

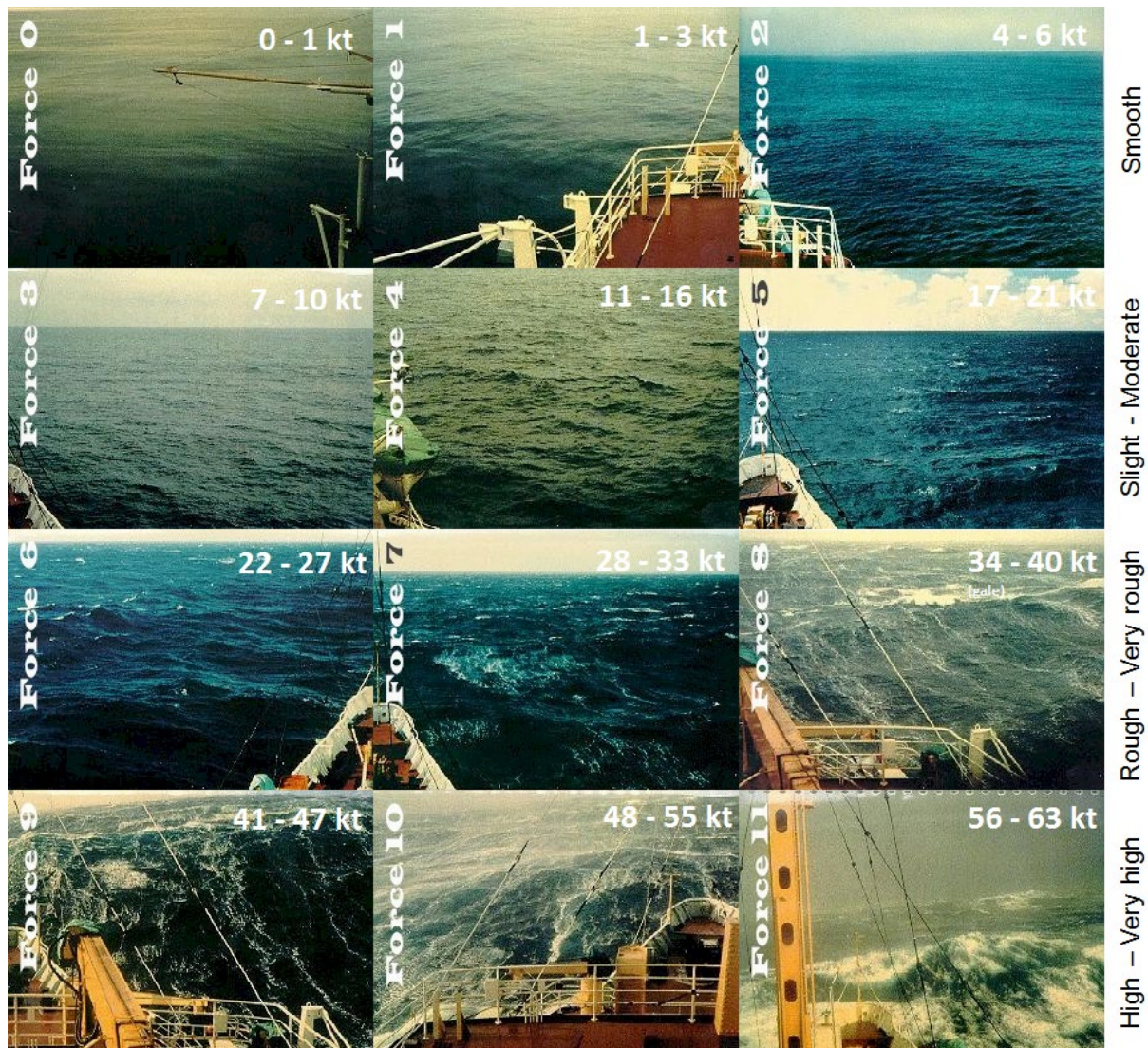


# **Enhancing coastal intelligence in the US Caribbean using high- resolution modeling and data product development**

**Miguel Canals & the CARICOOS Team**



# The challenge



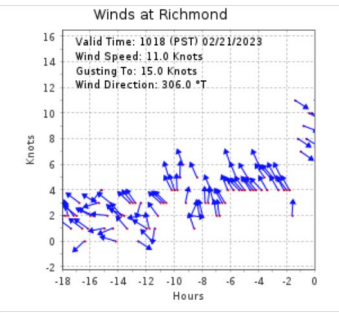
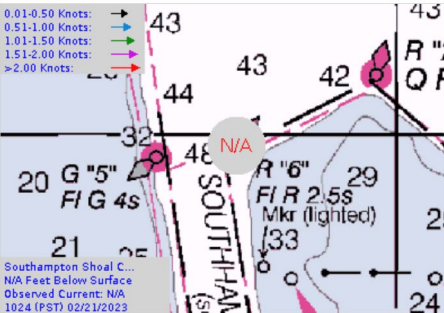
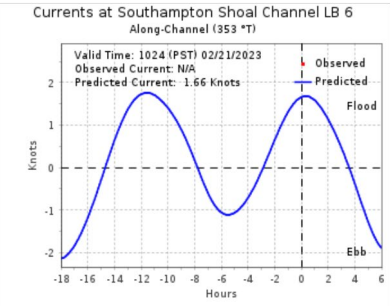
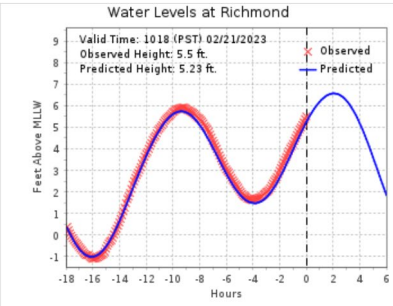
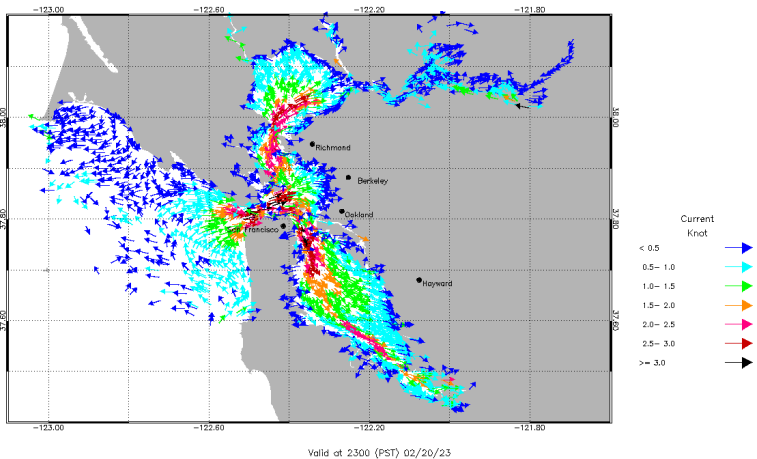
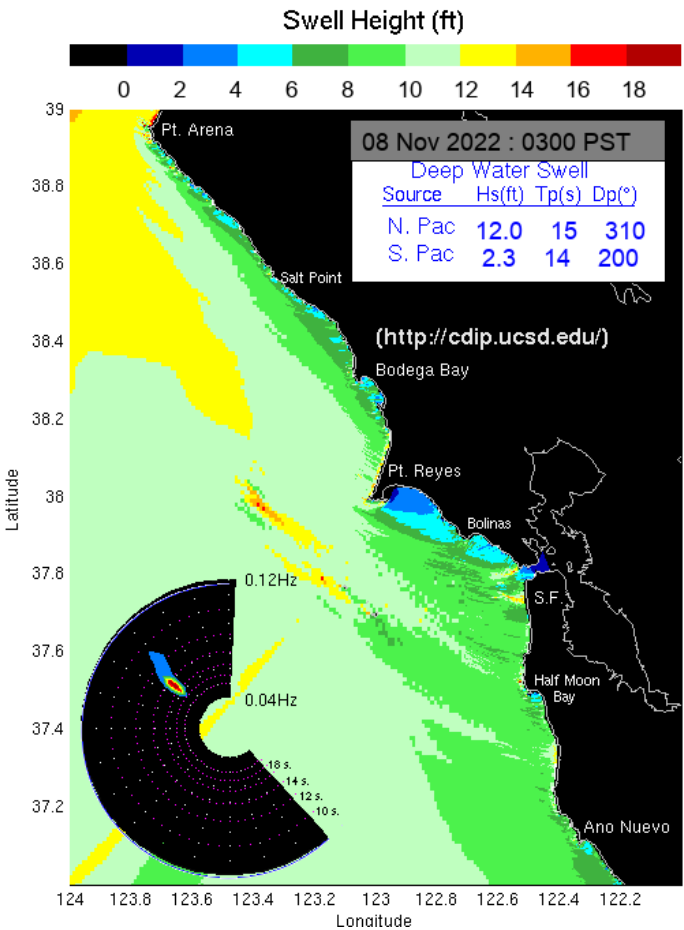
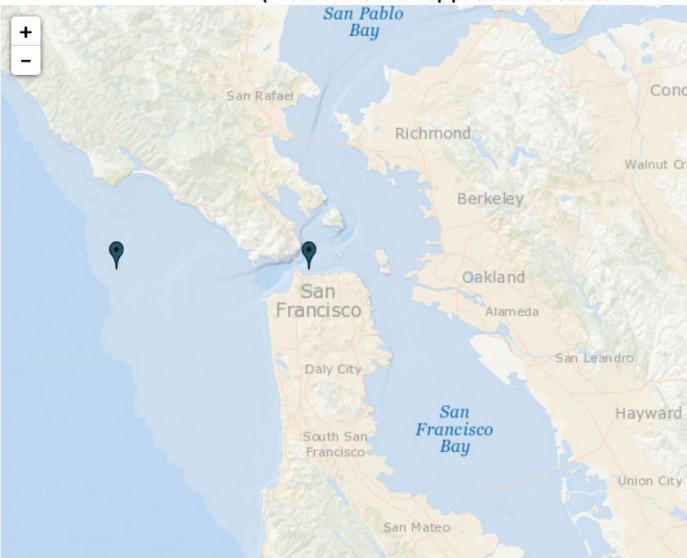


