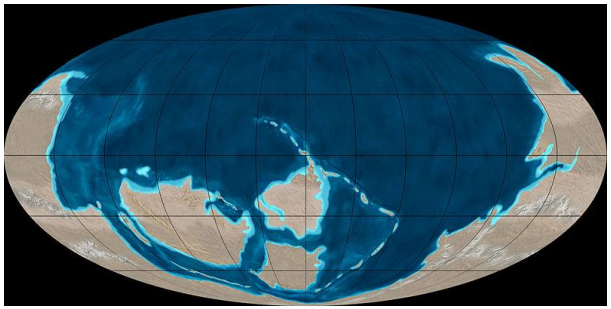
Global Paleogeography

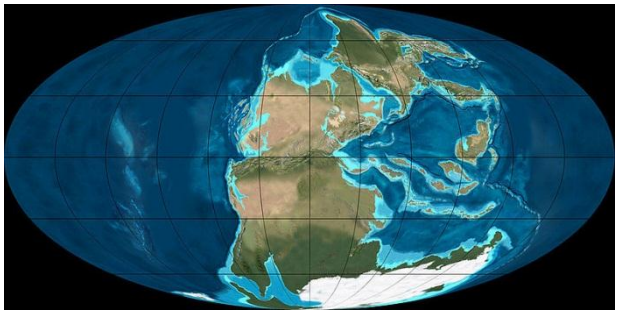
Overview of Global Paleogeography

Paleogeography is the study of how the Earth's geography has changed during the course of history. Using geological data, scientists reconstruct how the continents formed and broke apart. Using visual representations of the data—like the ones below—scientists can see how the Earth's surface has shaped itself over many millions of years.



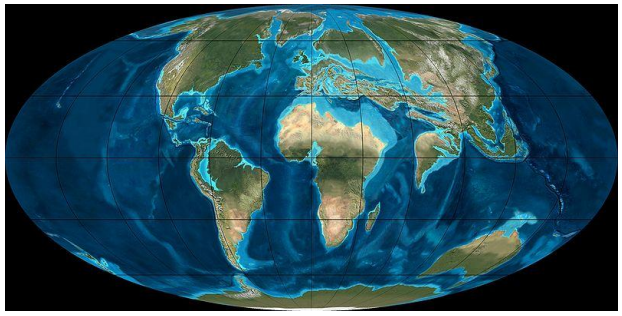
Early Cambrian period

540 million years ago



Late Permian period

260 million years ago



Eocene period

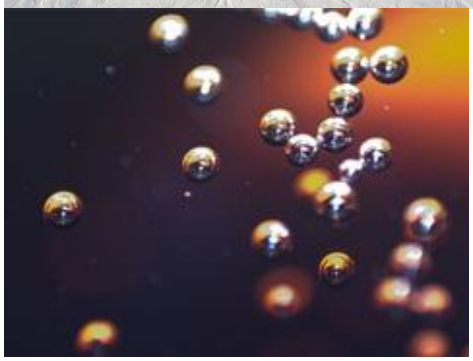
50 million years ago

Climate Changes Through Earth's History

As continents shifted, the global climate varied as well. Geological data can also reveal that there were changes in temperature, ice cover, and carbon dioxide concentrations throughout the history of our planet.

Temperature: The Earth has had periods in the past that were really cold and other times that were really hot, but the oceans never completely froze, nor did they ever boil away.

