

Lesson 3.2

Reading "Climate Change Solutions"

SAMPLE



Lesson Overview

In "Climate Change Solutions," students read about two approaches to lessening the impact of climate change: (1) reduce the amount of carbon dioxide and methane added to the atmosphere, and (2) remove carbon dioxide and methane so they do not build up. Students use the Active Reading process, focus on summarizing, and then share their annotations with a peer. They revisit a statement from the anticipation guide, reflecting on their original responses, and add evidence to support their thinking. For homework, students investigate how forest cover affects carbon dioxide and temperature. The purpose of this lesson is for students to understand that human actions do change Earth's atmosphere and specific actions are being taken to reduce their negative impact on the Earth system.

Anchor Phenomenon: Ice on Earth is decreasing.

Design Problem: Design solutions to reduce climate change.

Students learn:

- Scientists (and others) are creating and implementing solutions to combat climate change.
- Humans can take actions in their daily lives to reduce the amount of carbon dioxide and methane in the atmosphere.

Earth's Changing Climate

Lesson Guides

Lesson 3.2



Lesson at a Glance

ACTIVITY

1

Warm-Up (5 min)

The Warm-Up serves both to activate students' prior knowledge and to prompt thinking about topics that will be covered in today's lesson.



WARM-UP

2

Active Reading: "Climate Change Solutions" (25 min)

Students read to find out about several solutions that are being proposed and implemented to combat climate change. The teacher uses this opportunity as an On-the-Fly Assessment of students' ability to engage with scientific texts and summarize main ideas.



READING

3

Discussing Annotations (10 min)

Students discuss their thinking about the reading in order to share important insights and/or correct misconceptions. The teacher uses the annotations collected at the end of this activity as an On-the-Fly Assessment.

STUDENT-TO-STUDENT
DISCUSSION

4

Revisiting the Anticipation Guide (5 min)

Students reflect on their own learning and write responses that show their current understanding about climate change.



CLASS

5

Homework

Students investigate the effect of forest cover on carbon dioxide and temperature.



HOMEWORK



Materials & Preparation

Materials

For the Class

- Claims charts* (from Lesson 3.1)
- Annotation Tracker*
- masking tape*

For Each Student

- optional: printed copies of the "Climate Change Solutions" article*
- optional: *Earth's Changing Climate* Investigation Notebook, pages 93–98*

Digital Tools

- "Climate Change Solutions" article in Amplify Library
- [Earth's Changing Climate Simulation](#)

*teacher provided

Preparation

Before the Day of the Lesson

1. **Preview the "Climate Change Solutions" article.** Read this article that focuses on describing possible solutions for removing or curtailing the amounts of carbon dioxide and methane in the atmosphere.
2. **Print a copy of the Annotation Tracker for each class.** A PDF file of the Annotation Tracker can be found in Digital Resources. Read the Annotation Tracker Instructions for more information, if needed.
3. **Prepare to model Active Reading.** You can use the think-aloud script that is provided in Activity 2, or you can modify the script, modeling in a way that makes the most sense for your students.



VOCABULARY

- atmosphere
- carbon dioxide
- climate
- climate change
- combustion
- energy
- fluctuation
- human activities
- methane
- stability
- temperature
- trend



UNPLUGGED?

Digital Devices Not Required

This lesson can be taught without devices. If students do not have access to devices, print copies of "Climate Change Solutions" and the Investigation Notebook pages for this lesson. (PDF files of both can be found in Digital Resources.)

If students do not have access to Amplify Science at home, adjust your schedule to make time to complete the Sim activity in class.

Earth's Changing Climate

Lesson Guides

Lesson 3.2 Brief



4. **Prepare for On-the-Fly Assessments.** There are two On-the-Fly Assessments included in this lesson. Activity 2 provides an opportunity to informally assess students' progress in engaging with scientific texts and summarizing main ideas. The end of Activity 3 provides an opportunity to informally assess students' attempts at annotating an article in the unit. Press the hummingbird icon and then select the ON-THE-FLY ASSESSMENT for details about what to look for and how you can use the information to maximize learning by all students.
5. **Review the Hands-On Flexension: Measuring Trees for Carbon Content and decide if you will teach it after this lesson.** The Flexension lesson guide and Flexension copymaster are available in Digital Resources.

Immediately Before the Lesson

1. **Post the Claims chart.** Post the Claims chart for your first class.
2. **List two solutions on the board.** Write "Kinds of Solutions" as a heading; underneath it write, "1. Produce less carbon dioxide and methane" and "2. Remove carbon dioxide and methane from the atmosphere".
3. **Have on hand the following materials:**
 - Annotation Trackers
 - additional Claims charts
 - masking tape
 - optional: digital devices
 - optional: printed copies of the "Climate Change Solutions" article
 - optional: *Earth's Changing Climate* Investigation Notebook, pages 93–98

Between-Class Prep

1. **Remove the Claims chart and post the version belonging to your next class.**
2. **Locate a new Annotation Tracker for your next class.**
3. **Erase digital annotations.** Erase the digital annotations you made in the Amplify Library article before modeling annotations for the next class.

**DIGITAL RESOURCES**

Climate Change Solutions

Printable article: "Climate Change Solutions"

Annotation Tracker Instructions

Annotation Tracker

Annotation Summary Sheet

Example Annotation Trackers and Summary Sheet

Active Reading Guidelines

Earth's Changing Climate Investigation Notebook, pages 93–98

Hands-On Flexension lesson guide: Measuring Trees for Carbon Content

Hands-On Flexension copymaster: Measuring Trees for Carbon Content

Earth's Changing Climate Glossary

Earth's Changing Climate Multi-Language Glossary



At the End of the Day

1. **Print a copy of the Annotation Summary Sheet for each class.** A PDF file of the Annotation Summary Sheet is in the Digital Resources.
 - **Use the Annotation Trackers to review students' submitted articles.** If you have time to review students' submitted articles and annotations, continue to fill out each Annotation Tracker to identify questions, alternate conceptions, and exemplary annotations.
 - **Use the Annotation Summary Sheets to analyze students' annotations.** The Annotation Summary Sheet is intended to help you identify trends in student thinking, recurring questions students have about the text, and other issues that you might want to address. Use your Annotation Trackers to fill out the Annotation Summary Sheets.
 - **Collect exemplary annotations and recurring alternate conceptions to share with the class.** Exemplary annotations and recurring alternate conceptions can be shared in the subsequent lesson. Identify examples of student annotations that are thought provoking, exemplify the Active Reading approach, and/or target key science ideas.

Differentiation

Embedded Supports for Diverse Learners

Explicit discussion of solution examples prior to reading. The article, "Climate Change Solutions," offers many examples of different ways that people can affect the amount of carbon dioxide (and methane) that gets into the atmosphere. One frame from which students can organize thinking about these solutions is by identifying the difference between solutions that work by keeping down the levels of these gases that enter the atmosphere and solutions that focus on capturing and "holding" these gases by natural and other means. The lesson is set up so the teacher identifies these as important solution categories before reading. This allows the teacher to do a bit of pre-teaching, and students a bit of pre-thinking. It also provides the supportive frame of these categories so students will have one way to consider each solution before reading.

Returning to a relevant Anticipation Guide statement after reading. The Anticipation Guide statement revisited in today's lesson is *Human actions cannot change Earth's atmosphere*. This revisit serves several supportive purposes. First, it provides an opportunity for all students to reflect on what they have learned that allows them to now respond to this prompt in an informed way and provides a confirmation of learning. Second, it is thematically meshed with the content of today's lesson, so students can use this as a way to further reflect on the content. Revisiting this particular anticipation guide statement at the end of this lesson is a small but supportive activity to help students see and respond to their own learning.



Potential Challenges in This Lesson

Making connections between different solutions when reading. The article offers students a brief view of several possible solutions for preventing too much carbon dioxide and methane from entering the atmosphere. Each solution by itself is fairly complex and reading about several solutions can be overwhelming. Students are supported in understanding how each solution is related by the conversations they have before and after the reading, and they are given the opportunity to read one solution more closely in the next lesson. Connecting and understanding each solution can be cognitively challenge despite these supports. You may want to consider other ways of supporting students, including some of suggestions offered under other headings in this section—Strategies for English Learners or Strategies for Students who Need More Support.

