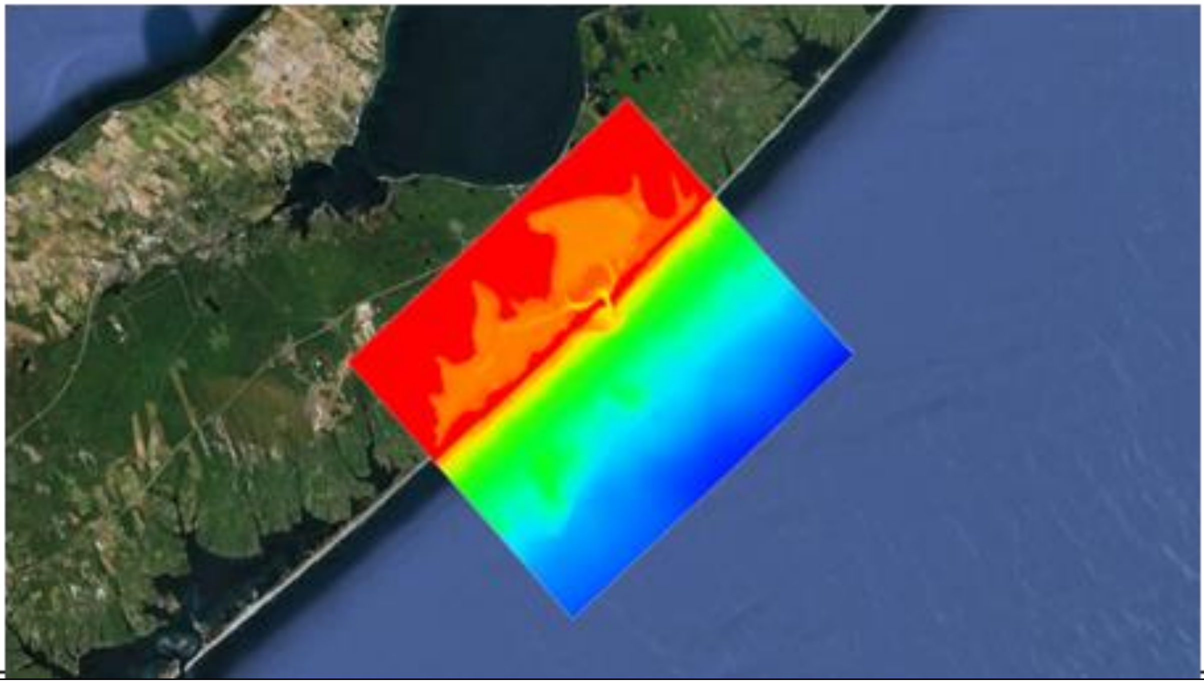
SMS

v. 12.2

SMS 12.2 Tutorial

CMS-Wave Analysis



Objectives

This workshop gives a brief introduction to the CMS-Wave interface and model. This model is similar to STWAVE and the tutorial for the models is similar. As with the STWAVE tutorial, data from the Shinnecock Inlet, Long Island, New York, is used. A CMS-Wave grid will be created over a small section of the scatter set.

Prerequisites

- Overview Tutorial
- CMS-Flow Tutorial

Requirements

- CMS-Wave
- Map Module
- Cartesian Grid Module
- Scatter Module

Time

- 45–60 minutes

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1 Importing Scatter Set Data

1.1 Importing the Scatter Set Data Files

First, open the scatter set data of the area around Shinnecock Inlet on the south shore of Long Island, New York. For convenience, the scatter set data and an XMDF version of the current file are supplied in the *data files* folder for this tutorial.

To open the files:

1. Select *File* | **Open...** to bring up the *Open* dialog.
2. Browse to the *data files* folder and select “shinfinal.h5”.
3. Click **Open** to import the scatter set file and exit the *Open* dialog.

The project should appear similar to Figure 1.

