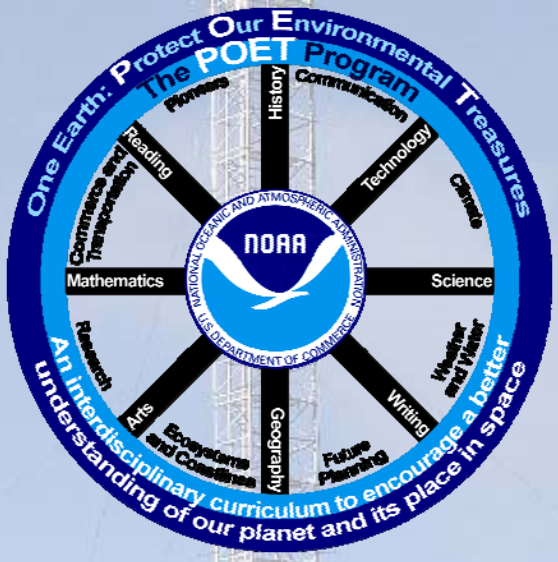
Carbon Dioxide and Seasons

Category

Mathematics, Science, Technology

Real World Connection

Climate, Research, Future Planning



Materials

Calculator

Data for Global Monthly Mean Carbon Dioxide Concentrations (Included)

Problem Question

How does the carbon dioxide concentration (monthly – globally averaged) change as Earth's seasons change throughout several years?

Prior Knowledge What I Know	Conclusion What I Learned
Based on your prior knowledge, answer the problem question to the best of your ability.	*Answer the problem question after completing the activity.*

Background Information

Carbon dioxide (CO_2) - too much...too little...or just right?

On planet Earth, CO_2 helps to keep the temperature of our atmosphere at a comfortable average of 57 Degrees Fahrenheit (^{o} F). What would happen to Earth's temperature if the amount of CO_2 increases or decreases?

To find out, researchers track carbon atoms as they move through Earth's atmosphere, oceans, land, plants, and animals. Since carbon atoms travel in a repeating pattern, this movement is called the Carbon Cycle.

Without CO_2 in Earth's atmosphere, the average temperature would be about 0 ^{o} F (-18 Degrees Celcius [^{o} C]). On the other hand...the planet Venus is so hot that lead will melt on its surface! Why? On Venus, 97% of the atmosphere is CO_2; on Earth, much less than 1% of the atmosphere is CO_2. Why is there so much less CO_2 on Earth? The Carbon Cycle holds the answer.

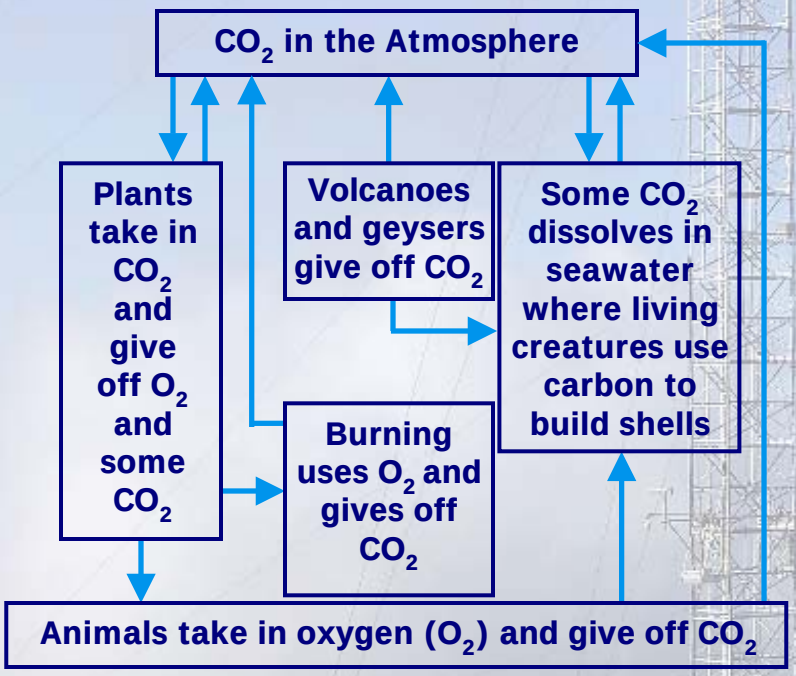
FYI

Carbon dioxide (CO_2) is a colorless, odorless gas formed by one atom of carbon and two atoms of oxygen.

The CO_2 concentration in Earth's atmosphere is measured in parts per million (ppm). For example, a carbon dioxide concentration of 350 ppm means that there are 350 parts of carbon dioxide in a total of one million parts of dry air.

A Short Version of the Carbon Cycle

Note: In nature a cycle is NOT a circle...but a pattern of repetition



Here is a list of processes that describe how carbon atoms can move from one place to another in the Carbon Cycle.

