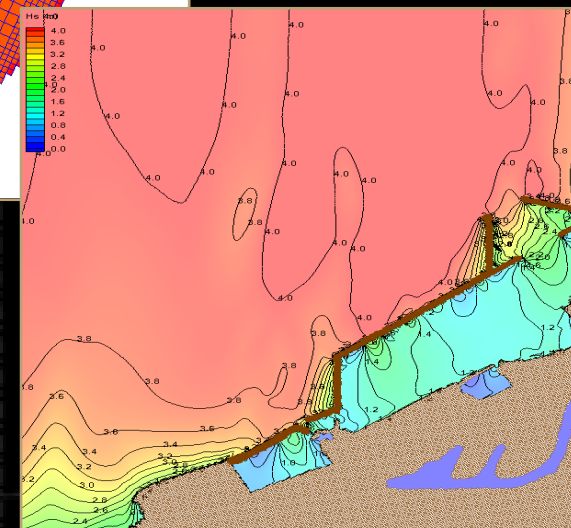
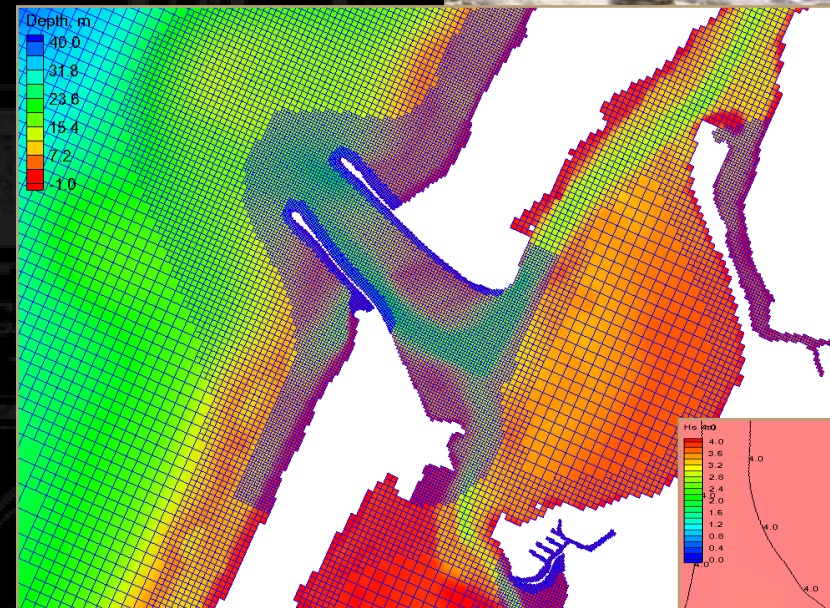


CMS-WAVE: MODEL SETUP

Mitchell Brown
Liz Holzenthal
Honghai Li

Coastal & Hydraulics Laboratory
US Army Engineer Research and Development
Center (ERDC)

CMS Basics Webinar Series
29 July – 02 August 2024



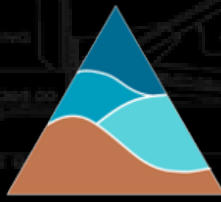
U.S. ARMY



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ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER



CIRP



Presentations

- CMS-Wave grid creation
- CMS-Wave Spectra and Model Control



Demo

- Creating CMS-Wave grids
- Creating Wave Spectra from bulk criteria
- Importing Wave Spectra information from Wave Gauge/Buoy/WaveNet
- Export/Launch CMS-Wave
- Steering – Interactive CMS-Flow and CMS-Wave

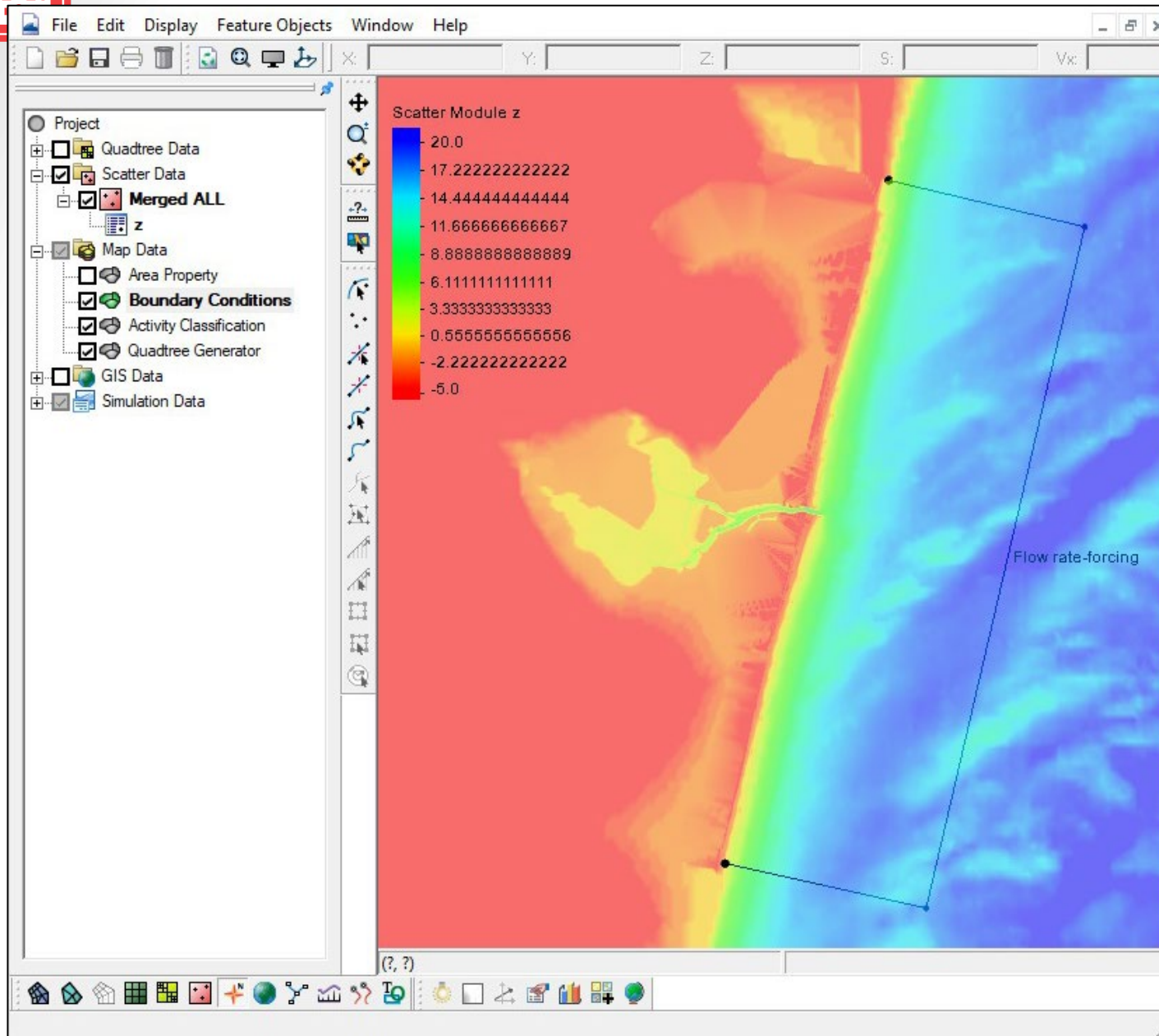


inar > Day4 > 1-afterDay3

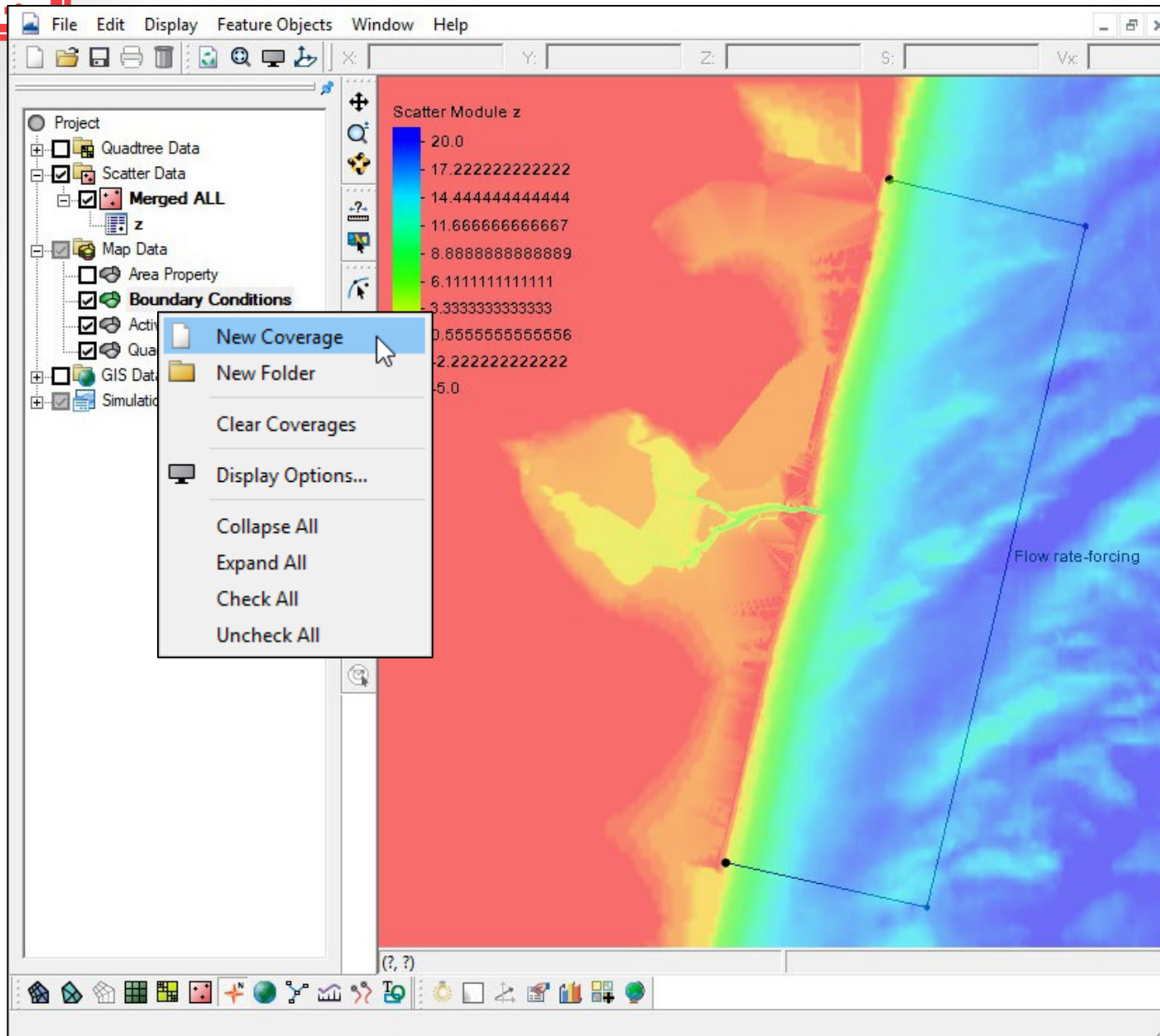
Search 1-afterDay3

Name	Date modified	Type	Size
 Workshop_SharkRiver_13.3_data	8/1/2024 9:43 AM	File folder	
 Workshop_SharkRiver_13.3.sms	8/1/2024 9:43 AM	SMS File	2,954

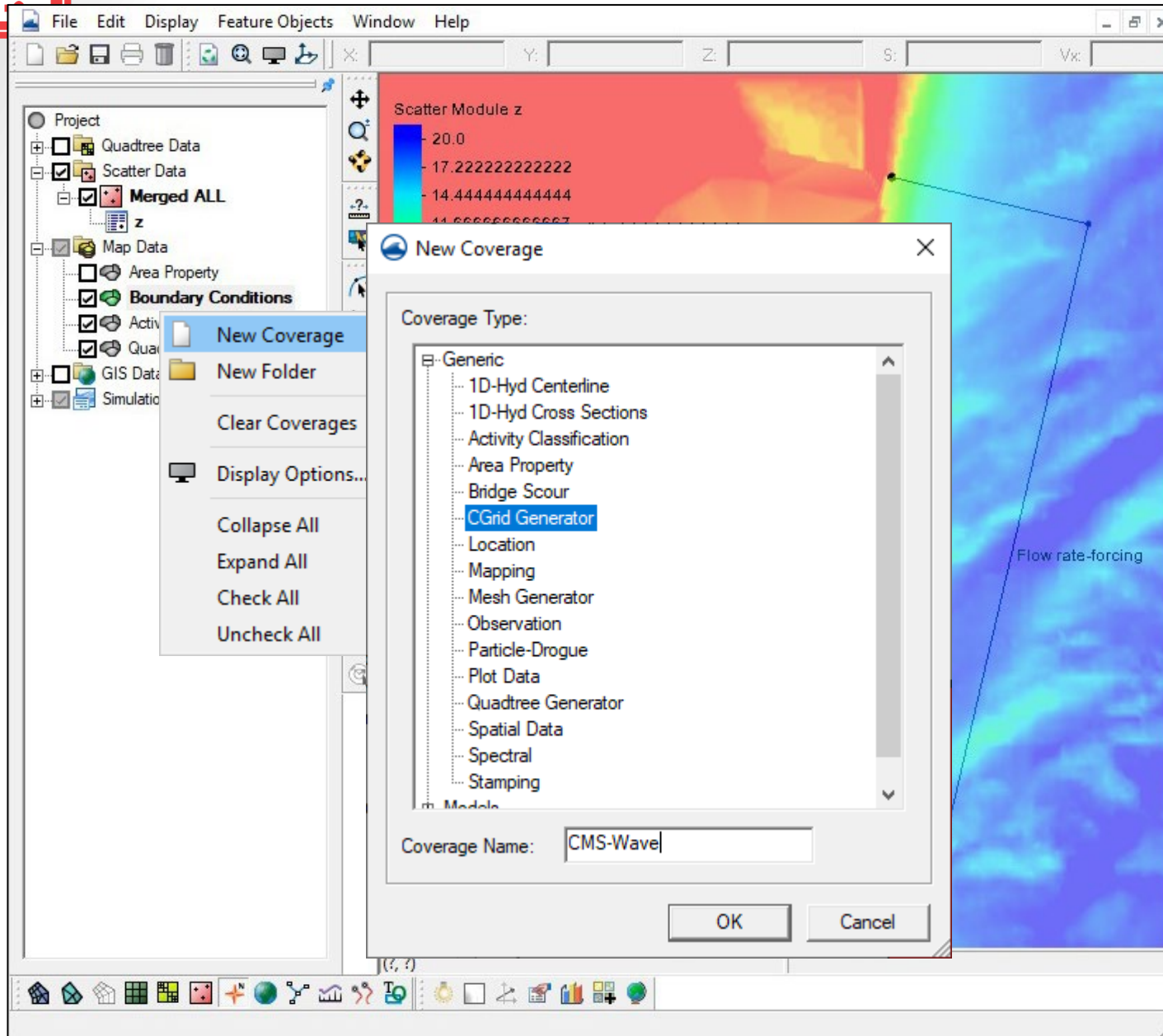
- Load project from previous work
 - Files can be found in Day4/1-afterDay3 folder



