Section 12.1

Objectives
- Compare and contrast weather and climate.
- Analyze how imbalances in the heating of Earth’s surface create weather.
- Describe how air masses form.
- Identify five types of air masses.

Review Vocabulary
heat: transfer of thermal energy from a warmer material to a cooler material

New Vocabulary
weather, climate, air mass, source region

Figure 12.1 A desert climate is dry with extreme variations in day and night temperatures. Only organisms adapted to these conditions, such as this ocotillo, can survive there.

The Causes of Weather

MAIN Idea Air masses have different temperatures and amounts of moisture because of the uneven heating of Earth’s surface.

Real-World Reading Link Have you ever walked barefoot on cool grass and then stepped onto hot pavement on a sunny summer day? Around the world, the Sun heats the different surfaces on Earth to different extents. This uneven heating causes weather.

What is meteorology?

What do you enjoy doing on a summer afternoon? Do you like to watch clouds move across the sky, listen to leaves rustling in a breeze, or feel the warmth of sunlight on your skin? Clouds, breezes, and the warmth of sunlight are examples of atmospheric phenomena. Meteorology is the study of atmospheric phenomena. The root word of meteorology is the Greek word meteoros, which means high in the air. Anything that is high in the sky—raindrops, rainbows, dust, snowflakes, fog, and lightning—is an example of a meteor.

Atmospheric phenomena are often classified as types of meteors. Cloud droplets and precipitation—rain, snow, sleet, and hail—are types of hydrometeors (hi droh MEE tee urz). Smoke, haze, dust, and other particles suspended in the atmosphere are lithometeors (lih thuh MEE tee urz). Examples of electrometeors are thunder and lightning—signs of atmospheric electricity that you can hear or see. Meteorologists study these various meteors.

Weather versus climate Short-term variations in atmospheric phenomena that interact and affect the environment and life on Earth are called weather. These variations can take place over minutes, hours, days, weeks, months, or years. Climate is the long-term average of variations in weather for a particular area. Meteorologists use weather-data averages over 30 years to define an area’s climate, such as that of the desert shown in Figure 12.1. You will read more about Earth’s climates in Chapter 14.

Reading Check Differentiate between weather and climate.

Heating Earth’s Surface

As you learned in Chapter 11, sunlight, which is a part of solar radiation, is always heating some portion of Earth’s surface. Over the course of a year, the amount of thermal energy that Earth receives is the same as the amount that Earth radiates back to space. In meteorology, a crucial question is how solar radiation is distributed around Earth.
**Imbalanced heating** Why are average January temperatures warmer in Miami, Florida, than in Detroit, Michigan? Part of the explanation is that Earth’s axis of rotation is tilted relative to the plane of Earth’s orbit. Therefore, the number of hours of daylight and amount of solar radiation is greater in Miami during January than in Detroit.

Another factor is that Earth is a sphere and different places on Earth are at different angles to the Sun, as shown in Figure 12.2. For most of the year, the amount of solar radiation that reaches a given area at the equator covers a larger area at latitudes nearer the poles. The greater the area covered, the smaller amount of heat per unit of area. Because Detroit is farther from the equator than Miami is, the same amount of solar radiation that heats Miami will heat Detroit less. Investigate this relationship in the MiniLab on this page.

**Thermal energy redistribution** Areas around Earth maintain about the same average temperatures over time due to the constant movement of air and water among Earth’s surfaces, oceans, and atmosphere. The constant movement of air redistributes thermal energy around the world. Weather—from thunderstorms to large-scale weather systems—is part of the constant redistribution of Earth’s thermal energy.

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**MiniLab**

**Compare the Angles of Sunlight to Earth**

**What is the relationship between the angle of sunlight and amount of heating?** The angle at which sunlight reaches Earth’s surface varies with latitude. This results in uneven heating of Earth.

**Procedure**

1. Read and complete the lab safety form.
2. Turn on a flashlight, and hold it 20 cm above a piece of paper. Point the flashlight straight down.
3. Use a pencil to trace the outer edge of the light on the paper. This models the angle of sunlight to Earth at the equator.
4. Keep the flashlight the same distance above the paper, but rotate it about 30°.
5. Trace the outer edge of the light. This is similar to the angle of sunlight to Earth at latitudes nearer the poles.

**Analysis**

1. **Describe** how the outline of the light differed between Step 3 and Step 5. Explain why it differed.
2. **Compare** the amount of energy per unit of area received near the equator to the amount at latitudes nearer the poles.

