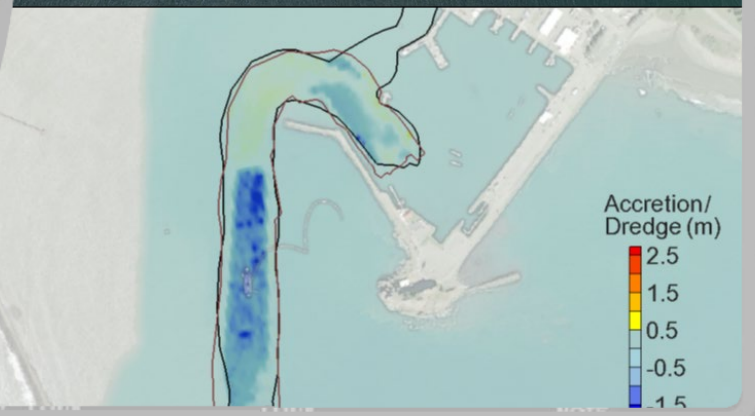
Crescent City Dredged Material Management Plan Modeling and Analysis



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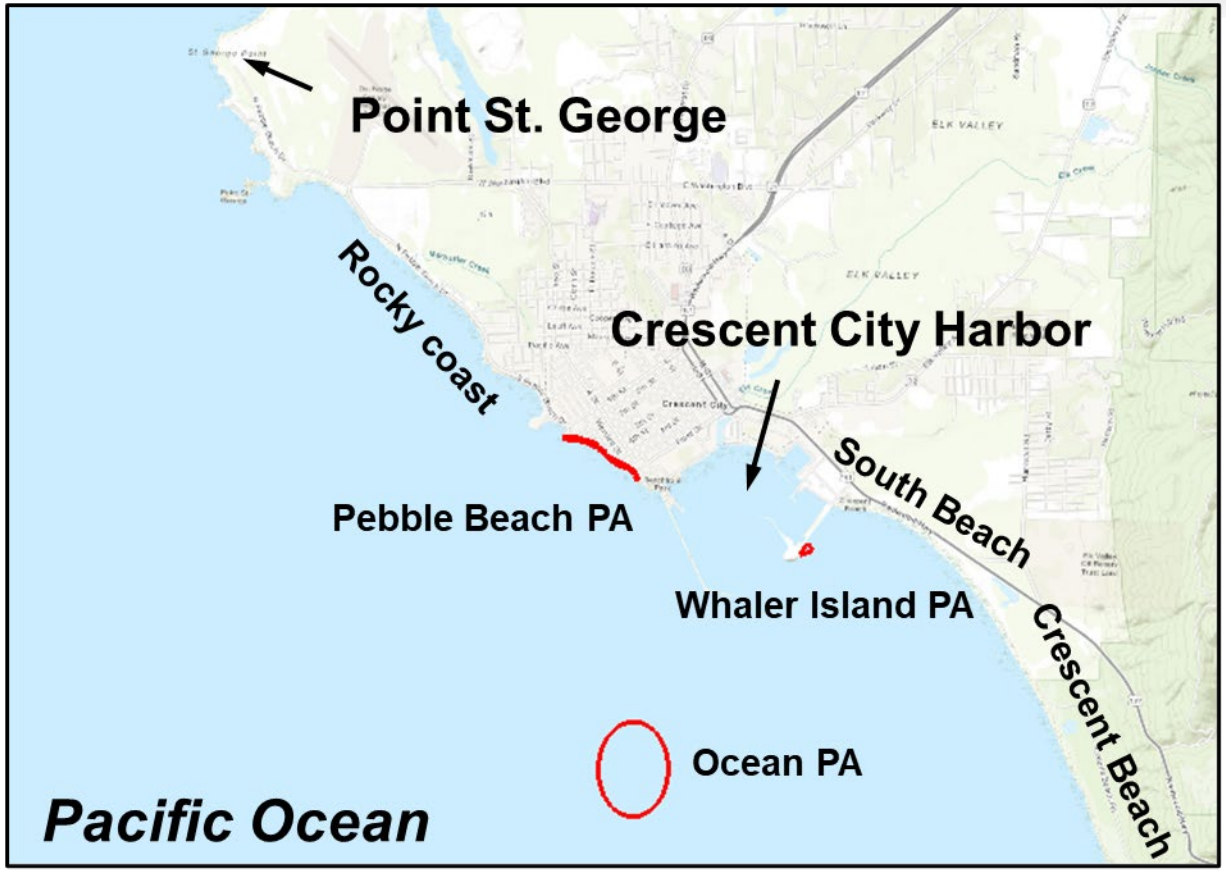
Background

- Crescent City Harbor, located on the upper coast of California and approximately 20 miles south of the Oregon border, provides a safe environment for local recreational and commercial fishing boats.
- The coastal geometry around and uneven seafloor surrounding the harbor have the infamous effect of focusing tsunamis occurred far from the Gulf of Alaska and offshore Pacific Coast of Japan.
- The harbor entrance is protected by a 1.5-km long West Jetty (the Lighthouse Jetty) and a 1.4-km long jointed East Jetty/Breakwater structure thru the historical Whaler Island.
- The Federal Channel, approx. 1.5-km long with mixed sandy bottom (D50 ~ 0.15 mm), extends from the jetty entrance to the inner harbor/marina and turning basin.

