Hydrodynamic Conditions and Sediment Movement at Port of Port Orford

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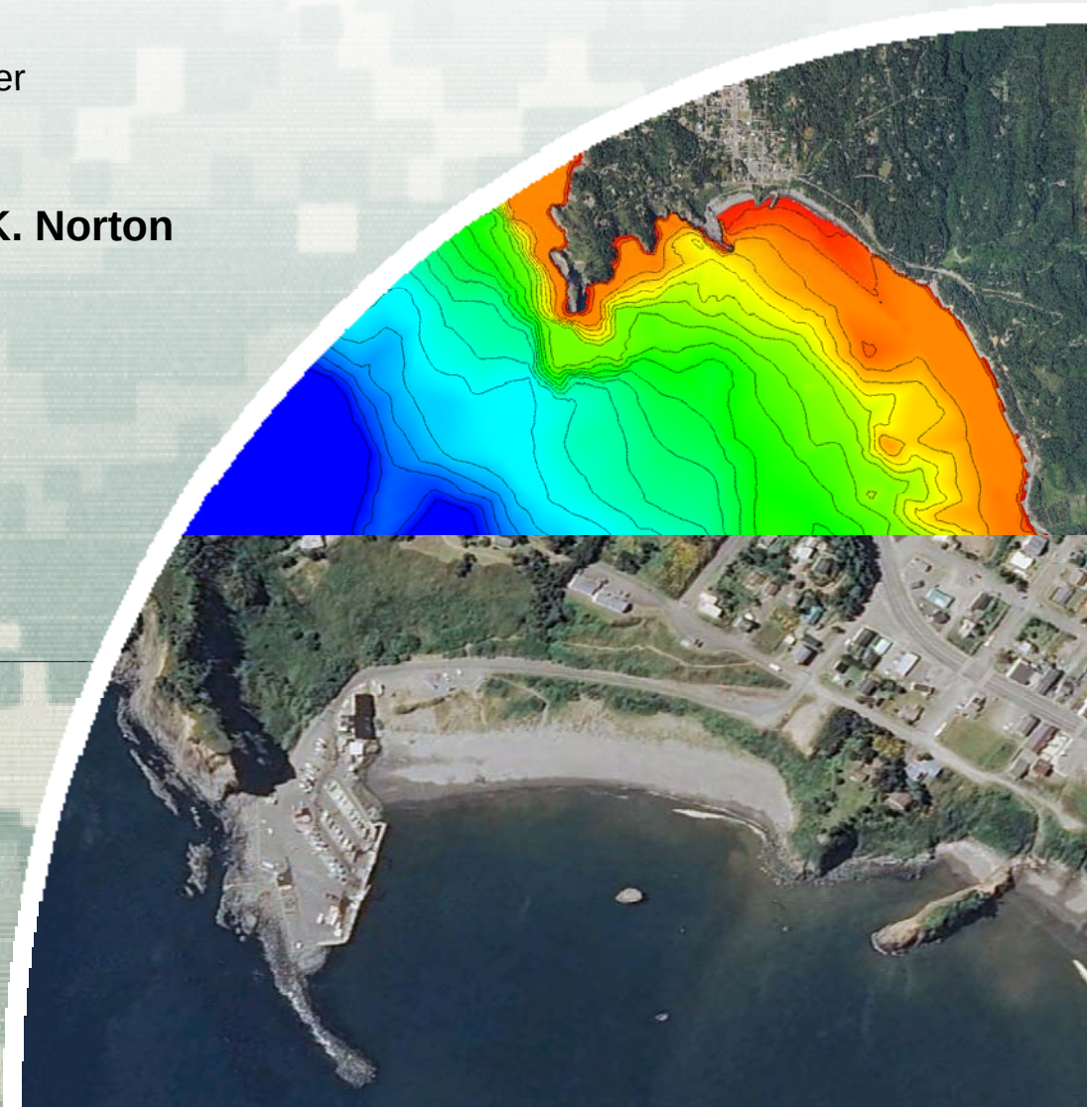

Coastal Sediments 2015
San Diego, California
May 14, 2015

US Army Corps of Engineers
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Outline

- **Background and objective**
- **Method**

  Hydrodynamic and particle tracking models
  Data and model forcing
  Sources and sinks

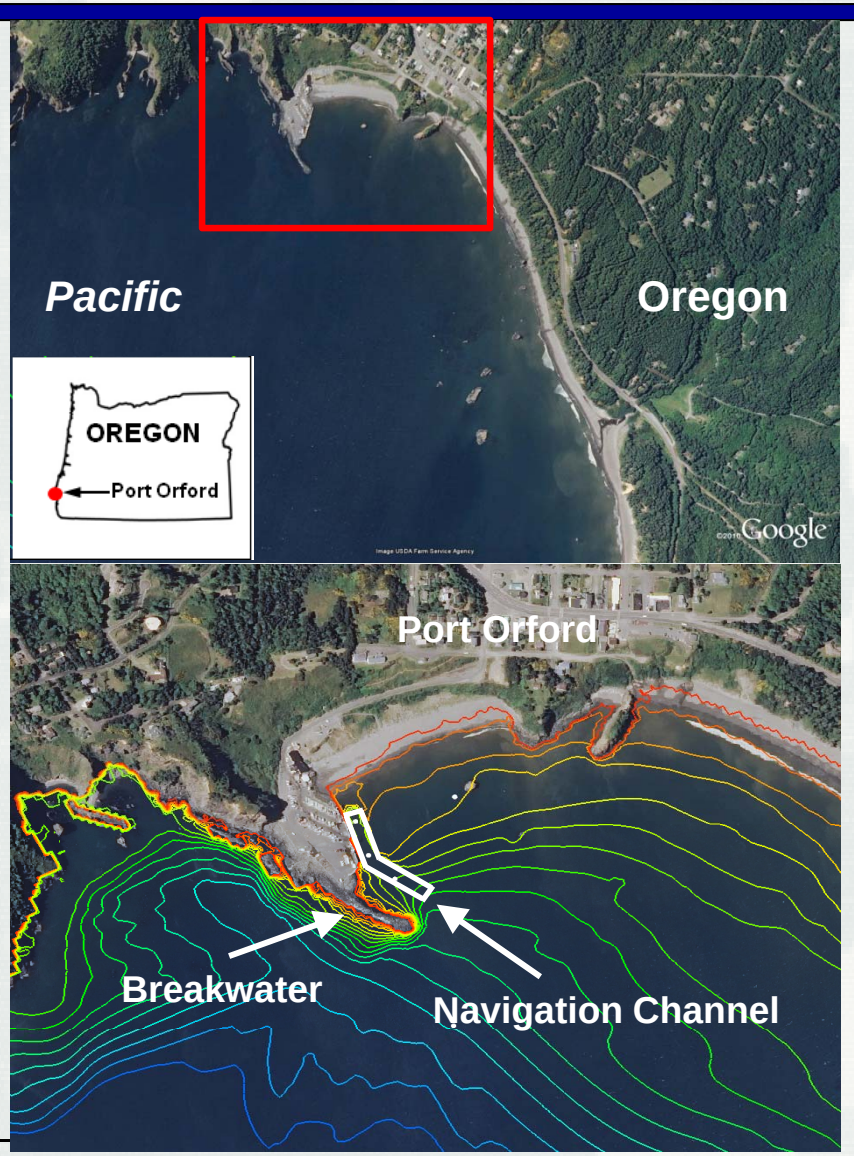
- **Results**

  Currents
  Waves
  Particle tracking

- **Summary**

Background and Objective

- Maintain a federal navigation channel at the Port of Port Orford
- Evaluate alternative breakwater configurations to reduce recurring dredging needs/costs
- Define littoral sediment transport pathways that affect shoaling at Port Orford
- Determine long term solution other than annual dredging maintenance

