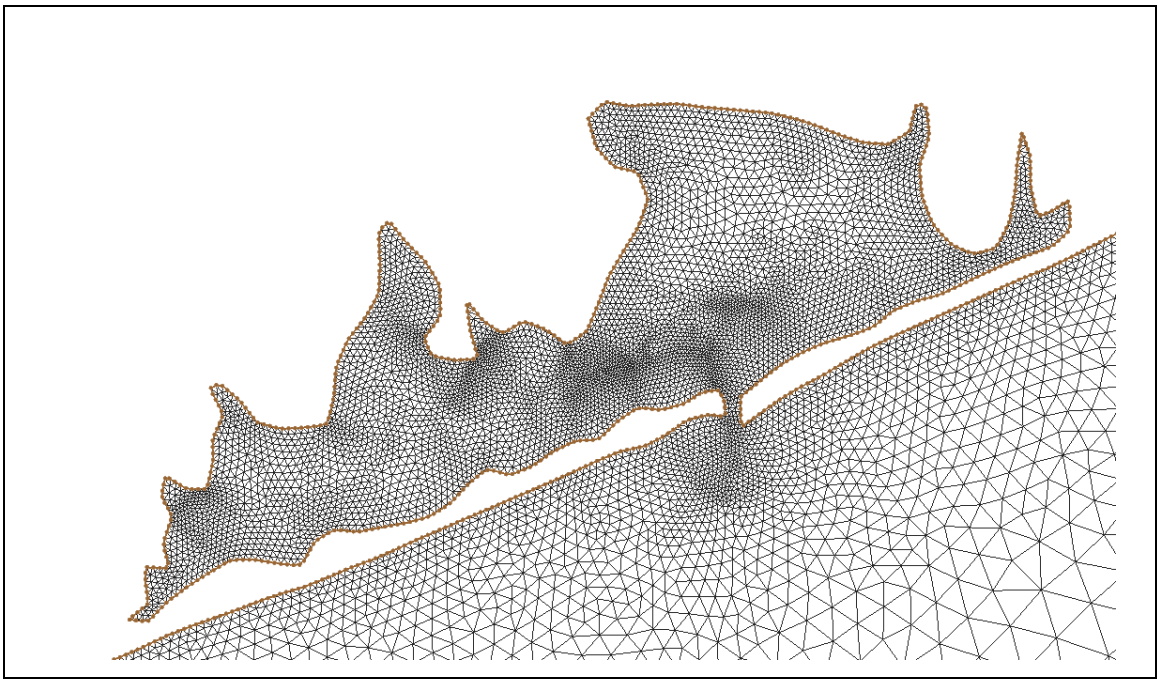
SMS

v. 13.1

SMS 13.1 Tutorial

ADCIRC LTEA



Objectives

Demonstrate how to use the LTEA toolbox to create finite element meshes of varying resolutions for ADCIRC analysis in SMS.

Prerequisites

- ADCIRC Tutorial
- Overview Tutorial
- Map Module Tutorial

Requirements

- ADCIRC
- Map Module
- Mesh Module
- Scatter Module

Time

- 15–30 minutes

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1 Introduction

LTEA stands for the "Local Truncation Error Analysis." The name refers to an analysis methodology for measuring local truncation error in a numerical analysis. The LTEA toolbox incorporated into SMS uses the LTEA algorithm as the heart of a utility which creates finite element meshes of varying resolution for ADCIRC analysis.

Before the LTEA toolbox can be accessed, the geometric definition for an ADCIRC simulation should be imported. This definition consists of a bathymetric survey of the area to be modeled and an ADCIRC coverage in the Map module with arcs describing the shape of the modeling domain.

An existing ADCIRC mesh must be used as the basis for the analysis since it defines both the bathymetry and a domain boundary.

This tutorial makes use of a bathymetric survey and a coastline arc, as well as a 2D mesh and harmonic datasets from an ADCIRC model run. A modeler acquires this type of data from local surveys or from a data source such as those described in the *GeoSpatial Data Acquisition* page (http://xmswiki.com/xms/GSDA:GSDA) maintained by Aquaveo.

