DUNE RESPONSE TOOL & AEOLIS

TOOLS FOR SIMULATING AEOLIAN TRANSPORT NEAR INLETS

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COASTAL INLETS RESEARCH PROGRAM

FY20 IN PROGRESS REVIEW

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CIRP: Mission Support, Technology Transfer, Research & Development

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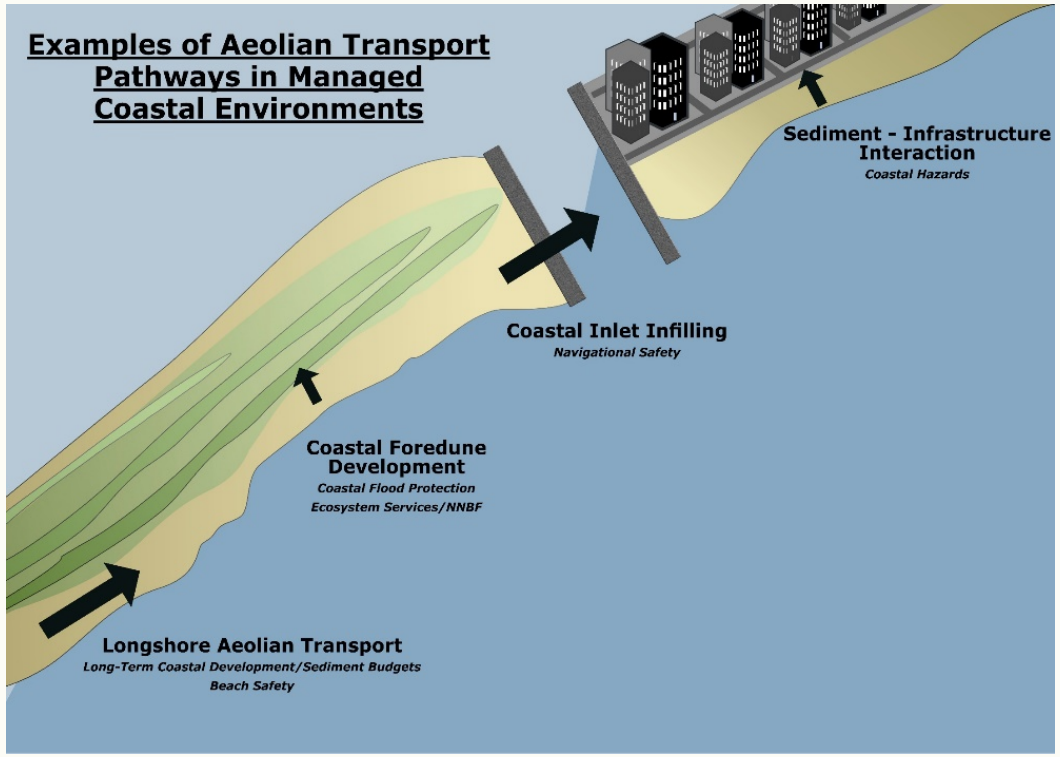
CHL COASTAL & HYDRAULICS LABORATORY

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

Problem Statement

- **Wind can transport sand and modify landscapes in managed coastal systems, resulting in sediment deposition that may adversely (inlet infilling) or positively (dune growth) impact project performance**
- **Suitable tools do not currently exist for USACE to simulate wind-blown sediment transport and related hazards**



Relevant Statements of Need:

2014-N-10 Update of Engineering Guidance for the Development and Maintenance of Coastal Dune Systems

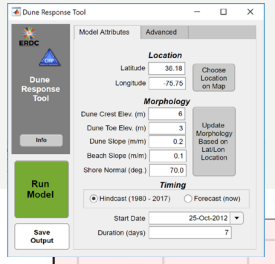
2017-N-72 Improved Simulation of Dune Morphological Response at Short & Long Time-scales

2020-F-1539 Improved Capabilities for Quantifying Coastal Dune Evolution and Resilience

Capability and Strategic Impact Statement

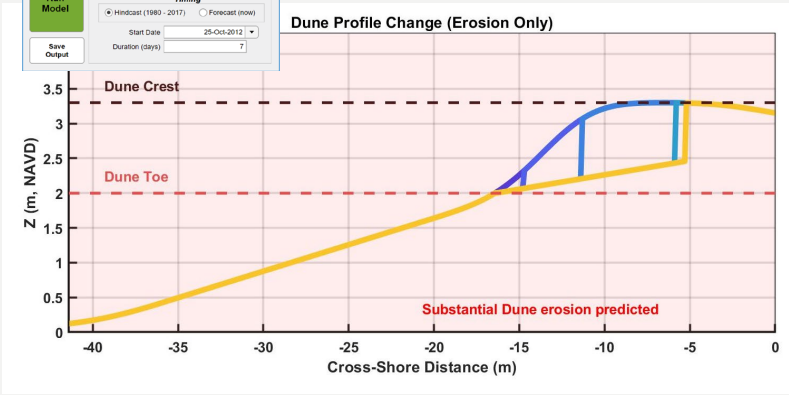
USACE currently has limited capabilities to predict wind-blown sediment transport processes and related morphological changes, including near complex inlet systems. This work aims to develop and extend state-of-the-art tools for simulating wind-driven sediment transport processes, including foredune evolution, in proximity to navigational channels and in other USACE-managed coastal settings.

Work Unit Tool Development

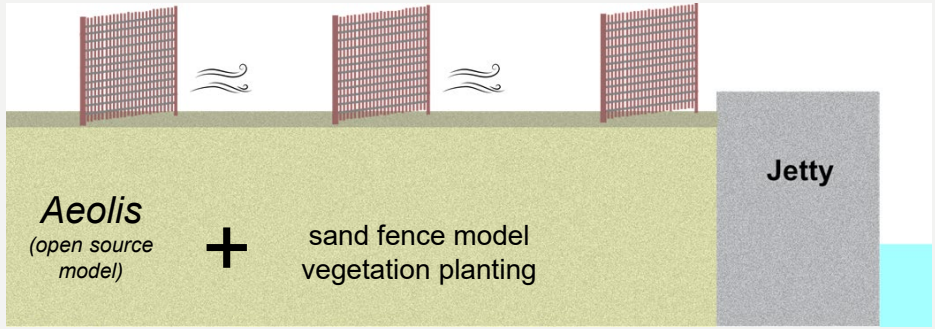


Dune Response Tool (*DRT*)

