
# *Analyzing Greenhouse Gases and Global Temperature Data Over Time*

## Overview

Recent data on the concentrations of various greenhouse gases in Earth's atmosphere will be plotted by the students. They will look for trends in the data.

## Concepts

- Plotting data allows us to more easily see trends in the data.
- In the case of data taken over a period of time, graphs also make it easier to see what might occur in the future.
- The quantities of several greenhouse gases are increasing in our atmosphere. The production of *chlorofluorocarbons* (CFCs) is now decreasing.

## Materials

- Raw Data (attached)
- Pencil
- Graph Paper
- Ruler

## Preparation

Note that students can plot the data by hand or enter it into appropriate computer software, depending upon the desires of the teacher, equipment available, and level of the students.

Divide the class into small research teams and assign each one table of data.

## Procedure

### Engagement

Inform the students that they have been assigned a position in a research institute dealing with global climate issues. A research scientist has just given them some "raw" data regarding *greenhouse gases* in Earth's atmosphere. Within a week there will be a major international conference on global change. The data need to be presented and organized in a meaningful and useful way.

Greenhouse gases allow the Sun's light to pass through them to the surface of Earth, but they also absorb some of the infrared radiation from Earth's surface. This creates an effect similar to that in a greenhouse. Gases, like glass in a greenhouse, help trap heat and keep it from escaping. There is concern over whether increases in these gases are contributing to *global warming*. The first step in investigating this is to determine whether amounts of greenhouse gases in the atmosphere have been increasing.

### Activity

1. Discuss where data come from, types of graphs available, what a trend is, and how to project a trend.
2. For at least one table of data, have the students plot the following data points and connect them with a curve. There are four different graphs, therefore make sure that all four are assigned so that each can be discussed.
3. Upon completion of the graph(s) have the students project the trend of the curve for another 50 years.

4. Have each group develop a conclusion for their particular chart. Students with the same graph should get together and compare graphs for accuracy and conclusions.
5. Ask for a spokesperson for each graph to report a majority view and a minority view (if one exists) for the data and projected trends.
6. Discuss the role of data analysis in scientific research. How do choices in displaying data, for example as tables of data or as graphs, affect communication?

**Explanation**

The graphs indicate the rising trend of several greenhouse gases, which may or may not contribute to global warming. There is much debate among scientists and policy makers over this issue. Note however the decrease in production of CFCs because of an international agreement to reduce their production. CFCs not only are a greenhouse gas, but more significantly damage the earth's ozone layer which protects us from the Sun's harmful ultraviolet light.

## Extension

The following is an account of one scientist's study of carbon dioxide concentrations in Earth's atmosphere. Students can read this to better understand how he needed to gather data over many decades in order to recognize and document their trend.

Dr. Charles David Keeling was the geochemist at Scripps Institute of Oceanography who first studied atmospheric carbon dioxide ($CO_2$) in the 1950s. He developed the first *manometer* to extract and measure $CO_2$ in parts per million (ppm) and set up a measurement facility on Mauna Loa volcano in Hawaii. Air found there has been well mixed in the atmosphere and thus serves as a good example of global average air.

The first decade of his data showed the $CO_2$ levels to be increasing at a rate of 1 ppm each year. After that, data showed that $CO_2$ levels are increasing at a faster pace - about 1.5 ppm per year. In the last 40 years $CO_2$ levels have increased form 315 ppm to 350 ppm. The trend indicates the amount of $CO_2$ in the earth's atmosphere will likely continue its increase.

The amount of $CO_2$ and other greenhouse gases in the atmosphere is increasing in large part due to human activity. Average global temperatures are also increasing. Is there a connection? It is not totally clear yet, but those who believe there is feel that the amount of $CO_2$ being pumped into the atmosphere from human activities should be reduced.

Discuss with your students the types of changes that can be made to reduce $CO_2$ emissions. What is their county, state, or country doing (if anything) to help? Have the students ask older family members or friends about the impact that reducing CFCs has had on their daily lives. Do they feel changing their lifestyle or spending habits to help reduce $CO_2$ is worthwhile?

## Links to Related CD Activities, Images, and Movies

Activity *Making a Greenhouse*

## Vocabulary

*chlorofluorocarbon (CFC)* *global warming* *greenhouse gas*
*manometer*

## Source

Adapted from Global Climate-Past, Present, and Future, S. Henderson et al. (Eds.), Environmental Protection Agency Report No. EPA/600/R126, pp. 77-89.

