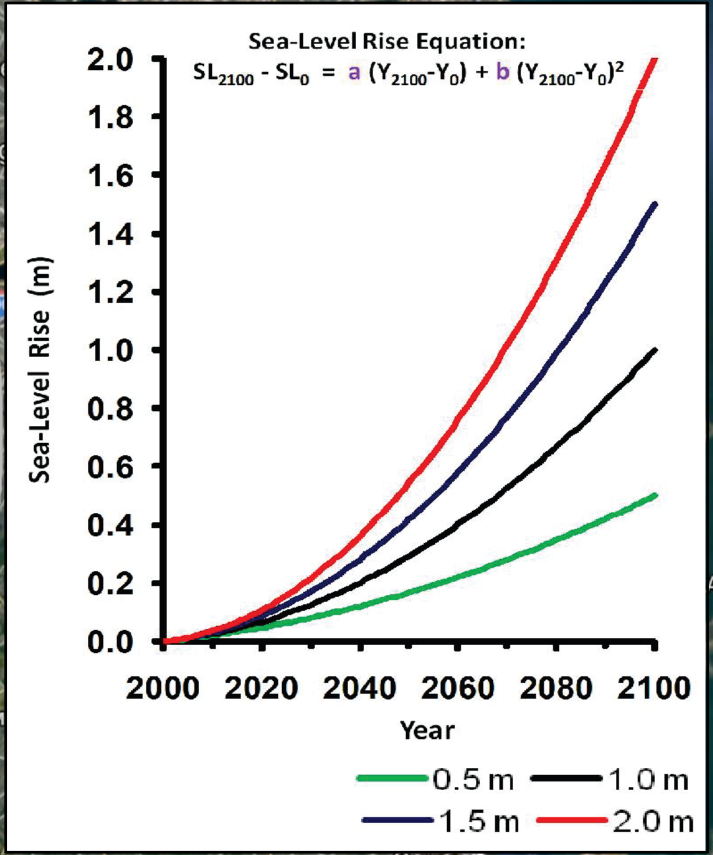
Coastal Modeling System: Advanced Topics using CMS 5.1 and SMS 13.0

Day 4: CMS Simulation with SLR



Honghai Li, Mitchell Brown

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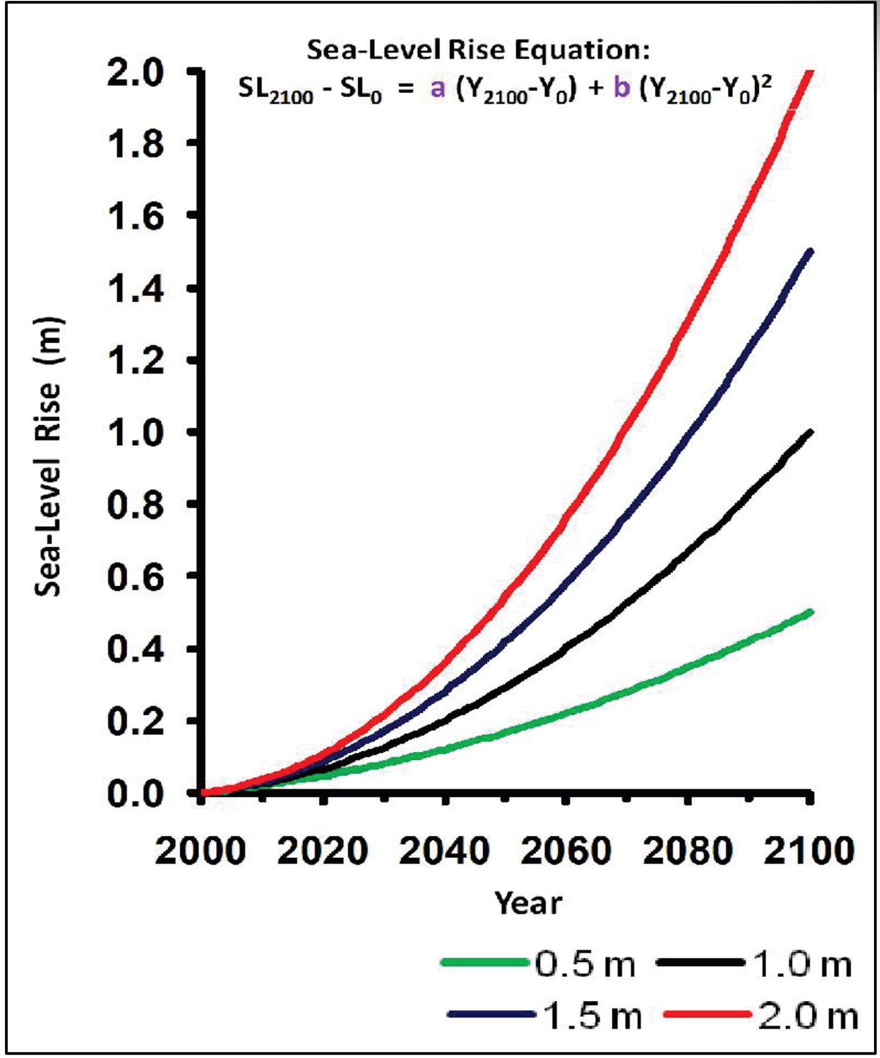
Outline

