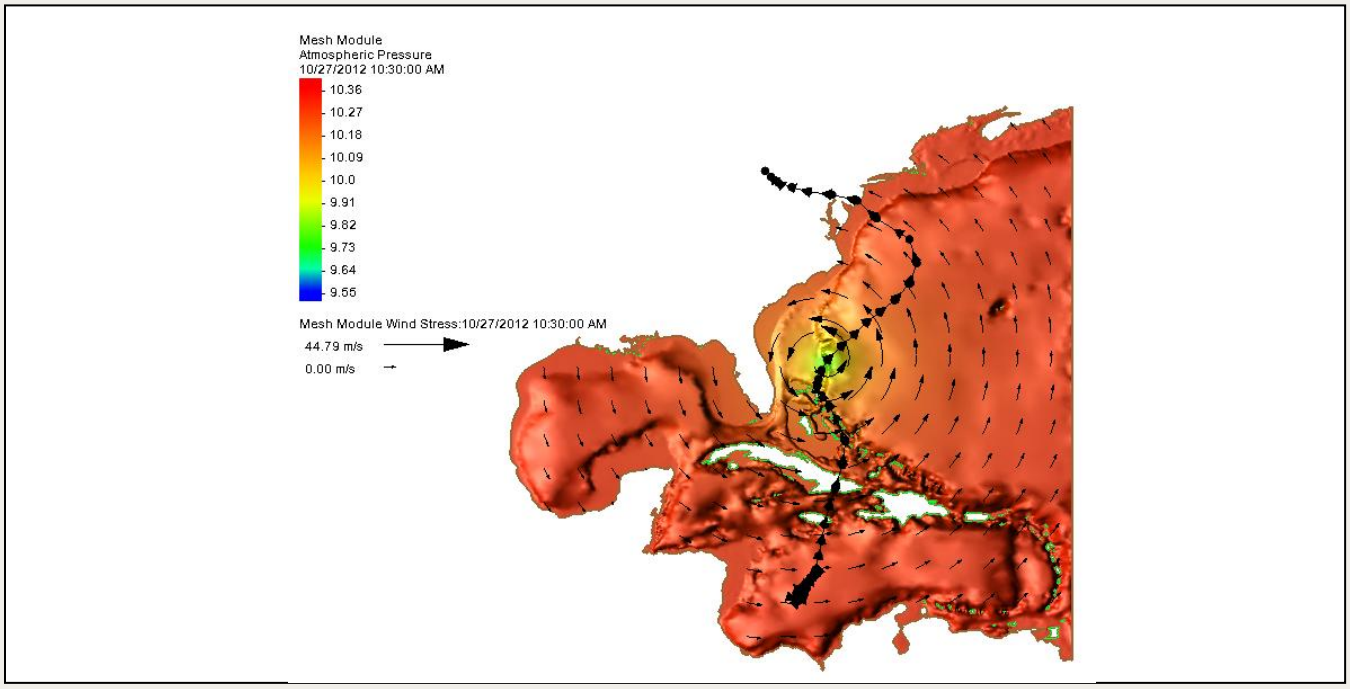
SMS 14.0 Tutorial

NWS 8 Meteorologic Run



Objectives

This tutorial demonstrates how to load and view an ATCF storm into SMS and apply that storm to an ADCIRC meteorologic only simulation. This could be a preprocess to including this type of storm in a hydrodynamic ADCIRC simulation.

Prerequisite Tutorials

- Overview
- Map Module
- Raster
- Background Data
- Simulation Domain
- Mesh Generation
- Mesh Quality
- ADCIRC Simulation

Required Components

- SMS Core

Time

- 15–20 minutes

1 Introduction

This exercise illustrates how to perform a meteorologic only simulation using an Automated Tropical Cyclone Forecast (ATCF) data file in the Surface-water Modeling System (SMS) to increase numerical stability.

This exercise utilizes a mesh of the western north Atlantic. The meteorologic simulation can be performed on a small domain, but tidal surge usually includes impacts over large areas, so the typical application includes at least regional domains.

