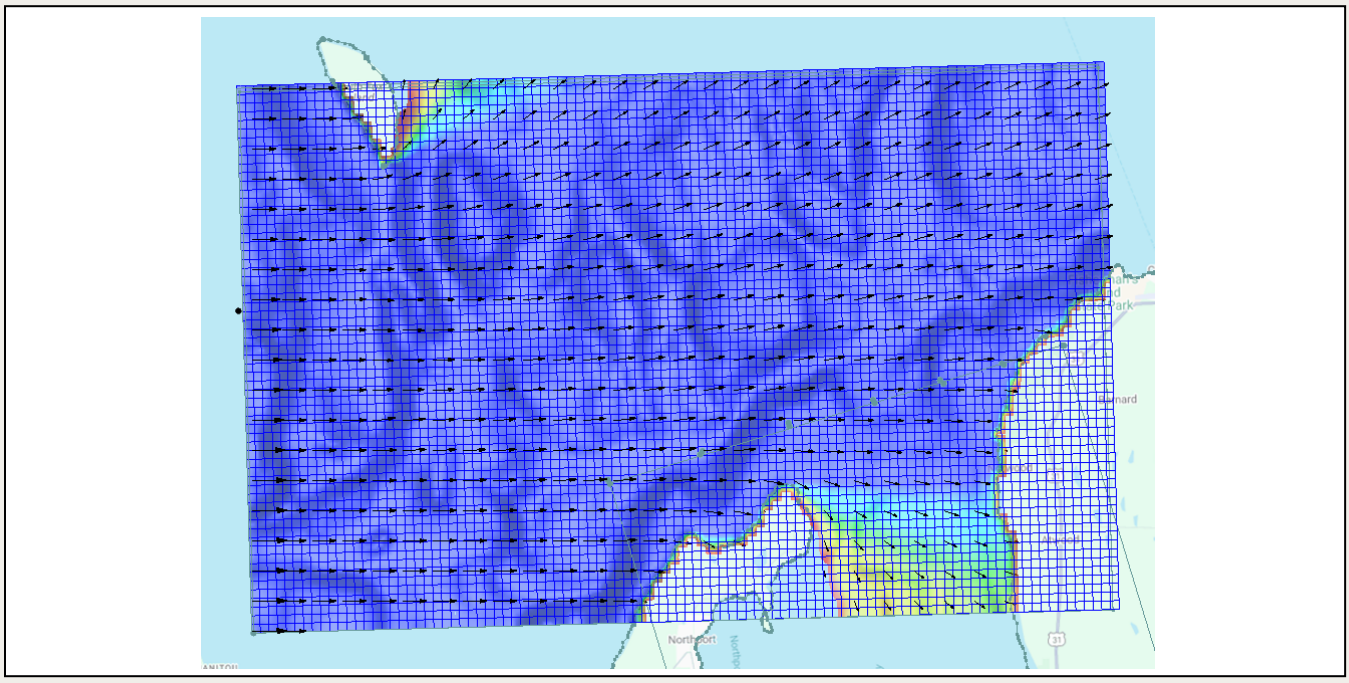
SMS 13.5 Tutorial

STWAVE Parent Simulation

Setting Up an STWAVE Parent Simulation



Objectives

This tutorial demonstrates setting up an STWAVE simulation to provide input for a child simulation in the Surface-water Modeling System (SMS).

Prerequisite Tutorials

- Overview
- Map Module
- STWAVE

Required Components

- SMS Core
- STWAVE Interface

Time

- 5–10 minutes

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1 Introduction

The Steady State Spectral Wave (STWAVE) numeric engine includes the option to export spectra at nesting locations. These spectra can be used as input for a child simulation. This tutorial illustrates how ocean spectra can be transformed to locations closer to shore.

2 Getting Started

For consistency, start by importing a project file containing some guidance information:

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 *data files* folder for this tutorial and select “GrandTraverseBay.sms”.
5. Click **Open** to import the project and exit the *Open* dialog.

The initial project should appear similar to Figure 1. It includes:

- A spectral coverage containing a single point with wave spectra.
- A background map of the area of Grand Traverse Bay in Lake Michigan (online image).
- Two coverages that define the approximate bounds of the parent and child STWAVE domains.
- A DEM (in tiff format) of the area of Lake Michigan around including Grand Traverse Bay in the northeast portion of Lake Michigan.
- A coverage that contains the shoreline of the lake extracted from the DEM using the *Contours from Single Raster Value* tool. This is just included for convenience.

