



U.S. ARMY

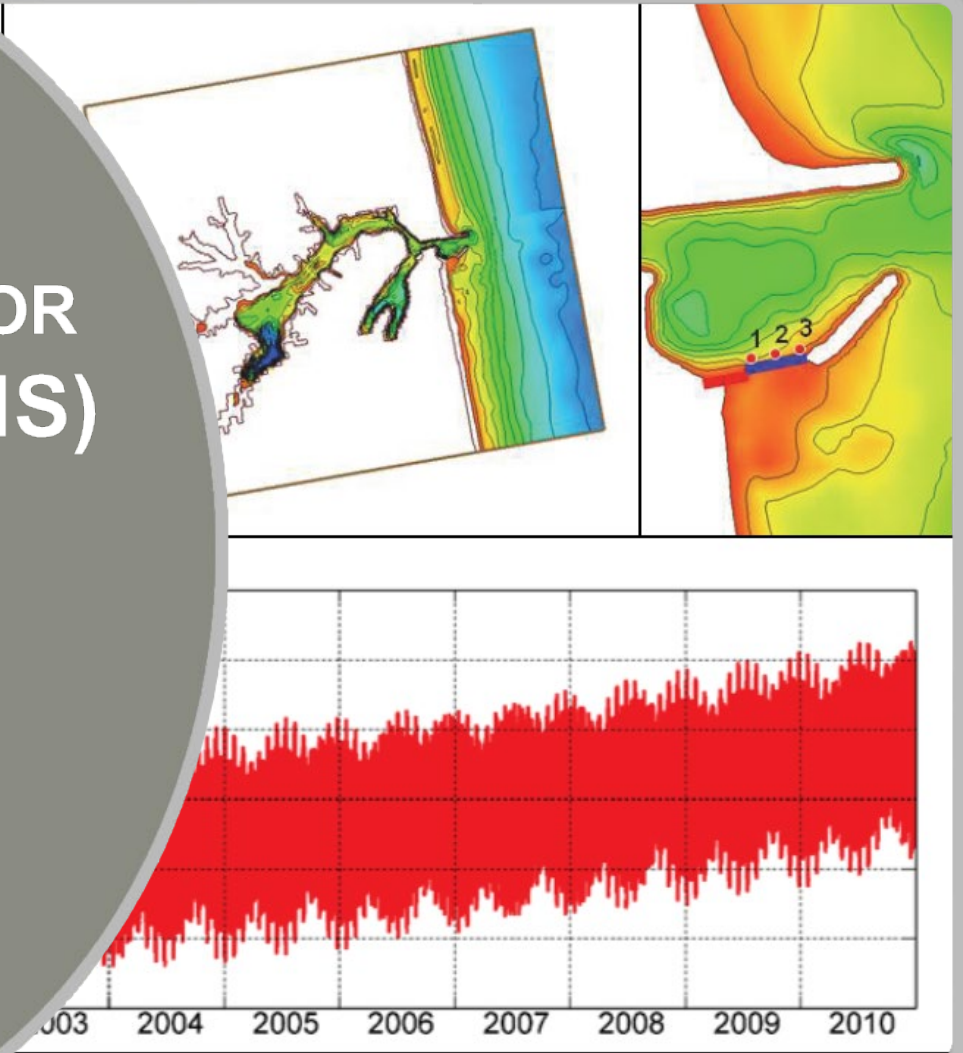


RECENT UPDATES WITHIN SMS 13.0 FOR THE COASTAL MODELING SYSTEM (CMS)

Mitchell Brown

Coastal & Hydraulics Laboratory

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US Army Corps
of Engineers®

**CHL**

COASTAL &
HYDRAULICS
LABORATORY



ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER



BLUF

Changes to SMS beginning with SMS 12.x allow Pls to design/implement new features into the SMS GUI relatively quickly with a Dynamic Model Interface (DMI).

