

The History of Oceanographic High Frequency Radar at Rutgers University

RadarConf'24
2024 IEEE RADAR CONFERENCE

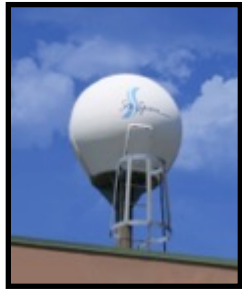
*Hugh Roarty
Josh Kohut
Tim Stolarz
Michael Smith*

*Jacquelyn Veatch
Ethan Handel
Scott Glenn*



Rutgers University - Coastal Ocean Observation Lab

Observatory Operations, Data Fusion & Training Center



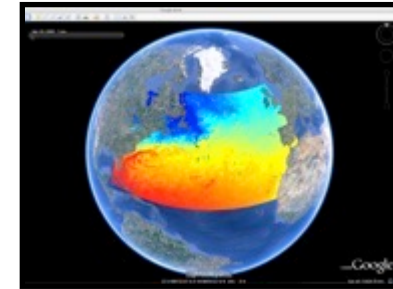
**L-Band & X-Band Satellite
Receivers**



CODAR Network



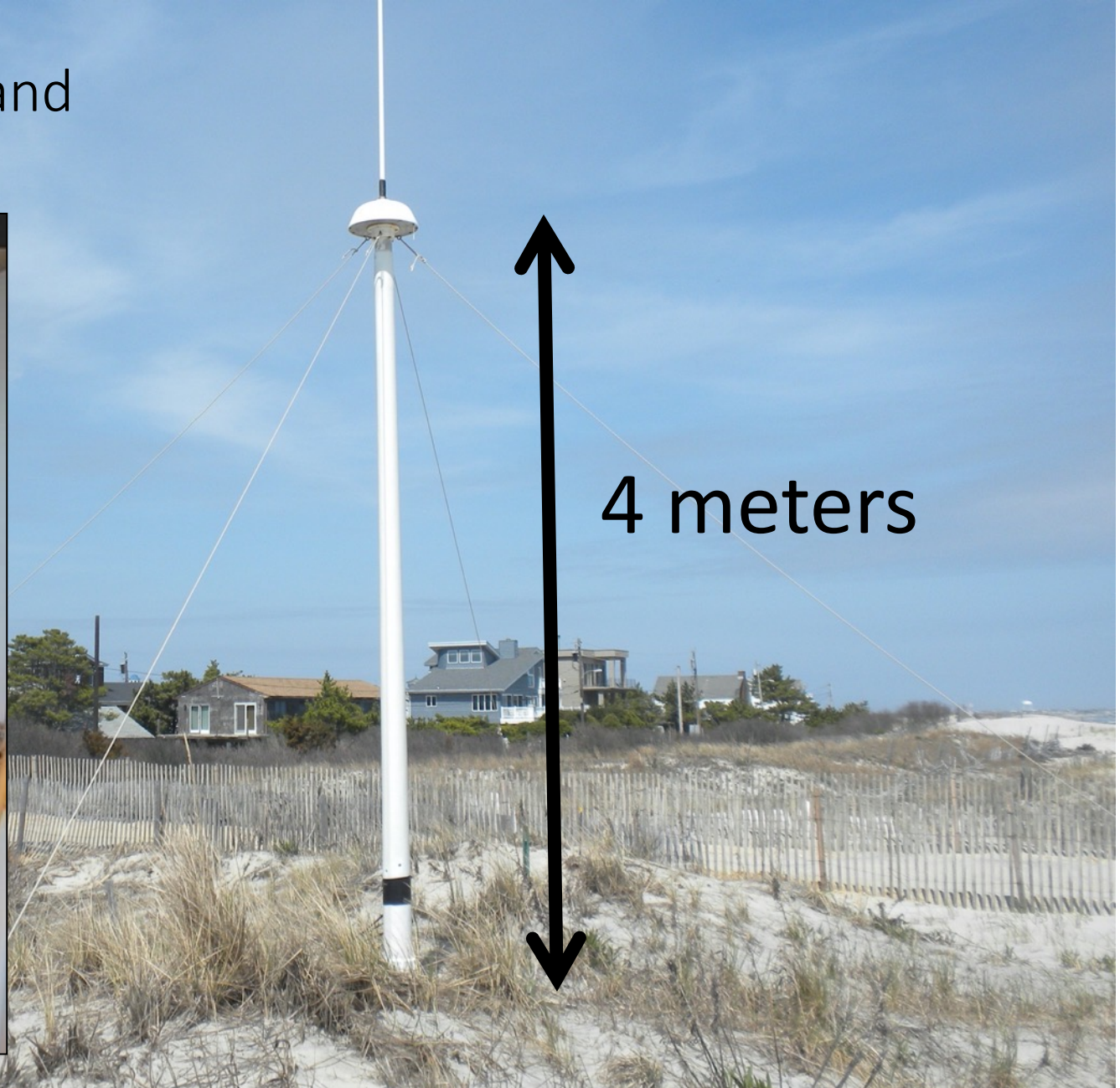
Glider Fleet

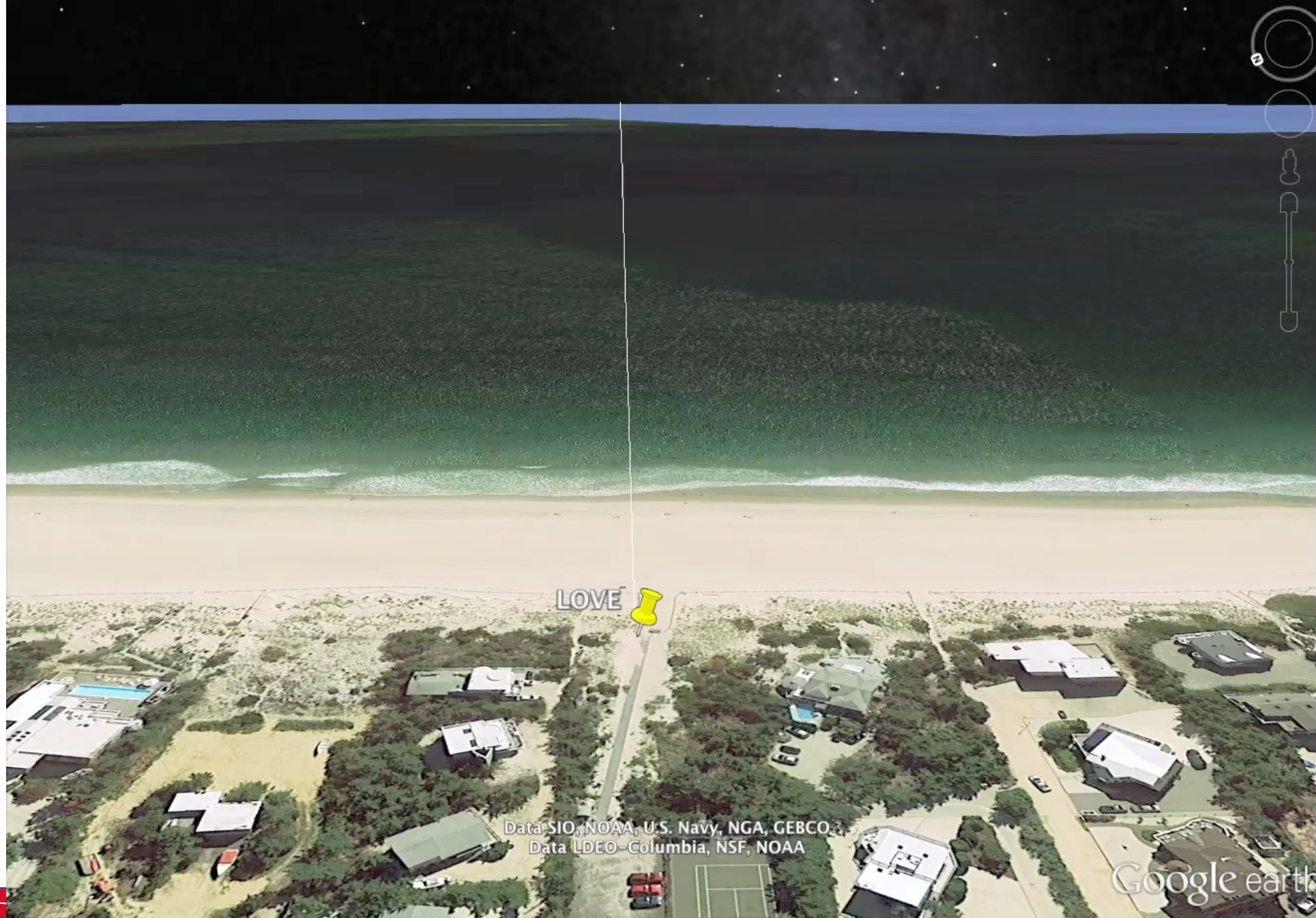


**3-D Nowcasts
& Forecasts**



13 MHz Transmit and Receive Antenna

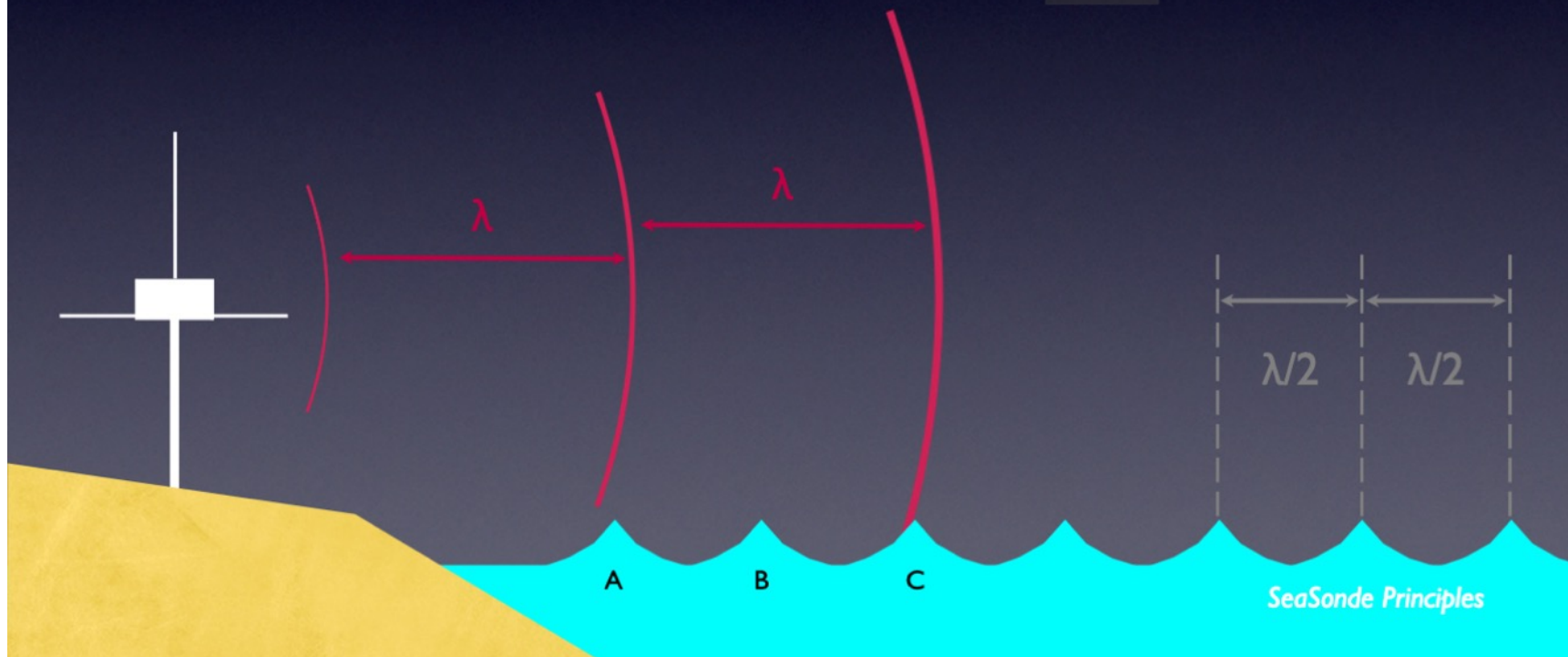




Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data LDEO-Columbia, NSF, NOAA

