LAB ASSIGNMENT #9

(due Thursday, October 13)
10 points

Learning Objectives:
Upon completion of this lab, you will be able to:
- Plot the individual forcing terms for the QG omega equation.
- Understand their contribution to the observed vertical motion field.
- Employ and discover the utility of the Q-vector as a diagnostic for vertical motion.

This assignment involves examination of vertical motion employing QG diagnostics to investigate the forcing for precipitation occurring over the Great Lakes region today. In preparation for your upcoming case studies, your plots should be ***presentation quality***. This means, for example, that the **contours should be smooth** (you can set contur=3/1), the **titles clear and succinct** with all the proper information, the **color schemes neat and not messy** (e.g. use appropriate cints, fints etc.). Use an appropriate garea and projection, along with the following parameters for ***all*** plots in this assignment:

```
GDFILE    = /weather/data/garp/hds/16100512_eta.gem
gdattim = f42
garea = wi-
proj = utm
```

1. Synoptic Overview
Create a **three-panel** plot containing the following fields (hand in the plot and the script).

<u>Upper-left:</u> 500 hPa geostrophic relative vorticity (color fills), 500 hPa geopotential heights (contours), and 500 hPa geostrophic wind barbs (knots)

<u>Upper-right</u>: 700 hPa temperature (contours), 700 hPa geostrophic temperature advection [contours with positive (negative) values solid (dashed)], and 700 hPa geopotential height (contours).

- For geostrophic temperature advection, remember to scale your gfunc appropriately.

<u>Lower-left</u>: Sea-level pressure every 4 hPa (contours)

2. The traditional QG omega equation
Create a **four-panel** plot containing the following fields (hand in the plot and the script). In each panel, omit the zero contour, contour positive values with a solid line, and contour negative values with a dashed line. For negative omega, only plot the positive values.

<u>Upper left</u>: Negative Laplacian of temperature advection at 700 hPa
<u>Upper right</u>: Differential geostrophic vorticity advection between 900 hPa and 500 hPa
<u>Lower left</u>: Q-vectors (arrows) and Q-vector convergence (color fills) in the 600-800hPa layer
<u>Lower right</u>: Negative omega (ascent) at 700 hPa (color fills) and 700-hPa heights (contours)

Address the following questions:

1) *Qualitatively*, how does the temperature advection field compare with that of the negative Laplacian of temperature advection? Discuss some of the physical reasoning behind your findings.

2) Are there regions in which cancellation occurs between the two terms in the traditional QG omega equation? Where? In general, is it possible to diagnose the upward vertical motion (negative omega) successfully if you only consider one of the two terms from the traditional QG omega equation on its own?

3) Compare the Q-vector convergence field with the vertical velocity field. Describe how well the Q-vector convergence and upward vertical motion correspond, and, in particular, make note of locations where the two fields do not correspond all that well. Why is the Q-vector so much more effective than consideration of the two individual forcing terms on their own?

4) Why might Q-vector convergence not completely account for the plotted upward vertical motion (e.g. what did we neglect as part of deriving the QG omega equation)?