

# Lesson 6: How does human activity affect the trend of warming temperatures on Earth?

## MS Climate Change Unit

Previous Lesson....Where we've been: We learned what the world's temperature trend was in the past and that temperatures have been rapidly increasing over the past 200+ years.

	<b>This Lesson....What we are doing now:</b> This lesson explores whether human activities release greenhouse gases, like CO <sub>2</sub> , and whether they can cause temperatures on Earth to increase.		
Lesson Question	Phenomena	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), <i>New Questions</i> and <i>Next Steps</i>
<p><b>L6: How does human activity affect the trend of warming temperatures on Earth?</b></p> <p>(2.5-3 periods)</p>  <div style="border: 1px solid gray; padding: 5px; margin-top: 10px;"> <p>Building toward ↓ <u>NGSS</u> <u>PEs:</u> MS- ESS-3- 5</p> </div>	<p>The natural Greenhouse Effect keeps temperatures on Earth habitable for life.</p> <p>Human activities that release greenhouse gas emissions amplify the natural Greenhouse Effect, which results in human-caused global warming.</p> <p><a href="#">PhET The Greenhouse Effect simulation</a></p> <p><a href="#">The Greenhouse Effect video</a></p> <p><a href="#">US Greenhouse Gas Emissions chart</a></p> <p><a href="#">Following Carbon Dioxide Through the Atmosphere visualization</a></p> <p><a href="#">The Carbon Cycle</a></p> <p><a href="#">Carbon Dioxide and the Carbon Cycle</a></p>	<p><b>Develop and use a model that...</b> is based on evidence for <b>how greenhouse gases help maintain a relatively constant temperature in a range in which humans can live</b> and describes <b>how increases in greenhouse gas emissions by human activities cause the amplification of the greenhouse effect that result in global warming.</b></p>	<p>We decided that we want to explore how human activity since the Industrial Revolution is affecting the Earth's temperature. We also wondered what it is that has kept the Earth's temperature relatively stable for so long until recently.</p> <p>We've heard about greenhouse gases. One that we've heard a lot about and that is connected with fossil fuels is CO<sub>2</sub>. We have some initial ideas about where carbon dioxide comes from. Humans and animals breathe out CO<sub>2</sub>. Burning things produces CO<sub>2</sub>. Some things burn in nature (forest fires) and we burn things (e.g., wood for campfires, gas for vehicles).</p> <p><i>We go back to the Driving Question Board, and we add some more questions:</i></p> <ul style="list-style-type: none"> <li>• <i>How could we explore what CO<sub>2</sub> does in the atmosphere?</i></li> <li>• <i>What can we do to understand the relationship between CO<sub>2</sub> levels and increasing global temperatures?</i></li> </ul> <p><b>We decide that we need to learn a bit about how the atmosphere works and understand what increasing CO<sub>2</sub> in the atmosphere does to global temperatures. As a class, we use a simulation to explore if there is a connection between CO<sub>2</sub> in the atmosphere and temperature.</b></p> <p><i>Using the simulation, we investigate the following questions as a whole class:</i></p> <ul style="list-style-type: none"> <li>• <i>What variables are in the simulation?</i></li> <li>• <i>How do the variables in the simulation respond to each other?</i></li> <li>• <i>How does this simulation help explain what causes the Earth's temperature to either stay stable, increase, or decrease?</i></li> </ul> <p><b>We figure out:</b></p> <ul style="list-style-type: none"> <li>• There is relationship between the amount of CO<sub>2</sub> in the atmosphere and Earth's temperature.</li> <li>• We learn that CO<sub>2</sub> is in the atmosphere and that CO<sub>2</sub> absorbs heat and this causes the temperature of the atmosphere to rise.</li> <li>• We call that the "Greenhouse Effect," and that's why people call CO<sub>2</sub> a greenhouse gas. The Greenhouse Effect is how Earth's temperature is managed by greenhouse gases trapping heat.</li> <li>• When there's more CO<sub>2</sub> in the atmosphere, more heat is trapped, and temperatures rise more.</li> <li>• The amount of greenhouse gases in the atmosphere make a difference to Earth's temperature.</li> </ul> <p><i>We now know more about greenhouse gases and the Greenhouse Effect and how they work to regulate Earth's temperature.</i></p> <p>We now want to know more about the increase in CO<sub>2</sub> in the atmosphere.</p>