# Motivation – CARICOOS has been greatly influenced by your work at NOS (and CDIP!)

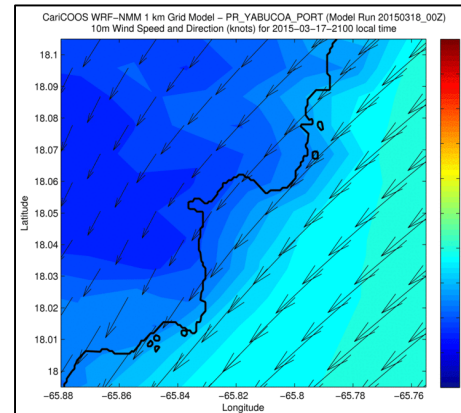
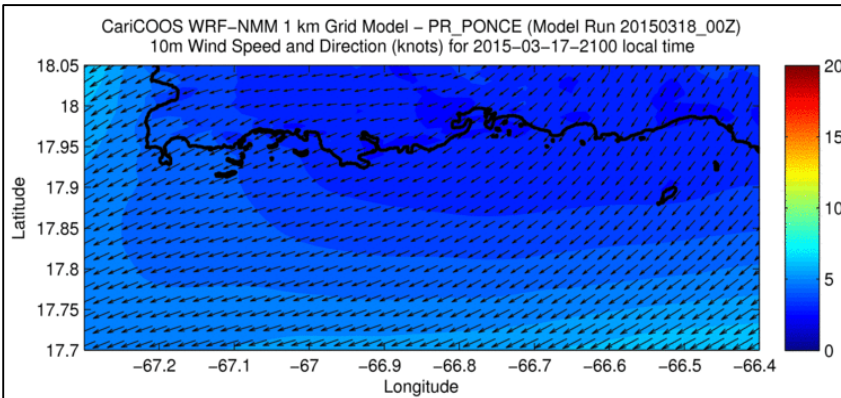
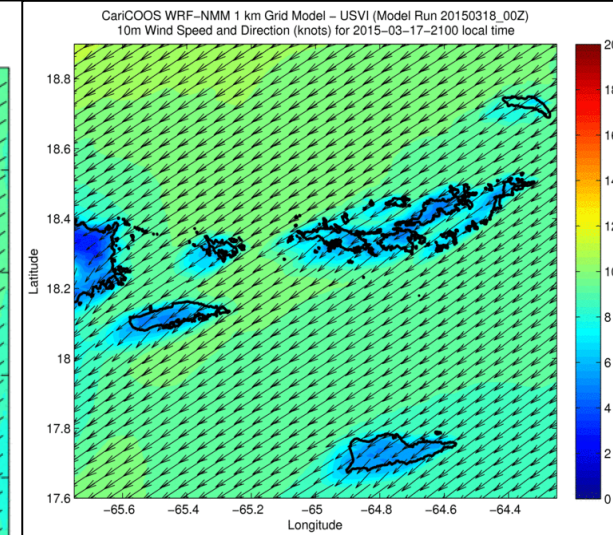
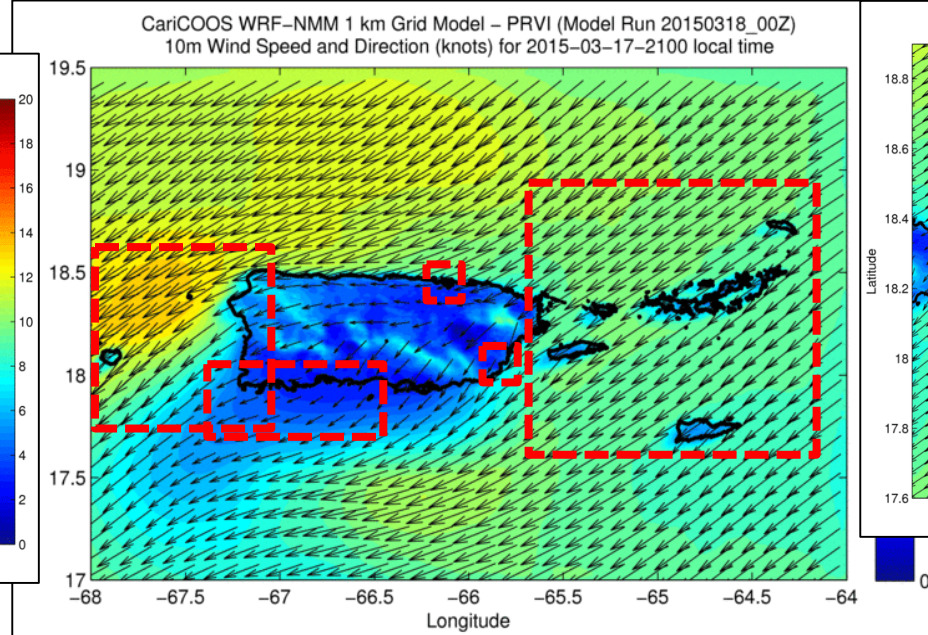
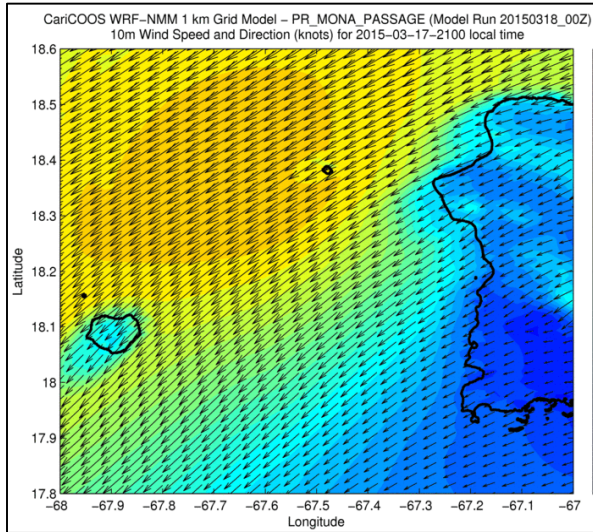


## San Francisco Bay Operational Forecast System (SFOFS)

(Please click on the map pins below to access the time series plots)



# Wind forecasting – WRF (OPERATIONAL)

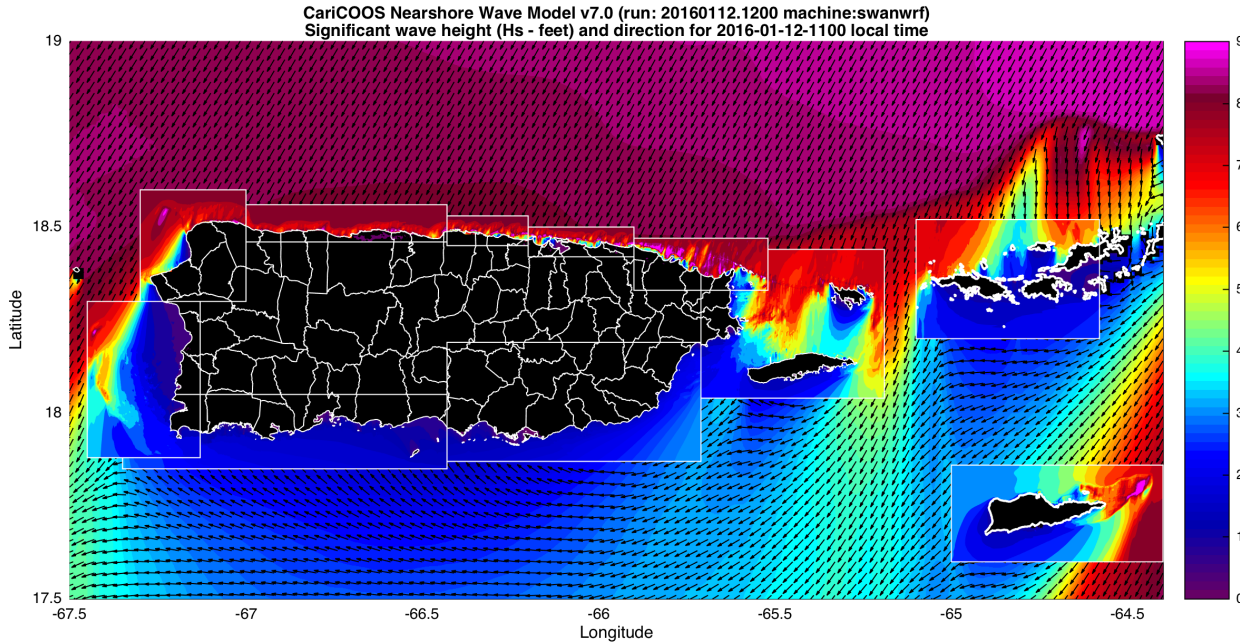


Developers:  
L. Aponte, P. Chardón





# Wave forecasting – where we are: Multigrid SWAN + Parameterized Breaking Model (OPERATIONAL)

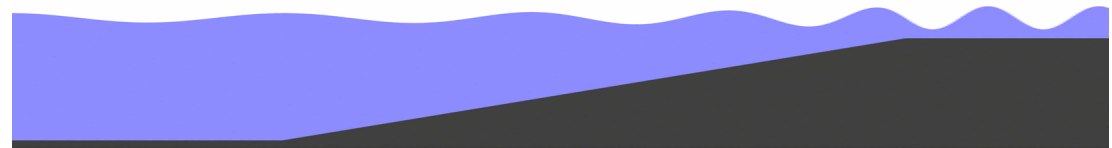
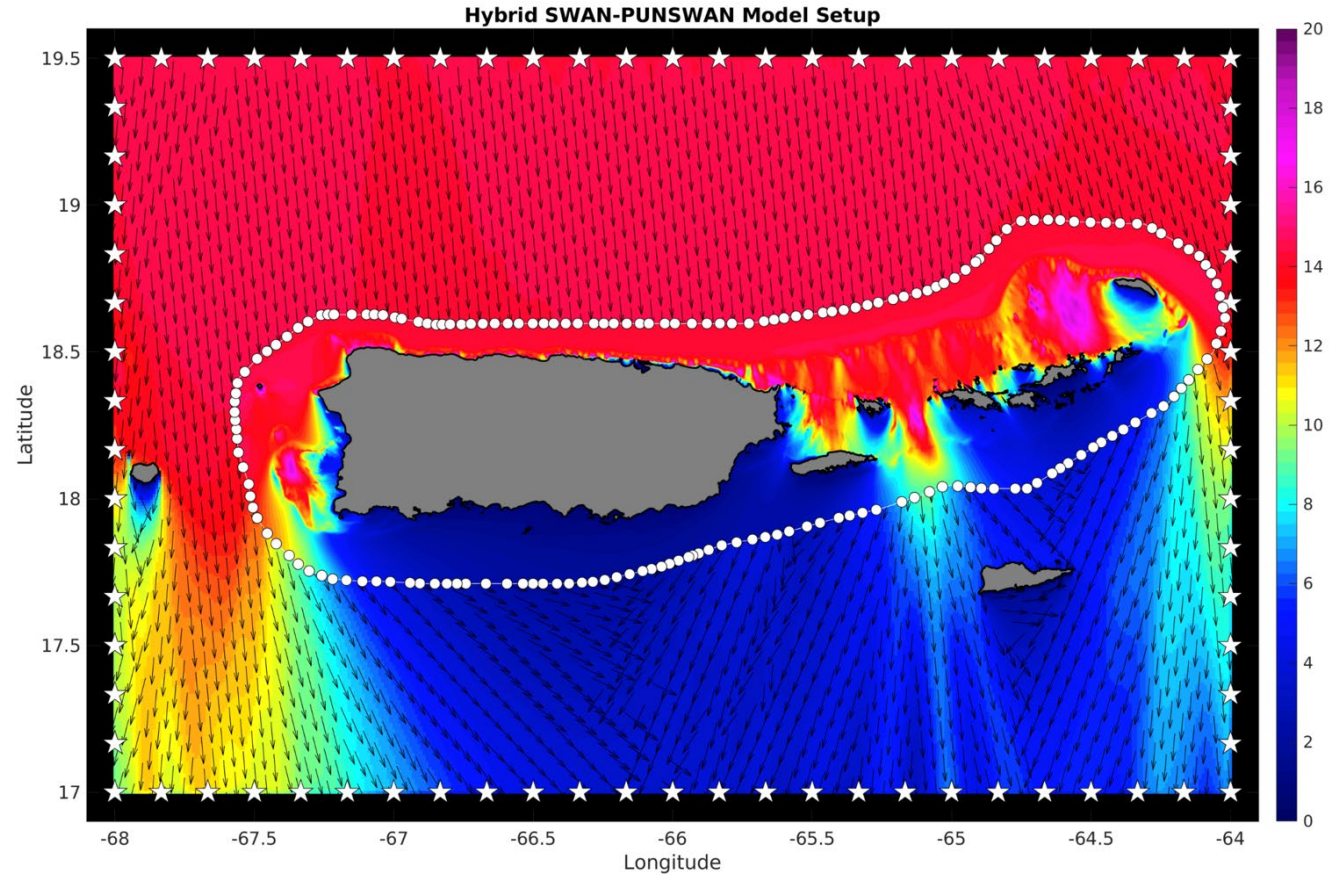
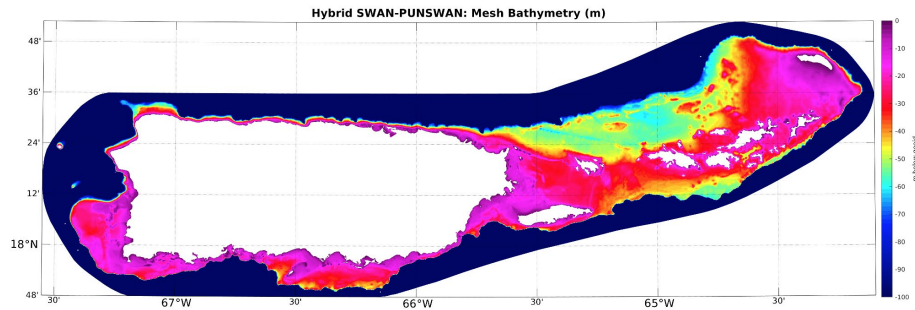
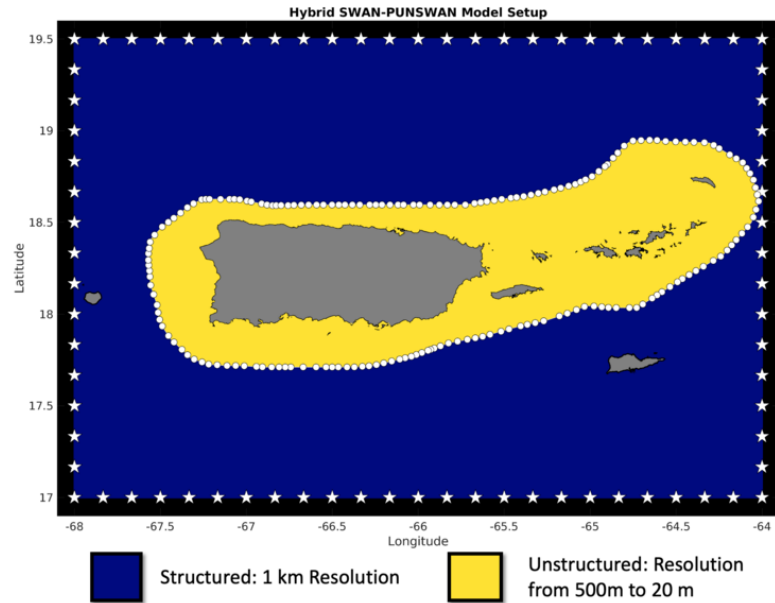


