Homework 5 Solutions

1.) You are given ELR = 7ºC/km, RH=100%, and the ground-level temperature is 15ºC. To figure out if a parcel raised from the ground to 1km will be able to rise further on its own, you must realize that if the RH=100% then the parcel must go up at the MALR(6ºC/km). So, if the Environment loses 7ºC/km, at 1km it has a temperature of 8ºC. The parcel on the other hand loses only 6ºC/km, so at 1km it has a temperature of 15-6=9ºC. The parcel is therefore warmer than the environmental air around it so it will rise on its own.

2.) You are given the following in the problem: ELR = 8ºC/km, surface temperature =10ºC, surface dewpoint temperature = 2ºC/km. Since the ELR(8ºC/km) is between the MALR(6ºC/km) and the DALR(10ºC/km), the air is conditionally unstable. Since the temperature of your parcel at ground level is not equal to the dew point temperature, it has to be unsaturated, so it will rise at the DALR until its temperature equals the dewpoint temperature. When this occurs you have found the LCL. You also need to remember that the dew point temperature decreases by 2ºC/km. We will solve this graphically.

Clearly the parcel temperature equals the dewpoint temperature at 1000m so that is the level of the LCL. Also, the temperature at that level for the parcel and the dewpoint both equal 0ºC. Also, the environment at 1000m has lost 8ºC compared to the ground level so it is at 2ºC.

b.) Lets add to the graph to make it valid up to 3000m. Now that the parcel temp.=dew point temp it will now rise at the MALR (6ºC/km).
Since the parcel was at 0°C at 1000m and loses 6°C per 1000m now, we can now see that its temperature at 3000m is –12°C.

c.) The LFC is where the environmental temperature line crosses the parcel’s line. This occurs at exactly 2000m according to our picture.

3.) Now if the parcel is at –12°C at the top of the mountain, and the moisture leaves the parcel, it will then rise or fall at the DALR of 10°C/km. So if it goes down 3000m it gains 30°C on the descent. –12+30= 18°C. So the temperature of the parcel on the east side of the mountain at ground level is 18°C. This is shown below:

4.) Adding some ice nuclei to a cloud will increase the number of points for droplets to form on. Basically the ice nuclei “steal” water from the millions of water droplets surrounding the ice nuclei. This causes the ice nuclei to grow into a droplet, while the water droplets disintegrate. However, if we add too many ice nuclei, there aren’t enough water droplets for each ice nuclei to “steal” water from so they will not grow very large, and hence not fall out of the cloud as precipitation. The process by which the ice nuclei “steals” by is known as the Bergeron process.