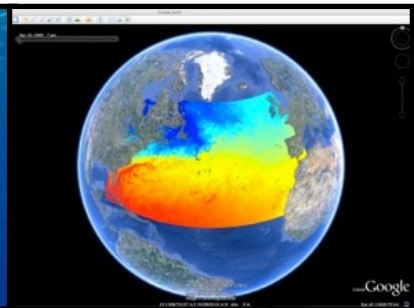
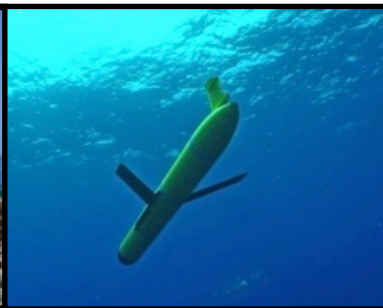


Rutgers University

Coastal Ocean Observation Lab

>20 Researchers, > 100 Undergrads, >\$100 M Funding



Satellite Data Acquisition Stations

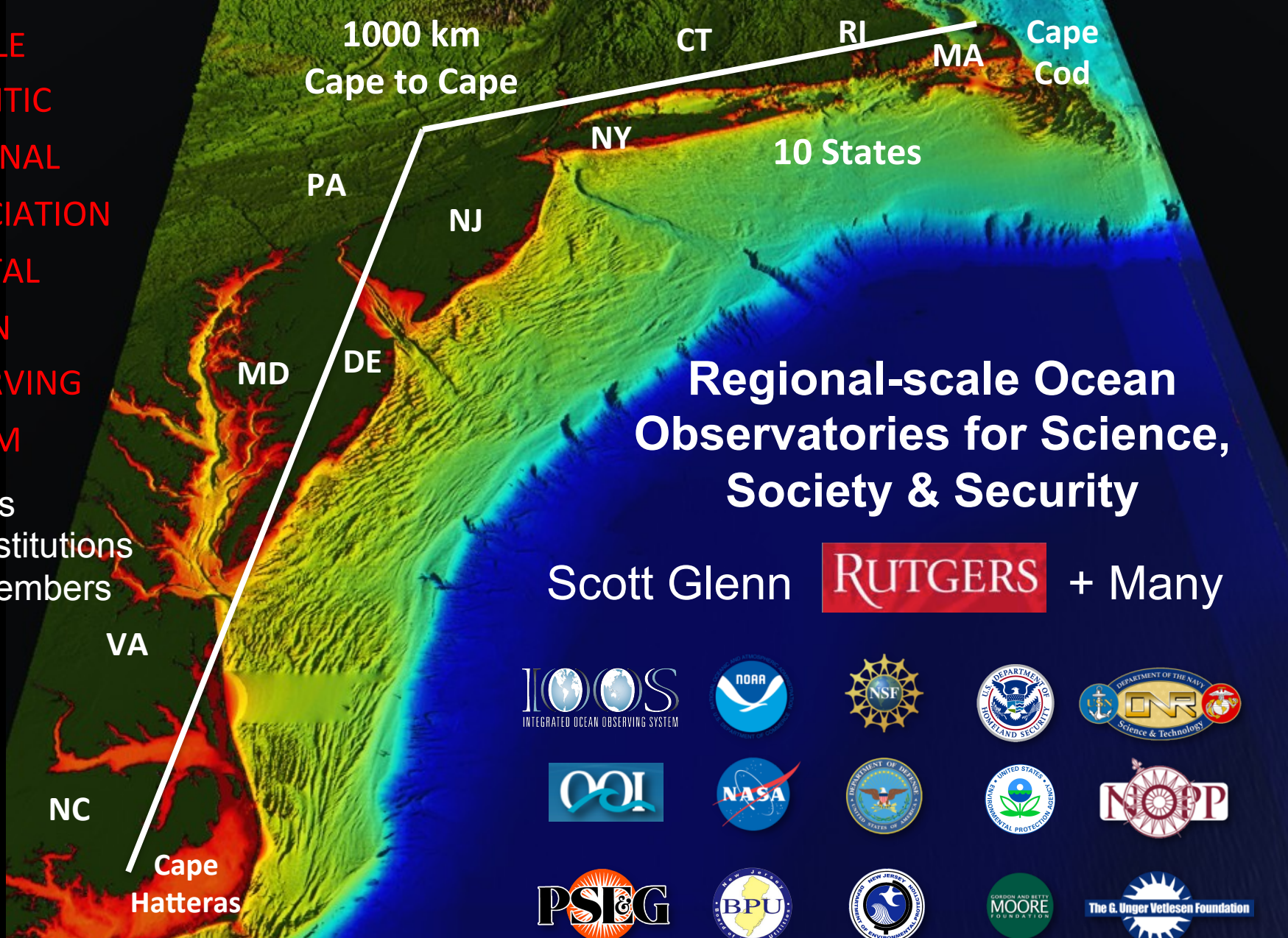
CODAR Network

Glider Fleet

3-D Forecasts

MIDDLE
ATLANTIC
REGIONAL
ASSOCIATION
COASTAL
OCEAN
OBSERVING
SYSTEM

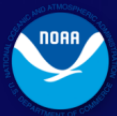
>40 PIs
>20 Institutions
>50 Members



Scott Glenn



+ Many



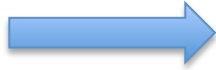
MARACOOS
Ocean Information for a Changing World



U.S. Integrated Ocean Observing System



International Component



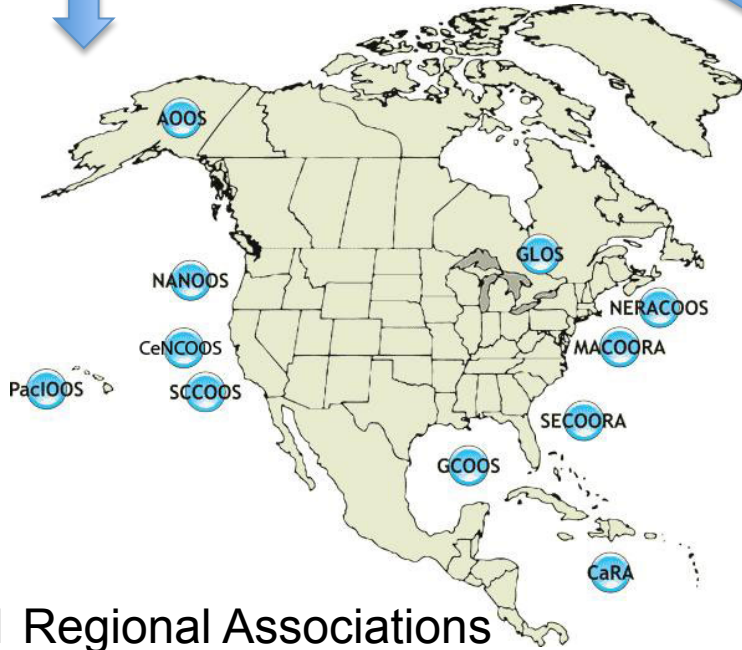
Where are the Gliders Today?

Glider Asset Map
Glider Fleet
Technologies and Applications

Global High Frequency (HF) Radar Network Component
High Frequency Radars

Regional Component

National Component



Globally Coordinated Initiatives



11 Regional Associations

17 U.S. Federal Agencies



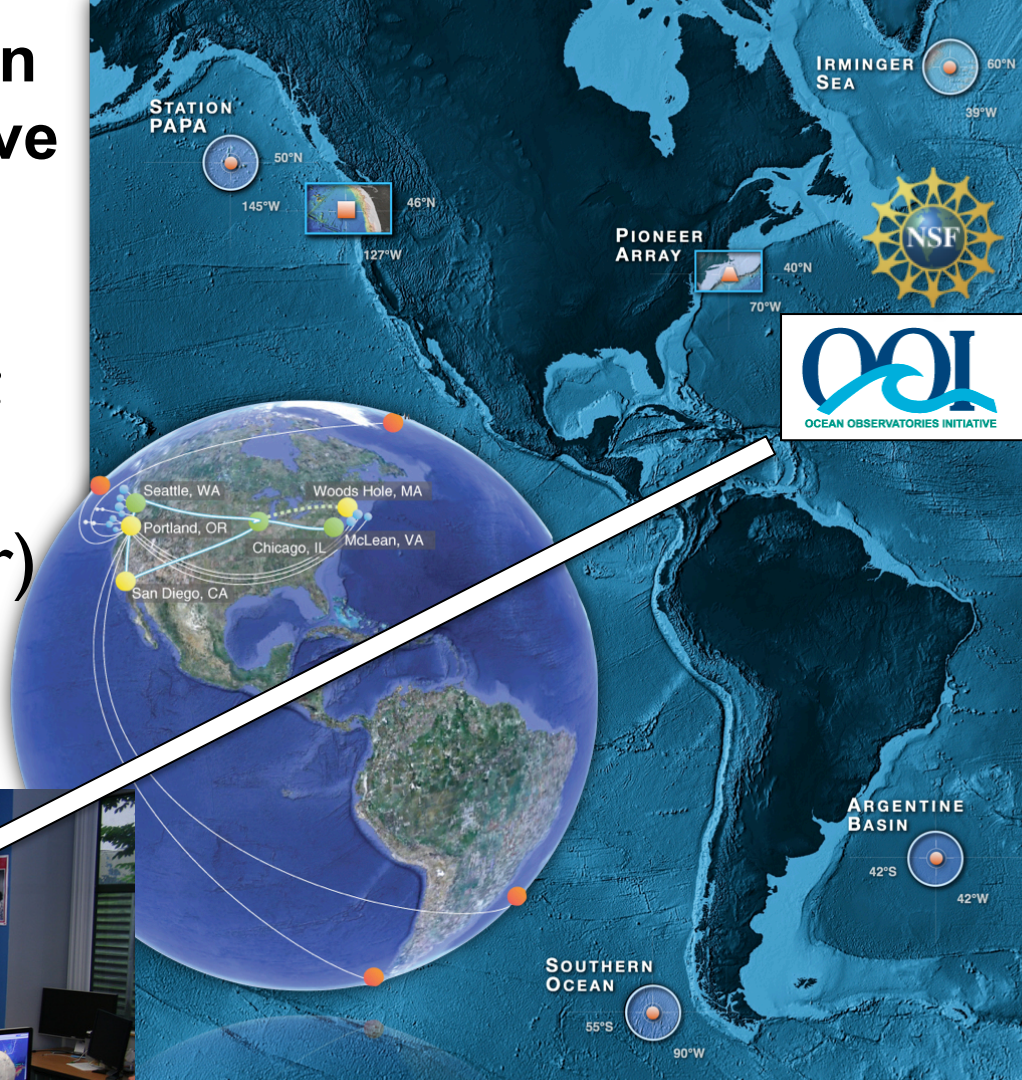
<http://ioos.gov>

National Science Foundation Ocean Observatories Initiative

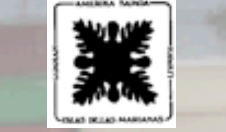
Construction Phase: \$386 M

Implementing Organizations:

- Marine (Global, Regional, Endurance, Pioneer)
- Cyber Infrastructure
- Education



The Center for Secure and Resilient Maritime Commerce (CSR)



The Center for Secure and Resilient Maritime Commerce (CSR)



Rutgers University – CODAR Ocean Sensors
Academic – Industry Partnership since 1998

CSR's HF Radar Mission:

1. Develop & Verify the HF Radar Multi-Use Capability for Current Mapping & Vessel Tracking.
2. Transition these Capabilities to Operational Use for Search And Rescue (SAR) and Maritime Domain Awareness (MDA).
3. Educate the Workforce Required to Operate these National Systems.



The Center for Secure and Resilient Maritime Commerce (CSR)



HF Radar Team

Rutgers University -

Scott Glenn, Josh Kohut, Hugh Roarty, Mike Crowley, John Kerfoot, Ethan Handel, Mike Smith, Colin Evans

CODAR Ocean Sensors -

Don Barrick, Pete Lilleboe, Chad Whelan, Belinda Lipa, Bill Rector, Jimmy Isaacson

University of Puerto Rico - Mayaguez

Jorge Corredor, Julio Morell, Miguel Canals

Applied Mathematics, Inc -

Bill Browning

University of Alaska - Fairbanks

Tom Weingarter, Hank Statscewich

Ocean Power Technologies -

Debbie Montagna, Bruce Downie

Naval Research Laboratory

Michael Lovellette, Dan Newton

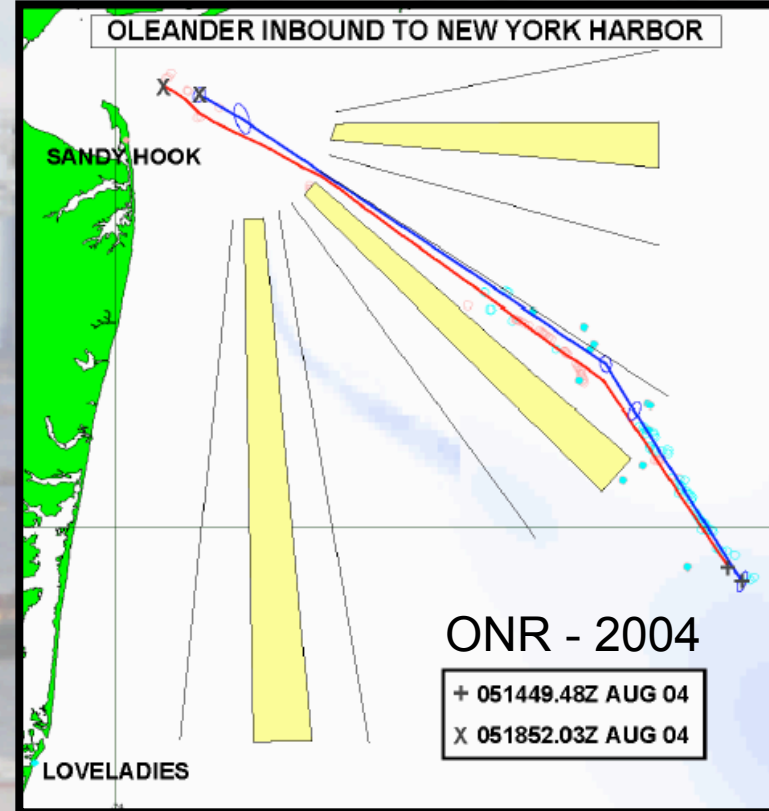
Norwegian Defence Research Establishment (FFI)

