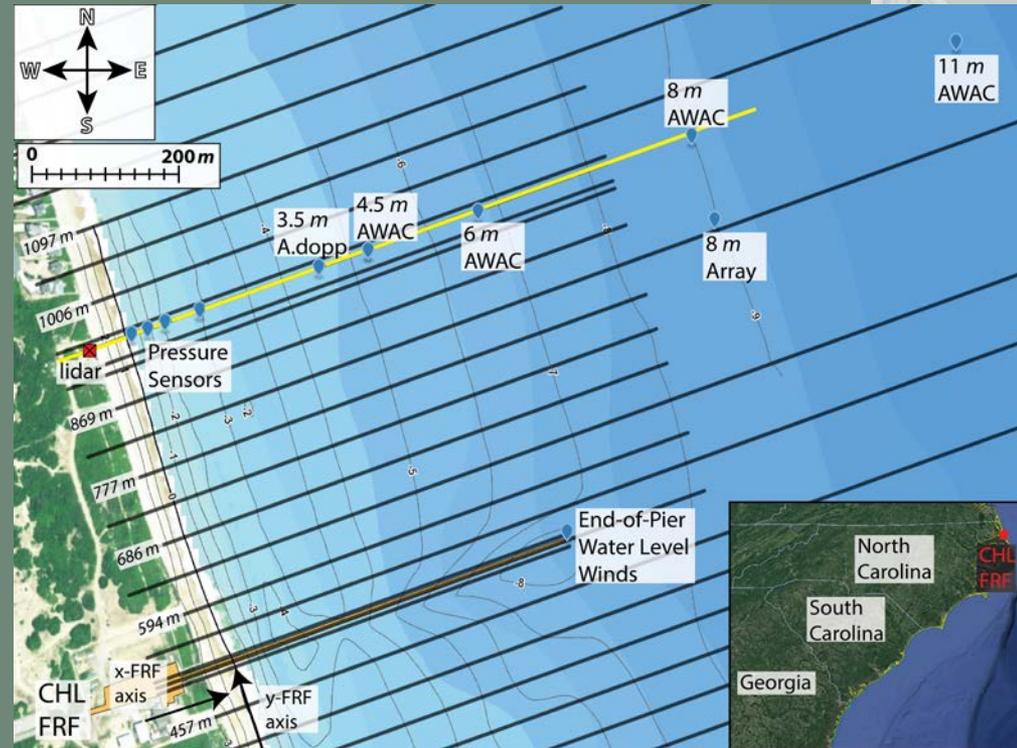


ONGOING CIRP WORK IN THE COASTAL MODEL TEST BED



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US Army Corps
of Engineers®



COASTAL MODEL TEST BED OVERVIEW

- Automated evaluation of coastal numerical models.
 - Use ERDC CHL FRF data.
- Assess/quantify model uncertainty.
- Test model parameterizations under range of conditions.
- Targeted model development cycle.
- Test/develop data assimilation techniques.



Altimeter Installation.

