Proceedings, The Asian Seas International Acoustics Experiment (ASIAEX) International Symposium, Chengdu, China, October 14–18, 2002

by Dajun Tang,[1] Steven R. Ramp,[2] Peter H. Dahl,[1] James Lynch,[3] Jixun Zhou,[4] Renhe Zhang,[5] Ching-Sang Chiu,[2] Robert C. Spindel,[1] and Jeffrey Simmen[6]

[1]*Applied Physics Laboratory, University of Washington, Seattle, Washington*
[2]*Naval Postgraduate School, Monterey, California*
[3]*Woods Hole Oceanographic Institution, Woods Hole, Massachusetts*
[4]*Georgia Institute of Technology, Atlanta, Georgia*
[5]*Institute of Acoustics, Chinese Academy of Sciences, Beijing*
[6]*Office of Naval Research, Arlington, Virginia*

Technical Report
APL-UW TR 0201
December 2002

Applied Physics Laboratory University of Washington
1013 NE 40th Street Seattle, Washington 98105-6698

Contract N00014-99-1-0275

Acknowledgments

The Asian Seas International Acoustics Experiment (ASIAEX) was sponsored by the U.S. Office of Naval Research, Ocean Acoustic Program, Drs. Jeffrey Simmen and Ellen Livingston, Program Managers, and by the Navy International Cooperation Program (NICOP). The support of these agencies is gratefully acknowledged. Ms. Beverly Kuhn and Prof. Jixun Zhou skillfully assisted with the arrangements for the Chendgu symposium. Many contributed to the success of the ASIAEX field program. Particular thanks are extended to the officers and crew of the *Roger Revelle* and *Melville* from the United States, the *Shi Yan 2* and *Shi Yan 3* from the People's Republic of China, and the *Fisheries Researcher 1*, *Ocean Researcher 1*, *Ocean Researcher* 2, and *Ocean Researcher 3* from Taiwan. The work could not have been accomplished without their patience, dedication, and skill.

CONTENTS

INTRODUCTION

The final international symposium for the Asian Seas International Acoustics Experiment (ASIAEX) was held October 14–18, 2002 at the Holiday Inn Crowne Plaza Hotel in Chengdu, China. Approximately sixty representatives from four countries attended to present results from the field programs conducted during spring and early summer 2001. The first research program focused on acoustic reverberation from the surface, bottom, and sub-bottom in shallow (less than 100 m) water, while the second was dedicated to the study of volume interaction of low frequency (200–400 Hz) sound propagating up the continental slope and shelf. The reverberation experiment was conducted in the East China Sea (ECS) in the region bounded by 28°–30°N, 126° 30'–128°E (Figure 1). This was same region studied during the spring 2000 pilot study. The volume interaction experiment took place in the South China Sea (SCS) in a box bounded by 21°–22° 30'N, 117°–119°E (Figure 2). The goals and rationale for these experiments were detailed in earlier workshop reports, most notably from the final planning workshop held June 21–23, 2000 in Kailua Kona, Hawaii [Ramp, *Workshop Report: The Asian Seas International Acoustics Experiment (ASIAEX) Final Planning Meeting, Kailua Kona, Hawaii, June 21–23, 2000*, Naval Postgraduate School Tech. Rept., NPS-OC-01-001, Monterey, California, June 2001].

The first day of the Chengdu workshop was dedicated to the presentation and summary of SCS results; physical oceanographers presented environmental findings first then acousticians discussed the acoustic ramifications. The talks during the second day-and-one-half focused on the East China Sea in similar order. Day three allowed for tours of some local cultural attractions in the greater Chengdu area. Beginning on Thursday afternoon, the SCS and ECS groups met separately to discuss their own issues and plan manuscripts for the special ASIAEX volume of the *IEEE Journal of Oceanic Engineering*. The groups reconvened in a plenary session on Friday morning to jointly plan the way ahead. All the major objectives of the workshop were accomplished. The group is looking ahead to the publication of outstanding papers that advance coupled physical oceanography and environmental acoustics programs.

This document consists of the symposium agenda and presentation abstracts. A summary of the ECS and SCS working group sessions follow. Also included are symposium participants and technical report distribution lists. Individual presentations are included as separate files on the CD-R.

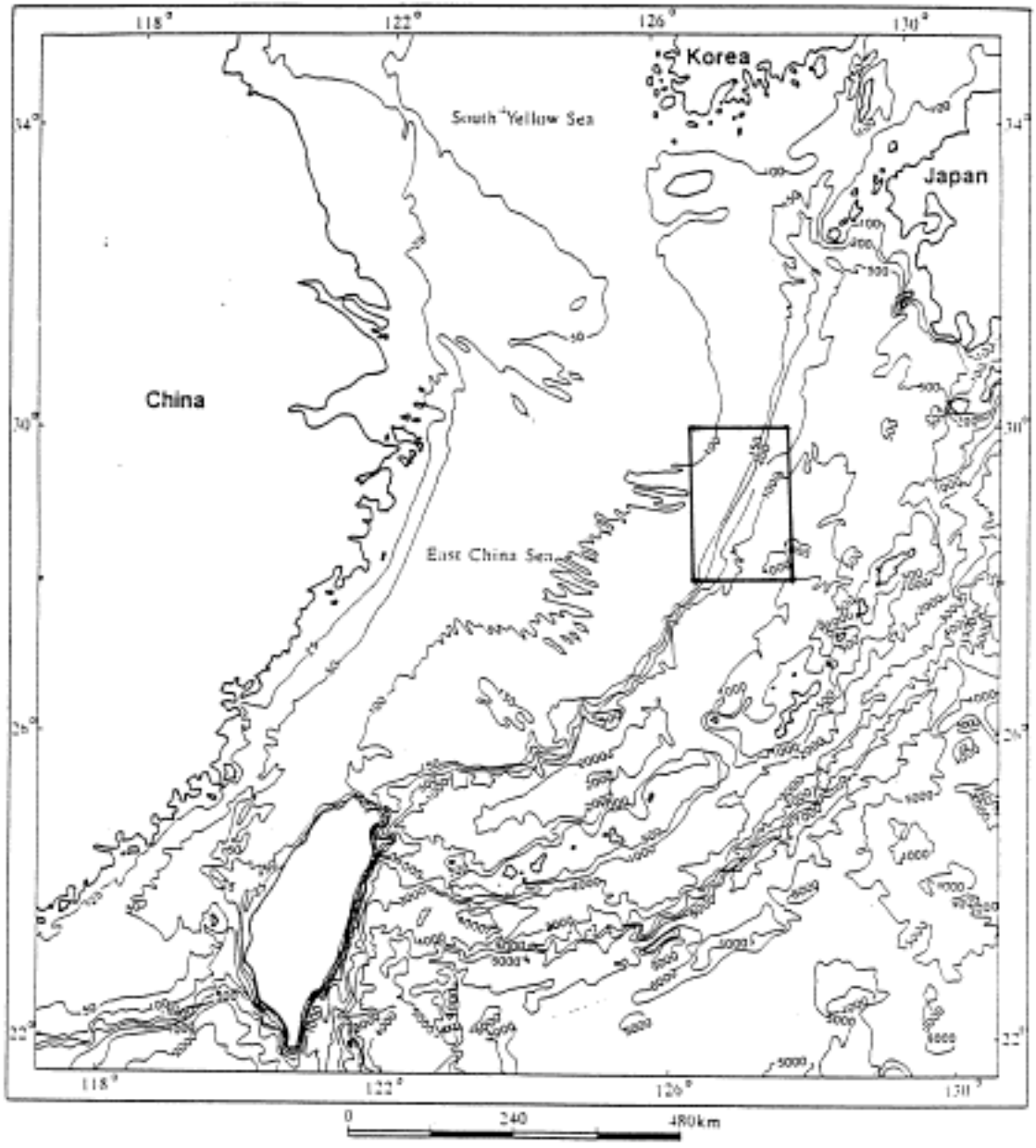

Figure 1. The box indicates the study region for the R/V Roger Revelle *pilot study cruise of April – May 2000 and for the reverberation experiment during June 2001. The June 2001 work was focused mainly on the shallow water region in the NW corner of the box.*

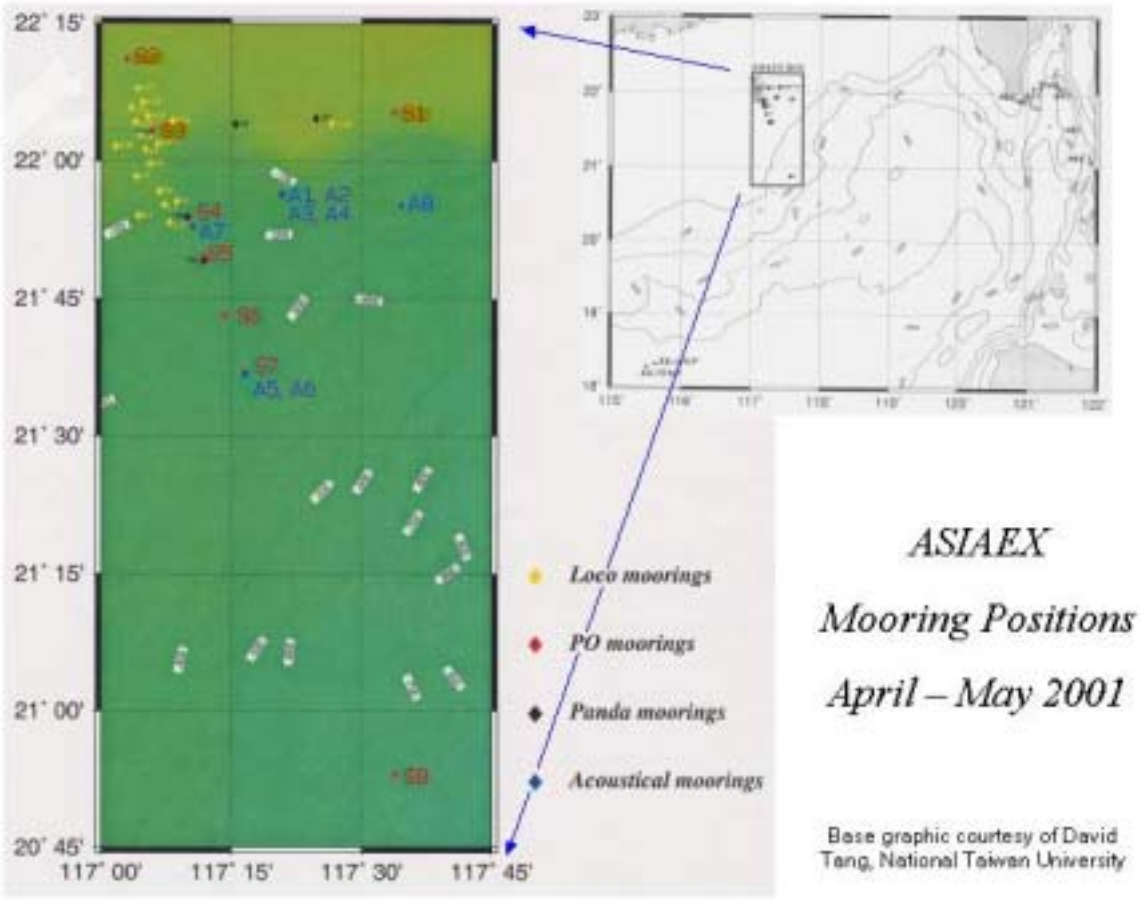

Figure 2. Locator map for the South China Sea ASIAEX program during April 2001.

