



U.S. ARMY

# TOOLS TO INVESTIGATE VESSEL WAKE EFFECTS AT USACE NAVIGATION PROJECTS

HARBORS & NAVIGATION COMMITTEE AND QPI MEETING

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American Association of Port Authorities

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US Army Corps  
of Engineers



DISCOVER | DEVELOP | DELIVER

# Outline

## Charleston Harbor Deepening Project

Project scope

Stakeholder concerns

Approach

Data collection efforts

Year 1 results

Wave height & vessel  
wake measurements

Source of vessel wake by  
vessel type



# Charleston Harbor Deepening Project (Post 45)

- Channel improvements to deepen navigation channel to accommodate Post-Panamax vessels
- Increase depth to 52 feet
- Completed Reconnaissance Phase in 2010
- Pre-construction phase end of 2015 (include ship simulation at ERDC)
- Authorized for construction December 2016
- Construction of the entrance channel is underway





## Stakeholders Concern with the Deepening Project

### Programmatic Agreement

*“The NPS and the South Carolina State Historic Preservation Office (SHPO) have identified concerns about erosion and structural stability at Fort Sumter and believe that the proposed deepening of the navigation channels in Charleston Harbor may exacerbate existing erosion and stability problems at Fort Sumter”*

*“The NPS is concerned that sediment transport changes will result in: (1) increased erosion and deepening in the shallow near-shore areas in the vicinity of Fort Sumter and Fort Moultrie; and (2) potential effects on their long-term structural integrity.”*

Historical properties of concern: Ft. Sumter, Ft. Moultrie and Castle Pinckney



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# Address Stakeholders Concerns

## Programmatic Agreement Monitoring Requirements:

### Field Data Collection Effort:

1. Monitor wave climate, vessel traffic, & vessel wake to generate a baseline to describe 'as is' conditions
2. Continue monitoring of waves, vessel wake, vessel traffic through the life of the agreement
3. Quarterly surveys to monitor shoreline change
4. Quarterly bathymetric surveys
5. Timeline: 1 year pre-construction and 5 years post construction

# Monitoring Locations – Instrumented Platforms

Hog Island  
Range,  
N of  
Shutes  
Folly Island

Fort  
Sumter  
Range,  
SE of Fort  
Sumter

Fort  
Moultrie  
Structure,  
W of Fort  
Moultrie



# Platforms

Measurement	Ft. Sumter	Ft. Moultrie	Hog Isle Rng
Wind	✓		
Waves	✓	✓	✓
Currents	✓	✓	✓
Photos	✓	✓	✓





## Quantifying the relative effect of vessel wake

### Analysis & Metrics

- Magnitude of vessel wake versus wind waves
  - Is average vessel wake height gt. or lt. wind waves? (distribution)
- Duration
  - How long is the shoreline exposed to vessel wake/wind waves?
- Wave conditions over threshold
  - Are the waves/vessel wake sufficient to re-suspend/mobilize sediment near the shoreline?

### Considerations

How do the vessel wake and wind wave characteristics evolve overtime?

1. Seasonal differences
2. Changes related to vessel traffic patterns (pre, during, and post construction phases)

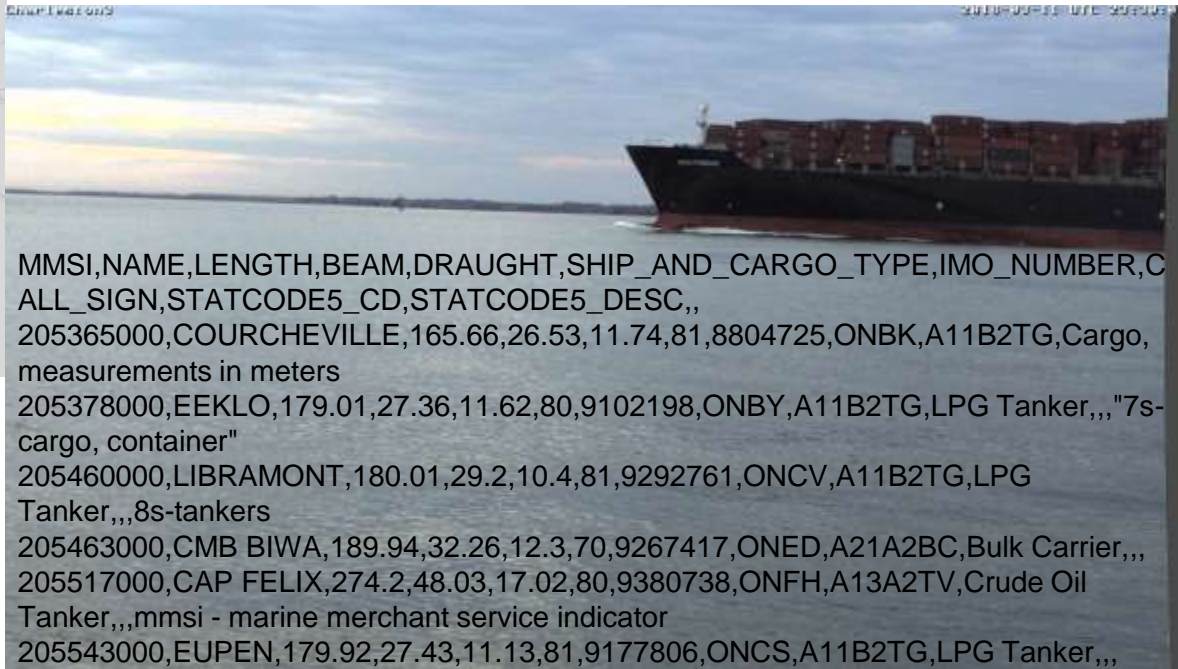
How do the vessel wake characteristics vary between vessel types?

