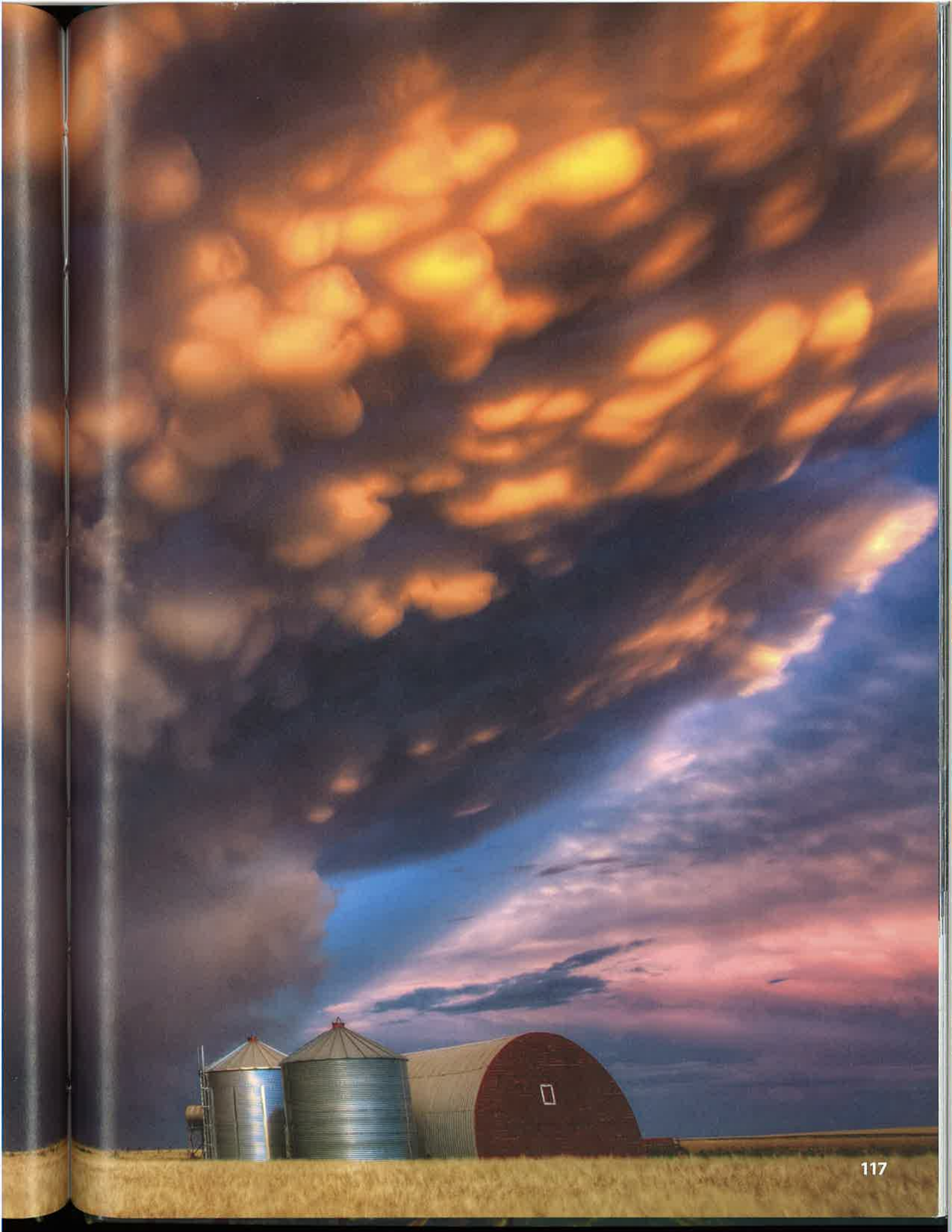
Earth Science

Weather and Climate

This farm sits in the path of an oncoming storm.



Weather

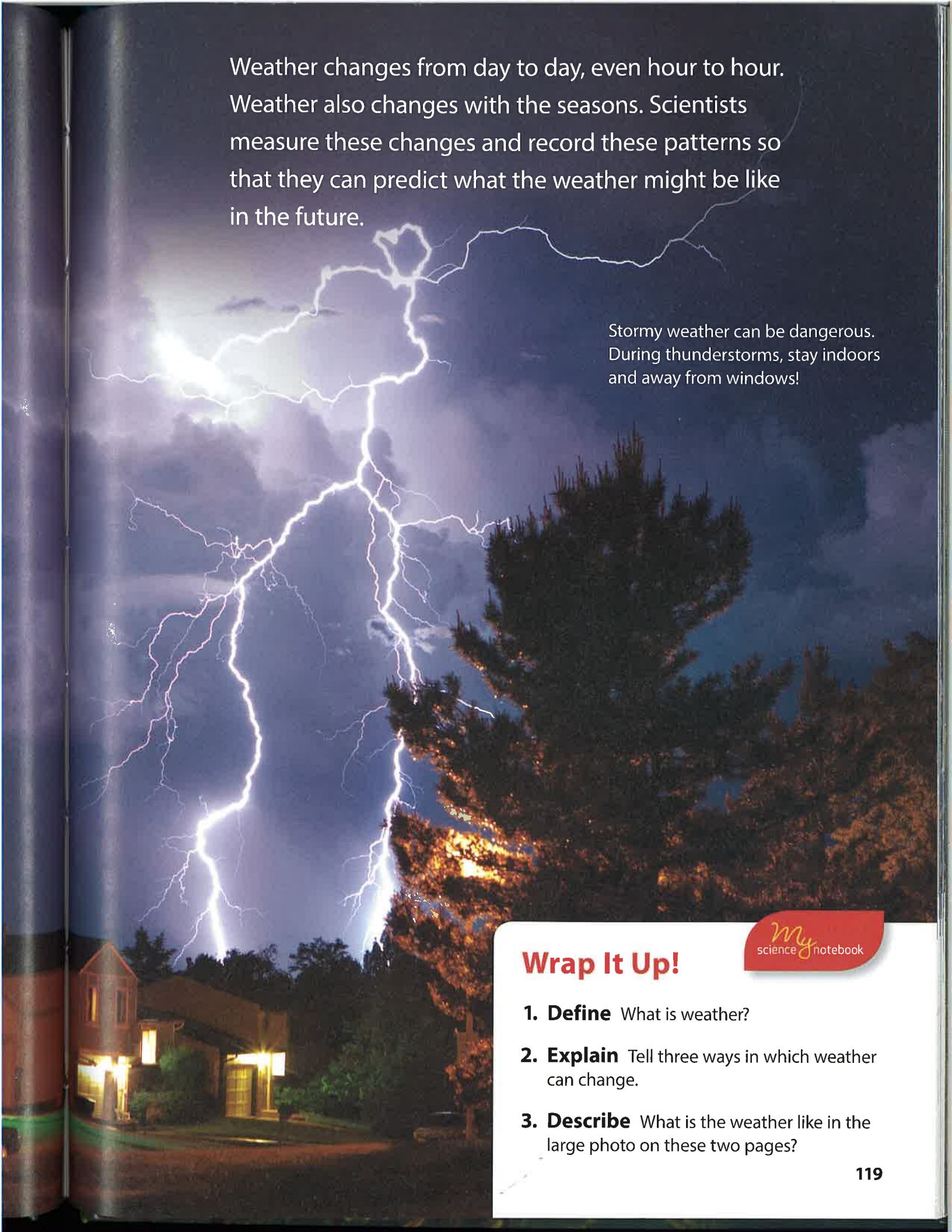
How would you describe the weather? **Weather** describes what the conditions in the air outside are like at a certain time and place. You might say it was sunny or cloudy, hot or cold, windy or calm, or dry or wet. You would probably use several of those words.

How would you describe the weather in this photograph? Do you think the temperature is more likely to be warm or very cold?

How would you describe the weather in this photograph? How is it different from the weather in the photograph above?

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS2.D: Weather and Climate
Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1)

Weather changes from day to day, even hour to hour. Weather also changes with the seasons. Scientists measure these changes and record these patterns so that they can predict what the weather might be like in the future.