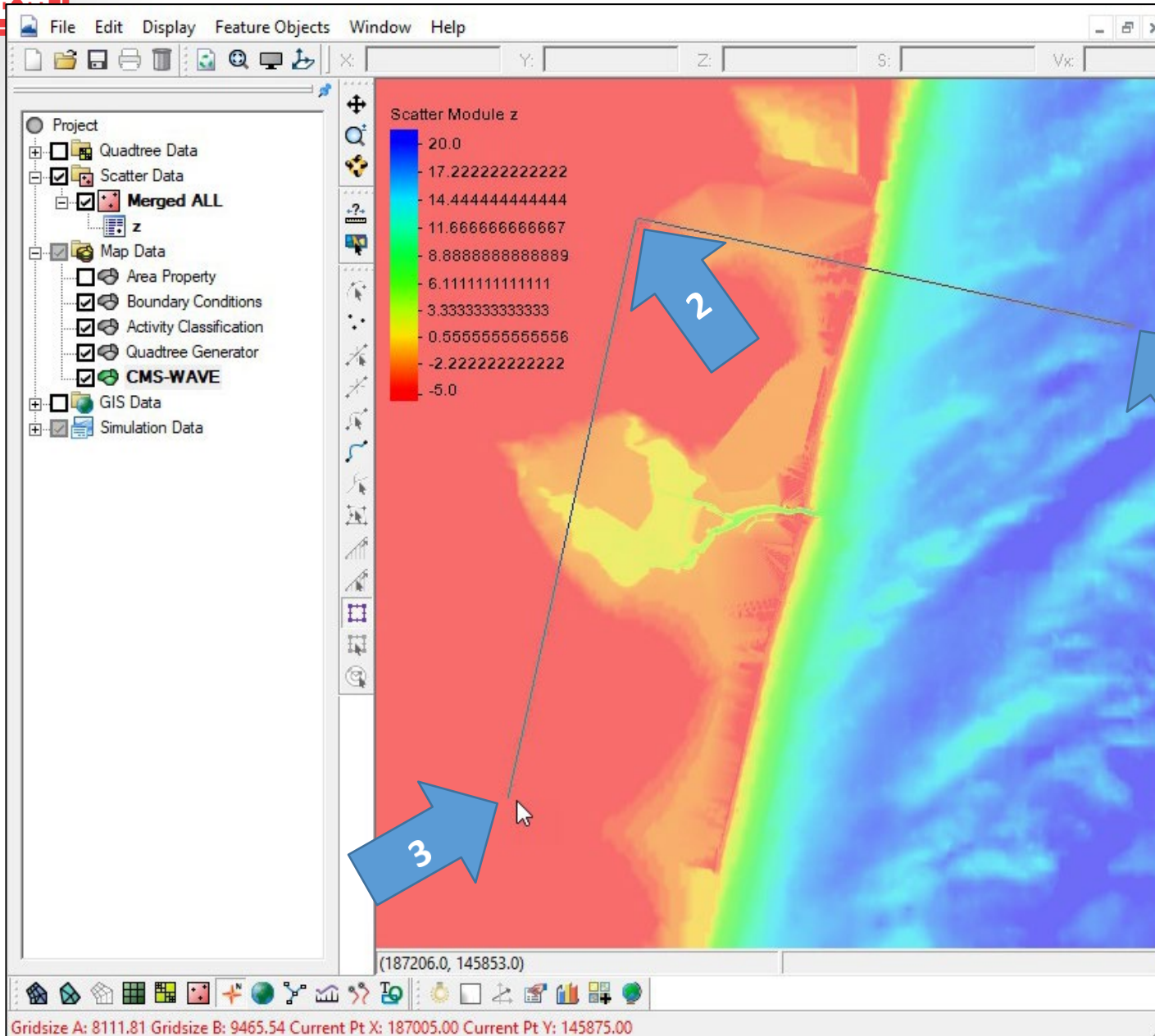
- Load project from previous work
 - Files can be found in Day4/1-afterDay3 folder



- Load project from previous work
 - Files can be found in Day4/1-afterDay3 folder
- Right click on "Map Data"
 - New Coverage



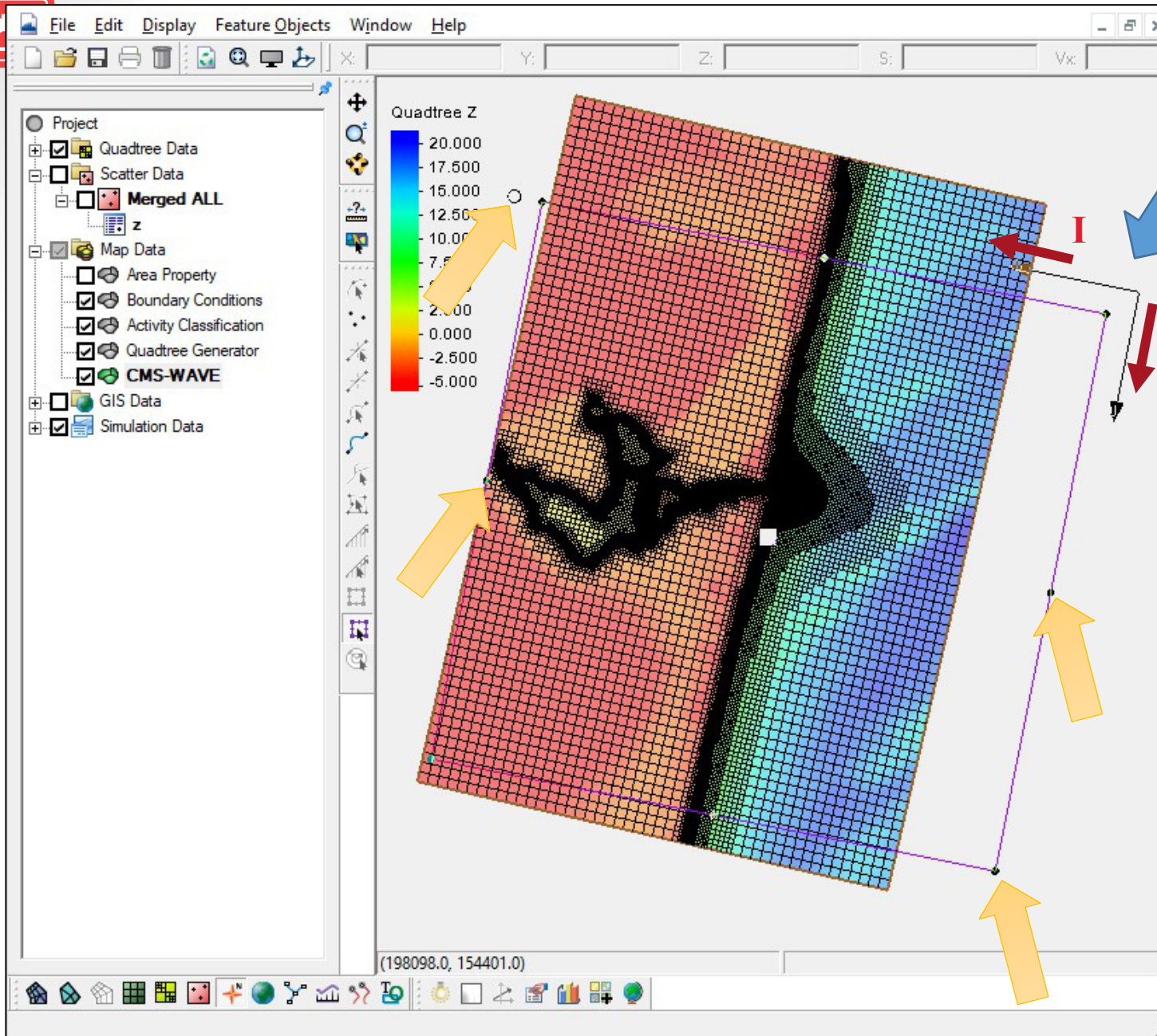
- Load project from previous work
 - Files can be found in Day4/1-afterDay3 folder
- Right click on "Map Data"
 - New Coverage
 - Generic | Cgrid Generator
 - Rename to "CMS-Wave"



- Select CMS-Wave
- Select Create Grid Frame tool 

- Define domain of CMS Wave grid by clicking three points –
- Starting offshore (1) moving toward shoreline (2), then other corner on land side (3)
- Note: Order **MUST** be correct

- Accuracy not required, we can edit afterward.

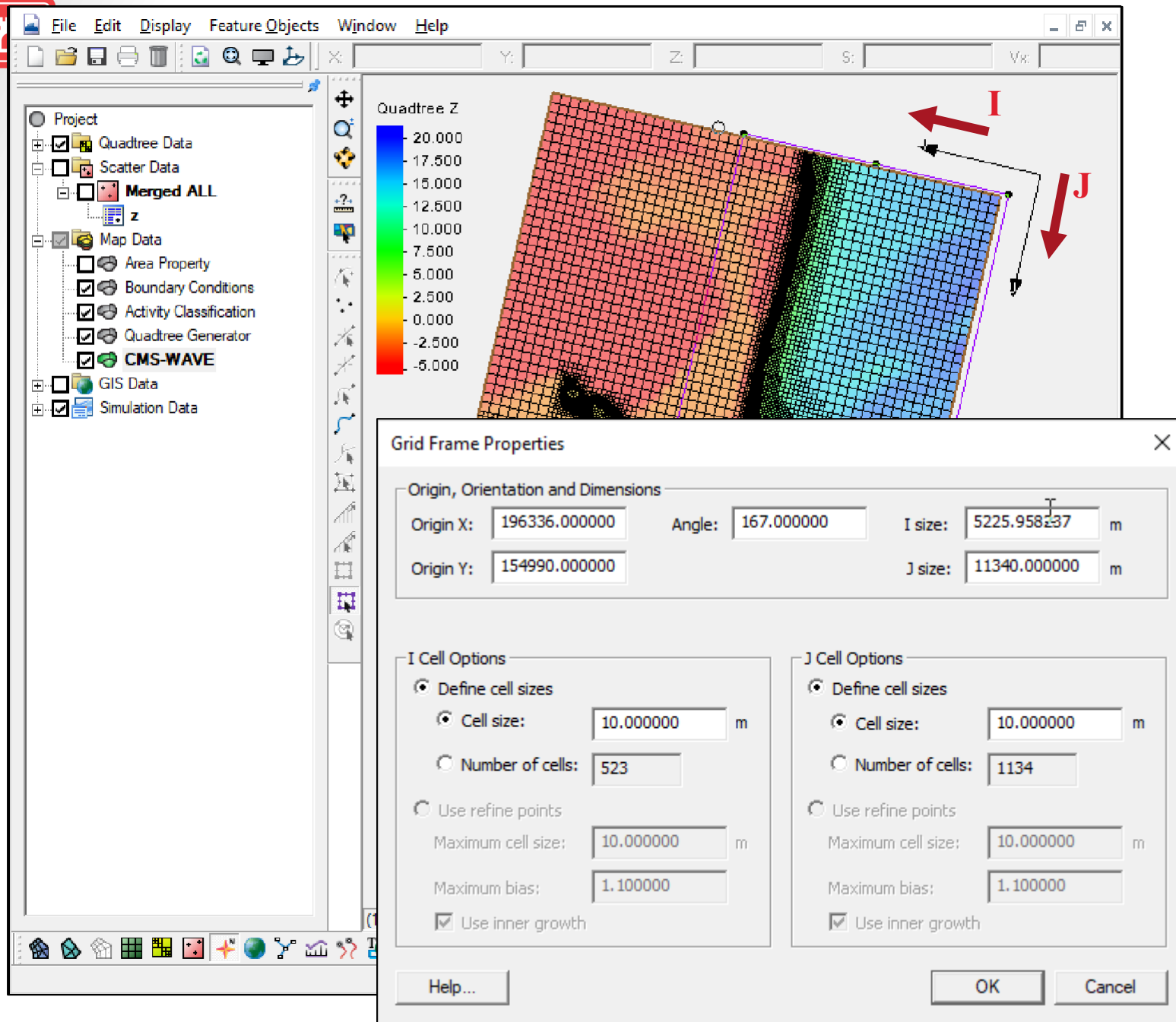


- Click Select Grid Frame tool

- Click frame selector
- You can now resize with corner or edge center points
- You can rotate around IJ Axis with handle

- Make sure to SAVE frequently as you go along.

**** Note:** the location of the IJ Triad. I-direction is directed onshore.



Grid Frame Properties

Origin, Orientation and Dimensions

Origin X: 196336.000000 Angle: 167.000000 I size: 5225.958237 m

Origin Y: 154990.000000 J size: 11340.000000 m

I Cell Options

Define cell sizes

Cell size: 10.000000 m

Number of cells: 523

Use refine points

Maximum cell size: 10.000000 m

Maximum bias: 1.100000

Use inner growth

J Cell Options

Define cell sizes

Cell size: 10.000000 m

Number of cells: 1134

Use refine points

Maximum cell size: 10.000000 m

Maximum bias: 1.100000

Use inner growth

Help... OK Cancel

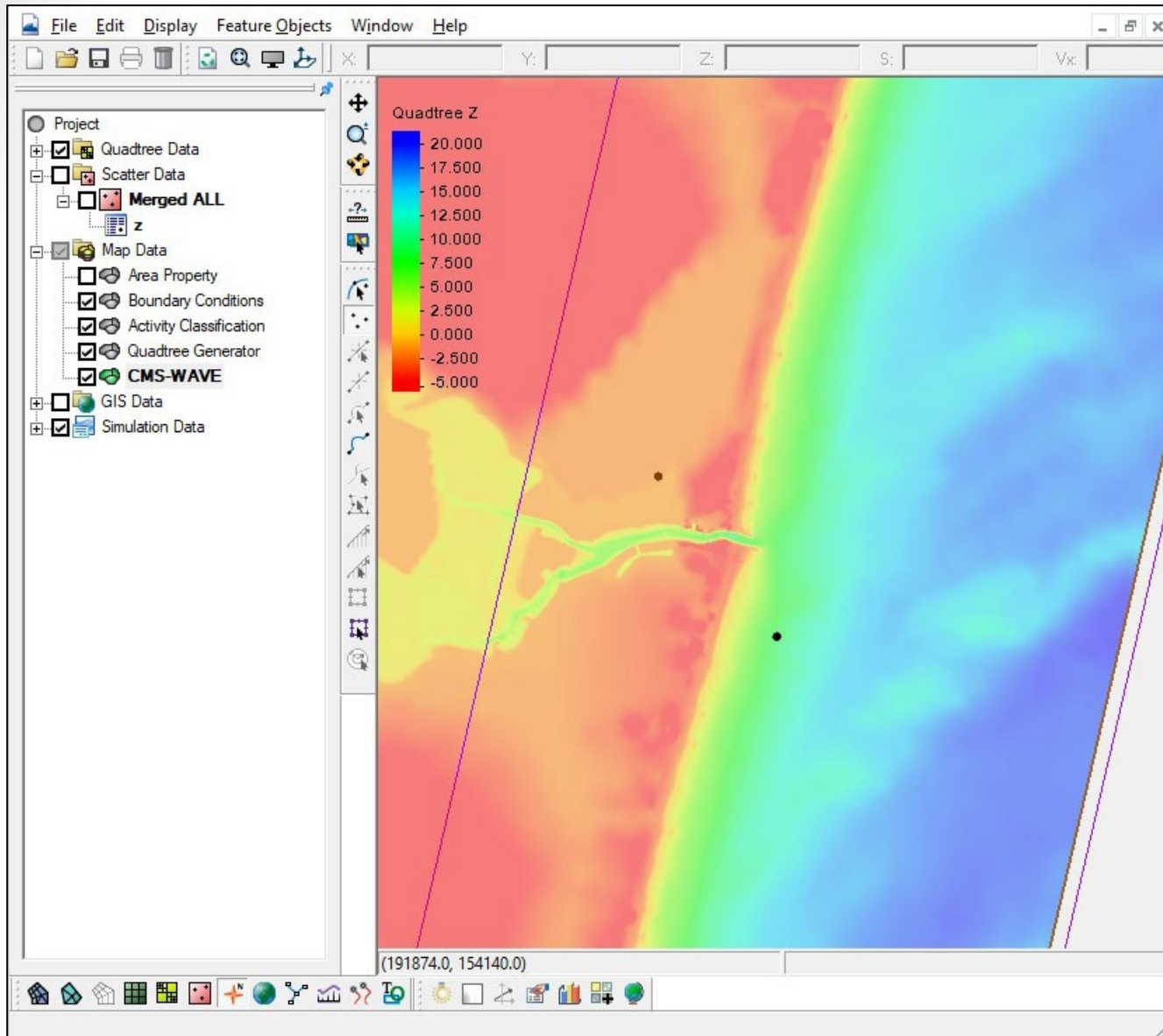
- Many times, we make the Wave Grid the same size or just a little larger than the Flow grid, unless the flow grid is very large.

