Introduction to Numerical Modeling -

Steps, grid generation, model parameters, boundary conditions and datasets.

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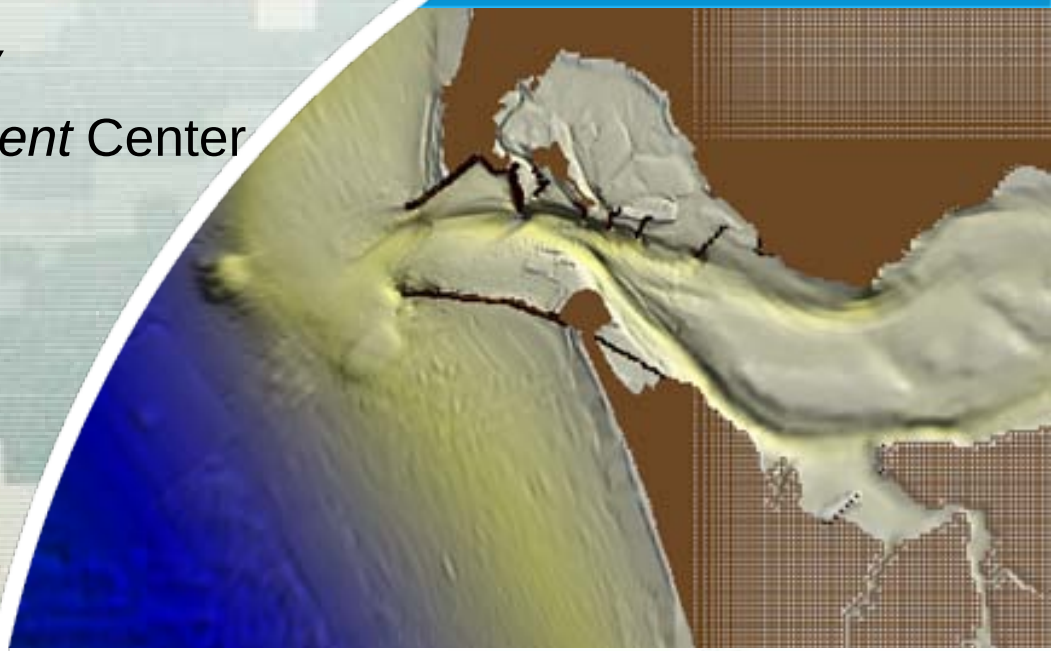

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Steps in developing a good hydro model

1. Create an initial grid with accurate bathymetry and topography.
   - Navigation channel surveys
   - Nearshore elevations (LIDAR, beach profiles, shoreline)
   - Digital Elevation Model (DEM)
   - Offshore bathymetry
2. Apply appropriate boundary and domain forcing.
   - Water surface elevation
   - River flow
   - Wind

Tasks

- Load and merge survey/bathymetry information for study area
- Get Aerial/Topographic images for study area
- Create CMS-Flow grid for project area using merged bathymetry set
  - Add forcing
  - Set up run-time parameters
- Create CMS-Wave grid for project area
  - Create from CMS-Flow grid
  - Import wave characteristics

❑ Load and merge survey/bathymetry information for study area

Bathymetry Surveys can come from various Sources:

- Gov't Agencies (USACE, NOAA, USGS, etc)
- Educational and Private Consulting
- Student Muscle

Surveys can come in various Types:

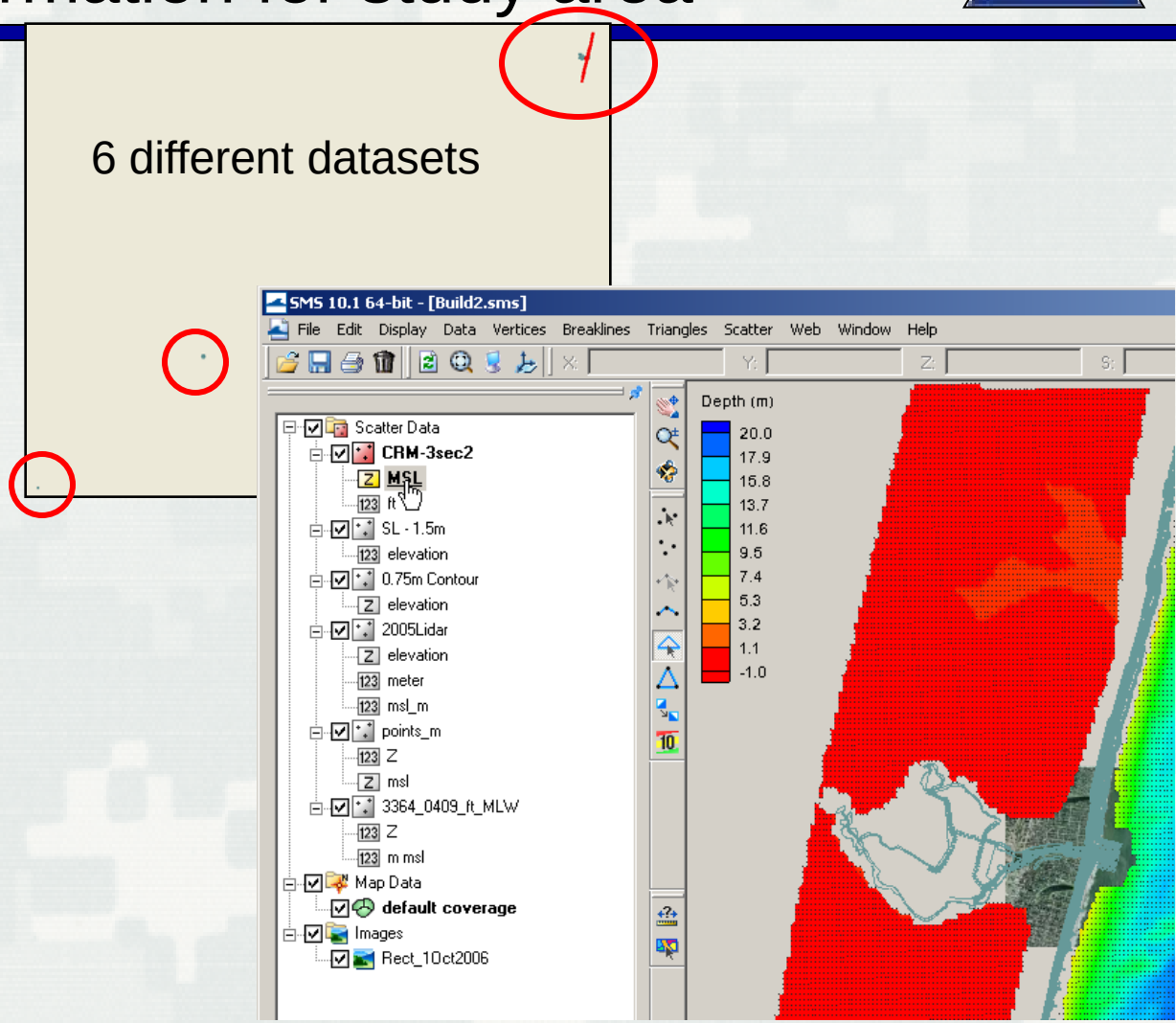
- Boat tracks, Jet ski, Profile lines
- DEMs, Airborne Laser systems (LIDAR)

❑ Load and merge survey/bathymetry information for study area

Various bathymetry datasets for a given area are usually not all in the same coordinate system.

Similarly, these datasets do not usually use the same reference datum.

The user must convert to the same coordinate system and datum before using them for bathymetry in a numerical model.



