LESSON 1: Why are floods and droughts happening more often?

PREVIOUS LESSON *There is no previous lesson.*

THIS LESSON

ANCHORING PHENOMENON

3 days

In this lesson, we observe two news clips that tell the story of extreme flood and drought events in two different communities and share our own stories of when water in our communities has changed. We examine headlines that show a "new normal" of increased floods and droughts across the United States and notice that, in both situations, there is a pattern of record heat and rising temperatures. We develop an initial model explaining what could be causing those warmer temperatures and how those warmer temperatures could lead to both droughts and floods. We develop questions for our Driving Question Board (DQB) and brainstorm investigations we could do and sources of data that could help us figure out answers to our questions.

NEXT LESSON *We will develop a systems model to describe where Earth's freshwater is stored above, at, and below the surface. We will analyze and interpret temperature, precipitation, and drought or flood data in our local community and six other places in the US to figure out whether water or temperatures in these communities is changing over time.*

BUILDING TOWARD NGSS

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

WHAT STUDENTS WILL DO

1.A Develop a model to explain how a small change in temperature can cause large scale changes in precipitation leading to floods and droughts.

1.B Develop a model to explain what could cause an increase in temperatures that are linked to an increase in floods and droughts.

1.C Ask questions that arise from initial observations of stories and headlines about rising temperatures, floods, and droughts to clarify whether increasing temperatures are related to or causing both floods and droughts.

WHAT STUDENTS WILL FIGURE OUT

- Droughts and floods are happening more often, and both cases seem to be linked to warmer temperatures.
- Changes in evaporation may be related to why, where, and when droughts and floods occur.
- We have some ideas and many questions about what might be causing the warmer temperatures.

Lesson 1 • Learning Plan Snapshot

Part	Duration	Summary	Slide	Materials
1	25 min	**INTRODUCE TWO STORIES ABOUT FLOODS AND DROUGHTS** Record and share noticings and wonderings from two news clips—a drought in Porterville, CA, and flooding in Vicksburg, MS. Discuss what it might be like to live in one of those communities.	A-H	The Town Without Water video clip, Floods Hit U.S. Small Towns along Mighty Mississippi video clip, chart paper, markers
2	15 min	**IDENTIFY PATTERNS IN HEADLINES ABOUT FLOODS AND DROUGHTS IN SMALL GROUPS** Distribute headlines from across the United States related to floods and droughts. In small groups, students read and organize the headlines in order to identify patterns that they add to a shared document.	I-K	*Drought and Flood Headlines*, sticky notes, Lesson 1 Headline Jamboard (optional)
3	5 min	**ASSIGN HOME LEARNING** Assign students the task of talking to members of their families or communities to share stories about floods or droughts they may have experienced.	L	
				End of day 1
4	7 min	**SHARE OUR WATER STORIES** Navigate back to the communities we explored on day 1 and add our water stories in relation to those communities.	M	large sticky notes
5	8 min	**DISCUSS PATTERNS IN HEADLINES ABOUT FLOODS AND DROUGHTS AS A CLASS** Return to the headlines from day 1 and identify similarities and differences between the drought- and flood-related headlines.	N	T-chart of drought/flood headline patterns
6	5 min	**IDENTIFY WHAT WE NEED TO INCLUDE IN OUR MODELS** Identify what we need to include in our models to explain how increasing temperatures could lead to increased floods and droughts and what is causing the temperatures to rise.	O-R	
7	15 min	**DEVELOP AN INITIAL MODEL AND COMPARE WITH A PARTNER** Develop an initial model to answer the questions, "How can increased temperatures lead to both droughts AND floods?" and "What is causing the temperatures to increase?"	S-T	
8	10 min	**BEGIN TO DEVELOP AN INITIAL CONSENSUS MODEL** Gather in a Scientists Circle and facilitate a Consensus Discussion among students to develop the first classroom consensus model.	U-V	chart paper, markers
				End of day 2
9	10 min	**CONTINUE TO DEVELOP AN INITIAL CONSENSUS MODEL** Reconvene in a Scientists Circle and continue the Consensus Discussion with a focus on what is causing temperatures to rise.	V	
10	5 min	**INDIVIDUALLY GENERATE QUESTIONS** Students individually generate questions about the phenomenon in preparation for building the DQB.	W	2 sticky notes, marker

Part	Duration	Summary	Slide	Materials
11	20 min	**BUILD THE DRIVING QUESTION BOARD** Develop a Driving Question Board to create a shared space for student questions.	X	
12	10 min	**BRAINSTORM IDEAS FOR DATA AND INFORMATION WE NEED** Use the categories of questions and have students identify the data and information that would help them answer each category of questions.	Y	Driving Question Board, chart paper

End of day 3

Lesson 1 • Materials List

	per student	per group	per class
Lesson materials	• science notebook • 2 sticky notes • marker	• *Drought and Flood Headlines* • sticky notes • Lesson 1 Headline Jamboard (optional)	• The Town Without Water video clip • Floods Hit U.S. Small Towns along Mighty Mississippi video clip • chart paper • markers • large sticky notes • T-chart of drought/flood headline patterns • Driving Question Board

Materials preparation (20 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.

Test *The Town Without Water* video clip and the *Floods Hit U.S. Small Towns along Mighty Mississippi* video clip from www.teachersopensciedfieldtest.org/droughtsfloods .

Use *Drought and Flood Headlines* to prepare cards for the headline sorting activity. If you are doing the headline sorting activity virtually, make a copy of the Lesson 1 Headline Jamboard from https://jamboard.google.com/d/16eSMvRBukeliNLkPHEAdMmOtLFpJVQRVKIxCMB0OSOk/edit?usp=sharing (or a copy is located in the OpenSciEd Google Folder or on the field test website). Copy enough frames of the headlines for the groups in your class.

Prepare all posters (e.g., Notice and Wonder charts, Ideas for Data and Information We Need) ahead of time.

Determine where to set up the Driving Question Board (DQB) and posters so that students can gather around them.

Make and post a discussion norms poster near your DQB space if you haven't already.

