Implementation of a Sargassum Seaweed Tracker for the Caribbean

Hugh Roarty
Joe Anarumo

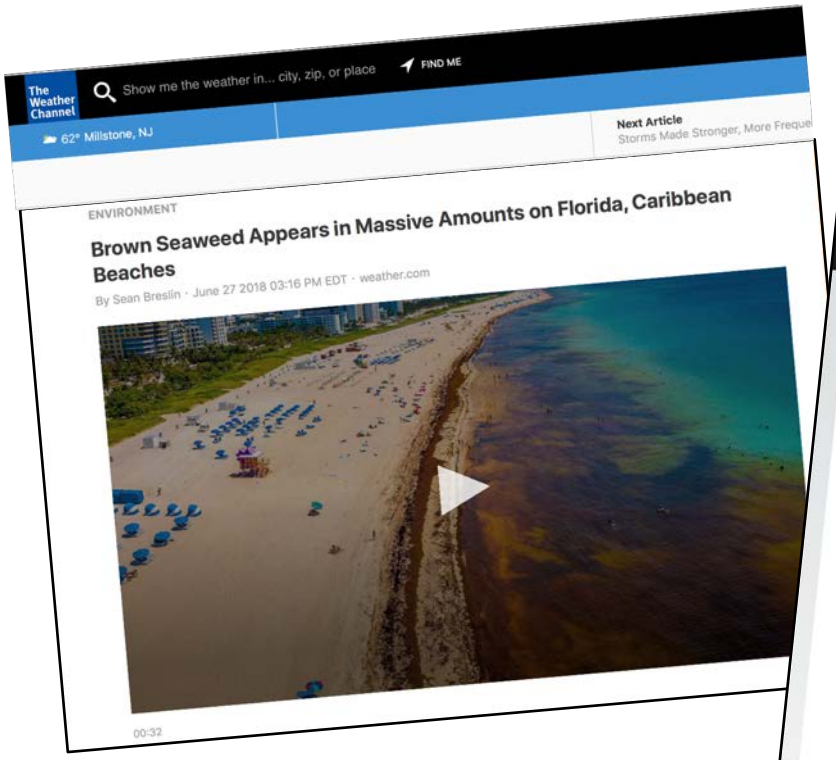
Molly Aeschilman

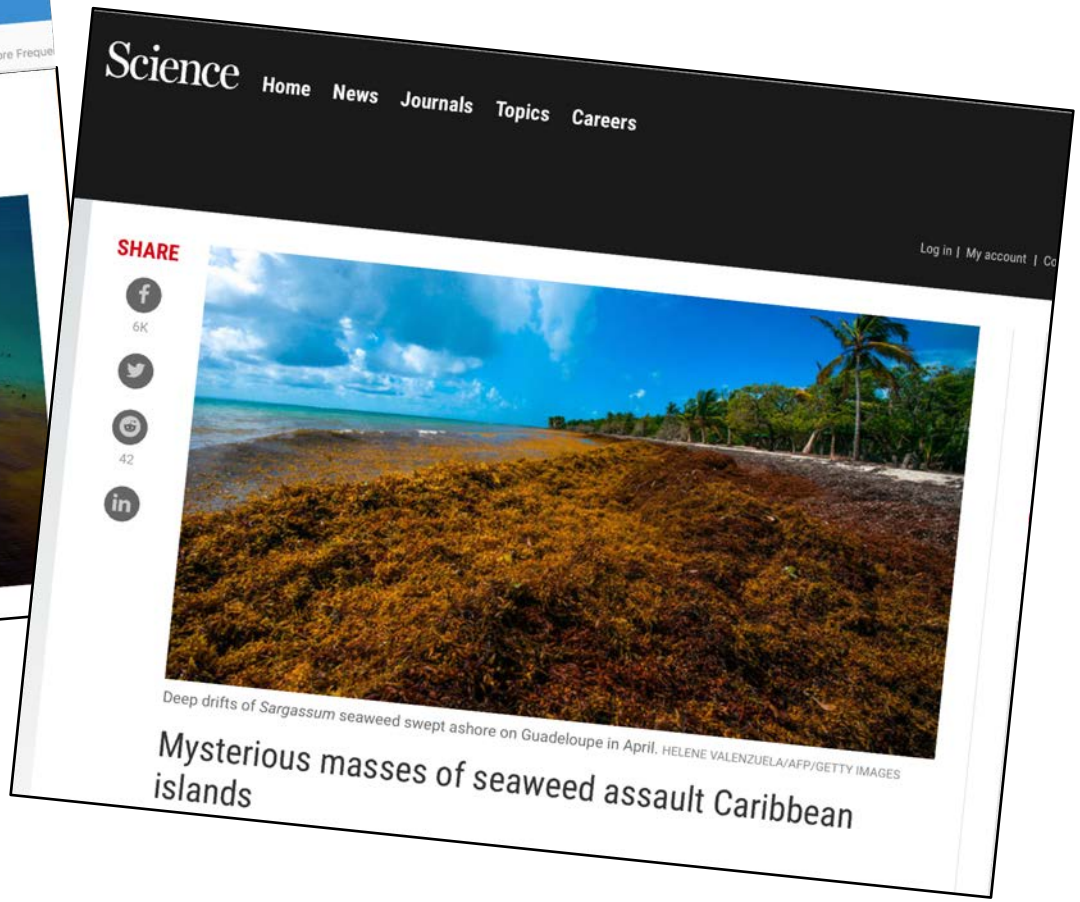
Outline

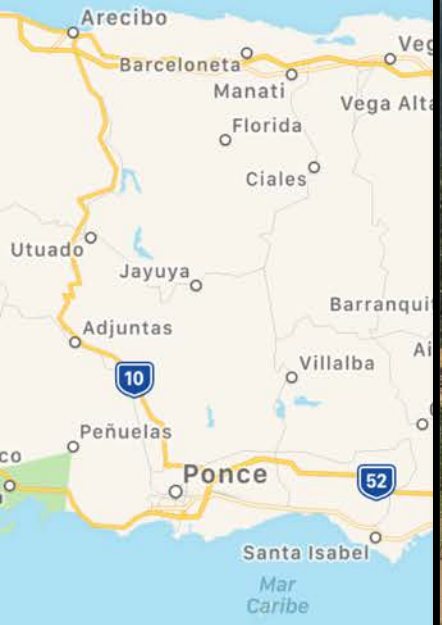
- **Description of the Sargassum Seaweed around Puerto Rico**
- **Development of a detection and forecasting tool for the Sargassum**
- **Validation of the model**
- **Next Steps**

