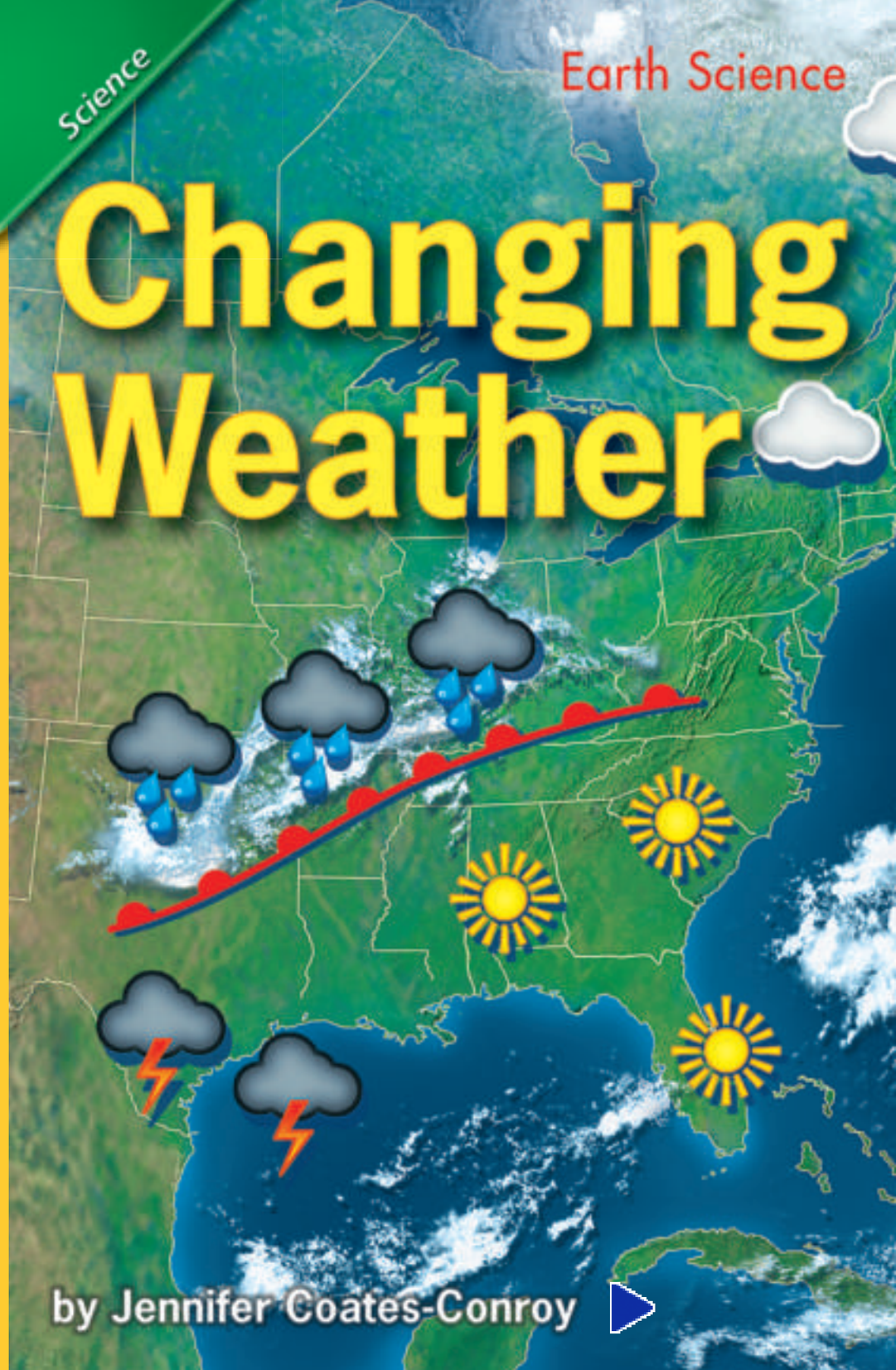
Science

Science

Earth Science

Changing Weather



by Jennifer Coates-Conroy

Genre	Comprehension Skill	Text Features	Science Content
Nonfiction	Draw Conclusions	• Captions • Maps • Diagrams • Glossary	Weather Patterns

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Vocabulary

air mass
anemometer
barometer
climate
convection current
front
rain gauge

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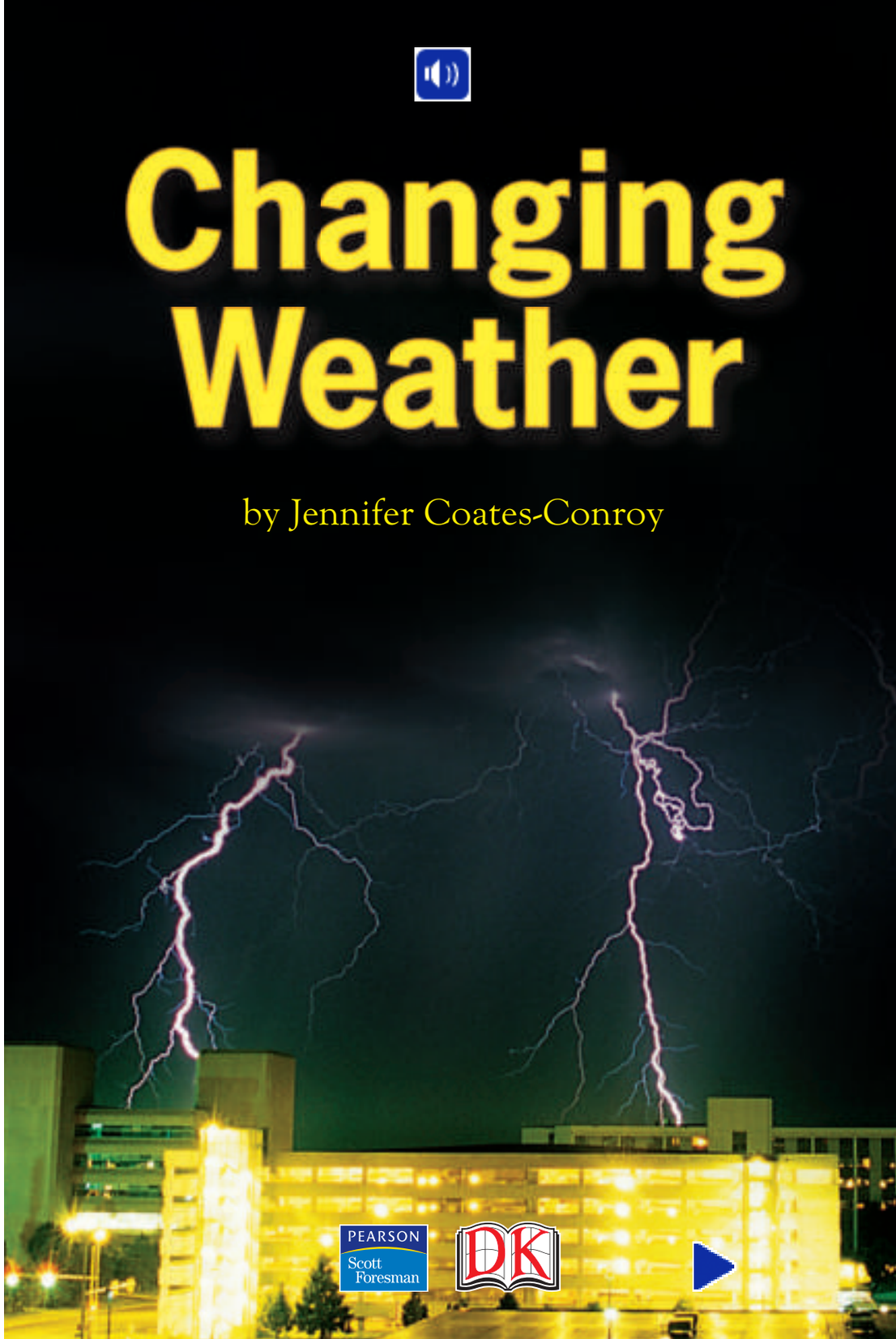