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[SC.912.E.7.4: Summarize the conditions that contribute to the climate of a geographic area, including the relationships to lakes and oceans. SC.912.N.3.5: Describe the function of models in science, and identify the wide range of models used in science.]
Air Masses

In Chapter 11, you learned that air over a warm surface can be heated by conduction. This heated air rises because it is less dense than the surrounding air. On Earth, this process can take place over thousands of square kilometers for days or weeks. The result is the formation of an air mass. An air mass is a large volume of air that has the same characteristics, such as humidity and temperature, as its source region—the area over which the air mass forms. Most air masses form over tropical regions or polar regions.

### Types of air masses

The five types of air masses, listed in **Table 12.1**, influence weather in the United States. These air masses are all common in North America because there is a source region nearby.

**Tropical air masses**

The origins of maritime tropical air are tropical bodies of water, listed in **Table 12.1**. In the summer, they bring hot, humid weather to the eastern two-thirds of North America. The southwestern United States and Mexico are a source region of continental tropical air, which is hot and dry, especially in summer.

**Polar air masses**

Maritime polar air masses form over the cold waters of the North Atlantic and North Pacific. The one that forms over the North Pacific primarily affects the West Coast of the United States, occasionally bringing heavy rains in winter. Continental polar air masses form over the interior of Canada and Alaska. In winter, these air masses can carry frigid air southward. In the summer, however, cool, relatively dry, continental polar air masses bring relief from hot, humid weather.

**Reading Check** Compare and contrast tropical and polar air masses.

### Table 12.1 Air Mass Characteristics

<table>
<thead>
<tr>
<th>Air Mass Type</th>
<th>Weather Map Symbol</th>
<th>Source Region</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arctic</td>
<td>A</td>
<td>Siberia, Arctic Basin</td>
<td>bitter cold, dry</td>
<td>cold, dry</td>
</tr>
<tr>
<td>Continental polar</td>
<td>cP</td>
<td>interiors of Canada and Alaska</td>
<td>very cold, dry</td>
<td>cool, dry</td>
</tr>
<tr>
<td>Continental tropical</td>
<td>cT</td>
<td>southwest United States, Mexico</td>
<td>warm, dry</td>
<td>hot, dry</td>
</tr>
<tr>
<td>Maritime polar</td>
<td>mP</td>
<td>North Pacific Ocean</td>
<td>mild, humid</td>
<td>mild, humid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>North Atlantic Ocean</td>
<td>cold, humid</td>
<td>cool, humid</td>
</tr>
<tr>
<td>Maritime tropical</td>
<td>mT</td>
<td>Gulf of Mexico, Caribbean Sea, tropical and subtropical Atlantic Ocean and Pacific Ocean</td>
<td>warm, humid</td>
<td>hot, humid</td>
</tr>
</tbody>
</table>

To explore more about air masses, visit [glencoe.com](http://glencoe.com).
Arctic air masses  Earth’s ice- and snow-covered surfaces above 60° N latitude in Siberia and the Arctic Basin are the source regions of arctic air masses. During part of the winter, these areas receive almost no solar radiation but continue to radiate thermal energy. As a result, they become extremely cold and can bring the most frigid temperatures during winter.

Air mass modification  Air masses do not stay in one place indefinitely. Eventually, they move, transferring thermal energy from one area to another. When an air mass travels over land or water that has characteristics different from those of its source region, the air mass can acquire some of the characteristics of that land or water, as shown in Figure 12.3. When this happens, the air mass undergoes modification; it exchanges thermal energy and/or moisture with the surface over which it travels.

**Section 12.1 Assessment**

**Section Summary**
- Meteorology is the study of atmospheric phenomena.
- Solar radiation is unequally distributed between Earth’s equator and its poles.
- An air mass is a large body of air that takes on the moisture and temperature characteristics of the area over which it forms.
- Each type of air mass is classified by its source region.

**Understand Main Ideas**
1. **Main Idea** Summarize how an air mass forms.
2. Explain the process that prevents the poles from steadily cooling off and the tropics from heating up over time.
3. Distinguish between the causes of weather and climate.
4. Differentiate among the five types of air masses.

**Think Critically**
5. Predict which type of air mass you would expect to become modified more quickly: an arctic air mass moving over the Gulf of Mexico in winter or a maritime tropical air mass moving into the southeastern United States in summer.

6. Describe how a maritime polar air mass formed over the North Pacific is modified as it moves west over North America.