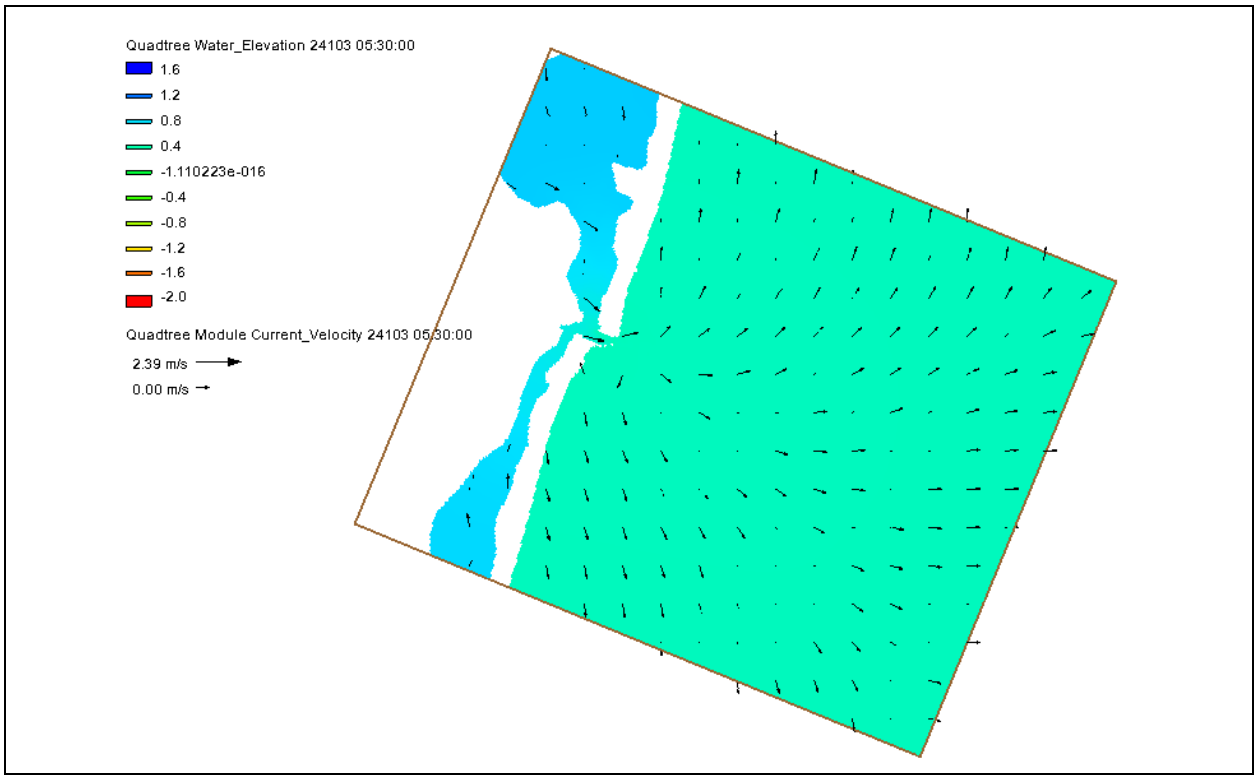
SMS 12.1 Tutorial
CMS-Flow



Objectives

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

Prerequisites

- SMS Overview

Requirements

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

Time

- 30-45 minutes

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1 Getting Started

Launch the SMS application. This tutorial will start with importing a project file with the data for the CMS-Flow simulation.

1. Select *File* | **Open** to bring up the *Open* dialog.
2. In the dialog, browse to the "Data Files" folder for this tutorial and select the "ocean_city.sms" file then click **Open**.

An image similar to Figure 1 should appear in the Main Graphics Window. The data used for this tutorial is from Ocean City inlet and the surrounding coastline in the state of Maryland. An elevation dataset and an area property coverage have been included for use in the tutorial. The projection for the project has already been set.