2 Getting Started

Start by importing a project file containing an existing mesh:

1. Launch the SMS application.
2. From the *Menu* bar, select the *File* | **Open…** menu item to bring up the *Open* dialog.
3. From the *Files of type* drop-down menu, select “Project Files (*.sms)”.
4. Navigate to the *Exercises/WNAT* folder.
5. Select the “WNAT_mesh.sms” file.
6. Click the **Open** button to import the project and exit the *Open* dialog.

The initial project should appear similar to Figure 1.

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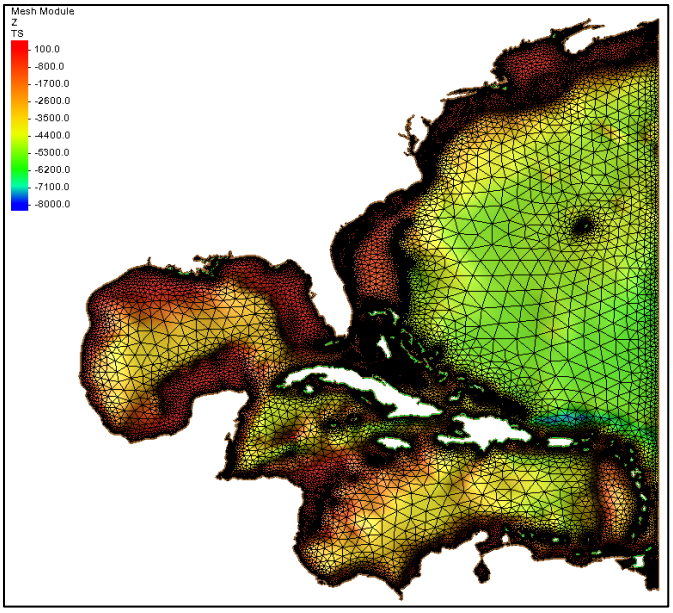

Figure 1: Initial Project

3 Supported Mesh Formats

This tutorial makes use of an existing project to initialize the display settings and contents for consistency. Typically, an effort of this type will begin with a geometric mesh. You may create this mesh as illustrated in one of the mesh generation tutorials, or they may come from external sources. SMS supports a number of mesh formats including:

- Native ADCIRC format (fort.14).
- Aquaveo/SMS formats (.xmc (ascii & binary), .h5, .2dm).
- Stereolithography formats (.stl (ascii & binary)).
- ParaView formats (.vtu ascii & binary).

Samples of each of these file formats, containing the mesh used in this tutorial are included in the *Extra Exercises/WNAT/External Data/mesh formats* folder.

The most compact and efficient formats (both for size and speed) are the binary formats.

Some of these formats are loaded into SMS as UGrids (Unstructured Grids). This is an alternate geometry format being added to SMS. It currently does not perform as optimally as the traditional *mesh* format, but it is more flexible. It supports both node centric and cell centric datasets.

A UGrid can be converted to a mesh and vice versa by right clicking on the object and selecting “Convert”.

4 Saving the Project

To prevent overwriting the initial data provided for this tutorial you can save the project to the work folder. To do this:

1. From the *Menu* bar, select the *File* | **Save As...** menu item to open the *Save As* dialog.

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2. Navigate to the *Extra Exercises/WNAT/work* folder.
3. For the *File name,* enter "WNAT_met_only.sms".
4. Click the **Save** button to save the file and close the *Save As* dialog.

5 ATCF File (Best track)

This tutorial illustrates the use of the Automated Tropical Cyclone Forecast (ATCF) file format which is provided by NOAA's National Hurricane Center. This format is also known as the "Best Track". We will use the data from Hurricane Sandy.

