SMS-303: Integrative marine sciences III.

Lab 3, Mixing.

Stations and activities:

I. Convective mixing:
You have three tanks. In one you have a heating element on the bottom, in one you have a heating element near the surface and in the third you will put ice.
Before you do anything answer the following:
Q: Which do you expect to cause the most mixing through entrainment of adjacent waters?

Plug both heating element, put ice in the third tank and use food coloring to trace the waters.

Q: Observe the circulation and speculate where in the oceans does such a circulation takes place. Discuss at least one oceanic setup for which each tank is an analogue for.

II. Kelvin-Helmholz billows:
In a long skinny cylinder you have water overlaid by mineral baby oil. You are about to lift one side (the right one) and observe what happens at the interface between two fluids flowing in opposite directions (why do will they flow in opposite direction?).
Q: What do you think will happen at the interface between the two fluids?
Lift the right side 10-20cm above the table and observe the interface.
Q: Why don't the two fluids mix?

III. Mixing of dyed water:
Fill a small rectangular tank with water from the tap. Put a divider between both sides of the tank and put 4 drops of green food coloring in one side and 4 drops of yellow food coloring at the other side. Mix each side and wait until the fluid is at rest.
Q: What will happen when you raise the barrier between the two sides?
Raise slowly the barrier and observe what happens. Write carefully the time when you opened the barrier on the tank and come periodically to observe the evolution of the fluid.

IV. Diffusion of momentum:
You have a round vessels full of water on a rotating table.
Q: How will the fluid react when you start/stop the rotating tank?

Use dye to check your answers as you start the fluid rotating and then stop it. Use pieces of paper to determine how fast the fluid is rotating.

V. Wind mixing:
You have two tanks filled with water and a hair dryer. One tank is stratified the other is not.
Before you start discuss the following questions:
Q: How can you use the food dye to determine which is stratified?
Q: How different will the mixing be in the stratified tank compared with the non-stratified one?

Keep the dryer on low and direct it parallel to the water's surface. Perform the experiment and explain the observations. BE VERY CAREFUL NOT TO INSERT THE HAIR DRYER IN THE WATER.

VI. Breaking internal waves.
You have a tank with fresh water on top of blue salty water. Slowly move up and down a paddle to generate internal waves. See how they interact with the sloped surface on the other side of the tank. Can you observe the mixed fluid formed by the breaking waves?

Homework:

You are hired by a consulting firm to study a lake in Maine which is 50m deep and 1km wide and where contaminants have been disposed off. The questions that follow are based on the mixing processes you studied in the class and lab (if you know of others, don't hesitate to add them for extra credit).

1. What mixing processes that may disperse the pollutant will you take into account and why (35pts)?

2. Which mixing processes will dominate in different seasons (35pts)?

3. What processes are likely to be more important if the contaminants are heavy and sink down to the bottom (e.g. sewage sludge) vs. if they are mixed into the fluid (30pts)?

I encourage you to study relevant material regarding the annual cycle in lakes in the library or on the WWW.

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