

A Field Method for Studying Surface Currents from the Shore, and Using the SMBO & SCCOOS Data Portals to Help Examine Surface Currents

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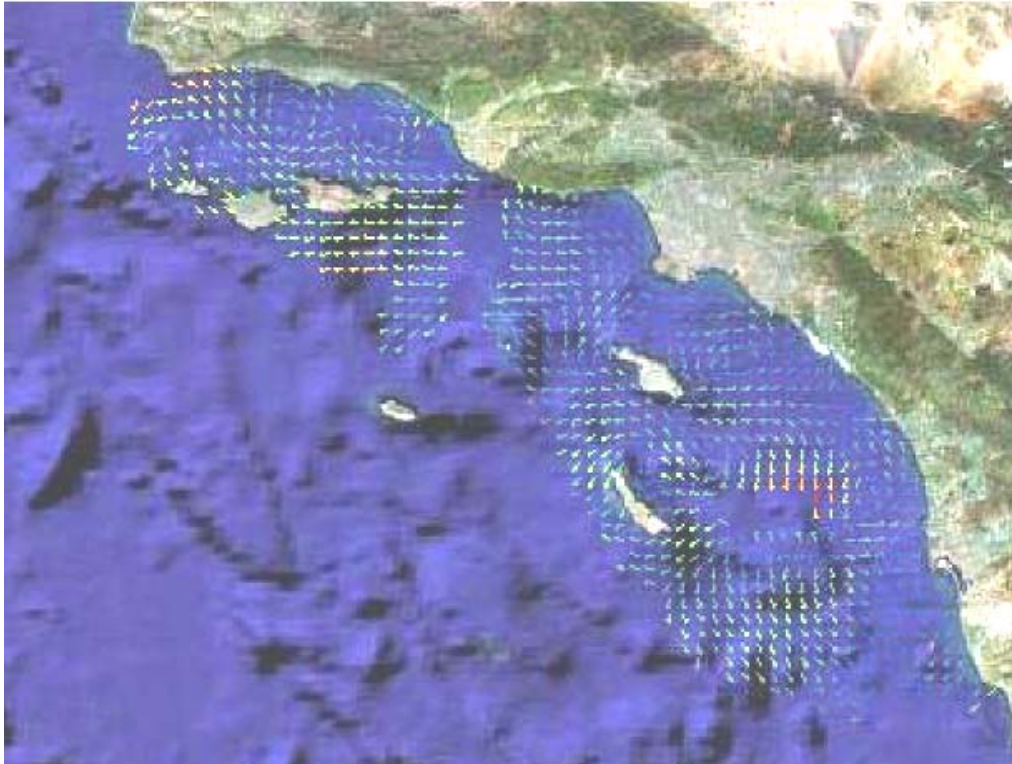
Grade: 9 - 12

Group Size: any

Time: 1 hour classroom prep time

1 hour computer time

1 hour field activity



BACKGROUND

- UCLA's Santa Monica Bay Observatory (or SMBO) is an instrument-packed buoy moored at the outer edge of Santa Monica Bay (33° 56' N, 118° 43' W). For further information about all of the instruments on board the buoy, see:
http://www.sccoos.org/docs/mooring_smbo_specs.pdf
- The SMBO Data Portal is located on the web at:
http://quercus.igpp.ucla.edu/smbo/smbo_data.html
- Among the instruments on board the SMBO that provide continuous, real-time data, an Acoustic Doppler Current Profiler (or ADCP) looks at water movements around the mooring in 3 dimensions. Please use this link for a direct connect to the latest SMBO ADCP data display:
http://quercus.igpp.ucla.edu/smbo/mucla_adcp_lastday.gif
- Also, the SMBO is part of the Southern California Coastal Observing System (SCCOOS), and a link to maps of "surface currents by HF radar" is found on the SMBO Data Portal web page, or can be viewed directly on the web at:
<http://www.sccoos.org/data/hfrnet/>

Students and teachers should have the ability to link to the above sites and view their contents.

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There are two general causes of surface currents found along the beaches of southern California.

- 1) On the broad scale, the California Current flows from Alaska towards the equator, with an associated late fall and winter countercurrent (sometimes called the Davidson Current) running right along the coast. Daily and up-to-the-minute radar images of this current system can be viewed on the SCCOOS site above.
- 2) Currents very close to the shore may be generated by high surf conditions. These “rivers” along the immediate beach are known as *longshore currents*, and their strength and existence depend on the size and direction of the waves. On days with little or no surf, there will be little or no longshore current. Conversely, when the surf is large, the long shorecurrent can be very swift.

