

CLIMATE CHANGE

Climate is the long-term pattern of weather in a particular area. Weather can change from hour to hour, day to day, month to month or even from year to year. For periods of 30 years or more, however, distinct weather patterns occur. A desert might experience a rainy week, but over the long term, the region receives very little rainfall. It has a dry climate.

Because climates are mostly constant, living things can adapt to them. Polar bears have adapted to stay warm in polar climates, while cacti have evolved to hold onto water in dry climates. The enormous variety of life on Earth results in large part from the variety of climates that exist.

Climates do change, however—they just change very slowly, over hundreds or even thousands of years. As climates change, organisms that live in the area must adapt, relocate, or risk going extinct.

Earth's Changing Climate

Earth's climate has changed many times. For example, fossils from the Cretaceous period (144 to 65 million years ago) show that Earth was much warmer than it is today. Fossilized plants and animals that normally live in warm environments have been found at much higher latitudes than they could survive at today. For instance, breadfruit trees, now found on tropical islands, grew as far north as Greenland.

Earth has also experienced several major ice ages—at least four in the past 500,000 years. During these periods, Earth's temperature decreased, causing an expansion of ice sheets and glaciers. The most recent Ice Age began about 2 million years ago and peaked about 20,000 years ago. The ice caps began retreating 18,000 years ago. They have not disappeared completely, however. Their presence in Antarctica and Greenland suggests the Earth is still in a sort of ice age. Many scientists believe we are in an interglacial period, when warmer temperatures have caused the ice caps to recede. Many centuries from now, the glaciers may advance again.

Climatologists look for evidence of past climate change in many different places. Like clumsy criminals, glaciers leave many clues behind them. They scratch and scour rocks as they move. They deposit sediment known as glacial till. This sediment sometimes forms mounds or ridges called moraines. Glaciers also form elongated oval hills known as drumlins. All of these geographic features on land that currently has no glaciers suggest that glaciers were once there.

Scientists also have chemical evidence of ice ages from sediments and sedimentary rocks. Some rocks only form from glacial material. Their presence under the ocean or on land also tells scientists that glaciers were once present in these areas.

Scientists also have paleontological evidence—fossils. Fossils show what kinds of animals and plants lived in certain areas. During ice ages, organisms that are adapted to cold weather can increase their range, moving closer to the Equator. Organisms that are adapted to warm weather may lose part of their habitat, or even go extinct.

Climate changes occur over shorter periods, as well. For example, the so-called Little Ice Age lasted only a few hundred years, peaking during the 16th and 17th centuries. During this time, average global temperatures were 1 to 1.5 degrees Celsius (2-3 degrees Fahrenheit) cooler than they are today.

A change of one or two degrees might not seem like a lot, but it was enough to cause some pretty massive effects. For instance, glaciers grew larger and sometimes engulfed whole mountain villages. Winters were longer than usual, limiting the growing seasons of crops. In northern Europe, people deserted farms and villages to avoid starvation.

One way scientists have learned about the Little Ice Age is by studying the rings of trees that are more than 300 years old. The thickness of tree rings is related to the amount of the trees' annual growth. This in turn is related to climate changes. During times of drought or cold, trees could not grow as much. The rings would be closer together.

Some climate changes are almost predictable. One example of regular climate change results from the warming of the surface waters of the tropical eastern Pacific Ocean. This warming is called El Niño—The Child—because it tends to begin around Christmas. In normal years, trade winds blow steadily across the ocean from east to west, dragging warm surface water along in the same direction. This produces a shallow layer of warm water in the eastern Pacific and a buildup of warm water in the west.

Every few years, normal winds falter and ocean currents reverse. This is El Niño. Warm water deepens in the eastern Pacific. This, in turn, produces dramatic climate changes. Rain decreases in Australia and southern Asia, and freak storms may pound Pacific islands and the west coast of the Americas. Within a year or two, El Niño ends, and climate systems return to normal.

Natural Causes of Climate Change

Climate changes happen for a variety of reasons. Some of these reasons have to do with Earth's atmosphere. The climate change brought by El Niño, which relies on winds and ocean currents, is an example of natural atmospheric changes.

Natural climate change can also be affected by forces outside Earth's atmosphere. For instance, the 100,000-year cycles of ice ages are probably related to changes in the tilt of Earth's axis and the shape of its orbit around the sun. Those planetary factors change slowly over time and affect how much of the sun's energy reaches different parts of the world in different seasons.

Small changes in the amount of sunlight that reaches the Earth can also have an effect on global temperatures. One popular theory, which has not been proved, is that the Earth's climate is related to the number of sunspots on the sun's surface. Sunspots are storms that appear as dark marks on the sun. Some scientists say the number of sunspots has doubled in the past 100 years, making the sun brighter to us—and making it warmer here on Earth. Scientists have noticed that an unusually quiet period of sunspot activity coincided with the Little Ice Age.