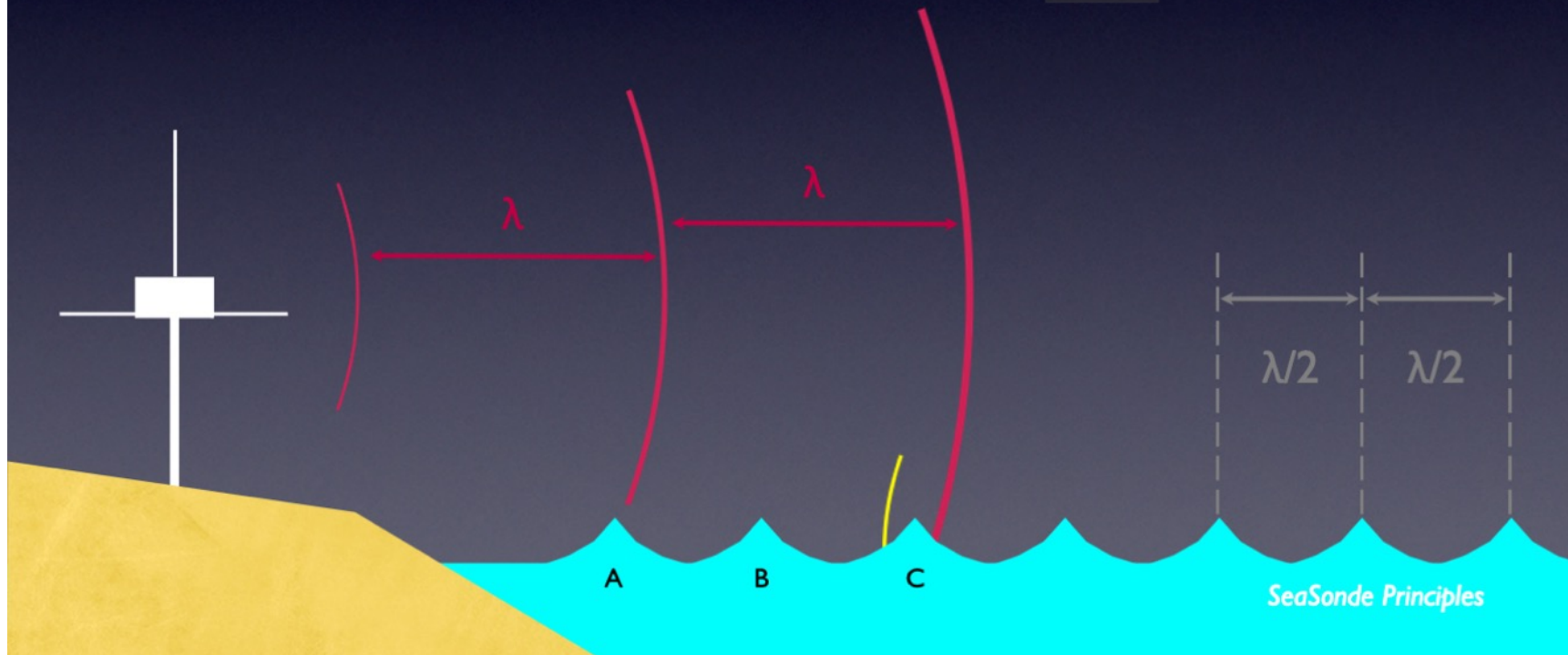
Bragg Sea Echo

| Freq | λ | $\lambda/2$ | T |
|------|-----------|-------------|---------|
| mhz | meters | meters | 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 |



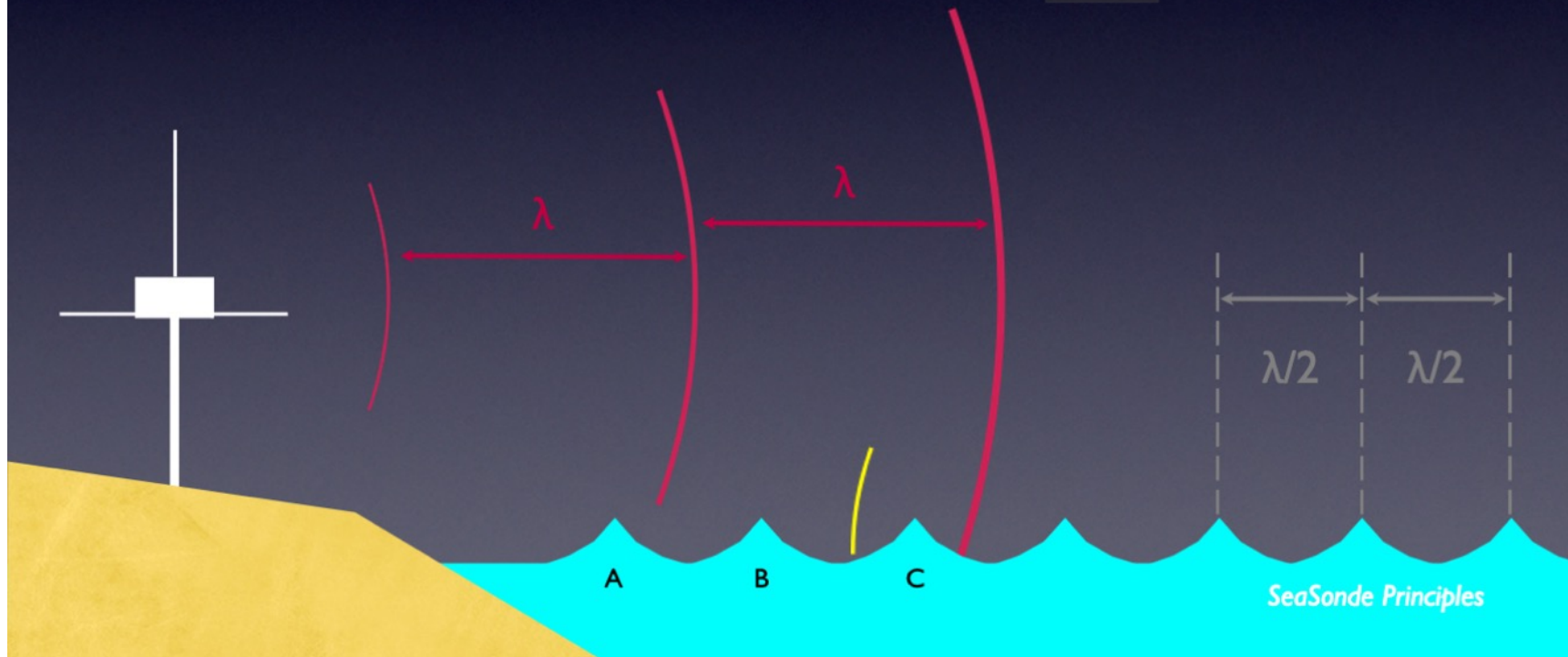
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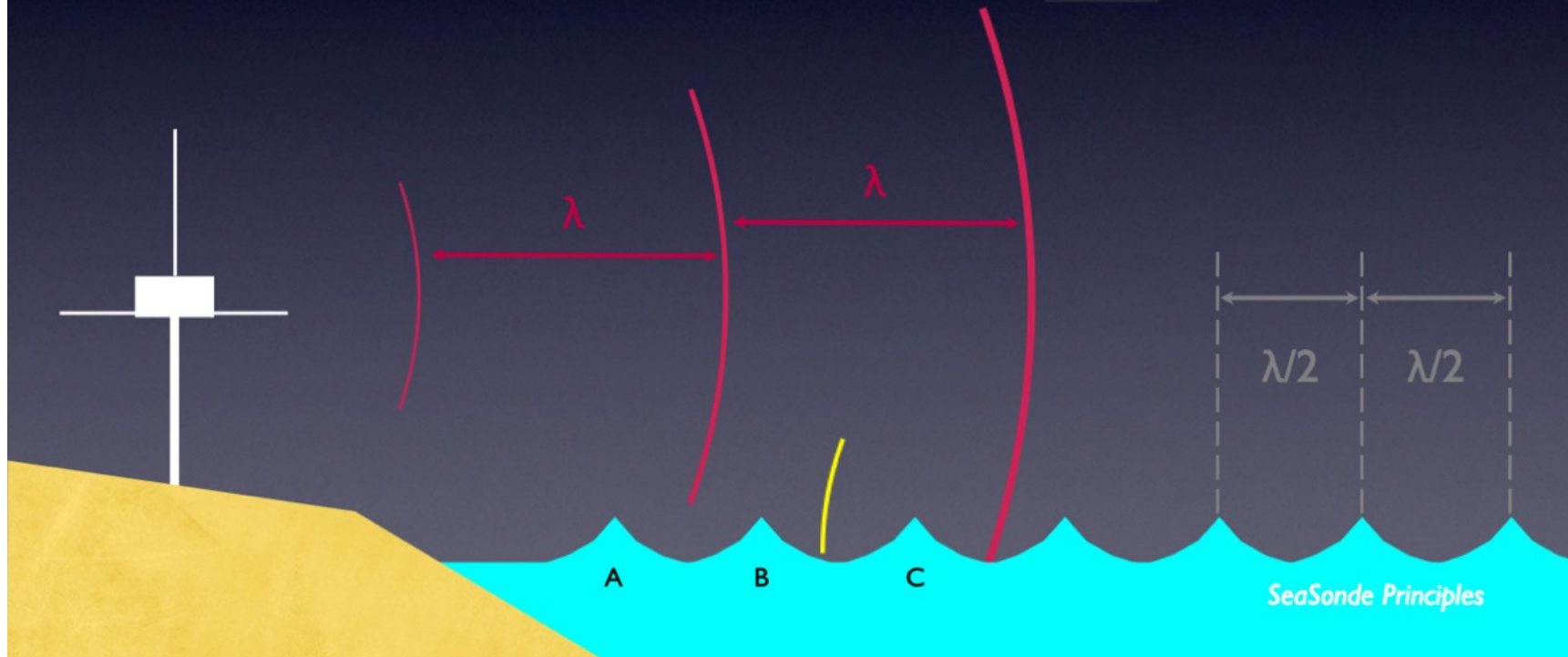
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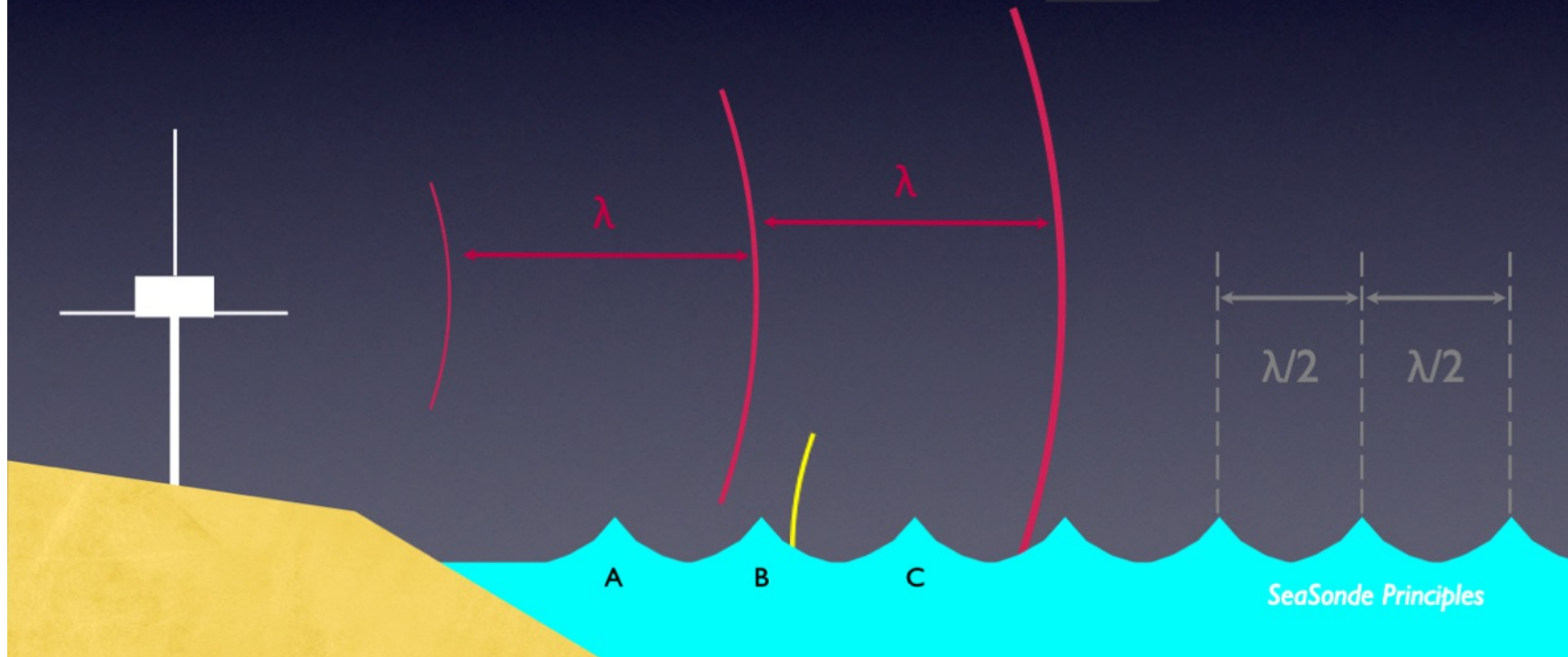
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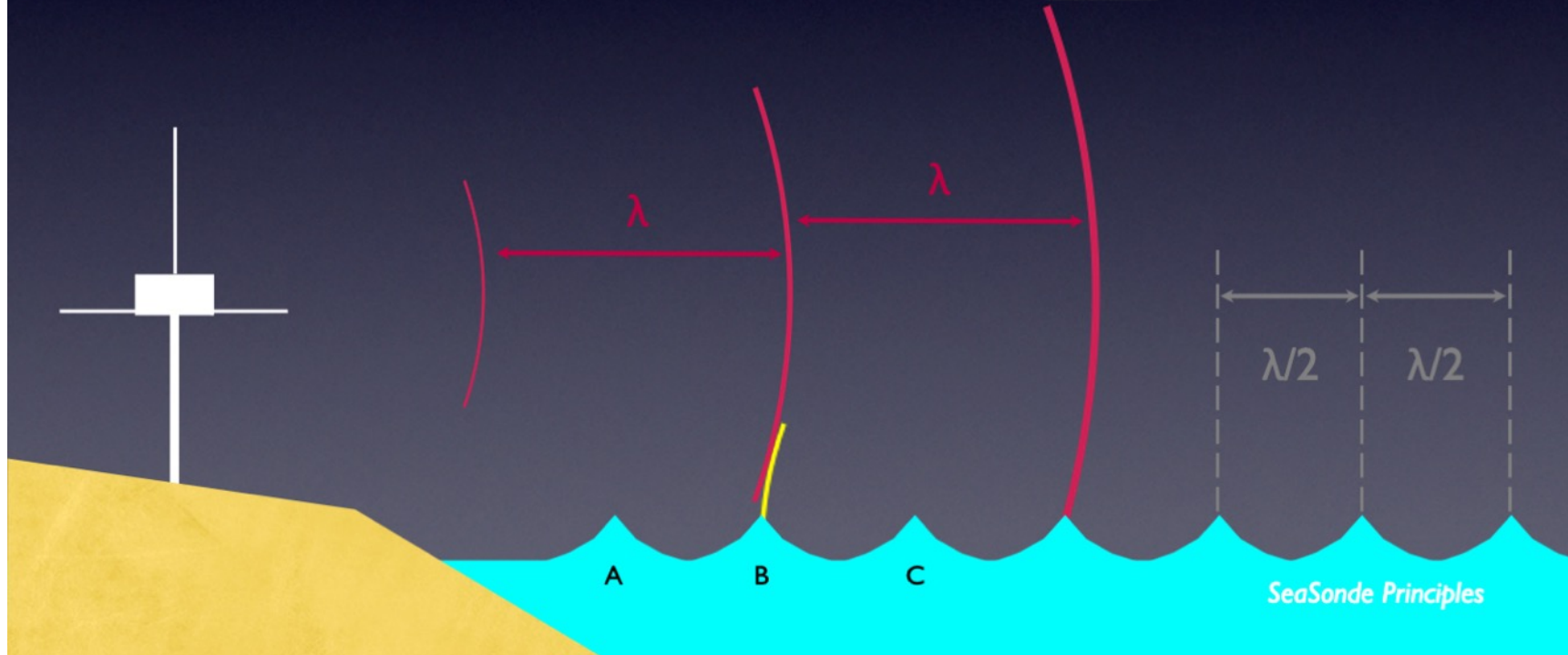
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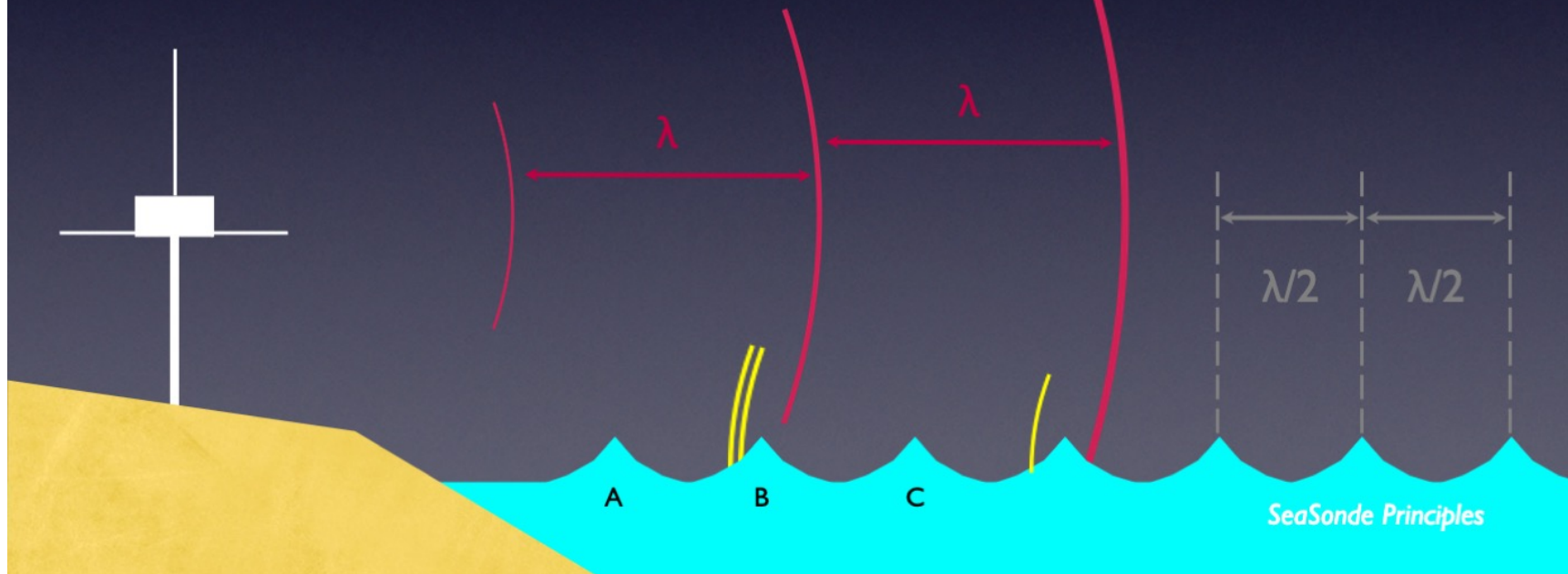
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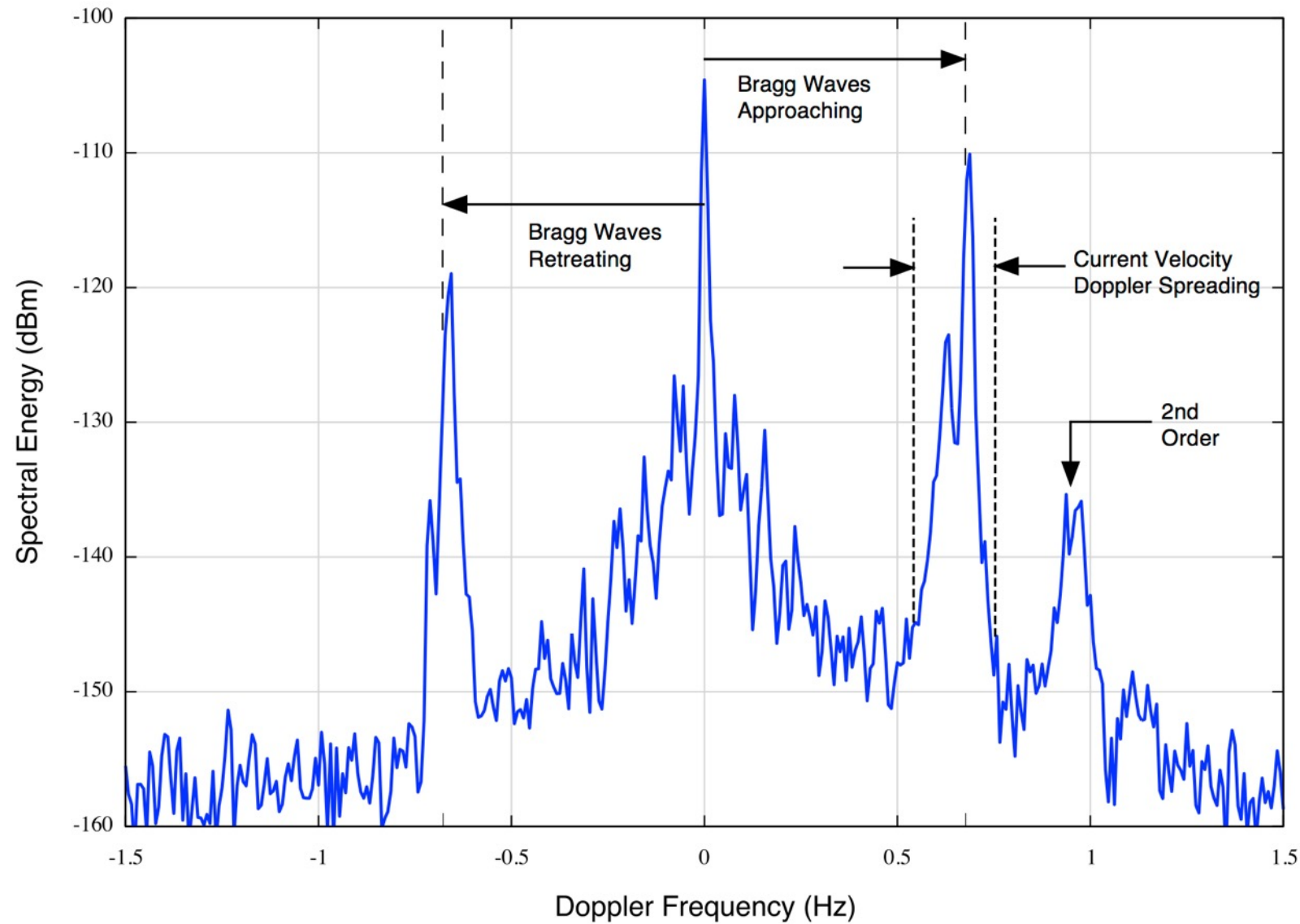


