Hurricanes – Forecasts and Paths (Part 1)

This week you will be working with a variety of different hurricane data to see how well atmospheric scientists are able to predict hurricane paths and to analyze the frequency of hurricanes hitting different parts of the Atlantic coast of the US. New tools you will use in this part of the lab include displaying XY data from a table, buffers, and turning points into lines.

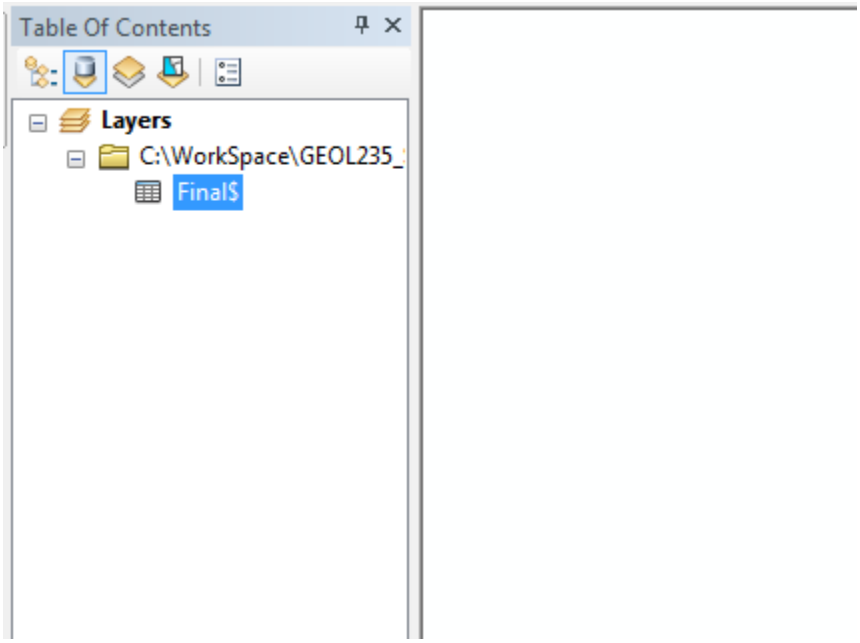
Due for this lab

For this part, specifically: I expect that you will be done with this part of the lab by the time class starts on Thursday, 11 February (1:30 pm).

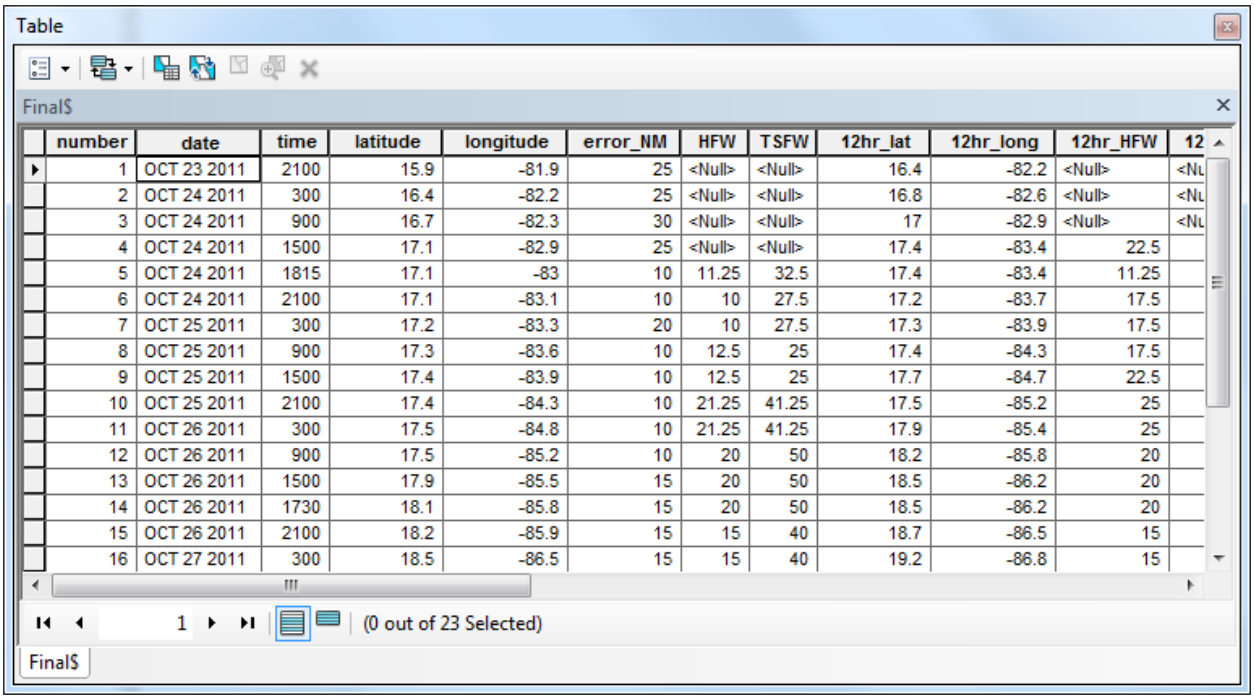
In general for this lab: You will write a letter to Uncle Don explaining what you did, make a workflow for the entire lab, and create a map (or two) showing something related to all parts of the exercise by Sunday 18 September 11:59 pm as a *single* PDF file to Blackboard.

