Topic 3.1

What is climate, and how has it changed during Earth's history?

Key Concepts

- Climate is different from weather, but they are also linked.
- Climate has changed frequently throughout Earth's past.
- Climate is currently changing around the world.

Key Skills

Inquiry

Key Terms

atmosphere
weather
climate

TV, radio, magazines, newspapers—whatever you watch, listen to, or read these days, it's hard to avoid headlines that link climate change to an increase in storms, heat waves, cold spells, and other deadly and damaging events. But wait—isn't this just news about some wild and wacky weather? What do these headlines have to do with climate change? Before you can answer these questions, it's necessary to understand what climate is, how it is different from weather, and how each is linked to the other.

Starting Point Activity

Some of the headlines on these two pages are about weather. Some are about climate. And some are about both. What do you assume these terms, "climate" and "weather", mean? Share your ideas with your classmates. Come to an agreement about what "climate" and "weather" mean. Then brainstorm ideas to explain how they are different and how they are linked. Based on your discussions, decide which headlines are talking about weather, climate, or both.

Climate is different from weather, but they are also linked.

Imagine that a friend across the country asks you what it's like outside where you live. You say that you are sitting under a cloudy sky on a warm, humid day. It is just starting to rain gently and a wind is starting to pick up.

The details you are talking about—the clouds, the warmth of the air, its moisture, the wind—are conditions of the **atmosphere** at a certain time and in a certain place. Put simply, you're talking about the weather. The current temperature, wind speed, humidity, cloud cover, and precipitation—these are all parts of the **weather**. Weather conditions can change hourly. This is one reason many people watch, read, or listen to weather forecasts, as shown in **Figure 3.1**.

atmosphere: the layer of gases that surrounds Earth

weather: the conditions of the atmosphere for a specific place at a specific time

▶ **Figure 3.1** The weather is monitored continuously, and forecasts are updated many times each day.

How Climate Is Different from Weather

Weather describes *current* conditions of the atmosphere in a specific place and at a specific time. Climate is different. **Climate** describes patterns of weather conditions within a large region over a long period of time. A "long period of time" means years, decades, centuries, and even longer.

climate: the pattern of weather conditions within a region over a long period of time

Weather changes are discussed in terms of short periods of time, such as hourly and daily. Climate changes take place much more slowly. Not surprisingly, a change in the weather conditions that a region experiences over a long period of time is called *climate change*.

Climate Change and Global Warming Are *Not* the Same Thing

Over the past decades, scientists have observed an increase in average global (world-wide) temperature. This increase is known as global warming. However, while it's true that the whole planet's *average* temperature is increasing, many places on Earth are not getting warmer. In fact, some regions on Earth are cooler than they were in the recent past.

Global warming refers to an average increase in one part of weather—air temperature—as it affects the whole planet. But climate involves more than just temperature change over a longer period of time. So climate change refers not only to changes in temperature, but also to changes in other parts of weather such as precipitation (rain and snow), wind, and storms. When scientists talk about climate change, they mean changes in patterns that involve *all* parts of weather, not just temperature.

Literacy Focus

Activity 3.1

CLIMATE CHANGE: WHAT HAVE YOU HEARD?

1. Discuss the following in small groups. One way you could record your answers and ideas is with a KWL chart.
   - **a)** Share two or more pieces of information that you have heard, read, or learned about climate change and global warming. What are the sources of this information?
   - **b)** What questions do you have about the climate and about climate change that you would like answered?
2. A misconception is an idea about something that is false, misleading, or based on incomplete or false assumptions.
   - **a)** You have learned about two misconceptions that involve climate change. Identify these two misconceptions.
   - **b)** Look at your answers to question 1a). Which, if any, of the ideas you shared about climate change might be misconceptions? Explain why you think so.

