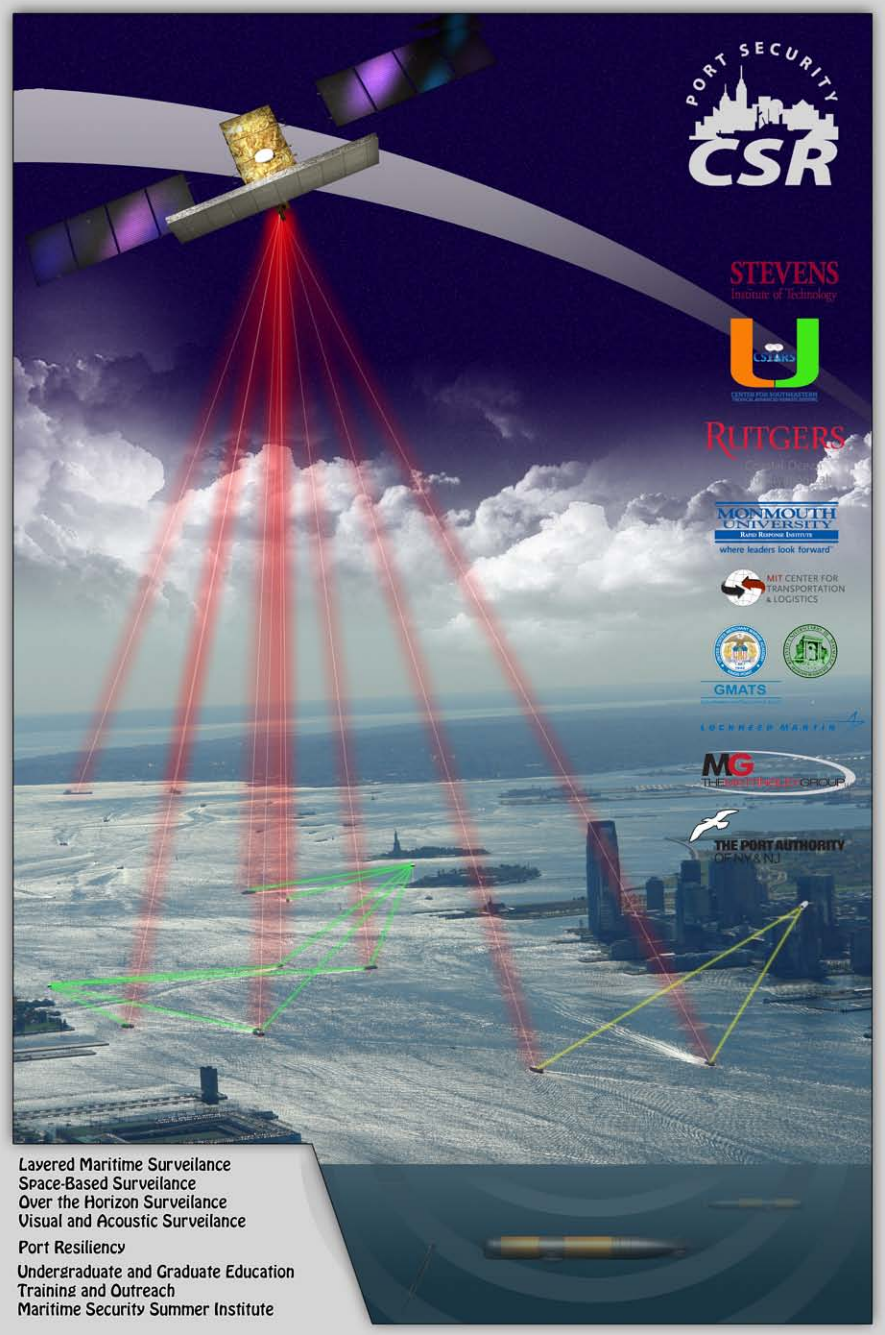
The National Center for Secure and Resilient Maritime Commerce and Coastal Environments: Results from the First NY Harbor Testbed Exercise

Scott Glenn
Rutgers University

Hans Graber
University of Miami

Michael S. Bruno
Stevens Institute of Technology

Presented at
2009 University Programs Summit



The National Center for Secure and Resilient Maritime Commerce

PORT SECURITY CSR

NY Harbor

Maritime Domain Awareness

Approach –
Demonstrate Nested Coverage
Global > Approaches > Port

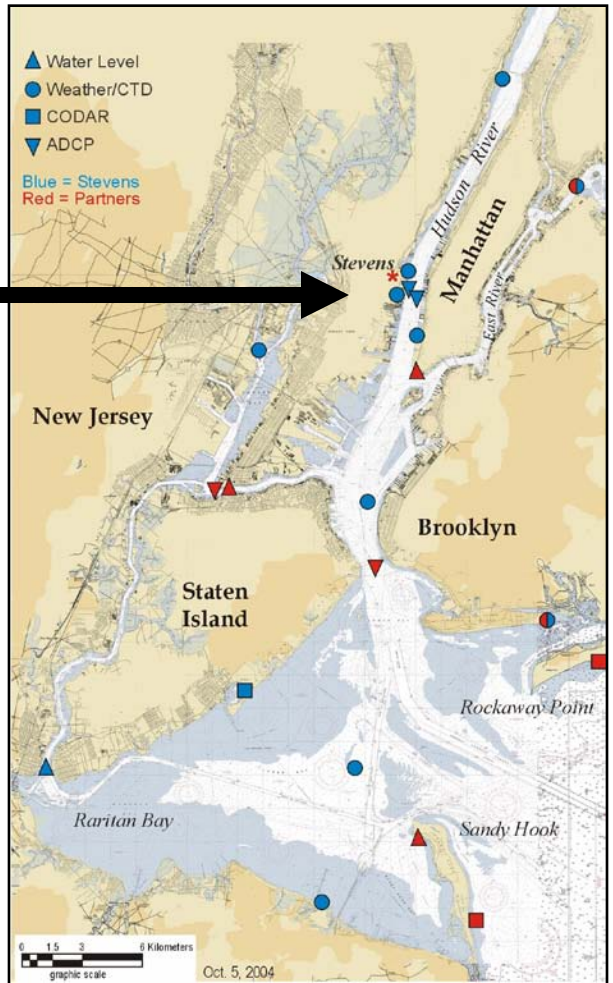
University of Miami –
Global Satellite Coverage,
Visible & Microwave

Rutgers University –
Over-the-Horizon Compact
High Frequency Radar Networks

Stevens Institute of Technology –
Local High-Resolution Optics &
Shallow Underwater Acoustics

Maritime Security Laboratory (MSL)

Fig. 1 The MSL Test Sites
Figure 1 The MSL Test Sites



Laboratory features:

- **Real-time command & control**
- **ems-level experiments & integration**
- **vant environments and scenarios**

Stevens Assets for CSR Research

Boats

UUV

Divers

Hydrophones

Hydrophone array

Stand alone buoy

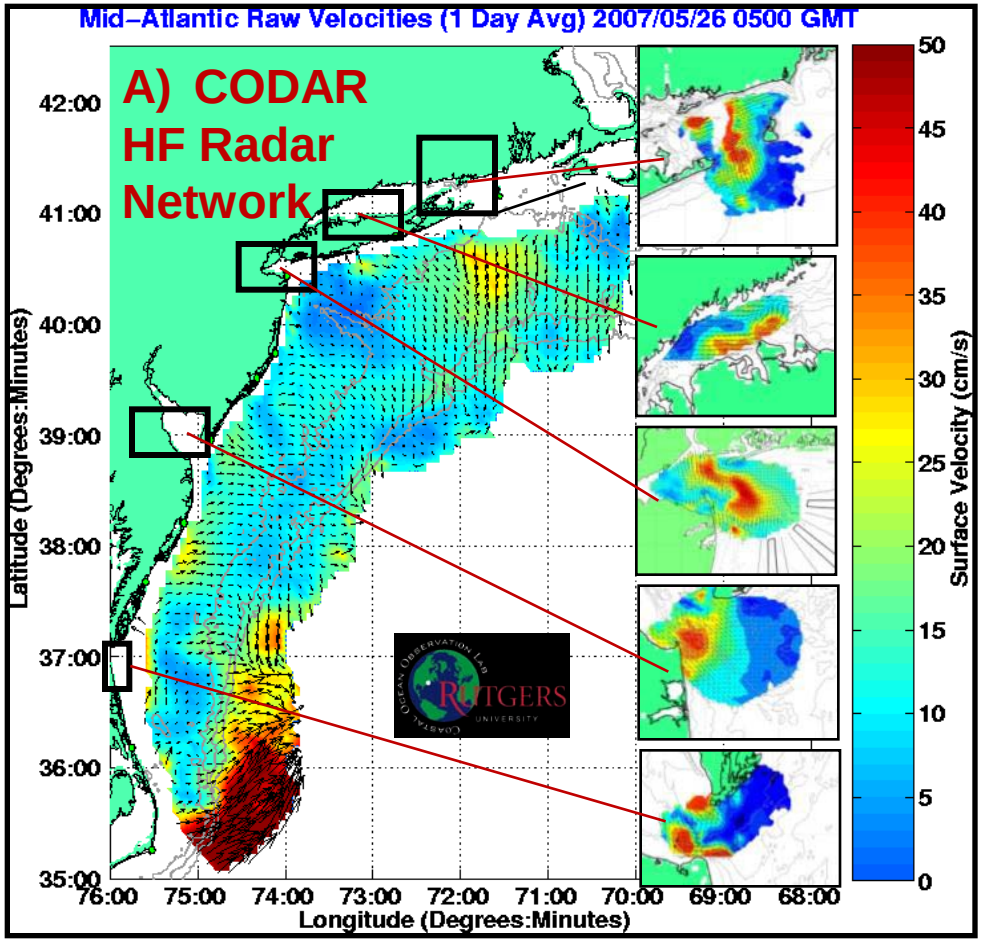
Rutgers University - Coastal Ocean Observation Lab Operations, Data Fusion & Training Center

CODAR Network

L-Band & X-Band Satellite Receivers

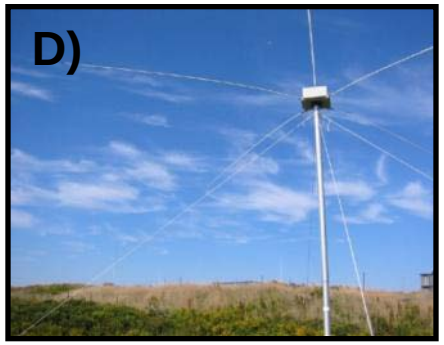
3-D Nowcasts & Forecasts

Glider Fleet


Mid–Atlantic Raw Velocities (1 Day Avg) 2007/05/26 0500 GMT
A) CODAR
HF Radar
Network
Latitude (Degrees:Minutes)
Longitude (Degrees:Minutes)
Surface Velocity (cm/s)
42:00
41:00
40:00
39:00
38:00
37:00
36:00
35:00
76:00
75:00
74:00
73:00
72:00
71:00
70:00
69:00
68:00
50
45
40
35
30
25
20
15
10
5
0
RUTGERS
UNIVERSITY

B)

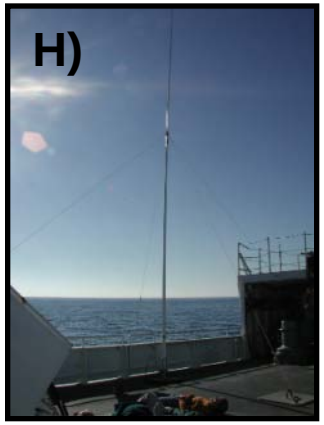
C)


D)

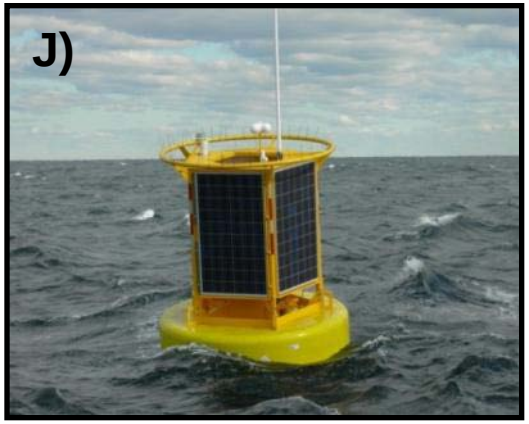
E)

F)

G)

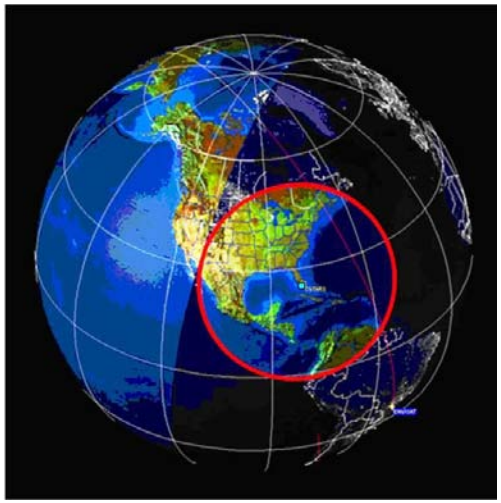

H)

I)


J)

Center for Southeastern Tropical Advanced Remote Sensing (CSTARS) University of Miami

Former U.S. Naval Observatory Alternate Time Tracking Station



Sponsors:
Office of Naval Research (DoD) and NASA

A Satellite Data Reception and Analysis Facility

for Environmental Monitoring and Time Sensitive Tactical Applications in the Southeastern US, Gulf of Mexico, Caribbean Basin and Equatorial Atlantic

