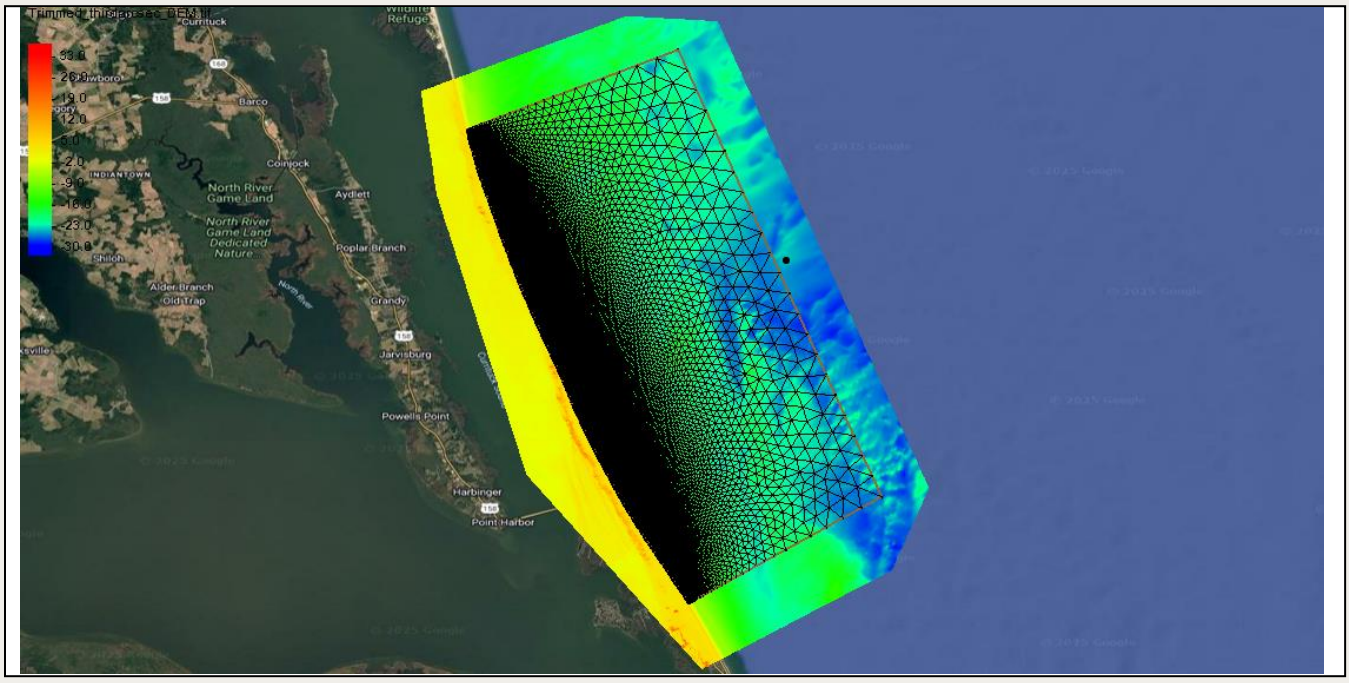
SMS 13.4 Tutorial

WaveWatch III

Overview of the WaveWatch III Interface in SMS



Objectives

Learn how to set up a WaveWatch III simulation and export the simulation files.

Prerequisite Tutorials

- None

Required Components

- SMS Core

Time

- 10–20 minutes

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1 Introduction

This tutorial covers the steps of creating the data files for a WAVEWATCH III® (WW3) simulation in the Surface-water Modeling System (SMS).

WW3 models waves and how waves interact with the coast.

For wavenumber-direction spectra, WW3 solves the random phase spectral action density balance equation. This equation assumes that the properties of water depth, current, and the wave field will vary on much larger time and space scales compared to that of a single wave.

Wave spectrum propagation can be solved using unstructured triangular grids, or rectilinear or curvilinear regular grids. Options for this model include wetting and drying of grid points for tidal zones and shallow-water, surf zone applications.

The online manual for SMS (https://www.xmswiki.com/wiki) includes detailed explanation of SMS.

The online manual for WW3 (https://polar.ncep.noaa.gov/waves/wavewatch/) includes more detail on the model.

