Hands-On Practice – (Grays Harbor, WA, Example)

CMS Application to Grays Harbor

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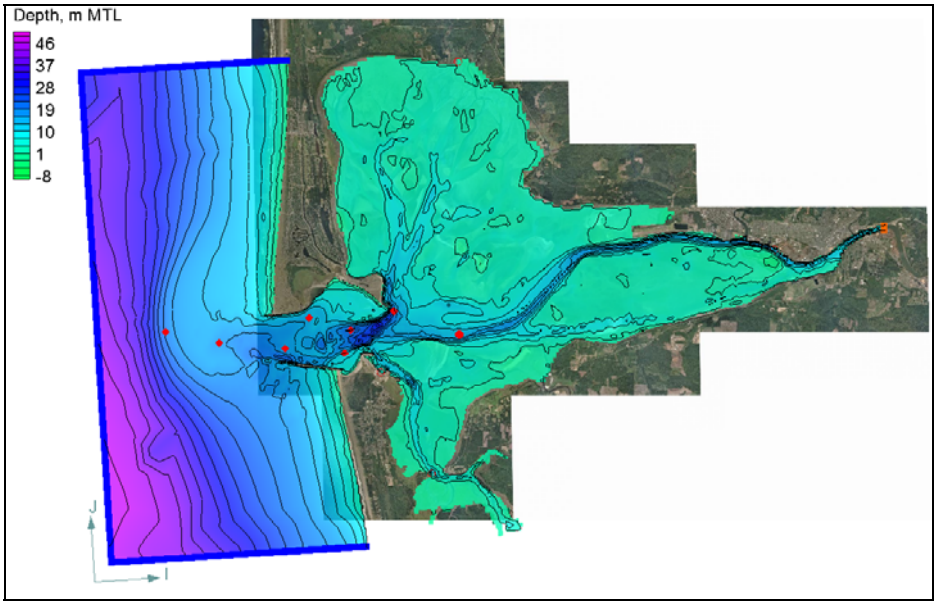

Grays Harbor, WA

Topics:

1. Getting started – Gathering input data

2. Setting up CMS-Flow – Grid generation, model options, parameters, and boundary conditions

3. Setting up CMS-Wave – Grid generation, model options, parameters, and input spectra

4. Running CMS in the Steering Module

CMS Application to Grays Harbor, WA – Self Paced Guided Practice

1. Getting Started

1.1 Gathering Input Files

Unzip the folder *16-Self-Paced_GH.zip* to a directory. The zip file contains the following folders:

- Measurements – Contains bathymetry, field measurements of currents, water levels, and winds.
- boundary_cond – Contains input files for boundary conditions
- images – Contains aerial photos
- CMS-GH – Contains the reference CMS project files

1.2 Setting the Projection

When first starting a project, it is essential to define a coordinate system in which all the files will saved. For this guided practice, all of the input files are in is State Plane Washing South (FIPS 4602), and in meters for both the planar (horizontal) and vertical dimensions. To set the project coordinate system, follow the three steps outlined in Fig. 1.

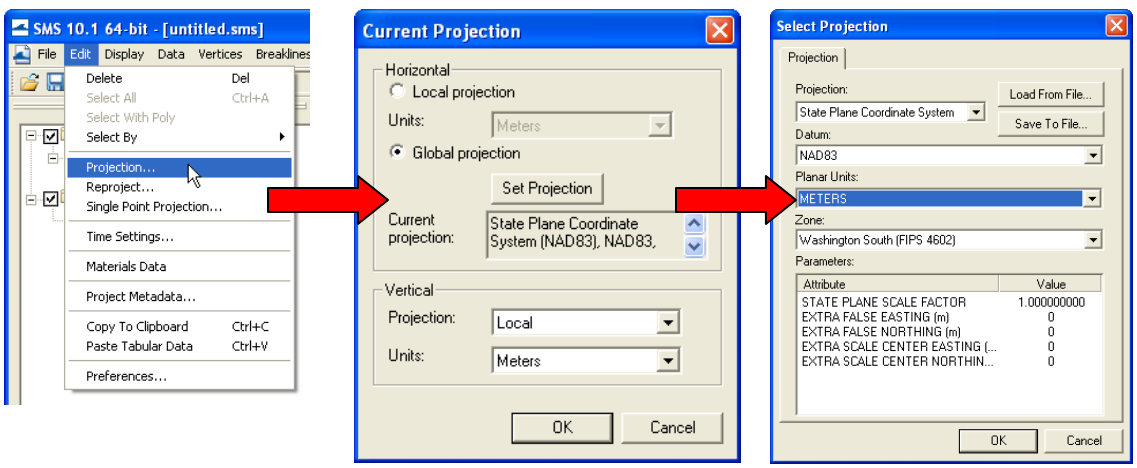

Fig 1: Steps for defining the project coordinate system.

2. Setting up CMS-Flow

2.1 Grid Generation

2.1.1 Load Aerial Photo (optional)

When generating a grid, it is useful to have an aerial photograph as a reference. A reference aerial photo called *GH-base1999.jpg* has been provided in the folder names *image*. Load the image into SMS by dragging and dropping in the project window.

2.1.2 Load Bathymetric Data

Load the prepared bathymetric scatter set called *Bathy99_sp-mtl-m_grid.h5* located under the directory *measured_data | bathy*.

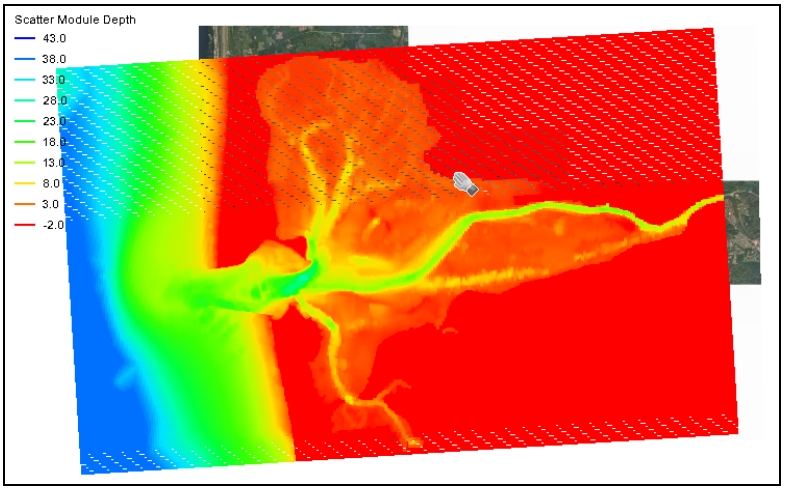

Fig 2. Grays Harbor bathymetric scatter set and aerial photograph.

2.1.3 Create CMS-Flow Map Coverage

There are two approaches for generating a CMS grid. The first is by using the *Create Cartesian Grid* tool in the *Cartesian Grid Module* and the second is by creating a *CMS-Flow Map Coverage* in the *Map Module*. In this tutorial, only the second is covered, since it offers the most flexibility. To create a *CMS-Flow Map Coverage*. either create a new *Map Coverage* must of type *CMS-Flow* by right-clicking on *Map Data* in the *Project Explorer* and selecting New Coverage, or change the type of the current Map Coverage to CMS-Flow by right-clicking on the current *Map Coverage* and selecting *Type | Models | CMS-Flow*.

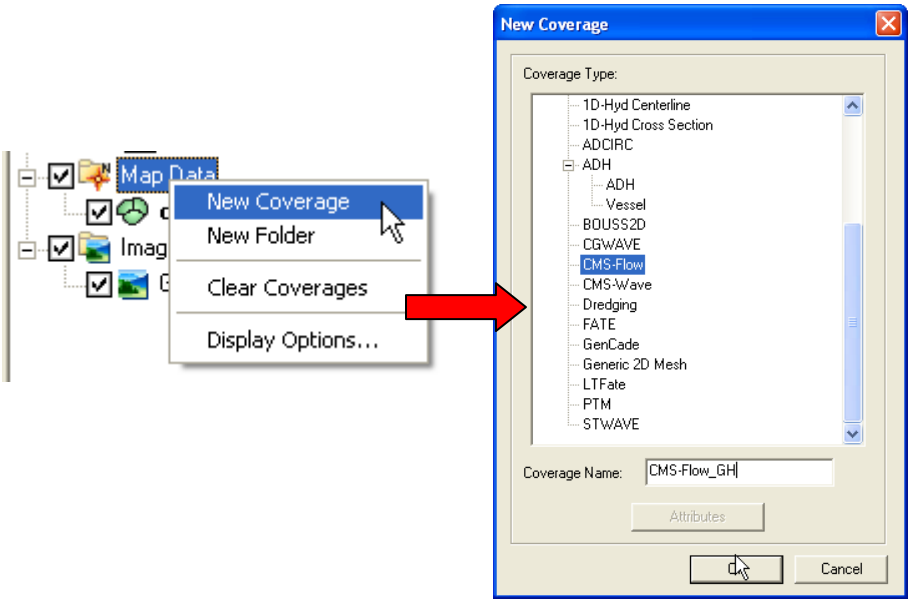

Fig 3. Creating a new *Map Coverage* in SMS of type *CMS-Flow*.

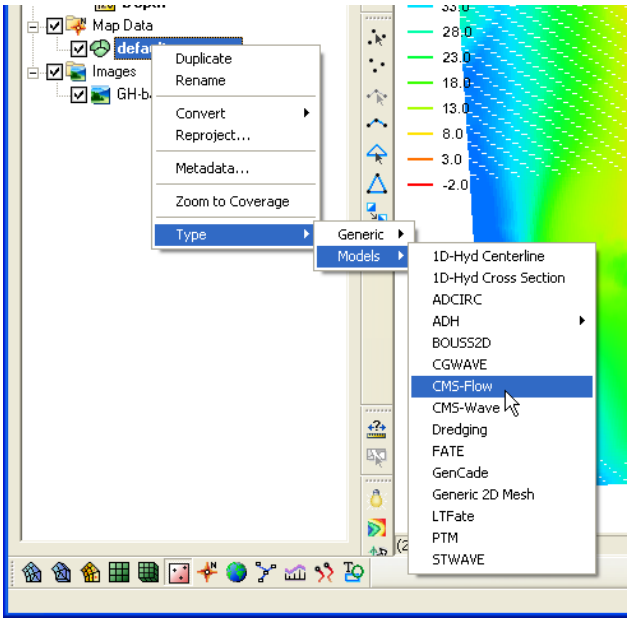

Fig 4: Changing the type of a *Map Coverage* to *CMS-Flow*.