Terje Johnsen, Walther Asen

CODARNor

Anton Kjelaas

Rutgers University - CODAR Ocean Sensors
Academic - Industry Partnership since 1998



27 Researchers @ 9 Institutions

CODAR Compact HF Radar Antennas



25 MHz



13 MHz



5 MHz

Combined Transmitter & Receiver

Separate Transmitter & Receiver

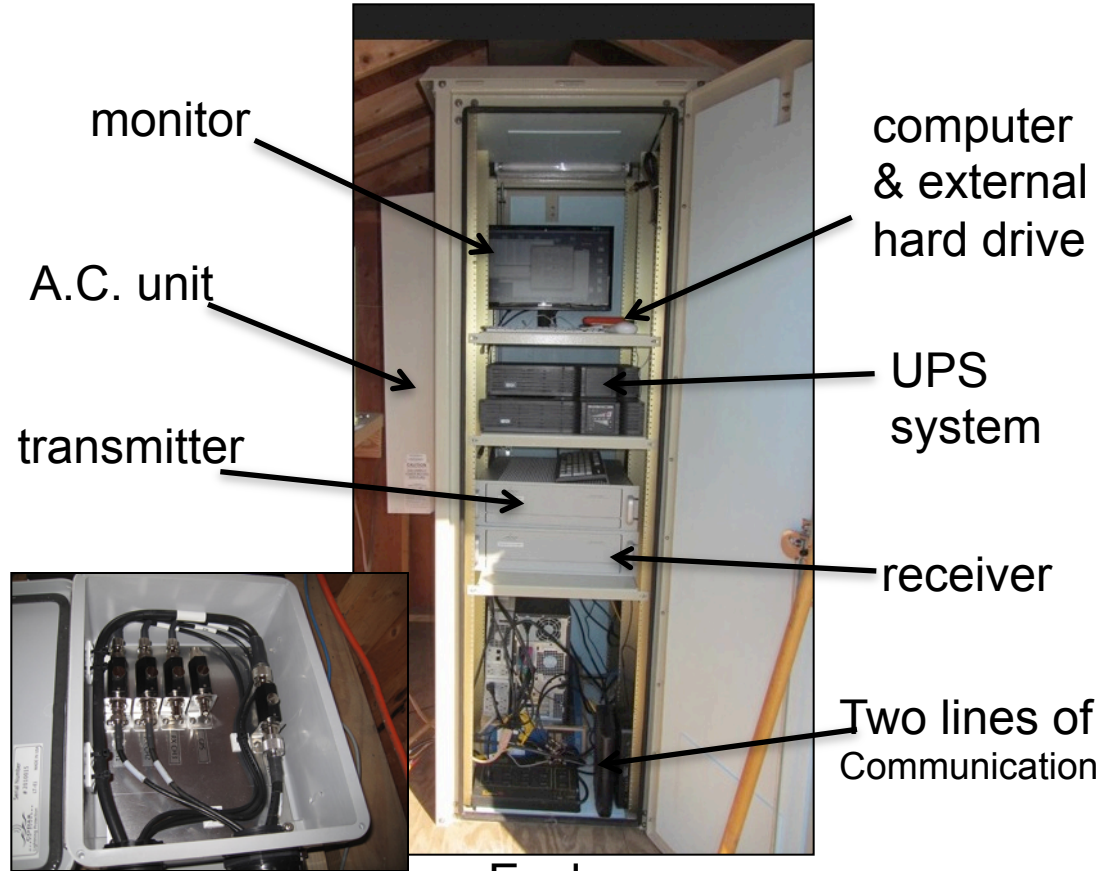


Standard CODAR Shore Site:

Shed, Enclosure, Tx/Rx, Comms, Power, GPS, AIS



Shed



Lightning Protection

Enclosure



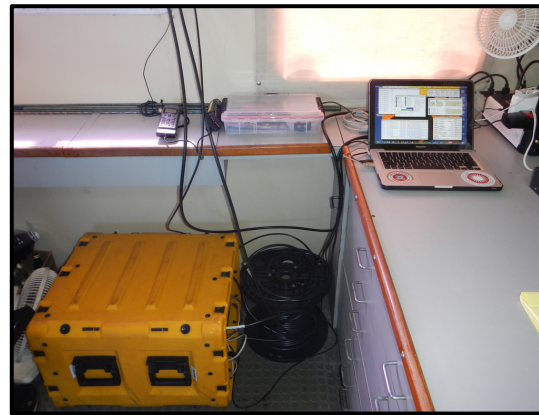
HF Radar Bistatic Transmitters – Extending Range & Number of Look Angles



On Buoys



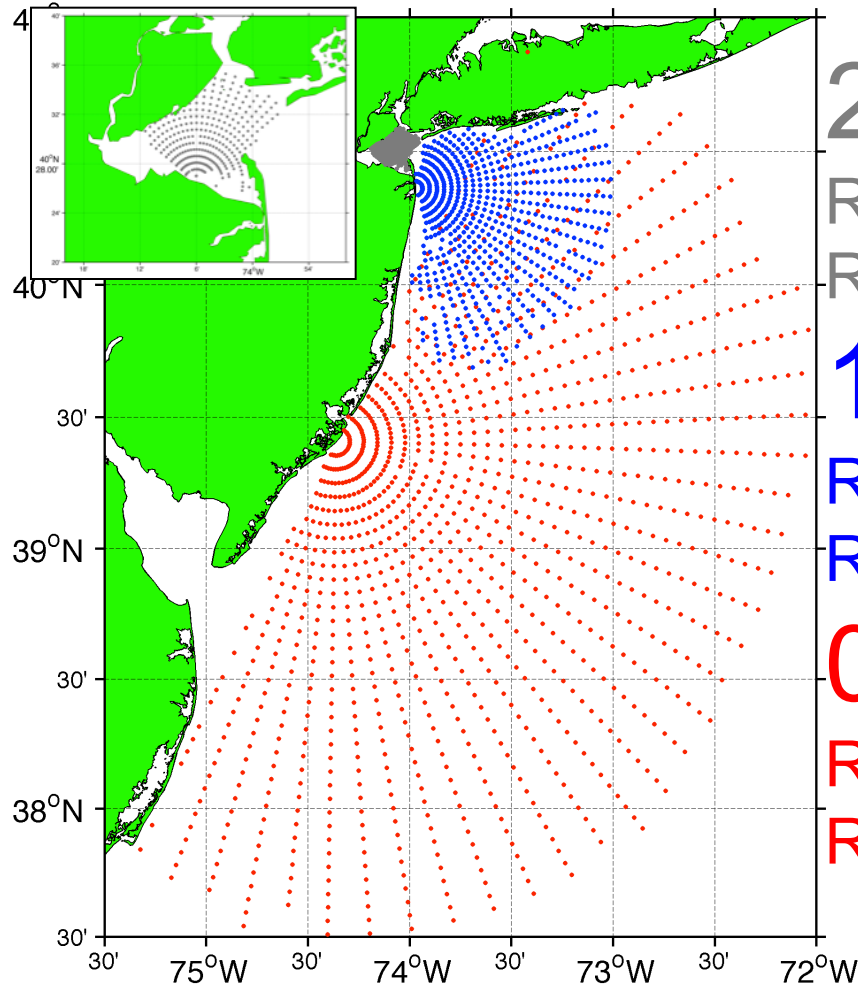
On Ships



On Shore



Surface Current Mapping Capability



25 MHz

Radar λ : 12 m

Range: 30 km

Ocean λ : 6 m

Resolution: 1 km

13 MHz

Radar λ : 23 m

Range: 80 km

Ocean λ : 12 m

Resolution: 3 km

05 MHz

Radar λ : 60m

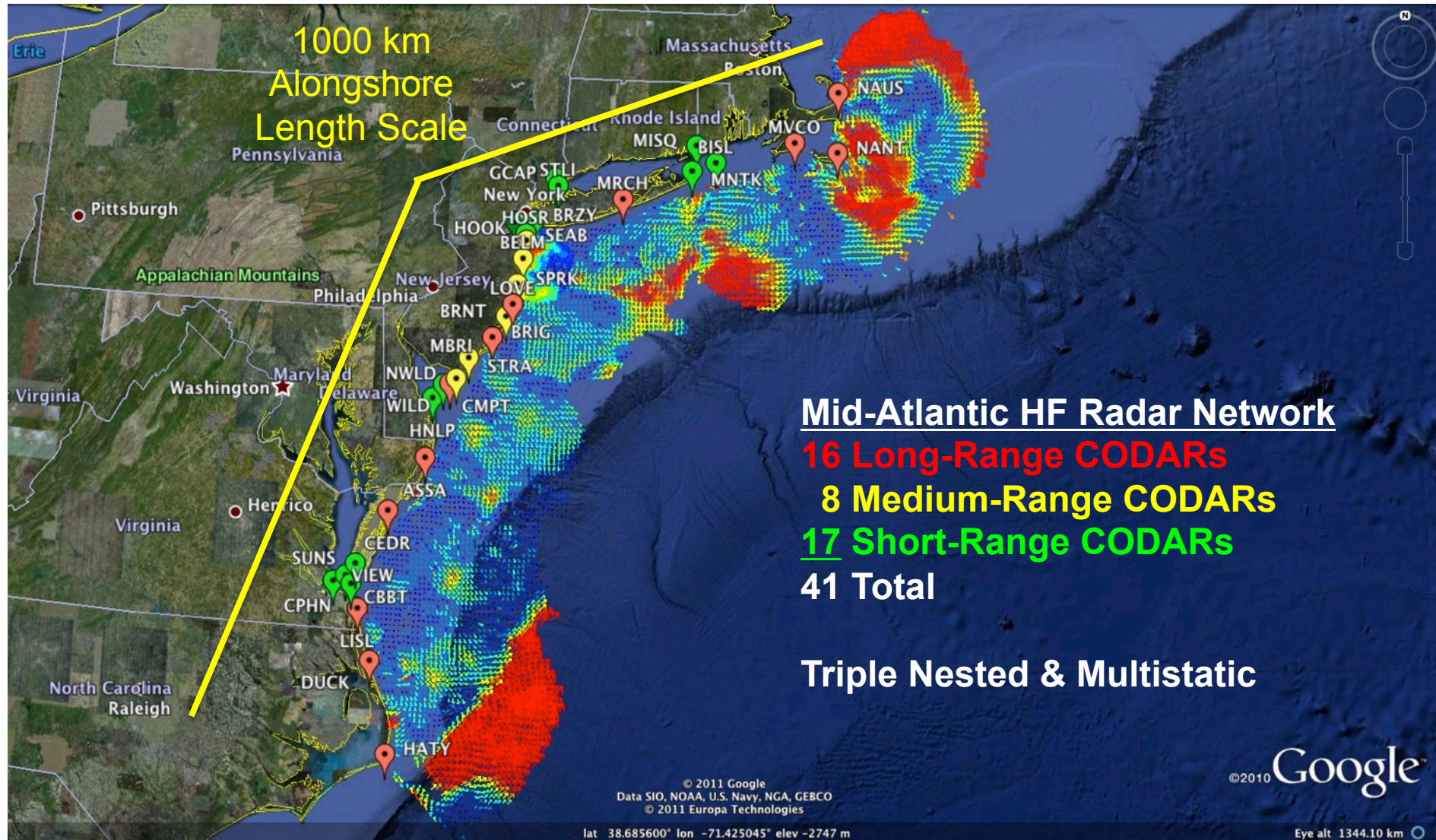
Range: 180 km

Ocean λ : 30 m

Resolution: 6 km

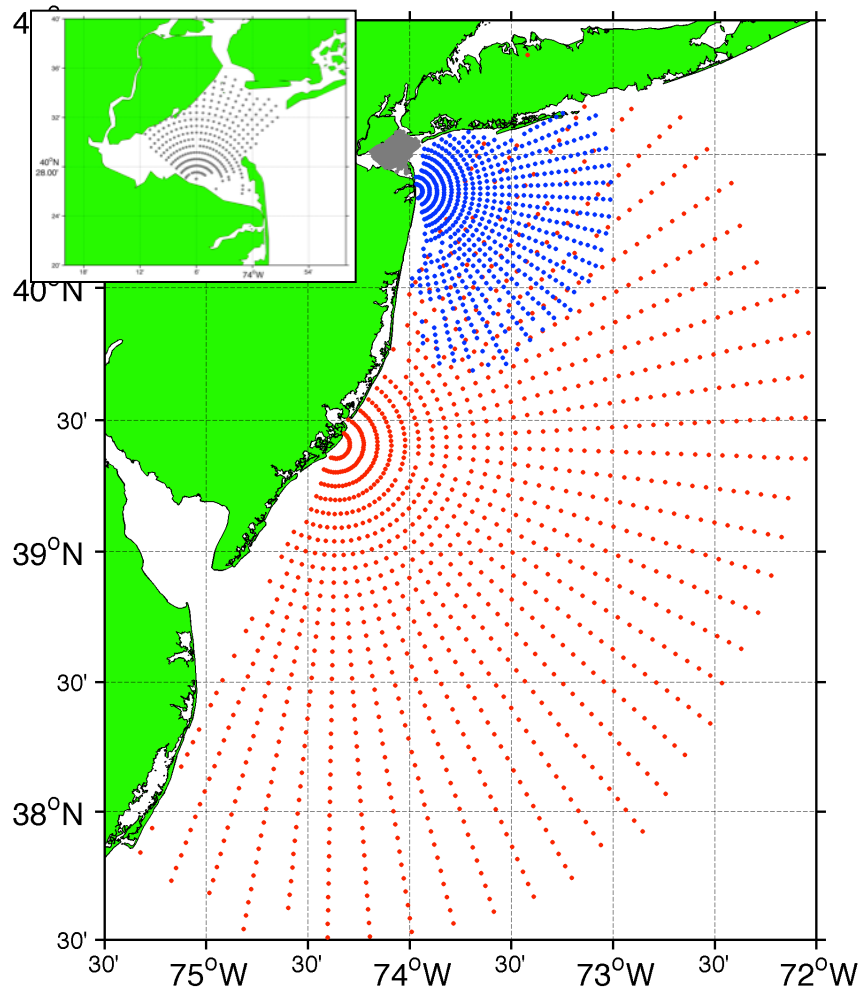


Mid-Atlantic Bight HF Radar Network



The Center for Secure and Resilient Maritime Commerce (CSR)