- Turn off Scatter visibility
- Turn on Quadtree visibility



- Back side does not need to match the flow if the wave energy will most likely be dissipated.



DEFINE LOCATIONS FOR FINER RESOLUTION



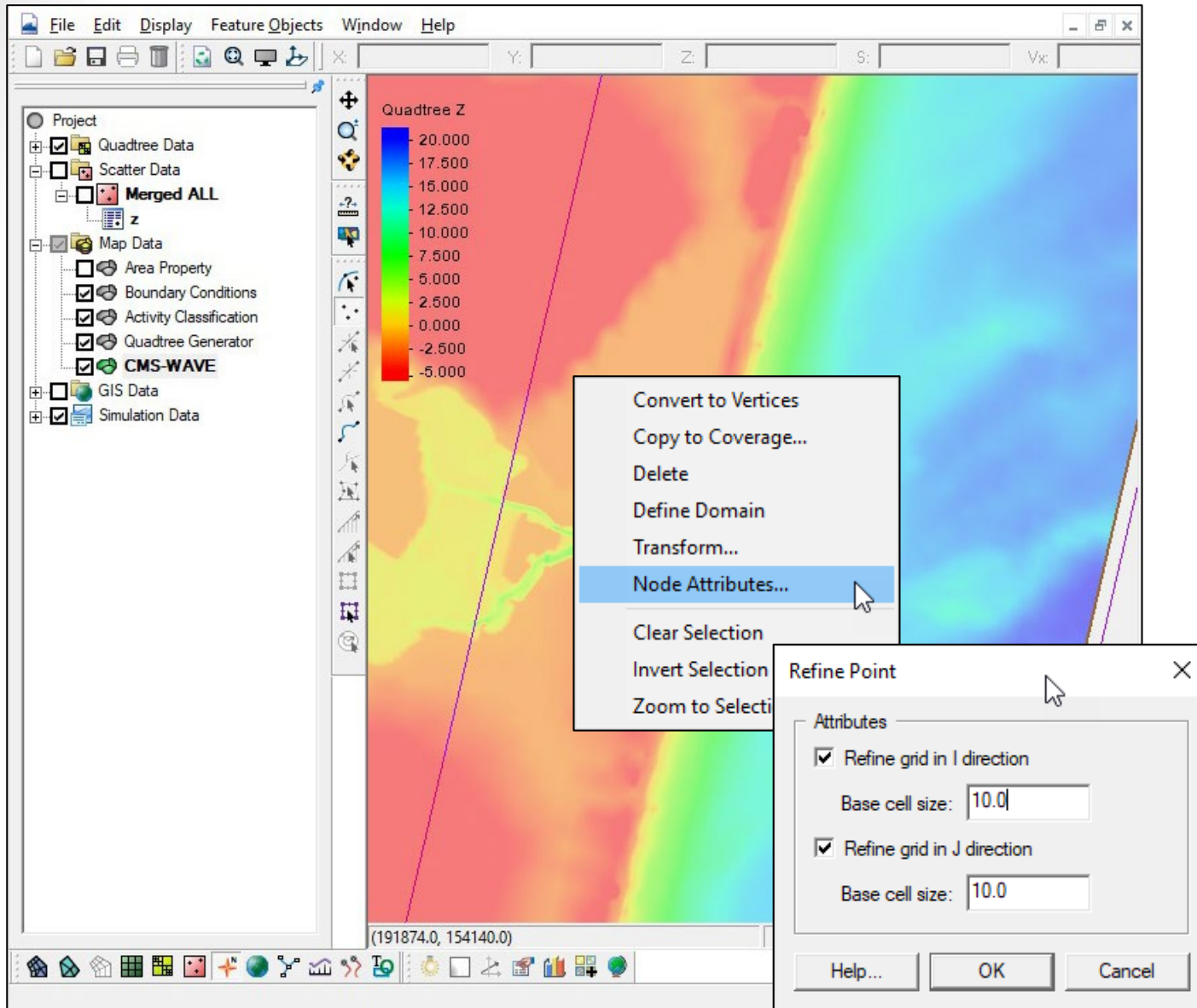
Resolution for Cartesian Grids is done with “refine points”.

- Create feature points. 
- Then select | right-click and set node attributes 



- You can set refinement in:
 - I-direction
 - J-direction
 - Both
- Refinement starts at feature point center and increases outward.



DEFINE LOCATIONS FOR FINER RESOLUTION



Resolution for Cartesian Grids is done with “refine points”.

- Create feature points. 
- Then select | right-click and set node attributes 

- You can set refinement in:
 - I-direction
 - J-direction
 - Both
- Refinement starts at feature point center and increases outward.



CREATE CARTESIAN GRID



Map -> 2D Grid

Grid name: CMS-WAVE Grid

Origin, Orientation and Dimensions

Origin X: 196336.000000 Angle: 167.000000 I size: 5225.958237 m

Origin Y: 154990.000000 J size: 11340.000000 m

I Cell Options

Define cell sizes

Cell size: 200.000000 m

Number of cells: 27

Use refine points

Maximum cell size: 200.000000 m

Maximum bias: 1.050000

Use inner growth

J Cell Options

Define cell sizes

Cell size: 200.000000 m

Number of cells: 57

Use refine points

Maximum cell size: 200.000000 m

Maximum bias: 1.050000

Use inner growth

Depth Options

Source: Scatter Set

Select... z

Mark cells [] m above datum as land.

Vector Options

Map vector Current

Constant

X: 0.000000

Y: 0.000000

Interpolated

Select none selected

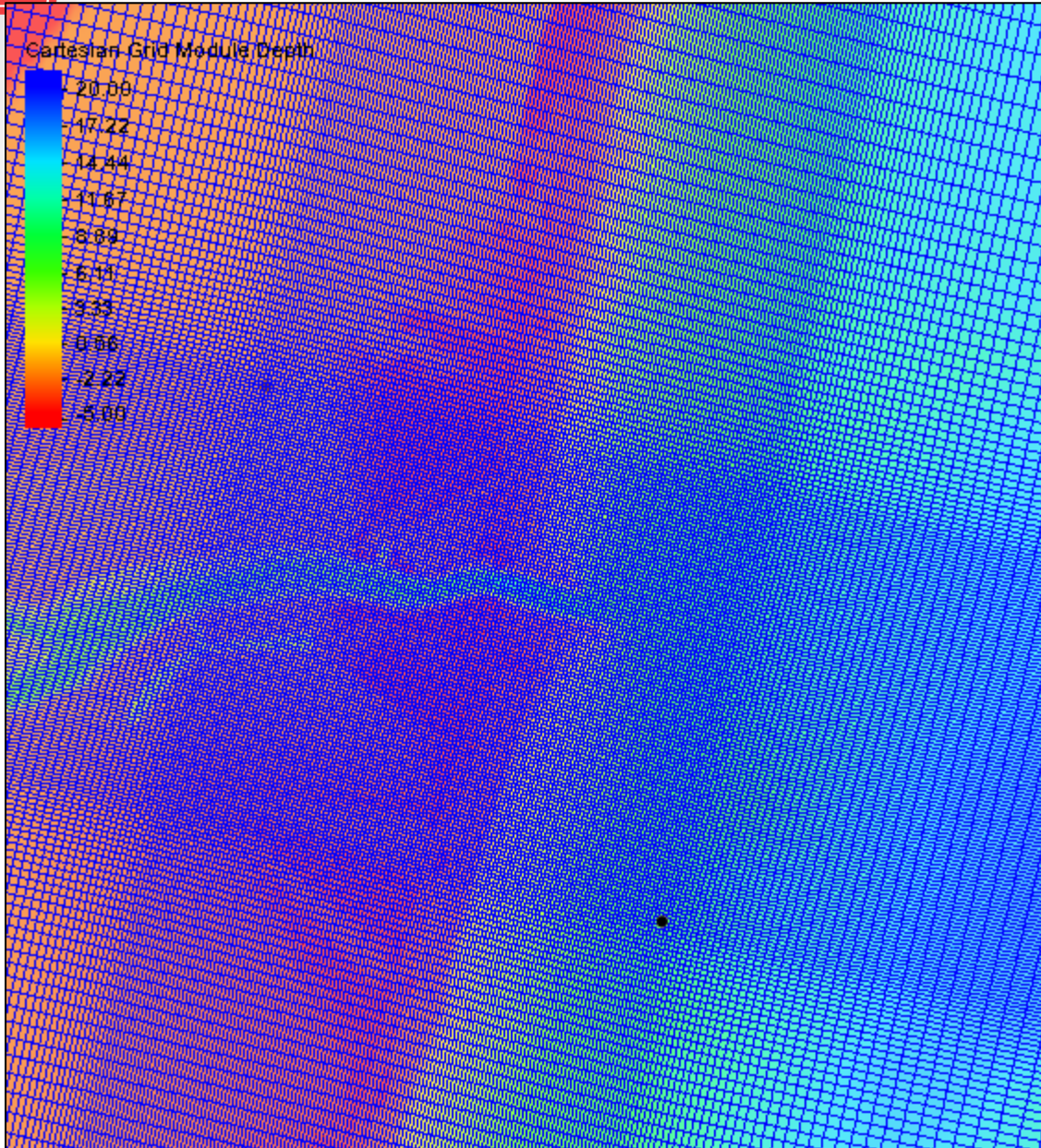
Help... OK Cancel

- Right-click on CMS-Wave coverage in data tree
- Convert | Map -> 2d Grid

- Use refine points
- Maximum cell size – the size of the largest cells away from refine points.
- Maximum bias – determines how fast the increase in cell size away from refine points.
- Use inner growth – Unchecked, keeps cell resolution small until the next/last refine point.



