



Lesson 5: What was Earth's temperature like in the past?

MS Climate Unit

Previous Lesson....Where we've been: We found out that other parts of the world are also changing and getting hotter.

	This Lesson....What we are doing now: This lesson explores what the world's temperature trend was in the past and whether temperatures have changed recently.		
Lesson Question	Phenomena	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), <i>New Questions and Next Steps</i>
<p>L5: What was Earth's temperature like in the past?</p> <p>(1.5 periods)</p>  <p><i>Building toward</i> ↓ <u>NGSS</u> <u>PEs:</u> <u>MS-</u> <u>ESS-3-</u> <u>5</u></p>	<p>Trend and Variations video</p> <p>Global Temperature 1880's to Present</p> <p>A Timeline of Earth's Average Temperature infographic</p> <p>Earth's Temperature as a Rollercoaster video</p> <p>Summary reading on how scientists determine Earth's temperatures in the distant past</p> <p>Summary reading about the Industrial Revolution</p>	<p>Analyze and interpret data... of graphical displays about global temperature at different timescales to identify linear and nonlinear relationships.</p> <p>Obtain, evaluate, and communicate information... by critically reading scientific texts adapted for classroom use to determine the central ideas about the changes in human activity resulting from the Industrial Revolution.</p>	<p>We decided to look at why the world's temperature is getting hotter and to look at more data over time to see if this is a trend.</p> <p>We have some initial ideas about what we mean by a trend. We think it is a pattern. A trend can be increasing, decreasing, or stay the same over time. An increasing trend in temperature on a graph shows a line going up. Some trends are cyclical.</p> <p>We watch a video to understand about trends. One thing we need to do when we look at a graph is pay attention to the overall pattern of the graph. We can draw a line on the graph (trendline) that helps us see the pattern. We give names to the kinds of patterns we see in trends - increasing, decreasing, stable, linear relationship and nonlinear relationship.</p> <p><i>We are wondering about the trend of Earth's temperature:</i></p> <ul style="list-style-type: none"> Is this trend of increasing temperature long-term, or is it short term? We want to know if the recent increase in temperature is unusual or not? <p>We know that there used to be oceans in Colorado and there were ice ages. If we look at just the past 200 years, we might still be looking at the "dog's feet section" in the video. We need to look at a longer period of the Earth's history.</p> <p>We decide to look at some more data over a longer period of time. We discuss what patterns we notice in the graph over time.</p> <p>On graphs about Earth's temperature, we notice that the x-axis represents time and the y-axis represents temperature. The trends for temperature look different depending on the timescale. This seems true to what we can experience. It's hard for us to know whether the trend is changing over many years when temperatures are going up and down. We give a name to the daily trends as "weather", and the longer trends as "climate".</p> <p>We watch an animation on Earth's temperature trend.</p> <p>We figure out that:</p> <ul style="list-style-type: none"> Over time for many thousands of years, the temperature was gradually increasing. Then, it flattened out and there was something called a "mini-ice age". In the last hundred years, the temperature shot up quickly. We noticed that there were human activities like inventions and the "Industrial Revolution" and fossil fuel use that happened just before the temperature rapidly shot up. <p><i>We are wondering:</i></p> <ul style="list-style-type: none"> How do scientists know what the temperature was before scientists could record temperatures?

			<ul style="list-style-type: none"> • <i>What methods do scientists use to measure what the temperature was in the past?</i> <p>We read that scientists use ice cores to look at samples from where there has been ice for 400,000 years or more in Antarctica. The lower they go down the older the ice. We call this superposition.</p> <p>We also look at global temperature through the last 200 years or so, and see that the temperature is going up. We say that the trend is that the temperature worldwide is increasing.</p> <p><i>It appears for a majority of Earth's history that the temperature went up and down more slowly and was relatively stable, but then over the last 200 years it went up much more quickly. We are wondering:</i></p> <ul style="list-style-type: none"> • <i>We wonder what allows Earth's temperature to go up and down.</i> • <i>Why did the temperature bounce around within a small range for long periods of time?</i> • <i>What about human activity, which started in the Industrial Revolution, could this help us explain why there was such a big temperature increase in the last 200 years?</i> <p>We decide we need to know a bit more about what helped keep the Earth's temperature stable for so long and also about the effects of the Industrial Revolution since that was when temperatures started to rise a lot.</p>
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Next Lesson....Where we're going: We want to know whether human activities release greenhouse gases, like CO₂, and whether they can cause temperatures on Earth to increase.





Getting Ready: Materials Preparation

Materials For Each Group

Preparation of Materials (30 min.)

- Review and bookmark on teacher computer/smartboard, classroom computers or tablets to view as a class:
 - Trend video (dog and person)
<https://www.youtube.com/watch?v=e0vj-0imOLw>
 - Global temperature 1880s-Present
<http://climate.nasa.gov/vital-signs/global-temperature/>
 - A Timeline of Earth's Average Temperature graph
<https://xkcd.com/1732/>
and downloadable file (click on image to zoom in)
https://imgs.xkcd.com/comics/earth_temperature_timeline.png
 - Earth's Temperature as a Rollercoaster video
<https://www.climate.gov/news-features/videos/earths-temperature-history-roller-coaster>
- Copies of Student Activity Sheet (1 per student)
- Have Driving Question Board centrally located and updated.

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 this lesson with very different levels of understanding and alternate conceptions. Some may think that global warming is a hoax and is not happening, and some may think ONLY humans cause it. At the end of the lesson, students should be able to see that the Earth is indeed warming, but it was also warming before humans had a huge impact. However, the scary trend is how fast the increase has happened since humans have been using fossil fuels.

Linking Our Understanding to Scientific Terminology

- Increasing, decreasing, constant, no trend
- Ice Core Data
- Industrial Revolution





Lesson 5 Learning Plan: What was Earth's temperature like in the past? (75 min)

1. (5 min) Begin with a Do Now to activate their previous knowledge from the last lesson. Use a Consensus Building Discussion ¹ to help reorient students in the story line. Use the following prompts to help students articulate what they figured out in the last lesson. Students will be answering on their paper first (3 minutes) and then share out (2 minutes).

Yesterday we decided that we needed to look at more data over time to determine if this was really a trend.

Suggested Prompts:

- What did we figure out last time?
- What did we investigate?

Listen for *student responses* ² that refer to what we figured out last time, such as:

- We investigated the albedo and temperature of Earth to see if they are changing.
- We figured out that other parts of the world are getting warmer, too.

2. (5 min) Next, shift to a Sharing Initial Ideas Discussion ³. Use the following prompts to guide students to articulate what they think they should focus on in today's lesson.

Suggested Prompts:

- In your own words, what is a trend?
- Where have you seen trends before in your life?
- At this point in our investigation, do you think that the rising temperatures are a trend?
- What do you think we could/should do to help us decide whether this is a trend?
- How will we know if this is a trend?

Listen for *student responses* such as:

- To find out if it is a trend, we need to learn about what a trend is. We need to look at data over time to see if it is a trend or something unusual. Then we need to find out where the data is coming from and decide if we trust it.



Teacher Supports & Notes



Strategies for this Consensus Building Discussion

1: 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 do next in this lesson.



Additional Guidance

2: If students struggle to recall the previous lesson, prompt them to consider what phenomena they examined or what activities they engaged in. Refer to the rising heat video from day 1.



3. (10 min) Now that students have decided the path of the lesson, draw the students' attention to the part of their Student Activity Sheet where they will summarize or draw what a trend is from watching a video. Show the "Trends and Variations" video and discuss what a trend is.

<https://www.youtube.com/watch?v=e0vj-0imOLw>

Suggested Prompts:

- What do you notice about the person and the dog?
- What is a trend?

Listen for student responses such as:

- *Even though the dog is walking all over the place, they are still walking up (increasing trend)*
- *A trend is an overall pattern over time. There might be little changes along the way, but we are looking at the bigger picture to see real trends.*

Discuss the four major types of trends, and have the students draw the four types on their Student Activity Sheet.

Suggested Prompts:

- What are the four different types of trends?
- What are the differences between the various trends?

Listen for student responses such as:

- *An increasing trend means that both of the axes are increasing.*
- *A decreasing trend means that one goes down while the other goes up.*
- *A constant trend means that while one goes up, the other stays the same.*
- *No trend means that you can't draw a line because the data is all over the place.*

Have students apply what they have learned about trends to the graph of the world's human population over time.

Suggested Prompts:

- What do you notice about the world's human population over time?
- Does this make sense based on what you've learned about in history classes?
- What do you think will happen to the population as time goes on?

Listen for student responses such as:

- *A long time ago the population was mostly constant.*
- *The world's human population has been increasing for a while, but recently it's been increasing much faster.*

Make sure students have a summary or drawings in their observations section of the Student Activity Sheet so that they can refer back to it later.



**Strategies for this
Initial Ideas Discussion**

3: 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.



4. (10 min) Have the students look at the graph and visualization of global temperatures.

Show the “Global Temperatures 1880s-Present” graph and visualization:

<http://climate.nasa.gov/vital-signs/global-temperature/>

Ask students to describe the trends they observe. Draw a line on the graph if the technology allows so that students can see the increasing trend and discuss the color change of the visualization (color change represents warming temperatures worldwide). Refer students back to their Do Now answers and have a discussion⁴.

Suggested Prompts:

- Look back at your answers to the Do Now. Are these increased temperatures really a trend?
- What kind of trend do we see in this data?
- Now that we know there is a trend, is about 150 years of information enough?

5. (20 min) Once you have completed the discussion, students should have said that 150 years is not enough time to know the Earth's average temperature compared to the age of the Earth (4.5 billion years).

Show “A Timeline of Earth's Average Temperature” infographic to explore further back in time:

<https://xkcd.com/1732/>

and downloadable file (click on image to zoom in)

https://imgs.xkcd.com/comics/earth_temperature_timeline.png

Slowly scroll through the comic and highlight the temperature and important events in the world. Ask students what the temperature trend is like (VERY slow, steady increase in temperature or moving to the right of the graph, the warmer it gets). At the end of the graph point out the 1800s (where the graph from the previous slide started). Ask students to describe what the temperature is like from this point on to the present point (super sharp increase in temperature).

After going over the graph, show the short video “Earth's Temperature as a Rollercoaster”:

<https://www.climate.gov/news-features/videos/earths-temperature-history-roller-coaster>

Suggested Prompts:

- Has the Earth's temperature changed over a longer period of time (starting during the last ice age 22,000 years ago to present)?
- What things do you notice about the trend of Earth's temperature over a longer period of time (22,000 years vs. 200 years)?
- Are there any key events or changes that stand out in this graph? (start of Ind. Rev., fossil fuel use, etc.)
- Was there ever an increase that quickly in the first part of the timeline?
- How do we know the temperatures from before we had thermometers to measure it?

Listen for *student responses* such as:

- *No. There was a slow increase throughout the whole comic, but then right at the end there was a sharp increase.*



6. (10 min) Once you have completed the discussion around there being a gradual increase, but not really knowing where that data comes from, have students read the paragraph on Ice Cores in their Student Activity Sheet and summarize or draw what they read.

Suggested Prompts:

- What do you notice in this diagram?
- What do you wonder about?
- What's in here that can help us see if there's a link between human activities and temperature?

Listen for student responses such as:

- Scientists drill into ice and can find out the amount of CO₂ that was in the atmosphere at a certain time. The further down they drill the older the ice, so they can determine what the atmosphere was like thousands of years ago. There is a relationship between CO₂ and temperature, so they can calculate the temperature from the amount of CO₂ in the ice. Looking back at the comic, there was the Industrial Revolution, airplanes, and more fossil fuel usage that was happening around 1700-1800.
- How the heck do scientists know?

Have students analyze some ice core data -- see what it looks like, or watch a video about it: cleanet.org: <https://www.youtube.com/watch?v=oHzADI-XID8>. The video clearly explains the relationship between CO₂ and temperature.

7. (10 min) Have students read the half page in their Student Activity Sheet and record what they notice and wonder about ⁵ in the box underneath the reading. Push students thinking that the sharp increase really did not happen until humans started mass production of things in cities.

Suggested Prompts:

- What did you notice about the Industrial Revolution?
- What are you still wondering about?

Listen for student responses such as:

- There were a lot more people coming to the cities in the Industrial Revolution and they were building a lot more factories that were releasing the CO₂. They were also increasing their transportation by cars and inventing trains to transport the things that they made.

Conclusion: "What have we figured out so far?"

Suggested Prompts:

- What did we find out after we watched the trend video?
- What kind of trend did we decide is happening to our temperatures?
- What other questions do we have about the increase in temperatures on Earth?



Strategies for this Building Understandings Discussion

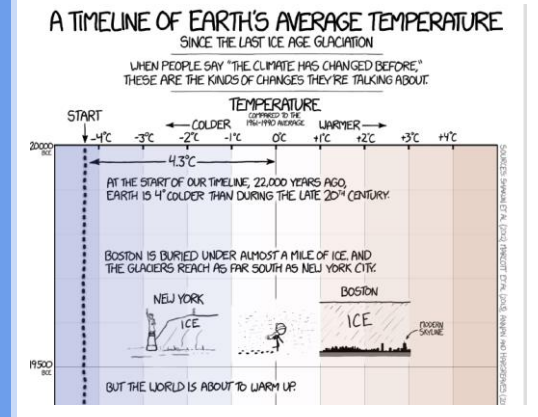
4: In order to involve as many students as possible in this discussion, you may want students to turn and talk then have one share out per table.

If students are struggling, refer back to the 4 types of trends slide and then ask specifically what type of trend is the climate data.



Example / Sample

5: Earth's Temperature Infographic::



Listen for *student responses* such as:

- *We figured out that trends are patterns that happen over time. We found out that the Earth has been very slowly warming, but there was a super crazy sharp increase in temperatures around the time of the Industrial Revolution, which has us thinking that humans and the factories have something to do with the increase in temperature.*
- *We also found out that scientists get this data from ice cores because the further you drill down, the older the ice (called superposition) and we can find out the amount of CO₂ from these cores. We still aren't sure how the amount of CO₂ fits into the increasing temperatures that we have seen recently, so we will need to investigate what types of things release CO₂.*

Record and post what we figured and what we are wondering on the Driving Question Board.

8. (5 min) Before dismissing students, ask student to brainstorm what our next steps should be in our investigations.⁸

Suggested Prompts:

- What should make sure to do in our next science class?
- What do we need to investigate next time we meet for science?

Listen for *student responses* such as:

- *We need to find out if human activities since the Industrial Revolution release CO₂ and cause Earth's temperature to rise.*



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 -

MP2: 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)