Vessel Detection Capability



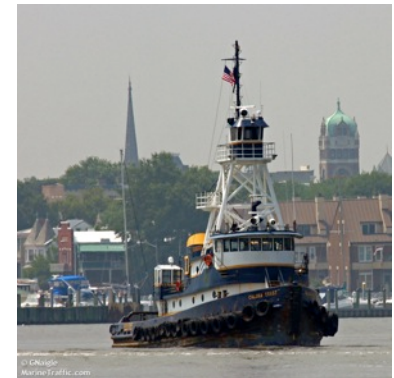
25 MHz

Range: 11 nmi
Height >10 ft



13 MHz

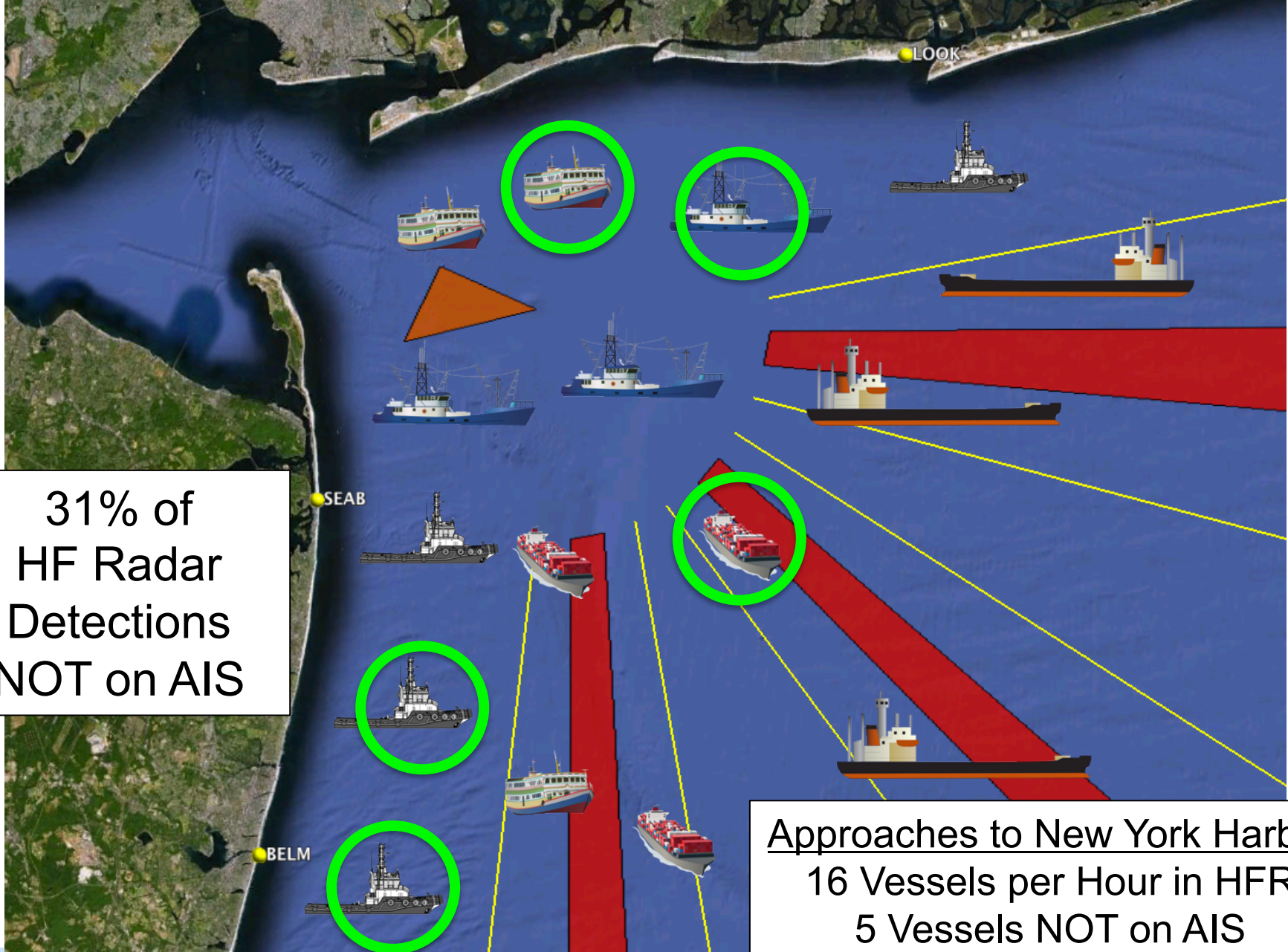
Range: 43 nmi
Size: >19 ft



05 MHz

Range: 65 nmi
Size: >49 ft





31% of
HF Radar
Detections
NOT on AIS

Approaches to New York Harbor
16 Vessels per Hour in HFR
5 Vessels NOT on AIS



Transition Success Stories – Making a Difference

Optimizing HF Radar for SAR using USCG Surface Drifters



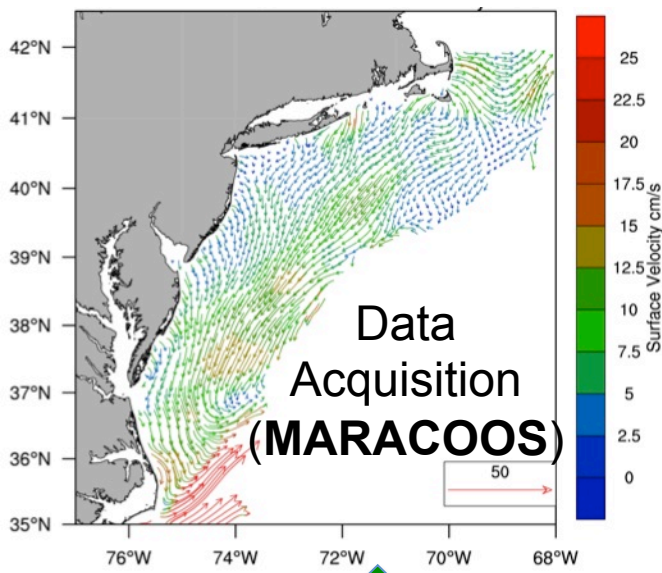
Art Allen
U.S. Coast Guard

Scott Glenn
Rutgers University

Mid-Atlantic Regional Association
Coastal Ocean Observing System



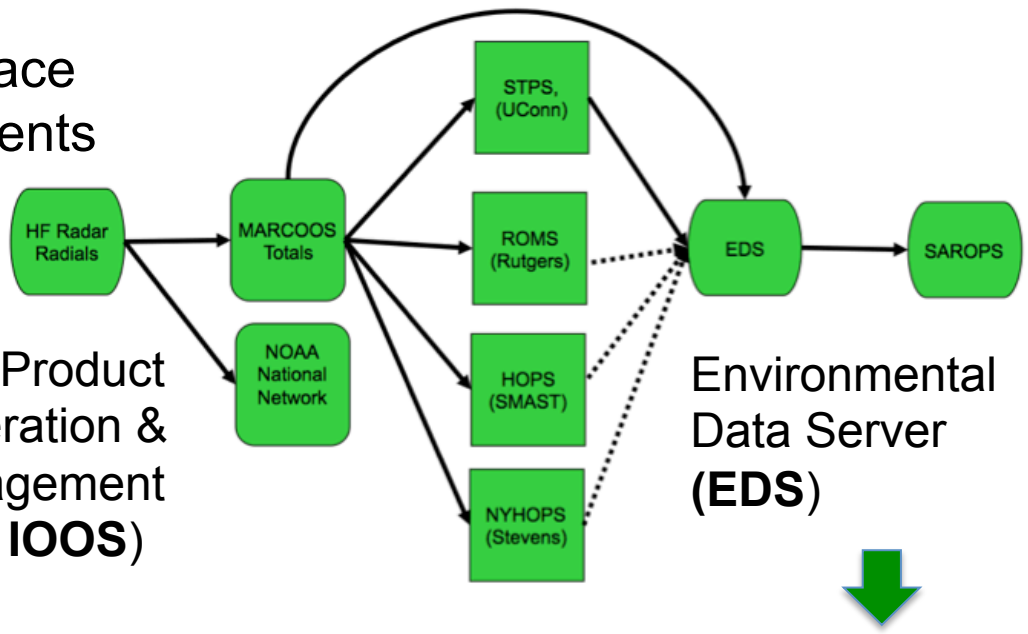
Transition Objective – Operational Use of HF Radar Surface Currents for Search And Rescue



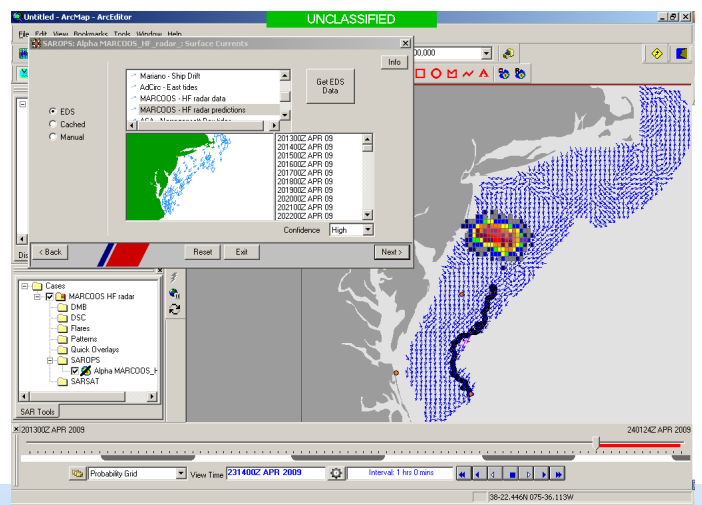
Surface Currents



Data Product Generation & Management (U.S. IOOS)



Search And Rescue Optimal Planning System (SAROPS)

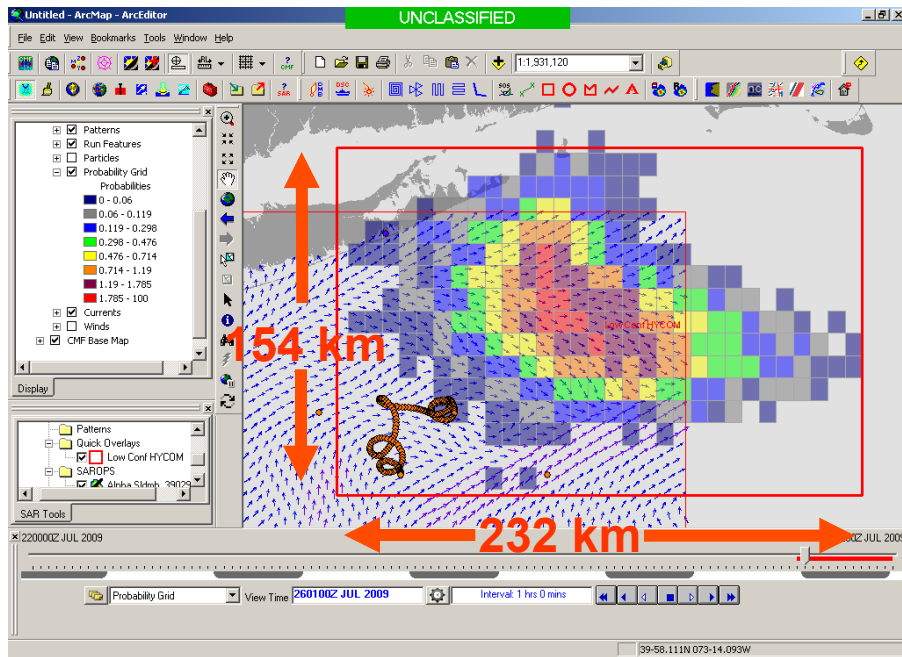


The Center for Secure and Resilient Maritime Commerce (CSR)



