



U.S. ARMY

DUNE RESPONSE TOOL & AEOLIS

TOOLS FOR SIMULATING AEOLIAN TOOLS NEAR INLETS

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COASTAL INLETS RESEARCH PROGRAM

FY21 IN PROGRESS REVIEW

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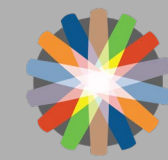
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Acting Associate Technical Director, Navigation



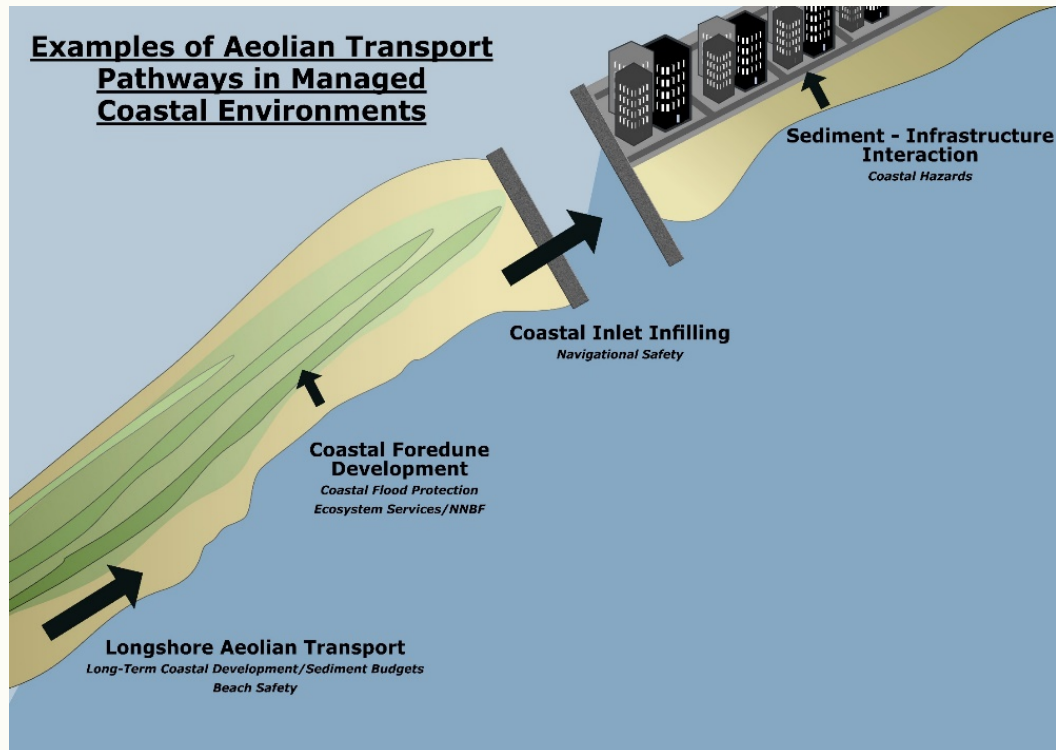
US Army Corps of Engineers



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

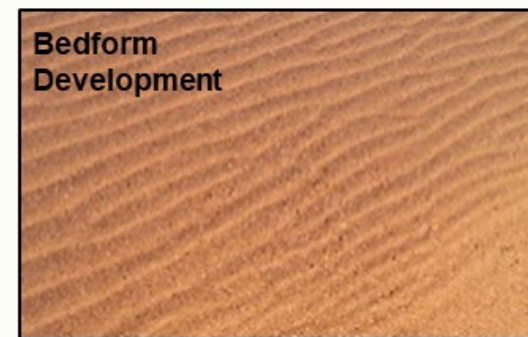
2017-N-72 Improved Simulation of Dune Morphological Response at Short & Long Time-scales

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 in proximity to navigational channels and in other USACE-managed coastal settings.



