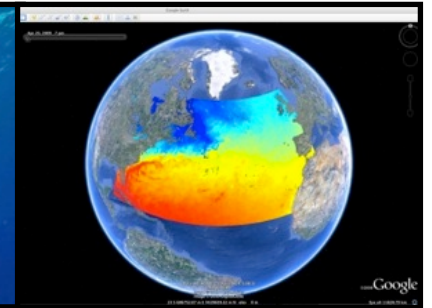
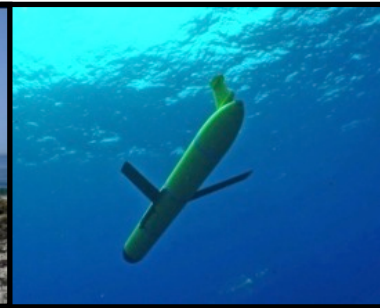
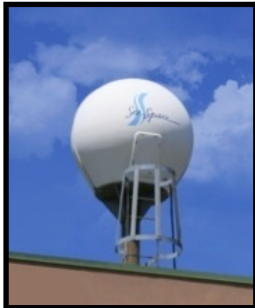


Rutgers University

Coastal Ocean Observation Lab

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

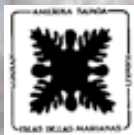


Satellite Data Acquisition Stations

CODAR Network

Glider Fleet

3-D Forecasts



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 –

Tom Weingarter, Hank Statscewich

Ocean Power Technologies –

Debbie Montagna, Bruce Downie

Naval Research Laboratory

Michael Lovellette, Dan Newton

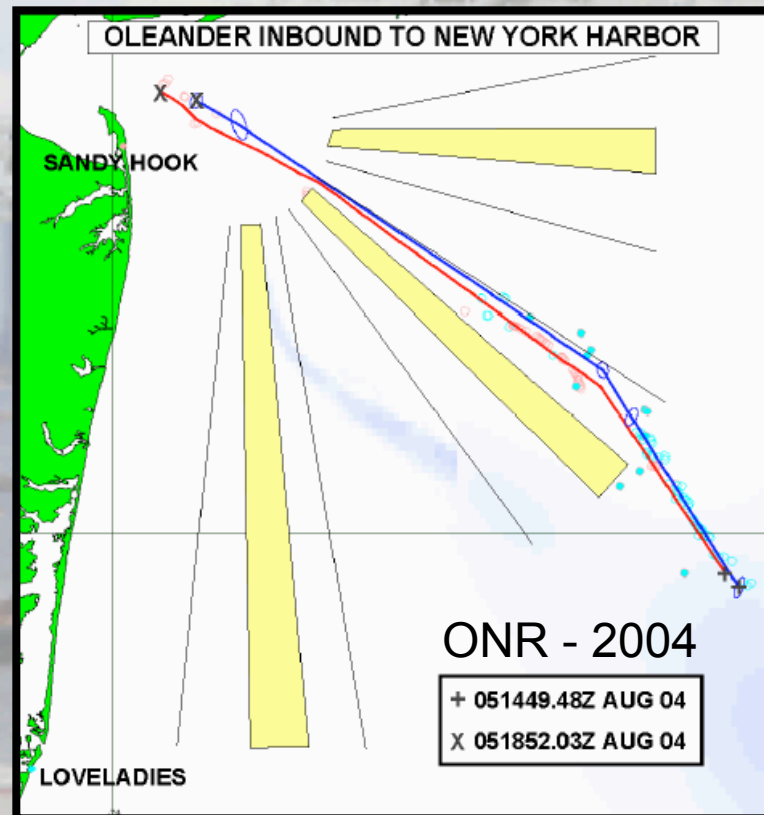
Norwegian Defence Research Establishment (FFI)

Terje Johnsen, Walther Asen

CODARNor

Anton Kjelaas

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



INTRODUCTION TO HF RADAR



The Center for Secure and Resilient Maritime Commerce (CSR)

CODAR Compact HF Radar Antennas



25 MHz

Combined Transmitter & Receiver



13 MHz



5 MHz

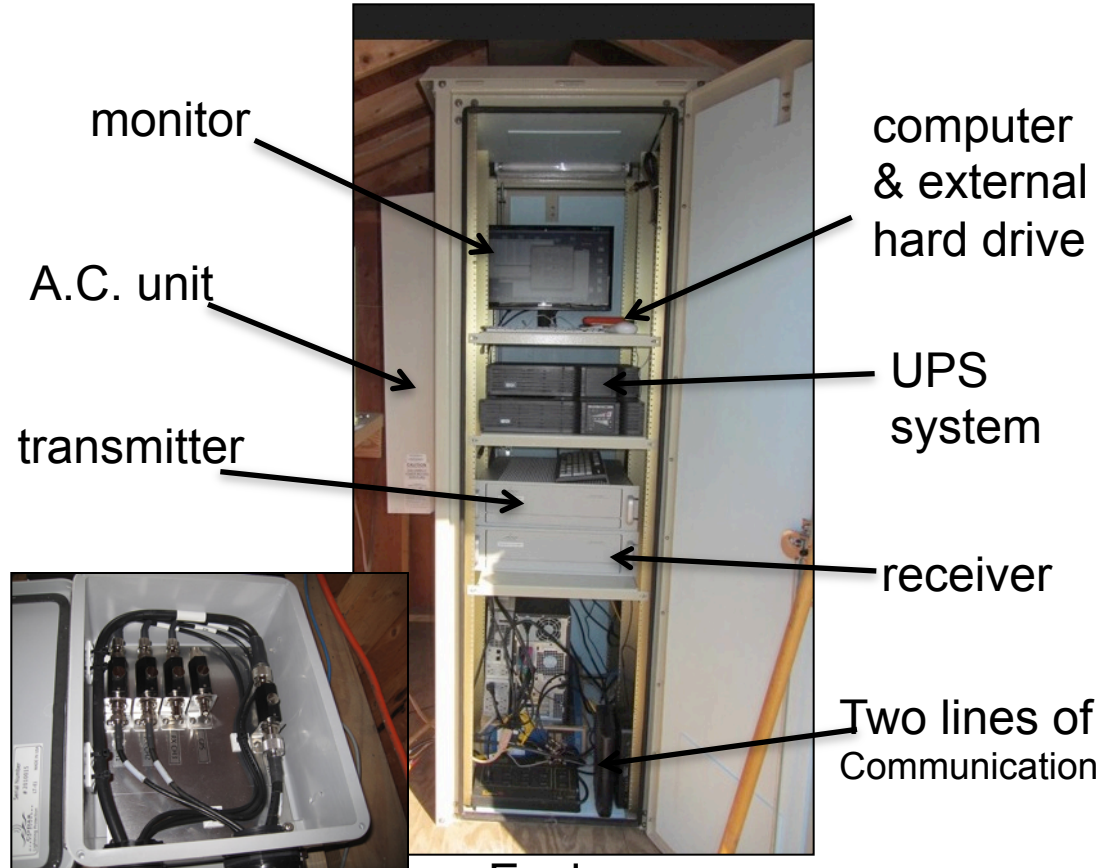
Separate Transmitter & Receiver

Standard CODAR Shore Site:

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



Shed



Lightning Protection

Enclosure

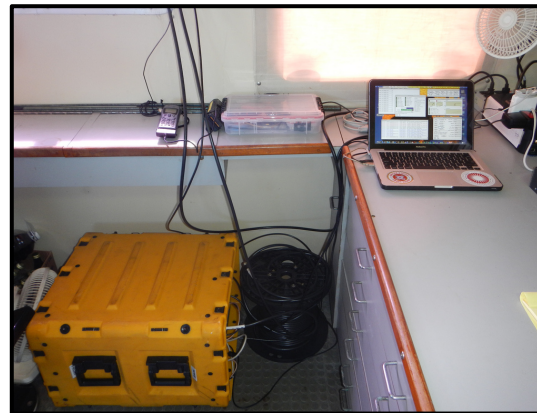


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HF Radar Bistatic Transmitters – Extending Range & Number of Look Angles