Previously, when new features were to be implemented, a task order to the Aquaveo contract would have to be created and funded. Aquaveo would implement the new feature within a defined time frame (~3-6 mo.)

Now, ERDC staff can write XML statements to define the new interface changes in-house with the finished product ready within a much shorter window of time.

```
<declare_page text="Advanced" display="NO_NAV">
  <contains>
    <item text="Table of Advanced Cards">
      <table unique_name="tblAdvanced" min_height="150">
        <column text="Cardname">
          <edit_box unique_name="edtAdvancedCardname" type="text"></edit_box>
        </column>
        <column text="Value">
          <edit_box unique_name="edtAdvancedValue" type="text"></edit_box>
        </column>
      </table>
    </item>
  </contains>
</declare_page>
```

- Hiding parameters only advanced users should modify.
- Adding forgotten options/capabilities (multiple sediment grain options)
- Adding new feature for Temperature calculations

[illegible]

Turbulence parameters

Turbulence Model:

Subgrid ▼

☐ Edit Turbulence Parameters (not recommended)

Multiple Grain Sizes:

Specify number of size classes only ▼

1

Note: Grain size values assigned by CMS using standard deviation

Sediment Standard Deviation (mm):

1.5

Bed Composition Input:

D50 Sigma ▼

D50 Bed Layer definition:

Select (none selected)

Number of Bed Layers:

5.0

Constant Thickness for Mixing Layer:

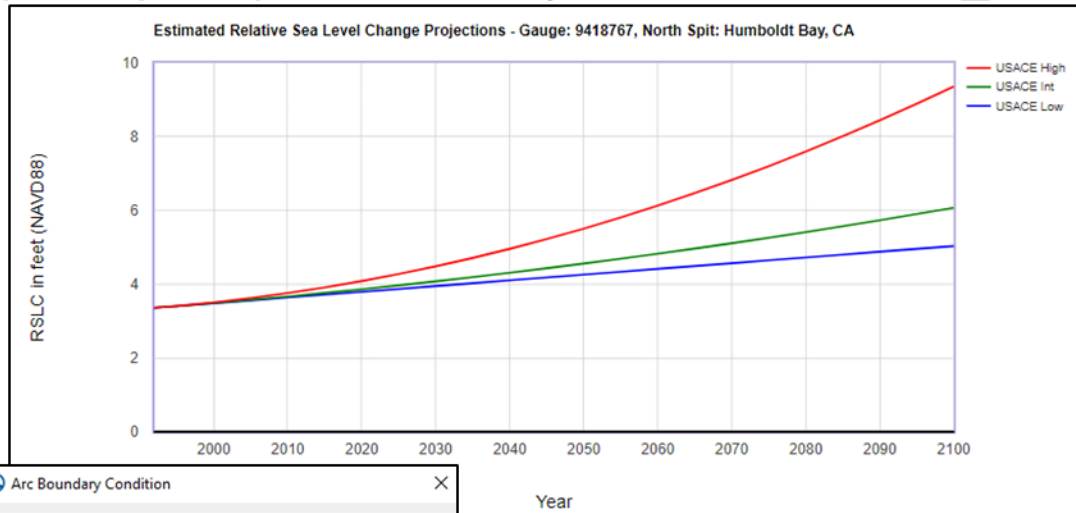
0.0

Constant Thickness for Bed Layers:

0.0

Creation of DMI for Sea-level change into SMS 13.0

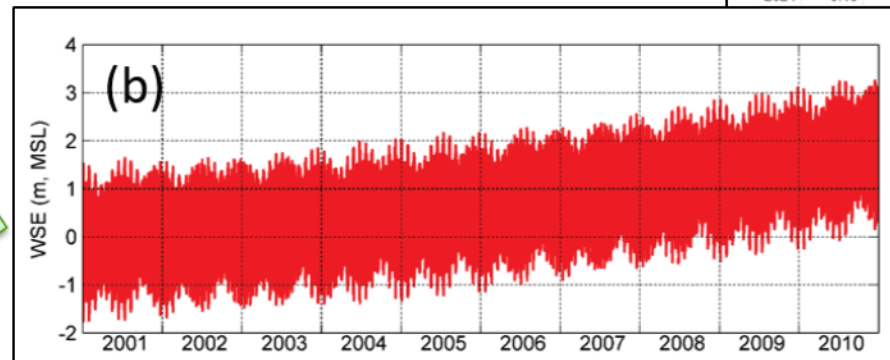
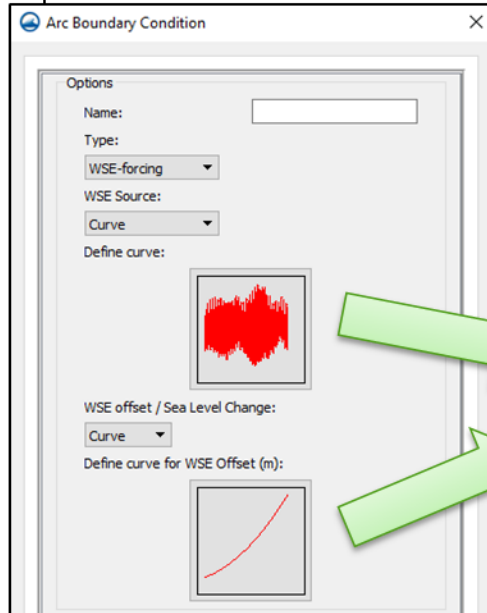
http://corpsmapu.usace.army.mil/rccinfo/slc/slcc_calc.html



Print Curves

Long-term Morphology Simulation
9418767, North Spit, Humboldt Bay, CA
NOAA's Regional Rate: 0.00513 meters/yr
All values are expressed in meters relative to MSL

Year	USACE Low	USACE Int	USACE High
2000	0.04	0.04	0.05
2001	0.05	0.05	0.06
2002	0.05	0.05	0.06
2003	0.06	0.06	0.07
2004	0.06	0.07	0.08
2005	0.07	0.07	0.09
2006	0.07	0.08	0.09
2007	0.08	0.08	0.10
2008	0.08	0.09	0.11
2009	0.09	0.10	0.12
2010	0.09	0.10	0.13
2011	0.10	0.11	0.14
2012	0.10	0.11	0.15
2013	0.11	0.12	0.16
2014	0.11	0.13	0.17
2015	0.12	0.13	0.18
2016	0.12	0.14	0.19
2017	0.13	0.14	0.19
2018	0.13	0.15	0.19
2019	0.14	0.16	0.19
2020	0.14	0.17	0.19
2021	0.15	0.17	0.19
2022	0.15	0.18	0.19
2023	0.16	0.19	0.19
2024	0.16	0.19	0.19
2030	0.20	0.23	0.36
2031	0.20	0.24	0.37
2032	0.21	0.25	0.39
2033	0.21	0.26	0.40
2034	0.22	0.26	0.42
2035	0.22	0.27	0.43
2036	0.23	0.28	0.44
2037	0.23	0.29	0.46
2038	0.24	0.29	0.48
2039	0.24	0.30	0.49
2040	0.25	0.31	0.51
2041	0.25	0.32	0.52
2042	0.26	0.32	0.54
2043	0.26	0.33	0.56
2044	0.27	0.34	0.57
2045	0.27	0.35	0.59
2046	0.28	0.36	0.61
2047	0.28	0.36	0.62
2048	0.29	0.37	0.64
2049	0.29	0.38	0.66
2050	0.30	0.39	0.68
2051	0.30	0.40	0.70
2052	0.31	0.41	0.72
2066	0.38	0.53	1.00
2067	0.39	0.54	1.02
2068	0.39	0.55	1.04
2069	0.40	0.56	1.07
2070	0.40	0.56	1.09
2071	0.41	0.57	1.11
2072	0.41	0.58	1.13
2073	0.42	0.59	1.16
2074	0.42	0.60	1.18
2075	0.43	0.61	1.20
2076	0.43	0.62	1.23
2077	0.44	0.63	1.25
2078	0.44	0.64	1.28
2079	0.45	0.65	1.30
2080	0.45	0.66	1.33
2081	0.46	0.67	1.35
2082	0.46	0.68	1.38
2083	0.47	0.69	1.40
2084	0.47	0.70	1.43
2085	0.48	0.71	1.45
2086	0.48	0.72	1.48
2087	0.49	0.73	1.51
2088	0.49	0.74	1.53