Lesson 1 • Where We Are Going and NOT Going

Where We Are Going

In this lesson students are introduced to the anchoring phenomena—two news clips that tell the story of extreme flood and drought events in two different communities, their own stories of changes in water in their communities, and headlines that show a "new normal" of increased floods and droughts across communities in the United States. This lesson elicits students' initial ideas about what could be causing warmer temperatures and how those warmer temperatures could lead to an increase in both droughts and floods.

Students will come to this unit with prior knowledge and experiences that can be leveraged. Students might use terms like global warming, greenhouse gases, and climate change. However, this unit pushes students to understand the mechanisms behind increasing global temperatures.

Students should come to this unit with prior knowledge from [materia: wc] unit related to these three NGSS performance expectations:

- MS-ESS2-4: Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
- MS-ESS2-5: Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.
- MS-ESS2-6: Develop and use a model to describe how unequal heating and rotation of Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

Relevant ideas from this previous work include these:

- Air particles near the ground get warmed up by the sun, and this energy is transferred from the particles in the ground to the air through conduction.
- As heat is added, water molecules from a water source and moist soil also heat up.
- As more energy is added, some water molecules turn into a gas and become water vapor (evaporation).
- As water vapor rises in the atmosphere, it cools and will turn back into liquid. It condenses on dust particles or other things in the air and begins to form clouds and eventually falls as precipitation.
- The role of wind in moving parcels of air around.
- Weather is the minute-by-minute or day-by-day variation in the condition of the atmosphere, while climate is longer term (years to centuries).

When students set up their initial models, push students to bring this prior knowledge to their modeling work and to push their models to think about how temperature could affect what they already know about the system.

Where We Are NOT Going

The terms "climate change" and "global warming" will likely be used throughout this lesson. At this point in the unit, it is not important for students to have a complete understanding of these words, and most likely, many students will use them without a full understanding. This is OK at this point in the unit, and students will develop a fuller understanding of both across the unit.

In addition, it is not important for students to have a complete understanding of the different components and interactions in the system as students will most fully build a water system model in Lesson Set 1 and a carbon system model in Lesson Set 2.

LEARNING PLAN for LESSON 1

1 · INTRODUCE TWO STORIES ABOUT FLOODS AND DROUGHTS

25 min

MATERIALS: science notebook, The Town Without Water video clip, Floods Hit U.S. Small Towns along Mighty Mississippi video clip, chart paper, markers

Set the stage by making a connection to a local water story.✱ Tell students about a local situation related to a change in the amount of precipitation in your area. Here are some possible connections:

- Share a picture of a local body of water that is or was unusually low. Say something like, *I remember that this reservoir was really high in March, and now it is super low. I was thinking maybe we are getting less rain than usual or we are in a drought or something. It got me thinking about what else is out there, so I found some videos of other locations experiencing something like this, too.*
- If you are in an area that has put in measures to address water shortages (e.g., no watering of lawns, etc.), say something like, *We have been doing things to address the recent water shortages. It got me thinking about what it's like in other places and what they are doing about things like water shortages. It also made me wonder about places where the opposite is happening.*
- If you are in a place that has experienced floods or the bodies of water are unusually high, say something like, *Who can remember the recent flood we had? It got me thinking—are we the only place experiencing this, and what are other people doing about floods? It also made me wonder about places where the opposite is happening.*
- If you are in a place where neither droughts nor floods seem to be happening with enough frequency or seemingly little direct impact on the people living there, you could connect to other issues related to too much or too little water, such as earlier snowmelt or dry conditions that lead to wildfires.

Set up for Notice and Wonder charts. Display **slide A**. Tell students that you have found 2 news stories that may relate to our own experiences with places that are getting too much or too little water. After preparing space in their notebook for this new unit, have students make a two-column chart on the next available page to record their noticings and wonderings from the videos. If students need support in recording noticings and wonderings from a video, you can show optional **slide B** and **slide C**, which offer suggestions for ideas they could include.

SCIENCE NOTEBOOK

This is the first use of the science notebook for this new unit. You may need time to organize a new section in the notebook. It is recommended to have students do the following:

- Reserve a blank page at the start of the unit, to be titled on day 3 of this lesson when students are ready for the unit question.
- After the title page, reserve 2 pages (4 pages front-to-back) for the table of contents (unless all tables of contents are at the front of the notebook).
- Reserve 8 pages (16 pages front-to-back) for the Progress Tracker.
- Number the pages so that everyone begins the first investigation on the same page number (e.g., page 1 for the first page of the table of contents, page 5 for the first page of the Progress Tracker, and page 21 for the first Notice and Wonder chart they are making).

Remind students that the notebook is their tool for recording their observations, evidence, and ideas to share with the classroom community. They should see it as a space to brainstorm and record their thinking, as well as a place to show how their thinking changes as they learn more.

ALTERNATE ACTIVITY

You may wish to change the order of the stories that you show to connect to the situation that is more closely connected to what your community has experienced. For example, if your community has experienced flooding, you may want to start with the Vicksburg, MS, story and then show the drought story. If the story order is changed, you will also need to change the Notice and Wonder titles on **slides A**, **B**, **C**, **D**, and **F**.

✱ ATTENDING TO EQUITY

Students will find the anchoring phenomenon more compelling if it is presented in a meaningful context. Additionally, throughout Lessons 2-5, there are opportunities to weave your community's story into the overall storyline. Therefore, adding a local story or local connection now will serve to increase relevance and interest for your students and will engage them in a deeper study of their community across the first lesson set.

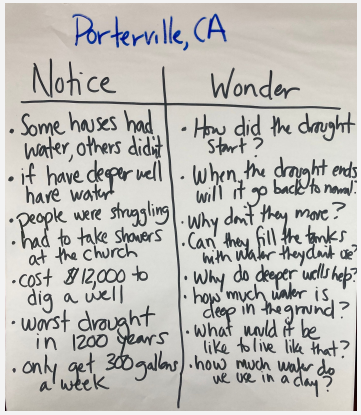
✱ ATTENDING TO EQUITY

Supporting empathy and emotions: A unit on floods and droughts is likely to elicit emotional stress from some students, either in terms of the empathy they feel for those affected, or from experiencing the natural hazard directly or through the experiences of family and friends.

