LESSON PLAN:
GO WITH THE FLOW

DESIGNING OCEAN DRIFTERS

Objective: To introduce students to concepts in ocean engineering and design, as well as to gain knowledge related to the way in which data is collected for research.

Challenging students to be creative inventors, developing the next great scientific instruments.

STANDARDS: Ocean Literacy Principles 1,7; SC.912.N.1.7, SC.912.N.1.6, SC.912.P.12.2

Time Required: Five class periods (Three for building, one for presentation, and one for testing)

Keywords: drifter, currents, buoyancy, CARTHE, GPS, STEAM

Materials:
A wide variety of materials can be used. Some examples include:

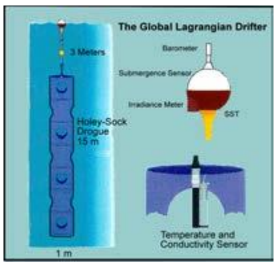
- Various household materials
- Styrofoam, other types of foam
- Natural materials (coconuts, palm fronds)
- Cloth
- String
- Duct tape
- PVC piping
- Wood, wooden dowels
- Spray paint
- Zip ties
- Washers
- Measuring tape
- Scissors
- Copies of the article, "UM Scientists Develop Eco-Friendly Ocean Instruments for Oil Spill Research" (page 6)
- Computer and projector to watch the video, "Drifting Into The Gulf"

BACKGROUND

A drifter is an object that drifts with the ocean currents and collects data along the way about its location and speed. The more we know about how ocean currents move, the better prepared we will be to predict the movement of ocean pollution, larval fish, or even someone lost at sea. Surface drifters consist of a marine anchor/sail and a float. The anchor/sail catches the water and moves through the ocean with that piece of water. The float is used to keep the drifter at the surface and to hold the GPS transmitter, which is used to send data to orbiting satellites.

Physical oceanographers use a variety of drifters to study different currents throughout the ocean:

- The NOAA Global Drifter Program studies the mixed layer currents in the upper ocean so their drifters consist of a round buoy at the surface and a 6m long drogue (sea anchor). (*photos a and b below)*
- The "CODE" surface drifters consist of "X" shaped sails and is only 1m deep, so they are specialized to measure the surface currents only. (*photos c and d below)*

a 

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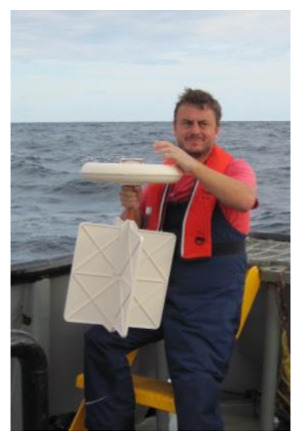
d 

CARTHE (Consortium for Advanced Research on Transport of Hydrocarbon in the Environment) based at the University of Miami has conducted several large-scale experiments to study the currents in the Gulf of Mexico. For each one, they have designed and built new drifters that will measure the currents in the study area. They want to determine how oil in the water gets from the site of a spill, through the surf zone, and onto the beaches. This data is then used to make more accurate computer models that can predict the fate of spilled oil or marine debris, or even be used to predict where larval fish or people lost at sea may end up.



For the 2016 LAgrangian Submesocale ExpeRiment (LASER), CARTHE scientists planned to release 1000 drifters during the 3 week long expedition in the northern Gulf of Mexico. The traditional CODE drifters they used in previous experiments would take too long to put together and were made of thick plastic, something you don't want to put into the ocean. Therefore, they decided to design their own drifters that were easy to assemble, low cost, and biodegradable. It took 2 years to develop but the CARTHE drifters were successfully released and have collected millions of data points. We invite you and your students to try your hand at developing equipment for measuring the movement of surface currents too, creating the next generation of surface drifters.

In this lesson, students will have the opportunity to design and build their own easy-to-use, low-cost drifter that can move with surface currents. Each drifter will be evaluated on buoyancy, durability, and portability. Students should consider eco-friendly materials that might be best for future scientific research as well as how wind, currents, storms, and boats will affect their drifter.

There are widespread applications for drifters in optimizing shipping routes, recreation, search and recovery, and oil spill mitigation.