	<p><a href="#">Climate Bits: Carbon Dioxide</a></p>	<p><i>We go back to the Driving Question Board, and we add questions:</i></p> <ul style="list-style-type: none"> <li>• <i>Why is there more CO<sub>2</sub> in the atmosphere now than in the past?</i></li> <li>• <i>Where is the new CO<sub>2</sub> in the atmosphere coming from?</i></li> <li>• <i>What human activities release CO<sub>2</sub>?</i></li> </ul> <p><b>We decide we need to figure out where CO<sub>2</sub> comes from. We look at a diagram of the Carbon Cycle to find out where the carbon in CO<sub>2</sub> comes from, the main sources of CO<sub>2</sub> in the atmosphere, and how human activity is part of that.</b></p> <p>We look at some infographics and an online interactive tool that help us examine how carbon moves in and out of the atmosphere. We compare human versus non-human sources of CO<sub>2</sub> moving into and out of the atmosphere.</p> <p>We see that the air (atmosphere), oceans (hydrosphere), trees and plants (biosphere), and rocks and fossil fuels (geosphere) store carbon in sinks or reservoirs and that carbon is “recycled” as it moves through different parts of the Earth. We know now that there is a certain amount of carbon on Earth and that it flows in a cycle between different places called reservoirs (or sinks) on Earth. We learn that when carbon moves from one sink (storage reservoir) to another that CO<sub>2</sub> can be released or stored. The oceans and plants absorb CO<sub>2</sub> from the air. Digging up fossil fuels from the ground or cutting down trees and burning them releases CO<sub>2</sub> into the atmosphere.</p> <p><i>We’ve figure out:</i></p> <ul style="list-style-type: none"> <li>• <i>Fossil fuels contain carbon and are mined from the ground.</i></li> <li>• <i>We burn fossil fuels, for example, when driving cars, and one of the by-products is CO<sub>2</sub>, which goes into the atmosphere.</i></li> <li>• <i>Fossil fuel burning by humans is the main cause for the increase in CO<sub>2</sub> in the atmosphere.</i></li> <li>• <i>Other human causes like deforestation contribute smaller amounts of CO<sub>2</sub>.</i></li> <li>• <i>There are activities that are naturally occurring like volcanoes that move carbon from underground to the atmosphere.</i></li> <li>• <i>The natural processes don’t account for as much as human activities do to increase CO<sub>2</sub> in the atmosphere.</i></li> <li>• <i>It’s when we do things like take oil and gas out of the ground and cut down trees, all of which store carbon, that causes more CO<sub>2</sub> to be added to the atmosphere compared to natural sources.</i></li> </ul> <p><i>(Optional Lesson 7) We are wondering:</i></p> <ul style="list-style-type: none"> <li>• <i>How do everyday human activities, like driving cars, affect the amount of CO<sub>2</sub> to the atmosphere?</i></li> </ul> <p><b>We decide to find out more on how cars that use fossil fuels impact CO<sub>2</sub> in the atmosphere.</b></p> <p><i>(Jump to Lesson 8) We are wondering:</i></p> <ul style="list-style-type: none"> <li>• <i>Is there a causal relationship between the CO<sub>2</sub> and temperature? (go to Lesson 8)</i></li> <li>• <i>We still want to have a real-world experience that shows that increasing CO<sub>2</sub> increases temperature compared to room air.</i></li> </ul> <p><b>We decide that we need to do an investigation to get concrete experience that CO<sub>2</sub> traps heat and increases temperature.</b></p>
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**Next Lesson....Where we’re going:** We want to know how fossil fuel burning in cars contributes CO<sub>2</sub> to the atmosphere.