Sargassum Seaweed

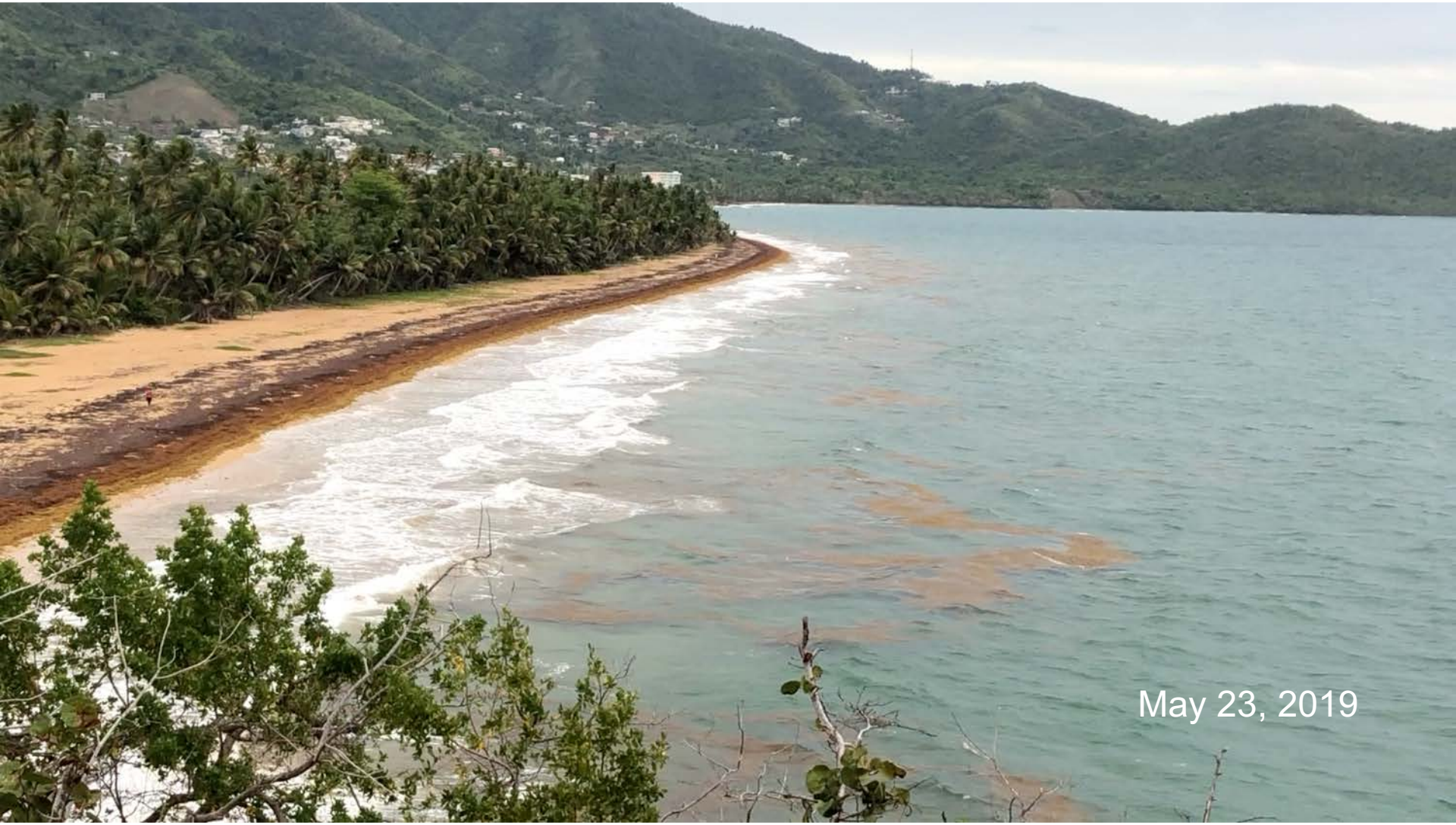
Sargassum in the News







August 21, 2018


May 23, 2019

Detecting and Tracking the Sargassum

Development of Sargassum Seaweed Tracking Tools

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***Abstract*—By accurately measuring and predicting ocean currents we can influence multiple industries including commercial fishing, recreational boating, shipping, and tourism, as well as assist with hazardous material cleanup (i.e. oil and chemical spills) and aid in search and rescue missions. Surface current data was collected from five (5) High Frequency (HF) radar stations located on the west and south coast of Puerto Rico. The surface currents from the HF radar were compared against the Navy Coastal Ocean Model (NCOM) for the American Seas (AMSEAS) as well as surface drifters that were deployed in April 2017. In the Mona Passage the flow is predominantly from south to north at a monthly average of 15 cm/s in the central part of the passage. On the south shore of Puerto Rico, the flow is predominantly from east to west at a monthly average of 18 cm/s. The surface current data around Puerto Rico was used as one component of a Sargassum seaweed tracking system was developed by the authors. Satellite data made available by the University of South Florida was used to calculate the location and amount of Sargassum around Puerto Rico. By collecting high spatial and temporal resolution information on the ocean currents, as well as fine tuning the ocean models to make them more accurate this can better predict the movement of items floating on the surface like Sargassum or a person lost at sea. This paper will also chronicle the repair of the HF radar network after Hurricane Maria in September 2017.**

***Keywords*—Sargassum, Tracking, AMSEAS, CODAR, NCOM, Hurricane Maria, Image Processing, remote sensing, HF radar**

I. Introduction

The Caribbean has been plagued with increasing amounts of Sargassum since 2011 [1]. Sargassum is a genus of brown seaweed that is prevalent throughout the tropical oceans of the world. The Caribbean region is expecting a record-setting bloom for 2018. Much is unknown of the asexual reproduction of Sargassum. While its reproduction cycle is not deemed to be seasonal, high amounts of the foliage are usually observed during the late spring and through the summer months. Theories on the increase of Sargassum include global warming and increasing ocean temperatures, as well as nitrogen heavy fertilizer and sewage waste pollution, which adds nutrients to the water that would otherwise not be present during reproduction. Issues associated with Sargassum are linked to seasonal weather. When storms and rough currents arise the Sargassum patches will break up and disperse, making it harder to track, but also less of a large scale issue. When the seas are calmer the undisturbed patches grow to larger sizes and can cause marine life damage and then wash ashore and cause other problems for local economies. If a reliable forecasting system can be developed, then local communities can be empowered to collect resources days in advance of a possible landfall in order to better manage the Sargassum problem.

In this paper we outline a system to utilize satellite imagery to detect and surface currents from a High Frequency radar network and an ocean model to track Sargassum seaweed around the island of Puerto Rico. There is a potential use for established HF Radar networks to work in conjunction with satellite imagery and associated data products to help track and predict the movement of the disruptive Sargassum seaweed.

II. Methods

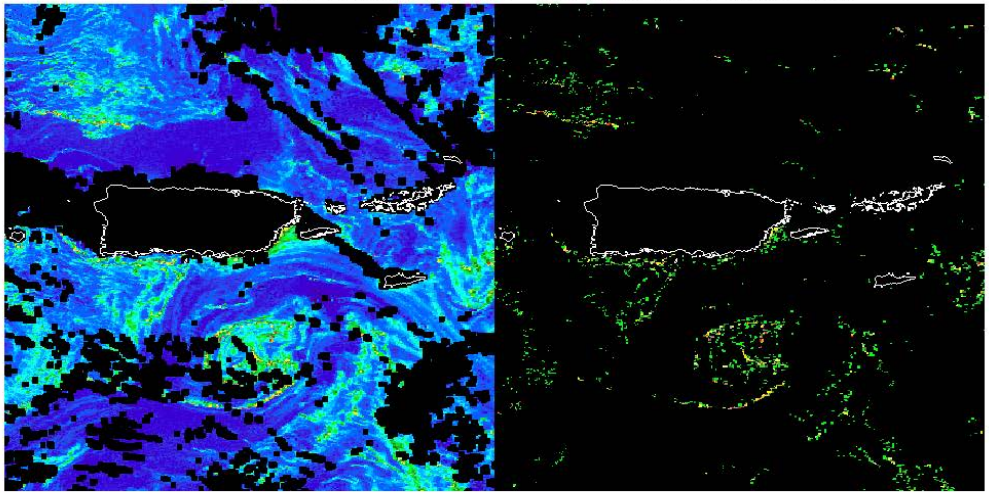
A. HF Radar Network

High Frequency radar measurements of coastal surface currents have been collected every hour off the west coast of Puerto Rico since 2010. Starting in 2015, the network was expanded [2] with radars along the southern coast of Puerto Rico. Figure 1 shows a map of the radar network with the location of the five radar stations along with theoretical radial and total coverage. The radars on the west coast operate in the 13 MHz band, have a range of 90 km and spatial resolution of 3 km. The stations are located at Anasco (FURA) and Cabo Rojo (CDDO). The radars on the southern coast operate in the 5 MHz band, have a range of 180 km and a spatial resolution of 6 km. The stations are located at Cabo Rojo (FARO), Ponce (PYFC) and Manuabo (MABO).

The radars in Puerto Rico were taken down before Hurricane Maria made landfall on September 20, 2017. PYFC was the first station reinstalled after the hurricane and

Step 1: Identify Locations of Sargassum

USF Figure vs. Concentrations >0.01 2018-06-17 18:05 GMT



CHARLESTON, SC
OCTOBER 2018

OCEANS'18 MTS/IEEE Charleston

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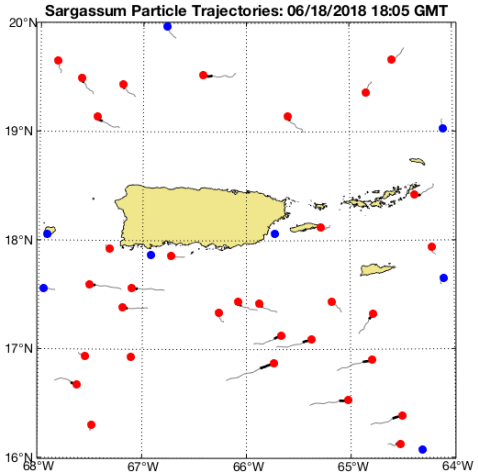
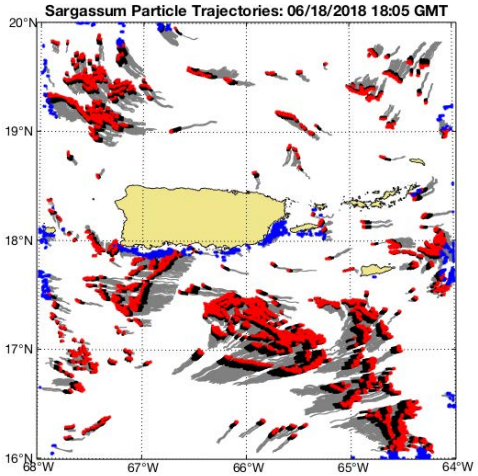
Step 2: Initiate Drifters at Sargassum Locations





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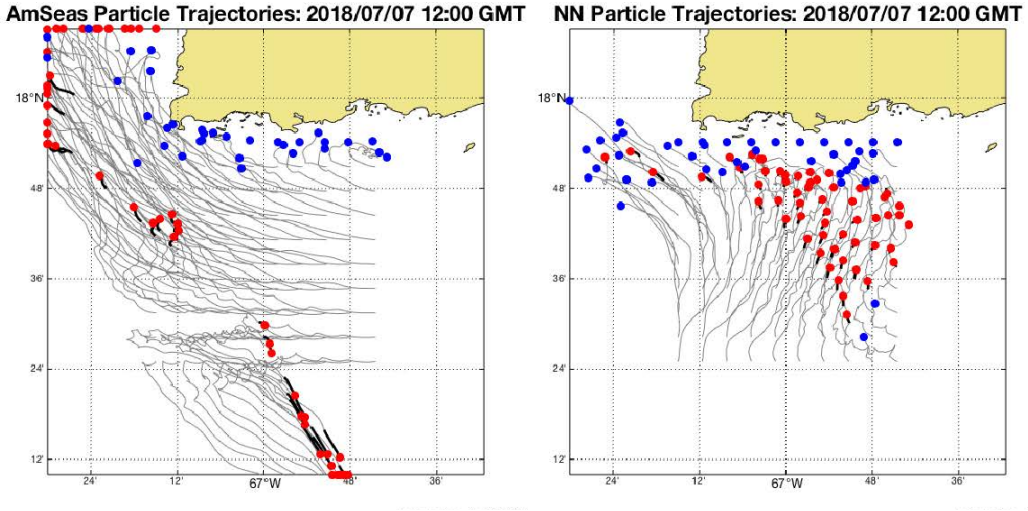
Step 3: Advect Drifters with AMSEAS Model