SYMPOSIUM AGENDA

October 14, 2002

Welcome
Chairpersons: Renhe Zhang and Robert Spindel

Jeff Simmen, welcome speech, 10 minutes
Jing Tian, welcome speech, 10 minutes

SESSION 1 SOUTH CHINA SEA

Acoustics — 9:30–12:00 (4 reports)
Chairpersons: C.-S. Chiu and Dinghua Guan

1. Seabed attenuation estimated from chirp sonar data collected along acoustic propagation lines during ASIAEX in the South China Sea
   Steven G. Schock

2. Satellite observations of surface fronts, currents and winds in the northeast South China Sea
   Michael J. Caruso and Robert C. Beardsley

BREAK

3. Current and thermohaline structure near the shelf edge in the South China Sea from SeaSoar surveys
   Glen Gawarkiewicz, Joe Wang, and Frank Bahr

4. Nonlinear internal waves in the South China Sea during ASIAEX
   Antony K. Liu, David Tang, and Steve Ramp

SESSION 2 SOUTH CHINA SEA

Environment — 2:00–6:00 (8 reports)
Chairpersons: Steve Murray and Ping Shi

1. Moored observations of internal waves at the site the ASIAEX South China Sea acoustic propagation study
   Timothy F. Duda

2. Tracking the generation sites and packet variability of internal solitons in the South China Sea
   Steven R. Ramp, Ching-Sang Chiu, Fred Bahr, James Lynch, Tim Duda, Tswen-Yung David Tang, and Tony Liu

3. Measurement and analysis of acoustic intensity fluctuations induced by South China Sea internal solitons
   C.-S. Chiu, S. Ramp, C. Miller, J. Lynch, T. Duda, J. Kemp, and K. von der Heydt

4. Acoustic transmission intensity fluctuation observations in the SCS ASIAEX experiment
   Wu Lixin, Timothy Duda, and James Lynch

BREAK

5. Environmental observations taken aboard the *OR3*
Peter C. Mignerey and Marshall H. Orr

6. Acoustic horizontal coherence and beamwidth variability observed in ASIAEx (SCS)
Stephen N. Wolf, Bruce H. Pasewark, Marshall H. Orr, Peter C. Mignerey, James F. Lynch, and Theodore Schroeder

7. Influence of wind waves on surface and bottom stress to circulation modeling in Southeast Asian Seas
Hong Zhang

8. Diagnosing the behavior of a numerical forecasting system for the South China Sea
David C. Chapman, Dong-Shan Ko, and Ruth Preller

October 15, 2002

SESSION 3 EAST CHINA SEA
Geoacoustic Inversion — 8:00–12:00 (9 reports)
Chairpersons: James H. Miller and Ling Xiao

1. Broadband matched-field source localization in the East China Sea
Renhe Zhang, Zhenglin Li, Jin Yan, Zhaohui Peng, and Fenghua Li

2. Geoacoustic measurements in the East China Sea
James H. Miller, Louis R. Bartek, Gopu R. Potty, Peter H. Dahl, Colin J. Lazauski, Chuen-Song Chen, and Katy Westhoff

3. A progress report on the estimation of geoacoustic parameters from measured time series taken during the East China Sea component of ASIAEX
D. P. Knobles, T. Yudichak, P. Cable, and Y. Dorfman

4. Broadband geoacoustic matched field inversion from ASIAEX2001
Yang Kunde and Ma Yuanliang

5. Determination of the ocean bottom parameters in ASIAEX2001 using the SVD method
Shengchun Piao, Jixun Zhou and Zhaohui Peng 3

BREAK

6. Matched field inversion of explosive signals from the ASIAEX ECS 2001 experiment
Jin Yan, Zhenglin Li, and Renhe Zhang

7. Geoacoustic inversion by MFP combined with the vertical reflection coefficients and transmission loss
Zhenglin Li, Renhe Zhang, Jin Yan, Fenghua Li, and Jianjun Liu

8. Bottom reflection phase shift parameter estimation from ASIAEX data and propagation modeling based on reflection parameters
H.L. Ge, H.F. Zhao, X.Y. Gong, and E.C. Shang

9. Horizontal Coherence of Acoustic Field in the East China Sea
Ling Xiao, Zaixiao Gong, and Zhenglin Li

SESSION 4 EAST CHINA SEA
Bottom scattering and reverberation — 2:00–6:00 (9 reports)
Chairpersons: Ellen Livingston and Fenghua Li

1. Seabottom acoustic parameters from shallow-water reverberation
   Ji-Xun Zhou and Xue-Zhen Zhang

2. Mid-frequency bottom backscatter, environmental measurements, model/data comparison, and implications to reverberations
   Dajun Tang

3. Low-frequency shallow water reverberation and bottom scattering model
   Fenghua Li, Jianjun Liu, Renhe Zhang, and Jixun Zhou

4. Spatial coherence of signals forward scattered from the sea surface and seabed in the East China Sea
   Peter H. Dahl, Christian J. Eggen, and Russell D. Light

BREAK

5. Progress report on comparisons of East China Sea bottom scattering strengths at low frequency
   Peter Cable, Yevgeniy Dorfman, David Knobles, and Tom Yudichak

6. Preliminary analysis of reverberation data in ASIAEX experiment
   Jianjun Liu, Fenghua Li, and Renhe Zhang

7. Progress report on low-frequency bottom scattering for the ASIAEX East China Sea experiment
   Yevgeniy Dorfman, Peter Cable, David Knobles, and Thomas Yudichak

8. An experiment study of mid-frequency bottom backscattering strength in shallow water
   Zhongkang Wang, Hangzhou, and Dajun Tang

9. The modal-vertical-beam (MVB) transmission loss analysis and mode filtering with help of array extrapolation
   H.F. Zhao, H.L. Ge, X.Y. Gong, and E.C. Shang

October 17, 2002

SESSION 5 EAST CHINA SEA
Fluctuation — 8:00–12:00 (8 reports)
Chairpersons: Nick Chotiros and Wang Ning

1. Several aspects of the dynamics of the East China Sea currents
   Yan Du, Yiquan Qi, and Ping Shi

2. The shelf-edge environment in the central East China Sea and its impact on low frequency acoustic propagation
   Steven R. Ramp, Ching-Sang Chiu, and Fred Bahr, James Lynch and Tim Duda, Peter Dahl, Jim Miller, Yiquan Qi, and Renhe Zhang

3. Analysis on the ray travel times according to the ray invariant theory
   *Shi-e Yang, Shengchun Piao, and Yiwang Huang (**Cancelled**)*

4. Numerical simulation of sound fluctuation due to ocean environmental change
Wang Ning, Liu Jinzhong, and Yang Feng

BREAK

5. Direct path fluctuations due to shallow water variability
Stephen Karpi, Kevin B. Smith, Steven Ramp, and Peter H. Dahl

6. Acoustic tomography of dynamic processes in a sea shelf zone with the use of complex signals
V.A. Akulichev and Yu N. Morgynov (Electronic copy not received)

7. Characteristic of the internal waves at location of 126°54.32' E 29°24.01' N
Shihong Zhou, Jixun Zhou, and Jie Yang

8. Frequency dependence of effective bottom attenuation due to environmental variability
Kevin B. Smith and James D. Nickila

October 17, 2002

SESSION 6
Discussion — 2:00–6:00
Chairpersons: Jim Lynch (SCS) and Peter Dahl (ECS)

October 18, 2002

SESSION 7
Conclusion — 8:00–12:00
Chairpersons: Steven Ramp and Jeffrey Simmen

SYMPOSIUM ABSTRACTS

(*alphabetical by first author*)

Progress report on comparisons of East China Sea bottom scattering strengths at low frequency

Peter Cable and Yevgeniy Dorfman
BBN Technologies
David Knobles and Tom Yudichak
Applied Research Laboratories, University of Texas at Austin

East China Sea bottom scattering strengths in the decade below 1 kHz have been determined from ASIAEX 2001 reverberation data gathered by Jixun Zhou, Renhe Zhang, Zhaohui Peng, Fenghua Li, and Zhenglin Li on *Shi-Yan III* using IOA sources and vertical receiving array, and from transmission data obtained by Peter Dahl, Jim Miller, and Gopu Potty on the APL-UW/URI receiving array on R/V *Melville*. The ASIAEX values are compared with two other determinations of East China Sea low frequency bottom scattering strength. One of these latter values was obtained using a horizontal array and a calibrated reflector target, and the other used omni-directional sonobuoy receivers; both methods used explosive sources and each was measured at sites different from but close to the ASIAEX site. The sensitivity to experiment and environment variability of these comparisons will be reviewed.

Satellite observations of surface fronts, currents and winds in the northeast South China Sea

Michael J. Caruso and Robert C. Beardsley
Woods Hole Oceanographic Institution

We have extended our archive of satellite-derived data sets for the South China Sea into the spring of 2002. These data sets include high and low resolution sea surface temperature data from the Advanced Very High Resolution Radiometer (AVHRR) from 1990 to present, ocean color images from SeaWiFS from 1997 to present, scatterometer wind fields from QuikSCAT from 1999 to present and altimeter sea surface height anomalies from TOPEX from 1993 to present. We have added low-resolution sea surface temperature data from the Tropical Rainfall Measuring Mission (TRMM) to this archive. Wind stress and wind stress curl was derived from the QuikSCAT winds on a 0.25 x 0.25 degree grid. Monthly statistics and climatologies were calculated from each of these data sets.

Sea surface temperature images from AVHRR are limited due to cloud cover which was persistent during the field observations. However, the sea surface temperature images acquired from TRMM provided low-resolution coverage under cloudy conditions. These images provided enough temporal and spatial resolution to analyze surface features in the region and to validate

mesoscale features visible in SSH anomalies. Previous analysis of SSH demonstrated that conditions are considerably different prior to the two field programs in the spring of 2000 and 2001. SST imagery will be presented to substantiate the differences in mesoscale circulation between the two years seen in the SSH analysis. In the spring of 2000, there is a large-scale anti-cyclonic circulation between the Luzon Strait and the shelf-break. In contrast, during the spring of 2001, there is a small cyclonic circulation near the shelf-break bringing cold shelf water into the basin. Unfortunately, a warm surface layer masks the circulation patterns seen in winter and spring SST during the summer and fall. However, the correlation between the mesoscale circulation patterns in SSH and SST provides confidence in an eddy census using the altimeter.

Diagnosing the behavior of a numerical forecasting system for the South China Sea

David C. Chapman
Woods Hole Oceanographic Institution
Dong-Shan Ko and Ruth Preller
Naval Research Laboratory

The U.S. Naval Research Laboratory operates an automated real-time ocean prediction system for the northern part of the South China Sea. It produces daily nowcasts and forecasts of sea-level variations, three-dimensional currents, temperature and salinity. It is based on the Princeton Ocean Model (POM) with 1/24° resolution and 30 vertical levels. Real-time surface data (wind stress, temperature, surface heat flux, atmospheric pressure, altimetry) are assimilated and extended to depth using the Modular Ocean Data Assimilation System (MODAS). Open boundary conditions are provided by the larger scale North Pacific Ocean Nowcast/Forecast System.

In order to evaluate and improve such a sophisticated system, it is important to understand the model behavior and sensitivities to the various forcings. We have begun such a diagnostic study by repeatedly running the system, starting at the same forecast state, but applying the forcings individually and then comparing the results. We chose the time period 1 February 2001 to 15 May 2001 to encompass the second South China Sea field program. Preliminary examination of the volume-averaged kinetic energy for most of the model domain shows that the wind stress and the inflow through Luzon Strait provide most of the system kinetic energy. Surface heat flux and atmospheric pressure make negligible contributions. Data assimilation has the dynamical effect of damping or relaxing the system to a much less energetic state. Without any forcing applied, the system produces large gyre-like circulations that form southwest of Taiwan and appear to propagate along the continental slope toward the southwest. These gyres can also be generated by the large wind-stress curl that occurs on the southwest side of Taiwan.