A WW3 simulation consists of the following components:

- an unstructured grid (UGrid) or mesh of triangular cells/elements
- a wave energy spectra defined at a specified location
- a set of model parameters

This tutorial begins with some of the components having already been created. Specifically, the 2D mesh used for the simulation has already been generated. An example of how a mesh like this can be generated is found in the “Mesh Generation” tutorial.

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, select “Project Files (*.sms)”.
4. Browse to the *data files* folder for this tutorial and select “start.sms”.
5. Click the **Open** button to import the project and exit the *Open* dialog.

The project should appear similar to Figure 1. The project contains an elevation raster, a coarse mesh covering that raster and a couple of display themes that will be used later. Refer to the display themes tutorials for more information on creating display themes.

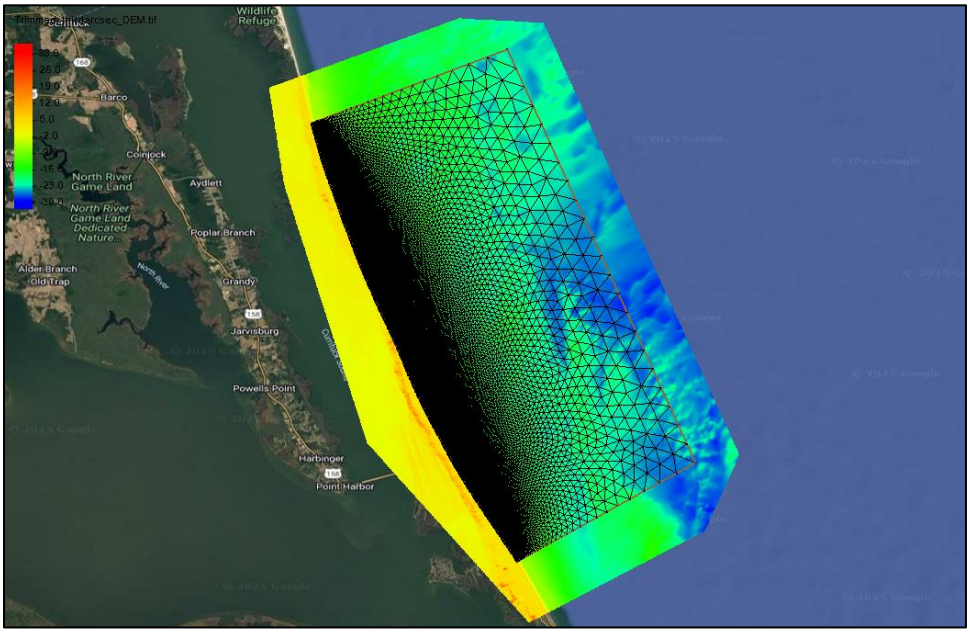

Figure 1 Initial project

3 Define Wave Spectra

In addition to a mesh, WW3 requires a set of wave conditions to be simulated.

3.1 Define a Spectral Coverage

Wave conditions are represented as wave spectra, associated with a specific geographic location. SMS manages these on a spectral coverage.

To illustrate this:

1. In the Project Explorer, right-click on “ Map Data” and select the **New Coverage** context menu item to bring up the *New Coverage* dialog.
2. In the *Coverage Type* section, under the *Generic* section, select “Spectral”.
3. For the *Coverage Name,* enter “Global_Spectra”.
4. Click the **OK** button to close the *New Coverage* dialog and create the new “ Global_Spectra” coverage in the Project Explorer.
5. In the Project Explorer, right-click on “ Map Data” and select the **New Folder** context menu item.

6. Right-click on the new folder, select the **Rename** context menu item, and enter "WW3" for the name.
7. Drag the "Global_Spectra" coverage to be under the "WW3" folder.

3.2 Define Spectral Point (Location of the Spectra)

The location associated with wave conditions is defined as a spectral point in the spectral coverage.

To illustrate this:

1. From the Dynamic tool bar, use the **Create Feature Point** tool, to create a feature point somewhere near the middle of the offshore boundary in the Graphics Window as in Figure 2.