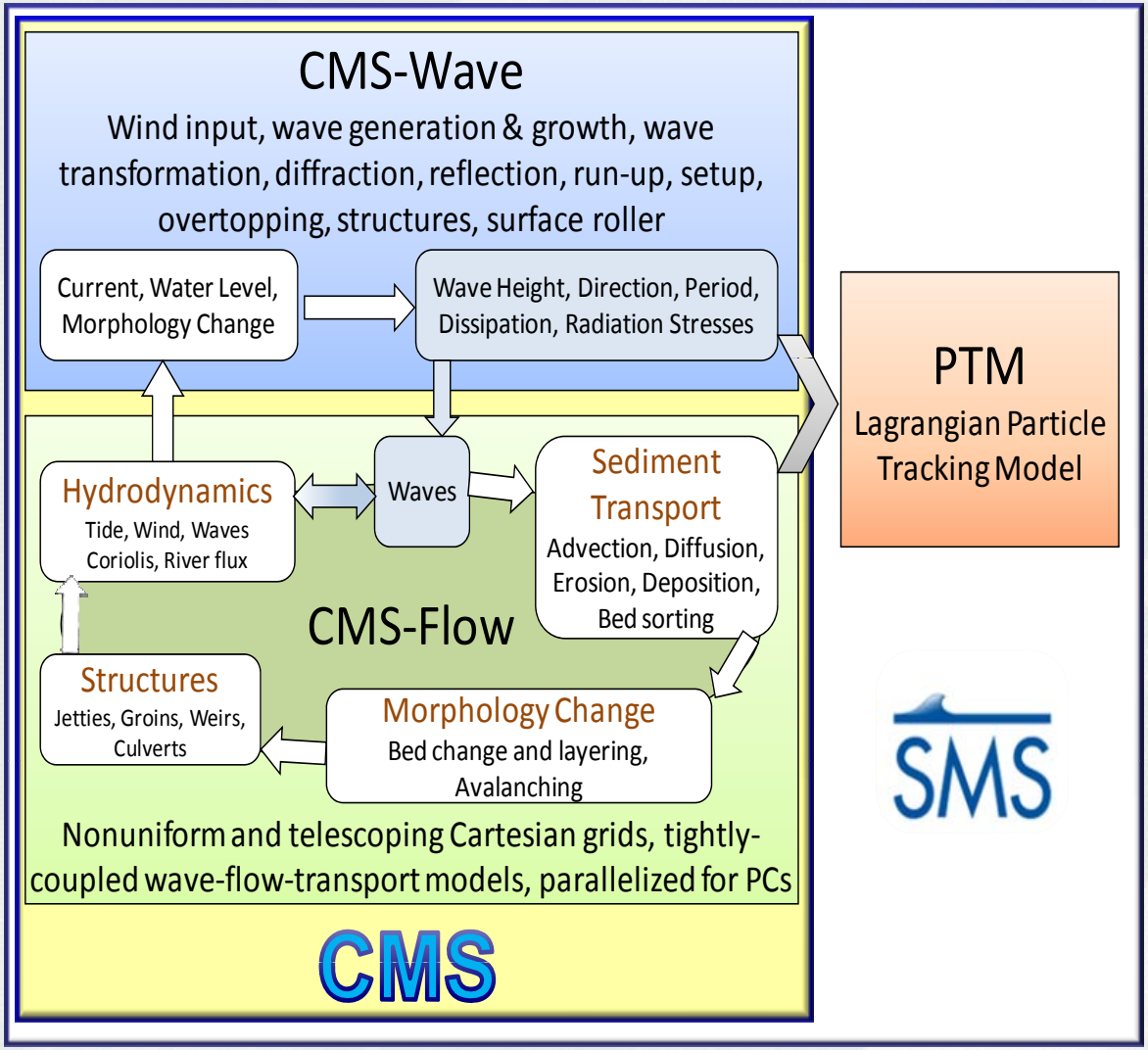


Method

Integrated waves, current, and sediment transport model in the Surface-water Modeling System (SMS)

CMS-Flow and CMS-Wave

Coupled with Particle Tracking Model (PTM)



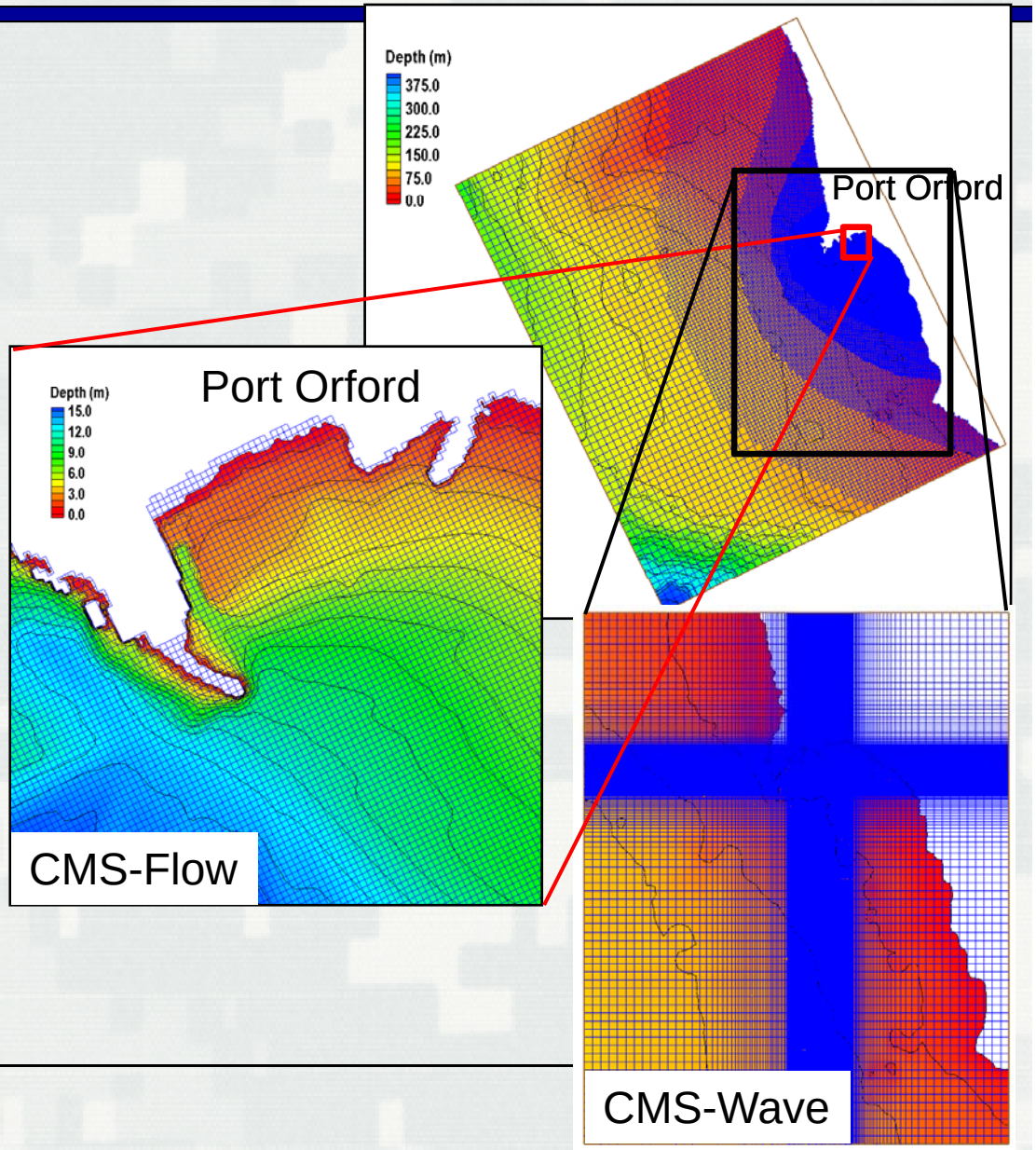
CMS Configuration

CMS-Flow:

- Telescoping
- Domain Size: 21 x 16 km
- Cell Size: 10 to 320 m
- Water Depth: 0 to 400 m

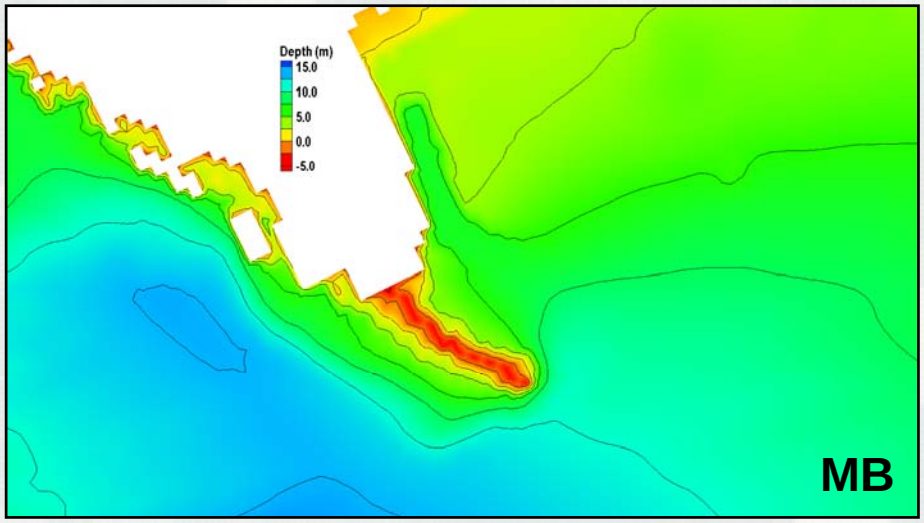
CMS-Wave:

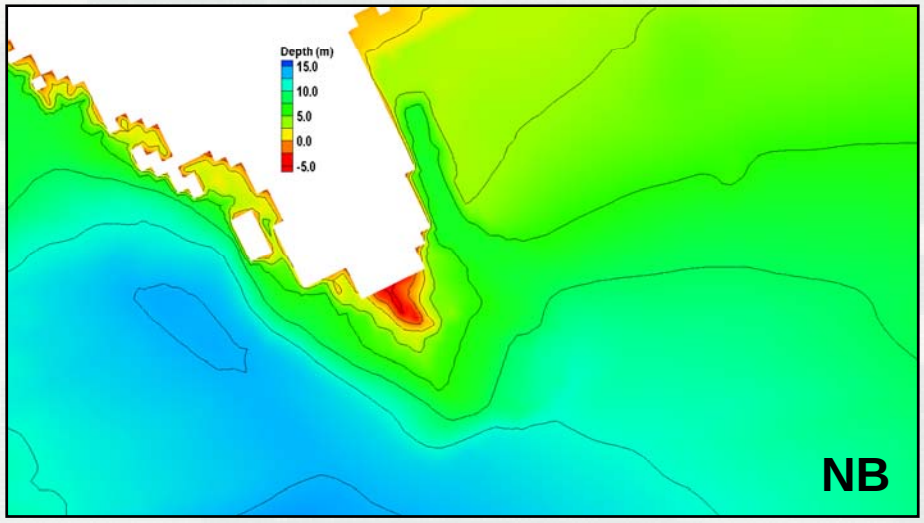
- Non-uniform rectangular
- Domain Size: 13 x 10 km
- Cell Size: 8 to 200 m
- Water Depth: 0 to 90 m

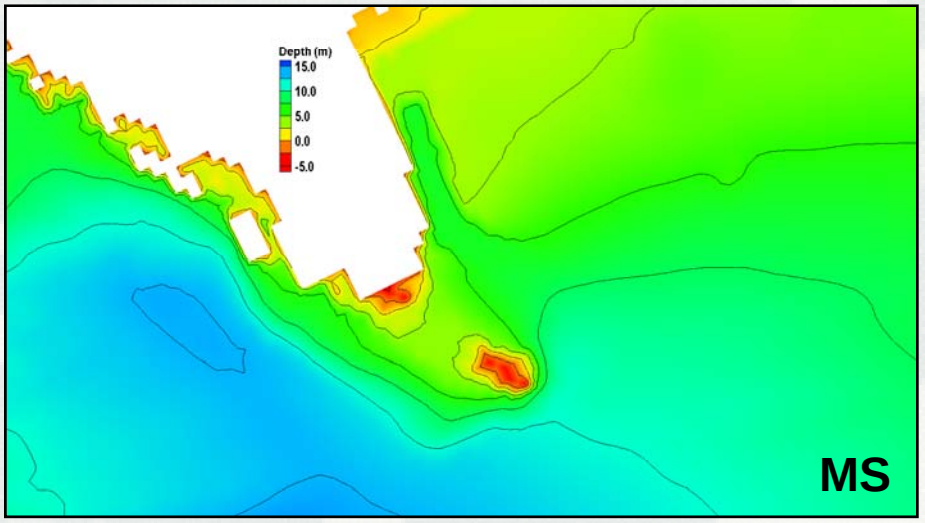


Breakwater Configuration

- Restore breakwater (MB)
  - Crest elevation:4.9 m above MSL
- Open mid-section notch (MS)
  - Length: 76.2 m
  - Crest elevation: 2.7 m below MSL
- Remove breakwater (NB)







Water Level

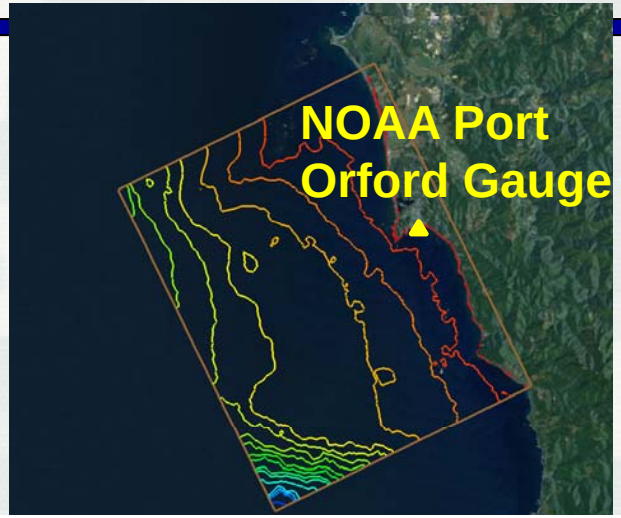
- NOAA tide gauge (Port Orford: 9431647)
- 6 November – 15 December 2007 and June 2010
- Mixed, predominately semi-diurnal tide
- Mean tide range:

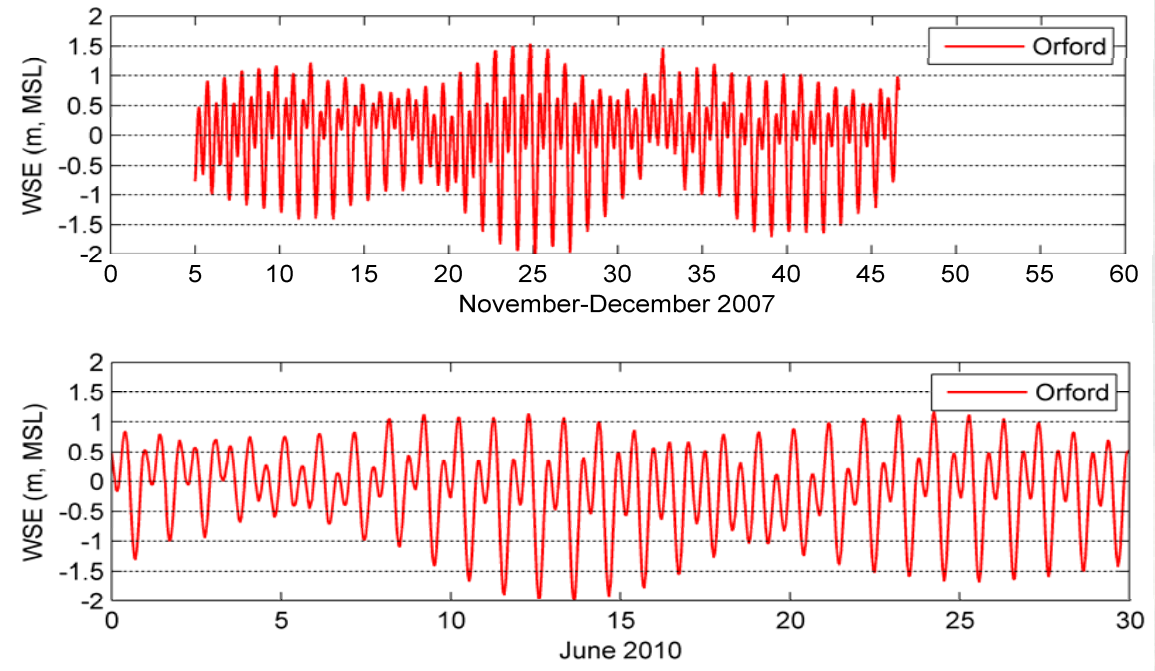
  MHW – MLW =

  1.6 m (5.2 ft)
- Diurnal tide range:

  MHHW-MLLW =

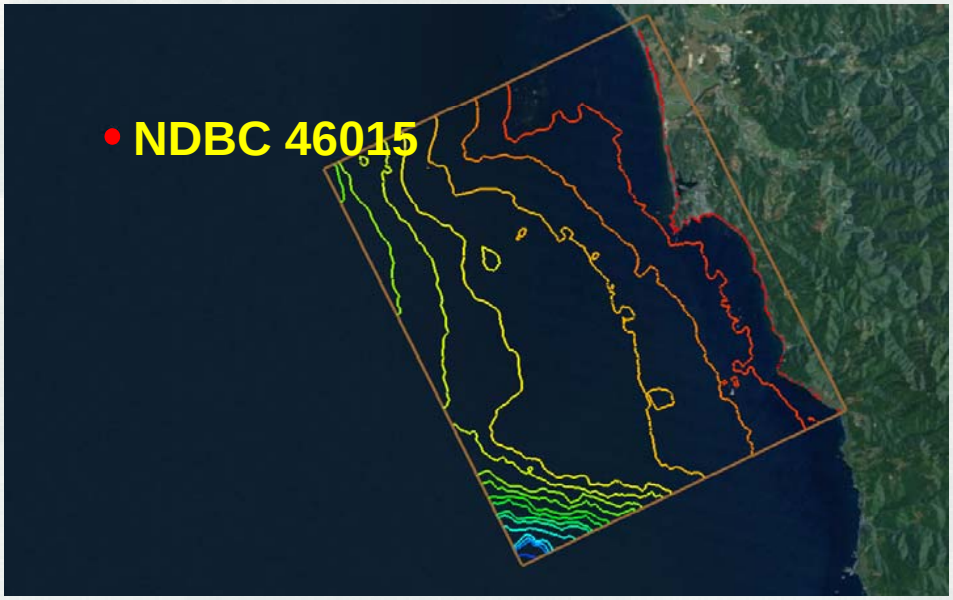
  2.2 m (7.3 ft)

