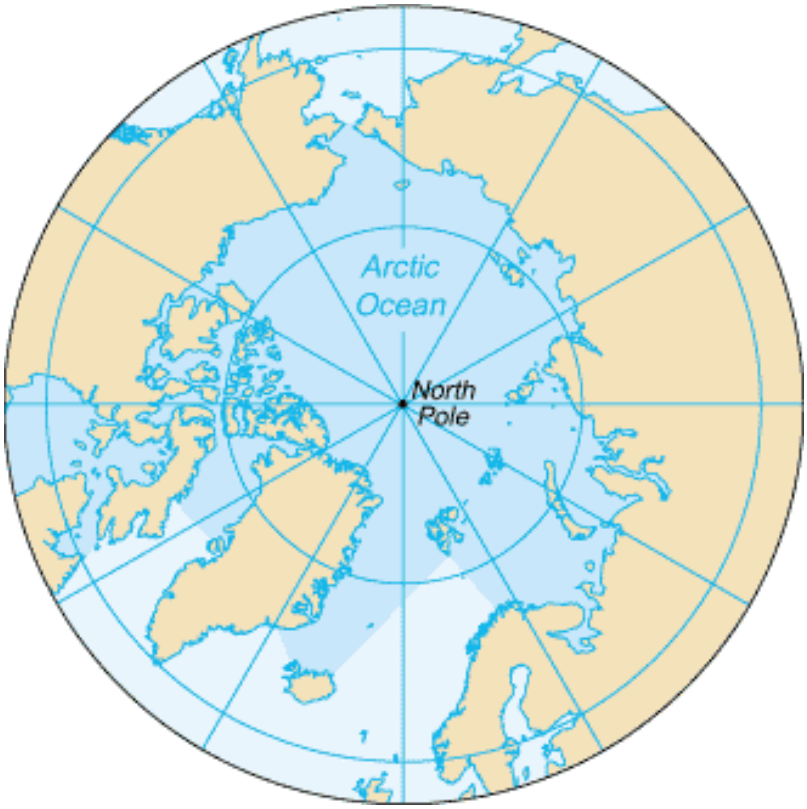
Climate Change
How does it affect me?



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Climate Change

What Are Greenhouse Gases?

Some greenhouse gases occur naturally in the atmosphere, while others result from human activities (anthropogenic gases). Naturally occurring greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Certain human activities, however, add to the levels of most of these naturally occurring gases:

Carbon dioxide is released to the atmosphere when solid waste, fossil fuels (oil, natural gas, and coal), and wood and wood products are burned.

Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from the decomposition of organic wastes in municipal solid waste landfills, and the raising of livestock.

Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels.

Very powerful greenhouse gases that are not naturally occurring include *hydrofluorocarbons* (HFCs), *perfluorocarbons* (PFCs), and *sulfur hexafluoride* (SF6), which are generated in a variety of industrial processes.

Each greenhouse gas differs in its ability to absorb heat in the atmosphere. HFCs and PFCs are the most heat-absorbent. Methane traps over 21 times more heat per molecule than carbon dioxide, and nitrous oxide absorbs 270 times more heat per molecule than carbon dioxide. Often, estimates of greenhouse gas emissions are presented in units of millions of metric tons of carbon equivalents (MMTCE), which weights each gas by its GWP value, or Global Warming Potential. (USEPA 2005)

Section 1:
Climate Change: Carbon Dioxide

During the past 200 years, humans have caused a remarkable change in the levels of atmospheric greenhouse gases. Since the 1960's, direct measurements have been taken by scientific instruments to measure changes in the earth's atmosphere. Using these measurements, scientists have noticed changes in the greenhouse gases, particularly carbon dioxide. In recent years, scientists have used the deep ice cores from Antarctica to determine carbon dioxide measurements in the geologic past. This was done by examining bubbles containing the trapped atmosphere in the polar ice. Scientist have been able to examine ice that is 650 000 years old in Antarctic. These measurements were done by the European Project for Ice Coring in Antarctica (EPICA) and release to the scientific community in November 2005. (Edward J. Brooks 2005)

Question 1a. Line Graph

Using the data provided, construct a line graph to illustrate the carbon dioxide levels measured by the European Project for Ice Coring in Antarctica Team (EPICA). (PPM = Parts per million) Put the time on the (X) axis and the carbon dioxide levels on the (Y) axis. (http://news.bbc.co.uk/2/hi/science/nature/4803460.stm)

In millions of years ago (mya)	Carbon Dioxide Level (ppm)
650	190
600	220
500	245
400	270
300	250
200	245
100	240
Today (0)	381

Question 1b.

