

Advancing Coastal Intelligence in the US Caribbean: Surface Currents

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Performance Period: December 1, 2017 – June 1, 2018

LONG-TERM GOALS

Rutgers University Center for Ocean Observing Leadership (RUCOOL) is a global leader in High-Frequency radar (HFR) network implementation and management. Through this proposal, RUCOOL looks to assist CariCOOS in the expansion and operation of their HFR network. The US Coast Guard has identified the ocean surface current data from the five existing HFR stations as an important resource for their search and rescue activities. The real-time surface current information improves the decision-making capabilities during critical lifesaving search and rescue missions.

The HFR network is part of the observational sensor subsystem for CariCOOS. The other subsystem for CariCOOS is a modeling and forecast component. The subsystem is comprised of wave, storm surge, wind and ocean circulation models. The ocean circulation model is based upon the Regional Ocean Modeling System (ROMS). The goal of this proposal is to compare the surface current measurements of the HF radar network with the output of the circulation model and test the capability of the other models to assimilate the measured ocean surface current data.

MILESTONES / OBJECTIVES

1. Identify weather events where the use of surface current data may impact wave, circulation and surge models
2. Develop validation metrics for the comparison of the HFR data with the models
3. Measure observation impact and skill on the suite of models
4. Reestablish HFR Network after Hurricane Maria with hourly totals operational
5. Extend HFR Network Coverage with new sites
6. Track Sargassum seaweed movement with surface current data
7. Develop algorithm to identify high floating algae areas for tracking
8. Use ocean current forecasting models to predict movement of Sargassum Seaweed

WORK COMPLETED

1. The funding for year 2 did not arrive until February 2018. We have requested a no cost extension and plan to complete milestones 1-3 in the summer of 2018. Below is a summary of the radar operations for the progress period.
2. The HF radar data is comprised of radial and total vector data. The radial data availability over the progress period is provided in Figure 1. Totals are typically created on a 2 km and 6 km grid. The radars that are responsible for the 2 km grid just came back online so only monthly plots from the 6 km grid are shown in Figure 2.
3. The radars in Puerto Rico were taken down before Hurricane Maria made landfall on September 20, 2017. PYFC became operational on December 15, 2017. FARO followed and became operational on February 20, 2018. On February 21st hourly totals became operational again. After MABO became operational on April 4th, 2018, coverage of southern Puerto Rico expanded by April 13th, 2018. After the coverage expansion with the 5 MHz sites, two 13 MHz (CDDO and FURA) are in process of being made operational again.
4. [Powerpoint presentations](#) created providing background information on the Sargassum Seaweed problem in the Caribbean were created.
5. The process for tracking Sargassum seaweed is still under development but has taken priority due to the record high bloom of the seaweed this year¹. Currently the process entails utilizing images of floating algae density maps ([Figure 3](#)), provided by the University of Southern Florida's Optical Oceanography Laboratory, and running these images through an image processing algorithm that identifies and clusters the higher concentrations of floating algae. The points with the greatest potential of being Sargassum seaweed are then identified ([Figure 4](#)). The latitude and longitude for the centroids of the clusters are used as starting locations for virtual drifter particles. The virtual particles are then advected using the HF Radar network ([Figure 5](#)) or the AMSEAS model. The images use raw satellite data and USF's floating algae index (FAI) to identify floating algae and other materials on the ocean surface.
6. [Daily drifter animations](#) of the southern coast of Puerto Rico have been created, for April to September 2017. For 2018, daily drifter animations have been generated for the months of April, May, and June up to the current date. The images cover a 150 km range with a 12 km resolution. The animations can be seen in separately attached zip file containing all generated gifs.
7. Monthly idealized and measured [mean vectors](#) and [mean percent coverage](#) plots have been compiled tracing back to June 2017 and up to May 2018. This can be seen in the separately attached PowerPoint files.
8. [Photo compilation of HF Radar](#) sites before Hurricane Maria made landfall and after, for site cleanups, restorations, and repairs can be seen in separately attached PowerPoint file.

