Today I Learned About Clouds

Description:

How do clouds form? How are clouds affected by (and affect) climate change? Students create a cloud in the classroom, and then investigate climate models and real-time cloud observation data.

Skills & Objectives

SWBAT

- Explain that clouds need a nucleus around which to form.
- Understand that climate models can predict future climate patterns, but that factors such as carbon emissions make specific predictions uncertain.
- Describe observed and predicted changes in precipitation in the continental US.

Skills

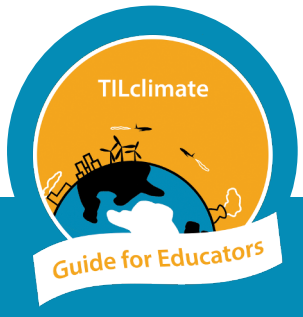
- Map reading
- Observation

Students Should Already Know That

- Weather and climate systems are large and complex.

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-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems.

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

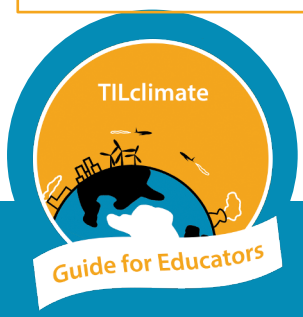
All student pages are designed to be printable in grayscale. Larger versions of the maps on pages 3 and 4 are included, which could be projected or printed to share in color.

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.

Representative Concentration Pathways (RCPs)

On page 3, students are introduced to the *Representative Concentration Pathways* RCP8.5, RCP4.5, and RCP2.6. These terms refer to modeled *radiative forcing* (heat) in watts per square meter. For more on radiative forcing, read the MIT Climate Explainer at https://climate.mit.edu/explainers/radiative-forcing.

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 clouds, either as pre-class work at home or in the classroom. https://climate.mit.edu/podcasts/e2-til-about-clouds	10-15
1	Cloud in a Bottle	Hands-on demonstration: Make a cloud in a bottle. Students read about the sizes of particulate matter (PM.)	5-10
2-3	Climate Models and Uncertainty	Reading: an introduction to emissions scenarios (RCPs) from the National Climate Assessment.	5-10
4-6	Precipitation Observations and Predictions	With maps from the Fourth National Climate Assessment, students investigate observed and predicted changes in precipitation patterns in the continental US.	15-25
7-8	Clouds and Particulates (internet required)	Students explore clouds, storms, and particulates around the globe in real time.	30+
9	NASA GLOBE Cloud Gaze (internet required)	Become a community scientist and help NASA identify and track clouds.	10+

Materials for Cloud in a Bottle Demonstration

- A clear container with a flat top, such as a large lab flask, empty jar, or vase.
- Warm (not boiling) water
- Ice
- A metal pie plate or similar flat-bottomed metal surface
- A stirrer
- A match

https://www.jpl.nasa.gov/edu/learn/project/make-a-cloud-in-a-bottle/

Today I Learned About Clouds

Particulate Matter, Clouds, and Climate Models

This Educator Guide includes a hands-on activity, reading materials, and two map-based investigations. 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: Cloud formation, atmospheric chemistry
- History/social science: Debates about geoengineering
- ELA/nonfiction: Understanding and communicating complex science 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 06 Predicting climate
  - Chapter 09 How long can we wait to act?
  - 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
  - Climate Models
  - Greenhouse Gases
  - Wildfires
  - Radiative Forcing
  - The National Climate Assessment

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Wrap-Up Discussion Questions

- What are some ways that human actions increase the amount of particulate matter (PM) in the atmosphere?
- What are some factors that affect cloud formation, size, and precipitation? How are these factors affected by a warming planet and human actions?
- Did any of the observed or predicted precipitation patterns surprise you? What have you observed?
- Why is it important for climate modelers to include carbon emissions predictions?
- Why is it important to model different emissions scenarios?
- In the episode, Professor Cziczo says, “Uncertainty is not a call for inaction.” What do you think he meant by that?

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.