**Is It Getting Hot in Here?**

**Lesson Objective:** Students learn about the effects of carbon dioxide on the climate system and investigate temperature and carbon dioxide levels over the past 400,000 years. This knowledge will help them understand anthropogenic climate change and the need for a sustainable lifestyle.

**Materials:**

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| Computer w/ Microsoft Excel |  |  |
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**Instructions:**

Set Up

1. Before each session:
	1. Make sure that there are enough computers for each student to have one, or if that is not possible, then they can partner up
	2. Have a copy of the Vostok Data excel spreadsheet on each computer

Introduction

1. Present the powerpoint entitled “Is It Getting Hot in Here?” This will give the students an introduction to carbon dioxide and the greenhouse effect
2. For the slide “Weather vs. Climate”, be sure to ask the students about the climate of PA and NJ. Correct answers could include that the climate is relatively wet and temperate (i.e. neither too hot or cold on average)
3. For the slide “Carbon Dioxide and Climate”, also explain the side effects of higher global temperatures such as droughts, floods, increased likelihood of tropical storms and sea level rise.
4. Allow time for questions
	1. If someone asks if the carbon dioxide cycles are natural: In the past they have been, but now humans are adding far more carbon dioxide to the atmosphere than is natural.
	2. How did the Earth get out of the ice ages?: Changes in the amount of insolation or sunshine are the primary driver of climate, and they are mainly responsible for the natural glacial cycles that you will see in the graphs you make for the activity.

Activity

1. Briefly explain to the students what the Vostok ice core is, as they will be using data collected from the core to complete the activity
	1. The Vostok ice core was drilled in East Antarctica and contains climate information going back 400,000 years. The ice can tell us about the past concentrations of CO2 in the atmosphere because ancient air bubbles are trapped in the ice, preserving past atmospheric conditions! A tree ring analogy should work to explain how the ice accumulates: a new layer of snow each year, just like a new tree ring each year. Snow and ice accumulates vertically as opposed to outward like trees.
	2. To help explain 400,000 years to the students, first ask them about the oldest thing that they can think of, and then go from there. The oldest Giant Sequoia trees in California are about 3,000 years old, so how many tree lifetimes would go back to 400,000? (~133 sequoia lifetimes). Other things to consider, 400,000 years ago Mammoths and Saber-tooth cats were around, but dinosaurs were already extinct. Modern humans evolved ~50,000 years ago.
2. You may want to have an example plot already made in Excel, so that the students know what their final product should look like.
3. Have students open the excel file “Vostok Data” on their computers. Go over the slide entitled “Activity” and explain that they are going to make two line/scatter graphs: one of age vs. carbon dioxide and one of age vs. temperature.
4. This may be some of the students’ first time using excel, or they may not be familiar with graphs. Here are the key strokes:
	1. Highlight the columns entitled “Ice Age” and “Temperature”
	2. Go to the “Insert” menu and select “scatter”, then choose “scatter with straight lines”
	3. Right click on the plot that appears and select “Move Chart…” and then choose “New Sheet”. This should open a new sheet that only contains the plot that you just made.
	4. On the new sheet, right click on the vertical axis and select “Format Axis…” Change the axis minimum to -65 and the axis maximum to -51.
	5. Add axis titles. To do this go to Chart Layout and select “Axis Titles”, you will be able to edit the text once the title appears on the plot.
	6. Have the students print their plots.
	7. Repeat steps 3a-e with the “Gas Age” and “CO2” columns. Axis minimum = 150. Axis maximum = 310.
5. Using the “Results” slide as a guide, help the students understand what their graphs mean. Then ask the students if they notice and similarities between the graphs that they just made. Hopefully they will notice that the pattern is very similar suggesting a correlation between carbon dioxide and temperature.
6. The current concentration of CO2 in the atmosphere is 400 ppm. Have the students add this to their CO2 plot and predict how the temperature might respond.
7. To relate this activity back to sustainability, refer back to modern climate change and connect to sustainable energy, water and food practices to mitigate the effects of climate change.
	1. How might climate change affect the world’s supply of food and water?
		1. Drought may make water more scarce, especially a threat in places that are already dry. Drought also affects the growth of crops, which could limit the amount and/or variety of food produced.
		2. Flooding and destructive weather events could have similar effects on food and water supply.
		3. By reducing the amount of fossil fuels and water that humans use, it will help prevent environmental issues from getting out of hand.

If you need something extra to do, have the students complete an online carbon calculator. Cool the Earth has a good one for kids, <http://www.cooltheworld.com/kidscarboncalculator.php>

Mind that it was made in the UK, so the one question about travel may get a few questions from students.