Bragg Sea Echo

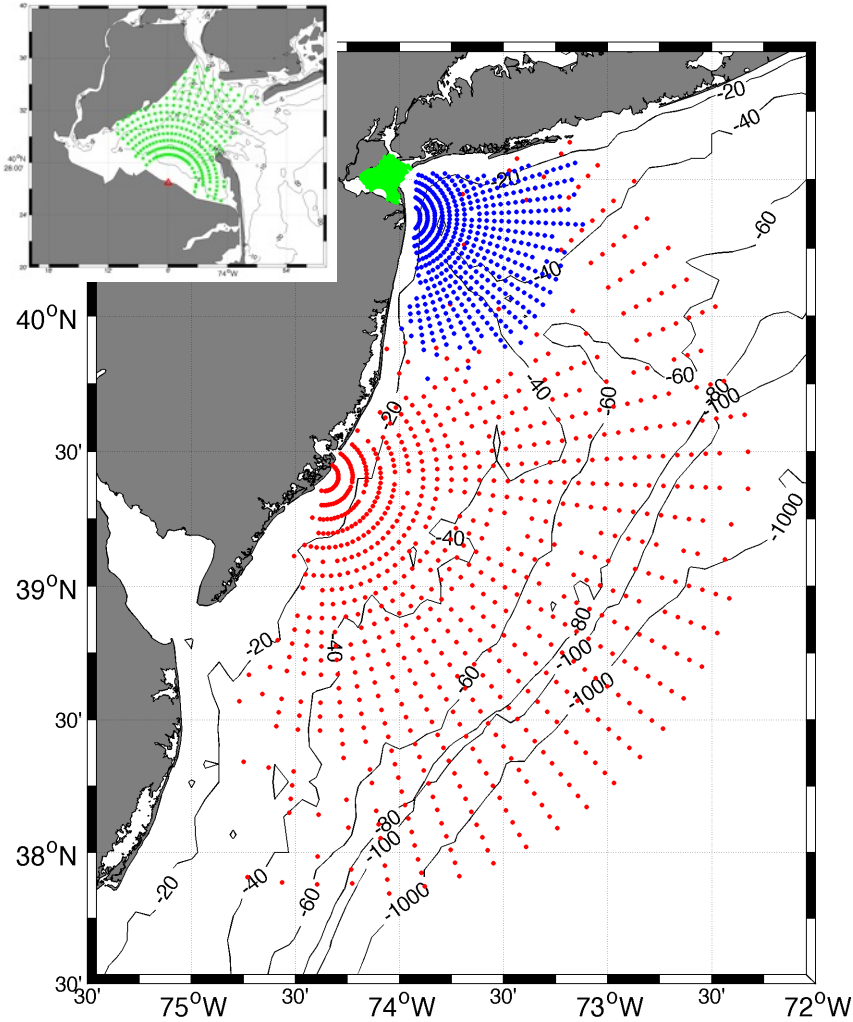
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Doppler Spectra From the Radar



