Problem set 3: GEF4500: Due: Nov. 11, 2010

Problem 1: Reflection at a northern wall.

Consider Rossby waves incident on an east-west wall, located at $y = 0$. Proceed as we did in class, with one incident and one reflected wave. What can you say about the reflected wave?

Hint: there are two possibilities, depending on the sign of l_r.

Problem 2: Basin waves.

We solved the Rossby wave problem on an infinite plane. Now consider what happens if there are solid walls. Take the one-dimensional version of the vorticity equation (set all derivatives in the y-direction to zero) with $U = 0$. Let $\psi = 0$ at $x = 0$ and $x = L$; this ensures that there is no flow into the walls. What are the solutions for ω and k?

Hint 1: Assume $\psi = A(x)cos(kx - \omega t)$, and impose the boundary conditions on A.

Hint 2: The coefficients of the sine and cosine terms should both be zero.

Hint 3: The solutions are *quantized* (have discrete values).

Problem 3: Is there really western intensification?

To convince ourselves of this, we can solve the Stommel problem in 1-D, as follows. Let the wind stress be given by:

$$\vec{\tau} = y\hat{i} \tag{1}$$

Write the vorticity equation following Stommel (linear, U=V=0, steady). Ignore variations in y, leaving a 1-D equation. Assume the domain goes from $x = 0$ to $x = L$, as before. Solve it.

Note that you should have two constants of integration. This will allow you to satisfy the boundary conditions $\psi = 0$ at $x = 0$ and $x = L$. Plot the meridional velocity $v(x)$. Assume that $(\beta\rho_0 D)^{-1} = 1$ and $L(r\rho_0 D)^{-1} = 10$. Where is the jet?