Name _____ Date _____ Class _____

SECTION 4-1 SECTION SUMMARY

What Causes Climate?

Guide for Reading

- What are the factors that influence temperature and precipitation?
- What causes the seasons?

Climate is the average, year-after-year conditions of temperature, precipitation, winds, and clouds in an area. The climate of a region is determined by two main factors: temperature and precipitation.

The main factors that influence temperature are latitude, altitude, distance from large bodies of water, and ocean currents. Earth's surface is divided into three temperature zones. The **tropical zone** is the area near the equator, between about 23.5° north latitude and 23.5° south latitude. It has a warm climate because it receives direct sunlight all year. The **polar zones** extend from about 66.5° to 90° north and 66.5° to 90° south latitudes. They have cold climates because the sun strikes the ground at a lower angle. The **temperate zones** are between the tropical and polar zones—from about 23.5° to 66.5° north and 23.5° to 66.5° south latitudes. They have weather that ranges from warm in the summer to cold in the winter. Altitude is an important climate factor because air temperature decreases as altitude increases. Large bodies of water influence temperatures because water heats up and cools down more slowly than land. **Marine climates** have relatively warm winters and cool summers. **Continental climates** occur in inland areas and are often characterized by cold winters and warm or hot summers. Many marine climates are also influenced by ocean currents.

The main factors that affect precipitation are prevailing winds and the presence of mountains. The amount of water vapor in prevailing winds depends on how warm or cool the air is and where the winds come from. Warm air can carry more water vapor than cold air. Winds blowing inland from oceans also carry more water vapor than winds that blow over land. A mountain range in the path of prevailing winds influences where precipitation falls. Winds are forced to rise up and pass over the mountains. The rising warm air cools, and its water vapor condenses and falls as rain or snow on the **windward** side of the mountains, the side the oncoming wind hits. The land on the **leeward,** or downwind, side of mountains does not receive as much precipitation.

The same factors that affect climate regions also affect small areas. Mountains, deserts, lakes, forests, and other natural features influence the climate nearby, resulting in **microclimates,** small areas with specific climate conditions.

Most places on Earth, outside the tropics, have four seasons. **The seasons are caused by the tilt of Earth's axis as Earth travels around the sun.** The seasons change as the amount of energy each hemisphere receives from the sun changes. For example, in June the north end of Earth's axis is tilted toward the sun. The Northern Hemisphere receives more energy. It is summer in the Northern Hemisphere and winter in the Southern Hemisphere.

Name _____ Date _____ Class _____

SECTION 4-1 REVIEW AND REINFORCE

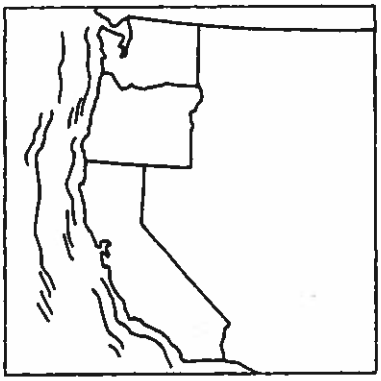
What Causes Climate?

◆ Understanding Main Ideas

On a separate sheet of paper, identify the climate factor(s) that influence the climate in each picture. Indicate whether the climate factors are affecting temperature, precipitation, or both.

1. Alaska

2. Rocky Mountains



3. West Coast

4

Answer the following questions on your other sheet of paper.

4. Explain how Earth's tilted axis causes the seasons.
5. At what times of the year do both of Earth's hemispheres receive the same amount of energy from the sun? Explain why this occurs.

◆ Building Vocabulary

Match each term with its definition by writing the letter of the correct definition on the line beside the term.

_____ 6. leeward

_____ 7. polar zones

_____ 8. climate

_____ 9. windward

_____ 10. tropical zone

_____ 11. microclimate

_____ 12. temperate zones

a. the average year-after-year conditions of temperature, precipitation, winds, and clouds

b. an area near the equator that receives direct sunlight all year round

c. the side of a mountain that faces the oncoming wind

d. a small area with specific climate conditions

e. areas that extend from about 66.5° to 90° north and south latitudes

f. the side of a mountain that is downwind

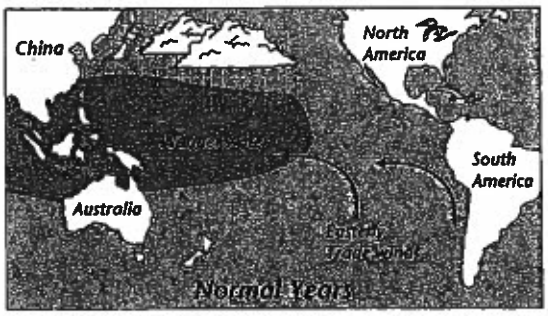
g. areas located from about 23.5° to 66.5° north and south latitudes

