**Graph analysis lesson 1- CO2 measurements at Baring Head and Mauna Loa**

**5 mins intro Rally chart:**

In partners write quick-fire 1 or 2 words at a time about Climate Change. Three minutes total, get as many words as possible to beat neighbouring group.

Share ideas – hopefully CO2 / greenhouse gases / temperature increase / fossil fuels will be common thread. Relate to current learning about compounds, prior learning on gases, combustion.

**5 mins background:**

Coming up in Social Studies you will look at Climate Change. This will match nicely with a number of or Science Capabilities – especially ‘Engaging with Science’.

Here’s a great example of how scientists ‘Gather and Interpret Data’ – measuring atmospheric CO2 in NZ – just around the corner at Baring Head!

**10 minutes Thin Ice video clip:** [Measuring CO2 at Baring Head, Wellington, New Zealand](http://thiniceclimate.org/blog/details/1830/measuring-atmospheric-gases-baring-head-new-zealand)

**5 minutes intro to graph activity:**

One Science Capabilities focus for this topic (Particles) is ‘Interpreting Representations’. Partly that has been about using conceptual model of particle nature of matter, partly about interpreting graphs.

Talk through graphs of CO2 record from Baring Head: <https://www.niwa.co.nz/atmosphere/our-data/trace-gas-plots/carbon-dioxide> for CO2 (and methane) data collected from Baring Head and Arrival Heights, Antarctica.

**25 minutes graph interpretation activity 1:**

Complete page one in groups of 3.

Extension questions for fast finishers:

* What **processes** do you know of that ‘**use up**’ CO2?
* What **processes** do you know of that **release** CO2?
* What **percentage** is 350ppm equal to?
* **Compare** and **contrast** atmospheric CO2 and air (describe the similarities and differences).

**5 minutes review of answers.**

Determine difference between seasonal variation and average/overall CO2­ trend, including accelerating rate of increase.

Identify the seasonal variation and discuss possible reasons for such regular variation.

**5 minutes review Rally chart:**

**Additional/follow-up CER activity:**

Use Claim/Evidence/Reasoning template with graph of atmospheric CO2 at Baring Head / Mauna Loa / Arrival Heights, Antarctica

How many of your words were covered in the activity/video?

2 minutes to add any new words to chart.

**Graph analysis lesson 2 - CO2 measurements around the world**

**5 mins intro:**

Review seasonal pattern identified in Mauna Loa data. Identify calendar timing of Northern Hemisphere seasons and the relationship with the measured timing of CO2 peaks/troughs.

Overview of possible reasons for variations in CO2. Relate to processes that use up or release CO2 *(Examples identified with trial class included increased use of electricity, increased combustion of fuels, photosynthesis and growth of plants, release of CO2 from melting ice)*.

**25 mins graph interpretation activity 2:**

Shuffle groups of three (spread out students from groups that had correct ideas during activity 1).

Complete questions on second activity with data from four locations. Encourage students to focus on questions 4 and 5 to draw out differences in range of CO2 variation between Northern and Southern Hemisphere records and seasonal timings of peaks and troughs.

**10 minutes review of answers:**

Discuss increased photosynthesis during spring, reducing concentration of CO2 in atmosphere and decreased photosynthesis during autumn. South Pole record has opposite phase due to opposite seasons (note that Samoa matches Northern Hemisphere seasons, but less variation).

Discuss Northern Hemisphere having greater variation due to greater total landmass and greater plant cover so greater effect of photosynthesis.

So why does South Pole show any variation at all, given the lack of land-based planet life in Antarctica and limited plant cover in lower Southern Hemisphere? *(one student offered idea of phytoplankton)*.

**NOTE:** students probably have some prior knowledge of photosynthesis, but hopefully at least have idea of plants ‘using up’ carbon dioxide and producing oxygen.

**6 minutes Thin Ice video clip:** Voyage to the Southern Ocean - Part 6: Oceans and CO2

<http://thiniceclimate.org/blog/details/2020/voyage-to-the-southern-ocean-part-6-oceans-and-co2>

**4 minutes Thin Ice video clip:** Voyage to the Southern Ocean - Part 7: Forests of the Ocean

<http://thiniceclimate.org/blog/details/2021/voyage-to-the-southern-ocean-part-7-forests-of-the-ocean>

**5 minutes summary:**

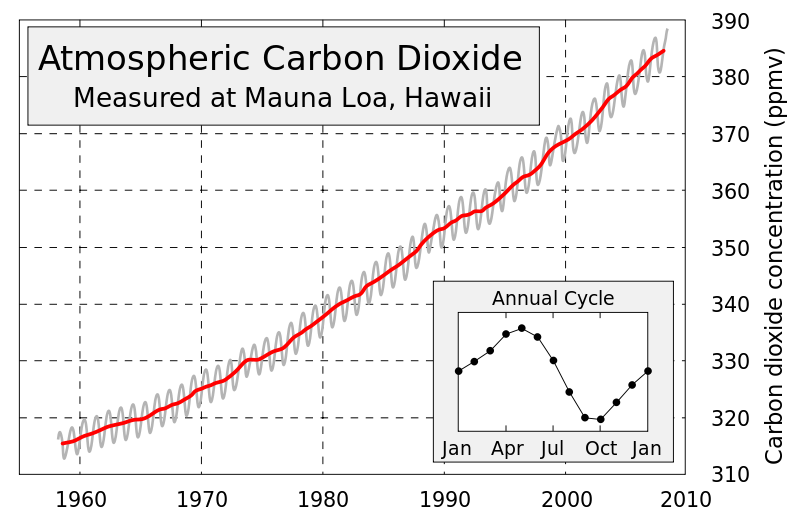
Write a summary paragraph identifying the key reasons why CO2 shows seasonal variation and the different organisms responsible for this.

