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NOTE: All Journal articles and Letters to the Editor are peer reviewed before publication. Program abstracts, however, are not reviewed before publication, since we are prohibited by time and schedule.

MONDAY MORNING, 16 JUNE 1997 ROOM P, 8:00 TO 11:50 A.M.

Session 1aAO

Acoustical Oceanography and Underwater Acoustics: Acoustical Measurement of Coastal Ocean Processes I

James F. Lynch, Chair
Woods Hole Oceanographic Institution, 203 Bigelow Building, Woods Hole, Massachusetts 02543

Chair's Introduction—8:00

Invited Papers

8:05

1aAO1. Preliminary report on the summer '96 joint China–U.S. internal wave/acoustic wave experiment in the Yellow Sea. Ji-Xun Zhou, Peter H. Rogers, Gary W. Caille (School of Mech. Eng., Georgia Inst. of Technol., Atlanta, GA 30332-0405), Renhe Zhang, Guoliang Jin, Liangying Lei (Chinese Acad. of Sci., Beijing 100080, PROC), Peter H. Dahl, Robert C. Spindel (Univ. of Washington, Seattle, WA 98105), and Zijun Gan (South China Sea Inst. of Oceanology, Guangzhou 510301, PROC)

Simultaneous observations of internal wave activity and acoustic wave propagation in 70-m water in the Yellow Sea were made in the late summer of 1996. The primary objective of this experiment was to validate the predicated modal coupling and fluctuations induced by shallow-water internal waves. The Yellow Sea provides an ideal environment for such research because it has a very flat and homogeneous bottom and a very strong, sharp thermocline. The environment lends itself to relatively simple models for both the acoustic field and the internal wave field. Propagation was measured over distances up to 55 km in the frequency range of 50 Hz–5 kHz. The receivers were three moored and two suspended hydrophone arrays. Internal wave activity was monitored using thermistor chains, SAR satellite imagery, and high-frequency sonar. Propagation data were taken as a function of range, as a function of time at a fixed range, and as a function of azimuth in the presence of differing levels of internal wave activity. Supporting environmental data obtained during the experiment include ADCP, bottom profile and surface wave-height spectra, and bottom coring. Preliminary data on internal wave field, sound propagation, reverberation, and bottom acoustic parameters will be presented. [Work supported by ONR and the Chinese Academy of Sciences.]

8:25

1aAO2. Intimate '96: Shallow water tomography in the Sea of the Condemned. Emanuel Coelho (Hydrographic Inst., P-1296, Lisbon, Portugal), Sergio Jesus (Univ. of the Algarve, Faro, Portugal), Yann Stephan, Xavier Demoulin (EPSHOM/CMO, F-29275, Brest, France), and Michael B. Porter (Math. Dept., New Jersey Inst. of Technol., Newark, NJ 07102)

As is well-known, the tidal force of the moon and the sun can cause notable changes in the sea level. Besides this so-called barotropic effect, the tidal force also drives internal waves in a daily rhythm. Thus, the internal wave spectrum is often dominated by a single component with perhaps 10 km from crest to crest. This ''internal tide'' tends to propagate toward shore and has its greatest height near the shelfbreak. As this tide propagates it modulates the surface duct and its acoustic signature is often seen in data. The Intimate '96 experiment (conducted off the coast of Portugal) was specifically designed to acoustically image the internal tide with an

eye toward a more precise understanding of its structure and acoustic impact. A towed source emitted chirps every 8 s for several days and the chirps were received on the SACLANTCEN portable array. The data show a textbook multipath structure with early refracted paths followed by some 30 distinct bottom and surface echoes which shift with the internal tide. The acoustic and oceanographic interpretation of this data will be discussed.

8:45

1aAO3. Observations of cnoidal internal waves and their effect on acoustic propagation in shallow water. David Rubenstein (Sci. Applications Int. Corp., 1710 Goodridge Dr., P.O. Box 1303, McLean, VA 22102, davidr@osg.saic.com)

Packets of cnoidal internal waves were observed during a shallow-water experiment in the Gulf of Mexico. They lasted about 3 h and were always observed at the same time of day, clearly in response to tidal forcing. The cnoidal waves had 2–10 m amplitudes, narrow frequency bandwidths with central frequencies of about 9 cph, wavelengths of about 435 m, and they propagated in the along-slope direction. Data from a set of three thermistor arrays were processed to obtain directional wave spectra. These spectra establish the strong directionality of the cnoidal wave packets. The background ''continuum'' spectrum is resolved into a small set of discrete, strongly directional components. Observations of low-frequency acoustic propagation along several baselines showed fluctuations induced by cnoidal waves. These effects were simulated using a time-step PE approach. A mode-coupling resonance with the internal wave field results in elevated acoustic variability along a set of discrete spokes, emanating from the acoustic source. While acoustic variability tends to increase with range and with internal wave amplitude, tangential and radial correlation scales do not show a systematic dependence. Other implications of relative directionality between internal wave and acoustic propagation are discussed.