Name _____ Date _____ Class _____

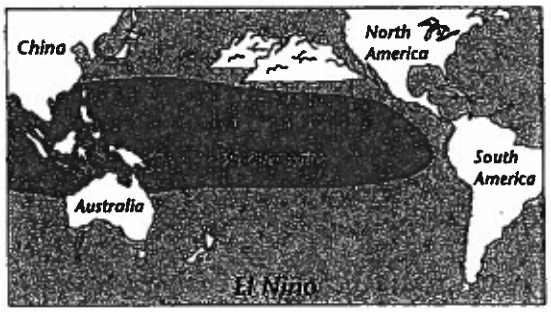
SECTION 4-1 ENRICH

El Niño—A Warm Ocean Current

From the fall of 1997 through the spring of 1998, the weather across the United States, and the rest of the world, was highly unusual. Tornadoes devastated parts of Florida. The upper Midwest enjoyed a mild winter. The West Coast braced for floods and mudslides. Australia and Indonesia faced droughts and brush fires. All of these unusual weather patterns could be traced to one event—El Niño.



El Niño is a warm current in the Pacific Ocean off the coast of South America. El Niño is a Spanish term that means the Christ child. Peruvian sailors gave this name to the current because it usually appears during the Christmas season. An El Niño occurs when the easterly trade winds over the central and western Pacific Ocean weaken. Normally, these trade winds blow off the coast of South America to the west. These winds push the warm ocean water at the surface toward the western part of the Pacific Ocean near Australia and Indonesia. As the warm water evaporates, clouds form that bring rain to Indonesia and Australia. The water that is blown westward is replaced by an upwelling of cold water along the coast of South America. This cold water is full of food and nutrients for fish and other marine animals.



During an El Niño, the easterly trade winds blowing off the coast of South America weaken, and the warm water flows back toward the east. The upwelling of cold water along the coast of South America stops. Since the warm water is moving eastward, the clouds form much farther east. These clouds bring rain to the coasts of North and South America, leaving Australia and Indonesia with droughts.

An El Niño occurs every three to seven years and is sometimes followed by a La Niña, a cold ocean current. El Niño is not just a recent event. Historical records show occurrences of El Niños as early as 1567.

Answer the following questions on a separate sheet of paper.

1. What causes an El Niño to occur?
2. Identify the climate factors that change during an El Niño.
3. How would an El Niño affect the fishing industry in South America?
4. Why do countries in the western Pacific, such as Australia and Indonesia, experience droughts during an El Niño?
5. Does El Niño cause a permanent change in the climate? Explain.

Name _____ Date _____ Class _____

SECTION 4-3 SECTION SUMMARY

Long-Term Changes in Climate

Guide for Reading

- What principle do scientists follow in studying ancient climates?
- What changes occur on Earth's surface during an ice age?
- What theories have been proposed to explain natural climate change?

Climates change, both in small areas and throughout the world. Climates change very slowly, but the consequences are great. **In studying ancient climates, scientists follow an important principle: If plants or animals today need certain conditions to live, then similar plants and animals in the past also required those conditions.** Scientists use three sources of information to learn about ancient climates: fossils, tree rings, and pollen records. Fossils tell scientists what kinds of plants and animals once lived in an area. The thickness of tree rings tells scientists whether a certain year was cool or warm, wet or dry. From the pollen record, scientists can identify the types of plants that lived in the area. From this, they can infer what the climate once was.

Over millions of years, warm climate periods have alternated with cold climate periods known as **ice ages,** or glacial episodes. **During each ice age, huge sheets of ice called glaciers covered large parts of Earth's surface.** Scientists have determined from fossil and other evidence that there have been at least four major ice ages in the past two million years. The most recent ice age ended only about 10,500 years ago. During this ice age, ice sheets covered much of northern Europe and North America, reaching as far south as present-day Iowa and Nebraska. So much water was frozen in the ice sheets that the average sea level was much lower than it is today. When the ice sheets melted, the rising oceans flooded coastal areas and large inland lakes were formed.