Measurement and analysis of acoustic intensity fluctuations induced by South China Sea internal solitons

C.-S. Chiu, S.R. Ramp, and C. Miller
Naval Postgraduate School
J. Lynch, T. Duda, A. Newhall, K. Von Der Heydt, and J. Kemp
Woods Hole Oceanographic Institution

In May 2001, a suite of acoustic and oceanographic sensors was deployed by a team of U.S., Taiwan, and Singapore scientists in the NE South China Sea to study the effects of ocean variability on low-frequency sound propagation in a shelfbreak environment. The primary acoustic receiver was an L-shaped hydrophone array moored on the continental shelf that monitored a variety of signals transmitted parallel to and across the shelfbreak by fixed and towed sources. This talk discusses and contrasts the amplitude fluctuations in the signals measured by the vertical segment of the listening array in two different days, one with the passage of several huge solitons that depressed the shallow isotherms to the sea bottom, and one with a much less energetic soliton field. In addition to exhibiting large temporal changes, the acoustic data also show a much more vertically diffused sound intensity field as the huge solitons occupied and passed through the transmission path. Using a space-time continuous empirical sound speed model based on the moored temperature records, the observed acoustic intensity fluctuations are explained using coupled-mode physics.
[This work is sponsored by ONR under the ASIAEX program.]

Spatial coherence of signals forward scattered from the sea surface and seabed in the East China Sea

Peter H. Dahl, Christian J. Eggen, and Russell D. Light
Applied Physics Laboratory, University of Washington

Measurements of sea surface and seabed forward scattering made in 100 m of water in the East China Sea as part of ASIAEX 2001 are discussed. Signals (frequency 2–20 kHz) were received at ranges near 500 m on two vertical line arrays that were co-located but separated in depth by 25 m. In the analysis of the sea surface scattering data, estimates of the vertical spatial coherence along these arrays as a function of frequency, path geometry, and sea surface environmental conditions are compared with a model for spatial coherence. The model is based on identifying the probability density function that describes vertical angular spread at the receiver position. An alternative approach, utilizing the van Cittert-Zernike theorem from radio astronomy, is shown to give equivalent results. Both approaches require computation of the sea surface bistatic cross section, as done with the small slope approximation and incorporating sea surface environmental measurements. In the analysis of the seabed scattering data, preliminary estimates of bottom loss are used to estimate the seabed critical angle. The intent of this work is to support the other investigations whose goal is a comprehensive geoacoustic model for the East China Sea consistent with both seabed environmental data and independent acoustic measurements.

Moored observations of internal waves at the site of the ASIAEX South China Sea acoustic propagation study

Timothy F. Duda
Woods Hole Oceanographic Institution

Moored time series observations of temperature were made at twenty locations near the edge of the continental shelf at the ASIAEX April/May 2001 experimental site in the northern South China Sea. Currents were also measured at six of these locations. These time series show that high-frequency internal wave activity fluctuated, with alternating periods of high and low activity each lasting approximately one week and not in phase with the spring-neap tide cycle. Tidal-frequency internal waves (internal tides) were also present. The internal tide activity also fluctuated, but with a different pattern than the high-frequency waves. Orbital velocities, phase velocities, and displacements of the high-frequency waves show that they refracted and evolved as they moved upslope. The internal tides had high amplitudes and were dominantly diurnal. The internal waves, which produce large time-dependent sound-speed perturbations, affected the cross-slope and up-slope acoustic signals differently.

Progress report on low-frequency bottom scattering for the ASIAEX East China Sea experiment

Yevgeniy Dorfman and Peter Cable
BBN Technologies
David Knobles and Thomas Yudichak
Applied Research Laboratories, University of Texas at Austin

Low frequency monostatic reverberation were collected in the East China Sea by Jixun Zhou, Renhe Zhang, Zhaohui Peng, Fenghua Li, Zhenglin Li on the R/V *Shi-Yan III* using IOA sources and vertical line array (VLA). Transmission data obtained by Peter Dahl, Jim Miller, and Gopu Potty on the APL-UW/URI receiving array on R/V *Melville* aided in propagation loss determination.

In this report, reverberation data originating from ranges from 3–15 km is analyzed using coherent array processing methods to determine scattering strengths as a function of frequency and angle at the scatterer. Subaperture processing is used to separate sea surface and bottom contributions. Modeled transmission loss obtained from analyses of measured forward propagation data and a numerical source model enable the extraction of the scattering strength. A preliminary assessment of the scattering strength function sensitivity to uncertainties caused by source and environment is presented.

Several aspects of the dynamics of the East China Sea currents

Yan Du, Yiquan Qi, and Ping Shi
South China Sea Institute of Oceanology, Chinese Academy of Sciences

The East China Sea is a shallow marginal sea. Almost half of it is over a broad continental shelf about 100~150 m, but at the shelf breaks the slope angle changes abruptly. The Kuroshio flows on the steep continental slope, which is the main sea current system in the East China Sea. The dynamics of the East China Sea currents directly or indirectly associate with the Kuroshio. On average, the Kuroshio has a transport of about 21~33 Sv and curves three times in the East China Sea. Under Kuroshio and on the east of the Kuroshio, observations show a counter-current, and the east part of counter-current has no more than one-third of the Kuroshio transport. The Tsushima Warm Current and the Taiwan Warm Current are two main branch currents associated with the Kuroshio. The Taiwan Warm Current is thought to be a branch current of the Kuroshio originating from Luzon Strait. The Tsushima Warm Current is thought to be a branch of the Kuroshio in the East China Sea.

The coastal water and current are dominated by the Yangtze River, which is fresher than the Kuroshio water. The front of the Kuroshio water meeting with the coastal water usually makes an intensively mixed environment between saline and fresh water. In addition, an evident upwelling current system on the continental shelf also is confined by the cruise observations. So the water exchange is very intense in the East China Sea. Warm eddy breaking away from the Kuroshio is found having a period of about 50 days. The separated warm eddy mixed with the coastal water at last.

Several questions about the dynamics of the East China Sea Currents are mainly focused on four aspects. Firstly, what is the seasonal variation of the axis and current speed of the Kuroshio and its width, and why? Secondly, how does the Kuroshio water exchange with the other water mass? What are the dynamics of the counter-current and upwelling in the deep sea, especially the mechanism of the strong current in the Okinawa Trough? Thirdly, what dominates the distribution of the branch current of the Kuroshio, such as the Taiwan Warm Current and the Tsushima Warm Current? Fourth, how do the current systems in the East China Sea affect the vertical structure of the temperature and salinity?

Current and thermohaline structure near the shelf edge in the South China Sea from SeaSoar surveys

Glen Gawarkiewicz and Frank Bahr
Woods Hole Oceanographic Institution
Joe Wang
Institute of Oceanography, National Taiwan University

High-resolution surveys of the ASIAEX site in the South China Sea were undertaken in April-May 2000 and 2001 using the National Taiwan University and Woods Hole Oceanographic Institution SeaSoars. The use of the towed instruments enabled us to obtain horizontal resolution of 1 km or less on the surveys.

During the field work in 2000, the dominant feature near the shelfbreak was an energetic Kuroshio Intrusion. Shipboard ADCP fields revealed onshore flows of 50–60 cm/s in the intrusion. After intersecting the steep topography, the flow became polarized along isobaths, with an eastward flow of up to 90 cm/s. Relative vorticities within the intrusion were large after the flow was aligned along the topography, with maximum values comparable to the Coriolis parameter.

In addition to the Kuroshio Intrusion, there were cross-shelf density gradients associated with a cool near-bottom layer over the continental shelf. This water mass most likely originated near the shallow banks to the northeast of the study region. The cold water was concentrated near a canyon, which may have topographically steered the cold water off the shelf. Some cool shelf water was transported offshore at intermediate depths.

In contrast, there was no Kuroshio Intrusion during the 2001 field season. Water mass contrasts between the continental shelf and slope were weak, and the temperature and salinity fields were dominated by the large amplitude internal solitary waves and internal tidal bores. Seaward of the shelfbreak the flow was to the southwest with a mean velocity of up to 20 cm/s, consistent with the thermal wind shear.

The strength of the monsoons is another possible factor in the difference between the two years. Analysis of the wind stress curl fields between the two years shows that the April fields were quite similar but there were substantial differences in the May fields of wind-stress curl.

Over the shelf, the seasonal thermocline appears to intersect the bottom near the 60 m isobath. A near-bottom maximum in turbidity in this area suggests there may be some resuspension of sediments. Ocean color imagery indicates enhanced productivity near this feature.

Thus, there were very dramatic differences in the shelfbreak environment between the two years. These were due to both the influence of the Kuroshio Intrusion from Luzon Strait as well as the differences in cooling from the previous winter.

Bottom reflection phase shift parameter estimation from ASIAEX data and propagation modeling based on reflection parameters

H.L. Ge, H.F. Zhao, and X.Y. Gong
State Key Laboratory of Oceanic Acoustics, Hangzhou
E.C. Shang
Scripps Institution of Oceanography

Based on the WKB modal condition, the bottom reflection phase shift can be extracted. The key input data for this inversion is the modal wave number. In this paper, the CSDM combined with mode-shooting method is used to extract the modal wave number. Both the reverberation CSDM and the single source at large range (arrival time separation) CSDM are processed. The propagation modeling based on reflection parameters is also discussed.

Direct path fluctuations due to shallow water variability

Stephen Karpi, Kevin B. Smith, and Steven Ramp
Naval Postgraduate School
Peter H. Dahl
Applied Physics Laboratory, University of Washington

The current interest in enhancing the forecasting capabilities of both active and passive sonar systems employed in littoral regions has greatly escalated. This requires a need for improvements in the general understanding of the influence of shallow water internal waves on acoustic propagation. This work will contribute to a more fundamental understanding of ocean acoustic propagation and fluctuations in shallow-water regions and examine the influence of shallow water variability on the relatively short-range water-bourne propagation paths. Specifically, internal wave fluctuations will be considered and the influence on the acoustic propagation will be quantified in terms of spatial (vertical) correlation measures. The data to be examined will be generated numerically based on an acoustic propagation model employing environmental data taken from the East China Sea as part of the ONR-sponsored ASIAEX experiments. The results of this analysis will be compared with the measured data currently being analyzed at the Applied Physics Laboratory at the University of Washington.

A progress report on the estimation of geoacoustic parameters from measured time series taken during the East China Sea component of ASIAEX

D. P. Knobles and T. Yudichak
Applied Research Laboratories, University of Texas at Austin
P. Cable and Y. Dorfman
BBN Technologies

Time series data collected by P. Dahl and J. Miller on the APL-UW/URI VLA in the East China Sea as part of the Asian Sea International Acoustics Experiment are analyzed for the information they contain on the characteristics of the seabed. A broadband normal mode approach is used to model the measured time series in the 10–500-Hz band. The complex multipath arrival pattern as a function of source-receiver range and source depth allows one to infer certain characteristics of the seabed. In the present case, values for the surface sound speed and attenuation appear well determined. Good agreement is obtained between measured and modeled time series data on the VLA. Further, the geoacoustic profile that is used to simulate the measured time series is also employed to simulate transmission loss data taken at a nearby location during a Harsh Environment Projects (HEP) measurement. Good agreement is demonstrated between the measured and modeled transmission loss. Also, the geoacoustic structure is consistent with the properties of measured monostatic reverberation and the ambient noise as a function of vertical angle. Finally the geoacoustic structure that describes the measured CW transmission loss and time series data is consistent with previous core and shear wave measurements reported by Collins, Sutton, and Ewing (*J. Acoust. Soc. Am.* **100**, 3646–3654, 1996).

The effects of the internal waves on the time stability of sound channel in shallow water

Zhenglin Li, R. Zhang, Xiaodi Huang, and Jin Yan
National Laboratory of Acoustics, Institute of Acoustics, Academia Sinica
Jixun Zhou
School of Mechanical Engineering, Georgia Institute of Technology

Internal waves are one of the primary sources of ocean variations in shallow water. The time stability of the sound channel may be degraded by the activities of internal waves. Based on the ASIAEX2001 oceanographic data, the effects of Garrett-Munk and solitary internal waves on broadband sound field correlation are investigated in this paper. The correlation time of sound field with internal wave is simulated numerically and compared with the experiment data. It is shown that the length of correlation time has depth structure, and it is longer than hundreds of seconds at a range of 20 km for the signal at frequency band from 450 Hz to 500 Hz.

