

Dive Into Learning:

Bringing Ocean Science to Your Classroom

Melissa Rummel, UCAR Center for Science Education
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UCAR CENTER FOR SCIENCE EDUCATION

October 22, 2026



Where are you joining from?
What grades/subjects do you teach?

Anchorage project: Land Acknowledgement

- land.codeforanchorage.org

About the UCAR Center for Science Education

- Develop educational experiences and resources
- Create connections to Earth systems science for all learners
- Build pathways towards a scientifically literate society

SciEd website: scied.ucar.edu



In partnership with...







Which seal are you feeling today?



What ocean science topics do you currently teach about?



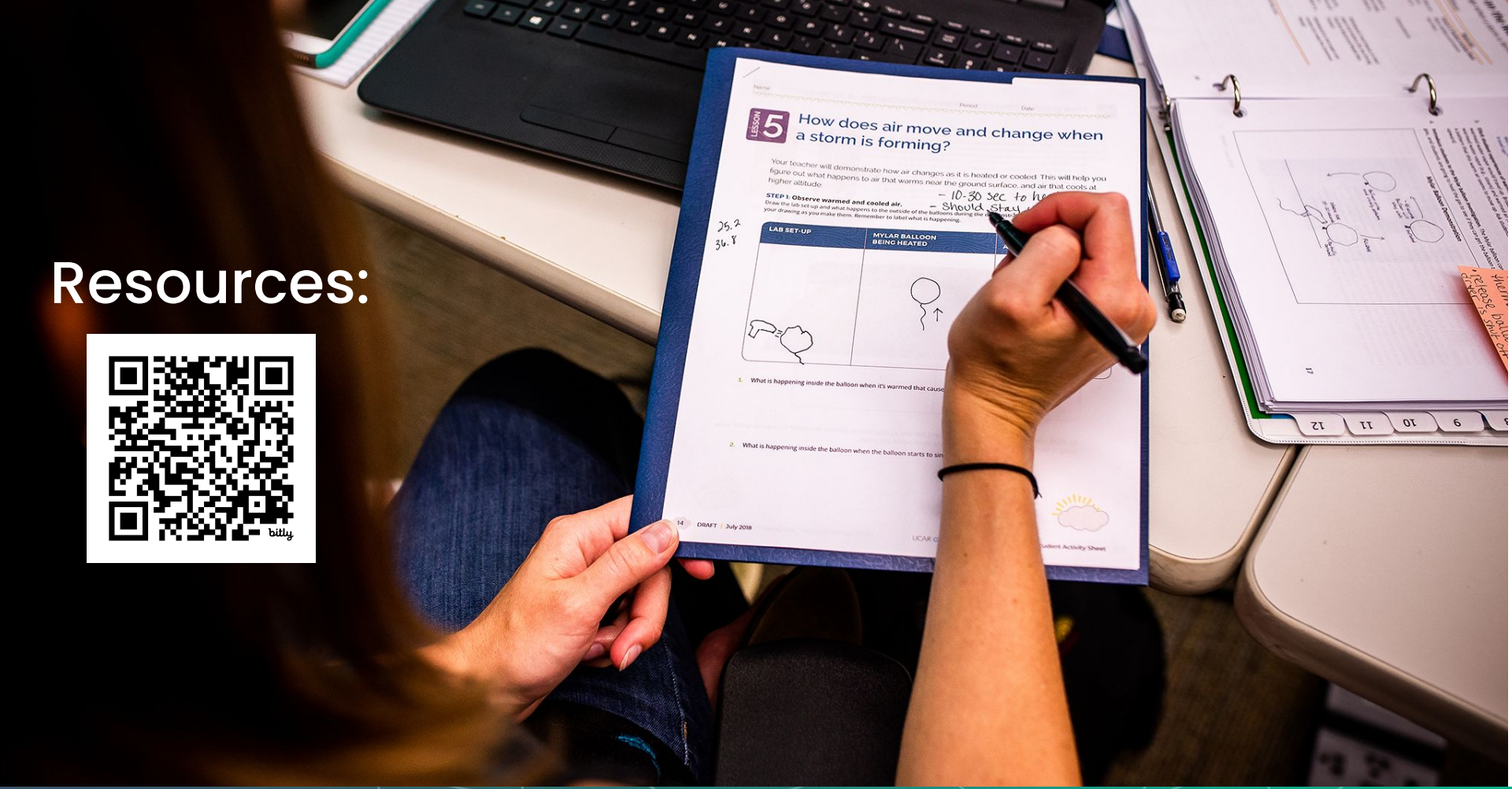


What else would you like to know about the ocean?

In today's workshop…

- Quick review of ocean science basics
- IOOS Association & how we observe the ocean
- Share activities related to ocean observing
- Learn how you can get involved with the National Ocean Sciences Bowl (NOSB)
- Discover additional learning resources from SciEd

Resources:

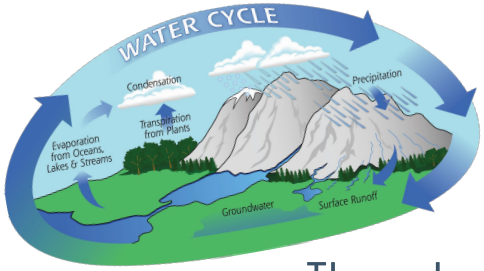


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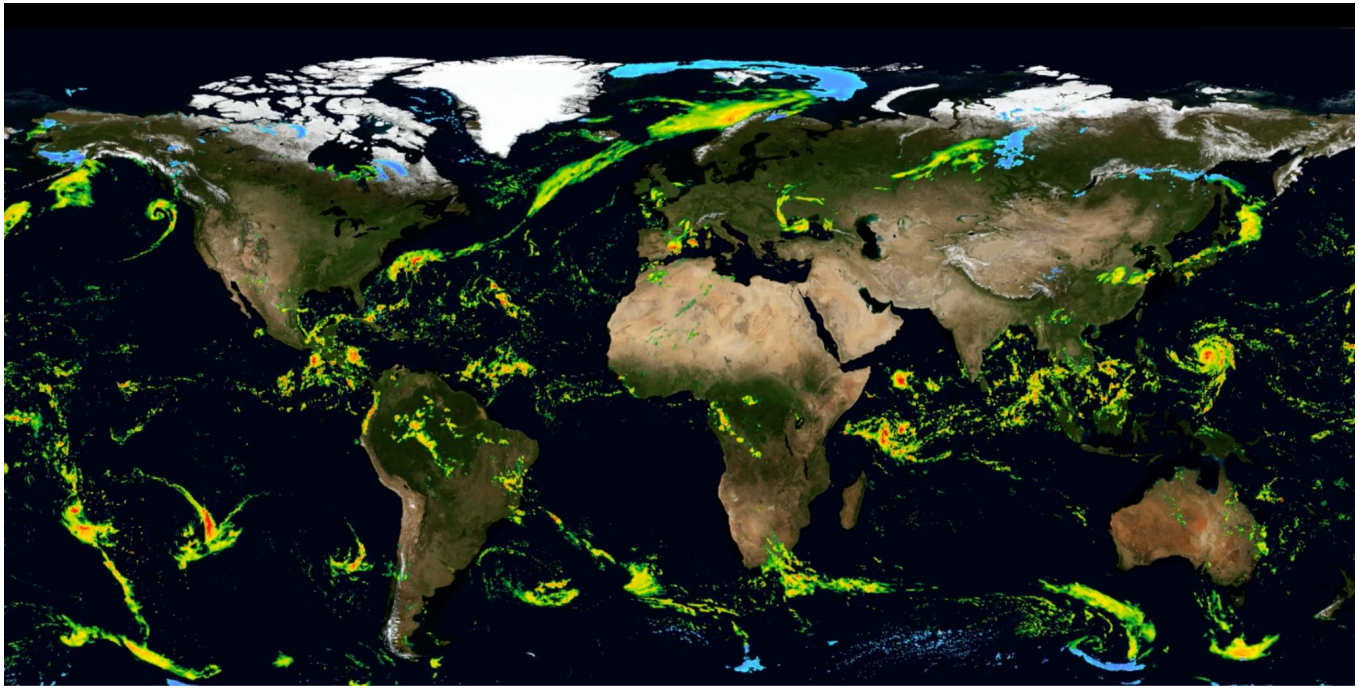
How does the ocean influence the Earth system?



