

Climate Change Lesson 1: *The Solve*

Educator’s Resource Guide: Live Video Phenomenon

The Solve contains two mini lessons: The [live video lesson](#) and the [animation lesson](#). For the most comprehensive learning experience, conduct both. If you’re short on time, choose one. Which lesson?

- For a more structured lesson, choose the animation.
- For a more inquiry-based lesson, choose the live video lesson (the lesson below) and assign the animation for homework.

Objective

In *The Solve*, students will:

1. Observe two phenomena: one that shows a receding glacier and the other that shows a hungry polar bear.
2. Analyze graphs on global temperatures, arctic sea ice, greenhouse gas emissions, and population growth.
3. Create a presentation in which they will:
 - a. Gather their own photographic evidence to show how various locations have been impacted by climate change through a “Before & After Challenge.”
 - b. Answer reflection questions: using data from the graphs and evidence from the #Before&AfterChallenge, explain the cause of the original video phenomena and propose an idea about human impact on climate change.
 - c. Put climate terms into context.

Time Required: 80–110 minutes

Materials Required	
<ul style="list-style-type: none"> • Student Guide • Video clip 1: Time-lapse of Mendenhall Glacier • Video clip 2: Polar Bear in Danger • Climate Solve Presentation • Computer with speakers (for projecting video) or headphones (for student viewing on laptops) • Appendix A: Search Resources for Before and After Images 	
Safety Considerations	Science & Engineering Practices
None	<ul style="list-style-type: none"> • Analyzing and Interpreting Data • Constructing Explanations or Arguments from Evidence

Inquiry Scale: Leveling Information

The Solve can be completed in various settings, including presentation-style, small groups, or individually.

Level 1: Most teacher-driven

View the video clips several times as a class. Discuss the video clips as a class. After the first viewing, prompt students with questions to lead them to more observations and get them to ask questions about what they are seeing. Students will jot down observations in their Student Guide.

Discuss as a class how the videos could be related. Students will then be required to analyze four different graphs. They should write down notes beside each graph to describe the information presented in each. As a class, discuss possible trends and how the data in the graphs may be related to the videos. Students should write their answers in their Student Guide. Students will create a three-part presentation. As a class, check in after each section to ensure understanding. Have students complete their exit ticket.

Level 2: Most student-driven

View the video clip as a class, individually, in groups, or pairs several times. Working in student groups, students should discuss how the video clips might be related. Students will jot down observations and questions in their Student Guide. Working individually, students will then analyze four different graphs and write down notes explaining their interpretation of each graph. They can then share their ideas with their group. Groups will then share ideas about how the data in these graphs might be related to the videos in Section 1. Students will brainstorm possible explanations based on their video observations and graph analysis, and then write their explanation in the Student Guide. Students will work in small groups to create a three-part presentation and will then complete their exit ticket.

Agenda

Part 1: The Phenomena

View the video clips (5–10 minutes)

Differentiation Tip: The video can be viewed as a class, in small groups, or individually.

Instruct students to watch each video. As they watch, they should write down *observations* and *reactions* to each video in their Student Guide.

[Video 1: Time-lapse of Mendenhall Glacier](#)

(Teacher information only: Do not yet share this information with the students.) This time-lapse video shows Mendenhall Glacier, in Alaska, receding. Glaciers retreat when their ice melts more quickly than snowfall can accumulate and form new glacial ice. Rising temperatures due to global warming have caused glaciers around



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the world to recede more rapidly in recent years. Because of global warming, our planet's glaciers continue to melt, losing up to 390 billion tons of ice and snow per year.

[Video 2: Polar Bear in Danger](#)

(Teacher information only: Do not yet share this information with the students.) The video shows polar bears struggling to survive as the ice around them melts. As the sea ice melts, bears have a harder time hunting seals and therefore, can starve to death.



Information to share with students

Students might wonder why polar bears need ice. Share with them that polar bears need ice to survive because, among other things, they rely on ice to hunt their prey. Polar bear diets are made up primarily of seals. In the winter, seals underwater come up for air every 15–20 minutes through breathing holes in the ice. Polar bears will locate the hole, wait for a seal, and attack their prey when the seal comes up. At times, they'll wait for hours or days before they make a confident attack. Polar bears also use the ice to travel, find mates, and teach their cubs how to live.