- Background
- Sea level change in CMS-Flow
- Obtain SLC curve
- Setup of sea level change in CMS-Flow
- Work with SMS to specify SLC at open boundary
- Export CMS-Flow files

Background

- Increasing sea level due to global warming and rise in ocean temperature
- Potential global sea level rise (SLR) can change the depth of navigation channels and introduce sediment into navigation channels through shore erosion
- Coastal model simulations need to incorporate SLR to assess risk and vulnerability of navigation projects and to support operations and maintenance practice



Sea Level Change in CMS-Flow

- **CMS-Flow lateral open boundaries allow water exchanges with specifications of water level variations**
- **Water level boundaries can be obtained from the measurements at coastal tidal gauges or composed from tidal constituents**
- **The general formula for the boundary WSE is specified by**

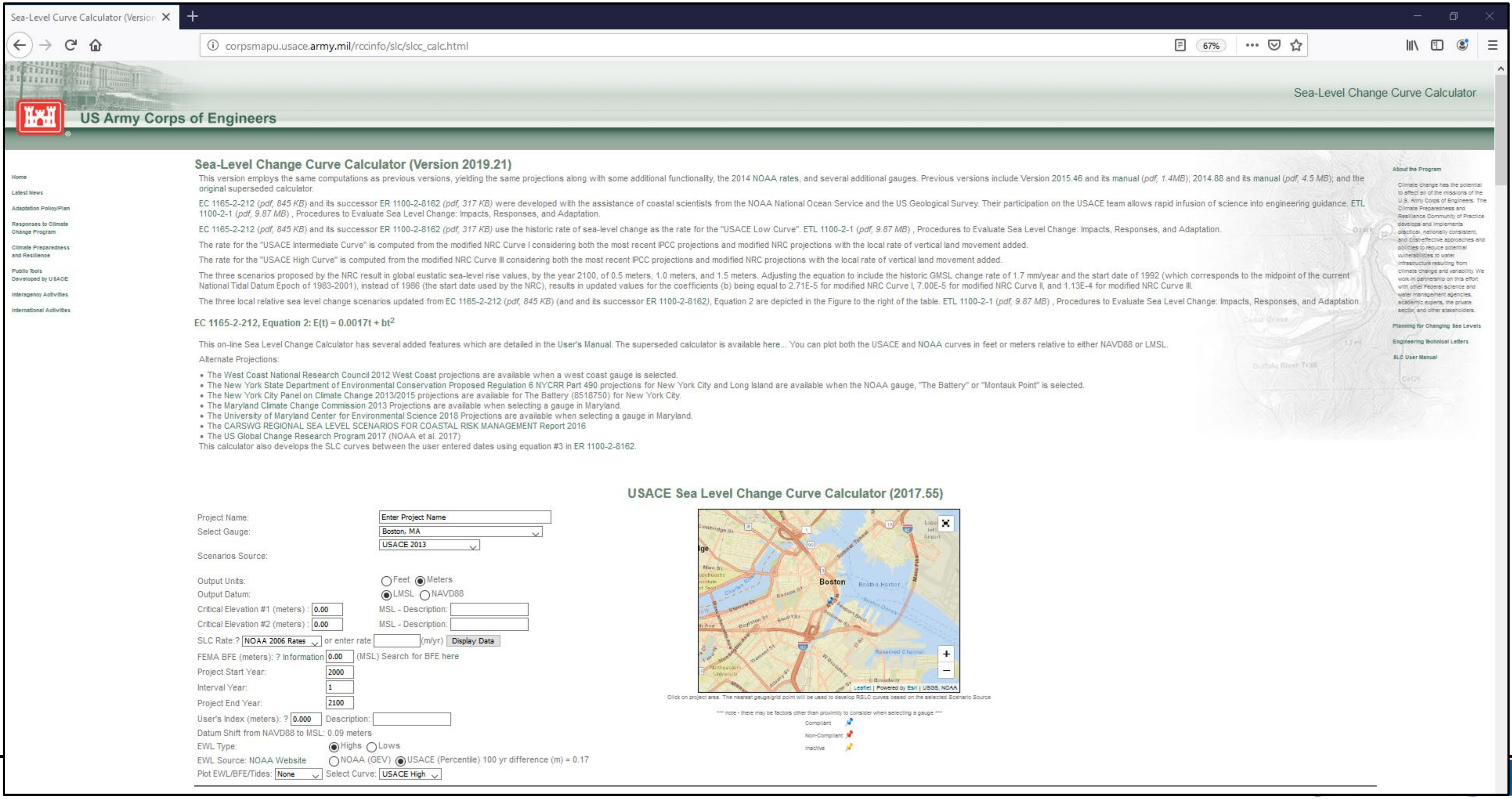
$$\eta_B = \eta_0 + \eta_E + \Delta\bar{\eta}$$