Using the data above, determine the percentage change for the following time periods.

From (mya)	To (mya)	% Change
Today	100	
100	200	
200	300	
300	400	
400	500	
500	600	
600	650	

Question 1 c.

What is the percent change for each interval of time above? What is the average percent change over the last 650 million years?

Question 1d.

Using the carbon dioxide measurements above, what is the percent change from 650 mya to today?

Question 1 e.

Construct a list of anthropogenic gas sources admitted in your city, town or community?

Question 1 f.

Detail a management strategy to reduce (1) one of the anthropogenic gas sources in your community.

Section 2:
Climate Change: Temperature

Global sea level and the Earth's climate are closely linked. The Earth's climate has warmed about 1.5°C during the last 100 years. As the climate has warmed following the end of a recent cold period known as the "Little Ice Age" in the 19th century, sea level has been rising about 1 to 2 millimeters per year due to the reduction in volume of ice caps, ice fields, and mountain glaciers in addition to the thermal expansion of ocean water. If present trends continue, including an increase in global temperatures caused by increased greenhouse-gas emissions, many of the world's mountain glaciers will disappear. For example in Iceland, about 11 percent of the island is covered by glaciers (mostly ice caps). If warming continues, Iceland's glaciers will decrease by 40 percent by 2100 and virtually disappear by 2200. (USGS 2005)

Question 2 a. Line Graph

Construct a line graph to illustrate the annual global surface temperature anomalies (land and sea) from 1880 to 2005. Put the Years on the (X) axis and the temperature on the (Y) axis.

Year	Temperature in Celsius
1880	-0.23
1890	-0.33
1900	-0.11
1910	-0.45
1920	-0.25
1930	-0.10
1940	+0.03
1950	-0.23
1960	-0.08
1970	-0.03
1980	+0.11
1990	+0.28
2000	+0.28
2005	+.0.52

National Climate: Data Center (NOAA) 2005

Questions 2 b.

Speculate on the implications that might be felt by these temperature changes currently and in the future for the following? Explain.

a. **Extreme Weather Phenomena: (Hurricanes, Flooding, Droughts)**
b. **Farming Activity: Developed and Developing countries**

http://en.wikipedia.org/wiki/Global_warming

Section 3:
Climate Change:
Anthropogenic Sources

Question 3 a. Bar Graph

Using the following data below, construct a bar graph to illustrate the top ten carbon dioxide contributors globally.

The Top Ten Carbon Dioxide Emission Nations: 2005
MMT = Million Metric Tons

Country	Emissions (MMT) Annually
United States of America	2498
China	737
Japan	667
Russia	356
Germany	351
India	305
Brazil	276
Canada	276
Saudi Arabia	210
Iran	198

International Energy Annual: 2005

Question 3 b.

All of the nations above, with the exception of the United States have signed a global agreement to reduce greenhouse gas emissions (Kyoto Protocol 2005). Why is the United States reluctant to participate in the Kyoto Protocol?

http://news.bbc.co.uk/1/hi/sci/tech/4267245.stm
http://inside.bard.edu/politicalstudies/student/PS260Spring03/kyotocol.htm

Question 3c.

Canada like many industrialized countries is having challenges to meet the Kyoto Protocol targets to reduce greenhouse emissions, why?

http://www.cbc.ca/news/background/kyoto/timeline.html

The One Tonne Challenge

Canada has not only targeted business and industry to reduce greenhouse gases, but has started a national program called the "One Tonne Challenge" for the general population.

Question 3d.