Identify poorly resolved physics

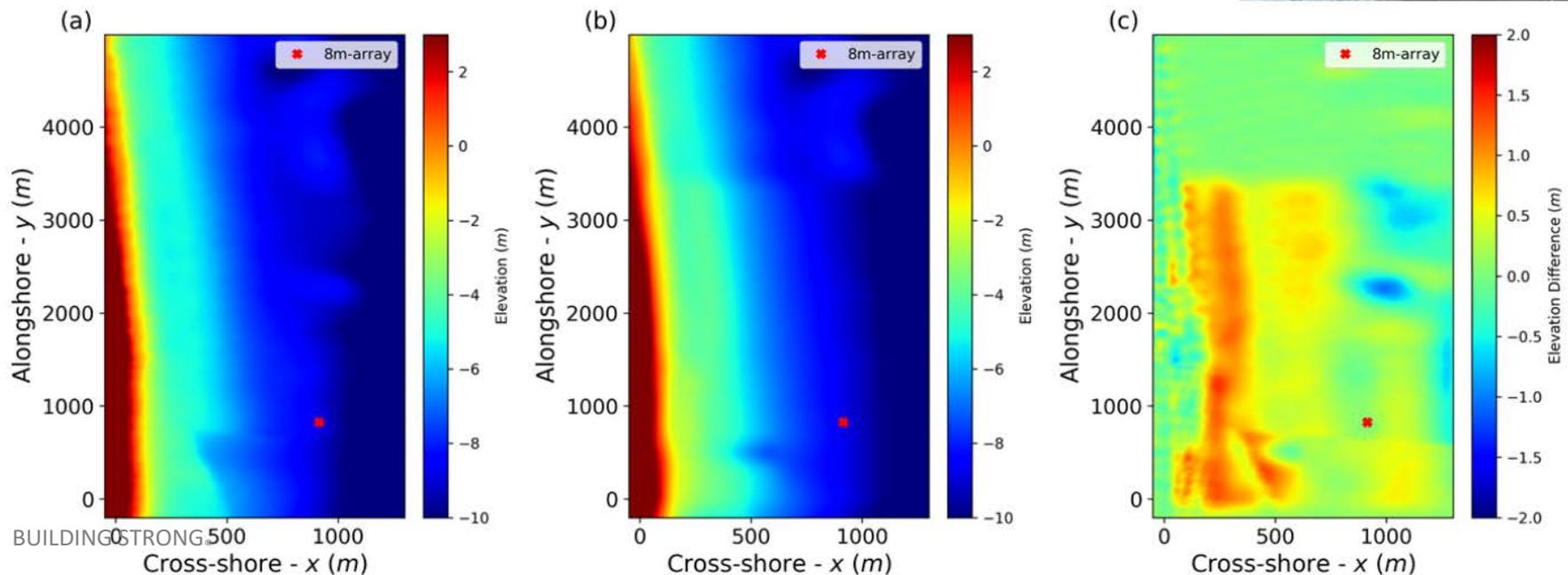
Direct research to address deficiencies

Add improvements to model

ONGOING WORK IN COASTAL MODEL TEST BED

- Refining integrated bathymetry product to:
 - Include hourly beach topography
 - Taper large cross-shore movement in sandbar position.
- CMS-Flow – being finalized.
- Implementation of:
 - Coupled CMS-Wave/Flow, ADCIRC, XBEACH, C2SHORE.
- Evaluation of optical current measurements (OCM).

Wave impact damage
Kitty Hawk, NC



CSHORE HYDRODYNAMIC PREDICTION PERFORMANCE

- 15 month evaluation period at CHL FRF.
 - October 1st 2015 – January 1st 2017.
- Wide range of offshore waves/water level.
- Focusing on model skill at simulating:
 - Wave transformation across surf zone.
 - Alongshore/cross-shore currents.
 - Runup.

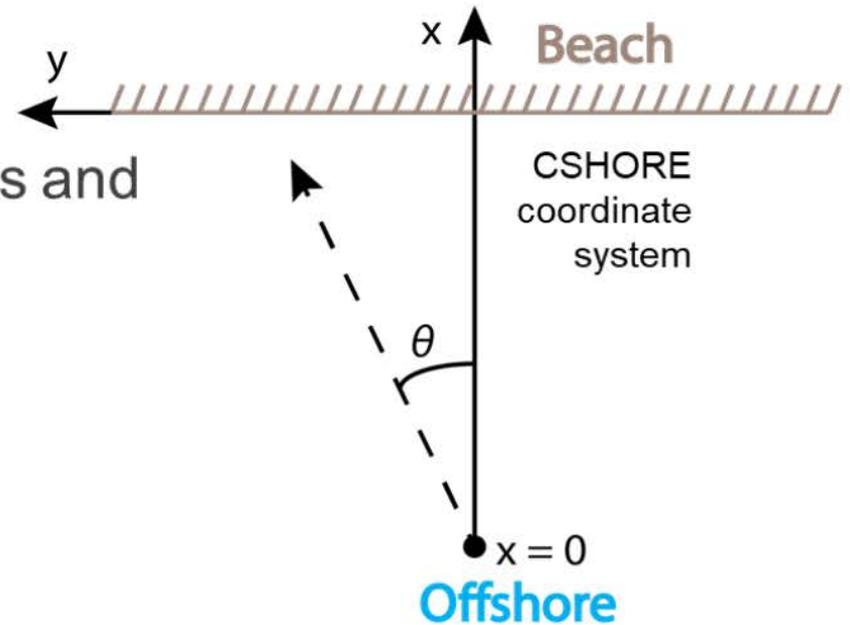
Storm at CHL FRF



Wave runup on Maui, HI
©Lahaina News

CSHORE OVERVIEW

- Phase-averaged time-steady 1D cross-shore numerical model.
- Predicts nearshore hydrodynamics and morphology evolution.
- Includes effects of:
 - Irregular breaking waves.
 - Wave roller contributions.
 - Quadratic bottom shear stress.
- See Johnson et al. 2012 for details.



Variable Name	Description	Units
H_s	Significant wave height at the model boundary for each time step.	<i>m</i>
T_m	Wave mean period at the model boundary for each time step.	<i>s</i>
θ	Wave angle at the model boundary for each time step (see Figure 1)*	<i>decimal °</i>
<i>MWL</i>	Mean water level at the model boundary for each time step.	<i>m (NAVD88)</i>
z_b	Initial bed elevation at each node in the model domain.	<i>m (NAVD88)</i>
<i>Salinity</i>	Single value of water salinity (for entire model duration).	<i>PSU</i>
<i>Temp</i>	Single value of water temperature (for entire model duration).	<i>°C</i>

*Measured counter-clockwise positive in model coordinates system.

