

# Announcements

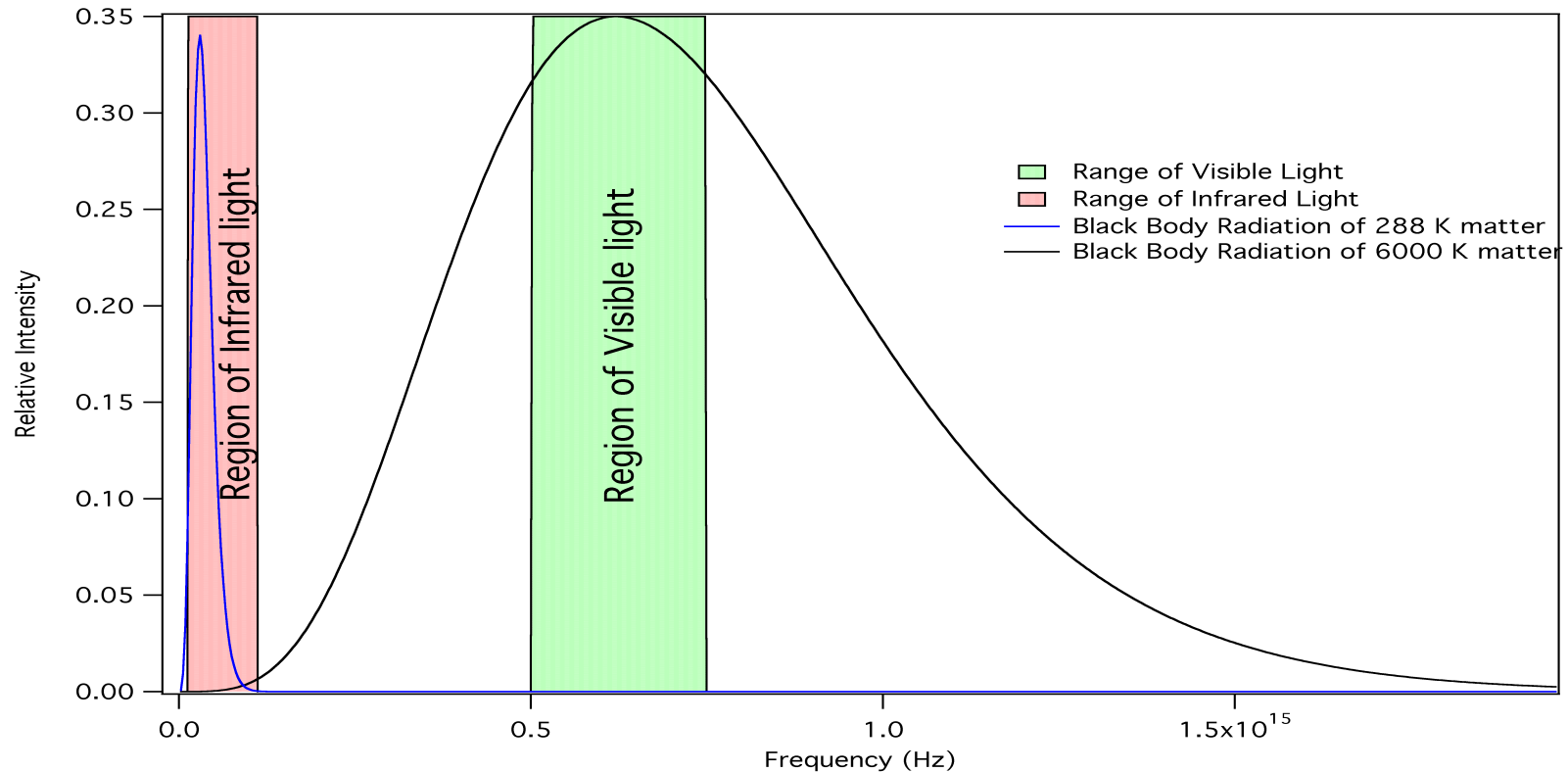
To join clicker to class today  
(Clickers with LCD display  
join automatically):

- Turn on the Clicker (the red LED comes on).
- Push “Join” button followed by “20” followed by the “Send” button (switches to flashing green LED if successful).
- Exam 3 scores posted on D2L.
- Let me know if you find any scoring errors.
- No quiz in discussion today, just a worksheet.
- **No shorts, sandals or skirts allowed in Lab!!**
- Volunteer to help with Earth Day Science Fun

