WMS

v. 11.1

WMS 11.1 Tutorial

GSSHA – Modeling Hurricane Sandy

Learn how to integrate the outputs of two hydraulic models, the ADvanced CIRCulation (ADCIRC) model and the Gridded Surface Subsurface Hydrologic Analysis (GSSHA) model to simulate compound flooding for Hurricane Sandy.

Objectives

This tutorial shows how to simulate compound flooding.

Prerequisite Tutorials

- Images and Projections
- Overland Flow Modeling with GSSHA
- Overland Boundary Conditions

Required Components

- Data
- Drainage
- Map
- Hydrology
- 2D Grid
- GSSHA

Time

- 60 minutes

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1 Introduction

See the Modeling Hurricane Sandy Presentation for a summary of the model objectives, results, and explanation of the input data and creation of the model.

2 Getting Started

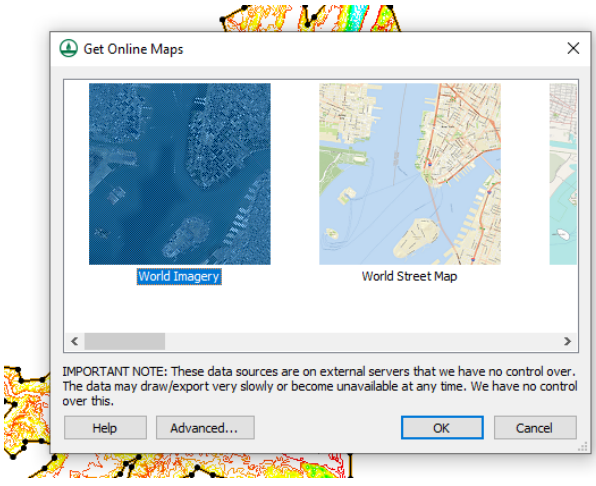
Starting WMS new at the beginning of each tutorial is recommended. This resets the data, display options, and other WMS settings to their defaults. To do this:

1. If necessary, launch WMS.
2. If WMS is already running, press *Ctrl-N* or select *File* | **New…** to ensure that the program settings are restored to their default state.
3. A dialog may appear asking to save changes. Click **Don't Save** to clear all data.

The graphics window of WMS should refresh to show an empty space.

4. Click **Open** to bring up the *Open* dialog under the File menu.
5. Change the *Files of type* to "WMS XMDF Project File (*.wms)".
6. Navigate to *HurricaneSandy\NewYork_Begin* and select "NewYork.wms" then click **Open** to close the *Open* dialog and import the project file.
7. The project has two rainfall gage locations that are away from the main project area. You can zoom in to the main project area using the **Zoom** tool.
8. Select the GSSHA coverage in the map data tree to show the boundaries of the watershed.

9. Use the **Get Online Maps** tool and select "World Imagery." Click OK.



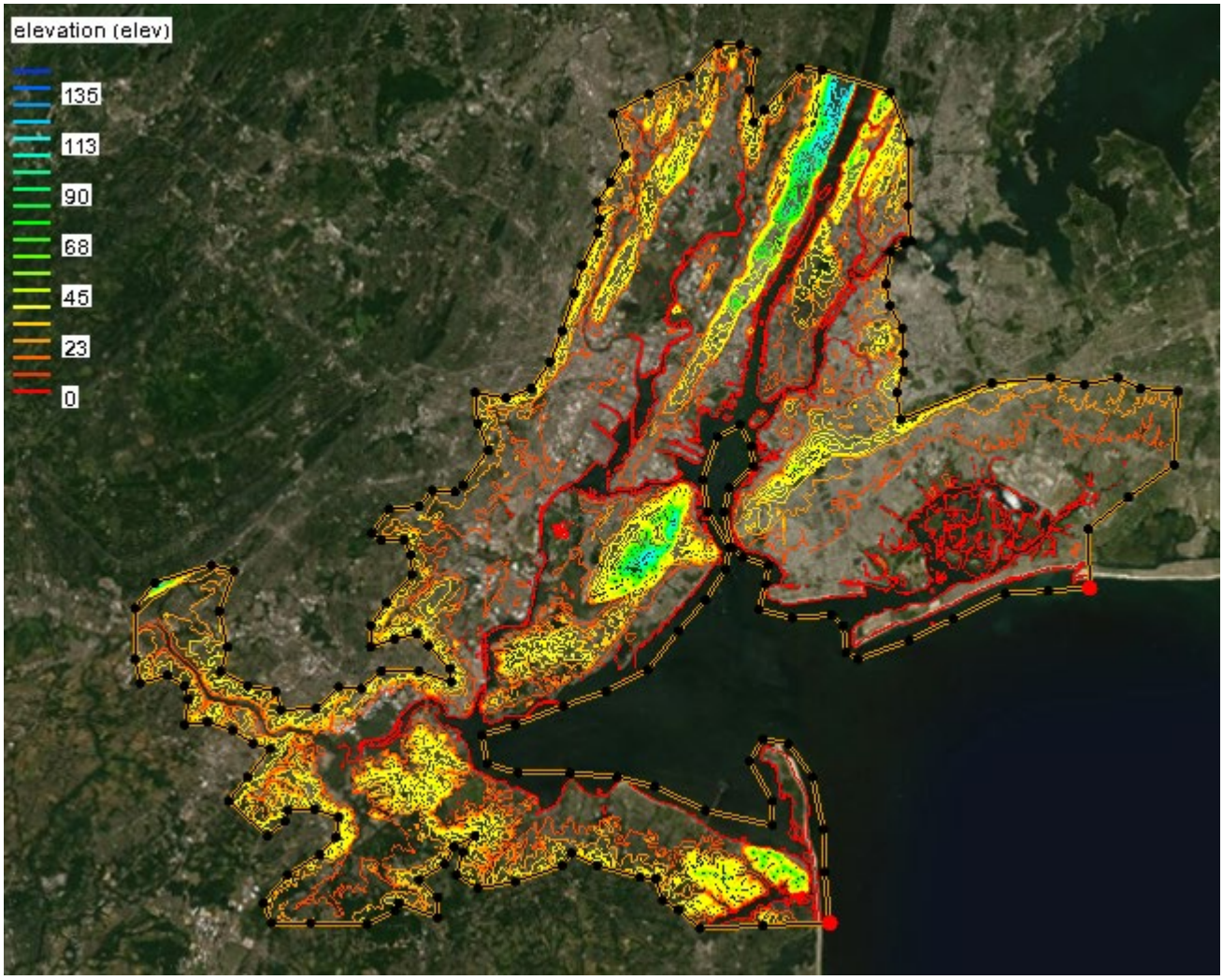
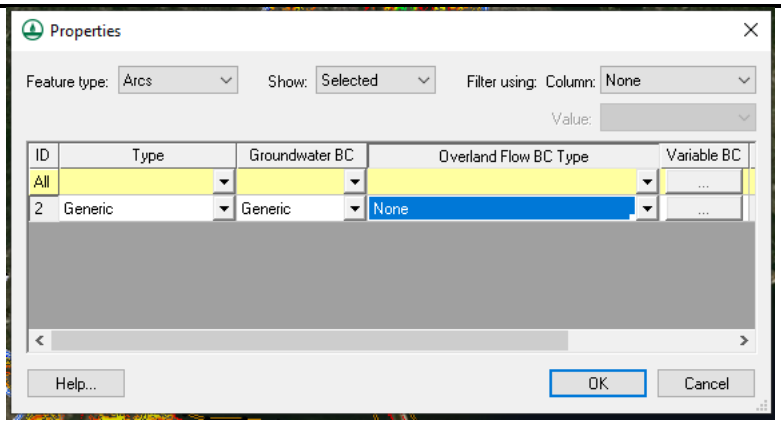


Figure 1. Initial project.

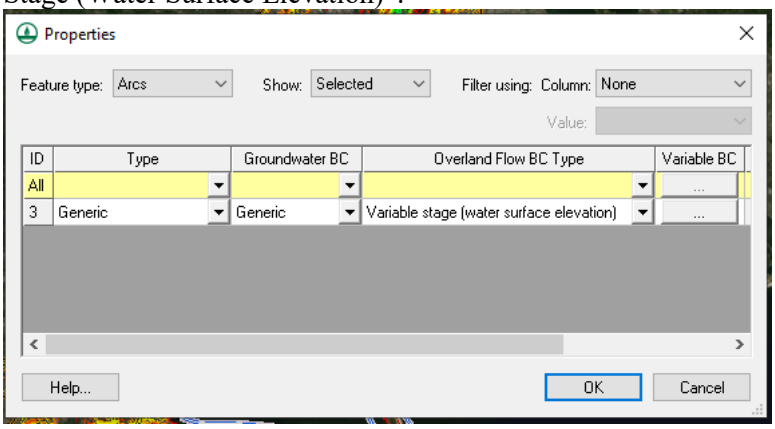
3 Examine boundary conditions

Let's look at the boundary conditions of the model. You'll notice the boundary polygon is split into two arcs.