Specific Differentiation Strategies for English Learners

Use a graphic organizer to organize student thinking about solutions. Graphic organizers are a helpful way for English learners and other students who need more support to keep track of important ideas and organize their thinking. If you feel that some or all of your students would benefit from using a graphic organizer before or after reading. You may want to use a T-chart with one column headed, "Solutions that keep carbon dioxide or methane from being produced" and another, "Solutions that keep carbon dioxide or methane from entering the atmosphere."

Specific Differentiation Strategies for Students Who Need More Support

Read with a small group. With your guidance, you may want to have a small group of students read the beginning of the article (or throughout, if needed) together. One student can read aloud a paragraph as others in the group read along to themselves. After each paragraph, all students should stop to annotate. Depending on the group, you can have students discuss as they annotate to help them generate and summarize their ideas.

Specific Differentiation Strategies for Students Who Need More Challenge

Asking deeper questions and making broader connections. You could challenge students to create diagrams or visual representations of the climate change solutions in the article in order to demonstrate what they learned from the reading. Their visuals should show what they understand to be happening with gases involved, energy entering and exiting, energy absorbed by the surface, and temperature, based on the explanations presented in the article. Students could use the classroom wall as a reference for vocabulary words and concepts, as well as what they have seen in the Sim and Modeling Tools for a visual reference.



Standards

Key

Practices Disciplinary Core Ideas Crosscutting Concepts

3-D Statement

Students **ask questions and obtain information** as they read "Climate Change Solutions," an article about how **some human actions cause climate changes, and others reduce climate change** (cause and effect).

Next Generation Science Standards (NGSS)

NGSS Practices

- **Practice 1:** Asking Questions and Defining Problems
- **Practice 6:** Constructing Explanations and Designing Solutions
- **Practice 8:** Obtaining, Evaluating, and Communicating Information

NGSS Disciplinary Core Ideas

- **ESS3.C: Human Impacts on Earth Systems:**
 - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)
- **ESS3.C: Human Impacts on Earth Systems:**
 - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3),(MS-ESS3-4)
- **ESS3.D: Global Climate Change:**
 - Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)

NGSS Crosscutting Concepts

- Cause and Effect

**Common Core State Standards for English Language Arts (CCSS-ELA)**

- **CCSS.ELA-LITERACY.RST.6-8.1:** Cite specific textual evidence to support analysis of science and technical texts.
- **CCSS.ELA-LITERACY.RST.6-8.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics
- **CCSS.ELA-LITERACY.CCRA.SL.4:** Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience
- **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.WHST.6-8.9:** Draw evidence from informational texts to support analysis, reflection, and research

Common Core State Standards for Mathematics (CCSS-Math)**CCSS-Math Practices**

- **CCSS.MATH.PRACTICE.MP1:** Make sense of problems and persevere in solving them.
- **CCSS.MATH.PRACTICE.MP2:** Reason abstractly and quantitatively.
- **CCSS.MATH.PRACTICE.MP4:** Model with mathematics.
- **CCSS.MATH.PRACTICE.MP5:** Use appropriate tools strategically.
- **CCSS.MATH.PRACTICE.MP7:** Look for and make use of structure.

CCSS-Math Content

- **CCSS.MATH.CONTENT.6.RP.3:** Use ratio and rate reasoning to solve real-world and mathematical problems.
- **CCSS.MATH.CONTENT.6.SP.5:** Summarize numerical data sets in relation to their context.
- **CCSS.MATH.CONTENT.7.RP.2:** Recognize and represent proportional relationships between quantities.
- **CCSS.MATH.CONTENT.7.RP.2a:** Decide whether two quantities are in a proportional relationship.



1

WARM-UP
Warm-Up

Warm-Up

This Warm-Up provides students with a first opportunity to think about possible solutions for combatting climate change.



Instructional Guide

1. Project Warm-Up; students work independently. Collapse the instructional guide and project the student screen, or have students turn to page 94 in their Investigation Notebooks. Allow a few minutes for students to individually respond to the Warm-Up.

Teacher Support

Rationale

Pedagogical Goal: Why Request Student Ideas Before Reading?

Asking students to share their initial thoughts provides an opportunity for them to think through earlier ideas they may have considered as they participated in Lesson 3.1. It's also a chance to connect ideas they have heard outside class—from the media, their parents, etc.—to unit content. Finally, this prompt also prepares students for the content of today's lesson.

Possible Responses

What are your ideas about how humans can reduce the amount of carbon dioxide and methane they add to the atmosphere?

Humans can reduce the amount of carbon dioxide and methane we add to the atmosphere by driving less, getting more fuel-efficient vehicles, and also by eating less meat.



2

READING

Active Reading: "Climate
Change Solutions"


Active Reading: "Climate Change Solutions"



Students are introduced to and read the article, "Climate Change Solutions."

Instructional Guide

1. Review students' climate change evidence. Point to the Claims chart and the newly posted key concept, and acknowledge the evidence that students have gathered about one cause of our current climate change.

 We started this unit by making claims about why temperatures were increasing and ice was melting. We have gathered a lot of evidence suggesting that increasing carbon dioxide and methane are causing the temperature to increase. In the previous lesson, we found evidence that carbon dioxide and methane in the atmosphere are increasing as a result of human activities.

2. Introduce focus of next two lessons. Explain to students that after identifying a cause, they will now try to figure out what can be done to stop the increase of carbon dioxide and methane.



3. Project each prompt and hold a short, paired discussion. Introduce the paired discussion routine as a way to prepare for today's reading. Project one prompt at a time, have students discuss in pairs, and then share with the class, before moving to the next prompt.

- **Prompt 1:** When talking about climate change, what does the term *human activities* mean? [Things people do that affect the Earth system.]

When talking about climate change, what does the term *human activities* mean?

- **Prompt 2:** What kinds of human activities lead to more carbon dioxide and methane in the atmosphere? [Combustion for activities like driving cars and producing energy and keeping livestock.]


What kinds of *human activities* lead to more carbon dioxide and methane in the atmosphere?



- **Prompt 3:** Why do increasing levels of carbon dioxide and methane cause the Earth system to become warmer over time? [Students should use ideas about energy entering and exiting, redirection of energy, and absorption.]

Why do increasing levels of carbon dioxide and methane cause the Earth system to become warmer over time?


4. Point out the two solution categories on the board. Explain that students will find these two kinds of solutions in the article.

 You will be reading about two different approaches to reducing the amount of carbon dioxide and methane in the atmosphere. One way is to stop making so much carbon dioxide and methane. Another way is to remove carbon dioxide or methane that has already been produced. The different solutions you will read about fall into one of these two categories.

5. Share and categorize Warm-Up ideas. Have students think through these two approaches by asking them to briefly discuss the solutions they proposed in the Warm-Up and share them with a peer. Then ask several student pairs to share with the class.


6. Model Active Reading with a special emphasis on summarizing. Project "[Climate Change Solutions](#)" in the Amplify Library, or project the printed article using a document camera. Point out the Active Reading Guidelines on the classroom wall or on page 95 in the Investigation Notebook. Tell the class that you will think aloud as you read the introduction. Remind students that in this unit they are focusing on summarizing, and you would like them to summarize their thinking as they read, as well as using all the other strategies they have been practicing this year. The outline that follows is one suggestion for modeling; you may adapt it to your own process.

- **Read the title and first paragraph, make a connection, and ask a question.**


 I know a lot about how carbon dioxide works to warm the Earth system. I remember when I used the Sim yesterday, I saw that combustion, or burning fuels, caused the temperature to increase. I will write a connection about that. I also have a question—so far it hasn't mentioned methane as a source, but we have been studying that gas. I'll write a question about that, too.



- Add a note near the first paragraph, and type or write, "Combustion in the Sim showed this."
- Add another note near the first paragraph, and type or write, "What about methane?"
- Read the second paragraph.

