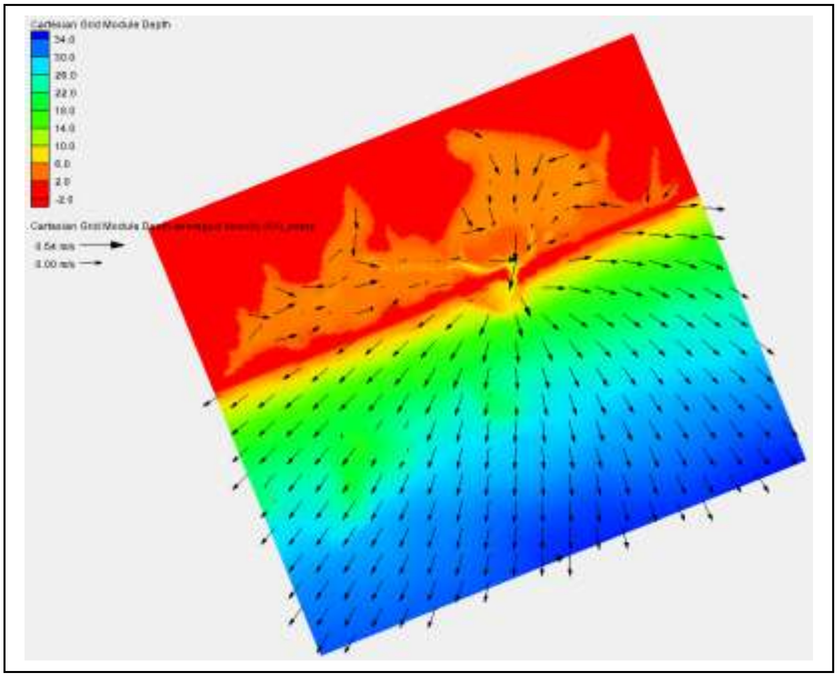
v. 11.2

SMS 11.2 Tutorial

CMS-Wave Analysis



Objectives

This workshop gives a brief introduction to the CMS-Wave interface and model.

Prerequisites

- Overview Tutorial
- CMS-Flow Tutorial

Requirements

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

Time

- 45-60 minutes

1 Introduction

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

2 Loading Scatter Set Data

First, import 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 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. Select the file "shinfinal.h5" from the *data files* folder.
3. Click **Open** to import the file.

2.1 Coordinate Conversions

It is necessary to set the display projection to a state plane coordinate system. The geographic coordinates of the objects need to be set and reprojected to state plane coordinates for New York Long Island.

To set the general projection in the project, do the following:

1. Select *Display* | **Projection…** to open the *Display Projection* dialog.
2. Select *Global Projection* to bring up the *Select Projection* dialog.
3. On the *Projection* tab, set the following:
    - From the *Projection* drop-down, select "State Plane Coordinate System".

- Select “New York- Long Island (FIPS 3104)” from the *Zone* drop-down.
- Select “NAD83” from the *Datum* drop-down.
- Select “METERS” from the *Planar Units* drop-down.

4. Click **OK** to close the *Select Projection* dialog.
5. In the *Vertical* section, select “Meters” from the *Units* drop-down.
6. Click **OK** to close the *Display Projection* dialog.

To set the object projection for the scatter set, do the following:

1. Right-click on the “split from shinfinal” scatter set and select **Projection** to bring up the *Object Projection* dialog.
2. Select *Global Projection* and click on the **Set Projection…** button to bring up the *Select Projection* dialog.
3. On the *Projection* tab, set the following:
    - From the *Projection* drop-down, select “Geographic (Latitude/Longitude)”.
    - Select “NAD83” from the *Datum* drop-down.
4. Click **OK** to close the *Select Projection* dialog.
5. In the *Vertical* section, select “Meters” from the *Units* drop-down.
6. Click **OK** to close the *Object Projection* dialog.
7. **Frame** the project.