The ocean is the main source of humidity & weather



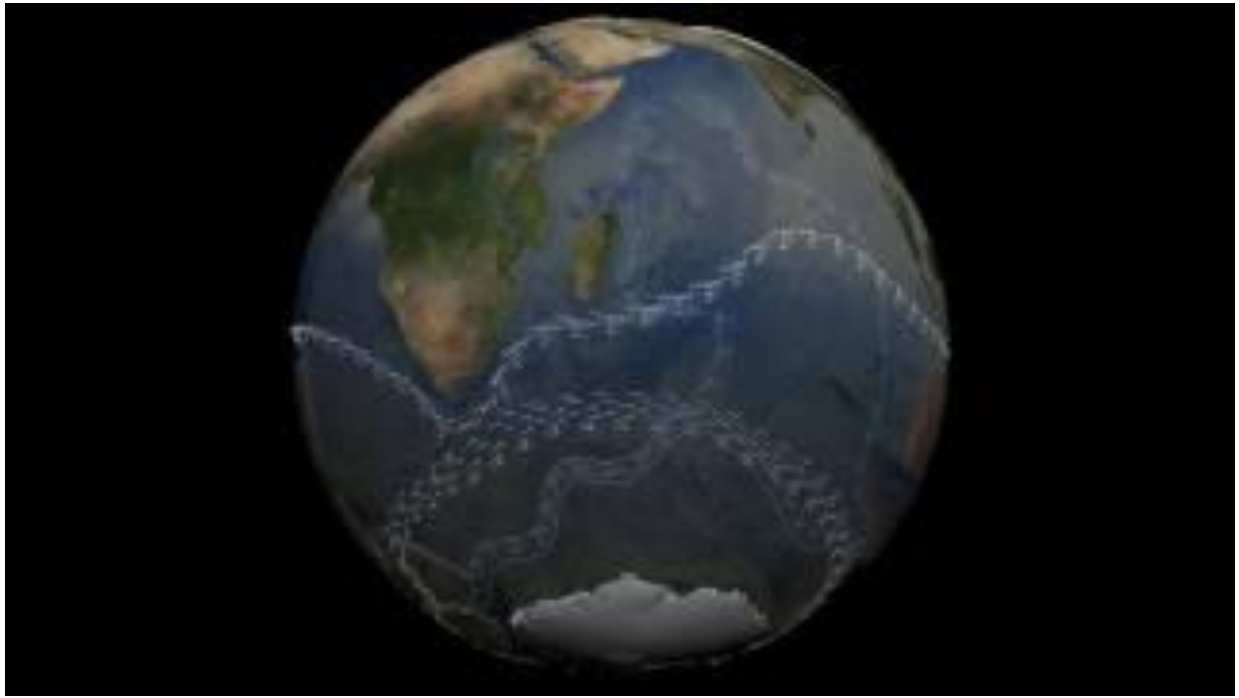
Through the water cycle, the ocean generates about ⅔ of the global precipitation that falls on land



Ocean circulation moves heat around the planet

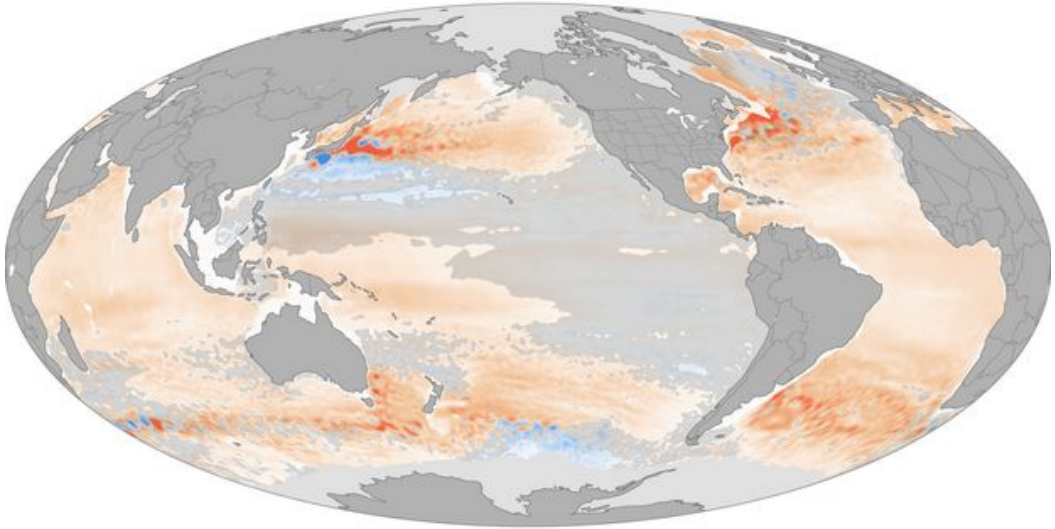
Thermohaline circulation - the ocean's conveyor belt!

- Cold, dense water sinks to create deep ocean currents
- Moves heat from the tropics to the poles
- A complete cycle can take 1600 years or more!



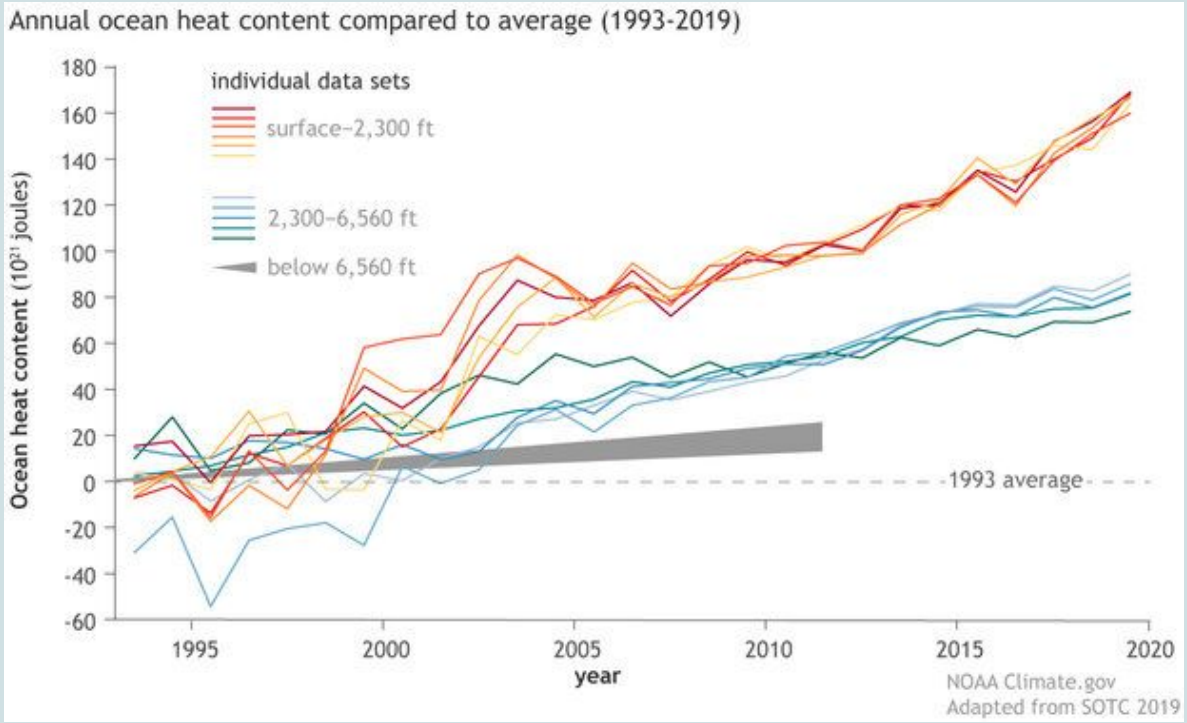
The ocean stores (and releases) heat

- Ocean+land absorbs 47% of incoming solar energy
  - Ocean covers 71% of the surface, low albedo
- Maintains global temperatures
  - Slow to warm up & slow to cool down
- Stabilizes Earth's climate system
  - Absorbing 90% of excess heat trapped by greenhouse gases



Ocean Heat Trends (1993-2024)