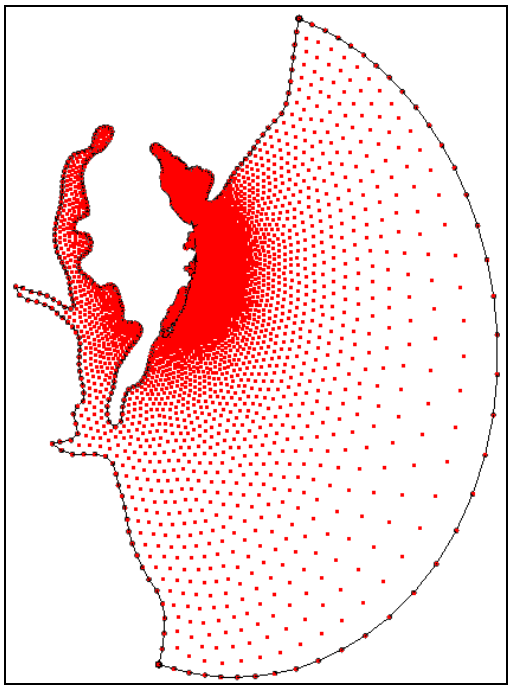

Figure 1 Ocean City inlet

The next sections of the tutorial will go over the components for the CMS-Flow model. Components for CMS-Flow include an Activity Classification coverage, a Quadtree grid, a CMS-Flow Boundary Conditions coverage, and a CMS-Flow Save Points coverage.

2 Creating a Quadtree Grid

The data provided to start this tutorial includes the bathymetry and an arc that defines the shoreline. The bathymetry is in the form of a scatter dataset (or triangulated irregular network or TIN) and shoreline is in a coverage named "CMS-Flow".

To create the grid that will be used for numerical computations:

1. Click on the "CMS-Flow" coverage to make it active.
2. Select the **Zoom** tool and drag a box over the area show in Figure 2.

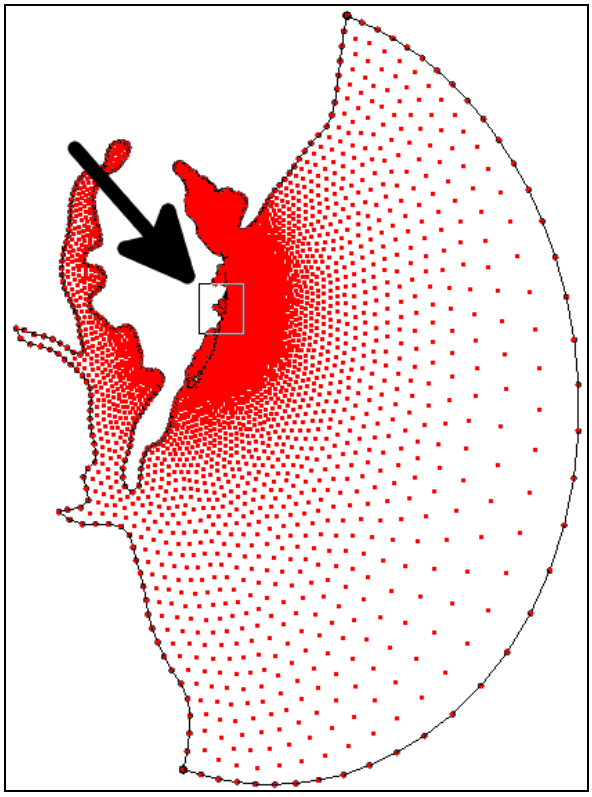

Figure 2 Zoom area

3. Right-click on the Map Data folder and select **New Coverage** to bring up the *New Coverage* dialog.
4. In the dialog, select the *Coverage Type* as "Quadtree Generator" and enter "CMS-Flow Quadtree" as the *Coverage Name*.
5. Click **OK** to close the *New Coverage* dialog and create the new coverage in the Project Explorer.
6. Select the "CMS-Flow Quadtree" coverage to make it active.
7. Using the **Create 2-D Grid Frame** tool, define the extents of the computational domain. This is done with three clicks (see Figure 3).
   - The first click defines a corner of the domain (usually the origin). Click near the upper left corner of the data for this point.

- The second click defines the first direction of the grid and extent of the grid in that direction. Click near the upper right of the data for this point.
- The third click defines the extent of the domain perpendicular to the first direction. Click at the lower right corner of the domain to define this distance. The thick purple line just inside the data extents in Figure 3 illustrates a grid frame.

