Session 2

1. Derive the hypsometric equation:

$$Z_2 - Z_1 = -\frac{R}{g_0}\langle T\rangle \ln\frac{p_2}{p_1},$$

where $\langle T\rangle = \dfrac{\int_{p_1}^{p_2} T\,\mathrm{dln}p}{\int_{p_1}^{p_2} \mathrm{dln}p}$.

Suppose that the 1000-600 hPa thickness is 4200 m. Calculate the mean temperature in that layer. Calculate the thickness of the layer 1000-500 hPa for isothermal conditions with temperature of 273 K.

2. Suppose a 1-kg parcel of dry air is rising at a constant vertical velocity. If the parcel is being heated by radiation at the rate of 0.1 W/kg, what must the speed of rise be to maintain the parcel at a constant temperature?

3. Suppose an air parcel starts from rest at the 800 hPa level and rises vertically to 500 hPa while maintaining a constant 1 K temperature excess over the environment. Assuming that the mean temperature of the layer is 260 K, compute the energy released due to work of the buoyancy force. Assuming that all the released energy becomes the kinetic energy of the parcel what will be the vertical velocity at 500 hPa?