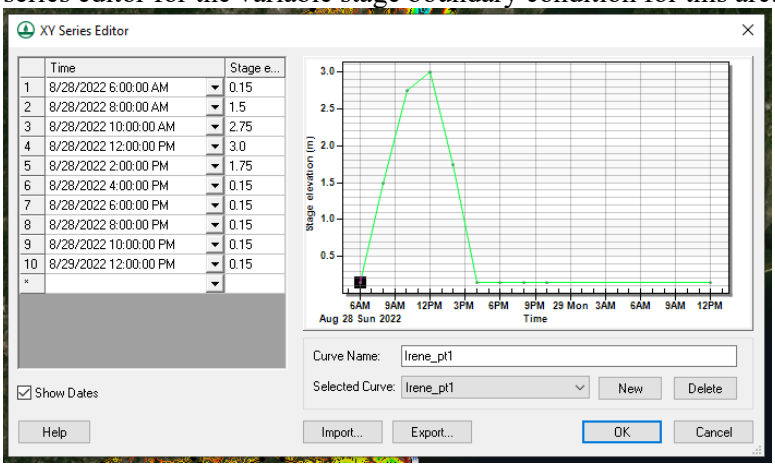
1. In the Map Module, using the Select Feature Arc tool or the Select Feature Object tool, double-click on the land-side arc. You'll notice that the arc has an overland flow boundary condition type of "None". This means the arc is a no-flow boundary. This is conceptually equivalent to a parallel-flow boundary.



2. Click OK.
3. Now double-click the NY Harbor-side feature arc.
4. You'll notice the harbor-side feature arc has a boundary condition type of "Variable Stage (Water Surface Elevation)".



5. Click on the "…" button in the Variable BC column. This will bring up the XY series editor for the variable stage boundary condition for this arc.



6. Note the dates and stages that reflect the storm surge (in meters). This type of boundary condition will set a uniform value across the entire boundary at any given time. Note also that the "background" water surface elevation is set to 0.15m. Because the model doesn't have bathymetry of the harbor or rivers, this will effectively try to make a small amount of standing water around the edge. Very shallow water moves slowly because of the roughness of the bottom, which is not conceptually appropriate for our model. Thus, trying to add a little bit of water to cover the lack of bathymetry to start the model will help the model perform better.

7. Click OK to close the XY series editor and the feature arc attributes dialog boxes.

4 Editing the Project File

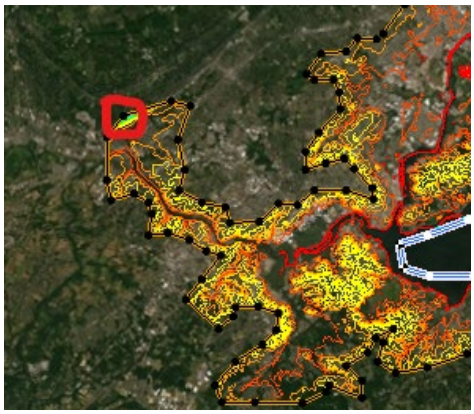
The model is reasonably set up as it is, but let's make it better. To do this we'll need to not use WMS as these options have not been implemented in WMS yet.

In the *HurricaneSandy* folder is a *Workspace* folder. Inside this folder are two folders, *NewYork_Irene* and *NewYork_Sandy*. Each of these is just a copy of the *NewYork_Begin* folder. We'll work in the *NewYork_Irene* folder.

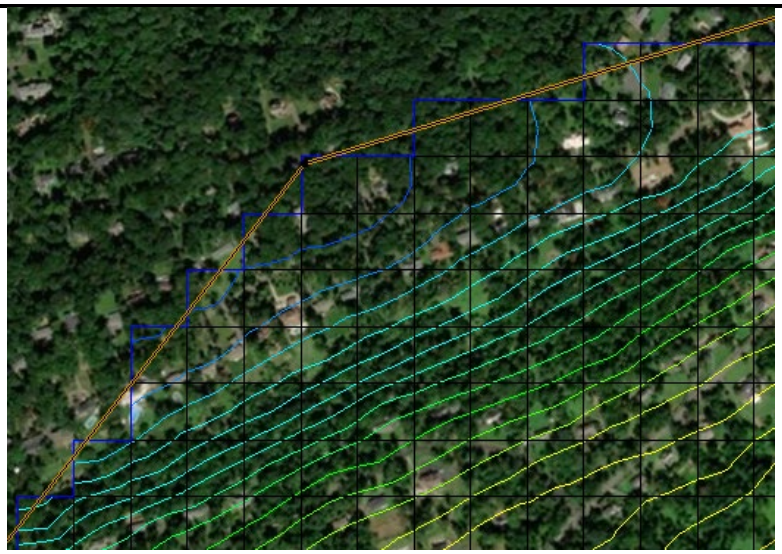
1. In the *NewYork_Irene* folder, use your favorite text editor (TextPad or Notepad++ are good options) to edit the "NewYork.prj" file. The .prj file is the project file. It is the control file for the simulation. Each line has the format [card] [value]. For example, ELEVATION "NewYork.ele" instructs GSSHA to read the NewYork.ele file as the land surface elevations for the simulation.

```
GSSHAPROJECT
WMS WMS 11.1.10 (64-bit)
WATERSHED_MASK          "NewYork.msk"
PROJECT_PATH            ""
#PROJECTION_FILE        "NewYork_prj.pro"
NON_ORTHO_CHANNELS
FLINE                   "NewYork.map"
METRIC
GRIDSIZE                75.000000
ROWS                    839
COLS                    991
TOT_TIME                960
TIMESTEP                2
OUTROW                  605
OUTCOL                  466
OUTSLOPE                0.001000
MAP_FREQ                15
HYD_FREQ                30
MAP_TYPE                1
ELEVATION               "NewYork.ele"
DEPTH                   "NewYork.dep"
FLOOD_GRID              "NewYork.gfl"
TIME_SERIES_FILE        "NewYork.xys"
OVERTYPE                ADE
#INDEXGRID_GUID         "unif.idx" "08b4c25e-8640-4e8d-a68f-8bc672deb010" 0
OV_BOUNDARY
#OV_BOUNDARY_TSF        "NewYork_bc.tsf"
MAPPING_TABLE           "NewYork.cmt"
SUMMARY                 "NewYork.sum"
OUTLET_HYDRO            "NewYork.otl"
PRECIP_FILE             "IreneRainfall_Aug26Est.gag"
RAIN_INV_DISTANCE
```

2. First, we'll edit the outlet row, column, and slope. When GSSHA simulations do not have a stream network, WMS looks for the lowest cell on the boundary and makes it the outlet. As we are not running a traditional watershed model, our outlet as the lowest point (i.e. somewhere on our storm surge boundary) doesn't make much sense. It will be better to make the outlet somewhere else, and then simply make the outlet slope very flat so that it effectively does nothing. We'll use WMS to get the grid coordinates of a better cell. In WMS, pick an edge of the model that is relatively high and use the zoom tool to zoom into it. For example, the one shown here.



3. In the **Display Options**, under **2D Grid**, toggle on the **cells**. You'll see the underlying GSSHA grid. If you are not zoomed in enough to hover over individual cells along the boundary, zoom in more.



4. As you move the mouse around and hover over individual cells, you'll see the I and I grid coordinates in the lower right corner changing. You'll notice the I changes as you move up and down (row) and J changes as you move left and right (column). Make note of the I and J of the highest elevation boundary cell in your area. For the image above, it is Cell info: ID: 506421 I: 512 J: 20 I=512, J=20.

5. Back in the project file in the text editor, change the OUTROW to be the I value, and OUTCOL to be the J value. Change the OUTSLOPE to 0.00001.

```
OUTROW                  512
OUTCOL                  20
OUTSLOPE                0.00001000
```

6. Now that we have fixed the outlet location, we'll add the base water level for the model. At the end of the list of project commands, add a new card: the initial elevation head value. It looks like this: "INIT_ELEV_HEAD 0.15". This instructs GSSHA to look across the entire domain, find any surface elevations that are below 0.15, and set the water depths sufficient that the water surface will be at elevation 0.15. There are a couple of other ways we could initialize the water surface elevations. This one is one of the simplest.