## Getting Ready: Materials Preparation

### Materials For Each Group

- Data Sheet (color, 1 per 2 students/class copy)

### Preparation of Materials (45 min.)

- Print:
  - Student Activity sheet (1 per student)
  - Data Sheet (color, 1 per 2 students/class copies)
- Review and bookmark on teacher computer/smartboard, classroom computers or tablets to view as a class. \*Requires download
  - \*PhET The Greenhouse Effect simulation  
<http://cleanet.org/resources/47895.html>
  - The Greenhouse Effect video  
<https://cleanet.org/resources/42808.html>
  - US Greenhouse Gas Emissions chart  
<http://cleanet.org/resources/47840.html>
  - Following Carbon Dioxide Through the Atmosphere visualization  
<https://www.nasa.gov/feature/goddard/2016/eye-popping-view-of-co2-critical-step-for-carbon-cycle-science>
  - The Carbon Cycle (diagram)  
<https://scied.ucar.edu/carbon-cycle>
  - Carbon Dioxide and the Carbon Cycle  
<https://rmpbs.pbslearningmedia.org/resource/pcep14.sci.ess.co2cycle/carbon-dioxide-carbon-cycle/#>
  - Climate Change Basics video  
<http://cleanet.org/resources/45172.html>

### Materials For Each Student

- Student Activity Sheet (1 per student)

### Safety

- N/A





## Getting Ready: Teacher Preparation

### ***Background Knowledge***

From elementary school:

#### **ESS3.C. Impacts of Human Activities on Earth's Systems**

**“Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space.”**

- Industrial activities have shaped the air, including the climate.

### ***Alternative Student Conceptions***

Students may come into the lesson thinking that population growth has been steady over the span of human history. They have little concept of where the majority of human growth has occurred. They may not connect dead plant and animal material to fossils to coal, oil, and gas as a fuel made from fossils. They may not understand how matter can change states and that chemical reaction releases energy.

Students may think from the last lesson that the Industrial Revolution was a moment in time like a birthday, over and done, and not connected to human activities that directly impact the Earth's climate.

### ***Linking Our Understanding to Scientific Terminology***

- Greenhouse Effect
- Greenhouse Gas
- Carbon Cycle
- Carbon reservoir/Carbon sink
- Phases/States of matter
- Conservation of matter
- Fossil Fuels
- Engine
- Combustion



# Lesson 6: How does human activity affect the trend of warming temperatures on Earth? (110 min)



## Teacher Supports & Notes

1. (5 min) Hand out Student Activity Sheets to each student and begin with a Do Now to activate students' previous knowledge about human activities related to the Industrial Revolution. Have a Consensus Building Discussion <sup>1</sup> to help reorient students in the storyline. Use the following prompts to help students articulate what they figured out in the last lesson. Students write down their responses on the Do Now section of their Student Activity Sheet.

### Suggested Prompts:

- What did we figure out last time?
- What are we wondering about now?

### Listen for *student responses* <sup>2</sup> such as:

- We learned that the Industrial Revolution started in the late 1700s (in the UK) to early 1800's (in the US).
- The world's population has also increased a lot since the Industrial Revolution.
- We also learned that ice cores tell us about the Earth's past temperature and that the temperature has increased a lot since the start of the Industrial Revolution.
- We're wondering if human activities affect the Earth's temperature since the graphs we looked at show that since the start of the Industrial Revolution, the temperature has increased a great deal and at a faster rate than in Earth's past.

2. (5 min) Next, shift to a Sharing Initial Ideas Discussion <sup>3</sup>, to guide students to articulate what they think they should focus on in today's lesson. Focus on how they think post-industrial human activity is related to the increase in temperatures on Earth. Propose the question "How would data show us that fossil fuel use by humans is causing the trend of warming global temperatures?" to direct students' learning toward this lesson's driving question.

