A Hydro-Morphodynamical modeling framework for SE-FL

Integrated field measurements and computational modeling to understand coastal processes - Southeast Florida

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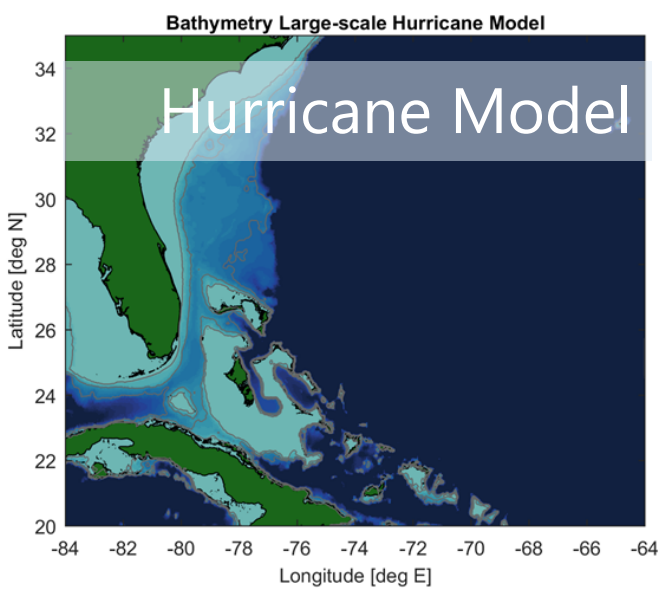
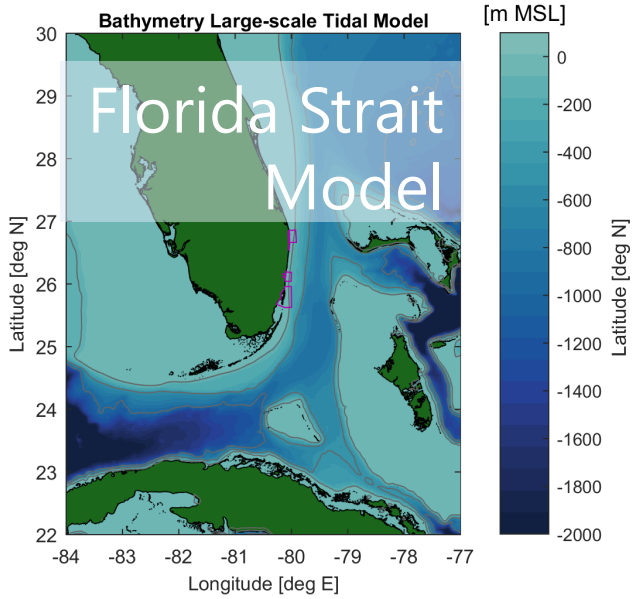
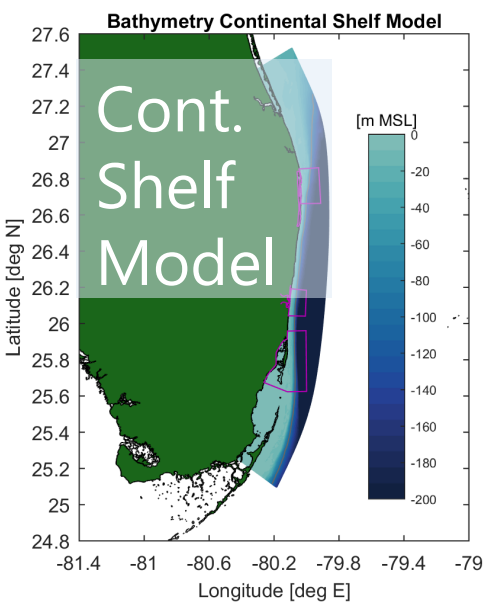
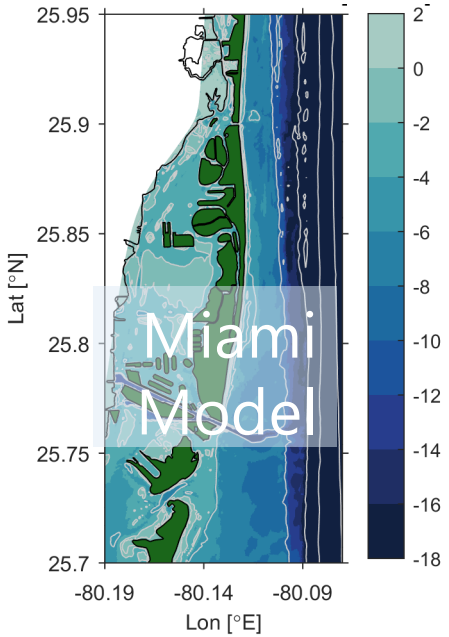
US Army Corps of Engineers ®
Jacksonville District

