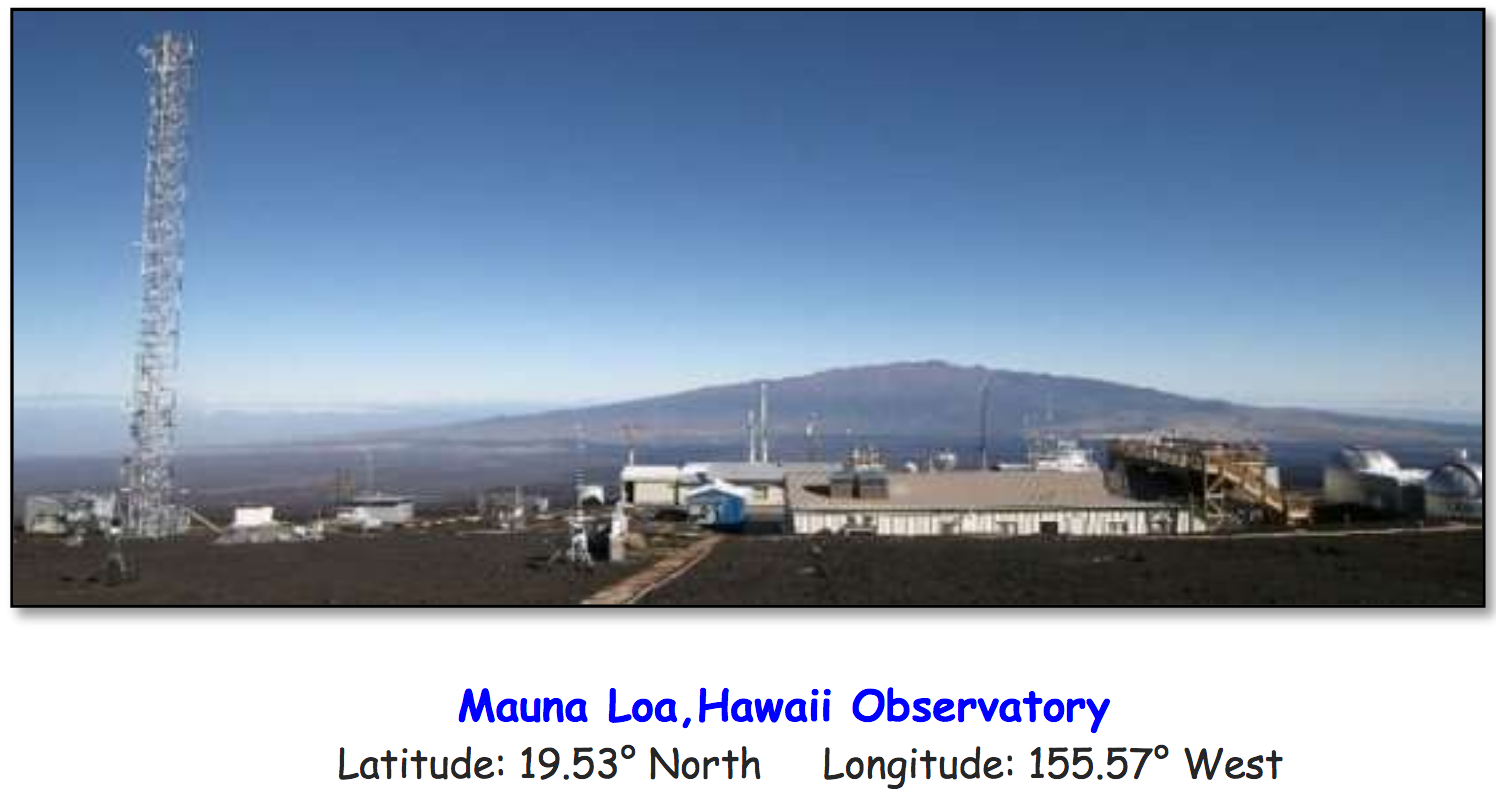
**BIOL101 Biology and Society**

**Understanding Global Climate Change**

**Part I: The Present**

Carbon dioxide is the primary greenhouse gas emitted through human activities, accounting for about 82% of all U.S. greenhouse gas emissions from human activities in 2013.The continuous measurement of changes in atmospheric CO2 concentrations was started in March 1958 at the Mauna Loa Observatory, Hawaii, by Charles David Keeling and has continued and expanded in scope since then.

