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# Multi-Mission Radar for the US Coast Guard

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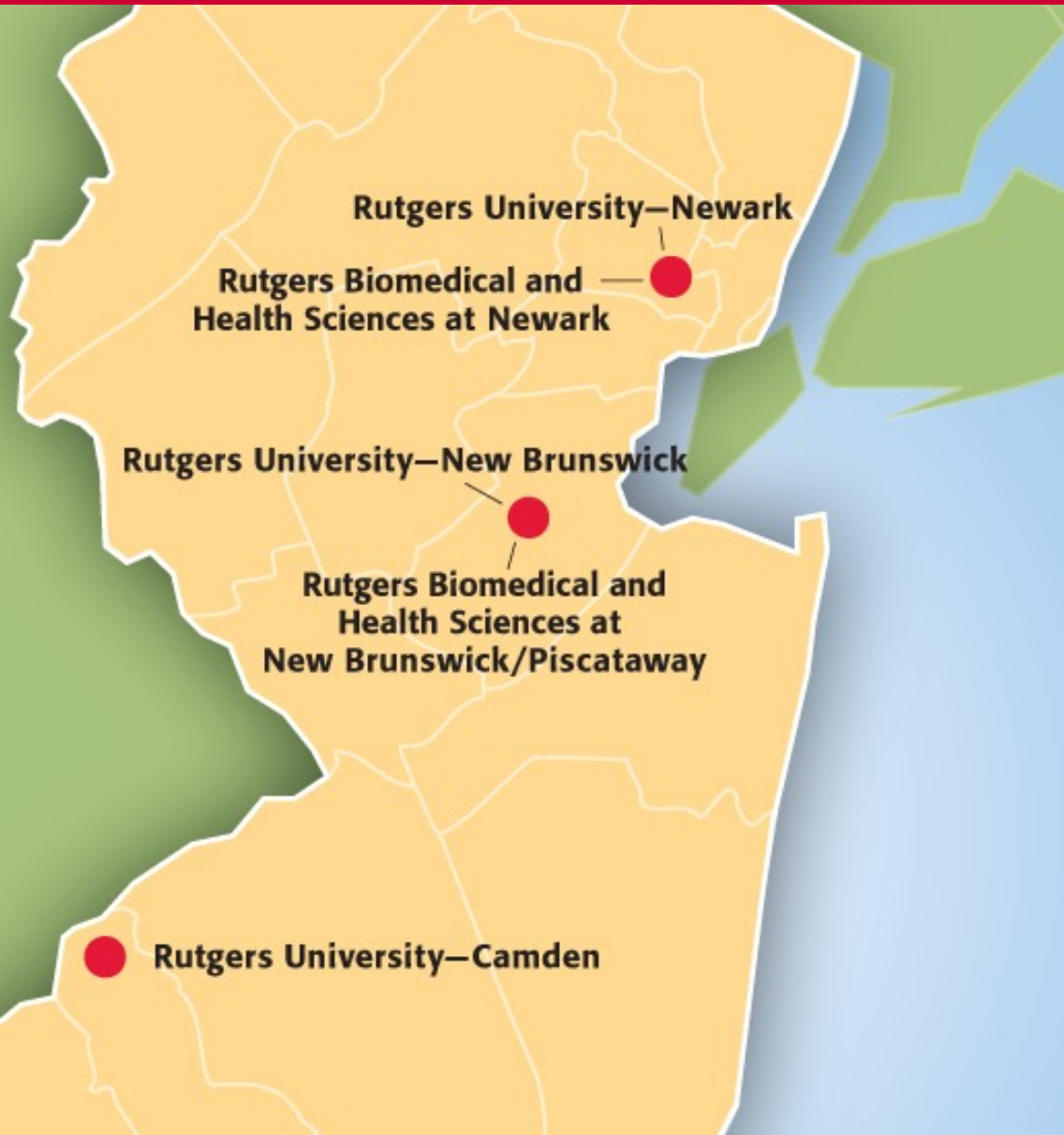

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**LSU**

# Outline

- Introduction to Rutgers
- Radar Overview
- Vessel Traffic Service (VTS)
- Current and Future Radar Applications Within VTS
- Wrap Up

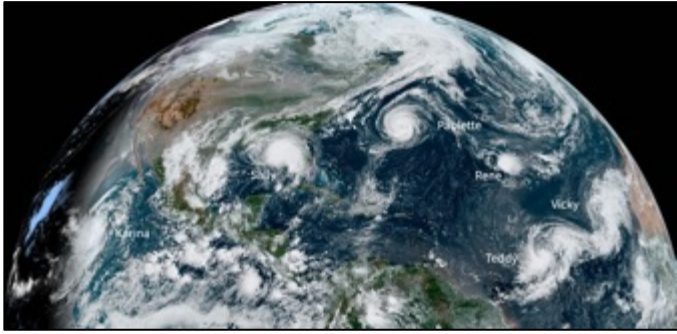
# The State University of New Jersey



- 71,000 students
- \$750 million in research grants and sponsored programs
- 24,000 faculty and staff
- 530,000 alumni



# *Rutgers University Center for Ocean Observing Leadership*



**HURRICANE SCIENCE**



**OFFSHORE WIND**



**OCEAN POLLUTION**



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*RUCOOL is creating knowledge of our ocean planet by pushing the limits of science and new technologies while inspiring future generations of ocean explorers, within these core focus areas:*

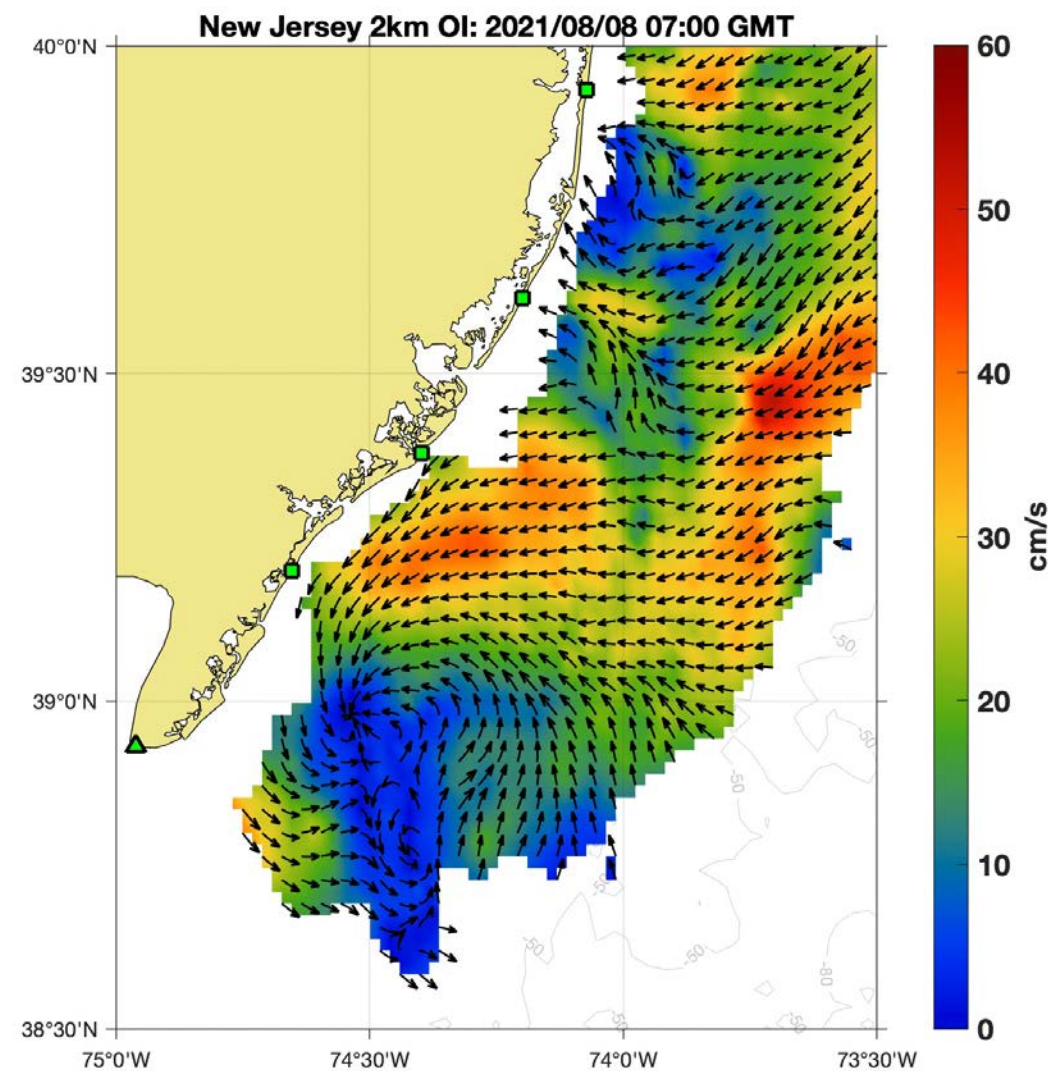
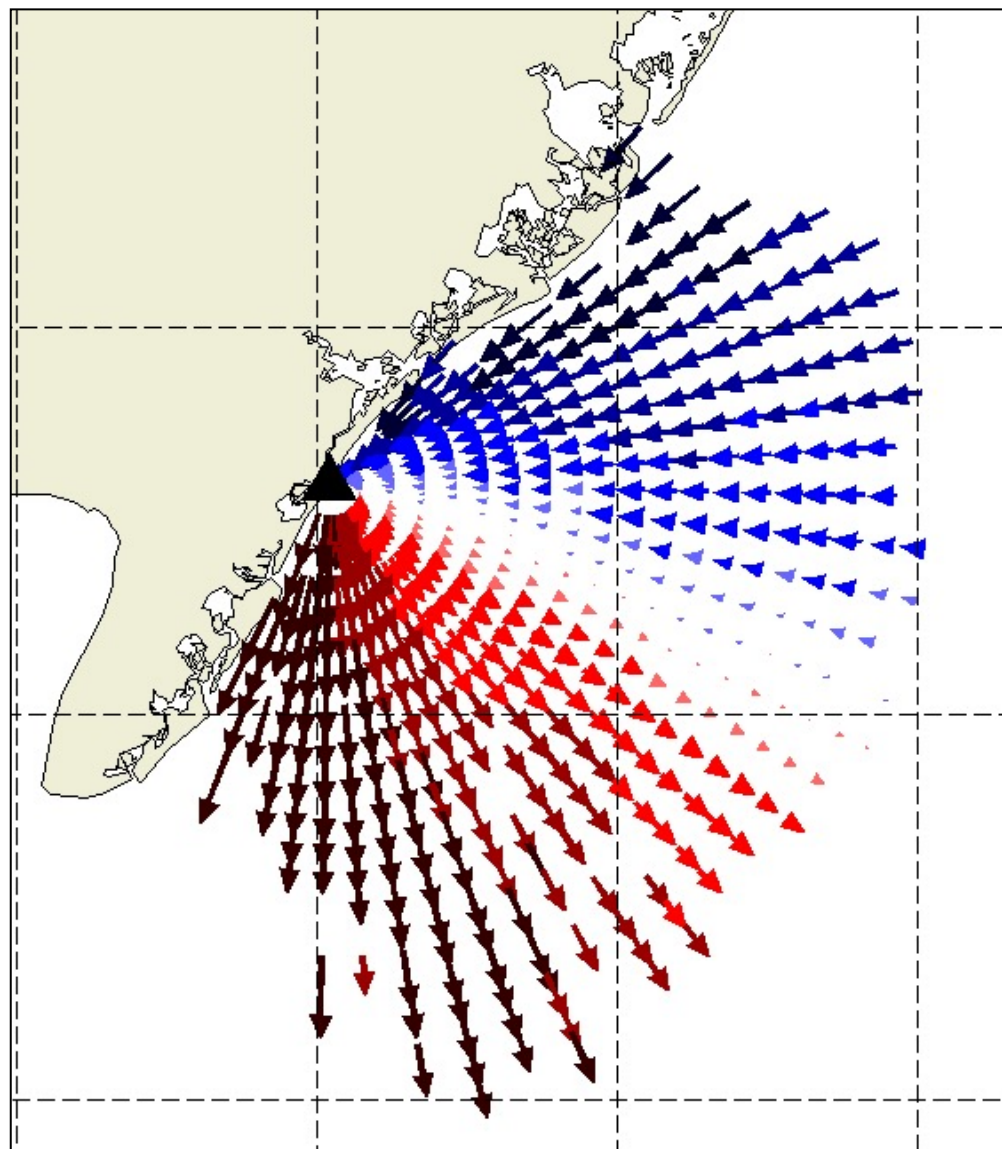