### Suggested Prompts:

- How did the Industrial Revolution change human activities?
- More fossil fuels, are being used since then. What are fossil fuels, where do they come from, what are they used for?
- What is the connection between fossil fuels and CO<sub>2</sub>?
- How do you think we can explore the connection between fossil fuels, CO<sub>2</sub>, and the Earth's temperature?

### Listen for *student responses* such as

- Since the Industrial Revolution, people started using fossil fuels more.
- Fossil fuels are mined and drilled from underground. They're formed the remains of ancient plants and animals.
- We've heard that fossil fuels release greenhouse gases (GHGs), like CO<sub>2</sub> and that they're related to the Greenhouse Effect (GHE).
- We should look at model of how CO<sub>2</sub> affects temperature.



### Strategies for this Consensus Building Discussion

1: Whole class discussion, team round robin or pair-share are each useful. Do make sure to bring the class back to together to review answers to the question.



### Strategies for this Consensus Building Discussion

2: The goal of this discussion is to put students in the driver's seat. Use the prompts to help students recall and restate what we as a class figured out in the last lesson. Their ideas should motivate what we are going to need to do next, in this lesson.



3. (20 min) As a whole class, explain that scientists use models to build an understanding of phenomena (e.g. weather, climate). Project the PhET Greenhouse Effect simulation and explain that it is a model to explore what factors affect the Earth's temperature. Give a brief introduction as to how the simulation works and explain the right sidebar features (legend, GHG concentration, time frame, temperature, etc.).

Direct students to observe what the status of CO<sub>2</sub> and temperature is at each time frame. Have them decide to go back or forward in time (Last Ice Age, 1750 start of the Industrial Revolution, Today or vice versa) and observe what happens to the variables, especially CO<sub>2</sub> concentrations and temperature.

Suggest ways to alter the simulation to increase the temperature the most and the least—ask students to describe how CO<sub>2</sub> and temperature respond. Have students suggest changes to each variable in the simulation and describe the outcome that they observe and what they understand is happening as a result.

There are other GHGs listed, explore with them but keep the focus on CO<sub>2</sub> since that is the GHG of most concern for human activities in relation to global temperatures.

PhET The Greenhouse Effect simulation: <https://phet.colorado.edu/en/simulation/greenhouse>

Next, have a whole class discussion to assess student understanding of the Greenhouse Effect by asking students to share out how the amount of CO<sub>2</sub> affects temperature (more CO<sub>2</sub>, higher temperatures and less CO<sub>2</sub> lower temperatures). Ask students to complete the Exploring Greenhouse Gases simulation section of their Student Activity Sheet.

Now watch “The Greenhouse Effect” video to connect CO<sub>2</sub> and its role in the warming of Earth:

<https://cleanet.org/resources/42808.html>

Check for understanding by asking students to give claims, evidence, and reasoning about the relationship between GHGs, the GHE, and Earth's temperature. Students write down their responses on the Understanding GHGs and the GHE section on their Student Activity Sheet.

#### **Suggested Prompts:**

- What did you notice when we explored the Greenhouse Effect simulation? What are the conditions of the GHGs when the temperature is the warmest, when it is the coolest?
- What is the role of CO<sub>2</sub> in the atmosphere? Why is this important?
- How do you think that having more people using more resources affects the amount of CO<sub>2</sub> in the atmosphere?

#### **Listen for student responses such as:**

- CO<sub>2</sub> traps heat to warm the Earth. When the amount of this greenhouse gas (GHG) is changed the temperature changes.
- There is naturally CO<sub>2</sub> in the atmosphere, which traps heat and allows life and liquid water to exist on our planet by keeping the planet at a habitable temperature.
- It makes sense that the more fossil fuels used for energy then the more CO<sub>2</sub> is put in the atmosphere and temperatures will rise.

