

Activity 2.2: Expert Group B Worksheet

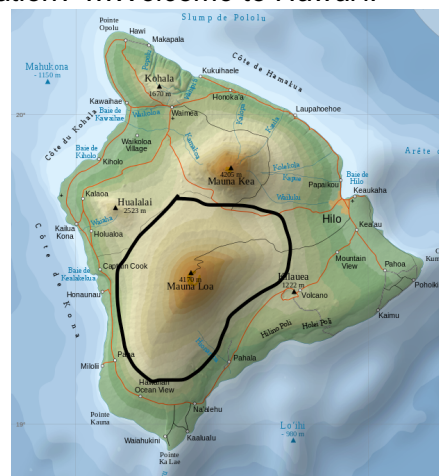
In your expert group, complete each task answer the questions related to each task. In the next activity, you will explain your phenomenon to your home group members. Be sure to ask questions about anything you don't understand about your phenomenon.

☐ Task A: Read about the Phenomenon: The CO₂ Trend Line

- a. *What is atmospheric CO₂ concentration?* Gas concentrations are measured in units called parts per million (ppm), which means out of a million molecules of air how many are a particular gas, such as CO₂. So, if the CO₂ concentration of the air is about 400 ppm, that means that out of a million molecules of air, 400 of them are CO₂.

- b. *How do we measure today's atmospheric CO₂ concentration? ...Welcome to Hawai'i!*

- Watch just the first 1:20 in this video (know that when the speaker says "Noah" he is referring to NOAA, the National Oceanic and Atmospheric Administration, the government agency that monitors the ocean and the atmosphere): <https://youtu.be/3jOAIC2dVtA>.
- Mauna Loa is a mountain on the main island of Hawaii where the facility in the video has been measuring atmospheric CO₂ continuously for 60 years. CO₂ **measurements from Mauna Loa are representative of the Northern hemisphere** for two reasons: 1) It is far from large continents and very high above the earth, so the air there is not affected by local sources of CO₂, which would make the measurements less representative of a larger area; and 2) Because of global air circulation the air within the northern hemisphere (same is true for southern hemisphere) mixes together every 1-2 months making one location representative of other locations in the hemisphere.



Hawai'i's main island with Mauna Loa circled in black. From Wikimedia Commons https://commons.wikimedia.org/wiki/File%3AHawaii_Island_topographic_map-fr.svg

- c. *How do we know what the CO₂ concentrations were in the past? ...Use ice to time travel!*
- As snow falls, air is trapped in spaces within the snow. Over time, more snow weighs down the older, deeper snow, compacting it into distinct layers of ice that maintain the trapped air in bubbles. Scientists drill cores out of the ice to understand the ancient climate. Most of these ice cores are from Antarctica, Greenland, and glaciers worldwide.
 - Using ice cores, scientists can measure the concentration of CO₂ and other gases in the trapped air bubbles as far back as 400,000 years. Watch this video on ice cores <https://youtu.be/oHzADI-XID8>.
- d. *Why is the atmospheric CO₂ concentration important?*
- Well, investigators, this one is on you to figure out as you learn more about the greenhouse effect in the next lesson!

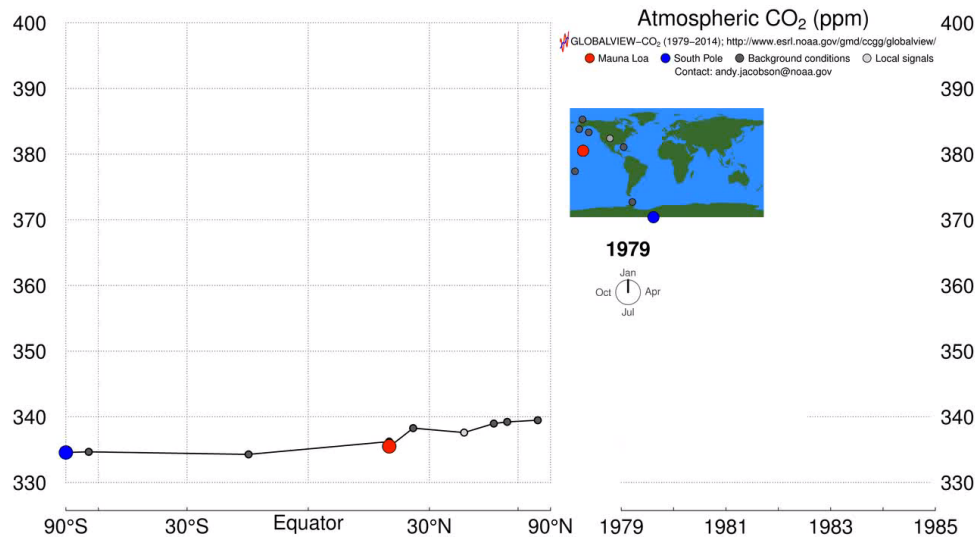
☐ Task B: Watch the first half of a pumphandle video about the CO₂ concentrations in the atmosphere over the last 50 years (from 0:00 until 02:11). Then answer the questions below. <http://www.esrl.noaa.gov/gmd/ccgg/trends/history.html>