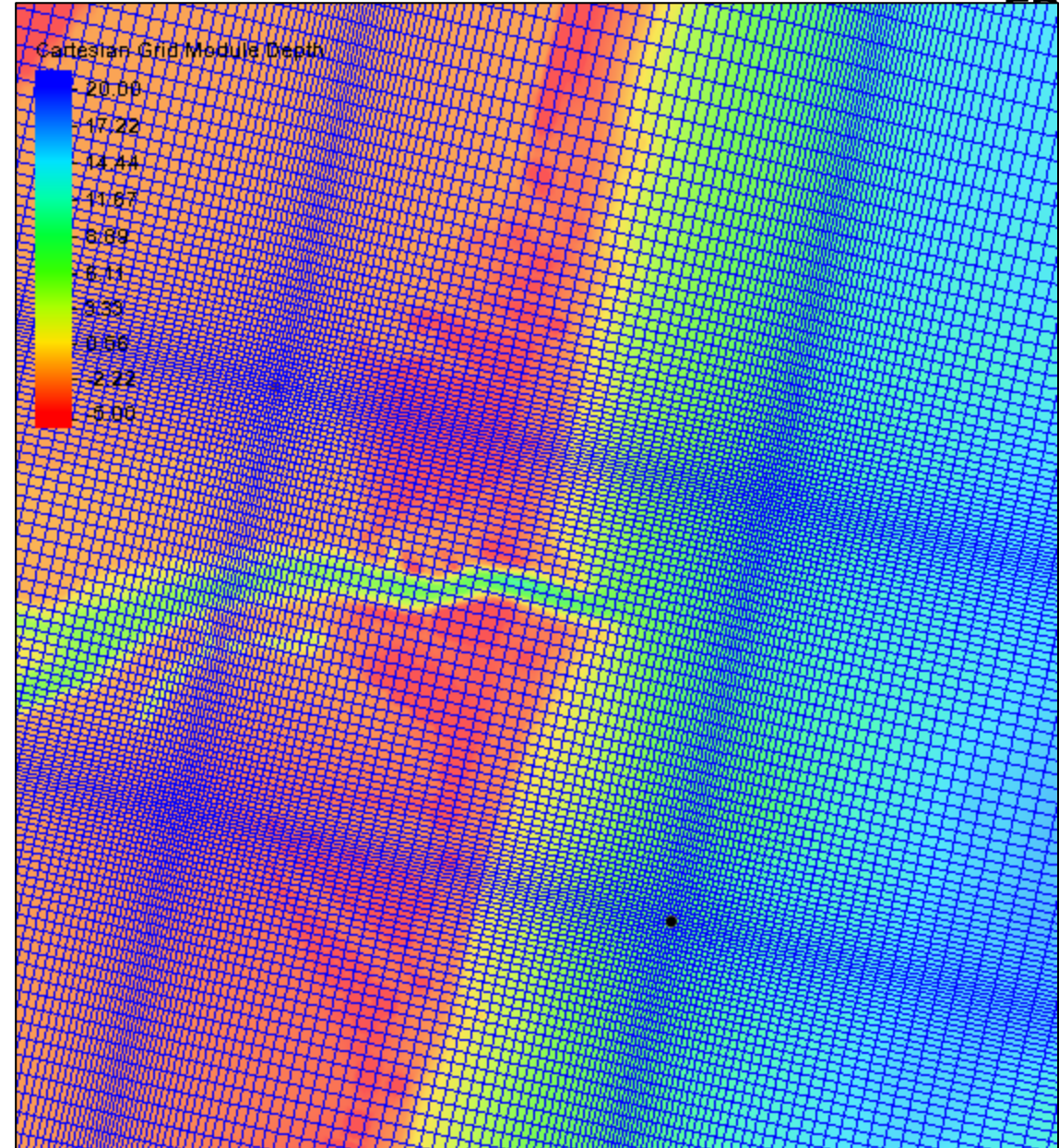
Inner Growth - *unchecked*



(192886.0, 150580.0, 14.014243125916) s: 14.0142431259

LASS

Inner Growth - *checked*



(193004.0, 149671.0, 15.735763549805) s: 15.7357635498



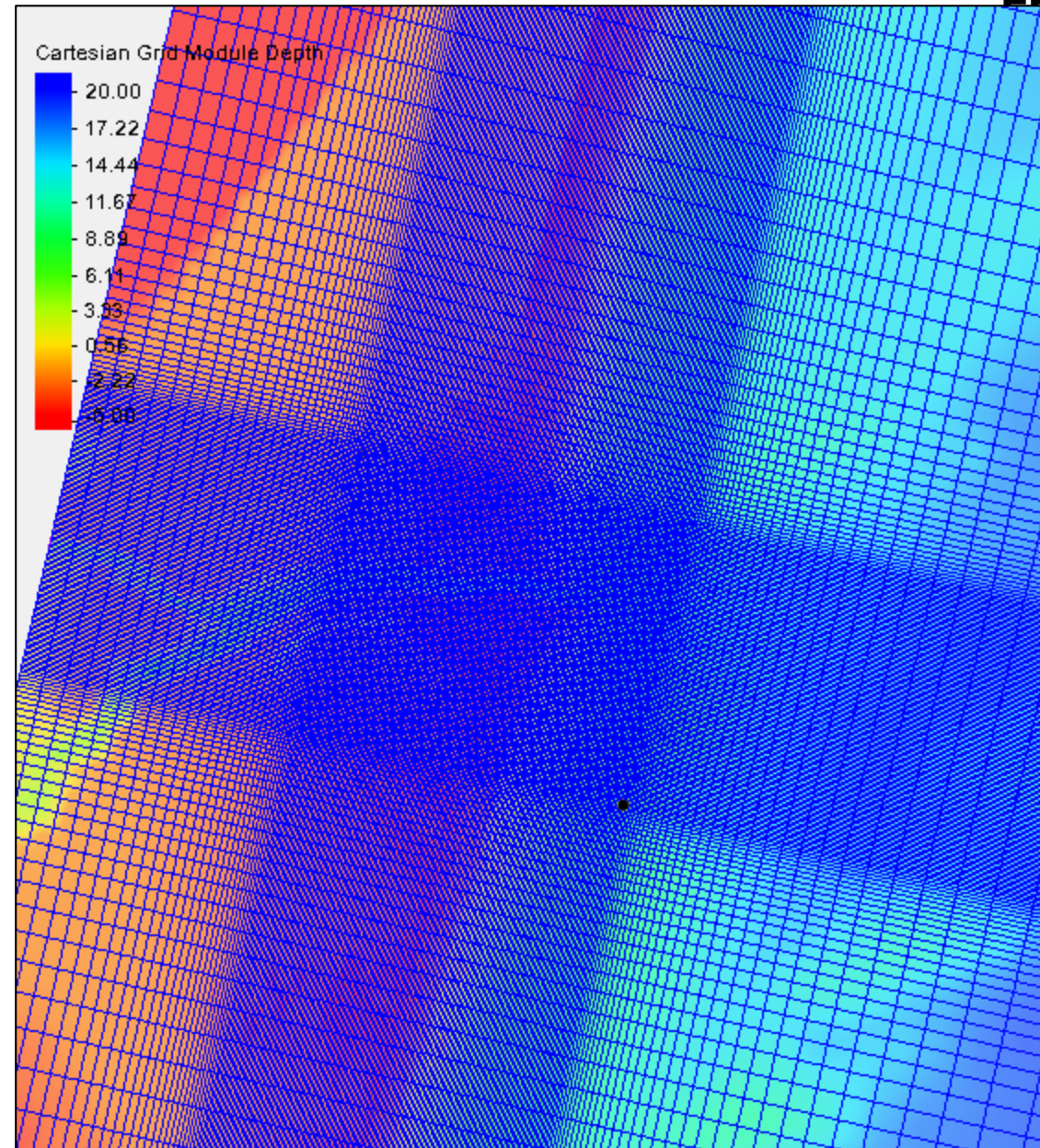
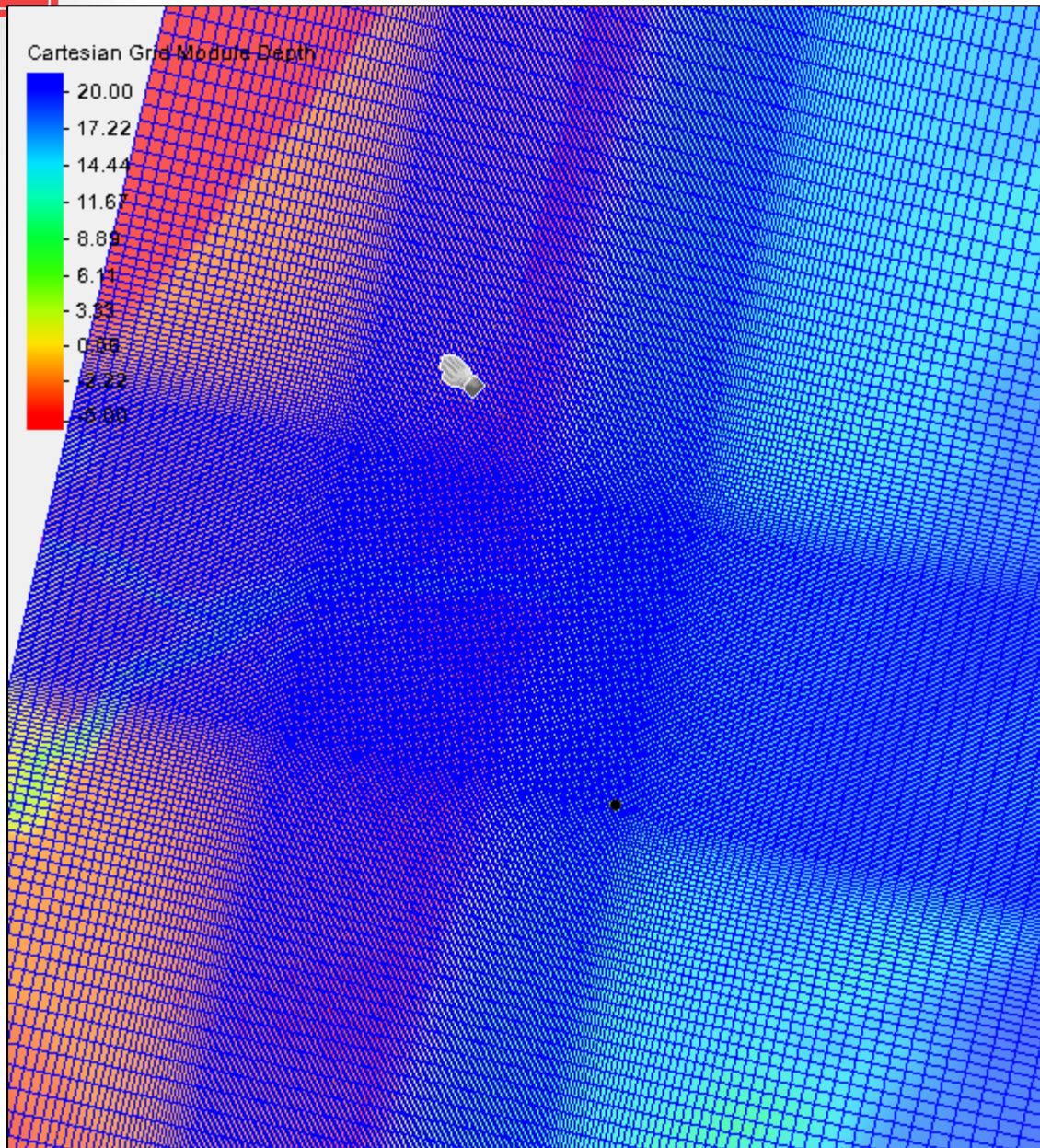


Bias – 1.05

Bias – 1.10

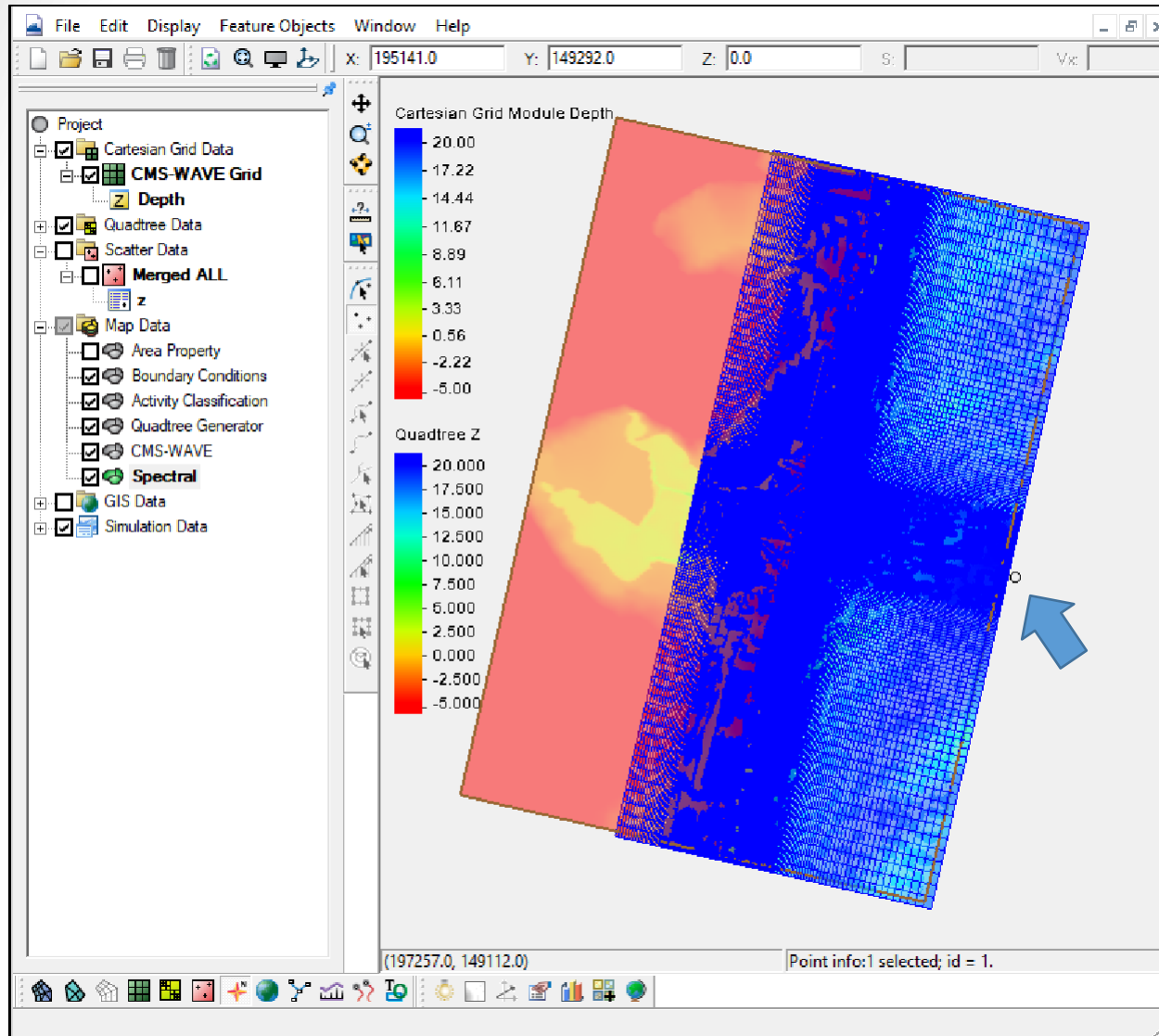


EDDC





SPECTRAL INPUT



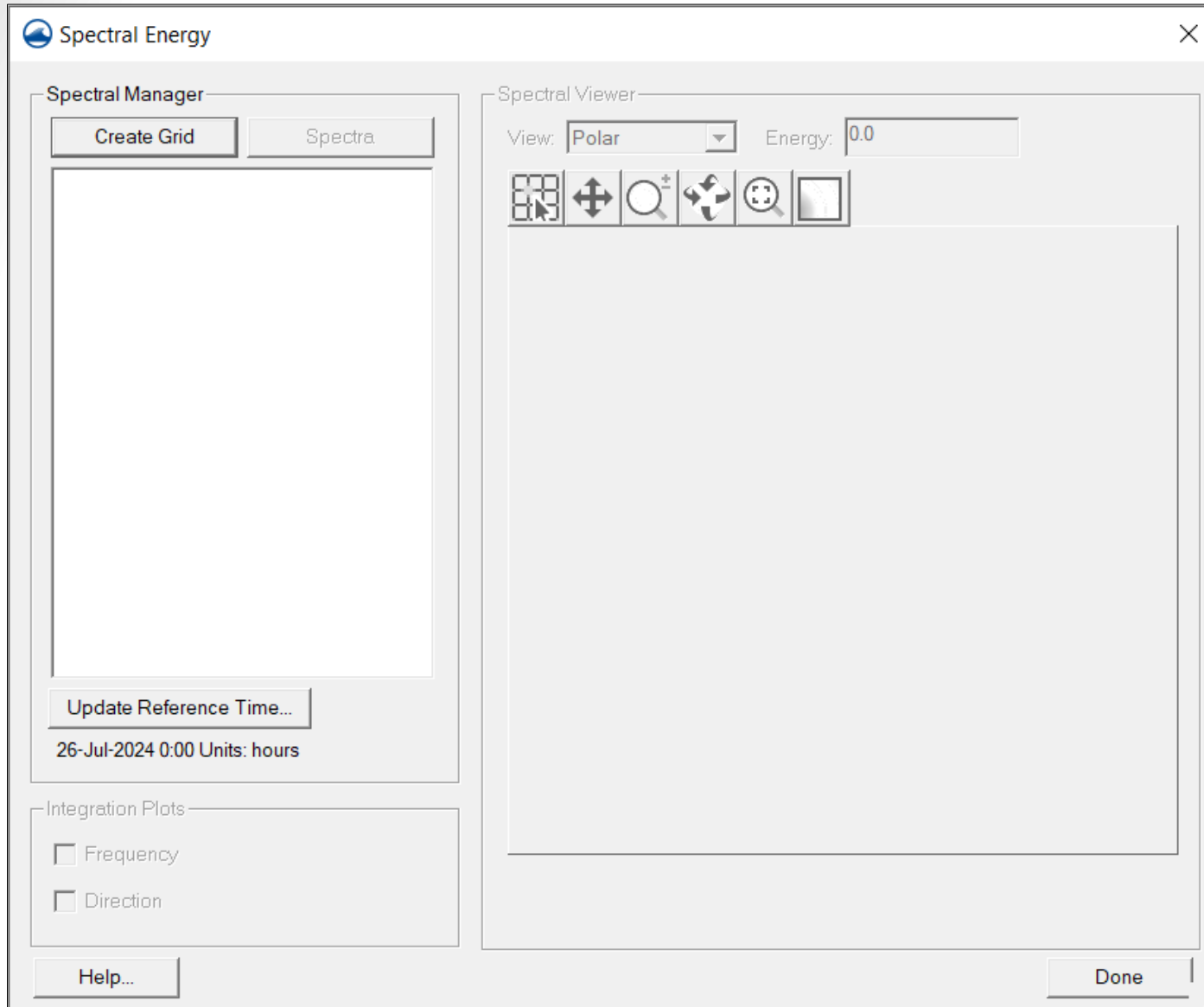
Project files saved at this point in
– Day4/2-afterWaveCreate folder