Rename the *Map Coverage* to something mnemonic for the project.

2.1.4 Create CMS-Flow Grid Frame

Click on the *Create 2-D Grid Frame* tool icon , and select three points that define the extent of the CMS-Flow grid. Use the *Select 2-D Grid Frame* tool icon to select the grid frame, move, rotate and adjust the sides.

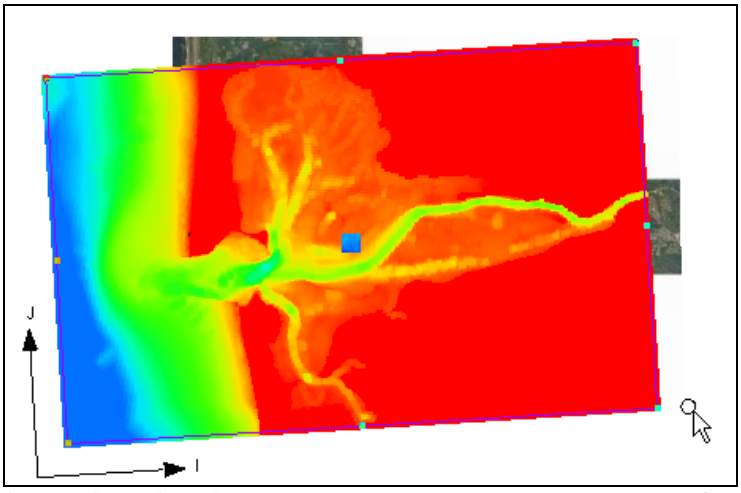

Fig 5: Changing the type of a *Map Coverage* to *CMS-Flow*.

2.1.5 Create CMS-Flow Refine Points

Select the *Create Feature Point* tool icon and click on locations where the grid resolution needs to be refined in either direction. To set the base cell size in

either direction at each *Refine Point*, select points with the *Select Feature Point* tool icon , right-click, and select the option *Node Attributes*.

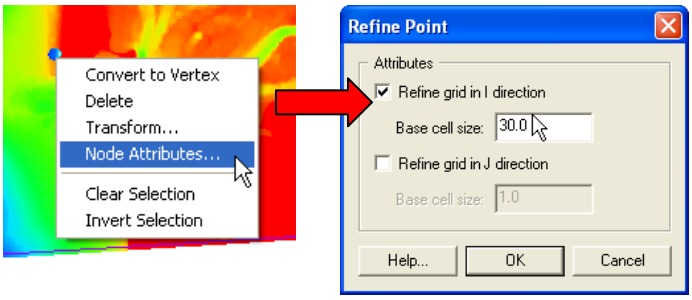

Fig 6: Example of selecting a *Refine Point* and setting the base cell size.

Repeat the process of creating *Refine Points* and specifying the base cell size until the project area is sufficiently covered.

2.1.6 Create a Coastline (optional)

A coastline is useful for delimiting active ocean cells from the inactive land cells. There are several ways of creating a coastline in the SMS. One way is to manually create a feature arc and the second is to use a reference coastline, such as a previous ADCIRC grid or a coastline downloaded from the internet and convert this into a feature arc. To manually create a feature arc, select the *Create Feature Arc* tool and click on the points defining the coastline. Note that the points may be moved or deleted afterwards and additional points be added to the arc. Once the a feature arc is created set the arc type by clicking on the *Select Feature Arc* tool , right-clicking once on the feature arc, and selecting *Attributes*.

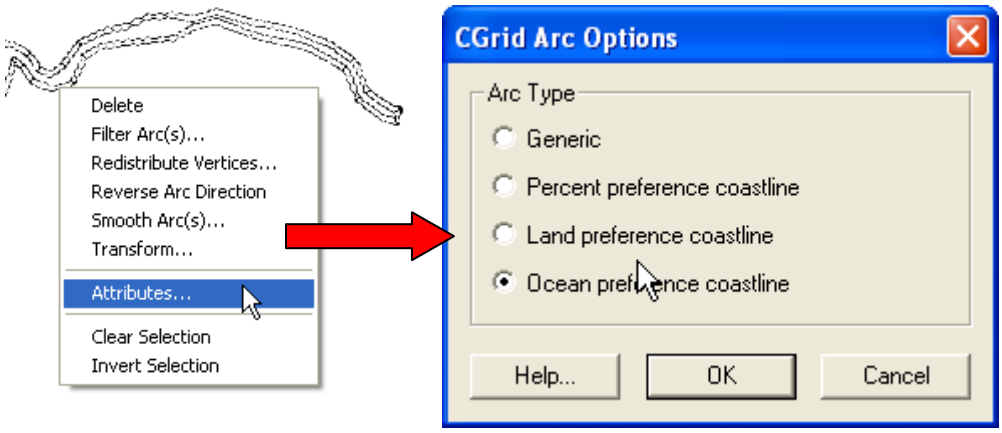

Fig 7: Changing the type of a *Feature Arc* to *Ocean preference coastline*.

The preference of the coastline indicates the cell type for cells which intercept the coastline arc.

The directions of land and ocean regions are defined by the arc direction as indicated by the blue (ocean) and brown (land) arrows when the arc is selected.

The change the direction of the arc, select the arc, and select *Reverse Arc Direction*.

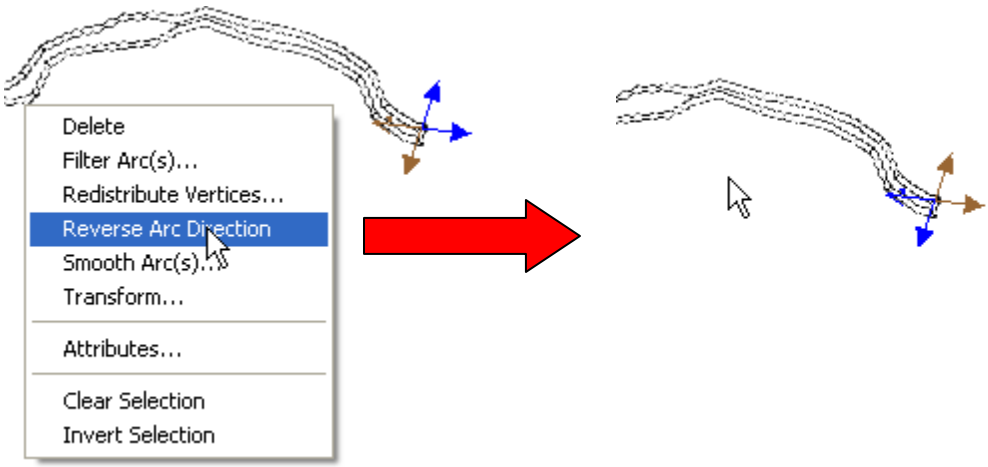

Fig 8: Changing the direction of the Coastline *Feature Arc.*

2.1.7 Set the Grid Frame Properties

Go to the *Grid Frame Properties* window by selecting the grid frame, and right-clicking on the *Grid Frame* handle.

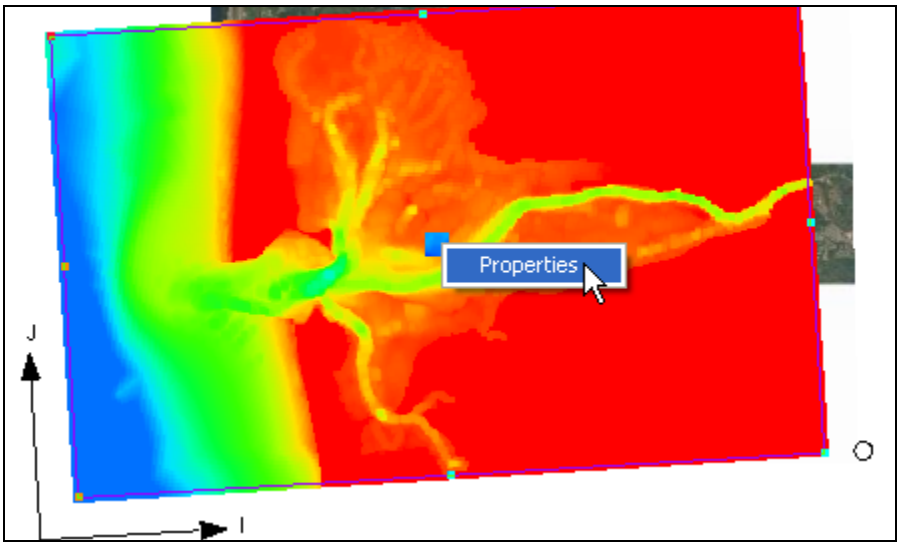

Fig 9. Selecting the *Grid Frame*.

In the *Grid Frame Properties* window, change the settings as shown in Fig 10.

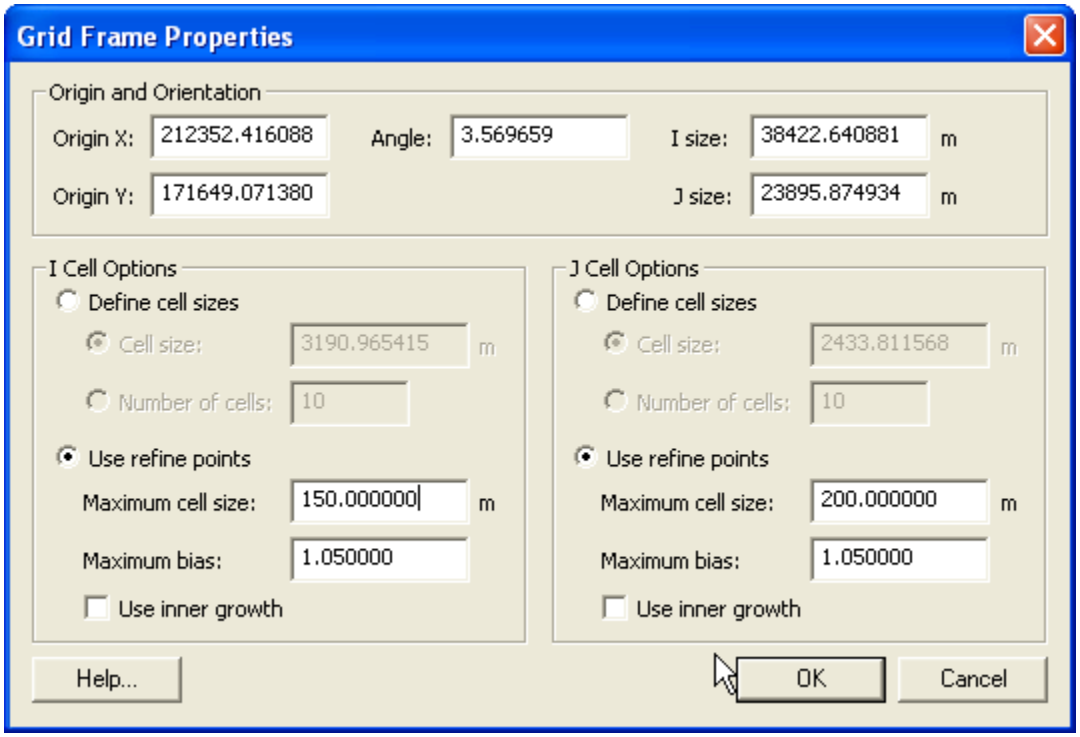

Fig 10. Example *Grid Frame Properties* window and properties for Grays Harbor.

