CLUE into CLIMATE



education network

Science ready to EXPLORE

Strand 1 Educator Guide – Increased Greenhouse Gases Contribute to Climate Change

SUBJECTS

OVERVIEW

Earth Science

Life Science

Physical Science

Investigation & Experimentation

GRADE LEVELS

4-8

In this strand, students learn how the greenhouse effect works and how increased levels of greenhouse gases entering the atmosphere are altering climate patterns worldwide. By the end of the strand, students will understand the evidence and models that suggest that climate change is occurring and that human activities are the predominant cause of this change. They will know how the greenhouse effect works, how carbon dioxide and methane emissions enhance this effect, and how human activities produce greenhouse gases. Furthermore, they will explore the role of the Amazon in climate regulation and will be able to describe how changes to the Amazon affect global climate. In order to complete this strand, students should already have a general understanding of what climate is and what carbon dioxide is, and they should be able to interpret data presented in graphs.

STRAND UNIT PLAN

Week	Monday	Tuesday	Wednesday	Thursday	Friday
1	Lesson 1a: Activity 1	Lesson 1a: Activity 2	Lesson 1a: Media Literacy Discussion and Activity	Lesson 1b: Activity 1, Complete Media Literacy Activity	Lesson 1b: Activity 2, Begin Climate Careers Discussion
2	Lesson 1b: Climate Careers Research	What Can We Do at School? Survey and Analysis	Lesson 1c: Activity 1	Lesson 1c: Activity 2	Lesson 1c: STEM Literacy Research and Discussion
3	Lesson 1d: Activity 1	Lesson 1d: Activity 2, Global Impact Discussion	Lesson 1d: Global Impact Research	Explore Your Earth: Exploring Your School's Carbon Sink	Lesson 1e: Activity 1
4	Lesson 1e: Activity 2 (First set of measurements)	Lesson 1e: Activity 2 (Second set of measurements)	Lesson 1e: Activity 2 (final measurements)	Lesson 1e: Activity 3	Field Trip or Speaker
5	Begin Alternative Assessment or Review for Traditional Assessment	Complete and Share Alternative Assessment or Give Traditional Assessment			

EXPLORE YOUR EARTH

Plants are part of Earth's carbon sink, absorbing carbon dioxide from the atmosphere. Survey vour school grounds to examine your school's carbon sinks. Estimate the area of land that contains plants, and compare this with the area of land that contains buildings or pavement. Are there areas of your school that could support more plant life, thereby contributing to Earth's carbon sink?

Take a hike in a local forest. On

average, a single mature tree can absorb 48 pounds of carbon dioxide each year. Use this statistic to estimate how much carbon dioxide the forest can absorb each year, and discuss the role of forests in mitigating climate change.

STRAND ESSENTIAL QUESTIONS

- 1. How does human activity cause an increase in greenhouse gases?
- 2. How do greenhouse gases affect the climate?
- 3. What role do forests such as the Amazon play in the regulation of greenhouse gases?

LITERACY CONNECTIONS

Lesson	Media Literacy	STEM Literacy	Global Impact	Climate Careers
Lesson 1a: Carbon Dioxide and	X			
Lesson 1b: The Greenhouse Effect and Climate Change				X
Lesson 1c: Methane and Our Changing Climate		X		
Lesson 1d: Greenhouse Gases and the Amazon			X	

STRAND ASSESSMENT IDEAS

1. Strand 1 Traditional Assessment (attached)

This test uses multiple choice and short-answer questions to assess student learning for the entire strand.

2. Strand 1 Alternative Assessment: Educating Our Communities

Scientists already know that there are many steps that individuals can take to help mitigate climate change. Simple changes in your home, your traveling patterns, and your energy use can dramatically alter your carbon footprint. In this assessment, students create a flyer to teach their community about the causes of climate change, how the greenhouse effect works, and how personal actions can affect our carbon footprint. To effectively communicate the importance of this issue, flyers should contain the following information:

- What is global warming and climate change? How do we know it is happening? Why is it a concern?
- What is the most likely cause of climate change? How do we know?
- What are greenhouse gases and where do they come from? How do they affect the greenhouse effect?
- What steps can people take to reduce the amount of greenhouse gases they produce?
- Have students select the most effective flyers, then distribute them to the families in your school.

SCIENCE STANDARDS

Lesson	California State Science Content Standards, Grades 4–8	California's Environmental Principles and Concepts	National Science Education Standards for Middle School	Earth Science Literacy Principles	The Essential Principles of Climate Literacy
Lesson 1a: Carbon Dioxide and Climate Change	Grade 4: Investigation and Experimentation. 6. Scientific progress is made by asking meaningful questions and conducting careful investigations. (6.a.) Grade 5: Physical Sciences. 1. Elements and their combinations account for all the varied types of matter in the world. (1.g.) Grade 6: Investigation and Experimentation. 7. Scientific progress is made by asking meaningful questions and conducting careful investigations. (7.a.)	Natural Systems Change in Ways that People Benefit from and can Influence (Concepts a, b, c) There are no Permanent or Impermeable Boundaries that Prevent Matter from Flowing between Systems (Concepts a, b, c)	Science As Inquiry: Abilities necessary to do scientific inquiry Science in Personal and Social Perspectives: Natural hazards	Big Idea #7: Humans depend on Earth for resources. (7.9) Big Idea #9: Humans significantly alter the Earth. (9.1, 9.3)	Principle #2: Climate is regulated by complex interactions among components of the earth system. (C) Principle #4: Climate varies over space and time through both natural and man- made processes. (A, B, C, D, E) Principle #6: Human activities are impacting the climate system. (A, B)
Lesson 1b: The Greenhouse Effect and Climate Change	Grade 6: Heat (Thermal Energy) (Physical Sciences). 3. Heat moves in a predictable flow from warmer objects to cooler objects until all the objects are at the same temperature. (3.d.) Energy in the Earth System. 4. Many phenomena on Earth's surface are affected by the transfer of energy and through radiation and convection currents. (4.b.)	Natural Systems Change in Ways that People Benefit from and can Influence (Concepts a, b, c)	Physical Science: Properties and changes of properties in matter; Transfer of energy Science in Personal and Social Perspectives: Natural hazards	Big Idea #9: Humans significantly alter the Earth. (9.1, 9.3)	Principle #1: The sun is the primary source of energy for Earth's climate system. (A) Principle #2: Climate is regulated by complex interactions among components of the earth system. (B, C) Principle #6: Human activities are impacting the climate system. (A, B)
Lesson 1c: Methane and Our Changing Climate	Grade 5: Physical Science. 1. Elements and their combinations account for all the varied types of matter in the world. (1.b.) Grade 6: Resources (Earth Sciences). 6.	There are no Permanent or Impermeable Boundaries that Prevent Matter from Flowing between Systems (Concepts a, b, c)	Physical Science: Properties and changes of properties in matter	Big Idea #9. Humans significantly alter the Earth. (9.1, 9.3, 9.7)	Principle #2: Climate is regulated by complex interactions among components of the earth system. (B, C)

Lesson	California State Science Content Standards, Grades 4–8	California's Environmental Principles and Concepts	National Science Education Standards for Middle School	Earth Science Literacy Principles	The Essential Principles of Climate Literacy
	Sources of energy and materials differ in amounts, distribution, usefulness, and the time required for their formation. (6.a.) Grade 8: Structure of Matter. 3. Each of the more than 100 elements of matter has distinct properties and a distinct atomic structure. All forms of matter are composed of one or more of the elements.				Principle #6: Human activities are impacting the climate system. (B, C)
Lesson 1d: Greenhouse Gases and the Amazon	 (3.b.) Grade 4: Life Sciences. 3. Living organisms depend on one another and on their environment for survival. (3.b.) Grade 5: Physical Sciences. 2. Plants and animals have structures for respiration, digestion, waste disposal, and transport of materials. (2.f., 2.g.) Grade 8: Chemistry of Living Systems (Life Sciences). 6. Principles of chemistry underlie the functioning of biological systems. (6.a.) 	Natural Systems Change in Ways that People Benefit from and can Influence (Concepts a, b, c) Decisions Affecting Resources and Natural Systems are Complex and Involve Many Factors (Concepts a, b)	Physical Science: Properties and changes of properties in matter Science in Personal and Social Perspectives: Natural hazards	Big Idea #3: Earth is a complex system of interacting rock, water, air, and life. (3.1, 3.3) Big Idea #9. Humans significantly alter the Earth. (9.1, 9.3, 9.7)	Principle #2: Climate is regulated by complex interactions among components of the earth system. (D) Principle #4: Climate varies over space and time through both natural and man- made processes. (G) Principle #6: Human activities are impacting the climate system. (C, D)
Lesson 1e: Climate Models: Predicting the Future	Grade 7: Investigation and Experimentation. 7. Scientific progress is made by asking meaningful questions and conducting careful investigations. (7.c.) Grade 8: Periodic Table. 7. The organization of the periodic table is based on the properties of the elements and reflects the structure of atoms. (7.b.)	Decisions Affecting Resources and Natural Systems are Complex and Involve Many Factors (Concepts a, b)	Unifying Concepts and Processes: Evidence, models and explanation	Big Idea #1. Earth scientists use repeatable observations and testable ideas to understand and explain our planet. (1.4, 1.5, 1.6) Big Idea #9. Humans significantly alter the Earth. (9.1, 9.3, 9.7)	Principle #5: Our understanding of the climate system is improved through observations, theoretical studies, and modeling. (A, B, C)

WHAT CAN WE DO AT SCHOOL?

How much carbon dioxide is produced by the teachers and students at your school? Use the Nature Conservancy's Carbon Footprint Calculator and survey members of the staff and students about their carbon-producing activities. What behaviors tend to increase one's carbon footprint? What changes should students and staff members make to reduce their impact on the greenhouse effect? Summarize your findings on a bulletin board posted for the school to see. Link: http://www.nature.org/i nitiatives/climatechang e/calculator/

INTERDISCIPLINARY CONNECTIONS (CA CONTENT STANDARDS)

Lesson	Mathematics	English Language Arts	Visual and Performing Arts
Lesson 1a: Carbon Dioxide and Climate Change	Grade 4: Statistics, Data Analysis, and Probability. 1.0. Students organize, represent, and interpret numerical and categorical data and clearly communicate their findings. (1.3.)		
Lesson 1b: The Greenhouse Effect and Climate Change			Grade 4: 5.0. Connecting and applying what is learned in the visual arts to other art forms and subject areas and to careers (5.3. Visual Literacy)
Lesson 1c: Methane and Our Changing Climate		Grade 4: 1.0. Listening and Speaking Strategies; Comprehension (1.2) Grade 4: 1.0. Listening and Speaking Strategies; Analysis and Evaluation of Oral Media Communication (1.10)	Grade 4: 5.0. Connecting and applying what is learned in the visual arts to other art forms and subject areas and to careers (5.3. Visual Literacy)
Lesson 1d: Greenhouse Gases and the Amazon		Grade 4: 1.0. Listening and Speaking Strategies; Comprehension (1.1, 1.2)	

ABOUT THE AUTHOR

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STRAND 1 ASSESSMENT ANSWER KEY

- 1. A 2. A
- 3. B
- 4. C
- 5. D
- 6. C 7. B
- 7. Б 8. В
 - 9. D
 - 10. No. One cold day with snow indicates a change in weather, which is constantly fluctuating. To be evidence that global warming has stopped, you would need to see a change in climate, or the long-term average weather conditions. Temperatures would need to be below average for a longer period of time than one day to indicate climate change.
 - 11. Answers may vary. Sample answer: Average surface temperatures have increased, and glaciers are on average shrinking.
 - 12. Answers may vary. Sample answer: More greenhouse gases would enhance the greenhouse effect, causing average temperatures to rise. This would cause sea levels to rise, which could flood coastal communities. This could also cause drought in some regions, harming agriculture and reducing water supplies.
 - 13. Answers may vary. Sample answer: To reduce greenhouse gases, people could drive less in their cars. People can eat less meat, so that fewer cows are raised, thus reducing emissions from livestock.
 - 14. Answers may vary. Sample answer: Plant life in the Amazon absorbs carbon dioxide from the atmosphere. Without the Amazon rain forest, levels of carbon dioxide would be much higher.

