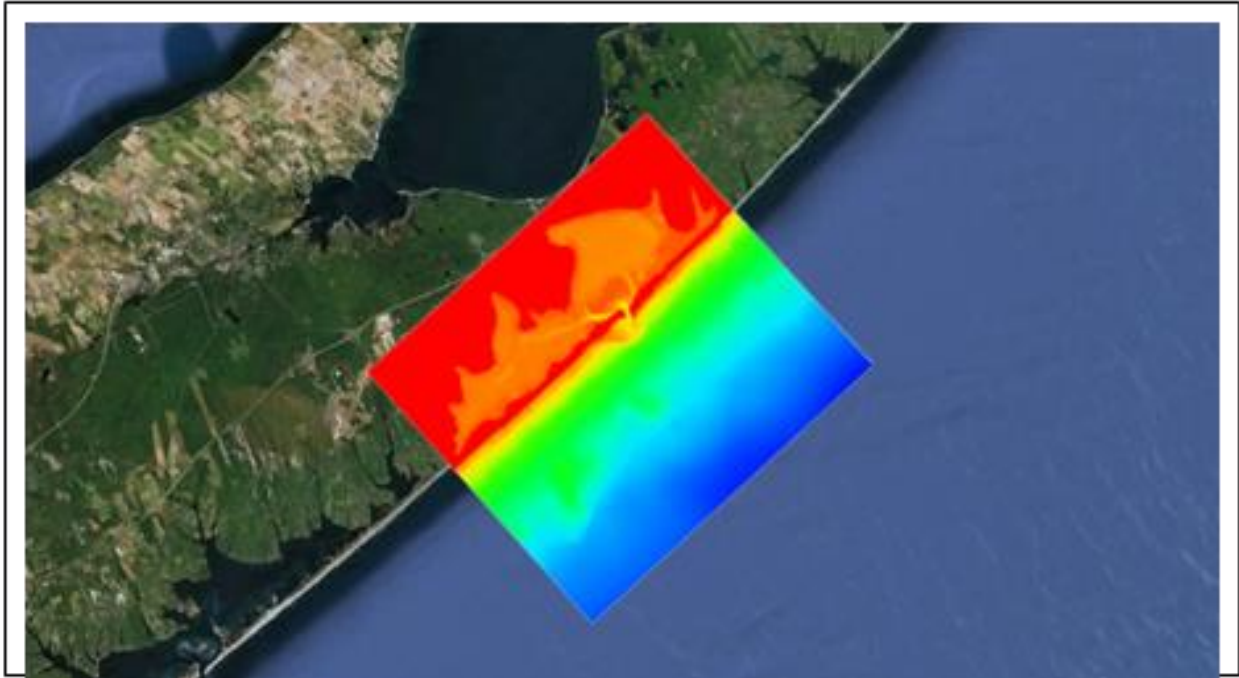


SMS 12.1 Tutorial

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 Loading Scatter Set Data

1.1 Reading in 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...** and select the file “shinfinal.h5”.
2. Push **Open** to read in the scatter set file.


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. Make sure that *Global Projection* is toggled on. A new dialog should appear. If it doesn't appear, click **Set Projection** and to bring up the new dialog.
3. In the *Select Projection* dialog, set the *Projection* to “State Plane Coordinate System” with a *Zone* of “New York- Long Island (FIPS 3104),” a *Datum* of “NAD83,” and *Planar Units* set to “Meters”.
4. Click **OK** to close the *Select Project* dialog.
5. Make sure that the *Vertical Units* are set to “Meters” as well. Click **OK** to close the *Display Projections* dialog.
6. Right-click on the “split from shinfinal” scatter set and select **Projection** to bring up the *Object Projection* dialog.
7. In the dialog, toggle on *Global projection* and click **Set Projection** to bring up the *Select Projection* dialog.
8. In the dialog, set the *Projection* to “Geographic (Latitude/Longitude)” and set the *Datum* to “NAD83”.
9. Click **OK** to close the *Select Projection* dialog.
10. Make sure that the *Vertical Units* are set to “Meters” as well. Click **OK** to close the *Object Projection* dialog.
11. Next, right-click on the “Area Property” coverage and select **Projection** to bring up another *Object Projection* dialog.
12. In the dialog, set the *Projection* to “Geographic (Latitude/Longitude)” and set the *Datum* to “NAD83” just as was done for the scatter set.
13. Click **OK** to close the *Select Projection* dialog.
14. Click **OK** to close the *Object Projection* dialog.



