What Is Climate and How Is It Changing?

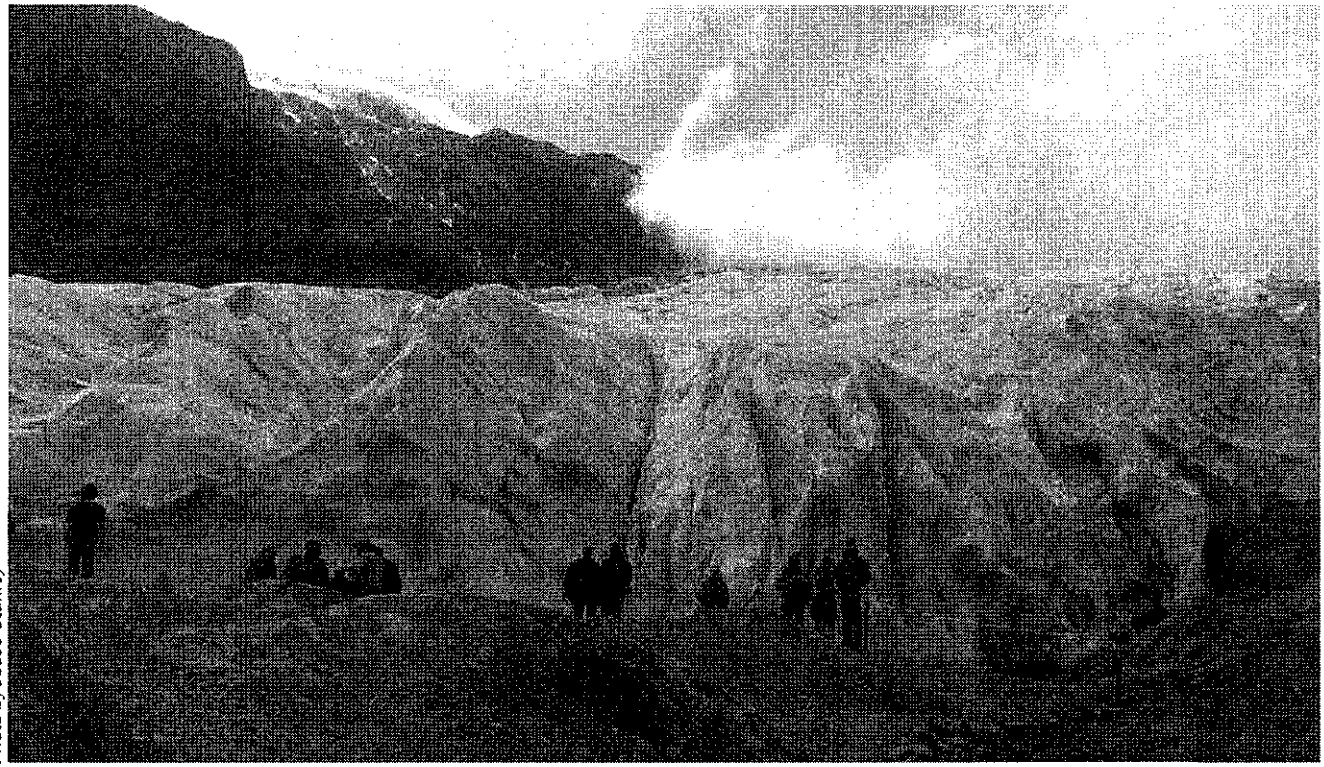


Photo by Jesse Stanley

Student Reading 1

You have probably seen or heard the term **climate change** in many places, from magazines to movies, at school, and at home. Everyone is talking about it. But what exactly is climate change, and how does it relate to our lives?

Climate change refers to any change in climate over time, whether caused by natural factors

Exit Glacier in Alaska has receded significantly in the last century. *Photo by Jesse Stanley*

When the amount of greenhouse gases in the atmosphere rises, temperatures on Earth rise as well, causing a change in climate.

(such as volcanic eruptions) or human activities. Climate is average weather (including temperature, precipitation, and wind) over a period of time (from months to millions of years).[1] When we examine weather over many years, we can see climate patterns.