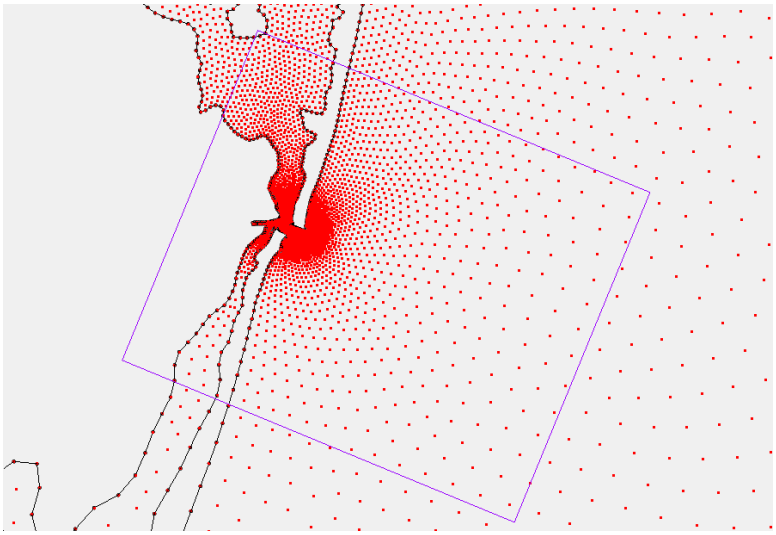

Figure 3 Grid dimensions

8. Right-click the "CMS-Flow Quadtree" and select *Convert* | **Map→Quadtree Grid** to bring up the *Map→Quadtree Grid* dialog.

This dialog allows modification of the extents of the grid frame explicitly and set the desired grid attributes. The exact values for the position and size of a grid do not generally matter in a real world simulation.

9. For consistency in this tutorial, however, set the following in the *Origin, Orientation and Dimensions* section:
   - *Origin X* to "560770.5"
   - *Origin Y* to "70055.4"
   - *Angle* to "337.6"
   - *I size* to "15445"
   - *J size* to "12963"
10. In the *I Cell Options* section, select the *Cell size* radio button and enter "50" (this is the column cell size).
11. In the *J Cell Options* section, select the *Cell size* radio button and enter "50" (this is row cell size).

Notice that the number of cells is computed and reports that there will be 309 columns and 260 rows.

12. In the *Depth Options* section, select "Scatter Set" from the *Source* drop-down.
13. Click the **Select** button to bring up the *Interpolation* dialog.

14. In the *Scatter Set To Interpolate From* section, select "depth". This defines the source for depth data for the model.

CMS-Flow uses depths (measured from the surface downward, so a positive number gives the distance below the surface). If a survey is done relative to a sea level datum and the data is measured as elevation (distance above sea level), the datum would need to be switched or a depth dataset computed using the data calculator.

15. Click **OK** to close the *Interpolation* dialog.
16. Click **OK** to close the *Map→2D Grid* dialog.

SMS creates a quadtree grid within the defined grid frame and adds it to the Project Explorer. An object named "CMS-Flow Quadtree Grid" will be in the "Quadtree Data" entry of the data tree. SMS has defined the cells, assigned depth values to each cell and created cell strings around the boundaries.

To better see the depths on the grid, change the grid display.

1. With the "CMS-Flow Quadtree Grid" object selected, click on the **Display** macro to bring up the *Display Options* dialog.
2. In the dialog, make certain the "Quatree" item is selected on the list to the left the turn off all options except for the *Contours* and *Boundary* options.
3. Select the *Contours* tab.
4. Change the *Contour Method* to "Color Fill" then click **OK** to close the *Display Options* dialog.

The Graphics window should resemble Figure 4.

