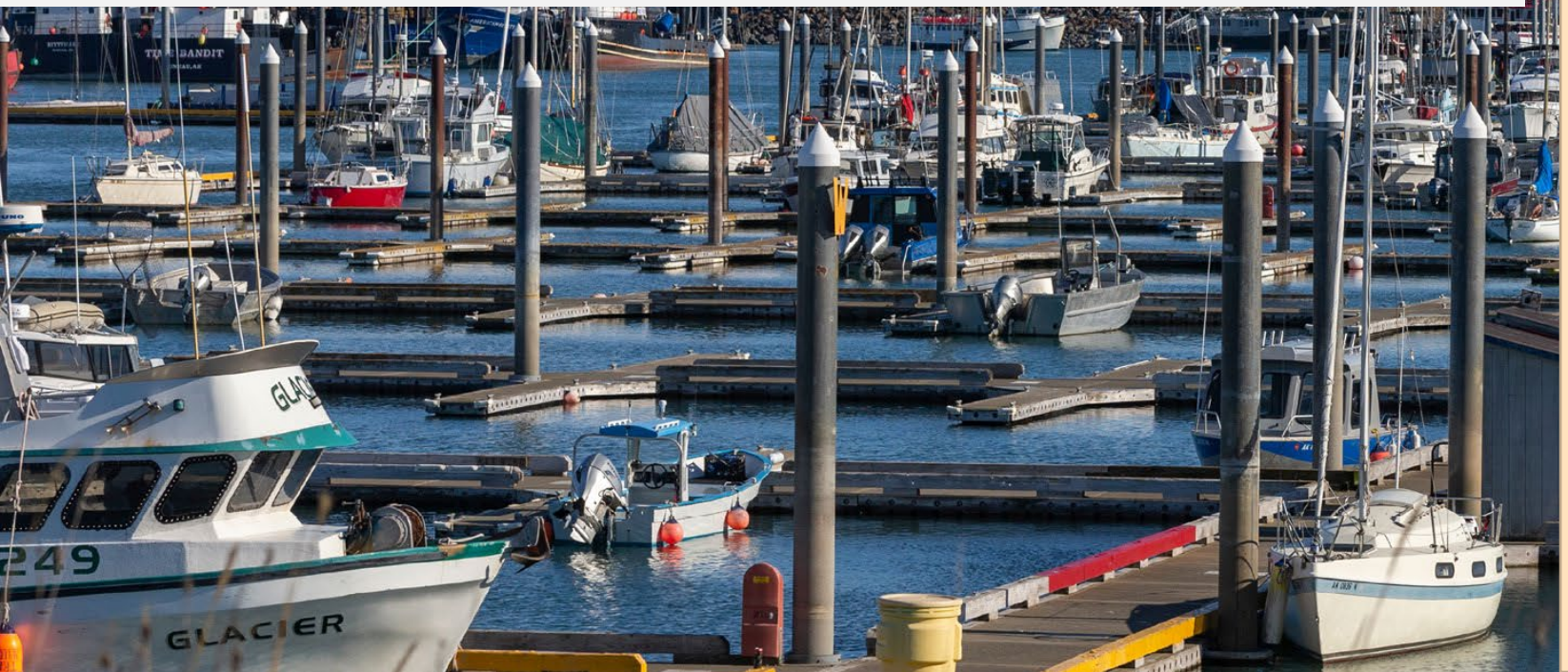
Homer Harbor Expansion Study Update

January 22, 2024

Agenda

1. Baseline Conditions Report
    1. Purpose
    2. Water Level
    3. Winds
    4. Topography/Bathymetry
    5. Circulation (MIKE21 HD model)
    6. Waves (MIKE21 SW and BW models)
    7. Sediment Transport
2. Next steps

Baseline Conditions



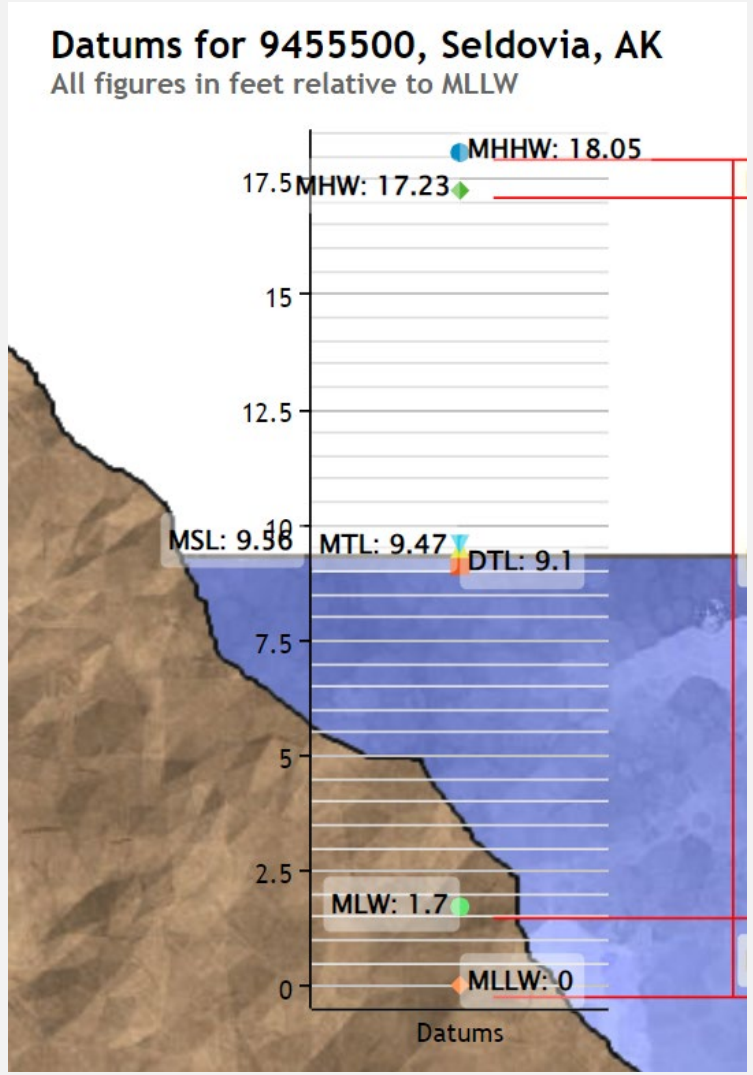
1. **Baseline Conditions**
2. Next Steps

Purpose

- Determine baseline meteorological and oceanographic (metocean) conditions at Homer Harbor
- Used to determine design conditions for conceptual design of alternatives
- Used to compare metocean conditions of alternatives versus "no action" alternative

Water Level – Data Sources

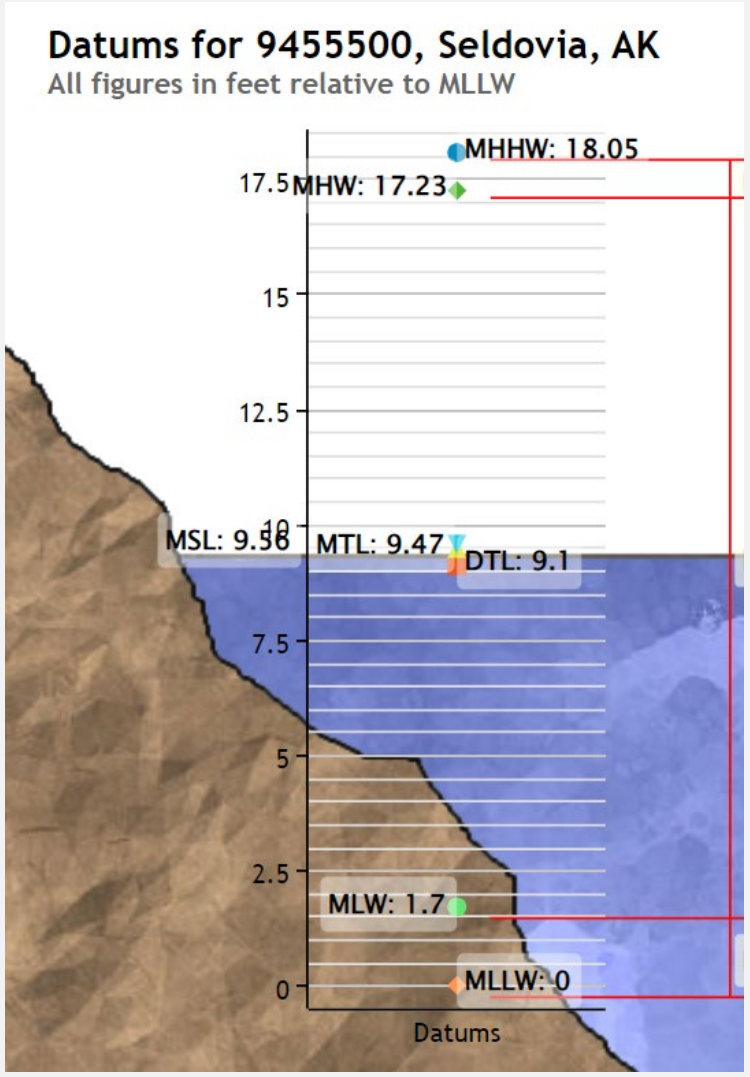
- Tide Gauges
  - NOAA Seldovia Gauge
    - 1-hour intervals from 1979
    - 6-min intervals from 2001
    - Used for modeling and extreme sea level analyses
  - Kachemak Bay National Estuarine Research Reserve Homer Dolphin Deep Water Quality gage
    - 15-min intervals from 2003
  - Ramp 8 Tidal Gage
    - 1-hour intervals from 2020
- Tidal to Geodetic Datum Conversion
  - Alaska Depart. Geological & Geophysical Surveys – Coal Point



Water Level – Tidal Datums

- Tidal Datum

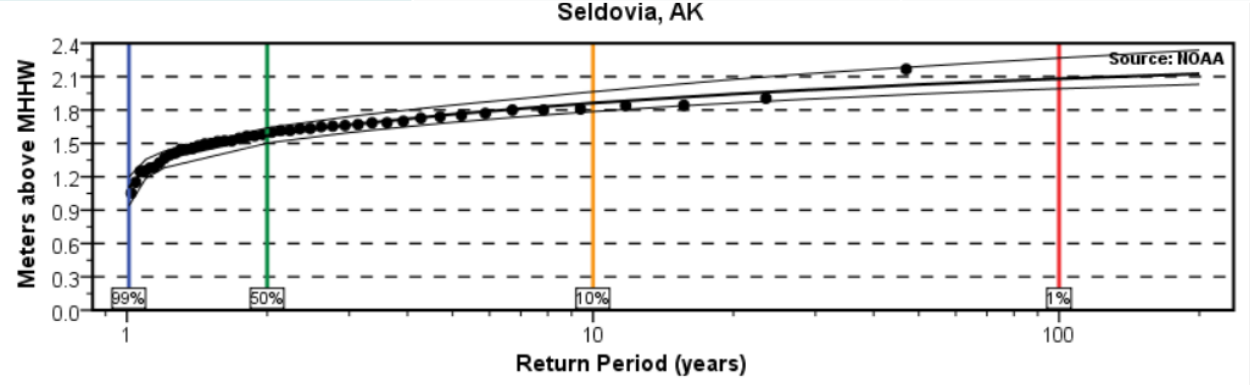
Datum	Elevation, feet MLLW	Elevation, feet NAVD88
Mean Higher High Water (MHHW)	18.43	13.33
Mean High Water (MHW)	17.59	12.49
Mean Sea Level (MSL)	9.73	4.63
Mean Tide Level (MTL)	9.63	4.53
NAVD88 (North American Vertical Datum of 1988)	5.10*	0.00
Mean Low Water (MLW)	1.66	-3.44
Mean Lower Low Water (MLLW)	0.00	-5.10



Water Level – Storm Surge

- Extreme Water Levels

	Elevation, feet MLLW	Elevation, feet NAVD88
Mean Lower Low Water (MLLW)	0	-5.1
Mean Sea Level (MSL)	9.73	4.63
Mean Higher High Water (MHHW)	18.43	13.33
5% Annual Exceedance Probability (AEP)	24.826	19.726
2% AEP	25.072	19.972
1% AEP	25.2524	20.1524
1% AEP + Relative Sea Level Change (USACE High)	25.6824	20.5824