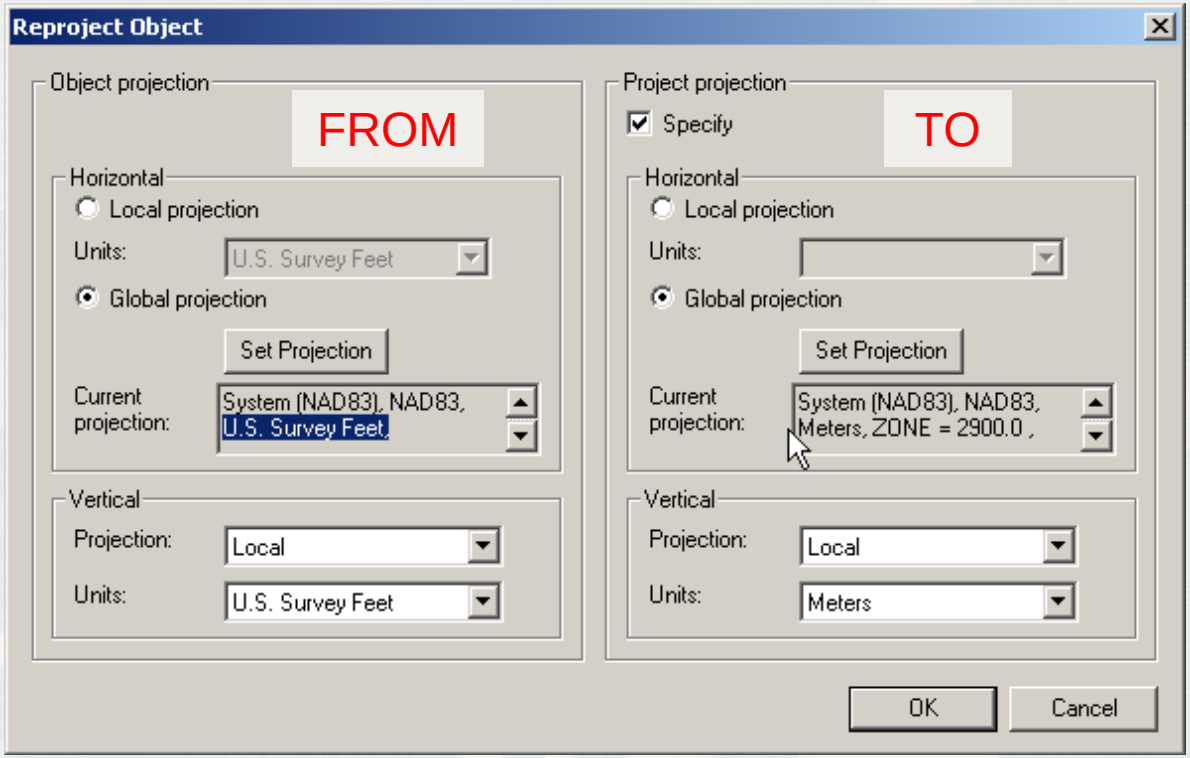
Steps for importing multiple surveys

1. Load individual surveys into the SMS
2. Load background bathymetry data for areas where there was no survey information available
3. Convert each dataset to a common horizontal coordinate system and vertical datum (if not already done)
4. Merge all bathymetry datasets together, giving priority to best/newest data if they overlap
5. Inspect merged dataset to view possible problem areas
6. Convert the final merged dataset to a datum near mean water level such as MTL or MSL (if not already done)

Datums

- Careful attention should be paid to ensuring all datasets share the <u>same</u> horizontal and vertical datums
- For CMS, choose a vertical datum that is very close to the mean water level for your area (typically MTL or MSL are used)
  - Horizontal datum should be in <u>meters</u> and should use a <u>Cartesian</u> coordinate system
  - Vertical datum should be in <u>meters</u>

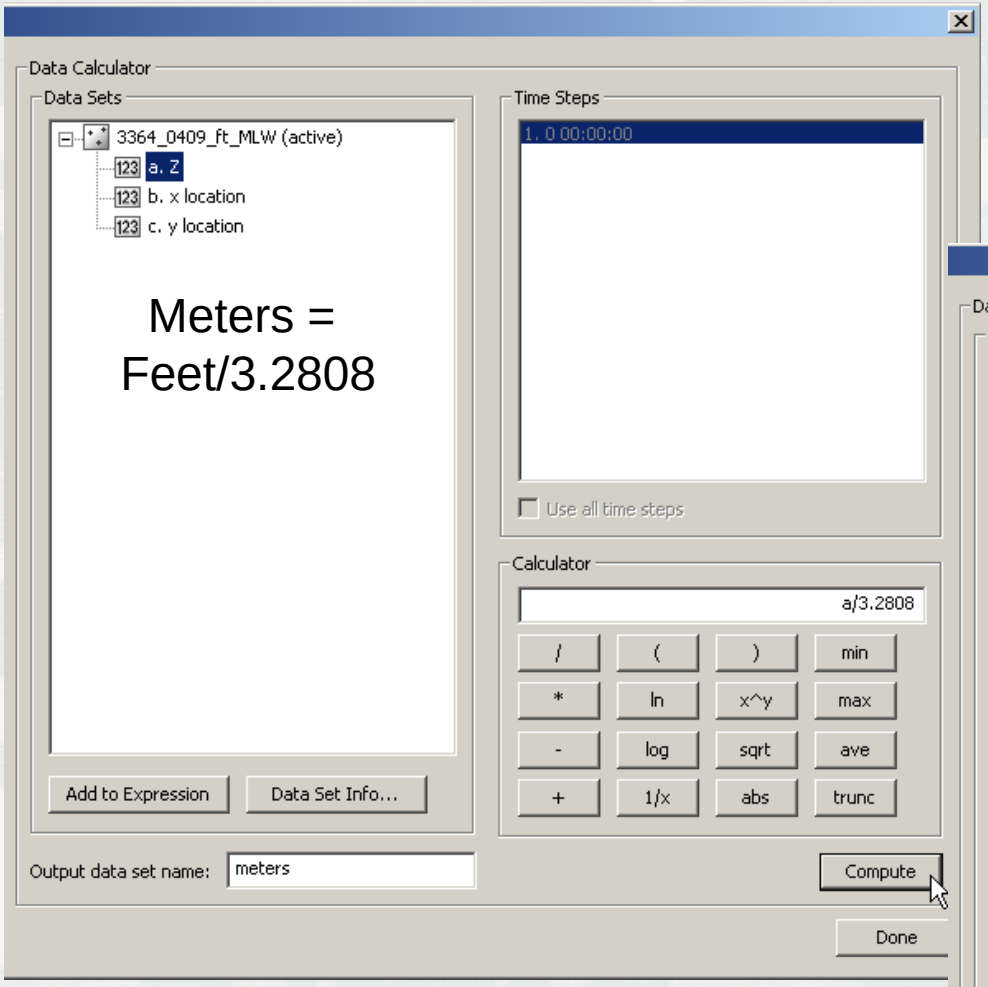
Reprojecting Coordinates

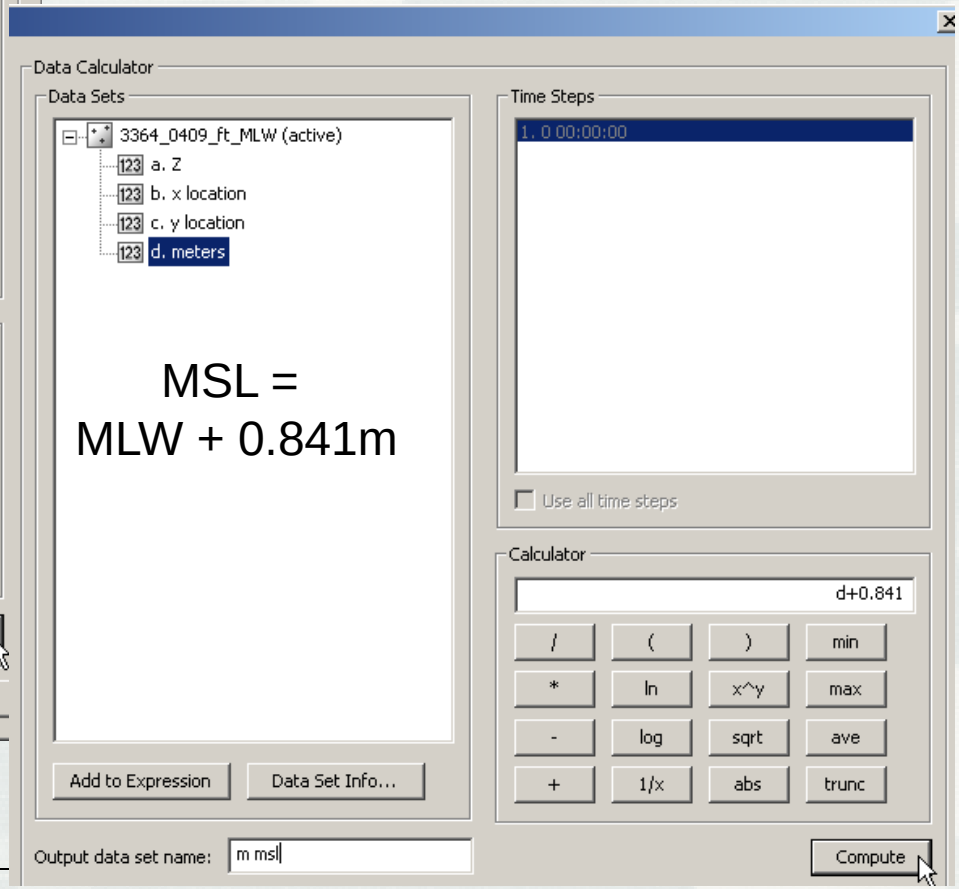


- Object projection is the system that the selected dataset is already in.
- Project projection is the system that your project will be in.
  - If the project projection has already been set, this side will be grayed out unless the “Specify” box is checked.
  - The user can then change the “Project projection”, if needed.