15. Right-click on the scatter set again and select **Reproject** to bring the *Reproject Object* dialog. If a warning appears, click **Yes**.
16. In the dialog, make sure that the *Current Projection* is set to “Geographic”, then set the *New Projection* to “State Plane Coordinate System”, with the *Datum* set to “NAD83,” a *Zone* of “New York Long Island (FIPS 3104)” and the *Planar Units* set to “Meters”. Make sure that the *Vertical Units* are set to “Meters” as well. Click **OK** to close the *Reproject Object* dialog.
17. Right-click on the “Area Property” coverage again and select **Reproject** and repeat step 12.

2 Creating the Cartesian Grid

Now it's time to create a Cartesian grid for running STWAVE. 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.

2.1 Creating the Cartesian Grid Frame

To create the grid frame:

1. Switch to the Map  module. Right-click on “Area Properties” coverage in the Project Explorer, select *Type*, and select **CMS-Wave** under *Models*.
2. Right-click on the “Area Property” coverage again and select the **Rename** command. Give the coverage the name “CMS-Wave”.
3. Select the **Create 2-D Grid Frame**  tool from the toolbox.
4. Zoom out a little and click out three corners of the grid in the order shown in Figure 1 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.

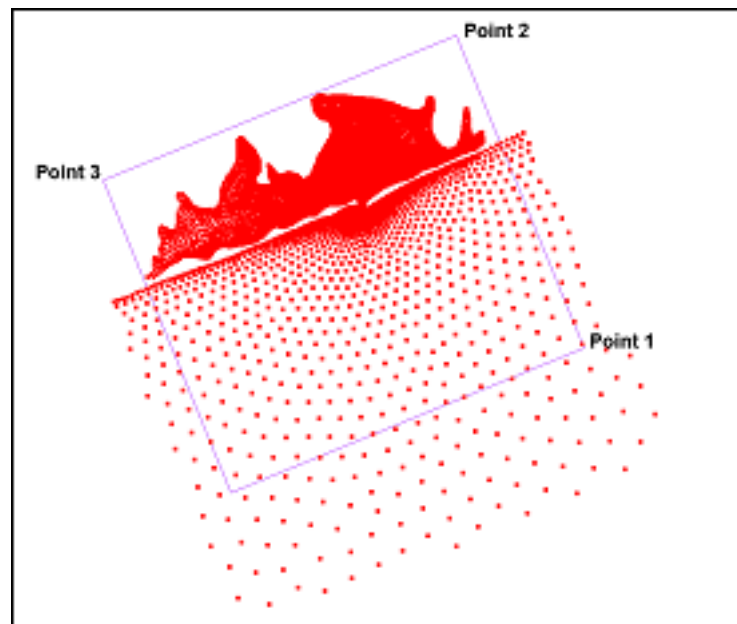




Figure 1 Creating the Cartesian Grid Frame

5. Switch to the **Select Grid Frame**  tool and select the box in the middle of the grid frame. The origin should be in the bottom right corner of the grid.
6. 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 grid.
7. Double-click on the grid to bring up the *Grid Frame* dialog. It's possible to type in the origin and angle in this dialog. For consistency purposes set the *Origin X* to "438,000," the *Origin Y* to "70,000," and the *Angle* to "112".
8. Also set the grid size by entering "15,000" meters in the *I size* direction and "17,000" meters in the *J size* direction. These values can also be edited when generating the 2D-Grid in section 3.2.
9. Click **OK** when done to close the *Grid Frame* dialog.
10. Click outside the grid frame to unselect the grid and **Frame**  the data on the screen when finished.

