UCF Physics: AST 6165 Planetary Atmospheres

Spring 2020 Homework 3, DUE Tuesday, 4 February 2020

Reading for this assignment: Andrews, sections 2.5 – 2.7.
Use the values in file earthatm.

Problems:

1. (Derivation: 12 points, each calculation: 4 points) Andrews, problem 2.3.
2. (10 points) Andrews 2.4
3. (a) (10 points) Using the standard atmosphere in the file `earthatm`, extract/calculate T, θ, N, the oscillation period, Γ, p, and ρ in the atmosphere over the range of this file. Make it big and use colors and a non-obscuring legend to distinguish the curves. Plot them on the same plot. Truncate it at $z = 120$ km on the vertical axis. Leave T and θ unscaled. Crop the plot horizontally so that θ runs off the right side in the middle of the mesosphere. Scale the rest by round numbers (100, 0.003, etc.) so that they occupy most of the width of the plot. Include the scale factors in the legend. Plot big so you can see everything.
   (b) (5 points) Using the plot, consider the stratosphere at 30 km and 8.848 km (Mt. Everest). What are the similarities and differences between these altitudes? (Everest is actually climbed on warmer days, typically a balmy -22° C, see http://jap.physiology.org/content/86/3/1062.full).
   (c) (5 points) A mole of nitroglycerine, on ignition, heats its chemical products to 682 K at sea level. Assuming adibatic expansion and no entrainment of environmental air, calculate how high this plume rises. Give the height of the last layer it passes through in `earthatm`. Do not interpolate.
4. (5×2 points = 10 points) Consider a parcel of air that is saturated at T = -5°C and $p = 500$ mbar. Calculate the values of the saturation vapor pressure, mixing ratio, specific humidity, and equivalent potential temperature. You will need to find (perhaps on the web) an empirical expression for the saturation vapor pressure. What would the relative humidity of the same parcel be if the temperature were T = -2° C?