¹ Langin, K. (2018) "Mysterious masses of seaweed assault Caribbean islands" *Science*, [doi:10.1126/science.aau4441](https://doi.org/10.1126/science.aau4441)

MAJOR OUTCOMES

In preparation for Hurricane Maria the five HF radars in Puerto Rico were taken down and have been in the process of being operational again since December 15th. The 5 MHz radars all became operational by April 13, 2018 and the two 13 MHz stations (CDDO and FURA) are in progress of being operational as of May 31, 2018. The majority of the progress period was spent restoring operational status to the sites.

A web portal is currently under development/renovation in order to publish all work online and provide an access point to all the figures and animations that may be useful for tracking Sargassum seaweed. Looking to the future, ocean current forecasting models are being considered and tested to try and predict where Sargassum seaweed may flow.

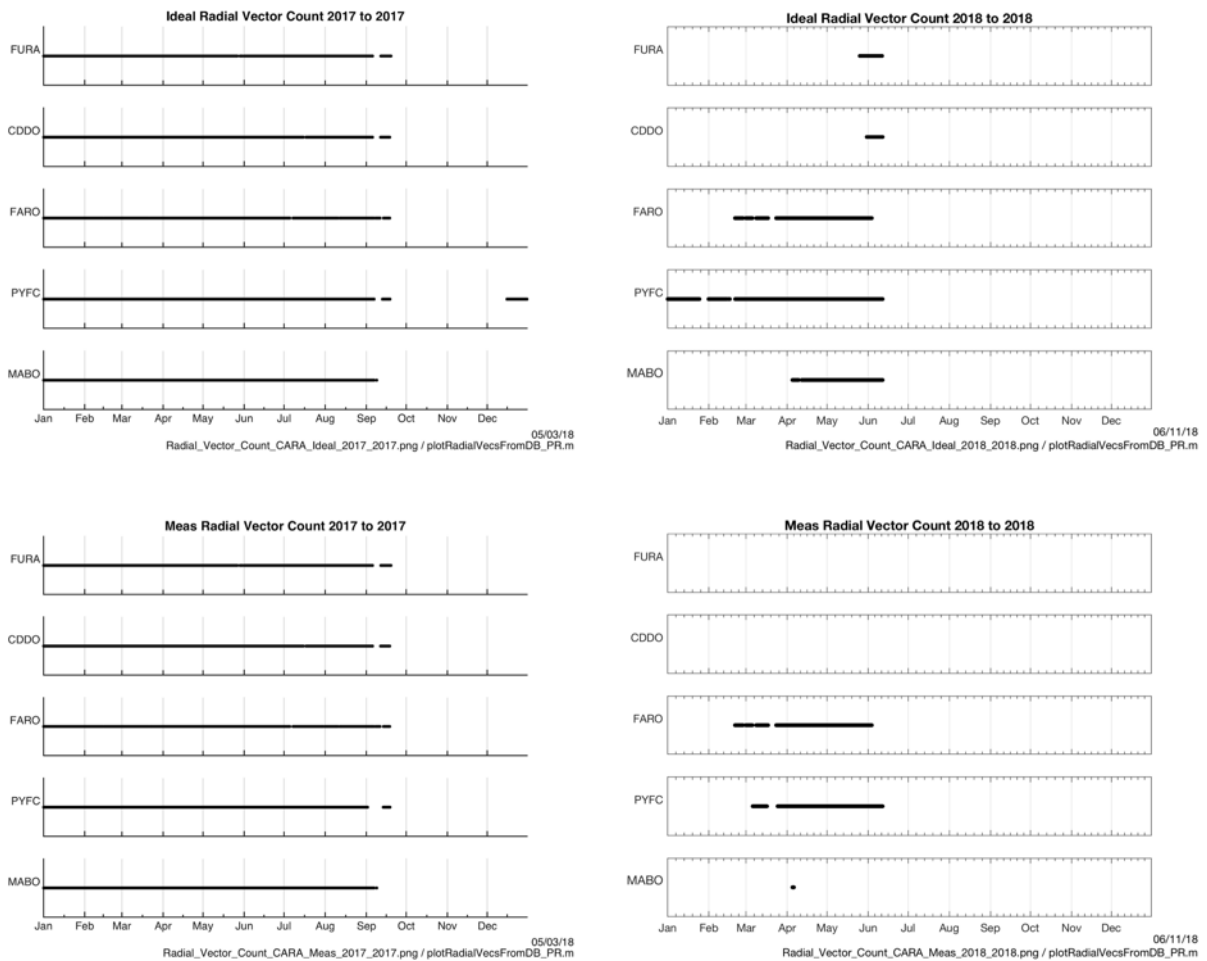
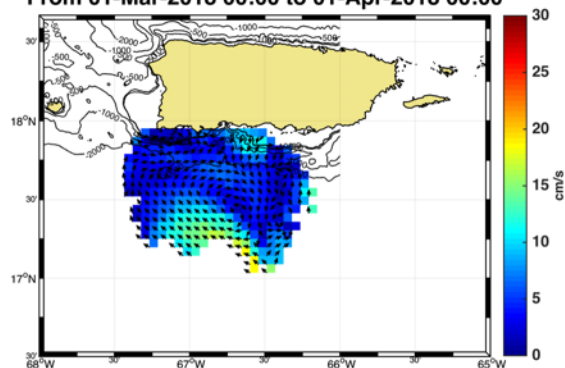