Water Level – Relative Sea Level Change

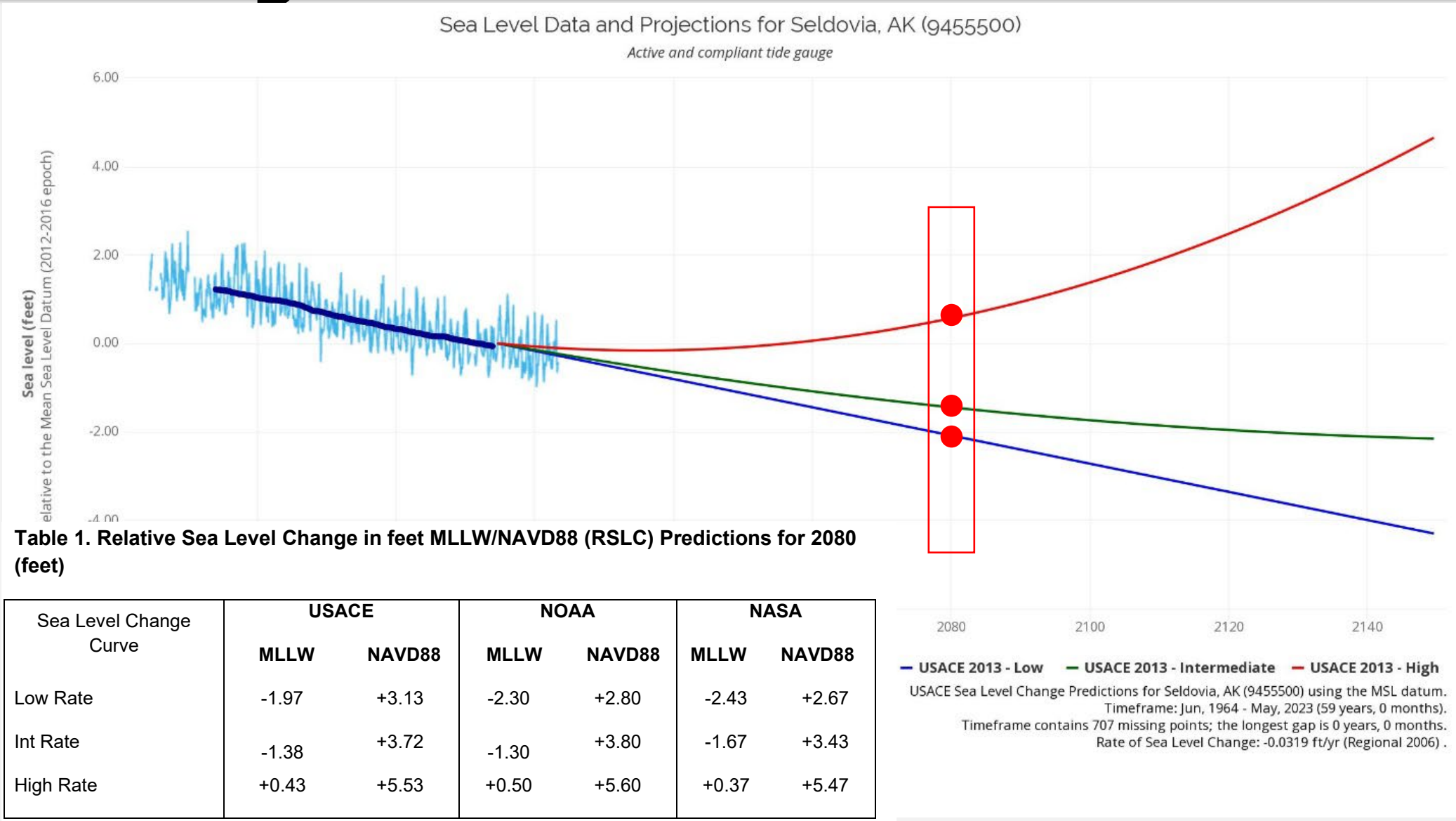


Table 1. Relative Sea Level Change in feet MLLW/NAVD88 (RSLC) Predictions for 2080 (feet)

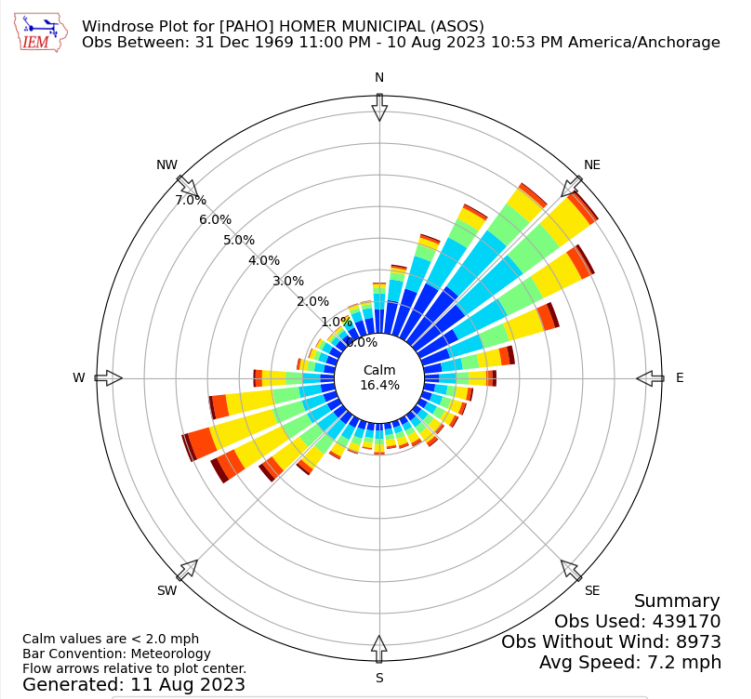
Sea Level Change Curve	USACE		NOAA		NASA	
	MLLW	NAVD88	MLLW	NAVD88	MLLW	NAVD88
Low Rate	-1.97	+3.13	-2.30	+2.80	-2.43	+2.67
Int Rate	-1.38	+3.72	-1.30	+3.80	-1.67	+3.43
High Rate	+0.43	+5.53	+0.50	+5.60	+0.37	+5.47

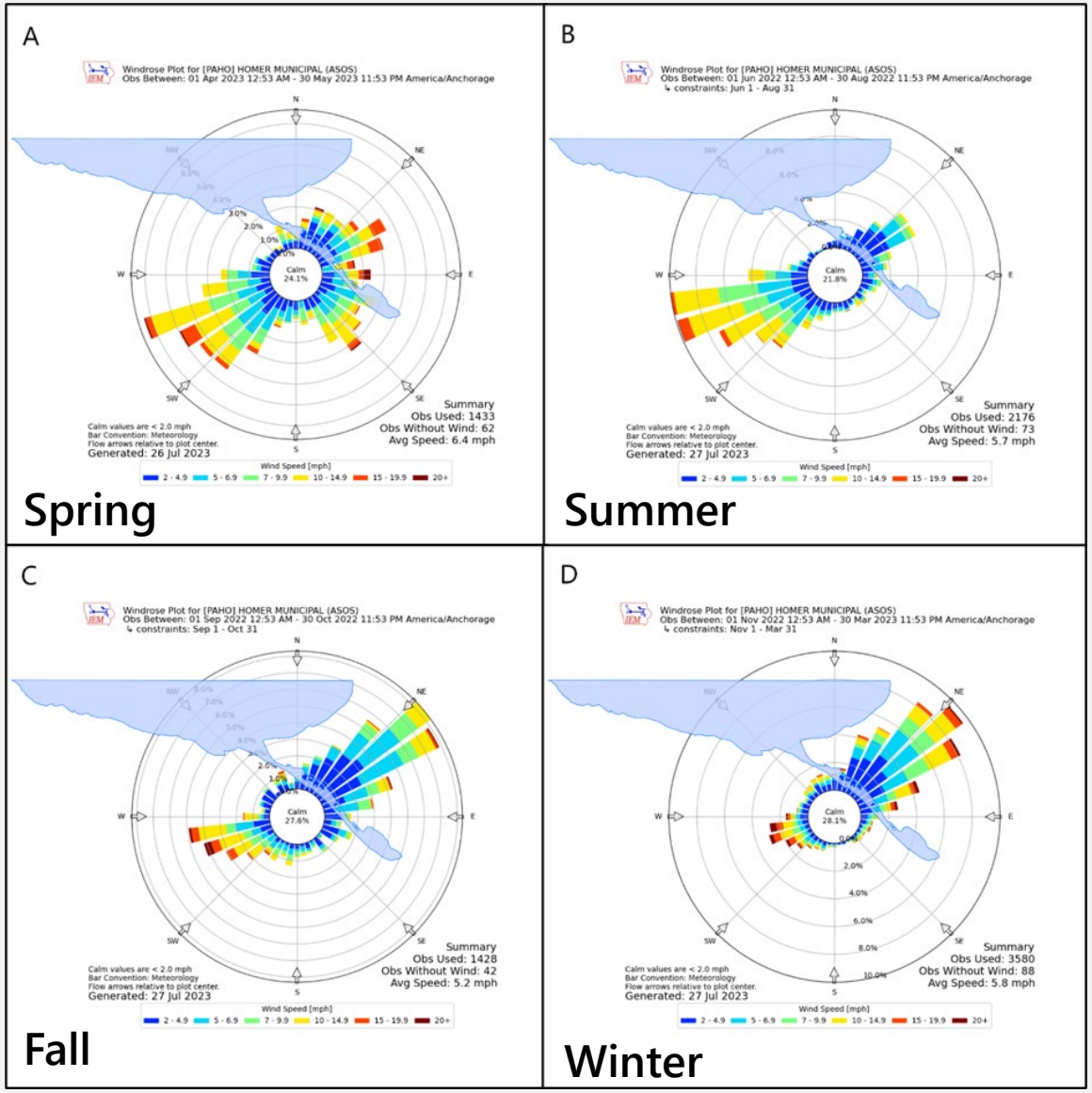
Wind – Data Sources

- Homer Spit
  - Not used as primary source due to length of available record
- Homer Airport (PAHO ASOS)
  - Analysis of direction, speed, and duration

