Ongoing CMS work in the Coastal Model Test Bed

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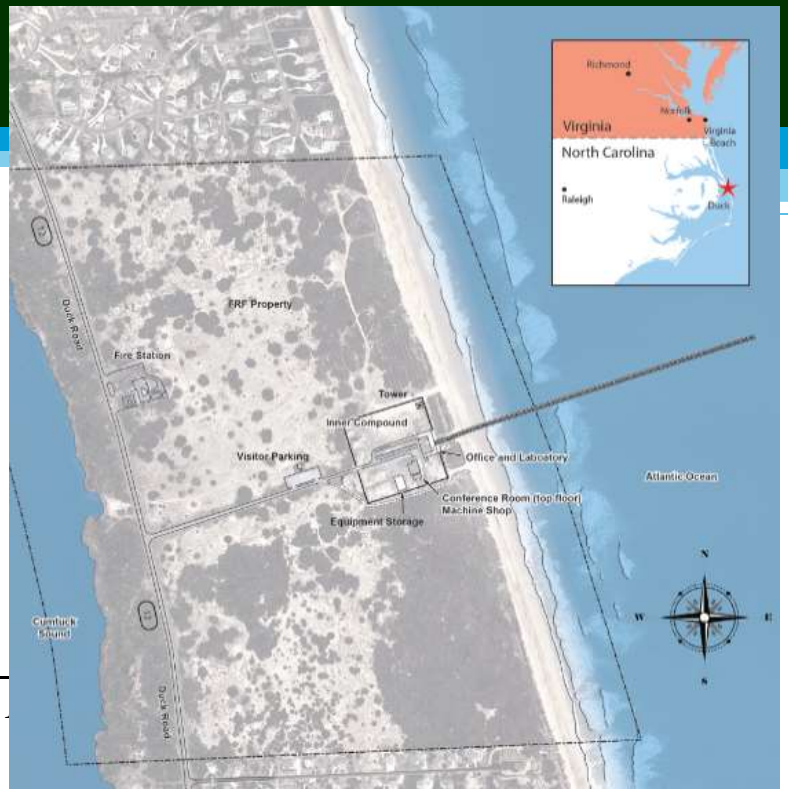
USACE CHL

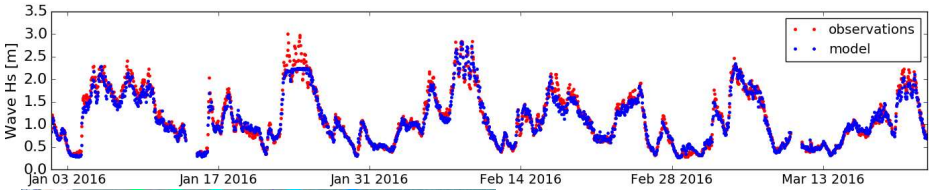


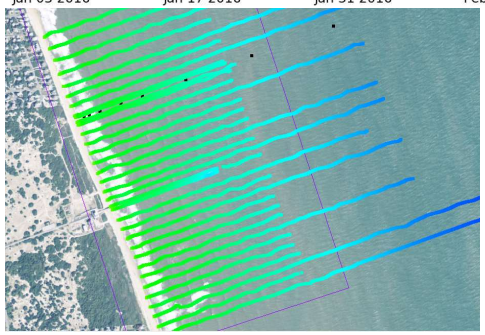
Motivation

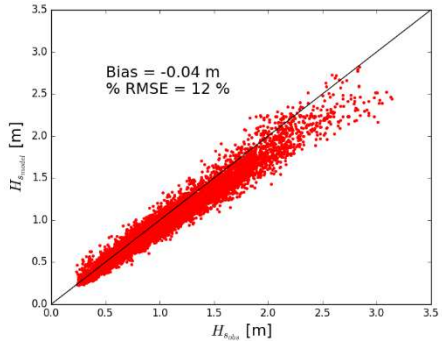
Automated evaluation of coastal numerical models in near real-time utilizing ERDC CHL Field Research Facility data to:

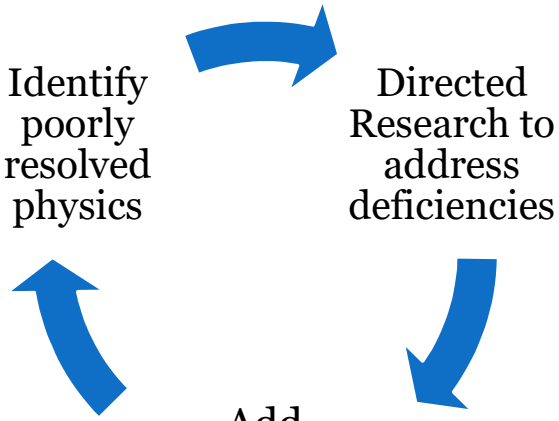
- Assess and quantify model uncertainty
- Assess model parameterizations in range of conditions
- **Targeted model development cycle**

