ESS 414/514
Problem Set 2
Due Friday, April 16, 2010

Problems for all students

1. A cylindrical container is partially filled with water and rotates about its axis which is vertical. Calculate the shape of the water surface. Hint: what is the shape of the equipotential surface due to gravity and the rotation about the axis?

2. An ice arena in Salem, OR (45 degrees N) is frictionless and 26 meters wide.

   (a) At what speed would a hockey puck have to move to travel in a circle that exactly fits in the ice arena?
   (b) How big would an oceanic ``inertial gyre'' at the same latitude off the Oregon coast be if the water velocity is 10 cm/sec?

3. A Hurricane in the Gulf of Mexico (25°N) is 500 km in diameter and has an "eye" 50 km in diameter. The wind just outside the eye is 200 km/hour while at the outer edge it is only 50 km/hour.

   (a) Compare the centrifugal force about the center of storm rotation to the corriolis force due to Earth's rotation at the outer edge of the storm.
   (b) Repeat this calculation just outside the eye.
   (c) Compare (a) and (b) – what can you learn about Hurricane physics?

Problem for 414 students only

4. An ice sheet of uniform thickness is tilted at angle θ with respect to the horizontal. Assuming that the ice is a Newtonian fluid, calculate the velocity variation with depth in the ice.

Problem for 514 students only

5. A glacier completely fills a straight valley of semi-circular cross-section. The valley is tilted at an angle θ with respect to horizontal.

   (a) Assuming that the glacier is a Newtonian fluid, calculate the velocity distribution in the ice. Hints: What happens to flow in a pipe if you cut it along a diagonal?
   (b) If instead of being Newtonian, the ice has a viscosity that decreases where the velocity shear is higher, describe qualitatively what happens to the variation of the velocity across the channel at the upper surface.