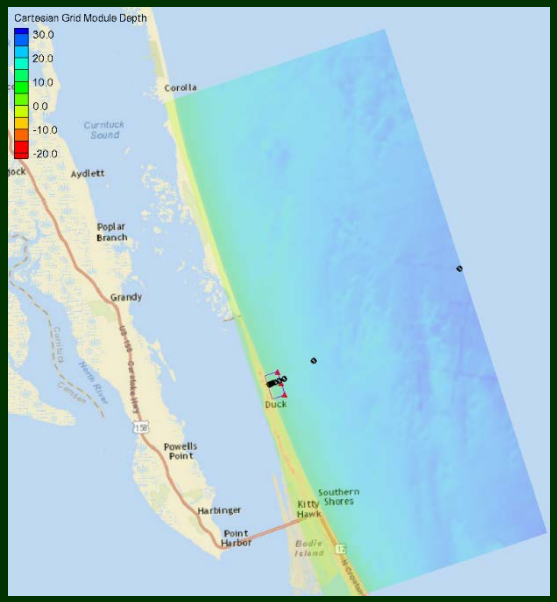
Analysis of Wave Predictions from the Coastal Model Test Bed using cBathy



Spicer Bak, Ty Hesser, Jane Smith

U.S. Army Engineer Research & Development Center

Duck, NC

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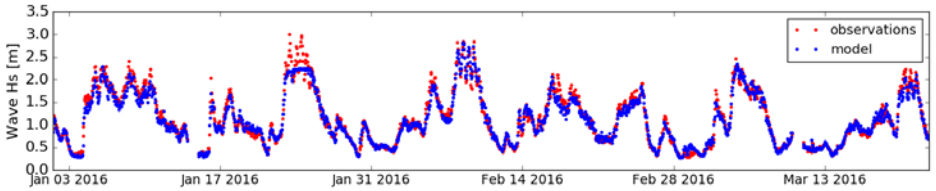
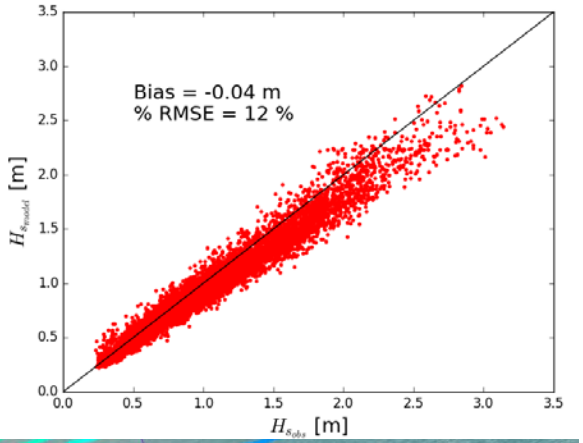
Coastal Model Test Bed

Purpose:

Automated evaluation of coastal numerical models in near real-time utilizing ERDC CHL Field Research Facility data to:

- Assess model parameterizations in range of conditions
- Identify poorly resolved model physics
- Evaluate model uncertainties
- Provide framework to develop data assimilation techniques in the nearshore





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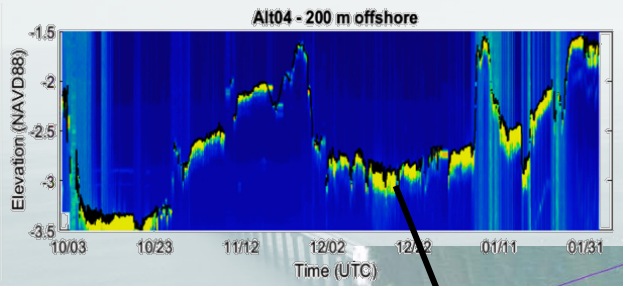
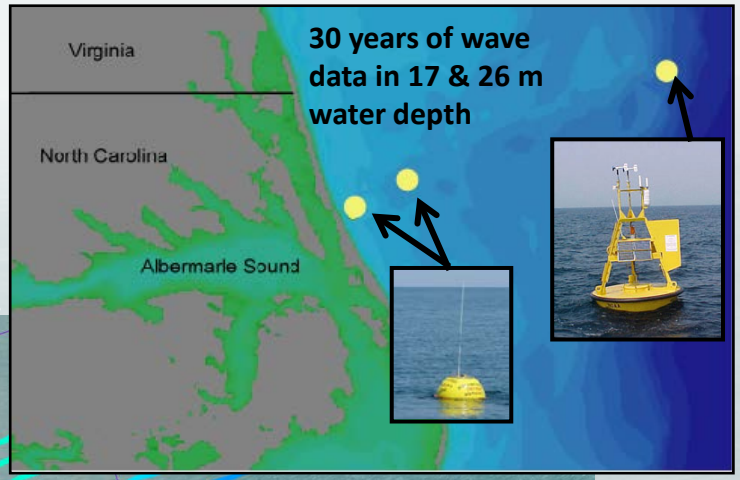
FRF Data

1 year continuous altimeter seafloor elevation data
- **150, 200, 300 m (red circles)**
- **2 new arrays of 5 altimeters (orange circles)**

