



# Maryland and Delaware Climate Change Education Assessment and Research (MADE CLEAR)

## Session 2: Examining Changes in Earth's Temperature and Atmosphere A Focus on Climate Change and the Next Generation Science Standards

### Overview

This session focuses on the mechanism (cause) of climate change and examining data related to the enhanced greenhouse effect. Teacher interns begin by debriefing the experience of engaging in the blended learning online sea level rise investigation, and (optionally) considering the potentially sensitive nature of the climate change education topic. They examine their own understanding of the causes and effects of climate change through a drawing activity, and then engage in a group activity to examine data related to the causes of climate change. Teacher interns consider strategies and activities to address the topic of climate change and related phenomena (e.g. enhanced greenhouse effect), as well as the incorporation of Next Generation Science Standards (NGSS) (including disciplinary core ideas, science and engineering practices, and cross-cutting concepts) into their science teaching. The session ends with an opportunity for the teacher interns to revisit their drawings and reflect on their thinking about the three dimensions of the NGSS related to climate change education.

### Objectives

Teacher interns will:

1. Examine their own understandings of the disciplinary core ideas (science content) related to the causes and effects of global climate change
2. Use real data to describe the nature of the relationship between greenhouse gases and global temperatures
3. Consider strategies for incorporating NGSS science and engineering practices and cross-cutting concepts into their science teaching
4. Find age-appropriate resources to support their teaching about the topic of climate change

### Materials

- [Sensitive topics in science education PPT presentation](#) (optional)
- Print copies of the [climate change drawing assessment](#) for each intern
- Colored pencils, markers, or crayons
- [Examining Evidence activity instructions](#) (available to interns electronically)
- Student computers (at least 1 per small group)
- [CO2 and Temperature Investigation PPT presentation](#)
- [NGSS Dimensions PPT presentation](#)
- Beach ball and clear plastic bag (optional)



Sessions were designed by the MADE CLEAR Learning Sciences Research Team ([www.ClimateEdResearch.org](http://www.ClimateEdResearch.org)) at the University of Maryland and implemented in courses taught by J. Randy McGinnis ([jmcginni@umd.edu](mailto:jmcginni@umd.edu)) and Emily Hestness ([hestness@umd.edu](mailto:hestness@umd.edu)). Please contact the instructors with any questions or comments.



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## Getting started

To debrief the online [Sea Level Rise investigation experience](#), begin the class session with small group discussions in which teacher interns respond to these questions: “*What did you learn from the online Sea Level Rise investigation experience?*” and “*What do you still want to know?*” You may also choose to ask questions or make comments about the ideas they provided in their completed investigation guides, or ask how they see 1) the blended (online and in-class) learning approach, and 2) the use of locally-relevant examples, as potentially applicable to their own teaching.

If interns completed the optional online [Climate Profile Survey](#), or if you want to engage in conversation about the potentially sensitive nature of the climate change topic, share the ideas provided in the [PowerPoint presentation on sensitive topics in science education](#).

## Procedure

### Engage

Introduce climate change as a salient topic in science education due to its presence in the Next Generation Science Standards – the first national standards document in the U.S. to include the topic of climate change. Allow teacher interns about 10 minutes to consider what they already know about climate change by completing the [drawing assessment](#) in response to the prompt: Draw all that you know about the causes and effects of global climate change.

Ask teacher interns to discuss their drawings in pairs or small groups, particularly the components they may have included related to temperature and greenhouse gases.

Present the questions:

- *What is the nature of the relationship between greenhouse gas concentrations and global temperatures at different timescales?*
- *How can we engage students in examining data to make sense of this relationship?*

Explain that teacher interns will be examining data in small groups in order to answer these questions.

### Explore

In this modified jigsaw activity, teacher interns will work in eight small groups (1A, 1B, 1C, 1D and 2A, 2B, 2C, 2D). Four of the groups (1A, 1B, 1C, and 1D) will examine atmospheric carbon dioxide data at different timescales, considering the guiding question “*How has CO<sub>2</sub> concentration in the Earth’s atmosphere changed over time?*”. The other four groups (2A, 2B, 2C, and 2D) will examine global temperature data, considering the question “*How has average global temperature changed over time?*”

Each group needs an electronic copy of the [Examining Evidence activity instructions](#). This page provides a link to the data that each of the eight groups will examine.

Allow groups about 15 minutes to complete Part A listed on the activity instructions. They are asked to examine their group's data and discuss their guiding question ("How has CO<sub>2</sub> concentration changed over time?" or "How has average global temperature changed over time?"). They also consider the questions:

- *What is the data source? Is it reputable?*
- *What story do you think the data is telling?*
- *What questions do you have about the data?*

After groups have completed Part A, they will combine with the other small group that shares their letter (1A & 2A, 1B & 2B, 1C & 2C, 1D & 2D) to complete Part B. Each of these four group combinations (now group A, B, C, and D) examined data extending over a similar timeframe.

Groups will discuss the question:

- *What does your data suggest about the relationship between temperature and carbon dioxide?*

Groups should be prepared to share the highlights of their conversation.

## Explain

To address the question "What is the nature of the relationship between greenhouse gas concentrations and global temperatures at different timescales?," ask each of the four groups (A, B, C, and D) to share the highlights of their group's discussion related to the question. Presentations should be very brief (1-2 minutes).

\*Graphs of group data are presented on slides 2-5 of the [Carbon Dioxide and Temperature Investigation PowerPoint presentation](#).

Share an example standard\* from the Next Generation Science Standards related to this topic:

\*Standard shown on slide 6 of the PowerPoint presentation

**Code:** MS-ESS3-5

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

**Clarification Statement and Assessment Boundary:**

*Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.*

Discuss how examining data can help students think about the causes of increasing global temperatures over the last century\*.

\*Slide 7 of the PowerPoint presentation shows temperature and carbon dioxide data from the past century compared to data from the past 400,000 years

Introduce the greenhouse effect as a key phenomenon that students would need to understand in order to understand the relationship between greenhouse gas concentrations and global temperatures. Do the data support the claim that human activity (e.g. burning fossil fuels) is currently enhancing the greenhouse effect?

If time allows, show an animation illustrating the concept, such as the Environmental Protection Agency (EPA) video here: <http://www.epa.gov/climatestudents/basics/today/greenhouse-effect.html>

\*Link is on Slide 8 of the [Carbon Dioxide and Temperature Investigation PowerPoint presentation](#)

You can also model a hands-on demonstration that shows the context of the greenhouse effect on the Earth by putting a beach ball (representing Earth) in a clear plastic bag, filling the bag (representing Earth's atmosphere as a protective layer) with air, and discussing the effects of excess fossil fuel burning.

Explain that science education researchers (e.g. Dove, 1996; Groves & Pugh, 1999; Boyes & Stanisstreet, 1993, 1997) have suggested that many students (and sometimes teachers) may come to the classroom with alternative conceptions about the enhanced greenhouse effect. For example, many learners conflate the enhanced greenhouse effect with the ozone hole (i.e., the hole in the ozone is allowing more solar energy to reach the Earth, increasing global temperatures).

## Elaborate

Teacher interns will now consider the kinds of teaching activities and strategies that can help to teach climate change related concepts.

Ask teacher interns to consider the data examination activity they just completed. Which of the NGSS science and engineering practices and cross-cutting concepts were modeled? How might additional ones have been incorporated? How do you see climate change as relating to the NGSS disciplinary core ideas in Earth Science?

\*The [NGSS Dimensions PowerPoint presentation](#) lists the practices (slide 2), cross-cutting concepts (slide 3), and Earth Science disciplinary core ideas (slide 4).

If time allows, invite teacher interns to examine teaching resources available on the CLEAN network website, a reviewed collection of educational resources to build students understanding of the cores idea in climate and energy science: <http://cleanet.org> (link is on slide 5 of the PowerPoint presentation)

Ask teacher interns to consider how they could use one or more of these resources to teach the topic of climate change to their students.

## Evaluate

Ask teacher interns to revisit their [climate change drawings](#), and add any new elements they would include based upon today's class.

You may also choose to have them turn the paper over and write down a few ideas in response to the question:

*How did today's class influence your thinking about planning to teach the topic of global climate change to your students?*