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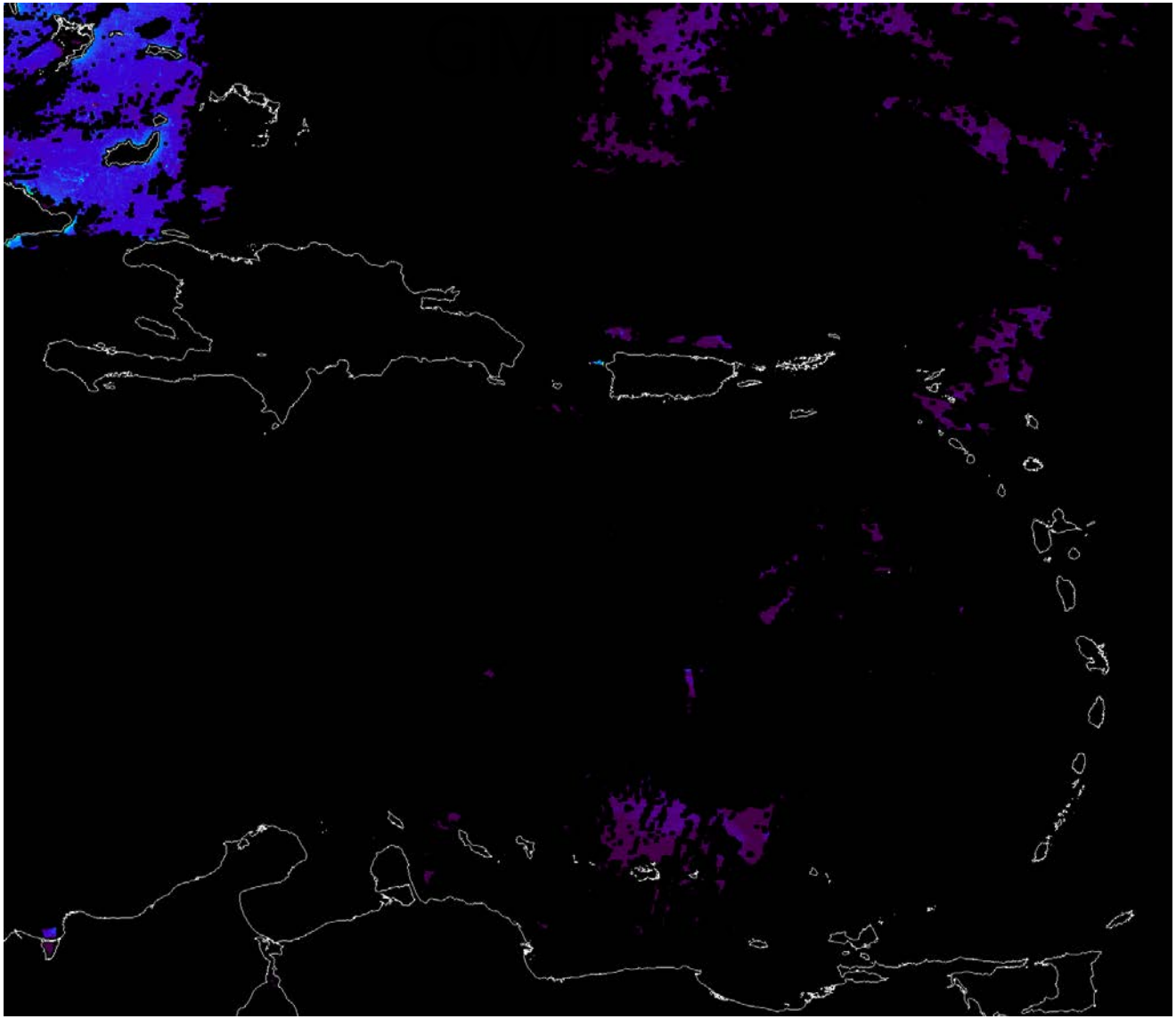
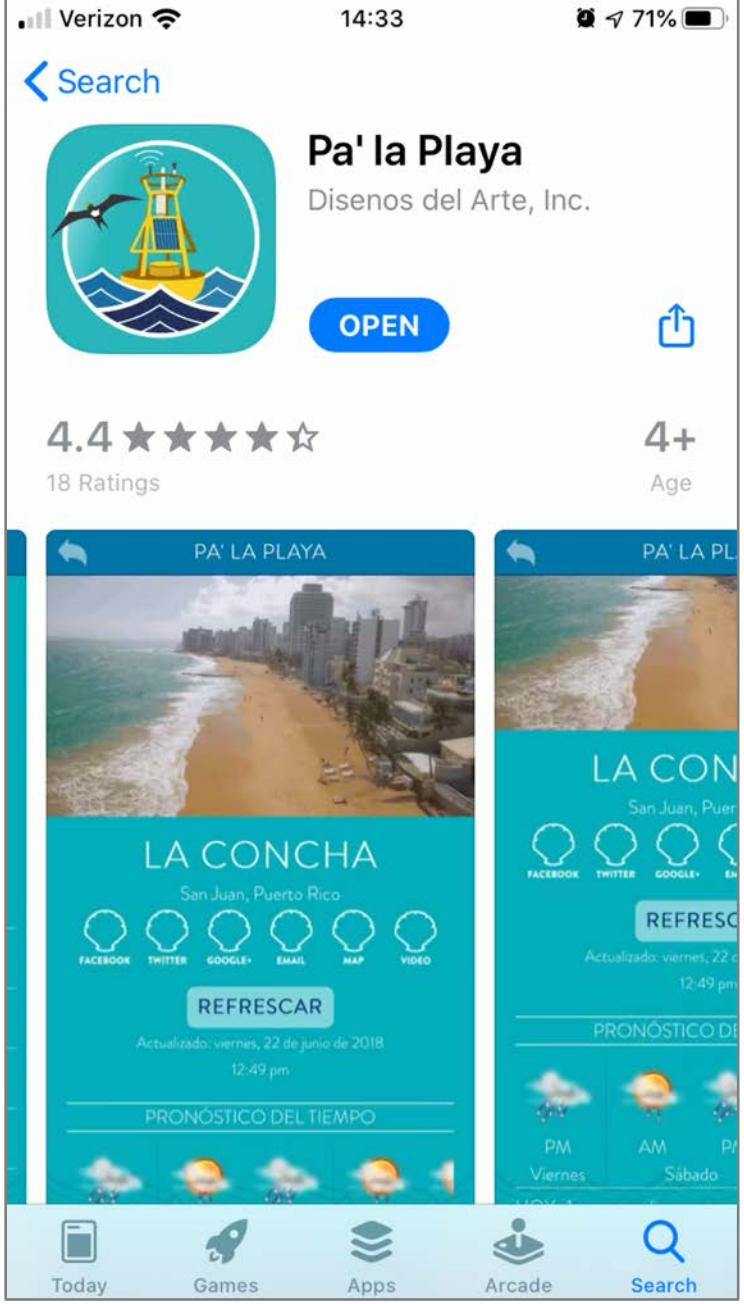
AFAI Product at May 22, 2019 15:30

