

Climate Regions

CALIFORNIA

Standards Focus

5.6.4.e Students know differences in pressure, heat, air movement, and humidity result in changes in weather.

- What factors are used to classify climates?
- What are the six main climate regions?

Key Terms

- rain forest
- savanna
- desert
- steppe
- chapparral
- humid subtropical
- subarctic
- tundra
- permafrost

Lab zone

Standards Warm-Up

How Do Climates Differ?

- Collect pictures from magazines and newspapers of a variety of land areas around the world.
- Sort the pictures into categories according to common weather characteristics.



Think It Over

Forming Operational Definitions Choose several words that describe the typical weather for each category. What words would you use to describe the typical weather where you live?

Suppose you lived for an entire year near the equator. It would be very different from where you live now. The daily weather, the amount of sunlight, and the pattern of seasons would all be new to you. You would be in another climate region.

Scientists classify climates according to two major factors: temperature and precipitation. They also consider the distinct vegetation in different areas. This system, developed around 1900 by Vladimir Köppen, identifies broad climate regions, each of which has smaller subdivisions.

There are six main climate regions: tropical rainy, dry, temperate marine, temperate continental, polar, and highlands. California has a wide variety of climate regions, including dry, temperate marine, and highlands.

Maps show boundaries between the climate regions. In the real world, of course, no clear boundaries mark where one climate region ends and another begins. Each region blends gradually into the next.

Tropical Rainy Climates

The tropics have two types of rainy climates: tropical wet and tropical wet-and-dry. Tropical wet climates are found in low-lying lands near the equator.

Tropical Wet In areas that have a tropical wet climate, many days are rainy, often with afternoon thunderstorms. These thunderstorms are triggered by midday heating. Another source of precipitation is prevailing winds. In many areas with a tropical wet climate, the trade winds bring moisture from the oceans. With year-round heat and heavy rainfall, vegetation grows lush and green. Dense rain forests grow in these rainy tropical climates. **Rain forests** are forests in which large amounts of rain fall year-round. Tropical rain forests are important because it is thought that at least half of the world's species of land plants and animals are found there.

In the United States, only the windward sides of the Hawaiian islands have a tropical wet climate. Rainfall is very heavy—over 10 meters per year on the windward side of the Hawaiian island of Kauai. The rain forests of Hawaii have a large variety of plants, including ferns, orchids, and many types of vines and trees.

Tropical Wet-and-Dry Areas that have tropical wet-and-dry climates receive slightly less rain than tropical climates and have distinct dry and rainy seasons. Instead of rain forests, there are tropical grasslands called **savannas**. Scattered clumps of trees that can survive the dry season dot the coarse grasses. Only a small part of the United States—the southern tip of Florida—has a tropical wet-and-dry climate. The graphs in Figure 14 show how temperature and precipitation vary in Makendu, Kenya, in East Africa.



What parts of the United States have tropical rainy climates?



Figure 13
Tropical Rain Forests
Lush tropical rain forests grow in the tropical wet climate.