LEARNING CHECK

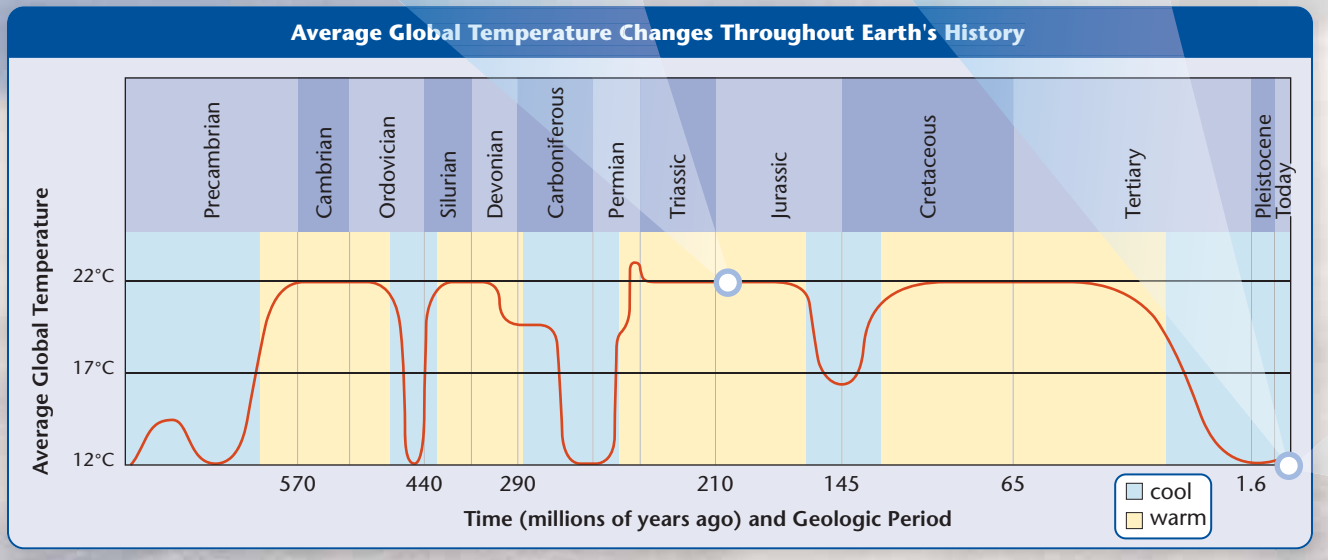
1. Use a double-bubble organizer to compare weather and climate.
2. Use a different graphic organizer to compare global warming and climate change.
3. Some regions on Earth are experiencing decreases in average global temperature. Other regions on Earth are experiencing increases in average global temperatures. If this is true, how can people claim that global warming is taking place? Explain.
4. Do you think you have an impact on weather? How about climate? Give specific examples to support your answers.

Climate has changed frequently throughout Earth's past.

Earth's climate has been different in the past. Some of these changes have been dramatic and have occurred over millions of years. Some of these changes have been less dramatic and have occurred over hundreds and thousands of years. The graphs in **Figure 3.2** and **Figure 3.3** highlight some of the changes in Earth's climate that have occurred in the past.

▼ Fossils of dinosaurs and trees that have been found in Antarctica are evidence that the climate there was very different in the past.

▼ An ice age is a time period in Earth's history when glaciers covered a large part of the surface. The last ice age peaked about 26 000 years ago. Sheets of ice as deep as 3 km covered much of Canada.



▲ **Figure 3.2** This graph shows how average global temperature has varied since Earth was formed.

