

# High Frequency Radar Science and Event Highlights 2022-2023

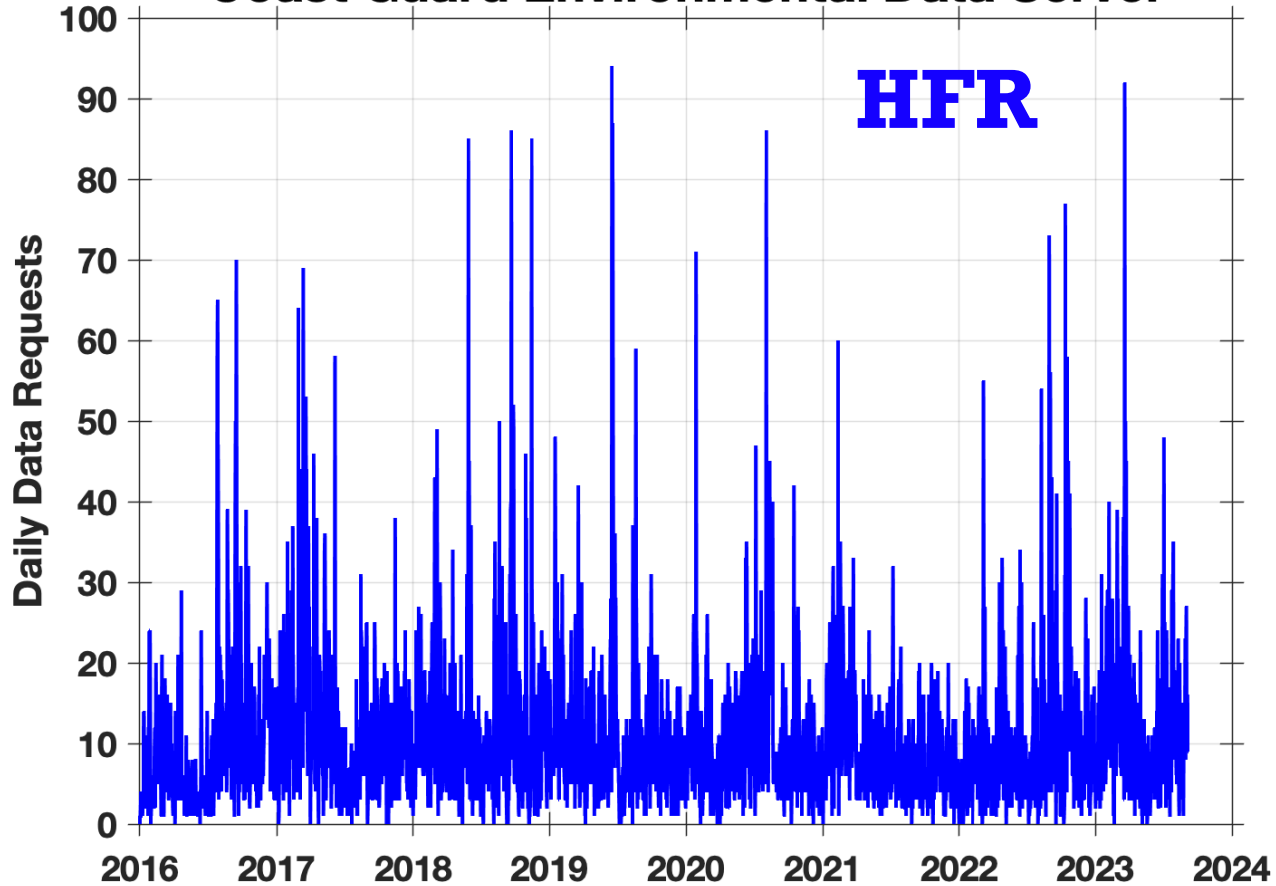
MARACOOS Annual Meeting  
Baltimore, MD  
September 12-13, 2023



# HFR Data and Forecasts to USCG

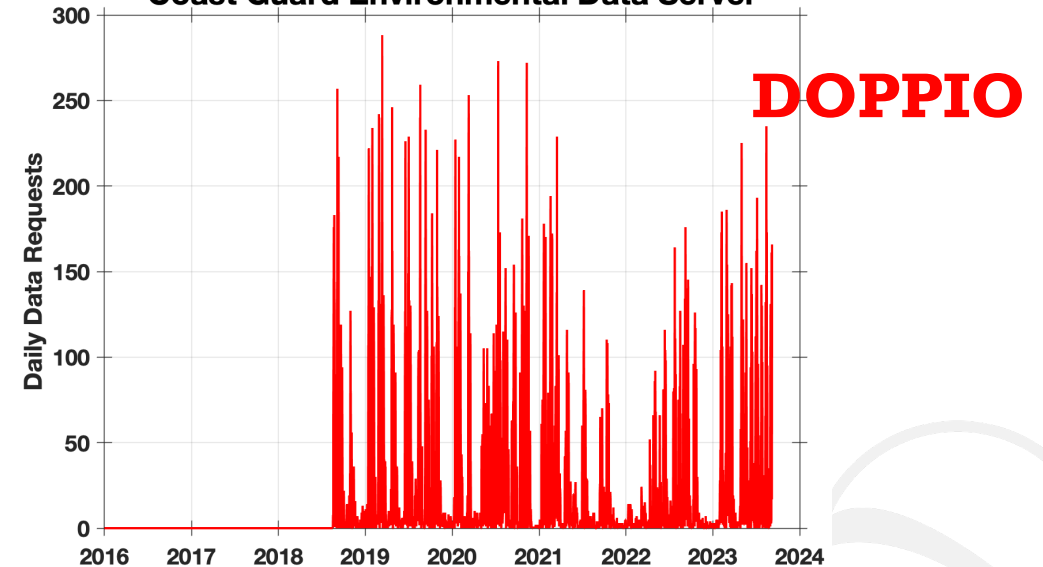


Daily HF Radar Surface Current Data Requests to Coast Guard Environmental Data Server