1. Changes in vessel wake energy based on changes in channel usage

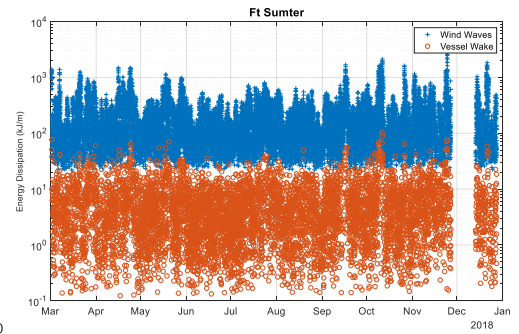
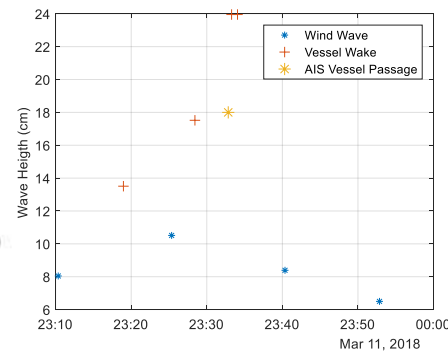
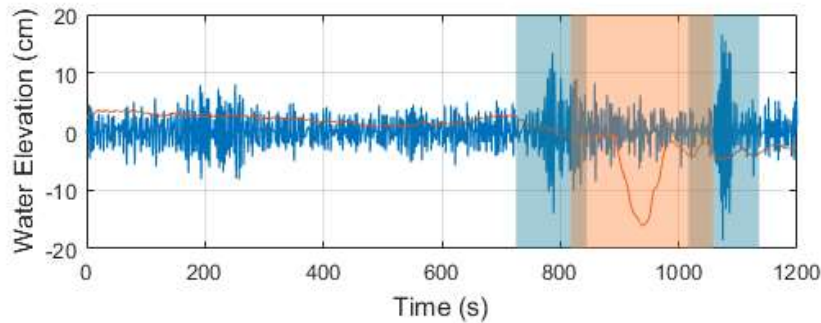
- ❖ Develop software to extract vessel wake signature from water level records
- ❖ Cross-reference with AIS (using CPT) to identify vessel type



