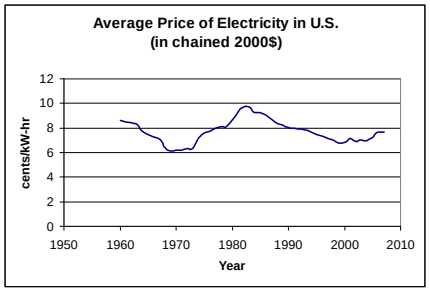
Class 2 Presentation

Ch En 310
Fall, 2008

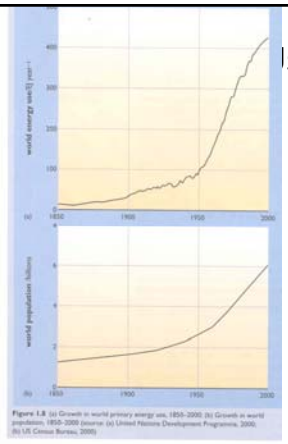
Cost of electricity

Figure 1.41 Average household rates for US electricity, 1900–2000, expressed in real terms, i.e. taking into account the effects of inflation (source: Smil, 2000)



From DOE/EIA pages
http://www.eia.doe.gov/emeu/aer/elect.html Table 8.10
This is the total, which includes residential, commercial, industrial, etc., in chained 2000 U.S. dollars.

- lse



Source: Boyle textbook

Population Trends

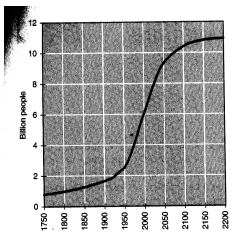


Figure 11 World population 1750–2200, the UN's medium variant forecast from 2000. Source: UNPD 2001b:27; 1998b:37, 1998c.[11]

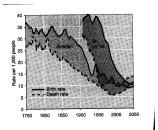


Figure 12 The demographic transition showing birth and death rates in Sweden (1750–2050) and Sri Lanka (1910–2050), forecast for 1999–2050. Notice how first the death rate declines, and then the birth rate. As the population begins to age, the death rate rises slightly. Source: Mitchell 1975, 1995, World Bank 2000c, USBC 2001a.

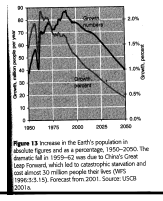


Figure 13 Increase in the Earth's population in absolute figures and as a percentage, 1950–2050. The dramatic fall in 1959–62 was due to China's Great Leap Forward, which led to catastrophic starvation and cost almost 30 million people their lives (WPS 1998:tt.5.15). Forecast from 2001. Source: USCB 2001a.

Source: Skeptical Environmentalist

World Energy Use
(by fuel)

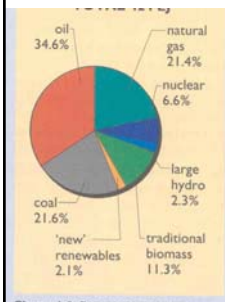
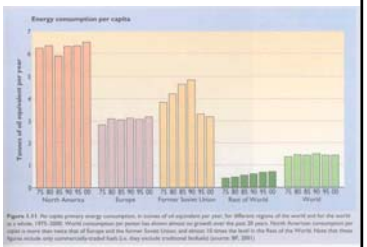
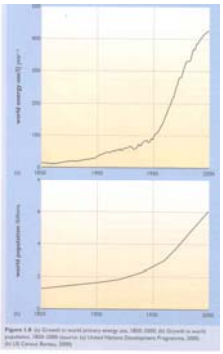


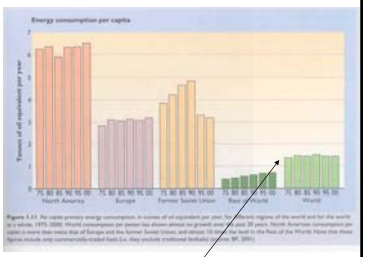
Figure 1.9 Percentage contributions of various energy sources to world primary energy consumption, 2000.