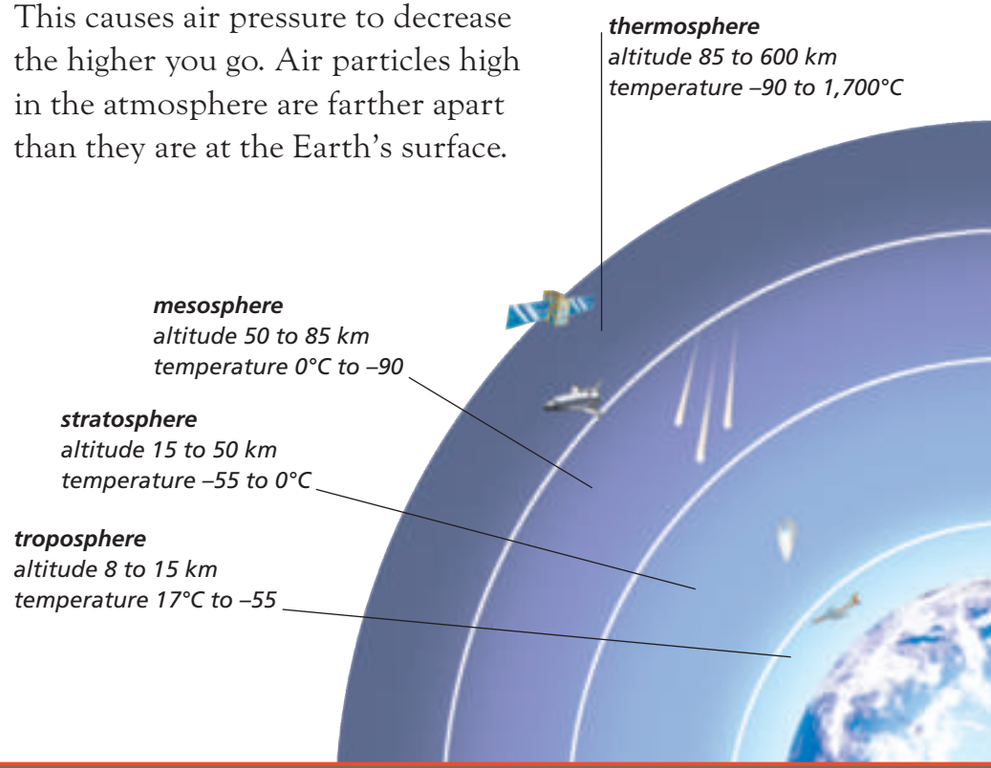
Moving Air

It is a beautiful, sunny day. The air is warm, and there are no clouds anywhere in the sky. But the weather report you saw on TV said it would rain this afternoon. Sure enough, a few hours later it is raining heavily. How did such a big change happen? And how did the weather reporter on TV know about it? Weather can be quite complicated, and it is always changing. But scientists have special tools and methods that allow them to predict the weather.

Layers of Air

The Earth is surrounded by a blanket of gases called the atmosphere. Our atmosphere is different from the atmospheres of all the other planets in our solar system. It is full of air, a mix of gases that allows life to exist on Earth. Air is about $\frac{8}{10}$ nitrogen and about $\frac{2}{10}$ oxygen. A tiny fraction of air is made up of carbon dioxide, water vapor, and other gases.

The atmosphere is divided into layers. The bottom layer, called the troposphere, is where most of our weather happens. The different layers have different temperatures and air pressures. Air pressure is caused by the weight of air above pushing down. As you go higher into the atmosphere, there is less and less air above you. This causes air pressure to decrease the higher you go. Air particles high in the atmosphere are farther apart than they are at the Earth's surface.