Rapid prototyping tool for storm-driven dune erosion and volumetric dune accretion



Aeolis *Process-based aeolian transport model with USACE management alternatives being added*



Aeolis+C2Shore: *Fully coupled subaqueous-subaerial model for simulating the co-cvolution of coastal morphology from wind and waves*

Short (hours to days) — **Time Scale of Interest** — *Long (months to years)*

Low (Limited Number of Processes Resolved) — **Model Fidelity** — *High*

High — **Tool Level of Maturity (at Start of Work Unit)** — *Low*

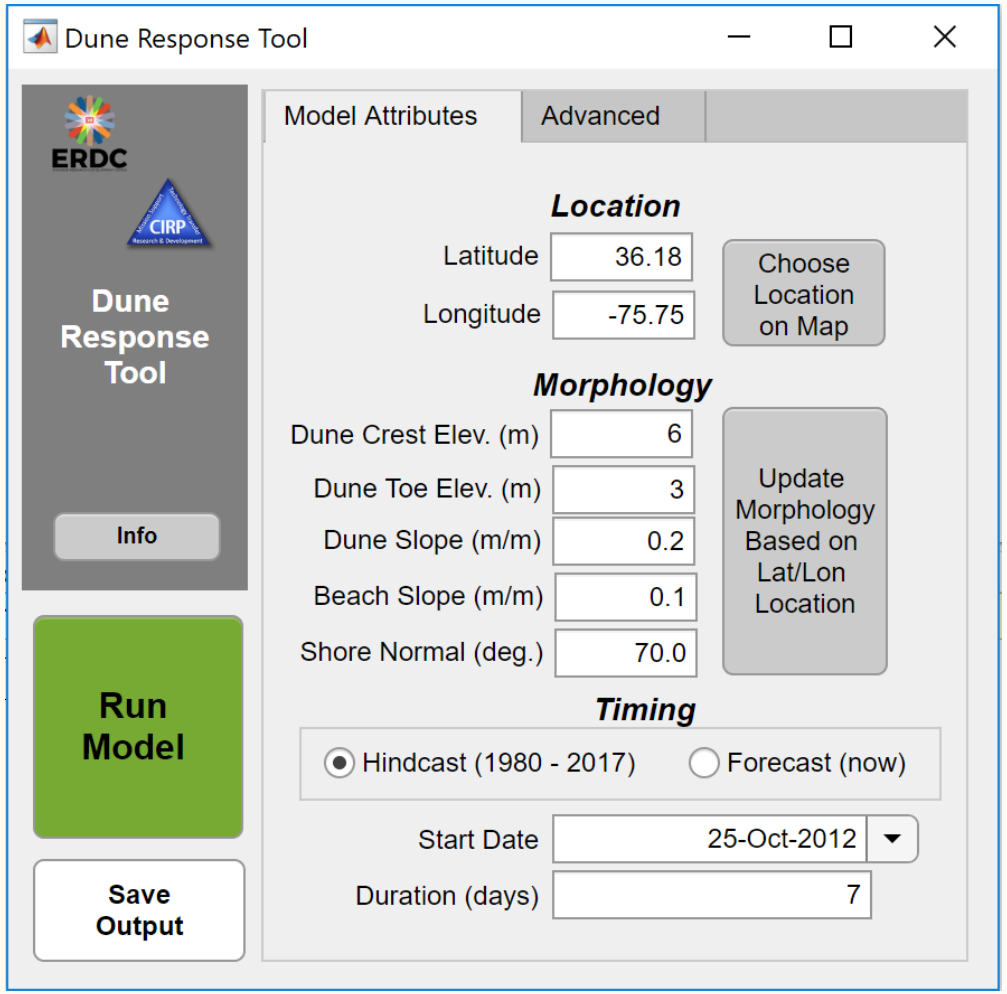
Faster (Seconds to Minutes) — **Computational Speed** — *Slower (Minutes to Days)*

Dune Response Tool

Capabilities:

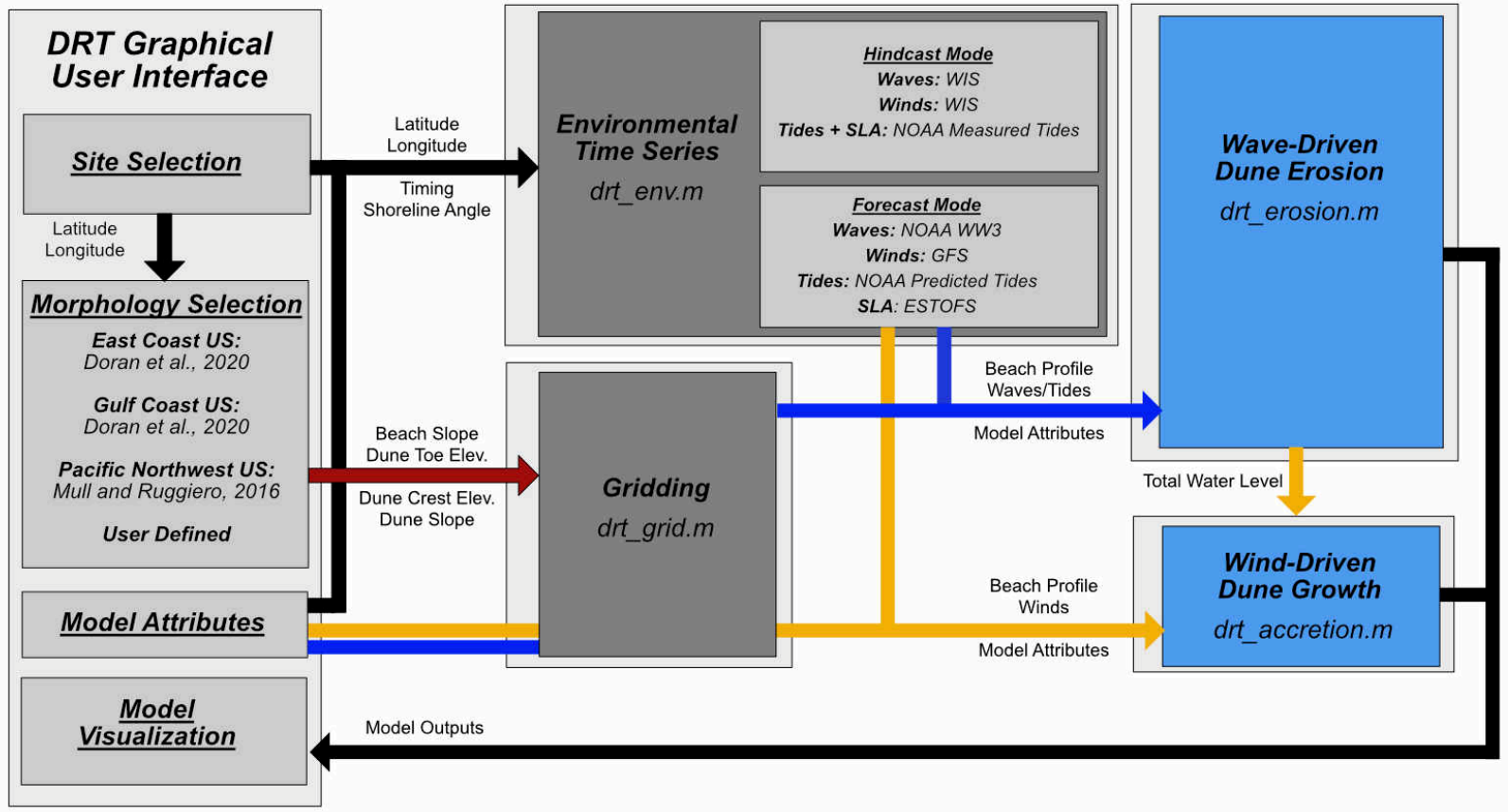
- Rapid dune retreat model (Palmsten and Holman, 2012) for simulating storm-induced foredune erosion
- Fetch-based aeolian transport model for rapid aeolian flux calculations for dune growth
- Built in morphologic and environmental databases. No user-supplied external data inputs needed for continental US coastal sites