1.1 Getting Started

To get ready to use LTEA:

1. Select *File* | **Open** to bring up the *Open* dialog.
2. Browse to the file "LTEA_start.sms" located in the data files folder for this tutorial.
3. Click **Open** to import the file and close the *Open* dialog.

The project will appear in the Graphic Window as seen in Figure 1. The project contains a scatter set and an ADCIRC map coverage containing a coastline arc and an ocean domain arc. The projections for both the ADCIRC coverage have already been set. An ADCIRC map coverage is required to run the LTEA toolbox. Review the "Wavelength Based Mesh" tutorial for information on how the domain was created.

For this tutorial, the coastline definition is less precise than the survey data. When using LTEA with real world data, define the level of detail for the coastline, keeping in mind the impact on numerical analysis.

Before continuing, save the project file under a new name to preserve the original data.

4. Select *File* | **Save As** to open the *Save As* dialog.
5. Enter "LTEArun.sms" and click **Save**.

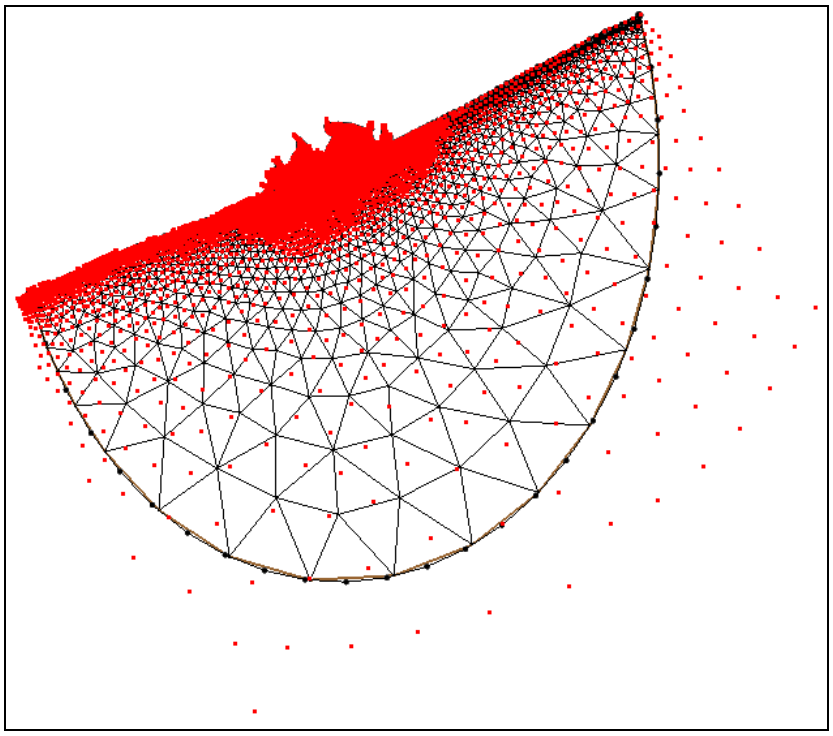

Figure 1 The starting ADCRIC project

2 Using the Toolbox

The LTEA toolbox consists of a wizard that guides through various steps in creating a mesh with varied resolution for an ADCIRC analysis.

2.1 Launching the Toolbox

To launch the toolbox:

1. Right-click on "Shin Domain" and select **Mesh Generation Toolbox**. This will bring up the *Mesh Generation Toolbox* dialog.
2. Select "Localized Truncation Error Analysis (LTEA)" and click **Run** to bring up the *LTEA Tool* dialog.

2.2 Specifying the Input

If a mesh already exists, the domain and bathymetry can be derived from it.

To generate a simple mesh in order to run ADCIRC do the following (Figure 2):

1. Set *Boundary* to "Shin Domain."
2. Click the **Select** button next to *Bathymetry* to bring up a *Select Dataset* dialog.
3. Select the "depth_bathymetry" dataset and click **Select** to close the *Select Dataset* dialog.

4. Click the **Select** button next to *Mesh* to bring up a *Select Dataset* dialog.
5. Select the "Initial Mesh" entry and click **OK** to close the *Select Dataset* dialog.