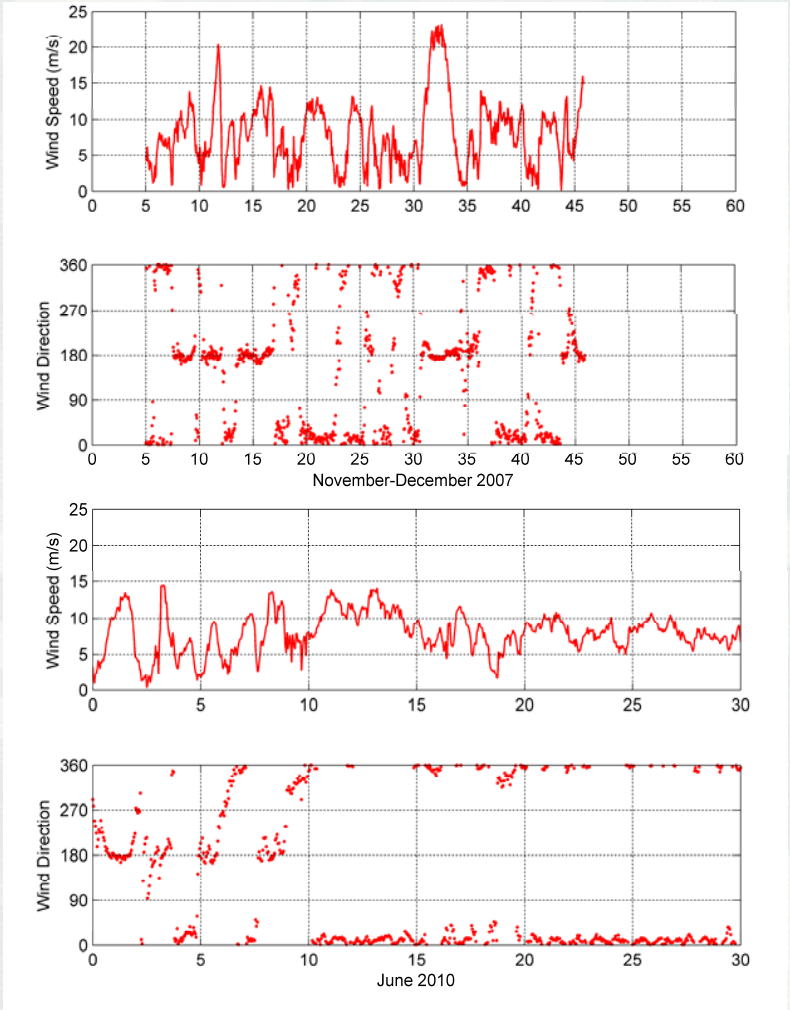




Wind

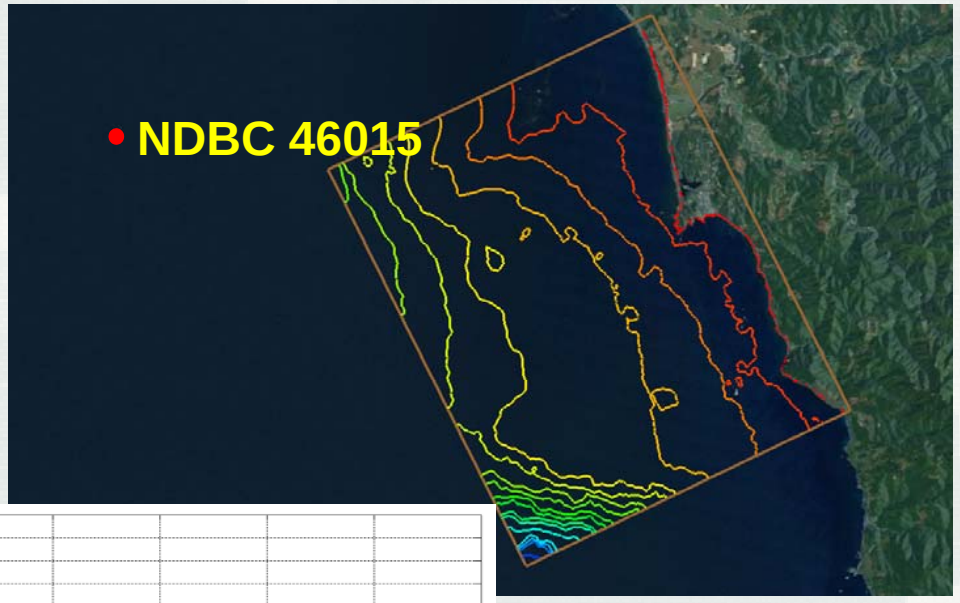
- Wind at NDBC Buoy 46015
- Surface boundary forcing
- Wind direction:
  0° North, 90° East, etc.
  from which wind blowing



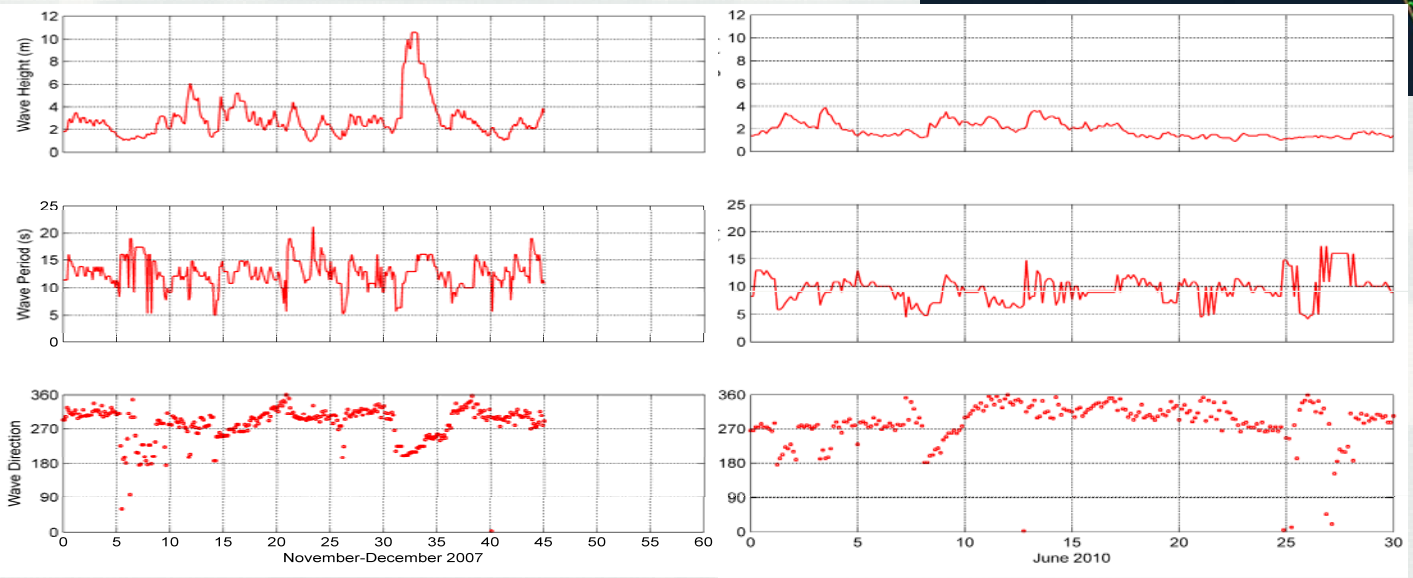


Waves

- Wave transformation to seaward boundary

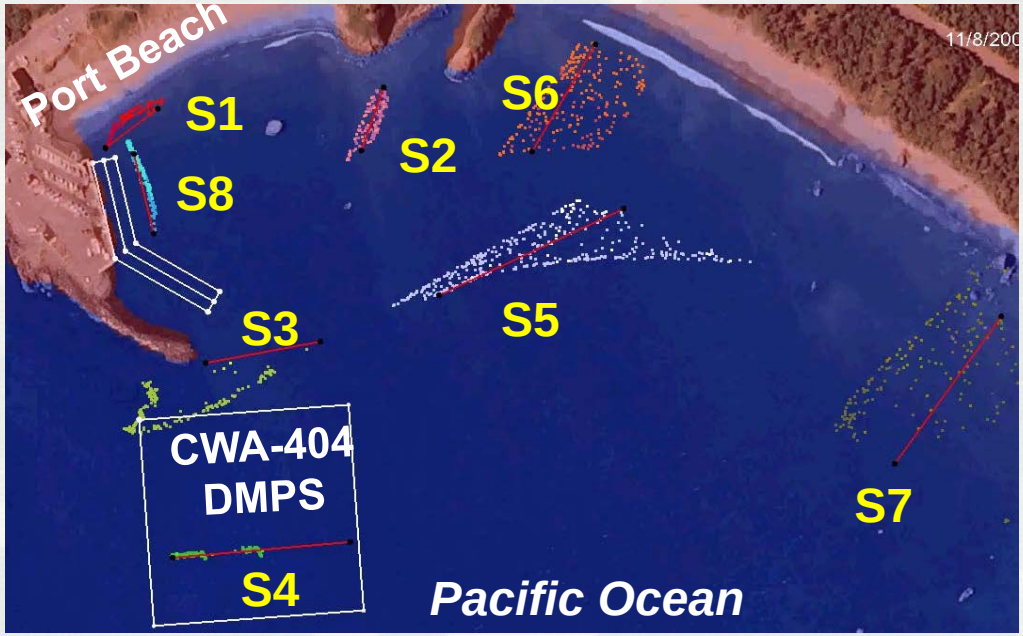


First winter storm and an extreme winter storm



Summer month

Particle Tracking Model (PTM)