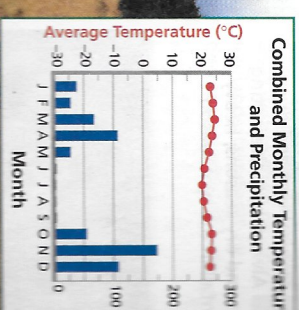
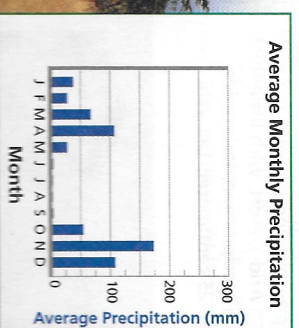
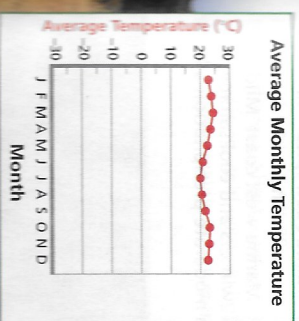
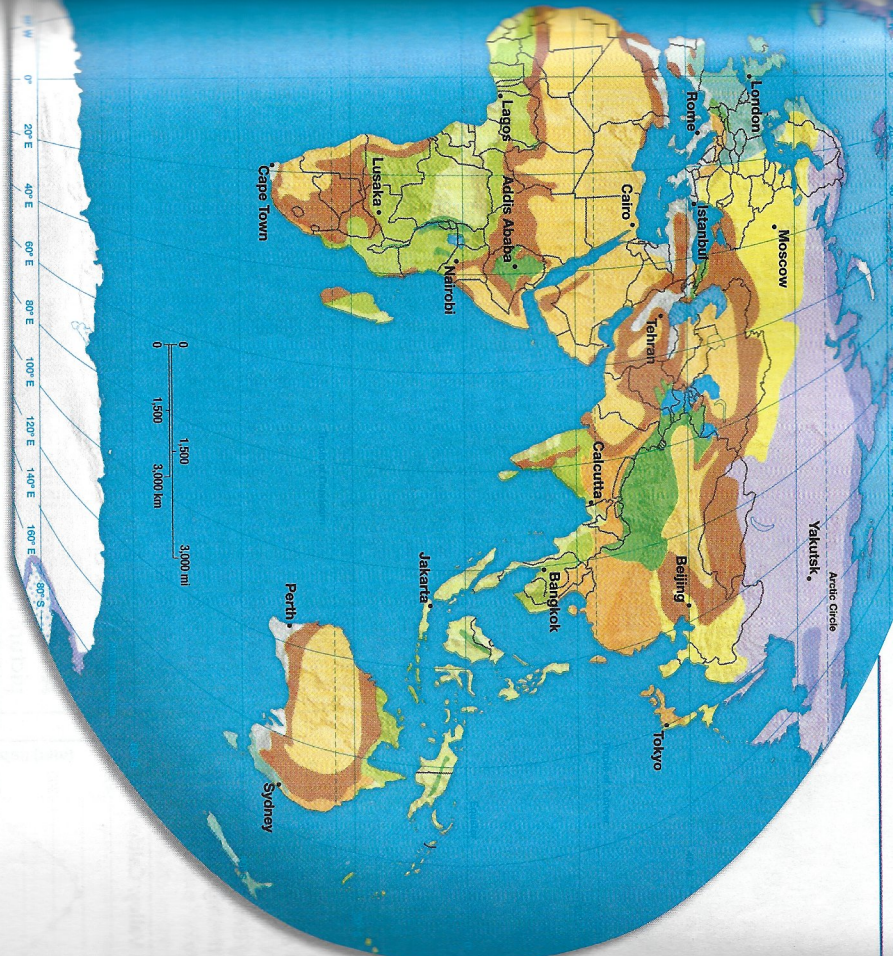
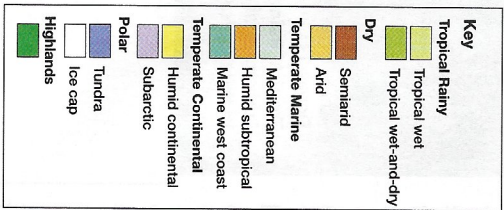


Figure 14

Climate Graphs
A graph of average temperature (left) can be combined with a graph of average precipitation (middle) to form a climate graph. These graphs show data for a tropical wet-and-dry region.

Figure 15
Climate Regions

Climate regions are classified according to a combination of temperature and precipitation. Climates in highland regions change rapidly as altitude changes.



Tropical Rainy
Temperature always 18°C or above

- Tropical wet** Always hot and humid, with heavy rainfall (at least 6 centimeters per month) all year round
- Tropical wet-and-dry** Always hot; alternating wet and dry seasons; heavy rainfall in the wet season

Dry
Occurs wherever potential evaporation is greater than precipitation; may be hot or cold

- Semi-arid** Dry but receives about 25 to 50 centimeters of precipitation per year
- Arid** Desert, with little precipitation, usually less than 25 centimeters per year

Temperate Marine
Averages 10°C or above in warmest month, between -3°C and 18°C in the coldest month

- Mediterranean** Warm, dry summers and rainy winters
- Humid subtropical** Hot summers and cool winters
- Marine west coast** Mild winters and cool summers, with moderate precipitation all year

Temperate Continental
Average temperature 10°C or above in the warmest month or below in the coldest month