- provide framework to develop data assimilation techniques









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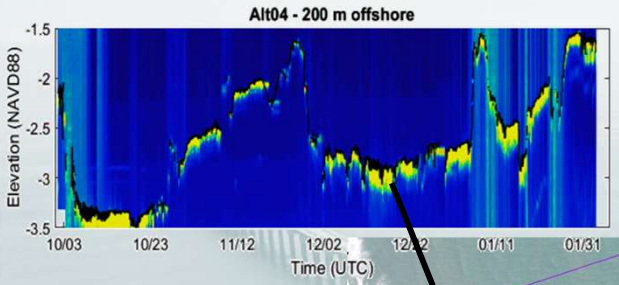
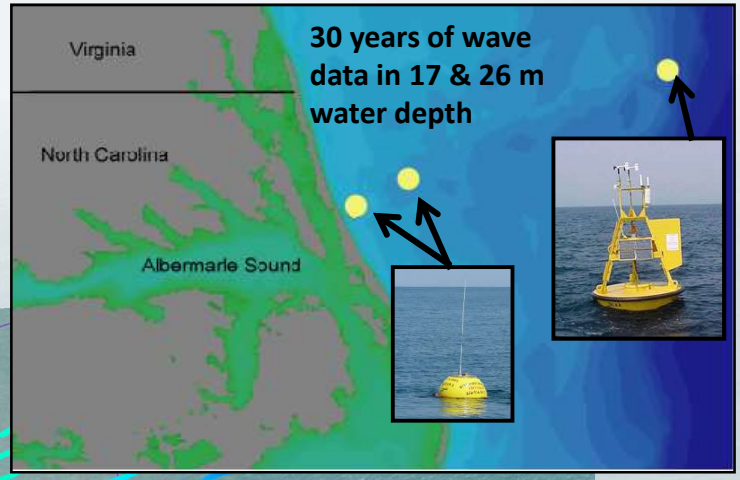
FRF Data

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



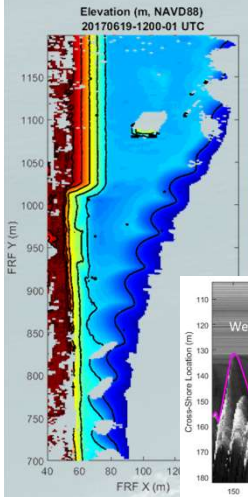


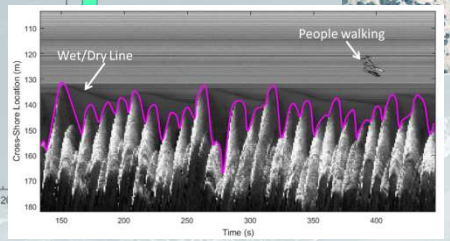
30 years of wave data in 17 & 26 m water depth

FRF XShore Wave and Current Array in operation since July 2008

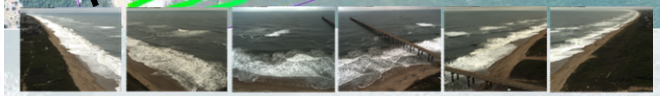
- **Directional waves and currents in 26, 17, 11, 8, 6, 4.5, & 3.5 m depth**
- **Non-directional waves at 100, 125, 150, 200 m cross-shore**
- **8 m pressure gauge array**

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





Nearshore Acoustic Array (3.5-11 m depth; blue circles)