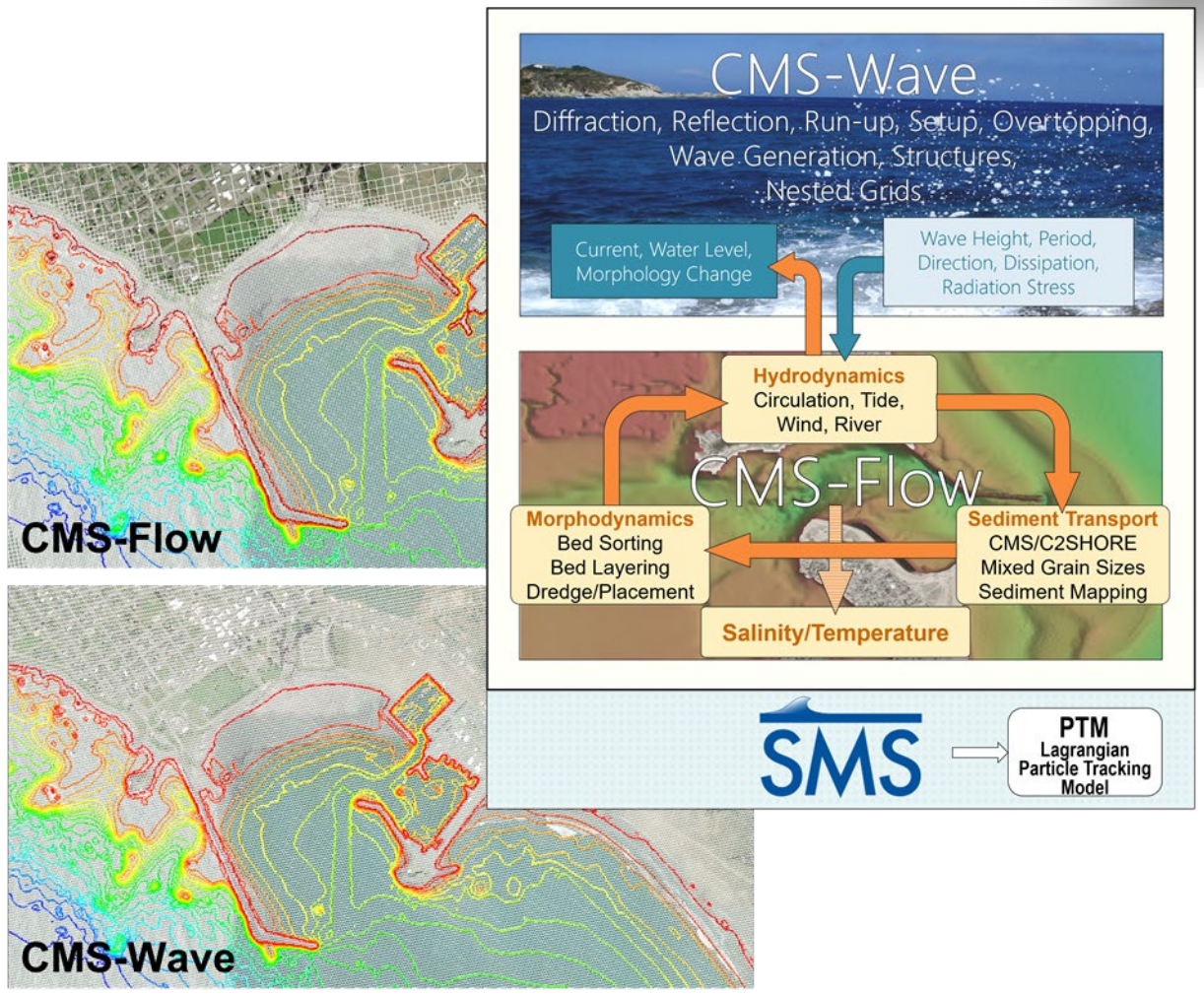
Objectives

- Regular and frequent maintenance dredging of Federal Channel (in a 2-year dredging cycle) requires the expansion/design and evaluation of existing and potential placement sites.
- Selected sites should provide adequate space for long-term maintenance dredging, improve protection of coastal infrastructure and environment, and support beach nourishment.
- Federal navigation projects must demonstrate sufficient dredged material disposal capacity for a minimum of 20 years.
- Dredged Material Management Plan (DMMP) for O&M project needs to understand the fate of sediment currently placed at Whaler Island and also evaluate the feasibility of new sites.



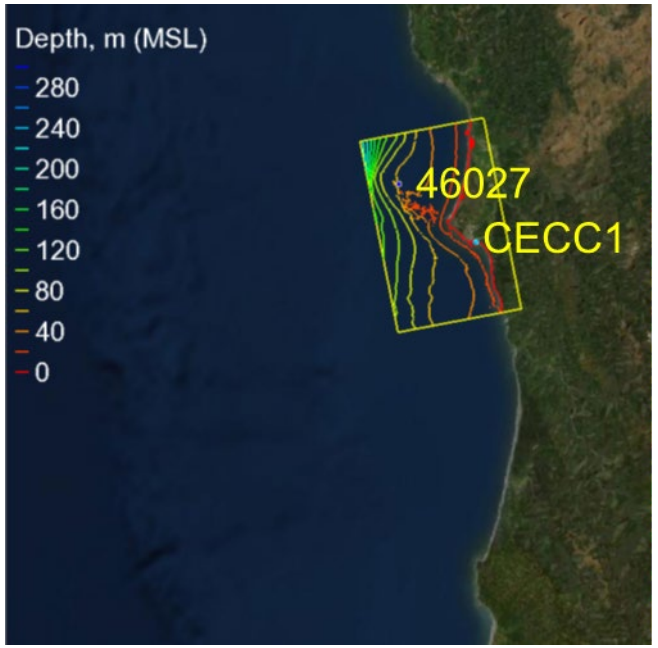
Modeling Approach

- Coastal Modeling System (CMS) and Particle Tracking Model (PTM) are used to investigate physical conditions around the harbor and assess fate and transport of sediment for placement site alternatives.
- CMS-Flow – Hydrodynamics, sediment transport, morphology change
- CMS-Wave – Wave transformation
- Dynamic coupling to simulate all relevant processes
- PTM – Modeling framework that moves with the flow and use waves and currents as forcing functions to identify sediment pathways.

