

Wave-Model

Yakutat Case

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Day 3

Wave energy converter modeling



Develop Yakutat Wave Model

- This tutorial will go over how to add WECs to the Yakutat, Alaska wave model

Adding WECs

- › Add obstacles
- › Setup

Load Yakutat Wave Model

› Load the previously created Yakutat wave model.

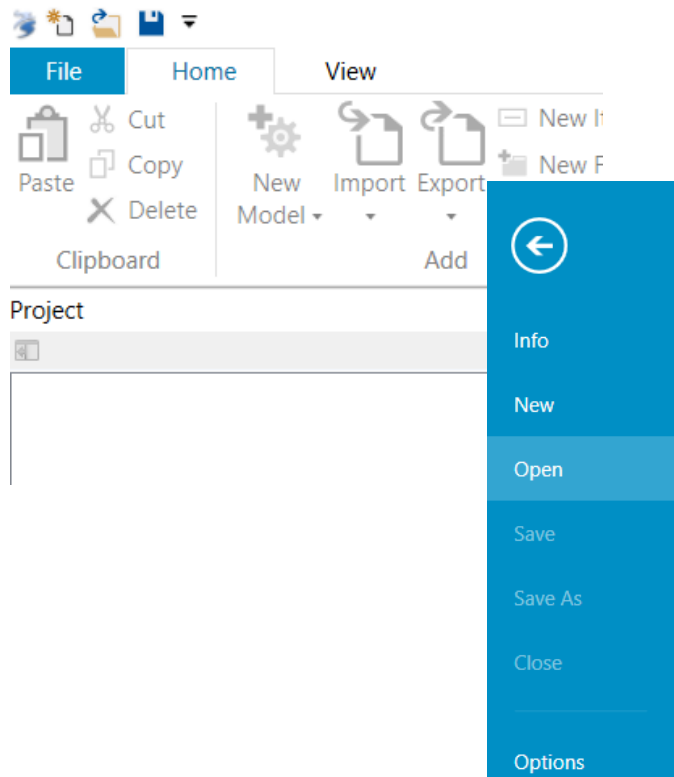