Look For: When you are watching the pumphandle video, pay attention to these things:

1. *The graph on the left:* This will show CO₂ concentrations taken at different scientific field stations around the planet.
2. *The graph on the right:* This will show the data from just two field stations: Hawaii (which represents the Northern Hemisphere) and Antarctica (which represents the Southern Hemisphere).
3. *The picture of the earth:* This will show you the major scientific field stations where the data were collected. Note the colors match the colors in the graph on the left.
4. *The date:* Note the date and month change in the first half of the video.
5. *The time scale:* The first half of the video will show data between 1979-2014.

Figure 1: The First Half of the Pumphandle Video



The scale on the left (y-axis) represents parts per million (ppm) of CO₂ in the atmosphere. One ppm of CO₂ means that if you had one million grams (1000 kg) of well-mixed atmospheric gases, one gram would be CO₂.

Questions: Answer these questions about the first half of the pumphandle video.

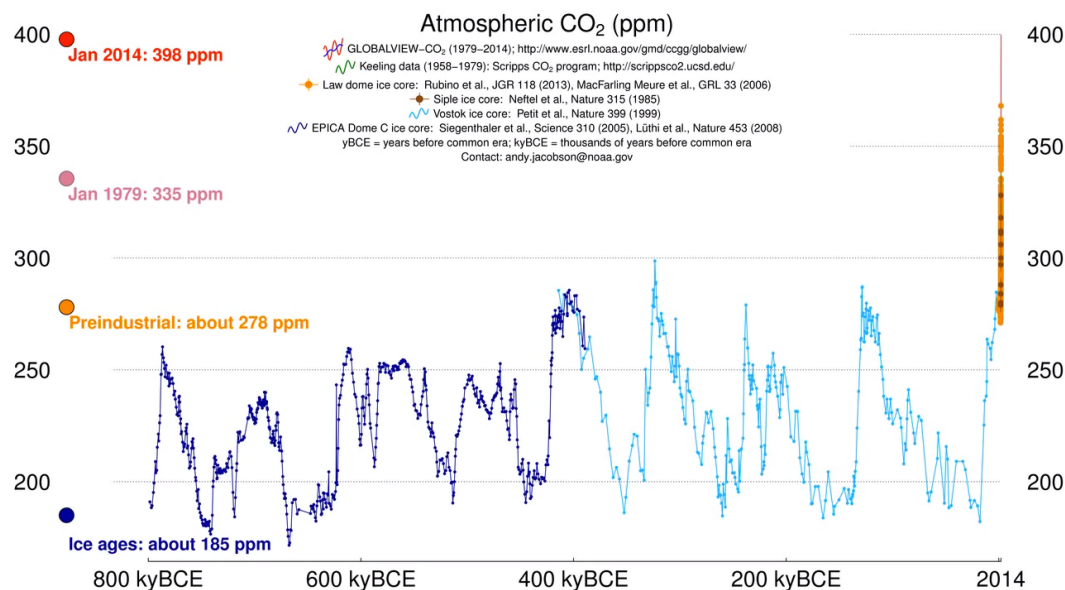
1. What is the video showing?

2. What do the red, blue, and grey dots represent?

3. What questions do you have about the video or the data it represents?

☐ **Task C:** Watch the second half of the pumphandle video (from 02:11 until the end) and answer the questions below.