5.1 Previewing a Storm Online

NOAA provides a graphical viewer to review storms. To access this:

1. Open a web browser and browse to: https://www.nhc.noaa.gov/archive/2012/
2. Click on the **Hurricane Sandy** link from the list of Atlantic storms. Note: this is the 18th storm in the list for 2012.
3. Click on the **Graphics Archive** link near the top of the page.
4. Click on the **3-Day Track Forecast, Uncertainty Conde, and Watch Warning** link.
5. Experiment with the different graphics listed on the left side of the window.
6. Return to SMS.

5.2 Download the Data

For this tutorial, the data for hurricane Sandy has been included in the *Extra Exercises/WNAT/External Data/atcf-best track* folder.

NOAA also maintains an archive of historic storms in ATCF format available at:
https://ftp.nhc.noaa.gov/atcf/archive/
(Note: this can be found from a google search for the term "atcf archive")

If you wish to download this data for yourself:

1. Go to URL indicated above and scroll to the year **2012** and click to open the folder.
2. Click on the **bal182012.dat.gz** link to download the file.
3. Uncompress the GZ file.

Note: Hurricane Sandy was storm 18 in the Atlantic basin in 2012, the name of this file can be broken down into parts. The "b" indicates the forecast type. The "al" refers to the Atlantic basin, as opposed to "ep" for the eastern Pacific. The "18" refers to the storm number, and "2012" refers to the year.

The archive includes four "decks", or types of forecast data including:

- "a" deck – all forecasts
- "b" deck – historical / hindcast
- "e" deck – probability
- "f" deck – parameters

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Of these four, the “b” deck is the concise representation most suitable for inclusion in SMS.

5.3 Load the Data

To load the storm data into SMS:

1. From the *Menu* bar, select the *File* | **Open…** menu item to bring up the *Open* dialog.
2. From the *Files of type* drop-down menu, select “All files (*.*)”.
3. Browse to the directory where you extracted the “bal182012.dat” file. (It is included in *Exercises/WNAT/External Data/atcf-best* track in case the internet is not available).
4. Click the **Open** button to import the project, exit the *Open* dialog, and open the *Open File Format* dialog.
5. Select the *Select File Type* radio button.
6. From the drop-down menu, select the “ATCF best track wind (*.atcf)” menu item.
7. Click the **OK** button to close the *Open File Format* dialog and import the file into the *Map Data* folder.

Note: Drag and drop functionality also works for this file type.

Note: Renaming the file with an “.atcf” extension will allow SMS to recognize the file format.

SMS will load the storm data into a cyclonic storm coverage, and the storm path will appear. Figure 2 illustrates this path. The contours have been turned off from this display for clarity.

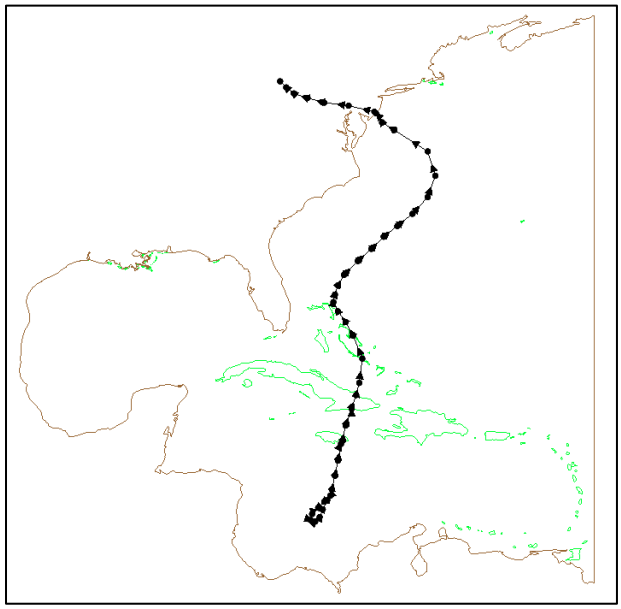

Figure 2: The Storm Track

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6 Review the Storm

SMS loads the ATCF file by default as a symmetrical Holland cyclonic storm. This corresponds to the *NWS = 8* option in ADCIRC. This can be modified to simulate more complex wind options. The most common of these would be the *NWS = 20 (GAHM)* option.