- Turn on display of Quadtree grid to see both

- Add Spectral Coverage to Map Module
 - Right-click on “Map Data”
 - New Coverage
 - Generic | Spectral
- Add Feature Point for spectral information (normally middle of offshore edge)



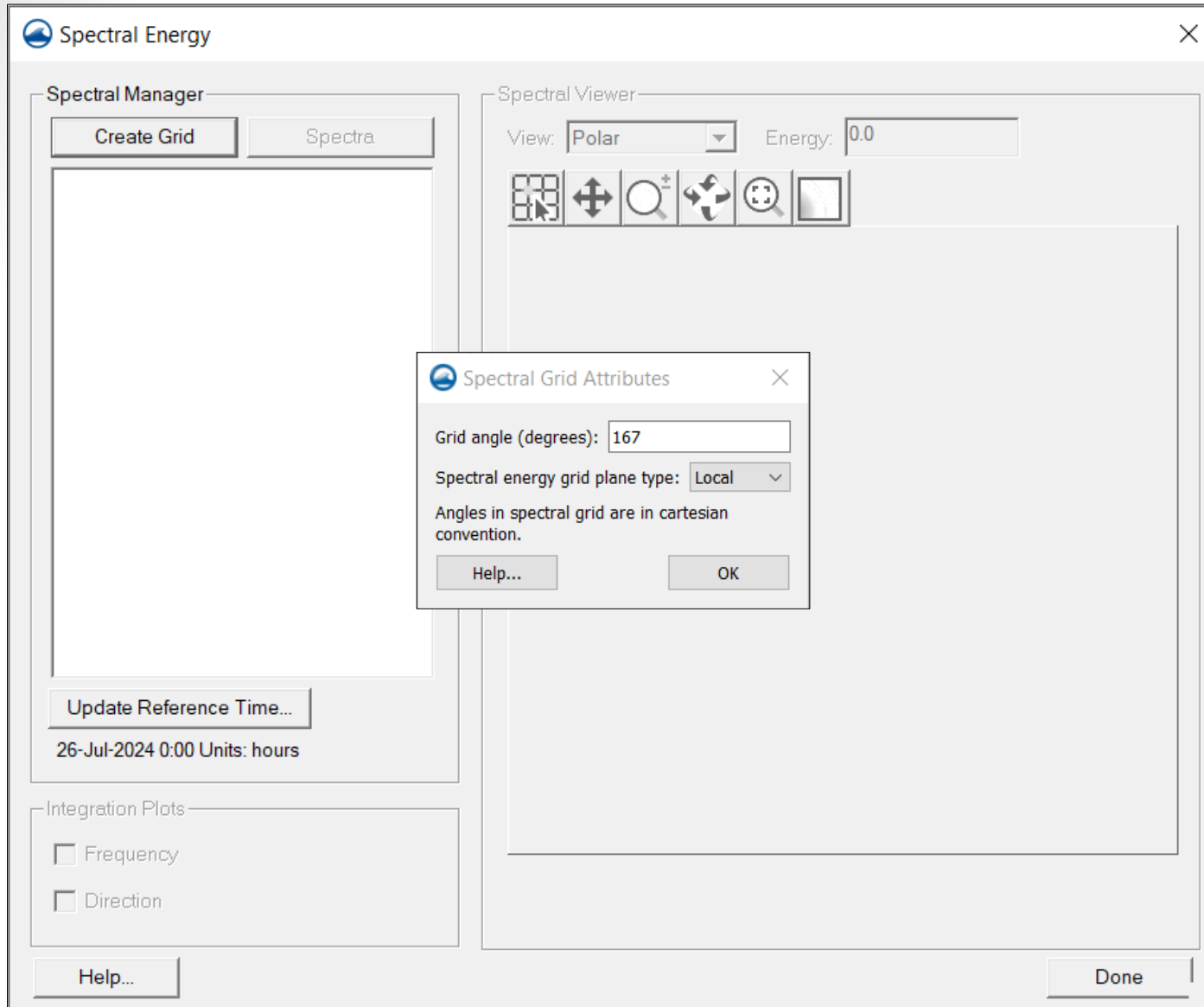
SIMPLE SPECTRAL INPUT



- Select point
- Right-click | Node Attributes
- Click Create Grid
 - Enter 167 degrees
 - Select “Local”
 - Click OK
- Click OK on Spectral Energy Grid dialog
- Define Spectral Energy Grid
 - Number bins (freq., dir.)
 - Set frequency bin ranges
 - Set direction bin ranges
 - Click OK



SIMPLE SPECTRAL INPUT



- Select point
- Right-click | Node Attributes
- Click Create Grid
 - Enter 167 degrees
 - Select “Local”
 - Click OK
- Click OK on Spectral Energy Grid dialog
- Define Spectral Energy Grid
 - Number bins (freq., dir.)
 - Set frequency bin ranges
 - Set direction bin ranges
 - Click OK



SIMPLE SPECTRAL INPUT



- Select point
- Right-click | Node Attributes
- Click Create Grid
 - Enter 167 degrees
 - Select “Local”
 - Click OK
- Click OK on Spectral Energy Grid dialog
- Define Spectral Energy Grid
 - Number bins (freq., dir.)
 - Set frequency bin ranges
 - Set direction bin ranges
 - Click OK



SPECTRAL INPUT FROM WAVE CHARACTERISTICS (CUT/PASTE OR HAND ENTRY)



Spectral Energy

Spectral Manager

Create Grid Spectra

Local-167.000

Update Reference Time...

26-Jul-2024 0:00 Units: hours

Integration Plots

Frequency

Direction

Help...

Spectral Viewer

View: Polar Energy: 0.0

0.33 Hz

0.04 Hz

Tracking: f = 0.567333; angle = 248.920590

Done

We need to enter the wave characteristic data to create a wave spectral grid.

- Click "Spectra"



SPECTRAL INPUT FROM WAVE CHARACTERISTICS (CUT/PASTE OR HAND ENTRY)



Generate Spectra

Parameter Settings

Generation Method: JONSWAP

By Specifying: Hs and Tp

Directional Spreading Distribution:

Wrapped Normal

Cosine Power

Seaward Boundary Depth:

Specify once for all spectra

20.0 m

Specify for each spectrum

Angle Settings

Projection: Shore Normal

Spectral Parameters

	Time Offset (hrs)/Index	Angle (deg)	Hs (m)	Tp (s)	Gamma	nn
1	0.0	20.0	3.0	8.0	3.3	4
2	3.0	20.0	3.5	9.0	3.3	4
3	6.0	20.0	4.0	10.0	3.3	4
4						

Import Import from GenCode Export Delete All Spectral Defaults >>

Help... Generate Cancel

We need to enter the wave characteristic data to create a wave spectral grid.

- Click "Spectra"

- Manually enter Wave Angle, Height, Period, and spectral defaults by hand entering or cut/paste from another location.
- Enter offshore grid depth



SPECTRAL INPUT FROM WAVE CHARACTERISTICS (CUT/PASTE OR HAND ENTRY)



Generate Spectra

Parameter Settings

Generation Method: JONSWAP

By Specifying: Hs and Tp

Directional Spreading Distribution:

Wrapped Normal

Cosine Power

Seaward Boundary Depth:

Specify once for all spectra

20.0 m

Specify for each spectrum

Angle Settings

Projection: Shore

Spectral Parameters

	Time Offset (hrs)/Index	Angle (deg)	Hs (m)	Tp (s)	Gamma	nn
1	0.0	20.0	3.0	8.0	3.3	4
2	3.0	20.0	3.5	9.0	3.3	4
3	6.0	20.0	4.0	10.0	3.3	4
4						

Import Import from GenCode Export Delete All

Help... Generate

Spectral Defaults

Double-click a row of values to update selected spreadsheet row(s):

Tp (s)	Gamma	nn
10	3.3	4
11	4.0	8
12	4.0	10
13	5.0	12
14	5.0	16
15	6.0	18
16	6.0	20
17	7.0	22
18	7.0	24
19	8.0	26

We need to enter the wave characteristic data to create a wave spectral grid.

- Click "Spectra"

- Manually enter Wave Angle, Height, Period, and spectral defaults by hand entering or cut/paste from another location.
- Enter offshore grid depth
- Enter Gamma and nn
 - See "Spectral Defaults"



SPECTRAL INPUT FROM WAVE CHARACTERISTICS (CUT/PASTE OR HAND ENTRY)



Spectral Energy

Spectral Manager

Create Grid Spectra

New grid

0.0000
3.0000
6.0000

Update Reference Time...
01-Jan-2013 0:00 Units: hours

Integration Plots

Frequency
 Direction

Help...

Spectral Viewer

View: Polar Energy: 0.0

Spectral Energy
Jonswap 0 - 6
0 00:00:00

24.0
18.0
12.0
6.0
0.0

0.45 Hz
0.06 Hz

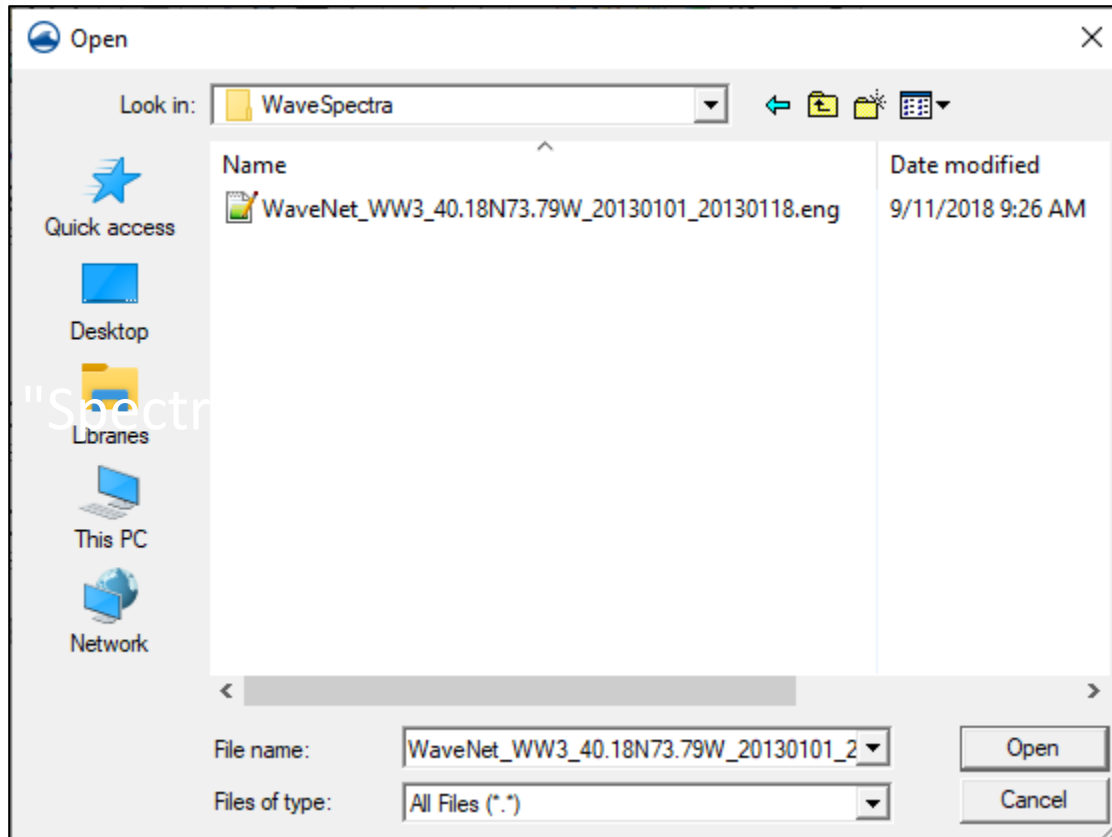
Done

We need to enter the wave characteristic data to create a wave spectral grid.

- Update Reference Time



SPECTRAL INPUT FROM GAUGE



There are tools to take information from gauges and buoys (CDIP/WW3/NDBC) and put in correct CMS-Wave format. We will discuss some of these in an Advanced Webinar.

- On the main screen, choose File | Open from the pull-down menus.
- Go to the “WaveSpectra” folder underneath Day 4.
- Select the “WaveNet...” file and Open.



SPECTRAL INPUT FROM GAUGE



Spectra Grid Info - Process ID: 28764

Spectra Location X:
0.0

Spectra Location y:
0.0

Grid Orientation Angle (CCW from East):
0.0

OK

Spectra Grid Info - Process ID: 4456

Spectra Location X:
195221.0

Spectra Location y:
149704.0

Grid Orientation Angle (CCW from East):
176.0

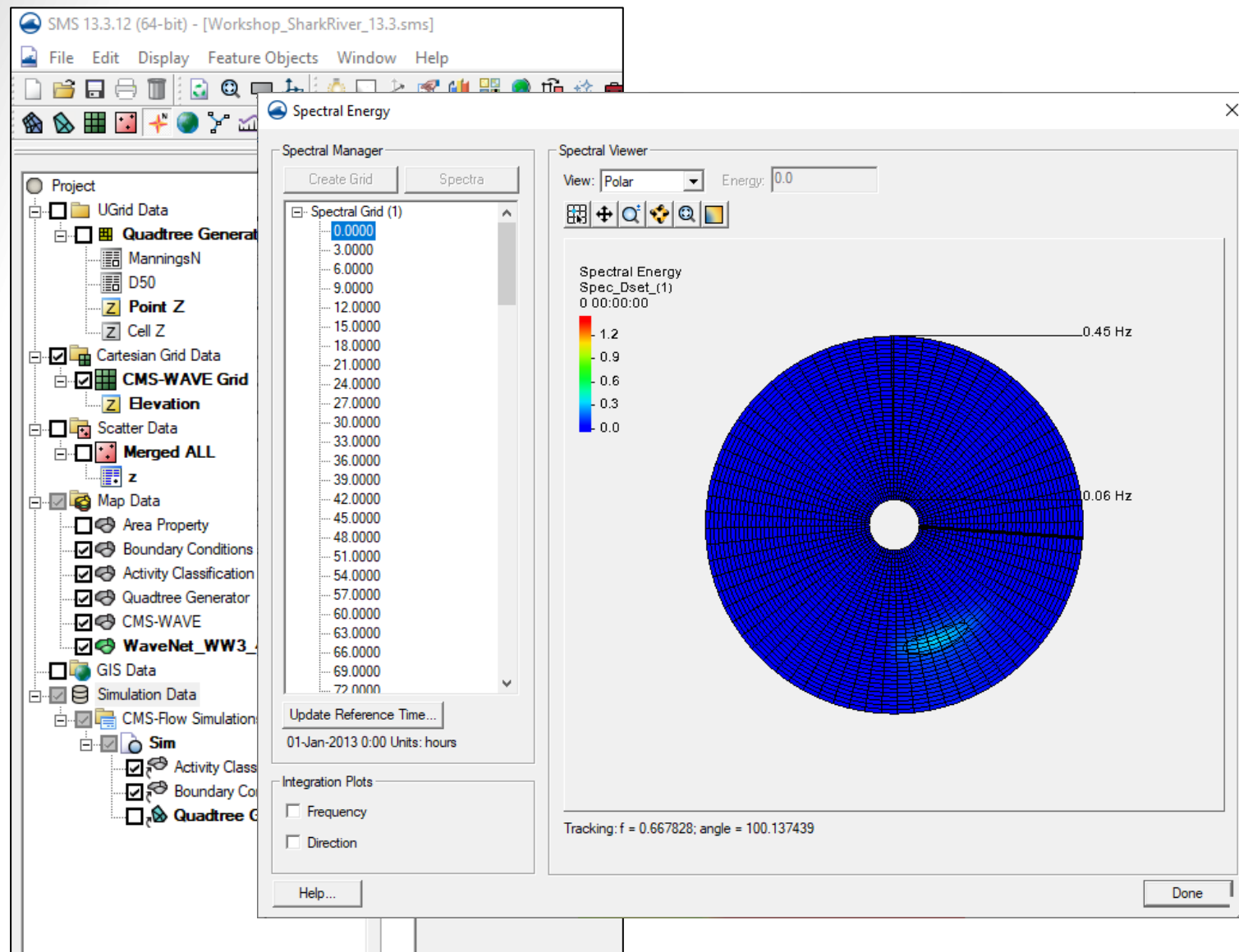
OK Cancel Help

There are tools to take information from gauges and buoys (CDIP/WW3/NDBC) and put in correct CMS-Wave format. We will discuss some of these in an Advanced Webinar.

- Enter the X/Y coordinates for the location of the Spectral Forcing (195221,149704)
- Enter the Grid Angle (176)
- Click OK



SPECTRAL INPUT FROM GAUGE

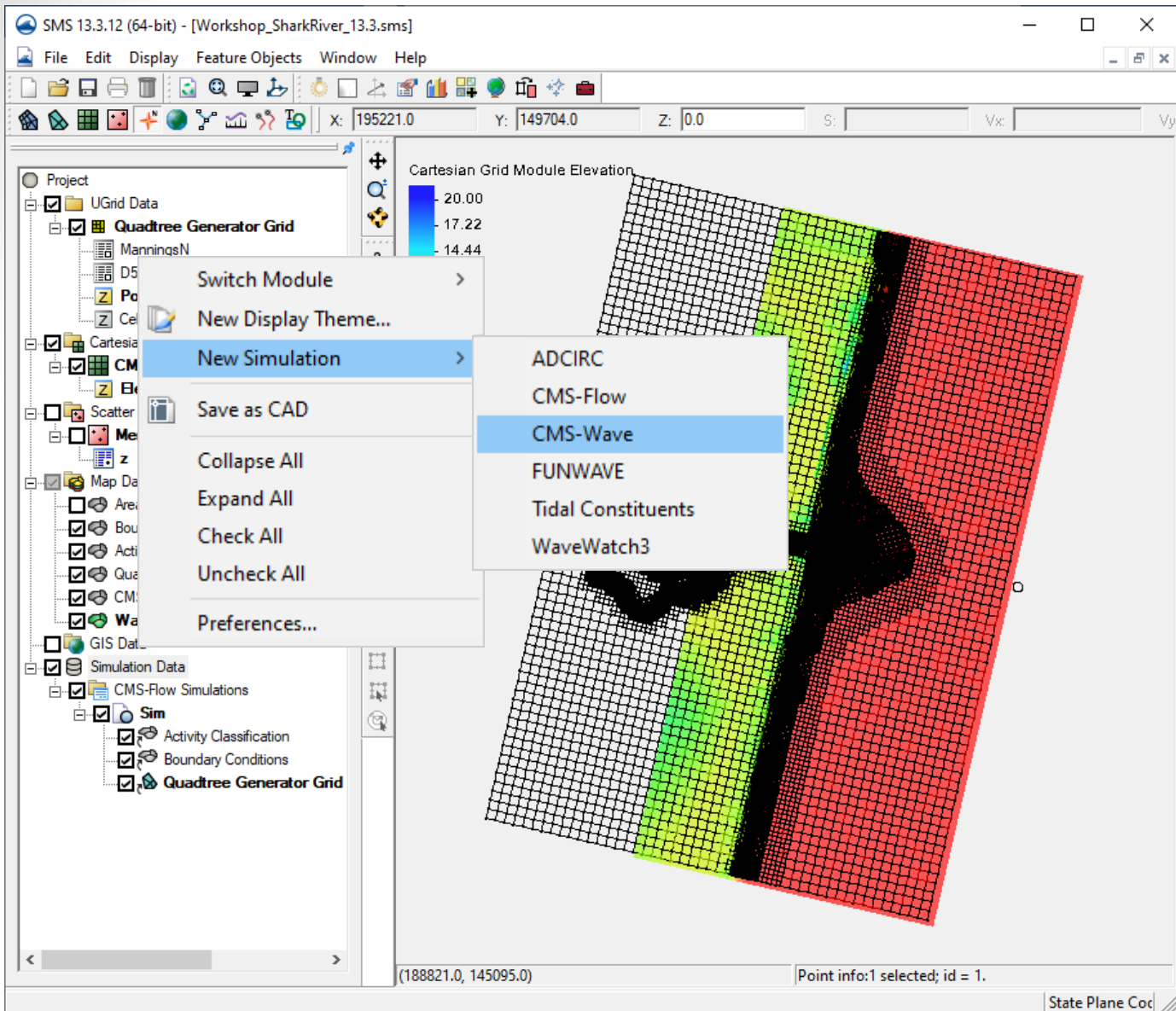


There are tools to take information from gauges and buoys (CDIP/WW3/NDBC) and put in correct CMS-Wave format. We will discuss some of these in an Advanced Webinar.

- A new coverage is created.
- Double-click the spectra point and open the spectral dialog.
- All times and spectra from the file are added to a new spectral grid.
- The reference time should already be set.



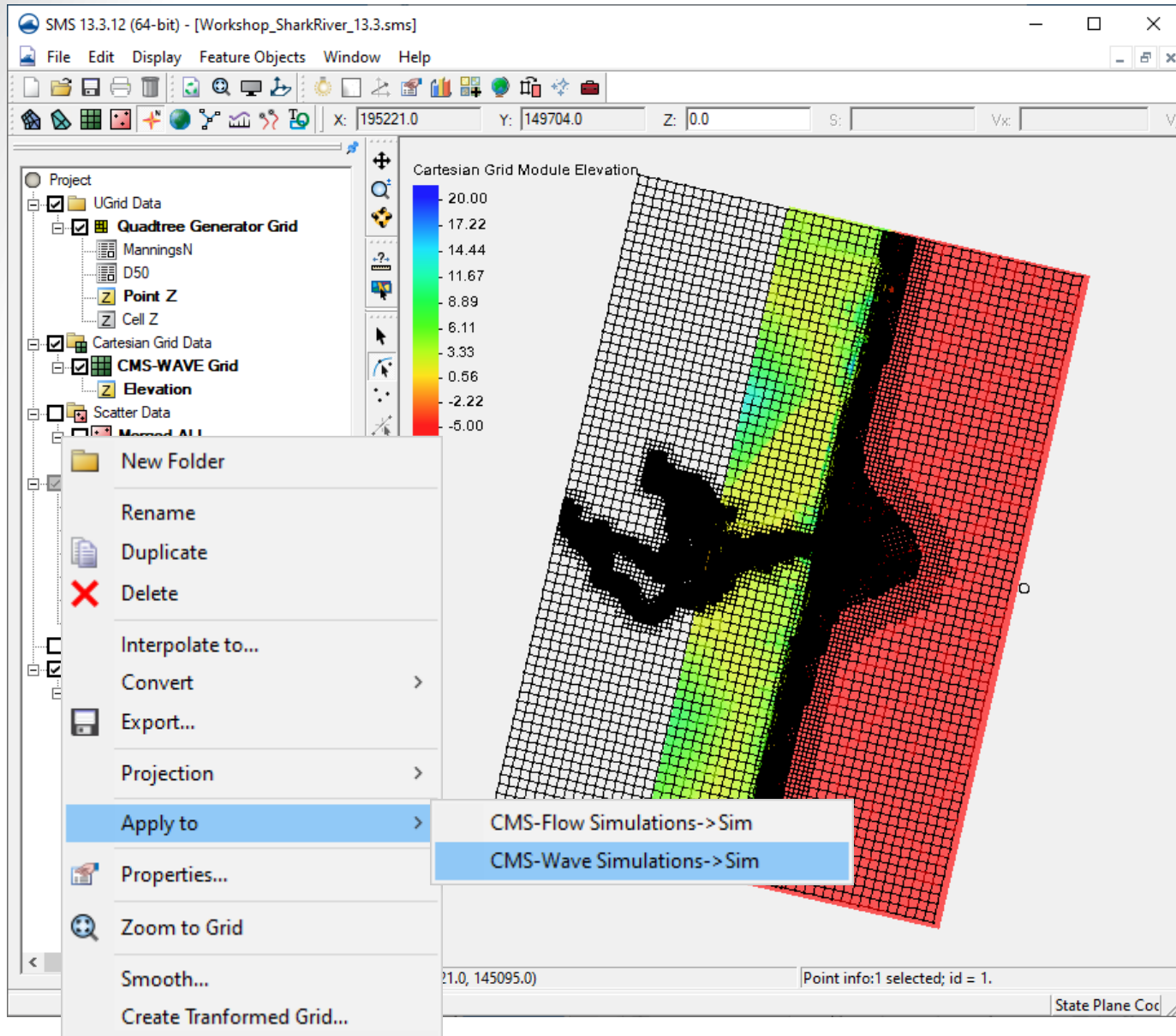
CREATE CMS-WAVE SIMULATION



- Right click in open area in Data Tree and choose “New Simulation” | “CMS-Wave”



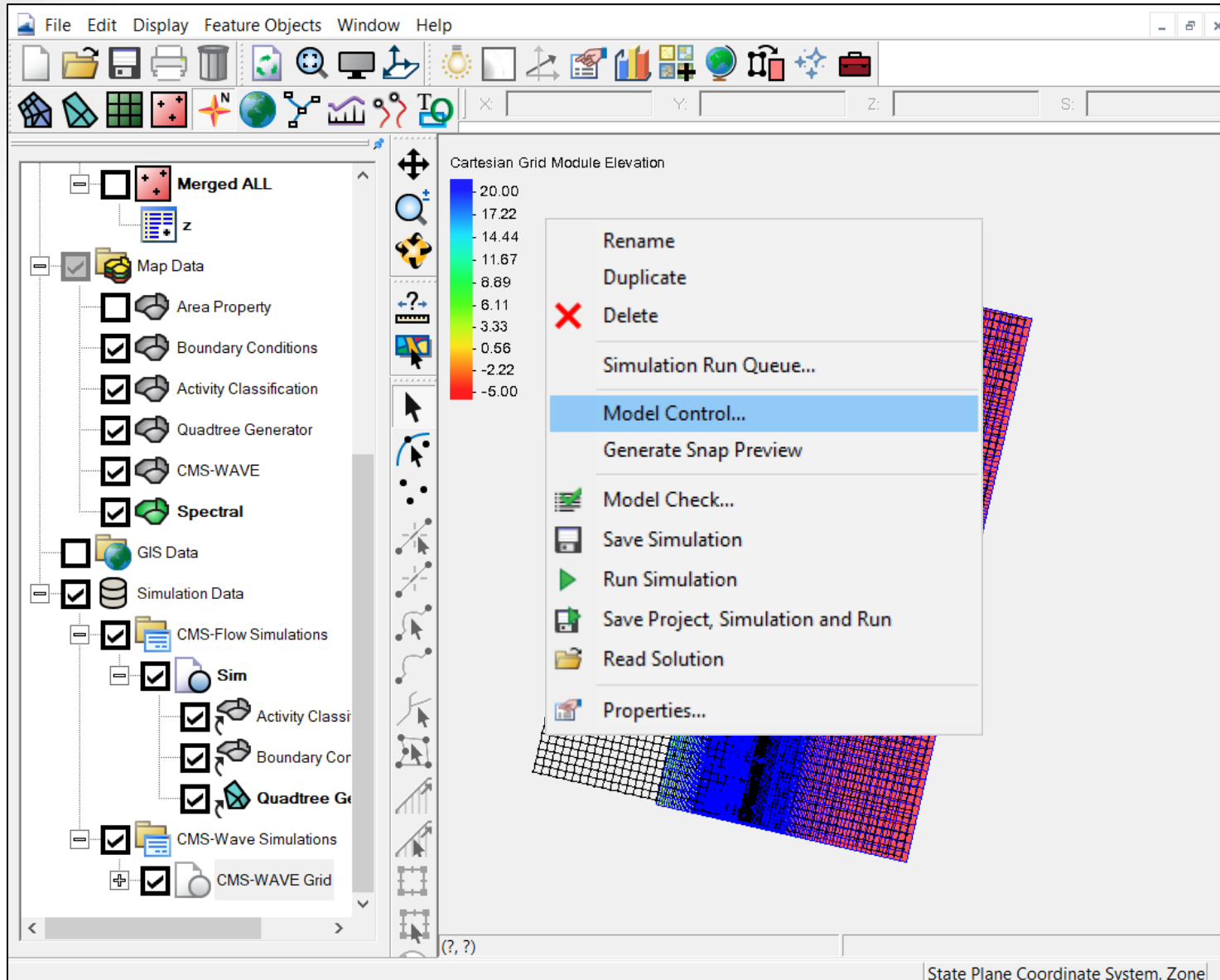
CREATE CMS-WAVE SIMULATION



- Right click in open area in Data Tree and choose “New Simulation” | “CMS-Wave”
- Right click on CMS-Wave Grid and choose “Apply to”, then “CMS-Wave Simulations → Sim”



CMS-WAVE MODEL CONTROL



- Right click on CMS-Wave Simulations → CMS-Wave Grid
- CMS-WAVE menu option appears
- Choose Model Control



CMS-WAVE MODEL CONTROL



The screenshot shows the 'Model Control' software interface. The 'Boundary control' tab is selected. The 'Grid Preview' window displays a 'CMS-WAVE Grid' with four sides labeled Side 1, Side 2, Side 3, and Side 4. A dialog box titled 'Select Spectral Coverage for Side 1' is open, showing a tree view with 'Map Data' and 'Spectral' options. The main interface includes sections for 'Parameters', 'Computational spectral grid', 'Sides', and 'Case data'.

- Right click on CMS-Wave Simulations → CMS-Wave Grid
- CMS-WAVE menu option appears
- Choose Model Control
- Boundary control tab
 - Side 1 – open boundary (always!)
 - Specified spectrum, Select...