Special thanks to Carlos Anselmi,  
CARICOOS grad student and now at SJU  
NWS  
for leading initial model development



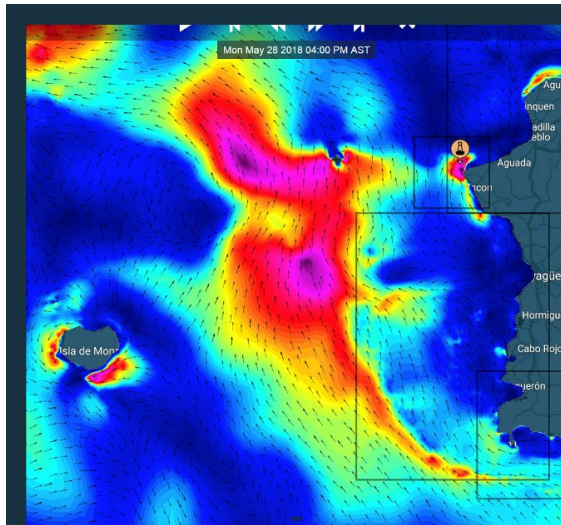
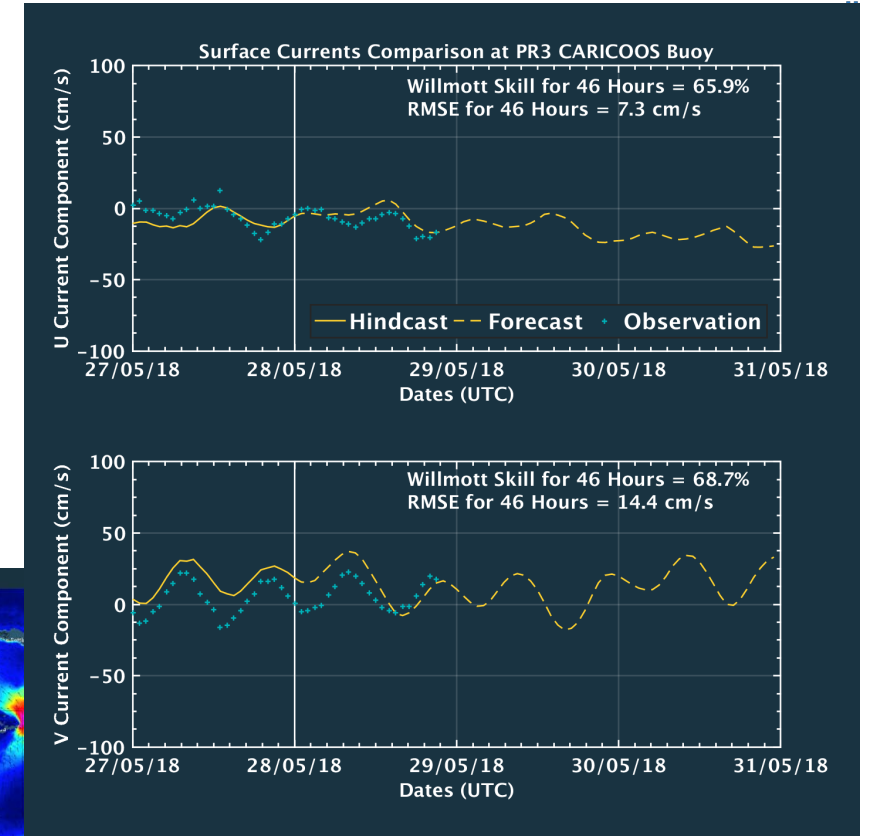
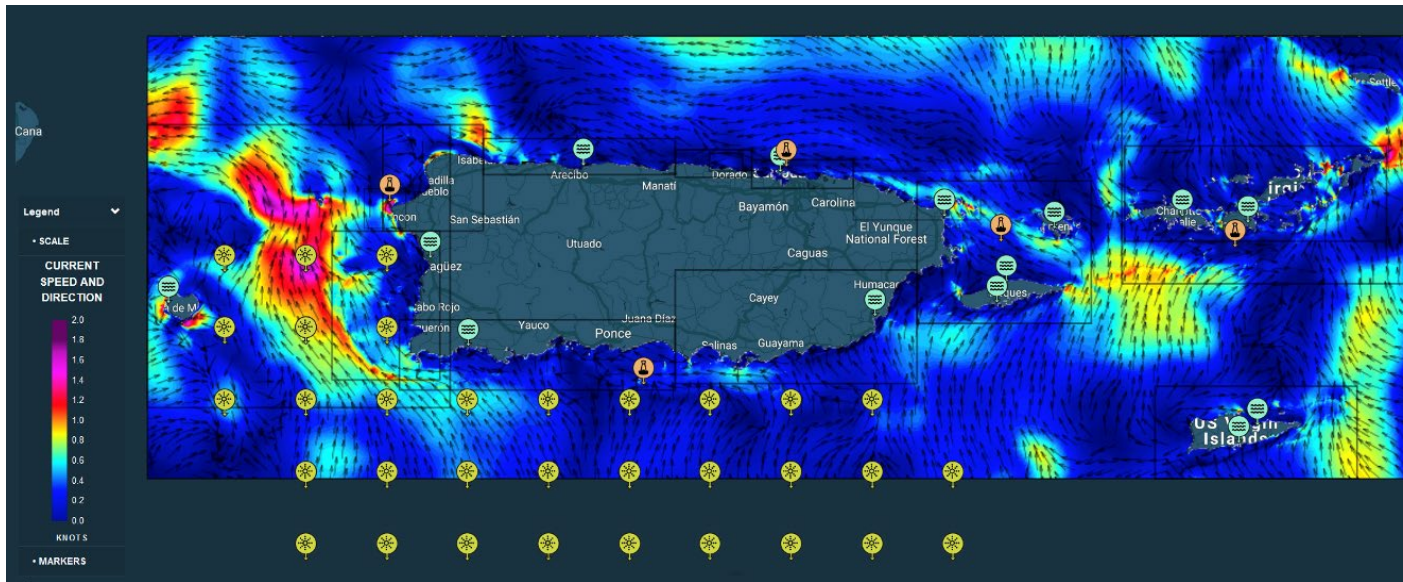


# Wave forecasting – where we're going: Hybrid PunSWAN + coupled 1D SWASH explicit wave breaking modeling (selected beaches)

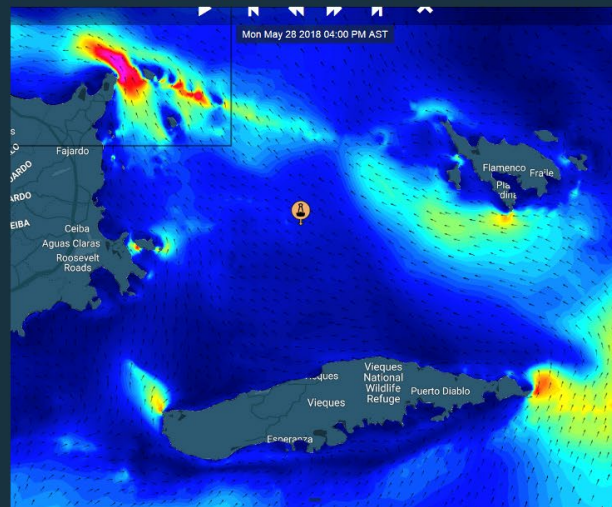




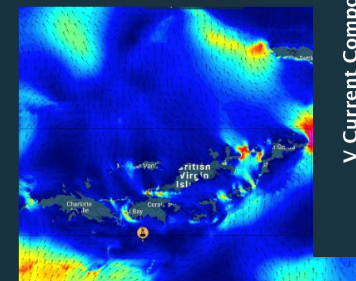
# Coastal circulation forecasting – FVCOM (EXPERIMENTAL)



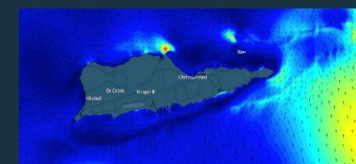
Mona Passage zoom window



Northeast Corridor zoom window



Virgin Islands zoom window

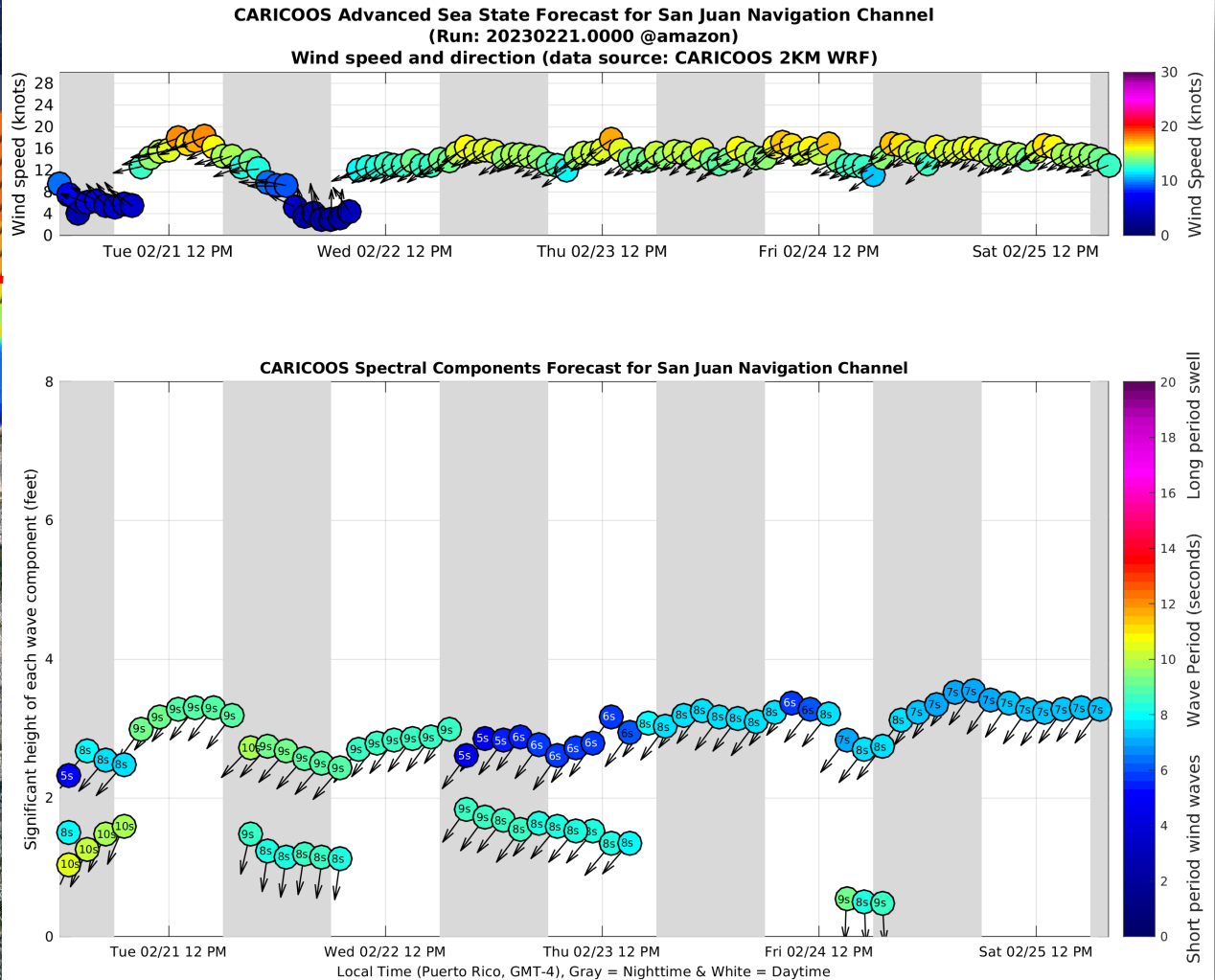
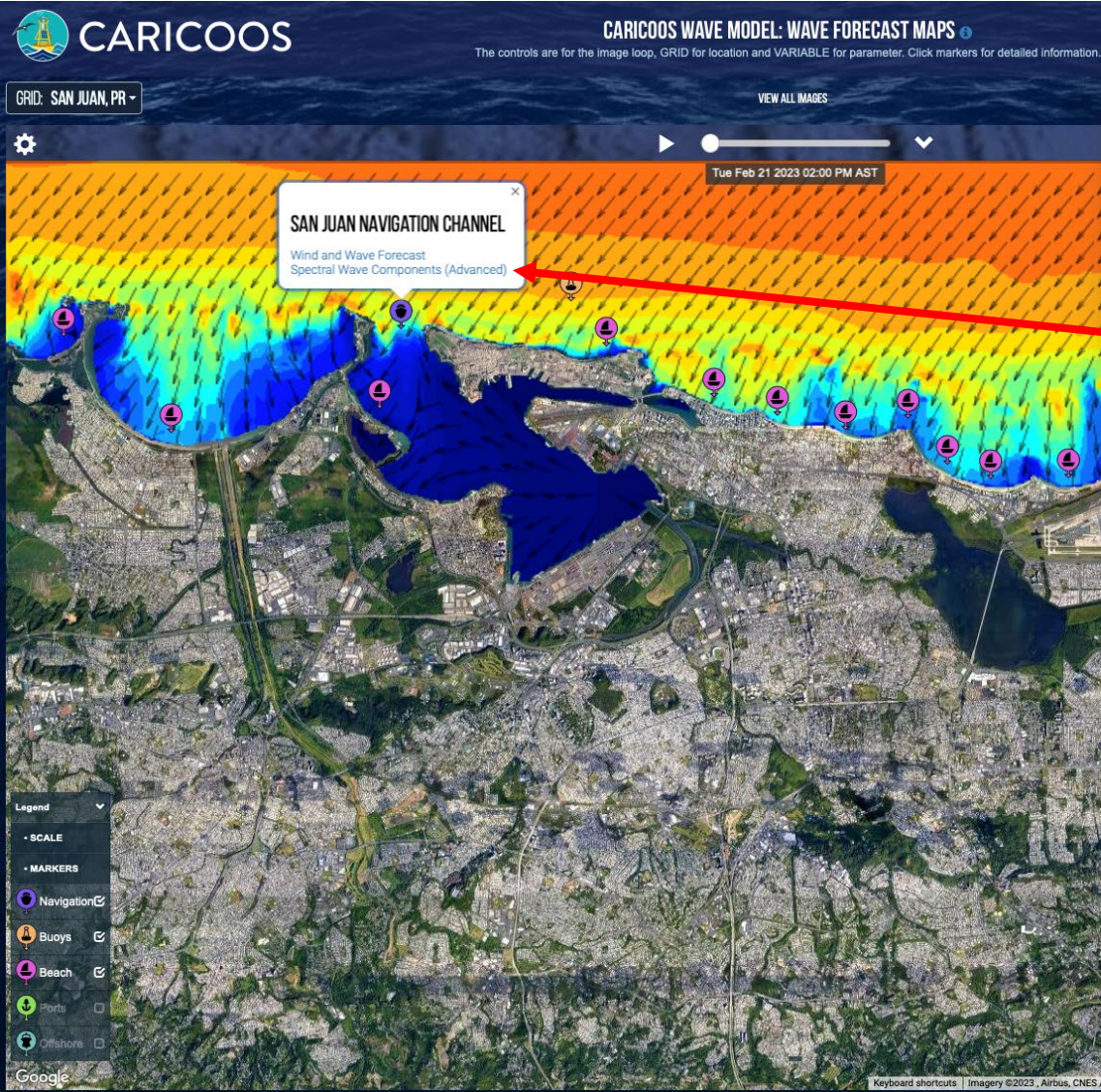