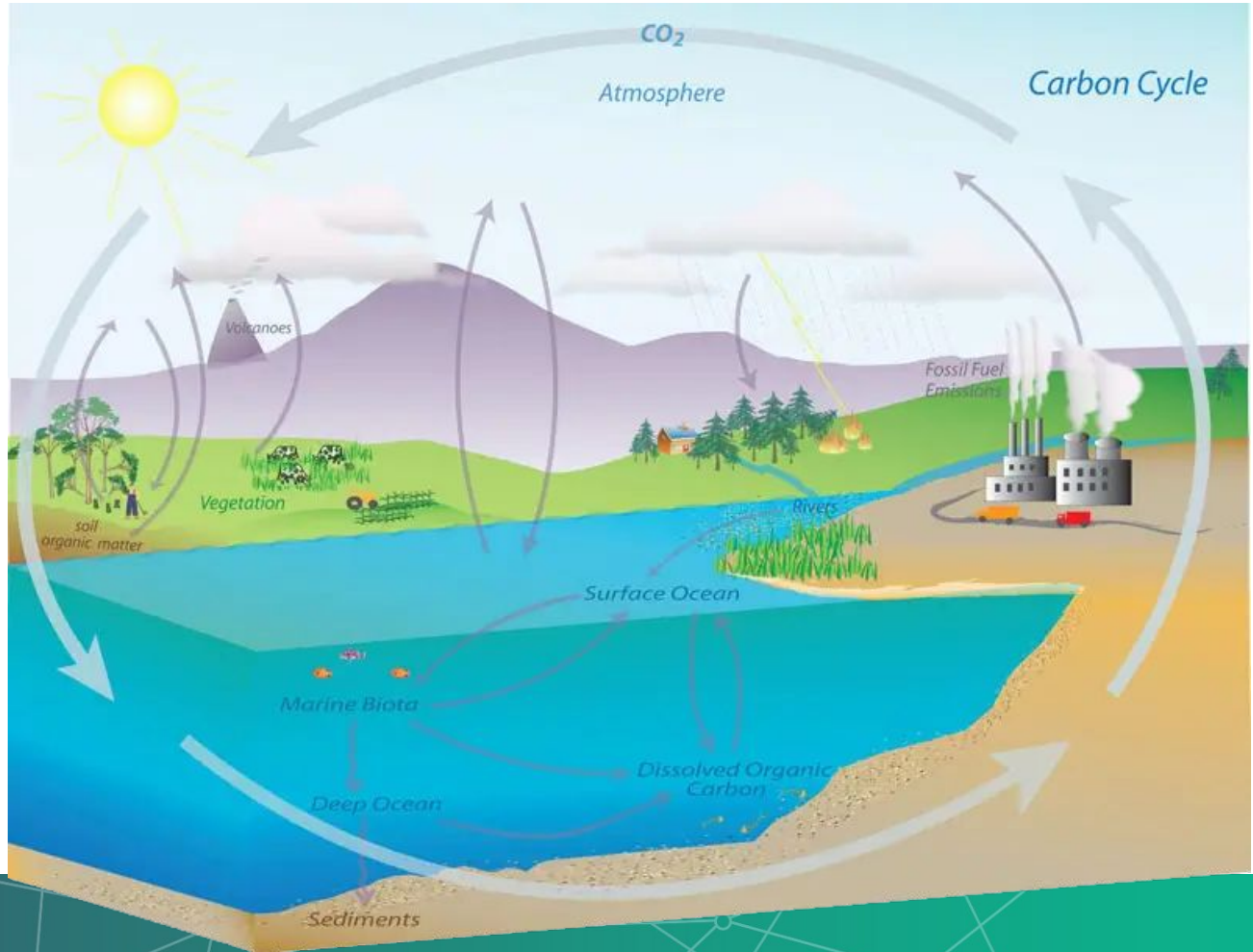
Most of the warming over the last 50 years has happened in the ocean (90%)



NOAA

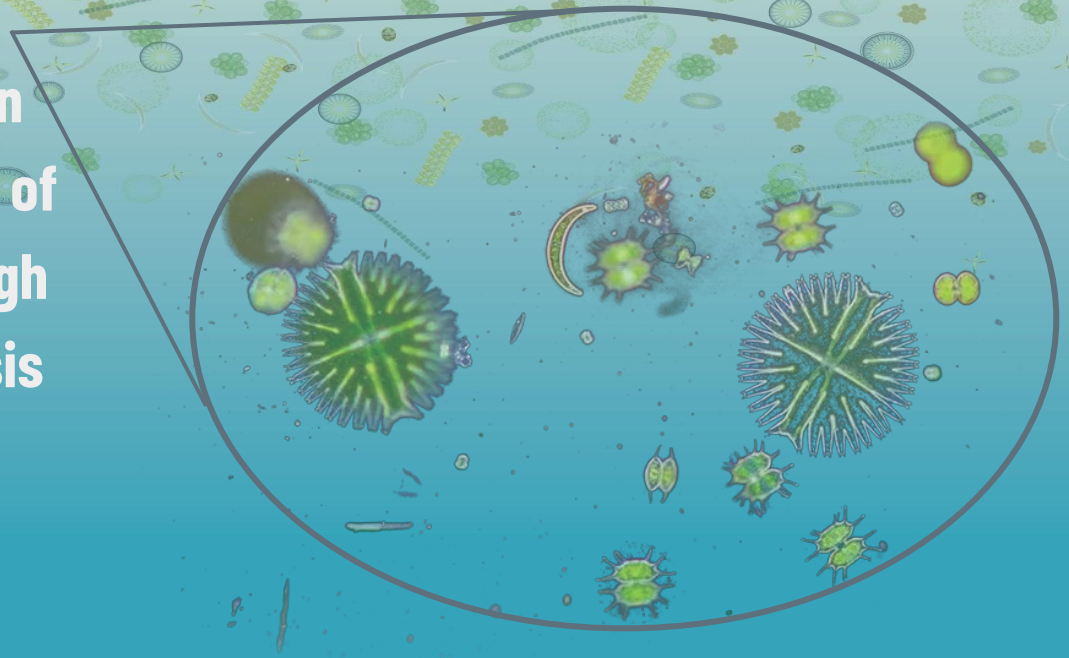
The ocean is a carbon sink

- Organic matter & dissolved CO_2 sinks to the sea floor; remains there for centuries
- The ocean absorbs 31% of CO_2 emissions created by human activity



The ocean is a source of oxygen

Phytoplankton produce 50% of oxygen through photosynthesis



The ocean is a source of biodiversity and food

- 25% of all known species live in the ocean
- Supplies food for over 3 billion humans



How do we know what's happening in the ocean?





Anna Barboza

Program Specialist, IOOS Association

IOOS Science and Learning Resources

U.S Integrated Ocean Observing System (IOOS)

IOOS | Integrated Ocean Observing System

Regional Associations

CARICOOS

MARACOOS
Ocean Information for a Changing World

AOOS
Alaska Ocean Observing System

NANOOS
Northwest Association of Networked Ocean Observing Systems

CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

NERACOOS
NORTHEASTERN REGIONAL ASSOCIATION OF COASTAL OCEAN OBSERVING SYSTEMS

GCOOS
GULF OF AMERICA
COASTAL OCEAN OBSERVING SYSTEM
20 YEARS

PacIOOS
PACIFIC ISLANDS OCEAN OBSERVING SYSTEM

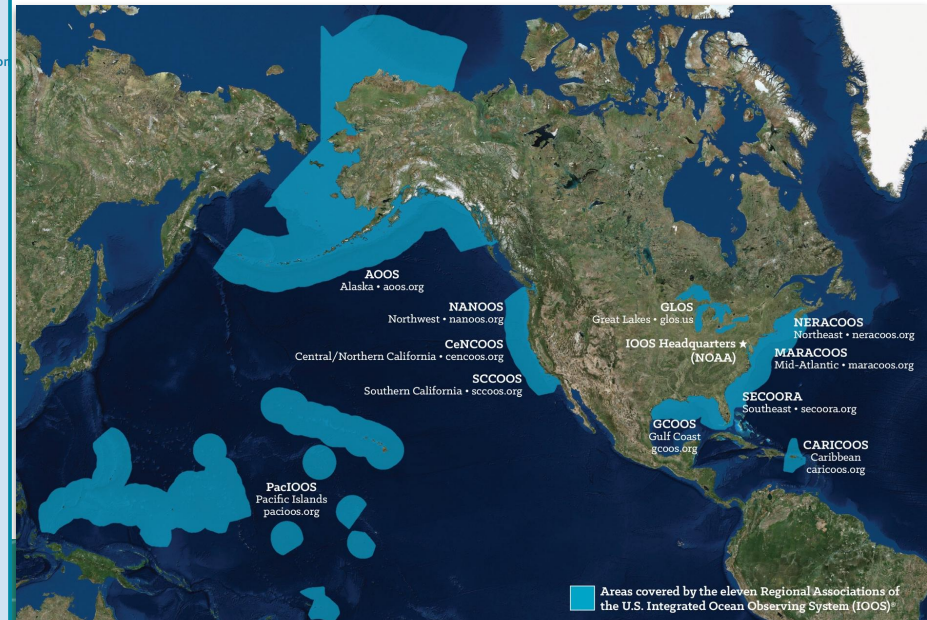
SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

great lakes observing system

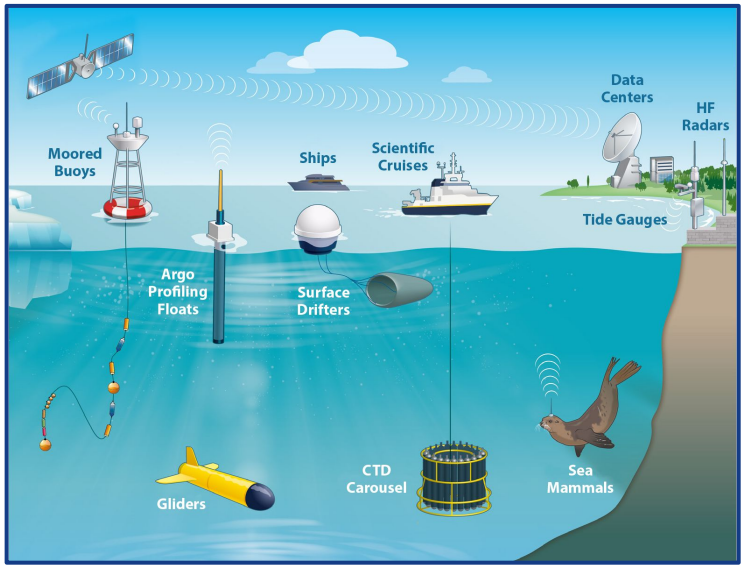
SECOORA

What is IOOS?

