

# Wave Data from HF Radar

Dr. Hugh Roarty

**RUTGERS**

Center for Ocean Observing Leadership

Mr. Chad Whelan

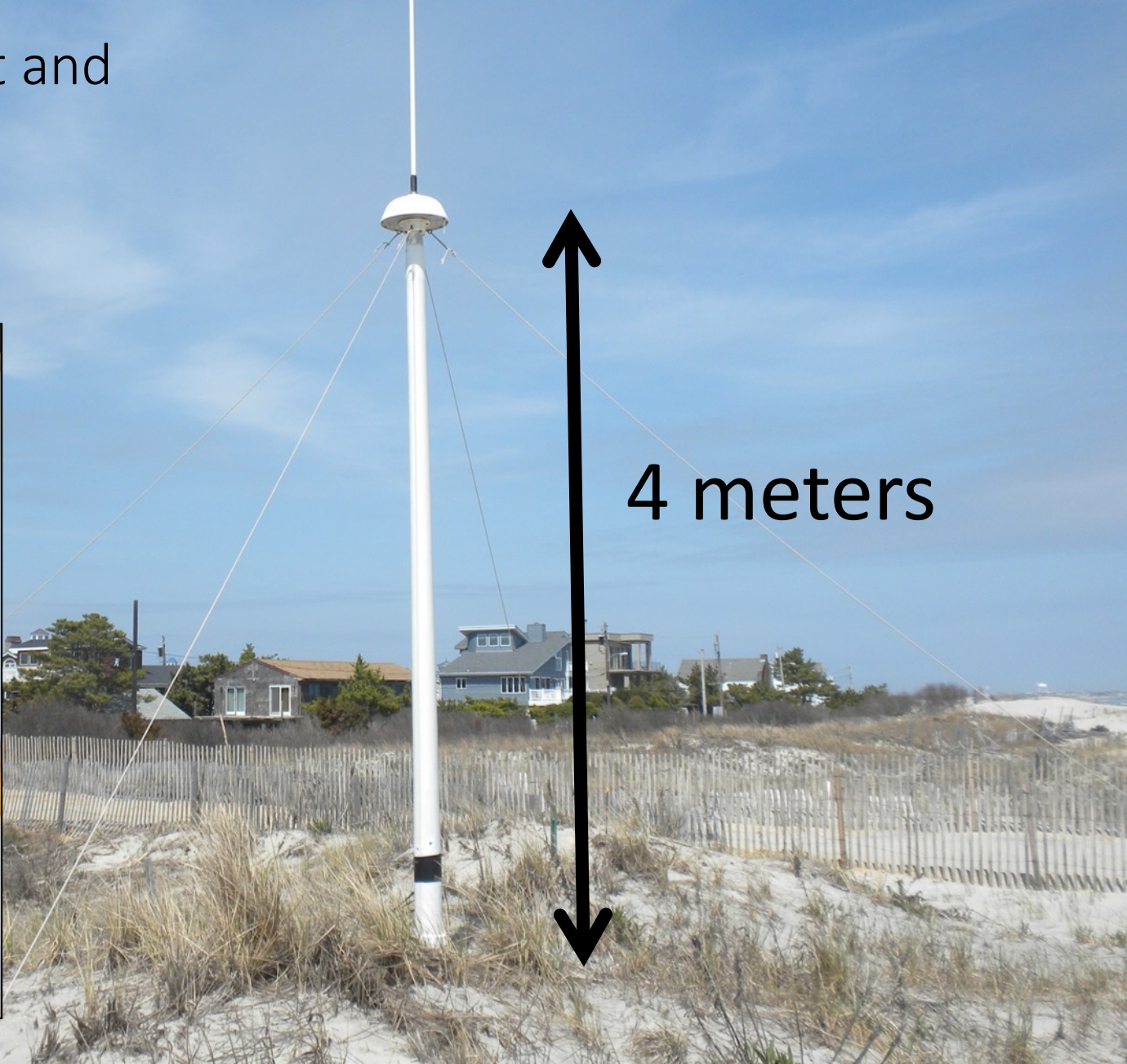


# Outline

- Introduction to HF Radar
- IOOS HFR Wave Evaluation Program
- HFR Wave Data Use by Weather Services
- Individual Cases of HFR Wave Data