Graphical User Interface

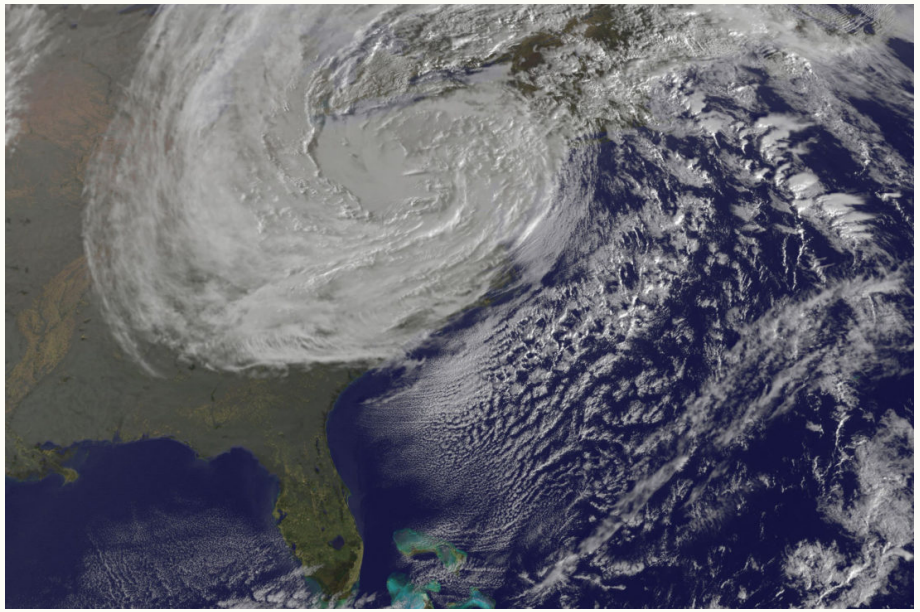


Dune Response Tool

- **Morphology:** public USGS datasets, PNW dataset from OSU, future incorporation of JALBTCX data
- **Environmental Data:** web-based fetching of hindcast (1980 – 2017) and forecast (now + 3 days) data products