Wind - Trends

All Seasons

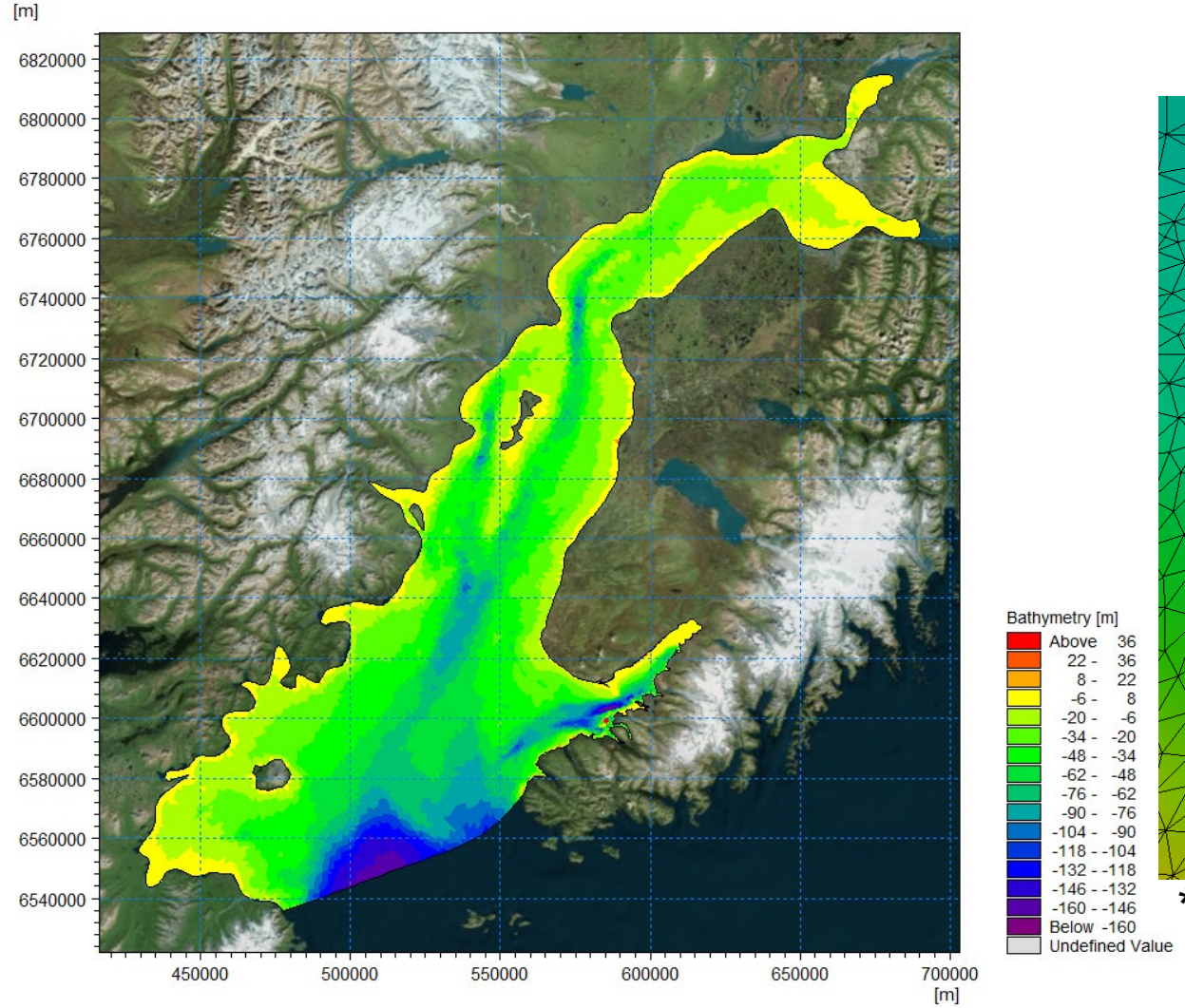


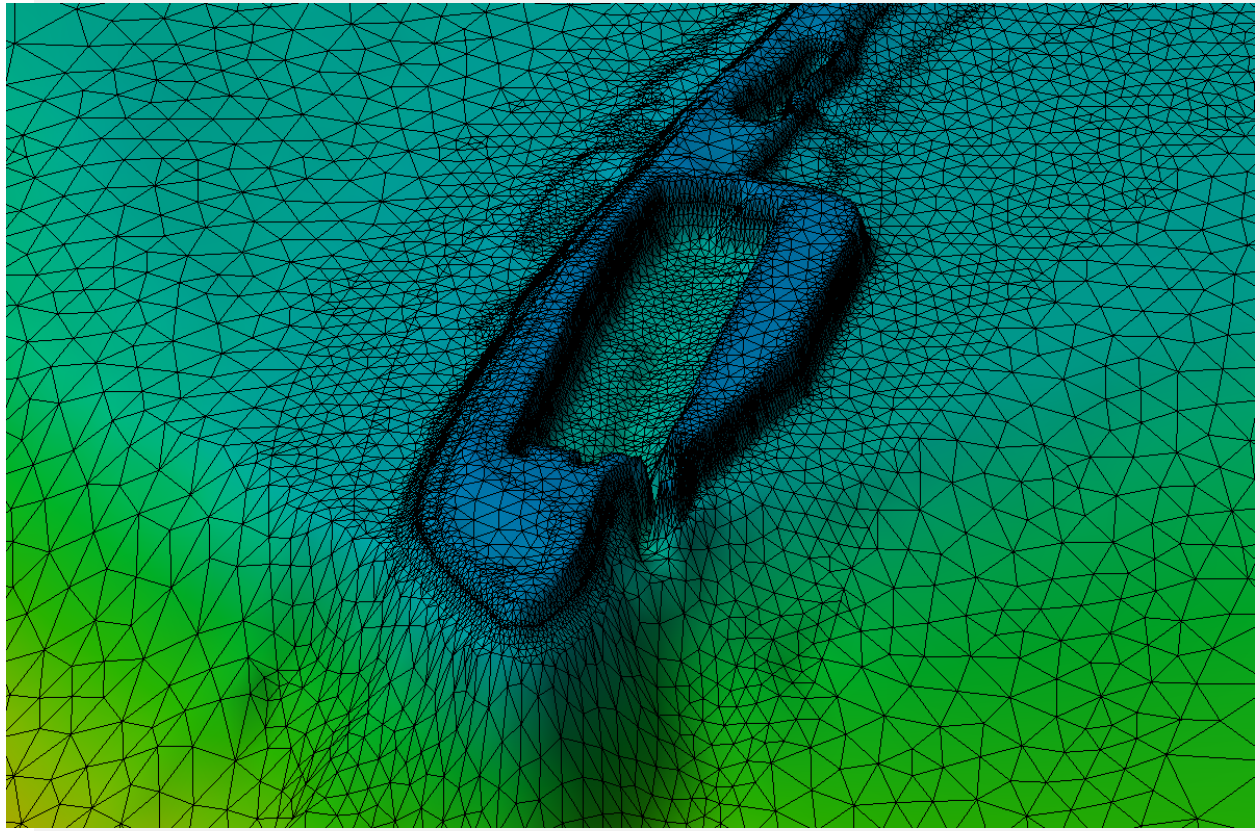


Topography and Bathymetry – Data Sources

- Topography
  - 2018 NOAA Digital Elevation Model
  - 2019 USACE LiDAR (light detecting and ranging)
- Bathymetry
  - 2019 USACE LiDAR
  - 2021 NOAA Navigation Charts
  - 2019 USACE Maintenance Dredge Survey
  - 2008 NOAA Hydrographic Survey
- Used to build a structured mesh of Cook Inlet and surrounding areas

Topography and Bathymetry - Uses

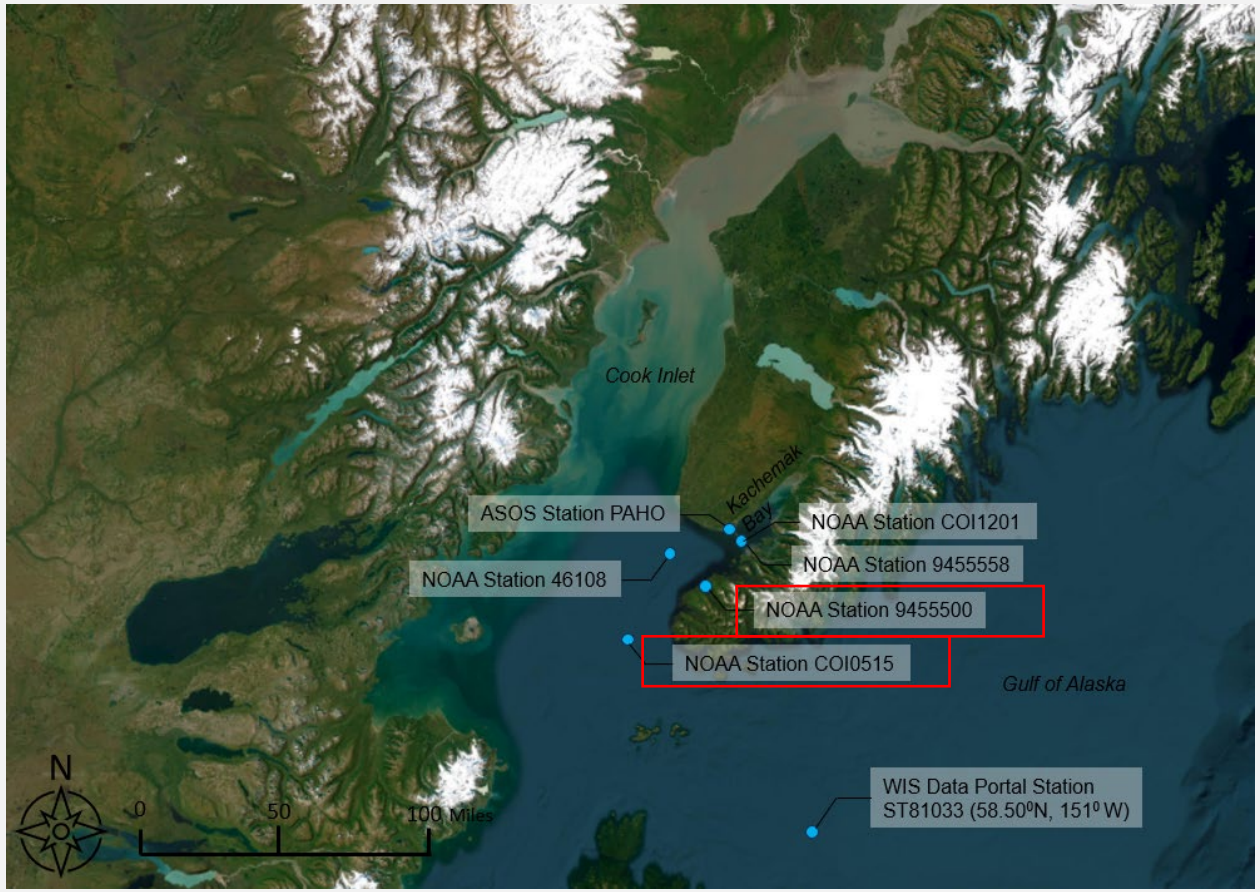




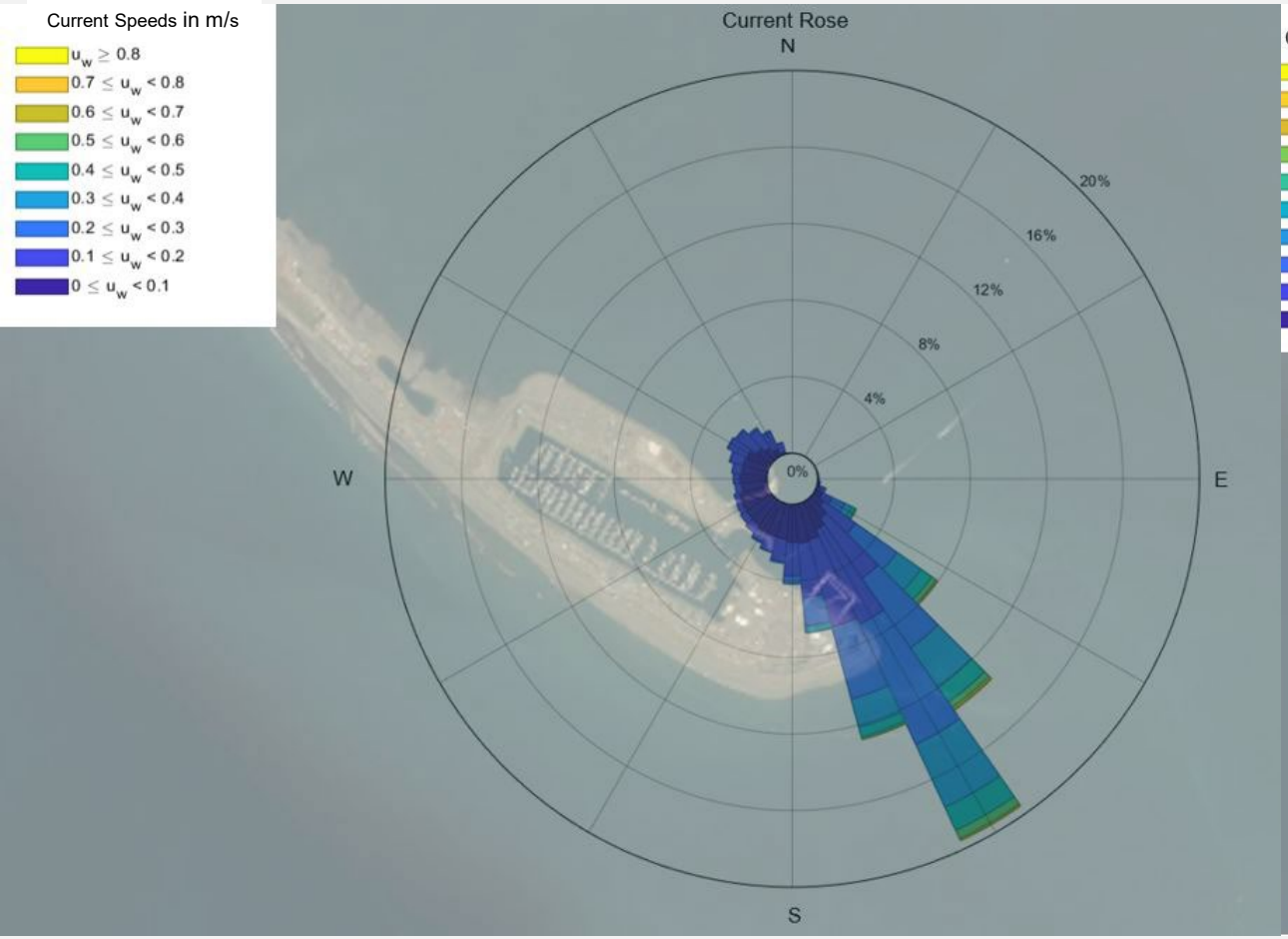
*Mesh is exaggerated in the Z-axis to highlight definition

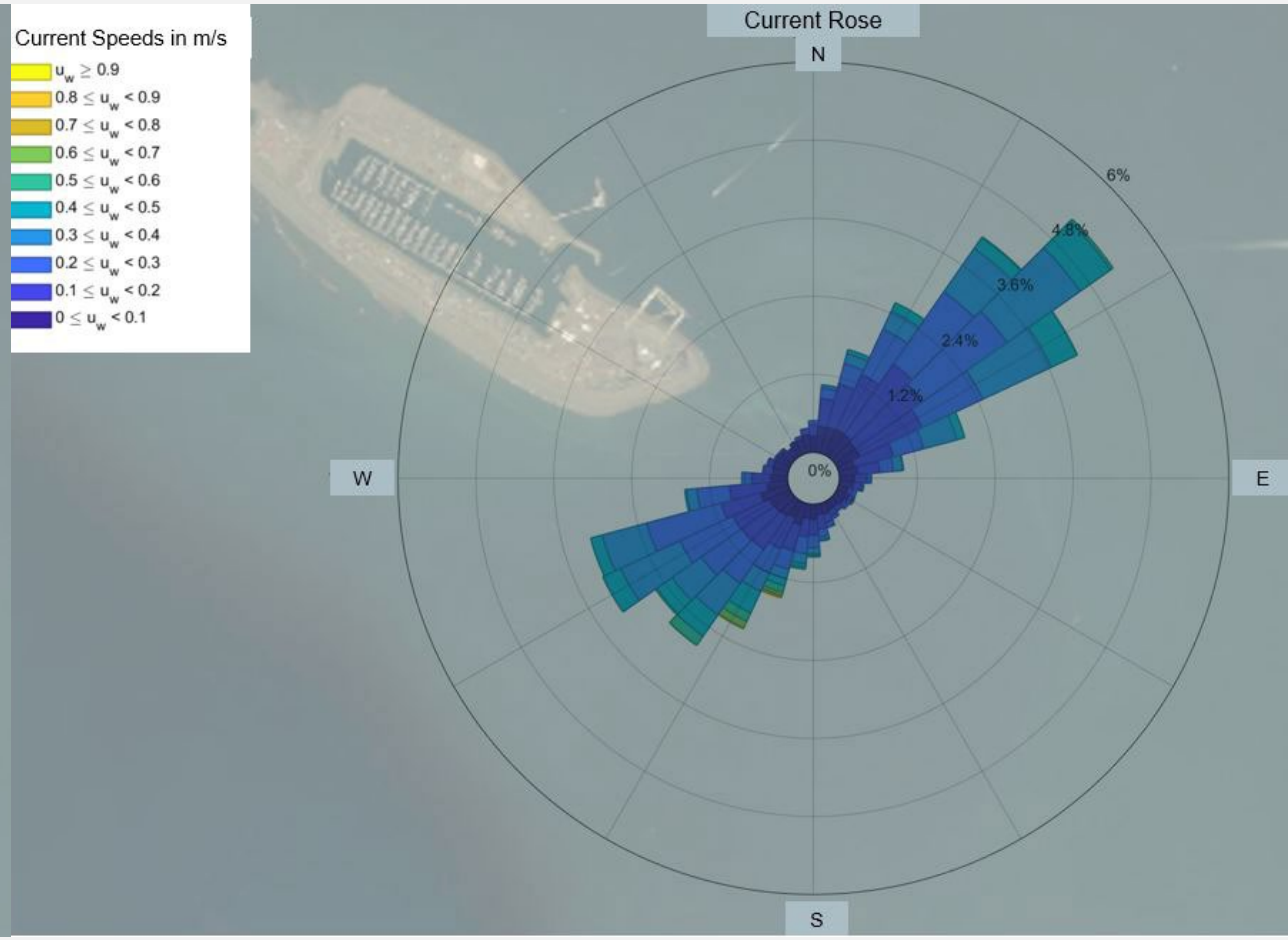
Circulation – Data Sources

- Temporary current gages
  - Deep Water Dock
  - Off the tip of the Spit
- Current roses based on direction and speed
- NOAA Seldovia Gauge (Water Level)
- NOAA Kachemak Bay (Current)