On Buoys

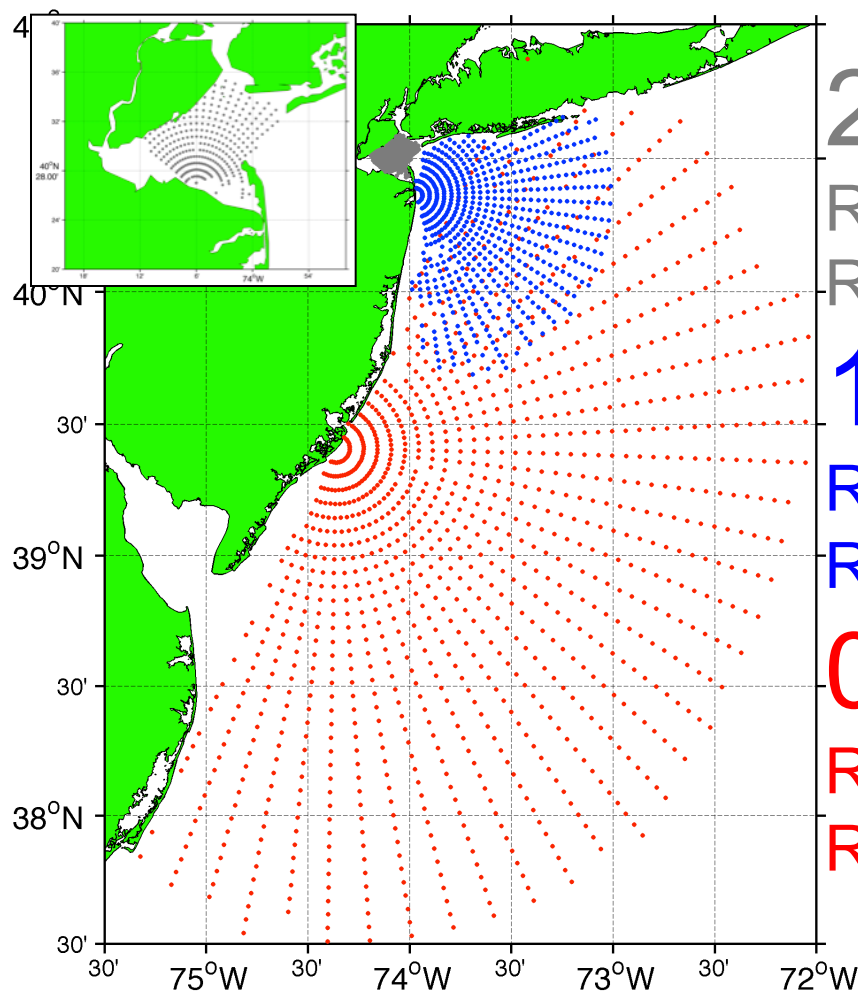


On Ships



On Shore

Surface Current Mapping Capability



25 MHz

Radar λ : 12 m

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

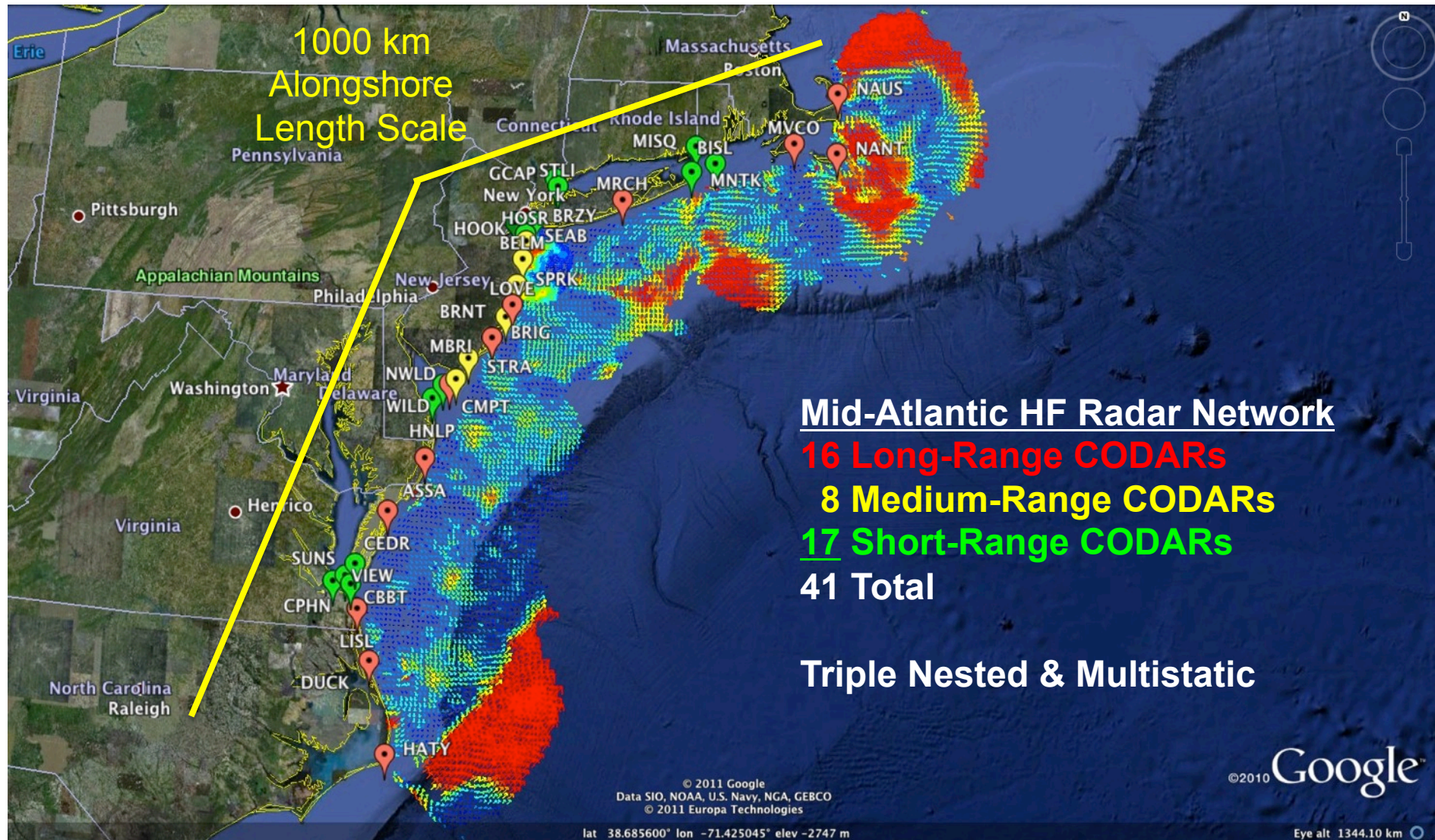
Range: 180 km

Resolution: 6 km



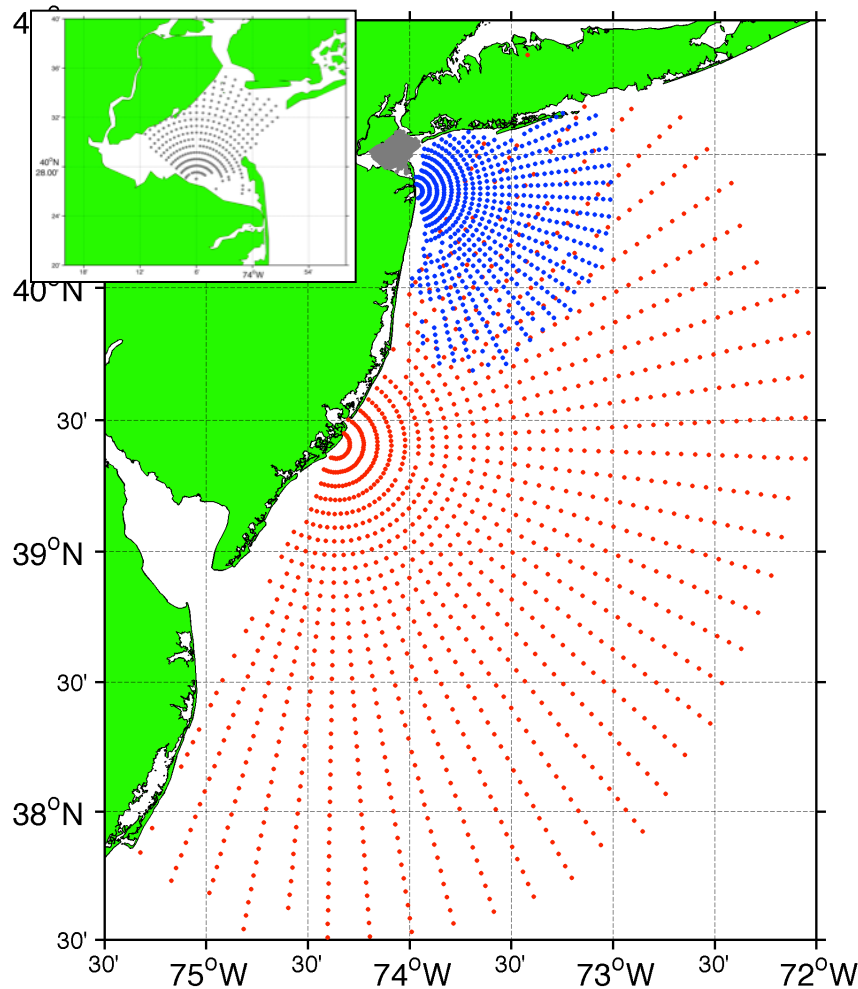
The Center for Secure and Resilient Maritime Commerce (CSR)

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



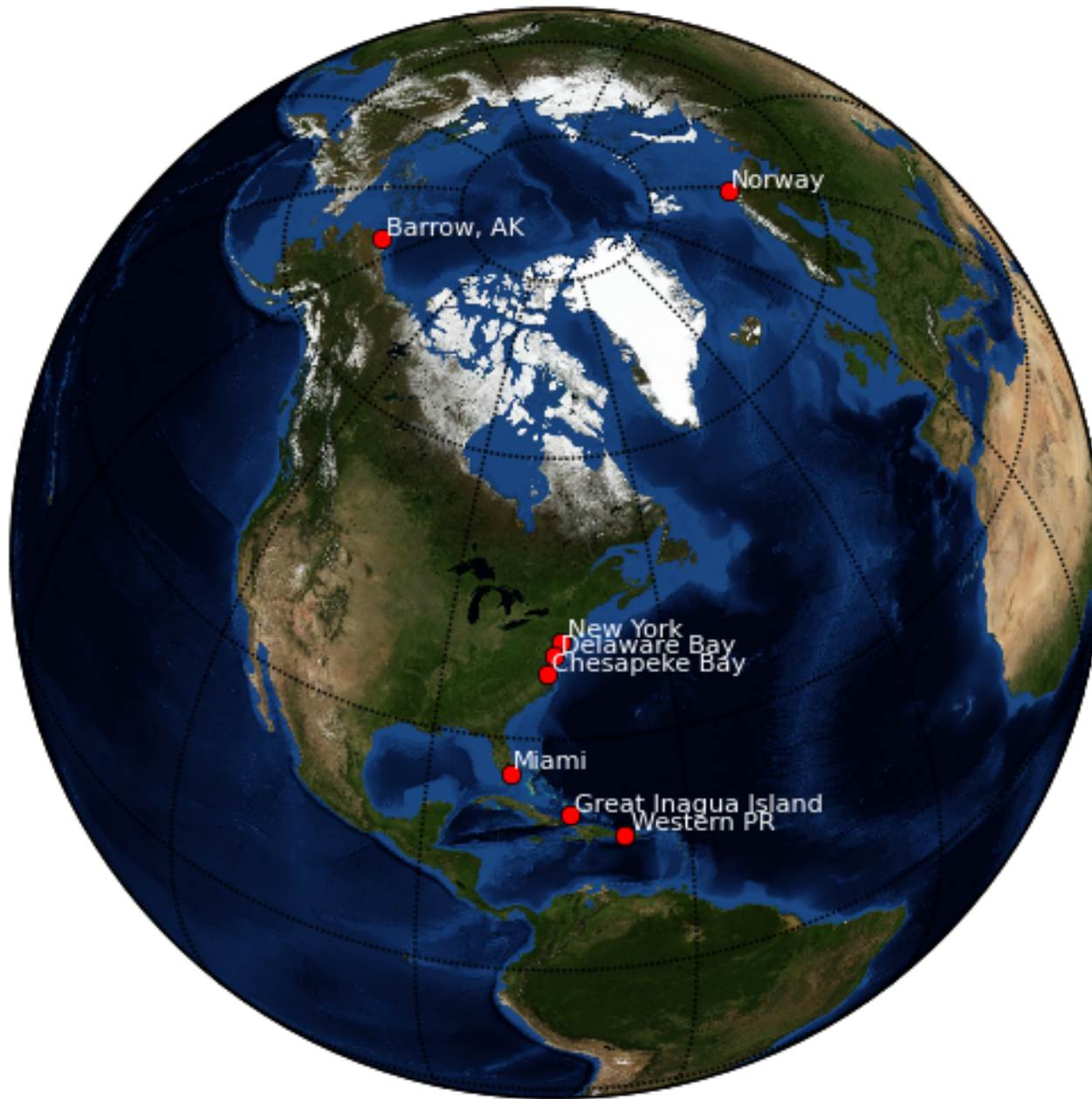
05 MHz

Range: 65 nmi

Size: >49 ft



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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

NEW YORK HARBOR TESTBED RESULTS



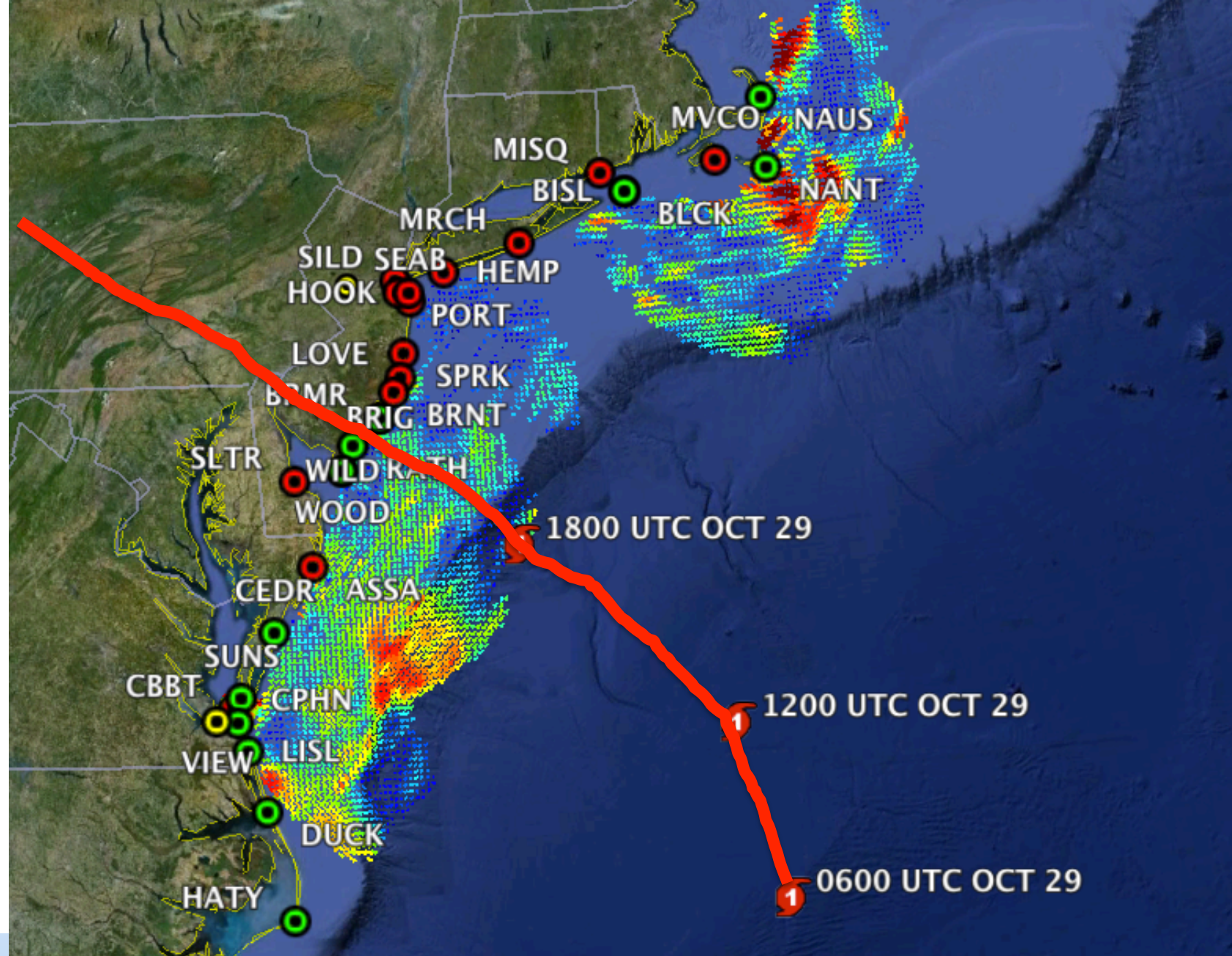
The Center for Secure and Resilient Maritime Commerce (CSR)

