SMS-303: Integrative marine sciences III.

Lab 1, Waves.

Purpose of the lab: familiarize the students with waves. Students generate seich, measure three dimensional velocities associated with waves, observe particles in waves and generate internal waves. The students observe the development of mean circulation by periodic forcing. Concepts such as wavelength, frequency, period, amplitude, resonance are all emphasized.

Class demo: 'dead-water' – famous oceanographic problem- boat in stratified fluid can encounter large resistance. Many different explanations until Ekman (1904) provided the correct one. See: Ekman V. W., 1904. On dead water. Sci.Results Norw. North Polar Expedi. 1893-1896, 5(15).

Stations:
I. You are about to measure the period of wave sloshing back and forth in a small vessel.
Q: Which do you expect to propagate faster: a wave in a tank with little water or that where the water is deeper?

Have one student raise one side of the tiny aquarium and another be the timer. Measure (using a stopwatch) how many sloshing back and forth you get in a tank with little water (1.5cm) and one with 4 times the depth (6cm) within a period of 5seconds. How much faster is one from the other? Is it consistent with the dependence you derived from dimensional analysis above?
Please record this data as you will need it for your homework.

II.
Buoyancy oscillations:
In a tall cylinder with salty water on the bottom and fresh water on top you have a floating object parked between the fluids.
Q: What will happen if you push the ping-pong ball down? Why?
How will the period of the oscillation change if the water is more/less stratified?

III.
Large tank with paddle + current meter (ADV) attached to a computer.
A power supply is attached to the paddle allowing us to change the frequency of the forcing.

a. Q: How do you think the wave amplitude will change with the frequency of the paddle?

Using the ADV measure the velocity at a point within the middle of the fluid. Change the voltage from 12→17V in increment of 1V and plot the change in the amplitude of the along channel velocity as function of voltage. How do you explain your observations?

b. Observe particles within the fluid. How are they distributed? Why?

c. Observe the behavior of the beach as you change the forcing. How is the beach changing? Can the change of the beach affect the waves (e.g. *feedback*)?

d. Observe some particles floating on the water or suspended at depth. Are they simply oscillating or can they be observed drifting in a given direction? Can a periodic forcing force a current (that has a none zero mean velocity)?

IV:
Slinky- use a slinky to make a transverse wave (where the wave motion is at 90 to that of the particles) and a longitudinal wave (where the wave and particles move in the same direction). Classify sound, light, and gravity waves as transverse of longitudinal. Use: http://www.kettering.edu/~drussell/Demos/waves/wavemotion.html displayed on the computer next to you to learn more about them.

V.
Internal waves:
You have a small tank with a partition in the middle. Fill one side of the partition with cold fresh water and the other with hot and fresh or cold and salty water. Q: What will happen when you raise the partition between the fluids?

Remove the partition. What is happening? How does the speed of the perturbation compare with those in St. 1? If you used the hot cold combination, put your finger in, can you feel the different waters?

VI.
You have a large aquarium with a 2-layered stratified fluid. Use a plastic container to excite waves within the tank. Can you excite the internal gravity waves without exciting the surface gravity waves? Which has higher frequency? Try to match the frequency of the wave you want to excite with the motion of the container.

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