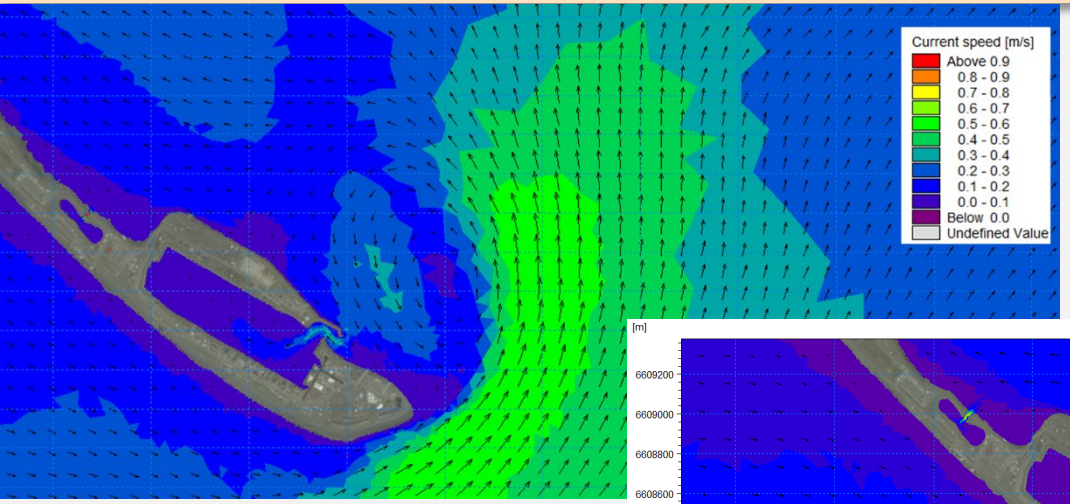


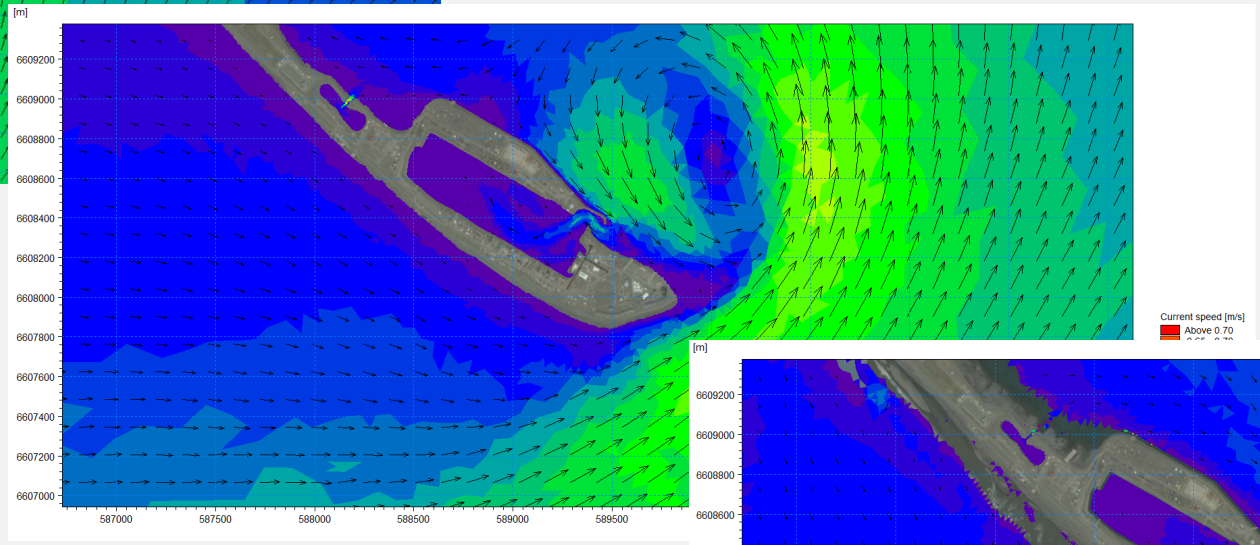
Circulation – Existing Conditions

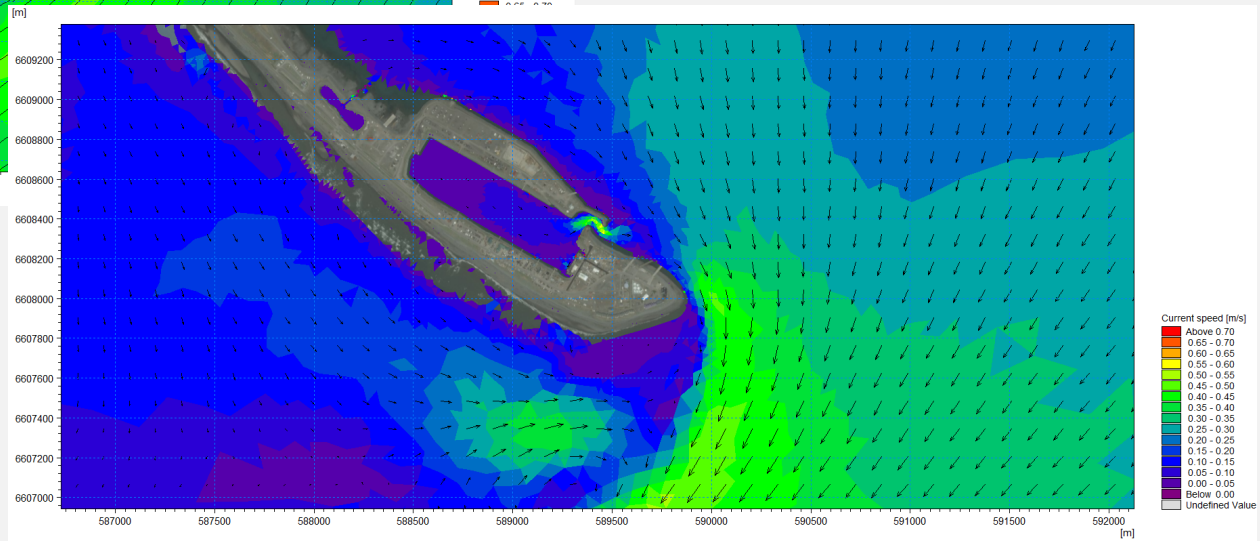




Circulation – Model Results







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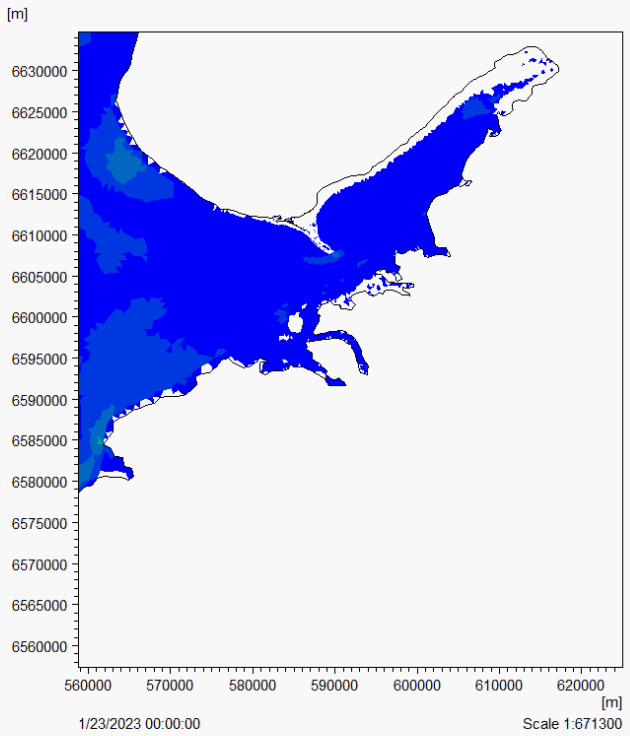
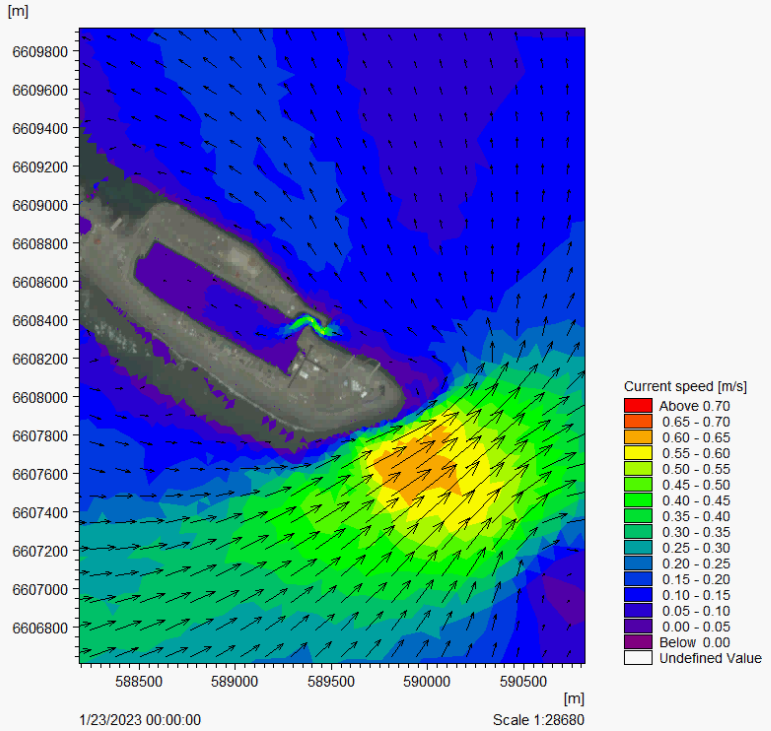
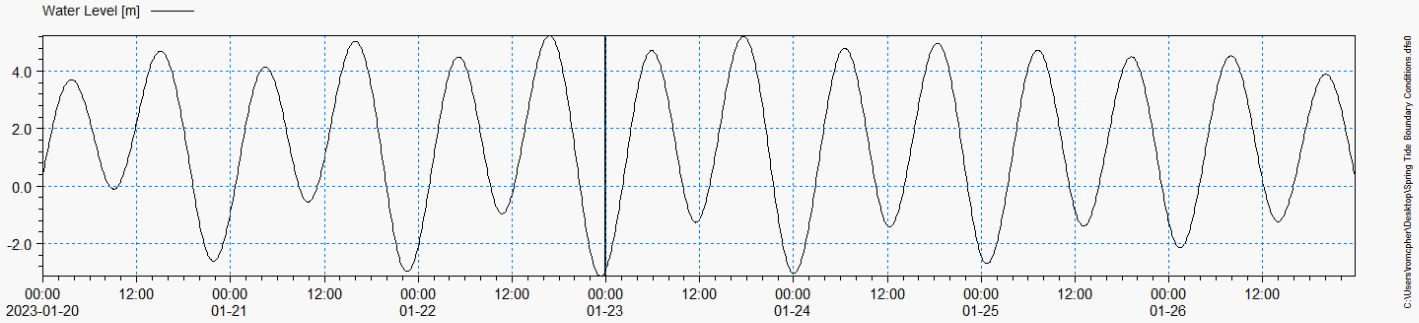


