Unit 8 ATM401, ATM601 and CHEM601

Review of thermodynamics

Application, analysis, and evaluation

1. Undergraduate students: Calculate the potential temperature at 1013.25 hPa, 500 hPa, 100 hPa, and 10 hPa assuming that the air temperatures at these pressure levels are 15^oC, -10^oC, -55^oC, and -30^oC, respectively. Comment on the behavior of the potential temperature with height. Discuss how this profile relates to the material we covered in unit 1.

2. Undergraduate students: An air parcel has the following properties: 1000hPa, 30^oC, r=14g/kg. Calculate the RH, the mixing ratio at saturation, specific mixing ratio q, the virtual temperature T_v, the dewpoint temperature, potential temperature. Discuss your results.

3. All students: Calculate the pressure in $3000m$ height in the case that, at a height of $0m$, air pressure is 1013 hPa and the column between these altitudes has (a) a constant air temperature of 0^oC, (b) a constant density of $1kg/m^3$. How are these atmospheres called?

4. All students: Determine the work done, the change in internal energy, and the heat required for freezing of $10^{-3}\,kg$ of water at 0^oC and normal pressure.

5. Graduate students: Normand's rule states that you can determine the wet-bulb temperature by lifting an air parcel dry adiabatically to its LCL and then follow the moist adiabate back down to the parcel's actual pressure level. Determine the highest air temperature for with the wet-bulb temperature is at zero degree Celsius.

6. Graduate students: A plant releases hot dry air with a temperature of 20^oC. To what height will the plume ascend if the ambient air temperature varies with height according to (a) $T(z) = (-10-6z)^oC$ and (b) $T(z) = (-10+z)^oC$ where z is in km. Comment on your results.

7. Graduate students: Determine the dewpoint temperature corresponding to a mixing ratio of $4g/kg$ at pressure $1013.25hPa$ and temperature 10^oC.

8. ATM601 students: Potential temperature increases with height. Show that the atmosphere has a static stability with respect to dry air.