- Humid continental** Hot, humid summers and cold winters, with moderate precipitation year round
- Subarctic** Short, cool summers and long, cold winters; light precipitation, mainly in summer

Polar
Average temperature below 10°C in the warmest month

- Tundra** Always cold with a short, cool summer—warmest temperature about 10°C
- Ice cap** Always cold, average temperature at or below 0°C

Highlands
Generally cool

- Highlands** Wetter than lowlands; temperature decreasing with altitude



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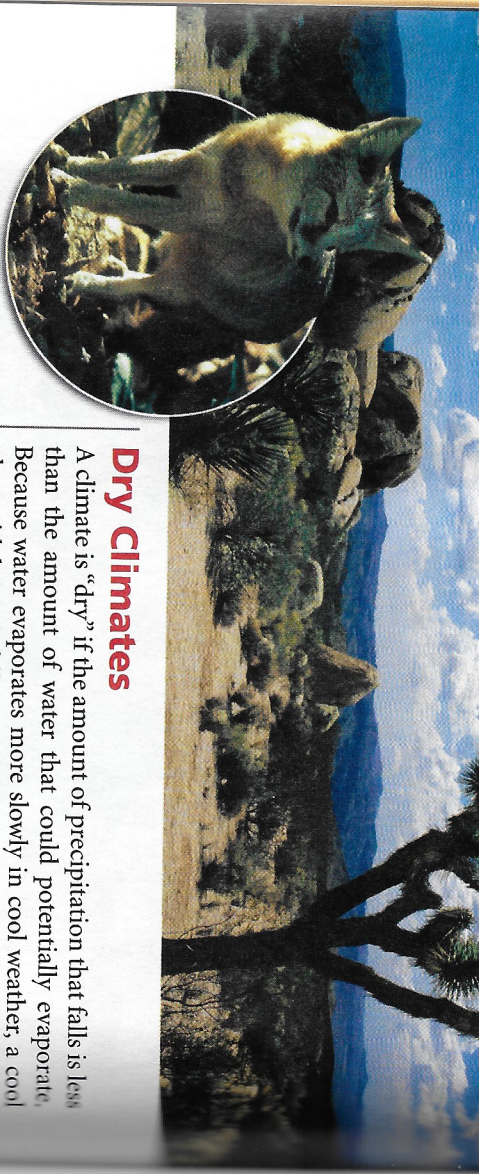
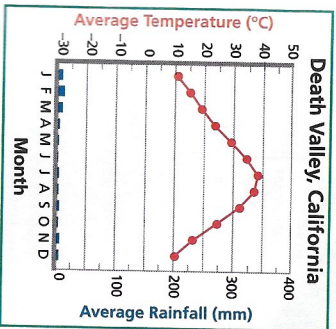


Figure 16
Arid Climate

California's deserts are home to a variety of animals, including the kit fox.

Interpreting Graphs Which month has the highest average temperature?



Dry Climates
A climate is “dry” if the amount of precipitation that falls is less than the amount of water that could potentially evaporate. Because water evaporates more slowly in cool weather, a cool place with low rainfall may not be as dry as a warmer place that receives the same amount of rain. ➔ **Dry climates include arid and semiarid climates.**

Look at the map of world climate regions in Figure 15. What part of the United States is dry? Why is precipitation in this region so low? As you can see, dry regions often lie inland, far from oceans that are the source of humid air masses. In addition, much of the region lies in the rain shadow east of the Sierra Nevada and Rocky Mountains. Humid air masses from the Pacific Ocean lose much of their water as they cross the mountains. Little rain or snow is carried to dry regions.

Arid When you think about **deserts**, or arid regions, you may picture blazing heat and drifting sand dunes. Some deserts are hot and sandy, but others are cold or rocky. On average, arid regions, or deserts, get less than 25 centimeters of rain a year. Some years may bring no rain at all. Only specialized plants such as cactus and yucca can survive the desert’s dryness and extremes of hot and cold. Much of California’s southeast, including Death Valley and the rest of the Mojave Desert, has an arid climate.

Semi-arid Locate the semiarid regions in Figure 15. As you can see, large semiarid areas are usually located on the edges of deserts. These semiarid areas are called **steppes**. A **steppe** is dry but gets enough rainfall for short grasses and low bushes to grow. For this reason, a steppe may also be called a prairie or grassland. The Great Plains are the major steppe region of the United States. Portions of southeastern California are considered semiarid.



