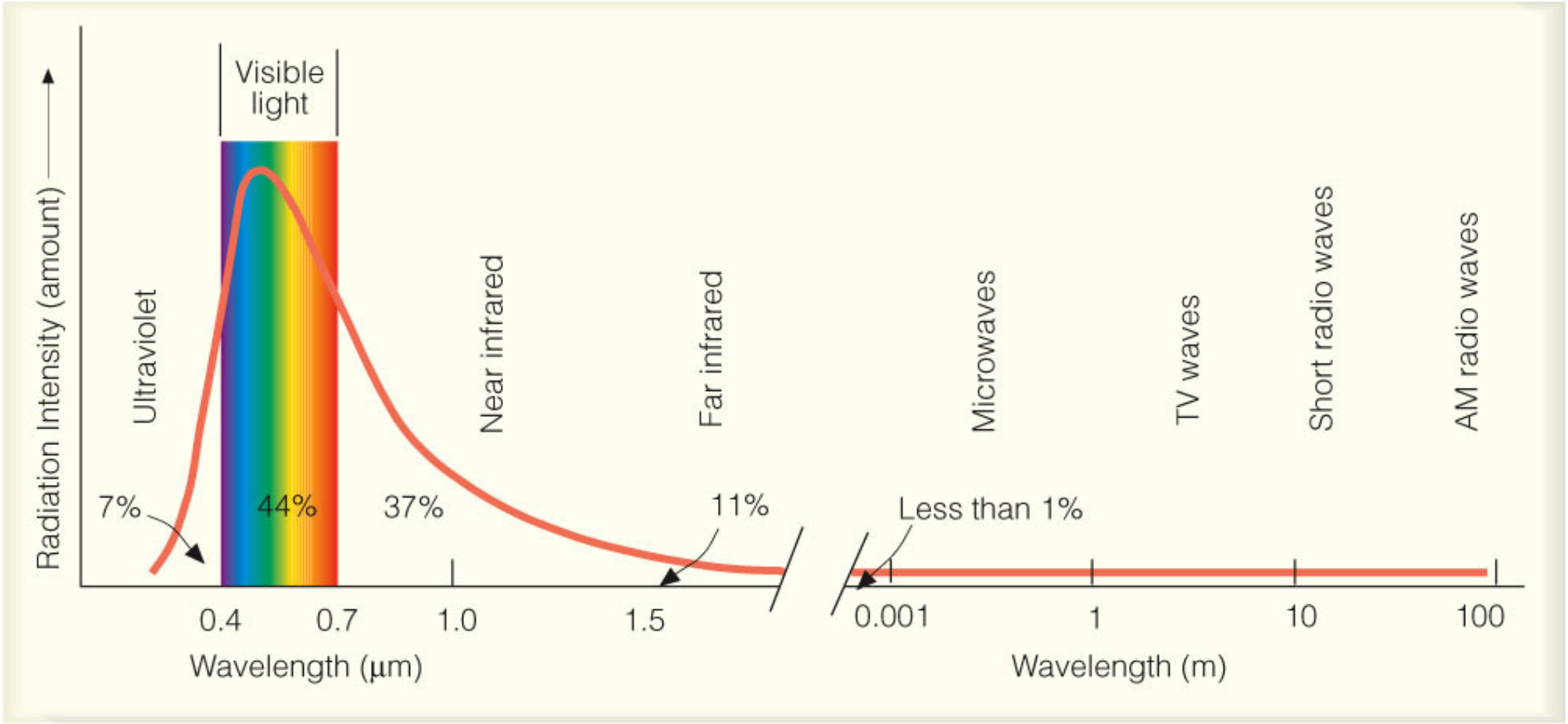
Outline so far

- History of the composition of Earth's atmosphere
- Energy Temperature and Heat
- Electromagnetic Radiation and Greenhouse Effect
  - Everything emits radiation (T > 0k)
  - Radiation travels in waves
  - Spectrum of radiation emitted from the Sun and Earth
  - Absorption, Reflection (albedo) and Transmission
  - Absorbers and Emitters (emissivity; Kirchhoff's law)
  - Blackbody Radiation (Stefan Boltzman Eq. and Wein's Law)
  - Radiative Equilibrium (energy in = energy out)
  - Greenhouse Effect
  - A detailed look at the Earth's energy balance