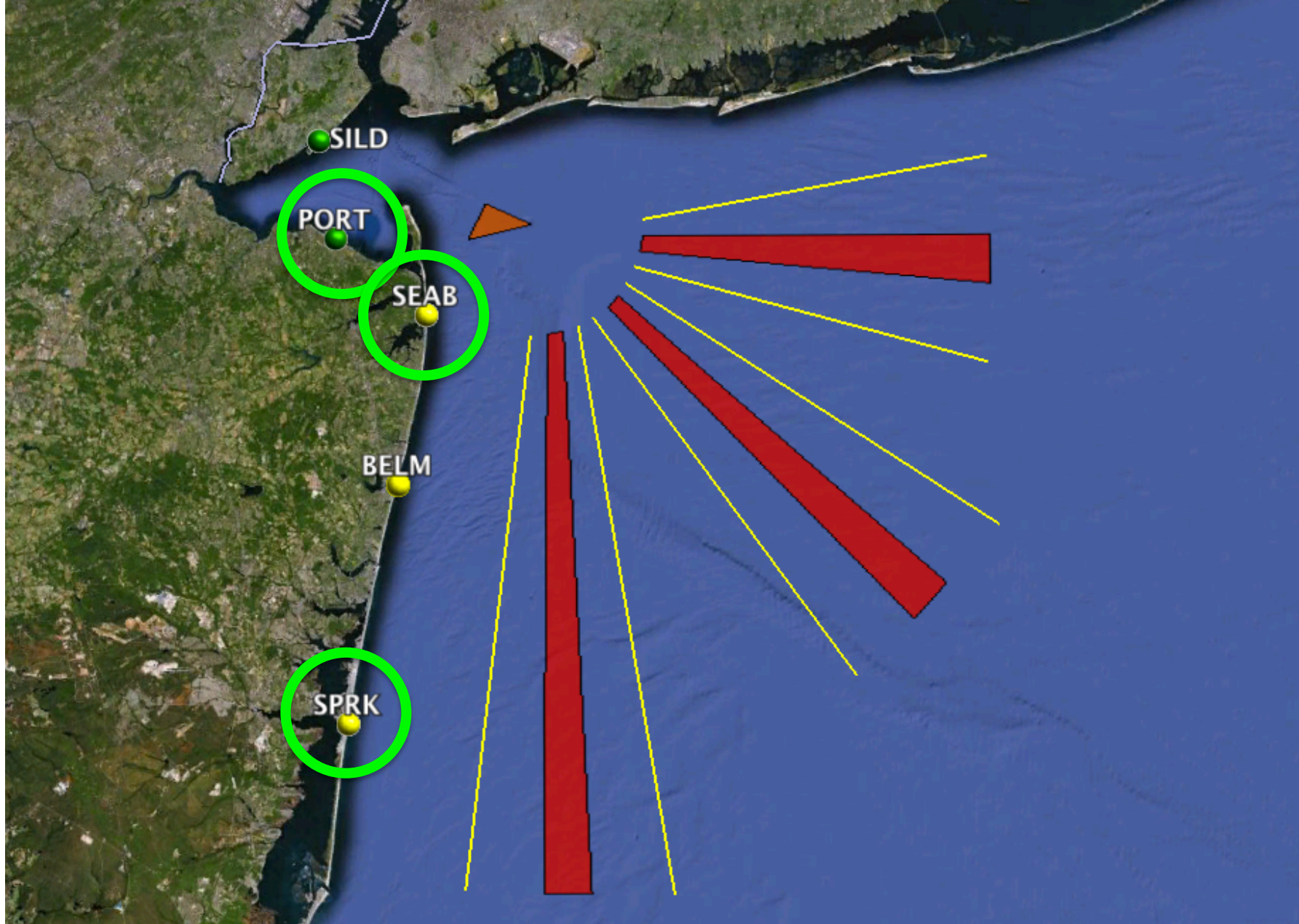


Track of Hurricane Sandy



The Center for Secure and Resilient Maritime Commerce (CSR)





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PORT MONMOUTH



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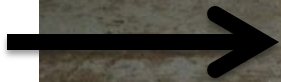


The Center for Secure and Resilient Maritime Commerce (CSR)

Sandy
2012



Irene
2011



SEA BRIGHT



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SEAB PRE



SEAB POST





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Shed Starting
Location



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SEASIDE PARK



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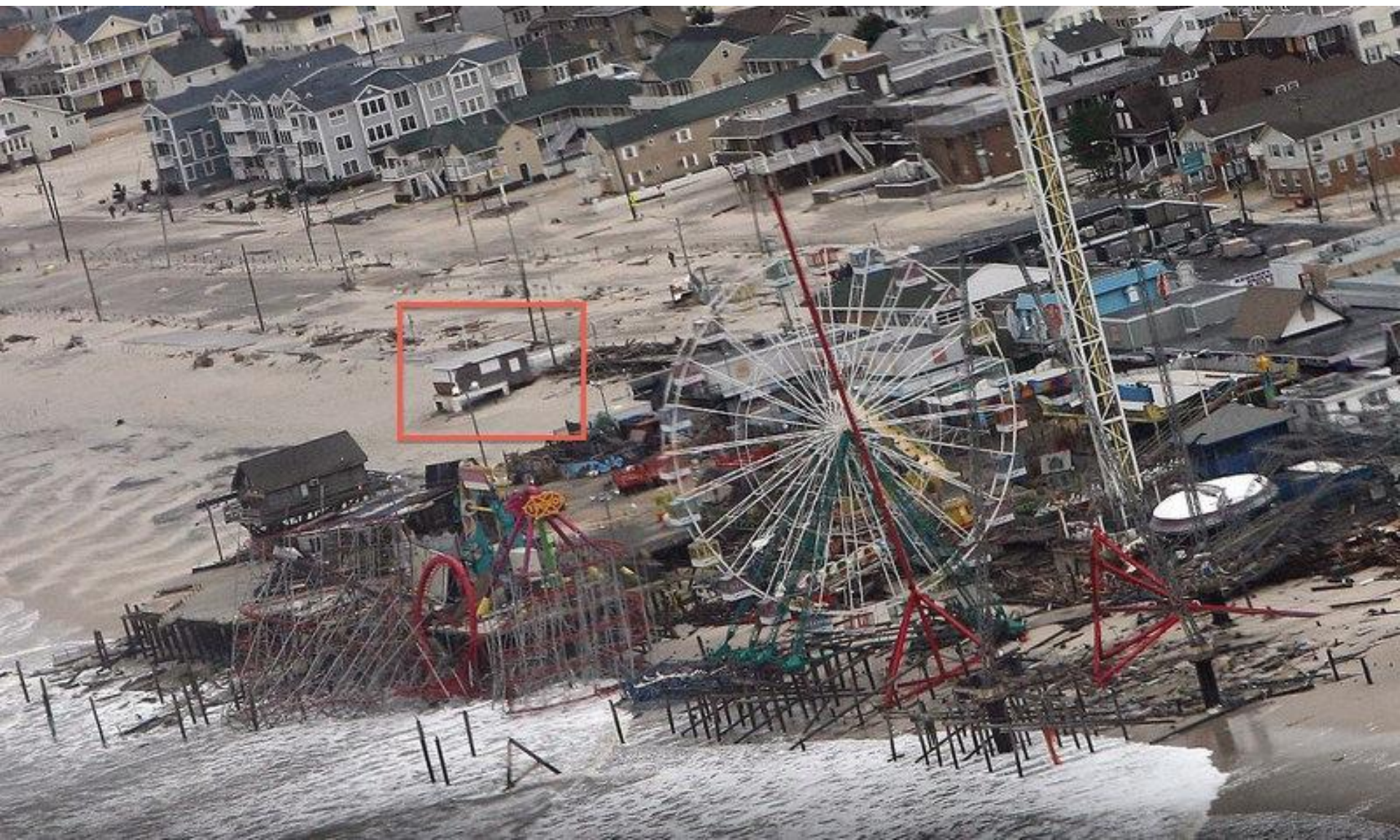
The Center for Secure and Resilient Maritime Commerce (CSR)

SPRK PRE



SPRK POST





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Resources

- <http://google.org/crisismap/2012-sandy>
- http://www.flickr.com/photos/rutgers_cool/sets/72157631995293198/



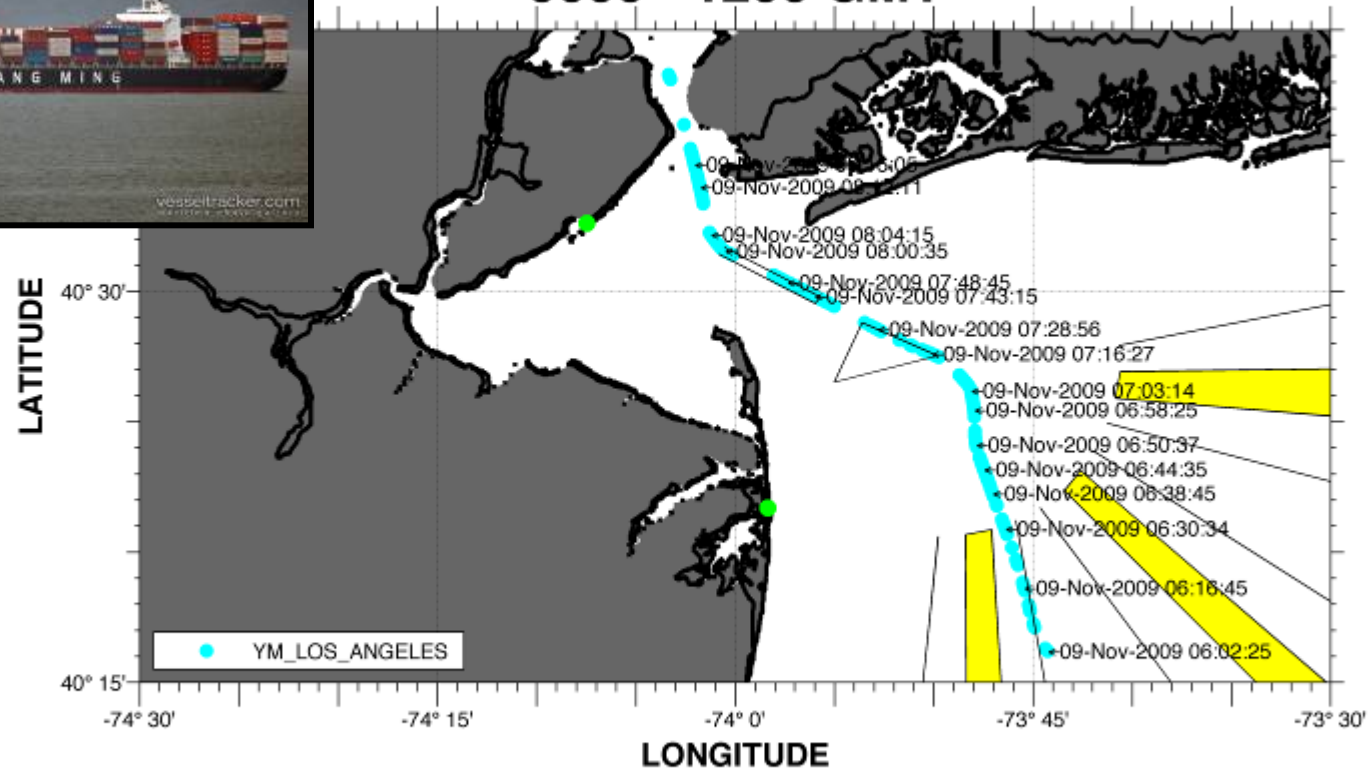
NY HARBOR RECENT RESULTS



The Center for Secure and Resilient Maritime Commerce (CSR)