2.1.7 Convert the Map Coverage to a Cartesian Grid

Right-click on the *CMS-Flow Map Coverage* and select *Convert | Map -> 2D Grid*.

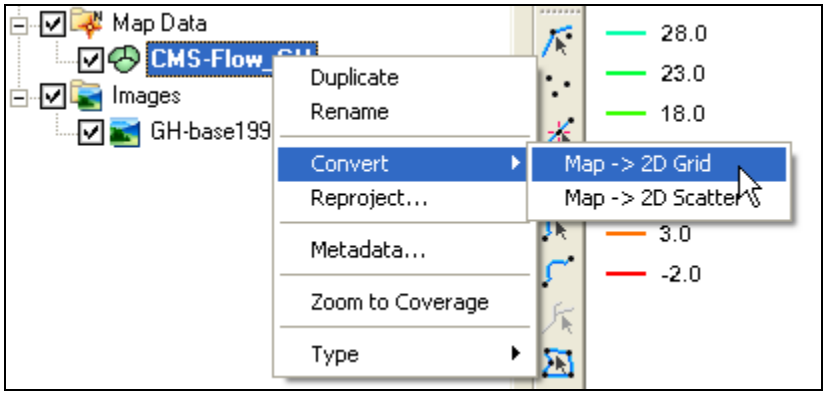

Fig 11: Converting the *CMS-Flow Map Coverage* to a Cartesian Grid.

The *Map -> 2D Grid* window will appear. Change the settings as necessary and click *OK*. An example of the settings in shown in Fig 12 and the resulting grid is shown in Fig 13.

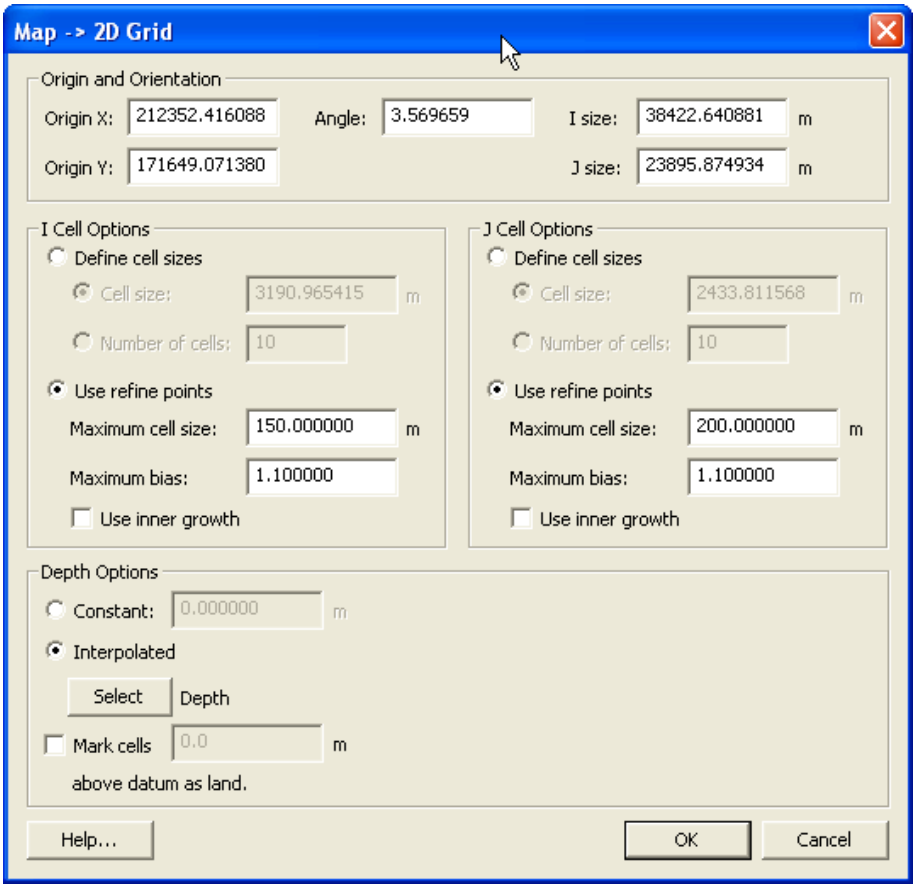

Fig 12: Example settings in the *Map -> 2D Grid* window.

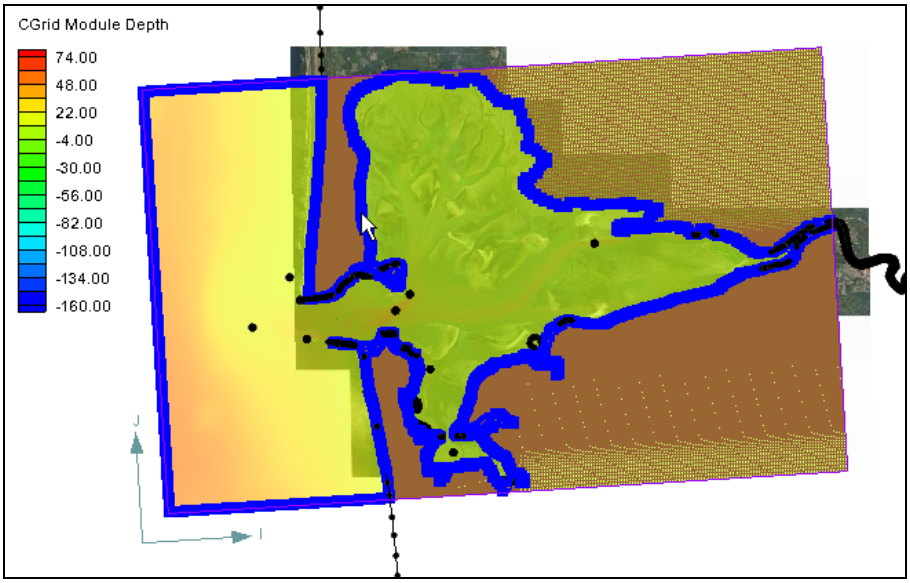

Fig 13: Example CMS-Flow grid for Grays Harbor generated from Map Module.

Save the CMS grid by going to *File | Save CMS-Flow*.

2.2 Hard-bottom

2.2.1 Create a new hard-bottom dataset

Hard-bottom cells are cells that are non-erodible and represent hard structures on the grid. In the case of the Grays Harbor, hard-bottom cells are required to represent the jetties. The hard-bottom depth is specified in the *Hard Bottom* dataset in *CMS-Flow*. The hard-bottom depths can be specified either by manually editing the Hard Bottom dataset in CMS or by creating a new dataset and specifying it as the Hard Bottom dataset in the Model Control under the Transport tab. Often, if there are many hard-bottom cells to specify, it is easier to use the water depths dataset as the starting point for the *Hard Bottom* dataset. To create a new Hard Bottom dataset, follow the steps outlined below:

1. In the SMS menu, click *Data | Data Calculator*.
2. In the *Dataset Toolbox* window, double-click on the *Depth* dataset or entering the letter *d* under *Calculator*.
3. Rename the output dataset to something useful such as *new hard bottom.*
4. Click on *Compute*.
5. Click on *Done*.

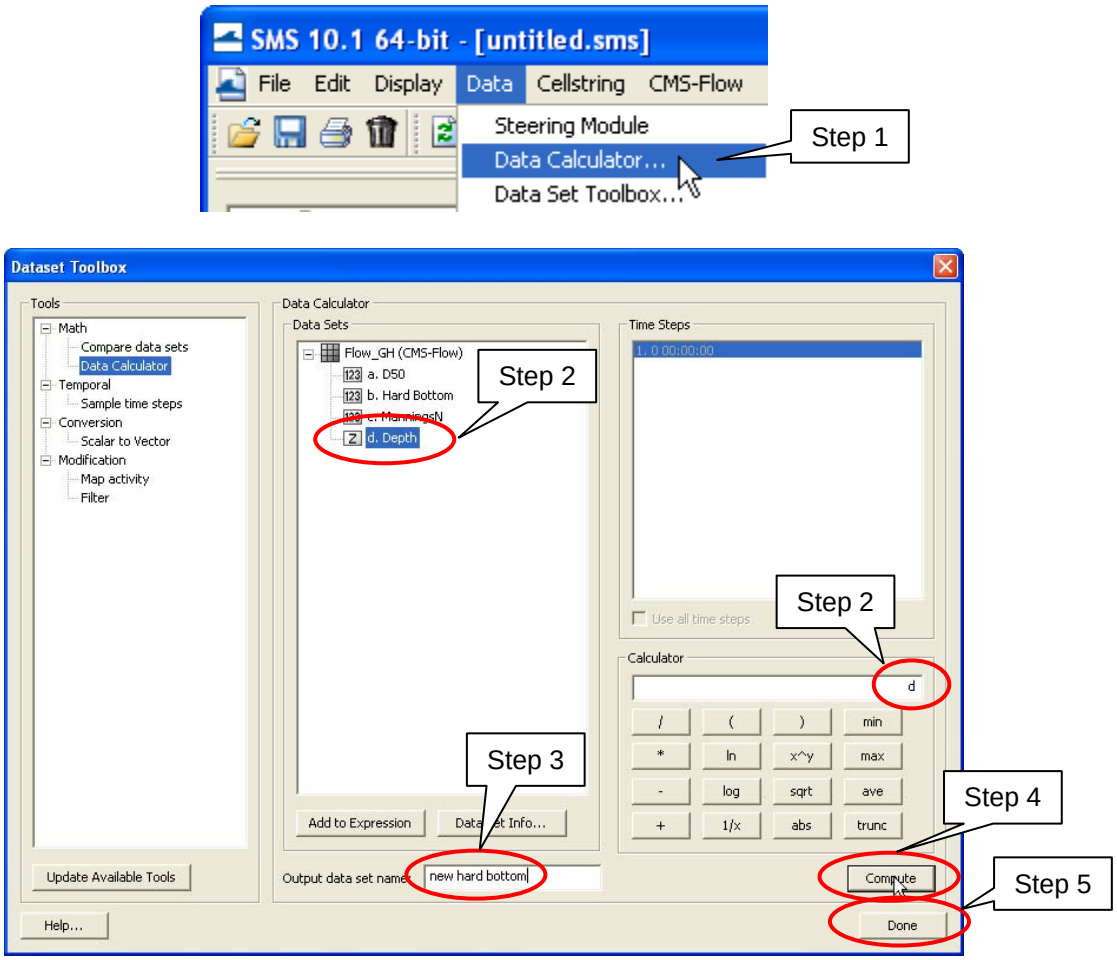

Fig 14: Steps for creating a new *Hard Bottom* dataset.