Source: Boyle textbook

Compare Figs. 1.8 & 1.11





(424 x 10^{18}J/6.1 x 10^{9} people)*(toe/42 x 10^{9} J) = 1.65 toe/person/year

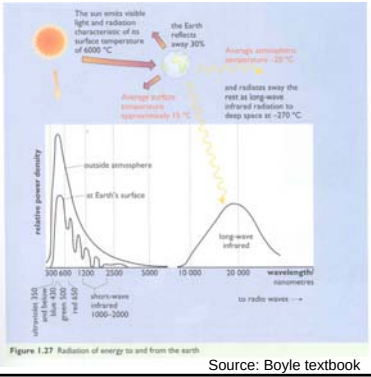
More like 1.4!

Source: Boyle textbook

Fig. 1.8 includes traditional biomass fuels!

Thoughts on Global Warming

Global Warming



Sunlight heats earth (visible wavelengths)

Earth radiates heat to space (infrared wavelengths)

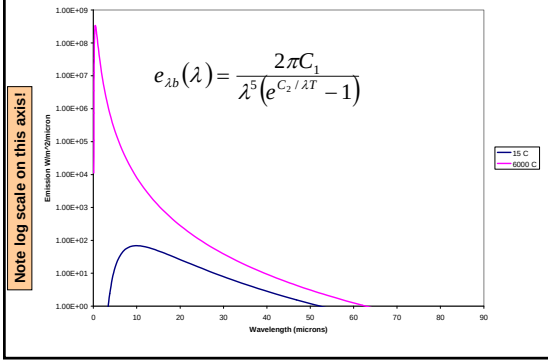
Some gases absorb infrared radiation (H_2O, CO_2, etc.)

Gases heat up and then transfer heat to surface

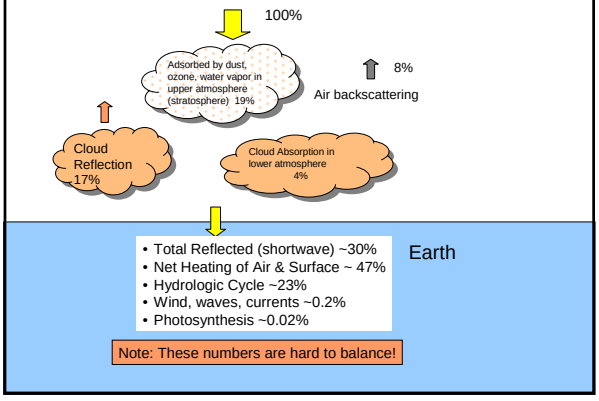
Source: Boyle textbook

Planck's Law

$$e_{\lambda b}(\lambda) = \frac{2\pi C_1}{\lambda^5\left(e^{C_2/\lambda T} - 1\right)}$$



Sunlight



Energy Balance for Earth

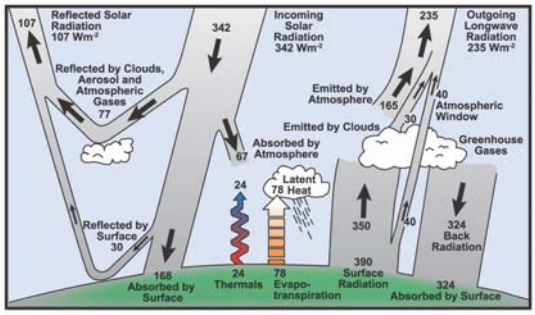
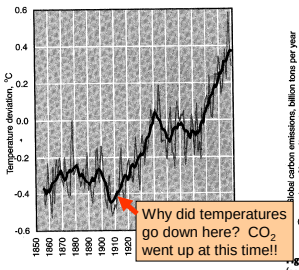


Figure FAQ 1.1, Figure 1, Climate Change 2007, IPPC report

Temperature and CO_2 Data

Source: Skeptical Environmentalist



Why did temperatures go down here? CO_2 went up at this time!!