Part B. Displaying table data in ArcGIS

1. Open a new map document in your Lab4 folder, turn on all the extensions, change to relative path names, and save it **HurricaneMap.mxd**.
2. Using the "add data" button rather than dragging from ArcCatalog, add your spreadsheet to your map. You may have to choose the exact sheet name you want if the entire file won't add.
3. You should have something that now looks like this. The worksheet in the Excel file I added is called Final$. If you are having trouble importing the Excel file, save it as a CSV file before adding it to your map.



4. Notice that you don't see anything in your map. That's ok. Your data are there. What you're looking at is the table of contents listing by source. So rather than sorting your data by order of display, it's sorted by where it came from.
5. Let's make sure our data are all there. Right click on your table and click "open". If there isn't anything there (for example, it says <null> for all the spots), there is probably a small error in the column headers for the spreadsheet. Remove the file from ArcMap and open the file in Excel. It may want to open it as read only because it doesn't know it isn't open in Arc anymore. Close Arc and it should solve that problem. Go across all the column headings and make sure there are NO spaces in any of the headers.
6. Open it in ArcMap again, right click on it, and open the table. It should look something like this:



Table

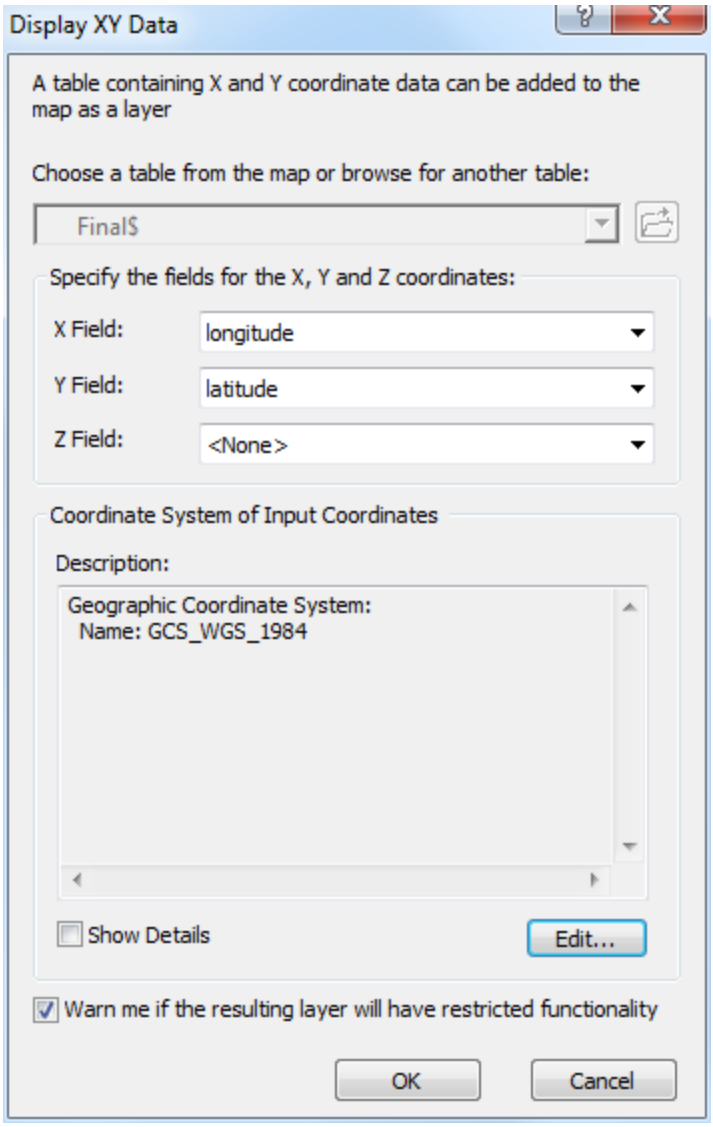
Final$

number	date	time	latitude	longitude	error_NM	HFW	TSFW	12hr_lat	12hr_long	12hr_HFW	12
1	OCT 23 2011	2100	15.9	-81.9	25	<Null>	<Null>	16.4	-82.2	<Null>	<Nu
2	OCT 24 2011	300	16.4	-82.2	25	<Null>	<Null>	16.8	-82.6	<Null>	<Nu
3	OCT 24 2011	900	16.7	-82.3	30	<Null>	<Null>	17	-82.9	<Null>	<Nu
4	OCT 24 2011	1500	17.1	-82.9	25	<Null>	<Null>	17.4	-83.4	22.5	
5	OCT 24 2011	1815	17.1	-83	10	11.25	32.5	17.4	-83.4	11.25	
6	OCT 24 2011	2100	17.1	-83.1	10	10	27.5	17.2	-83.7	17.5	
7	OCT 25 2011	300	17.2	-83.3	20	10	27.5	17.3	-83.9	17.5	
8	OCT 25 2011	900	17.3	-83.6	10	12.5	25	17.4	-84.3	17.5	
9	OCT 25 2011	1500	17.4	-83.9	10	12.5	25	17.7	-84.7	22.5	
10	OCT 25 2011	2100	17.4	-84.3	10	21.25	41.25	17.5	-85.2	25	
11	OCT 26 2011	300	17.5	-84.8	10	21.25	41.25	17.9	-85.4	25	
12	OCT 26 2011	900	17.5	-85.2	10	20	50	18.2	-85.8	20	
13	OCT 26 2011	1500	17.9	-85.5	15	20	50	18.5	-86.2	20	
14	OCT 26 2011	1730	18.1	-85.8	15	20	50	18.5	-86.2	20	
15	OCT 26 2011	2100	18.2	-85.9	15	15	40	18.7	-86.5	15	
16	OCT 27 2011	300	18.5	-86.5	15	15	40	19.2	-86.8	15	

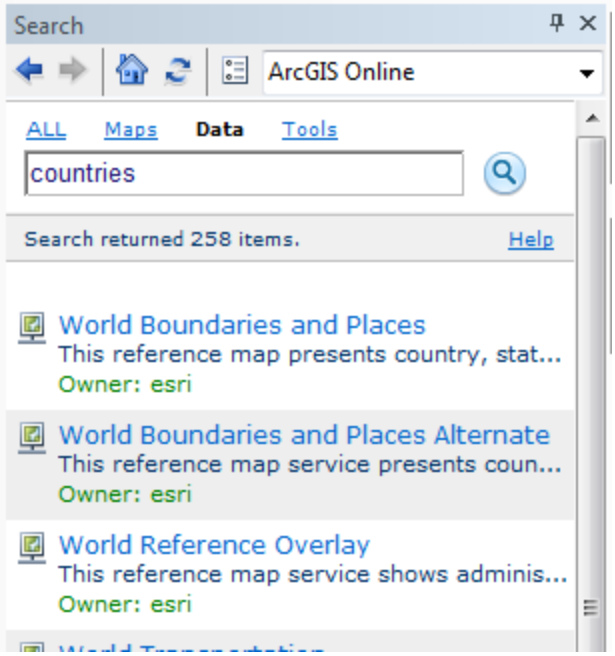
1 (0 out of 23 Selected)