Figure 2: The Second Half of the Pumphandle Video



Look For: When you are watching the second half of the pumphandle video, pay attention to these things:

1. *The graph:* This will show concentrations of CO₂ levels from very far in the past that scientists know from analyzing ice that is drilled out of the Antarctic.
2. *The data sources:* The key at the top of the screen (in tiny letters) will tell you which research produced the data for each section of the graph.
3. *The time scale:* The second half of the video will show data between 800,000 years ago until 2014.

Questions: Answer these questions about the second half of the pumphandle video.

4. What do you notice about atmospheric CO₂ over the past 800,000 years?

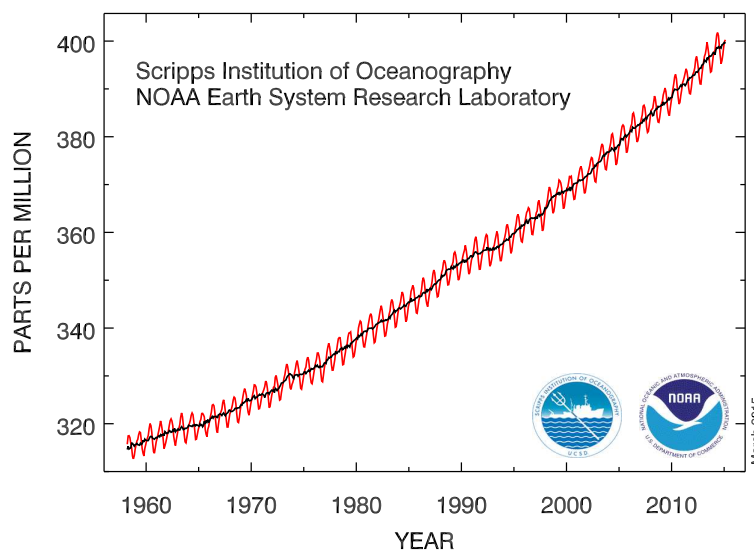
5. What do you notice about the atmospheric CO₂ over the past 100 years?

6. What is the highest atmospheric CO₂ concentration recorded in the last 800,000 years?
(approximately) _____ppm

7. In what year was this recorded? _____

☐ **Task D:** Interpret a graph about atmospheric CO₂ from 1960-2014 (the “Keeling Curve”)
To simplify things a bit, we are going to focus on data collected at one point on the earth (the red dot in the video). Mauna Loa is a mountain in Hawaii where a facility for measuring atmospheric CO₂ has been continuously collecting data since 1958. Everyday scientists send a balloon into the atmosphere to measure CO₂ levels. The graph below shows the monthly atmospheric CO₂ concentration (red line). The black line represents the yearly average.

Figure 3: The Keeling Curve (Atmospheric CO₂ in Hawaii)¹



Questions: Answer these questions about the “Keeling Curve.”

8. Circle the data in the graph in Figure 2 that corresponds with the data in Figure 3.

9. What was the approximate concentration of CO₂ in the atmosphere in 1960? _____ppm

¹ Credit: Dr. Pieter Tans, NOAA/ESRL (www.esrl.noaa.gov/gmd/ccgg/trends/) and Dr. Ralph Keeling, Scripps Institution of Oceanography (scrippsco2.ucsd.edu/).

Circle this point on the graph.

10. What was the approximate concentration of CO₂ in the atmosphere in 2000? _____ppm
Circle this point on the graph.

11. The jagged (red) line represents the monthly CO₂ concentrations in the atmosphere. These go up each winter and down each summer in the northern hemisphere. This shows us the short-term variation. But what does the smoother black line show us?

12. What is the approximate highest atmospheric CO₂ concentration recorded so far at Mauna Loa? _____ppm

13. In what year was this recorded? _____

☐ **Task D:** Complete the charts below. Discuss anything you don't understand with your group or teacher. Use this to explain your phenomenon to your home group.

Representation

	What variables are represented?	Which part(s) of the Earth are represented?	What time period is represented?
Pumphandle Video			
CO ₂ graph from Mauna Loa			

Generalizability

What information does the video tell us that the graph (Figure 3) leaves out?	What does the graph (Figure 3) tell us that the video leaves out?	Which of Earth's regions are included?	What does this data tell you about global patterns?

Short-Term Variability vs Long-Term Trends

Describe the short-term variability in the data. Is it predictable or unpredictable?	Describe the long-term trend in the data. Is it predictable or unpredictable?