Nonlinear internal waves in the South China Sea during ASIAEX

Antony K. Liu
NASA Goddard Space Flight Center
David Tang
Institute of Oceanography, National Taiwan University
Steven R. Ramp
Naval Postgraduate School

Internal wave distribution maps have been compiled from more than one hundred ERS-1/2, RADARSAT, and Space Shuttle SAR images in the South China Sea (SCS) from 1993 to 2000. Based on these distribution maps, most internal waves in the northeast part of the SCS were propagating westward. The wave crest can be as long as 200 km with amplitude of 100 m, due to strong current from the Kuroshio branching out into the SCS. In the recent Asian Seas International Acoustics Experiment (ASIAEX) moorings were deployed in April 2000 and May 2001. Simultaneous RADARSAT SAR images have been collected during the field test to integrate with the model and the *in-situ* measurements in the SCS. Besides providing synoptic information, satellite remote sensing is critical to several aspects of ASIAEX, including tracking the internal waves, and locating surface fronts and mesoscale features. During ASIAEX in May 2001, many large internal waves were observed at the test area and were the major features for acoustic volume interaction. The evolution and dissipation of huge internal waves on the shelf break, mode-two waves, and wave-wave interaction have been studied and are very important issues for acoustic propagation. Nonlinear internal wave models have been applied to integrate and assimilate both SAR and mooring data. Numerical simulations have been performed using SAR data in deep water as an initial condition to produce the wave evolution on the continental shelf and compared with the mooring measurements. The implication of internal wave effects on acoustic propagation will also be discussed.

Environmental observations taken aboard the *OR*3

Peter C. Mignerey and Marshall H. Orr
Naval Research Laboratory

An overview of the CTD, ADCP and high-frequency flow visualization data taken aboard the *OR3* will be presented. Temperature and salinity data obtained by the CTD show the ocean had a weak thermocline and a strong halocline. During the course of the experiment the surface layer warmed while deeper water cooled. Salinity changes were smaller and more complex with freshening in the surface layer, salinification just above the halocline, and freshening of the deep layer. One large soliton was observed in 350 m water with the CTD along with the other systems. Two soliton packets in the process of converting from depression to elevation waves were repeatedly observed with the ship-board ADCP and high-frequency flow visualization systems as they propagated 16.5 km up slope from 240 to 110 m water. ADCP velocity fields of the depression and elevation waves correspond to alternating circulation cells that extend from the surface down to the bottom. The soliton packet's energy decreased from 91.2 MJ/m in 260

m of water to 32.3 MJ/m in 110 m of water with an exponential dissipation-rate coefficient of 0.063 km^{-1}. This corresponds to an energy dissipation rate of 0.17 W/m/m over the observed propagation path.
[Work supported by ONR]

Geoacoustic measurements in the East China Sea

James H. Miller, Gopu R. Potty, Colin J. Lazauski, and Chuen-Song Chen
University of Rhode Island
Louis R. Bartek and Katy Westhoff
University of North Carolina
Peter H. Dahl
Applied Physics Laboratory, University of Washington

The geological and oceanographic measurements collected in the East China Sea component of the ASIAEX experiment are reviewed. Historic surficial sediment data is summarized. Gravity core data taken on the 2000 R/V *Revelle* cruise and the historic sediment maps were used to design the experimental geometry for the Long-Range Sediment Tomography experiment in 2001. Although the gravity cores taken in 2000 were less than 1/2 meter in length, the analysis using a Geotek Multi-Sensor Core Logger on board the *Revelle* provided a consistent picture of the surficial sediments in the region. Concurrent with the *Revelle* coring, sub-bottom profiling using chirp and water-gun was also performed. The chirp and water-gun measurements indicate that the sub-bottom structure consists of a thin (<few meters) veneer of sediment of variable thickness directly beneath the seafloor. Beneath this veneer there is an extensive package of sediment with relatively uniform acoustic attributes. Three channels dissect this unit. Channel fill consists of sediment that produces an extremely heterogeneous distribution of acoustic attributes. After the 2001 main field experiment, we returned to the experiment site on the R/V *OR2* and collected a large number of piston cores, mostly 2 meters in length. The core analysis provided by KORDI is discussed (S. Huh, personal communication, June 17, 2002). Compressional sound speed is estimated in the piston cores with a technique based on Biot theory and using density and porosity profiles. These environmental measurements are compared to sediment tomography inversions. The surficial sediments in the experimental area vary in compressional sound speed from a low of 1600 m/s in the northwest corner to 1660 m/s in the southeast corner. This spatial variation is observable in the tomography inversions also.
[Work supported by ONR.]

Analysis on the ray travel times according to the ray invariant theory

Shengchun Piao, Shi-e Yang, and Yiwang Huang
Harbin Engineering University

Travel-time-based tomography is a classical method for inverting sound-speed perturbations in an arbitrary environment. And source localization method also needs analysis on ray travel time, such as the single hydrophone source localization method. The spatial resolution of these methods is limited by the number of resolved and independent arrivals. It was pointed out that in deep water the number of resolved arrivals is equal to the number of independent arrivals, while in shallow water the number of independent arrivals can be much smaller than the number of resolved arrivals. Those limitations have been explained through the analysis of an equivalent environment with constant sound speed. In this paper, the limitation is analyzed again according to the ray invariant theory for arbitrary sound speed profile. The results obtained on the ASIAEX 2001 data set are also used to support this analysis.

Determination of the ocean bottom parameters in ASIAEX2001 using the SVD method

Shengchun Piao
Harbin Engineering University and Georgia Institute of Technology
Jixun Zhou
Georgia Institute of Technology

Ocean bottom plays an important role in underwater sound propagation. How to determine the bottom parameters is one of the research topics in ASIAEX2001. Mode extraction method accomplished by performing a singular value decomposition (SVD) of individual frequency components of the spatial cross-spectral density matrix has already be presented (*J. Acoust. Soc. Am*. **111**, 748–756, 2002). Modes were successfully extracted from cw tones and ambient noise. In this paper, the SVD method is applied to the ASIAEX 2001 data set to extract the modes. Furthermore, the ocean bottom parameters in ASIAEX2001 are obtained from these modes parameters.

The shelf-edge environment in the central East China Sea and its impact on low frequency acoustic propagation

Steven R. Ramp, Ching-Sang Chiu, and Fred Bahr
Naval Postgraduate School
James Lynch and Tim Duda
Woods Hole Oceanographic Institution
Peter Dahl
Applied Physics Laboratory, University of Washington
Jim Miller
University of Rhode Island
Yiquan Qi
South China Sea Institute of Oceanology
Renhe Zhang
Institute of Acoustics, Chinese Academy of Sciences

A summary of the key physical oceanographic results from both the ASIAEX 2000 pilot study, and the ASIAEX 2001 main field program are presented, with application to the across-slope low-frequency acoustic propagation problem. Two very complete across-shelf sections were obtained during 2000, but only an XBT section was obtained during 2001. A temperature and salinity (T/S) relation was derived using the best available data from both years to synthesize the salinity, density, and sound speed from the XBT section during 2001. Acoustic model runs were conducted using the sections from both 2000 and 2001, and the model results were compared to the wide-band source (WBS) drops during 2001.

The key oceanographic variability stemmed mostly from the Kuroshio Current, flowing alongshore from SW to NE during both experiments. The Kuroshio frontal meandering and/or eddy and filament shedding provided most of the mesoscale variability observed. The June 2001 continental shelf data were also notably warmer and fresher than the April 2000 data, a well known seasonal effect. The modeled propagation loss between a 50-m source and the *Melville*/*Shi Yan* receiver location showed a sharp increase across the Kuroshio front. The T/S variability in a small filament during April 2000 over the continental slope has little impact on the acoustic propagation.

Internal waves represent a source of uncertainty in the acoustic modeling results. One large soliton was observed during April 2000, while only ordinary linear internal waves were observed during June 2001. The two-layer KDv theory suggests that the across-slope flow at the shelf break is sub-critical most of the time and solitons are not generated in this region. They may occasionally be formed, however, during times when Kuroshio meanders rapidly offshore and the total flow (tidal plus mesoscale) becomes supercritical.

Tracking the generation sites and packet variability of internal solitons in the South China Sea

Steven R. Ramp, Ching-Sang Chiu, and Fred Bahr
Naval Postgraduate School
James Lynch and Tim Duda
Woods Hole Oceanographic Institution
Tswen-Yung David Tang
Institute of Oceanography, National Taiwan University
Tony Liu
NASA Goddard Space Flight Center

An array of seven moorings was deployed across the Chinese continental shelf and slope near Dongsha Island as part of the ONR-sponsored Asian Seas International Acoustics Experiment (ASIAEX). The moorings spanned 82 to 350 m depth and sampled temperature, salinity, and velocity at 1 or 2 minute intervals from April 21 to May 19, 2001. The most energetic features observed in the data set were the highly nonlinear internal solitary waves. This paper attempts to identify the generation sites for these waves and determine their predictability. A statistical analysis was performed on the wave orbital velocities to determine their direction of propagation, and inversely, their sources. The bimodal directional histograms point to two generation sites: The largest waves came from around the Batan Islands in the Luzon Strait, and the smaller ones from near Dong-sha Island. The large wave arrivals were semidiurnal with a very strong diurnal inequality, such that the strongest waves arrived every 24 hours. The wave packets arrived in two groups separated by a five-day period in between when weak or no waves arrived. The wave groups had an unusual and counter-intuitive relationship to the barotropic tide, and two hypotheses will be advanced to explain this phenomenon.

Seabed attenuation estimated from chirp sonar data collected along acoustic propagation lines during ASIAEX in the South China Sea

Steven G. Schock
Florida Atlantic University

A chirp sonar generates acoustic data useful for estimating the attenuation coefficient of sediments in the South China Sea by transmitting FM pulses over the band of 1 to 15 kHz at normal incidence to the seabed. After cross-correlating the acoustic returns with the transmission waveform, a wideband reflection profile is generated showing sediment layering. The time series data is filtered into 8 pass bands to generate 8 images with center frequencies of 1 kHz spacing starting at 1.6 kHz and ending at 4 kHz. The rolloff of the attenuation function of the uppermost sediment layer is estimated by dividing the average reflection amplitude of the sediment layer interface echo from the base of the surficial layer by the average amplitude of the sediment-water interface echo for each bandpass image. The amplitude ratios are plotted as a function of frequency. The slope of a line fitted to the frequency function in a least squares sense is called the attenuation rolloff. For the across shelf propagation line, the slope of the attenuation function varied from about 0.4 dB/m/kHz near the receiver arrays at the shallow end

in about 120 meters of water to a minimum of 0.12 dB/m/kHz in about 250 meters of water to 0.40 dB/m/kHz near the source in 340 meters of water. For the along shelf propagation line the attenuation rolloff varies between 0.51dB/m/kHz and 0.11 dB/m/kHz.

Frequency dependence of effective bottom attenuation due to environmental variability

Kevin B. Smith
Naval Postgraduate School
James D. Nickila
Naval Undersea Warfare Center

Over the past several years, concern has grown over the appropriateness of bottom attenuation models that assume a linear frequency dependence. Empirical analyses of experimental data have suggested power law dependence with frequency exponents as high as 1.7 and above, but with large variability between geographic regions (Zhou, et al., *J. Acoust. Soc. Am.* **82**, 287–292, 1987). The fundamental cause of this dependence is unknown. In this analysis, the influence of the propagation and interaction with environmental variability is investigated. Specifically, a propagation model that assumes linear frequency dependence is employed which incorporates such environmental variability as range-dependent water column sound speed profiles, bottom sound speed gradients, bottom sound speed and density fluctuations, and rough water/bottom interfaces. This data is then correlated with results from similar calculations without environmental variability but with attenuation as a free parameter used to maximize the correlation. By performing such comparisons over a band of frequencies, the frequency dependence of the effective bottom attenuation can be determined. The dominant environmental influences will then be identified and quantified.