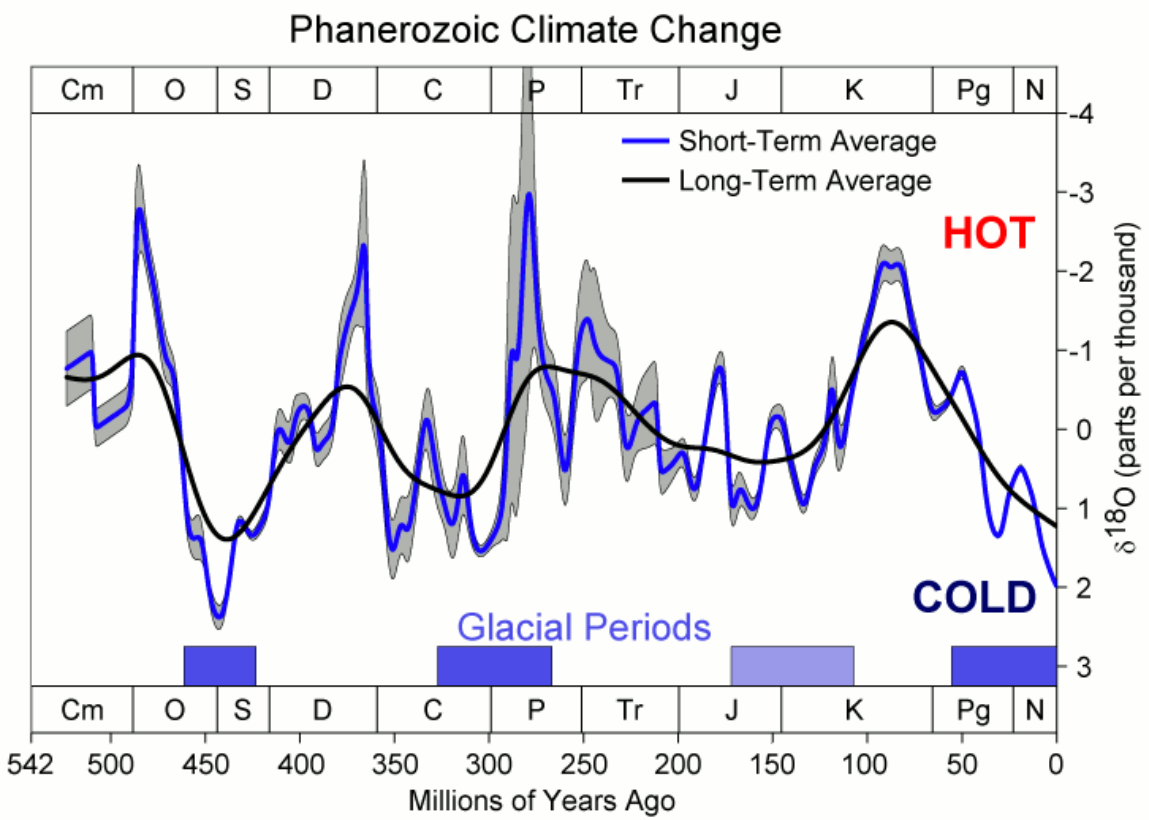
Ice Cover: The amount of ice covering the planet has increased and decreased throughout history.



Carbon Dioxide: The concentration of carbon dioxide in Earth's atmosphere has cycled between low levels and high levels.

Historical Look at Temperature Changes

Throughout time, the average temperature of the global climate has oscillated between warm and cold as compared to today's average temperature (plotted as 0 $\delta^{18}O$ on the graph axis below).



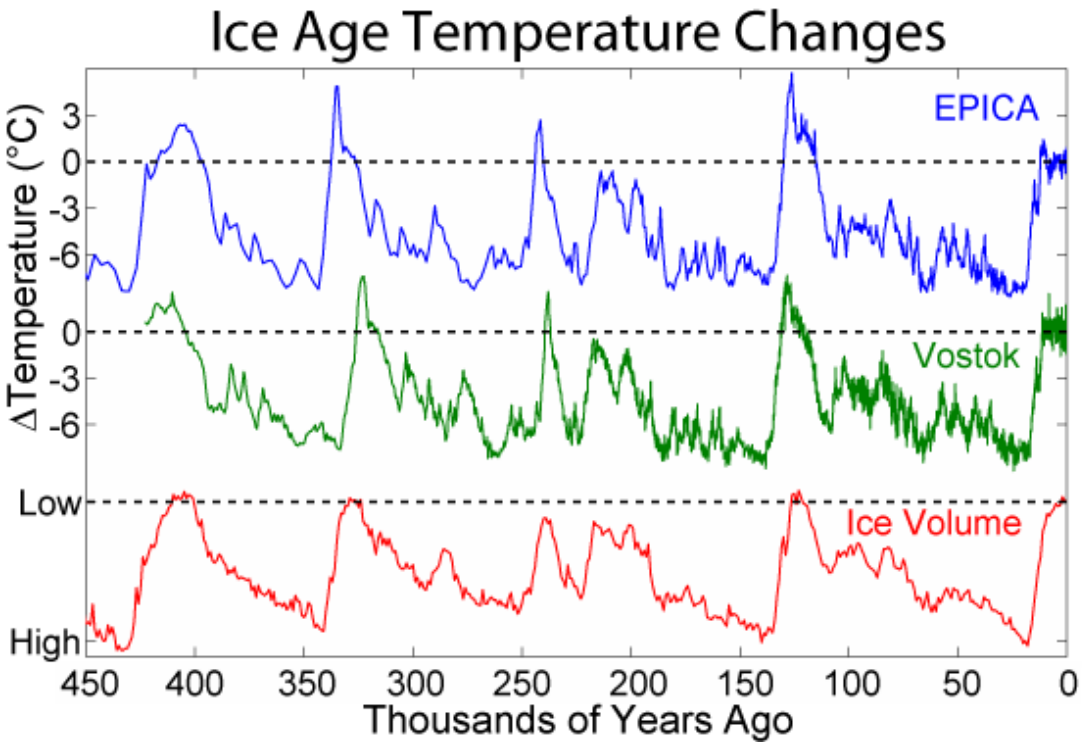
Notice how the blue line spikes up on the chart. The global average temperature was hot during these times. There was probably little or no ice cover. When it spikes down, it was colder, and there may have been much ice cover.

