Today I Learned About the Changing Ocean

Description:

Modern climate change is causing our ocean to warm and changing the ocean's chemistry. Students directly experience the ability of cold and warm water to uptake carbon dioxide and learn about ocean acidification. They explore the role of the ocean in the climate and one tool scientists use to understand ocean warming. Then, they are challenged to communicate one of the Ocean Literacy Principles to a chosen audience.

Skills & Objectives

SWBAT

- Understand that cold water can absorb more carbon dioxide.
- Explain some of the impacts of ocean acidification.
- Explain the role of ocean currents in shaping global climate.
- Understand how scientists use Argo floats to explore the ocean.
- Describe and educate on the Ocean Literacy Principles.

Skills

- Basic lab safety
- Modeling & communicating complex scientific ideas
- Map-reading
- Asking scientific questions

Students Should Already Know That

- Water can absorb gases, and the gases can remain in their 'true' form in the water or react with the water to form new compounds.
- The ocean varies considerably in temperature, salinity, and many other variables around the world and at depth.

Standards Alignment:
HS-PS1-5: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
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.
RST.11-12.9: Synthesize information from a range of sources into a coherent understanding of a process, phenomenon, or concept.

Disciplinary Core Ideas:
PS1B: Chemical Reactions
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.

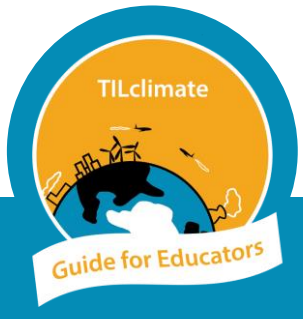
Each of the included activities is designed to be used as a standalone, in sequence, or integrated within other curriculum needs. A detailed table of contents, on the next page, explains what students will do in each activity.

A Note About Printing

All student pages are designed to be printable in grayscale, except for the map on pages 7&8. A few copies of these pages could be printed color for students to share, or the images 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

Carbon Dioxide Demonstration

Materials and Setup

For each group of students, you will need:

- 500ml graduated cylinder
- Funnel
- Petri dish cover
- Clear basin (aquarium, bowl, etc.) shorter than the graduated cylinder
- Stand and clamp
- Water - cold and warm
- 2-4 effervescent tablets (AlkaSeltzer® or similar)

Depending on time, number of students, material availability, and space, you may have each group perform both the cold trials and the warm trials, or you may have some groups only working with one temperature and combine data.

Instructions to do the activity are found on page 1 of the student worksheets.

Background information can be found with the original activity at http://www.carboeurope.org/education/CS_Materials/CO2solubility.pdf

Extensions

- What happens if the water is more saline? Salinity is not as strong a determinant as temperature, so you will need to compare distilled water vs high-saline (35ppt or higher) water of the same temperature to see a difference.
- What happens if you add a second tablet after the first one finishes fizzing? If the water has already reached saturation, a larger volume of carbon dioxide gas will be produced above the water.
- If you have pH strips, what is the pH of water that has had carbon dioxide added? While much of the carbon dioxide stays in gas form in the water, some of it will react to create carbonic acid and make the water more acidic.

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The Ocean

This Educator Guide includes a classroom demonstration, data visualizations, scientific question-asking, and a communications 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: Currents, waves, warming, and ocean chemistry.
- Life/environmental science: Effects of ocean currents, how oceanic research is done, effects of carbon dioxide in water.
- History/social science: Communication about ocean importance and impacts.
- ELA/literature: Connections to climate literature, ocean literature, stories about storms, and stories about shellfishing.
- ELA/nonfiction: Understanding and communicating complex 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 05

    Chapter 08

        Chapter 10

- MIT Climate Portal Explainers are one-page articles describing a variety of climate topics. New Explainers are posted monthly. https://climate.mit.edu/explainers

    Ocean Acidification

        Phytoplankton

        Coastal Ecosystems and Climate Change

    Freshwater and Climate Change

        Climate Models

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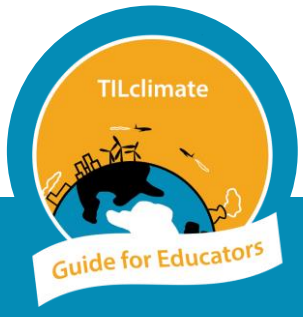
Wrap-Up Discussion Questions

- What will be a consequence of a warming ocean? How will this affect the role of the ocean as a CO_2 sink?
- In what ways is the hands-on carbon model accurate? In what ways does the ocean behave differently than this model? (Consider currents, storms, etc. – how would these systems affect the ocean's ability to take up CO_2?)
- What kinds of organisms are affected by ocean acidification?
- In what way is the ocean the "heart" of Earth's climate? How would you explain the relationship between the ocean and weather and climate systems?
- What makes the ocean difficult to study?
- Which Ocean Literacy Principle is your favorite?
- Which Ocean Literacy Principle surprised you?

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.