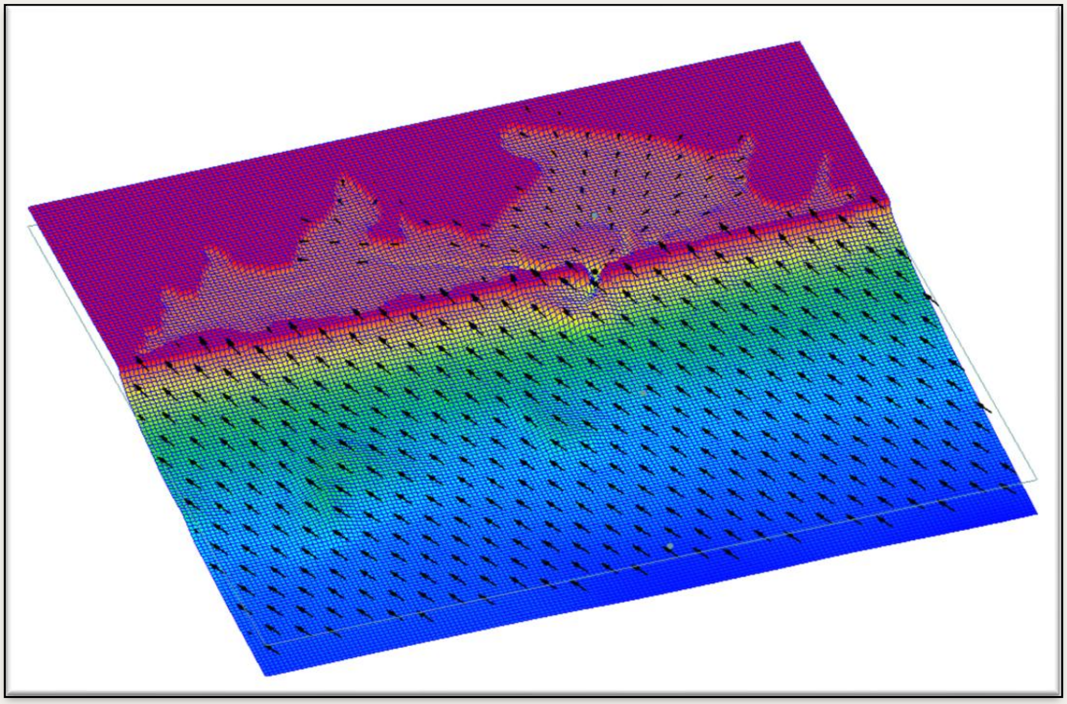
SMS 14.0 Tutorial

STWAVE Analysis

Introduction to using STWAVE



Objectives

This tutorial gives a brief introduction to the STWAVE model. An energy spectra will be created to represent wave conditions and use as a boundary condition. Then the STWAVE model will be set up and launched and model results reviewed.

Prerequisite Tutorials

- Overview
- Map Module
- Grid Generation

Required Components

- SMS Core
- STWAVE Model & Interface

Time

- 20–30 minutes

1 Introduction

This tutorial uses data from the Shinnecock Inlet, Long Island, New York, as an example. A grid has been created over the inlet. See the “Grid Generation” tutorial for more information on how this grid was generated

Start by opening an existing project file. For convenience, projections have already been applied to the data in the project.

To open the file:

1. If necessary, launch SMS.
2. If SMS is already running, select *File* | **New** to ensure that the program settings are restored to their default state.
3. Select *File* | **Open...** to bring up the *Open* dialog.
4. Select the file “shin_start.sms” located in the data file folder for this tutorial and click **Open** to read in the project.

The project should appear containing a Cartesian grid and the data that was used to generate the grid. The Cartesian grid contains an elevation dataset. Remember that the elevation dataset is positive upward (cells below sea level have negative elevation values).

Before continuing, save the project under a different name to preserve the original project file. To save the simulation:

1. Select *File* | **Save As** to open the *Save As* dialog.
2. Make sure the *Save as type* is set to “Project Files (sms),” and enter the *File name* “shin.sms”.
3. Click the **Save** button to close the *Save As* dialog and save the project.

2 Generating Spectral Energy Distribution

To generate the spectral energy distribution:

1. Right-click on “Map Data” in the project explorer and select **New Coverage** to open the *New Coverage* dialog.
2. Select the *Coverage Type* as **Spectral**.

3. Enter a *Coverage Name* as "Spectral" then click **OK** to close the *New Coverage* dialog.

4. Using the **Create Feature Point** tool, create a point along the middle of the bottom grid boundary as shown in the Figure 1. Exact placement is not important. It can be inside or outside of the grid.

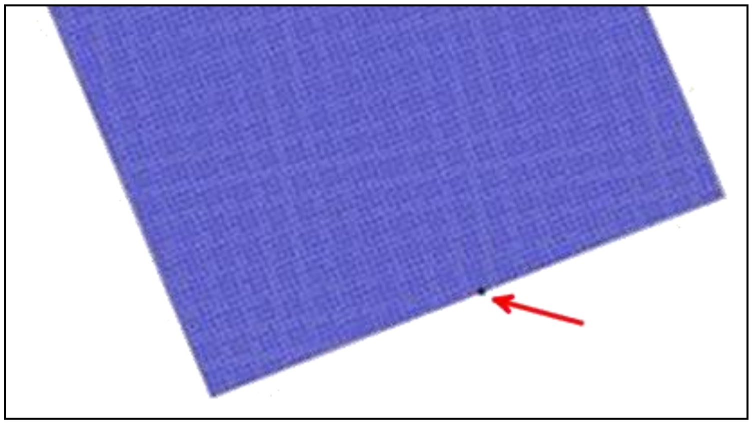


Figure 1 Spectral point location

5. Use the **Select Feature Point** tool and double-click on the point to open the *Spectral Energy* dialog.

6. Click on the **Update Reference Time…** button to make the *Time Settings* dialog appear.

7. For the *Reference time*, enter "04/05/2018 12:00 AM".

The reference time only needs to be set if wave data for a specific date/time will be used. SMS defaults the reference time to the start of the current day. It is necessary to know what reference time is being used when setting up a STWAVE simulation.

8. Click **OK** to close the *Time Settings* dialog.

9. In the *Spectral Manager* section, click **Create Grid** to bring up the *Spectral Grid Attributes* dialog.

Leave the *Grid angle (degrees)* as it is computed from the grid and "Local" as the *Spectral energy grid plane type.* This orients the spectra to the active grid. Alternatively, wave conditions could be defined in a global convention.

10. Click **OK** to close the *Spectral Grid Attributes* dialog and open the *Create Spectral Energy Grid* dialog.

11. Click **OK** to create a new spectral energy grid and close the *Create Spectral Energy Grid* dialog.

This grid represents frequencies from a minimum of 0.04 to 0.34 Hz (3 to 25 second waves). The new spectral energy grid will appear in the *Spectral Manager* tree control. And a preview of the new grid appears in the *Spectral Viewer*.

12. Click the **Spectra** button to open the *Generate Spectra* dialog.

13. Enter the following parameters into the spreadsheet.

Time Offset (hrs)/Index	Angle (deg)	Hs (m)	Tp (s)	Gamma	nn
0.0	25.0	1.0	18.0	7.0	26
1.0	25.0	1.0	12.0	4.0	10

2.0	25.0	1.0	6.0	3.3	4

This tutorial assumes that the wave gauge is approximately at the offshore edge of the grid. Therefore:

14. Under the *Seaward Boundary Depth,* select *Specify once for all spectra* and enter “32” meters.

If the gauge was in deeper water, specify the actual depth of the gauge.

15. Click the **Generate** button to close the *Generate Spectra* dialog.

Three new spectrum time steps should appear below the grid in the spectral energy tree. The "0.0000", “1.0000” and “2.0000” represent the time offset from the reference time in hours. The reference time is displayed below the tree control. This case illustrates how separate wave conditions can be illustrated as time steps.

16. Select each spectrum ("0.0000", “1.0000” and “2.0000”) in turn.

The contours show the energy distribution. The 18.0 second wave is quite focused and concentrated while the 6.0 second wave is much more distributed. Select cell corners to view/edit their energies. Feel free to experiment with rotating the spectra or viewing the frequency and/or direction distribution plots.

17. Click **Done** to exit the *Spectral Energy* dialog.

3 Assigning Monitoring Cells

STWAVE supports two methods for generating transformed spectra inside the domain. These include “Observation Cells” and “Nesting Points”. Functionally, these two options are almost identical. They are both supported to match the historic functionality of the engine. This exercise will use “Observation Cells”. This requires defining the location of the observation cells by completing the following:

1. Right-click on “Map Data” in the project explorer and select **New Coverage** to open the *New Coverage* dialog.
2. Set the *Coverage Name* as "Observation Cells" and click **OK** to close the *New Coverage* dialog.

This coverage will be used for locations only, so the coverage type does not matter.

3. Using the **Create Feature Point** tool, create a point inside Shinnecock Bay as shown Figure 2.

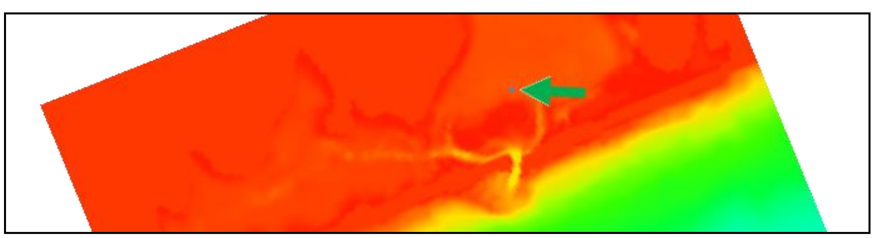


Figure 2 The first selected cell (indicated by arrow)

4. To illustrate putting this observation point at a specific location, such as at the location of a buoy, with the point still selected, change the X and Y coordinates in the Edit Window to “428397” for *X* and “77920” for *Y*.

5. Repeat steps 3–4 to add two more points with the coordinates (428501,76036) and (429701,71986). One of these is in the inlet and the other is offshore.

4 Setting up the STWAVE Simulation

The SMS interface for STWAVE uses a simulation-based representation. The simulation based approach allows for reuse of grids, spectral coverages and other model components. Multiple simulations can be created in a single SMS project file.

4.1 Creating the Simulation

To create the simulation:

1. Right-click in empty area of the Project Explorer and select *New Simulation* | **STWAVE**.

A new " STWAVE Simulations" group will appear in the Project Explorer along with a new simulation named " Sim".

2. Right-click on the " Sim" simulation and select **Rename**.
3. Enter the name "shin_half" for the simulation and press *Enter*.

4.2 Adding the Components to the Simulation

An STWAVE simulation consists of a grid (basis of computations), spectra data, and model parameters. The components already exist in the Project Explorer, now they must be linked to the new simulation. Two methods exist to link the components. This section illustrates both.

To add the components:

1. In the Project Explorer, right-click on the " 100m" object and select *Apply to* | **STWAVE Simulations→shin_half**.

Notice the " 100m" grid item has been added under the " shin_half" simulation. The " 100m" grid item creates a link between the simulation and the grid which tells the simulation to use the specified grid during the model run. If multiple simulations were in the project, the same grid can be linked to more than one simulation. Any changes to the grid will automatically be updated in every simulation using that grid.

Now to add a map coverage to the simulation.

2. Click-and-drag the " Spectral" coverage down to the " shin_half" simulation. As the cursor moves below the simulation name, a black line appears indicating this object can be added to this simulation. Let go of the mouse button to drop the " Spectral" coverage into the simulation.

The simulation will now make use of both the grid geometry with the spectral and monitor cell map coverages.

5 Setting the Model Control

In the *Model Control* dialog, STWAVE inputs can be set for use in the model run. The dialog contains multiple tabs which will be discussed below.

5.1 General Parameters

The *Parameters* tab contains general settings for the model run. Set the following options.

1. Right-click on the " shin_half" simulation and select **Model Control** to bring up the *Model Control* dialog.
2. In the *Parameters* tab, select "Half plane" for the *STWAVE Plane Mode*.
3. Change the *Source Terms* to "Propagation Only".

This means that wind conditions will not be specified to simulate wave generation in the domain.

4. Leave the other settings at their default and continue to the next section.

5.2 Boundary Control

The *Boundary Control* tab contains options for assigning spectral data for the model run.

1. Select the *Boundary control* tab in the *Model Control* dialog.
2. Leave "Spectral coverage" selected in the *Source* combo box.

SMS associates the spectral coverage that was added to the simulation, so it doesn't need to be selected here.

3. Click the **Populate** button to automatically enter a case for the spectra defined in the coverage.

Note: while it is common for the computational spectrum grid and the times for the cases to match the spectral coverage, it is not required. SMS will redistribute the spectral energy and interpolate between spectral times if needed.

5.3 Output Control

The *Output Control* tab contains additional options for outputting results from the STWAVE model run.

1. Select the *Output control* tab in the *Model Control* dialog.
2. Turn on *Use monitoring cells*. This instructs STWAVE to compute full spectra at the specified locations.
3. Click *Select* to open the *Select Monitoring Cell Coverage* dialog.
4. Select the "Observation Cells" coverage.
5. This defines the locations that will be passed to STWAVE.
6. Click OK to close the *Select Monitoring Cell Coverage* dialog.

5.4 Iteration Control

The *Iteration control* tab contains options when running in full plane mode. These options will not be used at this time.

1. Select **OK** to exit the *Model Control* dialog.

6 Running STWAVE

To run STWAVE:

1. Right-click on the " shin_half" simulation in the Project Explorer and select **Save Project, Simulation and Run**. The *Simulation Run Queue* dialog will appear.
    a. If a message such as "stwave.exe – not found" is given, click the file browser button to manually find the STWAVE executable.

A *Simulation Run Queue* dialog will show the progress of the STWAVE run. It may take a few minutes for the model run to finish.

2. When STWAVE finishes, select **Load Solution**.

The solution will be loaded into SMS.

3. Select *Edit* | **Time Settings…** to bring up the *Time Settings* dialog.
4. Set *Display as* to "Absolute Date/Time".
5. Click OK to close the *Time Settings* dialog.

SMS has several visualization options to view the solution.

6.1 Visualizing the STWAVE Solution

To see the solution results:

1. Select *Display* | **Display Options** to bring up the *Display Options* dialog.
2. Select "Cartesian Grid" from the list on the left.
3. Turn on the *Contours* and *Vectors* options. Turn off the *Cells* option.
4. Select the *Contours* tab. Verify the *Contour Method* select "Color fill". Also verify the *Transparency* is set to "30" percent.
5. Click on the **Color Ramp…** button. This will bring up the *Choose color ramp* dialog.
6. Select the *Color Ramp Shader* ramp in the *Aquaveo* section.
7. Click **OK** to close the *Choose color ramp* dialog.
8. Select the *Vectors* tab. Make sure the *Shaft Length* is set to "Define min and max length" and set the *Min length* to "10" and the *Max length* to "35".
9. Under *Vector Display Placement and Filter,* change the *Display* to "on a grid." Leave the spacing at "30" pixels in each direction and set the *Offset* to "10".
10. Select **OK** to exit the *Display Options* dialog.
11. Click on the "Z Elevation" dataset to make it active.

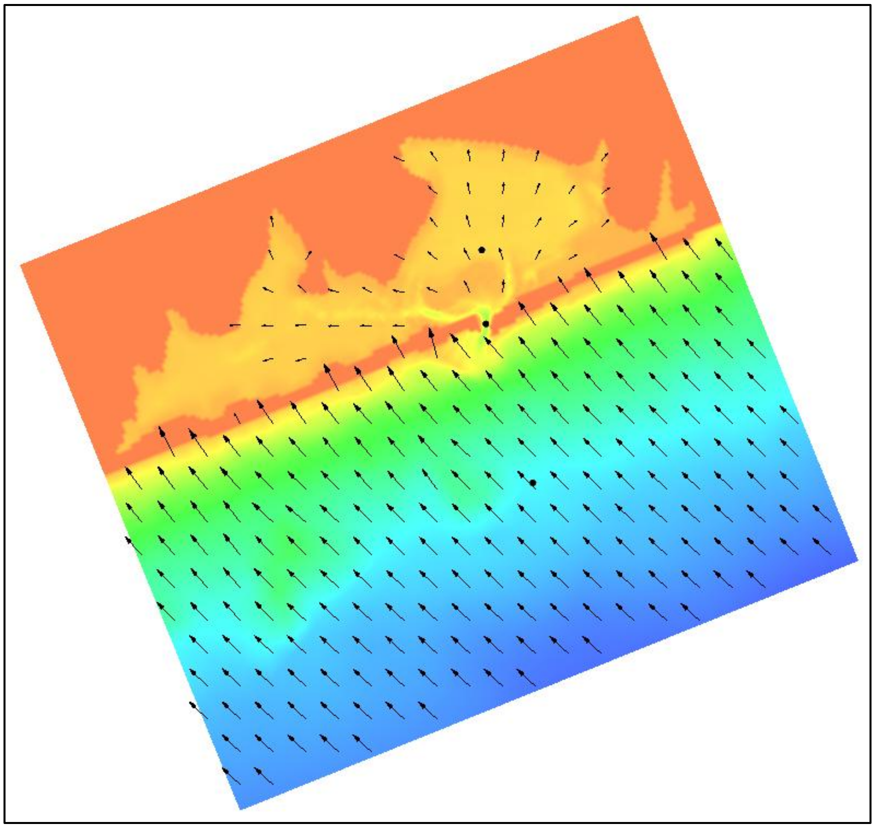


Figure 3 Elevation dataset contours with wave direction vectors.

12. Select the different scalar datasets under the " 100m" grid in the Project Explorer to view their contours and vectors.
13. **Zoom** into the inlet and **Pan** along the coast to view variations.

Notice that the waves do not cover the entire bay. STWAVE is limited on how fast the waves will spread out after going through the inlet.

6.2 Visualizing the Spectral Energy

The spectral energy is recorded at each monitoring station in the grid frame and written by STWAVE to an observation file (*.obse). The observation file is automatically read in at the end of an STWAVE run. The data in this file is put into a spectral coverage. In this case the coverage is named " shin-half - OBSE". To view the spectral energy:

1. In the Project Explorer, select the coverage " shin_half - OBSE" under the " shin_half (STWAVE)" folder to make it the active coverage.

Notice that there are nodes at each of the monitoring locations.

2. To view the data in each location, double-click on the desired node using the **Select Feature Point** tool to bring up the *Spectral Energy* dialog.

Look at the spectral energy at each monitoring station using the *Spectral Viewer*. The ocean station is not much different than the input spectral energy (labeled as *1*). The energy in the inlet has been dissipated, and the direction is now in line with the inlet and the grid. The energy in the bay is even more spread out and dissipated.

3. When finished, select **Done** to exit the *Spectral Energy* dialog.

7 Conclusion

This concludes the “STWAVE Analysis” tutorial. The model contains many more features and capabilities that have not been explored in this document. Refer to the STWAVE User’s manual and SMS help file found in *Help* | **SMS Help…** for more information.