High ← energy per photon → Low

Fig. 2-9, p. 37

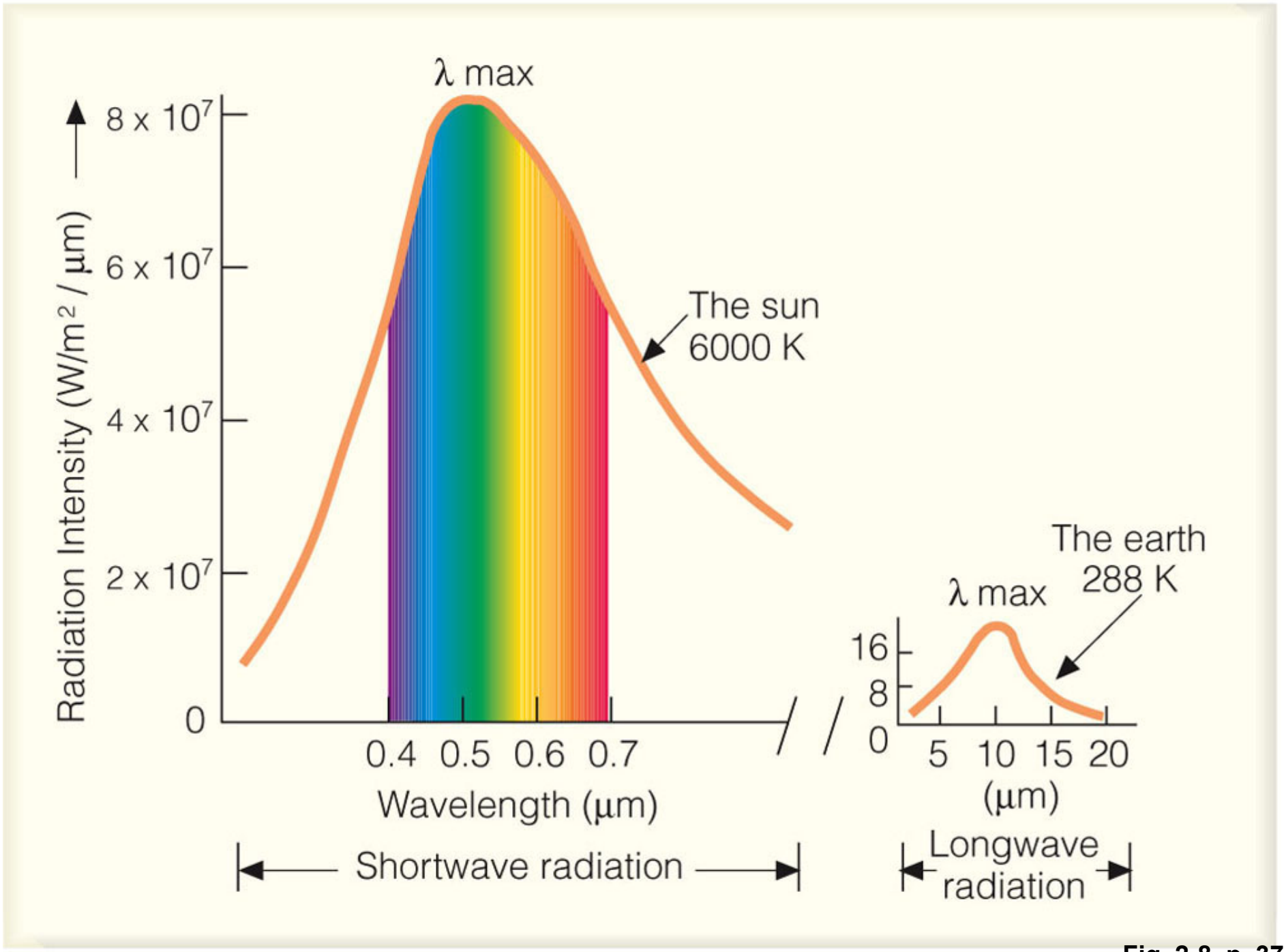
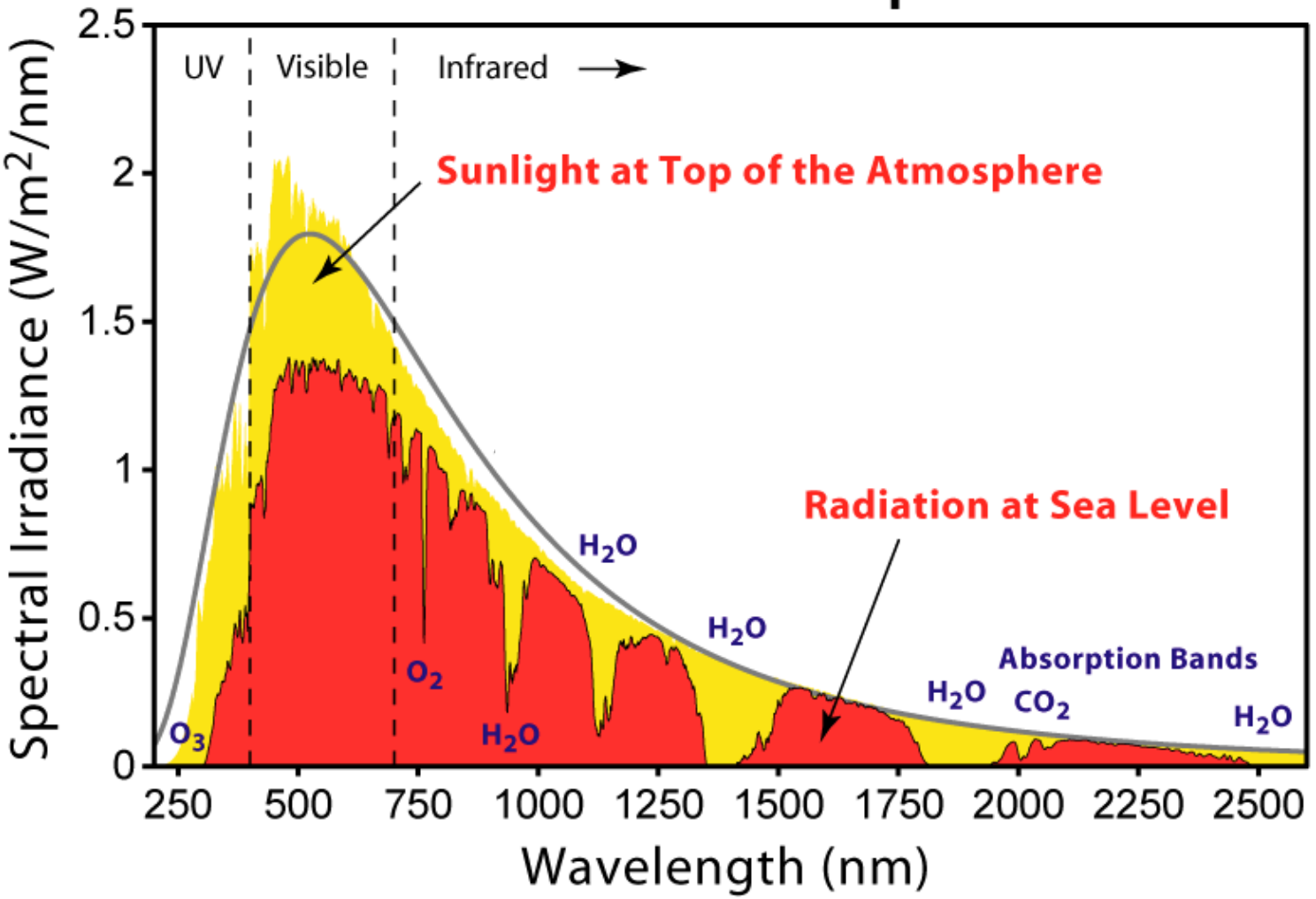