2.2.2 Map Elevation to New Dataset

To modify the values of the new hard-bottom dataset, the dataset must be set or mapped as the elevation dataset. Once the changes to the new dataset are complete, the elevation can be mapped back to the Depth dataset. Follow the steps below:

1. In the SMS menu, click on *Data | Map Elevation*.
2. Select the *new hard bottom* dataset.
3. Click on *Select* button.

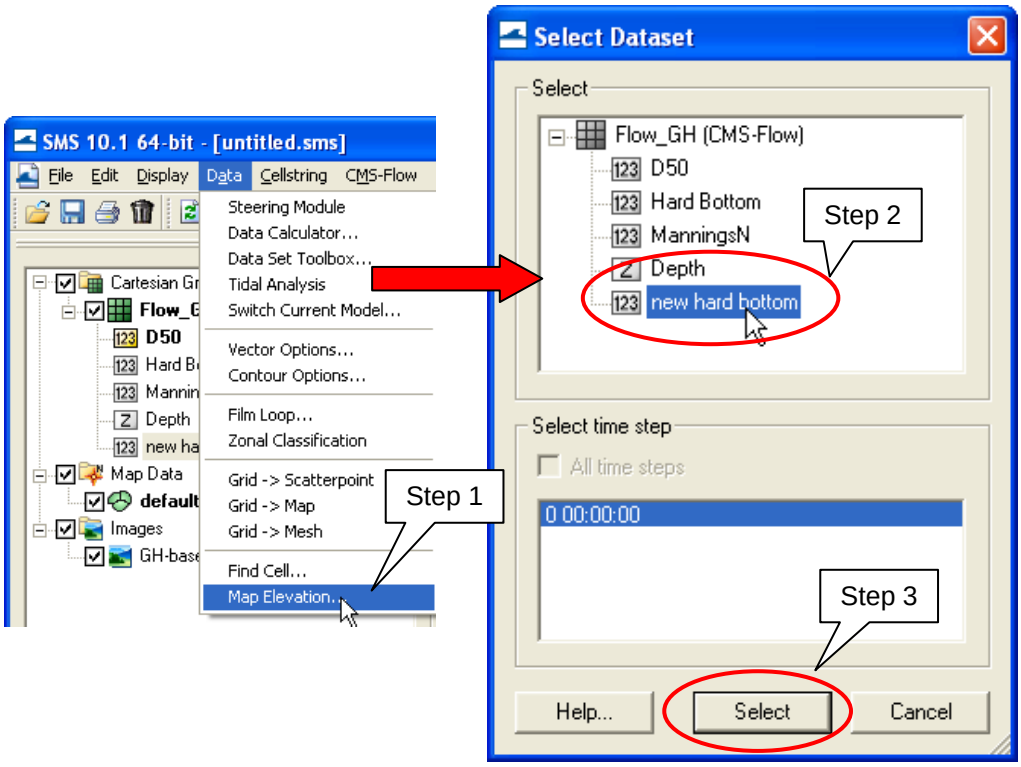

Fig 15: Mapping the new dataset as the elevation dataset.

2.2.2 Editing the hard-bottom dataset

The new hard-bottom dataset has depths everywhere on the grid. However, only the depths over the structures are required. Remove the had-bottom values outside of the south jetty by following the steps below:

1. In the SMS menu, go to *Edit | Select by Poly*.
2. Make a polygon of the cells outside of the structure(s).
3. Enter -999 as the value for the selected cells in the Z field.

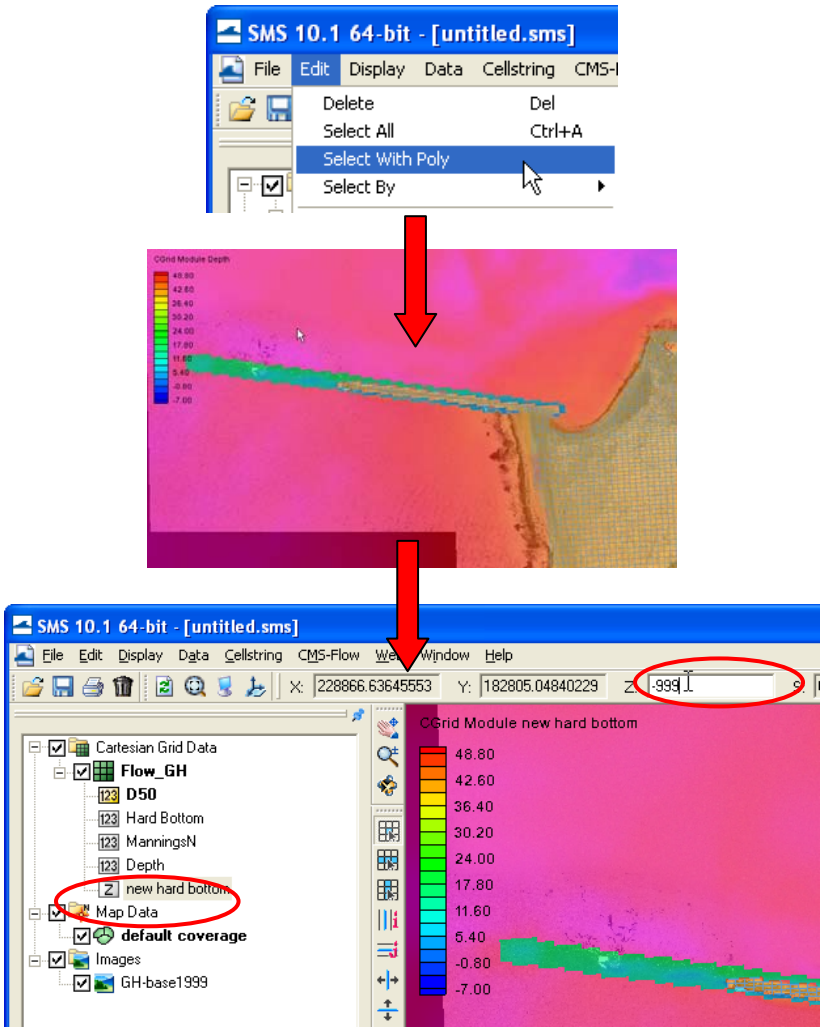

Fig 16: Editing the new hard-bottom dataset.

When finished editing the hard-bottom dataset, remember to map the elevation back to the *Depth* dataset.

2.2 Manning's coefficient

Make sure the *Mannings* dataset is selected in the *Project Explorer*, and edit the whole value for the whole grid by using the *Select Grid Cell* tool, and set the values to 0.018 in the S-field.

2.2 CMS-Flow Model Options and Parameters

2.2.1 Model Parameters

Go to the *Model Control* window by clicking *CMS-Flow | Model Control*. In the first tab called *Model Parameter*, change the starting date and time, simulation duration, ramp duration, hydro time step, anemometer height and average latitude, as shown in Fig 17.