# Introduction to HF Radar

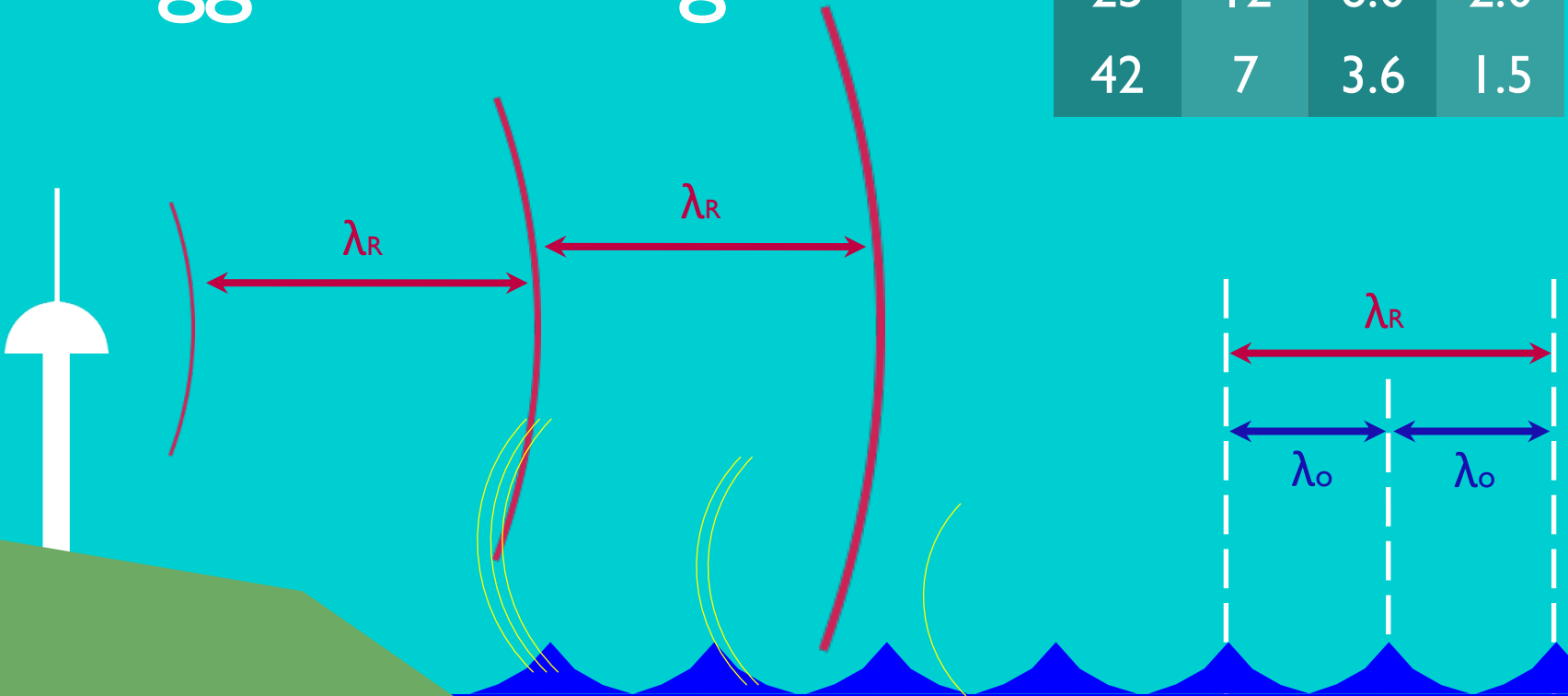
# 13 MHz Transmit and Receive Antenna



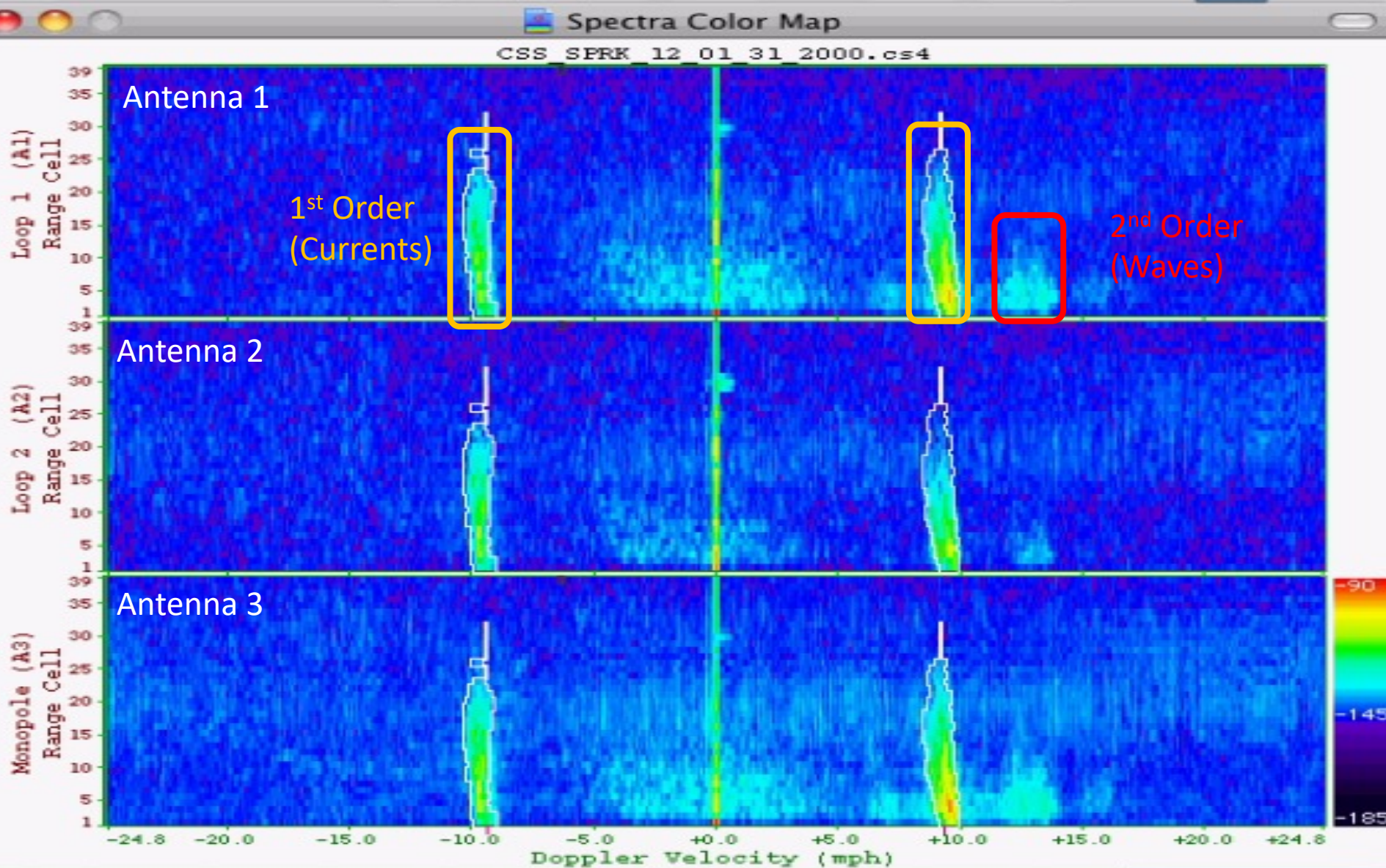


# Bragg Scattering

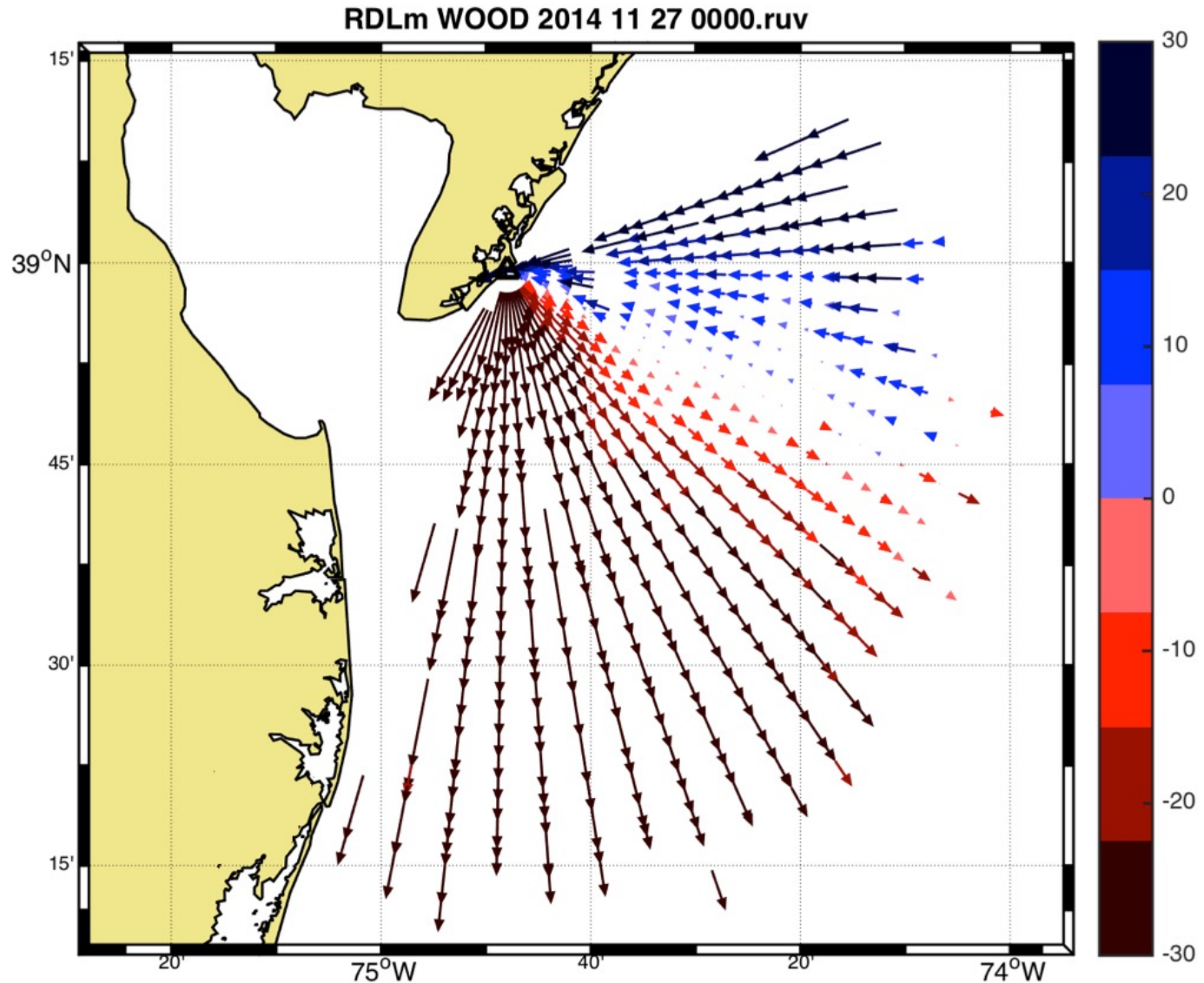
Freq mhz	$\lambda_R$ meters	$\lambda_o$ meters	$T_o$ seconds
5	60	30.0	4.4
13	23	11.5	2.7
25	12	6.0	2.0
42	7	3.6	1.5



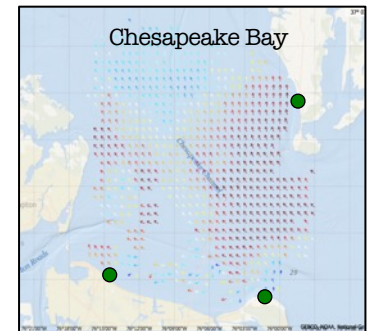
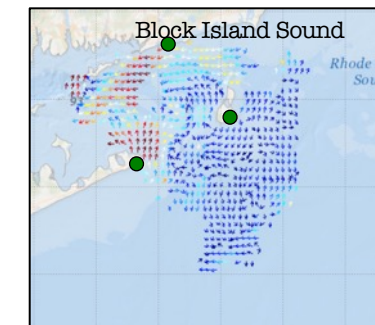
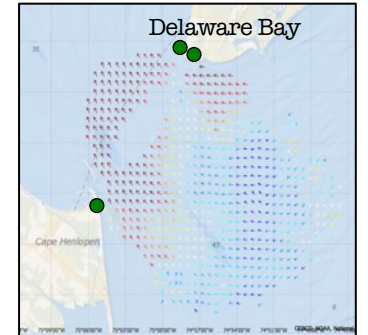
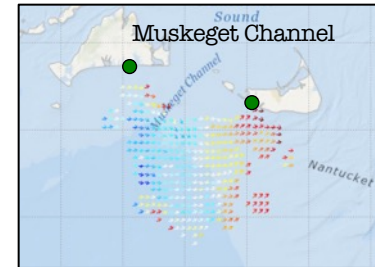
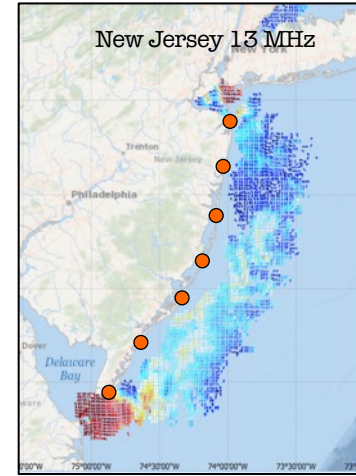
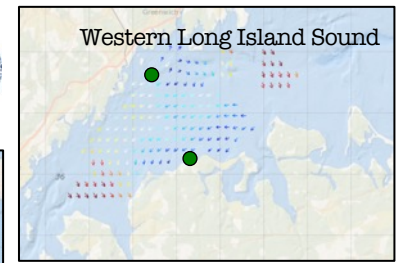
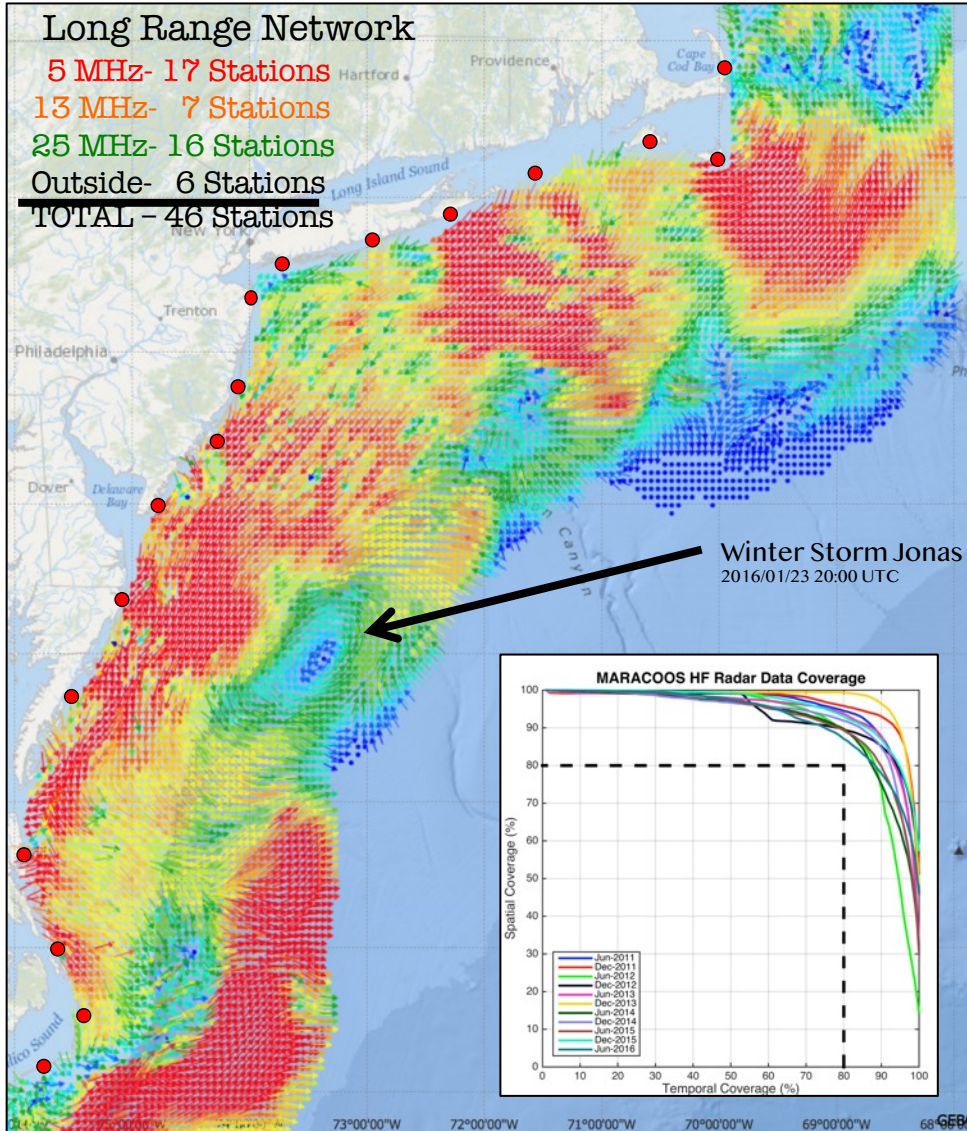
# Doppler Spectra From the Radar