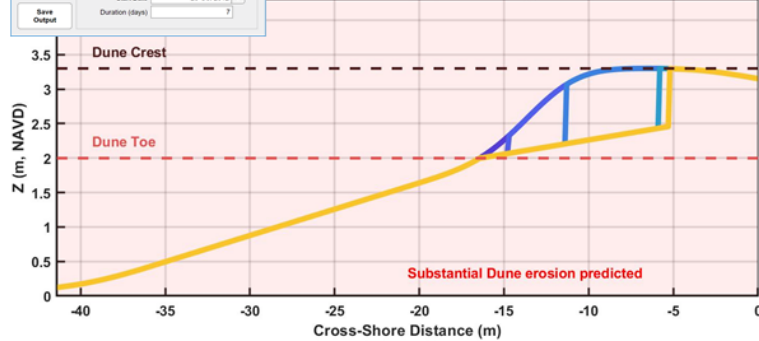
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Work Unit Tool Development

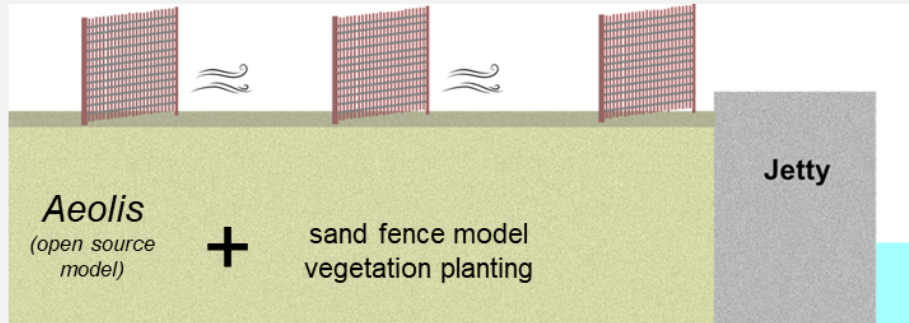


Dune Response Tool (DRT)
 Rapid prototyping tool for storm-driven dune erosion and volumetric dune accretion

Dune Profile Change (Erosion Only)



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



Aeolis+C2Shore: Fully coupled subaqueous-subaerial model for simulating the co-evolution 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

Graphical User Interface

Dune Response Tool

ERDC
CIRP
Dune Response Tool

Info

Run Model

Save Output

Model Attributes **Advanced**

Location

Latitude: 36.18

Longitude: -75.75

Morphology

Dune Crest Elev. (m): 6

Dune Toe Elev. (m): 3

Dune Slope (m/m): 0.2

Beach Slope (m/m): 0.1

Shore Normal (deg.): 70.0

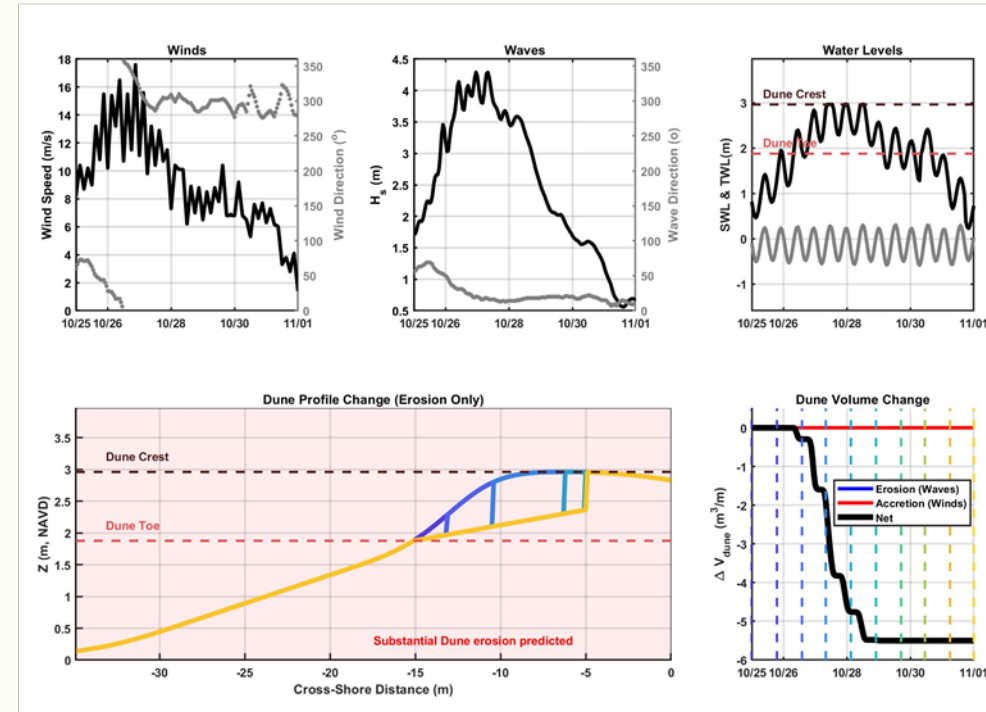
Timing

Hindcast (1980 - 2017) Forecast (now)

