

**U.S.ARMY**

CIRP TECHNICAL DISCUSSION:
*TOOLS FOR SIMULATING AEOLIAN SEDIMENT
TRANSPORT NEAR INLETS*
INLET ENGINEERING TOOLBOX

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**US Army Corps
of Engineers®**



CHL

**COASTAL &
HYDRAULICS
LABORATORY**



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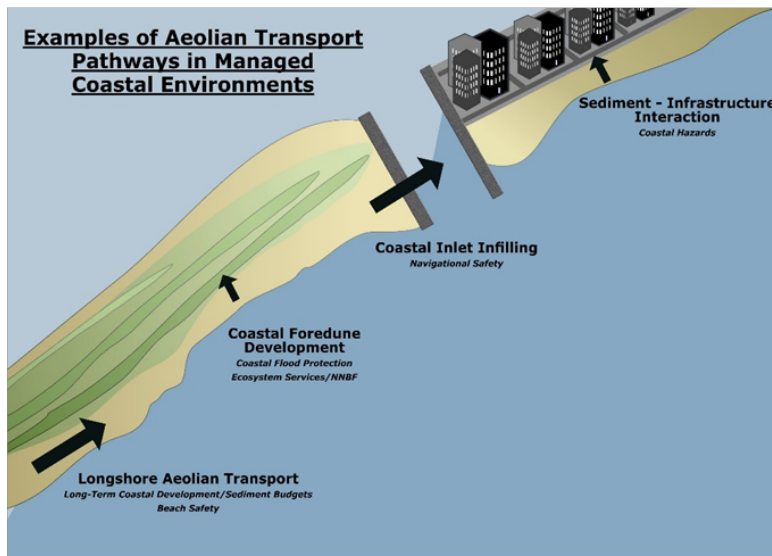
Tools for Simulating Aeolian Sediment Transport Near Inlets



Inlet Engineering Toolbox

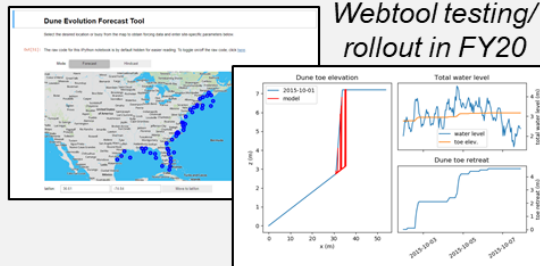
Nick Cohn, Kate Brodie

Primary Work Unit Goal: Development of process-based numerical modeling tools for simulating aeolian transport and dune evolution in managed coastal environments



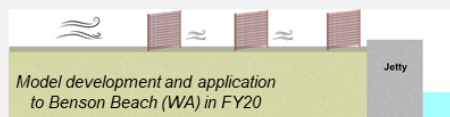
Rapid Dune Erosion Forecasting Tool (DEFT)

Webtool testing/
rollout in FY20



Modeling Aeolian Transport and Coastal Management Alternatives Near Inlets

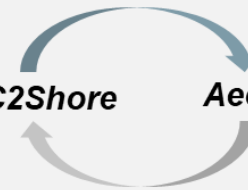
Aeolis + sand fence model
(open source model) vegetation planting



Co-Evolution of Coastal Morphology from Wind and Waves

CMS/C2Shore **Aeolis**

Initial coupled
model testing
in FY20



High

Tool Level of Maturity

Low

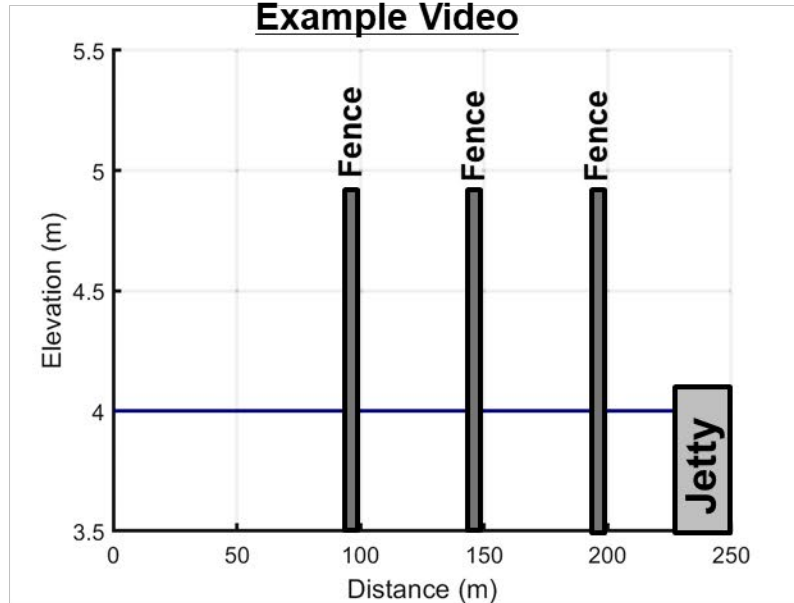
Short (hours to days)