This project also establishes the display and working projection to be UTM Zone 16.

Note: the DEM for this tutorial was downloaded as an 88 MB geotiff in geographic space. See the following link for more information:

https://www.ncei.noaa.gov/products/great-lakes-bathymetry

Using the *Trim Raster* tool in SMS, in UTM space resulted in this DEM.

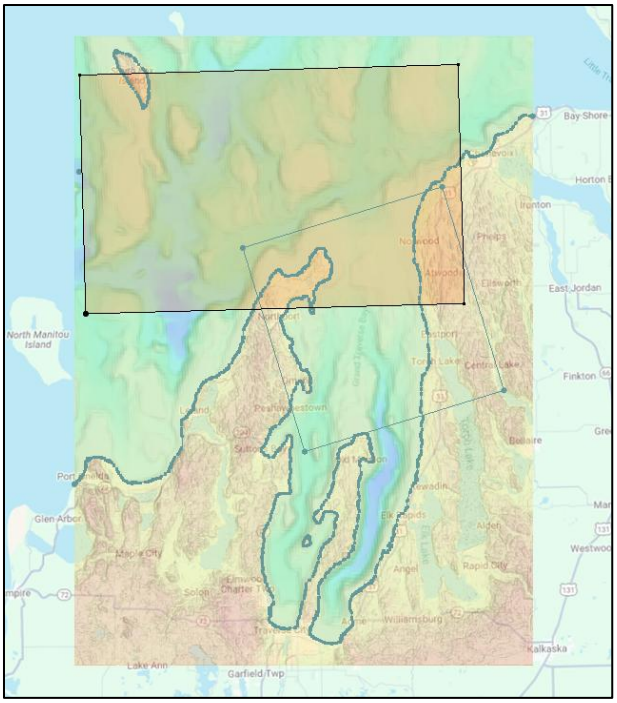

Figure 1 Initial project

3 Create the Parent Grid

The basis of an STWAVE analysis is bathymetry data in the form of a Cartesian grid. To create this grid:

1. Right-click on "Map Data" in the Project Explorer and select **New Coverage** to open the *New Coverage* dialog.
2. Under *Coverage Type*, select **CGrid Generator**.
3. For the *Coverage Name,* enter "Parent".
4. Click **OK** to close the dialog.

This creates the "Parent" coverage that will be used to create the grid.

5. Select the "Parent" coverage to make it active.
6. Using the **Create 2-D Grid Frame** tool, click on the lower left corner of polygons in the "Parent Domain" coverage (highlighted in Figure 1). This is the offshore origin of the Cartesian grid.
7. Click on the lower right corner of the polygon. This defines the "shoreward direction" of the grid. This must be somewhat aligned with the principal wave direction.
8. Click on the upper right corner of the polygon to finish defining the grid frame.

The exact position of a wave grid is not important. The polygon is provided in this case for guidance and consistency. It is important that the entire grid frame should be inside the boundary of the DEM since this provides elevation data to the grid.

If desired, the grid frame can be edited graphically or explicitly using the **Select 2-D Grid Frame** tool.

9. Right-click on the "Parent" coverage and select *Convert* | **Map** → **2D Grid** to open the *Map → 2D Grid* dialog.
10. Set the *Grid name* to "Parent".
11. In the *I Cell Options* section, set the *Cell size* to "500".
12. In the *J Cell Options* section, set the *Cell size* to "500".
13. In *Elevation options* section, set the *Source* to "Raster".

Since there is only one raster loaded, there is no need to select the raster.

14. Click **OK** to close the *Map → 2D Grid* dialog and create the grid.

The "Parent" grid will appear in the Project Explorer and the Graphics Window. This grid consists of cells that are 500 m x 500 m and have elevations extracted from the DEM.

4 Create and Assemble the STWAVE Simulation

Now create and assemble the STWAVE simulation by completing the following:

1. Right-click on the background of the Project Explorer window and select *New Simulation* | **STWAVE** from the popup menu.
2. Right-click on the "Sim" simulation and select **Rename**.
3. Enter "Parent" as the new name.
4. Drag the "Parent" cartesian grid to the "Parent" simulation to include this grid in the simulation. A line will appear under the simulation. When that line appears, let go of the mouse button to drop the grid.
5. Right-click on the "Parent Spectral" coverage and select *Apply to…* | **STWAVE Simulations** → **Parent**. This is the other method of linking a component to a simulation.