Datum Conversion

Use the Data Calculator within the Dataset Toolbox

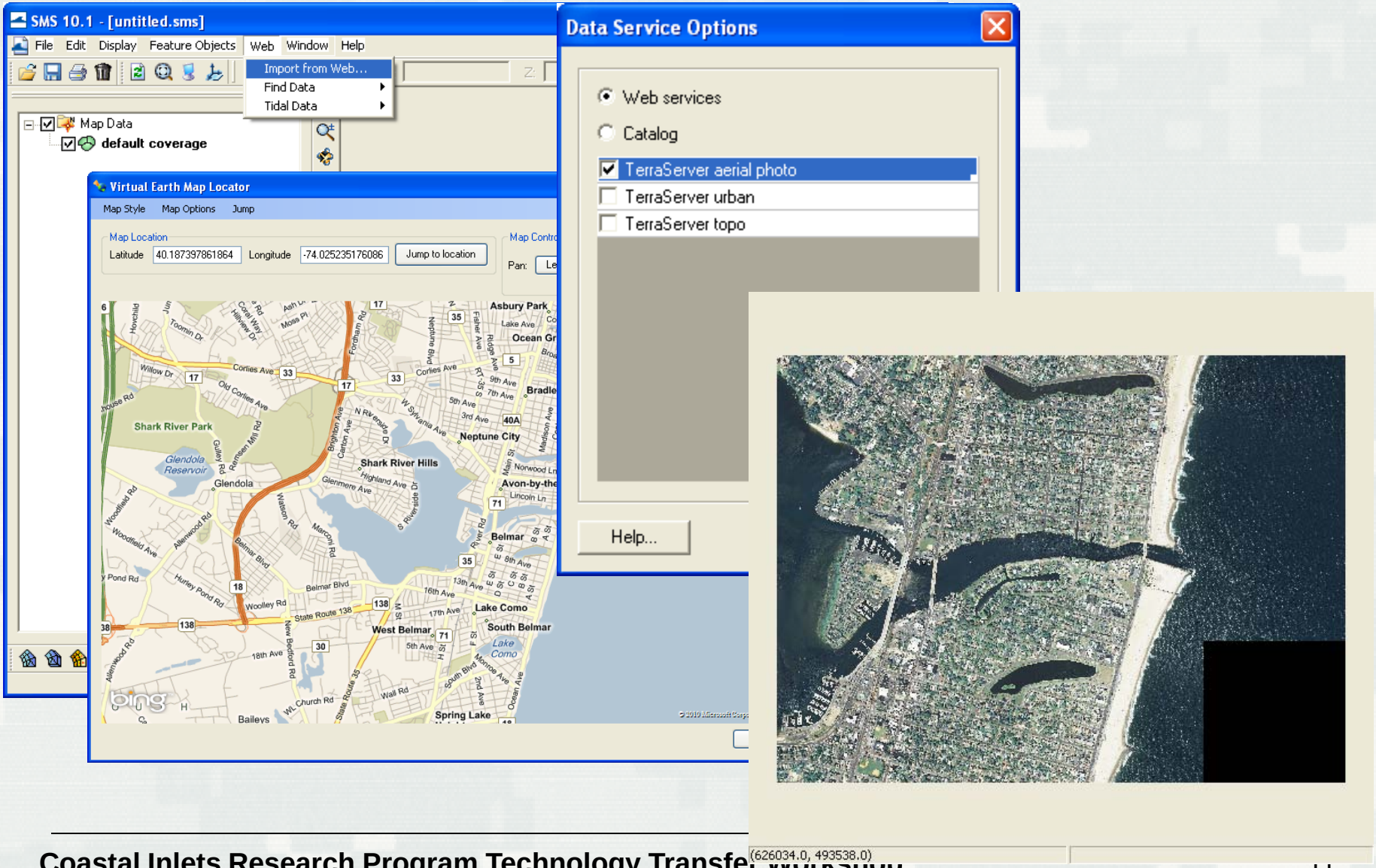




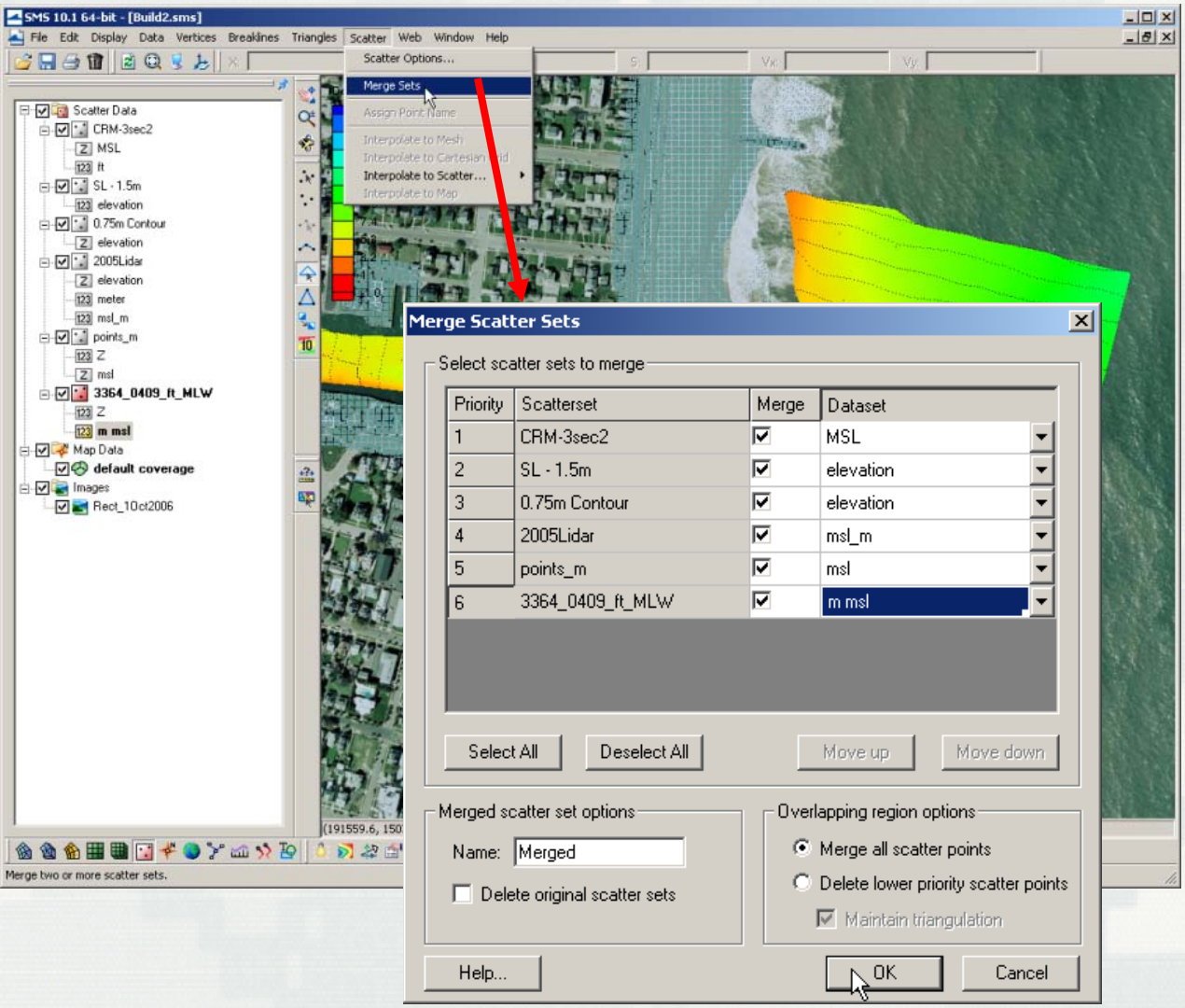
❑ Import Aerial / Topo from Web

- When loading georectified images, inspect the metadata and find out the horizontal projection and datum
- After loading images, reproject the images to the common coordinate system associated with your bathymetry data
- SMS has a built-in utility to download georectified images from the “terraserver” image database
  - These images will be automatically converted to the correct projection

