HF Radar in Puerto Rico System Operation and Vessel Detection Validation

Samuel Rivera & Hugh Roarty

Project Introduction

High Frequency Radars have increased their importance in oceanographic studies during the last decade. A system known as SeaSonde has had the most success. The system is usually used as a reliable surface current measurement tool, but this system can be used too for the reliable detection of vessels by reading the second-order Bragg scatter. By using this data, information such as the direction, velocity and distance of the vessel can be obtained. This information is useful to organizations such as the Homeland Security and the U.S. Cost Guard since it enhances national security, maritime security, emergency response and environmental management.

As any recently installed system some validation and quality control analysis must be done in order to verify that the system is working properly and that the data obtained is reliable. This project intends to validate the existing data and perform a quality control check on the system and the incoming vessel detection data obtained from the SeaSonde (CDDO) HF radar in Puerto Rico.

Hypothesis:

The HF Radar in Puerto Rico would present a normal operational behavior with a good quality vessel detection data and a good detection rate.

Location of the 13 MHz Codar System CDDO

Puerto Rico recently installed a High Frequency (HF) radar systems known as SeaSonde Club Deportivo Del Oeste (CDDO), in the western cost. The installation was performed in February 2009, and the system was placed at the town of Cabo Rojo, latitude: 18.1003 and longitude: -67.1905. The radar operates on an average frequency of 13.45 MHz with an average range of 84.64 Km.

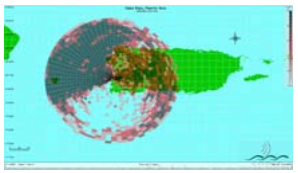


Figure 1

Figure 2

Figure 3

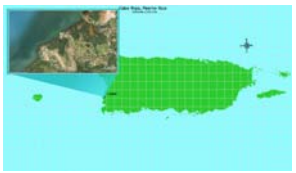


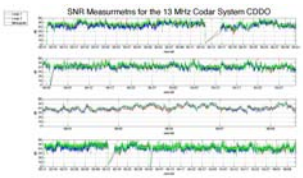
Figure 4

Figure 1 & 4 – Location of the 13 MHz Codar System CDDO
Figure 2 – Rx antenna pointing towards the Mona Passage
Figure 3 - Installation day at the CDDO site. (From left to Right Julio Morrell, Chip Haldeman and Jorge Corredor)

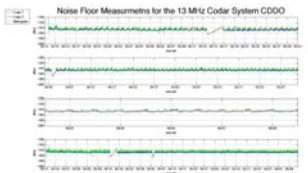
Diagnostic Comparison Analysis for the 13 MHZ Codar Systems SEAB vs. CDDO

Average	SEAB	CDDO
Noise Floor (dBm)		
Loop 1	-152	-144
Loop 2	-152	-147
Monopole	-156	-144
Signal to Noise Ratio (dB)		
Loop 1	28	44
Loop 2	27	43
Monopole	32	45
Amplitude (1/v^2)		
Loop 1	1	1
Loop 2	0	1
Phase (deg)		
Phase 13	-7	-11
Phase 23	8	-30
Dual Angle Percentage (%)	42	43
Range (Km)	61	81
Salinity (psu)	32	36

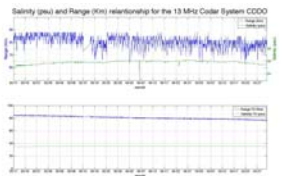
Diagnostic Data Comparison Table



Signal to Noise Ratio (dB) for the Codar System CDDO

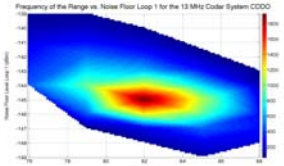


Noise Floor (dBm) for the Codar System CDDO

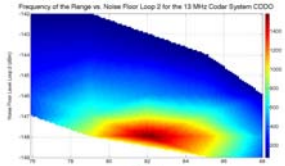


Salinity Versus Range (Km) for the Codar System CDDO

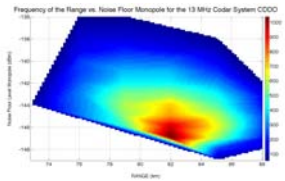
Relationship Between Range (Km) and Noise Floor Levels (dBm)



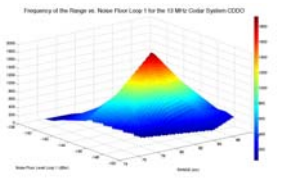
Loop 1



Loop 2



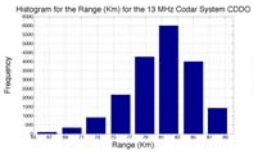
Monopole



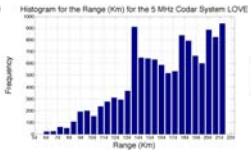
3D Plot

• Frequency with which of a pair of Noise Floor Level (dBm) and Range (Km) repeat throughout the data.