Stormy weather can be dangerous. During thunderstorms, stay indoors and away from windows!

Wrap It Up!

My science notebook

1. **Define** What is weather?
2. **Explain** Tell three ways in which weather can change.
3. **Describe** What is the weather like in the large photo on these two pages?

Weather Measurements

Scientists use different instruments to measure changes in weather. They record patterns of weather across different times and areas. They use this information to predict what kind of weather might happen next.

THERMOMETER

A **thermometer** measures air temperature.

WIND VANE

A **wind vane** shows the direction from which the wind is blowing.

BAROMETER

A **barometer** measures air pressure.

RAIN GAUGE

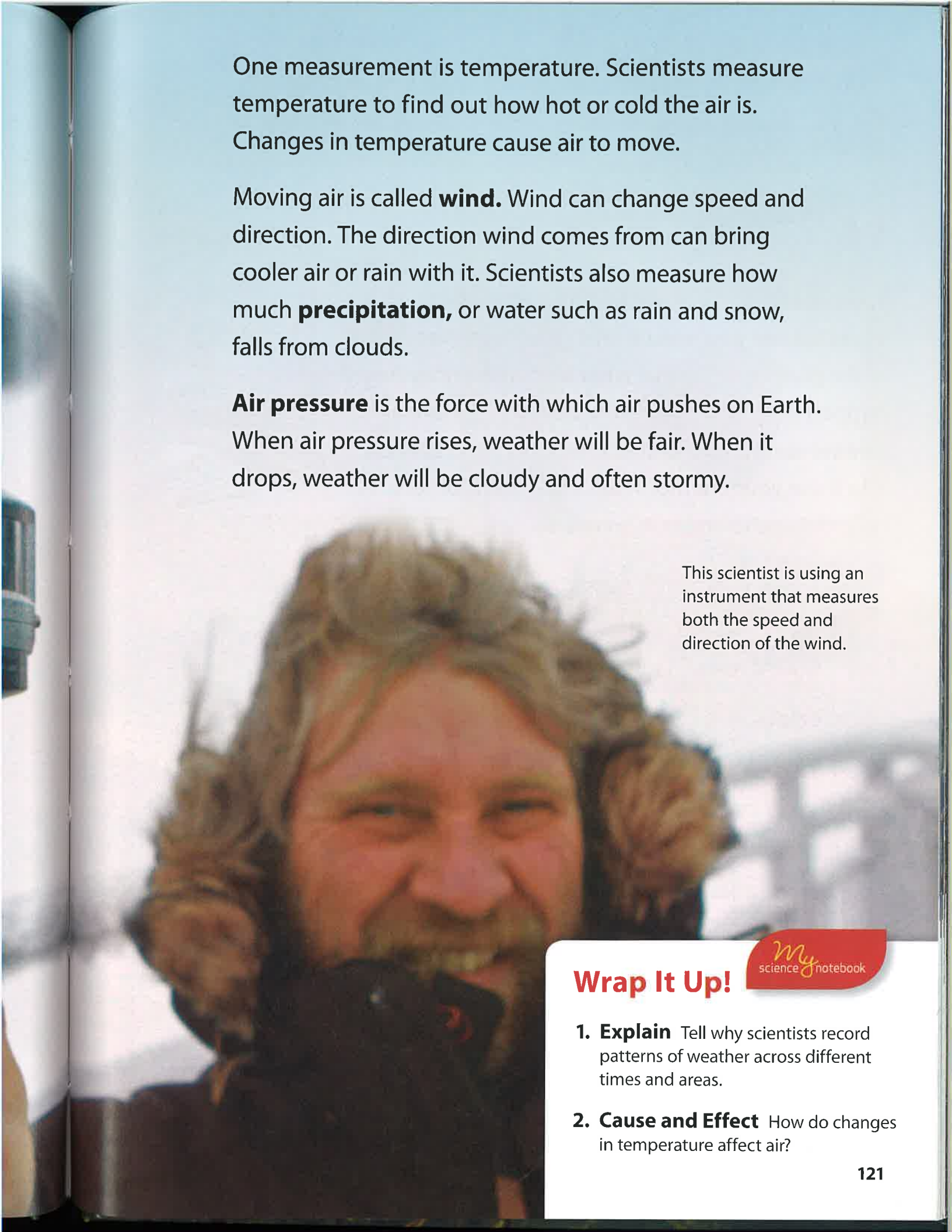
A **rain gauge** measures rainfall.

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS2.D: Weather and Climate
Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1)

One measurement is temperature. Scientists measure temperature to find out how hot or cold the air is. Changes in temperature cause air to move.

Moving air is called **wind.** Wind can change speed and direction. The direction wind comes from can bring cooler air or rain with it. Scientists also measure how much **precipitation,** or water such as rain and snow, falls from clouds.

Air pressure is the force with which air pushes on Earth. When air pressure rises, weather will be fair. When it drops, weather will be cloudy and often stormy.



This scientist is using an instrument that measures both the speed and direction of the wind.

Wrap It Up!

My science notebook

1. **Explain** Tell why scientists record patterns of weather across different times and areas.
2. **Cause and Effect** How do changes in temperature affect air?

Investigate

Weather

How can you measure some changes in the weather?

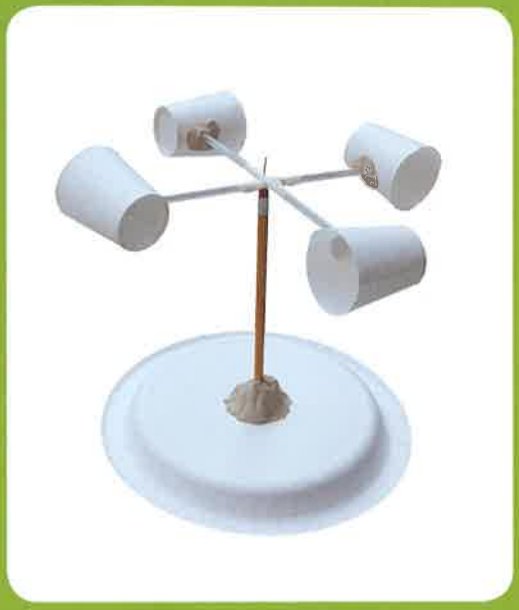
You have read about some of the instruments that scientists use to measure changes in weather and make predictions about what kind of weather might happen next. In this investigation, you'll make an **anemometer,** or tool that measures wind speed. You'll use your anemometer and a thermometer to record some changes in weather.

Materials

paper plate 	clay 	pencil 	2 straws	tape 
4 cups 	marker 	pin 	timer 	thermometer 

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEA
ESS2.D: Weather and Climate
Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1)

1 Follow your teacher's instructions for making the anemometer.



2 Place the anemometer in an open area outside. Each group should choose a different area. Use the timer to estimate wind speed by counting the number of times the cup with the X spins around in 1 minute. Record the data in your science notebook.

3 At the same spot, use the thermometer to measure air temperature. Record your measurement in degrees Celsius.

4 Repeat steps 2 and 3 at the same place and time each day for a week. Compare and contrast your data with those of other groups.

Wrap It Up!

1. **Summarize** How did the data for wind speed and temperature change during the week?
2. **Explain** How did your weather tools help you to measure the weather conditions?
3. **Compare and Contrast** How were the data collected at different areas alike and different?