SMS can get georeferenced images for you



Merge datasets



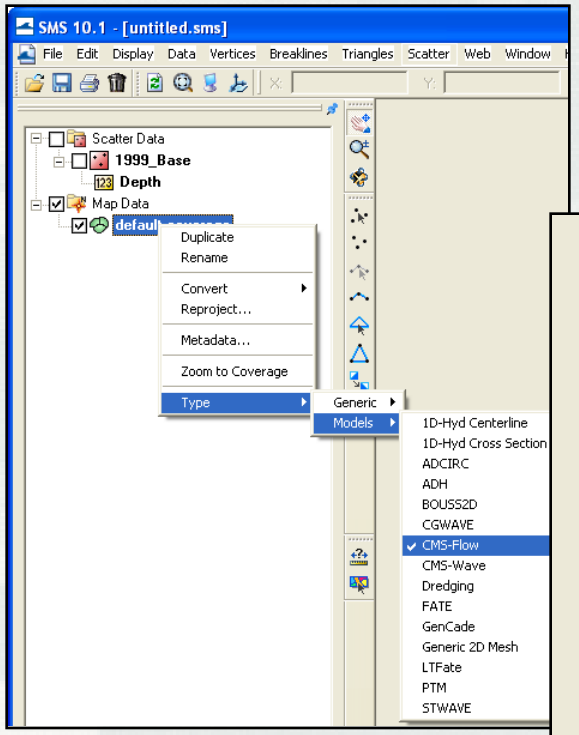
Once all datasets have been referenced to a common vertical datum (MSL) and are all in a common horizontal coordinate system, one complete dataset can be created by merging them all together.

This will be the base bathymetry used in grid creation.

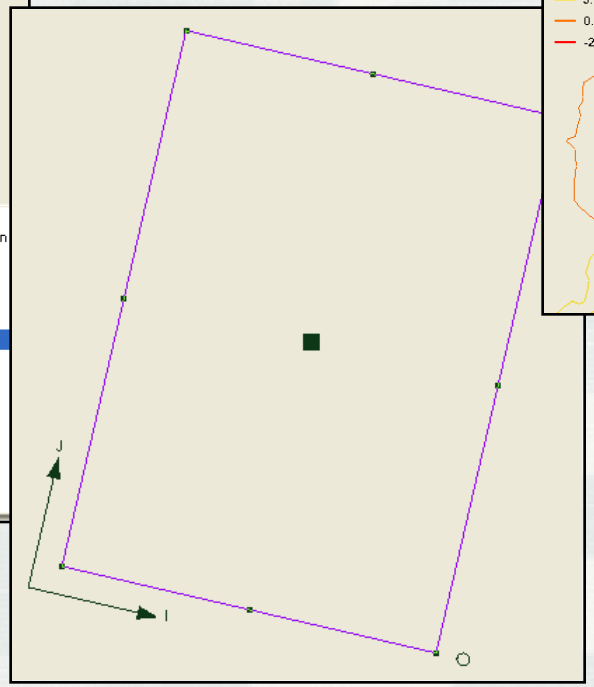
❑ Create CMS-Flow grid for project area using merged bathymetry

- Load merged bathymetry and image(s), if they are not already loaded.
- Save your project frequently. There is no UNDO.
- Map Module:
  - Create “CMS-Flow” coverage and grid frame
  - Add refine points if needed
  - Generate Flow grid, and inspect
  - Add boundary forcing, set model control parameters
- Cartesian Grid Module:
  - Add boundary conditions/forcing
  - Set model control parameters
- Save your project before running…

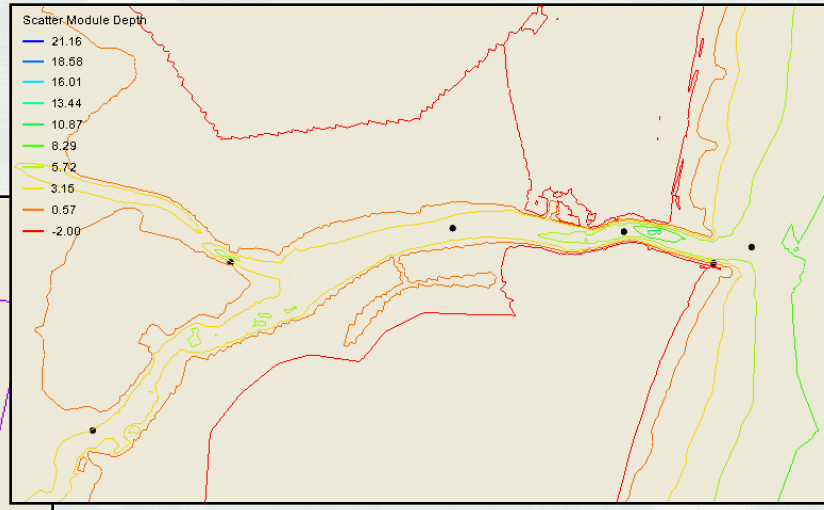
Map module



CMS-Flow Coverage

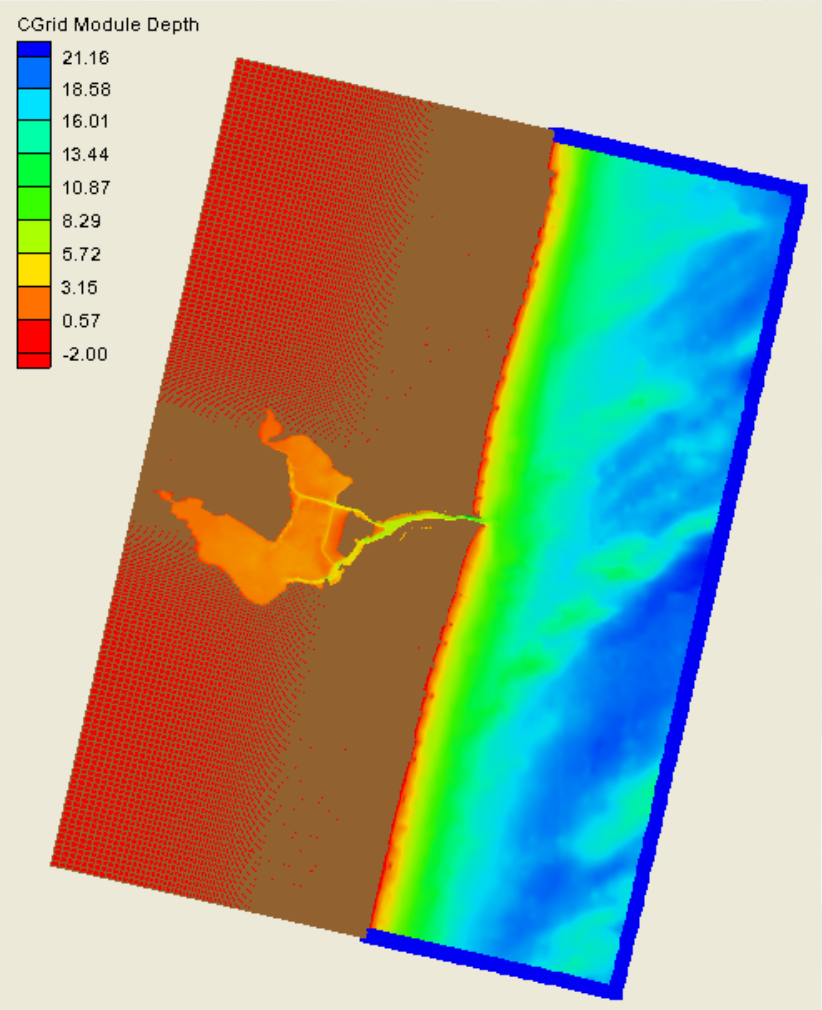


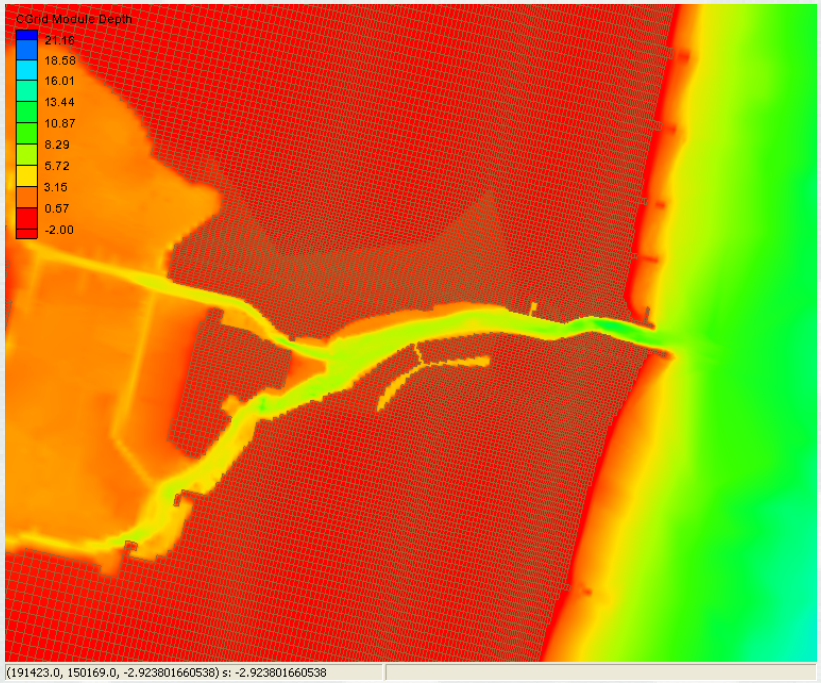
Create grid frame for desired size and rotation



Create refine points to set regions of finer resolution

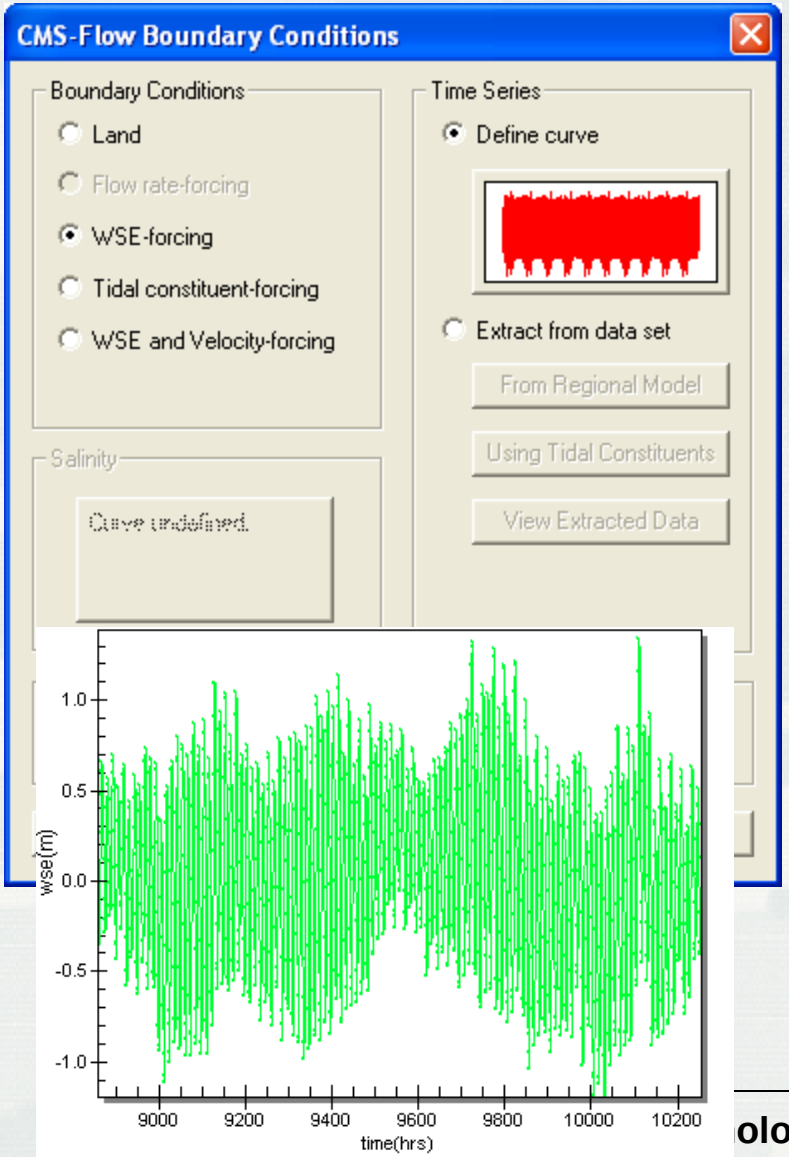
Generate Flow grid





Iterate between generating flow grids and changing refine points until resolution is sufficient for all necessary areas (jetties, structures, channels, rivers,etc).

Boundary Conditions



A single water level curve taken from a tidal gauge is often the main forcing for CMS-Flow.

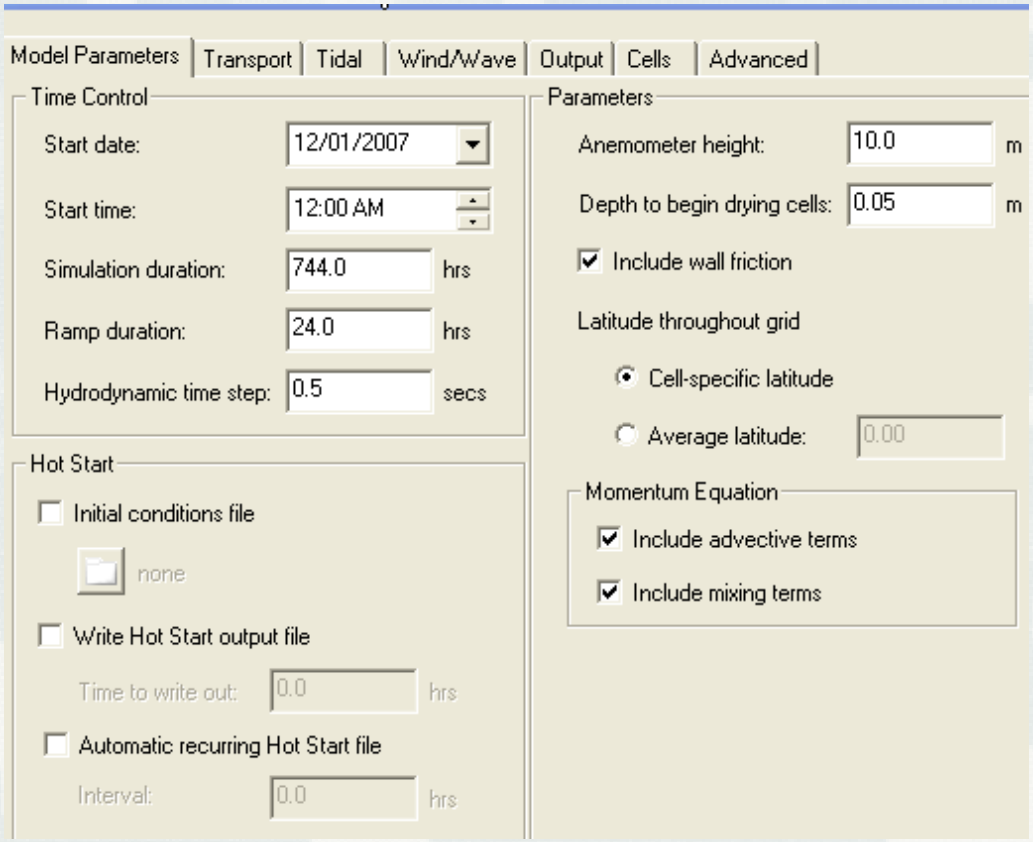
WL can also be extracted from a larger CMS-Flow or other numerical model (such as ADCIRC).