Effective WSE forcing with SLC curve

SLC is incorporated in the CMS through application of a constant value or a time-series curve within the SMS framework.

SLC/WL Offset is applicable to the *WSE-forcing* open boundary type specified as a WSE Curve or by *Tidal Constituents* in the CMS.

Scheduling dredging/placement during simulation



Issue: How to simulate a long time-period during which a navigation channel or other area was dredged and material placed in a new location?

Previous Solution:

1. Start the simulation and stop just before the material was moved.
2. Modify grid bathymetry as indicated by dredge/placement event.
3. Start a new simulation with the new bathymetry until desired end time.
4. Combine solution datasets and evaluate.

New Solution:

1. Use CMS with the Dredge Module interface in SMS 13.0.9+
 - Dredge/Placement areas are pre-defined and triggered by one of multiple methods.

Implementation of Dredge Module into SMS 13.0



☒ Enable Dredge Module

Name:

CapitolDredge

Dredging Update Interval (Explicit scheme only)

0.0

seconds

Dredge Dataset

Select

DredgeArea

Dredge Method

Specified Cell

Note: A dredging starting point is defined by a specified cell ID and progresses to cells farther

5292

Enter Cell ID for starting cell

Dredge Rate

10000.0

m³/day

Trigger

Method:

Depth

Note: Dredging is triggered when the depth of a cell in the source area exceeds a depth thresh

Trigger Depth and Units

6.0

Enter depth beyond which dredging begins.

m

Distribution

Percent

Note: A percentage of the dredge material is assigned for each placement area.

The percentages of all placements must sum up to 100.

☒ Define Placement Area 1

Placement Area 1

Placement Dataset

Select

PlacementArea

Placement Method

Specified Cell

Note: The dredge material is placed starting at the user-specified point.

2679

Enter Cell ID for starting cell

Distribution Percentage

100.0

Enter percentage of material from Dredge Area placed in Placement Area 1

Choose Method for Limits on Placement in this Placement Area

Depth

3.0

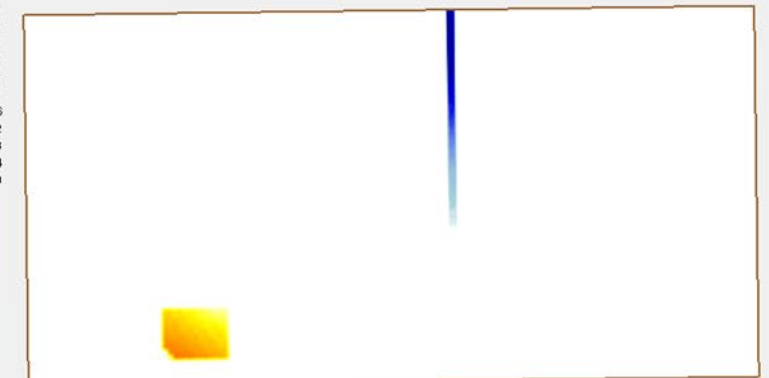
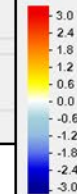
m

Enter the depth below water surface that material placement cannot exceed.