   NOTE: There are a few rules about the order of the cards in the project file, but the project file is generally very flexible about the ordering. If you are after the project path card you will be able to move cards around and not change the project with only a few exceptions. So you could, for example, organize the inputs and outputs, or organize by process, or just leave them as they are.

```
OV_BOUNDARY
#OV_BOUNDARY_TSF        "NewYork_bc.tsf"
MAPPING_TABLE           "NewYork.cmt"
SUMMARY                 "NewYork.sum"
OUTLET_HYDRO            "NewYork.otl"
PRECIP_FILE             "IreneRainfall_Aug26Est.gag"
RAIN_INV_DISTANCE
INIT_ELEV_HEAD          0.15
```

7. Let's also turn on overland flow momentum equations. At the end of the project file add a new line that has "OVERLAND_MOMENTUM".

```
OUTLET_HYDRO                "NewYork.otl"
PRECIP_FILE                 "IreneRainfall_Aug26Est.gag"
RAIN_INV_DISTANCE
INIT_ELEV_HEAD              0.15
OVERLAND_MOMENTUM
```

8. Save the project file.

9. Let's also add variable depth manning's roughness. Open the NewYork.cmt file in your text editor. We'll work on the ROUGHNESS index map, the first one in the file.

```
GSSHA_INDEX_MAP_TABLES
INDEX_MAP               "unif.idx" "unif"
INDEX_MAP               "NewYork_bc.idx" "NewYork_bc"
ROUGHNESS "unif"
NUM_IDS 1
ID    DESCRIPTION1                    DESCRIPTION2                          ROUGH
1     Roughness ID                                                        0.300000
GREEN_AMPT_INFILTRATION ""
NUM_IDS 0
ID    DESCRIPTION1                    DESCRIPTION2                       HYDR COND
```

10. To add the variable depth Manning's roughness, we need to add the exponent as a parameter to the roughness table. If it is not there, then GSSHA uses a value of 0. To add the parameter, just add a couple of spaces and the exponent value (0.5 is a good starting value) to the end of the roughness value for each ID. You can add a header, too, if you want. The header lines are ignored by GSSHA.

```
GSSHA_INDEX_MAP_TABLES
INDEX_MAP               "unif.idx" "unif"
INDEX_MAP               "NewYork_bc.idx" "NewYork_bc"
ROUGHNESS "unif"
NUM_IDS 1
ID    DESCRIPTION1                    DESCRIPTION2                          ROUGH  EXP
1     Roughness ID                                                        0.300000  0.5
GREEN_AMPT_INFILTRATION ""
NUM_IDS 0
ID    DESCRIPTION1                    DESCRIPTION2                       HYDR_COND  CAPIL_HEAD
GREEN_AMPT_INITIAL_SOIL_MOISTURE ""
```

11. Save the .cmt file and run GSSHA from the command line. If you re-open the GSSHA project in WMS, and then save the project, you'll lose these changes. (The trick, then, is to not save over your project.) Once you run the project you can read the solution into WMS.

12. There are two options to run GSSHA projects that have been manually edited. **OPTION A**: Command line. To run GSSHA from the command line, open a command window. In the windows search bar type "cmd" and the cmd.exe app will appear. Run that app. Use the "change directory" command "cd" to navigate to the *NewYork_Irene* folder. The "dir" command is helpful for listing the contents of a folder so you can see what to type next.

    Once you get to the right folder, you'll need to tell it to run GSSHA. As the GSSHA executable is likely not in a conveniently placed spot (i.e. somewhere in your PATH system environment variable) you'll need to reference the full path to the executable. The command to run GSSHA for a project is "[gssha executable] [projectname.prj]".

```
C:\Users\RDCHLARB\Documents\work\Briefings\GSSHA Training\HurricaneSandy>cd Workspace

C:\Users\RDCHLARB\Documents\work\Briefings\GSSHA Training\HurricaneSandy\Workspace>cd NewYork_Irene

C:\Users\RDCHLARB\Documents\work\Briefings\GSSHA Training\HurricaneSandy\Workspace\NewYork_Irene>C:\Program Files\WMS 11
.1 64-bit\gssha\gssha.exe NewYork.prj
```

    And if you get and error like this, it is because you didn't put quotes around your path with spaces in it. Hit the up arrow and move your cursor back along the line to add the quotes.

```
C:\Users\RDCHLARB\Documents\work\Briefings\GSSHA Training\HurricaneSandy\Workspace\NewYork_Irene>C:\Program Files\WMS 11
.1 64-bit\gssha\gssha.exe NewYork.prj
'C:\Program' is not recognized as an internal or external command,
operable program or batch file.

C:\Users\RDCHLARB\Documents\work\Briefings\GSSHA Training\HurricaneSandy\Workspace\NewYork_Irene>"C:\Program Files\WMS 1
1.1 64-bit\gssha\gssha.exe" NewYork.prj
```

    Without the outlet changes you'll see outlet flow values in the range of -0.2.

```
reading precip data from file: IreneRainfall_Aug26Est.gag
Initialized Arrays
simulation duration 960 minutes
event  1 elapsed time     0.00   8/28/2011 06:00:00 Qout=      0.00000000 cms
event  1 elapsed time     0.03   8/28/2011 06:00:02 Qout=     -0.21453190 cms
event  1 elapsed time     0.07   8/28/2011 06:00:04 Qout=     -0.21444642 cms
event  1 elapsed time     0.10   8/28/2011 06:00:06 Qout=     -0.21431461 cms
event  1 elapsed time     0.13   8/28/2011 06:00:08 Qout=     -0.21422912 cms
event  1 elapsed time     0.17   8/28/2011 06:00:10 Qout=     -0.21409730 cms
event  1 elapsed time     0.20   8/28/2011 06:00:12 Qout=     -0.21401180 cms
event  1 elapsed time     0.23   8/28/2011 06:00:14 Qout=     -0.21387998 cms
```

With the outlet changes you'll see outlet flow values very close to 0.0.

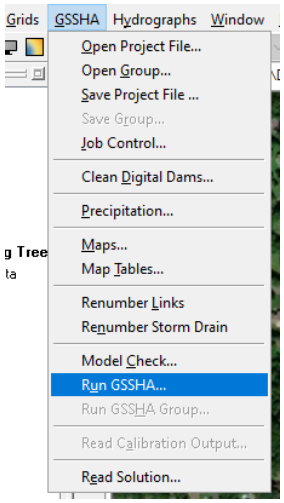
```
reading precip data from file: IreneRainfall_Aug26Est.gag
Initialized Arrays
simulation duration 960 minutes
event  1 elapsed time     0.00   8/28/2011 06:00:00 Qout=      0.00000000 cms
event  1 elapsed time     0.03   8/28/2011 06:00:02 Qout=      0.00000000 cms
event  1 elapsed time     0.07   8/28/2011 06:00:04 Qout=      0.00000001 cms
event  1 elapsed time     0.10   8/28/2011 06:00:06 Qout=      0.00000001 cms
event  1 elapsed time     0.13   8/28/2011 06:00:08 Qout=      0.00000002 cms
event  1 elapsed time     0.17   8/28/2011 06:00:10 Qout=      0.00000003 cms
event  1 elapsed time     0.20   8/28/2011 06:00:12 Qout=      0.00000004 cms
event  1 elapsed time     0.23   8/28/2011 06:00:14 Qout=      0.00000005 cms
event  1 elapsed time     0.27   8/28/2011 06:00:16 Qout=      0.00000006 cms
event  1 elapsed time     0.30   8/28/2011 06:00:18 Qout=      0.00000008 cms
event  1 elapsed time     0.33   8/28/2011 06:00:20 Qout=      0.00000009 cms
```

OPTION B: From WMS. If for some reason you can't run from the command line, you can still run GSSHA from WMS. This one is a bit more tricky as it involves knowing exactly when WMS saves a project. It is highly recommended to save a copy of your project in another location before trying this option. To do this option:

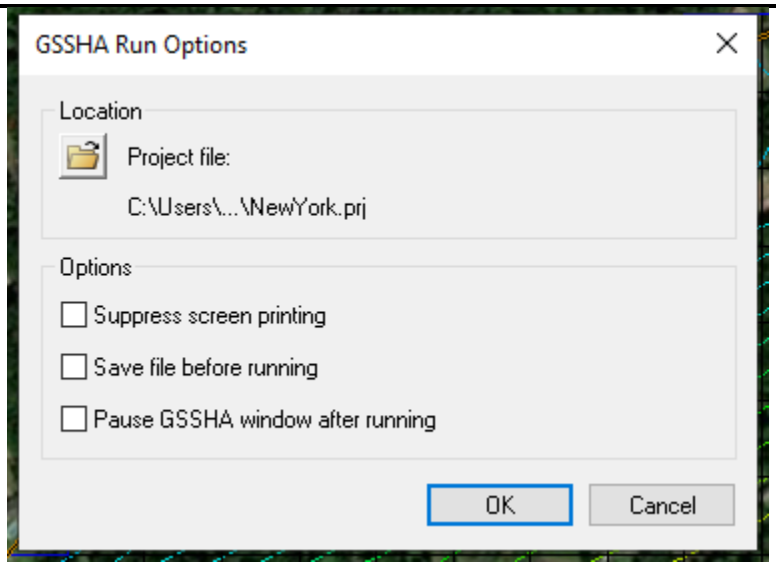
A. Open a new WMS.

