Advancing the Caribbean Coastal Ocean Observing System

Program Performance Report

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1. Introduction:

In the period here reported all existing subsystems including observational and modeling capabilities as well as DMAC systems have been kept in operation and enhanced. A brief summary of the activities per sector / focus area is included below.

Operations in ports, harbors and approaches and emergency response

Implementations of very high-resolution (VHR) wind (WRF), wave (SWAN) and hydrodynamic (FVCOM) models during FY14 in San Juan and Yabucoa Harbor are undergoing rigorous validation before implementation in other critical port areas. VHR modeling for Yabucoa harbor and approaches, financed by Buckeye LLC, is approaching completion.

Observational data from CARICOOS HF Radars and drifters continues to support not only operations but also model validation for assessing the effectiveness of models available to USCG SAROPS via EDS. Also, drifters have been regularly deployed off western and southern Puerto Rico. In March 2016, CARICOOS will host a SAR community meeting with the purpose of sharing CARICOOS activities in their support including the installation of an additional HF Radar antenna in Maunabo (SE Puerto Rico).

Minimizing coastal hazards

CARICOOS has continued to participate in the IOOS-sponsored Coastal Ocean Modelling Testbed component focused on identification of numerical models capable of improving near real time storm and surge forecasts for the CARICOOS region. Also, the CARICOOS Nearshore Breaker Model (NBM), developed with PR Sea Grant support and utilized by San Juan WFO as part of their operational Surf Zone Forecast, is being further validated and enhanced.

CARICOOS keeps sponsoring a pilot beach monitoring program for coliform bacteria, performed by Surfrider Foundation. Also, Virtual Beach, an existing probabilistic model developed by EPA and implemented for two beaches in western PR, has yielded promising results and will undergo validation at other beaches in the region.

Coastal resource management

CARICOOS has continued offshore water monitoring efforts using 2 SEAGLIDER AUVs, in collaboration with NOAA-AOML. A graphical product, soon to be published, depicting existing near and subsurface temperature and anomalies in the region using SeaGlider data has been implemented and used for documenting the subsurface extension of a major anomaly reported by NOAA Coral Reef Watch program.

Funding by the NOAA Ocean Acidification Program has allowed continued operation of the MAP CO2 buoy and a discrete sampling program in collaboration with the U. of New

Hampshire. A parallel effort funded by CARICOOS has continued monitoring offshore-nearshore gradients of OA-pertinent parameters in La Parguera.

A project funded by the Caribbean Fisheries Management Council to examine the effectiveness of Marine Protected Areas (MPA) region is nearing completion. CARICOOS has hosted this effort through provision of data, computational facilities and logistic support.

Outreach and Engagement (O&E):

CARICOOS has procured presence in social media through regular publishing of focused messages informing about significant coastal "events" either observed and or forecasted by CARICOOS, periodical publication of CARICOOS news in bulletins, press releases and social media. We also have engaged stakeholders in the neighbor countries British Virgin Islands, Dominican Republic and Saba who have expressed interest in developing observing capabilities in their coastal waters.

2. Progress and Accomplishments

2.1. Observing subsystem:

Activity / Milestone	Progress
Operate and maintain the CARICOOS data buoy network including UVI's buoy.	All five buoys have been operational during the performance period, with no down-time except for a brief issue cell phone communications issue with the UVI/EPSCoR CARICOOS St. Thomas buoy.
Operate and maintain the CARICOOS Rincón Wave Buoy	The Rincón Wave Buoy was successfully refurbished and redeployed in June 2015 and has remained operational during the performance period, with data management support from CDIP/SCCOOS.
Operate and maintain WeatherFlow MESONET and CARICOOS WindNet	WeatherFlow MESONET: Financial support, via a P.O. was awarded to contractor WeatherFlow Inc. for the operation of a MESONET including thirteen weather stations located in Puerto Rico (XAGU, XCDP, XMRS, XYAB, XREY, XGUR, and XJUA) and six in the USVI (XCRX, XWGO, XBUK, XBRO, XSAV, and XRUP). A maintenance visit was carried out by WeatherFlow on station XYAB located in the Port of Yabucoa, PR during the reporting period. Final approval from the USCG has been granted to WeatherFlow to install a new site at Culebrita Lighthouse, prior authorization from the Municipality of Culebra had been arranged. Data acquired from WeatherFlow MESONET are sent to CARICOOS