River flow information can be used as well.

Very soon (in testing now), real tidal constituents will be available that are tied to the modeling starting date and time.

Model Control

The model control dialog consists of various pages (or tabs) of related information. As this is a basic course, we will cover only a few of the interface tabs. The remainder will be covered at a later time.



Model Parameters

Start Date/Time – Beginning date of simulation. Time referenced to GMT.

Simulation Duration – Number of hours that the simulation will run.

Ramp Duration – The number of hours of reduced forcing to prevent instabilities. Forcing is gradually increased to full forcing over the ramp period.

Anemometer height – Height that the anemometer was installed, if wind forcing has been selected.

Depth to being drying cells – Minimum water depth at which a cell is designated as dry within CMS-Flow.

Include wall friction – Additional friction is included for cells next to land.

Include advective terms – Switch to turn on/off advective terms in the model run.

Include mixing terms – Switch to turn on/off mixing for the model run.

Wind Forcing

- Include wind – Switch to turn on/off wind forcing. Further options for wind are only available if this switch it checked.
- Import wind from file – Import wind information from one file that contains both velocity and direction information.
- Velocity (m/s) – Edit box to specify/import wind velocity information.
- Direction (deg.) – Edit box to specify/import wind direction information. Note: Directions are in “From direction” and follow the convention that wind directions start at zero from the north and increase in a clockwise direction (e.g., Wind from due East is 90 deg).

Output tab

- Output Times Lists – Four separate available lists of output times. Each list can contain a separate list of output times that will be assigned to a certain type of dataset.
- Add by time step – Specify the Start and End time and an increment, then "Add" to the list which appears under the "Output Times" section. NOTE: Times added DO NOT have to be all at the same rate (e.g., Every 2 hours, etc).
- Output Datasets – Four types of datasets (Water surface elevation, Velocity, Morphology, and Transport), which can use any one, two, three or all four of the "Output Times Lists."
- Simulation Label – Label that will act as a prefix for the solution data when loaded. Can be used to separate various alternatives all generated for a basic grid geometry, so they can be loaded at the same time for comparison.

NOTE: Make sure you assign at least one output times lists to the available datasets in this section. If you fail to do so, your run will complete but you will have NO output to view.

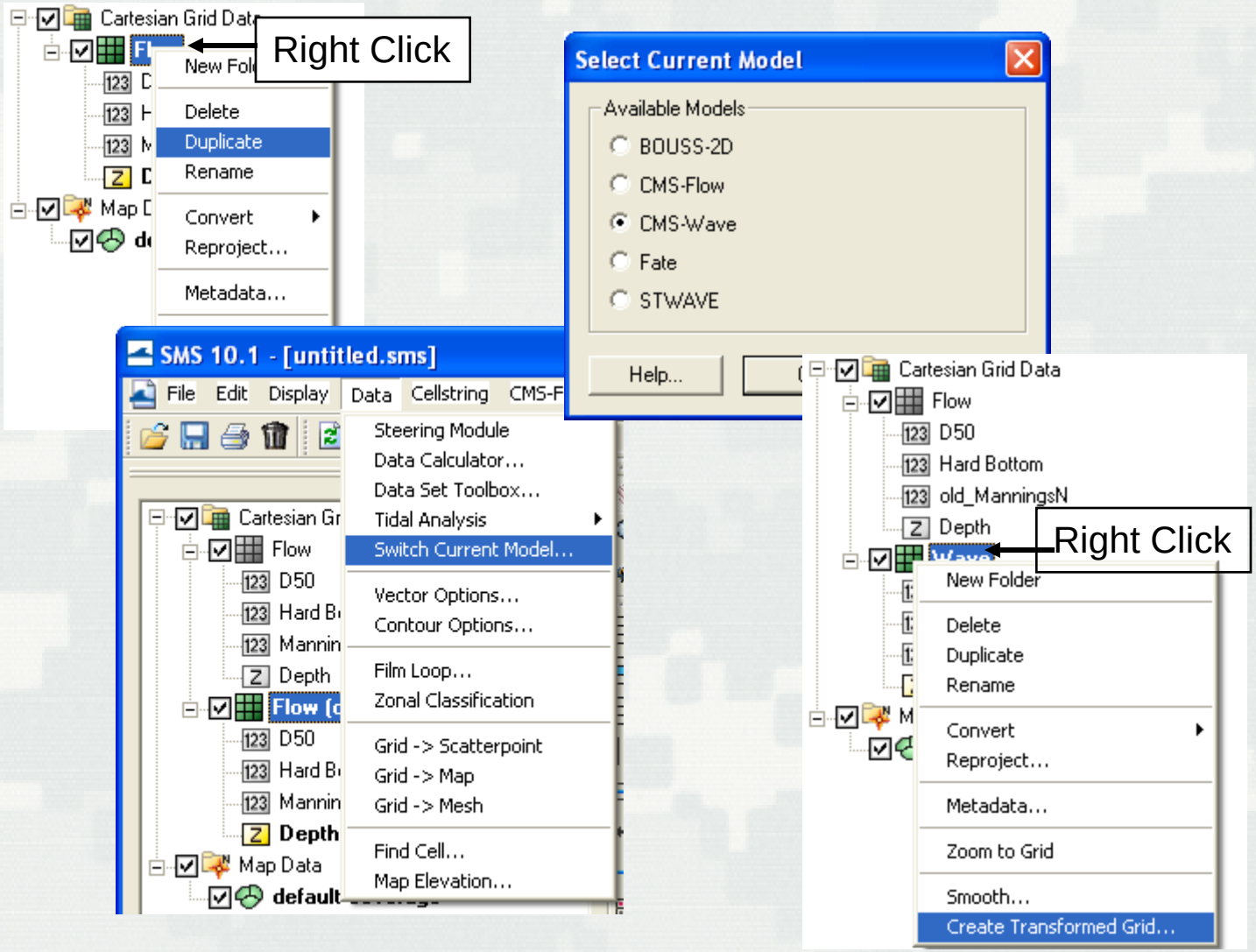
Advanced Tab

- The area on this tab is mainly for features developed for CMS-Flow that have not yet made it into the SMS interface. Rather than requiring multiple updates of the interface over a given period, this allows testing of new features without changes to the SMS graphical interface. A user can add a CARDNAME with options here, SMS will write the lines out to the parameter file, and CMS-Flow will run with the options (assuming it recognizes the CARD information).
- For the **Explicit** version of CMS, this Advanced section can enable use of multiple processes on your PC.
- For the **Implicit** version of CMS, this Advanced section is used for other parameters (to be discussed later this week).