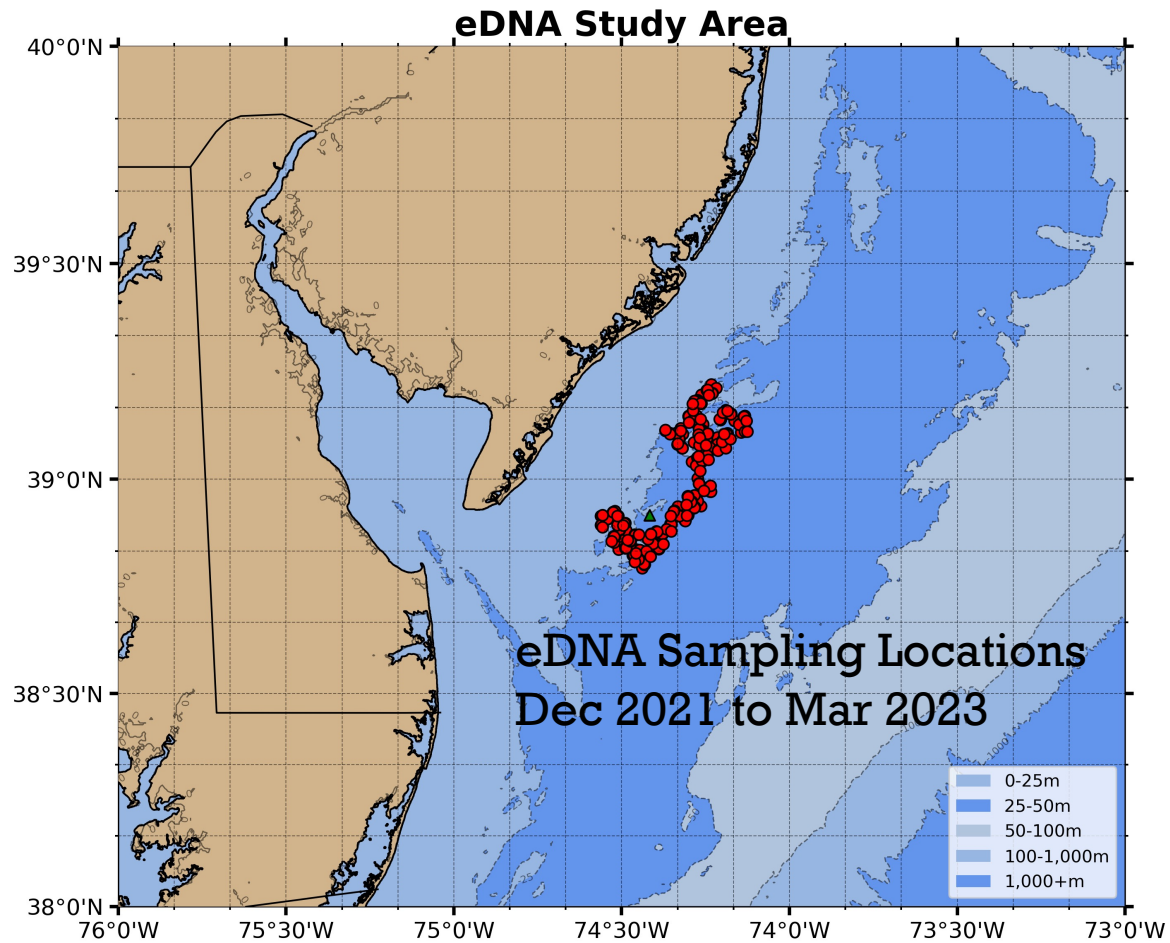


- US Coast Guard requests the data 11 times per day
- Maximum number requests 94 on June 17, 2019