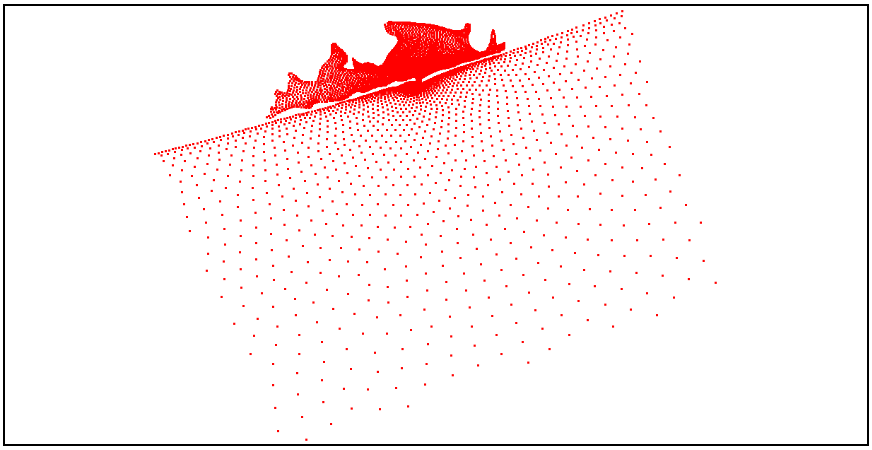

Figure 1 Initial scatter set appearance

1.2 Coordinate Conversions

First, it's necessary to set the display projection to a State Plane coordinate system. Then the coordinates of the objects need to be set to geographic coordinates and reprojected to state plane coordinates for New York Long Island.

To do this:

1. Select *Display* | **Projection…** to open the *Display Projection* dialog.
2. In the *Horizontal* section, select *Global Projection* and bring up the *Select Projection* dialog. If the dialog does not appear, click **Set Projection…** to bring up the dialog.
3. On the *Projection* tab, select "State Plane Coordinate System" from the *Projection* drop-down.
4. Select "New York- Long Island (FIPS 3104)" from the *Zone* drop-down.
5. Select "NAD83" from the *Datum* drop-down.
6. Select "METERS" from the *Planar Units* drop-down.
7. Click **OK** to close the *Select Projection* dialog.
8. In the *Vertical* section, select "Meters" from the *Units* drop-down.
9. Click **OK** to close the *Display Projections* dialog.

Now set the projection for the scatter set:

10. Right-click " split from shinfinal" and select **Projection…** to bring up the *Object Projection* dialog.
11. In the *Horizontal* section, select *Global projection* and click **Set Projection…** to bring up the *Select Projection* dialog.
12. On the *Projection* tab, select "Geographic (Latitude/Longitude)" from the *Projection* drop-down.
13. Select "NAD83" from the *Datum* drop-down.
14. Click **OK** to close the *Select Projection* dialog.
15. In the *Vertical* section, select "Meters" from the *Units* drop-down.
16. Click **OK** to close the *Object Projection* dialog.

The project may disappear from the main view. If this happens, **Frame** the project to make it visible again.

17. Right-click "Area Property" and select **Projection…** to bring up the *Object Projection* dialog.
18. In the *Horizontal* section, select *Global Projection* and click **Set Projection…** to bring up the *Select Projection* dialog.
19. On the *Projection* tab, select "Geographic (Latitude/Longitude)" from the *Projection* drop-down.

20. Select "NAD83" from the *Datum* drop-down.
21. Click **OK** to close the *Select Projection* dialog.
22. Click **OK** to close the *Object Projection* dialog.
23. Right-click " split from shinfinal" and select **Reproject…** to open the *Reproject Object* dialog.
24. If a warning regarding potential round-off errors appears, click **Yes**.
25. In the *Current projection* section in the *Horizontal* subsection, verify the box under *Global projection* begins with "Geographic (Latitude/Longitude)"
26. In the *New projection* section in the *Horizontal* subsection, select *Global projection* and click **Set Projection…** to bring up the *Select Projection* dialog.
27. On the *Projection* tab, select "State Plane Coordinate System" from the *Projection* drop-down.
28. Select "New York Long Island (FIPS 3104)" from the *Zone* drop-down.
29. Select "NAD83" from the *Datum* drop-down.
30. Select "METERS" from the *Planar Units* drop-down.
31. Click **OK** to close the *Select Projection* dialog.
32. In the *New projection* section in the *Vertical* subsection, select "Meters" from the *Units* drop-down.
33. Click **OK** to close the *Reproject Object* dialog.
34. Right-click " Area Property", select **Reproject…**, and repeat steps 24–33.