Surface Current Mapping Capability



25 MHz

Radar λ : 12 m Ocean λ : 6 m

Range: 30 km Resolution: 1 km

13 MHz

Radar λ : 23 m Ocean λ : 12 m

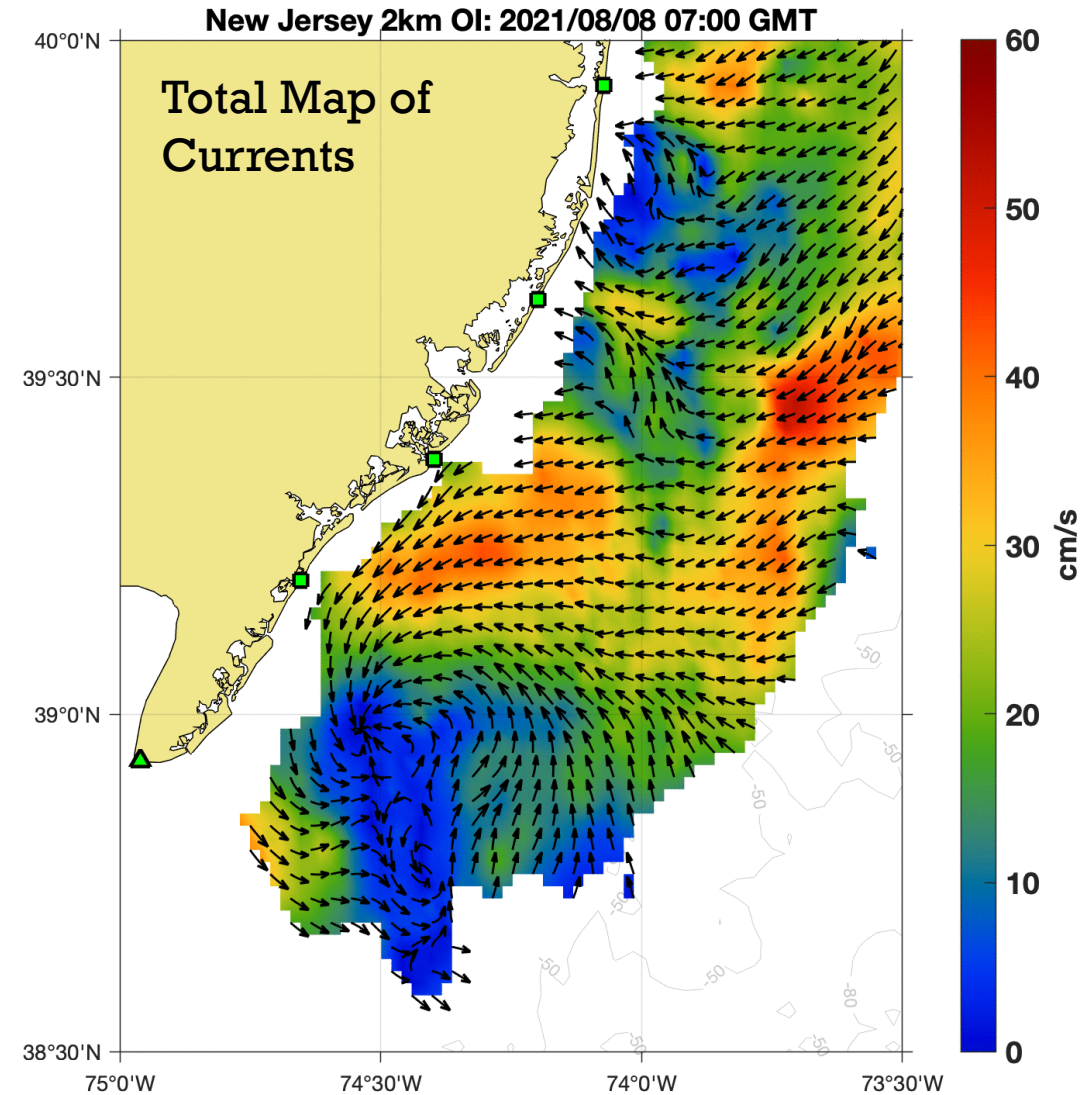
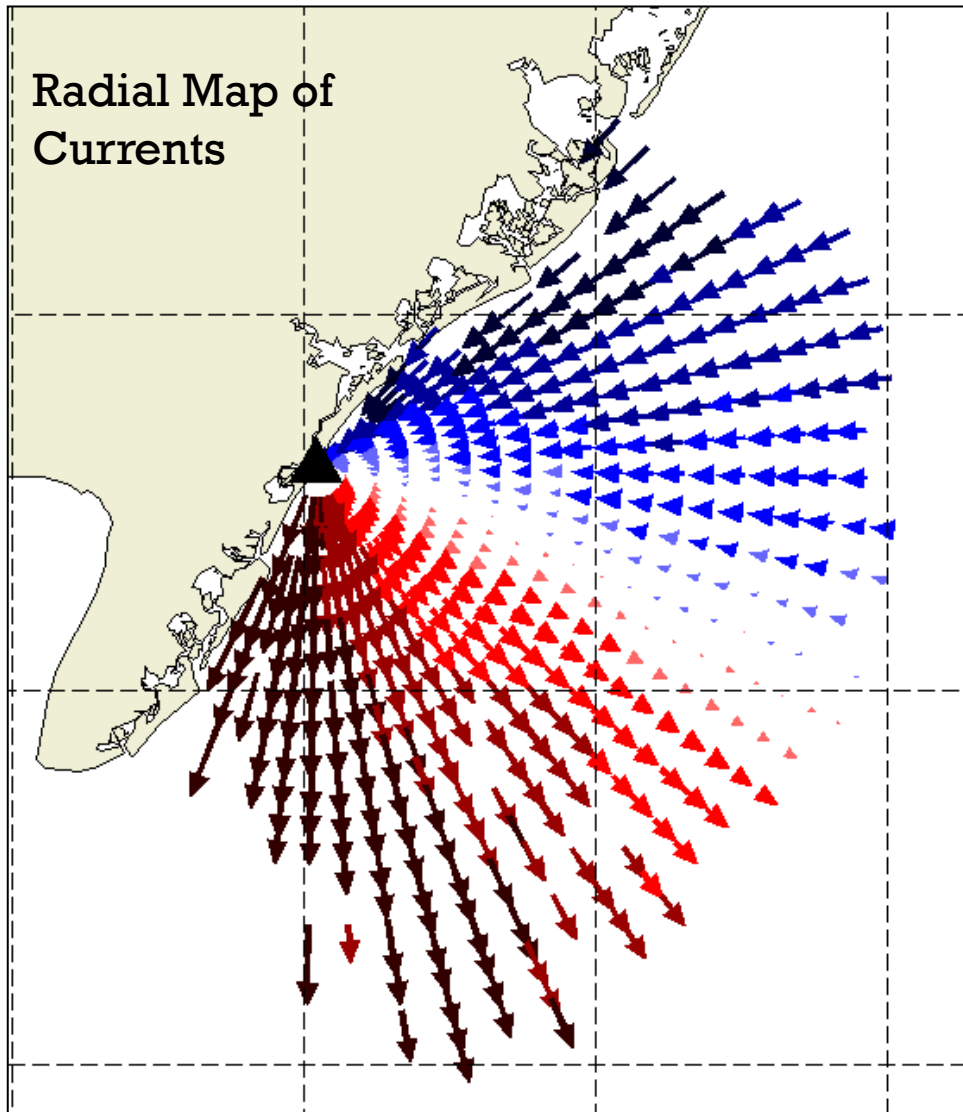
Range: 80 km Resolution: 3 km

05 MHz

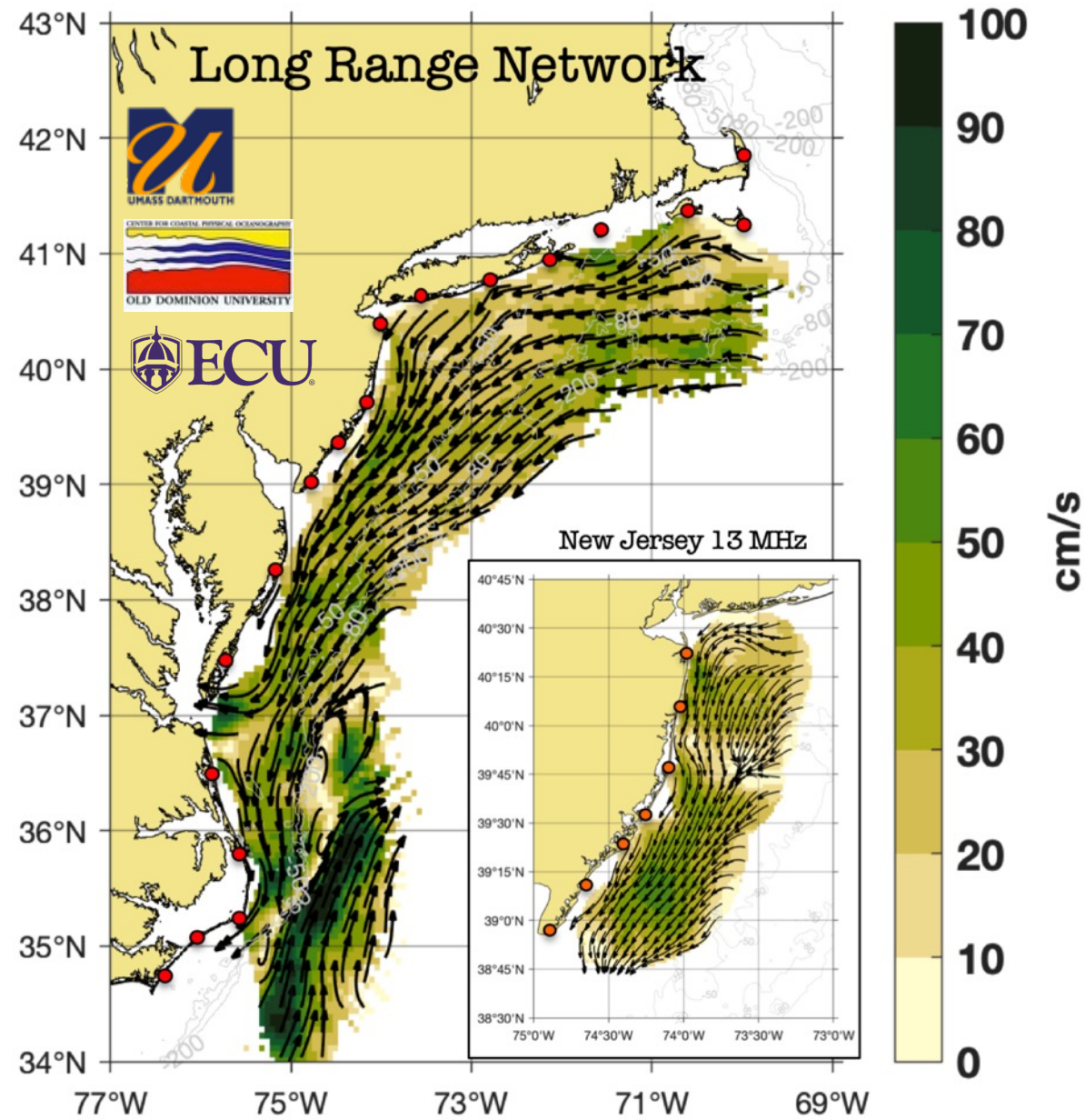
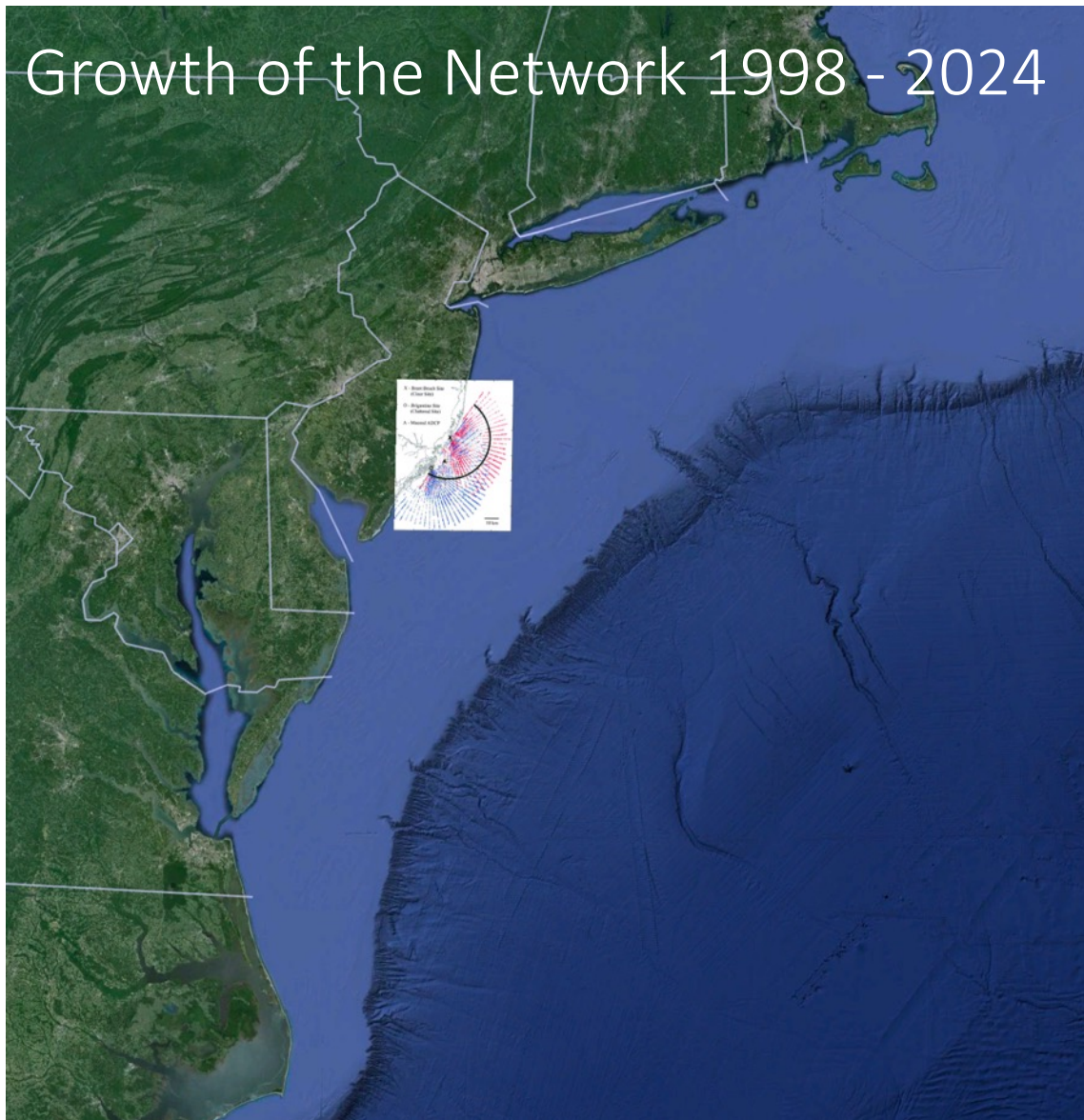
Radar λ : 60m Ocean λ : 30 m