 This paragraph is a lot of review for me because these are ideas we have been learning over the last few weeks. I want to remember what this paragraph says, so this is a good place to write a short summary statement. Later, when I go back and read my summary, it will remind me what this paragraph was about.

- Add a note near the second paragraph and type or write, "Carbon dioxide redirects energy back toward Earth's surface, which causes it to become warmer."
- Read the final paragraph.

 There was one phrase in here that I'm not sure about. What does it mean to "capture" carbon dioxide? What does that word mean here? I know it means to grab or take something away, but does it mean the same thing here? I am going to make a note about that. I am also going to summarize this paragraph, so I can remember what it says.

- Add a note near the last paragraph and type or write, "What does capture mean here?"
- Add another note near the last paragraph and type or write the summary, "There are solutions that scientists and others have proposed for decreasing carbon dioxide in the atmosphere."

7. Discuss when to summarize. Remind students that not every paragraph needs a summary. Sometimes two or more paragraphs together will make up an important idea that needs to be summarized. It is a personal choice, based on when you think an especially important idea is presented that you want to note. Tell students that you won't require them to summarize every paragraph, but you would like to have them try to use this strategy at least one or two times while reading today. Students should also continue to use the other strategies they have been practicing all year.

8. Prompt students to read and annotate while you circulate with the Annotation Tracker. Use the Annotation Tracker to record annotations that you would like to invite students to share during the class discussion.

9. On-the-Fly Assessment: Summarizing Main Ideas from the Text. For further suggestions on how to support student annotations as you circulate, press the hummingbird icon and select ON-THE-FLY ASSESSMENT 12.

 Embedded Formative Assessment**On-the-Fly Assessment 12: More Practice with Summarizing Main Ideas in the Text**

Look for: This reading lesson is an opportunity to check on students' progress with summarizing main ideas, as modeled in Lesson 2.2 and at the beginning of this lesson. As with all reading lessons, students should annotate in those unique ways that are helpful to each individual student's learning and personal style. Look for students to be actively engaged in the reading and annotation process. They may be making a wide range of annotations that reflect their varying levels of science understanding, and that is fine. Go over student annotations that pertain to the summarizing of main ideas and have the following questions in mind as you check their work:

- Are students attempting to summarize multiple paragraphs in the text?
- Do these summaries capture the main ideas, or do they include peripheral ideas?
- Are students attempting to use simpler phrases and their own words, rather than copying entire chunks of text?

Now what? This reading experience is intended to be a space for students to have a personal conversation with a text, but some students may need support identifying and summarizing main ideas in the text. Consider periodically reading an exemplary annotation aloud. Provide positive, encouraging feedback about why this annotation is a good example of Active Reading. You can also offer general prompts to support deeper engagement, such as "What questions do you have about this [illustration, paragraph, photograph]? Were there any words or phrases that were confusing to you? Was there something in this text that caused you to wonder or have a question? If so, what?" To support students as they identify and summarize main ideas, you may want to prompt them with questions such as, "Which parts of this paragraph seem the most important to you?" or "Is there a simpler way that you can express this specific idea?" If students who are more familiar with annotating and summarizing during reading are copying long, complex sentences directly from the text instead of writing concise summarizing statements, challenge them to write a summary without looking back at the text. You might also challenge them to summarize a paragraph in the fewest words possible, which may motivate students to use their own words rather than copying directly from the text.

Teacher Support

Background**Science Note: About Photosynthesis and Carbon Dioxide**

Trees, as well as other plants and algae, take carbon dioxide out of the atmosphere as part of the process of photosynthesis. These organisms use energy from sunlight to power the process of photosynthesis in which carbon dioxide and water react to produce carbohydrate molecules, such as glucose. The more photosynthesis that occurs in Earth's biosphere, the more carbon dioxide gets removed from the atmosphere. When these photosynthetic organisms die, however, they are digested by microorganisms that digest the carbohydrate molecules in the organisms and release carbon dioxide back to the atmosphere. Trees are both larger and longer lived than most other photosynthetic organisms. Because they are large they take in and hold more carbon dioxide, and because they are long-lived they keep the carbon dioxide out of the atmosphere for longer than small plants and algae do. For this reason, forests have



an important effect on the amount of carbon dioxide in the atmosphere. If your students have studied photosynthesis (for example in the Amplify Science unit *Matter and Energy in Ecosystems*) this would be an excellent opportunity to ask them to make a connection to this concept.

Background

Science Note: About Gas Capture (Carbon Sequestration)

There are several technologies that capture carbon dioxide or methane at sources, including many technologies that are very new, or still under development. They all involve two steps: first, capture the carbon dioxide or methane, usually with some kind of filter, and second, dispose of the captured gas. Captured carbon dioxide is usually reacted with another substance to form a solid that can be buried. Captured methane is often burned as a fuel. This, of course, leads to carbon dioxide being released to the atmosphere, but is still a net gain since on a per-molecule basis, methane has a much bigger effect on energy and temperature than does carbon dioxide. These gas-capture technologies are most effective where there is one large stationary source, such as a fossil-fuel burning power plant (carbon dioxide) or a landfill (methane). This solution would be much more difficult to implement for smaller mobile sources such as cars (carbon dioxide) or cattle (methane). These technologies are often referred to as carbon sequestration, even though methane can be involved as well.

Background

Science Note: About Solar Power

Most solar power generates electrical energy by converting solar energy (light energy) into potential energy that is stored in a battery, which can then be converted into electrical energy. Solar power technology has improved dramatically in recent years, making it much more efficient and much cheaper. To replace the electrical energy generated from fossil fuel combustion with electrical energy generated from solar power will require significant improvements in battery technology so we are better able to store this energy as potential energy. This will allow people to rely on solar power even during times with less sunlight in their area, such as cloudy days or winter.

Background

Science Note: About the Carbon Cycle

The investigation of human-influenced processes that add and subtract carbon dioxide and methane to and from the atmosphere is related to the study of the carbon cycle. The carbon cycle is a focus in the NGSS high school standards, and what students learn in this unit should help prepare them for that later learning. If your students have studied chemical reactions and/or an introduction to the carbon cycle, you could help them make connections to those concepts here.



3

STUDENT-TO-STUDENT
DISCUSSION

Discussing Annotations

Discussing Annotations



Students share annotations with their peers and revisit the summarizing strategy.

Instructional Guide

1. Project and review Discussing Annotations. Collapse this instructional guide and project the student screen. Prompt students to choose one or two annotations they'd like to share with a partner. Guide students to select a question or connection since sharing their personal summaries won't spark much student-to-student discussion. Explain that in order to edit an annotation as one to share, students should press EDIT and write "#share." If students are not using digital devices, they can indicate which annotations they want to share by writing directly on their printed copies.

2. Partners discuss annotations. Ask students to update the tags in their shared annotations to "#discussed" if they feel that their partner discussions gave them a deeper meaning of their annotations or if they answered their tagged questions. After a few minutes, ask students to choose an annotation they would like to share or discuss with the whole class. Explain that these can be the same annotations they shared with their partners if the questions are still unresolved. Ask students to tag the annotations they would like to share with the class by pressing EDIT and writing "#present," or if students are not using digital devices, they can indicate which annotations they want to share by writing directly on their printed copies. Circulate and listen for annotations that would be appropriate for a class discussion.

3. Discuss a few student annotations with the class. Try to have students share questions or ideas that are helpful for supporting deeper content learning or surfacing alternate conceptions of the content.

4. Focus on the strategy of summarizing. If you noticed a particular student summary that you would like to acknowledge, use this opportunity to share that student's work. Ask her to explain how she created the summary, what kinds of thoughts went into making it, etc. If you didn't choose one ahead of time, ask for student volunteers to share what they did and follow the same procedure.

5. Reflect on the utility of summarizing while reading. Ask students whether or not they think this is a useful strategy and how or why it is (or is not) useful. Acknowledge that summarizing can slow you down and interfere with the flow of reading, but for difficult texts, such as science texts, it is often very helpful to employ this strategy.



6. On-the-Fly Assessment: Insight from Student Annotations. For further suggestions on how to review student annotations, press the hummingbird icon and select ON-THE-FLY ASSESSMENT 13.