6.1 Storm Attributes

SMS refers to variations of how a wind coverage is used as the storm attributes. To view the type of coverage:

1. In the *Project Explorer,* right-click on the "bal182012" coverage and select the *Cyclonic Wind Properties* context menu item to open the *Storm Attributes* dialog.
2. Review the *Storm Attributes* dialog. By default, the *Holland Symmetrical* radio button is selected, and the *Basin* and *Subregion* are set to Atlantic.
3. Click the **OK** button to close the *Storm Attributes* dialog.

6.2 Storm Parameters

The ATCF file includes a parametric definition of the storm at different date/time snaps. For each time record, the parameters for the storm include:

- Location of the storm center (lat/lon).
- Maximum sustained wind speed (knots).
- Minimum sea level pressure (mb).
- Radius of the last closed isobar (nautical miles).
- Radius of maximum winds (nautical miles).

There are actually many more parameters that can be used to describe the storm, but these are the parameters required for the *ADCIRC NWS = 8* format.

To review this storm data:

1. From the *Dynamic Tool* bar, click on the **Select Feature Point** tool.
2. In the *Graphic Window,* double-click on any node in the storm path to open the *Storm Track Node Attributes* dialog.
3. Review the table (Figure 3). Note: the dialog is resizable.

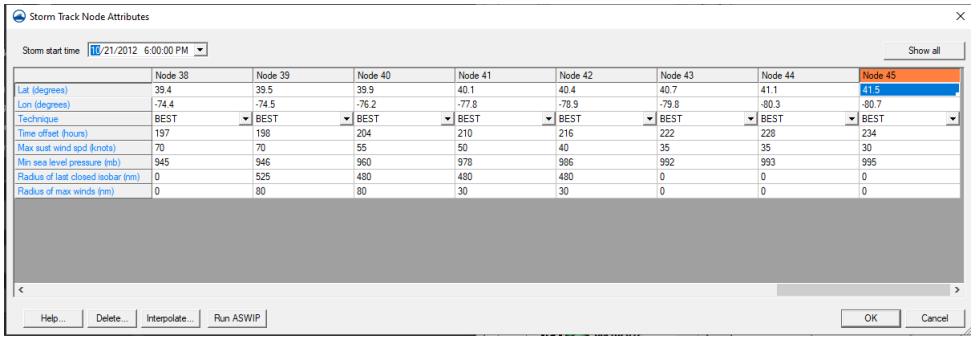

Figure 3: The Storm Parameters

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4. Make note of the *Storm start time* (10/21/2012 6:00:00 PM) and storm duration from the *Time offset (hours)* row (234 hours at node 45).
5. You may want to click the **Show all** button to see the full table of parameters.
6. Click the **OK** button to close the *Storm Track Node Attributes* dialog.

7 Meteorologic-only Boundary Condition

All ADCIRC simulations require a mesh and a boundary condition coverage. The mesh was loaded as part of the project. For this simulation all mesh boundaries will be treated as closed (land) boundaries since no hydrodynamics will be performed.

7.1 Create the Boundary Condition Coverage

First, we need to create a boundary condition coverage for a meteorologic-only run. To create the boundary conditions:

1. In the *Project Explorer,* right-click on the "WNAT 53K" object and select the *Convert* | **Mesh** → **Map** context menu item to open the *Mesh* → *Map* dialog.
2. Select the *Mesh Boundaries* → *Polygons* radio button.
3. Click the **Create New Coverage** button to open the *New Coverage* dialog.
4. Set the *Coverage Type* to "Models | ADCIRC | **Boundary Conditions**".
5. For the *Coverage Name,* enter "Met Only BC".
6. Click the **OK** button to close the *New Coverage* dialog.
7. Click the **OK** button to close the *Mesh* → *Map* dialog.

7.2 Apply the Boundary Condition

Second, we need to apply the boundary condition coverage by selecting arcs.