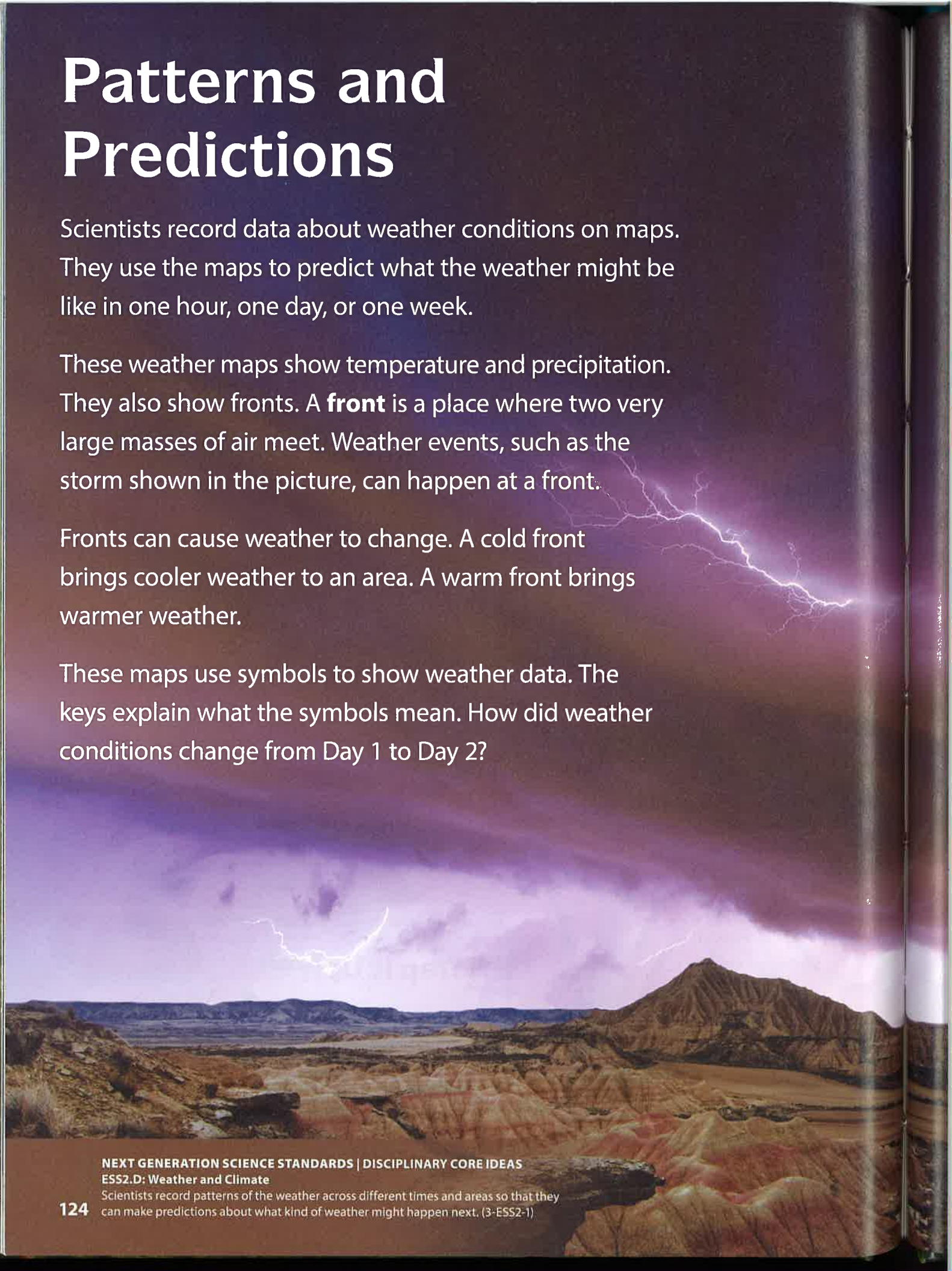
Patterns and Predictions

Scientists record data about weather conditions on maps. They use the maps to predict what the weather might be like in one hour, one day, or one week.

These weather maps show temperature and precipitation. They also show fronts. A **front** is a place where two very large masses of air meet. Weather events, such as the storm shown in the picture, can happen at a front.

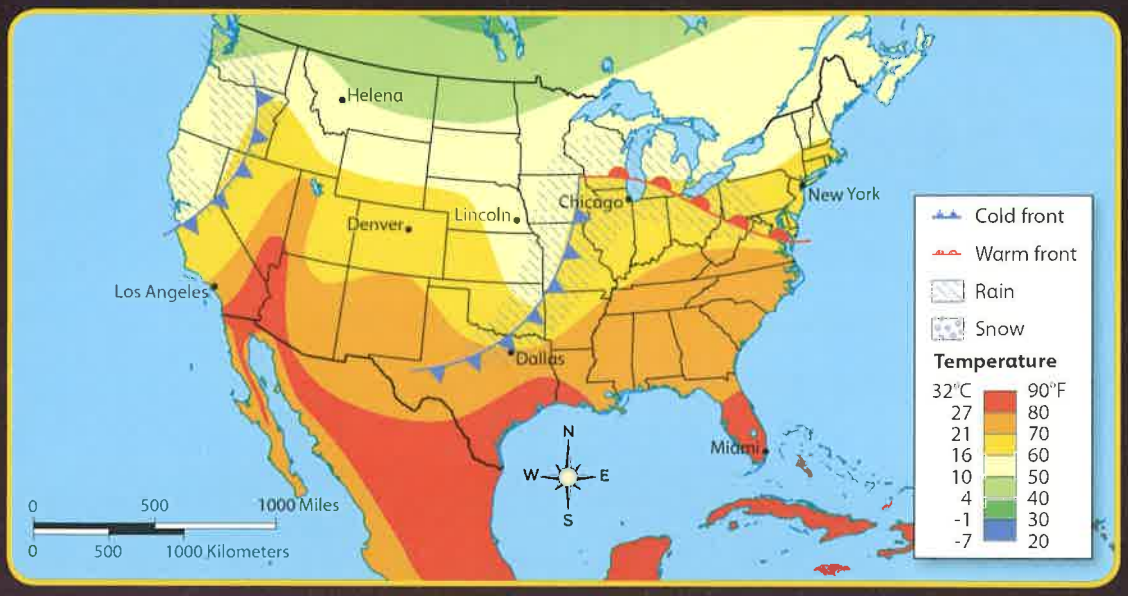
Fronts can cause weather to change. A cold front brings cooler weather to an area. A warm front brings warmer weather.

These maps use symbols to show weather data. The keys explain what the symbols mean. How did weather conditions change from Day 1 to Day 2?

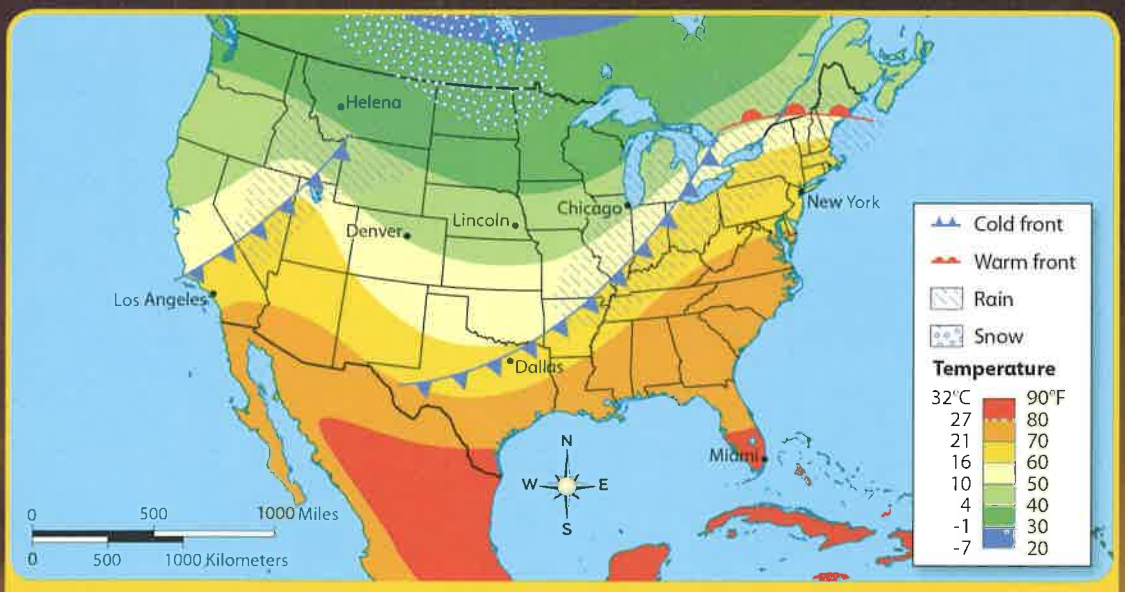


NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS2.D: Weather and Climate
Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1)

DAY 1



DAY 2



Scientists use maps of weather data to predict when storms may be coming.