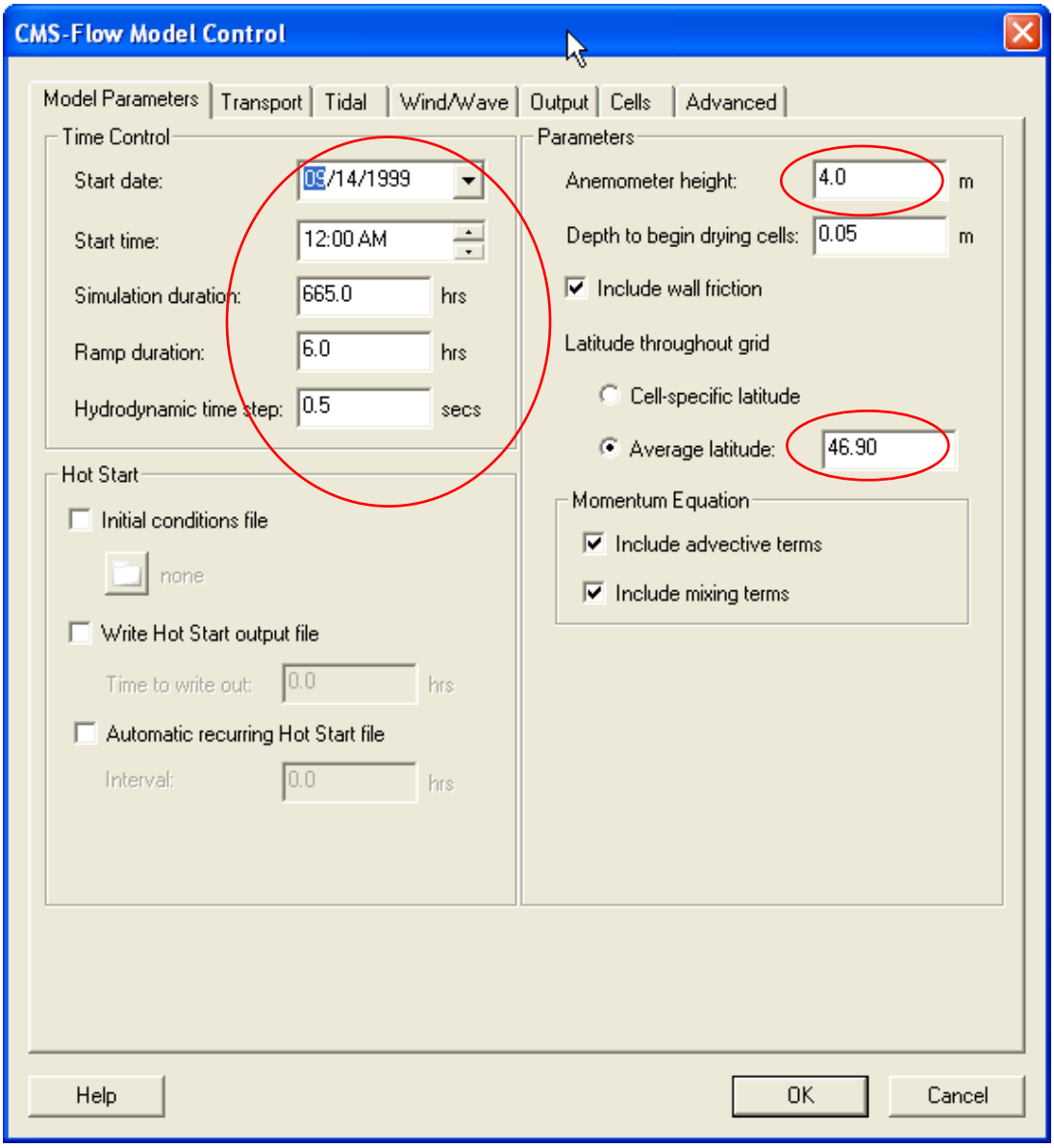

Fig 17: Example settings in the *Model Parameters* tab in the *CMS-Flow Model Control* window.

2.2.2 Transport Parameters

In the tab called *Transport* set the transport and morphologic time steps as shown in Fig 15. Scroll down in the Sediment parameters and select *Constant* as the *Total load adaptation length method.* Leave the *Total load adaptation length* as the default of 10 m.

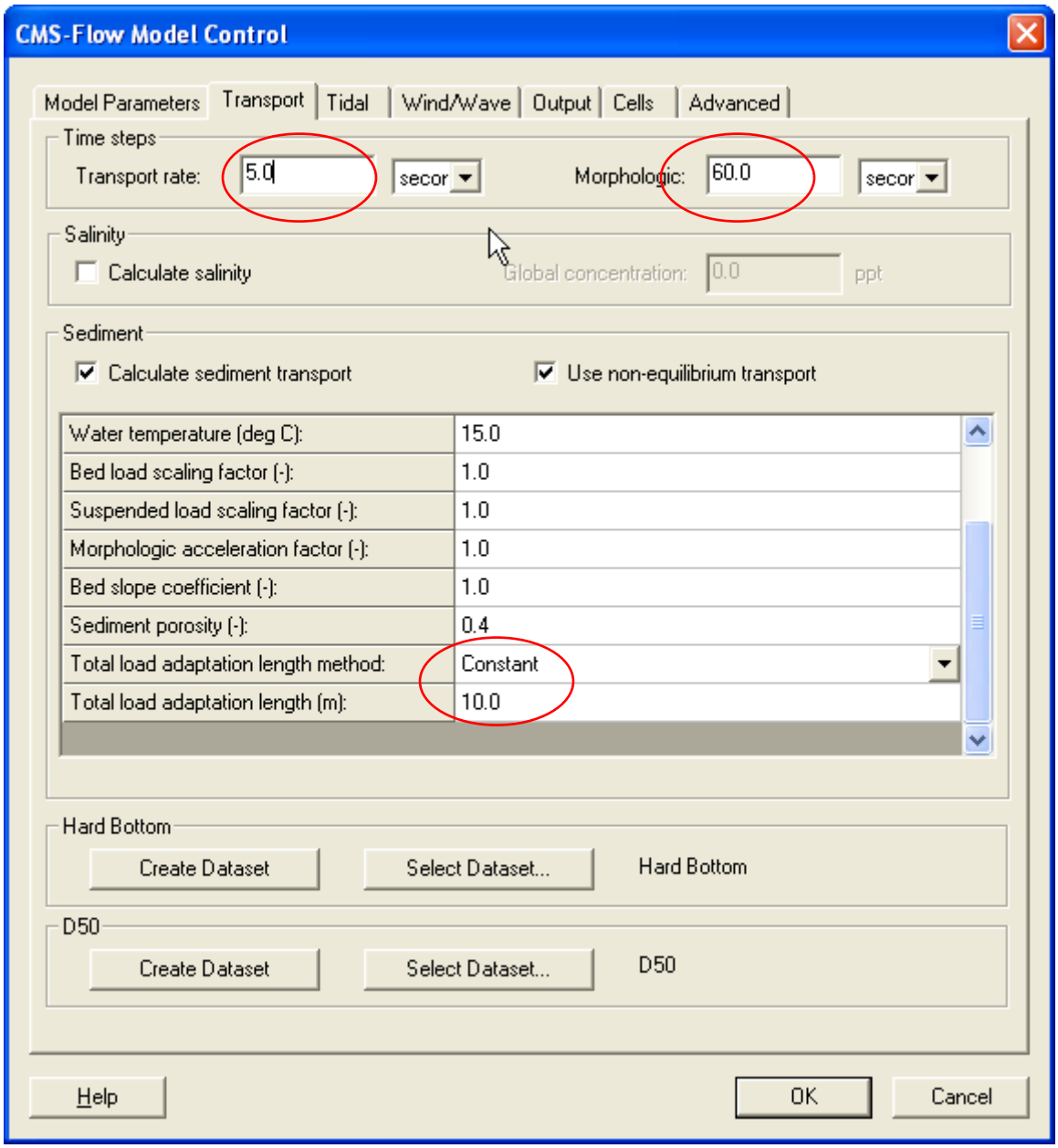

Fig 18: Example settings in the *Transport* tab in the *CMS-Flow Model Control* window.

2.2.3 Wind Data

In the tab called *Wind/Wave*, check the box that says *Include Wind*. Then load the wind velocity and direction data by clicking on their respective buttons that say *Curve undefined*. The *XY series Editor* window will pop up. Import the wind time series by clicking on *Import* and selecting the files *Hoquiam_Wind_Speed_1hr.xys* and *Hoquiam_Wind_Direction_1hr.xys* under the *boundary_cond* directory.

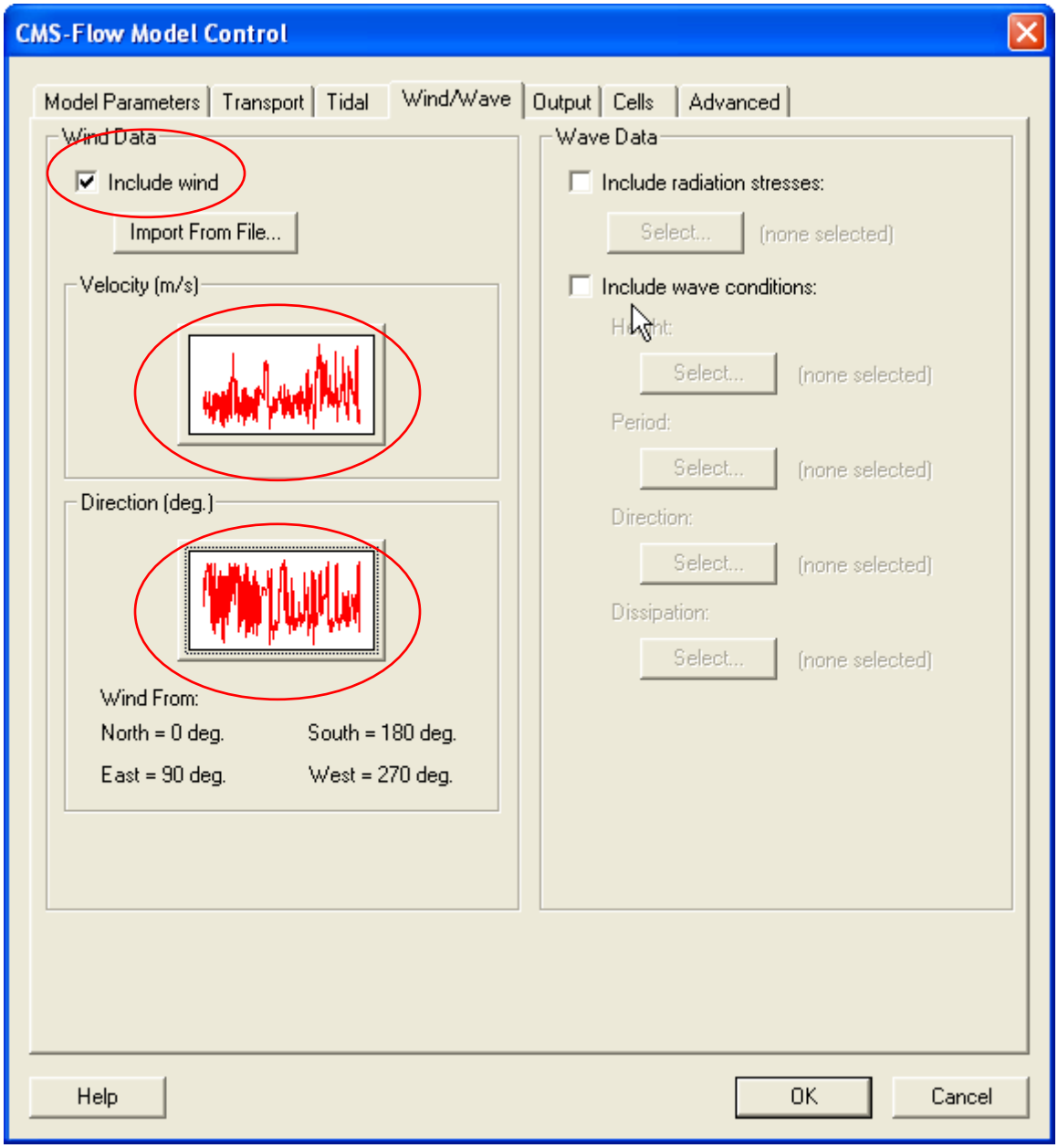

Fig 19: Example settings in the *Transport* tab in the *CMS-Flow Model Control* window.

2.2.4 Model Output

In the tab called *Output*, create out time lists by selecting a start time, end time, and increment and clicking on the button that says *Add.* Make sure to assign an *Output Times List* to each *Output Datasets* on the right-hand-side.

