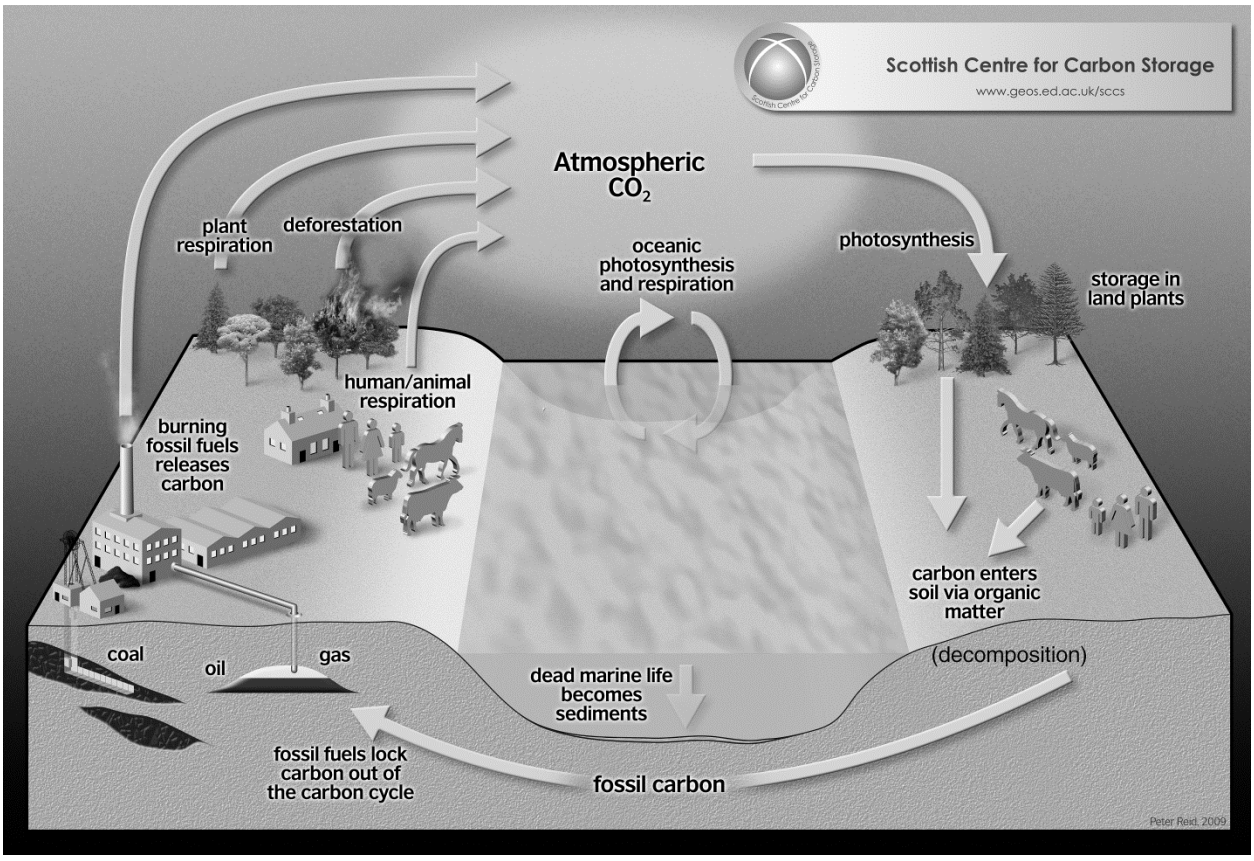
# Lab 13. Carbon Cycling: Which Carbon Cycle Process Affects Atmospheric Carbon the Most?

## Introduction

Organisms live together in ecosystems and rely on each other for food. All living things also require different amounts and kinds of *nutrients*, including nonliving factors in an ecosystem. Nutrients are chemicals that are essential for plant and animal growth. Animals get nutrients by eating plants or other animals. Plants get nutrients from the nonliving parts of an ecosystem, such as water and soil. In fact, nutrients often cycle through an ecosystem, which means they change forms and move through both living and nonliving parts. Carbon, nitrogen, and phosphorus are chemicals that cycle through an ecosystem. The carbon cycle is one of the most important cycles that support life in an ecosystem. Figure L13.1 illustrates the sources and storage of carbon as it cycles through an ecosystem.

## FIGURE L13.1

**The carbon cycle in ecosystems**




The following list traces the path of a carbon atom:

- Atmospheric carbon dioxide gas ($CO_2$) is a source of carbon in the cycle. The atmosphere is the layer of gases that surround the planet. $CO_2$ passes into the ecosystem through living organisms and nonliving elements through different processes.
- $CO_2$ leaves the atmosphere through *photosynthesis*, which is the chemical process used by plants to make food (in the form of sugar) using $CO_2$ from the atmosphere. This carbon material is eventually moved into other organisms through the food web. Forests and other areas with a lot of plant life are where the greatest amounts of photosynthesis happen.
- $CO_2$ can be released into the atmosphere through *combustion*. When trees are burned, $CO_2$ is released. The burning of large areas of trees is known as *deforestation*. Human activities add more

$CO_2$ into the atmosphere through activities like the burning of *fossil fuels*, which are carbon-rich materials made from the broken-down remains of plants and animals that lived millions of years ago. These fuels include coal, oil, and natural gas. Humans use these fuels to provide energy for technology and communities.