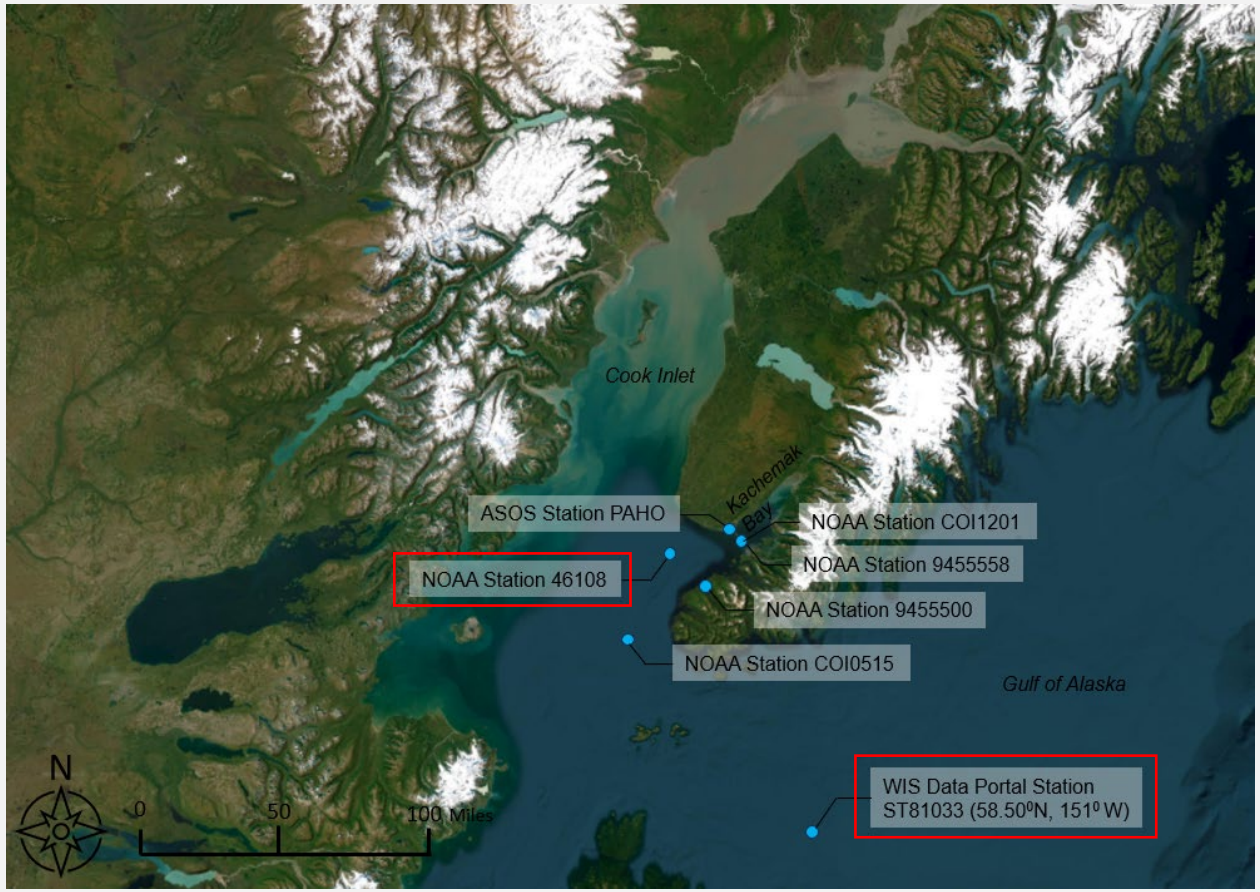




Waves – Data Sources

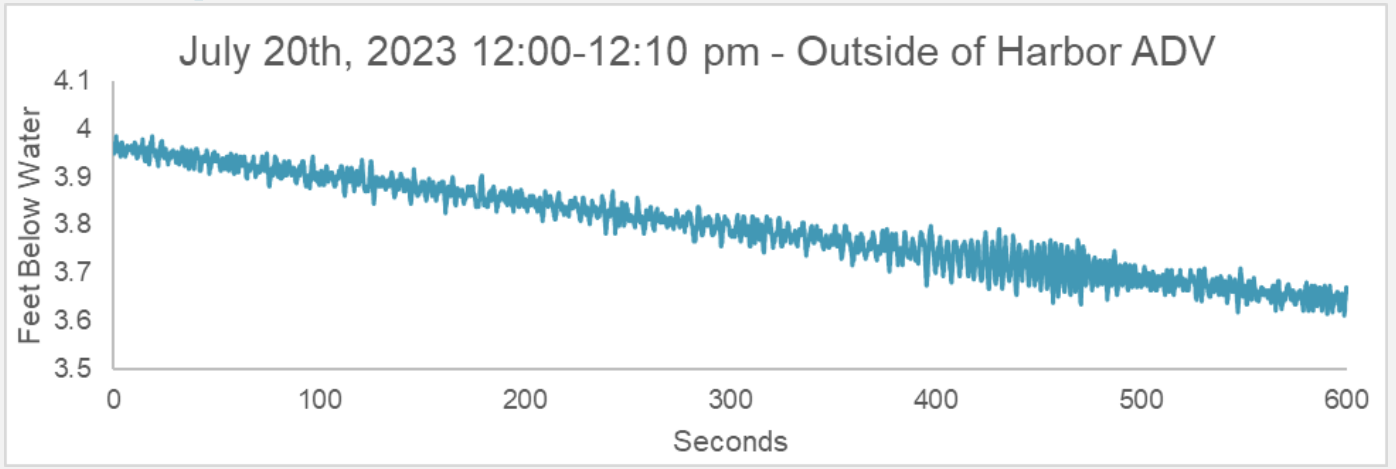
- Temporary Wave Gauge at Deep Water Dock
- Kachemak Bay (NDBC Station 46108)
- Gulf of Alaska (WIS ST81033)

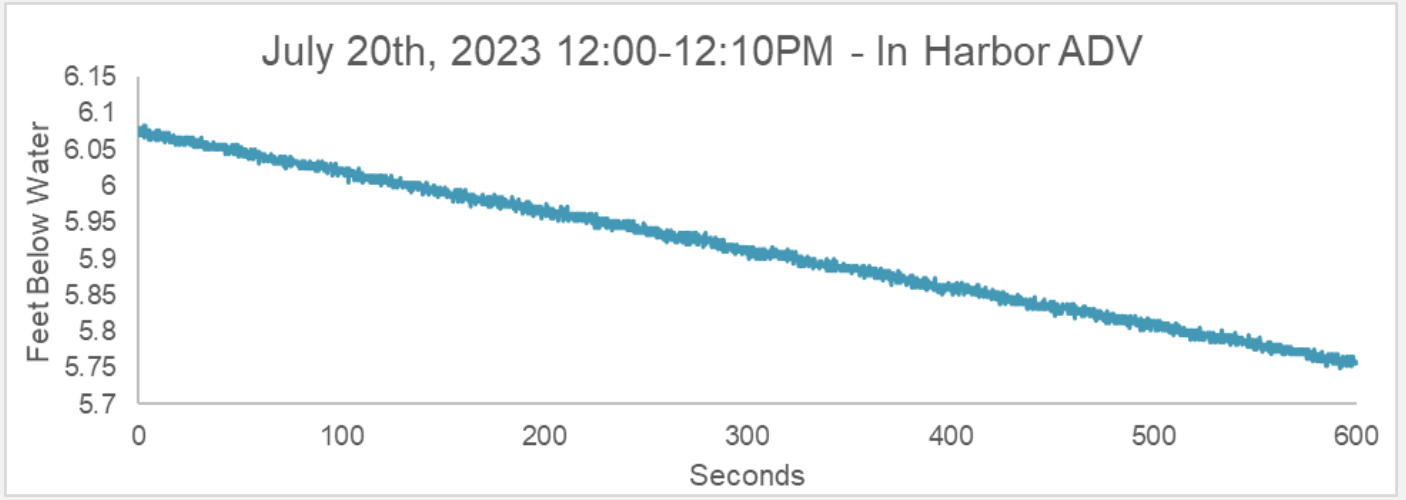
Return Period, year	Gulf of Alaska, Wave Height, feet	Mouth of Kachemak Bay, Wave Height, feet
2	30.12	14.73
5	32.47	16.53
20	38.86	18.92
50	41.01	20.54
100	43.34	21.65



Waves - ADV

- Acoustic Doppler Velocimeters placed July 20-August 15, 2023
  - Ramp 8
  - Deep Water Dock Dolphin



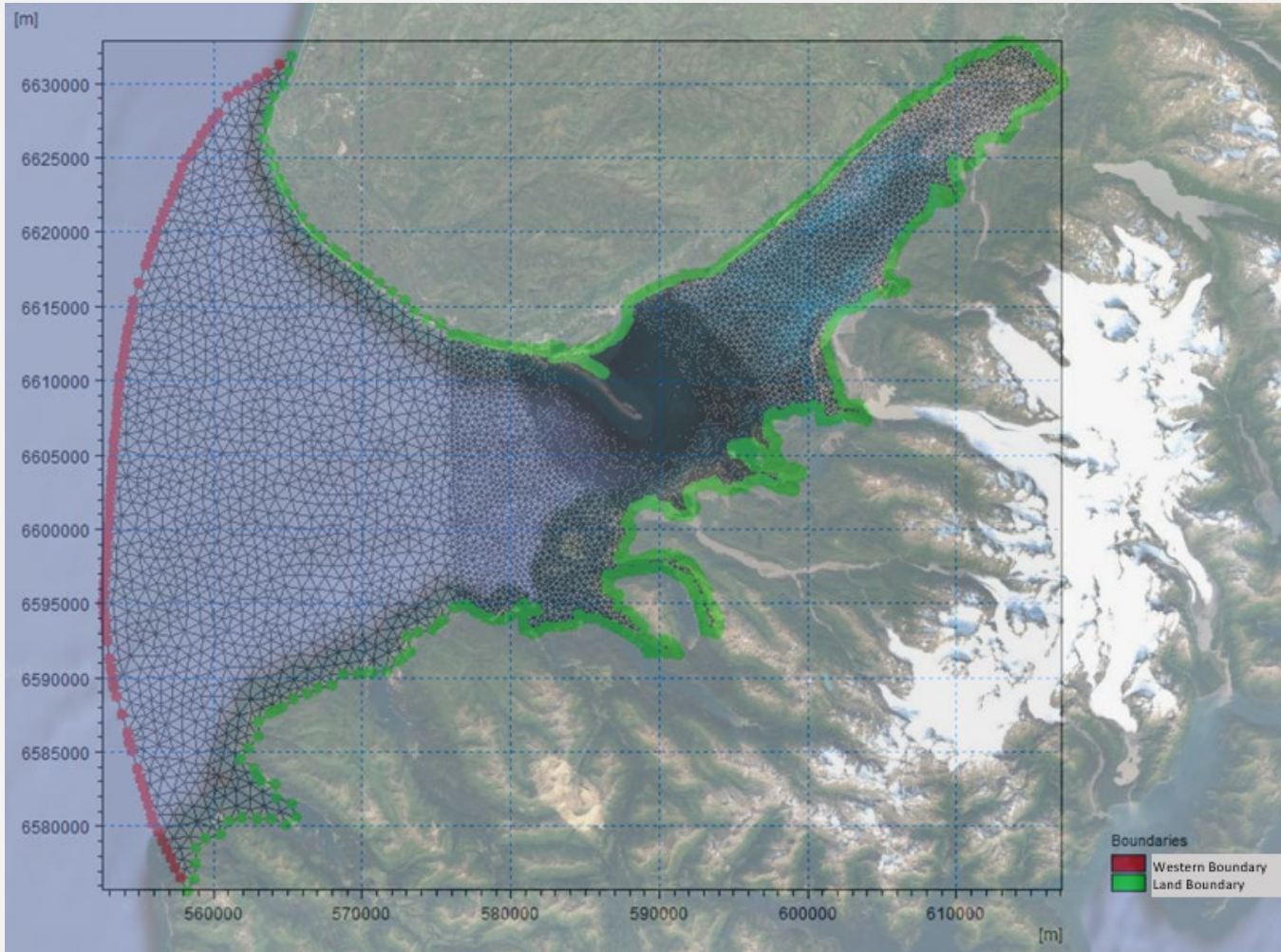


Waves – Modeling Overview

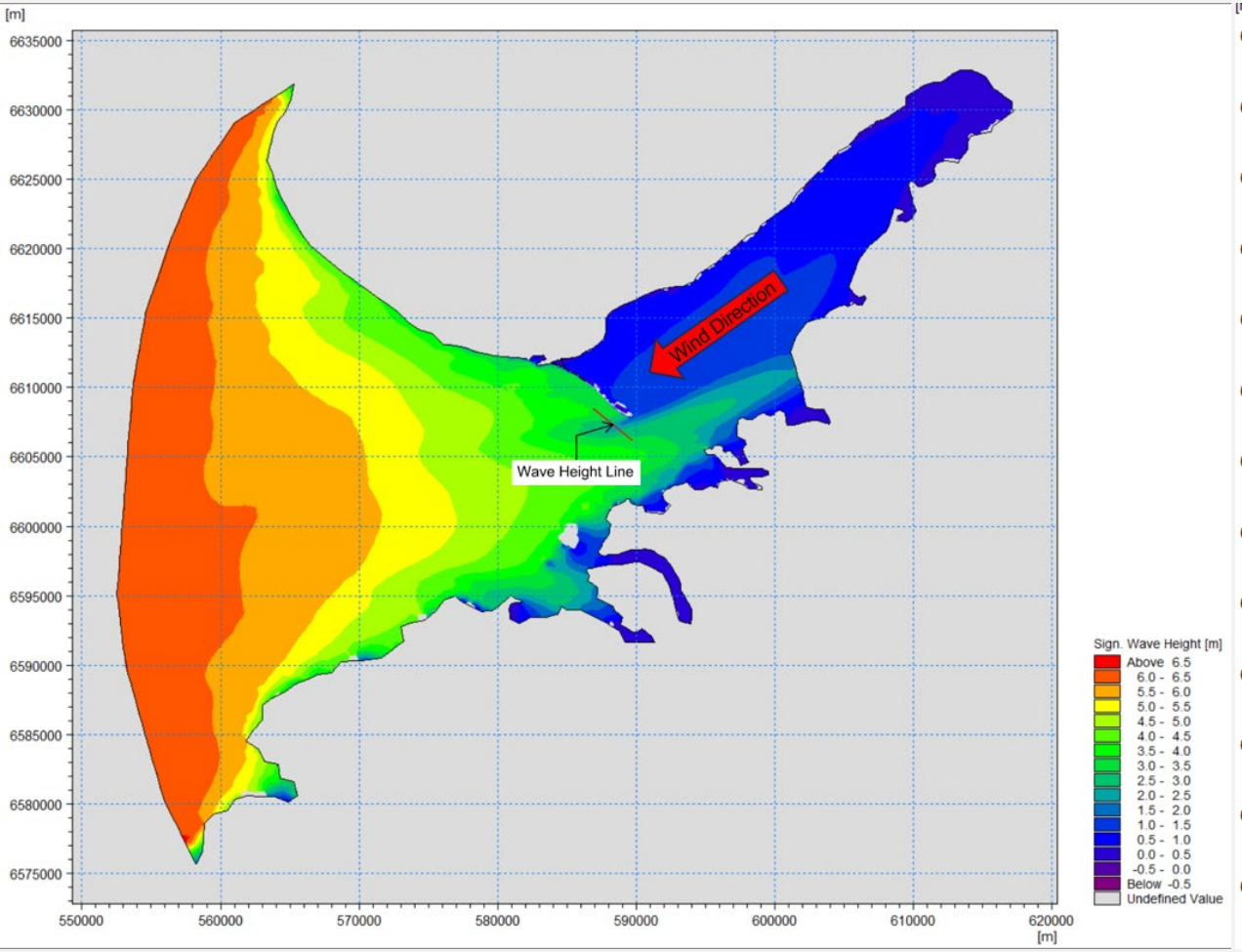
- Two wave models used
  - MIKE21 Spectral Wave (SW)
  - MIKE21 Boussinesq Wave (BW)
- MIKE21 SW
  - Regional Model
  - Used for outer harbor design conditions
  - Used to create boundary conditions for MIKE21 BW
- MIKE21 BW
  - Local (time-domain) model
  - Used to understand harbor dynamics

