# Atmosphere and Climate

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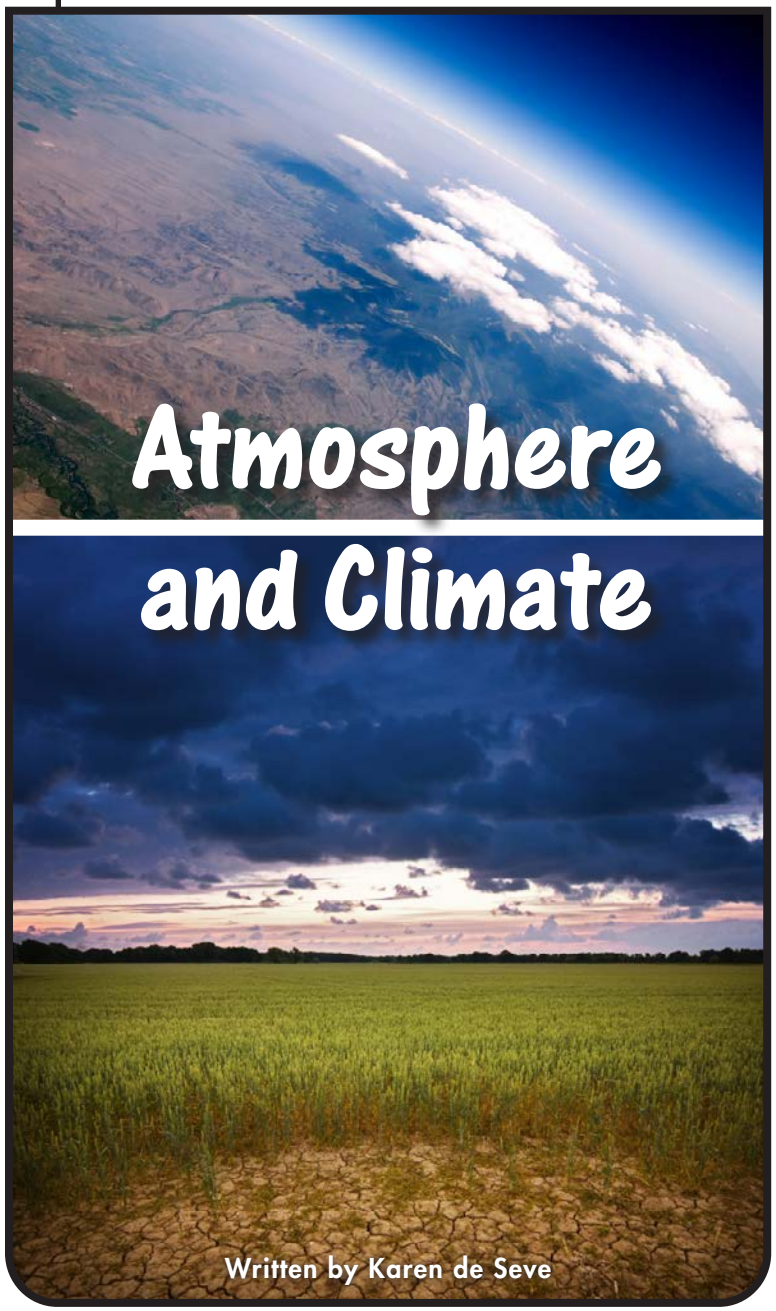


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# Atmosphere and Climate

Written by Karen de Seve

**www.sciencea-z.com**

## KEY ELEMENTS USED IN THIS BOOK

**The Big Idea:** Our atmosphere contains the air we breathe, keeps the planet at a comfortable temperature, and shields us from harmful radiation. Understanding our atmosphere helps students realize the importance of protecting it. To reduce the release of excess greenhouse gases, many people conserve energy, use alternative energy resources, reuse and recycle products, and make other changes. They do so in hopes that this planet will always be a good home.