GPS Track YM Los Angeles

CSR Experiment
AIS Data November 09 2009
0600 - 1200 GMT



01/19/10

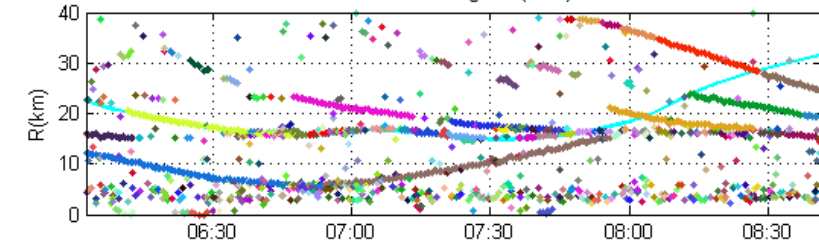
/Users/lemus/Documents/AIS/ship_detection/CSR_experiment/ship_11_09_09/create_trak.m



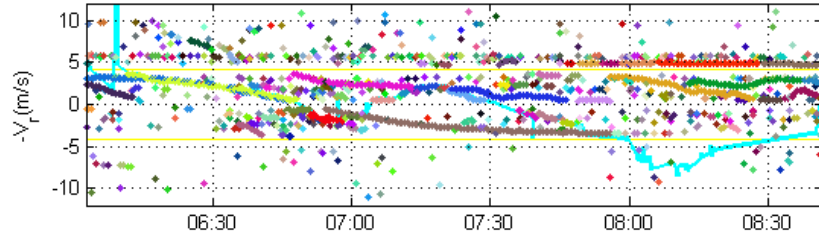
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Pepper Plot

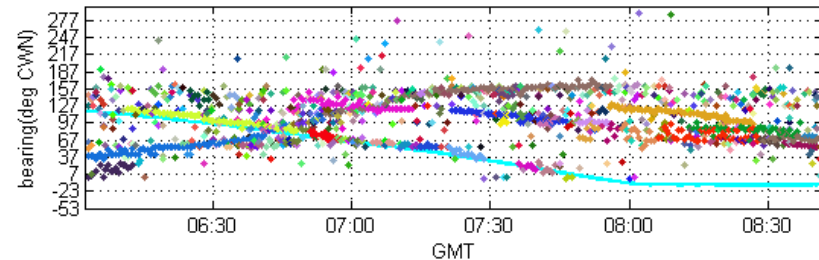
Rx = SEAB, $N_{FFT} = 128$, threshold = 8dB
Median bck. gnd. (3x7)



09-Nov-2009 06:02:43 - 09-Nov-2009 08:41:39 (Today : 19-Jan-2010)

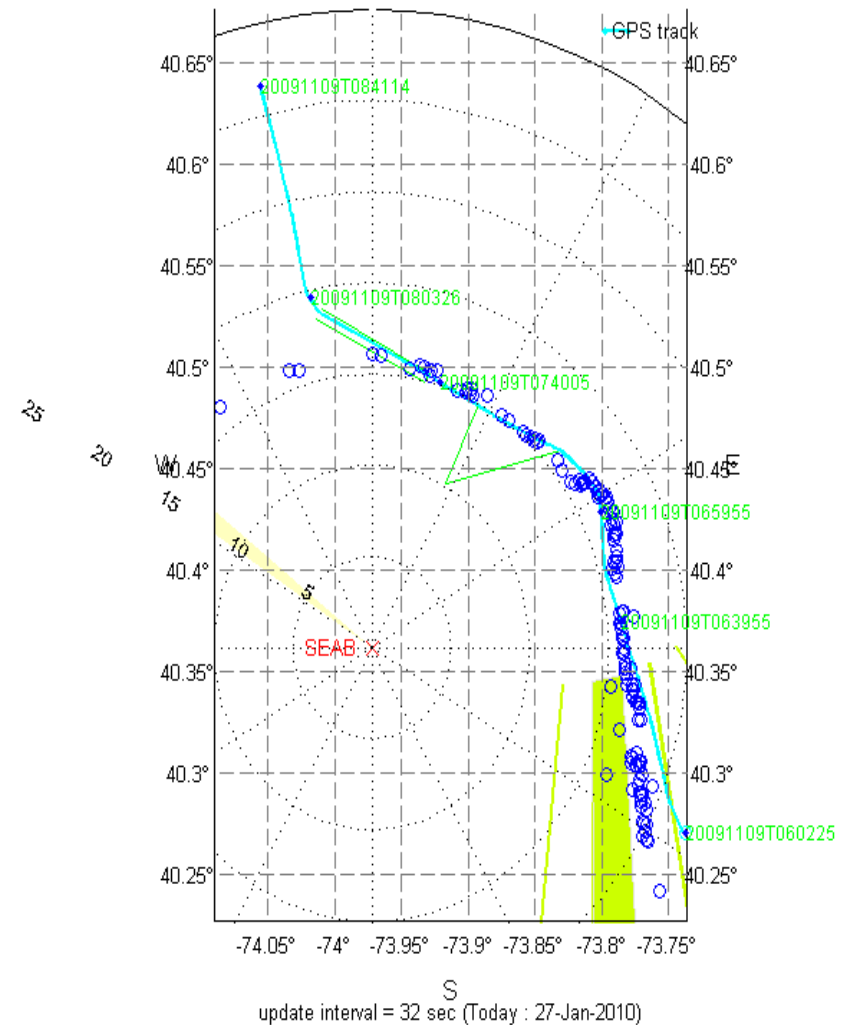


GPS Data (09-Nov-2009 06:02:25 - 09-Nov-2009 08:41:14) (Today : 19-Jan-2010)

