Climate Change – The Science: Suggested Projects

Project 1: Climate Stories

Aside from the scientifically rigorous approach to understanding climate past, present, and future, there is the human side of our collective memories and perceptions of the climates in which we live. Weather is a common topic of conversation but beyond the day-to-day, our collective discussions shed light on the ongoing changes in our climate system.

For this project, select someone significantly older than you and ideally someone with a particular interest in weather/climate (e.g. farmers, gardeners, those with a nautical background). Interview them using a list of preformulated questions regarding their own experiences and observations of weather over the years.

Here are some sample questions:

- Describe the overall weather patterns you remember from your early years. How do these differ from the patterns you observe today?

- How have any changes in climate affected you personally or professionally? (Examples might be difficulty growing certain crops as a home or market gardener, dealing with flooding/drought, or simply enduring very wet family holidays.)

- Do you think that weather overall is more difficult to predict now than in previous years?

- Do you recall your parents or grandparents discussing weather? If so, what did they say on the matter?

- Do you think Ireland's climate is more or less stable overall at present than in your youth? Do there seem to be more extreme weather events and do they happen at unusual times (such as gale-force winds in summer)?

Encourage the subject to give years (exact or broad ranges) for the weather events or trends they mention.

Synthesise: Write up a summary of the interview (taking an audio recording along with notes may prove helpful) to share with your class. In addition to this text, look up cited years/weather events online (Met Eireann's database is a good starting point) to find specific data to enhance the narrative. Compare climate stories with your classmates, noting time frames and locations, and see how well they correlate to the relevant meteorological statistics. How do these personal stories augment the science?

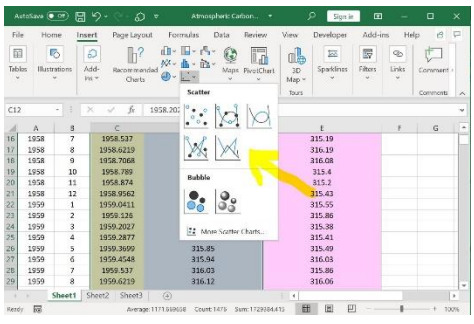
Project 2: Exploring the rise and fall (and rise) of atmospheric CO_2

As we can see from palaeoclimate 'proxies' such as ice cores, atmospheric concentrations of the greenhouse gas carbon dioxide (CO_2) have varied widely over the course of Earth's history. These climate records also reveal that global temperature has fluctuated more or less in synchrony with CO_2. This project can be completed both individually and as groups and will have students plot *actual* climate data on three very different timescales – the last ~60 years, the last 2000 years, and the last 800,000 years – to explore patterns of CO_2 change and put modern emissions into context.

To complete this project, students will need access to the spreadsheet titled '**Atmospheric Carbon Dioxide**' and analytical software such as Microsoft Excel or similar. As students will need to be able to carry out simple functions in Excel, such as plotting a graph, this project is designed for those classes with sufficient technical skill or with an Excel-fluent teacher.

1) Download and open in Excel the Atmospheric Carbon Dioxide dataset from the TY Sustainability Dropbox folder. The dataset file consists of three separate tabs, one for each time period that we shall reconstruct.

2) Open the first tab, titled '**60 yr CO2**'. Scripps Institute of Oceanography in San Diego has measured CO_2 concentrations in the free atmosphere since 1958, from the Mauna Loa summit observatory in Hawai'i. The columns of data given in this tab correspond to all measurements made between March 1958 and August 2019. For this exercise, you will first plot atmospheric CO_2 (Column D; blue) against time (Column C; yellow) to explore *visually* the evolution of carbon dioxide concentration over the last six decades. The measurements in Column D are smoothed data and reported in ppm – or parts per million – referring to the number of molecules of CO_2 per million air molecules. Be sure to use a line graph (see image) for the clearest display:



- **Q.** ***What is the general pattern in CO_2 since 1958?***

Next, plot Seasonally adjusted filled CO_2 (Column E; pink) against time (Column C; yellow). These data are the actual concentrations measured at Mauna Loa each month and have not been smoothed, and so provide a more detailed, monthly view of atmospheric CO_2 variability:

- ***Q. What is the key difference between annual (Column D) and seasonal (column E) plots, and what might be the reason for this difference?***

- ***Q. How much has the concentration of atmospheric CO_2 risen (in ppm) during your own lifetime?***

3) Now open the second tab, titled '**Law Dome_2000 yr**'. This dataset derives from an ice core retrieved from Law Dome in Antarctica and is based upon measurements of CO_2 in tiny bubbles of air trapped in the ice. Because the oldest ice (and thus trapped air) is found at the bottom of the core, our record starts in the year 13 AD and ends in 2006 AD. Using the same plotting tools as in the previous exercise, plot the trend of atmospheric CO_2 (Column C; blue) against time (Column B; yellow) for the last two millennia.

- ***Q. What is the long-term trend in CO_2 concentration over this period?***

- ***Q. When does CO_2 begin to rise above the 'background variability'? In other words, when do we see CO_2 increase towards modern levels?***

4) Finally, open the tab titled '**EPICA CO2**', where you will find two columns of data: Years before present (Column A; yellow) and CO_2 concentration (Column B; blue). These data are derived from the EPICA ice core, a 3270 m-deep core extending back 800,000 years that was extracted from Antarctica by a European consortium between 1996 and 2004. Plot up the data as before and note that the time scale (x-axis) goes the opposite direction from the pervious two exercises; this is because we are looking at years before present. With your new curve in hand, answer the following questions:

- ***Q. What is the long-term pattern? Is this a picture of overall stability or dynamism?***

- ***Q. When was CO_2 last as high as it is today? Pay attention to actual ppm values when you address this question, drawing from your previous CO_2 curves if needed.***

- ***Q. Are modern CO_2 levels likely to be part of a long-term natural cycle?***

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