**Key words:** air pressure, atmosphere, carbon dioxide, climate, condense, dense, deserts, emissions, evaporate, exosphere, force, gases, global warming, gravity, greenhouse effect, mesosphere, methane, molecules, nitrogen, oxygen, ozone layer, polar zones, precipitation, solar radiation, stratosphere, temperate zones, temperature, thermosphere, tropical zone, troposphere, ultraviolet rays, water cycle, water vapor, weather

**Key comprehension skills:** Cause and effect
*Other suitable comprehension skills:* Compare and contrast; classify information; elements of a genre; identify facts; interpret graphs, charts, and diagrams; using a glossary and boldfaced terms; using a table of contents and headings

**Key reading strategy:** Summarize
*Other suitable reading strategies:* Ask and answer questions; connect to prior knowledge; visualize; retell

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## Introduction

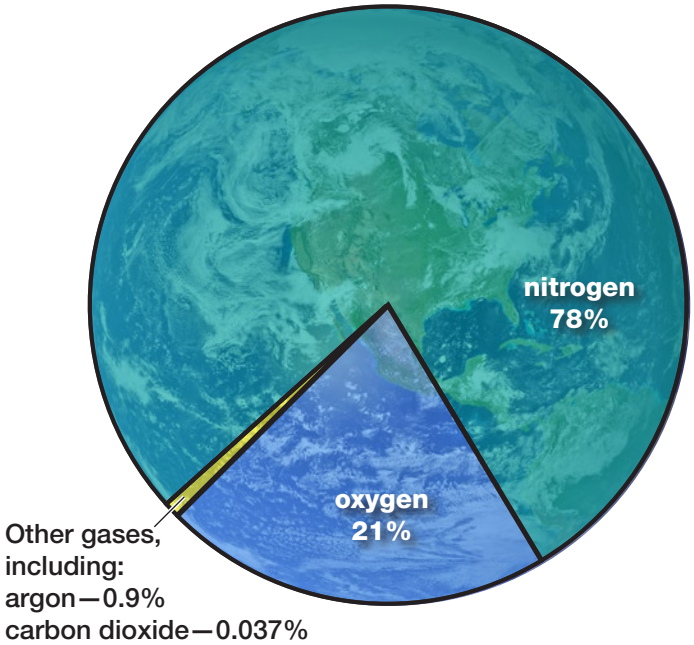
Look up into the sky. There's a very thin, invisible shield surrounding Earth. It's called the **atmosphere**. This invisible shield makes life on Earth possible. It provides the air we breathe, the **weather** we experience, and the conditions needed for life on Earth. It protects us from the Sun's harmful rays. It controls the amount of Earth's heat that escapes into space.

In this book, you will learn about Earth's atmosphere, what it is made of, and how it makes life possible. You will learn the difference between weather over short and long periods of time. You'll also learn what makes up the atmosphere and how it is changing.