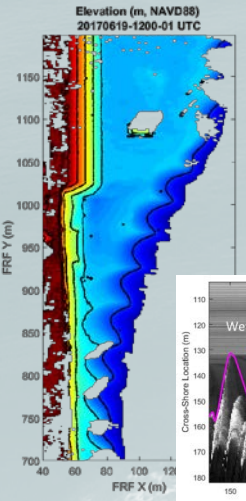


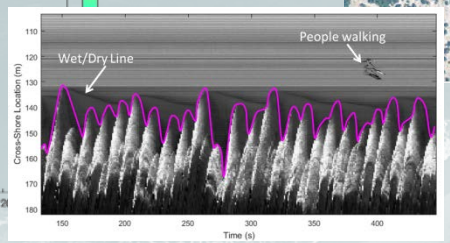


FRF XShore Wave and Current Array in operation since July 2008

- **Directional waves and currents in 26, 17, 11, 8, 6, 4.5, & 3.5 m depth**
- **Non-directional waves at 100, 125, 150, 200 m cross-shore**
- **8 m pressure gauge array**

2 years continuous lidar:
- **beach topography, wave runup, inner-surf waves**



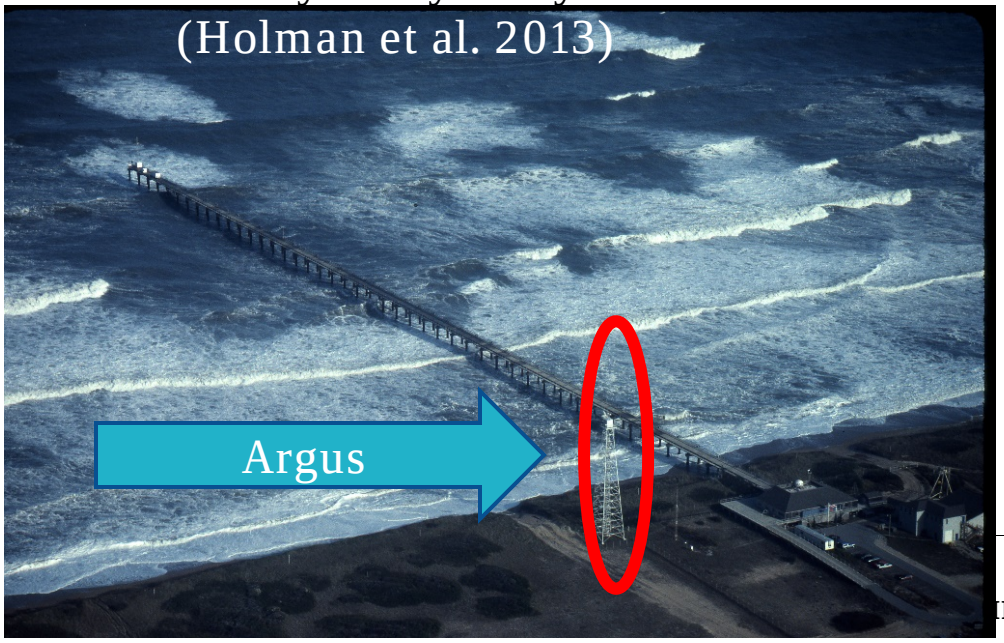


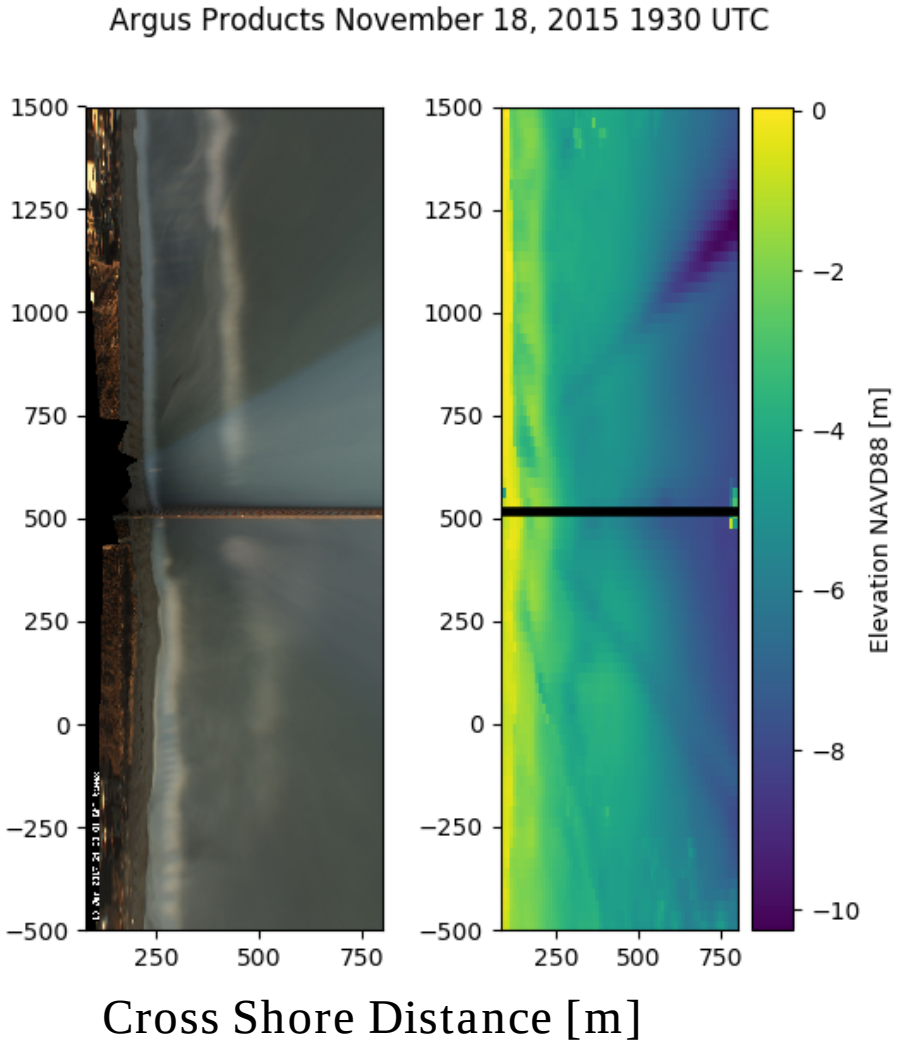
30+ years of monthly bathymetric surveys