Figure 1: Ideal (top) and measured (bottom) radial data availability of the 5 HF radar stations in Puerto Rico on the Rutgers servers for years 2017 (left) and 2018 (right).

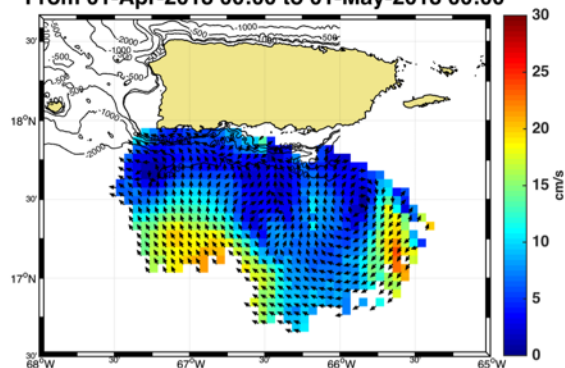


**Puerto Rico UWLS Average, 745 possible hourly maps
From 01-Mar-2018 00:00 to 01-Apr-2018 00:00**



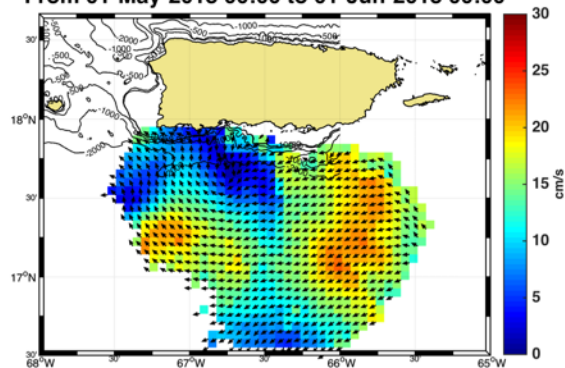
06/11/18
HJR_Scripts/total_plots/mean_vector_plot_PR_NN_curly.m

**Puerto Rico UWLS Average, 721 possible hourly maps
From 01-Apr-2018 00:00 to 01-May-2018 00:00**



06/11/18
HJR_Scripts/total_plots/mean_vector_plot_PR_NN_curly.m

**Puerto Rico UWLS Average, 745 possible hourly maps
From 01-May-2018 00:00 to 01-Jun-2018 00:00**



06/11/18
HJR_Scripts/total_plots/mean_vector_plot_PR_NN_curly.m

Figure 2: Monthly mean surface current measurements on the 6 km grid (left) from March 2017 to May 2018. The color bar indicates speed from 0-30 cm/s and the arrow on the map indicates direction the current is towards.