Dune Response Tool



Example Case – Hurricane Sandy

Mantoloking, NJ

Long Beach Island, NJ

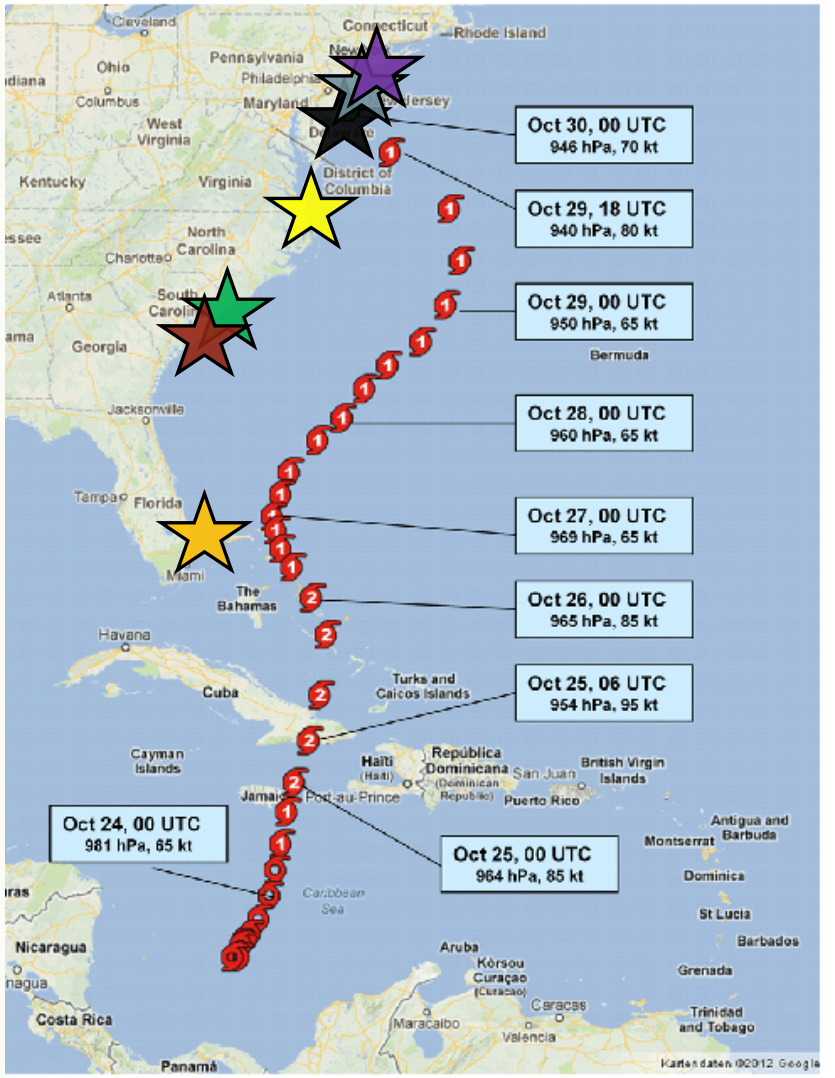
Dewey Beach, DE

Virginia Beach, VA

Myrtle Beach, SC

Folly Beach, SC

Ft. Lauderdale, FL



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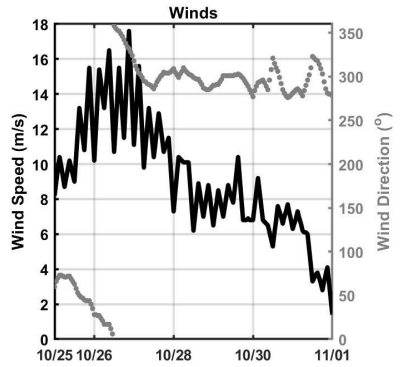
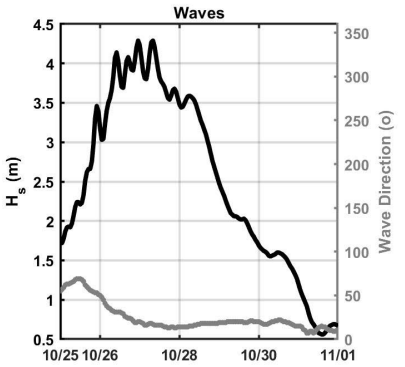
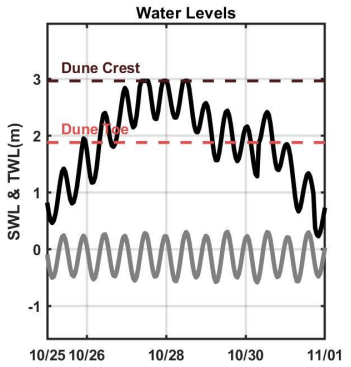
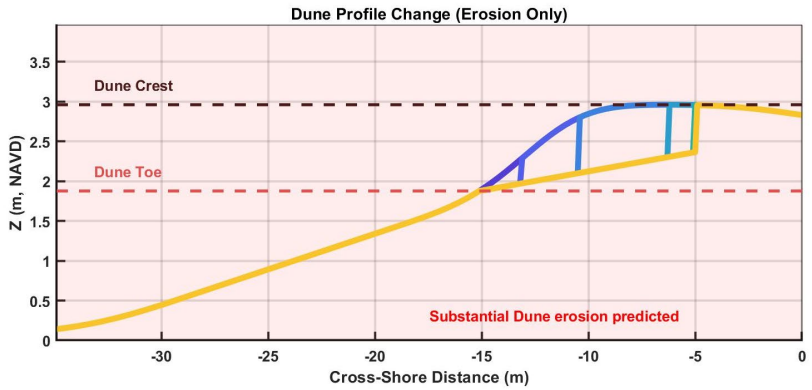
Dune Response Tool

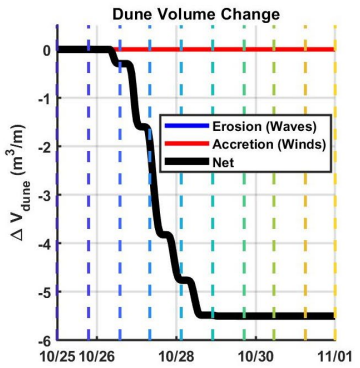
Ft. Lauderdale, FL









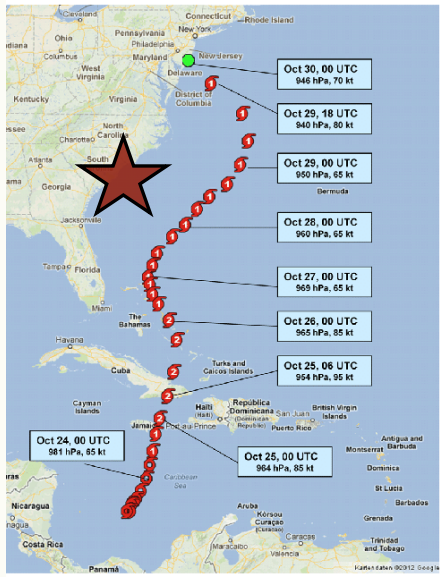


Observed:
Major dune erosion, overwashing

Predicted:
Major dune erosion

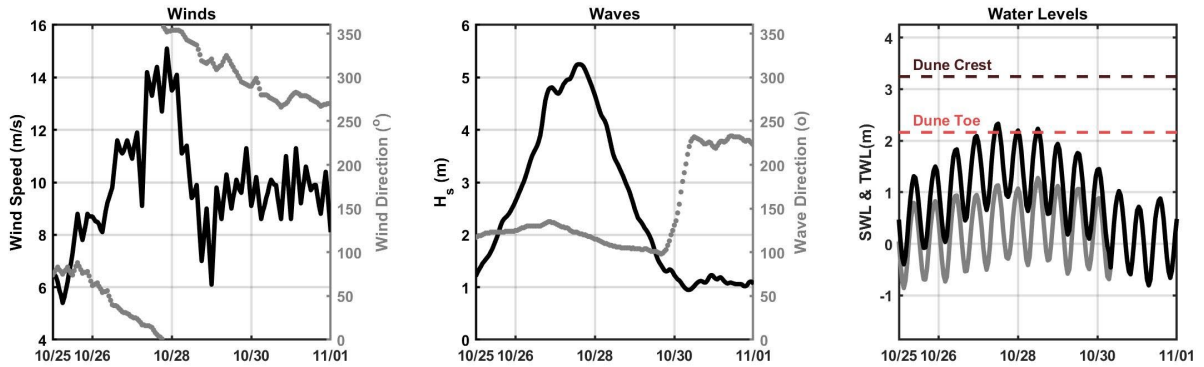
Dune Response Tool

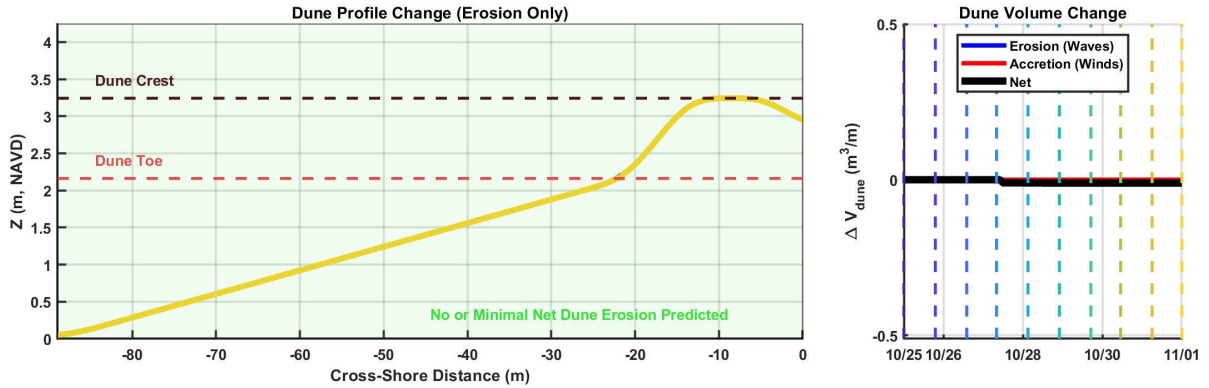
Folly Beach, SC



Observed:
Beach erosion, limited dune impacts

Predicted:
Limited dune impacts





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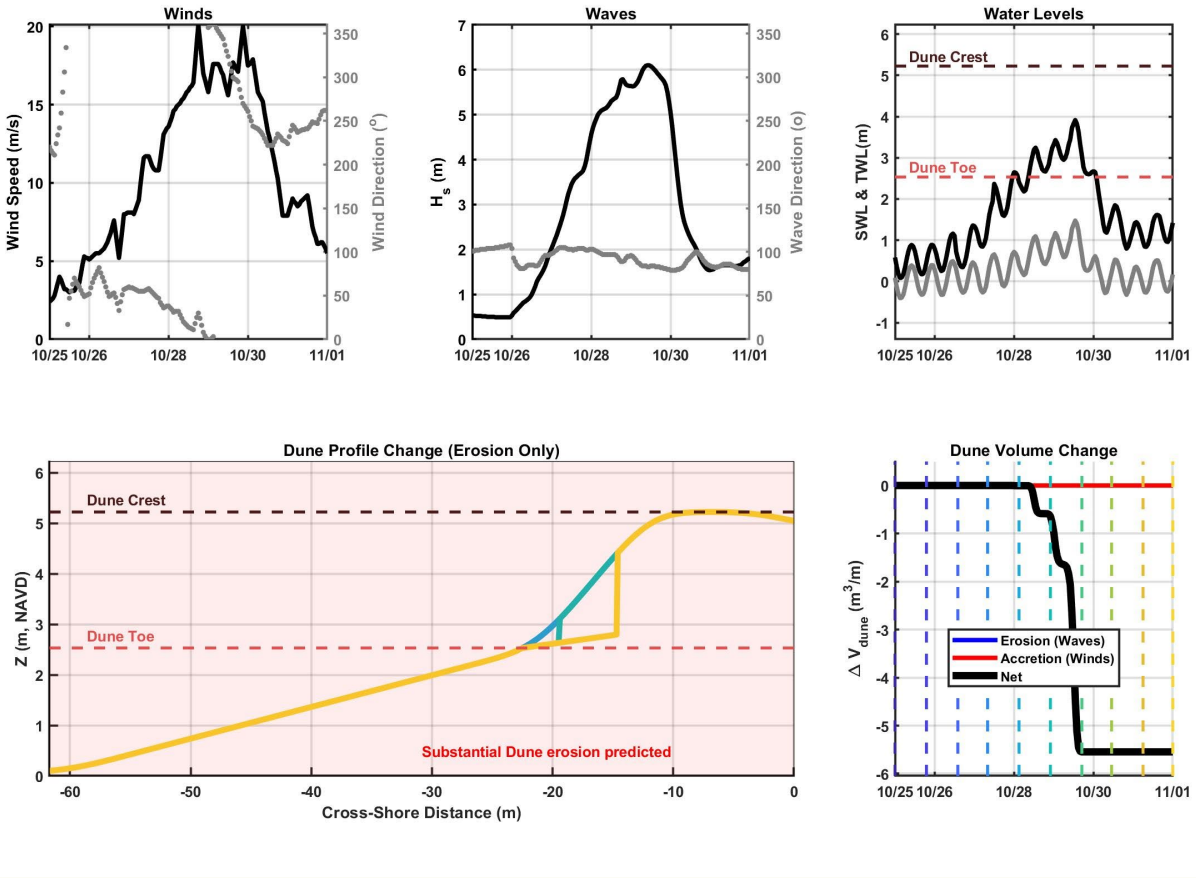
Dune Response Tool