30 years of Argus video imagery
- **Wave runup**
- **surface currents**
- **bathymetry inversion**
- **Sandbar placement**

Argus Tower & cBathy

- Tower mounted camera system
  - 6 cameras
  - Georectified and stitched imagery
- Provides:
  - Proxy for sandbar position
  - Shoreline and wave runup measurements
  - Ocean surface currents
  - cBathy bathymetry inversions (Holman et al. 2013)





Motivation and Question

- Bathymetry data are expensive to collect & often out of date
- Remotely sensed data are cheaper, more expansive (temporal and spatial)
  - Higher error
  - More data at lower cost!

Question: What scales of errors in wave height predicitions are introduced when modeling over remotely sensed bathymetry?

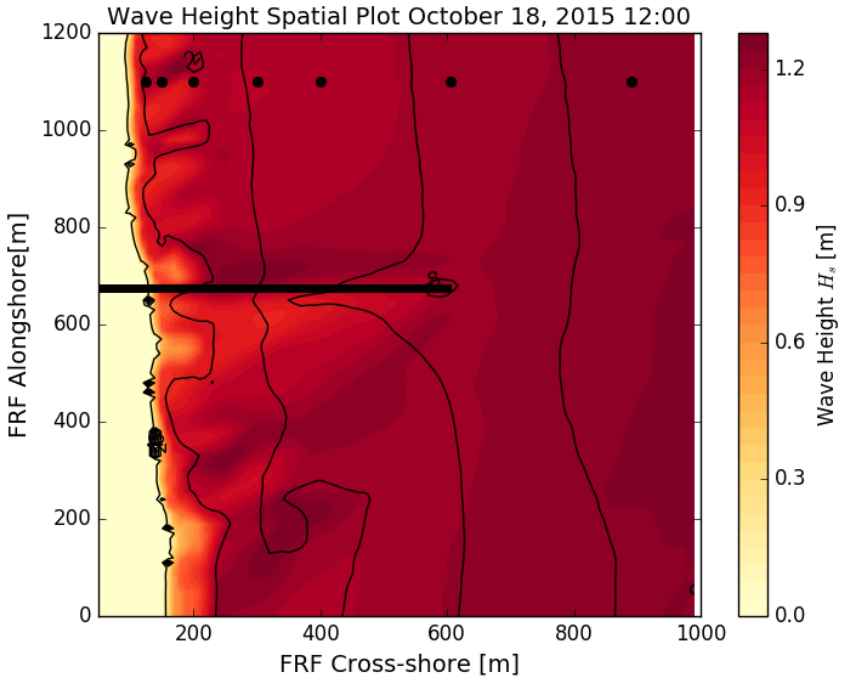
Approach

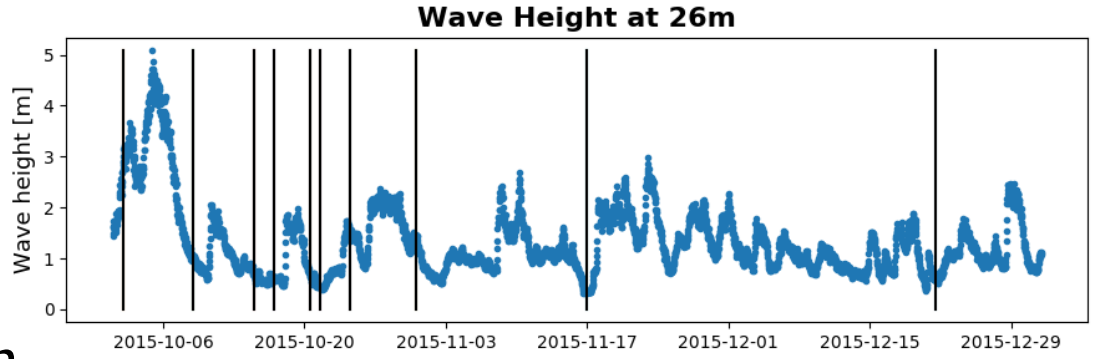
- Evaluate performance of STWAVE over:
  - Static surveyed bathymetry – December 2013 **(Static)**
  - Up-to-date surveyed bathymetry **(Updated)**
  - Half-hourly Kalman-filtered cBathy bathymetry **(cBathy)**

- October 2015 – December 2015
  - Joaq'easter

Methodology

- STWAVE
  - Phased averaged nearshore spectral wave model
- Parent Domain 38.5 x 17 km:
  - 50-m parent cell
- Nested 1.4 x 1 km
  - 10-m nearshore cell
- Automatic bathymetry update (as available)
- Forced from FRF's 26-m Waverider measurements