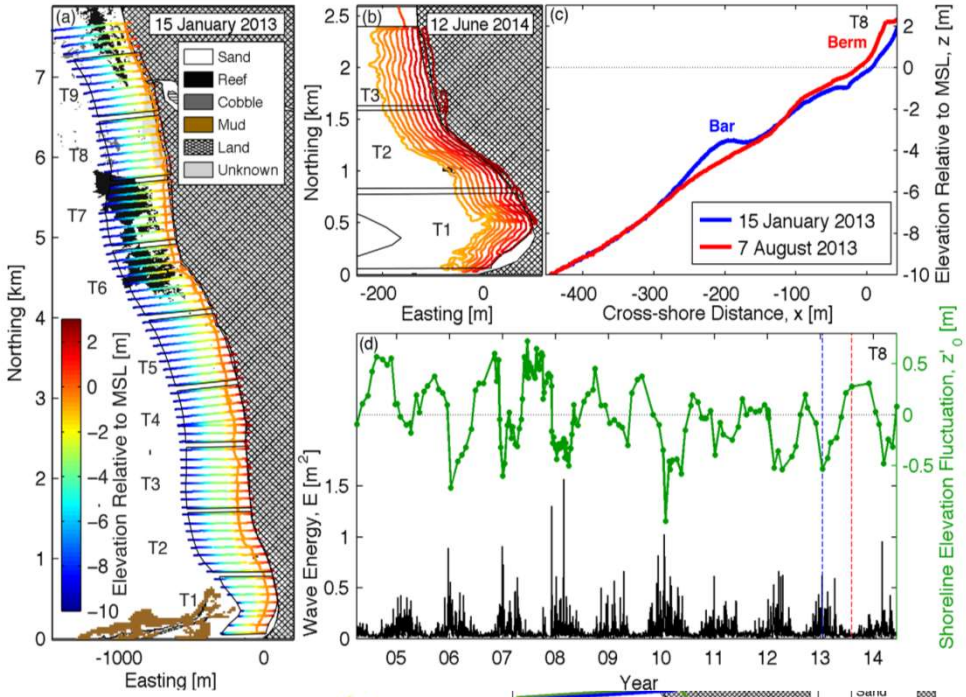
30+ years of monthly bathymetric surveys

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

SCRIPPS INSTITUTE OF OCEANOGRAPHY: DATA SET EXPANSIONS

Goal: Provide curated data observational datasets to test existing models for the evolution of sandy beach profiles.

- Start with relatively simple 1D cases (cross-shore, rather than alongshore, transport is the dominant process).
- Models can be physically based or empirical/statistical.

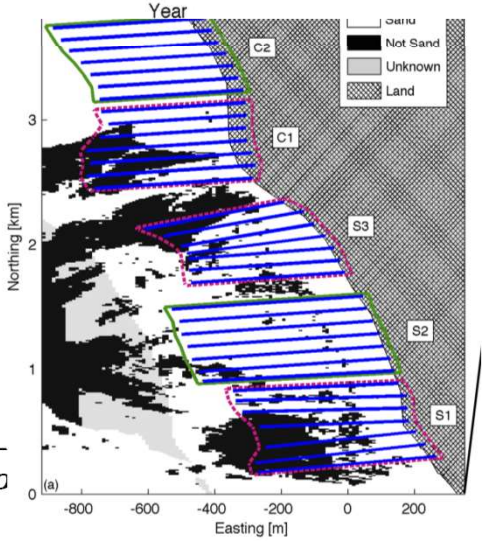


Current Status:

- Working to create database:
  Cardiff, Solana, Torrey Pines, Imperial Beach

Future Goals:

- Get CSHORE model setup and run, using SIO data
- Empirical, equilibrium-type model (Yates et al., 2009)
- Xbeach, Delft3D, Unibest
- Runup (SWASH model already setup) - lidar data (Cardiff, Agate)



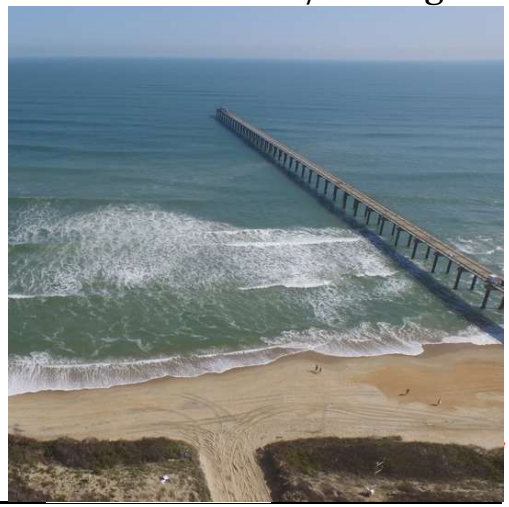
Innovative solutio

International Coastline Observatory Network

- **In-situ measurements**
  - wave gauges, water level, MET, elevations (bathy & topo)
- **Remote sensing**
  - cameras, radar, infrared, satellite, lidar
- **Centralized** modeling to compliment the observation stations
  - Multiple models
  - Hind-cast, Now-cast, (maybe/probably) forecast
  - Explore option of centralized computing capability (cloud?)

