RUTGERS
Coastal Ocean Observation Lab

NOS Integrated Ocean Observations Systems (IOOS)

Repair and Hardening of Mid-Atlantic Ocean Observing Assets After Hurricane Sandy

NOAA Award No. NA14NOS4830003

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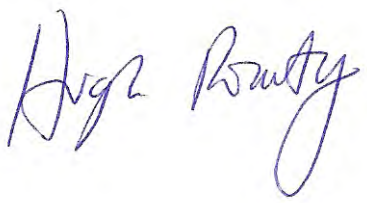

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INTRODUCTION

Seventeen High Frequency radars were damaged within the Mid Atlantic Regional Association Coastal Ocean Observing System when Hurricane Sandy passed through the region in October 2012. The objective of this work is to repair and harden these observing system assets as well as some computer and ADCP assets lost during Sandy. The benefits of this work will increase the coverage and data quality of the surface current measurements in the region. The US Coast Guard uses the surface currents operationally for search and rescue, and the NOAA Office of Response and Restoration uses them for oil spill response. Other users of the data include New Jersey and Massachusetts Department of Environmental Protection offices, county health offices and Mid Atlantic Fishery Management Council. The technical networks that will be leveraged are the Mid-Atlantic Regional Association Coastal Ocean Observing System, NOAA National High Frequency Radar Network, DHS National Center for Secure and Resilient Maritime Commerce and the NJ Board of Public Utilities Radar Network.

1. PROGRAM INFORMATION AND HIGHLIGHTS

During the 2nd quarter of 2014, the following technical progress was made:

A. Procurement

Two full CODAR sites, three dual transmit upgrades, and four combined antennas (batches 2-3) were delivered between early May and late June. The full systems are to replace the Seaside Park, NJ and Port Monmouth, NJ sites (13 MHz and 25 MHz, respectively). The dual transmit upgrades are to improve the Loveladies, NJ and Martha's Vineyard, MA sites. The combined transmit/receive antennas are to replace the antennas located at Staten Island, NY, Belmar, NJ, Brant Beach, NJ, and Brigantine, NJ. Much progress has been made with the installations and data analysis since the delivery of batch 2a and is outlined in the following sections.

B. Site Installations

The new equipment delivered in batches 2 and 3 has been fully installed at two locations: Hempstead, NY and Sandy Hook, NJ. Loveladies, NJ is still in progress of the dual transmit installations. During the second quarter of 2014 the following progress was achieved:

1. Installation of second transmit antenna and chassis at HEMP (Hempstead, NY 5 MHz system). This includes power and phase tuning.
2. Installation of second transmit antenna and chassis at HOOK (Sandy Hook, NJ 5 MHz system). This includes power and phase tuning.
3. Upgrade of old equipment at LOVE (Loveladies, NJ 5 MHz system).
4. HOMR antenna calibration and installation of AIS Pattern software compatible with Mavericks OS.
5. Data analysis and QA/QC checks of HEMP, HOOK, and HOMR.

Included in the following sections on the next page are photos of each of the dual transmit upgrades at HEMP/HOOK and also the upgrade of old equipment at LOVE:

1. Hempstead, Long Island, NY (HEMP)

2. Sandy Hook, NJ

3. Loveladies, NJ

Below is the most up to date inventory list of equipment and software keys installed up to the end of June where the second quarter ends:

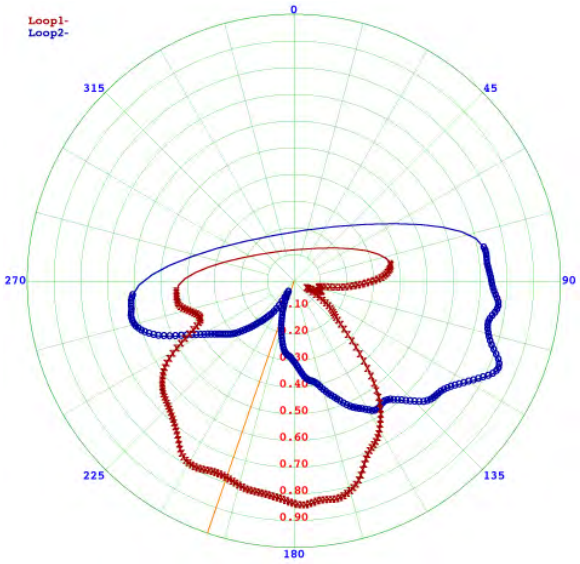
5 MHz								
Site	**Tx**	**Rx**	**Tx2**	**Antenna**	**Radial Key**	**Elliptical Key**	**MDA Key**	**AIS Pattern Key**
MVCO	2013374	2013374	N/A		101172238075399		N/A	
NAUS			N/A		101828618375501		N/A	
NANT			N/A		101768939147949		N/A	
BLCK			N/A		101680672504435	N/A	N/A	N/A
MRCH	2006183	2006183	N/A		101762740130717	N/A	N/A	N/A
HEMP	200150	2004149	2013405	2013195	101508529085203	301502976842515	501534279375615	N/A
HOOK	200149	2007189	2014410	2013196	101691691274383	N/A	N/A	N/A
LOVE	2007189	9814	N/A	2013197	101498835290737	N/A	N/A	N/A
BRIG	200043	200033	N/A	2013195	101607178305171	301218432872073	N/A	N/A
WILD	200039	2001059	N/A	2013164	101588161375581	301362673261907	N/A	N/A
13 MHz								
Site								
HOMR	2013403	2013403	N/A	2013199	101346080061571		N/A	801134297971215
BRNT	2011334	2011334	N/A	2011073	101724448598979	301143439322081	N/A	N/A
BRMR	2011335	2011335	N/A	2011102	101758959828695	301186584481455	N/A	N/A
RATH	2011336	2011336	N/A	2011100	101080799843501	301705026270391	N/A	N/A
WOOD	2011333	2011333	N/A	2013156	101138543071215	N/A	N/A	801197178215987
FURA					101084414102727		501179369711863	N/A
CDDO					101423092935405		501983889092239	N/A
25 MHz								
Sites								
SILD	2003097	2003097	N/A		101758104831715	N/A	N/A	N/A
PORT	200033	98013	N/A		101191365584637	301170776565521	501187042322183	N/A

C. Antenna Calibrations

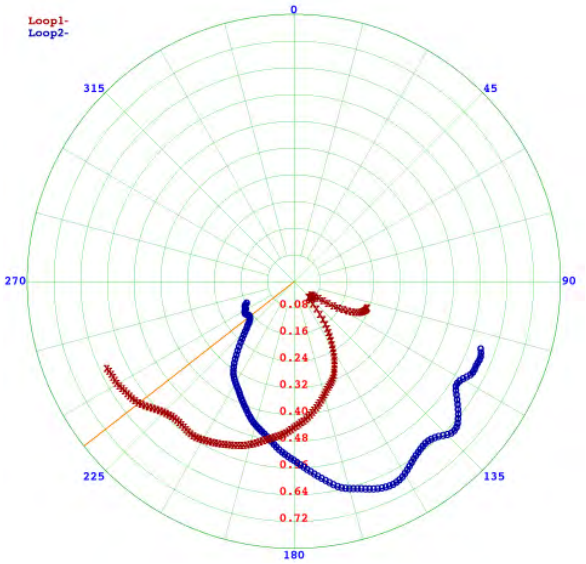
At each of the sites included in Batch 1, walking antenna calibrations were performed to correct for radial bearing errors at the radial level.

1. HEMP

a. A walking pattern measurement was performed with receive dome-style antenna S/N 2013195 on April 9th, 2014. The pattern generated was fairly close to ideal and is displayed below:



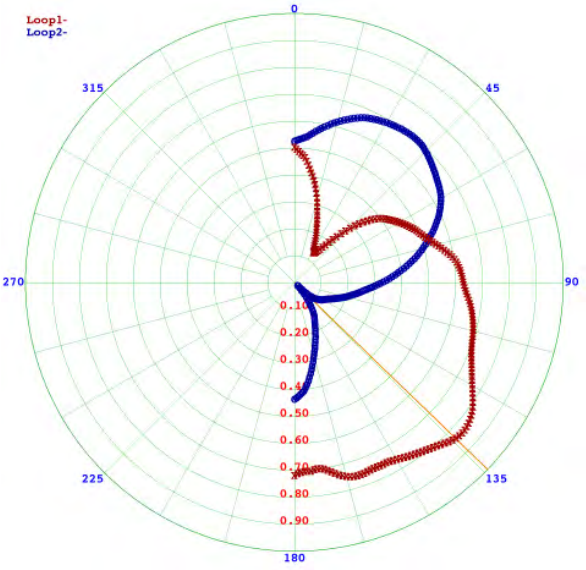
b. The newly released AIS Pattern suite was also installed at HEMP. The software allows a pattern to generate based on AIS hits. The pattern measured with this software is as follows:



After the dual transmit upgrade to HEMP and cable splice, the generated pattern is no longer valid. The AIS pattern software is still running at the site and will be installed in the upcoming weeks.