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Disenos del Arte, Inc.
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4+
Age
PA' LA PLAYA
LA CONCHA
San Juan, Puerto Rico
FACEBOOK
TWITTER
GOOGLE+
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Today
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Apps
Arcade
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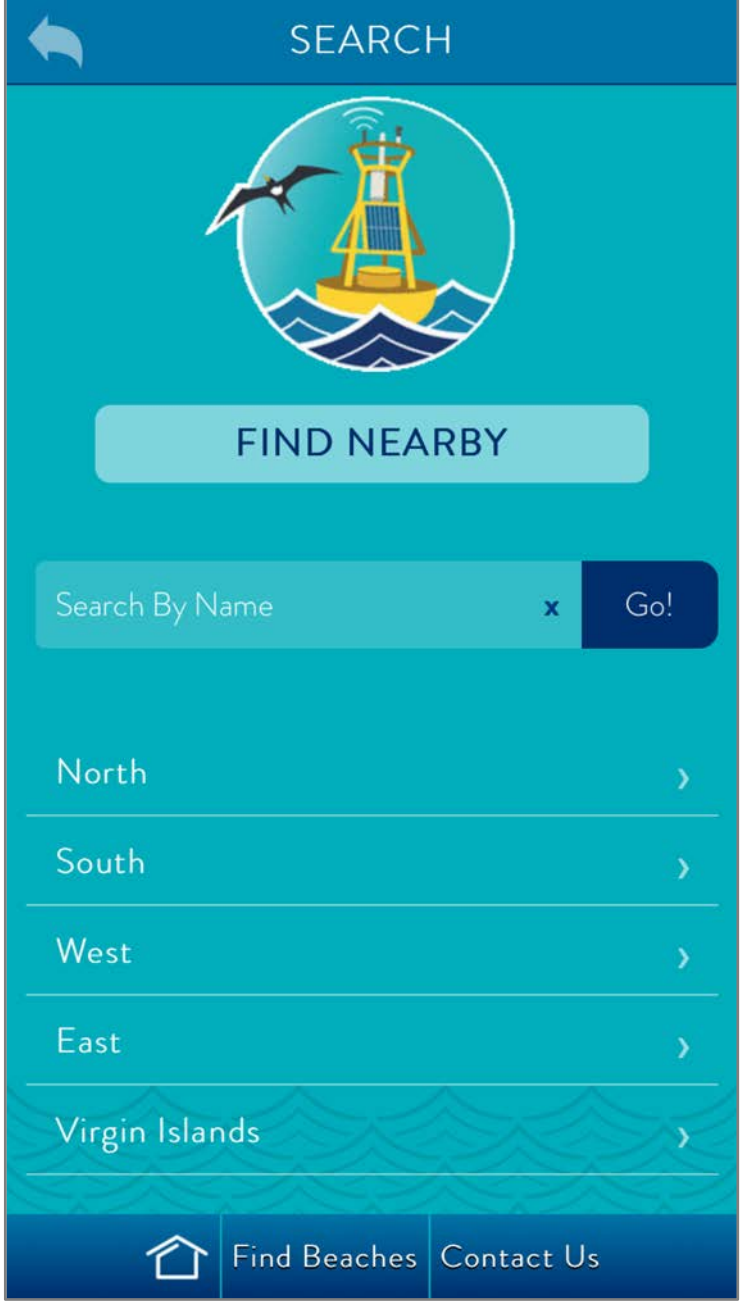
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Search By Name
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Go!
North
South
West
East
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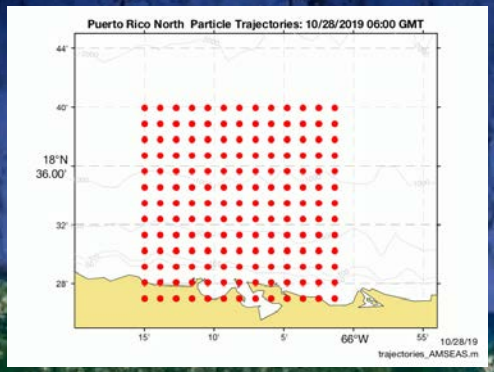
Find Beaches
Contact Us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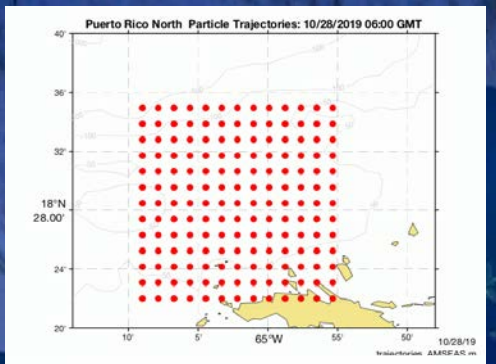
36.00'
66°W
10/28/19
trajectories_AMSEAS.m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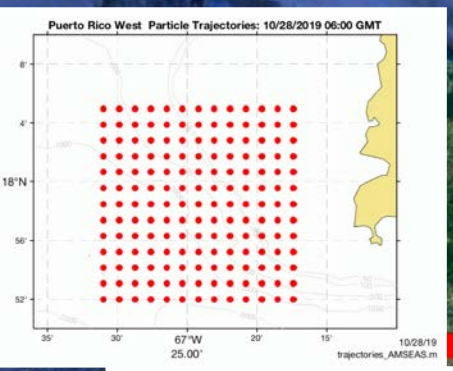
10/28/19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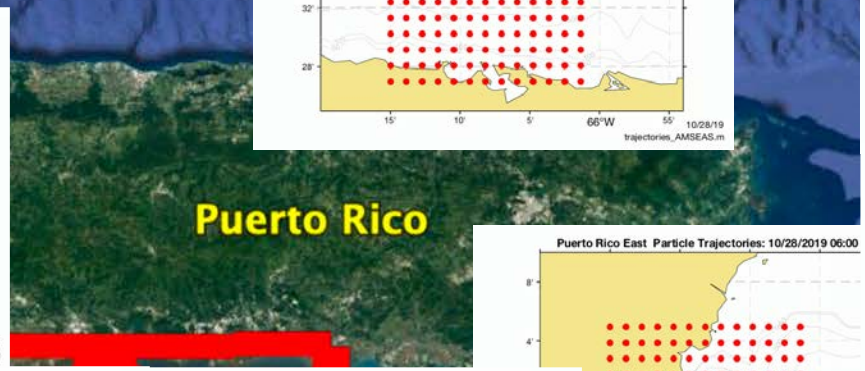
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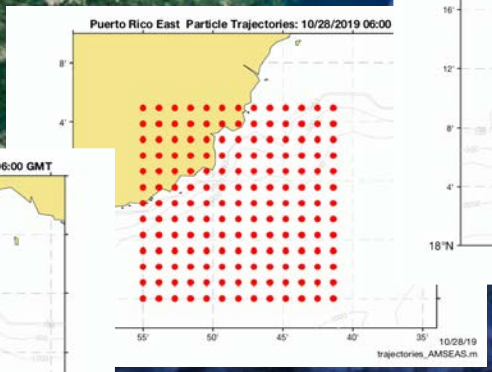
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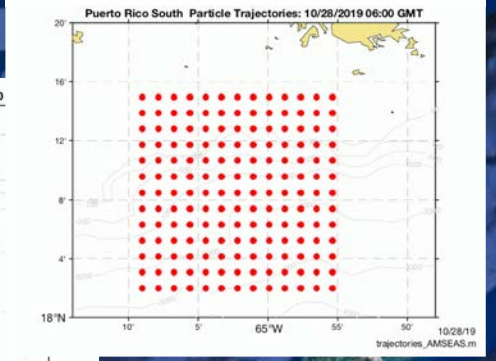
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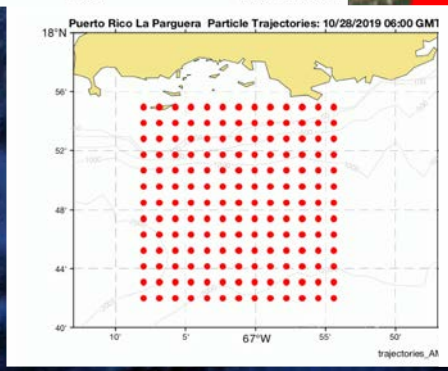
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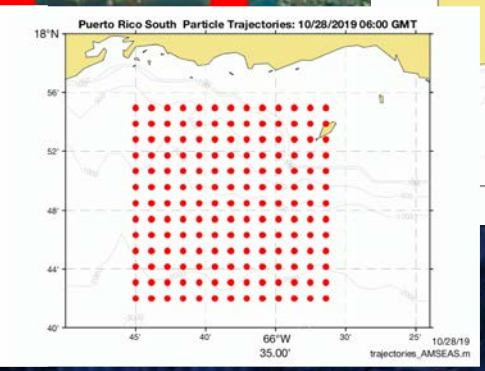
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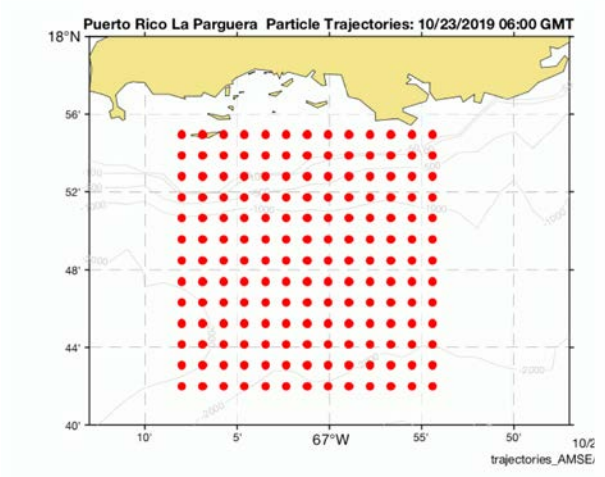
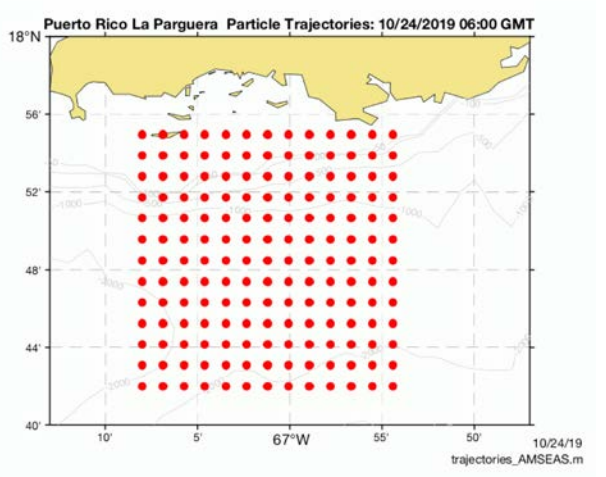
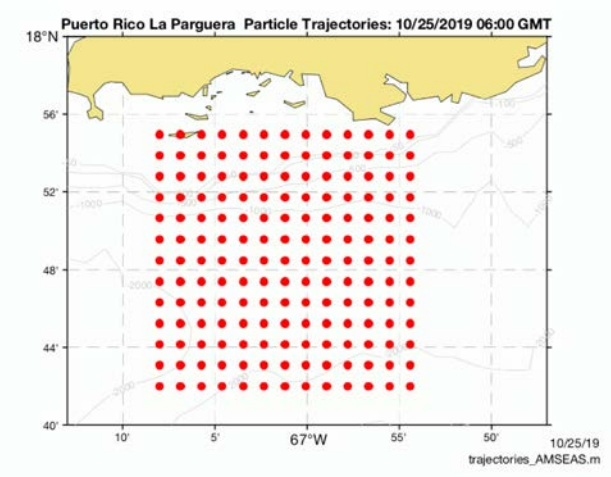
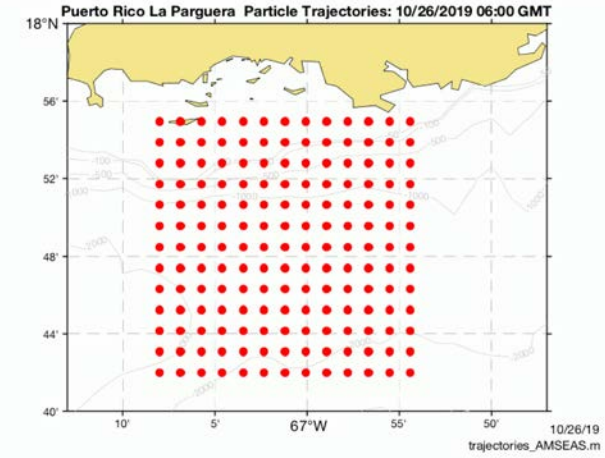
trajectories_AMSEAS.m

