LESSON 9

M2D STWAVE Steering

This lesson will illustrate the use of the steering module to couple hydrodynamic solutions from *M2D* with wave solution data from *STWAVE*. Model coupling can increase how well the model represents real world conditions.

This lesson will demonstrate:

- How to setup an *STWAVE* simulation coinciding with an *M2D* simulation location.
- Using the steering module to run the simulation.
- Analyzing the differences between solution files when coupling is used and when coupling isn't used.

9.1 Simulation Overview

The simulation used for this lesson is a model of an idealized inlet. While this simulation is not a real-world example, it is a useful exercise because it is easy to see the effects of the model coupling in the solution. The simulation duration will be 24 hours with wave events being supplied every 6 hours. The steering module will use two-way coupling. Two-way coupling in this case indicates we will be using current data from *M2D* to affect wave data in *STWAVE* and wave data from *STWAVE* will be used in *M2D*. It may be useful to refer back to the lesson on *ADCIRC-STWAVE* Steering. That lesson gives more detailed information about the various coupling types. The *M2D-STWAVE* Steering process is very similar to *ADCIRC-STWAVE*

Steering, except that *M2D* is used as the circulation model. Feel free now to spend a few minutes reviewing the *ADCIRC-STWAVE* lesson.

9.2 Opening the M2D Simulation

This workshop uses a previously generated simulation (grid and model parameters) for *M2D*. To open the *M2D* grid and control files:

1. Select *File* | *Open*.
2. Path to the workshop directory and select the file, "ideal_m2d.m2c."

Now you need to tell *SMS* what coordinate system is being used. For this simulation the coordinate system is local meters. To set the current coordinates:

1. Select *Edit* | *Current Coordinates…*
2. For the *Horizontal System*, select *Local* and set the *Units* to *Meters*.
3. For the *Vertical System*, set the *Units* to *Meters*.

9.3 Setting up the STWAVE Simulation

Now you need an *STWAVE* grid that coincides with the *M2D* grid. The *STWAVE* grid will be somewhat different than the *M2D* grid. The *STWAVE* grid needs to have the x axis oriented towards shore, and must have square cells with a constant size. A grid has been already generated for this lesson. The *STWAVE* grid spans the same domain as the *M2D* grid, but its resolution is much finer. There are 334 columns and 327 rows which give this grid almost 110,000 cells. To load the *STWAVE* grid:

1. Select *File* | *Open*.
2. Path to the workshop directory and select the file, "ideal_stwave.sim."

Notice that *SMS* has the ability to handle simultaneous Cartesian grids. This is a relatively new feature in *SMS* and allows the user to work concurrently on *M2D*, *STWAVE*, and other Cartesian grid models.

Now, with an *STWAVE* grid loaded, you can setup the input wave spectra. Since the model coupling to be performed involves passing *STWAVE* wave radiation stresses every 6 hours for a 24-hour period, 5 energy spectra (for t=0, 6, 12, 18, 24) must be defined. The spectra for this lesson have already been defined in an EXCEL spreadsheet. To define the spectra in *SMS*:

1. Read the file, "SpectralValues.xls" into Microsoft EXCEL.

2. Copy the block of data in the Excel spreadsheet to the clipboard. Return to *SMS*.

3. Select *STWAVE* | *Spectral Energy*.

4. In the *Spectral Energy* dialog, press the *Generate* button.

5. Paste the data from the clipboard into the *Generate Spectra* dialog.

6. Press the *Generate* button to generate the energy spectra and exit the *Generate Spectra* dialog.

7. Press the *OK* button to exit the *Spectral Energy* button.

Since new *STWAVE* spectral energy data was generated in *SMS*, the *STWAVE* data must be saved before running the *Steering Module*.

To save the *STWAVE* data, select *File* | *Save STWAVE*.

Notes about multiple grids in *SMS*:

- Only one Cartesian grid can be displayed at a time in *SMS*.
- *SMS* keeps each grid in memory and switching between grids is very easy.
- The currently displayed grid is referred to as the "active grid."

Before beginning the steering process for these two models, set the *M2D* grid as the active grid. To switch to the *M2D* grid, select "ideal_m2d" from the drop-down list labeled *CGrid*. It is located just below the list of menus near the top of the SMS screen.

9.4 Using the steering module

As mentioned previously, this lesson sets up a two-way steering process, which passes currents and wave radiation stresses every 6 hours over a 24-hour simulation period. To initiate the steering process:

1. Select *Data* | *Steering Module*.

2. In the *Steering Module* dialog, enter 6.0 in the edit field to run *STWAVE* every 6 hours.

3. Check the *Current field* option. With this option checked, *M2D* current field data will be interpolated to the *STWAVE* grid.

4. Check the *Wave data* option. With this option checked, *STWAVE* wave radiation stress data will be interpolated to the *M2D* grid.

5. For *Extrapolation*, select *Set to zero*.

6. Press the *M2D location* button. In the *Run Model* dialog, select the file "m2d.exe" in the *Models* directory and press *OK*.

7. Press the *STWAVE location* button. In the *Run Model* dialog, select the file "stwave.exe" in the *Models* directory and press *OK*.

8. Press the *START* button to begin the steering process.

SMS begins steering the models and a dialog similar to the one shown below appears. This dialog gives real-time updates of the progress of the simulations being run. The top progress bar shows the overall progress of the steering run. The numbers in the *STWAVE* area of the dialog show the current run over the total number of *STWAVE* runs. The plot shows wave height vs. column for the current *STWAVE* run. The bottom progress bar shows the progress of the current *M2D* run.