FORCING AND COMPARISON DATA

Forcing

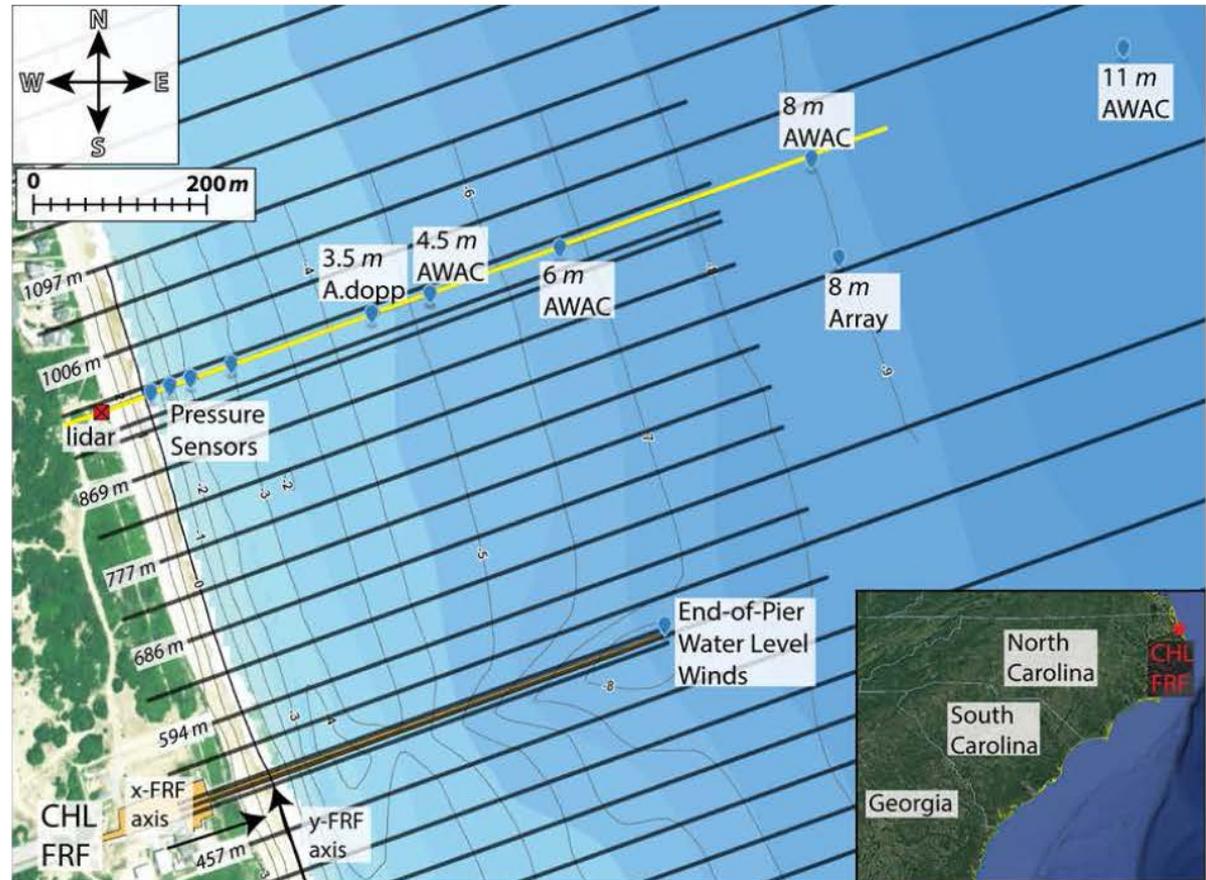
- Water level from NOAA WL gauge.
- 8m Array for offshore waves
- No wind.

Comparison gauges

- 6m AWAC - H_s , U , V
- 4.5m AWAC - H_s , U , V
- 3.5m Aquadopp - H_s , U , V
- Paros (200, 150, 125, 100m) – H_s
- lidar – Runup ($R_{2\%}$)

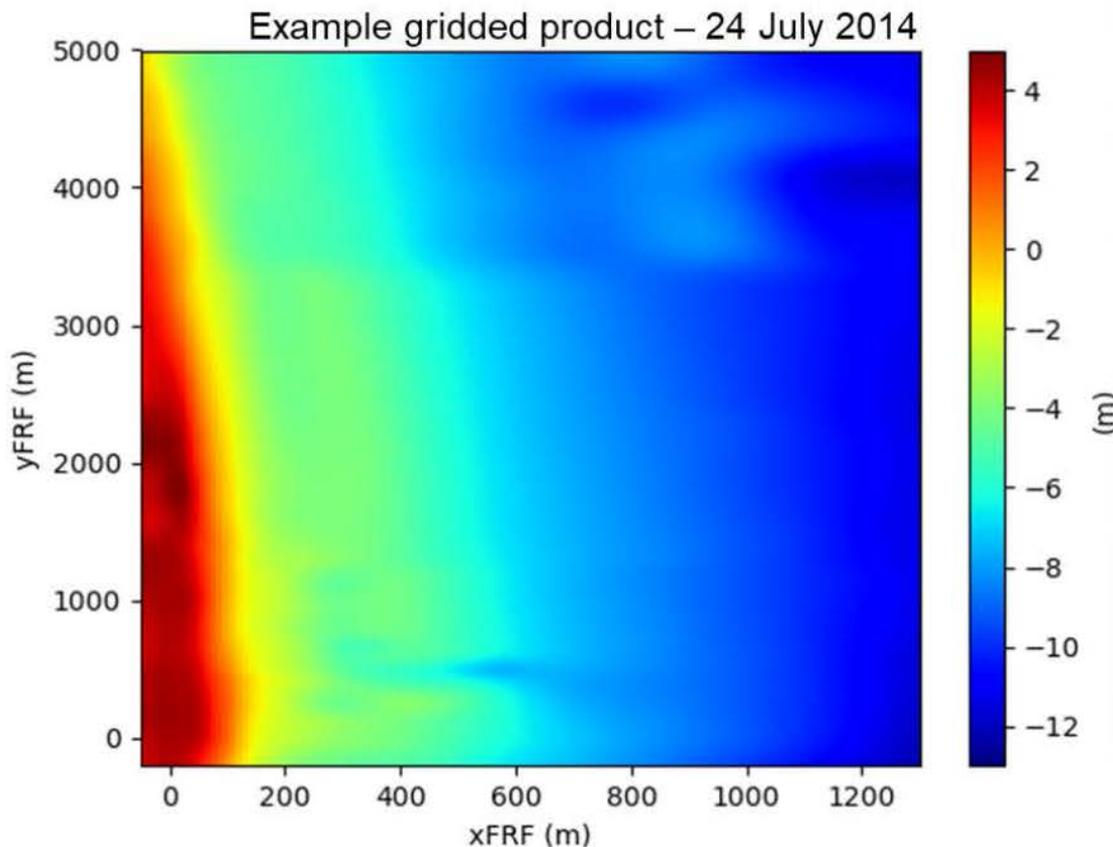
Modeled Profile

- Yellow line

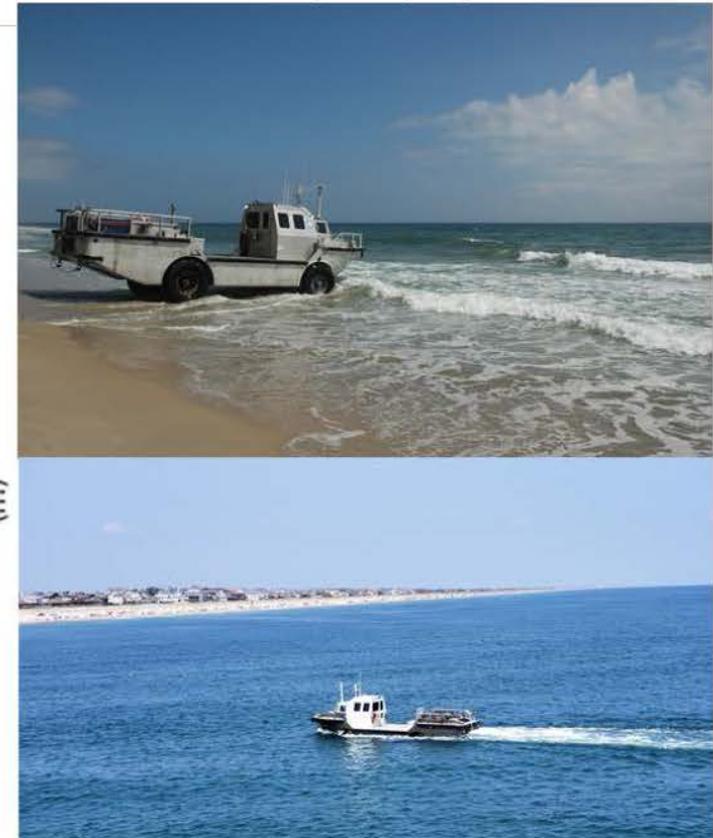


BATHYMETRY

- Bathymetry from integrated bathymetry product. (Plant et al 2003, 2009)
 - Gridded, smoothed ($L_x = 20\text{m}$, $L_y = 100\text{m}$), splined to background.