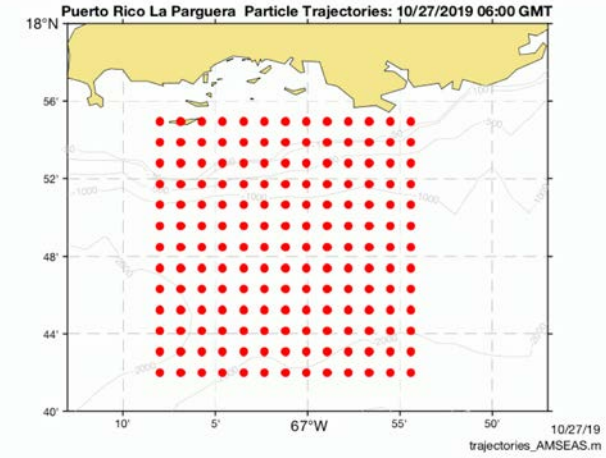
Daily Animations 10/23-10/28

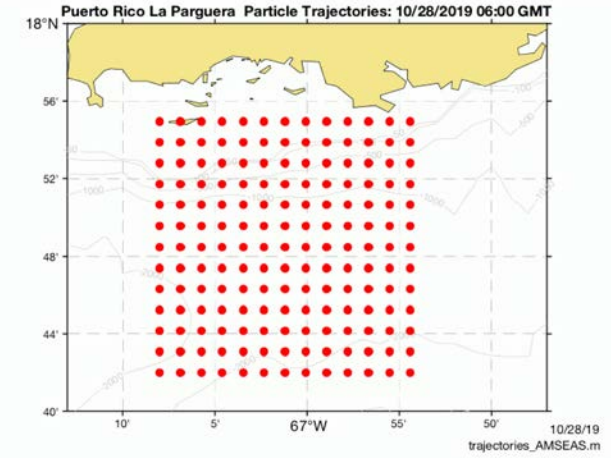




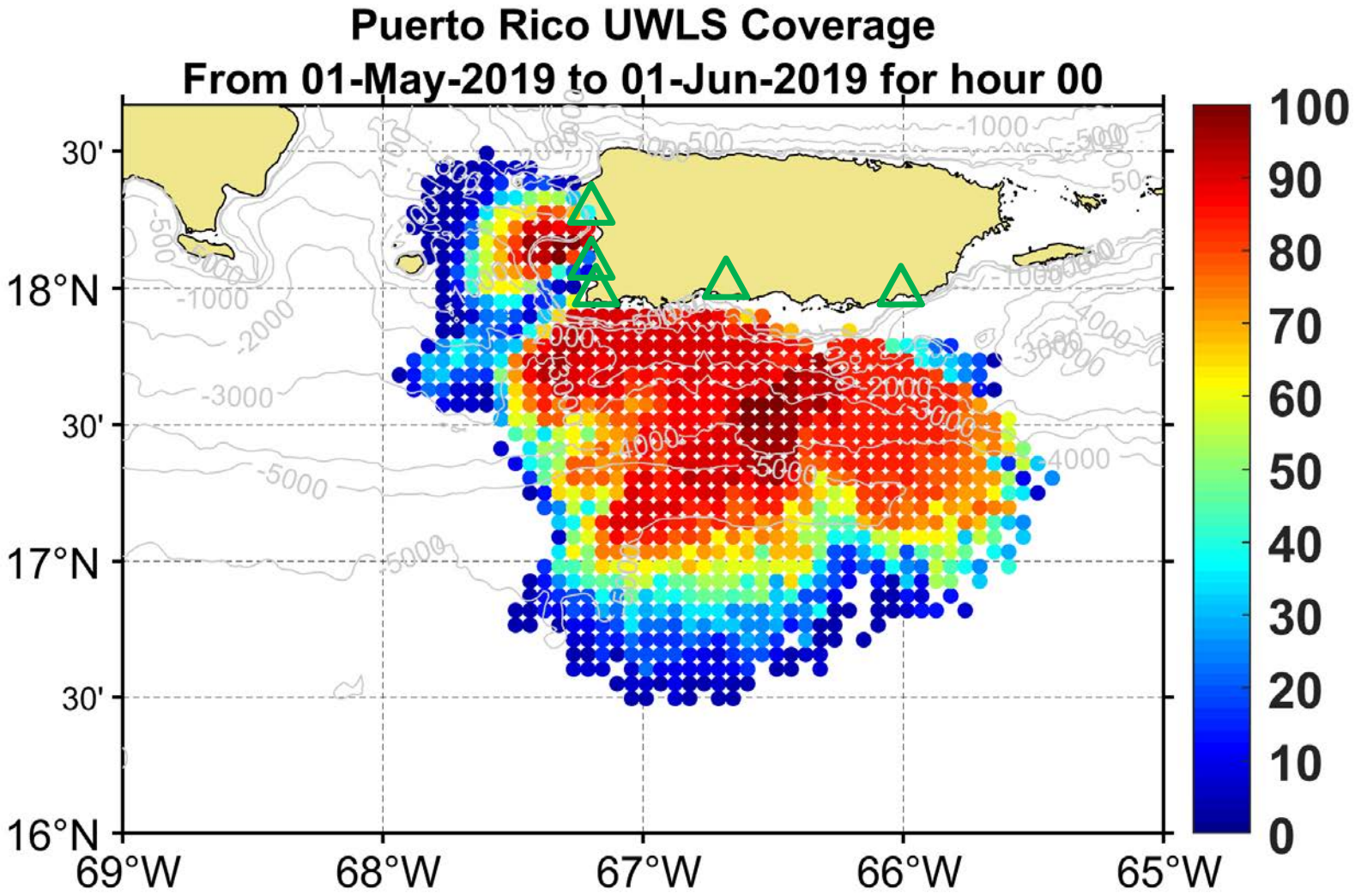


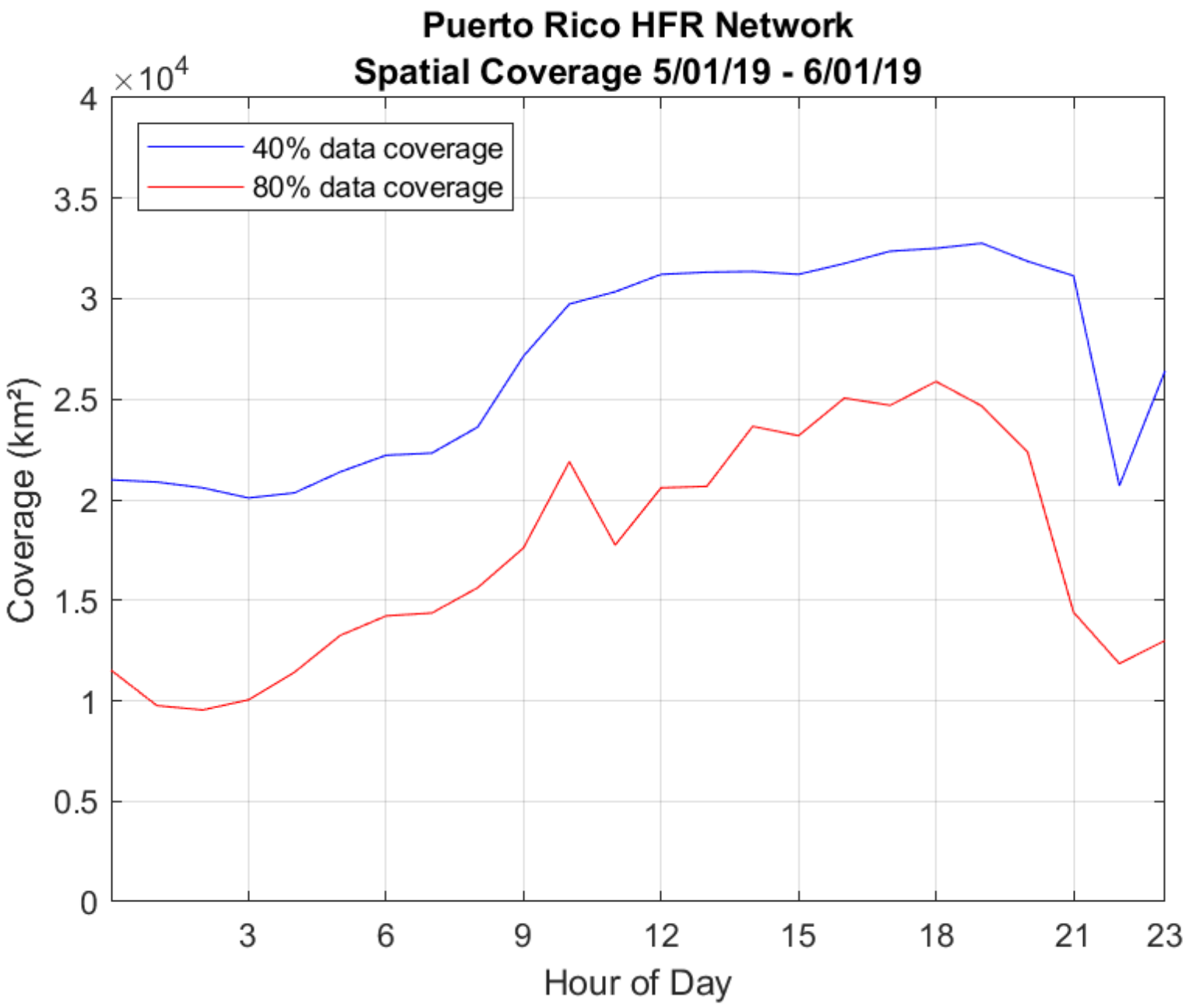




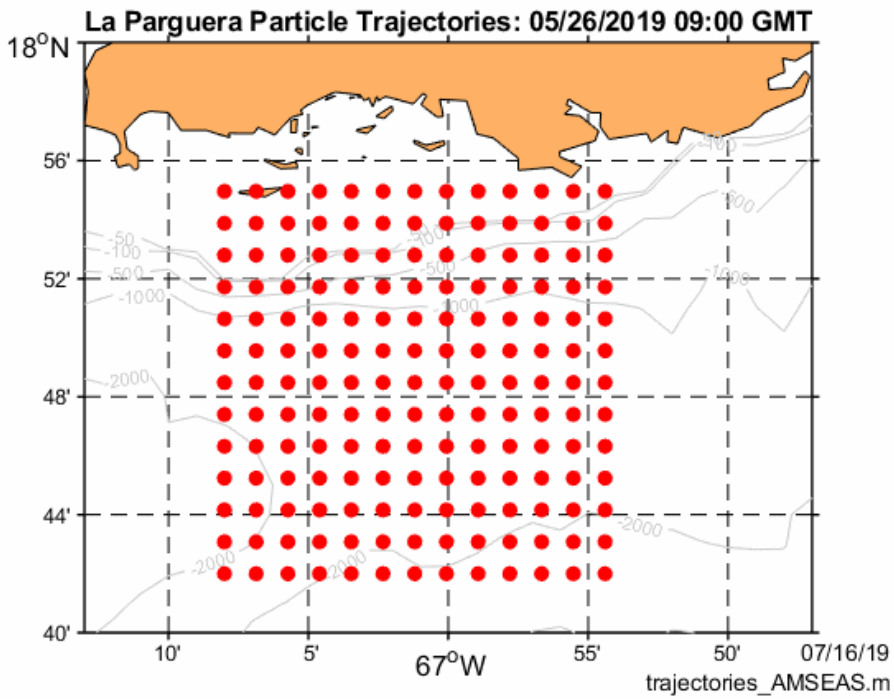


Validating the Drifting Model

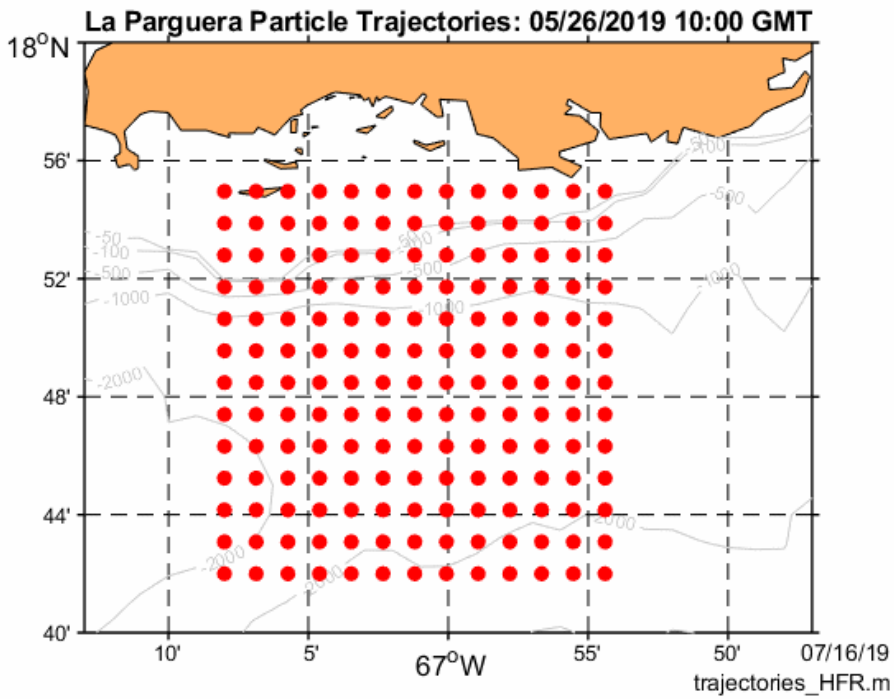

Puerto Rico UWLS Coverage
From 01-May-2019 to 01-Jun-2019 for hour 00
30'
18°N
30'
17°N
30'
16°N
69°W
68°W
67°W
66°W
65°W
100
90
80
70
60
50
40
30
20
10
0
%
mean_coverage_plot_PR_NN_hourly.m


Puerto Rico HFR Network
Spatial Coverage 5/01/19 - 6/01/19
×10^4
4
3.5
3
2.5
2
1.5
1
0.5
0
40% data coverage
80% data coverage
Coverage (km²)
3
6
9
12
15
18
21
23
Hour of Day

