Erosion and Inundation of Hatteras Island at Dune- and Region-Scales During Hurricane Isabel
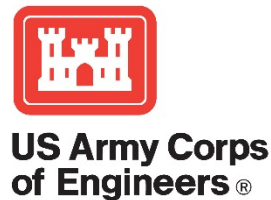
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[2] Institute of Marine Sciences, University of North Carolina at Chapel Hill

ASBPA National Coastal Conference 2018
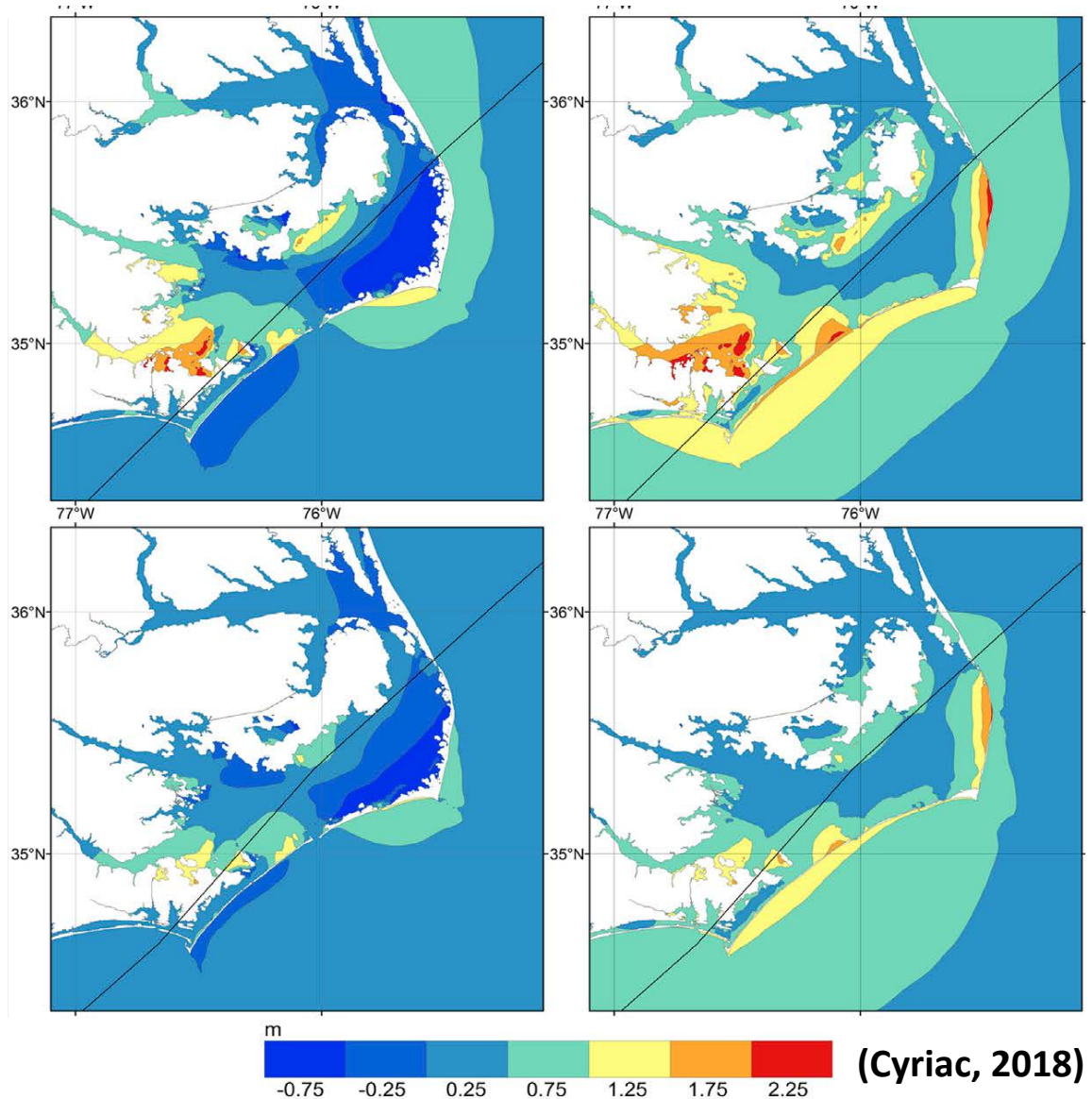
Motivations

