We're All Part of the Solution!

Purpose

- To help students understand that, while humans are contributing to climate change, we can also take action to solve this challenge.

Overview

This activity is comprised of three parts. In Part 1, students will learn about greenhouse gases and how an increase in greenhouse gases due to human activity is causing the climate to change on Earth. In Part 2, students will use a carbon footprint calculator to evaluate the greenhouse gases they are emitting. In Part 3, students will develop ideas for how their home, school, and community can reduce greenhouse gas emissions, and they will share these ideas with others.

Student Outcomes

Students will understand what greenhouse gases are, how they impact our climate, and how actions in their daily lives produce greenhouse gases in the atmosphere. Students will explore ideas for how to reduce greenhouse gas emissions and how to help solve climate change.

NGSS PE K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

NGSS DCI ESS3.C: Human Impacts on Earth Systems

NGSS ETS1 A: Defining and Delimiting an Engineering Problem (K), B: Developing Possible Solutions (K), C: Optimizing the Design Solution (2)

NGSS Science and Engineering Practice: Obtaining, Evaluating and Communicating Information

NGSS Crosscutting Concept: Cause and Effect

Time

- Part 1: One class period (45 minutes)
- Part 2: One class period (plus additional time with younger students)
- Part 3: Two to three class periods (45 minutes), depending on the activity selected for students to share their solutions

Level

Elementary (most appropriate for grades K-4)

Materials

Part 1

- Computer and projector or smartboard
- Copy of the *We Are All Part of the Solution! How the Greenhouse Effect Works* handout
- Student journals
- Pencils or pens
- Chart paper and markers

Part 2

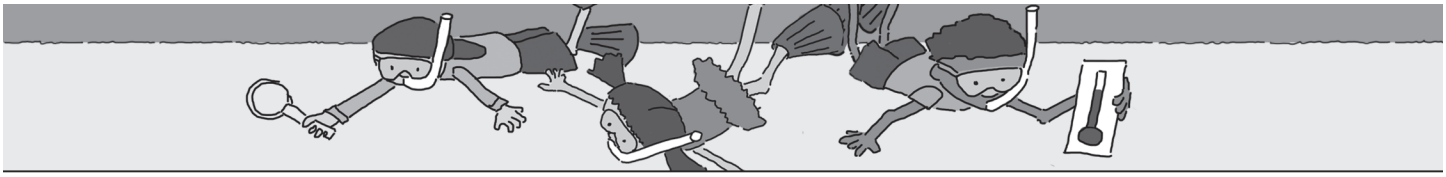
- Laptop computers (enough for one computer for each group of 2-3 students)
- Access to the Internet
- Student journals
- Pencils or pens

For the "Adaptation for Younger Students":

- 11x14" and 8x11" construction paper
- Markers
- Scissors
- Magazines
- Glue sticks
- Pennies, paper clips, and/or Unifix® blocks for non-standard measurement tasks

Part 3

- Copies of the *We Are All Part of the Solution! Student Activity Sheet*
- Pens or pencils
- Supplies to complete activity selected for sharing solutions (See Part 3 instructions.)



Preparation

- Review carbon footprint calculators available online and select one that will work best for your students. Some options include:

  EPA Calculator: A Student's Guide to Climate Change
  www3.epa.gov/climatechange/kids/calc/index.html

  THE GREENS: What's Your Footprint?
  meetthegreens.pbskids.org/features/carbon-calculator.html

  Cool California Carbon Footprint Calculator for Kids
  www.coolcalifornia.org/calculator

- Decide which activity you want to have your students do to share their ideas for solutions in Part 3, and gather the supplies needed for that activity.
- Prepare to either project the *We're All Part of the Solution! How the Greenhouse Effect Works* handout for the class or make copies to share with groups of students.
- Ensure you have enough computers for each group of 2-3 students.
- Make copies of the *We're All Part of the Solution! Student Activity Sheet* for each student or groups of students.