# Radial Current Measurements from a Single Station



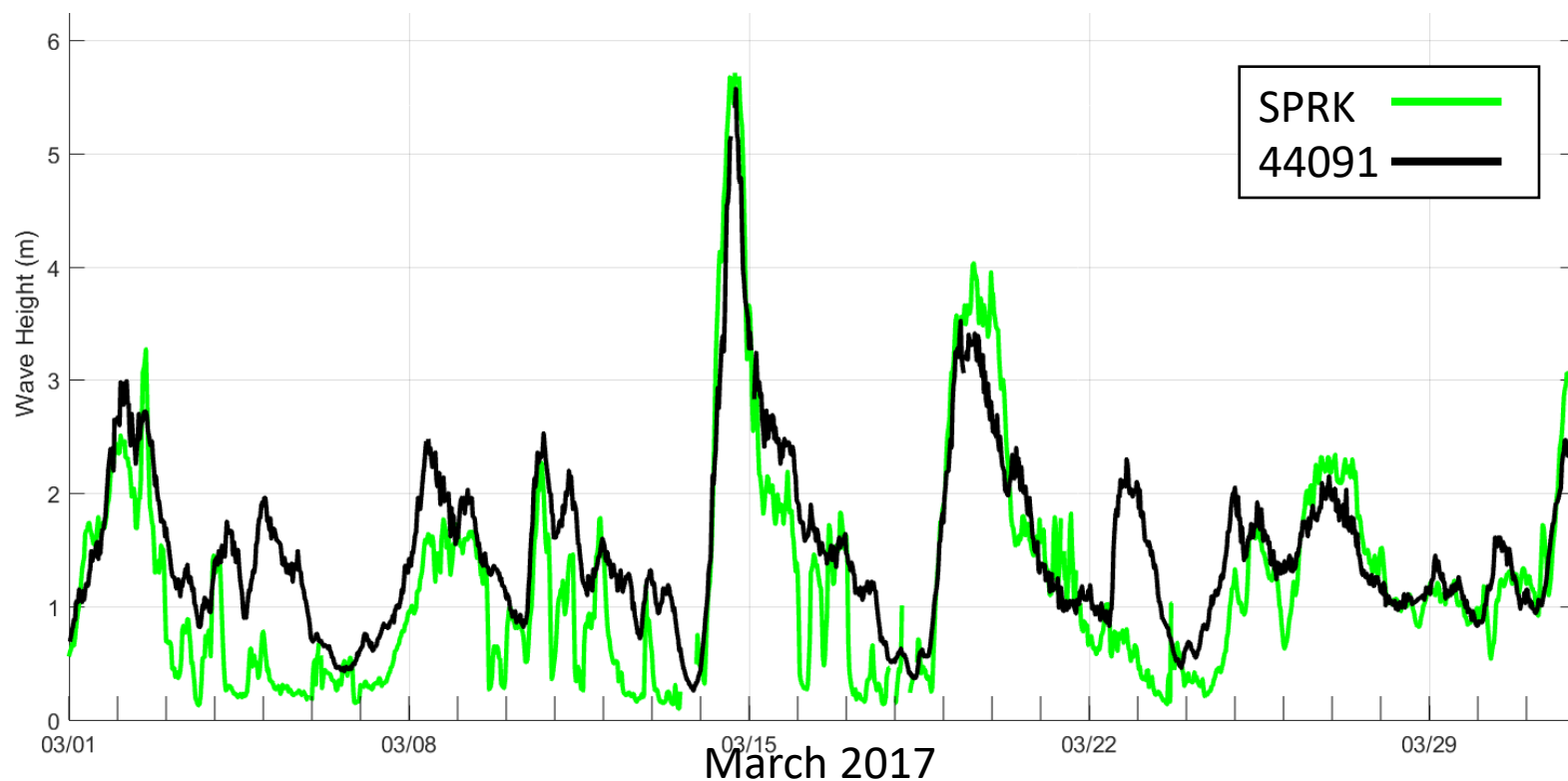
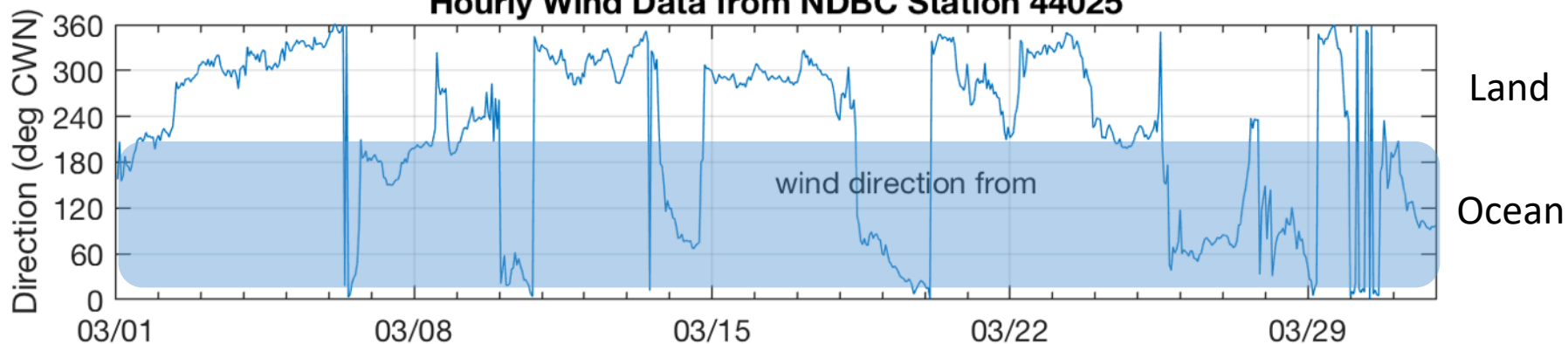
# MARACOOS HF Radar Network





Wind from

### Hourly Wind Data from NDBC Station 44025



A satellite-style map of the United States and surrounding regions, showing the locations of HF radar stations. The stations are marked with red pushpin icons along the West Coast, the Gulf of Mexico, the Atlantic coast, and the Caribbean. A yellow line traces the coastline. A semi-transparent green box is overlaid on the map, containing the title and URL.

