Global Climate Change and Carbon Dioxide Lesson – Earth & Environmental Science

Objective: Research and analyze data about global atmospheric carbon dioxide and temperature in order to infer and draw conclusions about global climate change.

Materials needed: SOS Explorer on your computer and access to Internet.

Answer the questions below in complete sentence using SOS Explorer, Internet links and diagrams.

1. Read this article to gather background information about global climate change and CO_2 levels: https://scripps.ucsd.edu/programs/keelingcurve/2015/05/12/what-does-this-number-mean/

    a. What is the "Keeling Curve"?

    b. What is the unit of measurement to measure CO_2 levels?

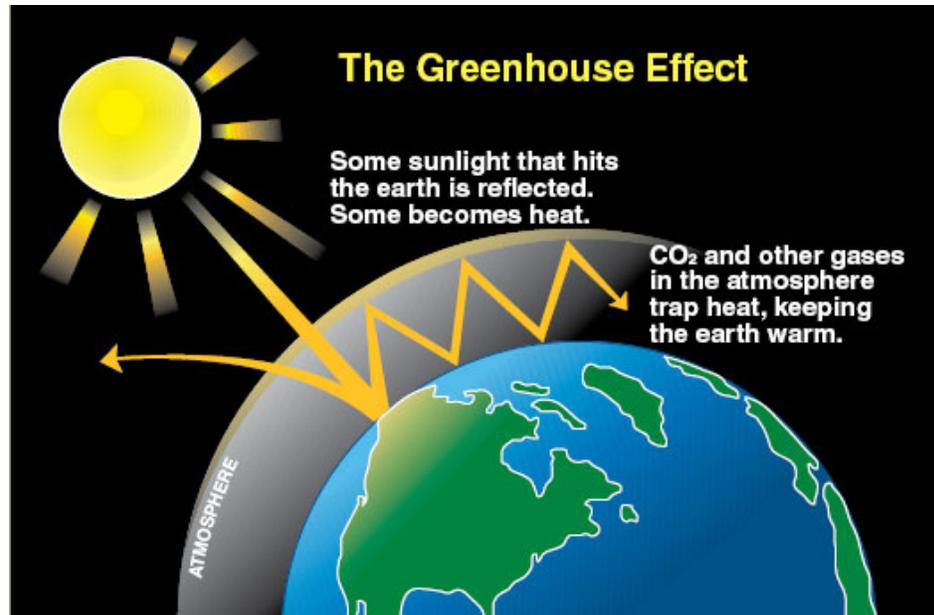2. Here is an image to help understand the impact of greenhouse gases like CO_2:

Figure 1: The Greenhouse Effect (Department of Ecology, State of Washington)

    a. Summarize the diagram in your own words.

NOAA

3. Open SOS Explorer. Take a moment to play around and become familiar with the program. Then, click *Datasets > CarbonTracker 2005 – 2010 > Load.* You should see a colorful animation.

   a. What do the colors represent? Give an example.

   b. Take a minute to watch the animation. Describe what you see.

4. Then click *Tools > Analyze and Probe.* This will allow you to measure the CO_2 levels in the following locations at the end of winter and the end of summer during 3 years. You can adjust the month and year using the controls in the animation window in the upper right corner of screen.

   Use the Probe tool to measure the CO_2 concentrations (ppm) at the specified times and locations and record them in the table below.

   a. Table 1:

Location	05/2005	09/2005	05/2007	09/2007	05/2010	09/2010
Mauna Loa, Big Island, Hawaii						
South Pole, Antarctica						
Your location						

   b. Graph the data from in Table 1 for your three locations. Title the graph: CO_2 Levels 2005-2010.

   c. Explain the pattern you see in your graph/data.

   d. Rotate sphere to view Atlantic Ocean. Click on *Tools > Analyze > choose transect tool.* Right click far in the northern part of the Atlantic Ocean, move your mouse and right click again far in the southern part of the Atlantic Ocean. Watch the graph that is made for a while or increase the frame rate. Is this the same pattern you saw in your data? Describe it.

5. Load a new dataset. Click *Datasets > Biosphere: Marine Chlorophyll and Land Vegetation > Load.*

a. Watch the animation for a minute then, describe what you see.

b. Specifically looking at the northern hemisphere, in which months are the vegetation and chlorophyll concentration highest and lowest?

c. Specifically looking at the southern hemisphere, in which months are the vegetation and chlorophyll concentration highest and lowest?

d. How does that compare to your CO_2 data differences between seasons recorded in Table 1 and graph from question 4?

e. Chlorophyll refers to green pigments in algae and plants. It is an extremely important biomolecule, critical in photosynthesis. Photosynthesis is a process where by plants convert light energy into chemical energy to fuel the organisms' activities. This process allows plants to take in CO_2 and release Oxygen. In winter, this process slows dramatically.

