



Operational Modeling of Waves, Winds and Currents in the US Caribbean

Miguel Canals, Patricia Chardón and Haibo Xu
CARICOOS / UPRM Center for Applied Ocean Science and Engineering
miguelf.canals@upr.edu / patricia.chardon@upr.edu

Performance Period: December 1, 2020 – May 30, 2021

LONG-TERM GOALS

Develop and maintain accurate, high-resolution operational wave, wind and ocean circulation models and forecast products with the goal of enhancing available information that supports decision-making by stakeholders in the maritime sector.

MILESTONES / OBJECTIVES

Wave modeling

The following table includes the **wave modeling** milestones / tasks as included in the FY20 scope of work, and their current status.

Milestone / Task	Original Completion Date	Status
Maintain and enhance CARICOOS Nearshore Wave Model	Continuous	Completed
Maintain and enhance the operational CARICOOS - Sea Grant Nearshore Breaker Model	Continuous	Completed
Continue operation of the Yabucoa Port Metocean observation and prediction system	Continuous	Completed
Numerical wave modeling in support of the CARICOOS Beach App & CARICOOS Boating App	Continuous	Completed
Final publication of CARICOOS Boating App	December 2020	Completed
Finalize web interface for Puerto Rico Wave Climate Atlas (ROP)	December 2020	The web interface has been completed and is available at



CARICOOS

CARIBBEAN COASTAL OCEAN OBSERVING SYSTEM

Milestone / Task	Original Completion Date	Status
		the CAOSE website, and is currently under migration to the CARICOOS webpage

Wind modeling

The following table includes the **wind modeling** milestones / tasks as included in the FY20 scope of work, and their current status.

Milestone / Task	Original Completion Date	Status
Maintain and enhance CARICOOS WRF Model (1 km & 2 km resolution)	Continuous	Completed

Circulation modeling

The following table includes the **circulation modeling** milestones / tasks as included in the FY20 scope of work, and their current status.

Milestone / Task	Original Completion Date	Status
Maintenance, validation, and improvement of CARICOOS FVCOM circulation model	Continuous	Complete, model is operational
Continue with the implementation of CARICOOS FVCOM to understand the hydrodynamics in La Parguera Marine Reserve (NOAA sponsored Ocean Acidification studies) and nearshore processes.	May 2020	Implementation of the model for La Parguera Marine Reserved was completed. The model is being validated.

WORK COMPLETED

Wave modeling



1. Maintain and enhance CARICOOS Nearshore Wave Model

The CARICOOS Nearshore Wave Model has run operationally without issues during the performance period. Work to transition to hybrid SWAN-PUNSWAN (structured-unstructured) implementation has begun. A new graduate student, Roy Marengo, has been hired and will work 50% of his time starting Fall 2021 with the implementation of SWAN-PUNSWAN as well as improvements in breaker modeling (see below)

2. Maintain and enhance the operational CARICOOS - Sea Grant Nearshore Breaker Model

Model has run operationally without issues during the performance period. As mentioned above, a new student has been hired to implement the Breaker Model into the new SWAN-PUNSWAN (structured-unstructured) CARICOOS Wave Model formulation. The work will include evaluating the use of 1D SWASH at selected locations to determine if it is possible to improve breaker height forecasts. This work is expected to be completed in FY21.

3. Continue operation of the Yabucoa Port Metocean observation and prediction system

Web interface has been operated without issues during the performance period, although the Yabucoa Port tide gauge, operated by NOAA NOS, has been out of service since Hurricane María in September 2017.