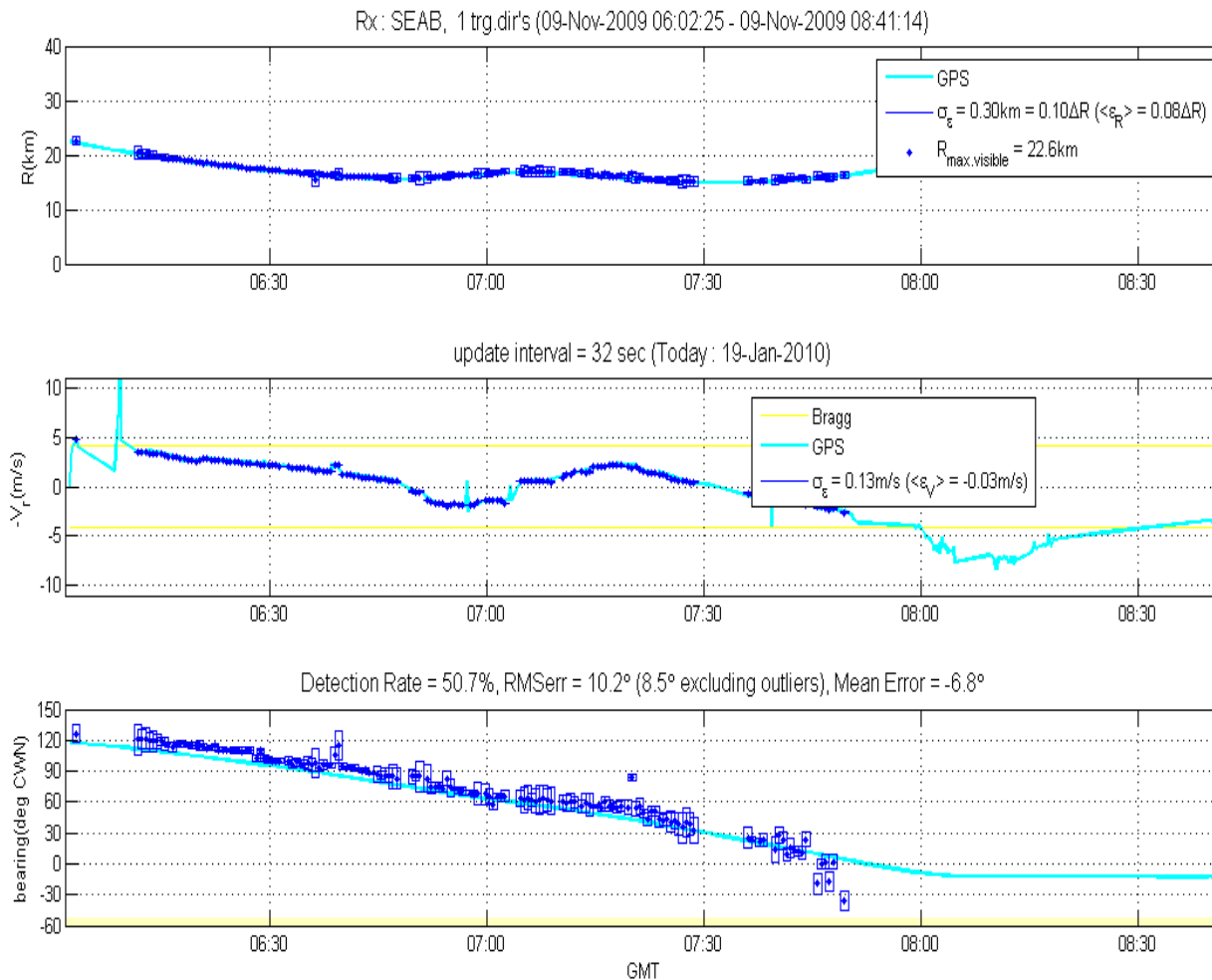


Detections on a Map

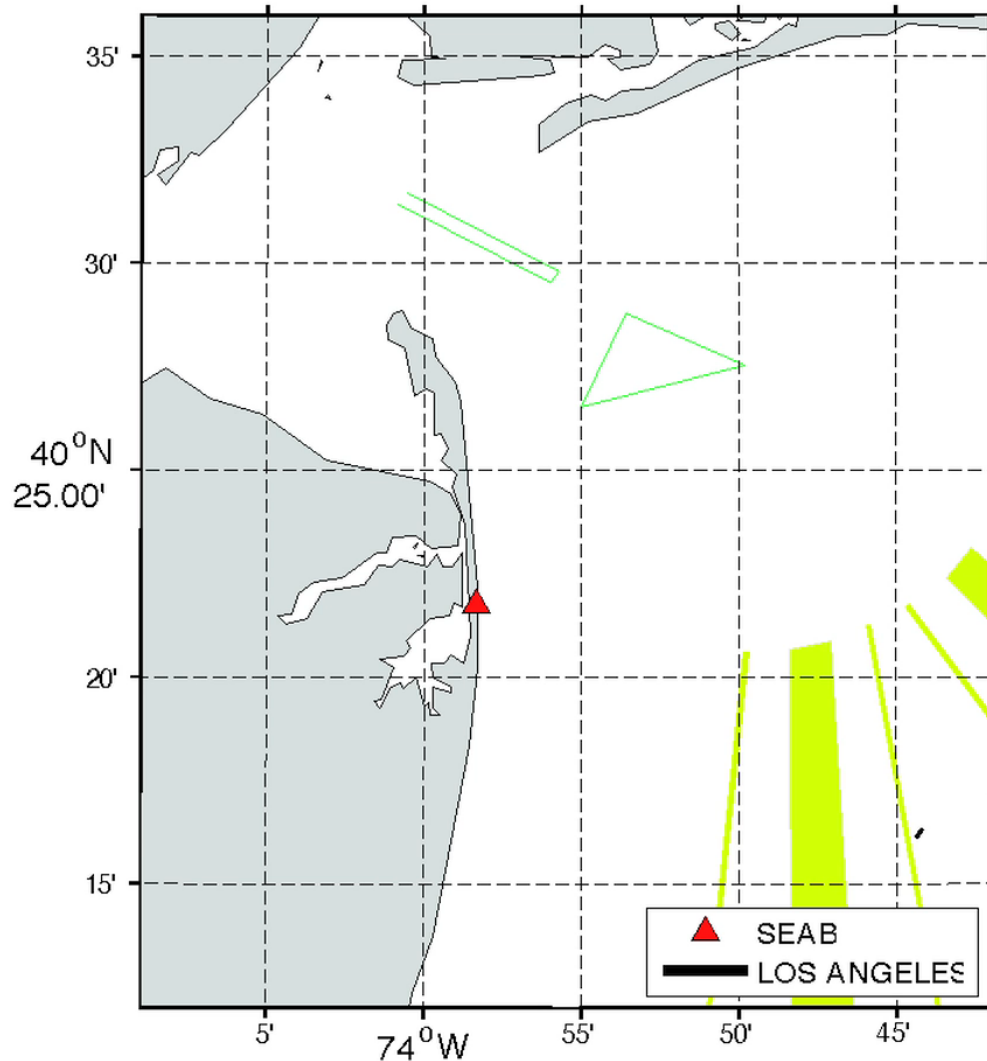
Rx : SEAB, 1 trg.dir's (09-Nov-2009 06:02:25 - 09-Nov-2009 08:41:14)



Association of GPS with Detections



Los Angeles
09-Nov-2009 06:02:00 - 06:03:00



Processing Matrix - YM Los Angeles 11/9/09

Threshold (dB)

FFT Points	6	7	8	9	10	11	12	13
	16	NSD	NSD	NSD	NSD	NSD		
	32	6.6	6.1	4.1 11.8	1.7 9.0	0.8 5.8	NSD 3.0	1.4 0.3
	64	21.7	20.2	17.8 28.9	16.2 22.4	13.7 15.0	10.6 9.3	6.1 3.1
	128	<u>41.8</u>	41.1	39.7 <u>50.3</u>	37.4 <u>48.6</u>	36.0 46.6	34.3 43.0	39.0 36.1
	256	<u>42.7</u>	41.6	39.9 <u>47.1</u>	39.2 46.1	37.9 45.7	35.5 44.0	43.0 39.9
	512	33.7	32.3	30.9 36.5	29.8 34.0	28.4 32.6	26.0 30.5	29.5 28.8
	1024			29.7	28.6	26.1	25.0	22.1 19.6

IIR – Red

Median – Blue

NSD = No Ship Detected



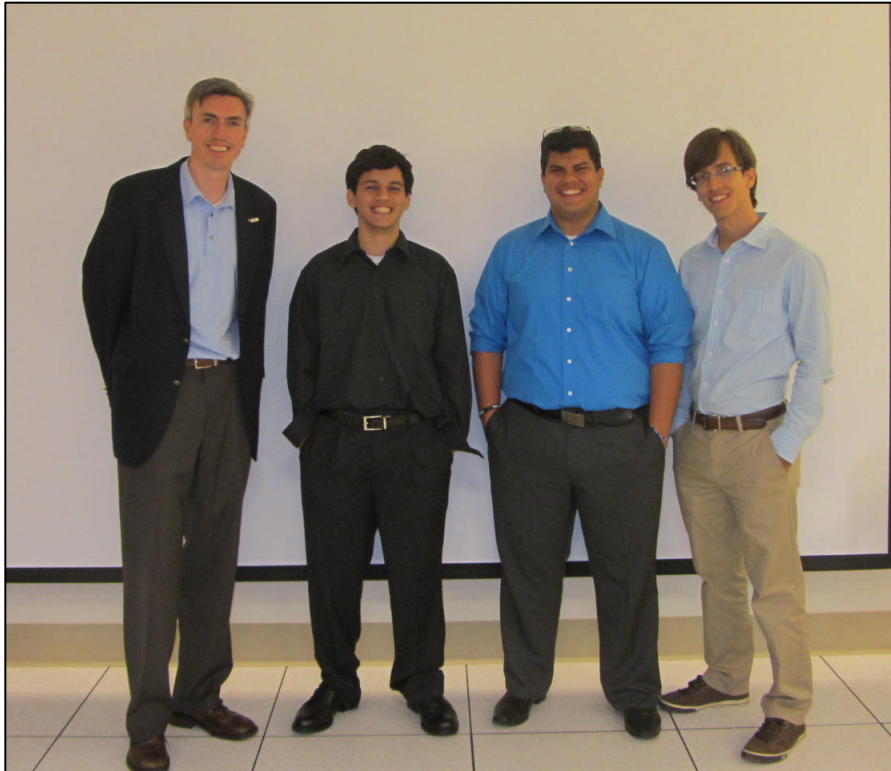
The Center for Secure and Resilient Maritime Commerce (CSR)

NY HARBOR 2012 RESULTS



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2012 Summer Research Institute



The Center for Secure and Resilient Maritime Commerce

2012 Summer Research Institute

High Frequency Radar Final Report

Submitted to
CSR Summer Research Institute

By

Fernando Valverde Valle
Raul A. Huertas Avila
Isaac Jourdan Forty

July 25, 2012

Written and presented with the support of the National Center for Secure and Resilient Maritime Commerce (CSR), A Department of Homeland Security and Technology Center of Excellence

"This material is based upon work supported by the U.S. Department of Homeland Security under Grand Award Number 2008-ST-061-ML0002." "The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Department of Homeland Security."



The Center for Secure and Resilient Maritime Commerce (CSR)

Vessels Detected June 11, 2012

Real time software allows for increased processing

Coast Guard searching N.Y., N.J. for fake boat explosion caller

Published: Wednesday, June 13, 2012, 3:15 PM Updated: Wednesday, June 13, 2012, 3:15 PM



By James Queally/The Star-Ledger

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SANDY HOOK — The person behind the fake distress call that sent hundreds of rescue personnel racing to Sandy Hook Monday may have sent the message from some point between New York City and Monmouth County, U.S. Coast Guard officials said today.

The preliminary investigation into Monday's probable hoax — which sent nearly 200 people to Sandy Hook looking for the scene of a reported yacht explosion that killed three people



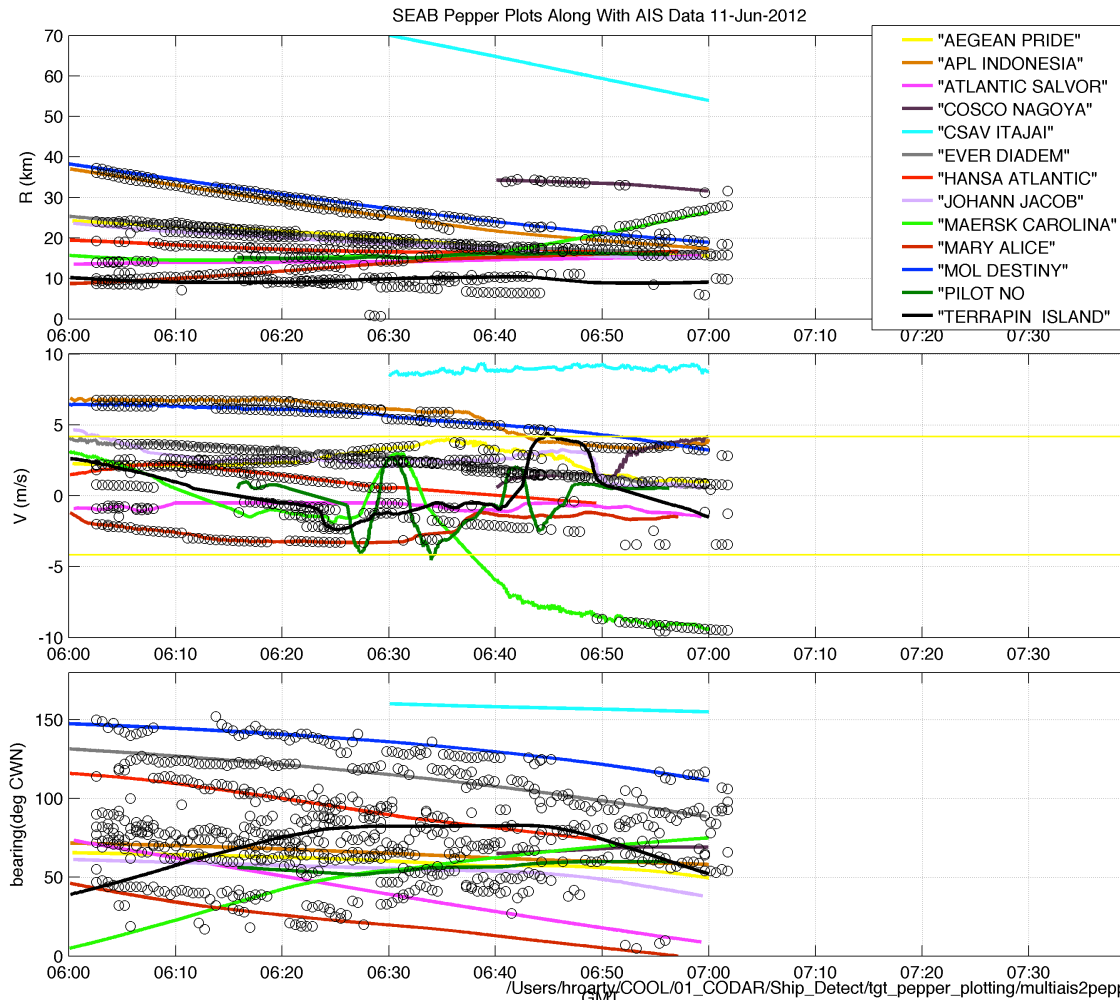
[+ Enlarge](#)