Teacher's Notes

The Greenhouse Effect - How it Works
Solar energy absorbed at the Earth's surface is radiated back into the atmosphere as heat. As the heat makes its way through the atmosphere and back out to space, greenhouse gases absorb much of it. They radiate the heat back to the Earth's surface, to another greenhouse gas molecule, or out to space.

There are several different types of greenhouse gases. The most prevalent gases are carbon dioxide, water vapor, methane, and nitrous oxide. These gas molecules all are made of three or more atoms. The atoms are held together loosely enough that they vibrate when they absorb heat. Eventually, the vibrating molecules release the radiation, which will likely be absorbed by another greenhouse gas molecule. This process keeps heat near the Earth's surface.

- **Carbon dioxide:** Made of one carbon atom and two oxygen atoms, carbon dioxide molecules make up a small fraction of the atmosphere, but have a large impact on climate. There was about 270 parts per million volume (ppmv) of carbon dioxide in the atmosphere in the mid-19th century, at the start of the Industrial Revolution. The amount is growing as the burning of fossil fuels releases carbon dioxide into the atmosphere. There was about 400 parts ppmv of carbon dioxide in the atmosphere in 2015.
- **Methane:** A powerful greenhouse gas, able to absorb far more heat than carbon dioxide, methane is made of one carbon and four hydrogen atoms. It is found in very small quantities in the atmosphere (less than carbon dioxide) but is able to make a big impact on warming because of its huge heat-trapping abilities. Methane gas is also used as a fuel. When burned, it releases carbon dioxide into the atmosphere.

More Greenhouse Gases = A Warmer Earth
Even though only a tiny amount of the gases in the Earth's atmosphere are greenhouse gases, they have a huge effect on climate. Sometime during this century, the amount of carbon dioxide in the atmosphere is expected to be double the mid-19th century levels. Other greenhouse gases, like methane and nitrous oxide, are increasing as well. The quantity of greenhouse gases is increasing as fossil fuels are being burned, which releases the gases and other air pollutants into the atmosphere. Greenhouse gases also make their way to the atmosphere from other sources. Farm animals, for example, release methane gas as they digest food. As cement is made from limestone, it releases carbon dioxide.

With more greenhouse gases in the air, heat passing through on its way out of the atmosphere is more likely to be trapped. The added greenhouse gases absorb the heat. They then radiate this heat. Some of the heat will head away from the Earth, some of it will be absorbed by another greenhouse gas molecule, and some of it will wind up back at the planet's surface again. With more greenhouse gases, heat will stick around, warming the planet.