Time Scale of Interest

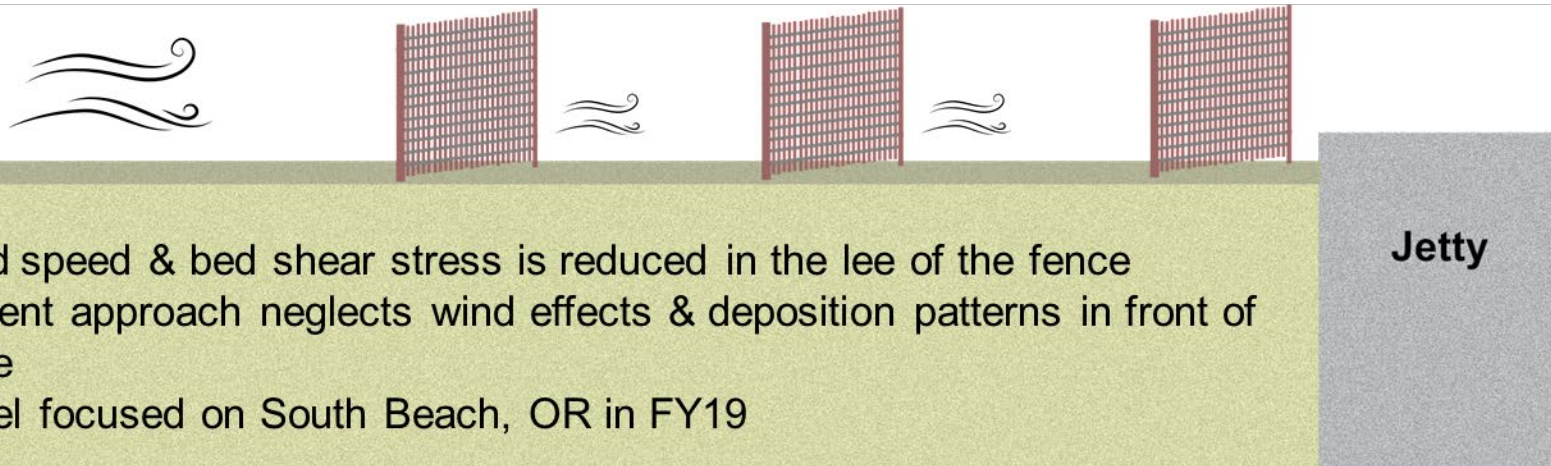
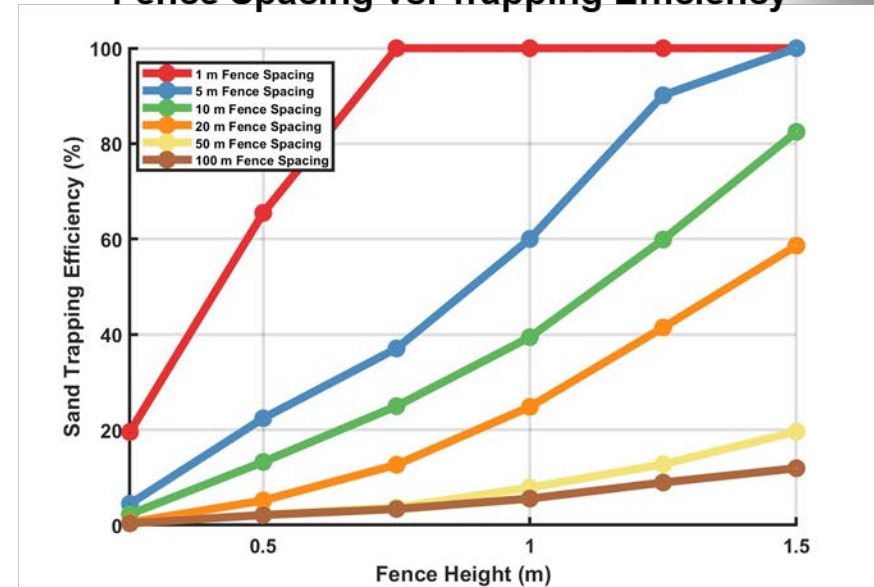
Long (months to years)

Recap from FY19 – 1D Aeolis

Example Video



Example Output: Fence Height vs. Fence Spacing vs. Trapping Efficiency

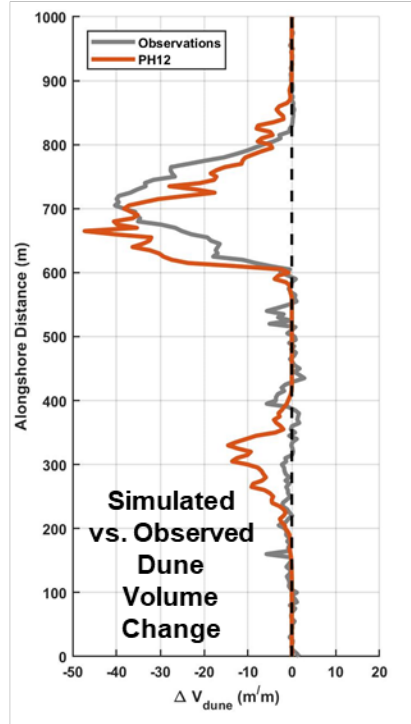


- Wind speed & bed shear stress is reduced in the lee of the fence
- Present approach neglects wind effects & deposition patterns in front of fence
- Model focused on South Beach, OR in FY19

Recap from FY19 – DEFT

Model/Tool Application

Hotspot Dune Erosion during Hurricane Joaquin (2015)



Model tested against dune erosion data at the FRF during Hurricane Joaquin.

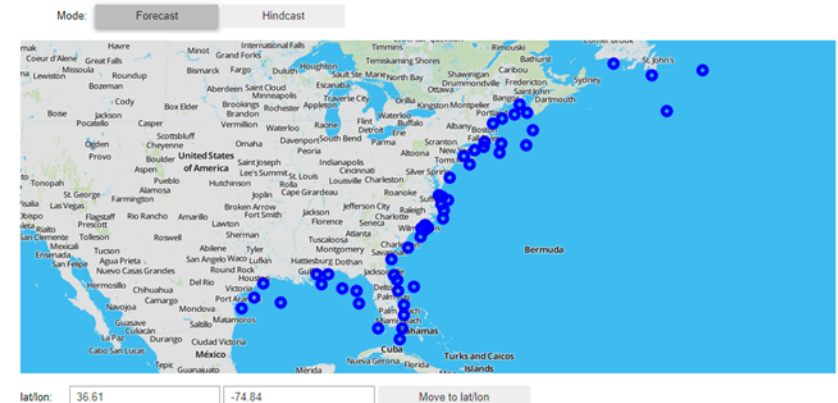
Captured alongshore characteristics of hotspot dune erosion, despite being a reduced complexity model

Webtool Development

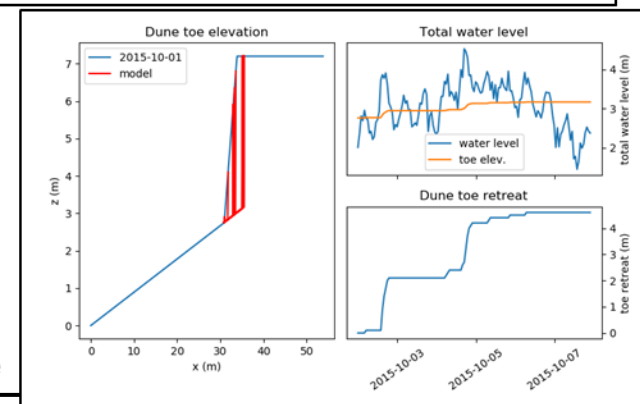
Dune Evolution Forecast Tool

Select the desired location or buoy from the map to obtain forcing data and enter site-specific parameters below.