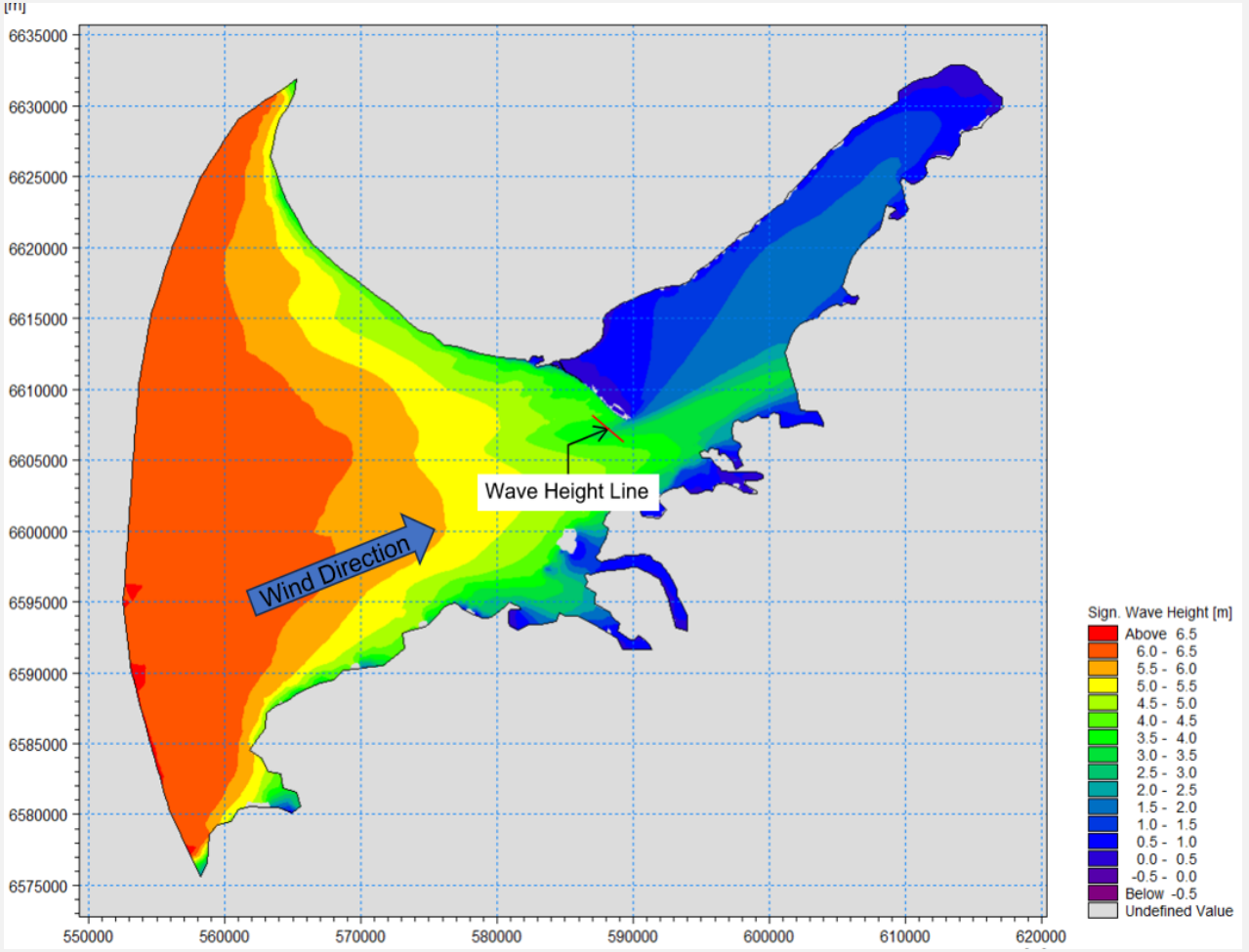
Waves - Spectral Wave Model

- 335 model runs, varying the conditions at the mouth of Kachemak Bay
- Inputs Include:
  - Water Level
  - Wind (16 cardinal directions)
  - Swell (from 277 degrees)

