Lab 2: Introduction to Python

Objective: We will begin learning how to use Python. In today's lab, you will learn how to download Global Forecasting System (GFS) GRIB2 formatted data from the Internet, convert it to Netcdf format, read the file contents, and make a plot.

Materials: Access to an SoM machine and allocated user space, including remote access if you have a laptop or personal computer.

Procedure:

1) Setting up your environment
   (a) Log into a Linux machine in NWC 5720 (somclass01...somclass24).
   (b) Go to your home directory by typing `cd ~`.
   (c) Type `ls -a`. If you have a file called '.cshrc', then copy it to '.cshrc_save'
   (d) Use a text editor to either create a `.cshrc` file or edit your existing one and add the following lines:
   ```
   setenv NCARG_ROOT /usr/local/ncl
   set path = (/usr/local/ncl/bin /usr/local/epd/bin $path)
   ```
   The above allows you to use NCAR graphics (used with NCL commands) and points to the version of Python we will be using this semester.
   (e) Type 'source .cshrc' to make the changes go into effect, and make sure there are no error messages.
   (f) Type 'which python' and make sure you are linking to a version of Python that says 'epd' in it.
2) Setting up a Python working directory
   (a) Create a python directory on your SoM user space. For instance, from your home directory:
   ```
   >cd ~
   >mkdir scripts
   >mkdir data
   >cd scripts
   >mkdir python_scripts
   ```

   (b) Explore your directory structure. You should be able to follow the steps below:
   ```
   >cd ~
   >pwd
   >/home/username
   >cd scripts
   >ls
    python_scripts
   >cd ..
   >cd data
   ```

   (c) Download the following scripts from our class Github repository (`https://github.com/metr4424`) into your `python_scripts` directory:
   ```
   weather_modules.py
   ```

```
utilities_modules.py
get_gfs_gribfile.py
plot_gfs_field_example.py
```

    (d) If you have permission problems, set the permissions by typing `chmod 755 [filename.py]`.

3) Obtaining data

    (a) Open the Python script `get_gfs_gribfile.py` using a text editor

    (b) In the 'user options' section, set 'datenow' to the most recent GFS analysis time. Note that 'datenow' is in `yyyymmddhh` format, where `yyyy` is the year, `mm` is the month, `dd` is the day, and `hh` is the hour.

    (c) Make sure 'fcst_hr' is set to '000' to specify that it is an analysis and not a forecast.

    (d) Set 'datadir' to a path in YOUR user allocation (i.e. $+$**/home/username/data/**).

    (e) Run the script by typing `python get_gfs_gribfile.py` from the directory where the python script is located. If successful, you will have a file with a `.grib2` extension in 'datadir'

    (f) Change the name of the grib2 file, so that is looks like the following: `gfs_4_yyyymmdd_hh00_fhr.grib2`, where `fhr` is the forecast hour ('000' means analysis, '006' means 6-hour forecast, etc.).

    (g) Convert the file to netcdf format. To do this, type `ncl_convert2nc [filename.grib2]` where you need to replace `filename.grib2` with the exact filename of the GFS analysis file you just named.

    (h) To view the dimensions and variable names of a netcdf file, you can type:
`ncdump -h [filename.nc] >& gfs_fields`
Then use a text editor to open `gfs_fields` so you can view the netcdf file information. What name is used to denote pressure on isobaric surfaces? How many isobaric levels are there?

    (i) Now find the field that contains geopotential height on isobaric surfaces. What is it it called? What are its dimensions?

    (j) Using `gfs_fields`, fill in Table 3 below.

4) Plotting

    (a) Open `plot_gfs_field_example.py` with a text editor.

    (b) Edit 'fpath' so that it points to the GFS file you downloaded above.

    (c) Set 'level_option' to 50000, and set 'date_string' to the time of the GFS analysis file.

    (d) Run the script. If successful, it will plot 500 hPa height contours over the globe centered on North America. You will also have an image saved as 'example.png'. Print this and hand it in with the rest of your lab when finished.

    (e) Can you infer the direction and relative magnitude of the winds that correspond to these heights? If so, how? If not, why?

    (f) Write a paragraph discussing the 500 hPa height pattern. Be sure to point out specific geographic locations, and use the proper units when describing specific values.

This lab is due at the beginning of class on Wednesday 8/29.

Desired field	Variable name	Number of dimensions	Number of vertical levels	North-south dimension size	East-west dimension size
Latitude					
Longitude					
Isobaric levels					
Geopotential height on isobaric levels					
Temperature on isobaric levels					
U-wind height on isobaric levels					
V-wind on isobaric levels					
Tropopause temperature					
10-meter V-wind					
Sea level pressure					

Table 1: Fill in this table!