η_B: **boundary WSE**
η_0: **initial boundary WSE**
η_E: **specified external boundary WSE**
$\Delta\bar{\eta}$: **WSE offset**

- **The external WSE (η_E) may be specified as a time series, either spatially constant or varying, or may be calculated from tidal/harmonic constituents**
- **SLC is specified as $\Delta\bar{\eta}$**

Setup of Sea Level Change
(Obtain SLC Curve)

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



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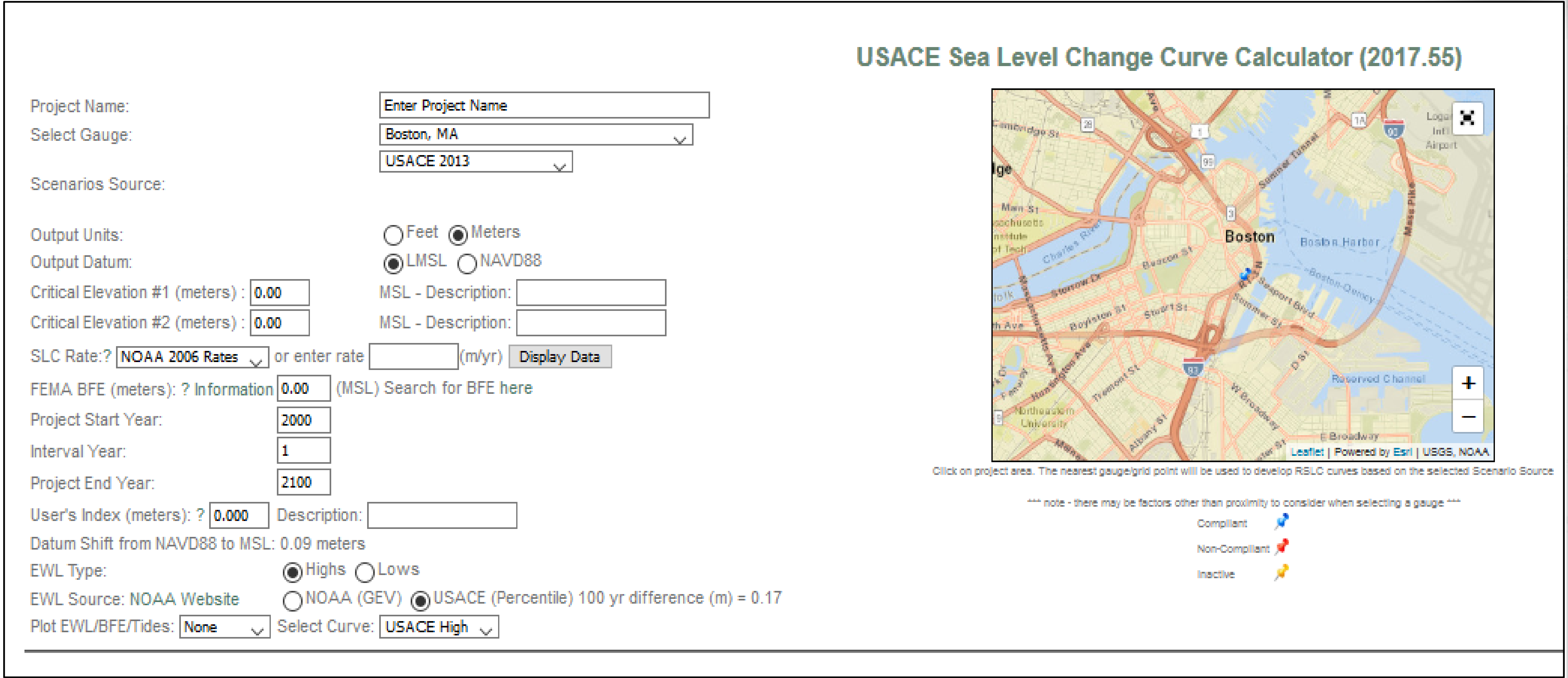
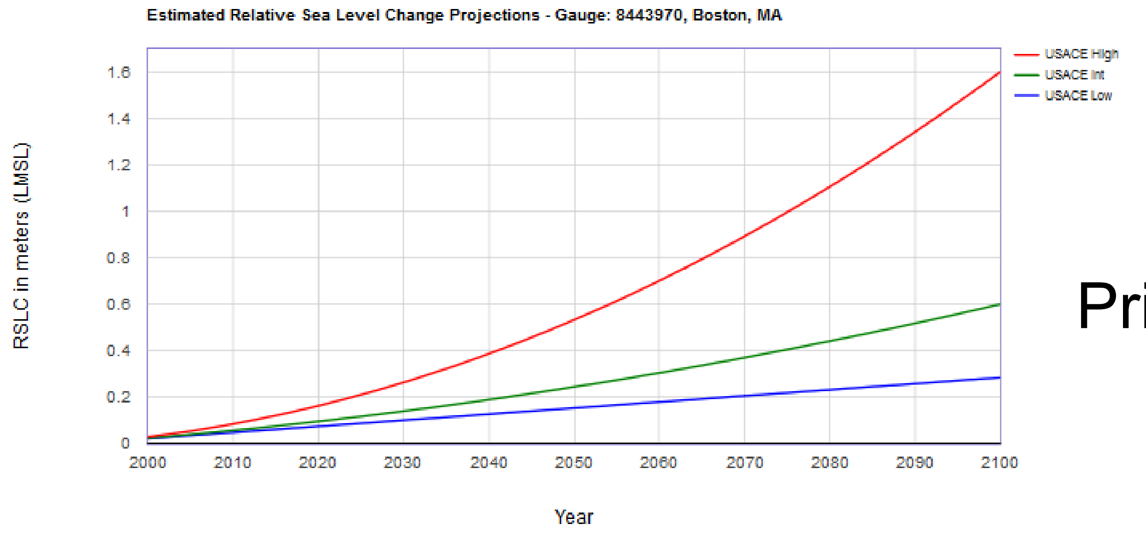
Setup of Sea Level Change
(Obtain SLC Curve)



Setup of Sea Level Change
(Obtain SLC Curve)

8443970, Boston, MA
NOAA's 2006 Published Rate: 0.00263 meters/yr



Print Curve

Print Curves

8443970, Boston, MA
NOAA's 2006 Published Rate: 0.00263 meters/yr
All values are expressed in meters relative to LMSL

