Today I Learned About Planes

Description:

How much of an impact does air travel have on climate change? What can be done about it? Through a hands-on demonstration and a short literature review, students consider the impacts and future of aviation. With data, students consider why climate communicators and scientists focus on carbon dioxide.

Skills & Objectives

SWBAT

- Understand that dark surfaces absorb more of the sun's energy than light surfaces.
- Explain why carbon dioxide is a focal heat-trapping gas.
- Understand a few promising technologies for the future of aviation.

Skills

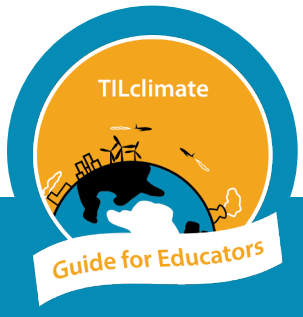
- Data collection & graphing
- Interpreting science writing aimed at the general public

Students Should Already Know That

- Airplanes burn jet fuel, a fossil fuel that releases carbon dioxide (CO_2) as a byproduct.
- Airplanes also leave narrow temporary clouds behind, called contrails.

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-ESS3-4 Evaluate a technological solution that reduces impacts of human activities on natural systems.
HS-ETS1-3 Evaluate a solution to a complex real-world problem

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.

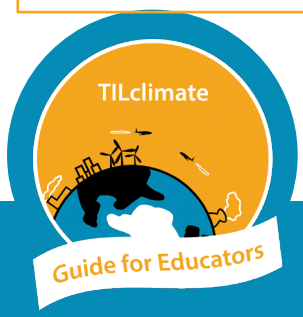
A Note About Printing/Materials

All student pages are designed to be printable in grayscale, except for the maps on page 4. A few copies of this 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.

Materials for the Albedo Demonstration are listed on a separate page.

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

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Planes, Clouds, and Climate

This Educator Guide includes a demonstration, a map-reading exercise, and an article review. 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: Albedo, cloud formation, atmospheric levels
- Life/environmental science: Impacts of climate change on ecosystems
- History/social science: Impact of flight on international relations, travel, etc.
- ELA/nonfiction: Reading scientific articles for content, argument, and connection.

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 02b Our atmosphere
  - 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
  - Aviation
  - Climate Models
  - Greenhouse Gases
  - Radiative Forcing
  - Biofuel

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Wrap-Up Discussion Questions

- In the podcast episode, we learn that temporary clouds produced by airplanes (condensation trails, or "contrails") can reflect the sun's energy if they are over dark areas with low albedo, and act like a jacket trapping heat if they are over light areas with high albedo or during the night. How could you model this effect in the lamp demonstration?
- Airplanes help families connect, people experience the world, and businesses grow in new ways. How can we reap the benefits of air travel while reducing or eliminating CO_2 emissions? You could list technological, behavioral, or other kinds of solutions.
- Why do we focus on carbon dioxide as the main heat-trapping gas?
- How could governments, businesses, and decision-makers change air travel's impact on 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.

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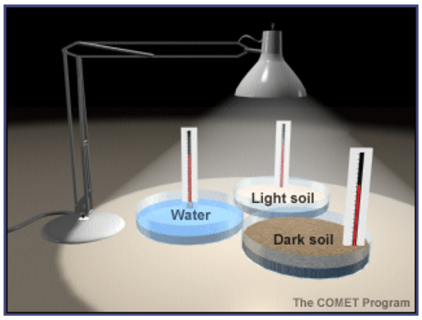
Albedo Demonstration: Materials

- Incandescent lamp(s) that can point down at a table
- Three identical pie pans or dishes
- Dark-colored potting soil
- Light-colored sand, perlite, sugar, or salt (any light-colored particulate)
- Water
- Three thermometers that can be read while left in the containers
- Timer
- Graph paper, chart-pack, whiteboard, or simple graphing computer program
- Three colors of colored pencils, markers, etc.

Albedo Demonstration: Setup

This demonstration can be set up for a whole class, or groups can run multiple copies of the demonstration simultaneously. For multiple stations, multiply supplies as needed.

- Pour equal depths of dark potting soil, light material, and water into three equal-sized dishes, pie pans, or similar.
- Ideally, leave containers out overnight so that all materials are at the same starting room temperature.
- Set up incandescent reflector lamp(s) over containers. You may set up three lamps (one equally over each surface) or one lamp equally over all three. Make sure that lamps are identical, have the same wattage of bulb, and are the same distance above each surface. Do not turn lamp(s) on.



- Put one thermometer into each substance. Depending on the type of thermometer, this could be just below the surface or stuck upright in the substrate. The thermometers should be readable without removing them from the substrate. Digital aquarium thermometers ($8-15 online) are ideal for this, but other thermometers will work well.

Albedo Demonstration: Data Collection & Graphing

Students can collect data on the included chart individually, in groups, or as a whole class. Since measurements are taken once per minute for 20 minutes, one group of students could be collecting data while others are doing a different activity.

Data is collected with the lamp on for the first 10 minutes after getting an initial starting temperature. Then the lamp is turned off, and data is collected for a further 10 minutes.

Depending on your goals, you may graph the results individually, as a whole class, or in groups. Graph paper, chart pack, a whiteboard, or a simple graphing program may be used.