Figure 135 Global temperature, 1856–2000, expressed as deviations (anomalies) from the average of the period 1961–90. Temperature is a weighted average of land air and sea surface temperatures. Light lines, actual yearly measurements; black heavy line, moving 9-year average. To obtain absolute global temperature add 14.0°C (57.2°F). Source: Jones *et al.*

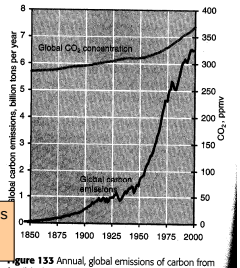
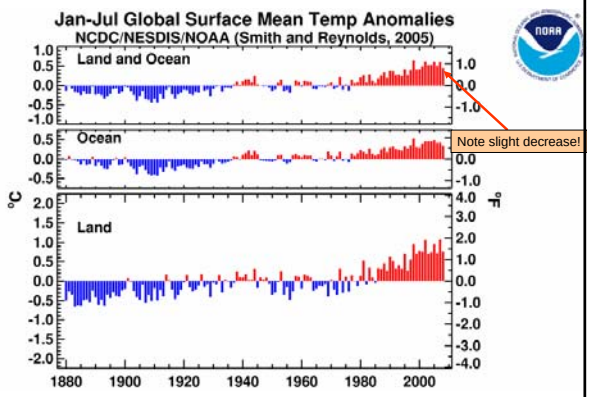


Figure 133 Annual, global emissions of carbon from fossil fuels and cement production, 1850–1999, and concentration of CO_2 in the atmosphere (ppmv: parts per million volume), 1850–2000. Source: Marland *et al.* 1999, Etheridge *et al.* 1998, Hansen and Sato 2000, Keeling and Whorf 1999, WI 2000a:67, pers. comm. P. Tans, Climate Monitoring and Diagnostics Laboratory, National Oceanic and Atmospheric Administration, USA.



Note slight decrease!

http://www.ncdc.noaa.gov/img/climate/research/2008/jul/glob-jan-jul-pg.gif

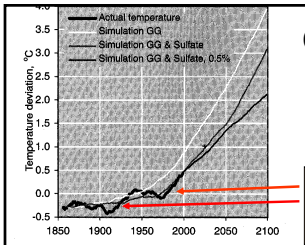
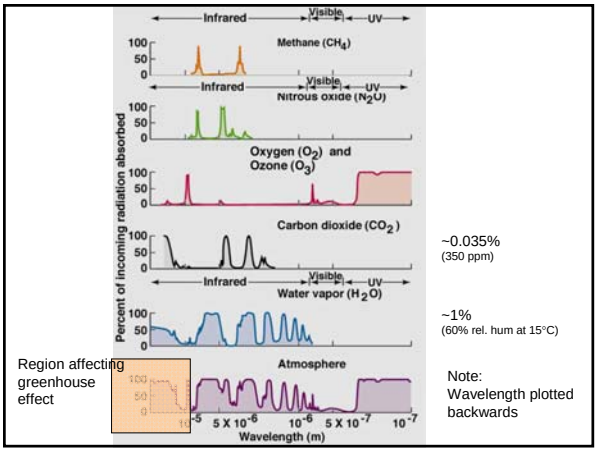


Figure 138 Global average temperature simulations from the Hadley Centre GCM (CM2), for just greenhouse gases (GG) and for greenhouse gases plus sulfate aerosols with standard IPCC assumptions (historic CO_2 and SO_2 from 1861–1989, 1 percent annual CO_2 equivalent increase and IS92a SO_2 emissions 1990–2099), 1861–2099. Extra simulation for 1990–2099 with more realistic emissions of greenhouse gases and sulfate aerosols (0.5 percent annual CO_2 equivalent increase and IS92d for 1990–2099). Actual temperature 1856–1999 for reference. All simulations average of 4 runs, smoothed by 19 year running means and forced to average of instrumental temperature record, 1861–99, as in

Global Warming Models

None of the models show an increase in temperature in these time periods, even though CO_2 increases substantially!!