# High Frequency Radar

CODAR Tx/RX ANTENNA  
LEWES BEACH, DE USA

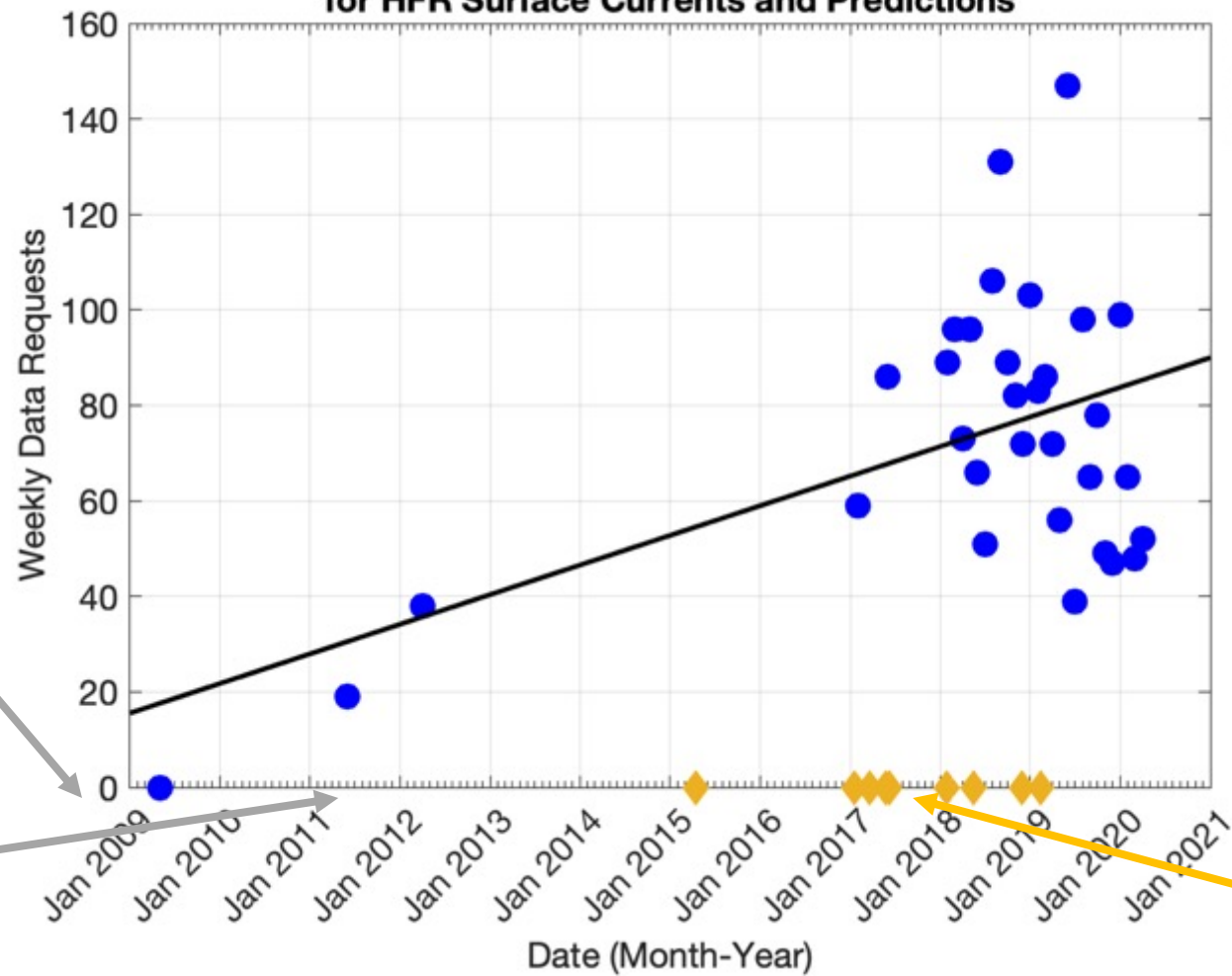






# Weekly HFR Data Requests by USCG

US Coast Guard EDS Requests  
for HFR Surface Currents and Predictions



MARACOOS  
surface currents  
operational with  
USCG May 4, 2009

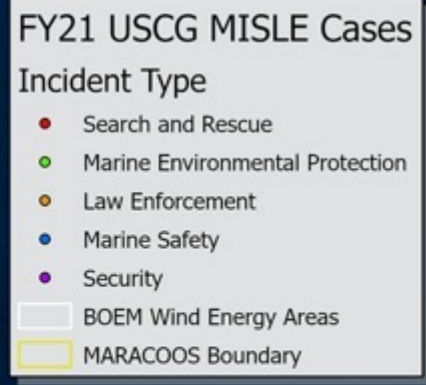
US IOOS surface  
currents operational  
with USCG March  
2011

MARACOOS engagement  
events with USCG





# 30,000 MW by 2030



# Introduction to Radar





# Why RADAR for remote sensing?



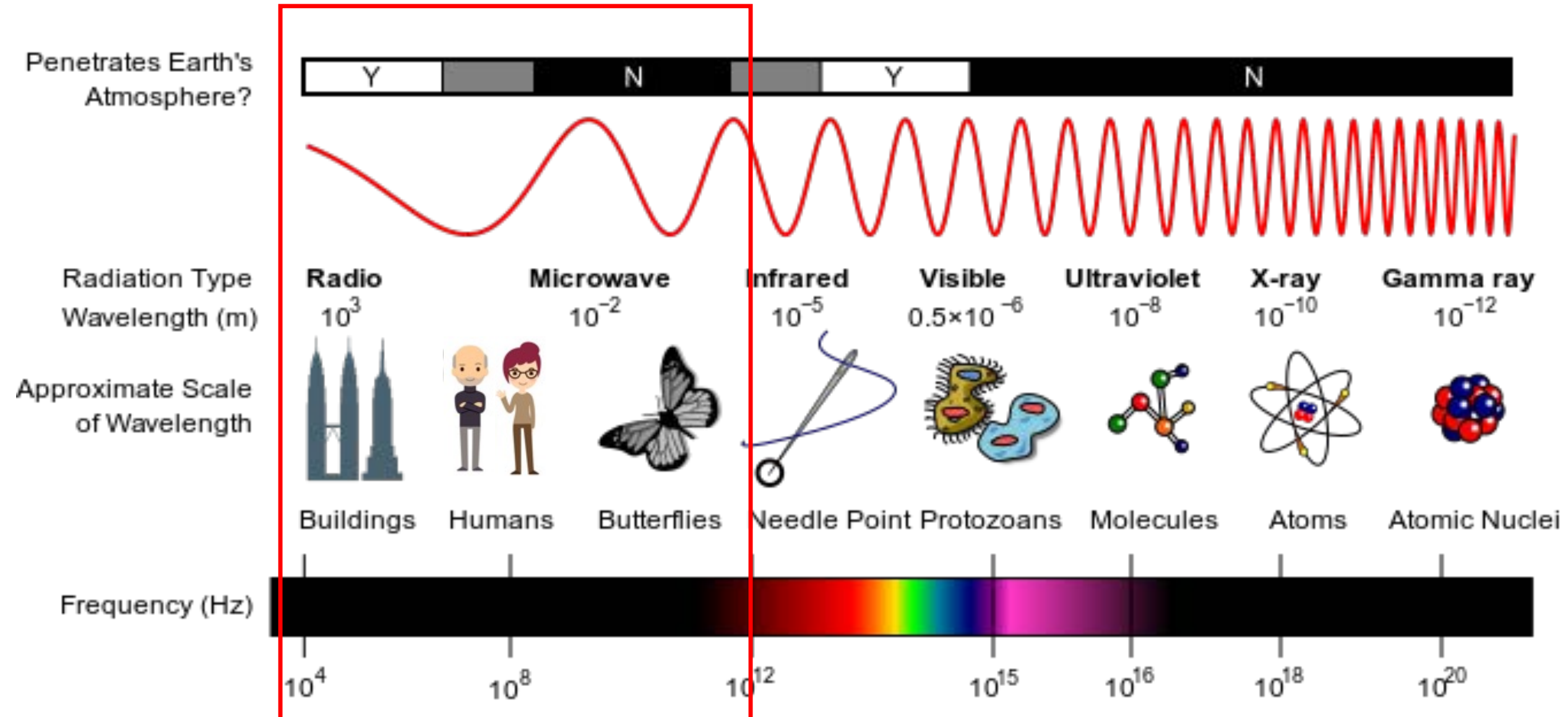


# What is Radar?

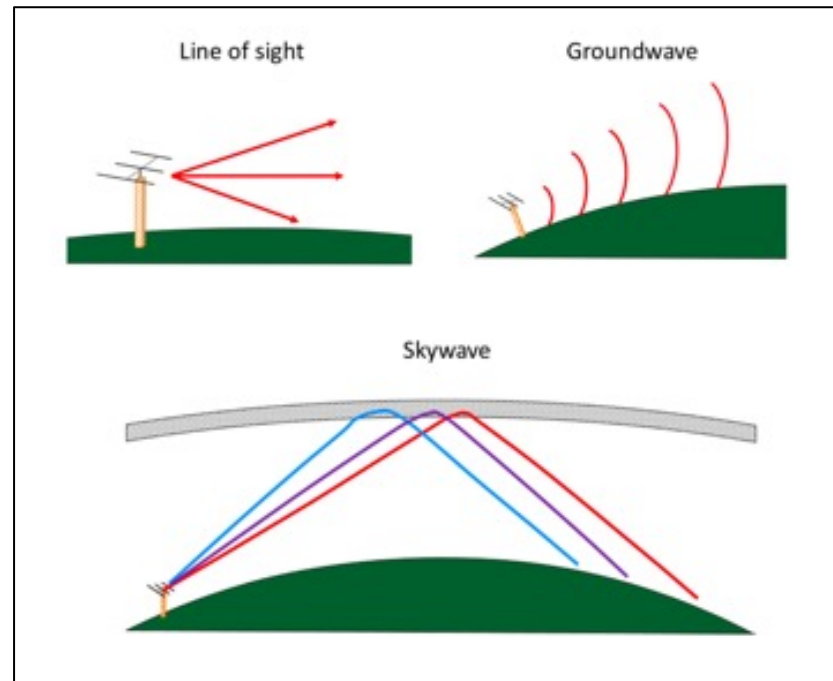
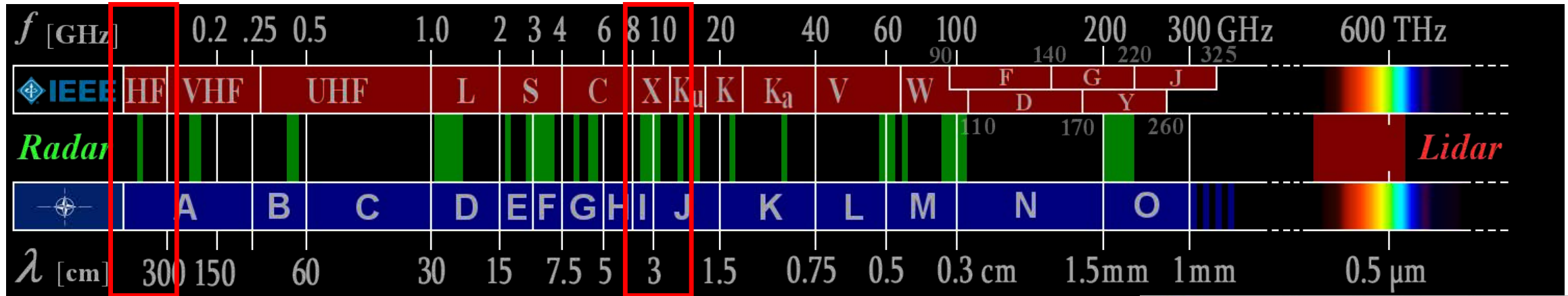
- **RA**dio **D**etection **A**nd **R**anging
- Search/detect – is an object there?
  - Need range and bearing
- Track – where is the object going?
  - Need range, bearing and velocity
- Classification
  - Scattering, polarization