Emotional stress from these events can often be great in students who feel they do not understand the situation or that they have no control over the situation. While droughts and floods often bring impacts that students cannot control, the aim of this unit is to help students understand what is happening to cause these events and to feel as though they can understand them and use their knowledge to understand a community's response to them (e.g., water restrictions, flood warnings).

If you have students who have traumatic experiences from a drought or flood event, a recommended source to read is located at the CDC Children in Disasters: Teachers and Childcare website at https://www.cdc.gov/childrenindisasters/schools.html

Show the first clip. Play *The Town Without Water* video clip from www.teachersopensciedfieldtest.org/droughtsfloods , which is also linked on **slide D**. This clip takes place in Porterville, CA. Have students record noticings and wonderings as the clip plays. Once the clip is over, give students an additional minute to record their noticings and wonderings on their charts.



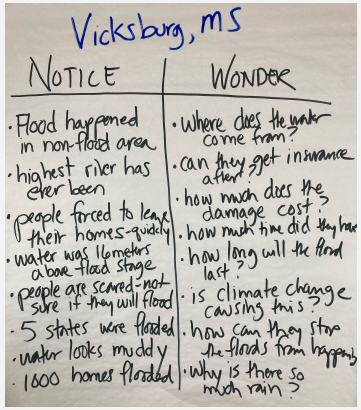
Share noticings and wonderings from the first clip. Show **slide E**. Take 3-4 minutes to have students share a few of the things they noticed and wondered about from the clip. There are two additional prompts on the slide to help guide students as they share noticings and wonderings. Start a public record of what they share, using chart paper, whiteboard, or digital document.

Show the second clip. Say, *I found another case that is having the opposite problem—too much water.* Ask students to add a heading for Vicksburg, Mississippi, on the opposite page, and draw a second Notice and Wonder chart. Then play the *Floods Hit U.S. Small Towns along Mighty Mississippi* video clip from www.teachersopensciedfieldtest.org/droughtsfloods , which is linked on **slide F.** As the clip plays, have students record noticings and wonderings. When the clip concludes, give students an additional minute to record their ideas.

Share noticings and wonderings from the second clip. Show **slide G**. Take 3-4 minutes to have students share their noticings and wonderings with the class. There are two additional prompts on the slide to help guide students as they share noticings and wonderings. Start a public record of what they share, using chart paper, whiteboard, or digital document.

Reflect on how it might feel to live in one of these communities. Show **slide H**. Ask students to turn and talk about the questions on the slide: ✱

- How might you feel if your town ran out of water? How would it change your daily life?
- How might you feel if your town flooded and you had to leave your home?



Briefly hear a few ideas (e.g., ask someone to share an idea their partner said). Some sample student ideas are listed below:

- *If my town was flooded, I would feel scared because I could lose everything, and my house that I paid a lot of money for did not have flood insurance.*
- *I would feel nervous and scared because, if my house flooded, I don't know where I would go and if I could still even live in it.*
- *I would feel sad and frustrated if my town had flooded and I had to leave, since I would lose a lot of things.*
- *If my town ran out of water, I would feel scared and would have to collect water for my family.*
- *I would feel upset because I literally depend on water. I only take hot showers, I drink only water, and I wash my hands all the time. It would be a very difficult thing to not have water.*
- *It would be more difficult without having water for a while. Everything requires some form of water to operate, so without water nothing will work.*
- *I would feel stressed or overwhelmed because then I would constantly be counting the gallons of water I used.*

2 · IDENTIFY PATTERNS IN HEADLINES ABOUT FLOODS AND DROUGHTS IN SMALL GROUPS

15 min

MATERIALS: *Drought and Flood Headlines*, sticky notes, Lesson 1 Headline Jamboard (optional)

ALTERNATE ACTIVITY

Virtual option: You can make a copy of the Jamboard from www.teachersopensciedfieldtest.org/droughtsfloods or the OpenSciEd Google Drive with the images of the headlines and then duplicate the frames so that you have enough for all of the groups in the class. Students can also copy their sticky notes that they used to label the patterns they identified to a class T-chart on a shared frame in the Jamboard.

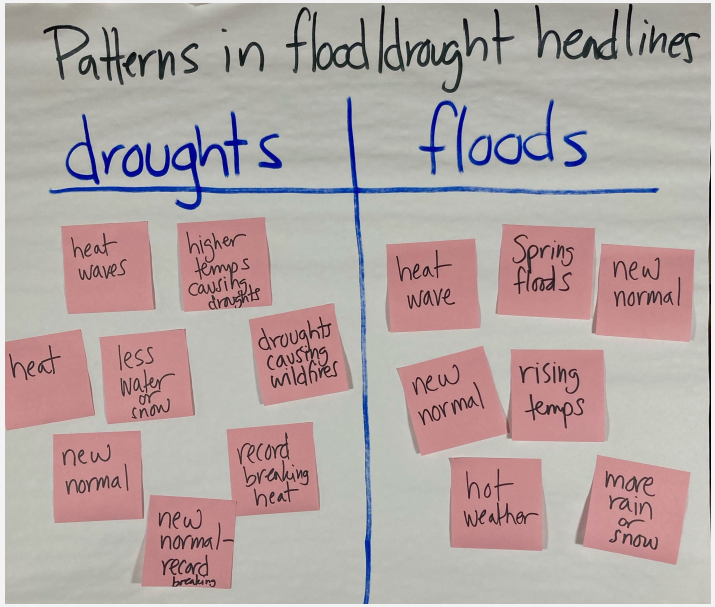
Introduce the headlines. Show **slide I**. Say, *These stories made me wonder what is happening with floods and droughts in other parts of the country, and I found some other locations that seem to be having problems with too little and too much water as well. I gathered some headlines from those locations that might help us learn more about what is happening elsewhere.*

Explain that the map shows locations that have had droughts and floods in just the past few years. Brown markers represent a location that experienced a drought, while green marks a location of a flood.

Say, *Let's look at headlines from these locations to see if we can find any patterns to help us explain what's going on.*
Arrange students in pairs or small groups to examine headlines✱. Project **slide J**. Pass out the headline cards or provide a link to the headlines on an electronic whiteboard, such as Jamboard. Assign half of the pairs to the drought headlines and half to the flood headlines. Give students about 8-10 minutes to read and organize the headlines in order to identify patterns.