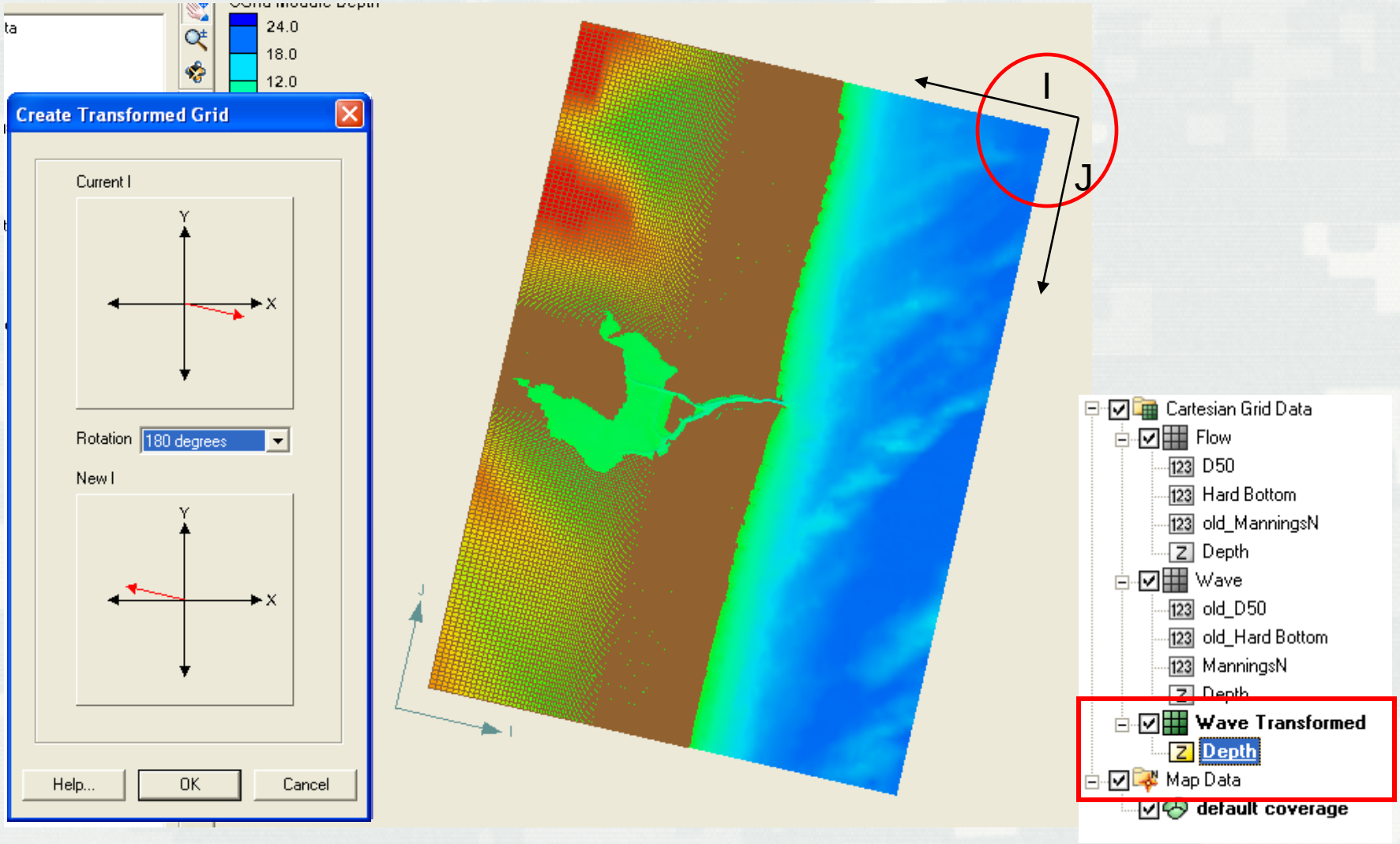
❑ Create CMS-Wave

- If you want the same flow and wave domain, you can directly convert your Flow grid over to a Wave grid.
  - Duplicate your Flow grid, Change origin,
  - Switch to Wave model, then save.
- If you want to remove some of the bay portion of the grid, you can use the flow “grid frame” as a template, then make changes.
  - In the map module, duplicate your flow coverage, change coverage to “CMS-Wave”.
  - Move the grid frame extents in the back bay to where you want it.
  - Generate the grid exactly as you generated the flow grid.
- Cartesian Grid Module:
  - Add spectral energy

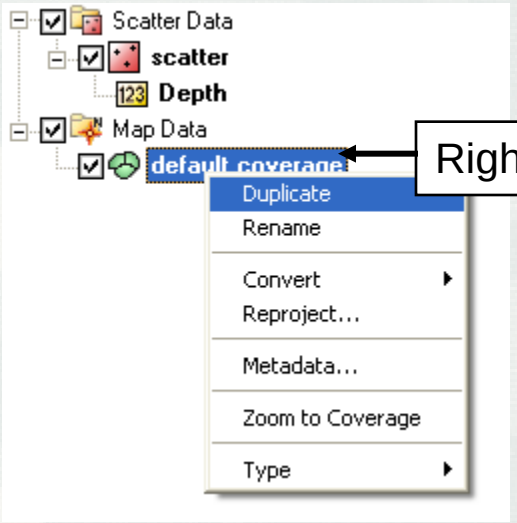
Duplicate Flow grid as Wave grid

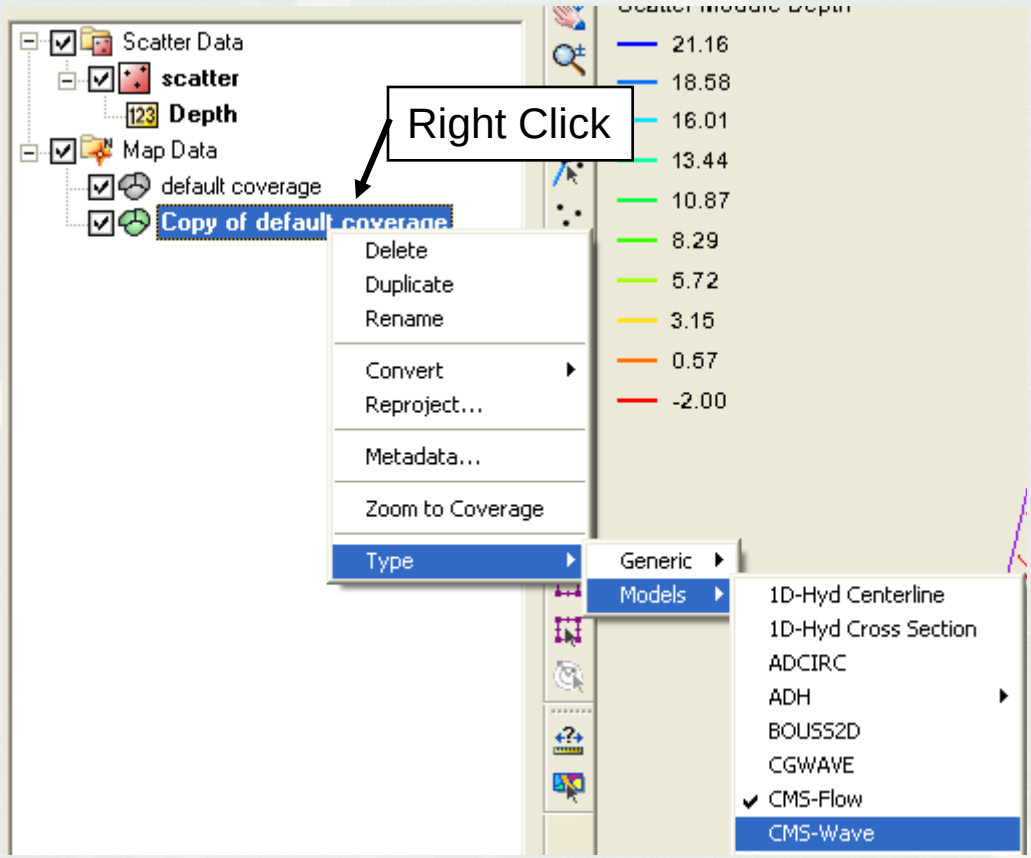


Duplicate Flow grid as Wave grid, cont.