- Plants take in and give off mostly oxygen (O_2) with some CO_2 .
- Animals use O_2 and give off CO_2 .
- Some CO_2 dissolves in seawater where living creatures use carbon to build shells.
- Fire (burning) uses O_2 and gives off CO_2 .
- Volcanoes and geysers give off CO_2 .

This natural movement of carbon through the Carbon Cycle helps to control the amount of CO_2 in Earth's atmosphere.

But human beings can complicate Earth's natural carbon cycle. Evidence shows that the amount of CO_2 in Earth's atmosphere has been rising since the time of the Industrial Revolution. Not only is the amount of CO_2 rising, but the increase is speeding up!

??What is happening??

By burning fossil fuels, people increase the amount of CO_2 in our atmosphere. Today, driving cars, heating buildings, and producing consumer goods all add to the amount of CO_2 in Earth's atmosphere, complicating the natural Carbon Cycle even more.

Background Information - Continued

Researchers observe and measure the amount of CO_2 in Earth's atmosphere, looking for clues to help understand the Carbon Cycle, how people affect its natural flow, and most importantly, what effect thia has on our environment. We need to know if there is too much, too little, or just the right amount of CO_2 in our atmosphere. Our life depends on it!

Procedure

In this activity, you will plot a curve for the monthly average CO_2 (ppm) concentration amount found in the Earth's atmosphere over several years.

In much the same way a scientist would monitor concentrations of gases in the atmosphere, you will look for changes and trends, as well as maximum and minimum concentrations, using data collected at sites around the world, such as the Mauna Loa Observatory on the Island of Hawaii.

Established in 1957, on the northern flank of the Mauna Loa Volcano, at an elevation of 3397 meters (11,145 feet), the Mauna Loa Observatory has grown to become the Earth's premier long-term atmospheric monitoring facility and is one of the the sites where the ever-increasing concentrations of global atmospheric CO_2 were determined.

1. Using data from Table 8-1, plot the points corresponding to the recent global monthly mean CO_2 concentration over time on Figure 8-2.
2. Print a title at the top of your graph in the white box.

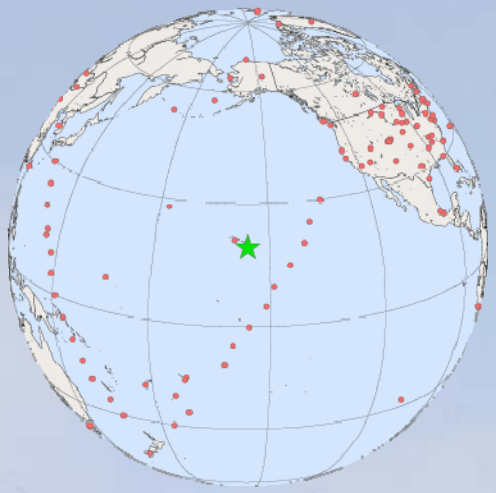


Figure 8-1. Mauna Loa Observatory (MLO) – Location and Image (note also that watermark for this activity is the air sampling tower at MLO)

Global Monthly Mean Carbon Dioxide Concentrations (Parts per Million – ppm)

Month												Cal. Year
Jan (1)	Feb (2)	Mar (3)	Apr (4)	May (5)	Jun (6)	Jul (7)	Aug (8)	Sep (9)	Oct (10)	Nov (11)	Dec (12)	
372.31	372.69	373.20	373.54	373.52	372.66	371.23	370.16	370.48	371.75	373.10	374.09	2002
374.75	375.29	375.72	376.19	376.33	375.48	373.93	372.70	372.90	374.20	375.48	376.32	2003
376.98	377.50	377.92	378.28	378.21	377.34	375.80	374.34	374.24	375.55	377.00	377.99	2004
378.58	379.00	379.61	380.12	380.24	379.42	377.72	376.49	376.56	377.87	379.36	380.34	2005
381.05	381.69	382.10	382.43	382.38	381.52	379.86	378.30	378.42	379.82	381.18	382.14	2006
382.82	383.35	383.81	384.10	383.95	383.08	381.39	380.12	380.50	381.89	383.22	384.26	2007
385.02	385.62	385.98	386.33	386.30	385.35	383.79	382.47	382.34	383.50	385.08	386.43	2008

Table 8-1. Global Monthly Mean Carbon Dioxide Concentrations – January 2002 through December 2008

