Reading Assignment

• Big World Small Planet p. 7-29  
  (Our Ten Key Messages)

• Global Warming p. 19-27  
  (Chapter 3)

• Beyond Smoke and Mirrors p. 29-44  
  (Chapter 3)

iClicker Quiz Monday Feb 24th
James decided to make a visual record of climate by photographing glaciers every ________ for three years.

a) Hour  
b) Week  
c) Two days  
d) 5 hours  
e) day
“CHASING ICE” ICLICKER QUESTION #2

James was a climate skeptic, but he became convinced about climate change by

a) A persuasive documentary
b) Ice core data
c) Rising sea levels
d) Increasing amounts of pollution
e) State-of-the-art computer modeling
Greenhouse Gas

• A greenhouse gas allows energy from the sun (visible, ultraviolet) in.

• A greenhouse gas “scatters’ some of the outgoing radiation (infrared).
How Does The Greenhouse Effect Works

• The greenhouse effect is due to “greenhouse” gases that absorb radiation in the infrared but that are transparent to the visible part of the spectrum.
Greenhouse Gases

The most important greenhouse gases:

• Water vapor (H₂O):
  - The most abundant greenhouse gas in the atmosphere.
  - As atmospheric temperature rises, more water is evaporated from ground storage (oceans, rivers, etc.)
Greenhouse Gases Contd.

• **Carbon dioxide \((CO_2)\)**
  - Production and absorption through terrestrial biosphere and the ocean.
  - Humankind has altered the natural carbon cycle by burning coal, etc.
  - \(CO_2\) was the first greenhouse gas demonstrated to be increasing in atmospheric concentration.
  - Prior to industrial revolution concentrations fairly stable at 280ppm, today around 413ppm (48% increase).

• **Methane \((CH_4)\)**
  - Effective absorber of radiation.
  - Atmospheric concentration less than \(CO_2\)
  - Lifetime in atmosphere is brief (10-12 years) compared to other greenhouse gases.
  - Over past few decades human activities (growing rice, raising cattle, usage or natural gas and coal mining) have contributed to the atmospheric concentration of methane.
Greenhouse Gases Cotd.

• Ozone ($O_3$)
  - UV radiation and oxygen interact to form ozone in the stratosphere.
  - During the 20th century (tropospheric) ozone has been supplemented by ozone created by human processes.
  - Concentrations of ozone have risen by around 30% since the pre-industrial era.

• Nitrous oxide ($N_2O$)
  - $N_2O$ concentrations began to rise from the beginning of the industrial revolution.
  - Produced by microbial processes in soil and water (including reactions which occur in fertilizer containing nitrogen).
Greenhouse Gases Contd.

- Chlorofluorocarbons “CFC’s” \( (CCl_2F_2) \)
  - No natural source, entirely synthesized for refrigerants, aerosol propellants, cleaning solvents.
  - Since their creation in 1928 CFC’s in the atmosphere have been rising.
  - Discovery that they are able to destroy stratospheric ozone led to global effort to halt production. **Effort was extremely successful.**
Greenhouse Gasses Contd. 

$\textit{CO}_2$

$\textit{CO}_2$ absorbs right at the peak of the blackbody spectrum of the earth!

longer wavelength $\rightarrow$

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How much energy does a 100 W lightbulb consume if it is on for an entire year?

a) 100 J/s
b) 876 kWh
c) 876 J
d) 9 MJ
e) None of the above.
The kilowatt-hour (kWh) is a unit of

a) Time  
b) Power  
[ ] c) Energy  
d) None of the above
How much does this cost to keep a single 100 W lightbulb on 5 hours a night for one year?

• The cost of energy in New Brunswick is about $0.19/kWh

• For now we ignore the cost of the lightbulb(s).

\[ E = P \times t \]

\[ E = 100W \left( \frac{365 \text{ day}}{\text{year}} \right) \left( \frac{24 \text{ h}}{\text{day}} \right) = 182.5 \text{ kWh} \]

\[ \text{Cost} = 182.5 \text{ kWh} \left( \frac{$0.19}{\text{kWh}} \right) = $34.68 \]
In Class Activity

• Stefan – Boltzmann Law: \( I = \sigma T^4 \)

• Intensity = \( \frac{\text{Power}}{\text{Area}} \) \( I = \frac{P}{A} \)

• Stefan – Boltzmann Constant \( \sigma = 5.67 \times 10^{-8} \text{ W/m}^2\text{K}^4 \)

• The solar energy flux that reaches Mars is \( I_{\text{Mars}} = 145 \text{ W/m}^2 \)

• The albedo on Mars is \( \alpha = 0.25 \) (i.e. 25%).

• Percent Error: \( \%\text{error} = \frac{|T_{\text{measured}}-T_{\text{actual}}|}{T_{\text{actual}}} \times 100\% \)