

Topic 3.1

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

Specific Expectations

- **D2.1** use appropriate terminology related to Earth's dynamic climate, including, but not limited to: *anthropogenic, atmosphere, carbon footprint, carbon sink, climate, greenhouse gases, hydrosphere*, and *weather* [C]
- **D3.7** identify indicators of global climate change

Skills

- formulate scientific questions
- make predictions and hypotheses

Materials

Please see the teaching notes for each activity for a list of the materials required. Please see pages TR-47 to TR-49 for a summary of the materials required in this topic.

Overview

In this topic, students will identify the difference between *climate* and *weather*, and *climate change* and *global warming*. Students will explore the world's current rapidly changing climate, past climate changes, such as ice ages, and the causes of climate change now.

Common Misconceptions

- **Some students may believe that global warming is a good thing. Canadian winters will not be as cold and summers will be longer.** Explain that Earth is a delicate and complex system and when the average global temperature increases, even slightly, there are enormous consequences. Plants will not grow as well and the animals that depend on them may die off. Sea water will evaporate more quickly and ice will melt. Changes in the oceans will mean changes in weather patterns globally; there will be droughts in some places and flooding in others. Melting Arctic ice, for example, is the cause of polar bear deaths due to drowning. Scientists estimate that today there are about 25 000 polar bears, but that owing to loss of Arctic habitat the population will decrease to fewer than 8500 by 2050. For more information go to www.scienceontario.ca and follow the links.
- **Some students may believe that climate change is a natural process.** Direct students' attention to Figure 3.2 and Figure 3.3 on pages 196 and 197. Explain that Earth's climate does change over time, but that these changes are subtle and gradual, occurring over millions of years. The current climate change is happening much more quickly and the results are very dramatic.

Background Knowledge

Many scientists consider climate change to be one of the most serious problems facing people today. The pollution that we are adding to Earth's atmosphere are building up and creating a global change to the climate of the planet: the greenhouse effect. Just like in a greenhouse where the Sun's rays penetrate through the glass and then remain trapped inside, heating the space, pollution is heating our atmosphere on a global scale. Carbon dioxide from manufacturing, cars, and even large-scale farming is changing the atmosphere, creating a blanket-like covering over the Earth that allows sunlight in but does not allow the heat to escape. There is currently 32% more carbon dioxide in the atmosphere than at the beginning of the industrial era. Topic 3.3 covers the greenhouse effect in more detail. For more information about the greenhouse effect, go to www.scienceontario.ca and follow the links.

Global warming is the increase of the Earth's average surface temperature. Earth's temperature has increased approximately 0.6°C over the last century. Scientists predict that it will increase between 0.5 to 0.6 additional degrees in the 21st century. Although as a whole, Earth's average temperature is on the rise, regional temperatures may actually decrease and weather patterns may change, often with more severe storms. This phenomena is related to Earth's oceans and the gigantic ocean current system known as the Great Ocean Conveyor. Earth's ocean currents are responsible, to a large extent, for our weather patterns. Ocean currents and winds move warm and cold water and air in complex patterns around the globe. The increased temperatures in the northern and southern regions are melting polar ice, adding more fresh water to the salt oceans. This influx of fresh water, and many other factors, is changing the density of the ocean water and changing the currents. Go to www.scienceontario.ca and follow the links for more information.

Over Earth's history, there have been approximately 11 colder periods called ice ages, or glacial ages. These long-term cold periods caused the expansion of continental ice sheets and glaciers. The last ice age ended about 11 000 years ago. During this Great Ice Age, more than a third of Earth was covered by ice sheets the size of continents. Scientists believe Earth is currently experiencing a mini-ice age. Go to www.scienceontario.ca and follow the links to learn more.

Literacy Strategies

Before Reading

- **ELL** Draw students' attention to how the topic is organized. Show them where to look for key term definitions (in the margins) and how the sections are split into main headings and subheadings. Demonstrate how to quickly find an important fact or reference by scanning through the heads and subheads. This skill will be especially useful for English language learners and other students who find reading challenging. Students can practise this skill in a game format. Place students in small groups and call out information for them to locate in the text. Each group attempts to locate the information before other groups. Groups can attempt to break their own record. Explain that being able to navigate through a text and find what you need is a skill that will be useful throughout high school.
- **ELL** Preview the key terms with English language learners. Encourage them to use sketches to assist them in understanding the vocabulary. You may want to encourage them to collect these sketches and create a personal glossary to refer to as they work through the unit.

During Reading

- Have students make jot notes of the key concepts as they read. Recording important information during reading will assist in retention. Students can read through their notes later as a review.

After Reading

- Remind students of the text navigation skills you explained before reading. As a review, select a few key concepts and have students find the relevant section on that concept. For example, you may wish to ask students to find the section that explains climate change (page 195).

Assessment FOR Learning

Tool	Evidence of Learning	Supporting Learners
Activity 3.1, page 195	Students' answers reflect an understanding of the terms <i>climate change</i> and <i>global warming</i> and how they are related. For climate change, students refer to overall changes in weather patterns over time, such as increased frequency and violence of storms, extremes of temperature and precipitation. Global warming refers to Earth's average temperature over time.	<ul style="list-style-type: none"> • ELL Students may need to refresh their memories about the meaning of the mathematical term <i>average</i>. English language learners might also need help recognizing the significance of the word in the definition of <i>global warming</i>. Ask students to list the marks they received on their last four tests (or have them invent marks, if they wish). Ask them to calculate their <i>average</i> mark for the four tests. For example, $68 + 72 + 87 + 70 = 302$, $302 \div 4 = 75.5$. This result 75.5, represents the <i>average</i> mark. Explain that global warming is calculated in much the same way.
Learning Check, page 195 Review, question 2, page 201	Students correctly identify the differences and similarities between <i>weather</i> and <i>climate</i> .	<ul style="list-style-type: none"> • Provide students with BLM G-41 Double Bubble Organizer. For students who are struggling, scaffold the activity by providing them with a list of terms to place on the organizer: temperature, wind speed, humidity, cloud cover, precipitation, long period of time, short period of time, large area, and specific area.
Learning Check, page 195 Review, question 8, page 201	Students correctly identify the connection and distinction between <i>global warming</i> and <i>climate change</i> .	<ul style="list-style-type: none"> • Provide students with BLM G-49 Venn Diagram. For students who are struggling, scaffold the activity by providing students with a list of terms to place on the diagram: changes in temperature up or down, changes in precipitation up or down, changes in winds, changes in storms, changes in temperature, and increase in Earth's average global temperature.
Learning Check, page 195	Students identify that humans are responsible for the rapidly increasing global temperature.	<ul style="list-style-type: none"> • ELL English Language learners may struggle with the sentence structure in both the question and the first paragraph. Rewrite the question on the board as: "Earth's average global temperature is increasing quickly. Why?" Have students reread paragraph 1. You may wish to provide them with a photocopy of the paragraph and have them highlight important concepts as they read. Alternatively, conduct a class discussion on the topic and have students offer suggestions as to why Earth's temperature is rising so quickly.

Topic 3.1 (Student textbook pages 192-201)

Using the Topic Opener

- Refer students to the topic opener. Have them read a few headlines aloud. Ask students to consider why this collage of headlines was chosen for the topic opener. Then, have them read the opening paragraph. Explain that every day, we are bombarded with messages about climate and weather that seem confusing and that in this topic, they will learn about these ideas.

Starting Point Activity (Student textbook page 193)

Pedagogical Purpose

The terms *climate* and *weather* are often confused. This activity prepares students by having them analyze the terms as a group. Then, students apply their understanding to sort weather and climate headlines similar to what they may see in their daily lives.

Planning	
Materials	BLM G-49 Venn Diagram (optional)
Time	30-40 min in class

Activity Notes and Troubleshooting

- Have students work in small groups for the first part of this activity. Then, have the groups share their thoughts on the definitions of *climate* and *weather*.
- As a class, create a class definition of *climate* and *weather*. Record these definitions on the chalkboard or on chart paper. Have students use the class definition in their discussions of the headlines.

Additional Support

- **ELL** English language learners may benefit from using a graphic organizer, such as **BLM G-49 Venn Diagram**, to help them analyze and organize their thoughts on weather and climate.
- **DI** Students with strong interpersonal skills will enjoy this activity. Group these students with students who are developing these skill sets.
- **DI** Students with strong linguistic skills may enjoy researching the origins of the terms *weather* and *climate*. Have them share their findings with the class.
- Enrichment—Have students research definitions for *climate* and *weather* in the dictionary. They may also wish to research the origins of the terms.
- Enrichment—Bring in climatology-related articles from newspapers and magazines. Have students read the headlines only first, and decide if the article refers to climate or weather. Then, have them read the article to confirm their prediction.

Starting Point Activity Answer

Climate is the pattern of weather conditions within a region over a long period of time. Weather is the set of conditions of the atmosphere for a specific place at a specific time. Answers may vary.

Instructional Strategies for Topic 3.1

Student textbook pages 194-195

- Create a class daily weather board. For several days or a week before beginning the topic, have students check various sources (newspaper, radio, Internet, television) for the local weather report and bring the information to class to post on the weather board.
- **DI** **ELL** English language learners and visual learners may prefer to use graphic representations of weather (cloud shapes, lightning bolts, etc.). Allow these options and encourage them to choose images that are respectful of their age and are not childish or cartoonish.
- Enrichment—Several days before, or as an extension activity, have students research what the weather was like on important days in the past in their community. Students could, for example, research the weather on the date of their birth, an important past sporting event, or an important historic event. Have them share their findings with the class and add their information to the weather board.
- As an introduction to the topic, ask students to consider the weather board and the information they have collected. As a class, brainstorm a definition of *weather*. Then, assign the first two paragraphs on page 194. Ask students how their class definition compares to the text definition. Amend the class definition and post it on the weather board.
- Have students read the section How Climate Is Different from Weather on page 194. Then, ask them to consider the term *climate* in terms of the class *weather* board. [As a whole, all the information on the board could be considered climate.]
- Have students read the text on page 195 and assign the activity. When students have completed the activity, assign the Learning Check questions. These questions could also be assigned as homework. Provide students with **BLM G-41 Double Bubble Graphic Organizer** for question 1 and **BLM G-49 Venn Diagram** for question 2.
- You may wish to use **BLM A-14 Venn Diagram Checklist** to assist you in assessing your students. If you plan to assess students, you may wish to provide them with a copy of the checklist when you assign the activity to ensure they are aware of what is expected of them.

Student textbook pages 196-197

- To assist students with visualizing the points in this section, consider using graphic elements. Create an Earth climate timeline but using blank $8\frac{1}{2}$ in. \times 11 in. sheets of paper hung horizontally with a line drawn horizontally through the centre or hand out **BLM 3-5 Climate Timeline**. Have students work as a class to mark the major events noted on this spread on the timeline.
- To demonstrate the scale of the continental ice sheets, have students create a scale outline of the CN Tower and other major structures of the world (consider using the image on the graphic in Strange Tales of Science). Then, have them mark where 3 km would be in scale with these structures. You may wish to have students return to this activity when they do question 3 of Strange Tales of Science, on page 200.

Student textbook pages 198-199

- **ELL** Prior to assigning the reading, draw students' attention to the world map and the captions. Have them read the captions as a class and consider what they mean. Then, assign the reading. Pair English language learners with strong linguistic learners.
- Before students read page 198, you may wish to conduct a class discussion or brainstorming session for question 1 of Learning Check, page 199. Have students speculate why Earth's average temperature is rising so quickly. Then, have them read page 198 to verify their ideas.

- If possible, arrange for a screening of *An Inconvenient Truth*, the award-winning documentary on climate change. For more information on how to obtain the DVD and relevant educational resources, go to www.scienceontario.ca.

Activity 3.1 Climate Change: What Have You Heard?

(Student textbook page 195)

Pedagogical Purpose

Students are being continuously bombarded by the media with information, and misinformation, about climate change and global warming. This activity provides an opportunity to identify what they have heard and to correct any misconceptions they may have.

Planning	
Materials	BLM G-44 K-W-L Chart (optional) BLM 3-7 Climate Change Information (optional)
Time	30-40 min in class

Skills Focus

- critically analyze sources of information
- summarize and communicate findings

Activity Notes and Troubleshooting

- Have students work in groups for this activity.
- Ensure that groups are balanced with students of different abilities represented.
- You may wish to have students use **BLM G-44 K-W-L Chart** for question 1.
- Alternatively, you may wish to work through question 1, part a) as a class and record students' responses on the chalkboard or on chart paper. Then, assign question 1, part b) to students as homework. It may be helpful to have students read a few articles on climate change before completing part b). Have students bring in newspaper and magazine articles and Internet news article printouts. On their blackline master, have students record the name of the article(s) they read before completing the activity.
- As a wrap up for this activity, encourage students to watch the documentary, *An Inconvenient Truth*, or arrange for a screening.

Additional Support

- **ELL** Have English language learners or students who are struggling use **BLM 3-7 Climate Change Information** to record their thoughts for question 1, part a) and for question 2, part b).
- Students with strong interpersonal skills will enjoy working in groups for this activity. Group work will encourage the development of these skills in other students.

Activity 3.1 Answers

1. Answers may vary.

a) Students may voice concerns about global warming and their future. They may mention articles about drowning polar bears, or other losses of species. Sources may include television, radio, magazines, newspapers, the Internet, or conversations with parents or teachers.

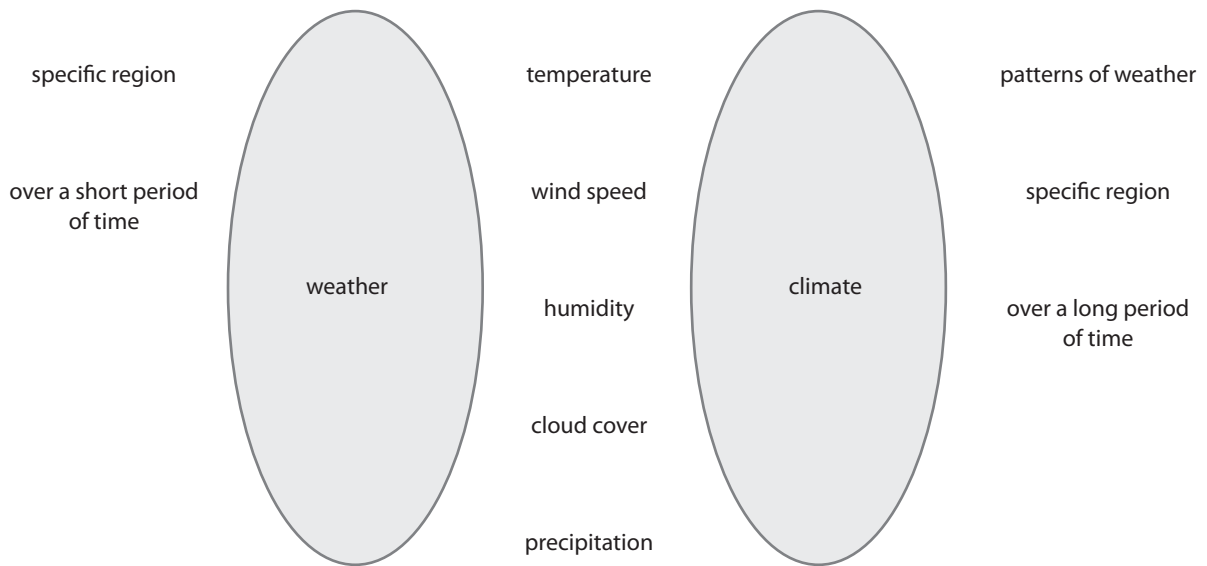
b) Students should write specific questions and return to their K-W-L Charts at the end of the topic to see if these questions were answered.

2. a) Climate change and global warming are often thought to be the same thing but they are different. Global warming is thought to mean that Earth is getting warmer everywhere. But this is not true. Some places are getting colder.

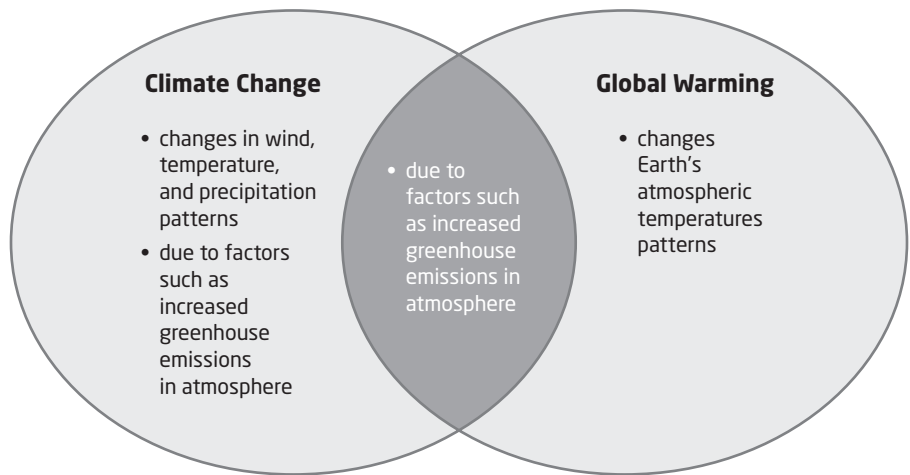
b) Answers may vary. For example: I thought climate change is only happening in the Arctic but it is happening all over the globe.

Learning Check Answers (Student textbook page 195)

1. Answers may vary. For example:



2. Answers may vary. For example:



3. Global warming is the increase in Earth's average world-wide temperatures. So, although some areas may actually experience colder average temperatures, overall, Earth's temperature is getting warmer.
4. Answers may vary. For example: I do not think I have any impact on the weather. I cannot make it stop raining or make tomorrow be a warm day. I have some effect on climate though. If I bike to school instead of getting a ride I can help reduce global warming, which is climate.

Learning Check Answers (Student textbook page 197)

1. Both graphs show that Earth cycles through periods of warming and cooling.
2. Scientists are worried because this means we might be headed into a new ice age.

Learning Check Answers (Student textbook page 199)

1. Scientists think that humans are causing the global temperature to rise quickly.
2. Areas near the equator are getting less precipitation and areas near the poles are getting much more precipitation.
3. Answers may vary. For example: All the examples are related to climate change. All the examples mention record-breaking or record-setting temperatures or precipitation so there has been a change in climate over long time periods. They also mention severe storms, which is linked to climate change.

Using Strange Tales (Student textbook page 200)

Literacy Support

Before Reading

- Read the opening paragraph aloud to students.
- As a class, have students brainstorm one important question that this opening paragraph asks. For example: "Will Earth ever become completely frozen?"
- As a class or in small groups, have students work together to identify the images of structures on the giant snowball. Have them note what areas the structures represent. (Toronto: CN Tower, Rogers Centre, etc.; Paris: Eiffel Tower; New York City: Statue of Liberty; Egypt: Pyramids; China: Pagoda; Asia: the Himalayas.) Ask students why they think these particular images may have been selected. Ask them if the structures are appropriate. Ask if there are other structures that may have been better choices.

During Reading

- As students read through the opening paragraph and the questions individually, provide students with a copy of the page, **BLM 3-8 Strange Tales of Science** and have them highlight important passages. (Students should consider highlighting "whole Earth", "oceans included", "completely frozen over in the past", "several times", "did it really happen?", "could it happen again?") Alternatively, students could make jot notes of these important points.

After Reading

- As a class, answer any questions students may have before assigning the questions.

Instructional Strategies

- Open the Strange Tales with a discussion on recent depictions of climate change in the movies and on TV. Ask students if any of these films or shows have worried them.
- **DI** **ELL** You may wish to provide students with **BLM G-49 Venn Diagram** to help organize their thoughts for question 1. Visual learners and English language learners in particular may benefit from using a graphic organizer for this question.

- Students may benefit from using **BLM G-18 Internet Research Tips** and **BLM G-19 Internet Research Worksheet** for the research in question 2.
- You may wish to have students work in small groups or in pairs for question 3.
- **ELL** English language learners may not be familiar with the format of a graphic novel. Bring in a few examples (or ask students to bring in an appropriate selection) as a guide for question 3. Discuss the various characteristics of a graphic novel while displaying them in the novel.
- You may wish to adapt **BLM A-10 Poster Checklist** to assist you in assessing your students' responses to question 3. If so, you may wish to provide a copy of the assessment criteria to students when you assign the question so they know what is expected of them.

Strange Tales Answers

Answers may vary.

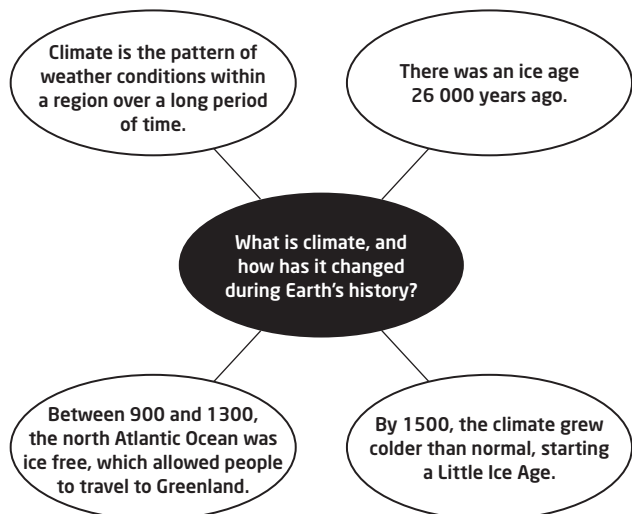
1. The exaggeration in the picture uses familiar landmarks to show how many countries would be covered in ice. It does not help because the landmarks are not placed accurately. For example, the Himalayas seem to be located in Antarctica.
2. Answers should show documented research with respected sources.
3. Students' graphic novels should show a progression of time and conditions, and should accurately depict an ice age.

Topic 3.1 Review (Student textbook page 201)

Please see also **BLM 3-9 Topic 3.1 Review (Alternative Format)**.

Answers

1. Answers may vary. For example:



2. **a)** Weather is the set of conditions of the atmosphere for a specific place at a specific time.
- b)** Climate is the pattern of weather conditions within a region over a long period of time.
- c)** A heat wave is an extended time interval of abnormally and uncomfortably hot and humid weather. It should last at least one day but usually it last from several days to several weeks. Since the heat wave happens over a short period of time, it is not an indicator of climate change.
3. **a)** A hypothesis is a statement intended to explain a phenomenon and is intended to be the basis of for experiments to prove or disprove the hypothesis. A theory is a set of statements, sometimes including a hypothesis, which explains a group of observations of phenomena.
- b)** No, a hypothesis wouldn't tell us whether Earth was frozen or not. A hypothesis is an idea that is being tested to see whether it is true or not.
- c)** It would mean that all the current evidence and reasoning supports the hypothesis that Earth was frozen in the past.
4. Three ways in which climate is currently changing are the rise in average temperature at the surface of Earth, the change the patterns of precipitation, and the increase in more severe storms.

5. The approximate average temperatures for each year are shown.

Year	Temperature (°C)
1400	13.9
1500	13.6
1600	13.2
1700	13.4
1800	13.8
1900	13.6
2000	14.2

From 1400 to 1600, there was a decrease in temperature, then a rise afterward with the greatest increase from 1900 to 2000.

6. Answers may vary. Students should include a drastic effect on the agricultural and summer recreation industry. Winter recreation industry would have a prolonged season. All Canadians will be a little poorer due to additional heating and fuel costs.
7. Answers may vary. For example: Yes, we might become extinct. Extensive drought would led to crop failure and lack of water, which would cause wide spread famine. Excessive precipitation could cause flooding, destruction of agricultural land, and many deaths.
8. **a)** People are confused because they do not know the proper definitions of *weather* and *climate change*. People in the media also get these terms confused when presenting information. Climate change is gradual and occurs over long periods of time. Weather occurs over a short period of time. People need to see immediate evidence to make connections.
- b)** When presenting information, always define weather and climate change. Provide examples and always clarify the information that is presented.