



Investigation of Sea Ice Levels and CO2 Feedback Loops

Grade: 8

Lesson Duration: 90 Minutes

Course Name: Earth Science

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BIG IDEAS

Students will explore how melting sea ice in the cryosphere interacts with atmospheric CO2 levels to create climate feedback loops that accelerate global warming. Through analyzing NASA data, conducting a hands-on experiment, and connecting these concepts, students will understand the connection between Earth's systems and discussing the importance of addressing climate change.

EDUCATION STANDARDS

Science Performance Expectations (or state Science standard):

HS-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

Science and Engineering
Practices

Disciplinary Core Ideas

Crosscutting Concepts:

<p>Analyzing and Interpreting Data</p> <p>Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.</p>	<p>ESS2.A: Earth Materials and Systems</p> <p>Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.</p> <p>ESS2.D: Weather and Climate The foundation for Earth’s global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy’s re-radiation into space.</p>	<p>Stability and Change</p> <p>Feedback (negative or positive) can stabilize or destabilize a system.</p> <p>Connections to Engineering, Technology, and Applications of Science</p> <p>Influence of Engineering, Technology, and Science on Society and the Natural World New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.</p>
<p>Common Core State Standards:</p> <p><i>ELA/Literacy -</i> RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS2-2) RST.11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS2-2)</p> <p><i>Mathematics -</i> MP.2 Reason abstractly and quantitatively. (HS-ESS2-2) HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS2-2) HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-2)</p>		
<p>ITEEA Standards None</p>		
<p>Other Standards None</p>		

MEASURABLE STUDENT LEARNING OBJECTIVES

Science Objective: Students will analyze NASA data on sea ice and atmospheric CO2 to understand their impact on climate feedback loops.

Engineering and Technology Objective: Students will utilize NASA's Earth System Data Explorer to visualize real-world climate data.

Math Objective: Students will use data analysis and graphing to interpret trends in CO₂ and sea ice levels.

MATERIALS NEEDED

Computers or tablets with internet access

NASA Earth System Data Explorer

Ice cubes, trays, thermometers, lamps, calcium carbonate, water, transparent boxes

Student handouts with guided questions and worksheets

Reflection worksheet

Projector or screen for visuals

ENGAGING CONTEXT/PHENOMENON

The lesson focuses on polar sea ice melting and its role in climate change, using NASA data to reveal real-world impacts on ecosystems and weather patterns. By examining feedback loops between CO₂ and sea ice, students connect global climate issues to their lives, understanding the significance of climate science in addressing environmental challenges.

DATA INTEGRATION

Using the NASA Earth System Data Explorer, students analyze real-time data on sea ice levels and atmospheric CO₂ to observe the link between rising CO₂ and melting sea ice. This tool helps students identify patterns over time, to reinforce the connection of Earth's systems and make climate feedback loops more tangible and relevant.

TEACHER BACKGROUND KNOWLEDGE

Teachers should have a foundational understanding of climate change, specifically how CO₂ emissions contribute to global warming and the feedback loops involving the cryosphere and atmosphere. Familiarity with NASA's Earth System Data Explorer is essential for guiding students in data interpretation and helping them visualize trends in sea ice levels and CO₂ concentrations. Additionally, teachers should be comfortable explaining the albedo effect (how reflective surfaces like ice affect heat absorption) and how changes in one Earth system can impact others through interconnected processes.

DIFFERENTIATION OF INSTRUCTION

To support students with disabilities, this lesson includes simplified data with visual aids, guided notes, and graphic organizers to help with data interpretation and organization. Group work is structured to encourage peer support, with clear, step-by-step instructions provided for the hands-on ice melting experiment. Visual instructions and demonstrations are included to ensure all students understand each task.

Additional accommodations include alternative assessments, such as oral responses or visual diagrams, and extended time for activities and assessments. Scaffolding complex concepts with visuals and real-world examples ensures that all students can grasp the interconnected feedback loops between CO₂ and sea ice in climate change.

REAL-WORLD CONNECTIONS FOR STUDENTS

This lesson connects climate science to students' everyday lives by showing the real-world impacts of melting sea ice and rising CO₂ levels on global and local scales. By examining NASA data on sea ice and atmospheric CO₂, students see how climate change affects weather patterns, ecosystems, and human communities around the world. Understanding feedback loops between the cryosphere and atmosphere emphasizes the urgency of addressing climate change, helping students grasp the importance of global warming as it relates to their own environment and future.

POSSIBLE PRIOR or MISCONCEPTIONS

"Melting Ice Only Affects Sea Levels": Some students may think that melting ice primarily impacts sea levels, without recognizing its broader effect on global temperatures through decreased reflectivity (albedo effect) and increased heat absorption.

"Separate Earth Systems": Students might view the cryosphere and atmosphere as isolated systems, rather than as interconnected parts of a whole. This lesson clarifies that changes in one sphere can directly impact others, especially through feedback loops.

"Immediate Effects": Students may believe that changes in sea ice or CO₂ levels have immediate climate impacts. This lesson can help them understand that while effects may be gradual, they have cumulative, long-term consequences on Earth's climate.

LESSON PROCEDURE

5E	Details of 5E Lesson Implementation
<u>Engage</u>	<p>Lesson Objective: Students will analyze NASA data on sea ice and atmospheric CO₂ to understand their impact on climate feedback loops.</p> <p>Standards: HS-ESS2-2</p> <p>Materials & Resources: https://svs.gsfc.nasa.gov/13075 https://earth.gsfc.nasa.gov/cryo/data/current-state-sea-ice-cover</p> <p>Procedure: Show a brief video of melting sea ice, using dramatic visuals of ice retreat and changes over recent years. Ask students:</p> <ul style="list-style-type: none">• “What do you think is causing these changes in sea ice?”• “How might CO₂ levels in the atmosphere contribute to these changes?” <p>Link this to prior knowledge from the previous CO₂ lesson.</p> <p>Formative Assessment: Gauge students’ prior knowledge and curiosity through class discussion.</p> <p>Modifications: Provide visual aids, closed captioning, and clear verbal explanations for students who need support with complex concepts.</p>

Explore

Lesson Objective: Students will analyze NASA data on sea ice and atmospheric CO₂ to understand their impact on climate feedback loops.

Standards: HS-ESS2-2

Materials & Resources:

- [NASA Earth System Data Explorer](#)
- <https://docs.google.com/document/d/1BKyuhKHpKtGZL89jX8OSPQh9OTa5ci8qQdgPxH7KzeA/edit?usp=sharing>

Procedure: Using the NASA Earth System Data Explorer, students analyze sea ice data and compare it with CO₂ levels over time. They will complete a worksheet with questions guiding them to identify patterns in the data and connect these to global warming and the cryosphere.

- Example questions:
 - “What patterns do you observe in the sea ice data over the past decade?”
 - “How might changes in CO₂ levels relate to the observed changes in sea ice?”

Formative Assessment: Review students’ completed worksheets to ensure understanding of data interpretation and trend recognition.

Modifications: Provide structured graphs, simplified data sets, or guided examples for students who may need additional support.

Explain

Lesson Objective: Students will analyze NASA data on sea ice and atmospheric CO₂ to understand their impact on climate feedback loops.

Standards: HS-ESS2-2

Materials & Resources:

<https://larc-mynasadata-2df7cce0.projects.earthengine.app/view/earth-system-data-explorer>

Procedure: Facilitate a class discussion to help students connect their findings. Guide students to understand that melting sea ice reduces reflectivity, leading to more heat absorption by the Earth's surface, which accelerates warming. This feedback loop concept is central to the lesson's focus on interconnected systems.

- **Guiding Questions:**

- "How does reduced sea ice affect Earth's temperature?"
- "Why is this feedback loop important in understanding climate change?"

Formative Assessment: Assign homework for students to find a current event or recent scientific study related to polar ice melt or CO₂ levels. They will bring a brief summary of their findings to share at the start of Day 2.

Modifications: Use visuals such as feedback loop diagrams for students who benefit from concrete examples.

<p><u>Elaborate</u> <u>Day 2</u></p>	<p>Lesson Objective: Students will analyze NASA data on sea ice and atmospheric CO2 to understand their impact on climate feedback loops.</p> <p>Standards: HS-ESS2-2</p> <p>Materials & Resources: Ice cubes, trays, transparent boxes, calcium carbonate, water, thermometers, lamps, and a handout for experiment data recording.</p> <p>Procedure: Students conduct an experiment to simulate sea ice melting. Each group sets up two trays: one with ice cubes under a lamp and one without. They'll record the temperature changes in each tray to see how ice presence affects heat absorption (the albedo effect).</p> <ul style="list-style-type: none"> ● Data Collection: Students record the initial and final temperatures in both trays, observing differences in heat absorption. <p>Formal Assessment: Investigation of Sea Ice Worksheet</p> <p>Modifications: Pair students who need extra support with those more comfortable conducting experiments.</p>
<p><u>Evaluate</u></p>	<p>Lesson Objective: Students will analyze NASA data on sea ice and atmospheric CO2 to understand their impact on climate feedback loops.</p> <p>Standards: HS-ESS2-2</p> <p>Materials & Resources: Investigation of Sea Ice Worksheet</p> <p>Procedure: Students complete a final reflection on the cryosphere-atmosphere connection, describing how feedback loops amplify climate effects. Prompt them to connect their findings from the sea ice and CO2 activities.</p>

	<ul style="list-style-type: none">● Reflection Prompt: “Explain how CO₂ in the atmosphere and melting sea ice create a feedback loop. Why is it important to understand this connection?” <p>Summative Assessment: Collect and review reflections to assess understanding of the cryosphere-atmosphere connection and feedback loops.</p> <p>Modifications: Provide sentence starters or graphic organizers for students who need additional support organizing their reflections.</p>
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REFERENCES

NASA's Scientific Visualization Studio. (2019, December 12). *Global temperature anomaly (1880-2019)* [Video]. NASA. <https://svs.gsfc.nasa.gov/13075>

NASA Earth Science Division. (n.d.). *Current state of sea ice cover*. NASA Goddard Earth Sciences. <https://earth.gsfc.nasa.gov/cryo/data/current-state-sea-ice-cover>

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