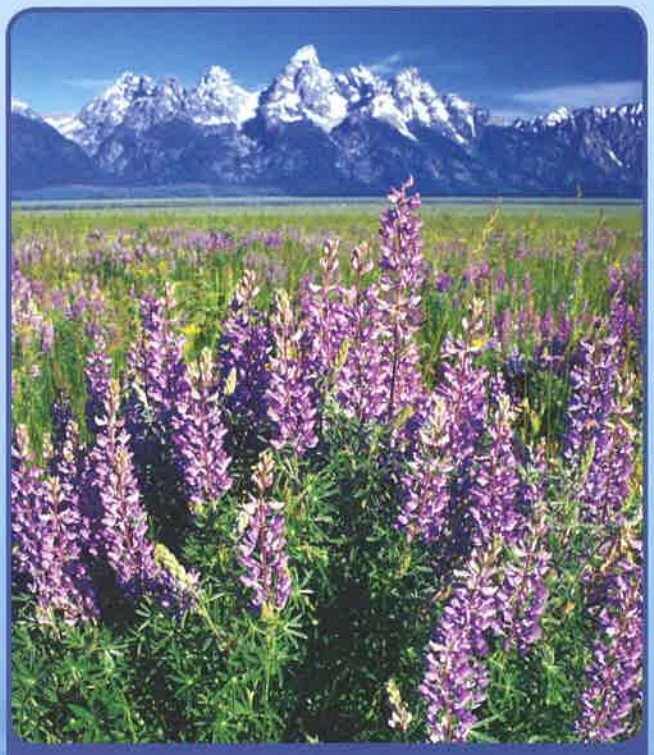
Wrap It Up!

My science notebook

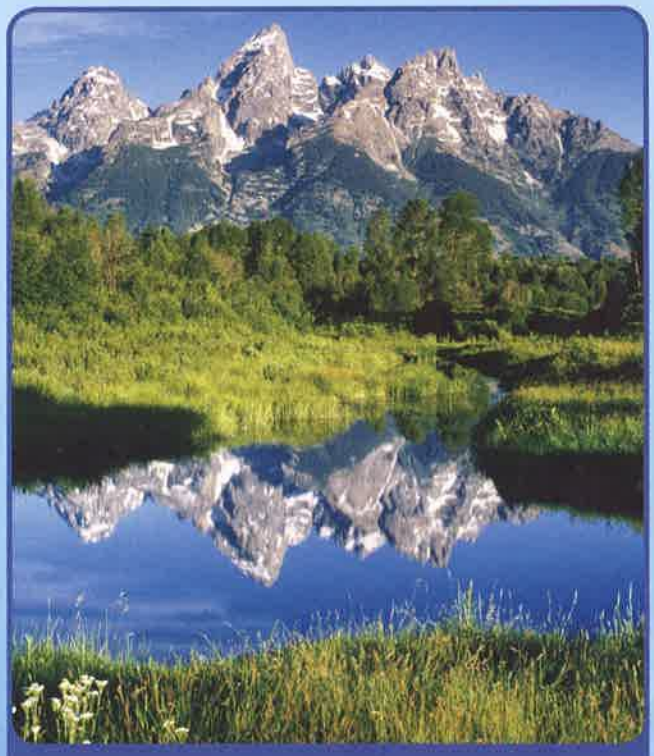
1. **Describe** In general, how did the fronts move from Day 1 to Day 2?
2. **Interpret Maps** Look at the Day 1 map. Describe the weather in Chicago on that day.
3. **Predict** Study both maps. Tell what you think the weather will be like in Chicago on the day after Day 2.

The Pattern of the Seasons

In most places on Earth, weather changes with the seasons. In many areas, winter weather is cold and snowy. As winter changes to spring, the weather



SPRING In spring, the temperatures warm. Spring weather can be very windy and wet.

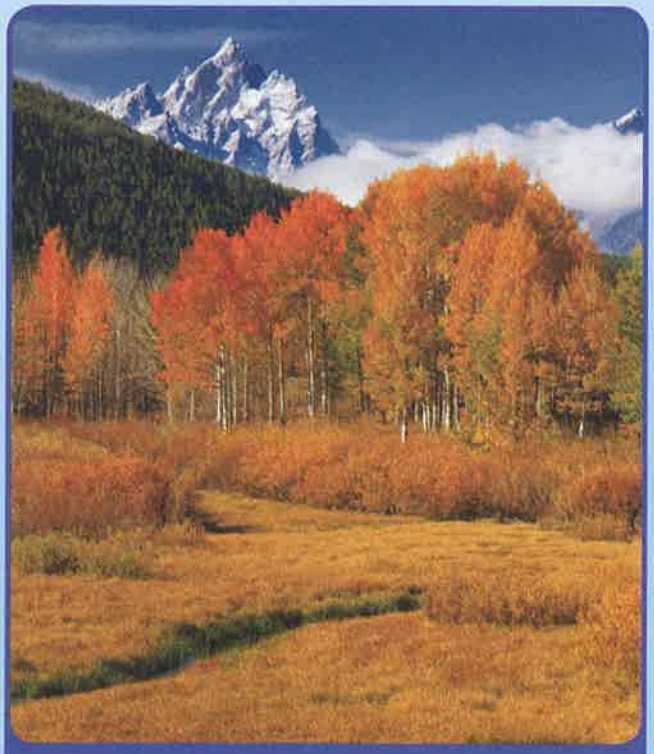


SUMMER Summer is the hottest season. In Wyoming, the summer weather is often dry.

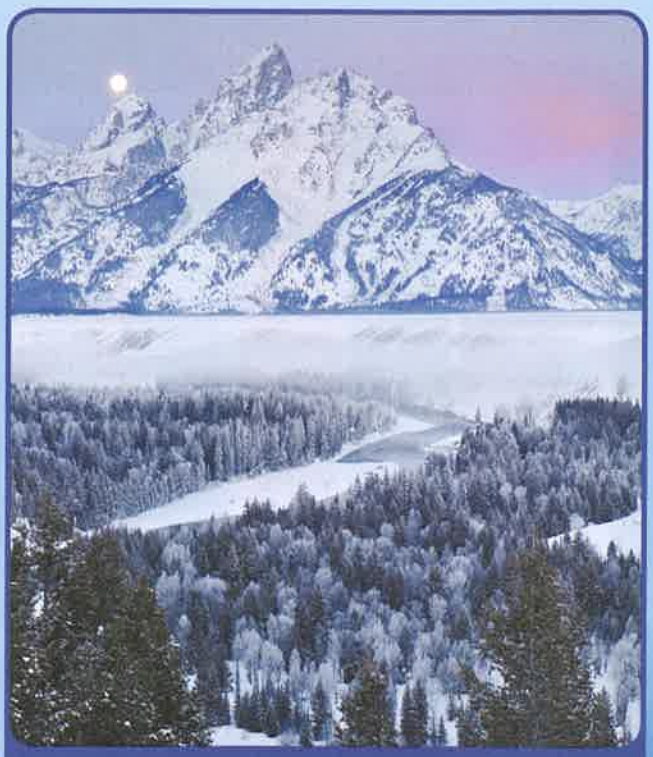
These photos show Grand Teton National Park in Wyoming during different seasons.

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS2.D: Weather and Climate
Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1)

warms and can be very rainy. As spring changes to summer, the weather gets even warmer. Some places have very hot, dry summers. As summer changes to fall, the weather gets cooler and drier. As fall changes to winter, weather becomes colder again. This pattern repeats year after year.



FALL In fall, the weather cools. Fall weather in Wyoming is drier than spring and winter.



WINTER Winter is the coldest season. Snow falls in some areas in winter.

Wrap It Up!

My science notebook

1. **Sequence** Name the seasons in order, starting with winter.
2. **Contrast** Tell how weather differs in spring and summer.
3. **Estimate** The average temperature of a city is 9°C (48°F) in winter and 29°C (83°F) in summer. Estimate what its average spring temperature might be.

