

LESSON 4: Are rising temperatures affecting anything else in Earth's water system?

PREVIOUS LESSON We created closed bottle setups to determine that increased temperatures can increase the evaporation rate and water vapor in the atmosphere. We wondered how the water vapor behaves in an open system. We observed NASA water vapor and temperature visualizations and determined that temperatures affect the amount, location, frequency, type, and timing of precipitation events.

THIS LESSON

UNKNOWN TYPE

1 day



We obtain additional scientific and technical information about other components of Earth's water system and how those components are changing as temperatures increase. We discuss the sources of data, amount of data, and the information from scientists as we draw conclusions. We conclude that all components and processes in the system have been affected by a temperature rise. We update our model and add an entry to our Progress Tracker. We think we can now explain why communities are experiencing problems with precipitation and their water sources due to rising temperatures.

NEXT LESSON We will use our key models ideas to explain how changes in temperature have an impact on our case site communities. We will revise our explanations using peer feedback and apply our key model ideas in an Alaskan assessment transfer task.

BUILDING TOWARD NGSS

MS-ESS3-1, MS-ESS3-3, MS-ESS3-4, MS-ESS3-5, MS-ETS1-2



WHAT STUDENTS WILL DO

Integrate scientific information with media and graphical displays of data to clarify how a small change in temperature affects components of Earth's water system.

WHAT STUDENTS WILL FIGURE OUT

- Changes to sources of water affect communities in different ways.
- A small change in temperature in the atmosphere can have big changes in Earth's water system.

Lesson 4 • Learning Plan Snapshot

Part	Duration	Summary	Slide	Materials
1	3 min	NAVIGATION Review predictions made in the previous class period about how components of the water system could be changing.		Earth's Water System model with sticky note predictions from Lesson 3
2	20 min	OBTAIN INFORMATION FROM TEXT AND VISUALS Assign students to read about research conducted on a component of their system model. Then have students work in groups to share the information they have gathered from the text.	A-B	<i>Obtaining Information about Other Components, Changes to Snowpack, Changes to Sea Level, Changes to Glaciers and Land Ice, Changes to Streamflow, Changes to Groundwater</i> , sticky notes, marker
3	12 min	FACILITATE A CONSENSUS DISCUSSION ABOUT OBSERVED CHANGES Facilitate groups through sharing what they learned from their reading and come to consensus about how temperature change has changed components of the water system with different impacts on communities.	C-D, G-K	Earth's Water System model, Model Ideas list, markers
4	5 min	UPDATE PROGRESS TRACKER Individually reflect on what we figured out in this lesson.	E	
5	5 min	NAVIGATION Have students turn and talk to discuss how their understanding of the problem in these communities has changed since they first started learning about them.	F	

End of day 1

Lesson 4 • Materials List

	per student	per group	per class
Lesson materials	<ul style="list-style-type: none">• science notebook• <i>Obtaining Information about Other Components</i>• <i>Changes to Snowpack</i>• <i>Changes to Sea Level</i>• <i>Changes to Glaciers and Land Ice</i>• <i>Changes to Streamflow</i>• <i>Changes to Groundwater</i>	<ul style="list-style-type: none">• sticky notes• marker	<ul style="list-style-type: none">• Earth's Water System model with sticky note predictions from Lesson 3• Earth's Water System model• Model Ideas list• markers

Materials preparation (15 minutes)

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

The texts are slightly leveled to be accessible to below and on grade level readers. One text is designed to challenge above grade level readers. While all texts fall within a 810L-1000L lexile range, the Flesch-Kincaid score shows the slight differences in reading level. Additional modifications can be made to the texts to make them more accessible or more challenging depending on your students' needs.

- *Changes to Sea Level* Lexile range: 810L-1000L; Flesch-Kincaid Grade Level: 6.2
- *Changes to Streamflow* Lexile range: 810L-1000L; Flesch-Kincaid Grade Level: 6.4
- *Changes to Glaciers and Land Ice* Lexile range: 810L-1000L; Flesch-Kincaid Grade Level: 6.6
- *Changes to Snowpack* Lexile range: 810L-1000L; Flesch-Kincaid Grade Level: 7.0
- *Changes to Groundwater* Lexile range: 810L-1000L; Flesch-Kincaid Grade Level: 8.4

Lesson 4 • Where We Are Going and NOT Going

Where We Are Going

Students will have partially explored some of the components of the water system previously during Lesson 2. This lesson should offer a deeper dive into those components to better understand how the components are changing over time around the world and not just at single case sites. Use opportunities in this lesson to reinforce the ESS2.C learned in previous units, including that (1) most freshwater is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere (5th grade) and (2) that water continually cycles among land, ocean, and atmosphere via evaporation and precipitation, as well as downhill flows on land (6th grade in material:wc.n). The lesson also offers a moment to reinforce parts of ESS3.A that humans depend on Earth for many different resources, including freshwater, and that these resources are distributed unevenly around.