# Vessel Identification AIS



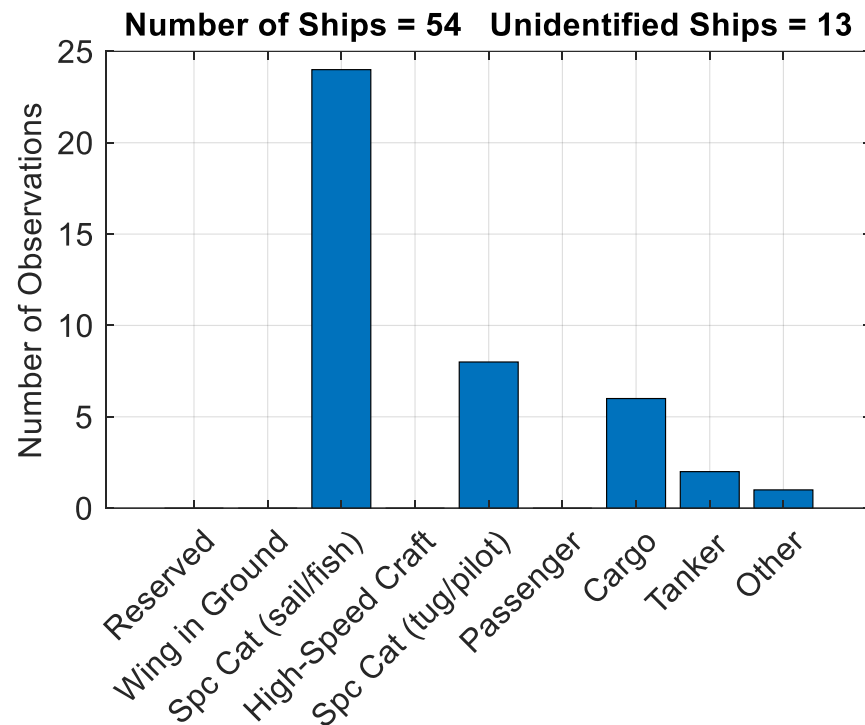
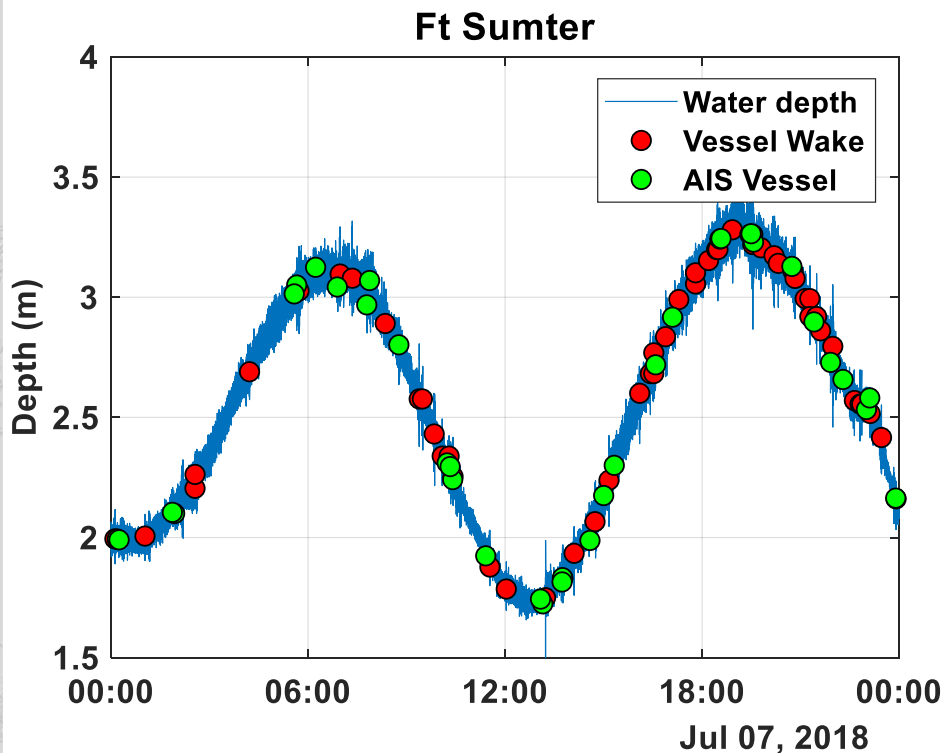
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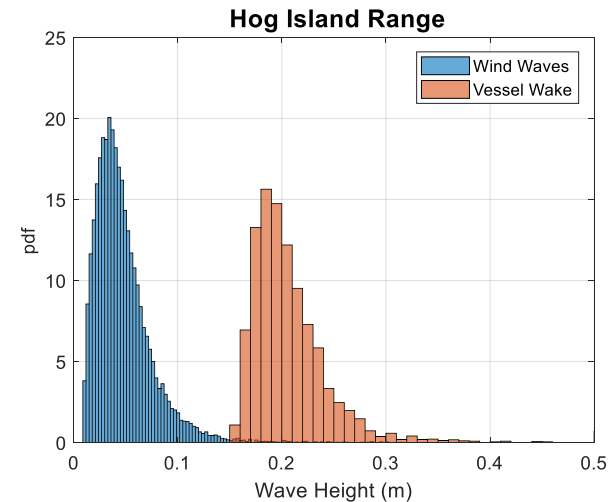
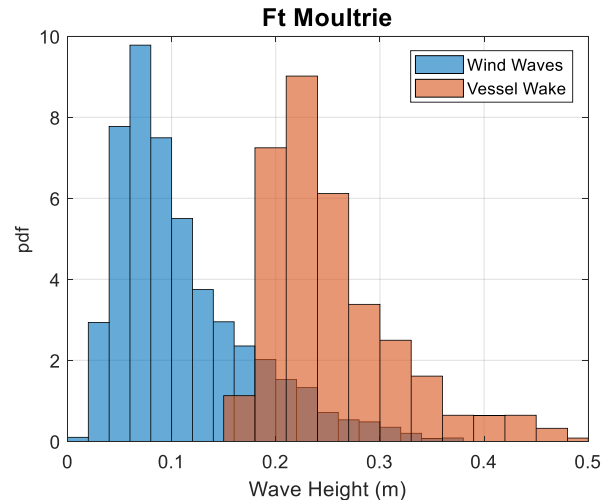
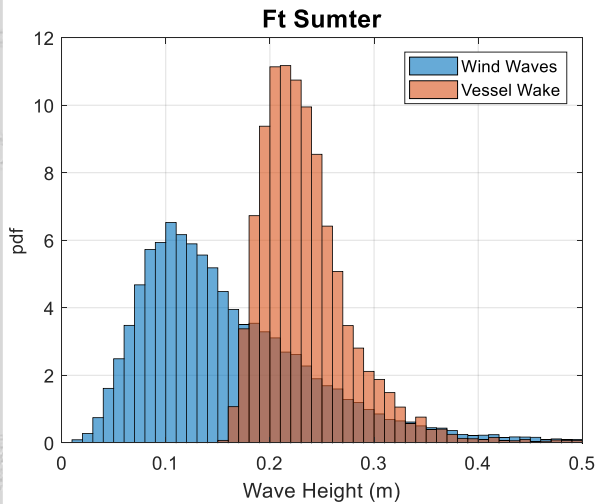
- ID vessel with AIS
- Determine vessel characteristics, beam, type, etc.
- ID vessel wake in water level record
- Cross-reference vessel/w wake signature