Scientists have formed several hypotheses to explain what causes climates to change. **Possible explanations for major climate changes include variations in the position of Earth relative to the sun, changes in the sun's energy output, and the movement of continents.** The combined effects of changes in Earth's movements may be the main cause of ice ages. Short-term climate changes have been linked to **sunspots,** which are dark, cooler regions on the surface of the sun. Sunspots increase and decrease in regular 11-year cycles. These cycles could be caused by changes in the energy output of the sun. Another explanation for changes in Earth's climates is that Earth's continents have not always been located where they are now. About 225 million years ago, most of the land on Earth was part of a single continent called Pangaea. Over millions of years, the continents broke apart and gradually moved to their present positions. These changes in the locations of land and sea also affected global patterns of winds and ocean currents, which in turn slowly changed climates. As the continents continue to move, climates will continue to change.

Name _____ Date _____ Class _____

SECTION 4-3 REVIEW AND REINFORCE

Long-Term Changes in Climate

◆ Understanding Main Ideas

Answer the following questions in the spaces provided.

1. What principle do scientists follow when they study ancient climates?

_____

_____

_____

2. List three sources of information scientists use to learn about ancient climates.

_____

_____

_____

3. How does Earth's surface change during an ice age?

_____

_____

_____

4. Why is Earth's sea level lower during an ice age?

_____

_____

_____

5. What are three possible causes of climate change?

_____

_____

_____

◆ Building Vocabulary

Fill in the space to complete each sentence.

6. Dark, cooler regions on the surface of the sun, called _____, have been linked to short-term climate changes.

7. Over millions of years, warm climate periods have alternated with cold climate periods known as _____, or glacial episodes.

4

Name _____ Date _____ Class _____

SECTION 4-4 SECTION SUMMARY

Global Changes in the Atmosphere

Guide for Reading

- **How might human activities be affecting the temperature of Earth's atmosphere?**
- **How have human activities affected the ozone layer?**

Most changes in world climates are caused by natural factors. However, human activities in the last hundred years have also had an effect on Earth's climate and atmosphere. Over the last 120 years, the average temperature of the troposphere has risen by about 0.5° Celsius. Some scientists think that an increase of gases in Earth's atmosphere has trapped more heat from the sun, causing an increase in the temperature of Earth's atmosphere. Gases in the atmosphere that trap heat are called **greenhouse gases.** Water vapor, carbon dioxide, and methane are some of the greenhouse gases. **Human activities that add greenhouse gases to the atmosphere may be warming Earth's atmosphere.** If the increased greenhouse gases trap more heat, the result could be **global warming,** a gradual increase in the temperature of Earth's atmosphere. Not everyone, however, agrees about the causes of global warming. Some scientists think the increase in global temperatures over the past 120 years may be the result of natural variations in climate.

Global warming might have both positive and negative effects. Farmers in cool areas could plant two crops per year. Places that are too cold for farming today could become farmland. However, higher temperatures would dry out fertile soils, making some farm fields "dust bowls." An increase in temperature could also warm up ocean water, causing an increase in the number of hurricanes. Glaciers and polar ice caps might partially melt, which would increase sea levels and cause flooding in low-lying coastal areas.

Another global change in the atmosphere involves the ozone layer. Ozone in the atmosphere filters out much of the harmful ultraviolet radiation from the sun. In the 1970s, scientists noticed that the ozone layer over Antarctica was becoming thinner. The area of the thinner ozone has been increasing since then. **Chemicals produced by humans have been damaging the ozone layer.** The main cause of ozone depletion is a group of chlorine compounds called **chlorofluorocarbons,** or CFCs. CFCs rise all the way to the stratosphere before being broken down into atoms, including chlorine. The chlorine atoms break ozone down into oxygen atoms. Because ozone blocks ultraviolet radiation, a decrease in ozone means an increase in the amount of ultraviolet radiation that reaches Earth's surface. Ultraviolet radiation can cause eye damage and some skin cancers. To reduce ozone depletion, many countries around the world, including the United States, have agreed to stop producing and using CFCs.

Name _____ Date _____ Class _____

SECTION 4-4 REVIEW AND REINFORCE

Global Changes in the Atmosphere

◆ Understanding Main Ideas

Fill in the spaces in the table below.

Global Changes in the Atmosphere

Atmospheric Change	Cause	Possible Negative Effects
1. _____	Increase in greenhouse gases	Fertile farmland dries up 2. _____ 3. _____
Ozone depletion	4. _____	Eye damage Higher risk of sunburn 5. _____

4

◆ Building Vocabulary

Fill in the space to complete each statement.

6. A gradual increase in the temperature of Earth's atmosphere is called _____.

7. A group of chlorine compounds called _____ is the main cause of ozone depletion.

8. Gases in the atmosphere that trap heat are called _____.