LTEA analysis utilizes the harmonic solution data from an ADCIRC run. Normally, this solution comes from a linear run of the ADCIRC model on the linear mesh generated in the previous step.

The term "linear ADCIRC" is used because several of the non-linear terms in the ADCIRC solution schemes are turned off. To include the solution set in the LTEA analysis, do the following:

6. Select the *Provide harmonic solutions* option.
7. Click the **Select** button next to *Eta amplitude* to bring up a *Select Dataset* dialog.
8. Select the "M2 WSE Amplitude" dataset and click **Select** to close the *Select Dataset* dialog.
9. Click the **Select** button next to *Eta phase* to bring up a *Select Dataset* dialog.
10. Select the "M2 WSE Phase" dataset and click **Select** to close the *Select Dataset* dialog.
11. Click the **Select** button next to *Velocity amplitude* to bring up a *Select Dataset* dialog.
12. Select the "M2 VEL Amplitude" dataset and click **Select** to close the *Select Dataset* dialog.
13. Click the **Select** button next to *Velocity Phase* to bring up a *Select Dataset* dialog.
14. Select the "M2 VEL Phase" dataset and click **Select** to close the *Select Dataset* dialog.
15. Click the **Continue >** button.

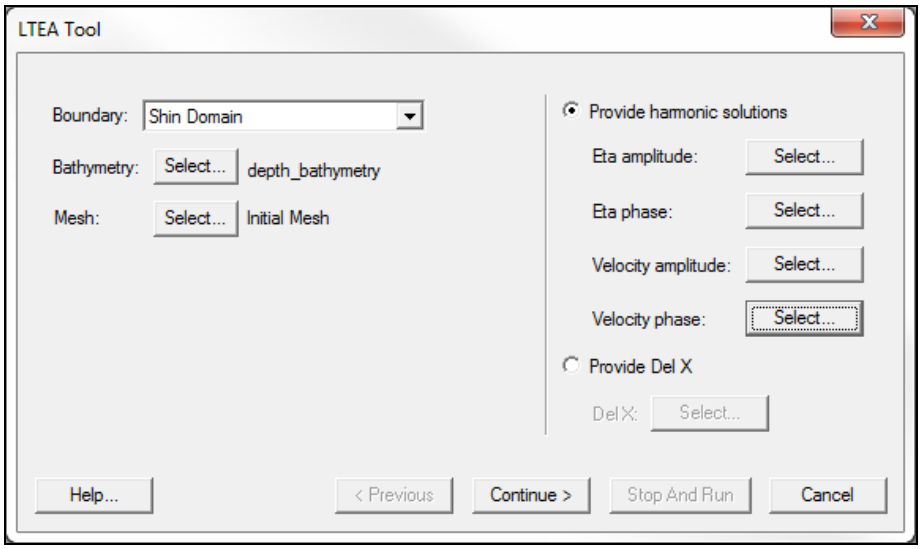

Figure 2 Initial mesh page of the LTEA toolbox

2.3 LTEA Analysis

The LTEA analysis can now use the harmonic datasets created from the ADCIRC run to create a size function called "DelX".

1. In order to get LTEA values close to the domain boundary, make sure that the *Use partial molecule* check box is selected (Figure 3).

