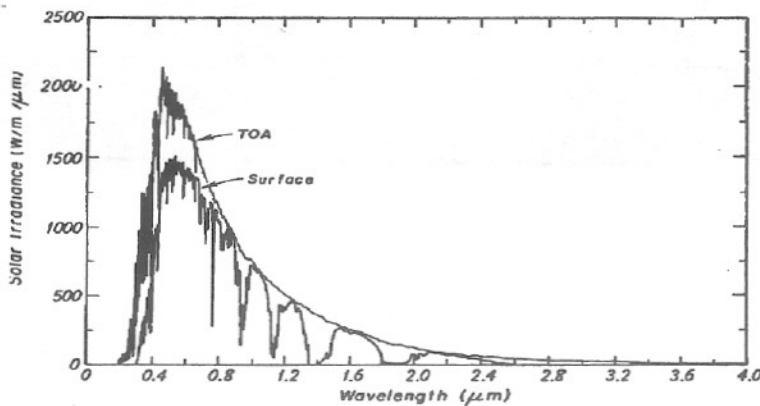


1. Processes that transfer energy: conduction (too slow), convection (dry and moist) and radiation (solar and terrestrial)
2. The electromagnetic spectrum and the Planck function: The sun (at 6000K) emits energy at short wavelengths (visible part of the spectrum). The earth (at 300K) emits energy in the longer wavelengths (thermal or infrared part of the spectrum).
3. Scattering: changes direction of the radiation. Depends on wavelength of the radiation versus the size of the object. Scattering = reflection when size of object is much much greater than wavelength. Albedo = percent of incident radiation that is reflected. Sun's energy is scattered by clouds, aerosols, and bright surfaces.
4. Absorption: changes magnitude. Depends on the wavelength of the radiation and the structure of the molecules (e.g. greenhouse gases).  $\text{CO}_2$ ,  $\text{H}_2\text{O}$  are greenhouse gases that absorb infrared radiation from the Earth.
5. Concept of equilibrium: net energy input from the sun = energy emission from Earth.
6. Water controls the dial: Oceans with its low albedo ( $\sim 6\%$ ) is the principal absorber of solar energy. Ice with its high albedo ( $\sim 60\%$ ) is the principal reflector of solar energy. Evaporation from the ocean and condensation in the atmosphere (clouds!) is one mechanism for transferring heat from the ocean to the atmosphere. Liquid water as clouds reflects solar energy (cools the surface). Water vapor is a greenhouse gas and contributes to warming of surface.



Incoming solar radiation at top of atmosphere: 7 million calories per square meter per day, averaged for the Earth as a whole

Outgoing radiation

