

**Carbon Cycle**  
**Cassandra Williams**

**Eyes on Earth: Teaching Earth Science from Space**

**Spheres Lesson Plan #1**

<b>Grade/ Grade Band:</b> 6 Science	<b>Topic:</b> Connecting the Carbon Cycle to Earth's atmosphere	<b>Timeframe:</b> 5-7 days
<p><b>Brief Lesson Description:</b> After reading Lynch, I originally wanted to re-do my whole carbon cycle lesson plan. I wanted to delve deeper into CO<sub>2</sub> data and integrate the spheres. I also aimed to integrate human influence on the carbon cycle. Students played the Carbon Cycle Game/Journey last year and loved the movement and recording of their journey. The writing element (RAFT- as a Carbon Atom) of the assignment allowed them to reflect on their journey and thus generate meaningful questions that guided our next lessons.</p> <p>The goals of this new version of the lesson are to 1) use authentic data from NASA satellites (OCO-2/GEOS5) to show Carbon Movement through the Earth's spheres and 2) concentrate more on the human impact of the carbon that moves through Earth's spheres.</p> <p>When we began brainstorming for this lesson plan, I wanted to find a way to incorporate as many resources from NASA as I could. Seeing the vast resources available on these topics lead me to almost a full unit on the carbon cycle. Then I viewed the live session with Dr. Joyner. I was inspired to select fewer, more meaningful pieces of data. My goal became to simplify and use the data in a meaningful way.</p> <p>By the end of the lesson development, I had simplified even further to the movement of CO<sub>2</sub> through the atmosphere. I was not able to investigate each area of the carbon cycle that influences each sphere and felt I would not be able to fit in a unit of this depth. I chose to focus on introducing students to the specific NASA satellite and computer model that creates the data. We will learn how carbon moves through pools and luxes and travels through our atmosphere. We conclude our study of the carbon cycle analyzing how human affect it.</p> <p>I feel this more simplistic approach is better for the level and age of my students this year and is beneficial because I can also integrate data literacy. Students learn more about how NASA collects data and how to search for patterns to predict future possibilities.</p>		
<p><b>Performance Expectation(s):</b></p> <p><b>MS-ESS3-1</b> Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.</p> <p><b>MS-ESS2-1</b> Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.</p>		
<p><b>Specific Learning Outcomes:</b></p> <ul style="list-style-type: none"><li>• Students will complete a journey as a carbon atom identifying fluxes and pools of the carbon cycle.</li><li>• Students will investigate NASA data from satellites and computer models to understand how CO<sub>2</sub> moves through our atmosphere and Earth's spheres.</li><li>• Students will research how humans influence the carbon cycle.</li></ul>		

**Narrative / Background Information**

**Prior Student Knowledge:**

The following topics will have been covered but at a very basic level of introduction:

- Atoms, Elements, Periodic Table
- Earth's Spheres
- Photosynthesis and Cellular Respiration
- Biogeochemical Cycles (water, nitrogen, phosphorus)

Future lessons include Earth's atmosphere and its layers, etc. This lesson will be the last biogeochemical lesson before we transition to the atmosphere.

**Science & Engineering Practices:**

***Constructing Explanations and Designing Solutions***

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

***Developing and Using Models***

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena.

**Disciplinary Core Ideas:**

***ESS3.A: Natural Resources***

- Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.

***ESS2.A: Earth's Materials and Systems***

- All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.

**Crosscutting Concepts:**

***Cause and Effect***

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

***Connections to Engineering, Technology, and Applications of Science***

***Influence of Science, Engineering, and Technology on Society and the Natural World***

- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.

***Stability and Change***

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.

**Connections to ELA Standards:**

**WHST.6-8.2**

Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS3-1)

**WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-1)

**SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

**Possible Preconceptions/Misconceptions:**

- Students who are still concrete-operational may still believe that the Carbon that is in the Carbon Cycle is not the same as the Carbon in Carbon Dioxide.
- Students may not be aware of the direct human influences on the Carbon Cycle and may not think they are as profound as they actually are.

**LESSON PLAN – 5-E Model**

1 day- **ENGAGE: Phenomenon Video showing NASA Data.**

A-Eye-popping phenomenon video. Introduction to lesson using a 3 minute video showing the movement of CO<sub>2</sub> in atmosphere and introducing OCO-2 and GEOS 5.

Dissect the video then as the class watches once with no sound, then a second time with sound.

Background information for teacher and analysis questions (NASA- A Year in the Life of Earth's CO<sub>2</sub>) to facilitate discussion in attachments.