## Earth's Invisible Shield

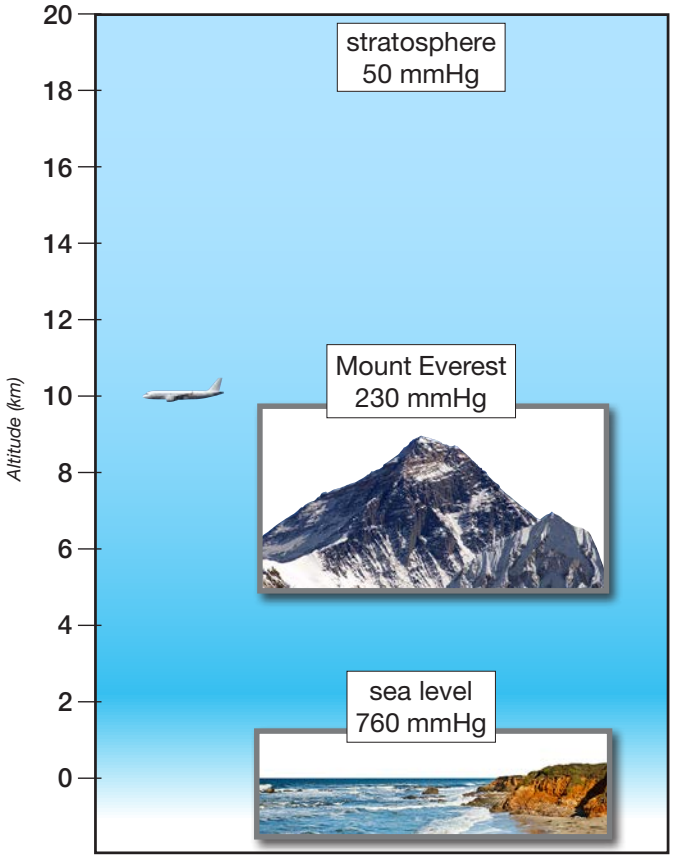
The atmosphere is like a blanket. It protects and warms Earth's surface. The atmosphere rises more than 700 kilometers (430 mi.) above Earth's surface. It contains all the **gases** needed for life, such as nitrogen and oxygen. The atmosphere also contains small amounts of the gases argon, carbon dioxide ($CO_2$), water vapor, and a few others. Oxygen is the gas that we need most. Without oxygen, life as we know it could not exist.

COMPOSITION OF EARTH'S ATMOSPHERE




The atmosphere is mostly made up of nitrogen and oxygen. It also has small amounts of other gases.






Scientists measure air pressure in several ways. At sea level, air pressure is about 760 millimeters of mercury (mmHg), or 14.7 pounds per square inch.

Gases are like all matter. They are made up of small, invisible particles called **molecules**. Gravity pulls the molecules toward Earth, packing them together. This blanket of gas molecules creates **air pressure** on all things within the atmosphere. At the bottom of the atmosphere—at sea level—air pressure is fairly high. Far up in the atmosphere, the air pressure is much lower.

You do not usually feel air pressure. The reason is because the pressure inside your body is about the same as the pressure outside your body. But when you take off in an airplane or drive up a mountain, you go higher in the atmosphere, where the air pressure is lower. As the outside air pressure drops, the air pressure inside your ears stays the same. As air exits your ears, you might hear a popping sound.

**Do You Know?**

Air pressure drops the higher you go. If you go high enough, the air molecules are very spread out. You will need extra oxygen in order to breathe.



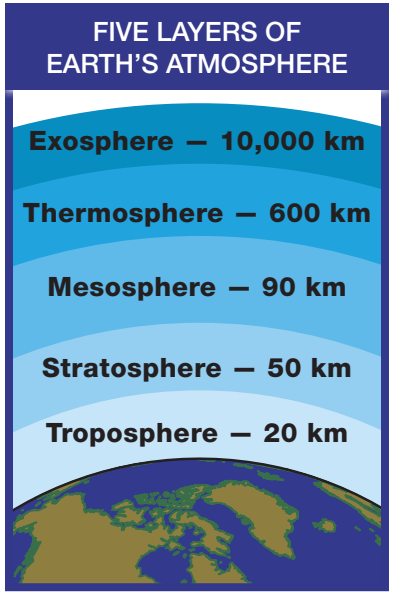
## Layers of Atmosphere

Scientists have divided Earth's atmosphere into five layers. Each layer gradually changes into the next one.

We live in the first layer—the **troposphere**—where Earth's weather forms and changes.

The **stratosphere** is above the troposphere. This layer protects Earth from the Sun's radiation. The lowest part of the stratosphere is the **ozone layer**. This lower part is important to living things because it absorbs harmful **ultraviolet rays** from the Sun. Certain chemical gases that people release at Earth's surface threaten the ozone layer. These chemicals can float up into the stratosphere and break down ozone. The ozone is then less able to absorb ultraviolet rays.