Reading Checkpoint

What is a desert?

Temperate Marine Climates

Look once again at Figure 15. Along the coasts of continents in the temperate zones, you will find the third main climate region, temperate marine. ➔ **There are three kinds of temperate marine climates: marine west coast, Mediterranean, and humid subtropical.** Because of the moderating influence of oceans, all three are humid and have mild winters.

Marine West Coast The coolest temperate marine climates are found on the west coasts of continents north of 40° north latitude and south of 40° south latitude. Humid ocean air brings mild, rainy winters. Summer precipitation can vary considerably.

In North America, the marine west coast climate extends from northern California to southern Alaska. In the northwestern United States, humid air from the Pacific Ocean hits the western slopes of the Coastal Ranges. The air rises up the slopes of the mountains, and it cools. As the air cools, large amounts of rain or snow fall on the western slopes. The eastern slopes lie in the rain shadow of the mountains and receive little precipitation.

Because of the heavy precipitation, thick forests of tall trees grow in this region, including coniferous, or cone-bearing, trees such as Sitka spruce, Douglas fir, redwoods, and Western red cedar, as shown in Figure 17. One of the main industries of this region is harvesting and processing wood for lumber, paper, and furniture.

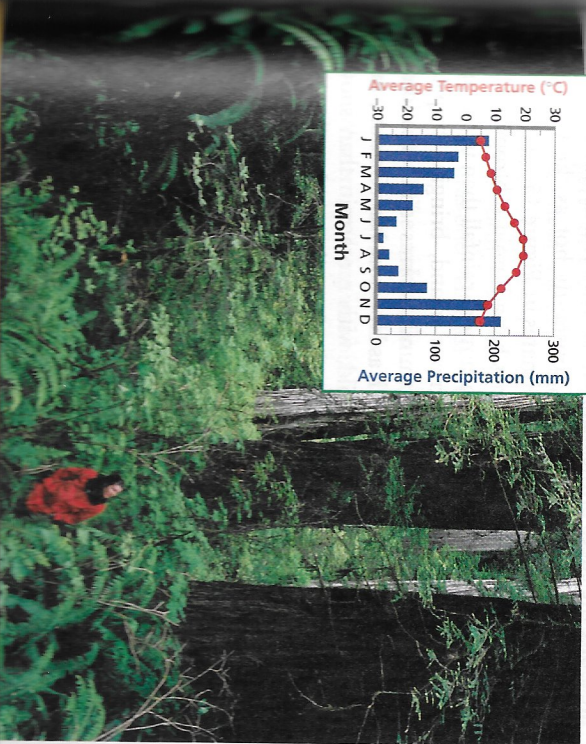
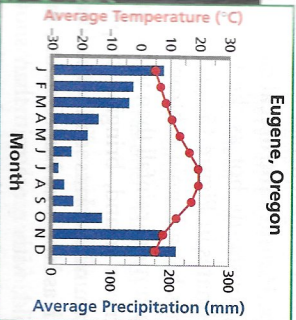


Figure 17

Marine West Coast Climate
Redwoods, Douglas fir, and spruce dominate the lush forest found in marine west coast

Lab Try This Activity

Modeling a Climate

Here's how you can model humidity.

1. Put the same amount of water in each of plastic bowls.
2. Place a sheet of transparent plastic over each bowl. Leave each sheet with a band.
3. Place one bowl on sunny windowsill and the other on a radiator. Put the bowl in a cool location.
4. Wait a day and then at the two bowls, you see on the plastic wrap over each bowl.

Inferring Would you find more water in the air in a warm climate or in a cool one? Why? Your results in terms of energy.

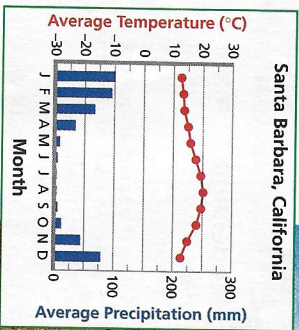


Figure 18

Mediterranean Climate

Santa Barbara, on the coast of southern California, has a Mediterranean climate. Mild temperatures throughout the year make the area ideal for growing olives and citrus fruits.