CMS-WAVE MODEL CONTROL



The screenshot shows the 'Model Control' window with the 'Boundary control' tab selected. The 'Grid Preview' window displays a 'CMS-WAVE Grid' with four sides labeled Side 1, Side 2, Side 3, and Side 4. A dialog box titled 'Select Spectral Coverage for Side 1' is open, showing a tree view with 'Map Data' expanded and 'Spectral' checked. The main interface includes sections for 'Parameters', 'Computational spectral grid', 'Sides', and 'Case data'.

Parameters

- Source: Spectral coverage
- Interpolation: IDW

Computational spectral grid

Frequency distribution		Angle distribution	
Number:	30		35
Delta:	0.01	Hz	5.0°
Minimum:	0.04	Hz	-85.0°

Sides

- Side 1: Specified spectrum (Select... (none selected))
- Side 2: (none selected)
- Side 3: Zero spectrum
- Side 4: (none selected)

Case data

- Shore normal
- Wind direction angle convention
- Populate from Spectra (Populate)
- 5/9/2019 12:00:00 AM Units: hours (Set Reference Time)

Grid Preview

CMS-WAVE Grid

156000

Side 2

Side 1

Side 4

200019400019600

Select Spectral Coverage for Side 1

- Map Data
 - Spectral

OK Cancel

OK Cancel Help

- Right click on CMS-Wave Simulations → CMS-Wave Grid
- CMS-WAVE menu option appears
- Choose Model Control
- Boundary control tab
 - Side 1 – open boundary (always!)
 - Specified spectrum, Select...
 - Check box for Spectral map coverage



CMS-WAVE MODEL CONTROL



Model Control

Parameters | Boundary control | Output control | Options

Source: Spectral coverage

Interpolation: IDW

Computational spectral grid

Frequency distribution		Angle distribution	
Number:	30		35
Delta:	0.01	Hz	5.0°
Minimum:	0.04	Hz	-85.0°

Sides

Side 1: Specified spectrum Spectral

Side 2: Open lateral boundary

Side 3: Zero spectrum

Side 4: Open lateral boundary

Case data

Shore normal

1/1/2013 12:00:00 AM Units: hours

Grid Preview

CMS-WAVE Grid

Time | Wind Magnitude | Wind Direction

OK Cancel Help

- Right click on CMS-Wave Simulations → CMS-Wave Grid
- CMS-WAVE menu option appears
- Choose Model Control
- Boundary control tab
 - Side 1 – open boundary (always!)
 - Specified spectrum, Select...
 - Check box for Spectral map coverage
 - Set Reference Time (01/01/2013)



CMS-WAVE MODEL CONTROL



Model Control

Parameters Boundary control Output control Options

CMSWAVE plane mode: Half plane

Source terms: Source terms and propagation

Current interaction: None

Bottom friction: Manning constant 0.025

Surge fields: None

Wind fields: Constant value

Limit wave inflation for winds ≥ 50 m/sec

Matrix Solver: Gauss-Seidel Number of threads: 1

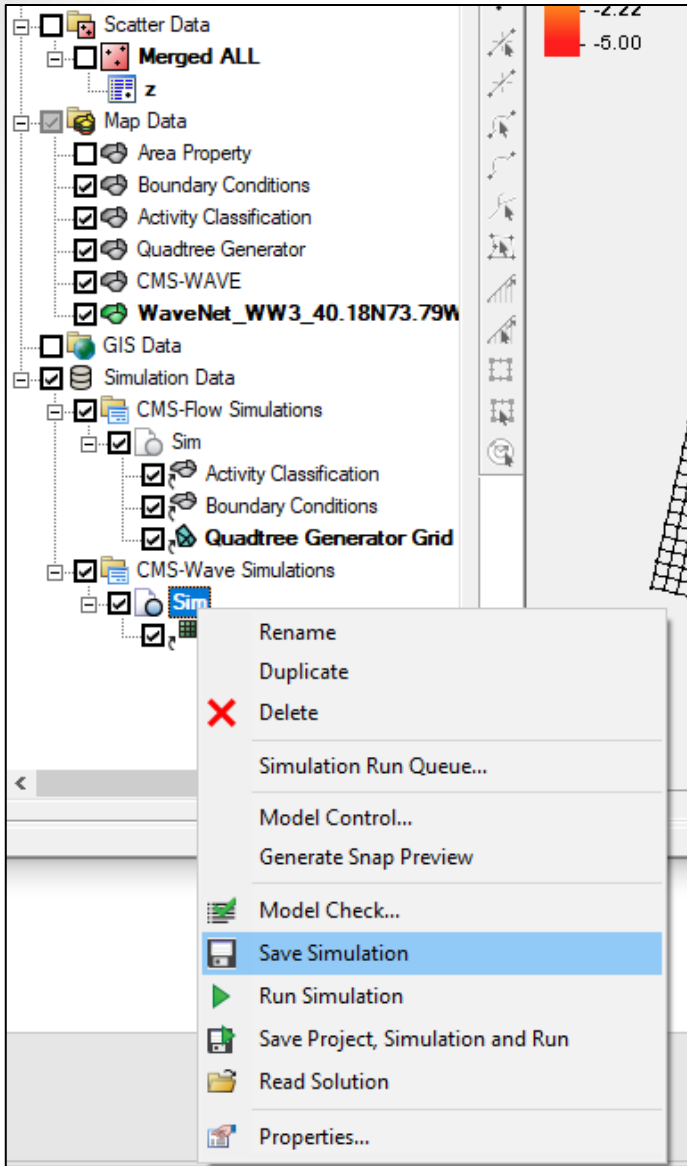
OK Cancel Help

Modify options in Model Control as desired

- Bottom Friction type/value
- Wave breaking type
- Fast mode ON | OFF
- Extra output datasets
- Number of threads (processors)
- Wetting/Drying
- Runup
- ...
- Click OK



CMS-WAVE MODEL RUN



Save Project

Right click on “Sim” under wave simulations.

- Save Simulation, then
- Run Simulation

Or

- Save Project, Simulation, and Run



CMS-WAVE MODEL RUN



Simulation Run Queue

Maximum number of concurrent processes allowed: 4

Process Name	Progress	Abort	Remove
▼ CMS-W...	0%	Abort	Remove
> CM...	0%		

Monitoring data

Monitoring data for simulation: CMS-WAVE Grid

Command line

```

Column 50
Average wave height = 0.2459
Column 51
Average wave height = 0.2454
Column 52
Average wave height = 0.2450
Column 53
Average wave height = 0.2445
Column 54
Average wave height = 0.2441
Column 55
Average wave height = 0.2436
  
```

Help... Close

Save Project

Right click on “Sim” under wave simulations.

- Save Simulation, then
- Run Simulation

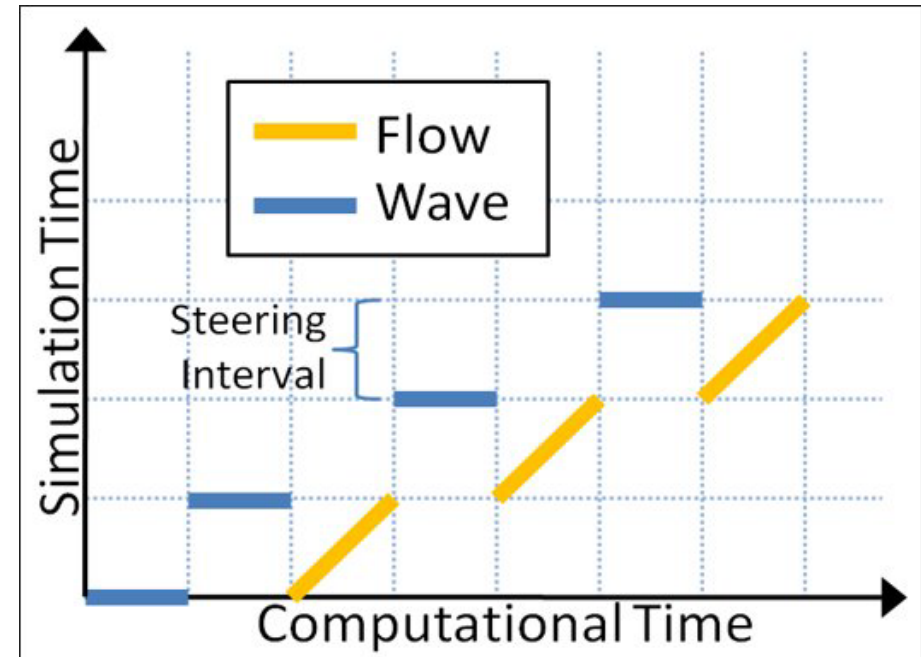
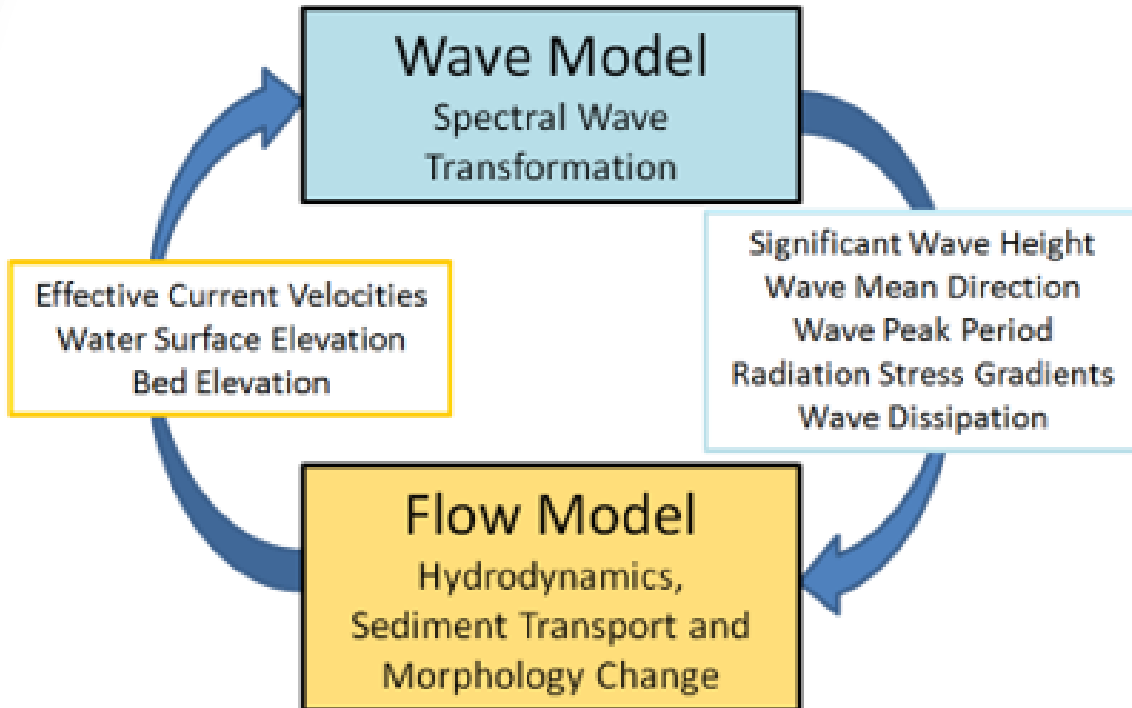
Or

- Save Project, Simulation, and Run

COUPLED FLOW & WAVE: INLINE STEERING



Inline steering – wave-induced currents and radiation stress gradients *steer* flow towards updated solution



Adjustments to future water levels made with astronomical tide estimates to reduce the effect of a time lag in response.