B. Read in the WMS project or GSSHA project. (Reading in the WMS project reads in the GSSHA project, and vice versa.)

C. In the **2D Grid Module**, select GSSHA | Run GSSHA



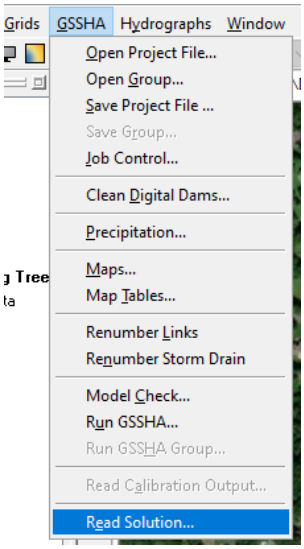
D. This is the "danger close" action: UNCHECK "Suppress Screen Printing" and then UNCHECK "Save File Before Running".



E. Double check that those are both UNCHECKED.

F. Now select OK. WMS will run GSSHA without saving the project file, which means your changes won't be written over. Don't save the project file or WMS file. After you run this, just exit WMS WITHOUT SAVING.

G. Go back to your previous WMS instance or open a new WMS with a version of the project that doesn't have your changes. From the **2D Grid Module**, chose GSSHA | Read Solution. Navigate to the modified project file and WMS will read in the results.

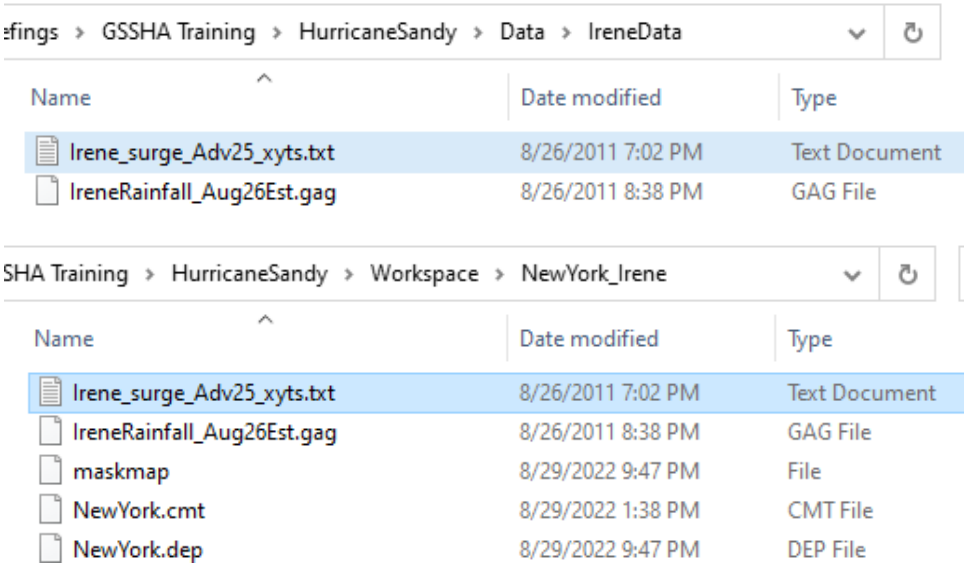


5 Add Multiple Overland Boundary Time Series

Another option that we can do is to have multiple time series for the overland boundary condition. This would be helpful when the overland boundary conditions need to vary across space as well as time. This also cannot be done in WMS yet. We'll add it to the Irene model for now and then explore the file format when we adjust it for Sandy.

1. First, we need to copy the storm surge file from the *Data/IreneData* folder to the

Workspace/NewYork_Irene folder.



2. Back in your favorite text editor, editing the NewYork.prj file, add the line "XYBDYINPUT_OVDEPTHINTERP "Irene_surge_Adv25_xyts.txt"":

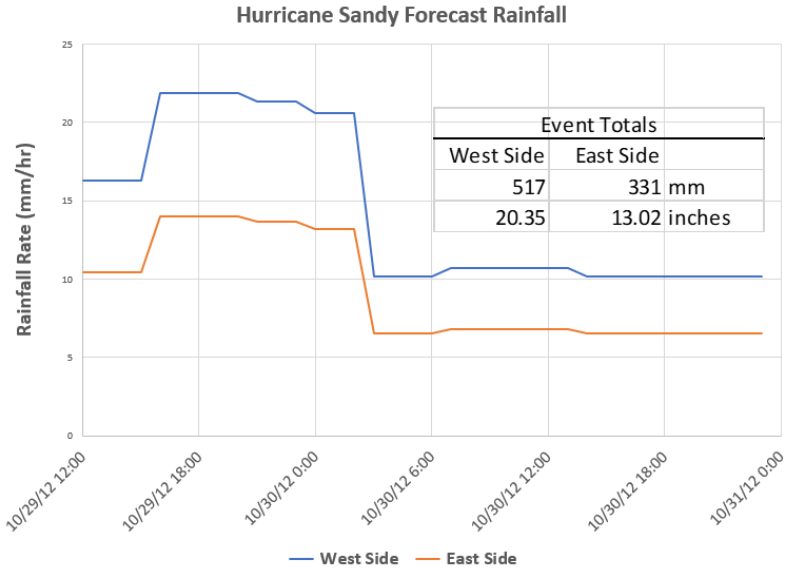
```
PRECIP_FILE               "IreneRainfall_Aug26Est.gag"
RAIN_INV_DISTANCE
INIT_ELEV_HEAD            0.15
OVERLAND_MOMENTUM
XYBDYINPUT_OVDEPTHINTERP  "Irene_surge_Adv25_xyts.txt"
```

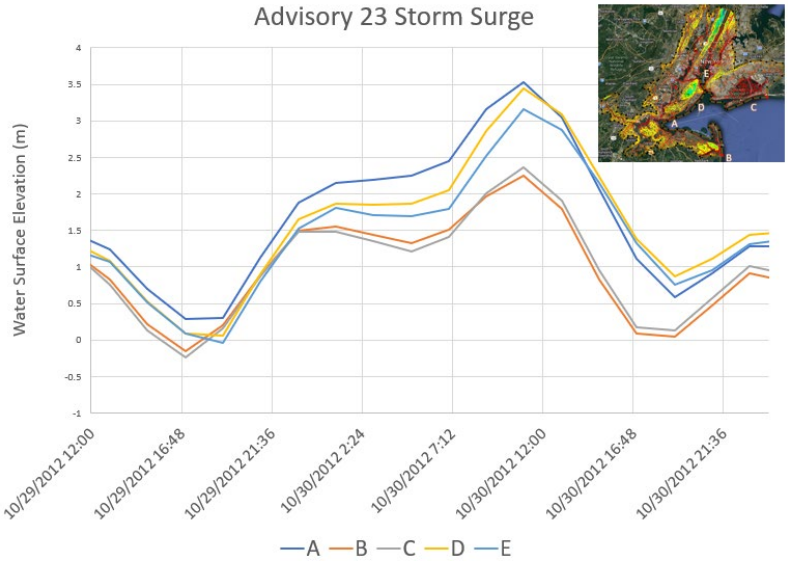
This command will signal to GSSHA to interpolate variable stage overland boundary values from the set of time series in the file rather than use the reference to the single time series.

8. Save the file and run. If you want to keep your previous results, save the entire folder to a new location before running. You can close the NewYork.prj text editor.

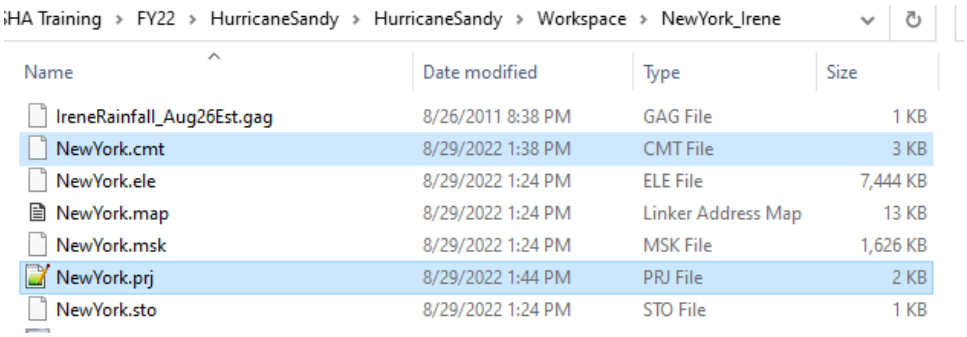
6 Hurricane Sandy Forecast Model

When running in forecast mode, the rainfall used in the model will come from another model. For Hurricane Sandy, the forecast rainfall came from estimating the rainfall amounts of the Hurricane several days in advance. The storm surge forecast came from ADCIRC runs several days in advance. We'll adjust the Hurricane Irene model to use the forecast data.

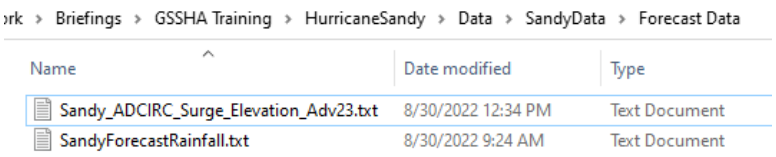




1. In the *Workspace/NewYork_Irene* folder, select and copy (CTRL-C) the NewYork.prj and NewYork.cmt files.



2. In the Workspace/NewYork_Sandy_Forecast folder, paste (CTRL-V) the files. When you are asked to replace or skip the files, choose replace.
3. In the *Data\SandyData\Forecast Data* folder, copy the two files there.



4. Switching back to the *Workspace\NewYork_Sandy_Forecast* folder, paste the files.
5. Using your favorite text editor, open the NewYork.prj file.
6. Change the PRECIP_FILE and XYBDYINPUT_OVDEPTHINTERP card values to the two files you just copied into the folder.

```
OUTLET_HYDRO              "NewYork.otl"
PRECIP_FILE               "SandyForecastRainfall.txt"
RAIN_INV_DISTANCE
INIT_ELEV_HEAD            0.15
OVERLAND_MOMENTUM
XYBDYINPUT_OVDEPTHINTERP  "Sandy_ADCIRC_Surge_Elevation_Adv23.txt"
```

7. Change the TOT_TIME from 960 to 1560.

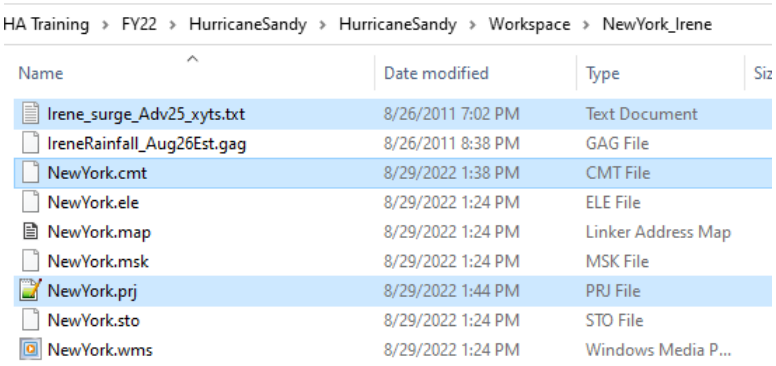
```
ROWS                      839
COLS                      991
TOT_TIME                  1560
TIMESTEP                  2
OUTROW                    512
OUTCOL                    20
```

8. Save the file. You are now ready to run the forecast.

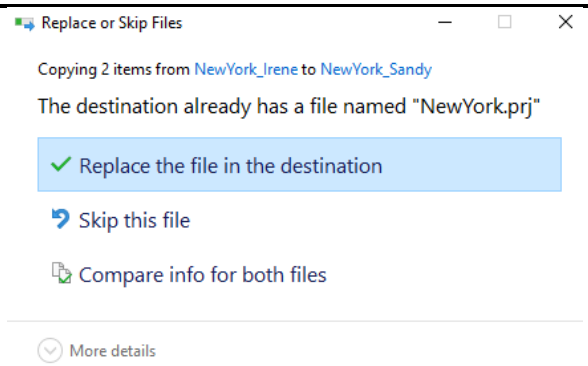
7 Hurricane Sandy Hindcast Model

The Hurricane Sandy model was built by adjusting the Hurricane Irene model to match the rainfall and storm surge conditions of Sandy. We'll work through the same process for the hindcast data. Start by copying our recent changes to Irene to the NewYork_Sandy_Hindcast folder.

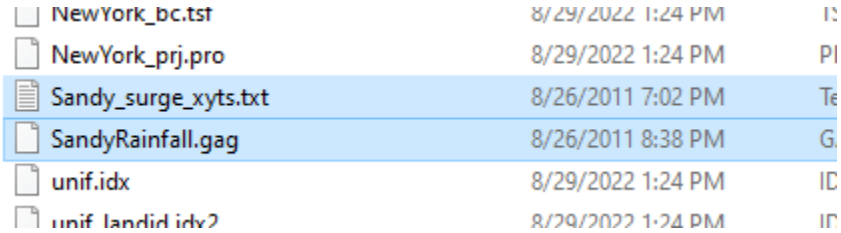
9. In the *Workspace/NewYork_Irene* folder, select and copy (CTRL-C) three files: NewYork.prj, NewYork.cmt, and Irene_surge_Adv25_xyts.txt.



10. In the Workspace/ NewYork_Sandy_Hindcast folder, past (CTRL-V) the three files. When you are asked to replace or skip the files, choose replace.



11. Now we'll change the names of the rainfall and surge files:



12. Using your favorite text editor, edit the NewYork.prj file. Change the files names after PRECIP_FILE and XYBDYINPUT_OVDEPTHINTERP to match the new "Sandy" names.

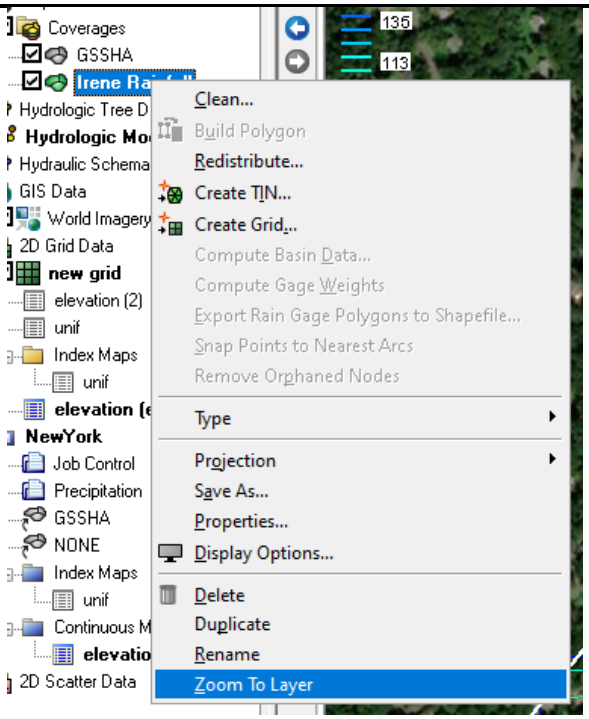
```
OUTLET_HYDRO              "NewYork.otl"
PRECIP_FILE               "SandyRainfall.gag"
RAIN_INV_DISTANCE
INIT_ELEV_HEAD            0.15
OVERLAND_MOMENTUM
XYBDYINPUT_OVDEPTHINTERP  "Sandy_surge_xyts.txt"
```

13. Change the TOT_TIME from 960 to 1560.

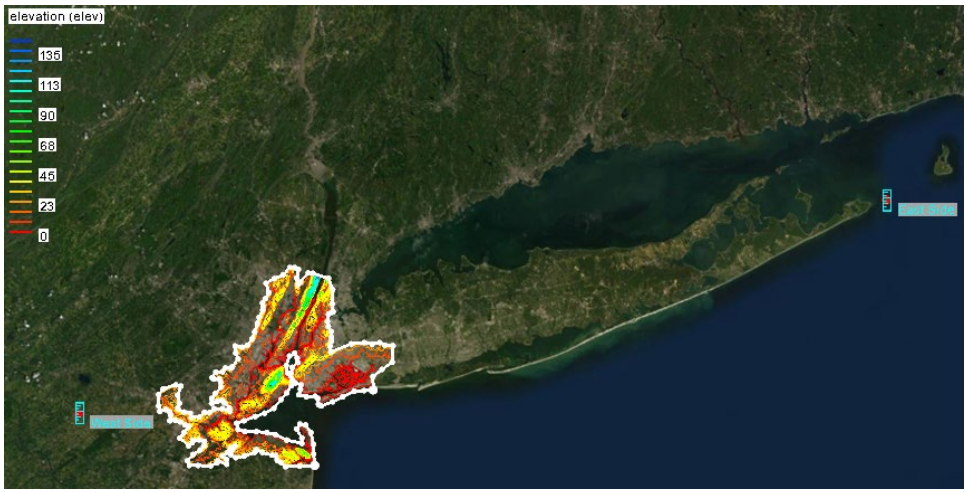
7.1 Creating the Hindcast Rainfall

Now we have the file structure correct for the Hurricane Sandy project. We need to edit the rainfall and the storm surge. First, we'll edit the rainfall.

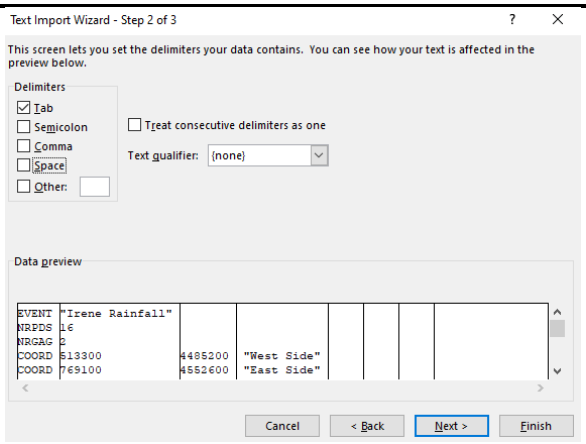
1. Switch back to WMS, or open a new WMS and read in the project if you closed WMS. If you have the grid lines still turned on from before, in the **Display Options**, under **2D Grid**, toggle off the **cells**. Click OK.
2. You'll notice in the data tree the rainfall coverage is still called "Irene Rainfall" because we haven't changed the name of the event in the rainfall file yet. Right-click on the "Irene Rainfall" coverage and select "Zoom to Layer".



You'll notice that the "East Side" gage is off the tip of Long Island, while the "West Side" is west of they harbor in New Jersey.



3. Using your favorite spreadsheet app, open the "SandyRainfall.gag" file. You'll likely need to import the data and use a "text to columns" feature. You can use a "delimited" format with a tab delimiter.

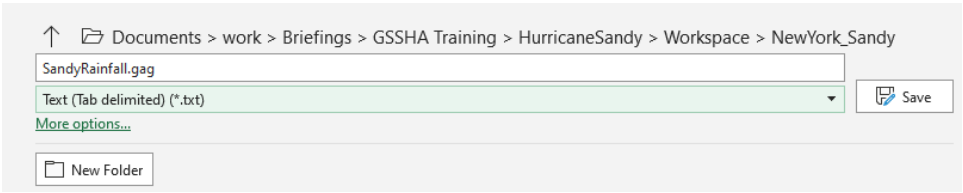


Select “Finish”.

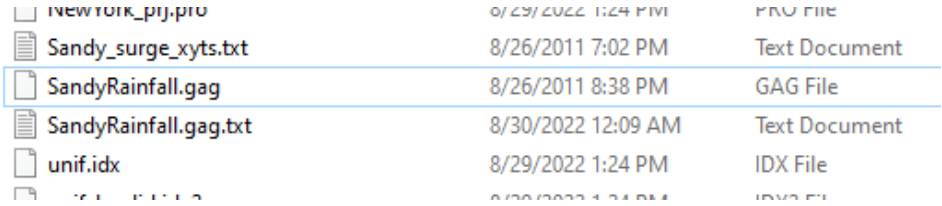
4. We need to adjust the date/time values as well as the rainfall values. Here is a good reference: https://www.weather.gov/phi/sandyreport. The rainfall totals were much less than Irene, with roughly 2” of rainfall on the east side, and ½” of rainfall on the west side. We’ll start the time at 0100 UTC on the 29th of October 2012 and go through 3am on the 30th.
    - Adjust the date/times, adding rows as needed. Once you have the right number of rows, change the NRPDS value to match the number of rows of date/time data you have.
    - Adjust the rainfall rates to be more similar to the Sandy imagery. The storms came in pulses, with more rainfall (roughly 2”) on the west than the east (roughly ½”).
    - Change the name to “Sandy Rainfall”

	A	B	C	D	E	F	G	H
1	EVENT	"Sandy Rainfall"						
2	NRPDS	27						
3	NRGAG	2						
4	COORD	513300	4485200	"West Side"				
5	COORD	769100	4552600	"East Sided"				
6	RATES	2012	10	29	1	0	2	5
7	RATES	2012	10	29	2	0	0	0
8	RATES	2012	10	29	3	0	2	5
9	RATES	2012	10	29	4	0	0	0
10	RATES	2012	10	29	5	0	2	5
11	RATES	2012	10	29	6	0	0	0
12	RATES	2012	10	29	7	0	2	5
13	RATES	2012	10	29	8	0	0	0
14	RATES	2012	10	29	9	0	2	5
15	RATES	2012	10	29	10	0	0	0
16	RATES	2012	10	29	11	0	2	5
17	RATES	2012	10	29	12	0	0	0
18	RATES	2012	10	29	13	0	2	5
19	RATES	2012	10	29	14	0	0	0
20	RATES	2012	10	29	15	0	0	0
21	RATES	2012	10	29	16	0	0	0
22	RATES	2012	10	29	17	0	0	0
23	RATES	2012	10	29	18	0	0	12
24	RATES	2012	10	29	19	0	0	12
25	RATES	2012	10	29	20	0	0	0
26	RATES	2012	10	29	21	0	0	0
27	RATES	2012	10	29	22	0	0	0
28	RATES	2012	10	29	23	0	0	0
29	RATES	2012	10	30	0	0	0	0
30	RATES	2012	10	30	1	0	0	0
31	RATES	2012	10	30	2	0	0	0
32	RATES	2012	10	30	3	0	0	0

5. Save the file as the SandyRainfall.gag file. You'll want the "tab delimited" text file option.



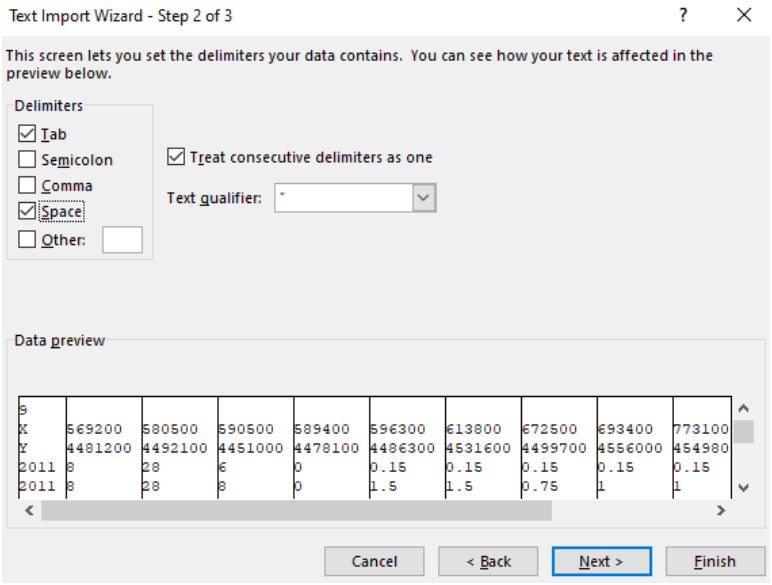
6. Close your spreadsheet editor. Check the name of the file that was saved. If it is "SandyRainfall.gag.txt" then delete the old .gag file and rename the new file to "SandyRainfall.gag".



7.2 Edit the Storm Surge Time Series

Similarly to the rainfall data, we'll edit the storm surge data in a spreadsheet.

1. Using your favorite spreadsheet app, open the "Sandy_surge_xyts.txt" file. You'll likely need to import the data and use a "text to columns" feature. You can use a "delimited" format with both tab and space delimiters.



2. The X and Y values will be offset of their time series. While this doesn't matter to GSSHA, it will help readability if we adjust them over. Just cut and paste the X and Y values over the columns of data.

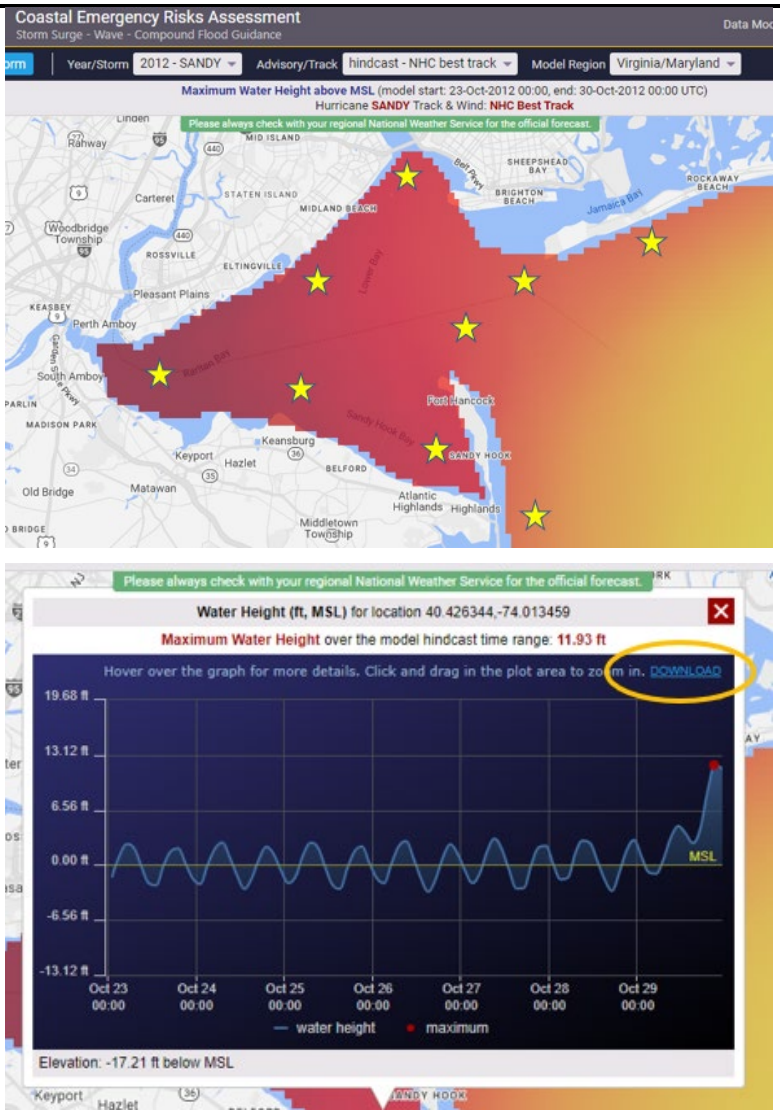
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	XY_OV_DEPTH_INTERP													
2	9													
3	X					569200	580500	590500	589400	596300	613800	672500	693400	773100
4	Y					4481200	4492100	4451000	4478100	4486300	4531600	4499700	4556000	4549800
5	2011	8	28	6	0	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
6	2011	8	28	8	0	1.5	1.5	0.75	1	1	0.15	1.5	0.15	0.15
7	2011	8	28	10	0	2.75	2.5	1.75	2	2	1.5	2	0.15	1.5
8	2011	8	28	12	0	3	3	1.85	2.5	2.5	1.75	2.5	1	1.5
9	2011	8	28	14	0	1.75	1.5	0.75	1	1	2	2	2	1
10	2011	8	28	16	0	0.15	0.15	0.15	0.15	0.15	2	0.15	2	0.5
11	2011	8	28	18	0	0.15	0.15	0.15	0.15	0.15	1.5	0.15	1.75	0.15
12	2011	8	28	20	0	0.15	0.15	0.15	0.15	0.15	0.15	0.15	1	0.15
13	2011	8	28	22	0	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14	2011	8	29	0	0	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15