Mid-frequency bottom backscatter, environmental measurements, model/data comparison, and implications to reverberations

Dajun Tang
Applied Physics Laboratory, University of Washington

To understand bottom backscattering mechanism at the mid-frequency (nominally 3.5 kHz), direct measurements of bottom roughness and sub-bottom heterogeneity were made along with concurrent backscatter measurements in a shallow water site with 105 m water depth. This is a collaborative work with the Hangzhou Applied Acoustics Laboratory (HAARI). The backscatter was recorded on a vertical line array with 31 elements with a 3.5 kHz source attached at the bottom of the array. Bottom roughness and sub-bottom heterogeneity were measured using an *in situ* conductivity probe. The roughness measurements cover a one-dimensional profile of approximately 4 meters in length with vertical resolution of 4 mm and horizontal resolution of 1.5–2.5 cm. Heterogeneity measurements cover a depth of 5–10 cm. Ambient noise received by the vertical line array was used to estimate the sound speed, density, and attenuation coefficient

of the surficial sediments. A Monte Carlo modeling capability was developed to extensively simulate the backscatter with different environmental inputs. The results of this effort covering all three areas of acoustics, environments, and modeling will be reported. The emphasis of the report is on understanding scattering physics through definitive model/data comparison with known model input parameters.
[Work supported by the Office of Naval Research]

An experiment study of mid-frequency bottom backscattering strength in shallow water

Zhongkang Wang
Hangzhou Applied Acoustics Research Institute
Dajun Tang
Applied Physics Laboratory, University of Washington

Bottom backscattering results primarily from the roughness of the seafloor and the heterogeneity of the sub-bottom. A preliminary experimental study of the backscattering using the 32-element, 3.5-kHz reverberation array deployed from the R/V *Melville* has been accomplished in ray theory. The direct, bottom-reflected, surface-reflected, bottom-surface reflected, surface-bottom reflected, and surface-bottom-surface reflected waves are first found from the analyzed data and then the bottom backscattering strength changing with time and grazing angle obtained. This research gives a preparation for further modeling and predicting of mid-frequency bottom reverberation in shallow water.

Numerical simulation of sound fluctuation due to ocean environmental change

Ning Wang, Jinzhong Liu, and Feng Yang
Department of Physics, Ocean University of Qingdao

Numerical simulation using data taken in ASIAEX 2001 is made. The temporal fluctuations of local modal wave number (MWN), sound propagation loss (SPL) due to ocean environmental change, and EOF expansion of sound speed profile are investigated by numerical simulation. It was found that (1) modal wave number fluctuations have better cross correlation for high modes than low modes, the fluctuation of MWN is a order 10^{-3} for source frequency 250 Hz; (2) the SPL fluctuation for range independent model is dominated by the low frequency components of environmental change for source frequency 250 Hz; (3) EOF expansion seems difficult to express SSP temporal change in few functions. The simulations for broad-band signal and sound propagation along the path ocean internal wave propagating are also simulated and discussed in the report.

Acoustic horizontal coherence and beamwidth variability observed in ASIAEx (SCS)

Stephen N. Wolf, Bruce H. Pasewark, Marshall H. Orr, Peter C. Mignerey, James F. Lynch, and Theodore Schroeder
Naval Research Laboratory

The temporal variability of horizontal array beamwidth at the South China Sea shelf break has been related to the passage of large amplitude internal wave packets through the acoustic propagation path. Beamwidths were found to range from ~1.5 deg (aperture-limited) to ~ 3 deg. WHOI's 32-element (460-m length) horizontal line array was deployed on the continental shelf near the 125 m isobath. Three moored acoustic sources (NRL 300 and 500 Hz LFM, and NPGS 400 Hz PRN) were positioned at 18.7 km range to provide an acoustic propagation path near the 125 m isobath. Additional acoustic sources transmitting PRN signals at 224 Hz (WHOI) and 400 Hz (NPGS) were moored in 350 m of water at a range of ~31 km in a direction downslope from the receiver. Signals received by the horizontal line array were recorded nearly continuously from 2 to 18 May 2001. During the experiment, internal wave packets periodically propagated through the acoustic propagation path. The internal wave packet repeat period ranged from diurnal to semi-diurnal over the neap-spring-neap lunar cycle. Large amplitude internal soliton packets incident upon the experimental area from the Luzon Basin were a major contributor to the temporal variability of the sound speed field and acoustic signal variability. This paper will discuss horizontal acoustic array beamwidths and broadband correlations obtained from the 224, 300, and 500 Hz signals.
[Work sponsored by the Office of Naval Research]

Acoustic transmission intensity fluctuation observations in the SCS ASIAEX experiment

Lixin Wu
National Laboratory of Acoustics
Timothy Duda and James Lynch
Woods Hole Oceanographic Institution

We will discuss the most recent results of our analyses of the fluctuations in acoustic intensity from transmissions made during the ASIAEX South China Sea experiment. In particular, we will focus on the results from the 224 Hz and 400 Hz source transmissions, which took place over a sixteen day period from May 2, 2001 to May 18, 2001. For these data, we have constructed time series of: 1) peak intensity at a point sensor and 2) temporally integrated intensity at a point sensor.

We plan to look at the combined temporally and spatially (vertically) integrated intensity in the near future. Further, we have looked at the temporal spreading of the arrivals due to scattering. In doing our analyses, we have also examined the acoustic intensity fluctuation statistics for both high and low oceanographic frequencies, so as to understand the oceanographic forcing of the acoustic fluctuations. The “oceanographically band-passed” acoustic time series are contrasted with the oceanographic temperature/sound speed time series to accomplish this. Strong tidal

influences are noted. Future work will consist of examining the remainder of the moored acoustic source frequencies available, specifically the 300 and 500 Hz LFM sources deployed by NRL.

Matched field inversion of explosive signals

Jin Yan, Zhenglin Li, and Renhe Zhang
National Laboratory of Acoustics, Institute of Acoustics, Chinese Academy of Sciences

During the ASIAEX ECS 2001 experiment explosive charges were dropped along predetermined tracks, and the signals were recorded by several hydrophone arrays. Data collected by IOA vertical line array (VLA) are chosen for geoacoustic inversion. Two models of liquid bottom are assumed, a homogeneous half space model and a three-layer model, respectively. For the homogeneous bottom, the acoustic impedance was estimated from the reflection measurements first, then multi-frequency matched field processing was performed to search the appropriate bottom parameters with the constraint of impedance. For the three-layer bottom, multi-frequency matched field processing is also used, and the parameters are obtained via two stages. First, all unknown parameters are inverted using signals from sources at several ranges, and the parameter uncertainties are estimated. Then, the parameters with small uncertainties are fixed and others are inverted using the signal from the closest source. Based on the inversion results for the two bottom models, the sound transmission losses are calculated and compared.

Broadband geoacoustic matched field inversion from ASIAEX2001

Kunde Yang and Yuanliang Ma
Northwestern Polytechnical University

Inversion by matched field processing can be considered as a complex and non-linear optimization problem. The ease of inversion by MFP depends on the number of parameters to be optimized. In general, the complexity of the problem increases with the number of unknown parameters because there are many local minima in the multi-dimensional parameters space that obscure the search for the global minimum. Meanwhile, whether a parameter can be inverted effectively depends mainly on the amount of its influence on the acoustic field during matching. Sensitive parameters can be estimated better than the less sensitive parameters.

In order to get satisfactory environmental parameter inversion results from ASIAEX2001 in the ECS in June 2001, this paper studies the sensitivity of the inverted parameters including geometric and geoacoustic parameters at different frequencies. According to the fact that the different parameter has different sensitivity on the matched field inversion power, we propose the multi-step inversion approach. Firstly, it inverts the more sensitive parameters using high frequency data. Secondly, it inverts the less sensitive parameters using few high and several low frequency data. Finally, it inverts the least sensitive parameters using low frequency data. If

necessary, execute the above three steps iteratively until suitable values are obtained. This paper compares the performance between direct inversion and multi-step inversion strategy by simulation, and proves its efficiency. Using multi-frequency incoherent matched field inversion processor and genetic algorithm to process the explosive data, we present the geoacoustic inversion results from ASIAEX2001.

Broadband matched-field source localization in the East China Sea

Renhe Zhang, Zhenglin Li, Jin Yan, Zhaohui Peng, and Fenghua Li
National Laboratory of Acoustics, Institute of Acoustics, Academia Sinica

Broadband matched-field is applied to source localization by using the vertical line array in the 2001 jointed ASIAEX experiment. The site of the experiment is the continental slope shallow water environment, where the water depth varies from 97 m to 150 m in 50 km ranges. In this paper, incoherent frequency domain Bartlett processor is used to the detonation signals for source localization. The coupling normal mode-parabolic equation theory based on the WKBZ approximation is used to calculate the replica fields in the slope bottom environment. The experimental data show that the accuracy of the source localization is largely improved with the consideration of the slope of the bottom. The range estimates of the most signals by MFP in the range from 1.0 km to 50.0 km are consistent with the GPS measured ones. The effects of water sound speed profile on the matched field source localization are also studied in the paper.

Influence of wind waves on surface and bottom stress to circulation modeling in Southeast Asian seas

Hong Zhang
National University of Singapore

The POM-based Southeast Asian Ocean Model (SEAOM) is applied to simulate the circulation in the Southeast Asian seas. The model is configured with realistic coastlines, topography, 1/6 horizontal resolution and 20 sigma-coordinate layers. The model is driven by the wind force and thermodynamic force and relaxed to the climatological values of temperature and salinity.

Commonly the circulation model relies on the specification of a bottom roughness scale, in order to evaluate the bottom boundary condition. Recent advances in modeling near-bottom turbulent wave-current boundary layers have revealed that the flow resistance, and hence the effective roughness, experienced by slowly varying currents depends dramatically on the near-bottom intensity of wind-wave motions. At surface the wave modifies the surface roughness that enhances the drag coefficient.

The simulation results in the period of April 25 to May 2001 show that wave-induced surface stress increases the magnitude of currents both at the surface and near the seabed. On the other

hand, wave-induced bottom stress retards the currents in the water column. Therefore the net effect of wind waves on currents depends on the significance of current changes due to surface stress and bottom stress, respectively.

The modal-vertical-beam (MVB) transmission loss analysis and mode filtering with help of array extrapolation

H.F. Zhao, H.L. Ge, and X.Y. Gong
State Key Laboratory of Oceanic Acoustics, Hangzhou
E.C. Shang
Scripps Institution of Oceanography

The propagation data of an explosive source at 50 m depth are collected by a 60-m VLA up to 40 km. The modal-vertical-beam analysis is performed to extract the beam-averaged modal attenuation coefficient and the results are compared with the modal attenuation coefficient by mode filtering with help of array extrapolation. These data are important for the inversion of modal back-scattering matrix from reverberation data as well as propagation modeling.