Remind students to press NEXT (or return to page 95 in the Investigation Notebook) to continue this activity.

10. Prompt students to review their annotations on their digital devices and submit their annotated articles. On each student's screen, the "Climate Change Solutions" article and the annotations that each student made in the Amplify Library should be visible. Students should submit their articles by pressing HAND IN. If students are not using digital devices, they can answer the reflection question on page 95 in the Investigation Notebook.



Embedded Formative Assessment

On-the-Fly Assessment 13: Insight from Student Annotations

Look for: Review submitted student annotations after class. You can use these annotations to assess students' annotation skills, reading comprehension, and content understanding. Use the Annotation Tracker and Annotation Tracker Instructions for guidance.

Now what? See the Annotation Tracker Instructions for suggestions on how to further support students.

Teacher Support

Instructional Suggestion

Literacy Note: Discussing Student Summaries

Students respond well to examples provided by their peers. This is especially true for student examples of connections, questions, and finding difficult vocabulary in the text, but can be less true for examples of summaries. Questions, connections and vocabulary bring in a personal tie, which makes them more interesting to peers, while summaries ask students to restate the text in a simpler way, which isn't as exciting. However, if your goal is to more deeply engage students in thinking about how to come up with better summaries, it is often more useful to use student examples than it might be to show a manufactured summary from an unknown author. If you want to engage students in discussions about how to make decisions about what to include in a summary, what the purposes of written summaries are, and what a good summary might look like for a particular piece of text, you may want to take time to examine student summaries after class and request permission to share exemplary work. As those students share, they can explain their goals and what they were thinking as they created their summaries. Student-modeled think-alouds can be extremely helpful exemplars for their peers.



4

CLASS

Revisiting the Anticipation
Guide

Revisiting the Anticipation Guide



Students reflect on their thinking about human activities and Earth's atmosphere by revisiting a statement in the Anticipation Guide.

Instructional Guide

1. Project Anticipation Guide. Remind students that they completed this on the first day of the unit, based on what they knew then. Acknowledge their learning, and urge them to celebrate changing a response from agree to disagree or disagree to agree. This means that they not only learned something, but learned enough to be able to explain why their thinking has changed.

1. Earth's atmosphere is made of different gases that can affect Earth's climate in different ways.	2. Climate has to do with how much energy is in the Earth system.
<input type="text"/>	<input type="text"/>
3. Earth's atmosphere does not change.	4. There have been times in the past when Earth's climate was very different.
<input type="text"/>	<input type="text"/>
5. Energy from the sun that enters the Earth system does not leave.	6. It is possible for gases in the atmosphere to change the behavior of energy on Earth.
<input type="text"/>	<input type="text"/>
7. Human actions cannot change Earth's atmosphere.	8. Human actions can lead to a decrease in Earth's temperature.
<input type="text"/>	<input type="text"/>

2. Focus on highlighted statement. Read the statement aloud and suggest that information in the article, "Climate Change Solutions," might help them decide if they now agree or disagree with this statement. Remind students that they can consider this a claim, and they should use evidence from the text or other classroom activities to explain why they agree or disagree with this statement.



3. **Project directions.** Ask students to follow these directions when discussing.

Directions

1. Review your original response to this statement. Did you **agree** or **disagree**?
2. Change your response if you think differently now.
3. Discuss with a partner why you now agree or disagree with this claim. Use evidence from the text as you explain your thinking.

4. **Provide time for students to discuss the statement and record their current thinking.** As students discuss and complete the activities on their devices or on page 96 in the Investigation Notebook, remind them that they can change their responses, but no matter what, they need to record the evidence that supports their newest thinking about the claim.

5. **Point out the homework, a Sim investigation focused on how forest cover affects the atmosphere (Activity 5 or pages 97–98 in the Investigation Notebook).** If students do not have access to Amplify Science at home, adjust your schedule to make time to complete the Sim activity in class.

Teacher Support

Rationale

Pedagogical Goals: Revisiting Anticipation Guide

Students are encouraged to revisit their initial responses from early in the unit as way to reflect on their learning. Based on what they have learned, students may find that some of their original responses can be changed, modified, or strengthened with the addition of evidence to support their thinking. You can tell students that this habit of reflecting on ideas and gathering evidence to support or refute them is one way that learning happens. Remind students that having to change, modify or strengthen a response does not necessarily mean they were wrong; instead, it shows they have learned.



Possible Responses

Answers will vary.

SAMPLE



5

HOMEWORK

Homework



Homework

For homework, students investigate forest cover and how it affects carbon dioxide and temperature.

Instructional Guide

1. If needed, make additional time to explain the homework. If students do not have access to Amplify Science at home, adjust your schedule to make time to complete the Sim activity in class.

Possible Responses

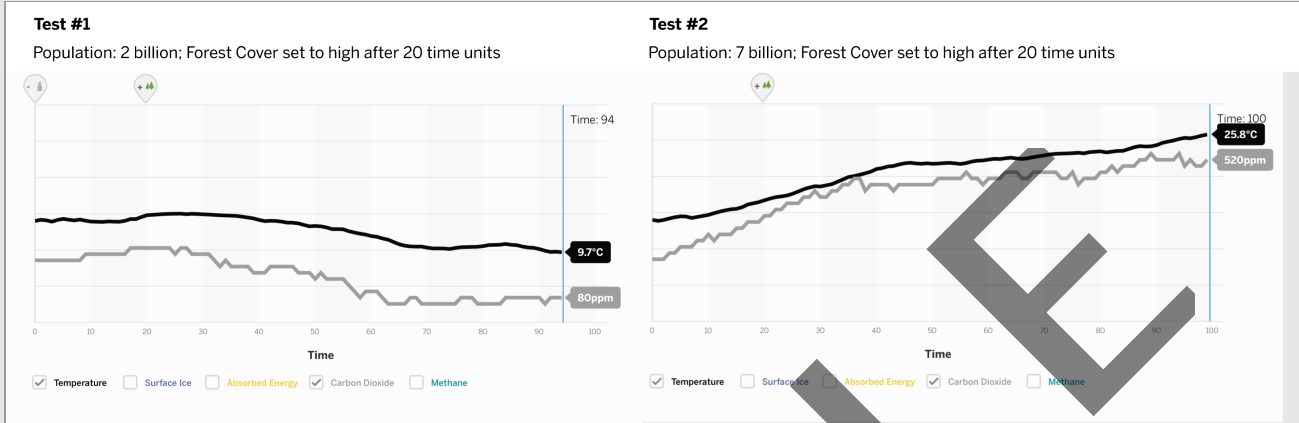
What students should do and notice in the Sim:

First, students predict what happens to carbon dioxide levels when the amount of forest cover increases. After that, they run two tests:

1. Decrease population to 2 billion; increase Forest Cover to High after 20 time units.
2. Keep population at 7 billion; increase Forest Cover to High after 20 time units.

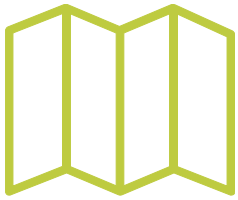
In the first test, students will observe a decrease in the amount of carbon dioxide, which results in a decrease in temperature. In the second test, students will observe that, despite increasing the amount of forest cover, temperature still increases. This is because even a high amount of forest cover is not sufficient to prevent carbon dioxide levels and temperature from increasing with a population of 7 billion people continuing the same level of combustion per person.

The image shows two possible student tests.



SAMPLE

SAMPLE



Lesson 3.3

Explaining Possible Solutions

SAMPLE



Lesson Overview

Students investigate how people might be able to reduce the amount of carbon dioxide and methane in the atmosphere. Students focus on one of the solutions presented in the article "Climate Change Solutions." They apply their understanding of unit concepts to make sense of the selected solution: what it is, why it is needed, how it works, and whether or not it is a good idea. Students share what they learned with a partner, before modeling their solution in the Modeling Tool. These activities serve to prepare students for the homework, which is a written explanation of the solution and its effect on climate. The purpose of this lesson is to allow students to use what they learned and share their understanding of how people can combat climate change.