St. Croix zoom window

\*Real-time validation.  
Subtidal flows still need  
significant improvement  
through data assimilation



# CARICOOS POINT-BASED FORECASTS





# COASTAL HAZARDS: Beach safety & wave-induced drownings



- PR's 15 most dangerous beaches are wave-dominated beaches (Sea Grant UPRM data):



Source: Primera Hora /Sea Grant UPR

Web Images News Videos More Search tools

About 85,600,000 results (0.61 seconds)

[Minnesota tourist dies while snorkeling in Puerto Rico | Mail Online](#)  
[www.dailymail.co.uk/.../Minnesota-tourist-dies-snorkeling-Puerto-Rico.htm...](http://www.dailymail.co.uk/.../Minnesota-tourist-dies-snorkeling-Puerto-Rico.htm...)  
 Dec 8, 2013 - Puerto Rico police say a 30-year-old tourist from Minnesota died Sunday while ... Rip currents can be deceiving and aren't always visible to the ...

[New York tourist drowns near Puerto Rico resort - Topix](#)  
[www.topix.com/forum/world/puerto-rico/T70BPJH1JME8NPARQ](http://www.topix.com/forum/world/puerto-rico/T70BPJH1JME8NPARQ)  
 Oct 27, 2007 - 12 posts - 3 authors  
 I was there also, I witnessed it from when they got in trouble to when they were pulled out of the water...It was terrifying and very sad.

[Tourist Killed](#)  
[touristkilled.com/](http://touristkilled.com/)  
 Australia: British man drowns in strong currents while trying to save sons · Australia: ... Costa Rica: Tourist becomes ill with Malaria in Costa Rica, authorities ..... to sea by strong current · Puerto Rico: American tourist drowns while swimming at ...

[Puerto Rico: Canadian man drowns after being swept to sea by ...](#)  
[touristkilled.com/puerto-rico-canadian-man-drowns-after-being-swept-to-...](http://touristkilled.com/puerto-rico-canadian-man-drowns-after-being-swept-to-...)  
 Sep 12, 2013 - Puerto Rico: American tourist drowns while swimming at beach in San ..... Canadian man drowns after being swept to sea by strong current ...

[Tourist from Minnesota dies while snorkeling in Puerto Rico :: Latin ...](#)  
[latinamericacurrentevents.com/tourist-from...dies...puerto-rico/30234/](http://latinamericacurrentevents.com/tourist-from...dies...puerto-rico/30234/)  
 Dec 10, 2013 - Puerto Rico police say a 30-year-old tourist from Minnesota has died while snorkeling off the island's north coast. Police identified the victim as ...

[Tourist drowns at Puerto Rico beach :: Latin America Current Even...](#)  
[latinamericacurrentevents.com/tourist-found-drowns...puerto-rico.../272...](http://latinamericacurrentevents.com/tourist-found-drowns...puerto-rico.../272...)  
 Mar 17, 2013 - Aguadilla (CyberNews) – A tourist drowned at 3:41 Crash Boat Beach in Aguadilla, police said. The tourist has been identified as David A.

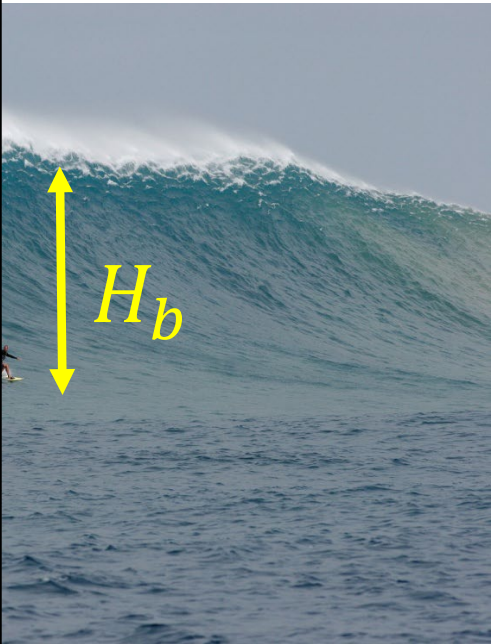


CARICOOS

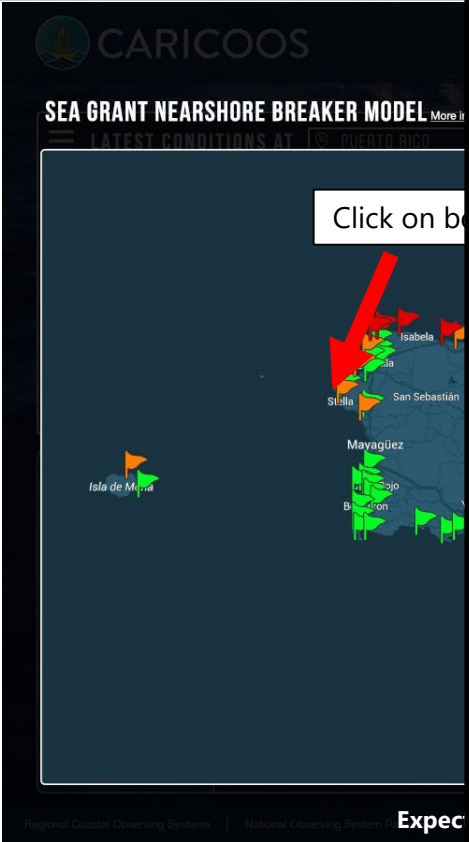
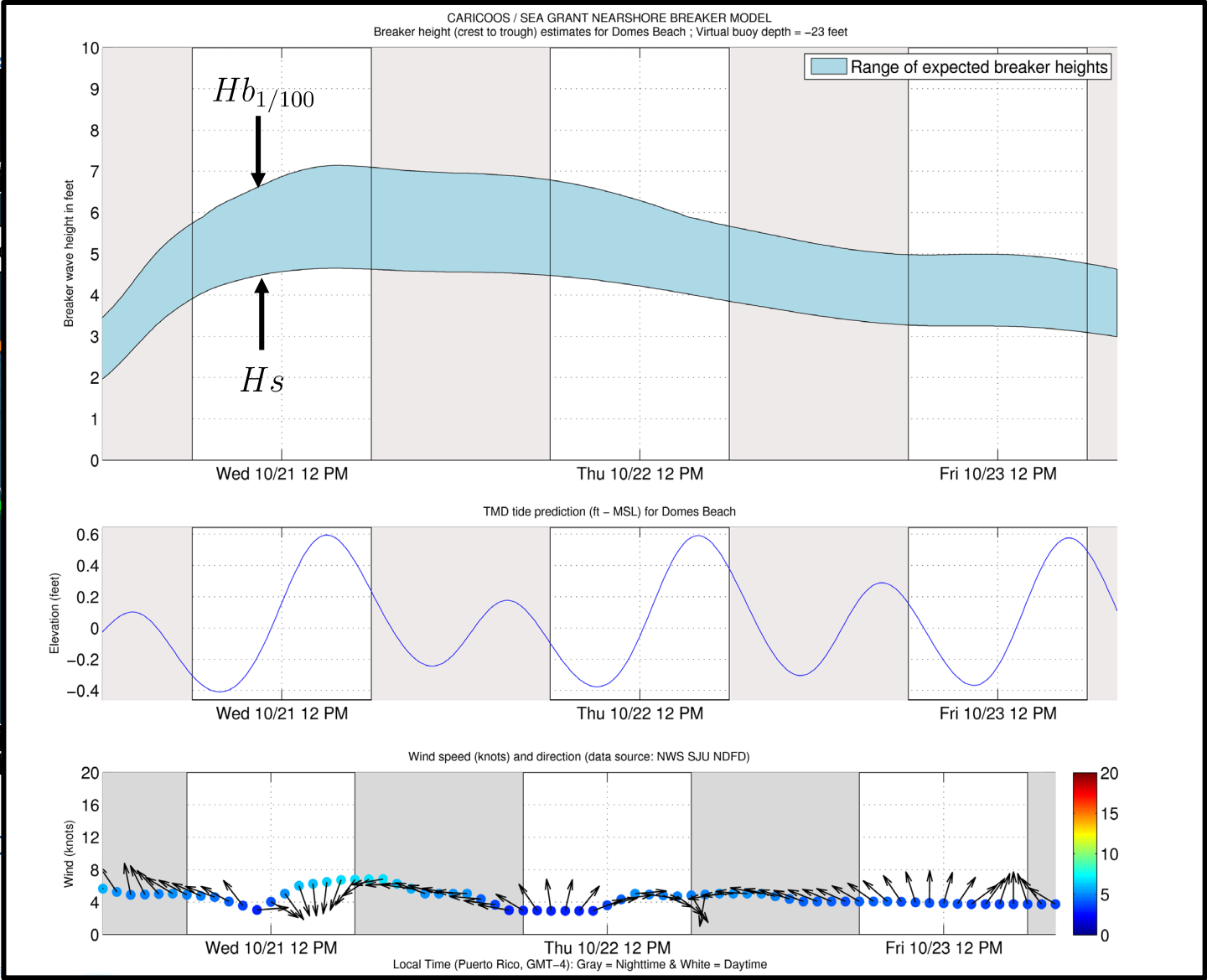
CAOSE



# COASTAL HAZARDS: Beach safety & wave-induced drownings



$H_b < H_{b_{max}}$



- Breaker height prediction

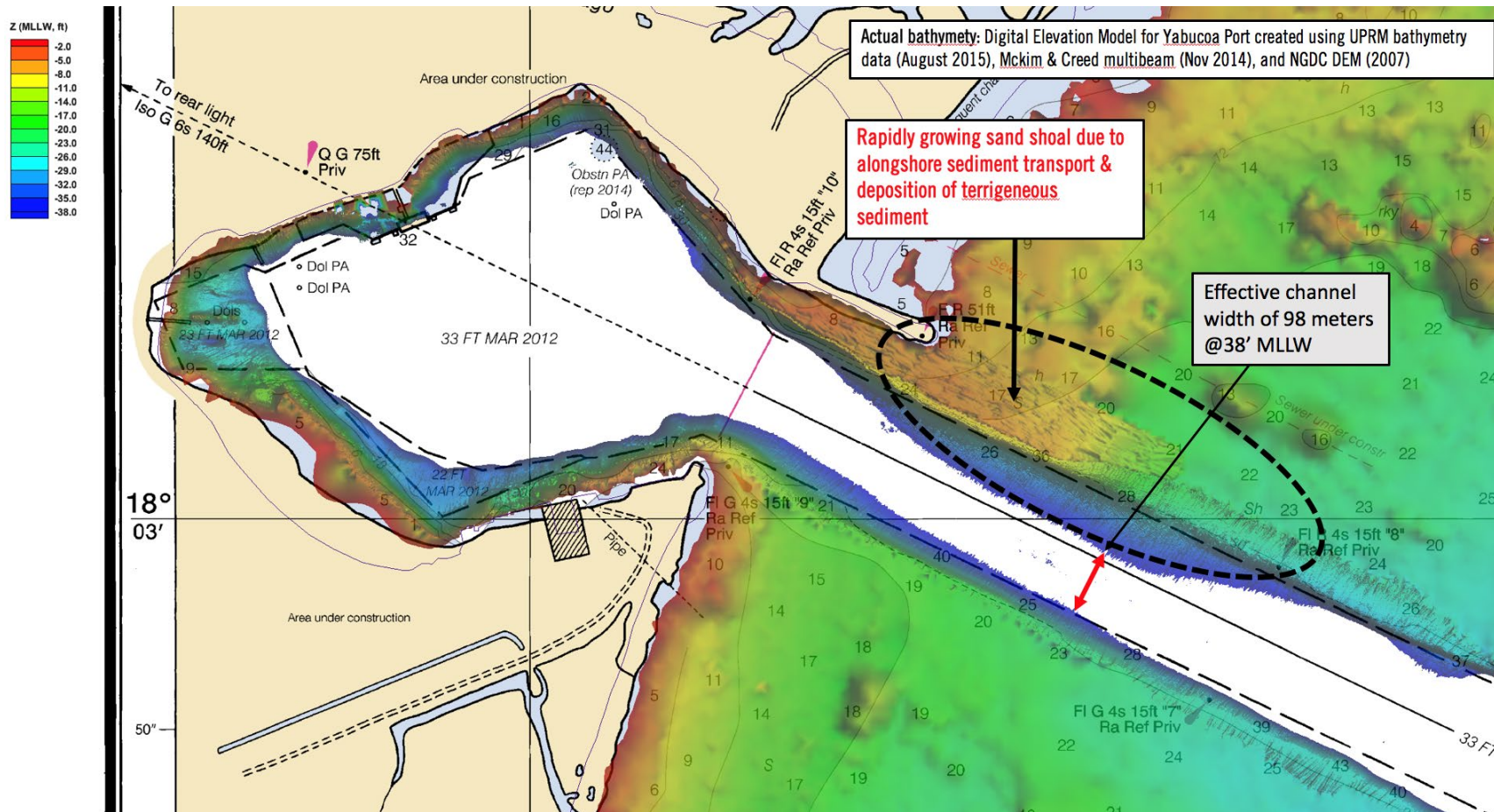


CARICOOS

CAOSE



# MARITIME SAFETY: Coastal intelligence in support of port OPS



Case study: Port of Yabucoa (work funded by Buckeye Global LLC)

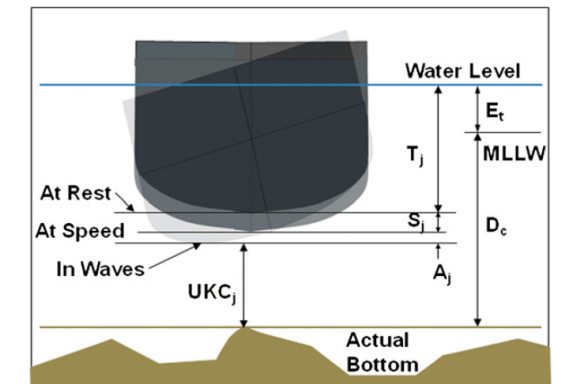
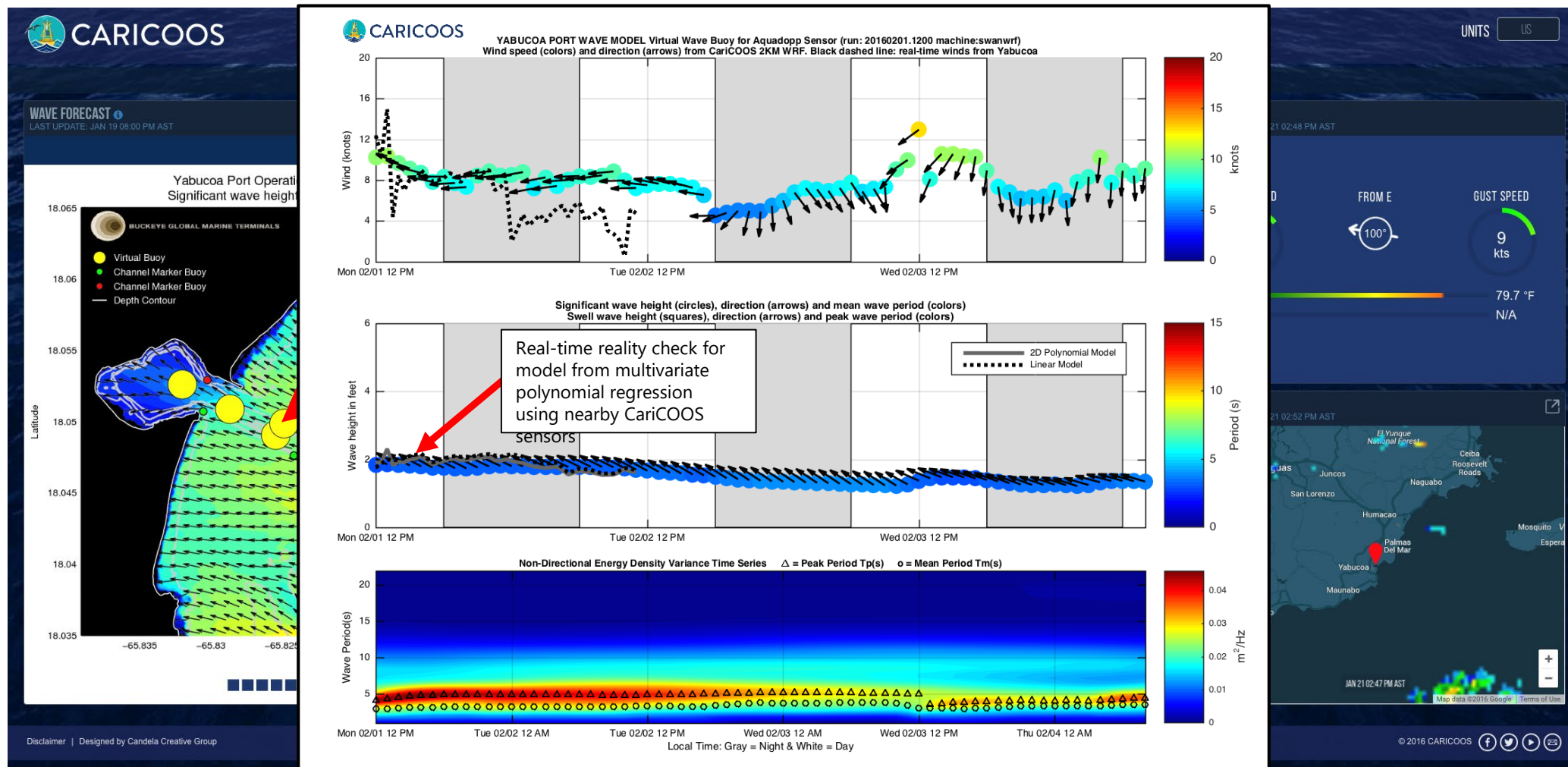


Fig. 1. Parameters defining the vertical position of a ship in a channel



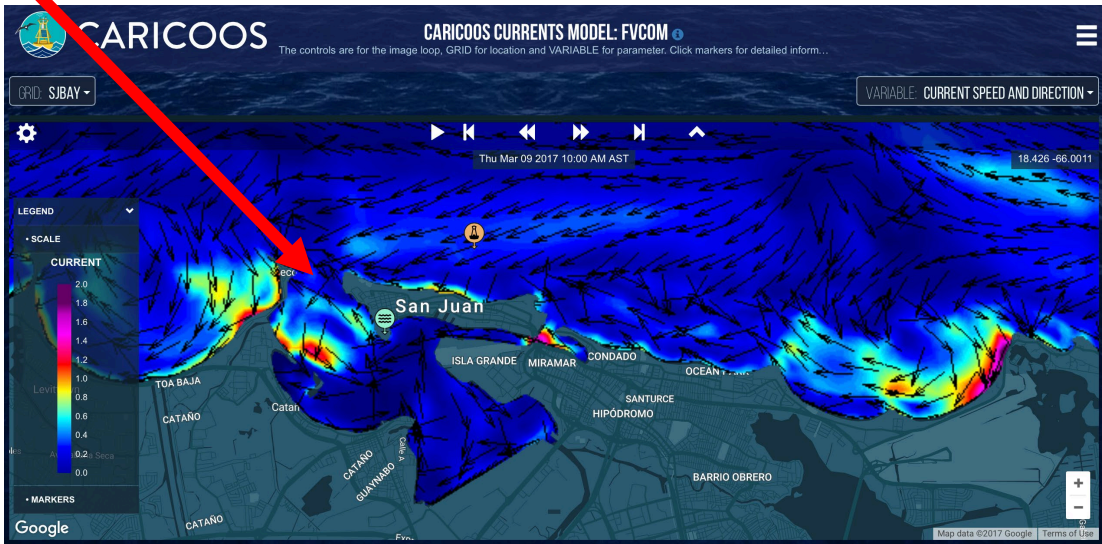
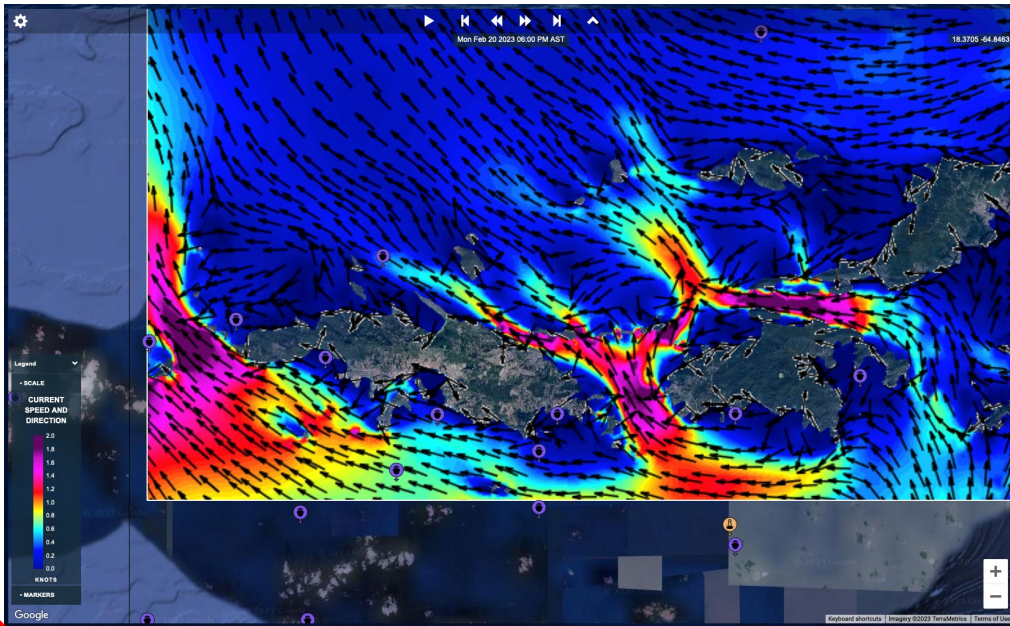
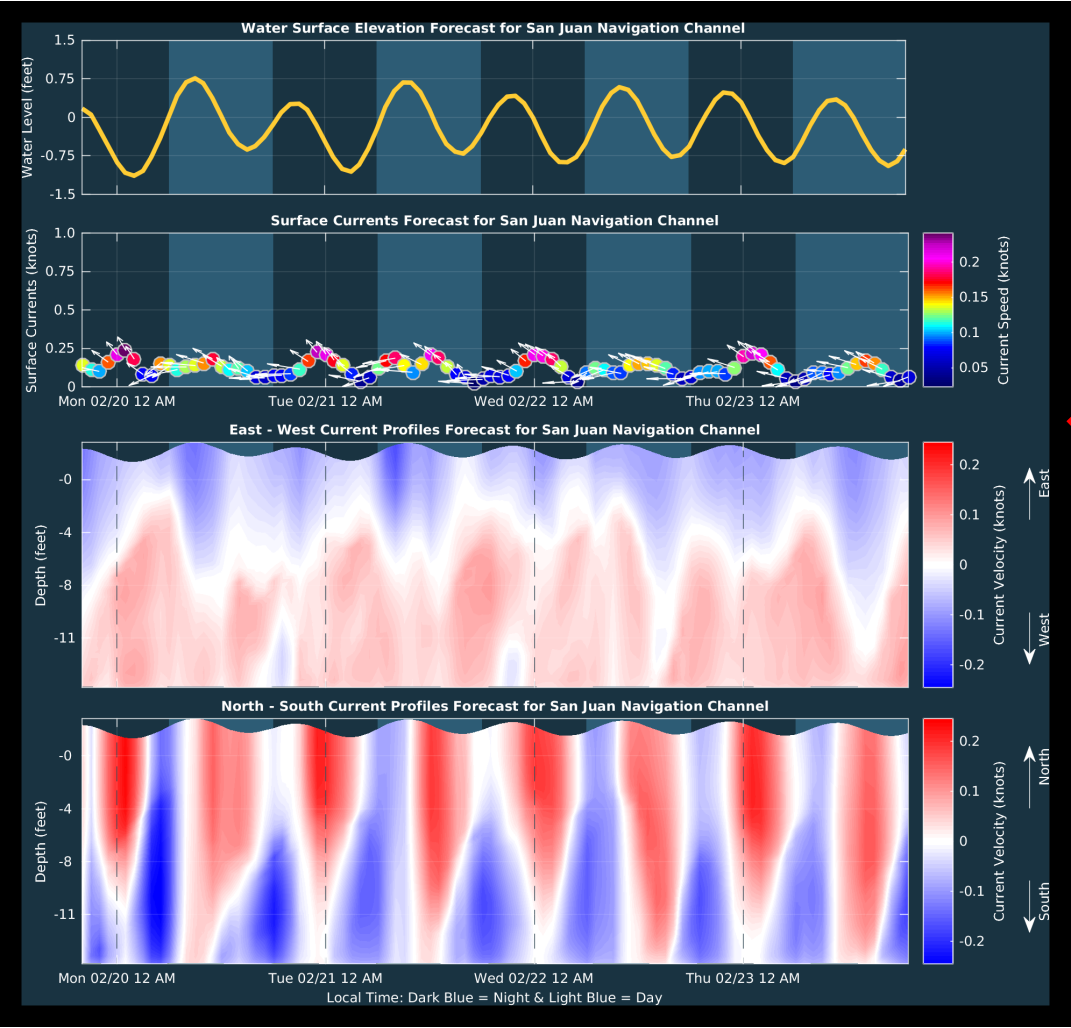
# MARITIME SAFETY: Yabucoa Port Metocean Observations and Prediction System