☐ Define Placement Area 2

☐ Define Placement Area 3

Morphology Change, m



Morphology Change, m

opment Cen

Creation of multiple Sediment Management Alternatives



Issue: How to define multiple alternatives which incorporate various sediment removal/placement sites with defined volumes?

Current Solution:

1. Create multiple grids based on initial bathymetry.
2. For each grid, select cells in areas of removal/placement and hand-enter values for depth to get as close to the desired volumes as possible.
3. Repeat steps as needed for each area.
4. Save and move on to next grid.
 - This is very tedious to get the exact desired volumes.

New Solution (SMS 13.1):

1. Use SMS Sediment Volume Operations tool to define the areas and to assign the exact volumes/depth desired.
2. Confirm the quantities from a table.
3. Click a button to create a new grid based on the initial grid.

Sediment Volume Operations tool coming in **SMS 13.1**



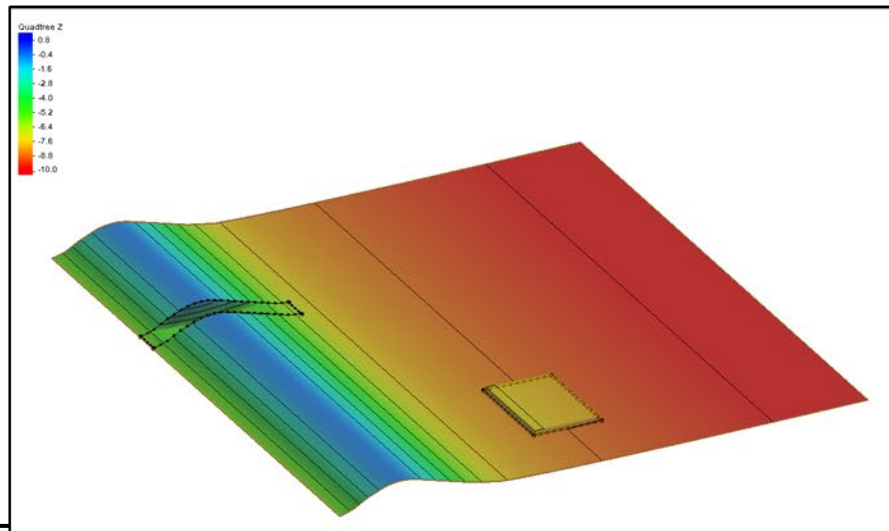
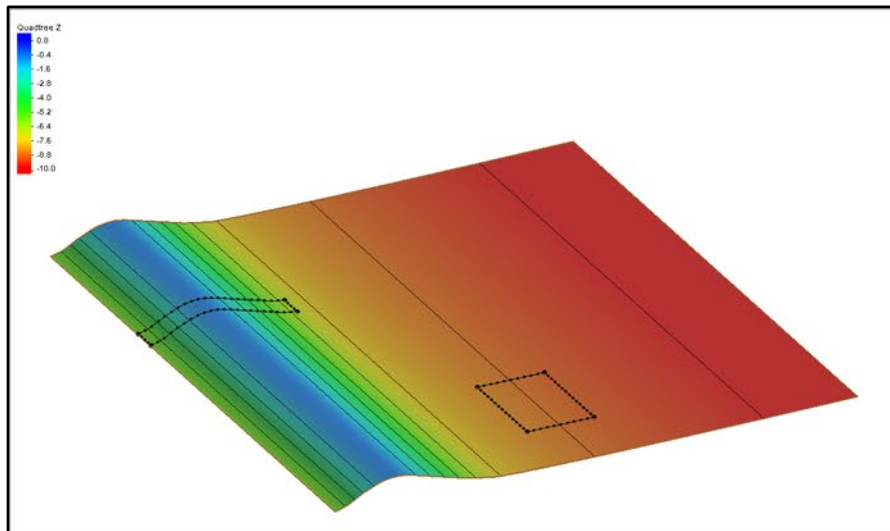
Mass Balance Table