Start Date: 25-Oct-2012

Duration (days): 7

Example Model Outputs



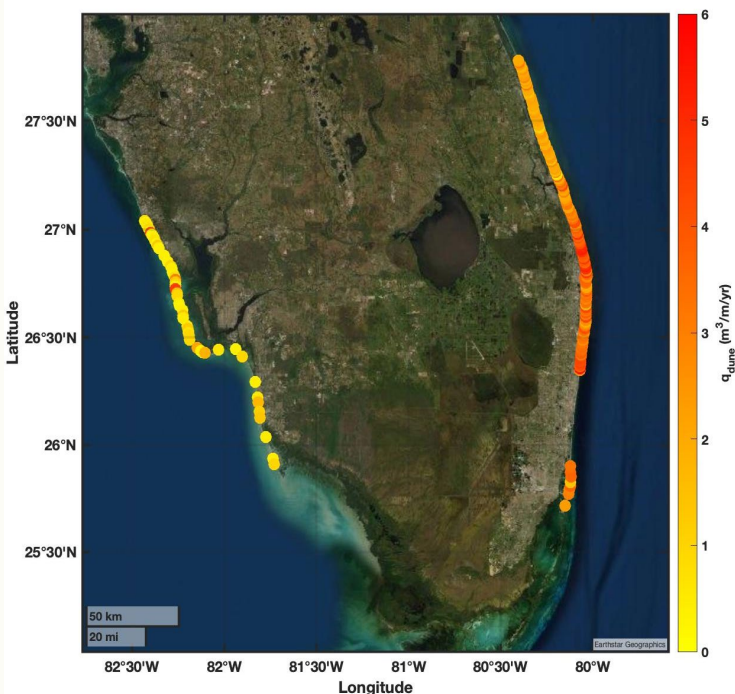
FY21 Development Activities:

- Open-Source Release of Code: <https://github.com/erdc/dune-response-tool>
- Integration of JALBTCX ArcGIS Server Data into DRT
- Exploration of WebTool Deployment
- ERDC/CHL Tech Note Submitted

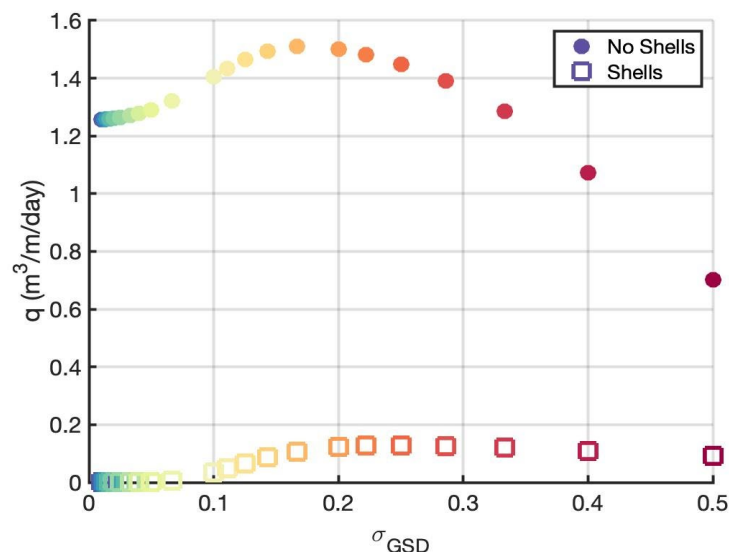
Aeolis Model Development

Example model applications as presented in ERDC/CHL TN submitted for review in FY21

