Geophysical Fluid Dynamics Laboratory - Research School of Earth Sciences

Baroclinic Instability

1) Fill the annulus to a depth of ~12cm. Note the temperature of the water with the thermal camera.

2) Bring the water to solid-body rotation at Ω = 0.5 rad/s.

3) Begin filming with the overhead thermal camera.

4) Set the temperature of the inner pot with the pumped thermal control bath.

5) Carefully release dye tracer at the inner edge of the annulus.

6) Observe the development of the warm current at the surface near the inner pot, noting the direction of flow.

7) In time, waves will begin to develop on the current, progressively growing into large amplitude cyclonic and anti-cyclonic eddies. Estimate the wavelength λ of these disturbances.

8) Reset the tank and return the pumped thermal control bath to lab temperature. Repeat this process with a different rotation rate, different inner pot temperature, and/or different water depth, making note of the wavelength λ.

The current velocity scales with that of a gravity current,

$$u \approx \sqrt{\frac{gH\Delta\rho}{\rho_0}},$$

where g is gravity, H is the water depth, $\Delta\rho$ is the density difference between the warm and ambient waters, and ρ_0 is the reference density (ρ_0 = 1000kg/m^3). The density difference can be approximated with the temperature difference, $\Delta\rho = \rho_0 \alpha \Delta T$, where α is the thermal expansion coefficient.

Use this scaling for the current velocity to estimate the Rossby deformation radius, $L_R = u/f$, where the Coriolis parameter $f = 2\Omega$, and compare this to the wavelength λ of the disturbances.