ATM 240 – Fall 2019

Problem set #6 30 pts Due: 7 November 2019

1. Below is a list of the annual mean cloud amounts (Ca) in different latitude bands as measured in a particular year. Plots created below should look roughly similar to various plots in the book. Using a spreadsheet or a computer program is expected; please submit the electronic file and printed output.

a. (3 pts) Calculate the global average cloud amount ("Ca"). Hint: weight the amounts by the area of the latitude band. Hint: a "Ca" value is essentially percentage coverage of the sky by cloud.

Ca	lats	Ca	lats	Ca	lats
83.5	80-90 N	77	70-80 N	69.5	60-70 N
73	50-60 N	69.5	40-50 N	61	30-40 N
49	20-30 N	52.5	10-20 N	66	0-10 N
55.5	0-10 S	57	10-20 S	57	20-30 S
70.5	30-40 S	84	40-50 S	89	50-60 S
82	60-70 S	59.5	70-80 S	40	80-90 S

b. (2 pts) plot cloud amount Ca as a function of latitude

c. (2 pts) Compare your plot to albedo information given in Figure 3.7a of the (2020) Chapter 3.

d. (9 pts) Incoming solar radiation is approximated by: $\boldsymbol{S} = 165 + 260*\cos\varphi$. Calculate the following at the 18 latitudinal belts. Ignore scattering and absorption by the atmosphere. Absorption (=**A**) has these values:

A	lats	A	lats	A	lats
37	80-90 N	77	70-80 N	113	60-70 N
155	50-60 N	193	40-50 N	231	30-40 N
279	20-30 N	301	10-20 N	303	0-10 N
321	0-10 S	311	10-20 S	292	20-30 S
254	30-40 S	203	40-50 S	161	50-60 S
119	60-70 S	81	70-80 S	31	80-90 S

i. determine the amount of radiation (=I_{FW}) reaching the ground for completely reflective clouds
ii. determine the amount of radiation (=I_{FC3}) reaching the ground for clouds that are 40% reflective and assuming they are not absorptive. (Completely reflective is 100%)
iii. determine the total albedo given the *S* and A data

e. (5 pts) Plot *S*, I_{FW}, I_{FC3}, A as a function of latitude

f. (4 pts) Calculate the global average albedo given S and A. Calculate the global average non-cloud albedo from I_{FC3} and A. (Again, weight by area in each latitude band.)

g. (2 pts) Compare your results with figure: 3.6a of the (2020) Chapter 3. Which of I_{FW} or I_{FC3} seems more realistic and why?

2. (3 pts) **Spherical coordinates practice**. Beginning with the total derivative in its usual form, derive the total derivative in flux form using pressure as the vertical coordinate. Show all steps.

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.