Mass Balance Table

Name	ID	Polygon type	Cut / fill type	Value	Priority	Priority %	Total (m ³) based on slope	Required (m ³)	Available (m ³)	Cut (m ³)	Fill (m ³)
1 Channel	2	Specified cut region ▼	Constant elevation (m) ▼	-5			1.03508e+6	(350078)		(350078)	
2 Placement	1	Available fill region ▼	Relative thickness (m) ▼	5	1 ▼	100	3.78217e+6		1.60559e+6		350078
3									Sum	(350078)	350078
4									Net	0	0

Sort/Normalize Compute Save to File...

Help...



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Reintroduction of CMS Advanced Cards to SMS 13.1



One feature widely used in CMS applications was the Advanced Card tab. This allowed the user to quickly add cards that SMS does not presently understand. It was useful when loading older CMS grids into newer SMS version.

With the DMI and Python scripts, we are adding this feature back to SMS starting in Version 13.1.

The image shows a screenshot of the 'Model Control' dialog box, specifically the 'Advanced' tab. The dialog has several tabs: General, Flow, Sediment Transport, Salinity/Temperature, Wave, Wind, Output, and Advanced. The 'Advanced' tab is selected, displaying a 'Table of Advanced Cards:' with the following data:

	Cardname	Value
1	IMPLICIT_WEIGHTING_FACTOR	1.0
2	CALC_ROLLER	OFF
3	TIDAL_CORRECTIONS	OFF

Below the table, there is a checkbox for 'Copy/Paste Mode' and several buttons: 'Import...', 'Export...', 'Insert Above', 'Insert Below', and 'Delete'.

Creation of DMI for CMS Structure types in **SMS 13.1**



Rubble Mound Jetties

US Army Corps of Engineers
Implementation of Structures in the CMS:
Part I, Rubble Mound
by Honghai Li, Alejandro Sanchez, Weiming Wu,
and Christopher Reed

Weirs

US Army Corps of Engineers
Implementation of Structures in the CMS:
Part II, Weir
by Honghai Li, Alejandro Sanchez, Weiming Wu,
and Christopher Reed

Culverts

US Army Corps of Engineers
Implementation of Structures in the CMS:
Part III, Culvert
by Honghai Li, Alejandro Sanchez, Weiming Wu,
and Christopher Reed

Tide Gates

US Army Corps of Engineers
Implementation of Structures in the CMS:
Part IV, Tide Gate
by Honghai Li, Alejandro Sanchez, and Weiming Wu

PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) describes the mathematical formulation, numerical implementation, and input specifications of tide gates in the Coastal Modeling System (CMS) operated through the Surface-water Modeling System (SMS). A coastal application at an idealized inlet is provided to illustrate the implementation procedure and demonstrate the model capability.

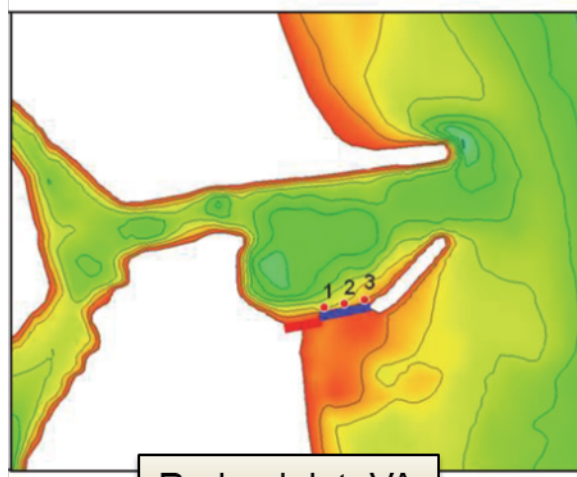
INTRODUCTION: A tide gate is an opening structure built across a river or a channel in an estuarine system. By preventing saltwater intrusion to farm land and allowing freshwater drainage to the estuary, tide gates are commonly used for flow and flooding control, and salinity and sediment management (Figure 1). Because a tide gate is a significant component of hydrodynamic and sediment transport controls in the coastal zone, it is important to incorporate the structure and to simulate its effect in the CMS.