Surveys in progress



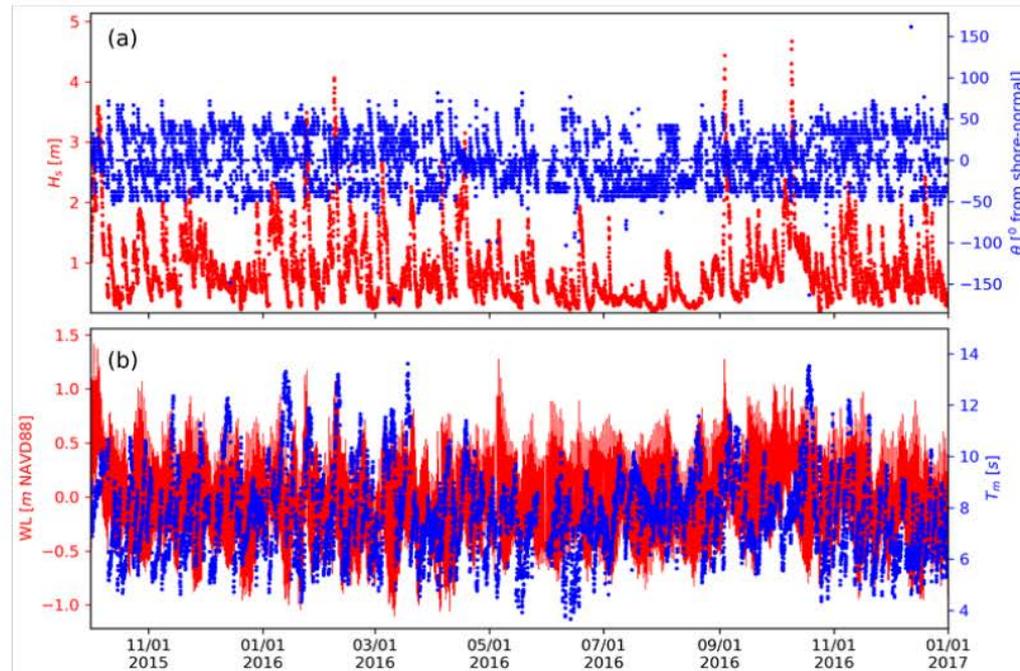
MODEL SETUP

- Fixed bed configuration.
- Mobile bed implemented, not analyzed.
- Bathymetry updated 20 times.

CSHORE model settings

Toggle	Description	Setting
γ	Depth limited wave breaker coefficient.	0.8
friction factor	Bed friction factor.	0.007
roller	Toggle roller model on/off.	on
Predicted <u>runup</u>	Swash depth tracked for <u>runup</u> calculations.	1 cm