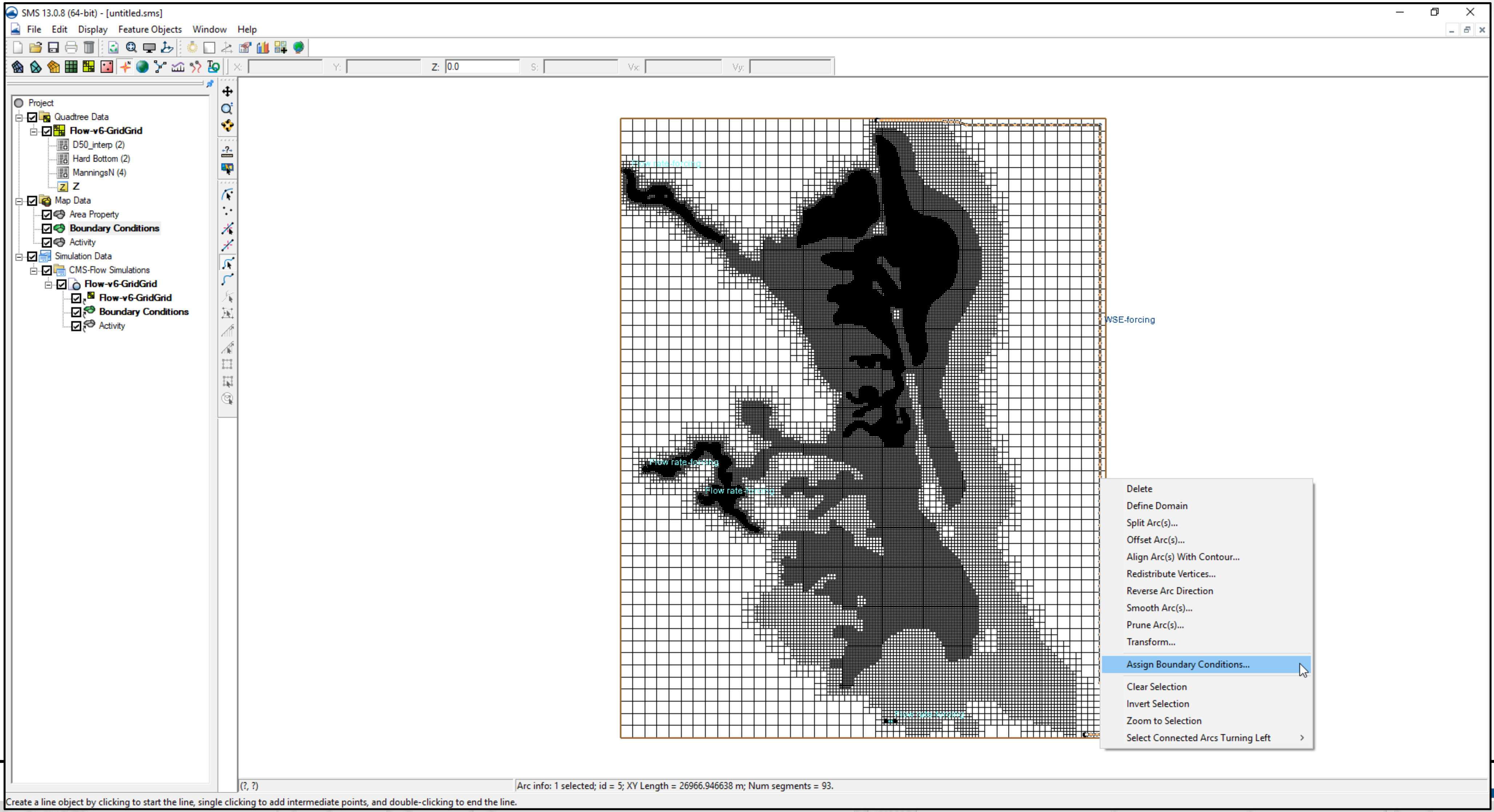
Year	USACE Low	USACE Int	USACE High
2000	0.02	0.02	0.03
2001	0.02	0.03	0.03
2002	0.03	0.03	0.04
2003	0.03	0.03	0.04
2004	0.03	0.04	0.05
2005	0.03	0.04	0.05
2006	0.04	0.04	0.06
2007	0.04	0.05	0.07
2008	0.04	0.05	0.07
2009	0.05	0.05	0.08
2010	0.05	0.06	0.08

