

## The Greenhouse Effect

- Overview:** Students will understand the greenhouse effect and the role of greenhouse gases in Earth's atmosphere.
- Keywords:** Greenhouse Gas (GHG), Carbon Dioxide, Methane, Greenhouse Effect, Radiation, Climate Change, Global Warming Potential (GWP)
- Age / Grade Range:** 5th-6th Grade students
- Background:** Of all energy received from the sun, 6% is scattered by the atmosphere, 20% is reflected by clouds, 19% is absorbed by clouds, 4% is reflected from the Earth's surface and 51% is absorbed by the Earth's surface<sup>1</sup>. As Earth's surface releases the energy absorbed by the sun the energy travels back into space. The type of energy that the Earth's surface releases is thermal energy. As the thermal energy travels through the atmosphere greenhouse gas molecules absorb this energy through their molecular bonds between their atoms. After absorbing the thermal energy from the surface the bonds release the thermal energy and it is redirected back at the Earth's surface or reflected around the atmosphere "trapping" the thermal energy<sup>23</sup>. With enough greenhouse gases the overall temperature of the Earth can be raised. This is called the Greenhouse Effect, named for the same principals greenhouses use.
- There are four sources of greenhouse gases (GHG) that contribute to the greenhouse effect. They are carbon dioxide, methane, nitrous oxide and fluorinated gases<sup>4</sup>.
- Greenhouse gases are measured using the Global Warming Potential (GWP) scale. Carbon dioxide is the standard unit which all GHG effects are measured against. Methane has a GWP of 20, which means 1 pound of methane would have the same GWP as 20 pounds of carbon dioxide. Nitrous oxide has a GWP of 300 and some fluorinated gases have GWP over 10,000. An example of a fluorinated gas would be aerosol cans and refrigerant gases used in the 1970-1990. These gases have been phased out of use after their environmental impact was studied<sup>5</sup>.

<sup>1</sup> [https://www.ucar.edu/learn/1\\_3\\_1.htm](https://www.ucar.edu/learn/1_3_1.htm)

<sup>2</sup> [https://www.ucar.edu/learn/1\\_3\\_1.htm](https://www.ucar.edu/learn/1_3_1.htm)

<sup>3</sup> <http://www.epa.gov/climatestudents/basics/today/greenhouse-effect.html>

<sup>4</sup> <http://www.epa.gov/climatechange/ghgemissions/gases.html>

<sup>5</sup> <http://www.epa.gov/climatechange/ghgemissions/gases/co2.html>

Based on 2012 GHG emission in the US alone, 82% is from carbon dioxide, 9% is from methane, 6% is from nitrous oxide, and 3% is from fluorinated gases.

It is important to note **that without greenhouse gases** Earth would not be warm enough to support life. Mars is an example of not having enough GHG to support life (also very thin atmosphere) with  $-50\text{ }^{\circ}\text{C}$  the average temperature<sup>6</sup> during the day while Venus is an example of having too much GHG to support life with an average temperature  $464\text{ }^{\circ}\text{C}$ <sup>7</sup>. Understanding how GHG can effect Earth lead to responsible stewardship of our planet and environment.

**Next Generation Science Standards:**

**5-ESS2-1:** Develop a model using an example to describe ways to geosphere, biosphere, hydrosphere, and/or atmosphere interact.

**5-ESS3-1:** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

**MS-ESS3-4:** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

**Common Core:**

**RI.5.9:** Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.

**MP.2:** Reason abstractly and quantitatively

**RST.6-8.7:** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually

**WHST.6-8.1** Write argument focused on discipline content.

**Goals:**

Greenhouses gases can raise the temperature of the atmosphere though the greenhouse effect. Greenhouse gas is not bad, we need the right balance to survive.

**Disclaimer :** Be aware of where your students come from. There are skeptics that global warming/global climate change is caused by human activity generating greenhouses gases. Know where you students and chaperones come from and be prepared to defend your claims.