# U.S. HF Radar Network

<https://ioos.noaa.gov/project/hf-radar/>

Google Earth

Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image Landsat / Copernicus

2400 km



# IOOS-NWS Project to Evaluate HF Radar Derived Wave Data

2017-2020

# Project Partners

## Rutgers University

Dr. Hugh Roarty  
*HF Radar Network Coordinator*



## CODAR Ocean Sensors

Mr. Chad Whelan,  
*Chief Technology Officer*



## University of Puerto Rico

Mr. Colin Evans  
*HF Radar Lead*



CARICOOS

## NWS WFO Mt. Holly

Mr. Alan Cope  
*Science and Operations Officer*  
Mr. Walt Drag,  
*Senior Meteorologist*



## IOOS

Dr. Jack Harlan,  
*HF Radar Project Manager*

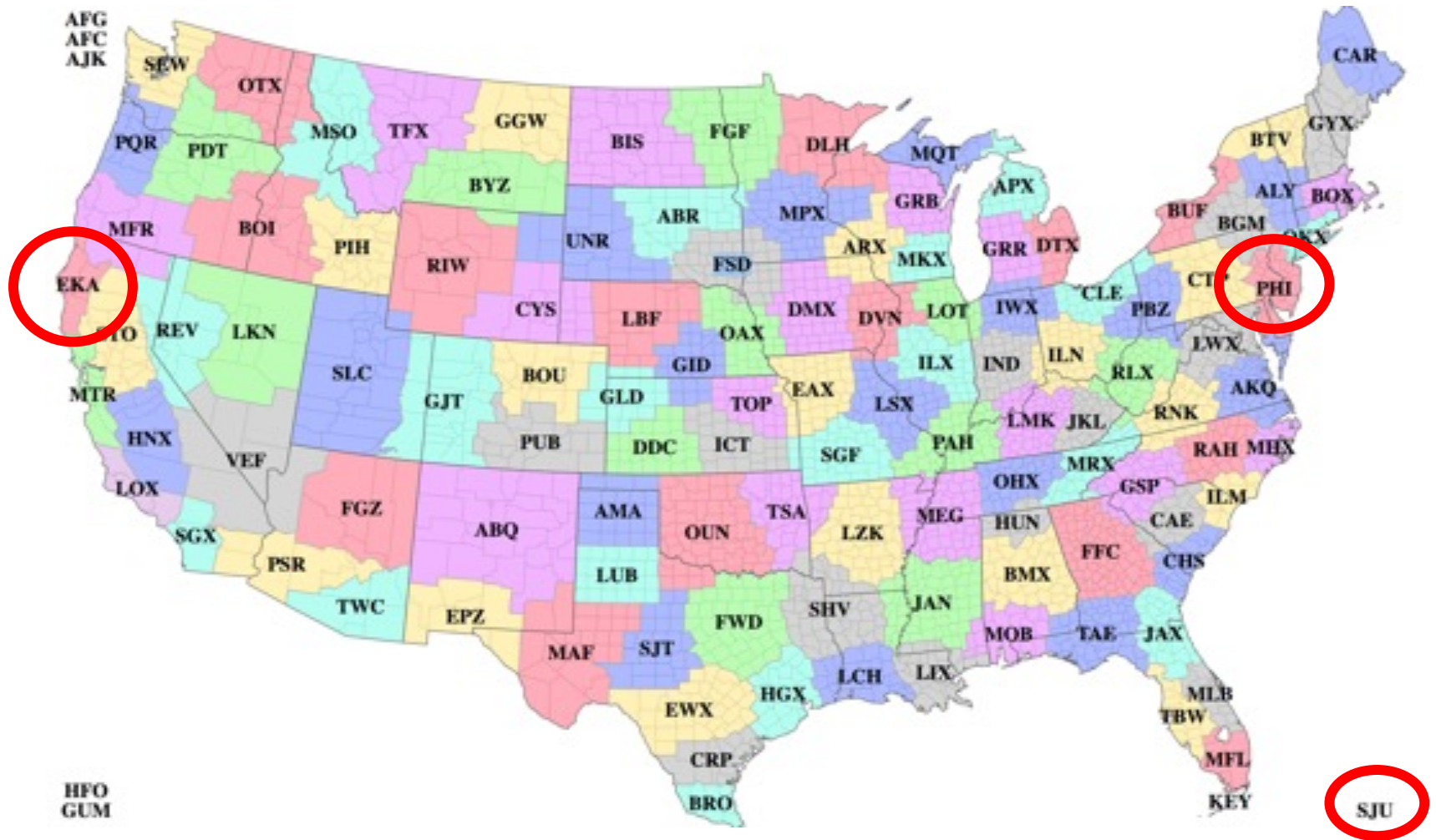


## NWS Office of Science and Technology Integration

Mr. Dennis Atkinson  
*Meteorologist*



# National Weather Service Pilot Project



# Recommendations from

Atkinson, D., & Roarty, H. (2020). *Significant Wave Height Project - White Paper*. NOAA.

“the Significant Wave Height Project conclusion is a strong recommendation that the HF radar data be used for routine NWS operations”

“The Mt. Holly, San Juan, and Eureka WFOs concur on the significant value of the HF radar wave data”

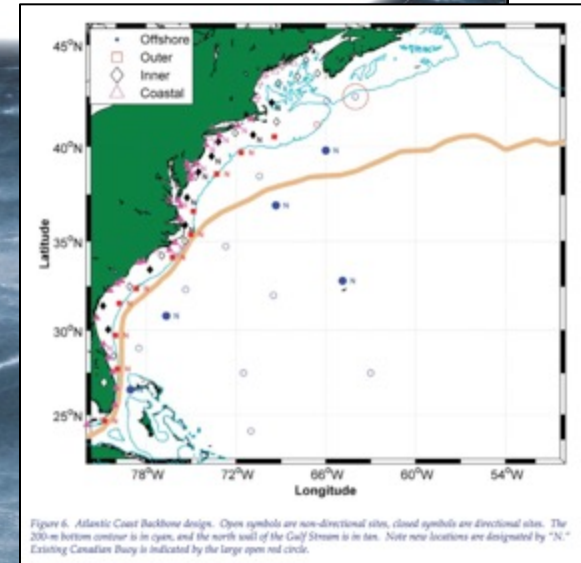
# Impact

A National Operational Wave Observation Plan calls for 133 wave sensors in the Coastal Subnet while only 67 are currently deployed

Potential for some of the 160 HF Radars currently deployed to fill that gap

Surface gravity waves have a profound impact on navigation, offshore operations, safety and economic vitality of the nation's maritime and coastal communities

## A National Operational Wave Observation Plan



An Integrated Ocean Observing System plan for a comprehensive, high quality surface-wave monitoring network for the United States, which addresses the requirements of the maritime user community.

Prepared for the Interagency Working Group on Ocean Observations

March 2009



US Army Corps of Engineers

# HFR Wave Data Use by Weather Services







SeaSondes  
Worldwide

# Ocean/Met Agencies Using SeaSonde

# Wave Data Viewer

## ERDDAP > List of All Datasets

12 matching datasets, listed in alphabetical order.

Grid DAP Data	Sub-set	Table DAP Data	Make A Graph	W M S	Source Data Files	Title	Summary	FGDC, ISO, Metadata	Back-ground Info	RSS	E mail	Institution	Dataset ID
	set	data	graph			* The List of All Active Datasets in this ERDDAP *		M	background			Rutgers Universit...	allDatasets
data			graph			bathymetry: GEBCO_2014 Grid		F I M	background	RSS		GEBCO, BODC .	bathymetry_gebco_2014_grid
	set	data	graph			Drifter Data - SLDMB - US Coast Guard		F I M	background	RSS		Rutgers Center fo...	uscg_slidmb_drifters
data			graph	M		Palmer Deep Antarctica 0.5 km Sea Surface Currents		F I M	background	RSS		Center for Ocean ...	converge_reprocess
data			graph	M	files	Surface Currents - MARACOOS - 5MHz - Realtime with QARTOD radials		F I M	background	RSS		Center for Ocean ...	realtime_maracoos_6km_totals_qartod
data			graph	M	files	Surface Currents - MARACOOS - 5MHz - Realtime with raw radials		F I M	background	RSS		Center for Ocean ...	realtime_maracoos_6km_totals_qartod
data			graph	M		Surface Currents - SWARM - 25MHz - Reprocessed with QARTOD radials		F I M	background	RSS		Center for Ocean ...	realtime_maracoos_6km_totals_qartod
	set	data	graph		files	Wave Data - CODAR SeaSonde - 13MHz - Brant Beach, NJ							
	set	data	graph		files	Wave Data - CODAR SeaSonde - 13MHz - Brigantine, NJ							
	set	data	graph		files	Wave Data - CODAR SeaSonde - 13MHz - Cape May Point, NJ							
	set	data	graph		files	Wave Data - CODAR SeaSonde - 13MHz - Sea Bright, NJ							
	set	data	graph		files	Wave Data - CODAR SeaSonde - 13MHz - Seaside Park, NJ							

The information in the table above is also available in other file formats (.csv, .htmlTable, .itx, .json, .jsonCSV1, .jsonCSV, .jsonKVP, .mat, .nc, .nccsv, .tsv, .xhtml) via a RESTful web service.

ERDDAP, Version 2.17  
Disclaimers | Privacy Policy | Contact

**ERDDAP**  
Easier access to scientific data

**ERDDAP > tabledap > Make A Graph**

Dataset Title: **Wave Data - CODAR SeaSonde - 13MHz - Seaside Park, NJ**

Institution: Center for Ocean Observing and Leadership, Department of Marine & Coastal Sciences, Rutgers University (Dataset ID: realtime\_waves\_13mhz\_sprk)

Range: longitude = -74.07255 to -74.07255°E, latitude = 39.9325 to 39.9325°N, time = 2017-06-07T15:00:00Z to 2022-05-06T16:00:00Z

Information: Summary | License | FGDC | ISO 19115 | Metadata | Background | Subset | Data Access Form | Files

Graph Type: markers

X Axis: time

Y Axis: wave\_height

Color: wave\_period

Constraints

Optional Constraint #1

Optional Constraint #2

Server-side Functions

Graph Settings

Marker Type: Filled Square

Color: [Color Selection]

Size: 5

Continuity: [Continuity Selection]

Scale: [Scale Selection]

N Sections: [N Sections Selection]

Ascending: [Ascending Selection]

