

# **SW06 Shallow Water Acoustics Experiment**

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[www.apl.washington.edu/projects/SW06/](http://www.apl.washington.edu/projects/SW06/)

## **LONG TERM GOALS**

The long term goal of our shallow water acoustics work is to understand the nature of low frequency (10-1500 Hz) acoustic propagation and scattering in shallow water when strong oceanic variability in the form of fronts, eddies, boundary layers, and internal waves is present. The long term goal of our FY06 fieldwork planning and preparation task is to develop and eventually execute a scientifically sound and Navy relevant basic research experiment in shallow water acoustics, concentrating on both low and medium frequencies.

## **OBJECTIVES**

Our primary objectives this year were to: 1) plan and 2) prepare for a large scale shallow water acoustics experiment in 2006 which will combine low-frequency and medium-frequency acoustics work. A secondary objective was to continue some of our ongoing analyses in shallow water acoustics, both in data analysis and theory.

## **APPROACH**

Our approach to planning the SW06 experiment has included: 1) organizing and participating in large ONR workshops that involve all the SW06 components and PI's (including the LEAR, NLIWI, and AWACS components), 2) organizing the at-sea plans for the SW06 experiment, including ship schedules, equipment positions, deployment and recovery timetables, logistics, etc. and 3) organizing data communications for the experiment, including helping with the web site. This has been done in close collaboration with Dr. Dajun Tang of APL/UW (Co-Chief Scientist on the experiment) and the ONR-OA Program Managers.

Our approach to preparing for the experiment has revolved about the construction and testing of 34 oceanographic moorings, 4 large source moorings, a large HLA/VLA mooring, 5 SHRU's (single hydrophone receiver units), a REMUS AUV thinline towed acoustic array system, a drifting VLA receiver unit, and assorted other equipment. A significant fraction of the equipment for this experiment was funded through the ONR DURIP initiative.

## **WORK COMPLETED/ACCOMPLISHMENTS**

Initial planning for the SW06 shallow water acoustics experiment was accomplished by holding two major workshops for the community at the University of Washington and the Naval Postgraduate School during 2003-2004. This was followed up by a major workshop this year held at Alexandria, VA

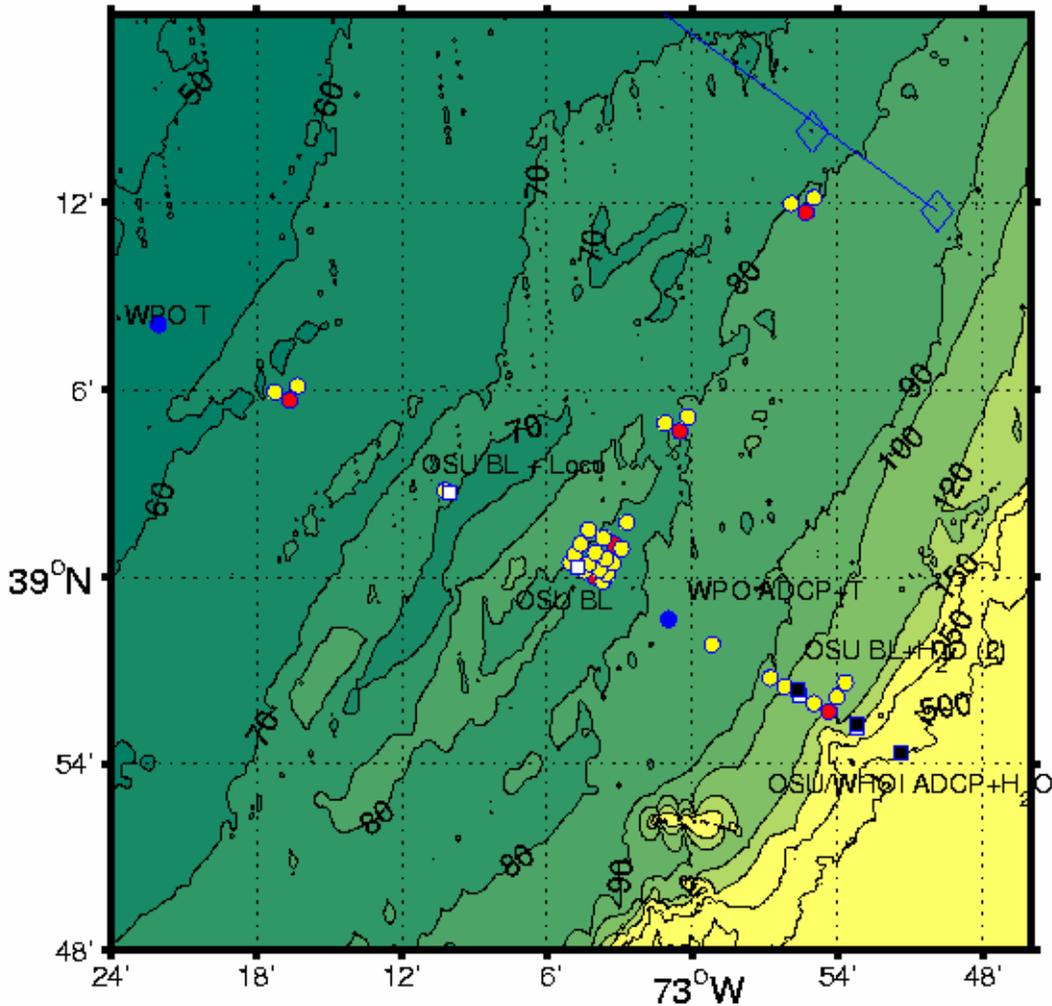
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on March 22, 2005. Another major workshop is planned for October, 2005 in conjunction with the Acoustical Society of America meeting in Minneapolis, MN. After that meeting, the experimental plan for the experiment should be largely complete. As an example of the planning done, we show in Figure 1 a diagram of the SW06 oceanography mooring array that will be used to support the acoustics, as well as answer basic research questions in physical oceanography.