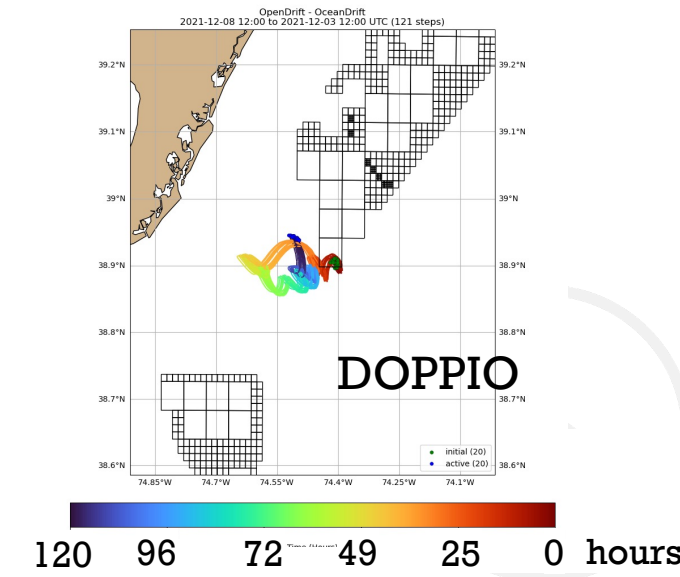
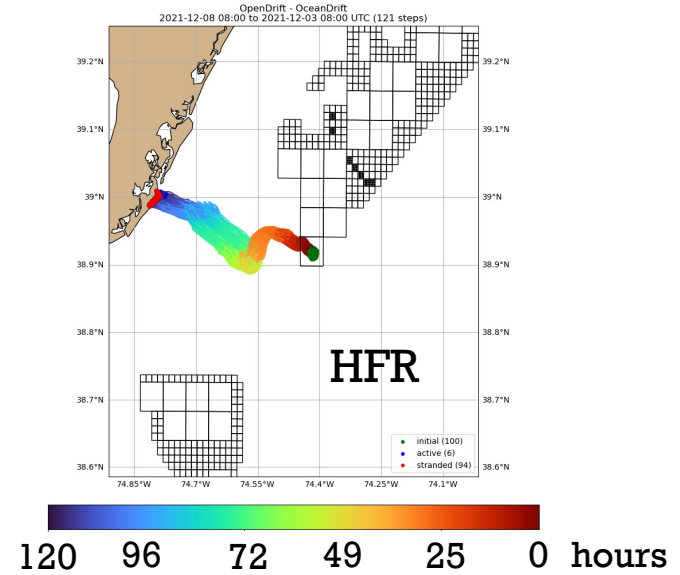
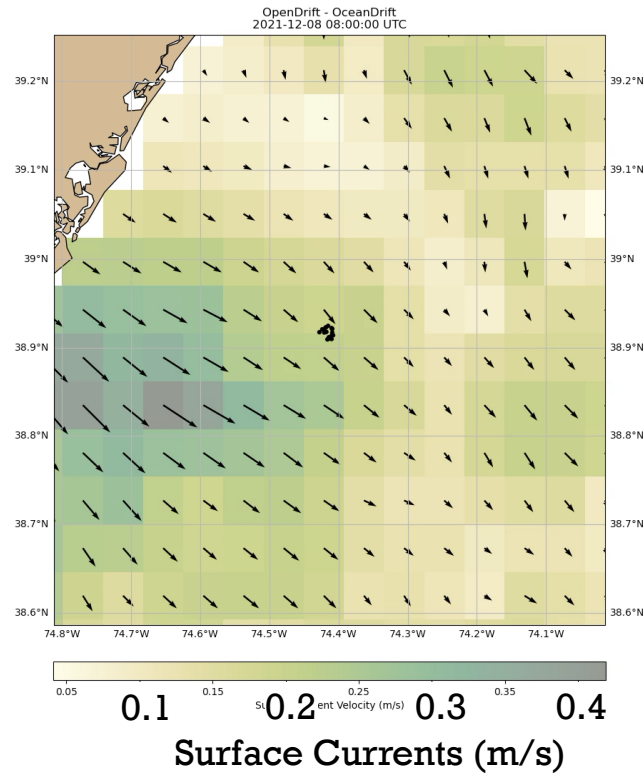
Daily DOPPIO Surface Current Data Requests to Coast Guard Environmental Data Server