Notice how the black line goes up and down less extremely than the blue line. This is an average of temperature over a longer time period than the blue line so it smooths out the spikes.

Notice the blue bars near the bottom of the chart designating glacial periods. The average temperature was very cold during these times with a lot of ice cover around the globe

Historical Look at Ice Cover Changes

As the average global temperature gets colder, the ice sheets cover more of the planet. These periods are scientifically termed glaciations. Glaciations have repeatedly occurred in Earth's history. It requires only a temperature change of 5-10˚C to advance the world into a full ice age.



The top two lines show information recovered from ice cores collected from Antarctica.

The blue line represents EPICA which stands for the European Project for Ice Coring in Antarctica.

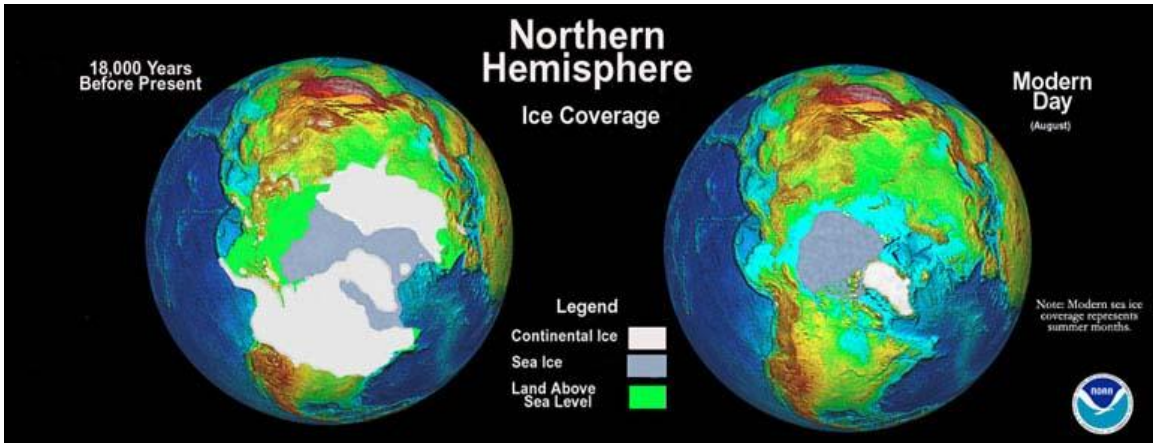
The green line is data from the Russian Antarctic research station called Vostok.

The red line is data about global ice volume derived from sediment cores.

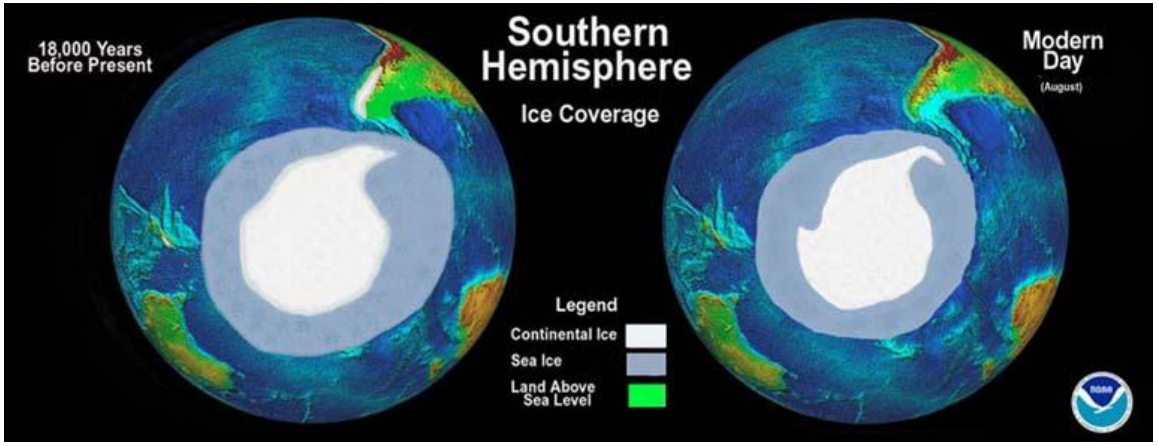
Notice the similarities between all three lines. Ice volume—or, in other words, ice cover—is low when temperatures are high. Ice volume is high when temperatures are low.

Recent Changes in Ice Cover

In geological terms, it does not take long to see significant changes in ice cover on Earth. Eighteen thousand years ago was the peak of the last ice age. Now, in the modern era, we are in a warm period between glacial advances.



