How Was Earth’s Climate Different in the Past?

The geologic record shows that Earth’s climate in the past was different from its climate today. During some periods in the past, Earth was much warmer. During other periods, Earth was much colder. In fact, much of Earth was covered by sheets of ice during some times in the past.

An **ice age** happens when ice at high latitudes expands toward lower latitudes. Scientists have found evidence of many major ice ages in Earth’s history. The most recent one began about 2 million years ago.

Many people think of an ice age as a time when the temperature is always very cold. However, during an ice age, there can be periods of colder or warmer weather. A period of colder weather is called a **glacial period**. A period of warmer weather is called an **interglacial period**.

During glacial periods, large sheets of ice grow. These ice sheets form when ocean water freezes. Therefore, sea level drops during glacial periods. The figure below shows the coastlines of the continents during the last glacial period. Notice that the continental coastlines extended further into the ocean than they do today.
What Can Cause Climates to Change?

Scientists have several theories to explain ice ages and other forms of climate change. Factors that can cause climate change include Earth’s orbit, plate tectonics, the sun’s cycles, asteroid impacts, volcanoes, and human activities.

CHANGES IN EARTH’S ORBIT

A Serbian scientist, Milutin Milankovitch, found that changes in Earth’s orbit and tilt can affect Earth’s climate. He modeled the way Earth moves in space and found that Earth’s movements change in a regular way. These changes happen over tens of thousands of years. For example, Earth’s orbit around the sun is more circular at some times than at others.

These variations in Earth’s orbit and tilt affect how much sunlight Earth gets. Therefore, they can also affect climate. The figure below shows how these factors can change the amount of sunlight Earth gets.

Critical Thinking

3. Infer Could changes in climate over 100 years be caused by changes in Earth’s orbit and tilt? Explain your answer.

TAKE A LOOK

4. Identify How does the shape of Earth’s orbit change?
PLATE TECTONICS

Plate tectonics and continental drift also affect Earth’s climate. When a continent is closer to the equator, its climate is warmer than when it is near the poles. Also, remember that continents can deflect ocean currents and winds. When continents move, the flow of air and water around the globe changes. These changes can strongly affect Earth’s climate.

THE SUN

Some changes in Earth’s climate are caused by changes in the sun. Many people think that the sun is always the same, but this is not true. In fact, the amount of energy that the sun gives off can change over time. The sun follows a regular cycle in how much energy it gives off. Because the sun’s energy drives most cycles on Earth, these changes can affect Earth’s climate.

IMPACTS

Sometimes, objects from outer space, such as asteroids, crash into Earth. An asteroid is a small, rocky object that orbits the sun. If a large asteroid crashed into Earth, the climate of the whole planet could change.

When a large object hits Earth, particles of dust and rock fly into the atmosphere. This material can block some sunlight from reaching Earth’s surface. This can cause temperatures on Earth to go down. In addition, plants may not be able to survive with less sunlight. Without plants, many animals would die off. Many scientists believe that an asteroid impact may have caused the dinosaurs to become extinct.

TAKE A LOOK

5. Identify How was the climate of India different when it was part of Pangaea?

6. Explain Why do changes in the sun’s energy affect the climate on Earth?

Critical Thinking

7. Identify Relationships Why may animals die off if there are fewer plants around?
VOLCANIC ERUPTIONS
Volcanic eruptions can affect Earth’s climate for a short time. They send large amounts of dust and ash into the air. As with an asteroid impact, the dust and ash block sunlight from reaching Earth’s surface. The figure below shows how volcanic dust can affect sunlight.

TAKE A LOOK
8. Compare How are the effects on climate of volcanic eruptions and asteroid impacts similar?

What Is Global Warming?
A slow increase in global temperatures is called global warming. One thing that can cause global warming is an increase in the greenhouse effect. The greenhouse effect is Earth’s natural heating process. During this process, gases in the atmosphere absorb energy in sunlight. This energy is released as heat, which helps to keep Earth warm. Without the greenhouse effect, Earth’s surface would be covered in ice.