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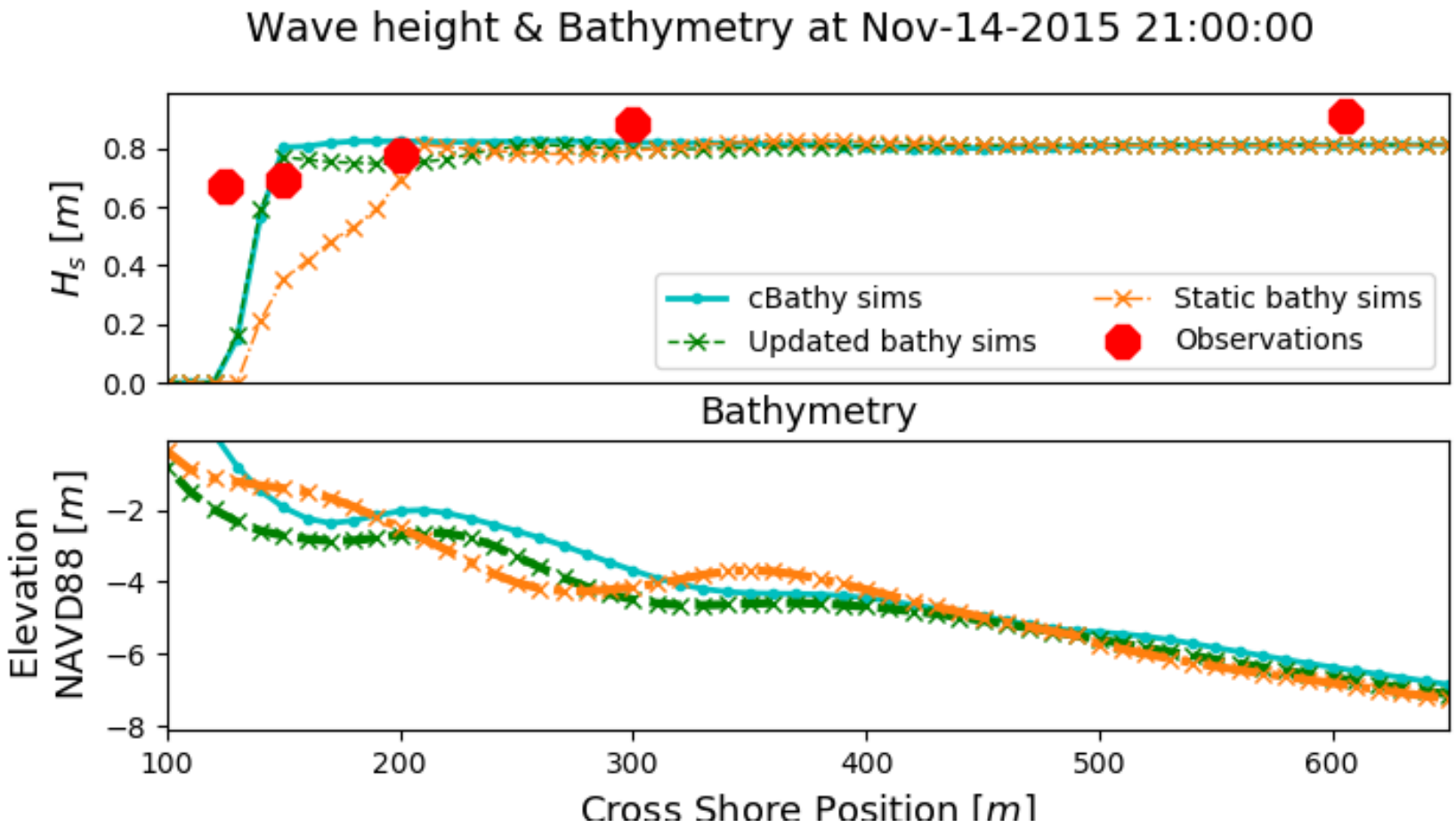
