Homework-2: Thermodynamics-dry air-1

March 3rd, 2015, Due March 10th, 2015 in class

Explain or interpret the following:

1. Which of the following pairs of quantities are conserved when unsaturated air is lifted: potential temperature and mixing ratio, potential temperature and saturation mixing ratio?

2. If water vapor comprises 1% of the volume of the air (i.e., if it accounts for 1% of the molecules in air), what is the virtual temperature correction?

3. Typical hot air balloons used on sightseeing flights attain volumes of 3000 m³. A typical gross weight (balloon, basket, fuel and passengers, but not the air in the balloon) on such a balloon flight is 600 kg. If the ground temperature is 20°C, the lapse rate is zero, and the balloon is in hydrostatic equilibrium at a cruising altitude of 900 hPa, determine the temperature of the air inside the balloon.

4. A cheap aneroid barometer aboard a radiosonde is calibrated to the correct surface air pressure when the balloon leaves the ground, but it experiences a systematic drift toward erroneously low pressure readings. By the time the radiosonde reaches the 500 hPa level, the reading is low by 5 hPa level (i.e., it reads 495 hPa when it should read 500 hPa). Estimate the resulting error in the 500 hPa height. Assume a surface temperature of 10°C and an average temperature lapse rate of 7°C km⁻¹. Assume the radiosonde is released from sea level and that the error in the pressure reading is proportional to the height of the radiosonde above sea level (which, from eqn. (3.29), makes it nearly proportional to ln p). Also, assume that the average decrease of pressure with height is 1 hPa per 11 m of rise between sea level and 500 hPa.