# Reverse Particle Tracking of eDNA



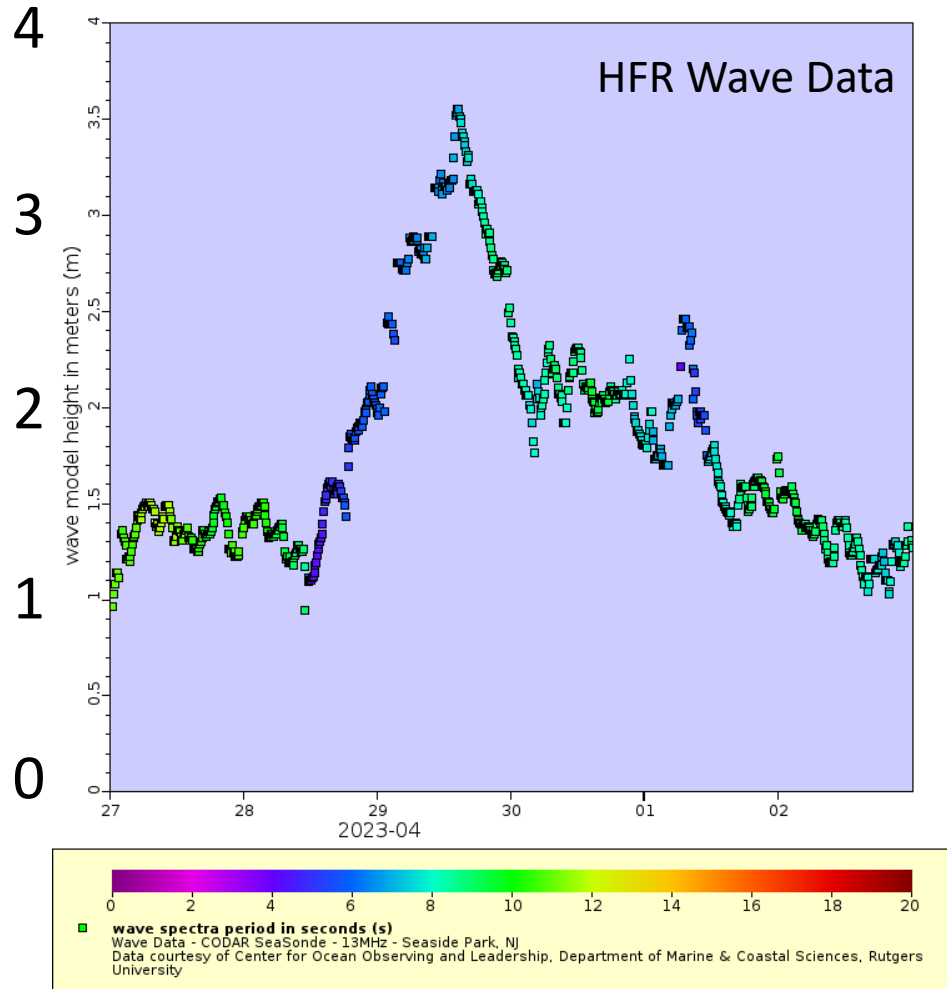
## Reverse Drift Dec 8 to Dec 4 2021



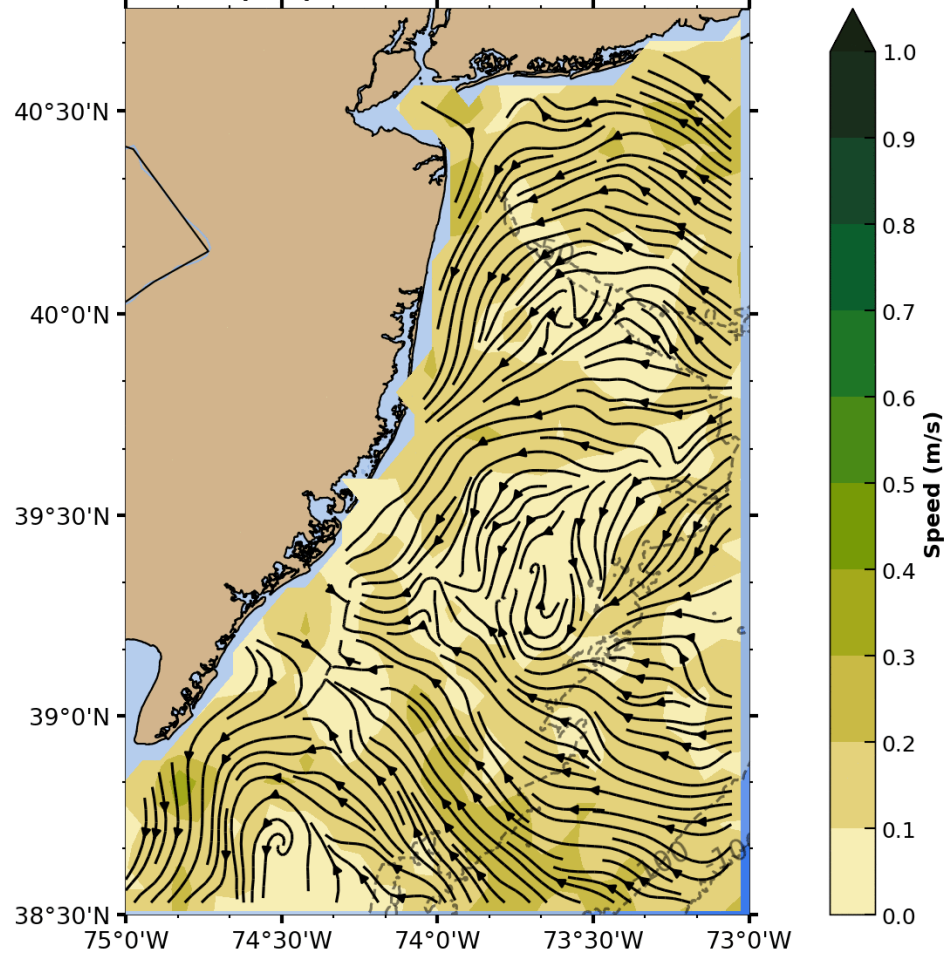
eDNA 1/2 life is on the order of 1 day

# Nor'easter April 2023

## Wave Height (m)

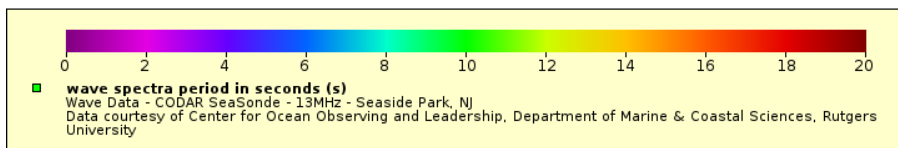
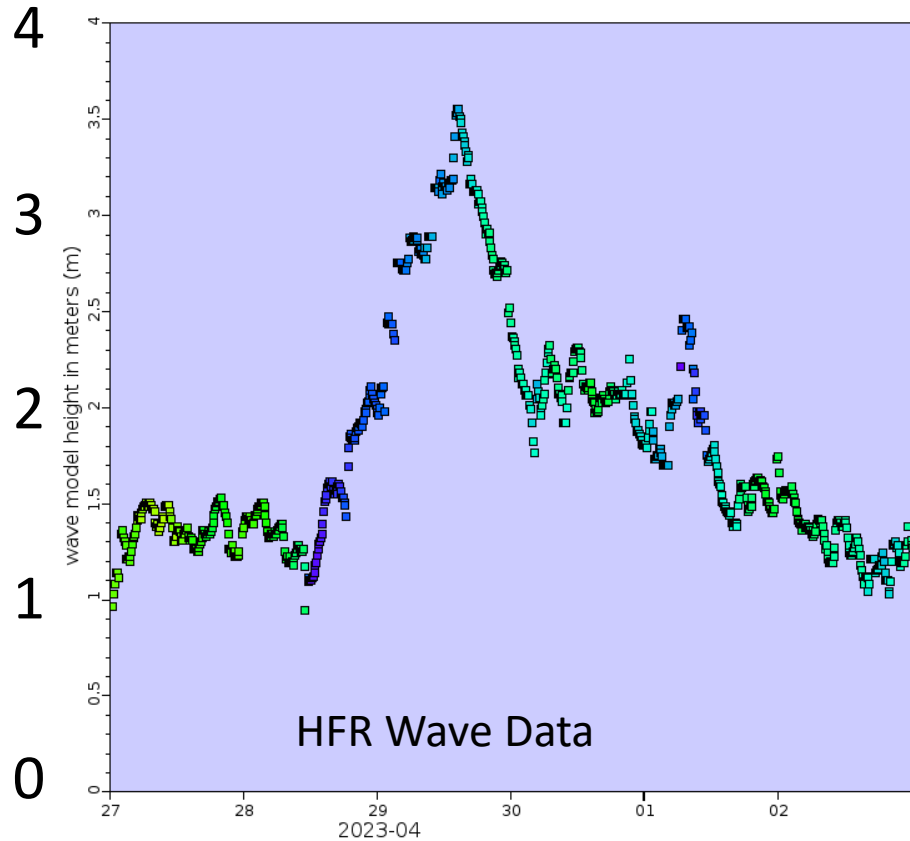


## HFR - Currents (0 m) - OI - MARACOOS - 2023-04-29T00:00

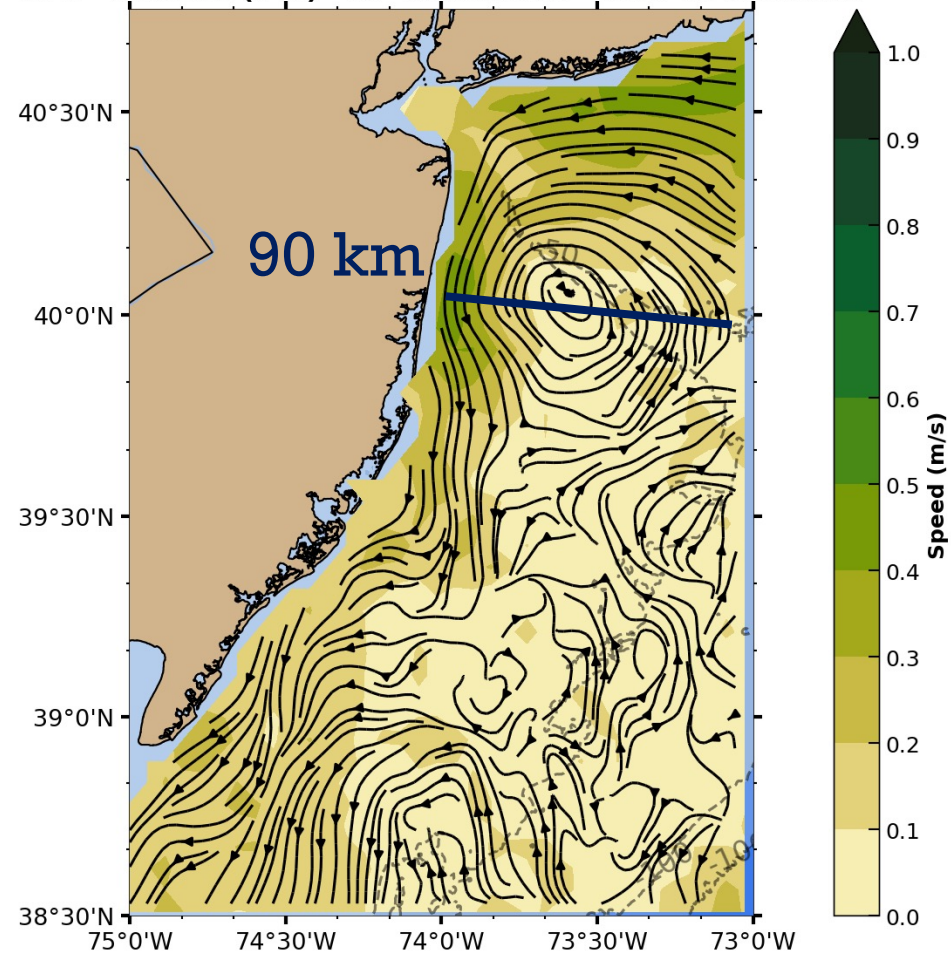


# Nor'easter April 2023

Wave Height (m)