Model and HFR Surface Currents

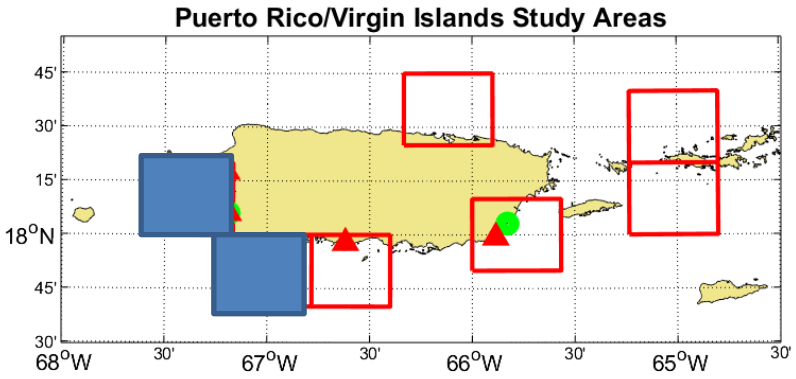


AMSEAS Ocean Model



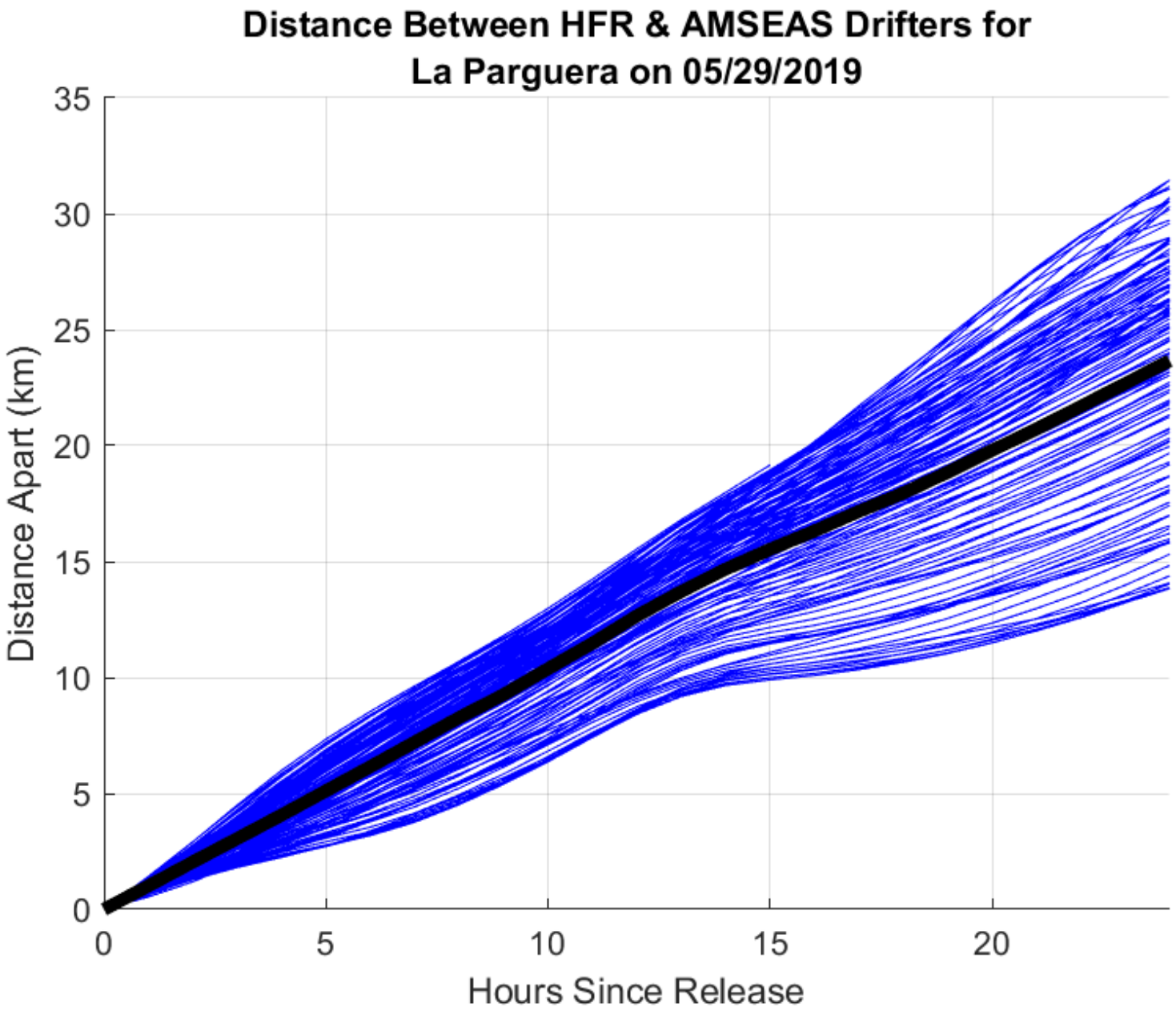
HF Radar

Validation of AMSEAS Model



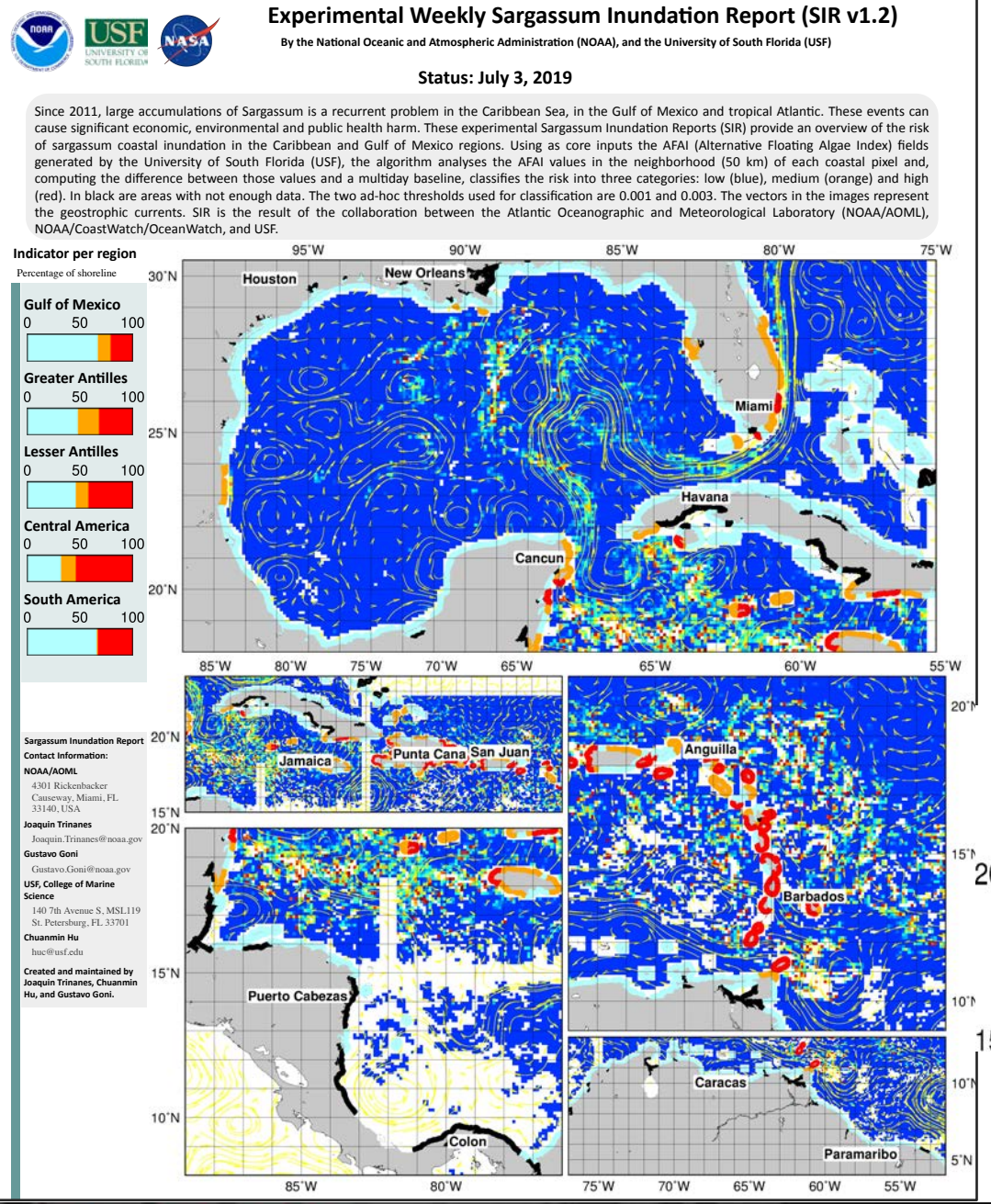
		AMSEAS		HFR	
		Meridional	Zonal	Meridional	Zonal
La Parguera	22-May	North	West	N/A	N/A
	23-May	North	West	North	West
	24-May	North	West	North	West
	25-May	North	West	North	West
	26-May	North	West	North	East
	27-May	North	West	North	East
	28-May	North	West	North	West
	29-May	North	West	North	West
	30-May	North	West	North	West
	31-May	North	West	North	West
West	22-May	North	East	North	West
	23-May	North	West	North	West
	24-May	North	West	North	West
	25-May	South	West	North	West
	26-May	South	West	South	West
	27-May	North	West	South	West
	28-May	North	West	North	West
	29-May	North	West	North	West
	30-May	North	West	North	West
	31-May	North	West	North	West

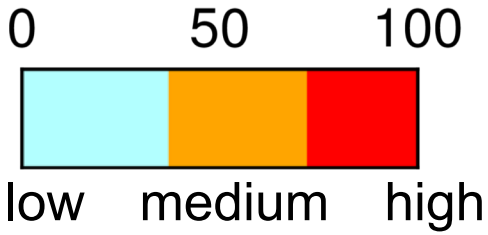
10 days


Distance Between HFR & AMSEAS Drifters for
La Parguera on 05/29/2019
Distance Apart (km)