Convection Currents

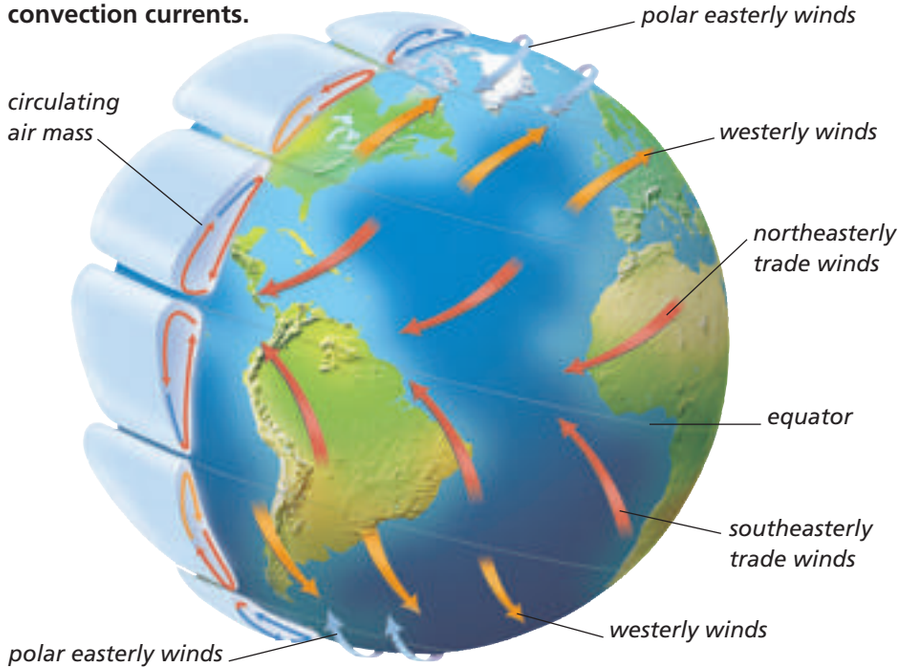
Have you ever gone to the ocean on a hot summer day? If so, you may have noticed a cool breeze blowing in off the water. These sea breezes are caused by a difference in temperature between the land and the water. During the day, the Sun heats the land faster than the ocean. This causes the air over the land to be warmer than the air over the water. The warm air rises, and cool air sinks, rushing in under the warm air. When the cool air flows in from over the ocean, you feel a sea breeze. This type of air movement is called a **convection current.**

The convection current near the ocean is the opposite at night. At night, the land cools quickly. But the ocean, which has been heating up in the Sun all day, cools much more slowly. The air over the warm ocean water rises, and the cool air from the land flows in underneath it. The result is a land breeze, which blows from the land toward the water.

Sea breezes occur during the day.

Land breezes occur at night.

The Earth's major wind patterns are caused by convection currents.



The convection currents that create sea and land breezes are small compared to some others in the Earth's atmosphere. There are six huge convection currents that help to cause weather. They are caused in part because the surface of the Earth is warmer near the equator than at other places. These currents, combined with the spinning of the Earth, create winds over huge areas. For example, in the United States, winds usually blow from west to east because of convection currents.

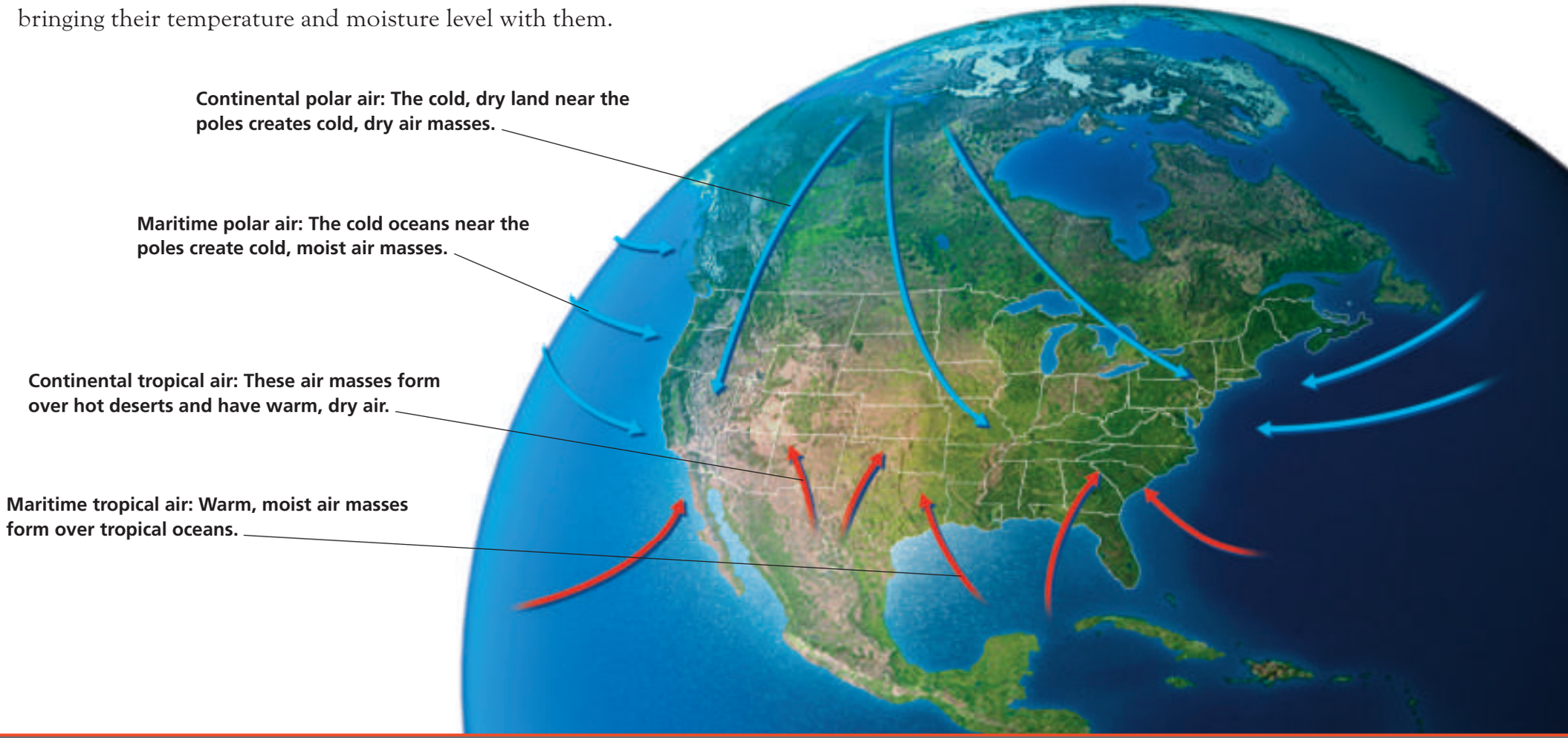
If you watch a TV weather report, you will probably hear about the jet stream. This is a band of very fast-moving wind that forms between the huge convection currents. Even though jet streams are very high in the atmosphere, they have a big effect on our weather.