Noah K. Murray/ The Star-Ledger



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Detections Overlaid on AIS

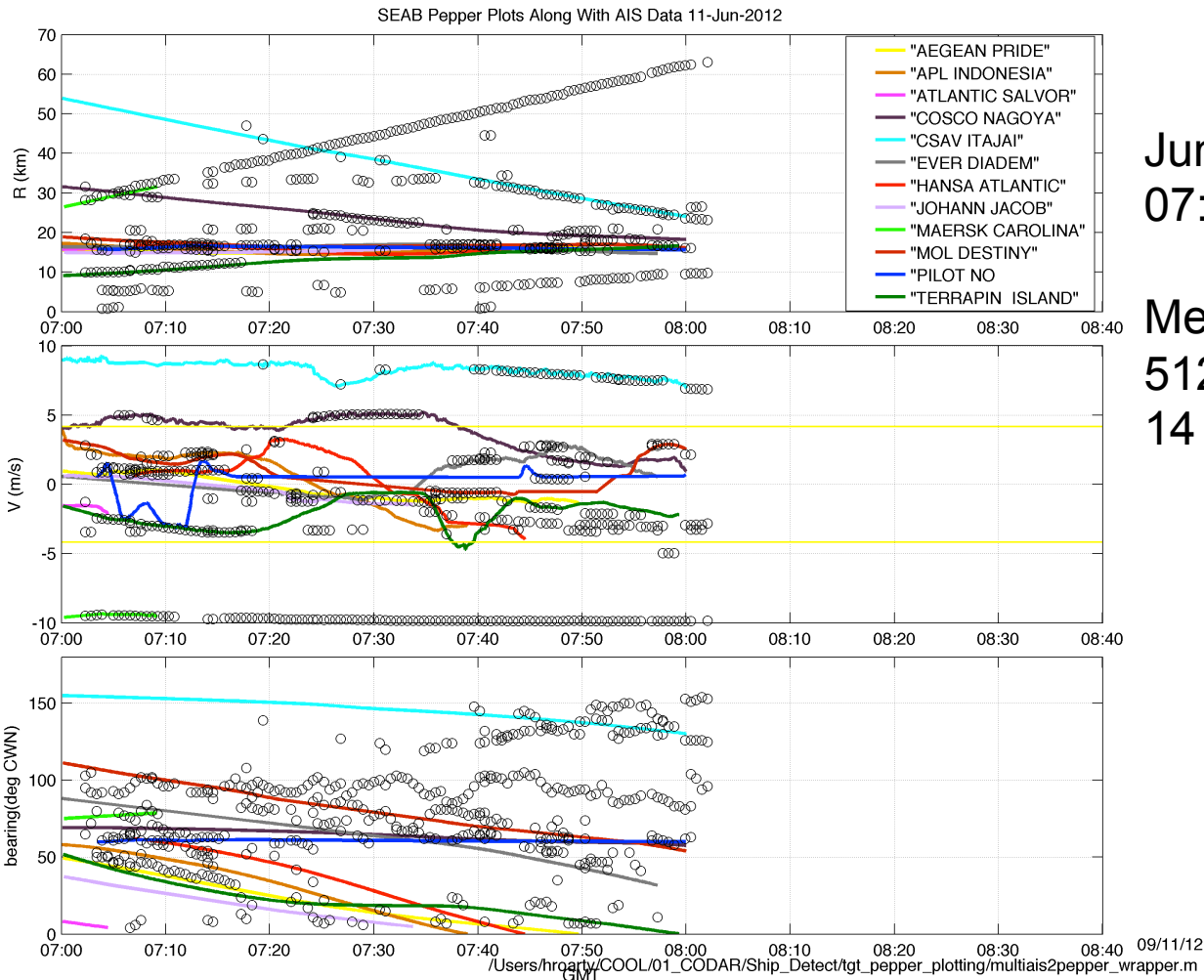


June 11, 2012
06:00-07:00

Median Background
512 pt. FFT
14 dB SNR



Detections Overlaid on AIS



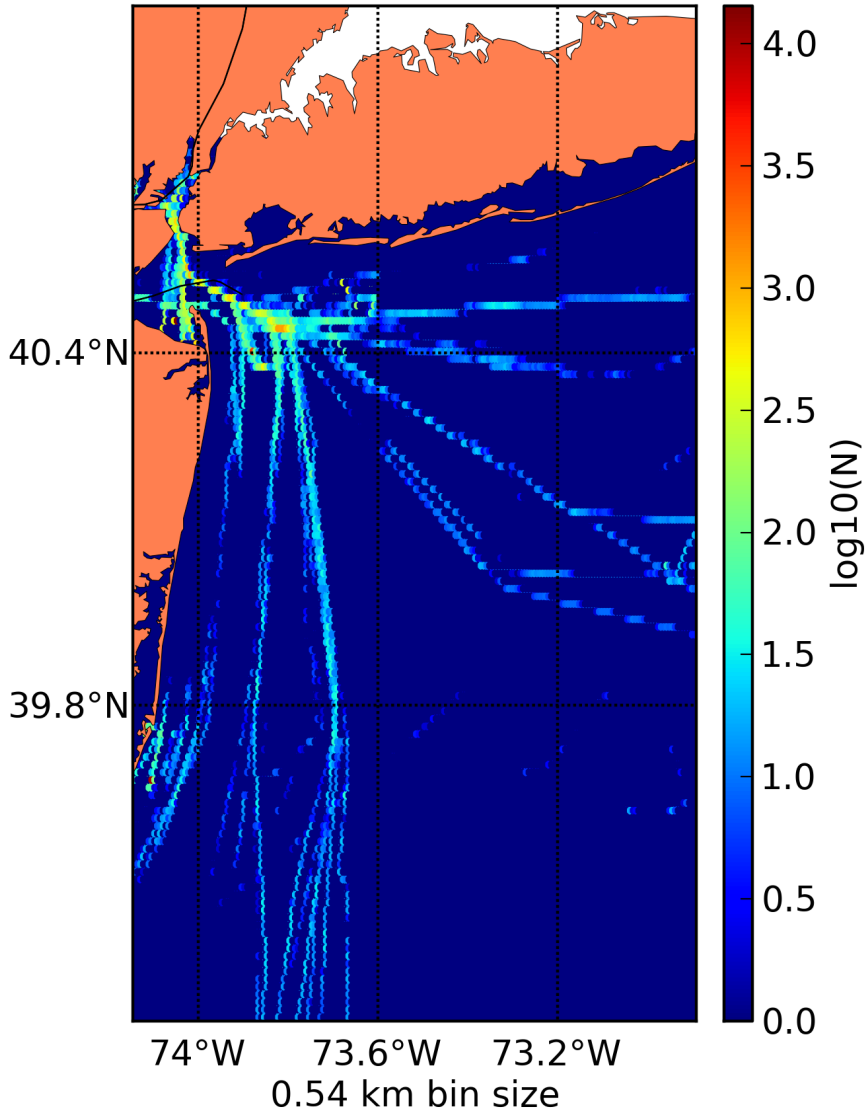
June 11, 2012
07:00-08:00

Median Background
512 pt. FFT
14 dB SNR

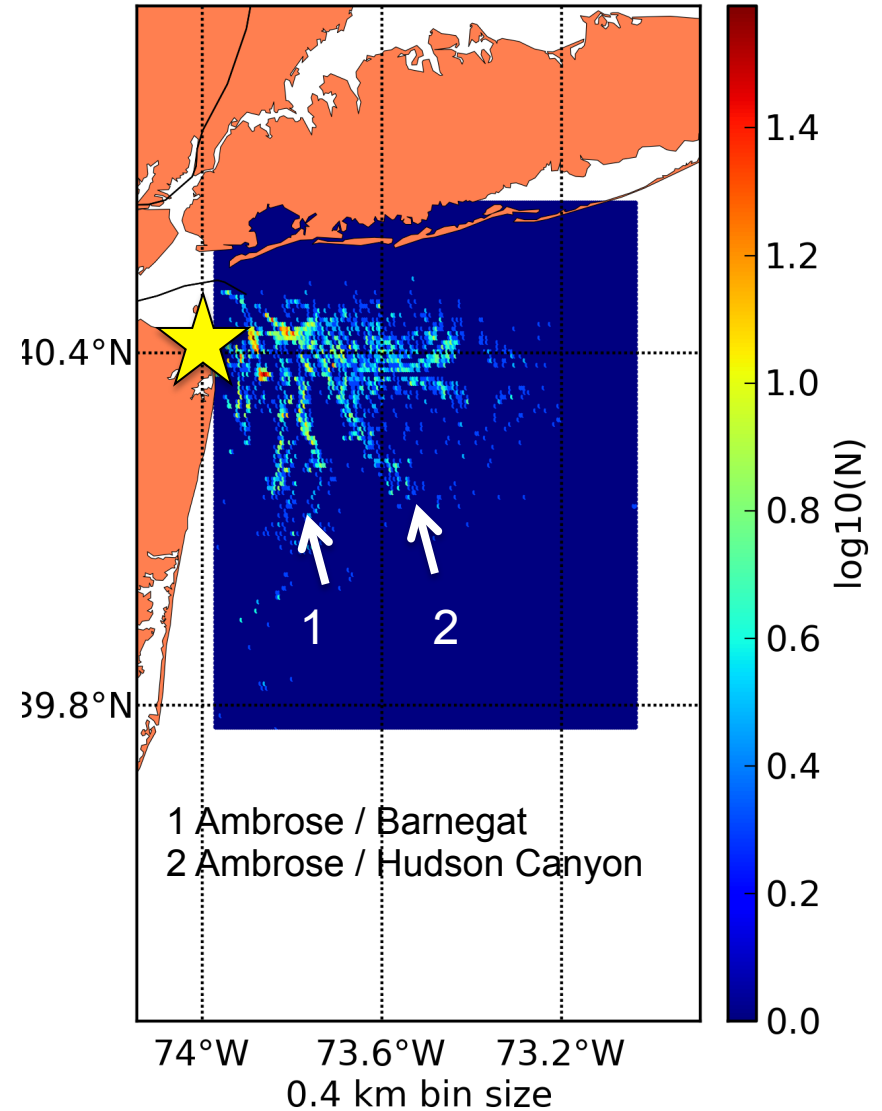


The Center for Secure and Resilient Maritime Commerce (CSR)

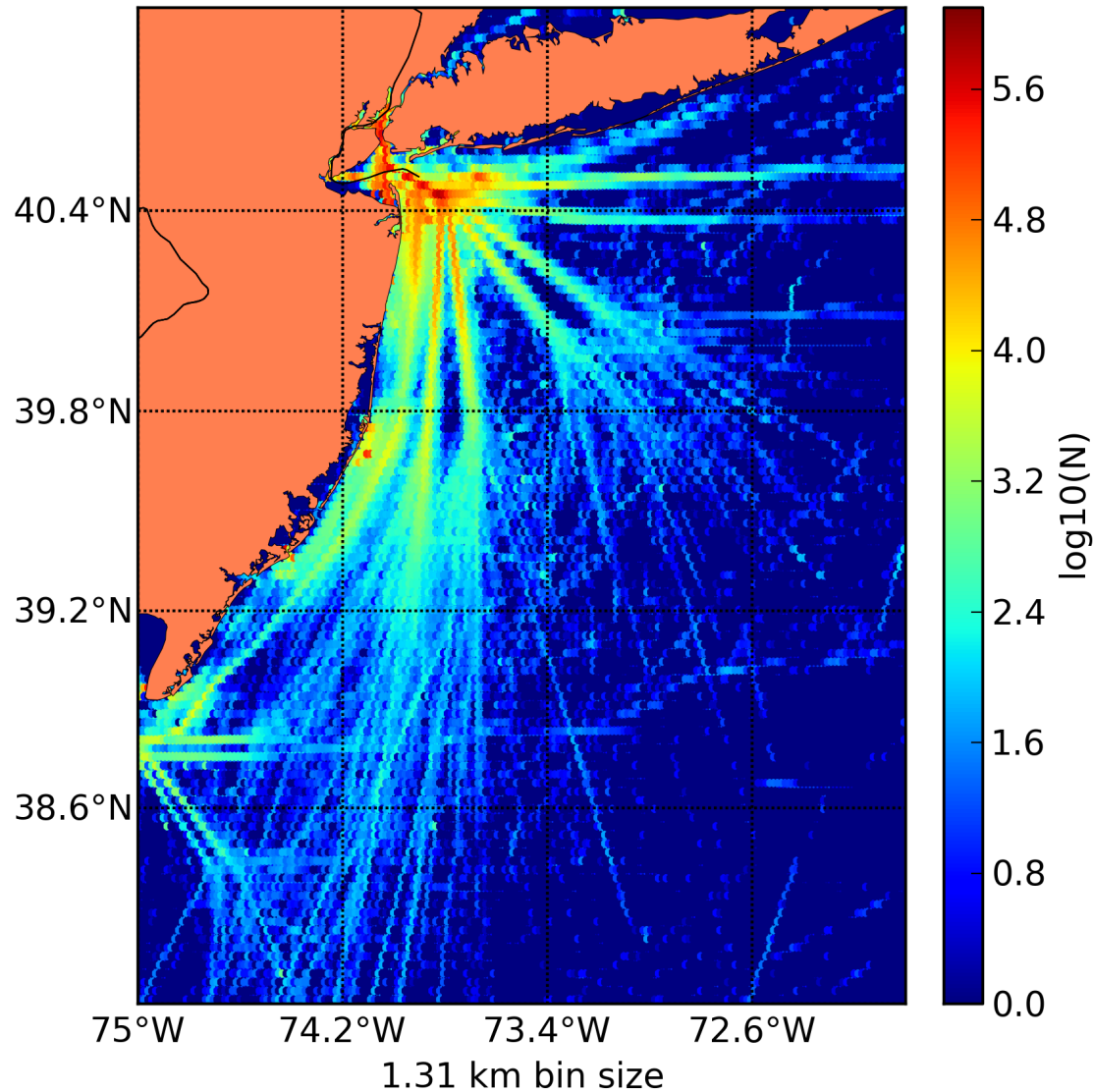
AIS Density Chart
June 11, 2012 - AIS.html