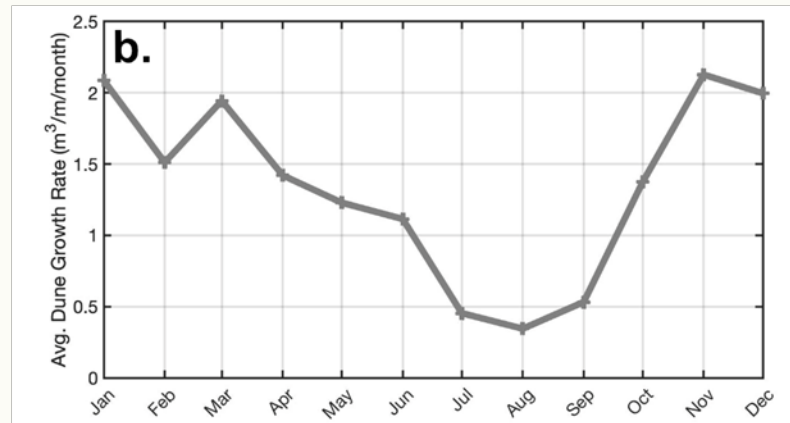
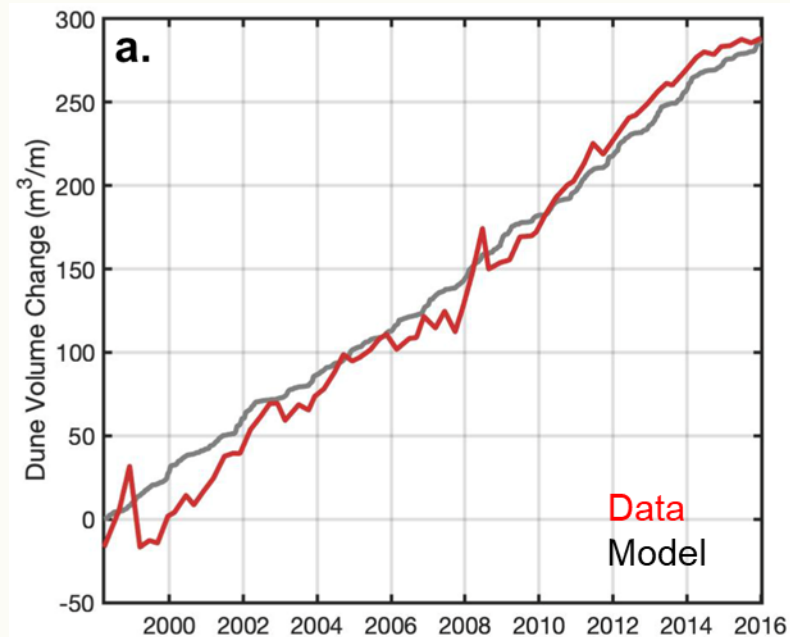
Estimation of Annual Dune Volume Growth at Regional Scale in Southern Florida



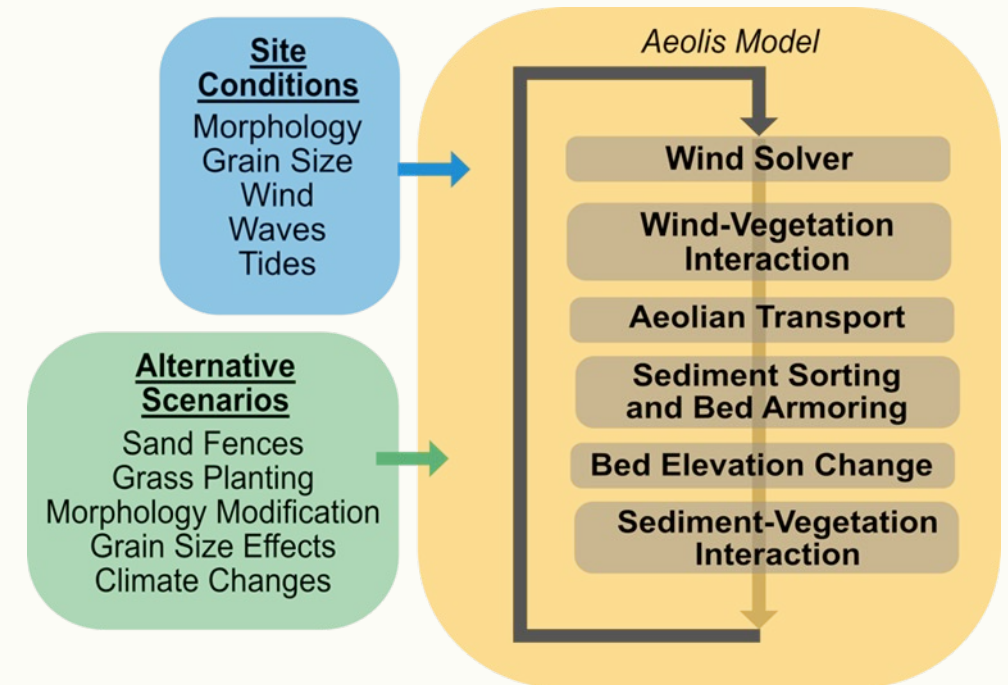
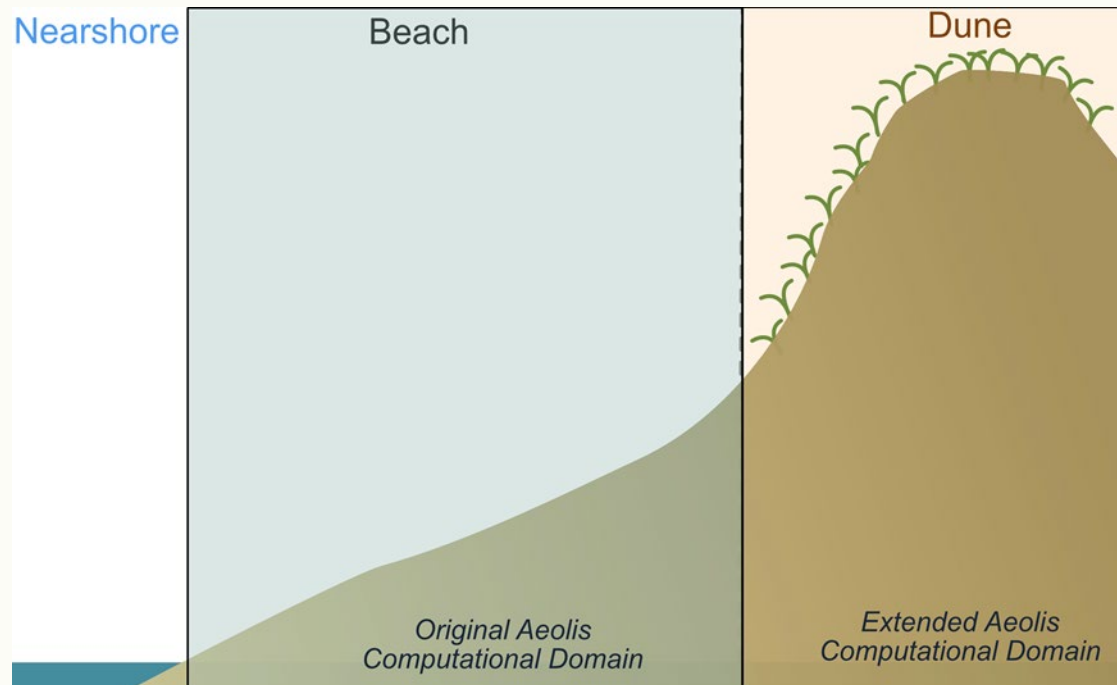
Role of Grain Size Distributions on Rate of Aeolian Transport