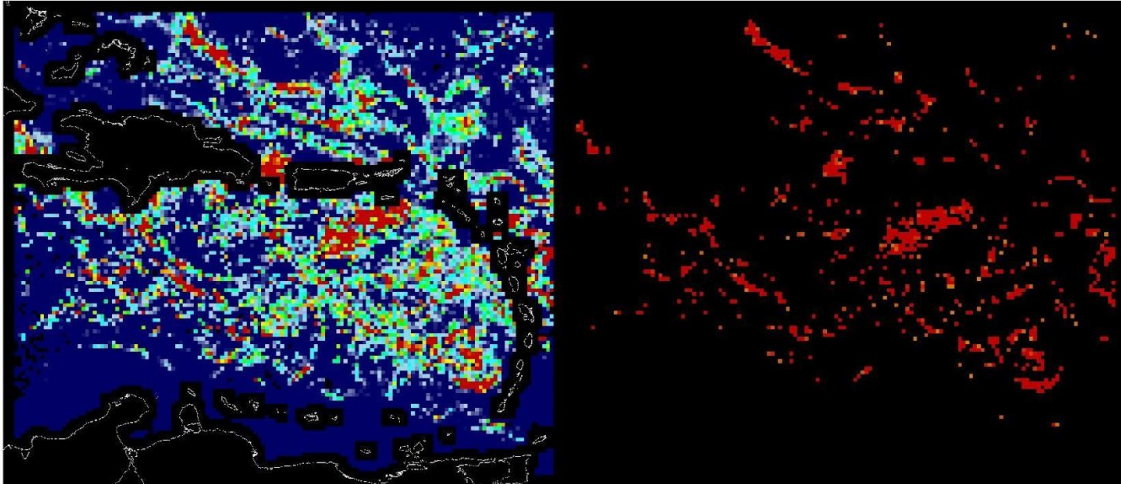


Figure 3: Floating algae density map in terms of percentage area cover (left), density map after first set of image processing to determine higher concentration areas of Sargassum (right).

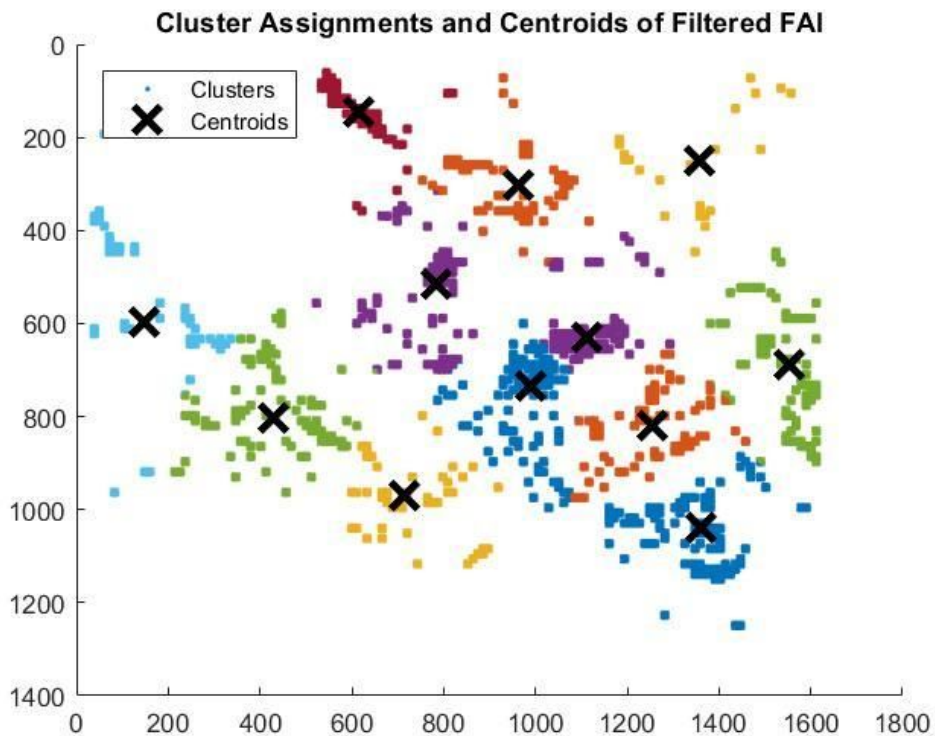


Figure 4: High Floating Algae Index concentrations clustered together by k-means for centroid locations to pinpoint coordinates for particle movement.