2 Creating the Cartesian Grid

Now that the projection is set correctly, create a Cartesian grid for running STWAVE. The grid frame is created in the **Map** module, which contains tools for creating GIS objects such as points, arcs, and polygons. It is also used for creating a frame, which will be filled in by a Cartesian grid.

2.1 Creating the Cartesian Grid Frame

To create the grid frame:

1. Switch to the **Map** module.
2. Right-click " Area Properties" in the Project Explorer, select *Type* | *Models* | **CMS-Wave**.
3. Right-click " Area Property" and select **Rename**.
4. Enter "CMS-Wave" and press *Enter* to set the new name.

5. Using the **Create 2-D Grid Frame** tool, click out three corners of the grid in the order shown in Figure 2 to create the grid frame.

The first two points clicked define the i-direction, which is the direction of the incoming waves, and the last two points clicked are placed on the land.

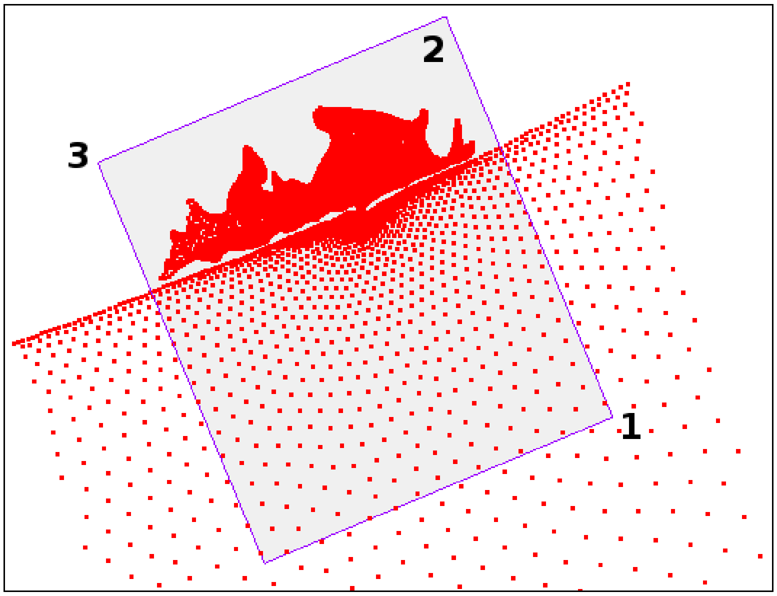

Figure 2 Creating the Cartesian grid frame

6. Using the **Select Grid Frame** tool, click on the selection box in the middle of the grid frame. The origin should be in the bottom right corner of the grid, as indicated by the arrows (Figure 3).

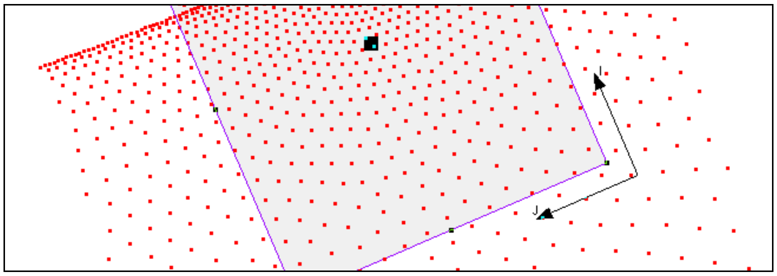

Figure 3 The origin is at the bottom right corner of the grid

7. Resize the grid frame by dragging the corners or edges until the grid frame fits over the desired area.

Dragging a corner or side resizes the frame. Dragging the middle point moves the entire frame. Rotate the frame around the origin by dragging the circle located at the top right corner just outside the grid.

8. Double-click on the grid to bring up the *Grid Frame Properties* dialog.

The origin and angle can be manually entered in this dialog. This allows for greater precision in placement of the grid.

9. In the *Origin, Orientation and Dimensions* section, enter “438,000” as the *Origin X*.
10. Enter “70,000” as the *Origin Y*.
11. Enter “112.0” as the *Angle*.
12. Enter “15,000” as the *I size* and “17,000” as the *J size*.

These values can also be edited when generating the 2-D grid in section 2.2.