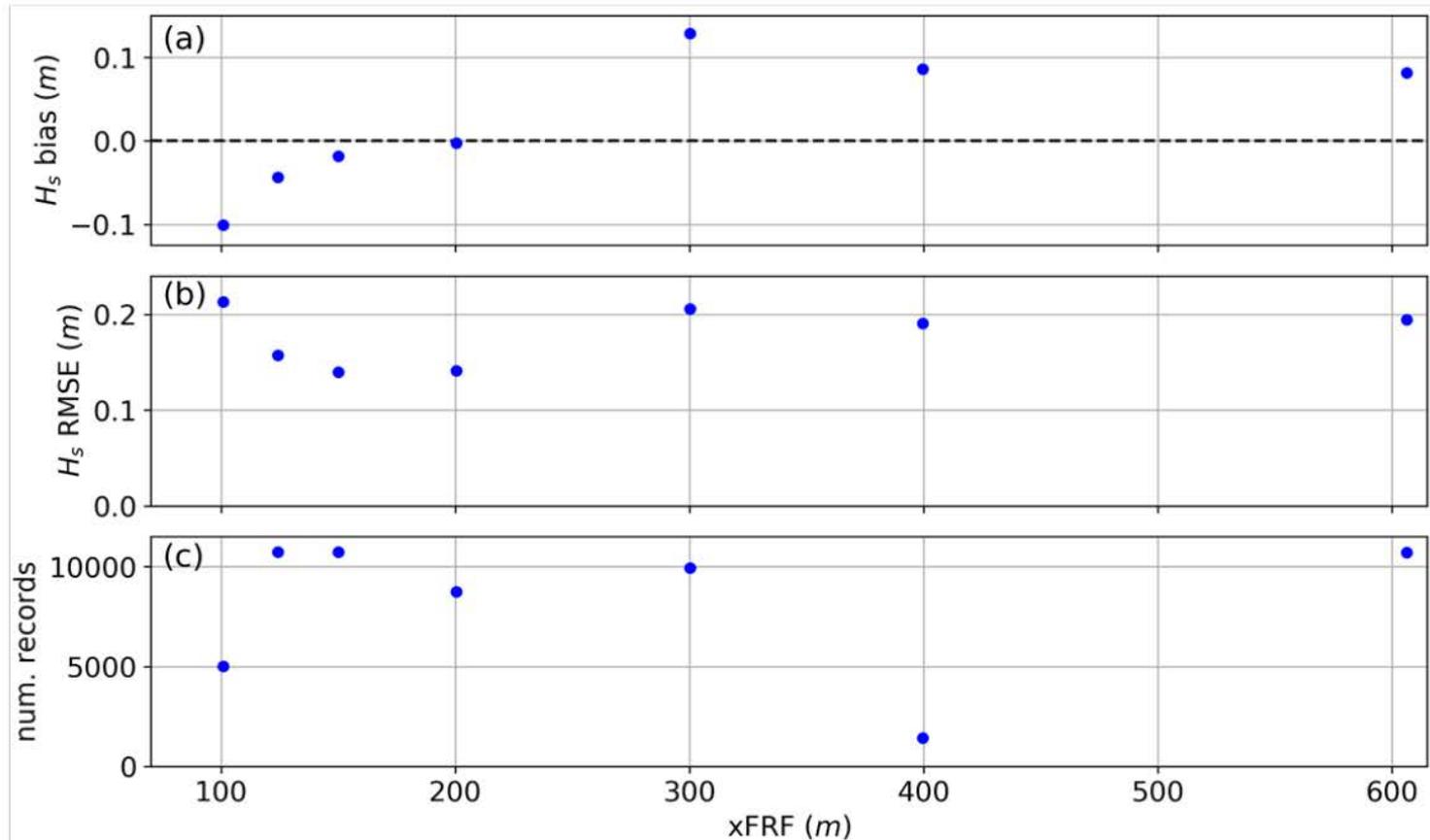
Boundary conditions during model run



CROSS-SHORE WAVE TRANSFORMATION

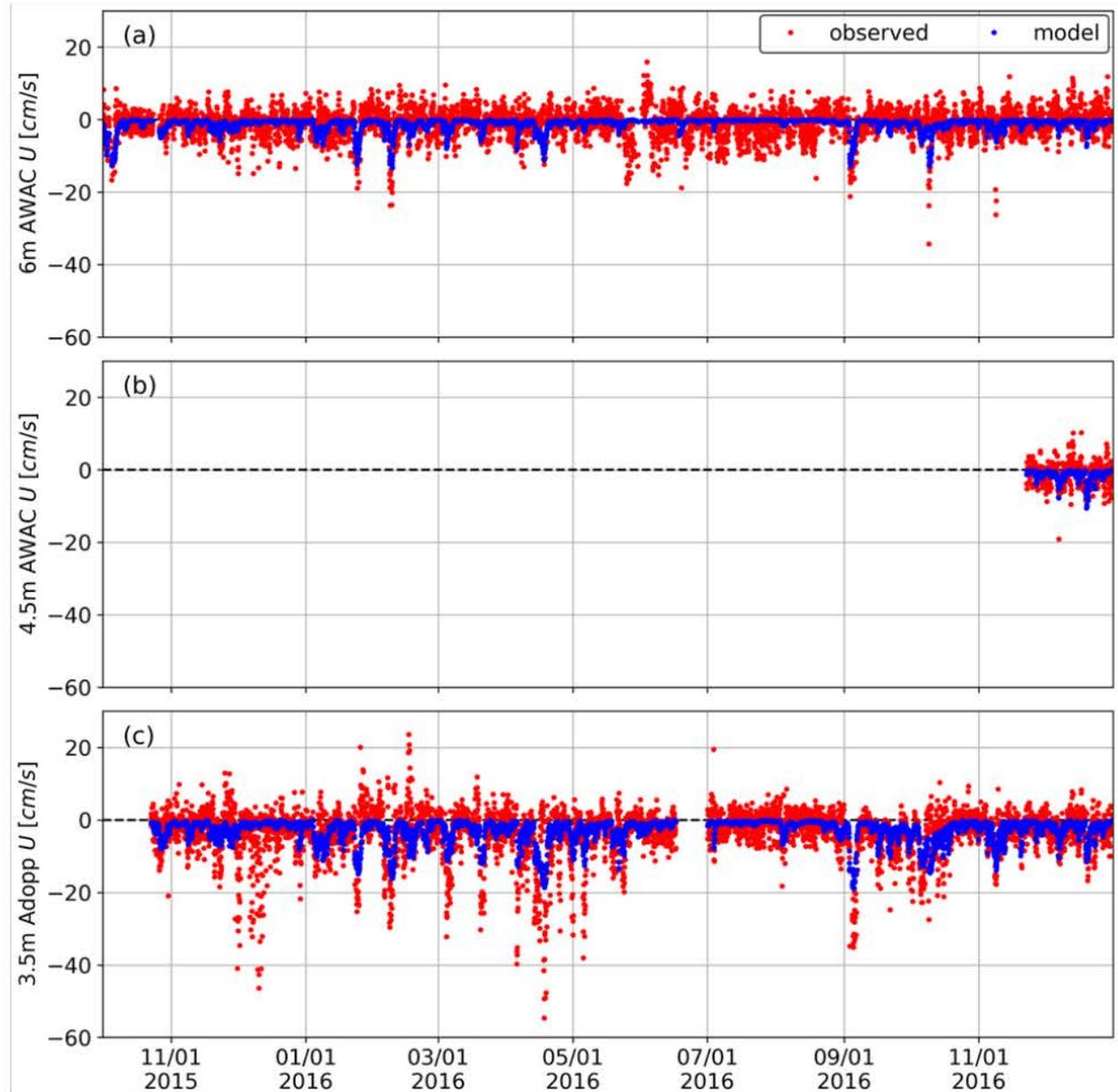
- Underpredicts wave heights offshore (AWACs, Aquadopp)
- Overpredicts wave heights in surf zone (Paros)
- RMSE high offshore, drops at most offshore Paros.