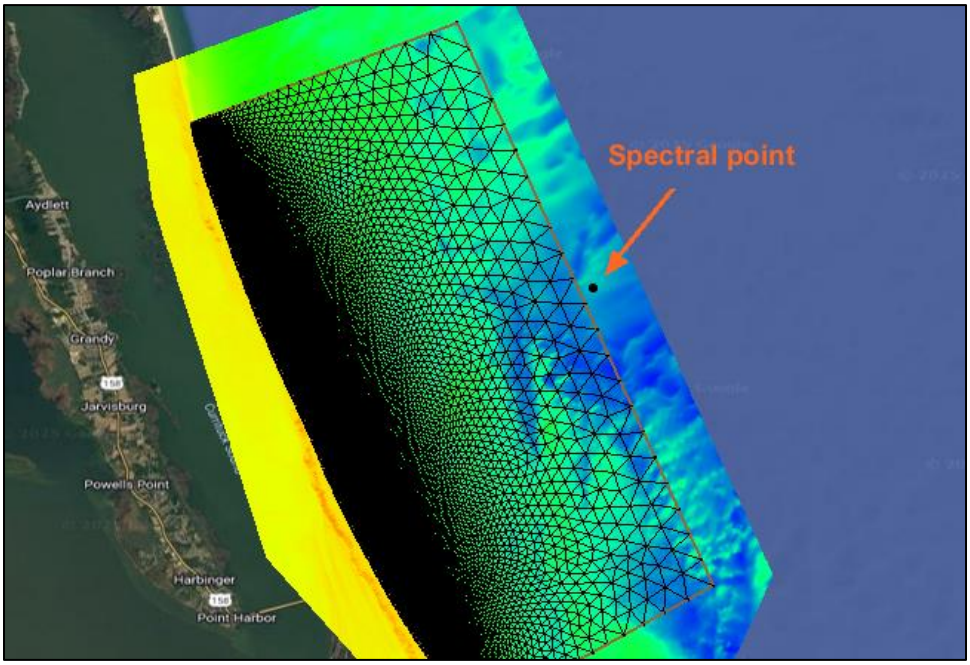

Figure 2 Spectral point general location

3.3 Define Spectral Grid

WW3 requires a specific type of spectral grid. This grid is created in SMS as an attribute of the spectral point.

To illustrate this:

1. From the Dynamic tool bar, use the **Select Feature Point** tool, to select the newly created point.
2. Double-click on the point to bring up the *Spectral Energy* dialog.
3. In the *Spectral Manager* section, click the **Create Grid** button to open the *Spectral Grid Attributes* dialog.
4. From the *Spectral energy grid plan type* drop-down menu, select "Global".
5. Click the **OK** button to close the *Spectral Grid Attributes* dialog and open the *Create Spectral Energy Grid* dialog.

6. In the *Frequency Distribution* section, from the drop-down menu, change the “Delta” drop-down option to “Power series”.
7. Click the **OK** button to close the *Create Spectral Energy Grid* dialog and return to the *Spectral Energy* dialog. In the Spectral Viewer section, a polar plot appears.

WW3 requires power series distributions for frequencies in the spectral grid.

3.4 Set the Spectral Time

Wave spectra may be associated with a specific point in time. This is particularly true when using wave data from a global monitoring or simulation source such as WIS. In SMS it is often recommended to set the “Zero” time for the wave spectra.

1. In the *Spectral Energy* dialog, under the *Spectral Manager* section, click the **Update Reference Time** button to open the *Time Settings* dialog.
2. Set the *Reference Time* based on when the data was recorded.
3. Click the **OK** button to close the *Time Settings* dialog and return to the *Spectral Energy* dialog.

3.5 Define Spectral Energy Distribution

The wave spectra are composed of energy density values for each direction and frequency. These can be measured (field data) or generated from parameters. This example will generate the spectra from parameters.

To illustrate this:

1. In the *Spectral Energy* dialog, under the *Spectral Manager* section, click the **Spectra** button to open the *Generate Spectra* dialog.
2. In the *Parameter* Settings section, under *Seaward Boundary Depth*, select *Specify once for all spectra* and enter “20.0” for the value in meters (m).
3. In the "Spectral Parameters" table enter the following values:
4. As values in the first row, enter "0.0, 45, 1.0, 3.0, 3.3, 4".
5. As values in the second row, enter "1.0, 90, 3.0, 5.0, 3.3, 4".

