Lecture Summary for April 3, 2009:
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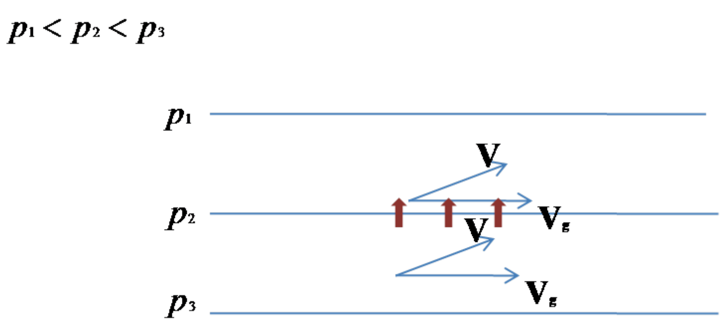
In class, we derived the Ekman Solution, which shows how the actual wind deviates from the geostrophic wind with height in the boundary layer. An important check we made on the solution was that at $z = 0$, both u and v are zero, and also as $z \rightarrow \infty$, $u \rightarrow u_g$ and $v \rightarrow v_g$.

The Ekman Solution:

$$u = \left[1 - e^{-z/d}\cos(z/d)\right]u_g + e^{-z/d}\sin(z/d)v_g$$

$$v = e^{-z/d}\sin(z/d)u_g + \left[1 - e^{-z/d}\cos(z/d)\right]v_g$$

A helpful example in class put these equations to use. We assumed that we were in the boundary layer, so that $0 < z < d$. We also assumed that the geostrophic wind was purely zonal, so that $u_g > 0$ and $v_g = 0$. The geostrophic wind vector is shown below. The actual wind, following the Ekman solution, is to the left of the geostrophic wind. Because there is a component of the actual wind down the pressure gradient, there will be mass transport across the isobars.



In the cyclonic circulation shown below, mass is transported toward a trough, and by mass continuity, must continue upward. This frictionally driven ascent is called Ekman pumping.