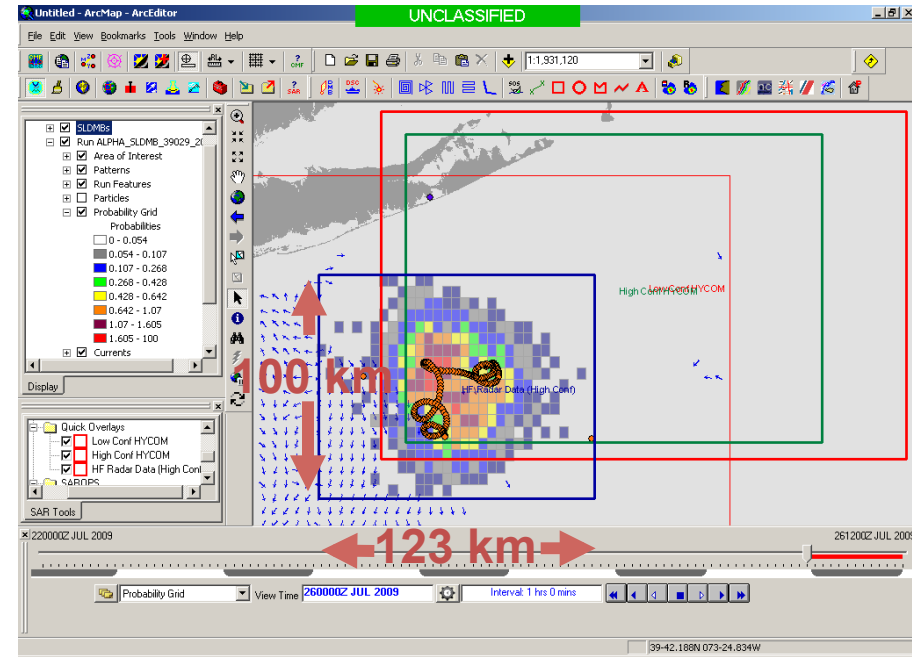
SAROPS Test Case

5000 Virtual Drifters +
1 Real Drifter (Black Line):
Search Area After 96 Hours



HYCOM

36,000 km²



CODAR

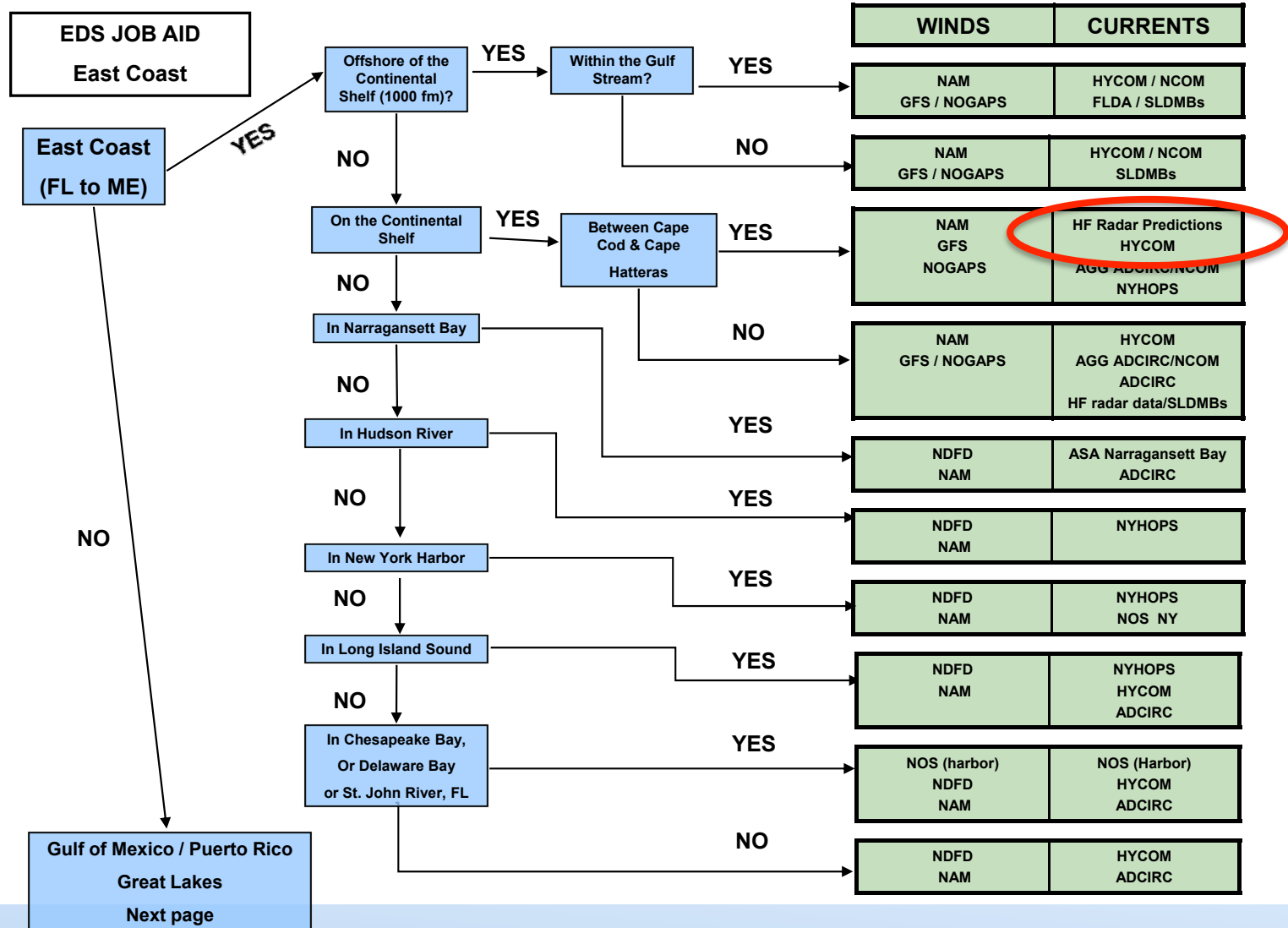
12,000 km²



The Center for Secure and Resilient Maritime Commerce (CSR)

Environmental Data Server (EDS) & SAROPS

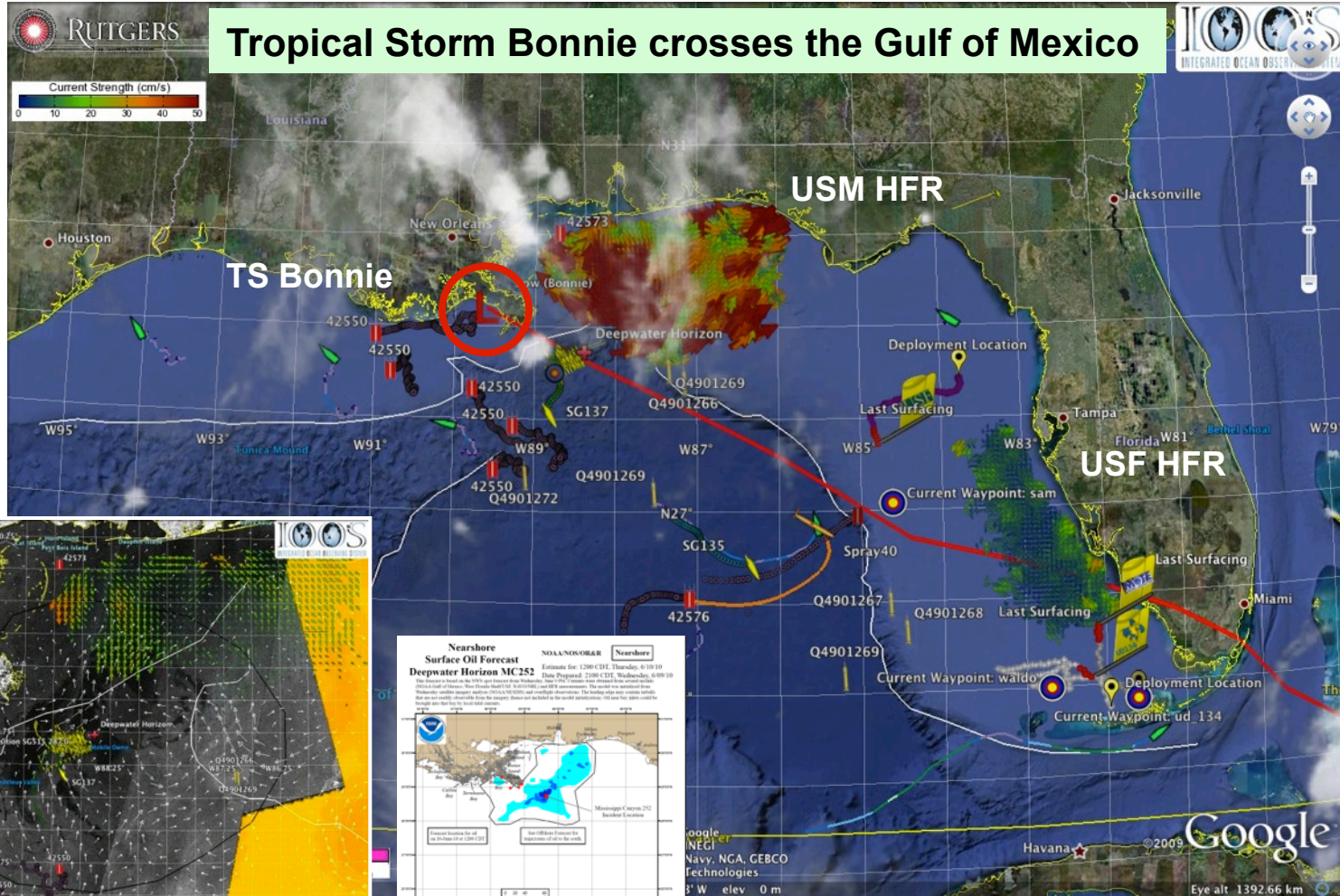
Operational May 4, 2009



IOOS Coordinated Rapid Response: *Deepwater Horizon Oil Spill*

Contributed Assets:

- HF Radar Networks
 - USF, USM
- Gliders
 - iRobot, Mote, Rutgers, SIO/WHOI, UDeI, USF
- Drifters & Profilers
 - Horizon Marine, Navy
- Satellite Imagery
 - CSTARS, UDeI
- Ocean Forecasts
 - Navy, NCSU
- Data/Web Services
 - ASA, Rutgers, SIO

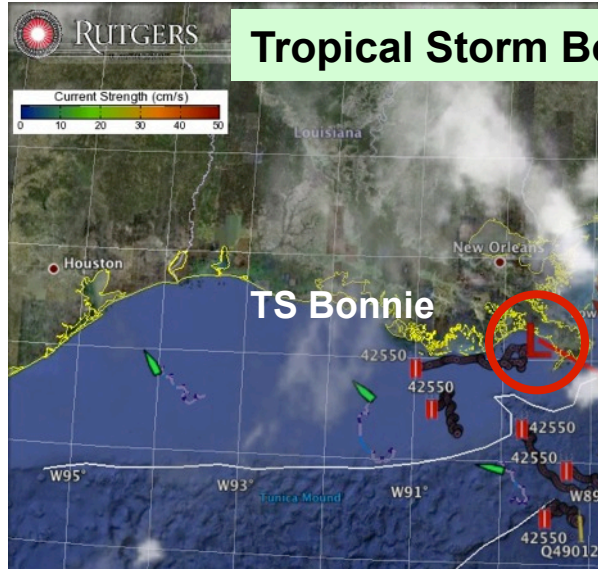


The Center for Secure and Resilient Maritime Commerce (CSR)

IOOS Coordinated Rapid Response: *Deepwater Horizon Oil Spill*

Contributed Assets:

- HF Radar Networks
USF, USM
- Gliders
iRobot, Mote, Rutgers, SIO/WHOI, UDel, USF
- Drifters & Profilers
Horizon Marine, Navy
- Satellite Imagery
CSTARS, UDel
- Ocean Forecasts
Navy, NCSU
- Data/Web Services
ASA, Rutgers, SIO





S&T Impact Award

Center for Secure and Resilient Maritime Commerce (CSR)

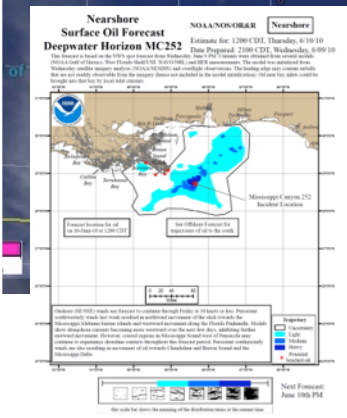
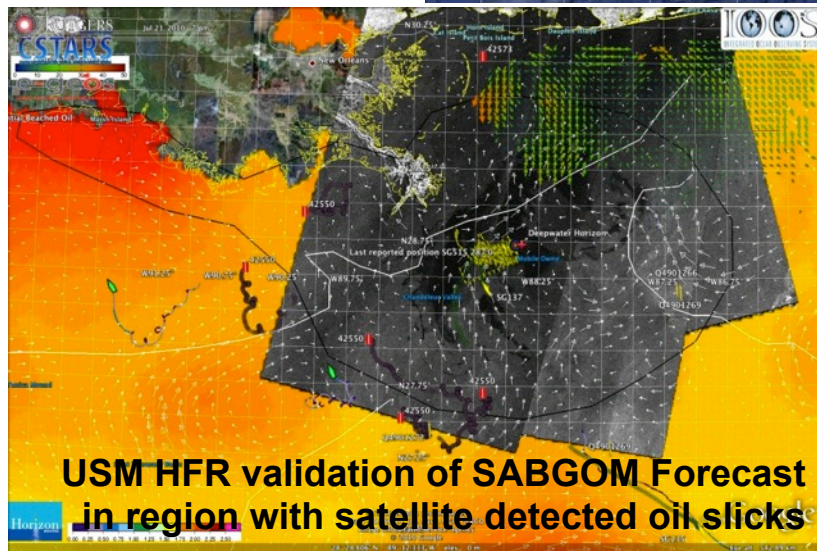
Rapid Response to the Gulf of Mexico Oil Spill

The DHS Center for Secure and Resilient Maritime Commerce (CSR) at the Stevens Institute of Technology (SIT) provided the U.S. Coast Guard and other stakeholders with data and analysis, which quickly became central to the Federal Government's coordinated response to the Deepwater Horizon Oil Spill in the Gulf of Mexico. Three research labs, all partners with the Center, at the University of Miami, Rutgers University and SIT, provided surface and underwater monitoring of the oil spill using space-based surveillance, ground-based High Frequency Radar and underwater gliders. The basic image data was used to generate daily maps, keep track of the spill and support forecasts of the spread and landfall of oil along the coastline and wetlands.

Matthew Clark

Matthew Clark, Ph.D.
Director, University Programs
Science and Technology Directorate
Department of Homeland Security

March 30, 2011



HFR used for Oil Slick Forecasts by NOAA/NOS/OR&R



The Center for Secure and Resilient Maritime Commerce (CSR)

WRITTEN STATEMENT OF
JANE LUBCHENCO, Ph.D.
UNDER SECRETARY OF COMMERCE FOR OCEANS AND ATMOSPHERE
AND NOAA ADMINISTRATOR
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

ON THE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION'S
FY 2012 BUDGET REQUEST
BEFORE THE
COMMITTEE ON NATURAL RESOURCES
SUBCOMMITTEE ON FISHERIES, WILDLIFE, OCEANS, AND INSULAR AFFAIRS
U.S. HOUSE OF REPRESENTATIVES

March 31, 2011

From Page 10:

Also in support of oil spill response, NOAA requests a **\$5.0 million** increase to implement the U.S. Integrated Ocean Observing System (IOOS®) **Surface Current Mapping Plan** using high frequency (HF) radar surface current measurements. HF radar provides information vital to oil spill response, national defense, homeland security, search and rescue operations, safe marine transportation, water quality and pollutant tracking, and harmful algal bloom forecasting.