1. Open Delft3D FM Suite 2024.01 HMWQ

2. Click File

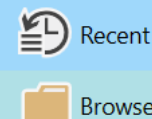
3. Click Open

4. Browse

Locate the File or load
Demos/yakutat_nowecs_utm.ds
proj

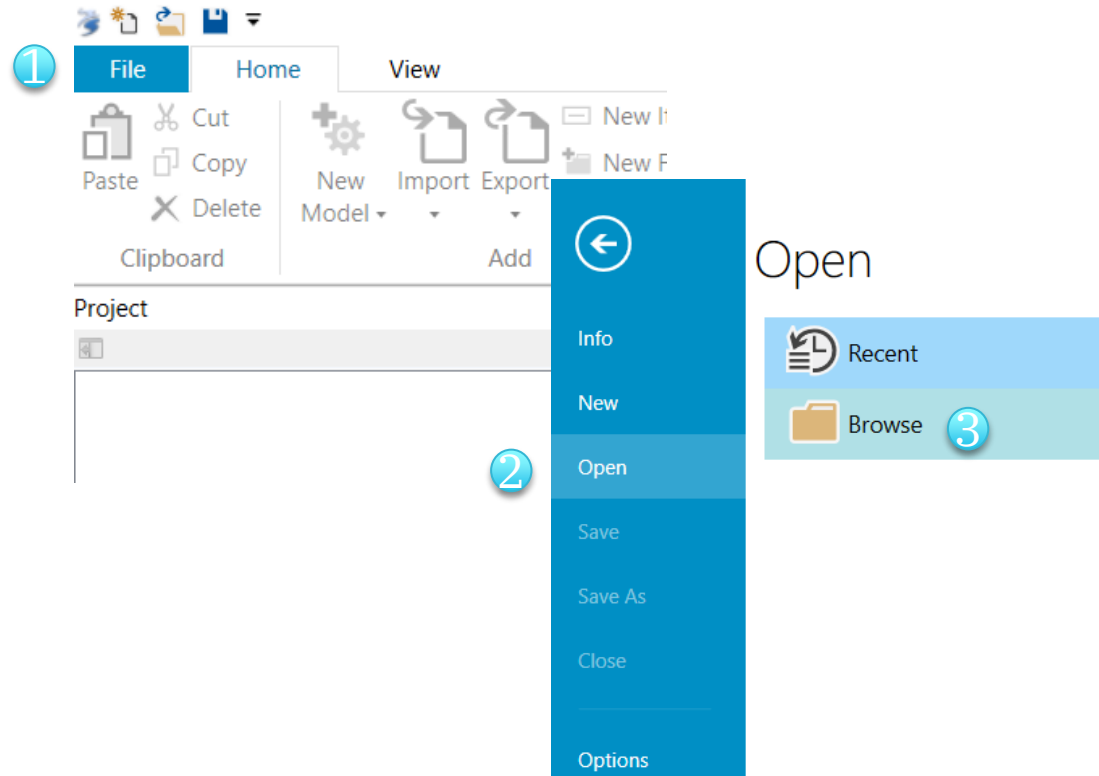


Open



Save Yakutat Wave Model with WECS

1. Click File
2. Save As
3. Save as
yakutat_wecs_utm.dsproj

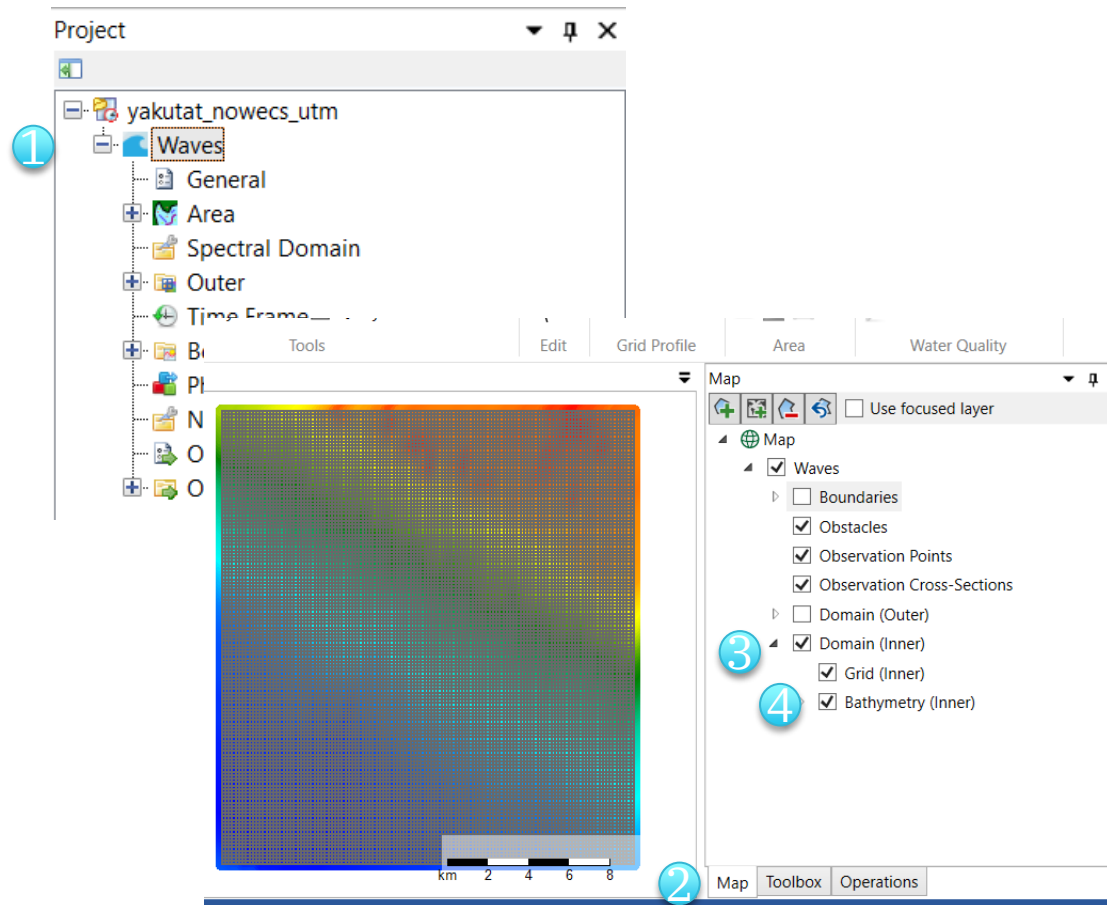


Add WECs