To set the object projection for the coverage, do the following:

1. Right-click on the “Area Property” coverage and select **Projection…** to bring up the *Object Projection* dialog.
2. Select *Global Projection* and click on the **Set Projection…** button to bring up the *Select Projection* dialog.
3. On the *Projection* tab, set the following:
    - From the *Projection* drop-down, select “Geographic (Latitude/Longitude)”.
    - Select “NAD83” from the *Datum* drop-down.
4. Click **OK** to close the *Select Projection* dialog.
5. In the *Vertical* section, select “Meters” from the *Units* drop-down.
6. Click **OK** to close the *Object Projection* dialog.

To reproject the scatter set and the coverage, do the following:

1. Right-click on the “split from shinfinal” scatter set and select **Reproject…** to bring up the *Reproject Object* dialog.
2. If a warning appears regarding possible round-off errors, click **Yes**.
3. In the *Current Projection* section in the *Horizontal* sub-section, verify that *Global projection* is set to “Geographic (Latitude/Longitude), NAD83, arc degrees”. This section cannot be edited unless *Set* is toggled on.

4. In the *New Projection* section in the *Horizontal* sub-section, verify that *Global projection* is set to “State Plane Coordinate System (NAD27), Zone: New York – Long Island (FIPS 3104), Datum from system 0: NAD83, meters”.
5. In the *Vertical* section, select “Meters” from the *Units* drop-down.
6. Click **OK** to close the *Reproject Object* dialog.
7. Right-click on the “Area Property” coverage and select **Reproject…** to bring up the *Reproject Object* dialog
8. Repeat steps 2-6.

3 Creating the Cartesian Grid

A Cartesian grid for running CMS-Wave needs to be created. The grid frame is created in the Map Module. The Map module 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.

3.1 Creating the Cartesian Grid Frame

To create the grid frame:

1. Switch to the Map Module.
2. Right-click on “Area Property” coverage in the Project Explorer and select *Type* | *Models* | **CMS-Wave**.
3. Using the **Create 2-D Grid Frame** tool, click out the corners of the grid as shown in **Error! Reference source not found.**. The first two points clicked define the J-direction, which is the direction of the incoming waves, and the last two points clicked are placed on the land.

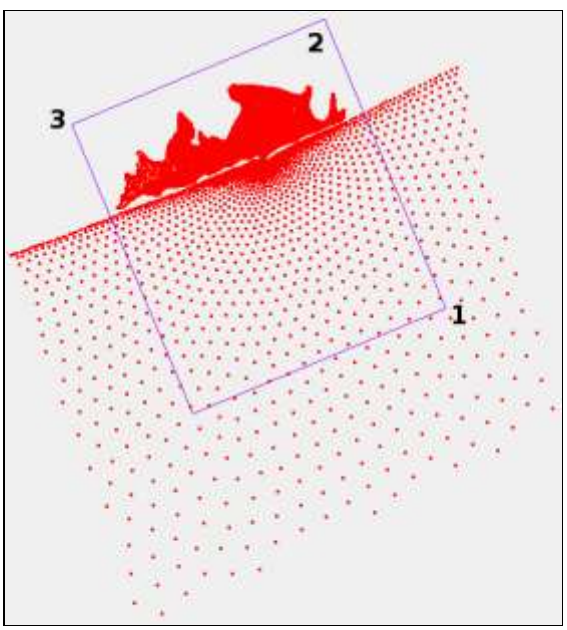


Figure 1 Creating the Cartesian grid frame

4. Using the **Select Grid Frame** tool, select the box in the middle of the grid frame. The origin should be in the bottom right corner of the grid.

Users can drag and 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 just outside the top right corner grid (near point 2 as in **Error! Reference source not found.**).

A user can also type in the origin and angle in the *Grid Frame Properties* dialog that opens when the when double-clicking on the selected grid.

