AOSC 470/600 Synoptic Meteorology 1 - Python Tutorial 1 - Intro/Basic Plot

In addition to the slide decks available on the course web page, the supplementary python scripts from the NASA training can be found on halo at:
/data/op/dkleist/aosc600/pythonTraining/Examples/

First, we are going to log in to the department server and set up your workspace.

1. Open a terminal on the Mac
   Command + spacebar, type terminal, press return

2. Log into the AOSC server, halo over SSH:
   ssh -Y username@halo.atmos.umd.edu

3. Create a folder for class and this tutorial:
   mkdir -p AOSC600/tutorial (-p will create both directories if the top level doesn't exist)

4. Copy all necessary files to your newly created directory
   cp -r /data/op/dkleist/aosc600/tutorial/* AOSC600/tutorial/. (* is a wildcard, will copy all files in that directory, /. says to just copy it all to that location)

5. Change to the tutorial directory:
   cd AOSC600/tutorial

Let's create a simple contour plot of 500mb heights from a netCDF file

1. Take a look at the file first using one of the netCDF command line utilities, ncview or ncdump. ncview is graphical, ncdump is text-only.

   ncview /data/op/dkleist/aosc600/data/oct2010/cfsr/pgbhnl.gdas.2010102712.nc

   Try to plot a 2D field and see some of the functionality of ncview. Next try "ncdump"

   ncdump -h <filename> (-h flag only shows headers and not data values)

   We can use these tools to find the names of the variables (as well as get an idea of what the data looks like). If you want the ability to page through, try sending the ncdump command through a second command called "more:

   ncdump -h <filename> | more

   Then simply hit the space bar to page through (or escape to exit). Alternatively, you can force the output to a text file in your local directory with the following command:

   ncdump -h <filename> > filename.ncdump.txt

You will now have a text file called filename.ncdump.txt in your directly. Take a look at the contents using the "more" command or a text editor (gedit, emacs, or vi).

2. Next, open the example script in a text editor (you can use emacs or vi if you are familiar, else feel free to try gedit or nedit which are better for novices)

   gedit contour.py & (the & allows the terminal to still be in use while the other window is open)

3. All things within brackets (<INSERT THING HERE>) are to be edited/modified by you! Make sure you remove the brackets when editing!
   Things to edit include:

   a. your name at the top of the script
   b. the path to the file we'll be plotting '**/data/op/dkleist/aosc600/data/oct2010/cfsr/pgbhnl.gdas.2010102712.nc'**
   c. the variable we wish to plot **'HGT_500mb'**
   d. add your name to the title **'YOUR NAME - 500mb tutorial plot'**
   e. save figure to a filename **'500mb1.png'**

4. Save the modified script and go back to the terminal prompt

5. Run the python script: **python contour.py**

6. If no errors, success! You've just made your first Python plot! If there is an error message, it should give some clue as to the problem(s) with your modified script

   Now let's copy the image to your Mac so that it can be pasted into a Word document* (note: may not need to do so in instructional lab, as your home directory should be accessible on the Mac)

   Your plot should look something like this:
   http://www.aosc.umd.edu/~dkleist/aosc600/tutorial/500mb_hgt.png

1. Open another terminal window

2. Use SCP to copy from the Linux server to your local machine:
   Scp username@gw.atmos.umd.edu:~/AOSC600/tutorial/500mb1.png ~/Desktop/.

3. The image should now be on your desktop!

4. Also, feel free to attempt to contour other variables for other levels by modifying the "contour.py" template and by perusing the file with ncdump to see what is available.

Now let's get crazy!

We are going to plot surface temperature as well as wind barbs.

1. Again, look at the file, but this time it's NARR data rather than CFSR
   ncview /data/op/dkleist/aosc600/data/oct2010/narr/narr-a_221_20101027_1200_000.nc

   See if you can figure out the variable names in the netcdf file for winds and temperature near the surface (using ncview or ncdump).

2. This time, we are going to start with temp_wind.py, and modify it.
   gedit temp_wind.py &

3. Once again, all things within brackets (<INSERT THING HERE>) are to be edited/modified by you! Make sure you remove the brackets when editing!

   Things to edit include:
   a. your name at the top of the script
   b. the path to the file we'll be plotting
      '/data/op/dkleist/aosc600/data/oct2010/narr/narr-a_221_20101027_1200_000.nc'
   c. the variables we wish to plot
      'TMP_221_SFC','U_GRD_221_HTGL','V_GRD_221_HTGL'
      (SFC is for surface, HTGL is for height above ground level)
   d. add your name to the title **'YOUR NAME - SFC T 10m wind'**
   e. color bar label (the color fill will be for surface temperatures.

4. Save figure to a name **'T_10mwind.png'**

5. Save the modified script and go back to the terminal prompt

6. Run the python script: **python temp_wind.py**

Your plot should look something like this:
http://www.aosc.umd.edu/~dkleist/aosc600/tutorial/sfc_winds_temp.png

Now let's try some fields that are derived from the file contents (i.e. include some computation). For this, we will compute the instantaneous 850 mb temperature advection: $-\vec{V} \bullet \nabla T$.

1. This time, we are going to start with adv850.py, and modify it.

gedit adv850.py &

2. Enter the filename (same as before), plot title, and plot name.

3. This time, the variable names have already been entered. Unlike last time, we will be using pressure level (isobaric) instead of surface data. This is why you'll see ISBL instead of SFC or HTGL. Take note for how the gradient of the temperature is computed using the numpy gradient calculation.

4. Run the python script: **python adv850.py**

You should end up with a plot similar to this:
http://www.aosc.umd.edu/~dkleist/aosc600/tutorial/850_tadvection.png

Finally, let's try to compute something that requires doing a difference between two different times requiring the opening of two different files. For this, let's look at the surface pressure tendency at the very end of this significant cyclone. Here, we will plot the mean sea level pressure (contours) and also the surface pressure tendency (color fill)

1. This time, we are going to start with 850adv.py, and modify it.
   gedit p_tend.py &

2. As before, enter the usual things like name, filename (this time there will be two files), plot title, and plot name. Here, let's compute the tendency from 00z on the 27th until 12z on the 27th. The two files you need to open are

   '/data/op/dkleist/aosc600/data/oct2010/narr/narr-a_221_20101027_0000_000.nc'
   '/data/op/dkleist/aosc600/data/oct2010/narr/narr-a_221_20101027_1200_000.nc'

3. Run the python script: **python p_tend.py**

You should end up with a figure similar to this:
http://www.aosc.umd.edu/~dkleist/aosc600/tutorial/psfc_tend.png

That's it! These four scripts should provide you a solid basis to be able to perform other diagnostic and create graphics for map discussion or case studies using netcdf data. Please be sure to check out the supplemental tutorial slides provided in class and try some things out on your own.