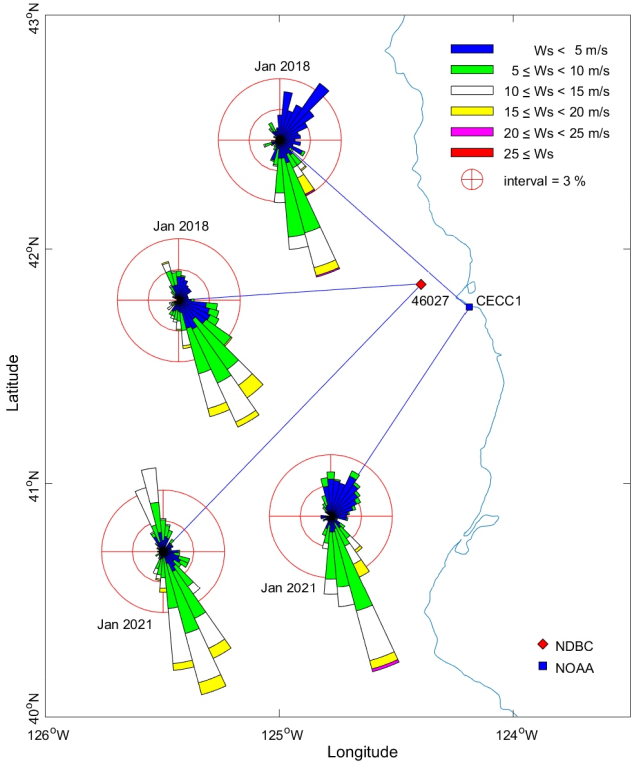


Surface Wind Data

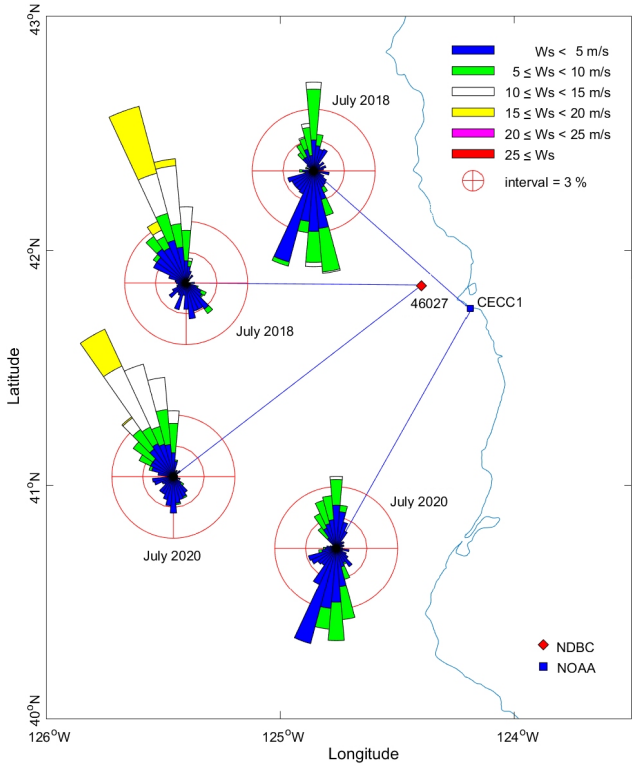
- NOAA Coastal Station CECC1 at Crescent City, CA.
- National Data Buoy Center (NDBC) St. Georges Buoy 46027.



Wind Roses at NDBC 46027 and NOAA CECC1



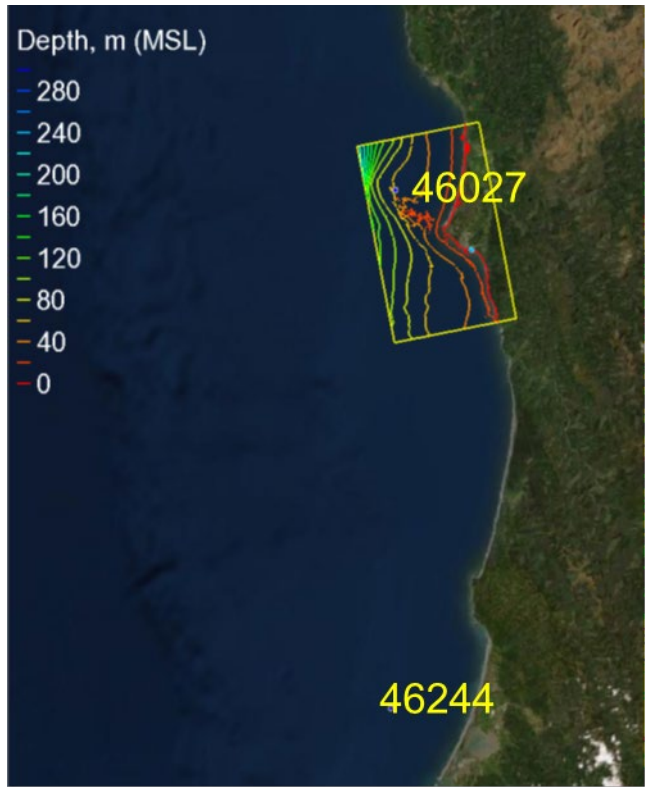
January 2018 and 2021 (winter month)



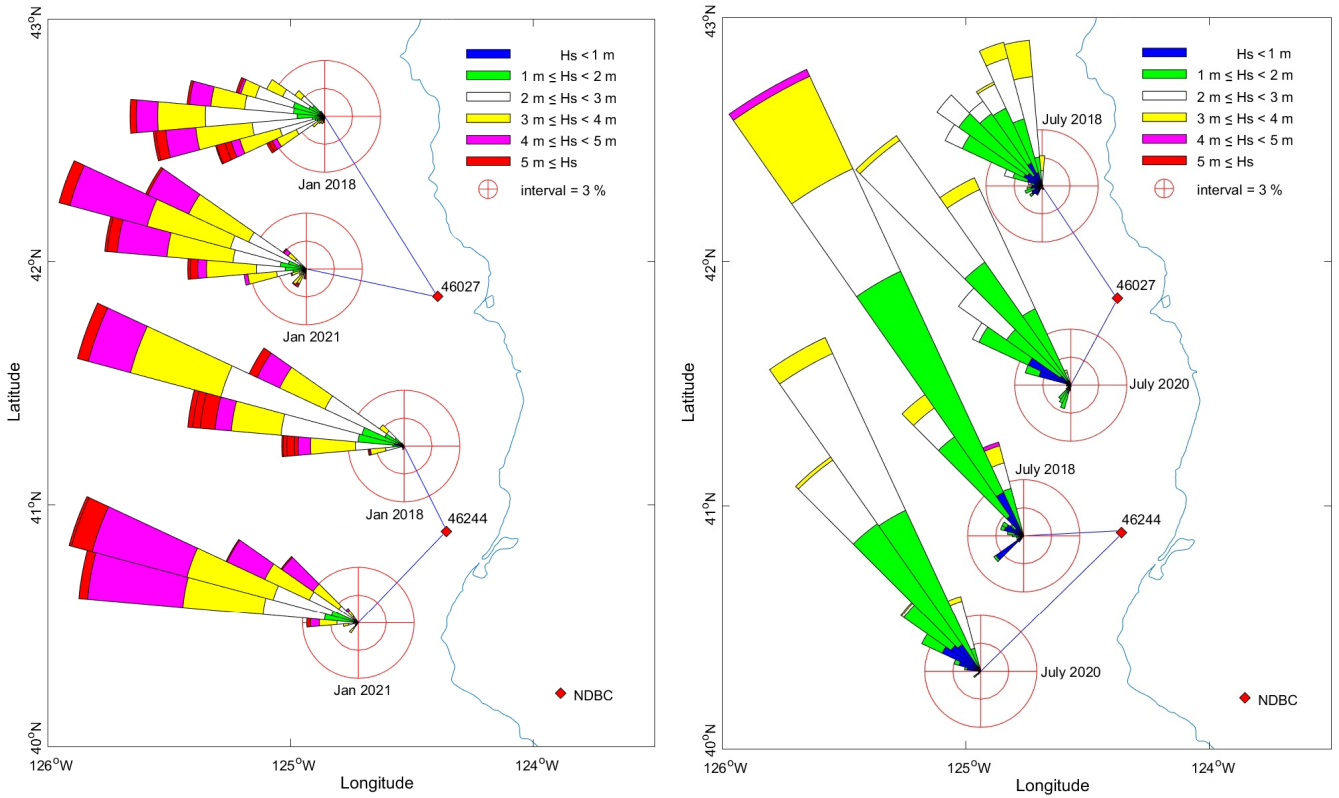
July 2018 and 2020 (summer month)

Coastal Wave Data

- NDBC Buoy 46027.
- Coastal Data Information Program (CDIP) Humboldt Inlet North Spit Buoy 46244.