Anchor Phenomenon: Ice on Earth is decreasing.

Design Problem: Design solutions to reduce climate change

Students learn:

- Some ways to stop the increase of carbon dioxide and methane include decreasing combustion and removing these gases from the atmosphere.
- Humans can take actions in their daily lives that will reduce the amount of carbon dioxide and methane in the atmosphere.

Earth's Changing Climate

Lesson Guides

Lesson 3.3



Lesson at a Glance

ACTIVITY

1

Warm-Up (5 min)

Students consider how more combustion or less combustion affects carbon dioxide and temperature.



WARM-UP

2

Rereading About One Solution (20 min)

Students focus their reading on one solution in order to gain a thorough understanding of why that solution is needed and how it works so they are able to construct and model an explanation. This On-the-Fly Assessment gauges students' understanding of the relationship between human activity and climate change and students' progress in constructing explanations.



READING

3

Modeling One Solution (20 min)

Students model their climate change solutions, making the model as complete as possible by using all the concepts they have learned. This On-the-Fly Assessment gauges students' ability to model how human activities can lead to lowering the global average temperature.

MODELING
TOOL

4

Stable Temperature in the Sim (optional)

Students apply their understanding of stability and change and of the effects of human activities on climate by taking on the challenge of keeping temperatures stable in the Sim.



SIM

5

Homework

Students write a blog post for the head climatologist that explains both the solution and its effect on the atmosphere. Students also read an article that describes how people are preparing for a future with higher ocean levels.



HOMEWORK

6

Self-Assessment (Optional)

Students check their understanding of key content in the unit and reflect on any additional questions they have about climate change.



HOMEWORK



Materials & Preparation

Materials

For the Classroom Wall

- key concept: *Some ways to stop the increase of carbon dioxide and methane include decreasing combustion and removing these gases from the atmosphere.*
- key concept: *Humans can take actions in their daily lives that will reduce the amount of carbon dioxide and methane in the atmosphere.*

For the Class

- masking tape*

For Each Student

- optional: printed copy of "Climate Change Solutions" article*
- optional: printed copy of "What Are We Doing About Sea Level Rise?" article*
- optional: *Earth's Changing Climate* Investigation Notebook, pages 99–106*

Digital Tools

- "[Climate Change Solutions](#)" article in Amplify Library
- *Earth's Changing Climate* Modeling Tool activity: [Climate Change Solution](#)
- [Earth's Changing Climate Simulation](#)
- "[What Are We Doing About Sea Level Rise?](#)" article in Amplify Library

*teacher provided

VOCABULARY

- atmosphere
- carbon dioxide
- change
- claim
- climate
- climate change
- combustion
- energy
- evidence
- human activities
- methane
- stability
- temperature

UNPLUGGED?

Digital Devices Required

It is highly recommended that students have access to digital devices for this lesson. If students do not have individual devices, print copies of the Investigation Notebook pages for this lesson and have students complete the Modeling Tool and Simulation activities in

Earth's Changing Climate

Lesson Guides

Lesson 3.3 Brief



Preparation

Before the Day of the Lesson

1. Gather the following items for the classroom wall:

- key concept: *Some ways to stop the increase of carbon dioxide and methane include decreasing combustion and removing these gases from the atmosphere.*
- key concept: *Humans can take actions in their daily lives that will reduce the amount of carbon dioxide and methane in the atmosphere.*

2. **Choose student annotations to share.** Use your completed Annotation Trackers and Annotation Summary Sheets from Lesson 3.2 to identify exemplary annotations that you will share in Activity 2.

3. **Review the purpose of the second read of "Climate Change Solutions."** Students reread sections of this article in Activity 2.

4. **Familiarize yourself with the *Earth's Changing Climate Modeling Tool* activity: *Climate Change Solution*.** Students complete models in Activity 3.

5. **Review the *Earth's Changing Climate Simulation* activity in this lesson.** Students use the Sim in Activity 4 of this lesson. Note that this activity is optional.

6. **Preview the "What Are We Doing About Sea Level Rise?" article.** Locate and read the article in Digital Resources or the Amplify Library. Students will read the article for homework.

7. **Prepare for On-the-Fly Assessments.** This lesson includes two On-the-Fly Assessments. In Activity 2, you can gauge students' understanding of the influence of human activity on climate and assess students' progress with the practice of constructing explanations. In Activity 3, you have the opportunity to evaluate individual student understanding of how human activities can decrease the amount of carbon dioxide or methane in the air, and what effect this will have on the climate. Press the hummingbird icon on the menu bar and select ON-THE-FLY ASSESSMENT for details about what to look for and how you can use the information to maximize learning by all students.

pairs. (PDF files of the article and Investigation Notebook pages can be found in Digital Resources.)

If students do not have access to Amplify Science at home, provide them with copies of pages 104–106 from the Investigation Notebook and copies of the "What Are We Doing About Sea Level Rise?" article for homework.

 DIGITAL RESOURCES

Climate Change Solutions

Printable article: "Climate Change Solutions"

What Are We Doing About Sea Level Rise?

Printable article: "What Are We Doing About Sea Level Rise?"

Earth's Changing Climate Investigation Notebook, pages 99–106

Earth's Changing Climate Glossary

Earth's Changing Climate Multi-Language Glossary

Immediately Before the Lesson

1. **Write discussion instructions on the board.** Write, "When you share with your partner, be sure to include the following:



- what the solution is
- why it is needed
- how the solution works
- whether you think it is a good solution or not"

2. **Have on hand the following materials:**

- digital devices
- optional: printed copies of "Climate Change Solutions" article
- optional: printed copies of "What Are We Doing About Sea Level Rise?" article
- optional: *Earth's Changing Climate* Investigation Notebook, pages 99–106

At the End of the Day

1. **Post the following key concepts to the wall:**

- *Some ways to stop the increase of carbon dioxide and methane include decreasing combustion and removing these gases from the atmosphere.*
- *Humans can take actions in their daily lives that will reduce the amount of carbon dioxide and methane in the atmosphere.*

Differentiation

Embedded Supports for Diverse Learners

Reading and discussing before modeling and writing. Students are expected to create a model of one solution and then to write an accompanying explanation of the model and solution as well. To support success in creating an accurate, thoughtful model and written explanation, students are guided through a focused second read about one of the solutions, using embedded textual questions. They then discuss and explain the solution with a partner. This work earlier in the lesson helps to prepare students to complete the final model and report.

Potential Challenges in This Lesson

Complex activities and thinking. Although students have had a lot of experience with the content that is required to complete today's activities, the work that they are asked to do requires thoughtful and careful reading, focused discussion and modeling that is complex. Some students may need adjustments to the workload or more time to complete these activities.

Earth's Changing Climate

Lesson Guides

Lesson 3.3 Brief

**Specific Differentiation Strategies for English Learners**

Discussion time during reading. During the reading activity, English learners might benefit from a partner or small-group discussion of the information presented in "Climate Change Solutions" and how it connects to concepts from the unit. This would be especially helpful in this lesson because students are required to become very familiar with the details of one particular climate change solution. They then connect this new information to all that they have learned in this unit in order to explain this solution orally to a partner as well as in writing. This additional discussion time as they read will help students develop a better understanding of the new information and how to relate it to other concepts. Providing this support early in the lesson prepares English learners for the rest of the activities and sets them up for success in subsequent discussion, modeling, and independent writing.

Graphic organizers. If your English learners have found graphic organizers to be helpful, including one in this lesson may support some English learners as they make sense of information presented in the reading and begin to construct their explanation of the climate change solution. For this activity, the Bubble Concept Map is a good choice. In the center, have students write the name of their climate change solution. Next, have them answer each of the four guiding questions in the remaining bubbles: (1) Adds less gas OR Takes out gas, (2) Why do we need it?, (3) How does it work?, (4) Is it a good idea? WHY? After answering the questions, it might also be a good idea to give students the vocabulary that will be used in the blog post and have them add these words to their concept maps. This completed graphic organizer will help students prepare for the partner discussion as well as to write their blog post.