*NCDOT

* Daniel Pullen Photography

Cape Hatteras, NC Outer Banks, Florence Sep 2018

Motivations

ADCIRC

- Large scale model
- Unstructured mesh
- Tide, Surge, Wave, flooding
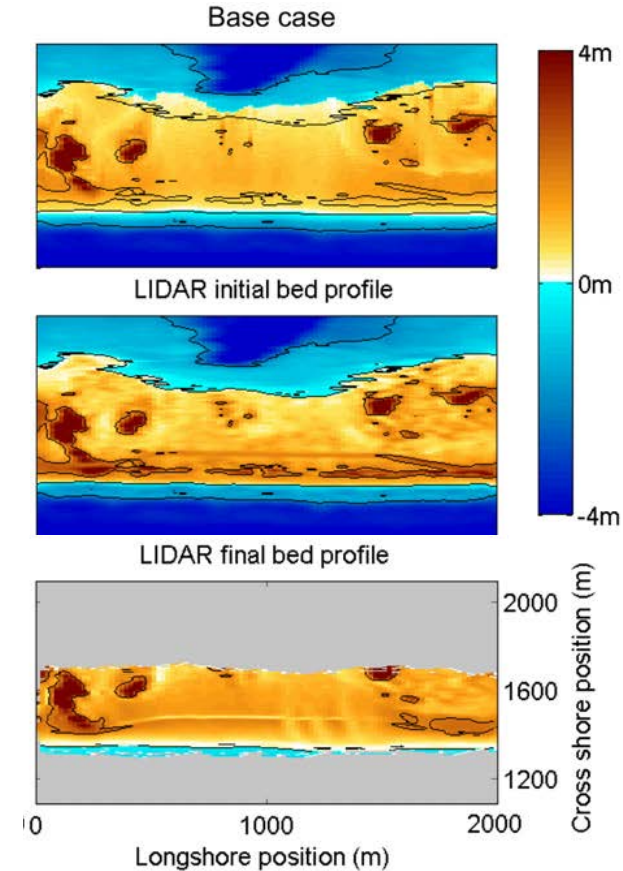- No morphodynamics
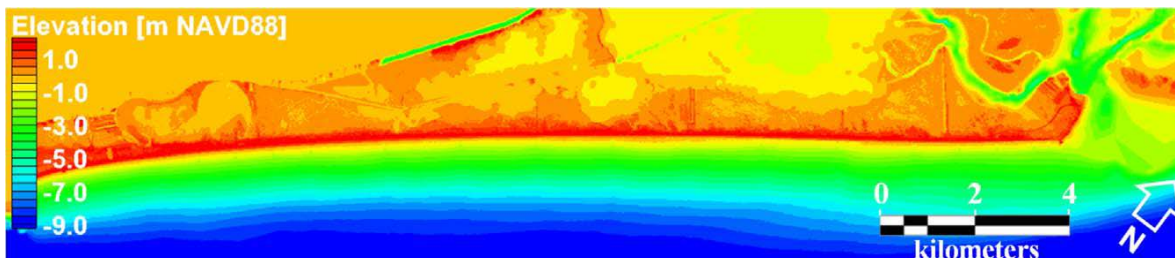

(Cyriac, 2018)

Motivations

XBeach

- Nearshore hydrodynamics and morphodynamics

- Small scale features (dune erosion, overwash, breach)

- Structured mesh

- Higher resolution mesh compared to ADCIRC mesh

(McCall, 2010)

(Harter, 2017)

Goals and Objectives

Goals:

- Predict storm-driven erosion over large domains

- Develop techniques for coarsening predictions and coupling back to flooding models
 - First step toward ADCIRC+XBeach

Objectives:

1. Validate XBeach erosion predictions on larger domains

- Apply to 30km of Hatteras Island during Isabel

- Quantify performance via skill score, WOA

2. Evaluate XBeach accuracy at coarser resolution

- What happens if we use a coarser mesh?