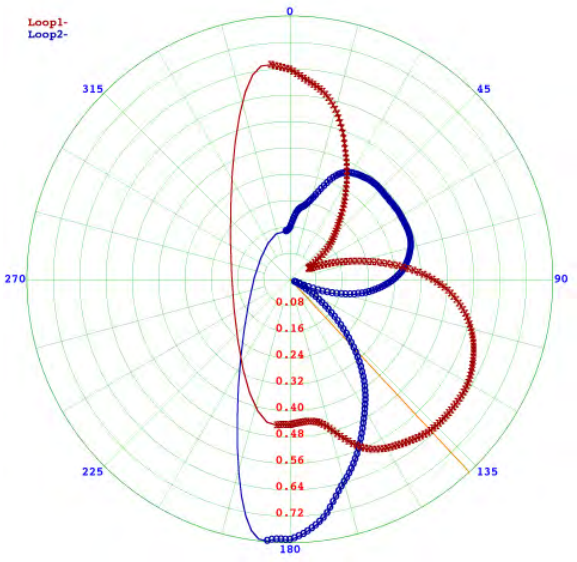
2. HOOK

The latest antenna calibration was performed on April 16th, 2014:



3. HOMR

Details of the site installation are included in the first quarterly report. The calibration was performed on April 16th, 2014 when the combined antenna was relocated to protect the cables from being severed when the beach entry is reopened. The antenna pattern measurement is below:



Since the computer at HOMR is running Mavericks, there was a wait period for the AIS software to be installed that was compatible with that OS. The software was installed on July 24th, 2014 and the pattern will be installed within the next couple weeks.

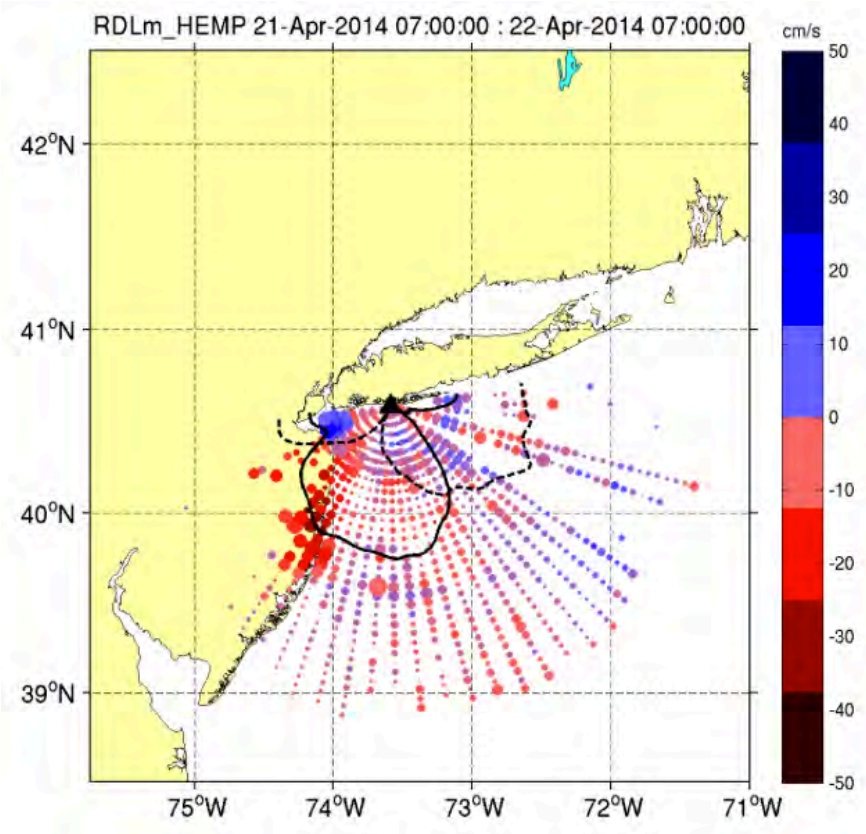
4. LOVE

Dual transmit upgrades are still currently in progress.

D. Data Quality

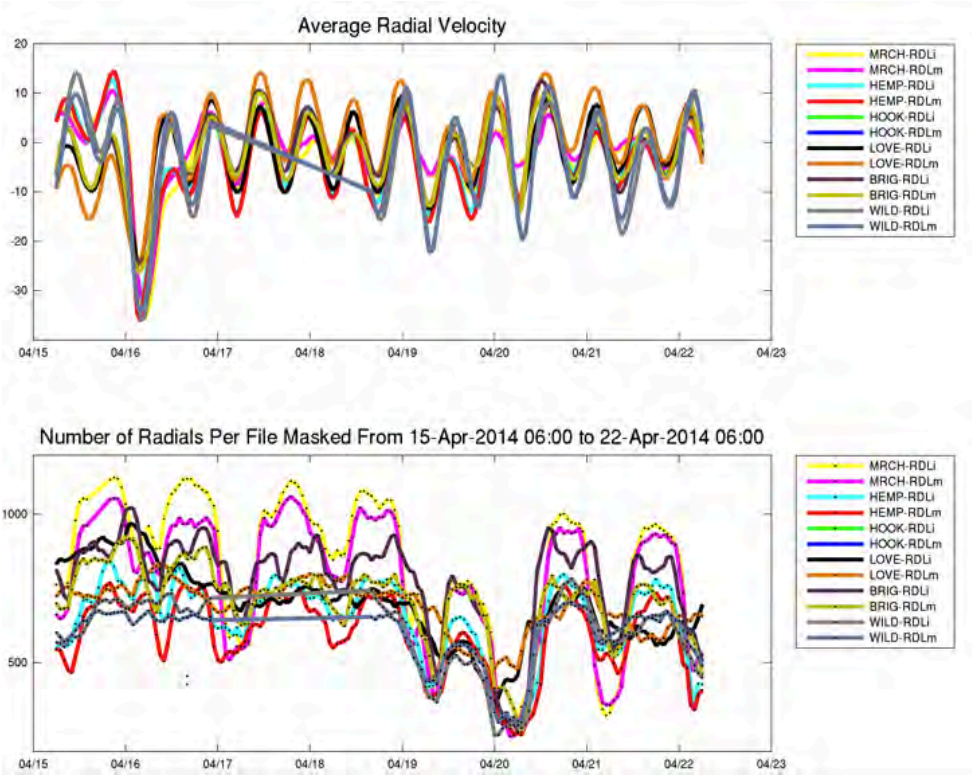
Several QA/AC methods are implemented to analyze the quality of the data reaching Rutgers and the National Network. Radial vector count, average radial velocities, radial coverage, and data latency are just a few qualities that are examined to determine how well a site is operating.

1. Standard deviation radial coverage plots are created daily to analyze radial velocities averaged over a 24-hour period for each range and bearing. The minimum vector count for each range and bearing must be greater than 12 to provide a better visual of what the currents are doing. Below is an example of what these plots show:



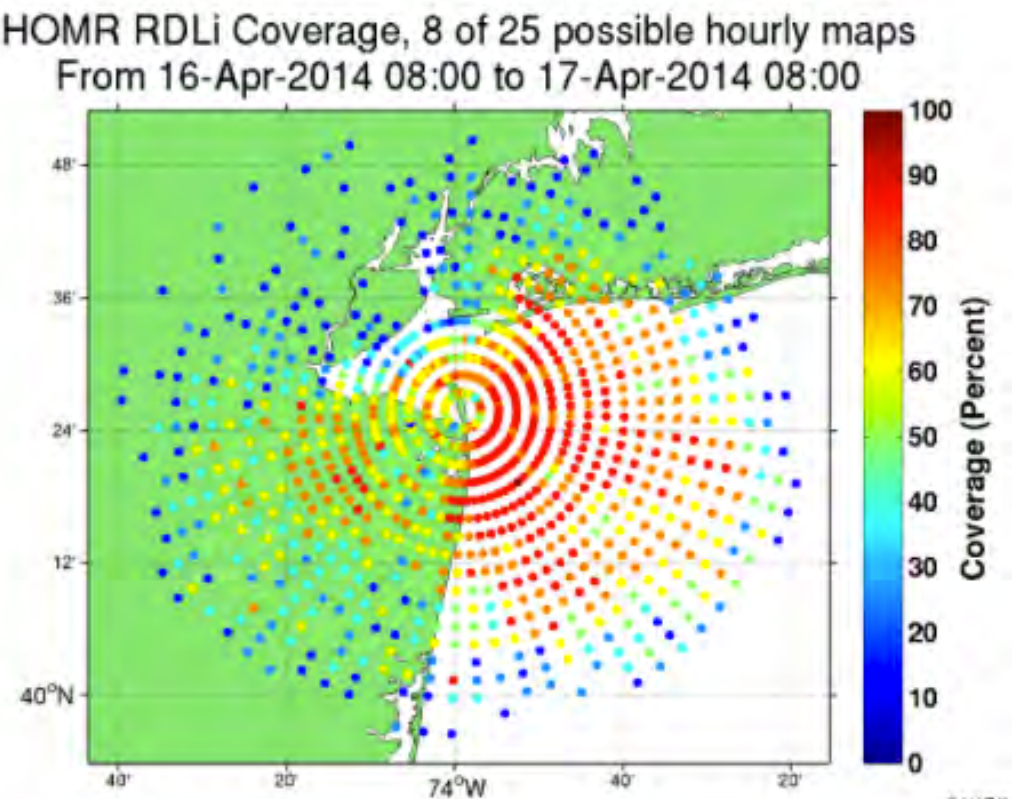
The measured radial standard deviation plots have the current pattern overlaid on top to better explain potential gaps in coverage or outlier vectors. When large circles appear in the coverage, there may be an indication that either a hardware issue is occurring at the site or First Order Line settings are not set correctly. These plots have aided in the understanding of how well our sites are operating.

2. Hourly averaged radial plots are created every hour spanning over the course of approximately one week. The importance of these plots is to show the M2 tidal constituent. There should be two positive radial velocity peaks throughout the day, which will be seen by averaging all of the radial velocities every hour. Ideal and measured radial velocities are compared with each site. A plot is shown on the next page.



The number of radials per file is another indication of how well the site is operating. Few radials per file could mean there is a hardware issue (e.g. power output/reflected), but it could also be an indication that Bragg is not being processed properly with the set parameters. Large files could indicate that a lot of radials are being placed overland or there are a lot of outlier vectors. Such instances could mean interference or noise was processed as First Order Bragg which would call for the need to reprocess.

3. Radial coverage plots show how often the radar is receiving a signal at each range and bearing. These plots are generated daily and averages the total amount of radial vector measurements for each range and bearing. A plot is shown on the next page.



The high percentage over water is a good indication that the radar is operating well, which would not be the case if most of the coverage is overland or is simply minimal over water. Combining the various methods of data analysis provides the operators with a few ways of examining the data. By using these QA/AC methods, along with site diagnostics, it can be determined whether a site visit is in need or software adjustments should be implemented.

2. ISSUES/RISKS & MITIGATION

Based on almost two decades of previous experience with CODAR HF-Radar site installations, high level potential risks to the success of this project include:

1. If the municipality, park or land owner of the potential installation site location refuses to allow installation of a site, then there could be delays in site installation or it could force us to move the site location to a less than optimal location.
    a. Mitigation: As these are replacement sites with previous approvals, this risk should not come to fruition.
2. If CODAR delays the delivery of sites due to a backlog of orders or lack of personnel, site installations could be delayed.
    a. Mitigation: There are two mitigation strategies here: The first strategy was to discuss and plan the orders with CODAR in August with a goal to insert these into the CODAR construction process; The second strategy was to build an additional 1-2 weeks of slack in the schedule based on delivery dates estimated by CODAR in August, and then again in late December.
3. If CODAR delivers faulty equipment, then we would be forced to ship the equipment back to CODAR for repair, thereby delaying potential installations of the systems by several weeks.
    a. Mitigation: The CODAR equipment will be delivered in four batches of 3 to 6 sites at a time. If some of the equipment is faulty, it can be shipped back to CODAR to be fixed while technicians, test, install, calibrate and retest another system in the batch.
4. If there is severe weather such as winter snows, frozen ground, or a hurricane/nor'easter causing beach destruction, then installations could be delayed.
    a. Slack has been built into the schedule for these events which will occur over the 2 years of the project at one or more of the site locations.
5. If a technician departs Rutgers or UConn, then the team will lose technical proficiency and some of our capability to install the sites in a timely manner.
    a. There are now additional technicians at Rutgers not currently funded through this project that could replace funded team members should they depart for another job.

3. SCHEDULING

The baseline schedule for this project is shown below in figure 1. As mentioned in the previous report, the exact dates and install sites were subject to change based on logistical challenges including but not limited to weather, municipality support/approval and strategic need. The first three sites originally scheduled for installation were HEMP (3/13/14), MVCO (4/22/14) and SEAB (6/5/14). Original installation date details are shown in figure 2. HEMP and SEAB (now HOMR) were installed, but HOOK was installed instead of MVCO as HOOK and HOMR are adjacent to each other in Sandy Hook, NJ.

The HOMR and HOOK sites were installed four and eight weeks ahead of schedule, however, the complete post installation work for each site, including HEMP, must still be performed. QA/QC, calibration, antenna pattern measurements and data delivery to the national network must still be completed for all sites over the next 2 months. Overall, we estimate that the project is approximately 2-3 weeks ahead of the baselined schedule.

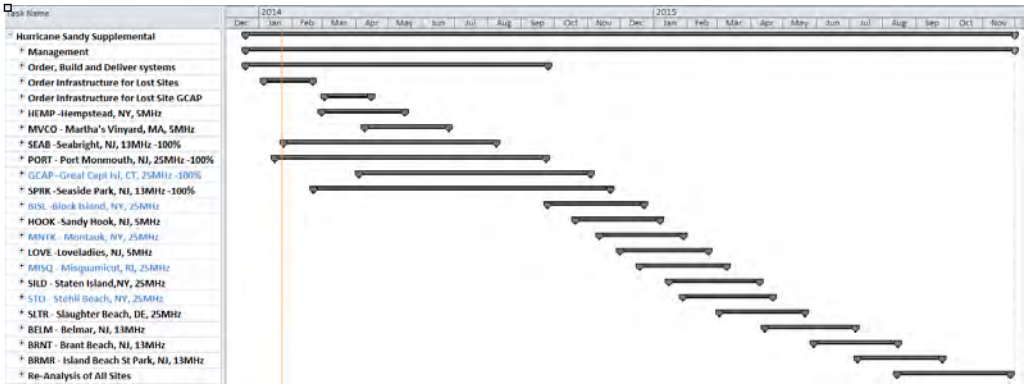
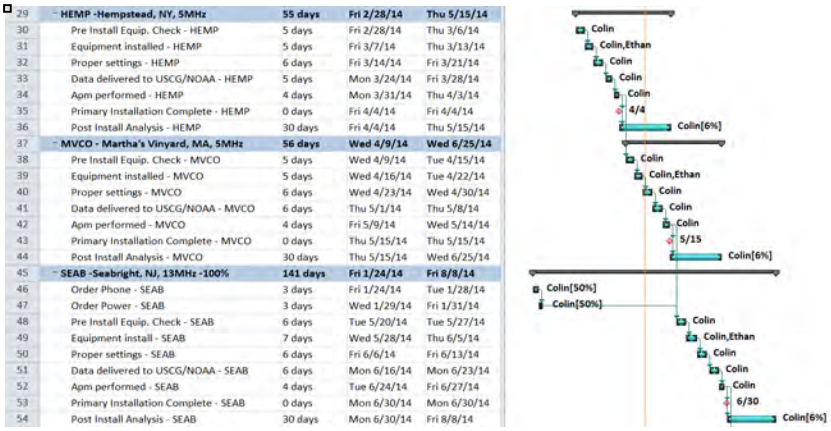


Figure 1. High level schedule for the CODAR installations.



29	HEMP -Hempstead, NY, 5MHz	55 days	Fri 2/28/14	Thu 5/15/14
30	Pre Install Equip. Check - HEMP	5 days	Fri 2/28/14	Thu 3/6/14
31	Equipment installed - HEMP	5 days	Fri 3/7/14	Thu 3/13/14
32	Proper settings - HEMP	6 days	Fri 3/14/14	Fri 3/21/14
33	Data delivered to USCG/NOAA - HEMP	5 days	Mon 3/24/14	Fri 3/28/14
34	Apm performed - HEMP	4 days	Mon 3/31/14	Thu 4/3/14
35	Primary Installation Complete - HEMP	0 days	Fri 4/4/14	Fri 4/4/14
36	Post Install Analysis - HEMP	30 days	Fri 4/4/14	Thu 5/15/14
37	MVCO - Martha's Vinyard, MA, 5MHz	56 days	Wed 4/9/14	Wed 6/25/14
38	Pre Install Equip. Check - MVCO	5 days	Wed 4/9/14	Tue 4/15/14
39	Equipment installed - MVCO	5 days	Wed 4/16/14	Tue 4/22/14
40	Proper settings - MVCO	6 days	Wed 4/23/14	Wed 4/30/14
41	Data delivered to USCG/NOAA - MVCO	6 days	Thu 5/1/14	Thu 5/8/14
42	Apm performed - MVCO	4 days	Fri 5/9/14	Wed 5/14/14
43	Primary Installation Complete - MVCO	0 days	Thu 5/15/14	Thu 5/15/14
44	Post Install Analysis - MVCO	30 days	Thu 5/15/14	Wed 6/25/14
45	SEAB -Seabright, NJ, 13MHz -100%	141 days	Fri 1/24/14	Fri 8/8/14
46	Order Phone - SEAB	3 days	Fri 1/24/14	Tue 1/28/14
47	Order Power - SEAB	3 days	Wed 1/29/14	Fri 1/31/14
48	Pre Install Equip. Check - SEAB	6 days	Tue 5/20/14	Tue 5/27/14
49	Equipment install - SEAB	7 days	Wed 5/28/14	Thu 6/5/14
50	Proper settings - SEAB	6 days	Fri 6/6/14	Fri 6/13/14
51	Data delivered to USCG/NOAA - SEAB	6 days	Mon 6/16/14	Mon 6/23/14
52	Apm performed - SEAB	4 days	Tue 6/24/14	Fri 6/27/14
53	Primary Installation Complete - SEAB	0 days	Mon 6/30/14	Mon 6/30/14
54	Post Install Analysis - SEAB	30 days	Mon 6/30/14	Fri 8/8/14

Figure 2. Detailed installation schedule of the first three installation sites.

There are 21 major milestones over the course of this project which include delivery of the four batches of CODAR systems to Rutgers and the University of Connecticut, and primary installation completion of each of the 17 sites. Table 2 lists the scheduled dates of the installations as well as current progress towards every milestone. It should be noted that we expect to maintain site installations for each date in the Milestone Table, however, the exact site installation may vary based on availability/permission of local authorities, communication installations, power installations, etc.

	Milestone Name	Date	Complete
1	Deliver Batch 1: of SEAB, MVCO, HEMP	2/28/2014	Yes
2	Deliver Batch 2: SPRK, PORT, HOOK, LOVE	5/2/2014	Yes
3	Deliver Batch 3: of, SILD, BELM, BRNT, BRMR	8/8/2014	Yes
4	Deliver Batch 4: of GCAP, BISL, MNTK, MISQ, SLTR, STLI	9/26/2014	
5	Primary Installation Complete - HEMP	4/4/2014	Yes
6	Primary Installation Complete - MVCO	2/15/2015	
7	Primary Installation Complete - SEAB	6/30/2014	Yes
8	Primary Installation Complete - PORT	8/13/2014	
9	Primary Installation Complete - GCAP	9/23/2014	In Progress
10	Primary Installation Complete - SPRK	10/13/2014	In Progress
11	Primary Installation Complete - BISL	11/11/2014	In Progress
12	Primary Installation Complete - HOOK	11/26/2014	Yes
13	Primary Installation Complete - MNTK	12/18/2014	In Progress
14	Primary Installation Complete - LOVE	1/12/2015	In Progress
15	Primary Installation Complete - MISQ	1/27/2015	In Progress
16	Primary Installation Complete - SILD	2/26/2015	In Progress
17	Primary Installation Complete - STLI	3/10/2015	In Progress
18	Primary Installation Complete - SLTR	4/9/2015	
19	Primary Installation Complete - BELM	5/26/2015	
20	Primary Installation Complete - BRNT	7/6/2015	
21	Primary Installation Complete - BRMR	8/14/2015	Yes

Table 2. The 21 Major project milestones include deliveries of the four batches of CODAR systems as well as primary installation of each of the 17 sites.

4. BUDGET AND EXPENDITURES

Table 3 highlights the budget by line item, expenses, commitments (largely CODAR hardware) and the remaining balance of the account. Subcontractors are listed as single line items.

Description	Budget	Expenses	Commitments	Adjustments	Balance
Salaries Regular Employee	$132,600.00	$37,590.39	$0.00	$0.00	$95,009.61
Other Compensation	$0.00	$640.00	$0.00	$0.00	-$640.00
Fringe Benefits Manual Adj	$58,477.00	$0.00	$0.00	$0.00	$58,477.00
Fringe Benefits - FICA	$0.00	$2,232.75	$0.00	$0.00	-$2,232.75
Fringe Benefits - Medicare	$0.00	$522.23	$0.00	$0.00	-$522.23
Fringe Benefits 12000	$0.00	$14,171.58	$0.00	$0.00	-$14,171.58
Project Supplies DCGA	$4,324.00	$5,950.32	$7,437.75	$0.00	-$9,064.07
PERM EQP-DCGA < $5,000	$18,000.00	$1,249.55	$0.00	$0.00	$16,750.45
Mobile Phone Charges	$0.00	$61.27	$0.00	$0.00	-$61.27
Telephone Toll Charg	$3,600.00	$0.00	$0.00	$0.00	$3,600.00
Postage	$0.00	$276.20	$0.00	$0.00	-$276.20
Other Services	$185,600.00	$0.00	$0.00	$0.00	$185,600.00
PERM EQP-DCGA > $5,000	$1,145,095.00	$1,105,594.95	$9,650.00	$0.00	$29,850.05
Travel Domestic DGCA	$20,000.00	$3,192.20	$0.00	$0.00	$16,807.80
Facility & Admin Costs	$99,520.00	$19,959.30	$0.00	$9,653.96	$69,906.74
U Connecticut	$401,713.00	$28,930.58	$372,782.42	$0.00	$0.00
U Delaware	$48,409.00	$0.00	$48,409.00	$0.00	$0.00
U Rhode Islande	$203,170.00	$8,910.00	$194,260.00	$0.00	$0.00
Rent Equipment DGCA	$10,002.00	$0.00	$0.00	$0.00	$10,002.00
	$2,330,510.00	**$1,229,281.32**	**$632,539.17**	**$9,653.96**	**$459,035.55**

Table 3. Sandy Supplemental budget by line item with subcontractors listed at the bottom of the table.

5. Appendix 1:

Rutgers is repairing and hardening 11 of its HF radar stations through this grant. The delivery schedule is given in table 4.

Table 4: Delivery dates for CODAR Ocean Sensors equipment for project.

Batch	Delivery Date	Station Equipment
1	February 14, 2014	SEAB, HOOK, HEMP
2	May 1, 2014	SPRK, PORT, MVCO, LOVE
3	July 11, 2014	SILD, BELM, BRNT, BRMR

The second major delivery equipment was Batch 2. This included a 13 MHz SeaSonde for Seaside Park, a 25 MHz SeaSonde for Port Monmouth and antennas for the 5 MHz SeaSondes at Martha's Vineyard and Loveladies, NJ. This Batch was broken into three shipments which all arrived in this progress period. The packing lists for Batch 2 are shown in Figure 1 through Figure 4. The equipment was delivered to Rutgers on May 16, 2014 and June 25, 2014.

CODAR OCEAN SENSORS

CODAR Ocean Sensors, Ltd.
1914 Plymouth Street,
Mountain View, California 94043 USA
Phone: 408-773-8240 Fax: 408-773-0514

Packing List
Order Number: OR-2516
Ship Number: PAC03

To: **Rutgers, The State University of New Jersey**
Email: hroarty@marine.rutgers.edu
Phone: 732-445-2717

Address: Hugh Roarty
Rutgers, The State University of New Jersey
Coastal Ocean Observation Laboratory
71 Dudley Road
New Brunswick, NJ
08901
US

Supplier: CODAR Ocean Sensors, Ltd.
1914 Plymouth Street,
Mountain View, California 94043 USA

Purchase Order: 1962828

US Export Broker: Panalpina Inc.

Shipper: Allison Mendes

Ship Date: 5/1/2014
2A

	Item	*Serial Number*	*Model Number*	Qty.	Box#
1	**SeaSonde Transmitter** RMA#1847	*200149*	*SSTX-100-0500-110*	1	1
2	**SeaSonde Transmitter**	*2004410*	*SSTX-100-0500-110*	1	2
3	**SeaSonde Receiver CE** RMA#1847	*2007189*	*SSRX-100A-LRD-0513-110*	1	1
4	**HF Antenna Tuner & Tunning Cable**	*N/A*	*MFJ-971*	2	3

Figure 1: Packing list for Batch 2A

CODAR Ocean Sensors, Ltd.
1914 Plymouth Street,
Mountain View, California 94043 USA
Phone: 408-773-8240 Fax: 408-773-0514

Packing List

Order Number: OR-2516
Ship Number: PAC04

To: **Rutgers, The State University of New Jersey**
Email: hroarty@marine.rutgers.edu
Phone: 732-445-2717

Address: Hugh Roarty
Rutgers, The State University of New Jersey
Coastal Ocean Observation Laboratory
71 Dudley Road
New Brunswick, NJ
08901
US

Supplier: CODAR Ocean Sensors, Ltd.
1914 Plymouth Street,
Mountain View, California 94043 USA

Purchase Order: 1962828

US Export Broker: Panalpina Inc.

Shipper: Allison Mendes

Ship Date: 5/1/2014
2B

	Item	*Serial Number*	*Model Number*	Qty.	Box#
1	**Long Range Transmit Antenna Assembly**	*130*	*SSTA-201-5*	1	1
2	**Long Range Transmit Antenna Assembly**	*131*	*SSTA-201-5*	1	2
3	**Dome Antenna Mast (5MHz)**	*2013197*	*SSRA-SA310-05RX*	1	3
4	**Receive Antenna Cable (75m)**	*N/A*	*RXCBL-STD*	1	4
5	**Extended Lightning Protection Kit for Twin Tx Antenna**	*2014101*	*LT-E2*	1	7
6	**SeaSonde Radial Suite Software**	*1011923216032*	*SSDA-RAD7-ON*	1	7
7	**Transmit Antenna Cable (75m)**	*N/A*	*TXCBL-STD*	1	5
8	**Transmit Antenna Cable (75m)**	*N/A*	*TXCBL-STD*	1	6
9	**Dome Antenna (5MHz Dome Only)**	*2013197*	*SSRA-SA101-05*	1	8
10	**SeaSonde Elliptical Software**	*3011057816859*	*N/A*	1	1
11	**SeaSonde AIS Pattern Software**	*8013622402179*	*N/A*	1	1

Figure 2: Packing list for Batch 2B

CODAR Ocean Sensors, Ltd.
1914 Plymouth Street,
Mountain View, California 94043 USA
Phone: 408-773-8240 Fax: 408-773-0514

Packing List

Order Number: OR-2516
Ship Number: PAC05

To: **Rutgers, The State University of New Jersey**
Email: hroarty@marine.rutgers.edu
Phone: 732-445-2717

Address: Hugh Roarty
Rutgers, The State University of New Jersey
Coastal Ocean Observation Laboratory
71 Dudley Road
New Brunswick, NJ
08901
US

Supplier: CODAR Ocean Sensors, Ltd.
1914 Plymouth Street,
Mountain View, California 94043 USA

Purchase Order: 1962828

US Export Broker: Panalpina

Shipper: Allison Mendes

Ship Date: 6/18/2014
Batch #2C:

	Item	*Serial Number*	*Model Number*	Qty.	Box#
1	**Dome Antenna Mast (13MHz)**	*2014200*	*SSRA-SA310-13*	1	18
2	**Dome Antenna (13MHz Dome Only)**	*2014200*	*SSRA-SA101-13TR*	1	15
3	**SeaSonde Transmitter (13MHz)**	*2014412*	*SSTX-100-1300-110*	1	2
4	**SeaSonde Receiver (13MHz GPS)**	*2014412*	*SSRX-100A-SG-1325*	1	1
5	**TR Antenna Cable (75m)**	*N/A*	*TRCBL-Std*	1	9
6	**Remote Site Computer Monitor**	*Z6MXHCLDA02647N*	*SSDA-100-M*	1	7
7	**Remote Site Computer**	*C07MJA4PDWYL*	*SSDA-100*	1	7
8	**TR Antenna Cable (75m)**	*N/A*	*TRCBL-Std*	1	10
9	**Remote Site Computer Monitor**	*Z6MXHCLDC00808B*	*SSDA-100-M*	1	8
10	**Remote Site Computer**	*C07MJA01DWYL*	*SSDA-100*	1	8
11	**SeaSonde Receiver (25MHz GPS)**	*2014413*	*SSRX-100A-SG-2513*	1	3
12	**SeaSonde Transmitter (25MHz)**	*2014413*	*SSTX-100-2500-110*	1	4
13	**Dome Antenna Mast (25MHz)**	*2014218*	*SSRA-SA310-25*	1	19
14	**Dome Antenna (25MHz Dome Only)**	*2014218*	*SSRA-SA101-25TR*	1	16
15	**AIS Receiver**	*208577*	*N/A*	1	14
16	**AIS Receiver**	*208438*	*N/A*	1	14
17	**AIS Receiver**	*208442*	*N/A*	1	14
18	**AIS Receiver**	*208443*	*N/A*	1	14
19	**Extended Lightning Protection Kit - 1 Tx Antenna**	*2014104*	*LT-E1*	1	14
20	**Extended Lightning Protection Kit for Twin Tx Antenna**	*2014102*	*LT-E2*	1	14
21	**Extended Lightning Protection Kit - 1 Tx Antenna**	*2014103*	*LT-E1*	1	14
22	**SeaSonde Receiver CE** Upgrade, RMA#1862	*200039*	*SSRX-100A-LRD-0513*	1	5
23	**SeaSonde Transmitter** Upgrade, RMA#1862	*2002082*	*SSTX-100-05-110*	1	5
24	**Transmit Antenna Cable (75m)** Upgrade	*N/A*	*TXCBL-STD*	1	11
25	**Transmit Antenna Cable (75m)** Upgrade	*N/A*	*TXCBL-STD*	1	12

Figure 3: Packing list for Batch 2C

CODAR Ocean Sensors, Ltd.
1914 Plymouth Street,
Mountain View, California 94043 USA
Phone: 408-773-8240 Fax: 408-773-0514

Packing List
Order Number: OR-2516
Ship Number: PAC05

26	**Receive Antenna Cable (100m)** Upgrade	*N/A*	*RXCBL-STD*	1	13
27	**HF Antenna Tuner** Upgrade	*N/A*	*MFJ-971*	2	14
28	**SeaSonde Transmitter** Upgrade	*2014411*	*SSTX-100-0500-110*	1	6
29	**AIS Antenna**	*N/A*	*N/A*	4	23
30	**Dome Antenna Mast (5MHz)**	*2013198*	*SSRA-SA310-05RX*	1	20
31	**Dome Antenna (5MHz Dome Only)**	*2013198*	*SSRA-SA101-05*	1	17
32	**Long Range Transmit Antenna Assembly**	*134*	*SSTA-201-5*	1	21
33	**Long Range Transmit Antenna Assembly**	*133*	*SSTA-201-5*	1	22

Figure 4: Packing list for Batch 2C continued

The last major equipment delivery was Batch 3. This included antennas and cables for the 25 MHz SeaSonde at Staten Island, the 13 MHz SeaSonde at Belmar, Brant Beach and Brigantine. The packing list from Batch 3 is shown in Figure 5 and was delivered to Rutgers on June 30, 2014.

CODAR Ocean Sensors, Ltd.
1914 Plymouth Street,
Mountain View, California 94043 USA
Phone: 408-773-8240 Fax: 408-773-0514

Packing List
Order Number: OR-2516
Ship Number: PAC06

To: **Rutgers, The State University of New Jersey**
Email: hroarty@marine.rutgers.edu
Phone: 732-445-2717

Address: Hugh Roarty
Rutgers, The State University of New Jersey
Coastal Ocean Observation Laboratory
71 Dudley Road
New Brunswick, NJ
08901
US

Supplier: CODAR Ocean Sensors, Ltd.
1914 Plymouth Street,
Mountain View, California 94043 USA

Purchase Order: 1962828

US Export Broker: Panalpina Inc

Shipper: Allison Mendes

Ship Date: 6/20/2014
Batch #3:

	Item	*Serial Number*	*Model Number*	Qty.	Box#
1	**TR Antenna Cable (75m)**	*N/A*	*TRCBL-Std*	1	1
2	**TR Antenna Cable (75m)**	*N/A*	*TRCBL-Std*	1	2
3	**TR Antenna Cable (75m)**	*N/A*	*TRCBL-Std*	1	3
4	**TR Antenna Cable (75m)**	*N/A*	*TRCBL-Std*	1	4
5	**Receive Antenna (13MHz Dome)**	*2013202*	*SSRA-SA101-13*	1	5
6	**Receive Antenna (13MHz Dome)**	*2013201*	*SSRA-SA101-13*	1	6
7	**Receive Antenna (13MHz Dome)**	*2014220*	*SSRA-SA101-13*	1	7
8	**Extended Lightning Protection Kit - 1 Tx Antenna**	*2014105*	*LT-E1*	1	8
9	**Extended Lightning Protection Kit - 1 Tx Antenna**	*2014106*	*LT-E1*	1	8
10	**Extended Lightning Protection Kit - 1 Tx Antenna**	*2014107*	*LT-E1*	1	8
11	**Extended Lightning Protection Kit - 1 Tx Antenna**	*2014108*	*LT-E1*	1	8
12	**AIS Receiver**	*208434*	*N/A*	1	8
13	**AIS Receiver**	*208435*	*N/A*	1	8
14	**AIS Receiver**	*208576*	*N/A*	1	8
15	**AIS Receiver**	*208578*	*N/A*	1	8
16	**AIS Antenna**	*N/A*	*N/A*	1	9
17	**Dome Antenna (25MHz Dome Only)**	*2014219*	*SSRA-SA101-25TR*	1	10
18	**Dome Antenna Mast (25MHz)**	*2014219*	*SSRA-SA310-25*	1	11
19	**Dome Antenna Mast (13MHz)**	*2014220*	*SSRA-SA310-13*	1	12
20	**Dome Antenna Mast (13MHz)**	*2013202*	*SSRA-SA310-13*	1	13
21	**Dome Antenna Mast (13MHz)**	*2013201*	*SSRA-SA310-13*	1	14

Figure 5: Packing list for Batch 3

As part of the equipment purchase on this grant, we requested $15,000 for Acoustic Doppler Current Profiler (ADCP) for the New York Harbor Observing and Prediction System (NYHOPS). A copy of the invoice is given in Figure 6 and a picture of the instrument is shown in Figure 7. These current meter is a replacements for the one lost during Hurricane Sandy. The current meter was purchased in May 2014 and delivered to Stevens Institute of Technology on June 20, 2014.

Commercial Invoice

Vangkroken 2,1351 Rud, Norway
Phone: +47 67 17 45 00
Fax: +47 67 13 67 70
E-mail: inquiry@nortek.no
Internet: www.nortek-as.com
Org no.: NO996707415 MVA

NORTEK AS

Sold To
NortekUSA

27 Drydock Avenue
Boston MA 02210-2377
USA

Attn: Chris Kontoes
Fax: +1 617-275-8955
Phone: +1-617-206-5750

Ship To
Gillen, Patricia
Marine Sciences Building
71 Dudley Road, Rm 204
New Brunswick, NJ 08901-8521

Date	Customer Order	Ship via	Ship Terms	Nortek PO
27.Mai.2014	2002019	UPS	NortekUSA UPS account	27169

Description	Quantity	Unit Price	Discount	Amount
Aquadopp, Profiler 1MHz	1	USD 15,000.00		USD 15,000.00
1MHz Standard head-AQP	1			
Standard housing, for two batteries or one 100Wh package	1			
Pressure sensor, 0-100m	1			
Compass and tilt sensor	1			
10-m RS232 polyurethane cable with 8-pin Inline connector with USB Converter	1			
Harness RS232 w/An. In 8/5 AQD & Vector. 375mm	1			
One 100 Wh battery alkaline battery	1			
Endbell with two inline connectors	1			
Two connector endbell = 8pin + 6pin				

Subtotal	USD 15,000.00
Freight and Insurance	
Total	**USD 15,000.00**

Remarks No of boxes: 1
Tracking no:1Z5W41886693766376

Shipping info HS code for customs clearance:
9015.80.80 Oceanographic instruments
Instruments for measurement of waves and currents
All import charges to NortekUSA UPS account 18V900

COMMERCIAL INVOICE - FOR CUSTOMS PURPOSES ONLY

COUNTRY OF ORIGIN: NORWAY
The exporter of the products covered by this document NO/13-996707415 declares that, except when otherwise clearly indicated, these products are of EEA preferential origin.

Figure 6: Invoice for the Nortek Aquadopp

Figure 7: Picture of the deliverd ADCP.

6. Appendix 2:

University of Connecticut
And
University of Rhode Island
Progress Report

1. PROGRAM INFORMATION AND HIGHLIGHTS

During the 2nd quarter of 2014, the following progress was made:

A. Procurement

Two full CODAR sites were delivered late July at UCONN. The full systems are to replace the Stehli Beach, NY and Great Captain Island, CT sites (Both 25 MHz). Both of these sites have the old box style combined antenna, which requires an installation redesign for the antenna. The machine shop here in the Marine Sciences Department at the University of Connecticut is fabricating a new mounting bracket design for the Stehli Beach installation, which is located on top of a roof. Great Captain Island will be less of a custom install. Both sites are also getting upgraded communication package, computer, ups system, webpower switch, enclosure, and air conditioning unit.

A new dome style antenna, cables, air conditioners unit, ups, and communication packages have been delivered to URI early July. The antenna and cables will be installed out at the Block Island, RI 25 MHz site. The air conditioner, ups, webpower switch and communication package will be installed at Block Island, RI; Misquamicut, RI; and Montauk, NY 25 MHz sites. Currently Misquamicut, RI site and Montauk, NY 25 MHz site have upgraded dome style antennas. However these sites do not have GPS timing. Both transmitters and receivers from Misquamicut and Montauk have been shipped back to CODAR in early July for upgrades.

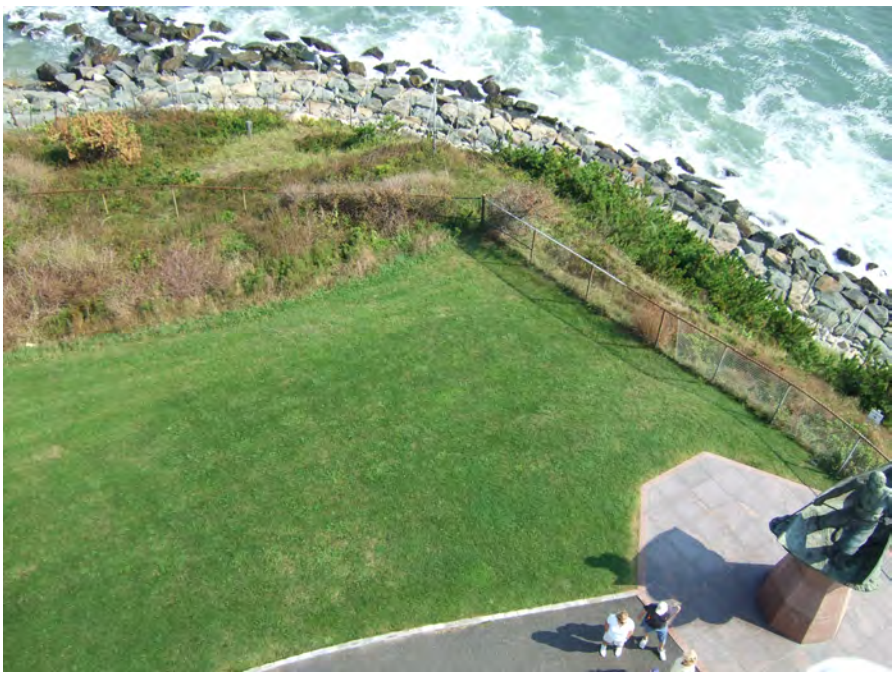
B. Site Installations

Arrangements are being made to start installation Great Captain and Stehli Beach, which should start taking, place the beginning of August. Montauk, Misquamicut, and Block Island will get new air conditioning unit, ups, webpower switch, computers, and communication package installed over the month of August and September. Once CODAR upgrades the transmitter and receiver for Block Island and Misquamicut that hardware will be reinstalled. Block Island antenna and cable upgrades will take place over the next two months. The current installation of all 5 sites is detailed in the images below.

1. Block Island

2. Misquamicut, RI

3. Montauk, NY



4. Stehli Beach, NY

5. Great Captain Island, CT

The proposed timeline to perform repairs and harden the sites is below.