Model-Field Comparison in Long Beach Peninsula, WA



Aeolis Model Development



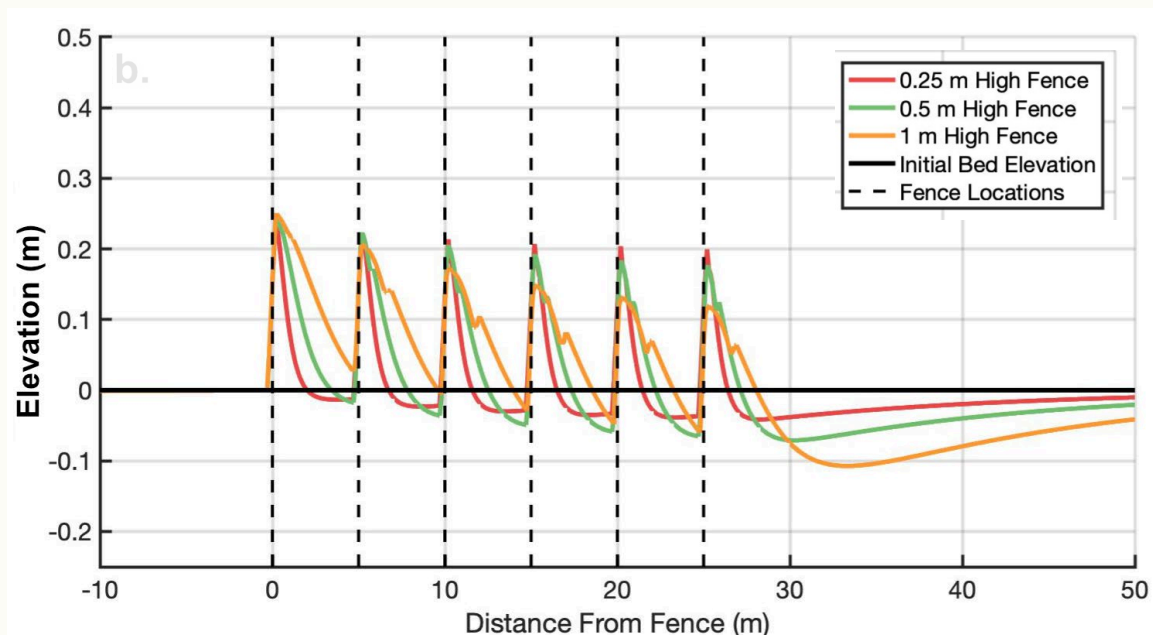
FY21 Development Activities:

- Code updated to python3
- 1D version of Kroy wind solver added,
- Updated 2D fence solver with rotating grid,
- 1D fence wind solver changed to exponential relationship
- Non-grid based vegetation shear coupler added

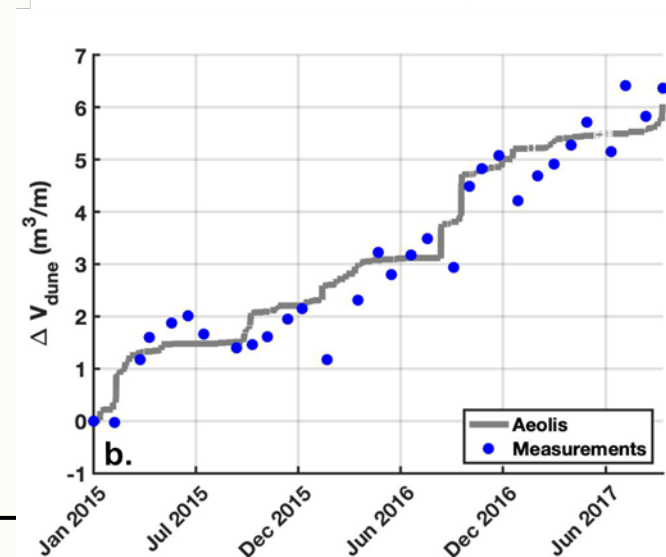
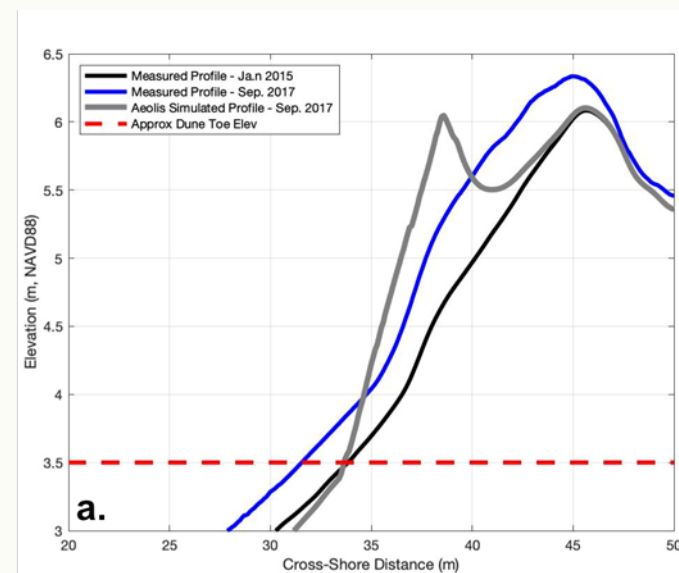
Aeolis Model Development

Example applications with new processes added to resolve feedbacks relevant for simulating subaerial landscape evolution

*Role of Sand Fencing on Limiting Aeolian Transport Into Waterbodies
(New Exponential Fence Reduction Approach Added)*

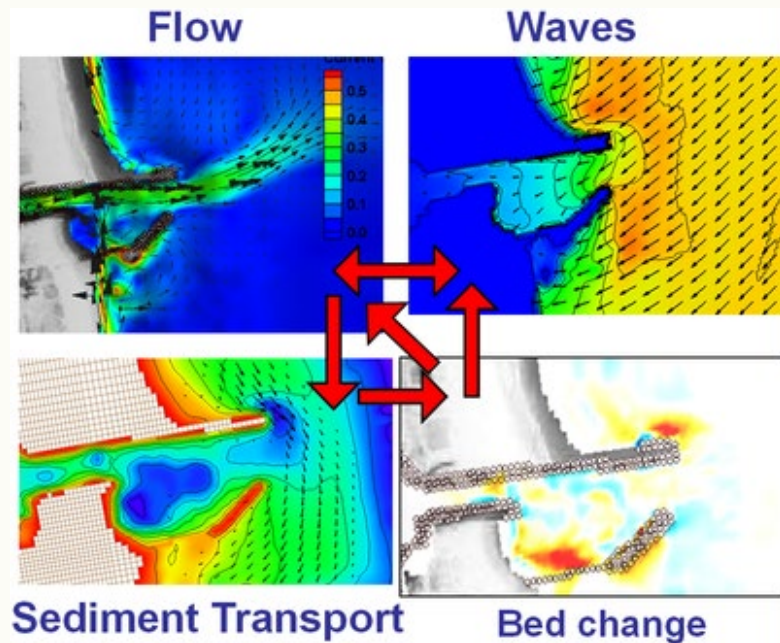


*Model to Field Comparison of Dune Evolution: Duck, NC
(New Wind Routine Added)*



2D CMS-Aeolis Coupling

*Traditional CMS Workflow –
Aeolian Transport Not Considered*



FY21 New Model Development

Goal:

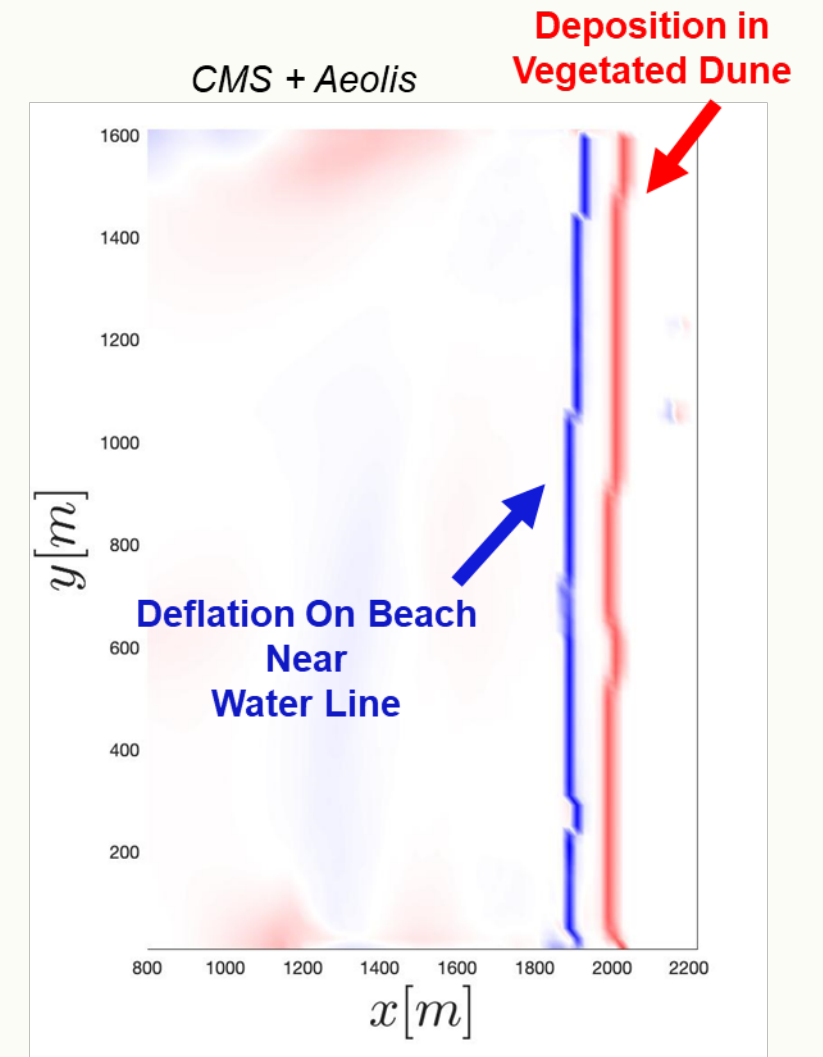
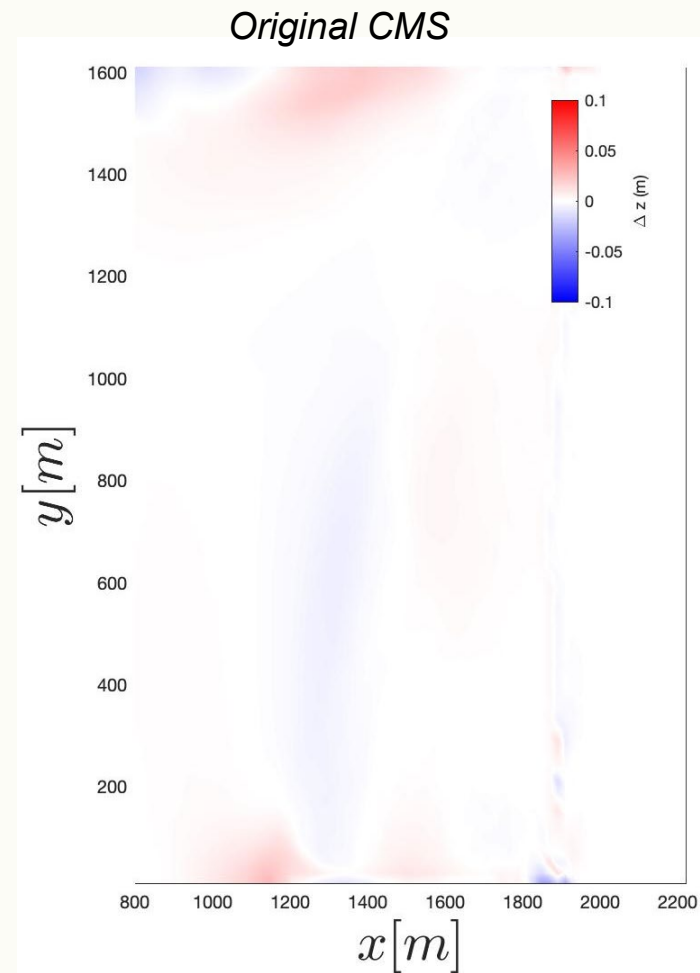
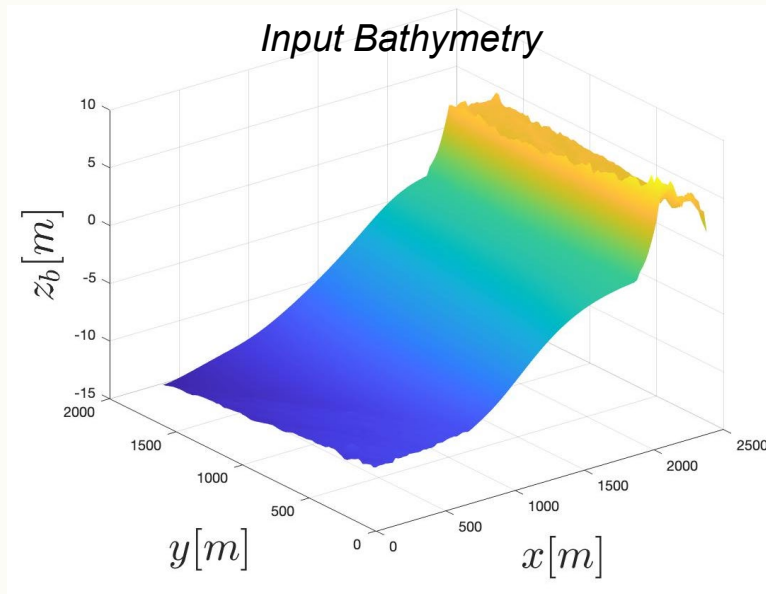
Add in capability to directly couple Aeolis with CMS for 2D applications