4. (10 min.) Ask students to brainstorm human activities that use fossil fuels for energy and which activities they think produces the most CO<sub>2</sub>.<sup>4</sup> Hand out the Data Sheet to student teams to compare their responses to the “US Greenhouse Gas Emissions” chart (Figure 6.1): <http://cleanet.org/resources/47840.html>

Have students complete the Human Activities that Emit CO<sub>2</sub> and Other GHGs section in their Student Activity Sheet and then share out what they learned from the GHG Emission chart.



#### **Additional Guidance**

3: If students struggle to recall the previous lesson, prompt them to consider what phenomena they examined or what activities they engaged in. Stated in Lesson 5, students will most likely have heard the terms climate change, global warming, and greenhouse gases. However, they have not made a concrete connection between global temperature increase with human activity, which begun at the start of the Industrial Revolution (late 1700s-early 1800s).

Background information resources-

Global Climate Dashboard:

<https://www.climate.gov/maps-data>

Climate Time Machine:

<https://climate.nasa.gov/interactives/climate-time-machine>

Carbon Cycle - GlobalChange.gov:

<https://www.globalchange.gov/explore/carbon-cycle>

Carbon Cycle interactive presentation:

<https://cleanet.org/resources/43438.html>

What Contains carbon? activity:

<https://www.calacademy.org/educators/lesson-plans/what-contains-carbon>

Carbon Cycle Role Play activity:

<https://www.calacademy.org/educators/lesson-plans/carbon-cycle-role-play>

Keeling Curve” of Carbon Dioxide Becomes

Chemical Landmark video

[https://www.climate.gov/news-](https://www.climate.gov/news-features/videos/keeling-curve-carbon-dioxide-levels-becomes-chemical-landmark)

[features/videos/keeling-curve-carbon-dioxide-levels-becomes-chemical-landmark](https://www.climate.gov/news-features/videos/keeling-curve-carbon-dioxide-levels-becomes-chemical-landmark)

Carbon Dioxide: Earth's Hottest Topic is Just

Warming Up:



**Suggested Prompts:**

- What connections can you make about human activities and GHGs from the infographic?
- What GHGs are emitted?
- Which GHG is emitted the most?

**Listen for student responses such as:**

- We emit GHGs mainly from transportation, electricity, generating heat, and industry.
- GHGs include carbon dioxide, methane, and nitrous oxide, plus some others gases.
- CO<sub>2</sub> is emitted the most (85%) by human activities.

Now that students have a basic understanding about the GHE, GHGs and their sources ask students, what they think happens to the CO<sub>2</sub> after it is emitted (released) into the atmosphere. Accept all student ideas.

Next, show the “Following Carbon Through the Atmosphere” visualization:

<https://www.nasa.gov/feature/goddard/2016/eye-popping-view-of-CO2-critical-step-for-carbon-cycle-science>

Repeat the visualization and ask students to state what they observe happening to CO<sub>2</sub> once it is emitted into the air (CO<sub>2</sub> disperses through the atmosphere, most CO<sub>2</sub> is emitted in the Northern Hemisphere and stays there as that is where most people and industry are found).

**Suggested Prompts:**

- What happens to CO<sub>2</sub> after it is emitted into atmosphere?
- Where does it look like most of the CO<sub>2</sub> is coming from?

**Listen for responses, such as:**

- CO<sub>2</sub> seems to be coming mostly from areas that have many people, which makes sense based on our previous lessons.
- Carbon flows in a cycle, similar to how the water cycle works.

5. (45 min) Now bring in the concept of the Carbon Cycle by asking students where they think all of the extra CO<sub>2</sub> that is being emitted into the atmosphere originally came from, where the carbon in carbon dioxide comes from, and where it is going to end up (conservation of matter).<sup>5</sup> Accept all student ideas.

