Homework 4 ATM445/645 Fall 2014
Given out 23 Sept 2014, due 30 Sept 2014

1) (Holton problem 2.5) 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 10^{-1} W kg^{-1}, what must the speed of rise be to maintain the parcel at a constant temperature?

2) (Holton problem 2.6) Derive the expression for the density ρ that results when an air parcel initially at pressure p_s and density ρ_s expands adiabatically to pressure p.

3) (Holton problem 2.7) An air parcel that has a temperature of 20°C at the 1000-hPa level is lifted dry adiabatically. What is its density when it reaches the 500-hPa level?

4) (Holton problem 2.8) Suppose an air parcel starts from rest at the 800-hPa level and rises vertically to 500 hPa while maintaining a constant 1°C temperature excess over the environment. Assuming that the mean temperature of the 800- to 500-hPa layer is 260K, compute the energy released due to the work of the buoyancy force. Assuming that all the released energy is realized as kinetic energy of the parcel, what will the vertical velocity of the parcel be at 500 hPa?

5) (Holton problem 2.11) French scientists have developed a high-altitude balloon that remains at constant potential temperature as it circles the earth. Suppose such a balloon is in the lower equatorial stratosphere where the temperature is isothermal at 200K. If the balloon were displaced vertically from its equilibrium level by a small distance δz it would tend to oscillate about the equilibrium level. What is the period of this oscillation?

6) (Lynch & Cassano problem 4.6) Isolines of 1000 to 500 hPa thickness are often drawn on surface weather maps using a contour interval of 60m. What is the corresponding layer mean temperature interval?

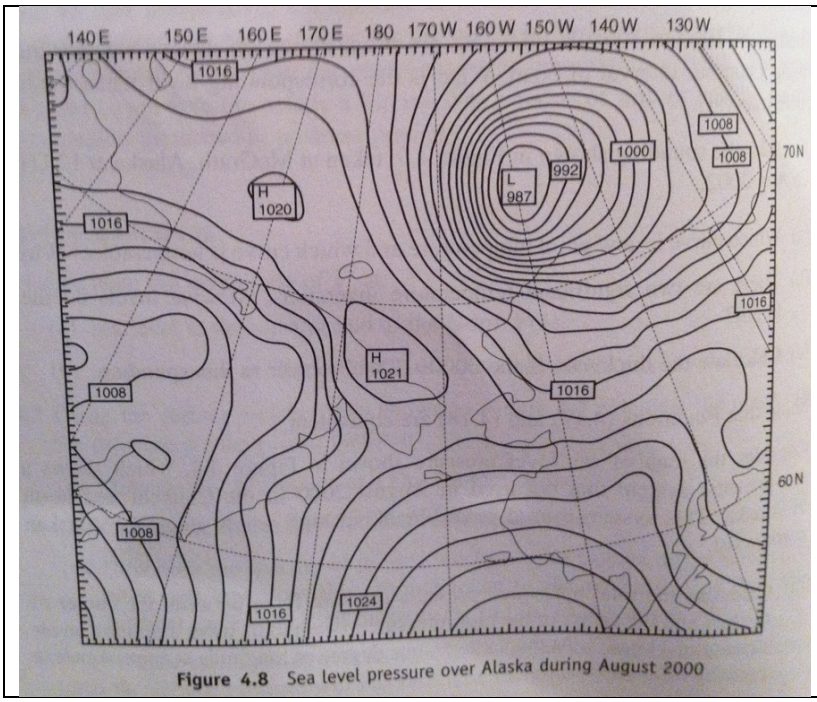

Figure 4.8 Sea level pressure over Alaska during August 2000

7) (Lynch & Cassano problem 4.9) Consider the map of sea level pressure shown in the above Figure (4.8), which shows a low-pressure system that occurred in August 2000 in the Chukchi Sea north of Alaska. This system caused record-breaking high winds along the Alaskan north coast.

a) Calculate the total horizontal pressure gradient force between the center of the low and the center of the high-pressure system to its west, assuming an air density of 1 kg m^{-3}. At this latitude, one degree of longitude is approximately equivalent to 28 km.

b) A 1 kg parcel of air starts from rest at 175°W, 75°N. In what direction wouyld it be accelerated if it was under the influence along of the above pressure field? How many hours does it take for the parcel to achieve a speed of 35 m s^{-1}?

c) Suppose the high-pressure system was displaced 50 km further to the west. Without performing an additional calculation, would the parcel take more or less time to reach this speed? Why?