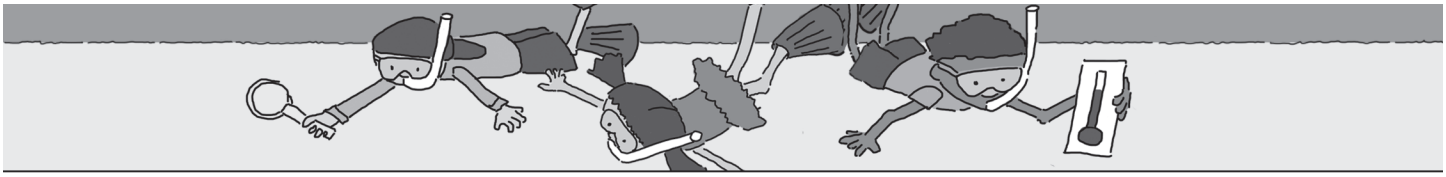
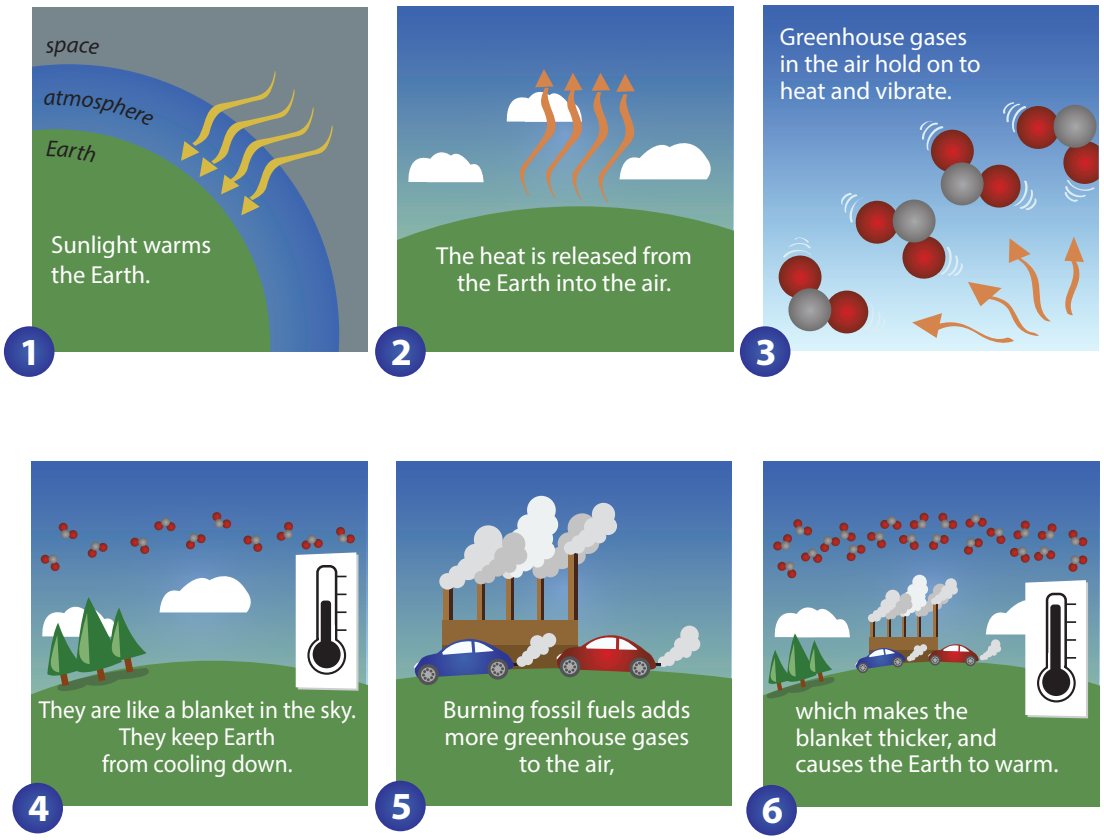


Figure 1. How greenhouse gases trap heat in the atmosphere, and how more greenhouse gases are causing more heat to be trapped.



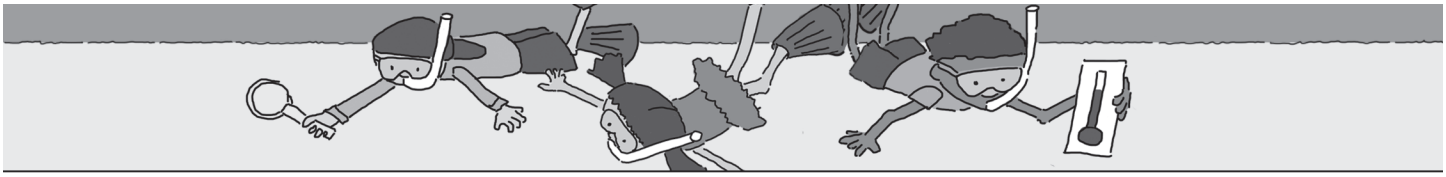
Humans: Contributing to Climate Change and Helping with Solutions

While humans contribute to greenhouse gas emissions as a result of going about our daily lives, we can make choices in some aspects of our lives that reduce these emissions. A "carbon footprint" refers to the total amount of carbon dioxide that is released into the atmosphere as a result of human activities. By reducing our carbon footprint, thus reducing our greenhouse gas emissions, we will be lessening our contributions to climate change. The choices we make in our homes, our travel, the food we eat, and what we buy and throw away all influence our carbon footprint and can help ensure a stable climate for future generations.

What to Do and How to Do It

Part 1: Sources of Greenhouse Gases

1. Discuss the concept of a greenhouse with your students in order to build their background knowledge. If needed, show them a photo of a greenhouse and discuss this analogy.
2. Have a discussion with your students about greenhouse gases, including what they are, how they impact our climate system, and how human activity produces these gases. Highlight that greenhouse gases are made when oil, gas, and coal are burned to make energy.
3. Share the illustration from this activity that illustrates greenhouse gases in our atmosphere (*We're All*



Part of the Solution! How the Greenhouse Effect Works handout), and review how these gases work.

4. Have the class brainstorm a list of human activities that produce greenhouse gases. If students need help brainstorming a list, ask students what in the classroom is using energy. (If the energy is coming from fossil fuels, then the power for the classroom lights, heat, computers, and hot water is producing greenhouse gases.) List their responses on a whiteboard or chart paper. Some responses might include:
    - driving a car
    - heating or cooling a home
    - using a gas-powered lawn mower
    - watching television
    - using lamps to light a home
5. Summarize the responses from this brainstorm discussion and group the responses by category. If needed, discuss each of these categories and talk to the students about how greenhouse gas emissions relate to each of these areas (for example, trucks that transport food from farms to grocery stores burn fossil fuels). Categories may include:
    - Food
    - Travel
    - Home
    - Manufacturing (stuff that you use)
    - Waste

Part 2: Calculate Your Carbon Footprint.

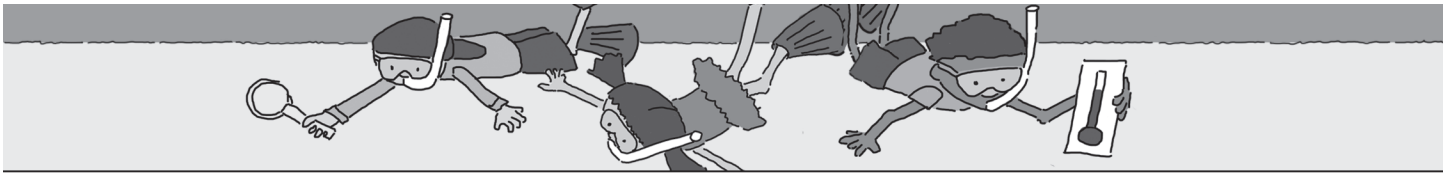
1. Introduce students to the concept of a carbon footprint and that we can calculate the total amount of carbon dioxide that is released into the atmosphere as a result of our activities with a Carbon Footprint Calculator. Note: for younger students, consider first doing the footprint activity in the "Adaptations for Younger Students" section of this activity.
2. Using a projector, pull up one of the Carbon Footprint Calculators from the materials list for this activity and take the students through each step.
3. Then divide the students into small groups and have them work on a laptop (one laptop per group) to fill out the Carbon Footprint Calculator. Circulate throughout the room to answer questions and to help the students when they need it.
4. After the students have completed their calculations, have each student record their results in his or her journal.
5. Ask the students the following questions and discuss as a class: What did you learn? What surprised you? What do you want to know?

Part 3: Be a Part of the Solution.

1. Talk to students about how people can help solve climate change by shrinking their carbon footprint. Below is a list of some solutions that people can do. There is not one single action that is the solution to climate change; instead, it will take many different solutions. Small-scale solutions can be done at home or at school. Larger-scale solutions might involve support from your school principal, or they could be solutions that students can do with the community. Let the students know that these solutions are important and that they can help make a difference. In reducing greenhouse gas emissions, these solutions help reduce our carbon footprint, which lessens our contributions to climate change. In addition to these solutions, talk about how state and federal governments are also working on even larger solutions, such as changing infrastructure to reduce our reliance on fossil fuels and creating more capacity for alternative transportation options. This work is even in collaboration with other countries around the world.

    Smaller-scale solutions:
    - making a school garden
    - reducing food waste/composting
    - energy use (turning off the lights when they are not in use, putting computer to sleep when not used, etc.)
    - recycling
    - getting to school by walking, riding a bike, or taking public transportation

    Larger-scale solutions (would need school administration/facility manager buy-in and fundraising):
    - installing a green roof
    - having a bike/walk to school event
    - installing solar panels



Adaptations for Younger and Older Students

Help younger students make the connection from a concrete idea to an abstract idea (i.e., going from their actual footprint to their carbon footprint) before doing Part 2 of this activity. The following activities could be used to scaffold student learning.

Student Footprints:

- Have the students work in pairs to trace around each other's footprint. Next have students cut out their footprints and write their names on the inside of their footprints.
- Have the students do some comparison by lining up their footprints in order of size: from smallest to largest or largest to smallest. Which is the largest footprint? The smallest? Which are equal?
- Have students measure the length of their footprints using non-standard measurement by using a variety of objects that could include, but not limited to: paper clips, Unifix® blocks, pennies, etc.

Footprints of Others:

- After using the above activity about their own footprint, proceed to a discussion of where students may have left a footprint behind or where they have seen human or animal footprints. The discussion could include places that they are familiar with, such as their backyard, schoolyard or park. It could also include places that they may have visited or seen, such as pictures of the beach, a muddy construction site, or the moon.
- This session could also include reading books to students, including the following three suggestions: *Footprints in the Snow* by Cynthia Benjamin, *A Snowy Day* by Ezra Jack Keats, and *Footprints in the Sand* by Cynthia Benjamin.

Student Carbon Footprints:

- To transition students to the abstract idea of a carbon footprint, explain that everyone has a footprint, (Student Footprints) and that footprints can be physically made and seen by others (Footprints of Others). The idea or concept behind a carbon footprint is that it is a footprint that everyone makes on the Earth. This footprint can be big or small, depending on the actions a person does every day and over time. Explain that the difference is that their footprint gets bigger over time as they grow. In order to help our Earth, a carbon footprint needs to get smaller over time. Explain that they can help make that happen.
- Have a discussion with the whole class about everyday things that people might do in their lives that can impact their carbon footprint. Using the Elementary GLOBE book *What in the World Is Happening With Our Climate?* as a reference, activities could include the following: brushing teeth with the water running, leaving on a computer, lights, and/or video games when leaving a room, throwing away all waste without recycling anything, etc.
- Next have each student cut out a pre-drawn giant footprint, the size of a 11" by 14" piece of construction paper. Then have students cut out pictures or draw activities that would represent making a carbon footprint on the Earth (such as mentioned above).
- Have students draw their own footprint and show ways to reduce their carbon footprint by drawing their solutions on their smaller footprint and share with the class. Discuss how making changes, such as using alternative energy sources, will help make their footprint smaller.

Further Investigations

- After discussing the students' ideas for solutions, ask them to think outside the box; have them come up with inventions they would like to develop to help reduce climate change.
- Have students select one solution they would like to try at home, or as a class at school. Track their actions and have the students determine the impacts these actions are having in terms of reductions in greenhouse gas emissions.
- If there's support from the school administration or PTA, work on implementing some of the solutions the students proposed. Have the students provide status updates on the impacts of these solutions. For example, if they plant a school garden, how much food did they grow? Was this food served in the cafeteria, and, if so, did it reduce the amount of food the school needed to purchase?

We're All Part of the Solution! Student Activity Sheet

Group members: _____

Date: _____

What are your ideas of things people can do to help solve climate change? Write or draw your ideas in the box below. Use one page per idea.

Idea title: _____

This is a ☐ small-scale solution

☐ large-scale solution

Describe why this idea will help solve climate change.

We're All Part of the Solution! Handout

How the Greenhouse Effect Works