<sup>6</sup> <http://quest.nasa.gov/aero/planetary/mars.html>

<sup>7</sup> <http://nssdc.gsfc.nasa.gov/planetary/factsheet/venusfact.html>

**Objectives:** Students will understand that greenhouse gases are natural for Earth. Students will understand that since the industrial revolution, humans have been altering the carbon cycle and releasing more GHGs into the atmosphere in the form of carbon dioxide. Students will differentiate the effect that different amounts of GHG will affect the climate of Earth. Students will identify everyday methods to reduce carbon dioxide emissions.

**Materials:** Multiple outer layers  
IR Thermometer / (Surface temperature Probe)  
(Labquest needed if using the surface temperature probe)  
(Masking tape if using Labquest)

**Set up:** Bring extra outer layers with you before you run this activity. Determine whether or not this will be an indoor/outdoor activity or a Program Host activity.

When gathering extra layers jackets and blankets would work the best to keep the core body warm.

Have the materials ready for use.

**Classroom Time:** 10-25 minutes

**Overview**

1. Gather layers
  - a. Jackets or blankets to cover the body core
2. Have three student volunteers
  - a. Have students begin with base layers, no jackets or sweatshirts
3. Record temperature at collar bone for all three students
4. Layer students with clothing or blanket
  - a. One student remains at base layer
  - b. One student receives a thin jacket or sweat shirt
  - c. One student receives many layers, sweatshirts and blankets
  - d. Account environmental conditions when layering students
5. Have students exercise at the same rate.
  - a. Jumping jacks, running, walking
6. Record temperature after exercise is over.
7. Relate GHGs to layers of clothing during debrief.

**Introduction (Engage):** **Note: Text in "quotations" signifies suggested dialogue to engage students in and is not intended to be a script. Use your best judgment when delivering these lessons.**

I. Introduction:

"This activity will explore the effects of the greenhouse effect on Earth. Let's see the effect of GHG in our atmosphere."

- a. "What do you know about the greenhouse effect?"
- b. "What do you think causes the greenhouse effect?"

**Activity (Explore):**

"I will need three volunteers!" (Try to pick students with a lot of layers already. If doing this activity during warmer conditions have extra blankets or clothes from the washing room/salmon A)

Field or Indoor Activity:

"We will have three different situations to look at with our three different Earths! First each Earth will have to go down to your base layer (t-shirt, long sleeves shirt, no jackets or sweaters) Each layer of clothing represents a layer of greenhouse gas. We're going to record the temperature of these Earths before we add greenhouse gases to them. (Record their temperature. If using IR thermometer aim for the collar bone, if using surface temperature probes, tape the probe on their collar bone. Advantage of using the labquest is that you'll be able to record the change in temperature)

"Great, now Earth one has a lot of cars that produce Carbon dioxide,(See disclaimer on how you say this) lots of cows that can produce methane so they have a lot of greenhouse gases. (Heap clothing onto the volunteer, make them super bundled) Earth two has less cars, a more balanced amount of carbon dioxide and methane in the atmosphere (Give volunteer two one layer) Earth three has no greenhouse gas at all (Give volunteer three no new layers) Let's see how their temperatures will change after some time."

**IMPORTANT CONSIDERATION: Factor weather conditions when doing this activity and plan accordingly. Do not let students freeze in winter and overheat in summer.**

*Time options:* You can have students walk at the same pace for 1 minute, jog in place for 30 seconds, or have students do jumping jacks. Something short that all students can do at the same pace to control the variables between students.

(While volunteers are moving or sitting) "We need to create heat that can be reflected from the surface of the Earth, which is their skin, to see effect of greenhouse gases on our Earths. (After the allotted time has passed measure their temperature again) Lets see our results!"

(The student who has not layers should have the lowest temperature rise while the student with the most clothes should have the highest temperature rise)

Program Host Optional Morning Activity

Same as above with a few modifications

1. Use the Labquest instead of the IR thermometer. This way you will be able to project the data recorded onto the Smartboard with the Program Host Computer using Photobooth application.
2. Instead of having the volunteer sit for a minute have them engage in a brief time period of cardio. Instead of representing the whole Earth they can represent one side. As they exercise it demonstrates the sun heating the Earth, after they stop it can represent the "night" phase of Earth.