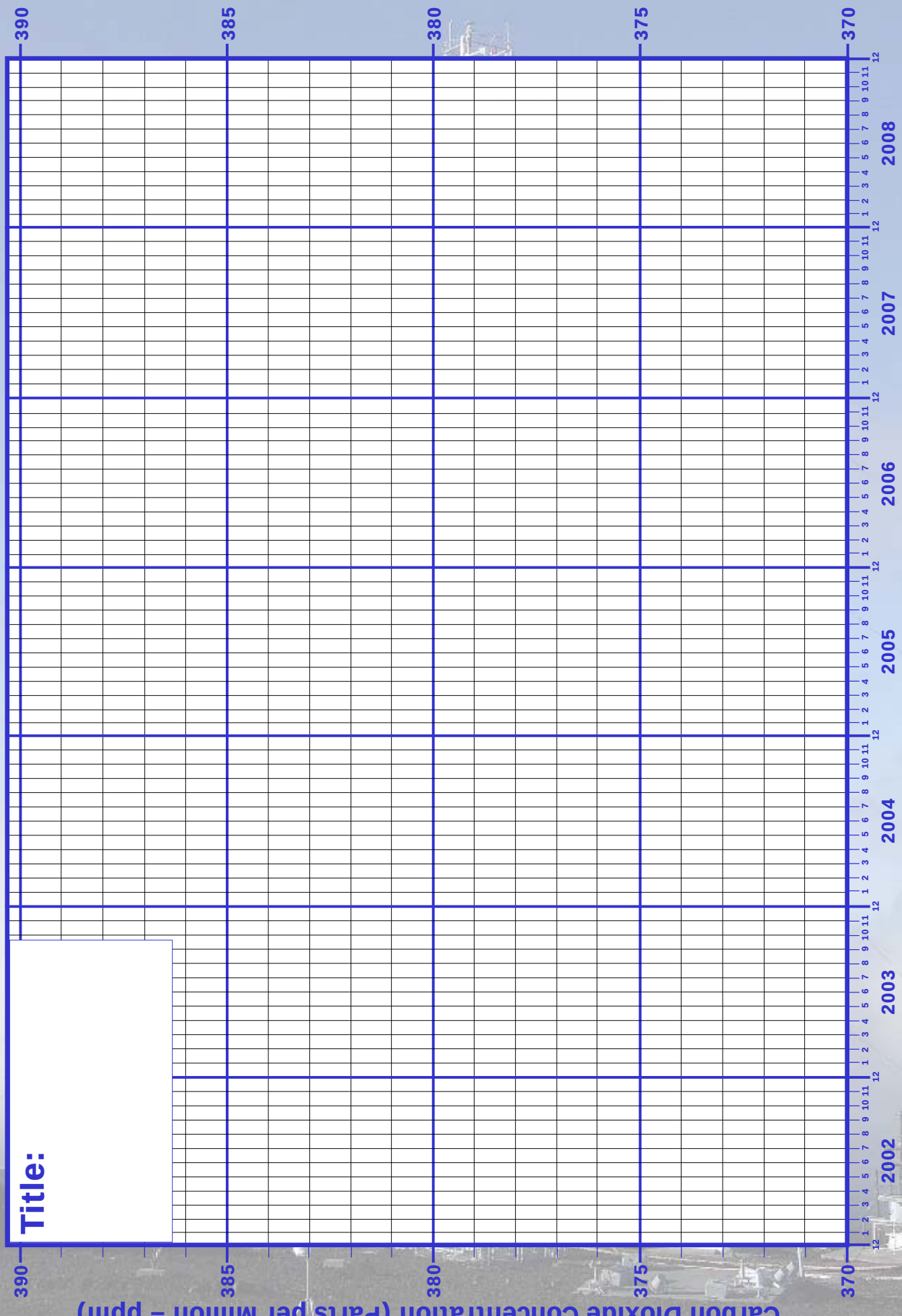


Figure 8-2. Graph for Carbon Dioxide Plot

Questions

1. What patterns do you notice in your graph? (Keep these patterns in mind as you answer the following questions.).

2. What is the mathematical range for the CO_2 concentration between January 2002 and December 2008?

3. Calculate the mean CO_2 concentration for each year listed in the table below. Then complete the table using your calculations.

Year	Mean CO_2 Concentration (ppm)	Amount of CO_2 Change (ppm)	Change Since the Previous Year (Increase, Decrease, Unchanged)
2002			
2003			
2004			
2005			
2006			
2007			
2008			

Does the CO_2 concentration increase, decrease, or remain unchanged from year to year?

4. According to your data, during what month and during what season is the CO_2 concentration highest? Lowest?

5. Explain how the seasonal changes of CO_2 concentration in the atmosphere and the growing season for plants and are related.

Questions – Continued

6. There is more land in the Northern Hemisphere than in the Southern Hemisphere. How might this difference affect CO_2 concentration?

7. Earlier, you noticed that your line graph has a repeating pattern. Explain**.**

8. A curved graph that follows a regular pattern can sometimes be used predict an event, or the strength of an event. Follow the directions in this section to show how you might have predicted the amount of atmospheric CO_2 for 2008.

   Begin with January, 2006, and draw a second curve on your graph using a dashed line (-----). However, instead of plotting data, extend the graph from January 2006 to the end of 2008 using the pattern that you identified earlier. Then, compare the shape of the curve made with actual data to the shape of the curve made to forecast the amount of CO_2 in our atmosphere. What do you see?