Seasonal Changes

You might have a coat you wear only in winter because you know the weather is usually cold. But you know that on any given day it might also be sunny, rainy, or snowy.

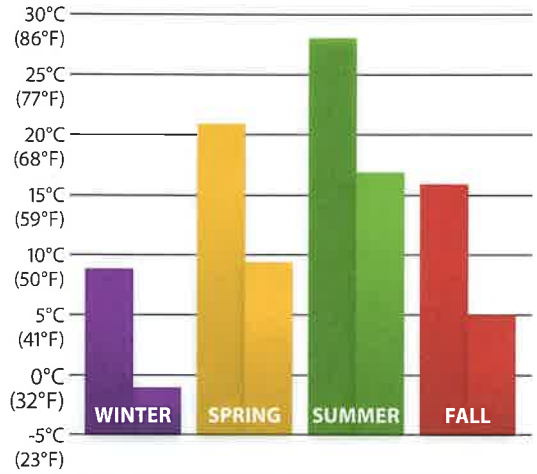
SEASONAL PATTERNS IN CHARLOTTESVILLE, VIRGINIA.

	WINTER Dec. 22–Mar. 19	SPRING Mar. 20–June 20	SUMMER June 21–Sept. 21	FALL Sept. 22–Dec. 21
AVERAGE HIGH TEMPERATURE	**9°C** (48°F)	**21°C** (70°F)	**28.5°C** (83°F)	**16°C** (61°F)
AVERAGE LOW TEMPERATURE	**-1°C** (30°F)	**9.5°C** (49°F)	**17°C** (63°F)	**5°C** (41°F)
AVERAGE PRECIPITATION	**20.68 cm** (8.14 in.)	**27.42 cm** (10.80 in.)	**33.78cm** (13.80 in.)	**26.24 cm** (10.33 in.)

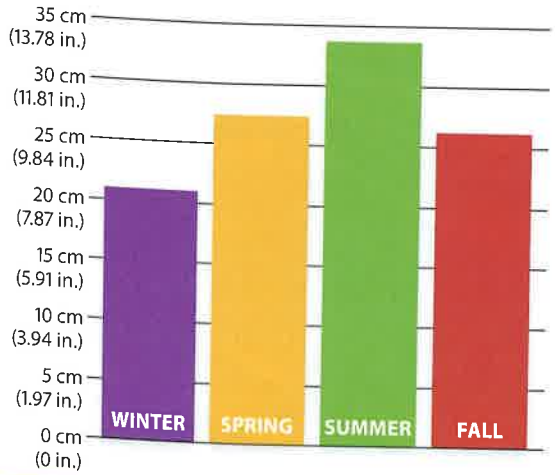
NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS2.D: Weather and Climate
Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1)

Weather changes often, even within a season. So scientists collect a lot of data to describe the average weather for an area during a season. Look at what the weather data show about each season in Charlottesville, Virginia.

AVERAGE HIGH AND LOW TEMPERATURES IN CHARLOTTESVILLE, VIRGINIA.



AVERAGE PRECIPITATION IN CHARLOTTESVILLE, VIRGINIA.



It is fall in the Blue Ridge Mountains near Charlottesville, Virginia.

Wrap It Up!

My science notebook

1. **Interpret Graphs** What is the difference between the average high and low fall temperatures in Charlottesville?

2. **Predict** What might the average amount of precipitation be in Charlottesville next summer?

Represent Data

You have seen how graphs and tables were used to represent data. Now you will find and organize some weather data for your area.

1. **Ask a question.**
   How can you represent some weather data for one season in your area?

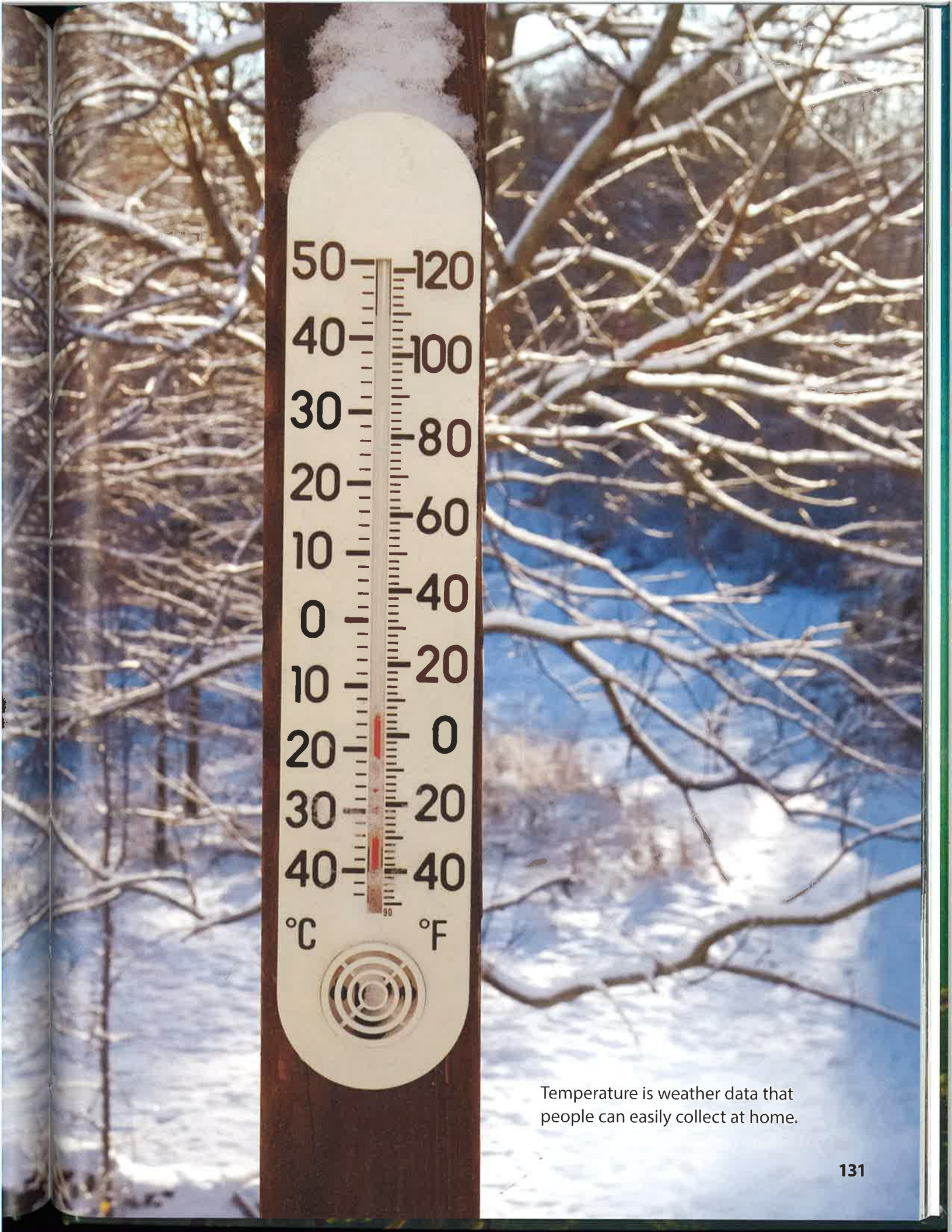
2. **Research and organize data.** 
   Choose a season.

   - Collect the following data for that season: average low and high temperature, average precipitation, and average wind speed. Also record data on the direction the wind most often blows.
   - Organize your data in one or more tables.
   - Use colored pencils to make bar graphs of your temperature, precipitation, and wind speed data.

3. **Analyze and interpret data.**
   Meet with other students who researched data on the same season you chose. Compare your data. How is the data alike or different? Do more research until your group is satisfied that your data charts and tables are accurate.

4. **Present and explain.**
   As a group, present your season data to the class. Listen to other groups as they present their data. What is the typical weather like in each season in your area?

NEXT GENERATION SCIENCE STANDARDS | PERFORMANCE EXPECTATION
3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.