5. Using the **Select Grid Frame** tool, double-click on the grid to bring up the *Grid Frame Properties* dialog.
6. In the *Origin, Orientation and Dimensions* section, set:
   - *Origin X* to "438,000".
   - *Origin Y* to "70,000".
   - *Angle* to "112.0".
   - *I size* to "15,000".
   - *J size* to "17,000".
7. Click **OK** to close the *Grid Frame Properties* dialog.
8. **Frame** the data on the screen when finished. (Figure 2)

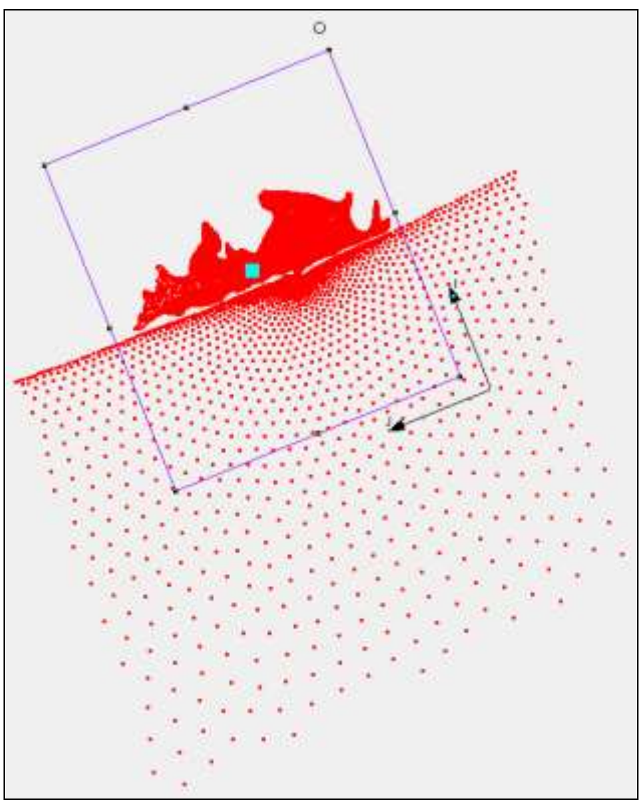


Figure 2 Cartesian grid frame after adjusting the properties

3.2 Mapping to the Grid

Next is to 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. Go to *Feature Objects* | **Map→2D Grid** to bring up the *Map →2D Grid* dialog.
2. Verify the following settings in the Origin, Orientation and Dimensions section:
    - "438,000" for *Origin X* .
    - "70,000" for *Origin Y*.
    - "112.0" for *Angle*.
    - "15,000" for *I size*.
    - "17,000" for *J size*.
3. In both *I Cell Options* and *J Cell Options*, select *Cell Size* and set both to "100.0".
4. In the *Depth Options* section, select "Scatter Set" from the *Source* drop-down.
5. Click the Select… button to bring up the *Interpolation* dialog.
6. In the *Interpolation Options* section, select "Single Value" from the *Extrapolation* drop-down.
7. Enter "-2.0" in the *Single Value* field.
8. Select "elevation" from the list in the *Scatter Set To Interpolate From* section.

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

9. Click **OK** to exit *Interpolation* dialog.
10. In the *Vector Options* section, toggle on *Map Vector* and enter "Current" in the field to the right.
11. Select the *Interpolated* radio button.
12. Click on the **Select** button to bring up the *Interpolation* dialog.
13. In the *Scatter Set To Interpolate From*, select "Depth-averaged Velocity (64)" from the list.
14. In the *Time Step Interpolation* section, select the *Single Time Step* radio button and select "0 02:20:00" from the drop-down (the bottom option in the list).
15. Click **OK** to exit the *Interpolation* dialog.
16. Click **OK** to create the Cartesian grid and close the *Map →2D Grid* dialog. The project should appear as in Figure 3.

