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

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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
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

Nearshore Acoustic Array (3.5-11 m depth; blue circles)
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- Bathymetry data are expensive to collect & often out of date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 predictions 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
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**
cBathy’s over predictions

- cBathy Performs poorly in large breaking waves 
  \textit{(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
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
Updated measured bathymetry
Static 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

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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

Updated measured bathymetry

Static measured bathymetry

Thresholded Kalman Filtered cBathy
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