Figure 1. West River tide gate, New Haven, Connecticut: (a) Low outgoing tide; (b) High incoming tide (<http://www.flickr.com/photos/34512088@N00/5088888888/>).

COASTAL MODELING SYSTEM: The CMS, developed by the Coastal Inlets Research Program (CIRP), is an integrated suite of numerical models for simulating water surface elevation, current, waves, sediment transport, and morphology change in coastal and inlet applications. It consists of a hydrodynamic and sediment transport model, CMS-Flow, and a spectral wave model CMS-Wave (Sanchez et al. 2011a; Sanchez et al. 2011b; Lin et al. 2011). Both are described in Part I of this series (Li et al. 2013).

Approved for public release; distribution is unlimited.



Rudee Inlet, VA

```

1 WEIR_BEGIN
2 NUMBER_WEIRS 2
3 NUM_CELL_WEIRS 8 8
4 CELLS 16864 16865 16866
5 DISTRIBUTION_COEFFICIENT
6 ORIENTATION 3 3
7 TYPE 2 2
8 FLOW_COEFFICIENT 0.46
9 CREST_ELEVATION 0.0 -0.0
10 METH 1 1
11 WEIR_END
12

```

Old method

Arc Structure Definition

Options

Type: Weir

Distribution Coefficient: 0.95

Sea Side Orientation: South

Weir Type: Sharp Crested

Bay to Sea Flow Coefficient: 0.46

Sea to Bay Flow Coefficient: 0.46

Crest Elevation (positive is upward): 0.0

Weir Method: Approach 1

User will have an interface to define the weir and all properties assigned to feature arcs. Information will automatically get written to the parameter file upon Export.

New interface

Next steps – Finish DMI for GenCade



Type:

- Generic
- Generic
- Initial Shoreline
- Reference Line
- Regional Contour
- Breakwater
- Seawall
- Groin
- Inlet
- Left Jetty on Inlet
- Right Jetty on Inlet

Type:

Breakwater

Detached Breakwaters

Depth 1 (ft):

0.0

Depth 2 (ft):

0.0

Transmission:

Constant

Breakwater Attributes

Coefficient

0.0

Type:

Inlet

Inlets (Reservoir Model and Jetties)

Name of Inlet

Inlet Shoal Volumes (cu yd)

	Initial	Equilibrium
Ebb	0	0
Flood	0	0
Left Bypass	0	0
Left Attachment	0	0
Right Bypass	0	0
Right Attachment	0	0



Copy/Paste Mode

Import...

Export...

Dredging Events

	Begin Date	End Date	Shoal to be Mined	Volume (cu yd)
1	12/2/2019 5:55:43 pm	12/2/2019 5:55:43 pm	-choose type-	0

- choose type-
- Left Attachment
- Left Bypass
- Ebb
- Flood
- Right Bypass
- Right Attachment



Copy/Paste Mode

Import...

Export...

Insert Above

Insert Below

Delete

Next steps – Start DMI for CMS-Wave

CMS-Wave is still using the same static interface as much older versions of SMS (11.2 and previous) and is in need of updating.