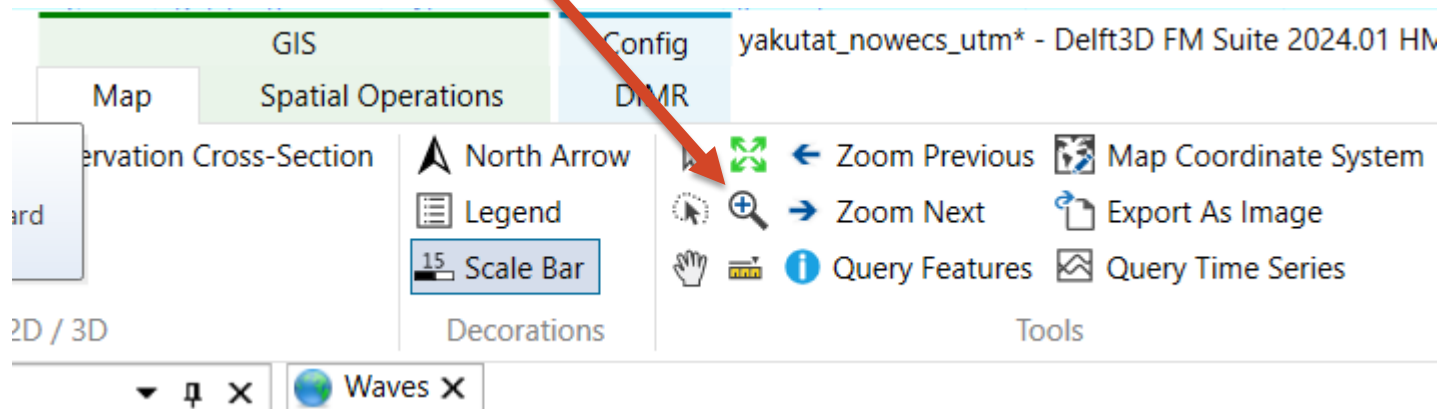
Add Obstacles

1. Double Click on Waves to open the model window.
2. Click on the Maps Panel
3. Select the Domain (Inner) and expand.
4. Select Grid (Inner) and Bathymetry (Inner)



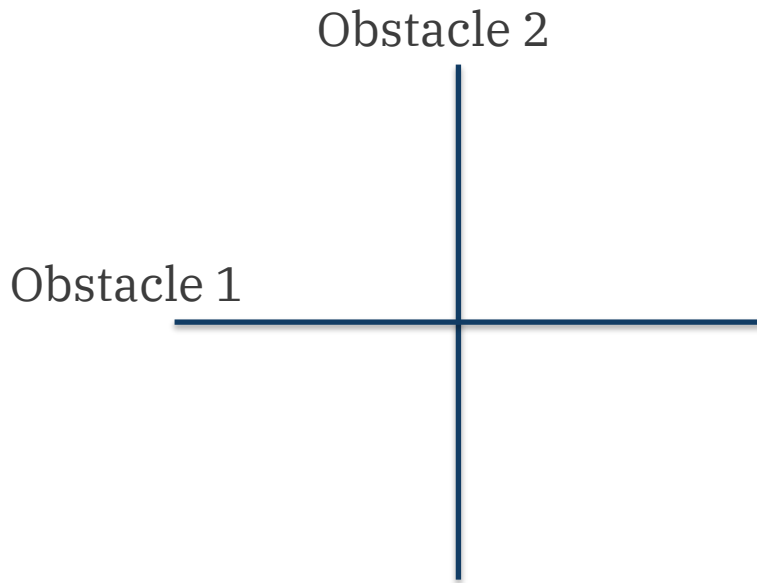
Add Obstacles

- › Zoom into a second of the grid using the wheel on the mouse or the zoom icon in GIS – Map tab in the Tools section