<http://yabucoa.caricoos.org/us>



# FVCOM at port scales: San Juan Bay and Port of Charlotte Amalie (ongoing work)



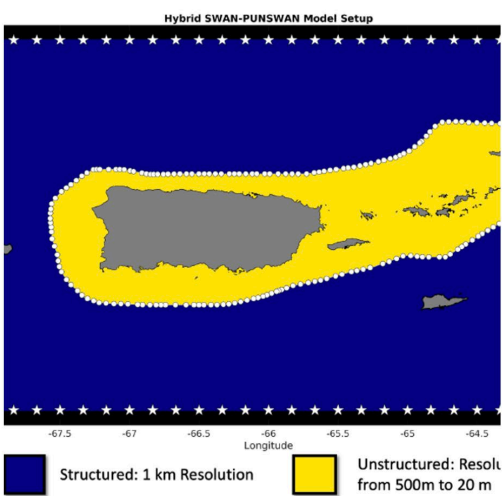


# LONG TERM PRODUCTS: The Puerto Rico/USVI High-Resolution Wave Climate Atlas

(Website: <https://www.caricoos.org/waveclimateatlas>)



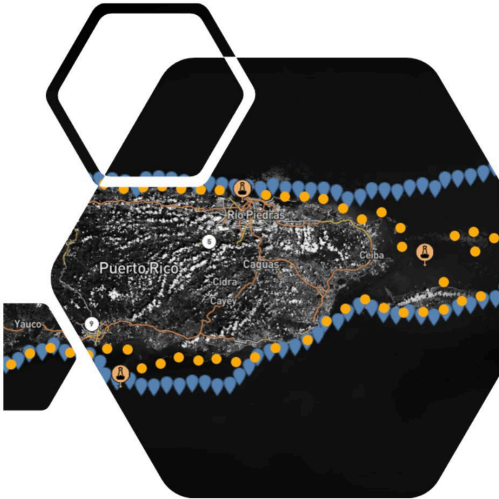
The Puerto Rico Wave Climate Atlas was funded by the [Puerto Rico Department of Natural Resources](#) (through the [Puerto Rico Coastal Zone Management Program](#)) and with funds from [The Puerto Rico Science, Technology and Research Trust](#). Administrative, financial and technical support was also provided by [UPR Sea Grant](#) and [CARICOOS](#). The Puerto Rico Wave Climate Atlas is a tool to analyze seasonal, interannual and long-term changes in Puerto Rico's wave climate over the 40-year period from 1979-2019 using very high-resolution numerical simulations. These simulations have been validated with CARICOOS buoy data to ensure the atlas accurately captures PR's wave climate. This atlas is meant to serve as a tool for scientists, planners, engineers and other professionals working in Puerto Rico's coastal zone. For technical or data access questions please contact the Principal Investigator Miguel F Canals Silander via email: [miguelf.canals@upr.edu](mailto:miguelf.canals@upr.edu).



TECHNICAL OVERVIEW

This page includes a brief technical description of the model setup, mesh, resolution, and wave and wind boundary conditions.

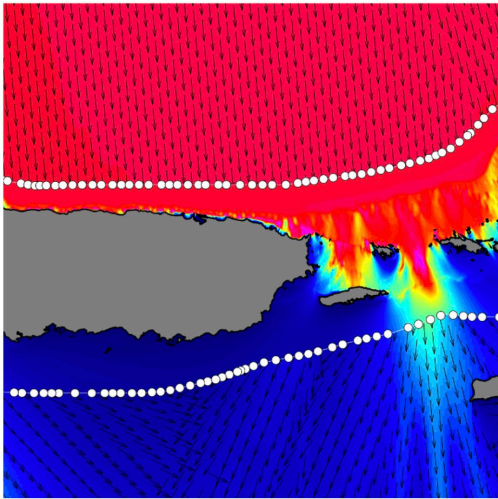
EXPLORE TECHNICAL ASPECTS



MODEL POINT OUTPUT

In this web interface, time series data and graphical products are provided at buoy locations and points along the 20-meter and 100-meter depth contours.

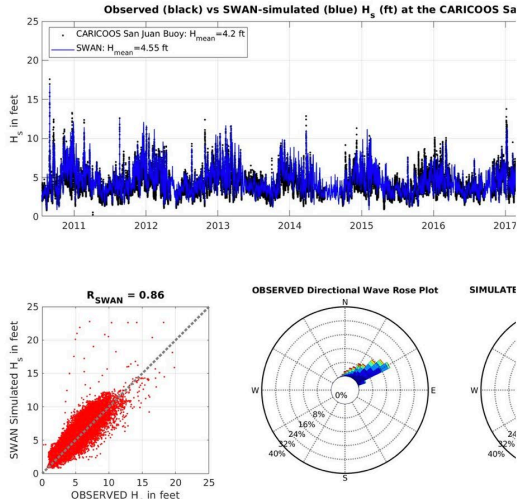
ACCESS POINT OUTPUT



MAP PRODUCTS

This page includes maps of average and extreme parameters such as wave height, wave power, and other spatially-variable quantities.

ACCESS MAP PRODUCTS



MODEL VALIDATION

To ensure the high fidelity of the simulations, the model has been validated using all buoy data during the CARICOOS era (2009 to present).

SEE MODEL PERFORMANCE



CARICOOS



Puerto Rico  
Science, Technology  
& Research Trust

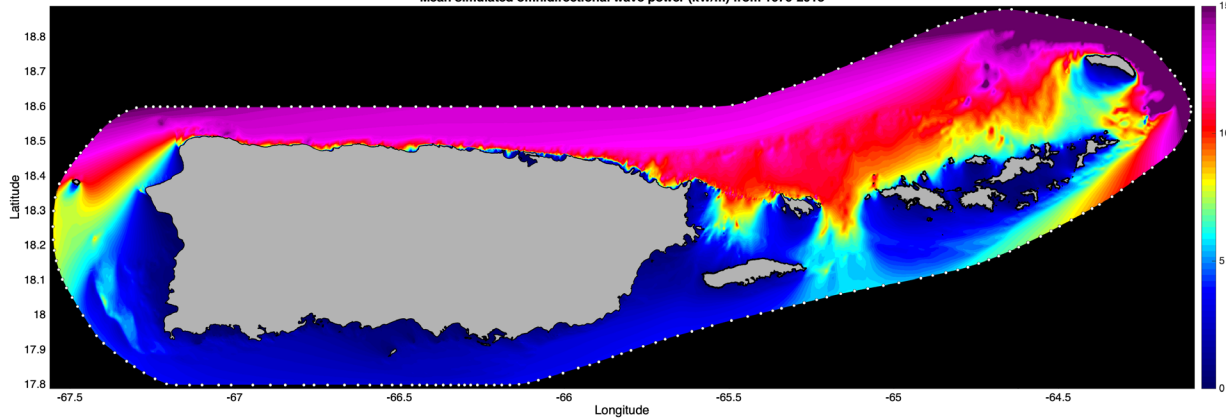


# DST Example: The Puerto Rico Ocean Energy Atlas

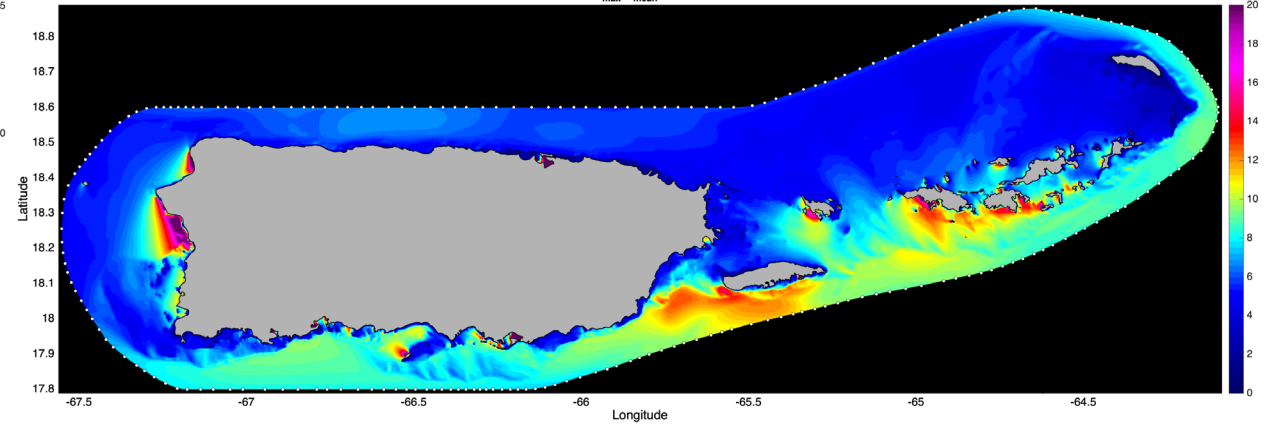
(Website: <http://www.canalsresearch.com/ocean-energy-atlas>)