Print Table

2062	0.18	0.32	0.74
2063	0.19	0.32	0.76
2064	0.19	0.33	0.78
2065	0.19	0.34	0.79
2066	0.20	0.34	0.81
2067	0.20	0.35	0.83
2068	0.20	0.36	0.85
2069	0.20	0.36	0.87
2070	0.21	0.37	0.89
2071	0.21	0.38	0.91
2072	0.21	0.38	0.93
2073	0.21	0.39	0.95
2074	0.22	0.40	0.98
2075	0.22	0.41	1.00
2076	0.22	0.41	1.02
2077	0.22	0.42	1.04
2078	0.23	0.43	1.06
2079	0.23	0.43	1.08
2080	0.23	0.44	1.11
2081	0.23	0.45	1.13
2082	0.24	0.46	1.15
2083	0.24	0.46	1.18
2084	0.24	0.47	1.20
2085	0.25	0.48	1.22
2086	0.25	0.49	1.25
2087	0.25	0.49	1.27
2088	0.25	0.50	1.29
2089	0.26	0.51	1.32
2090	0.26	0.52	1.34
2091	0.26	0.53	1.37
2092	0.26	0.53	1.39
2093	0.27	0.54	1.42
2094	0.27	0.55	1.44
2095	0.27	0.56	1.47
2096	0.27	0.57	1.50
2097	0.28	0.57	1.52
2098	0.28	0.58	1.55
2099	0.28	0.59	1.58
2100	0.28	0.60	1.60

Print Table

Setup of Sea Level Change
(Work with SMS to Specify Open Boundary Condition)



Setup of Sea Level Change

(Work with SMS to Specify Open Boundary Condition)