Source: Skeptical Environmentalist



~0.035%
(350 ppm)

~1%
(60% rel. hum at 15°C)

Region affecting greenhouse effect

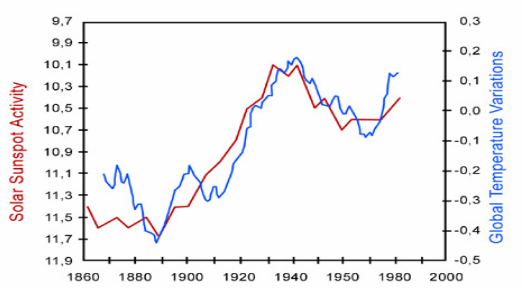
Note: Wavelength plotted backwards

Science Problem

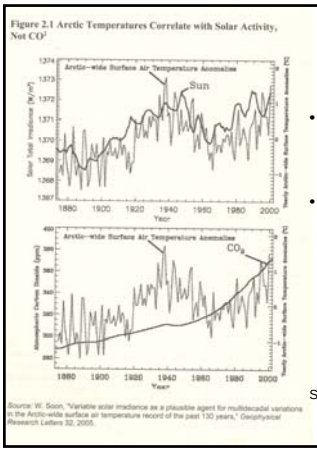
- If CO_2 (or any other infrared absorber) causes extensive warming, then the atmosphere should show increased temperature change before the earth
  - All theories operate on this scientific principle
- No major changes have been observed in the atmospheric temperature at the correct altitudes!

Are There Any Other Possible Explanations for Rise in T_{earth}?

Correlation with Sunspot Activity



There is also some evidence that the temperature increase precedes the CO_2 increase

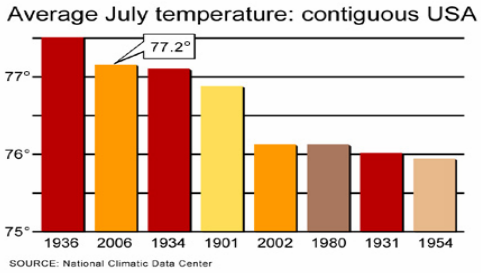


Solar Activity

- CO_2 should have most effect on temperature in polar regions
  - No apparent correlation with CO_2!
- Good correlation with solar activity
  - Not enough change in solar flux to account for temperature change
  - Thought to be the solar wind deflection of cosmic rays, which affects cloud formation

Singer & Avery, Unstoppable Global Warming (2007)

Hot U.S. Temperatures Do Not Correspond to CO_2



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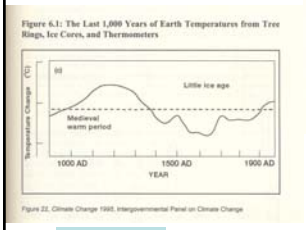
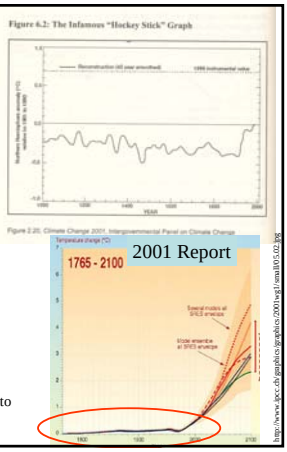


1995 Report

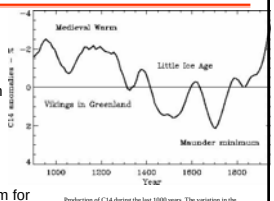


The natural temperature variations were erased to make it look more serious!

(taken from Singer and Avery, Unstoppable Global Warming (2007))

Bottom Line

- The global temperature is increasing
  - We have been in a "Little Ice Age"
  - There seems to be a 1500 year cycle
- There have been periods when the earth was warmer
  - Greenland was actually farmable
  - No CO_2 mechanism was responsible
- The evidence that CO_2 is causing the temperature increase leaves lots of room for doubt (in my mind)
- The media and many politicians have decided that CO_2 is a problem
  - Many scientists doubt this, but do not get heard
  - No viable sequestration or replacement is available
  - No replacement is available on a large scale



Production of C14 during the last 1000 years. The variation in the C14 production is caused by changes in solar activity. When solar is high the production of C14 is low, due to the shielding effect of the solar wind against cosmic rays. Note that the axis for the C14 production has been reversed. The Maunder minimum refers to the period 1645 – 1715 when very few sunspots where observed on the sun. In this period the production of C14 was very high in agreement with a low solar activity.

In This Class

- We will recognize that CO_2 emission regulations are coming
- We will discuss options to reduce CO_2 emissions
- You do not have to agree with my opinion on this matter