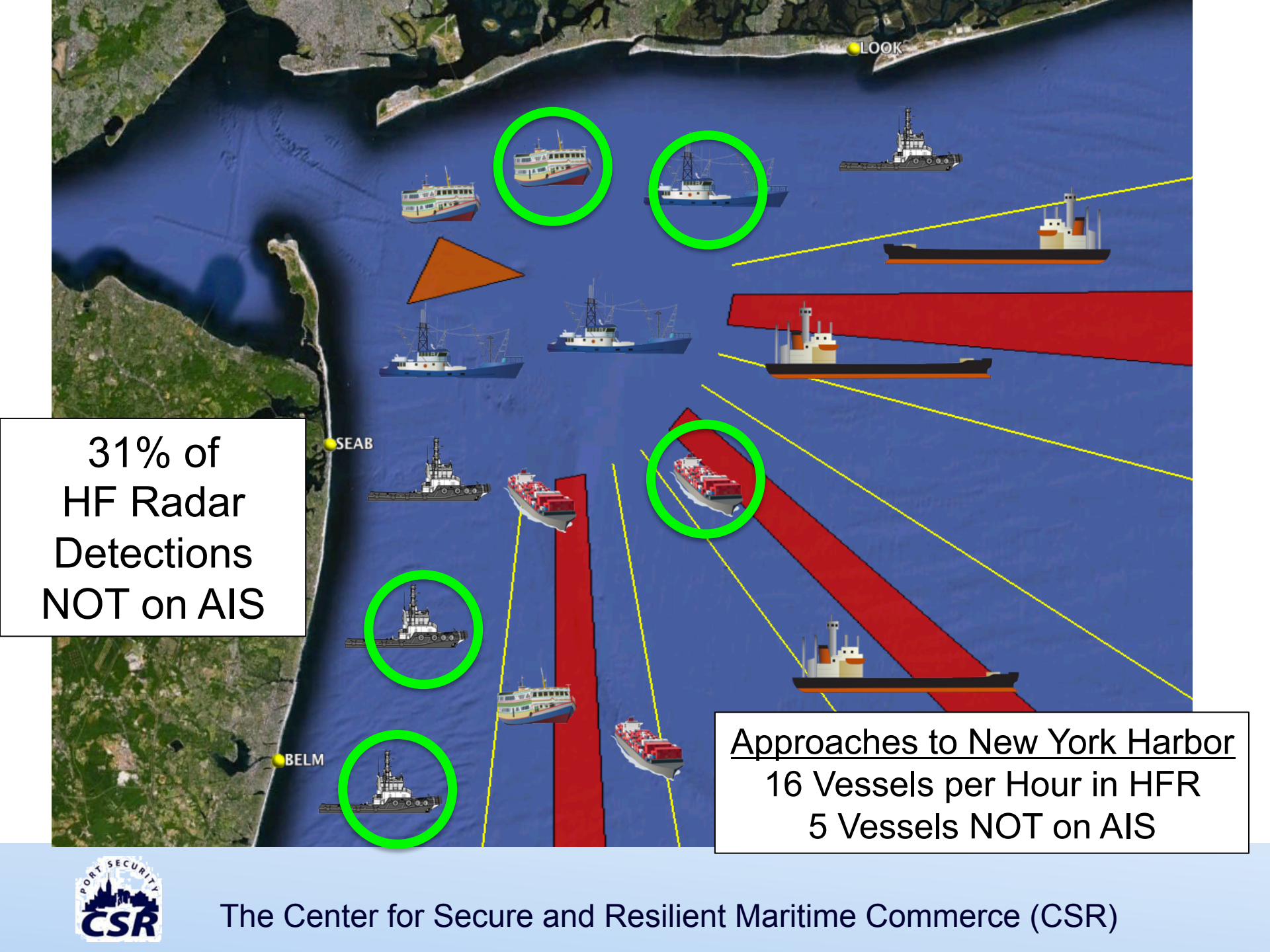


TGT Density Chart
june-11th-20db.txt



AIS Density July 2011 to June 2012





31% of
HF Radar
Detections
NOT on AIS

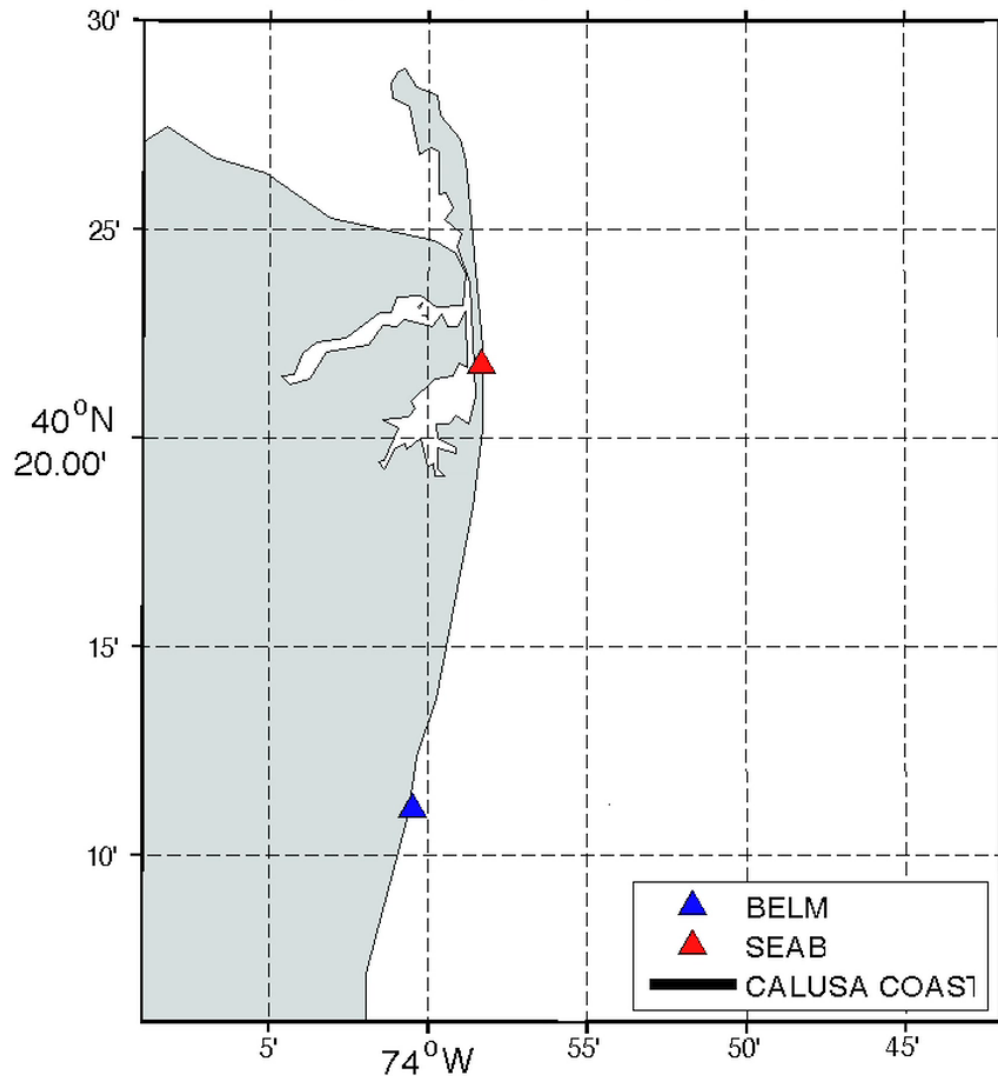
The background is an aerial map of New York Harbor. Several ship icons are overlaid on the map. Five of these ships are circled in green: a tugboat in the upper left, a tugboat in the upper center, a tugboat in the lower left, a tugboat in the lower center, and a container ship in the lower right. Yellow lines radiate from various points on the map, representing radar coverage. A yellow dot labeled 'LOOK' is at the top right, and yellow dots labeled 'SEAB' and 'BELM' are on the left side. Large red and orange shapes represent specific radar coverage areas or boundaries.

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



The Center for Secure and Resilient Maritime Commerce (CSR)