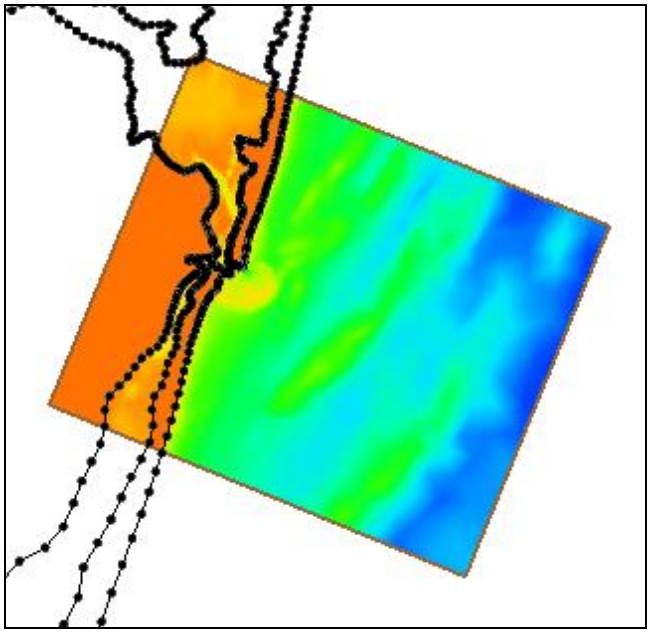

Figure 4 Quadtree contours with color fill

3 Defining Boundary Conditions

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

Create the boundary condition coverage by duplicating the "CMS-Flow" coverage:

1. Right-click on the "CMS-Flow" coverage and select the **Duplicate** command. A new coverage will appear in the Project Explorer.
2. Right-click on the new coverage and select the **Rename** command.
3. Give the new coverage the name "CMS-Flow BC".
4. Right-click on the "CMS Flow BC" coverage and change the coverage type by going to *Type* | *Models* | *CMS-Flow* | **Boundary Conditions**.

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

1. With the "CMS-Flow BC" coverage active, select the **Create Feature Arc** tool.
2. Click out an arc along the grid boundary covering the ocean as seen in Figure 5.

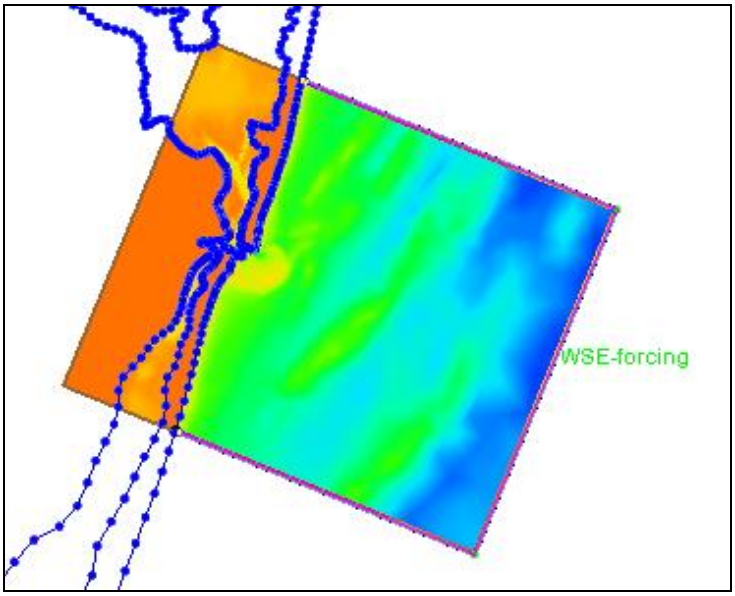

Figure 5 Boundary arc

Currently all of the arcs are unassigned by default. The arc around the grid boundary needs to be assigned additional data.

1. Using the **Select Feature Arc** tool, right-click on the arc around the grid boundary and select the **Assign Boundary Conditions…** command. The *Arc Boundary Condition* dialog will appear.
2. In the dialog, the following attributes:
   - *Type*: "WSE-forcing"
   - *WSE Source*: "Tidal Constituent"
   - *Inflow direction*: "0"

- *WSE offset*: "0"

3. For the *Constituents* area, click add button twice. Two rows will be added to the field. For these rows, enter the following attributes:

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

4. Click **OK** to close the *Arc Boundary Condition* dialog.
5. 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 the Map Data folder and select **New Coverage** to bring up the *New Coverage* dialog.
2. In the dialog, select the *Coverage Type* as "Save Points" under "CMS-Flow" and enter "CMS-Flow Save Points" as the *Coverage Name*.
3. Click **OK** to close the *New Coverage* dialog and create the new coverage in the Project Explorer.
4. Right-click on the "CMS-Flow Save Points" coverage and select the **Save Points Properties** command to bring up the *Save Points Properties* dialog.
5. In the dialog, under *Hydro* enter "0.5" and change the units to "hours".
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 6.

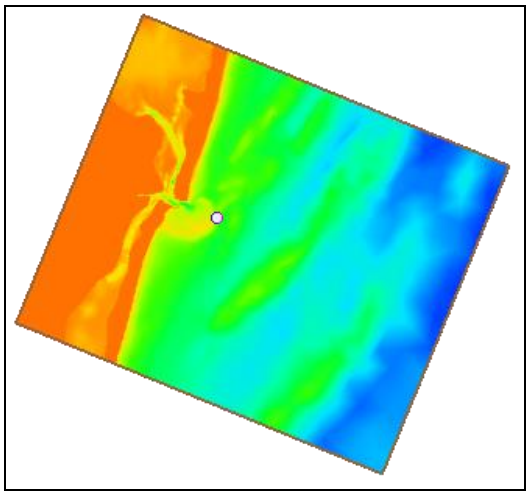

Figure 6 Save point

8. Using the **Select Feature Point** tool, right-click on the point that was just created and select the **Assign Save Points…** command to bring up the *Assign Save Points* dialog.
9. Check on the *Hydro* option and click **OK** to close the *Assign Save Points* dialog.

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

5 Defining Activity

The project needs to define where the active and inactive areas for the CMS-Flow run. CMS-Flow does this automatically, however, adding an activity coverage can speed up the model run time.

Start by duplicating the "CMS-Flow" coverage and the creating polygons that define the active and inactive areas of the model.

1. Right-click on the "CMS-Flow" coverage and select the **Duplicate** command. A new coverage will appear in the Project Explorer.
2. Right-click on the new coverage and select the **Rename** command.
3. Give the new coverage the name "CMS-Flow Activity".
4. Right-click on the "CMS Flow Activity" coverage and change the coverage type by going to *Type* | *Generic* | **Activity Classification**.

Now create polygons on the activity coverage.

1. With "CMS-Flow Activity" as the active coverage, select the **Create Feature Arc** tool.
2. Click out an enclosed arc around the coastline and ocean as shown in Figure 7.
3. Select the *Feature Objects* | **Build Polygons** command.
4. Select the **Select Feature Polygon** tool and double-click on the central ocean polygon. This will bring up the *Activity Classification Coverage* dialog.
5. By default, all polygons are inactive. The polygon that represents the ocean needs to be active. Select the *Active* option and click **OK** to close the *Activity Classification Coverage* dialog.

The active and inactive definitions are now ready.

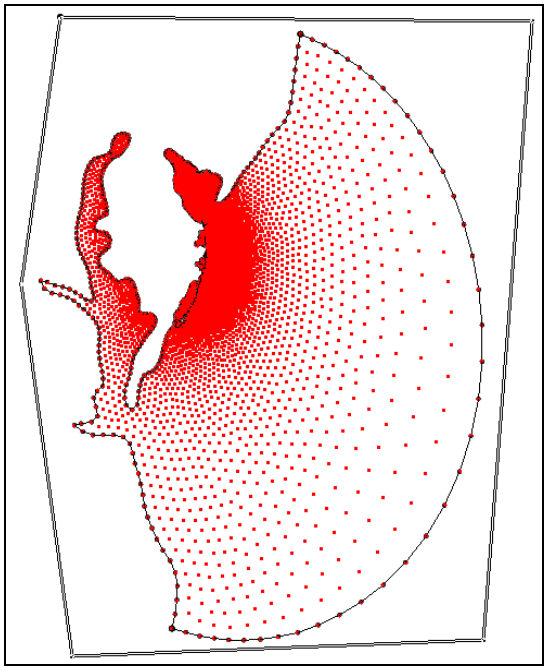

Figure 7 Enclosed arc on the activity classification coverage

6 Setting Up the Simulation

CMS-Flow makes use of simulations. Simulations are useful as multiple simulations can be used in the same project.