Range: 180 km Resolution: 6 km

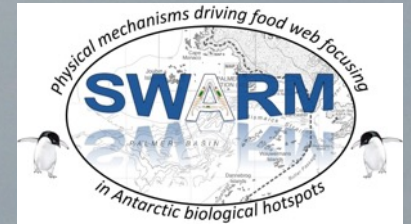
Surface Currents from SeaSonde HF Radar

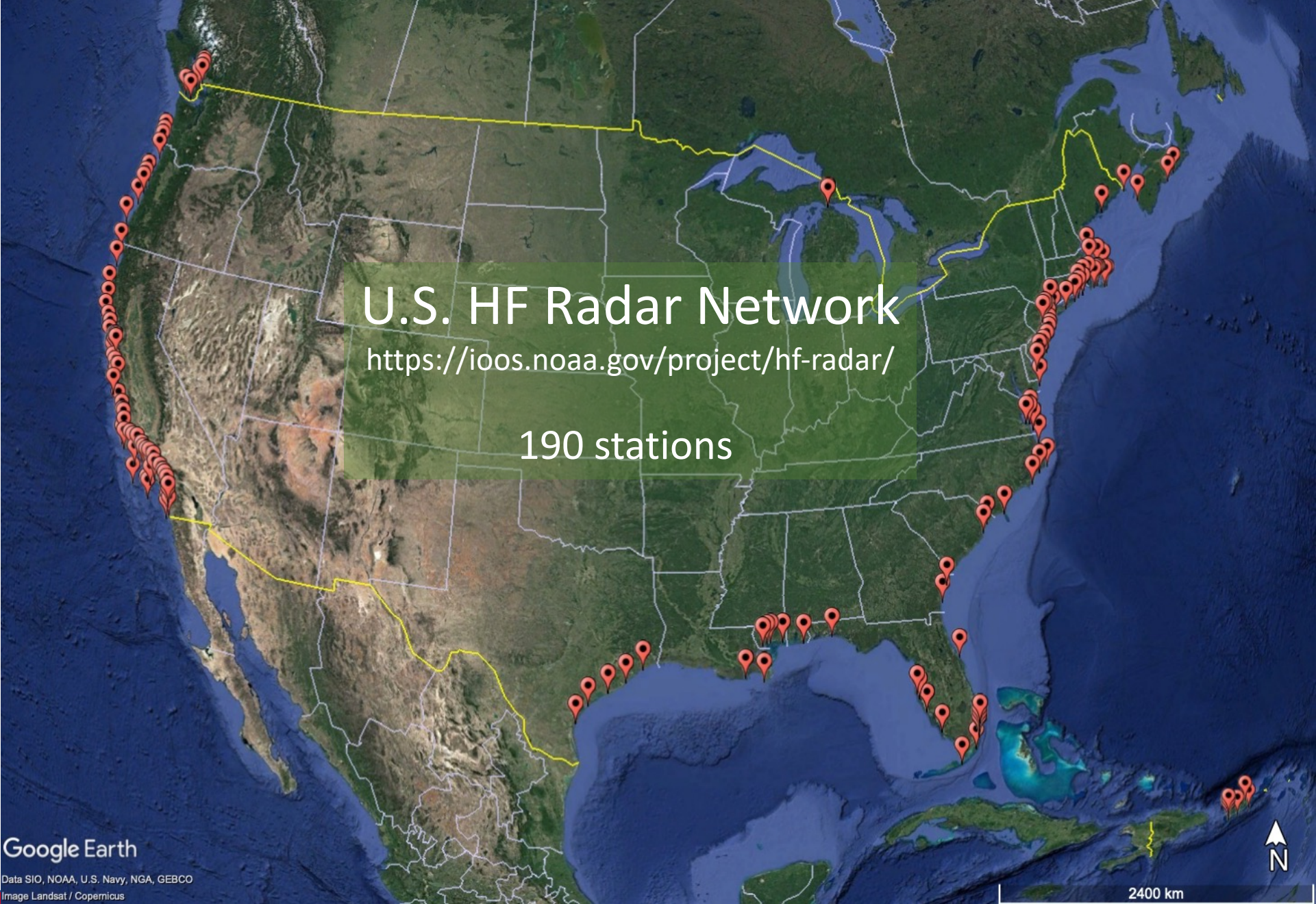


Growth of the Network 1998 - 2024

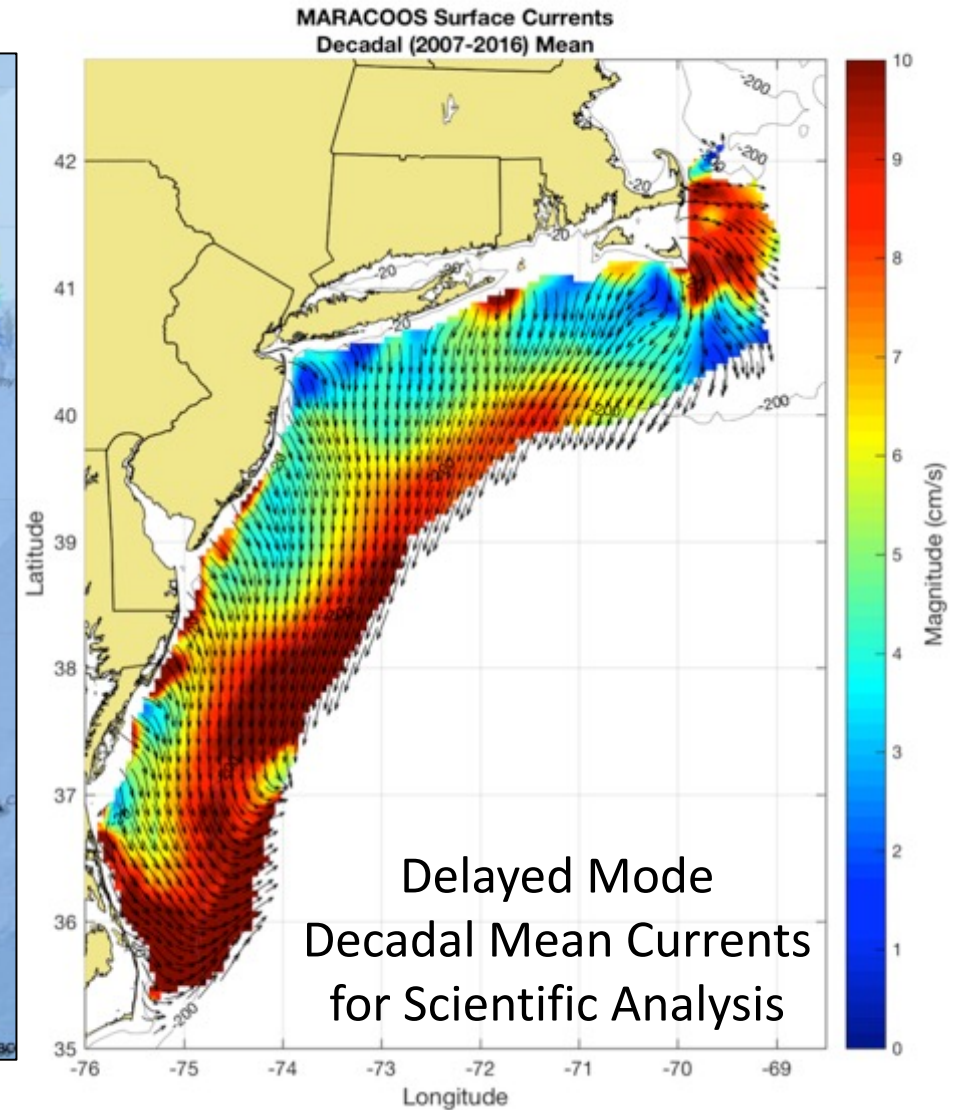
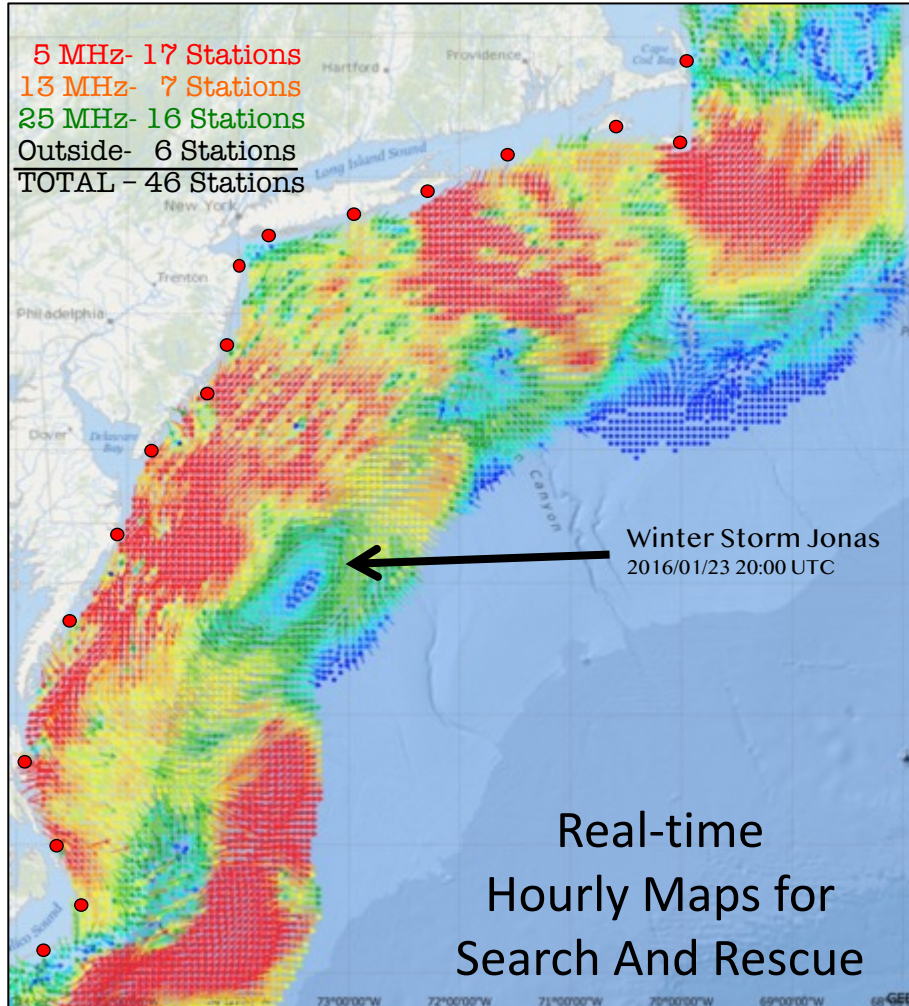