# Electromagnetic Spectrum



# Radar Spectrum & Propagation Modes



radartutorial.eu

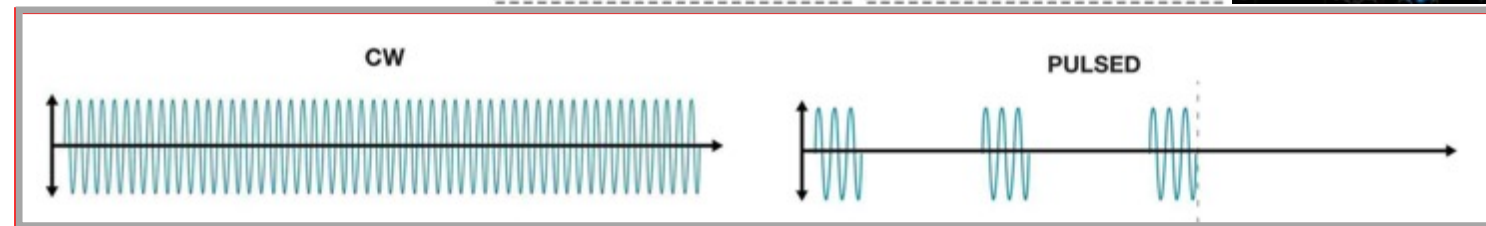
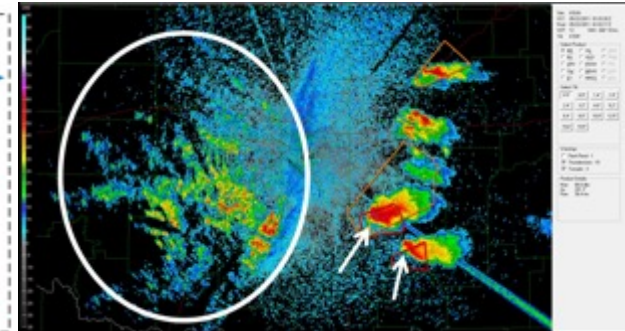
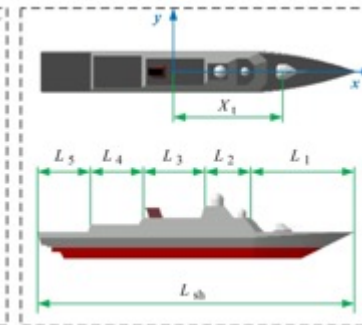
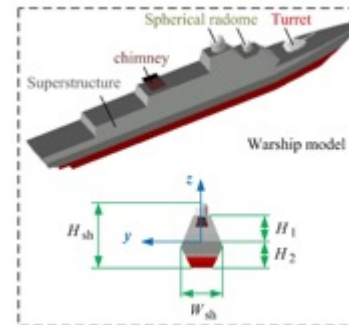
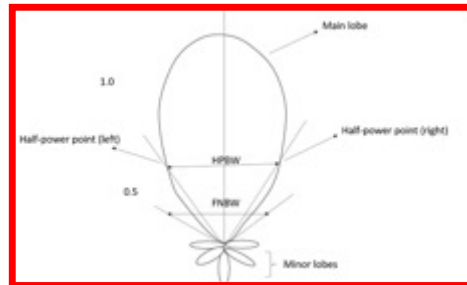
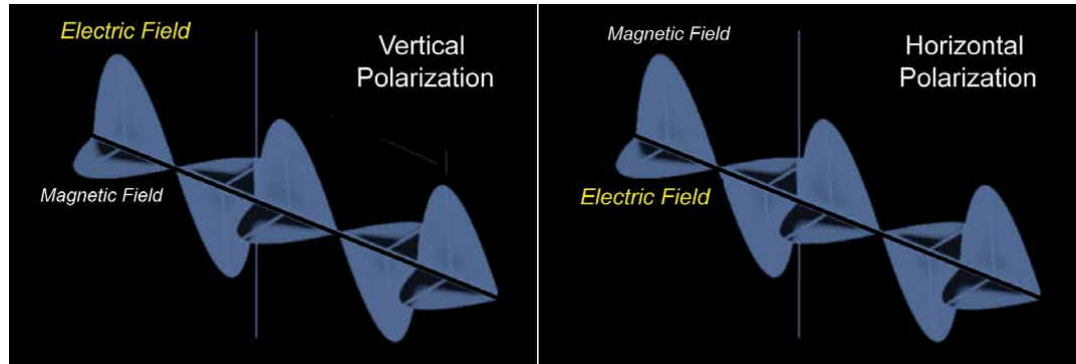
**ROHDE & SCHWARZ**  
Make ideas real





# RADAR terms

- Solid State
- Polarization
- Pulse vs CW
- Coherent
- Beamwidth
- Antenna Gain
- Phased Array
- Doppler Shift
- Clutter
- Radar Cross Section (RCS)

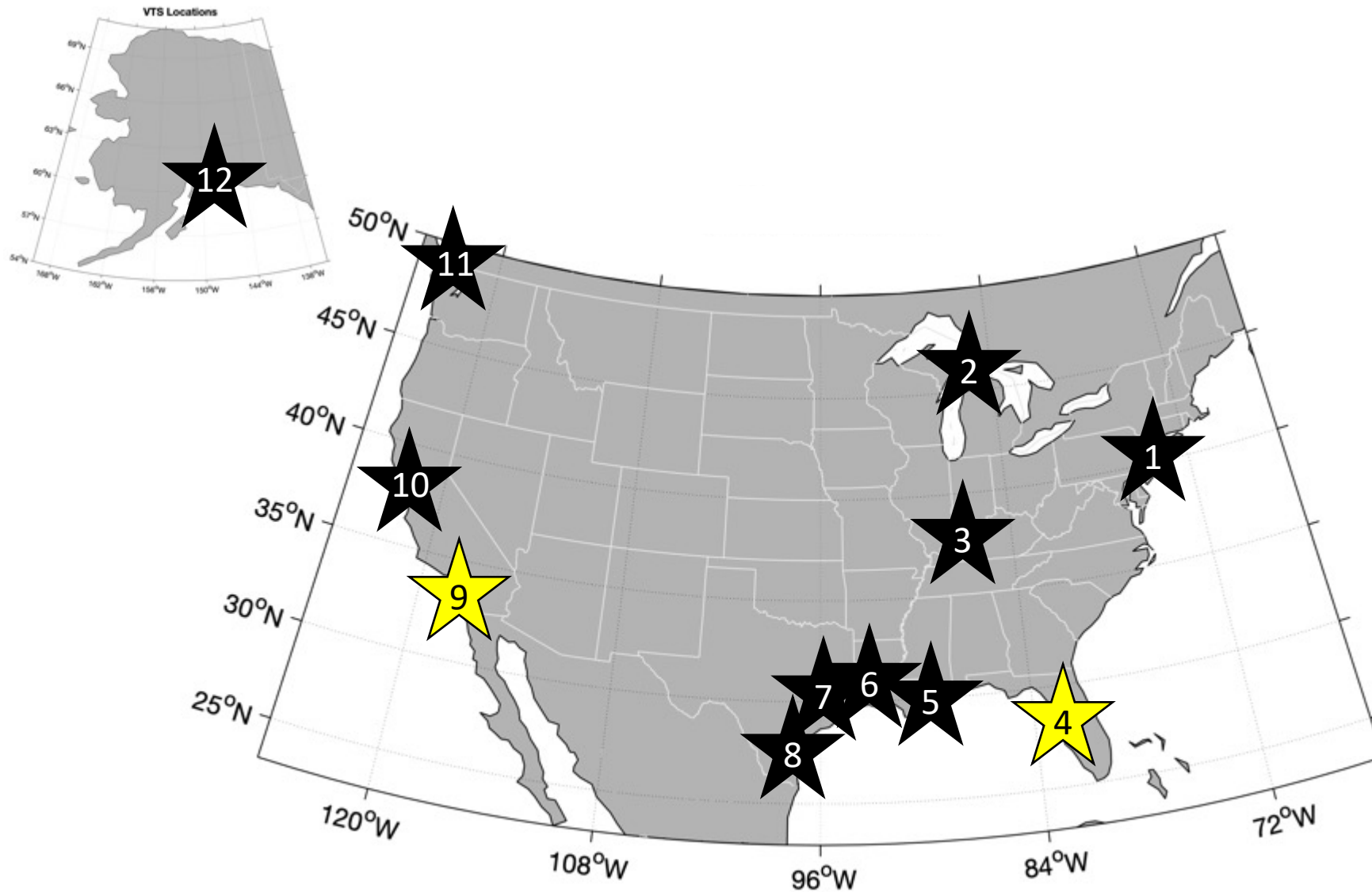


The background of the slide is a map of the United States, with the landmasses rendered in a light gray color. Overlaid on this map are numerous thin, yellow lines that represent the movement paths of vessels. These lines are most concentrated in the eastern half of the country, particularly along the Atlantic and Gulf of Mexico coasts, and in the Great Lakes region. The lines form a dense network, indicating high levels of vessel traffic in these areas.