Set up the CMS-Flow simulation by completing the following:

1. Right-click in a blank area in the Project Explorer.
2. In the right-click menu, select *New Simulation* | **CMS-Flow**. This will create the simulation object in the Project Explorer.
3. Right-click on the newly created "Sim" object and select **Rename**.
4. Rename the simulation "Ocean City".
5. Link components to the simulation by right-clicking on each component and selecting the *Link to* | **CMS-Flow Simulations→Ocean City**. Do this for the "CMS-Flow Quadtree Grid" item, the "CMS-Flow BC" coverage, and the "CMS-Flow Save Points" coverage.
6. For the "CMS-Flow Activity" coverage, use an alternative method of linking components to a simulation. Click on the "CMS-Flow Activity" coverage and drag it under the simulation folder to create a link between the component and the simulation.

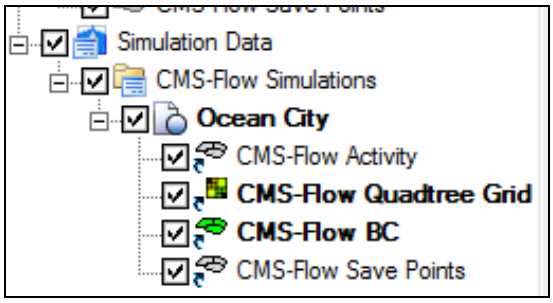

Figure 8 Components linked to the simulation in the Project Explorer

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 the "Ocean City" simulation and select the **Model Control…** command to bring up the CMS-Flow *Model Control* dialog.
2. Select the *General* tab. Set the *Simulation Duration* to "192" hours and the *Ramp duration* to "1" day.
3. Make sure the *Solution scheme* is set to "Implicit" and enter "4" for the *Number of threads*.
4. Select the *Output* tab. Under *List 1*, enter "0" for *Start time (hrs)*, "0.5" for *Increments (hrs)*, and "48" for *End time (hrs)*.
5. Select the *Flow* tab. Scroll down to the Bottom roughness dataset section. Make certain "Mannings N" is selected then select the **Select** button to bring up a *Dataset* dialog.
6. In the *Dataset* dialog, select the **Create** button to bring up the *Dataset Toolbox* dialog.
7. In the *Calculator* field enter "0.025" and enter "n" in the *Output dataset name* field. Click on the **Compute** button.
8. Click **Done** to close the *Dataset Toolbox* dialog.
9. Click **OK** to close the *Dataset* dialog.

The *Salinity* and *Sediment* tabs allow the sediment transport and salinity diffusion to be turned on for a simulation. The *Wave* and *Wind* tabs allow the definition of the wind and wave options. These tabs will not be used in this tutorial, so skip these tabs.

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

7 Saving the Simulation

It is recommended to save the project prior to running CMS-Flow by doing the following:

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 and close the *Save As* dialog.

8 Using CMS-Flow

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

1. Select "Ocean City" in the Project Explorer to make it active.
2. Right-click on the "Ocean City" simulation and select the **Save, Export, and Launch CMS-Flow...** command to bring up the *CMS-Flow* dialog containing the *Simulation Progress* and *CMS-Flow Output* sections. The *Simulation Progress* section on top only displays a progress bar that will turn green when the model run ends. The *CMS-Flow Output* section on the bottom will display the model execution and any errors that occur during the model run. Skip to step 4 if the model is running.

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.

3. If the CMS-Flow is not found, click the **File Browser** button to browse and find the CMS-Flow executable, then click the **OK** button to run the model.

When SMS launches the model, it performs a quick model quality check. If any problems are detected, a message box will display that shows what problems have been found and what steps to take to correct those problems.

4. When CMS-Flow finishes running, make certain the *Load Solution* option is checked on and click the **Exit** button to close the *CMS-Flow* dialog.

SMS will add new datasets to the Project Explorer under "CMS-Flow Quadtree Grid".

To view the solutions:

5. Go to *Display* | **Display Options...** to bring up the *Display Options* dialog.
6. Select *Quadtree Grid* from the list on the left.
7. Toggle on *Contours* and *Vectors*.
8. On the *Contours* tab in the *Contour method* section, select "Color Fill" from the drop-down.
9. Click **OK** to close the *Display Options* dialog.
10. Click through the time steps to observe the changes.

9 Conclusion

This concludes the CMS-Flow tutorial. Continue to experiment with the SMS interface or quit the program.

