

## Lesson Adaptation Activity: Engaging in Argument from Evidence

### Related MA STE Framework Standard:

**MS-ESS3-4.** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

- [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]

### Lesson Description & Introduction

*In this middle school earth science lesson, students are gathering evidence to answer the question: What is causing the average global temperature on Earth to increase? Students will examine data on human population growth, energy consumption, carbon emissions from fossil fuels, atmospheric carbon dioxide levels, carbon sources and sinks, volcanic activity, and global temperature to find evidence to construct their arguments.*

**Ms. Maxie:** Good morning, class. Last time we talked about the effect of greenhouse gases on the Earth's average temperature and looked at an animation that explained this. Could someone remind us what greenhouse gases are and what role they play in the "greenhouse effect"?

**Valerie:** Greenhouse gases trap heat in the atmosphere so they make Earth warmer.

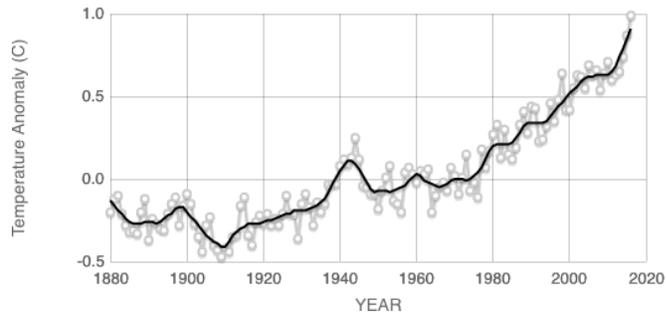
**Ms. Maxie:** Great, does anyone want to add anything else?

**Jayden:** Some greenhouse gases are carbon dioxide, water vapor, and methane.

**Sam:** The greenhouse effect is needed for life on Earth. Without it, the Earth would be much colder.

**Ms. Maxie:** Great. Speaking of Earth's temperature...who can tell us what is going on in this graph? In this graph, zero represents the average global surface temperature from 1951-1980, which is our reference point. And temperature anomaly means temperature "irregularity" from the reference. I'll give you a minute to think about your answers.

## GLOBAL LAND-OCEAN TEMPERATURE INDEX



Source: climate.nasa.gov

**Ms. Maxie:** Jacob?

**Jacob:** It's showing how the temperature has changed over time.

**Ms. Maxie:** Could you describe how it's changed?

**Jacob:** The average global surface temperature has been increasing since around 1910. After around 1970 the temperature is always above the reference point of zero. Right now it's around 1 degree Celsius higher than the reference.

**Ms. Maxie:** Wonderful, today you are going to use what you learned about greenhouse gases and the greenhouse effect and look at some evidence, including this graph, to answer the question on the board:  
*What is causing the average global temperature on Earth to increase?*

## Lesson Adaptation A

**Ms. Maxie:** You will be working in groups to analyze the data. We will then have a discussion on your answers. *Ms. Maxie provides students with graphs and information. After students analyze the data, the following dialogue occurs.*

**Ms. Maxie:** All right class, each group will share their claims and I will write them on the board. Make sure to include your evidence.

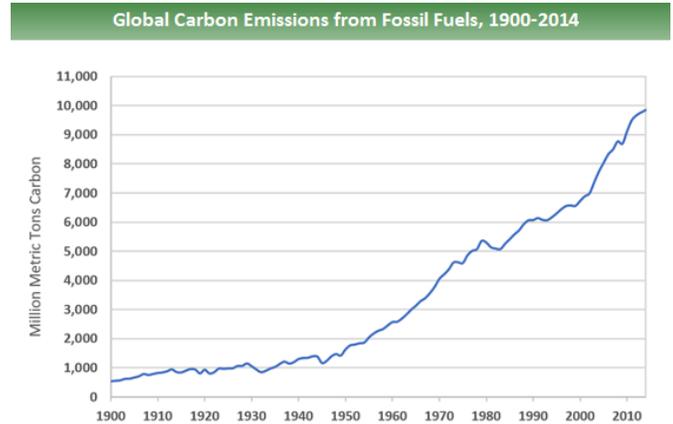
**Sam:** We think that burning fossil fuels is increasing Earth's temperature. Burning fossil fuels releases carbon dioxide. We have a graph that supports this (right). It shows how carbon emissions from fossil fuels are increasing over time.

**Valerie:** Our group thinks that cutting down trees is increasing Earth's temperature. Trees take in carbon dioxide. We found an article on National Geographic that says that 20% of the Amazon Rainforest has been cut down in the past 40 years. All of those trees that are now gone can't take in the carbon dioxide in the atmosphere, so it's making the Earth warmer.