Final$

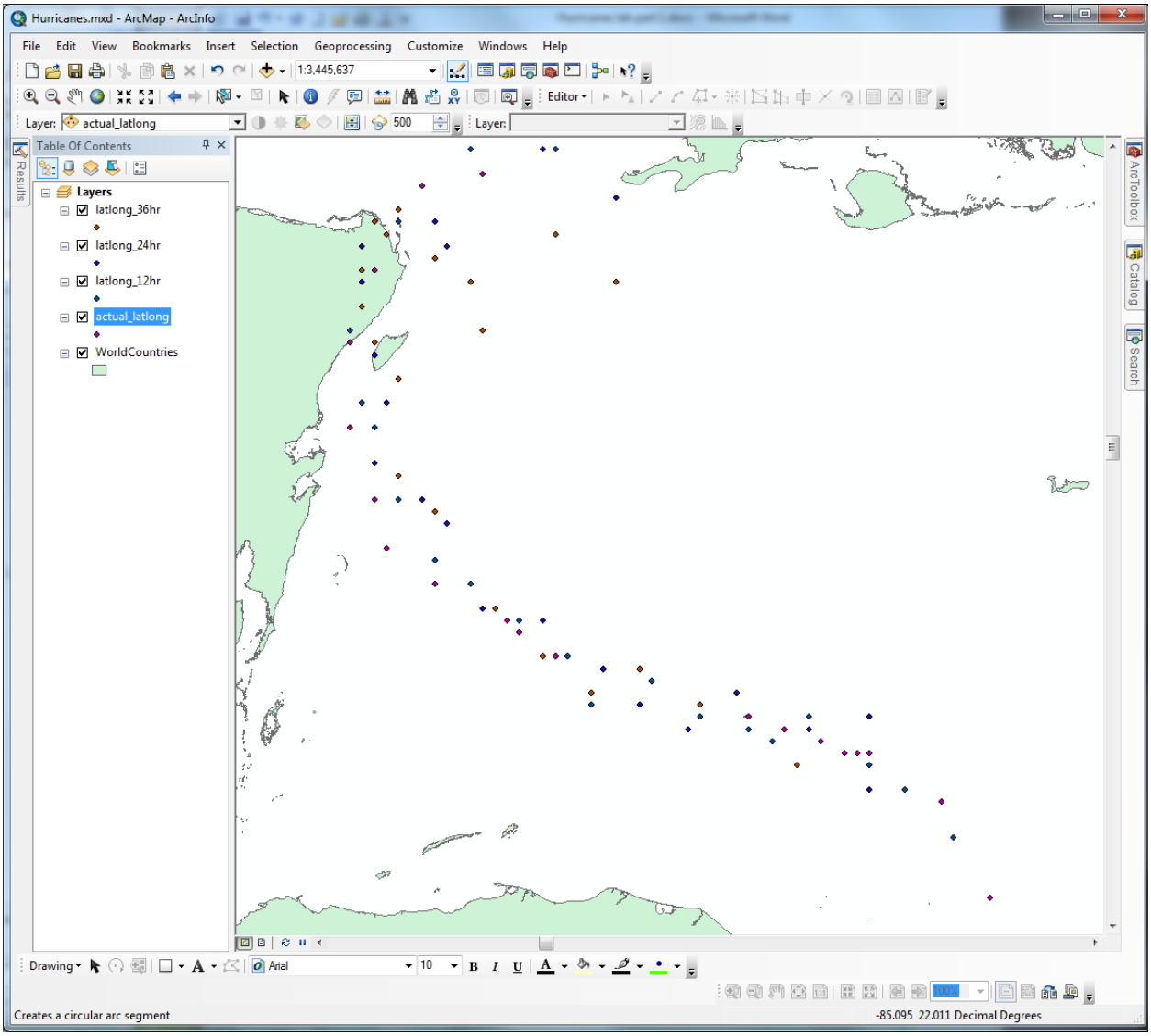
7. Great. So now we have the data we need. But it's in table format, and that isn't really too helpful for us, as we can't see anything with it. Close the table. Right click on the file again and this time choose Display XY Data.
8. You will see a new window where you can specify the x field, y field, z field, and the coordinate system of the table. We'll use longitude for the x field, latitude for the y field, <none> for the z field, and WGS1984 for the coordinate system (remember, this is GCS). The picture on the next page shows you what it should look like. We can repeat this later for our 12hr, 24hr, and 36hr forecasts. It's pretty cool that Arc tries to guess what you want for the x and y field, so that is a good reason to name your fields logically.



