

## Tropical Meteorology – Homework #5

**Due Date:** Thursday, 19 April 2018 (via e-mail)

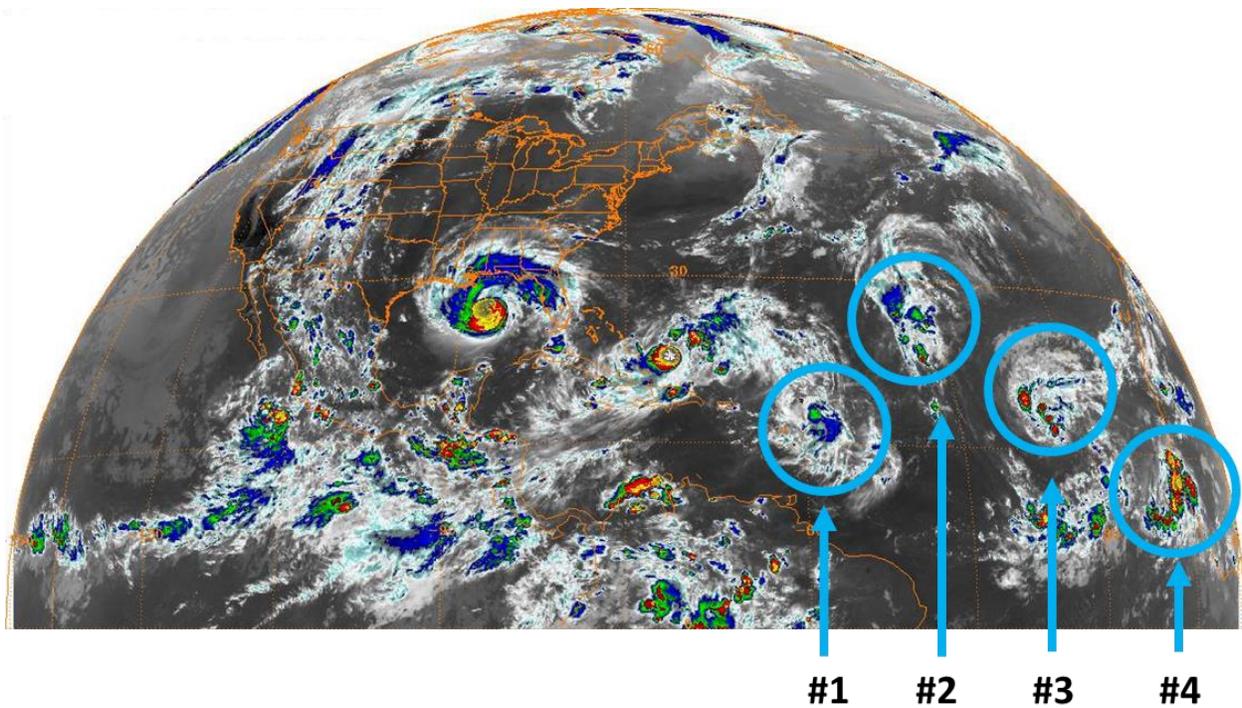
**Learning Objectives:** In this assignment, you will *apply* your knowledge about tropical cyclone development to forecast the 48-h development likelihood for four Atlantic basin disturbances from September 2008.

You are a Senior Hurricane Specialist at the National Hurricane Center tasked with creating this forecast cycle's 48-h [Graphical Tropical Cyclone Outlook](#). An example from the 2017 season can be obtained by clicking the linked text above. In this assignment, you are forecasting development potential for four distances at 0000 UTC 1 September 2008, as highlighted in Figure 1.

To assist in making this forecast, you are to use the Grid Analysis and Display System, or GrADS, to create plots of analysis (0-h) and forecast (12-, 24-, 36-, and 48-h) fields roughly corresponding to the Gray (1968) necessary conditions: sea-surface temperature, total column precipitable water (as a proxy for tropospheric relative humidity), 850-200 hPa vertical wind shear, 850 hPa absolute vorticity, and 600 hPa vertical motion (as a proxy for conditional instability). The data needed for this assignment are available at <http://derecho.math.uwm.edu/classes/TropMet/assignments/hw5/>. Log on to one of the Macs in EMS W434 and download each of these files to a new directory.

Create figures at each of the requested times for each of the requested fields. You can place up to three fields on a single image so long as a different display type (e.g., contours, shading, and barbs) are used for each variable. All shaded fields should include a color bar, which can be obtained by running the `cbarn.gs` script immediately after displaying the shaded field. Narrow the region over which data are plotted to 0-60°N, 110-0°W. Title each plot with the forecast hour and the field(s) shown with units. The end of this assignment contains some helpful hints regarding getting started with GrADS and using it to display some of the requested fields.