The U.S. Integrated Ocean Observing System (IOOS) network connects **11 Regional Associations (RAs) and their partners** to collect and share ocean observing data about our ocean, coasts, and Great Lakes.

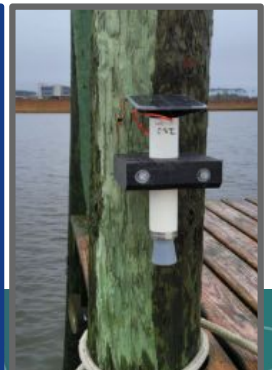


U.S Integrated Ocean Observing System (IOOS)

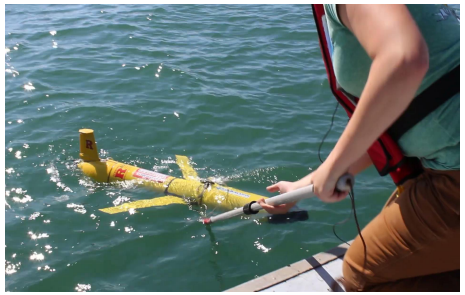














What does IOOS do?

Observe: Using different observing technologies such as buoys, underwater gliders, sensors, and more.

Inform: Observations are publicly available tailored to community needs.

Support decisions: Develop data information products and decision making tools.

IOOS RAs' technologies provide near real-time updates and historical data available on the Regional Data Portals.

IOOS Association

Ocean Observations for Everyone

Ocean information connects science to everyday life helping us understand changing conditions and weather patterns, make informed decisions, and protect communities.

Ocean information supports:

- **Research & Discovery:** Study our oceans, coasts, and Great Lakes
- **Weather Forecasting:** Improve forecasting and understand hurricane conditions
- **Public Safety:** coastal and beach safety, search and rescue, and public health

Connecting ocean and coastal conditions to local ecosystems, livelihoods, and economies.

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OTT: Fishing for Hypoxia: An Academic-Industry-Tribal Partnership to Observe the Coastal Ocean

Home / OTT: Fishing for Hypoxia: An Academic-Industry-Tribal Partnership to Observe the Coastal Ocean



SAFE HARVESTING

Real-time ocean and coastal data on tides, currents, water levels, and weather gives fishers and growers the insight they need to plan vessel routes, time harvests, and avoid hazardous conditions, reducing risk to personnel, vessels, and equipment while supporting healthy coastal ecosystems and aquaculture operations.

PREVENTING LOSSES

During a 2023 harmful algal bloom event, early alerts helped shellfish growers avoid tens of thousands of dollars in product losses by adjusting harvest schedules. Early warning tools and data from IOOS give growers and public safety officials lead time for safer seafood.

Aquaculture success depends on responding to changing ocean conditions before they become costly. Data for site selection, coastal acidification data, forecasts and alerts for low oxygen events and marine heat waves provide critical lead time to protect producers' investments and stock.

Alaska trollers gather year-round data

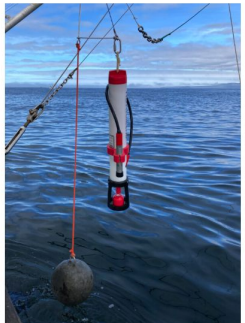
May 19, 2023

Salmon fishermen are collecting data near fishing spots and along transit routes as part of the new Southeast Alaska Trolling Vessel Ocean Measurement program. The Alaska Trollers Association leads the project in partnership with AOOS, Alaska Sea Grant, and UAF.

"It is great to have a community-led observation program, and to work with the trollers as an organization eager to conduct science," said UAF research assistant professor Tyler Hennon, who is the principal investigator of the project.

Since August of 2022, participating trollers have conducted vertical profiles of the water column using hand-held CTD's attached to their gear. Hennon explained that regular measurements of temperature, salinity, and pressure will help establish a baseline for seasonal cycles of ocean mixing. These processes affect how nutrients from the deep Pacific are brought to the surface and distributed around Southeast Alaska. One of the CTD's is also capable of measuring chlorophyll and detected the beginning of the spring phytoplankton bloom near Sitka.

Fishermen are currently taking measurements in Frederick Sound, Sitka, and Chatham Strait. The program will expand to include waters near



Fishermen attach instruments slightly larger than a water bottle to their gear to profile the water column in a new partnership with the Alaska Trollers Association. Photo by Jim Moore.

Wave Forecasting for Marine Operations at Wave Energy Test Site

The U.S. Navy Wave Energy Test Site (**WETS**) off Kāne'ohe Bay, which is the first grid-connected site in the U.S., is strategically located off the east shore of O'ahu. Year-round trade wind waves, seasonal north swells, and occasional wind swells from passing systems provide a unique environment for testing wave energy converters (WECs), yet pose a challenge for site maintenance as well as WEC installation and retrieval. The **PacIOOS wave forecast** has been providing reliable prediction of wave conditions to support WEC testing and at-sea operations at WETS since 2014.



As predicted, ocean conditions were calm enough to allow for modifications of the WEC shore cable anchor. Credit: P. Cross

IOOS Education ToolKit

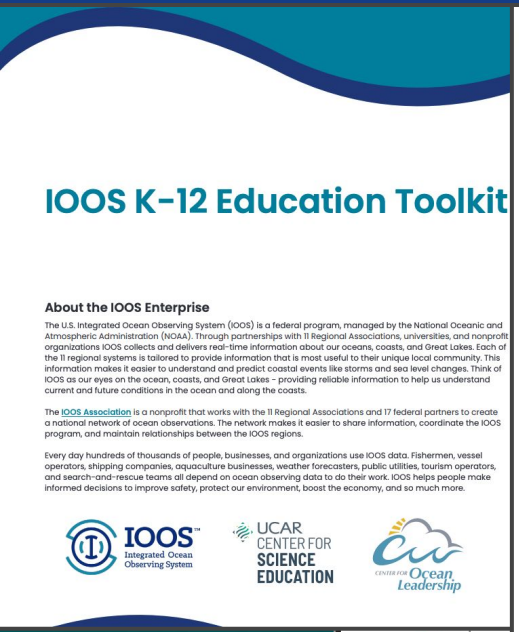




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- Compilation of **seven activities**
  - Accompanying powerpoints, worksheets, and interactive activities
  - Developed in English and Spanish
  - Themes: ocean observations, coastal hazards, ecosystem changes, and seafood
- Activities focus on **place-based case studies** and **leverage existing resources** from the IOOS RAs
  - Customizable learning experience
  - Adaptable to local context
  - Highlighting regional perspectives

IOOS Association

IOOS Education ToolKit–Build A Buoy Demo

Build a Buoy

In this activity, students learn how buoys are made, deployed, used, and maintained. They use materials from your classroom recycling bin to build their own model buoy and test them out in a buoy float challenge. Finally, they create a story about a day in the life of their buoy.

Learning Goal

- Students will learn how different types of buoys collect data about the ocean and how the data is used to inform decision-making.

Learning Objectives

- Students differentiate between different types of buoys.
- Students design and build a physical model of an oceanographic buoy.
- Students create a story that reflects their understanding of the parts of an oceanographic buoy, how data is collected, and how data flows to the end user.

Materials

- Projector and computer with Internet access
- Build a Buoy slide deck
- Build a Buoy Student page
- Oceanographic Buoy infographic
- Buoys from Head to Toe infographic
- Video: Ocean Buoys Awareness
- Recyclable, reusable, and/or environmentally friendly materials to build buoy models. See what you can find in your recycling bins that can be repurposed for this activity and try to minimize the use of new plastics and styrofoam as much as possible. Suggested materials include but are not limited to:
  - Aluminum foil or cans
  - Repurposed plastic bottles
  - Cardboard (e.g., boxes, paper towel rolls)
  - Paper
  - Plates, cups, bottles, or bowls
  - Popsicle sticks
  - Skewers
  - Toothpicks
  - Corks
  - Legos

GRADE LEVEL
Upper elementary and middle school

TIME
Two class periods (about 90 minutes)

NEXT GENERATION SCIENCE STANDARDS

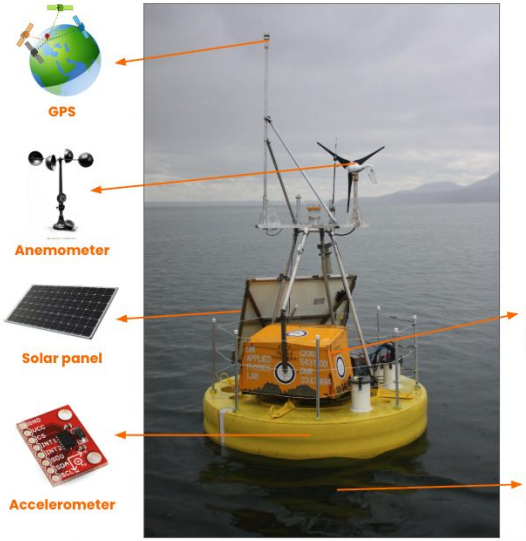
- 3-5-ETS1.1: Define a simpl design problem reflecting need or a want that includes specified criteria for succes and constraints on materials, time, or cost.
- MS-ETS1.4: Develop a model to generate data for iterative testing and modification o a proposed object, tool, or process such that an optimal design can be achieved.
- SEP: Asking Questions and Defining Problems Developing and Using Models
- DCI ETS1.A: Defining an Delimiting Engineering Problems
- DCI ETS1.B: Developing Possible Solutions
- CCC: Influence of Science Engineering, and Technology on Society and the Natural World

OCEAN LITERACY PRINCIPLES

- OLP6: The ocean and humans are inextricably interconnected.
- OLP7: The ocean is largely unexplored.