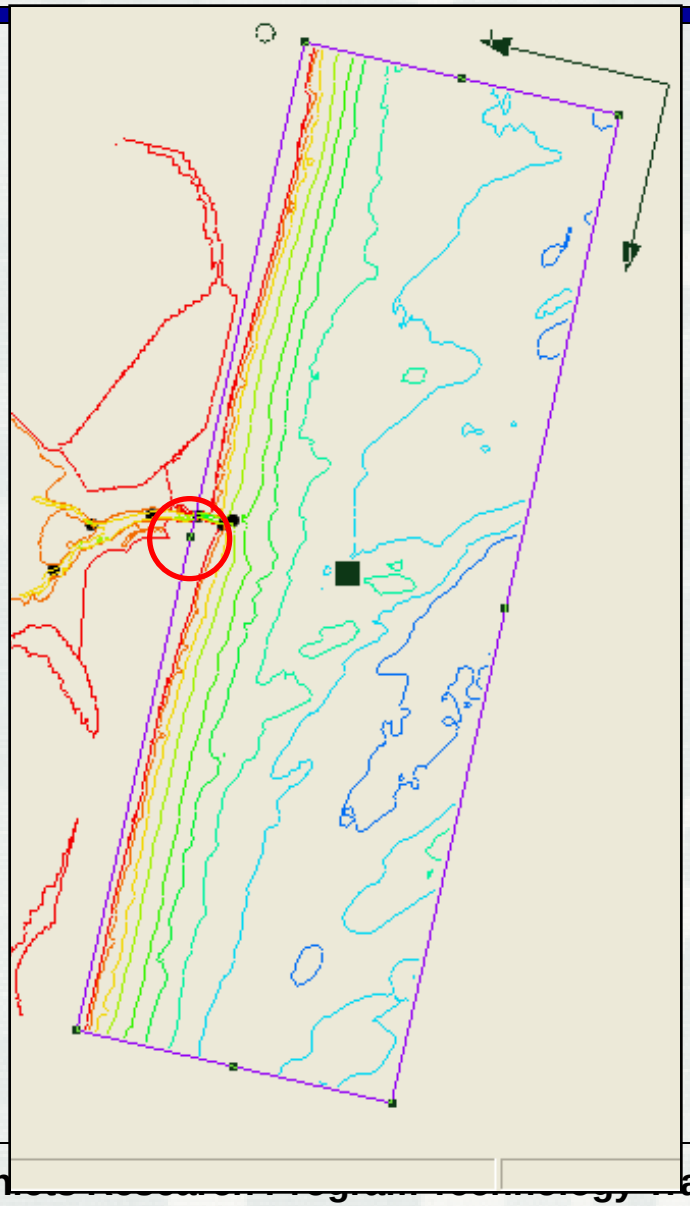


Make smaller wave grid using flow grid frame





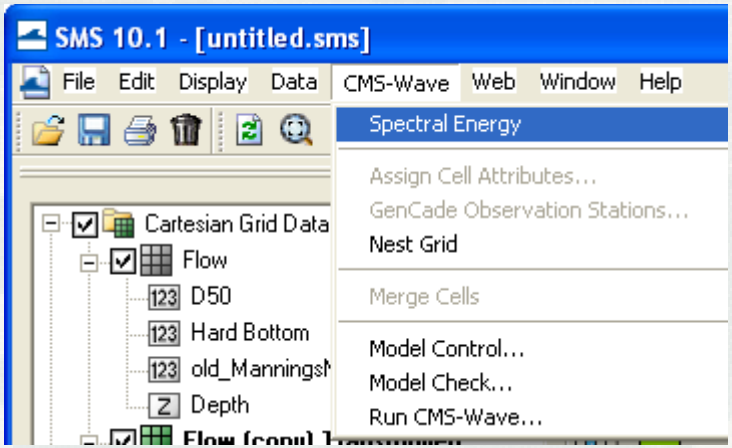
Make smaller wave grid using flow grid frame, cont.

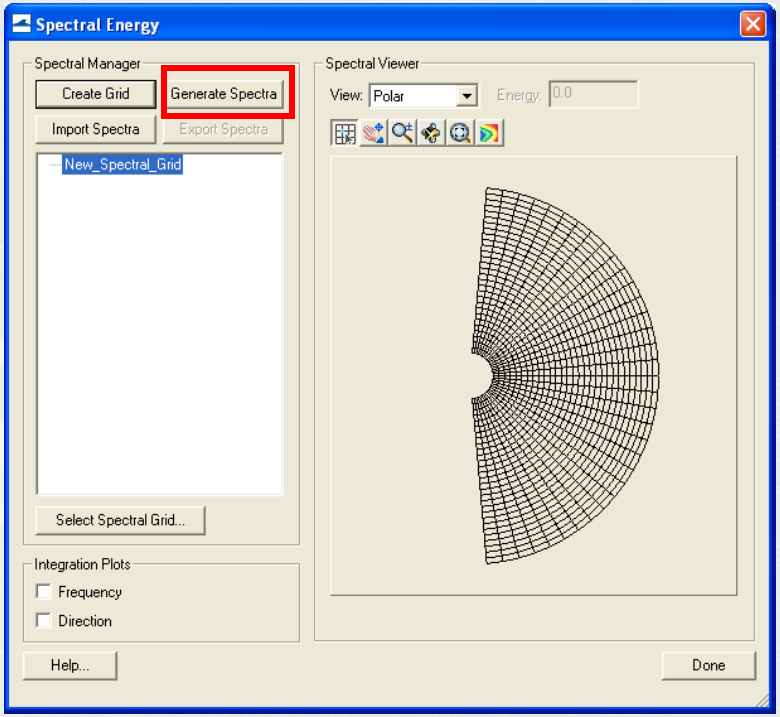


- Reduce size of grid frame on bay side using “drag” points
- Generate a new Wave grid using same technique as for Flow grid

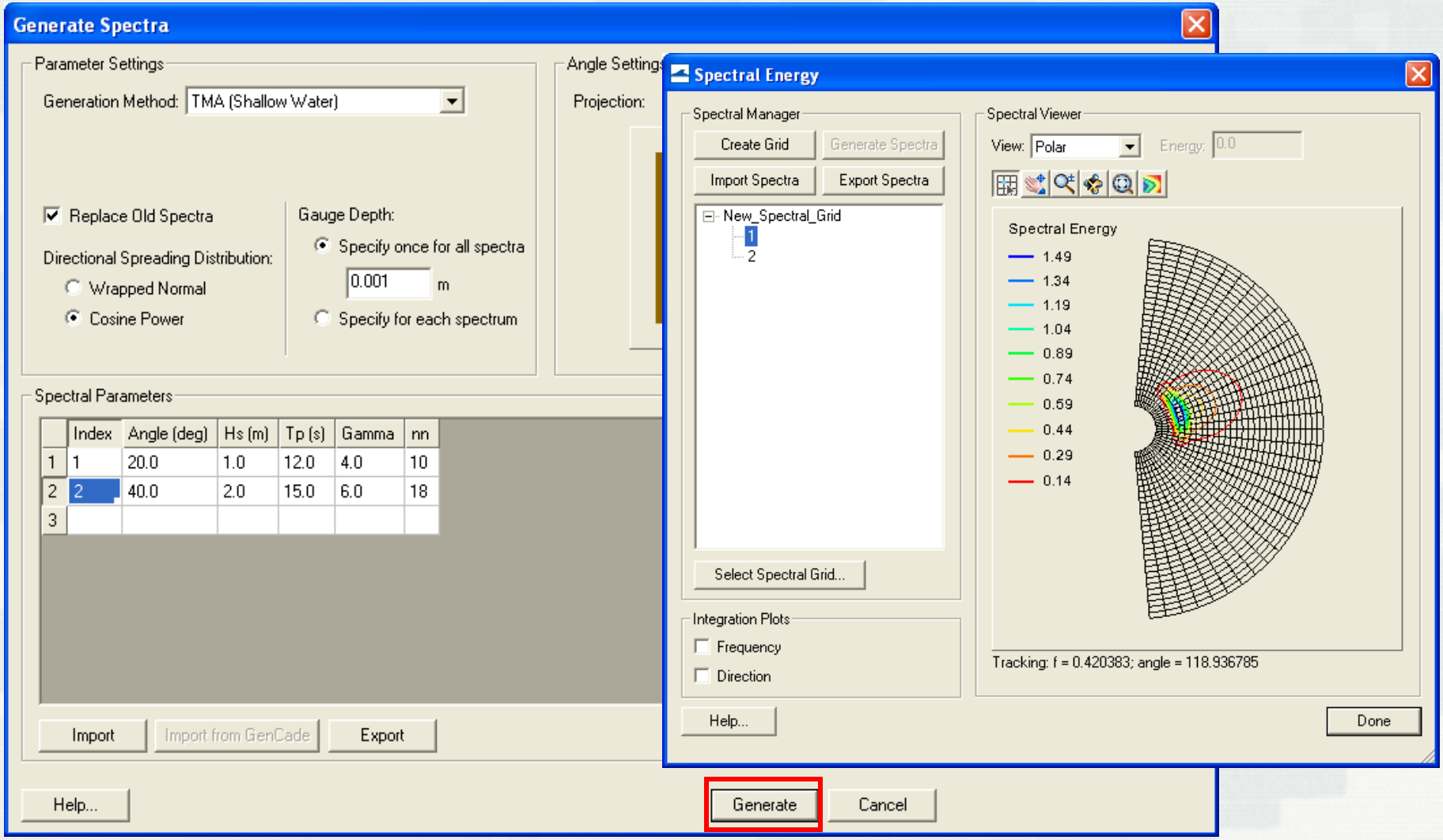
Basic wave parameters

- Wave grid uses spectral energy to force with.
  - Information can be entered by bulk parameters
  - Or directly from spectral output from a wave gauge.
- We will use only bulk parameters today.





Basic wave parameters, cont.



Questions?

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