Wave Roses at NDBC 46027 and 46244



January 2018 and 2021 (winter month)

July 2018 and 2020 (summer month)

CMS Setup

Hydrodynamics and Sediment Transport

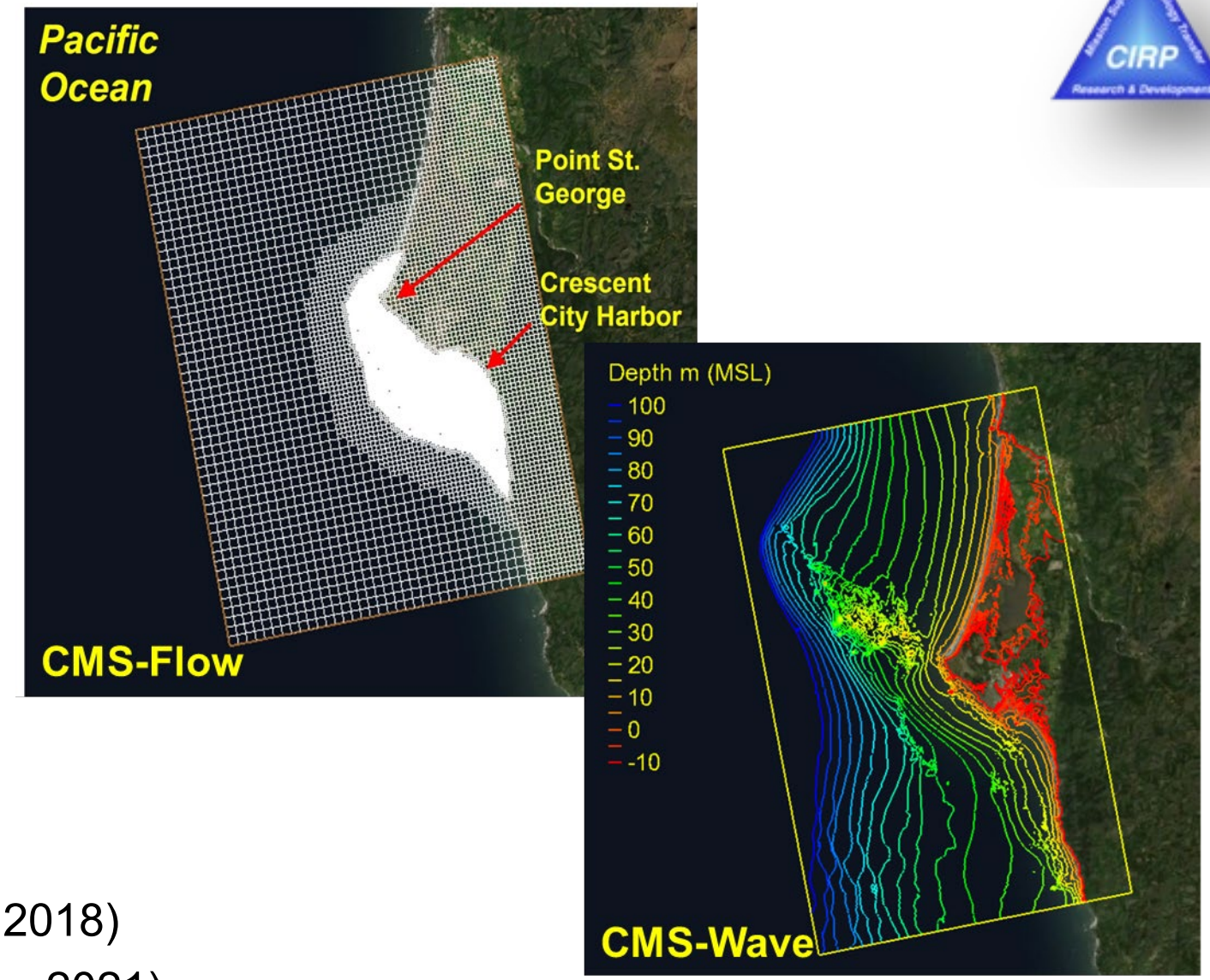
- Domain size: 26 x 35 km
- No of cells: ~ 130,000
- Cell size: 10 ~ 640 m
- Average water depth: 4 m (harbor)
  100 m (offshore)

Waves

- Domain size: 26 x 41 km
- No of cells: ~ 800,000
- Cell size: 10 ~ 80 m

Simulation Periods

- Two winter months (Jan 2018, July 2018)
- Two summer months (July 2020, Jan 2021)



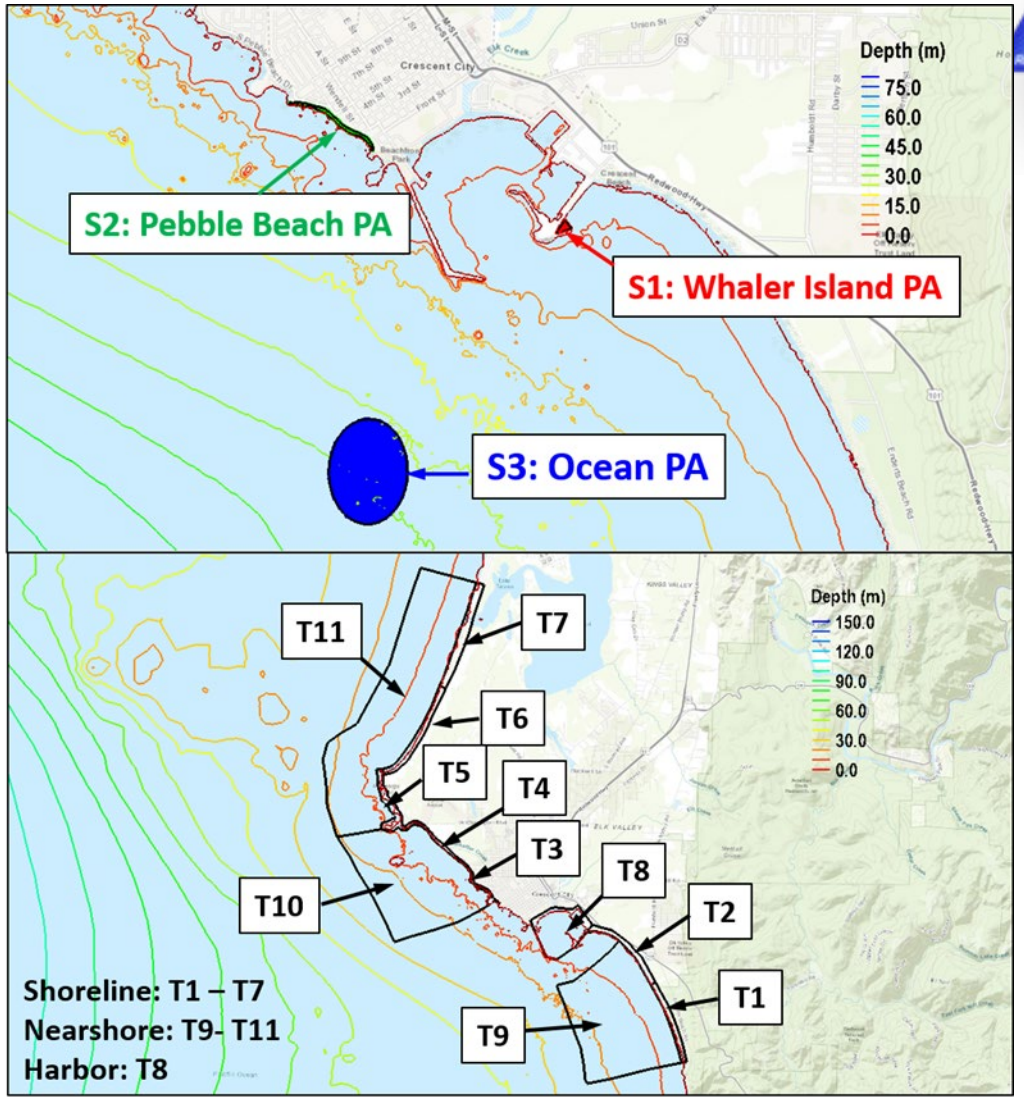
PTM Setup

Sediment sources

- Specify placement sites as sediment sources
- Dredged material released from those sites (~ 60,000 cy)