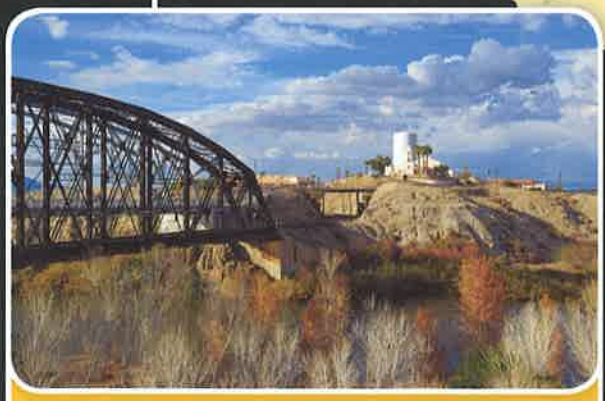
Temperature is weather data that people can easily collect at home.

Climate

Scientists summarize the yearly weather data in an area to describe that area's climate. **Climate** is the general pattern of weather in an area over a long period of time. Climate doesn't change very much from year to year.

The climate of an area can be very dry or very wet, or humid. Similarly, one climate might be very hot or very cold, while others have mild temperatures.

Portland, Oregon
AVERAGE JANUARY TEMPERATURE: **4.2°C** (39.6°F)
AVERAGE JULY TEMPERATURE: **20.1°C** (68.2°F)
AVERAGE ANNUAL PRECIPITATION: **92.1 cm** (36.3 in.)



Yuma, Arizona
AVERAGE JANUARY TEMPERATURE: **13.6°C** (56.5°F)
AVERAGE JULY TEMPERATURE: **34.2°C** (93.6°F)
AVERAGE ANNUAL PRECIPITATION: **7.7 cm** (3 in.)

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS2.D: Weather and Climate
Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years. (3-ESS2-2)

Syracuse, New York

AVERAGE JANUARY TEMPERATURE: **-4.5°C** (23.9°F)
AVERAGE JULY TEMPERATURE: **21.7°C** (71.1°F)
AVERAGE ANNUAL PRECIPITATION: **93.8 cm** (36.9 in.)

0 200 400 Miles
0 200 400 Kilometers

St. Petersburg, Florida

AVERAGE JANUARY TEMPERATURE: **15.9°C** (60.6°F)
AVERAGE JULY TEMPERATURE: **28.3°C** (82.9°F)
AVERAGE ANNUAL PRECIPITATION: **132.4 cm** (52.1 in.)

N W E S

Climate Regions

- Dry
- Very Dry
- Humid Mild
- Warm Summer, No dry season
- Cool Summer, Dry season
- Humid Warm
- Unclassified Highlands

Wrap It Up!

My science notebook

1. **Define** What is climate?
2. **Describe** What is the climate like in much of Florida?
3. **Interpret Maps** What is the climate like in your area?

Obtain and Combine Information

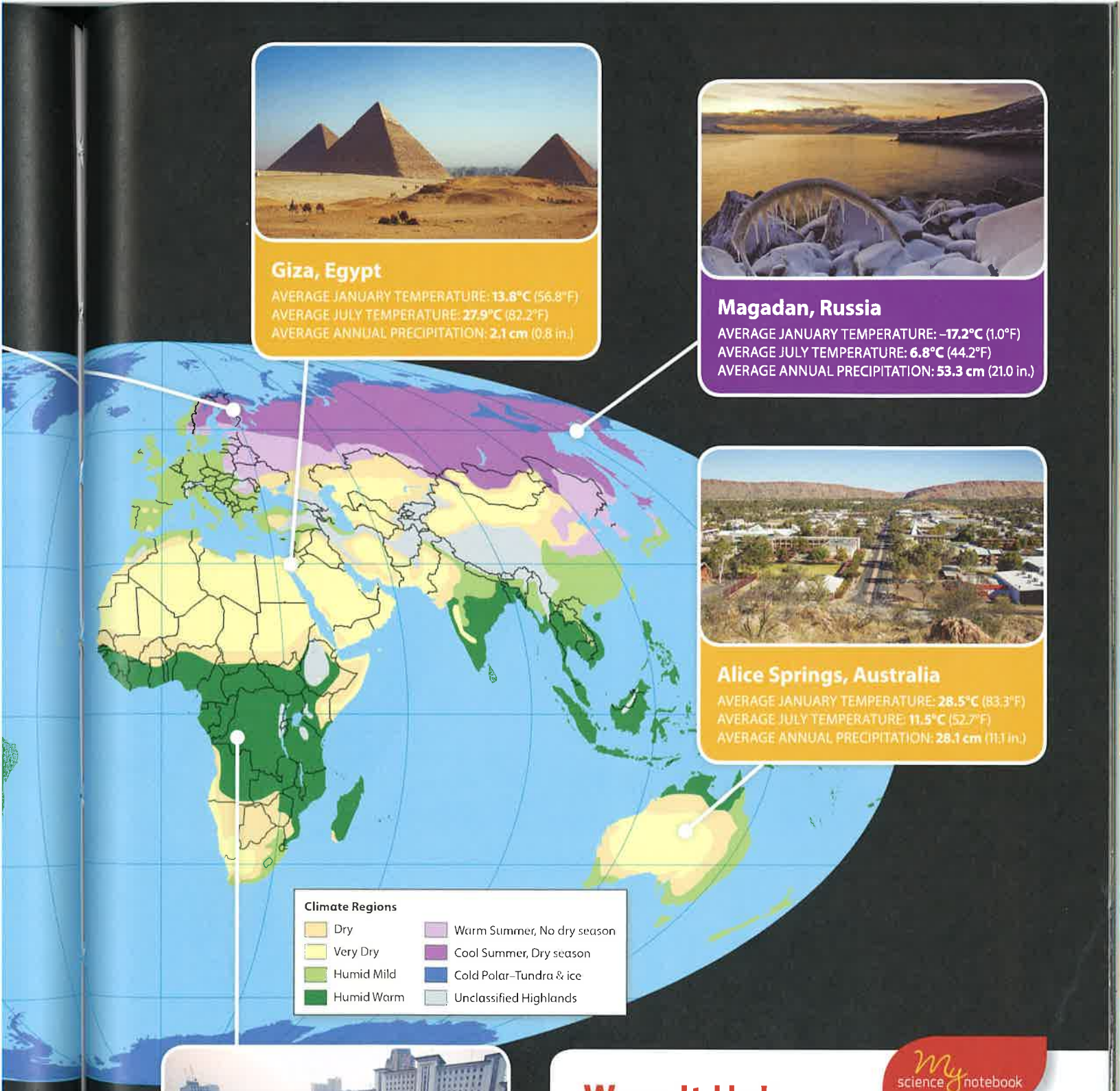
Imagine living in each city on the map. Use the map, photos and data to determine what the climate would be like in each city and how they compare.

Oulu, Finland
AVERAGE JANUARY TEMPERATURE: **–11.8°C** (10.8°F)
AVERAGE JULY TEMPERATURE: **15.7°C** (60.3°F)
AVERAGE ANNUAL PRECIPITATION: **45.3 cm** (17.8 in.)

Minneapolis, Minnesota
AVERAGE JANUARY TEMPERATURE: **–1.7°C** (28.9°F)
AVERAGE JULY TEMPERATURE: **26.9°C** (80.4°F)
AVERAGE ANNUAL PRECIPITATION: **68.4 cm** (26.9 in.)

Buenos Aires, Argentina
AVERAGE JANUARY TEMPERATURE: **23.5°C** (74.3°F)
AVERAGE JULY TEMPERATURE: **10.0°C** (50.0°F)
AVERAGE ANNUAL PRECIPITATION: **100.5 cm** (39.6 in.)

NEXT GENERATION SCIENCE STANDARDS | PERFORMANCE EXPECTATION
3-ESS2-2. Obtain and combine information to describe climates in different regions of the world.



Wrap It Up!