# Cross-Reference Vessel Wake with AIS

## July 7<sup>th</sup>, 2018 (Saturday after 4<sup>th</sup> of July)

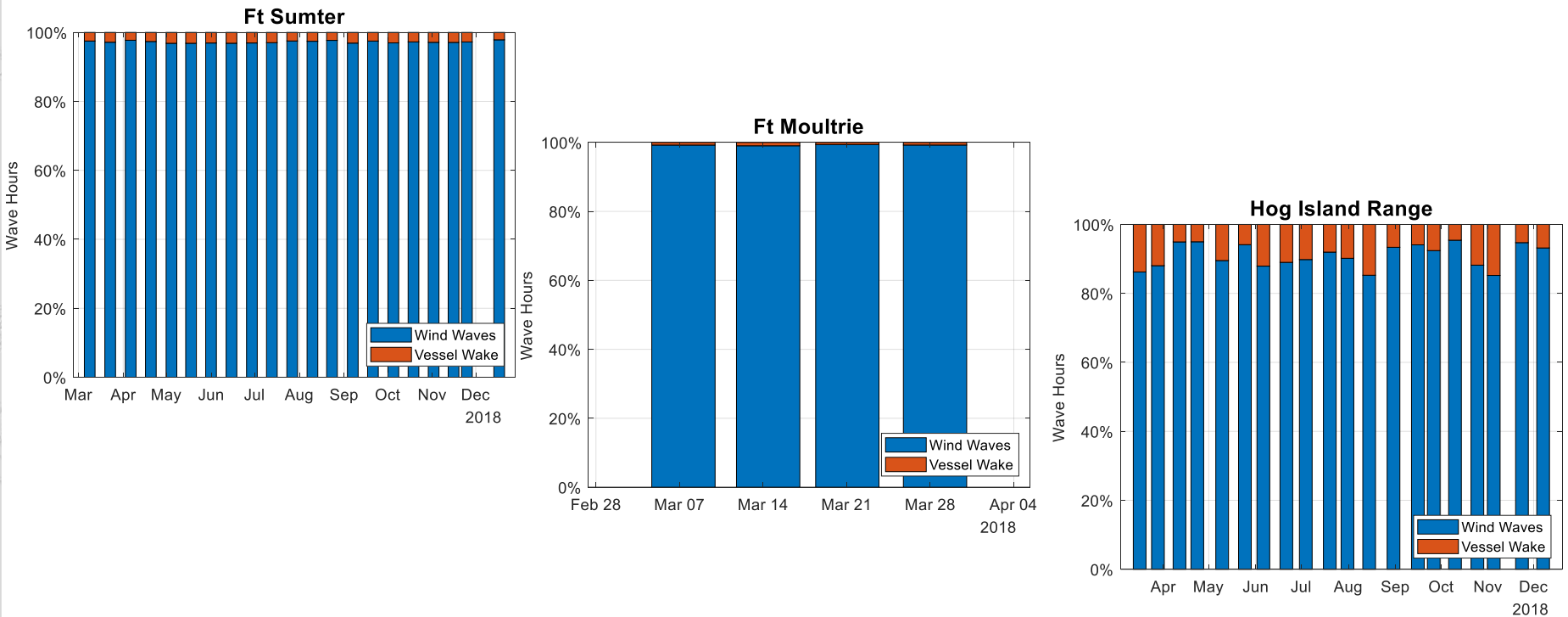


# Wave Height - 2018



- Average height of vessel wake is similar at all three locations
- Wind wave height is similar at Ft. Moultrie and Ft. Sumter
- Wind wave height at Hog Island Range is less than Ft. Sumter or Ft. Moultrie
- Average height of vessel wake is greater than average wind waves at all three locations

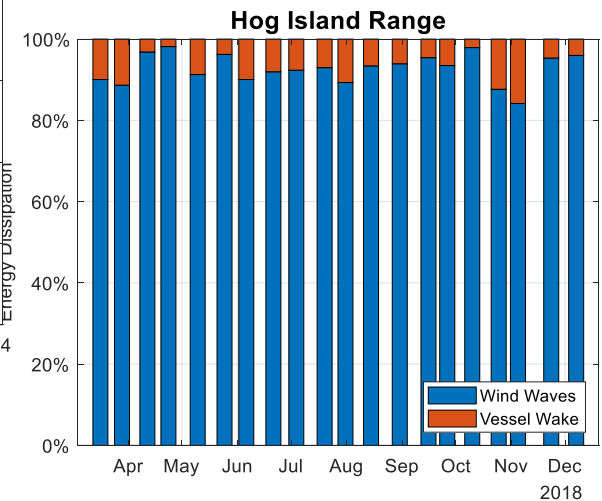
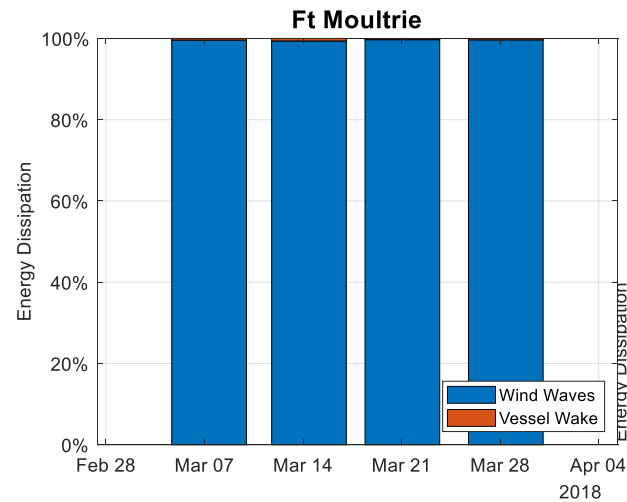
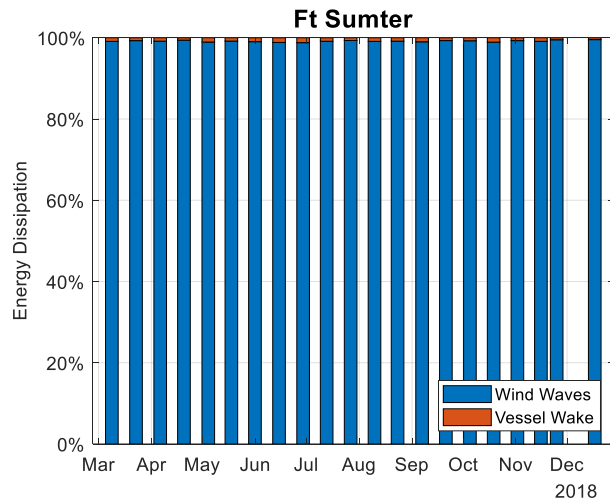
# Total Hours (2-week) with Waves Sufficient to Mobilize Sediment 2018



