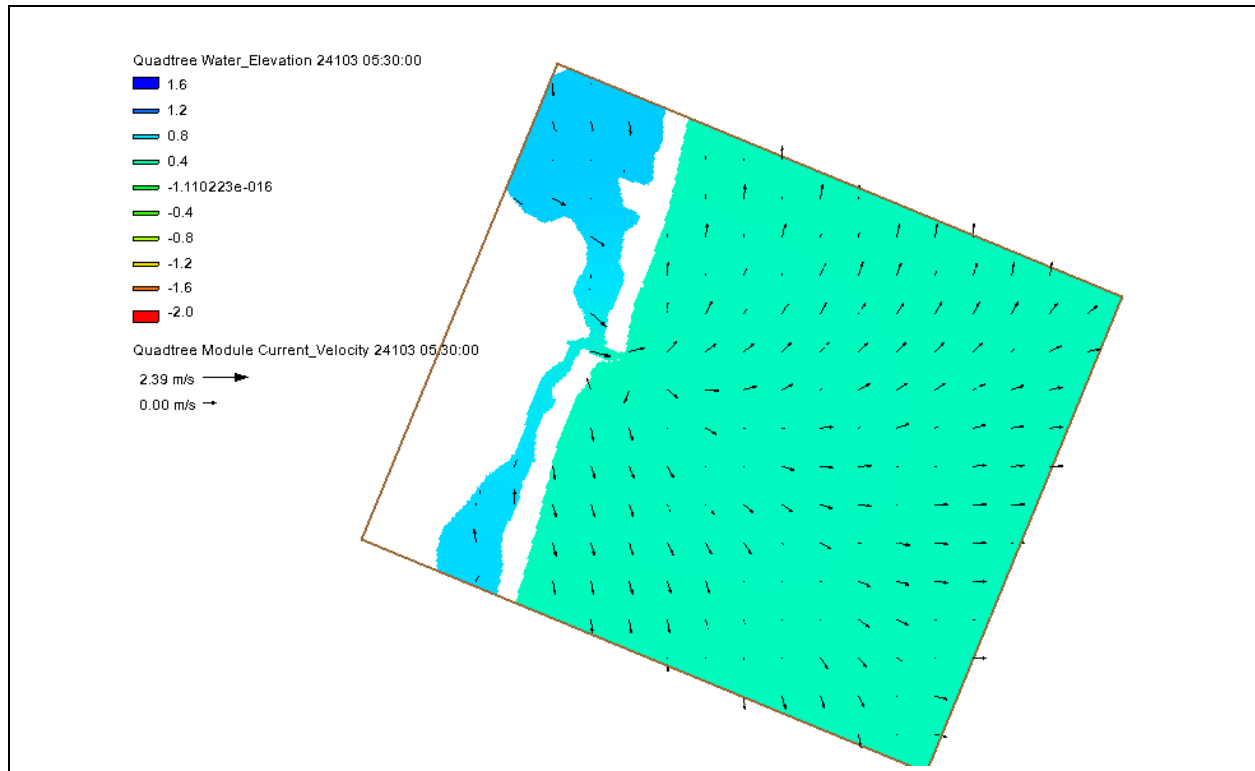*SMS 13.0 Tutorial*

CMS-Flow

Objectives

This tutorial demonstrates how to prepare a quadtree grid and run a solution using CMS-Flow.

Prerequisites

- SMS Overview

Requirements

- Map Module
- Cartesian Grid Module
- Scatter Module
- CMS-Flow

Time

- 20–30 minutes
- 1–2 hours runtime

1   Introduction

This tutorial demonstrates creating most of the components for the CMS-Flow model, including a CMS-Flow boundary conditions coverage, an activity coverage, and a CMS-Flow save points coverage.

A quadtree grid is also required, but is not generated in this tutorial. Instead, a pre-generated quadtree grid is included in the tutorial project file. For more information on generating a quadtree grid, see the "Quadtree Generation" tutorial.