PROCEDURE

1. **Introduction**: Have students read the article, "UM Scientists Develop Eco-Friendly Ocean Instruments for Oil Spill Research," and watch the video "Drifting Into the Gulf" (https://vimeo.com/257792941) by Waterlust about the development of the CARTHE drifters. Explain to the students that they will be designing a new drifter to study ocean currents, based on the following criteria:

Criteria for Drifters:

- Buoyancy - Must be able to float!
- Durability - Must be durable and sturdy enough to withstand wind, waves and strong currents
- Portability - Should be easy to hold on to (i.e. have a handle to assist with deployment and retrieval)
- Must be small and light enough to be carried on a jet ski (between 3-5 kilos)
- Visibility - Must be visible from the surface of the water so it can be retrieved
- Create a designated space for data collection mechanisms (i.e. GPS and sensors)
- Must include the following labels: your Institution, Transmitter ID, email address, and "Drifter Study"

2. **Design Plan & Presentation**: Have students form groups of two or three and come up with a design for their drifter. Groups will then prepare a presentation that includes the following components:

   i. Picture of drifter design
   ii. List of materials
   iii. Description of construction
   iv. Justification: Why do you think this will work? How will you make this visible? How will it right itself if it gets tumbled in the surf?

3. **Feedback**: After each presentation, provide feedback to each group on their drifter design. As a class, discuss any improvements that need to be made before testing.

4. **Construct Drifter**: Pending teacher approval, students will build drifters to be tested in a pool, at the beach, or in a lake (wherever is most convenient).

5. **Test Your Drifter**:
   i. Have each group place their drifter in the body of water.
   ii. Using the judging rubric, evaluate the drifters on how well they meet each of the criteria.
   iii. If using a pool or lake, create a disturbance in the water to make sure that the drifter is self-righting and can withstand wind and waves.
   iv. Recollect the drifters, make adjustments as needed to fix the design. (*Make sure all materials are recovered and reused or disposed of properly*)

EXTENSIONS

- Build mini-drifters and test in a small tank.
- Could be used as an afterschool science club project.
- Plot the drifter's trajectories.
- Write a short story about the journey your drifter might take out in the ocean.
- Write a poem about ocean movement, or your relationship with the ocean (consider submitting to the Piano Slam youth poetry competition).

RESOURCES & REFERENCES

Surfzone Coastal Oil Pathways Experiment (SCOPE)
http://carthe.org/scope/

LAgrangian Submesoscale ExpeRiment (LASER)
http://carthe.org/laser/

Biscayne Bay Drift Card Study (Bay Drift)
http://carthe.org/baydrift/

Global Drifter Program
http://www.aoml.noaa.gov/phod/dac/gdp_drifter.php - design

Student Drifters
http://studentdrifters.org/

This lesson was originally produced for *Deep-C's Gulf of Mexico Multi-disciplinary Curriculum for High School Science: Physical Oceanography Module,* and updated by CARTHE in 2018 to reflect the new advances in drifter technology.
http://deep-c.org/education-and-outreach/gom-curriculum

Drifter Judging Rubric

Name of Drifter: Group Members:	Superior	Above Average	Average	Below Average
Design Originality and Creativity:				
Efficient Use of Low-Cost Materials:				
Timely Construction:				
Presentation:				
Meets specific requirements: -Buoyancy -Durability -Portability -Visibility				
Other Comments:				

Assessment Questions:

1. What was your team's inspiration for the design?
2. What are specific challenges your team faced while building the drifter?
3. What information can be gained by using this drifter in surface currents?
4. After testing the drifter, how would you change the design to make it better?

ARTICLE REPRINT

UM SCIENTISTS DEVELOP ECO-FRIENDLY OCEAN INSTRUMENTS FOR OIL SPILL RESEARCH

Posted online March 14, 2018
Source: University of Miami RSMAS https://news.miami.edu/rsmas/stories/2018/03/um-scientists-develop-eco-friendly-ocean-instruments-for-oil-spill-research.html

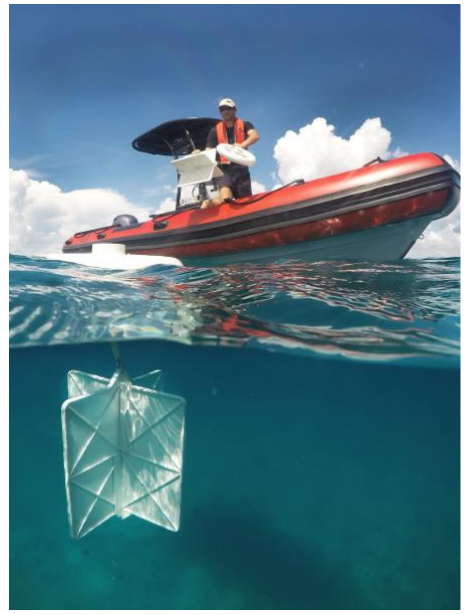


Figure 1 CARTHE drifters being released by University of Miami researchers

MIAMI—Studying small-scale ocean currents is important to understand how pollutants like oil and micro-plastics, or tiny sea creatures like plankton, travel in the world's oceans. One research team has developed a new biodegradable drifter instrument to study ocean currents that don't contribute to the growing marine debris problem.