**Explanation**

"Which Earth had the greater increase in temperature? Why do you think that?" (Field answers) "In a greenhouse, light from the sun passes through the greenhouse and warms the plants inside. The energy is absorbed by everything in the greenhouse such as the plants, the ground, the shelves, and pots. This energy is radiated back out into the environment except the greenhouse glass or plastic traps the heat causing the greenhouse to be warmer inside of it than outside of it. This is called the greenhouse effect and the Earth has a similar process."

"The Earth is heated by the sun. 49% of the energy never reaches the surface of the Earth, 51% actually makes it down to the Earth's surface. The energy that makes it to the surface is radiated back into space. However there are specific gases that trap the heat inside the Earth's atmosphere causing the temperature to rise, just like the plastic or glass in the greenhouse. These gases that trap heat are called greenhouse gases. Does anyone know what one of the four is called?" (Field answers)

"The four main greenhouse gases are Carbon dioxide, methane, nitrous dioxide, and fluorinated gases. Carbon dioxide and methane are the two most common GHG. Of the greenhouse gases present in our atmosphere 82% is from carbon dioxide." (Depending on the age group and time you can add information about the percentages each GHG makes up out of the total GHGs being studied)

"What are some sources of carbon dioxide?" (Field answers. Cars, and electricity generation are major contributors)

Program Host Option:

If you were to do this during the morning it would be a good fit after you reviewed energy audit to tie in that generating electricity is a contributing factor to adding greenhouse gases into the atmosphere.

"Should we try and get rid of all greenhouse gases? Why?" (Field answers, refer back to the volunteer students when explaining this next part)  
We currently have a lot of GHGs, we are on track to being in on an Earth like

volunteer one (See disclaimer), lots of layers trapping that heat. However, if we remove all those GHGs we find Earth in a situation like volunteer three, no layers. "

"What is the temperature like in winter to you? (field answers) That's with greenhouse gases present, what do you think would happen to the temperature if they were gone? (Pause and let them think about that while fielding answers) This issue isn't an easy one. We must strive to find balance in our actions, our choices. Too much of anything can harm us, water, food, and sunlight. Too little of anything can also harm us as well, not enough water, not enough food, and not enough sunlight. We need to be mindful of what we do and the effects they may have."

**Elaboration/  
Content Tie-in:**

This activity can be referred back to when teaching What's a Watt Worth, Energy Explorations, Value of a Tree, firebox, and fire boards.

**What's a Watt Worth:** You could refer back to this activity when you have a discussion on electricity energy sources and expand the talk to carbon dioxide emissions

**Energy Explorations: Tag and Beans:** Different energy sources release different amounts of carbon dioxide at different stages in their use. i.e. Coal has carbon dioxide emissions during mining, transportation, and burning while wind will have carbon dioxide emissions from manufacturing, transportation and assembly.

**Value of a Tree:** when discussion slash piles you can tie in carbon dioxide is a result of burning slash piles instead of processing them for biofuel or letting them decompose back into their environment.

**Firebox and Fireboards:** When talking about wild fires and forest management you could tie in how carbon dioxide is released as forests burn which is an additional environmental impact on top of the displaced animals, damaged ecosystem and affected humans.

**Evaluation:**

Field Group Activity:

Have students create an action plan they can use at home to reduce the amount of electricity used and carbon dioxide released.

Program Host:

Evaluation will have to be done with each groups field instructor.

**Additional resources:**

Greenhouse Gas information:

[https://www.ucar.edu/learn/1\\_3\\_1.htm](https://www.ucar.edu/learn/1_3_1.htm)

Overview of the Greenhouse Effect:

<http://www.epa.gov/climatestudents/basics/today/greenhouse-effect.html>

Information on Greenhouse Gas Emissions:

<http://www.epa.gov/climatechange/ghgemissions/>

<http://www.epa.gov/cleanenergy/energy-and-you/affect/air-emissions.html>

**See Appendix A for materials**