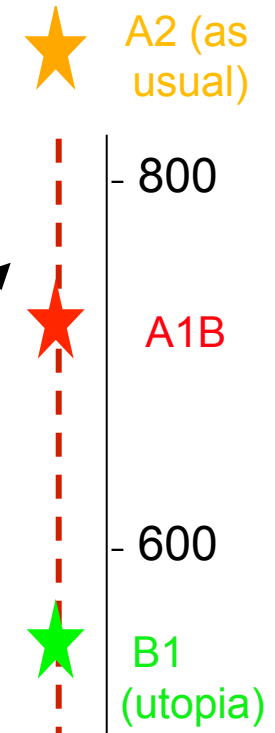
Fig. 2-8, p. 37

Solar Radiation Spectrum

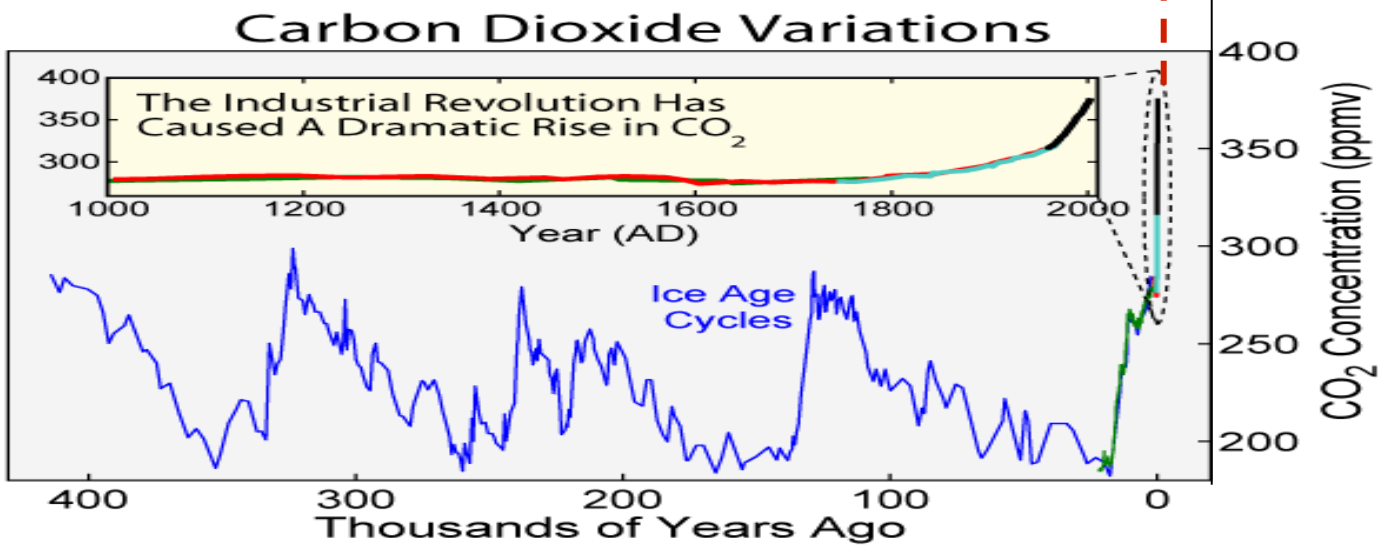


Atmospheric Carbon Dioxide

- What is your gut feeling? Will we actually burn enough coal/oil/biomass to reach 850ppm CO_2 by the end of this century (more than double today's value and three times pre-industrial levels)?