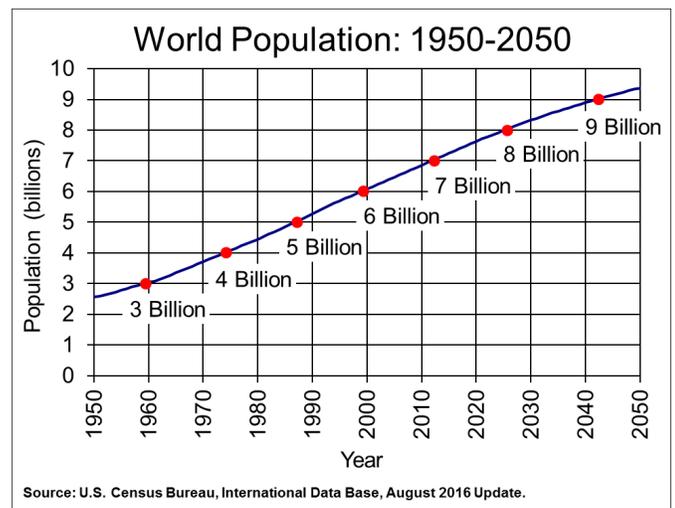
**Joseph:** We said that humans are causing Earth's temperature to increase. Human activity increases carbon dioxide. We found a graph that shows how the human population has increased a lot in the past 50 years (right).

**Sue:** We think that volcanic activity increases Earth's temperature. When volcanoes are active, they release carbon dioxide.

**Ms. Maxie:** Great job class. We need to wrap up. Tomorrow, you will make posters to present your claims.



<https://www.esrl.noaa.gov/gmd/ccgg/trends/full.html>



<https://www.census.gov/population/international/data/idb/worldpopgraph.ph>

## Lesson Adaptation B

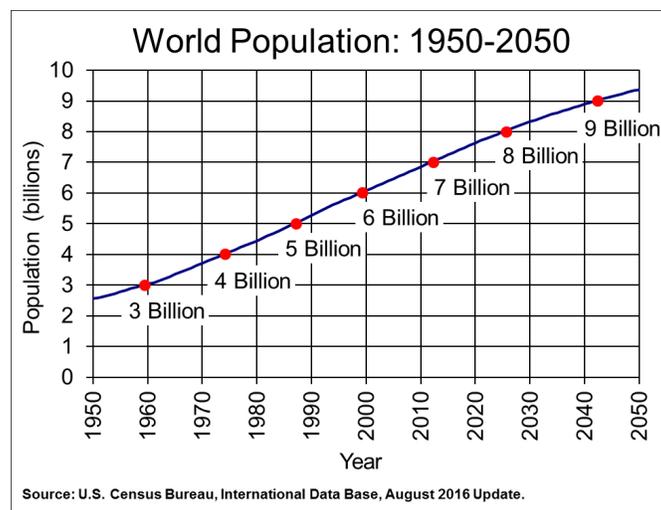
**Ms. Maxie:** Please take out your notebooks. You will be taking notes on the evidence in the presentation to answer our driving question.

**Ms. Maxie:** Here is our first source of information (graph on the right). What should we do first before interpreting the graph?

**Valerie:** We should look at the title and the x and y-axis labels and scales.

**Ms. Maxie:** Wonderful. Who can tell us about those?

**Sam:** The x-axis shows time in years from 1950-2050. And the y-axis shows the population in billions with a scale from 0 to 10.

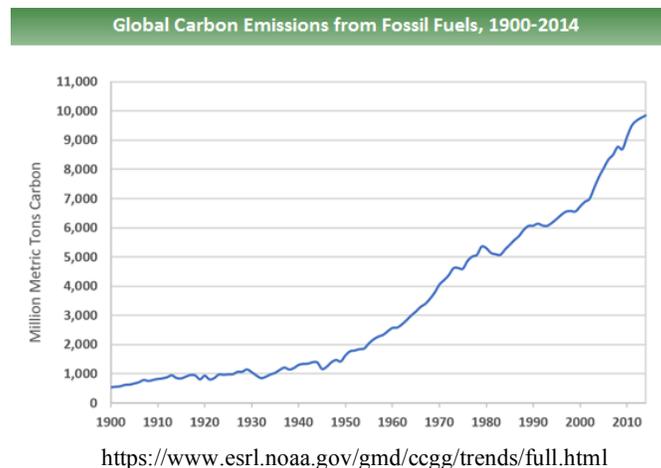


<https://www.census.gov/population/international/data/idb/worldpopgraph.php>

**Ms. Maxie:** Great, so we are looking at a graph showing the change in human population from 1950 to present and the projected population increase from present to 2050. So we can see that the world's population has more than doubled in the past 50 years. Now on this next graph (on the right) what do we see?

**Sue:** The graph shows the global carbon emissions from burning fossil fuels from 1900-2014.

**Ms. Maxie:** Right, and who can describe the trend we see?



**Joseph:** The carbon emissions steadily increased from 1900 to around 1950. After 1950 the line gets much steeper, so that means that more fossil fuels are being burned and more carbon emissions are being released.

**Ms. Maxie:** Great. And could someone tell us a few examples of fossil fuels and why they are used?

**Valerie:** Humans burn oil, coal and natural gas for energy. Fossil fuels have lots of carbon in them and when they are burned, carbon dioxide is released.