Virginia Beach, VA

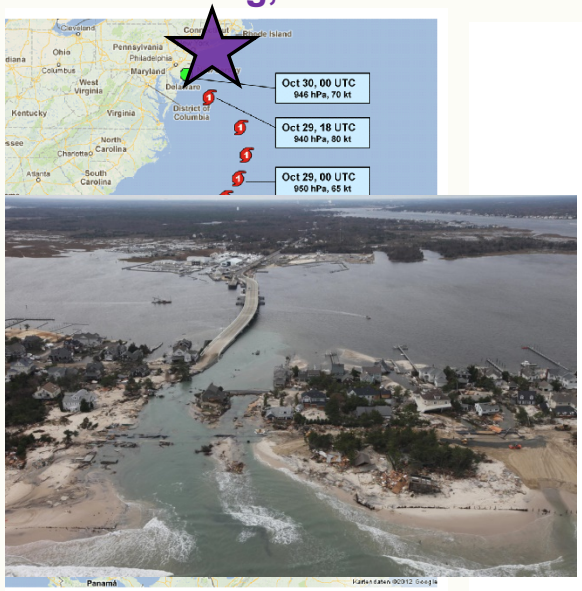


Observed:
Dune scarping/retreat

Predicted:
Dune scarping/retreat

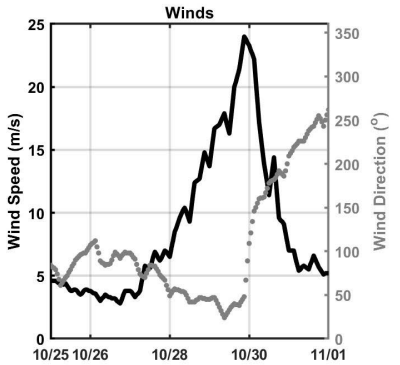
Dune Response Tool

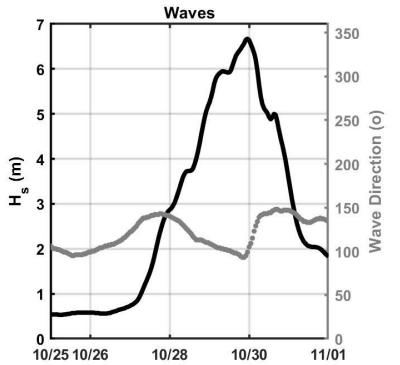
Mantoloking, NJ

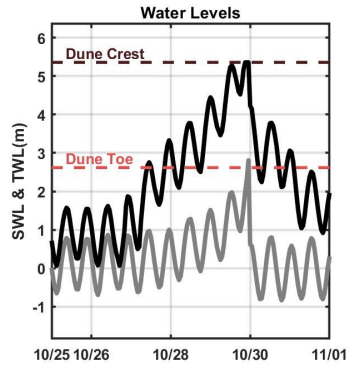


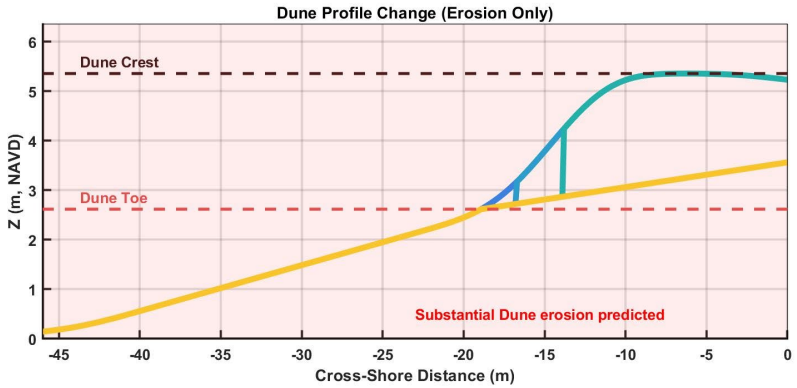
Observed:
Dune breaching/destruction

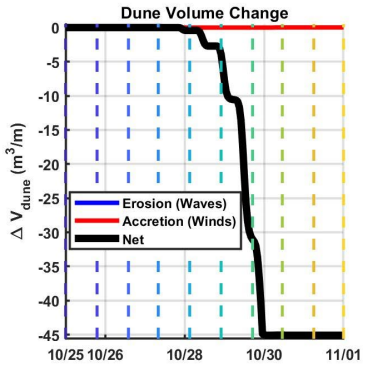
Predicted:
Dune destruction





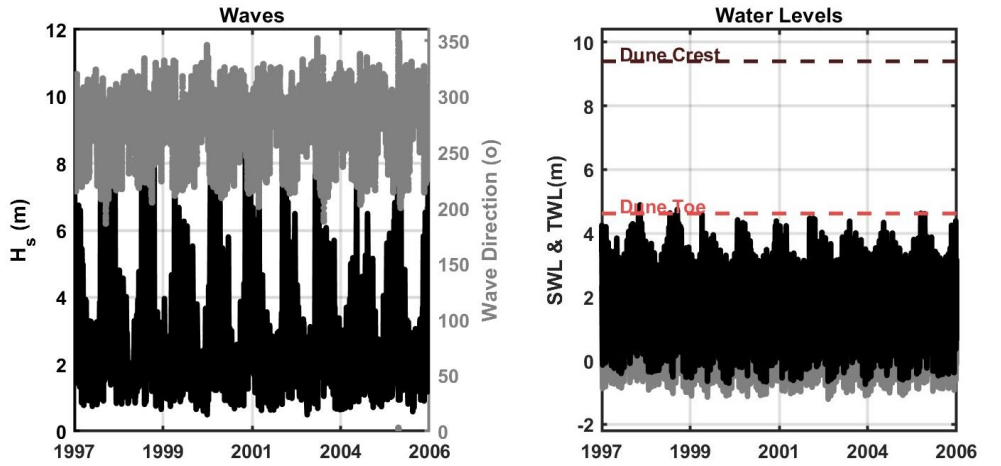


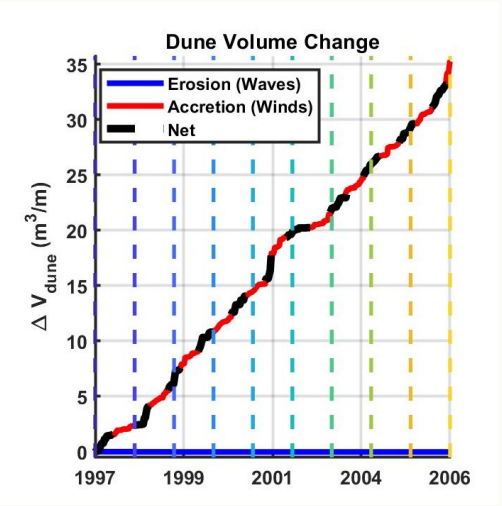




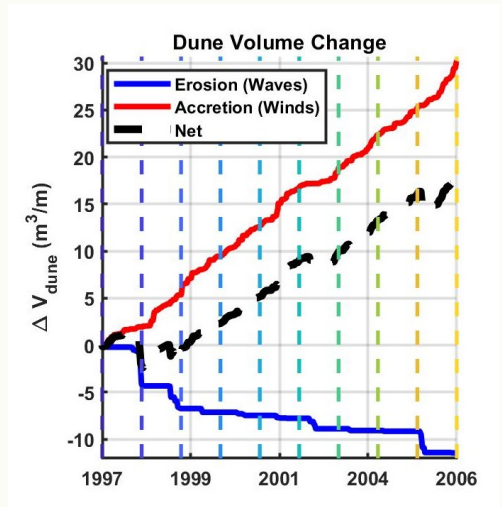
Dune Response Tool

Example Case – Long Term Dune Evolution, Oregon



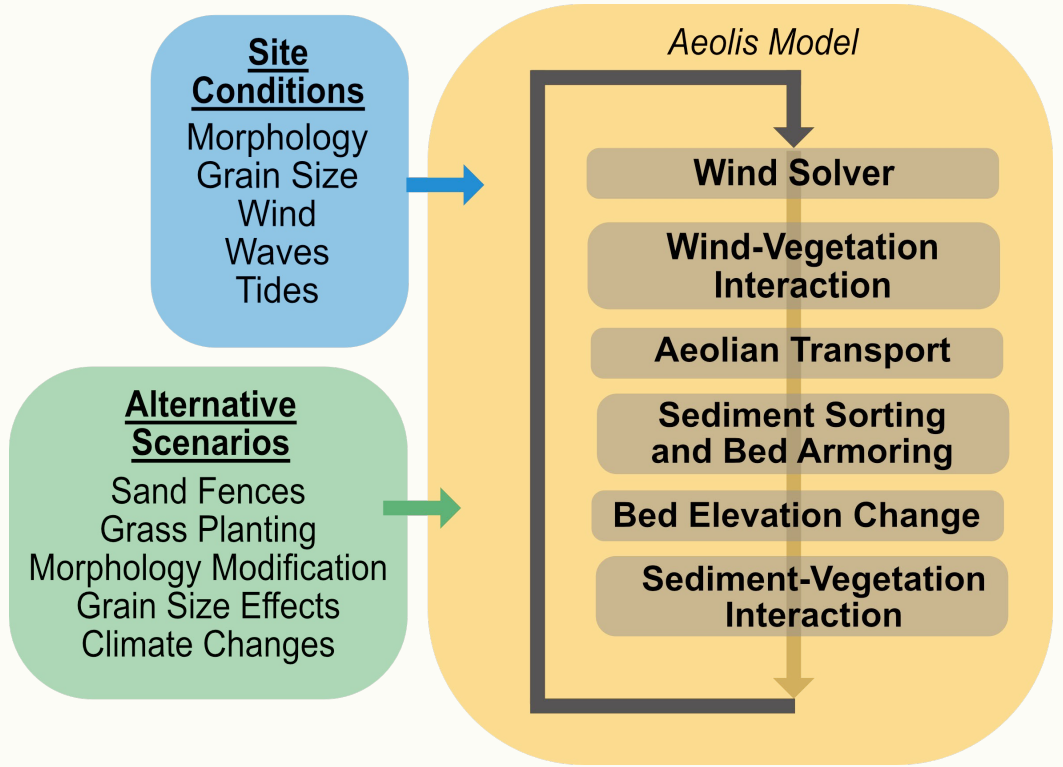