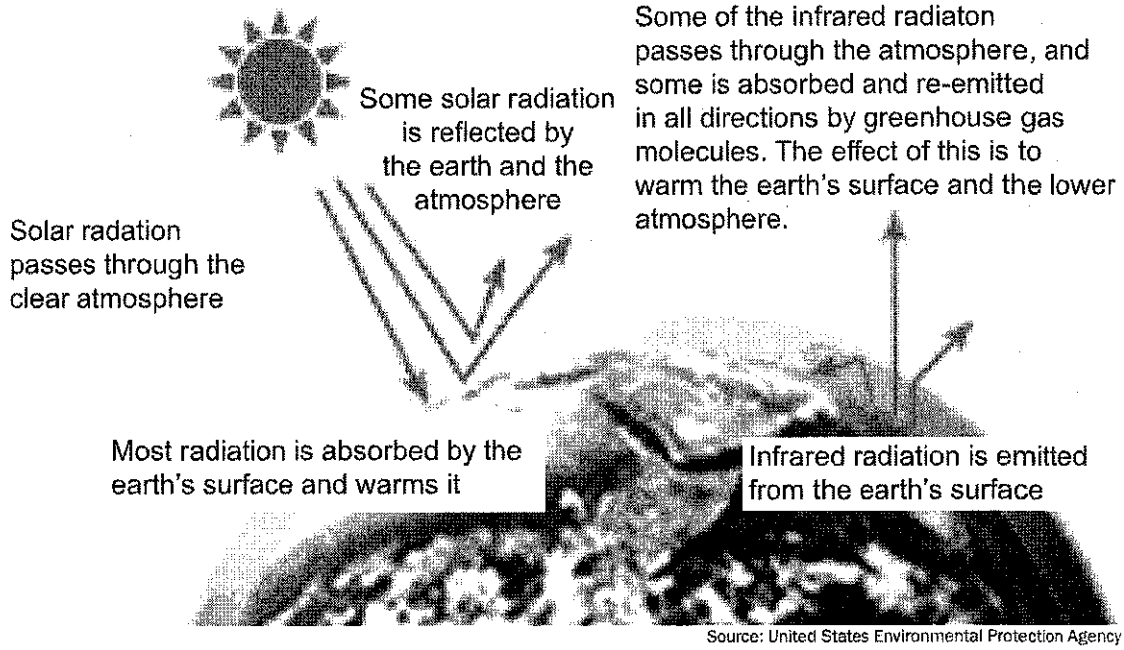
Earth's Greenhouse Effect

To study climate change, we need to understand Earth's **greenhouse effect**. The greenhouse effect is important because it makes conditions on Earth warm enough for many species to survive. Some of the sun's radiation that reaches Earth's surface is absorbed by the earth, but some of it is reflected back into space by clouds, air particles, snow, ice, and deserts. When reflected back, the radiation changes into heat (called infrared radiation). Certain gases in Earth's **atmosphere** act like a blanket to retain (and reflect back down to the earth) much of this infrared radiation, making surface temperatures on Earth about 34°C (61° F) warmer than they would be otherwise.[2]

When the amount of **greenhouse gases** in the atmosphere rises, temperatures on Earth rise as well, causing a change in climate. Some greenhouse gases occur naturally and some are man-made. Water vapor is a greenhouse gas that occurs naturally, as a result of Earth's water cycle. Other greenhouse gases such as chlorofluorocarbons (CFCs) are created entirely by humans.

Many greenhouse gases that occur naturally are also released through human activities. For example, carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) are all cycled through Earth's atmosphere naturally. Carbon dioxide is released by all living things (you are releasing some right now as you breathe). Nitrous oxide is released by organisms that live in the soil. Methane is released when dead things decay and decompose. Human activities that burn **fossil fuels** such as oil or gas (when we drive gasoline-powered cars, for example)

The Greenhouse Effect



Source: United States Environmental Protection Agency

increase the amounts of greenhouse gases in Earth's atmosphere, affecting the balance of natural cycles.

Scientists who study climate change often focus on carbon dioxide because the amount of CO_2 in the atmosphere is much greater than any other greenhouse gas produced by human activities. CO_2 accounts for 74% of global greenhouse gas emissions from human activities.[3] CO_2 can remain in the atmosphere for up to 200 years.[4]