<https://youtu.be/x1SgmFa0r04>

B-“Satellite Perspectives of the Carbon Cycle” in attachments. View and read together to informally discussed how this information adds to the first phenomenon.

*Attachments: NASA- A Year in the Life of Earth's CO<sub>2</sub>, Satellite Perspectives of the Carbon Cycle*

1 day- **EXPLORE: Students label the carbon cycle.**

Students receive a blank carbon cycle diagram and word bank. They have previously completed cycle diagrams as assessments for other biogeochemical cycles so they are familiar with the format.

Directions: The students attempt to label the steps of the carbon cycle using the words from the word bank. They are to guess the best they can and not worry about answers being correct.

This year I will add the following step using the information and video from

<https://mydasdata.larc.nasa.gov/basic-page/earth-system-matter-and-energy-cycles>. The students watch the following video <https://youtu.be/FgEZpX3n5mo> one time through, then the teacher plays it again and this time stops it each time movement of carbon is mentioned and asks students to add any labels or pictures that would complete the diagram they have (it does not include the ocean.)

I will also read the text from the link to the students describing carbon and they will complete an exit slip summarizing what they learned in 1-5 sentences (listening skill practice.)

*Assessment:* Following the students' independent efforts, the teacher can add the option to allow students to compare diagrams with partners. This teaches students how to have an academic conversation. Teacher models how to ask, “What is that label and why did you place it there?” as well as other question stems.

During this time, the teacher has discussion with students and can thus informally assess student knowledge of carbon cycle by asking probing questions.

*How assessment aids in planning:* If needed, based on class discussion and probing questions while completing the diagram, the teacher can add vocabulary activity as the next day's plan or simply front-load definitions as needed on the day the students take the Carbon Cycle Journey.

*Attachment: Carbon Cycle Diagram*

2-3 days- **EXPLAIN: Students take a journey on the carbon cycle and reflect using writing.**

Carbon Cycle Journey lesson. Students pretend they are a carbon atom and roll a dice to "travel" to places carbon is stored (pool) or ways carbon moves (fluxes.) These new words are introduced as part of the engage stage. Students document their whole journey. At the end of the journey, students answer questions to analyze where they went and how they got there as well as identifying which spheres of earth they may have moved to.

### **Carbon Cycle Journey**

Adapted from <https://www.globe.gov/documents/355050/c8f6e3d4-e7d3-4b6a-9629-38f616b59ff6>- This is how I used this lesson to fit my teaching situation last year. We used the Explore and Explain stage as the end of our journey. We did take the journey twice for pre 1700 data, we used the original Globe lesson sheet to document our journey and answer the questions.

SWOs: (We will \_\_\_\_\_ so we can \_\_\_\_\_.)

- We will learn about the major pools and fluxes of carbon so we can see where and how carbon travels.
- We will compare carbon data from the before and after the industrial revolution

**Teacher prep-** print station labels and directions from link above, label room with names of the carbon cycle stations (fossil fuels, marine life, surface ocean, soil, deep ocean, terrestrial life, atmosphere, ocean sediment), copy Carbon Travels Journey Table worksheet with questions, get enough dice for the class.

**1)** Ask students if they saw carbon this week. Remind them where carbon can be found. Allow partner-think-pair-share to brainstorm answer to question. Purpose is to have them recall where they have learned about carbon being present (atoms, CO<sub>2</sub> in atmosphere, part of photosynthesis and cellular respiration, glucose in food, etc.) Group students' ideas into the major carbon pools. Use remaining class time to document two new words: Carbon pool and Carbon flux. Students record these words on a doc and store in the Ecology folder in Google Drive. Teacher assigns examples of the pools/fluxes for students to informally research. Depending on how much class time left, teacher can give students specific questions to guide their research and present to class. (What is the name of your assigned pool or flux? What is the form of Carbon in your assigned area? How does carbon move from one place to another or in and out?)

*Pools-* atmosphere, terrestrial life, soil, surface ocean, deep ocean, marine life, fossil fuels, ocean sediment/Earth's crust.

*Fluxes-* Photosynthesis, ocean uptake, combustion, falls to ground, dissolved, carried, buried, decayed, come out of solution, water currents and ocean mixing, settle, stay, exhaled/respiration, drifting downwards, compressed, released by a volcano, extracted then burned. (These are underlined on the directions to be placed at the stations) Teacher can discuss them as verbs/action words that show what process the carbon is going through.

**2)** Each student receives a die and a copy of the Carbon Cycle Journey Table. Teacher models for

students what to do at a station (record where you are, roll the die, read the instructions at the station for you go, record where you go and HOW you got there, this is the flux. Assign equal number of students to the stations to begin. They complete 10 turns and then stop. Students answer questions on their paper as teacher changes out the instructions at each station to include the post-1700 directions for movement based on the roll of the die. Students flip paper over and complete the journey again. Students answer final questions on paper.

These questions should be reviewed in class for discussion and comparison of each student's journey. The last question leads us to the next phase about Carbon in the atmosphere. The original GLOBE lesson has them draw their journeys to show their path as a Carbon atom. I would add this to this year since I learned to plan for 2-3 days for this activity. Last year, students completed a RAFT (Role, Audience, Format, Topic.) The role was the carbon atom, the audience is an elementary class (second grade,) format is student choice; topic is "My Journey as a Carbon Atom." I was very impressed with the comic strips and slide shows that students made.

**New Vocabulary:**

- Carbon Pool
- Carbon Flux

*Attachments: Carbon Cycle Journey*

*Assessment:* Questions following two journeys on the carbon cycle, RAFT writing assignment.

*Assessment aids in planning:* Students can evaluate each other's products if time. Teacher grades to evaluate if the words for the carbon cycle pools and fluxes are used correctly.

**1-2 days- ELABORATE: Students connect their journey as a carbon atom with the atmosphere using text and data.**

Connect our journey to NASA satellite data of Carbon traveling through the atmosphere.

- Text Connection: <https://earthobservatory.nasa.gov/features/CarbonCycle/page1.php> Teacher reads this text with the students and note important ideas. This can be done using the note taking strategy decided upon by the teacher, team, subject or grade level. Last year, we used Cornell Notes in Science. This year in the hybrid environment, I plan to record myself reading this as an Edpuzzle for easier assessment of who is processing the main ideas.

*Assessment:* The Edpuzzle will provide quicker assessment data to know if a day is needed to reteach.

-Data Connection: Eye Popping view of CO<sub>2</sub> NASA simulation- data from the Orbiting Carbon Observatory-2 (OCO-2) satellite.

<https://www.nasa.gov/feature/goddard/2016/eye-popping-view-of-co2-critical-step-for-carbon-cycle-science>

Watch and read with students, compare to text information using informal discussion.

*Assessment:* In this phase, the reading, notes and discussion are designed to build knowledge. Teacher is continuing to grade and provide feedback on the products in this lesson thus far.

**1-2 days- EVALUATE: Students use NOAA data to evaluate human influence on the carbon cycle and how it influences the atmosphere.**

A-Students watch the following video: Human Impact and our future on Earth  
<https://youtu.be/8RvI6z80bal>

B-Students complete the assignment Interactive Atmospheric Data Visualization and Summary Questions from NOAA data adapted from the following link:  
[https://www.esrl.noaa.gov/gmd/education/carbon\\_toolkit/student\\_activity\\_ghg.html](https://www.esrl.noaa.gov/gmd/education/carbon_toolkit/student_activity_ghg.html)

*Attachments: Interactive Atmospheric Data Visualization*

**Formative Monitoring (Questioning / Discussion):** Throughout unit, notes in each section

**Summative Assessment (Quiz / Project / Report):** To conclude the Carbon Cycle:  
A- Students will receive the same carbon cycle diagram again with word bank to see if they can now label and add to the diagram at a higher rate of accuracy than the first time they attempted it, in the Elaborate phase.

B- Complete the summary questions from  
[https://www.esrl.noaa.gov/gmd/education/carbon\\_toolkit/student\\_activity\\_ghg.html](https://www.esrl.noaa.gov/gmd/education/carbon_toolkit/student_activity_ghg.html)

**Sources:**

Phenomenon visuals

<https://mynasadata.larc.nasa.gov/mini-lesson/systems-and-system-models-atmospheric-carbon-dioxide-model-2014>

<https://www.nasa.gov/feature/goddard/2016/eye-popping-view-of-co2-critical-step-for-carbon-cycle-science>

Satellite Perspectives of the Carbon Cycle

<https://cimss.ssec.wisc.edu/sage/ess/lesson1/concepts.html>

Carbon Cycle Lesson\_

<https://www.globe.gov/documents/355050/c8fbe3d4-e7d3-4b6a-9629-38f616b59ff6>

Text Connection

<https://earthobservatory.nasa.gov/features/CarbonCycle/page1.php>

NOAA satellite data assignment

[https://www.esrl.noaa.gov/gmd/education/carbon\\_toolkit/student\\_activity\\_ghg.html](https://www.esrl.noaa.gov/gmd/education/carbon_toolkit/student_activity_ghg.html)