13. Click **OK** to close the *Grid Frame Properties* dialog.
14. Click outside the grid frame to unselect the grid.
15. **Frame** the project.

2.2 Mapping to the Grid

Next, fill the interior of the grid. While the grid is filling, the depth and current values will be interpolated from the scatter set and mapped to each cell.

To do this:

1. Select *Feature Objects* | **Map→2D Grid** to bring up the *Map → 2D Grid* dialog.
2. Verify the values in the *Origin, Orientation and Dimensions* section match those given in steps 9–12 in section 2.1.
3. In both the *I Cell Options* and *J Cell Options* sections, select *Cell size* and enter “100.0” in the field to the right of each.
4. In the *Depth Options* section, select “Scatter Set” from the *Source* drop-down, then click **Select…** to bring up the *Interpolation* dialog.
5. In the *Scatter Set To Interpolate From* section, select “elevation” from the tree list.
6. In the *Interpolation Options* section, enter “-2.0” as the *Single Value*.

This makes sure that areas in the Cartesian grid with no scatter data will not have any flow during the simulation. It is important to take this step if elevation data for land masses is not available.

7. Click **OK** to exit *Interpolation* dialog.
8. In the *Vector Options* section, turn on *Map Vector* and enter “Current” in the field to the right.
9. Select *Interpolated* and click **Select** to bring up the *Interpolation* dialog.
10. In the *Scatter Set To Interpolate From* section, select the “Depth-averaged Velocity (64)” scatter set.
11. In the *Time Step Interpolation* section, select *Single Time Step* and select “0 02:20:00” from the drop-down.
12. Click **OK** to exit the *Interpolation* dialog.

13. Click **OK** to exit the *Map → 2D Grid* dialog and create the Cartesian grid.

The project should appear similar to Figure 4.

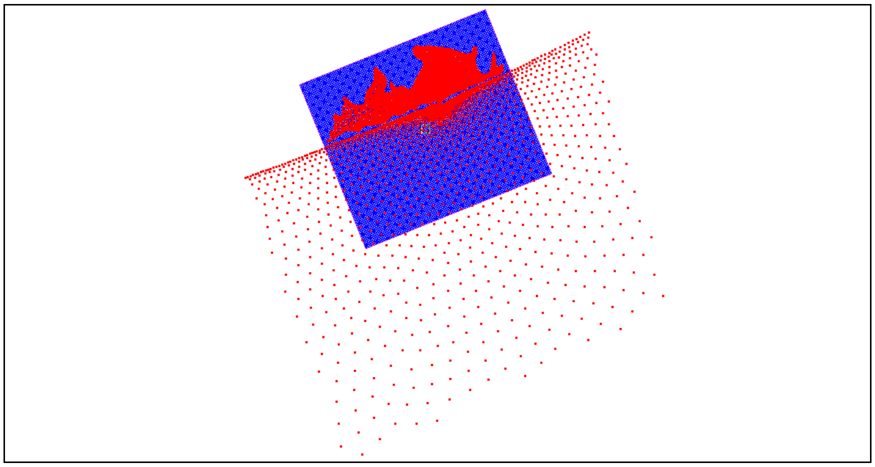

Figure 4 Cartesian grid with the scatter set

It is easiest to interpolate currents when creating the 2-D grid even if not using currents until a later simulation. Whether to use currents can be chosen in the CMS-Wave model control. When interpolating, specify a single time step or multiple steps. Single times come from any time in the dataset. For multiple steps, specify to match all the steps from the dataset, or specify a beginning and ending time step and a time step size.

A Cartesian grid has been created from the grid frame. To view only the grid:

1. Turn off " Scatter Data" in the Project Explorer.
2. **Frame** the project.
3. Select *Display* | **Display Options…** to bring up the *Display Options* dialog.
4. Select "Cartesian Grid" from the list on the left.
5. On the *Cartesian Grid* tab, click **All Off** and turn on *Contours*.
6. On the *Contours* tab, in the *Contour method* section, select "Color Fill" from the first drop-down.
7. Click **OK** to close the *Display Options* dialog.

The project should appear similar to Figure 5.