- Due to its low complexity, DRT can be run over long time periods (e.g. multi-year) to evaluate likelihood of erosive vs. accretive conditions.



Aeolis

Open-source model for simulating multifraction aeolian sediment transport



Items Missing for Coastal Engineering Applications:

-Coastal management alternatives (sand fences, grass planting)

-Easy to use interface

-Limited oceanographic processes (wave runup, wetting-drying, morphology change) which dominate beach dynamics

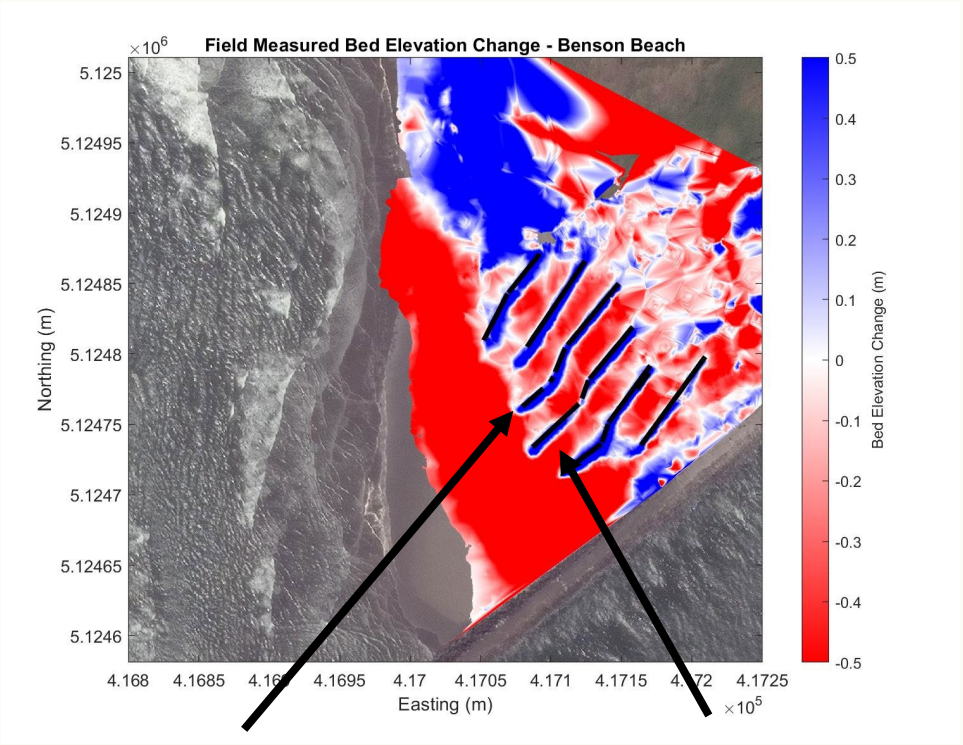
-Improvements needed to resolve ecological and windflow dynamics for simulating dunes

Aeolis Improvements: Sand Fences

New approaches for adding sand fences into 1D and 2D cases which allow optimizing configurations for sand trapping

