AOS 100/101
Spring 2017

SOLUTIONS
HOMEWORK #5

1)

Both parcels will cool at their respective moist adiabatic lapse rates. The moist rate actually varies a bit depending on the amount of moisture in the air. The greater the amount of moisture, the lesser the rate of cooling. Parcel A, with a specific humidity of 10 g kg^{-1} will cool at a greater rate than parcel B since, upon being lifted, parcel A has *less* water vapor available for condensation and so *less* latent heat is released into parcel A as it is lifted. This lesser amount of latent heat released results in a greater rate of cooling for parcel A.

2)

Clouds will begin to form when the relative humidity (RH) reaches 100%. Since on both days the surface parcels of air are originally unsaturated, you must determine which one will become saturated fastest upon being lifted. Since both are unsaturated, they will both cool at the dry adiabatic lapse rate upon being lifted. On Day 1, more cooling has to occur in order to reach the dewpoint than on Day 2. Thus, the lifted air parcels on Day 2 will reach saturation more quickly (at a lower elevation) than the parcels on Day 1. As a consequence, the cloud base on Day 1 will be higher than on Day 2.

3)

The parcel could cool at the dry adiabatic rate first since it could begin its ascent while unsaturated. As it cools upon moving to higher elevation, it would eventually become saturated (i.e. its RH would be 100%). As soon as this occurs, any additional ascent will result in cooling at the moist adiabatic rate since the expansion cooling will be counteracted by latent heat release into the parcel as a consequence of condensation of the original water vapor. As the lifting continues, it is possible that the parcel will condense all of the original water vapor into liquid. Additional lifting after the point where all the vapor has already condensed will no longer be accompanied by latent heat release so the parcel will begin to cool at the dry adiabatic rate again.

4)

Saturated air with a temperature of 15 °C at the surface will cool at the moist adiabatic lapse rate of ~6 °C km^{-1} upon being lifted. Therefore, the lifted parcel's temperature will be 9°C at 1 km. You are told that the environmental lapse rate (what is *observed*) over Madison that day is 7°C km^{-1}. Thus, the temperature of the environment is 8°C at 1 km above the ground. Since the lifted parcel's temperature is 9°C at that level and the environment's is 8°C, the parcel is *positively buoyant* and will rise further on its own.