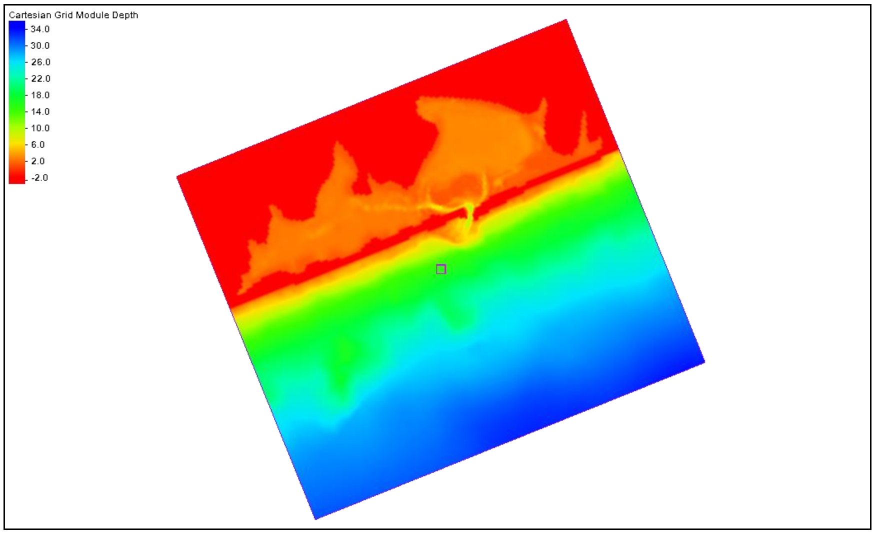

Figure 5 Cartesian grid with contours

3 Editing the Grid and Running STWAVE

3.1 Generating Spectral Energy Distribution

Now generate the spectral energy distribution by doing the following:

1. Right-click " Map Data" in the Project Explorer and select **New Coverage** to bring up the *New Coverage* dialog.
2. In the *Coverage Type* section, select *Generic* | **Spectral**.
3. Enter "Spectral" as the *Coverage Name*.
4. Click **OK** to close the *New Coverage* dialog.
5. Using the **Create Feature Point** tool, create a node near the middle of the bottom grid boundary (see arrow in Figure 6).

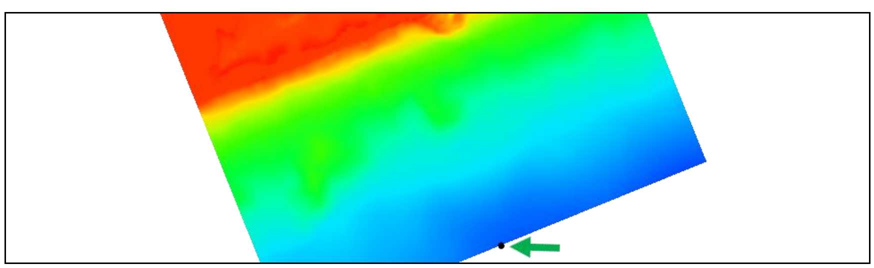

Figure 6 Node near the middle of the bottom grid boundary

6. Using the **Select Feature Point** tool, double-click on the node to bring up the *Spectral Energy* dialog.

7. In the *Spectral Manager* section, click **Create Grid** to bring up the *Spectral Grid Attributes* dialog.
8. Enter “112.0” as the *Grid angle*.

This matches the angle of the CMS-Wave grid.

9. Select “Local” from the *Spectral energy grid plane type* drop-down.
10. Click **OK** to close the *Spectral Grid Attributes* dialog and open the *Create Spectral Energy Grid* dialog.
11. In the *Frequency Distribution* section, enter “40” as the *Number*.
12. Click **OK** to create a new spectral energy grid and close the *Create Spectral Energy Grid* dialog.

The new spectral energy grid will appear in the *Spectral Manager* section below the four buttons at the top. This section is the spectral energy tree.

13. Select “Spectral_Grid” to see an example displayed in the *Spectral Viewer* section.
14. Click **Generate Spectra** to bring up the *Generate Spectra* dialog.
15. In the *Spectral Parameters* section, enter the following parameters into the spreadsheet.

Time Offset (hrs)/Index	Angle (deg)	Hs (m)	Tp (s)	Gamma	nn
1.0	25.0	1.0	20.0	8.0	30

14. In the *Parameter Settings* section, select *Specify once for all spectra* under *Seaward Boundary Depth* and enter “32.0” in the field below that.