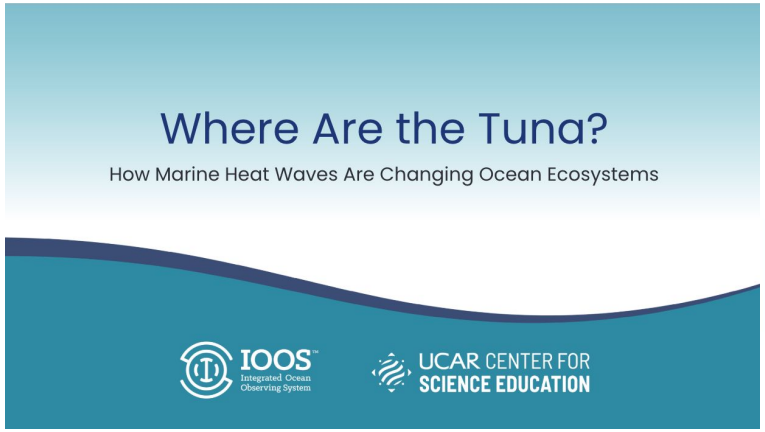


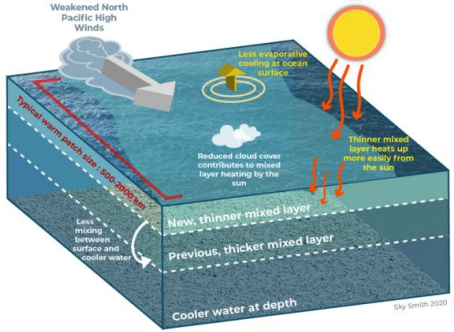
Your Challenge: Build Your Own Buoy Model!





IOOS Education ToolKit–Where are the Tuna?





- For grades 9-12 but adaptable
- Interpret data maps and explore impacts of marine heat waves

Real Time Data Platforms:

- NANOOS NVS Fishers Platform
- NANOOS NVS Climatology Dashboard



Name: _____

Where Are the Tuna?
STUDENT PAGE

Imagine you are a tuna fisher and want to find out whether you are likely to find tuna off the Washington coast today. You are going to use the NANOOS Visualization System (NVS) to see if tuna are likely in the area.

Remember:

- Tuna are in the Pacific Northwest region from July-November
- Most tuna catches occur when sea surface temperatures range from 16°C to 18°C (60.8°F to 64.4°F)
- Most tuna catches occur when sea surface chlorophyll concentrations range from 0.2 to 0.4 mg m^3

Directions:

Part 1: Are you likely to catch tuna today?

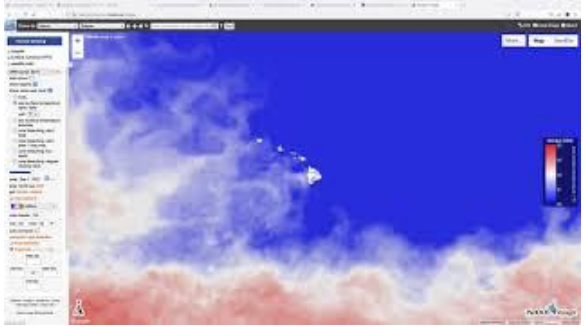
1. Go to: nvs.nanoos.org/Fishers
2. Use the zoom buttons to adjust your view to only the Washington coast, from the top of the Olympic Peninsula to where the Columbia River empties into the bay along the Washington-Oregon border (near Estoria).
3. Under Forecasts select Water Temp & Currents - Tuna to show water temperature and currents. The temperature is shown with color and currents are shown with arrows on the map.
   a. What are the warmest temperatures currently?
   b. Where are the warmest temperatures — along the coast, farther from the coast, or in Puget Sound?
   c. What are the coolest temperatures currently?
   d. Where are the coolest temperatures — along the coast, farther from the coast, or in Puget Sound?
4. Under **MODIS** select Chlorophyll (1 Day).
5. If you were a tuna fisher, would you expect to catch tuna along the Washington coast right now?
   - Yes
   - No

- Is this what you would expect, given what you have learned about tuna migration and time of year?

Other RA Resources

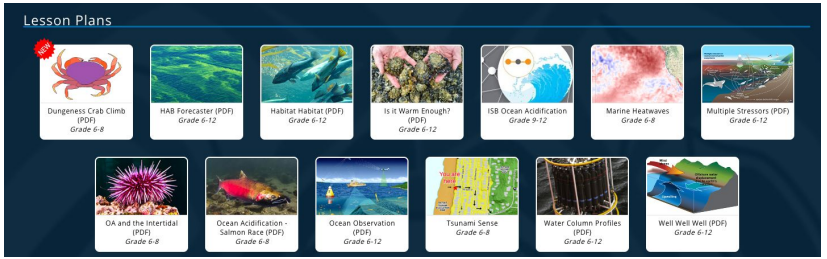
PacIOOS Voyager Lesson Plans

- Grades 8-12
- Preparatory homework or classroom exercise



NANOOS Lesson Plans

- Grades 6-12
- Tailored for Pacific Northwest coastal hazards



GCOOS Satori Mystery

- Grades 9-12
- Accompanying quiz and video



Other RA Resources

SECOORA Sea Level Rise Curriculum

- Grades 6-8
- Accompanying webinars to develop data visualizations of sea level rise



For Bilingual Classrooms:

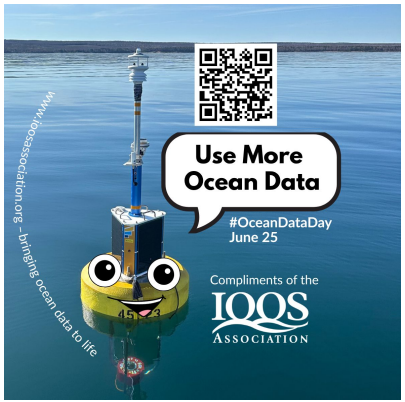
CARICOOS Waves Education Manual

- Four lesson plans with activity manuals

CARICOOS School- Education and Outreach Page (*Also in English*)

