Long Term Data Sets

Duration:
1 class

Objectives:
Students will:
- Discuss the benefits of long-term data sets and studies
- Use a long-term data set to plot graphs and examine patterns
- Extrapolate what future climates may be like
- Use empirical data to discuss how human activity is affecting the planet

Vocabulary:
Carbon Dioxide
A greenhouse gas found in the atmosphere in small amounts; it is released naturally into the environment and through human related activities.
Atmosphere
The gaseous layer surrounding the earth consisting of nitrogen, oxygen, and many trace gases, held in place by the earth's gravitational force

British Columbia PLO's:
Math 6, 7, 8
Social Studies 6, 7, 8

Background:
In this activity the students will use actual data from the Mauna Loa Observatory from 1958 to the present to graph CO_2 in the atmosphere. Using their graphs they will analyse any patterns observed, predict future CO_2 values and discuss how this long-term data set has contributed to our understanding of abrupt climate change. This activity can be used after an introduction to climate change, as the students should have a basic understanding of the topic.

Long-term data is invaluable in studying and understanding how organisms will respond to present-day abrupt climate change in the context of long-term climate variability.

One study that has been very useful in determining how CO_2 has increased over the last century was started in the mid 1950s at the Mauna Loa Observatory. Located on the big island of Hawaii, Mauna Loa – a shield volcano – is the largest volcano on the planet. The observatory sits on the north flank of the volcano looking over at Mauna Kea. Its remote location in the Pacific Ocean and high altitude of 3,397 meters makes it an ideal position to study the atmosphere.

Although the Mauna Loa Observatory examines a variety of subjects, in the last decade it has become well known for studying atmospheric CO_2. The long-term data set of atmospheric CO_2 from the observatory was one of the first pieces of evidence scientists used to explain how humans were impacting the climate. Increasing levels of CO_2 over the last half-century show a steadily uprising curve that has become known as the Mauna Loa curve or the Keeling curve (after Charles Keeling who was a pioneer in the monitoring of CO_2 in the atmosphere). CO_2 levels are now being used as a major indicator of global warming, and a movement has begun in most parts of the world to reduce CO_2 emissions.

Materials:
- Class set of *Ocean News* article *The benefits of long-term data*
- Access to the Mauna Loa data set or printouts of the spreadsheet
- BBC News article for students
- Images of Mauna Loa
- Graph paper
- Pencils
- Rulers

Procedure:

1. Place a picture of Mauna Loa up on the overhead or screen when the students walk into the classroom (see resource section).
2. Ask the students what the benefits of long-term data sets are? Get them to Think-Pair-Share.
3. With the students, create a list of why long-term studies are important. Have them list any long-term studies that they know of (i.e. bird counts, temperature studies, fish catch data). Note: they may even come up with the Mauna Loa CO_2 data set since it was featured in the movie *An Inconvenient Truth*.
4. Read the *Ocean News* article *The Benefits of Long-Term Data* as a class or as individuals.
5. Using information from the Mauna Loa Observatory, the class will plot data in order to assess climatic patterns and trends. Measurements at Mauna Loa are taken every month. The Mauna Loa data set might be too much to handle for many small graphs so it will need to be examined, discussed and possibly streamlined beforehand.
6. As a class, decide what data to use; the goal should be to simplify the graph but to still get a clear picture of what is happening. Plot at least one month from summer and one from winter for each year in order to observe seasonal patterns.
7. The students can graph the data by hand or use a computer. The data can be used from the website or from the accompanying excel spreadsheet.
8. If you have internet access in the classroom go to the live web cam page for the Mauna Loa Observatory and have a look at what the current weather conditions are like while the students are working on their graphs.
9. If time is limited, the students can complete the graph for homework and the lesson can be continued the next day.
10. Once the graphs are complete, get the students to answer some of the discussion questions in small groups. Place the plotted Mauna Loa graph (see the resource section) on the overhead for comparisons. Their graphs should show similar trends and patterns.
11. Get the students to extrapolate what the CO_2 levels might be like in 10 years? 20 years? 100 years? Discuss why extrapolations are only estimates. Ask the students to consider what might affect the curve over the next few decades or centuries to make their extrapolations inaccurate. Discuss (1) what is currently being done to reduce emissions globally, (2) carbon sequestration, and (3) increased fossil fuel consumption in some parts of the world.
12. To put the data in a larger context (after the discussion questions are taken up), show the students the atmospheric CO_2 values covering the last several millennia. What can we learn by looking at these even longer data sets? How was this data collected?
13. Have the students read the news article *Ice Cores Unlock Climate Secrets*. This can be done individually or out-loud with members of the class taking turns reading.
14. Discuss where this historical data comes from (ice cores). Ask the class to explain the difference between long-term data sets and historical data (data collected over a long-term versus data implied from current studies that look at data recorded naturally in a medium scientists can study and gather information i.e. archaeological information, ice cores, tree trunk cores etc).
15. To end the activity, get the students to write a short entry in their notebooks on the importance of using both long-term data sets and historical data to improve our understanding of the natural world.

Discussion:

- How is atmospheric carbon dioxide measured?

- Why is it important for carbon dioxide data to be taken in a remote location?
- Why does the data show a small oscillation pattern within the larger shape?
- What is the overall trend in CO_2 levels since the 1950s?
- What predictions for the future can we make using the graph?
- Why is it difficult to extrapolate future values of CO_2 at this time?
- What other data would be useful in determining atmospheric changes and how they relate to climate change?

Extension and Resources:

- A great photo of Mauna Loa www.summitpost.org/mountain/rock/151296/mauna-loa.html
- Mauna Loa at night image www.3dnworld.com/users/65/images/MaunaLoav1.1.jpg
- Mauna Loa data in spreadsheet taken from cdiac.ornl.gov/ftp/ndp001/maunaloa.co2
- Live web cam at the Mauna Loa Observatory www.mlo.noaa.gov/livecam/livecam.html
- Good source of background information on Mauna Loa and the carbon dioxide data www.eoearth.org/article/Mauna_Loa_curve
- Plotted Mauna Loa data in a graph for students to see and use to make comparisons. www.globalwarmingart.com/wiki/Image:Mauna_Loa_Carbon_Dioxide_png
- This Global Warming Art website has great images of CO_2 values over the last few decades to the last few millennia www.globalwarmingart.com/wiki/Image:Carbon_Dioxide_400kyr_Rev_png
- BBC News article *Ice Cores Unlock Climate Secrets* http://news.bbc.co.uk/1/hi/sci/tech/3792209.stm