AOS 100/101
Spring 2019

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 B, with a specific humidity of 20 g kg^{-1} (meaning it has more water vapor in it than A) will experience more latent heat release while it rises than Parcel A. Therefore parcel B will cool at a lesser rate than Parcel A. since, upon being lifted, parcel B has *more* water vapor available for condensation and so *more* latent heat is released into parcel B as it is lifted. This greater amount of latent heat released results in a lesser rate of cooling for parcel B.

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 2 will be lower than on Day 1.

3) Since the temperature and dewpoint are the same at both the ocean and 20 miles inland, the presence of the haze at the ocean cannot be a result of a higher relative humidity there. Recall that haze is a tiny liquid water droplet and so condensation must occur to form it. In the atmosphere, this condensation occurs on some object (which we call a cloud condensation nuclei, CCN). Salt particles form fantastic nuclei for the formation of haze since salt is soluble in water. A small solution droplet of water and salt can survive in unsaturated air. Since the ocean is full of salt water, it is not uncommon for the air near the ocean to be full of microscopic salt particles. These particles serve as CCN for the haze droplets and so the presence of the salt water and salt particles in the air is what explains this common observation.

4) Unsaturated air with a temperature of 15 °C at the surface will cool at the dry adiabatic lapse rate of 10 °C km^{-1} upon being lifted. Therefore, the lifted parcel's temperature will be 5°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 5°C at that level and the environment's is 8°C, the parcel is *negatively buoyant* and will sink back to its origin.