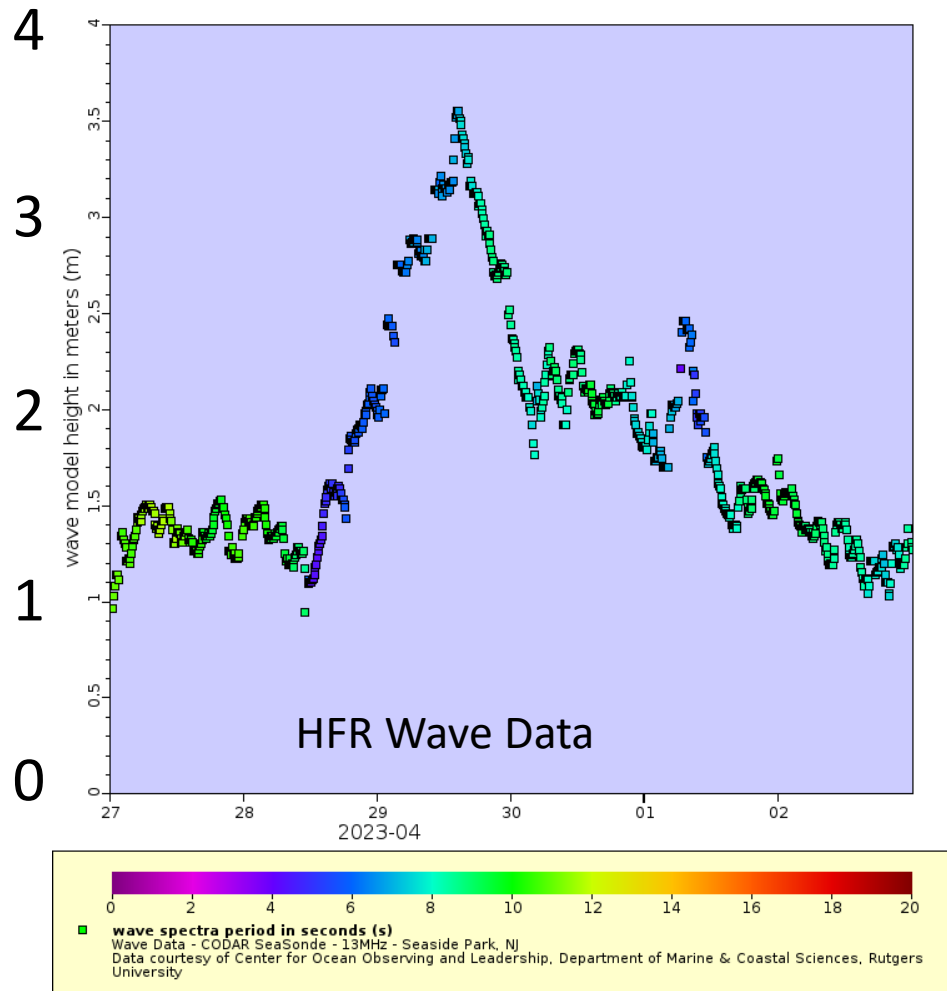
HFR - Currents (0 m) - OI - MARACOOS - 2023-04-29T19:00