The *mesosphere* is the middle layer, in which most meteors burn up. Spacecraft orbit in the *thermosphere*. The *exosphere* is the outermost layer.




Atmosphere not to scale

## Earth: Just Right for Life

Earth is just right for life because it has liquid water, and the **temperature** of the atmosphere is just right. Earth is at an ideal distance from the Sun. If Earth were much closer to the Sun, it would be too hot for life. If Earth were farther from the Sun, it would be too cold for life.

**Think About It**

Why might some people call Earth a "Goldilocks planet"?

Another reason Earth is able to support life is that its atmosphere works like a global greenhouse. A real greenhouse is a glass building that lets in sunlight and traps some of the heat energy. When sunlight, or solar radiation, passes through Earth's atmosphere, some of it is absorbed into oceans and the ground. This absorbed energy changes into heat energy. The heat radiates into the atmosphere and warms the air. The atmosphere prevents some of the heat from escaping back into space. This natural feature of our atmosphere is the **greenhouse effect**. (See diagram on page 20.)

a greenhouse



COMPARING ATMOSPHERIC TEMPERATURES


–60°C (–80°F) 10°C (50°F) 482°C (900°F)

*Atmospheres not to scale*

The amount of heat energy trapped by Earth's atmosphere is just right to support life. The average temperature on Earth is 10°C (50°F). Compare this to Venus, a very hot planet. Venus is closer to the Sun than Earth is. Its atmosphere traps even more $CO_2$ than Earth's atmosphere does, making the planet hot. Then there is Mars, a very cold planet. Mars is farther from the Sun than Earth is. Its atmosphere traps very little $CO_2$, so the planet is cold. Venus appears to be too hot for life to exist, and Mars appears to be too cold.

**WOWSER!**

The Moon has almost no atmosphere. With no protection from direct sunlight, the lunar surface temperature soars to 123°C (253°F) when the Sun shines on it. At night, the Moon cools to a frigid –233°C (–387°F) because there is nothing to trap the Sun's heat energy.

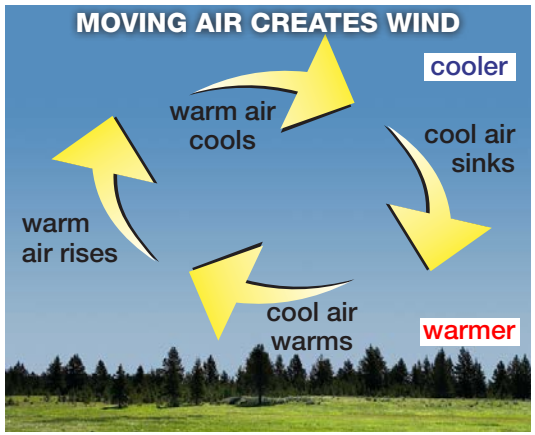
## The Atmosphere and Weather

Weather happens in the troposphere. Air constantly circulates up, down, and all around. Warmer air and cooler air combine. Areas of high and low air pressure meet. This mixing of air creates the conditions that cause weather to change.