To prepare your students for this lesson, you might use the UCLA OceanGLOBE “Ocean Circulation” PowerPoint slideshow,

<http://www.msc.ucla.edu/oceanglobe/ppt/oceancircNotes/OceanCirculation.htm>

and the OceanGLOBE classroom investigations on Currents on

<http://www.msc.ucla.edu/oceanglobe/investigations.htm>

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### OVERVIEW

In this lesson students will do two things:

- 1- Measure the nearshore surface current at the beach.
- 2- Use the SMBO and SCCOOS data portals to investigate images of near-real-time surface currents and relate them to their own beach measurements.

### CONTENT STANDARDS

#### Grade 7: Investigation and Experimentation

Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

Students will:

- a. Select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.
- b. Use a variety of print and electronic resources (including the World Wide Web) to collect information and evidence as part of a research project.
- c. Communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence.
- d. Construct scale models, maps, and appropriately labeled diagrams to communicate scientific knowledge (e.g., motion of Earth's plates and cell structure).
- e. Communicate the steps and results from an investigation in written reports and oral presentations.

#### Grade 8: Motion

The velocity of an object is the rate of change of its position. As a basis for understanding this concept:

- a. *Students know* position is defined in relation to some choice of a standard reference point and a set of reference directions.

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- b. *Students know* that average speed is the total distance traveled divided by the total time elapsed and that the speed of an object along the path traveled can vary.
- c. *Students know* how to solve problems involving distance, time, and average speed.
- d. *Students know* the velocity of an object must be described by specifying both the direction and the speed of the object.
- e. *Students know* changes in velocity may be due to changes in speed, direction, or both.
- f. *Students know* how to interpret graphs of position versus time and graphs of speed versus time for motion in a single direction.

### **Grade 8: Investigation and Experimentation**

9. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept, and to address the content the other three strands, students should develop their own questions and perform investigations. Students will:
  - a. plan and conduct a scientific investigation to test a hypothesis.
  - b. evaluate the accuracy and reproducibility of data.
  - c. distinguish between variable and controlled parameters in a test.
  - d. recognize the slope of the linear graph as the constant in the relationship  $y=kx$  and apply this to interpret graphs constructed from data.
  - e. construct appropriate graphs from data and develop quantitative statements about the relationships between variables.
  - f. apply simple mathematical relationships to determine one quantity given the other two (including speed = distance/time, density = mass/volume, force = pressure x area, volume=area x height).
  - g. distinguish between linear and non-linear relationships on a graph of data.

### **Grades 9 – 12: Physics**

#### Motion and Forces

1. Newton's laws predict the motion of most objects. As a basis for understanding this concept:
  - a. *students know* how to solve problems involving constant speed and average speed.

### **Grades 9 – 12: Ecology**

6. Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:
  - b. *students know* how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of non-native species, or changes in population size.

### **Grades 9 – 12: Earth Sciences**

#### Energy in the Earth System

5. Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents. As a basis for understanding this concept:
  - d. , *students know* properties of ocean water such as temperature and salinity can be used to explain the layered structure of the oceans, generation of horizontal and vertical ocean currents, and the geographic distribution of marine organisms.

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## **Grades 9 – 12: Investigation & Experimentation**

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept, and to address the content the other four strands, students should develop their own questions and perform investigations. Students will:
  - a. select and use appropriate tools and technology (such as computer-linked probes, spread sheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
  - d. formulate explanations using logic and evidence.
  - i. analyze the locations, sequences, or time intervals of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).
  - j. recognize the issues of statistical variability and the need for controlled tests.
  - k. recognize the cumulative nature of scientific evidence.
  - l. analyze situations and solve problems that require combining and applying concepts from more than one area of science.

## **PERFORMANCE OBJECTIVES**

Given lab and field supplies, students will collect data regarding the speed and direction of the current at a nearby beach.

Given access to an on-line computer and printer, students will produce a minimum 1-page illustrated document or a 5 slide PowerPoint series, showing ADCP images and California Current maps that relate to current measurements at the beach.

## **MATERIALS**

|                                         |                             |
|-----------------------------------------|-----------------------------|
| computer, software, internet connection | tennis ball or fresh orange |
| printer                                 | stopwatch                   |
| paper                                   | tape measure                |
| hand held compass                       |                             |

## **ADVANCE PREPARATION**

- 1- Students should understand the general circulation of surface water in the ocean by observing and taking notes using the UCLA OceanGLOBE Ocean Currents PowerPoint presentation.
- 2- Students should know where to go on the Web, and what to do on the SMBO and SCCOOS web sites.