Hours Since Release
0
5
10
15
20
25
30
35
0
5
10
15
20

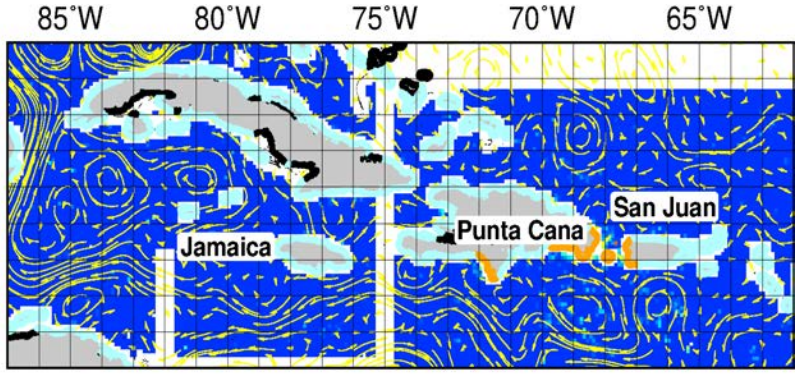
Next Steps

Weekly Sargassum Inundation Report





October 15-21, 2019 Report for Puerto Rico and Virgin Islands



https://www.aoml.noaa.gov/phod/sargassum_inundation_report/

ERDDAP
Easier access to scientific data

ERDDAP > griddap > Make A Graph

Dataset Title: **1-day USF AFAI Fields (USF AFAI 1D AOML) (USFAFAI)**
Institution: USDOC/NOAA/OAR/AOML/PHOD (Dataset ID: noaa_aoml_atlantic_oceanwatch_AFAI_1D)
Information: Summary | License | FGDC | ISO 19115 | Metadata | Background | Data Access Form

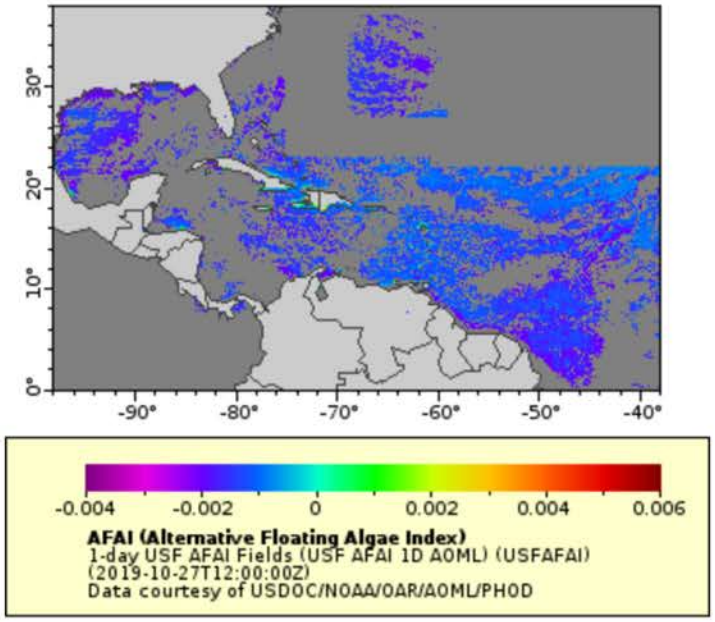
Graph Type: surface
X Axis: longitude
Y Axis: latitude
Color: AFAI

Dimensions	Start	Stop
time (UTC)	specify just 1 value →	2019-10-27T12:00:00Z
latitude (degrees_north)	0.0	38.0
longitude (degrees_east)	-98.0	-38.0

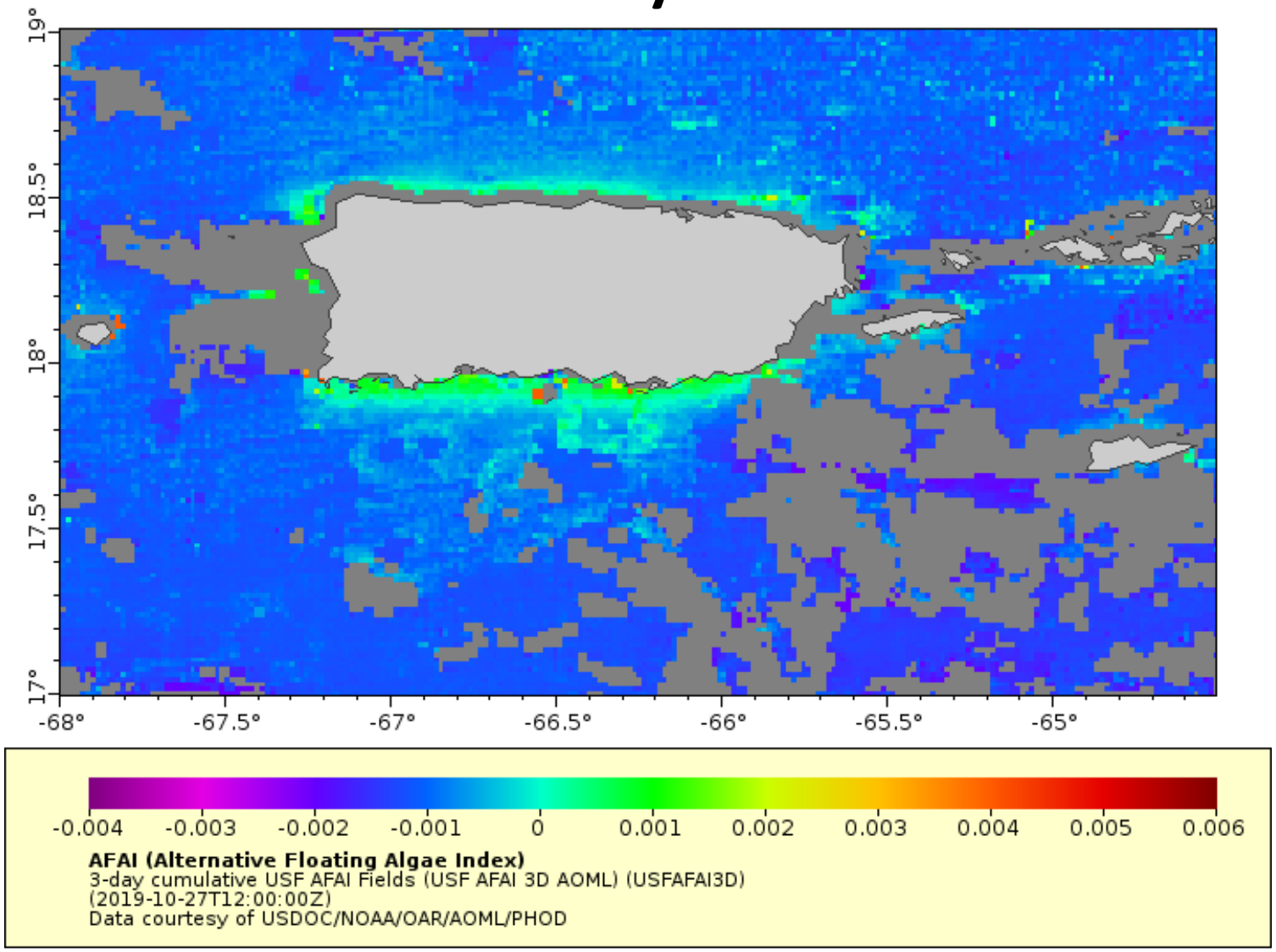
Graph Settings
Color Bar: Continuity: Scale:
Minimum: Maximum: N Sections:
Draw land mask:
Y Axis Minimum: Maximum: Ascending: ascending