Air Masses

Air moves across the surface of the Earth in huge bodies called air masses. An **air mass** has similar temperatures and amounts of water vapor all through it. Air masses take on the properties of the areas where they form. For example, an air mass that forms over a cold ocean will be cold and wet. One that forms over a hot desert will be hot and dry. Air masses keep these properties for a while as they move to new areas, bringing their temperature and moisture level with them.

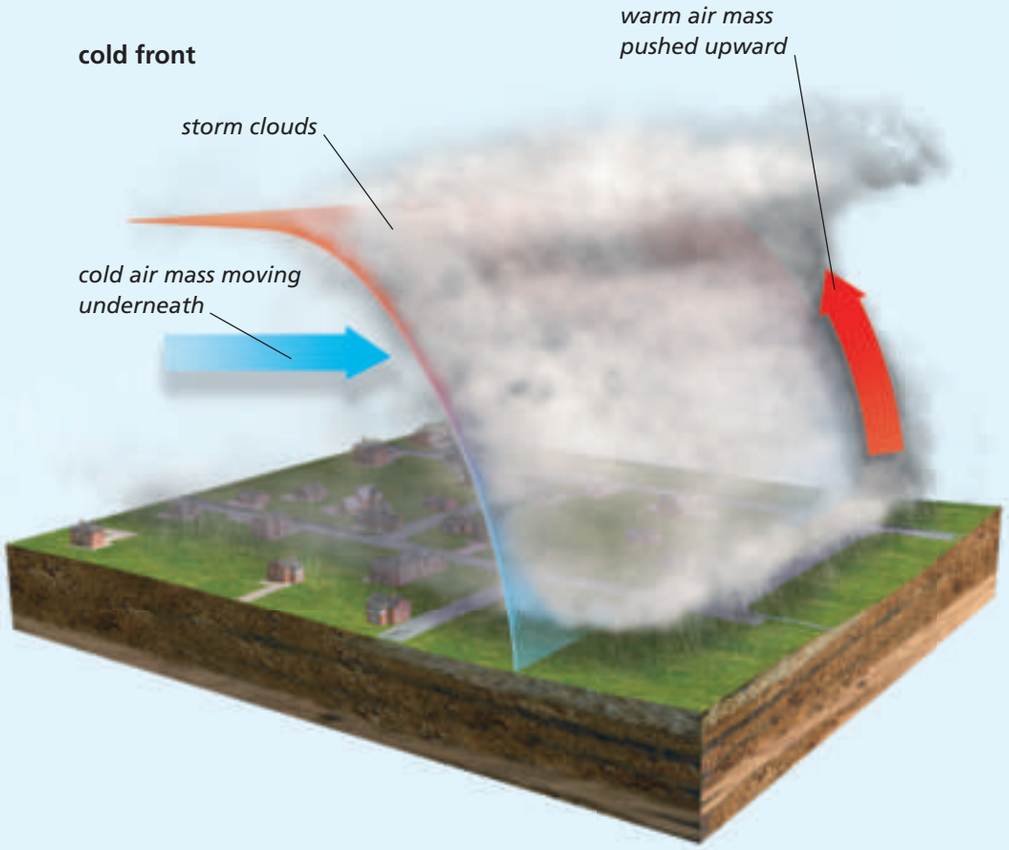
The weather is usually controlled by the type of air mass in the area. The four main types of air masses are shown in the diagram below. They are continental tropical air, continental polar air, maritime tropical air, and maritime polar air.

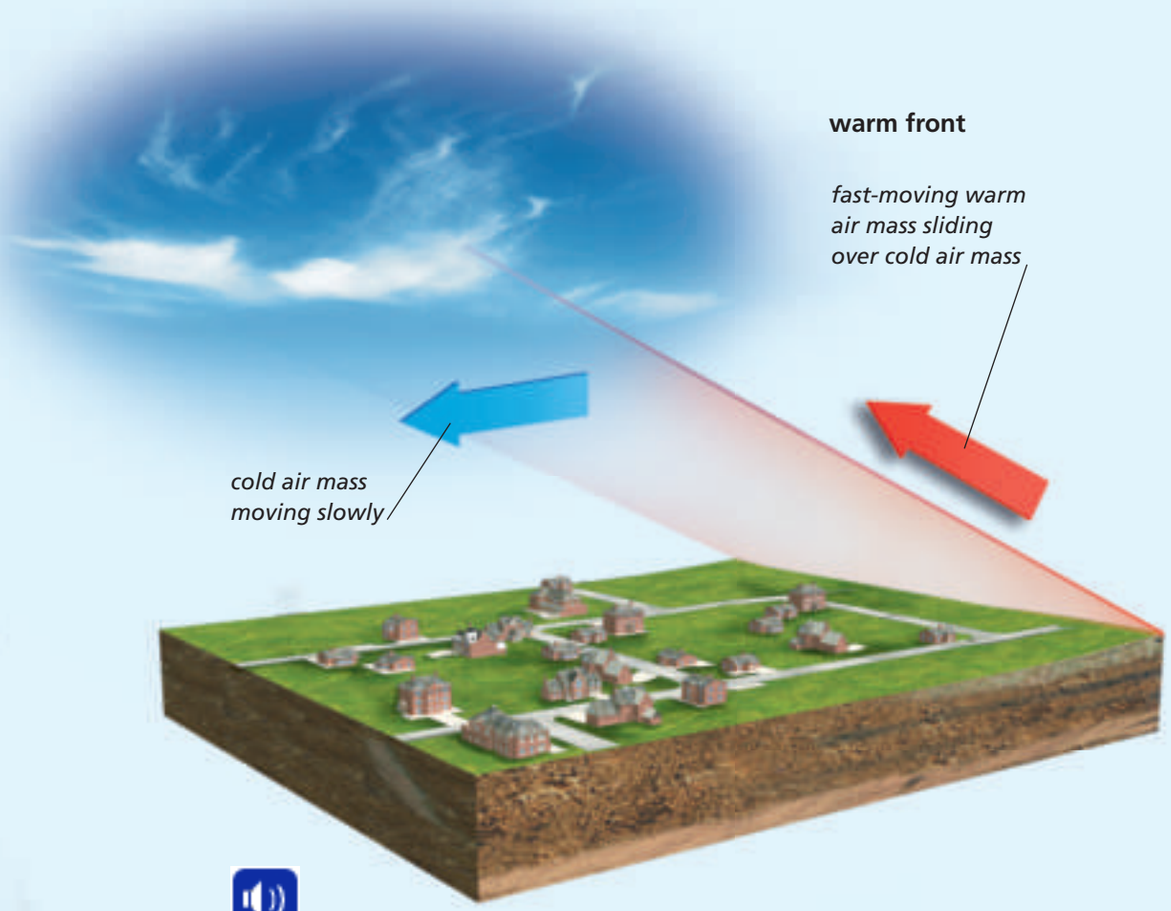
Air masses are moved around by winds. These may be winds close to the ground, or they may be jet streams. An area may experience storms as the edge of an air mass passes through.