Redraw the Graph

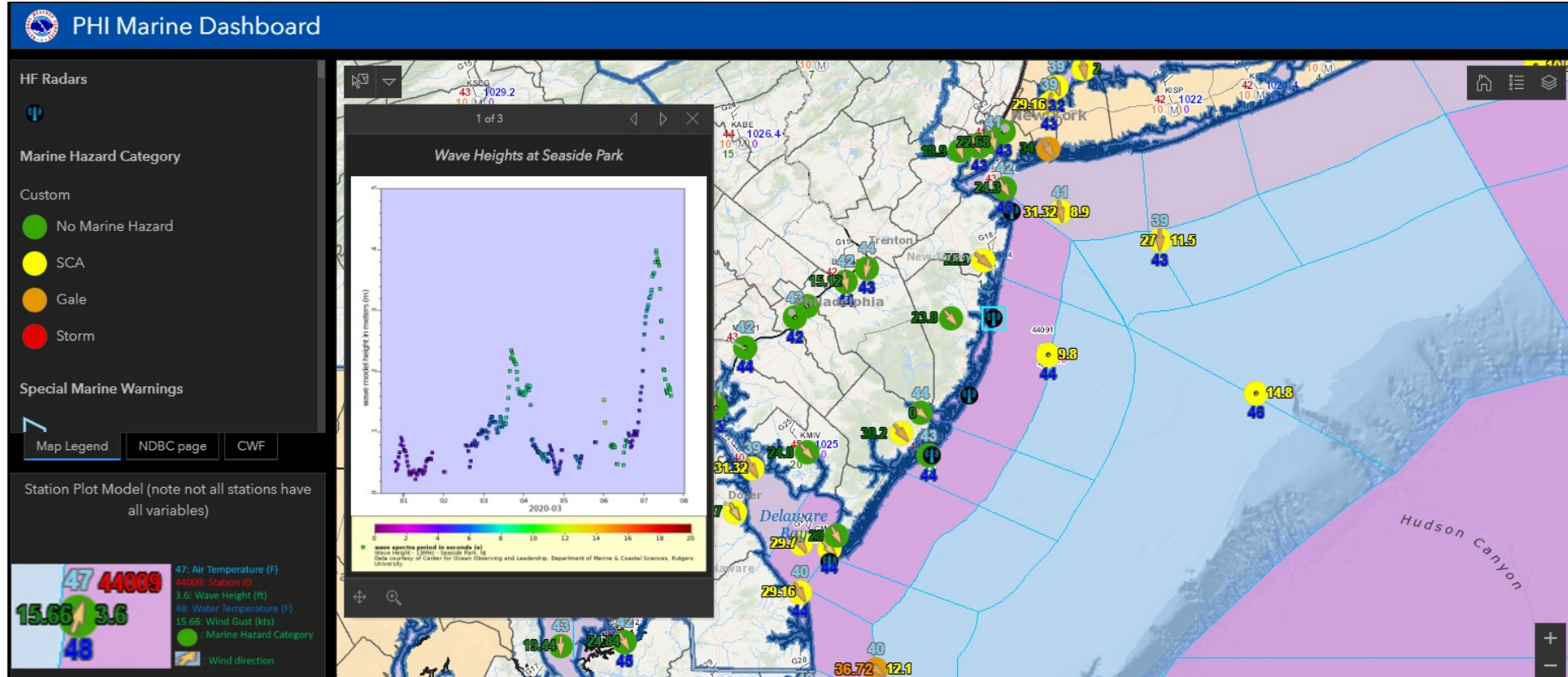
Optional:

Then set the File Type: .htmlTable

and view the URL: [http://hfr.marine.rutgers.edu/erddap/tabledap/realtime\\_waves\\_13mhz\\_sprk.html](http://hfr.marine.rutgers.edu/erddap/tabledap/realtime_waves_13mhz_sprk.html)

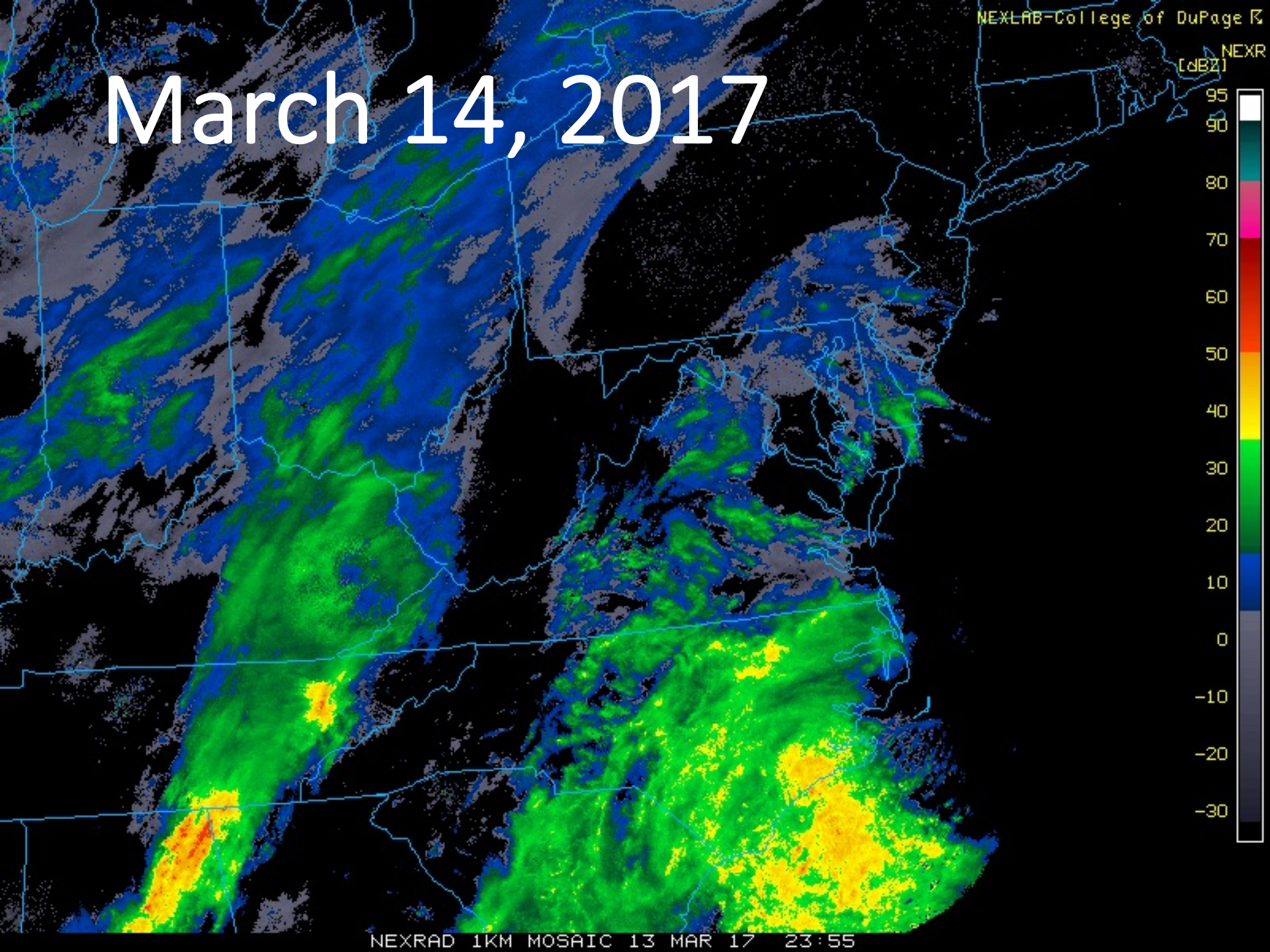
(Documentation / Bypass this form)