www.legislative.noaa.gov/Testimony/Lubchenco033111.pdf

**U.S. National
HF Radar
Network**

\$5 M First Year Investment
\$20 M/Year for 5 Years for Full Buildout

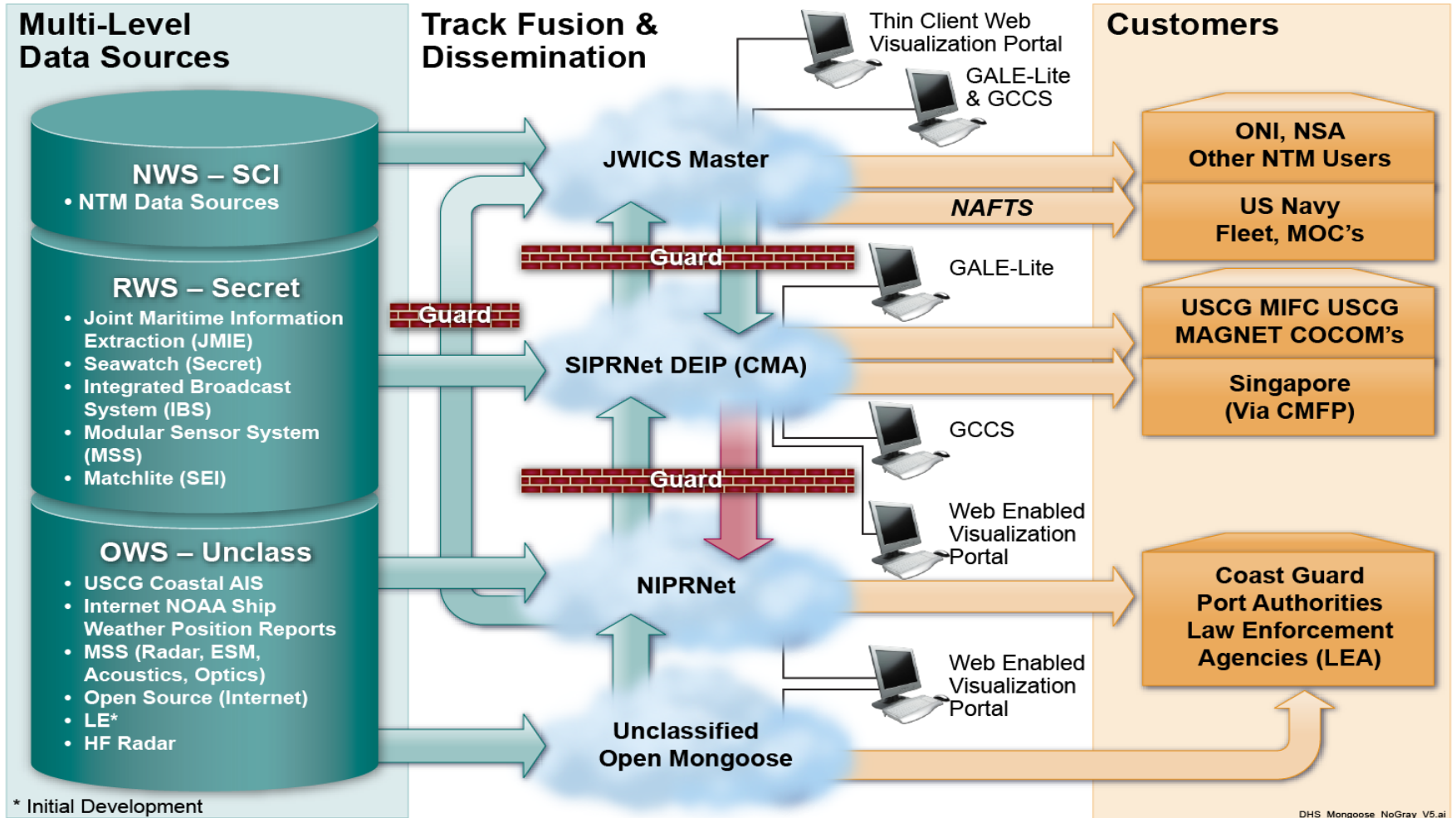


Summer
2011 Coverage
131 Radars

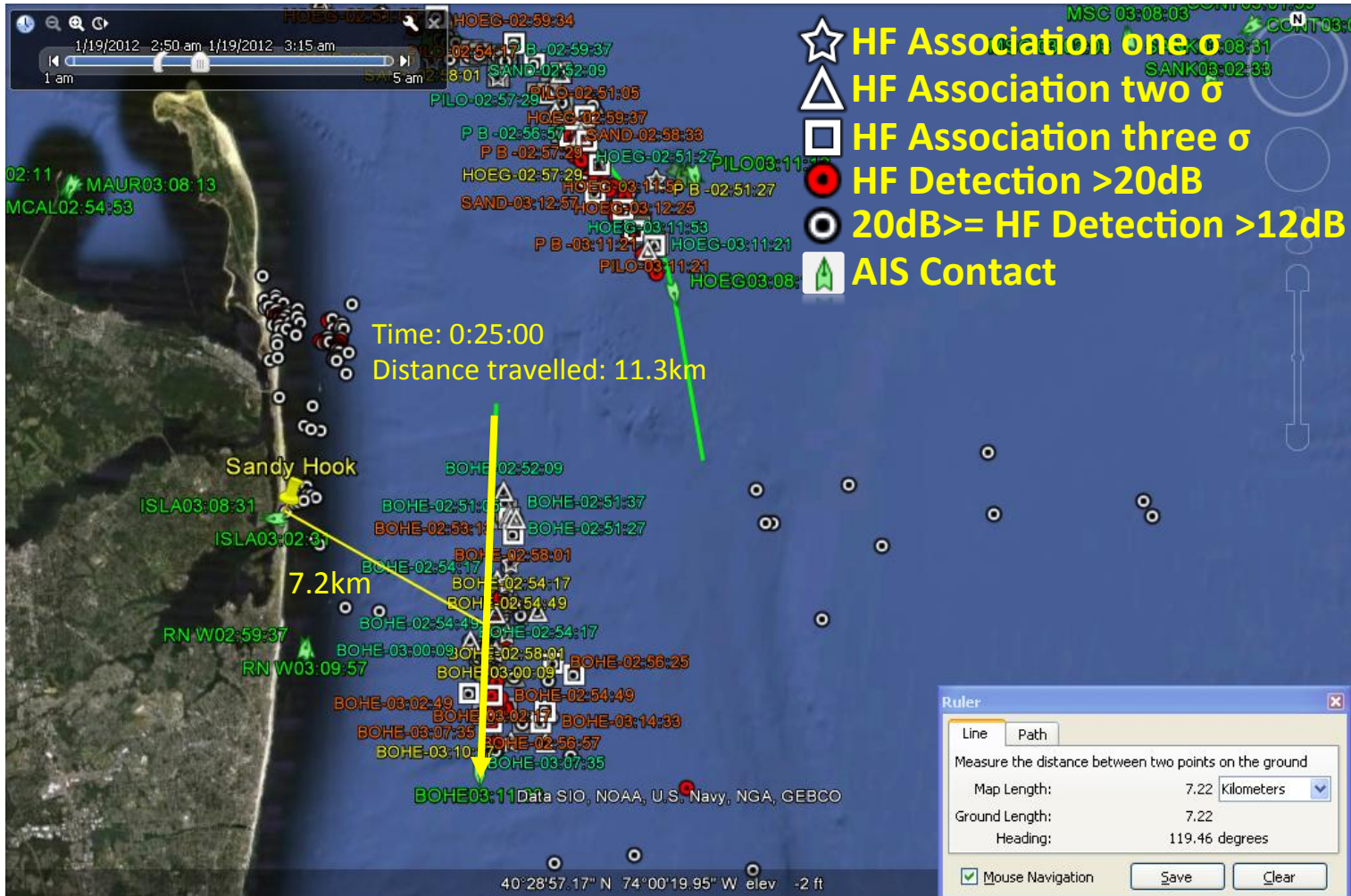


Multi-Level Access and Information Sharing with Open Mongoose (MDA CONOP)

(U) Multi-Level Enclaves Provide Appropriate Level Data to Customers



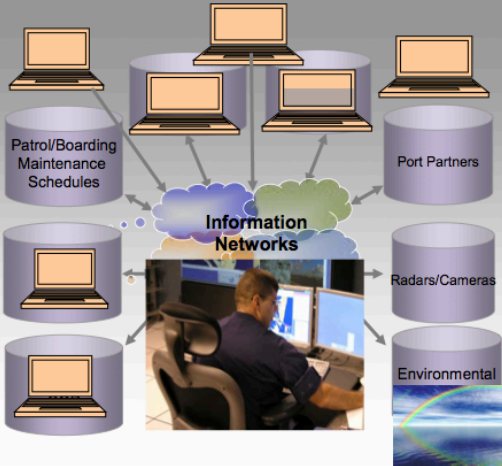
Bohemia AIS Track SNR>9



AIS Bohemia Velocity Range: 10.3KTS up to 10.4KTS. Several HF Radar detections associated by one, two and three standard deviations, Radar Characteristics: SNR>9, Distance from radar when tracked: 7.2 km



Watchkeeper



Today

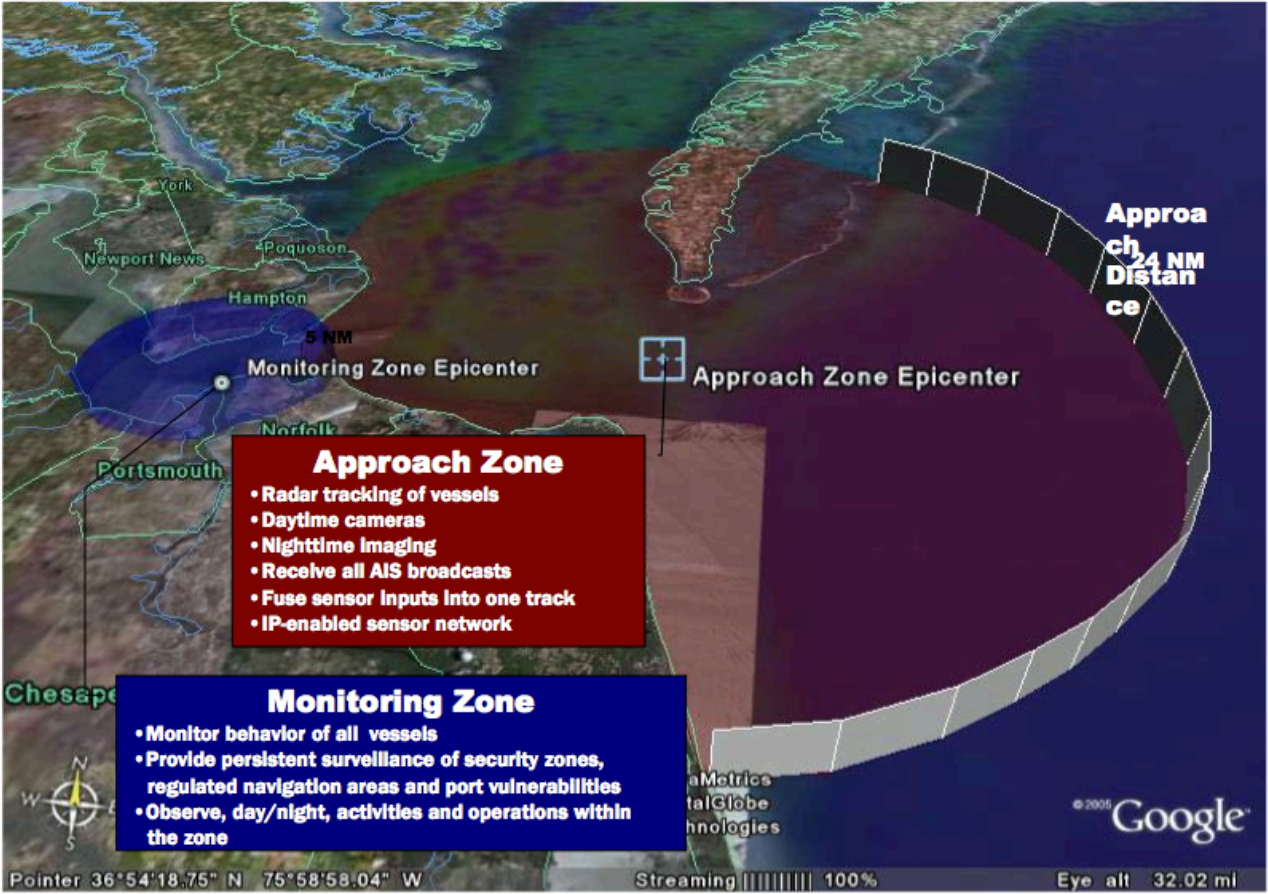
Operator is the Integrator

WatchKeeper



Tomorrow

Operator is the Evaluator

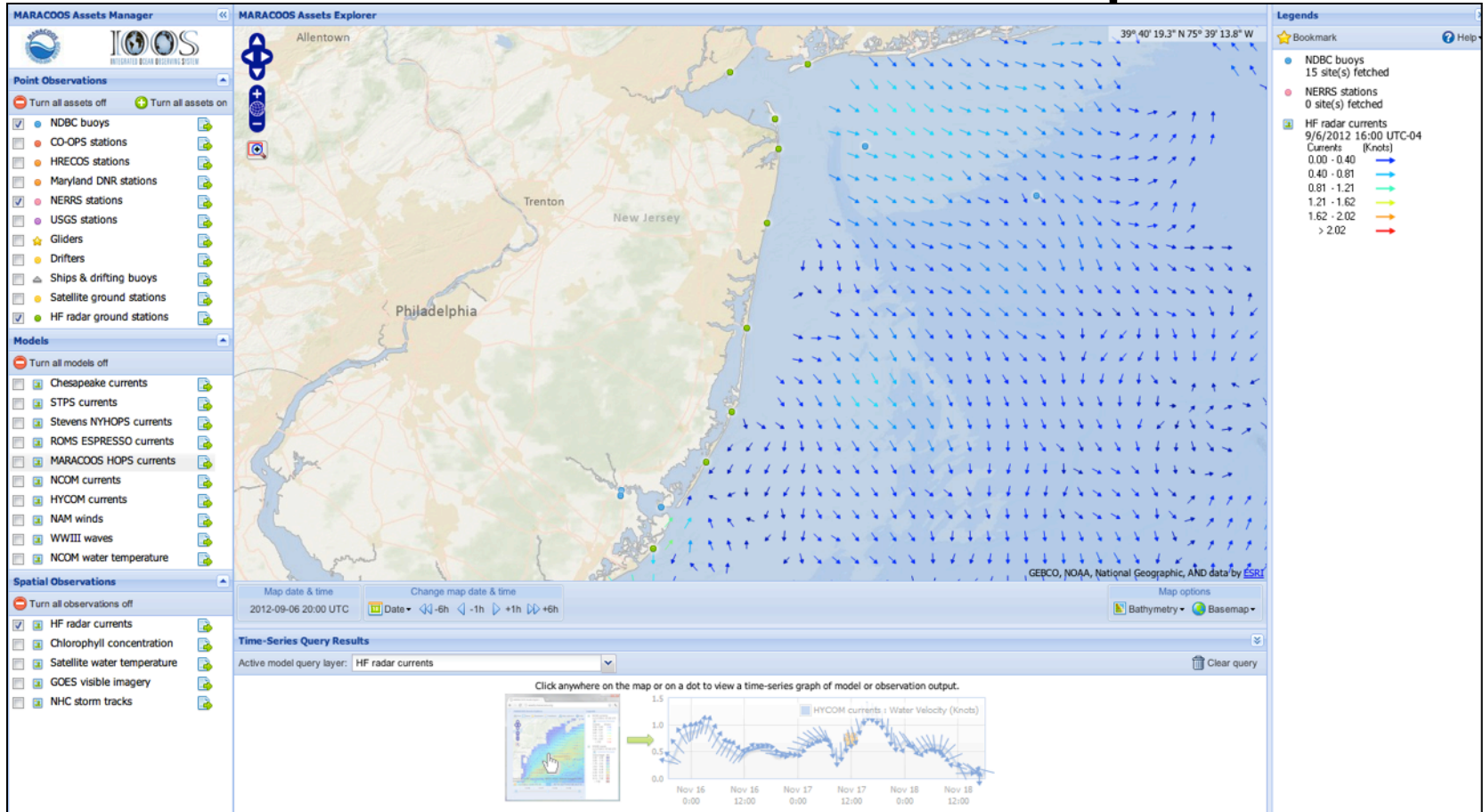


Watchkeeper pulls data from EDS



The Center for Secure and Resilient Maritime Commerce (CSR)