**NOTE**: Could use CER format for this.

**Additional/follow-up CER activity:**

Use Claim/Evidence/Reasoning template with graph of atmospheric CO2 at differing locations.

**Interpreting representations: CO2 Graphs #1**



Graph sourced from: <https://www.skepticalscience.com/warming-co2-rise.htm>

**Questions:**

1. Write a sentence that describes the **general** (overall) pattern shown for the measurements on the main graph.
   * ‘ppmv’ means ‘parts per million by volume’

On the main graph there are two lines; the grey line and the bold/red line.

1. Make lists of **differences** and **similarities** that you identify between the lines.
2. Why do you think there are two different lines?

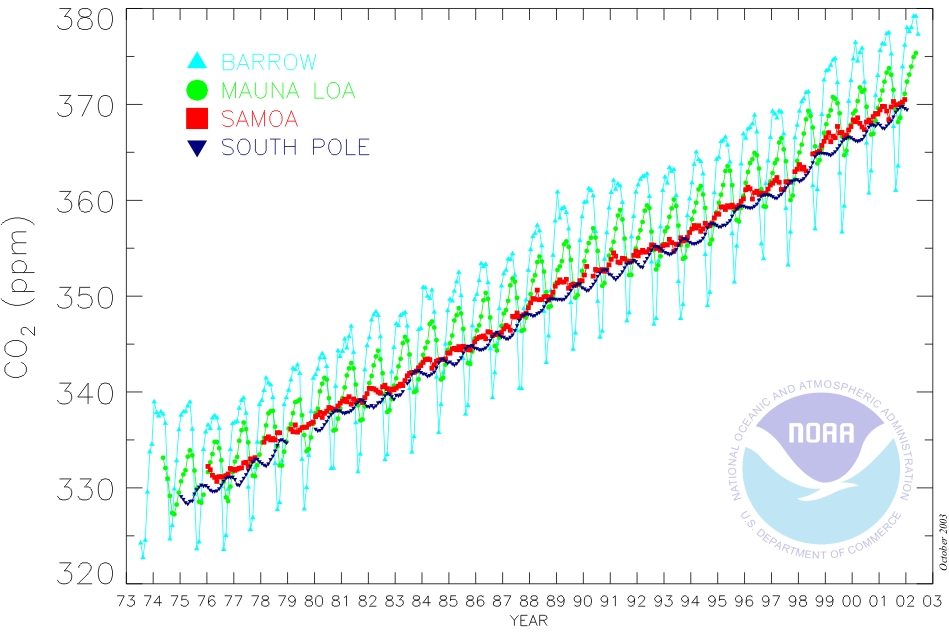
**Names**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

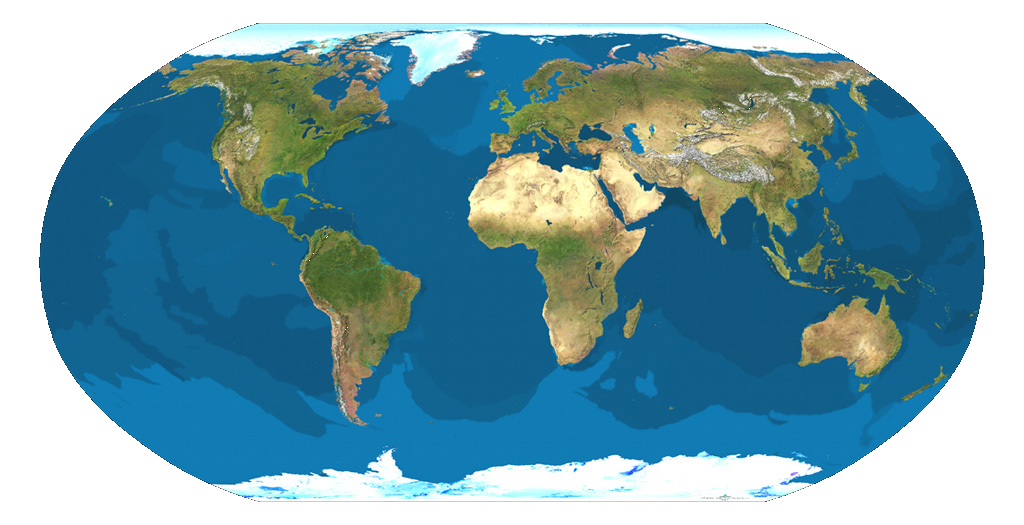
The wavy line has **peaks** (high points) and **troughs** (low points).

1. Label one peak and one trough on the graph.
2. How many peaks are there between 1960 and 1970?
3. How many troughs are there between 1980 and 1990?

There is a small graph **inset** titled ‘Annual Cycle’

1. What does this inset graph show?
2. Why is it included? (What does it show more clearly than the main graph?)
3. What happens to CO2 levels over this regular annual cycle?
4. Why do you think this might happen?

**Interpreting representations: CO2 Graphs #2**



**Questions**:

Graph sourced from: <http://www.co2.ulg.ac.be/objects/mangroves_co2_air.htm>

1. List the **similarities** between this **graph** and the first **graph**.
2. List the **differences** between this **graph** and the first **graph**.
3. What do the four different lines on the graph represent? Use the **map** to help your explanation.

**Names**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Look closely at both the **timing** of the peaks and troughs and the **range** of the variation in CO2 (the difference between the peaks and troughs) of the four lines.

1. What **similarities** can you find between the **different lines** on this graph?
2. What **differences** can you find between the **different lines** on this graph?
3. Why might the patterns for the South Pole data be different compared to the others? (Think about any differences between the Northern and Southern Hemispheres)