$$\text{Bias} = \frac{x_{obs} - x_{mod}}{x_{obs}}$$



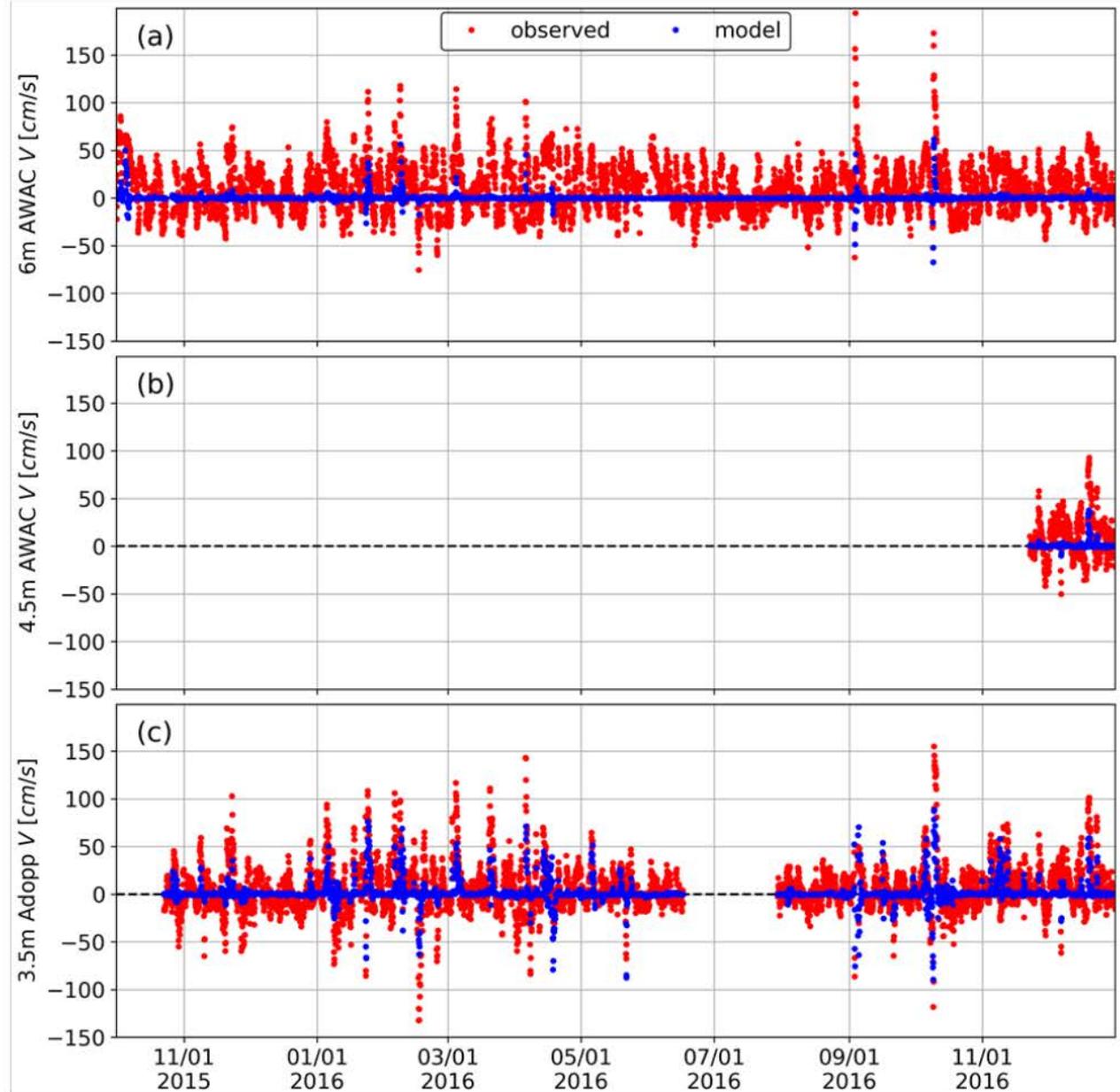
CROSS-SHORE CURRENT

- 1D model - offshore only.
- Data shows onshore and offshore.
- No winds, longshore uniformity violations.
- 4.5m AWAC installed mid-Nov. 2016.



ALONGSHORE CURRENT

- Driven by radiation stress gradients.
- Direction depends on incident wave angle.
- Periods of general agreement.
- Not including surface stress or pressure-driven flow.