# Greenhouse effect, molecular vibrations and shape

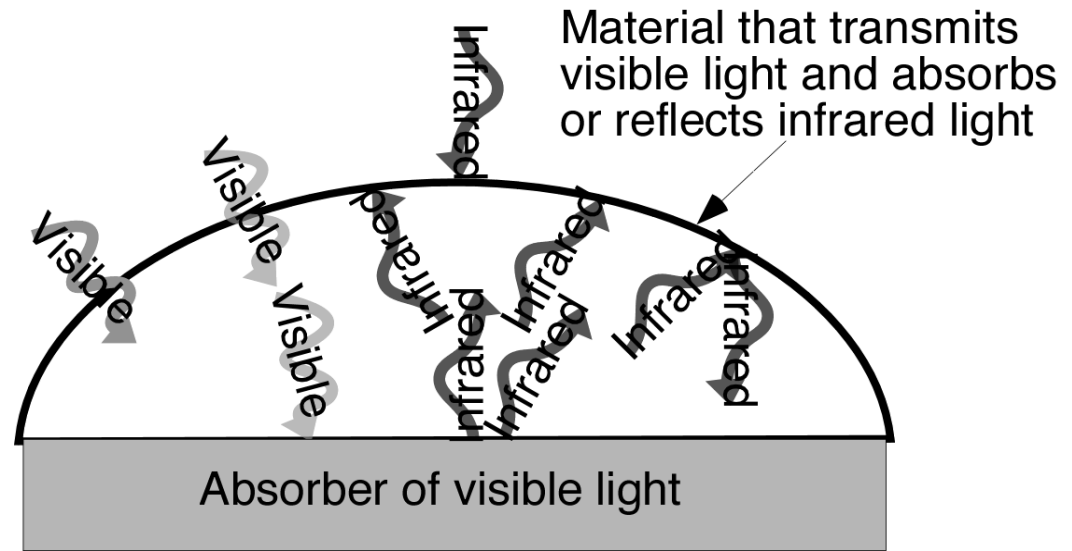
- Greenhouse Effect
- Infrared Spectroscopy
- VSEPR model (3-D molecular shapes)
- Valence Bond Theory and 3-D shapes
- Dipole moments and shapes of molecules

# Black Body Radiation



- All matter radiates electromagnetic energy with a frequency (wavelength) distribution determined by temperature.
- Higher temperatures radiate light of higher energy (shorter wavelength, higher frequency).

# Greenhouse Effect



- Surface is warmed by visible light from sun.
- Infrared radiation given off by warmed surface is trapped by gases in atmosphere.
- Keeps surface of Earth warm enough that all the water is not frozen.

Wavelengths absorbed by  
CO<sub>2</sub> versus wavelengths  
emitted by surface of Earth  
(see worksheet 9)

# Atmospheric Concentrations of Greenhouse Gases over the last 10000 years

- Started to increase at beginning of industrial revolution (~30 % from pre-industrial times).
- $^{14}\text{C}:^{12}\text{C}$  in atmosphere has been dropping because the C is from old sources (fossil fuels).
- Man IS the source of the added green house gases.

