

Carbon's Fate in a Changing World —through air, sea and ice

In this high school curriculum module, students in earth science, marine science, life science, integrated science, AP environmental science, biochemistry, biotechnology or STEM courses use real-world, big data to investigate “Carbon’s Fate” and how this influences ocean and Earth systems. All culminates with proposals for an innovation or invention to answer the question “What can you do?” and to share new knowledge with the broader community.

Carbon and oxygen remain in equilibrium in the ocean carbon cycle, inhaling and exhaling to maintain Earth’s biosphere, hydrosphere, atmosphere and geosphere, unless conditions change. What then? Scientists have been monitoring the ocean for decades, like doctors taking the vital signs of a patient. Changing atmosphere, melting glaciers, and the actions of individuals on Earth all affect the global balance. Learning to trace carbon can help to see changes occurring at the global scale.

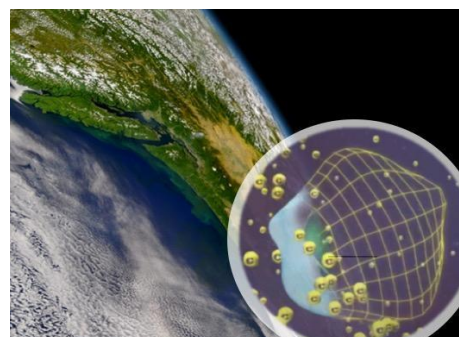


Photo Credit: NASA

This curriculum module is based on the oceanographic research of Dr. Monica Orellana and her team at University of Washington’s Polar Science Center at the Applied Physics Lab. These interdisciplinary STEM lessons were inspired by Dr. Orellana’s lab and field work, which focus on the chemical and microbial interactions that drive the ocean carbon cycle and ultimately Earth’s climate.

Students will explore the physical and chemical conditions in the ocean through labs and models and learn how phytoplankton drive the ocean carbon cycle. Following in the footsteps of climate and ocean scientists— they can explore carbon’s fate by observing patterns in large datasets collected over time and across the globe visualized through Ocean Data View (ODV) software. Culminating with proposals for an innovation to take action and to evaluate the resulting impact on the carbon system.

The Baliga Lab at the Institute for Systems Biology has been translating research into user-friendly curriculum modules since 2004 through the Systems Education Experiences (SEE) program. By forming collaborative teams of scientists, educators, and students, today’s research and methods have become hands-on, accessible activities for students. These activities provide authentic science investigations that engage students and build higher-level, interdisciplinary thinking skills while bridging the distance between the professional lab and the classroom. The Carbon’s Fate module is a phenomenon-based, Next Generation Science Standards (NGSS) three-dimensional learning unit. Its eight lessons weave in ways for students to model a system, investigate complex ocean phenomena, and gain inspiration for careers in ocean and climate research.

Name of Lesson	Main Question(s) Explored	# of 50 min. Class Periods
1. Blue Planet - What's in a Particle?	What are Earth systems and their connection to carbon?	1
2. What Goes Down Must Come Up	What is carbon's fate in the marine carbon cycle?	1
3. Daisy World: How can Carbon be the thermostat for life?	How does solar radiation, albedo, the biosphere and the carbon cycle influence Earth's climate?	1
4. Locking and Unlocking Carbon - exploring hydrogels and DOC Labs	How can biology and the chemistry of dissolved inorganic and organic carbon affect carbon circulation within the ocean?	3
5. Global Water Circulation — Carbon Highways Understanding Melting Ice and Density Labs	How do density and temperature affect the ocean conveyor of carbon?	1-2
6. Pools and Loops Game: Ocean carbon cycle and the microbial loop	How does a single carbon atom transfer and transform through the ocean carbon pumping system?	1
7. Making Sense of Ocean Carbon Phenomenon using ODV	What patterns can be observed in global data that influence the carbon cycle and ocean productivity?	2
8. What Can You Do? Interventions and Inventions	How do current interventions reduce human impact on the ocean carbon system and climate?	2-3