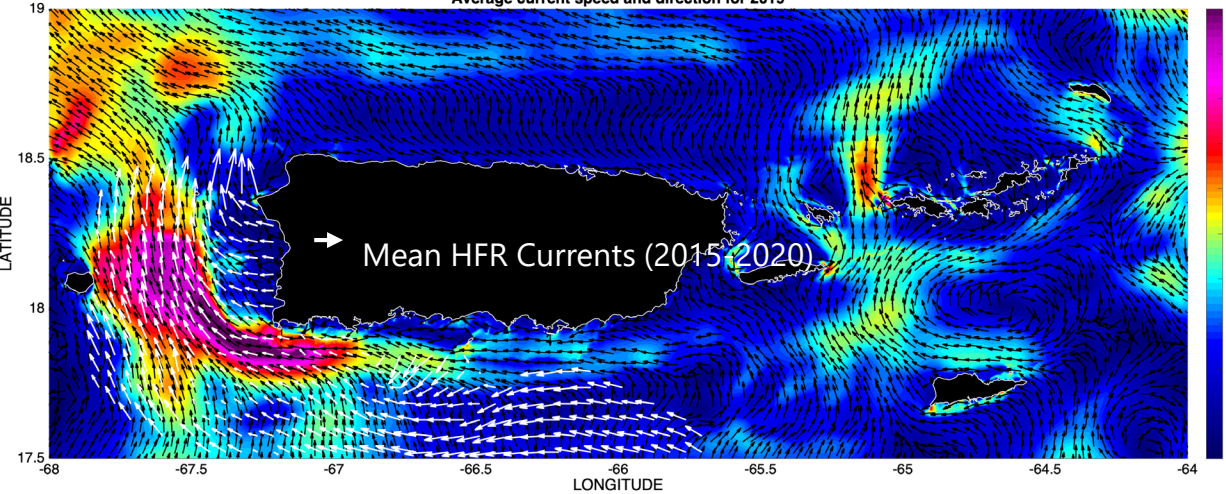
Mean simulated omnidirectional wave power (kW/m) from 1979-2018



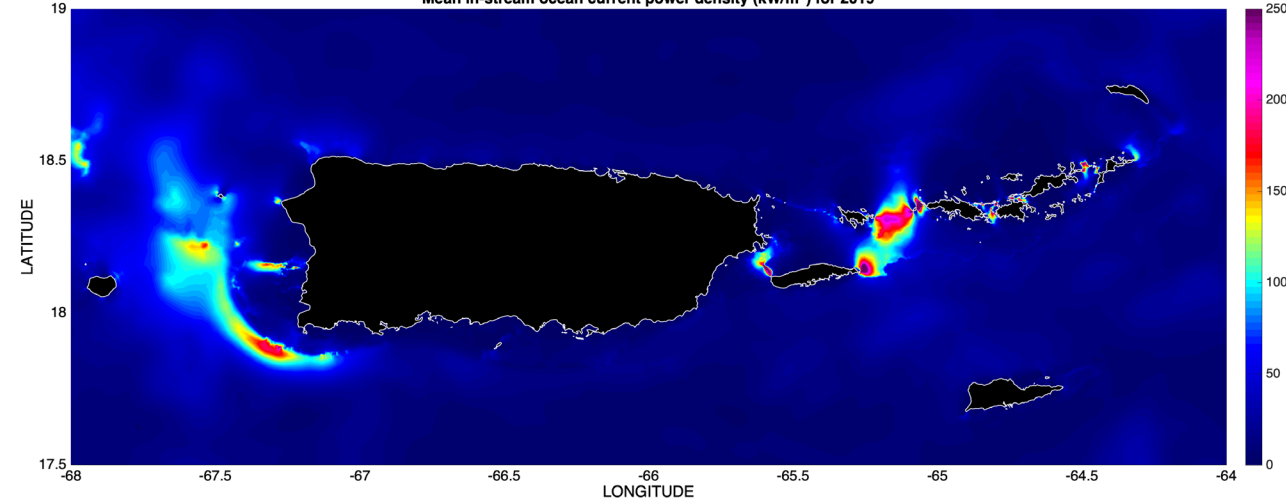
Risk Ratio ( $H_{max}/H_{mean}$ ) from 1979-2018



Average current speed and direction for 2019



Mean in-stream ocean current power density (kW/m<sup>2</sup>) for 2019



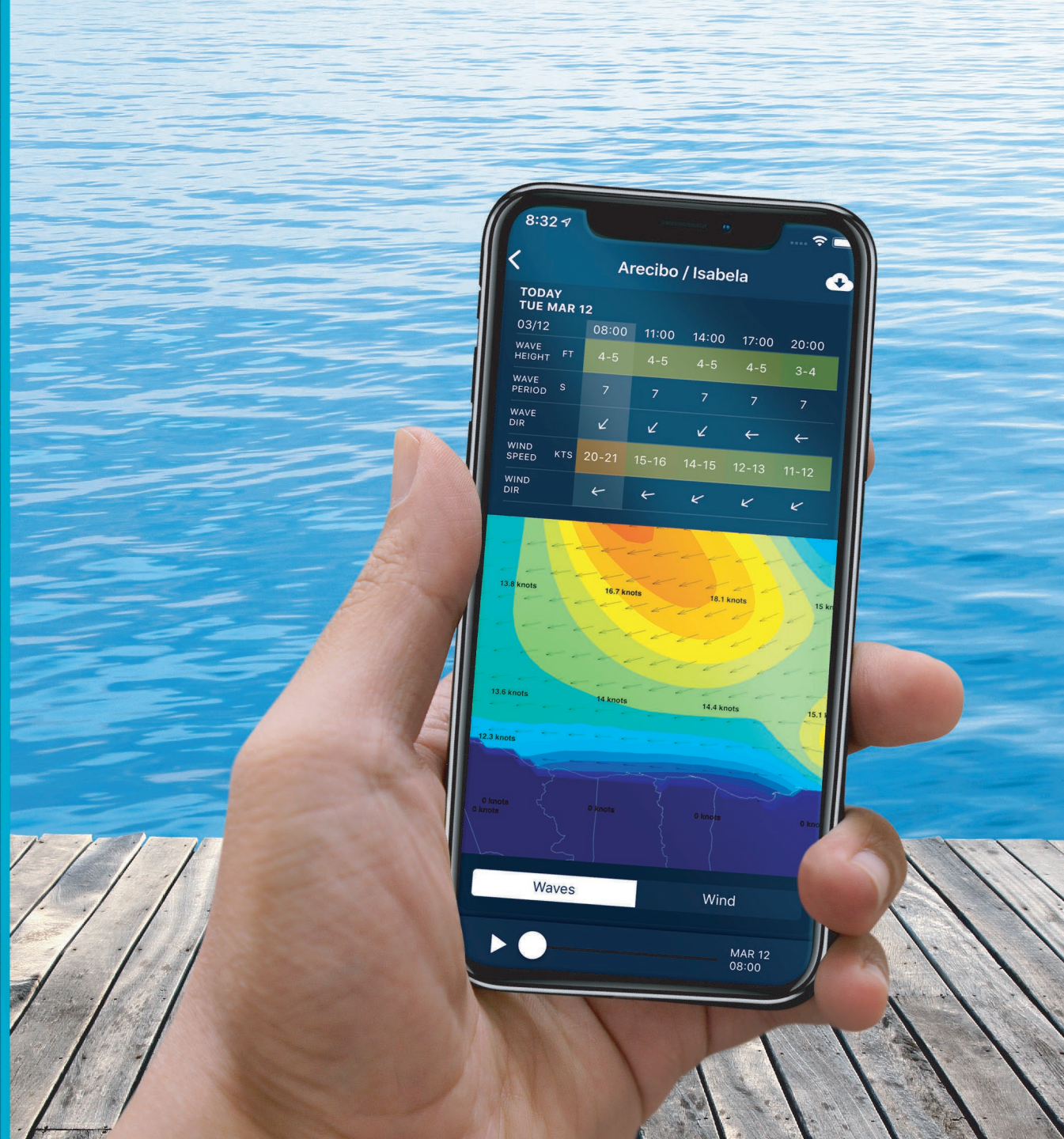




CARICOOS

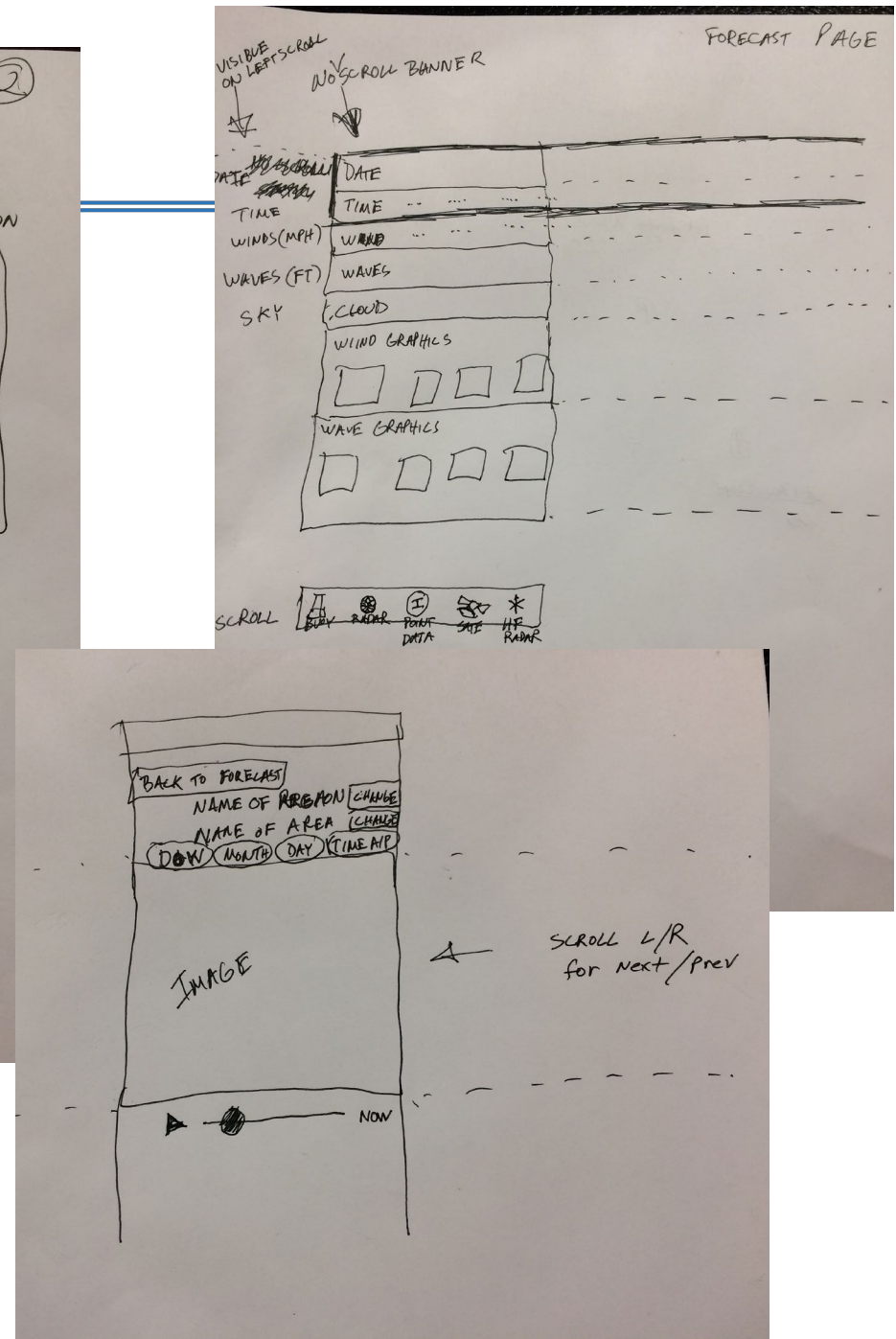
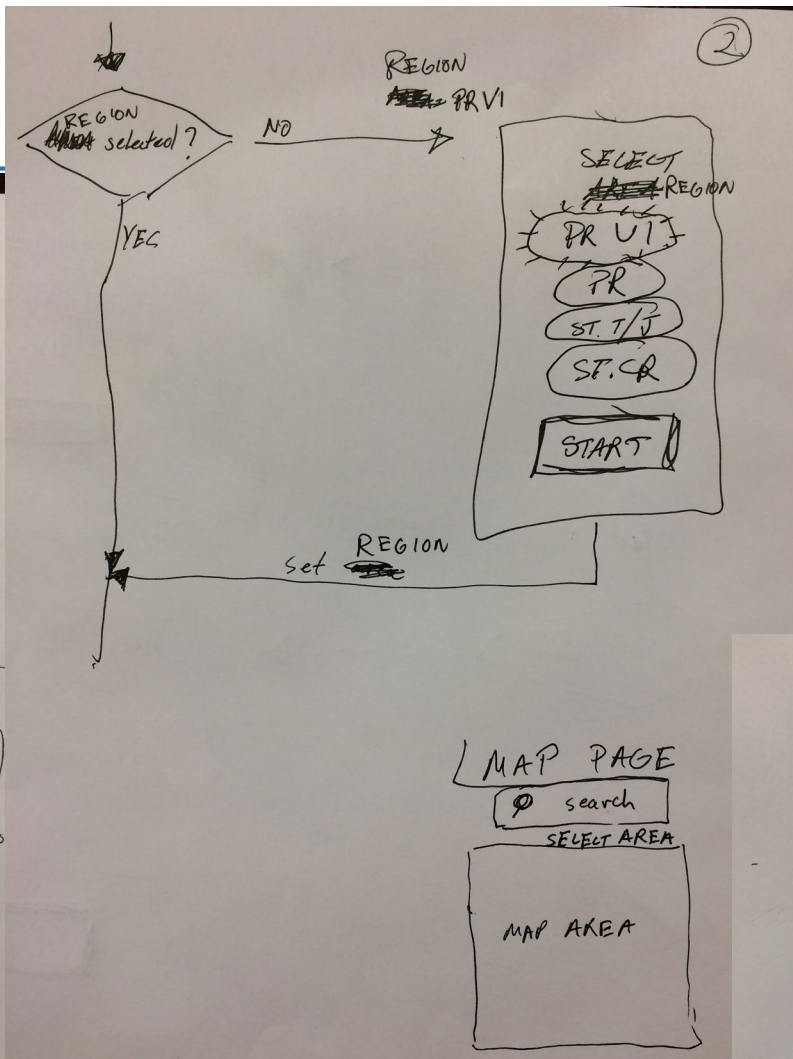
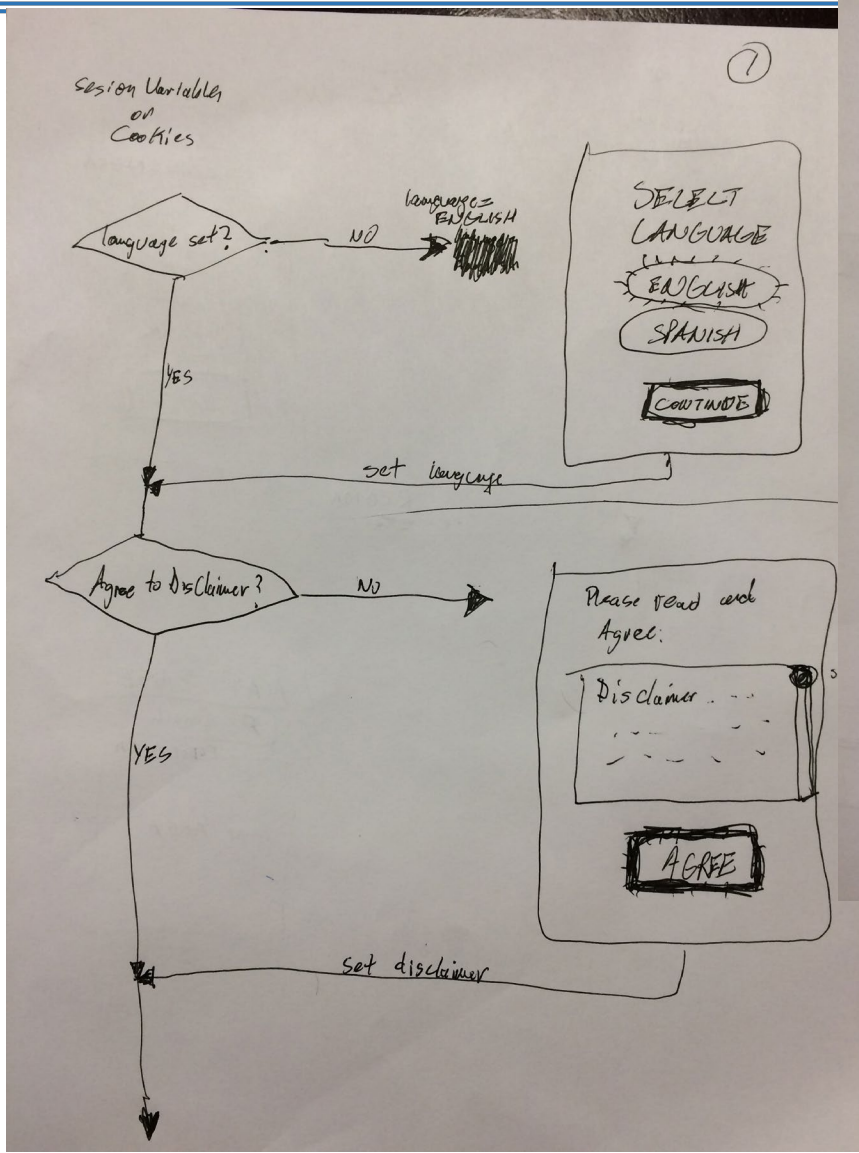
# BOATING APP