   How can you use this information to explain what you saw in the CarbonTracker and Biosphere animations? (Load the datasets again if you want to review.)
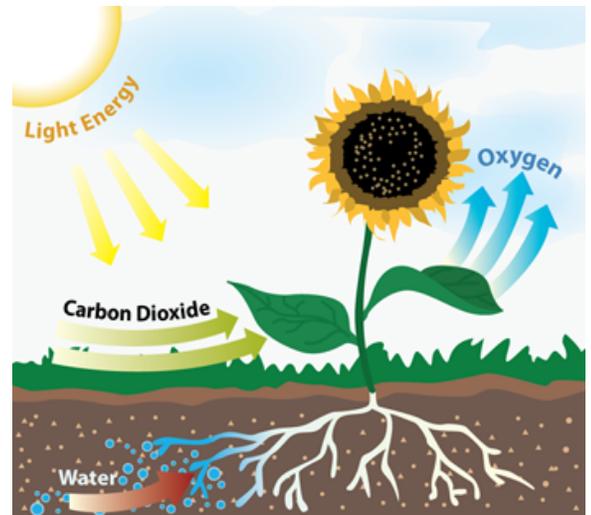
6. In your SOS Explorer CO_2 data collection (Table 1), although there were seasonal changes (CO_2 goes up and down depending on the season due to photosynthesis) you may have also seen the pattern of CO_2 going up as time goes on. Did you see this? Give a specific example in your data.
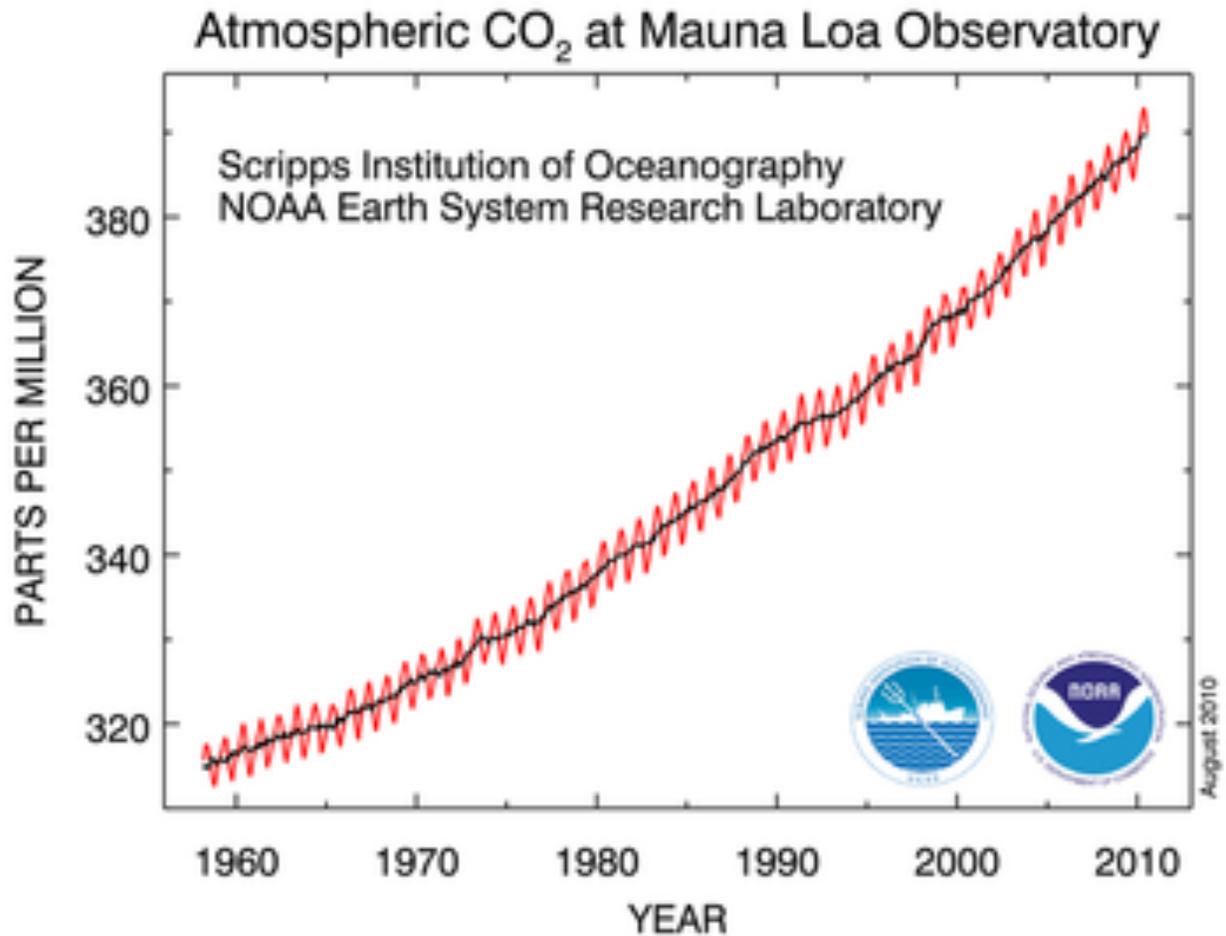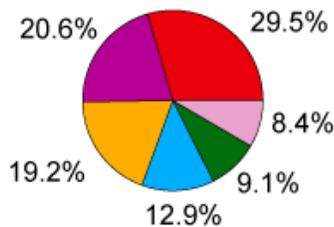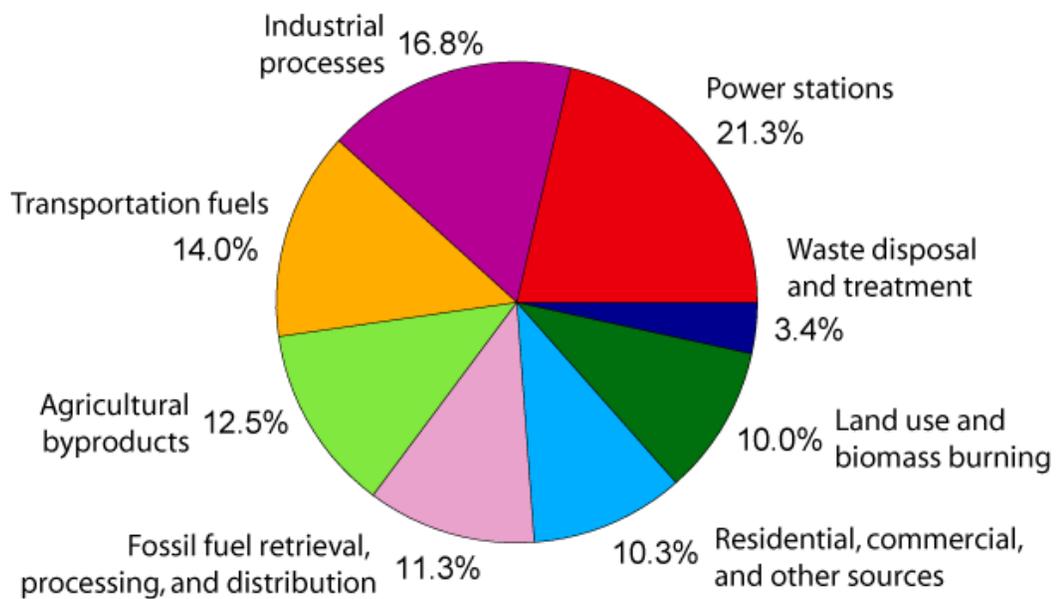
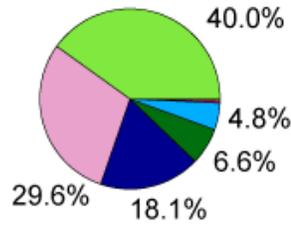## Atmospheric CO₂ at Mauna Loa Observatory