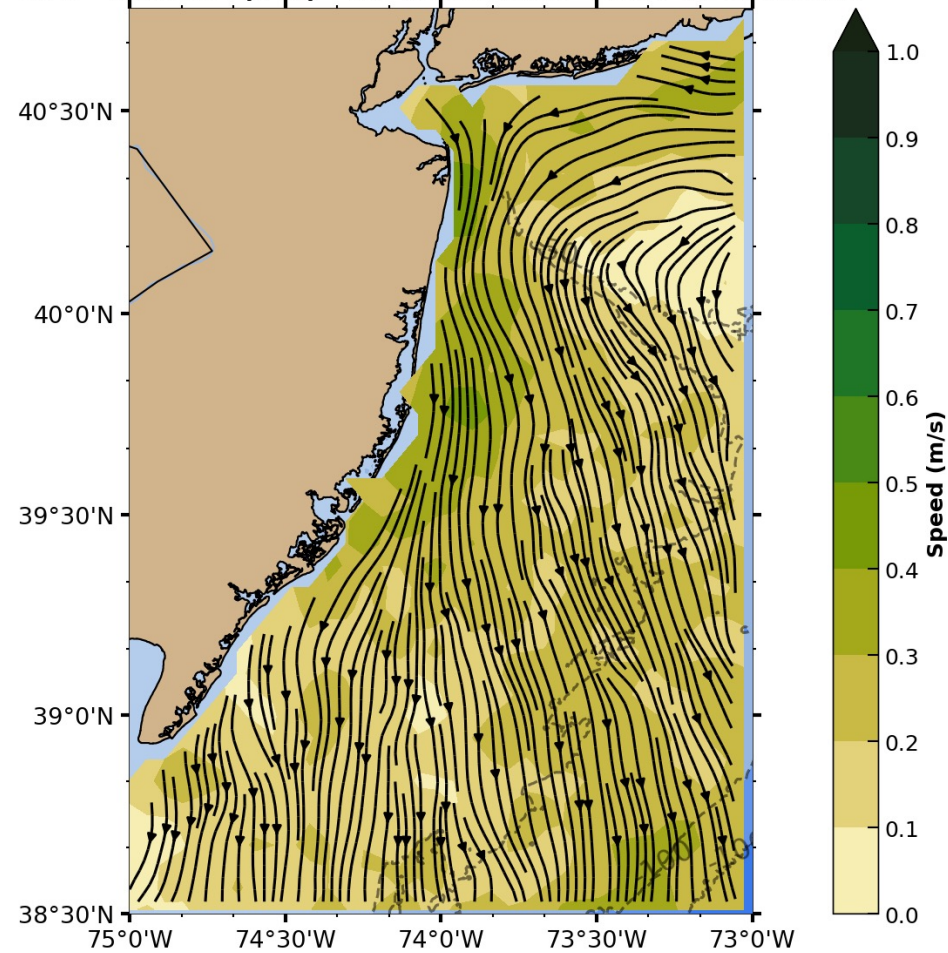


# Nor'easter April 2023

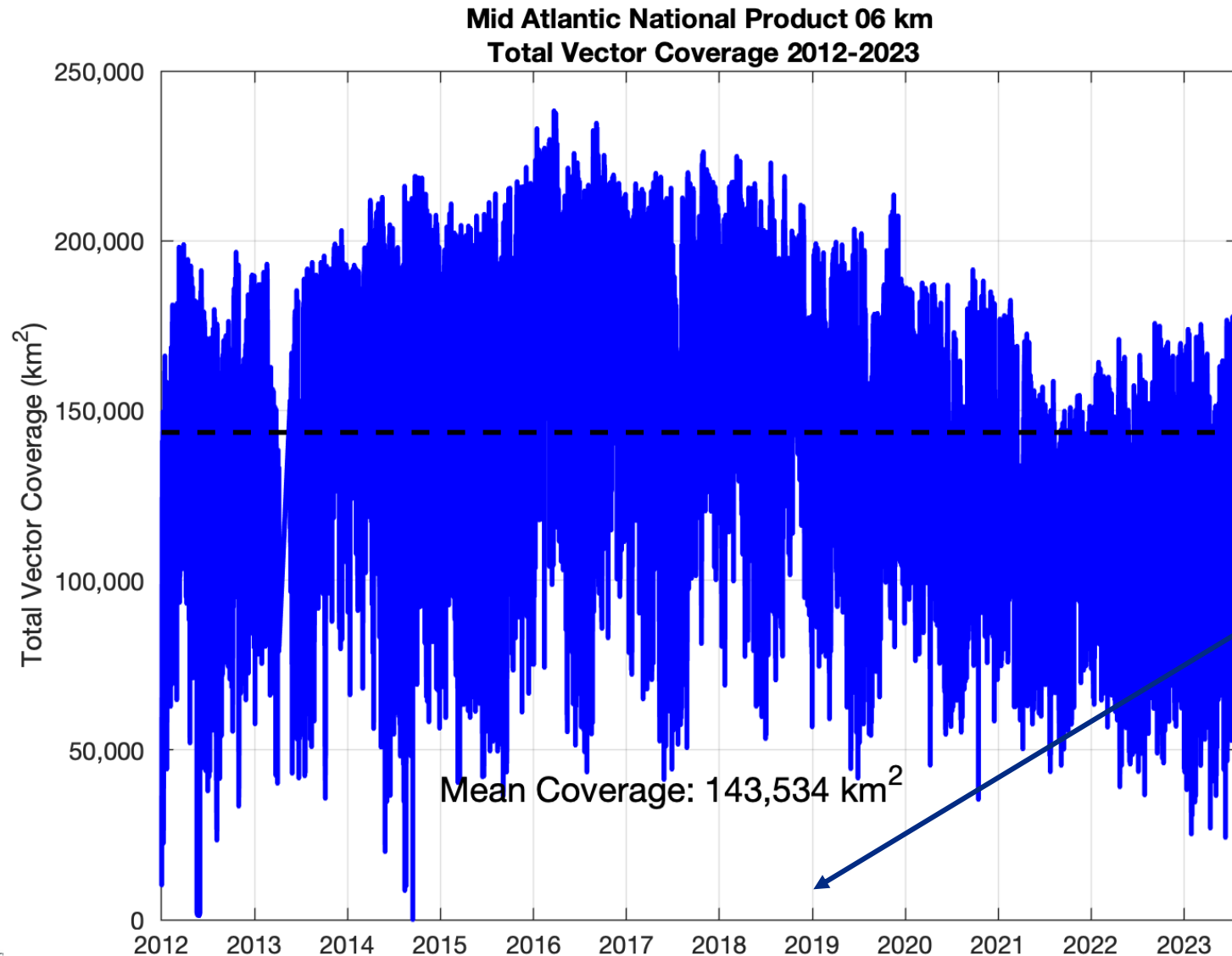
## Wave Height (m)



## HFR - Currents (0 m) - OI - MARACOOS - 2023-04-29T23:00



# HFR Network Coverage 2012 - 2023



14.4 billion total vectors

IOOS Aging Infrastructure  
Overview

Mike Crowley, Lisa Hazard, Hugh Roarty

IOOS | EYES ON THE OCEAN™



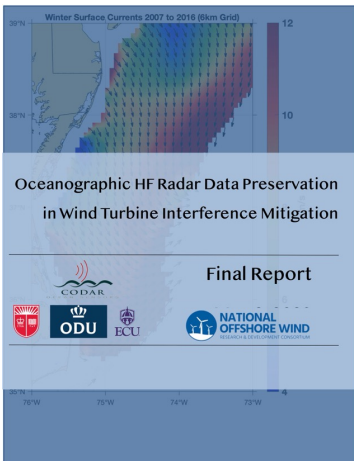
# Wind Turbine Interference Mitigation

Webinar on June 14, 2023



Mitigating Wind Turbine Interference in the US HF Radar Network

Dale Trockel<sup>1</sup>, Anthony Kirincich<sup>2</sup>, Brian Emery<sup>3</sup>, Hugh Roarty<sup>4</sup>, Josh Trockel<sup>1</sup>, Chad Whelan<sup>1</sup>



*NOWRDC Final Report, June 2023*

*“Oceanographic HF Radar Data Preservation in Wind Turbine Interference Mitigation”*