HF Radar - Antarctica



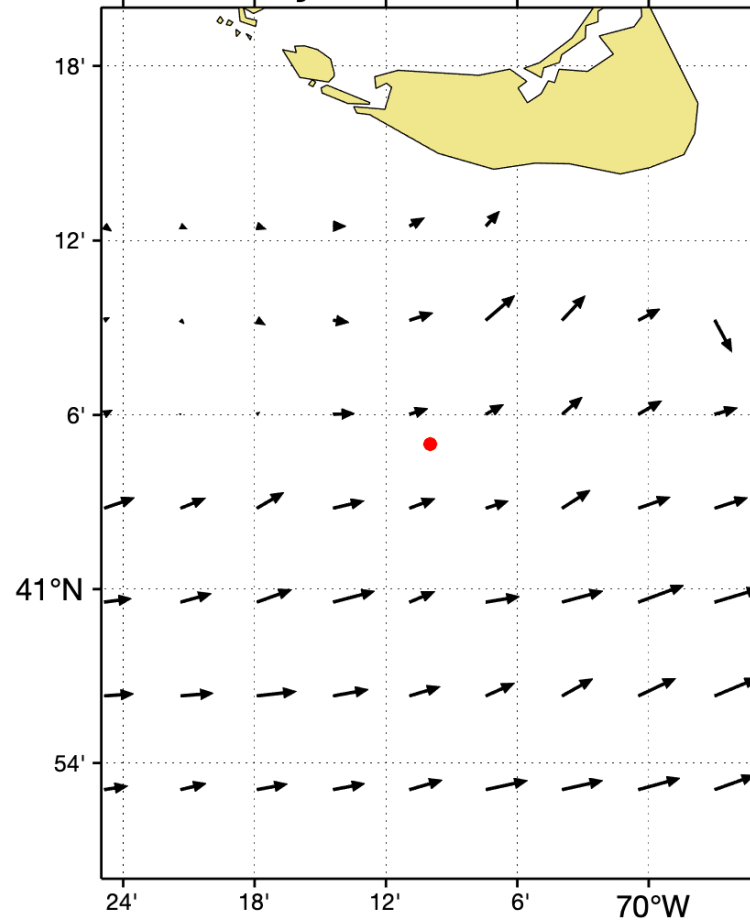


Generate Surface Current Maps Every Hour for a Decade



Surface Particle Trajectories

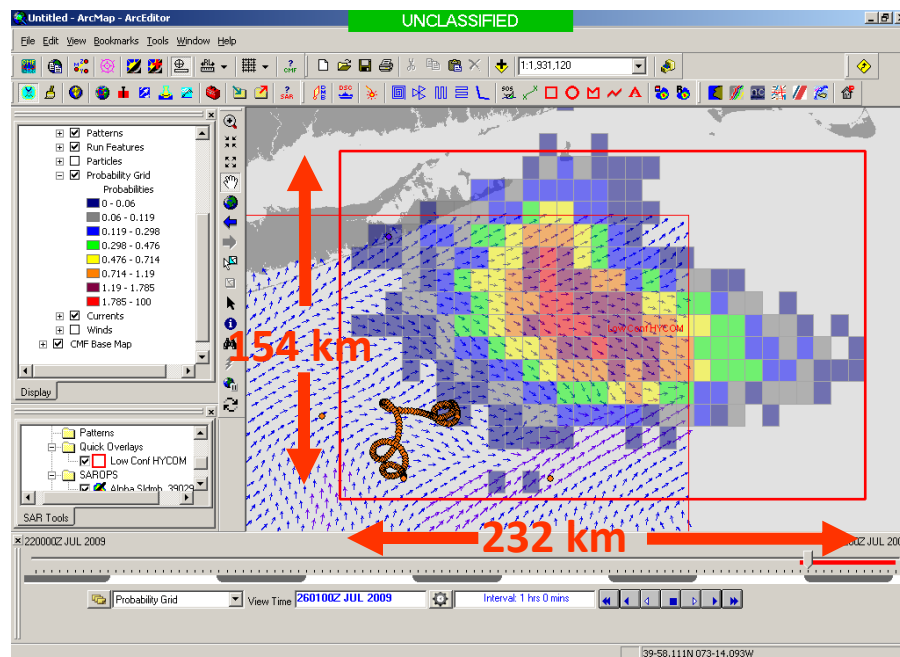
MARA Particle Trajectories: 2020/04/18 00:00 GMT



04/21/20 trajectories_from_5.m

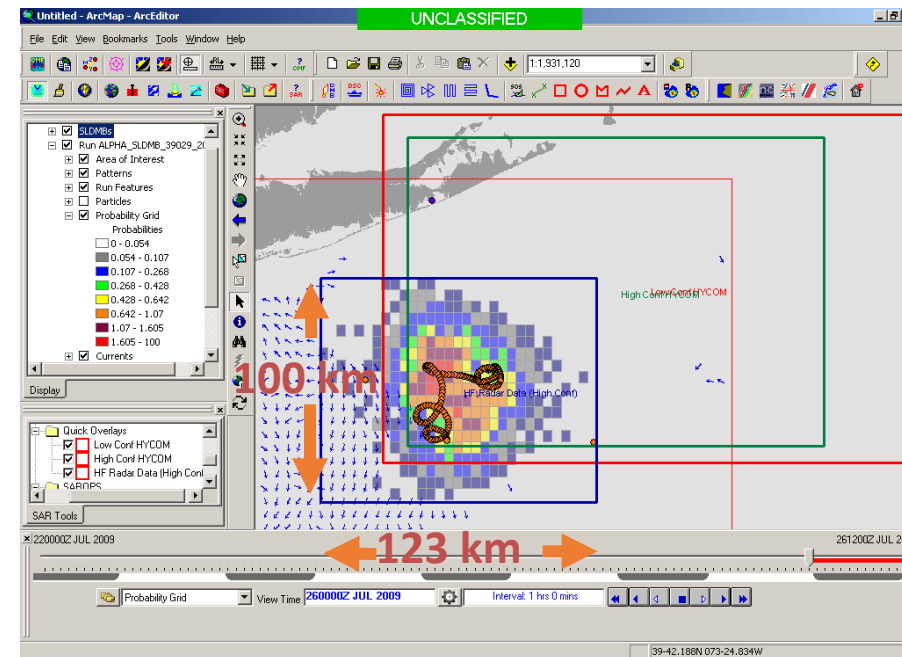


USCG Evaluation Process - 5000 Virtual Drifters & 1 Real Drifter: Compare Search Areas after X Hours