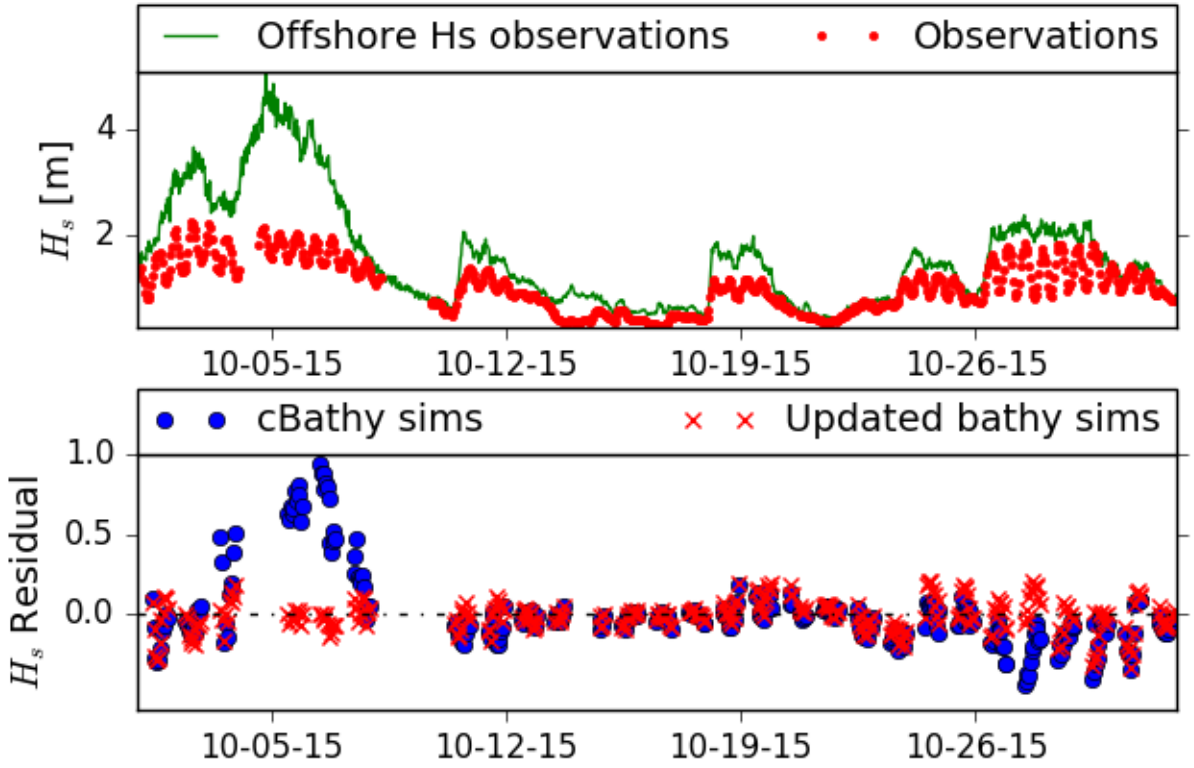
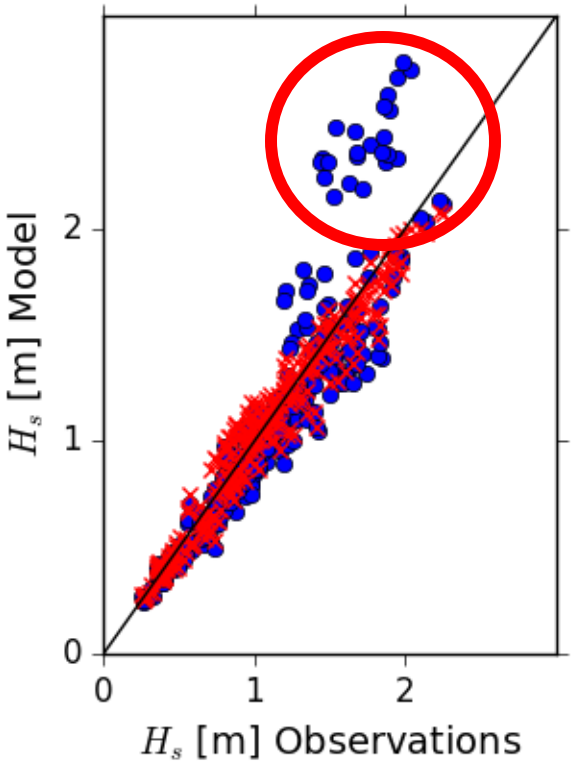
cBathy is shown to have some skill



Wave prediction residuals on the sandbar





- During **small waves**, cBathy simulations and surveyed simulations have **similar errors**
- During **large waves**, cBathy simulations have **large errors**

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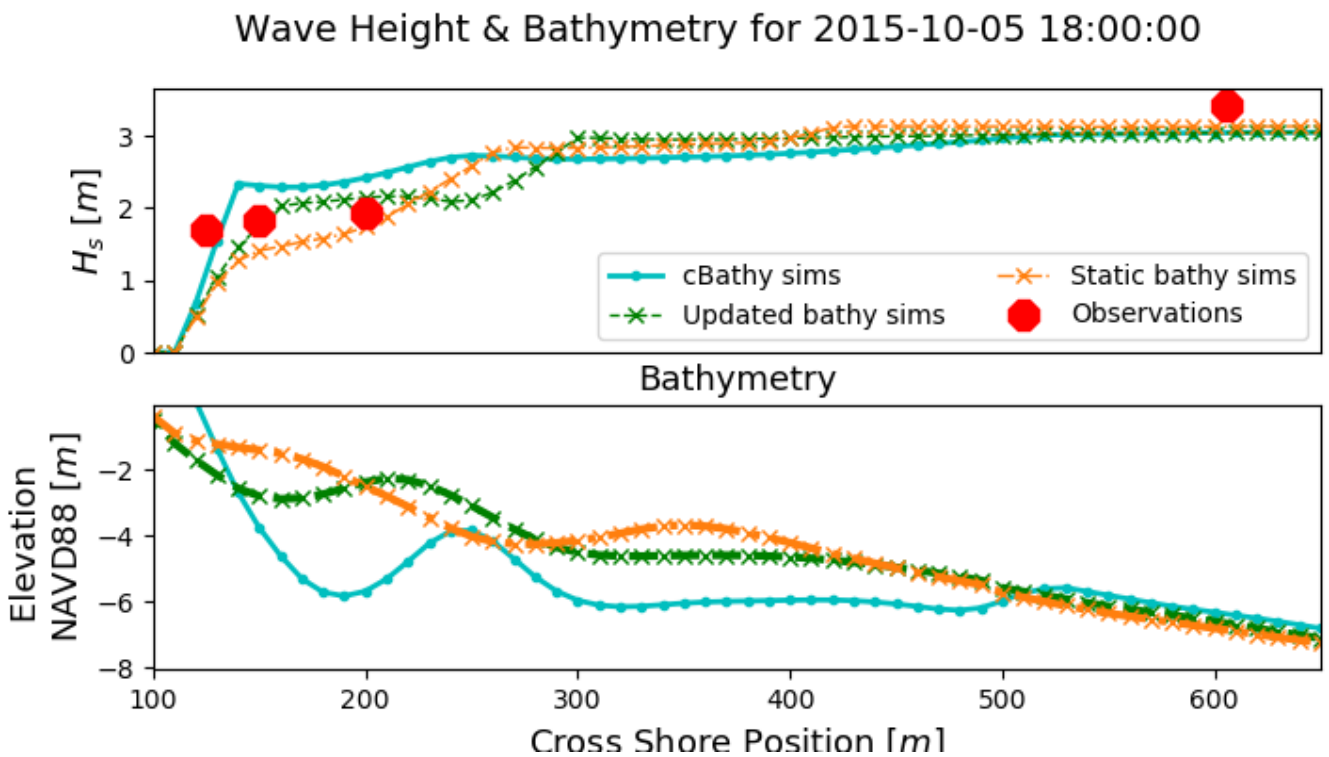
cBathy's over predictions