Sediment sources

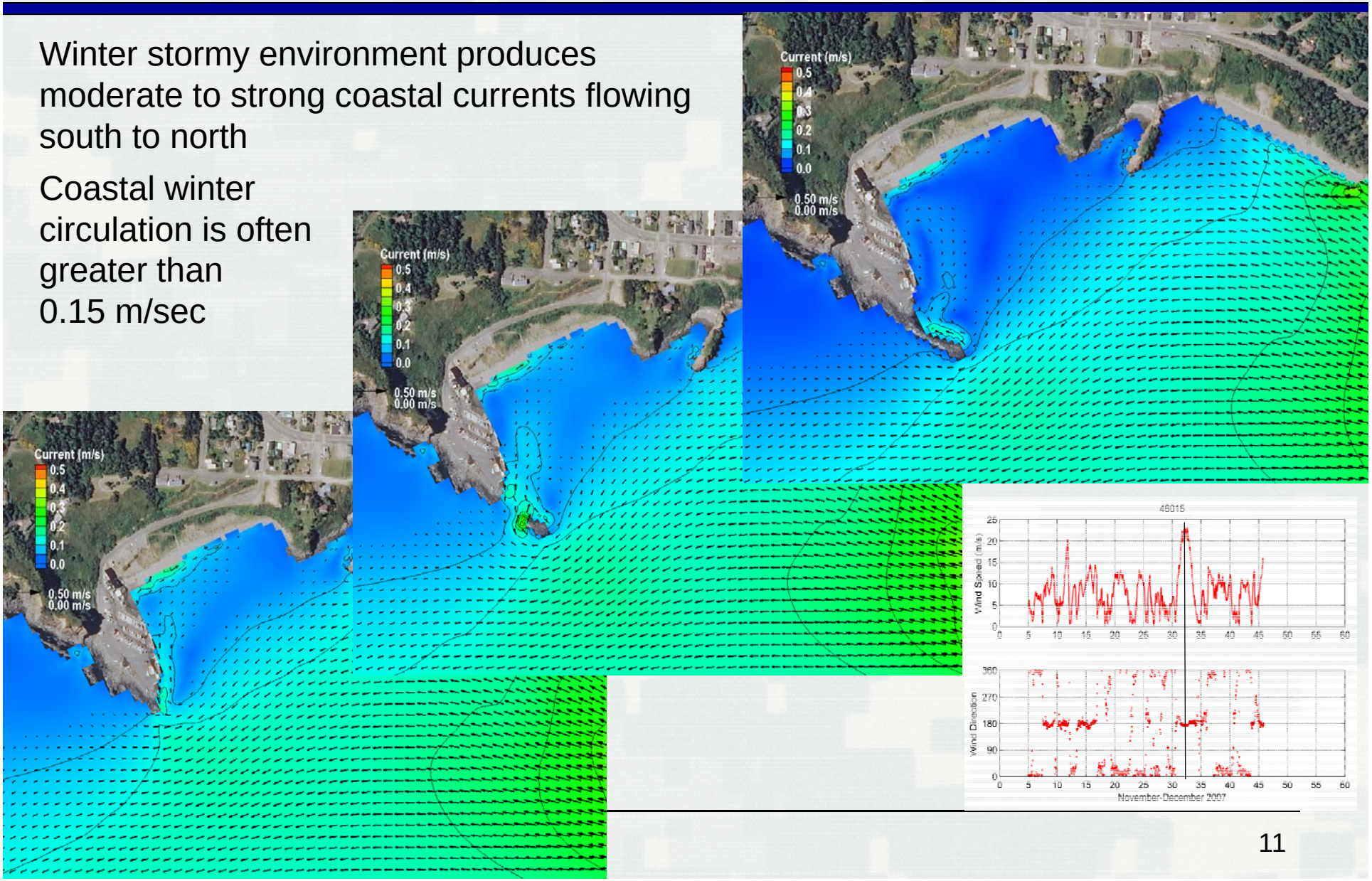
Sediment sinks

- Specify erosion sediment sources and sediment traps to assess sediment transport pathways
- Evaluate sediment transport for different configurations of the breakwater to alleviate channel shoaling

Current
(Extreme Winter Storm, 3 December, 2007)

Winter stormy environment produces moderate to strong coastal currents flowing south to north

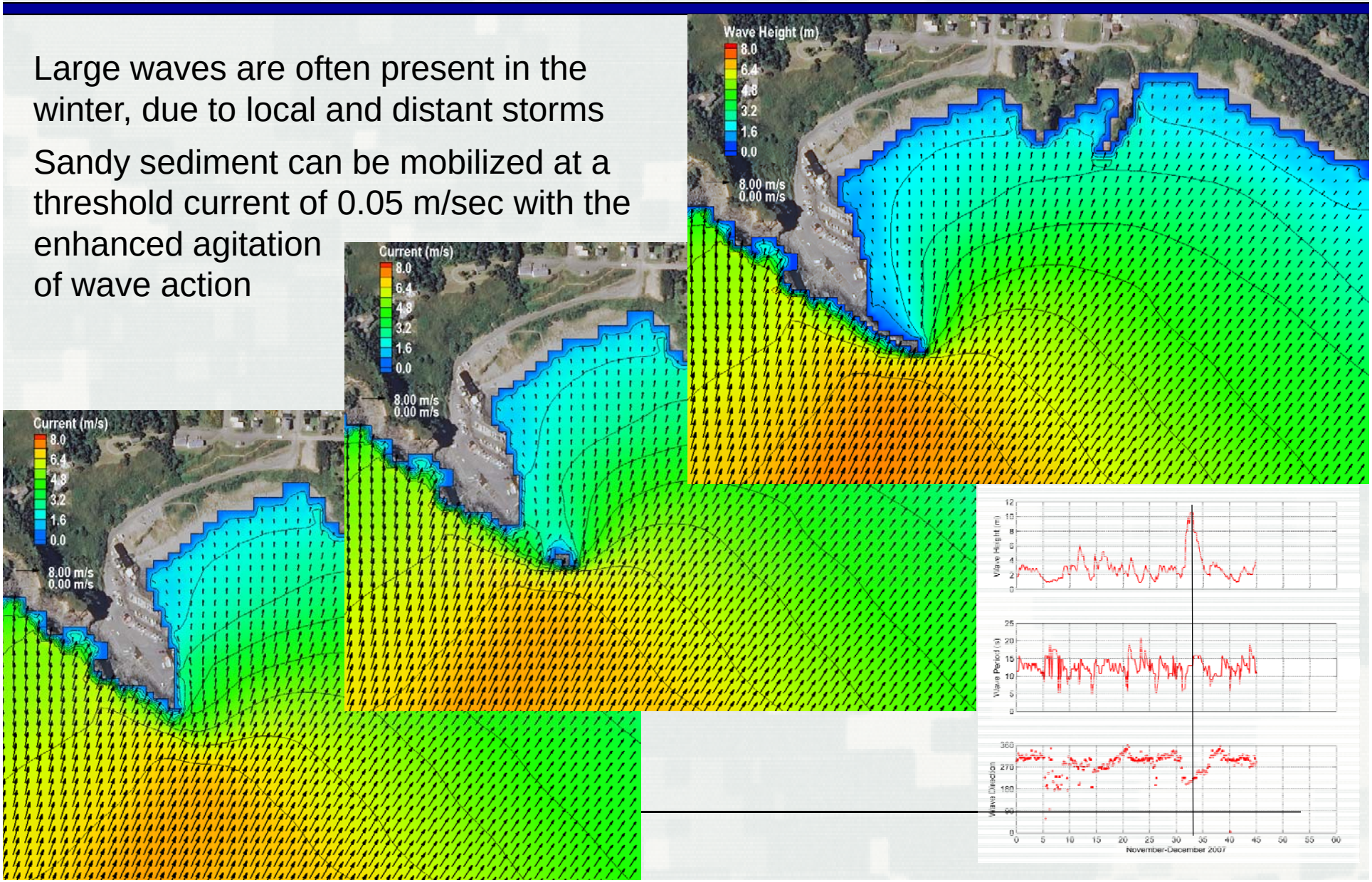
Coastal winter circulation is often greater than 0.15 m/sec



Waves
(Extreme Winter Storm, 3 December, 2010)

