Geophysical Fluid Dynamics Laboratory - Research School of Earth Sciences

Rossby Waves

1) Fill the tank to a depth of ~20cm.

2) Bring the water to solid-body rotation at Ω = 3.0 rad/s.

3) Note the water depth at the outer edgewall, h_o.

4) Switch on the pump and observe the initiation of the cyclonic jet.

5) Once the motion has stabilised, begin recording with the overhead camera, and inject dye into the cyclonic jet.

6) Use the trajectory of the surface particles to estimate the cyclonic jet velocity U.

7) Wavelike structures appear in cyclonic jet. Estimate the wavelength λ of these structures.

8) Reset the tank and replace the fluid if necessary (if dye concentration is too high). Repeat this process with a different rotation rate Ω (=2.5, 3.5, 4.0 rad/s), making note of the water depth at the outer edgewall h_o, and the wavelength λ of the structures in the cyclonic jet.

Pedlosky (1987) provides an estimate for the wavelength λ_R of "standing" Rossby waves in a background zonal flow U and a meridional vorticity gradient β as,

$$\lambda_R = 2\pi\sqrt{\frac{U}{\beta}},$$

where the vorticity gradient can be approximated as,

$$\beta = \frac{2\Omega\left(h_o - h_i\right)}{Hr},$$

where h_i is the water depth at the centre of the tank, H (=15cm) is the reference water depth, and r is the radius of the tank.

Use your estimates of U and β to evaluate whether the structures you observe in the cyclonic jet are indeed Pedlosky's standing Rossby waves.