Using the Data Sheets, review the basic Carbon Cycle diagrams (Figure 6.2 and Figure 6.3) and have students share out their observations. Have them write down their observations of what they can decipher from the images for where carbon is stored (sinks) and carbon dioxide is released (sources). Students write down their responses on the Connecting CO<sub>2</sub> and the Carbon Cycle section of their Student Activity Sheet.

**Suggested Prompts:**

- Where is carbon stored (sink)?
- Where is carbon released (source)?

<https://www.climate.gov/news-features/understanding-climate/carbon-dioxide-earths-hottest-topic-just-warming>

Global Warming: Carbon Dioxide and the Greenhouse Effect video:

<https://rmpbs.pbslearningmedia.org/resource/phy03.sci.ess.watcyc.CO2/global-warming-carbon-dioxide-and-the-greenhouse-effect/#.WeoyhhNSxBw>

Global Warming: The Physics of the Greenhouse Effect:

<https://rmpbs.pbslearningmedia.org/resource/phy03.sci.phys.matter.greenhouse2/global-warming-the-physics-of-the-greenhouse-effect/#.Wq9bgmaZPdc>

Global carbon Dioxide Emissions infographics:

<http://www.wri.org/blog/2014/05/history-carbon-dioxide-emissions>

World Passes 400 PPM Threshold Permanently graph:

<http://www.climatecentral.org/news/world-passes-400-ppm-threshold-permanently-20738>



#### Strategies for this Initial Ideas Discussion

4: In this discussion, students should lay out the path for the activities they will engage in today. Use the prompts to ensure that students do this heavy lifting to generate ideas.



**Listen for responses, such as:**

- Carbon flows in a cycle, similar to how the water cycle works.
- Carbon is stored in the atmosphere, ocean, and on land in plants, animals and the ground, etc.
- Carbon is released from volcanoes, forest fires, factories, soils, plants and animals, etc.
- CO<sub>2</sub> flows around the world, most of it is released and stays in the Northern Hemisphere (that is where most people live and industry is located).

Introduce the online interactive “Carbon Dioxide and the Carbon Cycle”<sup>6</sup>

<https://rmpbs.pbslearningmedia.org/resource/pcep14.sci.ess.co2cycle/carbon-dioxide-carbon-cycle/#>

Give a brief demonstration on how to use the interactive. Students will work in partners to complete the investigation and answer the interactive on the application section of their Student Activity Sheet.

Have the interactive website url pre-bookmarked on student computers or tablets. If these resources are unavailable, then project it from the teacher’s computer/smartboard. If technology is not available, make color copies of each interactive slide packet for each team of two students:

After students have completed the interactive activity, ask them to explain what they now know about carbon: where and how much is stored (sinks), where and how much is released (sources), describe how carbon moves from one part of the environment to another (atmosphere, geosphere, biosphere, hydrosphere), and consider what role natural events and human activities play in the cycling of carbon throughout Earth. Students write down their responses on the Connecting CO<sub>2</sub> and the Carbon Cycle section of their Student Activity Sheet.

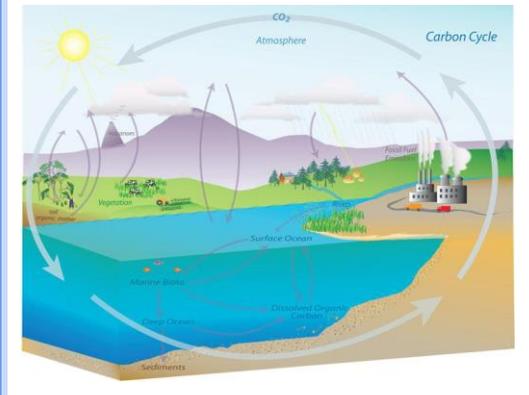
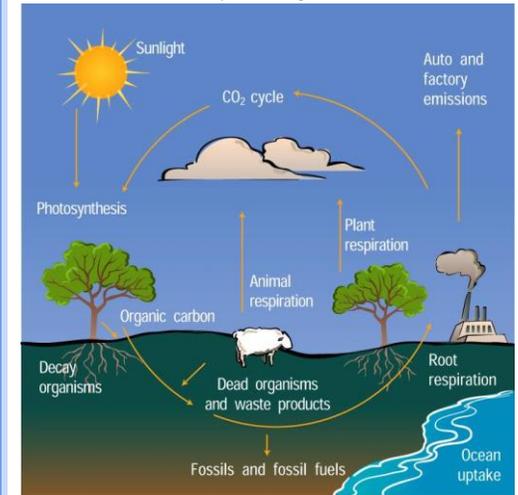
**Suggested Prompts:**