	Time Offset (hrs)/Index	Angle (deg)	Hs(m)	Tp (s)	Gamma	nn
1	0.0	45	1.0	3.0	3.3	4
2	1.0	90	3.0	5.0	3.3	4

6. Click the **Generate** button to close the *Generate Spectra* dialog.
7. In the *Spectral Energy* dialog, under the *Spectral Manager* section, under the *Global* folder, click on the *Spectral Time Offset Index* numbers to preview the

energy distributions on the polar plot, see Figure 3.

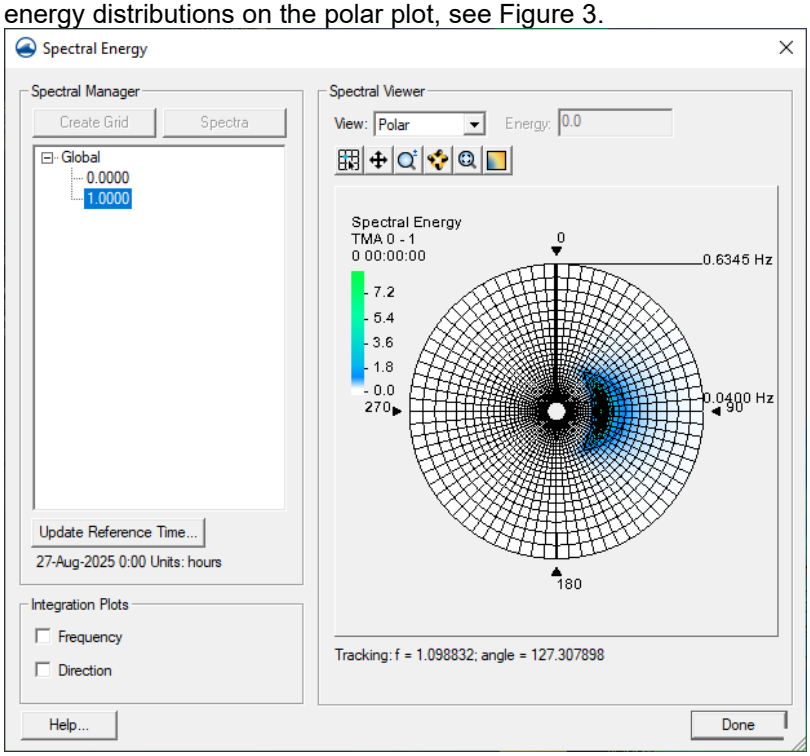

Figure 3: Spectral Energy Dialog with Polar Plot

8. Click the **Done** button to close the *Spectral Energy* dialog.
9. From the *Menu* bar, click the *File* | **Save Project** menu item.

Notes:

- The spectral point location would normally come from a location where spectral data is available.
- Spectra from buoys or databases can be imported.
- The dates associated with spectral data can be imported or specified.
- The "Spectral Parameters" table can be copied/pasted from a spread sheet.

4 Define Boundary Conditions

WW3 also requires that the attributes of the various boundaries of the domain are specified.

4.1 Define a Boundary Condition Coverage

Boundary conditions (BC) are also done using a map module in SMS. To create this coverage (layer):

1. In the Project Explorer, right-click on "Map Data" and select the **New coverage** context menu item to open the *New Coverage* dialog.
2. Set the "Coverage Type" to "*Models* | *WaveWatch3* | *Boundary Conditions*".
3. For the *Coverage Name*, enter “BC 1”.
4. Click the **OK** button to close the New Coverage dialog.

5. In the Project Explorer, drag the " BC 1" coverage into the " WW3" folder.

4.2 Define the Boundary Condition Arcs

Specification of boundary conditions in SMS is managed separately from the mesh. This allows the same boundary conditions to be applied to multiple meshes if desired. Arcs in a boundary condition coverage define the location of the different types of boundaries.

Define arcs around the wave field area of interest in the sea. To define these arcs:

1. From the Dynamic tool bar, select the **Create Feature Arc** tool.
2. Click somewhere near the intersection of the coastline and the north lateral boundary.
3. Double-click near the intersection of the north lateral boundary and the offshore boundary.
4. Click on the end of the newly created arc to start a new arc.
5. Double-click near the intersection of the south lateral boundary and the offshore boundary.
6. Click on the end of the newly created arc to start a new arc.
7. Double-click near the intersection of the south lateral boundary and the coastline arc, see Figure 4.