# Vessel Traffic Service

## Introduction

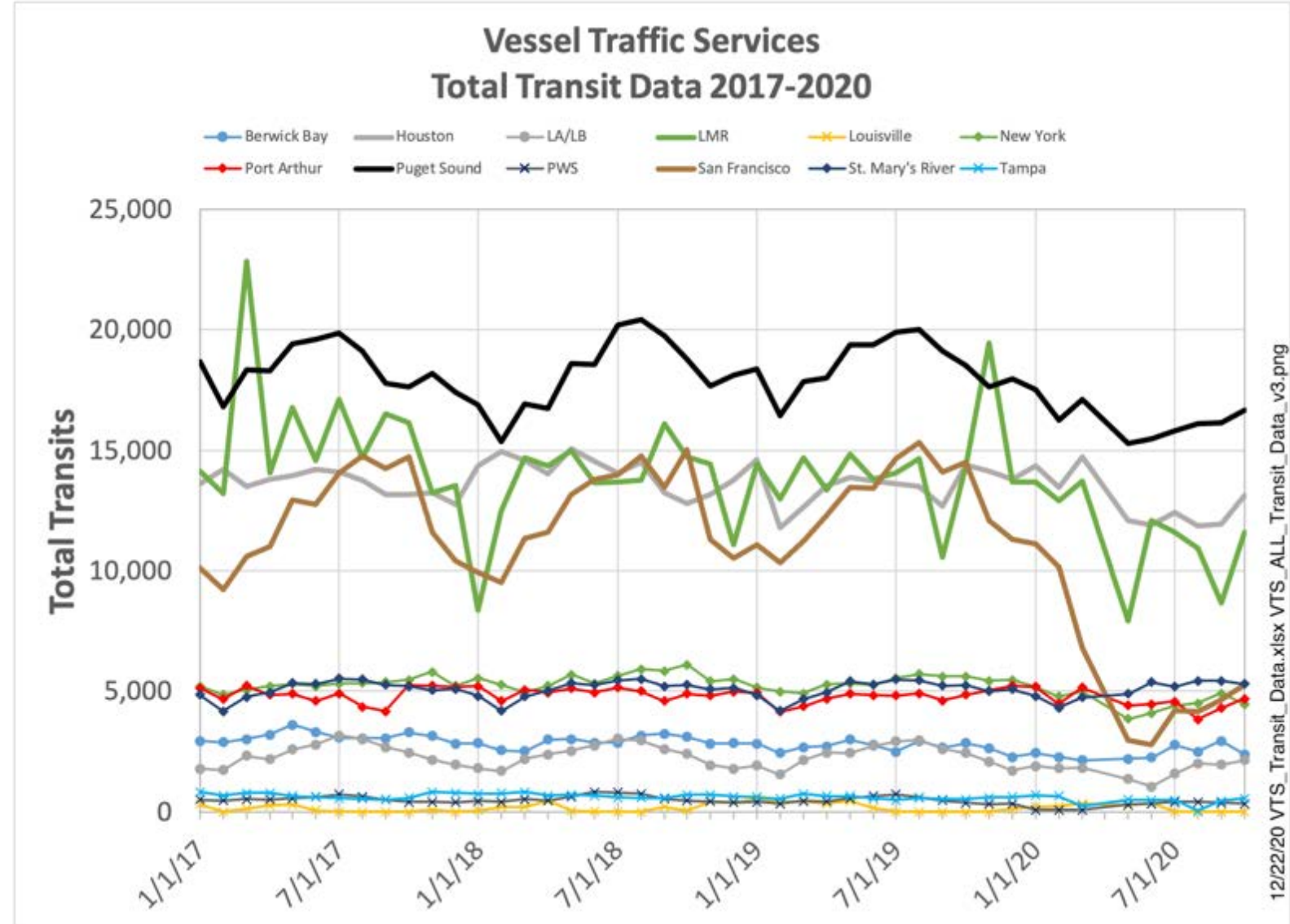
# VTS Locations



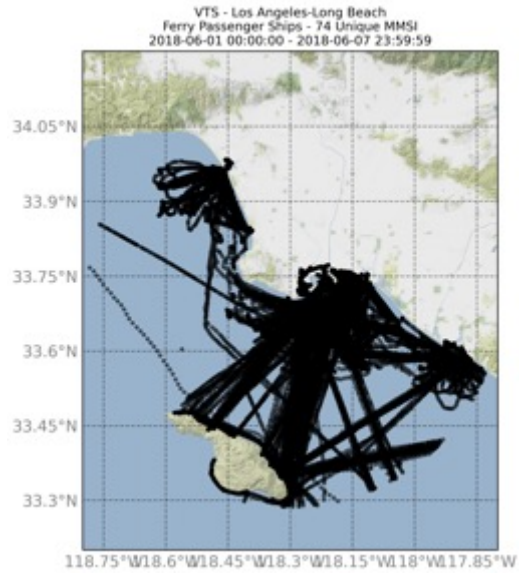


# VTS Traffic Volume

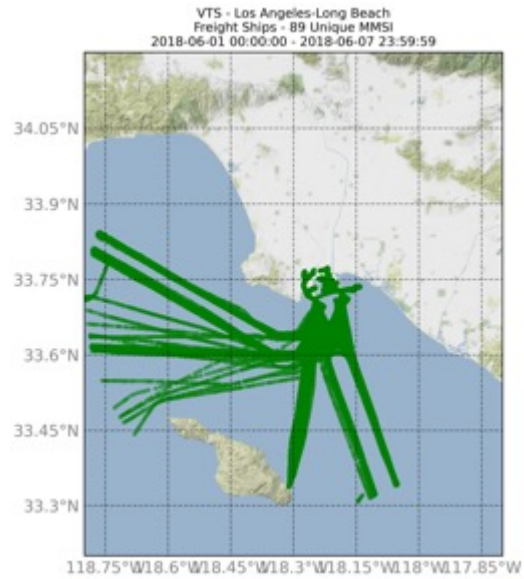
- 78,000 vessel per month
- 2,500 vessels per day
- Relatively constant for the past 3 years



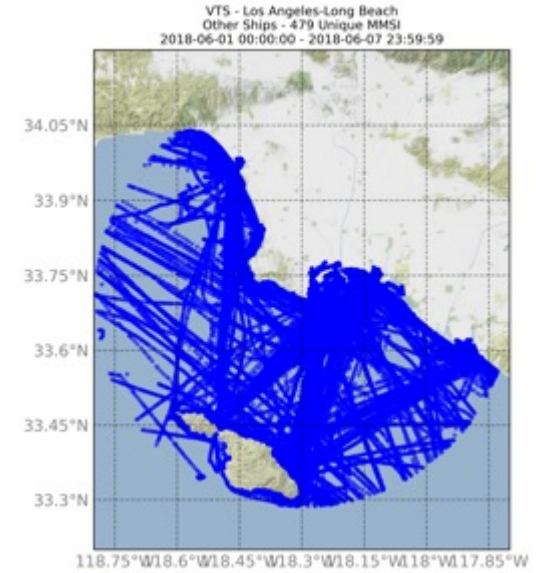
## Ferry



## Freight



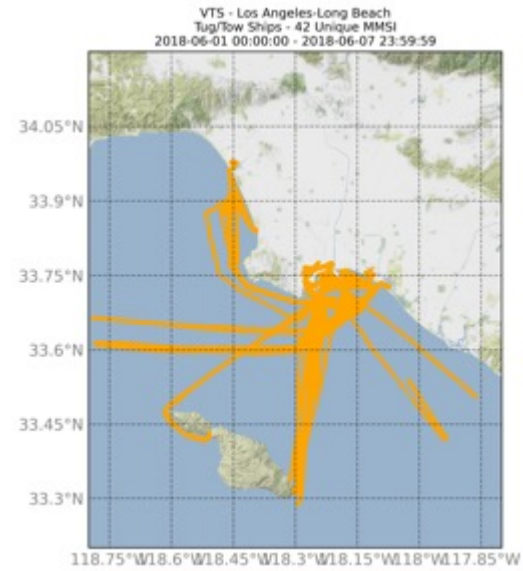
## Other



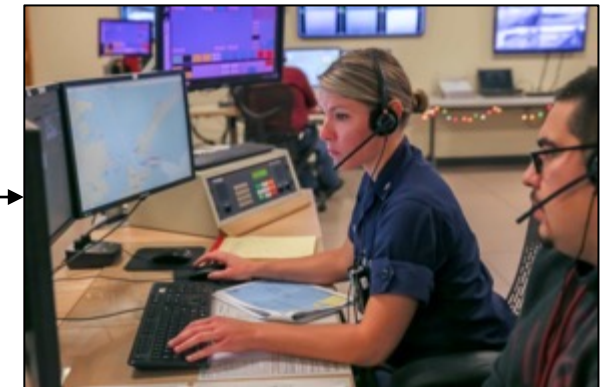
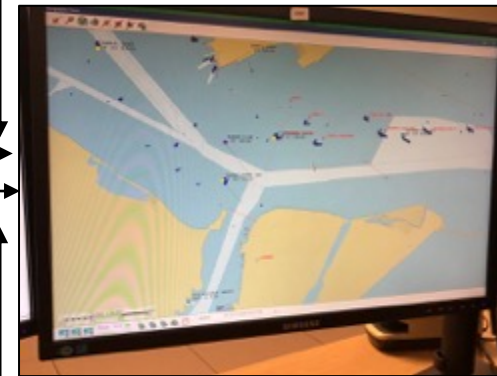
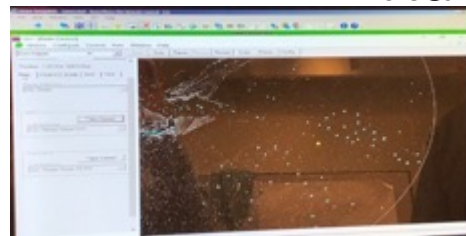
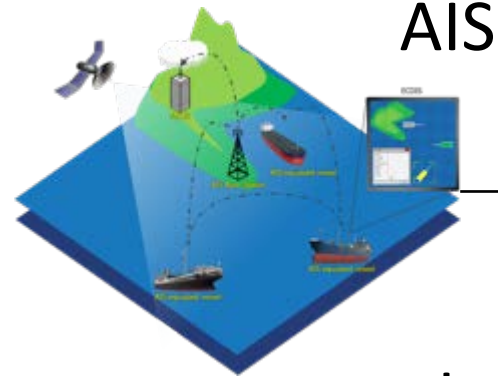
## Tanker



## Tug/Tow



# VTS Architecture Overview



MTM-300

CG Watchstander



The background of the slide features a map of the United States, with the landmasses rendered in a light gray color. Overlaid on this map is a dense network of bright yellow lines. These lines represent vessel traffic, with a high concentration of lines along the East and West coasts, particularly in the Gulf of Mexico and the Atlantic Ocean, indicating major shipping lanes. The lines are of varying thickness, suggesting different volumes of traffic.

# Vessel Traffic Service

## Current and Future



**Marine Exchange @MXSOCAL · Dec 16, 2021**

Ship Report 12/15: 113 ships inside 40 mi of LA/LB including 56 loitering or anchored & 57 at berths. Of the 113, 56 are container ships including 28 at anchor or loitering & 28 at berth. 29 ships loitering; 18 container, 8 bulk, 2 tankers & 1 general cargo.





# Inoperable radar in Prince William Sound concerns Council

January 6, 2021 by Amanda Johnson

## No plans for repair in near future

The U.S. Coast Guard's Vessel Traffic Service, or VTS, which monitors the location of vessels in Prince William Sound, has been operating without radar in recent months.

The Coast Guard monitors traffic in busy ports around the country through these VTS offices. The VTS in Prince William Sound usually operates with a combination of Automatic Identification System, or AIS; VHF radio; cameras; and radar.

AIS is a map-based online monitoring system required to be on board larger vessels. Equipment streams the vessel's position, along with its name, course, speed, heading, and destination to the system. VHF radio is used for two-way communications with vessels.

These various systems are integrated together and the information is relayed to the Coast Guard's Marine Safety Unit VTS in Valdez.

Radar is an integral part of the Coast Guard's monitoring of vessels in Prince William Sound as many small vessels and hazards only appear on radar.

Based on a National Transportation Safety Board report on the Exxon Valdez oil spill disaster, lack of radar is considered a contributing factor to the spill.



This screenshot is an example of how AIS maps show the location, speed, and direction of vessels, among other details. However, smaller objects or vessels do not appear in the system.

## UPCOMING DATES

JAN  
12  
Wed  
2022

12:00 pm Information  
and Education  
Commit... @  
Teleconference

JAN  
14  
Fri  
2022

9:00 am Scientific  
Advisory Committee  
me...