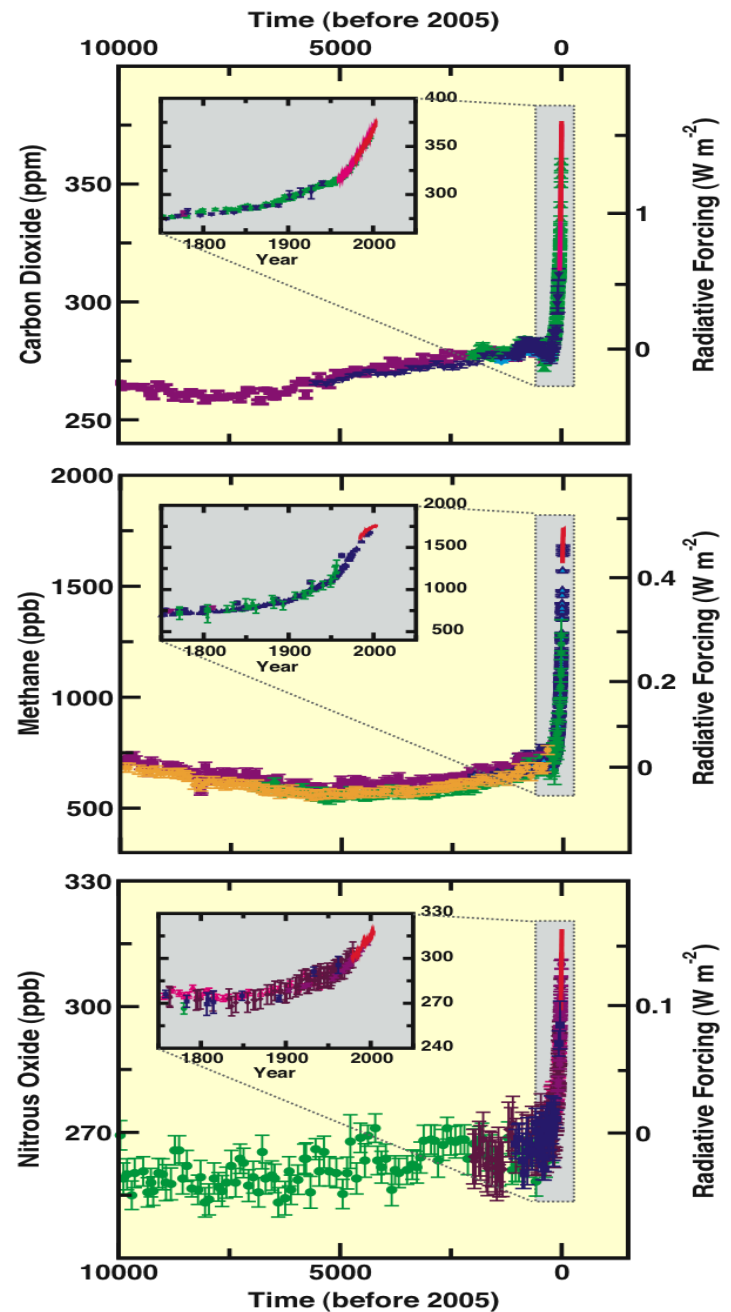


Figure from IPCC

# Modeling the Effects

- Models include many effects:
  - Changes in evaporation rate.
  - Cloud cover
  - Aerosols-fine particles that reflect sunlight back into space.
- Successfully predict dips even with rising greenhouse gas concentrations