- Where and how much carbon and CO<sub>2</sub> is naturally stored and released on Earth?
- Where does the carbon in CO<sub>2</sub> from fossil fuels originally come from?
- How can we know that we are releasing CO<sub>2</sub> into the atmosphere from human activities that uses fossil fuels?
- How do human activities affect the balance and flow of the Carbon Cycle?

**Listen for responses, such as:<sup>7</sup>**

- We see that carbon is stored in different “reservoirs” on Earth (water, air, land, living things) and it is cycled throughout the Earth in different amounts and timeframes.
- All living things have carbon in them. When these things die, they turn into fossil fuels after millions of years.
- When humans use fossil fuels, which are stored underground in a sink, and burn them for energy the carbon is released by this process and acts as a source carbon dioxide in the atmosphere.
- Human activities change the natural concentration of CO<sub>2</sub> in the atmosphere and the balance of the Carbon Cycle. Human activities act as a source that releases CO<sub>2</sub> into the atmosphere, which is happening at a faster rate than natural processes can take it out of the atmosphere and store it.

6. (15 min) Ask students to think about how this change in the Carbon Cycle balance from adding more GHGs to the atmosphere is changing how the Greenhouse Effect (GHE) works.

**Example / Sample****5. CO<sub>2</sub> and Carbon Cycle Diagrams:**

**Suggested Prompts:**

- How do you think human activities that burn fossil fuels, which release carbon in the form of CO<sub>2</sub>, affects the levels of GHGs in the atmosphere and how the Greenhouse Effect works?

**Listen for student responses such as:**

- Human activities that burn fossil fuels add more CO<sub>2</sub> to the atmosphere and that causes the GHE to trap even more heat and warm the Earth more.

As a class, watch and then discuss the basics of GHGs, the GHE, and what adding more CO<sub>2</sub> to the atmosphere from burning fossil fuels does to the natural balance of Earth's temperature.

"Climate Change Basics" video: <http://cleanet.org/resources/45172.html>

Have a whole class share discussion to assess student understanding of GHGs, the natural GHE and how human activities that release more GHGs are causing an enhanced or amplified GHE, which results in global warming. Bring in the opportunity to discuss ideas and solutions on how humans can also think of ideas and solutions to address the observed human-caused climate change. Students complete the CO<sub>2</sub> to Climate Change Connections section on their Student Activity Sheet.

**Suggested Prompts:**

- What is the main source of additional CO<sub>2</sub> that is being added to the atmosphere?
- How does this change the Greenhouse Effect?
- What does this change do to the temperature of Earth?
- What can we do to change the amount of CO<sub>2</sub> that we release into the atmosphere and the effects of it?

**Listen for student responses such as:**

- Greenhouse gases are naturally occurring and good but humans are increasing the amount of them, especially CO<sub>2</sub>, in the atmosphere by burning fossil fuels.
- The Greenhouse Effect is getting stronger since more CO<sub>2</sub> is being added by humans to the atmosphere.
- The Earth's temperature is rising because more GHGs, like CO<sub>2</sub>, are in the atmosphere because of humans burning fossil fuels.
- We can reduce our use of fossil fuels and conserve energy to slow down global warming.

