Using Proxy Data: Ice Cores and Past Temperatures

Background Information: Scientists who study the environment often want to know what the Earth was like in the past. Often the information that they seek is from times far more distant than the written record covers. Because no recorded data exists from the distant past for measurements like temperature and precipitation, scientists use what are known as proxy records. These are indirect methods for estimating climatic conditions of the distant past. Some common proxy records that help paleoclimatologists infer the climatic conditions of the past are tree rings, layers of ocean sediments, pollen, and ice cores. In this investigation, we will be looking at how scientists use the ratio of oxygen-18 to oxygen-16 in ice core samples to determine past temperatures.

In this investigation, you will be working with oxygen isotope data collected from twenty sites in Greenland that has been statistically averaged through a process known as Principal Component (PC) analysis. You will be creating a graph of this data compared to average temperature data collected in that region. Both the ice core and temperature data represent conditions in the winter season (November-April) for the years 1829-1970.

Procedures

1.   Using Excel and the data set provided, create a **straight marked scatter chart** of temperature vs. time, where temperature is the dependent variable. Make sure to give the graph a title and properly label each axis.

2.   Examine your completed graph of temperature vs. time to see if there are predictable or repeatable patterns.

3.   Now insert a trendline. Does the trendline indicate a long-term pattern in the temperature vs. time data? Explain.

4.   Create a second **straight marked scatter chart** using PC1 (Oxygen-18 isotope ratios) vs. time and add a trendline. Make sure that PC1 is your dependent variable.

5.   Is there a long-term pattern in the PC1 vs. time data? Explain.

6.   Now look at both graphs. What similarities and/or differences do you see in temperature and Oxygen-18 ratios in the ice core data over time? Does the data indicate that a relationship exists between temperature and Oxygen-18 ratios in the ice

cores? Remember, the smaller the PC1 value, the lower the ratio of Oxygen-18 to Oxygen-16.

7.   Finally, create a **marked scatter chart** using PC1 data as your dependent variable and temperature as your independent variable. Insert a trendline with the R^2 value. To see if a correlation exists, take the square root of the R^2 value. The closer this value is to 1, the stronger the correlation between PC1 and temperature.

Analysis Questions

1. Look at the first two line charts that you created.

    a) What 3 years had the lowest recorded average temperatures?

    b) What 3 years had the lowest PC1 values?

    c) Based on your answers to 1a and 1b and the observed trendlines for both charts, does there seem to be a relationship between temperature and the ratio of Oxygen-18 to Oxygen-16 in the ice sample (again, remember that the lower the PC1 value, the lower the Oxygen-18 to Oxygen-16 ratio)?

2. Look at the scatter chart you created.

    a) As temperatures increase, what happens to the ratio of Oxygen-18 to Oxygen-16?

    b) Explain why temperature would have an impact on the ratio of Oxygen-18 to Oxygen-16 present in the ice core samples.