Fronts

The boundary between two air masses is called a **front.** When a front arrives, it often brings a change of weather. A warm, wet air mass might be sitting over your area. Then a cold, dry air mass might move in, bringing colder, drier weather with it. Some fronts do not move, or they move back and forth over the same area. These are called stationary fronts.





When a cool air mass moves into a warm air mass, it is called a cold front. The cold air pushes the less dense, warm air up. As this air rises, it cools, causing any moisture in it to fall as rain. A line of clouds often forms at a cold front.

A warm front forms when a fast-moving mass of warm air runs into a slower-moving, cooler air mass. The warm air rides up over the cool air, causing high-altitude clouds. Warm fronts move more slowly than cold fronts and cause steady, long-lasting precipitation.

Severe Weather

Thunderstorms

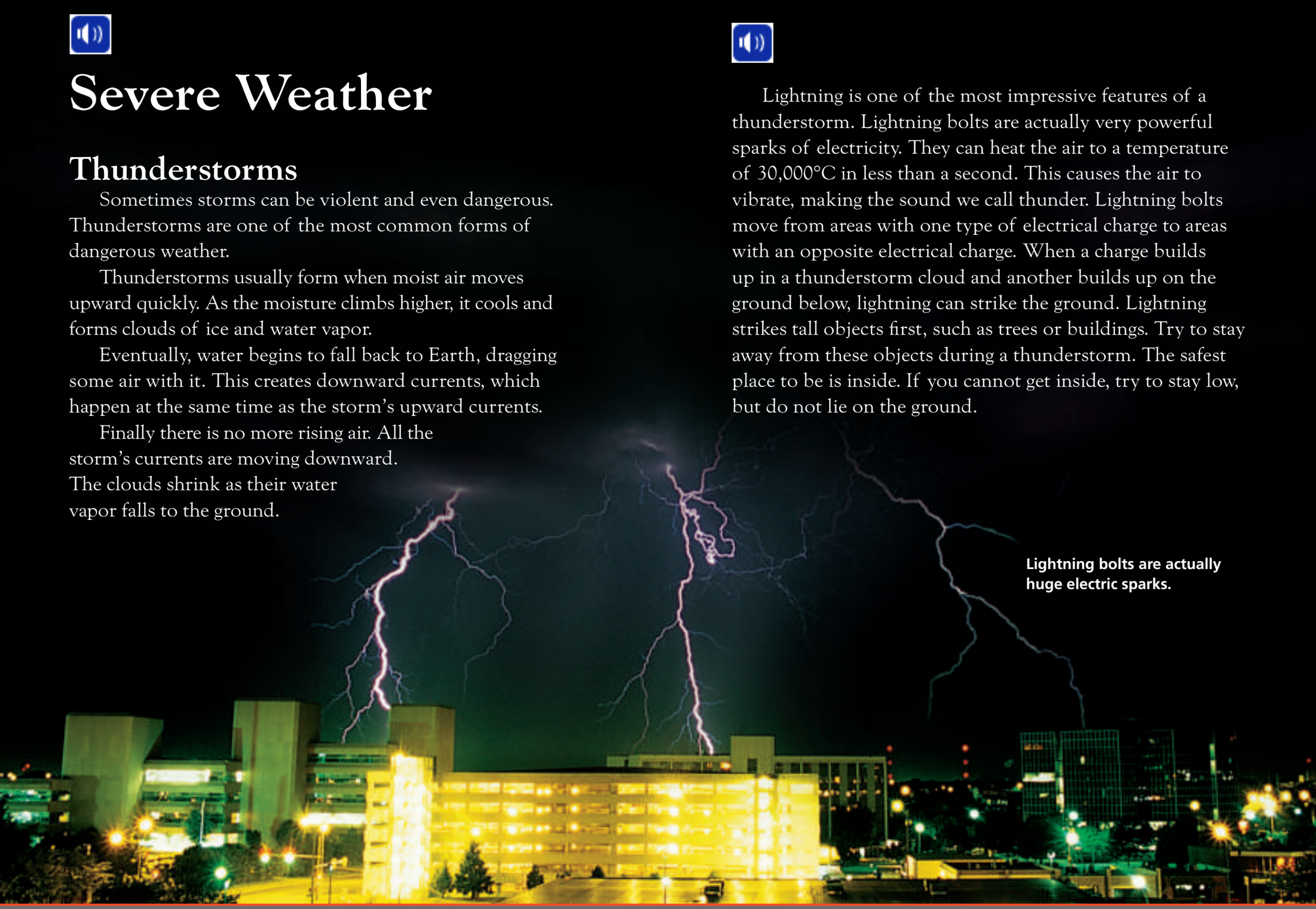
Sometimes storms can be violent and even dangerous. Thunderstorms are one of the most common forms of dangerous weather.

Thunderstorms usually form when moist air moves upward quickly. As the moisture climbs higher, it cools and forms clouds of ice and water vapor.

Eventually, water begins to fall back to Earth, dragging some air with it. This creates downward currents, which happen at the same time as the storm's upward currents.

Finally there is no more rising air. All the storm's currents are moving downward. The clouds shrink as their water vapor falls to the ground.

