



Activity 1.3 Greenhouse Gas Emissions – Natural and Human Causes

Grades 7 – 9

Description: In this activity, students dig deeper into the greenhouse effect and explore natural and human-caused greenhouse gas emissions and their impacts. Students will brainstorm and then research natural and human activities that contribute to greenhouse gas emissions and draw them in a diagram. Students then discuss how they can reduce their contributions to greenhouse gas emissions.

Time: One or two 45-minute class periods

Prior Knowledge: Students should have been introduced to the greenhouse effect and the Earth's energy balance.

Materials

- Overhead or LCD projector
- Computers with internet access (one for every 2-4 students)
- Books, articles, and other resources students can use to research sources of atmospheric CO₂ and other greenhouse gases
- Copies of Carbon Cycle and Natural & Human Sources of Greenhouse gases diagrams
- Where do Greenhouse Gases Come From handouts
- Greenhouse Gas Emissions Diagram handouts
- Colored pencils

National Science Education Standards

D.1.h The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor.

D.1.j Living organisms have played many roles in the Earth system including affecting the composition of the atmosphere.

F.3.b Human activities can also induce hazards through resource acquisition, land-use decisions, and waste disposal.

F.5.c Technology influences society through its products and processes.

AAAS Benchmarks

5D/H3 Human beings are part of the Earth's ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.

4B/M15 The atmosphere is a mixture of nitrogen, oxygen, and trace amounts of water vapor, carbon dioxide, and other gases.

4B/H6 pt 2 The burning of fossil fuels in the last century has increased the amount of greenhouse gases in the atmosphere, which has contributed to Earth's warming.

4C/M7 Human activities, such as reducing the amount of forest cover, increasing the amount and variety of chemicals released into the atmosphere, and intensive farming, have changed the Earth's land, oceans, and atmosphere. Some of these changes have decreased the capacity of the environment to support some life forms.

8C/M11 By burning fuels, people are releasing large amounts of carbon dioxide into the atmosphere and transforming chemical energy into thermal energy that spreads throughout the environment.

4C/H1 Plants on land and under water alter the Earth's atmosphere by removing carbon dioxide from it, using the carbon to make sugars and releasing oxygen. This process is responsible for the oxygen content of the air.



Student Misconceptions: The ozone hole causes global warming.

Adapted from <http://www.nasa.gov/missions/earth/f-ozone.html> and http://www.giss.nasa.gov/research/features/200402_tango/

The stratosphere is the layer of the atmosphere from 10 to 30 miles above sea level. When there's ozone in this layer, it protects us from solar radiation. Regular oxygen molecules (O_2), are made up of two oxygen atoms stuck together. Solar energy shoots in from space and splits that molecule into two atoms. These stray O atoms attach to other O_2 molecules to create ozone (O_3). Ozone helps block solar radiation, including ultra violet (UV) radiation, from reaching the Earth. UV radiation can cause skin cancer, but it also affects photosynthesis in plants, and that causes problems for the whole food chain. So the thinning of the ozone layer in the stratosphere, what is known as the “ozone hole” allows increased ultraviolet rays to reach the earth, but the “ozone hole” does not cause climate change or increased temperatures.

There is a complex relationship between ozone depletion and climate. Ozone's impact on climate consists primarily of changes in temperature. Ozone is a greenhouse gas and the more ozone in a given parcel of air, the more heat it retains. Ozone generates heat in the stratosphere, both by absorbing the sun's ultraviolet radiation and by absorbing upwelling infrared radiation from the lower atmosphere (troposphere). Consequently, decreased ozone in the stratosphere results in lower temperatures the opposite of global warming. Observations show that over recent decades, the mid to upper stratosphere (from 30 to 50 kilometers above the Earth's surface) has cooled by 1° to 6° Centigrade (2° to 11° Fahrenheit). This stratospheric cooling has taken place at the same time that greenhouse gas amounts in the lower atmosphere (troposphere) have risen. The two phenomena may be linked.

Vocabulary

- **Fossil fuel:** A source of energy such as coal or gas that was formed over many years from the remains of living organisms.
- **Carbon source:** A place or entity that releases carbon into the atmosphere (e.g.: an organism performing cellular respiration, decaying organic matter, a power plant).
- **Carbon sink:** A place or entity that removes or absorbs carbon from the atmosphere (e.g.: a plant performing photosynthesis).