CSTARS Current and Future Satellite Reception Capabilities

Current Agreements:

RADARSAT-1	*(microwave SAR)*
ERS-2	*(microwave SAR)*
* SPOT 2/4	*(hi-res electro-optical visible)*
* ENVISAT-ASAR	*(microwave SAR)*
ENVISAT-MERIS	*(med-res electro-optical visible)*
MODIS-TERRA/AQUA	*(med-res electro-optical visible)*
SPOT-5	*(very hi-res electro-optical visible)*

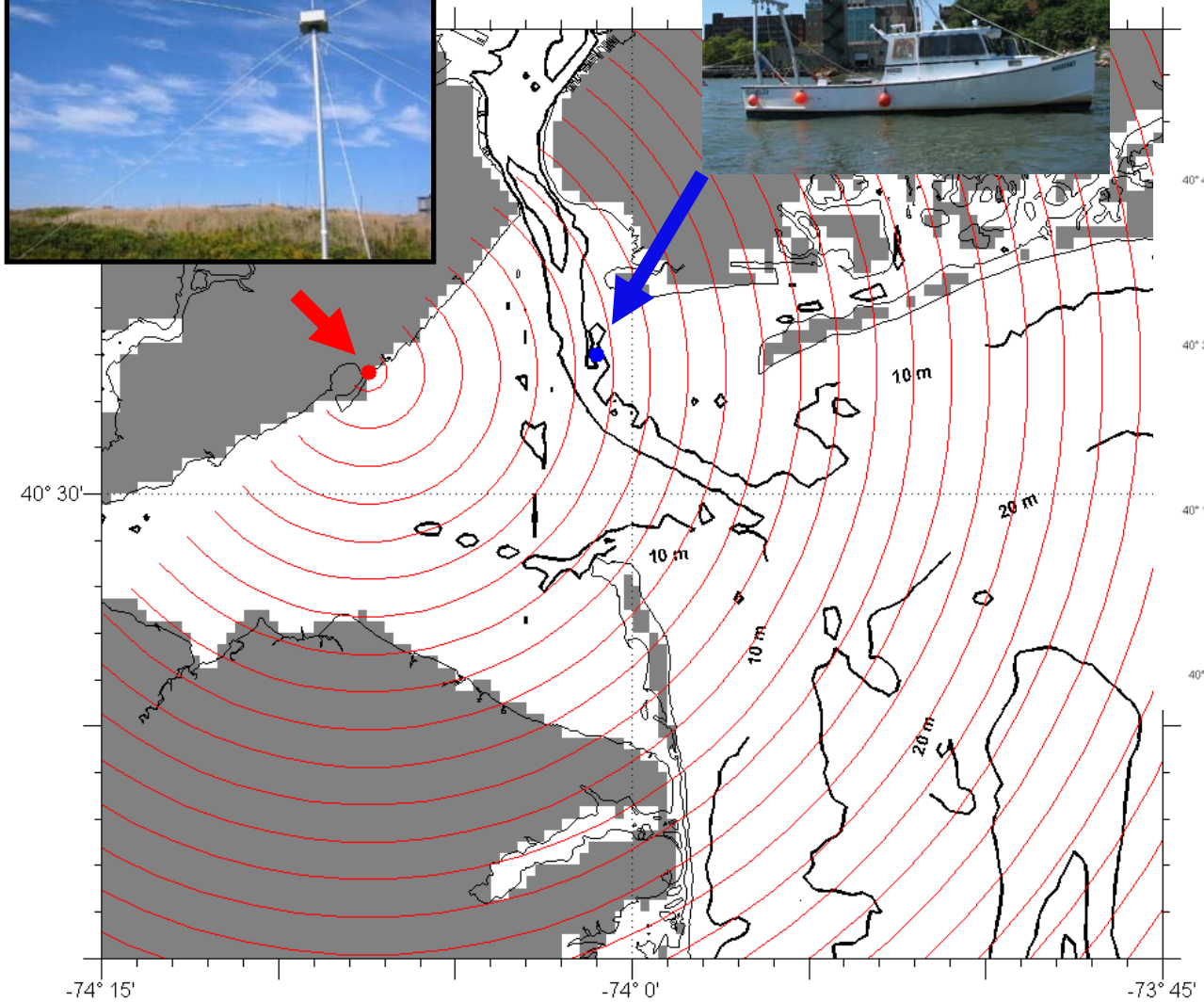
Future and Planned Agreements:

RADARSAT-2	*(very hi-res microwave SAR)*
TerraSAR-X	*(very hi-res microwave SAR)*
ALOS/PALSAR	*(hi-res optical & microwave SAR)*
** FormoSat 2*	*(very hi-res electro-optical visible)*
SarLupe	*(very hi-res microwave SAR)*
CosmoSkyMed	*(very hi-res microwave SAR)*

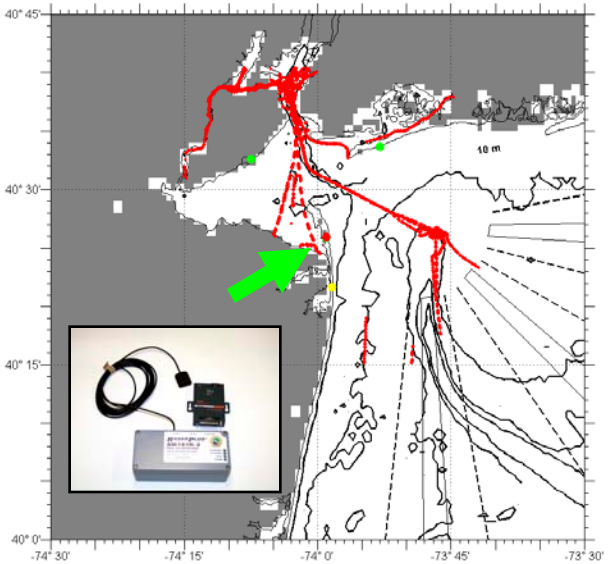
NY Harbor Testbed Experiment – November 19, 2008

CODAR Shore Site

R/V Savitsky

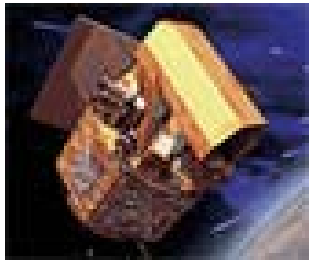


AIS Data from
Large Vessels



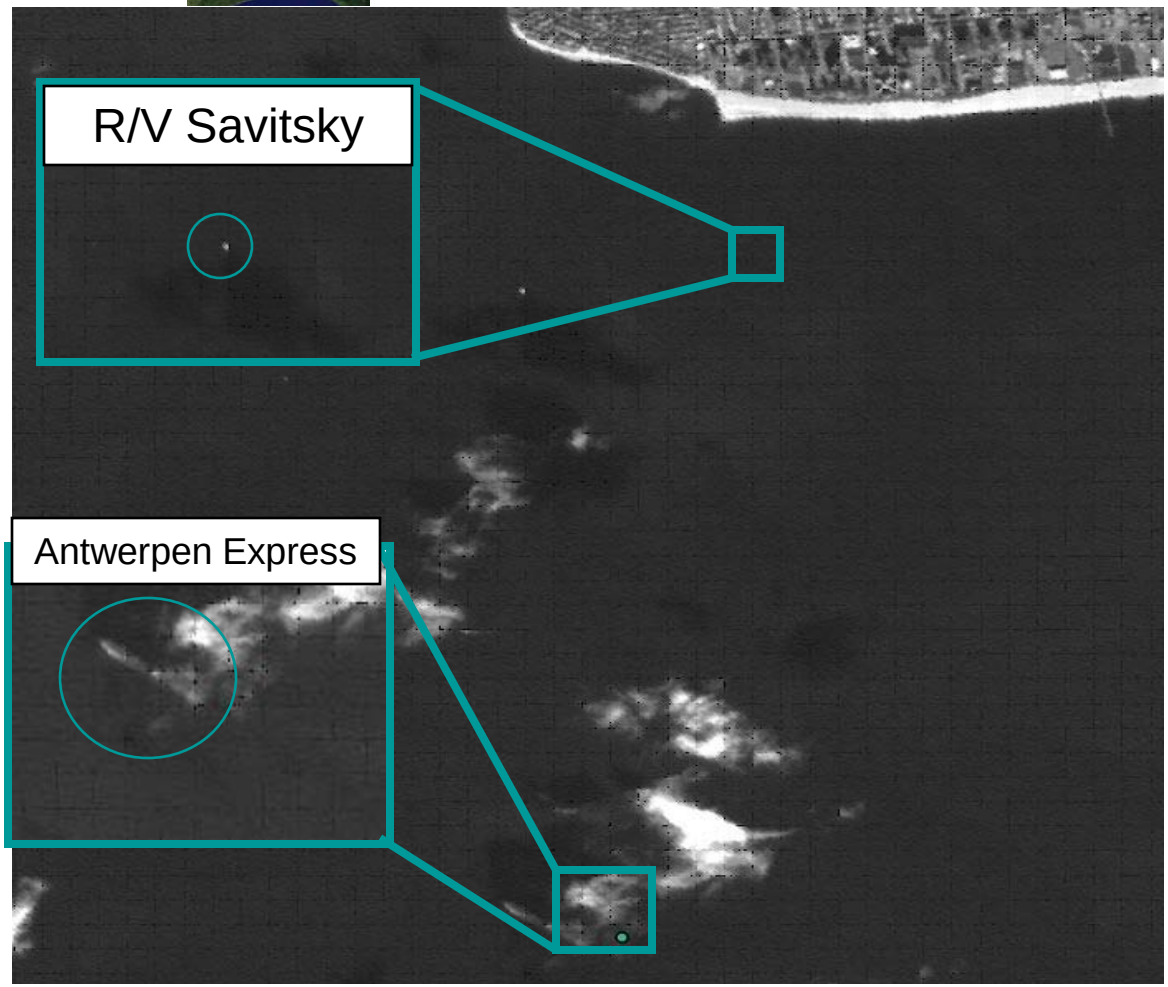
NY Harbor Testbed Experiment – November 19, 2008

Satellite Data Collection:
SPOT, ENIVSAT, FormoSat

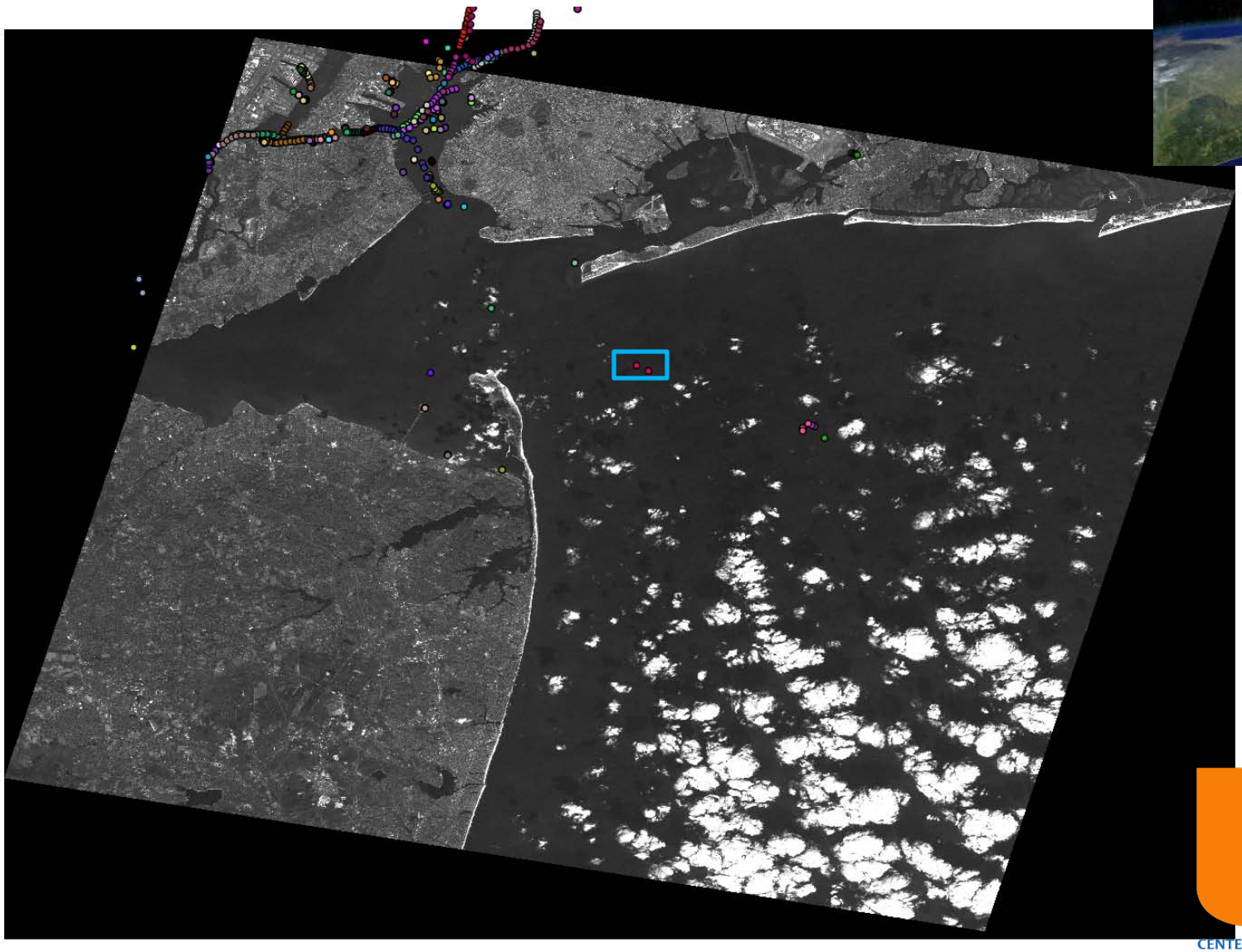


R/V Savitsky

Antwerpen Express

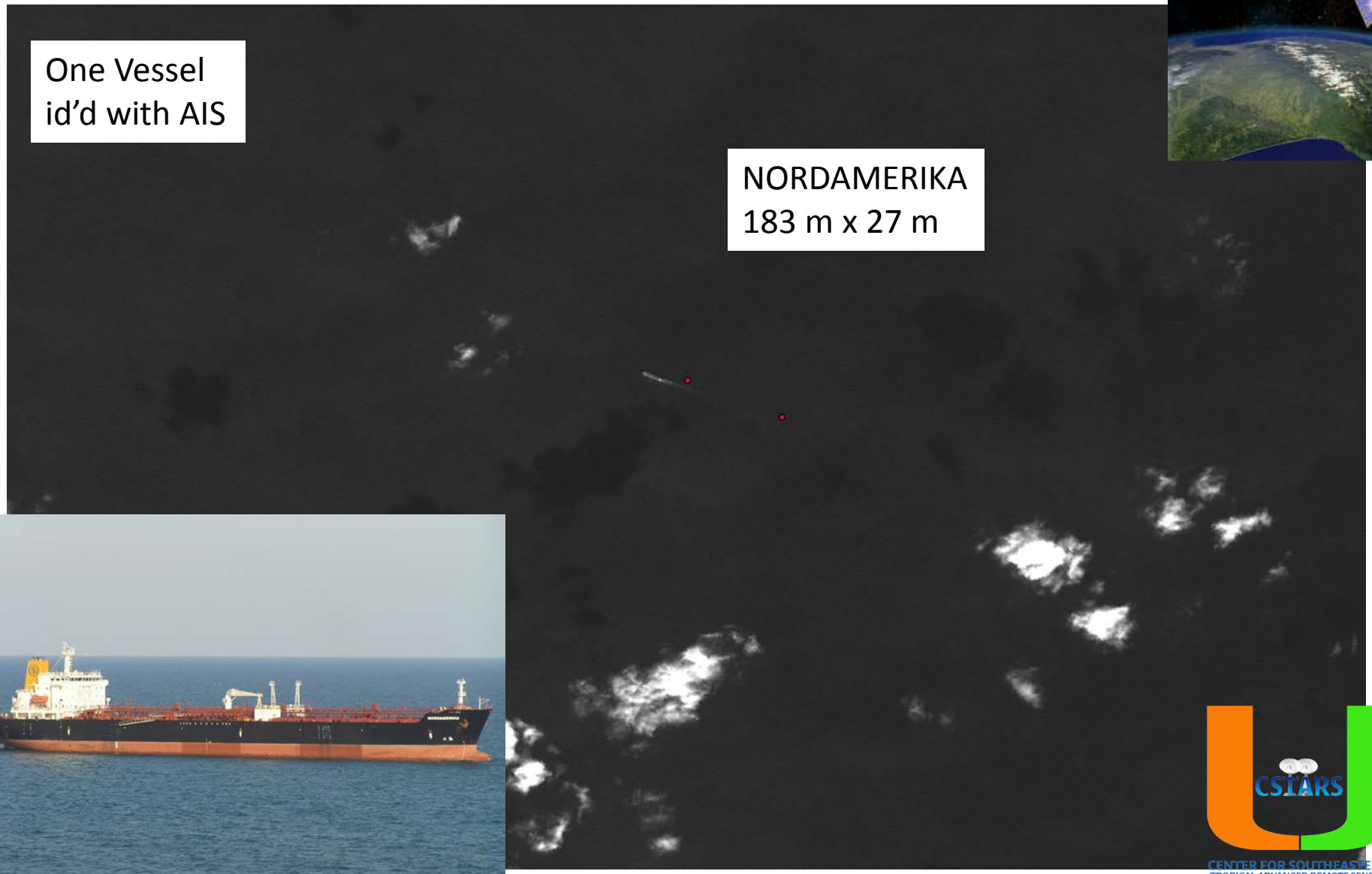


SPOT 4 with AIS data overlay



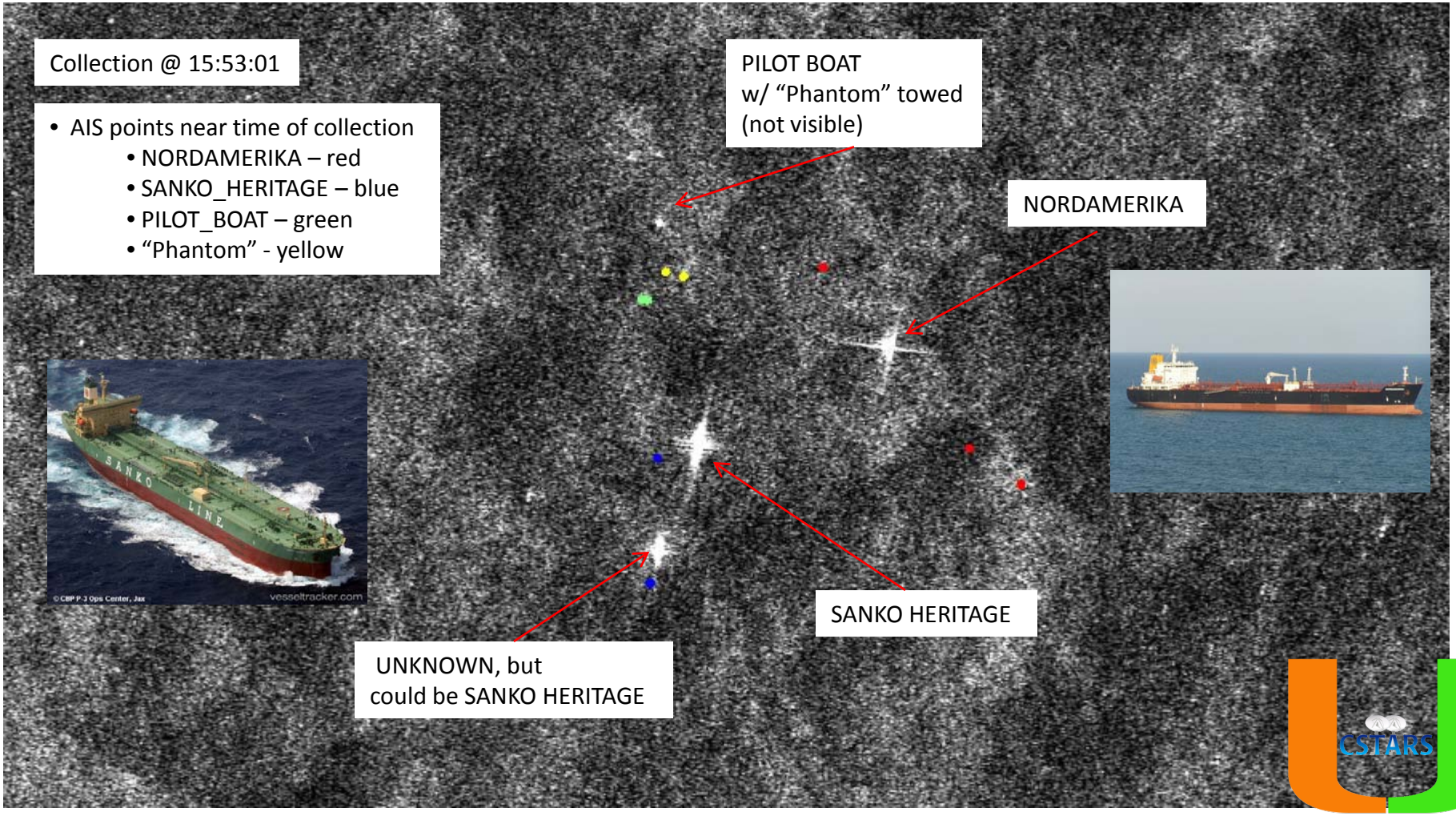
CENTER FOR SOUTHEASTERN
TROPICAL ADVANCED REMOTE SENSING

Close up of 60 km swath width 15:49:06 UTC



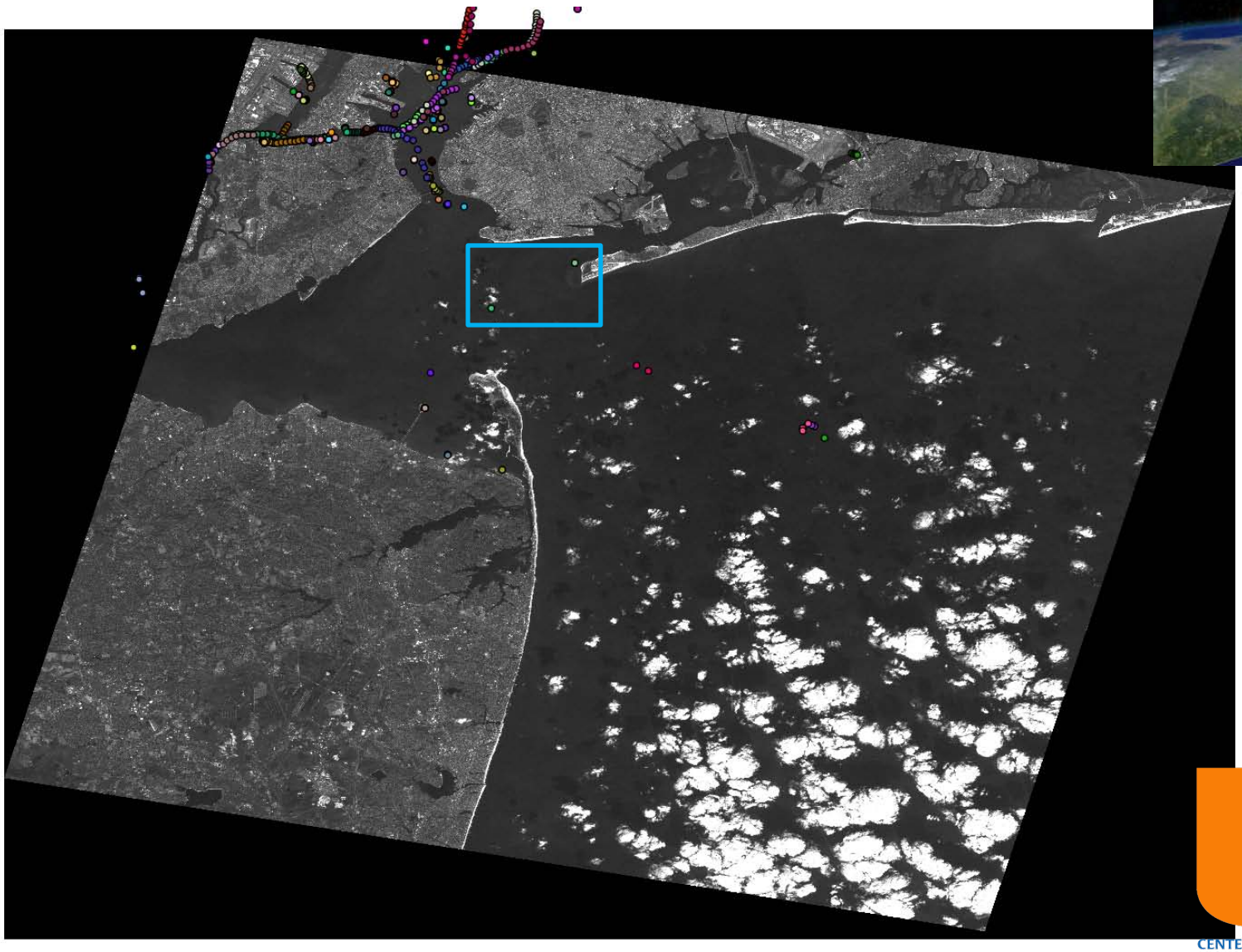
CSTARS
CENTER FOR SOUTHEASTERN TROPICAL ADVANCED REMOTE SENSING

ENVISAT 11/19/2008
All-weather Microwave



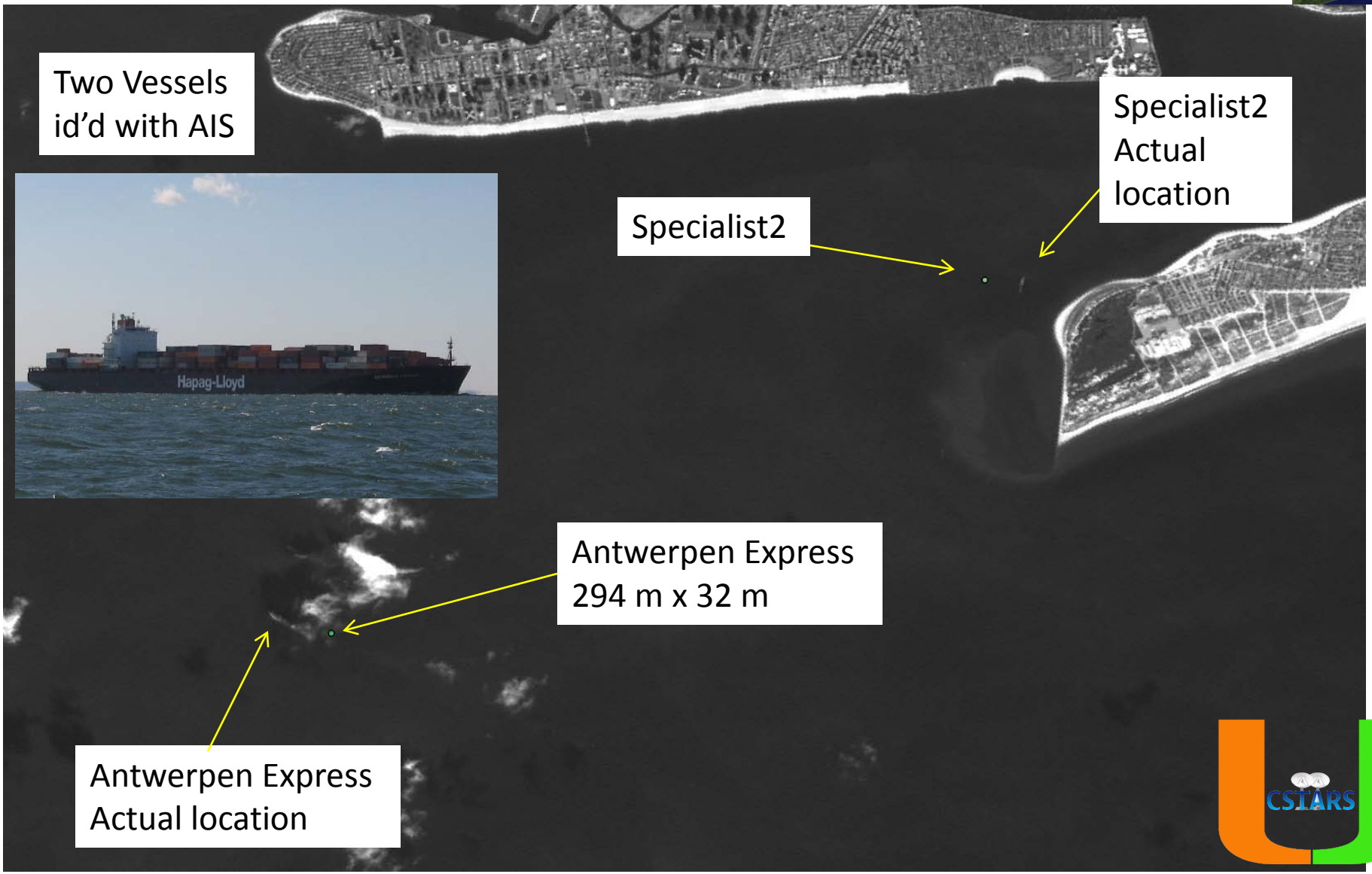
