

ESE 134: Cloud and Boundary Layer Dynamics (due May 7):

Dry convective boundary layer. Consider a mixed layer (ML) model for a dry convective boundary layer.

1. Explain (qualitatively and in words) why entrainment at the top of the ML enhances ML growth.
2. If the entrainment flux of buoyancy b at the top of the ML at height h is given by

$$\overline{(w'b')}_{h+} = -\beta \overline{(w'b')}_0,$$

where $\overline{(w'b')}_0$ is the surface buoyancy flux, show that the buoyancy jump at the top of the ML is given by

$$\Delta b = \Gamma_b \frac{\beta h}{1 + 2\beta}$$

where $\Gamma_b = \partial_z b|_{h+}$ is the vertical gradient of b just above the ML.

3. Show that for a fixed surface buoyancy flux, the ML height grows diffusively with time t , i.e., $h \propto \sqrt{t}$. Can you give qualitative physical arguments why the growth is diffusive?
4. Discuss (briefly) some limitations of the ML model for the dry convective boundary layer.