9. Click ok. If an error message about Object-IDs comes up, click ok. Voila, you have something in your display.
10. But we have nothing interesting to compare it to. Just a series of tracks in the middle of the ocean. We need some countries. Search ArcGIS online data for countries, the same way you searched for continents for class last week (see the picture on the next page).

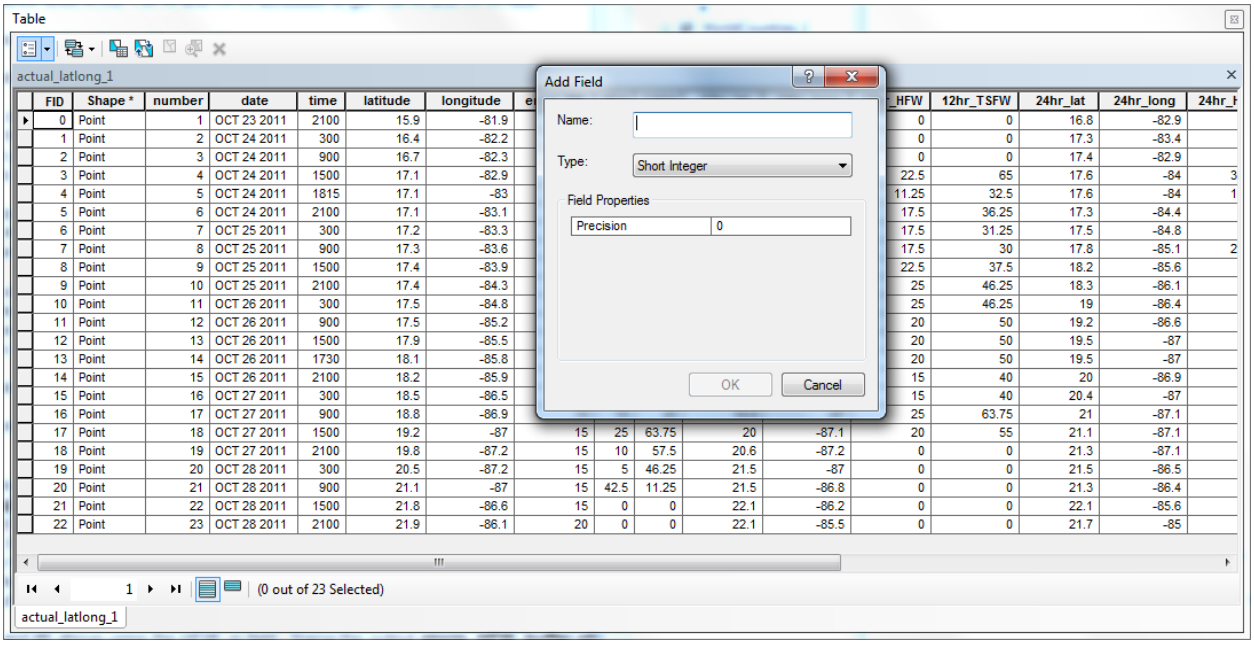


11. Add World Countries to your map. Remember that the ones with yellow symbols next to them are data. That looks better, doesn't it?
12. Now we need to export all the data displayed so that it is somewhere logical. As you did last week, export the data from World Countries and from your XY data (mine are called Final$ Events) to somewhere logical in your Lab4 folder. (Hint: right click on the layer and look in "data" for the tool you want). Be sure to choose the file format "shapefile".
13. Repeat steps 7, 8, 9, and 12 for your 12, 24, and 36 hr latitudes and longitudes. If you get drawing errors, recheck your typed data to make sure it doesn't have any problems in it.
14. Remove the layers that you don't need. Your map should look something like the one on the next page.
15. Now that you have these 5 shapefiles in a logical place with nice short names, reproject them all to **USA Contiguous Lambert Conic Conformal**. Use WGS1984 as the datum. You can try to use "batch project" to project them all or reproject them individually.
16. After the files are reprojected, remove all the layers from your map. You need to change your projection for the map itself, so right click on layers and go to properties. Under "coordinate system" choose **USA Contiguous Lambert Conic Conformal** to match your data. You also can look under "Layers" and choose it there.
17. Now add all your new files. You may need to refresh the view in catalog to see them. Mine are all the same name with _1 after them. If that isn't going to be clear to you later, rename the files before you add them.
18. Save your map.



Part C. Buffering

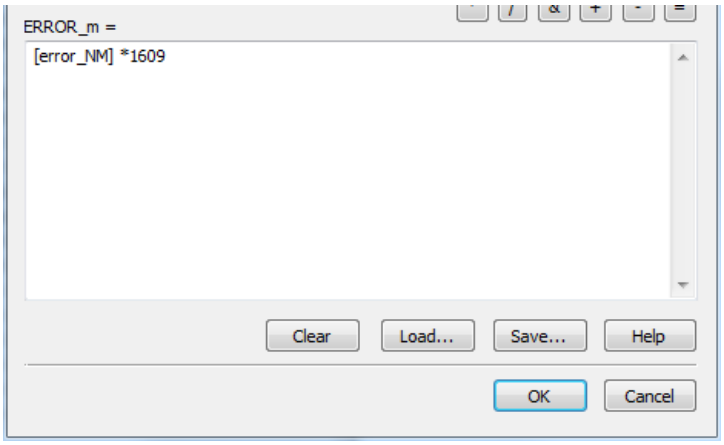
1. The first thing we need to do is to make the points actually represent the area that the hurricane might be in (since we all know that everything in science has errors associated with it, the location of a hurricane having errors shouldn't surprise you).
2. Converting the data to meters
    a. Unfortunately, our data are in weird units (nautical miles, to be exact), so we need to convert that. Open the attribute table for your actual latitudes and longitudes (mine is called actual_latlong_1).
    b. No go to table options (the upper left corner – highlighted in blue in the picture on the next page) and choose "add field".



c. Name your field ERROR_m, define the field as a long integer. Set the precision to 6. This says that you can have 6 numbers after the decimal place.

d. Now scroll right to your new field. Right click on the heading at the top and choose "Field calculator".

e. There are 1609 meters in a nautical mile. So in the field calculator, double click on error_NM, then click once on the * symbol, then type in 1609. It should look like this:



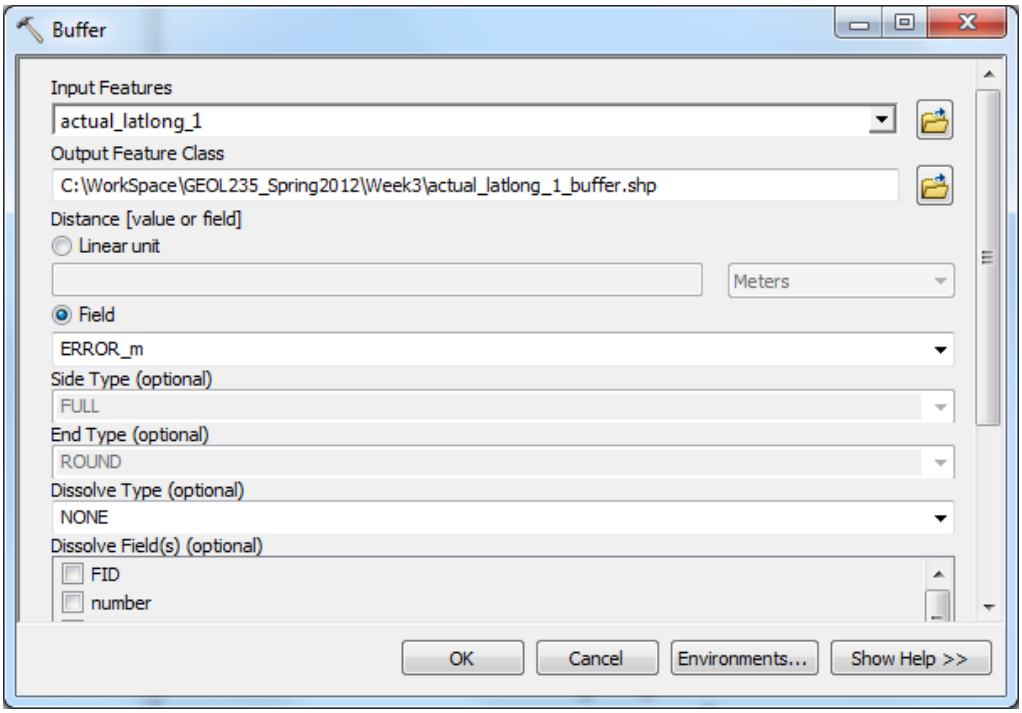
f. Close your attribute table.

g. Save your map.

3. Buffering the hurricane location with errors

a. Search for the tool "buffer" and open it.

b. Choose your projected actual storm locations file as your input. (You may have to navigate to the file use the folder icon.) Choose a logical output name and location. Click on "field" under distance and choose ERROR_m. Keep the rest of the defaults (see image on the next page) and click ok.



   c. When it's done running, you'll have a bunch of circles around each of your location points. Perfect. That's just what we want for knowing where the hurricane actually is at each of these times.
   d. Don't forget to keep saving your map.
4. Buffering hurricane and tropical storm force winds for actual hurricane locations
   a. Repeat step 2 (create "HFW_error_m" and "TSFW_error_m" fields) for the HFW and TSFW fields.
   b. Repeat step 3 (buffer via the appropriate error field) for HFW_m and TSFW_m fields. Click ok if the buffer tool warns you that you won't create buffers for 0 values. Clearly a 0 radius circle is just a point.
   c. I hope you're saving!
5. Buffering hurricane forecasts
   a. Repeat step 4 (create new error field and buffer your points by that field) for the three forecasts.
   b. I really hope you've been saving your map!

Part D. Turning your points into a line

In order to visualize hurricane paths more easily, we're going to turn the actual latitude and longitude of your hurricane into a line (rather than a series of points).

1. Search for "point line" in the search box. You'll see a tool called "Points to Line". Hover over the tool with your mouse or click on the description. It sort of sounds like what we're looking for, right?
2. Open the tool, drag in your hurricane locations, and choose an output file in a NEW folder. Keep all the defaults besides the file name and location. Click ok.

Part E. Combining datasets

It would be nice to visualize how the actual path of the hurricane that you just generated compares with the forecasted paths over time. To do this, you need to make a set of lines that each contain one point from each of your 0, 12, 24, and 36 hour files.

1. Search for the **Merge** tool. What does this tool do?
2. Use the Merge tool to combine your four point files into one large point file. Open up the attribute table of your new file and highlight one line. How many points are represented by each line of this file's attribute table?
3. Open up the attribute table of your new file. Select one line. What happened? Now how many points are represented by each line of this file's attribute table?
4. Make lines for each of the predicted hurricane tracks using the **Points to Line** tool. Be sure to use something that is unique to each row as the line field.

Part F. Some analysis

So now you have a bunch of information about the location of your hurricane at approximately 12 hr intervals, the extent of hurricane and tropical storm force winds at those times, and forecasts for both location of the storm and extent of hurricane and tropical storm force winds for 3 time periods after each current location. Create a map to show the accuracy of NOAA hurricane forecasts – think about how to display both the accuracy of locations as well as the accuracy of the extent of the wind forecasts.