Have students **complete the questions** in their Student Guide. Do not reveal any information about the video yet. Ask students to share some of their ideas.

Question 1: How do you think these videos are related? Jot down your initial observations. *Responses will vary. Encourage students to be as detailed as possible in their observations. Potential answers include: both involve ice, and specifically loss of ice; all of the ice breaking makes it harder for the polar bears to survive; ice is melting and the polar bears are losing their habitat because something is making the ice melt.*

Question 2: What do you think could be causing the changes observed in each video? *Guide students here by asking leading questions. For example: What was happening to the ice? What do you think is causing the ice to melt? Why are the polar bears in danger? What is the cause? Potential answers include increase in temperature, too much heat in the world, the weather becoming too warm and the ice melting, and/or the warming of the earth. If your students have studied climate change before, they may say the cause is a result of climate change.*

Part 2: Let's Look at the Data

A. Graph Analysis

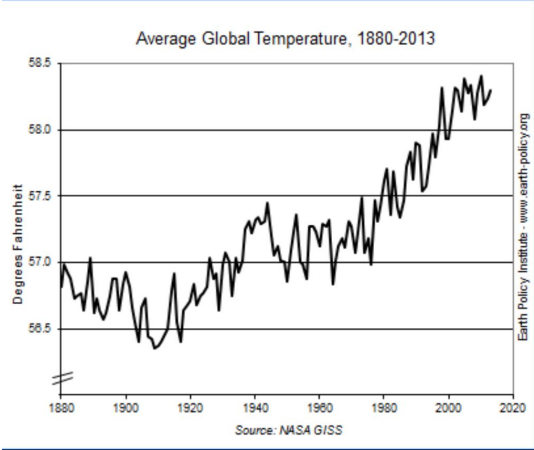
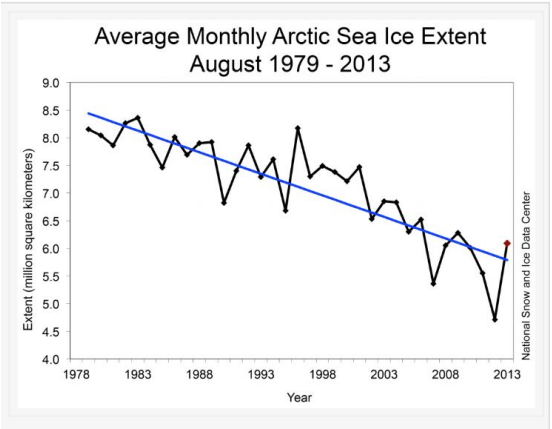
Share with students that they will be exploring data from four graphs presented in their Student Guide.

They will answer two questions about each graph:

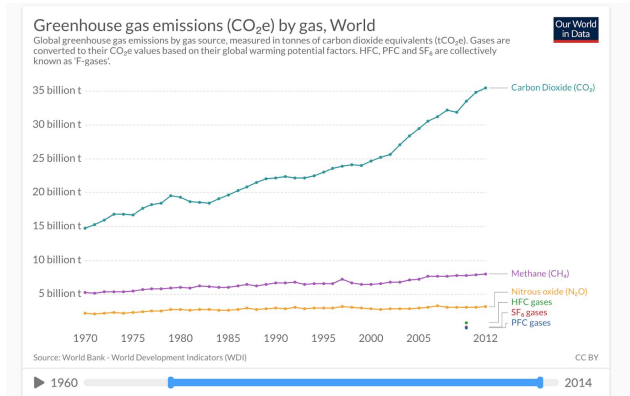
1. What information does this graph present?
2. What trends do you notice?

The first question asks students to focus exclusively on information presented in the graph, and the second asks about the graph trends.

Tip: For additional support, answer questions for graphs A and B as a class, and allow students to work in small teams to answer questions for graphs C and D. All four graphs are located on the first four pages of the [presentation](#) for review/use as needed.