CMS-WAVE Model Control

Input Forcing

Currents:

Water level:

Spectra

Plane type:

Interpolation type:

Date Format:

Wind Source:

Settings

Bed Friction

Cf = Darcy-Weisbach friction coefficient
n = Manning friction coefficient

Forward reflection:

Backward reflection:

Matrix Solver

Number of threads:

Muddy bed:

Wave breaking formula:

☒ Allow wetting and drying

☐ Infragravity wave effect

☒ Diffraction intensity:

☐ Non-linear wave effect

☐ Run up

☒ Fast-mode run

Output

☐ Radiation stresses

☐ Sea/swell

☐ Wave breaking

☒ Indices

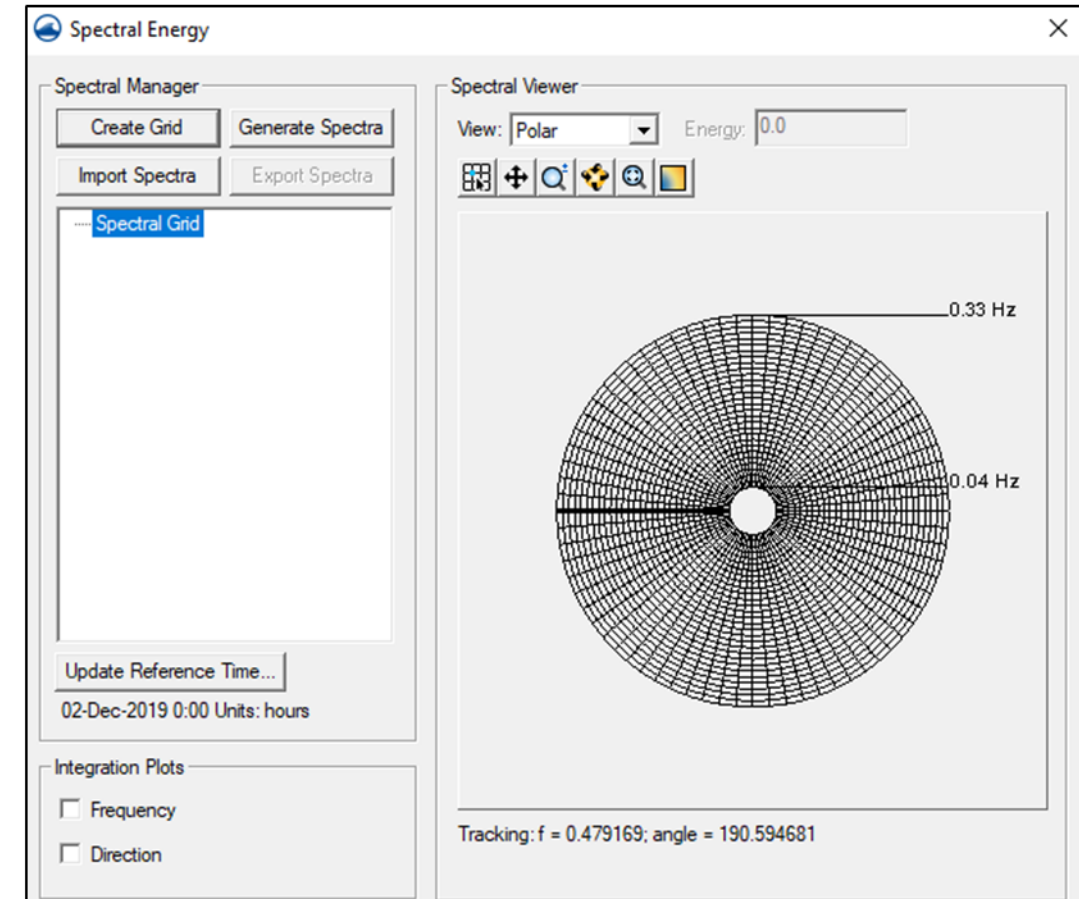
☐ Energy dissipation

Input Datasets

☐ Radiation stresses

Format:

Format:



What's Next?



FY20 –

- Finish remaining Structure types (Tide Gate, Culverts) with DMI interfaces
- Learn more about Python scripting combined into DMI
- Additional interfaces to be defined:
 - **Sediment Mapping**
 - **Cross-shore sediment option/parameters**
- CMS source code modified to support NetCDF input/output
- Creation of larger suite of test cases for VV/UQ of CMS-Flow and CMS-Wave





Thank You!

Questions?