2.2 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**.

2. In the *Map* → *2D Grid* dialog, make sure the X, Y, and Angle values are set to “438,000,” “70,000,” and “112” respectively. Make sure the *I size* value is “15000” m and the *J size* value is “17000” m.
3. Make sure *Cell Size* is selected in the *Cell Options* and change the cell size in both directions to “100” m.
4. In the *Depth Options* section, change the *Source* to “Scatter Set,” then select the **Select** button underneath it. This will bring up the *Interpolation* dialog.
5. In the *Interpolation* dialog, choose “elevation” as the *Scatter Set to Interpolate From*. Select “Single Value” for the *Extrapolation* and change the *Single Value* to “-2.0”. 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.
6. Click **OK** to exit *Interpolation* dialog.
7. In the *Vector Options* section, select *Map Vector* and make sure that it is set as “Current”. Make sure the *Interpolated* option is selected and click on the **Select** button to bring up another *Interpolation* dialog.
8. In the *Interpolation* dialog, select the “Depth-averaged Velocity (64)” scatter set. Make sure *Single Time Step* is selected and choose the time step corresponding to 2 hours 20 minutes (the last one).
9. Select **OK** to exit the *Interpolation* dialog.
10. Push **OK** to create the Cartesian grid.

Note on interpolation: It is easiest to interpolate currents when creating the 2D grid even if not using currents until a later simulation. Whether or not 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 the grid only:

1. Turn off the Scatter Data item in the Project Explorer.
2. **Frame**  the display.
3. Select *Display* / **Display Options** to bring up the *Display Options* dialog. Make certain the Cartesian Grid option is selected on the list on the left side.
4. Select the **All Off** button then check on the *Contours* option.
5. Click to the *Contours* tab, and set the *Contour Method* to “Color Fill”.
6. Click **OK** to close the *Display Options* dialog.

The data should look like Figure 2.