COUPLED FLOW & WAVE: INLINE STEERING



CMS-Flow Model Control

General Flow Sediment Transport Salinity/Temperature **Wave** Wind Output

Start date/time: 1/1/2001 12:00 AM

Simulation duration: 744.0 hours

Ramp duration: 24.0 hours

Second order skewness correction

Hot start

Initial conditions file File

Write single hot start output file

Single hot start time to write out: 48.0 hours

Write recurring hot start file

Auto hot start output interval: 0.5 hours

NOTE: Single Hot Start and Recurring Hot Start are different files

Solution scheme

Implicit

Matrix solver: GMRES

Threads

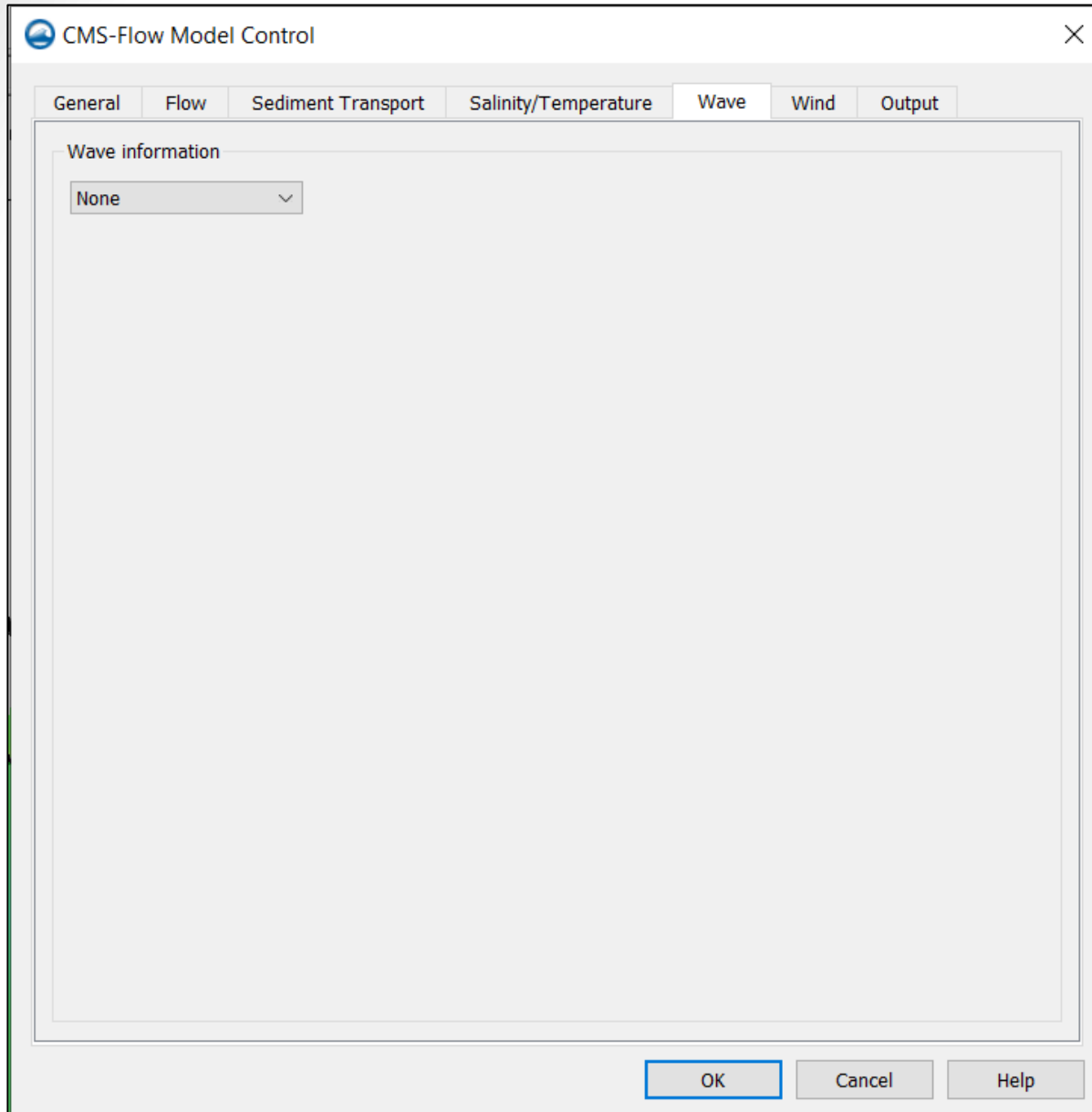
Number of threads: 4

OK Cancel Help

Steering control in CMS-Flow model control

- Open Wave tab

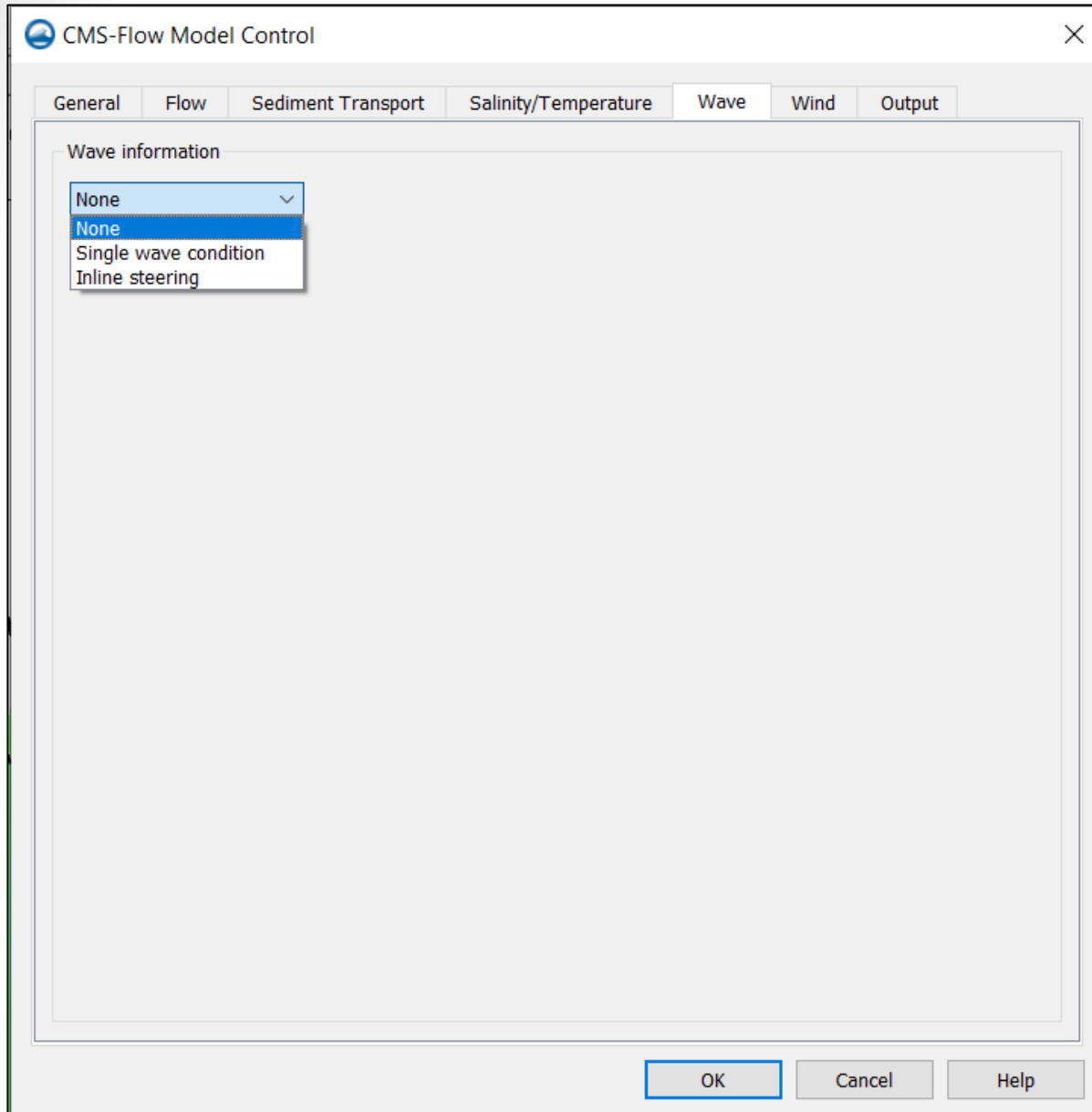
COUPLED FLOW & WAVE: INLINE STEERING



Steering control in CMS-Flow model control

- Open Wave tab
- Select drop-down menu...

COUPLED FLOW & WAVE: INLINE STEERING



Steering control in CMS-Flow model control

- Open Wave tab
- Select drop-down menu...

COUPLED FLOW & WAVE: INLINE STEERING



CMS-Flow Model Control

General Flow Sediment Transport Salinity/Temperature **Wave** Wind Output

Wave information

Single wave condition ▾

Significant wave height: Dataset (none selected)

Peak wave period: Dataset (none selected)

Mean wave direction: Dataset (none selected)

Wave breaking dissipation: Dataset (none selected)

Wave radiation stress gradients (m^3/s^2): Dataset (none selected)

OK Cancel Help

Potentially useful to look at single-point events (e.g., total water level at high tide), but generally not recommended.

Steering control in CMS-Flow model control

- Open Wave tab
- Select drop-down menu...
 - Single wave condition

COUPLED FLOW & WAVE: INLINE STEERING



CMS-Flow Model Control

General Flow Sediment Transport Salinity/Temperature **Wave** Wind Output

Wave information

Inline steering ▾

CMS-Wave file: File

Steering interval: 0.0 hrs

Wave water level prediction: Tidal plus variation ▾

Extrapolation distances

Flow to wave: User specified ▾ 0.0 m ▾

Wave to flow: User specified ▾ 0.0 m ▾

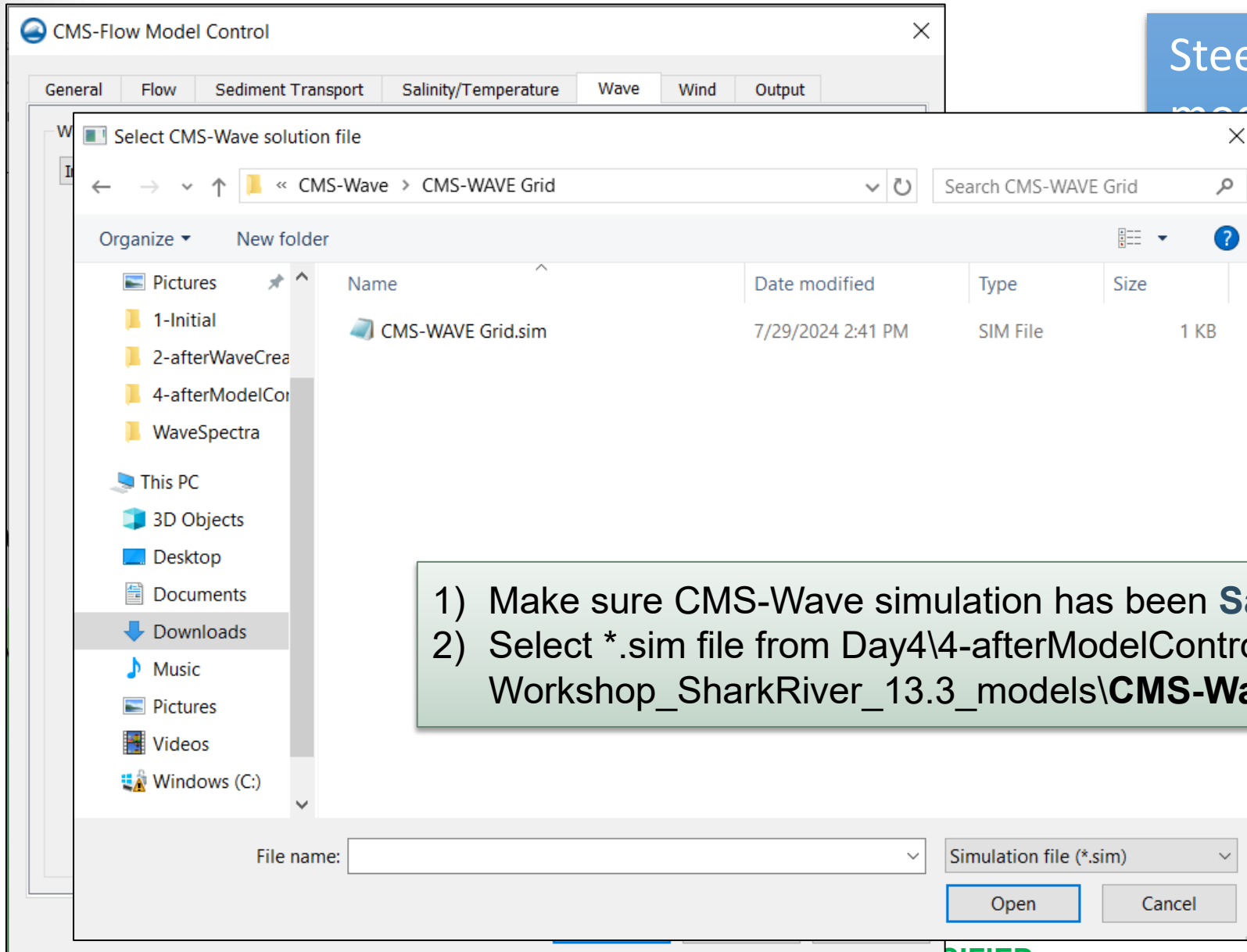
OK Cancel Help

Steering control in CMS-Flow model control

- Open Wave tab
- Select drop-down menu...
 - Single wave condition
 - Inline steering

- Select CMS-Wave file (*.sim)

COUPLED FLOW & WAVE: INLINE STEERING



Steering control in CMS-Flow
model control

Open Wave tab

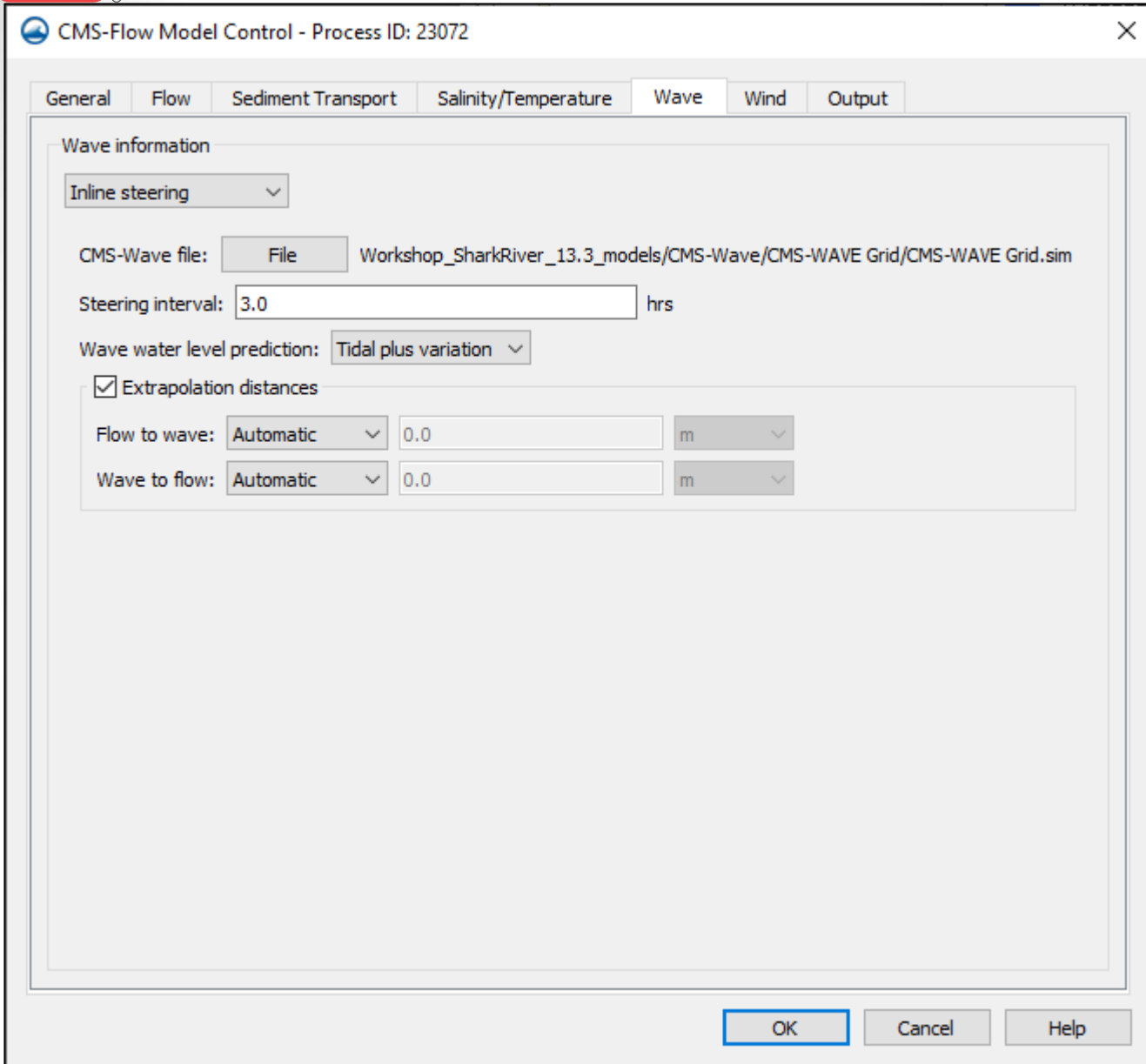
Select drop-down menu...

Single wave condition
Inline steering

- 1) Make sure CMS-Wave simulation has been **Saved (exported)**
- 2) Select *.sim file from Day4\4-afterModelControl\
Workshop_SharkRiver_13.3_models\CMS-Wave\CMS-WAVE Grid\

Select CMS-Wave file (*.sim)

COUPLED FLOW & WAVE: INLINE STEERING



CMS-Flow Model Control - Process ID: 23072

General Flow Sediment Transport Salinity/Temperature **Wave** Wind Output

Wave information

Inline steering ▾

CMS-Wave file: File Workshop_SharkRiver_13.3_models/CMS-Wave/CMS-WAVE Grid/CMS-WAVE Grid.sim

Steering interval: 3.0 hrs

Wave water level prediction: Tidal plus variation ▾

Extrapolation distances

Flow to wave: Automatic ▾ 0.0 m ▾

Wave to flow: Automatic ▾ 0.0 m ▾

OK Cancel Help

Steering control in CMS-Flow model control

- Open Wave tab
- Select drop-down menu...
 - Single wave condition
 - Inline steering

- Select CMS-Wave file (*.sim)
- Define steering interval (frequency of information exchange)
- Always set extrapolation distance from User specified to Automatic if you are not entering a good value for distance.

QUESTIONS?

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