Out[51]: The raw code for this IPython notebook is by default hidden for easier reading. To toggle on/off the raw code, click [here](#).



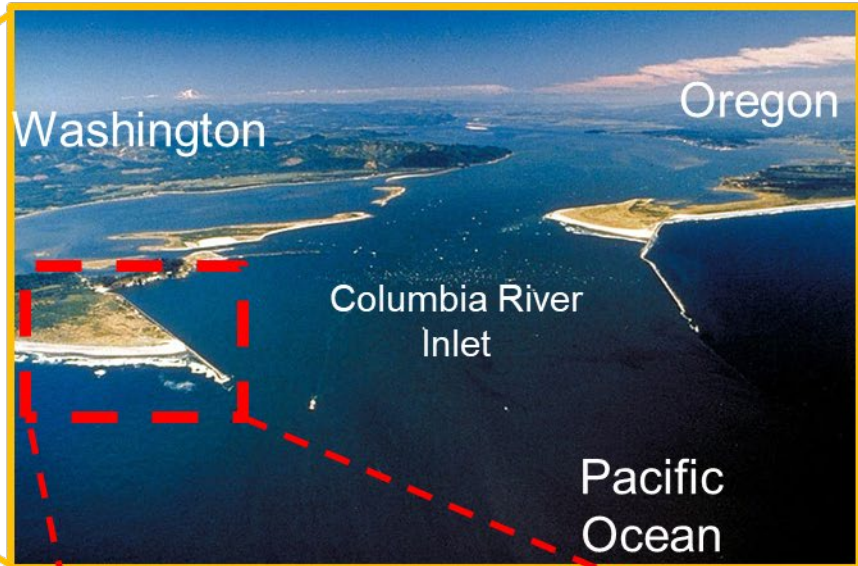
→ Jupyter notebook deployed on server
→ Can run in forecast (NOAA ESTOFS & WW3) or hindcast (WIS or NOAA bouys) mode





- Columbia River is the largest river on the US West Coast, with a drainage basin of 668,000 km²
- Between 2 to 4 million m³ of sand dredged annually from the Mouth of the Columbia River (MCR) region



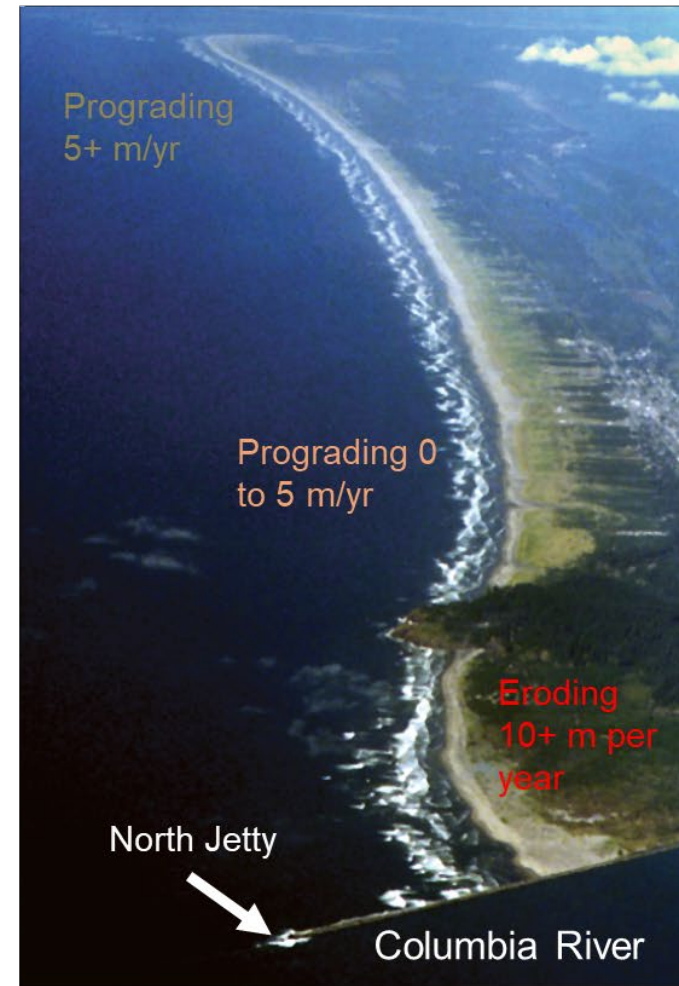
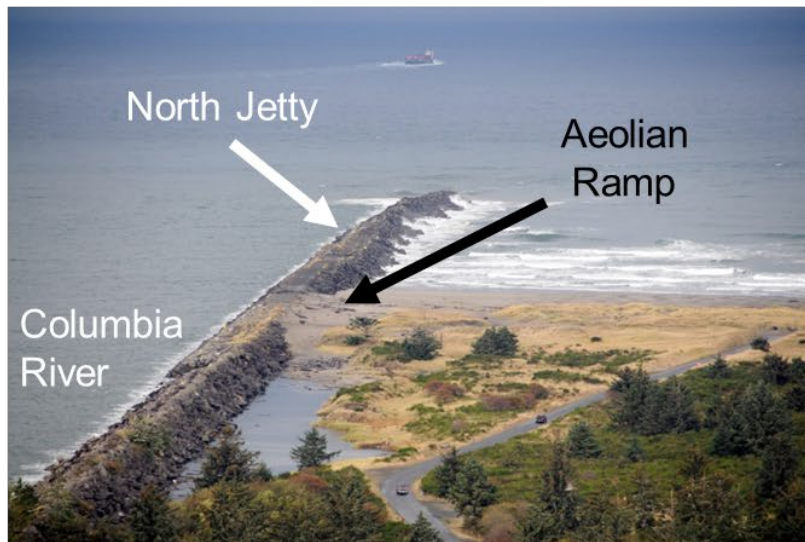


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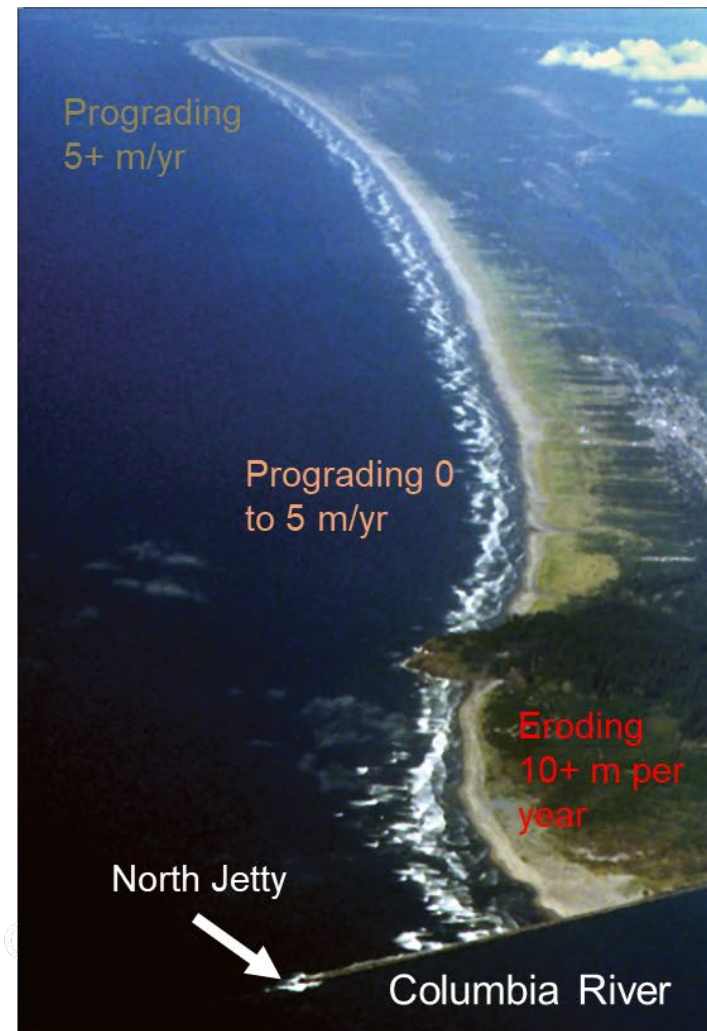
Relevant Management Problems Close to MCR

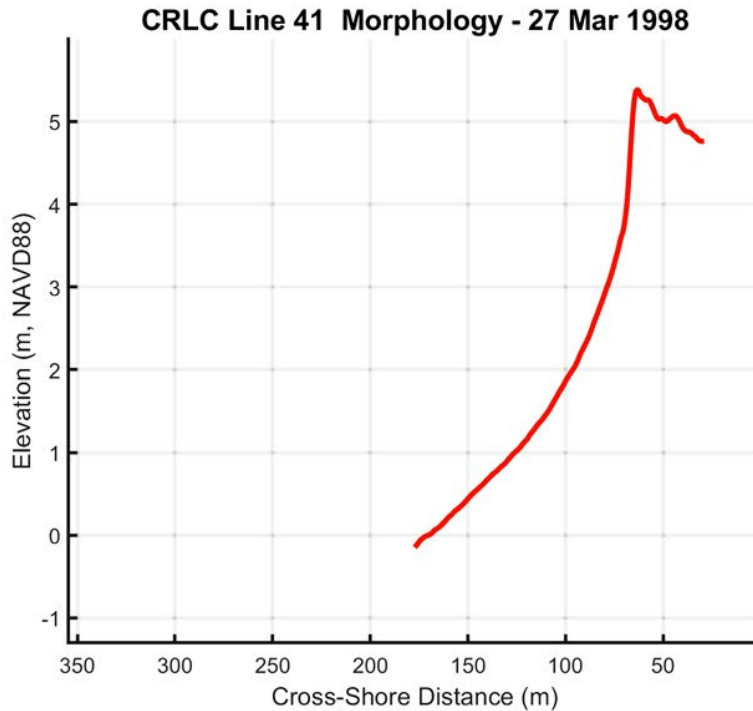
- Recent erosion of shoreline close to the north jetty
- Have done beach/berm nourishments and have a shallow water placement site for dredged material
- Have installed sand fencing to stabilize upper beach and control wind-blown transport