Lightning is one of the most impressive features of a thunderstorm. Lightning bolts are actually very powerful sparks of electricity. They can heat the air to a temperature of 30,000°C in less than a second. This causes the air to vibrate, making the sound we call thunder. Lightning bolts move from areas with one type of electrical charge to areas with an opposite electrical charge. When a charge builds up in a thunderstorm cloud and another builds up on the ground below, lightning can strike the ground. Lightning strikes tall objects first, such as trees or buildings. Try to stay away from these objects during a thunderstorm. The safest place to be is inside. If you cannot get inside, try to stay low, but do not lie on the ground.



Lightning bolts are actually huge electric sparks.

Tornadoes

A tornado is a very dangerous part of some storms. Tornadoes can flatten everything they touch, leaving a path of destruction hundreds of meters wide and many kilometers long. Winds inside a tornado can blow at hundreds of kilometers per hour, destroying houses, picking up cars, and even ripping the bark off trees! Despite the damage they cause, most tornadoes last only a few minutes.

Conditions have to be just right for a tornado to form. First, a storm must have layers of wind blowing at different speeds and in different directions. This causes a tube of wind to form between the layers. It rolls horizontally like a log, until upward and downward air currents tip it on its end. The tube is now a vertical column of spinning air called a funnel cloud. When the lower end of the funnel cloud touches the ground, it is called a tornado.

Tornadoes are one of the most destructive types of weather. When a tornado is approaching, there are often sirens and TV announcements to warn people. If you hear one of these warnings, you should go to a safe place as soon as possible. A basement is the best place to go. A room in the center of a building is the next best place. Wherever you go, you should try to stay away from windows, since the glass can break and fly around the room, causing injuries.

Tornadoes can do amazing amounts of damage in a very short time.

Hurricanes

A hurricane is another very dangerous type of storm. Hurricanes form over the ocean when the water is warm. Water vapor from the ocean moves into the air and condenses, forming clouds. When it condenses, it releases energy that can turn into the powerful winds of a hurricane. A storm must have winds of more than 120 kilometers per hour to be called a hurricane. Very strong hurricanes can have winds of more than 240 kilometers per hour.

Although hurricane winds are strong, they are not nearly as strong as a tornado's winds. Even so, hurricanes do much more damage than tornadoes. There are several reasons for this. First, hurricanes are huge. A tornado might be a few hundred meters across, but a hurricane can be hundreds of kilometers across. This means they damage a much wider area. Second, hurricanes last for days and travel long distances, possibly hitting several communities. Third, hurricanes cause huge waves and flooding that can do as much damage as their winds.

Hurricane Safety

There are a few things you can do to stay safe if a hurricane strikes. You should board up your windows to keep them from being smashed. Keep extra food and water on hand, in case the water supply is cut off or you cannot get to a store. Put things that could be ruined by floodwater into plastic containers. When the hurricane comes through, do not go outside. If a hurricane is dangerous enough, you may be told to evacuate. If this happens, leave right away.

Windows should be boarded up before a hurricane to keep them from being smashed.

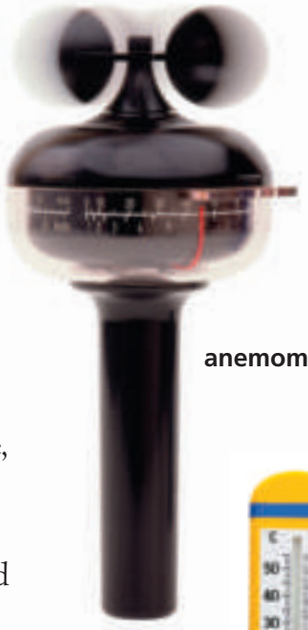
Signs such as this are found in areas where hurricanes are common.

Forecasting the Weather

Data Collection

Weather is a combination of temperature, moisture, clouds, precipitation, wind speed, air pressure, and wind direction. To measure each of these things, scientists use different tools. Some of them are very advanced and expensive. Some are very simple. In fact, you probably have one of them at home. Most houses have a thermometer, the tool used to measure air temperature.

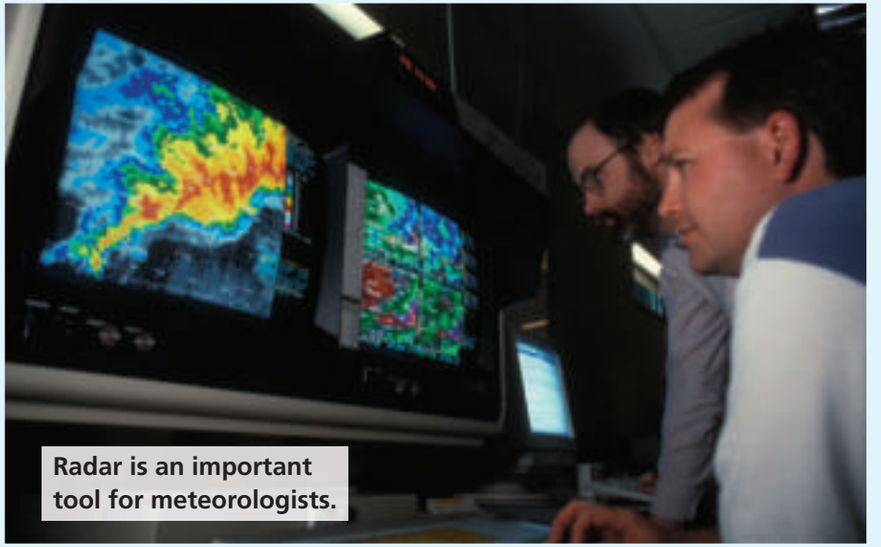
Another common weather tool is a barometer. A **barometer** measures air pressure. Many barometers use a small, sealed container with a dial attached. When air pressure squeezes the container, it moves the dial to show the pressure. Some barometers are tubes full of mercury. The level of the mercury rises or falls with changes in pressure.



anemometer

thermometer

barometer



Radar is an important tool for meteorologists.

An **anemometer** is a tool for measuring wind speed. It has several cups that spin when wind blows across them. The faster the wind blows, the faster the cups spin.