[View Calendar](#) →



# Analysis of Radar within Coast Guard VTS

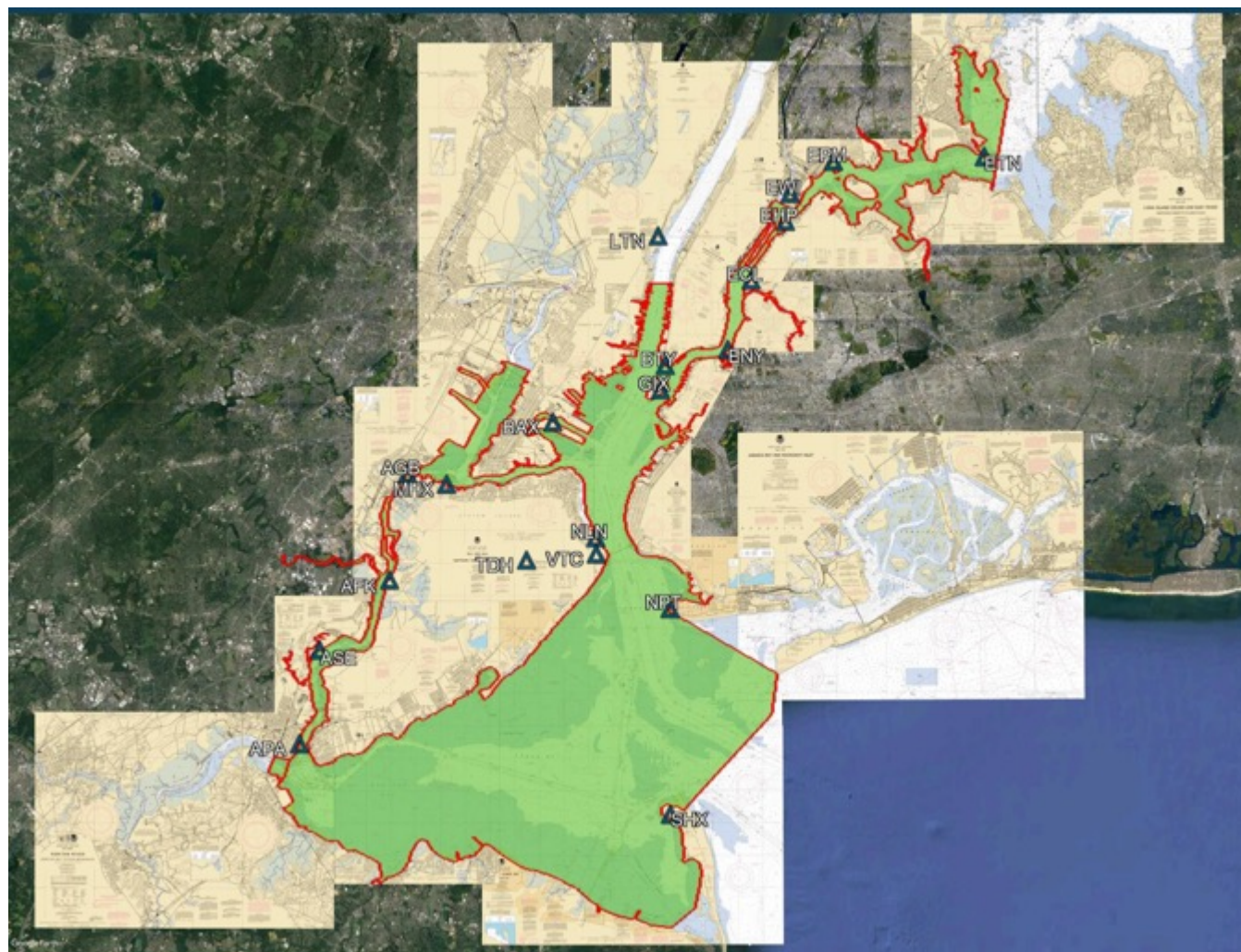
December 2020

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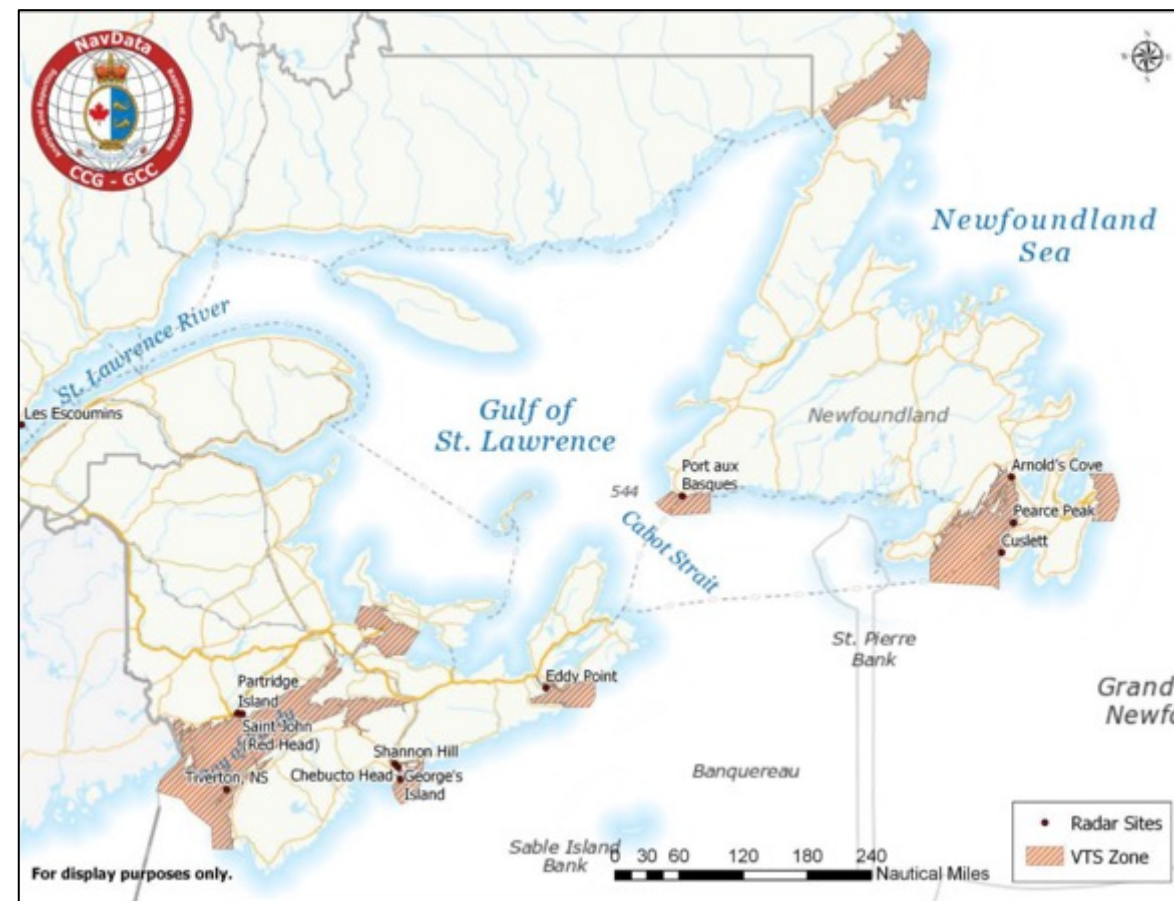


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# Canadian CG Requirements for Shore-based Radar Coverage

March 2018





# Radar Use Within VTS

- Anchorage Monitoring
- Small vessel detection (non VTS users)
- Ship and Barge breakaways
- Debris monitoring
- Monitoring Aids to Navigation (ATON)
- AIS failure
- Monitoring aspect ratio of vessel



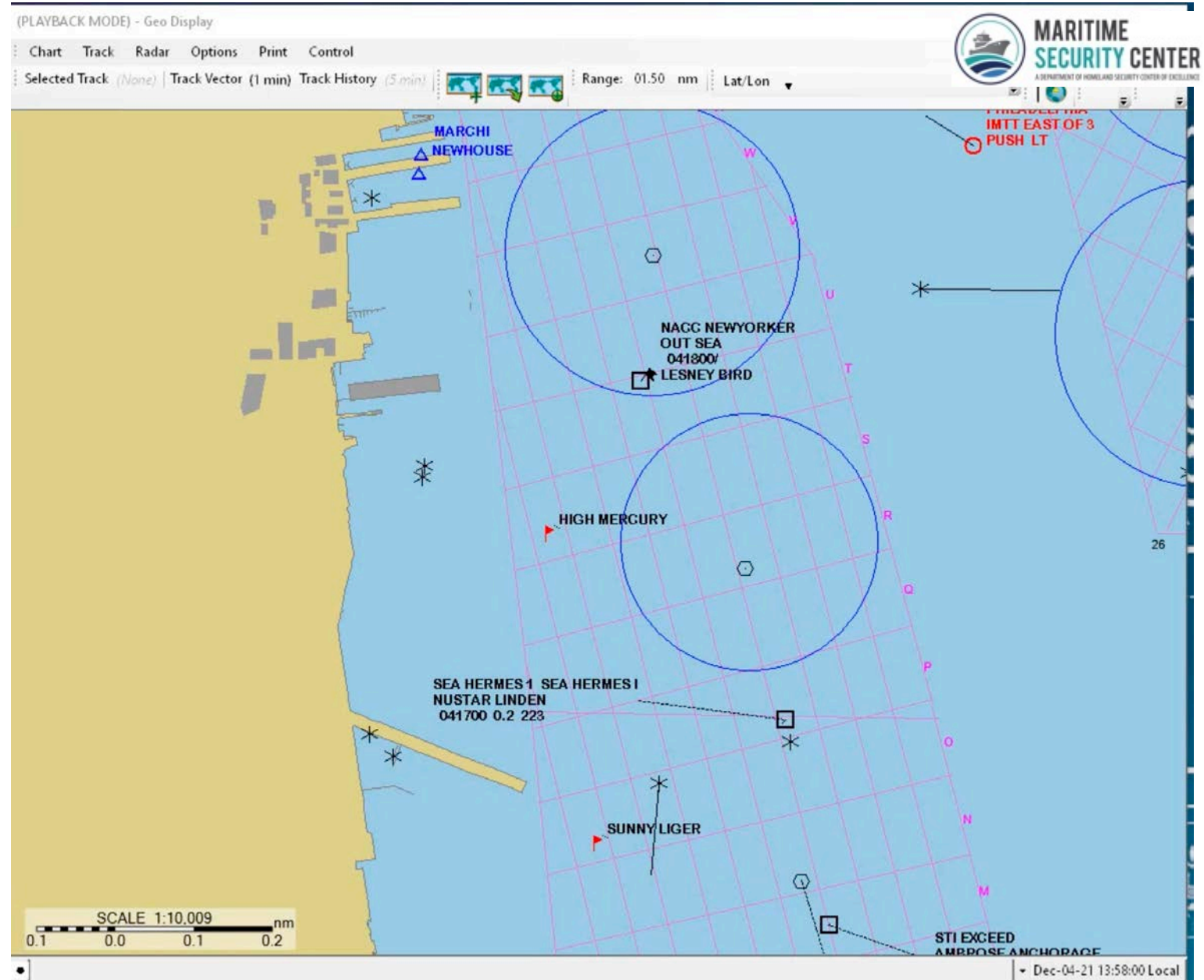
X Band Radar  
VTS Houston



# Sea Hermes Anchor Dragging



Oil Products Tanker  
Length: 180 m  
Beam: 32 m



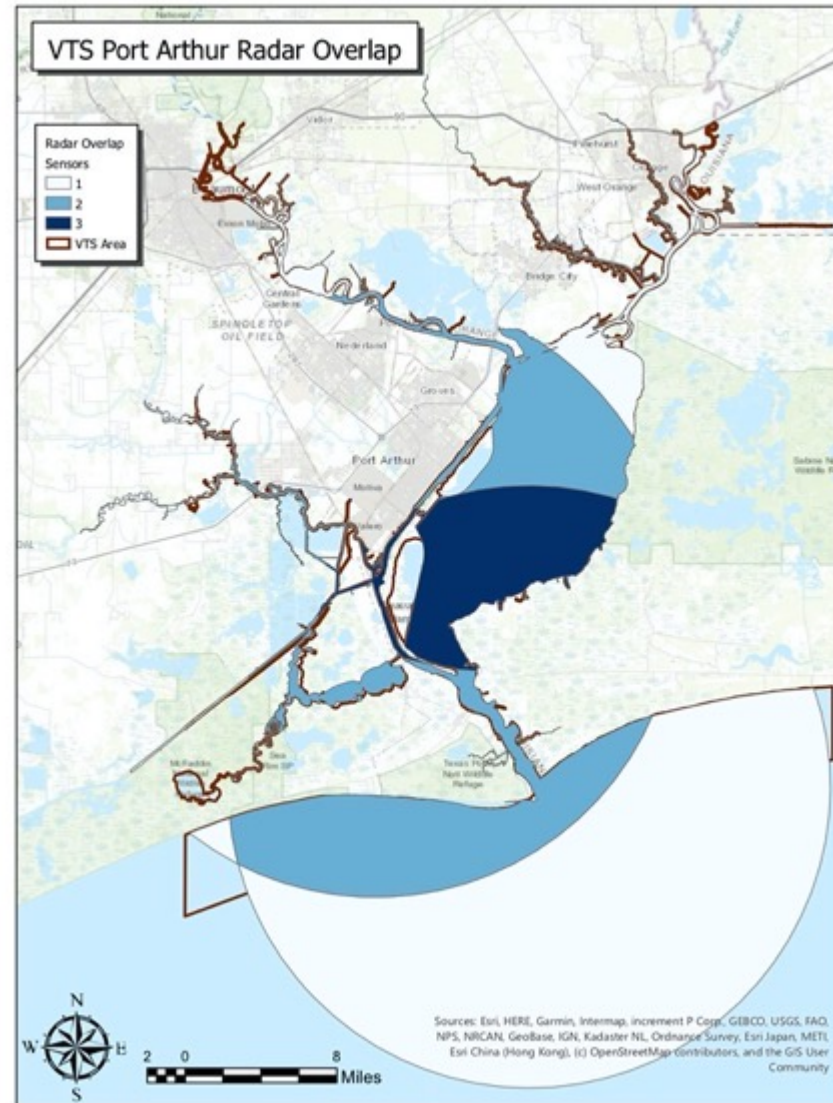
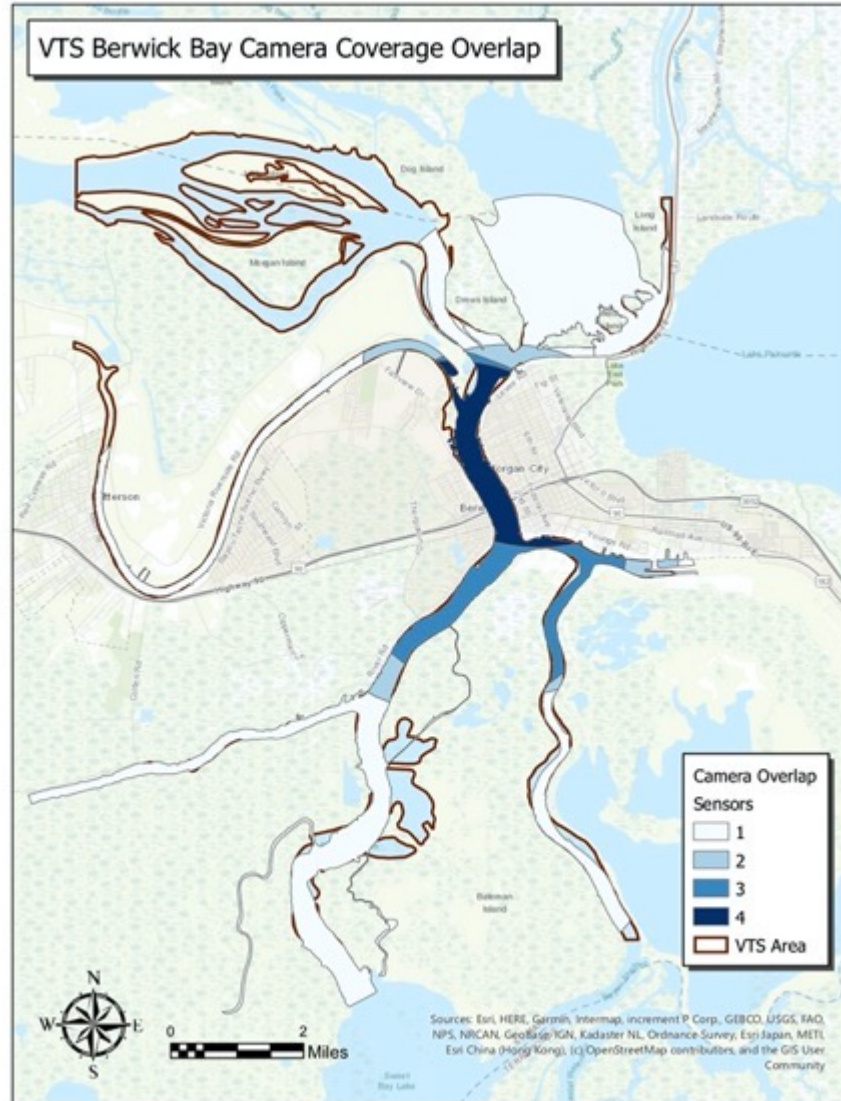


