AOS 100/101
Spring 2018

SOLUTIONS
HOMEWORK #5

1) Upon being lifted, saturated Parcel A will experience condensation of some of its 10 g of water vapor. The condensation will release latent heat into the air parcel which will mitigate against the expansion cooling. Parcel B is almost saturated at the surface but not quite. Therefore, when it is lifted it will start to cool at the dry adiabatic rate UNTIL its relative humidity has reached 100%. Further lifting after that point will result in condensation as in Parcel A. Since Parcel B has more water vapor, there is more latent heat release possible in it to counteract the expansion cooling. As a consequence, Parcel B will not have cooled as much by the time it gets to 1 km.

2) As soon as the parcels are lifted, they start to cool by expansion. Since both are unsaturated at the surface (i.e. their dewpoint depressions are greater than zero), they will both cool at the dry adiabatic rate of 10C km-1. This cooling will serve to increase the relative humidity of the parcels and will continue at the dry rate until the parcels are saturated. At that point, condensation and cloud formation will begin. Since the parcel on Day Two has a smaller dewpoint depression at the surface, that means it starts with a higher relative humidity than the parcel on Day One. Consequently, the parcel on Day Two needn't cool as much as the parcel on Day One to reach saturation. Therefore, the parcel on Day Two will reach saturation at a lower elevation and the cloudbase on Day Two will be lower.

3) Since the cloud liquid water is the same on both days but the number of CCN on which that water is distributed is different on the two days, the important difference will be in the number and size of the droplets on the two days. Since the cloud on Day One has fewer CCN, it will have larger droplets in its initial distribution than the cloud on Day Two. As a result, collision and coalescence of the larger droplets in the cloud on Day One will more likely produce a precipitation sized particle.

4) This question involves consideration of buoyancy and stability. You are told by your friend that the temperature is 4C at 2 km. That means, with a surface temperature of 20C, the observed lapse rate is 8C km-1. Since the air is saturated at the surface, it will cool at ~6C km-1 (the moist adiabatic rate) upon being lifted to higher elevation. As a result, the lifted parcel will always be warmer than its environment and will be positively buoyant. Such positive buoyancy leads to strong updrafts that can fuel a thunderstorm. I would certainly forecast thunderstorms for the afternoon.