CIRN Vision

- Focus of monitoring efforts
- Multi-disciplinary scope
- Open access
- Environmentally diverse sites, parameter space
- Self-organized and funded
- open source mantra data sharing agreements
- meeting established data host/serving standards



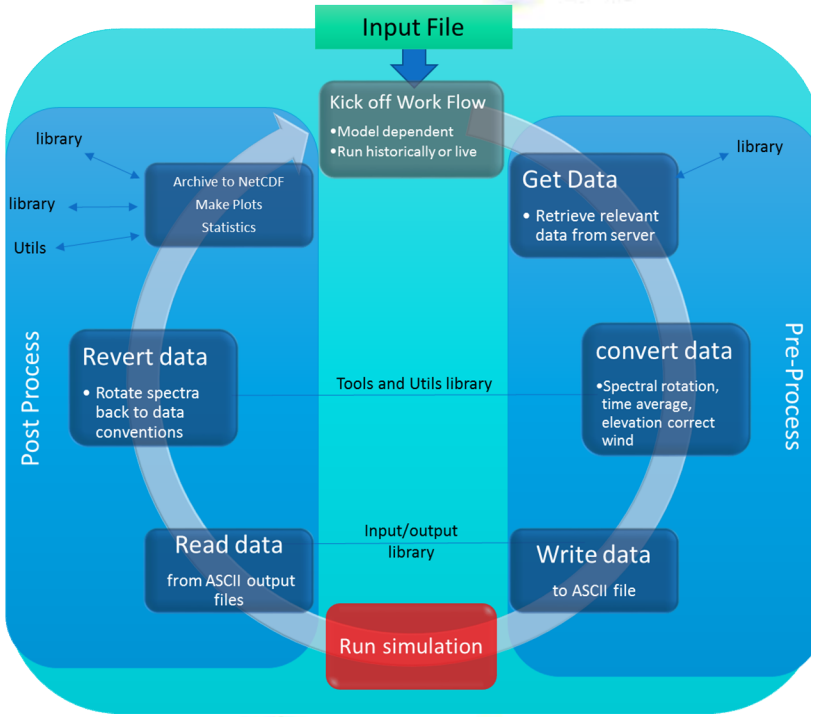
Development Status

- Modular, open-source approach
- Models Running Operationally
  - STWAVE - phase averaged wave model
  - CMS-WAVE – phase averaged wave model
  - CSHORE – 1D profile evolution Model
- Models in Development
  - SWAN – phase averaged wave model
  - WaveWatch3 – phase averaged wave model
  - Celeris – Bousinessq wave model

  - CMS-FLOW – circulation model
  - D3D FLOW – circulation model

  - Xbeach – 2D morphology model
  - C2SHORE – 2D morphology model
  - D3D MOR – 2D morphology model

- **Collaborative environment**



CMS – Wave / Flow

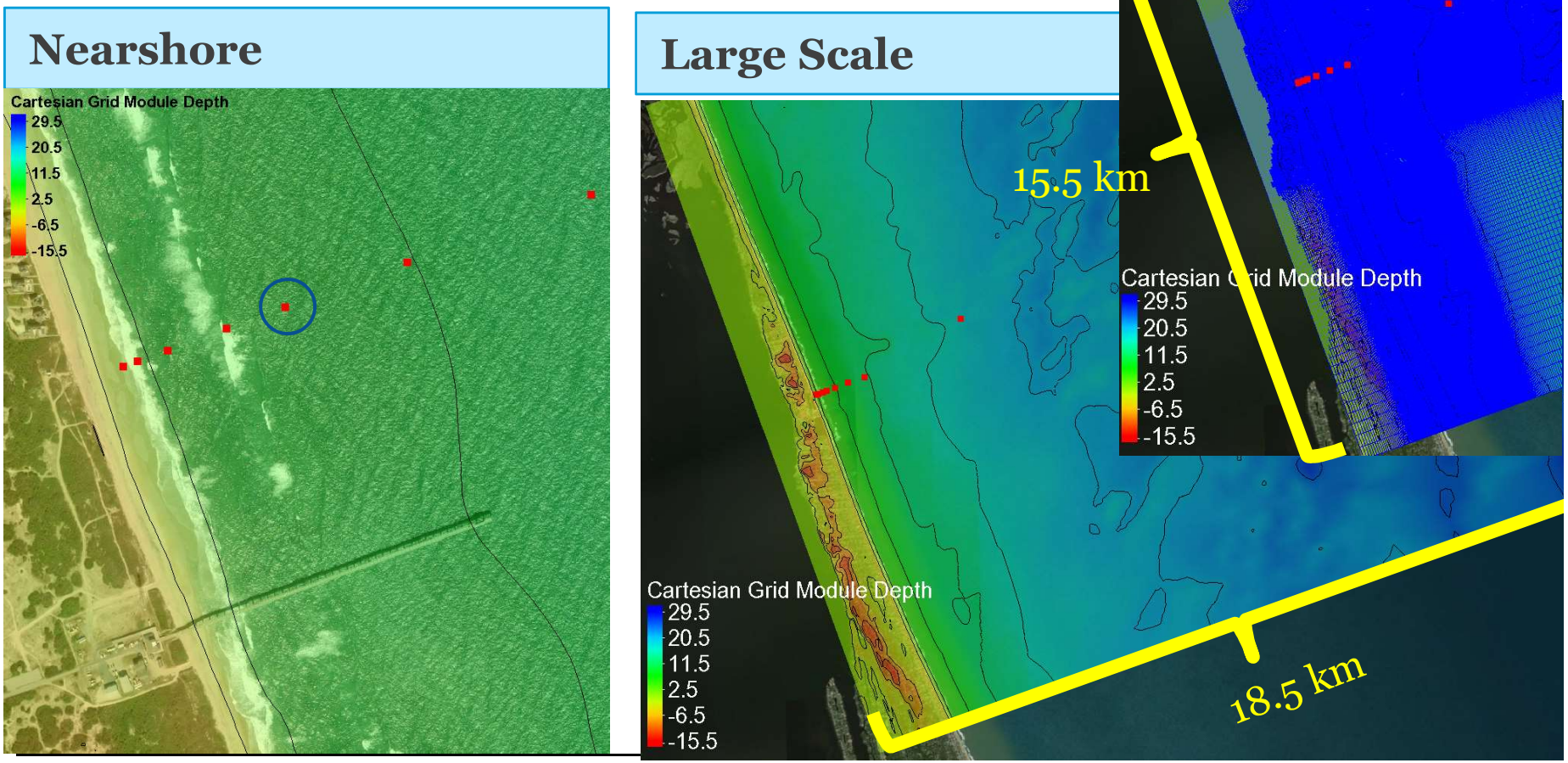
Funded by CIRP
leveraging work from CODS