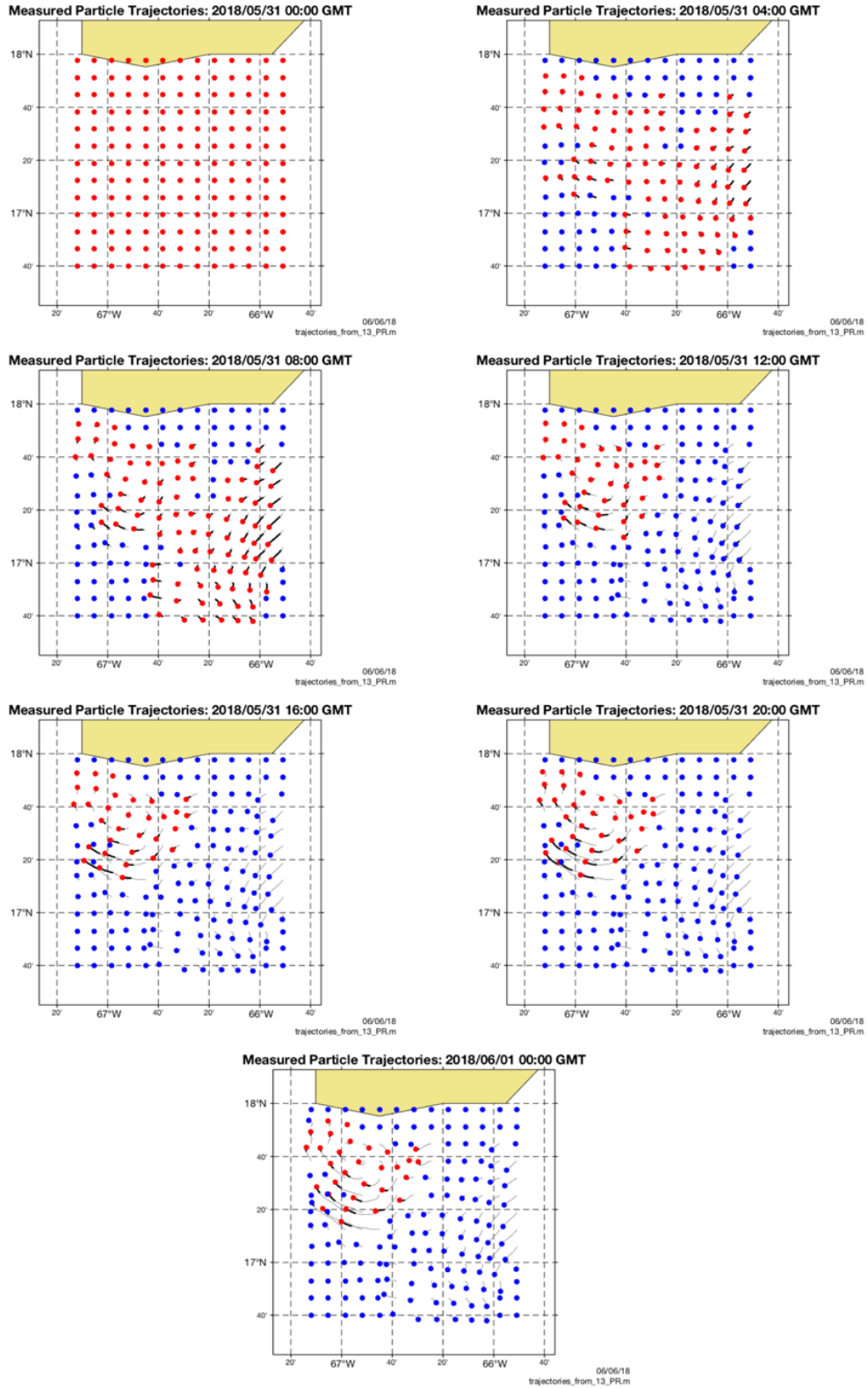


Figure 5: Virtual particle drifters hourly images shown every 4 hours for southern coast of Puerto Rico for May 31, 2018. The images are created every hour and are compiled into animated gifs to show particle movement through a 24-hour period.

RELATED PROJECTS

None

PUBLICATIONS & PRODUCTS

1. Roarty, Prakash, Evans (2018) “Observations of the Surface Circulation Around Puerto Rico” Marine Technology Society Meeting, Charleston, SC, October 22-25, 2018