Interpreting Graphs How much precipitation does Santa Barbara receive in July? In January?



Mediterranean A coastal climate that is drier and warmer than west coast marine is known as Mediterranean. Most areas with this climate are found around the Mediterranean Sea. In the United States, much of coastal California has a Mediterranean climate. This climate is mild, with two seasons. In winter, marine air masses bring cool, rainy weather. Summers are somewhat warmer, with little rain.

Mediterranean climates have two main vegetation types. One is made up of dense shrubs and small trees, called **chaparral** (shap uh RAL). The other vegetation type includes grasses with a few large trees.

Agriculture is important to the economy of California's Mediterranean climate region. Using irrigation, farmers grow many different crops, including rice, many vegetables, fruits, and nuts.

Humid Subtropical The warmest temperate marine climates are along the edges of the tropics. **Humid subtropical** climates are wet and warm, but not as constantly hot as the tropics. Locate the humid subtropical climates in Figure 15.

The southeastern United States has a humid subtropical climate. Summers are hot, with much more rainfall than in winter. Maritime tropical air masses move inland, bringing tropical weather conditions, including thunderstorms and occasional hurricanes, to southern cities such as Houston, New Orleans, and Atlanta. Winters are cool to mild, with more rain than snow. However, polar air masses moving in from the north can bring freezing temperatures and frosts.

Mixed forests of oak, ash, hickory, and pines grow in the humid subtropical region of the United States. Important crops in this region include oranges, peaches, peanuts, sugar cane, and rice.



What region of the United States has a humid subtropical climate?

Temperate Continental Climates Temperate continental climates are not influenced very much by oceans, so they commonly have extremes of temperature. **Temperate continental climates are only found on continents in the Northern Hemisphere, and include humid continental and subarctic.** The parts of continents in the Southern Hemisphere south of 40° south latitude are not far enough from oceans for dry continental air masses to form.

Humid Continental Shifting tropical and polar air masses bring constantly changing weather to humid continental climates. In winter, continental polar air masses move south, bringing bitterly cold weather. In summer, tropical air masses move north, bringing heat and high humidity. Humid continental climates receive moderate amounts of rain in the summer. Smaller amounts of rain or snow fall in winter.

What parts of the United States have a humid continental climate? The eastern part of the region—the Northeast—has a range of forest types, from mixed forests in the south to coniferous forests in the north. Much of the western part of this region—the Midwest—was once tall grasslands, but is now farmland.

Subarctic The **subarctic** climates lie north of the humid continental climates. Summers in the subarctic are short and cool. Winters are long and bitterly cold.

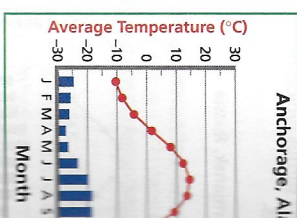
In North America, coniferous trees such as spruce and fir make up a huge northern forest that stretches from Alaska to eastern Canada. Wood products from this forest are an important part of the economy. Many large mammals, including bears and moose, live in the forest. Birds of many species breed in the subarctic.



Figure 19

Subarctic Climate

Subarctic climates have summers and cold winters. The world's largest subarctic forest is in Russia, Canada, and Alaska. This emperor goose is the subarctic climate.



Lab Skills Activity

The table shows some climate data for three cities.

	City A	City B	City C
Average Jan. Temp. (°C)	12.8	18.9	-5.6
Average July Temp. (°C)	21.1	27.2	20
Annual Precipitation (cm)	33	152	109

Describe the climate you would expect each city to have. Identify the cities of Miami, Florida; Los Angeles, California; and Portland, Maine. Use Figure 15 to help identify each city's climate.

Polar Climates

The polar climate is the coldest climate region, and includes the ice cap and tundra climates. Ice cap and tundra climates are found only in the far north and south, near the North and South poles. Most polar climates are relatively dry, because the cold air holds little moisture.

Ice Cap As Figure 15 shows, ice cap climates are found mainly on Greenland and in Antarctica. With average temperatures always at or below freezing, the land in ice cap climate regions is covered with ice and snow. Intense cold makes the air dry. Lichens and a few low plants may grow on the rocks.

