ATM 400: Synoptic Meteorology I
Lab #3: Plotting the QG omega equation with Python
Due: Tuesday, October 8

For your second Python-based lab, you will create and interpret plots depicting the leading forcing functions of the QG omega (ω) equation using the NCEP–NCAR Reanalysis data set for 0000 UTC 13 and 14 March 1993.

You will make four maps (two maps for each of the two times above), plotting the following:

1) 850-hPa geopotential heights (solid contours) and geostrophic absolute vorticity (filled)

2) 700-hPa geopotential heights (solid contours) and 500–850-hPa differential geostrophic absolute vorticity advection by the geostrophic wind (filled)

To begin, login to the JupyterLab at *https://ash.atmos.albany.edu:8000/user/<netid>/lab*. I strongly recommend duplicating the notebook you created for Lab #1 and changing/adding to it as required to make the plots above (i.e., *cp Lab1.ipynb Lab3.ipynb*).

To help you with your plots, please consult the following example notebooks that Kevin went through with you in ATM 350: */spare11/atm350/common/apr11/04_GriddedDiagnostics_Frontogenesis-CFSR.ipynb*, */spare11/atm350/common/apr11/01_GriddedDiagnostics_TempAdvection-CFSR.ipynb*, and */spare11/atm350/common/apr11/03_GriddedDiagnostics_DivergenceIsotachs-CFSR.ipynb*.

Also very helpful will be the following links to MetPy's diagnostic functions/meteorological calculations, units library, and example plots/code:

https://unidata.github.io/MetPy/latest/api/generated/metpy.calc.html
https://unidata.github.io/MetPy/latest/tutorials/unit_tutorial.html?highlight=units
https://unidata.github.io/python-gallery/examples/index.html

Questions:

1. Evaluate the assumption from class that $\vec{\nabla}_p^2\left(-\vec{V}_g \bullet \vec{\nabla}T\right) \propto \vec{V}_g \bullet \vec{\nabla}T$ using the maps at *https://www.atmos.albany.edu/daes/atmclasses/atm400/Homework_files/TempAdvection_Laplacian.png*; i.e., does the Laplacian of temperature advection look qualitatively the same as the temperature advection from Lab #2? Why, or why not? (Note: The scaling of the plots is different: 10^{-16} for the top panels [Laplacian] and 10^{-5} for the bottom panels [advection].)

2. Focusing only on the troughs associated with Superstorm 1993, where do the leading two forcing functions of the QG ω equation predict vertical motion will occur? Make sure to describe each term spatially, and note where the terms add and cancel.

3. Comparing the QG prediction of vertical motion from #2 to the actual omega (plots at *https://www.atmos.albany.edu/daes/atmclasses/atm400/Homework_files/Omega.pdf* or make your own for a 10 point bonus!), how successful is the QG ω equation? If there are significant differences between the forecast and reality, what may be causing these differences to appear?