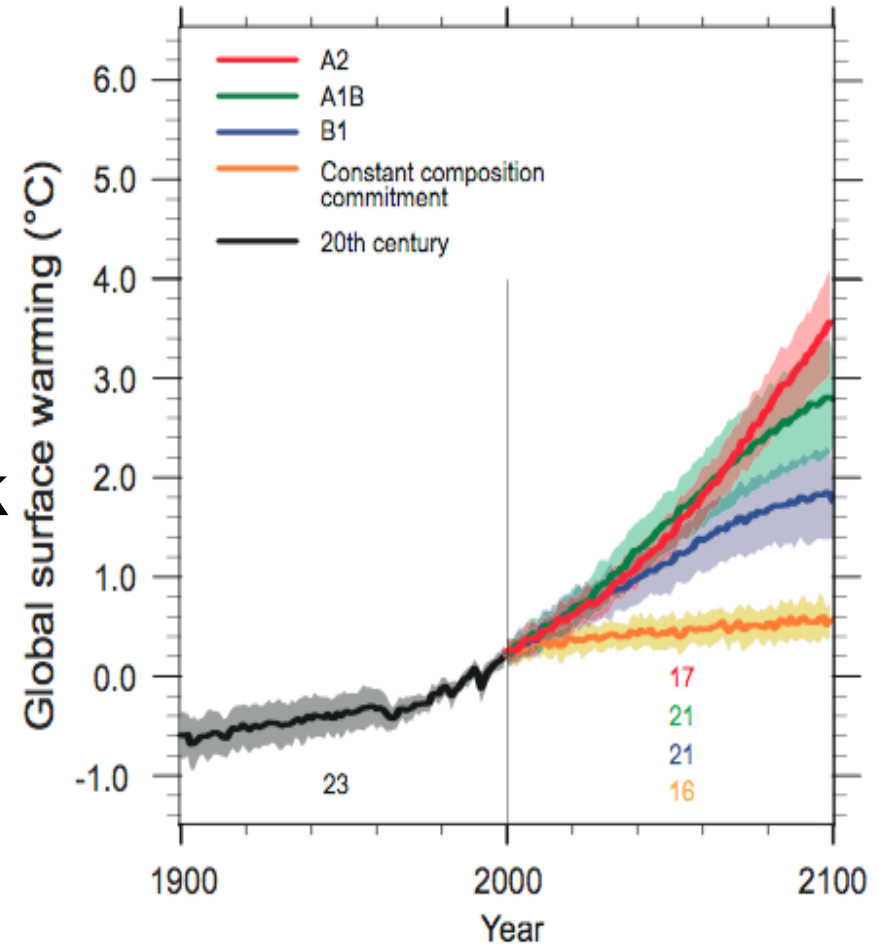
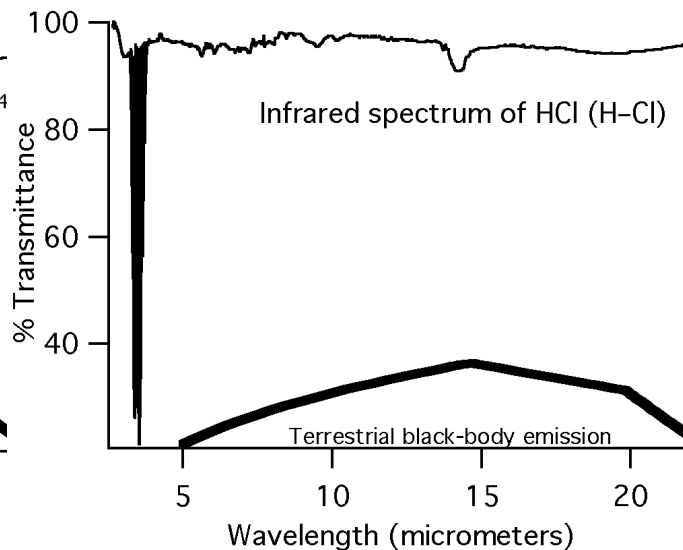
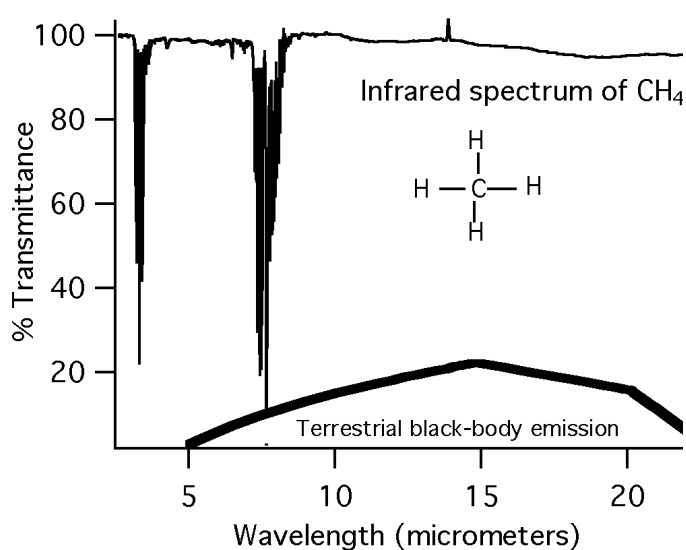
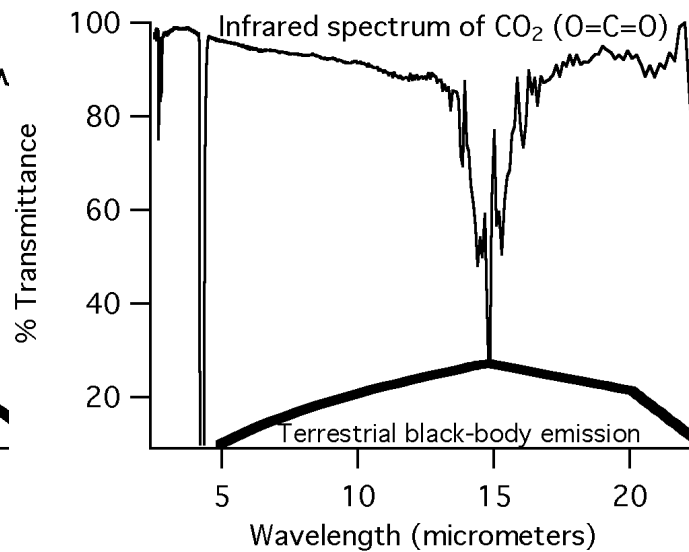
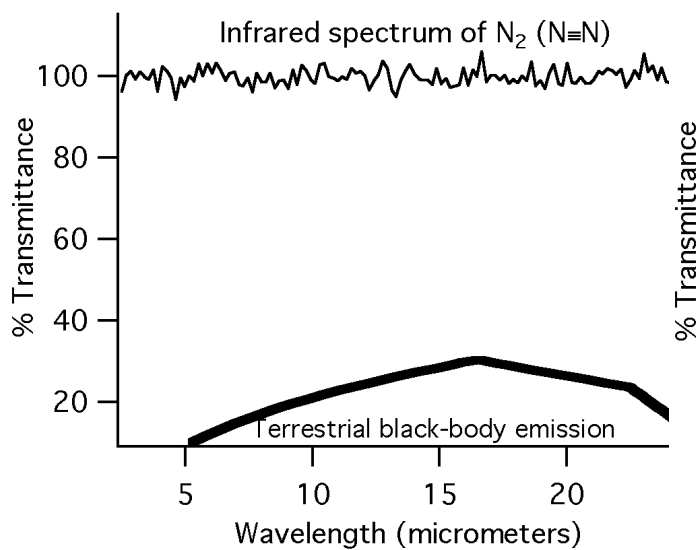


Figure from IPCC

# IR spectra of some atmospheric gases



Characteristic wavelengths of IR absorbances

Bond	$\mu m$
O-H	$\sim 3$
C-H	$\sim 3.5$
$C\equiv O$	$\sim 4.4$
C=O	$\sim 6.5$
C-O	$\sim 9.7$