The format is straight-forward. The first line is the file type identifier, "XY_OV_DEPTH_INTERP". The second line is the number of different locations. The remaining lines are Year Month Day Hour Minute [data values].

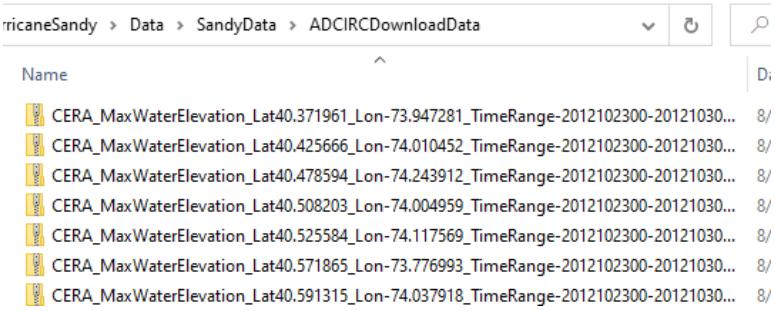
We will need to re-make this entire file. Starting from the right format, however, will make the process much simpler.

3. Obtain storm surge data.

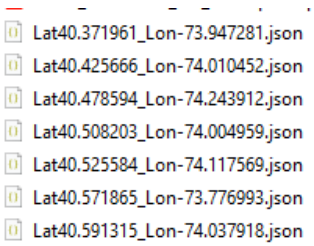
OPTION A: Access the CERA website (https://cera.coastalrisk.live/) and download data. If you have access to the CERA historical data, or live data if you are modeling a current storm, you can use their interface to select locations and download the corresponding ADCIRC modeled data. Select the forecast/hindcast data set you want, and then select a set of points, one by one, that covers the spatial changes in the harbor area well. For each point you'll need to click on the download link.



You'll end up with a set of files that looks like this:



Once you have the files downloaded you'll want to extract the ".json" files from the zip archive.



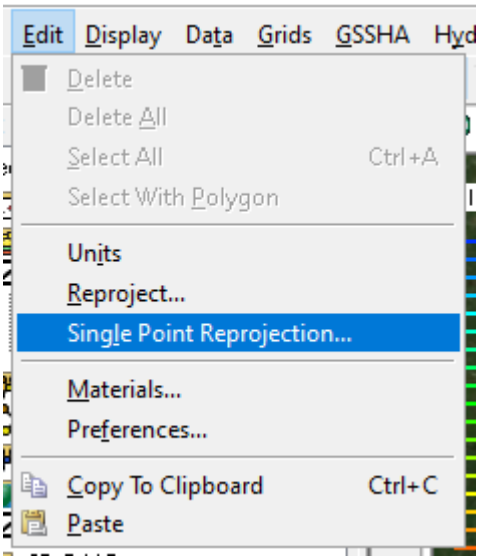
Notice that in the file name is the lat/lon coordinate of the point.

OPTION B: Use the already downloaded data in the *Data/SandyData\ADCIRCDownloadData* folder.

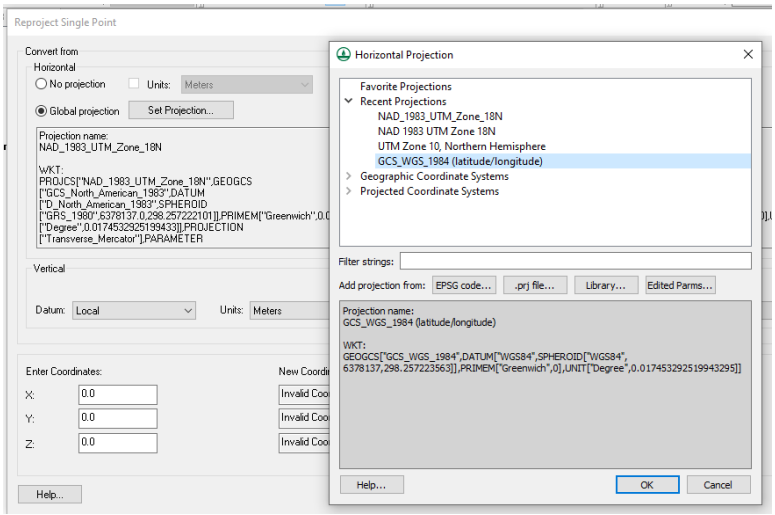
4. For the remainder of this exercise, we'll complete the spreadsheet of the downloaded data. The spreadsheet is in the *Data\SandyData\ADCIRCDownloadData*

5. Use WMS to do a coordinate conversion from Geographic NAD83 to UTM Zone 18N.

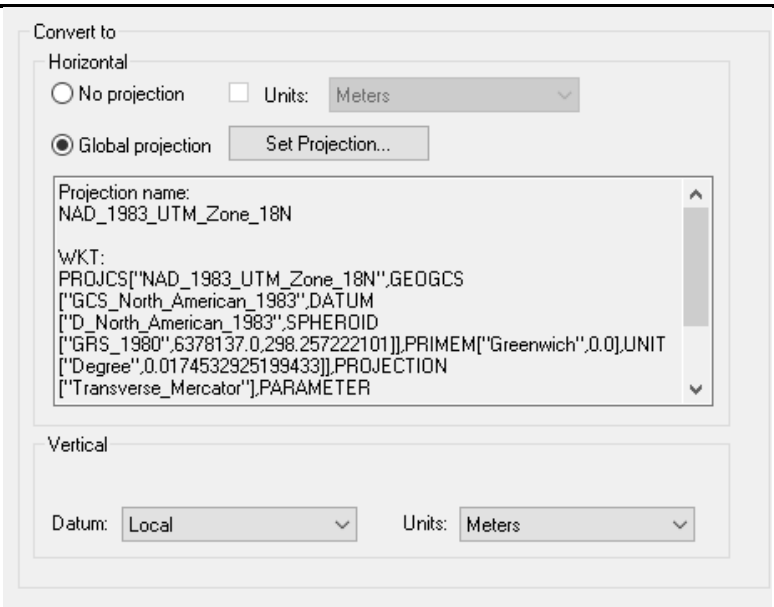
   A. In WMS, use the Edit | Single Point Reprojection option to bring up the reprojection dialog.



   B. In the Reprojection dialog, on the "Convert From" side, select "Global Projection". Select the "Set Projection" button and choose the "GCS_WGS_1984 (Latitude/Longitude)" option. If it doesn't appear in the recent projections, you can find it under Geographic Coordinate Systems, World, WGS 1984. Select OK to close the Horizontal Projection dialog box.