Ninety-five percent of the total hours of incoming waves are associated with the wind waves Ft. Sumter & Ft. Moultrie  
80% at Hog Island Range

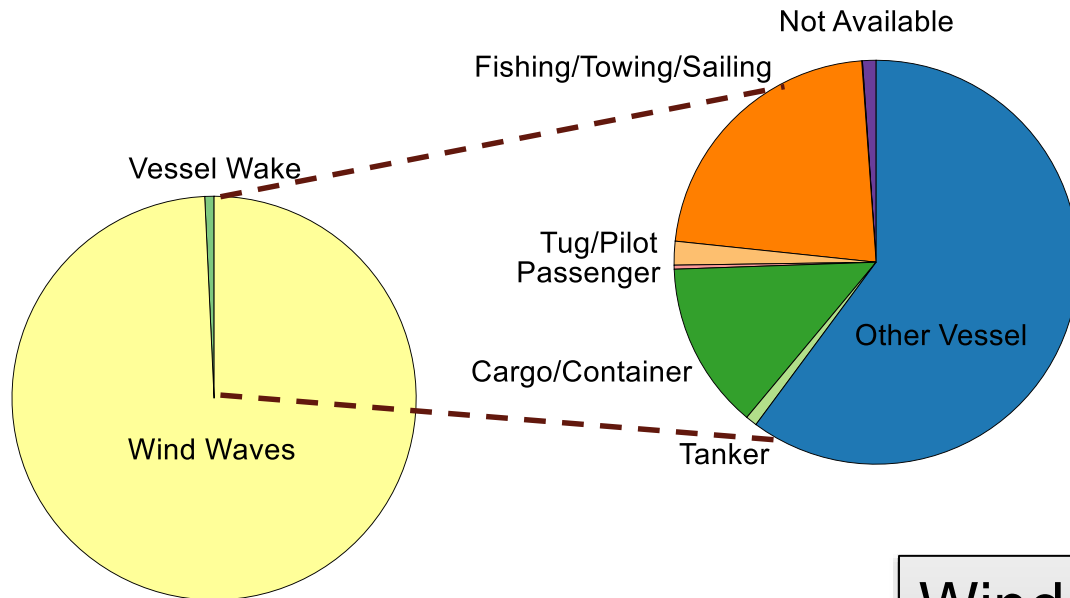


# Erosion Potential (wind waves vs vessel wake) - 2018



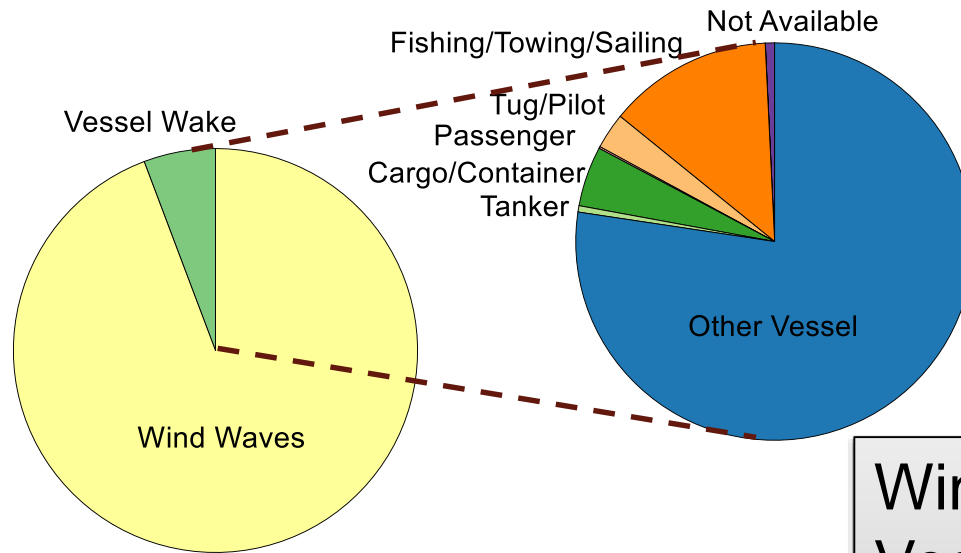
Wind waves account for 99% of the erosion potential at Ft. Sumter and Ft. Moultrie  
80% of the time at Hog Island Range

