CHEM 001A

Case Study #1

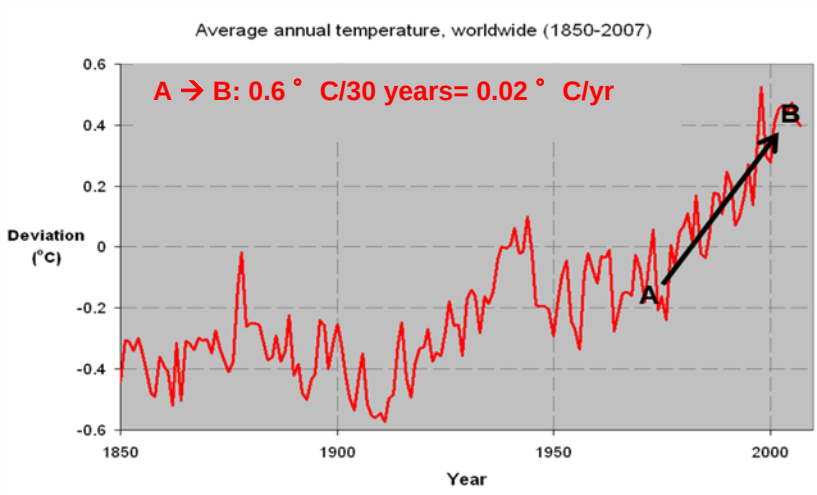
"The Global Warming Debate"

Global warming is one of the most contentious issues of our time. There is an ongoing debate about whether global warming is caused by human activity (primarily by burning of fossil fuels) or is simply part of the earth's natural climate cycle. What makes this debate even more noteworthy is the fact that there has been a politicization of the issues in the U.S., and because the scientific evidence used to determine if global warming is man-made is so difficult to evaluate.

This case study will provide you with atmospheric carbon dioxide data and global temperature data, and give you an opportunity to work in groups in an effort to identify what conclusions can be made and what limitations might exist in this data.

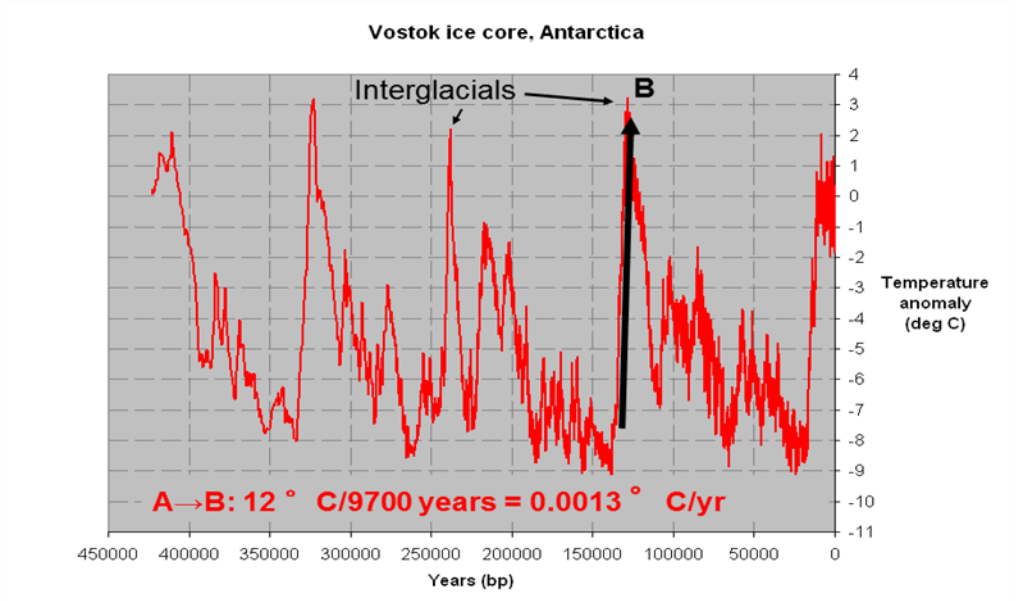
Data:

Figure 1



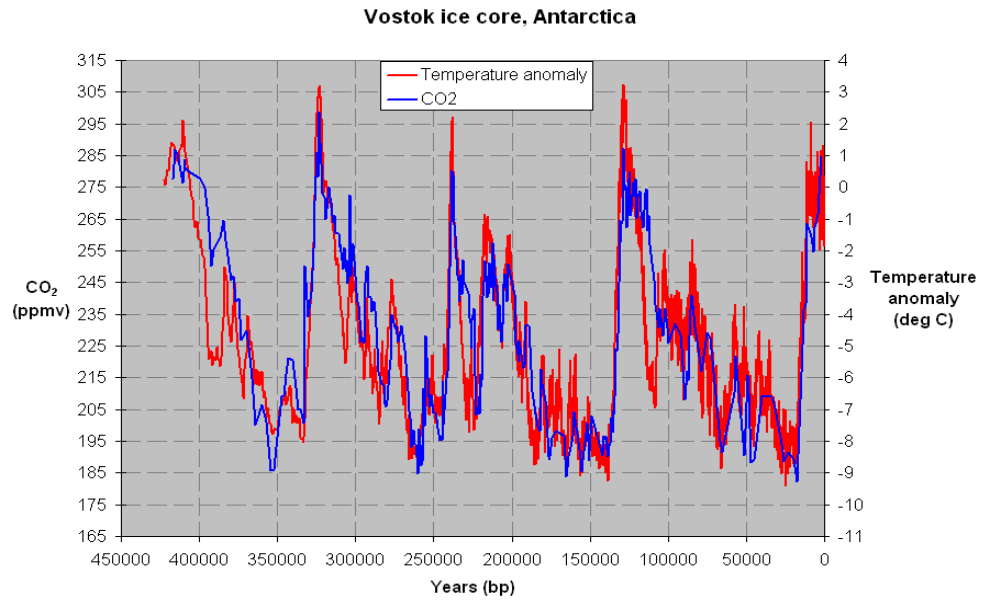
Average annual global temperature, 1850-2007, relative to the average for1961-1990. Data from Jones, P.D., D.E. Parker, T.J. Osborn, and K.R. Briffa. 2008. Global and hemispheric temperature anomalies--land and marine instrumental records. In Trends: A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. (Data accessed at: http://cdiac.ornl.gov/trends/temp/jonescru/data.html, 1/09). Rate is calculated for the period 1977-2007.

Figure 2



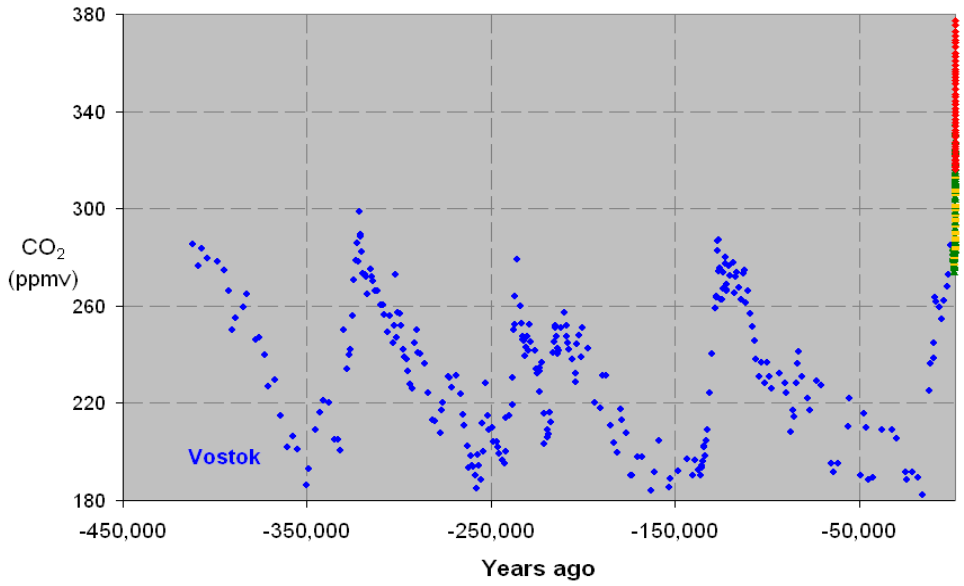
Temperature data from: Petit, J.R., D. Raynaud, C. Lorius, J. Jouzel, G. Delaygue, N.I. Barkov, and V.M. Kotlyakov. 2000. Historical isotopic temperature record from the Vostok ice core. In Trends: A Compendium of Data on Global Change.Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. Rate is calculated over a 10,000 year period. Although the scale of temperature change is much larger than has occurred in the last 30 years, the average rate of warming moving from a glacial to an interglacial period is an order of magnitude less.

Figure 3



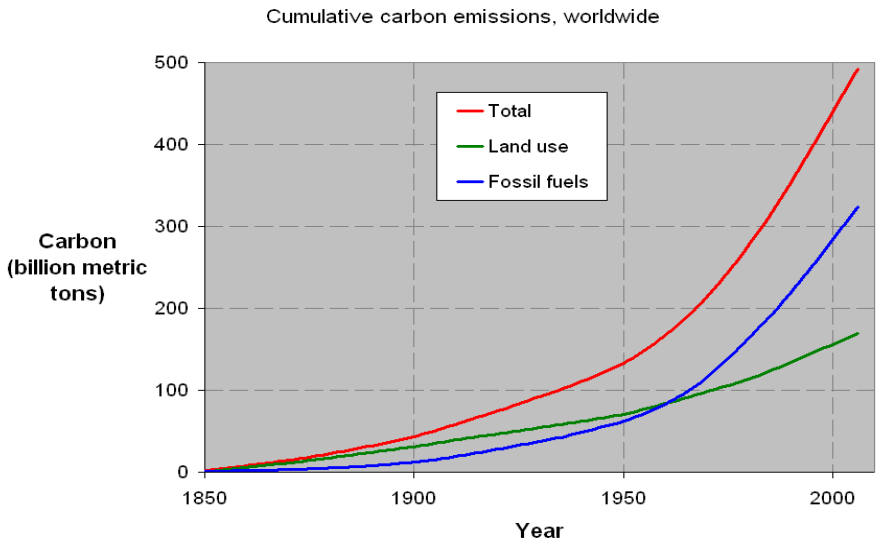
CO_2 data from: Barnola, J.-M., D. Raynaud, C. Lorius, and N.I. Barkov. 2003. Historical CO_2 record from the Vostok ice core. In Trends: A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. Concentrations are in parts per million by volume (ppmv). Vertical axis scales are adjusted to bring the two data sets visually close so that the synchronous covariation is clear. This correlation results because of mutual feedbacks between T and CO_2 via the carbon cycle, including the greenhouse effect.