1. From the *Dynamic Tool* bar, click on the ***Select Feature Arc*** tool.
2. In the *Graphics Window,* right-click anywhere and choose the **Select All** context menu item.
3. In the *Graphics Window,* right-click anywhere again (with all the arcs selected) and choose the **Assign BC…** context menu item to open the *Assign Linear BC* dialog.
4. From the *Linear boundary condition options* drop-down menu, for the *Boundary type,* select "Island", and then the *Boundary condition* drop-down menu appears.
5. From the *Boundary condition* drop-down menu, select "Natural".
6. Click the **OK** button to close the *Assign Linear BC* dialog.
7. In the *Graphics Window,* double-click anywhere on the outer boundary of the domain. The *Assign Linear BC* dialog appears again.
8. From the *Linear boundary condition options* drop-down menu, for the *Boundary type,* change the type "Mainland".
9. Click the **OK** button to close the *Assign Linear BC* dialog.

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8 ADCIRC simulation

Now with a mesh and a boundary condition coverage we can proceed to set up the simulation.

8.1 Create the Simulation

Create the simulation and add the mesh and boundary condition coverages. To do this:

1. Create a new ADCIRC simulation. In the *Project Explorer,* right-click in the white space and select the *New Simulation* | **ADCIRC** context menu item. A new folder for the simulation is created in "Simulation Data/ ADCIRC Simulations/ Sim".
2. Right-click on "Sim" and select the **Rename** context menu item.
3. For the name, enter "Met only Sandy".
4. Add the mesh to the simulation. In the *Project Explorer*, from the *Mesh Data* folder, drag the *WNAT 53K* mesh to the *Met only Sandy* simulation until a line appears below the simulation name then drop the mesh.
5. Add the boundary condition coverage to the simulation. From the *Map Data* folder, drag the *Met Only BC* coverage to the *Met only Sandy* simulation until a line appears below the simulation name, then drop the coverage.
6. Add the storm track coverage to the simulation. From the *Map Data* folder, drag the *bal182012* coverage to the *Met only Sandy* simulation until a line appears below the simulation name, then drop the coverage.

8.2 Setup the Simulation Parameters

Enter the simulation parameters into the model control.

1. Right-click on the *Met only Sandy* simulation and select the **Model Control** context menu item to open the *Model Control* dialog and set the following parameters:
2. Select the *General Parameters* tab and enter the following parameters:
    a. For the *Project title,* enter "Hurricane Sandy case study".
    b. For the *Run ID*, enter "version 1".
3. Select the *Timing* tab and enter the following parameters:
    a. In the *Interpolation reference date* section, set the storm date to "10/21/2012 6:00:00 PM".
    b. In the *Timing* section, for the *Time step (seconds),* enter "300" seconds (5 minutes).
    c. For the *Length of run (days),* enter "9.75" days (234 hours).
4. Select the *Wind* tab and enter the following parameters:
    a. In the *NWS* section, select the "NWS = 8 – Symmetric cyclonic storm from path" drop-down menu item.

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b. In the *Wind track coverage parameters* section, for the *Storm start date,* enter “10/21/2012 6:00:00 PM”.

5. Select the *Output* tab and enter the following parameters:
   a. In the *Output files* section, in the *Default* row enter:
      i. For *Start (days),* enter “0.0”.
      ii. For *End (days),* enter “30.0”.
   b. In the *Global elevation* row:
      i. Turn on the “Override Default” checkbox.
      ii. For the *Output,* select the “Off” drop-down menu item.
6. Click the **OK** button to close the *ADCIRC Model Control* dialog.

Note: Turning off hydrodynamic output puts ADCIRC into a meteorological-only mode.

8.3 Run the Simulation

Save the project, run the simulation and load the solution.