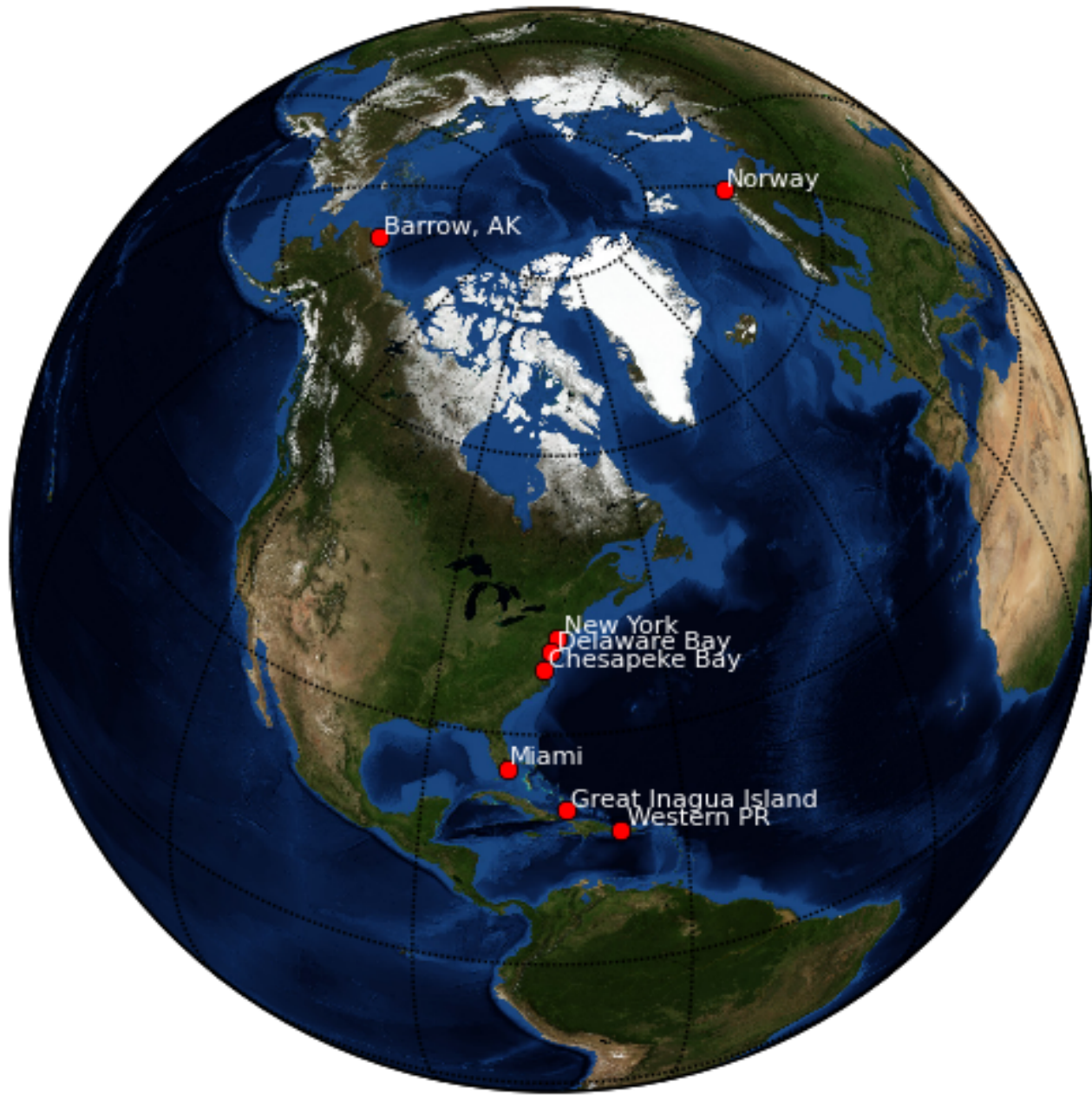
U.S. Integrated Ocean Observing System: Interactive Asset Map



Comprehensive General Purpose and User Specific Versions



The Center for Secure and Resilient Maritime Commerce (CSR)



Vessel Tracking Research Areas

Current Testbeds

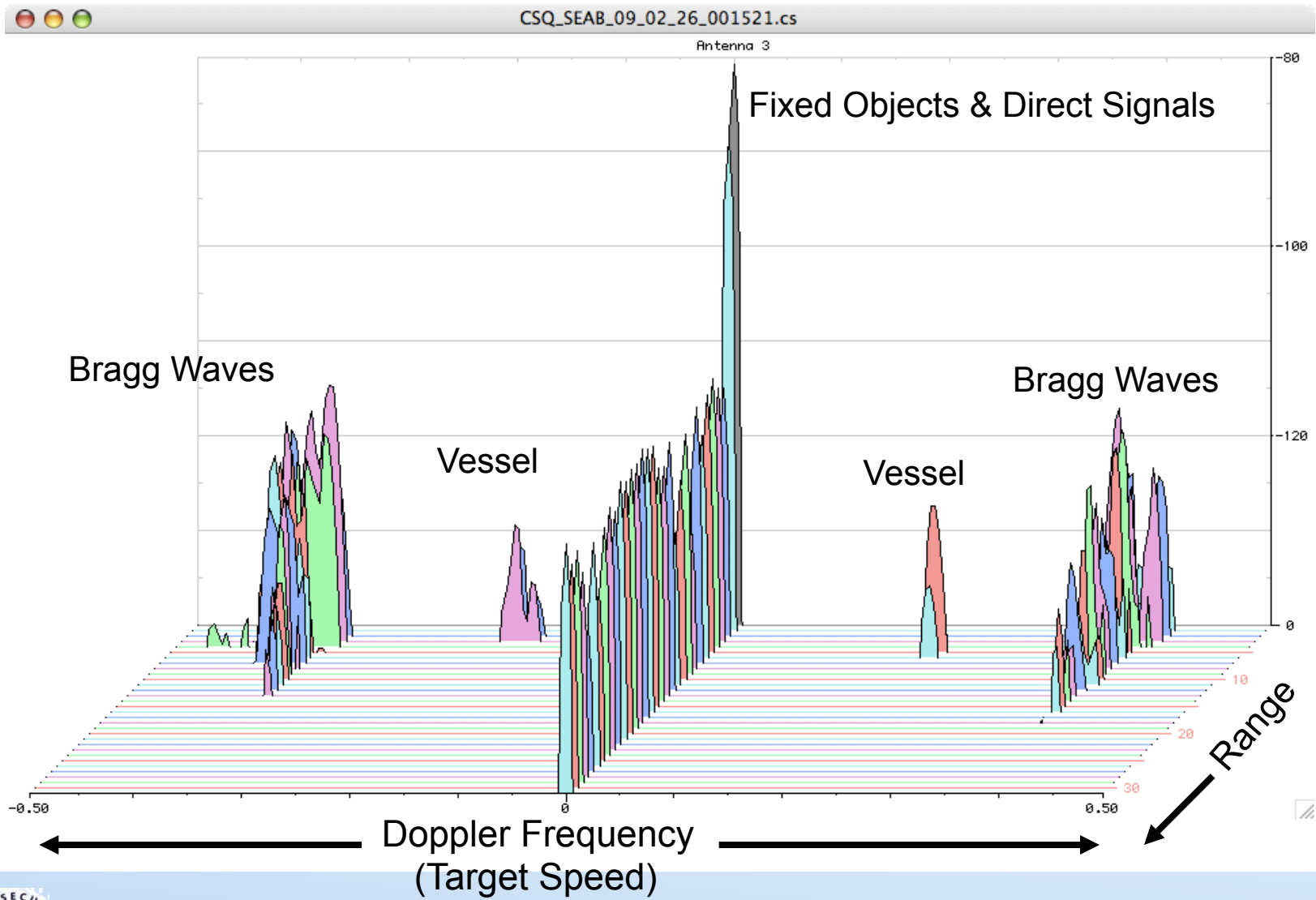
New York Harbor
Delaware Bay
Chesapeake Bay
Port of Miami
Western Puerto Rico
Barrow Alaska

Proposed Testbeds

Great Inagua
Norway
San Diego

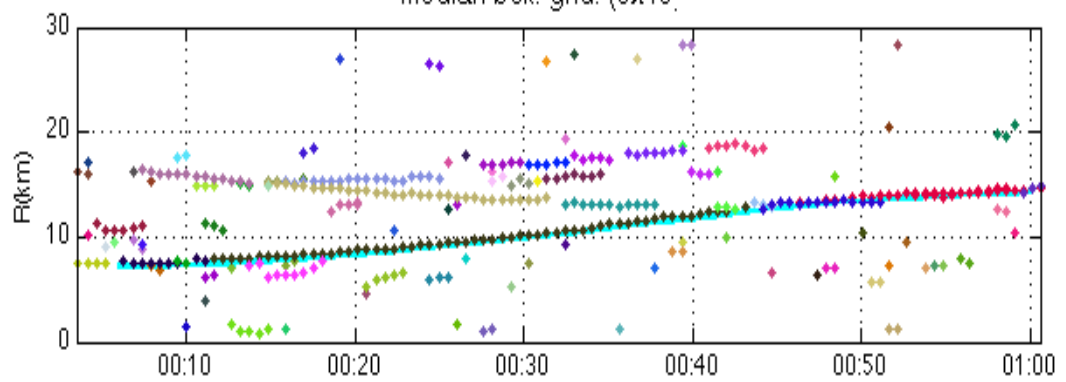


Doppler Spectra from all Range Cells with Detection Threshold above Background Applied



**Median Method FFT
256 Threshold 11 dB**

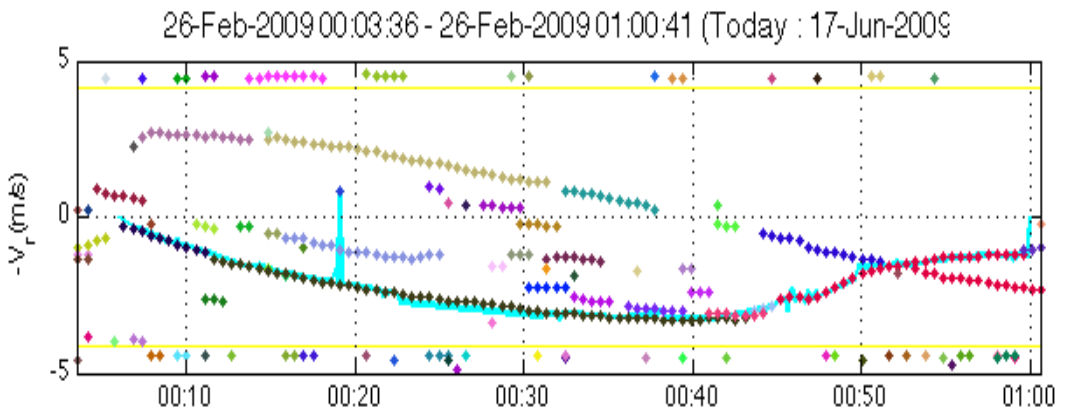
**Range
(km)**



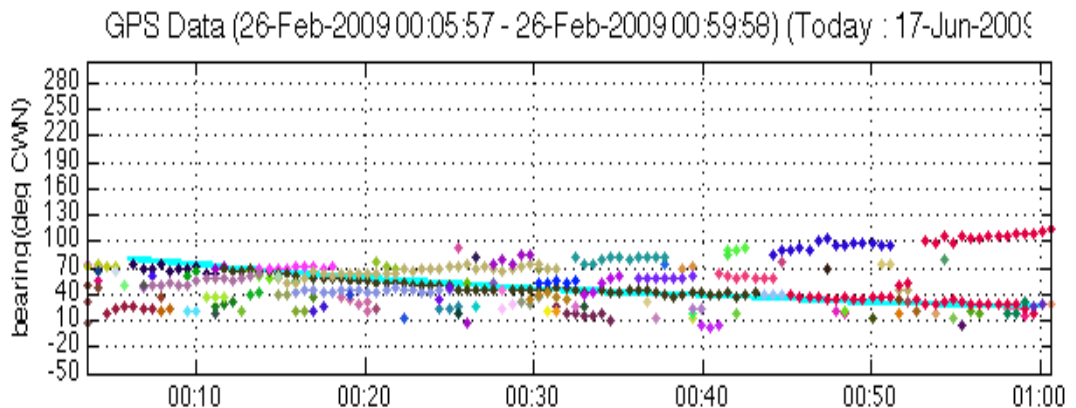
**Step 1
Raw Detections
From each HFR:**