Resources

- **Tim and Moby videos** are available through the Brain Pop website. There are hundreds of short educational videos on a variety of science, math, social studies, English, arts, and health. The site is a subscription site with different price points for home, classroom, school, and district use. A year's classroom subscription was \$205 in 2013. They make a small number available for free at http://www.brainpop.com/free_stuff/ and some can be found on YouTube.
- <http://climate.nasa.gov/causes/> (NASA's explanation of the causes of climate change)



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- <http://eo.ucar.edu/kids/green/cycles6.htm> (University Corporation for Atmospheric Research resources on climate change for kids.)
- <http://www.epa.gov/climatechange/ghgemissions/sources.html> (Environmental protection agency climate change resources, greenhouse gas emissions)
- <http://co2now.org/Know-the-Changing-Climate/Climate-System/ipcc-faq-human-natural-causes-climate-change.html> (IPCC explains human and natural causes of climate change)
- http://www.eia.gov/energyexplained/index.cfm?page=environment_where_ghg_come_from (U.S. Energy Information Administration explanation of where greenhouse gases come from)

Guiding Questions

- What is the role of greenhouse gases in the atmosphere?
- What are natural causes of greenhouse gas emissions?
- In what ways do humans contribute to greenhouse gas emissions?
- How can increased greenhouse gas emissions lead to climate change?

Assessment(s)

- Where do Greenhouse Gases Come From handout
- Greenhouse Gas Emissions Diagram

Before you start

- Collect reference materials on greenhouse gas emissions for students to use in their research activities (see list at the end of the unit).
- Review the websites on the *Where do Greenhouse Gas Emissions Come From?* handout.
- Reserve the computer lab.

Procedure:

Part 1: Researching Greenhouse Gas Emissions

1. Review with the students what they learned during the Activity 1.2 Greenhouse Effect lab. Write student responses on the board. Discussion questions might include:
 - a. “What is the greenhouse effect?” Students should know that the greenhouse effect is the idea that gases in our atmosphere act like a greenhouse (or a blanket), keeping in warmth (heat energy) that would otherwise escape into outer space.
 - b. Why greenhouse gases are important to life on earth. What would happen if the amount of greenhouse gases were to decrease? What if we had no greenhouse gases to keep the earth warm?
 - c. If greenhouse gases help keep the Earth warm, what do you think would happen if the amount of greenhouse gases in the atmosphere were to increase? Remind them of the results of their lab, if they are unsure of the response.
2. Tell students that though there are many greenhouse gases, we will be thinking about four today: carbon dioxide, methane, nitrous oxide and chlorofluorocarbons (CFCs). The most abundant greenhouse gas is water vapor. Water vapor increases as the Earth's atmosphere warms, but so does the possibility of clouds and precipitation, so it is an important feedback loop in the climate system. However, because we are not directly adding water vapor to the



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air through our actions, we are going to focus on the other four gases. Tell students that they are going to consider each of these gases, and how they get into the atmosphere.

3. They are going to start with carbon dioxide, since it is the best known greenhouse gas. Ask students what they know about carbon dioxide and the other greenhouse gases. Have them write their answers on the board. Responses might include: We breathe it out, plants breathe it in, it is in the atmosphere
4. Let the students know that there are natural cycles of carbon dioxide. When organisms breathe, through a process called respiration, they release carbon dioxide.
5. Ask all the students to breathe in. Have them hold in their breath and exhale at the same time. Let them know that they have released carbon dioxide into the atmosphere. All animals release CO₂ when they breathe. (Plants also undergo respiration and release small amounts of carbon dioxide into the atmosphere. However, depending on whether you have already covered photosynthesis, you may not want to highlight plant respiration at this point.)
6. Next, ask students if they know a process that takes carbon dioxide **out** of the atmosphere. Tell students that when plants perform photosynthesis, they use carbon dioxide to make sugars, which they can use for growth, or to make flowers or fruits. Tell students that plants are one of the few things on Earth that can actually remove carbon dioxide from the atmosphere (The oceans are the other large carbon sink, absorbing up to 50 percent of atmospheric CO₂.) Photosynthesis and respiration represent the natural cycle of carbon dioxide through the atmosphere. If you have covered photosynthesis, you may want to draw connections here with the chemical processes that remove CO₂ from the atmosphere.
7. Project the Carbon Cycle Diagram on a screen and walk students through each step, illustrating the steps they have just discussed. Highlight the natural sources of carbon dioxide in the atmosphere and remind students that without the greenhouse effect the Earth would be too cold to support life.
8. Ask students if they know of any ways that humans add CO₂ to the atmosphere besides breathing. Students may know that when fuels are burned, they release carbon dioxide. Examples of this are when wood is burned for heat, or when fossil fuels such as gas are burned in our cars, boats, airplanes, etc. Tell students they are going to take some time to investigate both natural and human-created sources of atmospheric CO₂
9. As a very general introduction to the carbon cycle and the greenhouse effect, show the short movie (about three minutes) *Tim & Moby: What can you tell me about the carbon cycle* <http://www.youtube.com/watch?v=jNIQ9KTMimQ&feature=related>, in which Tim & Moby describe the carbon cycle and how it is related to the greenhouse effect. Have students complete the accompanying handout while they watch the movie. (Tim and Moby videos are available through the Brain Pop website. There are hundreds of short educational videos on a variety of science, math, social studies, English, arts, and health. The site is a subscription site with different price points for home, classroom, school, and district use. A year's



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classroom subscription was \$205 in 2013. They make a small number available for free at http://www.brainpop.com/free_stuff/ and some can be found on YouTube.)