**Figure 1. Plot of positions of oceanographic moorings to be used in conjunction with acoustics measurements in SW06. Note cross shelf, along shelf, and intense measurement sites.**

We also worked on a number of other shallow water acoustics topics this past year, in addition to SW06 planning. These were: 1) ducting of acoustic energy between internal waves in shallow water, 2) “whispering gallery” trapping of acoustic energy by internal waves and the shelfbreak front, 3) array coherence studies, 4) attachment of a low frequency towed array to the small REMUS AUV (in conjunction with our AWACS efforts), 5) correlation of signal and noise characteristics in shallow water in the PRIMER experiment, 6) studies of propagation characteristics in the PRIMER area in winter, 7) studies of the uncertainty in bottom inversions due to water column uncertainty, 8) an

overview article on nonlinear internal waves, and 9) an overview of shallow water acoustics for *Physics Today*. This work has resulted in a number of publications as cited below.

## RESULTS

The results that we have to date re the SW06 experiment are simply some planning documents and our website. Equipment has been built and refurbished for this effort, but there are still many months of preparation left. As concerne the other analysis efforts, those results are best seen through the papers listed below.

## IMPACT/APPLICATIONS

The impact of our planning meetings will be in pursuing a focused and appropriate set of shallow water acoustics experiments in 2006.

## TRANSITIONS

One eventual transition of our data will be to ONR's Uncertainty DRI program, where the interest is in "the error bars" in ocean acoustic field and system performance prediction. We also hope to have our REMUS acoustic towed array transitioned to operational use in the future.

## RELATED PROJECTS

The SWARM acoustics/internal wave study, the PRIMER acoustics/shelfbreak front study, and ASIAEX were direct predecessors of SW06, and examined some of the same acoustic scientific issues, only with far fewer measurement resources. The "Non-linear internal waves initiative" (NLIWI) is strongly related to our SW06 LEAR effort via the environmental support that the oceanographic moorings (and other PO measurements) will provide. The SW06 experiment will also have an AWACS component, so that we may test both the engineering and the acoustics systems that we have developed.

## PUBLICATIONS

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- [8] Winter Primer ocean-acoustic solitary wave modeling studies. A. Warn-Varnas, S. Chin-Bing, D. King, J. Hawkins, K. Lamb and J. Lynch. Submitted to *IEEE Journal of Oceanic Engineering* (2005). [submitted, refereed]

**PUBLICATIONS (non-refereed)**

- [1] J.F. Lynch, Book review of “High Frequency Ocean Acoustics” edited by Porter, Siderius, and Kuperman, *J. Acoust. Soc. Am.* In press (2005). [in press, non-refereed]
- [2] Jason D. Holmes, William M. Carey, James F. Lynch, Arthur E. Newhall, and Amy Kukulya “An autonomous underwater vehicle towed hydrophone array for ocean acoustic measurements and inversions” Proceedings of IEEE OES Ocean’s 05 Europe, June 2005 [published, non-refereed]
- [3] Jason D. Holmes, William M. Carey, Allan D. Pierce, James F. Lynch. “Attenuation Characteristics of Sandy Sediments- A simplified Biot approach.” Proceedings of the boundary influences in high frequency, shallow water acoustics meeting. University of Bath, UK. Sept. 2005. [published, non-refereed]

**HONORS/AWARDS/PRIZES**

J. Lynch was made Fellow of the IEEE in January, 2005 and also recently awarded WHOI’s Robert Morse Senior Scientist Chair.