**Carbon Dioxide Concentrations**
**(in ppmv*), Mauna Loa, Hawaii**
Atmospheric Greenhouse Affected by Human Activities

| Year | ppmv |
|---|---|
| 1958 | 314.8 |
| 1959 | 316.1 |
| 1960 | 317.0 |
| 1961 | 317.7 |
| 1962 | 318.6 |
| 1963 | 319.1 |
| 1964 | 319.4 |
| 1965 | 320.4 |
| 1966 | 321.1 |
| 1967 | 322.0 |
| 1968 | 322.8 |
| 1969 | 324.2 |
| 1970 | 325.5 |
| 1971 | 326.5 |
| 1972 | 327.6 |
| 1973 | 329.8 |
| 1974 | 330.4 |
| 1975 | 331.0 |
| 1976 | 332.1 |
| 1977 | 333.6 |
| 1978 | 335.2 |
| 1979 | 336.5 |
| 1980 | 338.4 |
| 1981 | 339.5 |
| 1982 | 340.8 |
| 1983 | 342.8 |
| 1984 | 344.3 |
| 1985 | 345.7 |
| 1986 | 346.9 |
| 1987 | 348.6 |
| 1988 | 351.2 |

*ppmv = Parts per million by volume

**Methane Gas Concentration**
Atmospheric Greenhouse Gas Affected
by Human Activities

| Year | ppm* |
|---|---|
| 1850 | 0.90 |
| 1979 | 0.93 |
| 1880 | 0.90 |
| 1892 | 0.88 |
| 1908 | 1.00 |
| 1917 | 1.00 |
| 1918 | 1.02 |
| 1927 | 1.03 |
| 1929 | 1.13 |
| 1940 | 1.12 |
| 1949 | 1.18 |
| 1950 | 1.20 |
| 1955 | 1.26 |
| 1956 | 1.30 |
| 1957 | 1.34 |
| 1958 | 1.35 |
| 1975 | 1.45 |
| 1976 | 1.47 |
| 1977 | 1.50 |
| 1978 | 1.52 |
| 1979 | 1.55 |
| 1980 | 1.56 |
| 1981 | 1.58 |
| 1982 | 1.60 |
| 1983 | 1.60 |
| 1984 | 1.61 |
| 1985 | 1.62 |
| 1986 | 1.63 |
| 1987 | 1.65 |
| 1988 | 1.67 |
| 1989 | 1.69 |
| 1990 | 1.72 |

*ppm = Parts per million
Gaps in the record between 1958-1975.

**CFC (chlorofluorocarbon)[1] Production**
Atmospheric Greenhouse Gas Affected
by Human Activities

| Year | Amount[2] |
|---|---|
| 1955 | 100 |
| 1957 | 120 |
| 1959 | 140 |
| 1961 | 150 |
| 1963 | 150 |
| 1965 | 200 |
| 1967 | 225 |
| 1969 | 290 |
| 1971 | 320 |
| 1973 | 375 |
| 1975 | 350 |
| 1977 | 360 |
| 1979 | 330 |
| 1981 | 325 |
| 1983 | 320 |
| 1985 | 340 |
| 1987 | 300 |
| 1989 | 305 |
| 1991 | 310 |

[1]CFCs include the manufactured gas combinations of chlorine, fluorine, and carbon. These gases were not present in Earth's atmosphere until the 1930's.

[2]Values are in kilotons per year.

**Nitrous Oxide**
Atmospheric Greenhouse Gas Affected by Human Activities

| Year | ppbv* |
|---|---|
| 1750 | 283.0 |
| 1760 | 283.5 |
| 1770 | 284.0 |
| 1780 | 284.5 |
| 1790 | 285.0 |
| 1800 | 285.5 |
| 1810 | 286.0 |
| 1820 | 286.5 |
| 1830 | 287.0 |
| 1840 | 287.5 |
| 1850 | 288.0 |
| 1860 | 288.5 |
| 1870 | 289.0 |
| 1880 | 289.5 |
| 1890 | 290.0 |
| 1900 | 291.0 |
| 1910 | 292.0 |
| 1920 | 292.5 |
| 1930 | 293.0 |
| 1940 | 294.0 |
| 1950 | 295.0 |
| 1960 | 297.0 |
| 1970 | 299.0 |
| 1980 | 305.0 |
| 1990 | 310.0 |

*Parts per billion by volume (ppbv).