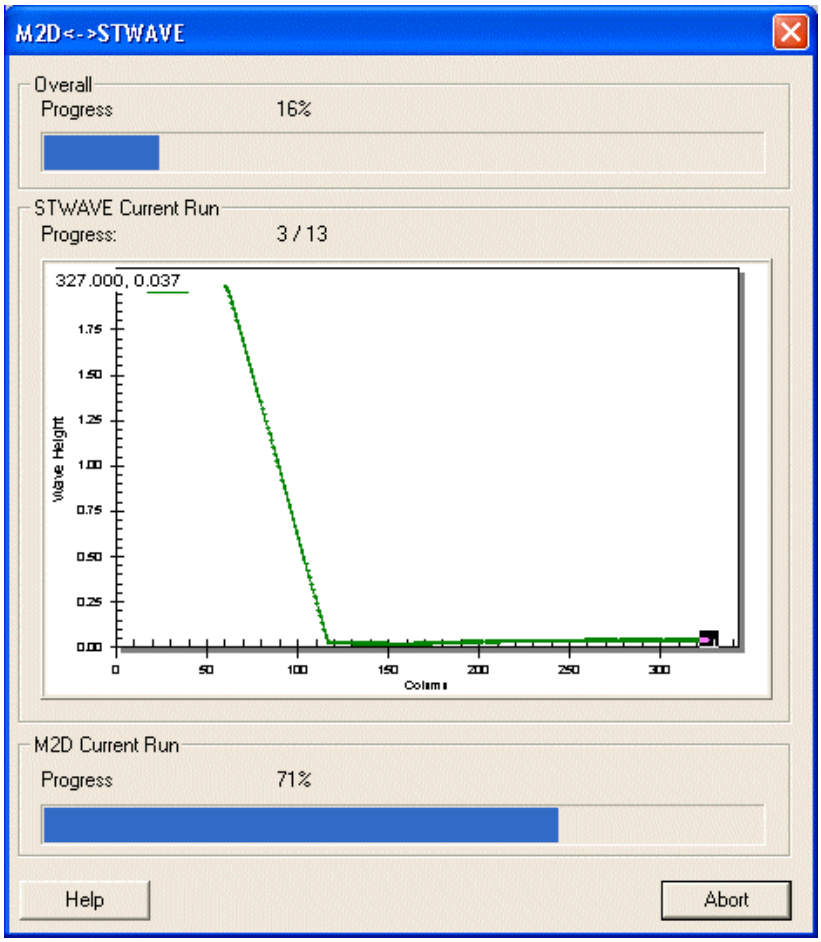

Figure 9-1M2D-STWAVE Steering Dialog.

You may want to experiment later on with the complete run. However, since this analysis takes more time to perform than we have available, you should abort the process after you have seen how the dialog works. To abort the steering process:

1. Press the button labeled *Abort* or *Exit*.

2. Wait several seconds while *SMS* shuts down the *Steering Module*.

9.5 Steering Module Output

While the *Steering Module* is working, a status file named "SteeringStatus.txt" is created. This file is located in the same directory as the model input files and contains a log of the *Steering Module* events. The *Steering Module* also creates another file, "ScreenOutput.txt", which captures all of the *M2D* and *STWAVE* output to the screen.

Once the steering process has completed, the original input files for *M2D* are restored. Solution files for *M2D* (*.m2s and *.m2v), which are similar to the unit 63 and unit 64 files for *ADCIRC*, are consolidated and contain data for the entire 24-hour simulation. All *M2D* simulation files that were created by the Steering Module are retained and are named "1m2steer.m2c" for first simulation, "2m2steer.m2c" for the second simulation, etc. In the future, an option will be available to have these files deleted at the completion of the steering run. All *STWAVE* simulation files that were created by the *Steering Module* are retained as well with a similar naming convention. For this lesson, "1swsteer.sim" corresponds to time 0 hr, "2swsteer.sim" corresponds to time 6 hr, etc.

The output files from the steering are in the "output" folder in the "Lesson09" folder.

9.6 Viewing Results

In Lesson 7, you used several methods to view the solutions generated by *ADCIRC* and compare solutions from an uncoupled run with a steering module run.

Similar methods may be applied to compare the results of an *M2D* analysis run without the influence of waves with an analysis that uses radiation stresses (run through the steering module). These solutions are stored in the output folder. Open the M2D solutions creating to solution sets in *SMS*. The solutions for the steering run are named "ideal_m2d.m2s" and "ideal_m2d.m2v". These should be read into a solution set named "2-Way Steering". The solution for one way steering are in files named "m2d_w_waves.m2s" and "m2d_w_waves.m2v". These should be read into a solution set named "1-Way Steering". Finally, the solution for *M2D* by itself is in files named "m2d_only.m2s" and "m2d_only.m2v". These should be read into a solution set named "m2d only".

Take the remainder of the time to experiment with several of the same methods used in Lesson 7 to view and compare the results from the three runs of *M2D.* A couple of methods that may be used include:

- Scroll through the timesteps of the soluitions, searching for changes in the velocity direction, velocity magnitude, water surface elevation, etc.

- Make a film loop of the results, using the timesteps of a peak ebb or a peak flood.

- Merge film loops of different solutions using the mergeavi executable so they may be viewed side by side for comparison.

- Use the *Data Browser* and *Data Calculator* to compute and view the differences in the velocity magnitude, water surface elevation, etc.

- Explore on your own.

NOTE: The peak floods occur at the time steps 1.7 and 12.95. The peak ebbs occur at time steps 6.9 and 19.4.