This tutorial assumes that the wave gauge is approximately at the offshore edge of the grid. If the gauge was in deeper water, specify the actual depth of the gauge.

15. Click **Generate** to generate the spectrum and close the *Generate Spectra* dialog.

The new spectrum, labeled “1.00000”, should appear below the grid in the spectral energy tree. The "1.00000" represents the time offset from the reference time in hours. The reference time is displayed below the tree control.

16. Select the spectrum “1.00000”.

The contours show the energy distribution. Select cell corners to view/edit their energies.

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

3.2 Model Control

In the model control, CMS-Wave inputs can be set. To view the wind parameters:

1. Select “ CMS-Wave Grid” in the Project Explorer to make it active.

2. Select *CMS-Wave* | **Model Control…** to bring up the *CMS-Wave Model Control* dialog.
3. In the *Spectra* subsection of the *Input Forcing* section, select "Spatially varied" from the *Source* drop-down.
4. Select "Half plane" from the *Plane type* drop-down.
5. Click **Spectral Grid...** to bring up the *Spectral Grid Properties* dialog.
6. In the *Frequency Distribution* section, enter "40" as the *Number*.
7. Click **OK** to close the *Spectral Grid Properties* dialog.
8. At the bottom of the *Input Forcing* section, click **Define Cases…** to bring up the *Spectral Events* dialog.
9. In the *Edge Boundary Type* section, click **(none selected)** to the right of *Side 1* to bring up the *Select spectral coverage* dialog.
10. Select " Spectral" from the list and click **OK** to close the *Select spectral coverage* dialog.

This assigns the spectral data contained in the coverage to the boundary.

11. In the *Events* section, click **Populate From Coverage**.

This creates an event for every time entry defined in the spectral coverage. In this case, there is one event created with a time of "1.000".

12. Click **OK** to exit the *Spectral Events* dialog.
13. Click **OK** to close the *CMS-Wave Model Control* dialog.

3.3 Selecting Monitoring Stations

The final step is to select cells to act as monitoring stations. When selecting a cell, the i and j location can be seen at the bottom of the screen in the status portion of the Edit Window. SMS can also select cells by selecting their i and j coordinates.

1. Select the **Select Grid Cell** tool.
2. Make sure no cells are selected and select *Data* | **Find Cell…** to bring up the *Find Cell* dialog.
3. Select *Find by (I,J)*, then enter "110" for *I* and "60" for *J*.
4. Click **OK** to close the *Find Cell* dialog.

A cell in the bay should now be selected (Figure 7). It is also possible to select cells by entering the nearest x and y values or entering the cell ID.

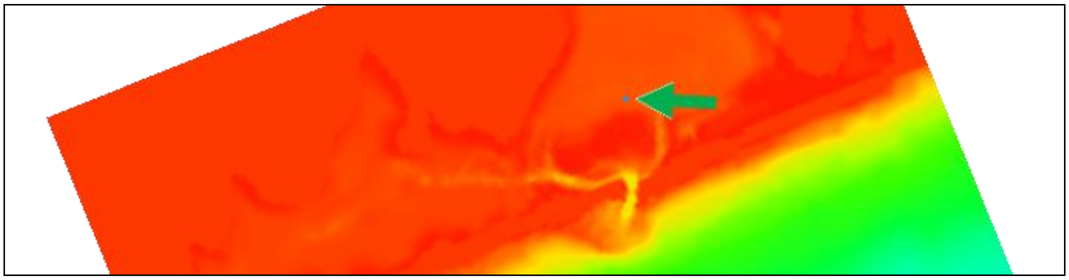

Figure 7 The selected cell (indicated by arrow)

5. Select *CMS-Wave* | **Assign Cell Attributes…** to bring up the *Cell Attributes* dialog.
6. In the *Cell Type* section, select *Monitoring Station* and click **OK** to close the *Cell Attributes* dialog.
7. Repeat steps 2 through 6 to assign monitoring stations in the inlet and the ocean. The i and j coordinates for the inlet cell are 92 and 66, respectively, and the i and j coordinates for the ocean cell are 50 and 70, respectively.