CSTARS
CENTER FOR SOUTHEASTERN
TROPICAL ADVANCED REMOTE SENSING

SPOT 4 with AIS data overlay



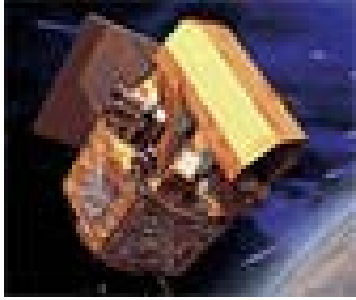
CENTER FOR SOUTHEASTERN
TROPICAL ADVANCED REMOTE SENSING

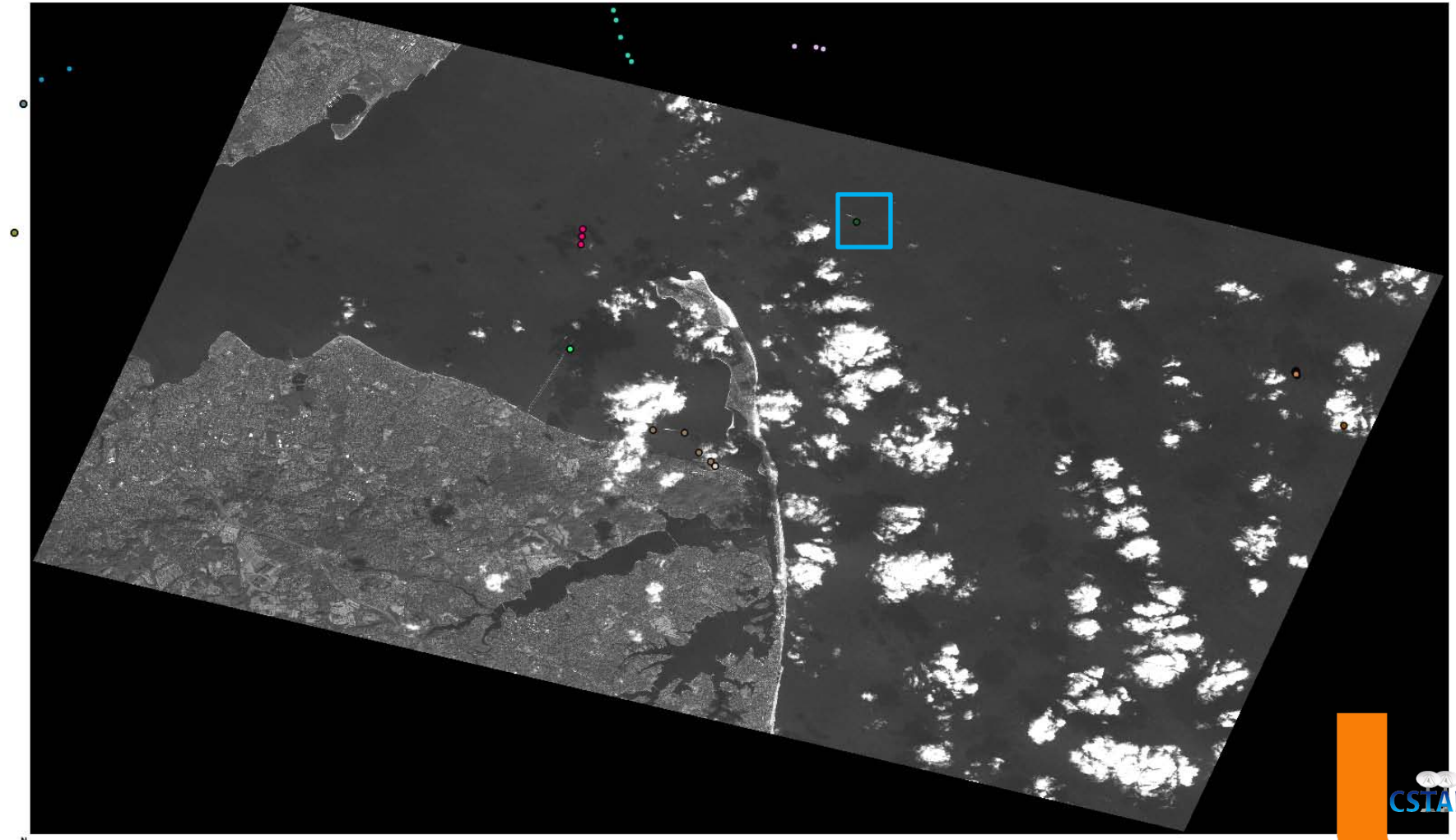
Close up of Spot 4



CSTARS
CENTER FOR SOUTHEASTERN TROPICAL ADVANCED REMOTE SENSING

Formosat with AIS data overlay 15:37:09 UTC

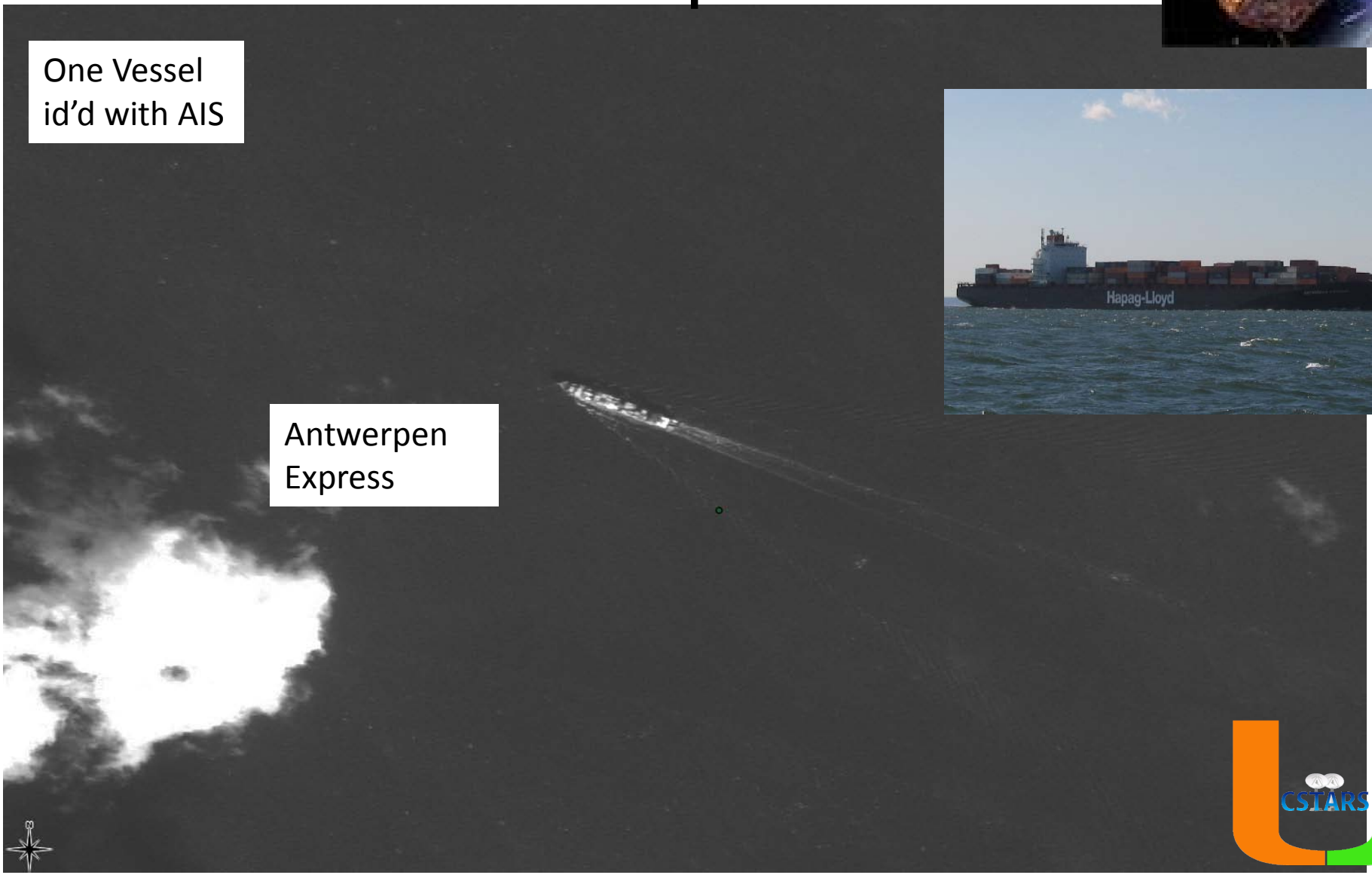




CSTARS

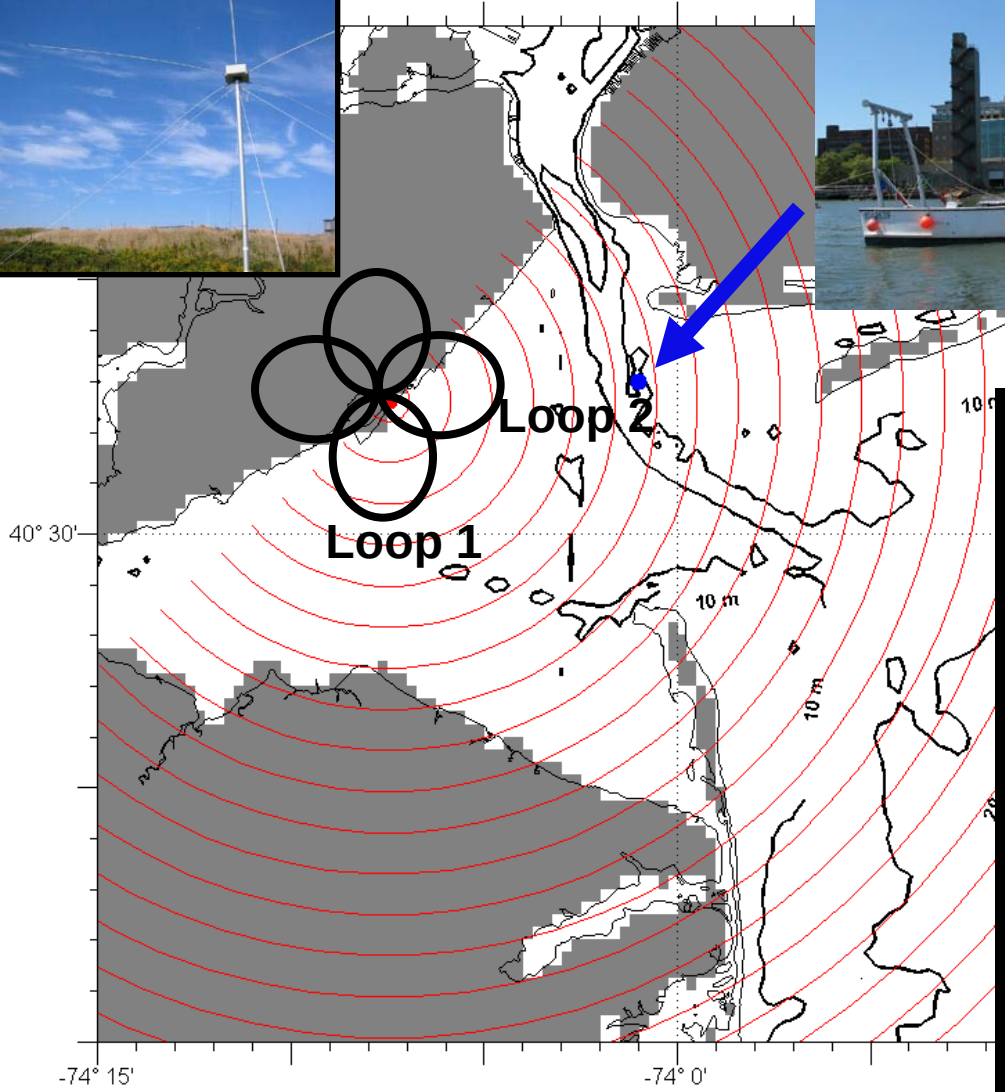
CENTER FOR SOUTHEASTERN TROPICAL ADVANCED REMOTE SENSING