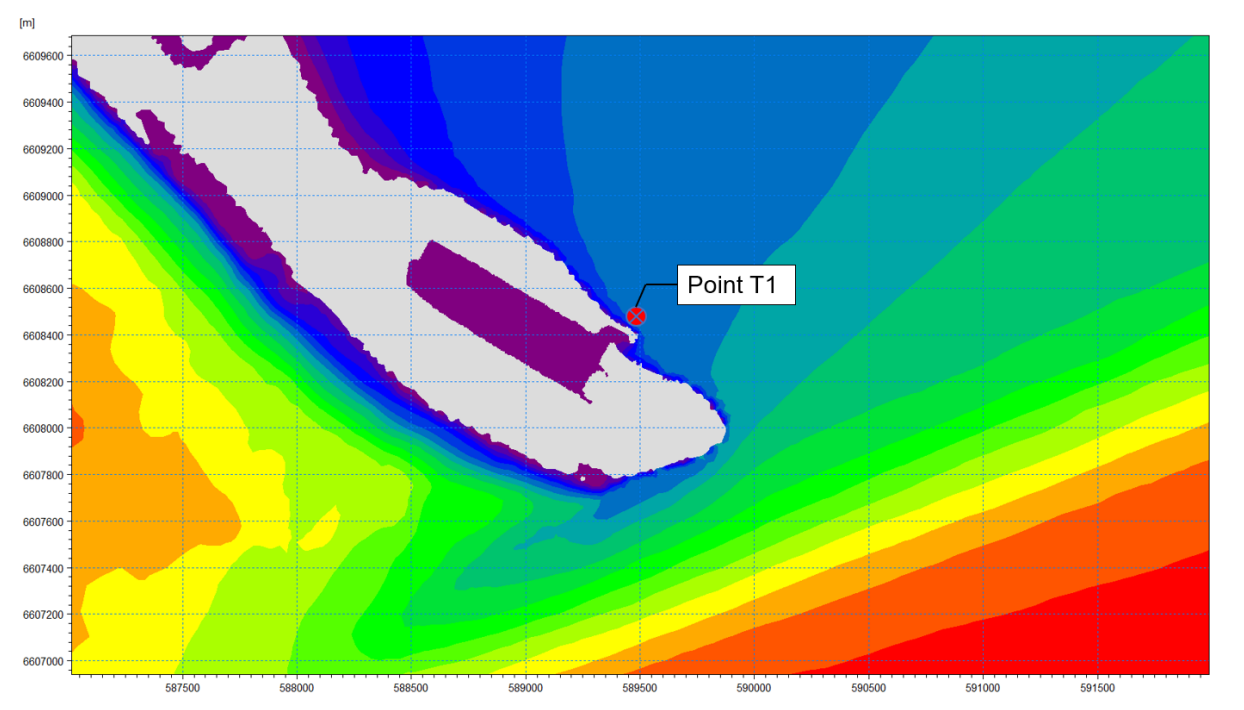


Spectral Wave Model Results





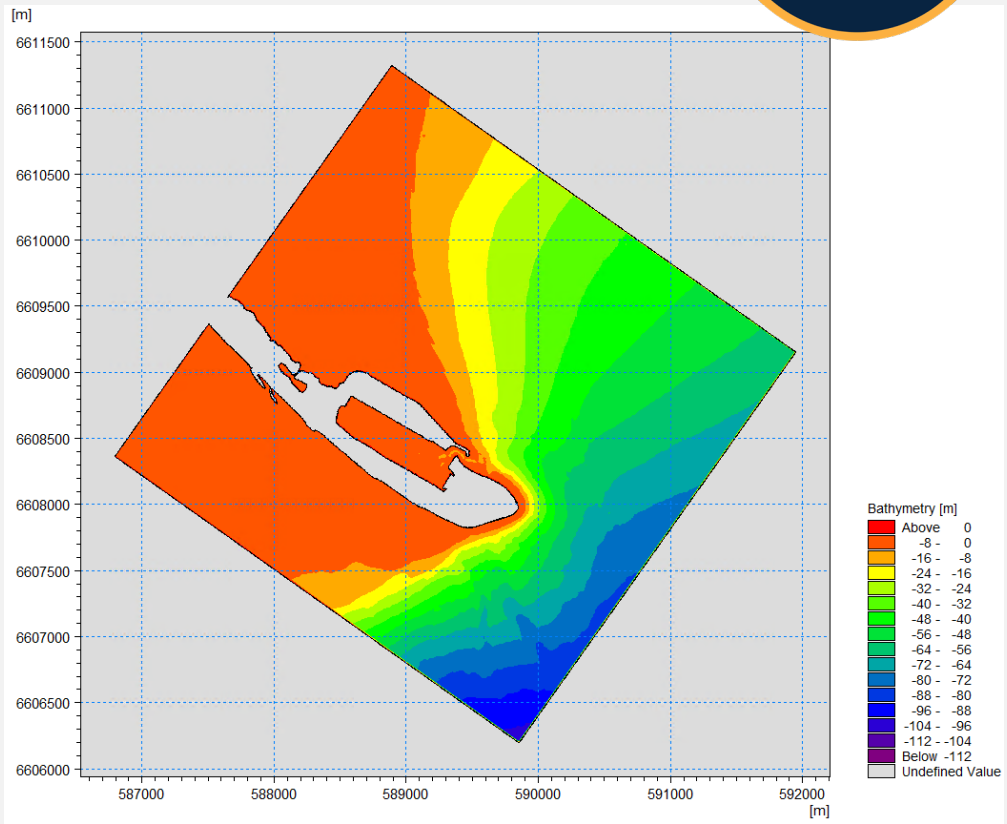
Spectral Wave Model Results



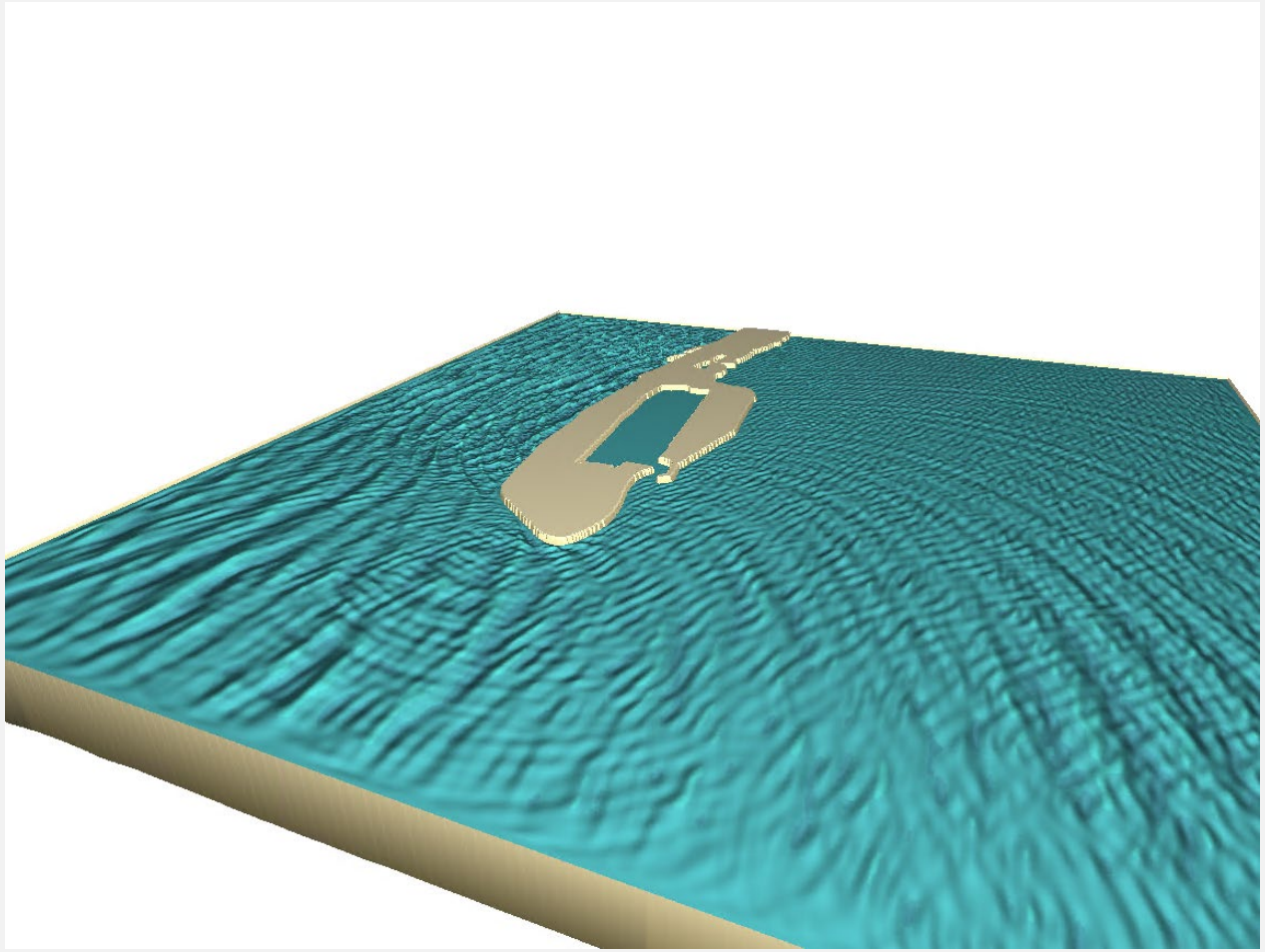
Water Condition	Wind Condition	Water Level NAVD88, feet	Wave Height, feet	Wave Period, seconds
MLLW	5% AEP	-5.10	2.65	3.17
MSL	5% AEP	4.63	2.82	3.11
MHHW	5% AEP	13.33	2.98	3.18
5% AEP	5% AEP	19.73	3.07	3.22
2% AEP Water	5% AEP	19.97	3.07	3.23
1% AEP Water	5% AEP	20.15	3.08	3.23
1% AEP Water + RSLR	5% AEP	20.58	3.08	3.23
MLLW	2% AEP	-5.10	2.85	3.27
MSL	2% AEP	4.63	3.04	3.21
MHHW	2% AEP	13.33	3.20	3.27
5% AEP	2% AEP	19.73	3.29	3.32
2% AEP Water	2% AEP	19.97	3.29	3.32
1% AEP Water	2% AEP	20.15	3.30	3.32
1% AEP Water + RSLR	2% AEP	20.58	3.30	3.32
MLLW	1% AEP	-5.10	3.04	3.38
MSL	1% AEP	4.63	3.22	3.29
MHHW	1% AEP	13.33	3.36	3.34
5% AEP	1% AEP	19.73	3.45	3.38
2% AEP Water	1% AEP	19.97	3.45	3.39
1% AEP Water	1% AEP	20.15	3.46	3.39
1% AEP Water + RSLR	1% AEP	20.58	3.46	3.39

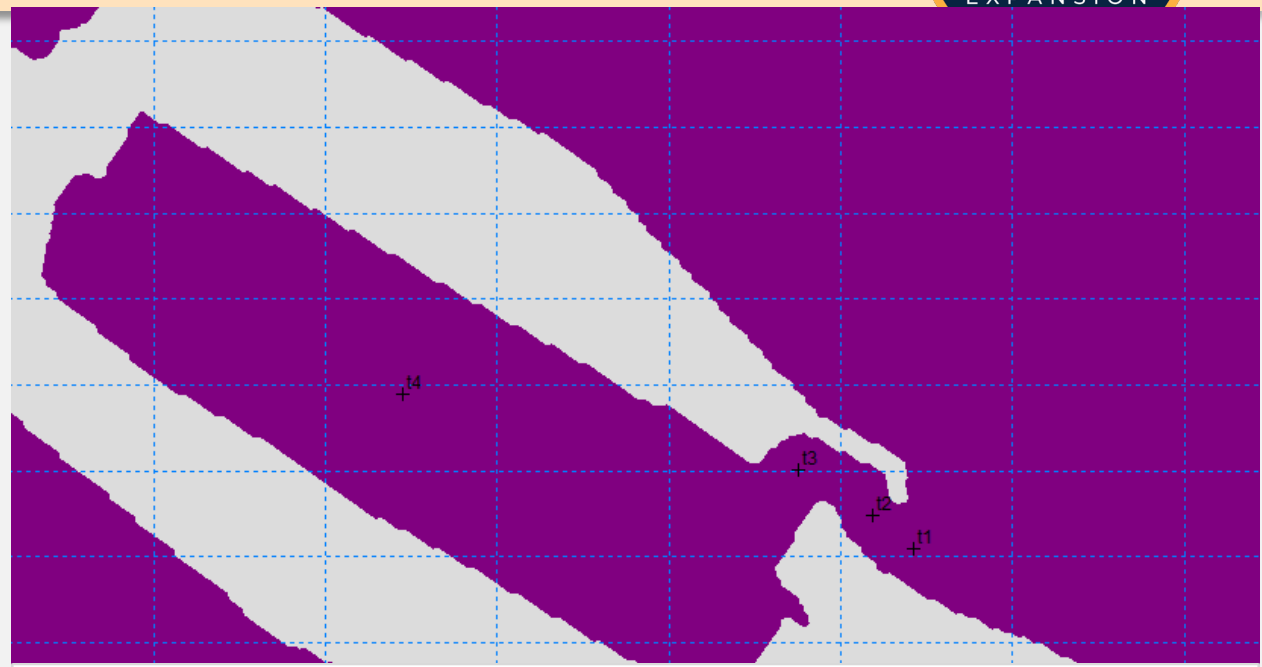
Waves - Boussinesq Wave Model

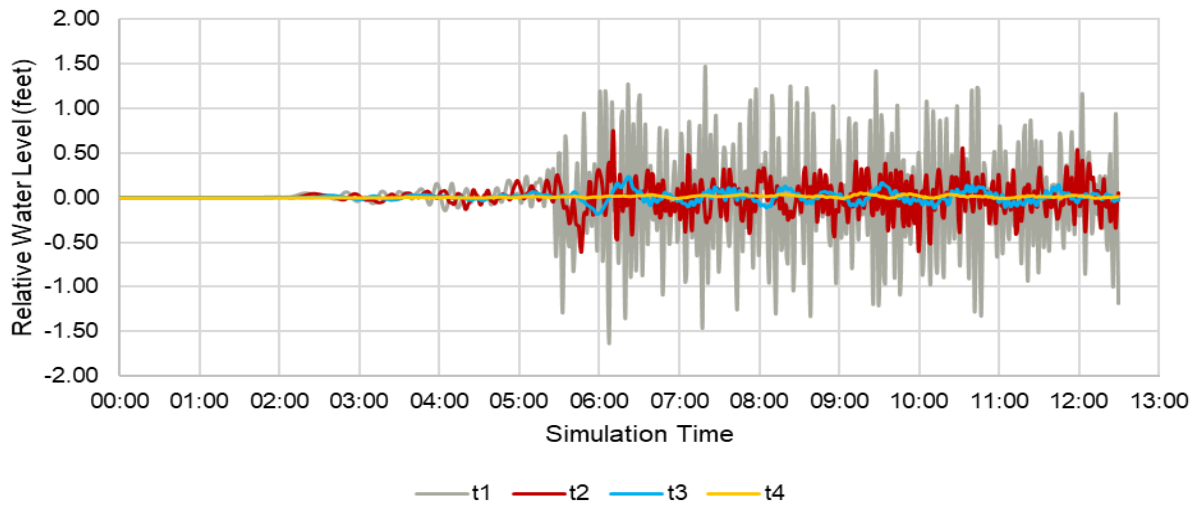
- Two-dimensional wave model
- Used to simulate:
  - Shoaling
  - Refraction
  - Diffraction
  - Wave Breaking
  - Bottom Friction
  - Moving shoreline
  - Partial reflection and transmission
  - Non-linear wave-wave interaction
  - Frequency spacing
  - Directional spreading
- Most interested in wave-wave interactions near the harbor and propagation into the harbor



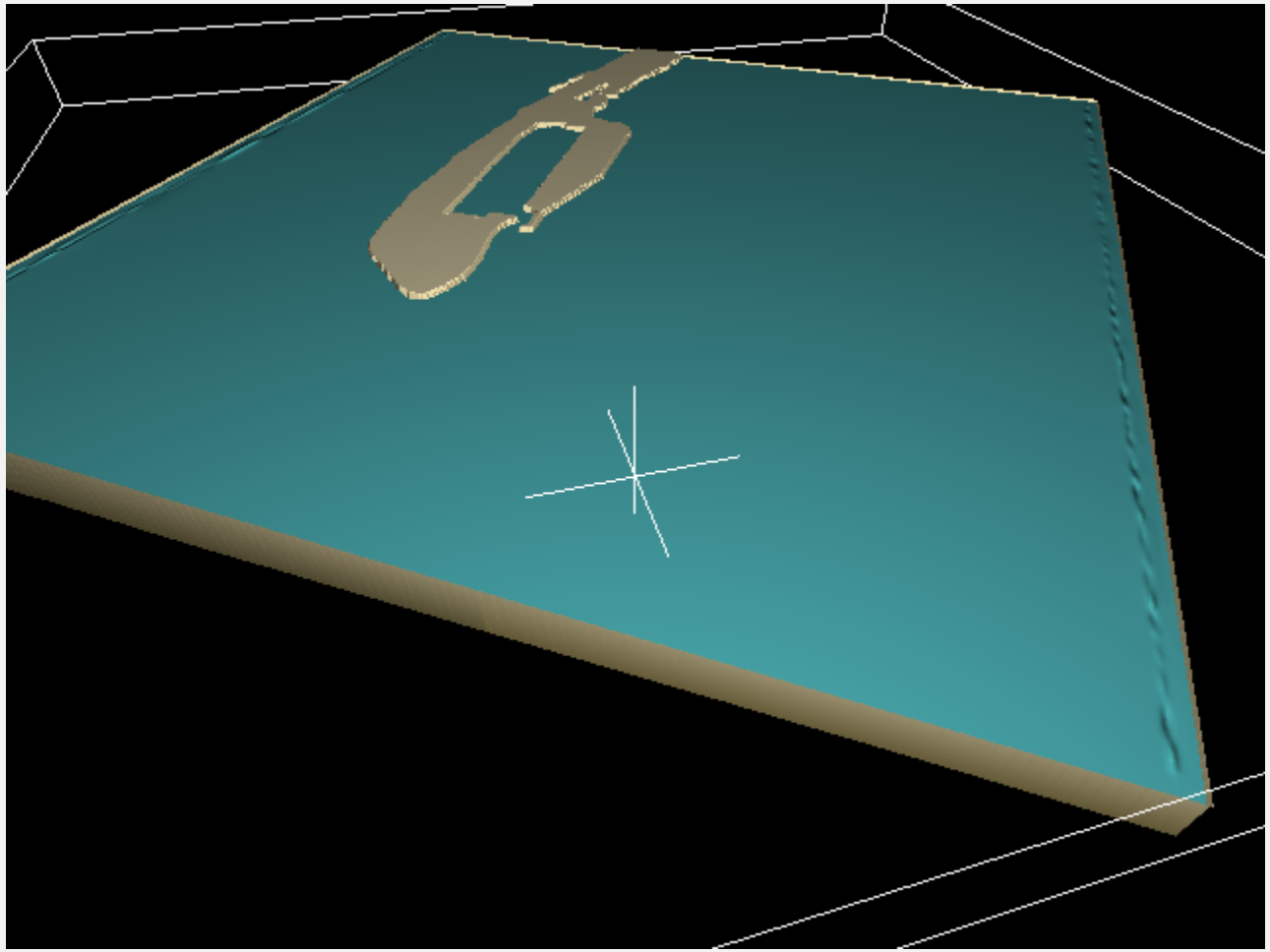
Waves - Boussinesq Wave Model Results







Waves - Boussinesq Wave Model Results

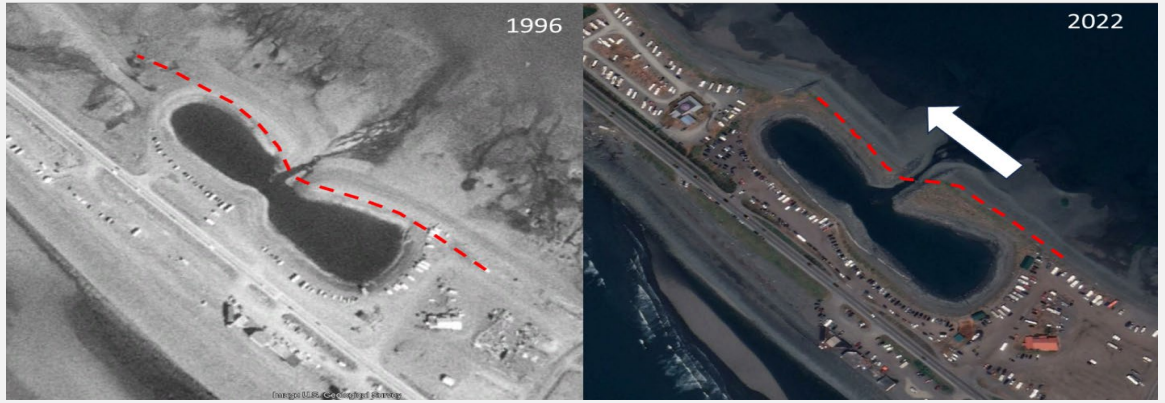


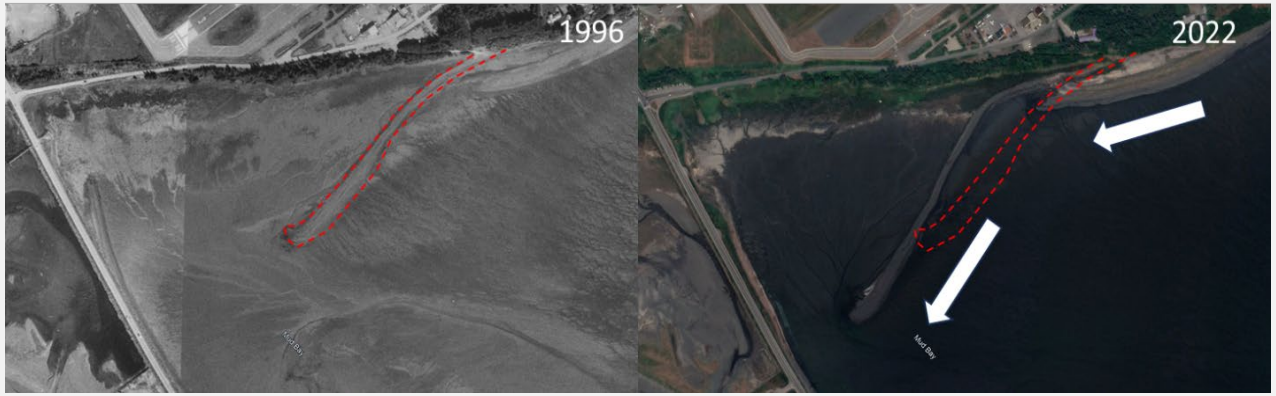
Sediment Transport - Overview

- Sediment Transport
  - Cross-Shore transport – seasonal (larger/higher summer beaches, narrow/lower winter beaches)
  - Long-shore transport – movement of sediment up and down (along) the shoreline
- Sediment Transport Literature Review
- Windrose Assessments
- Sediment trends using historical imagery