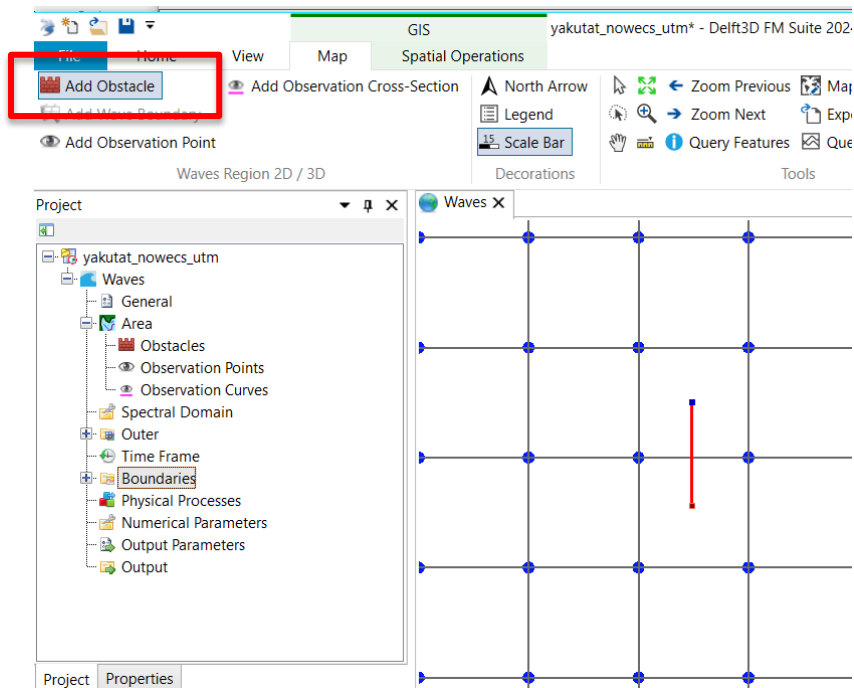
Add Obstacles

- › For this case we will use two obstacles for a single device. This will capture wave energy from multiple directions.
- › Obstacle 1 will capture the North-South component of wave energy
- › Obstacle 2 will capture the East-West component of wave energy