One of the gases that absorbs sunlight in the atmosphere is carbon dioxide (CO₂). If there is more CO₂ in the atmosphere, the greenhouse effect can increase. This can cause global warming.
WHERE CO₂ COMES FROM

Much of the CO₂ in the atmosphere comes from natural processes, such as volcanic eruptions and animals breathing. However, human activities can also increase the amount of CO₂ in the atmosphere.

When people burn fossil fuels for energy, CO₂ is released into the atmosphere. When people burn trees to clear land for farming, CO₂ is released. In addition, plants use CO₂ for food. Therefore, when trees are destroyed, we lose a natural way of removing CO₂ from the atmosphere.

PROBLEMS WITH GLOBAL WARMING

Many scientists think that if global warming continues, the ice at Earth’s poles could melt. This could cause sea levels to rise. Many low-lying areas could flood. Global warming could also affect areas far from the oceans. For example, the Midwestern part of the United States could become warmer and drier. Northern areas, such as Canada, may become warmer.

WHAT PEOPLE CAN DO

Many countries are working together to reduce the effects of global warming. Treaties and laws have helped to reduce pollution and CO₂ production. Most CO₂ is produced when people burn fossil fuels for energy. Therefore, reducing how much energy you use can reduce the amount of CO₂ produced. Here are some ways you can reduce your energy use:

- Turn off electrical devices, such as lights and computers, when you are not using them.
- Ride a bike, walk, or take public transportation instead of using a car to travel.
- Turn the heater to a lower temperature in the winter.
- Turn the air conditioner to a higher temperature in the summer.

READING CHECK

10. Identify What are two natural sources of carbon dioxide in the atmosphere?

11. Explain Why may sea level rise if global warming continues?
Section 4 Review

SECTION VOCABULARY

global warming  a gradual increase in average global temperature

greenhouse effect  the warming of the surface and lower atmosphere of Earth that occurs when water vapor, carbon dioxide, and other gases absorb and reradiate thermal energy

ice age  a long period of climatic cooling during which the continents are glaciated repeatedly

1. Identify Relationships  How is global warming related to the greenhouse effect?

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________________________________________________________________________

________________________________________________________________________

2. Describe  What did Milutin Milankovitch’s research show can affect Earth’s climate?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

3. Identify  Give two ways that plate tectonics can affect an area’s climate.

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4. Predict Consequences  How could global warming affect cities near the oceans? Explain your answer.

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________________________________________________________________________

5. List  Give three ways that human activities can affect the amount of CO₂ in the atmosphere.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
SECTION 2 THE TROPICS

1. They receive different amounts of rain and have different kinds of soil.
2. between 23.5°N and 23.5°S latitude
3. It gets about the same amount of sunlight all year long.
4. Nutrients are quickly used up by plants or washed away by rain.
5. Possible answer: Many plants would die out because they rely on fires for survival or reproduction.
6. about 3 ft
7. The temperature in a desert can be much lower at night than during the day.

Review
1. tropical rain forest, tropical desert, tropical savanna
2. high temperatures
3. First row, from left to right: over 200 cm per year, fern
   Second row, from left to right: tropical savanna, poor, thorny shrub
   Third row, from left to right: tropical desert, less than 25 cm per year, scorpion
4. No, because it is not located in the Tropics.
5. Africa
6. tropical deserts have the largest temperature range; tropical rain forests have the smallest temperature range.