Specific Differentiation Strategies for Students Who Need More Support

Synthesis across several complex activities. This lesson is meant to help students use what they have learned to develop an understanding of how people can reduce carbon dioxide and methane in the atmosphere. This understanding is maximized when students are able to synthesize the content learning from the entire unit. In order for students to be successful in this synthesis across all the activities—reading, discussion, Modeling Tool, and blog post writing—different students may require support in order to engage fully or make connections. If you think that any one of these activities or the connection from one to the next might pose a challenge to your students, you might want to consider explicitly supporting those activities. For example, if the content in "Climate Change Solutions" would be more accessible to students if they were able to model as they read, you might ask them to read and use the Modeling Tool simultaneously (with guidance), moving back and forth between the two so they can draw meaning from one and apply it to the other. Similarly, just as students are using the Modeling Tool as a visual to support the partner discussion, they could also use it as a support for their writing.

Specific Differentiation Strategies for Students Who Need More Challenge

Create additional models. Students who need more challenge should model more than one climate change solution. Modeling additional solutions will require these students to read in detail about multiple solutions, understand the specifics, and create Before Change and After Change panels for each. After modeling multiple solutions, students could compare and contrast the solutions.



Standards

Key

Practices Disciplinary Core Ideas Crosscutting Concepts

3-D Statement

Students construct visual models and make explanations to communicate how one action to reduce climate change would affect gases in the atmosphere (cause and effect) and energy flow into and out of the Earth system (stability and change, energy and matter).

Next Generation Science Standards (NGSS)

NGSS Practices

- **Practice 2:** Developing and Using Models
- **Practice 6:** Constructing Explanations and Designing Solutions
- **Practice 8:** Obtaining, Evaluating, and Communicating Information

NGSS Disciplinary Core Ideas

- **ESS3.C: Human Impacts on Earth Systems:**
 - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)
- **ESS3.C: Human Impacts on Earth Systems:**
 - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3),(MS-ESS3-4)
- **ESS3.D: Global Climate Change:**
 - Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)

NGSS Crosscutting Concepts

Earth's Changing Climate

Lesson Guides

Lesson 3.3 Brief



- Stability and Change
- Cause and Effect
- Energy and Matter

Common Core State Standards for English Language Arts (CCSS-ELA)

- **CCSS.ELA-LITERACY.RST.6-8.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics
- **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.CCRA.SL.2:** Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally
- **CCSS.ELA-LITERACY.RST.6-8.1:** Cite specific textual evidence to support analysis of science and technical texts.
- **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.6-8.9:** Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic
- **CCSS.ELA-LITERACY.WHST.6-8.9:** Draw evidence from informational texts to support analysis, reflection, and research

Common Core State Standards for Mathematics (CCSS-Math)**CCSS-Math Practices**

- **CCSS.MATH.PRACTICE.MP1:** Make sense of problems and persevere in solving them.
- **CCSS.MATH.PRACTICE.MP2:** Reason abstractly and quantitatively.
- **CCSS.MATH.PRACTICE.MP3:** Construct viable arguments and critique the reasoning of others.
- **CCSS.MATH.PRACTICE.MP4:** Model with mathematics.
- **CCSS.MATH.PRACTICE.MP5:** Use appropriate tools strategically.
- **CCSS.MATH.PRACTICE.MP6:** Attend to precision.
- **CCSS.MATH.PRACTICE.MP7:** Look for and make use of structure.

CCSS-Math Content



- **CCSS.MATH.CONTENT.6.RP.3:** Use ratio and rate reasoning to solve real-world and mathematical problems.
- **CCSS.MATH.CONTENT.6.SP.5:** Summarize numerical data sets in relation to their context.
- **CCSS.MATH.CONTENT.7.RP.2:** Recognize and represent proportional relationships between quantities.

SAMPLE



1

WARM-UP
Warm-Up

Warm-Up

Students differentiate between two graphs of carbon dioxide and temperature: one represents medium combustion, the other represents high combustion.



Instructional Guide

1. Project Warm-Up; students work independently. Collapse the instructional guide and project the student screen, or have students turn to page 100 in their Investigation Notebooks. Allow a few minutes for students to individually respond to the Warm-Up.

Possible Responses

Explain how you knew which graph was which.

The first graph shows high combustion and the second graph shows medium combustion. I knew this because combustion produces carbon dioxide so if there is more combustion there would be more carbon dioxide. The first graph shows more carbon dioxide.



2

READING

Rereading About One
Solution

Rereading About One Solution




Students reread one section of the article, "Climate Change Solutions," focusing on one solution and sharing what they read with another student.

Instructional Guide

1. Share selected annotations from the previous lesson. Compliment students on the careful reading they did in the previous lesson. Show and discuss several exemplary annotations that demonstrate thoughtfulness or creativity.

2. Introduce the second-read activity. Explain that this is a partner activity. Each partner will choose one solution from the article, but not the same solution. Both partners will answer questions and take notes as they read. Afterward, they will share their thoughts and information about their solutions with their partners.

3. Preview upcoming activities. After reading and sharing their ideas with a partner, they will be creating a blog post that includes a model of the solution (using the Modeling Tool) and a short explanation about why this solution works. The second-read activity will help prepare them to do this.

 Your job will be to become very familiar with one solution. You will be able to explain why the solution is needed and what the solution does to help reduce carbon dioxide or methane in the atmosphere.

4. Direct pairs to select their solutions. Have pairs discuss which solutions to reread. Make sure students know that partners should choose different solutions.

5. Provide students with time to read and answer questions. If students are not using digital devices, have them answer the questions on page 101 in the Investigation Notebook.

6. Regain students' attention and give sharing instructions. Refer to the discussion instructions written on the board. Explain that the questions they answered are a reference. As they share with their partners, they can look back to be sure they've responded thoroughly to all the items:

- what the solution is
- why it is needed
- how the solution works

Earth's Changing Climate

Lesson Guides


Lesson 3.3
Activity 2

- whether you think it is a good solution or not

7. On-the-Fly Assessment: Investigating Solutions to Climate Change. As partners discuss the solutions they read about, listen to their conversations. For ideas about what to listen for, press the hummingbird icon and select ON-THE-FLY ASSESSMENT 14.

8. Relate solutions to the Chapter 3 Question. Review the Chapter 3 Question by reading it aloud: *What can be done to stop the carbon dioxide and methane in Earth's atmosphere from increasing?* Call on volunteers to explain specific ways that the increase in carbon dioxide and methane can be stopped; encourage them to use their experiences with the Sim and their reading as evidence. [Decreasing combustion. Decreasing livestock. Decreasing population. Increasing forest.]

9. Emphasize limits of science knowledge.

 Science knowledge about climate change can help us predict the effects of making or not making these kinds of changes. But science knowledge doesn't actually make the decisions for us about what to do about climate change.

 Embedded Formative Assessment

On-the-Fly Assessment 14: Investigating Solutions to Climate Change

Look for: Listen in as pairs discuss their reading. They should explain how the solutions they read about will either reduce or slow the addition of carbon dioxide or methane. Students should explain how these gases affect energy and temperature. In addition, you can gauge students' progress in the practice of constructing explanations. Listen for how clearly they describe mechanisms, using scientific vocabulary and precise language that relates variables.

Now what? Students will revisit human activities and their impact on the atmosphere and the climate in Lesson 4.2 when they examine data about how volcanic eruptions can alter human activity. You could take this opportunity to conduct a full-class or small-group discussion of the connection between human activity and climate if this assessment indicates that students need more support with those concepts. In this lesson, students write a formal explanation of their solution. For students who struggle to make verbal explanations during class, you might pay special attention to providing feedback and coaching on the explanations they write for homework.

Possible Responses

Student responses will vary depending on which solution they focused on.



3

MODELING TOOL

Modeling One Solution



Modeling One Solution



Students model their selected climate change solution and show how it would affect the climate.

Instructional Guide

1. Project message from head climatologist and read it aloud.

Irene Lee

To: Student Climatologists

Re: Solutions



As promised, we're ready to share your solutions to climate change with the public. WCI will share these ideas by putting together a group of blog posts. It would be great if each of you would choose one possible solution. Create a diagram and write an explanation to show how your solution works to affect climate.