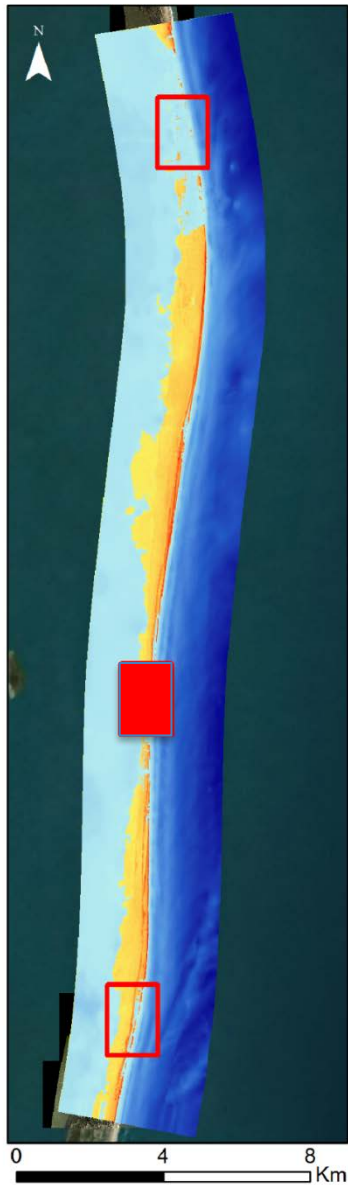- What are implications as a hydraulic control to stop or allow flooding?
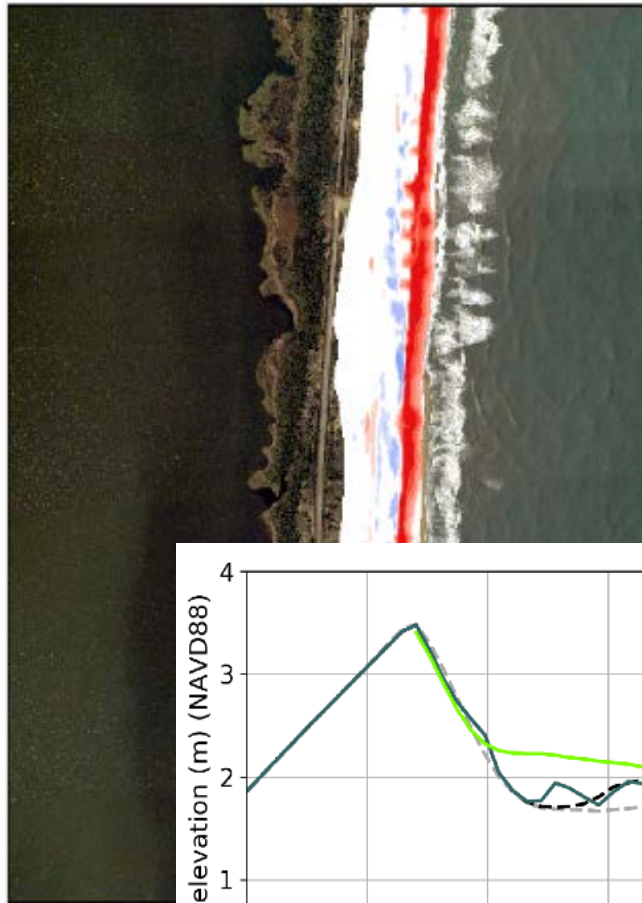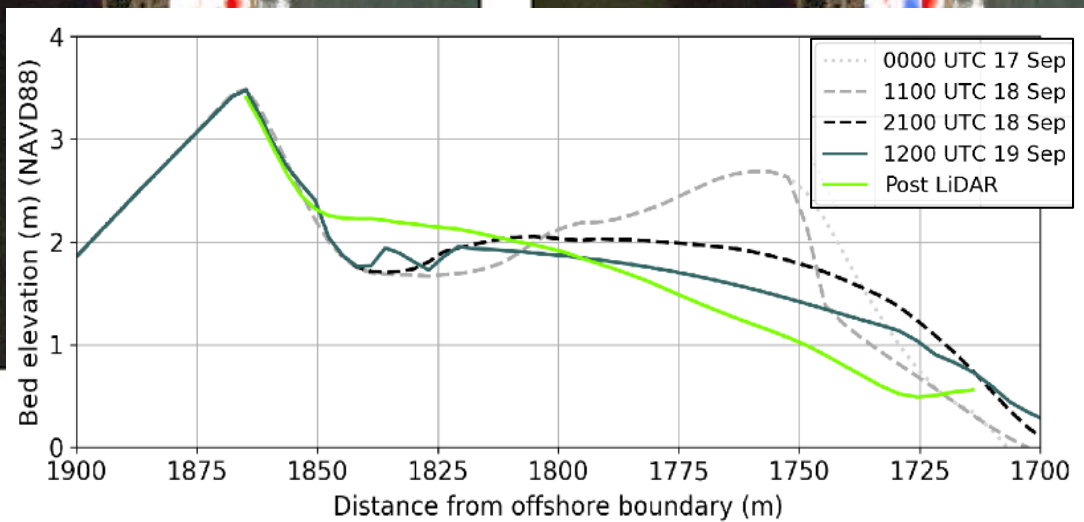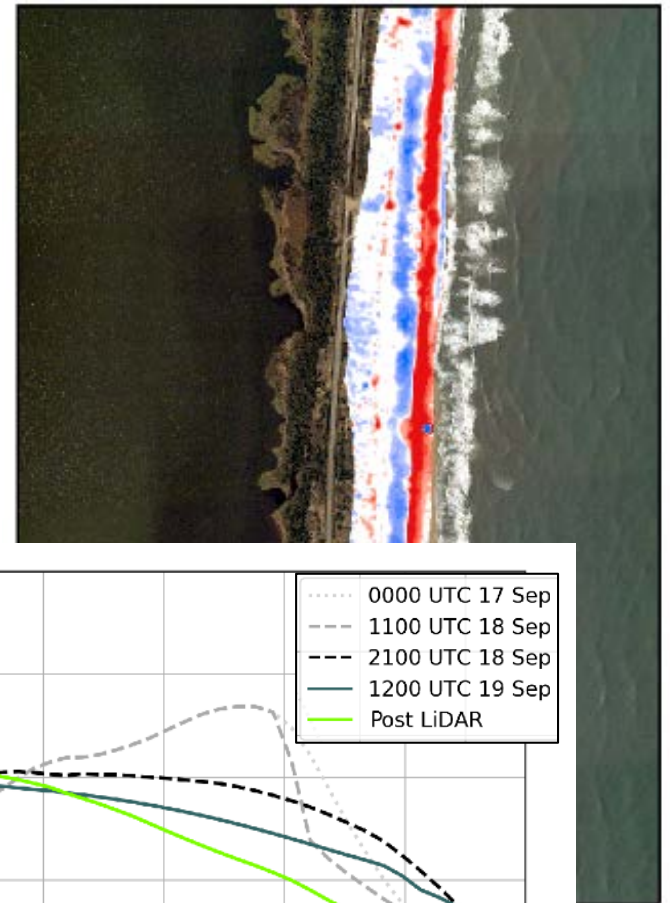
Hurricane Isabel (2003)

Survey width:

250-300 m

High resolution

LiDAR: 2m
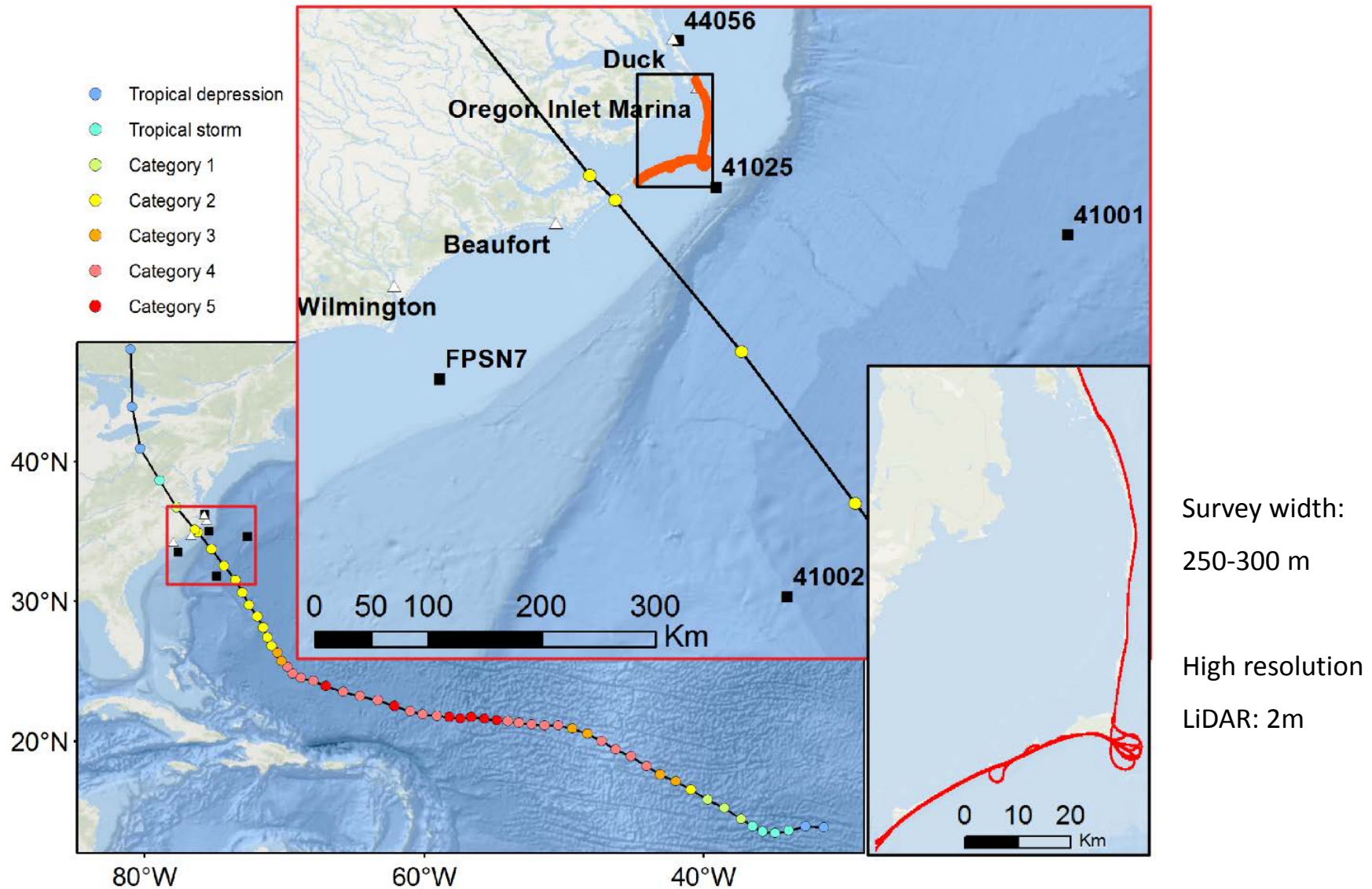
Study Area
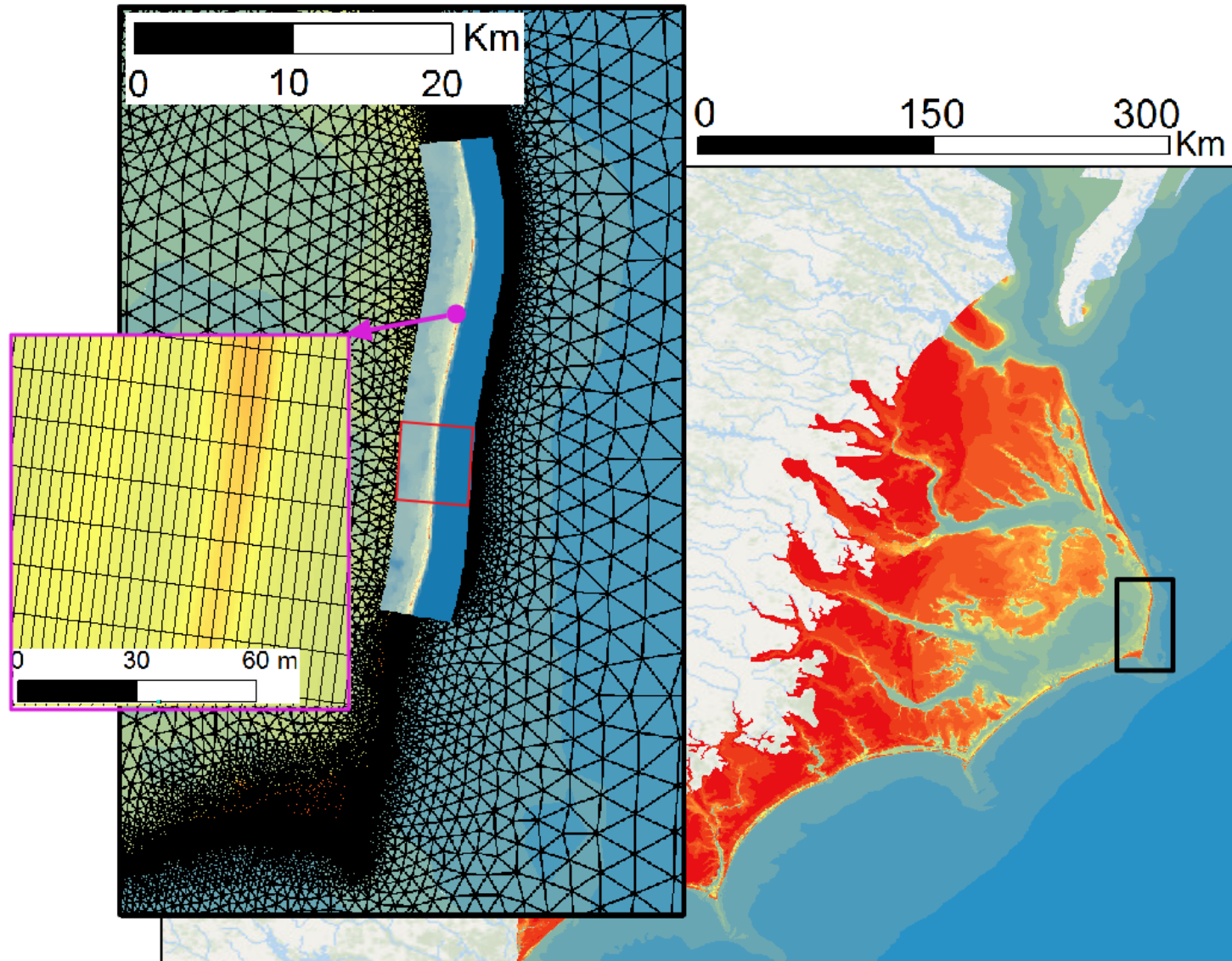
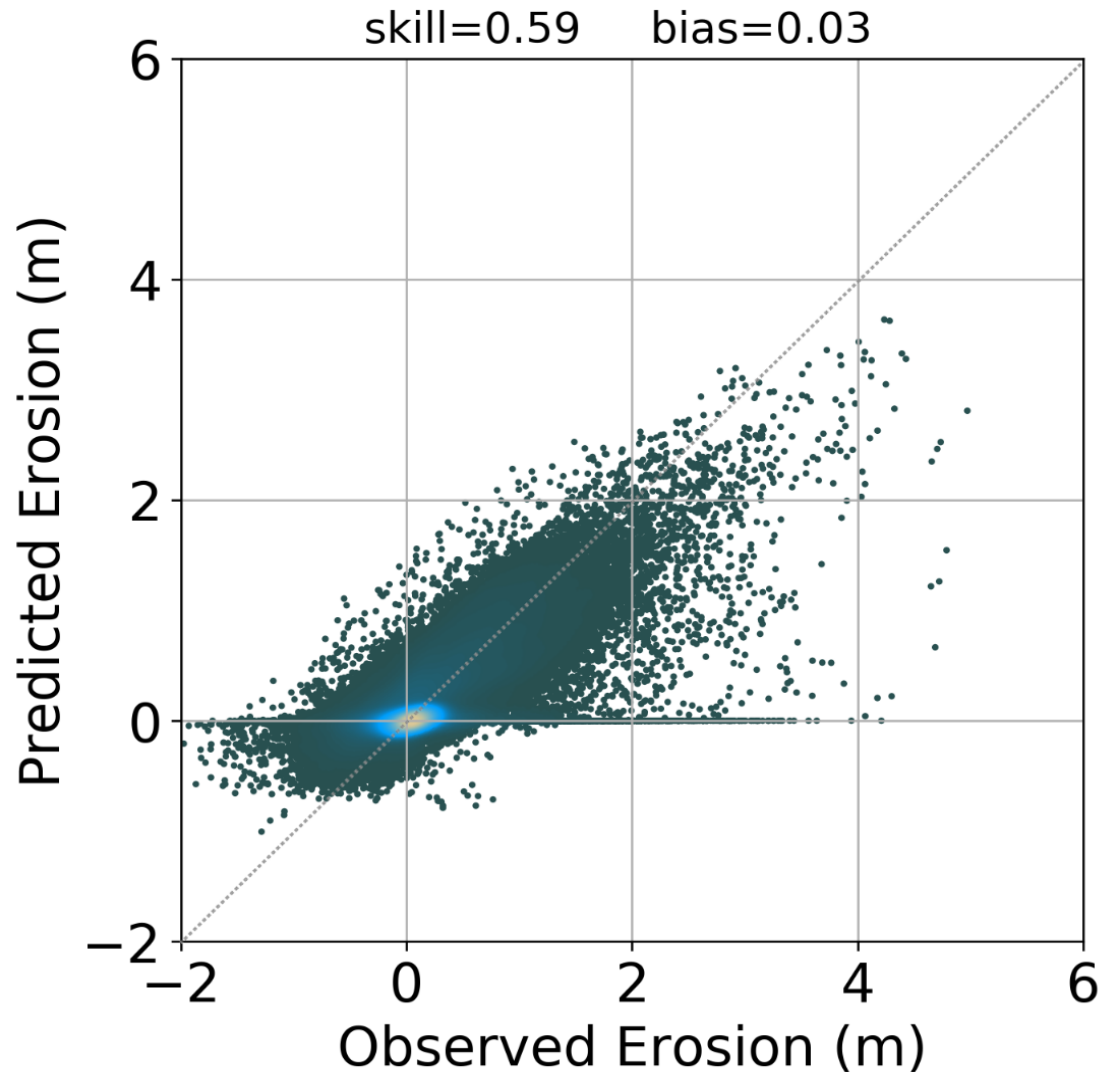# Model Prediction

Model

Observation

Model Accuracy

Skill Score

$$Skill = 1 - \frac{\sum\limits_{i=1}^{N} \left(dz_{b_{LIDAR,i}} - dz_{b_{XBeach,i}}\right)^2}{\sum\limits_{i=1}^{N} \left(dz_{b_{LIDAR,i}}\right)^2}$$
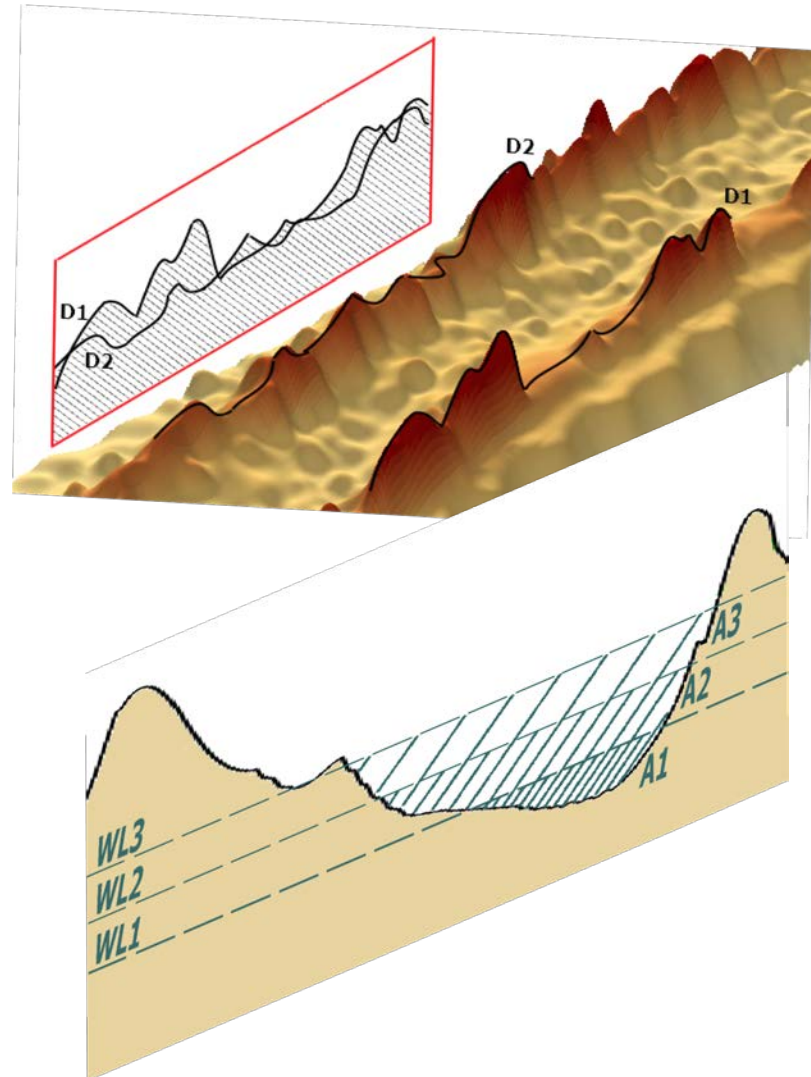
- Skill score greater than 0.5 is "Excellent"

skill=0.59   bias=0.03

Model Accuracy

**Water Overpassing Area (WOA)**

- Why WOA?
  - Dune crest will be a hydraulic control for surge from ocean to sound
  - For coupling with large-scale models
  - Focus on dune crest
- Represents the amount of water that overtops the dune crest
- Area between dune crest and water level
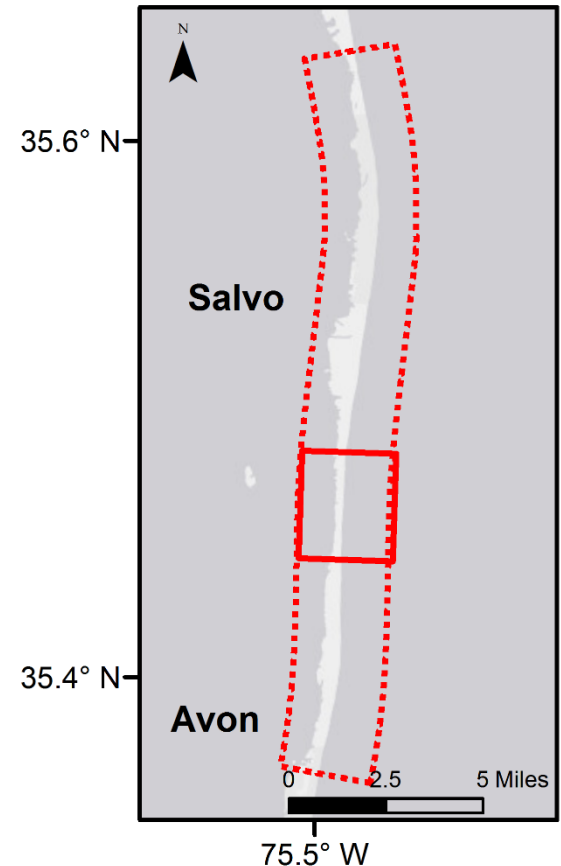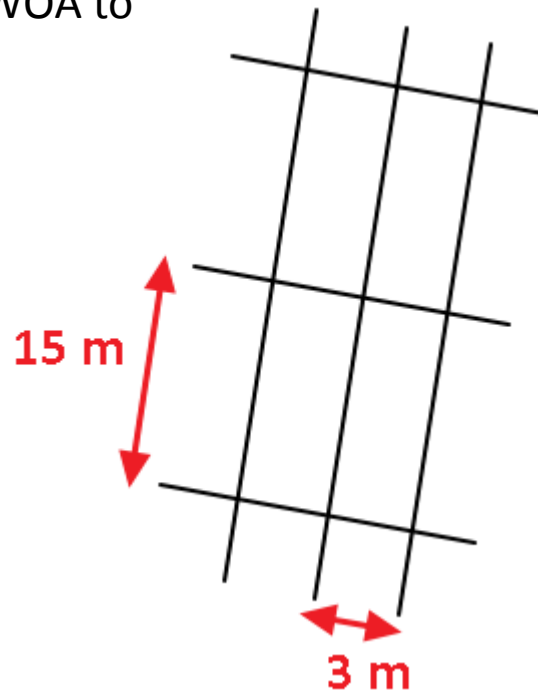
Model Accuracy

Water Overpassing Area (WOA)

- Represents the amount of water that overtops the dune crest

- Model WOA close to post storm

- Useful metric to estimate the flooding

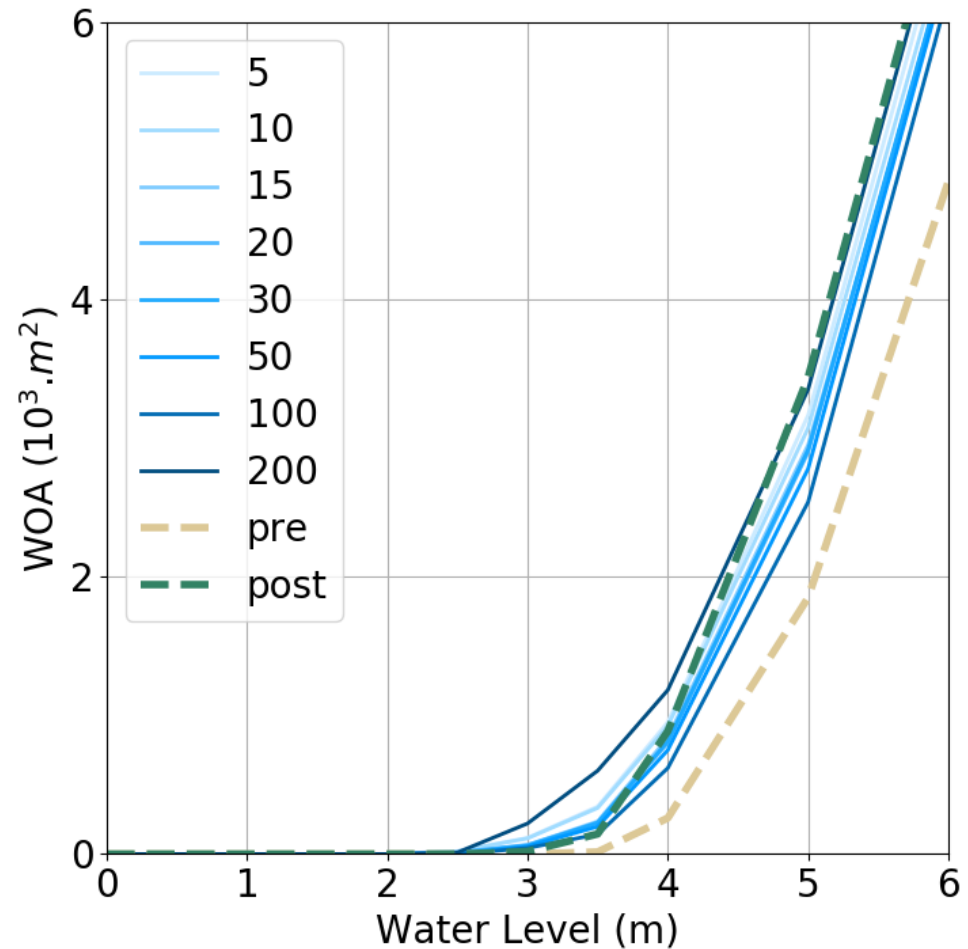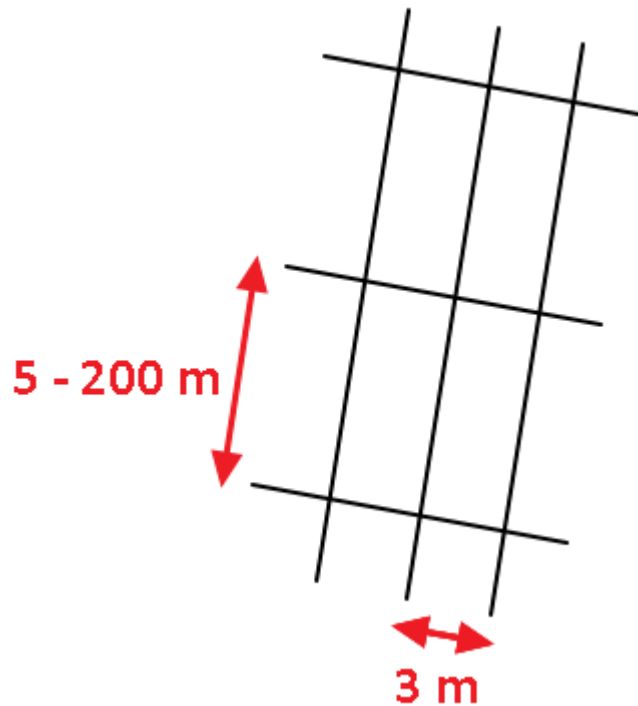- Can be used for coupling with large scale model
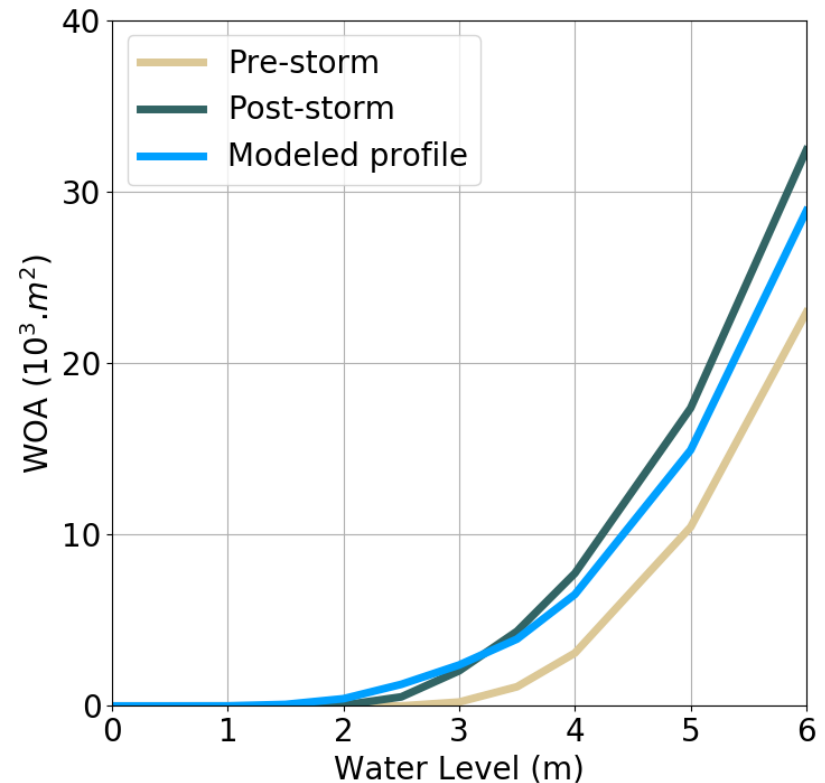
Mesh Resolution Sensitivity

- 4 km sub-domain

- Changing mesh spacing

  - Alongshore

  - Cross-shore
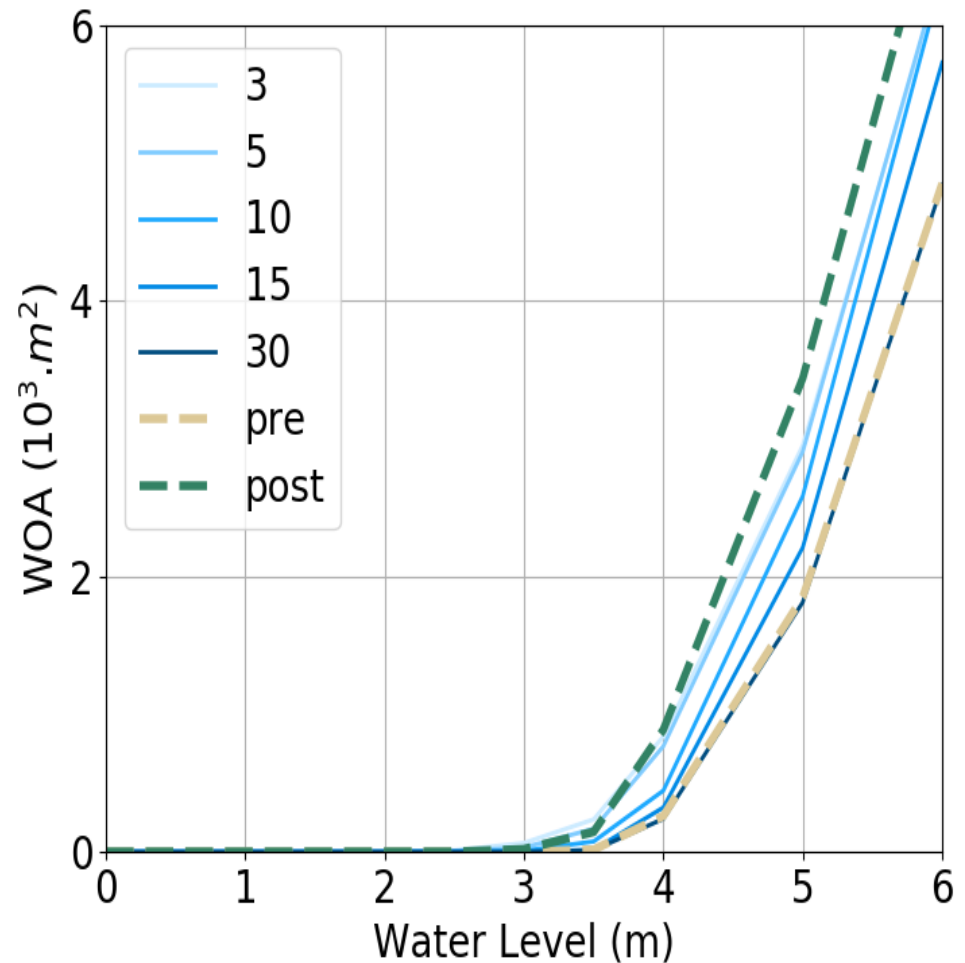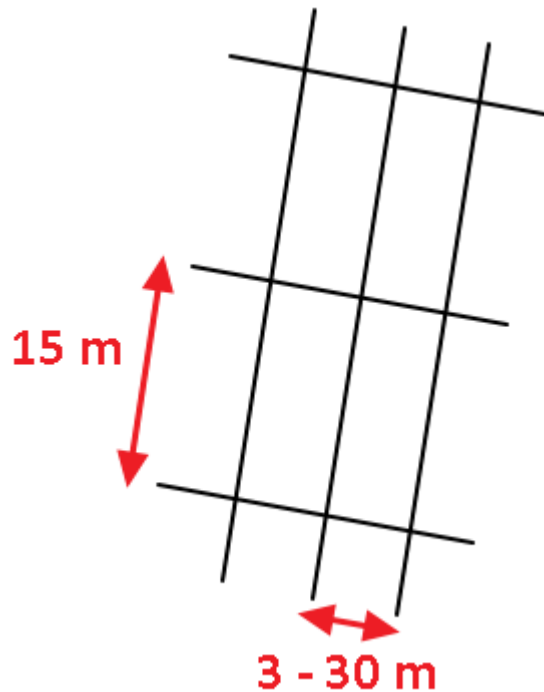
- Sensitivity of Skill and WOA to resolution

Mesh Resolution Sensitivity

- Alongshore spacing

Mesh Resolution Sensitivity

- Cross-shore spacing

Conclusion and Future Work

1. XBeach performance:

- Model performance on 30 km domain is very encouraging
  - Excellent Skill
  - Beach profile, Erosion events, flooding extents match post-storm observation
  - Predicted WOA close to post-storm condition

2. XBeach mesh resolution:

- Skill score is not sensitive to alongshore mesh spacing

- WOA slightly changes with increase in alongshore spacing

- Skill score and WOA gets worse as the cross-shore mesh resolution increases

Future Work

- Expanding the mesh to include more complex morphodynamics (breach)

- ADCIRC mesh resolution requirements and coupling the models

Questions?