(9 unread) - lqu52197@yahoo... | Harmonic Constituents - NOA...

https://tidesandcurrents.noaa.gov/harcon.html?unit=0&timezone=0&id=8423898&name=Fort+Point&state=NH

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Harmonic Constituents for 8423898, Fort Point NH

Constituent #
Order in which the National Ocean Service lists the constituents
Name
Common name used to refer to a particular constituent, subscript refers to the number of cycles per day
Amplitude
One-half the range of a tidal constituent
Phase
The phase lag of the observed tidal constituent relative to the theoretical equilibrium tide
Speed
The rate change in the phase of a constituent, expressed in degrees per hour. The speed is equal to 360 degrees divided by the constituent period expressed in hours
Description
The full name of the tidal constituent

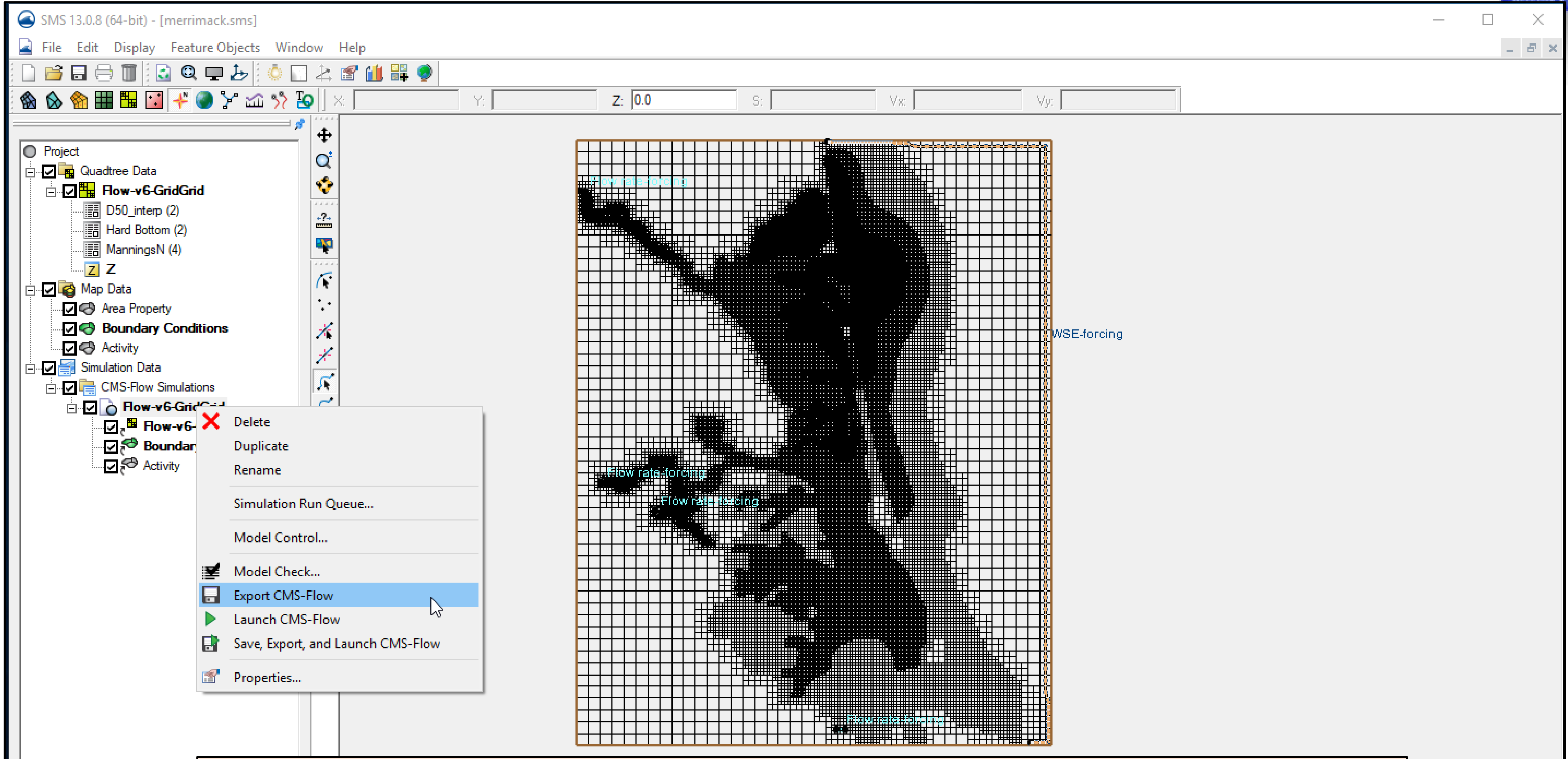
Showing Harmonic Constituents for
8423898 Fort Point, NH
Data Units: Feet / Meters
Timezone: Local / GMT
Submit