In order to build new understanding about changes in the water system, students will obtain more information through reading scientific technical texts coupled with visual displays of data. In particular, they will consider the claims made by scientists and evaluate the data provided to support those claims.

Furthermore, students will use the lens of stability and change coupled with systems models throughout the lesson, which is demonstrated by the focus question they take up at the start, and during their analysis of data: *Are rising temperatures affecting anything else in Earth's water system?* As students discuss what they have investigated, you can help to facilitate students' use of these CCCs by guiding students to consider how a small change in temperature has led to large changes in the water system. The focus of this discussion is to help students build the element: "small changes in one part of a system might cause large changes in another part."

Where We Are NOT Going

Students will not yet provide a full explanation for changes to Earth's water system, though, they will gather the last piece of that understanding in this lesson that they can use to develop a full explanation in the next lesson.

Students will not explore the specifics of how data was gathered and calculated across both satellite and ground observations to produce the findings shared in each reading. This topic would make for an excellent extension opportunity for any student with high interest in how scientists use satellite data to make surface measurements. NASA offers ample resources should a student want to learn more.

LEARNING PLAN for LESSON 4

1 · NAVIGATION

3 min

MATERIALS: Earth's Water System model with sticky note predictions from Lesson 3

Say, *In the last class, we thought several of these components could be losing water, but some could be getting more water. Seems pretty incredible that a small change in temperature could cause these things to happen. Some of you mentioned wanting to get more data, and I found information from different groups of scientists who study each of these components. These scientists make claims about how warmer temperatures are affecting the part of the system that they study. Let's look to see what claims and evidence they share and how their research matches or doesn't match what we predicted is happening. We really need to decide whether this small change in temperature is truly impacting all of the components like we think, and then if this has any impact on people.*

2 · OBTAIN INFORMATION FROM TEXT AND VISUALS

20 min

MATERIALS: science notebook, *Obtaining Information about Other Components, Changes to Snowpack, Changes to Sea Level, Changes to Glaciers and Land Ice, Changes to Streamflow, Changes to Groundwater*, sticky notes, marker

Set the purpose for reading the text. Display slide A. Say, *We're pretty certain that this temperature change is causing more problems in different places of our model, but we're not certain how. What could be important to pay attention to as we read more about each component? How can we tell if the information is showing something normal or not normal?*

Listen for students to suggest:

- whether temperature is affecting that component,
- if water in that component is changing, like increasing or decreasing,
- if the component is changing how we thought it would be changing,
- if the scientists give data to support their claims, and
- if the scientists are looking at enough data over a long enough time period to be able to see a change or whether it's normal.

Display **slide B** and pass out 1 copy of *Obtaining Information about Other Components* to each student.* Students have previously engaged in similar reading strategies to obtain information during the *Maple Syrup Unit*. Use the handout to preview the different information students should attend to and record as they read the text.

Assign students to read one of the texts. Assign each student to read, annotate, and record their ideas to one of the texts. Have students spend 10 minutes reading on their own.



Convene small groups for a discussion. Continue to display **slide B**. Arrange students in small groups with the same assigned text. Have students (1) compare what they learned from each text, (2) update their own notes as they hear something new that they think is important from a member of their group, and (3) discuss a summary conclusion.

In the last 2 minutes, direct small groups to brainstorm what conclusion they want to share about their component with others in the class. Have one student write on a sticky note how temperature is affecting that component of the system and be prepared to add this to their model.

* SUPPORTING STUDENTS IN THREE-DIMENSIONAL LEARNING

As students read, annotate, and record notes from the texts, they should engage in all three dimensions. The *Obtaining Information about Other Components* handout will guide students to consider how to obtain and evaluate technical information from the text. The handout also focuses students on the question of how a small change in temperature could be affecting a component of the water system (stability and change). As students engage in the practice of obtaining and evaluating information and use the lens of stability and change, they work toward an understanding that water cycling components and processes are changing as a result of temperature rise.