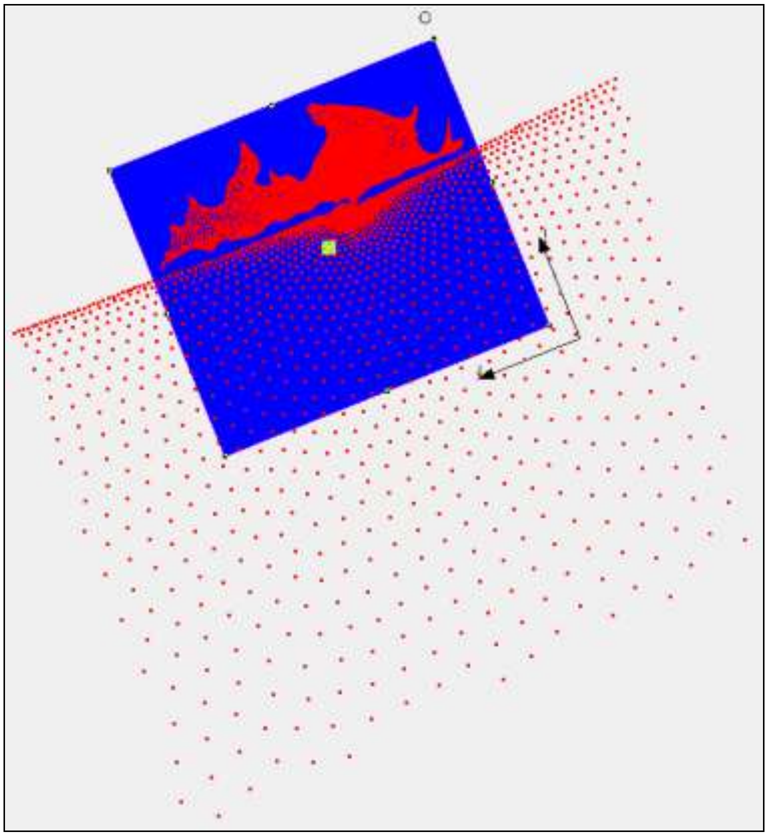


Figure 3 The Cartesian grid has been created

It is easiest to interpolate currents when creating the 2D grid even if not using currents until a later simulation. Users can choose whether to use currents in the CMS-Wave model control. When interpolating, a user can 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 the grid only:

1. Toggle off Scatter Data in the Project Explorer.
2. **Frame** the display.
3. Select *Display* | **Display Options…** to bring up the *Display Options* dialog.
4. Select "Cartesian Grid" from the list on the left.
5. Toggle off all options, and then toggle on *Contours*.
6. On the *Contours* tab in the *Contour method* section, select "Color Fill" from the drop-down.
7. Click **OK** to close the *Display Options* dialog.

The Main Graphics Display should appear as in Figure 4:

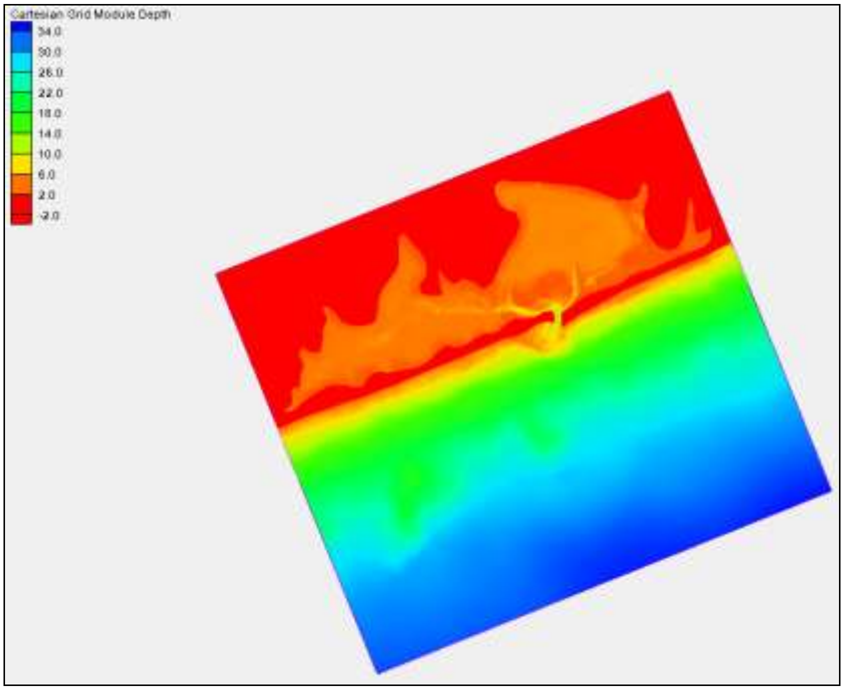


Figure 4 Cartesian grid with contours, and with scatter set turned off

4 Editing the Grid and Running CMS-Wave

4.1 Generating Spectral Energy Distribution

The spectral energy distribution can be generated as follows:

1. Right-click on 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" for the *Coverage Name*.
4. Click **OK** to close the *New Coverage* dialog.
5. Select the new “Spectral” coverage to make it active.
6. Using the **Create Feature Point** tool, create a point near the center of the bottom grid boundary, as shown in Figure 5.
7. Using the **Select Feature Point** tool and double-click on the node to bring up the *Spectral Energy* dialog.
8. In the *Spectral Manager* section, click the **Create Grid** button to bring up the *Spectral Grid Attributes* dialog.
9. Enter “112.0” in the *Grid angle (degrees)* field to match the angle of the CMS-Wave grid.
10. Select “Full – local” from the *Spectral energy grid plane type* drop-down.

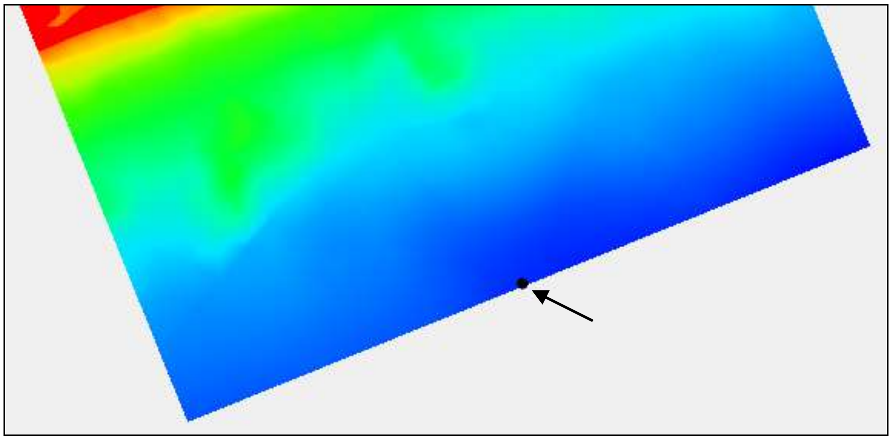


Figure 5 Location of the wave gage point

11. Click **OK** to close the *Spectral Grid Attributes* dialog and open the *Create Spectral Energy Grid* dialog.
12. In the *Frequency Distribution* section, enter “40” in the Number field.
13. Click **OK** to create a new spectral energy grid and close the *Create Spectral Energy Grid* dialog.

An entry titled “Spectral Grid” will appear in the list on the left. Select it to see an example displayed in the *Spectral Viewer* section on the right.

14. Click the **Generate Spectra** button to bring up the *Generate Spectra* dialog.
15. In the *Spectral Parameters* section, enter the following in row *1*:

Time	Angle (deg)	Hs (m)	Tp (s)	Gamma	nm
1.0	25.0	1.0	20.0	8.0	30

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

This tutorial assumes that the wave gage is approximately at the offshore edge of the grid. Therefore, the depth for the spectra is to 32m. If the gage was in deeper water, the actual depth of the gage would be specified here.

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

The new spectrum, labeled “1.00000,” will appear below “Spectral Grid” in the list on the left. The "1.00000" represents the time offset from the reference time in hours. The reference time is displayed below the tree control.

18. Select the spectrum “1.00000”. The contours show the energy distribution. Hover over cells in the Spectral Viewer to see the information for each cell..
19. Click **Done** to exit the *Spectral Energy* dialog.

4.2 Model Control

CMS-Wave inputs can be set in the *Model Control* dialog by doing the following:

1. Select the “Area Property” 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* sub-section 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 on the **Spectral Grid...** button to bring up the *Spectral Grid Properties* dialog.
6. In the *Frequency Distribution* section, enter “40” in the *Number* field.
7. Click **OK** to close the *Spectral Grid Properties* dialog.
8. At the bottom of the *Input Forcing* section, click the **Define Cases** button to bring up the *Spectral Events* dialog.
9. In the *Edge Boundary Type* section, click on the **(none selected)** button to the right of the drop-down for *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 on the **Populate From Coverage** button. This will create an event for every time entry that is defined in the spectral coverage. In this case, the user will see one event created with a time of “1.00”.
12. Click **OK** to close the *Spectral Events* dialog.
13. Click **OK** to close the *CMS-Wave Model Control* dialog.