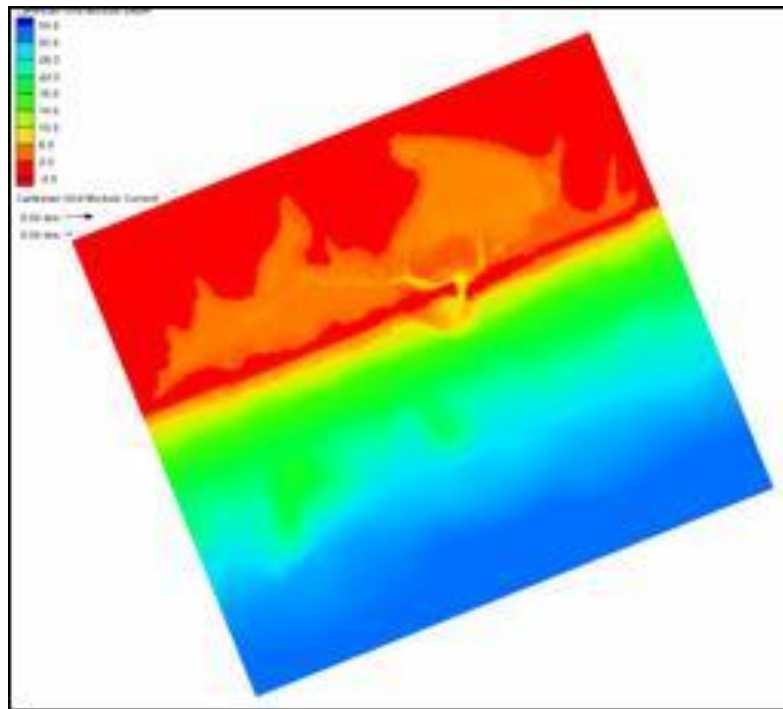



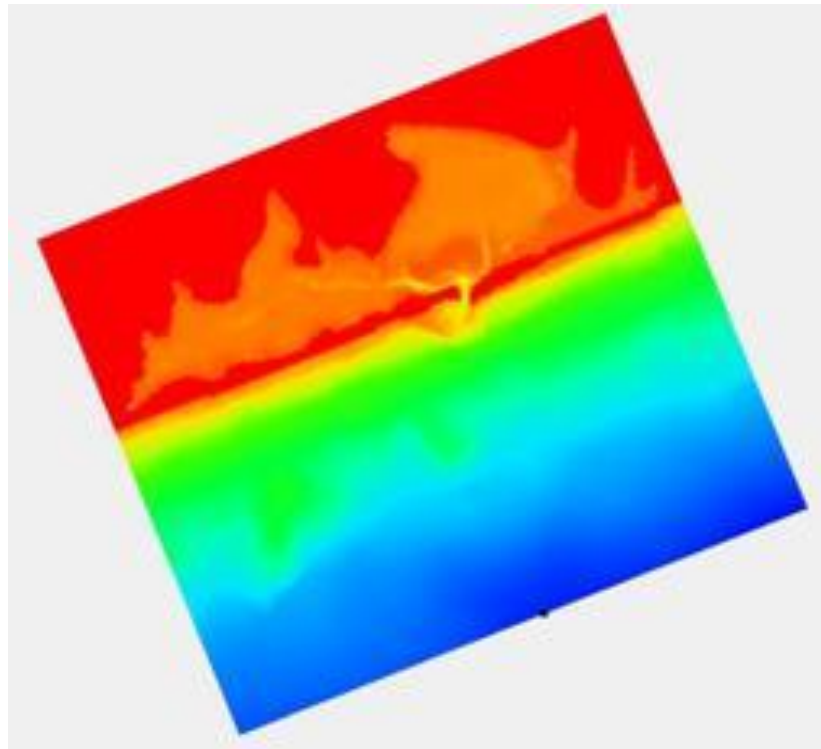
Figure 2 Cartesian Grid with Contours.


3 Editing the Grid and Running STWAVE

3.1 Generating Spectral Energy Distribution

Next generate the Spectral Energy distribution.

1. Right-click on Map Data in the Project Explorer and select **New Coverage**.
2. In the *New Coverage* dialog, select the *Coverage Type* as “Spectral” under the “Generic” section.
3. Set the name of the coverage to be "Spectral" and click **OK**.
4. Using the **Create Feature Point**  tool, create a node along the middle of the bottom grid boundary as shown in the figure.



5. Use the **Select Feature Point**  tool and double-click on the node. The *Spectral Energy* dialog will appear.
6. Click the **Create Grid** button to bring up the *Spectral Grid Attributes* dialog.
7. Set the *Grid angle* to “112.0” degrees. This will match the angle of the CMS-Wave grid.
8. Make sure that the *Spectral energy grid plane type* is set to “Full - local” and select **OK** to close the *Spectral Grid Attributes* dialog.
9. The *Create Spectral Energy Grid* dialog will appear. In the *Frequency Distribution* section of the dialog, change the *Number* to “40” and click **OK** to create a new spectral energy grid.
10. The new spectral energy grid will appear in the Spectral Energy tree control. Select the “Spectral_Grid” to see an example displayed in the *Spectral Viewer* section.
11. Click the **Generate Spectra** button to bring up the *Generate Spectra* dialog.
12. Enter the following parameters into the spreadsheet.

Time	Angle	Hs	Tp	Gamma	nm
1	25	1	20	8	30

13. This tutorial assumes that the wave gauge is approximately at the offshore edge of the grid. Therefore, set the *Seaward Boundary Depth* for the spectra to “32”

m under *Specify once for all spectrum*. If the gauge was in deeper water, specify the actual depth of the gauge.