# 54 Microwave Radars in 9 VTS Locations





# Digital Twins of Each VTS





# Request for Information

- Released July 31, 2020
- Received responses from 8 radar companies



Existing

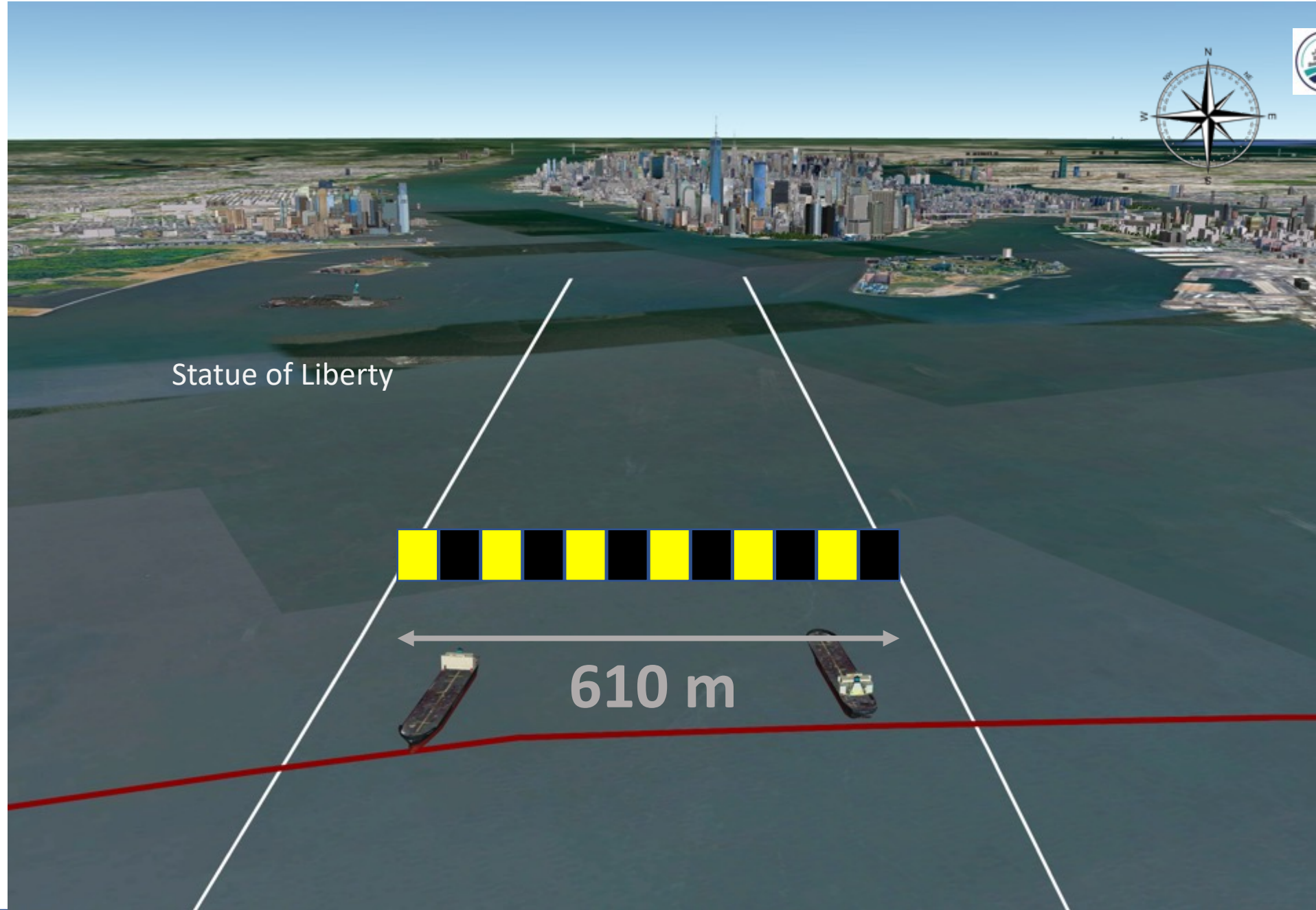


Proposed

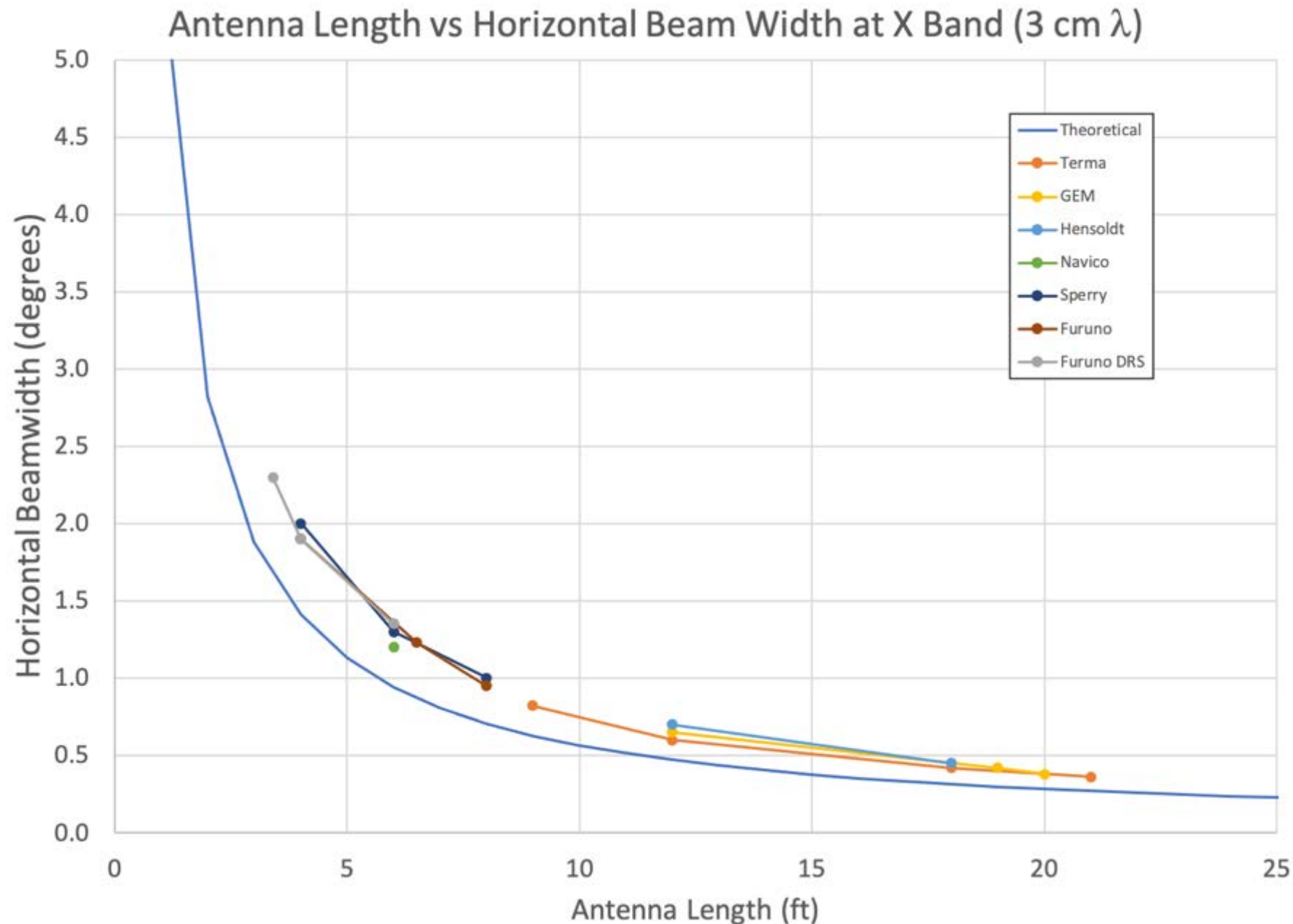
243 Cutters  
1,650 Boats



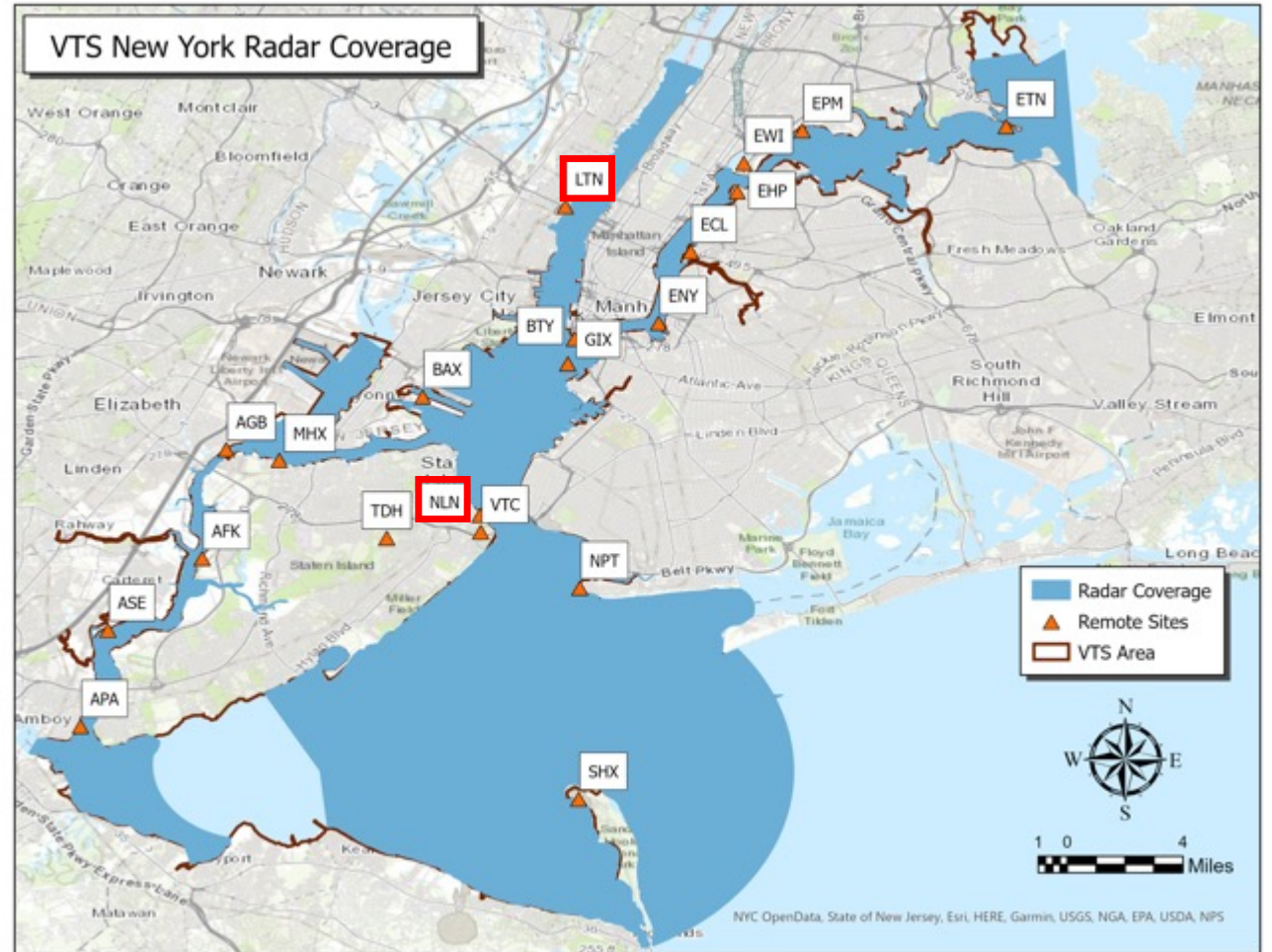






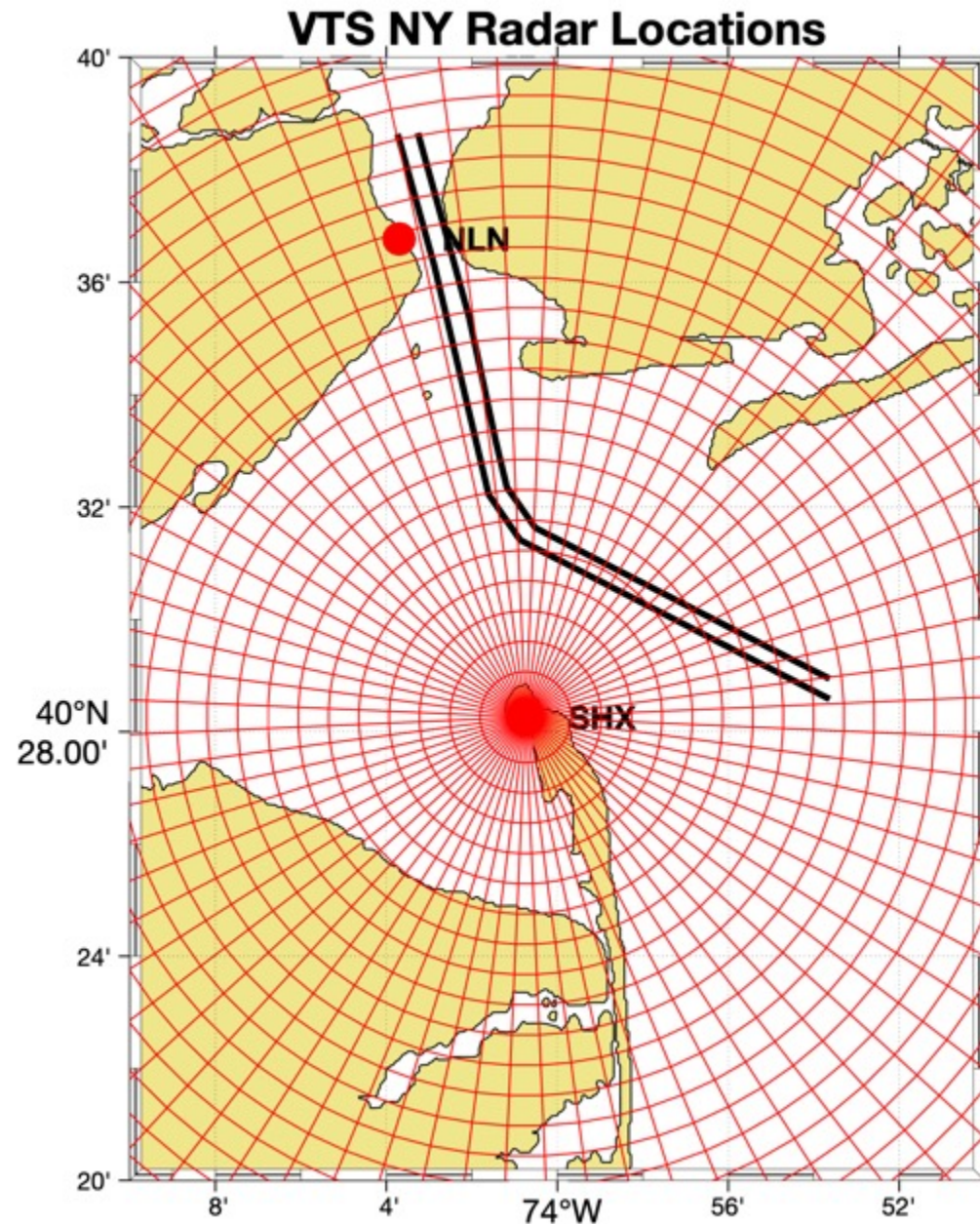


# Radar at New Lane (NLN) VTS New York



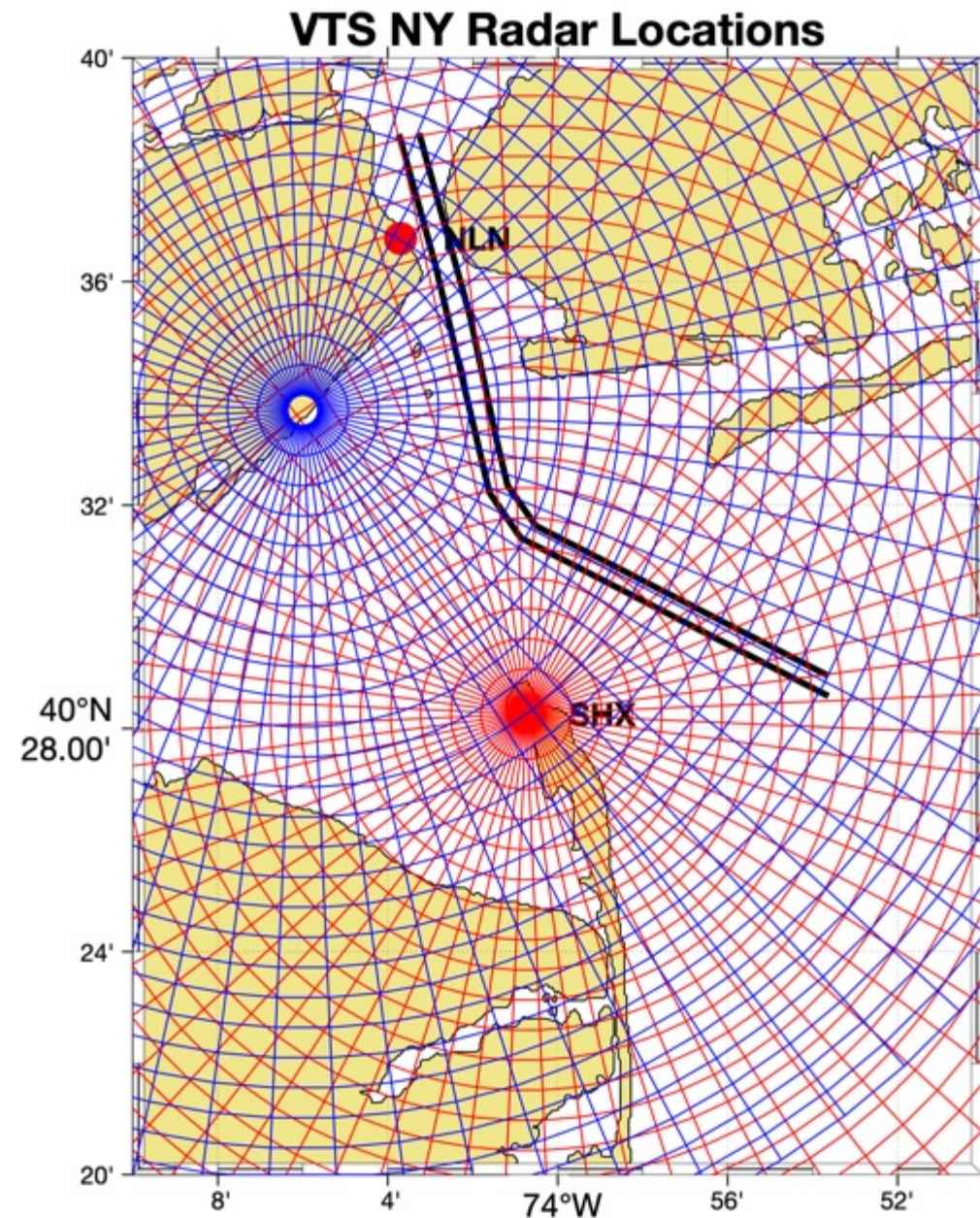


# Radar Coverage for Sandy Hook, NJ



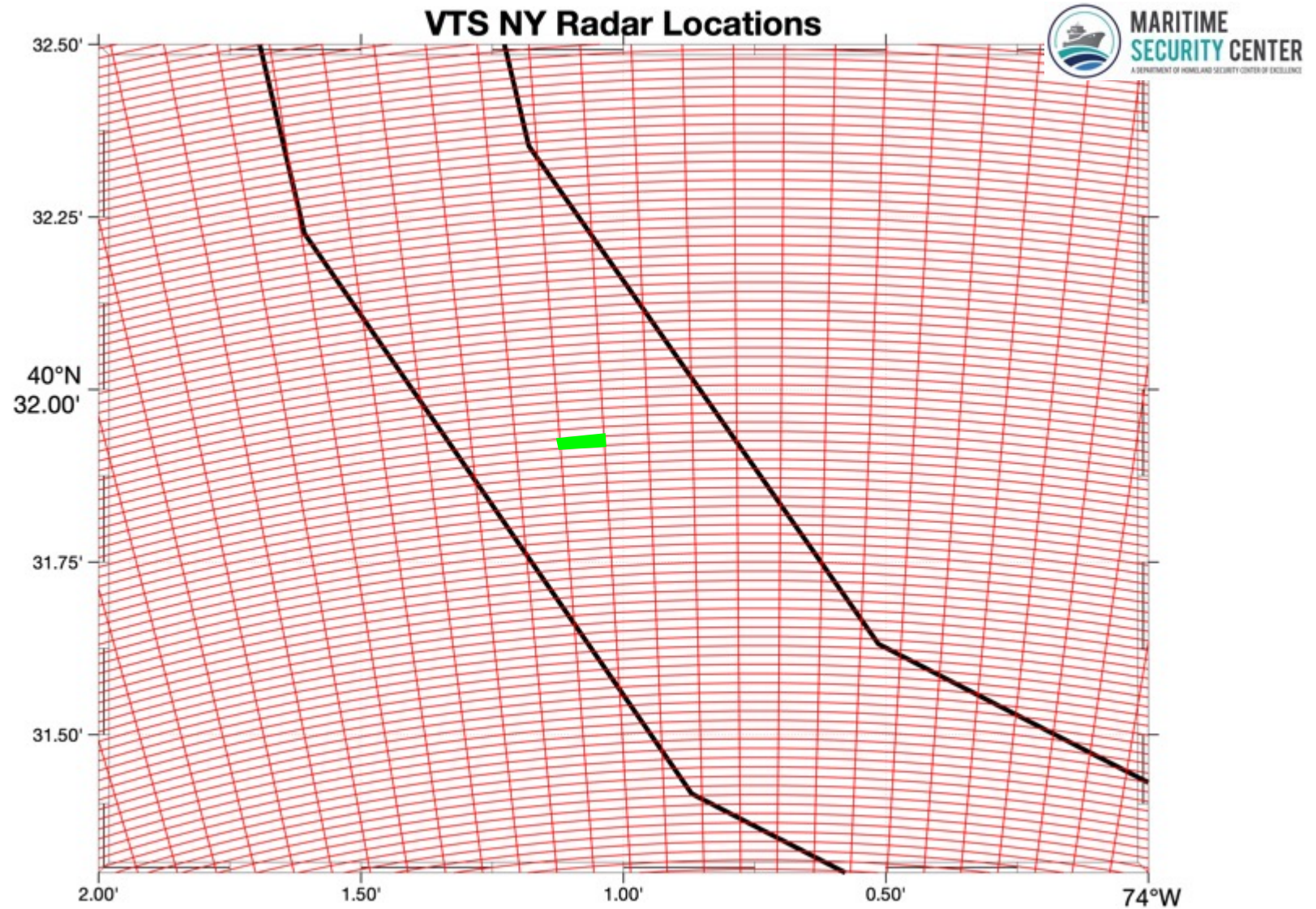


# Add a Second Station



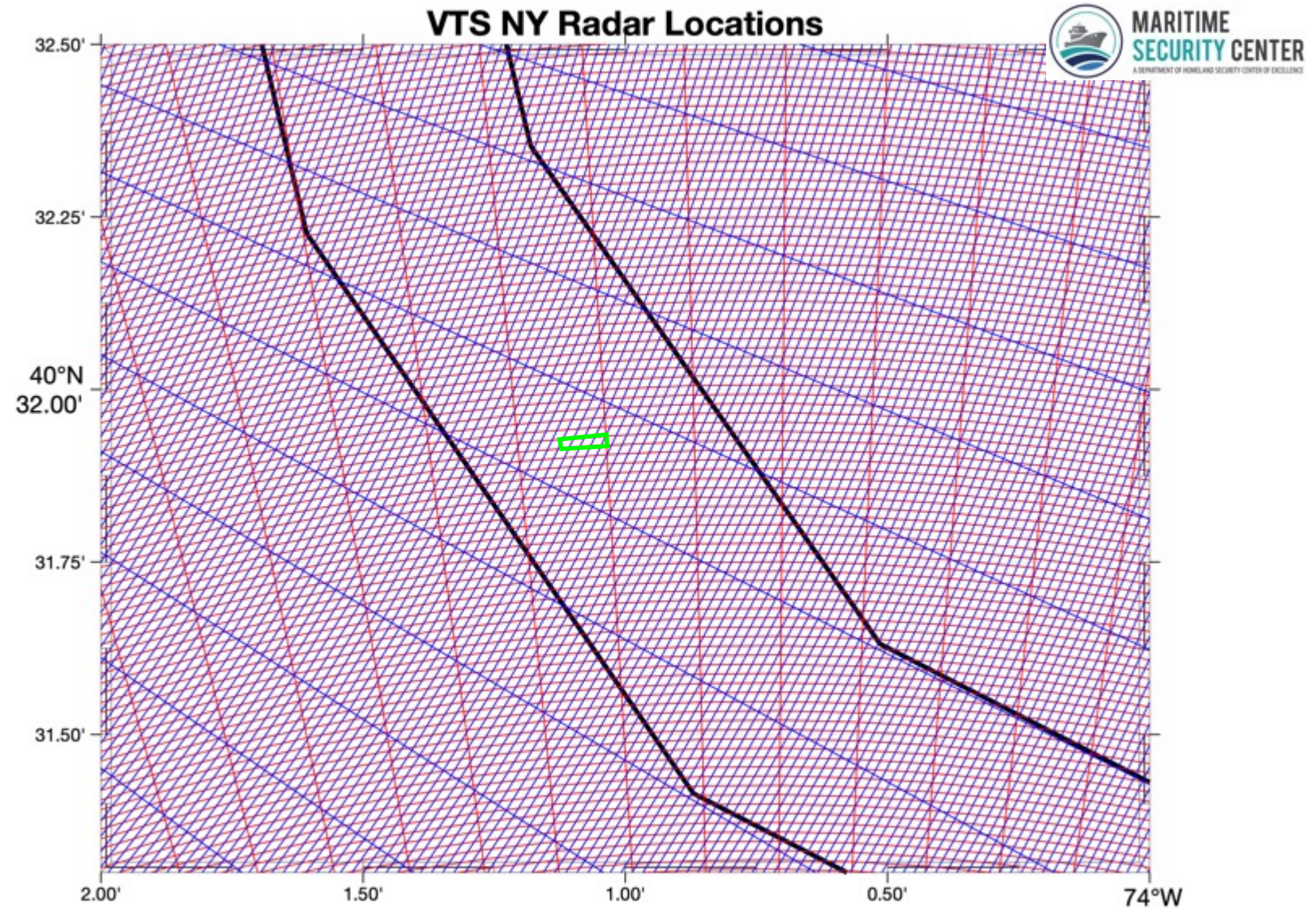
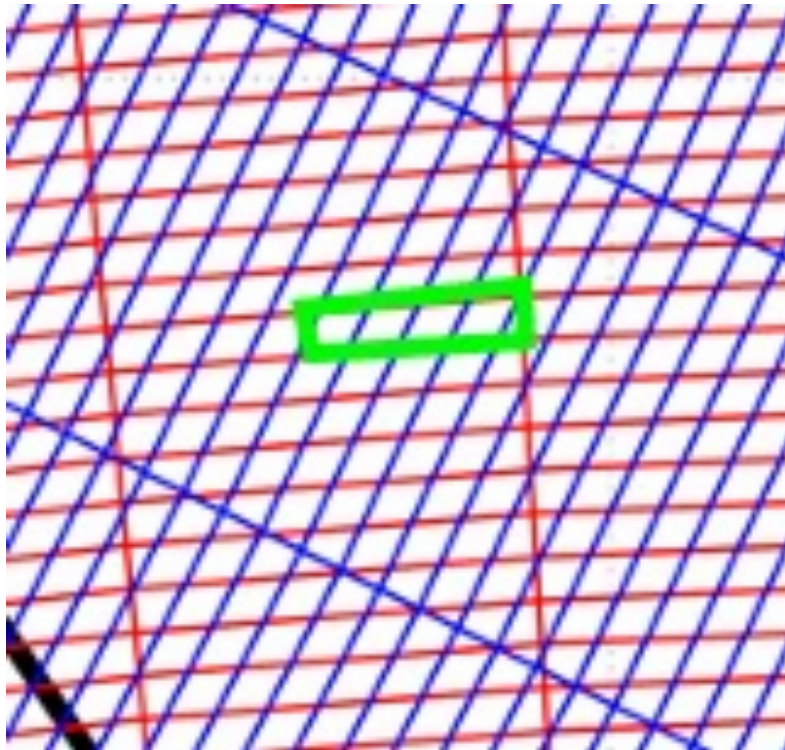


0.5° beamwidth,  
25 m range cells



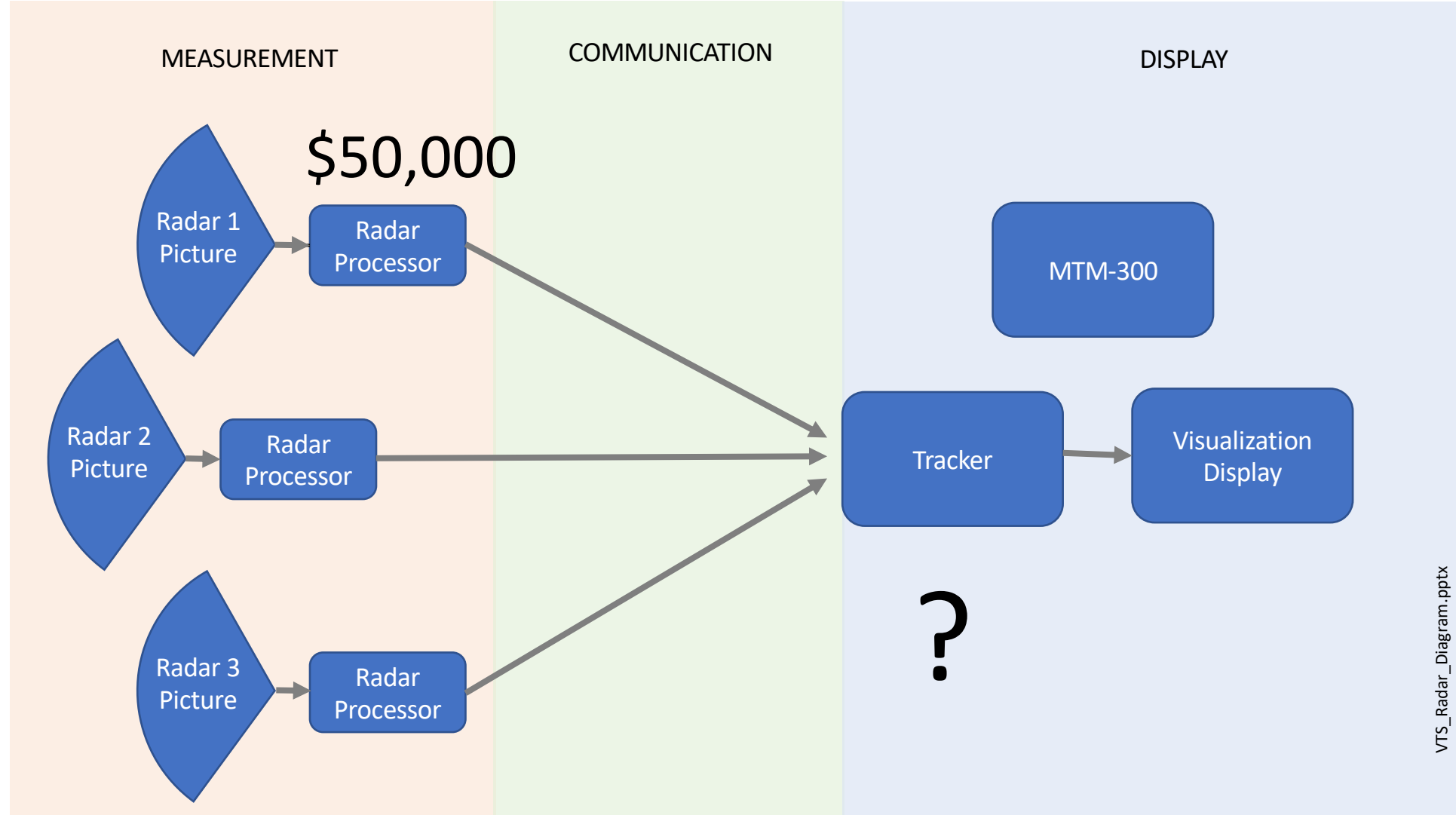


1° beamwidth,  
30 m range cells





# VTS Architecture



Remote Site Lease Costs?

