

Mesoscale Meteorology: Assignment #6

Due 13 April 2017

This assignment is a case study of the 9-11 January 2015 lake-effect snow event in proximity to Lake Erie in New York and Pennsylvania. You will use GrADS to create data visualizations from the 1200 UTC 9 January 2015 North American Mesoscale, or NAM, model forecast. Data are available every 3 h out to 84 h, although we will only use data out to 36 h (0000 UTC 11 January 2015). The necessary data and supporting files are available at:

<http://derecho.math.uwm.edu/classes/Meso/assignments/A6/>

As with Assignments 4 and 5, open a terminal window and use `wget` to transfer each file from this address to your local machine. Some helpful notes follow; the assignment itself starts on pg. 3.

- a. To change the time of the data that you are displaying, use the 'set time' command, i.e.,

```
set time 00z10jan2015
```

Note the format of this date and time stamp: a two-digit hour followed by a z (for Zulu, or UTC, time), a two-digit date, a three-digit month code, and a four-digit year.

- b. Recall the order in which data must be displayed: shaded fields first (including running the color bar script, if necessary), then contoured fields, then barb or vector fields.
- c. To add a title to an image you have created, use the 'draw title' command, i.e.,

```
draw title 850 hPa temperature, height, wind
```

Titles should be relatively short so that they fit on the line atop the plotted region.

- d. Two commands that you may find helpful when creating your images:

```
set display color white  
set mpdset hires
```

In order, these will set the background color to white (instead of the default black) and tell GrADS to use a high-resolution map data set with state and lake borders.

- e. When drawing wind barbs or vectors, you can use the skip command to display them only at every other, every third, etc. grid point, i.e.,

```
display skip(ugrdprs,2,2);skip(vgrdprs,2,2)
```

would display wind barbs (assuming `set gxout barb` has previously been issued) every other grid point in both the x and y directions (assuming an x - y plot). These numbers need not be identical, i.e.,

```
display skip(ugrdprs,3,1);skip(vgrdprs,3,1)
```

would display wind barbs every third grid point in the first direction and every grid point in the second direction. This is particularly useful for vertical cross-sections, where grid points are less closely-packed in the vertical than in the horizontal.

- f. To get a list of all variables contained in the NAM dataset, once you have opened nam.ctl in GrADS, issue the following command:

```
query file
```

This will provide a long list of variables, with their name in the first column and description (including default units) after each line's ** entry. You are responsible for unit conversions where a problem asks you to display a field in units other than their defaults. In case it is helpful, note that units of kg m^{-2} are equivalent to mm and that units of gpm are equivalent to m (i.e., you do not need to divide by the value of g to convert these to m).

- g. The accumulated precipitation variable apcpsfc (units: mm) only considers precipitation in the most recent 3 h period. To obtain a true accumulated precipitation forecast, you will need to make use of the sum command, i.e.,

```
display sum(apcpsfc,time=12z09jan2015,time=12z10jan2015)
```

would determine accumulated precipitation over the first 24 h of the model forecast. Note that this variable is liquid or liquid-equivalent; in general, snowfall ratios average 15:1 for this event; i.e., 1" of liquid-equivalent precipitation equals 15" of snow.

- h. To display a field in a single color other than its default, use the 'set ccolor' command, i.e.,

```
set ccolor 0
```

If you previously set the background color to white, this command will make the contours or wind barbs/vectors display in black. A listing of the available colors can be found at:

<http://cola.gmu.edu/grads/gadoc/16colors.html>

- i. Once you have created and saved an image, to move to the next time, simply run 'clear' (without the surrounding quotes). This will clear the display screen. It will *not* change the latitude, longitude, or vertical ranges that you set for the previous plot. You only need to set these again for your next plot if one or more of them change from the previous plot.
- j. Please refer to the descriptions for Assignments 4 and 5 to refresh your memory on GrADS-related commands that are not described below or have been introduced above.

1. (25 pts) Please create each of the following maps valid at 0000 UTC 10 January 2015 over the region 40-47°N, 78-85°W. Include each map with your completed assignment, and ensure that each has an appropriate title.
 - a. 2-m temperature (°F, shaded every 3°F from -6-21°F), sea level pressure (hPa, contours every 4 hPa from 1012-1036 hPa), and 10-m wind (kt, black barbs every 3rd grid point).
 - b. Temperature (°C, shaded every 3°C with values evenly divisible by three), height (m, contours every 30 m with values evenly divisible by 30), and wind (kt, black barbs every 3rd grid point) at each of 925 hPa, 850 hPa, and 700 hPa (as separate images).

Describe the influence of the lake on the temperature, pressure/height, and wind fields at each level, particularly with respect to the upwind and downwind sides of the lake, and how it varies with height. To what level can a lake influence upon the overlying air be conclusively identified? Describe your supporting evidence.

2. (15 pts) At 0000 UTC 10 January 2015, create a vertical cross-section between 1000-700 hPa with a logarithmic vertical axis from 79-83°W along 42.25°N of temperature (°C, shaded every 3°C from -24° to -9°C), height anomaly from the average between 83-79°W (m, contours every 2 m from -6-12 m), and wind (kt, black barbs every 3rd horizontal grid point and every vertical grid point). Ensure that it your chart is appropriately titled, and include it with your completed assignment.

To what level can a lake influence upon the overlying air be conclusively identified on this cross-section? Describe your supporting evidence. How does this compare to your answer to Question #1?

3. (60 pts) On Figure 1, please create a 36 h accumulated snowfall forecast valid at 0000 UTC 11 January 2015. This forecast should include the following isopleths: 1", 3", 6", 9", and 12" as appropriate. Prepare a discussion to accompany this forecast. In this discussion, you should discuss the factors discussed in class that control lake-effect band structure and accumulated precipitation that results from those bands. With your response, please include a *few* (i.e., not one, ten, or more) representative figures, and work them into your discussion as appropriate. I recommend that you decide what fields you wish to examine, and at what times you wish to examine them, *before* you start creating charts – work smarter, not harder!