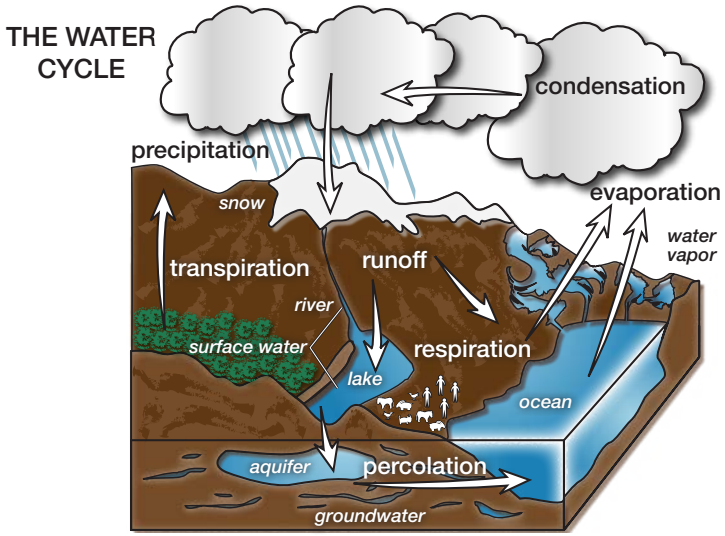
### *Wind's Driving Force*

When air passes over Earth's warm surface, it heats up. This heating makes the air molecules move farther apart. The air becomes less dense with molecules, so it expands and becomes lighter. The warm, lighter air rises.

As the rising warm air moves away from Earth's warm surface, it begins to cool. The molecules come together again, or become denser. The cooler air sinks to the surface, where it warms up again. Air keeps rising and sinking. It is also pushed along as Earth rotates. This movement of air is wind.






### *Water and Weather*

The **water cycle** begins when heat energy from the Sun warms up surface water, such as lakes, rivers, and oceans. Water molecules move apart when they are warmed up. The liquid water molecules evaporate into the air, becoming water vapor. As the invisible water vapor rises, it cools. The water molecules in the vapor lose energy. They begin to collect on dust particles and condense, or form small water droplets. Clouds form as millions of droplets gather together.

**Do You Know?**

When salt water evaporates from the oceans, the salt is left behind. Only the freshwater vapor rises.

**Word Wise**

*Humidity* is the amount of water vapor in the air at a certain location.

As tiny water droplets in clouds cool, they join to make bigger droplets. Gravity pulls these larger droplets to Earth. This falling water is called **precipitation**. It may fall as rain, snow, sleet, or hail.

As moist air warms and rises over land, it cools and forms clouds. The clouds may produce precipitation.



*A Balancing Act*

Moving air and water keep the environment in balance, making Earth just right for living things. The temperature range allows many different plants and animals to survive. Air is always on the move, providing the balance of gases that living things need. All plants and animals need water to live and grow, and many live in water habitats. Weather, the water cycle, and the greenhouse effect all help make our planet a great place to call home.

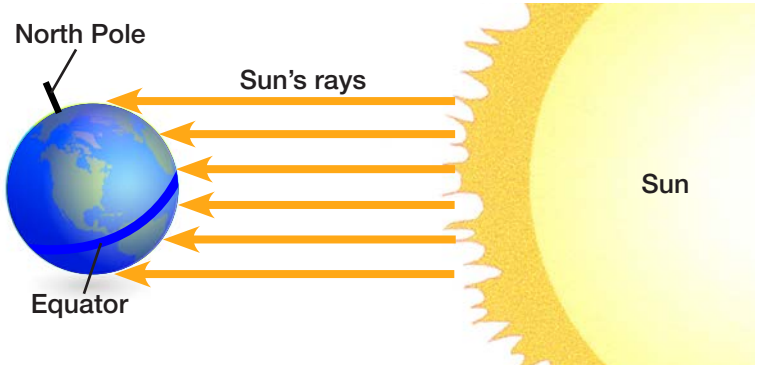
## The Atmosphere and Climate

Weather describes the conditions in a region's air today, tomorrow, or a few days from now. Weather can be hot or cold. It can be rainy, snowy, dry, or humid. Weather can change quickly.



**Climate**, on the other hand, is the average weather over many years in a location on Earth. Temperature and precipitation are major building blocks of climate. Think about the climate where you live. How does the temperature vary? How much precipitation falls?




Sunlight reaches Earth's surface more directly near the equator and less directly near the poles.

*Climate Zones*

Earth has three major climate zones. Each climate zone is made up of several climate types. The intensity of sunlight reaching Earth's surface affects the climate in each zone.