Sediment traps

- Defined areas to obtain information about the sediments entering and counted.
- Evaluate sediment pathways



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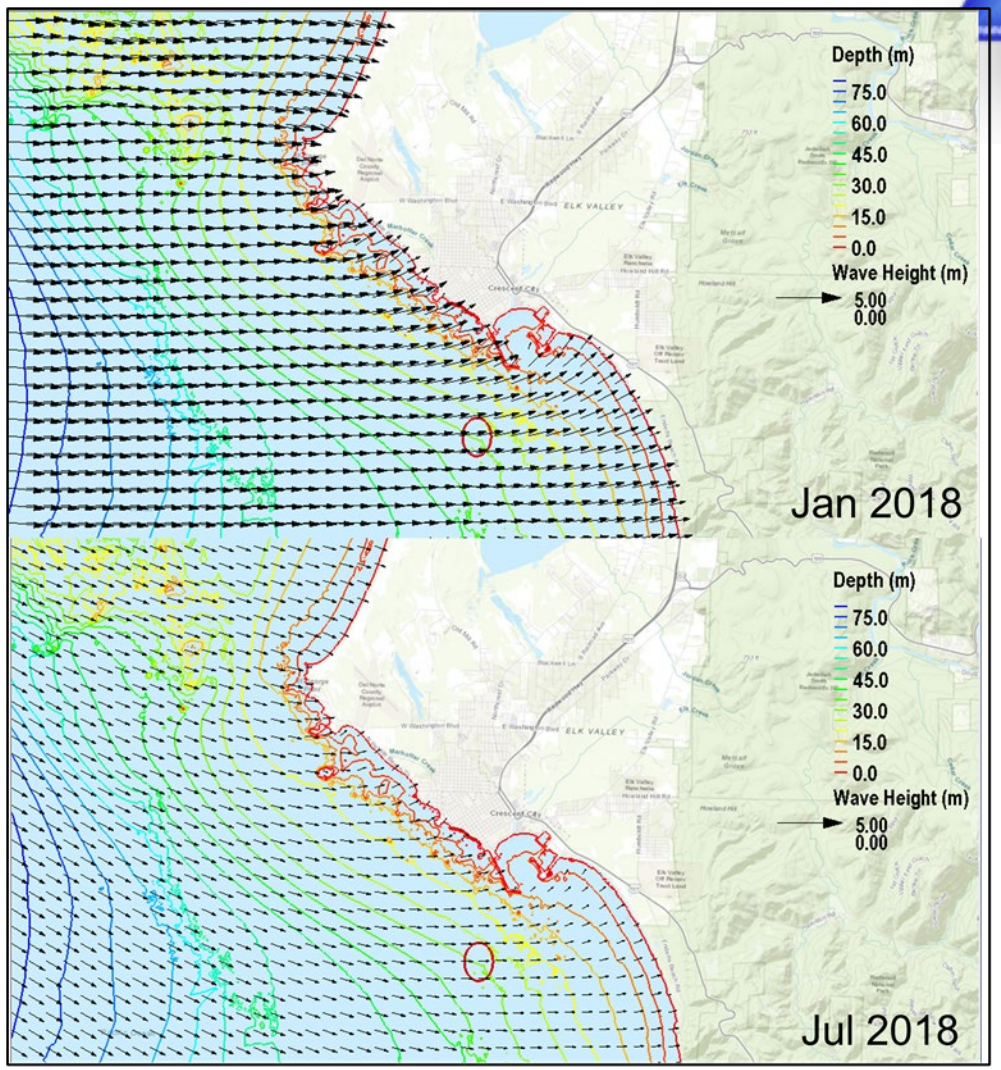
Waves

- Winter month

  Incident waves propagate from the west-northwest. Offshore average wave heights approximately 3 m. Nearshore wave heights are between 1.0-2.0 m. Wave heights at harbor entrance up to 1.0 m and inside harbor less than 0.1 m.

- Summer month

  Dominant wave directions are from the northwest. Offshore average wave heights approximately 1.5 m. Nearshore wave heights are between 0.5-1.0 m. Wave heights at harbor entrance less than 0.5 m and inside harbor between 0.02- 0.08 m.



