ATM 612 Homework 1: due Monday, Sept. 18

1) Given the basic system of equations for deep convective motions being used in this class, what modifications must be made for the system to be Boussinesq? or anelastic? What physical assumptions go into these approximations? What types of atmospheric motions are eliminated by using these approximations?

2) The potential strength of convective updrafts and downdrafts is usually estimated just using the thermodynamic contributions to buoyancy; e.g.,

$$W_{max} = (2CAPE)^{1/2}$$

or,

$$W_{min} = (2DCAPE)^{1/2}$$

a) Derive this expression, and list the approximations which must be made to obtain it.

b) Precipitation loading can also be a significant contributor. What is the relative contribution of precipitation loading to the net acceleration experienced by an air parcel (e.g., how much water/ice is needed to equal the acceleration produced by a 1 K temperature excess/deficit?) Also, estimate the net impact water loading could have on maximum updraft/downdraft strength for a A) high-plains severe weather environment and B) a tropical environment.

3) The theoretical speed of propagation of a steady state density current (cold pool) in uniform flow is given by

$$C^2 = 2\int_0^H (-B)\,dz \ ,$$

a) How can one estimate the depth and strength of a cold pool (e.g., “C”) using standard surface observations (other than the obvious method of tracking the cold pool)? What assumptions must one make to accomplish this?

b) How might one use a sounding to estimate the maximum potential cold pool potential temperature deficit for a given environment?