9:05

1aAO4. A review of the shelf edge studies acoustic measurement experiments—SESAME I and II. Robert L. Field (NRL Ocean Acoust. Branch, Stennis Space Center, MS 39529)

The shelf edge studies acoustic measurement experiments (SESAME) were performed in the North West Approaches to the British Isles. The SESAME experiments were a collaborative effort between the Natural Environment Research Council, the Defence Research Agency (both of the United Kingdom), and the Naval Research Laboratory (Stennis Space Center). The objective of the experiments was to determine the effects of internal waves formed at the shelf edge on acoustic propagation. Oceanographic measurements were gathered continuously over an 18-month period and acoustic experiments were performed during the summers of 1995 and 1996. Measurements of temperature, conductivity, and current were made within the water column, sediment cores were taken of the ocean bottom, and SAR images of the sea surface were taken of the experimental area. Range and time-varying acoustic experiments were performed in the along shelf and cross shelf directions over a frequency band of 100–2100 Hz. Both narrow- and broadband (frequency modulated) signals were transmitted. A review of the two experiments and some of the oceanographic and acoustic data collected will be presented. [Work supported by ONR and NRL.]

9:25

1aAO5. The shelfbreak front PRIMER experiment. Glen Gawarkiewicz, Robert Pickart, James F. Lynch (Woods Hole Oceanograph. Inst., Woods Hole, MA 02543), Ching-Sang Chiu, Kevin Smith (Naval Postgrad. School, Monterey, CA 93943), and James H. Miller (Univ. of Rhode Island, Narragansett, RI 02882)

In July and August 1996, a combined physical oceanography and acoustics experiment was performed in the Mid-Atlantic Bight south of Nantucket Shoals. The purpose of this experiment was to examine coastal frontal variability and its impact on acoustic propagation and imaging. Extensive oceanographic measurements of the experimental region were made. These measurements included: (1) SeaSoar hydrography; (2) moored T, S, and current meter sensors; and (3) satellite infrared imaging of the sea surface temperature. These measurements provided what is believed to be the highest resolution imaging of a shelfbreak frontal region yet obtained. Acoustic measurements in the experimental region included: (1) a three-dimensional tomographic imaging array; and (2) aircraft deployed SUS drop fields. Observations revealed the presence of a strong jet associated with sharp thermal gradients. During this time period, the front was contorted by the presence of a streamer of shelf water moving offshore, which resulted in large thermal gradients in both along the shelf and across the shelf direction. The oceanographic activity produced significant mode coupling in the acoustic signals, leading to large time spreading of the source pulses.

9:45

1aAO6. Acoustic travel time and intensity fluctuations measured in the SWARM95 experiment. Robert H. Headrick, Jr., James F. Lynch (Woods Hole Oceanograph. Inst., Woods Hole, MA 02543), Marshall Orr, Bruce Pasewark, Steve Wolf (Naval Res. Lab., Washington, DC 20375), Mohsen Badiey (Univ. of Delaware, Newark, DE 19716), Ching-Sang Chiu (Naval Postgrad. School, Monterey, CA 93943), and John Apel (Global Ocean Assoc., Silver Spring, MD 20908)

During the summer of 1995, a multidisciplinary, multilaboratory experiment entitled ''SWARM'' (shallow-water acoustics in a random medium) was conducted on the continental shelf off New Jersey. The purpose of this experiment was to examine the effects of internal waves, both linear and nonlinear, upon acoustic transmissions in the 10 to 1000-Hz range. Towards this goal, numerous oceanographic sensors were deployed along a fixed across shelf track, together with a fixed acoustic transmission range. Shipborne acoustic sources also allowed out of plane (along shelf) studies. Results will be presented of recent data analyses showing the nature of the measured acoustic travel time and intensity fluctuations, and how they correlate to environmental forcing, particularly by internal waves and the shelfbreak front. [Work supported by ONR.]

10:05–10:20 Break