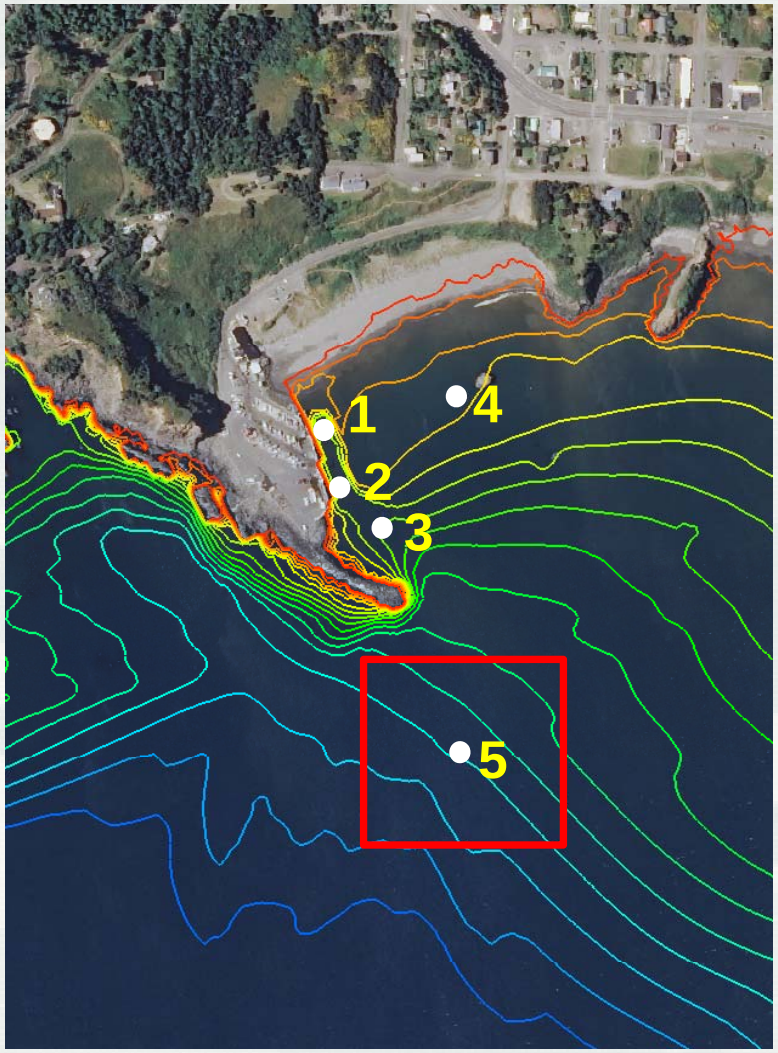
Large waves are often present in the winter, due to local and distant storms

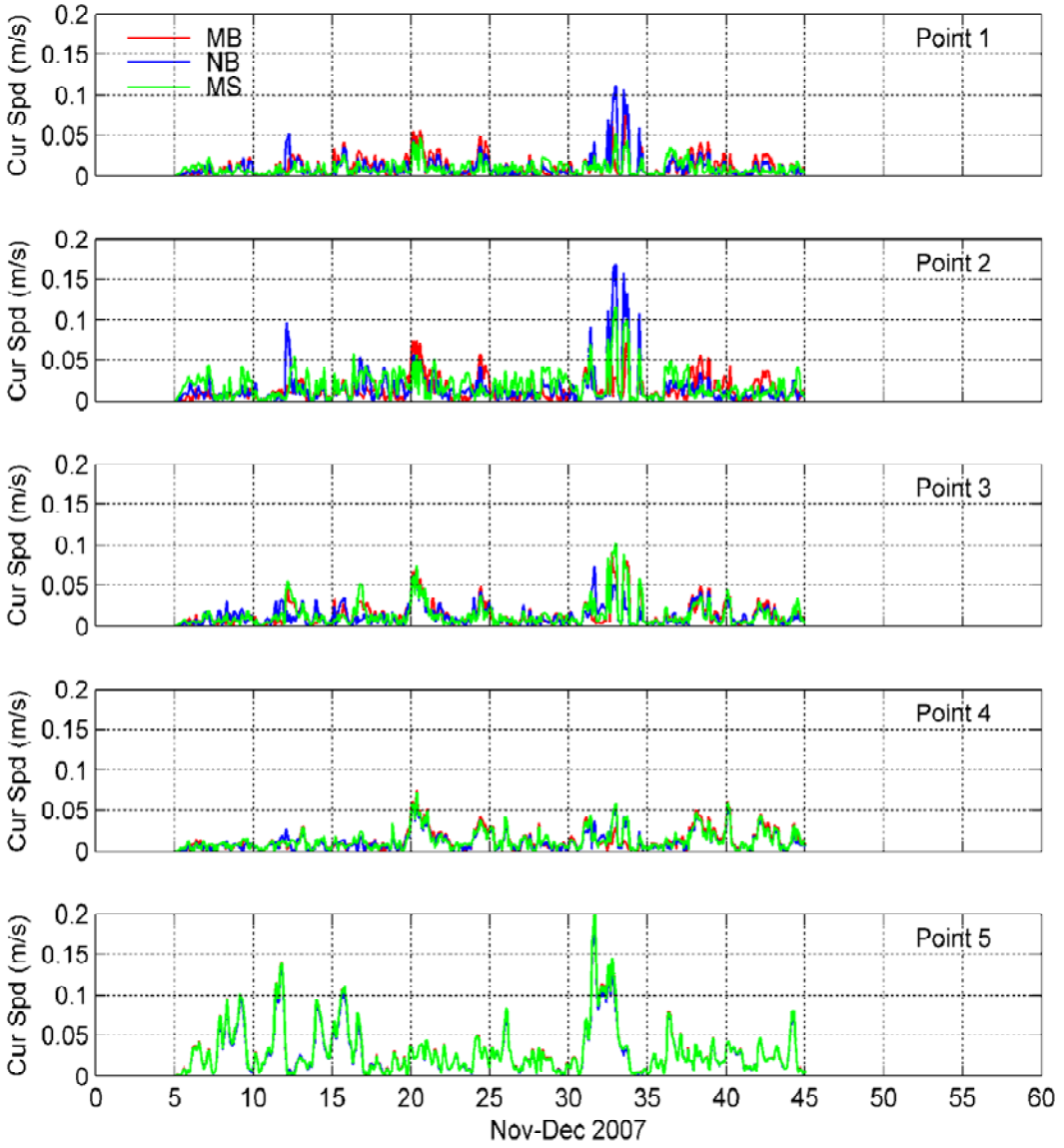
Sandy sediment can be mobilized at a threshold current of 0.05 m/sec with the enhanced agitation of wave action



Current at 5 Selected Sites

(6 November – 15 December, 2007)





