Greenhouse Gases and Climate Change

Description:

We hear about greenhouse gases, but what exactly are they? Students explore the metaphors and models surrounding the causes of climate change through hands-on demonstrations and modeling.

Skills & Objectives

SWBAT

- Explain how greenhouse gases trap heat
- Understand why certain atmospheric gases are considered “greenhouse gases”
- Create a model to explain the greenhouse effect.

Skills

- Modeling
- Following a protocol
- Communication

Students Should Already Know That

- Invisible gases make up the atmosphere and can interact with each other and with light and heat.

Standards Alignment:
HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth’s systems result in changes in climate.
HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
L.9-12.5 Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
L.9-12.6 Acquire and use accurately general academic and domain-specific words and phrases.

Disciplinary Core Ideas:
PS1.A: Structure and Properties of Matter
ESS2.A Earth Materials and Systems
ESS3.D Global Climate Change

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How To Use These Activities:

Pages with the circular "TILclimate Guide for Educators" logo and dark band across the top are intended for educators. Simpler pages without the dark band across the top are meant for students.

Each of the included activities is designed to be used as a standalone, in sequence, or integrated within other curriculum needs. A detailed table of contents, on the next page, explains what students will do in each activity.

A Note About Printing

All student pages are designed to be printable in grayscale.

The worksheets do not leave space for students to answer questions. Students may answer these questions in whatever form is the norm for your classroom – a notebook, online form, or something else. This allows you, the teacher, to define what you consider a complete answer.

A Note About Materials

The materials for the two hands-on demonstrations are designed to be low-cost and to use supplies you may already have in your classroom. Beakers can easily be replaced with a mason jar or similar vessel.

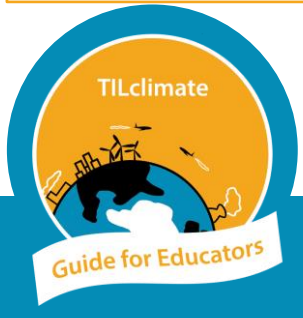
For the sealable flasks:

- A conical (Erlenmeyer) flask, either with a built-in tubing attachment point or a stopper with tubing.
- A plastic water bottle. Drill a hole in the lid and feed flexible aquarium tubing through.
- A takeout soda cup with a lid. Feed flexible aquarium tubing through the straw hole.

For the DIY spectrophotometer:

- A mug warmer can be purchased online for less than $20. Another heat source could also be used, as long as it can maintain a relatively constant temperature for 5 minutes.
- Infrared (IR) thermometers can be purchased from a hardware store or online for less than $20 and are useful for a number of climate-related investigations.

Share with us! We would love to hear any podcasts or see any other projects you or your students create! Email us at tilclimate@mit.edu, tweet us @tilclimate, or tag us on Facebook @climateMIT.



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Detailed Table of Contents

A Note On Models

The demonstrations on pages 4a-6c each take roughly the same amount of time to perform (after setup). You may choose just one activity, depending on your time, space, and materials needs. Alternatively, you may have teams of students performing all three demonstrations simultaneously.

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Greenhouse Gases and Modeling

This Educator Guide includes two hands-on demonstrations, an online model, and a design challenge. Educators may pick and choose among the pieces of the Guide, as suits their class needs.

Parts of this Guide may align with the following topics:

- Physical science: Chemistry and physics of light and molecules.
- Life/environmental science: Use of models.
- ELA/Humanities: Use of metaphors for communication.

MIT Resources

We recommend the following as resources for your own better understanding of climate change or as depth for student investigations. Specific sections are listed below:

- Climate Science, Risk & Solutions, an interactive introduction to the basics of climate change. https://climateprimer.mit.edu/
  Chapter 02, The Greenhouse Effect and Us

- MIT Climate Portal Explainers are one-page articles describing a variety of climate topics. New Explainers are posted monthly. https://climate.mit.edu/explainers
  Greenhouse Gases
  Climate Models
  Radiative Forcing
  The Intergovernmental Panel on Climate Change

- MIT professors can answer your and your students' questions about climate change! Submit your questions or see other answers at https://climate.mit.edu/ask-mit-climate
  "How can such a small amount of carbon dioxide in the atmosphere—only around 420 parts per million—cause so much warming?"

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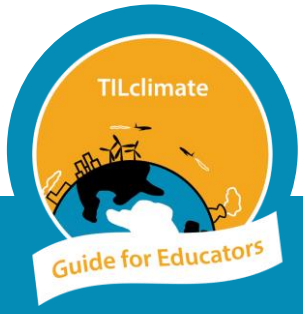
Wrap-Up Discussion Questions

- What parts of the electromagnetic spectrum have you experienced today?
- Which metaphor do you prefer – the greenhouse or the blanket? Why? Do you have another metaphor that you think works better?
- How do the physical and digital models of the greenhouse effect reflect what is actually happening on Earth?
- Explain greenhouse gases and the basics of climate change in a way that an elementary school child could understand.
- Why do scientists and policymakers focus on carbon dioxide as a key driver of climate change?

Climate Solutions

Climate solutions can be thought of as falling into four categories outlined below. Across all categories, solutions at the community, state or federal level are generally more impactful than individual actions. For example, policies that increase the nuclear, solar and wind mix in the electric grid are generally more effective at reducing climate pollution than asking homeowners to install solar panels. For more on talking about climate change in the classroom, see "How to Use This Guide".

- **Energy Shift**
  How do decision-makers make the switch from carbon-producing energy to carbon-neutral and carbon-negative energy?
- **Energy Efficiency**
  What products and technologies exist to increase energy efficiency, especially in heating and cooling buildings?
- **Adaptation**
  How can cities and towns adapt to the impacts of climate change?
- **Talk About It**
  Talking about climate change with friends and family can feel overwhelming. What is one thing you have learned that you could share to start a conversation?



What solutions are the most exciting in your classes? We would love to hear from you or your students! Images, video, or audio of student projects or questions are always welcome. Email us at tilclimate@mit.edu, Tweet us @tilclimate, or tag us on Facebook @climateMIT.