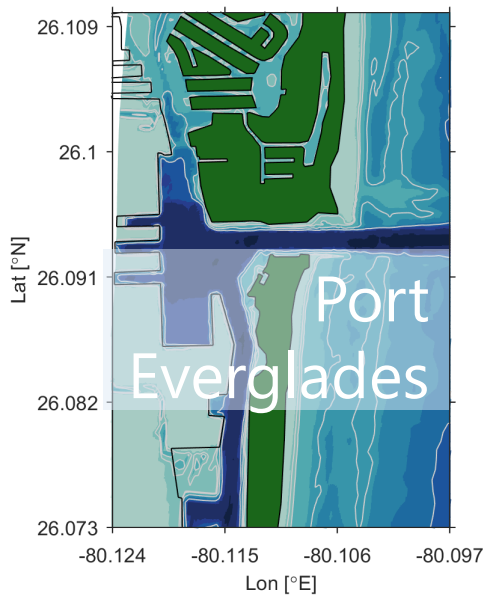
A modeling framework for SE-FL

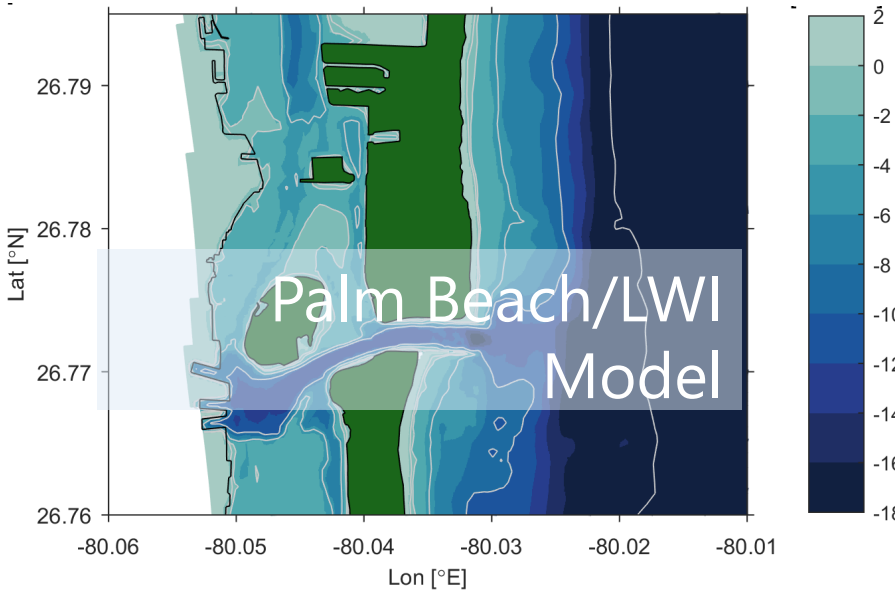






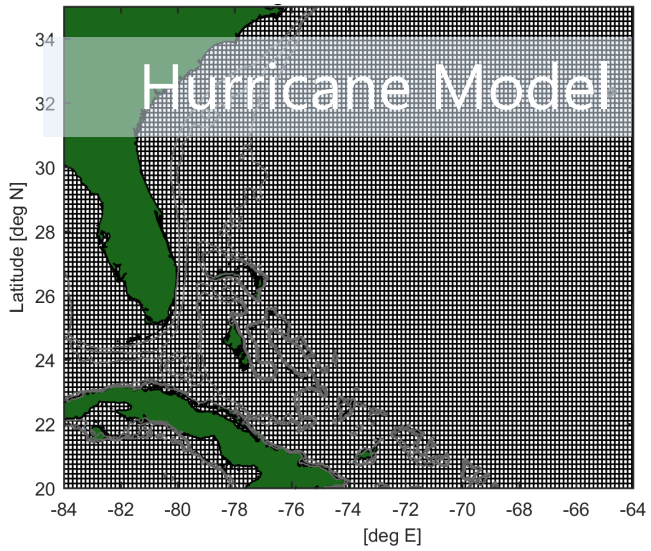


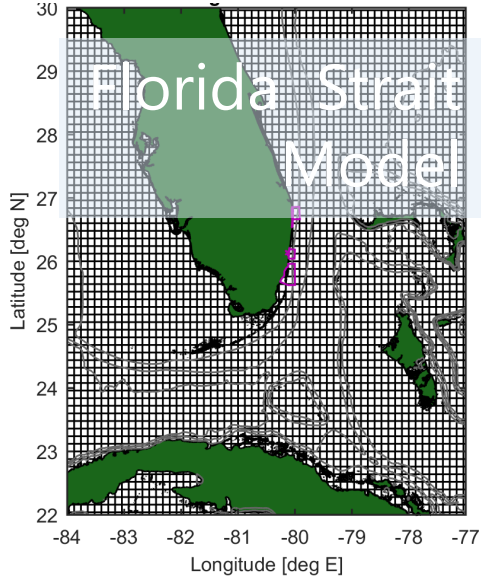


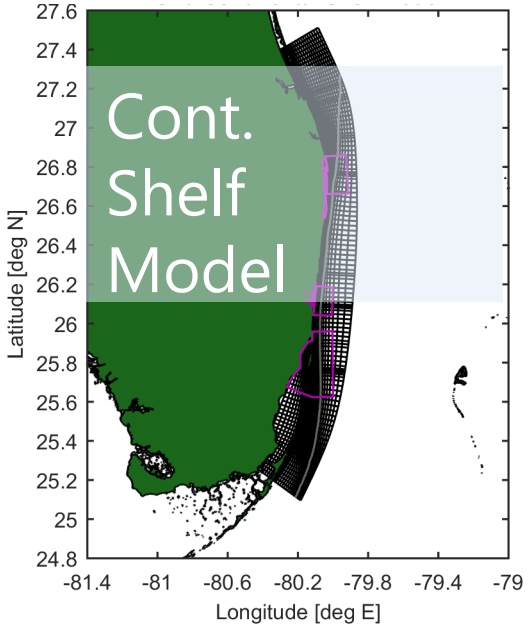


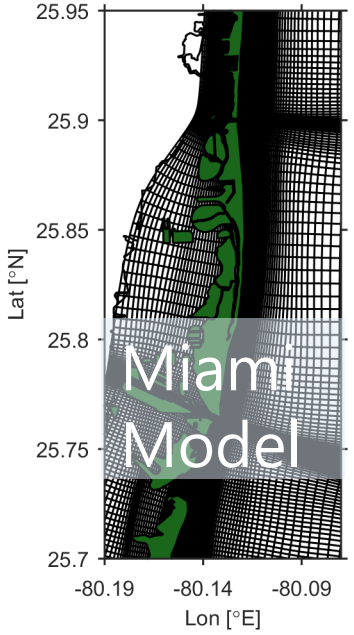
- Introduction

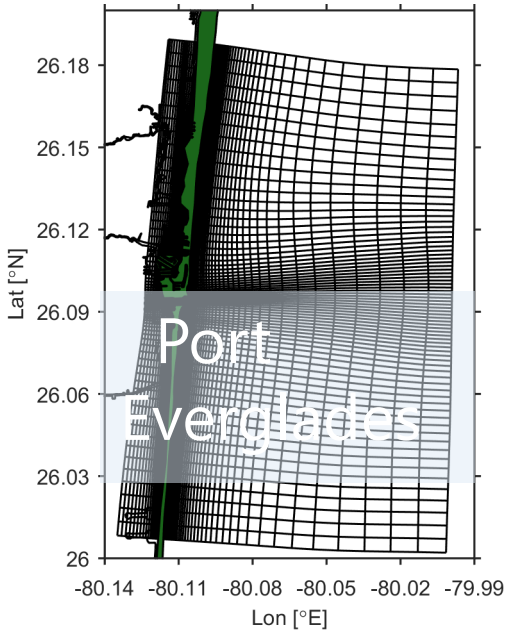
A modeling framework for SE-FL

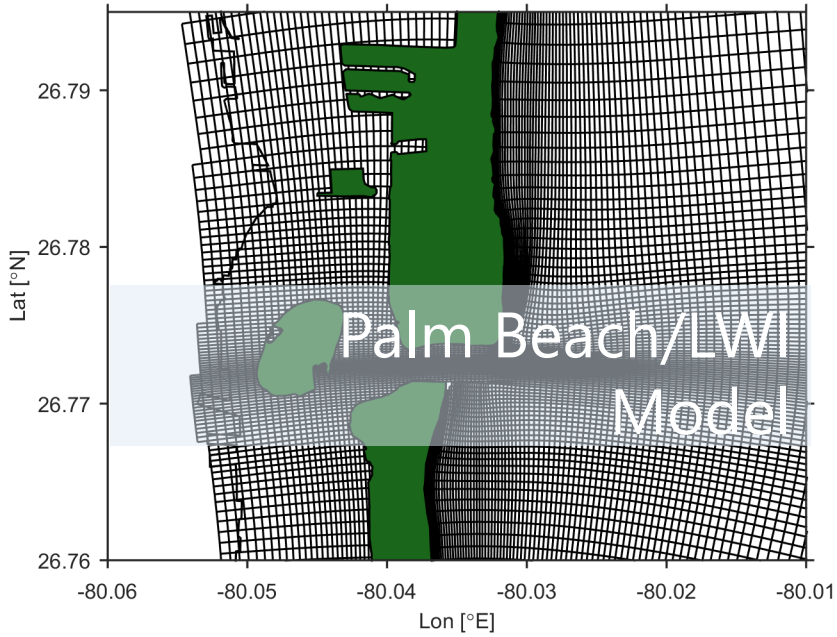












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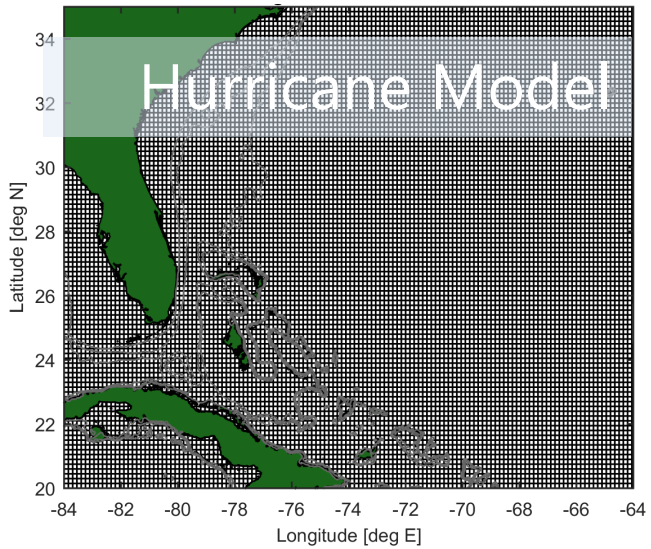
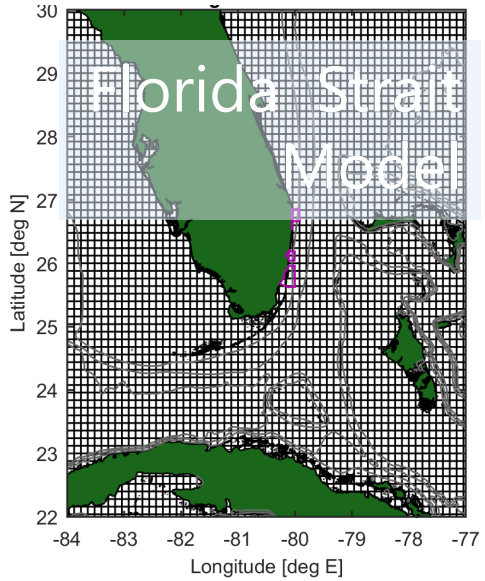
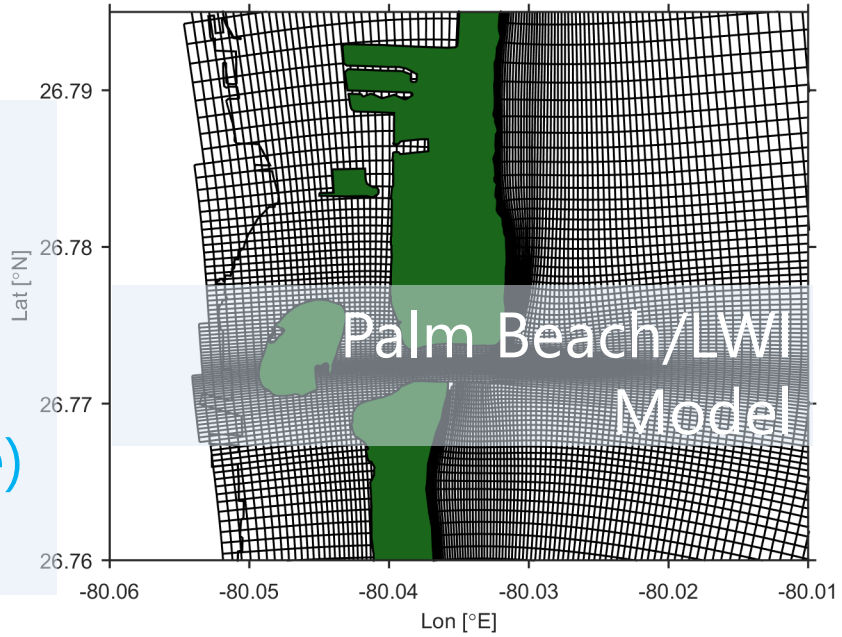


- Hurricanes (global scale)
- Surge levels (global scale)
- Currents (global scale)
- Waves (global scale)

A modeling framework for SE-FL



- Tides (global & local scale)
- Florida Current (local scale)
- Waves (local scale)
- Sediment Transport (local scale)



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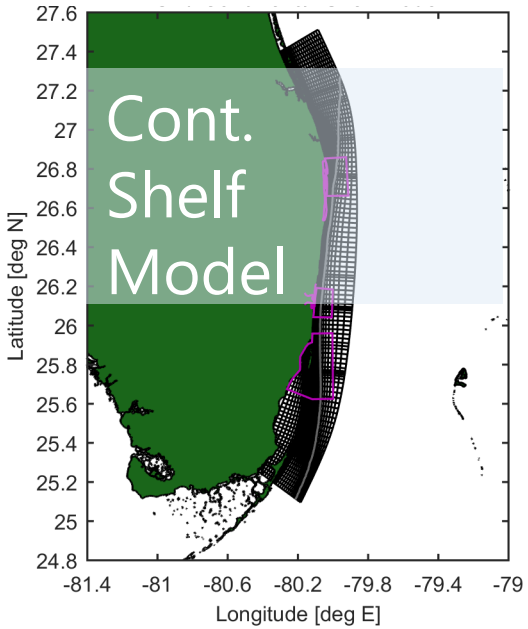
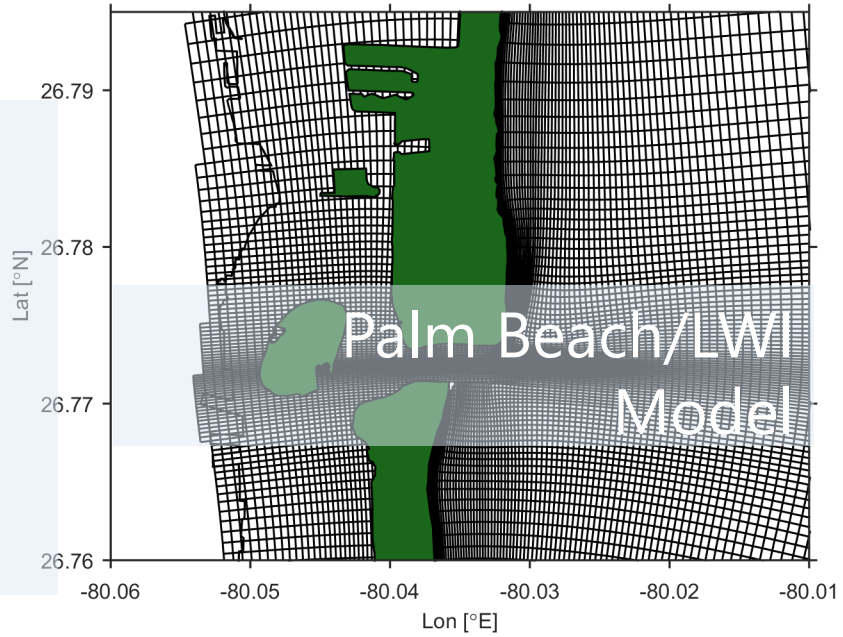
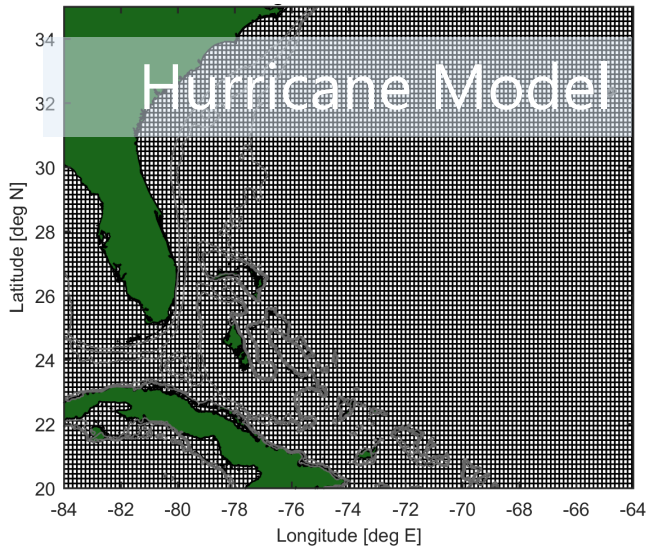


- Waves (global & local scale)
- Sediment Transport (global & local scale)



A modeling framework for SE-FL

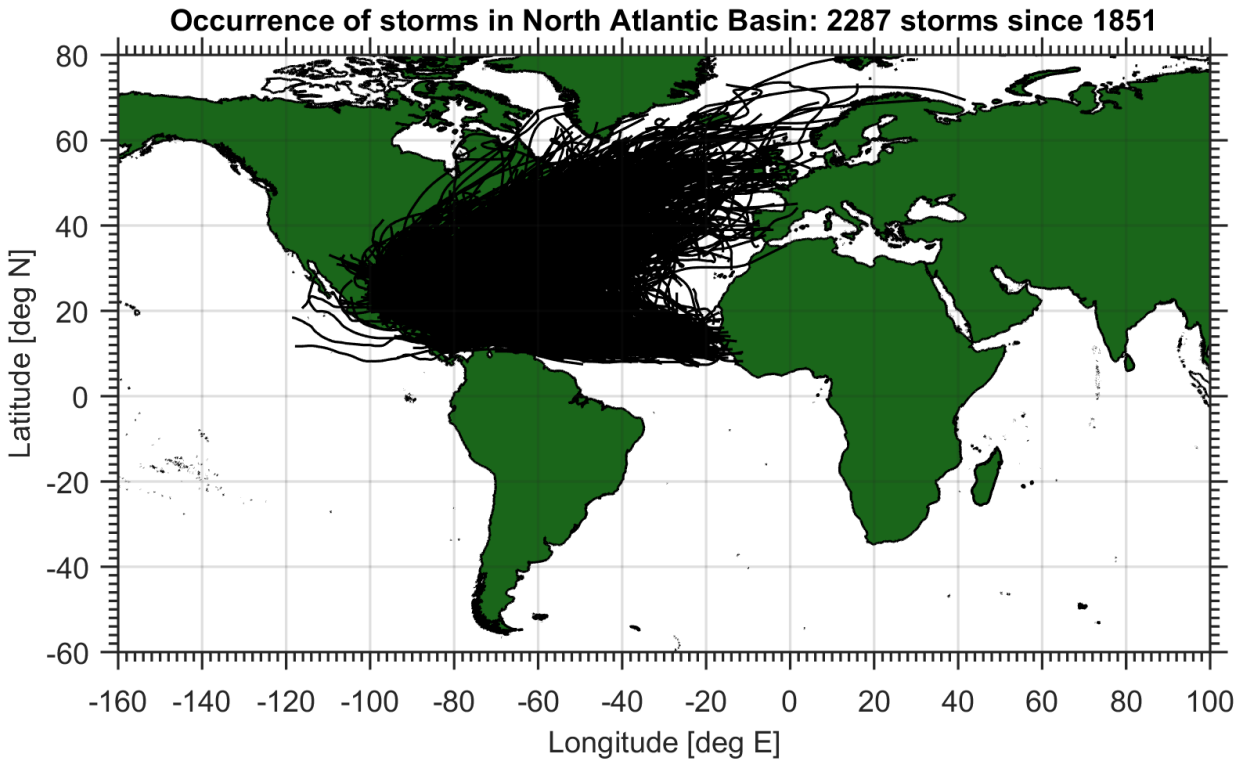


- Hurricanes (global scale)
- Surge levels (global scale)
- Currents (global scale)
- Waves (global scale)

A modeling framework for SE-FL

Hurricanes

- WES-Delft3D hurricane model



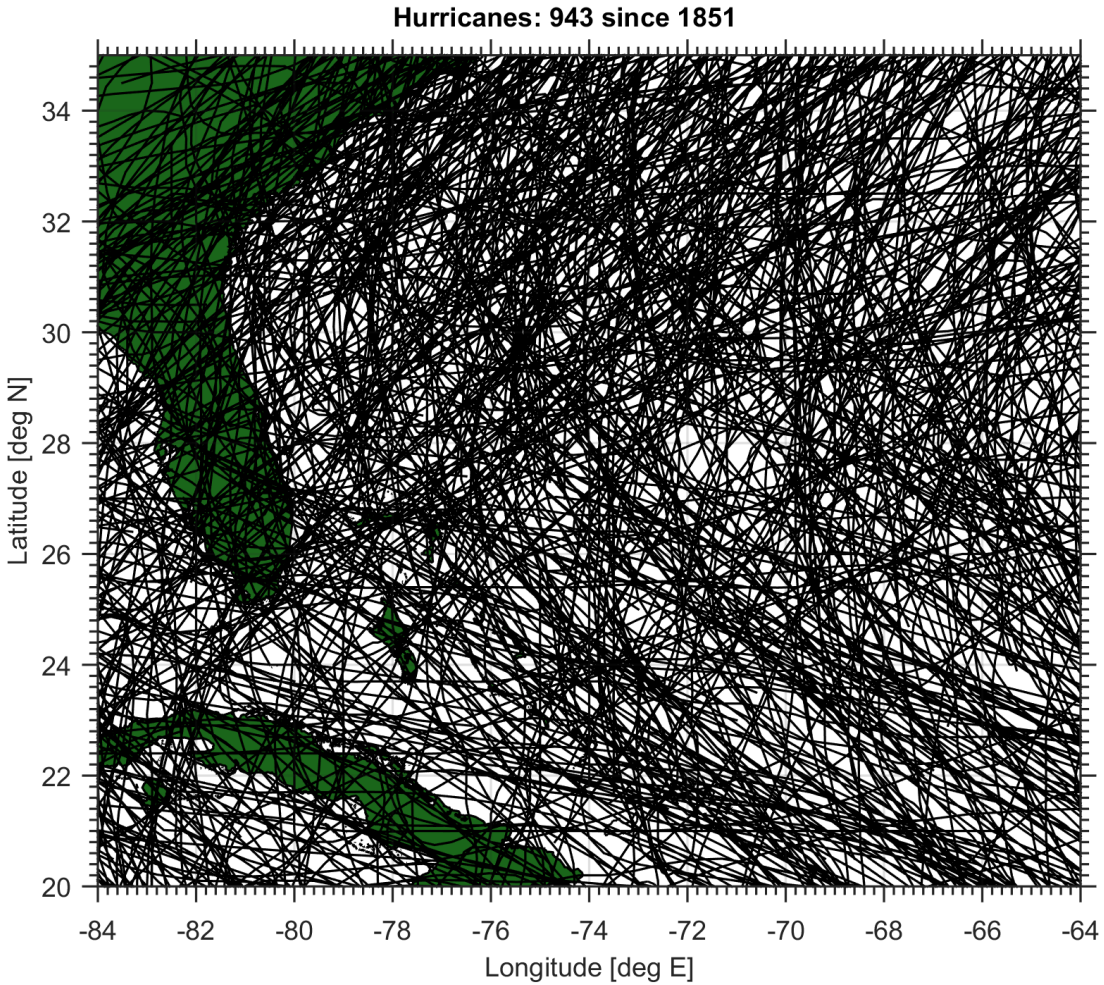
Introduction

Model example 1

A modeling framework for SE-FL

Hurricanes

- WES-Delft3D hurricane model

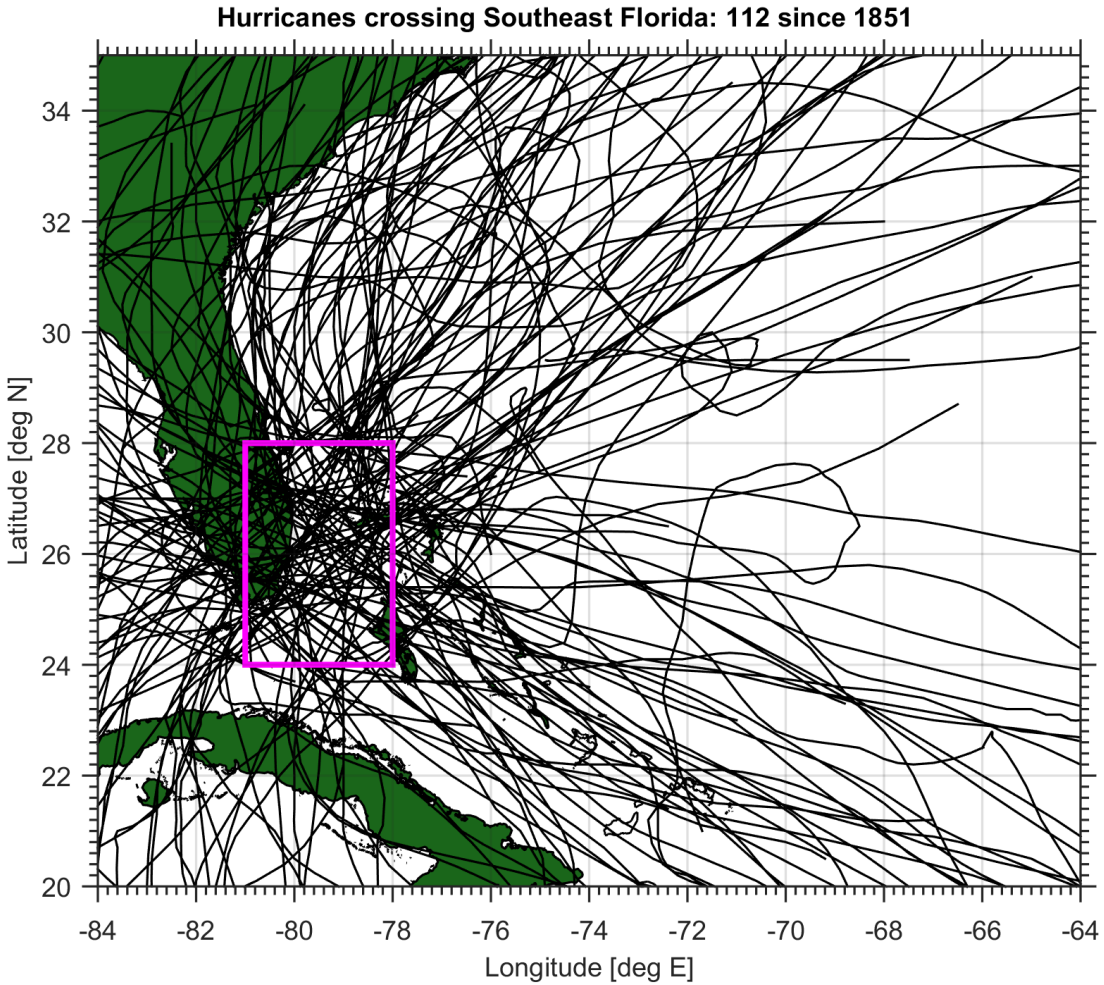


Introduction
Model example 1

A modeling framework for SE-FL

Hurricanes

- WES-Delft3D hurricane model



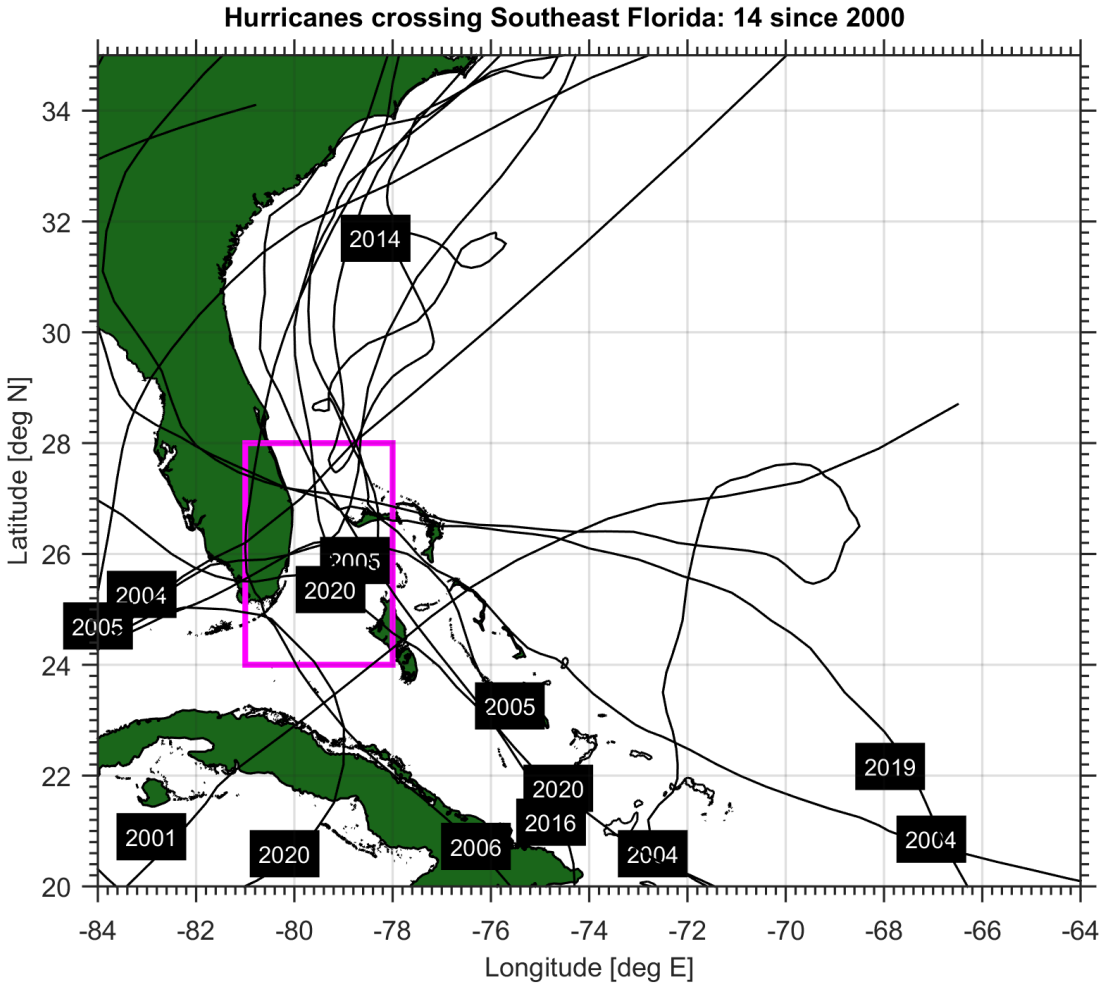
Introduction

Model example 1

A modeling framework for SE-FL

Hurricanes

- WES-Delft3D hurricane model



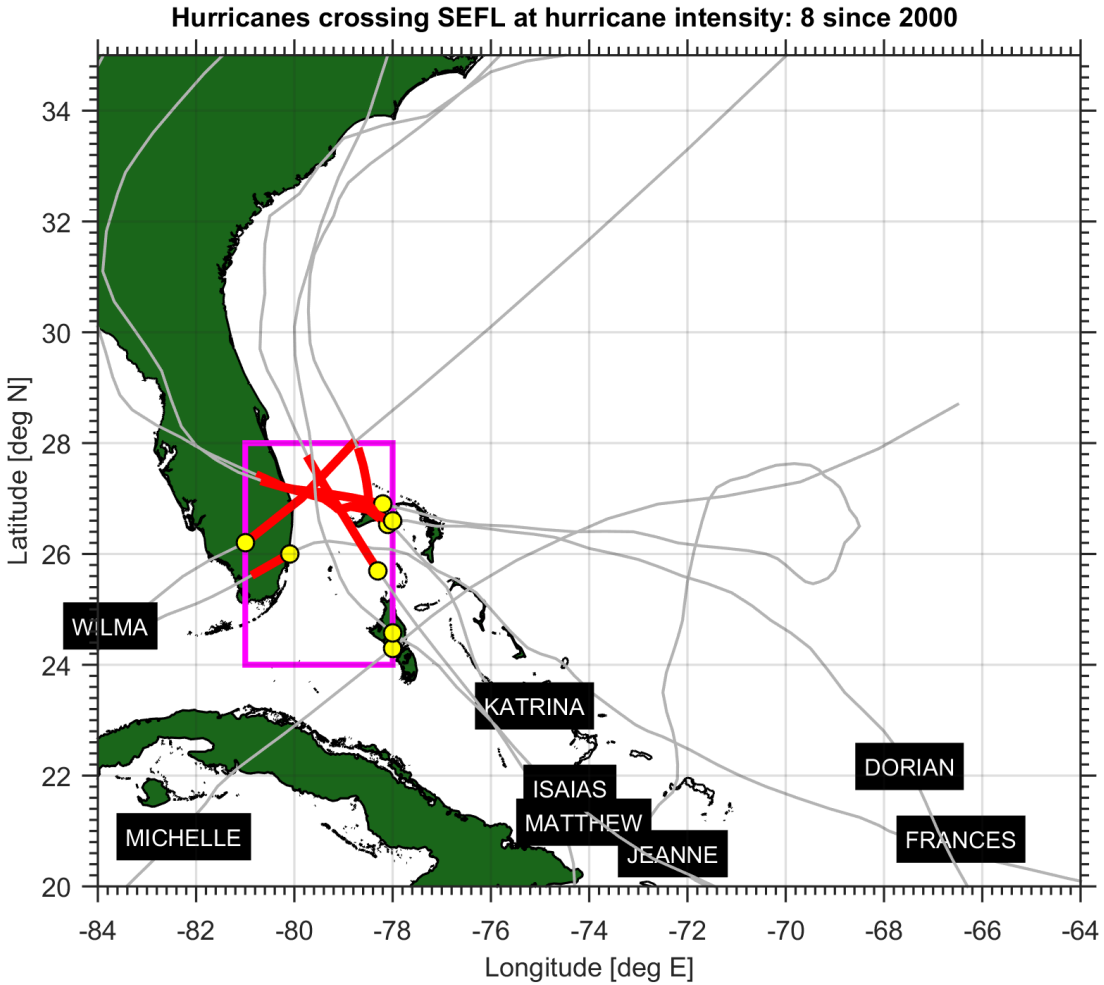
Introduction

Model example 1

A modeling framework for SE-FL

Hurricanes

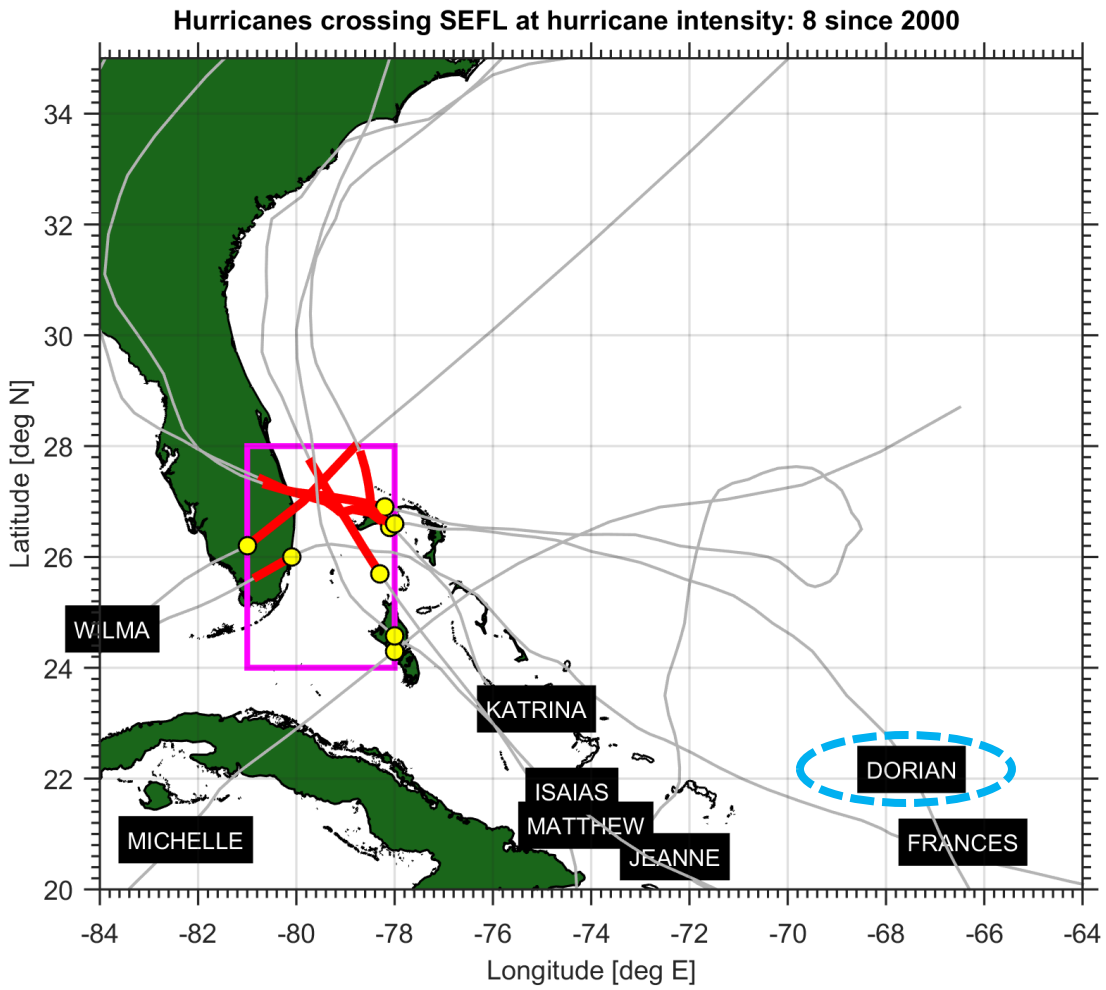
- WES-Delft3D hurricane model

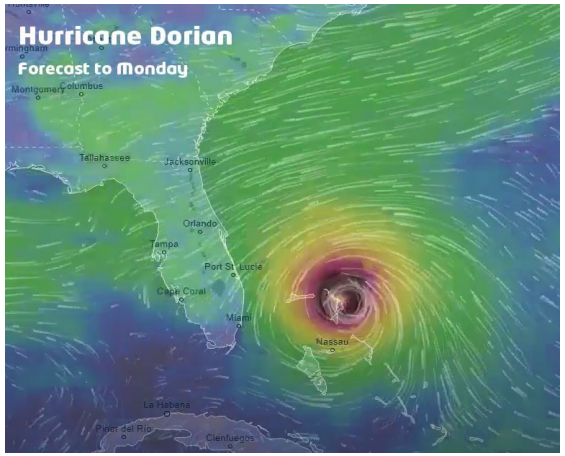


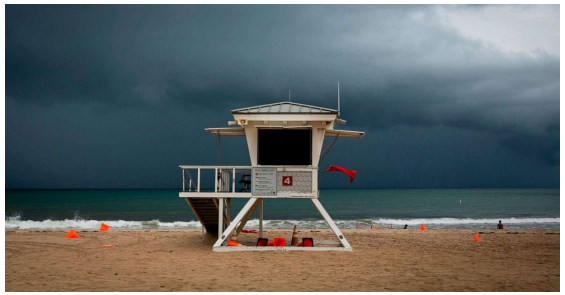
A modeling framework for SE-FL

Hurricanes

- WES-Delft3D hurricane model



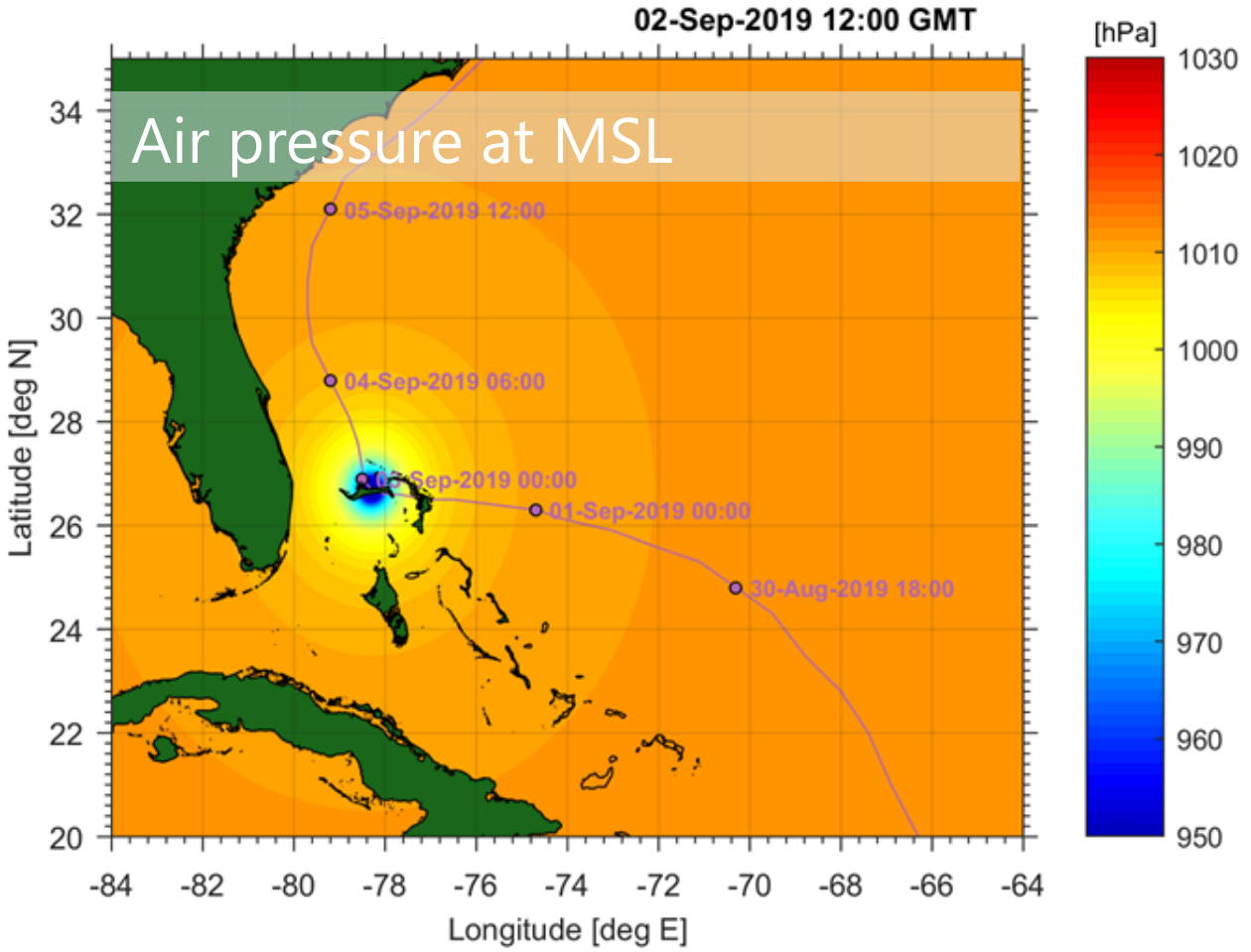




A modeling framework for SE-FL

Hurricanes

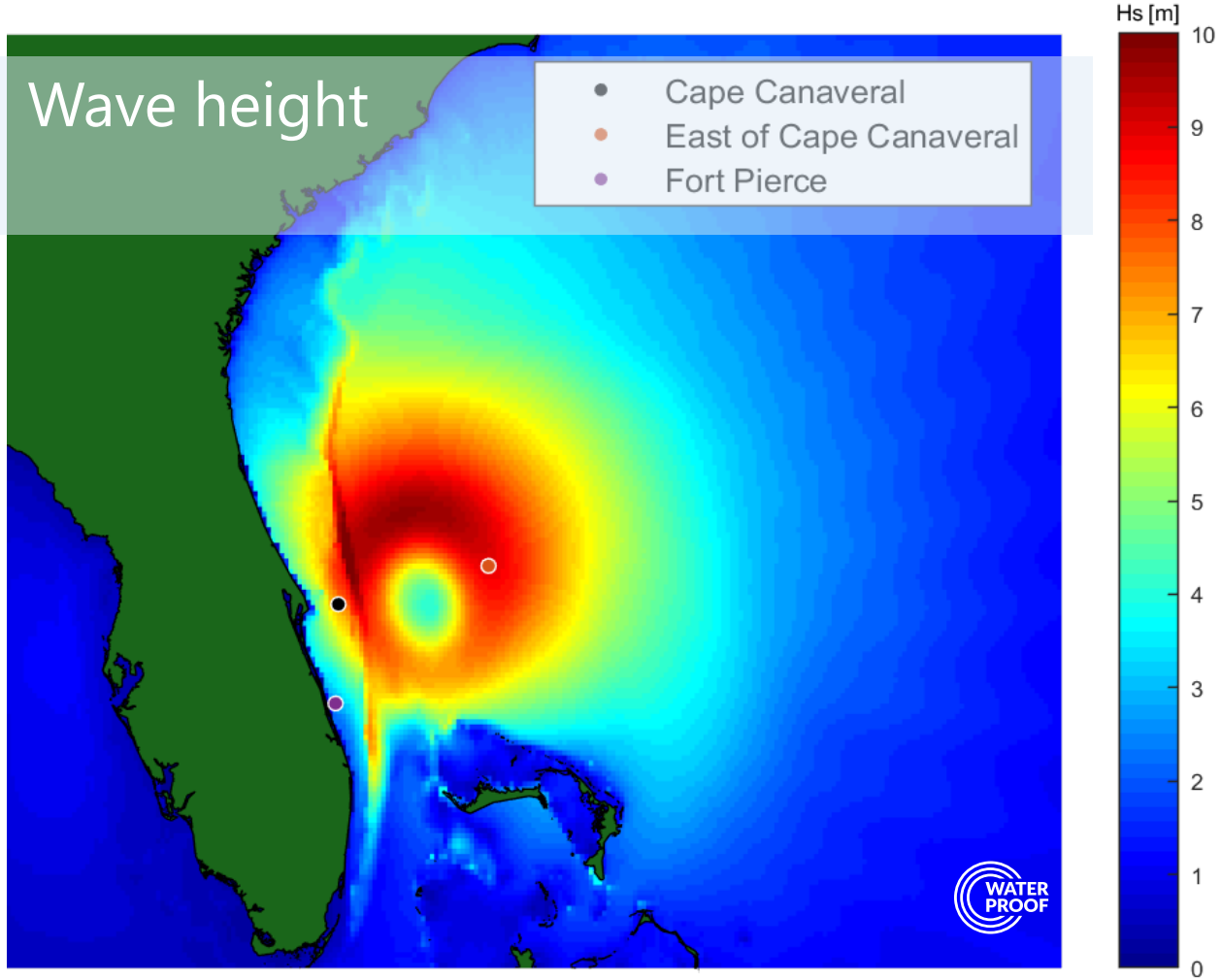
- WES-Delft3D hurricane model



A modeling framework for SE-FL

Hurricanes

- WES-Delft3D hurricane model



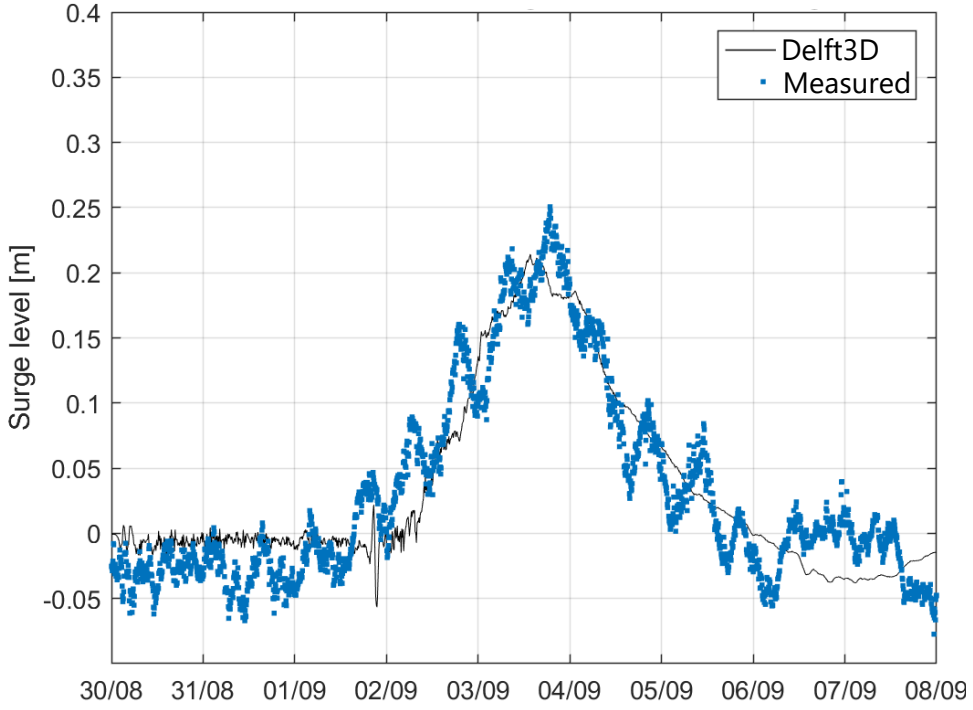
Introduction
Model example 1

A modeling framework for SE-FL

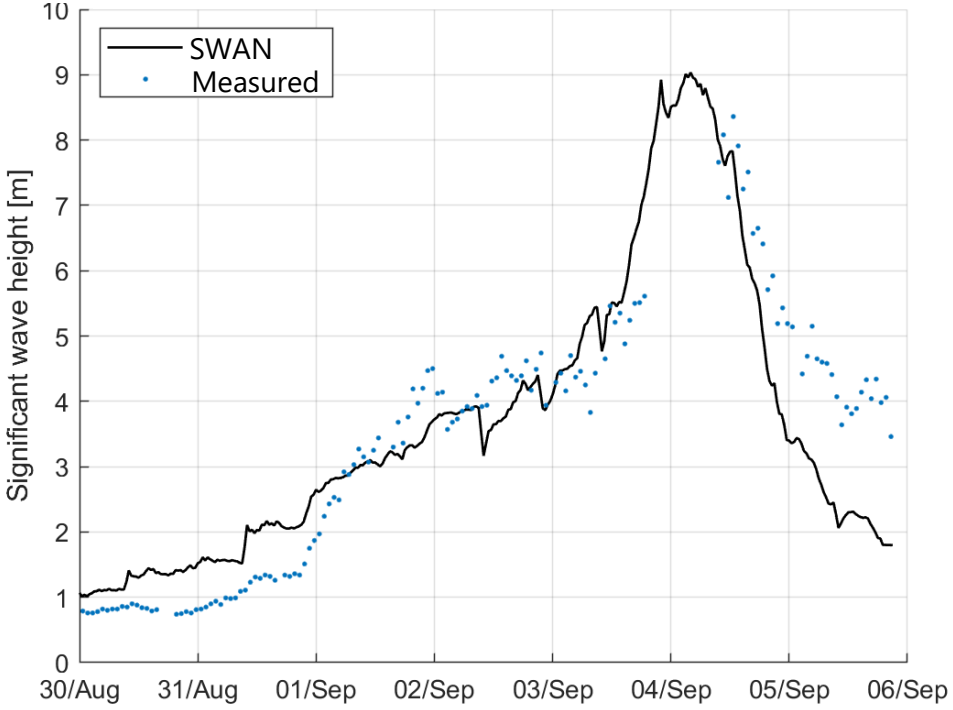
Hurricanes

- Validation WES-Delft3D hurricane model by reconstructed surge levels based on measurements
- Validation SWAN model by wave buoy measurements

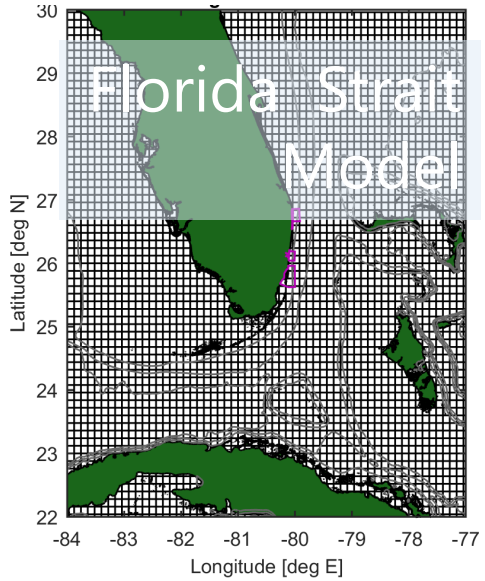
Surge at South Port Everglades



Wave height at East of Canaveral



A modeling framework for SE-FL



- Tides (global & local scale)
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- Waves (local scale)
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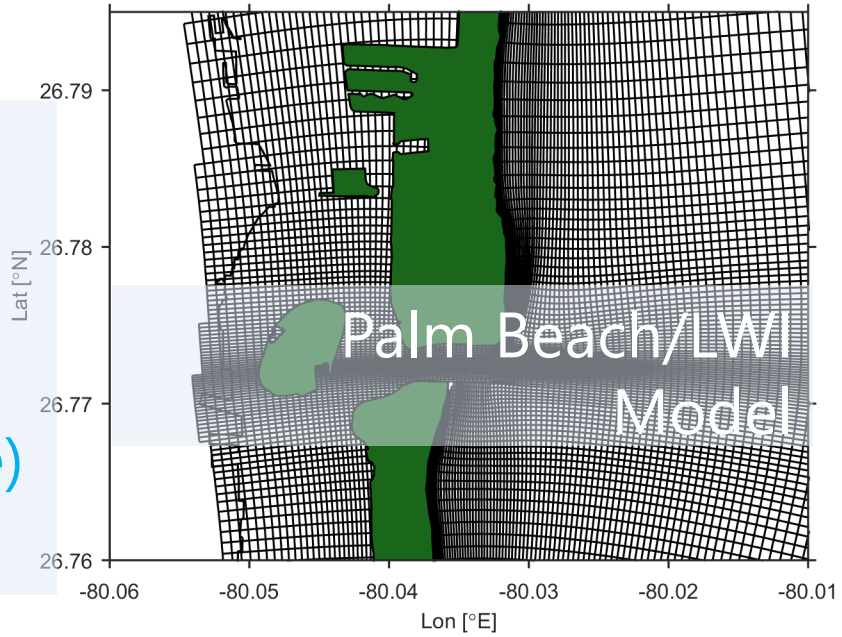
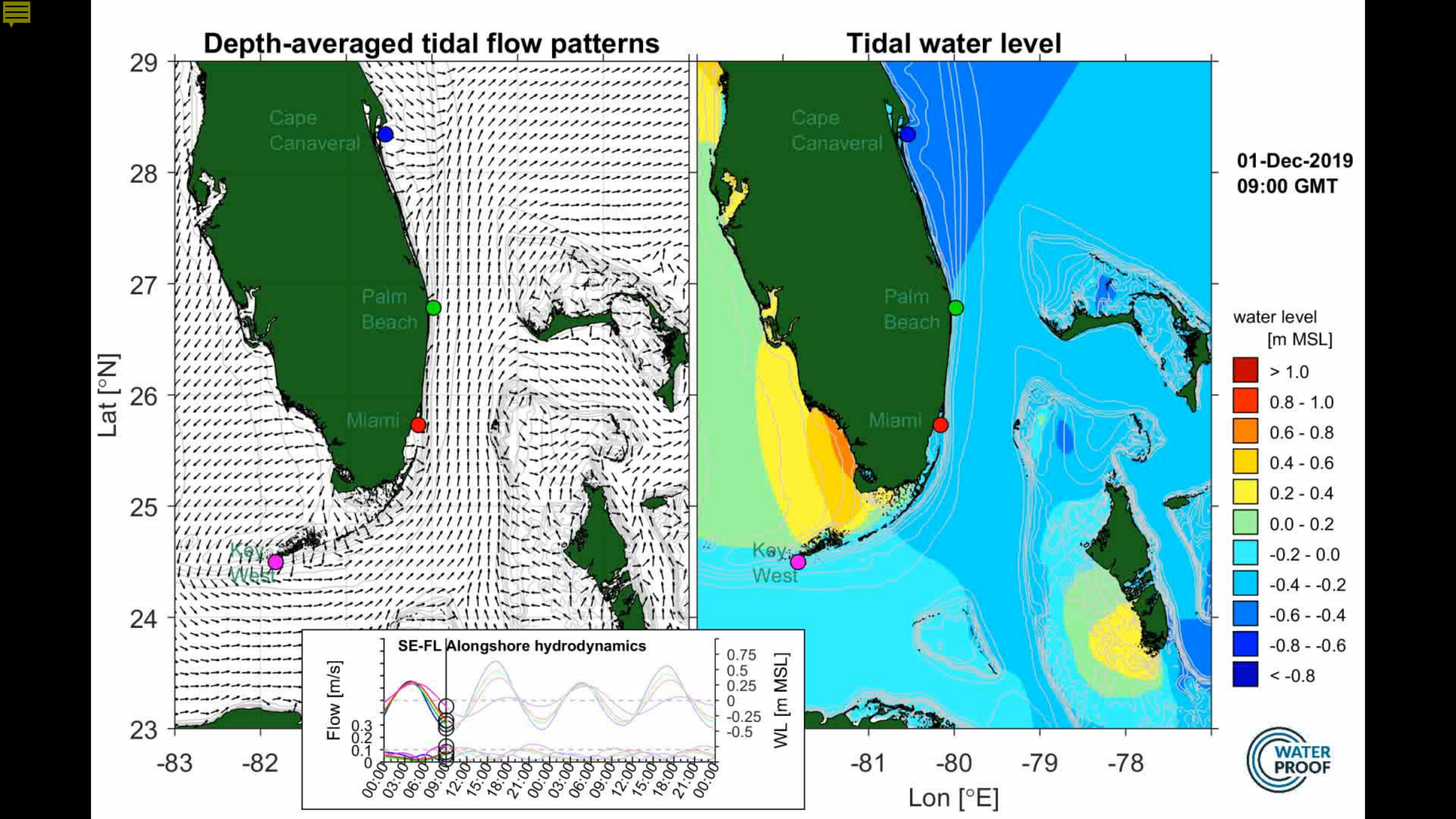


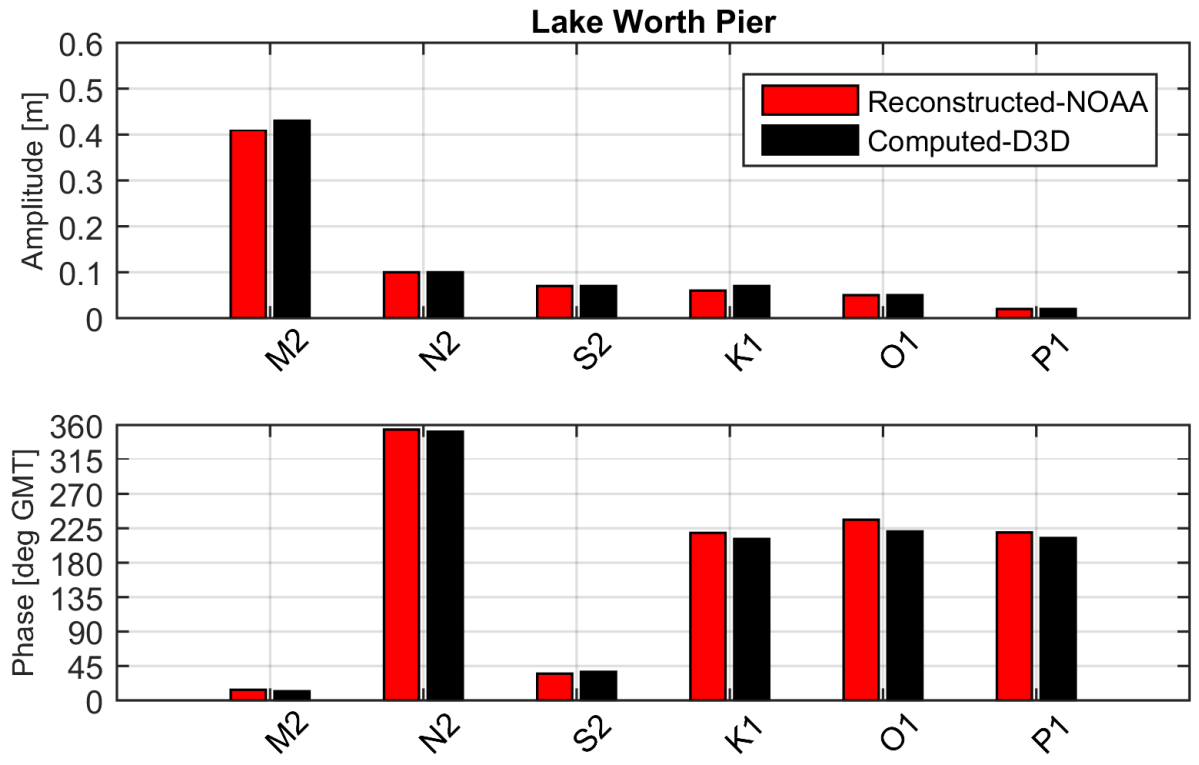

Depth-averaged tidal flow patterns
Tidal water level
Cape Canaveral
Palm Beach
Miami
Key West
01-Dec-2019
09:00 GMT
water level [m MSL]
> 1.0
0.8 - 1.0
0.6 - 0.8
0.4 - 0.6
0.2 - 0.4
0.0 - 0.2
-0.2 - 0.0
-0.4 - -0.2
-0.6 - -0.4
-0.8 - -0.6
< -0.8
Lat [°N]
Lon [°E]
29
28
27
26
25
24
23
-83
-82
-81
-80
-79
-78
SE-FL Alongshore hydrodynamics
Flow [m/s]
WL [m MSL]
0.3
0.2
0.1
0
0.75
0.5
0.25
0
-0.25
-0.5
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
WATER PROOF

A modeling framework for SE-FL

Validation Tides

Validation Delft3D model with tidal station data

Vertical tide (water levels)

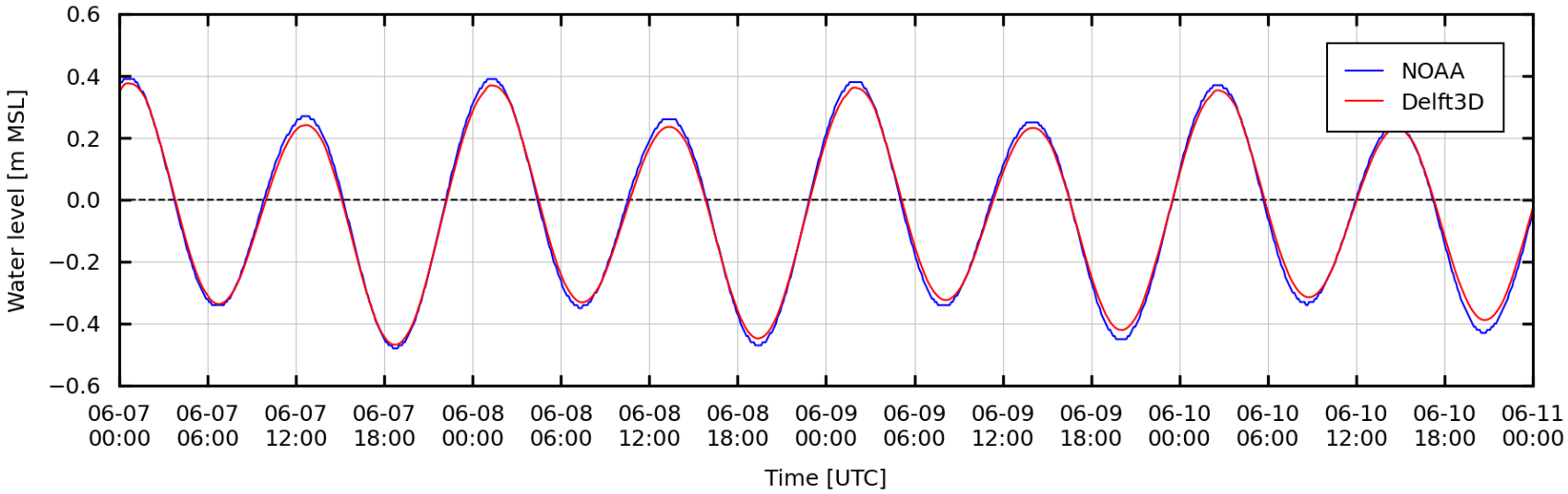


A modeling framework for SE-FL

Validation Tides

Validation Delft3D model with tidal station data

Vertical tide (water levels)

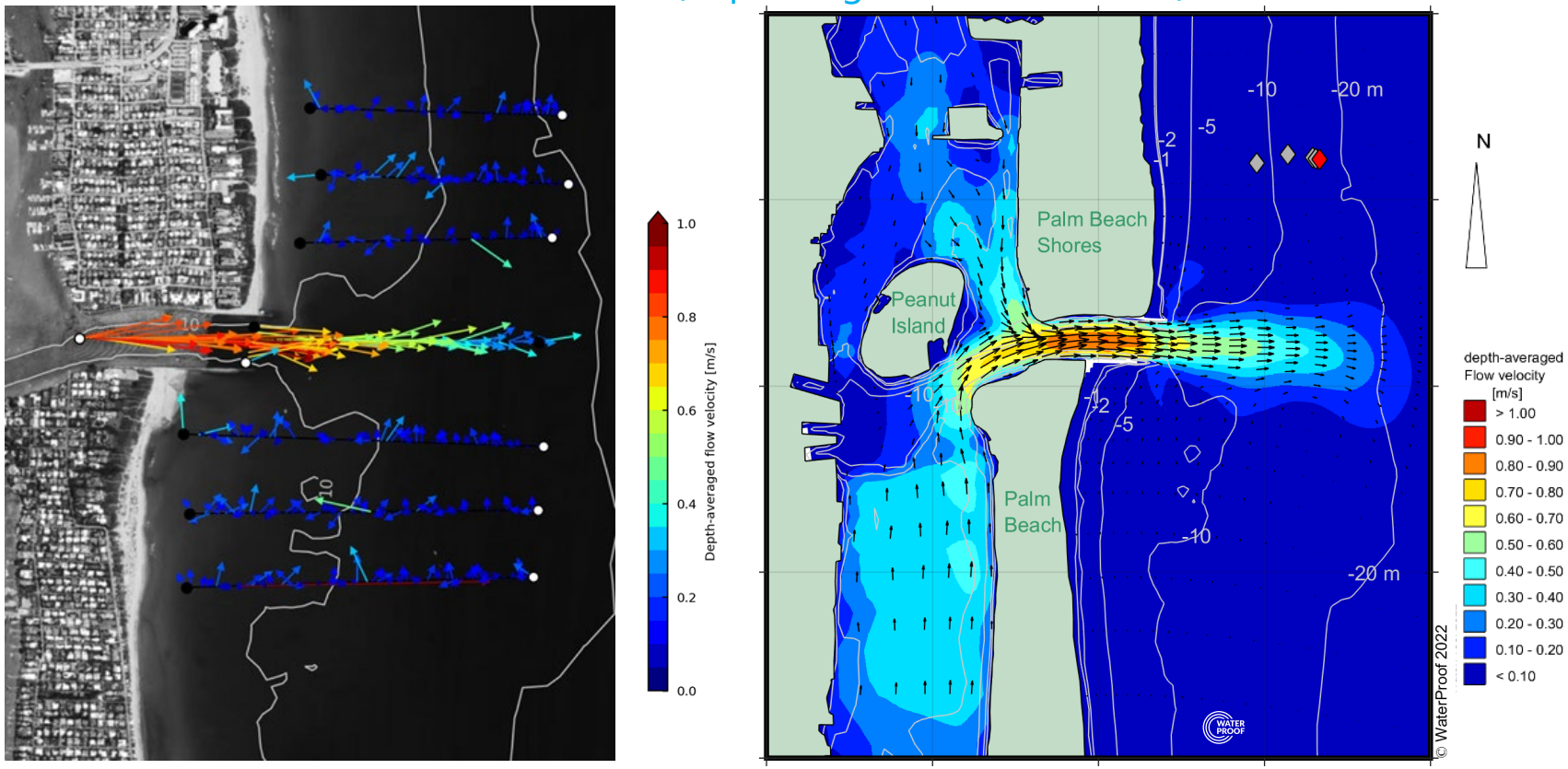


A modeling framework for SE-FL

Validation Tides

Validation Delft3D model with ADCP data

Horizontal tide (depth-avg. current velocities)



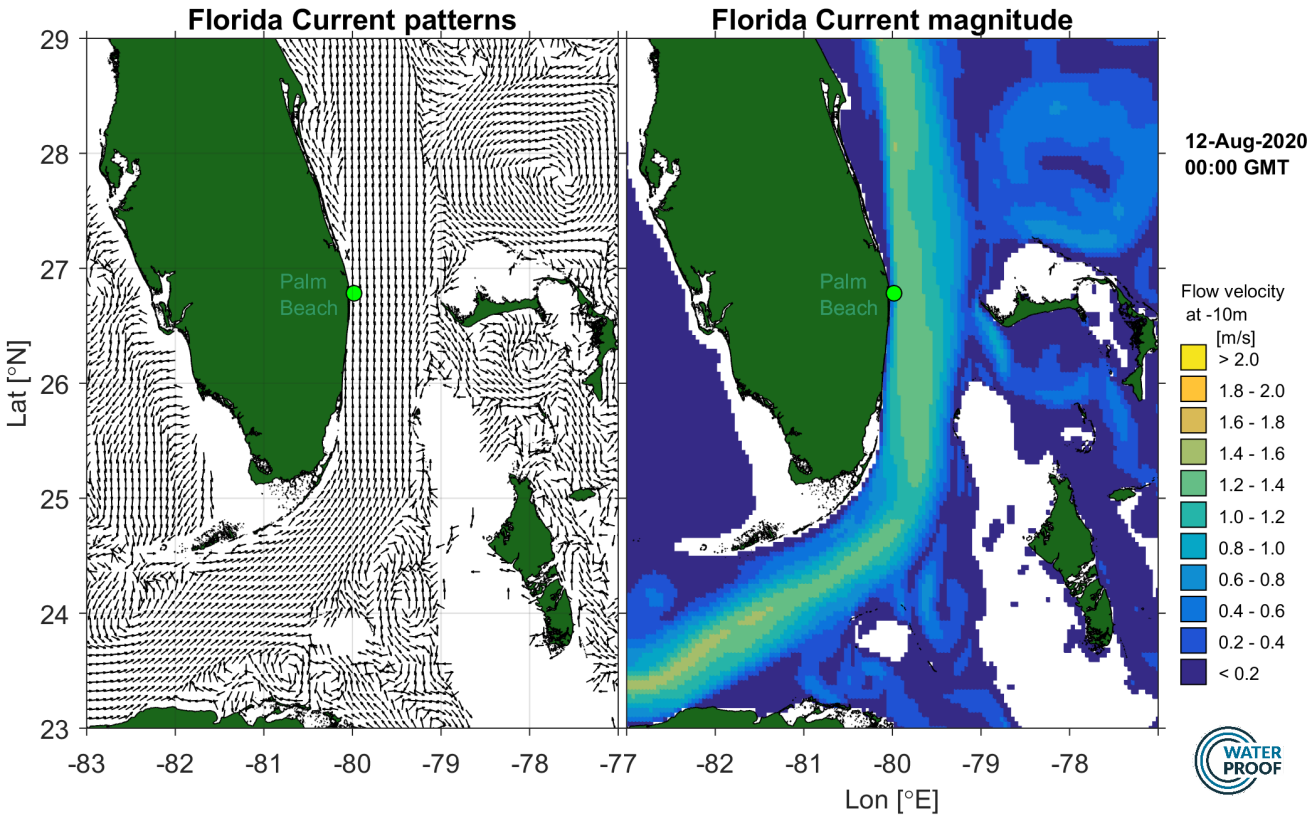
Measured

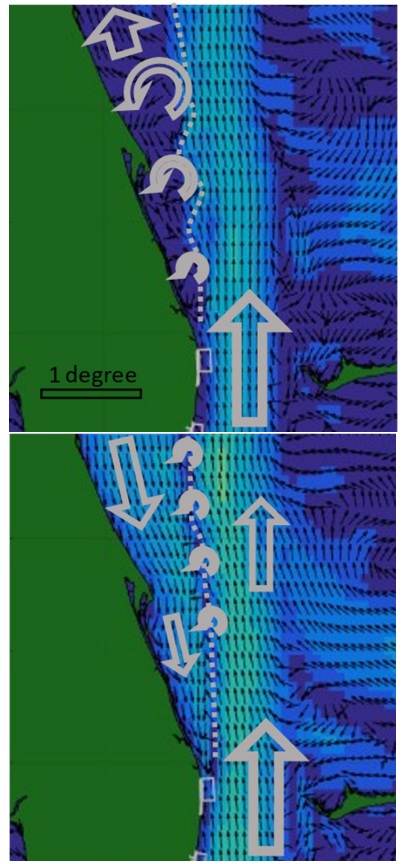
Modelled

A modeling framework for SE-FL

Florida Current (FC)

- Quasi-dynamic Delft3D model
- Fully-dynamic Delft3D model nested in HYCOM (U/C)

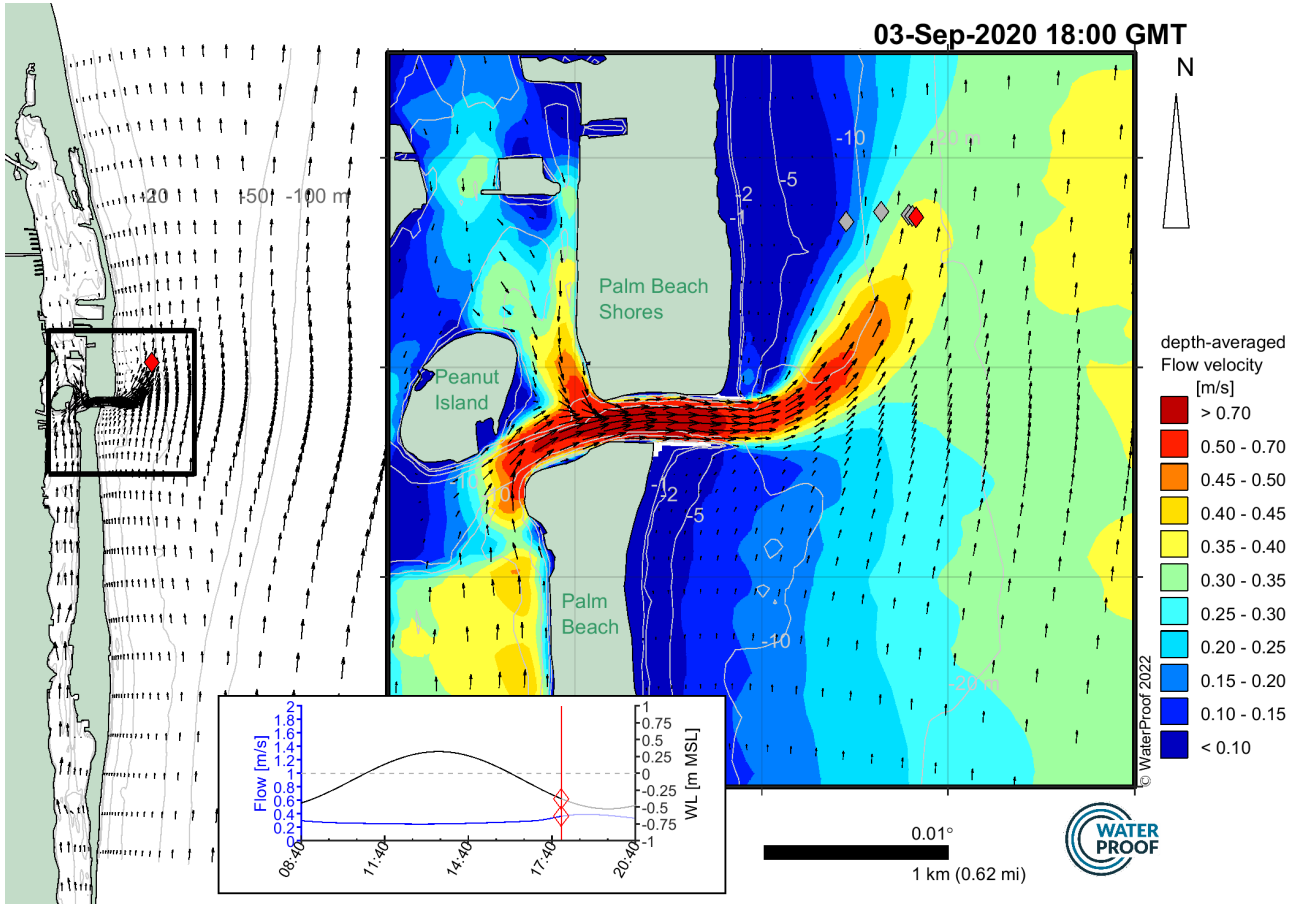




A modeling framework for SE-FL

Tides + Florida Current

Delft3D model Palm Beach/LWI

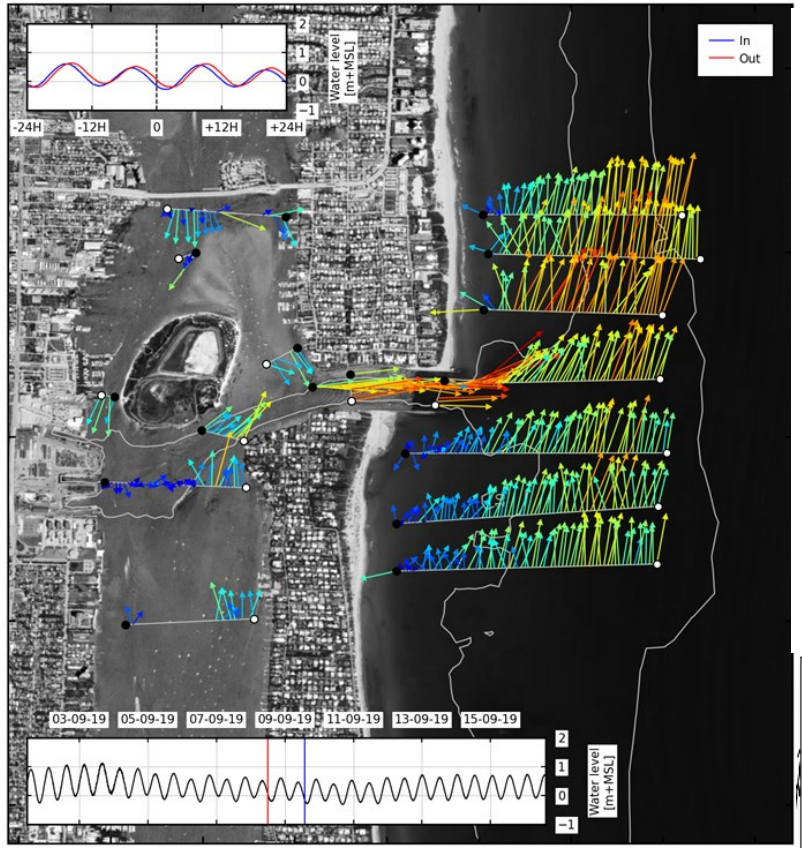


A modeling framework for SE-FL

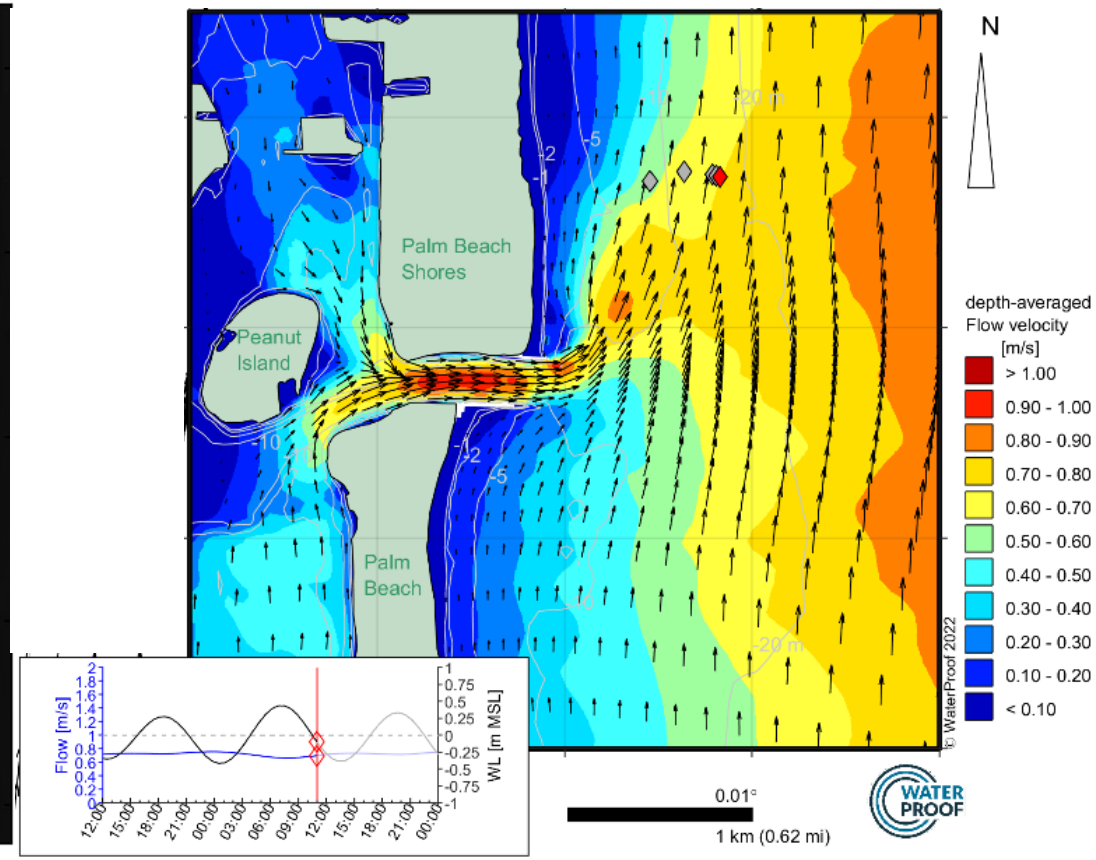
Validation Florida Current

Validation Delft3D model with current measurements by vessel-mounted ADCP tracks

Measured depth-avg. currents



Modelled depth-avg. currents



A modeling framework for SE-FL

Tides + Florida Current + Waves

Delft3D model Palm Beach/LWI

Introduction

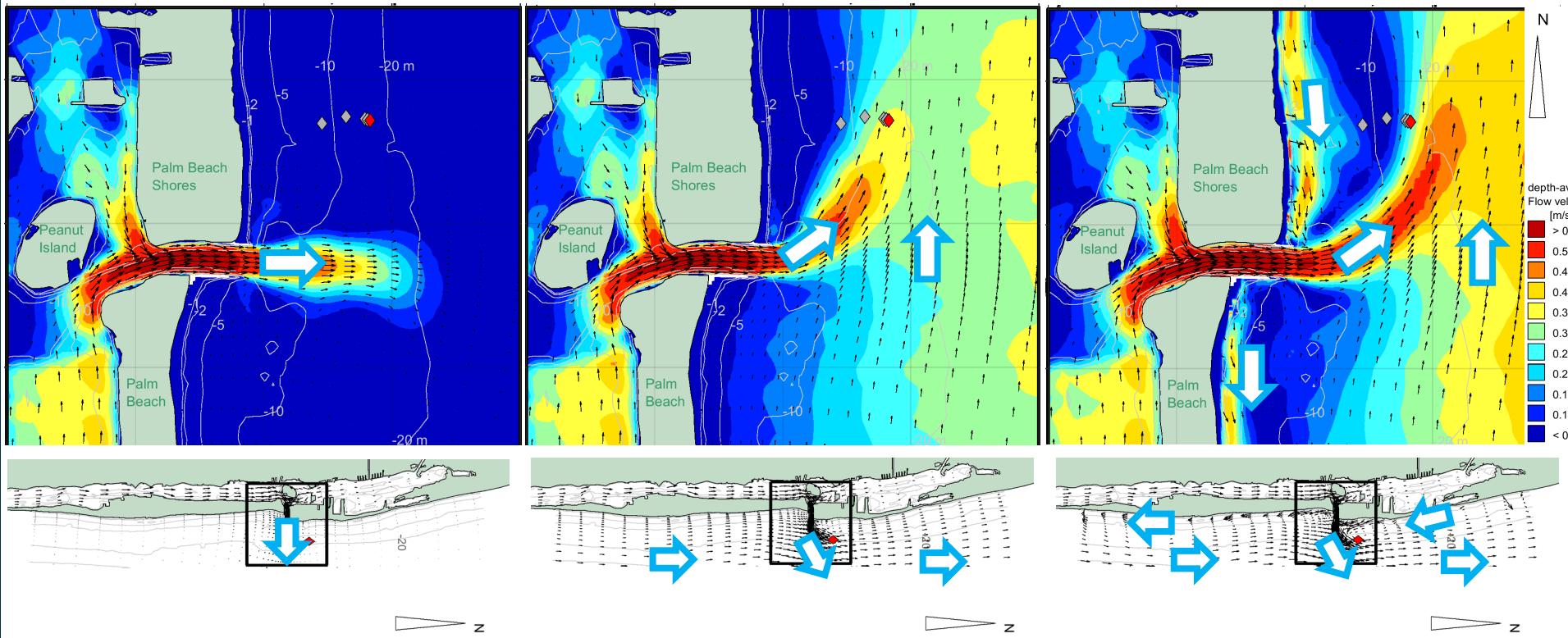
Model example 1

Model example 2

Tides

Tides + FC

Tides + FC+ Waves

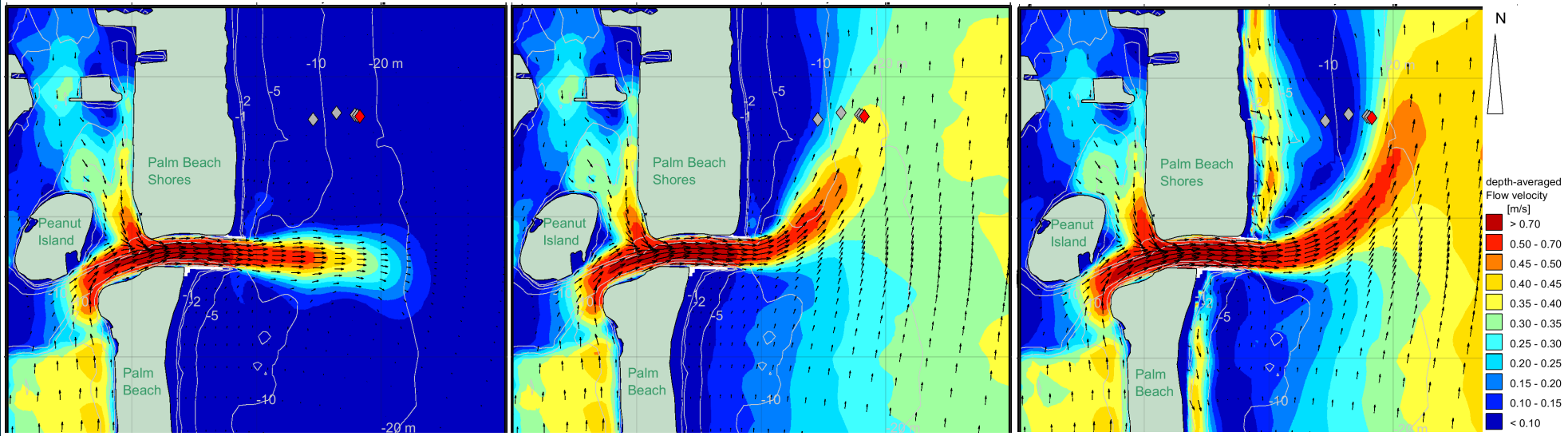


A modeling framework for SE-FL

Tides + Florida Current + Waves

Delft3D model Palm Beach/LWI

Spatial differentiation in governing mechanism or interactions



Introduction

Model example 1

Model example 2

Tides:
- Inlet
- Back-barrier basin

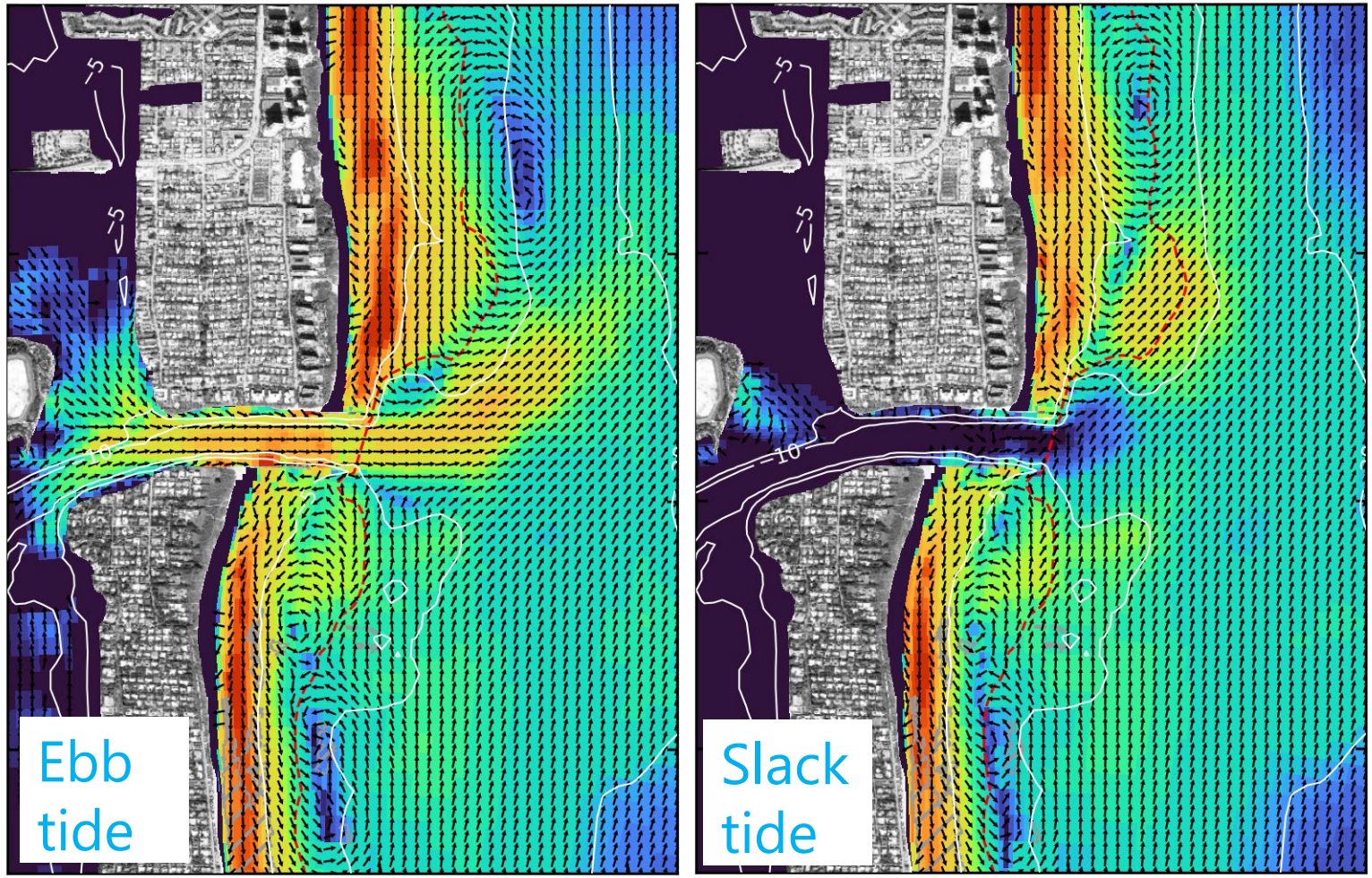
Florida Current:
- Intermediate zone
- Offshore

Waves:
- Beach
- Surf zone

A modeling framework for SE-FL

Tides + FC + Waves + Sediment Transport

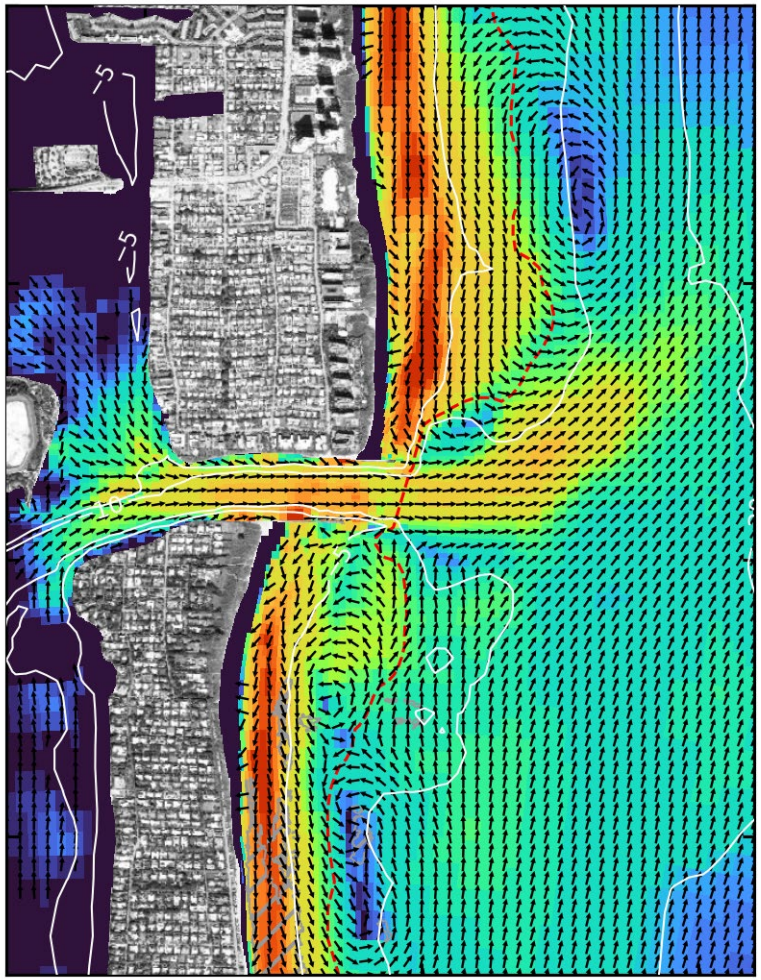
Delft3D-SWAN model Palm Beach/LWI

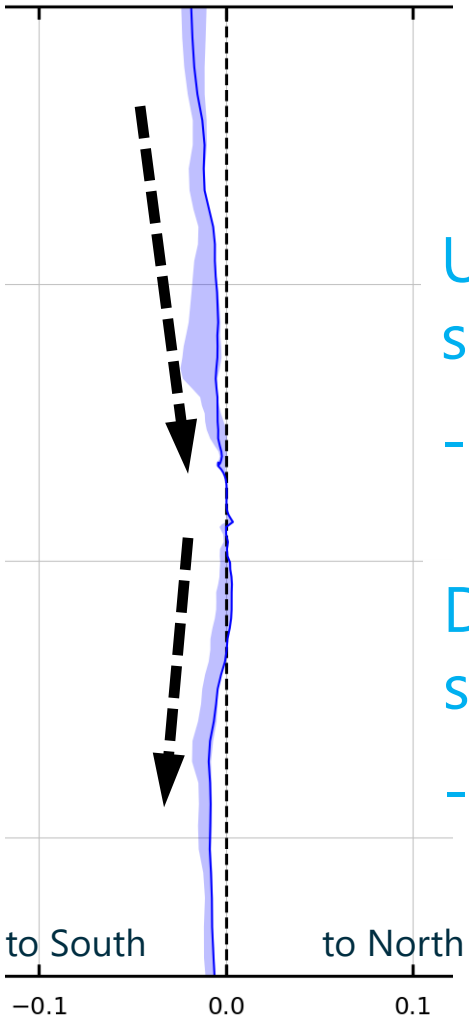


A modeling framework for SE-FL

Tides + FC + Waves + Sediment Transport

Delft3D-SWAN model Palm Beach/LWI





Updrift: **decreasing** southward-going LST

-> Shoreline Accretion

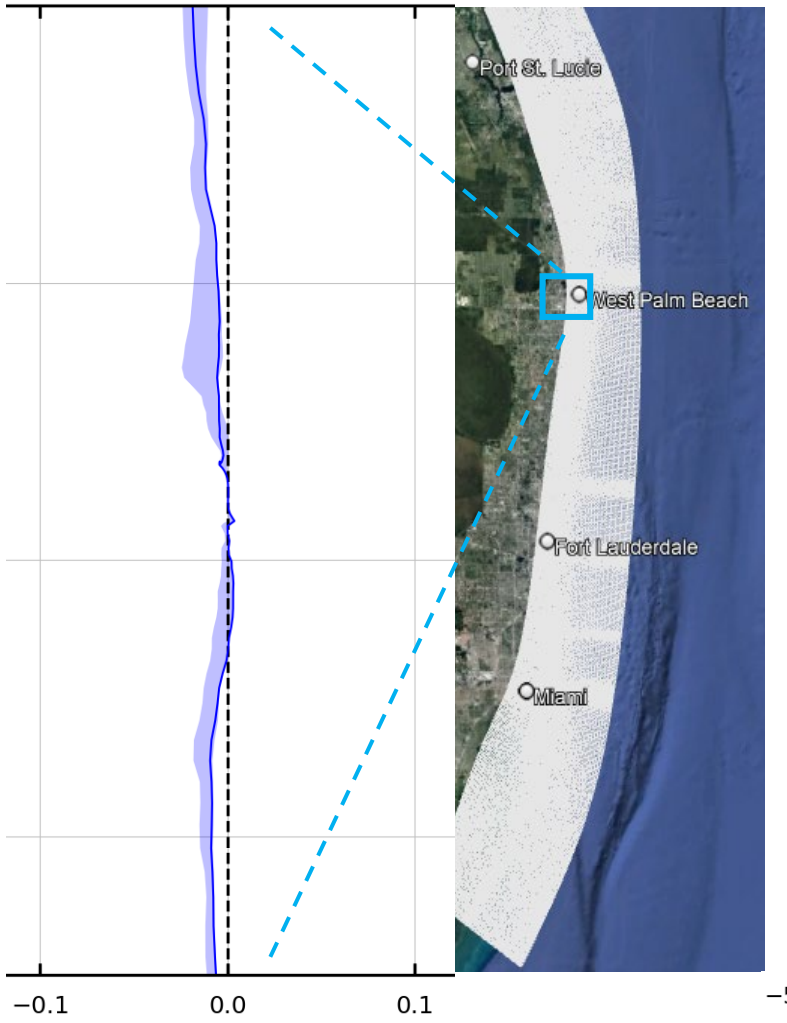
Downdrift: **increasing** southward-going LST

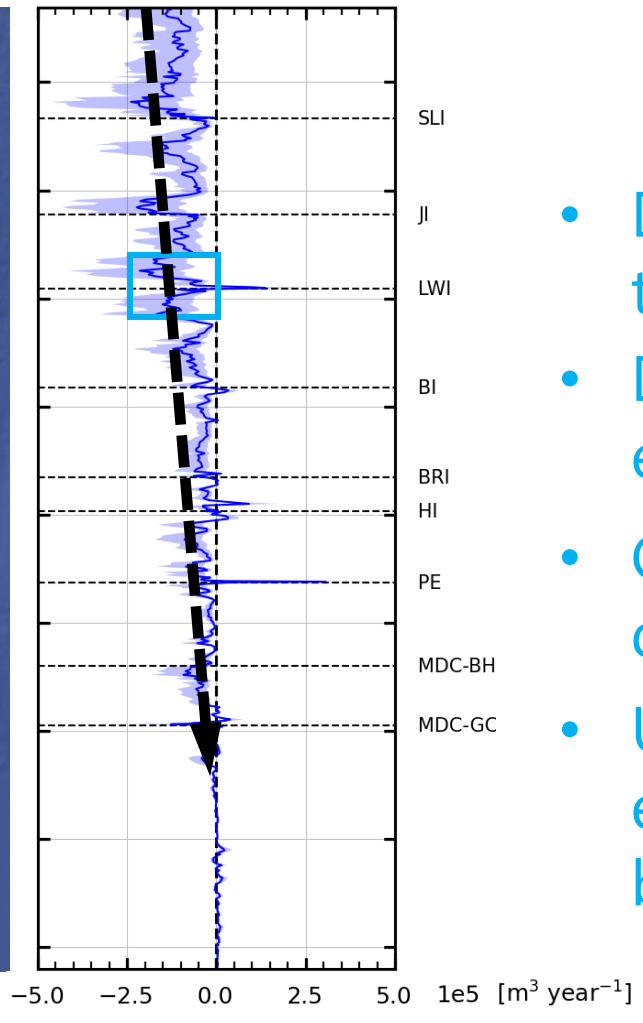
-> Shoreline Erosion

A modeling framework for SE-FL

Waves + Longshore Sediment Transport

- Continental Shelf Model





- Decreasing LST to S
- Distinct inlet effects
- Good agreement documented LST
- Useful tool for evaluation breakwaters

A modeling framework for SE-FL

Further application:

1. to increase our understanding of the coastal physics
2. to guide coastal management

   effects breakwaters, optimization sediment traps, sand transfer plant, nourishment lifetime, dredging plumes, etc.

Palm Beach Inlet- southern jetty, photo N. Geleynse, April 2022

Construction works, south of Port Everglades, photo N. Geleynse, April 2022

WATER PROOF Marine Consultancy & Services

Thank you!

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luitze.perk@waterproofbv.nl

Miami Harbor entrance channel, photo N. Geleynse, April 2022

MANAGEMENT DECISIONS AND NEXT STEPS FOR LWI

- To reduce shoaling and increase the time between O&M dredging, sand needs to either be trapped more efficiently and/or bypassed more efficiently.

- Dredging operations needs to be linked to the metocean conditions when sand moves and accumulates.