**Atm 622 Fall 2012**

**Problem Set #3**

1. For the unstable baroclinic wave which satisfies the conditions given in Problems 8.7 and 8.8 in Holton Ch. 8 (problems 3 and 4 of problem set #2) compute the energy conversion terms in Holton (8.37) and (8.38) and hence obtain the instantaneous rates of change of the perturbation kinetic and available potential energies.
2. Assume the existence of a Hadley type circulation between the equator and 30 oN. Let equatorial air rise adiabatically from 1000 hPa and 26 oC to 900 hPa where it becomes saturated and continues along the moist adiabat to 150 hPa and -76 oC. It then moves poleward and sinks losing heat radiatively to 280 hPa and -72oC after which is descends adiabatically to the surface. The air then returns along the surface (assumed to be 1000 hPa) while being heated to its starting point.

Calculate the energy released in the cycle by a unit mass of air. Express your answer in J kg-1. NOTE: It’s possible to work out this problem with the aid of an adiabatic chart. One cm2 on the DOD-WPC 9-16 Skew T-log p adiabatic chart is equivalent to 28.0 J kg-1.

If the overturning takes 6 months to complete, compare the rate of release of energy with the average input of solar radiation. Express your result in W m-2. Discuss the physical meaning of your results.

1. Compute the total potential energy per unit cross-section area for an atmosphere with an adiabatic lapse rate given that the temperature and pressure at the ground are p = 1000 hPa and T = 300 K, respectively.
2. Consider two air masses at the uniform potential temperature $θ\_{1}$= 320K and $θ\_{2}=340 K$ which are separated by a vertical partition as shown in Holton Fig. 8.7. Each air mass occupies a horizontal area of 104 m2 and extends from the surface ($p\_{0}=1000 hPa)$ to the top of the atmosphere. What is the available potential energy for this system? What fraction of the total potential energy is available in this case?