Scientists at the University of Miami (UM) Rosenstiel School of Marine and Atmospheric Science-based Consortium for Advanced Research on Transport of Hydrocarbon in the Environment (CARTHE), in collaboration with the ocean engineering company Bellamare LLC, recently developed and tested the new biodegradable drifter in a series of ocean current studies.

Drifters are buoy-like instruments that float at the surface of the ocean and transmit their location data to satellite as they drift with the currents to provide scientists with information about how water moves.

"New scientific instruments like the CARTHE drifter are quickly advancing our understanding of the ocean and ocean processes," said UM Rosenstiel School Professor Tamay Özgökmen, who leads CARTHE, a Gulf of Mexico Research Initiative (GoMRI)-funded research consortium studying how oil is transported in the ocean to help inform and guide response teams in the event of future oil spills.

The researchers spent two years testing various structures and materials before finalizing the new CARTHE drifter design, which is the first environmentally friendly drifter made from 85 percent seawater biodegradable components. Ten different prototypes were developed and vigorously tested in the UM Rosenstiel School's 30,000 gallon Alfred C. Glassell Jr. SUSTAIN Laboratory wind-wave tank before selecting the final design.

A study on the evolution of the drifter design and its deployment was recently published in the American Meteorological Society's *Journal of Atmospheric and Oceanic Technology*, which details their use during a massive near-surface currents sampling experiment led by CARTHE scientists called the [Lagrangian Submesoscale Experiment] (LASER). The 2016 LASER was the final test-bed for the CARTHE drifter as scientists deployed 1000 drifters, each programmed to capture location data every five minutes for three months.

A second CARTHE study published this year in the *Proceedings of the National Academy of Sciences* explains the results of the LASER study, which showed the drifters became more concentrated in the first 7-10 days after release. This, according to the researchers, shows that under certain conditions oil or other pollutants could collect along fronts or in eddies, possibly making clean up easier.

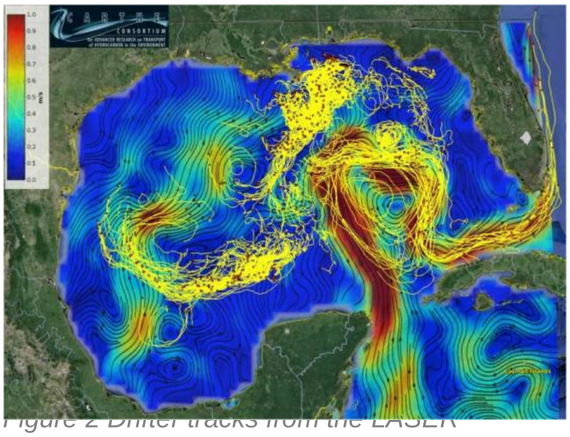


Figure 2 Drifter tracks from the LASER expedition in the Gulf of Mexico

The accumulation of discarded plastics in the world's oceans is a growing environmental concern since current hydrocarbon-based plastics have a very low biodegradability and stay in the marine environment for long periods of times. With this in mind, the CARTHE instrument development team was determined to create a product that would not contribute to this escalating issue.

The CARTHE drifter design benefited from recent advances in biochemistry by using new biodegradable and non-toxic thermoplastics known as polyhydroxyalkanoates (PHA). PHA products were a great fit for the drifter design since they are both readily available and meet the American Society for Testing of Materials (ASTM) standard for biodegradability in the marine environment. Additionally, PHAs being thermoplastics with strong mechanical properties similar to commonly used plastics fit the unique construction needs for the sacrificial oceanographic instruments.

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The CARTHE I program (2012-2014) includes 26 principal investigators from 12 research institutions in eight states. The CARTHE II program (2015-2017) includes 40 principal investigators from 27 research institutions. The CARTHE III program (2018-2019) includes 19 principal investigators from 12 institutions. Together these scientists are engaged in novel research through the development of a suite of integrated models and state-of-the-art computations that bridge the scale gap between existing models and natural processes.

For more information about CARTHE, please visit **www.carthe.org**.