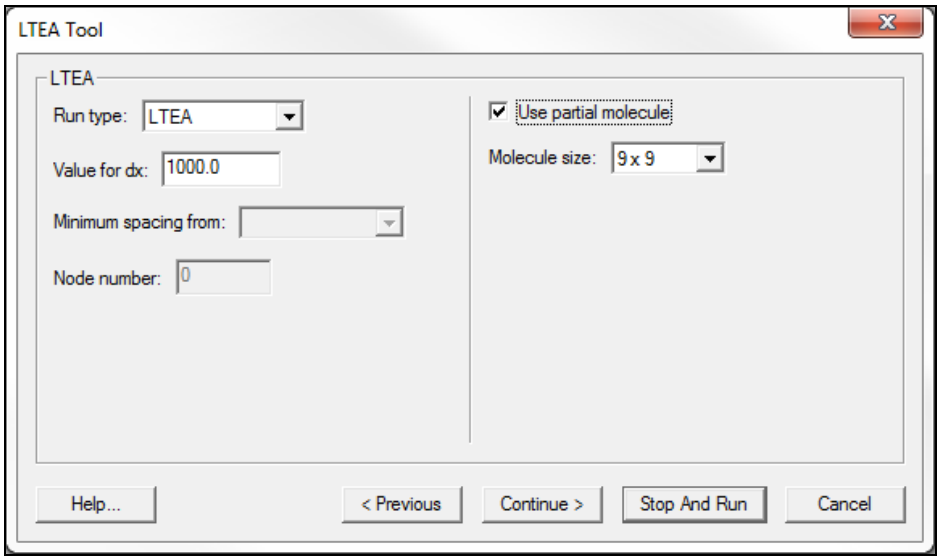

Figure 3 LTEA options page for the toolbox

The option for the molecule size should be left at "9 x 9." This means that a small, equally-spaced grid of nine cells by nine cells is created around each node, and values from the ADCIRC solutions are interpolated for all 81 cells. These values are then used for the LTEA analysis.

Nodes on the edges of the domain will not have values for cells outside of the domain and normally LTEA will not give a value for these nodes with partial molecules. If partial molecules are not used, the boundary spacing from the domain boundary will be used to place nodes on the final mesh until a region where LTEA values are present and the process then uses LTEA values.

2. Click on the **Continue >** button to move onto the next step.

If desired, the **Stop and Run** button would cause SMS to close the toolbox and run the LTEA analysis. The analysis generates several datasets used as size functions in the mesh generation process.

2.4 Generating the Mesh

With the size function "DelX" created, a mesh can be generated that is influenced by LTEA.

1. In the *Generate Final Mesh* section, enter "10,000" in the box below *Target number of nodes*.
2. Enter "500" in the *plus/minus* field.
3. Leave the *Element area change limit* at "0.5."

4. Check on *Redistribute Boundaries*.

This allows the mesh generation process to redistribute the domain spacing according to LTEA values to get more resolution in the body of the mesh rather than on the edges.

5. Click the **Run** button.

Wait a few seconds and the model will begin to run. The *LTEA Tool* dialog might still be showing.

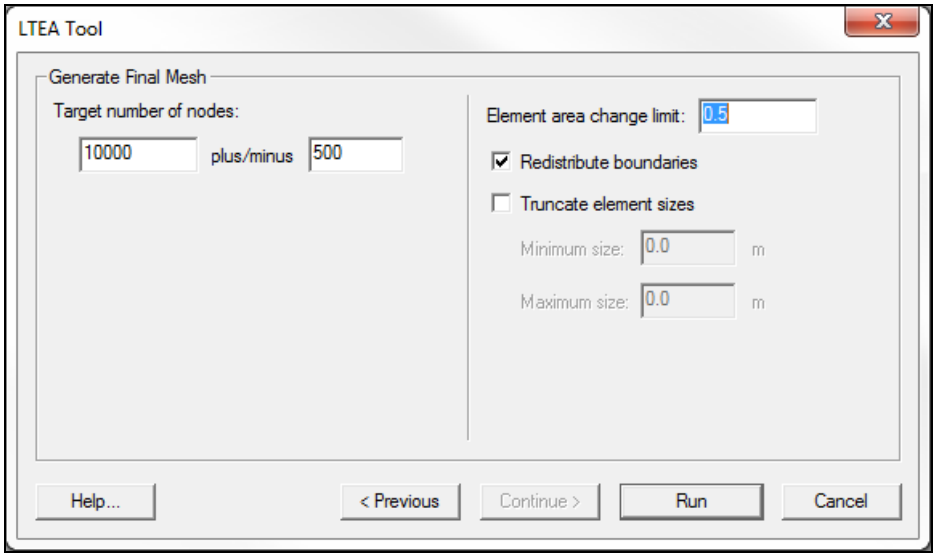

Figure 4 Final mesh page of the dialog

6. See below if a message about the "M2.legi" file appears.
7. Click **Done** on the *Mesh Generation Toolbox*.
8. Now **Save** the project for later review, if desired.