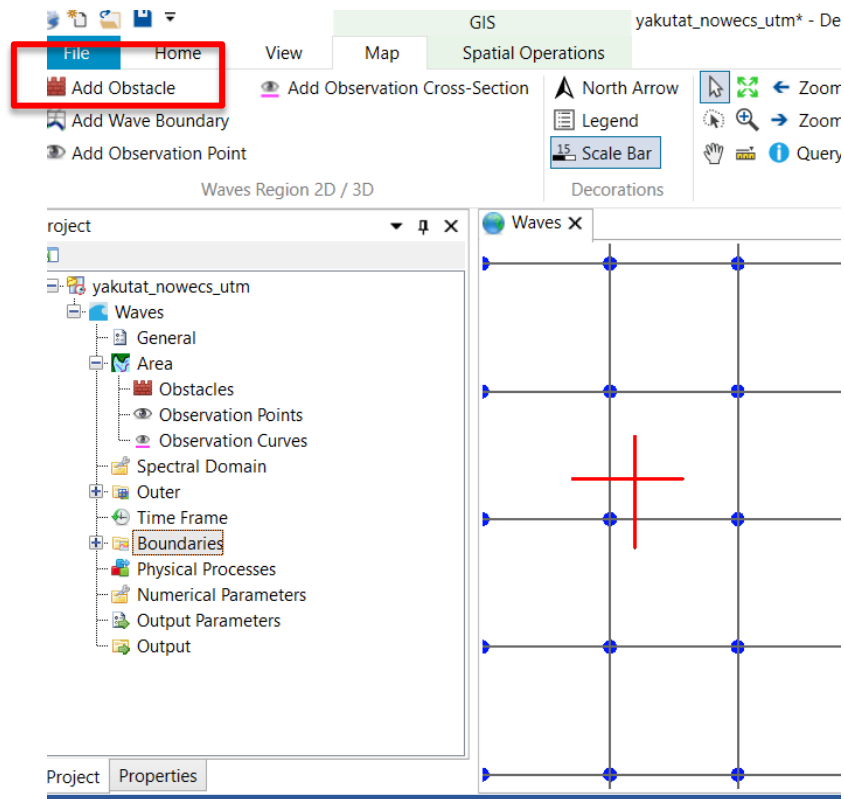
Add Obstacles, Continued

- Select Add Obstacles in the GIS-Map tab.
- Draw an obstacle by clicking within a grid cell, move the cursor across a grid line, and then double click to create the obstacle.
- Make the WEC 150m long and ensure that it aligns with the width specified in the Power Matrix
 - For real world cases, you want the grid resolution to match the WEC size. However, this add additional computational time for this demonstration



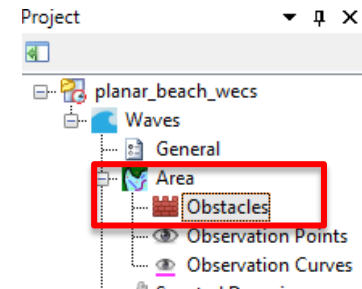
Add Obstacles, Continued

- › Add a second Obstacle crossing the previously drawn obstacle.
- › This now creates 1 device.
- › For best practice, use consecutive obstacles for the same device. For example:
 - Device 1 = Obstacles 1 and 2
 - Device 2 = Obstacles 3 and 4
- › Create 5 total devices
 - 10 Obstacles.



WEC integration, cont

- › In the Project panel, expand Area and **double click on Obstacles** to open the Obstacles panel.
- › Update the Parameters such of Transmission Coefficient and Reflection Type.
- › Set:
 - **Transmission Coefficient: 0.5**
 - Type: Sheet
 - Reflection Type: No
- › Save Project



Name	Type	Transmission Coefficient	Height	Alpha	Beta	Reflection Type	Reflection Coefficient
Obstacle01	Sheet	0.5				No	
Obstacle02	Sheet	0.5				No	
Obstacle03	Sheet	0.5				No	
Obstacle04	Sheet	0.5				No	
Obstacle05	Sheet	0.5				No	

Delft3D implementation

“.obt” file defines Obstacle parameters

```
[ObstacleFileInformation]
  FileVersion   = 02.00
  PolylineFile  = case_2_obs_new.pol

[Obstacle]
  Name          = Obstacle 1
  Type          = sheet
  TransmCoef    = 5.0000000e-001
  Reflections   = no

[Obstacle]
  Name          = Obstacle 2
  Type          = sheet
  TransmCoef    = 5.0000000e-001
  Reflections   = no

[Obstacle]
  Name          = Obstacle 3
  Type          = sheet
  TransmCoef    = 5.0000000e-001
  Reflections   = no
```

“.pol” file defines location of obstacles

```
Obstacle 1
2 2
235.85975 44.68599
235.86035 44.68599
Obstacle 2
2 2
235.85975 44.68859
235.86035 44.68859
Obstacle 3
2 2
235.85975 44.69118
235.86035 44.69118
```

- “OBCASE” file has a single number defining the obcase you choose
- These files must be located in the run directory

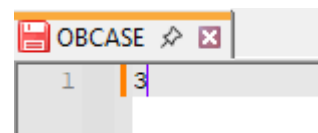
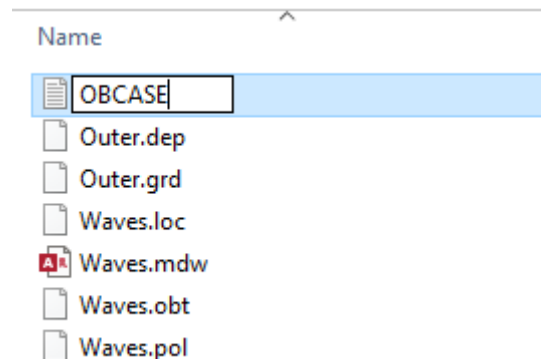
OBCASE options

- › Next, we will create the OBCASE and Power.txt files.
- › The OBCASE determines how what parameterization for the WEC is used.

