Lab 3: More Python

Objective: We will continue learning how to use Python. In today's lab, we will provide you with a GFS file that is already in NETCDF format. Your primary objective will be to reproduce the plots that you made by hand in lab 1.

Materials: Your laptop, Enthought Python, and access to the Internet. It will not be necessary to log into the SoM machines if you have a laptop, however if you do not have a laptop you can also complete this lab on any of the SoM machines in room 5720. **You will not be able to complete this lab via remote access to the SoM machines**.

Procedure:

1) Downloading the data
   (a) We have already downloaded and converted a GFS analysis file to NETCDF format. All you need to do is download it from `http://weather.ou.edu/~metr4424/files/`. Click on the file named `gfs_4_20120811_1200_000.nc`. It is big, so be patient if it takes a few minutes to download it.
   (b) The GFS netcdf file has the naming convention `gfs_4_yyyymmdd_hh00_fhr.nc` where `yyyy` is the four-digit year, `mm` is the 2-digit month, `dd` is the two-digit day, `hh` is the 2-digit hour, and `fhr` is the forecast hour. Note that if it is an analysis, `fhr` will be '000', and if it is a 6-hour forecast, `fhr` will be '006'. Given this naming convention, fill in the valid time of this GFS file below:
      (i) Year:
      (ii) Month:
      (iii) Day:
      (iv) Hour:
2) Updating your Python script repository
   (a) Go to `https://github.com/metr4424/classcode` and make sure you have the latest of the following scripts:
      `weather_modules.py`
      `utilities_modules.py`
      `plot_gfs_fields_forlab.py`

3) Set up the plotting script
   (a) Open up `plot_gfs_fields_forlab.py`. Examine the user options, near the top of the file, under the comment "Set user options."
   (b) Set `date_string` to the time that your netcdf GFS analysis file is valid. Note it is in `yyyymmddhh` format, where `yyyy` is the four-digit year, `mm` is the 2-digit month, `dd` is the two-digit day, and `hh` is the 2-digit hour.
   (c) Set `fpath` the the directory where your GFS netcdf file is located. Do not include the name of the GFS file itself, as the script will automatically extract this information from what you entered in `date_string` above.
   (d) Set `level_option` to 50000. This is the isobaric level that you desire to plot, in Pascals.
   (e) Make sure that `map_projection = 'lcc'`
4) 500 hPa heights
   (a) Set `level_option` to 50000. This is the isobaric level that you desire to plot, in Pascals.

(b) Set `plot_barbs = 'true'`.
(c) Set `plot_contours = 'true'`
(d) Run the script by typing `python plot_gfs_fields_forlab.py`
(e) If successful, you will get a plot on your screen, and an image in your directory called `gfs_500hPa_analysis.png`. This is the GFS model's analysis of 500 hPa heights valid at the same time as your hand analysis in lab 1. In addition to 500 hPa height contours, wind barbs and isotherms are also plotted. Note that you only used observations to create your analysis in lab 1. In a model analysis, a combination of observations and estimates from a short term forecast are used to create a continuous snapshot of the atmospheric state on the model's numerical grid. The model's numerical grid has a grid point for every latitude and longitude across the entire globe, as well as 26 vertical pressure levels.
(f) Recalling from memory your hand drawn analyses from lab 1, how does this compare? Describe any differences and explain why you think there are differences, or why you think there are not differences. If you need help recalling the observations, the 500 hPa plot can be obtained at `http://weather.ou.edu/~scavallo/classes/metr_4424/labs/20120811_12_500.pdf`.
(g) Would you describe the low height center located over the eastern Great Lakes as barotropic, equivalent barotropic, or baroclinic, or is there not enough information to determine? Why? Can you determine whether you expect this low to be strengthening? Why or why not?

5) 300 hPa heights
(a) Set `level_option` to 30000.
(b) Set `plot_barbs = 'false'`.
(c) Set `plot_contours = 'true'`
(d) Set `figname = "gfs_300hPa_analysis"`
(e) Run the script by typing `python plot_gfs_fields_forlab.py`
(f) If successful, you will get a plot on your screen, and an image in your directory called `gfs_300hPa_analysis.png`. This plot shows GFS model analysis contours of 300 hPa geopotential heights and isotachs.
(g) Recalling from memory your hand drawn analyses from lab 1, how does this compare? Describe any differences and explain why you think there are differences, or why you think there are not differences. Be sure to include the 2 jet streaks (a jet streak is a local wind maximum in the jet stream) located upstream and downstream of the trough axis in the eastern United States in your discussion. If you need help recalling the observations, the 300 hPa plot can be obtained at `http://weather.ou.edu/~scavallo/classes/metr_4424/labs/20120811_12_300.pdf`.
(h) Specifically regarding the jet streak that is located from southeastern Minnesota to southern Missouri (where 300 hPa winds are greater than 70 knots), discuss whether you shaded this same region on your hand analysis? Why or why not?
(i) Compare the location of the low height center located over the eastern Great Lakes to the 500 hPa analysis. Are they near the same locations? Is this consistent with your answer to part (g) of the 500 hPa height section?

6) Your own plot
(a) Suppose now that you want to see what the 850 hPa heights and isotherms from this GFS analysis look like.
(b) Set `level_option` to 85000.
(c) Set `plot_barbs = 'false'`.

(d) Set `plot_contours = 'true'`
(e) Set `figname = "gfs_850hPa_analysis"`
(f) Run the script by typing `python plot_gfs_fields_forlab.py`
(g) If successful, you will have gotten a blank plot. This is because the default contour intervals are based expected height values at 500 hPa. Set `base_cntr` to an appropriate value for 850 hPa. If necessary, refer to your handout from lab 1 that provides suggested contour values to use in analyzing constant pressure charts.
(h) Suppose you want to see more detail, so you desire to change the contour interval from 60 meters to 30 meters. Do this and plot it. Hint: Look for the line that says "Contour interval on surfaces other than 500 hPa or 300 hPa.")
(i) Note that your isotherms also did not show up on your plot. Adjust the script so that they will be plotted whenever you are plotting on a pressure surface greater than or equal to 500 hPa. Hint: How could you change the statement `elif (level_option == 50000)`? Another hint: the `==` is called a logical operator, which checks to see if `level_option` is equal to a certain value. Other logical operators are `<=`, meaning less than or equal to, and `>=`, meaning greater than or equal to.
(j) Is the 850 hPa low center over the Great Lakes near the same location as at 500 hPa and 300 hPa? Does this change your answer to part (g) of the 500 hPa height section?
(k) From this plot, how can you determine locations of cold and warm advection?

Print and hand in all plots for this lab with the answers to the questions above. This lab is due at the beginning of class on Wednesday September 5.