Approach:

- **cms_flow.f90 (modification)** – modify main code to call aeolian steering file and handle topographic updates
- **aeolian.f90 (new)** – interface between CMS and Aeolis which includes system call to **aeolian.py** which generates all Aeolis input files, runs Aeolis, and returns data for incorporation to CMS
- **scenario.cmcards (modification)** – new options for coupling interval and subaerial grain size

2D CMS-Aeolis Coupling

**Example 2D case for
Benson Beach, WA –
10 m/s onshore wind for
5 days**



Summary

FY21 Major Advances in Capability

- **Dune Response Tool**
 - ▶ Open-Source Release (ERDC legal approved)
 - ▶ Local simulation option available and webtool option in development
- **Aeolis**
 - ▶ Major code updates for 1D and 2D applications
- **2D CMS-Aeolis Coupling**
 - ▶ CMS modified to interface directly with Aeolis
 - ▶ Progress ongoing to refine implementation

FY21 Major Products & Collaborations

- **2 TNs submitted**
- **2 CIRP TDs and 1 PDT Meeting**
- **Collaboration with Oregon State University and TUDelft on Aeolis Development**
- **Leveraging with F&CS and NOAA funds on model development (eco-morphodynamic focused)**
- **Completed Revisions for MS submitted to Coastal Engineering in FY20**

Planned Outyear Products/Advances

- **Aeolis**
 - ▶ Further validation to define future R&D needs to improve parameterizations
 - ▶ Model training
- **CMS-Aeolis Coupling**
 - ▶ Application of tool to real world conditions
 - ▶ SMS integration