



Climate Change

Earth's Atmosphere

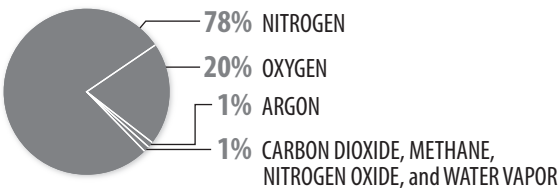
Our Earth is surrounded by layers of gases called the atmosphere. Without these gases in the atmosphere, the Earth would be so cold that almost nothing could live. It would be a frozen planet. Our atmosphere keeps us alive and warm.

The atmosphere is made up of many different gases. Most of the atmosphere (98 percent) is comprised of oxygen and nitrogen gases. Less than one percent is a mixture of heat-trapping gases. These heat-trapping gases are mostly water vapor, mixed with carbon dioxide, methane, CFCs, ozone, and nitrous oxide. These are called **greenhouse gases (GHG)**.

Carbon dioxide is the gas that is produced when we breathe, and when we burn biomass and fossil fuels. **Methane** is the main gas in natural gas—a fossil fuel. Methane is also found in oil and coal deposits, in magma, and in offshore methane hydrate formations. Methane is released into the atmosphere through natural processes such as volcanic eruptions, as well as during oil drilling and coal mining. Methane is also produced when plants and animals decay.

The other heat-trapping gases (ozone, CFCs, and nitrous oxide) are produced when fuels are burned, as by-products of manufacturing processes, and in other ways.

Gases in the Atmosphere



GREENHOUSE



Sunlight and the Atmosphere

Rays of sunlight (radiant energy) shine down on the Earth every day. Some of these rays bounce off molecules in the atmosphere and are reflected back into space. Some rays are absorbed by molecules in the atmosphere and are turned into thermal energy (heat).

About half of the radiant energy passes through the atmosphere and reaches the Earth. When the sunlight hits the Earth, most of it is converted into heat. The Earth absorbs some of this heat; the rest flows back out toward the atmosphere. This outward flow of heat keeps the Earth from getting too warm.

When this out-flowing heat reaches the atmosphere, most of it is absorbed. It can't pass through the atmosphere as readily as sunlight. Most of the heat becomes trapped and flows back toward the Earth again. Most people think it's sunlight that heats the Earth, but actually it's this contained heat that provides most of the warmth.

The Greenhouse Effect

We call the trapping of heat by the atmosphere the **greenhouse effect**. A greenhouse is a building made of clear glass or plastic in which we can grow plants in cold weather. The glass allows the sunlight to pass through, where it turns into heat when it hits objects inside. The heat becomes trapped. The **radiant energy** can pass through the glass; the **thermal energy** cannot.

What is in the atmosphere that allows radiant energy to pass through but traps thermal energy? It is the presence of greenhouse gases—mostly carbon dioxide and methane. These gases are very good at absorbing heat in the atmosphere, where it can flow back toward Earth.

According to studies conducted by NASA and many other researchers around the world, the concentration of carbon dioxide has increased by about 39 percent since the Industrial Revolution in the late 19th century. Climate change experts have concluded that this increase is due primarily to the expanding use of fossil fuels.

In addition to the increase in the level of carbon dioxide, there has also been a substantial rise in the amount of methane in the atmosphere. While there is much less methane in the atmosphere than carbon dioxide, it is many times more efficient than carbon dioxide at trapping heat. However, it does not remain intact as long in the atmosphere.

Global Climate Change

Increased levels of greenhouse gases are trapping more heat in the atmosphere. This phenomenon is called global **climate change** or **global warming**. According to NASA, the National Air and Space Agency, the average temperature of the Earth has risen by about 1°F in the last century. This increase in average temperature has been the major cause of a 12 to 22 centimeter rise in sea level over that time period, as well as an increase in extreme precipitation events. Sea levels are rising

because land-based ice is melting in the Arctic and Antarctic and in glaciers. Regions such as the Gulf Coast of the United States and several Pacific islands have already experienced losses to their coastlines. Recent research has also linked the increased severity of hurricanes and typhoons to global warming.

Climate scientists use sophisticated computer models to make predictions about the future effects of climate change. Because of the increased level of carbon dioxide and other greenhouse gases already in the atmosphere, NASA has determined that the Earth will experience at least another 2°F temperature increase by the end of the century. The climate models predict more floods in some places and droughts in others, along with more extreme weather, such as powerful storms and hurricanes. They predict an additional rise in sea level of up to one foot, which would lead to the loss of low-lying coastal areas.

These predictions have led many scientists to call for all countries to act now to lower the amount of carbon dioxide they emit into the atmosphere. Countries around the world are working to determine ways to lower the levels of carbon dioxide in the atmosphere while minimizing negative impacts on the global economy.

International Awareness

Climate change is impacting every person around the globe, so climate change is an international issue. There has been a history of the international community coming together to try and make plans to combat rising greenhouse gases. In 1997 the Kyoto Protocol was the first step in coming to an international agreement on greenhouse gas levels. The United States has not ratified the Kyoto Protocol because it did not have targets or timetables outlined for developing nations as well as industrialized nations.

This agreement expires in 2012 and in an effort to continue international efforts world leaders are meeting periodically. One of the main roadblocks is regulating GHG emissions from developing countries. These nations argue that since current climate change was primarily caused by emissions from the developed countries, those countries should bear the responsibility of lowering emissions. They see limits on GHG's as a limit to their development and their efforts to bring millions of their citizens out of poverty. While the developed nations accept that they need to curb their emissions, they feel that developing nations will have an unfair economic advantage if they are not regulated. An international conference in Copenhagen, Denmark in 2009 ended without a strong agreement on how to regulate emissions globally. Many, but not all, countries made commitments to specific GHG targets, but there is no international system to monitor or regulate their efforts. Meetings are continuing in hopes of crafting a strong international treaty.

The Greenhouse Effect

Radiant energy (light rays and arrows) shines on the Earth. Some radiant energy reaches the atmosphere and is reflected back into space. Some radiant energy is absorbed by the atmosphere and is transformed into heat (dark arrows).

Half of the radiant energy that is directed at Earth passes through the atmosphere and reaches the Earth, where it is transformed into heat.

The Earth absorbs some of this heat.

Most of the heat flows back into the air. The atmosphere traps the heat.

Very little of the heat escapes back into space.

The trapped heat flows back toward the Earth.