# Erosion Potential Sources Pre-construction Phase – Ft Sumter



Wind Waves:	98.6
Vessel Wake:	1.4
• Cargo/Tanker	.6
• Other Vessel	.8
Total Energy:	100

# Erosion Potential Source Pre-construction Phase – Hog Island Range



## Relative Energy

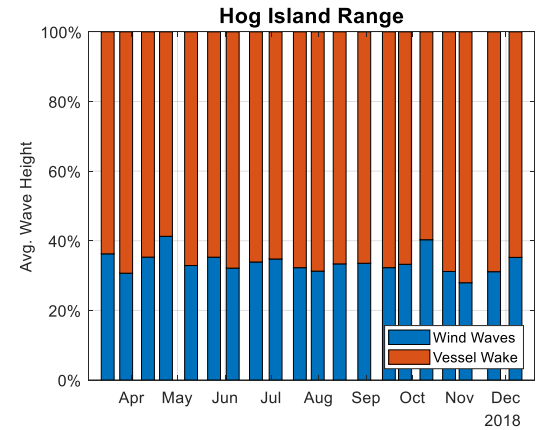
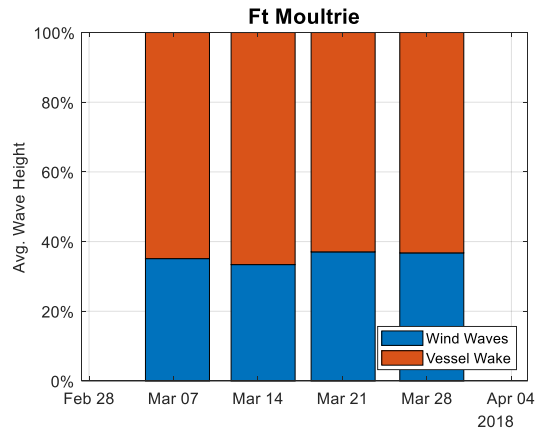
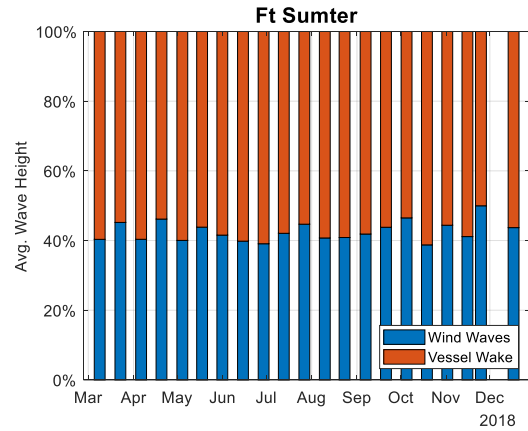
Wind Waves:	93
Vessel Wake:	7
• Cargo/Tanker	1
• Other Vessel	6
Total Energy:	100

# Questions?





# Bi-weekly Average Wave Height 2018

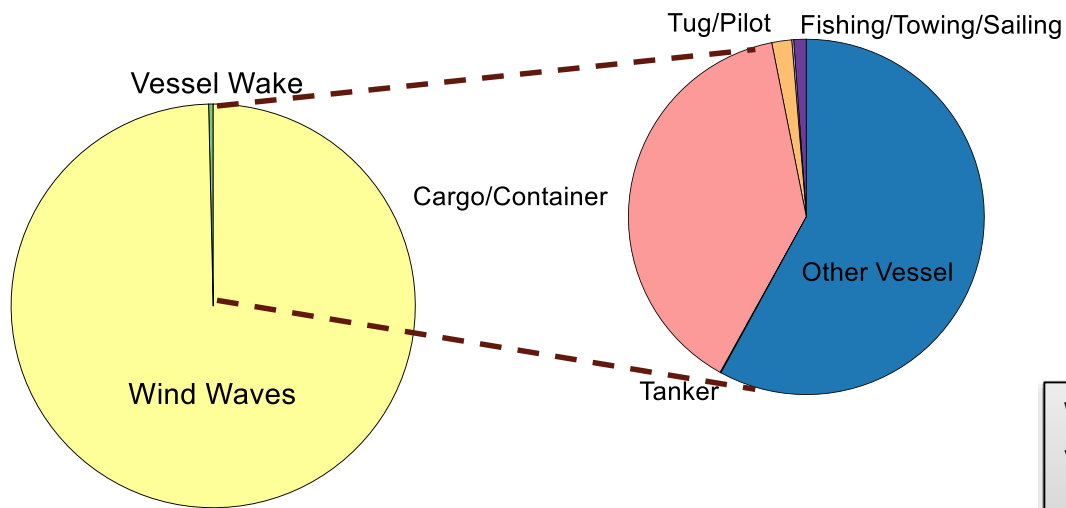


## Summary

Preliminary results indicate that the baseline conditions show potential shoreline erosion is due primarily to wind waves in the lower harbor

Vessel wake may be important in some instances, but the long-term effect of large Post Panamax vessels ??? is as much as 7% above

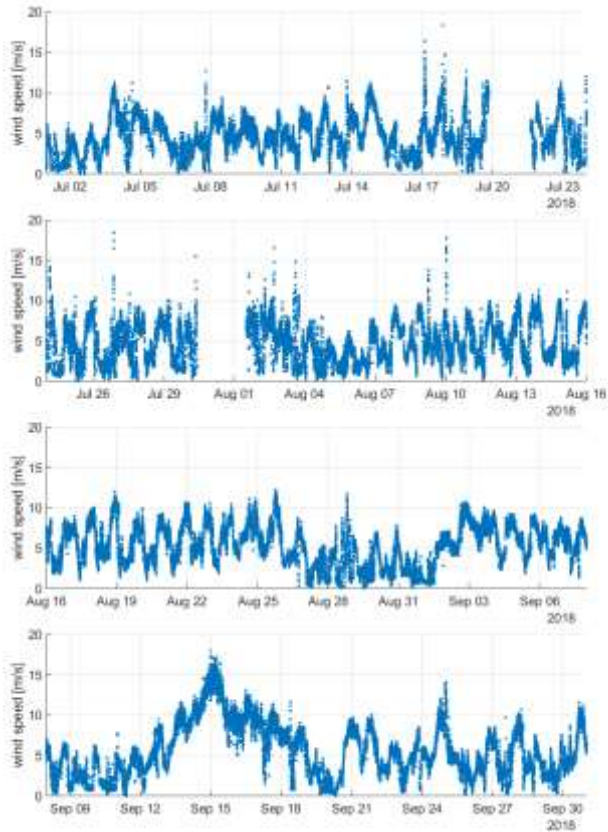
# Erosion Potential Source (Mar-Apr) Pre-construction Phase – Ft. Moultrie



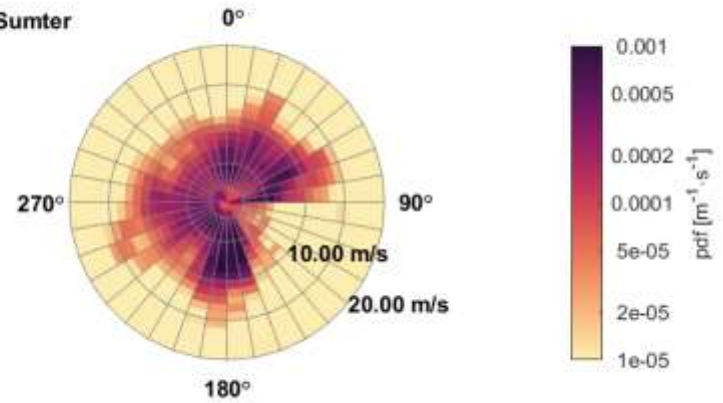
## Relative Energy

Wind Waves:	99
Vessel Wake:	1
• Cargo/Tanker	.3
• Other Vessel	.7
Total Energy:	100

# Wind



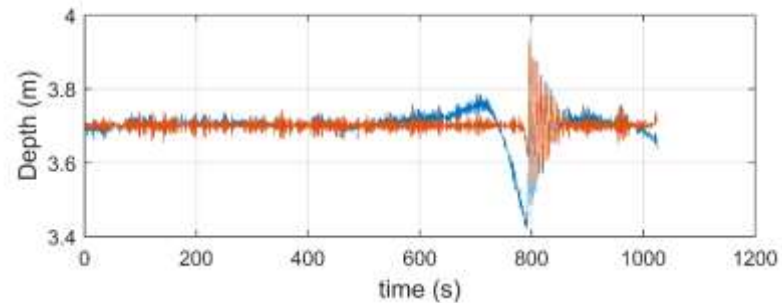
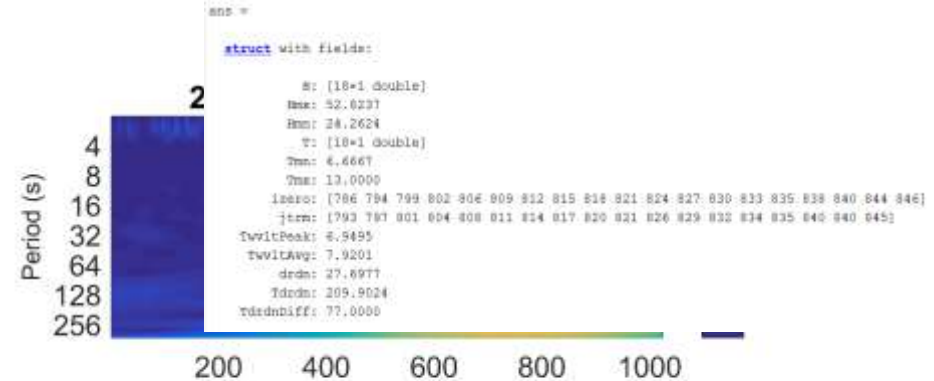
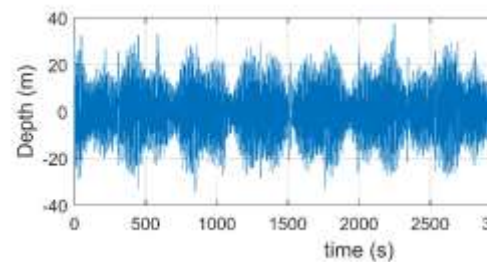
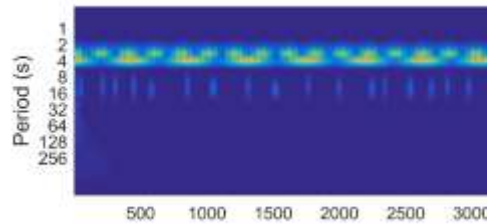
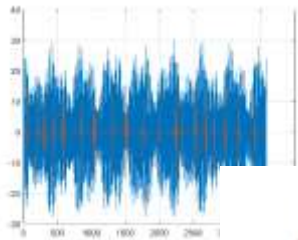
A) Ft Sumter