10. Discuss the movie and their answers to the questions. Ask students what the energy produced by fossil fuels being burned is used for. What in their everyday lives uses the energy that is created by burning fossil fuels? For instance, fuel (usually coal) is burned to generate electricity, which powers everything from our televisions, to computers and hair dryers.
11. Remind students that carbon dioxide is not the only greenhouse gas, and in the next section they will explore other greenhouse gases in more detail.

NOTE: You can skip to Part 2 after students watch the movie or you can extend this activity with a web-based research component using the “Where do greenhouse gases come from?” handout. The handout has identified fairly straightforward websites where the answers to the questions can be found. However, they are adult-focused websites and student reading levels should be taken into account.

12. Break students into groups of 3-4 and hand out the “Where do greenhouse gases come from?” handout. Provide each group of students with the resources you have available—books, articles, and/or a computer with internet access. They will explore the websites indicated on the handout to find the answers. If you do not have computers with internet access, you may want to print out and compile information from the referenced websites to create information packets for students to use to answer the questions.
13. Once students have completed their research, discuss their answers.

Part 2: Diagramming Greenhouse Gas Emissions

(this can be done as a class, in groups, or as homework)

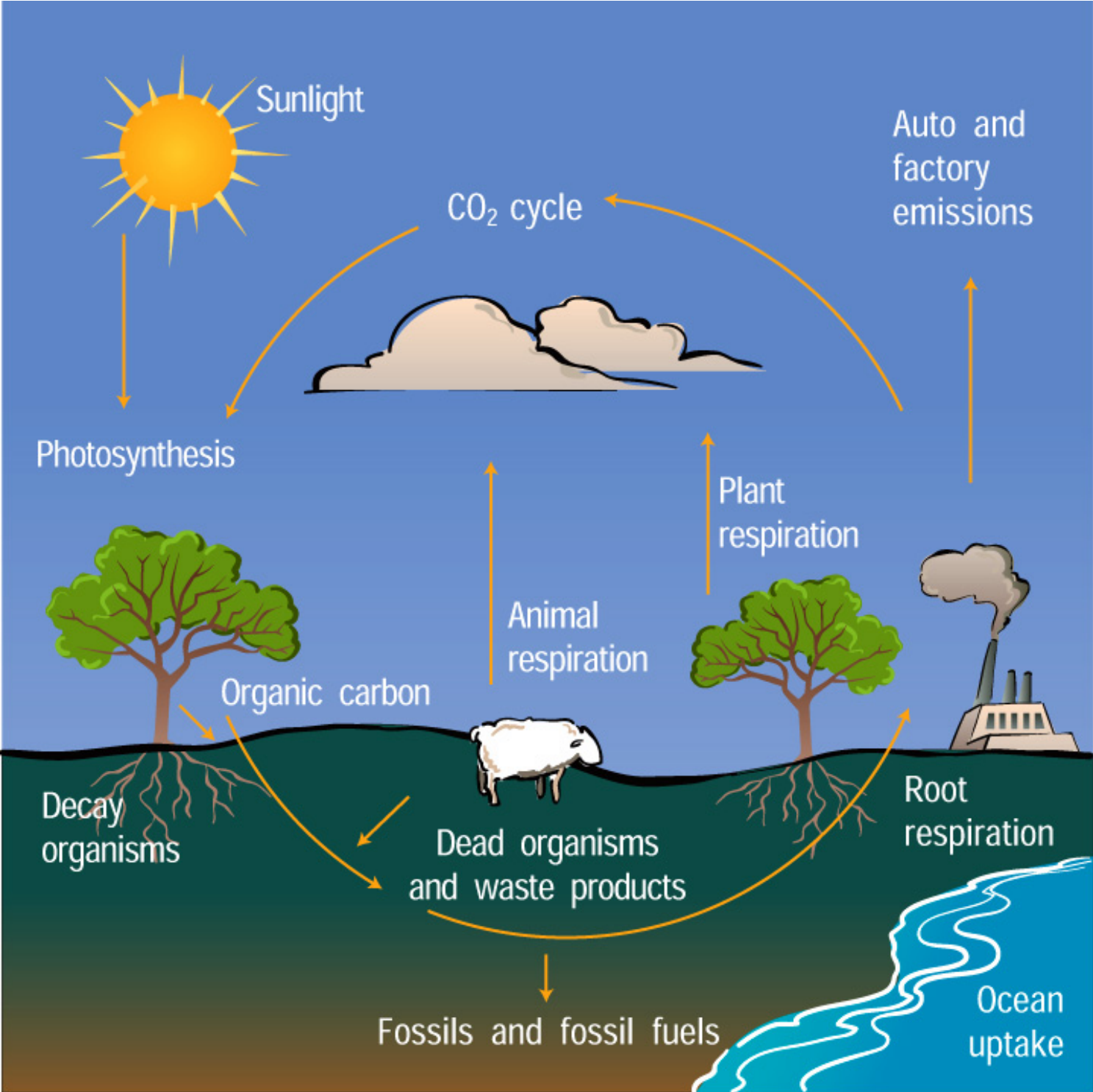
14. Next, hand out the student work page “Greenhouse Gas Emissions.” Point out to students the layer of greenhouse gases in the atmosphere and the Earth’s surface at the bottom of the page. Using the information they collected through their research, have students to draw natural and human-caused greenhouse gas emissions on their sheet. They can label the sources, as well as which are natural and which are human-caused.
15. After students have completed their diagrams, ask them to complete the two statements at the bottom of the page. Students are to write down the activities they think most contribute to greenhouse gas emissions and how they can work to reduce their emissions.
16. Have a discussion with students reviewing why they would want to reduce their emissions (reviewing the idea that increased greenhouse gas emissions contribute to climate change). For how they can reduce emissions, have students write down something they can, and actually will do. You can post the sheets around the room, or have students keep the sheets in their portfolio as a reminder of the commitments they have made to reduce greenhouse gas emissions.