Year	CO2 in atmos
1850	280 ppm
2010	392 ppm
2100	**???**



Blackbody Radiation

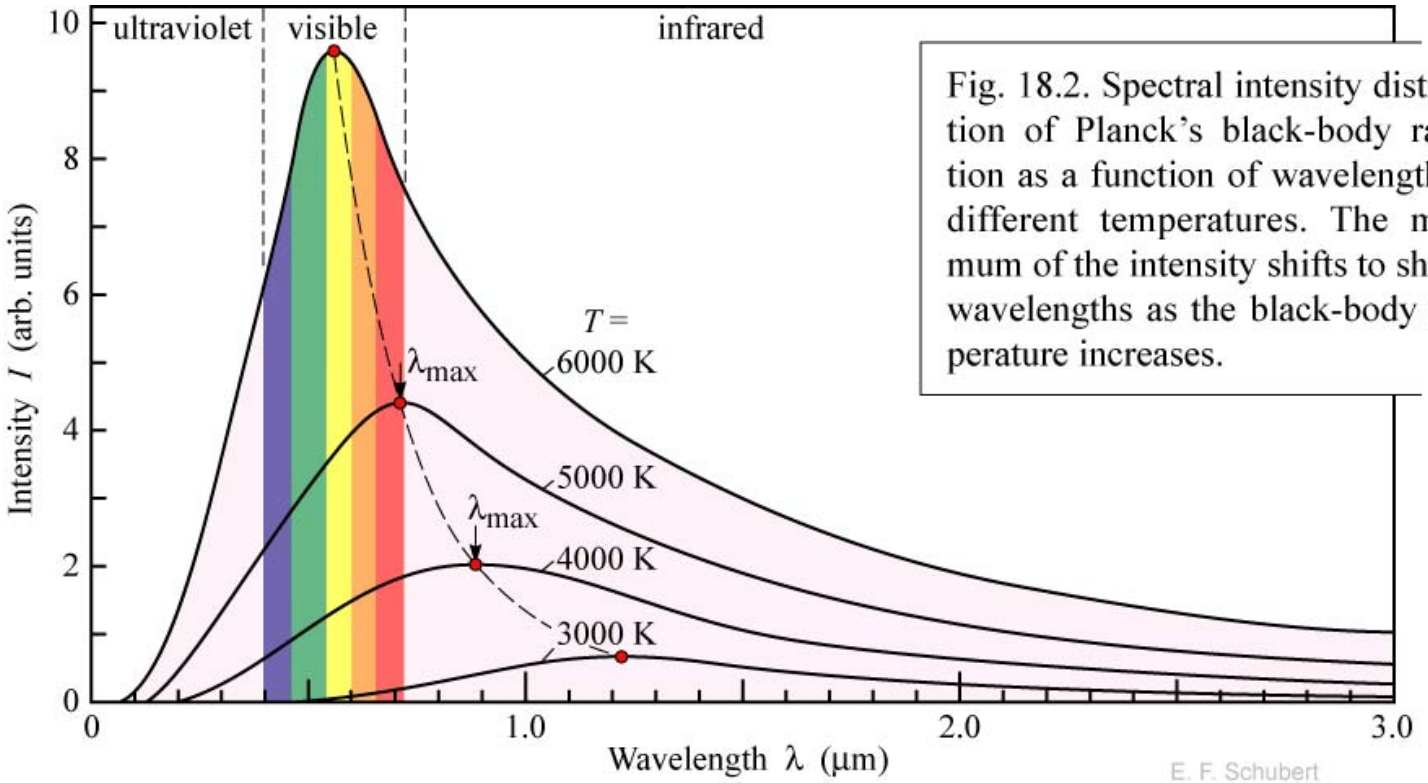


Fig. 18.2. Spectral intensity distribution of Planck's black-body radiation as a function of wavelength for different temperatures. The maximum of the intensity shifts to shorter wavelengths as the black-body temperature increases.

Equilibrium Temperature of Earth
(Energy In = Energy Out)

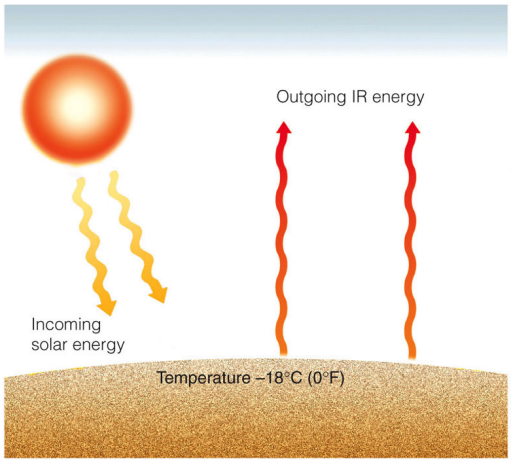
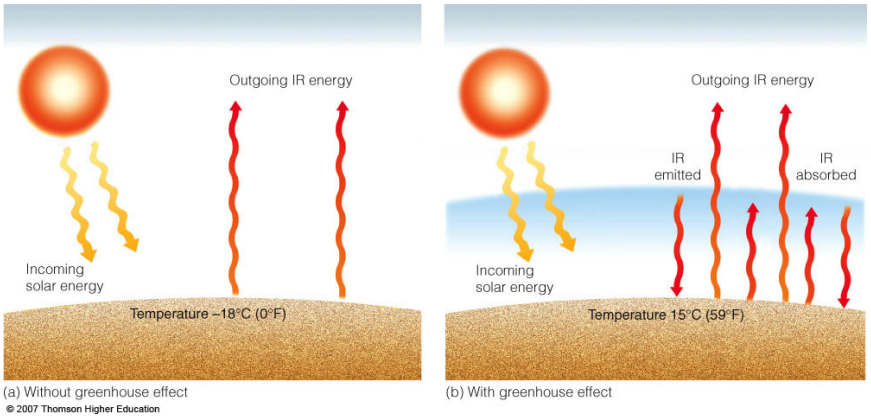


Fig. 2-12a, p. 42

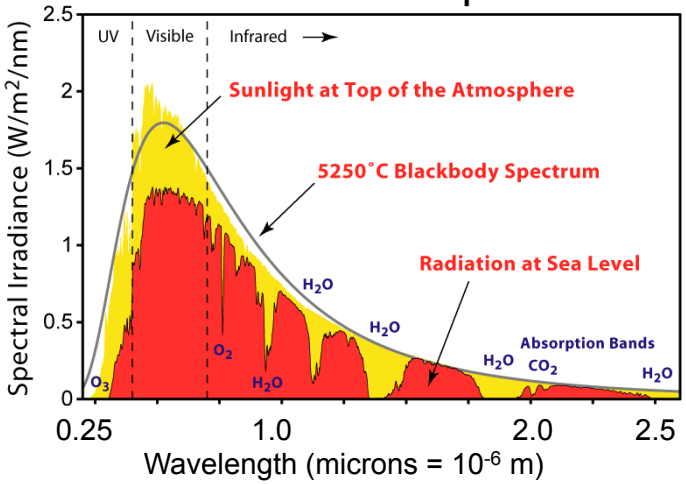
No Greenhouse Effect | With Greenhouse Effect