Near the equator—the imaginary line that circles Earth at the middle—sunlight strikes Earth's surface directly. More sunlight gets absorbed and changed into heat energy. As a result, the climate is warmer. The **tropical zone** is warm year-round. It often receives heavy rainfall. Rainforest climates are found in the tropical zone. They receive rain throughout the year. Wet-dry tropical climates receive heavy rainfall during part of the year but none during the rest of the year.

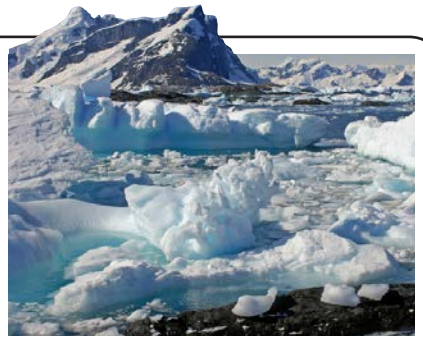
North and south of the tropical zone are the **temperate zones**. During summer, sunlight strikes the surface more directly, so the weather is warmer. During winter, the Sun's rays strike the surface less directly, so it is cooler. The temperate zones are warm during the summer and cold in the winter. But within these zones, the climates can be very different. They can be dry or humid, warmer or cooler.

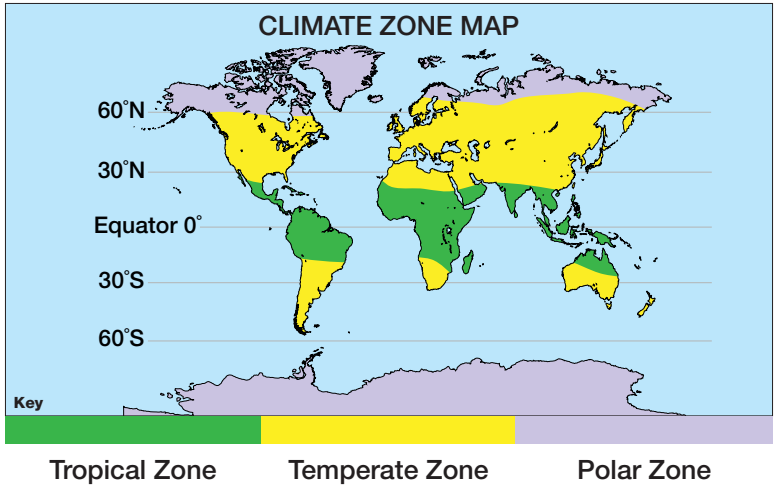


Near each of Earth's poles, sunlight reaches the surface at a less direct angle. The energy gets filtered through a lot of atmosphere. As a result, the climate in **polar zones** is much colder than in other zones. Some polar climates are extremely cold and fairly dry. Only a little precipitation falls as snow, and it does not melt. The buildup of snow over time has made permanent ice sheets. Another polar climate, called *tundra,* is not as cold and does not have permanent ice sheets.

**Do You Know?**

The coldest temperature ever recorded on Earth was in Antarctica, near the South Pole. That temperature was –89.2°C (–128.6°F).






Some climate types can be found in more than one climate zone. For example, deserts can be found in all three zones. Deserts are dry, with fewer than 25.4 centimeters (10 in.) of rain per year. Most deserts are hot, but the world also has cold deserts. Even in hot deserts, it can be very cold at night and in winter. The driest deserts are called *arid*. The Sahara Desert in Africa and the Great Australian Desert are arid. Other deserts, called *semi-arid*, get more precipitation. The western United States has several semi-arid deserts.