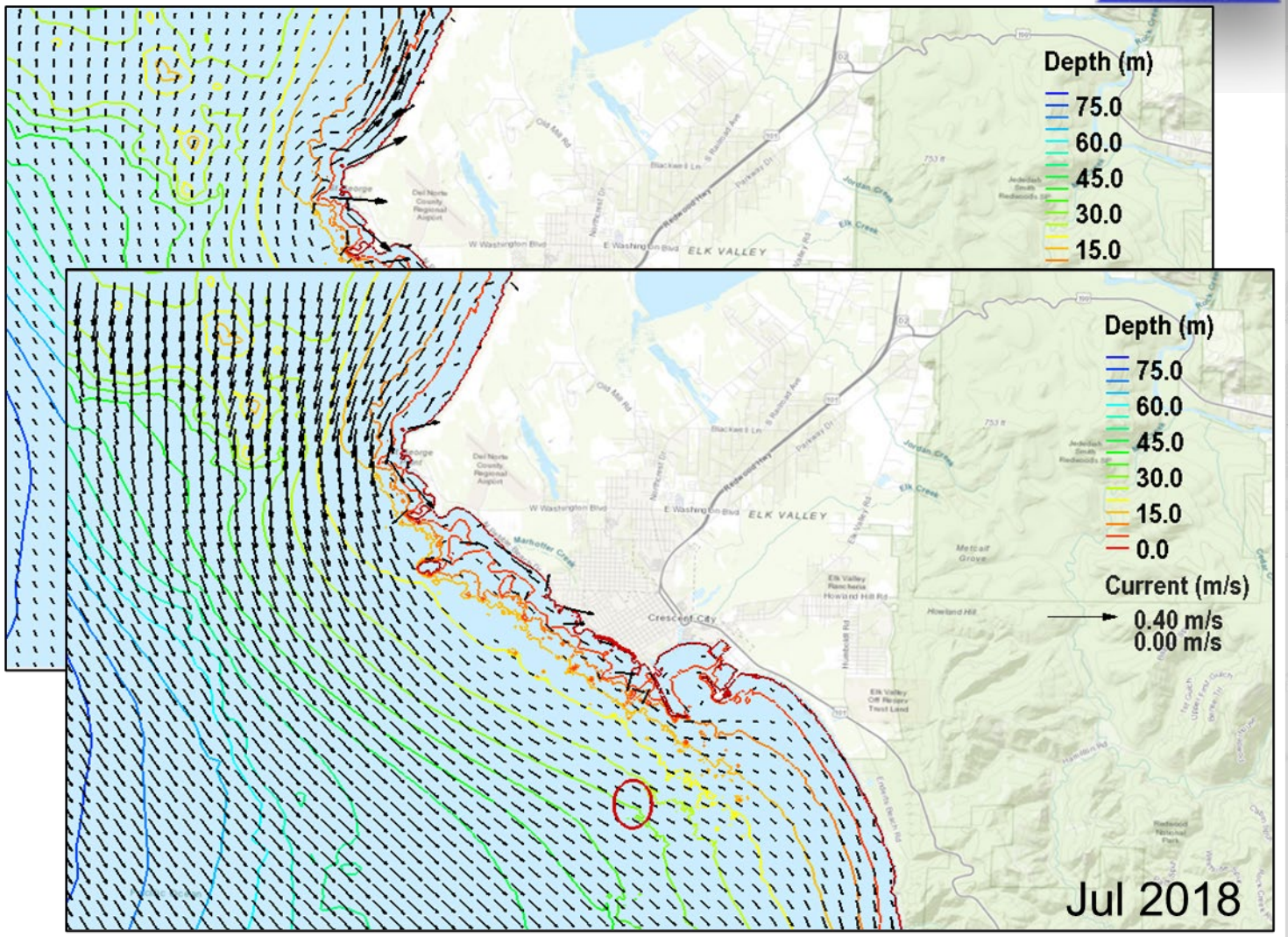
Currents

- Winter month

  Offshore current speeds less than 0.1 m/sec and dominant flow direction is northward. Nearshore current speeds as high as 0.9 m/sec. Longshore current direction associated with shoreline orientation.

- Summer month

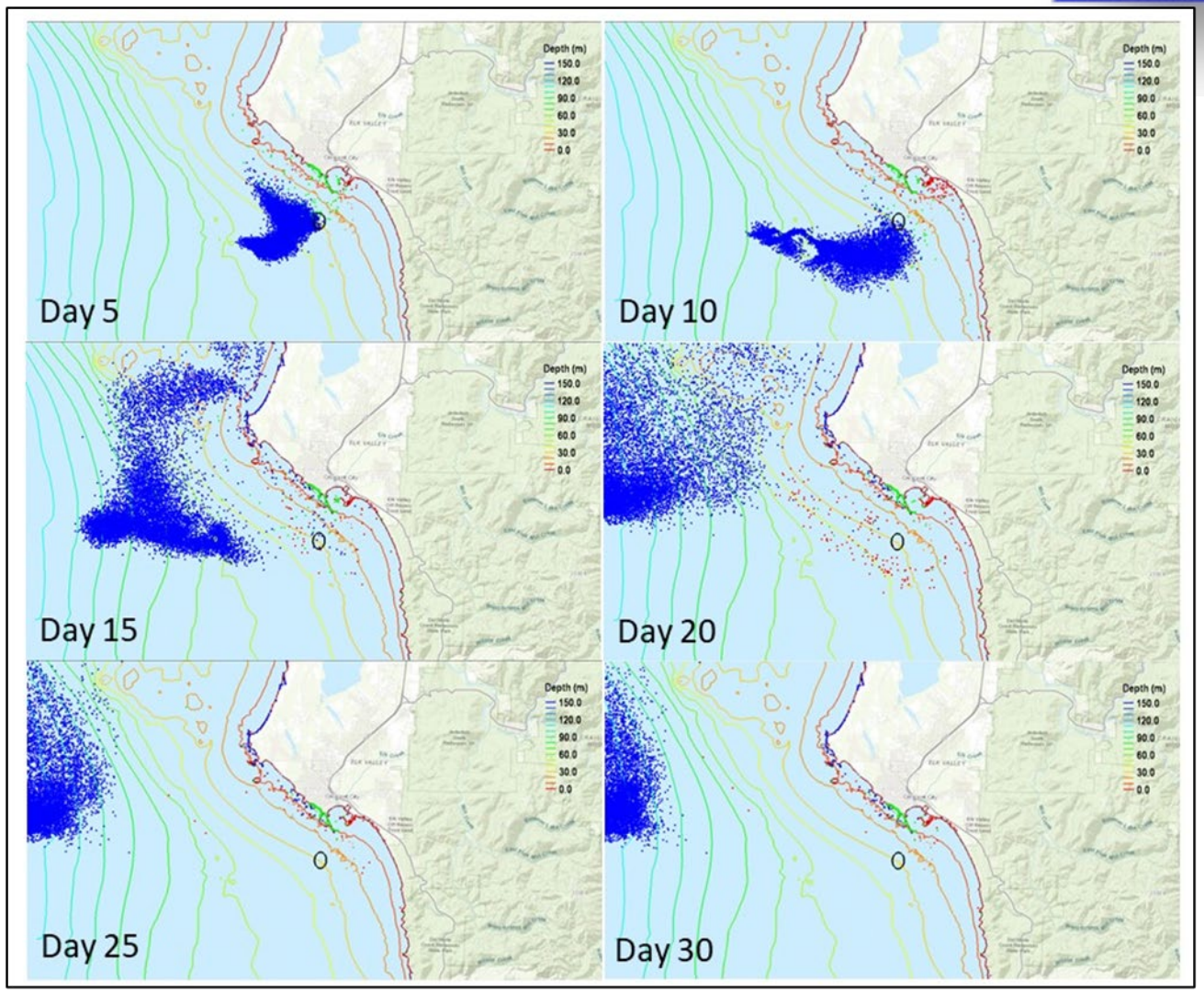
  Offshore current speeds greater than 0.1 m/sec and dominant flow direction is south-southeastward. Longshore current speeds 0.15 - 0.2 m/sec and flow direction consistent with the winter case. South-southeast longshore currents with speeds 0.05 - 0.15 m/sec south to the harbor.



Particle Tracking (winter)

- Whaler Island PA (red): Initially low mobility. Midmonth spread offshore towards the Ocean Site and then alongshore northward.
- Pebble Beach PA (green): Particle movement controlled by nearshore wave-driven current. Particles migrate southward along the shoreline and a few trapped within the harbor.
- Ocean PA (blue): At the initial stage particles moved westward and then spread in two separate directions. Some moving north trapped in the nearshore area around and north of Point St. George.