4.3 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 choosing the I and J coordinates.

1. Make sure no cells are selected and choose *Data* | **Find Cell…** to bring up the *Find Cell* dialog.
2. Select the *Find by (I,J)* radio button and enter “110” for *I* and “60” for *J*.
3. Click **OK**. A cell in the bay should now be selected, though the selection may not be visible in the Main Graphics Window.
4. Select CMS-Wave | **Assign Cell Attributes…** to bring up the *Cell Attributes* dialog.
5. In the *Cell Type* section, select the *Monitoring Station* radio button.
6. Click **OK** to close the *Cell Attributes* dialog.
7. Repeat steps 1-6 to assign a monitoring station in the inlet with I and J coordinates of “92” and “66”, respectively.
8. Repeat steps 1-6 to assign a monitoring station in the ocean with I and J coordinates of “50” and “70”, respectively.

4.4 Saving the Simulation

It is recommended to save the simulation prior to running CMS-Wave by doing the following:

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

4.5 Running CMS-Wave

To run CMS-Wave:

1. Select *CMS-Wave* | **Save Project, Export and Launch CMS-Wave** to bring up the *CMS-Wave* dialog (the wrapper window). This dialog will show the progress of CMS-Wave as it processes through the spectrum.
2. If a message such as “cmswave.exe – not found” is given, click the **File Browse** button to manually find the CMS-Wave executable. The default location is in the *Program Files\SMS 11.2 64-bit\models\CMSWAVE* folder. This location may differ depending on the installation.
3. Once CMS-Wave finishes, toggle on *Load solution* and click **Exit** to close the *CMS-Wave* dialog. A “shin1_Area Property.wav” folder will appear in the Project Explorer under the Area Property grid.

5 Post-Processing

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

5.1 Visualizing the CMS-Wave 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. On the *Cartesian Grid* tab, toggle on *Contours* and *Vectors*.
4. On the *Contours* tab in the *Contour method* section, select “Color Fill” from the drop-down.
5. On the *Vectors* tab in the *Vector Display Placement and Filter* section, select “on a grid” from the *Display* drop-down.
6. In the *Arrow Options* section, Select “Define min and max length” from the *Shaft Length drop-down.*
7. Enter “25” for the *Min length*.
8. Enter “50” for the *Max length.*

9. Push **OK** to exit the *Display Options* dialog.
10. Select the "Depth" scalar dataset in the Project Explorer to view the contours and vectors.

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

5.2 Visualizing Current Effects

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

1. Select *CMS-Wave* | **Model Control…** to bring up the *CMS-Wave Model Control* dialog.
2. In the *Input Forcing* section, select "Spatially varying" from the *Currents* drop-down.
3. Click on the **Select** button to bring up the *Select Currents Dataset* dialog.
4. Select the "Wave" vector dataset and click the **Select** button to close the *Select Currents Dataset* dialog.
5. Press **OK** to exit the *Model Control* dialog.

A new "Current" vector dataset will appear under the "Input Datasets" folder in the Project Explorer.

6. Select *File* | **Save As…** to bring up the *Save As* dialog.
7. Enter "shin_curr.sms" in the *File name* field.
8. Select "Project Files (*.sms)" from the *Save as type* drop-down.
9. Click the **Save** button to save the project and close the *Save As* dialog.
10. Select *CMS-Wave* | **Save Project, Export and Launch CMS-Wave** to bring up the *CMS-Wave* dialog (the wrapper window). This dialog will show the progress of CMS-Wave as it processes through the spectrum.
11. Once CMS-Wave finishes, toggle on *Load solution* and click **Exit** to close the *CMS-Wave* dialog. A "shin_curr_Area Property.wav" folder will appear in the Project Explorer under the Area Property grid.

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.

5.3 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 either the "shin1__Area Property.obs" or the "shin_curr__Area Property.obs" solution file.
3. Click the **Open** button to import the file into SMS.

The user should see three nodes 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.

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. 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.

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

6 Conclusion

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

This concludes the CMS-Wave Analysis tutorial. The user can continue to experiment, or quit the program.