WEC Performance Information	Frequency-variable Kt	Frequency-constant Kt
No Information	N/A	Obcase 0
Power Matrix (real seas, peak period)	N/A	Obcase 1
Power Matrix (regular waves and amplitude)	Obcase 3	N/A
RCW Curve	Obcase 4	Obcase 2

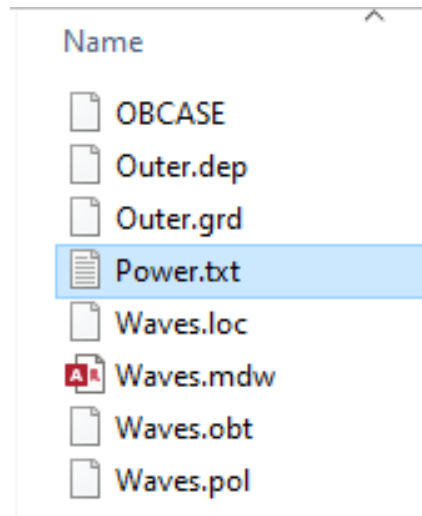
Create OBCASE file

- › Open the project input folder
yakutat_wecs_utm.dsproj_data/Waves/in
put
- › Create an extensionless file called
OBCASE
- › Open in an editor and end enter the
number 3 for this example.
- › Save file



Create Power.txt file

- › Open the project input folder
yakutat_wecs_utm.dsproj_data/Waves/input
- › Copy the *Power.txt* file from
“*Demos|yakutat_wecs_utm.dsproj_data|Waves|input*” into your project input directory



Define WEC Power Performance

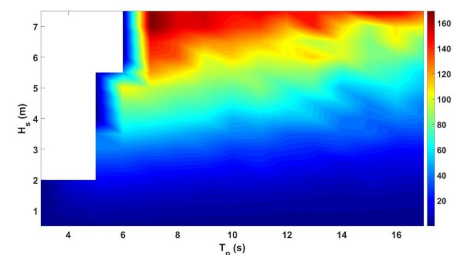
› Power Matrix (Power.txt)

- Line 1 - should usually be the WEC's physical dimension. This term is used to normalize the absorbed power value from the matrix by the width over which it is absorbed.
- Other lines are the wave and period information.
- Last entry is power matrix table, corresponding to the wave height and periods defined in the previous lines

```

50 # obstacle width
15 # number of significant wave height entries
0.5 # list of wave height entries
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
15 # number of peak period entries
9 # list of period values
4
5
6
7
8
9
10
11
12
13
14
15
16
17 # power matrix table is entered below
4.44 5.07 7.97 12.15 16.77 17.14 11.94 9.16 6.57 4.39 4.00 3.00 2.86 1.95 1.71
16.65 19.00 29.48 46.94 56.61 52.38 37.14 28.73 19.84 16.62 12.94 9.33 7.29 7.40 4.49
0.00 41.54 63.14 92.37 110.74 109.49 64.96 55.91 38.49 29.09 22.06 19.26 12.74 11.21 11.50
0.00 66.29 99.03 150.67 200.97 164.91 105.27 85.30 58.63 52.31 40.56 28.76 24.22 19.31 17.57
0.00 0.00 160.23 241.82 261.83 226.36 166.20 117.65 83.09 69.87 57.47 39.24 29.51 26.20 23.73
0.00 0.00 212.52 319.26 372.09 327.17 210.96 151.98 116.43 93.66 75.42 66.09 44.81 42.09 30.83

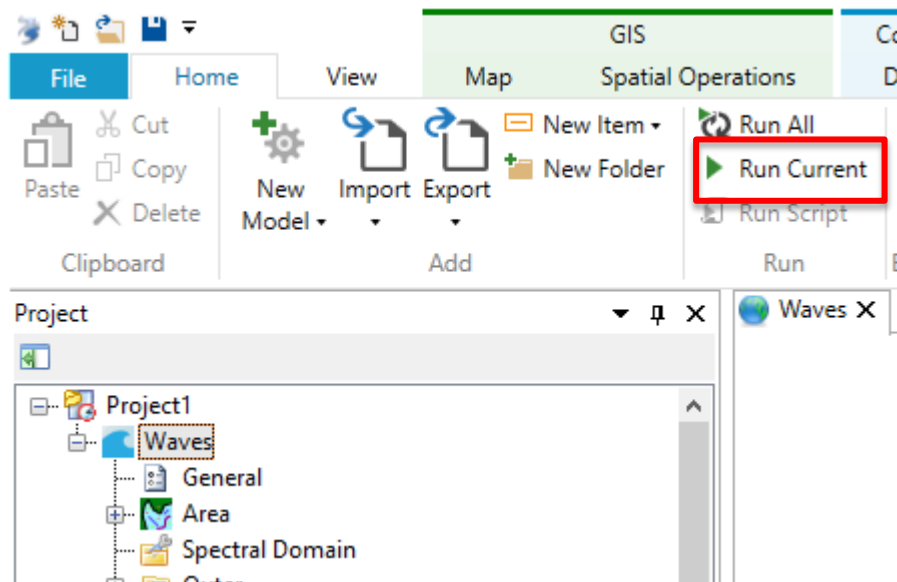
```