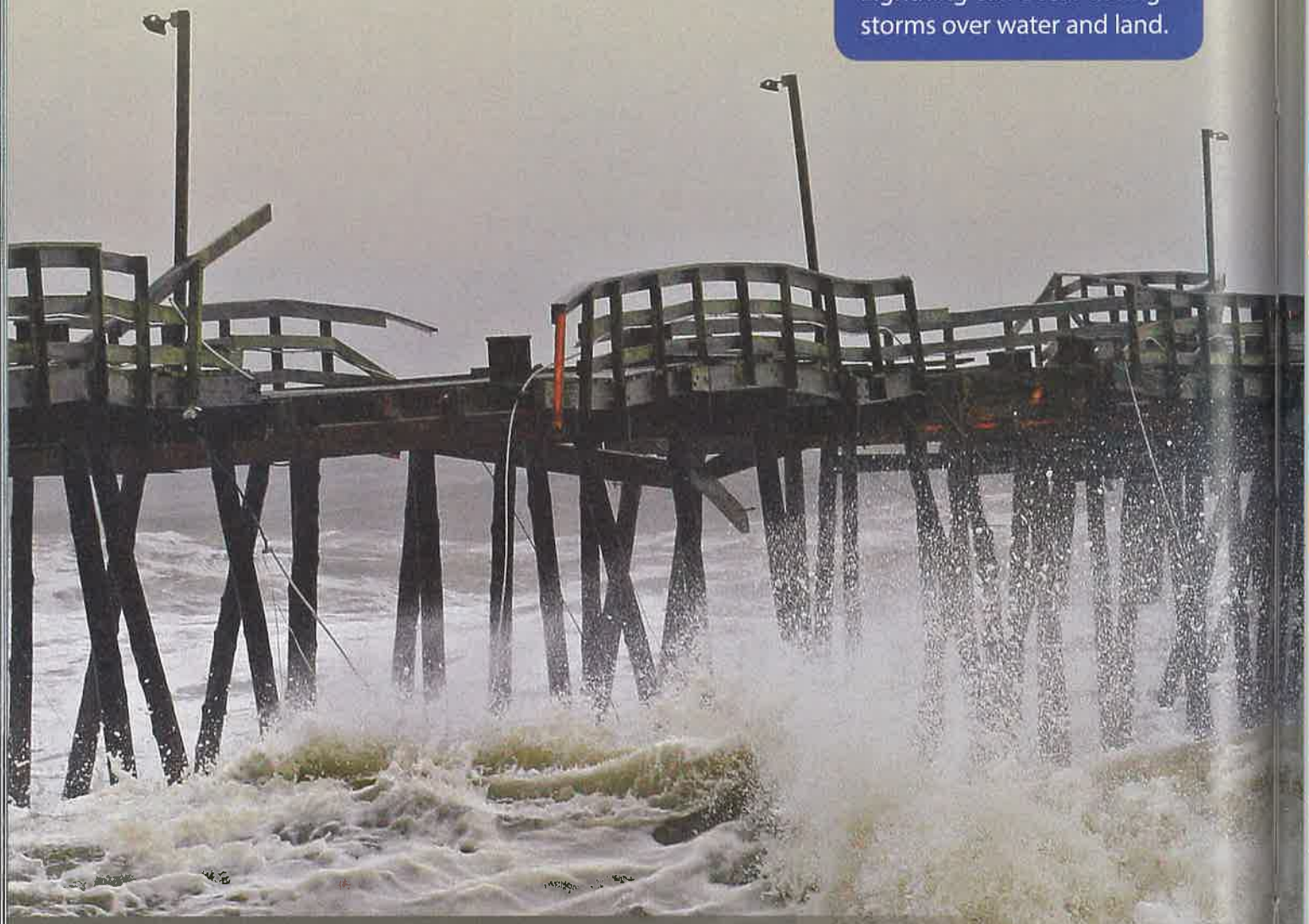
My science notebook

1. **Interpret Maps** Use the map key to describe the climate of Minneapolis, Minnesota.
2. **Identify** Name two cities with similar climates. How do you know they have similar climates?
3. **Contrast** How are climates near the equator different from climates closer to the poles?

Weather Hazards

Thunderstorms and hurricanes are types of weather that can damage property and harm people. Hurricanes are severe tropical storms that form over the ocean. They drop much rain in a very short time. When hurricanes reach the shore, they can cause water to rise into land areas that are normally dry. These floods can damage property. Floods are also dangerous for people who cannot get to higher ground.

Lightning can occur during storms over water and land.



NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS3.B: Natural Hazards
A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (3-ESS3-1)

Hurricanes bring strong winds, too. Trees can bend and break, and buildings can be damaged by the force of a hurricane's winds.

The Jet Star roller coaster fell into the ocean during Hurricane Sandy. The pier it was sitting on collapsed.

Thunderstorms that are not as big as hurricanes can still cause damage. Rain from such storms can cause flooding. Lightning can also damage property.

Strong wind and heavy waves batter this pier during Hurricane Sandy.

Wrap It Up!

My science notebook

1. **Identify** Name two types of hazardous weather.
2. **Explain** Why are hurricanes hazardous?
3. **Infer** Look at the large photo. What could this type of weather do to houses built along a beach?

Reducing the Impact of Flooding

A **flood** is an overflow of water that covers land that is usually dry. Floods can happen during short, heavy rains or when rain falls for a long time. Hurricanes can cause flooding, too. Both the heavy rains and the wind pushing ocean water onto land can cause floods during hurricanes.

The levee around this house helps protect it from floodwaters.

The Thames River sometimes floods parts of London, England. This barrier can move large walls of steel up to hold back high water.

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS3.B: Natural Hazards
A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (3-ESS3-1)

People try to reduce the impact of flooding in different ways. A **levee** is an earthen wall. Levees slow or stop water from flooding an area. A **dam** is a concrete wall built across a river. Dams hold back water that could cause flooding. Flooding can also be prevented using bags of sand to block the water or other materials that soak up water.

This tube contains a material that expands to form a barrier against floodwater.

High water after Hurricane Katrina flooded many homes in Louisiana.

Wrap It Up!

My science notebook

1. **Cause and Effect** What causes flooding?
2. **Explain** How do people try to reduce the damage caused by flooding?

Reducing the Impact of Wind

A gentle breeze might cool you on a warm day. But strong winds in tornadoes and hurricanes can cause much damage. Yet people can take action to protect their lives and property. They can protect themselves, too, from objects flung about by strong winds.

Special glass in doors and windows resists breaking as wind and flying objects blow against it. Also, roof tiles held down with nails instead of staples are not as easily blown off by the wind.

Tornadoes have stronger winds than any other kind of storm.

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS3.B: Natural Hazards
A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (3-ESS3-1)

People can protect themselves from strong winds by closing all of the doors in their homes. Staying in the basement or a small room without windows until the storm is over can help them stay safe, too.

Roofs that slope on all sides stand up better in high winds than roofs that slope on only two sides.

Storm shelters can keep people safe during a tornado.

Wrap It Up!

