RESOURCE LIBRARY I ACTIVITY : 50 MINS

Global Trends

Students read an encyclopedia entry on the Keeling Curve to introduce global climate data collection. Next, they engage with an interactive Keeling Curve to compare short and long-term carbon dioxide trends. Finally, they analyze data across time to create an evidence-based comparison of carbon dioxide levels.

GRADES

6, 7, 8

SUBJECTS

Earth Science, Climatology

CONTENTS

1 PDF, 1 Resource, 2 Links

OVERVIEW

Students read an encyclopedia entry on the Keeling Curve to introduce global climate data collection. Next, they engage with an interactive Keeling Curve to compare short and long-term carbon dioxide trends. Finally, they analyze data across time to create an evidence-based comparison of carbon dioxide levels.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/global-trends/

In collaboration with

educurious
learning that connects

DIRECTIONS

This activity is part of the Climate Change Challenge unit.

1. Introduce global climate data collection with an encyclopedia article.

- Prompt students to recall prior knowledge in a Think-Pair-Share by asking:
  - *What are some sources of carbon dioxide in our atmosphere?*
  - *What are some carbon sinks?*
- (Student responses will vary, but will likely reflect sources and sinks from the carbon cycle diagram from the *Carbon All Around* activity.)
- Given their knowledge of carbon sources and sinks, assign students to predict how carbon dioxide in Earth's atmosphere has changed recently, and to write this hypothesis in their notes. Ask:
  - *Do you think carbon dioxide levels in our atmosphere have been increasing, decreasing, or staying the same? Why?* (Student hypotheses will vary but look for the inclusion of reasoning related to the greenhouse effect and carbon cycle.)
- Distribute copies of *The Keeling Curve* encyclopedia entry and assign students to read and annotate this article in pairs, previewing the questions for discussion to follow their reading:
  - *What is the Keeling Curve?* (A graph representing the concentration of carbon dioxide in Earth's atmosphere since 1958.)
  - *Why does the amount of carbon dioxide increase and decrease a small amount each year?* (The amount of carbon dioxide goes up in the winter when there is less photosynthesis and more plant decomposition releasing carbon dioxide (a carbon source). The amount of carbon dioxide goes down in spring and summer, when there is more plant photosynthesis absorbing carbon dioxide.)
  - *How does the Keeling Curve help you confirm or revise your hypothesis regarding carbon dioxide levels since 1950?* (Student responses will vary but should address their hypotheses with updated reasoning, if necessary.)
- Discuss volunteers' responses as a class.

2. Engage with an interactive Keeling Curve to compare short- and long-term carbon dioxide trends.

- Project the *SCRIPPS interactive Keeling Curve*. Explain that this resource will allow the class to "zoom in" on the Keeling Curve data, asking questions about the amount of carbon dioxide in the atmosphere right now and over time.
    - With students, identify three critical elements of this graph (and others they will encounter in the unit):
        - Title (The title is frequently located above the graph. In this case, it is the current date, followed by "Carbon Dioxide Concentration at Mauna Loa Observatory").
        - Axis Labels (The x-axis label is typically found below this horizontal axis. In this case, it is a measure of the time or date. The y-axis label is typically found to the left of this vertical axis. In this case, it is a measure of the CO_2 concentration in parts per million (ppm)).
        - Key (if present). (The key helps to distinguish the nature of the data. It shows the meaning of colors or symbols, for example. In this case, the key helps to distinguish between averages taken at different time-scales).
- Moving the cursor over the following buttons, ask students to identify the direction of change (or trend) that they see in the data.
    - *One week* (Students will see daily fluctuations or cycles, but will not see an overall change.)
    - *One month* (Students may see a slight up or down trend, depending on the time of year.)
    - *Six months* (Students will see an up or down trend as part of the yearly fluctuation or cycle, depending on the time of year.)
    - *One year* (Students will see the yearly fluctuations or cycles. Prompt them to note whether the starting and ending points on the graph show a change.)
    - *Two years* (Students will see the yearly fluctuations or cycles. Prompt them again to note changes in the level of troughs and peaks in the curve.)
    - *Full record* (Only when the full record is visible is the long-term increase in carbon dioxide obvious).
- In a Think-Pair-Share, ask students to reflect on the following question:
    - *Why is it important for scientists to measure changes in carbon dioxide and the climate over long periods of time?* (Changes in long-term processes such as climate must be monitored over similarly long periods in order to accurately measure the trend).

3. Model data analysis across time to support student creation of an evidence-based carbon dioxide level comparison.

- Distribute the *Global Trends Calculation Tracker* handout to students.
- Ask volunteers to recall the meaning of mean, median, and range, using their notes from the *Our Greenhouse* activity. Record their definitions and any formulas they provide in a visible location.
- Project carbon dioxide data for twelve months of the first year (1959) in the *SCRIPPS Atmospheric CO_2 data* (use the monthly_in_situ_co2_mlo.csv link under "In situ CO_2 data"). Then model calculation of mean, median, and range for the 'CO_2 [ppm]' data by hand or with a calculator for these twelve months in a visible location, in a chart that mirrors Part A of the *Global Trends Calculation Tracker*.
- Repeat this step to model calculations with the whole class, using the last full year available in the dataset.
- Compare the mean, median, and range for these two years, asking students:
    - *Are these values different between 1959 and the most recent year?* (Yes, they are very different; the values for the current year are much higher.)
    - *Does this match what you saw in the Keeling Curve graphs?* (Yes, the Keeling Curve graphs also showed this increase over long periods of time.)
- Assign students to choose two other full years of data for which to compare mean, median, and range, and complete their calculations on Part A of the *Global Trends Calculation Tracker*.
    - They may wish to compare their birth year with the most recent full year, for example.
- Next, model how to write an evidence-based claim comparing 1959 and the most recent year. For example:
    - The year 2018 had more carbon dioxide than the year 1959: the mean and median are both over 90 ppm higher for 2018 than 1959, and these differences are much greater than the yearly ranges of only 4.96–5.71 ppm.
- Prompt students to reflect on the data from their two years of choice, and to write a similar evidence-based comparison of these years in Part B of their *Global Trends Calculation Tracker*.