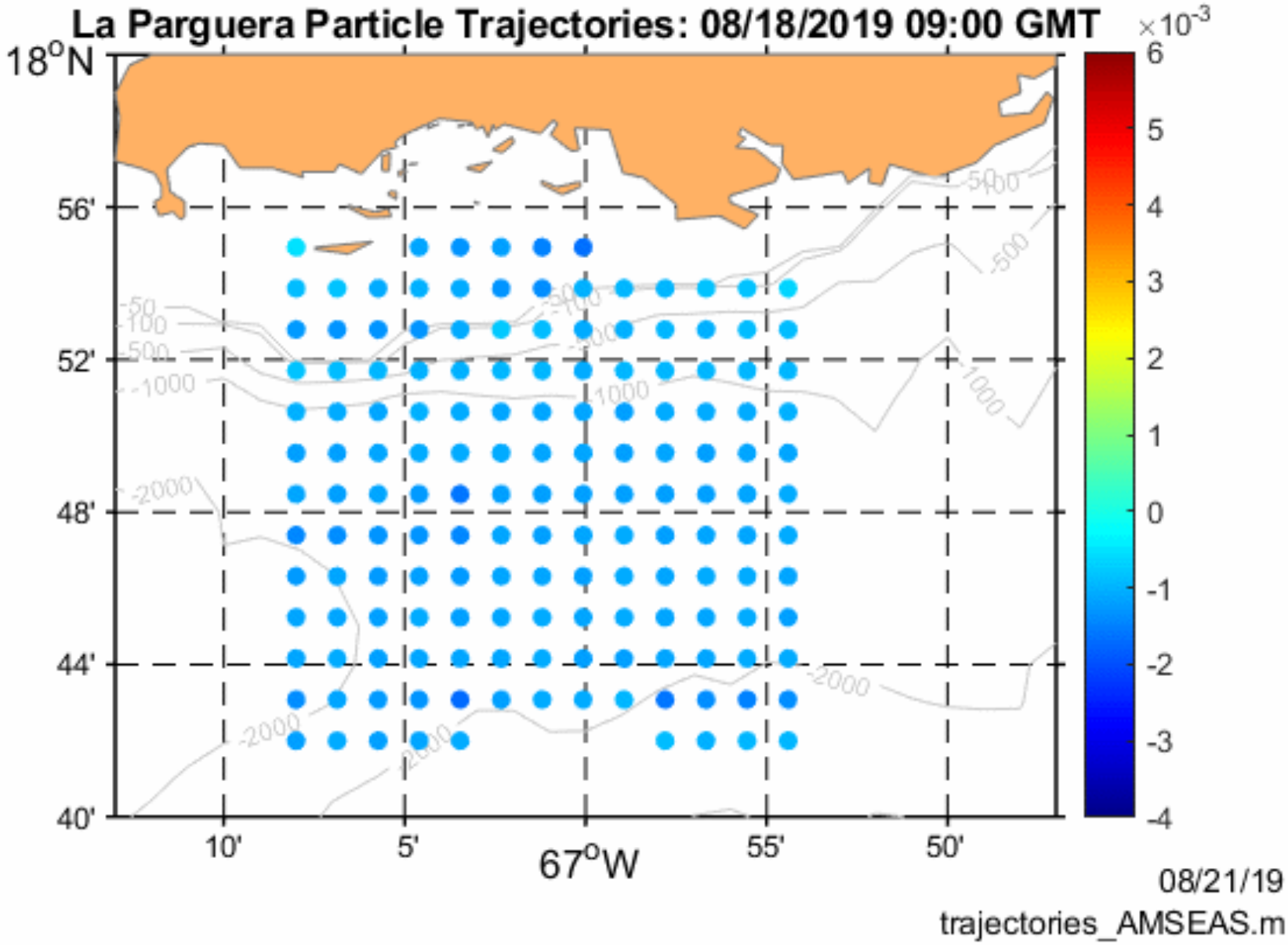
Redraw the Graph (Please be patient. It may take a while to get the data.)

Click on the map to specify a new center point.
Zoom: Data | Out 8x | Out 2x | Out | In | In 2x | In 8x

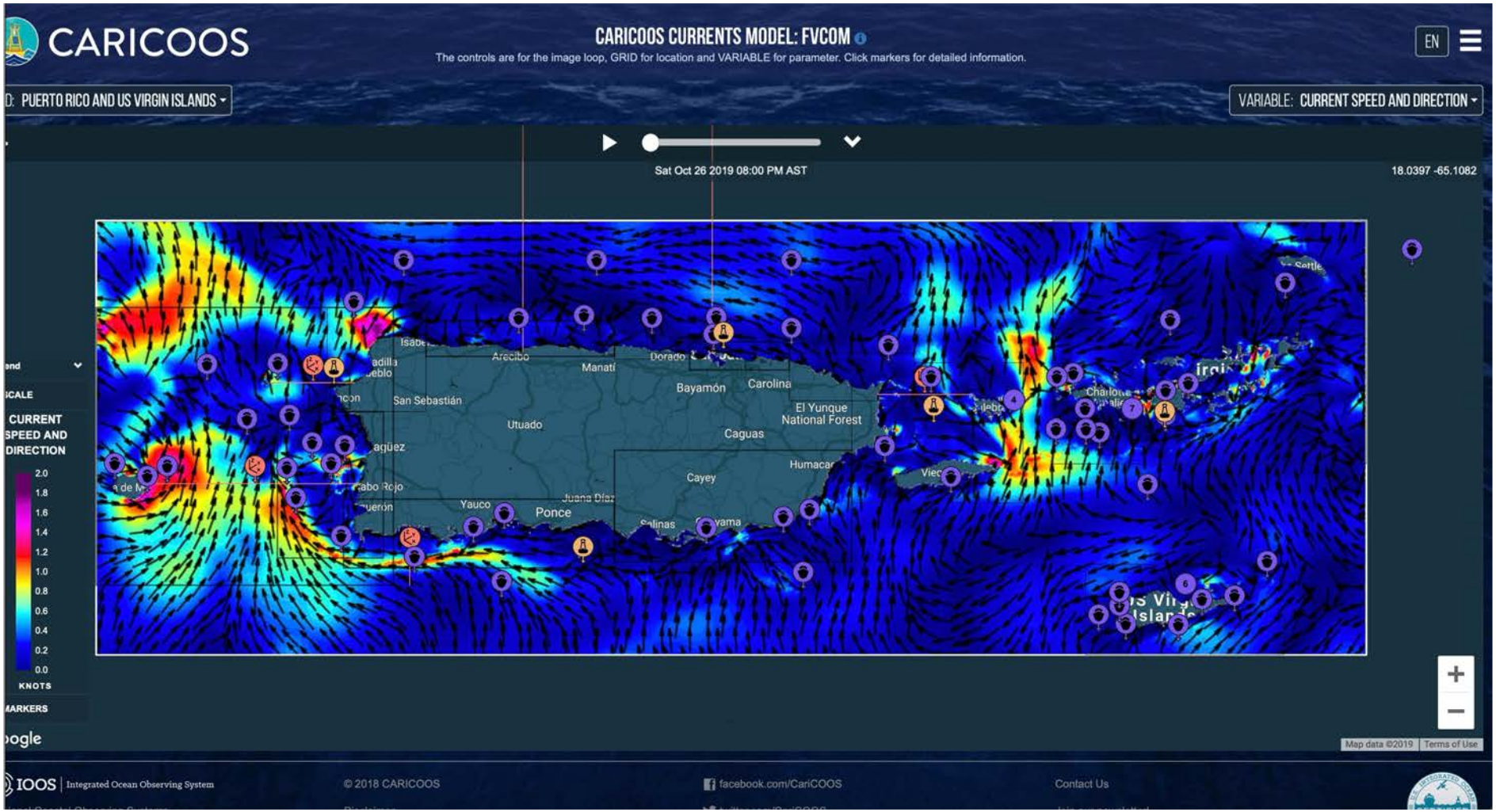


AFAI 3-day Product




La Parguera Particle Trajectories: 08/18/2019 09:00 GMT
18°N
56'
52'
48'
44'
40'
10'
5'
67°W
55'
50'
×10-3
6
5
4
3
2
1
0
-1
-2
-3
-4
-50
-100
-500
-1000
-2000
08/21/19
trajectories_AMSEAS.m

CARICOOS FVCOM Model



Conclusions

- **Description of the Sargassum Seaweed around Puerto Rico**
- **Development of a detection and forecasting tool for the Sargassum**
- **Validation of the AMSEAS model for surface circulation**
- **Utilizing the 3 day AFAI product and CARICOOS FVCOM model**

Implementation of a Sargassum Seaweed Tracker for the Caribbean

Thank You!

Dr. Hugh Roarty

RUTGERS
Center for Ocean Observing Leadership