We're hoping these posts will be motivating in two ways: first, they should increase public understanding of how climate change works and second, they should inspire people to get behind making these solutions happen.

Thank you!

Irene

Dr. Irene Lee, Head Climatologist
World Climate Institute

2. Project *Earth's Changing Climate* Modeling Tool activity: **Climate Change Solution** and highlight the features that students will use to generate their models.

- **Before and After panels.** Point out that the Before Solution panel represents a time *before* the solution goes into effect. The After Solution panel represents a time *after* the solution goes into effect and has had some time to affect the atmosphere and the climate.
- **Human Activity items.** Show students that they can use items for combustion, livestock, forest cover, and gas capture. Note that gas capture can be used to show capture of methane *or* carbon dioxide. Explain and demonstrate (if needed) how students can show an activity increasing (put less in the Before panel and more in the After panel) or decreasing (put more in the Before panel and less in the After panel).

Earth's Changing Climate

Lesson Guides

Lesson 3.3
Activity 3

3. Provide students with time to create their models. Remind students to use what they learned earlier in the unit about energy, the atmosphere, temperature, and ice in order to make their models as complete as possible.


4. Regain students' attention so pairs can discuss their models. If students are using individual digital devices, have partners take turns showing and explaining their models to each other.

5. Project key concepts and connect to the idea that as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth, unless human activities and technologies can change.

Ask volunteers to share examples of the different solutions presented in the article, as well as the different actions humans can take to reduce or stop the increase of carbon dioxide and methane.

 **Key Concept**

- Some ways to stop the increase of carbon dioxide and methane include decreasing combustion and removing these gases from the atmosphere.
- Humans can take actions in their daily lives that will reduce the amount of carbon dioxide and methane in the atmosphere.

 You have done excellent work discovering and explaining causes of our current climate change, along with carefully analyzing some possible solutions. In the next few lessons, we will consider a new puzzle about Earth's climate.

6. Explain the optional activity. If you have time and would like your students to complete the optional Sim challenge, direct students to Activity 4. Otherwise, let students know that they can skip this activity.

7. On-the-Fly Assessment: Modeling the Mechanism of Climate Change Solutions. For ideas about what to look for as you review students' submitted models, press the hummingbird icon and select ON-THE-FLY ASSESSMENT 15.

8. Point out the homework assignment (Activity 5 or pages 104–105 in the Investigation Notebook). If students do not have access to Amplify Science at home, provide them with copies of pages 104–105 from the Investigation Notebook and copies of the “What Are We Doing About Sea Level Rise?” article. Explain that students will write a blog post and then read an article to learn more about some of the ways people are preparing for a future with higher ocean levels.



9. Optional: Point out the Self-Assessment (Activity 6 or page 106 in the Investigation Notebook). If students do not have access to Amplify Science at home, provide them with copies of pages 106 from the Investigation Notebook. Remind students that in order to reflect on their own learning, they will revisit these questions at the end of every chapter.



Embedded Formative Assessment

On-the-Fly Assessment 15: Modeling the Mechanism of Climate Change Solutions

Look for: Students use the Modeling Tool to demonstrate their understanding of how their selected solutions will impact gases in the atmosphere, energy, and temperature with a cooling effect. When reviewing their work, check that the change they make to the atmosphere is consistent with the human activity they select (e.g., methane with cattle and carbon dioxide with combustion; either gas can be used with gas capture). The After Change panel should represent a decrease in the selected gas and an energy flow in which more exits than enters, such that absorbed energy and global average temperature decrease.

Now what? Some students are likely to have more difficulty modeling the reverse situation (cooling) than they have in previous chapters. These students might benefit from talking through their reasoning with a partner. You can refer them back to the article to guide their thinking. Help them to think about how redirection by carbon dioxide and methane affects energy and what the effect of decreasing gases will have on this cooling mechanism.

Teacher Support

Instructional Suggestion

Student Discussions of Modeling Tool: Formulating Ideas Before Writing

Providing students with the opportunity to hold more extensive discussions helps them solidify their understanding of the concepts. As students explain their models to a partner, they need to highlight relevant ideas and concepts from the reading as well as the unit. This process also helps students formulate ideas before writing. This partner discussion can also help less-certain students finalize ideas as they listen to the ideas of their peers. You might highlight key vocabulary words to include or provide a word-bank handout that students can draw from as they discuss and write.

Rationale

Pedagogical Goals: Understanding the Nature of Science

One goal set forth by the Next Generation Science Standards (NGSS) is for students to understand the nature of science as a discipline and how scientific knowledge develops over time. The NGSS call out eight understandings about the nature of science that are woven throughout the Amplify Science curriculum. This unit gives students an opportunity to experience the understanding that Science Addresses Questions About the Natural and Material World. Specifically, the excerpt that students reread in this activity from the article titled "Climate Change Solutions" illustrates the idea that science knowledge can describe consequences of actions but is not responsible for society's decisions.



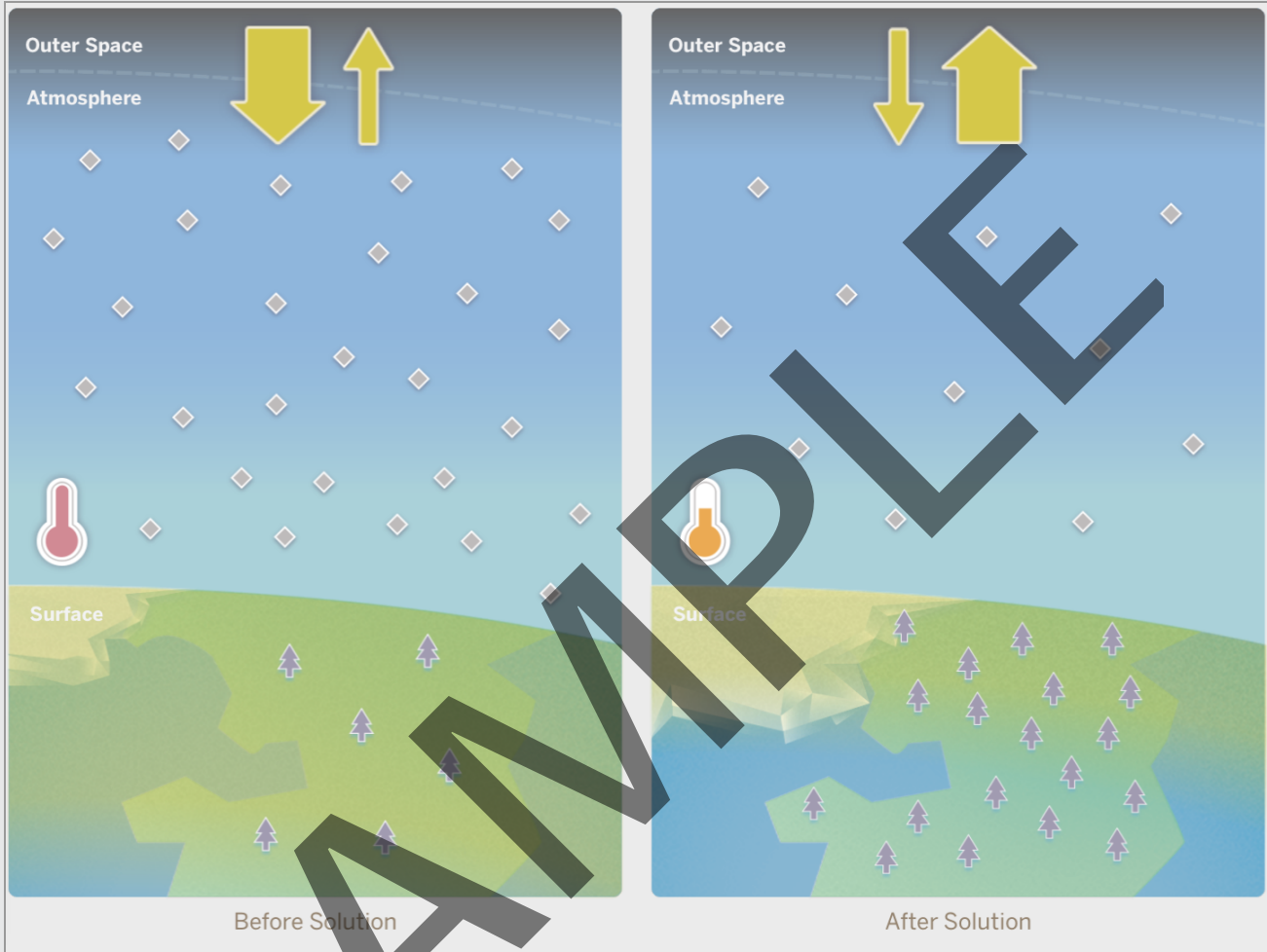
Possible Responses

Students can model a change in livestock, forest cover, combustion, or gas capture.

If students show an increase in forest cover, they should show carbon dioxide decreasing. If they show an increase in gas capture, they can show the decrease with either carbon dioxide or methane. In the After Solution panel, they should show less energy entering than exiting, lower absorbed energy, and temperature. Students may also show an increase in the amount of surface ice.

For students who model a decrease in livestock or combustion, the most correct answer is to show that the gas (methane for livestock and carbon dioxide for combustion) would increase more slowly or remain unchanged. The Modeling Tool does not give students a way to show a slower increase, so encourage students who want to show this idea to add it to their annotated screenshot. Students may also show a decrease in the gas. While this is not strictly correct, it is an acceptable answer and will still allow students to show an understanding of the effect of gases on temperature. If students show a decrease in gas, they may show energy entering and exiting as equal in the After Solution panel or less entering than exiting.

The image shows one possible proficient student model.



SAMPLE



4

SIM

Stable Temperature in the
Sim (optional)

Stable Temperature in the Sim (optional)

Students complete a Sim mission in which they attempt to set human activities levels so temperature remains stable.

Instructional Guide

1. If you have time during this lesson or in another, have students complete this Sim mission (page 103 in the Investigation Notebook).

Teacher Support

Instructional Suggestion

Going Further: Sim Mission

You could extend today's lesson, perhaps with an extra day of classroom instruction, by having students complete this activity and write an explanation telling why their Sim settings for human activity led to a stable temperature. You can relate the idea of gases being added and removed to energy entering and exiting the Earth system in order to help them think about what would need to happen for the temperature to become stable (carbon dioxide/methane produced needs to equal carbon dioxide/methane removed). Provide a word bank of terms (*energy, absorb, surface, produce, remove, atmosphere, carbon dioxide, methane, redirect*), and explain that these ideas from earlier in the unit will help them make an explanation that really describes the processes by which their settings led to a stable temperature. Have partners discuss how they succeeded at their mission and why they think those levels of activity led to stable temperature. At that point, students can draft their written explanations.



Possible Responses

Why do you think these human activity settings resulted in a stable temperature?

This made the temperature stable because the amount of carbon dioxide and methane were stable. Some of these gases were still being added to the atmosphere from combustion and livestock, but about the same amount was being taken out by forests and gas capture. I had to make the population pretty small to get these to balance.

SAMPLE



5

HOMEWORK
Homework

Homework

Students write an explanation about their climate change solution, and then they read an article to learn more about some ways people are preparing for a future with higher ocean levels.

Instructional Guide

1. If needed, make additional time to explain homework. If students do not have access to Amplify Science at home, provide them with copies of pages 104–105 from the Investigation Notebook and copies of the “What Are We Doing About Sea Level Rise?” article.

2. If needed, make additional time to explain the second part of the homework. If students do not have access to Amplify Science at home, provide them with copies of pages 104–105 from the Investigation Notebook and copies of the “What Are We Doing About Sea Level Rise?” article.

Teacher Support

Instructional Suggestion

Going Further: Extended Writing Instruction

If you have additional class periods, you could make this writing assignment an in-class experience rather than homework. Coach students in how to structure the explanation (separate the writing into paragraphs and start each paragraph with a topic sentence). Have students read each other’s work and provide feedback, or have students revise their writing based on peer and/or teacher feedback.

Rationale

Pedagogical Goals: Additional Reading About Preparing for Sea Level Rise

To expose students to concepts about the importance of monitoring the effects of human activity on the environment, they read the article, “What Are We Doing About Sea Level Rise?” From floating buildings to wetlands restoration, this article introduces students to some of the ways people are preparing for a future with higher ocean levels. Reading about how people prepare for the effects of climate change may inspire some students to consider solutions that they can develop in their own communities.



Assessment

Additional Assessment Opportunity: Student Understanding of Humans' Impact on the Environment

This activity can be used to assess students' understanding that sea level rise due to human activity will have a negative impact on coastal cities unless humans are able to engineer ways to minimize these impacts. Look for whether students can name some negative impacts of sea level rise as well as describe some of the specific ways that coastal cities are preparing for sea level rise. In particular, look for whether students can describe the ways that restoring wetlands is an effective way to prepare, because natural wetlands can protect cities without people having to build walls or other human-made structures. If students are not able to describe these ideas, consider spending some time in class looking at a visual example. Maps showing coastal cities that are in danger of being covered in water can be found online using the search terms "coastal cities sea level rise," or you may be able to find maps of your area by substituting the name of your state or country in place of "coastal cities." You might show the class a map of an area near where they live, and point out the nearest coastal cities that would be affected. Then ask students to think about the article and call out some things humans can do to protect coastal cities. If needed, have students return to the article to find ideas. Make a list of these on the board. Point out to students that although the human activities that have led to rising sea levels could have a big impact on many cities, there are a lot of things humans can still do to reduce that impact and protect cities from being lost. You can also point out that reducing human impact can also be achieved by addressing climate change itself, as well as by leaving existing natural wetlands and other natural habitats intact.

Possible Responses

Dr. Lee asked you to write a blog post that describes and explains the solution you read about in "Climate Change Solutions." When you write your explanation, remember that the general public is your audience. Try to be as convincing as possible. Carefully explain the solution, how it would affect climate change, and why it is needed.

One solution to climate change is to get more of our energy from solar power. Most electrical energy comes from combustion, which means burning fuels, like coal. If we put solar panels on our houses, less of our electricity will come from combustion. Combustion is one of the causes of Earth's increased temperature because combustion releases carbon dioxide into the atmosphere.

Carbon dioxide stops energy from leaving by redirecting energy that would have exited the Earth system, so more carbon dioxide in the atmosphere means more energy is entering than exiting. Earth's surface absorbs the extra energy and this makes Earth's average temperature increase. Earth's increasing temperature is causing ice to melt, oceans to rise, and dangerous weather events. If we decrease combustion by putting solar panels on our houses, we can reduce climate change.

1. What are some things that will happen if global sea levels rise?

Some places near the ocean will be covered in water. Weather patterns will change and cause flooding during storms.

2. What are the ways coastal cities are preparing for sea level rise?

Coastal cities are preparing for sea level rise in many ways. Some of them are improving their drainage systems. Others are exploring the idea of building floating buildings. Some coastal cities are considering restoring their wetlands.



3. Why is wetland restoration an effective way to prepare for sea level rise?

Wetland restoration protects coastal cities from flooding because wetlands and marshes act as a sponge to absorb extra water. They can also absorb energy from large waves and prevent erosion. Cities that restore their surrounding wetlands may not need to build walls or barriers to stop water from getting in.

SAMPLE



6

HOMEWORK

Self-Assessment
(Optional)

Self-Assessment (Optional)

Students assess their current understanding of the Unit Question, *What causes climate change?*

Instructional Guide

1. Make additional time to explain the self-assessment, if needed. If students do not have access to Amplify Science at home, provide them with copies of page 106 from the Investigation Notebook.

Teacher Support

Assessment

Student Self-Assessment: Reflecting on the Unit's Central Problem

This is the third of four student self-assessments (one at the end of every chapter), which invite students to reflect on their progress in solving the overall problem of the unit. Review students' responses and questions in order to gain insight into their thinking at this point in the unit.

Possible Responses

Answers will vary.