ADDITIONAL GUIDANCE

Assigning students to the different texts based on the considerations below should support accessibility and engagement with the text. There are three considerations to account for when assigning students to the texts: (1) student interest and questions, (2) reading level, and (3) assigned case study in Lesson 2.

Pay attention to students' curiosities and questions when assigning texts. For example, if a student asked a question about sea level rise on the DQB, assign them to the text that would most align to their question.

Take care to assign students to the text that will be most accessible at their reading level. Consider partner reading with heterogeneous grouping as needed. The texts are slightly leveled to be accessible to below and on grade level readers. One text is designed to challenge above grade level readers. While all texts fall within a 810L-1000L lexile range, the Flesch-Kincaid score shows the slight difference in reading level.

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Third, based on what you observed in students' analysis of data for the different case sites in Lesson 2, consider assigning students to texts that could help clarify some of their ideas and questions.

- Yakima, WA - Snowpack or glaciers
- Porterville, CA - Groundwater
- Navajo Nation, AZ - Streamflow, snowpack, groundwater
- Vicksburg, MS - Streamflow
- Windom, MN - Streamflow
- Boston, MA - Sea level rise

ASSESSMENT OPPORTUNITY

Building towards: 4.A *Integrate scientific information with media and graphical displays of data to clarify how a small change in temperature affects components of Earth's water system.*

What to look/listen for:

- Conclusions should:
 - generally be similar to the claims made by the scientists but in students' own words,
 - describe how the component is changing (e.g., increasing, decreasing, etc.),
 - describe how temperature is related to the change in the component (e.g., melting ice, changing precipitation from rain to snow, causing a process to happen earlier, etc.), and
 - be supported by the data included with the text.

What to do: Encourage students to use the lens of stability and change as they read their text and examine the data, looking for what was considered normal and what has changed. If students struggle with interpreting the data in their reading with the information in the text, prompt them to brainstorm strategies they have used in the past to help them analyze data. If they don't offer the I² strategy, encourage them to use the I² strategy on the data display in their reading and then to compare their WIS and WIM statements with the text provided by scientists.

3 · FACILITATE A CONSENSUS DISCUSSION ABOUT OBSERVED CHANGES

12 min

MATERIALS: Earth's Water System model, Model Ideas list, markers

Facilitate a sharing of what was learned. Bring students together for a whole-group discussion. Display **slide C**. Focus students on the first two questions on the slide.

- What did the scientists claim was happening and did their data support this claim?
- How did scientists' claims match or not match our initial predictions?

Have each group share for about 1 minute what they learned from their text. Ask them to also share what they concluded in terms of the relationship between temperature and changes to the component they investigated, posting their sticky note to the model.

Allow students from other groups to ask clarifying questions. The data visuals from the readings are included on **slides G-K** which students may want to display to the class as they share their conclusions.



Transition to a Consensus Discussion about how temperature affects the system and human communities that depend on the water system. Display **slide D**. Have the students connect back to the case sites from Lessons 1 and 2. Ask the following questions:

- How are changes to Earth's resources, like water, impacting communities we've looked at?
- How are these different water problems connected to each other?

KEY IDEAS

Purpose for this discussion: To develop a more comprehensive understanding that, while each community is having a slightly different problem, they connect because rising temperatures are changing Earth's water system. In particular, focus on building the following story:

- Communities depend on different water resources.
- These water resources are not evenly distributed, so each community has a slightly different problem.
- But all of their water problems seem to relate back to rising temperatures.