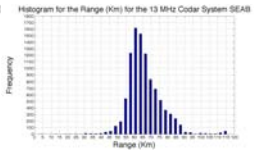
Comparison Analysis for the Distribution of Range 5 and 13 MHz Codar Systems



CDDO – 13 MHz



LOVE – 5 MHz



SEAB – 13 MHz

•The larger the transmission frequency, the less range but the more resolution in the data.

Troubleshooting the CDDO Site

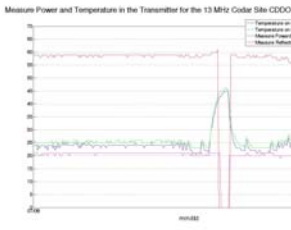


Figure 1

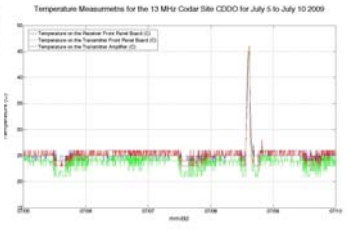


Figure 2

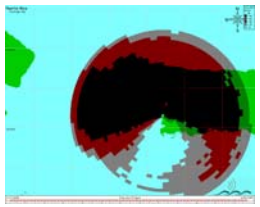


Figure 3

Figure 4

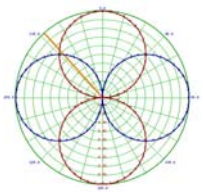
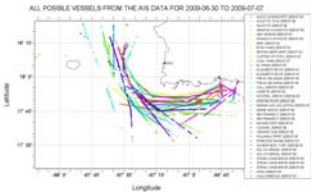


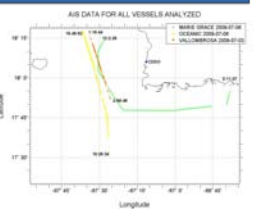
Figure 5

Figure 1 & 2 – July 10,2009 Troubleshooting - Temperature and Power problems in the transmitter
Figure 3 – Inland data is the HF radar current problem
Figure 4 – Damian Ruiz Measuring the bearing of the Receiving Antenna
Figure 5 – Ideal Antenna Pattern created for the Vessel Detection Validation

Vessel Detection Data Validation



Vessels Considered for the Validation Analysis for the time period of 06/30/2009 – 07/07/2009

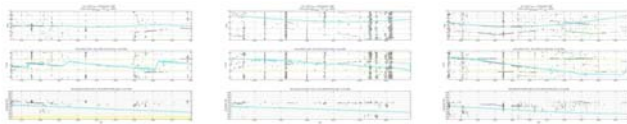


Track and Time Period of the Vessels Analyzed obtained from the CariCOOS AIS files

MARIE GRACE **VALLOMBROSA** **OCEANIC**

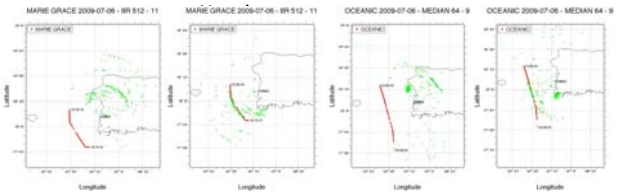
Range Cell 11 **Range Cell 13** **Range Cell 7**

Second–Order Bragg Scatter



Vessel Detection Analysis

Detection Rate of the



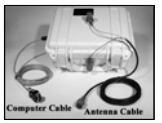
Possible Angle Offset of 160° with the Ship Detect Software
Ship Detect Software is still in Development

Conclusions:

- The 13 MHz Codar System CDDO presented a normal operational behavior with expected values for each parameter.
- Because of the quantity of inland data being gather by the HF radar, the data can't be use as a reliable source of information.
- The HF radar is detecting the vessels passing along the west coast of Puerto Rico although the output received from the Ship Detect software is not reliable.

Future Work:

- Perform an Antenna Pattern Measurement.
- Install and have a full operational second Codar System site in the West coast of Puerto Rico.



Acknowledgements:

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