1. Repairs	**Timeline**
a. Replace control computers at both sites (Mac Mini computers)	July, 2014
b. Replace air conditioners at both sites	July, 2014
c. Replace antennae and cables at both sites (from CO DAR)	August - September 2014
d. Replace transmitter and receiver at GeAP (from CODAR)	August - September 2014
e. Replace UPS at both sites	July, 2014
f. Calibrate both sites	September, 2014

2. Hardening	**Timeline**
a. Install waterproof enclosures at both sites	July, 2014
b. Install lightening protection kit at both sites (from CODAR)	August - September 2014
c. Install GPS timing at both sites (from CODAR)	August - September 2014
d. Install multi-static processing software at both sites (from CODAR)	August - September 2014
e. Install backup satellite communications for both sites	
f. Install power outage protection	
g. Replace transponder for calibration at GCAP, STLI, BISL, MNTK, and MISQ and other regional sites.	
h. Acquire backup antennae and cables for use at GCAP,STLI, BISL, MNTK and MISQ	
i. Acquire backup transmitterfor use at GCAP,STLI, BISL, MNTK and MISQ	
j. Acquire backup control computer for use at GCAP,STLI, BISL, MNTK, and MISQ	

7. Appendix 3:

CODAR Install Report

Rutgers University
May 5-9,2014

Prepared by:
Hardik Parikh, CODAR Ocean Sensors, Ltd. <hardik@codar.com>

BASIC INFORMATION

Customer/Project
Rutgers University

Location(s)
Sandy Hook(HOOK),NJ
Hempstead(HEMP),NJ

Dates of Travel
May 4 - May 12,2014

Lead CODAR Representative(s)
Hardik Parikh <hardik@codar.com>

Participants
- Hardik Parikh <hardik@codar.com>
- Ethan Handel <handel@marine.rutgers.edu>
- Colin Evans <colinevans7@gmail.com>

Purpose of Trip
The purpose of this trip was to install and calibrate Dual-TX systems at Sandy Hook, NY and Hempstead,NJ and possibly at Love Ladies site,time permitting.
Provide some hardware and software tips & tricks and training to Rutgers staff.

Work Timeline

- Reached NJ on May 4. Check-in to hotel.

Day 1: May 5,2014

- Met Hugh Roarty, Colin and Ethan at RUCOOL lab around 9am.
- Discussion about work plan for the day. Roundup of required equipment and tools.
- Left campus for Hempstead site around 11:30am.
- Reached HEMP around 2pm. Reviewed site location for 2nd TX antenna placement. Planned arrangement of chassis and other items in enclosure.
- Installed chassis and 2nd TX antenna about 20m behind the existing TX antenna.
- Installed tuners, lightning arrestor kit and made cable connections.
- Performed transmitter tuning of both transmitters with external tuners.
- Made phase adjustments to the 3rd channel for optimum signal transmission with dual-TX antennas to transmit maximum power towards ocean and minimum towards land. Made power measurements with SDR-IQ receiver.
- Phase change setting of 0c selected. Blanking base left at 1945us.
- There was about 50% difference in FW power readings on the tuner and internal power meter on TX 1. Several troubleshooting methods tried to confirm there was no hardware problem. Difference in reading was suspected due to difference in tuning of the internal power meter with the TX antenna.
- About 5W difference between TX 1 and TX 2 tuner readings.
- Sea condition was calm. Had weak bragg peaks and range of about 170km.
- Left the site around 9:30pm. Back to hotel around 11pm.

Day 2: May 6,2014

- Met Colin and Ethan at RUCOOL lab around 9am. Rounded up equipment.

- TX2 chassis meant to be installed at HOOK was accidentally shipped somewhere else. Left campus for Sandy Hook site around 10:30am with TX 1 chassis only.
- Reached site around 1pm. Reviewed site location for 2nd TX antenna placement. Planned arrangement of chassis and other items in enclosure.
- Installed TX1 chassis and 2nd TX antenna about 20m behind the existing TX antenna. Tested TX 1 and TX 2 antenna with TX1 chassis.
- Installed tuners, lightning arrestor kit and made cable connections.
- Left the site around 6pm.

Day 3: May 7,2014

- Met Colin at RUCOOL lab around 8am. Received the correct TX2 chassis and left for the site around 9am.
- Reached site around 12pm. Installed TX2 chassis. Made cable connections.
- Performed transmitter tuning of both transmitters with external tuners.
- Made phase adjustments and power measurements with SDR-IQ receiver.
- FW/Ref power readings between internal meter and external tuners matched well for both TX 1 and TX 2 and also between TX1 and TX2 after 1dB external attenuator was added at the back of TX1.
- Waited at the site to get at-least 1 merged radial output.
- Left the site around 6pm.
- There was no bragg on loop1.

Day 4: May 8,2014

- Raining forecast whole day. So no field trip was planned. Spent the day at RUCOOL lab.
- Reviewed HEMP and HOOK site settings and current status of the sites with Colin.
- Reviewed diagnostics. Informative discussion with Colin and Ethan on different tips and tricks on using different diagnostics parameters for troubleshooting.
- Informal tutorial to Colin about some Release 7 software and command line tools for data analysis and regular site monitoring and maintenance.
- Tried to set up preliminary GPS alignment values for the eight 4.513MHz sites from NAUS to LOVE.

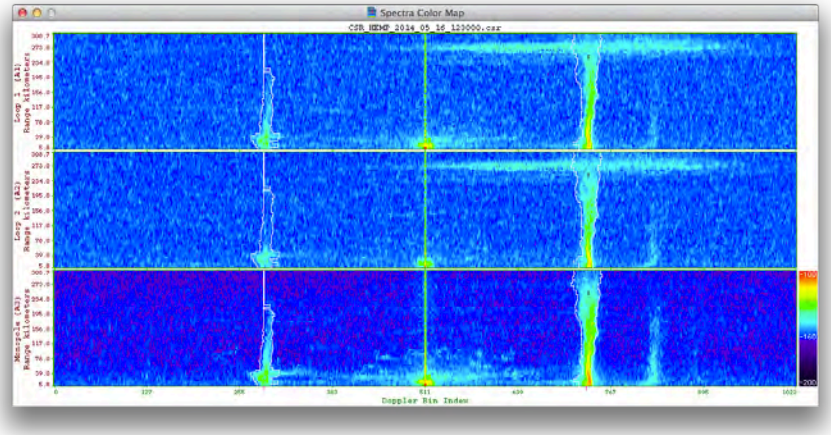
Day 5: May 9,2014

- Decided to visit HEMP site to redo the power measurements and reconfirm that there is no hardware problem causing unusual power readings mismatch between the two transmitters.
- Left RUCOOL lab around 9:30am. Reached HEMP around 11am.
- All dual-TX measurements redone including phase measurements using SDR.
- A new phase setting of 1d selected and stored in settings.
- Today, the difference in power readings was not as drastic(not at half-power) as on 1st day. So difference is attributed to tuning mis-match. Doesn't affect the performance of the systems.
- Left the site at 4pm. Reached back to RUCOOL lab at 7pm.

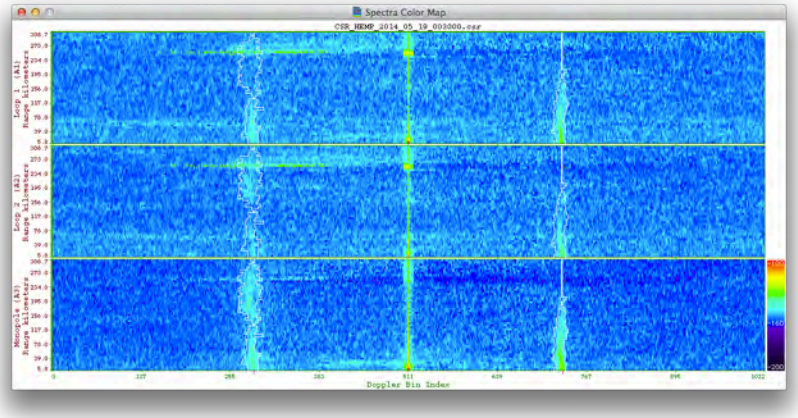
Post-Trip additional work and analysis

- There were 7 sites that were now operating at 4.513MHz with NAUS operating at 4.512035MHz which was interfering with some of the neighboring 4.513MHz sites.
- Tried to change NAUS to 4.513MHz and set up GPS alignment for all 8 sites. Challenging and very time consuming task due to the large number of sites involved and slow and intermittent internet connection at some of the sites.
- But after trying few days, concluded that it was not possible to set up GPS alignment for these 8 long-range sites, out of which there will be 4 dual-TX long range sites. The number of range cells available to stack 8 sites with their mult-static echoes and ionospheric echoes were not adequate to avoid interference between several sites.
- Also, straight line distance over water between HEMP and HOOK was only 37km, less than adequate for LR systems. This also made difficult to keep them on same frequency as they would result into more noise at these two sites.
- Rutgers had an alternate frequency available at 4.538MHz.So a couple of alternate plans were considered: 1)To split 8 sites into 2 groups of 4 with WILD,LOVE,HEMP,NAUS at 4.513MHz and HOOK,MRCH,BLCK,MVCO at 4.538MHz. or 2) Set all 8 sites from WILD to MVCO with alternating CF,with one at 4.513MHz and other at 4.538MHz.
- Option 1 above was finally chosen.
- During this period, NAUS site had a hardware failure and was shut down. So set up GPS timing alignments at WILD,LOVE,HEMP only with CF of 4.513MHz. Took couple of weeks due to intermittently unusable internet connection at HEMP site.
- Set up GPS timing alignments at HOOK,MRCH,BLCK,MVCO with CF of 4.538MHz. (intermittently unusable internet connection at MVCO site)
- At all LR sites, night time noise is higher and also from early evening to night time, usually there are stronger ionospheric echoes at all sites and also from other neighboring LR sites which will impact the range coverage.

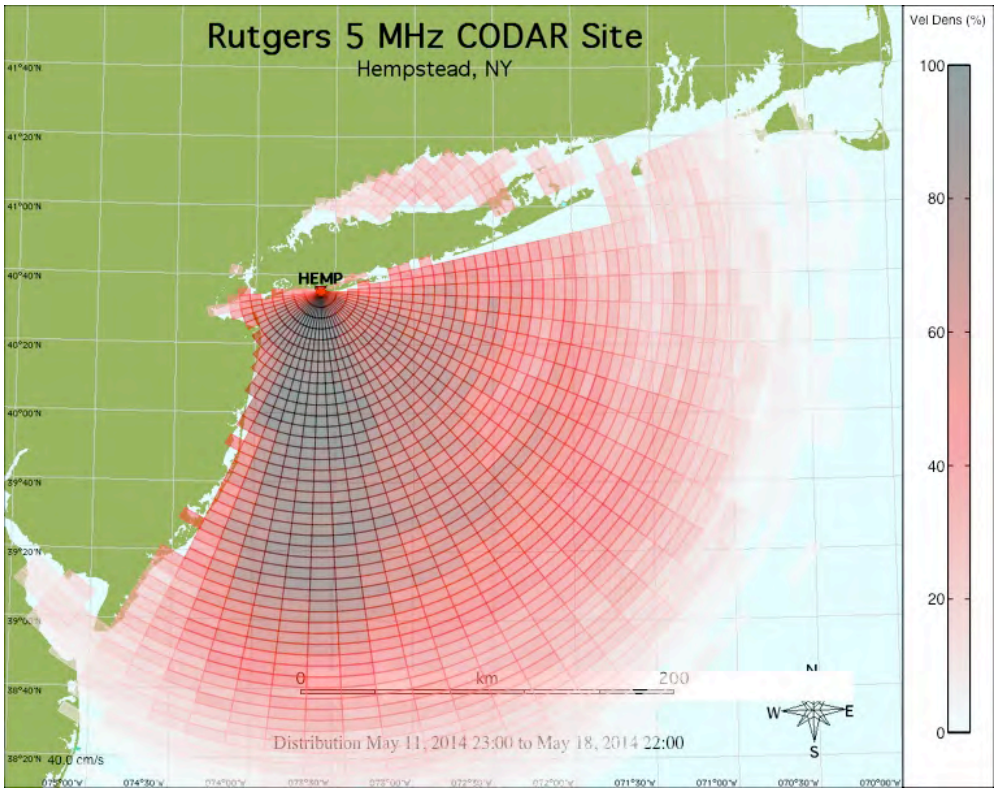
HEMP:



When ocean conditions were favorable and noise not too high, HEMP so far can get range upto 240-250km as shown in above CSS image.



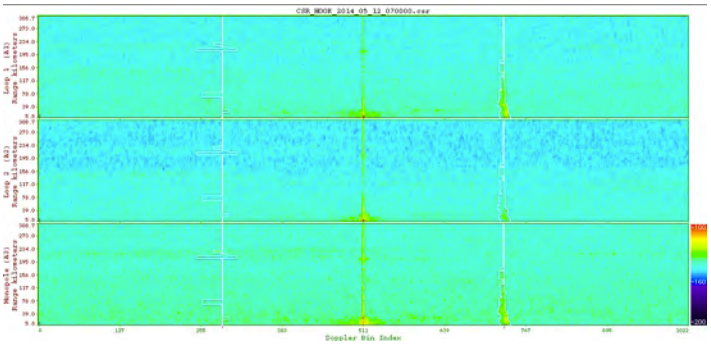
Above is a CSS image showing higher noise and weaker bragg peaks resulting into little less range.

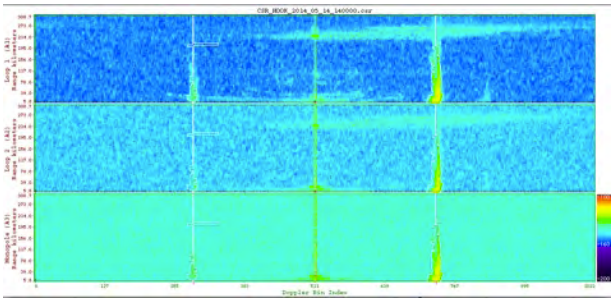


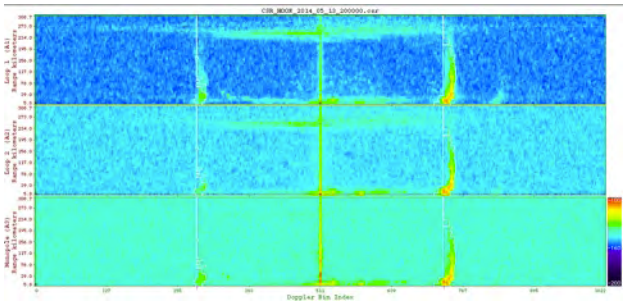
Ideal Radials distribution from May 11,23:00 to May 18,22:00. Average range about 240-250km.

HOOK:
Hook site sees higher overall noise than HEMP during both day and night times.
It is one of the factors why HOOK gets overall less range than HEMP.

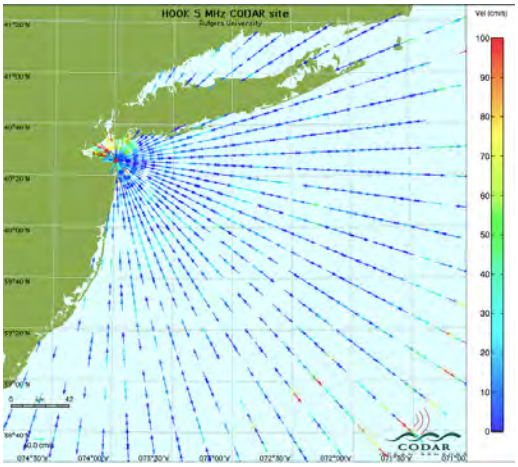
Below are different examples of CSS with high noise and relatively low noise along with ionospheric echoes.

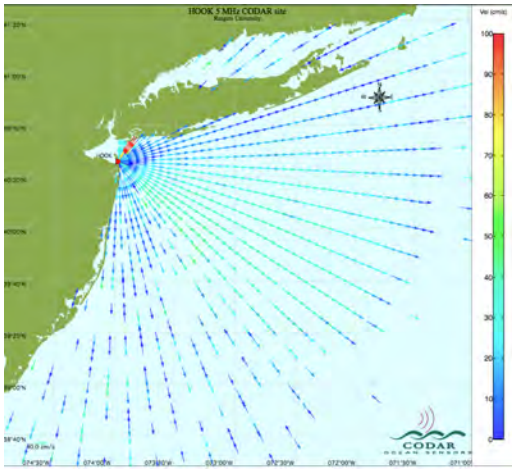






Below are examples of ideal radials at good times when range can extend upto 230km.





CODAR Ocean Sensors, Ltd. 1914 Plymouth Street, Mountain View, CA 94043, USA **p:**+1-408-773-8240

HOOK had some loop1 problem later due to which the coverage was affected in the loop1 direction. The pattern may be quite distorted at this site, guessed based on ideal radials.

There is a periodic external interference present at all 4.513MHz sites.
There is occasional higher noise at HOOK than at HEMP.

Recommendations and further follow-up work

- Perform APM at both sites.
- Fix loop 1 problem at HOOK
- Review the GPS alignments again at the sites for fine-tuning and also may have to re-do the GPS alignments when dual-TX is installed at the remaining 2 sites.
- Review First Order Line settings.