- cBathy Performs poorly in large breaking waves *(Brodie et al 2017 in review)*
  - Onshore bias to sandbar
  - Deep troughs inside the sandbar

Remove cBathy when wave heights > 1.2 m

- ~wave breaking

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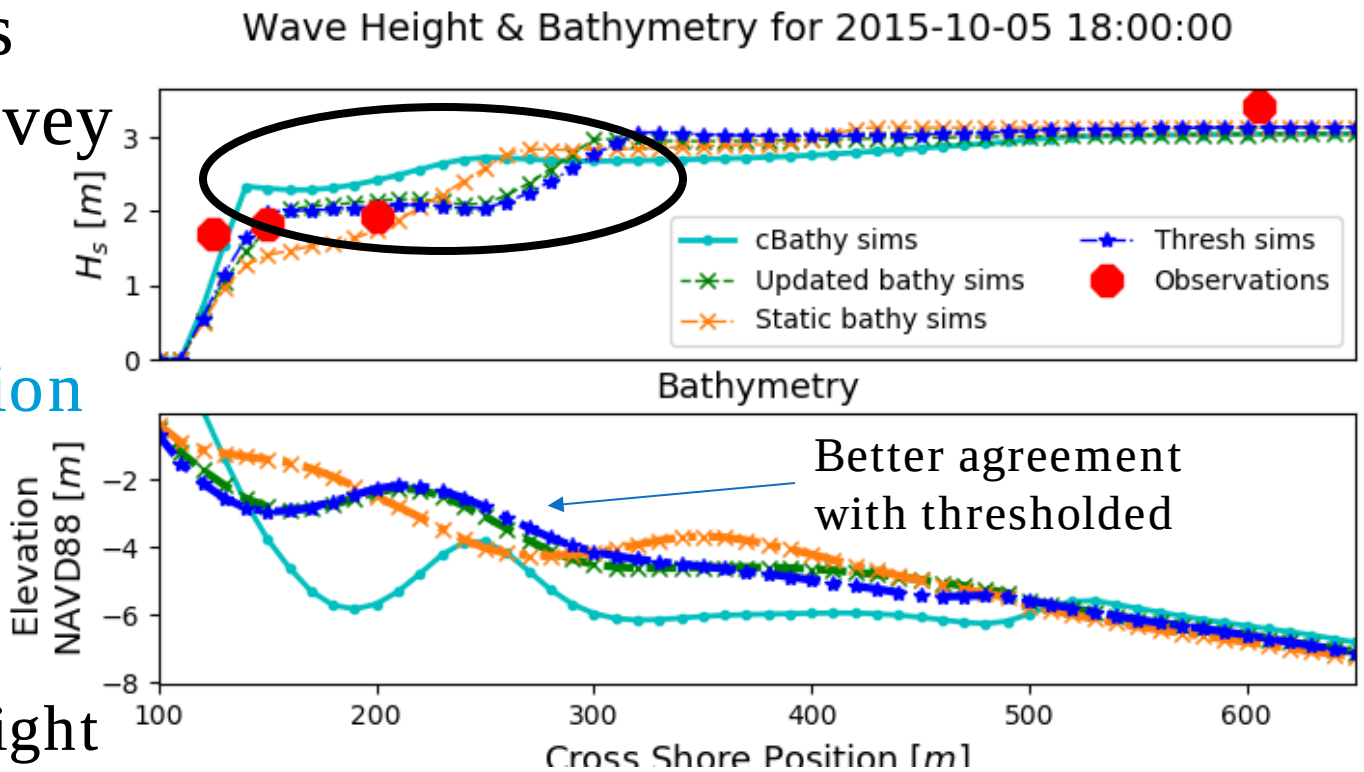
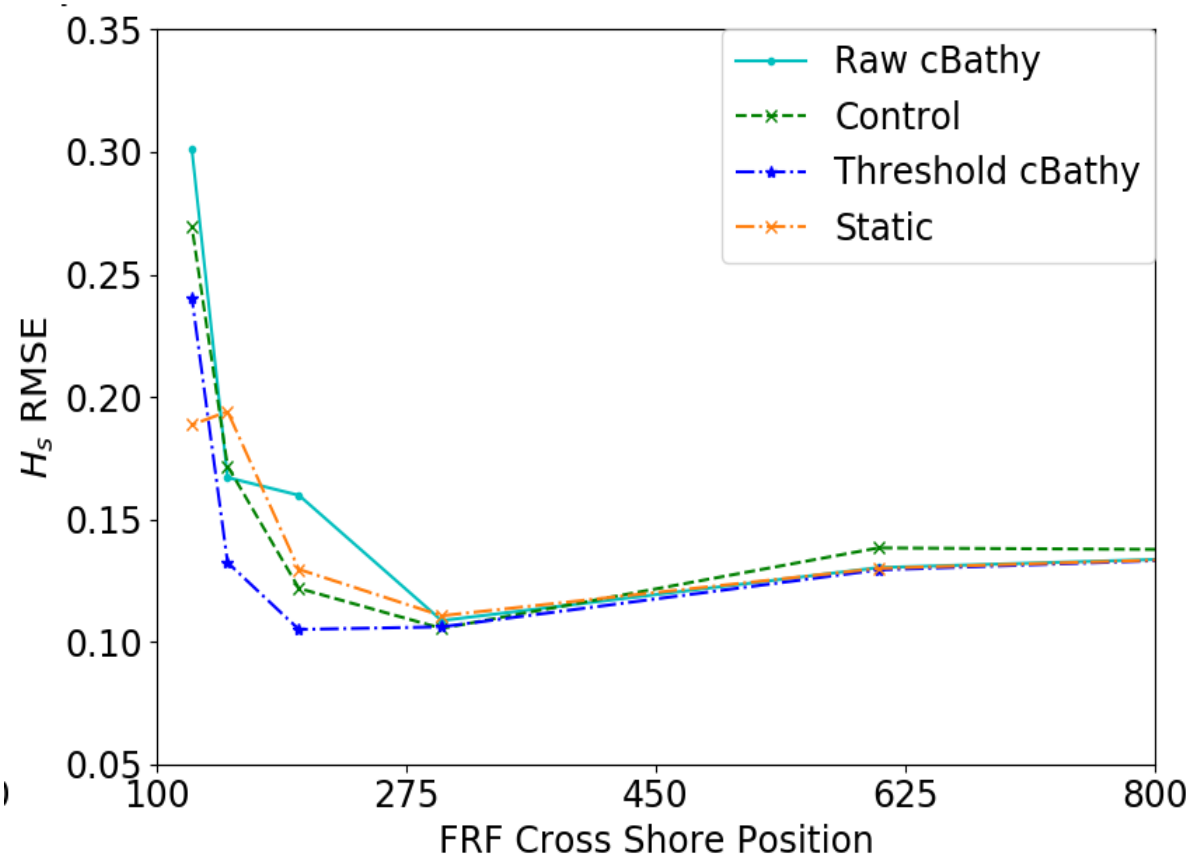
Fixed!

