



Lesson 5: Is it normal that world temperatures are rising this fast?

HS Climate and Resiliency Unit

Previous Lesson....Where we've been: We have determined natural and non-natural sources of greenhouse gases.

	This Lesson....What we are doing now: This lesson explores historical data to determine if the changes in global climate are normal for Earth or unusual.		
Lesson Question	Phenomena	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), <i>New Questions</i> and <i>Next Steps</i>
<p>L5: Is it normal that world temperatures are rising this fast?</p> <p>2 periods</p>  <div style="border: 1px solid gray; padding: 5px; margin-top: 10px;"> <i>Building toward</i> ↓ NGSS PEs: HS- ESS3-5 </div>	<p>Historic vs Current Atmospheric Greenhouse Gas Concentrations and Average Global Temperature Trends</p> <p>Article: The Last Time CO2 Was This High, Humans Didn't Exist</p> <p>Greenhouse Gases Info graphic: pie chart of earth greenhouse gas composition</p> <p>CO2 & Temp "hockey stick" graph</p>	<p>Analyze data to figure out how greenhouse gas concentrations are related to temperature trends.</p>	<p>Last class, we completed a computer simulation to understand the Greenhouse Effect.</p> <p>Then, we decided to figure out if it's normal that world temperatures are changing so fast. We have some initial ideas about how we can figure out how the greenhouse gases might be causing an impact on temperature rise and rate of change. We also have some initial ideas about how the Greenhouse Effect works and the different natural and non-natural sources of greenhouse gases in the atmosphere. We have heard that carbon dioxide (a greenhouse gas emitted by the burning of fossil fuels) levels are higher now than ever before.</p> <p>What data do we have about before? What is before? How long ago do we have to go back? We already looked at data 130+ years ago, how much further can we go back? We need to look at historical and current data over time for greenhouse gases and average global temperature.</p> <p>We split up into groups and jig sawed different data sets to see what we can figure out about greenhouse gas concentrations and temperature trends:</p> <ul style="list-style-type: none"> • Fossil fuel use and population growth (Data Set #1) • Global temperature and carbon dioxide concentrations (Data Set #2) • Carbon dioxide concentrations over time (Data Set #3) • Paleo ice core data (Data Set #4) • Average global temperature and fossil fuel carbon emissions (Data Set #5) • Climate model predictions (Data Set #6) • Greenhouse gas concentrations over time (Data Set #7) • Carbon dioxide and methane magnitude of impact (Data Set #8) <p>We have a discussion and we determine that:</p> <ul style="list-style-type: none"> • The spike in greenhouse gases and a theorized spike in temp that will follow is deadly • The rate is the key - ability for the planet to adapt, sudden warming • The more humans that are on the planet over time, the more fossil fuels we are using • Since humans have started using fossil fuels, the emission rate of CO2 has increased and the rate of temperature change has increased (It's getting hotter faster than before). • Temperature fluctuation is normal, natural, cyclical, but the current rate increase is not • We are leaving the normal amounts when we compare with data from 400,000 years ago • More greenhouse gases in the atmosphere, absorb more and re-radiate more IR radiation (heat) therefore reducing the amount of heat that can get out into space and increasing the global temperature. We are trapping more energy. <p>So then we relate our findings to come to a consensus claim about why global warming is happening and why we should be concerned about it?</p>

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			<ul style="list-style-type: none">Global warming is happening due to human action by burning fossil fuels for energy, causing an increase in average global temperature and it is concerning because the rate of increased temperature is happening so fast that the majority of life on earth can't adapt fast enough. <p>We figure out that now in year 20XX, we have elevated levels of greenhouse gases, which has been the case since the industrial revolution.</p> <p>We write a scientific explanation to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems.</p> <p>We have an explanation for how humans are causing climate change and how the rate of temperature rise is increasing. We are wondering - what impact does this have on people across the world, not just the hotter days in Denver.</p>
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Next Lesson....Where we're going: We will explore case studies to learn about the ways climate change is currently impacting people and other living things around the world.





Getting Ready: Materials Preparation

Materials For Each Group

- Copy of the [data sets](#) for jigsaw groups

Preparation of Materials (15 min.)

- Copies of articles
- Organized groups for jigsaw (if you want)
- [Slides](#)

Materials For Each Student

- [Student Activity Sheet](#)

Safety





Getting Ready: Teacher Preparation

Background Knowledge

ESS3 from the FRAMEWORK:

“Thus science and engineering will be essential both to understanding the possible impacts of global climate change and to informing decisions about how to slow its rate and consequences...”

Rate of and region of change matters for understanding climate change.

Cities are changing faster because of characteristics of cities - localized amplification because of the nature of cities like black top, resulting in heat islands in cities. But this isn't the entire explanation for climate change.

Overall regionally and globally human activities are increasing CO2 and greenhouse gases which result in global warming.

ESS3.C from the FRAMEWORK:

By the end of grade 8: Human activities have significantly altered the biosphere sometimes damaging or destroying natural habitats and causing the extinction of many other species. But changes to earth's environment can have different impacts (negative and positive) for different living things.

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.

ESS3.D from the FRAMEWORK:

By the end of grade 8: 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 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 and decisions and activities.

Alternative Student Conceptions

Students may have heard different theories about global warming from family members, friends, or the media. It is possible that they may not believe it to be true or that there are alternate explanations for the changes in global carbon dioxide concentrations.

Linking Our Understanding to Scientific Terminology

- Emissions
- Global Warming Potential (GWP)





Learning Plan: Is it normal that world temperatures are rising this fast?

(55 min)

1. (10 min) Have students complete the Do Now portion of their Student Activity Sheets. Then go over the student responses to get a sense for their answers and what they recall from the last class about the Greenhouse Effect.

2. (5 min). After this, guide students into a discussion to help reorient students in the story line. Use the following prompts to help students articulate what they figured out in the last lesson.

Suggested Prompts:

- What did we wonder about last class?
- We had some ideas about how to investigate our questions. What were our ideas?

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

- *Last class, we decided to figure out if it's normal that world temperatures are changing so fast.*
- *We have some initial ideas about how we can figure out how the greenhouse gases might be causing an impact on temperature rise and rate of change.*
- *We also have some initial ideas about how the greenhouse effect works and the different natural and non-natural sources of greenhouse gases in the atmosphere. We have heard that carbon dioxide (a greenhouse gas emitted by the burning of fossil fuels) levels are higher now than ever before.*
- *We are wondering if there is any data, we have from before. What is before? How long ago do we have to go back? We already looked at data 130+ years ago, how much further can we go back? We need to look at historical and current data over time for greenhouse gases and average global temperature.*

3. (20 min) Put students into jigsaw groups^A and explain that they only need to analyze one of the data sets on their own and that they will learn about the other data sets from the other members of their group. Then give them time to complete their student activity sheet for their data set, followed by time for them to share out with their groups.



Teacher Supports & Notes



Differentiation Strategies and Alternate Activities

A: There are a few ways you could do this jigsaw based on your students and the amount of time you want to spend on it. You could put students into groups of 8 randomly or intentionally.

You could also assign specific graphs to specific students as some of them may be easier to interpret than others.

Finally, you could provide time for all students who analyzed the same data set to discuss their graphs with each other before reporting back to their original groups and sharing out. This is beneficial to help students make sense of the data set with other students who looked at the same data set and ask clarification questions of each other. This also leads to better information when they share out the information from their data set.



Formative Assessment Opportunities

B: You could use the scientific explanations as a formative assessment to see what they got from the jigsaw and class discussion.



4. (10 min) Once students have had a chance to hear about all of the data sets, guide them into a Building Understandings Discussion using the following prompts.

Suggested Prompts:

- What are the main takeaways from the data sets?
- What does the data suggest about climate trends historically?
- What conclusions can we draw from the data?

Listen for *student responses* such as:

- *The spike in greenhouse gases and a theorized spike in temp that will follow is deadly*
- *The rate is the key - ability for planet to adapt, sudden warming*
- *The more humans that are on the planet over time, the more fossil fuels we are using*
- *Since humans have started using fossil fuels, the emission rate of CO₂ has increased and the rate of temperature change has increased.*
- *Temp fluctuation is normal, natural, cyclical, but the current rate increase is not*
- *We are leaving the normal amounts when we compare with data from 400,000 years ago*
- *More greenhouse gases in the atmosphere absorb more and re-radiate more IR radiation (heat) therefore reducing the amount of heat that can get out into space and increasing the global temperature. We are trapping more energy.*

5. (15 min) Give students an opportunity to write their scientific explanations^B in their Student Activity Sheets, as well as their new questions^C and next steps.

Suggested Prompts:

- What are you wondering now?
- How can we investigate/answer our new questions?

Listen for *student responses* that mimic the next row in the storyline, such as:

- *We have enough evidence to conclude that global warming is happening and that human activity is responsible. We are wondering if there are any effects already observable across the world.*
- *What current phenomena have been recorded or observed that are tied to global warming?*
- *We would like to read about news stories of people already affected by changes in average temperatures.*



Additional Guidance

C: At this time, you can check back with the driving questions board, especially if students are struggling to come up with questions



Alignment With Standards

Building Toward Target NGSS PE

- **HS-ESS3-5:** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems.

Building Toward Common Core Standard(s)

- **WHST.9-12.2:** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