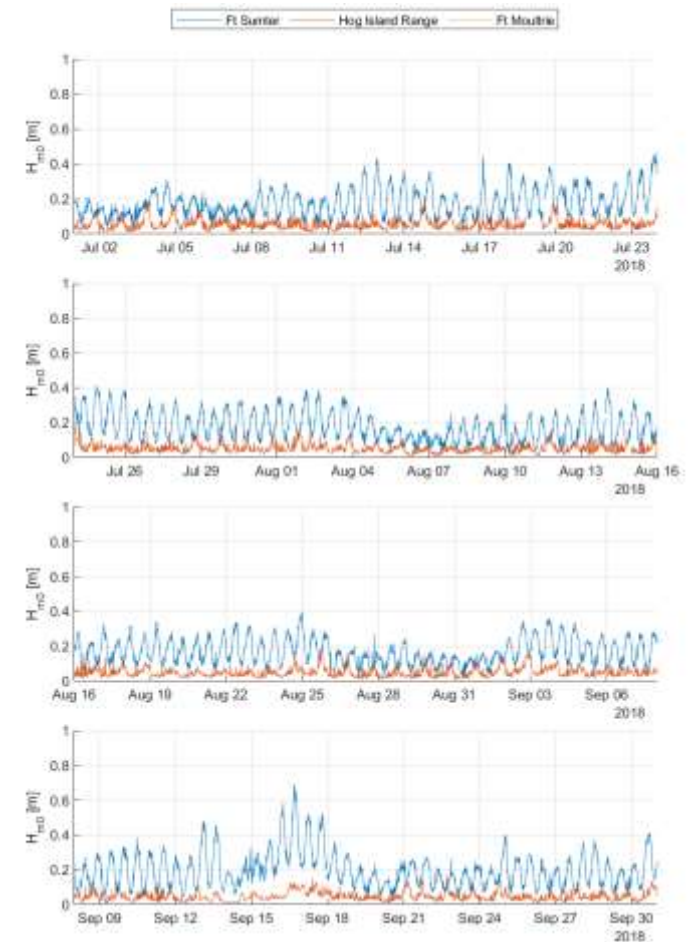
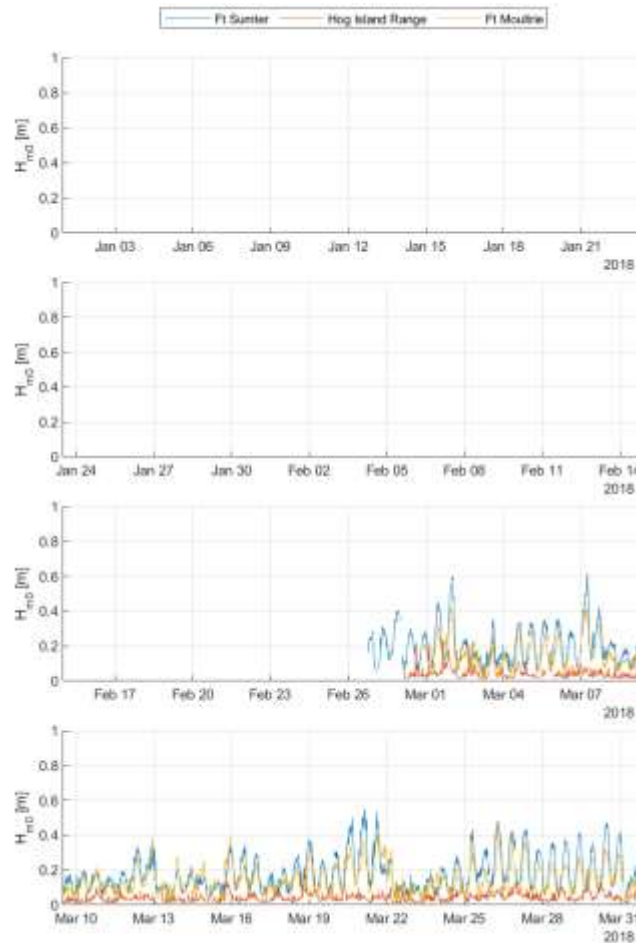
# Vessel Wake Detection from Water Surface Elevation



# Waves

Ft. Sumter and Ft. Moultrie are similar: Atlantic waves, tidally modulated.

Hog Island Range dominated by waves generated in the harbor. Smaller, higher frequency.



# Charleston Study Area

- North
- Chapin
- West
- Veteran
- Terminal
- Leatherman
- Cooper
- Wando
- Middle
- Ravenel
- Columbus
- Street Union
- Rebellion
- Mount Pleasant
- Range Fort Sumter
- Range Harbor
- Sea Overall
- Entrance

