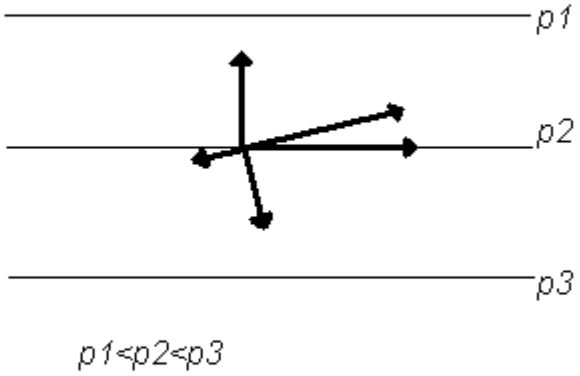
Lecture Summary for April 1st, 2009.
Matt Duerst



We began lecture by adding some additional material on to what we discussed in the previous lecture. The sub-geostrophic wind, angled slightly upward and pointing to the east in the diagram, is a balance of the geostrophic wind, the pressure gradient force, the coriolis force, and the small frictional force in the opposite direction.

The rest of lecture was dedicated to building up the concepts and equations to use for us to solve the Ekman problem. All wind and velocity variables are the Reynold's averages, so I will not mark them with an overbar for simplicity's sake. We first defined a few equations (with K being the eddy viscosity coefficient) as shown here.

$$(1)u'w' = -K\frac{du}{dz}$$

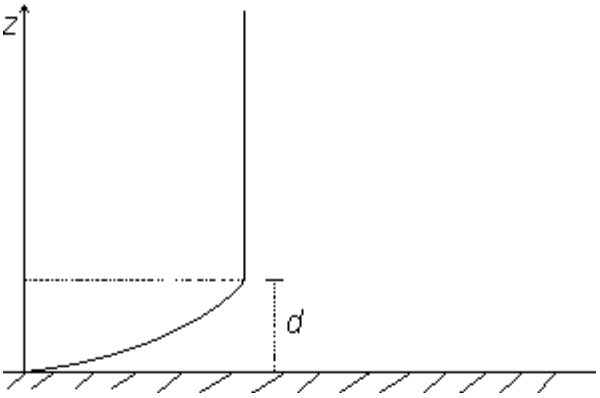
$$(2)v'w' = -K\frac{dv}{dz}$$

$$(3)f(v - v_g) = \frac{d}{dz}(K\frac{du}{dz}) = K\frac{d^2u}{dz^2}$$

$$(4)f(u - u_g) = \frac{d}{dz}(K\frac{dv}{dz}) = K\frac{d^2v}{dz^2}$$

The premise of the Ekman problem is to find the height, or depth, of the layer of the atmosphere that is effected by friction. In order to do that, we will make the following assumptions:

- $z \to \infty$
- Boussinesq approximation (constant density)
- u_g and v_g are known
- u=v=0 at z=0



To find the height *d* in the diagram, you use the Ekman number, which is the characteristic size of friction over the characteristic size of the coriolis force. Since we are looking for the layer where friction is important, we will set this ratio equal to 1 (so that the friction is just as large as the coriolis force). Using a scale analysis, you can determine the following:

$$EK = 1 = \frac{|K\frac{d^2u}{dz^2}|}{|fv|} = \frac{\frac{Ku}{d^2}}{fv} \sim \frac{K}{fd^2}$$

Solve for d, and you have your height (or depth) of the lower layer in the atmosphere that is affected by friction.