

Today I Learned About Geoengineering

Description:

Geoengineering includes a host of technologies and practices that seek to reduce the amount of heat trapped in Earth's atmosphere. Some of these technologies could have significant side effects that are not well understood. Who decides when or how to engineer the Earth's atmosphere?

Skills & Objectives

SWBAT

- Describe some key geoengineering technologies
- Understand some of the potential benefits and concerns about geoengineering

Skills

- Reading and discussing scientific writing
- Science communication

Students Should Already Know That

- The heat that is trapped by CO₂ and other heat-trapping gases in Earth's atmosphere is the heat of the sun.

Standards Alignment:

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.

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-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions.

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.

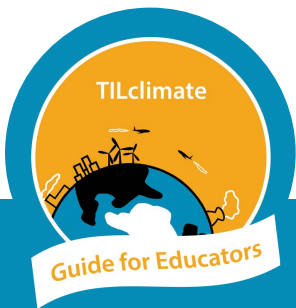
Disciplinary Core Ideas:

ESS2.A Earth Materials and Systems

ESS2.D Weather and Climate

ESS3.C Human Impacts on Earth 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.

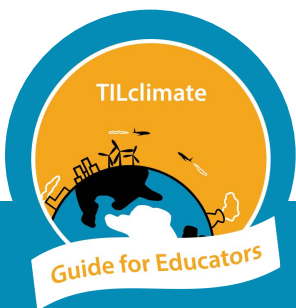
A Note About Printing

All student pages are designed to be printable in grayscale, except for the map and graph on page 1. A few copies of the next page could be printed color for students to share, or the image projected in the classroom.

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.

Podcasts in the Classroom: Throughout these Guides for Educators, we invite students to think about how they would share their learning with family and friends. One way to do this is to encourage your students to create their own podcasts - they're shareable, creative, and have multiple options for embedded assessment. 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.

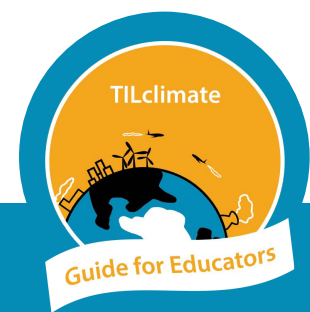
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Detailed Table of Contents

Page	Title	Description	Time (min)
	Podcast Episode	Students listen to TILclimate: TIL about carbon pricing, either as pre-class work at home or in the classroom. https://climate.mit.edu/podcasts/e7-til-about-carbon-pricing	10-15
1	Volcanoes and a Cooling Earth	Reading: What does the history of volcanic eruptions teach us about the effect of aerosols in the atmosphere?	5-10
	Images: Volcanoes and a Cooling Earth	Larger versions of the map and graph from page 1 for sharing or projecting	
2-3	How Do We Decide? Who Decides?	In small groups, students read three articles about geoengineering, and teach each other what they learned. Then, they discuss its possible benefits and concerns.	20-45+
4	Geoengineering Glossary	Brief definitions of some key geoengineering technologies and practices.	n/a



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Geoengineering

This Educator Guide includes a reading and a discussion. Educators may pick and choose among the pieces of the Guide, as suits their class needs.

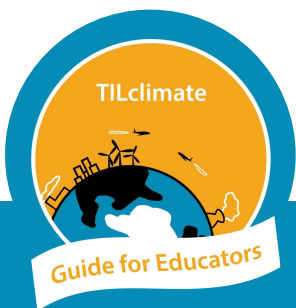
Parts of this Guide may align with the following topics:

- Physical science: atmospheric chemistry, aerosols, and atmospheric layers
- Life/environmental science: impacts of atmospheric chemistry on living systems
- History/social science: ethics and international decision-making
- ELA/literature: connections to terraforming science fiction
- ELA/nonfiction: explaining and discussing complex scientific topics

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
 - Chapter 05 How much of the CO₂ increase is natural?
 - Chapter 06 Predicting climate
 - Chapter 07 Understanding risk
 - Chapter 10 What can we do?
- MIT Climate Portal Explainers are one-page articles describing a variety of climate topics. <https://climate.mit.edu/explainers>
 - Soil-based Carbon Sequestration
 - Forests and Climate Change
 - Climate Models
 - Greenhouse Gases
 - Radiative Forcing
 - Carbon Capture



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Wrap-Up Discussion Questions

- What are some of the possible benefits of geoengineering?
- What are some of the concerns with geoengineering?
- What questions do you still have? How might you answer these questions?
- Some people have suggested that discussing and researching solar radiation management could slow down progress on reducing CO₂ emissions. What do you think?
- If the science became clear that solar radiation management was possible, who should decide whether to do it?
- Who needs to know about the possibilities and challenges of geoengineering?

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.