# PHI Marine Dashboard



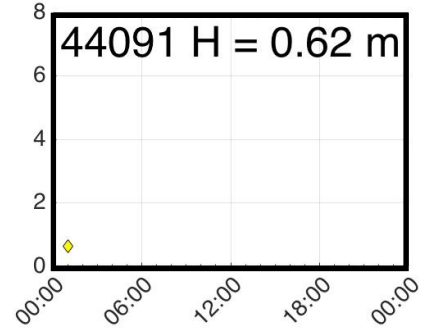
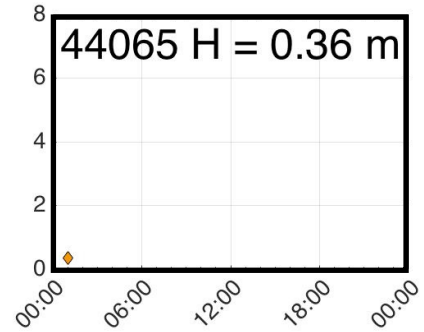
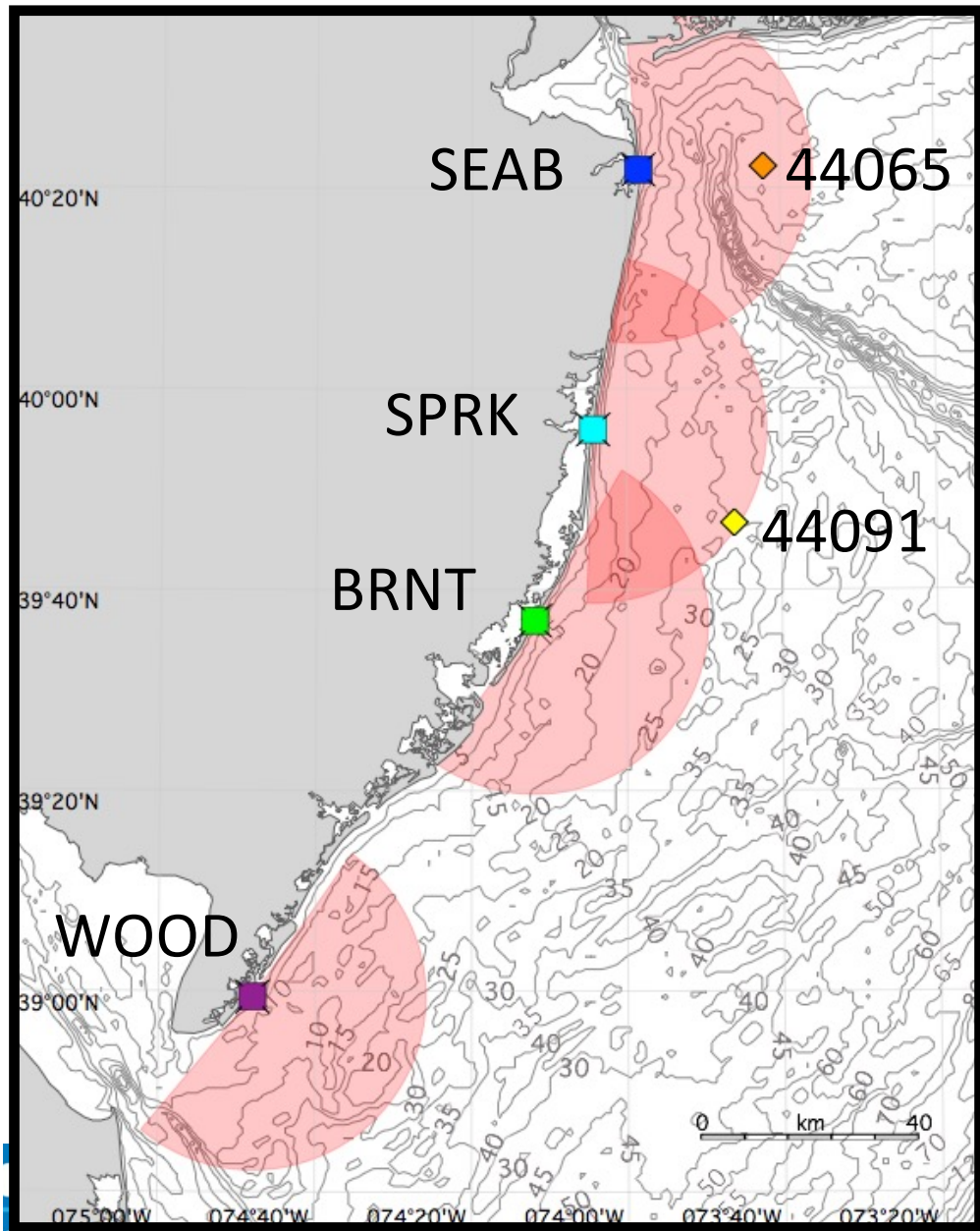
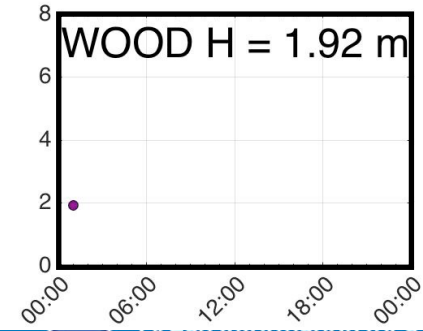
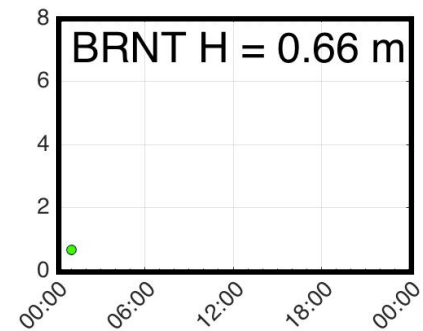
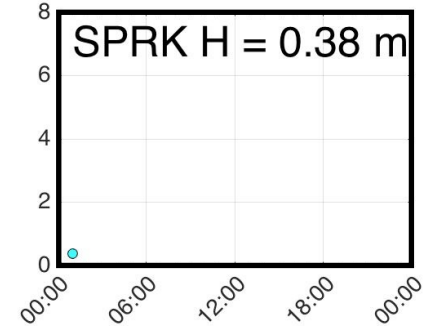
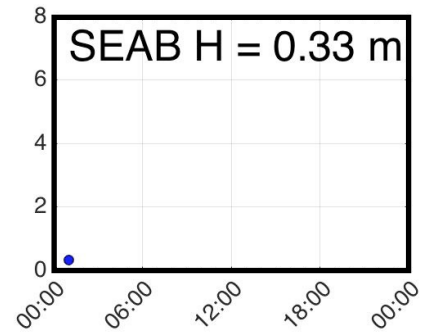
# Individual Cases of HFR Wave Data

# March 14, 2017



# Significant Wave Height (m) Versus Time

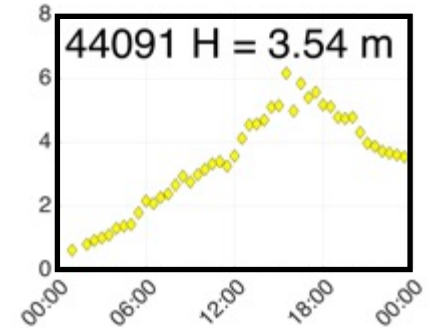
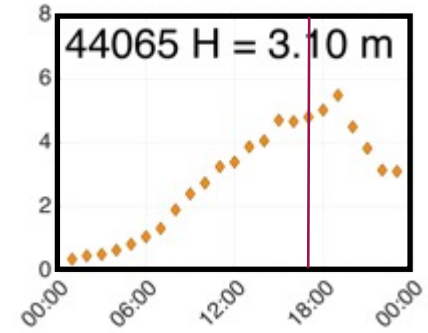
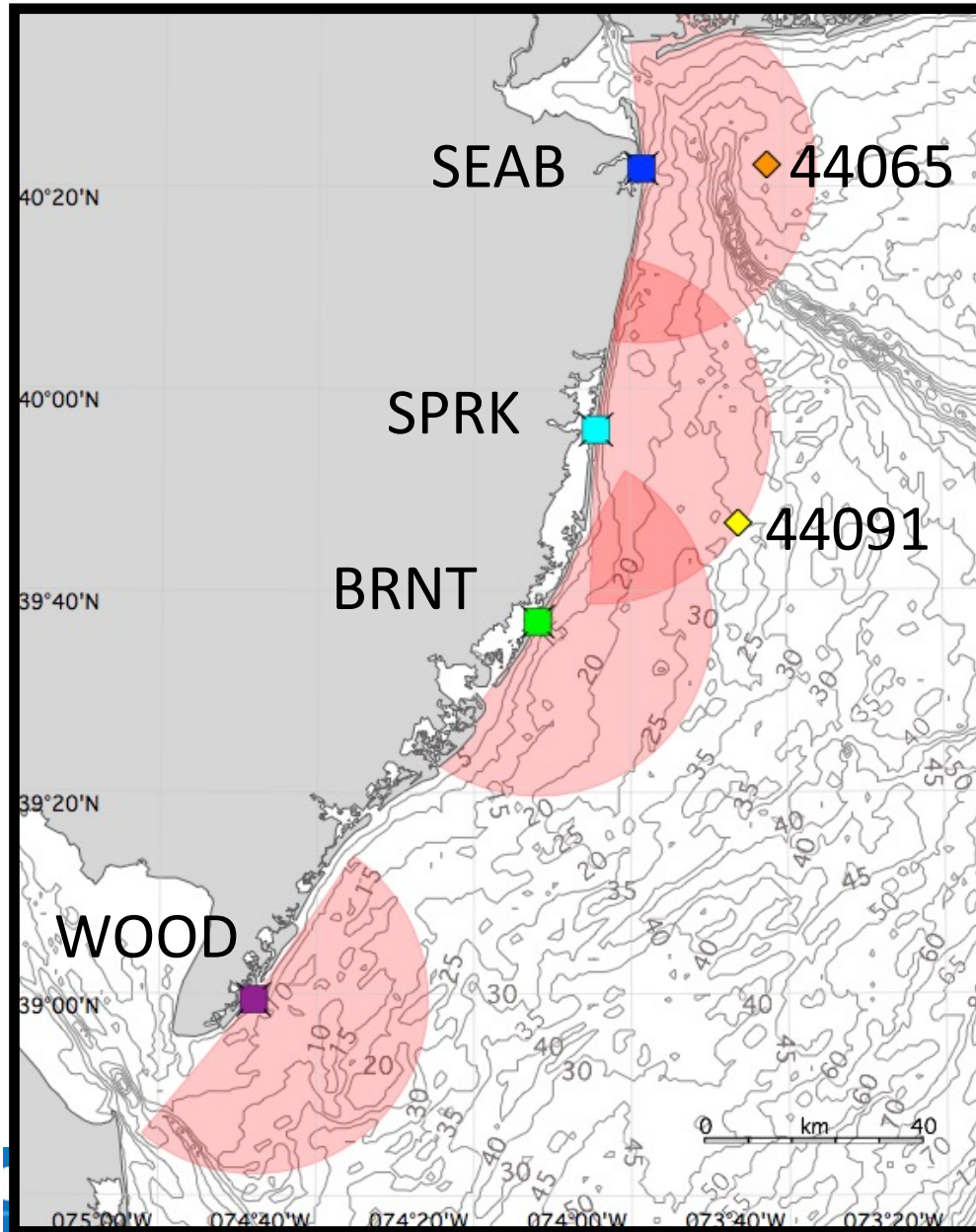
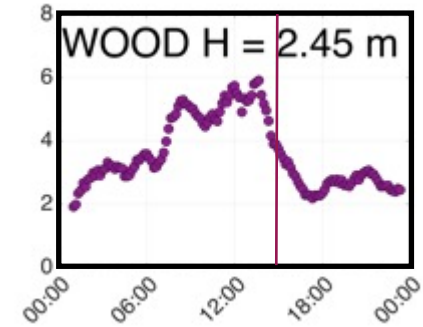
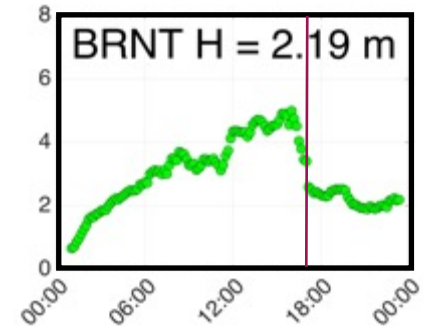
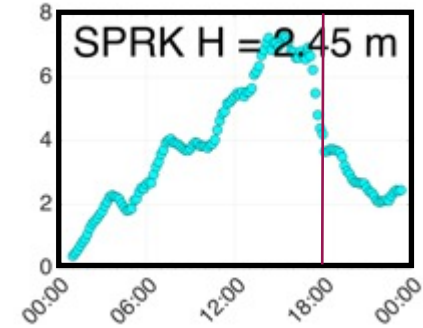
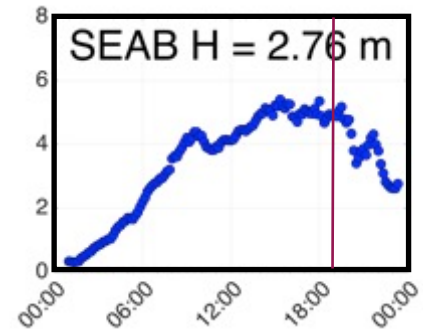
## Landward Winds For First Half+ of March 14, 2017