The impact of large meteors on Earth could also cause climate change. The impact of a meteor

would send millions of tons of debris into the atmosphere. This debris would block at least some of the sun's rays, making it cold and dark. This climate change would severely limit what organisms could survive. Many paleontologists believe the impact of a meteor or comet contributed to the extinction of the dinosaurs. Dinosaurs simply could not survive in a cool, dark climate. Their bodies could not adjust to the cold, and the dark limited the growth of plants on which they fed.

Plate tectonics also play a role in climate changes. Earth's continental plates have moved a great deal over time. More than 200 million years ago, the continents were merged together as one giant landmass called Pangaea. As the continents broke apart and moved, their positions on Earth changed, and so did the movements of ocean currents. Both of these changes had effects on climate.

Changes in greenhouse gases in the atmosphere also have an impact on climate change. Gases like carbon dioxide trap the sun's heat in Earth's atmosphere, causing temperatures on the surface to rise. Volcanoes—both on land and under the ocean—release greenhouse gases, so periods of high volcanic activity tend to be warmer.

Volcanoes contribute to the greenhouse effect. The greenhouse effect happens when carbon dioxide, water vapor, and other gases in the atmosphere absorb some of the sun's heat as it is radiated back from the surface of the Earth. This keeps the Earth warm. Without any greenhouse gases in the atmosphere, most life on Earth would freeze to death. However, adding too many of these gases to the atmosphere can intensify the greenhouse effect and slowly make the Earth warmer.

Human Causes of Climate Change

some human activities release greenhouse gases—burning fossil fuels for transportation and electricity, or using agricultural technology that increases meat production, for instance. Trees absorb carbon dioxide, so cutting down forests for timber or development contributes to the greenhouse effect. So do factories that emit pollutants into the atmosphere.

Many scientists are worried that these activities are causing dramatic and dangerous changes in Earth's climate. Average temperatures around the world have risen since the late 1870s, when scientists began tracking them. The seven warmest years of the 20th century occurred in the 1980s and 1990s. This warming trend may be a sign that the greenhouse effect is increasing because of human activity. This climate change is often referred to as "global warming."

Global warming is often linked to the burning of fossil fuels—coal, oil, and natural gas—by industries and cars. Warming is also linked to the destruction of tropical forests. Such human activity has increased the amount of carbon dioxide in the atmosphere by more than 20 percent in the past 100 years.

The amount of methane, a chemical produced by decomposing plant and animal matter, is also increasing. Increased amounts of methane in Earth's atmosphere are usually linked

to agricultural development and industrial technology. As economies grow, populations consume more goods and throw away more materials. Large landfills, filled with decomposing waste, release tons of methane into the atmosphere.

Chlorofluorocarbon (CFC), hydrochlorofluorocarbon (HCFC), and hydrofluorocarbon (HFC) chemicals are used in refrigeration and aerosol sprays. These chemicals are also greenhouse gases. Many countries are working to phase out their use, and some have laws to prevent companies from manufacturing them.

Global Warming

As the proportion of greenhouse gases in the atmosphere rises, so does the temperature of Earth. Climatologists worry that the global temperature will increase so much that ice caps will begin melting within the next several decades. This would cause the sea level to rise. Coastal areas, including many low-lying islands, would be flooded. Severe climate change may bring more severe weather patterns—more hurricanes, typhoons, and tornadoes. More precipitation would fall in some places and far less in others. Regions where crops now grow could become deserts.

As climates change, so do the habitats for living things. Animals that live in an area may become threatened. Many human societies depend on specific crops for food, clothing, and trade. If the climate of an area changes, the people who live there may no longer be able to grow the crops they depend on for survival. Some scientists worry that as the Earth warms, tropical diseases such as malaria, West Nile virus, and yellow fever will expand into more temperate regions.

The temperature will continue to rise unless preventive steps are taken. Most climatologists agree that we must reduce the amount of greenhouse gases released into the atmosphere. There are many ways to do this, including:

- Drive less. Use public transportation, carpool, walk, or ride a bike.
- Fly less. Airplanes produce huge amounts of greenhouse gas emissions.
- Reduce, reuse, and recycle.
- Plant a tree. Trees absorb carbon dioxide, keeping it out of the atmosphere.
- Use less electricity.
- Eat less meat. Cows are one of the biggest methane producers.
- Support alternative energy sources that don't burn fossil fuels, such as solar power and wind energy.

The climate has changed many times during Earth's history, but the changes have occurred slowly, over thousands of years. Only in this century have human activities begun to influence climate—and scientists are still struggling to understand what the consequences might be.