- Thresholded bathymetry is similar to survey
  - Removes overestimation of depths
- Brings wave height predictions closer to measured values



Summary of Statistics in the Cross-shore

- Simulations using cBathy bathymetry show some skill
  - no prior knowledge of bathymetry
- Large Raw cBathy RMSE inside the surfzone
  - Reduced with Threshold applied



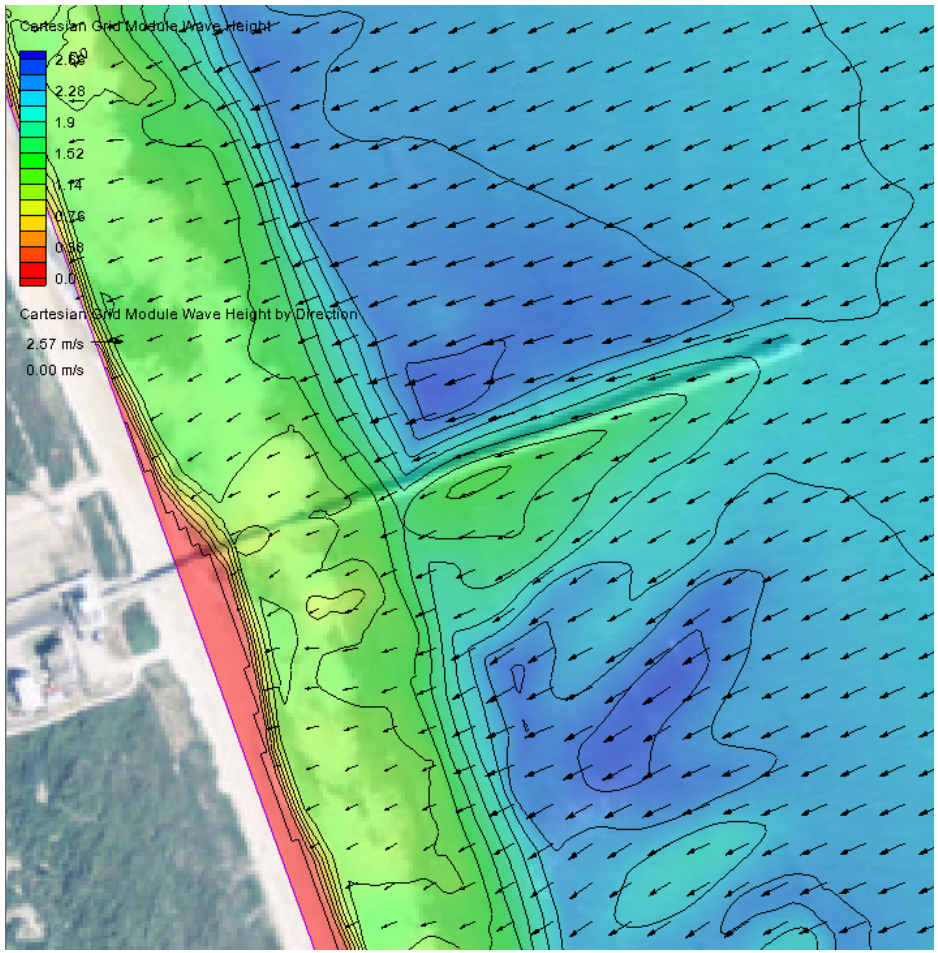
Raw cBathy

Static measured bathymetry

Updated measured bathymetry

Thresholded Kalman Filtered cBathy

Conclusions



- Simulations using KF cBathy are shown to have some skill
- During large events cBathy's depth promotes over estimates of wave height in the near shore
- Errors in simulations using remotely sensed cBathy are improved when bathymetry estimates during $H_s > 1.2$ m are removed
- Operating as a part of the US Nearshore Coastal Research Program Collaboration
- *Acknowledgements: Kate Brodie, Mary Bryant, Patrick Dickhudt, Kent Hathaway, FRF field operations*

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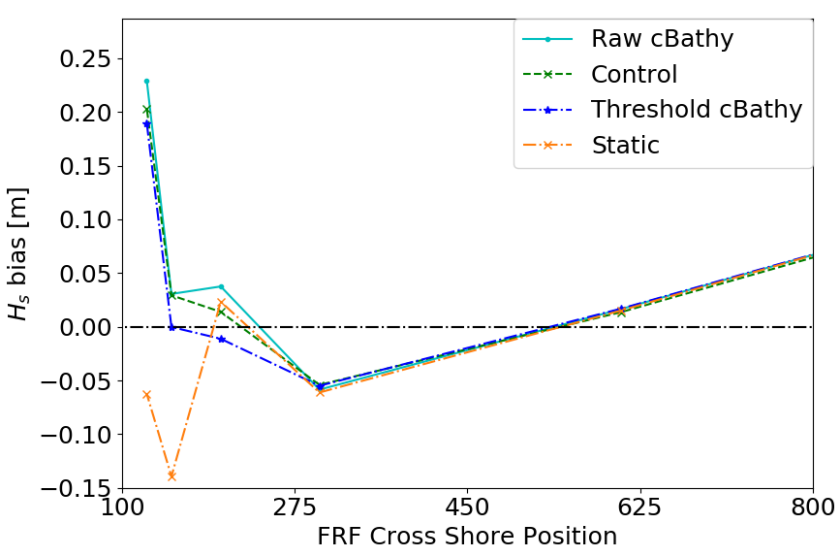
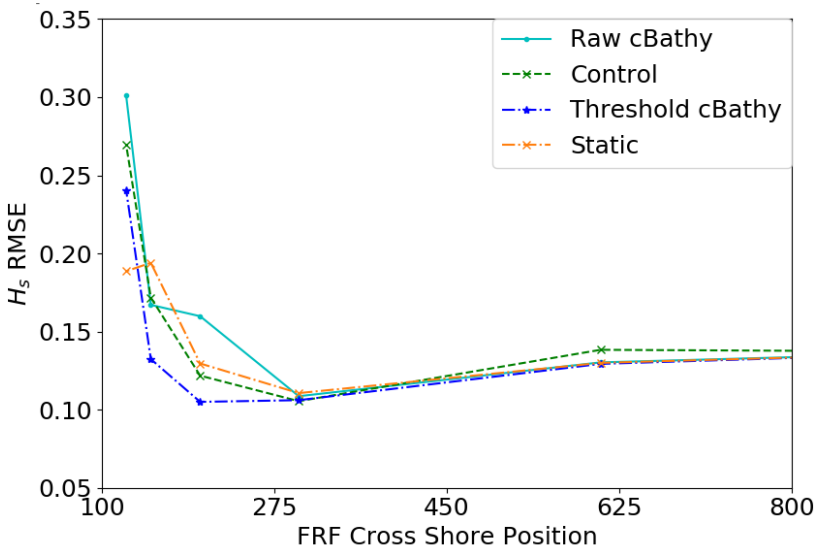
Summary of Statistics in the Cross-shore





- Comparable errors produced from remotely sensed bathymetry cBathy
  - no prior knowledge of bathymetry

- Large cBathy RMSE inside the surfzone
  - Reduced with Threshold applied

Raw cBathy

Static measured bathymetry

Updated measured bathymetry

Thresholded Kalman Filtered cBathy


Richmond
Norfolk
Virginia
Virginia Beach
North Carolina
Raleigh
Duck
FRF Property
Fire Station
Duck Road
Tower
Inner Compound
Visitor Parking
Office and Laboratory
Atlantic Ocean
Conference Room (top floor)
Machine Shop
Equipment Storage
Currituck Sound
Duck Road
N
W
E
S