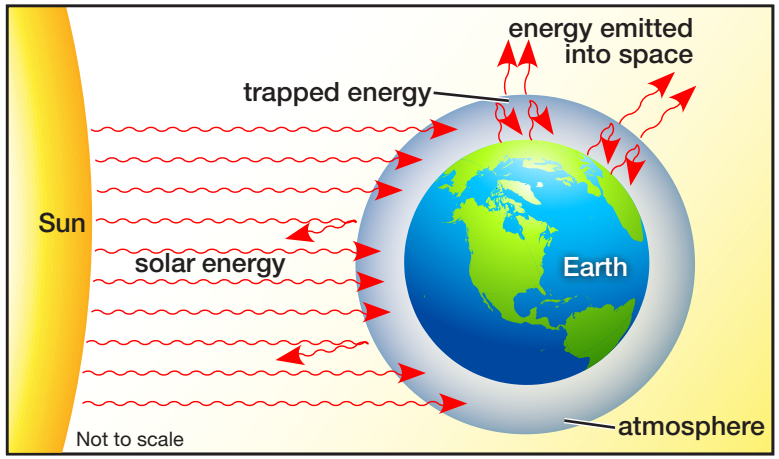
**WOWSER!**

If Earth were completely covered with sand, it would actually be cold, not hot. A lighter-colored, sandy surface would reflect, not absorb, most of the Sun's energy.



## Climate Change

The atmosphere and Earth's climates are closely linked. Changes in the atmosphere can change the climate. Remember that the atmosphere acts like a greenhouse surrounding Earth. Water vapor, carbon dioxide, and methane in the air are the main greenhouse gases. These gases float in the air, as do dust and other tiny particles. Normally, the air has just the right amount of these substances to trap some of the heat energy reflected from Earth. But in recent years, more heat is being trapped. The amounts of certain gases in the atmosphere have increased. During this time, humans have been burning more coal, gas, and oil. We use these resources to heat buildings, run vehicles, and manufacture goods. Could these actions be making our planet warmer?




More solar energy is being trapped by Earth's atmosphere now than in the past.

When coal burns, it gives off carbon dioxide ($CO_2$). We mainly use coal to generate electricity. Oil is another widely used fuel. It doesn't give off as much $CO_2$ as coal, but it still adds large amounts of greenhouse gas **emissions**.

Scientists have determined that the recent increase in $CO_2$ emissions is making the atmosphere trap more heat. This change is raising temperatures all over the planet. This widespread climate change is often known as **global warming**.

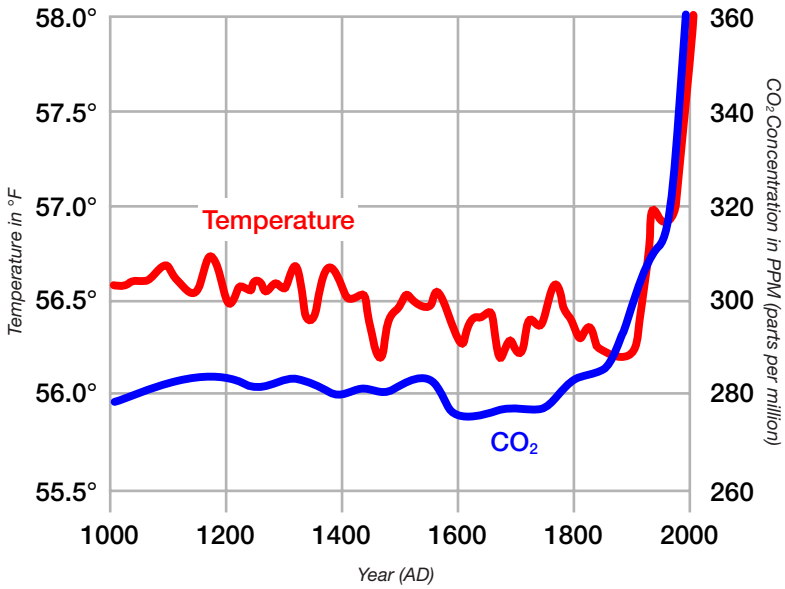
**Do You Know?**

During digestion, cows, sheep, and goats release methane, a greenhouse gas.