1. Radial Velocity (most accurate)
2. Range
3. Bearing (least accurate)

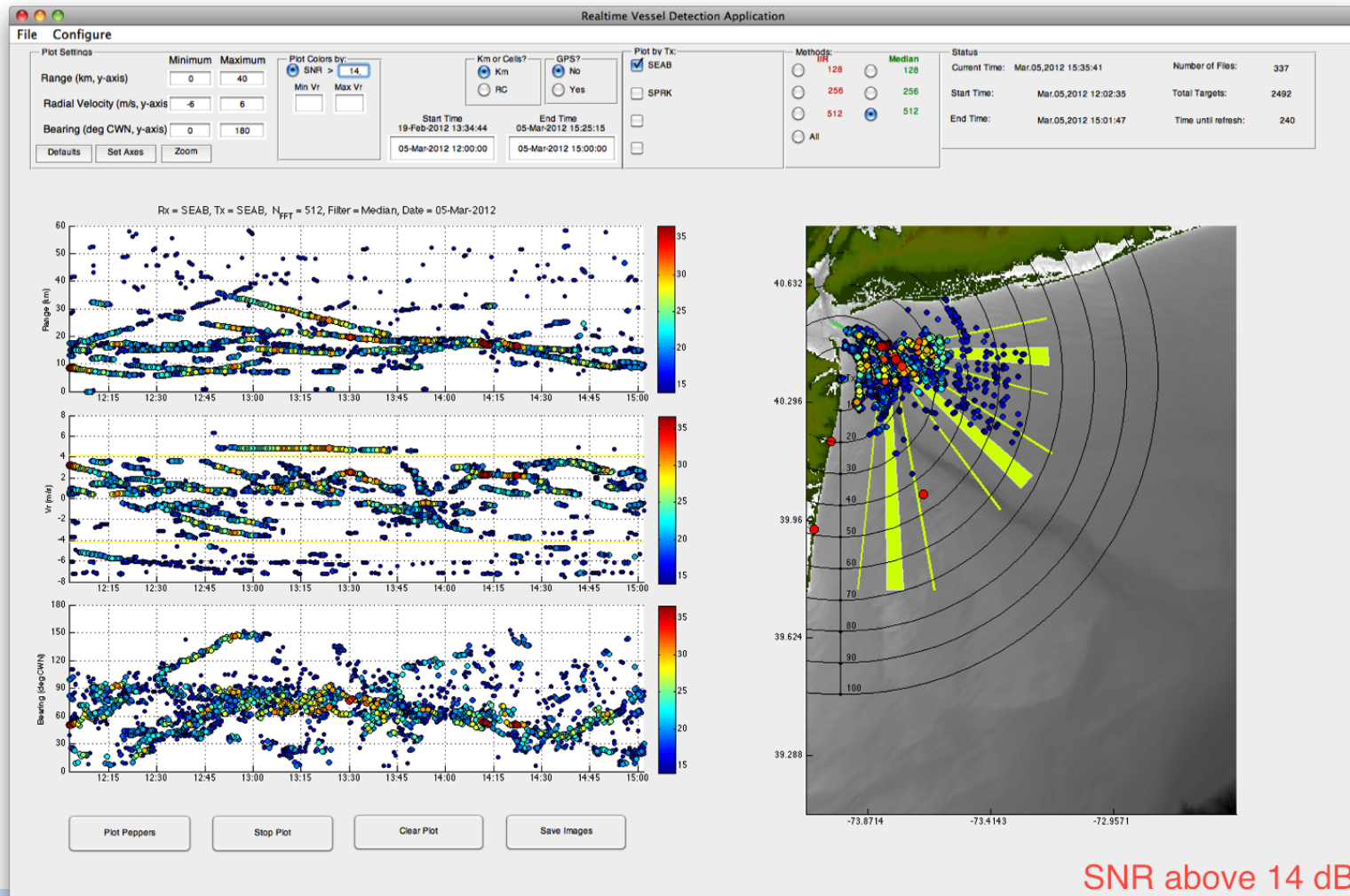
**Radial
Velocity
(m/s)**



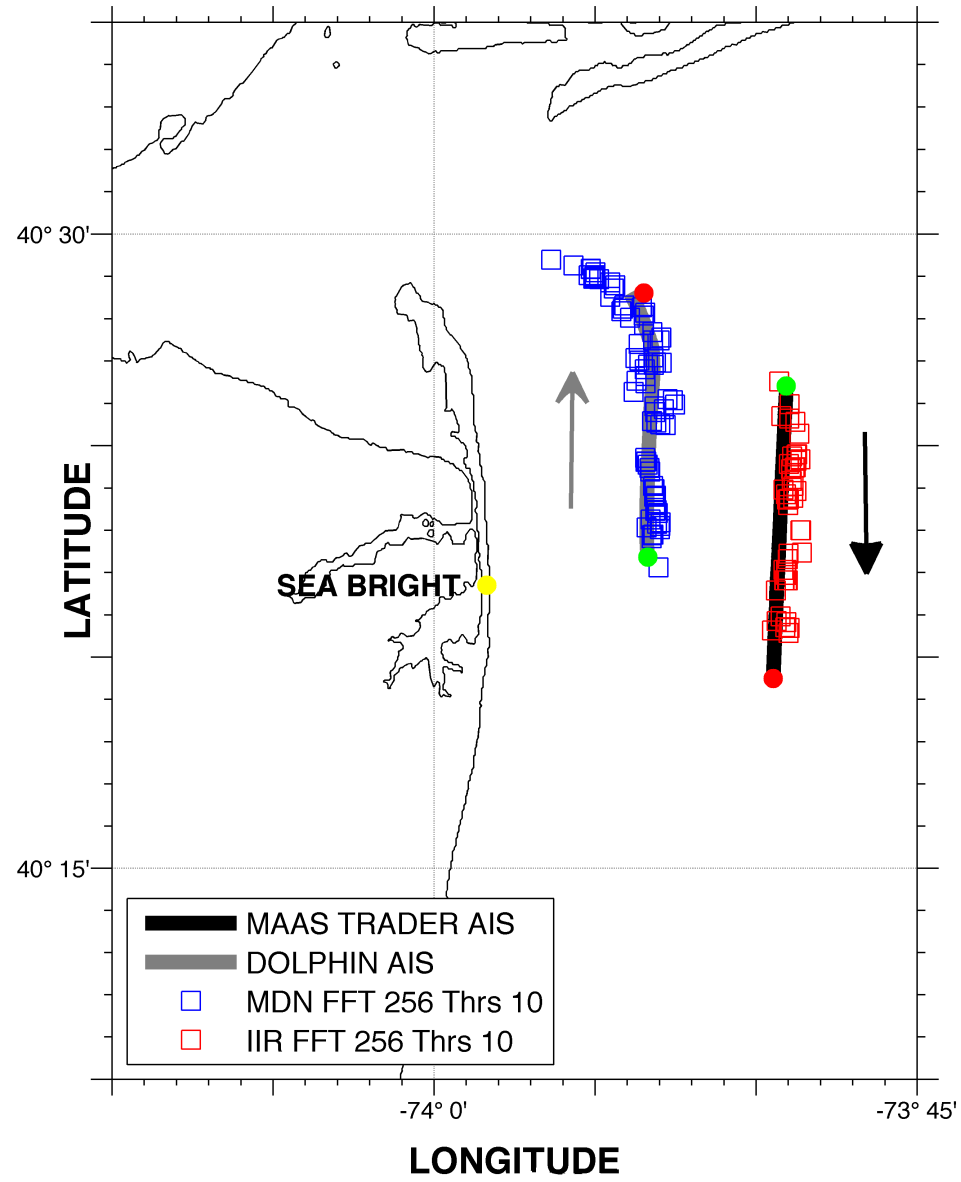
**Bearing
(°CWN)**



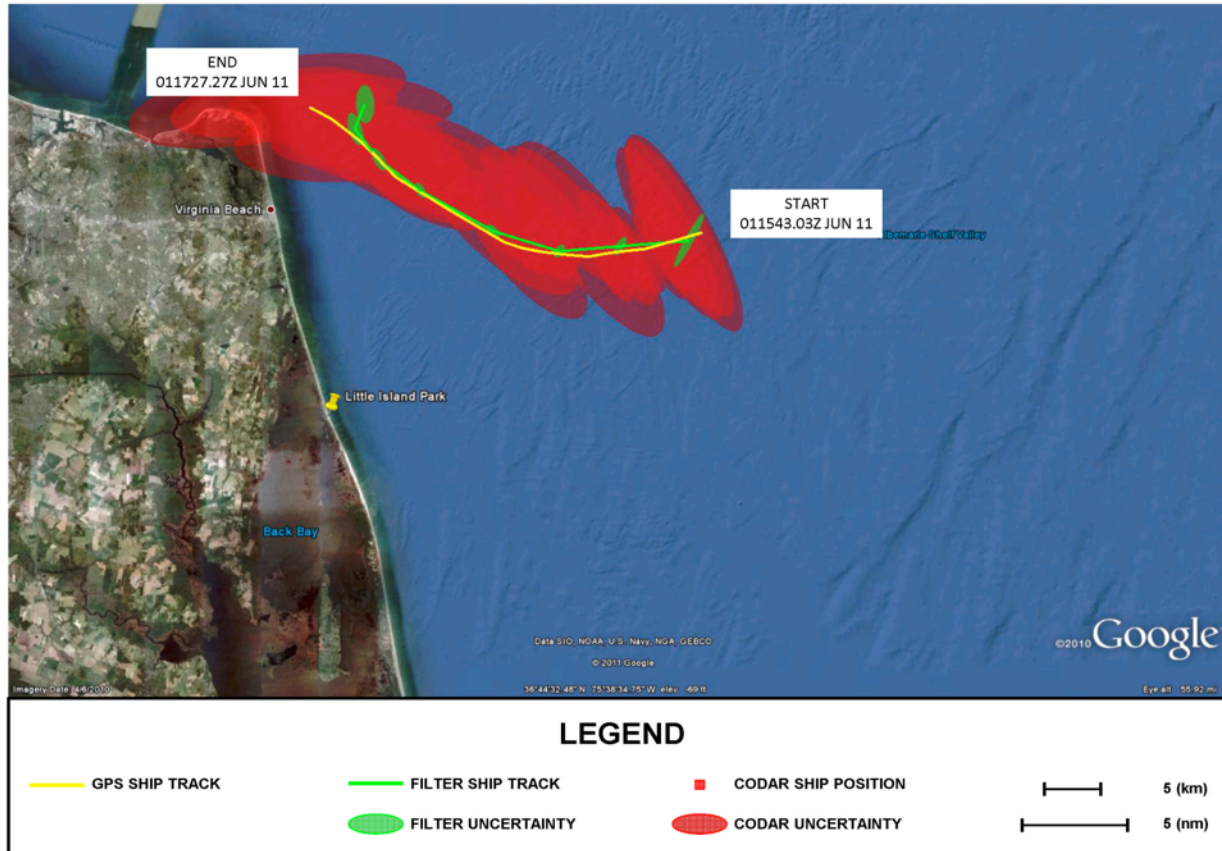
Adjusting the Signal to Noise



Step 2 Association: TRACK OF MAAS TRADER and DOLPHIN



Step 3 Track Fitting: M/V Victorious



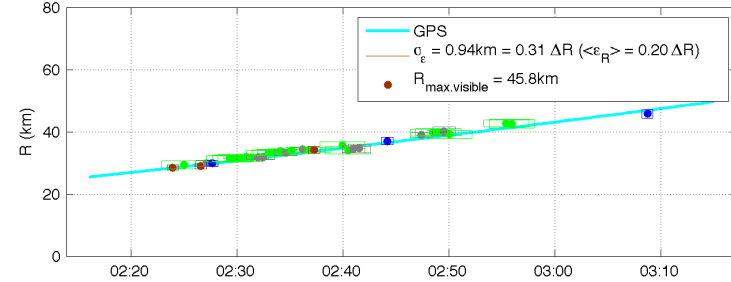
M/V VICTORIOUS: GPS Track, CODAR Data, and Ship Tracker Solution with Uncertainty Ellipses



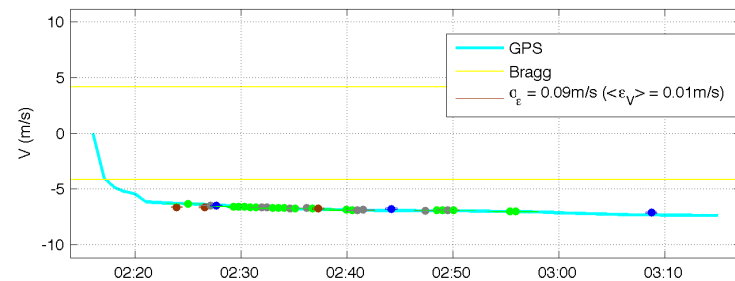
CSR Tropical HF Radar Testbed



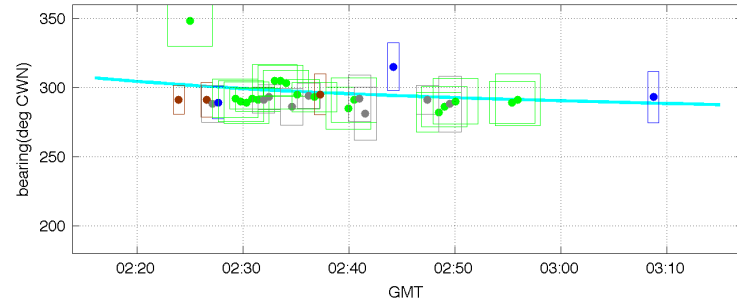
Rx : CDDO, 6 trg.dir's (08-Nov-2012 02:16:00 - 08-Nov-2012 03:15:00)



update interval = 32 sec (Today : 09-Jan-2013)



Detection Rate = 29.5%, RMSerr = 11.5° (8.3° excluding outliers), Mean Error = -2.6°