The data used in this tutorial is from the Ocean City inlet and the surrounding coastline in the state of Maryland in the United States. The projection for the project has been preset.

2   Getting Started

Start by importing a project file containing the data for this CMS-Flow simulation:

1. Launch the SMS application.

2. Select *File* | **Open…** to bring up the *Open* dialog.

3. Select "Project Files (*.sms)" from the *Files of type* drop-down.

4. Browse to the *CMS-Flow\data files* folder and select "ocean_city.sms".

5. Click **Open** to import the project and exit the *Open* dialog.

The project should appear similar to Figure 1. The contoured area near the center is the location of the pre-generated quadtree grid.
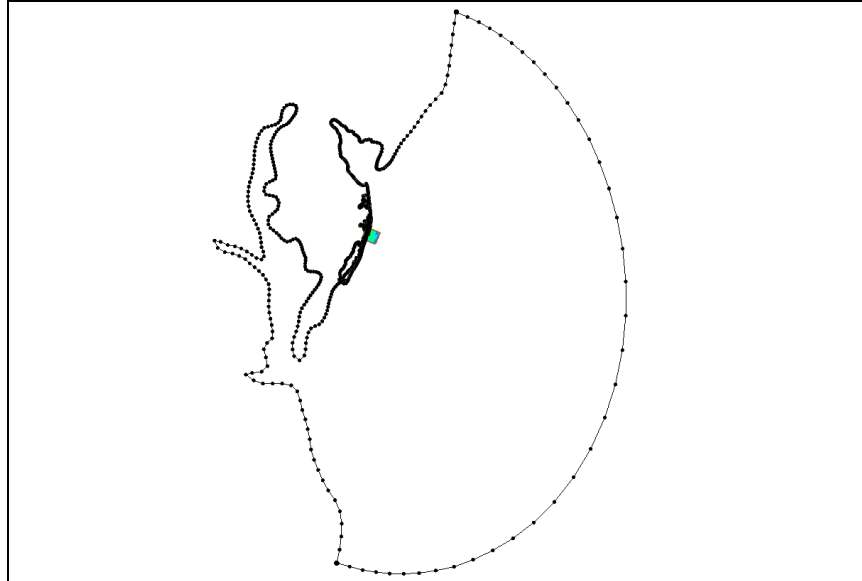
Figure 1   Ocean City inlet

3   Defining Boundary Conditions

Boundary conditions for a CMS-Flow simulation are defined using feature arcs in a CMS-Flow boundary conditions coverage.

Create the boundary condition by doing the following:

1. Right-click " CMS-Flow" and select **Duplicate** to create a new " CMS-Flow (2)" coverage.

2. Right-click on " CMS-Flow (2)" and select **Rename**.

3. Enter "BC" and press *Enter* to set the new coverage name.

4. Right-click on " BC" and select *Type | Models | CMS-Flow |* **Boundary Conditions**.

Next, an additional arc is needed that defines the boundaries of the quadtree grid.

5. Right-click " Inlet Grid" and select **Zoom to Quadtree**.

6. Select " BC" to make it active.

7. Using the **Create Feature Arc** tool, create a boundary arc enclosing the ocean side of the quadtree grid by starting at the top where the grid frame meets the shoreline arc, then following the grid frame border around to where it meets the shoreline arc again. The arc will automatically end by snapping to the shoreline arc.

