Density-Driven Currents

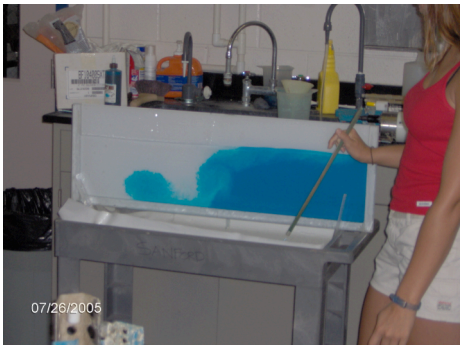
Objective
To demonstrate density differences that exist in open ocean and coastal water masses, and how these differences drive currents.

Correlations
National Science Education Standards:
Grades 5-8: B2; E1; E2; F5; G1; G2
Grades 9-12: B4; E1; E2; F6; G1; G2

California State Science Education Standards:
Grade 6: 2c; 3a; 3c; 4d; 7a; 7b; 7e
Grade 7: 7a; 7c; 7e
Grade 8: 8a; 8d; 9a
Grades 9-12: Earth Sciences: 5a, d, g, 6b, Investigation and Experimentation: 1a-d, f, g

Ocean Literacy Principles and Fundamental Concepts

Background
Circulation in estuaries and the ocean depends, in part, on differences in the density of different water masses. A water mass with more salt is heavier and sinks, while a water mass with fresher water is lighter and "floats" on the surface. The buoyancy differences between water masses results in the separation of water into layers (stratification) within an estuary or in the coastal ocean. Stratification can be disrupted by heating and cooling of surface waters and/or by wind-generated water movement like waves and currents. The primary source of fresh water in estuaries and coastal oceans is from rivers, which have a rating from 0 to 5 practical salinity units (PSU, formerly parts per thousand or PPT), while salty water masses are from the open ocean and have a rating from 32 to 35 PSU. In this demonstration, we will observe what happens when simulated river water (clear) is mixed with simulated ocean water (dyed blue).



Materials
- Glass or clear plastic tank (example, 10 gallon aquaria)
- Blue food coloring
- Tap water
- Salt (kosher salt works best)
- Straw (or hair dryer or small fan)
- Worksheet

Procedure
Part 1
1. Measure enough tap water (to simulate river water) to fill about one quarter of your tank and put it a container (beaker, bucket, carboy, etc.).

2. Measure enough tap water to fill about half your tank and put it in a second container. Add blue food coloring and add 10 grams of salt (to simulate ocean water) or use actual sea water if you have it available.

For each gallon of water, add about one half cup of salt to approximate ocean water.
For each liter of water, add about one ounce of salt to approximate ocean water.
1 US gallon = 3.79 liters

3. Set up the tank with a divider in the middle. You might need someone to hold the divider steady. The divider should be cut to fit the width of the aquarium. Use ¼ inch durable plastic or glass.

4. Slowly pour the "river water" (clear) in one side of the demonstration tank and the "ocean water" (dyed blue) to the other side. You might have one person pour the "river water" at the same time that someone else pours the "ocean water".

5. **Before you remove the divider from the tank, have the students draw this tank set up and write down their hypothesis predicting what will happen to the two water masses when the divider is removed.**

6. Remove the divider and observe.

7. Have your students record all of their observations on the worksheet.

Part 2
1. **Before you use the straw (or hair dryer or fan) to blow across the surface of the water, have your students write down their hypothesis predicting what they think will happen when you do this.**

2. Blow on the surface of the water through a straw and observe.

3. Have your students record all of their observations on the worksheet.

Density-Driven Currents Worksheet

Part 1

1. Draw the beginning tank set up with the divider and two different water masses. Label and/or color your diagram.

2. Which water mass has a higher density? Why do you think this?

3. What do you hypothesize will happen when the divider is removed?

4. After the divider is removed, what happened to the two water masses? Record your observations in words or drawings.

5. Where did the "ocean water" end up? Where did the "river water" end up? Why? Draw and label the tank now.

Part 2

1. What do you hypothesize what will happen when someone uses a straw to blow across the surface of the water?

2. While the wind is blowing across the surface of the water, what happens to the two layers of water? Draw and label the tank now.

3. What happens when the wind stops? Record your observations in words or drawings.

Suggestions for thought questions

1. How does this apply to the real world in coastal waters?

   a. What happens to the water masses near the coast when there is an offshore breeze? What is the name of this phenomenon?

   b. What happens to the water masses near the coast when there is an onshore breeze? What is the name of this phenomenon?

2. How does this relate to the water movements in the equitorial Pacific Ocean during an El Niño event?

   a. What do the equitorial waters of the Pacific look like during "normal" conditions? What is the wind direction and strength like? Where is the warm water? Where is the cold water?

   b. What do the equitorial waters of the Pacific look like during an El Niño event? What is the wind direction and strength like? Where is the warm water? Where is the cold water?

   c. What do the equitorial waters of the Pacific look like during an La Niña event? What is the wind direction and strength like? Where is the warm water? Where is the cold water?