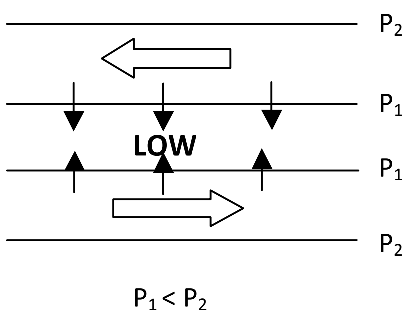
Sam Ahrendt

Lecture Summary for April 8th

We began lecture by reviewing the concepts that we learned about the Ekman solution on April 3, 2009. We discussed in the previous lecture that there is a component of the actual wind that flows down the pressure gradient and therefore there is mass transport across the isobars. In lecture we started by finding the mass transport term for a specific case and then found the general equations. The mass transport term for west to east transport (U) and the mass transport term for north to east transport (V) are shown below.

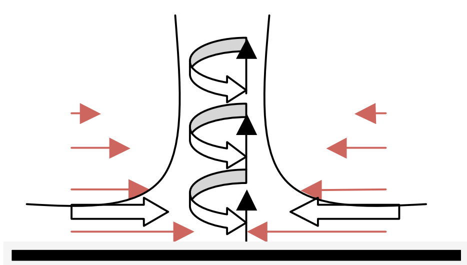
$$V = \int_0^\infty (v - v_g)dz = \frac{d}{2}(u_g - v_g) \qquad U = \int_0^\infty (u - u_g)dz = \frac{d}{2}(u_g + v_g)$$



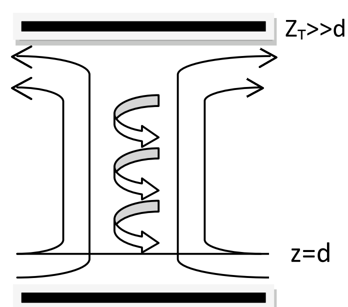
In the situation on the left mass continuity states that mass must go upward. In order to find a relationship between the mass transport terms and the mass continuity equation we integrated the mass continuity equation from 0 to infinity. After rearranging the terms we found that:

$$-w(\infty) = -\frac{d}{2}\left(\frac{\partial v_g}{\partial x} - \frac{\partial u_g}{\partial y}\right) = -\frac{d}{2}\zeta_g$$

Based on this we know that cyclonic circulation corresponds to upward motion and anti-cyclonic circulation corresponds to downward motion. This is referred to as "Ekman pumping". Following this we considered two situations, the upward motion of a steady state and upward motion considering the effects of the tropopause.



*Pink arrows show the magnitude of the ageostrophic wind. All other arrows show mass transport



Finally, we integrated the barotropic vorticity equation from d to the height of the tropopause (H). Since we already derived an expression for vertical velocity at the top of the boundary layer we substituted it in to get the equation:

$$\frac{D}{Dt}\zeta_g = -\frac{f\,d}{2}\zeta_g$$

From this we can come to the conclusion that vorticity decays exponentially with time.