The ocean boundary arc does not need to be precise as SMS will snap the boundary condition to the grid. Both the shoreline arc and the ocean boundary condition arc are unassigned by default (Figure 2). The arc around the grid boundary needs to be assigned additional data for this project.
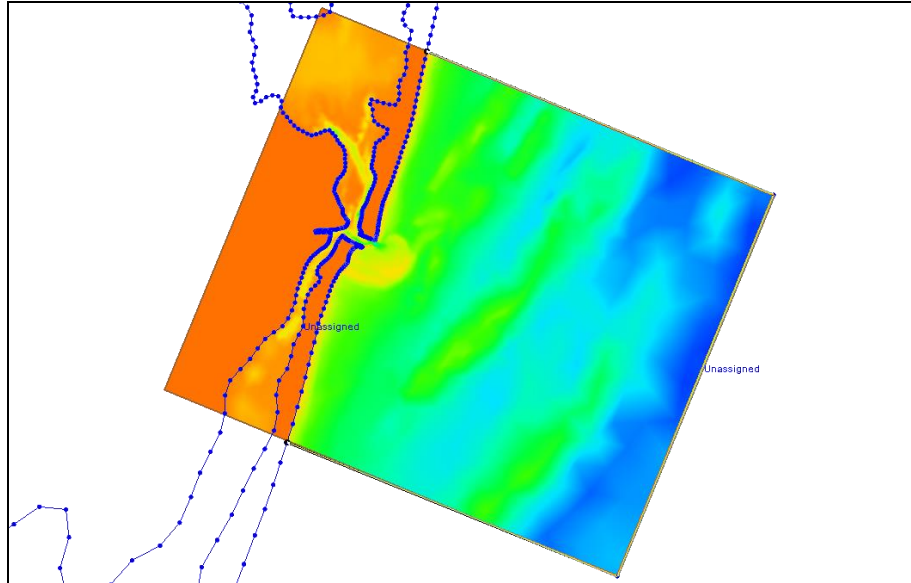
Figure 2   Ocean boundary condition arc

8.   Using the **Select Feature Arc** ⬚ tool, select the ocean boundary condition arc.

9.   Right-click on the selected arc and select **Assign Boundary Conditions…** to bring up the *Arc Boundary Condition* dialog.

10. In the *Options* section, enter "Ocean" as the *Name* and select "WSE-forcing" from the *Type* drop-down.

11. Select "Tidal Constituent" from the *WSE Source* drop-down.

12. Turn on *Specify Inflow Direction* and enter "0.0" as the *Inflow direction*.

13. Below the *Constituents* table, click **Insert Above** twice to add two constituent rows to the table.

14. Using the table below, enter the data defining a tidal signal with a maximum of 1.8 meters amplitude:

Constituent	Amplitude (m)	Phase (deg)
M2	1.3	0
O1	0.5	0

15. Enter "0.0" as the *Constant value for WSE offset (m)*.

16. Click **OK** to close the *Arc Boundary Condition* dialog.

CMS-Flow supports several other types of boundary conditions that will not be illustrated in this tutorial.

4   Defining Save Points

Save points can be used to specify data to gather during the model run. Create save points by doing the following:

1. Right-click on "🗁 Map Data" and select **New Coverage** to bring up the *New Coverage* dialog.

2. In the *Coverage Type* section, select *Models | CMS-Flow |* **Save Points**.

3. Click **OK** to close the *New Coverage* dialog and create the new "🌐 Save Points" coverage in the Project Explorer.

4. Right-click on "🌐 Save Points" and select **Save Points Properties…** to bring up the *Save Points Properties* dialog.

5. Select "minutes" from the *Hydro* drop-down and enter "10.0" as the value.

6. Click **OK** to close the *Save Points Properties* dialog.

7. Using the **Create Feature Point ⠶** tool, create a feature point within the grid area as in Figure 3.
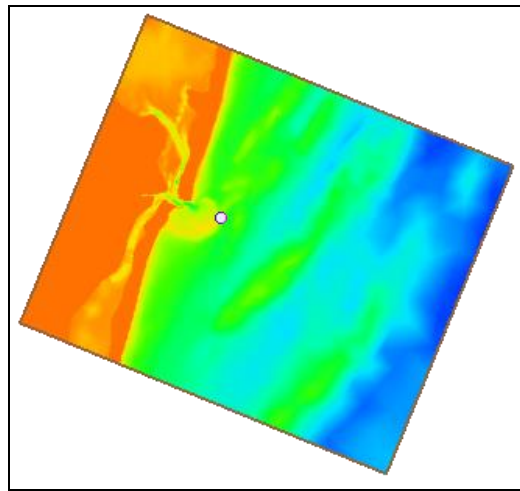

Figure 3   Save point

8. Using the **Select Feature Point 🖈** tool, select the newly-created point, then right-click on it and select **Assign Save Points…** to bring up the *Assign Save Points* dialog.

9. Enter "Ebb Shoal" as the *Name*.

10. Turn on *Hydro* and click **OK** to close the *Assign Save Points* dialog.

A save point has now been set, and it is ready to be added to the simulation.

5   Defining Activity

A CMS-Flow simulation can be made more efficient by assigning areas that will never get wet to be inactive. An activity coverage defines active and inactive regions. In the case of Ocean City, the land regions do not have any elevation data, so the grid creation process assigned an elevation of 0.0 as specified for the extrapolation value. Since the tide range is greater than 1.0 meter (an amplitude of 1.3 was specified for M2 alone), the resulting CMS-Flow simulation would inappropriately inundate the land.

To flag the land areas as inactive, do the following:

1. Right-click on "🔵 CMS-Flow" and select **Duplicate** to create a new "🔵 CMS-Flow (2)" coverage.

2. Right-click on "🔵 CMS-Flow (2)" and select *Type* | *Generic* | **Activity Classification**

3. Right-click on "🔵 CMS-Flow (2)" and select **Rename**.

4. Enter "Activity" and press *Enter* to set the new name.

5. Select "🔵 Activity" to make it active.

6. **Frame** 🔍 the project.

Now create a polygon in the activity coverage to enclose the land:

7. Using the **Create Feature Arc** 🔾 tool, create an arc enclosing the land side of the project (Figure 4).

Figure 4   Arc enclosing the land

8. Select *Feature Objects* | **Build Polygons**.

By default, all polygons are classified as inactive regions. This must be changed for the region of the ocean.

9. Using the **Select Feature Polygon** 🔼 tool, double-click on ocean side polygon to bring up the *Activity Classification Coverage* dialog.

10. In the *Classification Type* section, select *Active* and click **OK** to close the *Activity Classification Coverage* dialog.

11. Click anywhere outside the polygons to deselect them.

The active and inactive definitions are now ready.

6   Setting Up the Simulation

CMS-Flow makes use of simulations, and multiple simulations can be included in a project. Set up the CMS-Flow simulation by doing the following:

1. Right-click in a blank area in the Project Explorer and select *New Simulation |* **CMS-Flow**.

This creates in the Project Explorer a new "⬡ Sim" under a "🗎 CMS-Flow Simulations" folder under "🗐 Simulation Data".

2. Right-click on "⬡ Sim" and select **Rename**.

3. Enter "Ocean City" and press *Enter* to set the new name.

4. Right-click "⬛ Inlet Grid" and select *Link to |* **CMS-Flow Simulations →** **Ocean City**.

5. Repeat step 4 for "◑ BC", "◑ Activity", and "◑ Save Points".

6. **Frame** 🔍 the project.

The Project Explorer should now appear similar to Figure 5.
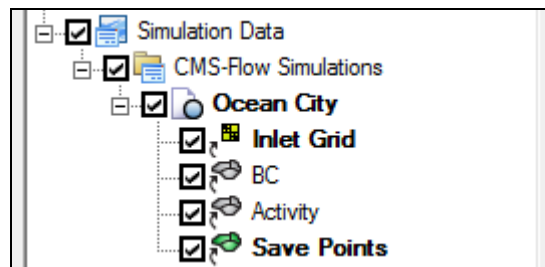

Figure 5   Components linked to the simulation in the Project Explorer

6.1   Defining the Model Control

Set the parameters for running CMS-Flow in the *Model Control* dialog by doing the following:

1. Right-click on "⬡ Ocean City" and select **Model Control…** to bring up the CMS-Flow *Model Control* dialog.

2. On the *General* tab, enter "6/1/2014 1:00:00 pm" as the *Start date/time*.

3. Enter "96.0" as the *Simulation duration* and select "hours" from the drop-down.

This simulates 96 hours (or four days).