(a) Without greenhouse effect (b) With greenhouse effect

Fig. 2-12, p. 42

Solar Radiation Spectrum

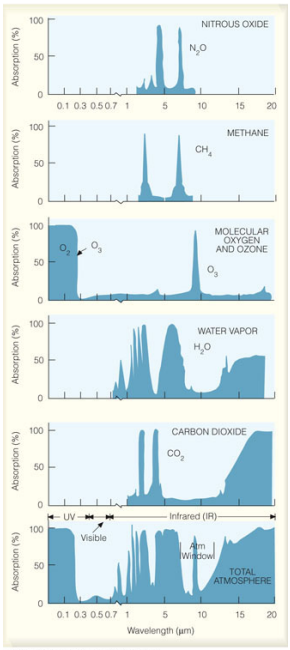


Black Line - Perfect Blackbody at 5250 °C

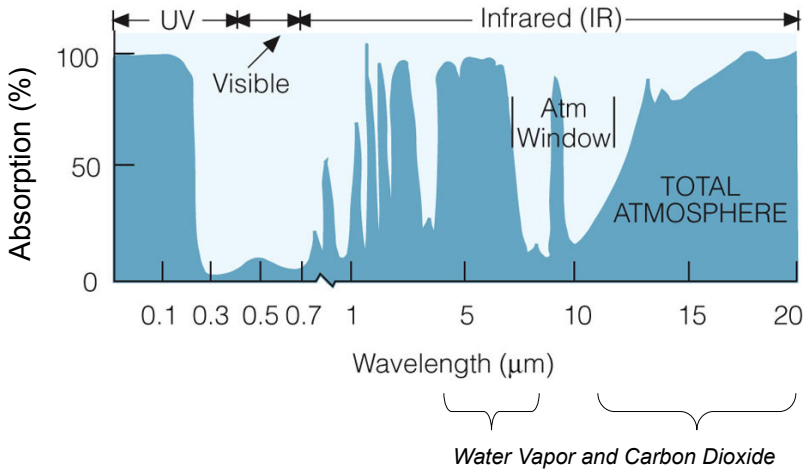
Absorptivity of the Atmosphere

Water vapor and carbon dioxide absorb infrared

Ozone absorbs UV and a small amount of visible



Absorptivity of the Atmosphere



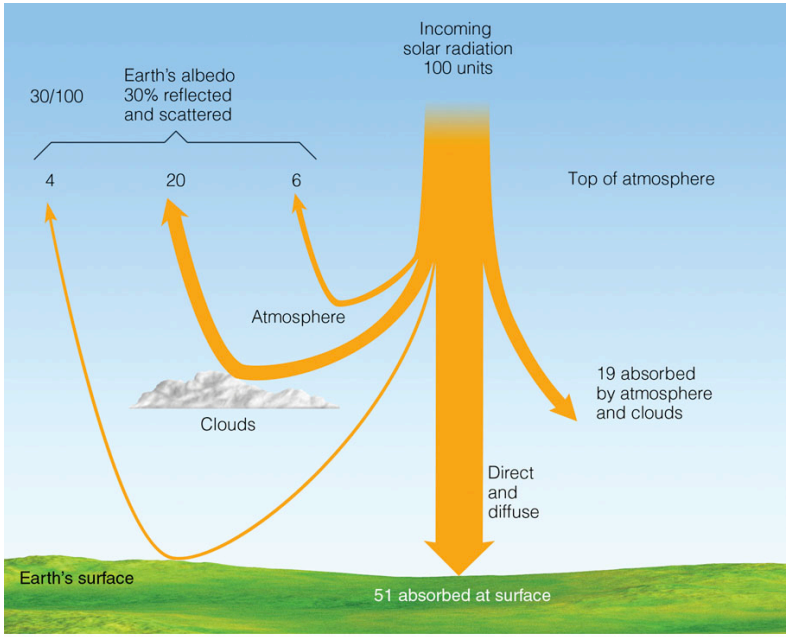


Fig. 2-15, p. 45

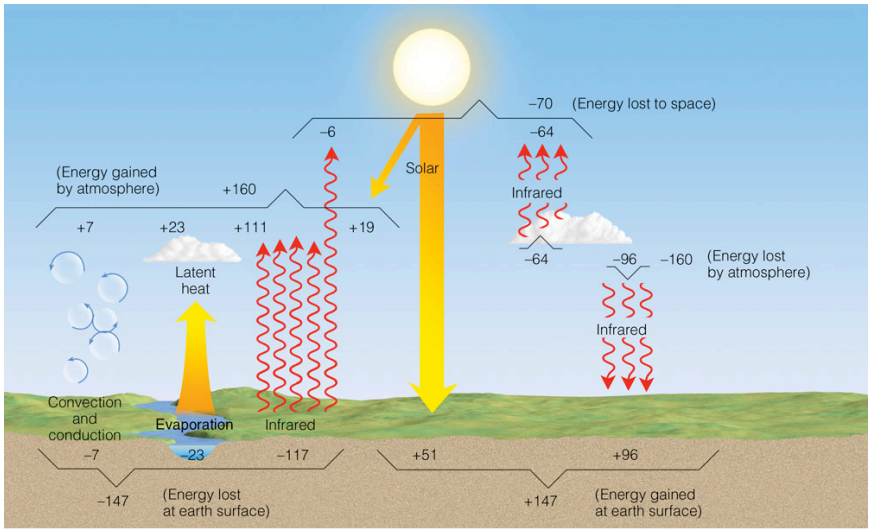


Fig. 2-16, p. 47