Field Observations of Sand Fence Sediment Trapping at Benson Beach,WA

Sep 2008 to June 2009



Deposition on both sides of fence

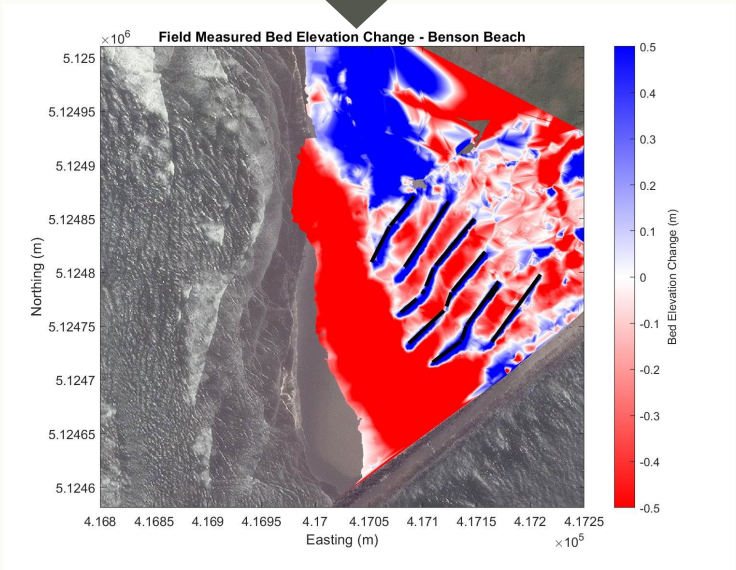
Wind-driven erosion in between fences

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

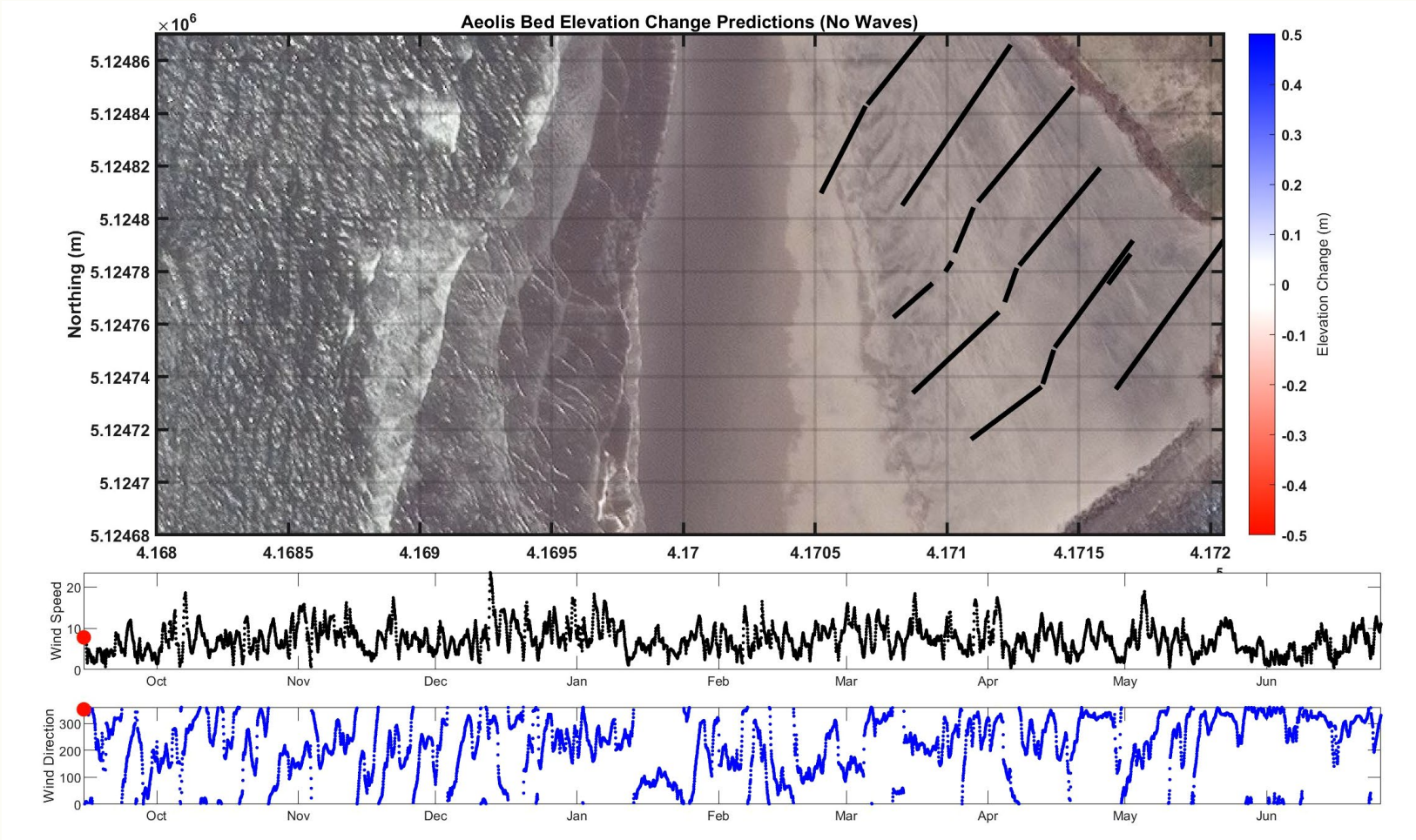
Aeolis Improvements: Sand Fences

Model

Field



Aeolis Model Simulation at Benson Beach with Sand Fences



Summary

FY20 Major Advances in Capability

- **Release of the** Dune Response Tool
  - **Rapid easy to use capabilities for storm-driven dune erosion and long-term volumetric dune accretion**
- **Advancement of** Aeolis **model**
  - **New engineering capabilities for simulating aeolian transport in managed systems**
  - **Initial coupling with subaqueous CIRP tools**

FY20 Major Products & Collaborations

- **2 CIRP TDs**
- **Ongoing model development collaborations with Oregon State University and TU Delft**
- **Leveraging with F&CS dune and modeling work units**
- **Leveraging with NOAA funded model development**
- **Summer intern from OSU working on project**
- **Collaborative paper with B. Johnson to be submitted by end of FY**

FY21 Products/Advances

- **Dune Response Tool**
  - **Early FY: Tool testing with Districts, Open-Source Release, JP**
  - **Cloud Deployment Testing**
  - **Collaborations with JALBTCX**
- **Aeolis**
  - **Applications to numerous USACE sites**
  - **Interface development within SMS**
  - **Coupling with CMS**