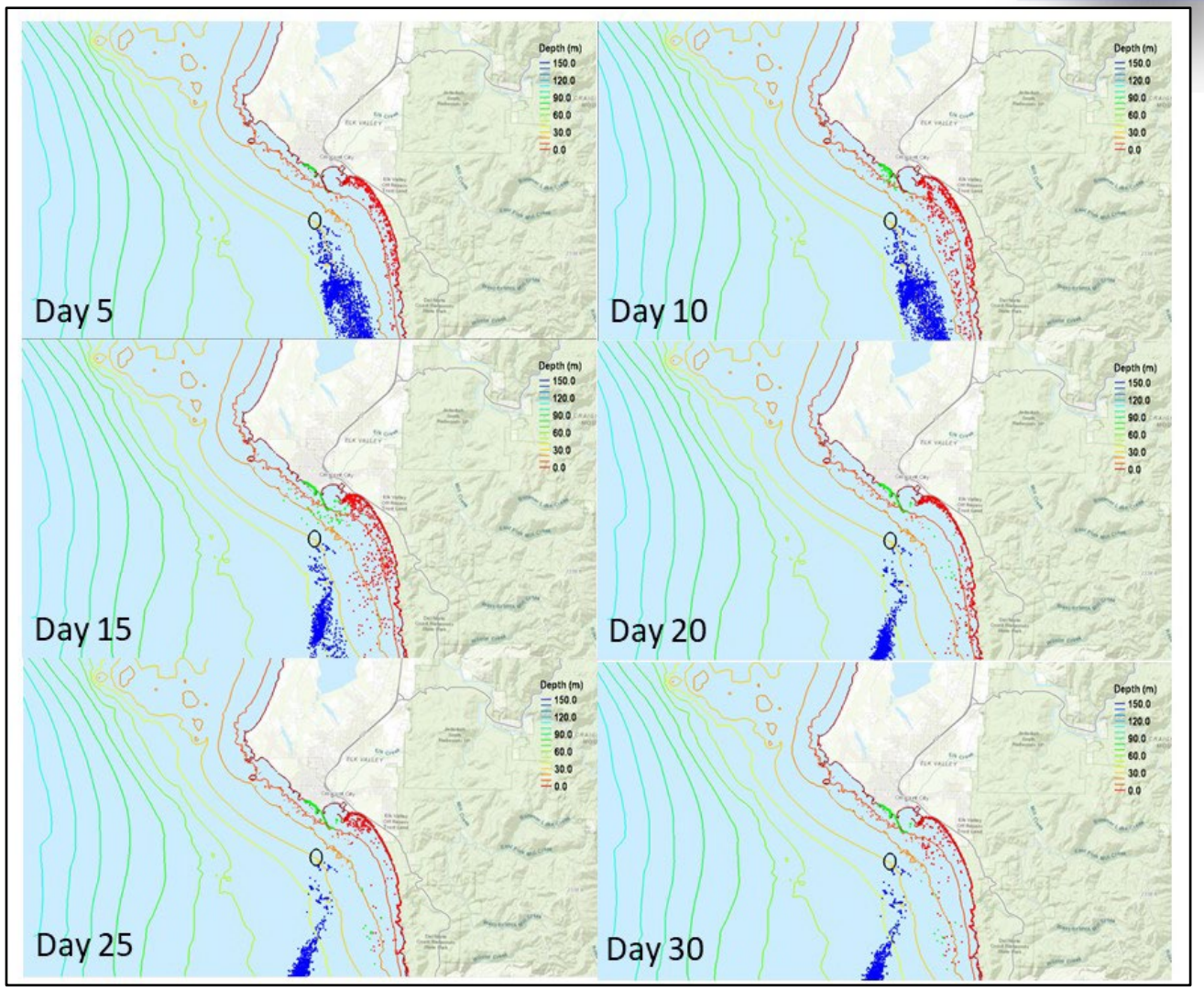
Jan 2018



Particle Tracking (summer)

- Whaler Island PA (red): Particles released moving southward along the shoreline, shifting offshore out of the domain or moving close to shoreline trapped in the nearshore area.
- Pebble Beach PA (green): Particles predominately migrating southward along the shoreline and moving in the Crescent City harbor.
- Ocean PA (blue): All sediment material moving away and predominantly southward. No onshore migration.

Jul 2018



Particle Trapping

Simulation duration	Source					
	Whaler Island		Pebble Beach		Ocean Site	
	Number	Ratio (%)	Number	Ratio (%)	Number	Ratio (%)
Jan-18	1106	8	3251	23	14379	100
Jul-18	4877	34	2668	19	14379	100

- Whaler Island PA: 2018 winter simulation shows low particle mobility rate. More than 90% of the particles remain within the site. Particle mobility rate quadrupled for 2018 summer releases. The traps south of the harbor (T1&T2) and nearshore (T9, T10, and T11) caught most of the particles.
- Pebble Beach PA: 75% of the particles remain but very small percentages caught in the nearshore traps. Particles moving direction from southward to northward in the offshore regions during winter month.
- Ocean PA: 100% mobility rate for winter and summer months. For 2018 winter case, the nearshore trap (T11) in the north caught a great number of particles. At the end of summer simulation, particles moved southward in the nearshore area.

	Trap	Source					
		Whaler Island		Pebble Beach		Ocean Site	
		Jan-18	Jul-18	Jan-18	Jul-18	Jan-18	Jul-18
Shoreline	1	0	13	0	0	0	0
	2	3	4	0	0	0	0
	3	0	0	0	0	0	0
	4	0	0	0	0	0	0
	5	1	0	0	0	1	0
	6	0	0	0	0	1	0
	7	0	0	0	0	1	0
Harbor	8	1	0	0	0	0	0
Nearshore	9	10	20	1	3	0	29
	10	4	0	0	0	1	0
	11	8	0	1	0	8	0

