SMS-303: Integrative marine sciences III.

Lab 4, Coriolis.

Stations and activities (most of which will be demo given the time it takes to spin the experiments and the number of rotating tables we have):

Rotating table 1:
I. Rotating flow over topography, Taylor Columns (from: http://www.ocean.washington.edu/courses/oc512/lab2-2004.pdf also in introduction to GFD, by Cushman-Roisin).

Put some dye (a permanganate crystal) on top of the 'sea mount' and a different dye around it. Observe the fluid at rest relative to the rotating fluid. You are about to change the rotation rate. What do you think will happen to the fluid?

Decrease a little the rotation rate (by decreasing the voltage). Observe the fluid flowing towards the 'seamount'. Does it climb over it?
What is happening to the dyed fluid?
The fluid in the tank has a specific angular momentum based on its motion, distance from the center and depth. If it were to climb the 'seamount' it will need to changed its height (and become fatter); if it did that, its velocity will need to change prompting it to stay away from the seamount. This rigidity of the fluid is a particular property of rotating fluids.

II. Coriolis in a fluid
A syringe with dye is attached to a rotating tank at solid body rotation. What do you think will happen when you skirt fluid into the tank at mid depth in direction of its center? Do it, and observe what happens to the fluid (Is it deflected?).
How does it compare to an analogue setup that does not rotate? Compare the fluid in both setups. Do they develop differently following the injection?

III. Rotating table Coriolis:
Spin the table and, when you can, release the ball into it through the duct on its side (it will take you a little time to get used to this simple setup).
Predict to what direction the bead will be deflected as function of the direction of rotation. Now, observe how the deflection direction and intensity varies with the spin direction and intensity.
How is this setup different from that in station I (think about the relative velocity of the bean and cannonballs when they leave the duct/cannon)?

IV. Inertial oscillations
Using a surface designed to be a geopotential for a given rotation rate, observe a ball at rest in the rotating frame of reference (via the camera). Perturb the ball and observe the motions in both rotating and nonrotating reference frames. These motions are called inertial oscillation and occur often in the oceans in response to a sudden impulse on it.

V. Faucualt's pendulum:
Observe how a pendulum is seen from a rotating frame (camera) and a frame at rest. This is one of the most striking experiments proving the Earth rotation that can be done without ever living ones room!

Rotating table 2:

VI. Taylor sheets.
Put dye in a rotating tank and a non rotating tank. Observe how the dye spread. Why is it different between the two?

VII. Ekman pumping.
Have a tank with a viscous fluid come to solid body rotation by spinning about 5min. Once in solid body rotation put a stationary beaker on top generating stress on the upper surface of the fluid. What direction is the stress (plot it) ? How would such a stress affect a fluid on the ocean? Using dye observe the motion within the fluid. Is it consistent with what you learned about Ekman pumping?

Computer exercise:

VIII. Cannon shooting Coriolis activity from:
http://des.memphis.edu/lurbano/vpython/coriolis/Coriolis_model.html

Experiment with the program. Start by picking a rotation direction.
Predict the trajectory in the inertial frame and in the rotating frame.
Shoot the cannon and observe the resulting trajectories. Change the rotation direction and observe the changes. Once you feel comfortable with these changes:
1. Add friction. Predict what will happen and compare to what happens.
2. Move the cannon. Predict what will happen and compare to what happens.

No Homework.
Merry Christmas, Happy Hanukah and Kwanza and Happy new year!!!

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