- For all grade level educators





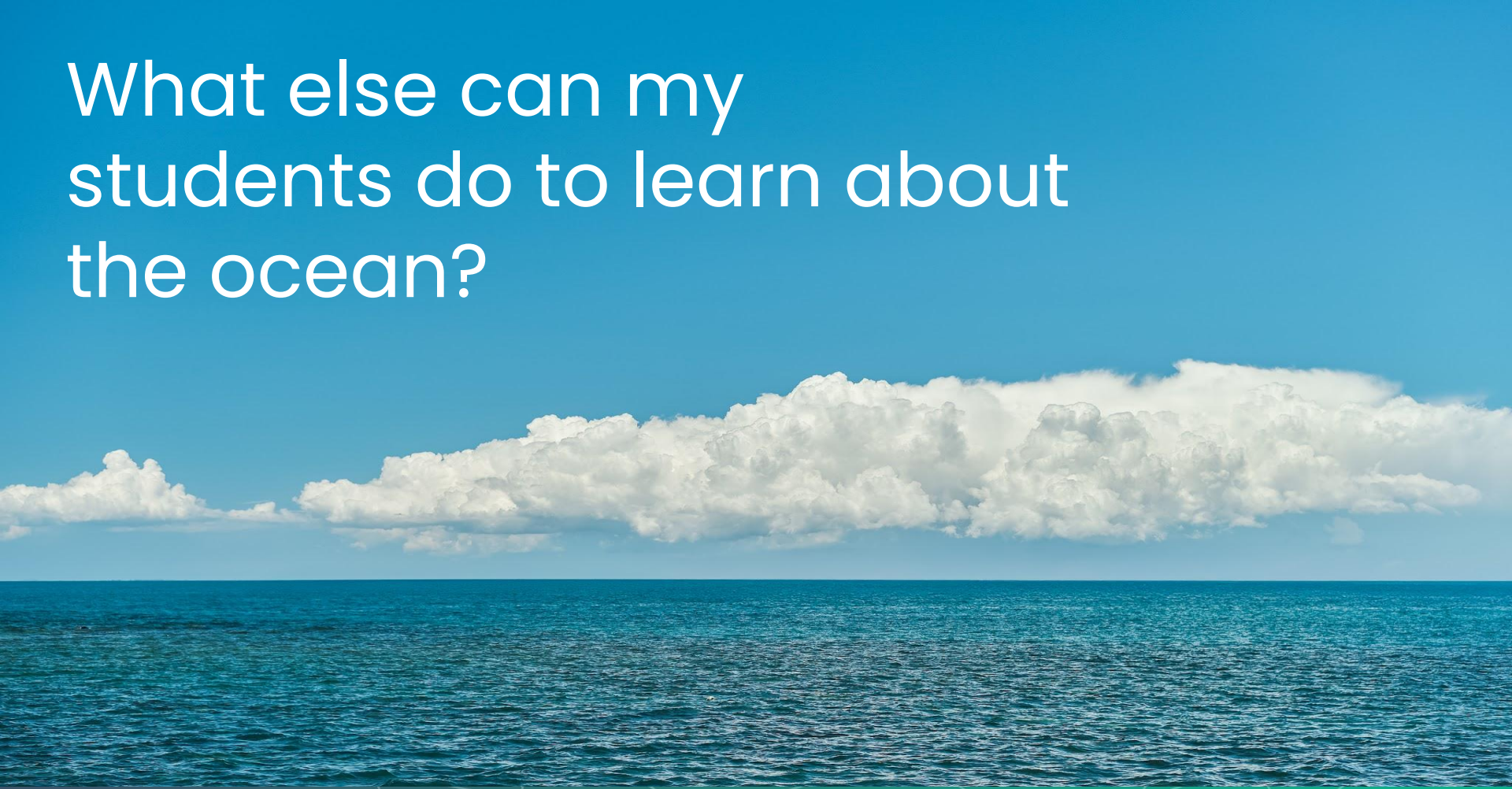
Stay in Touch

- Continue to explore the IOOS Education Toolkit and other resources
- Connect locally:
  - Get in contact with your local Regional Association
  - Regional Association Newsletters
- Follow us on LinkedIn
- Anna Barboza | anna@ioosassociation.org

Let's connect ocean information to your classroom and community

IOOS ASSOCIATION

What else can my students do to learn about the ocean?



The National Ocean Sciences Bowl

NATIONAL OCEAN SCIENCES BOWL®

A Program of

CENTER FOR Ocean Leadership

UCAR COMMUNITY PROGRAMS

Melissa Brodeur, NOSB Program Manager - mbrodeur@ucar.edu

Nicole Palma, NOSB Program Specialist II - npalma@ucar.edu

Inspiring Tomorrow's Ocean Leaders

- High school academic competition
- Tests students knowledge of ocean sciences including biology, chemistry, physics, geology, technology, geography, and policy
- Regional competitions and a National Finals





www.nosb.org
nosb@ucar.edu

More Than a Competition

Fills an important gap in high school education!

- Highlights ocean-related career options
- Develops future workforce pipeline
- Focuses on career skill development
- Provides important career mentoring and connections
- Supports professional development for teachers
- Includes hands-on field trips & award trips
- Awards student achievement through scholarship program

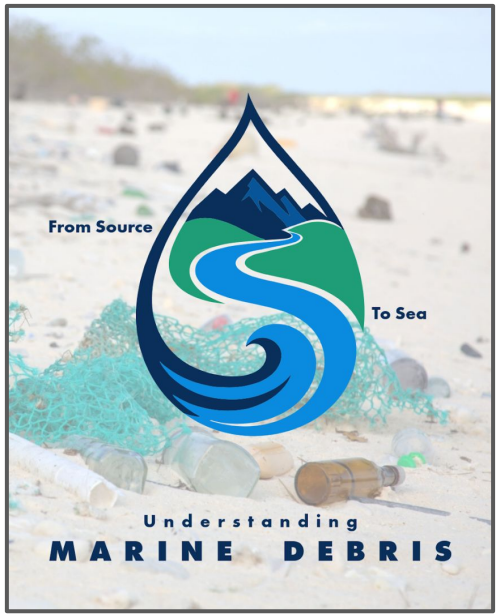


NATIONAL OCEAN SCIENCES BOWL®

www.nosb.org
nosb@ucar.edu

2026-2027 Competition Year

- Theme: From Source to Sea: Understanding Marine Debris
- 17 regional competitions in February and March
- Virtual Finals competition - poster activity
- 1st place summer award trip - NMEA 2027, Honolulu, HI



Time to Buzz-In



Toss-Up Question

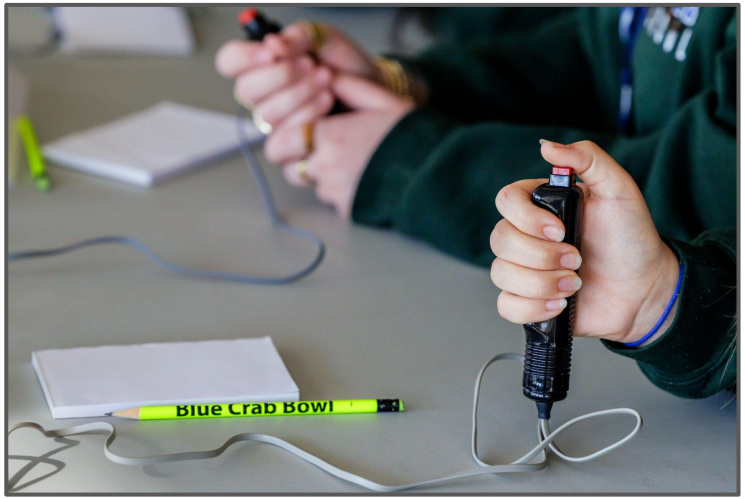
What commonly forms capillary waves?

W. Wind

X. Seismic activity

Y. Gravity

Z. An object breaking the surface of water



Toss-Up Answer

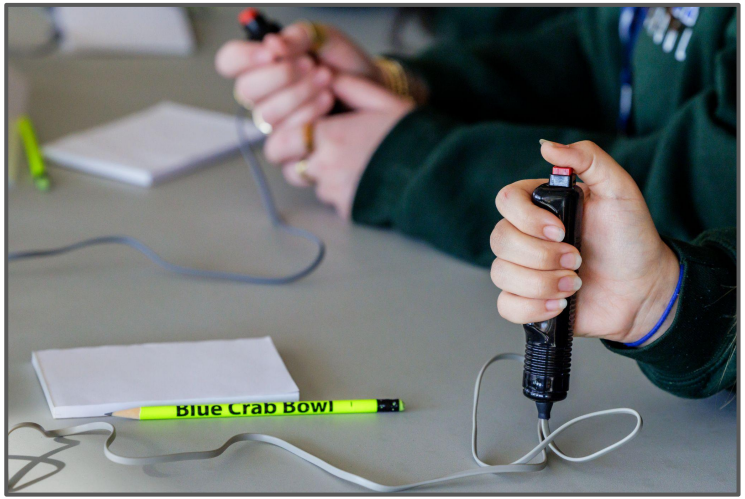
What commonly forms capillary waves?

W. Wind

X. Seismic activity

Y. Gravity

Z. An object breaking the surface of water



Bonus Question

What group behavior do fish exhibit that makes swimming more efficient and reduces predation risk?



Bonus Question

Schooling OR shoaling



Dive In to the NOSB

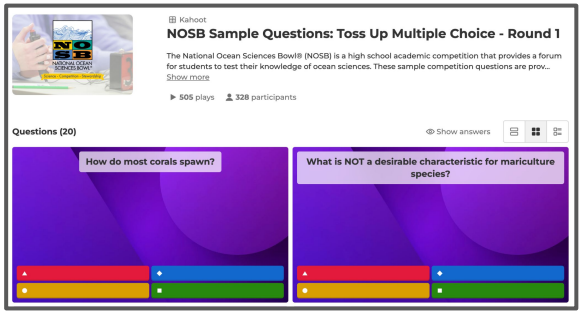
Get started at nosb.org today!

- **Step 1.** Identify the NOSB regional bowl closest to you. Check out the competition map on our home page.
- **Step 2.** Contact the coordinator for that region to see if they have an opening for a new team and get details on that regional bowl.
- **Step 3.** Find additional information on nosb.org for forming a team, registering, and preparing for competition!