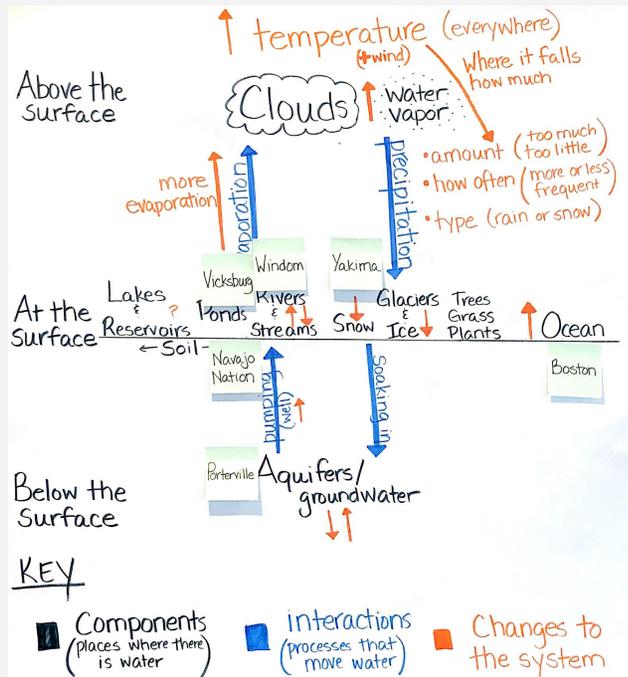
Listen for initially (question 1):

- Snowpack and glaciers in the mountains are getting less/smaller, and this affects places like Washington. Farmers and people rely on water when the snow melts, and there is less snow. And it's melting earlier in the year.
- Groundwater is not changing from temperature; but because places like Portersville are getting less rain, the groundwater is not refilling and people are still pumping from it, so it's getting less as people use it.
- Vicksburg, Mississippi, and Windom, Minnesota, had really high streamflow because snow was melting earlier when rain was also coming to the area.
- Sea level is rising, so places like Boston that are right on the ocean are having more flooding.
- Places like the Navajo Nation are experiencing problems with a lot of components, like less snow, dry rivers, and less groundwater, too.

Push students to make connections across cases (question 2). Listen for:

- The temperature rise is affecting the whole water cycle or water system.
- Because our water system is all connected, changes in one part are affecting other parts.

As students share, remove sticky notes on the class's Earth's Water System model and replace them with arrows or symbols drawn directly on the model. Add new ideas to the Model Ideas list.



Model Ideas List

- Normal precipitation = long-term trends in total amount, timing, intensity, and type of precipitation.
- Precipitation during individual years may be different from the long-term trend and this is normal.
- Not normal precipitation is a trend toward a change in precipitation that is outside of a typical range for a place.
- Climate is a measure of weather conditions for an area over a long period of time.
- \uparrow temperatures = \uparrow evaporation rates = \uparrow water vapor in atmosphere.
- Wet areas = \uparrow evaporation; dry areas = \downarrow evaporation.
- \uparrow temperature & wind affects where/how much precipitation falls.
- \uparrow temperature the type of precipitation that falls.
- Changes to sources of water affect communities in different ways.
- A small change in temperature in the atmosphere has big changes in Earth's water system.

4 · UPDATE PROGRESS TRACKER

5 min

MATERIALS: science notebook

Add an entry to the Progress Tracker for an individual reflection. Use slide E to guide students in adding an entry to their Progress Tracker below the previous one. Give students 5 minutes to quietly update their Progress Tracker, using words and drawings to show what they have figured out. Ask students to draw a line underneath their responses when they are done.

5 · NAVIGATION

5 min

MATERIALS: None

Take stock of the progress students have made. Display slide F. Say, *Wow. We started at the beginning just talking about a couple of places that were having droughts and floods, but this seems like a much bigger problem now. This change in temperature—just slight in some places—seems to really impact our water system. I'm wondering how these investigations have changed the way you think about the problem?* Give students 2 minutes to turn and talk to share how their understanding of the problem has changed now that they know more.

- How has your understanding of the problem changed since the first lesson? Any lingering confusions?*
- How is the small rise in temperature affecting more than just droughts and floods?

* ATTENDING TO EQUITY

Use this opportunity to support students in **Action and Expression** to monitor their progress on understanding the problem. In particular, asking questions to guide self-monitoring and reflection can support

Additional Lesson 4 Teacher Guidance

SUPPORTING STUDENTS IN MAKING CONNECTIONS IN ELA

CCSS.ELA-Literacy.RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

CCSS.ELA-Literacy.RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

CCSS.ELA-Literacy.RST.6-8.10 By the end of grade 8, read and comprehend science/technical texts in the grades 6-8 text complexity band independently and proficiently.

Students gather information from written text, images, and data depicting scientific research on different components of Earth's water system. Students must determine the central ideas, or claims made, and evaluate those claims using the explanations and data supplied in the text and visual displays.

students in making sense of where they have gained knowledge and where they may still have lingering confusions.