Ask groups to post their patterns to a shared document. Display **slide K**. Create a T-chart on chart paper, whiteboard, or digital document with the headings shown on **slide K**: patterns you noticed across drought-related headlines/patterns you noticed across flood-related headlines.

Ask groups to post their sticky notes for the patterns they recorded on the class T-chart. The sticky notes will need to be grouped and arranged together before the next class period. During the next class period, the class will use these groupings and headlines to discuss the patterns they noticed and what is similar or different between the droughts and floods.



✱ ATTENDING TO EQUITY

Universal Design for Learning: To promote student *engagement* you may choose to differentiate the degree of difficulty or complexity of the task by giving some groups both sets of headlines. Learners vary not only in their skills and abilities, but also in the kinds of challenges that motivate them to do their best work.

3 · ASSIGN HOME LEARNING

5 min

MATERIALS: None

Explain the home learning✱. Say, *Next class period we are going to share some of what we noticed about these headlines and floods and droughts in other communities. However, in the meantime, you and your families may have experienced or heard about situations that are similar to those we have heard about today.* Display **slide L**. Explain that students should talk to members of their families or communities and bring back any stories to share on day 2. Use the following prompts on the slide:

- Has our community experienced anything like this?
- Have you or your family lived in or traveled to a community that experienced anything like this?
- Has a member of your family or community experienced anything like this?

✱ ATTENDING TO EQUITY

Universal Design for Learning: This home learning is used to broaden students' thinking to related phenomena and leverage these everyday science experiences they have outside of school to augment the learning that happens in the classroom. Locating the anchoring phenomena in the context of their community helps the phenomenon become more personally meaningful to each student and supports student *engagement*. It also provides students an opportunity to talk about the phenomena with family members and other community members.

End of day 1

4 · SHARE OUR WATER STORIES

7 min

MATERIALS: large sticky notes

Navigate back to the stories from day 1. Say, *Yesterday we started with 2 communities that were facing challenges related to water. Let's look back at our Notice and Wonder charts. What was the problem in each of those communities?* Listen for the idea that Portersville was running out of water because of a drought, and Vicksburg was flooding worse than ever before.

Set up a visual continuum to record our water stories. Write "Vicksburg, MS," and "Porterville, CA," on 2 big sticky notes (or on chart paper or in Jamboard) and place at either ends of a continuum drawn between the two places. Say, *So, in one case, the community had too much water and, at the other end, not enough.* Add those labels to the continuum.

Ask students to share their water stories and add them to the continuum. Say, *In addition to Porterville and Vicksburg, we analyzed headlines for other places that are experiencing something similar. Our own community may be experiencing some problems, too. Let's come up with some example headlines from our own stories and think about where they fit in relation to the other stories and headlines we've already seen.* Show **slide M**. Ask a few students to share any stories they gathered about similar situations they or their families might have experienced. As students share, write a headline for what happened onto a sticky note and add it to the continuum (e.g., Hurricane Irene causes record flooding; Basements overflow as rivers rise; Families in Vietnam experience frequent floods and droughts).

5 · DISCUSS PATTERNS IN HEADLINES ABOUT FLOODS AND DROUGHTS AS A CLASS

8 min

MATERIALS: T-chart of drought/flood headline patterns

Return to the headlines to identify similarities and differences. Show **slide N**. Say, *Let's see if the headlines we analyzed yesterday have a similar story to what we/our community/our families have experienced. Let's return to our observations to see if we can find any patterns to help us explain what's going on.*

Return to the class T-chart and the sticky notes that students added. Discuss differences and similarities. Connect back to the stories the class added by posing the question, "Do any of these headlines have a similar story to what we/our community/our families have experienced?"

Patterns in drought-related headlines	Patterns in flood-related headlines
• **Less precipitation: e.g.** less rain/snow/dry;less winter snow;droughts, dry • **New normal:** e.g. normal changing;weird weather is new normal; record-breaking • **Record-breaking heat: e.g.** during drought;hot and dry;heat wave;hot • **Dry and fires**	• **More precipitation: e.g.** historic flooding; major flooding;worsening floods;more rain, floods, snow; wettest on record • **"new normal"**: e.g. more often; happening more • **Rising temps** • **More in spring**
Similarities: • "New normal"; historic, recording-breaking • Heat, heat wave, rising temperatures	

Say, *It's really curious to me how these two very different kinds of problems share some things in common. Let's see if we can explain these similarities.*

6 · IDENTIFY WHAT WE NEED TO INCLUDE IN OUR MODELS

5 min

MATERIALS: None

Discuss the new normal and what might be causing it. Say, *It's really curious to me how these two very different kinds of problems share some things in common.* Display **slide O** and discuss the prompts.

Suggested prompts	Sample student responses
What is happening in these stories that is "not normal"? What is the "new normal"?	*Places are getting way more rain or less rain than usual.* *There are changes in the amount of precipitation.* *Floods and droughts are happening more often or are getting worse.* *They are getting heat waves, which seems to be not normal for some of the areas.*

Suggested prompts	Sample student responses
It makes me wonder, how do we decide whether it's normal? How much of a difference does it have to be to be considered "not normal"?	*Maybe if it happens more often than it used to?* *There might be a bigger difference in what the weather used to be like and what it is now?* *Maybe it's happening in new places that haven't had this in the past?* *I don't know.Don't floods and droughts happen all the time?*
It seemed like a lot of the stories mentioned increases in temperatures. Do we have any ideas for what might be causing the increased temperatures?	*Some of the headlines said climate change.* *Maybe global warming?* *Pollution or CO_2.* *I don't really know.*

Set the purpose of the model. Display **slide P**. Say, *So, it seems like we have 2 puzzling questions—what is causing those warmer temperatures/increased heat and how could those warmer temperatures lead to both droughts and floods? We're going to try to explain as much as we know about this, but, first, let's decide what to include in our models.*

Identify possible components and processes that could lead to droughts and floods. Display **slide Q**. Lead a discussion to help students identify which components and processes that lead to changes in precipitation might be important to include in the model. Say, *We said earlier that there are changes in precipitation, like the amount of rain or snow a place gets. Let's brainstorm what we know about the components and processes in those locations getting water that we might want to include in our models.*

