ATM 240 – Fall 2019

Problem set #4 20 pts Due: 24 October 2019

1. **Fun with fluxes.**

You are provided with these values* of [v] and [q] at 10 N as a function of pressure (p):

[v]	p (mb)	[q] (gm/kg)	[v]	p	[q] (gm/kg)
-3.0	1000	20	-2.6	900	8
-1.0	800	2	0	700	0
0	600	0	0.2	500	0
1.0	400	0	1.8	300	0
3.1	200	0	1.0	100	0

Assume that there is no net transfer of mass above the 100 mb level.

a. (4 pts) Write down the general formula and then calculate the net flux of mass in a column of unit horizontal area across latitude 10 N between p=1000 and p=100 mb. You may use a trapezoidal rule formula to approximate the integral. (Hint: the flux of mass/unit area has units units =kg/{s m})

b. (2 pts) Now obtain the net flux of mass across the latitude circle at 10N. Hint: use the thin-shell approximation for the atmosphere (the height of the 'wall' at 10N << radius of the Earth). Express your answer in kg/s.

c. (6 pts) Assume: i) that the net flux of mass is spread evenly over the region between 10 N and the pole and ii) that the average mass flux over 90 days is half the rate found above. What is the average change of surface pressure over the region north of 10 N after those 90 days? The number you obtain will be unrealistically large. What would you suspect is wrong and why is that not surprising?

d. (4 pts) Calculate the latent heat flux (in units of W) across 10N given the information above. Hints: recall (3.3), where $L=2.4 \times 10^6$ J/kg and $g=9.81$ m/s^2. Assume linear variation between measurements; hence trapezoidal rule approximation to an integral. Your answer should be similar to fig. 3.15b datum.

e. (4 pts) From Fig. 3.15 one estimates the LHF (latent heat flux) across 10N is LHF= -8×10^{14} W, and LHF= $+1 \times 10^{15}$ W at 2 S. What is the annual and horizontal average rainfall for the region from 2S to 10N? Assume there are 365 days in one year. Hints: "rainfall" is actually a rain rate (=RR). The density of water is 10^3 kg/m^3.

NOTE: all homework is to be done by you as an INDIVIDUAL: no 'group' efforts, please.
For written answers, please use a word processor, so that penmanship is not an issue.
Equations and derivations can be *neatly* hand-written.
Any plot must be completely and unambiguously labeled, including title and axes.

*Values read in part from figure 3.16 of Grotjahn (1993) book.