Figure 2: Keeling Curve (NOAA)

a. Describe how your data collection for Mauna Loa, Hawaii (both seasonal and increase over time) compares to the Keeling Curve in Figure 2 above.

7. Go to the following link to find and record the current CO_2 level is for last week at Mauna Loa. http://www.esrl.noaa.gov/gmd/ccgg/trends/weekly.html

8. We saw that plants can change the CO_2 levels seasonally but that doesn't explain why CO_2 has gone up so much over the years – just look at Figure 2: Keeling Curve. How are humans impacting CO_2 levels? Give a few examples. Please use Figure 3 below image to help you answer this question:
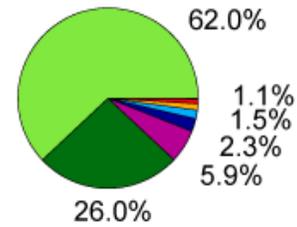

Annual Greenhouse Gas Emissions by Sector

Industrial processes 16.8%

Power stations 21.3%

Transportation fuels 14.0%

Waste disposal and treatment 3.4%

Agricultural byproducts 12.5%

Land use and biomass burning 10.0%

Fossil fuel retrieval, processing, and distribution 11.3%

Residential, commercial, and other sources 10.3%

Carbon Dioxide (72% of total)
29.5% 20.6% 8.4% 9.1% 12.9% 19.2%

Methane (18% of total)
40.0% 4.8% 6.6% 18.1% 29.6%

Nitrous Oxide (9% of total)
62.0% 1.1% 1.5% 2.3% 5.9% 26.0%

Figure 3: Emission Database for Global Atmospheric Research version 3.2, fast track 2000 project
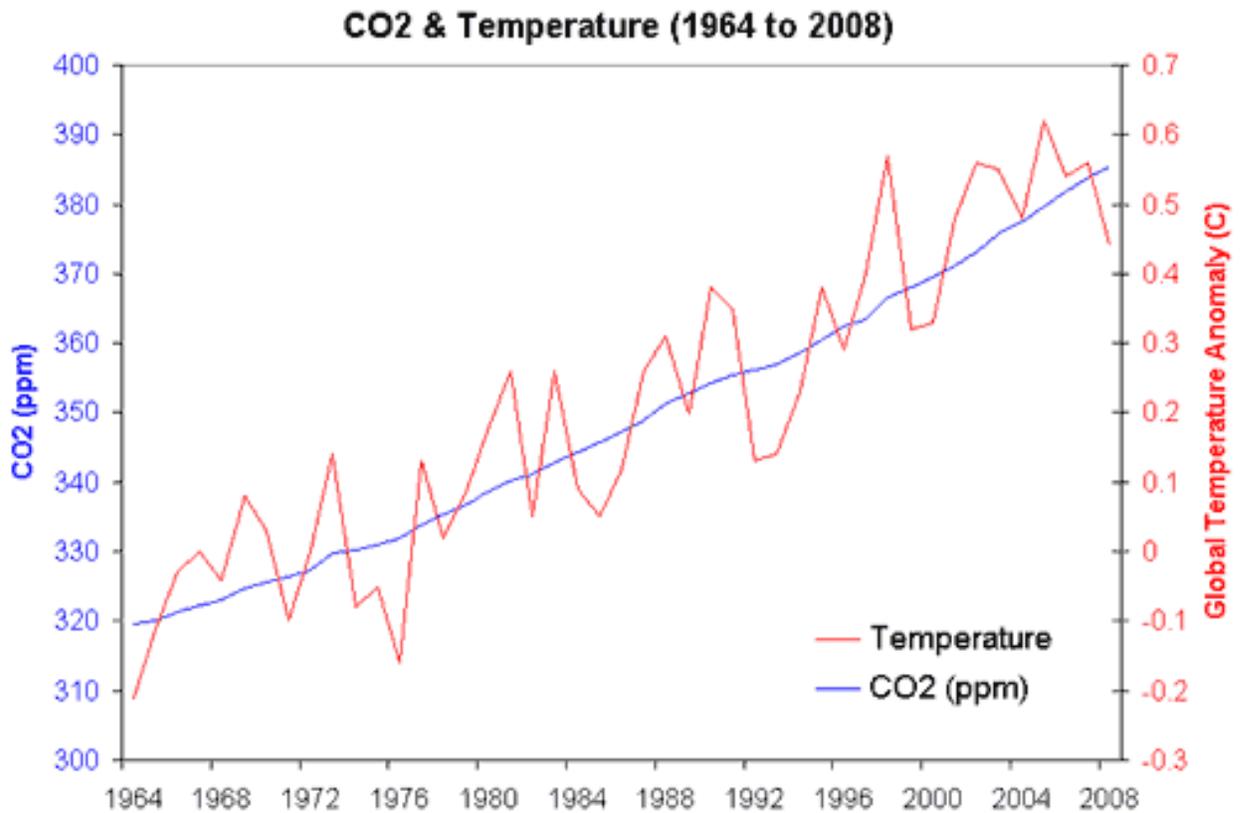
CO2 & Temperature (1964 to 2008)

Figure 4: Annual atmospheric carbon dioxide (NOAA) and annual global temperature anomaly (difference from average temperature) (GISS) from 1964 to 2008.

9. Finally, using the graph in Figure 4 above, how do global temperatures and CO_2 correlate? Why? Use Figure 1 on page 1 to help you.

10. Based on the data you have seen in this lesson, what is your conclusion about global climate change and it's causes. Give specific examples with data as support.

11. How do you think we, as humans, can change this?

Extension - Our Future

Scientists use computer models to make future predictions. Go to https://www.climate.gov/ scroll down to the Global Climate Dashboard and select Climate Projections.

a. Explain the graph of Simulation of Global Temperature according to the Climate Model Data.

b. How do you think it might be possible to follow the B1 path rather than the A2 path? What specifically could we do?