44.5C: Evidence of Global Climate Change

Global climate change can be understood by analyzing past historical climate data, such as atmospheric CO₂ concentrations in ice cores.

Learning Objectives

• Evaluate the evidence for global climate change

Key Points

• Climate change can be understood by approaching three areas of study: (1) current and past global climate change, (2) causes of past and present-day global climate change, and (3) ancient and current results of climate change.
• Since we cannot go back in time to directly measure climatic variables, such as average temperature and precipitation, we must rely on historical evidence of earth’s past climate, such as Antarctic ice cores.
• Three significant temperature anomalies, or irregularities, have occurred in the last 2000 years: the Medieval Climate Anomaly (or the Medieval Warm Period), the Little Ice Age, and the Industrial Era.
• With the beginning of the Industrial Era, atmospheric carbon dioxide began to rise.

Key Terms

• **fossil fuel**: any fuel derived from hydrocarbon deposits such as coal, petroleum, natural gas, and, to some extent, peat; these fuels are irreplaceable; their burning generates the greenhouse gas carbon dioxide
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Figure \(\PageIndex{1}\): **Measuring historical climate change**: By measuring the amount of CO2 trapped in ice, scientists can determine past atmospheric CO2 concentrations. Temperatures relative to the present are determined from the amount of deuterium (an isotope of hydrogen) present.

Climate change can be understood by approaching three areas of study: (1) evidence of current and past global climate change, (2) causes of past and present-day global climate change, and (3) ancient and current results of climate change.

It is helpful to keep these three different aspects of climate change clearly separated when consuming media reports about global climate change. It is common for reports and discussions about global climate change to confuse the data showing that earth’s climate is changing with the factors that drive this climate change.

Evidence for Global Climate Change

Since scientists cannot go back in time to directly measure climatic variables, such as average temperature and precipitation, they must, instead, indirectly measure temperature. To do this, scientists rely on historical evidence of
Earth’s past climates.

Antarctic ice cores are a key example of such evidence. These ice cores are samples of polar ice obtained by means of drills that reach thousands of meters into ice sheets or high mountain glaciers. Viewing the ice cores is like traveling backwards through time; the deeper the sample, the earlier the time period. Trapped within the ice are bubbles of air and other biological evidence that can reveal temperature and carbon dioxide data. Antarctic ice cores have been collected and analyzed to indirectly estimate the temperature of the earth over the past 400,000 years.

Before the late 1800s, the earth had been as much as 9°C cooler and about 3°C warmer. Atmospheric concentration of carbon dioxide also rose and fell in periodic cycles; note the relationship between carbon dioxide concentration and temperature. Carbon dioxide levels in the atmosphere have historically cycled between 180 and 300 parts per million (ppm) by volume.

Figure \( \PageIndex{1} \): Climate change and the Industrial Era: The atmospheric concentration of CO2 has risen steadily since the beginning of industrialization. The Industrial Revolution, which began around 1750, was characterized by changes in much of human society. Advances in agriculture increased the food supply, which improved the standard of living for people in Europe and the United States. New technologies were invented, providing jobs and cheaper goods. These new technologies were powered using fossil fuels, especially coal. The Industrial Revolution in the early nineteenth century ushered in the beginning of the Industrial Era, a period when atmospheric carbon dioxide began to rise. When a fossil fuel is burned, carbon dioxide is released.

Two significant temperature anomalies, or irregularities, have occurred in the last 2000 years. These are the Medieval Climate Anomaly (or the Medieval Warm Period) and the Little Ice Age. A third temperature anomaly aligns with the Industrial Era. The Medieval Climate Anomaly occurred between 900 and 1300 AD. During this time period, many climate scientists think that slightly-warmer conditions prevailed in many parts of the world; the higher-than-average temperature changes varied between 0.10 °C and 0.20 °C above the norm. Although 0.10 °C does not seem large enough to produce any noticeable change, it did free seas of ice. Because of this warming, the Vikings were able to colonize Greenland.

The Little Ice Age was a cold period that occurred between 1550 AD and 1850 AD. During this time, a slight cooling of a little less than 1 °C was observed in North America, Europe, and possibly other areas of the world. This 1 °C change is a seemingly-small deviation in temperature (as was observed during the Medieval Climate Anomaly); however, it also
resulted in noticeable changes. Historical accounts reveal a time of exceptionally-harsh winters with much snow and frost.