3.4 Saving the Simulation

Now save the simulation:

1. Select *File* | **Save As…** to bring up the *Save As* dialog.
2. Select "Project Files (*.sms)" from the *Save as type* drop-down.
3. Enter "shin1.sms" as the *File name*.
4. Click **Save** to save the project under the new name and close the *Save As* dialog.

3.5 Running CMS-Wave

To run CMS-Wave:

1. Select *CMS-Wave* | **Save project, Export and Launch CMS-Wave** to bring up the *CMS-WAVE* model wrapper dialog.
2. If a message such as "cmswave.exe – not found" is given, click the **File Browse** button to manually find the CMS-Wave executable.
3. When CMS-Wave has finished running, turn on *Load solution* and click **Exit** to close the *CMS-WAVE* model wrapper dialog.

4 Post Processing

SMS provides several tools for visualizing the results of model runs.

4.1 Visualizing the CMS-Wave Solution

To see the solution results:

1. Click **Display Options** to bring up the *Display Options* dialog.
2. Select "Cartesian Grid" from the list on the left.
3. On the *Cartesian Grid* tab, turn on *Contours* and *Vectors*.
4. On the *Contours* tab, in the *Contour method* section, select "Color Fill" from the first drop-down.
5. On the *Vectors* tab, in the *Arrow Options* section, select "Define min. and max. length" from the *Shaft length* drop-down.
6. Enter "25" as the *Minimum*.
7. Enter "50" as the *Maximum*.
8. In the *Vector Display Placement and Filter* section, select "on a grid" from the *Display* drop-down.
9. Click **OK** to exit the *Display Options* dialog.
10. Select " Depth" under " CMS-Wave Grid" in the Project Explorer to view their contours and vectors.

Notice that the waves do not cover the entire bay.

4.2 Visualizing Current Effects

To see the effects when a current is added at the inlet from the receding tide, do this:

1. Select *CMS-Wave* | **Model Control…** to bring up the *CMS-Wave Model Control* again.
2. In the *Input Forcing* section, select "Spatially varying" from the *Currents* drop-down and click **Select…** to bring up the *Select Currents Dataset* dialog.
3. Select " Wave" from the list in the *Select* section and click **Select** to close the *Select Currents Dataset* dialog.
4. Click **OK** to exit the *Model Control* dialog.
5. Use *File* | **Save As…** to save the simulation as "shin_curr.sms".
6. Rerun CMS-Wave by selecting *CMS-Wave* **| Save project, Export and Launch CMS-Wave** to bring up the *CMS-WAVE* model wrapper dialog.
7. When the model is finished running, turn on *Load solution* and click **Exit** to close the *CMS-WAVE* model wrapper dialog.
8. Select the different scalar and vector datasets of this simulation to view the contours and vectors.

Notice the difference that the current makes to the results.

4.3 Visualizing the Spectral Energy

The spectral energy is recorded at each monitoring station in the grid frame. To view the spectral energy:

1. Select *File* | **Open…** to bring up the *Open* dialog.
2. Select "shin1__CMS-Wave Grid.obs" and click **Open** to import the solution file and exit the *Open* dialog.

SMS will create a new coverage that can be used to visualize the spectral data contained in the observation file.

3. Select " shin1__CMS-Wave Grid" to make it active.

Three nodes should appear in this coverage located where the monitoring stations were specified. It may be necessary to turn off the display of the grid contours to see the nodes.

4. To view the data at each location, use the **Select Feature Point** tool and double-click on the desired node to bring up the *Spectral Energy* dialog.
5. Review the spectral energy at each monitoring station using the *Spectral Viewer* section.

The ocean station is not much different than the input spectral energy. The energy increases in the inlet and changes direction. The energy in the bay is very low compared to the inlet. Also look at the spectral energies of the monitoring stations with a current. Notice that the current dampens the energy in the inlet but slightly increases the energy in the bay.

6. When done reviewing, click **Done** to exit the *Spectral Energy* dialog.

5 Conclusion

This concludes the "CMS-Wave Analysis" tutorial. The model contains many more features and capabilities that have not been explored in this document. Refer to the CMS-Wave User Manual and the SMS help file found in *Help* | **SMS Help…** for more information.