Collaborators: Honghai Li, Mitch Brown, Zeki Demirbilek, Lihwa Lin

- Status:
  - CMS-wave running

- Highlights:
  - Added ASCII based input/output to CMS-Flow
  - Added Linux compatibility to source code
  - Identified and helped resolve bug fix for spectral wave model (stand alone only)

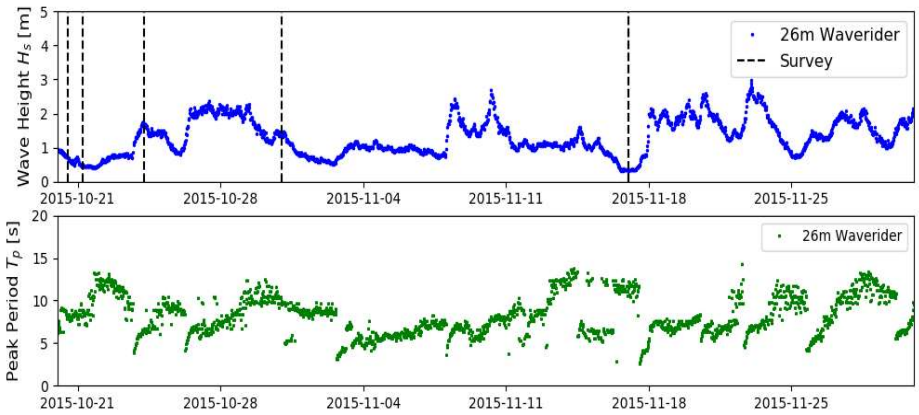
CMS-WAVE Model Grid



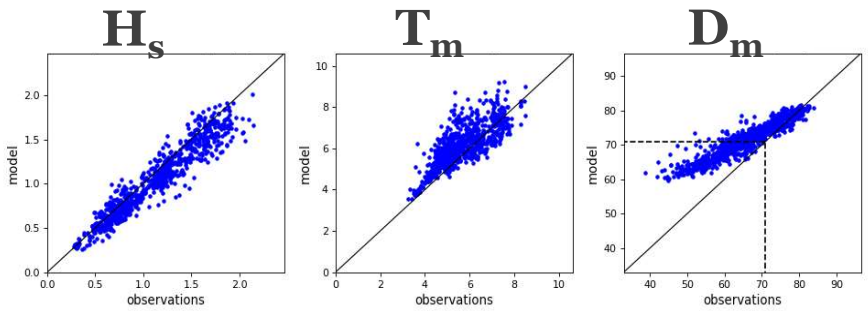
Quick Test:

- Initial evaluation period: 2 months
- Compared offshore of primary sandbar (3.5 m)
  - Under prediction of wave height during larger waves
- Large bias for directional resolution for waves approaching from the north