1. In the *Project Explorer,* right-click on the *Met only Sandy* simulation, and select the **Save the Project, Simulation and Run** menu item to open the *Simulation Run Queue* dialog.
2. If a coverage renumbering warning dialog appears, click the **Yes** button to continue.
3. When the simulation is complete, in the *Simulation Run Queue* dialog, click the **Close** button, to close the *Simulation Run Queue* dialog.
4. Load the solution. In the *Project Explorer,* right-click on the *Met only Sandy* simulation and select the **Read Solution** context menu item. The *Solution* folder will be added under the simulation. The *Time steps* window will appear under the *Project Explorer.*

9 Review output

For a meteorologic only simulation, the solution consists of:

- Pressure (units).
- Wind.

To review the solution:

9.1 Prepare the Display

1. In the *Time steps* window, right-click on the *Time steps* title and select the **Time Settings** context menu item to open the *Time Settings* dialog.
2. In the *Time display* section, from the *Display as* drop-down menu select the **Absolute Date/Time** drop-down menu item.
3. Click the **OK** button to close the *Time Settings* dialog.
4. Click on the “ Atmospheric Pressure” solution dataset to make it active.

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5. From the *Macro* bar, click on the **Display Options** macro to open the *Display Options* dialog.
6. From the list on the left, select the “2D Mesh” option.
7. From the section on the right, select the “2D Mesh” tab.
    a. Turn off the *Elements* checkbox.
    b. Turn on the *Vectors* checkbox.
8. Select the *Vectors* tab.
    a. In the *Vector display placement and filter* section, from the *Display* drop-down menu, select the “on a grid” drop-down menu item.
    b. From the *Origin* drop-down menu item, select the “relative to max elevation” drop-down menu item.
    c. In the *Arrow options* section, for *Maximum pixels,* enter “50”.
    d. Turn on the *Arrows follow flow path* checkbox.
9. Click the **OK** button to close the *Display Options* dialog.

9.2 Viewing Storm Node Attributes

Storm Attributes can be viewed at various points along the storm track.

1. In the *Time steps* window, select the timestep at 10/29/2012 at midnight 12:00:00 AM.
2. From the *Static* tool bar, select the **Zoom** tool.
3. In the *Graphic Window,* zoom to the center of the storm.
4. From the *Dynamic* tool bar, click on the **Select Feature Point** tool.
5. In the *Graphic Window,* double-click on the node in the storm path nearest the center of the storm to open the *Storm Track Node Attributes* dialog.
6. In the spreadsheet, if necessary, scroll right to “Node 33”. Note that the time is 174 hours into the storm (10/29/2012 at midnight) and the *Min sea level pressure (mb)* is 950.

Note the spreadsheet can be used to find values of interest such as lowest pressure.

9.3 Deleting “Blank” Values

Open the storm parameters and note that the “radius” values at these times are not specified. These are incomplete lines in the ATCF file and need to be filtered out. This can be done in the ascii file, or in the parameters dialog.

1. In the *Time steps* window, step through the times.

Note “blank” values at times when the eye of the storm is making landfall or emerging from land back to the ocean. To open the storm parameter dialog:

2. In the *Project Explorer,* select the **bal182012** storm coverage to make it active.
3. From the *Dynamic* tool bar, click on the **Select Feature Point** tool.

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4. In the *Graphic Window,* double-click on any node in the storm path to open the *Storm Track Node Attributes* dialog.
5. In the spreadsheet, note the *Radius of last closed isobar (nm)* and *Radius of max winds (nm)* rows for values of 0. For example, “Node 16”.
6. Click the **Delete** button to remove “Node 16”. Other nodes with *Radius of…* = 0 values can also be deleted.
7. Click the **OK** button to close the *Storm Track Node Attributes* dialog.

Note the impact of lower mesh resolution (“winking”).

10 Conclusion

This concludes the “ADCIRC Nodal Attributes” exercise. Several features have been demonstrated including:

- ATCF files.
- Meteorologic only run.
- Meteorologic output.

If time permits, you may wish to try experimenting with:

- Delete “blank” data values and rerun.
- Use HURDAT database instead of ATCF.
- Converting to NWS 20.
- Adding wind to tidal data.

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