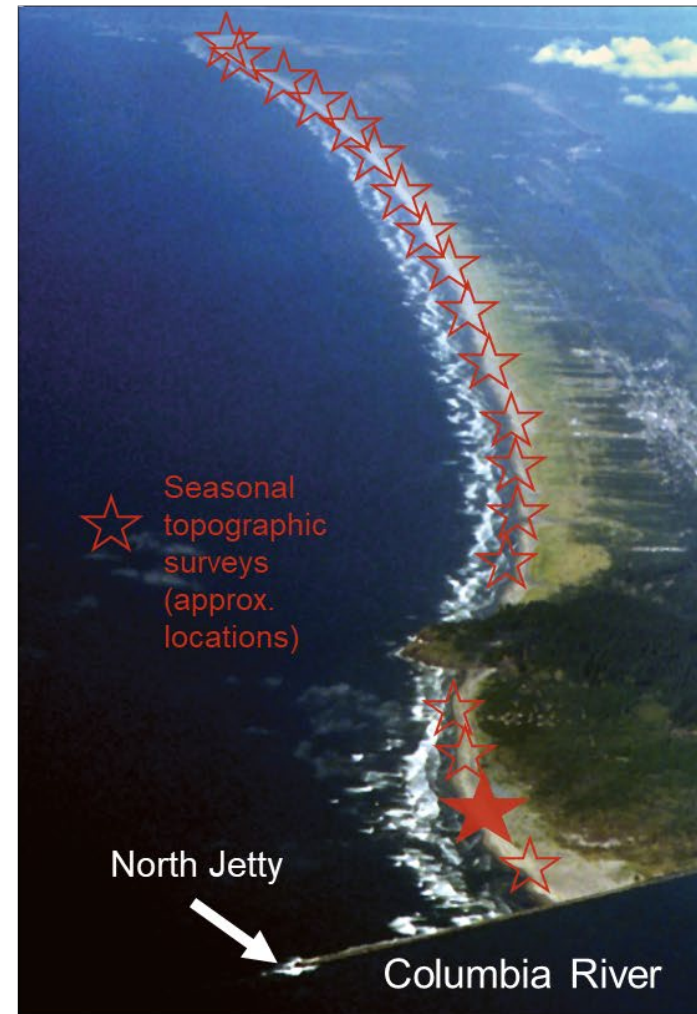
FY20 – Re-Focus to MCR

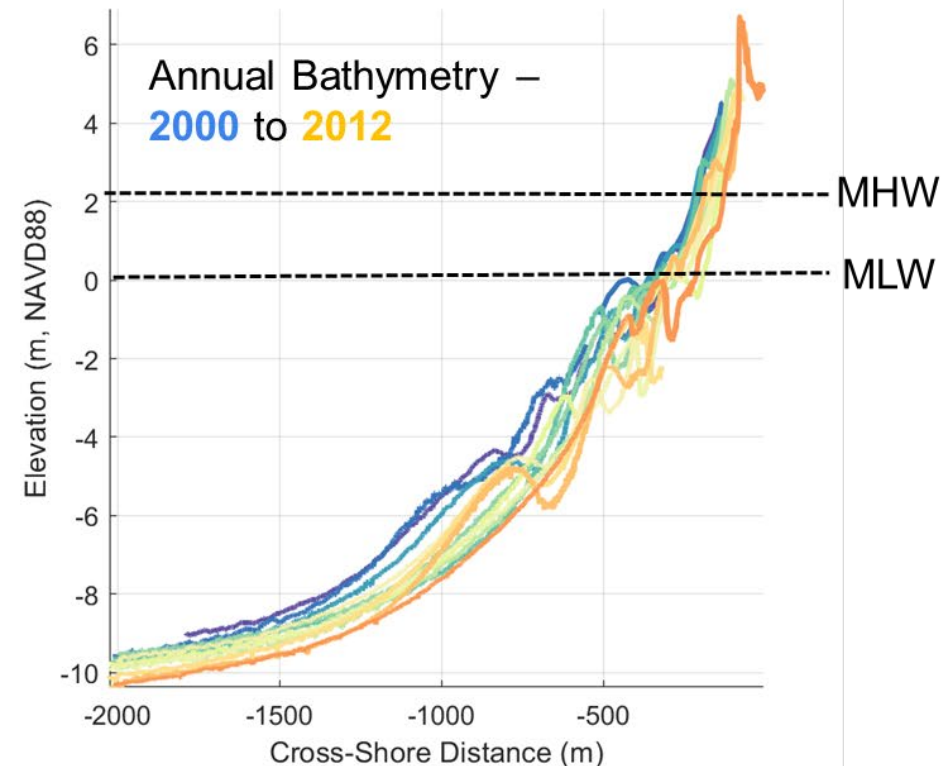
- Management relevant problems which require complex tools to address
 - Active dredging/placement
 - Erosion + accretion issues above and below water
 - Potential re-installation of sand fences in 2020
- Many existing **datasets** can leverage





Topographic data collected quarterly at field site by Washington Department of Ecology (funded by USACE NWP and NaNOOS)





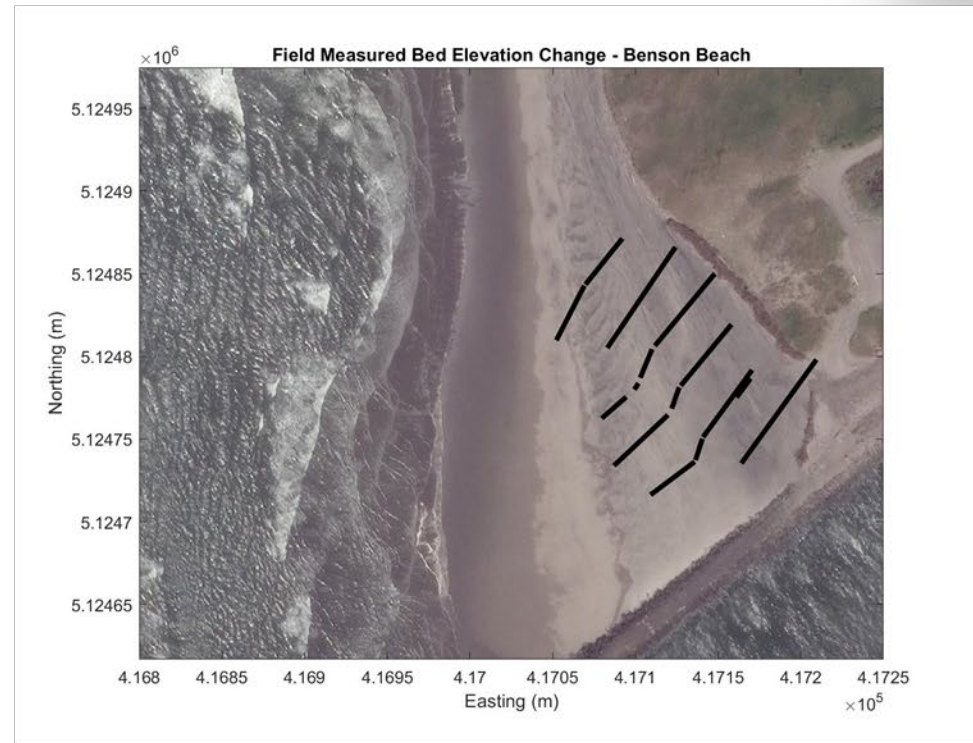
Nearshore bathymetry data collected annually at field site by Oregon State University and the USGS (funded by USACE NWP and NaNOOS)



Sand Fences at Benson Beach

Installed in Summer/Fall 2008
by USACE/ECY following the
installation of a beach berm

ECY completed numerous
high detail post installation
morphology change surveys



Data and Pics Courtesy of George Kaminsky (Washington
Department of Ecology)

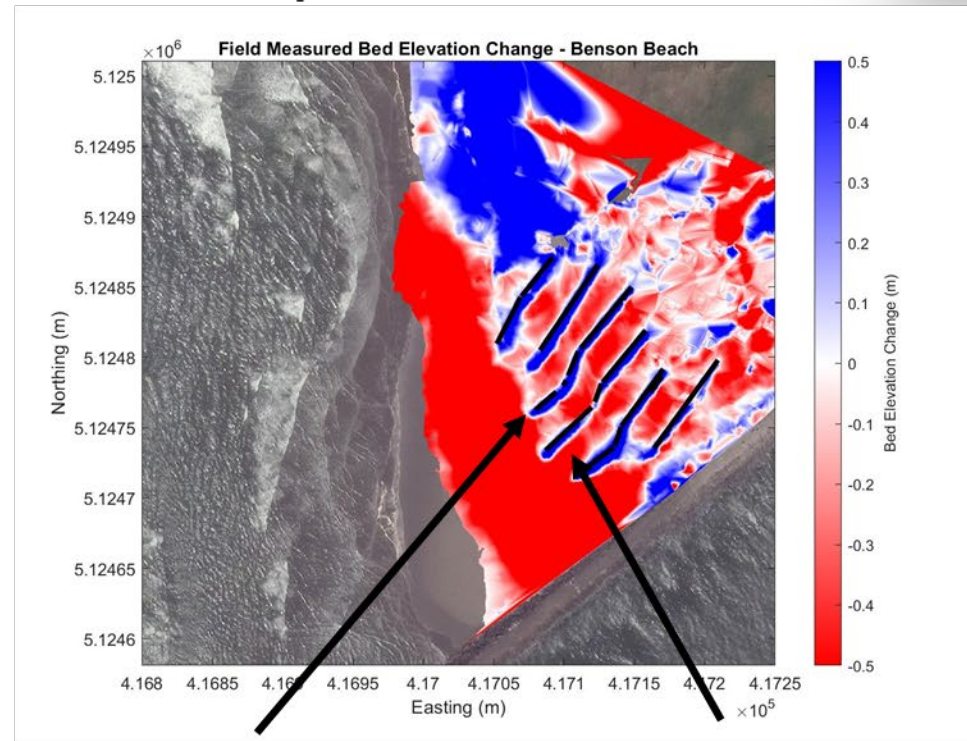
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Sep 2008 to June 2009



**Deposition on
both sides of
fence**

**Wind-driven
erosion in
between fences**

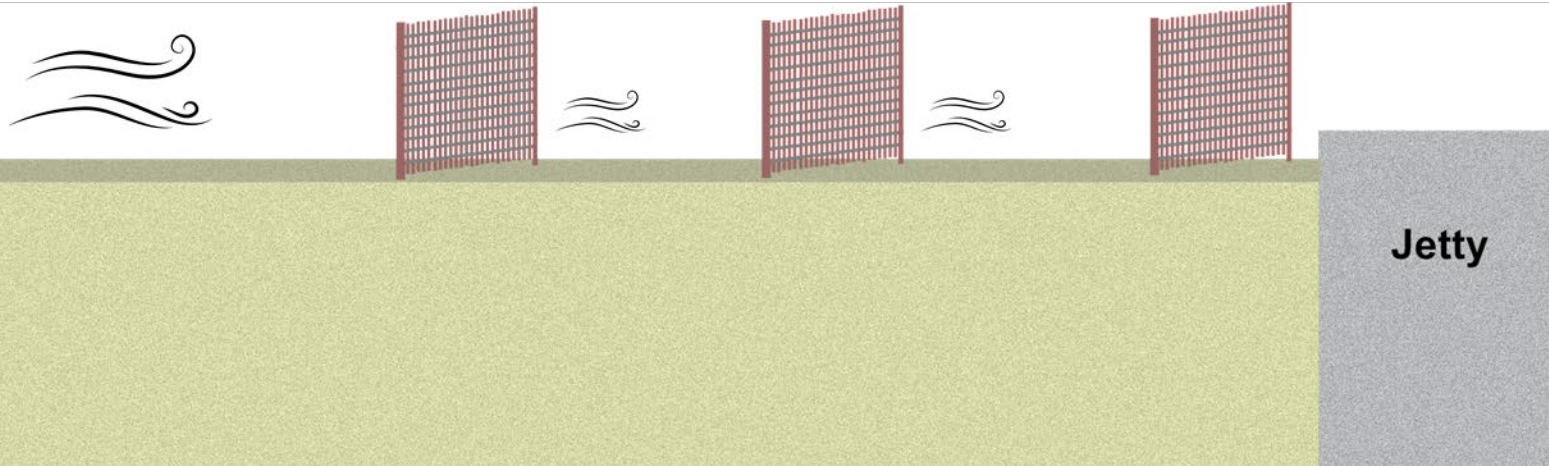
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Numerical Modeling

Goals:

- Take 1D approach and implement in 2D
- Apply to Benson Beach site





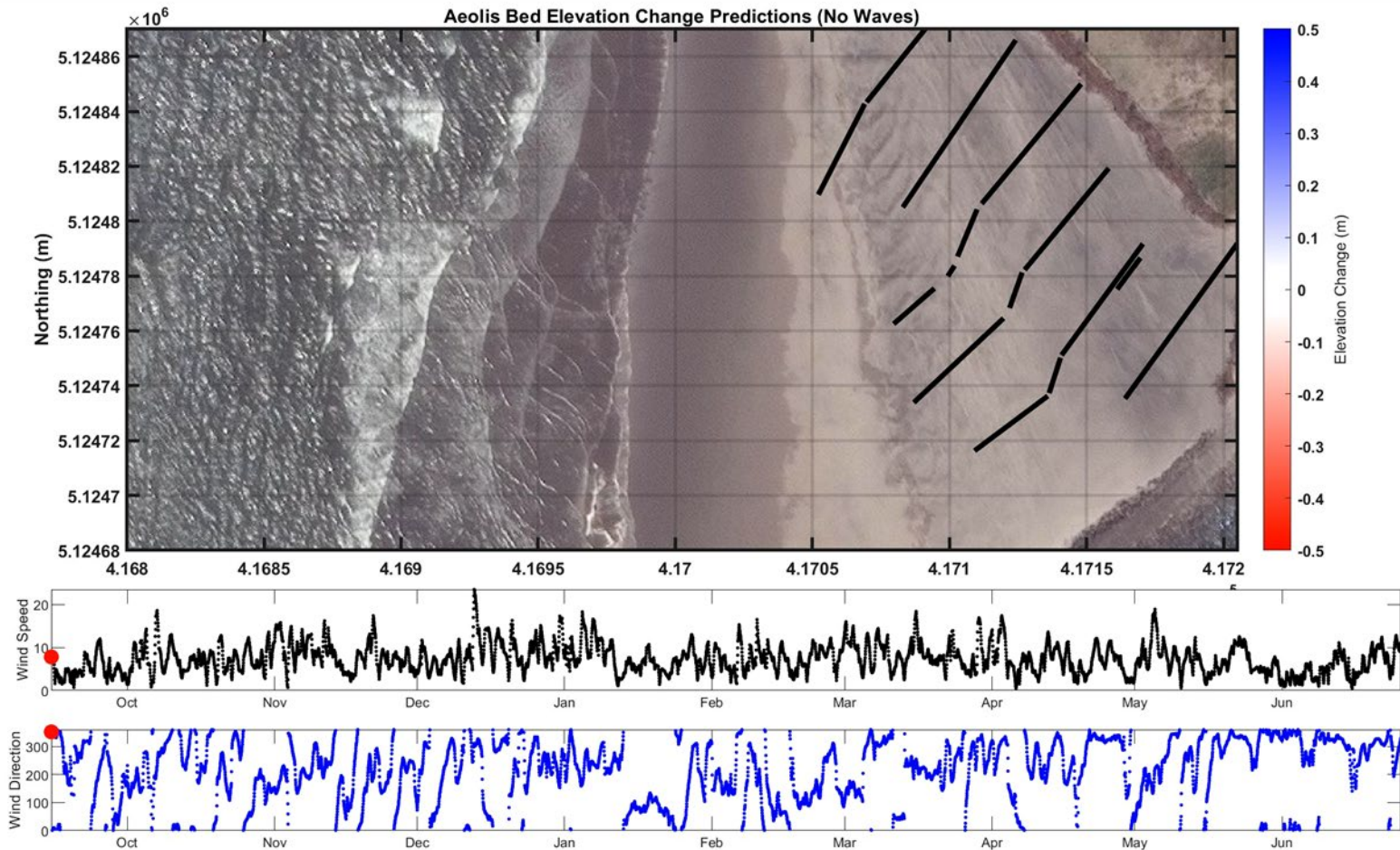
Numerical Modeling – *Aeolis Hindcast*

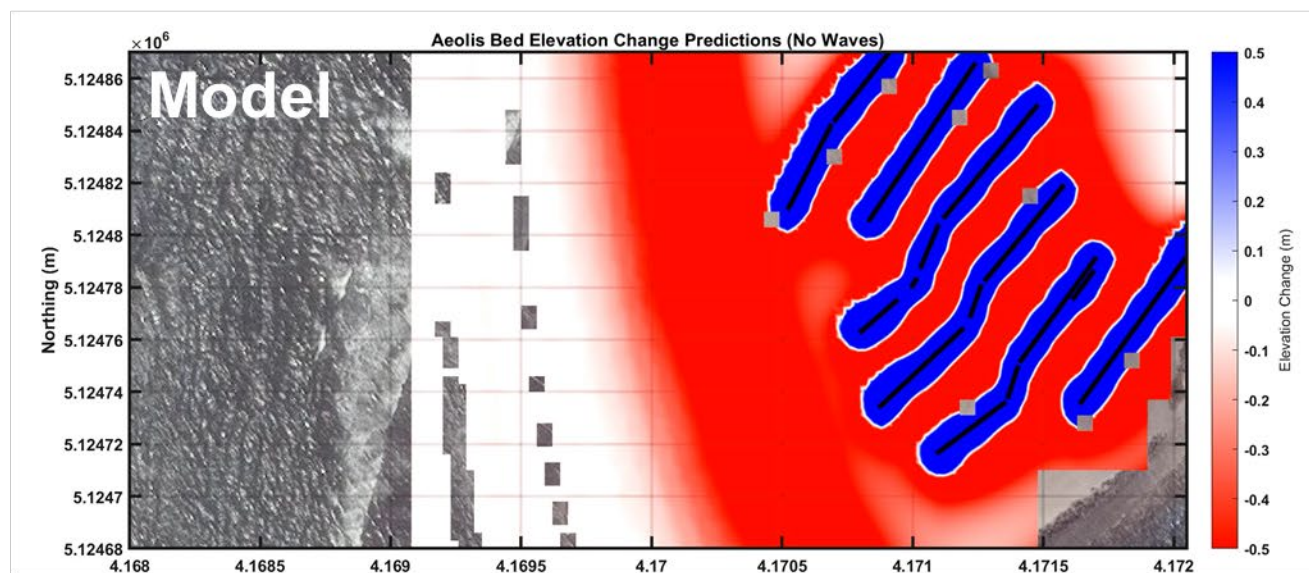
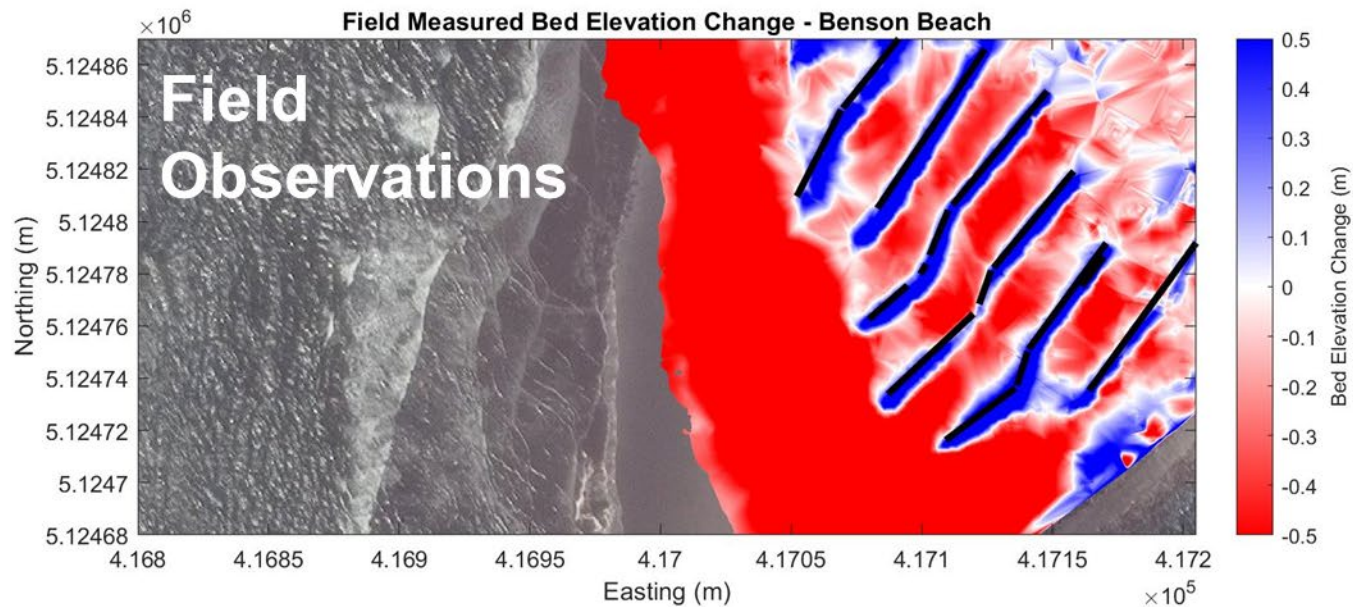
Scenario Attributes:

- Tides from Astoria, OR
- Winds from Wave Information Studies
- Wave runup and wave-driven morphology change ignored (for now)
- Ignore precipitation (for now)
- Local morphology incorporated into model
- Single grain size assumed
- Actual sand fence locations included in model
- Otherwise, all model defaults used



Numerical Modeling – *Aeolis Hindcast*







Progress Sofar:

- Simple approach to wind reduction in lee of fences re-creates general observed behavior (no model tuning done)
 - More complex approaches could be added

Ongoing/Needed Additions:

- Still working out some bugs and adding model improvements
 - Properly accounting for jetties and hard (unerodible) structures
 - Include localized dune grass planting
 - Testing grid resolutions and other environmental conditions
- Collaborators at TU Delft/Deltares:
 - Improving model documentation and model accessibility
 - Focusing on changes to numerical schemes and eco-morphodynamics
- Adding in more about marine processes
 - Marine environment quite important for morphology evolution, particularly for longer time periods
 - Ultimately results in destruction of fences
 - Important marine controls on aeolian processes



How to Make Model Accessible?

- **Model Requirements:**
 - Winds
 - Waves
 - Tides
 - Morphology
 - Management Alternatives
 - Ect.....



How to Make Model Accessible?

UI Figure

Aeolis/CShore Demo Interface

ERDC CIRP Research & Development

Step 1. Site Selection

Benson Beach, WA
South Beach, OR
Galveston Bay, TX
Sand Key, FL
Lexington, MI

Step 2. Grid Setup

Draw Grid Extent
(OPTIONAL) Load Sand Fences
Add Fence Locations
Grid dx (m) 1
Fence Height (m) 1

Step 3. Physical Processes


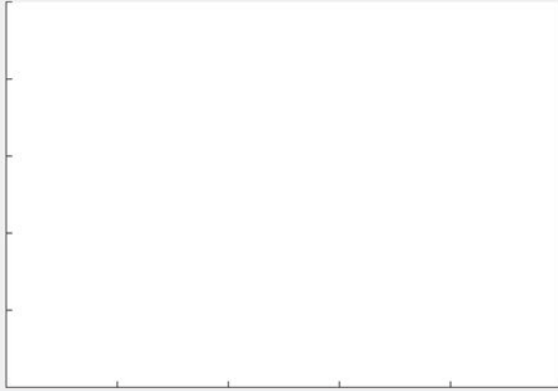
Waves Off ☐ On
Tides Off ☐ On
Winds Off ☐ On

Step 4. Scenario Attributes

Start Date 01-Jan-2000
Duration (days) 10
Time Step (secs) 3600

Step 5. Scenario Attributes Select Time Series Location

Run Model



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Waves Off On
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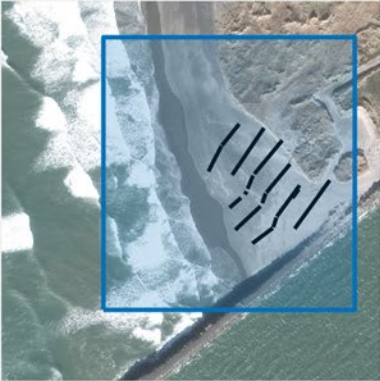
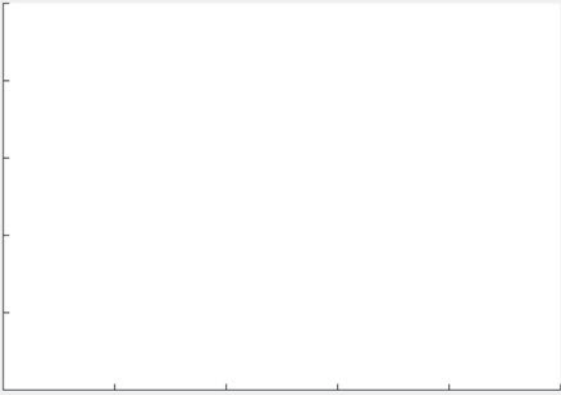
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Select Time Series Location

Run Model



Next Steps

■ Aeolis + C2Shore Coupling

▶ Simple (One-Way) Coupling To Start

» Total water levels from C2Shore to Aeolis

- Influences fetch and moisture for wind-blown sediment transport
- Waves result in reworking of sediment in intertidal zone (grain size distribution reset)
- Can influence fence destruction from high TWLs

» Morphology from C2Shore to Aeolis

▶ Two-Way Coupling (Long Term Goal)

» C2Shore and Aeolis exchange information back and forth, influence subsequent evolution

■ Continued Model Hindcasting at Benson Beach

▶ Algorithm refinement

■ Interface Development for Models (1D/2D Aeolis)

▶ Long-Term Solution → SMS

▶ Work with PDT on best way forward (+ DOTS request from Detroit District)

■ DEFT Wrapup



Questions?