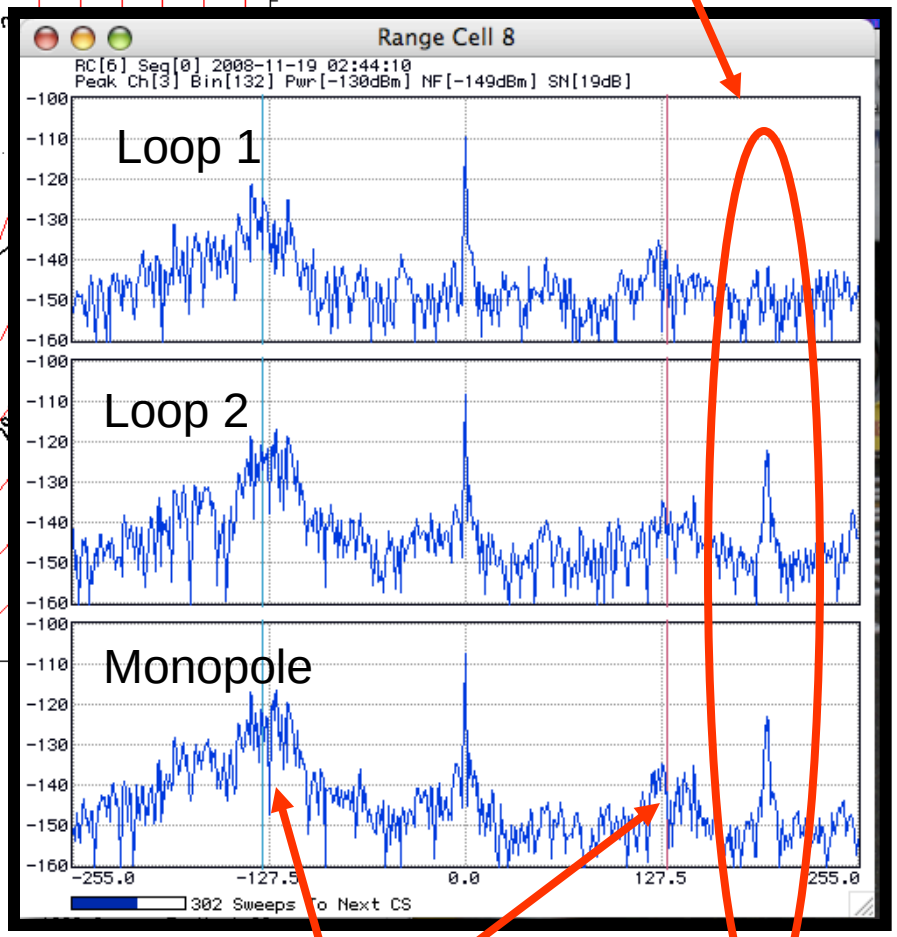
FormoSat 2 m Panchromatic Close Up



CSTARS
CENTER FOR SOUTHEASTERN TROPICAL ADVANCED REMOTE SENSING

Signal present in Loop 2 and Monopole. Signal originated in direction of Stevens anchor site.

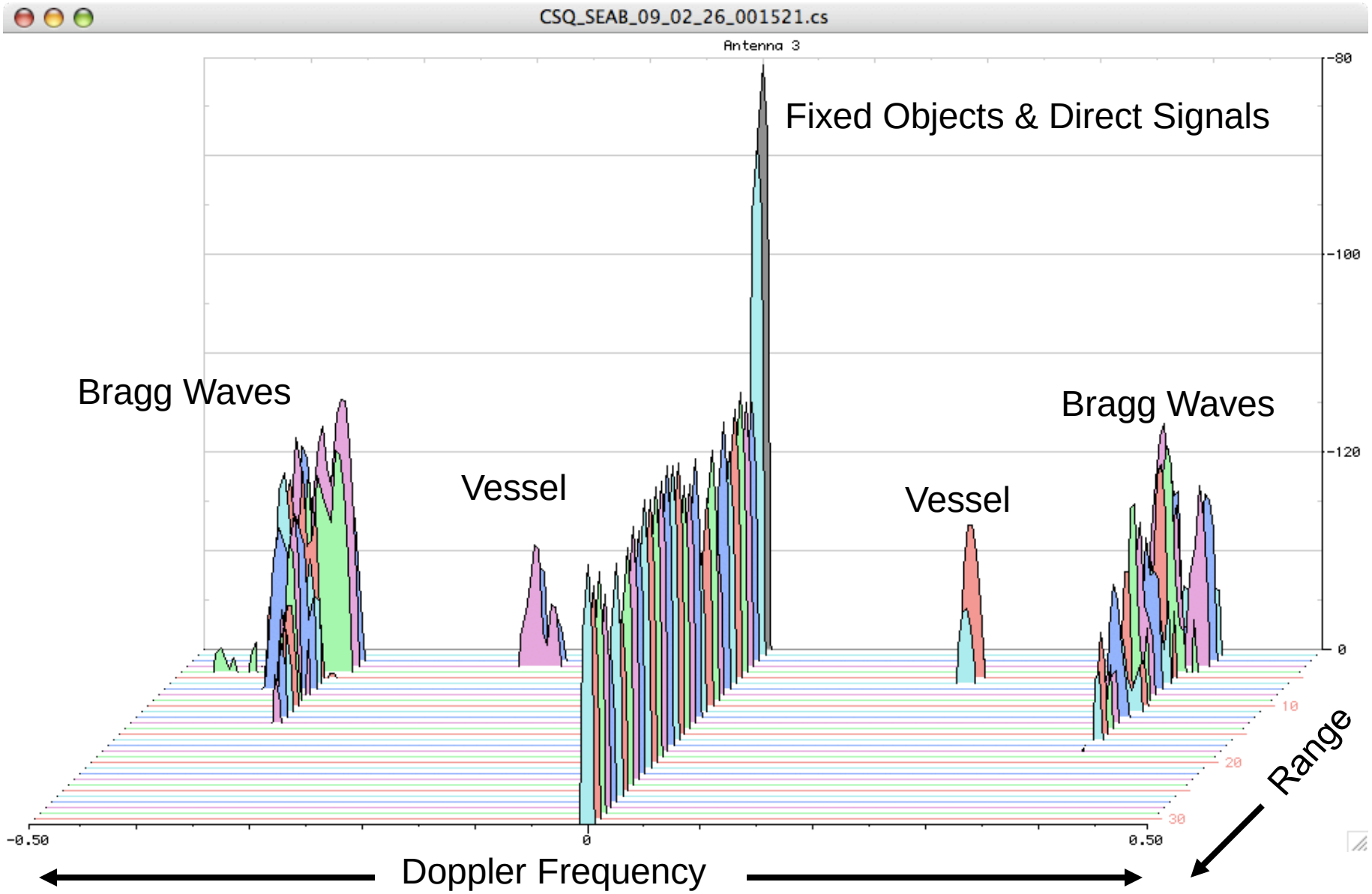




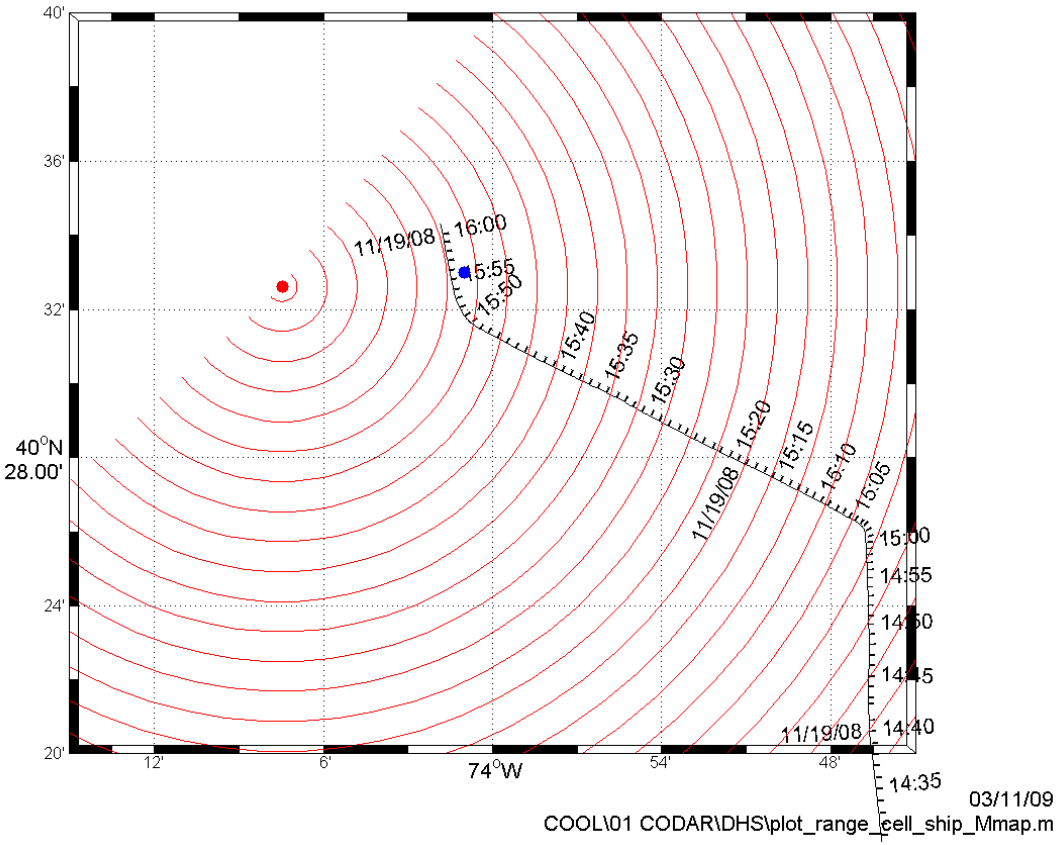
Bragg Waves

HF Radar Geometry & Doppler Spectra from Range Cell 8

Doppler Spectra from all Range Cells with Detection Threshold Applied



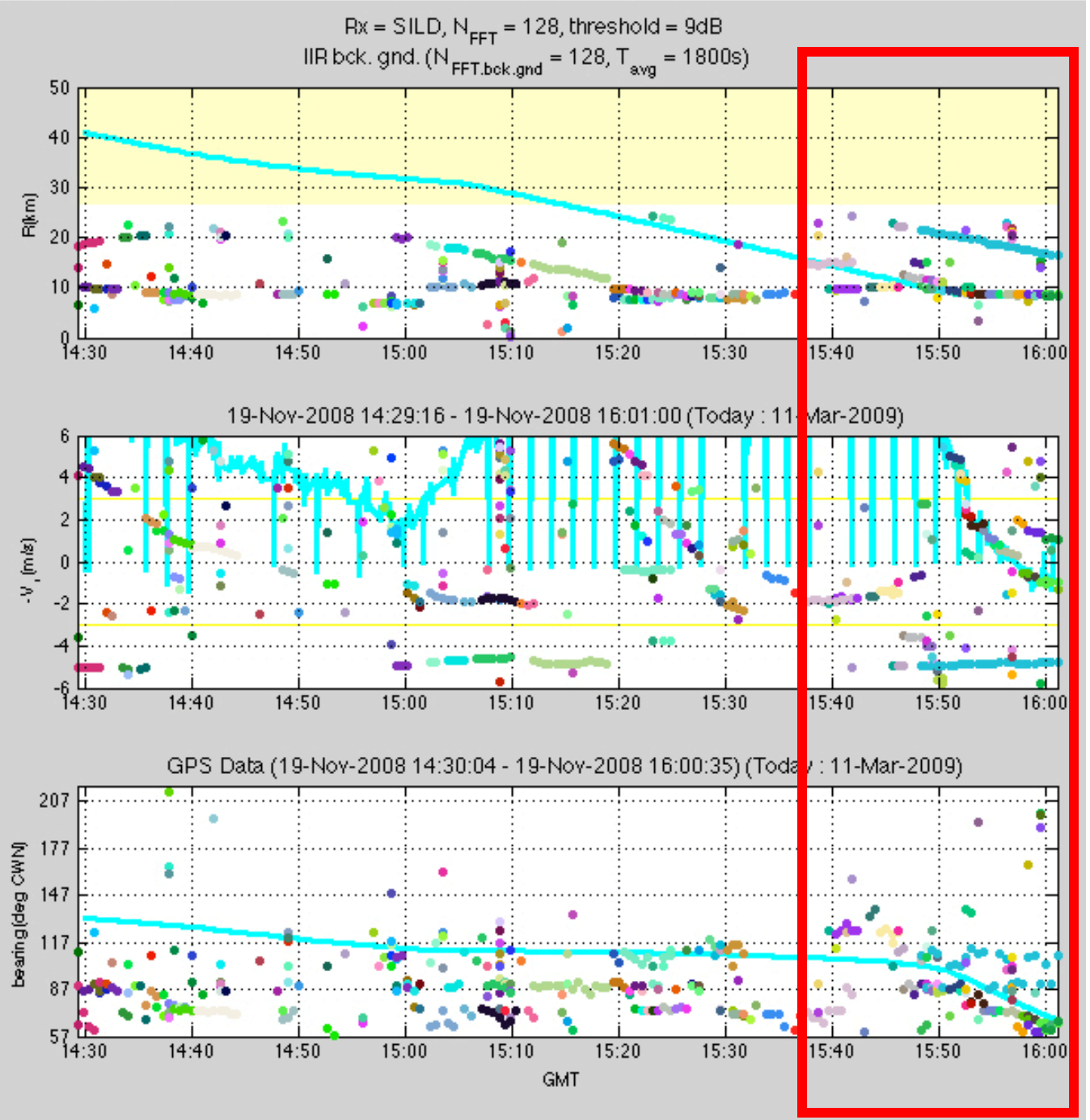
Antwerpen Express Inbound



ANTWERPEN EXPRESS

Vessel's Details:

Ship Type: Cargo
Year Built: 2000
Length x Breadth: 294m X 32m
DeadWeight: 67145 MT
Speed recorded (Max / Average): 21 / 20.8 knots
Flag: Germany [DE]
Call Sign: DGAF
IMO: 9193288, **MMSI:** 211311970



25 MHz Pepper Plot

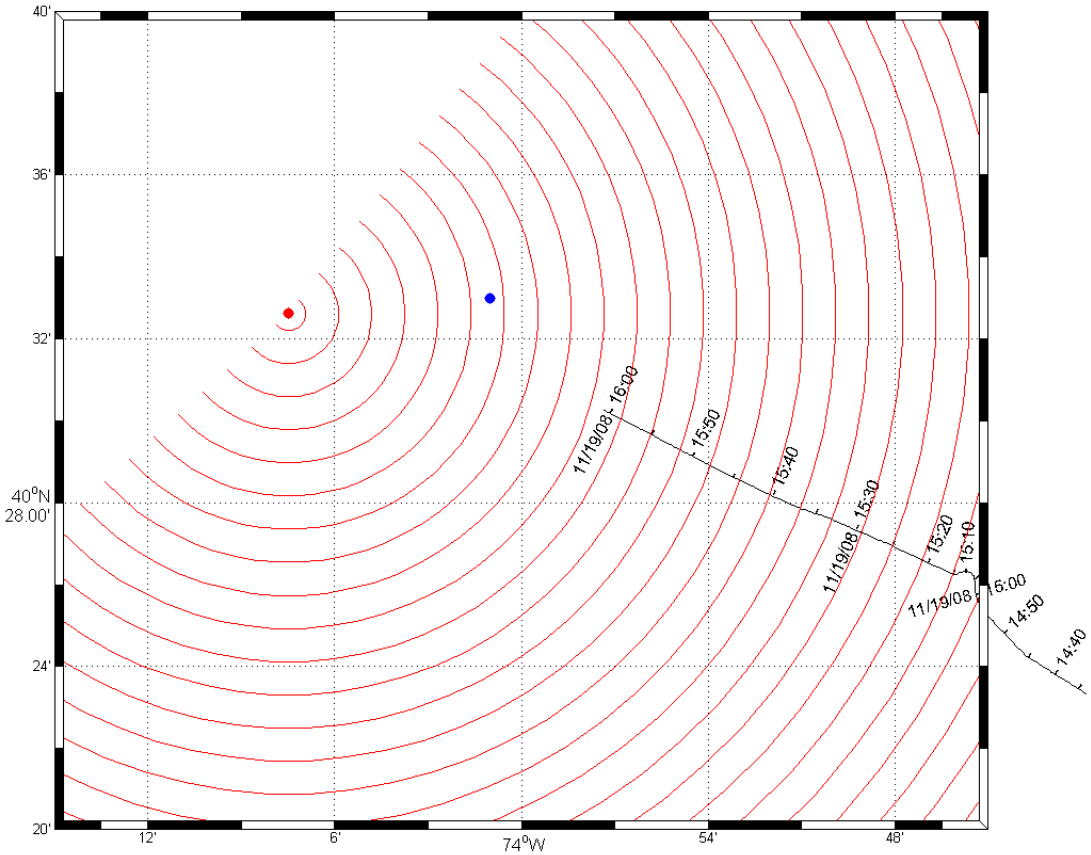
Aqua line represents Antwerpen Express

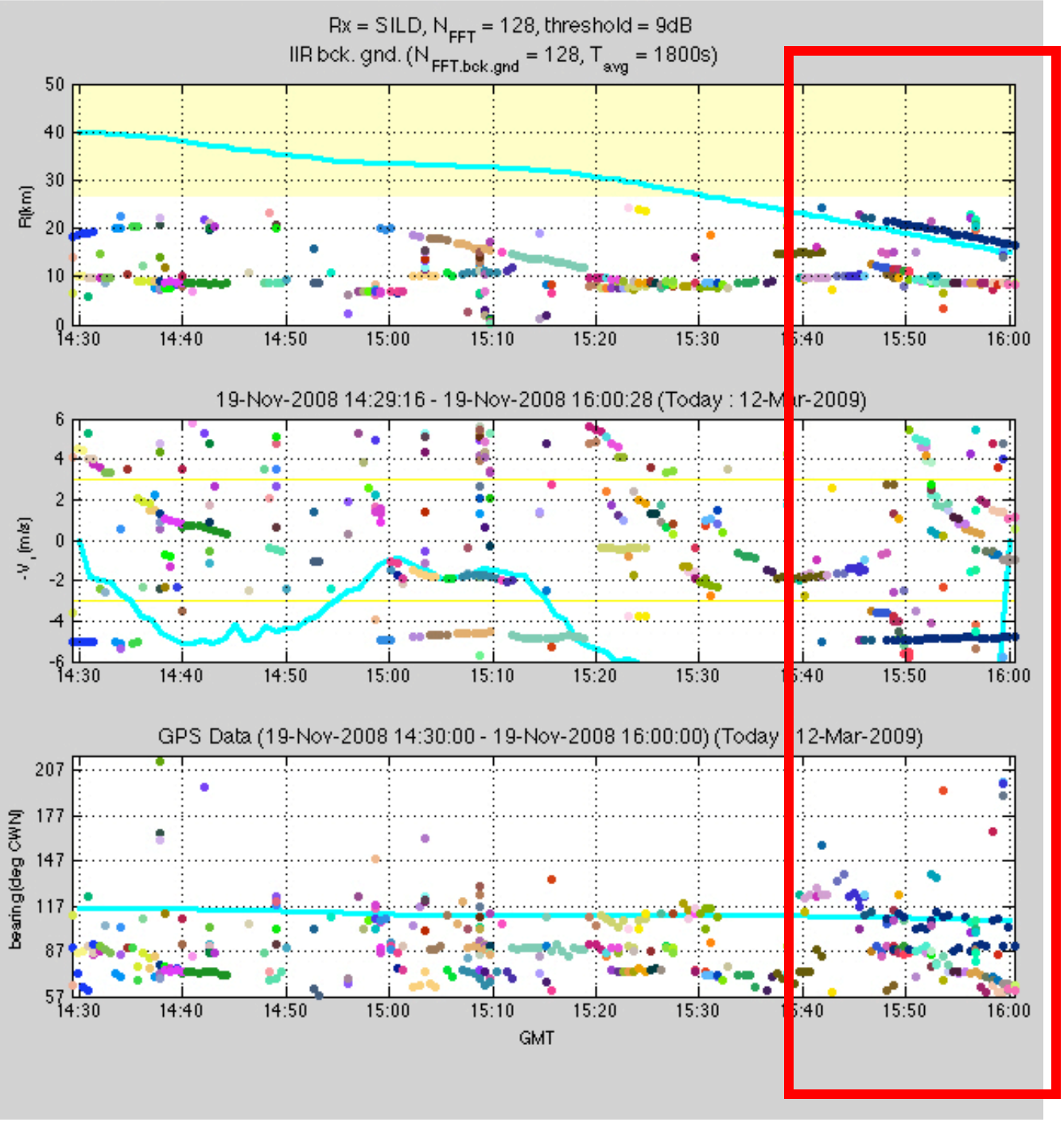
Nordamerika Inbound

NORDAMERIKA

Vessel's Details:

Ship Type: Tanker
Year Built: 2000
Length x Breadth: 183m X 27m
DeadWeight: 35775 MT
Speed recorded (Max / Average): 14.5 / 14 knots
Flag: Marshall Is [MH]
Call Sign: V7GG6
IMO: 9212400, **MMSI:** 538090216

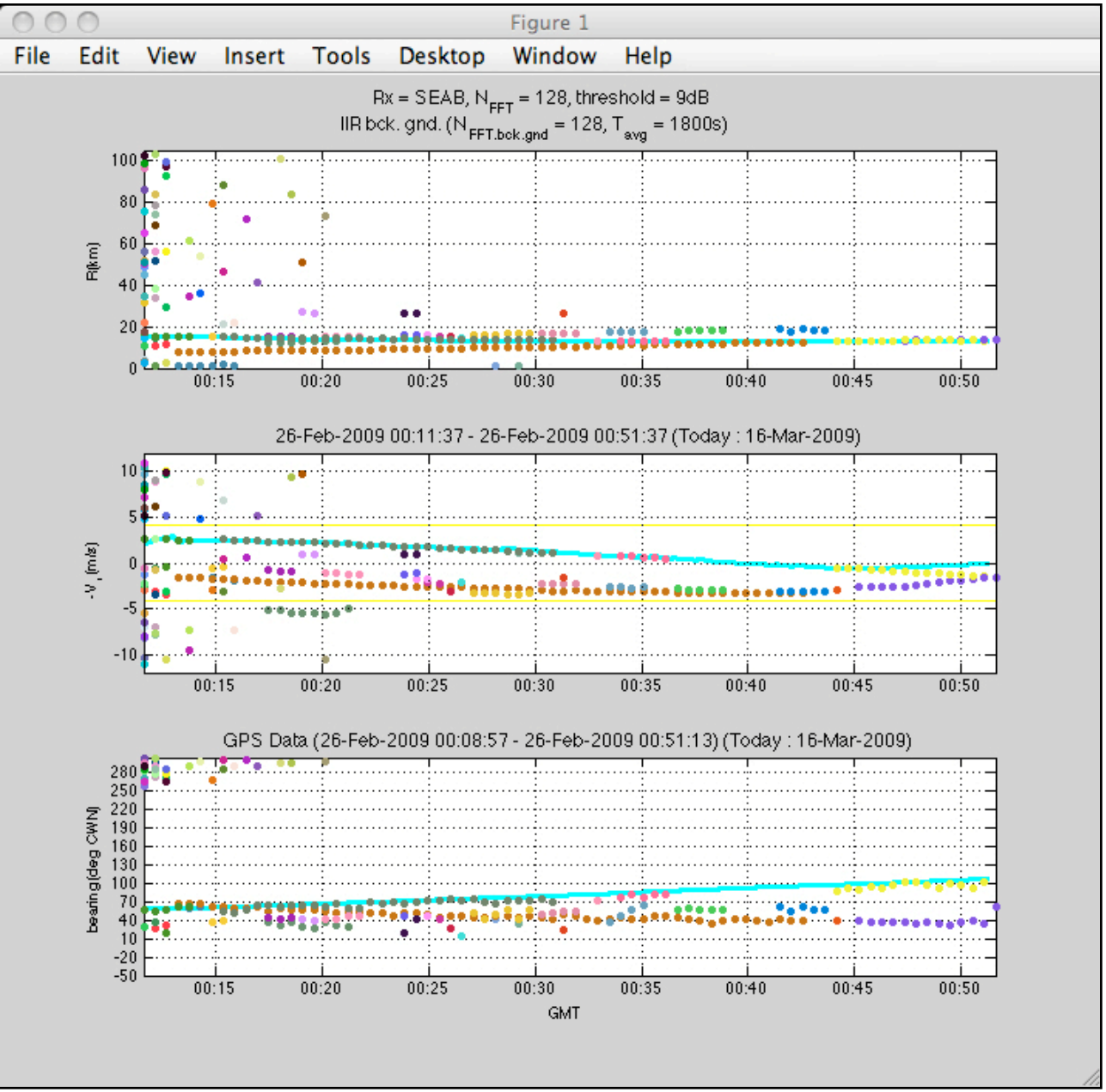




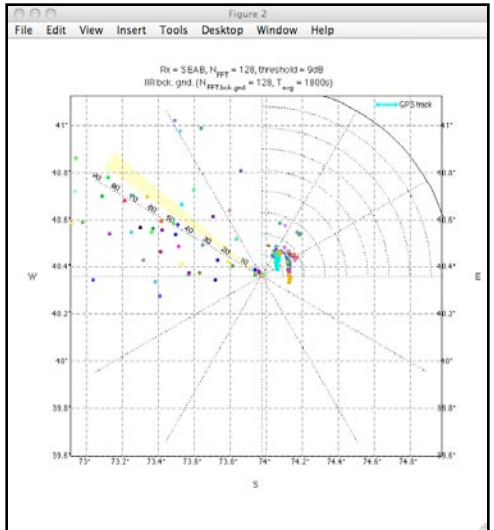
25 MHz Pepper Plot

Aqua line represents Nordamerika

First Detection Test for a Vessel Transiting Along the Coast

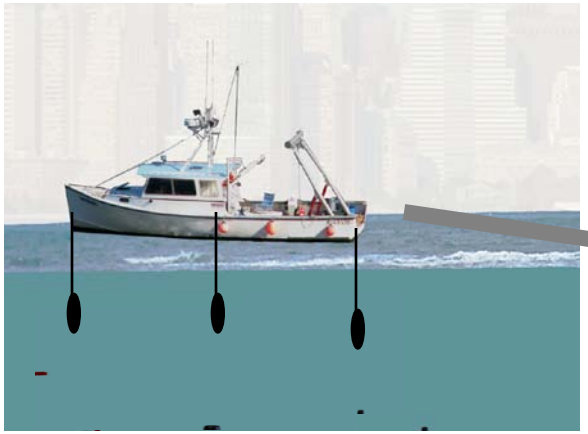


MAAS Trader, Container Ship, 139.49 meters, 9,881 tons, Netherlands

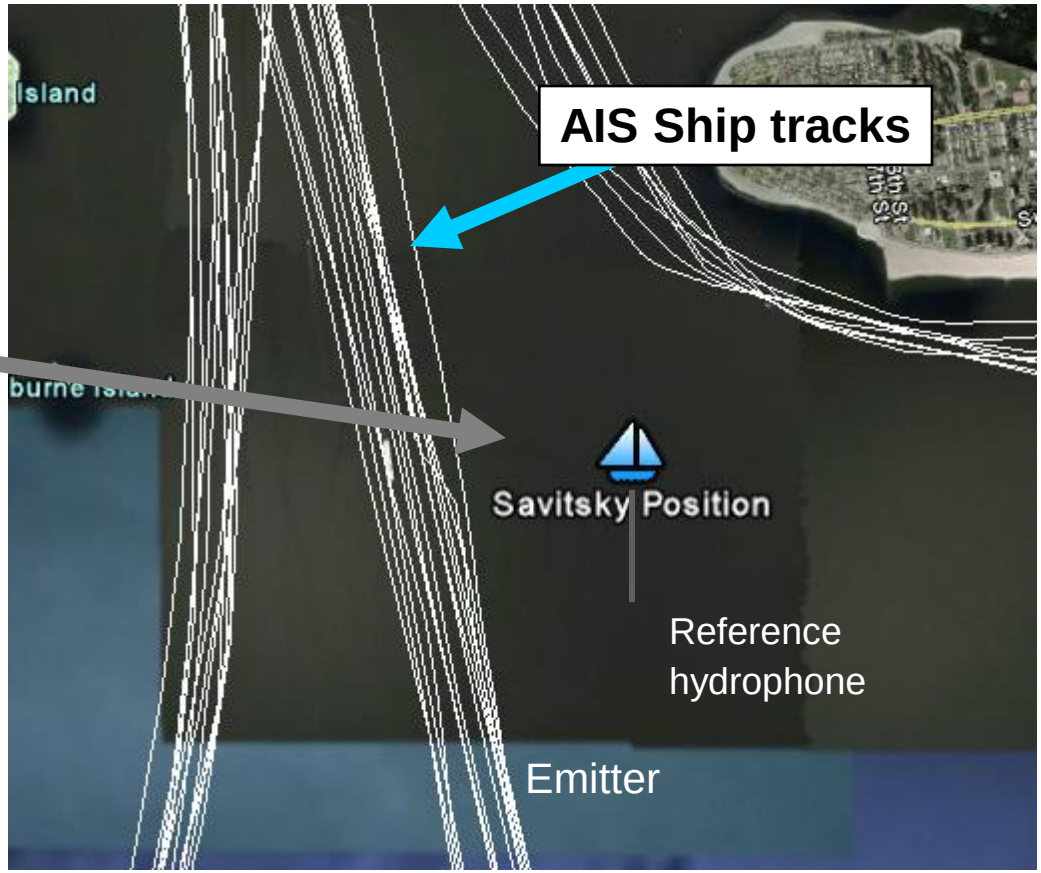


Acoustic ship signatures measured in NY Harbor

R/V Savitsky



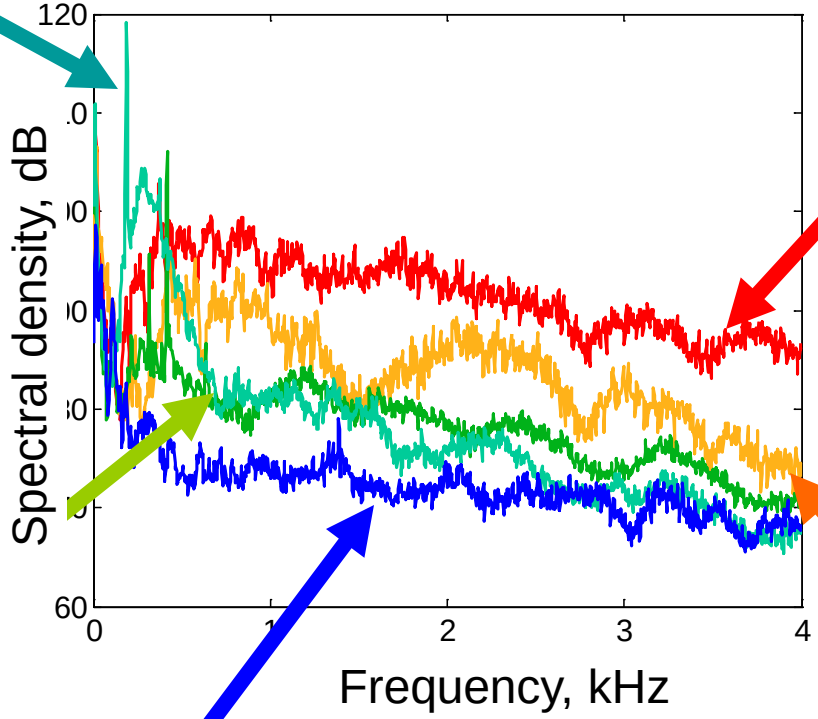
●Hydrophones



Acoustic signatures of various ships

Unknown – Passenger ship

Antwerpen Express - Cargo



Lincoln Sea - Tug

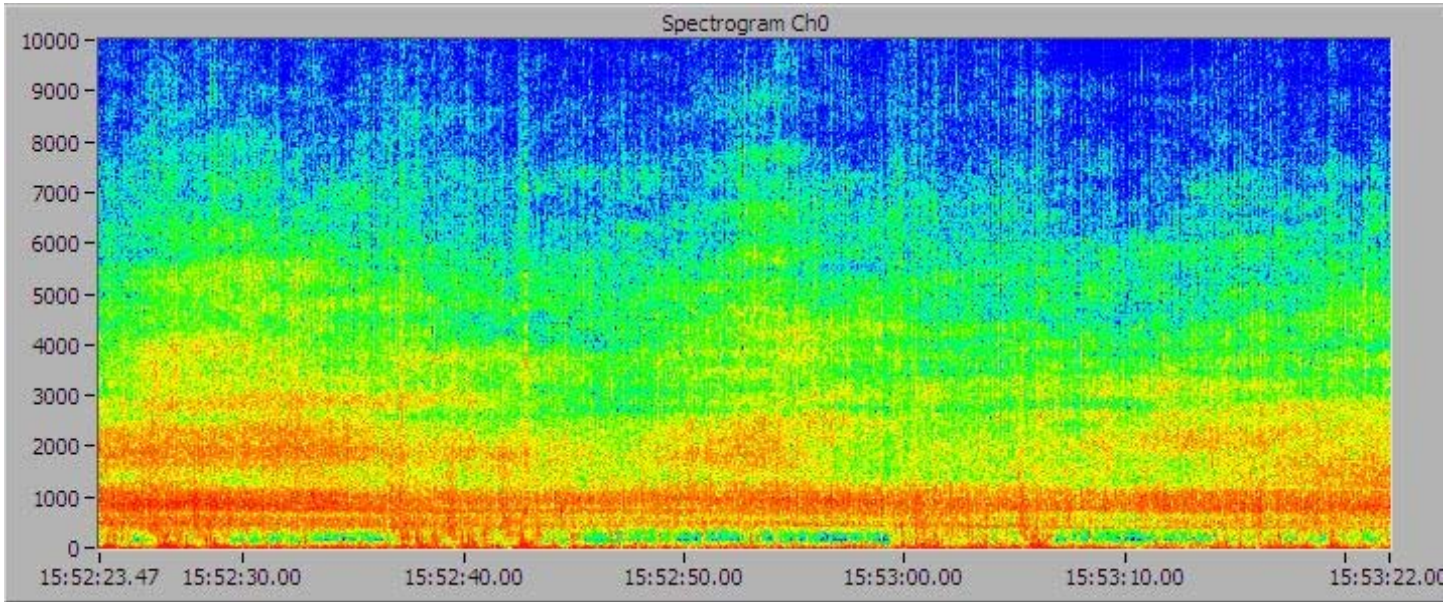
MOL Endurance - Cargo

Background noise, No ships

Acoustic signal analysis

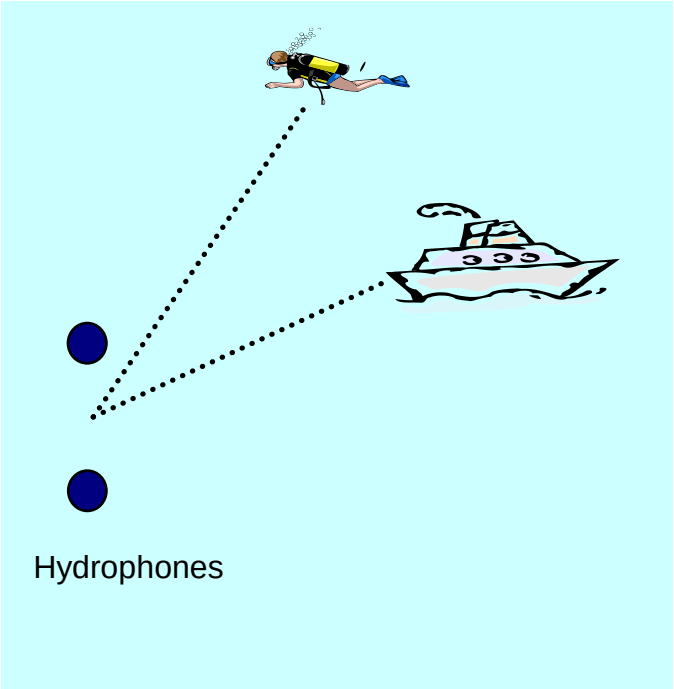
Antwerpen Express

Spectrogram

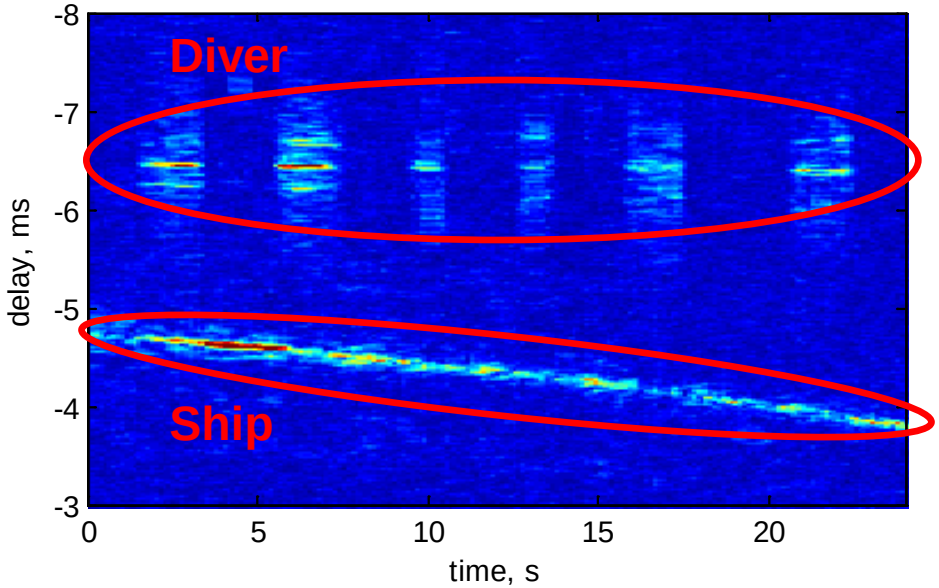


Cross-correlation technique for ship (and diver) signal separation

Sound reaches hydrophones with a **delay τ** that varies with direction.



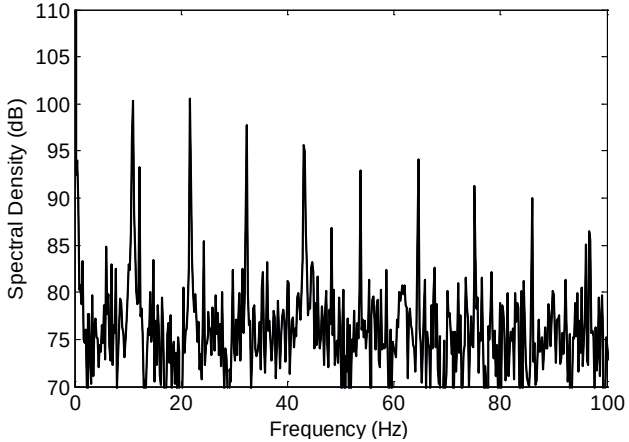
Cross-correlation allows analysis of delay between signals. Computing it as function of time enables tracking of moving sound sources

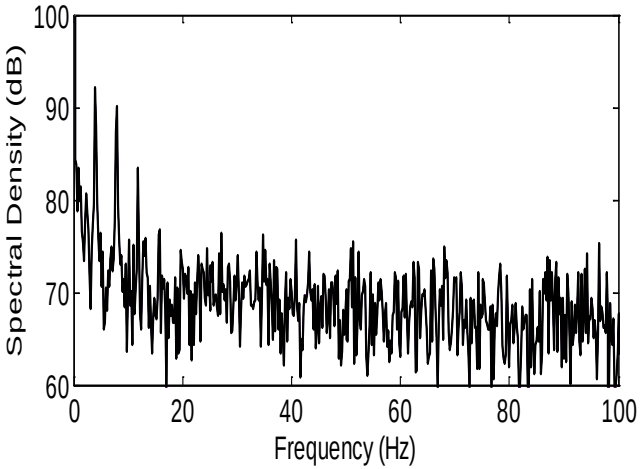


Comparison of Ship Acoustic Signatures

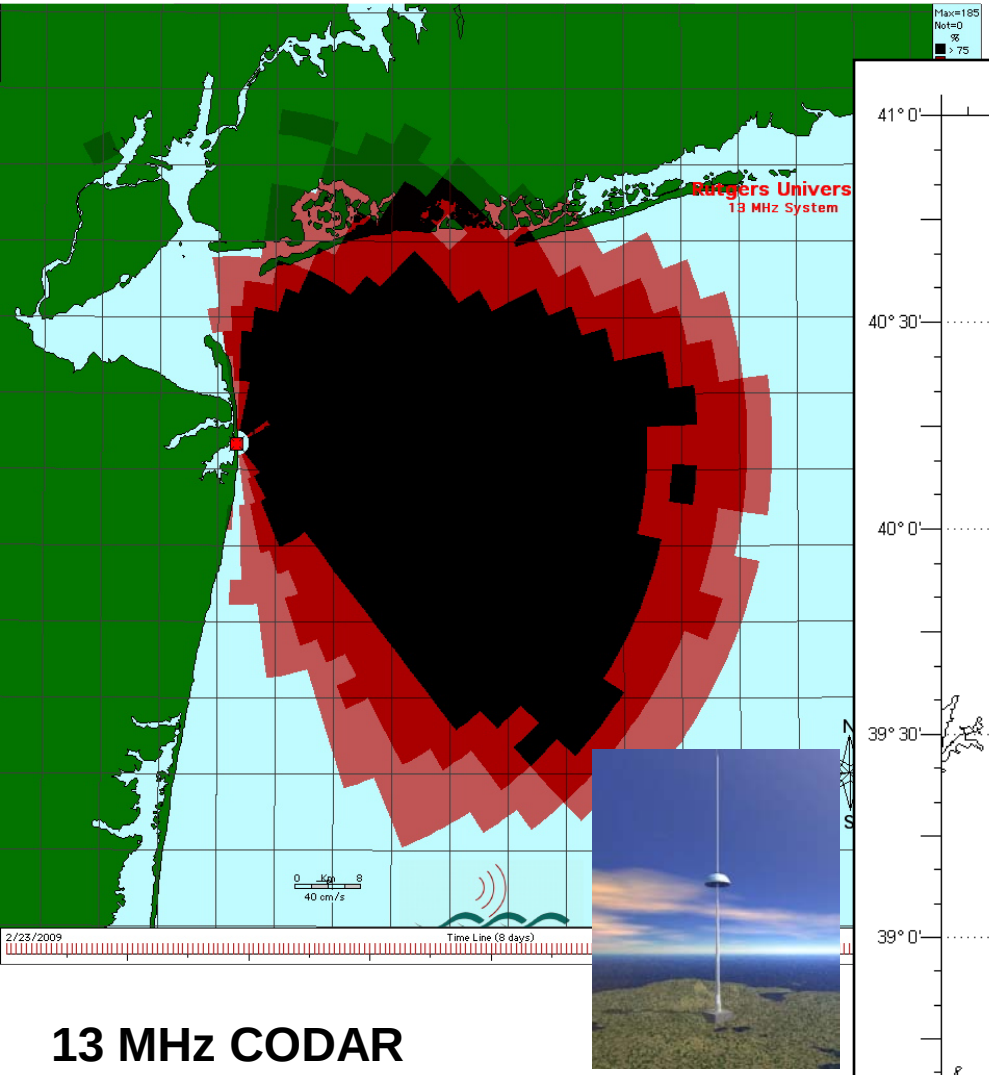
Spectra of ship noise envelop in high frequency band:

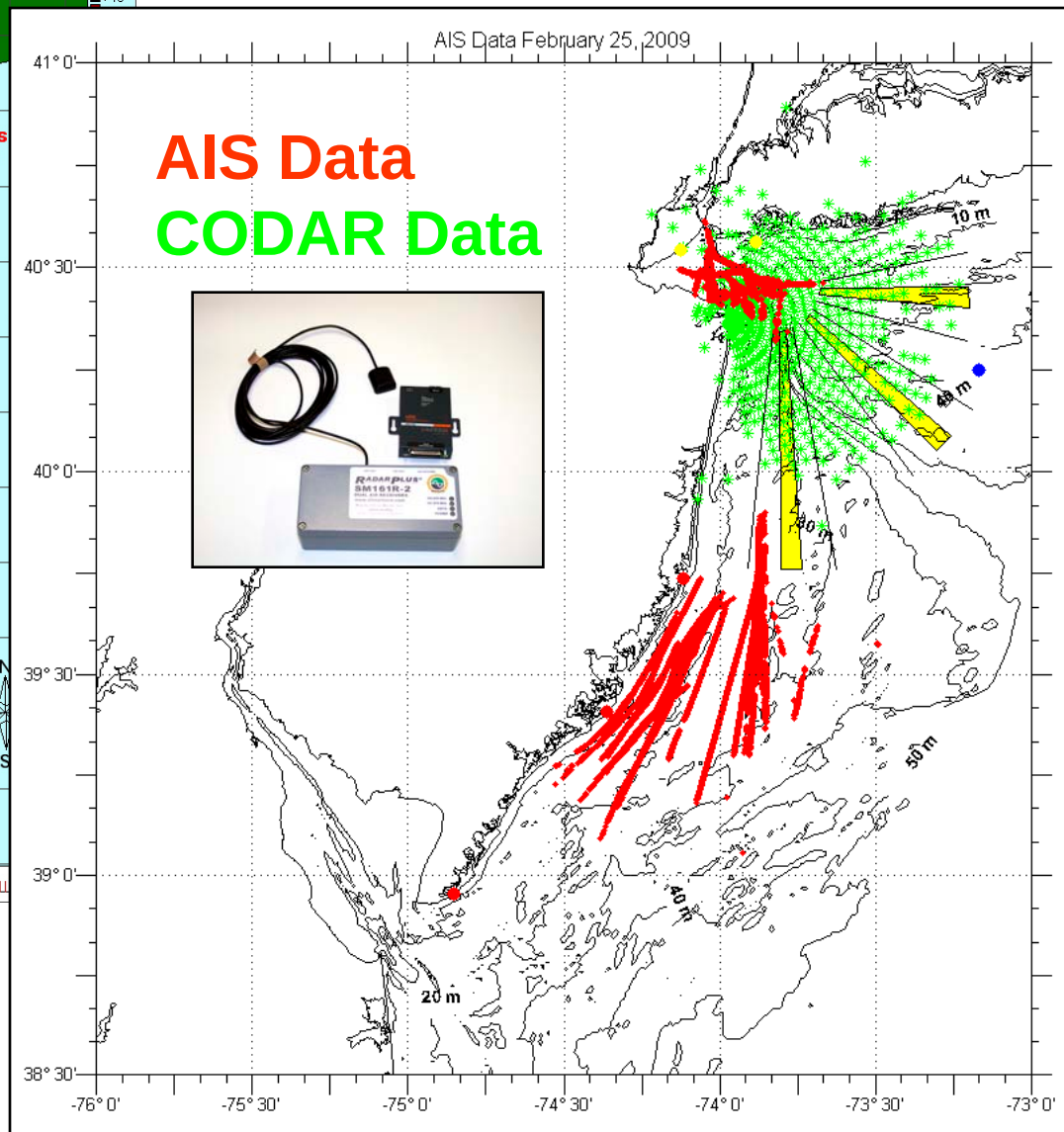
Classification parameters: Peak frequencies and their amplitudes





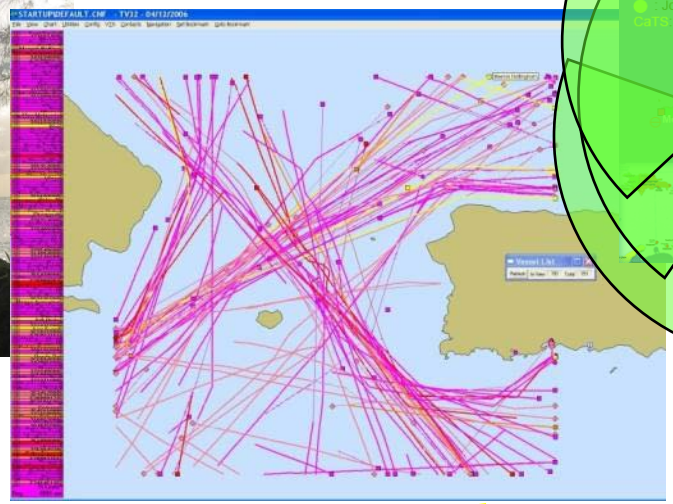
Future - Approaches to New York Harbor
13 MHz CODAR Testbed

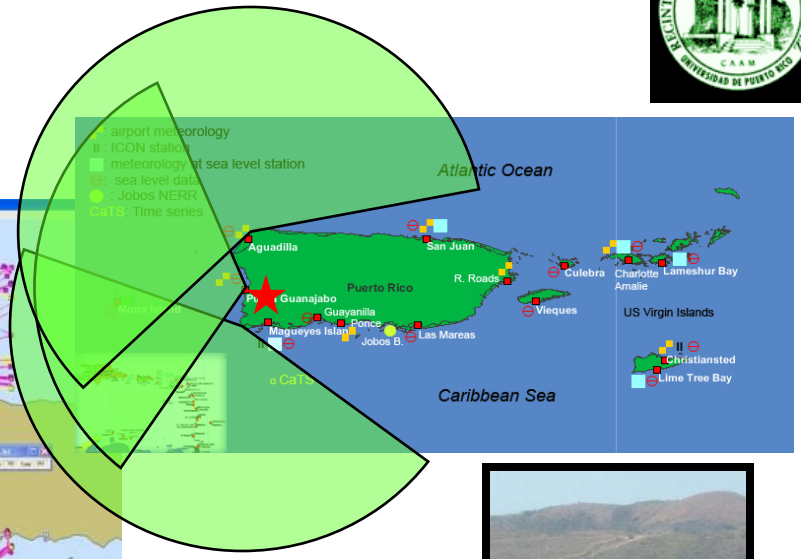
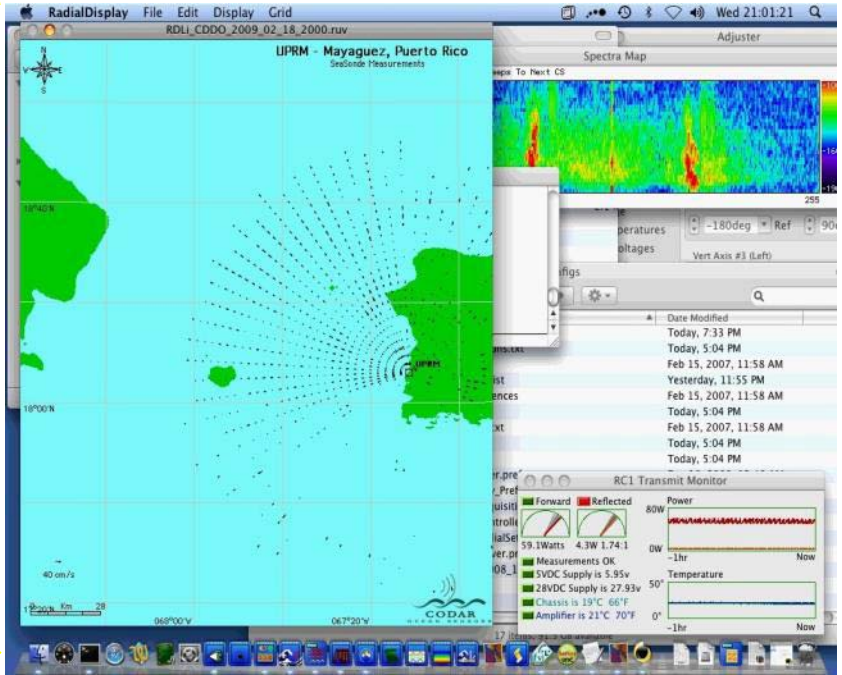




13 MHz CODAR
Surface Current Coverage
Average Range 70 km

Future - Caribbean 13 MHz HF Radar Testbed – University Puerto Rico





Average Range 85 km