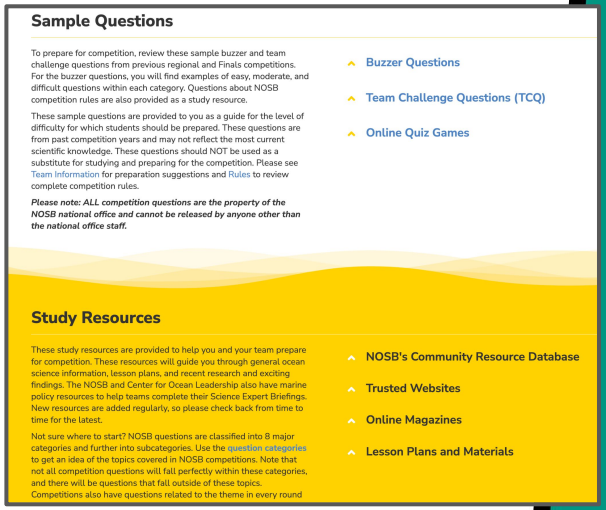


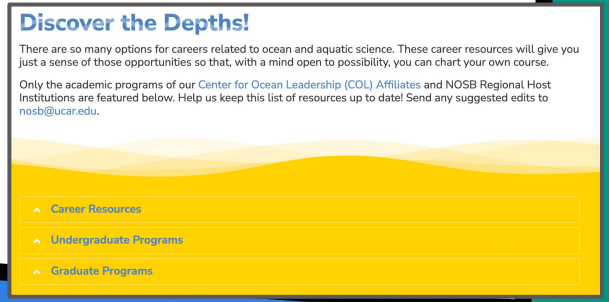
NOSB Resources

- Sample Questions and Study Resources
  - Online Quiz Games: Kahoot! and Blooket
- Theme Resource Pages
- Education and Career Resources









NATIONAL OCEAN SCIENCES BOWL®

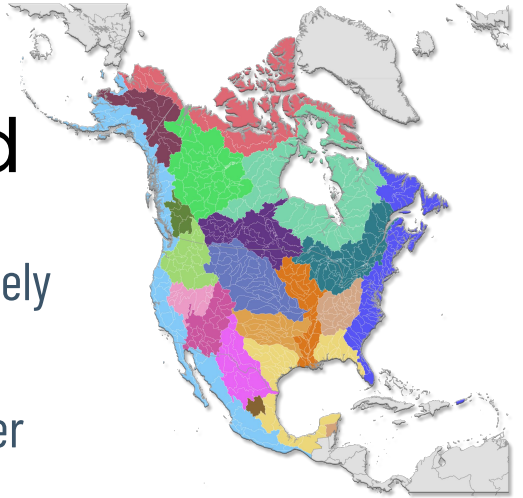
www.nosb.org
nosb@ucar.edu

How will you connect ocean science topics to your students' lives?

What will resonate with them?



Marine Debris - we're all connected

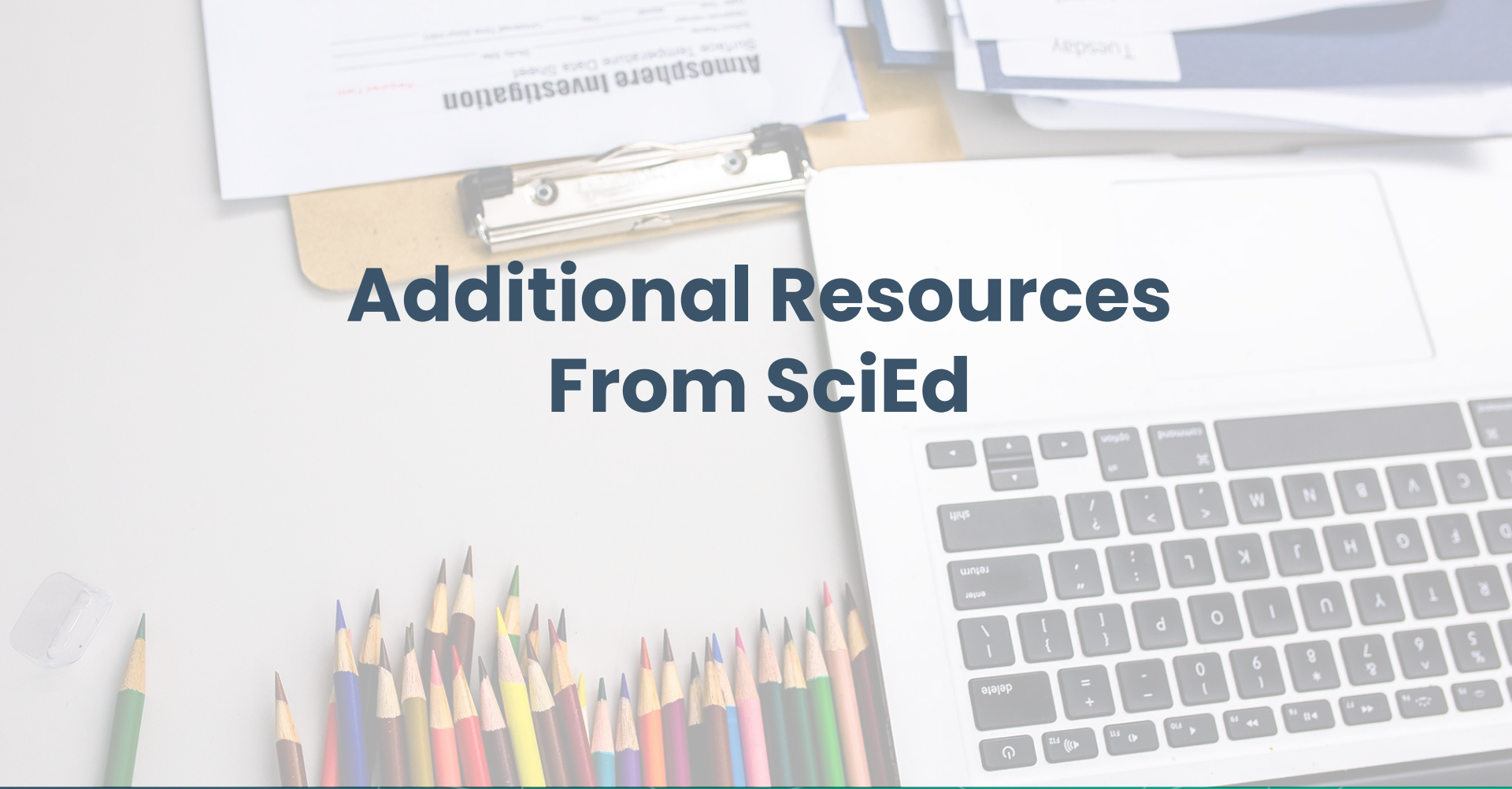


- Trash from inland areas travels through the watershed and ultimately reaches the ocean
- Microplastics from wearing/washing clothes end up in the air/water





Additional Resources From SciEd



UCAR Center for Science Education: scied.ucar.edu

Teaching Resources

Dive-in to our student-centered and teacher approved classroom activities, curriculum units, picture books, special collections, and more.



Classroom Activities

Peruse our collection of more than a hundred K-12 lessons about the science of our planet.



Curriculum Units

Multi-day sequences of activities developed by SciEd educators through grant-funded collaborations.



Learning Zone

Visit this hub for short articles, interactives, images, and videos to help you learn how the Earth works.

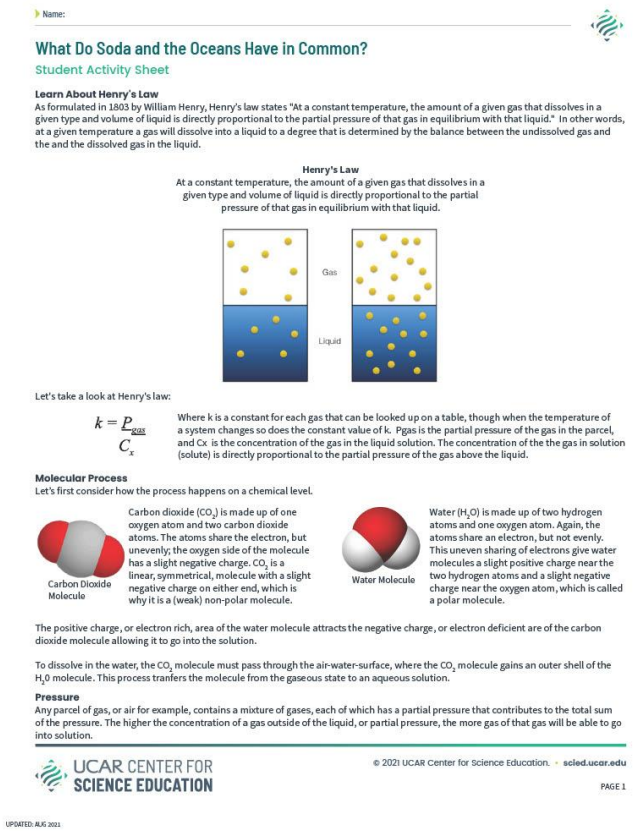
What do soda and the oceans have in common?

scied.ucar.edu/activity/what-do-soda-and-oceans-have-common

Students observe the carbonation of cups of soda at different temperatures.

Science concepts:

- Henry's Law: temperature and partial pressures; how much gas can dissolve into a liquid?
- Ocean connection to the carbon cycle
- Climate change: As temperatures rise, will the oceans absorb less CO_2?



Name:

What Do Soda and the Oceans Have in Common?

Student Activity Sheet

Learn About Henry's Law

As formulated in 1803 by William Henry, Henry's law states "At a constant temperature, the amount of a given gas that dissolves in a given type and volume of liquid is directly proportional to the partial pressure of that gas in equilibrium with that liquid." In other words, at a given temperature a gas will dissolve into a liquid to a degree that is determined by the balance between the undissolved gas and the and the dissolved gas in the liquid.