   C. On the "Convert To" side, select "Global Coordinate System" as well. Make sure NAD 83 UTM Zone 18N comes up.

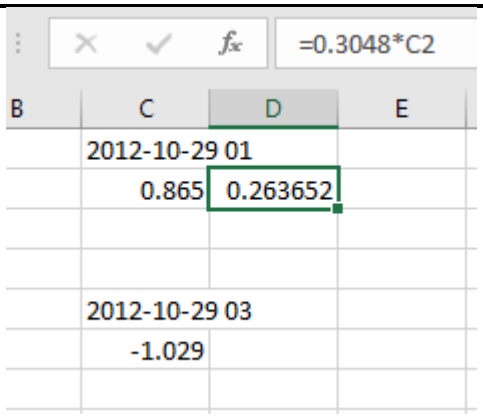


D. Put in the lat/lon values of the last file location and take note of the X/Y values. Put the X/Y values in the "Sandy_surge_xyts" worksheet in the spreadsheet, cells L3 and L4. This should be the results:

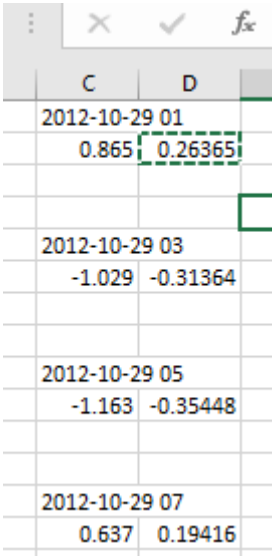
Lat	-74.037918
Lon	40.591315
X	581410.9
Y	4493835.5

E. From the JSON files, extract the data points. We'll just finish the last file and add the data to the spreadsheet. There are many ways of getting the data. The important thing to note is that the data needs to be converted from feet to meters. This sequence uses Excel.

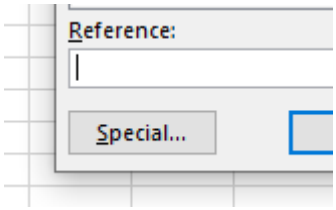
- Open the "Lat40.591315_Lon-74.037918.json" file in Excel.
- Select Column A.
- Do Text to Columns, with a delimeter of :
- Select Column B
- Do Text To Columns, with a delimiter of "
- Delete rows 1 to 295 (this will make the first hour of the 29th at the top of the worksheet)
- In cell D2, type in the formula "=C2*0.3048".



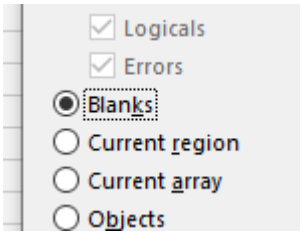
- Copy/paste this formula in column D in front of the other value in the C column.



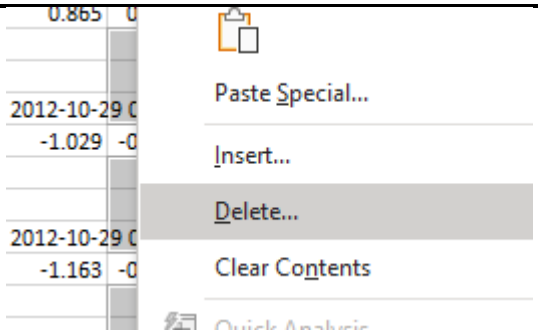
- Select the D column.
- Press F5
- Click on "Special"



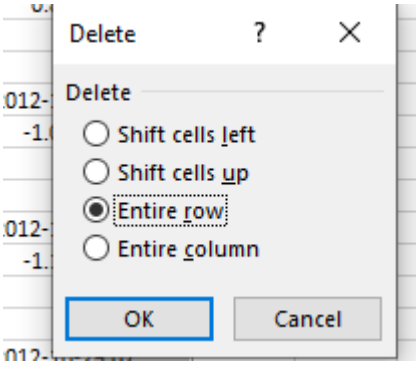
- Select Blanks. Click OK.



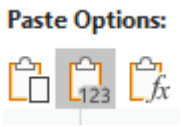
- On one of the selected blank cells, right-click and select Delete.



- Select "Entire Row" and press OK.



- Select Column D.
- Right-Click on D1 and Copy.
- Rick-Click on D1 and Paste Special, values.



- Add the backside of the storm surge curve:
- Copy D11, paste to D13
- Copy D10, paste to D14
- Copy D9, paste to D15
- Copy cells D1 to D15.
- Switch to the Sandy Surge spreadsheet.
- Paste in cell L5 in the Sandy_Surge_xyts worksheet.

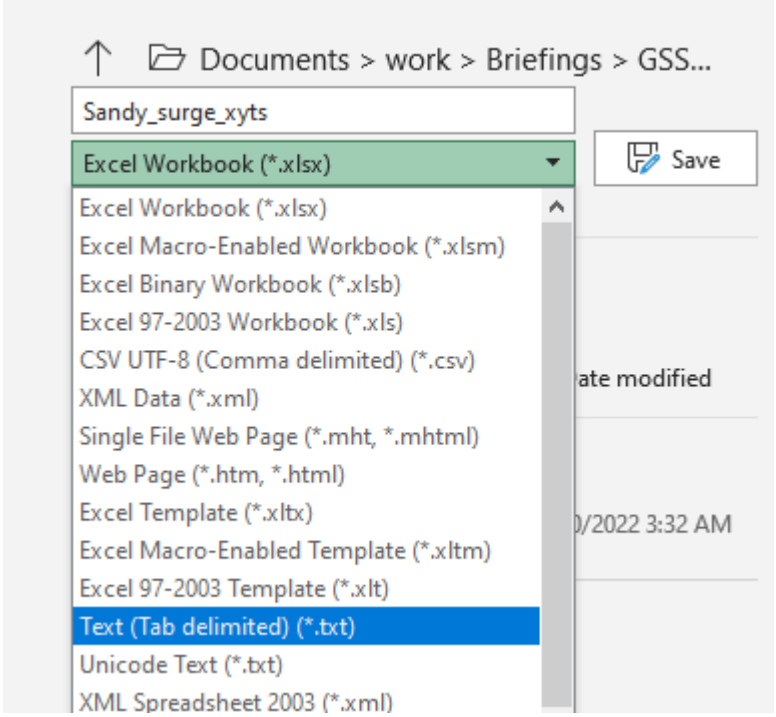
F. The Sandy_surge_xyts worksheet should now be complete. It just needs to be cleaned up of the extra data.

- Erase the Lat and Lon values (E1 to L2)
- Erase E3 and E4. It should now look like the Sandy_surge_xyts_done worksheet.

	A	B	C	D	E	F	G	H	I	J	K	L
1	XY_OV_DEPTH_INTERP											
2	7											
3	X					589371.1	583941.4	564086.9	584304.1	574743.8	603520.7	581410.9
4	Y					4469574.4	4475473.8	4481153.2	4484640.8	4486468.6	4491950.4	4493835.5
5	2012	10	29	1	0	0.2359152	0.3127248	0.3557016	0.2493264	0.2889504	0.1959864	0.263652
6	2012	10	29	3	0	-0.248412	-0.2642616	-0.2249424	-0.2816352	-0.2916936	-0.2862072	-0.3136392
7	2012	10	29	5	0	-0.2734056	-0.3194304	-0.2517648	-0.3203448	-0.3279648	-0.3102864	-0.3544824
8	2012	10	29	7	0	0.2633472	0.2127504	0.2764536	0.2188464	0.2136648	0.2328672	0.1941576
9	2012	10	29	9	0	0.9439656	0.939744	1.0814304	0.9518904	0.9857232	0.9144	0.9381744
10	2012	10	29	11	0	1.2316968	1.4176248	1.5249144	1.2981432	1.3816584	1.1774424	1.3011912
11	2012	10	29	13	0	0.9119616	1.1533632	1.3463016	0.9729216	1.09728	0.789432	0.9506712
12	2012	10	29	15	0	0.5907024	0.7952232	1.1103864	0.6483096	0.7571232	0.4666488	0.5650992
13	2012	10	29	17	0	1.1070336	1.313688	1.8031968	1.1972544	1.3508736	1.0070592	1.1030712
14	2012	10	29	19	0	2.4426672	2.6895552	3.13182	2.6343864	2.7840432	2.442972	2.5965912
15	2012	10	29	21	0	3.0547056	3.633216	4.0763952	3.4695384	3.7255704	3.0184344	3.4856928
16	2012	10	29	23	0	3.0675072	3.4942272	4.0669464	3.4802064	3.72618	3.080004	3.5271456
17	2012	10	30	1	0	3.0547056	3.633216	4.0763952	3.4695384	3.7255704	3.0184344	3.4856928
18	2012	10	30	3	0	2.4426672	2.6895552	3.13182	2.6343864	2.7840432	2.442972	2.5965912
19	2012	10	30	5	0	1.1070336	1.313688	1.8031968	1.1972544	1.3508736	1.0070592	1.1030712

G. Save the spreadsheet.

H. "Save As" the spreadsheet and change the type to Text (Tab Delimited).



I. Change the folder to the *Workspace\NewYork_Sandy_Hindcast* folder.

J. Select Yes to replace the file.

K. Select OK when Excel warns you that it can only save the active worksheet.

6. You can now exit Excel and run the Hurricane Sandy GSSHA model.