Suggested prompts	Sample student responses
What are some components or things we need in a model in which water is moving to and from different places?	*We need some water—like a lake or water in the ground.* *We need the sun or a heat source.* *Clouds*
What are some processes that are involved that help different locations get water and that might be changing?	*Evaporation* *Condensation* *Precipitation* *Wind*

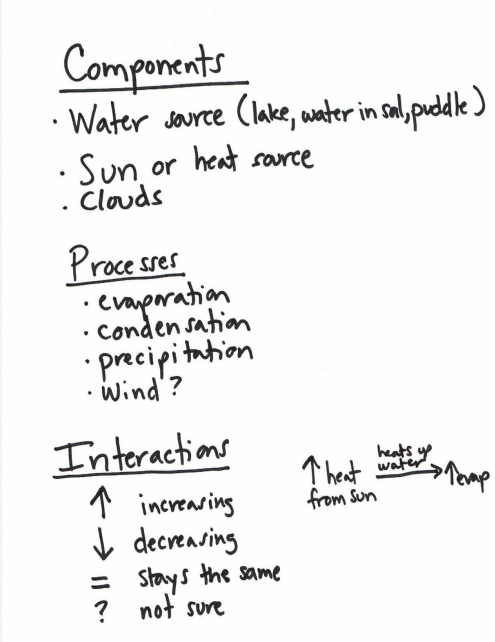
Discuss what could be happening to those components or processes. Ask students how these components and processes could be changing and how we could show that.

Suggested prompts	Sample student responses
It seems like this model shows what is normally happening. What might be changing with these processes or components in our model to lead to an increase in floods or droughts?	*Maybe there is more evaporation happening.* *Well, we know that there is more precipitation with floods.* *There is more sun to heat things up.*
How might we show that in our models?	*We could use arrows to show increases or decreases.*

Show students how to indicate whether the processes or components are going up, going down, staying the same, or don't know.

Discuss how to show what might cause a change to those processes or components. Ask students to reflect on how we showed connections and changes in processes on our model from the *Palm Oil Unit*. Students should respond that arrows and lines with simple explanations were used to connect processes and components in that model. Ask students how we could use those same conventions to indicate whether the processes are increasing and decreasing, and how we have shown that in other units. Students should respond with the ideas of increasing arrow size, or drawing arrows going up and down. Decide on a set convention as a class. Below is an example of the interaction between components using a line or an arrow with the quick explanation between each interaction.

Discuss the second question our model is trying to address. Display **slide R**. Remind students that we also want to explain what might be causing the warmer temperatures in the first place. Remind students to explain **why** this is happening, not just **what** is happening.



Example Components/Interactions

ADDITIONAL GUIDANCE

This lesson (and this unit) builds on ideas that students figured out in *OpenSciEd Unit 6.3: Why does a lot of hail, rain, or snow fall at some times and not others? (Storms Unit)* about how water cycles through the atmosphere. In that unit students figured out that air particles near the ground get warmed up by the sun and that this energy is transferred from the particles in the ground to the air through conduction. As heat is added, water molecules from a water source and moist soil also heat up. As more energy is added, some water molecules turn into a gas and become water vapor (evaporation). As water vapor rises in the atmosphere, it cools and will turn back into liquid. It condenses on dust particles or other things in the air and begins to form clouds and eventually falls as precipitation. Students may also recall the role of wind in moving parcels of air around. If your students have not experienced the *OpenSciEd Unit 6.3: Why does a lot of hail, rain, or snow fall at some times and not others? (Storms Unit)* unit you may need to spend additional time developing these ideas with your students.

7 · DEVELOP AN INITIAL MODEL AND COMPARE WITH A PARTNER

15 min

MATERIALS: science notebook

Individually develop an initial model. Project **slide S**. Give students about 8 minutes to develop an initial model to answer the questions, "How can increased temperatures lead to both droughts AND floods?" and "What is causing the temperatures to increase?" Keep the slide with the questions and image for the model, as well as the list of components, processes, and interactions, visible.

ASSESSMENT OPPORTUNITY

Building towards:
1.A Develop a model to explain how a small change in temperature can cause large scale changes in precipitation leading to floods and droughts.

1.B Develop a model to explain what could cause increased temperatures that are linked to increased floods and droughts.

What to look for:
1.A Look for students to use:

- Water cycling processes, such as evaporation and precipitation, in their initial causal accounts of floods and droughts. See if students are connecting temperature change to a change in these processes.
- Look at how students' individual models accounted for these changes in temperature and water cycling processes compared to the model co-constructed by the class. This will give you insight as to where each individual student is in their initial understanding of the phenomenon and their modeling practice to explain it.
- Look at students' causal accounts to see if they use single words, like evaporation, as a "sufficient" causal explanation, or if they elaborate on a mechanism for how temperature change could affect a water cycle process.

1.B Look for students to explain what is causing temperatures to rise using language or images that link the causes (e.g., greenhouse gases) to the effect (rising temperatures).

What do to: Ask students to leave their notebooks in the classroom for you to assess their work.
1.A If your students struggle with identifying important components and processes for the cycling of water, you may need to spend additional time reviewing those key processes before they develop their individual models. If students don't explain how the change in temperature is causing the changes to the processes and components that the class identified, use prompts to solicit those connections (e.g., I see you are showing that evaporation is changing, can you add some words to explain how that is connected to the increased temperatures?).

1.B If students use language they have heard connected to increased temperatures (e.g., climate change, greenhouse effect, pollution, global warming) but don't explain *how* this could cause increased temperatures, prompt them to use words or images to explain what the words they use mean to them, how those processes, such as climate change, work, and how they lead to increased temperatures.

Compare models and explanations in pairs. Display **slide T**. Explain that, as you were circulating the room, it seemed like we had ideas that were both similar and different across our models. Tell students that we should spend some time comparing our models and explanations to see what we can agree upon and where we aren't as sure about what is occuring. To help students begin this process, share examples and non-examples of productive comparisons (e.g., a non-productive example would be focusing on the artistry of the drawing or diagram; a productive example would be noting how other students talked about why a change could lead to increased temperatures or floods and droughts).

Arrange students in partner pairs to share their models. Ask students to focus on identifying similarities and differences in what they think is happening to cause increased floods and droughts and increased temperatures. Use prompts (shown on **slide T**) to support students:

- How did your partner explain how a small change in temperature leads to large changes in other parts of the system?
- What cause did your partner identify that led to an effect of temperature going up?
- Did they explain how or why that caused an increase in temperature?

As partner pairs note similarities between the diagrams, explain that students can make a small check mark on their diagram noting that it is similar to a diagram by their partner. If students have a different idea, or they are confused about part of the system, they can mark those parts of the model with a question mark.

8 · BEGIN TO DEVELOP AN INITIAL CONSENSUS MODEL

10 min

MATERIALS: science notebook, chart paper, markers

Gather students in a Scientists Circle to develop an initial consensus model. Have students bring their science notebooks with them to the circle. Take this opportunity to remind the class how we listen to one another, press upon one another's ideas, and ask questions of one another; and it's OK to disagree with ideas, but it's important to be respectful. Remind students of the agreed-upon classroom norms.

SCIENTISTS CIRCLE

Your students may be familiar with the Scientists Circle from a previous unit. Remind students of the norms for participation and the logistics for forming and breaking down that space. A Scientists Circle includes these important features:

- Students sitting so that they face one another to build a sense of shared mission and a community of learners working together.
- Celebrating progress toward answering students' questions and developing more complete explanations of phenomena.
- Focusing on where students need to go next and how they might go about the next steps in their work.

As a class, work together to build a consensus model. Project **slide U** to remind your students of the purpose of this initial consensus model discussion. Remind students that the model is a chance to decide what the class agrees upon with the explanation for the phenomenon/problem and where the class is less certain and has questions. Before starting the discussion, project **slide V** to remind students of the 2 questions our model is trying to explain.

KEY IDEAS

Purpose of this discussion: Develop an initial class consensus model to capture the ideas we agree and disagree on or are more uncertain about to explain how increasing temperatures could be causing an increase in floods and droughts and what could be causing the increasing temperatures. Help students realize that, while we have agreement upon some common ideas, we still have many questions.

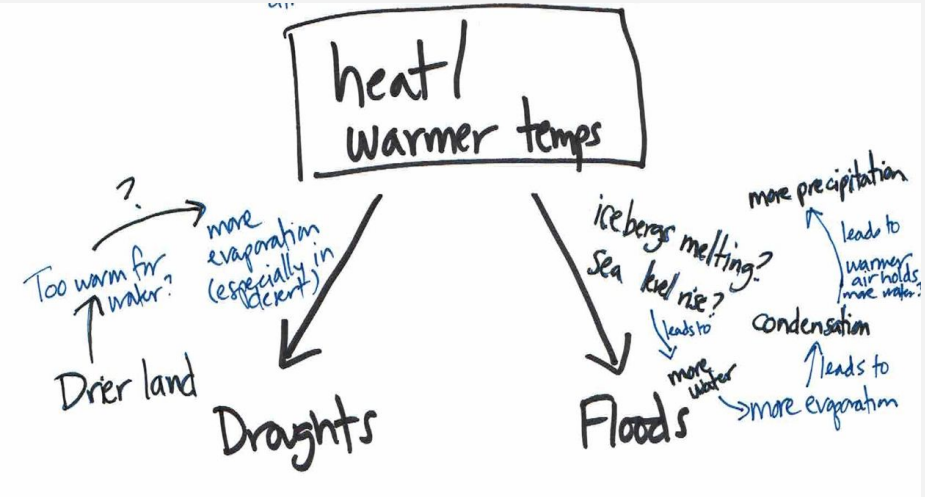
Listen for these ideas:
Possible areas of agreement:

- Precipitation is changing—more in the areas where there are floods and less in places where there are droughts.
- Increased temperatures mean changes in evaporation.
- Something has occurred to cause an increase in temperature, but we cannot agree on the exact cause of that temperature change.

Possible areas of disagreement or controversy:

- **How is evaporation changing in each situation?** Is it too dry in places where there are droughts for evaporation to happen or does it evaporate and then it is so hot it dries up and can't condense?
- **What else might contribute to increased water in the atmosphere?** Is this related to other things we have heard of like ice caps melting? What about sea levels rising?
- **What is actually causing temperatures to rise?** We've heard of global warming but what causes it? How do greenhouse gases cause temperatures to rise? How is carbon dioxide related to this problem? What is climate change? Does it have something to do with pollution?

Lead a discussion about how an increase in temperatures causes an increase in both floods and droughts. As students share their ideas, listen to what they believe is important to represent on the consensus model. During this modeling moment, it is important to honor students' ideas and create a model that reflects their thinking versus making an exact copy of the model shown here. An example of this first part of the initial consensus model can be found below. This is just one example of the model, and it could potentially have different areas of agreement and disagreement. It's important to follow your students' ideas during this discussion and not feel strongly tied to replicate this exact model.



Example Initial Consensus Model

Suggested prompts	Sample student responses	Follow-up questions
What are some ideas you and your partner agreed on for how increased temperatures might be leading to more droughts?	*We both said there isn't a lot of water because the ground is dry.*	*Is this something others showed?* *What might be causing this? Are there other sources of water besides the ground?*
What other ideas did you have for increased droughts?	*I said there was more evaporation because it's super hot.* *We said that, since it is so hot and it is dry, then there is less evaporation to then turn into clouds.*	*So, are you saying that the increased temperatures mean more evaporation? Can you say more about that?* *Can anyone put in their own words the different ideas that X and Y just shared?* *If more water is evaporating and it's not coming back down where there is a drought, where is it going?*
What about for floods—what were some ideas you and your partner had about that?	*We both showed a lot of precipitation and clouds.* *I also labeled water sources, like a river and melted snow.*	*Did anyone else show that?* *How does that relate to increased temperatures?*
What other ideas did you have for increased floods?	*I said that there is more evaporation when it is warmer, so then there is more water in the air that turns into clouds.* *If there is more water around, then there is more to condense and cause more rain.* *I added that there is more water because of the ice melting.*	*So, more heat means more evaporation? Can you say more about that?* *How is that different from what we showed for droughts?* *How might that relate to where we are seeing the floods?* *Which of these ideas are we sure about? Which of these ideas would we need more evidence for?*

Say, *It sounds as though we have some ideas about how increased temperatures might lead to changes in evaporation and precipitation but are still not sure about how both of these things could be happening at the same time when temperatures increase. Tomorrow we will continue with our model and compare our ideas for what is causing this increase in temperatures.*

End of day 2

9 · CONTINUE TO DEVELOP AN INITIAL CONSENSUS MODEL

10 min

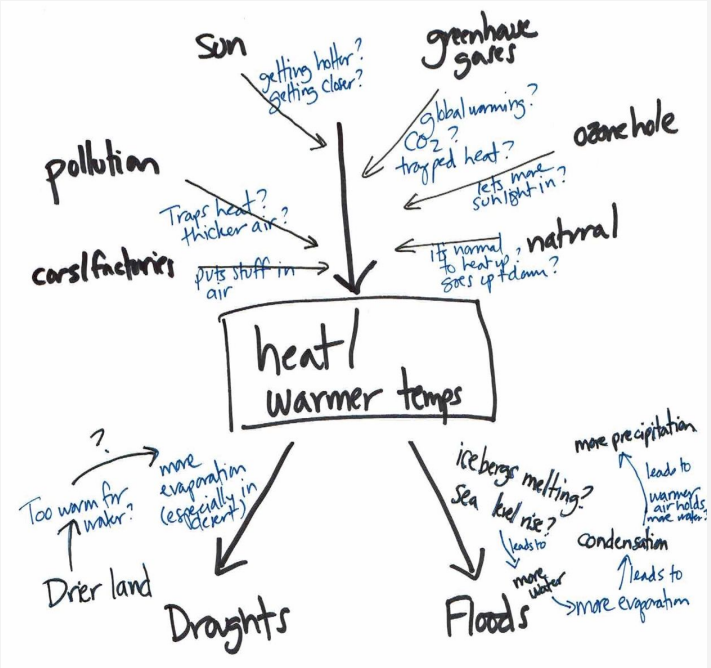
MATERIALS: None

Gather in a Scientists Circle to continue the initial consensus model. As students enter the classroom, have them bring their notebooks to the Scientists Circle. Display **slide V** and the first part of the model that the class worked on during the previous class period. Ask a student to remind the class of the questions we are trying to answer with our model.

Turn and talk about temperature changes. Give students 2 minutes to turn and talk with a partner about the ideas that they generated to answer the question: What is causing the temperatures to increase? If students are having trouble explaining what is causing the temperatures to increase, direct them to look back at their individual models and consider what their partners had shared with them while looking for similarities and differences.

Discuss similarities and differences in ideas. After students have had a chance to share their ideas with a partner, lead a discussion regarding the mechanism that might be causing an increase in temperatures. Capture ideas on the initial class consensus model as they are shared by the class, paying special attention to areas of agreement and disagreement.

An example of an initial consensus model can be found below. This is just one example of the model, and it's important to follow your students' ideas during this discussion and not feel strongly tied to replicating this exact model.



Example Initial Consensus Model

If students mention a widely used word, such as global warming, probe students to explain what the word means and how or why global warming could cause a temperature increase. Example prompts and responses are below.

Suggested prompts	Sample student responses	Follow-up questions
What are some ideas you and your partner agreed on for what might be causing increased temperatures?	*We both said global warming.*	*Can you say more about what you mean when you say global warming?* *Did others include this? How did you describe what global warming is and how it explains increased temperatures?*
What other ideas did you have for what might cause an increase in temperatures?	*I said pollution, and my partner said greenhouse gases.*	*So, are you saying that the pollution and greenhouse gases are the same thing?* *Did anyone else talk about this in their model?* *How could pollution or greenhouse gases be causing an increase in temperatures?*
For those who included greenhouse gases or the greenhouse effect, can you tell us more about how that might cause temperatures to rise?	*I said they trap heat.* *I don't really know how, but it's like a greenhouse—the air gets trapped and warmed up.* *I just put it down, but I'm not really sure how; I know they say it is connected to climate change.* *I know carbon dioxide is a greenhouse gas—are there other ones?*	*Hmm...that's interesting—how could gases trap heat?* *So, I'm hearing that greenhouse gases might trap heat somehow, but we're not sure how or exactly what they are. How could we represent that?*
What other ideas did you have for what might cause an increase in temperatures?	*I said the sun is getting hotter, or we are getting more heat from the sun.* *I heard someone say that Earth is tilted differently than it used to be, so it's just getting hotter in some places.*	*Can you say more about that? Does this connect to any other ideas that people had?*
What other words have you heard or read about that come up when people are discussing that Earth is getting warmer?	*I heard about a hole in the ozone layer.* *I heard that methane is bad.*	*Can you say more about those?*

Say, *It seems as though we have a lot of ideas about what might be causing temperatures to increase, but we have a lot of gaps in our ability to explain how they work. We don't really know exactly how these things we have heard of could be causing the temperatures to rise. Perhaps we need to find some more information or data or do more investigations to figure this out!*

10 · INDIVIDUALLY GENERATE QUESTIONS

5 min

MATERIALS: 2 sticky notes, marker, science notebook

Prepare for the Driving Question Board. Display **slide W**. Remind students that we are going to try to capture all of our questions about what could be causing an increase in floods and droughts and an increase in temperatures. Explain to students that we can use our questions to guide our investigation into what is going on. To do this, we are going to build a Driving Question Board (DQB).✱

Prompt students to take out and review the following resources (in their science notebooks):

- noticings and wonderings from stories and headlines
- your initial model
- the initial class model

Discuss types of questions that can help us get to an explanation for our phenomena. Say, *We are really curious about what is causing temperature changes, how temperature changes cause floods and droughts, and how even air temperature could be related to water cycling processes. Let's think about how we can ask our questions to help us get to these explanations. What kinds of questions could help us get at the causes of all this stuff? What kinds of questions could help us answer how all of the things—even things that don't seem related—could be connected?*

Post question stems like the ones below to support students in asking causal questions or systems-related questions.