Please refer to the Tide and Current Glossary for definitions of terms. Amplitudes are in meters. Phases are in degrees, referenced to GMT. Z_0 (MSL): 0 meters

Constituent #	Name	Amplitude	Phase	Speed	Description
1	M2	1.314	105.9	28.984104	Principal lunar semidiurnal constituent
2	S2	0.181	136.2	30.0	Principal solar semidiurnal constituent
3	N2	0.294	76.1	28.43973	Larger lunar elliptic semidiurnal constituent
4	K1	0.135	203.3	15.041069	Lunar diurnal constituent
5	M4	0.018	324.5	57.96821	Shallow water overtides of principal lunar constituent
6	O1	0.114	187.1	13.943035	Lunar diurnal constituent
7	M6	0.009	134.7	86.95232	Shallow water overtides of principal lunar constituent

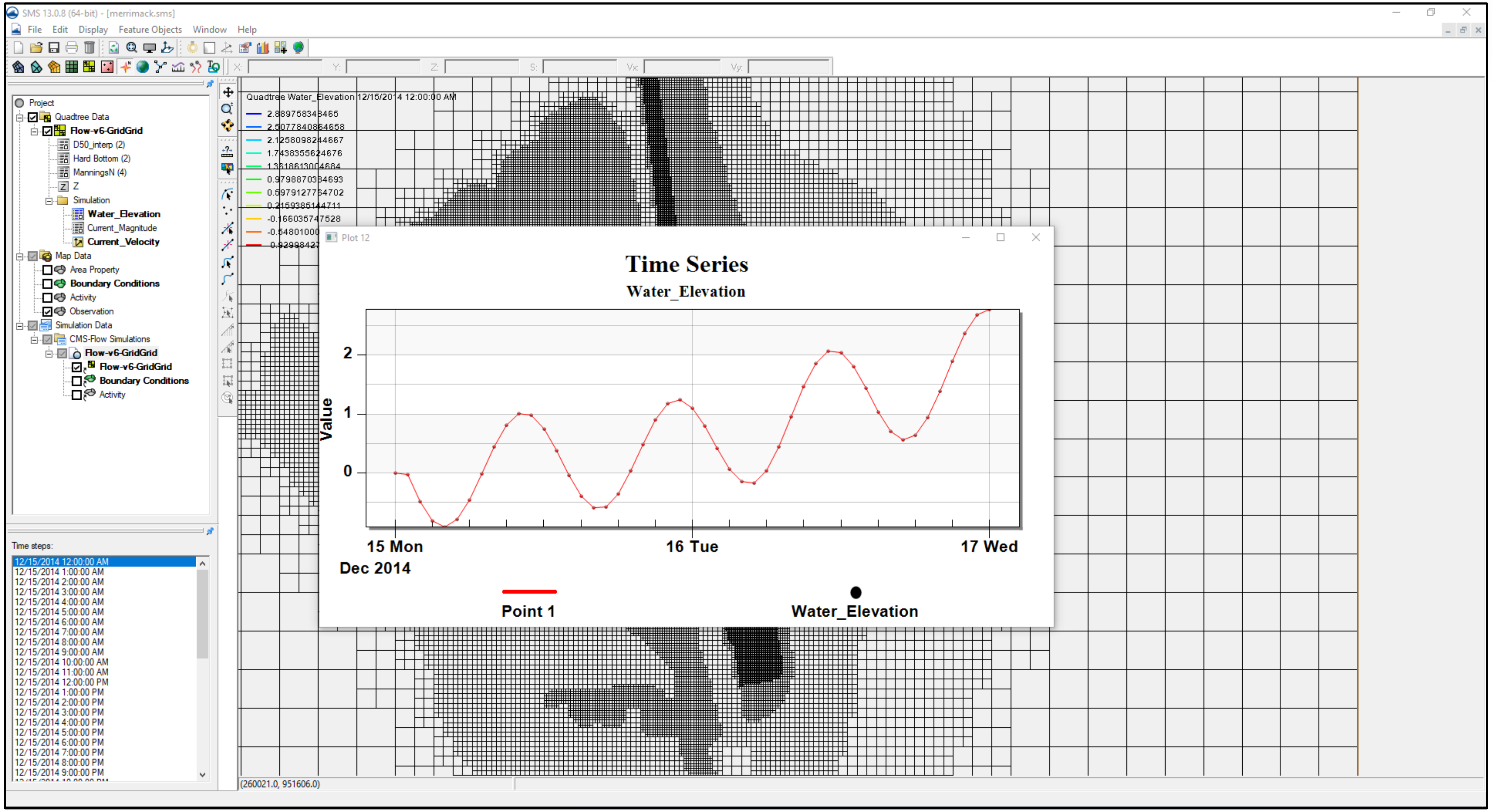
Help... | OK | Cancel

Export CMS-Flow Files



Save Project –> Export CMS-Flow –> Launch CMS-Flow

Model Simulation



References

Modeling Sea Level Change Using the Coastal Modeling System
Li, H. and Brown, M. (2019)
https://erdc-library.erdc.dren.mil/xmlui/handle/11681/33204

ERDC/CHL CHETN-IV-119
June 2019

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Modeling Sea Level Change Using the Coastal Modeling System

by Honghai Li and Mitchell E. Brown

PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) describes procedures to incorporate a sea level change (SLC) curve within the Coastal Modeling System (CMS) operated in the Surface-water Modeling System (SMS), version 13.0 (Aquaveo 2010). The defined procedures are demonstrated in a long-term modeling simulation configured around an idealized inlet.

INTRODUCTION: Increasing atmospheric concentrations of greenhouse gases are warming the atmosphere and oceans. The global warming and the rise in ocean temperature may gradually increase ocean volume and change sea level (Figure 1) (IPCC 2014). Potential global sea level rise (SLR) combined with coastal storms can drastically change the depth of navigation channels and introduce sediment into navigation channels through adjacent shore erosion. Recognizing the impacts of global climate change with potential SLR on coastal and estuarine waterways, measures need to be taken to assess risk and vulnerability of navigation projects, to conduct research and development that support a reduction of future operation and maintenance costs, and to develop adaptation strategies and management plans to support operations and maintenance practice (USACE 2011).

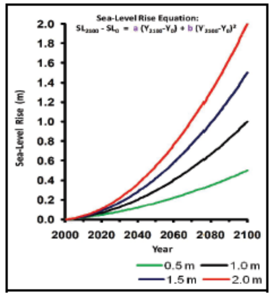

Figure 1. Projected 0.5, 1.0, 1.5, and 2.0 m SLR scenarios by the year 2100 (USACE 2011).

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