The Mauna Loa record, now known as the **Keeling Curve**, is the longest continuous record of direct measurements of CO2 and shows a steadily increasing trend from year to year. It is also easy to see the saw-tooth effect caused by changes in the rate of plant growth through the seasons (lower CO2 levels in summer, higher in winter). In May 1974, the National Oceanic and Atmospheric Administration (NOAA) started a global monitoring network to add to the work that Keeling started.The Mauna Loa Observatory today is part of the Earth System Research Laboratory (ESRL), Global Monitoring Division (GMD) in Boulder, CO.

*Mauna Loa Observatory, Hawaii Island, Hawaii. Latitude: 19.53o North; Longitude:155.57o West.* 

Concentrations of CO2 in the atmosphere are increasing at an accelerating rate from decade to decade and research into this trend is ongoing at observatories and research stations around the world. An atmospheric chemist, studying the components of the atmosphere, is dealing with a very tiny number of molecules within a huge sample of air. When researching concentrations of greenhouse gases, scientists will talk about concentrations of CO2 in terms of parts per million (ppm) because the amounts are so small. For example, a concentration of 1 ppm corresponds to 1 part material per 1 million parts of the gas, liquid, or solid it is found in.

While this may not sound like much, the increased concentration of CO2 is so powerful that even a small change in its concentration has caused significant increases in the surface temperature of the planet. The global average surface temperature has increased since 1861 and is due, in large part, to an 85 parts-per-million (ppm) increase in CO2 and a 1-ppm increase in methane (CH4) concentration. These changes are significant and likely to have resulted in the largest temperature change of any century during the past 1,000 years.

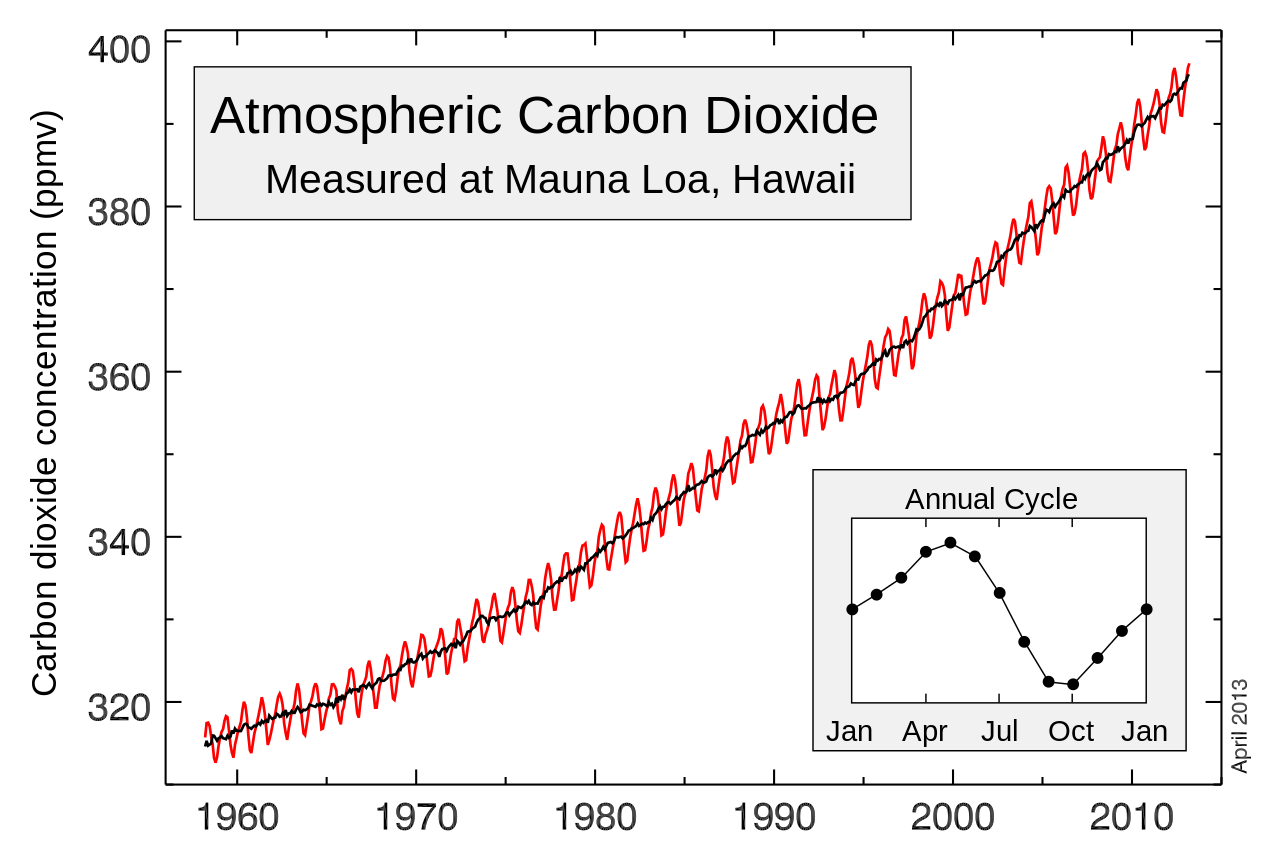
For this exercise, we’ll view this data in real-time on the NOAA Global Monitoring Laboratory website. First, explore the long-term data for CO2 levels from Mauna Loa by clicking on the following link: <https://www.esrl.noaa.gov/gmd/ccgg/trends/mlo.html>. Note that this shows the monthly average from 1958 through the past month. Answer the questions below.