Notes:

- The arcs that were created to define the domain could also have been used rather than digitizing new arcs in the boundary condition coverage.

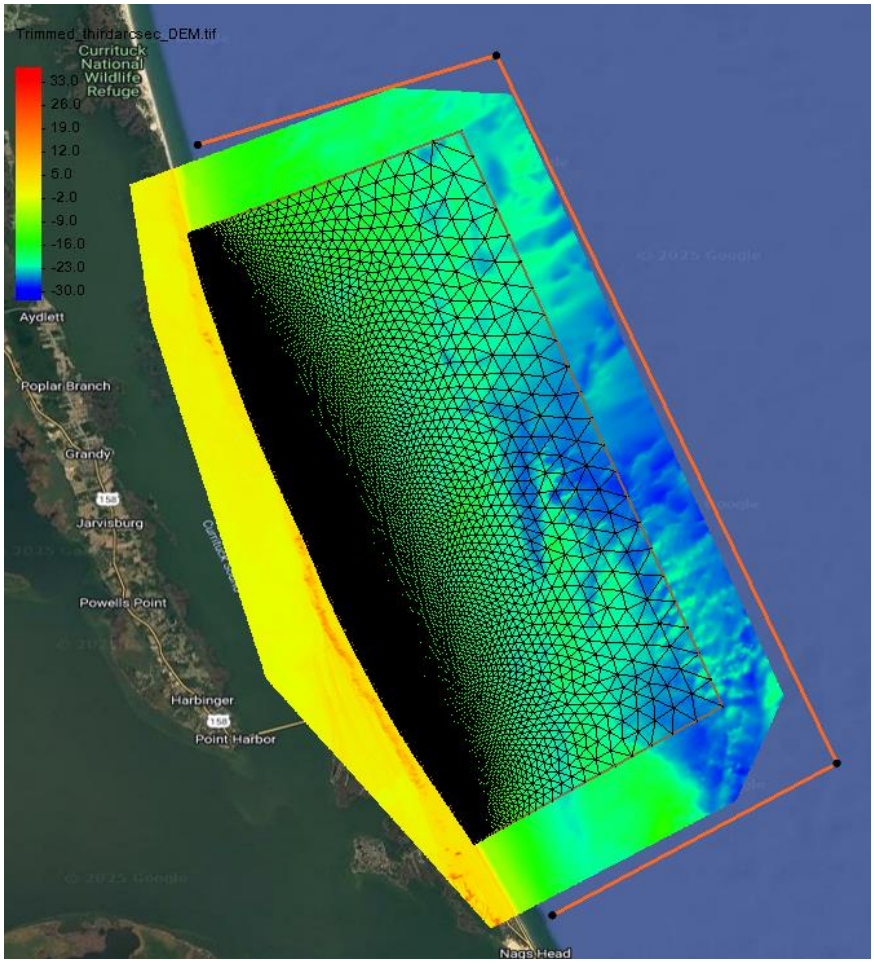

Figure 4: Boundary Condition Arcs

4.3 Define the Boundary Condition Types

Each arc in a Boundary Condition coverage is assigned a type, which instructs WW3 how that boundary is to be treated.

To assign these types:

1. From the Dynamic tool bar, switch to the **Select Feature Arc** tool.
2. Double-click on the arc near the north lateral boundary to open the *Arc Properties* dialog.
3. Turn on the "Lateral" checkbox.
4. Click the **OK** button to close the *Arc Properties* dialog.
5. Double-click on the arc near the south lateral boundary to open the *Arc Properties* dialog.
6. Turn on the "Lateral" checkbox.
7. Click the **OK** button to close the *Arc Properties* dialog.
8. Double-click on the arc near the offshore boundary to open the *Arc Properties* dialog.

9. Turn on the "Input" checkbox.
10. Click the **OK** button to close the *Arc Properties* dialog.
11. From the Menu bar, select the *File* | **Save Project** menu item.