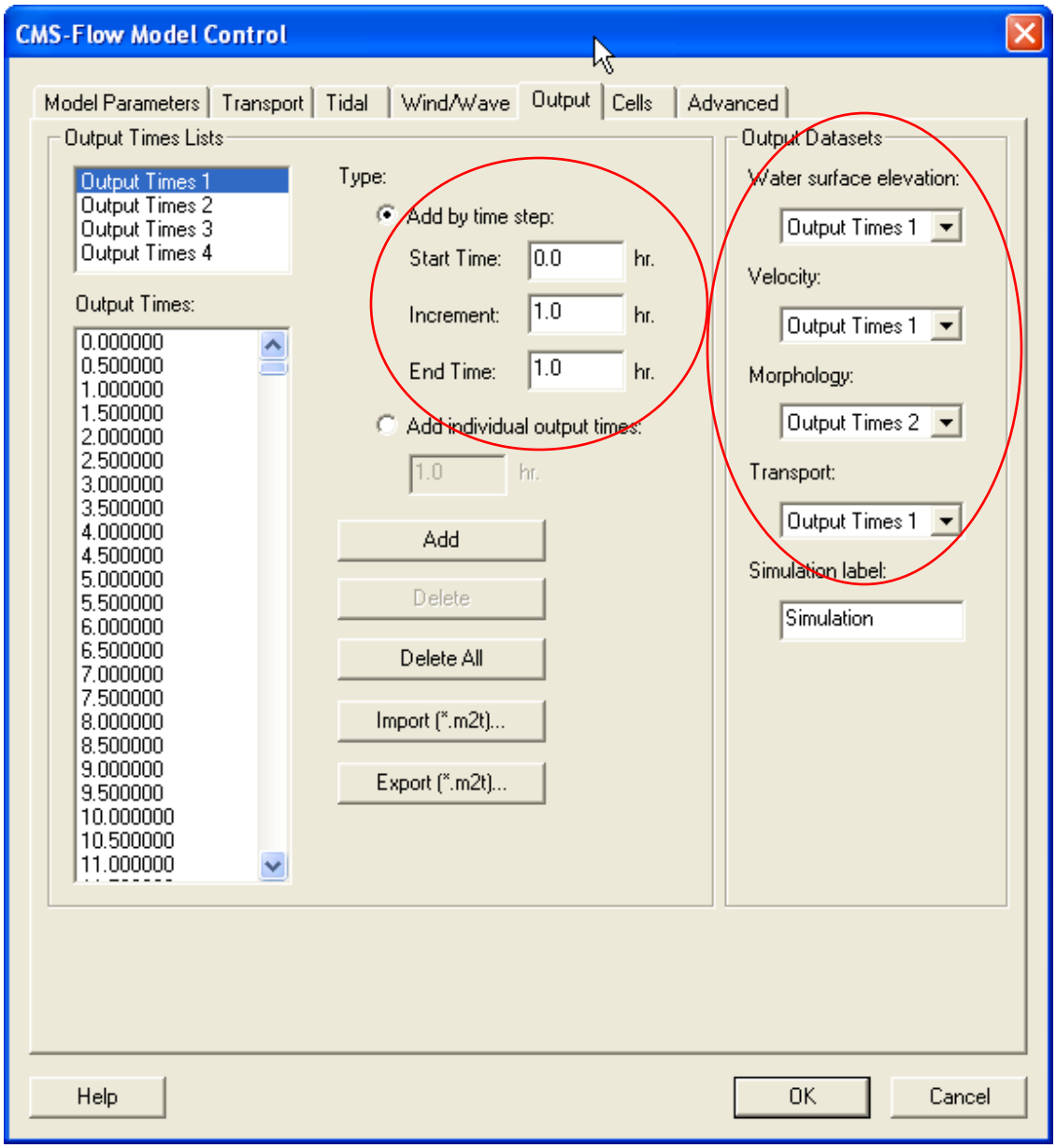

Fig 20: Example settings in the *Output* tab in the *CMS-Flow Model Control* window.

2.2.5 Observation Cells

Under the tab called *Cells*, check all of the output variables and set the output interval to 1,800 sec as shown in Fig 21.

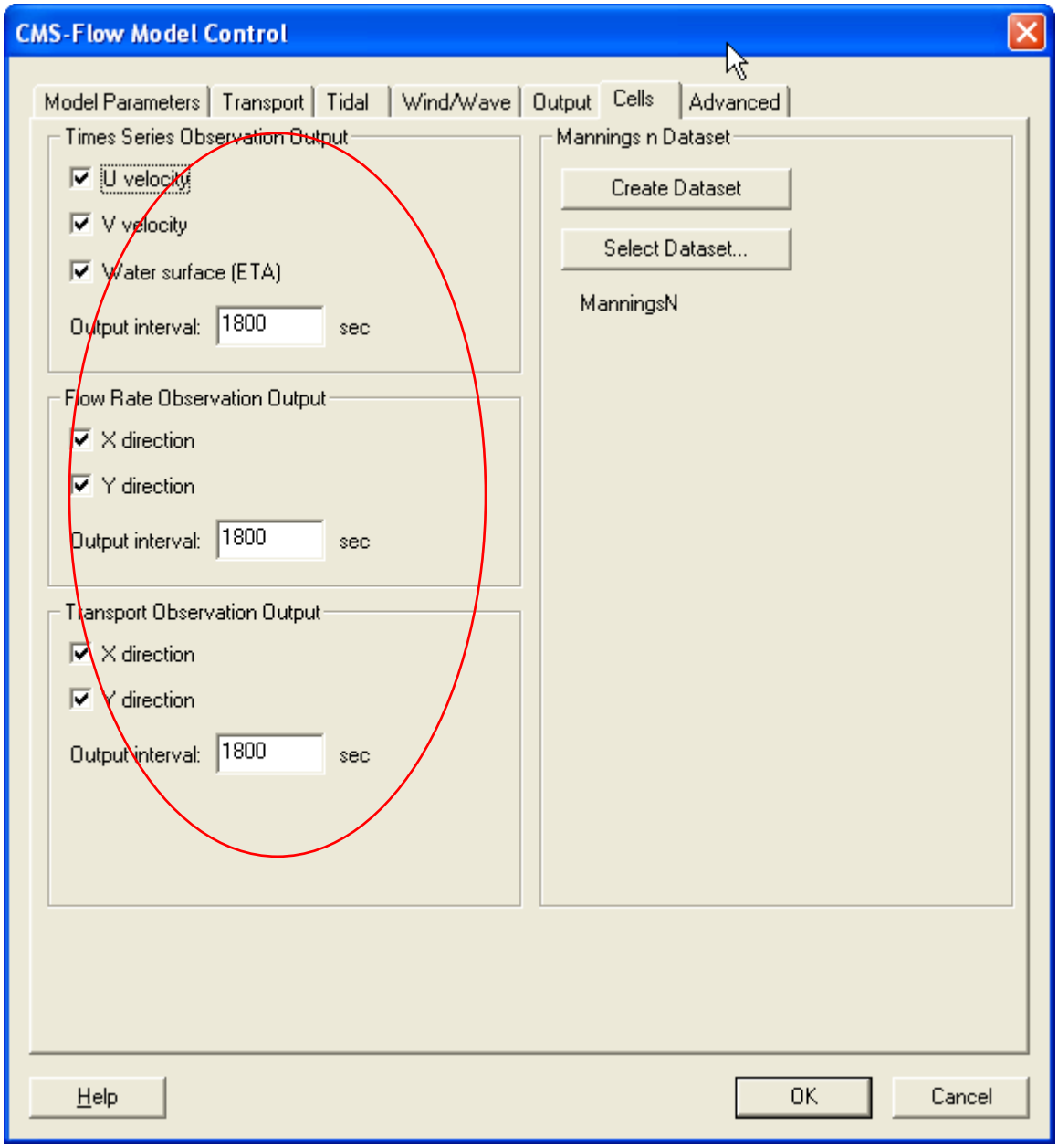

Fig 21: Example settings in the *Cells* tab in the *CMS-Flow Model Control* window.

Assign grid cells as observation cells by selecting individual cells with the *Select Grid Cell* tool and going to *CMS-Flow | Assign Cell Attributes*.

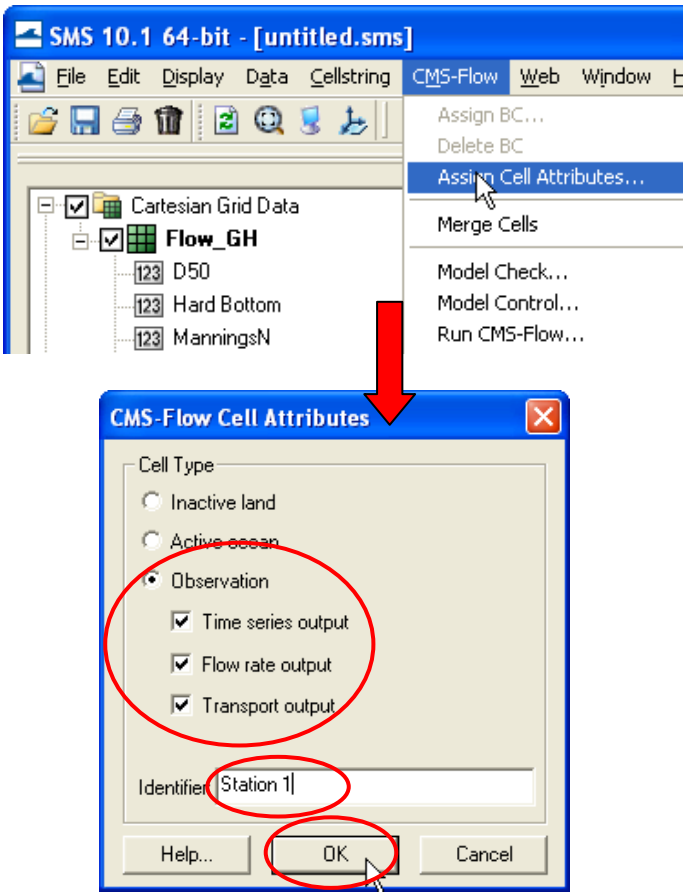

Fig 22: Example of assigning a cell as an *Observation Cell*.