Babarit, A., J. Hals, M.J. Muliawan, A. Kurniawan, T. Moan, and J. Krokstad (2012) Numerical benchmarking study of a selection of wave energy converters, *Renew. Energ.*, 41, 44-63.

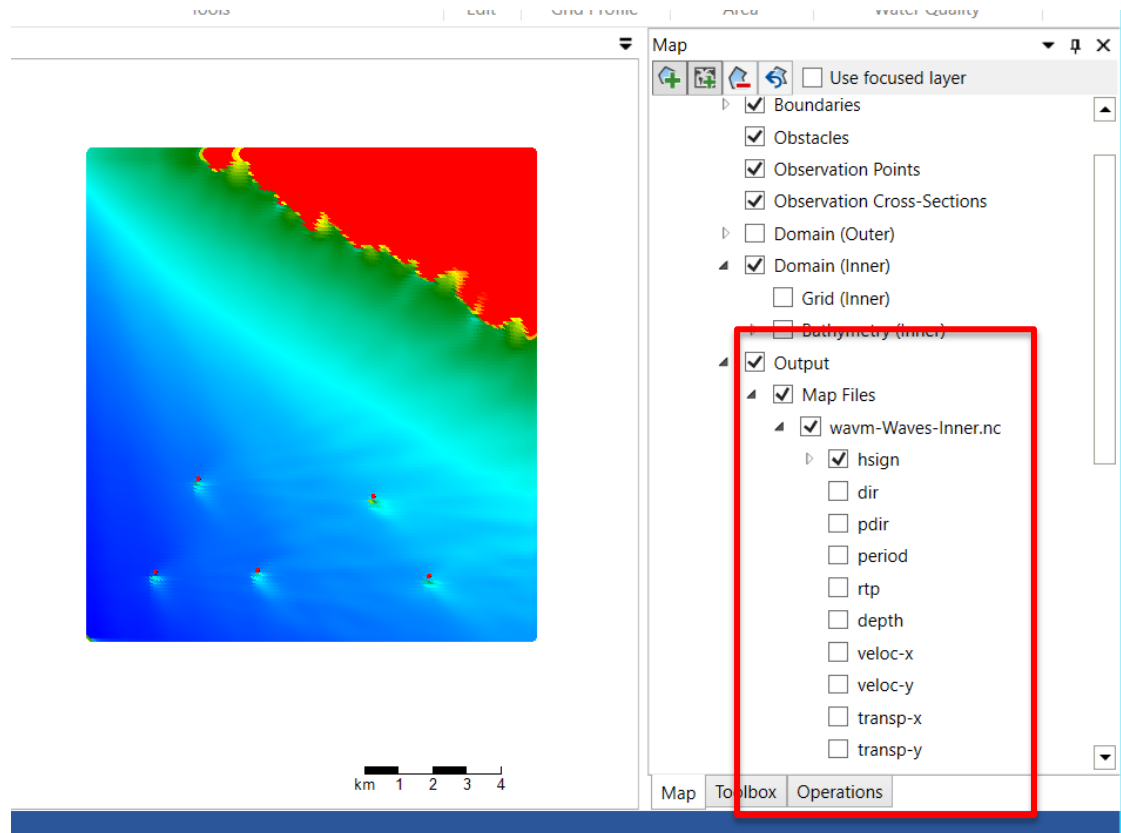
Run the model

- › Select **Run Current** from the Home tab
- › Or, right click on “Waves” and click on **Run Model**



Inspect the model results

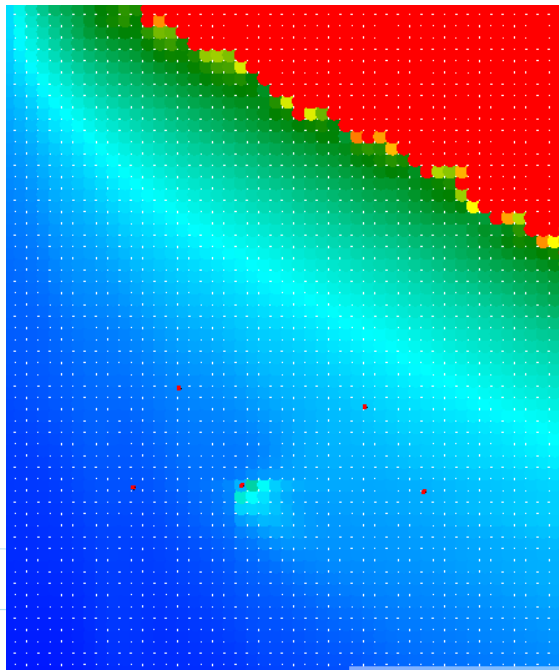
- › The model output will appear in the Project panel and the results can be displayed by selecting the Output variable in the Map panel.
- › Open the results for the Inner Grid
- › Notice the influence near the WECs.



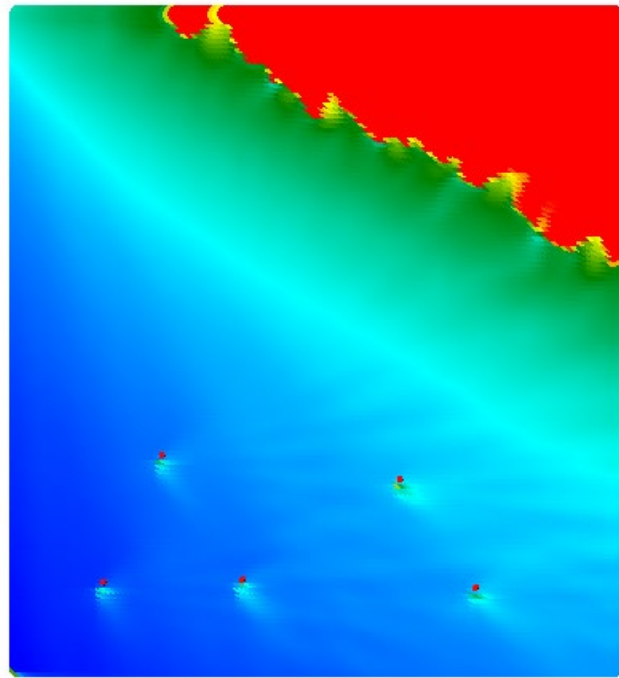
Inner vs. Outer Grid results

- Notice the difference between the Outer and Inner output. Only 1 of the WEC crossed an outer grid.

Outer



Inner



Save the Model

- › Save the model to save the Output.
- › Save model in File-> Save as
 - Select a save location and check to make sure it created
 - .dsproj file
 - Project folder and a subfolder called Waves and in that a subfolder called input

The model output will be in the *yakutat_wecs_utm.dsproj_data/Waves/output* directory.

Next Steps

- › Try to manipulate the inputs
 - Boundary condition, wave height and period
 - Obstacle length
 - Number of obstacles
 - Placement of obstacles