1. Who is responsible for beginning to measure CO2 at Mauna Loa Observatory, beginning in 1958? Who does the recording now?
2. Why do you think the island of Hawaiʻi is one of the more ideal locations for collecting atmospheric CO2 as a model of the concentration for the world?
3. What is the overall trend in CO2 levels in the atmosphere on Mauna Loa since 1958? Is this trend the same when global data that has been averaged across all sampling locations on the planet?
4. What is the current monthly mean? How much has it increased since last year?

We now know the effects of carbon dioxide (CO2) in the atmosphere and its effects on the planet as a whole. Photosynthesis is the sole mechanism by which CO2 in the atmosphere can be converted into organic molecules (glucose) that are available for living organisms to eat and use. Because plant tissues are full of carbon-containing compounds, photosynthesis and growth of plant tissues removes some CO2 from the atmosphere. Other monitoring stations besides Mauna Loa in Hawaii are located in Barrow, Alaska, and the South Pole. Examine the graphs from these two locations in comparison to Mauna Loa below.

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| --- | --- |
| **Location** | **Atmospheric CO2 Trend** |
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1. What is the **overall** trend in CO2 levels in the atmosphere since 1957? Is this trend the same across all sampling locations? Explain. You can also check out current global CO2 levels as averaged across all sites on the planet using the following link (<https://www.esrl.noaa.gov/gmd/ccgg/trends/global.html>) to explore the global monthly mean.
2. If growth of plants removes atmospheric CO2 from the atmosphere, why is there an overall increase in atmospheric CO2 levels? List and describe as many reasons as you can think of.
3. You may have noticed that there is an oscillation (pattern of increase and decrease) in CO2 levels at each of the measuring stations. This oscillation is shown in detail in the figure below. **Does this oscillation vary by region?** Describe the oscillation in each region.



South Pole:

Mauna Loa:

Barrow, AK:

1. What causes this annual cycle?

*Hint: think about WHY the oscillation might vary between the listed regions. What do you know about plant life in each of these areas, particularly in regards to the growing season?*

Next, examine the raw data for the yearly mean from 1959-2019 (60 years), copied into an excel spreadsheet (see Attachment A). Use the mean value, which is measured in ppm (the "unc" is the standard deviation).

1. By what percentage of the total has the concentration of CO2 in the atmosphere increased since 1959?

Explore the weekly data over the past year here: <https://www.esrl.noaa.gov/gmd/ccgg/trends/weekly.html>

1. What is the current weekly value for the week beginning this week? How much has it increased in 10 years?

1. Scroll downward in the data and read about how CO2 levels have changed since pre-industrial times. What CO2 level in ppm is given as the amount of CO2 in pre-industrial times? How do they know it was near this level? By what percentage of the total has that level increased?
2. How does the data collected at Mauna Loa tie in to scientists' recent predictions about climate change and global warming?
3. In light of recent events with the COVID-19 global pandemic, and exploring the reading on the using the link, <https://www.esrl.noaa.gov/gmd/ccgg/covid2.html>. Do scientists expect to see a change in CO2 levels? Why or why not?
4. What lessons have we learned from the COVID-19 pandemic that we could apply to climate change? Explain your reasoning.