14. Push the **Generate** button to close the *Generate Spectra* dialog. The new spectrum, labeled "1.00000," will appear below the grid in the Spectral Manager tree control. The "1.00000" represents the time offset from the reference time in hours. The reference time is displayed below the tree control.
15. Select the spectrum "1.00000". The contours show the energy distribution. Select cell corners to view/edit their energies.
16. Push **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 the 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* section, set the *Source* to "Spatially varied," and make sure the *Plane type* is set to "Half plane".
4. Click on the button **Spectral Grid...** to bring up the *Spectral Grid Properties* dialog.
5. In the *Frequency Distribution* section of the dialog, change the *Number* to "40".
6. Click **OK** to close the *Spectral Grid Properties* dialog.
7. In the lower left corner of the *CMS-Wave Model Control* dialog, click **Define Cases** which will bring up the *Spectral Events* dialog.
8. In the dialog, click on the button that corresponds to Side 1 in the *Edge Boundary Type* section to bring up the *Select spectral coverage* dialog.
9. Select the "Spectral" coverage and click **OK** to close the *Select spectral coverage* dialog. This assigns the spectral data contained in the coverage to the boundary.
10. 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, there is one event created with a time of 1.00.
11. Click **OK** to exit the model *Spectral Events* dialog.
12. 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:

1. Select the **Select Grid Cell**  tool.

2. 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 their *i* and *j* coordinates.
3. Make sure no cells are selected and choose *Data / Find Cell...* to bring up the *Find Cell* dialog.
4. Enter “110” for *I* and “60” for *J* and click **OK** to close the *Find Cell* dialog. A cell in the bay should now be selected. It is also possible to select cells by entering the nearest *x* and *y* values or entering the cell ID.
5. Select *CMS-Wave / Assign Cell Attributes...* to bring up the *Cell Attributes* dialog.
6. Change the *Cell Type* to *Monitoring Station* and click **OK** to close the *Cell Attributes* dialog.
7. Repeat steps 3 through 6 to assign a monitoring station 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

To save the simulation:

1. Select *File / Save As* to bring up the *Save As* dialog.
2. Make sure the *Save as type* is set to “Project Files (sms),” and enter the file name “shin1”.
3. Click the **Save** button to close the *Save As* dialog and save the project.

3.5 Running CMS-Wave

To run CMS-Wave:


1. Select *CMS-Wave | Save project, Export and Launch CMS-Wave*.
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. A dialog will come up showing the progress of the CMS-Wave run. To load the simulation after CMS-Wave finishes, make sure that *Load solutions* checkbox is on. Click **Exit** when CMS-Wave finishes.

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. Select *Display* / **Display Options**  to bring up the *Display Options* dialog again.
2. Make certain the *Cartesian Grid* item is selected on the left side list. Turn the *Contours* and *Vectors* toggles on.
3. Under the *Contours* tab for the *Contour Method* select “Color fill”.
4. Under the *Vector* tab make sure the *Shaft Length* is set to “Define min and max length” and set the *Min length* to “25” and the *Max length* to “50”.
5. Under *Vector Display Placement and Filter*, change the *Display* to “on a grid”.
6. Push **OK** to exit the *Display Options* dialog.
7. Select the “Depth” scalar dataset of the Cartesian grid model in the Project Explorer to view their 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.

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 *Currents* combo box, select “Spatially varying” and click on the **Select** button to bring up the *Select Currents Dataset* dialog.
3. Select the “Wave” vector set then click **Select** to close the *Select Currents Dataset* dialog.
4. Press **OK** to exit the *Model Control* dialog.
5. Use *File* | **Save As...** to save the simulation as “shin_curr.sms”.
6. Rerun CMS-Wave using the *CMS-Wave* | **Save project, Export and Launch CMS-Wave** command.
7. Make sure the *Load solution* checkbox is on before closing the model wrapper. 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. Use *File* | **Open** to bring up the *Open* dialog.
2. Browse for the “shin__CMS-Wave Grid.obs” solution file in SMS and click on **Open**. SMS will create a new coverage that can be used to visualize the spectral data contained in the observation file.

3. 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. 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.
6. When done, click **Done** to exit the *Spectral Energy* dialog.

5 Conclusion

This concludes the CMS-Wave Analysis tutorial. Obviously the model contains many more features and capabilities that have not been explored in this document. Refer to the CMS-Wave Users manual and SMS help file found in *Help / SMS Help...* for more information.