SECTION 3 TEMPERATE AND POLAR ZONES

1. They all experience seasonal changes in weather.
2. chaparral
3. They are probably evergreens, because they still have leaves in the winter and they are found in a temperate forest.
4. grass
5. waxy coatings on leaves to prevent water loss
6. Possible answer: Temperate deserts have a larger temperature range.
7. North America, Asia, Europe
8. The ice in it melts, but the permafrost prevents the water from draining away.
9. 16 in. to 24 in.
10. the climate of a small area

Review
1. temperate forest, temperate grassland, chaparral, temperate desert
2. between 23.5° and 66.5° north or south latitudes
3. They have clear skies and low humidity. This allows the land to heat up a lot during the day and the heat to move easily into the atmosphere at night.
4. The pavement and other structures in cities absorb solar energy and heat up, causing the climate to be warmer.
5. The main plants in the taiga are evergreens with acidic compounds in their leaves. When the leaves fall to the ground and decay, they make the soils acidic.
6. They both receive little to no precipitation.
7. They do not get enough rain.

SECTION 4 CHANGES IN CLIMATE

1. An ice age is a time period in which glaciers are found at lower latitudes than at other times.
2. Ocean water freezes to form ice. As a result, global sea level drops, exposing more land.
3. Probably not, because these changes take place over tens of thousands of years.
4. Sometimes it is more circular than others.
5. It was colder and covered with ice.
6. Energy from the sun powers many cycles on Earth.
7. Animals use plants for food.
8. Both release dust into the air, which blocks sunlight from reaching the Earth's surface. This causes the temperature to decrease.
9. a gradual increase in global temperatures
10. animals breathing, volcanoes
11. Polar ice could melt, putting more water into the oceans and making them deeper.

Review
1. Global warming can happen because of an increase in the greenhouse effect.
2. Changes in Earth's orbit and tilt can cause changes in the climate.
3. When continents move, they may be exposed to more or less solar radiation, which can change their climate. Also, continents deflect wind and ocean currents, so changes in their locations can have significant impacts on global climate.
4. Coastal cities could flood due to increases in global sea level.
5. Burning fossil fuels and trees can increase CO₂ in the atmosphere. Cutting down trees prevents them from removing CO₂ from the atmosphere. Using less electricity that comes from the burning of fossil fuels can help reduce the amount of CO₂ that is added to the atmosphere.

Chapter 18 Studying Space

SECTION 1 ASTRONOMY: THE ORIGINAL SCIENCE
1. by studying the motions of the planets, the moon, and the sun
2. Day: the time it takes the Earth to rotate once on its axis
   Month: roughly the time it takes the moon to orbit the Earth once
   Year: the time it takes the Earth to orbit the sun once
3. More information has become available to them.
4. The sun is not the center of the universe.
5. Ptolemy: The Earth is the center of the universe, and all other objects orbit the Earth.
   Copernicus: The sun is the center of the universe, and the planets orbit the sun.
6. He made detailed astronomical observations.
7. the sun

Review
1. A day is the amount of time required for the Earth to rotate once on its axis. A month is the amount of time required for the moon to orbit around the Earth. A year is the amount of time required for the Earth to orbit around the sun.
2. The movements are predictable and regular.
3. It predicted the motions of the planets more accurately than any other theory. Its predictions matched the observations of scientists living at the time.
4. Brahe gathered data that Kepler was able to analyze to develop the laws of planetary motion.
5. Galileo used a telescope to examine the night sky. Earlier astronomers could only observe the sky with their eyes.

SECTION 2 TELESCOPES
1. the place where light rays from a lens or mirror come together
2. The objective lens collects and focuses the light. The eyepiece lens magnifies the image.
3. with lenses
4. focuses the light and reflects it to the eyepiece
5. Light may reflect off water vapor in the air, causing images to be blurry.
6. gamma rays
7. Possible answers: radio waves, microwaves
8. using nonoptical telescopes
9. The atmosphere can prevent some kinds of radiation from reaching the Earth’s surface.
10. In each image, a feature that is not visible in any of the other images should be circled.

SECTION 3 MAPPING THE STARS
1. 88
2. Hydra
3. Different constellations are visible from different points on the Earth.
4. The Earth rotates and makes different parts of the sky visible.
5. The star should be drawn about halfway up the arc.