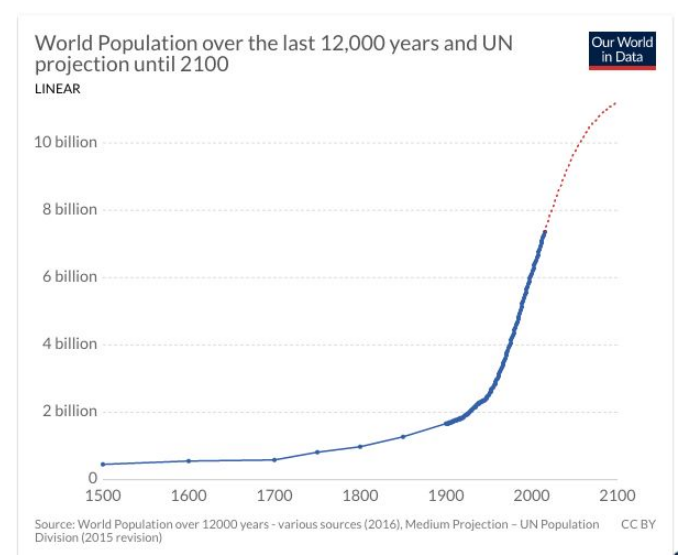
<p>A</p> 	<p>B</p>  <p><i>Note: Sea ice extent is a measurement of the area of ocean where there is at least some sea ice.</i></p>
<p>What information does this graph present? <i>This graph shows the average global temperature from 1880 to 2013.</i></p> <p>What trends do you notice? <i>I notice that global temperature from about 1910 to 2013 has increased.</i></p>	<p>What information does this graph present? <i>This graph shows the average monthly arctic sea ice extent, which is a measure of the areas in the ocean that have sea ice.</i></p> <p>What trends do you notice? <i>The average monthly arctic sea ice extent is decreasing, which means there are fewer places in the ocean that contain sea ice.</i></p>

C



What information does this graph present? *This graph shows the greenhouse gas emissions in the world, organized by the type of greenhouse gas.*
What trends do you notice? *I notice that carbon dioxide is the most emitted greenhouse gas. I also notice that since 1970, the amount of carbon dioxide has increased.*

D



What information does this graph present? *This graph shows the world population from 1500 to about 2000 and then shows the projection of the world population from about 2000 to 2100.*
What trends do you notice? *I notice that from 1500 to ~1950, the population increased steadily, and then from around 1950, it increased dramatically and continued to do so until the present day. I also notice that it is projected that the world population will continue to grow dramatically.*

B. Questions: Relationships between the graphs

The questions posed to students are phrased to encourage thinking about possible relationships among graphs as well as the possible relationship between the graphs and the videos.

Before students answer their questions, share the following to help them frame the questions:

- The graphs individually convey very specific pieces of information (data). When we combine the information on graphs, they begin to paint a fuller picture.
- Correlation does not necessarily indicate causation. *Tip: Just because students can suggest a connection or a relationship between two graphs, it doesn't necessarily mean that one causes the other, nor does it eliminate other variables as possibilities. What it does mean is that there are additional pieces of data or tests required to paint a fuller picture. It is only with the combination of the graphs that we begin to get a fuller, clearer picture. That said, in the case of climate change, human activities are proven to be the root cause of this increase in global temperature.*

1. How might the information in graph A and graph B be related? *Rising average global temperatures could be causing increased melting of the sea ice, resulting in an overall decreased sea ice extent. Tip: If a student suggests an opposite potential correlation (i.e. the melting sea ice might be causing a rise in global temperature), encourage them to think carefully about the potential cause and effect relationship in each scenario. Rather than direct their conclusions toward any particular outcome, remind students that these potential relationships will be explored further.*

2. How might the information in graph C and graph D be related? *An increase in greenhouse gases might be related to the growing human population.*

3. How might the information in graph A and graph C be related? *Increasing greenhouse gases in the air could be causing the global average temperature to increase.*

4. In what other ways might the four graphs be connected? Explain your answer. *Answers will vary. A potential answer includes: The increase in population might be causing an increase in greenhouse gas emissions, which in turn is causing sea ice to melt.*

5. How can the data presented in the graphs help to explain the footage observed in the videos (Part 1)? Refer to as many graphs as possible in your answer. *Potential answer elements: The videos that we watched showed the glacier getting smaller, which could mean there is melting and less sea ice. This matches the trend in graph B showing that the amount of sea ice is decreasing at a steady pace.*

The videos showed a glacier melting. Graph A shows that there could be a relationship between global temperature increase and melting ice.