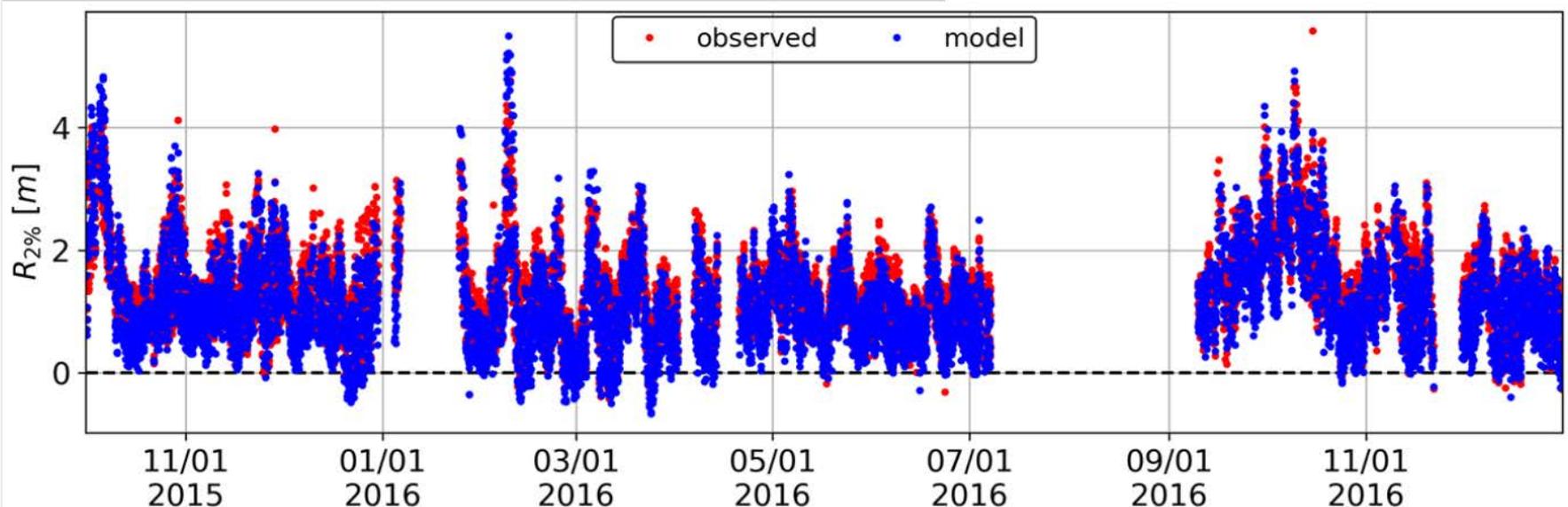
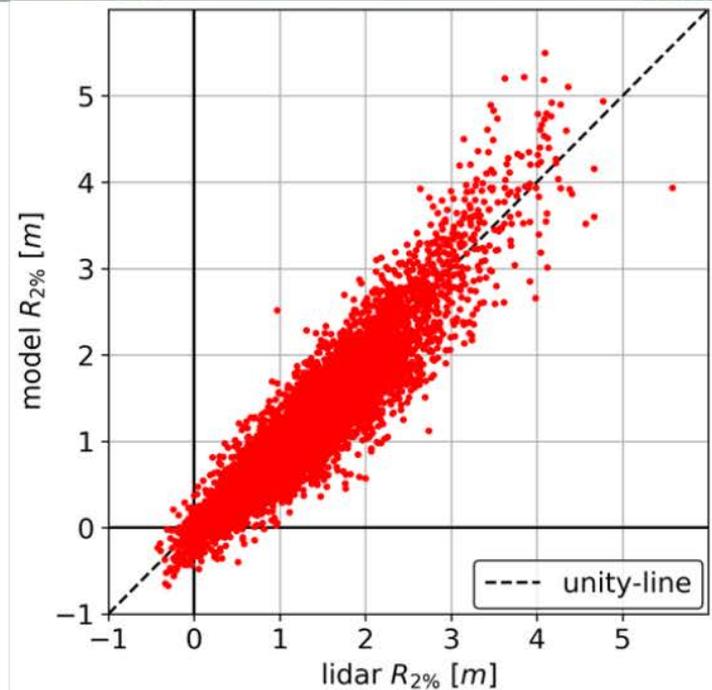


CURRENT COMPARISON STATS

Variable	Gauge	Bias	RMSE	Number of points
U (cm/s)	6m AWAC	0.2	3.8	5312
	4.5m AWAC	0.3	2.9	469
	3.5m <u>Aquadopp</u>	-0.8	5.7	5025
V (cm/s)	6m AWAC	9.8	26.0	5312
	4.5m AWAC	9.0	23.3	469
	3.5m <u>Aquadopp</u>	4.5	21.2	4677
R _{2%} (cm)	<u>lidar</u>	15.9	33.5	7982

LIDAR RUNUP

- Not all data manually QA/QC'ed
- Applied filter based on observation/model ratio.
- Model and observations generally in good agreement.



CONCLUSIONS

- Model
 - Underpredicts H_s in offshore region.
 - Overpredicts H_s in surf zone.
 - Only predicts offshore-directed cross-shore current.
 - Alongshore current direction generally agrees with observations.
 - Has good agreement with observed $R_{2\%}$