ATM 240 – Fall 2008

Problem set #1 29 pts Due: 2 October 2008

1. **Barotropic instability** of atmospheric flows to the formation of large scale eddies. In Grotjahn (2007, Dyn. Atmos. Oceans, 43:3-15) a meridional derivative of Q in equation (2) provides an estimate of the necessary condition for barotropic instability of the atmosphere. This problem estimates that condition using values for the month of _____

a. (4 pts) Download the values of 250 hPa data for U for grid points at latitudes 5N to 75N using a 2.5 degree interval from this location: http://atm.ucdavis.edu/~grotjahn/course/atm240/hwk08-1/. Once obtained, print and plot the data as a function of latitude from 5N to 75N. (29 values).

b. (6 pts) Use second order, centered, finite differences to obtain Q at grid points from 10N to 70N. Print and plot the values over this latitude range. (25 values)

c. (6 pts) Use second order centered differences to obtain Q_y at the grid points from 12.5N to 67.5N. Print and plot the values over this latitude range. (23 values)

Hints:
i) you must download latitudes (in radians) – and print next to the requested print values.
ii) note that $\beta = 1/a\ \partial f/\partial \varphi$ where φ is latitude in radians and $a \sim 6.4 \times 10^6$ m.
iii) second order differences include: $f_{x\,at\,pt\,i} = \dfrac{f_{i+1} - f_{i-1}}{2\,\Delta x}$ $\quad f_{xx\,at\,pt\,i} = \dfrac{f_{i+1} + f_{i-1} - 2\,f_i}{\Delta x^2}$
iv) solve the problem using a FORTRAN or C program or with a spreadsheet (e.g. Excel)

2. **Baroclinic instability** of atmospheric flows to the formation of large scale eddies. In Grotjahn (2007, Dyn. Atmos. Oceans, 43:3-15) the inequality (4) provides an estimate of the necessary condition for baroclinic instability of the atmosphere. Note error in (4): the constant is 10x too big, should be 62.25. Estimate the stability condition using values for the month of _____

a. (7 pts) Download the values of 700 and 250 hPa data for U and θ for grid points at latitudes 5N to 75N using a 2.5 degree interval from this location: http://atm.ucdavis.edu/~grotjahn/course/atm240/hwk08-1/. Once obtained, print the data and plot (on one chart) the data as a function of latitude from 5N to 75N. (4x29 values)

b. (4 pts) Using 250 and 700 hPa data for U and θ evaluate each side of the inequality (4) in Grotjahn (2007). Then print both sides of the inequality. Plot both sides of the inequality (4) on the same graph. (2x29 values)

c. (2 pts) If the vertical wind shear (LHS of eqn. 4) exceeds the static stability (RHS of eqn. 4) anywhere, indicate those latitudes.

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.