Notes:

- The boundary condition arcs will be snapped to the boundary automatically later on. They just need to be close to where they need to be for now.

5 Assemble the Simulation

An SMS project can include multiple WW3 simulations. Each simulation is a collection of a mesh, a spectral coverage and a boundary condition coverage, along with simulation run parameters.

5.1 Create the Simulation

The first step in defining a simulation is creating a blank simulation to hold the components. To do this:

1. In the Project Explorer, in a blank area, right-click and select the *New Simulation* | **WaveWatch3** context menu item.
2. The "Simulation Data" folder appears and populates with the "WaveWatch3 Simulations" Model Simulation folder and the "Sim" Simulation item.
3. Right-click on the "Sim" Simulation item, select the **Rename** context menu item, and rename the simulation to "FRF Case 1".

5.2 Add Components to the Simulation

The simulation is assembled by adding components to it. To do this:

1. In the Project Explorer, from the "Mesh Data" folder, drag the "45-1500 m Mesh" onto the "FRF Case 1" simulation (black drop location line will appear).
2. From the "Map Data" folder, in the "WW3" folder, drag the "Global_Spectra" coverage onto the "FRF Case 1" simulation.
3. From the "Map Data" folder, in the "WW3" folder, drag the "BC 1" coverage onto the "FRF Case 1" simulation.

Notes:

- Components can also be added to a simulation by right clicking on the component.
- You can also create an "Output points" coverage and add it to the simulation.

5.3 Set Model Parameters

The run options or model parameters are assigned to the simulation. To do this:

1. In the Project Explorer, right-click on "FRF Case 1" and select the **Calculate Default Timestep...** context menu item to fill in default values for timesteps.

2. An Info dialog will open saying that default timestep values were saved in model control. Press the **OK** button to continue.
3. Right-click on "FRF Case 1" and select the **Populate Spectral Parameters...** context menu item to fill in default values for spectral parameterization.
4. An Info dialog will open saying that default spectral parameters were saved in model control. Press the **OK** button to continue.
5. Right-click on "FRF Case 1" and select the **Model Control...** context menu item. The *Model Control* dialog will open.
6. From the list on the left, select the *Grids* entry. The associated parameters appear on the right:
7. Set the "Explicit or Implicit" option to the "Implicit" drop-down menu item.
8. Click the **OK** button to close the *Model Control* dialog.
9. Right-click on "FRF Case 1" and select the **Output Field Parameters...** context menu item. The *Output Field* dialog will open.
10. From the list on the left, select the "Forcing fields parameters" entry.
11. From the list on the right, turn on the "Water Depth [DPT]", and "Current velocity [CUR]" checkboxes.
12. From the list on the left, select the "Standard mean wave parameters" entry.
13. Turn on the "Wave height [HS]", "Peak direction [DP]", and "Peak period (from peak freq) [TP]" checkboxes.
14. Click the **OK** button to close the *Output Field* dialog.
15. From the Menu bar, select the *File* | **Save Project** menu item.

Notes:

- Several "Advanced Options" appear in the dialogs used above. These options include parameters that normally will not need to be modified. Default values will be used for these parameters.
- The date/time fields should be consistent with what is specified for the spectra.

6 Export the Simulation Files

SMS has now gathered all the information related to a WW3 simulation. We now need to tell SMS to save the input files for the analysis. To do this and review the files:

1. Right-click on the "FRF Case 1" simulation and select the **Save Simulation** context menu item. If a dialog opens saying that the coverages need to be renumbered before saving, click the **Yes** button to continue.
2. In the Project Explorer, right-click on "Project" and select **Open Project Folder**. This will open a File Explorer browser window of your operating system.
3. In the file browser, opened in the previous step, browse to "start_models\WaveWatch3\FRF Case 1" to find the associated files.

Notes:

- The simulation files for executing WaveWatch3 are saved in this directory.
- These files can be moved to the computation platform of your choice.

7 Conclusion

In this tutorial demonstrated the setup of a WW3 simulation and exported the files for the analysis. The tutorial covered the following:

- Creating spectral coverage and defining spectral wave attributes
- Defining WaveWatch 3 boundary conditions
- Creating and assembling the WaveWatch 3 simulation
- Exporting the WaveWatch 3 files