Tundra The tundra climate region stretches across northern Alaska, Canada, and Russia. Short, cool summers follow bitterly cold winters. Because of the cold, some layers of the tundra soil are always frozen. This permanently frozen tundra soil is called **permafrost**. Because of the permafrost, water cannot drain away, so the soil is wet and boggy in summer.

It is too cold on the tundra for trees to grow. Despite the harsh climate, during the short summers the tundra is filled with life. Mosquitoes and other insects hatch in the ponds and marshes above the frozen permafrost. Mosses, grasses, lichens, wildflowers, and shrubs grow quickly during the short summers. In North America, herds of caribou eat the vegetation and are in turn preyed upon by wolves. Some birds, such as the white-tailed ptarmigan, live on the tundra year-round. Other, such as the arctic tern and many waterfowl, spend only their summer breeding seasons there.

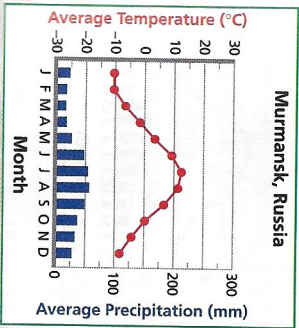


Figure 20

Tundra Climate
The Nenets people are reindeer herders on the tundra of northern Russia. These reindeer are grazing on some short shrubs typical of tundra plants.



Highlands

Why are highlands a distinct climate region?

Temperature falls as altitude increases, so highland regions are colder than the regions that surround them. Increasing altitude produces climate changes similar to the climate changes you would expect with increasing latitude. Precipitation also increases as air masses carrying moisture pass over highland areas.

The climate on the lower slopes of a mountain range is like that of the surrounding countryside. The Rocky Mountain foothills, for instance, share the semiarid climate of the Great Plains. But as you go higher up into the mountains, temperatures become lower and precipitation increases. Climbing 1,000 meters up in elevation is like traveling 1,200 kilometers toward the poles. The climate higher in the mountains is like that of the subarctic: cool with coniferous trees. The high mountains of California, including the Sierra Nevada, have a highland climate. Above a certain elevation—the tree line—temperatures are too low for trees to grow. The climate above the tree line is like that of the tundra. Only low plants, mosses, and lichens can grow there.

Section 3 Assessment

Target Reading Skill Create Outlines Complete your outline for this section. What important ideas did you include about temperate marine climates?

Reviewing Key Concepts

1. a. **Listing** What two major factors are used to classify climates?
b. **Reviewing** What other factor did Köppen use in classifying climates?
2. a. **Identifying** What are the six main climate regions?
b. **Comparing and Contrasting** How is a tropical wet climate similar to a tropical wet-and-dry climate? How are they different?
c. **Inferring** In what climate region would you find plains covered with short grasses and small bushes? Explain.
d. **Relating Cause and Effect** Why do marine west coast climates have much precipitation?

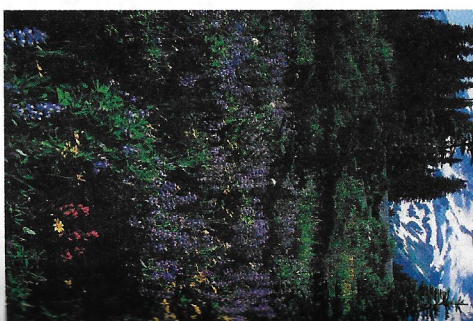


Figure 21

Highland Climate
Highland climates are generally found in surrounding regions. The Mount Rainier area in Washington State has the same climate as highland regions. Summers are long, severe winters are short. **Classifying** What climate zone do you think the highland climate zone of Mount Rainier resembles?

- e. **Predicting** Which place would have the coldest winter—central Russia or the coast of France? Why?
f. **Sequencing** Place the following climate zones in order from coldest to warmest: tundra, subarctic, humid continental, ice cap.
g. **Relating Cause and Effect** How do forest trees on a mountain that is surrounded by a desert?

Lab Zone

At-Home Activity

What's Your Climate? Describe to you the characteristics of the climate region in which you live. What plants and animals in your climate region? What characteristics do these plants and animals have that help them well adapted to the region?