## **INVESTIGATIONS**

### **Field Investigation**

#### **1. Hypothesis:**

Based on your knowledge of ocean currents, formulate a hypothesis about the direction a tennis ball, orange, or other floating object, should travel when thrown into the ocean.

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## 2. Procedure:

### A. Field Protocol - Measuring the nearshore current.

- 1- Make sure all instruments and people are ready. Reset timer to zero, and have tape measure ready. People using instruments should “keep their eyes on the ball” and be ready to start timing.
- 2- Throw the tennis ball into the ocean and simultaneously start the timer.
- 3- Begin to unwind tape measure as the ball moves downstream.
- 4- After 5 minutes, or reaching 100 meters, stop and record measurements:
  - date and time of day
  - distance ball traveled in meters (m) to the nearest tenth of a meter
  - time ball traveled in seconds (sec)
- 5- Record the direction the ball traveled in degrees magnetic, using a hand held compass.
- 6- Calculate the speed by dividing the distance (m) by the time (sec). Record the speed in cm/sec.

## 3. Inquiry Question:

- 1- How fast is the current along this beach, and what direction is it flowing?



tennis ball



student throwing ball



student with stopwatch



hand held compass



student with tape measure

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## Internet Investigation - Locating data for Santa Monica Bay and the California Current System

### 1 Procedure:

- 1- Explore real time ADCP data images from the SMBO site following this link:  
[http://quercus.igpp.ucla.edu/smbo/smbo\\_data.html](http://quercus.igpp.ucla.edu/smbo/smbo_data.html)
- 2- Explore the real time California Current maps from the SCCOOS site, following this link:  
<http://www.sccoos.org/data/hfrnet/>

### 2 Results:

Using images they have collected using the SMBO and SCCOOS web sites, students formulate an answer to these questions: “

How do our beach measurements of the current compare to

- (a) currents in Santa Monica Bay, and
- (b) the California Current?

### **EXTENSIONS**

- 1) Explore the direction and speed of currents in the field and online within one
  - a) day
  - b) week
  - c) month
- 2) Compare one year to the next
- 3) Find and compare data from other geographic locations
- 4) Find and explore data regarding past current patterns – e.g. in El Niño years vs. those in “normal” years

As directed by the instructor, students who make multiple recordings of current speeds and directions at the beach can prepare graphs that illustrate their measurements. Beach current measurements may be plotted against other variables such as wave height or range of tide level to look for relationships.

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## RESOURCES

### On-line Articles:

[http://www.scielo.cl/scielo.php?pid=S0717-65382004000200032&script=sci\\_arttext](http://www.scielo.cl/scielo.php?pid=S0717-65382004000200032&script=sci_arttext)

Emery, D. Matthews, R. Crocker & D. Baldwin. 2004. Surface current mapping radiometry and altimetry. *Gayana* 68(2) supl. t.I. Proc. 174-179.

[http://ono.ucsd.edu/pages/pubs/eos\\_miller.et.al\\_1999/CCS\\_final.text.html](http://ono.ucsd.edu/pages/pubs/eos_miller.et.al_1999/CCS_final.text.html)

A. J. Miller, et al. Observing and Modeling the California Current System. *Eos, Transactions, American Geophysical Union*, 80, 533-539.

<http://bragg.coas.oregonstate.edu/Papers2/huyer.1989.poleward.pdf>

A. Huyer et al. 1989. Poleward flow in the California Current System. No citation. (a discussion of the seasonal occurrence of the Davidson Current)

<http://www.codaros.com/>

CODAR Ocean Sensors  
(all you need to know about High Frequency Technology)

[http://www.whoi.edu/instruments/viewInstrument.do?id=81\\_9](http://www.whoi.edu/instruments/viewInstrument.do?id=81_9)

(all you need to know about ADCP and how it works; from WHOI)

### Images:

<http://www.icess.ucsb.edu/iog/realtime/index.php>

Realtime currents in Santa Barbara Channel:

<http://www7320.nrlssc.navy.mil/ccsnrt/>

Near Realtime Depiction of the California Current, Naval Research Laboratory

### Educational activities

[http://quercus.igpp.ucla.edu/smbo/smbo\\_edu\\_teacher.html](http://quercus.igpp.ucla.edu/smbo/smbo_edu_teacher.html)

Santa Monica Bay Observatory: K-12 Educational Activities

<http://www.msc.ucla.edu/oceanglobe/>

UCLA OceanG LOBE: K-12 field Investigations, classroom exercises, PowerPoint slideshows on various marine science topics