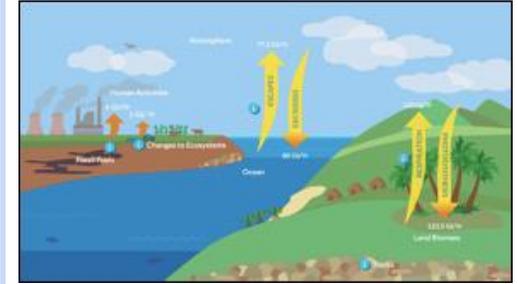
**7. (5 min) It is now time to ground the students in the process (focus question) and decide on the next step moving from a correlational connection to a causal mechanism. Students write down their responses on the Next Steps section of their Student Activity Sheet.**

**Suggested Prompts:**

- What have we figured out so far?
- Does this bring us closer to connecting human activity to the global temperature trend?
- What from our list of human activity might help us connect the two? Alternatively, maybe you have a different idea from what is on the list.

**Example / Sample**

6. CO<sub>2</sub> and Carbon Cycle Online Interactive:

**Differentiation Strategies and Alternate Activities**

**7:** For students who may begin to use the words "greenhouse effect" or "greenhouse gases," have them share their findings with their partners.

Notes: The amplified greenhouse effect is caused by human activities that release GHGs into the atmosphere. Use the greenhouse effect animation to:

- See a model of the how the greenhouse effect works.
- Compare and contrast how changing the GHG concentrations of the atmosphere affects the Earth's temperature



**Listen for student responses such as:**

- *We figured out that human population has increased and more people means more energy use.*
- *Energy use, mainly from fossil fuels, has also increased a lot so more GHGs are emitted.*
- *Fossil fuels release GHGs, like CO<sub>2</sub>, and they trap heat, warming the atmosphere and Earth.*
- *Humans use a lot of fossil fuel energy, but we can take action to reduce their use and effects.*

**8. (5 min) Ask students to brainstorm what our next steps should be in our investigation.<sup>8</sup>****Suggested Prompts:**

- *What should we make sure to do in our next class?*
- *What should we investigate next to understand how temperatures on Earth are warming?*

**Listen for student responses such as:**

- *We should do an investigation that shows CO<sub>2</sub> traps heat and causes the temperature to rise.*
- *Let's make a model that shows more CO<sub>2</sub> in the air causes warmer temperatures.*

The **natural greenhouse effect** keeps Earth's surface warmer (avg. global temp 52°F) than it would be otherwise. Without this phenomenon, Earth's surface would be too cold to support life (including human life) and all water would be frozen (avg. global temp 1°F).

The Greenhouse Effect starts with some of the energy from the Sun warming the surface of the Earth and some of it being reflected back out to space.

The Earth's surface emits heat from being warmed by the Sun. Some of the heat escapes into space and some of the heat is absorbed and reemitted by certain gases in the atmosphere, called greenhouse gases (GHG), which include water vapor, carbon dioxide, methane, and nitrous oxides. The GHGs essentially insulate the planet and allow temperatures to be warm enough to allow Earth to be habitable and have liquid water. Human activity has altered the natural balance of GHGs (e.g. increasing CO<sub>2</sub> concentrations), which has been observed in the warming of global temperatures.

**Formative Assessment Opportunities**

**8:** Ask students to complete an exit slip restating what they figured out in this lesson and/or what they think we should do in the next lesson.



## Alignment With Standards

### ***Building Toward Target NGSS PE***

- **MS-ESS3-5:** Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

### ***Building Toward Common Core Standard(s)***

*ELA/Literacy -*

**RST.6-8.1:** Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-5)

*Mathematics -*

**MP.2:** Reason abstractly and quantitatively. (MS-ESS3-5)

**6.EE.B.6:** Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.

(MS-ESS3-5)

**7.EE.B.4:** Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS3-5)