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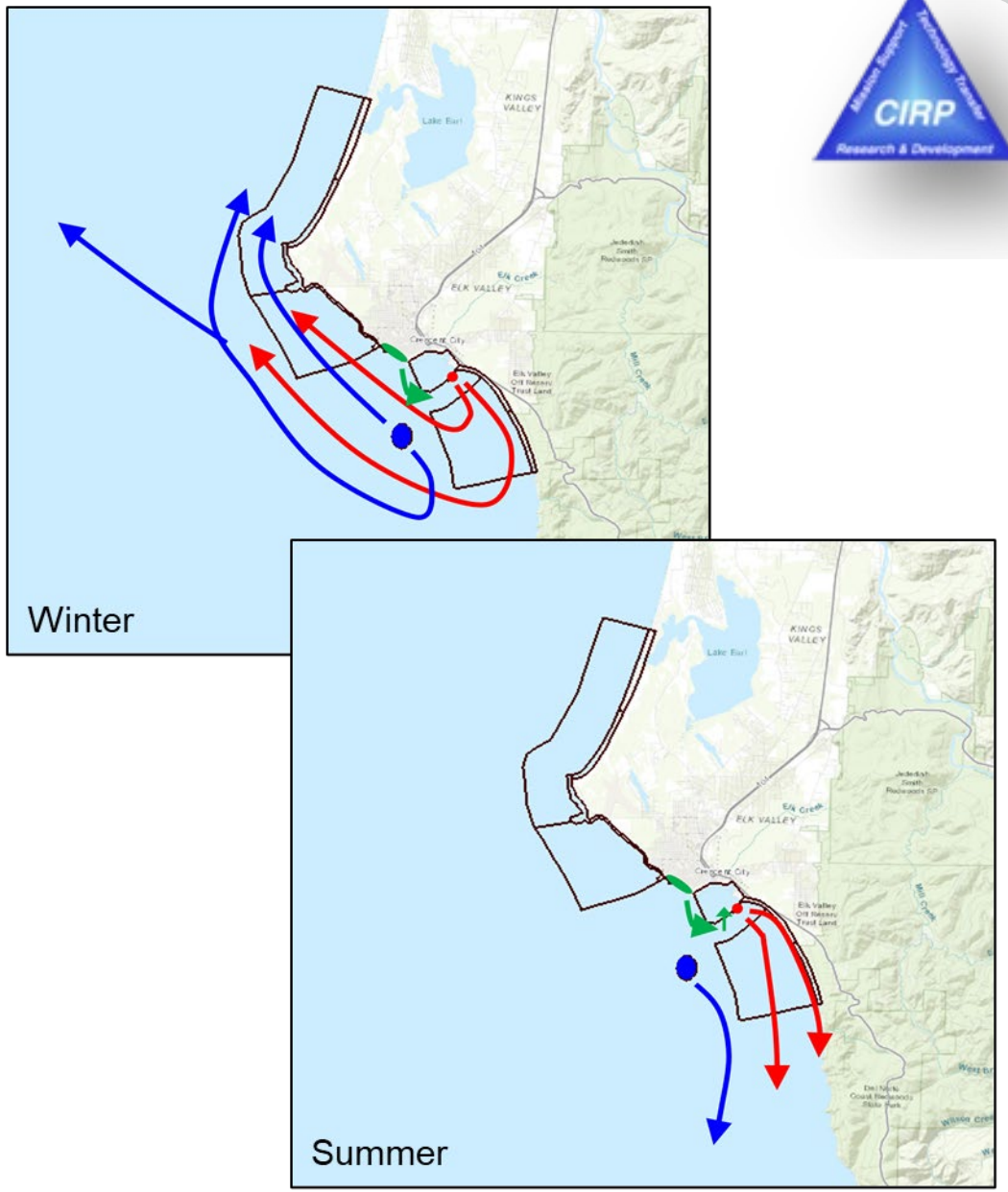
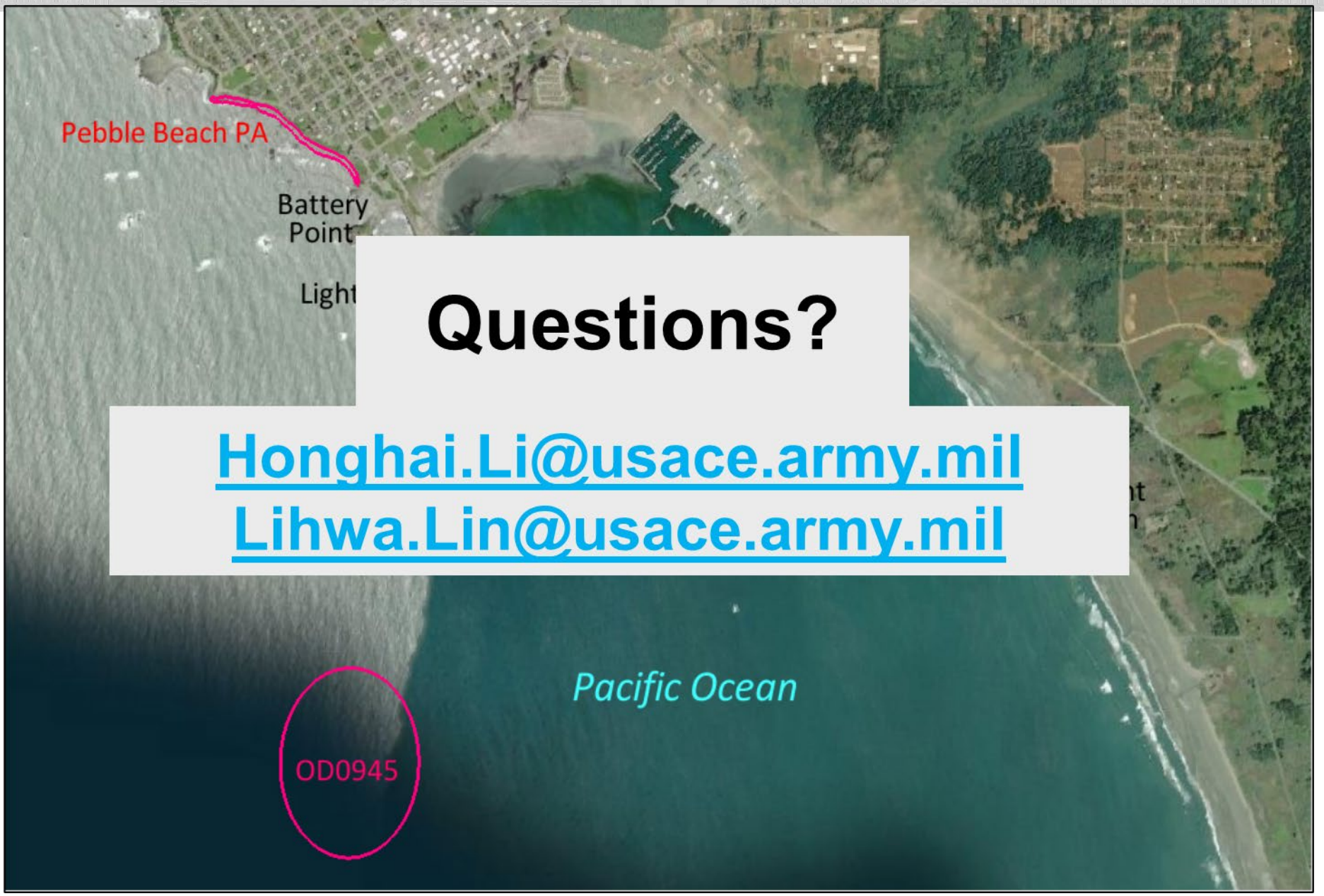
Summary

- The model analysis presents distinctive current and wave patterns for typical winter and summer months. Dominant winter flow direction is northward and summer flow direction is southward in the offshore area. Nearshore flow is along the shoreline and flow direction is associated with shoreline orientation and wave direction.
- Examining sediment particles moving away from release sources shows different mobility of sediment material placed in three placement sites. The Ocean Site has the highest mobility ratio (100%), the Pebble Beach site the lowest (17%), and the Whaler Island site a ratio of 25%.
- PTM results show that sediment transport pathways are consistent with flow and wave patterns under winter and summer conditions.





Questions?

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