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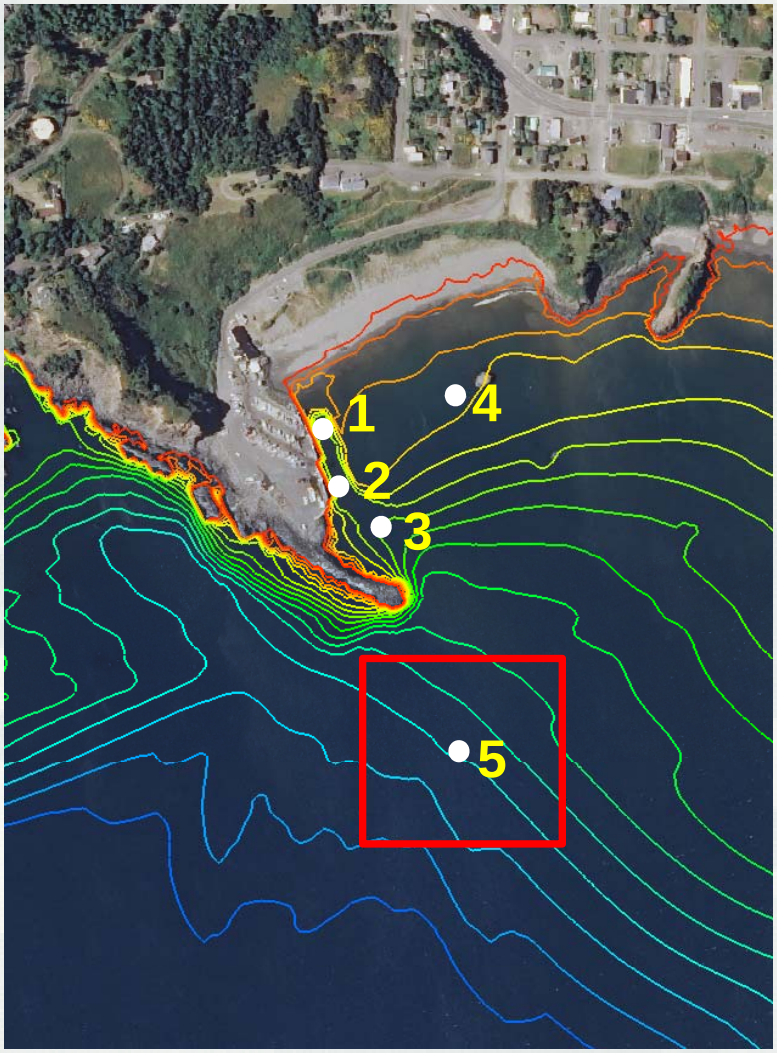
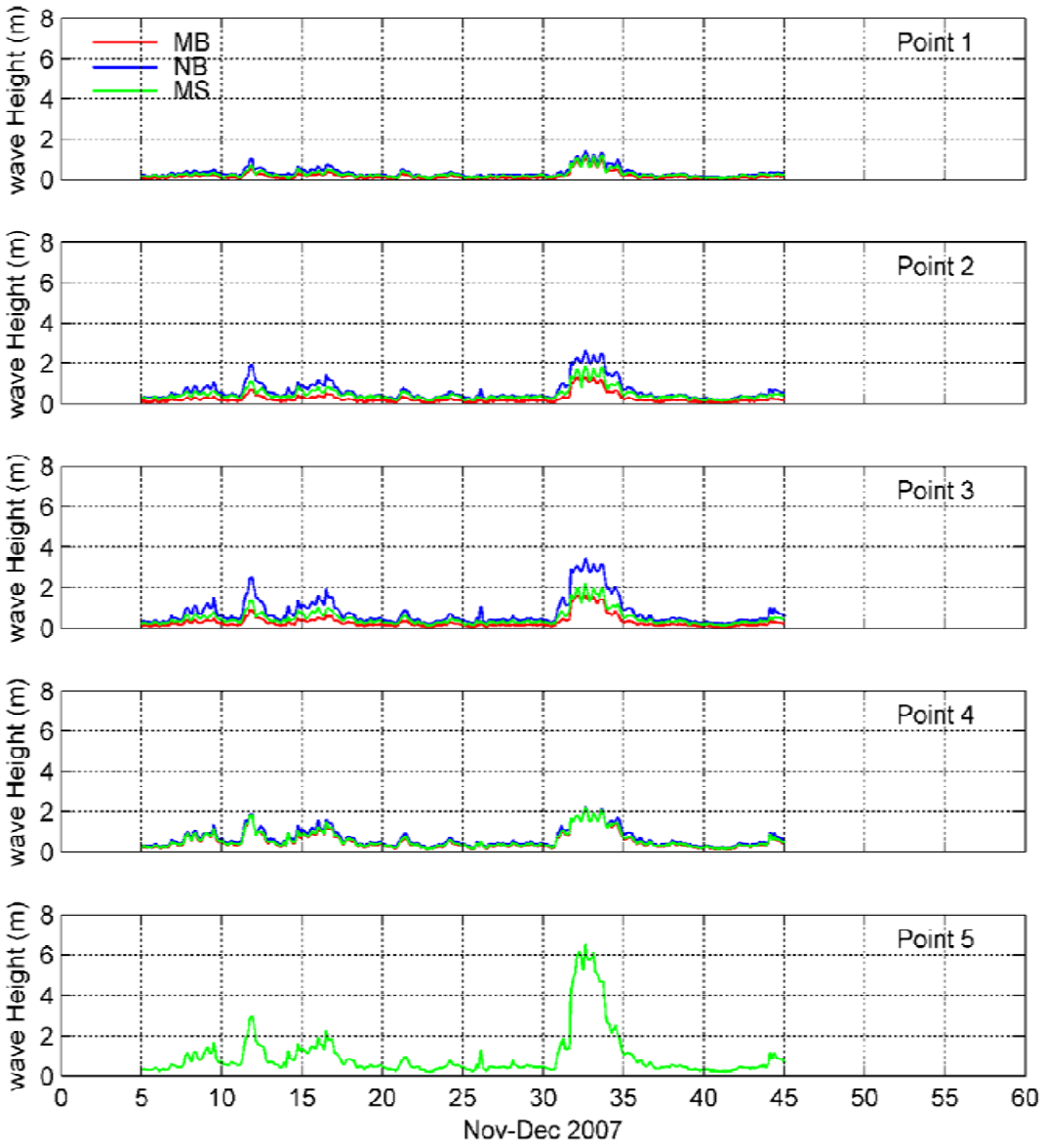
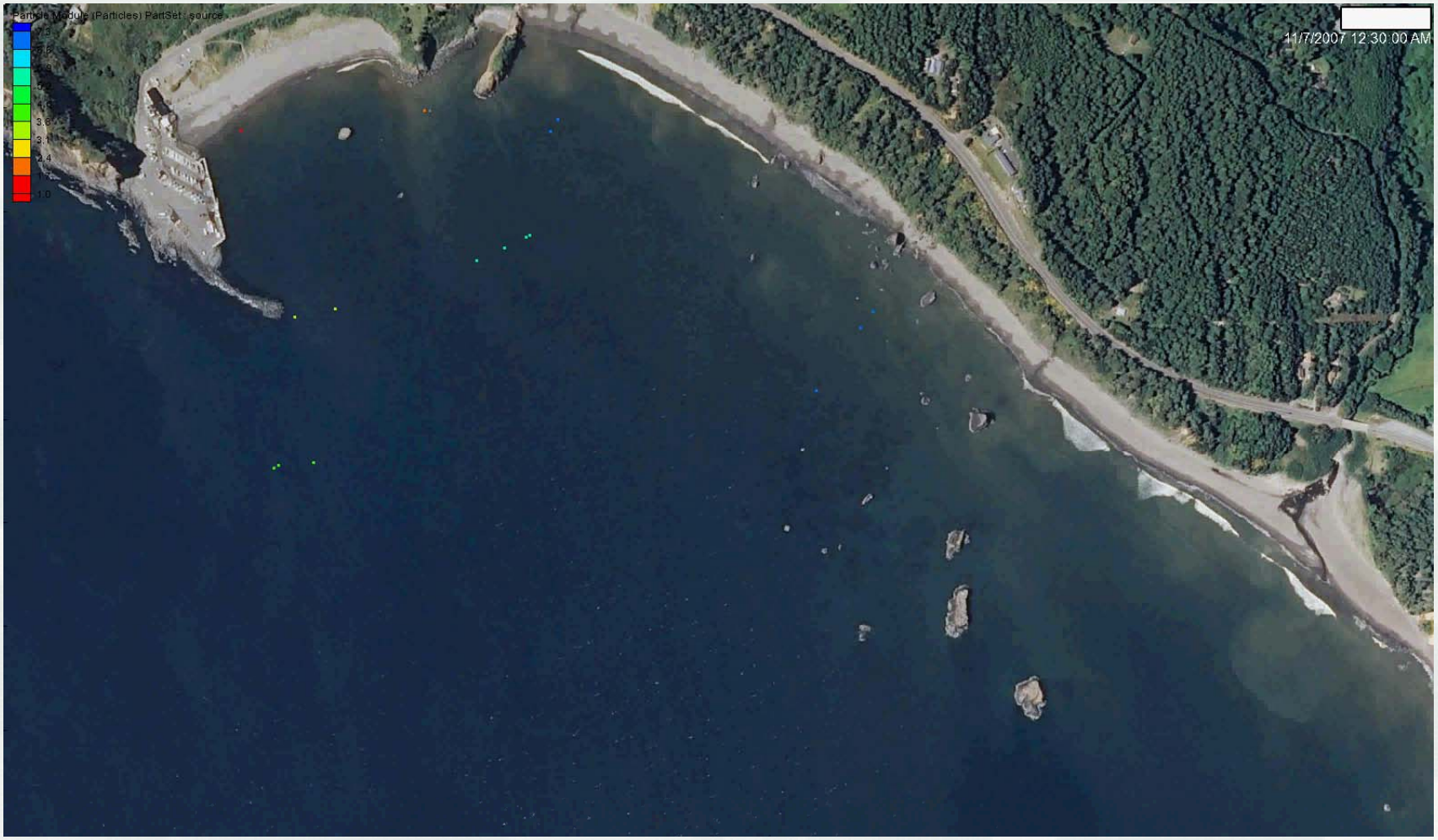
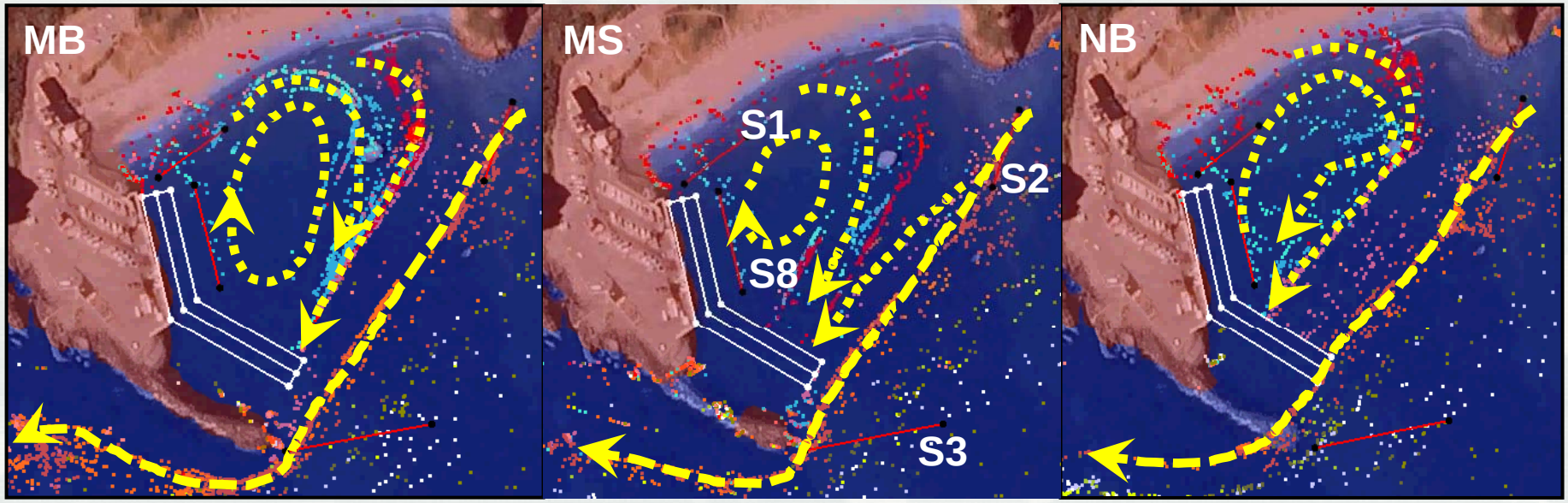