5 Specify Nesting Points

Before setting up the simulation parameters, remember that this simulation is to be used as a parent. That means that it will output transformed wave spectra at locations near the offshore boundary of a child simulation. To specify these locations, complete the following:

1. In the Project Explorer, turn off the "Grand Traverse Bay.tif" DEM to simplify the display.
2. Under the "Parent" Cartesian grid, select "Elevation" to make it active.
3. Click on the "Child Domain" coverage to make it more visible.
4. **Zoom** into the area around the north (offshore) boundary of the child domain.
5. Right-click on "Map Data" in the Project Explorer module and select **New Coverage** to open the *New Coverage* dialog.
6. Under *Coverage Type*, select **Location**.
7. For the *Coverage Name*, enter "Nesting Pt Locs".

8. Click **OK** to close the *New Coverage* dialog.

This creates the "Nesting Pt Locs" coverage and makes it active. The child domain polygon now appears as an inactive coverage.

9. Using the **Create Feature Point** tool, create 7 points along the offshore edge of the child domain as shown in Figure 2.Figure 1

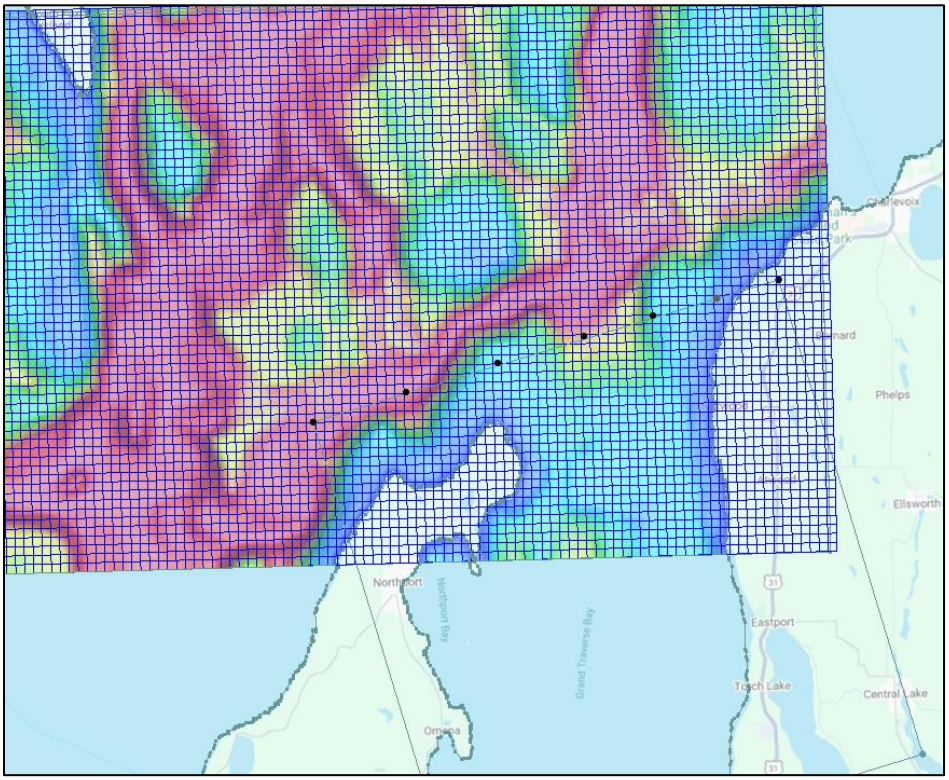

Figure 2 Nesting Points

These points can be created right on the child domain boundary or just outside of the child domain. These nesting locations will be snapped to the closes cell in the parent grid. The STWAVE simulation will save full wave spectra at each of these cells. The exact number of nesting points is not critical, however, do not create more points than there are cells in the parent grid along the child domain boundary.

Note: this process implies knowing the size and location of the child domain(s) before running the parent simulation. This will require planning. However, as modeling is an iterative process, this step may require revision in later iterations.

6 Specify STWAVE Parameters

We are now ready to specify the STWAVE simulation parameters. To do this:

1. Right-click on the "Parent" STWAVE simulation and select **Model Control** to open the *Model Control* dialog.
2. Leave all parameters in the *Parameters* tab set to default values.
3. In the *Boundary control* tab set the following:

a. In the *Computational spectral grid* section, set *Minimum* to “0.1”. This means that only waves with period less than 10 seconds will be included in this simulation.

b. In the *Case data* section, click on the **Populate** button. This creates a case for each of the 3 spectra that were defined in the provided spectral coverage.

4. In the *Output control* tab complete the following:

a. Turn on *Use nesting points*.

b. Next to *Use nesting points*, click on the **Select** button to open the *Select Nesting Points Coverage* dialog.

c. Select the “Nesting Pt Locs” coverage.

d. Click **OK** to close the *Select Nesting Points Coverage* dialog.

5. Click **OK** to close the *STWAVE Model Control* dialog.

The STWAVE simulation is now ready to run.

7 Running STWAVE

To execute the simulation:

1. Right-click on the “ Parent” simulation and choose **Save Project, Simulation and Run** to save the simulation files and open the *Simulation Run Queue*.

As implied, this command actually does three things. It saves the project, exports the simulation, and launches STWAVE. The *Simulation Run Queue* tracks the progress on the run.

8 Reviewing the Solution

To review the solution created by STWAVE:

1. When the simulation has finished running, click on the **Load Solution** button.

The solution for this simulation consists of two parts. The first consists of a set of five datasets loaded into the “ Parent” Cartesian grid. The second is the “ Parent - nest” coverage loaded into “ Solution” folder.

2. Right-click on the “ Parent” Cartesian grid and select **Zoom to Grid**.

3. Select the “ Wave Height” dataset to make it active.

The provided project includes display templates to set the contour options for this dataset. (Refer to the “Display Themes” tutorial for more information on these themes.) The Graphics Window now shows the wave heights and directions in the form of arrows focusing on wave heights below 0.5 meters. The colors (Figure 3) show that the wave heights behind the island and entering into Grand Traverse Bay reduce as they diffract. The output spectra will be reviewed in the “STWAVE Child Simulation” tutorial.

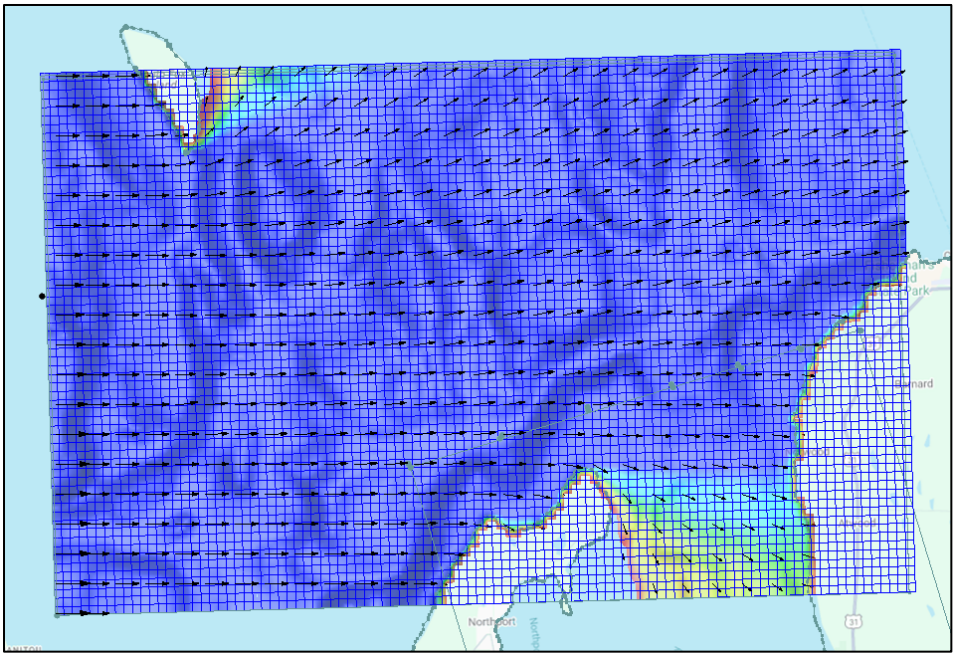

Figure 3 Wave heights and directions

9 Conclusion

This concludes the “STWAVE Parent Simulation” tutorial. Features that have been described include:

- Creation of a Cartesian grid.
- Specifying nesting locations to create wave spectra for children simulations.
- Assembling and defining an STWAVE simulation.
- Reading and viewing an STWAVE simulations solution.

If desired, experiment with different grid resolutions and orientations. The STWAVE modeling process is continued in the “STWAVE Child Simulation” tutorial.