Sea bottom acoustic parameters from shallow-water reverberation

Ji-Xun Zhou
School of Mechanical Engineering, Georgia Institute of Technology
Xue-Zhen Zhang
Institute of Acoustics, Chinese Academy of Sciences

Acoustic reverberation in shallow water involves a two-way sound propagation and boundary scattering process. It must, therefore, contain rich information on seabottom acoustic parameters. Reverberation from one shot offers a continuous spatial sampling of the surrounding sound field. Thus, inversion of seabottom acoustic parameters from shallow-water reverberation is very attractive for saving time and cost. Based on ray-mode analogies for shallow-water sound propagation, a theoretical model for reverberation spatial coherence and average reverberation intensity was developed in the late 1970s (Zhou, *Acta Oceanologia Sinica*, **1,** 212–218, 1979, and *Acta Acustica*, **5,** 86–99, 1980). This model can easily be converted back to a more familiar summation of normal-modes, and be calculated by available mode numerical codes. Experimental data on the reverberation vertical coherence obtained from Yellow Sea ‘78, Yellow Sea ‘96 and ASIAEX01 are in good agreement with theoretical prediction. With this model, the sound velocity/attenuation in sediments and bottom scattering strength have been derived from YS78, YS96, and ASIAEX01 reverberation data, including reverberation vertical coherence and absolute reverberation level.
[Work supported by U.S. ONR and CAS]

WORKING GROUP SUMMARIES

South China Sea

The first item of discussion was an upcoming cruise March 24–April 7, 2003 in the South China Sea. The Chief Scientist will be C.S. Liu and the lead American will be Lou Bartek (UNC). The primary purpose of the cruise is to obtain additional bottom data using chirp sonar and sub-bottom profiling. The issue was raised as to the possibility of sampling other things on this cruise, namely: 1) more gravity cores, 2) CTD sections, and 3) hull-mounted underway ADCP data. Drs. Gawarkiewicz and Duda (WHOI) both volunteered to go on the cruise with Dr. Bartek to facilitate collecting these data sets.

The second subject concerned data distribution issues. The bottom line is that most of the SCS investigators are satisfied with the way this has been handled and they have the data they need from other investigators. Tony Liu agreed to make the SAR data available to other ASIAEX investigators. Drs. Gawarkiewicz and Wolfe expressed interest in the *OR1* radar images. Prof. Ramp has them on CD-R from David Tang (NTU) and agreed to forward copies to Drs. Wolf and Gawarkiewicz.

The group agreed to extend the deadline for paper submission to the *IEEE J. Ocean. Eng.* special issue to April 2, 2003. Drs. Lynch and Ramp agreed to compile the list of papers via e-mail, especially considering the Taiwan delegation was missing from the Chengdu symposium. Some concern was expressed about keeping the quality of the manuscripts high for a special issue. Dr. Lynch will address this by making sure there are guest editors from outside the ASIAEX program for the special issue.

The official ASIAEX Web page has not been seeing much use. It is well organized and serves as a pointer to many other ASIAEX data Web pages. The ONR program mangers in the room expressed a need for an up-to-date Web site they can reference to tell people about the ASIAEX program. It was decided to update the public relations aspects of the Web page, to include a list of the ASIAEX principal investigators and their contact info. The site can remain where it is, hosted by the National University of Singapore (Dr. John Potter).

East China Sea

The ECS group agreed to extend the submission deadline for *IEEE J. Ocean. Eng.* manuscripts to April 2, 2003.

The most pressing data-need for the ECS group was for a digital version of the Bartek bottom data, to include bathymetry, geological transgressive surface tract, sequence boundary, and color maps that were shown for the ASIAEX-ECS area. The team also needs the grain size analysis of the cores. Dr. Jim Miller volunteered to contact Lou Bartek on these issues. Dr. Bartek reports that the digital data can be available by the end of the year and the grain size analysis for the cores by early next year.

There was considerable discussion within the ECS group led by Dr. Peter Dahl on the topic of resolution and variance in estimates of geoacoustic parameters representing the East China Sea, for example, resolution associated with different inversion approaches such as those utilizing reverberation data that have large inherent averaging area vs. those characterized by smaller averaging areas. This was discussed in the context of the known range-dependent properties of the ECS basin obtained from the coring data. Resolution also entered into the picture in terms of the frequency range of the data utilized, that is O(100–10000) Hz. It was stressed that these different components of resolution be highlighted in any subsequent papers (particularly for the *IEEE J. Ocean. Eng.* special issue) to avoid the impression of contradictory results when in fact results may be consistent.

This discussion also provided the backdrop for an engaging debate on the overall *philosophy* of geoacoustic inversions, namely the use of a halfspace model to represent an effective acoustic seabed vs. modeling approaches that include more complicated layering. The merits of each were discussed, and it was stressed that authors should include such discussion in their manuscripts submitted to the special issue.

Finally, it was emphasized that all papers submitted to the special issue will have to be very clear in regards to the variance of the estimates for geoacoustic parameters. Special attention was given to how variance can be derived when the underlying probability density function is not known, e.g., use of bootstrap methods.

Future Meetings

The next key meeting will be the Acoustical Society of America (ASA) pan-American meeting in Cancun, Mexico, December 2–6, 2002. There will be special sessions there on shallow water acoustics, including the ASIAEX results. Investigators are encouraged to attend this meeting and present papers. There is also a need to meet again with Taiwanese investigators because they are co- or first authors on many of the SCS papers, but could not travel to Chengdu. The SCS group decided to try to have a “mini-symposium” in Taipei during March 4–8, 2003 at National Taiwan University.

ATTENDEES

Name	Address	Phone/Fax	Email
Victor AKULICHEV	Director Pacific Oceanological Institute Far Eastern Br, Russian Academy of Sciences 43 Baltiyskaya Street Vladivostok 690041, RUSSIA	7-4232-31-1400	akulich@marine.febras.ru
Xuemei BAO	Hangzhou Applied Acoustics Research Institute 96 Huaxing Road Fuyang Hangzhou Zhejiang PRC 2000 5/22		sklbxm@163.net
Peter CABLE	BBN Technologies Union Station New London, CT 06320	703 284 4724	pcable@bbn.com
Michael CARUSO	MS#21 Remote Sensing and Analysis Woods Hole Oceanographic Institution Group 360 Woods Hole Rd. Woods Hole, MA 02543-1541	(508) 289-2901 (ph) (508) 457-2181 (fax)	mcaruso@whoi.ed
Dr. Ching-Sang CHIU	Code OC/Ci Department of Oceanography Naval Postgraduate School Monterey CA 93943	408-656-3239 (ph) 408-656-4142 (fax)	chiu@usw.nps.navy.mil
Jee Woong CHOI	Dept. of Earth and Marine Sciences Hanyang University 1271 Sa-1 dong Ansan 425-791 KOREA	82-31-400-4233	choijw@hanyang.ac.kr
Dr. Nick CHOTIROS	Applied Research Lab University of Texas at Austin 10000 Burnet Road, PO Box 8 Austin, TX 78713	512-835-3512 (ph) 512-835-3259 (fax)	
Dr. Peter DAHL	Applied Physics Laboratory University of Washington 1013 NE 40th St. Seattle WA 98105	206-543-2667 (ph) 206-543-6785 (fax)	dahl@apl.washington.edu
Yevgeniy DORFMAN	BBN Technologies 10 Moulton Street Cambridge, MA 02138	617 873 3173	edorfman@bbn.com
Tom DRAKE	Office of Naval Research, Code 322GG 800 North Quincy Street Arlington, VA 22217		draket@onr.navy.mil
Dr. Tim DUDA	AOPE Dept., MS 11 Woods Hole Oceanographic Institution Woods Hole, MA 02543	508 289-2495 (ph) 508-457-2194 (fax)	tduda@whoi.edu
Doug EDSALL	Ocean, Science, & Engineering, ONR Asian Office Akasaka Press Ctr. 7-23-17 Roppongi MINATO-KU Tokyo 106, JAPAN	81-3-3401-8924 (ph) 81-3-3403-9670 (fax)	edsalld@onrasia.navy.mil edsall@nadn.navy.mil

Name	Address	Phone/Fax	Email
Dr. Glen GAWARKIEWICZ	MS #21 Woods Hole Oceanographic Institution Woods Hole MA 02543	508-289-2913 (ph) 508-457-2181 (fax)	glen@paddle.whoi.edu
H. L. GE	Hangzhou Applied Acoustics Research Institute 96 Huaxing Road Fuyang Hangzhou Zhejiang PRC 2000 5/22		sklglh@163.net
Dr. Hyoung Rok KIM	Department of Oceanography Naval Postgraduate School Monterey, CA 93943	831 656 2052	hrkim@nps.navy.mil
Dr. Hui Liang GE	HAARI P.O. Box 1249 96 HuaXing Road Hang Zhou, ZheJiang, CHINA 310012	86-571-888660002 (ph)	sklghl@163.net
David KNOBLES	Applied Research Laboratories University of Texas at Austin	512 835 3687	knobles@arlut.utexas.edu
Mrs. Beverly KUHN	Office of Naval Research Code 321OA 800 N Quincy Street Arlington, VA 22217-5660	703-696-6998 (ph) 703-696-2710 (fax)	kuhnb@onr.navy.mil
Dr. Fenghua LI	Institute of Acoustics Chinese Academy of Sciences 17 Zhongguanchun Road Beijing, CHINA 100080	86-10-6262-0205 (ph)	lfh@farad.ioa.ac.cn
Dr. Zhenglin LI	Chinese Academy of Sciences 17 Zhongguancun St. Beijing 100080, P.R. of CHINA	86-10-6262-0205	lzhl@farad.ioa.ac.cn
Dr. Antony LIU	Oceans and Ice Branch, Code 971 NASA Goddard Space Flight Center Greenbelt MD 20771	(310)614-5714 (ph) (301)614-5644 (fax)	liu@neptune.gsfc.nasa.gov
Dr. Jianjun Liu	Chinese Academy of Sciences 17 Zhongguancun St. Beijing 100080, P.R. of CHINA	86-10-6262-0205	liujj@farad.ioa.ac.cn
Dr. Ellen LIVINGSTON	Code 3210A Office of Naval Research 800 North Quincy St. Arlington VA 22217-5660	703-696-4203 (ph) 703-696-2710 (fax)	livinge@onr.navy.mil
Dr. Jim LYNCH	Woods Hole Oceanographic Institution MS #11 Woods Hole MA 02543	508-289-2230 (ph) 508-457-7194 (fax)	jlynch@whoi.edu
Jim MILLER	Dept of Ocean Engineering University of Rhode Island 114 Middleton Bldg Narragansett, RI 02882	401-874-6540 (ph) 401-874-6837 (fax)	miller@oce.uri.edu
Dr. Peter MIGNEREY	Code 7120 Naval Research Lab/DC 4555 Overlook Ave SW Washington DC 20375-5320	202 767 2230	mignerey@nrl.navy.mil

Name	Address	Phone/Fax	Email
Dr. Yuri N. MORGUNOV	Head of Technical Division Pacific Oceanological Institute Far Eastern Br, Russian Academy of Sciences 43 Baltiyskaya Street Vladivostok 690041, RUSSIA	7-4232-31-1631	morgunov@poi.dvo.ru
Steve MURRAY	Office of Naval Research Code 322PO 800 N Quincy Street Arlington, VA 22217-5660	(703) 696-4533 (ph)	murrays@onr.navy.mil
Prof. Jungyul NA	Dept. of Earth and Marine Sciences Hanyang University 1271 Sa-1 dong Ansan 425-791 KOREA	82-3454005533 (ph) 82-3454066458 (fax)	najy0252@email.hanyang.ac.kr
Jimmy NG	Tropical Marine Science Institute National University of Singapore 10 Kent Ridge Crescent SINGAPORE 119260	65-6774-9914	tmsngkt@nus.edu.sg
Dr. Shengchun PIAO	Director, Underwater Acoustic Institute Harbin Engineering University Building 31 Wenmaiao Str. Harbin 150001, P.R. of CHINA	11864512518947 (ph) 11864512532060 (fax)	psyg@public.hr.hl.cn
Dr. Gopu POTTY	Dept of Ocean Engineering University of Rhode Island 114 Middleton Bldg Narragansett, RI 02882	401 874 6568	potty@oce.uri.edu
Dr. Yiquan QI	South China Sea Institute of Oceanology Guangzhou, P.R. of CHINA 510301		yqqi@scsio.ac.cn
Dr. Steve RAMP	Department of Oceanography Code Oc/Ra Naval Postgraduate School Monterey CA 93943	831-656-2201 (ph)	ramp@oc.nps.navy.mil
Dr. Steven G. SCHOCK	Dept. of Ocean Engineering Florida Atlantic University Boca Raton, FL 33431-0991	561-297-3447 (ph) 561-297-3885 (fax)	schock@oe.fau.edu
E. C. SHANG	Scripps Institution of Oceanography La Jolla, CA 92093-0101	760 770 2776	Ecshang32@aol.com
Dr. Jeff SIMMEN	Code 3210A Office of Naval Research 800 North Quincy St. Arlington VA 22217-5660	703-696-4204 (ph) 703-696-8423 (fax)	simmenj@onr.navy.mil
Prof. Kevin Smith	Department of Physics Naval Postgraduate School Monterey CA 93943	831 656 2107	kbsmith@nps.navy.mil
Dr. Robert SPINDEL	Director, Applied Physics Laboratory University of Washington 1013 NE 40th St. Seattle WA 98105	206-543-1310 (ph) 206-543-3521 (fax)	spindel@apl.washington.edu
Dr. Dajun TANG	APL/University of Washington 1013 NE 40th St. Seattle WA 98105	206-543-1290 (ph)	djtang@APL.washington.edu