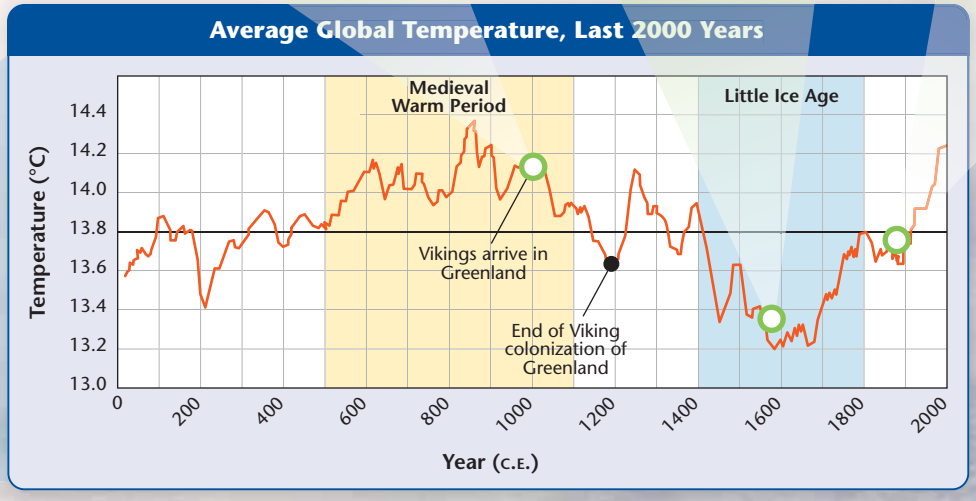
LEARNING CHECK

1. Graphs are helpful for showing patterns that let people make predictions. Do either of the two graphs show patterns in warming and cooling, or are the changes in temperature random? Explain.
2. The graph in **Figure 3.3** shows that Earth's average temperature in 2000 C.E. was about the same as during the Medieval Warm Period. Why do you think scientists are worried about climate change today?

▼ Between 900 and 1300 C.E. the north Atlantic Ocean was free of ice, which let Vikings travel from Europe. They settled briefly in Newfoundland and colonized Greenland for several hundred years.

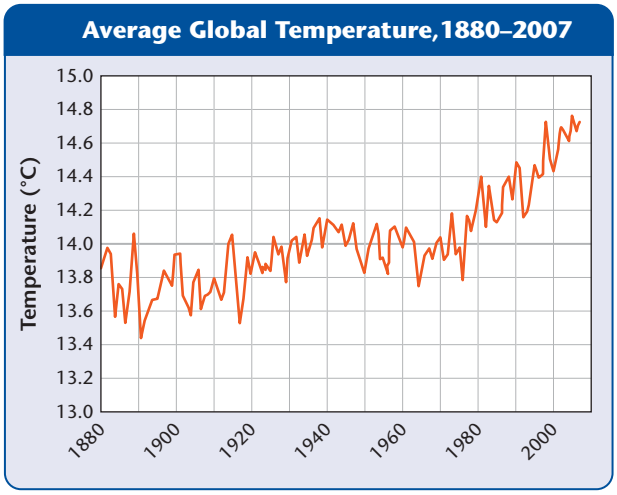
▼ By 1500, the climate had grown much colder than normal, beginning the period called the Little Ice Age. The frozen Thames River in England is now ice-free all year. But during the Little Ice Age, the surface was often solid in winter.

▼ Worldwide record-keeping of temperatures started in the 1880s. Since then, average global temperatures have been warming.



▲ **Figure 3.3** This graph shows changes in average global temperature between 0 C.E. and 2000 C.E.

Climate is currently changing around the world.



Source; NASA GISS

▲ **Figure 3.4** This graph shows the quick rise of average global temperature since 1880.

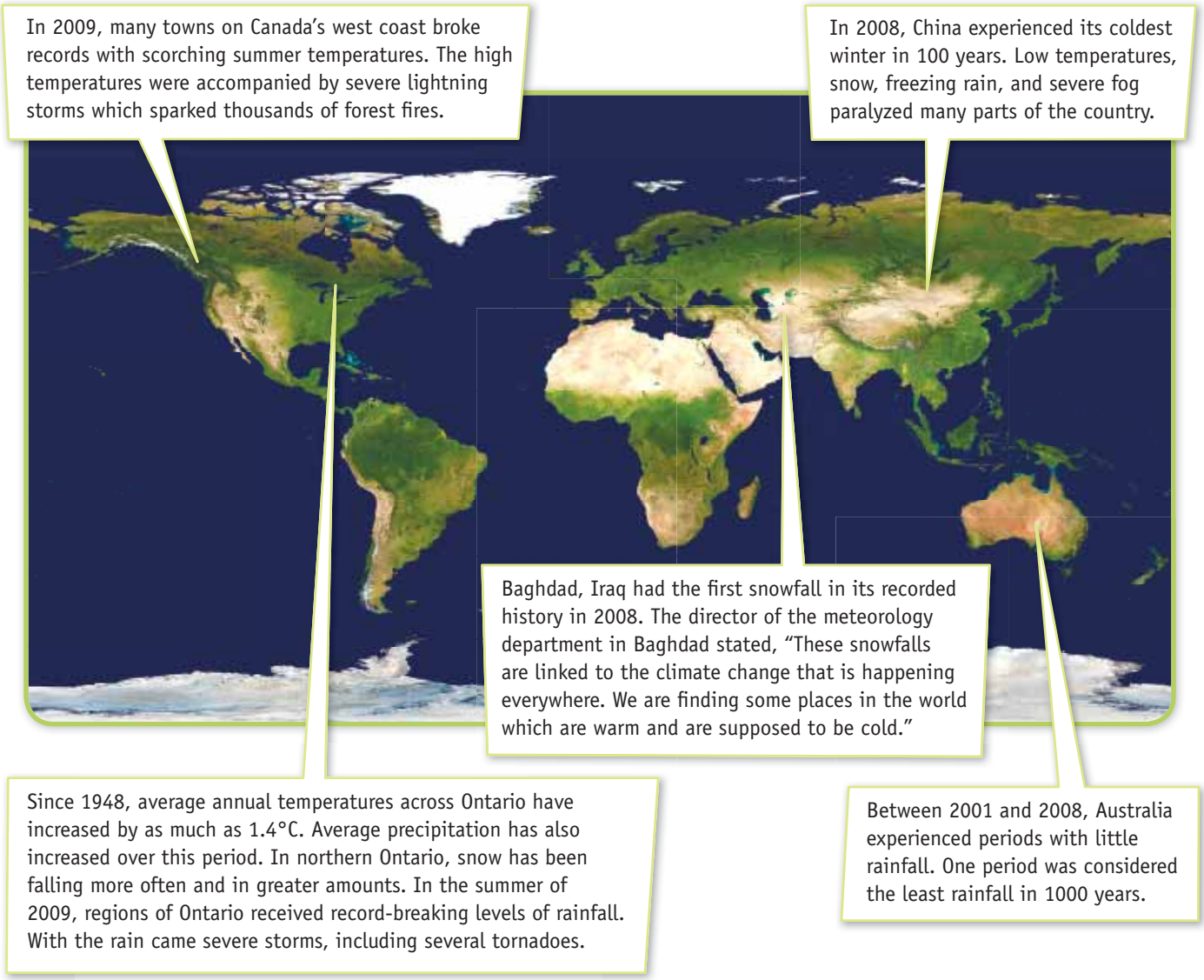
If Earth's climate has changed in the past, why are scientists concerned about the current warming trend? Scientists are concerned about current warming because it is occurring very quickly. In the past, climate has changed more slowly. Because the average global temperature has been changing so quickly, most scientists believe something unusual is going on. Based on their observations and the data they have analyzed, scientists have concluded that Earth's climate is being influenced by a factor that has never affected it before. That factor is us—humans.

Recall that climate change involves more than just changing temperatures. Read the text below and examine the graph in **Figure 3.4** to find out how climate is currently changing around the world. Then look at **Figure 3.5** to see some effects of climate change.

Rising Average Temperature Our planet is heating up, and it is doing so quickly. The average global temperature has risen almost 1°C since the 1800s. And scientists predict this trend will continue. Scientists estimate that Earth will warm several degrees by the next century. If this doesn't seem like such a big increase, consider this—the average global temperature during the last ice age was just 5°C cooler than it is now.

Changing Precipitation Warmer average temperatures increase evaporation. This has different effects in different regions. Closer to the equator, this generally means less rainfall. Polar regions, on the other hand, are experiencing uncommonly heavy precipitation.

More Severe Storms As Earth's atmosphere warms, so do its oceans. This warming results in increased severity and frequency of ocean-based storms, such as hurricanes. Storms on land are also becoming more severe. For example, despite the increase in average global temperature, some regions have experienced record-breaking snowfalls over recent years.



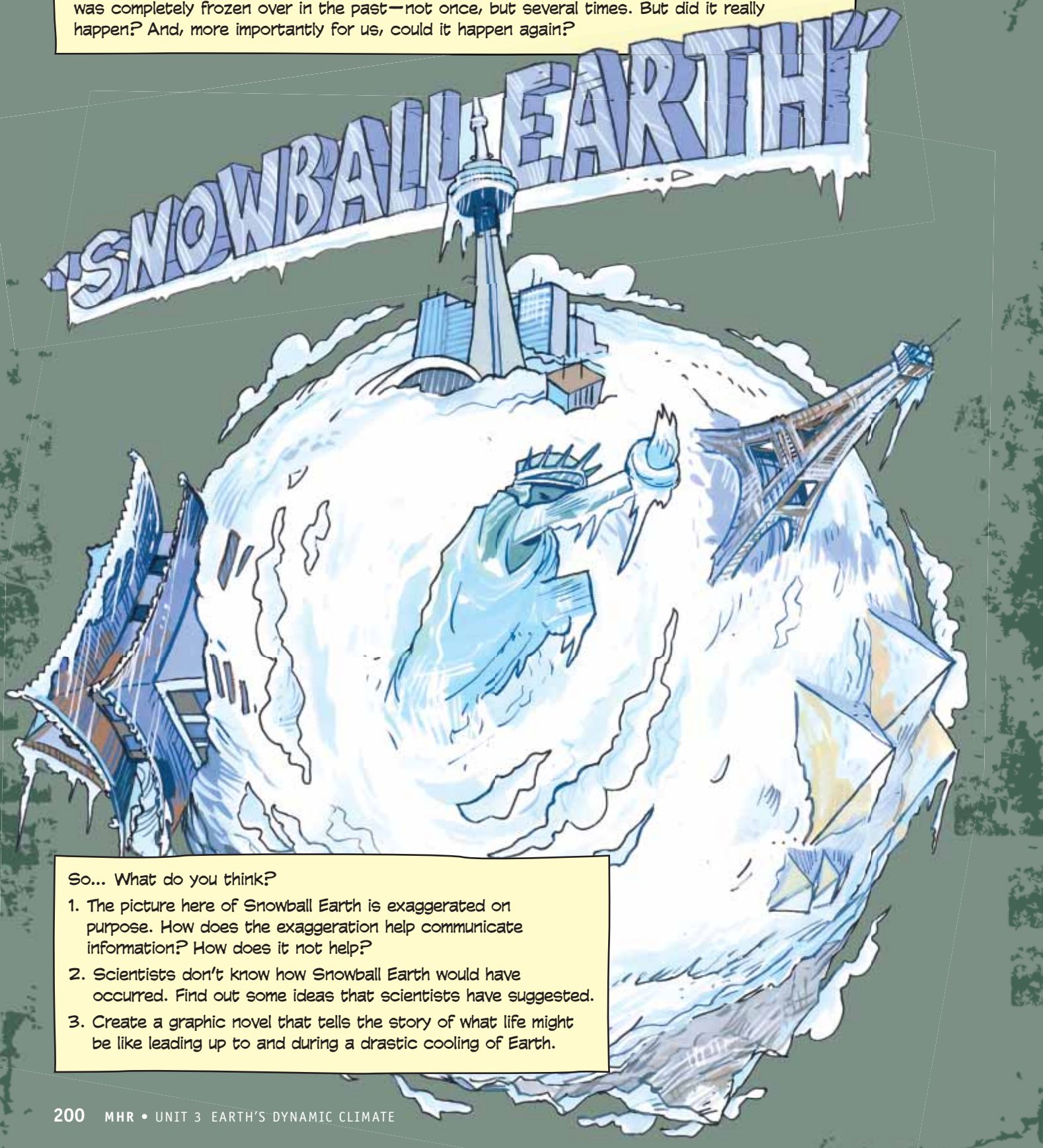
▲ **Figure 3.5** Changes in climate have affected regions in Canada and around the world.