For this assignment, assign a “probability of development” for each disturbance, from 0-100% (in multiples of 10%). Most importantly, describe the physical reasoning behind your forecast, making reference to your figures as necessary. Note that your answer will be evaluated primarily based on your discussion and not the precise percentages you assign to each disturbance. *Do not simply regurgitate the National Hurricane Center's archived forecast for this date and time!* Include all figures with your completed assignment.



**Figure 1.** Brighter colors on this image indicate colder cloud tops. Please refer to the disturbance numbers listed above in your write-up for each disturbance. To aid in interpreting the subsequent analyses, the approximate location of each disturbance is given below:

- **Disturbance 1:** 17°N, 59°W
- **Disturbance 2:** 28°N, 46°W
- **Disturbance 3:** 18°N, 35°W
- **Disturbance 4:** 12°N, 18°W

## Helping Hints for Using GrADS

Start by opening a terminal window by clicking on the Launchpad icon, then Other, then Terminal. Navigate into the directory into which you downloaded the files for this assignment by using `cd` to change directories. Open GrADS by typing `grads` into the terminal and hitting enter. When it asks you for landscape vs. portrait mode, hit enter to select the default of landscape mode.

The included `gfs.grib2`, `gfs.grib2.idx`, and `gfs.ctl` files contain the data, data index, and a descriptor file for reading the data. You will open the `gfs.ctl` file in GrADS to visualize the data in `gfs.grib2`. This descriptor file does just that: describes the data, including dimensions ( $x, y, p, t$ ) and available variables. You can open this file in a text editor (e.g., `'nano gfs.ctl'` in the terminal, without quotes) or query its contents in GrADS (`'open gfs.ctl'`, then `'query file'`, each without quotes).

Some helpful commands follow:

- To open a file: `open gfs.ctl`
- To set the display window: `set lat ### ##`  
`set lon ### ##`  
where each `###` are replaced by a number (positive values = Northern, Eastern hemisphere).
- To use a high-resolution map: `set mpdset hires`
- To use a white display: `set display color white`  
`clear`
- To change the display type: `set gxout option`  
(see <http://cola.gmu.edu/grads/gadoc/gradcomdsetgxout.html> for a full list of options)
- To set contour/shading levels: `set clevs ### ## ##`  
where each `###` (can be more or less than three) is replaced by a desired contour level
- To display a field: `display variable`  
(see the `gfs.ctl` file for a list of available variables and their units)
- To clear the screen: `clear`
- To print an image to file: `gxprint filename`  
where `<filename>` is replaced by the desired filename.
- To change the vertical level: `set lev ###`  
where the `###` is replaced by a desired level (in hPa)
- To change the time: `set time HHZDDmonYYYY`  
where HH = two-digit hour, DD = two-digit day, mon = three-letter month, YYYY = four-digit year; all times are in Zulu (Z) or UTC time, not local time.
- To display barbed/vectored fields: `display ucomp;vcomp`  
where `ucomp` and `vcomp` are replaced by the appropriate fields (e.g., *u*-wind, *u*-component of vertical wind shear, etc.).
- To draw a title: `draw title text`  
(can be on up to two lines with a separating `\` - i.e., `draw title line one\line two`)

- To display calculated fields: `display (tmp2m-273.15)*1.8+32`  
(as an example of converting tmp2m from K to °F)
- To display a difference between levels: `display u(lev=###)-u(lev=####)`  
where ### is replaced in each instance with a different level (in hPa).
- To mask out a field over land: `display maskout(tmpsfc,-landsfc)`  
(for this dataset, landsfc is a variable that describes land vs. water, 0 = water & 1 = land)
- To label the x- or y-axis: `draw xlab label` or `draw ylab label`
- To run a color bar after plotting a field: `run cbarn.gs`  
(presumes cbarn.gs exists in the same directory as the model data)

You can approximate the sea-surface temperature with the tmpsfc variable in the model dataset. All other necessary variables are natively available in the model dataset.

If you have never used GrADS before, you may find it helpful to first complete the GrADS tutorial, available at <http://cola.gmu.edu/grads/gadoc/tutorial.html>. Download the example.tar.gz file used in the tutorial to your local machine by copying the address, then issuing the following command in the terminal: `wget address`. Otherwise, follow the instructions contained therein.

An index of GrADS commands is available at <http://cola.gmu.edu/grads/gadoc/gadocindex.html>.