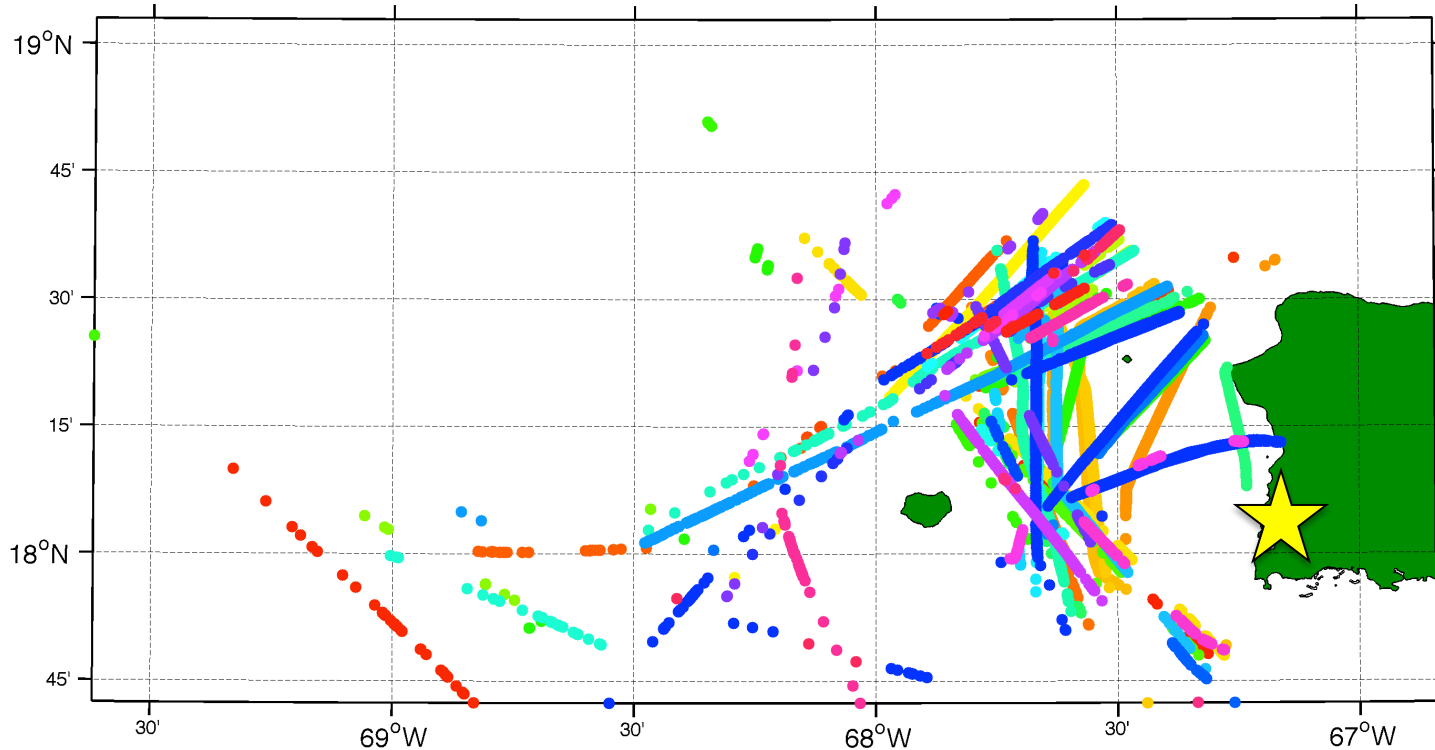


Detections of CGC Cushing



CSR Tropical HF Radar Testbed

AIS Data November 4 -9, 2012



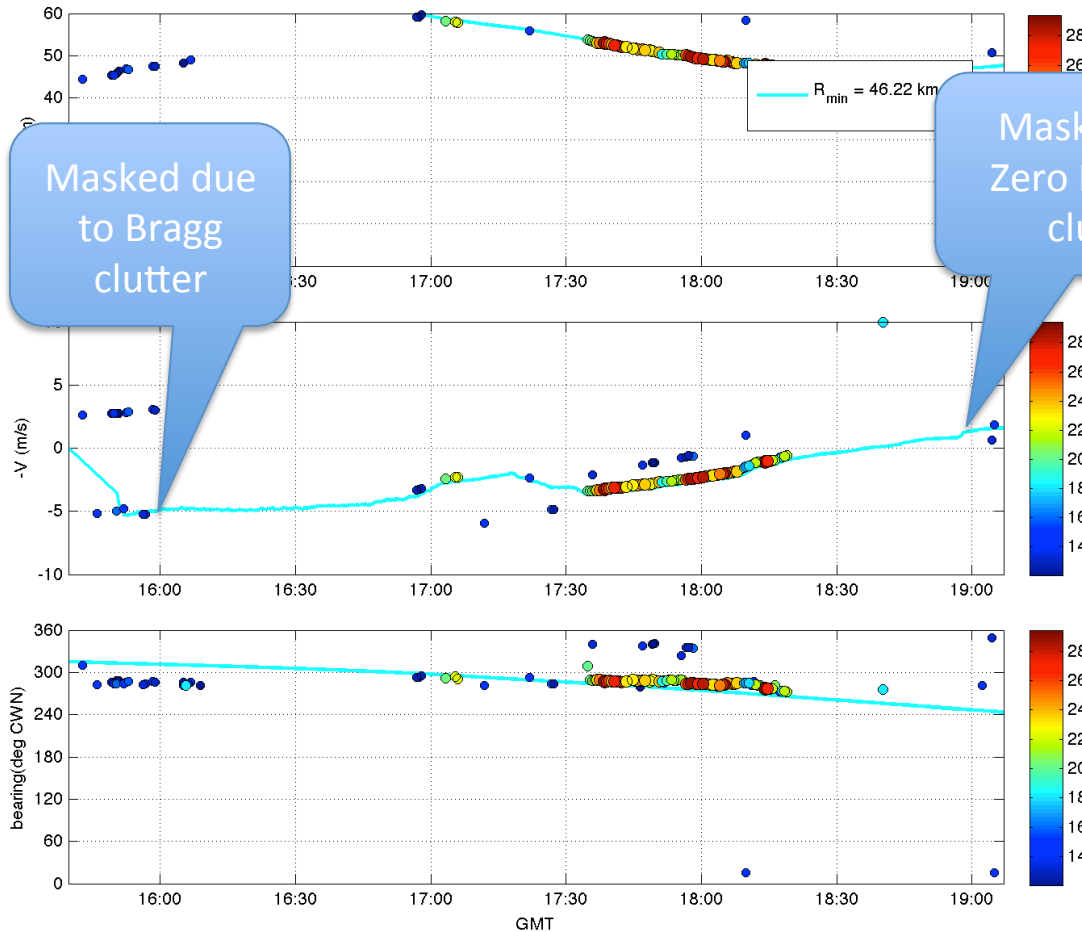
84 vessels captured on AIS
36 vessels within 100 km of the radar station
23 vessels detected by the radar that were on AIS
13 vessels detected by the radar NOT on AIS



Basilica Duckling Detections

Rx = CDDO, $N_{FFT} = 256$, threshold = 12dB, MMSI = "352179000"

Date = 08-Nov-2012



- Detected for ~ 1 hour
- Detected out to 46 km



CSR High Latitude HF Radar Testbed

Objective:

Test the capability of the SeaSonde HF Radar as a detection and surveillance sensor at high latitudes in anticipation of the polar ice cap melting and the increased usage of the Northwest Passage.

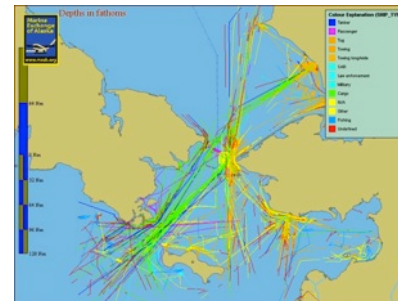
Sponsor:



Participants:



Northwest passage routes

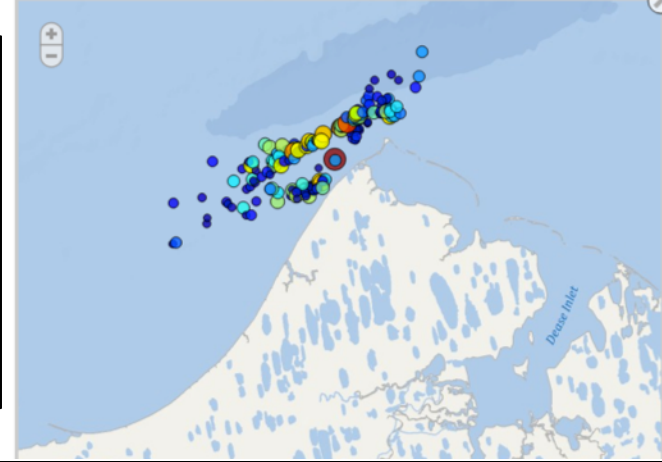


AIS traffic near Barrow, AK

Remote Power Module



Point Barrow Detections



Data Selection

Site:

Background:

FT Length:

Threshold:

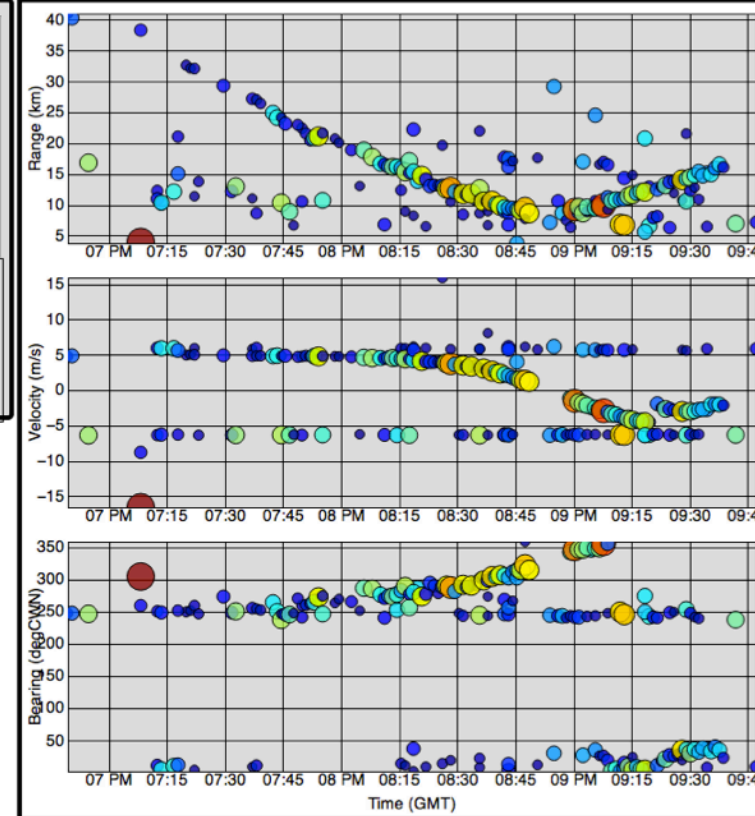
Start Time:

End Time:

Sort/Size by:

- SNR3 (km)
- RCS (dBSm)
- Range (km)
- Velocity (m/s)
- Bearing (deg CWN)

All AIS
vessels
detected.
Range to
70 km.



CSR Ship Detection Visualizer

Data Selection

Site: SEAB **A**

Background: IIR

FFT Length: 512

Threshold: 18

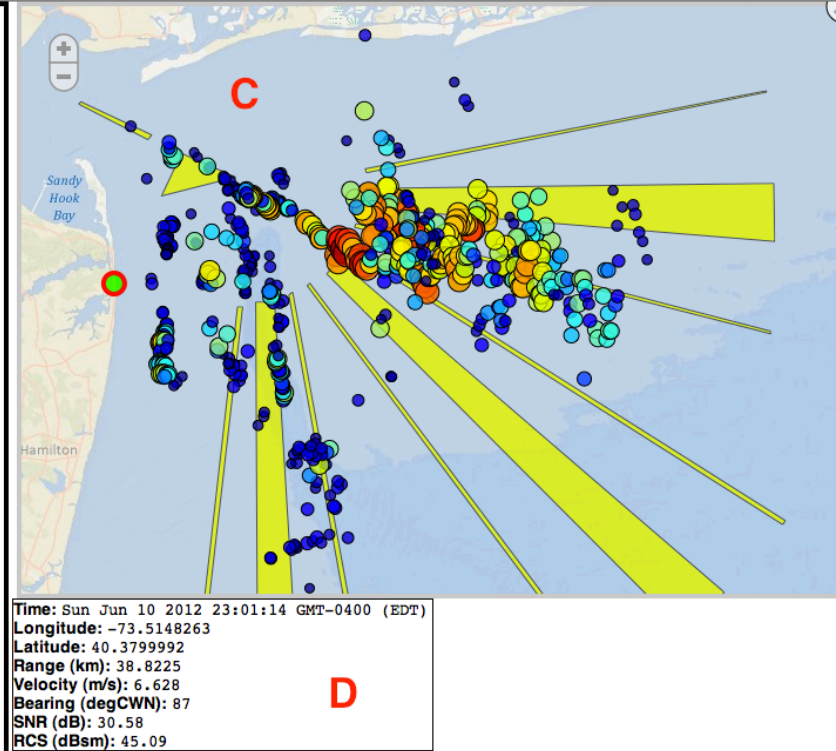
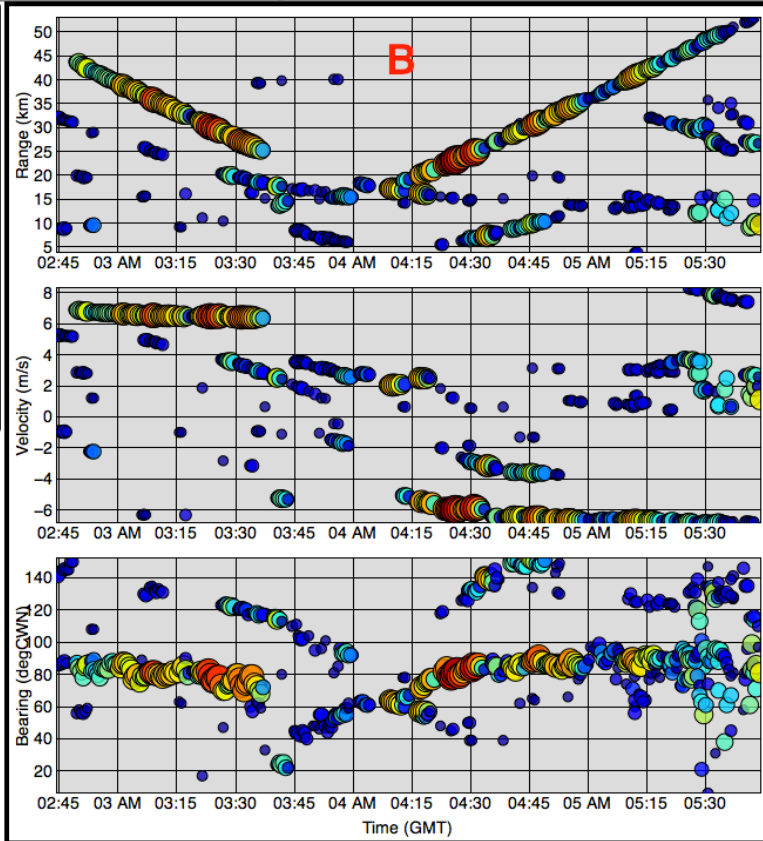
Start Time: 2012-06-11 02:44

End Time: 2012-06-11 05:44

Get Detections

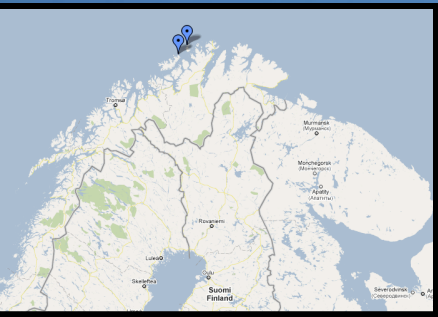
Color/Size by:

- SNR3 (km)
- RCS (dBsm)
- Range (km)
- Velocity (m/s)
- Bearing (deg CWN)



Rapid Response Capability

- Self Contained
- Transportable
- Propane generator
- Satellite Communications



The Center for Secure and Resilient Maritime Commerce (CSR)