4. Enter "2.0" as the *Ramp duration* and select "days" from the drop-down.

Full tidal runs often require a full lunar cycle of 28 days or at least 14 days. This run is shorter to allow for shorter run times.

5. Make sure *Second order skewness correction* is turned on.

6. In the *Hot start* section, make sure *Initial conditions file* is turned off.

This option instructs CMS-Flow to start from cold start conditions.

7. Set the *Single Hot Start time to write out* to "48.0" hours to tell CMS-Flow to start writing hot start files after 2 days of simulation time.

8. Enter "6.0" as the *Auto Hot Start output interval* to tell CMS-Flow to update the hot start file after each 6 hours of simulation time.

9. In the *Solution scheme* section, select "Implicit" from the first drop-down.

10. Select "GMRES" from the *Matrix solver* drop-down.

11. In the *Threads* section, enter "4" for the *Number of threads*.

12. On the *Flow* tab in the *Parameters* section, enter "600" as the *Hydrodynamic time step* and select "seconds" from the drop-down.

This defines the maximum time step to be 600 seconds (10 minutes). CMS-Flow will reduce this if needed to maintain stability.

13. Scroll down to the *Bottom roughness dataset* sub-section of the *Bottom and wall friction* section and select "Mannings N" from the drop-down.

14. Click **Select** to bring up the *Dataset* dialog.

15. Click **Create** to bring up the *Dataset Toolbox* dialog.

16. In the *Calculator* sub-section of the *Data Calculator* section, enter "0.025".

17. Enter "n" as the *Output dataset name* and click **Compute**.

18. Click **Done** to close the *Dataset Toolbox* dialog.

19. Click **OK** to close the *Dataset* dialog.

For this simulation, no sediment transport, salinity, wave, or wind options will be included. These functions are off (or set to "none"), so no changes will be made on the *Sediment Transport*, *Salinity*, *Wave*, and *Wind* tabs.

20. On the *Output* tab, enter "Ocean City" as the *Simulation label*.

21. In the *Output time lists* section under *List 1*:

    *   Enter "48" in the *Start time (hrs)* column.

    *   Enter "1" in the *Increments (hrs)* column.

    *   Enter "96" in the *End time (hrs)* column.

22. Click **OK** to close the *Model Control* dialog.

7   Saving the Simulation

It is recommended to save the project prior to running CMS-Flow.

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 "OceanCity.sms" as the *File name*.

4. Click **Save** to save the project under the new name and close the *Save As* dialog.

8   Using CMS-Flow

CMS-Flow can be launched from inside SMS by doing the following:

1. Right-click on "⬤ Ocean City" and select **Save, Export, and Launch CMS-Flow...** to bring up the *Simulation Run Queue* dialog.

If any problems are found in the model quality check, the problems will appear in the text field at the bottom of the dialog. The steps needed to correct the problems will also be displayed.

SMS saves the location of the CMS-Flow executable as a preference. If this preference is defined, the model will launch. If the preference is undefined, SMS shows a message that the executable is not found and the location of the executable must be specified.

2. If this happens, click the **File Browser** 📁 button to browse and find the CMS-Flow executable, then click the **OK** button to run the model.

3. Click **OK** when advised the "Activity" coverage will be renumbered.

The "Ocean City" simulation should be at the top of the list of simulations (there should be only one simulation in the list at this time). Depending on the speed of the computer, CMS-Flow may take one or two hours to complete its run.

