

Topic 3.5

How can we assess present climate change and reduce our impact?

Specific Expectations

- **D2.5** investigate their personal carbon footprint, using a computer simulation or numerical data, and plan a course of action to reduce their footprint
- **D2.6** compare different tools or systems used by scientist to make informed decisions on global climate change
- **D2.7** compare different perspectives and/or biases evident in discussions of climate change in scientific and non-scientific media

Skills

- find relevant sources of information
- analyze information for reliability and bias
- draw conclusions based on observations
- communicate using appropriate language, in a variety of formats
- use appropriate modes of representation

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 consolidate their knowledge about climate change and focus on how to assess and reduce humans' impact on climate change. They will also consider how to reduce their own impact.

Common Misconceptions

- **Some students may think that ice core samples help us to understand Earth's climate today.** Explain that this can only help us understand today's climate indirectly. Studying ice core samples helps us see patterns and understand Earth's systems in the past, which helps scientists predict what might happen in certain situations in the future. Discuss Antarctica with students. Explain that the ice of Antarctic is similar to a gigantic frozen fossil that is hundreds of thousands of years old. And because Antarctica is so remote, the samples have not been contaminated by human contact.
- **Students may not realize that satellite technology is used for more than just communication.** Explain that different satellites are designed and built for different purposes, such as mapping, ozone analysis, and wind and water cycle measurements.
- **Students may not be aware that their impact as individuals on the planet can be measured and changed.** Tell students about the concept of a carbon footprint. Explain that the idea of a footprint is used as an example of how lightly or heavily we walk somewhere. Have students imagine walking across snow, mud, or sand. Ask what would happen if they walked very carefully and lightly? What kind of footprint would they leave? What would happen if they stomped as heavily as they could across the snow? What would their footprints look like then? In this way, people can make smaller or larger "footprints" on the Earth. Small decisions we make every day can add up to large changes in the climate.

Background Knowledge

Activity 3.11 on page 247 lists various organizations for students to research. Go to www.scienceontario.ca to find these and other similar organizations.

NASA has been studying Earth and its systems in its Earth Science Program since its creation in 1958. The Earth Observing System (EOS) is a series of satellites designed to observe Earth and offer integrated measurements of Earth's processes. Phase 1 of this system involved free-flying satellites, air and ground-based studies and space shuttle missions. Phase 2 began with the launching of *Terra*, the first EOS satellite. Now, EOS boasts a series of polar-orbiting and low-inclination satellites for long-term study of Earth, the atmosphere, the biosphere, and the oceans.

Organic farming is a practice where no chemical fertilizers or pesticides are applied to the crops. In the case of meat production, animals are fed organic feed and are not given antibiotics or growth hormones. In Canada, organic products are subjected to a strict certification process. Only after passing this process can producers use the new Canadian organic certification label. More information about Canada's organic certification process can be found at www.scienceontario.ca.

Fair Trade is a trading practice where farmers and workers are paid a fair wage for their products. Many people are not aware, for example, that coffee and chocolate are largely products of slavery, often child slavery. Products that are certified fair trade are marked with a logo. For more information on fair trade products and certification, visit www.scienceontario.ca and follow the links.

Literacy Strategies

Before Reading

- Have students look at the headings to determine the main ideas in each section and to help them identify the most important information in the text. Students can use this information to organize their learning.
- Students may wish to combine the images in this section with the headings and use this to help organize their work.
- **DI** Encourage spatial learners to summarize the images throughout the section as a preview to the material.

During Reading

- Encourage students to make a main idea web to help them organize their understanding. They can begin their main idea web based on the topic headings and add to the web as they read through the text. Provide students with **BLM G-45 Main Idea Web**.
- **ELL** A triangle approach can help English language learners identify the main idea of a reading passage. Read a short passage aloud. Have students draw a large triangle and work in pairs to write the main idea of the passage at the top of the triangle. They then write two supporting ideas at the bottom of the triangle. They can use their completed triangle to share their ideas. Model this strategy for students first.

After Reading

- Ask students to write a short, two-sentence summary of the main points of the topic. Then, have students work in pairs or in small groups to share their summaries and draft a final summary that the group agrees on.

Assessment FOR Learning		
Tool	Evidence of Learning	Supporting Learners
Learning Check, page 245	Students explain how scientist can learn about past climates by studying fossils, tree rings, and ice cores.	<ul style="list-style-type: none"> • Have students re-read the information in the coloured boxes on pages 244 and 245. As they read, have them make jot notes on each of the topics. You may wish to have them use BLM 3-27 Sources of Information on Earth's Past Climate.
Learning Check, page 247	Students describe and compare the tools scientists use to collect climate-related data.	<ul style="list-style-type: none"> • Have students use BLM G-46 PMI Chart on Tools to help them organize their answers to question 2.
Learning Check, page 249	Students describe what a climate model is and explain why climate models cannot easily predict Earth's future climate.	<ul style="list-style-type: none"> • ELL Have students re-read page 249. Photocopy the page for students and have them use a highlighter to mark the key phrases in the text. Or supply them with BLM 3-28 Uncertainties in Climate Models.
Learning Check, page 251	Students analyze innovations that reduce our impact on climate change.	<ul style="list-style-type: none"> • For question 2, ask students what colour they would rather wear on a very hot summer day: black or white. (White.) Ask why they think this might be so. (Light colours reflect heat better.) Explain that it works the same way with roofs. Light colours reflect solar energy, or heat, and dark colours absorb it. So painting a roof white means it will reflect more solar energy and keep the house cooler.
Activity 3.14, page 254	Students analyze tree rings to learn about the past climate of their region.	<ul style="list-style-type: none"> • For What Did You Find Out? question 2, have students re-read section 1 Tree Rings on page 244 and review their notes from BLM 3-27 Sources of Information on Earth's Past Climate.
Review, question 7 a), page 259	Students use the concepts of potential capacity and actual load in their discussion on carbon dioxide emissions.	<ul style="list-style-type: none"> • Have students review their work on Investigation 3D and reread What To Do question 1 for information on potential capacity and actual load. Provide BLM 3-32 Investigation 3D.

Topic 3.5 (Student textbook pages 242-259)

Using the Topic Opener

- The topic opener juxtaposes two ideas: cloud-making ships and environmentally friendly skateboards. The first idea is large-scale and almost seems like science fiction and the second is very small-scale. Use this as a starting point for a class discussion. Have students consider which idea they find more appealing and which would have a greater impact on climate change. Students might consider whether the cloud ships would ever be built and what the impact of the materials, construction, and operation of the ships might be on the Earth. They might focus on the small scale of the skateboard manufacturing and whether something that local would have a large enough impact to matter. However, unlike the ships, the skateboards are already being manufactured. It is a simple, practical idea that could be repeated to replace other petroleum-based products. Consider having students compare the two ideas in terms of pros and cons.
- **ELL** English language learners might use **BLM G-49 Venn Diagram** or **BLM G-48 T-Chart** to compare the pros and cons of the two ideas.

Starting Point Activity (Student textbook page 243)

Pedagogical Purpose

This activity provides students with an opportunity to think globally and act locally. Students consider what actions they are already taking to reduce climate change and what they can do in the future.

Planning

Time

20-30 min in class

Activity Notes and Troubleshooting

- You may wish to have students record their thoughts in a personal journal or write a short, one-page report to share with the class.
- Have students work in pairs if you want them present their plans to the class. Working with a partner will help students consider more creative action plans.
- If students have trouble getting started, have them read their notes from Topic 3.4 Starting Point Activity question 2. Ask if any of these ideas apply to this activity.
- As students present their plans to the class, make a note of how many students have included similar ideas. Once all the students have completed their presentations, tally up the ideas and discuss with students what this could mean on a large scale. Have them consider the impact a small action could have if many people did it. For example, ask them what would happen if every grade 10 student in Ontario ate one less meat meal each week. How much less greenhouse gas would be emitted into the atmosphere?

Additional Support

- **ELL** **DI** English language learners and visual learners may benefit from using a graphic organizer, such as **BLM G-39 Cause-and-Effect Map** for this activity.
- If students have trouble getting started, have them add “recycling” to their list of the roles they play in reducing climate change. Remind them that landfills produce greenhouse gases both as the materials decompose and in the fossil fuels burned in transporting the garbage to the site.
- **ELL** **DI** English language learners and visual learners may prefer to draw or sketch their ideas in their personal journals.

Starting Point Activity Answers

Answers may vary. Examples of reducing their impact on climate change could include using public transit, using reusable shopping bags and mugs, or taking shorter showers. Examples for reducing their impact in the future could include buying a green home or a green car, choosing a home or apartment close to their work so they can walk or bike to work, or buying energy efficient appliances.

Instructional Strategies for Topic 3.5

Student textbook pages 244-245

- Read the opening paragraph as a class. Ask students if they have ever heard of using tree rings, fossils, or ice cores to gather information on climate change. (If students have watched the documentary *An Inconvenient Truth*, they may have heard about ice core samples.)
- Before reading further, ask students to brainstorm the type of information each source might provide. Split the class into three groups and assign each group one source. After brainstorming as a group, students can record their ideas individually in a graphic organizer of their choice. Have groups share their ideas as a class. Students should add the other two sources to their graphic organizers.
- If students are struggling, you may wish to use Learning Check question 2 as a class discussion topic.
- **ELL** English language learners may benefit from using **BLM G-44 K-W-L Chart** for this activity.
- Assign Activity 3.14 and the Learning Check questions.

Student textbook pages 246-247

- This section is chunked into sub-sections. Have students read each sub-section and discuss the tool as a class before proceeding to the next sub-section.
- **ELL** Encourage English language learners to study the visuals to get clues on the subjects as they are reading. Have them add sketches or diagrams of these images to their jot notes to help them keep organized.
- Assign Activity 3.11 and the Learning Check questions.

Student textbook pages 248-249

- Before reading, you may wish to have students work on Activity 3.15. Use the activity as an opener for this section. You may wish to have students include this section as part of the scientific articles they read for the activity. Alternatively, you could do the activity quickly as a class, or assign it as an enrichment activity to interested students.
- Students may find Figure 3.22 intimidating. To alleviate their concerns before they tackle the reading, read the caption and study the image as a class.
- **ELL** Ensure that English language learners are familiar with the vocabulary used to describe Figure 3.22, such as *horizontal*, *vertical*, and so on. If students mix up the meanings of horizontal and vertical, give them a mnemonic. Explain that *horizontal* comes from the same root as *horizon*, which is always side-to-side. The word *vertical* has the same root as *vertigo*, the dizzy feeling you get when you go up very high.
- **ELL** This section has vocabulary that may be unfamiliar to students. If you have not previously started a Word Wall for your class, you may wish to do so now. Alternatively, encourage students, English language learners, and others, to create a personal glossary. Have them add any unfamiliar words and a brief definition as they read through this section.
- Learning Check question 1 may be a useful tool to help students understand the terminology. Have students refer to their glossaries or use this question for a class discussion if students need more guidance.
- Assign Activity 3.12 and the Learning Check questions.

Student textbook pages 250-251

- Have students read through this section in small groups. Divide the class into six groups and assign each group one of the six innovations to analyze. Have each group read the assigned section, study the image and consider what message it conveys, and write a brief summary of the innovation. In their summary, have them also answer the appropriate Learning Check question. Then, have students present their summaries to the class. Students can add information about the other innovations to their notes.
- Assign the rest of the reading as homework.
- Assign Activity 3.16.

Student textbook pages 252-253, and 258

- You may wish to teach the Making a Difference feature after this section.
- Use this section as a positive affirmation of what students are already doing to reduce climate change as well as a call to action. Do not bring attention to students who may not be doing as much as other students.
- This section is chunked into sub-sections. Have students read each sub-section and discuss it as a class before proceeding to the next sub-section.
- This section will likely generate a lot of discussion so leave sufficient time for students to discuss their thoughts, ideas, and concerns. Remind students frequently to be respectful of others opinions.
- Depending on the knowledge base of your class and their interest level, you may wish to use this section as a jumping off point to discuss personal choice of other, related topics, such as organic produce and fair trade. Refer to the Background Information for more information about organic and fair trade certification.
- As an introduction to Activity 3.13, have students turn to Making a Difference on page 258 and read the section on Colin Carter. If possible, have students view Colin Carter's short film *Fight for the Planet*. Go to www.scienceontario.ca for information on how to obtain the film.

Learning Check Answers (Student textbook page 245)

- a)** Tree rings help scientists by indicating if drought, flooding, or forest fires occurred. In a year with good growing conditions, a tree ring is a light colour. A dark coloured ring indicates a hot, dry summer.
 - b)** Fossils tell scientists what kind of climate might have existed the region where the fossil was found. A tropical fish found in the rock of an Arctic island means that the climate was much warmer in the past.
 - c)** Ice cores tell scientists what the climate was like 100 000 years ago. Each year, a thin layer of ice is deposited. Each layer contains what was in the atmosphere during that year. Dust and ice indicate volcanic eruptions or forest fires. Plant pollen indicates what species of plants were alive that year. Ice crystal size tells what temperature and humidity conditions were like. Air bubbles tell how much oxygen, carbon dioxide, and other gases were in the atmosphere.
- 2.** A palm tree is a tree that grows in tropical climates. If a palm leaf fossil was found on an Arctic island, this would indicate that the region was much warmer some time in the past.

Activity 3.11 You Can Help Assess Climate Change

(Student textbook page 247)

Pedagogical Purpose

EIn this activity, students research how climate change data is collected and have an opportunity to get involved in collecting the data.

Planning	
Materials	Internet access
Time	30-40 min in class

Skills Focus

- find relevant sources of information

Activity Notes and Troubleshooting

- If class time is not available to have all students complete this activity, it could be assigned as enrichment with interested students researching and presenting their results to the class.
- Have students work in pairs or small groups for this activity.
- To simplify students' research, you could supply them with a list of climate change network organizations in Canada. Or assign each group a specific organization to research to avoid duplication and have students share their information with the rest of the class.
- You may wish to use this opportunity to assess students' group work. To assist you in assessing your students, you can use **BLM A-20 Group Investigation Group-Assessment Checklist**. If you plan to assess students' work, ensure they are aware of the assessment criteria beforehand so they understand what is expected of them.

Additional Support

- **ELL** English language learners and other students may benefit from reading **BLM G-18 Internet Research Tips** and **BLM G-19 Internet Research Worksheet** before starting their research.
- **ELL** **DI** If you plan to have students work in groups, put English language learners in groups with students who have strong interpersonal intelligence.

Activity 3.11 Answers

Answers may vary. Students should give a brief description of each organization they researched, what the organization does, and how the organization can help them get involved in collecting data that can be used to assess climate change.

Learning Check Answers (Student textbook page 247)

1. Earth has many different climates. Scientists need to examine many different places on Earth to understand what is happening to the climate globally.

2.

Balloons		
Pluses	Minuses	Interesting
<ul style="list-style-type: none"> • measure temperature, pressure, humidity, wind direction, and speed at different altitudes • can rise up to 30 000 m 	<ul style="list-style-type: none"> • can only gather information at altitudes below 30 000 m • when balloon gets too high, it will burst • parachute that brings instruments down could get damaged • information gathered is limited by the amount of time the balloon is in the air 	<ul style="list-style-type: none"> • parachute brings instruments down once balloon bursts • a tracking device is used to monitor the parachute's path

Radar		
Pluses	Minuses	Interesting
<ul style="list-style-type: none"> • detects precipitation, can be used to track storms • reflected images off water droplets and ice crystals provide images of cloud cover precipitation 	<ul style="list-style-type: none"> • limited use 	<ul style="list-style-type: none"> • reflected images can be very detailed

Satellites		
Pluses	Minuses	Interesting
<ul style="list-style-type: none"> • collect data on wind, water, ocean surface, solar energy, ocean-atmosphere interactions, ozone and air quality, atmospheric particles and gases, tropical rainfall, and Sun-land-air interactions • perform remote sensing and land mapping • provide constant daily monitoring of changing conditions 	<ul style="list-style-type: none"> • expensive to build and maintain • might become space junk 	<ul style="list-style-type: none"> • gathers more comprehensive data than balloons or radar • many nations work together to operate satellites

Learning Check Answers (Student textbook page 249)

1. A global climate model is a computer program that uses mathematical equations to help scientists understand and estimate changes in Earth's climate.

2. It is difficult to predict Earth's future climate using models because not all possible factors affecting climate can be added to the program. Also, scientists are uncertain how natural systems will respond to change so it is difficult to model them accurately.

Activity 3.12 Projecting Earth's Future Climate (Student textbook page 249)

Pedagogical Purpose

In this activity, students use graphs to study observed global warming trends and see how predicted models may change due to certain circumstances.

Planning	
Materials	graph paper (optional) BLM G-45 Reading and Interpreting Graphs (optional) BLM G-33 Organizing and Communicating Scientific Results with Graphs (optional) BLM G-34 Constructing Line Graphs (optional)
Time	30–40 min in class

Skills Focus

- fuse appropriate representations

Activity Notes and Troubleshooting

- You may wish to have students graph the scenarios in question 2. If so, provide them with graph paper.
- Students could work in small groups for question 2. Assign each group a different question and have them share their results with the class.

Additional Support

- **ELL** English language learners who are unfamiliar with working with graphs may benefit from using **BLM G-45 Reading and Interpreting Graphs** and/or **BLM G-33 Organizing and Communicating Scientific Results with Graphs**.
- If you plan to have students draw graphs for question 2, distribute **BLM G-34 Constructing Line Graphs** beforehand.
- **ELL** **DI** English language learners, logical-mathematical, and other students may wish to use graphing software for this activity. Encourage them to expand the activity if they are interested.

Activity 3.12 Answers

1. approximately 5°C
2.
 - a) If more greenhouse gases are produced, the temperature change will be greater than predicted. The green line will be steeper and the average global surface temperature will be closer to 6°C in 2100.
 - b) If the global population does not increase as much as predicted, then greenhouse gas emissions will be less than predicted. The temperature change will be less. The green line will be flatter and the average global surface temperature will be less than 4.8°C in 2100.
 - c) If sustainable energy technology is less advanced than predicted, then greenhouse gases emissions will be more than predicted. The temperature change will be greater. The green line will be steeper and the average global surface temperature will be more than 5°C by 2100.
 - d) If greenhouse gases are reduced more than expected, the temperature change will be less than predicted. The green line will be flatter and the average global surface temperature will be less than 4.8°C in 2100.

Learning Check Answers (Student textbook page 251)

1. Dr. Fradette is using the bacteria to capture carbon dioxide in industrial smokestacks. The proteins in the bacteria help change the carbon dioxide to calcium carbonate. The carbon carbonate can be collected and used in other industrial processes.
2. White roofs reflect sunlight energy, keeping the buildings cool. This reduces the need for air conditioning, which reduces greenhouse gases emissions.
3. Converting existing homes to NetZero houses would be very costly because the technology is new. Most people would not be able to afford the conversion and any gains in energy savings would not offset the cost of the conversion.
4. Answers may vary. For example: There are new roofing materials and shingles made of recycled paper products coated with a water impermeable sealant. These tiles are not made from petroleum so they will not emit greenhouse gases when they break down over time.

Activity 3.13 Climate Change on Prime Time (Student textbook page 253)

Pedagogical Purpose

In this activity, students apply their knowledge of climate change to present a personal solution to climate change, using a creative format.

Planning

Time

60-120 min in class

Skills Focus

- communicate using appropriate language, in a variety of formats

Activity Notes and Troubleshooting

- As an introduction to this activity, have students read the information on Colin Carter in Making a Difference on page 258. You may also wish to have students view his short film. Go to www.scienceontario.ca and follow the links. In addition to the film's message, students will benefit from seeing how the film is organized and produced to get ideas for their own scripts.
- Ensure that students understand that their script must contain facts and information in addition to being interesting and entertaining.
- Have students work in groups for this activity. You may also wish to allow students to work individually if they prefer. Some students may have a "vision" they wish to follow on their own.

Additional Support

- **DI** This activity provides both interpersonal and intrapersonal learners with the chance to work as they choose.
- **DI** Bodily-kinesthetic learners will enjoy the opportunity for a more active activity. Linguistic and musical learners will enjoy the chance to add their own creative touches to this activity. Encourage musical intelligence students to add their own original background music, or use other music of their choice for their film.

- **ELL** English language learners may prefer to script their production as a storyboard, or even as a graphic novel (with word balloons). Encourage them to participate and be creative.
- **DI** Enrichment—Encourage students to take this activity one step further by actually filming their scripts. Most cameras have video capabilities as do many computers if an actual video camera is not available. Alternatively, linguistic learners could storyboard their script, showing what they would like to see in each frame. Or they could use presentation software to create a slideshow.

Activity 3.13 Answers

Scripts may vary. Students should include a list of the cast and their roles, the script, an outline of the action and images, and a list of the facts and sources used in the script. Students might include music or drawings.

Activity 3.14 Analyze Tree Rings (Student textbook page 254)

Pedagogical Purpose

In this activity, students will examine real tree rings and analyze this indicator of climate change.

Planning	
Materials	Per group: tree cross-section with visible rings (preferably a local species) hand lens ruler BLM 3-29 Tree Ring Analysis Table (optional)
Time	30-40 min in class

Skills Focus

- draw conclusions based on observations

Activity Notes and Troubleshooting

- Before beginning the activity, discuss the tree ring samples with students. Explain how the samples were obtained and identify the species and regions the trees came from. If possible, provide students with a few leaves from each species to help them recognize it. Remind students that the tree ring samples came from dead trees. Ask students to think about why the trees might have been cut down. (For lumber, the tree was already dead, or the tree was cut down specifically for sample purposes.)
- To refresh students' memories on the value and significance of tree rings in the study of climate change, have them reread page 244 and review their notes.
- Have students work in groups for this activity. Depending on how many tree ring samples you have available, you may wish to have students rotate through work stations, such as Read the Material, Design a Table, Analyze the Tree Rings, and Answer the Questions.
- To save class time, you may wish to have students use **BLM 3-29 Tree Ring Analysis Table**, rather than design their own table. If a longer table is needed, have several copies of the second page of the blackline master available.

Additional Support

- **ELL** To assist English language learners, have them use **BLM 3-29 Tree Ring Analysis Table**.
- **DI** Students with bodily-kinesthetic intelligence will enjoy the tactile nature of this activity. Ensure that they have an opportunity to examine the tree ring sample in detail.
- **DI** Have students with spatial intelligence guess where on the tree the cross-section was cut from. For example, a fairly round sample would be cut from closer to the middle of the tree trunk. An irregular shape might be from nearer to the top of the trunk where the tree begins to branch.

Activity 3.14 Answers

What To Do

Answers may vary. The age of the tree will depend on the number of pairs of rings present. Students should list the year, colour of the pair of rings for each year, and any possible explanations (too wet, too dry, fire, insect infestation, turbulent wind, and so on) for their appearance.

What Did You Find Out?

1. Years will vary depending on samples.
 - a) Favourable climate conditions are indicated by a wide space between rings.
 - b) Unfavourable climate conditions are indicated by a narrow space between rings, burn marks, or insect scars.
2.
 - a) Very dry, hot conditions.
 - b) Very cool, wet conditions.
 - c) A forest fire.
3. Tree rings will be narrower and there will be less space between rings because trees will not grow as much each year.

Activity 3.15 Assessing Climate Change Articles

(Student textbook page 255)

Pedagogical Purpose

Students are bombarded with information and misinformation about climate change through the media. In this activity, they will analyze climate change articles for bias and reliability of source data.

Planning

Materials	Magazines and newspapers with scientific and non-scientific articles about climate change BLM 3-30 Climate Change Article Analysis (optional)
Time	30-40 min in class

Skills Focus

- analyze information
- make conclusions based on information

Activity Notes and Troubleshooting

- Have students work individually for this activity.
- About two weeks before assigning this activity, ask students to bring in articles on climate change from magazines and newspapers. Students can also gather articles from online news sources. Students can share the articles with the whole class or keep them for their own use in the activity.
- Include printouts of online articles in the selection of articles students can choose from. For some scientific articles, go to www.scienceontario.ca and follow the links. Many students spend a lot of time on the Internet and see enormous amounts of information and misinformation through this medium. Being able to identify bias and find reliable sources of data on the Internet is a valuable skill that students should develop.
- Before beginning this activity, have a class discussion about bias. Ask students to define the term. Record the class definition on the board or chart paper and have students refer to it as they work through the activity. Explain to students that bias is the personal opinion of the author that influences how the information is conveyed. This may be deliberate, in the case of persuasive writing, or it might be unconscious. Remind students that they should exercise some skepticism when reading news articles and should check the sources before accepting the information as true.

Additional Support

- **DI** This activity provides intrapersonal and linguistic learners with opportunities to develop their skills.
- **ELL** English language learners may find this activity challenging. Consider having these students work on one non-scientific article and screen the articles to find one that is less text-heavy.
- **ELL** If needed, have English language learners use **BLM 3-30 Climate Change Article Analysis** for their answers.
- **Enrichment**—Students with an interest in media and journalism may wish to conduct additional research on the subject of bias. Have them research and write a brief summary to share with the class. Excellent articles on bias in journalism can be found at www.scienceontario.ca.

Activity 3.15 Answers

Answers will vary. Students should give their impression of the article based on the visual features. Students should support their answers with examples. Summaries should be short but include statements about bias and accuracy.

Investigation 3D Transportation Choices and Your Carbon Footprint

(Student textbook page 256)

Pedagogical Purpose

In this Investigation, students will explore how their choices of transportation impact on their carbon footprint and add to climate change.

Planning

Materials	BLM A-29 Conduct an Investigation Rubric (optional) BLM G-35 Reading and Interpreting Graphs (optional) BLM G-49 Venn Diagram (optional)
Time	30-40 min in class

Background

There are many different websites that offer ways to calculate your carbon footprint. These calculators are not exact, but they can be useful tools to see what activities you can change in your life to be more climate friendly. Changing your driving habits—and your car—can have a big affect on your carbon footprint. Carbon emissions vary greatly between brands of vehicles. A Hummer, even with all the seats filled, will still produce more carbon emissions than a SmartCar. Go to www.scienceontario.ca and follow the links for carbon footprint calculators and details on vehicle carbon emissions and fuel economy for most Canadian vehicles.

Skills Focus

- draw conclusions based on data

Activity Notes and Troubleshooting

- Assign this investigation after students have read page 252, so students are familiar with the term *carbon footprint*.
- Have students work in pairs for this activity.
- As a class, read the What To Do information. Ensure that students are clear on the difference between potential capacity and actual load. If students have difficulty, they could use a graphic organizer to help them understand the differences and similarities between the two concepts.
- You may wish to use **BLM A-29 Conduct an Investigation Rubric** to assist you in assessing your students for this investigation. If you plan to assess students' work, provide students with copies of the rubric so they are aware of how they will be evaluated.

Additional Support

- **ELL** Students who are struggling with interpreting the graph may benefit from using **BLM G-35 Reading and Interpreting Graphs**.
- **ELL** English language learners may benefit from using **BLM G-49 Venn Diagram** to compare potential capacity and actual load.
- **ELL** **DI** Students with logical-mathematical intelligence will enjoy the calculations involved in this investigation. Pair students who have strong mathematics skills with English language learners and students who have weak mathematics skills.

Investigation 3D Answers

What Did You Find Out?

1. Airplane travel generates the most carbon dioxide emissions. Travelling by bus generates the least amount of carbon dioxide emissions.

2. a) Potential capacity is lower because you are dividing the maximum number of people by the amount of emissions from one vehicle. Actual load is less than the maximum number of people. The average emission per person is less for a full vehicle.
 - b) Most airlines will not fly an airplane unless it is almost to full capacity because airplane fuel is so expensive. So most active flights will be almost full. The other modes of transportation can carry on when not full.
 - c) Automobile emissions could be lower than bus emissions, if the automobile was electrically powered or had full capacity when the bus was almost empty.
3. Travelling in a full car would lead to a smaller carbon footprint, because the distribution of emissions would be over all occupants. Each person on the bus would have a greater emissions footprint because of the empty seats.
 4. Answer could include walking or cycling to school, buying locally grown food or growing your own vegetable without fertilizers, making your own compost, and so on.

Activity 3.16 Run a Climate-Friendly Business (Student textbook page 257)

Pedagogical Purpose

This activity allows students to consider how businesses, not just individuals, can make climate-friendly choices. Students will create an imaginary business, write a business plan, and incorporate climate-friendly practices in their business while still considering profits.

Planning	
Materials	BLM 3-31 Climate-Friendly Business Plan (optional)
Time	60-80 min in class

Skills Focus

- communicate using appropriate language, in a variety of formats

Activity Notes and Troubleshooting

- Explain to students that they can choose any type of business. It does not have to produce environmentally friendly products or offer services related to the environment, such as installing solar panels or building wind turbines. The goal is to consider how any business can incorporate climate-friendly practices.
- Have students work in small groups for this activity. They can imagine they are the board of directors for the business.
- You may wish to provide students with a list of different types of businesses to help them narrow down the choices. If they are excited about a business option not on the list allow them to pursue it as long as it is reasonable. Business options could include: dog grooming, pet sitting, babysitting, lawn care and snow removal, website design, writing, photography, computer virus and spyware removal, and so on.
- Students may want to research other business plans to use as models or to see what other businesses have done to minimize their impact on climate change. Go to www.scienceontario.ca and follow the links for examples.

Additional Support

- **ELL** English language learners may have trouble thinking of a possible business. Work with them and their group to come up with an idea that is interesting and accessible to them.
- **ELL** **DI** Have English language learners work with students who have strong interpersonal skills.
- **ELL** English language learners and students with difficulty writing may wish to use a scribe for this activity. Alternatively, have one student in each group act as a scribe to record their group's ideas.
- **ELL** You may wish to have English language learners use **BLM 3-31 Climate-Friendly Business Plan** for this activity.

Activity 3.16 Answers

Answers may vary. Students should include reasons for the price they have chose to charge for their service or product, prices or estimates for each item required in the start-up cost, and the outcome of carrying out their sustainable practices. Students may include the cost of advertising in their start-up cost.

Using Making a Difference (Student textbook page 258)

Literacy Support

Before reading

- Briefly explain what each student in the text accomplished. Ask students to connect these ideas to what they have learned in this unit. Ask: “Why might clean drinking water be in short supply in India?” (Students learned in topic 3.2 that climate change means some areas of the world are experiencing drought.) Ask: “Why might Colin have felt the need to make his short film?” (In topic 3.4 and topic 3.5, students learned that people need to be more aware of how human activities are creating climate change.)
- Have students read the questions in the blue boxes before reading the articles to help focus their learning.

During reading

- Pause at any time during the reading to clarify a point or allow students to ask questions.
- **ELL** Encourage English language learners to take notes in their first language and translate them into English later.
- **ELL** Have English language learners jot down any unfamiliar words as they read and look up the definitions after reading.

After reading

- Have students write a brief, two-sentence summary of each student's accomplishments in the Making a Difference reading. Have students compare their summaries with a partner and agree on one summary or rewrite their summaries to incorporate both.
- Have students personalize the information they read by connecting one or both of the stories to their own experiences. Use this as a launching point to address the questions posed in the blue boxes.

Instructional Strategies

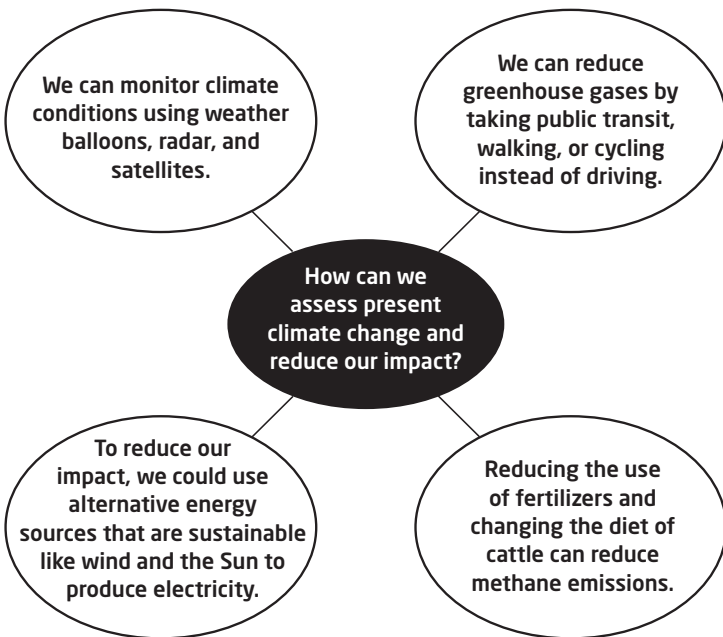
- You may wish to have students read the section on Colin Carter and view his short film before assigning Activity 3.13. More information on Colin Carter and links to his short film are available at www.scienceontario.ca.

Topic 3.5 Review (Student textbook page 259)

Please see also **BLM 3-33 Topic 3.5 Review (Alternative Format)**.

Answers

1. Answers may vary. For example:



2. Radar emits short pulses of microwaves. The pulses strike water droplets and ice crystal in the atmosphere and then bounce back to a receiver that feeds the data to computers. The data is used to create an image of cloud cover and precipitation.
3. Answers could include two of the following: temperature, moisture conditions, and wind patterns.
4. Analyze fossils in the region to determine climate conditions. There might not be glaciers in the region to take ice samples from. Trees growing now were not alive 65 million years ago so tree rings would not be useful.
5.
 - a) There might have been a volcanic eruption.
 - b) The climate must have cooled. After an eruption, ash is spewed into the air. This debris blocks the sunlight reaching Earth and cools it.
6. Answers may vary. Students might agree and suggest examples of technology or they might disagree and explain how people can learn how to change if they understand how important it is to our planet.
7.
 - a) Buying a hybrid or electric car would reduce greenhouse gas emissions and help the environment.
 - b) Answers may vary. For example: Consider where the car is manufactured. Imported cars have a larger carbon footprint than locally manufactured cars because they need to be shipped long distances. Consider the type of fuel. A hybrid or electric car would produce fewer emissions than a gas-powered car.
 - c) A hybrid car that uses a solar cell to produce electricity would have a smaller carbon footprint than a hybrid car that uses electricity from the power grid. The solar cell uses a renewable resource while most electricity on the power grid is produced using non-renewable resources like coal or nuclear energy.

Using Science at Work (Student textbook pages 260-261)

Literacy Support

Before Reading

- Ask students to share what they know or may have heard about green or living roofs. Have they ever seen one? Why do they think people might want one?

During Reading

- Have students compile a list of questions as they read through the text. This will help focus their reading.
- **ELL** Have English language learners add any unfamiliar words to their personal glossary as they read. They can look up the definitions after they have completed the reading.

After Reading

- Have students return to their list of questions to see if they are now able to answer them. Have a class discussion to answer any questions that remain.

Instructional Strategies

- Students may have trouble understanding what a green roof is. Explain that green roofs, sometimes called living roofs, are like giant planters that cover the tops of buildings. Instead of a flat roof covered with shingles or a rubber membrane and eaves troughs to take away the water, a green roof is covered with soil with a lip to keep the soil from washing away. The soil is planted with plants that grow well in extreme weather and do not need deep soil.
- You may wish to show students some photos of other green roofs to help them understand what the image in the photo is. Got to www.scienceontario.ca and follow the links.
- Have students consider the types of growing conditions that exist on a rooftop. It will be hot and dry in the summer and cold and wet in the winter. It will be windy as well.
- Explain that in many countries, such as Germany, all new buildings must have green roofs.
- Have students brainstorm all the different ways that green roofs can be beneficial. Encourage them to consider the benefits for the owners of the building with the green roof such as reduced noise, reduced heating costs due to better insulation, and additional green space for recreation, as well as the benefits to the community where the building is located, such as less heat being trapped, reduced carbon footprint, more green space in the skyline, and more habitat for birds and insects.
- Enrichment—Have interested students research green roofed buildings in their community or province. Have them share their research and photographs with the class.

Science at Work Answers

1. Possible questions include: "How do you maintain the roof during the winter?" or "What plants can you grow in the winter?" or "What was your favourite project?"
2. On-the-job training means you can learn practical information about the job from people who have learned the information through experience. You can learn things that are not necessarily taught in college programs.
3. Answers may vary. Students should include a description of the job, the essential skills needed for the job, the education required, and where to obtain the education or training.