

Chirp Sonar Remote Sensing for Ripples DRI and SAX04

Steven G. Schock
Department of Ocean Engineering
Florida Atlantic University
Boca Raton, Fl. 33431-0991
phone: 561-297-3442 fax: 561-297-3885 email: schock@oe.fau.edu

Grant Number: N00014-04-1-0477
Grant Number: N00014-01-1-0887
Grant Number: N00014-00-1-0847
Grant Number: N00014-00-1-0077
<http://www.oe.fau.edu/CHIRP/>

LONG TERM GOALS

The long-term research objective is to develop a cost effective technique for mapping the top 20 meters of sediment properties using acoustic remote sensing and recent developments in modeling the physics of sediments acoustics. The procedures for remotely estimating the physical and acoustic properties of sediments are tested using sediment properties from core data and insitu measurements.

OBJECTIVES

- 1) Generate reflection profiles of a region about 1 km offshore of Fort Walton Beach in order to select an site containing sandy homogeneous sediments for the SAX04 experiments.
- 2) Generate BOSS (buried object scanning sonar) imagery at the SAX04 site to verify the placement of buried objects and to measure the performance of BOSS against those buried objects
- 3) Measure the normal incidence acoustic impulse response of the seabed at locations where insitu or core data is collected
- 4) Compare remote chirp sonar estimates of the acoustic and physical properties of the seabed with measurements made by other investigators conducting insitu acoustic experiments and coring surveys to determine the accuracy of acoustic remote sensing

APPROACH

In previous years, a chirp sonar was developed to provide quantitative, wideband reflection measurements of the seabed with a vertical resolution of 10 cm. Signal processing techniques were developed to estimate the acoustic and physical properties of sediments using reflection coefficient and attenuation measurements and the Biot model..

The technical approach is to collect normal incidence FM reflection data with a towed chirp sonar using a dual pulse mode where the sonar alternately transmits 40 msec 1.5 to 4 kHz and 10 msec 1.5-15 kHz FM pulses providing images of the top 40 meters of sediments and generating wideband data sets that can be used for predicting vertical profiles of acoustic sediment properties needed by

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE SEP 2004		2. REPORT TYPE		3. DATES COVERED 00-00-2004 to 00-00-2004	
4. TITLE AND SUBTITLE Chirp Sonar Remote Sensing for Ripples DRI and SAX04				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Department of Ocean Engineering,,Florida Atlantic University,,Boca Raton,,FL,33431				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT The long-term research objective is to develop a cost effective technique for mapping the top 20 meters of sediment properties using acoustic remote sensing and recent developments in modeling the physics of sediments acoustics. The procedures for remotely estimating the physical and acoustic properties of sediments are tested using sediment properties from core data and insitu measurements.					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 5	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

scientists for modeling acoustic propagation. The multiband chirp technology allows the collection of normal incidence reflection data over a band of 1 to 15 kHz while the towed vehicle emulates a point acoustic source. Wide projector and receiver beamwidths reduce errors in the reflection coefficient measurements caused by scattering from a rough seabed interface. The point source is emulated using 2 piston sources that operate over different but overlapping frequency bands. Each single piston source has a wide beamwidth (greater than 40 degrees) over its band of operation. Multiple transducers can be driven simultaneously with chirp pulses with different bands to generate the wideband chirp pulse in the water that appears (in the far field) to emanate from a point acoustic source. Multiple rectangular receiving arrays of various sizes are used to control receiving beamwidth and scattering by spatial filtering. The 15 kHz bandwidth provides subsurface imagery with 10 cm vertical resolution. The enhanced bandwidth also improves the accuracy of attenuation and phase measurements needed for impedance inversion and dispersion measurements.

The Biot model is used to estimate the physical and acoustic properties of the seabed from reflection coefficient and attenuation measurements made with the chirp sonar. Bulk properties such as bulk density, porosity and sound speed are estimated from reflection coefficient measurements. Pore properties such as grain size and permeability are estimated from attenuation measurements

Dr. Schock supervises the research program including graduate and undergraduate students and at sea experiments. Jim Wulf is the lead engineer who designs and implements sonar modifications, and attends at sea experiments.

WORK COMPLETED

- 1) A chirp sonar survey off Fort Walton Beach was conducted in May 2004 to select a site for the SAX-04 experiment. The reflection profiles are posted on the APL-UW's SAX04 web site.
- 2) Conducted a chirp sonar and BOSS survey of the SAX04 target field off Fort Walton Beach in September 2004 just before Hurricane Ivan past through the region

RESULTS

Reflection profiles collected by the chirp sonar were used to select the SAX04 site. Figure 1 shows the selected region for the 60 by 60 meter target field. This sandy region was selected due to low subsurface volume scattering and the absence of significant sediment layering.

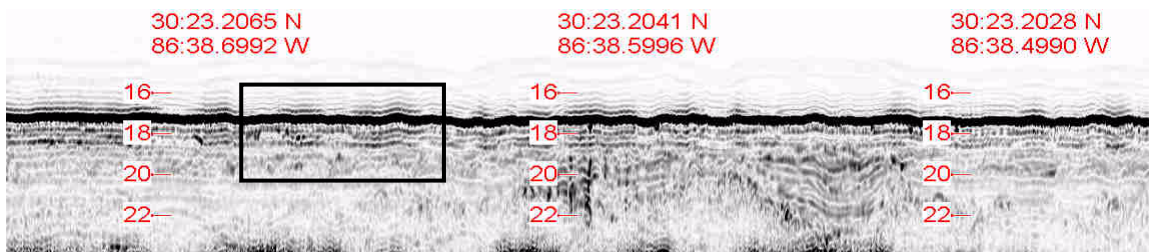


Figure 1 Chirp sonar line A5 showing selected location of the 60 by 60 meter target field indicated by the black box. Depth markers are in meters beneath the sea surface assuming the sound speed of seawater.

BOSS imagery of SAX04 targets in the 60 by 60 meter field was collected at the beginning of September 2004 to verify placement of targets and to check performance of BOSS against the buried targets. The image was generated by a 252 channel BOSS sonar vehicle operating in a 11 ping SAS mode which extended the 1.5 meter physical receiving aperture by an additional 1.5 meters.

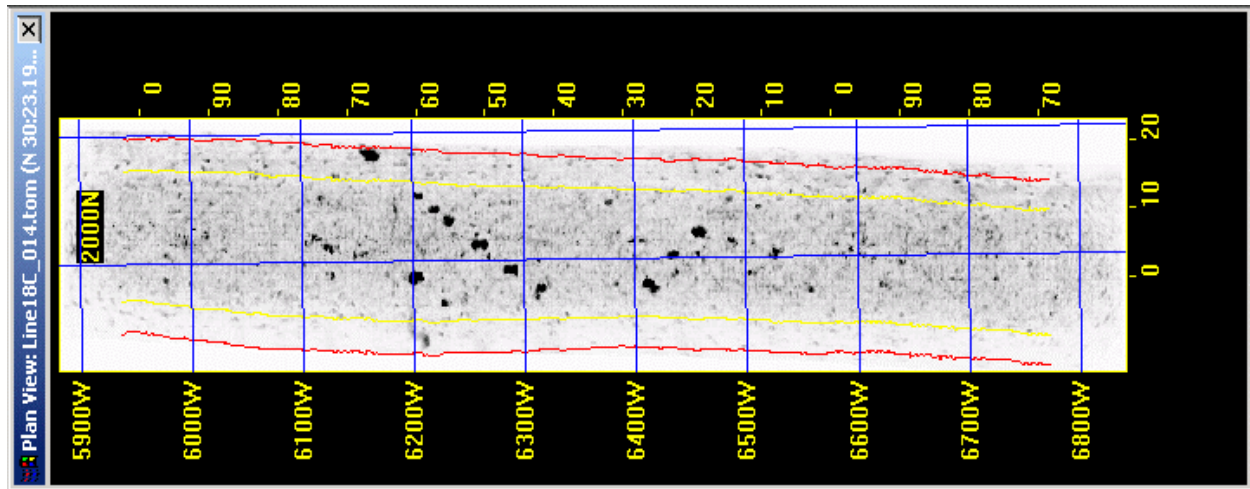


Figure 2 BOSS image (line 18C) of SAX04 targets buried within 1 meter of sediment water interface
Horizontal and vertical scales are in meters. The blue grid overlay is position given in latitude and longitude with units of 1/1000 minutes. BOSS was operating in operating in a 11 ping SAS mode which extended the 1.5 meter physical receiving aperture by an additional 1.5 meters.

IMPACT/APPLICATIONS

Instrumentation and sediment classification procedures have been developed to predict the acoustic and physical properties of the seabed using normal incidence reflection data collected by FM subbottom profilers. This development provides a cost effective method of surveying seabed sediments and obtaining remote estimates of the bulk density, grain size, porosity, attenuation, acoustic impedance, volume scattering and sound speed of ocean sediments.

PUBLICATIONS

“A Method for Estimating the Physical and Acoustic Properties of the Seabed Using Chirp Sonar Data,” S. G. Schock. IEEE J. of Oceanic Eng [accepted, under revision].

“Remote prediction of physical and acoustic sediment properties in South China Sea using chirp sonar data and the Biot model, S. G. Schock, IEEE J of Oceanic Eng. [accepted, under revision]

“Seabed characterization on the New Jersey middle and outer shelf: Correlability and spatial variability of seafloor sediment properties” John A. Goff, Barbara J. Kraft, Larry A. Mayer, Steven G. Schock, Christopher K. Sommerfield, Hilary C. Olson, Sean P. S. Gulick, and Sylvia Nordfjord, Marine Geology , 2004 [in print]

“ An estimate of the bottom compressional wave speed profile in the northeastern South China Sea using sources of opportunity” Ying-Tsong Lin, James F. Lynch, Nick Chotiros, Chi-Fang Chen , Arthur Newhall, Altan Turgut, Steve Schock, Ching-Sang Chiu, Louis Bartek, Char-Shine Liu, IEEE J. Oceanic Eng’g Special Issue on Asian Marginal Seas, 2004 [in print]