There can be more $CO_2$ in the atmosphere than plants can use in photosynthesis. This extra carbon in the atmosphere can lead to several changes in the environment. Extra $CO_2$ can trap heat energy coming from the planet's surface. As this heat energy gets trapped, it can raise the global temperature. This heating due to extra $CO_2$ is known as the *greenhouse effect*. Scientists have demonstrated that the rise in global temperature leads to changes in the climate of different regions of the world. *Climate* includes trends in different conditions in the environment that happen over long periods of time. Extra atmospheric $CO_2$ can also dissolve into bodies of water, especially oceans. When $CO_2$ combines with water, carbonic acid ($H_2CO_3$) is formed. Over time, this process leads to lower pH levels in the ocean, which is called *ocean acidification*.

## Your Task

Use a computer simulation to determine whether atmospheric $CO_2$ will decrease more from burning fossil fuels or from changing the amount of deforestation.

The guiding question of this investigation is, **Which carbon cycle process affects atmospheric carbon the most?**

## Materials

You will use an online simulation called *Carbon Lab* to conduct your investigation. You can find the simulation by going to the following website: *www.learner.org/courses/envsci/interactives/carbon/carbon.html*.

## Safety Precautions

Follow all normal lab safety rules.

## Investigation Proposal Required? ☐ Yes ☐ No

## Getting Started

Use the *Carbon Lab* simulation to estimate how decreasing plant life through deforestation and increasing the fossil fuel use will affect other parts of the planet. You will need to run simulations using different settings for increasing and decreasing the amount of fossil fuels burned. You will also need to run simulations using different settings for increasing and decreasing the amount of deforestation happening. You can adjust these settings using the sliding scales on the screen. Once you have set the scales, then you need to press the "Run Decade" button. One decade will show what happens to atmospheric $CO_2$ after 10 years at the settings you choose. The image will also show how $CO_2$ is distributed in different parts of the environment after that decade as well. You will need to run many decades to see what happens over longer periods of time. You may notice that the units of $CO_2$ provided are GT, which stands for gigatons; 1 GT is equal to 1,000,000,000,000,000 grams of a substance.

To answer the guiding question, you will need to observe changes in the amount of atmospheric carbon. You can also observe how much carbon is stored in different parts of the environment. To accomplish this task, you must first determine what type of data you need to collect, how you will collect it, and how you will analyze it. To determine *what type of data you will need to collect*, think about the following questions:

- What type of data is available in the simulation?
- What information about carbon cycle processes is provided by different data sources?
- What type of measurements or observations will you need to record during your investigation?

To determine *how you will collect your data*, think about the following questions:

- What will serve as a control (or comparison) condition?
- How will you make sure that your data are of high quality (i.e., how will you reduce error)?
- How will you keep track of the data you collect and how will you organize the data?

To determine *how you will analyze your data*, think about the following questions:

- What type of calculations will you need to make?
- What type of graph could you create to help make sense of your data?

## Connections to Crosscutting Concepts, the Nature of Science, and the Nature of Scientific Inquiry

As you work through your investigation, be sure to think about

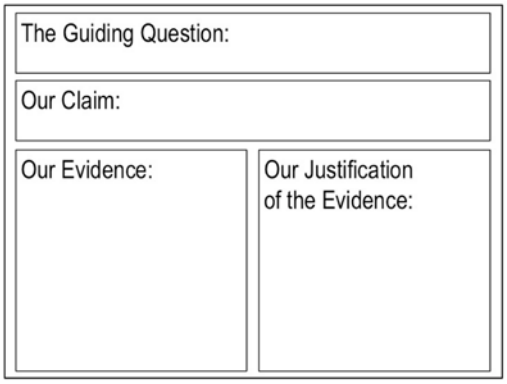
- how events of scientific interest occur over different scales of time,
- how changes to different parts of ecosystems affect their stability,
- the difference between data collected in an investigation and evidence created in an investigation, and
- how scientists use different methods in their investigations.

## Initial Argument

Once your group has finished collecting and analyzing your data, you will need to develop an initial argument. Your argument must include a claim, evidence to support your claim, and a justification of the evidence. The claim is your group's answer to the guiding question. The evidence is an analysis and interpretation of your data. Finally, the justification of the evidence is why your group thinks the evidence matters. The justification of the evidence is important because scientists can use different kinds of evidence to support their claims. Your group will create your initial argument on a whiteboard. Your whiteboard should include all the information shown in Figure L13.2.

**FIGURE L13.2**

**Argument presentation on a whiteboard**




## Argumentation Session

The argumentation session allows all of the groups to share their arguments. One member of each group will stay at the lab station to share that group's argument, while the other members of the group go to the other lab stations one at a time to listen to and critique the arguments developed by their classmates. This is similar to how scientists present their arguments to other scientists at conferences. If you are responsible for critiquing your classmates' arguments, your goal is to look for mistakes so these mistakes can be fixed and they can make their argument better. The argumentation session is also a good time to think about ways you can make your initial argument better. Scientists must share and critique arguments like this to develop new ideas.

To critique an argument, you might need more information than what is included on the whiteboard. You will therefore need to ask the presenter lots of questions. Here are some good questions to ask:

- What did your group do to collect the data? Why do you think that way is the best way to do it?
- What did your group do to analyze the data? Why did your group decide to analyze it that way?
- What other ways of analyzing and interpreting the data did your group talk about?
- What did your group do to make sure that these calculations are correct?
- Why did your group decide to present your evidence in that way?
- What other claims did your group discuss before you decided on that one? Why did your group abandon those other ideas?
- How sure are you that your group's claim is accurate? What could you do to be more certain?

Once the argumentation session is complete, you will have a chance to meet with your group and revise your original argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the most valid or acceptable answer to the research question!

## Report

Once you have completed your research, you will need to prepare an investigation report that consists of three sections that provide answers to the following questions:

1. What question were you trying to answer and why?
2. What did you do during your investigation and why did you conduct your investigation in this way?
3. What is your argument?

Your report should answer these questions in two pages or less. The report must be typed and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid!