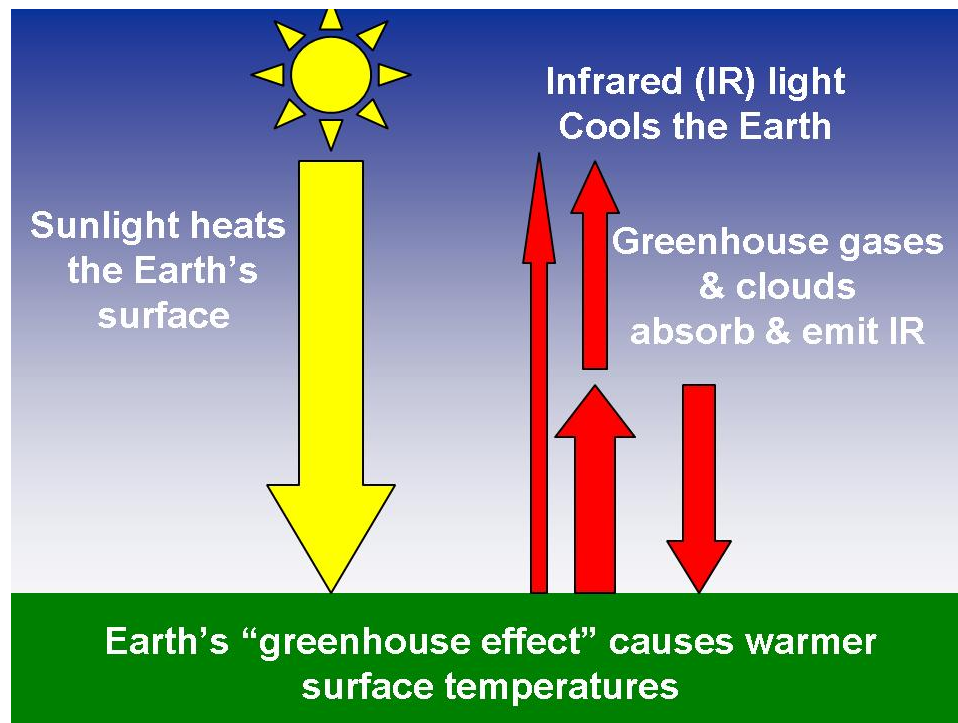


GREENHOUSE EFFECT

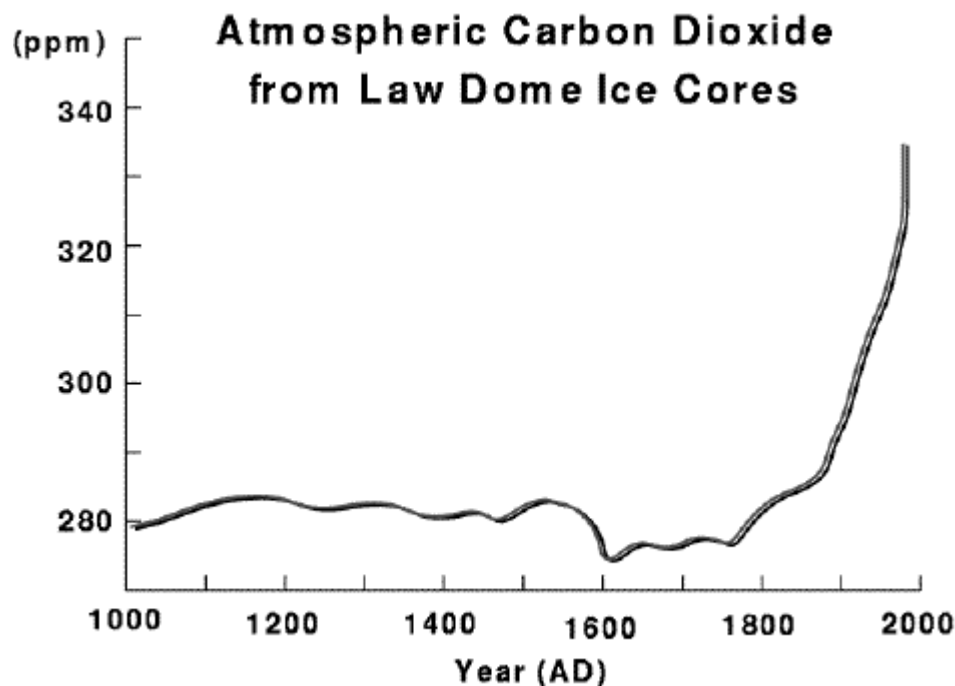
- The sun radiates as a blackbody (ideal radiator, $e = 1$) at a surface temperature of $T_{\text{sun}} = 5800 \text{ K}$.
- **Solar constant**— flux of solar radiation at top of earth's atmosphere at all wavelengths = 1.361 kW/m^2 (1 kW = 1000 W)
 - 50 % in infrared
 - 40 % in visible
 - 10 % in UV
- What becomes of solar radiation?
 - 6 % scattered back
 - 20 % reflected by clouds
 - 19 % absorbed by clouds
 - **51 % absorbed by earth's surface**
 - 4 % reflected back
- The radiation that is absorbed by the earth's surface heats it and is **re-radiated** back as heat energy at longer wavelengths (IR)
 - some of this IR radiation is reflected back to earth
 - some is absorbed and re-emitted by **Greenhouse gases**



Greenhouse effect: A process by which thermal (heat) radiation from the earth's surface is absorbed by atmospheric (GH) gases and re-radiated back to earth, resulting in an elevation of the average surface temperature above what it would be in the absence of such gases.

- The earth's natural GH effect makes life possible on earth, otherwise the earth's surface temperature would be -18°C , rather than $+14^{\circ}\text{C}$. (There is no atmosphere on the moon so its surface temperatures vary by hundreds of $^{\circ}\text{C}$ from night to day.)

- Greenhouse gases: certain gases absorb IR radiation that would normally be radiated into space.
 - water vapor -- 36 - 70%
 - CO₂ -- 9 – 26 %
 - methane – 4 – 9 %
- The GH effect has a critical significance for the earth's climate. We need some GH effect to keep the earth at a reasonable temperature, but not too much.
- The concentration of GH gases (particularly CO₂) has been increasing since the beginning of the industrial revolution.



Earth's surface temperatures have been rising at times.

- Is this part of a natural trend, or is it driven by human activity – i.e. burning of fossil fuels?
- Can the trend be reversed?
- Will there be some point at which the increase in temperatures cannot be reversed?
- Can we just wait?
- What are the potential consequences of waiting or moving to make changes too soon?