	and MADIS. CARICOOS disseminates the data via its THREDDS server and the NWS Global Telecommunication System (GTS). CARICOOS WindNet: Support is continued to maintain two weather stations located in Puerto Rico (PTRP4 and IMGP4). Spares purchase and periodic site maintenance visit were carried out during this reporting period by CARICOOS personnel. All data collected from these two sites are disseminated via CARICOOS THREDDS server and NDBC and made available via Global Telecommunication System (GTS).
Operate and Maintain CARICOOS HF Radar surface current monitoring system Enhance the CARICOOS HF Radar network by: • moving the FURA antenna to Rincón Lighthouse, if the site is deemed as a feasible HFR location • rental of additional HFR unit from Rutgers and installation at site in St. Croix or alternate location is St. Croix is unsuitable.	All four HFR stations have been operational during the performance period except for a period of several weeks after the passing of Tropical Storm Erika near our region. Installation of an HFR antenna at the original St. Croix location has been postponed due to logistical challenges. A suitable location was identified at the Maunabo Lighthouse in Puerto Rico's southeast coast. The permitting process has been completed and installation has commenced as of early December. The station (a rental unit from RUCOOL) is expected to become operational in late December 2015 or early January 2016. A decision on whether to move the FURA station to the Rincón Lighthouse will be made in early 2016 after further consultation with our partners at RUCOOL/MARACOOS.
Operate and maintain MAP CO_2 buoy and continue discrete sampling program under NOAA's Ocean Acidification program	All logistic arrangements are in place for the yearly maintenance of the La Parguera MAP CO2 buoy. Biweekly sampling for analysis of carbonate chemistry at selected sites has been carried out as proposed. A subaward to J. Salisbury, (U. New Hampshire) has been formalized for their collaboration in the CARICOOS OA program.
Continued dissemination of remotely sensed water quality products for the region	Ocean color imagery (Chl a and K490) collected by MODIS and VIIRS sensor has continued to be published daily at the CARICOOS webpage.
Deployment of Lagrangian drifters, both surface and SVP	2 CARICOOS drifters and two AOML SVP drifters were deployed from Saba Island during October 2015.

Deployment of side-looking Aquadopp at Port of Charlotte Amalie by UVI personnel	CARICOOS-UVI personnel have engaged Charlotte Amalie harbor pilots and the VI Port Authority. The type of current meter to be used has been selected and is currently being purchased by UVI personnel.

2.2. Modeling subsystem:

Activity / Milestone	Progress
Maintain and enhance operational high resolution WRF (weather) and SWAN (wave) model implementations	WRF: CARICOOS employs three operational configurations of the WRF NMM model. (1) The CARICOOS WRF 2km model setup is now operational and redundant, and runs in two independent servers twice a day on cycles 00Z and 12Z providing a 120-hour forecast. (2) The CARICOOS WRF 2km backup for NWS WFO SJU is run on operationally four times a day on cycles 00Z, 06Z, 12Z, and 18Z and provides a 72-hour forecast. (3) The CARICOOS WRF 1km model setup runs once a day on cycle 00Z and provides a 72-hour forecast. A sensitivity analysis of the 1km model configuration was performed employing different initial conditions of skin temperature and soil moisture gathered from NCEP NWP high-resolution models for the region. The graphical forecast and data are available via CARICOOS website. SWAN: Two versions of the operational CARICOOS Nearshore Wave Model are currently running: one is forced by the NWS NDFD operational wind model, and the second version is forced with CARICOOS WRF 2-km model output.
Maintain and enhance the operational CARICOOS - Sea Grant Nearshore Breaker Model	The CARICOOS Sea Grant Nearshore Breaker Model has remained operational and has been enhanced thorugh the inclusion of CARICOOS WRF wind forcing into SWAN. In addition, several additional beaches (Tres Palmas, St. Regis) have been added in response to requests from stakeholders.
Continue implementation of FVCOM for San Juan Bay	A mesh for Puerto Rico and the US Virgin Islands and a mesh for the San Juan Bay Estuary System have been constructed. These meshes have been stitched together to create the base hydrodynamic mesh for the operational model. Mr. Adail Rivera, the graduate stduent leading the FVCOM implementation, attended the 2015 FVCOM User's Workshop in Nova Scotia, Canada.