All you need to know  
before navigating in Puerto Rico  
and the Virgin Islands





# The design







CARICOOS

BOATING  
APP

# BOATING APP FEATURES

- Current Conditions: Wind, Waves, Tides and Meteorological
- Forecasts: Wind and Wave Forecasts from WRF and SWAN Models from Caricoos
- Other Forecasts: Tides and Meteorological from NWS
- Offline Mode to use in areas with no network coverage
- Weather Alerts from NWS
- Advanced caching system to increase speed
- English and Spanish
- Available for  







CARICOOS

## BOATING APP

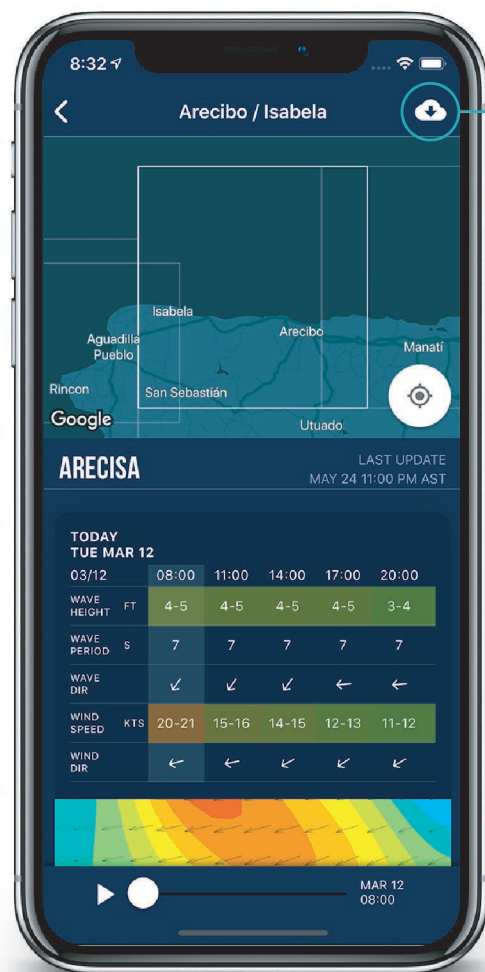
# NAVIGATION AREA DETAIL

### MAP

Shows Radar and allows to change to nearby Navigation Areas

### TABLE

Current Conditions and Forecasts in tabular form. Scroll horizontally for future dates

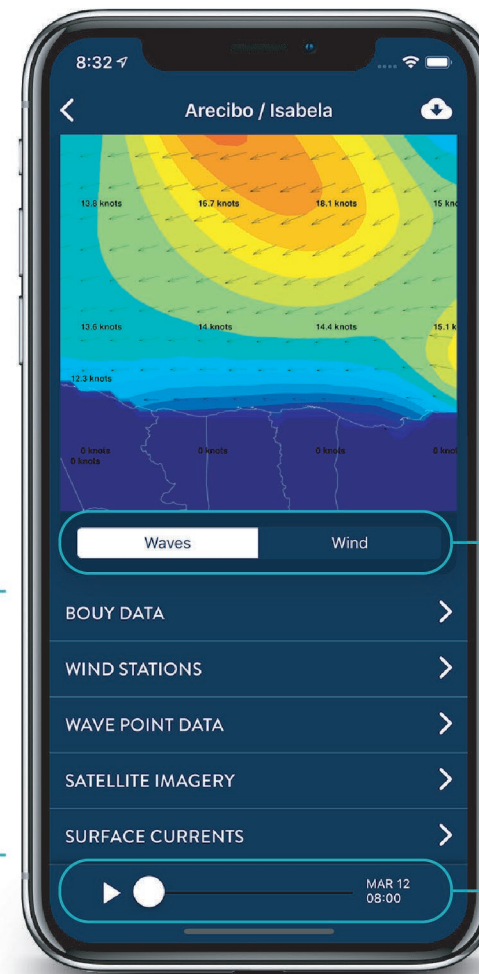


### DOWNLOAD

On/Off switch for Navigation Area Data Download for Offline View

### LINKS

Additional Resources



### GRAPHICS

Graphical Wind and Waves Forecasts for the Navigation Area

### TOGGLE

Select to view Wave or Wind Graphics

### ANIMATION CONTROLS

Play/Pause with Slider. Date and Time indicators





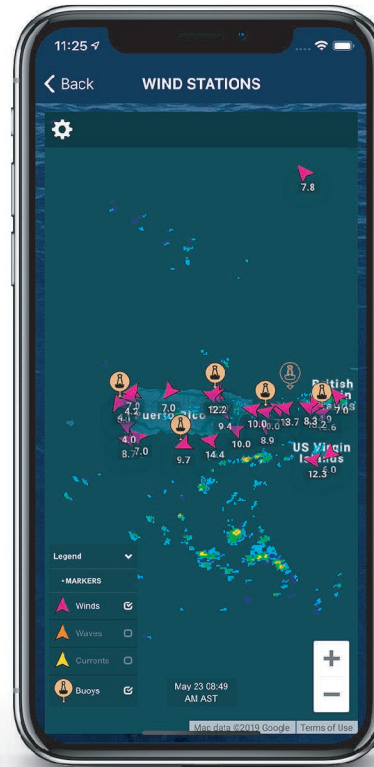
CARICOOS

BOATING  
APP

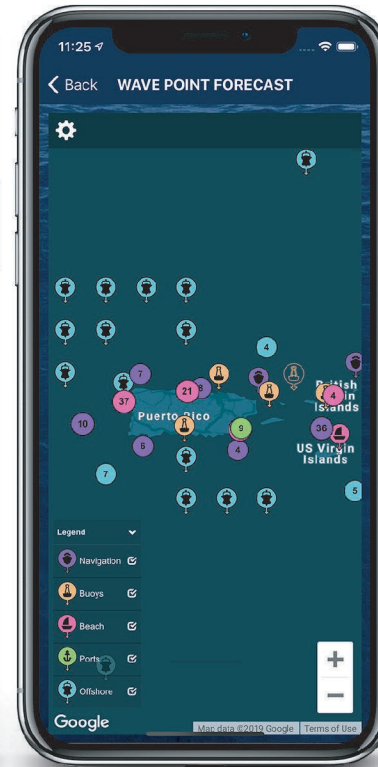
# ADDITIONAL RESOURCES



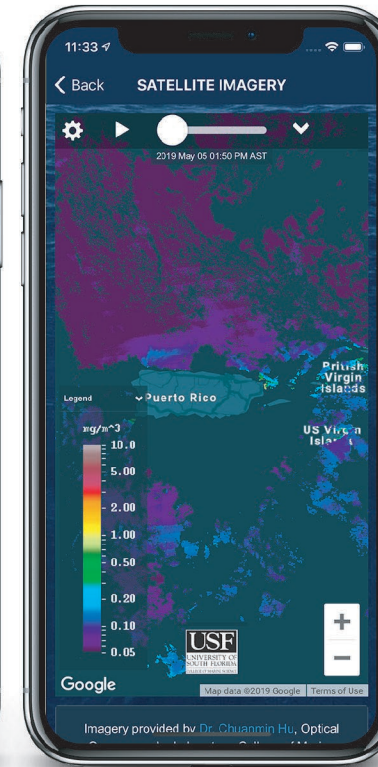
ALL CARICOOS  
BUOY DATA



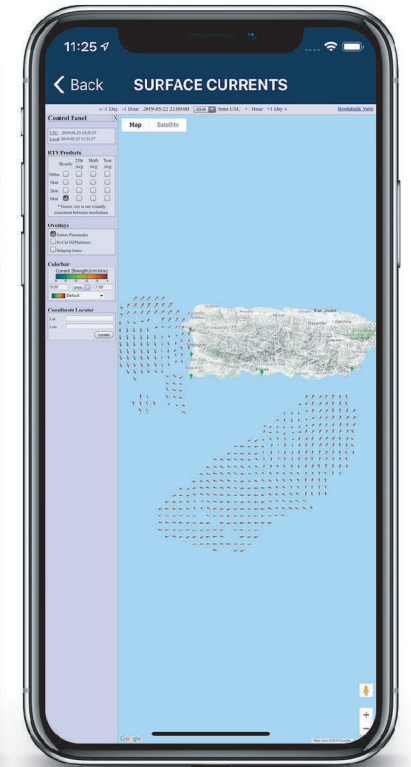
PR/VI WIND  
STATIONS



WAVE POINT FORECASTS  
(SWAN AND WWIII)



SATELLITE  
IMAGERY



HF RADAR  
SURFACE CURRENTS



An aerial photograph of a coastal city, likely Miami, showing a dense skyline of high-rise buildings along the shore. The ocean is a deep blue-green, with white-capped waves breaking in the distance. The sky is light blue with scattered white clouds. A white rectangular box is centered over the water, containing the word "GRACIAS" in bold black capital letters.

**GRACIAS**