# Coast Guard Missions



Maritime Law Enforcement



Maritime Response



Maritime Prevention



Defense Operations



Maritime Security Operations



Marine Transp. System Mgmt.



# Next Steps

- Obtain data of vessel position from MTM-300 and compare against raw radar feed
- Experiment with multiple radar images on a single target to see how MTM-300 fuses the data streams
- Experiment with other Coastal Surveillance platforms (Norcontrol, TimeZero) to see how well they can fuse multiple sensor data into a unified picture
- Opportunities for continued research leveraging the MSC Basic Ordering Agreement



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# Multi-Mission Radar for the US Coast Guard

Thank You

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-Julia Engdahl



Julia Engdahl, '20  
Oceanographic Data Specialist,  
NOAA



Joseph Anaruma, '20  
Environmental Analyst,  
Sage Services



Ted Thompson, '21  
Data Analyst,  
US Geological Survey



Ailey Sheehan, '21  
Research Assistant,  
Haskin Shellfish Lab



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- ocean modeling literacy
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**POLAR  
SCIENCE**



**INTEGRATING  
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Applications received by January 1 receive full consideration. For information about applying to Rutgers graduate school see this page: <http://gradstudy.rutgers.edu/>. This program is a track within the Oceanography (MS) degree in the School of Graduate Studies.

For more information about the Masters of Operational Oceanography, please contact Alexander López ([alopez@marine.rutgers.edu](mailto:alopez@marine.rutgers.edu))