4. Click small arrow to the left of "Ocean City" reveal sub-listings for "TelFix" and "CMS-Flow".

5. Select "CMS-Flow" to make the command line information display in the lower part of the dialog.

6. When CMS-Flow finishes, click **Load Solution** to the right of "Ocean City".

This removes the entry for "Ocean City" and loads the results into SMS.

7. Click **Close** to close the *Simulation Run Queue* dialog.

8.1   Viewing the Solutions

Once the simulation is completed, SMS adds the new solution datasets to the Project Explorer under "▦ Inlet Grid". To view the solutions:

1. Right-click "▦ Inlet Grid" and select **Zoom to QuadTree**.

2. Select "▥ Water_Elevation" to make it active.

3. Click **Display Options** 🖥 to bring up the *Display Options* dialog.

4. Select *Quadtree* from the list on the left.

5. On the *Quadtree* tab, turn on *Contours* and *Vectors*.

6. On the *Contours* tab in the *Contour method* section, select "Color Fill" from the drop-down.

7. On the *Vectors* tab, in the *Vector Display Placement and Filter* section, select "on a grid" from the *Display* drop-down.

8. Enter "15" for both *X spacing* and *Y spacing*.

9. Click **OK** to close the *Display Options* dialog.

10. Review all of the time steps to observe the changes over time.

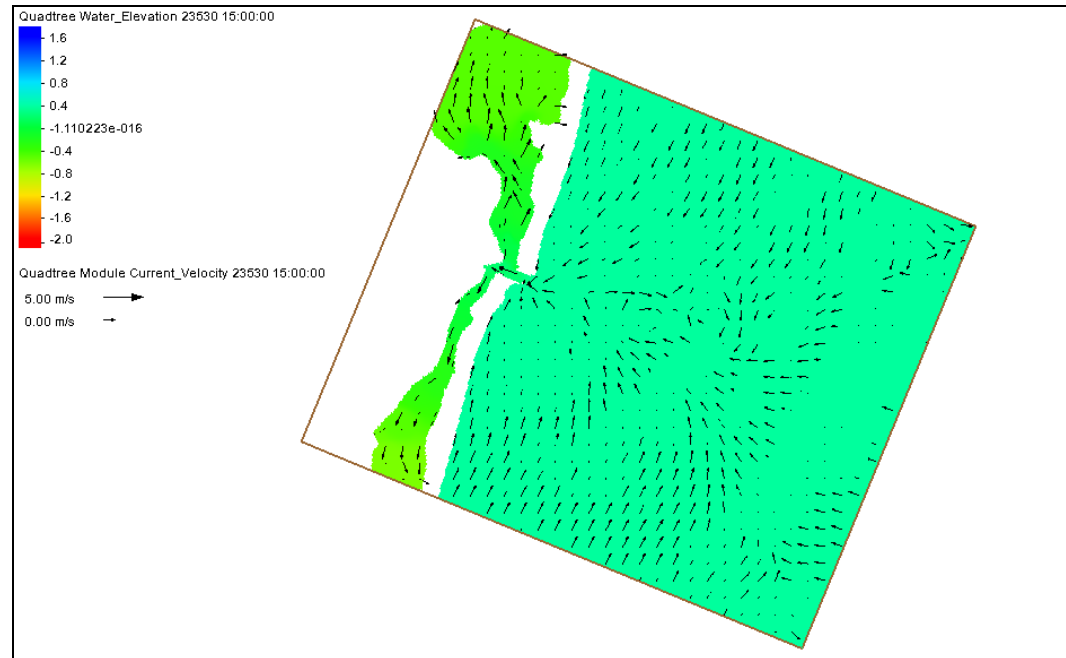The project should appear similar to Figure 6 at time step "23530 15:00:00".

Figure 6   Time step 23530 15:00:00

9 Conclusion

This concludes the "CMS-Flow" tutorial. Feel free to continue experimenting with the SMS interface, or exit the program.