Particle Parthways
(6 November – 15 December, 2007)



Sediment Pathways
(3 December 2007)



S1 - Local Beach
S2 - Harbor-Embayment
S3 - Nearshore
S4 - CWA-404-DMPS
S5 - Nearshore
S6 - Updrift Littoral
S7 - Updrift Littoral
S8 – Harbor-Embayment

Mean grain size: 0.45 mm

Total sediment release: 850 (10-kg) parcels/day

MB: S1, S2, S8, and S6 contribute to most of the channel shoaling

MS and NB: additional sediment from source S7

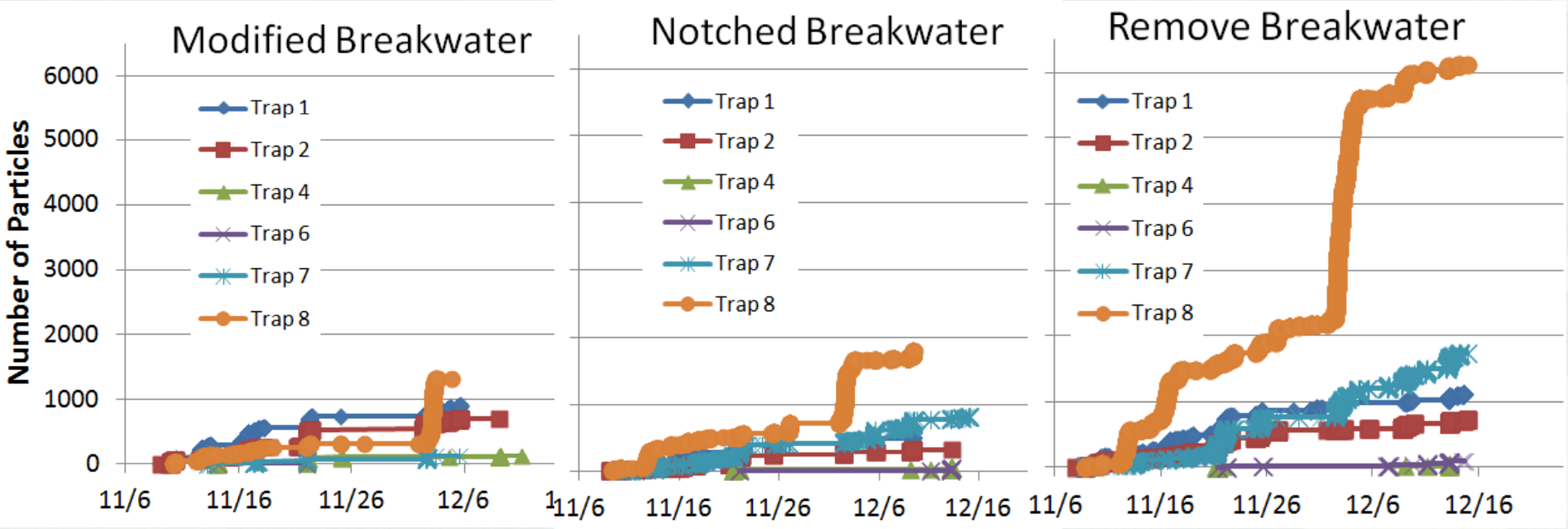
NB: S1, S2, S5, S6, S7, and S8 contribute to channel shoaling

Sediment Accumulation in the Channel
(6 November – 15 December 2007)

Times and locations of sediment parcels contributing to shoaling within the channel

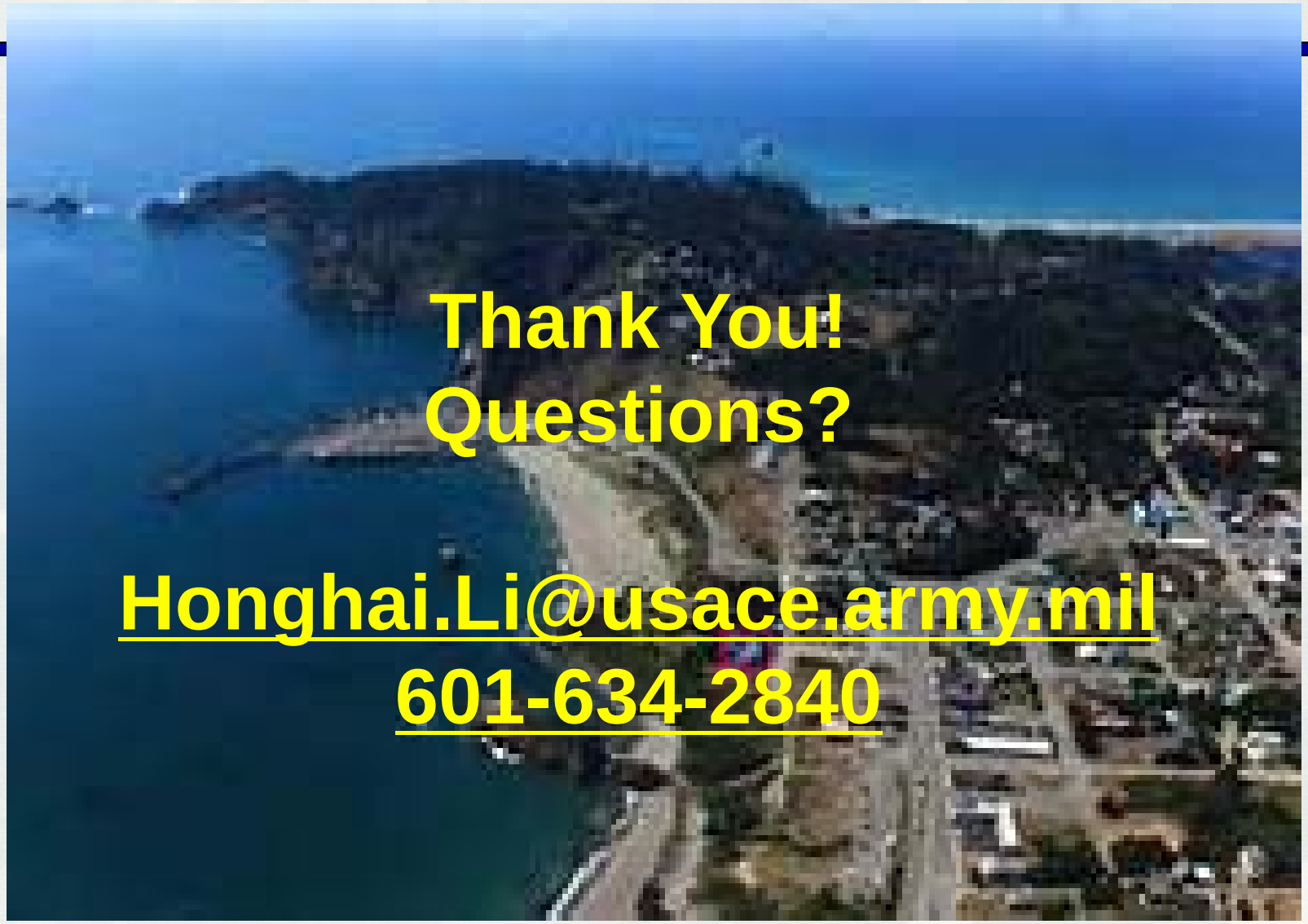
MB: S1, S2, S8, and S6 contribute to most of the FNC shoaling
MB and MS have the same amount of shoaling within the channel
NB: 200% more shoaling than the others

Rapid infill of the channel due to winter storms (persist for 1-3 days)



Summary

- Coastal area around Port Orford is located in a wave dominated environment. Depth averaged current is weak (~ < 0.1 m/s). Large long-shore current occurs south of the area during southerly waves.
- Wave height is greater than 2.0 m (6.5 ft) in front of the dock during an large winter storm (southerly waves).
- Restored breakwater can effectively protect the harbor from southerly waves. Without the breakwater, the refracted wave heights can be more than doubled in the harbor.
- Wave actions are more likely to enhance the transport of sediment due to wave-induced sediment resuspension.
- Rapid channel infilling occurs at Port of Port Orford due to the establishment of sustained sediment transport pathways during winter storms (southerly waves). The infilling is more severe for the breakwater removal case.


Thank You!
Questions?
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