This forecast should **not** be the NAM-forecast accumulated precipitation or a reproduction of the storm-total observations available online from the National Weather Service. Your grade on this question will be determined primarily by your discussion rather than forecast accuracy. I suggest that you organize your discussion into sections, one each discussing environmental conditions important for the forecast followed by a synthesis on which your forecast is based.

If you are interested in creating model-forecast skew T - $\ln p$ diagrams to support your analysis and discussion, a file named `plotskew.gs` is provided in the directory for this assignment. This

routine may be called inside GrADS once you have set the latitude and longitude to a specific point and the vertical range to, for example, 1000-200 hPa. It requires four inputs: temperature (in °C), dew point temperature (in °C), wind speed (in kt), and wind direction (in deg). Only the first of these variables are available by default in the NAM data, and even then it is in K; others must be computed.

For instance, to plot a skew T - $\ln p$ diagram at 0000 UTC 10 January 2015 at Buffalo, NY (42.88°N, 78.88°W), the following commands might be used. Note that the define td statement should be on a single line, not on the two as it appears below, and you can safely ignore any 'Data Request Warning: Request is completely outside file limits' errors that may appear when you define this variable.

```
set time 00z10jan2015
    set lat 42.88
    set lon -78.88
    set lev 1000 200
define tmp=tmpprs-273.15
define td=243.04*(log(rhprs/100)+((17.625*tmp)/(243.04+tmp)))/(17.625-log(rhprs/100)-
    ((17.625*tmp)/(243.04+tmp)))
    define wspd=mag(ugrdprs,vgrdprs)*1.94
define wdir=atan2(-ugrdprs,-vgrdprs)*180.0/3.14159265
run plotskew.gs tmp td wspd wdir
```

After creating this plot, you may title and create a hard copy of it if desired. If you desire to create a skew T - $\ln p$ diagram for a new location after creating one for another location, you will need to re-define the tmp, td, wspd, and wdir variables above after changing locations.

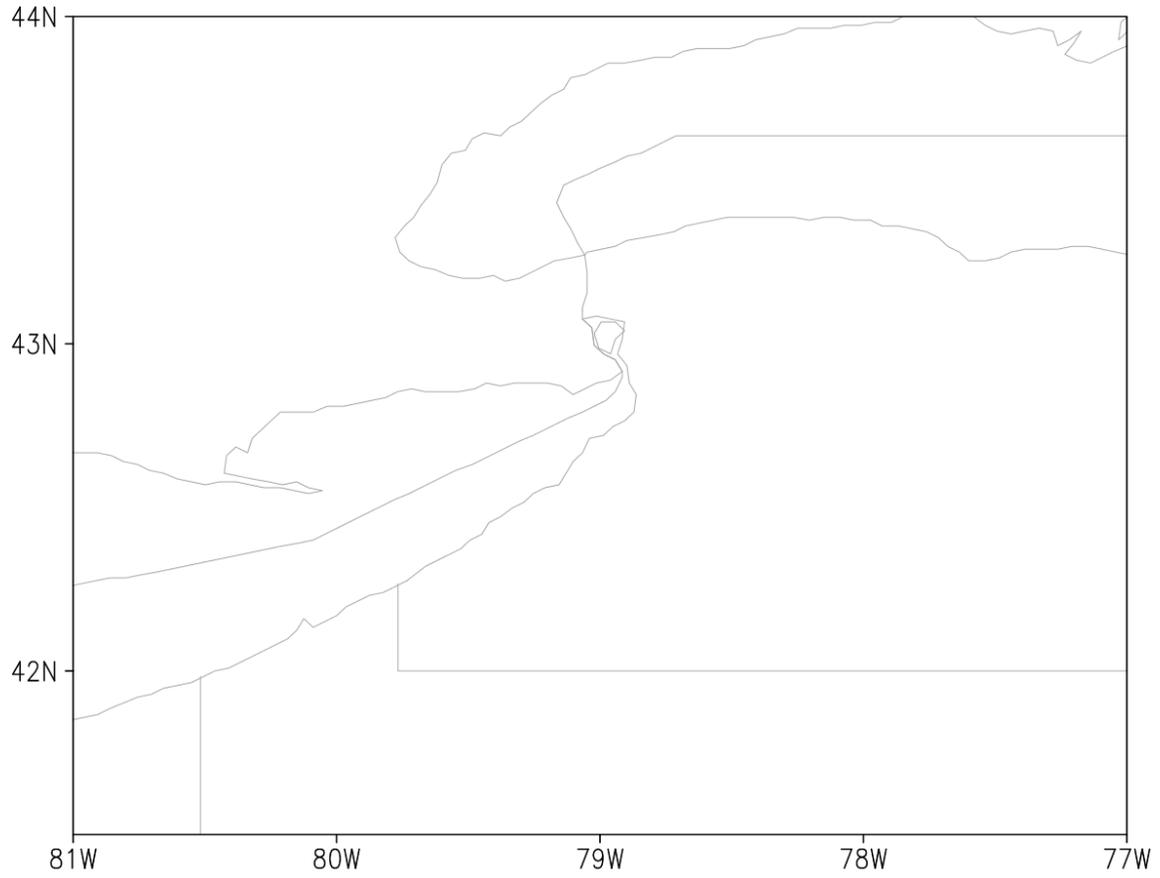


Figure 1. Blank map of western New York, southern Ontario, and northwestern Pennsylvania, for use with Question #3.