*Consequences of Climate Change*

The world's average temperature has only increased slightly (about 0.6°C or 1°F), but it has made a big difference. Global warming is causing changes in the weather. Extreme storms are on the rise, causing flooding and erosion. Heat waves that cause drought are more common. Areas that used to be green are now dry and no longer useful for farming. In the polar zones, ice is melting, putting some polar animals at risk. Many giant glaciers have melted to a much smaller size, while others are completely gone.




In recent times, there has been a sharp rise in greenhouse gases in Earth's atmosphere. During the same time, average global temperatures have increased.

Polar bears depend on sea ice for hunting and for raising their young. If sea ice keeps melting, polar bears might not survive.

According to scientists, we cannot rebalance the mixture of gases in the atmosphere. However, we may be able to slow down the changes. Instead of burning coal to produce electricity, we can use alternative energy sources, such as wind and solar power. Driving hybrid and electric cars can reduce the amount of oil and gas used by our vehicles. Constructing buildings that use less energy will lower our energy needs. When more people carpool, walk, ride a bike, or use mass transit, it lowers $CO_2$ emissions. All these actions can help reduce the amount of harmful gases added to the atmosphere.



## Conclusion

Now when you look up to the sky, you might think differently about our atmosphere. Scientists are already trying to understand how this invisible shield forms and how it is changing. They make recommendations so people can help prevent further climate change. Even small changes can have a big impact on the health of our planet. The future of Earth and everything that lives here is tied to a healthy atmosphere.

### Take Action!

Here are a few things people are doing to reduce their contribution to climate change.

- Waste less electricity: Every kilowatt hour (kWh) of electricity generated sends about 0.8 kilograms (1.7 lbs.) of $CO_2$ into the atmosphere.

- Use reusable shopping bags: Making 10,000 plastic bags gives off about 19 metric tons (20 US tons) of $CO_2$.
- Drive less: Each gallon of gasoline burned gives off 9 kilograms (20 lbs.) of $CO_2$.
- Reduce waste and reuse and recycle products: Making, packaging, and transporting new products gives off $CO_2$. Also, garbage dumps contribute to greenhouse gas emissions.

## Glossary

**air pressure** the force that air puts on an object (p. 6)

**atmosphere** the mass of air around Earth (p. 4)

**climate** the weather conditions in an area over a long period of time (p. 15)

**emissions** substances that are discharged into the air, such as from engines and factories (p. 21)

**gases** matter that can freely change shape and size; often can't be seen (p. 5)

**global warming** an increase in the average temperature of Earth's atmosphere and oceans, especially one great enough to change the climate (p. 21)

**greenhouse effect** the process by which heat is trapped inside Earth's atmosphere by gases (p. 9)

**molecules** the smallest parts of substances that can exist by themselves, made of two or more atoms (p. 6)

**ozone layer** a layer of the atmosphere that protects life on Earth by filtering out ultraviolet radiation from the Sun (p. 8)

**polar zones** Earth's coolest climate zones, located near the poles, where sunlight strikes the planet's surface at a low, slanting angle (p. 18)

**precipitation** water that falls from clouds in the form of rain, snow, sleet, or hail (p. 13)

**stratosphere** the layer of Earth's atmosphere located beyond the troposphere; the layer that protects Earth from solar radiation (p. 8)



**temperate zones** Earth's climate zones located between the tropical and polar zones, where the sunlight angle causes warmer summers and cooler winters (p. 17)

**temperature** the measurement of how hot or cold something is (p. 9)

**tropical zone** Earth's warmest climate zone, located near the equator, where sunlight strikes the planet's surface most directly (p. 16)

**troposphere** the layer of Earth's atmosphere closest to the planet's surface; the layer in which weather takes place (p. 8)

**ultraviolet rays** invisible light that makes up part of solar radiation; too much of it can harm living things (p. 8)

**water cycle** the path water takes, and the changes it goes through, as it moves on, above, and below Earth's surface (p. 12)

**weather** a description of the temperature, clouds, rain, wind, and other conditions in the air at a certain time (p. 4)

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