HYCOM @ 96 Hours

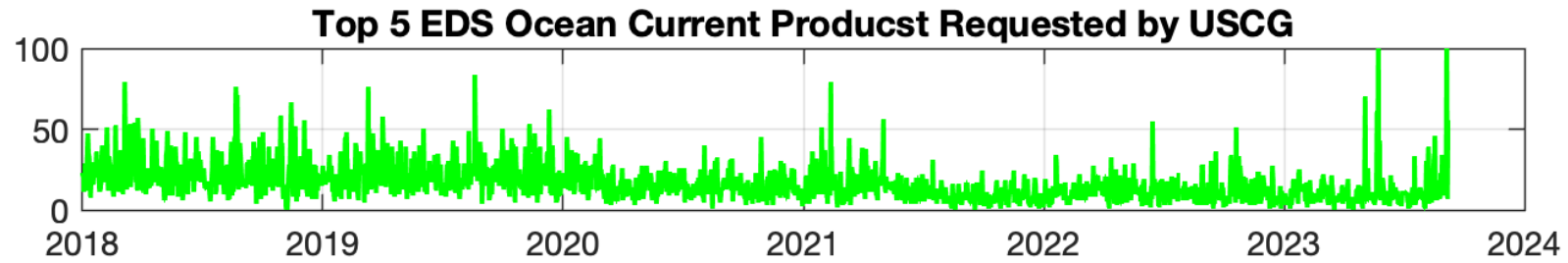
Search Area = 36,000 km²



CODAR @ 96 Hours

Search Area = 12,000 km²

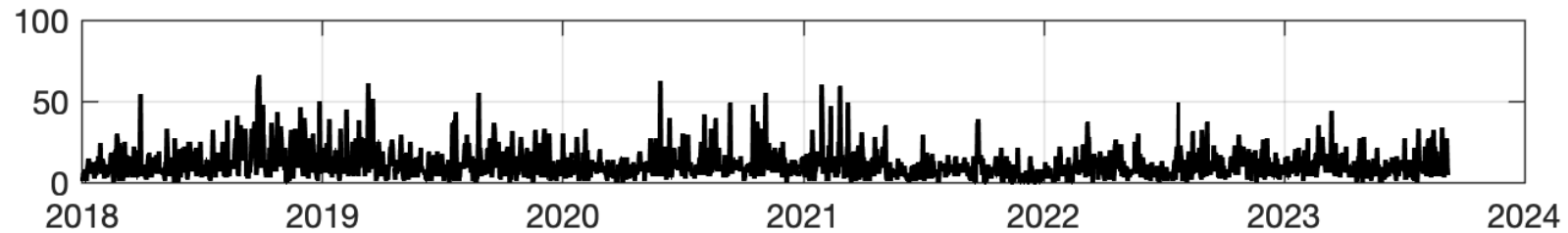
ADCIRC



Average Daily
Requests

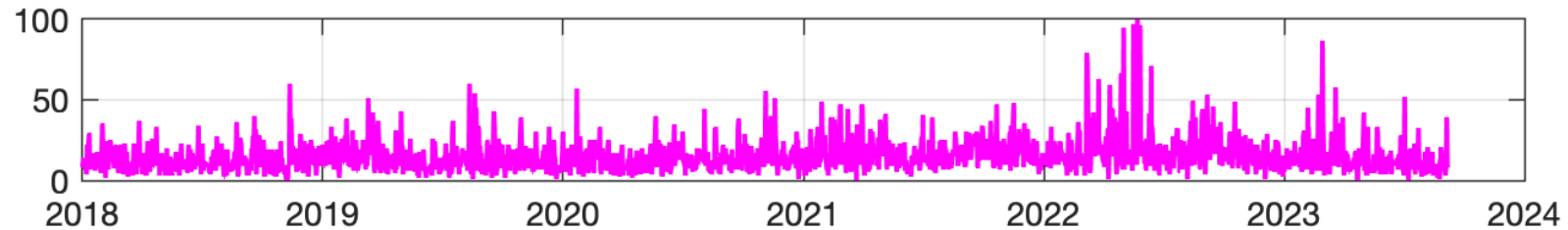
16

HYCOM Navy



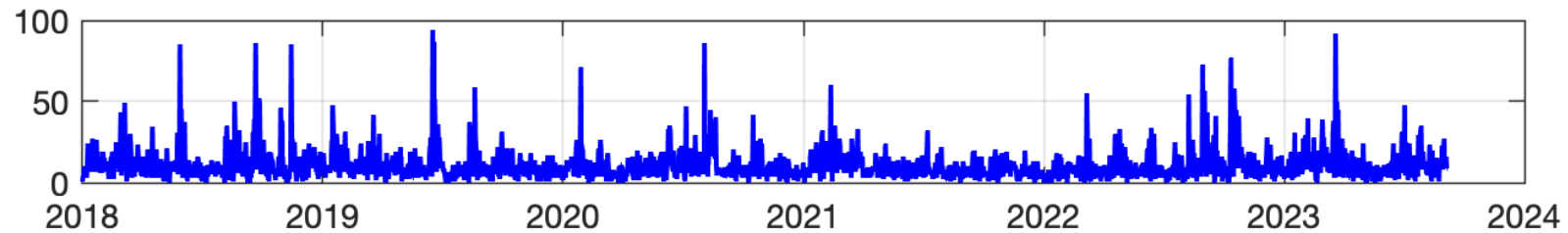
10

HYCOM NCEP



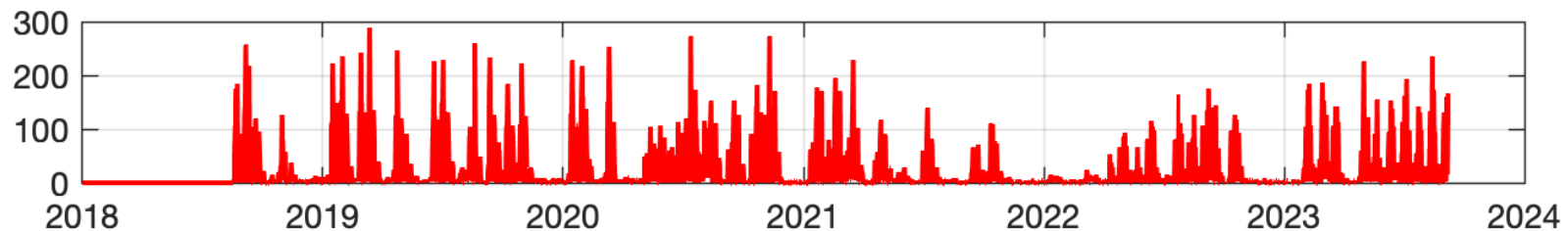
14

HFR STPS



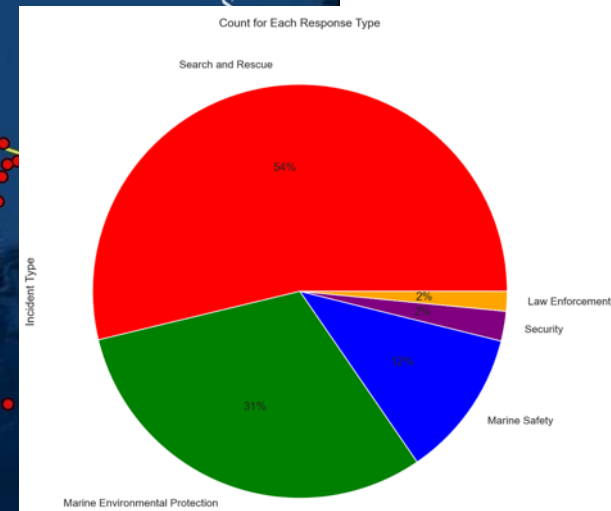
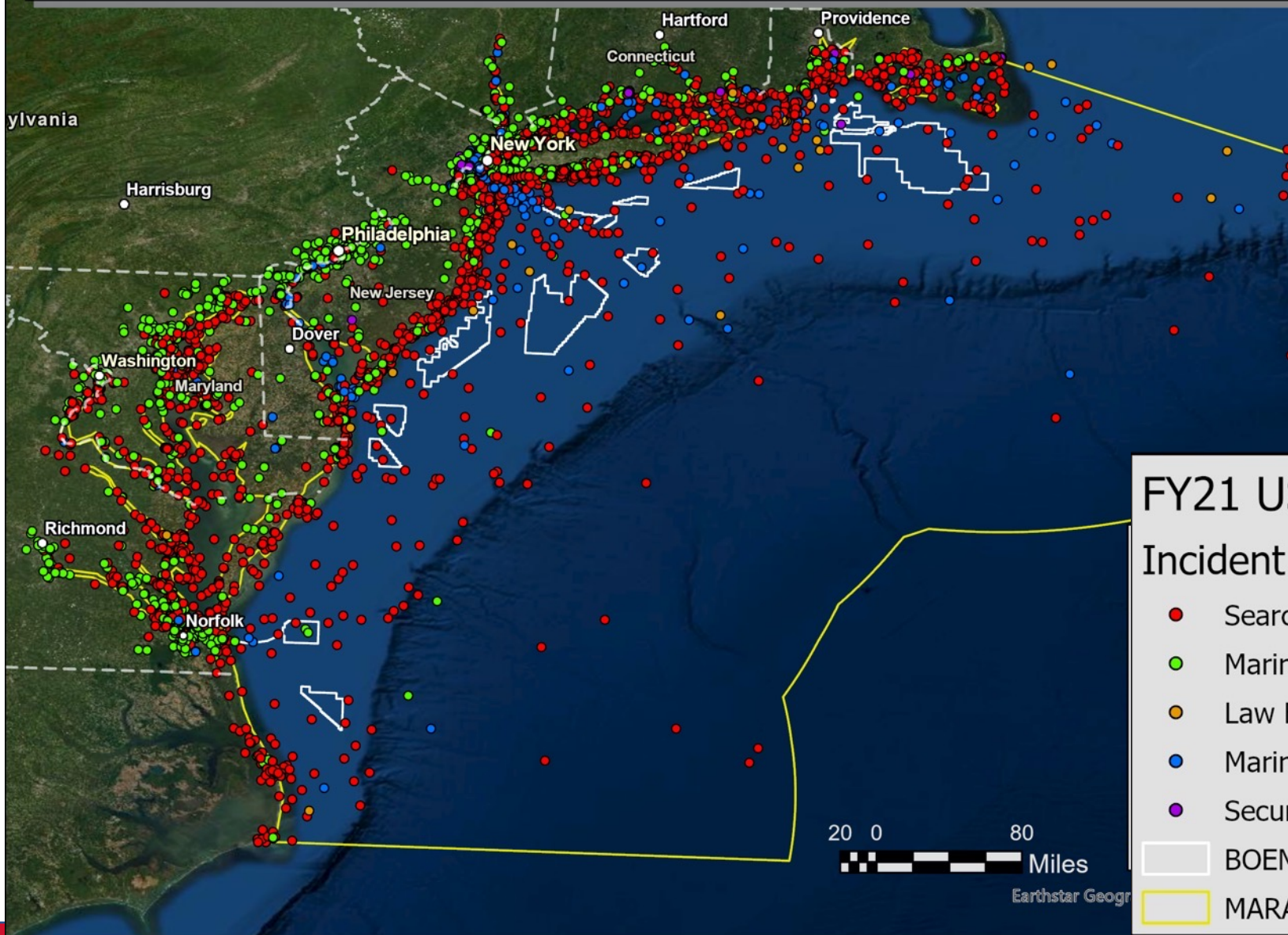
11

DOPPIO



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USCG FY21 MISLE Cases within 10 miles of MARACOOS Area



FY21 USCG MISLE Cases

Incident Type

- Search and Rescue
- Marine Environmental Protection
- Law Enforcement
- Marine Safety
- Security

□ BOEM Wind Energy Areas

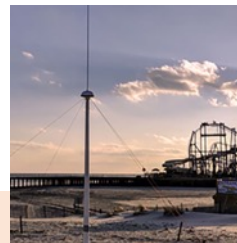
□ MARACOOS Boundary

High Frequency Radar

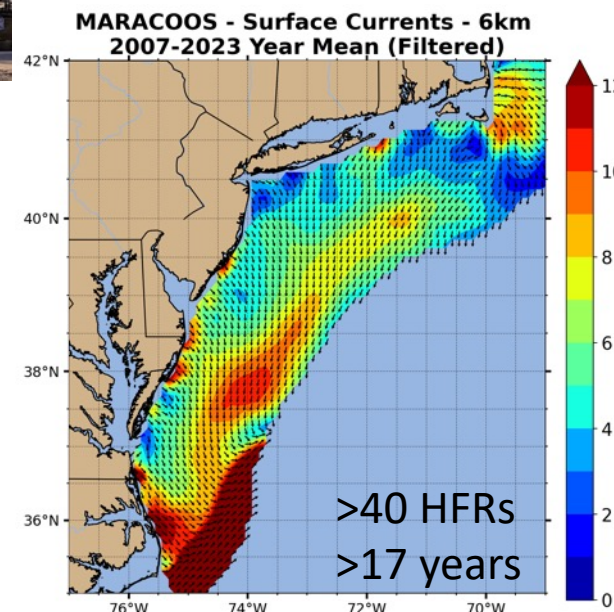


Innovation

- AIS APM
- AutoAPM
- Bistatic Buoy
- Dual Transmitter
- GPS Timing
- Lightning Protection
- Low Power
- RiverSonde
- SuperDirective Antenna
- Tx/Rx Single Antenna
- Wave Powered Buoy
- Multistatic Network
- QARTOD
- Vessel Det./Assoc./Track
- Windfarm Mitigation
- Coast Guard SAR
- Network KPIs
- ROWG
- Hurricane Science
- Lag. Coherent Structures
- Tidal Maps
- HFR Waves
- Tsunami Detection
- Remote Locations – Puerto Rico, Antarctica, Yucatan
- Global HFR Network

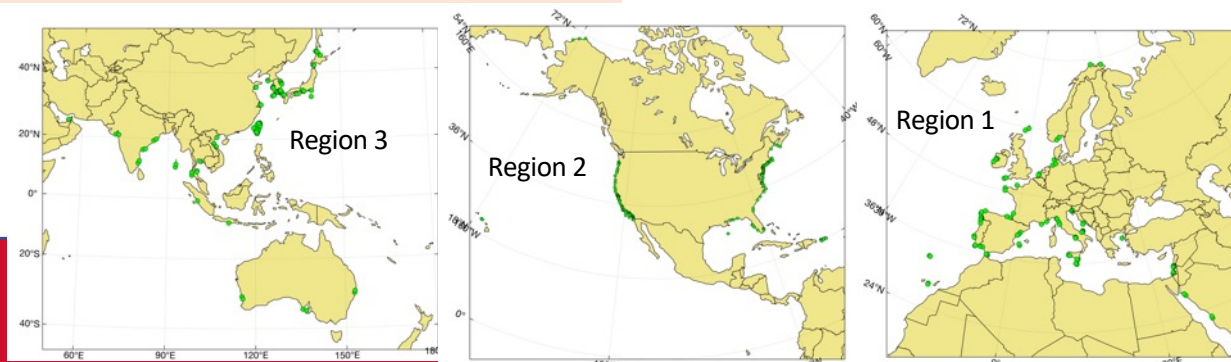


Expansion



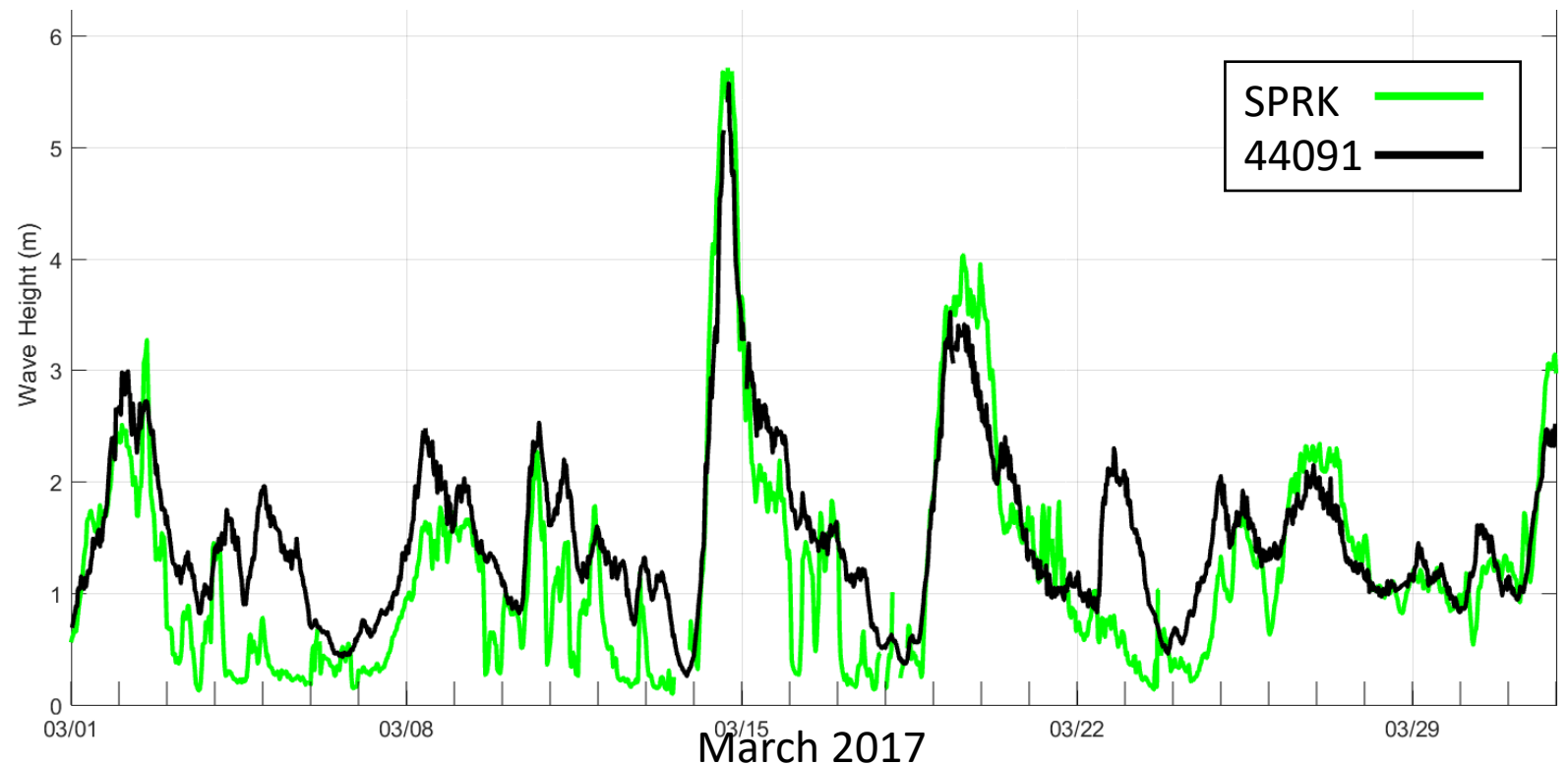
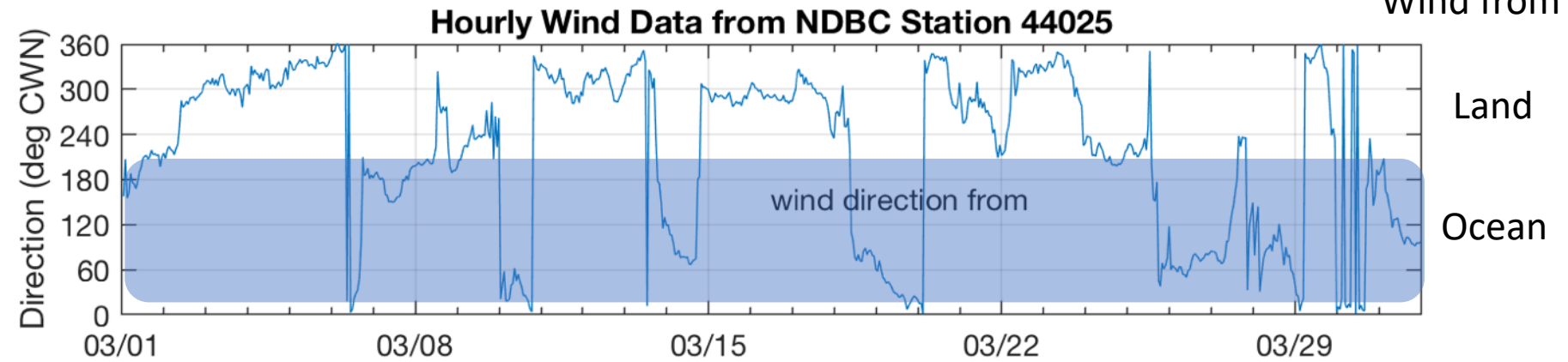
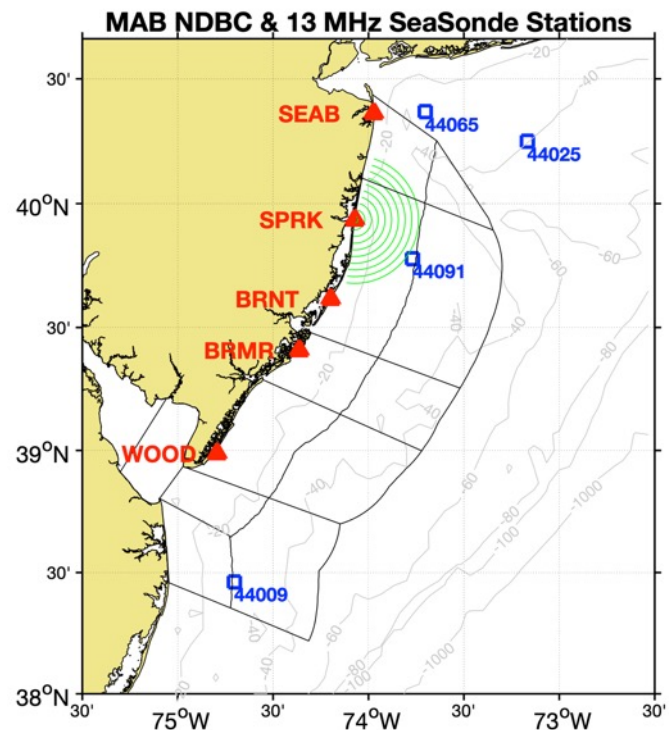
Timeline

