12.815

**Atmospheric Radiation and Convection**

Problem Set 5

1. The cabins of aircraft must be continuously ventilated for the health of passengers. Suppose a jet is flying at 200 hPa where the ambient temperature is  . The ambient air is brought into the cabin where the pressure is maintained at 850 hPa. How much heat energy must be supplied to each kilogram of air to bring it to a temperature of ? Take the gas constant of the air to be  and its heat capacity at constant pressure to be  .
2. The breath we exhale is nearly at body temperature () and has a relative humidity of about . It gradually mixes with ambient air. What is the maximum temperature of the ambient air that would result in some condensation of water vapor assuming that the ambient relative humidity is a) 90% or b) 10%? Assume that the ambient pressure is 1000 hPa and use equation 4.4.14 in *“Atmospheric Convection”* (available on the course Stellar site) for the saturation vapor pressure. The ratio of the molecular weight of water to that of the other constituents of air is 0.622. You will need a calculator or computational software such as MATLAB to do this.
3. In middle latitudes, air flows generally from west to east. Suppose air just to the west of California has a temperature of , a pressure of 1000 hPa, and is saturated with water vapor. It ascends the western slopes of the Sierra Nevada range to a minimum pressure of 600 hPa. Assume that all the condensed water falls out as rain, ignore the ice phase, and assume that the ascent is moist adiabatic. Then the air descends along the eastern slopes of the Sierra to a pressure of 950 hPa. Assume the descent is dry adiabatic. What will be the temperature of the air after it descends? Use the gas constants given in Problem 1 above and take  and the heat capacity of liquid water  .