The graph that shows decreasing sea ice (graph B) may explain why the polar bear is starving, since the polar bear needs ice to move across hunting areas.

Graph C shows the increase of greenhouse gases, which may be a cause for the increase in temperature that may also be a cause for glacial melting and sea ice reduction.

Graph D shows that human population growth might be responsible for this increase in greenhouse gas that may be a cause of the melting ice and sea ice reduction.

Part 3. Climate Change Presentation and Notes (40 minutes): [The presentation](#)

By this point, students will have discovered that the global temperature has increased, sea ice levels are decreasing, greenhouse gas emissions are increasing, and world population has increased. Now is also the time to share the information provided to you about the video phenomena on pages 2 and 3.

The PowerPoint will build on this knowledge and provide more information about greenhouse gases and their impact on the earth, and it will also introduce the students to their final presentation.

1. All teacher notes are located below each slide in the slideshow. Please review the PowerPoint Presentation teacher notes prior to presenting to the class to ensure understanding of the information included with each slide and the information that should be addressed with the class.
2. Students should complete the PowerPoint Presentation Guided Notes section of their Student Guide as you present the PowerPoint Presentation.

Question 1: What are greenhouse gases? *Answer: Greenhouse gases are naturally occurring gases in the atmosphere that trap heat around the earth. As the energy from the sun reaches the earth, the greenhouse gases surrounding the earth trap some of the energy.*

Question 2: Draw a model and explain how greenhouse gases trap heat in the atmosphere. *Answer: Slide 13 in the presentation provides a helpful model that students can use as a guide when constructing their answer.*

Question 3: What role do greenhouse gases play in climate change? *Greenhouse gases absorb heat in the atmosphere which warms the earth. An increase in greenhouse gases means an increase in global temperature.*

Question 4: What are some sources of greenhouse gases? *Sources include: Electricity and heat, agriculture & land, industry, transportation, other energy, food waste and buildings.*

Question 5: List and describe some of the environmental impacts due to rising greenhouse gases. *Answer: Some environmental impacts include rising global temperature, melting sea ice, and rising sea levels.*

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Part 4. Putting it All Together: Finding Evidence and Constructing an Explanation (15–20 minutes)

Part 4 is designed for students with access to a laptop. If you do not have laptop access, follow the directions here ([paper-based Educator Guide](#) and [paper-based Student Guide](#)).

Explain to students that they will be working in partners to create a presentation using Google Slides or PowerPoint. Their presentation is divided into three separate sections:

- Section 1 – #Before&AfterChallenge: Before and after photos showing how various locations have been impacted by climate change.
- Section 2 – Answers to reflection questions using data from the graphs and evidence from the #Before&AfterChallenge:
 - How Mendenhall Glacier and polar bears may be indicators of climate change. Students will use all of these terms in their explanation: greenhouse gas, atmosphere, melting, temperature, and climate change.
 - How might human activities contribute to climate change?
- Section 3 – Climate terms in context.

As guided by the Student Guide, students will set up the presentation, then complete sections 1 through 3.

Set Up the Presentation (instructions for students)

Open a digital presentation such as Google Slides or PowerPoint and put the following information on each slide:

Slide 1:

- a. Include the title “Climate Change: Evidence and Explanations.”
- b. Include your and your partner’s name.

Slide 2: include the text: “Section 1: The #Before&AfterChallenge.” This slide will be a section header.

Section 1

Section 1 of the presentation will focus on the photographic evidence of climate change, which students will find independently. The #10yearchallenge was started as a hashtag to see how people and places have changed over the past 10 years. Students will do something very similar with the #Before&AfterChallenge.

Students will be required to research and find four sets of “before and after” photos of locations that have been impacted by climate change. Suggested search terms include:

- Glacier melting
- Arctic sea ice changes
- Sea level rising

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Students can also refer to “Appendix A: Useful Image Links” in their Student Guide.