Calusa Coast Comparison
11-Jun-2012 10:59:00 - 11:00:00



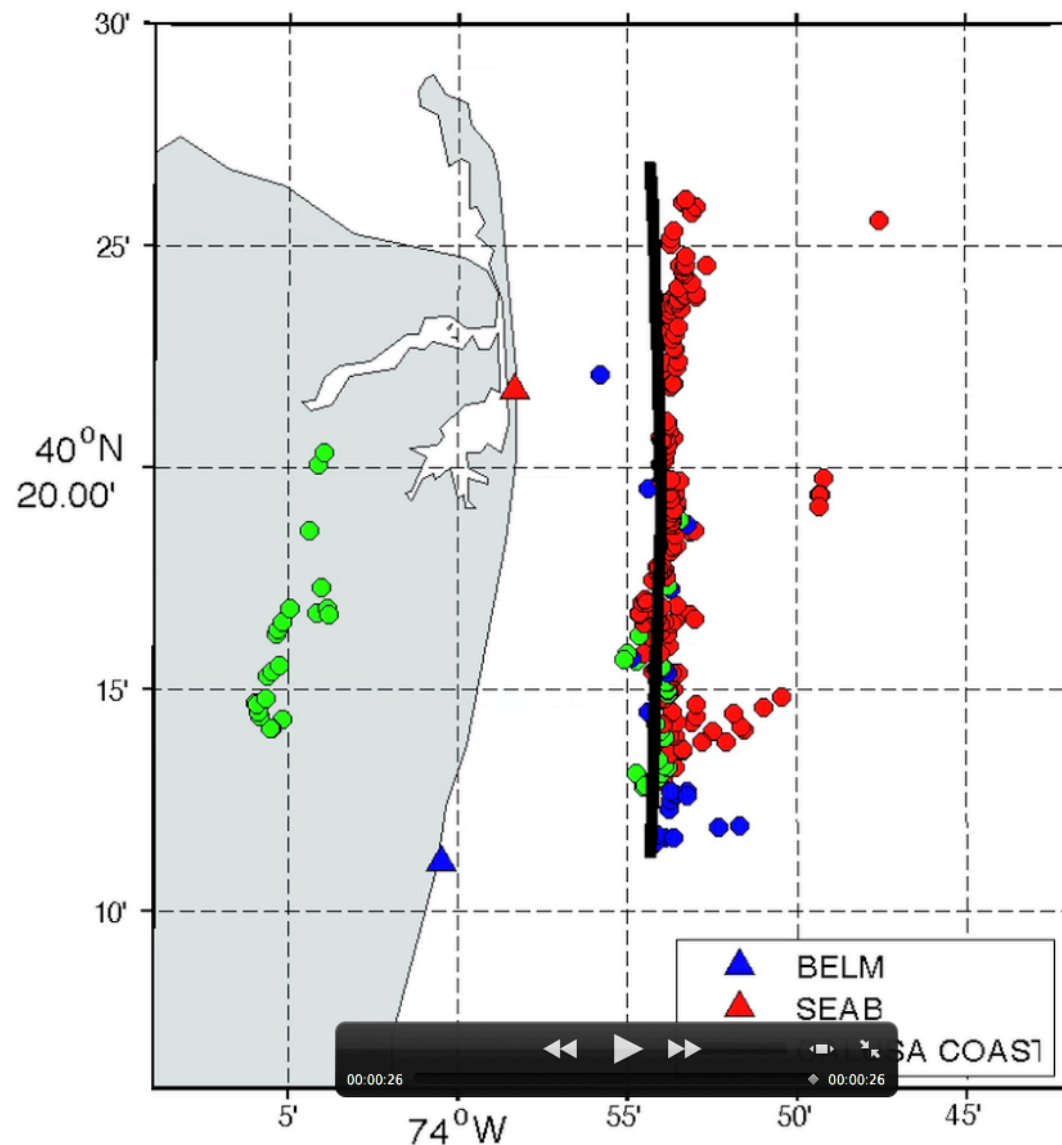
Calusa Coast Test Case



The Center for Secure and Resilient Maritime Commerce (CSR)

Calusa Coast Comparison

11-Jun-2012 13:37:00 - 13:38:00



CSR Ship Detection Visualizer

Data Selection

Site: **A**

Background:

FFT Length:

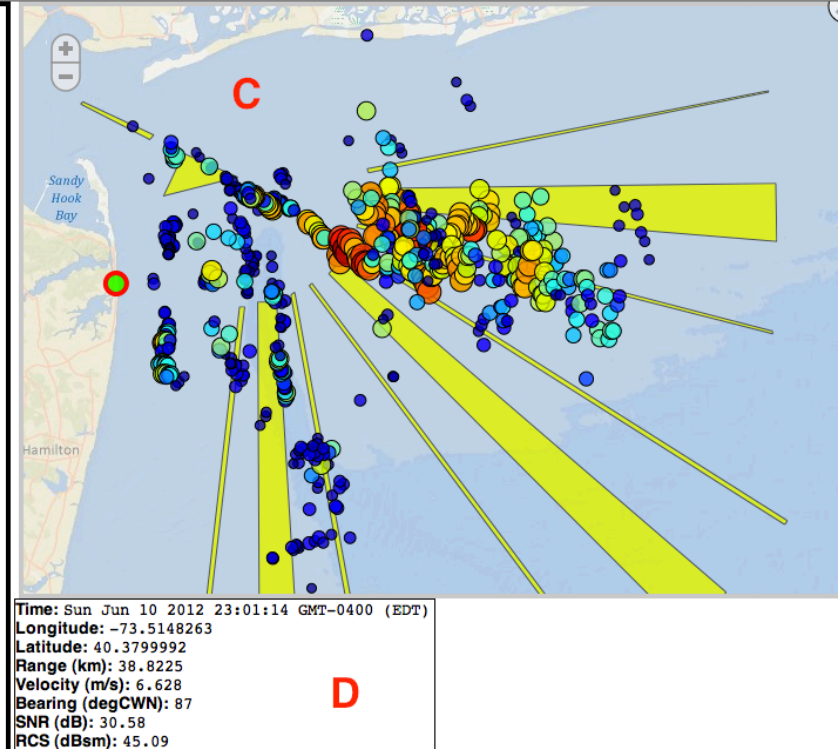
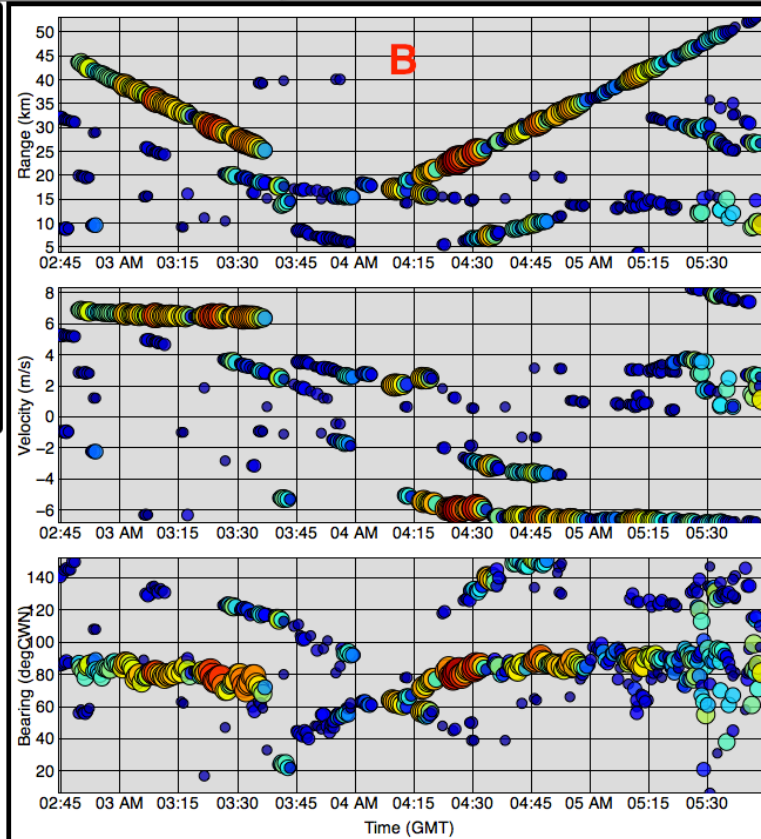
Threshold:

Start Time:

End Time:

Color/Size by:

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



The Center for Secure and Resilient Maritime Commerce (CSR)

Selected Recent Publications

HF Radar for Surface Current Mapping:

Roarty, Glenn, Kohut, Gong, Handel, Rivera, Garner, Atkinson, Brown, Jakubiak, Muglia, Haines, Seim, (2010). Operation and Application of a Regional High-Frequency Radar Network in the Mid-Atlantic Bight, Marine Technology Society Journal, V. 44, No. 6, p. 1-13.

Corredor, J. E., Amador, A., Canals, M., Rivera, S., Capella, J.E., Morell, J.M., Glenn, S.M., Roarty, H.J., Handel, E., Rivera, E. (2011) “Optimizing and Validating High Frequency Radar Surface Current Measurements in the Mona Passage” Marine Technology Society Journal, Vol. 45, No. 3, 49-58

Teague, C.C., Barrick, D. E., Lilleboe, P.M., Roarty, H., Holden, D., Goldinger, D. (2011) “Extended-Range RiverSonde Operation on the Hudson River, Current, Waves and Turbulence Measurements (CWTM), 2011 IEEE/OES 10th, 78-80, doi [10.1109/CWTM.2011.5759529](https://doi.org/10.1109/CWTM.2011.5759529)

Harlan, J., Allen, A., Howlett, E., Glenn, S.M., Kohut, J.T., Roarty, H., O'Donnell, J., Fake, T., Terrill, E., Kim, S.Y., Otero, M. (2011) “National IOOS HF Radar Search and Rescue Project”, Oceans 2011 MTS/IEEE – Kona



Selected Recent Publications

HF Radar for Surface Current Mapping:

Kohut, Roarty, Randall-Goodwin, Glenn, Lichtenwalner **(2012)** Evaluation of Two Algorithms for a Network of Coastal Radars in the Mid Atlantic Bight, Ocean Dynamics, Vol. 62, p. 953-968

Roarty, H.J., Riscica, J., Palamara, L., Bowers, L. , Seroka, G., Kohut, J., Glenn, S., Dunk, R. **(2012)** “Analysis of the Wind Resource off New Jersey for Offshore Wind Energy Development”, Oceans 2012 MTS/IEEE – Hampton Roads

Roarty, H.J., Smith, M., Kerfoot, J., Glenn S. **(2012)** “Automated Quality Control of High Frequency Radar Data”, Oceans 2012 MTS/IEEE – Hampton Roads

Roarty, H.J., Smith, M., Handel, E., Barrick, D. and Glenn S. **(2012)** “ Expanding the Coverage of HF Radar Through the Use of Wave Powered Buoys” Oceans 2012 MTS/ IEEE – Hampton Roads

Evans, C.W., Roarty, H.J., Kohut, J.T., Glenn, S.M. **(2012)** ‘Examination of the SeaSonde Wave Processing Settings and the Effects of Shallow Water on Wave Measurements” Oceans 2012 MTS/IEEE – Hampton Roads



Selected Recent Publications

HF Radar for Surface Current Mapping:

Seroka, G, Dunk, R., Glenn, S., Bowers, L., Kerfoot, J., Crowley, M., Roarty, H.J., Palamara, L., Kohut, J., **(2012)** “Rutgers University Coastal Ocean Observation Laboratory (RU-COOL) Advanced Modeling System Developed to Cost-Effectively Support Offshore Wind Energy Development and Operational Applications” Oceans 2012 MTS/IEEE – Hampton Roads

Schofield, O., Roarty, H., Saba, G., Yi, X., Kohut, J., Glenn, S., Manderson, J., Oliver, M. **(2012)** “Phytoplankton Dynamics and Bottom Water Oxygen During a Large Bloom in the Summer of 2011”, Oceans 2012 MTS/IEEE – Hampton Roads

Glenn, Schofield, Kohut, Dunk, Titlow, Roarty, Kerfoot, Palamara, Bowers, Seroka, Miles, Xu, Crowley **(2012)** “Impact of Ocean Observations on Hurricane Forecasts in the Mid Atlantic”, Oceans 2012 MTS/IEEE – Hampton Roads



Selected Recent Publications

HF Radar for Vessel Tracking:

Roarty, H.J., D. E. Barrick, J. T. Kohut, S. M. Glenn (2010) "Dual-Use of Compact HF Radars for the Detection of Mid and Large Size Vessels" Turkish Journal of Electrical Engineering and Computer Sciences, Vol. 18, No. 3, 373-388

Roarty, Lemus, Handel, Glenn, Barrick, Issacson, (2011). "Performance Evaluation of SeaSonde High-Frequency Radar for Vessel Detection", *Marine Technology Society Journal*, V. 45, No. 3, p. 14-24.

Newton, D. (2012) "Observations and Analysis of the Target Detection Performance of the CODAR HF Surface Wave Radar," *The Proceedings of the 2012 MSS Tri-Service Radar Conference*, Boulder, CO; 18-22 June 2012.

Roarty, Smith, Glenn, Barrick, Whelan, Statscewich, Weingartner (2013) "Expanding Maritime Domain Awareness Capabilities in the Arctic: High Frequency Radar Vessel-tracking" IEEE Radar Conference, Ottawa Canada

Roarty, Glenn, Barrick (2013) "Real-Time Beyond the Horizon Vessel Detection" Radar Sensor Technology XVII, SPIE Paper 8714-36



Selected Recent Publications

Education:

Glenn + 27 Researches + 57 Students, Jan-Feb 2011. The Trans-Atlantic Slocum Glider Expeditions: A Catalyst for Undergraduate Participation in Ocean Science & Technology, *Marine Technology Society Journal*, V. 45, No. 1, p. 52-67.

International Talks

Spain, Norway, Sweden, Poland, Brazil, United Kingdom, South Korea



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