2.3 Boundary Conditions

When the grid was generated, the SMS automatically produced cell strings and assigns them as type *Land*. For complicated grids, such as Grays Harbor, it is useful to manually assign the forcing boundary conditions. Start by deleting all of the cell strings using the *Select Cellstring* tool . Then manually generate the cellstrings for the ocean and river boundary conditions.

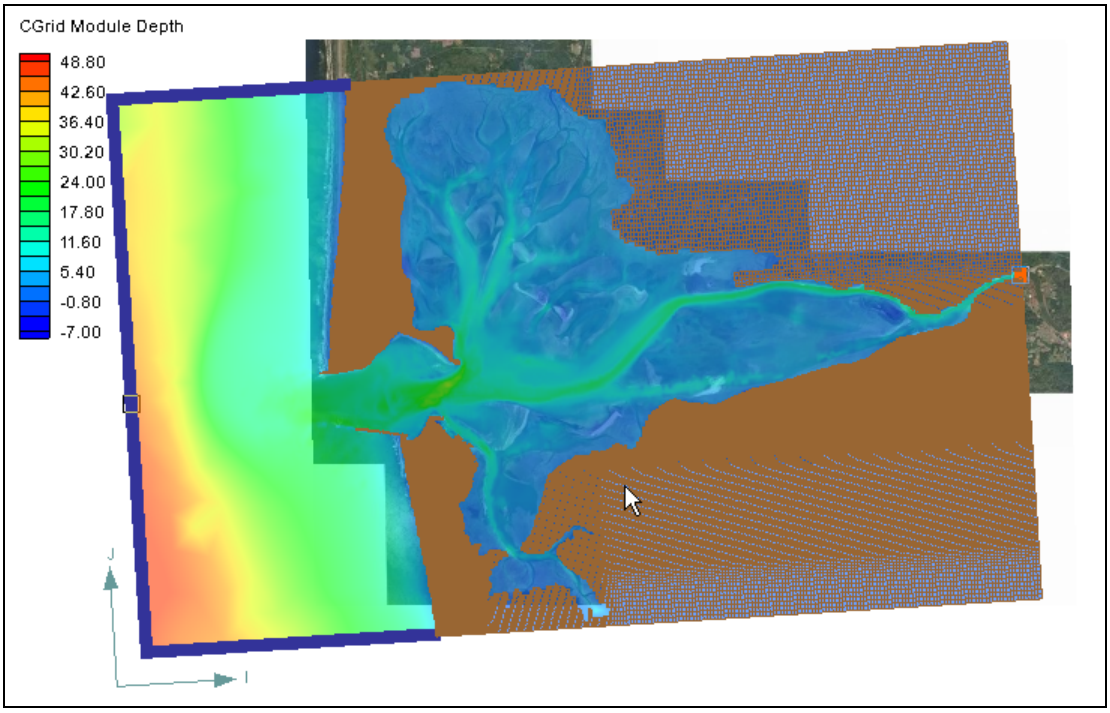

Fig 23: Grays Harbor grid with Ocean and River cellstrings shown in blue and orange respectively.

2.3.1 Ocean Boundary

Select the ocean boundary cellstring, and then go to *CMS-Flow | Assign BC*. In the *CMS-Flow Boundary Conditions* window, select *WSE-forcing* (Water Surface Elevation) and then left-click on the button that says *Curve undefined* under *Time Series | Define Curve*. The XY series editor will pop-up. Import the XYS series file names *S1_wse_d1_990914_mtl.xys* found in the *boundary_cond* folder.

2.3.2 River Boundary

Select the ocean boundary cellstring, and then go to *CMS-Flow | Assign BC*. In the *CMS-Flow Boundary Conditions* window, select *Flow-rate forcing* (River boundary) and then left-click on the button that says *Curve undefined* under *Time Series | Define Curve*. The XY series editor will pop-up. Manually enter a time series of river fluxes. For this case, since no data is available on the river flux, a time series equal to zero is used.

3. Setting up CMS-Wave

3.1 Grid Generation

To create a CMS-Wave grid from a CMS-Wave grid, follow the steps outlined below (see Fig 23):

1. Right-click on the *CMS-Flow* grid and select the *Duplicate* option.
2. Rename the new grid to something useful such as *Wave_GH*.
3. Switch the current model by clicking *Data | Switch Current Mode*
4. Select CMS-Wave
5. Save the CMS-Wave grid

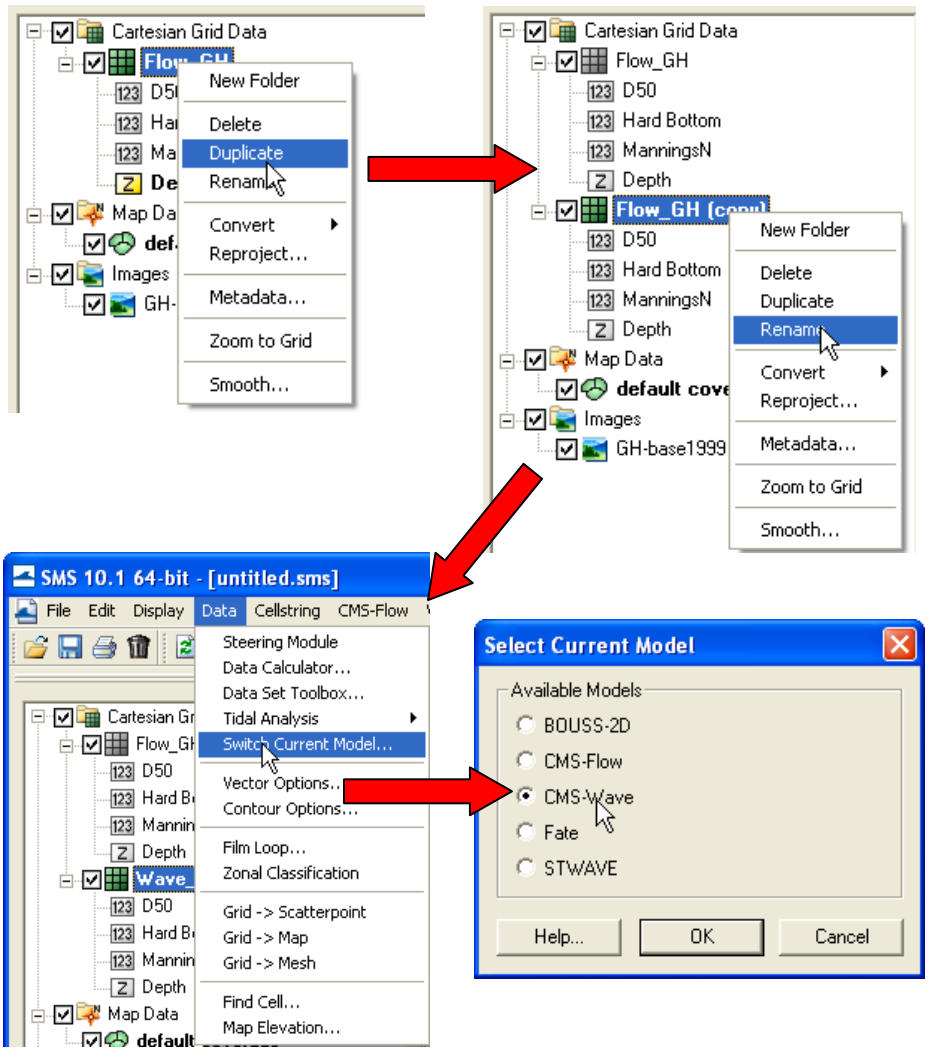

Fig 24: Copying a CMS-Flow grid to a CMS-Wave grid

3.2 Importing Input Wave Spectra

A *CMS-Wave Spectra File* (*.eng) was prepared before hand for this guided practice. To import the spectra file follow the steps outlines below:

1. In the SMS menu, click on *CMS-Wave | Spectral Energy*.
2. In the *Spectral Energy* window, click on *Import Spectra*.
3. In the *Import Spectra* window, click on the folder icon .
4. Go to the *boundary_cond* directory and select the file named *Wave_GH_1999Sept14toOct12.eng*
5. Click on the button that says *Done*.

3.3 CMS-Wave Model Options and Parameters

The change the *CMS-Wave* model options and parameters for Grays Harbor follow the steps outlined below:

1. In the SMS menu, click on *CMS-Wave | Model Control*.
2. Check the box that says *Bed friction*, and leave the friction as is.
3. Change the *Diffraction intensity* coefficient to 3.0.
4. Under *Wave Source*, click on the radio button that says *Spectra and wind*.
5. Under *Output*, click on the check boxes that say *Radiation Stresses* and *Breaking*.
6. Click on the *OK* button.