Tips:

- When students save photos, encourage them to title the photo with the name of the location and year. Encourage them to keep all photos in a folder for easy access for when they begin creating the presentation.
- Students may find pre-created “before and after” photos from websites. You may let them use these photos as long as they have the whole story (the name of the locations and the years).

Slides 3–6: On each slide, students will include one set of before and after photos. On each slide instruct students to complete the following:

- a. Title the page by the name of the location they are highlighting.
- b. Place the “before” photo on the left side and the “after” photo on the right.
- c. Below each photo, indicate the year that the photo was taken.
- d. Optional: Add annotations to the images to highlight their observations.
- e. In the notes section of the presentation, explain:
 - i. what they notice about the change and/or what they find most interesting about these photos; and
 - ii. reflecting on the information learned from the graphs, what might be a possible reason for the change presented in the images.

Sample slide format

Columbia Glacier, Alaska

Lots of ice!

Completely melted!

2009 2015

This is a before and after photo of Columbia Glacier, Alaska. In 2009, you can see a large sheet of ice. By 2015, this ice had completely melted. Information from the photo: Columbia Glacier, Alaska, has retreated by 6.5km (4 miles) between 2009 and 2015. Photo credit: James Balog and the Extreme Ice Survey

Section 2

Slide 7: Next, students will add the text “Section 2: Reflection Questions.” This will be a section header slide.

Slide 8: Students should write their answer to the following question:

Reflecting on everything you've learned in this lesson, explain how Mendenhall Glacier and polar bears may be indicators of climate change. Use all of these terms in your explanation: greenhouse gas, atmosphere, melting, temperature, and climate change. *Answers will vary. A potential answer might be that Mendenhall Glacier and polar bears may be indicators of **climate change** because we know that the average global **temperature** is rising and that **greenhouse gases** in our **atmosphere** are a cause of this **temperature** increase. This is causing glaciers, such as Mendenhall, to retreat. **Melting** ice, in general, poses a threat to polar bears because polar bears rely on ice to hunt. With less ice, polar bears have a reduced ability to hunt.*

Slide 9: Students should write their answer to the following question:

How might human activities contribute to climate change?
Answers will vary. Note that students are making an educated guess here based on the information they were exposed to in the presentation and graphs. A potential answer might be: There are many things that humans do that contribute to climate change because many of our actions release greenhouse gases into the atmosphere. This includes the production of electricity and heat, our use of agriculture, industry, and transportation.

Section 3

Slide 10: Students should add the text, "Section 3: My Climate Terms." This will be a section header slide.

Slides 11–15: *(Total slide number may vary depending on how many slides students use for identifying vocabulary terms.)* Students should find one image that illustrates each vocabulary term below. For example, one image that illustrates greenhouse gas, one image that illustrates atmosphere, and so on. Students can use as many terms in the same photo as they'd like, but they must label and define all terms. In the notes section, students explain where in the image the term appears.

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- Greenhouse Gas: A gas that absorbs the heat from the sun (infrared radiation) in the atmosphere. Examples include carbon dioxide and methane.
- Atmosphere: Layer of gas around a planet.
- Melting: The process of going from solid to liquid.
- Temperature: The degree or intensity of heat; the temperature of something is how hot or cold it is.
- Climate Change: A change to the average weather in a place over many years, primarily caused by increasing atmospheric temperatures. *Tip: it might be helpful to use a photo that shows evidence of climate change here.*

When students are done with all slides, they should click “Share” to share the slideshow with you.

Quiz: Check for Understanding (10 minutes)

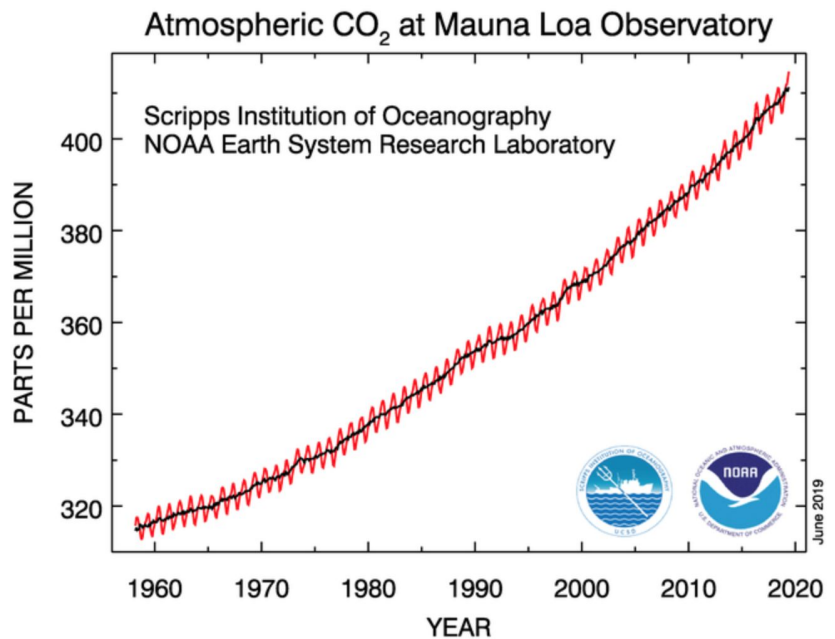
[Differentiation Tip: This can be done in groups, pairs, individually, or more formally as a quiz online.](#)

Students complete the exit ticket to check for understanding. This can be done online by selecting the **Quiz** button in Lesson 1 or on paper in the Student Guide. Answers are highlighted in bold below.

1. True or **False**: Global temperatures have remained steady for the past 30 years.
2. Earth’s global temperature change is due to which of the following factors?
 - a. The starvation of polar bears
 - b. The retreat of Mendenhall Glacier
 - c. The increase in atmospheric greenhouse gases**
 - d. The use of solar energy
3. All of the following statements about greenhouse gases are true except:
 - a. Greenhouse gases are naturally occurring gases in the atmosphere.
 - b. The amount of greenhouse gases in the atmosphere has declined over the past 30 years.**
 - c. Methane and carbon dioxide are two of the most abundant greenhouse gases in the atmosphere.
 - d. Greenhouse gases trap heat in the atmosphere, warming the earth.
4. Which of the following are sources of greenhouse emissions? Choose all that apply.
 - a. Industry**
 - b. Electricity and heat**
 - c. Agriculture**
 - d. Transportation**

5. Which of the following can result from climate change?
- Loss of arctic sea ice
 - Rising global temperatures
 - Rising sea levels
 - All of the above**
6. Too many greenhouse gases in the atmosphere block heat from escaping into space and trap too much heat next to the earth's surface causing _____.
- another ice age
 - an increase in average global temperature**
 - earthquakes
 - volcanic eruptions
7. Which of the following is the best conclusion that can be made from this graph?

- Atmospheric CO₂ levels have been decreasing since 1960
- Atmospheric CO₂ levels have been increasing steadily since 1960**
- Hawaii has a lot of CO₂
- Humans have been working hard to decrease CO₂ levels



Appendix A: Search Resources for Before and After Images

Provide suggestions from either the general search term list or specific search term list for students who would benefit from additional support. For students who would benefit from specific links, share resources from the specific link section.

Recommended General Search Terms:

- Global Temperature Rise
- Warming Oceans
- Shrinking Ice Sheets
- Glacial Retreat
- Decreased Snow Cover
- Sea Level Rise
- Declining Arctic Sea Ice
- Extreme Events (weather)*
- Ocean Acidification*

*The impact of climate change on these events may not be as directly clear to students. For students who would benefit from an additional challenge, ask them to explain how these two events are impacted by climate change.

Recommended Location to Search:

- Grinnell Glacier
- Hidden Lake
- Iceberg Glacier
- Swiftcurrent Glacier
- Grinnell Glacier Basin
- Arctic Sea Ice

Specific Links:

- [Before & after photos of melting glaciers capture climate change in action](#)
- [Getting the Picture: Our Changing Climate](#)
- [Nasa Images of Change](#)
- [USGS Repeat Photography](#)
- [NSIDC Arctic Sea Ice Comparison Tool](#)
- [UCAR Arctic Sea Ice Extent Side-by-Side](#)
- [Global Ice Viewer](#)
- [NSIDC Retreating Glaciers](#)