How much greenhouse gas is produced by the average Canadian citizen?
What are (5) things that could be done by each person or household to reduce greenhouse gas emissions?

http://www.climatechange.gc.ca/onetonne/english/

Section 4:
Climate Change: Disappearing Arctic Ice

For the fourth consecutive year, scientists using satellite data have tracked a stunning reduction in arctic sea ice at the end of the northern summer. The persistence of near-record low extents leads the group to conclude that Arctic sea ice is likely on an accelerating, long-term decline.

Question 4 a.

Using the data table on the next page, predict in percent how much of the arctic ice cap has been lost from 1979 to 2005?

Question 4 b. Line Graph

Using the data below, construct a line graph of Arctic Ice cover from 1978 – 2005.

IMPORTANT: When indicating time on the (X) axis, extent the year to 2020.

Year	Linear regression X values	Millions of square kilometers
1979	0	7.2
1980	1	7.9
1982	3	7.5
1983	4	7.6
1984	5	7.2
1985	6	6.9
1988	9	7.5
1989	10	7.1
1990	11	6.3
1992	13	7.5
1993	14	6.5
1994	15	7.2
1995	16	6.2
1996	17	7.8
1997	18	6.7
1998	19	6.6
1999	20	6.3
2000	21	6.4
2001	22	6.6
2002	23	6.0
2003	24	6.3
2004	25	6.1
2005	26	5.5

The National Snow and Ice Data Center (NSIDC)

Question 4 c.

On the graph using a line of best fit, predict the Arctic ice cover to the year 2020. Use a dashed line of best fit.

Question 4d.

Using linear regression, what would be the area of Arctic Ice cover in 2020?

Question 4e.

Using linear regression, in what year (calendar year) will the Arctic Ice cover disappear or reach zero cover?

Question 4 f.

As the arctic ice disappears, what implications are being felt currently or in the future to the following?

a. **Inuit People**
b. **Arctic Sovereignty**
c. **Polar Bears**

http://www.cbc.ca/news/background/climatechange/
http://www.cbc.ca/news/background/cdnmilitary/arctic.html
http://www.cbc.ca/news/background/polarbears/

Section 5:

Climate Change: Sea Level Rise and the Global Conveyer Belt

Over the last 100 years, the global sea level has risen by about 10 to 25 cm. Sea level change is difficult to measure. Relative sea level changes have been derived mainly from tide-gauge data. In the conventional tide-gauge system, the sea level is measured relative to a land-based tide-gauge benchmark. The major problem is that the land experiences vertical movements (e.g. from isostatic effects, neotectonism, and sedimentation), and these get incorporated into the measurements. (United Nations Environmental Programme 2006)

The major concern is what would happen if the Greenland and/or the Antarctic Ice Sheet melted? Experts predict if the Greenland Ice Sheet melts that global sea level will rise 7 meters.

This melting of the Greenland Ice Sheet also may have profound impacts on the Atlantic/Arctic Ocean water. The mixing of fresh water and salt water could affect the stability of the thermohaline in the Atlantic and Arctic and could also disrupt the "Global Conveyer Belt".

5a. The warm Atlantic Gulf Stream might be disrupted if the halocline changes in the North Atlantic. What implications might this present to European weather/climate?

http://science.nasa.gov/headlines/y2004/05mar_arctic.htm (audio)

5b. Using the map of Kentville provided, colour code the area from the present day coastline (sea level) to the predicted 13 meter contour elevation on both sides of the Cornwallis River. This would represent the worst case scenario if the Greenland Ice Sheet melted. Note: Mean High Tide mark is 5.7meters.

5c. How might local authorities deal with rising water levels in the town of Kentville?

Resources

http://www.guardian.co.uk/international/story/0,3604,1104241,00.html

http://www.breitbart.com/news/2005/12/07/051207182757.ht1oak7y.html

http://www.usatoday.com/news/world/2005-12-04-inuit-warming_x.htm?csp=34

http://www.countercurrents.org/cc-leahy110904.htm

http://news.nationalgeographic.com/news/2000/12/122900inuits.html

Resources

Question 2a. Global Surface Temperature Anomalies

http://www.ncdc.noaa.gov/oa/climate/research/anomalies/anomalies.html

United States Environmental Protection Agency (USEPA 2005)

http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html