- Revisit the class *Know and Need to Know* chart, prompting students to consider the connections between carbon sources, carbon dioxide levels in the atmosphere, and global temperatures.

Modification

Step 3: If students are already familiar with selecting, charting, and analyzing data digitally, they may move directly to calculating these statistics using a spreadsheet program, rather than the *Global Trends Calculation Tracker*. If students have less familiarity with digital technology, you may wish to wait until these skills are scaffolded in future lessons within the unit.

Informal Assessment

Informally assess students' ability to calculate mean, median, and range of months within years from carbon dioxide data, and to write evidence-based claims comparing years.

Extending the Learning

Step 1: Students can also read the encyclopedia entry *Mauna Loa Observatory* to gain an additional sense of where and how climate data are collected.

OBJECTIVES

Subjects & Disciplines

Earth Science

- Climatology

Learning Objectives

Students will:

- Analyze an interactive graph to identify short- and long-term trends.
- Write an evidence-based claim comparing carbon dioxide levels across years.

Teaching Approach

- Project-based learning

Teaching Methods

- Discussions
- Inquiry
- Reading

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information, Communications, and Technology Literacy
  - Learning and Innovation Skills
    - Communication and Collaboration
  - Life and Career Skills
    - Initiative and Self-Direction
- 21st Century Themes
  - Environmental Literacy
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Applying
- Science and Engineering Practices
  - Analyzing and interpreting data
  - Engaging in argument from evidence
  - Using mathematics and computational thinking

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.RST.6-8.7:**
Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
• **CCSS.ELA-LITERACY.W.7.1.A:**
Introduce claim(s), acknowledge alternate or opposing claims, and organize the reasons and evidence logically.

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 1:**
Patterns
• **MS. Earth and Human Activity:**
MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
• **Science and Engineering Practice 4:**
Analyzing and interpreting data
• **Science and Engineering Practice 5:**
Using mathematics and computational thinking
• **Science and Engineering Practice 7:**
Engaging in argument from evidence

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- Digital copy of *SCRIPPS Atmospheric CO2 data* prepared to share with students in a spreadsheet program.

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per learner, Monitor/screen, Projector

PHYSICAL SPACE

- Classroom
- Computer lab

SETUP

Familiarize yourself with the dataset to be used in this lesson (*SCRIPPS Atmospheric CO_2 data*) before class in preparation to orient and guide students.

GROUPING

- Large-group instruction
- Large-group learning
- Small-group instruction
- Small-group learning

RESOURCES PROVIDED: HANDOUTS & WORKSHEETS

- Global Trends Calculation Tracker

RESOURCES PROVIDED: REFERENCE

- The Keeling Curve

RESOURCES PROVIDED: ARTICLES & PROFILES

- SCRIPPS: The Keeling Curve
- SCRIPPS: Atmospheric CO2 Data

BACKGROUND & VOCABULARY

Background Information

In recent decades, carbon dioxide in Earth's atmosphere rose from approximately 315 to over 400 parts per million. The famous graph depicting this increase is called the Keeling Curve, after Charles David Keeling. Dr. Keeling began measuring carbon dioxide concentrations in 1958 at an observatory in Hawaii, and these measurements have continued to this day. Although yearly fluctuations in carbon dioxide concentrations occur as a result of photosynthesis by Earth's large northern forests, the overall trend shows a marked positive slope.

Mean, median, and range are numbers used to summarize information about groups of observations; for this reason, they are called 'descriptive statistics.' To calculate the mean, divide the sum of all observations in a list by the number of observations. To find the median, choose the middle observation in an ordered list, or average the two middle observations if there are an even number of observations. To calculate the range, subtract the smallest observation in a list from the largest. These three descriptive statistics are useful for working with large amounts of data, in particular, to describe and compare the average observation or the spread of observations in two groups.

Prior Knowledge

[]

Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
carbon dioxide	*noun*	greenhouse gas produced by animals during respiration and used by plants during photosynthesis. Carbon dioxide is also the byproduct of burning fossil fuels.
carbon sink	*noun*	area or ecosystem that absorbs more carbon dioxide than it releases.
carbon source	*noun*	process, area, or ecosystem that releases more carbon dioxide than it absorbs.
climate change	*noun*	gradual changes in all the interconnected weather elements on our planet.
global warming	*noun*	increase in the average temperature of the Earth's air and oceans.
Keeling curve	*adjective*	graph illustrating the amount of carbon dioxide (CO_2) in Earth's atmosphere as measured at the Mauna Loa Observatory in Hawaii.
mean	*noun*	mathematical value between the two extremes of a set of numbers. Also called the average.
median	*adjective*	situated in the middle.
range	*noun*	difference between the smallest and largest value in a set of numbers.

For Further Exploration

Instructional Content

- National Geographic: Resource Library: Collection: Climate
- National Geographic: Resource Library: Collection: Climate Change