ATM 645/445 Homework 5
Fall 2014, Given out: Wed Oct 1, 2014 Due: Fri Oct 10, 2014

1) (Problem 3.1 Holton) An aircraft flying a heading of 60˚ (i.e. 60˚ to the east of north) at air speed 200m/s moves relative to the ground due east (90˚) at 225 m/s. If the plane is flying at constant pressure, what is its rate of change in altitude (in meters per kilometer horizontal distance) assuming a steady pressure field, geostrophic winds and $f=10^{-4}$ s^{-1}.

2) (Problem 3.2 Holton) The actual wind is directed 30˚ to the right of the geostrophic wind. If the geostrophic wind is 20 m/s, what is the rate of change of wind speed? Let $f=10^{-4}$ s^{-1}.

3) (Problem 3.3 Holton) A tornado rotates with constant angular velocity ω. Show that the surface pressure at the center of the tornado is given by:

$$p = p_0 \exp\left(\frac{-\omega^2 r_0^2}{2RT}\right)$$

where p_0 is the surface pressure at a distance r_0 from the center and T is the temperature (assumed constant). If the temperature is 288K and the pressure and wind speed at 100 m from the center are 1000 hPa and 100 m/s, respectively, what is the central pressure?

4) (Problem 3.4 Holton) Calculate the geostrophic wind (m/s) on an isobaric surface for a geopotential height gradient of 100 m per 1000 km and compare with all possible gradient wind speeds for the same geopotential height gradient and a radius of curvature of +/- 500km. Let $f=10^{-4}$ s^{-1}.

5) (Problem 3.5 Holton) Determine the maximum possible ratio of the normal anticyclonic gradient wind speed to the geostrophic wind speed for the same pressure gradient.

6) (Problem 3.10 Holton) The mean temperature in the layer between 750 and 500 hPa decreases eastward by 3˚C per 100 km. IF the 750-hPa geostrophic wind is from the southeast at 20 m/s, what is the geostrophic wind speed and direction at 500 hPa? Let $f=10^{-4}$ s^{-1}.

7) (Problem 3.11 Holton) What is the mean temperature advection in the 750-500-hPa layer in Problem 6 (Holton 3.10)?

8) (Problem 3.18 Holton) Suppose that during the passage of a cyclonic storm the radius of curvature of the isobars is observed to be 800 km at a station where the wind is veering (turning clockwise) at a rate of 10˚ per hour. What is the radius of curvature of the trajectory for an air parcel that is passing over the station? (The wind speed is 20 m/s).

9) The divergence of the horizontal wind at various pressure levels above a given station is shown in the following table. Compute the vertical velocity at each level assuming an isothermal atmosphere with temperature 260K and letting ω=0 at 1000 hPa.

Pressure (hPa)	$\nabla \bullet \vec{V}(\times 10^{-5}\, s^{-1})$
1000	+0.9
850	+0.6
700	+0.3
500	0.0
300	-0.6
100	-1.0