Extensions:

- You may wish to issue a challenge to students regarding their greenhouse gas emissions. Have students choose a goal of reducing energy usage or transportation and assign them to keep a journal of the experience for a week or a month. You can also do a math extension asking students to quantify their greenhouse gas savings! (Note, there is a lesson in Unit 4 regarding carbon footprints. This may be a good time to introduce this lesson).
- You could also discuss alternative energies with students—such as wind power, hydropower, and geothermal energy. These alternative energies can generate heat and electricity without as much carbon dioxide emission as such traditional energy sources as coal.

The Carbon Cycle



<http://eo.ucar.edu/kids/green/cycles6.htm>

Natural and Human Sources of Greenhouse Gas Emissions



Tim & Moby: What can you tell me about the carbon cycle?

Watch and listen carefully to what Tim & Moby have to say about the carbon cycle and answer the following questions about the sources of greenhouse gas emissions.

1. List three places you would find CO₂ on the Earth.

- _____
- _____
- _____

2. List two sources of natural CO₂ in the atmosphere.

- _____
- _____

3. List three ways that humans put CO₂ into the atmosphere.

- _____
- _____
- _____

4. Since the Industrial Revolution, the amount of CO₂ in the atmosphere has increased by _____ percent.

5. Why is the fact that humans are adding to the usual amount of greenhouse gases in the atmosphere important?

6. What are two ways that we can restore balance to the carbon cycle?

- _____
- _____



Where do Greenhouse Gases Come From?

Use the following sites and the resources provided by your teacher to answer the following questions about the sources of greenhouse gas emissions.

1. List the five main greenhouse gases.

<http://climate.nasa.gov/causes/>

- | | |
|----------|----------|
| 1. _____ | 4. _____ |
| 2. _____ | 5. _____ |
| 3. _____ | |

2. List two sources of **natural CO₂** in the atmosphere.

<http://eo.ucar.edu/kids/green/cycles6.htm>

- | |
|----------|
| 1. _____ |
| 2. _____ |

3. List five sources of human-caused greenhouse gas emissions.

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

<http://co2now.org/Know-the-Changing-Climate/Climate-System/ipcc-faq-human-natural-causes-climate-change.html>

- | | |
|----------|----------|
| 1. _____ | 4. _____ |
| 2. _____ | 5. _____ |
| 3. _____ | |

4. What percentage of all of the human caused greenhouse gases is

http://www.eia.gov/energyexplained/index.cfm?page=environment_where_ghg_come_from

- a. CO₂: _____ percent
- b. Methane: _____ percent
- c. Nitrous oxide: _____ percent

5. Why is the fact that humans are adding to the usual amount of greenhouse gases in the atmosphere important?