Ice sheets used to stretch down and cover most of Canada and some of the United States (left image). In Europe, northern Germany and Poland were covered by ice.



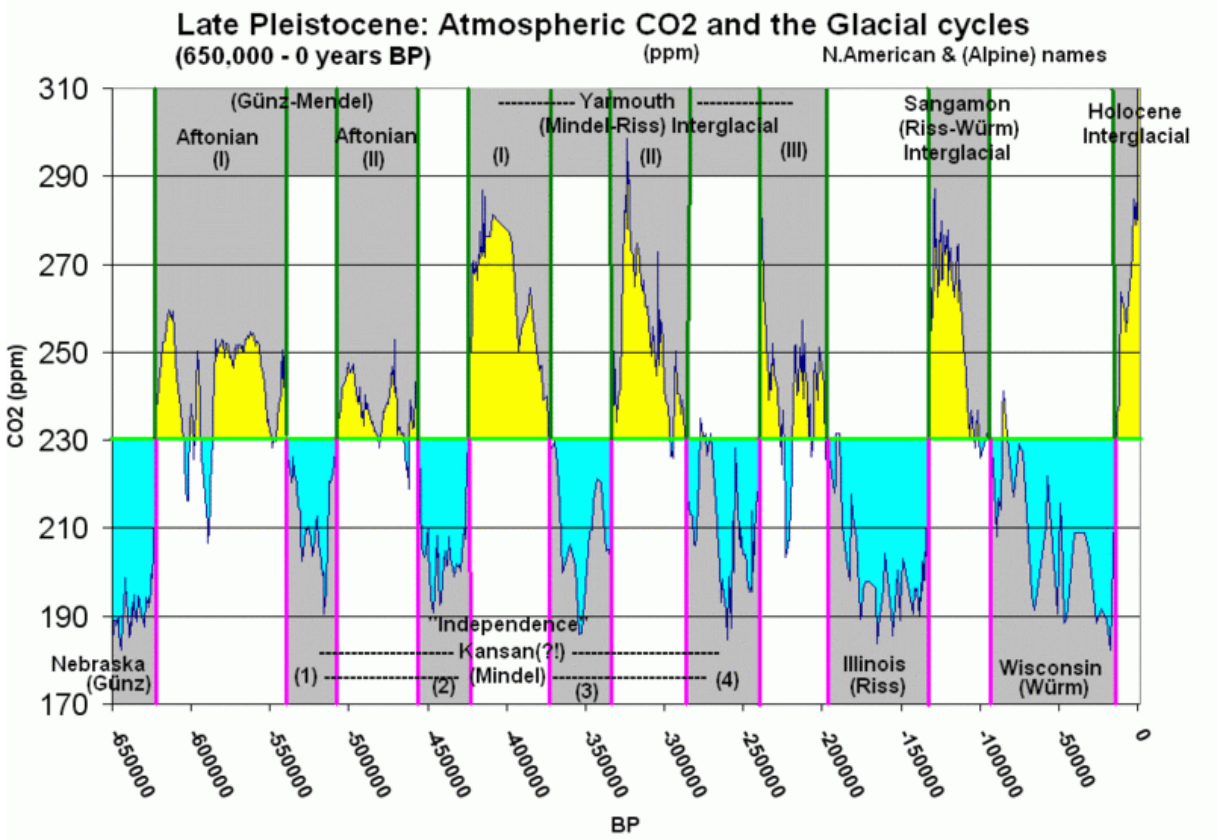
18,000 years ago (recent in geologic terms) Antarctica was covered by ice sheets up to four kilometers thick!

Historical Look at Changes in Carbon Dioxide Concentrations

When there is extensive ice cover, the earth's albedo effect is high. The ice reflects radiation back into the atmosphere. The more ice that reflects radiation, the colder it gets, so more ice forms, reflecting even more radiation. This is called a "positive feedback".

Cold water can dissolve more CO_2 than warm water (think of opening a can of warm vs. cold soda), so when the global temperature is cold, there is less atmospheric carbon dioxide because the ocean soaks it up. This is another positive feedback.

Positive feedbacks lead to extreme variations in climate. In modern times, since the industrial revolution about 150 years ago, people have burned fossil fuels that have added more CO_2 into the atmosphere. This has led to warming and started a positive feedback in the direction of further warming. Scientists are concerned that this could lead to harmful levels of climate change.



The yellow areas reflect periods between glacial cycles when global temperatures were warmer and there was significantly less ice cover. Notice that CO_2 levels are high.

The blue areas reflect periods when global temperatures were colder and there was greater ice cover. Notice that CO_2 levels are low.

Notice that low carbon dioxide levels correlate with glacial periods and high carbon dioxide levels correlate with interglacial periods.