- Significant wave height data are displayed for RC10 (left panel) and for buoys (right panel). SeaSonde dt=10 min, 44065 dt=60 min, 44091 dt=30 min.
- Winds are landward for the first part of this event.

# Significant Wave Height (m) Versus Time

## Landward Winds For First Half+ of March 14, 2017

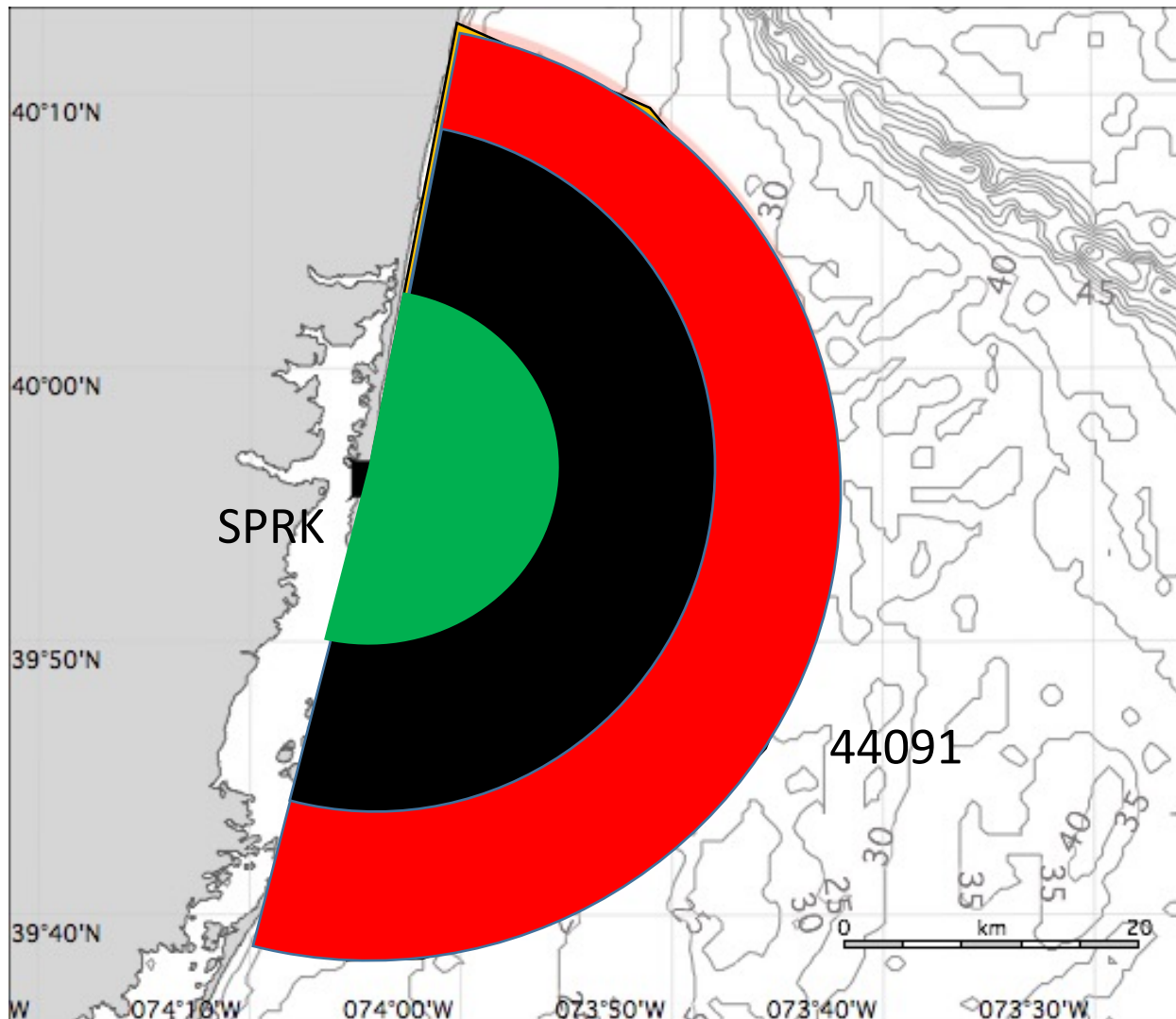


Winds become seaward at the times listed below, shown in time series plots with vertical lines. The first transition occurs at WOOD and progresses northward:

- SEAB (19:00)
- SPRK (18:00)
- 44065 (17:00 / 18:00)
- BRNT (17:00)
- WOOD (14:00)

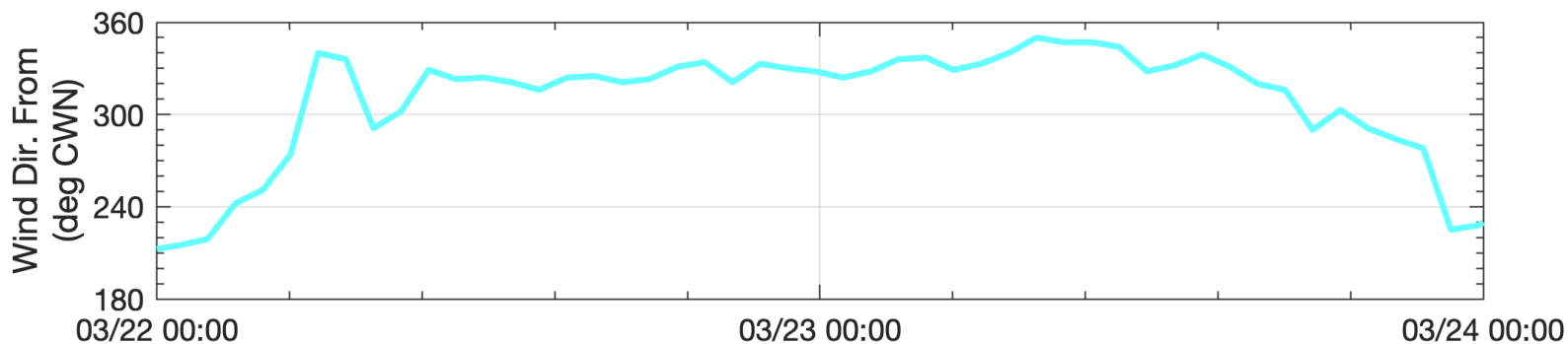
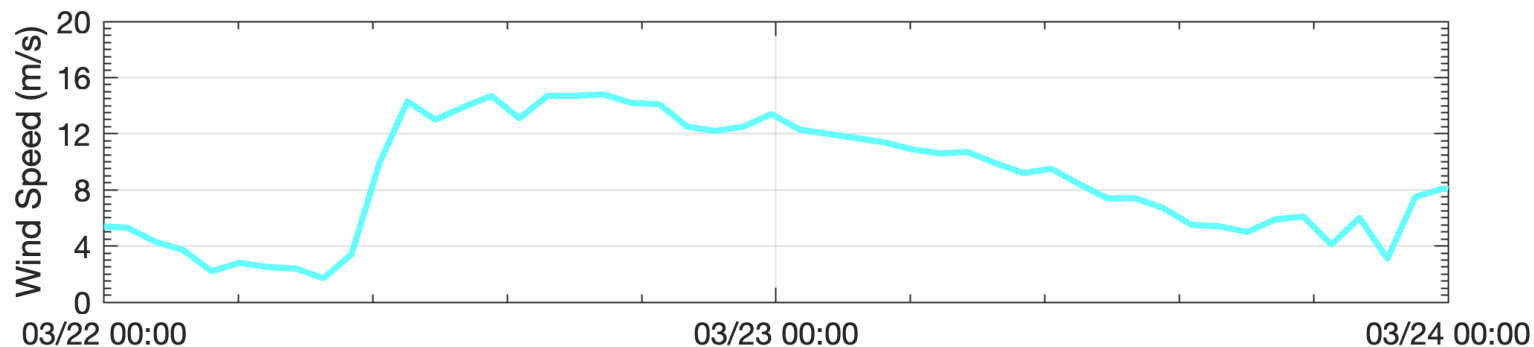
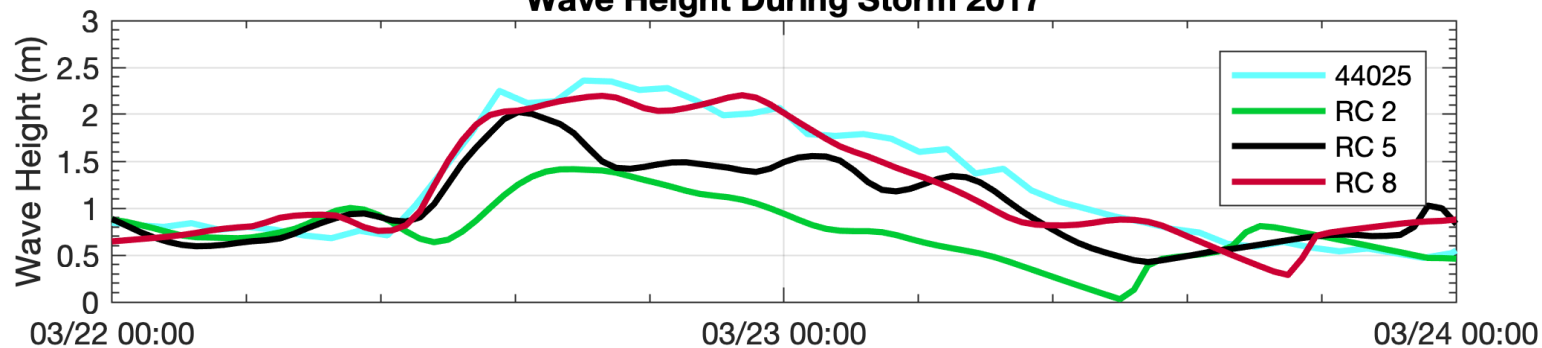