Figure 4



Measurements (1958 through 2008) are from Mauna Loa as reported by Pieter Tans of NOAA (http://www.esrl.noaa.gov/gmd/ccgg/trends/). Other ice core data from: Neftel, A., H. Friedli, E. Moor, H. Lötscher, H. Oeschger, U. Siegenthaler, and B. Stauffer. 1994. Historical CO_2 record from the Siple Station ice core. In Trends: A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. and D.M. Etheridge, L.P. Steele, R.L. Langenfelds, R.J. Francey, J.-M. Barnola and V.I. Morgan. 1998. Historical CO_2 records from the Law Dome DE08, DE08-2, and DSS ice cores. In Trends: A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A.

Figure 5



Fossil fuel-related emissions + cement production from: Marland, G., T.A. Boden, and R.J. Andres. 2008. Global, Regional, and National CO_2 Emissions. In *Trends: A Compendium of Data on Global Change*. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. Land use-related emissions from: Houghton, R.A. 2008. Carbon Flux to the Atmosphere from Land-Use Changes: 1850-2005. In *TRENDS: A Compendium of Data on Global Change*. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. Both cumulative starting in 1850.

Questions:

1. Skeptics of human-caused global warming often cite data such as that shown in Figures 1 and 2. What feature of the temperature increases over time shown in Figures 1 and 2 suggests the increases in global temperatures we are now observing are not unusual?

A) The overall temperature increases that occurred historically between warm and cool periods is much larger than what we have observed over the last 30 years.
B) There is actually no increase in global temperature over the last 30 years.
C) The rate of temperature increase after the historic cold periods is much higher than what we observe now.
D) A and B are both correct.
E) A and C are both correct.

2. If you analyze the data in Figures 1 and 2 more carefully, it is actually possible to argue that there is an unusual warming trend occurring in the last 30 years. Which of the following explains this?

A) The overall temperature increase over the last 30 years is much higher than what has been observed in historic warming periods.
B) The overall temperature increase over the last 30 years is not has high, but the rate of temperature increase over the last 30 years is much higher than in historic warming periods.
C) The temperature increase over the last 30 years represents a much smaller time period than the time periods studies over historic warming periods, therefore the rate of temperature increase we are observing now is much more alarming.
D) A and B are correct.
E) B and C are correct.

3. Figure 3 shows both historic global temperature variation and atmospheric carbon dioxide levels. How does the data in this figure provide evidence that current global warming trends are a concern?

A) These data indicate that current temperature changes are higher than normal.
B) There is a very strong correlation between increases in temperature and increases in atmospheric carbon dioxide.
C) These data suggest that sharp increases in carbon dioxide are very likely to cause sharp increases in global temperatures.
D) A and B are correct.
E) B and C are correct.

4. Why does one have to be careful in carrying out an analysis of the data in Figure 3?

A) Just because sharp increases in atmospheric carbon dioxide correlate with sharp increases in temperature, this is not conclusive evidence that higher carbon dioxide levels cause higher temperatures.
B) Atmospheric carbon dioxide is known to not have any effect on global temperatures, so the data in this Figure are completely misleading.
C) Higher temperatures actually cause more carbon dioxide to be produced in the atmosphere, therefore the data in Figure 3 are meaningless.
D) A and B are correct.
E) B and C are correct.

5. Figures 4 and 5 show atmospheric carbon dioxide concentrations and carbon emissions, respectively. What conclusion can be made about these data?

A) Current carbon dioxide levels are not higher than historic levels.
B) Current carbon dioxide levels are much higher than they have been in the last 400,000 years.
C) The current carbon dioxide levels in the atmosphere is likely attributed to the huge increase in fossil fuel combustion that has occurred in the last 150 years.
D) B and C are both correct.
E) None of these conclusions can be made given the data in Figures 4 and 5.

Individual Questions – Your responses to these should be typed and delivered to your discussion group TA electronically. Your responses from questions 6-8 should be no longer than one page (12 point font, single spaced).

6. Use the data from Figures 3-5 as evidence that global warming is a man-made problem. Explain your argument in a short paragraph (3-5 sentences).

7. What are the limitations in using the data from Figures 3-5 as evidence that global warming is a man-made problem? Explain in a short paragraph (3-5 sentences).

8. If you had to make a policy decision regarding whether the U.S. government should put limits on the amount of carbon dioxide/green house gases that are emitted, what would your decision be? Explain your answer (3-5 sentences).