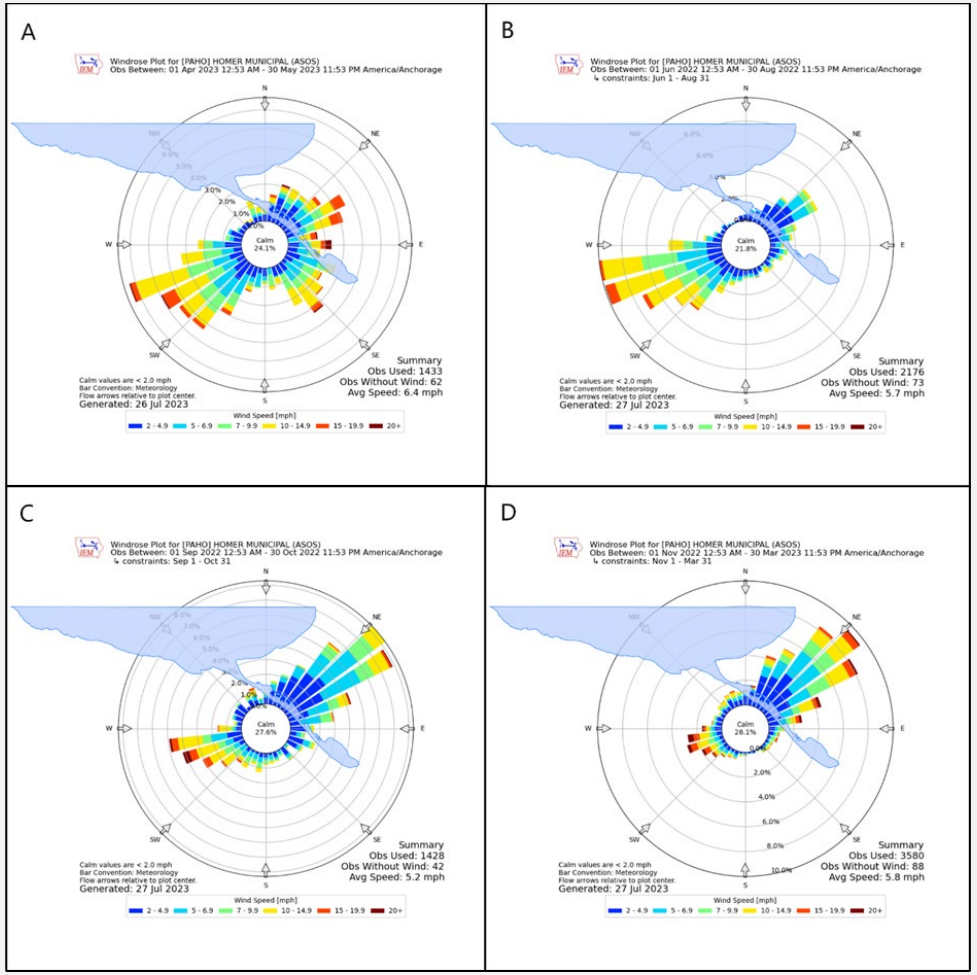
Sediment Transport - Trends

- Literary and Desktop review of sources, currents, sinks, and deposits completed

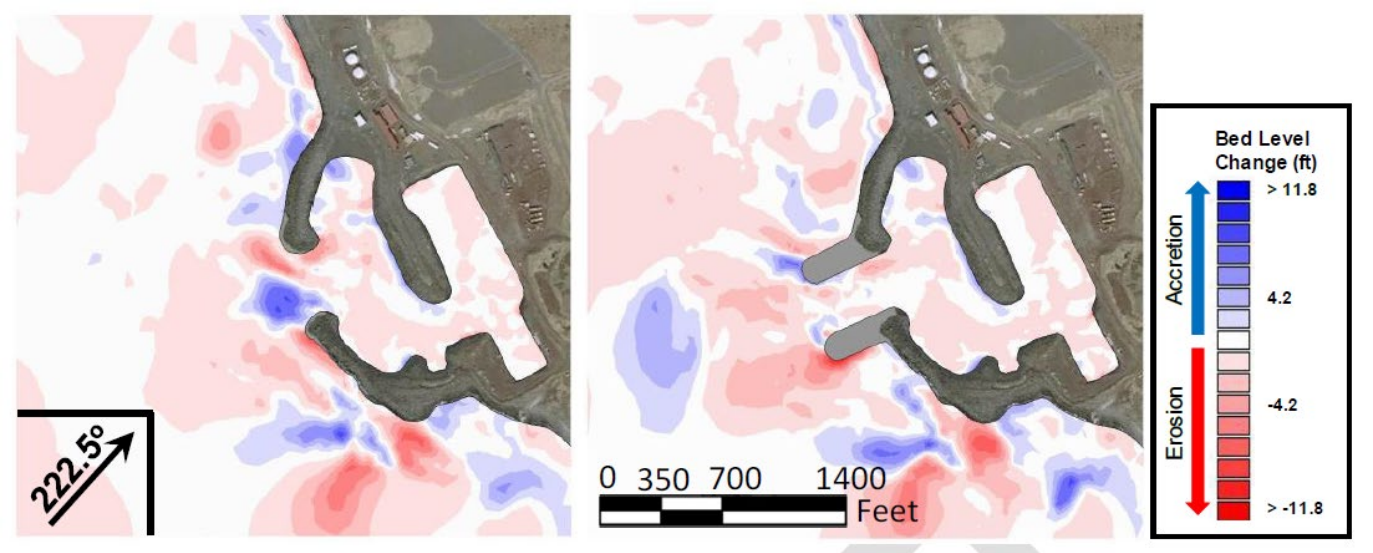


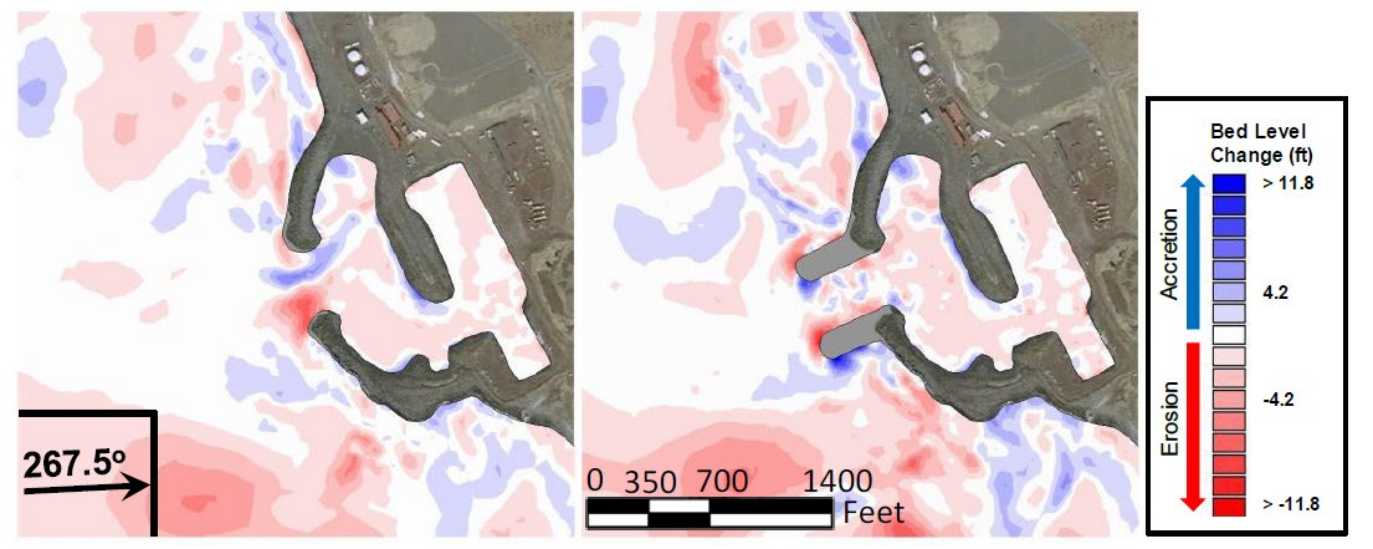


Sediment Transport – Windrose Analysis

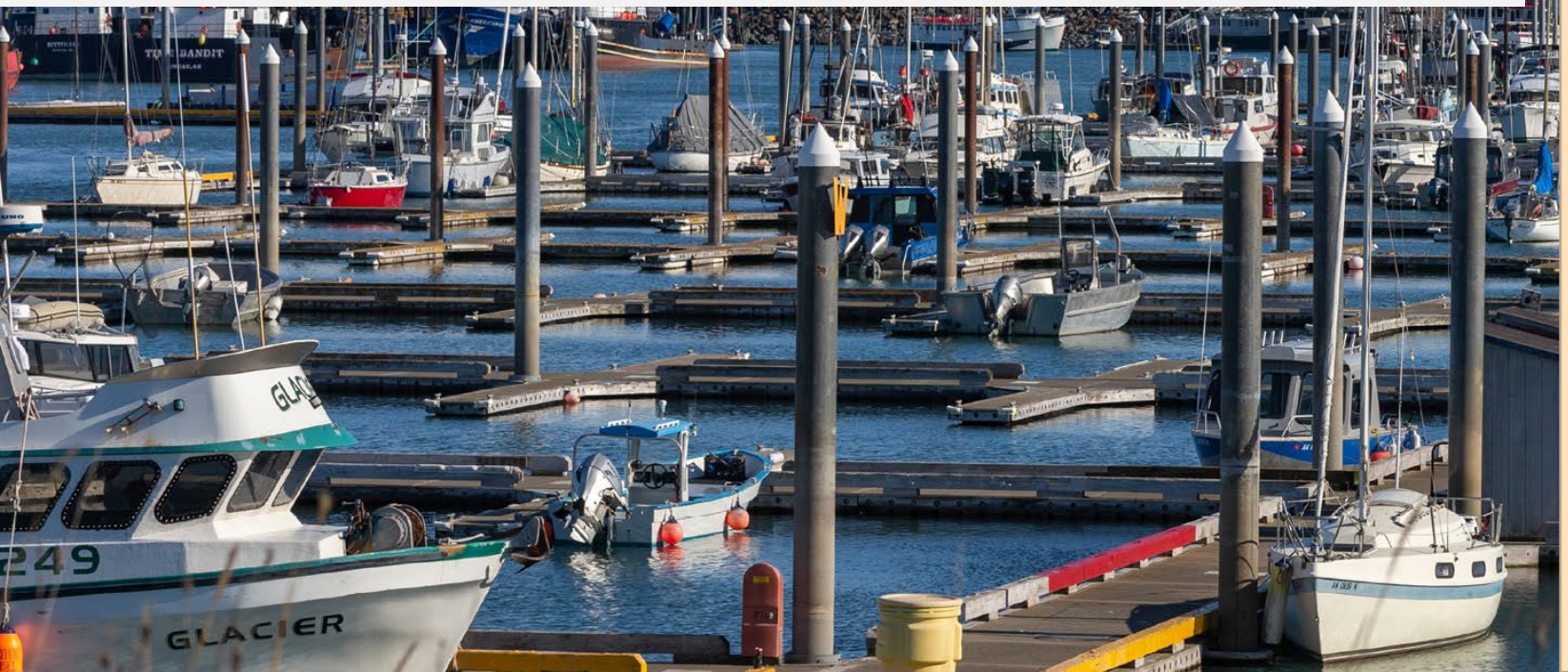


Sediment Transport – Future Modeling





Next Steps



1. Baseline Conditions
2. **Next Steps**