- 1996 OSCAR radar site
- 1998 SeaSonde 25 MHz
- 2000 SeaSonde 05 MHz
- 2003 Surf. Current Mapping Init.
- 2005 SeaSonde 13 MHz
- 2007 MARACOOS HFR
- 2009 USCG Operational
- 2010 Gulf Oil Spill
- 2010 National HFR Steering Team
- 2010 Global HFR Network
- 2016 GOOS Emerging Network
- 2022 GOOS Mature Network

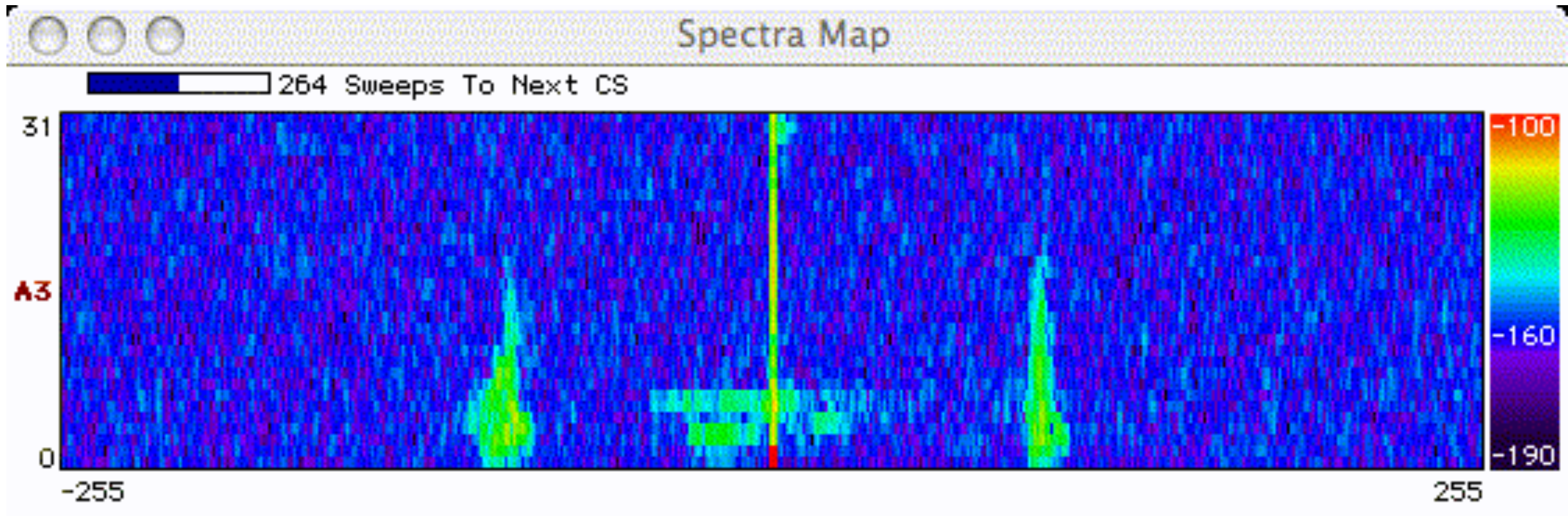


| Region Number | Geographic Coverage | Number of Stations |
|---------------|-----------------------------|--------------------|
| 1 | Europe, Africa, Middle East | 72 |
| 2 | North and South America | 195 |
| 3 | Asia and Oceania | 140 |

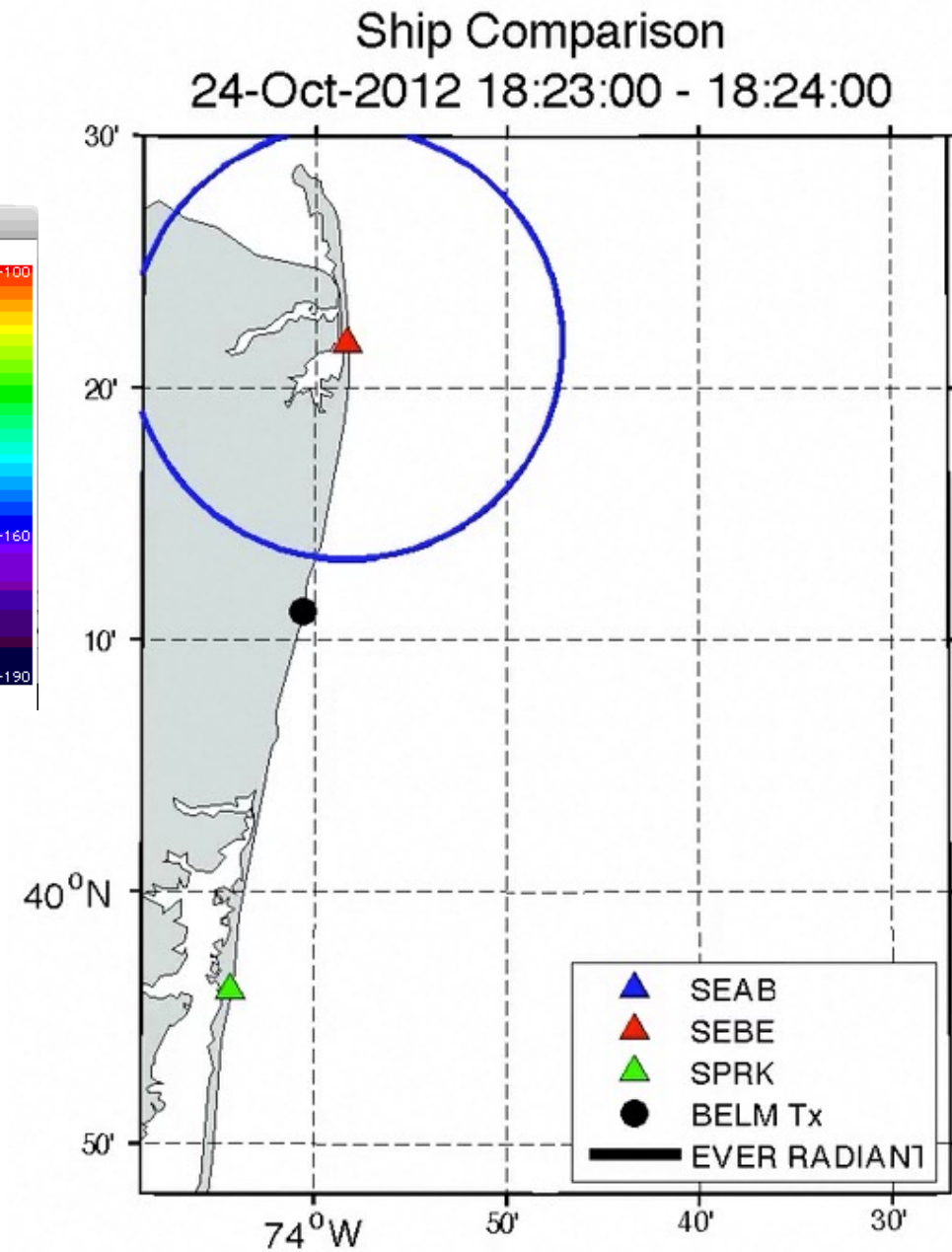
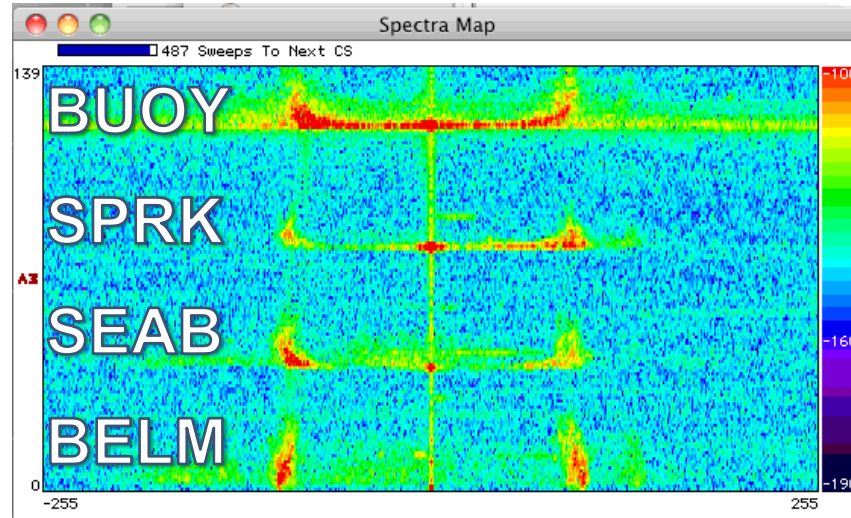
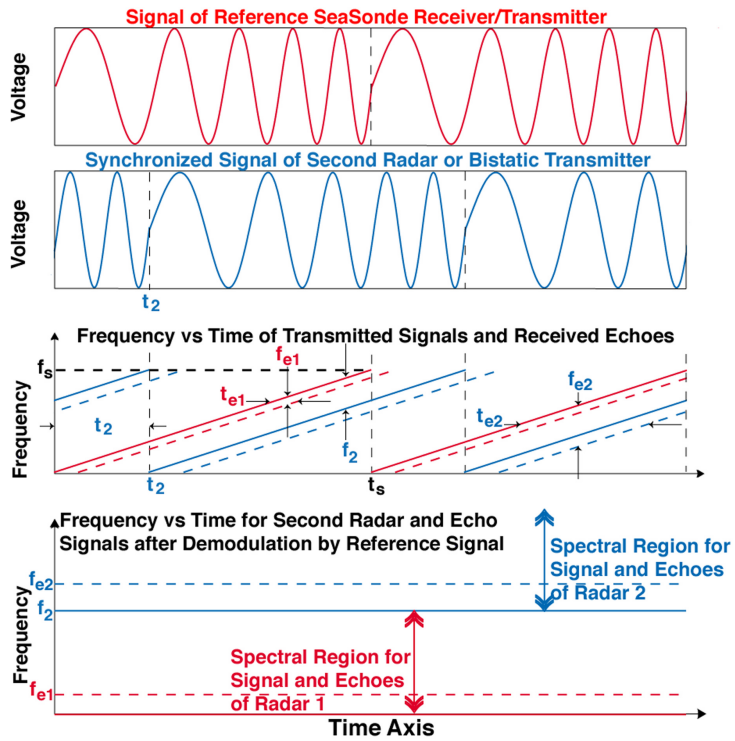
Wave Measurements from HFR



Vessels in the Spectra



Multistatic Vessel Detections



Conclusions

- Introduction to the radar technology
- Measuring surface currents and waves
- Application for Coast Guard SAR
- Dual use vessel detection capability

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Thanks

