Major ASL840 April 30, 2008 MMarks 45 Time Two Hours

Q1. Write the equations of the classical Ekman layer and solve it to determine the height dependence of the departure of the wind field in the boundary layer using appropriate boundary conditions.

Q2. Write the thermodynamic energy equation $\frac{d}{dt}\ln\theta = \frac{1}{Cp}\frac{dQ}{dt}$, where θ is potential temperature, in terms of Φ, the geopotential.

Q3. What is inertial stability? In midlatitude, if the basic geostrophic flow is stably stratified and the zonal current has horizontal shear, find the stability conditions in the northern hemisphere.

Q4. The mean temperature in 750-500 mb layer decreases eastward by $3^{0}C$ / 100km. If the 750mb geostrophic wind is from the southeast at 20m sec^{-1}, what is the geostrophic wind speed and direction at 500mb? Let the Coriolis parameter, $f = 10^{-4} sec^{-1}$.

Q5. Derive the equation of continuity in isobaric and isentropic coordinate systems.

Q6. Compute the circulation using the natural coordinate system and derive the vertical component of vorticity

Q7. Calculate the 100 – 50k Pa thickness for isothermal conditions with temperature of 273K and 250K, respectively.

Q8.

(i) Why does air pressure decrease with height more rapidly in cold air than in warm air?

(ii) What is considered standard sea-level atmospheric pressure in millibars, in inches of mercury and in hectopascals?

(iii) Explain how rotation of the earth, wind speed and latitude influence the Coriolis force

(iv) Since there is always a strong vertical pressure gradient force in the atmosphere, why doesn't the air flow upward?

(v) Explain the effect surface friction has on wind speed and direction.

(vi) What is an adiabatic process?

(vii) Draw a figure showing the rate of change of the unit vector $\hat{i}$ following the motion.

(viii) Draw a chart showing relationship between vertical shear of the geostrophic wind and horizontal temperature gradients.

(ix) Draw a 500-mb geopotential field chart and suppose the winds are blowing parallel to the contour lines, show the regions of positive and negative advections of relative vorticity and planetary vorticity.

(x) Draw westerly flow over a topographic barrier in which depth of a column is a function of x, and also draw trajectory of a parcel in the x,y-plane.