Commence FVCOM simulations for Parguera	No FVCOM simulations for Parguera have been conducted yet. Work during the first half of FY15 has focused on FVCOM implementation for San Juan Bay.
Evaluation of EPA's Virtual Beach as a pathogen forecasting tool for public beaches in Puerto Rico. A pilot study will be conducted for beaches in Rincón, PR to assess the feasibility of adopting EPA's Virtual Beach as a statistical tool to develop local predictive models for occurrence of beach pathogens.	A predictive model, currently running on hindcast mode, has been developed for Rincón Public Beach, where the most data for dependent and independent variables exist. The model is capable of predicting exceedance in enterococcus bacteria fairly well (high sensitivity), yet it struggles at predicting bacteria levels below the allowable limit (low specificity), which is the main component of the current fine-tuning stage. This exercise suggests that Virtual Beach promises to be a powerful tool for developing forecasting models for beach water quality in the region, yet it requires significant amount on data collection (for the modeling development stage) and parallel forecasting tools (such as rain accumulation) for the operational forecasting stage.
Exploration of the Delft3D suite of models as a potential tool for 3D simulation of nearshore hydrodynamics and water quality	This is an ongoing activity. The entire Delft3D suite of modules has been compiled successfully, and sample simulations, including water quality, have been also successfully completed. This will become a joint effort between CARICOOS and Sea Grant starting in 2016.
Implement the WRF-ARW wind model for improved representation of sea breeze dynamics	Experimental configuration of the WRF-ARW model continues to operate on a 24/7-basis, with the model running once a day on cycle 00Z, providing a 30-hour forecast. The WRF-ARW model has been implemented at a resolution of 500m at San Juan Bay, PR and the Port of Yabucoa, PR. Validation of modeled 10 m winds and 2m air temperature vs. CARICOOS in situ observations has revealed an improved forecast of sea and land when breeze dynamics when compared to the CARICOOS WRF NMM model configurations.
Implement WRF wind forcing in SWAN and compare performance vs. NDFD	Output from the 2 km resolution WRF implementation is now being used to force the operational CARICOOS Nearshore Wave Model.
Further improve CARICOOS ROMS by: • Continue validation of CARICOOS-ROMS • Securing a technical review of the current CARICOOS ROMS	Validation of CARICOOS ROMS with HF Radar and drifter data has been ongoing. Dr. John Wilkin has been hired by CARICOOS as a consultant to assist with model development and improvement. Dr. Wilkin is currently conducting a rigorous technical review of the existing system. No work on data assimilation has begun; idealized assimilation experiments are expected to begin in Spring 2016.

implementation by external consultant • transitioning ROMS operations from UTD to UPRM • beginning 4D-VAR assimilation experiments	
Continued participation in IOOS Coastal and Ocean Modeling Testbed for Puerto Rico and the Virgin Islands	CARICOOS participation, led by Prof. A. Mercado has continued as programmed. An extension of the project has been granted. Prof. Mercado will serve as P.I. in the upcoming cycle

2.3. Data management and dissemination subsystem:

Activity / Milestone	Progress
Continued development of CARICOOS DMAC subsystem while meeting IOOS requirements	DMAC systems and services up and running. During the performance period, DMAC-related work has focused on: • Performing compliance checking on our NetCDF file holdings, in collaboration with Mr. Mathew Biddle of NCEI. • Initiated the crafting and implementation of the CARICOOS Data Archiving plan, in collaboration with Mr. Mathew Biddle of NCEI. • Currently working with NetCDF non-compliance issues (mostly in standard names) in the buoy data files. • An upload directory has been created in one of our servers for NCEI to fetch our data files for archival. Currently being tested by NCEI. • Finalizing the DMAC SOP.
Deployment and optimization of CARICOOS new web interface	Development and deployment of the new CARICOOS.org has taken longer than expected but is reaching the final stage of page optimization and beta testing. New buoy pages are up and running, but not yet public. Final website version should be ready in February 2016.
Operate and maintain CARICOOS data streams, data products and dissemination interfaces	Our data streams, data products and dissemination interfaces are fully operational; their maintenance is a constant task. Development of the CARICOOS Explorer by RPS ASA continues.