SUPPORT

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ADDITIONAL RESOURCES (SPECIFIC TO THE BAY AREA)

- Visit the *Altered State: Climate Change in California* exhibit at the California Academy of Sciences and explore how human activities influence climate change both in California and around the world. http://www.calacademy.org/
- Examine real-world data on climate change at the Exploratorium's Global Climate Change website. <u>http://www.exploratorium.edu/climate/index.html</u>
- Participate in a Climate Change workshop at the Lawrence Hall of Science (appropriate for grades 4 and 5). <u>http://www.lawrencehallofscience.org/education/programs/workshops</u>

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STRAND 1 ASSESSMENT

Multiple Choice (1 point each)

1. How have average global temperatures changed over the past century?

- a. Average global temperatures have increased 1.2 to 1.4 degrees Fahrenheit.
- b. Average global temperatures have increased 10 degrees Fahrenheit.
- c. Around the globe, some temperatures have gone up and some have gone down. On average, there has been little change.
- d. Average global temperatures have gone down about 2 degrees Fahrenheit.
- 2. Which sentence best describes how levels of carbon dioxide in the atmosphere have changed over the past 150 years?
- a. The amount of carbon dioxide in the atmosphere has increased rapidly, and it continues to increase.
- b. The amount of carbon dioxide in the atmosphere has decreased during the past 150 years.
- c. The amount of carbon dioxide has gone up and down over the past 150 years. On average, the levels have remained about the same.

3. How does carbon dioxide affect Earth's climate?

- a. Carbon dioxide reflects the sun's energy, keeping Earth cooler.
- b. Carbon dioxide traps energy in Earth's atmosphere, making Earth warmer.
- c. Carbon dioxide is a pollutant that makes air difficult to breathe, but it does not affect Earth's climate.

4. Which sentence best describes the greenhouse effect?

- a. The greenhouse effect is bad for the planet, because it makes Earth too warm. All greenhouse gases should be eliminated from the atmosphere.
- b. The greenhouse effect is a new problem for Earth. It began when humans began polluting the air.
- c. The greenhouse effect is essential to life on Earth. Without greenhouse gases, Earth would be too cold for most life to survive.

5. Which of the following would cause a decrease in greenhouse gases?

- a. Running cars that burn fossil fuels
- b. Building dams and creating large reservoirs
- c. Raising cows for meat and dairy products
- d. Planting more forests

6. Which of these is not a greenhouse gas?

- a. Carbon dioxide
- b. Methane
- c. Oxygen
- d. Water vapor

7. Which of the following sentences about methane is true?

- a. Methane comes solely from human-related activities.
- b. Methane is a greenhouse gas. Two sources of methane include livestock and decomposing waste.
- c. Methane levels in the atmosphere have been relatively constant over the past 150 years.

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STRAND 1 ASSESSMENT

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8. How do forests affect the levels of greenhouse gases in the atmosphere?

- a. Forests emit large amounts of carbon dioxide into the atmosphere.
- b. Forests absorb carbon dioxide from the atmosphere, storing it in plants.
- c. Forests absorb large amounts of methane from the atmosphere.

9. Which kinds of data are used in climate models to predict what climate will be like in the future?

- a. Historical data from ice cores showing how temperature and greenhouse gases have changed in the past.
- b. Predictions about laws that governments will put in place regarding greenhouse gas emissions.
- c. Satellite data measuring ocean temperatures around the world.
- d. All of the above.

Short Answer (2 points each)

10. One January day in your hometown, snow falls and the temperature drops below average. Is this clear evidence that global warming has stopped? Why or why not?

11. List two pieces of evidence that climate change is occurring.

12. How would an increase in greenhouse gases affect the future of our planet? List two possible outcomes.

13. What are two ways that people can reduce greenhouse gas emissions?

14. Describe how the Amazon is important to the world's climate.