Name	Address	Phone/Fax	Email
Dr. Ning WANG	The College of Information and Engineering Qingdao University of Oceanology 5 Yushan Road Qingdao, CHINA 266003	86-532-203-2922 (ph)	wangyu@public.qd.sd.cn
Dr. Zhong Kang WANG	HAARI P.O. Box 1249 96 HuaXing Road Hang Zhou, ZheJiang, CHINA 310012	86-571-88866002 (ph)	kingwzk@netscape.net
Shanshan WANG			wssocean@hotmail.com
Steve WOLF	Naval Research Laboratory Code 7120 4555 Overlook Avenue, SW Washington, DC 20375	202-767-3079 (ph) 202-404-7813 (fax)	swolf@wave.nrl.navy.mil
Lixin WU	Chinese Academy of Sciences 17 Zhongguancun St. Beijing 100080, P.R. of CHINA	86-10-6262-0297	lxw@farad.ioa.ac.cn
Ling Xiao	Chinese Academy of Sciences 17 Zhongguancun St. Beijing 100080, P.R. of CHINA	86-10-6262-0297	xling@farad.ioa.ac.cn
Jin YAN	Chinese Academy of Sciences 17 Zhongguancun St. Beijing 100080, P.R. of CHINA	86-10-6262-0205	jy@farad.ioa.ac.cn
Shi-E YANG	Underwater Acoustic Institute Harbin Engineering University Building 31 Wenmaiao Str. Harbin 150001, P.R. of CHINA		yangse@public.hr.hl.cn
Kunde YANG	Institute of Acoustic Engineering Northwestern Polytechnical University Xian 710072, PR CHINA	86-29-8494504	ykdzym@nwpu.edu.cn
Prof. Renhe ZHANG	Director, National Laboratory of Acoustics Chinese Academy of Sciences 17 Zhongguancun St. Beijing 100080, P.R. of CHINA	86-10-62569079 (ph) 86-10-62569079 (fax)	zrh@farad.ioa.ac.cn
Hong ZHANG	Tropical Marine Science Institute National University of Singapore 10 Kent Ridge Crescent SINGAPORE 119260	65-6874-8971	tmszh@nus.edu.sg
Dr. H. F. ZHAO			sklzhao@yahoo.com.cn
Dr. Jixun ZHOU	School of Mechanical Eng. Georgia Institute of Technology Atlanta GA 30332	404-894-6793 (ph) 404-894-7790 (fax)	jixun.zhou@me.gatech.edu
Dr. Shihong ZHOU	Dalian Scientific Test & Control Tech Institute PO Box 67 Dalian CHINA 116013		xuzhou@mail.dlptt.ln.cn

DISTRIBUTION LIST FOR APL-UW TR 0201

Name	Address	Phone/Fax	Email
Philip ABBOTT	OASIS 5 Militia Drive Lexington, MA 02421	781-862-8339 (ph) 781-862-0572 (fax)	oasis@world.std.com
Victor AKULICHEV	Director Pacific Oceanological Institute Far Eastern Br, Russian Academy of Sciences 43 Baltiyskaya Street Vladivostok 690041, RUSSIA	7-4232-31-1400	akulich@marine.febras.ru
Xuemei BAO	Hangzhou Applied Acoustics Research Institute 96 Huaxing Road Fuyang Hangzhou Zhejiang PRC 2000 5/22		sklbxm@163.net
Dr. Louis BARTEK	Dept. of Geological Sciences CB 3315 University of North Carolina at Chapel Hill Chapel Hill, NC 27599-3315	919-962-0687 (ph) 919-966-4519 (fax)	bartek@email.unc.edu
Dr. Robert BEARDSLEY	Dept of Oceanography Clark Building Woods Hole Oceanographic Institution Woods Hole, MA 02543	508-457-2536 (ph)	rbeardsley@whoi.edu
Peter CABLE	BBN Technologies Union Station New London, CT 06320	703 284 4724	pcable@bbn.com
Michael CARUSO	MS#21 Remote Sensing and Analysis Woods Hole Oceanographic Institution Group 360 Woods Hole Rd. Woods Hole, MA 02543-1541	(508) 289-2901 (ph) (508) 457-2181 (fax)	mcaruso@whoi.ed
Prof. Eng-Soon CHAN	Physical Oceanography Research Laboratory National University of Singapore 10 Kent Ridge Crescent SINGAPORE 119260	65-8742275 (ph) 65-7791635 (fax)	cveces@nus.edu.sg
David CHAPMAN	Clark 316B, MS# 21 Woods Hole Oceanographic Institution Woods Hole, MA 02543	508-289-2792 (ph) 508-457-2181 (fax)	dchapman@whoi.edu
Dr. Wen-Ssn CHUANG	Institute of Oceanography National Taiwan University PO Box 23-13 Taipei, TAIWAN	88-622-3639761 (ph) 88-622-369-8526 (fax)	chuang@ccms.ntu.edu.tw
Dr. Chi-Fang CHEN	Dept. of Naval Architecture & Ocean Eng National Taiwan University 73 Chow-Shan Road Taipei, Taiwan 106	886-2-2366-1429 (ph) 886-2-2392-9885 (fax)	chifang@ccms.ntu.edu.tw
Dr. Ching-Sang CHIU	Code OC/Ci Department of Oceanography Naval Postgraduate School Monterey CA 93943	408-656-3239 (ph) 408-656-4142 (fax)	chiu@usw.nps.navy.mil

Name	Address	Phone/Fax	Email
Jee Woong CHOI	Dept. of Earth and Marine Sciences Hanyang University 1271 Sa-1 dong Ansan 425-791 KOREA	82-31-400-4233	choijw@hanyang.ac.kr
Dr. Nick CHOTIROS	Applied Research Lab University of Texas at Austin 10000 Burnet Road, PO Box 8 Austin, TX 78713	512-835-3512 (ph) 512-835-3259 (fax)	
Dr. Peter DAHL	Applied Physics Laboratory University of Washington 1013 NE 40th St. Seattle WA 98105	206-543-2667 (ph) 206-543-6785 (fax)	dahl@apl.washington.edu
Yevgeniy DORFMAN	BBN Technologies	617 873 3173	edorfman@bbn.com
Tom DRAKE	Office of Naval Research, Code 322GG 800 North Quincy Street Arlington, VA 22217		draket@onr.navy.mil
Dr. Tim DUDA	AOPE Dept., MS 11 Woods Hole Oceanographic Institution Woods Hole, MA 02543	508 289-2495 (ph) 508-457-2194 (fax)	tduda@whoi.edu
Doug EDSALL	Ocean, Science, & Engineering, ONR Asian Office Akasaka Press Ctr. 7-23-17 Roppongi MINATO-KU Tokyo 106, JAPAN	81-3-3401-8924 (ph) 81-3-3403-9670 (fax)	edsalld@onrasia.navy.mil edsall@nadn.navy.mil
Dr. Glen GAWARKIEWICZ	MS #21 Woods Hole Oceanographic Institution Woods Hole MA 02543	508-289-2913 (ph) 508-457-2181 (fax)	glen@paddle.whoi.edu
H. L. GE	Hangzhou Applied Acoustics Research Institute 96 Huaxing Road Fuyang Hangzhou Zhejiang PRC 2000 5/22		sklglh@163.net
Xian-Yi GONG	Hangzhou Applied Acoustics Research Institute 96 Huaxing Road Fuyang Hangzhou Zhejiang PRC 2000 5/22		Via yanfy@public.fy.hz.zj.cn
Prof. Dinghau GUAN	National Laboratory for Acoustics CAS 17 Zhongguancun St. Beijing 100080, P.R. of China	86-1062567998 (ph) 86-1062569079 (fax)	zrh@canna.ioa.ac.cn
Dr. Bill HODGKISS	MPL/Scripps Institute of Oceanography U. of California, San Diego 9500 Gilman Dr. La Jolla CA 92093-0701	619-534-1798 (ph) 619-822-0665 (fax)	wsh@mpl.ucsd.edu
Phil HSUEH	Florida State University Dept of Oceanography Tallahassee, FL 32305	858-644-6704 (ph) 858-644-2581 (fax)	hsueh@re.ocean.fsu.edu
Dr. Hyoung Rok KIM	Department of Oceanography Naval Postgraduate School Monterey, CA 93943	831 656 2052	hrkim@nps.navy.mil
Dr. Hui Liang GE	HAARI P.O. Box 1249 96 HuaXing Road Hang Zhou, ZheJiang, CHINA 310012	86-571-888660002 (ph)	sklghl@163.net

Name	Address	Phone/Fax	Email
David KNOBLES	Applied Research Laboratories University of Texas at Austin	512 835 3687	knobles@arlut.utexas.edu
Dr. Dong Shan KO	NRL Stennis Space Center, MS	228-688-5448 (ph) 228-688-4759 (fax)	ko@nrlssc.navy.mil
Mrs. Beverly KUHN	Office of Naval Research Code 321OA 800 N Quincy Street Arlington, VA 22217-5660	703-696-6998 (ph) 703-696-2710 (fax)	kuhnb@onr.navy.mil
Prof. Qihu LI	Director, Institute of Acoustics Chinese Academy of Sciences 17 Zhongguancun St. Beijing 100080 P.R. of CHINA	11861062565692 (ph) 11861062553898 (fax)	lqh@ocean.ioa.ac.cn
Dr. Fenghua LI	Institute of Acoustics Chinese Academy of Sciences 17 Zhongguanchun Road Beijing, CHINA 100080	86-10-6262-0205 (ph)	lfh@farad.ioa.ac.cn
Dr. Zhenglin LI	Chinese Academy of Sciences 17 Zhongguancun St. Beijing 100080, P.R. of CHINA	86-10-6262-0205	lzhl@farad.ioa.ac.cn
Dr. Antony LIU	Oceans and Ice Branch, Code 971 NASA Goddard Space Flight Center Greenbelt MD 20771	(310)614-5714 (ph) (301)614-5644 (fax)	liu@neptune.gsfc.nasa.gov
Jin-Yuan LIU (Jim)	Institute of Undersea Technology National Sun Yat-Sen University Kaohsiung 804, Taiwan		jimliu@mail.nsysu.edu.tw
Dr. Jianjun Liu	Chinese Academy of Sciences 17 Zhongguancun St. Beijing 100080, P.R. of CHINA	86-10-6262-0205	liujj@farad.ioa.ac.cn
Dr. Ellen LIVINGSTON	Code 3210A Office of Naval Research 800 North Quincy St. Arlington VA 22217-5660	703-696-4203 (ph) 703-696-2710 (fax)	livinge@onr.navy.mil
Dr. Jim LYNCH	Woods Hole Oceanographic Institution MS #11 Woods Hole MA 02543	508-289-2230 (ph) 508-457-7194 (fax)	jlynch@whoi.edu
Yuanliang MA	Institute of Acoustic Engineering Northwestern Polytechnical University Xi'an 710072, P. R. of CHINA		ylma@nwpu.edu.cn
Jim MILLER	Dept of Ocean Engineering University of Rhode Island 114 Middleton Bldg Narragansett, RI 02882	401-874-6540 (ph) 401-874-6837 (fax)	miller@oce.uri.edu
Dr. Jerry MILLER	ONR Europe PSC 802 Box 39 FPO AE London, UK 09499-0700	44 (0) 207514 4964 (ph) 44 (0)207 723 6359 (fax)	jmiller@onrifo.navy.mil
Dr. Peter MIGNEREY	Code 7120 Naval Research Lab/DC 4555 Overlook Ave SW Washington DC 20375-5320	202 767 2230	mignerey@nrl.navy.mil

Name	Address	Phone/Fax	Email
Dr. Yuri N. MORGUNOV	Head of Technical Division Pacific Oceanological Institute Far Eastern Br, Russian Academy of Sciences 43 Baltiyskaya Street Vladivostok 690041, RUSSIA	7-4232-31-1631	morgunov@poi.dvo.ru
Steve MURRAY	Office of Naval Research Code 322PO 800 N Quincy Street Arlington, VA 22217-5660	(703) 696-4533 (ph)	murrays@onr.navy.mil
Prof. Jungyul NA	Dept. of Earth and Marine Sciences Hanyang University 1271 Sa-1 dong Ansan 425-791 KOREA	82-3454005533 (ph) 82-3454066458 (fax)	najy0252@email.hanyang.ac.kr
Jimmy NG	Tropical Marine Science Institute National University of Singapore 10 Kent Ridge Crescent SINGAPORE 119260	65-6774-9914	tmsngkt@nus.edu.sg
Dr. Marshall ORR	Code 7120 Naval Research Lab/DC 4555 Overlook Ave SW Washington DC 20375-5320	202-767-3359 (ph) 202-404-7813 (fax)	orr@wave.nrl.navy.mil
Dr. Al OSBORNE	Code 322PO Office of Naval Research 800 North Quincy Street Arlinton, VA 22217		Alfred_Osborne@onr.navy.mil
Dr. Neal PETTIGREW	School of Marine Science University of Maine Orono ME 04469-5741		nealp@maine.maine.edu
Dr. Shengchun PIAO	Director, Underwater Acoustic Institute Harbin Engineering University Building 31 Wenmaiao Str. Harbin 150001, P.R. of CHINA	11864512518947 (ph) 11864512532060 (fax)	psyg@public.hr.hl.cn
Rob PINKEL	MPL/SCRIPPS Institute of Oceanography 9500 Gilman Drive La Jolla, CA 92093	61-534-2056 (ph)	rpinkel@ucsd.edu
Dr. John R. POTTER	Head, Acoustic Research Laboratory National University of Singapore 10 Kent Ridge Crescent SINGAPORE 119260	65-8742129 (ph) 65-7791103 (fax)	johnp@arl.nus.edu.sg
Dr. Gopu POTTY	Dept of Ocean Engineering University of Rhode Island 114 Middleton Bldg Narragansett, RI 02882	401 874 6568	potty@oce.uri.edu
Ruth PRELLER	Naval Research Laboratory Building 1009, Room 138 Code 7322 Stennis Space Center, MS 39529-5000	228-688-5444 (ph) 228- 688-4759 (fax)	preller@seahorse.nrlssc.navy.mil
Dr. Yiquan QI	South China Sea Institute of Oceanology Guangzhou, P.R. of CHINA 510301		yqqi@scsio.ac.cn
Luc RAINVILLE	Mail code 0226 Scripps Institution of Oceanography, La Jolla Ca 92093-0226		luc@mpl.ucsd.edu

Name	Address	Phone/Fax	Email
Dr. Steve RAMP	Department of Oceanography Code Oc/Ra Naval Postgraduate School Monterey CA 93943	831-656-2201 (ph)	ramp@oc.nps.navy.mil
Dr. Steven G. SCHOCK	Dept. of Ocean Engineering Florida Atlantic University Boca Raton, FL 33431-0991	561-297-3447 (ph) 561-297-3885 (fax)	schock@oe.fau.edu
E. C. SHANG	Scripps Institution of Oceanography La Jolla, CA 92093-0101	760 770 2776	Ecshang32@aol.com
Dr. Ping SHI	Chinese Academy of Sciences South China Sea Institute of Oceanology 164 West Xingang Road Guanzhou 510301 CHINA	86-20-84452227 (ph) 86-20-84451672 (fax)	pshi@scsio.ac.cn
Dr. Jeff SIMMEN	Code 3210A Office of Naval Research 800 North Quincy St. Arlington VA 22217-5660	703-696-4204 (ph) 703-696-8423 (fax)	simmenj@onr.navy.mil
Prof. Kevin Smith	Department of Physics Naval Postgraduate School Monterey CA 93943	831 656 2107	kbsmith@nps.navy.mil
Dr. Robert SPINDEL	Director, Applied Physics Laboratory University of Washington 1013 NE 40th St. Seattle WA 98105	206-543-1310 (ph) 206-543-3521 (fax)	spindel@apl.washington.edu
Dr. Chao SUN	MPL/SCRIPPS Institute of Oceanography University of California, San Diego 9500 Gilman Drive La Jolla, CA 92093-0238		csun@mpl.ucsd.edu
Dr. Dajun TANG	APL/University of Washington 1013 NE 40th St. Seattle WA 98105	206-543-1290 (ph)	djtang@APL.washington.edu
Dr. Tswen Yung TANG (David)	Oceanography Institute National Taiwan University PO Box 23-13 Taipei TAIWAN	88-623626097 (ph) 88-623626092 (fax)	tyt@ccms.ntu.edu.tw
Jing (Jerry) TIAN	Institute of Ocean Acoustics Chinese Academy of Sciences PO Box 2712 Beijing 100080, CHINA	86-10-62629249 (ph) 86-10-62553898 (fax)	tian@mail.ioa.ac.cn
Joe WANG	Natinal Taiwan University P.O. Box 23-13 Taipei, TAIWAN	886-2-2362-6040x125 (ph) 886-2-2392-5294 (fax)	wang@ipx.oc.ntu.edu.tw
Dr. Ning WANG	The College of Information and Engineering Qingdao University of Oceanology 5 Yushan Road Qingdao, CHINA 266003	86-532-203-2922 (ph)	wangyu@public.qd.sd.cn
Dr. Zhong Kang WANG	HAARI P.O. Box 1249 96 HuaXing Road Hang Zhou, ZheJiang, CHINA 310012	86-571-88866002 (ph)	kingwzk@netscape.net
Shanshan WANG			wssocean@hotmail.com

Name	Address	Phone/Fax	Email
Prof. Ruey-Chang WEI	Institute of Undersea Technology Natioanl Sun Yat-sen University 70 Lian-Hae Road Kaohsiung 804 Taiwan	886-7-5252000 x5280 (ph) 886-7-5255270 (fax)	rcwei@mail.nsysu.edu.tw
Prof. Ching-Ling WEI	Institute of Oceanography National Taiwan University P.O. Box 23-13 Taipei, Taiwan	02-2367-7134 (ph) 02-2369-2170 (fax)	weic@ccms.ntu.edu.tw
Steve WOLF	Naval Research Laboratory Code 7120 4555 Overlook Avenue, SW Washington, DC 20375	202-767-3079 (ph) 202-404-7813 (fax)	swolf@wave.nrl.navy.mil
Lixin WU	Chinese Academy of Sciences 17 Zhongguancun St. Beijing 100080, P.R. of CHINA	86-10-6262-0297	lxw@farad.ioa.ac.cn
Ling Xiao	Chinese Academy of Sciences 17 Zhongguancun St. Beijing 100080, P.R. of CHINA	86-10-6262-0297	xling@farad.ioa.ac.cn
Jin YAN	Chinese Academy of Sciences 17 Zhongguancun St. Beijing 100080, P.R. of CHINA	86-10-6262-0205	jy@farad.ioa.ac.cn
Shi-E YANG	Underwater Acoustic Institute Harbin Engineering University Building 31 Wenmaiao Str. Harbin 150001, P.R. of CHINA		yangse@public.hr.hl.cn
Kunde YANG	Institute of Acoustic Engineering Northwestern Polytechnical University Xian 710072, PR CHINA	86-29-8494504	ykdzym@nwpu.edu.cn
Yiing-Jang YANG	Natinonal Taiwan University No. 1, Sec. 4, Roosevelt Road P. O. Box 23-13 Taipei, Taiwan, ROC		yjyang@mail.cna.edu.tw
Prof. Renhe ZHANG	Director, National Laboratory of Acoustics Chinese Academy of Sciences 17 Zhongguancun St. Beijing 100080, P.R. of CHINA	86-10-62569079 (ph) 86-10-62569079 (fax)	zrh@canna.ioa.ac.cn
Hong ZHANG	Tropical Marine Science Institute National University of Singapore 10 Kent Ridge Crescent SINGAPORE 119260	65-6874-8971	tmszh@nus.edu.sg
Dr. H. F. ZHAO			sklzhao@yahoo.com.cn
Dr. Jixun ZHOU	School of Mechanical Eng. Georgia Institute of Technology Atlanta GA 30332	404-894-6793 (ph) 404-894-7790 (fax)	jixun.zhou@me.gatech.edu
Dr. Shihong ZHOU	Dalian Scientific Test & Control Tech Institute PO Box 67 Dalian CHINA 116013		xuzhou@mail.dlptt.ln.cn

REPORT DOCUMENTATION PAGE

Form Approved
OPM No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	December 2002	Technical Report

4. TITLE AND SUBTITLE
Proceedings, The Asian Seas International Acoustics Experiment (ASIAEX) International Symposium, Chengdu, China, October 14–18, 2002

5. FUNDING NUMBERS
N00014-99-1-0275

6. AUTHOR(S)
Dajun Tang, Steven R. Ramp, Peter H. Dahl, James Lynch, Jixun Zhou, Renhe Zhang, Ching-Sang Chiu, Robert C. Spindel, and Jeffrey Simmen

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Applied Physics Laboratory
University of Washington
1013 NE 40th Street
Seattle, WA 98105-6698

8. PERFORMING ORGANIZATION REPORT NUMBER
APL-UW TR 0201

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Dr. Jeffrey Simmen
Code 3210A
Office of Naval Research
800 N. Quincy St.
Arlington, VA 22217-5660

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The final international symposium for the Asian Seas International Acoustics Experiment (ASIAEX) was held October 14–18, 2002 at the Holiday Inn Crowne Plaza Hotel in Chengdu, China. Approximately sixty representatives from four countries attended to present results from the field programs conducted during spring and early summer 2001. The first research program focused on acoustic reverberation from the surface, bottom, and sub-bottom in shallow (less than 100 m) water, while the second was dedicated to the study of volume interaction of low frequency (200–400 Hz) sound propagating up the continental slope and shelf. The reverberation experiment was conducted in the East China Sea (ECS) in the region bounded by 28°–30°N, 126° 30'–128°E. This was same region studied during the spring 2000 pilot study. The volume interaction experiment took place in the South China Sea (SCS) in a box bounded by 21°–22° 30'N, 117°–119°E

The first day of the Chengdu workshop was dedicated to the presentation and summary of SCS results; physical oceanographers presented environmental findings first then acousticians discussed the acoustic ramifications. The talks during the second day-and-one-half focused on the East China Sea in similar order. On the fourth day the SCS and ECS groups met separately to discuss their own issues and plan manuscripts for the special ASIAEX volume of the *IEEE Journal of Ocean Engineering*. All the major objectives of the workshop were accomplished. The group is looking ahead to the publication of outstanding papers that advance coupled physical oceanography and environmental acoustics programs.

14. SUBJECT TERMS
Physical Oceanography, Environmental Acoustics, East China Sea, South China Sea, ASIAEX

15. NUMBER OF PAGES
40 + .ppt presentations

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR