Section 9.1 Discovering Past Climates

(Student textbook pages 351 to 358)

In this section, students will explore Earth's past climates. They will learn about how scientists reconstruct past climate conditions, and the evidence (such as tree rings, ice cores, sediment cores, rock cores, and fossils) that scientists use to support their reconstructions.

Specific Expectations

- **D2.1** use appropriate terminology related to climate change, including, but not limited to: *albedo, anthropogenic, atmosphere, cycles, heat sinks,* and *hydrosphere*
- **D2.3** analyse different sources of scientific data for evidence of natural climate change and climate change influenced by human activity
- **D3.8** identify and describe indicators of global climate change

Common Misconceptions

- Students may not believe that climate data can be known if it has not been directly recorded. Using only recorded data would limit climate data to the recent past when humans have kept records. Have students pay particular attention to how climate estimates are obtained with each type of data.
- Students may be unfamiliar with the branch of science called paleoclimatology. Explain that there are many different fields of science that study the distant past. Dinosaur specialists are called paleontologists. Historical botanists and zoologists are paleobotanists and paleozoologists, respectively. *Paleo* is a prefix that means prehistoric.

Background Knowledge

Much of the information we have about past climate has not been observed directly. Instead it has come from a type of data called proxy data. Proxy data are assessed by looking at materials with properties that were influenced by the climate of the past. The best-known types of proxy data are shown in this section: ice cores, sediments, and tree rings. Other types of proxy data include pollen and coral growth rings.

Proxy climate data do not provide direct measures of climate, or even one aspect of climate. Being able to draw conclusions from proxy data requires scientists to understand the sensitivity of the proxy material to climate. For example, tree rings indicate the temperature and rainfall of a particular growing season, but are also influenced by groundwater levels that are a result of previous seasons' rainfalls.

The Archival Climate History Survey project (ARCHISS) is dedicated to locating climate data and evidence from locations around the world where it may be stored in museums, colonial records, and company histories, etc. The ARCHISS project aims to digitize all of this data and make it available to interested scientists. The project is sponsored by the World Meteorological Organization, UNESCO, the International Council for Science, and the International Council for Archives.

Literacy Support

Using the Text

- Explain to students that when they read text that contains new ideas and new Key Terms they should stop after each chunk of text and make sure they have understood what they have just read. Encourage students to add a sticky note beside each new chunk of text as they read it. They can put a checkmark on the sticky note if they understand the material, or make a mark to follow up on the chunk of text when they are reviewing or summarizing.

Before Reading

- Have students flip through the section to preview the text features and the headings. Have them look at the Key Terms and consider if they are already familiar with any of the words. This will help them identify the main ideas contained in the section.

During Reading

- Chunk the reading into smaller, manageable parts. Teach each type of past climate data individually and provide structured directions to proceed through each chunk.

- Encourage students to make graphic organizers to help them organize the information into chunks as they read.

After Reading

- ELL English language learners can be encouraged to make study notes in their first language and to create an English translation.
- Have students make study notes after reading the section. They will need to identify the most important information and decide how to record it in a way that is most meaningful to them.
- Ask each student to write a short two-sentence summary of the main points of the section. You can then have students work in groups to compare summaries and agree on one. Summaries can be shared with the class and recorded to be used as a review.

Using the Images

- Before reading, have students make connections to visuals. In particular, have them identify if any of the photographs or illustrations describes a situation they have first-hand knowledge of. For example, some students may have experienced looking at tree rings, sedimentary rock formations, or fossilized plants and animals in local stones.
- As students work through the text, have them summarize the captions of the diagrams in their own words. They can combine these into an organizer for the section.
- Have students read the graphic text represented in Figure 9.3. Students can paraphrase what the captions and labels show, and then combine that information with the text material to make a study tool.

Assessment FOR Learning		
Tool	**Evidence of Student Understanding**	**Supporting Learners**
Learning Check questions, page 355	Students explain how tree rings and ice cores are used to study climate. They interpret a graph of the relationship between temperature and carbon dioxide levels. Students draw a cause-and-effect map to summarize how isotopes in ice are related to global temperature	Pair students to encourage peer tutoring. Questions 3 and 4 can be completed as part of a larger class discussion.
Activity 9-2 Analyzing Tree Rings, page 352	Students count tree rings and use them to infer the answers to the questions. Students use tree rings to compare growth patterns. They find relationships between tree rings, and climate and events that occurred during growth.	If students are unable to infer the data, have them draw their own tree cross section instead. Give them information (the tree is 10 years old, there was a forest fire when it was five years old, etc.). Guide them through the process of building a cross section. They should then be able to analyze the cross section provided.
Section 9.1 Review Questions, page 359	Students interpret a diagram representing varves from a glacial lake and explain their answer. They describe how sediment cores and fossils are used as evidence of past climates. Students compare different types of evidence used to study past climates. They explain how atmospheric carbon dioxide levels from thousands of years in the past can be graphed when levels have only been measured for the past few decades.	Encourage English language learners and students who are having difficulty with the questions to ask for assistance from peers, or pair them with students who will be able to provide support. Provide students with **BLM G-47 Venn Diagram** to help them assess their own answer to question 7.

Instructional Strategies

- DI Have students complete **BLM 9-2 Oxygen Isotopes and Climate.** Students who understand the difficulties of predicting future climate may draw their graphs to mismatch the past patterns, but will be able to support this with logical assumptions about future trends. Students who are having difficulty should be paired with logical-mathematical or spatial learners. If students are having difficulty coming up with predictions on their own, provide them with an example (for example, tell them that in 50 000 years it will be warm, but in 100 000 years it may be cold), and have them sketch what this would look like.
- ELL Have English language learners create first language translations to add to the word wall to support their vocabulary.
- Enrichment—Some students may be interested in pursuing independent work on a topic of particular interest. Provide these students with **BLM G-19 Scientific Research Planner** and **BLM G-20 Research Worksheet.** Refer students to Science Skills Toolkit 10 How to Do a Research-Based Project in the appendix of the student textbook.
- Have students complete **BLM 9-3 Discovering Past Climates,** which supports the text and provides students with the opportunity to perform an independent study on a term that interests them. Encourage students to present their findings in creative ways. **BLM A-9 Oral Presentation Checklist, BLM A-10 Computer Slide Show Presentation Checklist, BLM A-11 Poster Checklist** or **BLM A-46 Presentation Rubric** can be used to assess presentations.
- If you started a class word wall earlier in the unit, continue to add pictures or other visual aids to the wall to introduce and support the vocabulary in this section.

Activity 9-2 Analyzing Tree Rings (Student textbook page 352)

Pedagogical Purpose

Students will analyze tree growth rings in order to collect evidence of past temperature changes and precipitation patterns. They will be able to see how climate affects plant growth, and how that growth is captured in a cross section of a tree.

Planning		
Materials	Ruler Paper or notebook	Pencil Tree stump (sawn off) or other cross section of a tree
Time	20–30 min	
Safety	Have students take care when handling tree stumps. The stumps may break if dropped. They may also be heavy.	

Background

Information preserved in tree rings is very useful because it is preserved every year, is continuous, and can be dated accurately, provided information is available about when the tree was cut or the core was taken.

Small diameter radial cores can be used to access tree-ring data without cutting the tree. These cores cause no long-term damage to the tree. This is particularly useful for very old trees, such as bristlecone pines, which may be thousands of years old.

Chronologies of past climates can be made using tree-ring data. Scientists compare tree rings from a variety of trees in an area and then correctly align them. Then, yearly growth is averaged and the chronology of growth can be made. In certain circumstances, this chronology can even be extended back by taking data from dead trees, which may be preserved in peat bogs, riverbeds, or even in historical building materials.

Activity Notes and Troubleshooting

- This activity may be fun for many students, but it may frustrate some because it requires patience and attention to detail. Have students work in groups and divide students into roles that suit their temperaments, if necessary.
- Provide students with a quick demonstration at the beginning of the activity. Review where students will begin their measurements and how they will record the data.
- Look for examples of old forest fires in the tree cross sections. If you discover evidence, point it out to students to give them an example of what to look for.
- Provide students with **BLM G-20 Research Worksheet** to help them complete question 3.
- You can use **BLM 9-4 Analyzing Tree Rings** to help students with the activity, or as scaffolding before beginning.

Additional Support

- DI This is an excellent activity for logical-mathematical learners and spatial learners. Bodily-kinesthetic students will also enjoy the hands-on aspects of the activity. If you are having students work in groups, ensure that there is at least one of these types of learners (if possible) in each group.
- ELL For English language learners in particular, this activity can be achieved without requiring significant verbal skills.
- Enrichment—Have students research and explore tree-ring data online. They should easily be able to find several databases with information about tree rings, isotopes in tree rings, and chronology. Have students complete a short report on some aspect of dendroclimatology that interests them. Provide students with **BLM G-21 Internet Research Tips, BLM G-22 Internet Research Worksheet (A),** and **BLM G-23 Internet Research Worksheet (B).** Refer students to Science Skills Toolkit 10 How to Do a Research-Based Project in the appendix of the student textbook.
- Check for comprehension before beginning the activity and while students are performing the work. They may need to be reminded of the purpose of the activity.
- Use **BLM A-1 Making Observations and Inferences Assessment Checklist.**

Answers

1. Students' answers will vary, depending on their tree stumps and cross sections. Students may or may not see any variation in growing seasons. In some cases, it will be obvious that some rings are larger than others, indicating either a short growing season or a long one; however, it is unlikely that there will be a clear trend to longer seasons over the course of the lifespan of 20 to 40 years.
2. Students' comparisons will vary depending on their individual tree rings. The ages of the trees will be directly comparable by the number of growth rings. Whichever tree has the most growth rings is the oldest tree, assuming the trees were cut at the same time.
3. Students' answers will vary with how old their tree is and how much information there is about where it grew and how long ago it was cut. If it is a local tree, students may be able to correlate some of the tree-ring information with weather over the past few years.

Learning Check Answers (Student textbook page 355)

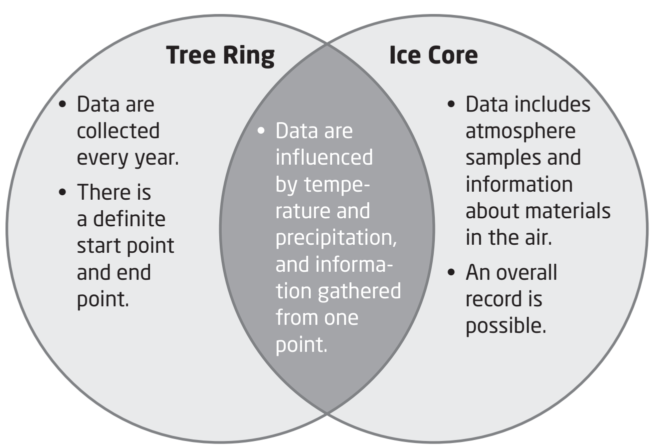
1. Tree growth is affected by temperature and rainfall. The amount that a tree grows each season is indicated by the size and colour of the annual rings. Paleoclimatologists use this information about annual temperature and rainfall to study climate.

2. dissolved and particulate matter, physical characteristics of the ice, chemical composition of the ice, chemical composition of trapped gases
3. Example: Although Figure 9.4 shows that carbon dioxide levels and temperature are related, the graph does not indicate whether a causal relationship exists between the two variables.
4. Answers may vary but should accurately reflect the information provided in the text and Figure 9.3. Example: When Earth is warm, water rich in oxygen-16 evaporates from the oceans, and clouds become rich in oxygen-16. Oxygen-16 returns to the oceans as run-off, maintaining the balance of oxygen-18 to oxygen-16. When Earth is cold, water rich in oxgen-16 evaporates from the oceans, clouds become rich in oxygen-16, oxygen-16 in precipitation falls and is stored as ice and does not return to the ocean. Oceans become enriched in oxygen-18 because a higher percentage of oxygen-16 is stored in ice sheets.

Section 9.1 Review Answers (Student textbook pages 359)

Please also see **BLM 9-5 Section 9.1 Review (Alternative Format).**

1. tree rings, ice cores, sediment cores and sedimentary rock, fossils
2. Information about precipitation levels, air composition, temperature, and particulate matter can all be recovered from ice and help paleoclimatologists reconstruct past climates.
3. Heavy water contains the naturally occurring oxygen isotope oxygen-18, which is denser than regular water with the isotope oxygen-16. This changes characteristics such as the freezing point. The relative concentrations of different isotopes in layers of ice reflects differences in temperature at the time of freezing. Scientists can reconstruct temperature changes using these relative concentrations of the different isotopes.
4. Example: In years 8 and 9, the area had a drought and little snow or rain fell, which meant that little sediment was washed into the lake.
5. Both sediment cores and ice cores can be analysed chemically to measure the ratios of isotopes. These ratios tell scientists about the global temperature at the time the ice or sediment formed.
6. It indicates that the rock formed in warm, shallow seas and that something must have happened to the sediment quickly, so that the fishes' bodies would be fossilized and not eaten.
7. Example:



8. Scientists can obtain air samples from ice cores for most of the last million years, and measure the concentration of carbon dioxide from little bubbles of air trapped in the ice.