If a message appears stating that the program could not find the file "M2.legi":

1. Go to *Aquaveo.com/downloads/SMS* and download the "ADCIRC Basic Utilities" under the *Database Files & Utilities* section.
2. Follow the directions in the "ReadMe.txt file" once the downloaded file has been unzipped. It explains where to place the files.
3. Once the above has been done, go back to SMS and click on **OK** to search for the files.
4. Browse to the folder where the files were placed and click on **Open** to tell SMS where to find the files.

With the final mesh being loaded, note the different scatter sets labeled "  Scaled", with varying numbers that follow. In order to reach the correct target number of nodes, the original size function is scaled and a mesh is created.

The final number of nodes in that mesh is then checked to the target to see if it is within the tolerance. If the total number of nodes is not within tolerance, it is deleted and the size function is rescaled and the process is repeated until the target number of nodes is reached. The number after "Scaled" is the scaling factor used to create the different number of meshes.

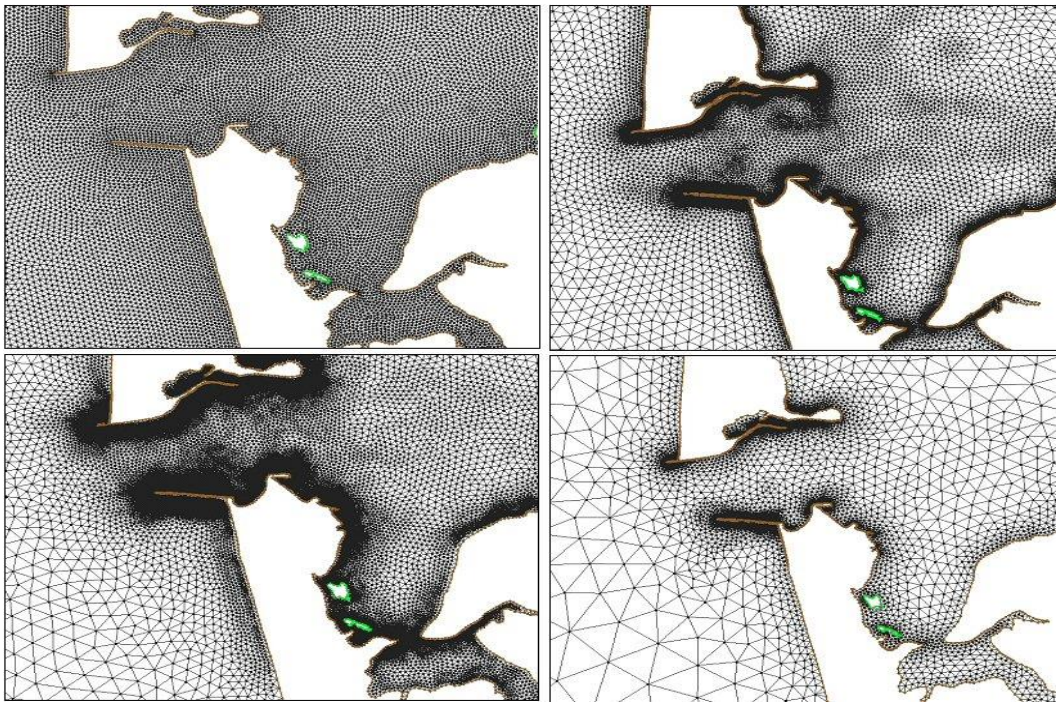

Figure 5 Various grid resolutions for a single domain

3 Conclusion

For this tutorial, the process was done step by step to explain the different options of each page. If desired, try running the toolbox straight through once by just filling in all of the required fields. The result will be the same. That is one of the most important parts of the toolbox. The process is repeatable: anyone can take those inputs and get the same result every time.

Finding the correct number of nodes for a mesh is an ambiguous task and depends on the research needs. With the toolbox, many different meshes can be created with varying target number of nodes. These meshes can then be tested to determine how many nodes are the most advantageous. Figure 5 shows a domain with several meshes created with varying number of nodes.

Continue experimenting with different scenarios, or exit SMS.