UPGUN CUTTERS TO MEET TODAY'S THREATS

## PROCEEDINGS

U.S. NAVAL INSTITUTE | The Independent Forum of the Sea Services

### NAVAL AVIATION

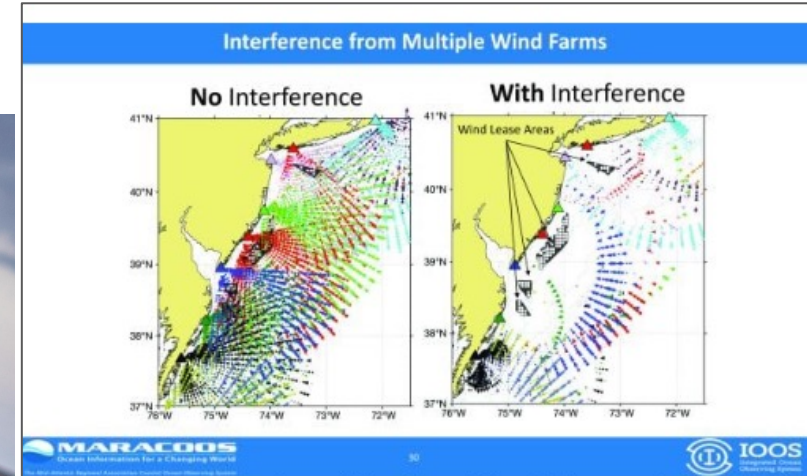
MQ-25 Must Be Multirole  
Heavier and Lighter Than Air  
TACRONS: 'T' Is for Tactical  
Aerostats Have a Role  
Lightning Carriers Are Neither

NOBODY ASKED ME, BUT...

**Offshore Wind Energy: A Rising Challenge to Coast Guard Operations**  
By Lieutenant (junior grade) Lowen M. Hobbs, U.S. Coast Guard  
July 2023  
The Coast Guard will face new challenges operating in and around offshore energy installation projects.

July 2023  
www.usni.org

150 U.S. NAVAL INSTITUTE 1873-2023  
READ THINK SPEAK WRITE



“offshore wind turbines have been shown to affect the capabilities of the Coast Guard’s Search and Rescue Optimal Planning System (SAROPS), which is used for drift modeling and search planning. The oscillating rotor blades and generator of a wind turbine emit high levels of electromagnetic interference that can affect high frequency radar capabilities around an OREI.”



# Engagement



UNESCO  
Integrated  
Ocean Observing  
System



The Global Ocean Observing System

UNESCO  
Integrated  
Ocean Observing  
System

WORLD  
METEOROLOGICAL  
ORGANIZATION

UN  
environment  
programme



### Evaluation and Transition Plans for the Use of High-Frequency Radar (HFR) Coastal Wave Observations within the National Weather Service (NWS)

**Participants:** Daniel Meléndez\*, Hugh Roarty\*, Brian Zelenke\*, Darren Wright\*, Chad Whelan\*, Dennis Atkinson\*, Ali Abdolali\*  
\*NOAA/NWS/OST, \*Rutgers University/MARACOOS, \*NOAA/NO/PODS, \*NWS/Marine Program, \*CODAR Ocean Sensors Inc., \*NWS/NCEP/EMC

#### Introduction

MMS is moving to incorporate coastal wave height, period, and direction data from HFRs in collaboration with NOAA's LL Integrated Ocean Observing System (IOOS) Office and its Regional Associations. Evaluation by Weather Forecast Office (WFO) resulted in a strong recommendation to use HFR wave data operationally. The HFR wave data supplement existing buoys and **constitute the primary validation**. Coastal wave data contribute to marine safety, thus supporting the larger goals of the NWS Weather Ready Nation.

#### How does HFR wave measurement work?

- Wave sites consist of 2<sup>nd</sup>-order Bragg Doppler spectra caused by the orbital motion of long traveling ocean waves.
- Wave parameters are determined for each radar Doppler spectrum at concentric range rings from the HFR and collapsed into a single-value spatial average.
- Spatial average and temporal resolution based on operating frequency: 3-5 km offshore & 30-60 mins.
- Assumes waves producing scatter do not interact with the ocean floor:  $Z < 0.05\lambda$ .
- 2<sup>nd</sup>-order scattering cross-section is given by Benoit (1977) and is similar to scattering by a sinusoidal grating.
- Wave direction extracted from fitting a wave spectrum model (Petersen-Munkowski card in direction).

#### What are strengths and limitations?

**Strengths:**

- Non-invasive remote sensor.
- Provides wave height, period, and direction.
- Uses existing surface current measurement HFR National Network.

**Limitations:**

- When ocean swellheight exceeds limit for radar frequency, the Doppler spectrum becomes unusable since the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> order spectra exist. This saturation threshold in terms of significant wave height (SWH) is:  $H_{s,max} = 1.2 \sqrt{g / \omega}$
- Examples:  $H_{s,max}(f = 3.3 \text{ MHz}) = 7.4 \text{ m}$   
 $H_{s,max}(f = 5.3 \text{ MHz}) = 5.2 \text{ m}$

**Validation Results**

Somehow large spatial temporal averaging.

Wave fetch limits offshore wave detection.

Background noise floor greatest at lower frequencies.

#### Research to Operations (R2O) Way

- Over 60 NOAA products use sea wave variables.
- More R2O requirements through validation and verification.
- Ensure data format is operationally viable.
- Test data impact with experimental model runs.
- Use HFR wave data to calibrate existing NOAA forecast models.
- Create new NOAA forecast models that assimilate wave data in near real-time.

Daniel Meléndez (daniel.melendez@noaa.gov)