LEARNING CHECK

1. Why do scientists think the average global temperature is increasing so quickly?
2. How is precipitation changing as average temperatures rise around the world?
3. Identify which of the examples in **Figure 3.5** might just be weather-related and which ones are evidence that the climate is changing. Explain how you made your choices.

Strange Tales of Science

If you think an ice age sounds cold, get ready for a hypothesis that makes an ice age look like a tropical paradise. Some scientists hypothesize that the whole Earth, oceans included, was completely frozen over in the past—not once, but several times. But did it really happen? And, more importantly for us, could it happen again?



So... What do you think?

1. The picture here of Snowball Earth is exaggerated on purpose. How does the exaggeration help communicate information? How does it not help?
2. Scientists don't know how Snowball Earth would have occurred. Find out some ideas that scientists have suggested.
3. Create a graphic novel that tells the story of what life might be like leading up to and during a drastic cooling of Earth.

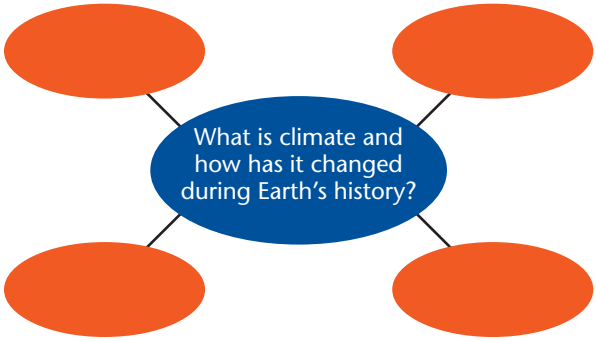
Topic 3.1 Review

Key Concept Summary

- Climate is different from weather, but they are also linked.
- Climate has changed frequently throughout Earth's past.
- Climate is currently changing around the world.

Apply the Concepts

1. K/U Answer the question that is the title of this topic. Copy and complete the graphic organizer below in your notebook. Fill in four examples from the topic using key terms as well as your own words.



2. K/U **a)** Define weather.

b) Define climate.

c) This summer, your region experienced a heat wave for one week. Use your definitions of the above two terms to explain whether this heat wave indicates that Earth's climate is changing.

3. T/I The feature to the left identifies a hypothesis called Snowball Earth.

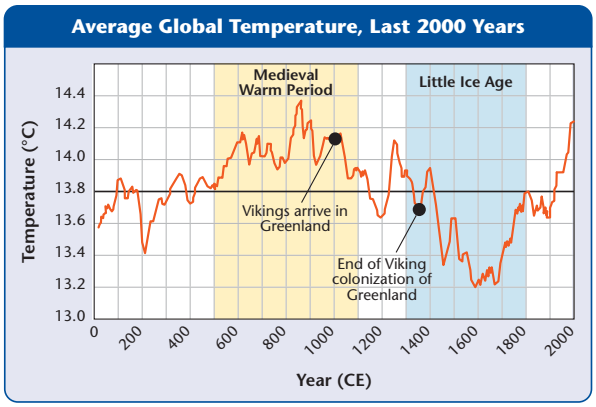
a) What is a hypothesis, and how does it differ from a theory?

b) If Snowball Earth is a hypothesis, does that mean it happened? Explain your answer.

c) If Snowball Earth were a theory, would that mean it happened? Explain your answer.

4. K/U Describe three ways in which climate is currently changing.

5. T/I Refer to the graph below, which you saw in Figure 3.3. Use the graph to compare how the climate was different in the following years: 1400, 1500, 1600, 1700, 1800, 1900, 2000.



6. C How do you think another Little Ice Age would affect the population of Canada today? Write a story or draw a comic strip to communicate your answer.

7. A Animal species such as woolly mammoths became extinct due to changes in Earth's climate. Do you think humans could be threatened with extinction at some point in the future due to drastic climate change? Give reasons to support your opinion.

8. A It is common for people to be confused about what they hear about climate change and global warming.

a) Provide at least two reasons why you think there is confusion.

b) In your opinion, how could the confusion be reduced or eliminated?