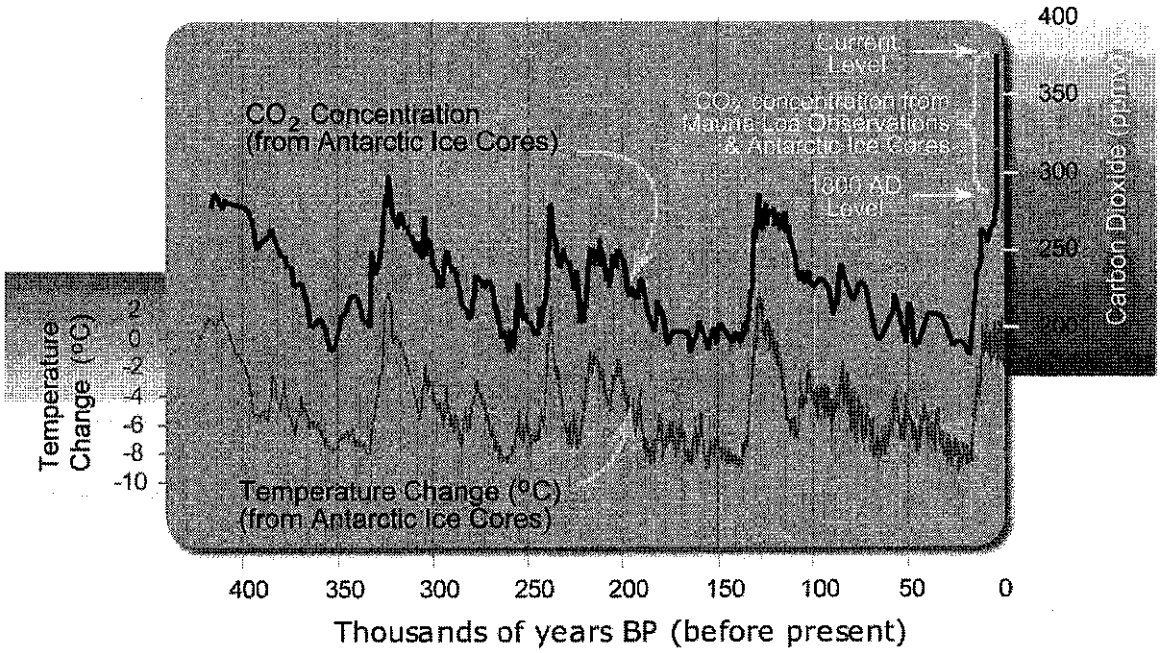
CO_2 levels in the atmosphere have been rising since 1750. Because this increase has happened at the same time as an increase in industrial activities (manufacturing, processing, and transporting goods), many experts agree that humans are responsible for the increased CO_2, primarily due to loss of forests and use of fossil fuels.[5]

Carbon Sources and Sinks

Carbon is one of the two elements that make up carbon dioxide (the other is oxygen). Many processes are **carbon sources** that add CO_2 to the atmosphere by releasing more carbon than they absorb. Carbon sources include burning fossil fuels (coal, petroleum oil, natural gas), deforestation (loss of forests), and agricultural processes, such as tilling soil and raising livestock. Many industrial processes, such as making cement, steel, and agricultural fertilizers, are also carbon sources.[6]

Certain places called **carbon sinks** can retain carbon for a long time, keeping it out of the atmosphere. They tend to absorb more CO_2 than they release. Forests, oceans, and soil are the main carbon sinks on Earth.

We can change the ability of carbon sinks to hold carbon. For example, when we remove trees from a forest or till soil, the carbon they have been holding is released into the atmosphere as CO_2. Fossil fuels can also



be considered carbon sinks because CO_2 is locked inside them for thousands of years. It is only when we burn them for energy (to heat our homes and drive our cars) that they release CO_2.

Measuring Carbon Dioxide and Temperature Trends

Historic levels of atmospheric CO_2 can be measured by studying ice cores. Tiny gas bubbles trapped deep in the ice tell us about gases present in Earth's atmosphere thousands of years ago. One set of ice cores at the Russian Vostok research station in East Antarctica has allowed scientists to determine CO_2 levels for over 400,000 years.[7]

A much shorter and more recent dataset has been obtained in a different manner, by sampling air from atop a volcano. The world's most complete CO_2 record has been collected since the 1950s at an observatory near the top of the Mauna Loa Volcano in the U.S. state of Hawaii.[8] Because this volcano is far from many human activities (a carbon source) and plants (a carbon sink), it is an ideal site for accurately measuring CO_2.

Both the Vostok ice cores and the Mauna Loa observatory show a steep increase in the amount of CO_2 in Earth's atmosphere in recent years.[9] The ice cores also show a strong link between CO_2 concentrations and temperature changes on Earth.

The increasing CO_2 concentrations have many consequences. Eleven years between 1995 and 2006 are among the twelve hottest years recorded since 1850, when global temperatures were first recorded by instruments. Warming air and ocean temperatures have caused snow and ice to melt. Melting snow and ice have led to sea level rise and affected ocean chemistry. Wind and precipitation patterns have changed in many regions during the past century, resulting in increased rainfall in some places and droughts in other places.[10]

Data Source CO2: ftp://cdiac.ornl.gov/pub/trends/co2/vostok.icecore.co2

Data Source Temp: http://cdiac.esd.ornl.gov/ftp/trends/temp/vostok/vostok.1999.temp.dat

Graphic by Michael Ernst, The Woods Hole Research Center