# SeaSonde Wave Measurement



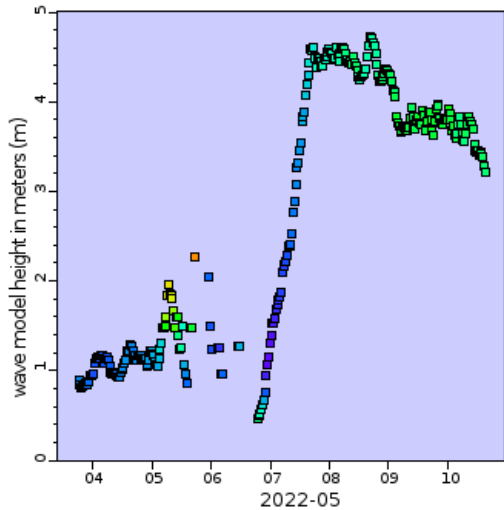
# March 2018

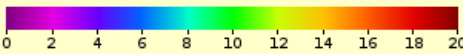
## Wave Height During Storm 2017



# Mothers' Day Nor'easter, May 2022

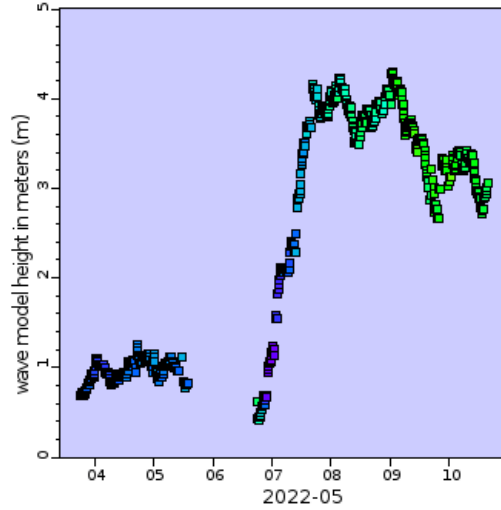
data    
Seaside Park, NJ Wave Measurements

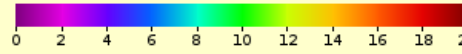


  
■ wave spectra period in seconds (s)  
Wave Data - CODAR SeaSonde - 13MHz - Seaside Park, NJ  
Data courtesy of Center for Ocean Observing and Leadership,  
Department of Marine & Coastal Sciences, Rutgers University


<http://hfr.marine.rutgers.edu/erddap/tabledap/realtime>

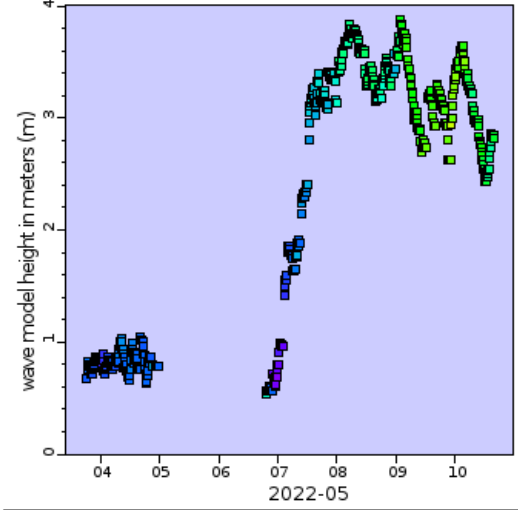
data    
Brant Beach, NJ Wave Measurements

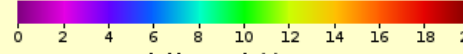


  
■ wave spectra period in seconds (s)  
Wave Data - CODAR SeaSonde - 13MHz - Brant Beach, NJ  
Data courtesy of Center for Ocean Observing and Leadership,  
Department of Marine & Coastal Sciences, Rutgers University

<http://hfr.marine.rutgers.edu/erddap/tabledap/realtime>

data    
Brigantine, NJ Wave Measurements

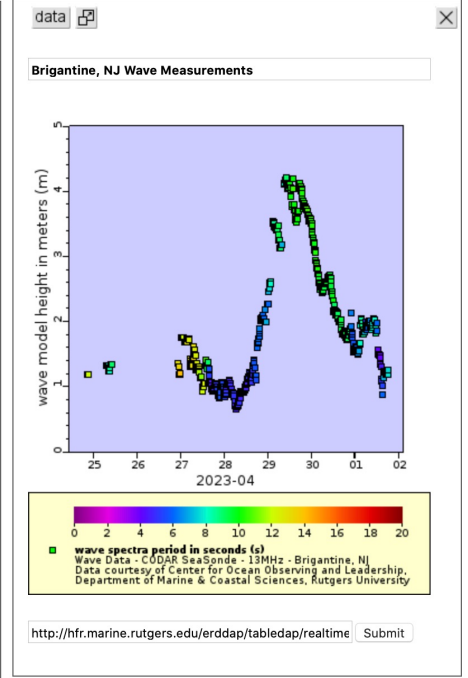
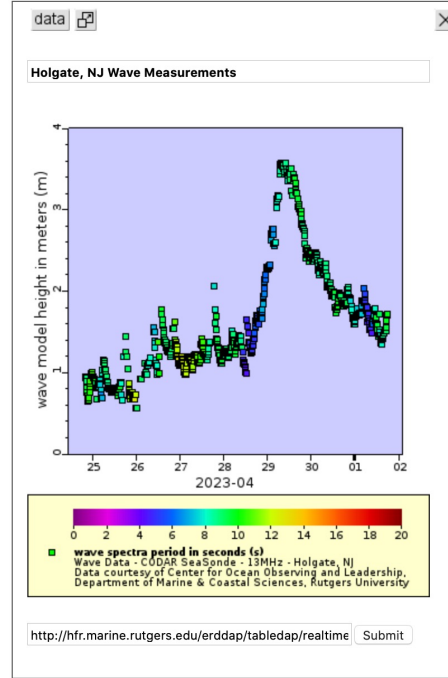
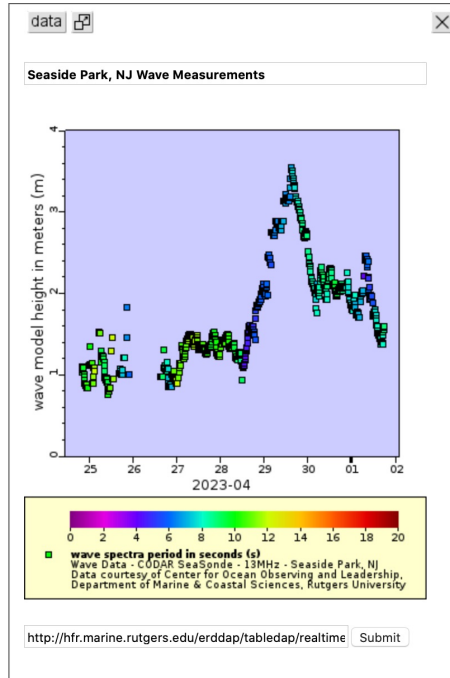
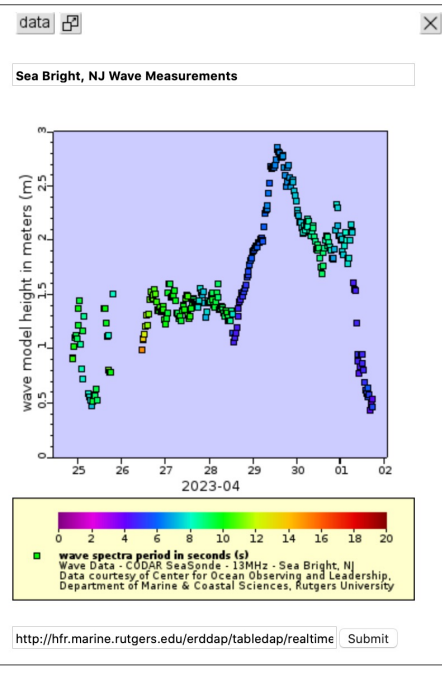


  
■ wave spectra period in seconds (s)  
Wave Data - CODAR SeaSonde - 13MHz - Brigantine, NJ  
Data courtesy of Center for Ocean Observing and Leadership,  
Department of Marine & Coastal Sciences, Rutgers University

<http://hfr.marine.rutgers.edu/erddap/tabledap/realtime>

# Nor'easter, April 2023

ERDDAP > Slide Sorter



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THANK YOU