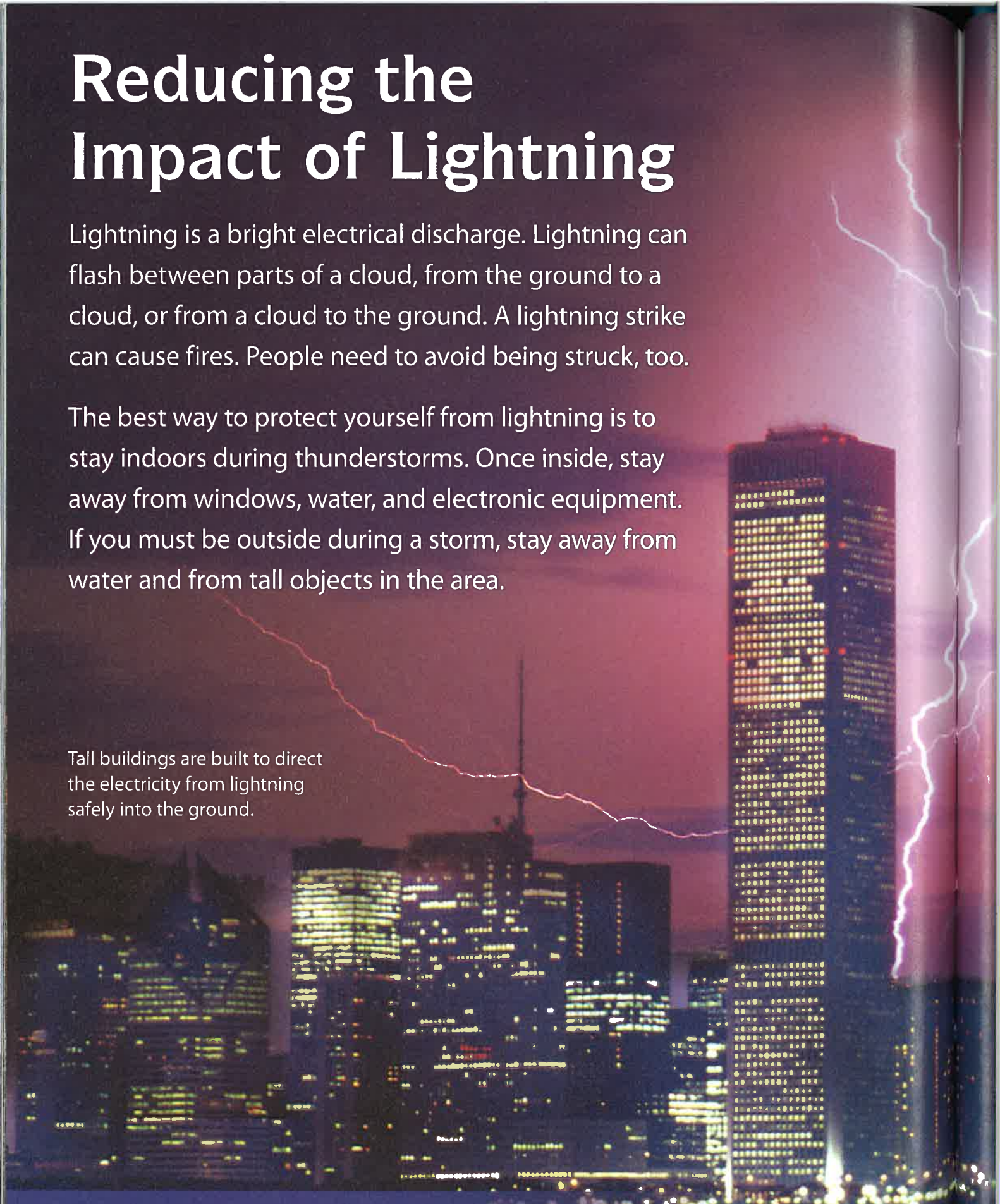
My science notebook

1. **Identify** Name two storms with strong winds.
2. **Explain** Tell how people can protect property from strong winds.
3. **Describe** How can people protect themselves during a storm with strong winds?

Reducing the Impact of Lightning

Lightning is a bright electrical discharge. Lightning can flash between parts of a cloud, from the ground to a cloud, or from a cloud to the ground. A lightning strike can cause fires. People need to avoid being struck, too.

The best way to protect yourself from lightning is to stay indoors during thunderstorms. Once inside, stay away from windows, water, and electronic equipment. If you must be outside during a storm, stay away from water and from tall objects in the area.

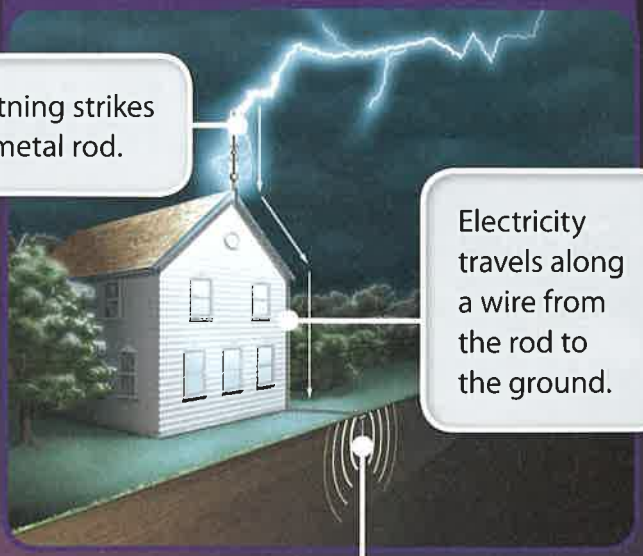


Tall buildings are built to direct the electricity from lightning safely into the ground.

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS3.B: Natural Hazards
A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (3-ESS3-1)

Many structures are protected from lightning by lightning rods. A lightning rod does not stop lightning. Instead, it safely guides the electricity from a strike along a wire to the ground.

Lightning rods can help prevent fires and other damage.



Wrap It Up!

My science notebook

1. **Describe** Why is lightning dangerous?
2. **Explain** What should you do if you are caught outdoors during a thunderstorm?
3. **Infer** Many people unplug their electronic equipment when a thunderstorm is predicted. Why do you think this is so?

Make a Claim

You know that hurricanes can cause a lot of damage. Engineers work to design structures that will stand up to the wind and rain of a hurricane. In this activity, you'll be the engineer. You will design a house for an area where hurricanes are common. You will present the design to others and explain why it will be successful. Then you will use feedback to change your design to make it even better!

1. **Define the problem.**
   How can you design a house to protect it from hurricane damage?

2. **Find a solution.** 
   Review what you know about hurricanes. What type of weather do they bring to an area? What kinds of damage do hurricanes cause? How can this damage be reduced or prevented? Do research or look back at other lessons. Decide on the solution you think would be best to protect a house from hurricane damage. Draw and label your solution. Write how your solution would work.

3. **Defend your solution.**
   Present your solution to your class. State why you think your solution is a good one. Support your claim with evidence. Listen to how your classmates say you might improve your solution.

4. **Refine or change your solution.**
   Use the feedback from your classmates to improve your solution. When you're sure that your revised solution is better than your first, present your solution and describe how you improved it. Support your claim that this solution is a good one with evidence.

NEXT GENERATION SCIENCE STANDARDS | PERFORMANCE EXPECTATION
3-ESS3-1. Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.

You can think like an engineer and identify a solution that will help a house stand up to the force of a hurricane.

Severe-Storms Researcher

As a small boy, Tim Samaras was fascinated by the tornado in *The Wizard of Oz.* This fascination would lead to a life's work.

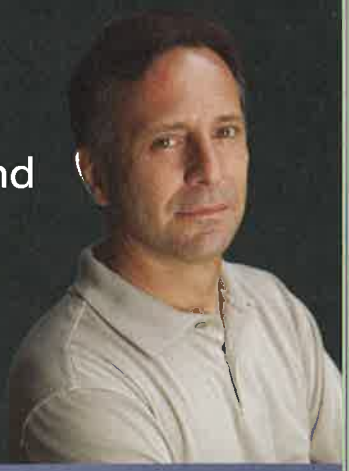
As an adult, Tim studied tornadoes to learn more about their winds and air pressure. Tim's goal was to answer questions about tornadoes to help people better prepare for these violent storms. In 2003, this storm chaser was in the right place at the right time. A very strong tornado touched down in Manchester, South Dakota. Tim was only about the length of a football field away from the edge of the storm, but he was able to put equipment in place to measure the violent winds. The tornado destroyed the town in less than a minute.

In 2013, Tim was near a tornado in Oklahoma. Sadly, his car was in the direct path of the two-and-a-half-mile-wide tornado. During this storm, Tim died doing what he loved—studying tornadoes.

NEXT GENERATION SCIENCE STANDARDS | CONNECTIONS TO NATURE OF SCIENCE
Science is a Human Endeavor
Science affects everyday life. (3-ESS3-1)

NATIONAL GEOGRAPHIC | Explorer

Tim Samaras (1957–2013) was an engineer and a storm chaser. He designed special instruments to study tornadoes. He hoped his work would reduce the deaths and damage caused by tornadoes.



The instruments mounted on Tim's truck gathered data that helped him better understand tornadoes.