Operate, maintain and upgrade computational infrastructure	All servers are up and operational. A new computational server was brought online for particle tracking calculations and data storage. Server loads have been balanced between our Mayaguez and Isla Magueyes server rooms. We will proceed with plans to migrate our Mayaguez computational assets into a designated, dedicated and climate-controlled, server area within UPRM. A cloud-based THREDDS mirror will be implemented in Spring 2016 for robustness.
Develop new specific data products in response to stakeholder needs	Several new products and visualization tools will be available in the upcoming CARICOOS website.
Operational deployment of new website	Operational deployment is slated for Spring 2016.
Historic metadata archival	This entry should read “Historic data archival.” Metadata are archived with the data. Initiated the crafting and implementation of the CARICOOS Data Archiving plan, in collaboration with Mr. Mathew Biddle of NCEI. Currently working with NetCDF non-compliance issues (mostly in standard names) in the buoy data files.

2.4. Outreach and Education (O&E) subsystem:

Activity / Milestone	Progress
Continue O&E formal and informal activities focused on enhancing awareness and appropriate utilization of CARICOOS products and services	CARICOOS continues issuance of quarterly newsletters and Facebook posts to enhance awareness of CARICOOS products and services. Product-oriented workshops for specific user groups have been postponed for the next cycle once the new webpage is fully operational. A new flyer with CARICOOS' new branding has been developed and distributed at various events where CARICOOS has set up its booth. These include surfing festivals, local conferences, and educational activities in collaboration with Sea Grant Puerto Rico.
Continued assessment of stakeholder/user needs	The results of the recreational need assessment survey developed and distributed during last reporting cycle were released this past summer. These findings, along with a direct consultation with CARICOOS Inc. Board of Director which took place during a formal meeting on 08-04-15 informed CARICOOS 5-yr proposal. Additionally, CARICOOS continues to engage new partners, such as the Environmental Quality Board (and others).
Continued engagement of the SAR community in the region	CARICOOS has remained in close contact with USCG regarding the expansion of the CARICOOS HFR network, and specific recommendations have been received from USCG SAR personnel regarding prioritization of future HFR sites.
Continue and enhance communication and consultation between CARICOOS, CaRA, regional programs, IOOS and IOOS Association	CARICOOS has been duly represented at all IOOS and IOOS Association meeting and teleconferences and the past IOOS Advisory Board meeting held in St. Thomas USVI. GOMOOS, SECOORA and CARICOOS co-organized the Climate Change and Fisheries Workshop on October in St. Petersburg Fla.
Provide support to CARICOOS Inc. (formerly CaRA) which will allow its development toward certification and operation as a Regional Information Coordination Entity as defined by the ICOOS Act (2009)	Activities during toward certification include acceptance of a filed revision of By-Laws and CaRA's certificate of incorporation evolving into CARICOOS INC. H. Kerkering was retained for assistance in procedures required prior to application for certification.

3. Leadership Personnel and Organizational Structure

- Dr. Silvia Rodríguez has been appointed as Deputy Director. She will assist Directors Morell and Canals in overall management of the project and lead the communication and educational initiatives. She will continue co-leading the water quality team.

4. Budget

- No major modifications required. All sub-awards have been duly formalized with the exception of the Subaward to CARICOOS Inc. pending formalization of a MOA with UPRM which will minimize its administrative structure and operational costs.

4.1. Personnel

- Dr. Juan Gonzalez has been hired as a postdoc. His main duties include active participation in hydrodynamic modelling efforts (ROMS and FVCOM) as well as collaboration in the DMAC team.