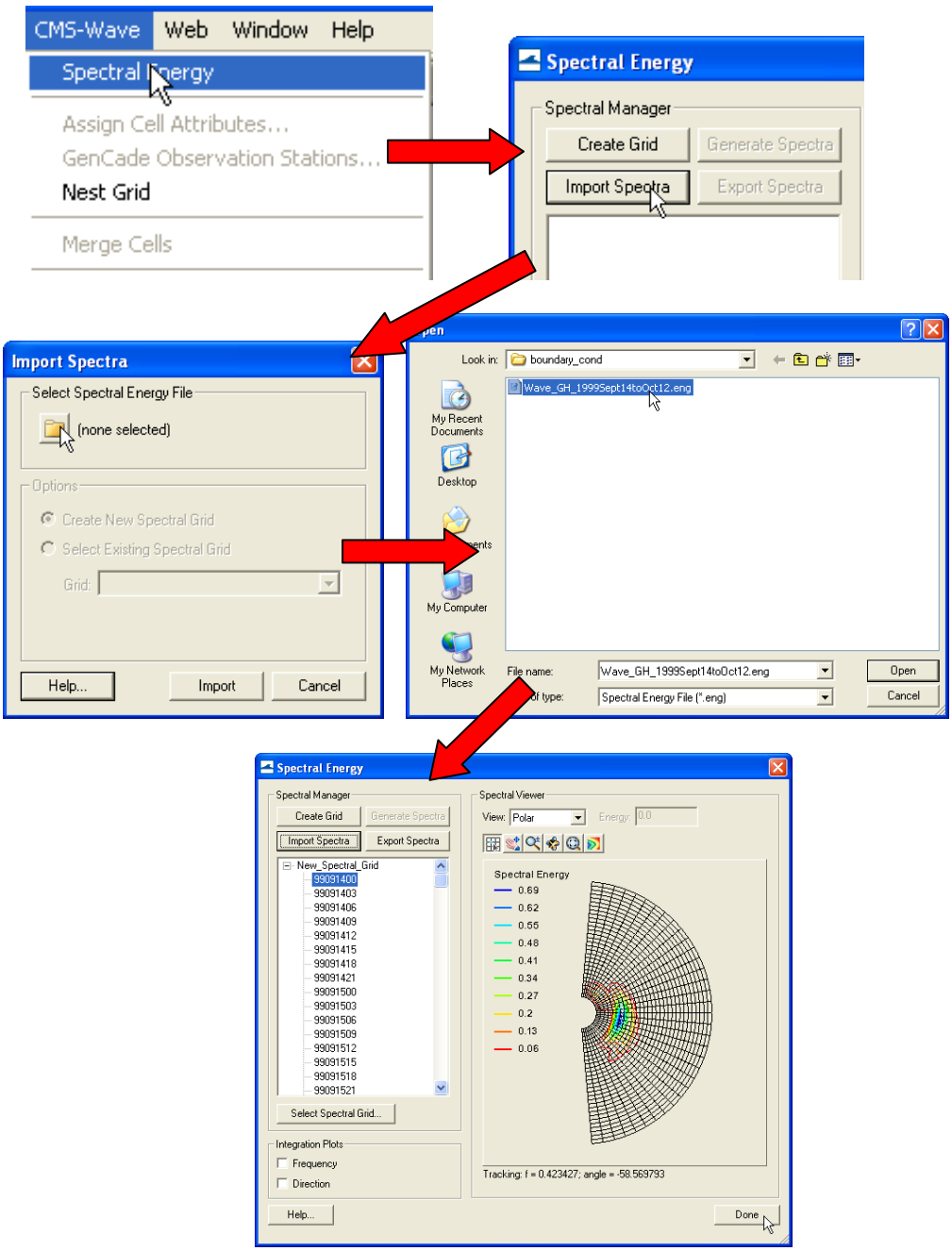

Fig 25: Steps for importing a *CMS-Wave Spectra File* (*.eng).

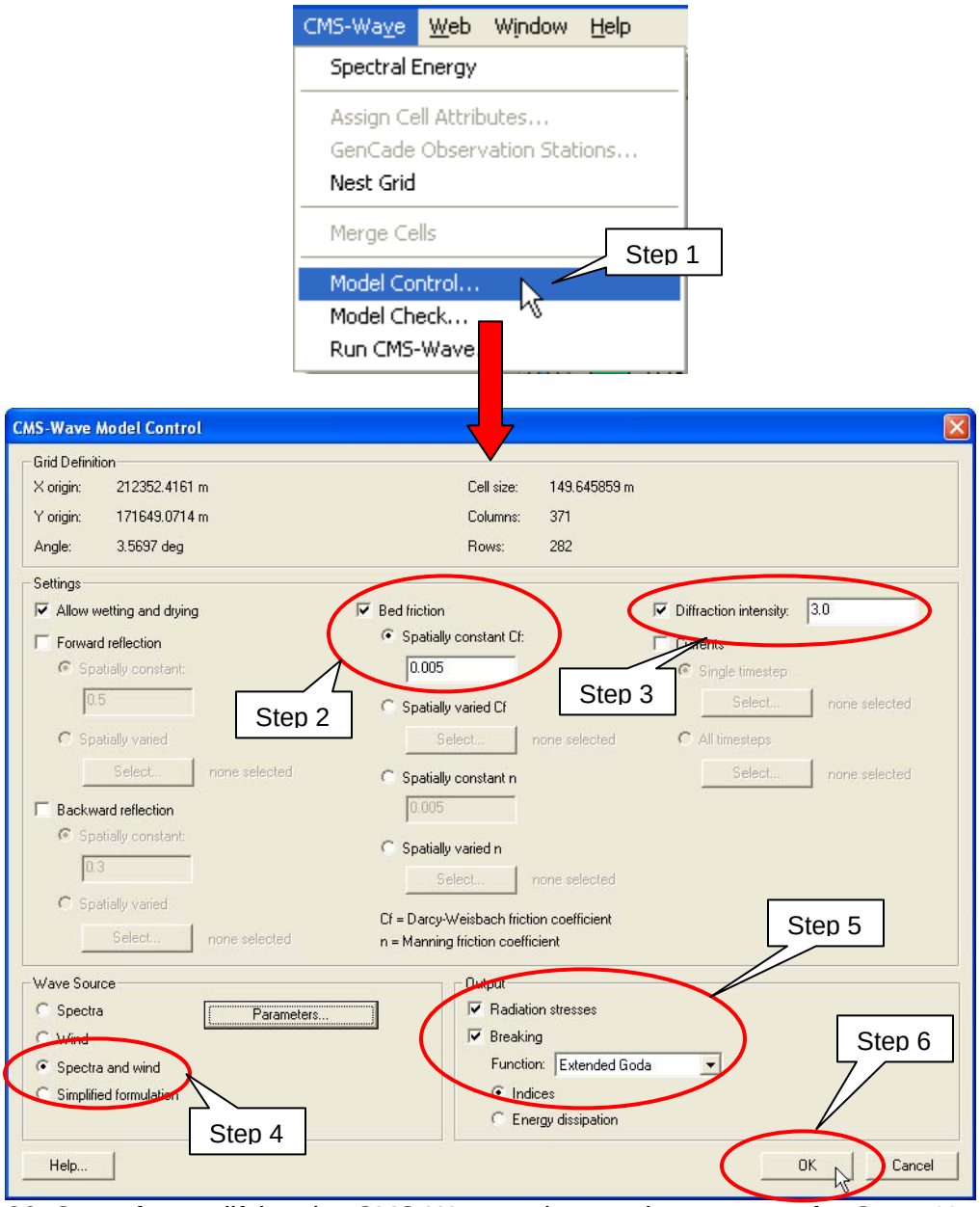

Fig 26: Steps for modifying the *CMS-Wave* options and parameters for Grays Harbor.

4. Running the CMS in the Steering Module

CMS-Flow and CMS-Wave pass information between each other through communication files. Presently, the SMS handles the interconnectivity between CMS-Flow and CMS-Wave. After each steering interval, the models write steering data to communication files. The SMS then interpolates the data to the grid of the other model and writes additional communication files. To run CMS-Wave and CMS-Flow in the Steering Module, follow the steps outlined below:

1. In the SMS menu, click *Data* | *Steering Module*.

2. In the *Steering Wizard* window, make sure the radio button that says *CMS-Flow <-> CMS-Wave* is checked and click *Next>*.

3. In the *Steering Wizard – CMS-Flow <-> CMS-Wave* window, set the steering interval to 3 hrs (the wave data is every 3 hrs), check the boxes *Current field*, and *Water Surface Elevation* in the *CMS-Flow -> CMS-Wave* section.

4. Check the box *Wave Data* in the *CMS-Wave -> CMS-Flow* section, and set the extrapolation distance to 100 m.

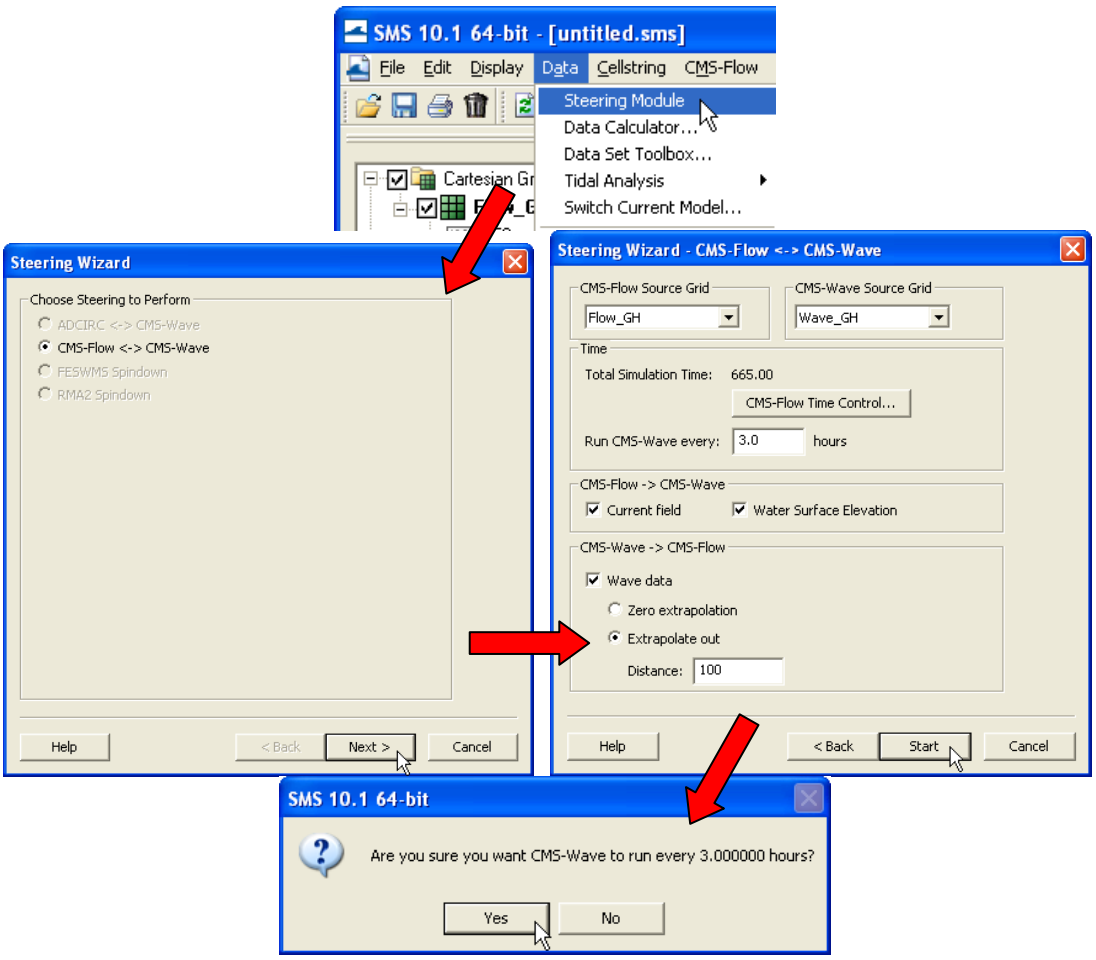

Fig 27: Example of running CMS in the *Steering Module*.