A hygrometer measures the air's moisture. Some hygrometers use a piece of horsehair to do this. When the air is dry, the hair gets shorter. When it is moist, the hair gets longer. This movement turns a pointer that shows the humidity.

A **rain gauge** is a tall, thin, clear container that measures how much rain has fallen. As rain falls, it fills the gauge. Sometimes the top of the rain gauge is wider than the bottom. This makes it easier to catch and measure small amounts of rain.

Scientists use radar for measuring wind and precipitation in a storm. It sends out invisible waves of energy, similar to those that come from a radio station. Some of the energy bounces off raindrops in the storm. Scientists can measure the energy that bounces back to tell what the storm is doing.

Weather Forecasts

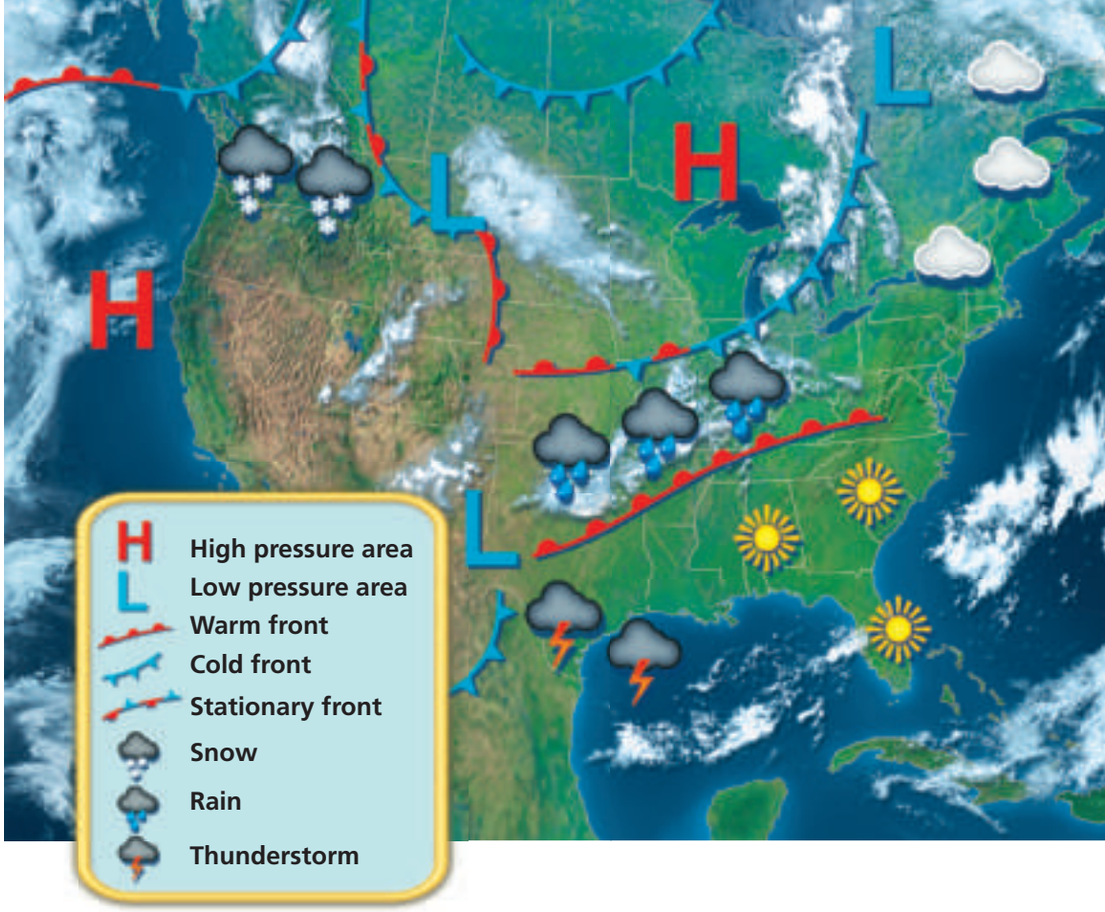
Weather may be complicated, but it does follow patterns. You have probably noticed some of these patterns where you live. Your area might have a lot of storms during the fall. Or you might notice that the weather starts to become drier at the end of spring. Scientists can use these patterns to predict what the weather will do in the future.

Weather forecasters gather information about weather patterns. Then they try to figure out how air, land, and water interact with each other to make these patterns. They use their inferences to predict what will happen in the future.

Weather usually acts like similar weather has in the past. If current weather matches past weather very closely, forecasters can be more sure of how it will change. Forecasters can make better predictions if they have more information about the current weather.

New York City experiences snow during the winter.

Summers in New York City are often hot.



Weather maps show current weather conditions. They also show predictions. Although there are many different kinds of weather maps, most of them have the same types of colors and symbols. Fronts are shown with lines. These lines have triangles on them to show a cold front or half circles to show a warm front. The shapes point in the direction the front is moving. High pressure areas are shown with an H, while low pressure areas have an L. Clouds and precipitation are shown with little pictures. Look at the map and legend above to learn more about these symbols.

Climate

Weather or climate?

As you have learned, weather changes fairly quickly. It is a description of what conditions are like in one place at a single moment. Climate is different from weather. The **climate** of a place is its average weather conditions over a long time, usually thirty years. While the weather in an area might change every day, climates usually do not change for a very long time.