Henry's Law

At a constant temperature, the amount of a given gas that dissolves in a given type and volume of liquid is directly proportional to the partial pressure of that gas in equilibrium with that liquid.

Gas

Liquid

Let's take a look at Henry's law:

$$k = \frac{P_{gas}}{C_x}$$

Where k is a constant for each gas that can be looked up on a table, though when the temperature of a system changes so does the constant value of k. Pgas is the partial pressure of the gas in the parcel, and Cx is the concentration of the gas in the liquid solution. The concentration of the the gas in solution (solute) is directly proportional to the partial pressure of the gas above the liquid.

Molecular Process

Let's first consider how the process happens on a chemical level.

Carbon Dioxide Molecule

Carbon dioxide (CO_2) is made up of one oxygen atom and two carbon dioxide atoms. The atoms share the electron, but unevenly; the oxygen side of the molecule has a slight negative charge. CO_2 is a linear, symmetrical, molecule with a slight negative charge on either end, which is why it is a (weak) non-polar molecule.

Water Molecule

Water (H_2O) is made up of two hydrogen atoms and one oxygen atom. Again, the atoms share an electron, but not evenly. This uneven sharing of electrons give water molecules a slight positive charge near the two hydrogen atoms and a slight negative charge near the oxygen atom, which is called a polar molecule.

The positive charge, or electron rich, area of the water molecule attracts the negative charge, or electron deficient are of the carbon dioxide molecule allowing it to go into the solution.

To dissolve in the water, the CO_2 molecule must pass through the air-water-surface, where the CO_2 molecule gains an outer shell of the H_2O molecule. This process tranfers the molecule from the gaseous state to an aqueous solution.

Pressure

Any parcel of gas, or air for example, contains a mixture of gases, each of which has a partial pressure that contributes to the total sum of the pressure. The higher the concentration of a gas outside of the liquid, or partial pressure, the more gas of that gas will be able to go into solution.

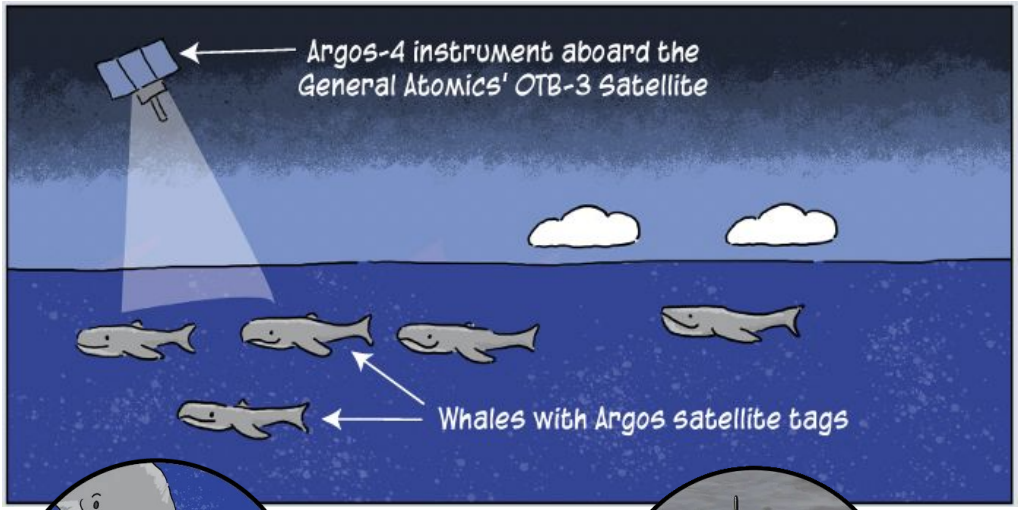
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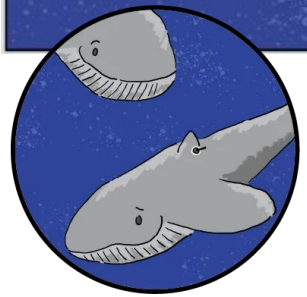
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UPDATED: AUG 2021

Using Satellites to Learn About Animals

scied.ucar.edu/using-satellites-to-learn-about-animals



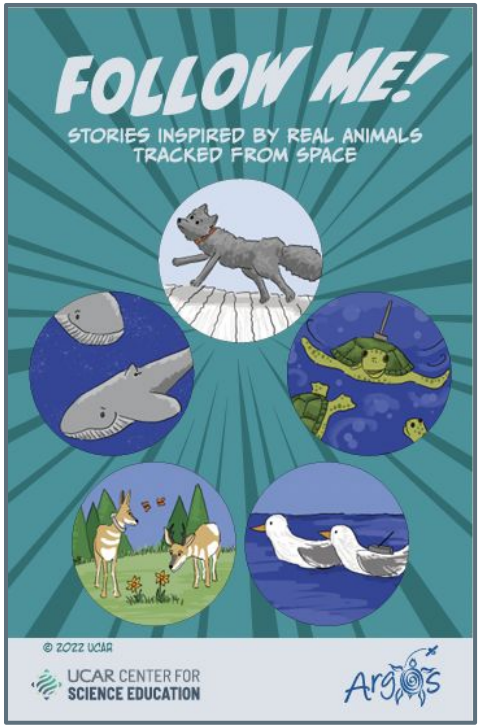


Upper Elementary: Where Are the Whales?



Middle School: The Plastic Path

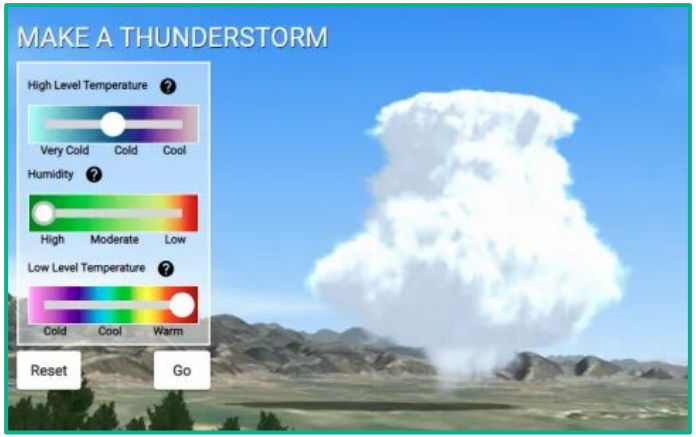
The *Follow Me!* Online Comic Book





The Learning Zone

A resource for public understanding of science and to support learning for secondary students



Learning Zone articles about the ocean

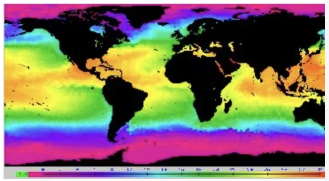
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Transfer and Storage of Heat in the Oceans

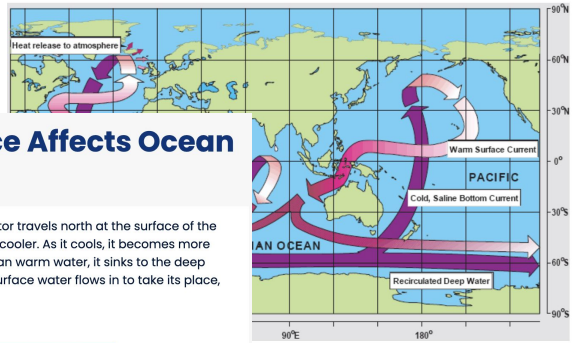
Seasonal temperature extremes are milder near large bodies of water and more extreme further inland because water is slower to heat up and cool down than air or even land. The ocean (as well as other large bodies of water) have considerable "thermal inertia." They warm slowly as heat is added, but also give up that heat slowly as their surroundings cool.



Sea surface temperatures. Pink and purple are coolest (starting near 0° C). Orange and red are warmest (up to around 32° C).
NOAA

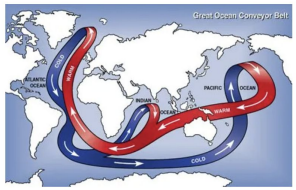
Here's an example. The average annual temperatures in Valdivia, Chile, and in Beijing, China are nearly identical.
However, the average temperature in the coldest month in Valdivia is 7° C (45° F), whi
the average in the hottest month is 16° C (61° F). In Beijing, the average temperature ir

Map of Ocean Circulation



How Melting Arctic Ice Affects Ocean Currents

In the North Atlantic, water heated near the equator travels north at the surface of the ocean into cold, high latitudes where it becomes cooler. As it cools, it becomes more dense and, because cold water is more dense than warm water, it sinks to the deep ocean where it travels south again. More warm surface water flows in to take its place, cools, sinks, and the pattern continues.



Worldwide, seawater moves in a pattern of currents known as thermohaline circulation, or the global ocean conveyor. The currents flow because of differences in water density and move between the deep and surface ocean.
Argonne National Laboratory

Teacher Professional Development from SciED

Snowfall Measurement: In Support of Aviation, Nov 10th, 5-6pm: NSTA Web Series



scied.ucar.edu/educators/teacher-professional-development/snow-science

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Thank You!