4. Numerical wave modeling in support of the CARICOOS Beach App & CARICOOS Boating App

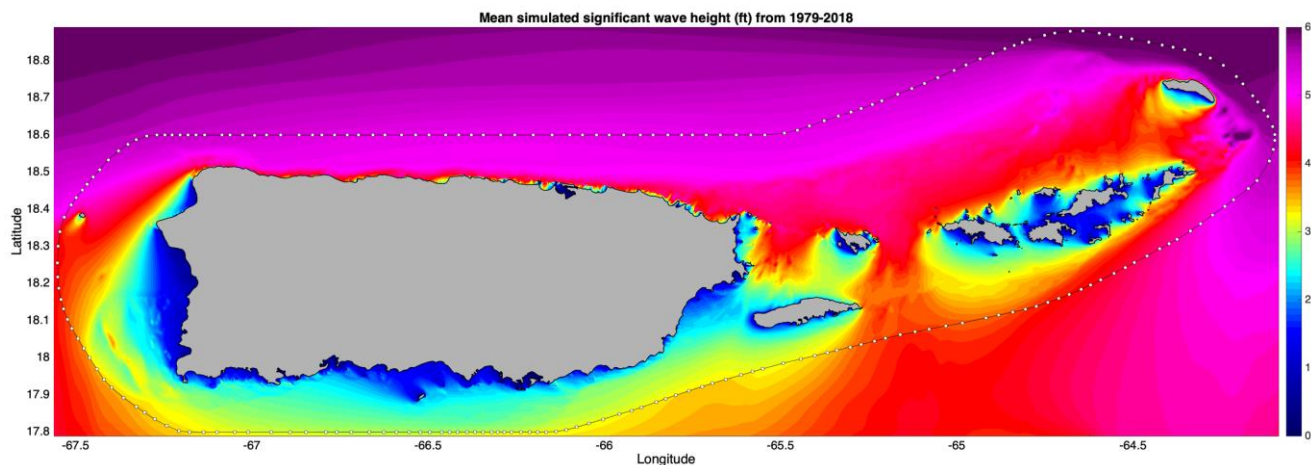
Scripts used to feed wave data to the CARICOOS Beach and Boating Apps have been functioning without issues during the performance period.

5. Final publication of CARICOOS Boating App

The CARICOOS Boating App was officially released to the public in December 2020 via the Google play and Apple App stores.

6. Finalize web interface for Puerto Rico Wave Climate Atlas (ROP)

The web interface for the climate atlas has been finalized and available at <http://www.canalsresearch.com/wave-climate-atlas>. Candela Creave Group was formally contracted in April 2021 to carry out the to its final URL (www.caricoos.org/waveatlas) as well the development of a wave climate calendar. While the bulk of the work has been completed, we expect that final migration will be finalized by August 2021. The figure below shows sample output from the atlas.



Wind modeling

1. Operate, maintain, and enhance CARICOOS WRF model (1 km & 2 km resolution)

The CARICOOS Operational Wind Model (COWM), based on the Weather Research Forecast (WRF)-NMM, have run without issues during this performance period. Efforts to improve model physics to better resolve the synoptic-, meso- and local-scale processes for a more accurate wind forecast on the coastal areas were performed with both WRF dynamical solvers, Advanced Research (ARW) and Non-hydrostatic Mesoscale Model (NMM). Simulations with WRF-ARW showed an improvement in the prediction accuracy of wind speed and direction. Work to transition to WRF-ARW has begun.

Circulation modeling

1. Maintenance, validation and improvement of CARICOOS FVCOM circulation model

In January 2021, the issues with HYCOM 3D data that began affecting FVCOM were resolved. Also, in January 2021 CARICOOS FVCOM lead student Haibo Xu finally obtained his Visa and has been able to return to Puerto Rico to resume his work running FVCOM operationally.

2. Continue with the implementation of CARICOOS FVCOM to understand the hydrodynamics in La Parguera Marine Reserve and nearshore processes

We are currently in the process of adjusting numerical and physical modeling parameters to improve the agreement between the model output and field data. For this, we are assessing different initial boundary condition sources and computational domain configurations.

MAJOR OUTCOMES

- All models have remained operational during the performance period.



CARICOOS

CARIBBEAN COASTAL OCEAN OBSERVING SYSTEM

WORK PLAN FOR UPCOMING PERFORMANCE PERIOD (June 1, 2021 – November 30, 2021)

1. Continue enhancement of the CARICOOS Nearshore Wave and Breaker Model, including transitioning to hybrid SWAN-PUNSWAN (structured-unstructured) implementation.
2. Begin training of new physical oceanography student Roy Marengo who will be assisting with CARICOOS wave modeling efforts under Co-PI Canals' supervision.
3. Continue enhancement of the CARICOOS Wind Forecast Model. A sensitivity analysis will be performed to improve the spatial resolution of the numerical domain (up to 500 meters). This initiative will help improve precipitation forecast for the CARICOOS beach water quality nowcasts.
4. Continue enhancement and validation of the CARICOOS FVCOM regional and coastal models.

RELATED PUBLICATIONS & PRODUCTS

None

RELATED PROJECTS

Oceanographic Pathways and Hydrodynamic Connectivity Between Marine Protected Areas in the US Virgin Islands and Eastern Puerto Rico. \$247k, March 2018 – December 2021, NOAA (through Caribbean Fishery Management Council)

Development of the Puerto Rico Digital Ocean Energy Atlas: Unlocking Puerto Rico's Marine Renewable Energy Potential, \$150k, August 2019 - July 2022, Puerto Rico Science and Technology Research Trust