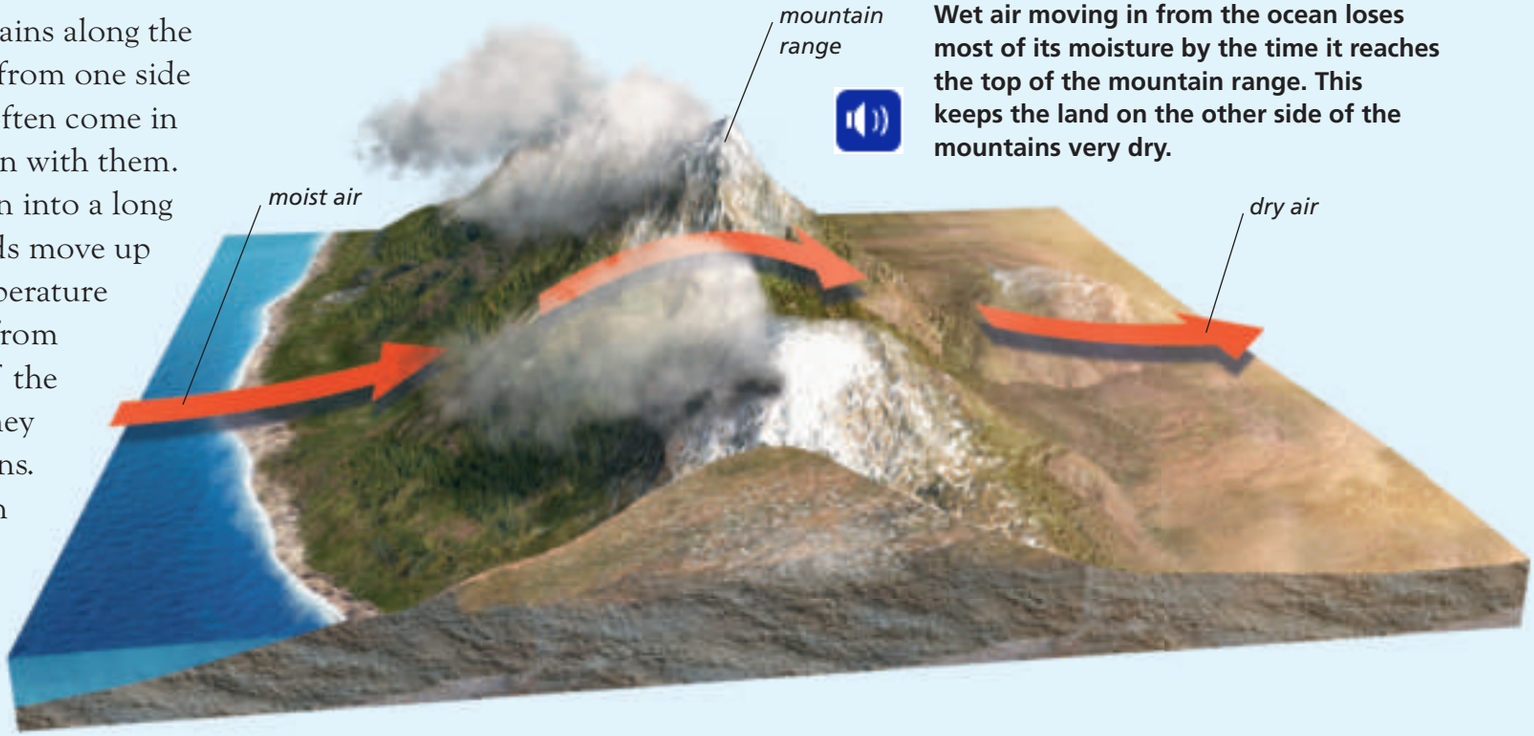
Landforms and Climate

Sometimes the shape of the land can have an effect on the climate. For example, mountains along the coast often have a different climate from one side to the other. In California, storms often come in from the Pacific Ocean, bringing rain with them. When they get to the coast, they run into a long mountain range. As the storm clouds move up one side of the mountains, the temperature drops. This causes moisture to fall from the clouds as precipitation. Most of the moisture leaves the clouds before they reach the other side of the mountains. This makes the climate on the ocean side very wet, while the climate on the other side is much drier.

Oceans and Climate

Ocean temperatures rise and fall more slowly than land temperatures. Because of this, an ocean can have an effect on climates by the shore. In the winter, oceans hold heat, so areas on the coast usually do not get as cold as inland areas. During the summer, an ocean stays cool, so land on the coast usually stays cool as well.

Ocean currents can affect climates too. Sometimes they bring warm weather to areas that would usually be cold or cold weather to areas that would usually be warm. For example, the Hawaiian Islands have a very mild climate, even though they are located in the tropics. This is because ocean currents bring cool air to the islands.



Wet air moving in from the ocean loses most of its moisture by the time it reaches the top of the mountain range. This keeps the land on the other side of the mountains very dry.

Past Climates

Although climates change very slowly, they do change. Sometimes the changes are very big. For example, thousands of years ago, an ice age began. This was the result of Earth's climate cooling off. During this ice age, part of what is now the United States was buried under a huge sheet of ice!

No one wrote down what the climate was like during the ice age. But scientists know it happened because of the clues it left behind. As the ice slowly slid across the land, it pushed dirt and rocks into certain types of hills and lakes. Scientists can tell how the ice moved by mapping these features.

Scientists can also look at fossils for clues about past climates. For example, a fossil of a lizard might be found in a very cold area. We know that lizards cannot live where it is very cold. The fossil shows that the climate in this place must have been warmer long ago for the lizard to survive.

The white areas on this map show how much of Earth was covered by glaciers during the last ice age.

Many scientists believe that air pollution is making Earth's climate warmer.

Changing Climates

Many things can cause a climate to change. Some of them are natural, and some of them are caused by humans. Climates can cool because of asteroids hitting Earth or volcanic eruptions. These rare events can send lots of dust into the atmosphere, which blocks the Sun, cooling Earth. It is also possible that the Sun produced less heat in the past.

You may have heard of global warming. Climates can become warmer if there is more carbon dioxide, methane, or water vapor in the air. These gases are produced by volcanoes, the water cycle, and decaying matter. They are also produced when humans burn things such as coal or gasoline.

The weather and climate are always changing. But if you know what to look for, you can predict what might happen. The next time you see a weather map, try to figure out what the changing weather will bring.

Glossary

air mass	a large body of air with similar properties all through it
anemometer	an instrument that measures wind speed
barometer	an instrument that measures air pressure
climate	the average weather conditions in one place over a long time
convection current	when gases or liquids rise and sink in a circular path
front	a boundary between two air masses
rain gauge	a tool that measures how much rain has fallen

What did you learn?

1. How do temperatures change as you go up through the layers of the atmosphere?

2. Where do jet streams form?

3. What is the difference between a warm front and a cold front?

4. **Writing** in Science Scientists can use fossils to learn about past climates. Write to explain how this works. Include details from the book to support your answer.

5. **Draw Conclusions** Cool currents give the Hawaiian Islands a mild climate, even though the islands are located in the tropics. What affect do you think a current flowing north from the tropics might have?