- How does ___ cause __ to happen?
- If we do ___, will ___ happen?
- How is this ___ in the system related to ___?
- What is happening with _____ to cause _____?

Using their resources, ask students to generate a list of questions that they have about what could cause increased temperatures and their link to droughts, floods, and other related phenomena.✱ Students should record their questions on sticky notes—one question per sticky note. They should write their questions so that they are big and bold and so that everyone can see the questions clearly.

✱ ATTENDING TO EQUITY

A DQB provides a public representation of the class's joint mission. Students can share their questions and wonderings with one another, and the visual representation offers another modality for students to access science in the classroom. The DQB should be centrally located in the classroom so that it can be referenced and added to throughout the unit.

✱ ATTENDING TO EQUITY

Supporting Emergent Multilingual Students: Asking questions in everyday language allows students to share their thinking or experiences, even if they do not have the appropriate scientific vocabulary yet. This is helpful for emergent multilingual students because, by not requiring scientific words at the onset, you do not limit their participation in classroom discourse.

ADDITIONAL GUIDANCE

It may be helpful to ask students to generate questions in rounds. For example, they could first generate a question about the floods and droughts and then generate questions about changing temperatures. This will encourage a range of questions across the model ideas.

ASSESSMENT OPPORTUNITY

Building towards: 1.C Ask questions that arise from initial observations of stories and headlines about rising temperatures, floods, and droughts to clarify whether increasing temperatures are related to or causing both floods and droughts.

What to look for: Look for questions that are open (how/why) and testable versus closed (yes/no) in the classroom. Also listen for questions that address both parts of our model.

What do to: Since students will put their initials on the backs of these sticky notes, you will have a few opportunities to take stock of the kinds of questions students ask in this initial lesson after they are posted on the DQB, as well as when they are writing them. When students share these questions for the DQB, they will likely only have time to share one. Collect the remaining questions that don't get posted after the development of the DQB is complete. If your students are asking mostly closed questions, you can provide a copy of a photo of the questions on the Driving Question Board, and ask them to work on refining three or more of these questions so that they become "how" and "why" questions that can help answer the original question posted, as well the original yes/no question. This could be an in-class or home-learning assignment.

11 · BUILD THE DRIVING QUESTION BOARD

20 min

MATERIALS: None

Instruct students to share their questions, one by one, with the whole group.✱ Display **slide X.** Explain to students how you will create the DQB:

- The first student reads his or her question aloud to the class, then posts it on the DQB.
- Students who are listening should raise their hands if they have a question that relates to the question that was just read aloud.
- The first student selects the next student whose hand is raised.
- The second student reads his or her question, says why or how it relates, and posts it near the question it most relates to on the DQB.
- The student selects the next student.
- Continue until everyone has at least one question on the DQB.

If the question is a new question and doesn't fit with any questions that are already on the board, students should create a new cluster.

Cluster the questions. After all students have shared their questions, you will end up with a DQB that has several different clusters of questions. As a class, decide on "umbrella" questions or topics for the clusters of questions.

After creating the DQB, discuss an overarching driving question. Say, *it seems like we have questions about how changes in things like temperature and amount of precipitation impact us and what we can do about it*. Suggest that we can add a broader question that our model and DQB are seeking to answer: How do changes in Earth's system impact our communities and what can we do about it?

✱ ATTENDING TO EQUITY

First and foremost during the formation of the DQB is reinforcing a classroom community wherein all ideas are valued and everyone has a question up on the board. Use your judgement on how to press students to form "how" and "why" questions. If a student struggles with sharing, encourage them to go public with questions rather than focusing specifically on forming a "how" or "why" question.

12 · BRAINSTORM IDEAS FOR DATA AND INFORMATION WE NEED

10 min

MATERIALS: science notebook, Driving Question Board, chart paper

Brainstorm ideas for data and information we need. Project **slide Y**. Now that the class has created a DQB, tell students that it is time to really dig into the hard work of figuring out what is going on! Stay in the Scientists Circle to brainstorm ideas for data and information we need. Ask students, *What kinds of information or data do we need to figure out the answers to our questions?*

Prompt students to use the categories of questions from the DQB to identify the data and information that would help them answer the category of question. Refer to the initial classroom consensus model and encourage students to also look at the areas where we have questions noted by question marks and think about what we could do to help us better understand these parts of our consensus model.

Have students turn and talk about their ideas before sharing out with the whole group. Assign each small group a category of questions. Once they have brainstormed for their assigned category, they can move on to the next.

Have small groups share out their ideas with the whole group. Make sure that all groups get to share at least a few ideas. Make a class record of the ideas for future investigations and data we need. Open it up at the end to allow other students to share additional ideas for other groups of questions. You may also want to prompt students to keep a record of our proposed investigations in their science notebooks.

Some examples are provided below:

Category of questions	Data and information that we need
What does pollution/greenhouse gases have to do with this?	Trap air in bottles/jars to see what changes it with certain gases? Make little greenhouses using plastic bags? Use a simulation.
What's happening with floods and droughts?	Look at other locations besides 2 videos—data and other videos?
What is happening with temperatures/global warming?	Look at temperature data over a really long period of time.

Say, *It seems like we have identified some areas that we think are changing. But what is changing? What is normal? How could we figure out what is normal for Porterville and Vicksburg, and if it is just in these places, or happening elsewhere?* Tell students we can pick up from there in the next class.

Additional Lesson 1 Teacher Guidance

SUPPORTING STUDENTS IN MAKING CONNECTIONS IN ELA	**CCSS.ELA-LITERACY.RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts.** On days 1 and 2, students analyze text in the form of headlines to find patterns in what is happening with floods and droughts in different locations and what might be causing them. **CCSS.ELA-Literacy.SL.6.1.c: Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.** When the class is building the Driving Question Board, if a student forgets to explain why or how their question is linked to someone else's question, press that student to try to talk through their own thinking. This is a key way to emphasize the importance of listening to and building off of one another's ideas and to help scaffold student thinking. If students can't figure out which question to connect their question to, encourage them to ask the class for help. After an idea is shared, ask the original presenter if there is agreement and why, and then post the question.