**Ms. Maxie:** Excellent, let's continue. *Ms. Maxie goes through the remainder of the presentation and pauses for student input. At the end of the presentation, she explains that the increase in the world's human population has led to increased greenhouse gas emissions, such as carbon dioxide, due to human activity (e.g. burning fossil fuels). Increased levels of greenhouse gases have led to a rise in the average global temperature.*

## Lesson Adaptation C

**Ms. Maxie:** You will be working in groups to analyze the data. You will then have a discussion on your answers. You all will be responsible for talking directly to each other in order to figure out the strongest claim for our question. Make sure you are agreeing and disagreeing with each other. You also want to make sure you are supporting your claims with evidence. *Ms. Maxie provides students with graphs and information. After students analyze the data, the following dialogue occurs.*

**Ms. Maxie:** All right class, each group will share their claims and I will write them on the board. Make sure to include your evidence and reasoning. After you share your answers, we will discuss them as a class.

**Sam:** We think that burning fossil fuels is increasing Earth's temperature. Burning fossil fuels releases carbon dioxide.

**Emily:** I agree with you, but could you explain more about the activity of burning of fossil fuels and how this affects the Earth's temperature?

**Sam:** Sure. Humans burn oil, coal and natural gas, which have lots of carbon in them. When they're burned, carbon dioxide is released.

**Joseph:** We also agree with Sam's group. And we think that increased human population is the main cause of the Earth's temperature increase. Humans burning fossil fuels for energy is a main source of carbon dioxide. Carbon dioxide is a greenhouse gas, which increases the Earth's average temperature.

**Valerie:** We agree with Sam's and Joseph's groups. We also think that deforestation is leading to an increase in the Earth's temperature. Trees take in carbon dioxide so if there are fewer trees, then there is more carbon dioxide in the atmosphere. Like Joseph said carbon dioxide is a greenhouse gas. It absorbs heat and makes the Earth warmer.

**Sue:** We actually disagree that humans are the main cause of the increase in global temperature.

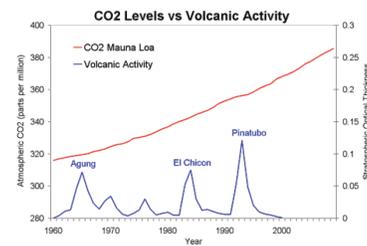
**Sam:** What's your evidence for that?

**Sue:** We think that the data shows that Earth's temperature has changed in the past before the human population was so great. For example, volcanic activity increases Earth's temperature because carbon dioxide is emitted. So the Earth's temperature has increased naturally from things like volcanic activity.

**Valerie:** You're right that natural causes like volcanic activity have caused the Earth's temperature to change in the past. But I found this graph on carbon dioxide levels and volcanic activity (right). It shows that atmospheric CO<sub>2</sub> levels have risen continuously since 1960, even when there was no volcanic activity. *Graph : <http://ngss.nsta.org/Resource.aspx?ResourceID=366>*

**Sam:** I also found another graph that compares the carbon dioxide emissions from volcanic activity and burning fossil fuels and it shows that burning fossil fuels has led to much greater carbon dioxide emissions when compared to volcanic activity since 1750.

**Ms. Maxie:** Wonderful job everyone. Now you will individually write a reflection to answer the question on the board (*What is causing the average global temperature on Earth to increase?*). Feel free to change or tweak your original answers based on the discussion you all just had.



## Lesson Adaptation D

**Ms. Maxie:** You will be working in groups to analyze the data. You will then have a discussion on your answers. You all will be responsible for talking directly to each other in order to figure out the strongest claim for our question. Make sure you are agreeing and disagreeing with each other. You also want to make sure you are supporting your claims with evidence. *Ms. Maxie provides students with graphs and information. After students analyze the data, the following dialogue occurs.*

**Ms. Maxie:** All right class, each group will share their claims and I will write them on the board. Make sure to include your evidence and reasoning. After you share your answers, we will discuss them as a class.

**Sam:** We think that burning fossil fuels is increasing Earth's temperature. Burning fossil fuels releases carbon dioxide.

**Joseph:** We agree with Sam's group. And we think that the increased human population is the main cause of the Earth's temperature increase. Humans burning fossil fuels for energy is a main source of carbon dioxide. Carbon dioxide is a greenhouse gas, so higher levels of carbon dioxide increase the Earth's average temperature.

**Sue:** We disagree with Joseph's group. We think that the data shows that Earth's temperature has changed in the past before the human population was so great. For example, volcanic activity increases Earth's temperature because carbon dioxide is emitted. So the Earth's temperature has increased naturally.

**Valerie:** We agree with Sam's and Joseph's groups. We also think that deforestation is leading the increases in the Earth's temperature. Trees take in carbon dioxide so if there are fewer trees, then there is more carbon dioxide in the atmosphere. Like Joseph said carbon dioxide is a greenhouse gas. It absorbs heat and makes the earth warmer.

**Ms. Maxie:** Wonderful job everyone. Now you will individually write a reflection to answer the question on the board (*What is causing the average global temperature on Earth to increase?*). Feel free to change or tweak your original answers based on the discussion you all just had.

## Ordering of Adaptations

**Directions:** Order the four adaptations (A-D) along the Science Practice Continuum (Levels 1-4) for the Engaging in Argument from Evidence practice.

	Level 1	Level 2	Level 3	Level 4
Adaptations				