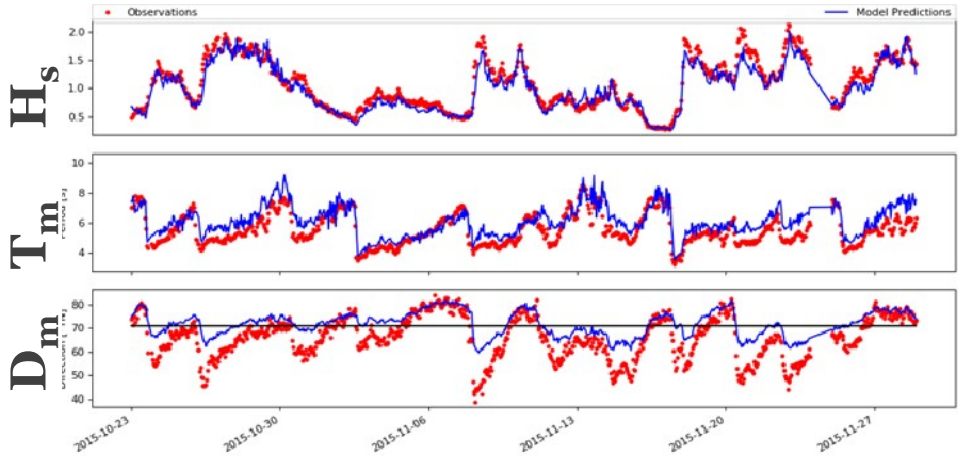
Offshore Wave Conditions



3.5 m Aquadopp comparison



	H_s	T_m	D_m
Bias	-0.08 m	0.5 s	5.7 º
RMSE	0.15 m	0.8 s	0.36 º
%RMSE	13 %	15 %	11 %



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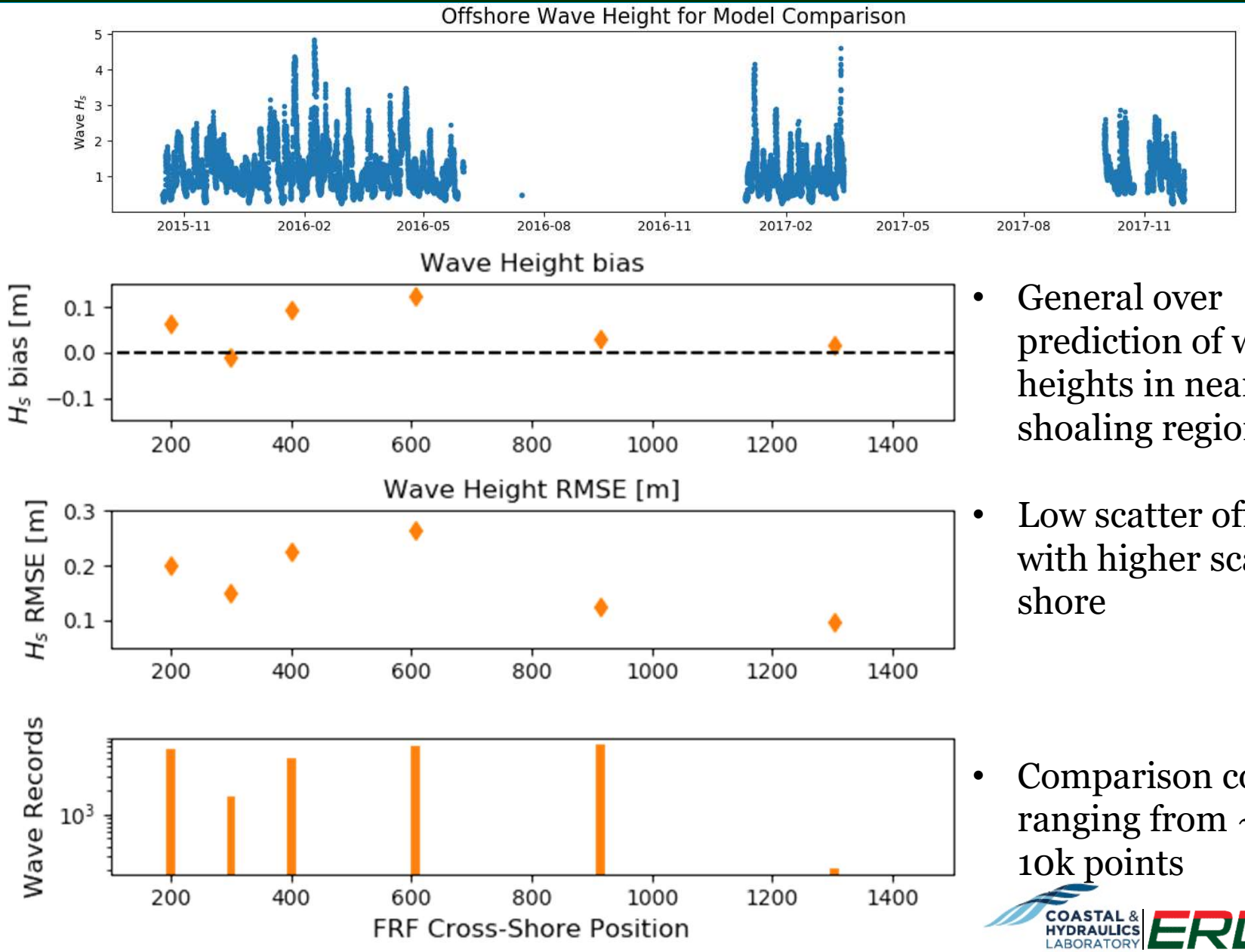

- General over prediction of wave heights in nearshore shoaling region
- Low scatter offshore with higher scatter in shore
- Comparison count ranging from ~400 to 10k points

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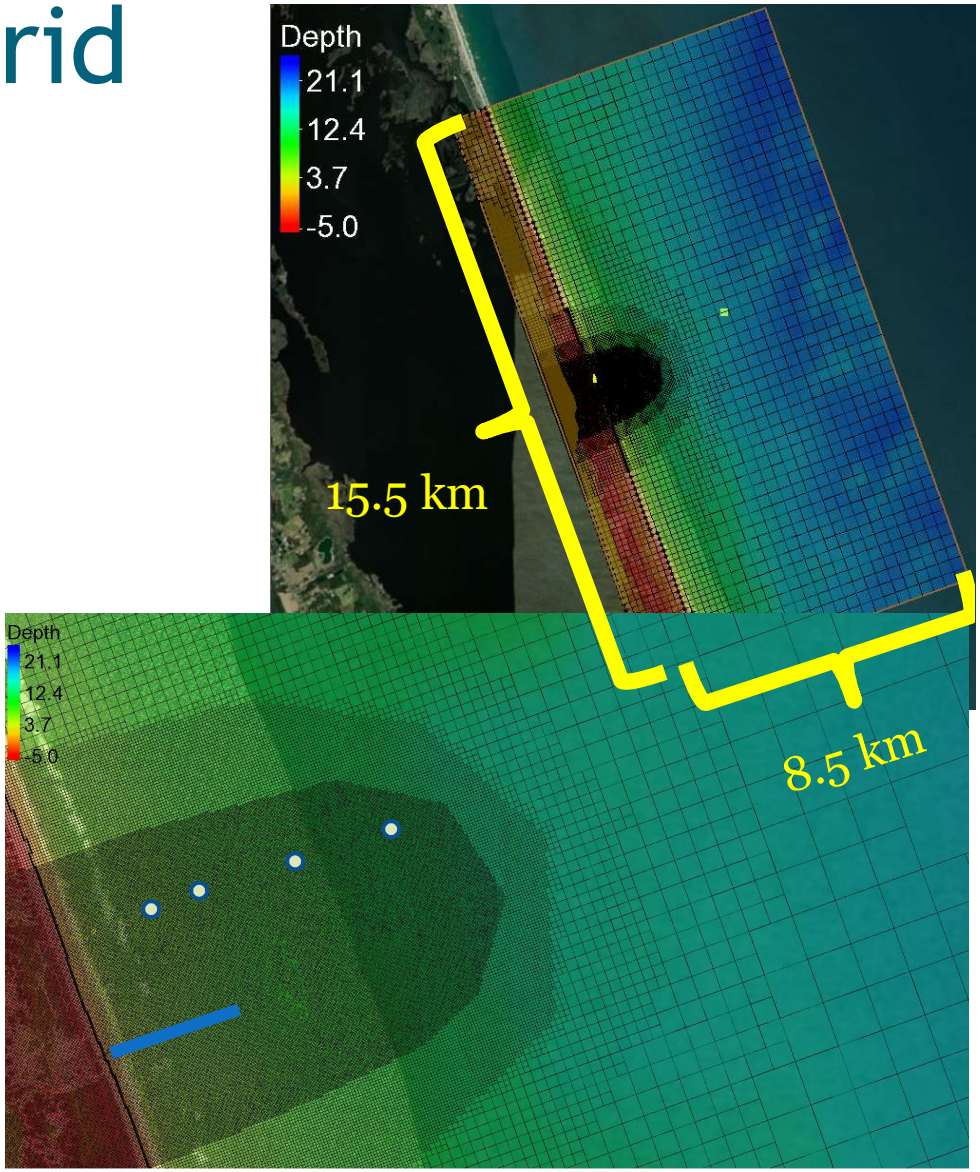
CMS-Flow Model grid

Model setup

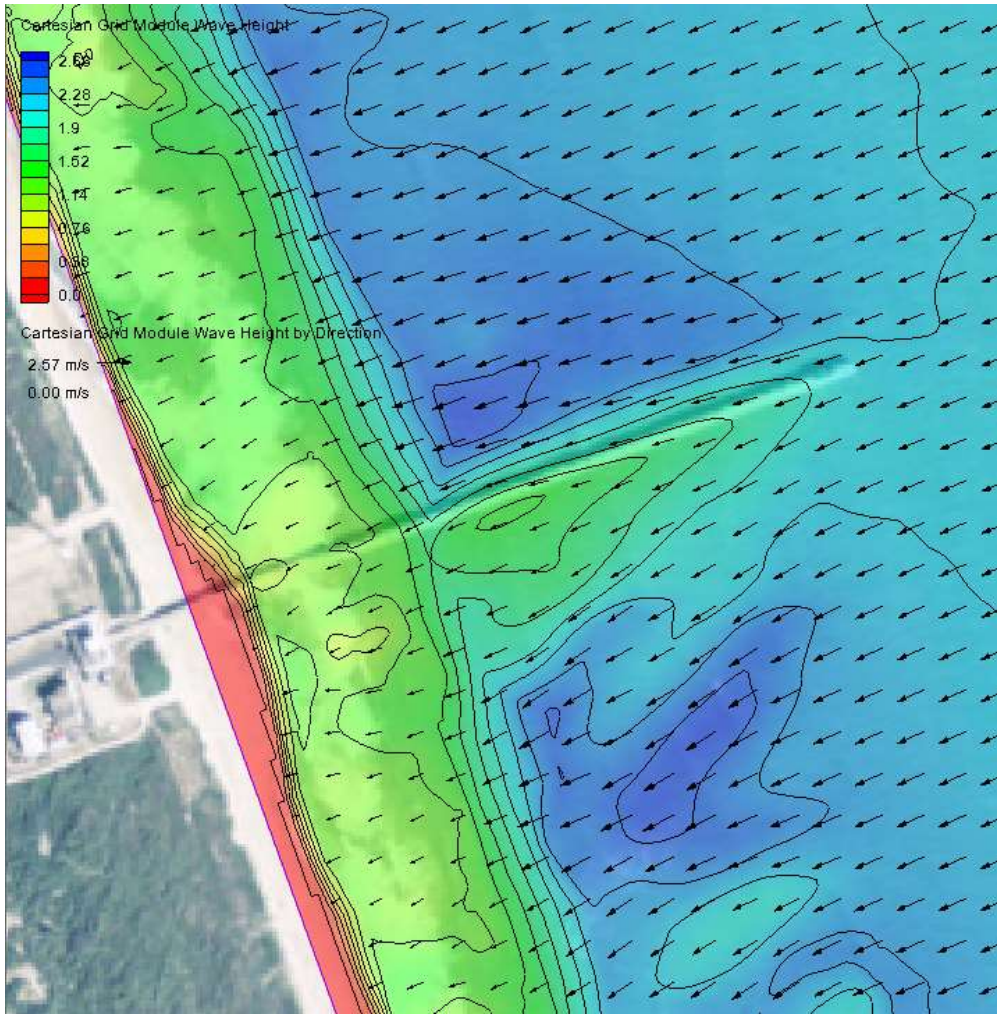
- Variable cell resolution
  - 315 m - > 5 m
- Domain
  - 8.5 Km in cross-shore
  - 15.5 Km in alongshore
- Spatially constant wind and water levels
  - Measured at end of pier
- Temporal Resolution:
  - Run Daily with 10 min. time-step
  - Cold Start with every measured bathymetry (~Monthly)
  - Hot Start: Each day
- Comparison Products:
  - Water Level and Directional Current Velocity at every appropriate gage.



Ongoing work with CMS-Wave / Flow

- Live Plot Delivery
- CMS-Wave
  - Investigate modeling domain size, shape, resolution
    - Direction poor performance (new domain?)
  - Examine Long duration model performance
  - Resolve spectral boundary bug issue for CMS-Wave in coupled source code
    - Develop external coupling
  - Examine wave breaking calibration over long durations
    - Calibrate over ~2 week period, look at performance in surf-zone over years of model runs
- CMS-Flow
  - Figure out bug related to ASCII input/output – cold start
  - Finalize setup
  - Begin testing
  - Use optical current measurement techniques for large scale spatial field comparisons for nearshore currents (Argus)
    - Chickadel, C. C., Robert A. Holman, and Michael H. Freilich. "An optical technique for the measurement of longshore currents." *Journal of Geophysical Research: Oceans* 108.C11 (2003).
    - No permanent installations of current measurements inside of the surfzone
      - This is where the optical current measurement technique works best
- C2SHORE (morphology model)
  - Start

Conclusions



- FRF is a data rich environment
- Numerical models are run in real time and continually evaluated using FRF data products
- Continual assessment relates model skill to specific environmental conditions and improves operational guidance (i.e. best practices), identify poorly resolved physics, and improve models

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