Session 3pAO

Acoustical Oceanography and Underwater Acoustics: Inverse Methods for Sub-Bottom Surveys II

Altan Turgut, Cochair
Naval Research Laboratory, Acoustics Division, Code 7127, 4555 Overlook Avenue, SW, Washington, DC 20375

David N. Lambert, Cochair
Naval Research Laboratory, Code 7431, Stennis Space Center, Mississippi 39529

Contributed Papers

1:00

3pAO1. Minimum samples sizes required to minimize variance and bias of geoacoustic estimates of seafloor properties. Ian Ingram, Aaron M. Thode, and Nicholas C. Makris (MIT, 77 Massachusetts Ave., Cambridge, MA 02139)

Analytic expressions for the first order bias and second order covariance of a maximum-likelihood estimate (MLE) [Naftali and Makris, J. Acoust. Soc. Am. **107**, 2859 (2000)] are used to rigorously determine the sample sizes necessary for a geoacoustic MLE to become unbiased and attain the CRLB. The analysis is applied to the specific case of a narrowband deterministic signal recorded on a vertical array. The biases and variances are computed for bottom sound speed, density, and attenuation in a Pekeris waveguide, for situations where the source location is either known, or must also be estimated from the acoustic data. The case of a two-layer bottom with a sound-speed gradient is also investigated. As the beamformed signal-to-noise ratio (SNR) descends below 0 dB, the bottom sound speed and density bias can exceed 100 m/s and 1 g/cc, repsectively, and at least 100 data samples are required to attain the CRLB. An optimum source range exists for minimizing bottom speed bias, and the bias sign is strongly dependent on source depth. These formulas can provide powerful tools for the design and interpretation of geoacoustic experiments.

1:15

3pAO2. Experimental design for geoacoustic parameter inversion. Mischa F. P. Tolsma, Adriaan van den Bos, and Gerrit Blacquière (Dept. of Appl. Phys., TU Delft, The Netherlands, m.tolsma@tn.tudelft.nl)

Both model-based and nonparametric classification benefit from a theoretical investigation into the information contained in reflections from the subbottom. Specifically, it is difficult to find out if the properties of a certain bottom type are identifiable with a given acoustical signal due to the complexity of the reflection models used. This problem is approached with the Fisher information matrix of the stochastic model for the measured acoustic response. The problem is unidentifiable when this matrix becomes singular. Its inverse, the Cramér–Rao lower bound, gives the best possible precision of the parameter inversion. This lower bound can be used to design appropriate signals for precise measurement of the subbottom. This has been done for a model of a surface layer with varying density given by Lyons and Orsi [IEEE J. Oceanic Eng. **23**, 411–422 (1998)]. It is found that precise measurement of the reported range of model parameters requires a signal with a frequency range of 1–50 kHz. This supports the finding that broadband or multifrequency techniques are needed for the classification of layers with continually varying properties. [Work supported by TNO TPD and Rijkswaterstaat, The Netherlands.]

1:30

3pAO3. Modal mapping in range and azimuth for shallow-water waveguides. Kyle M. Becker (MIT/WHOI, Joint Prog. in Oceanogr. and Oceanogr. Eng., Woods Hole Oceanogr. Inst., Woods Hole, MA 02543) and George V. Frisk (Woods Hole Oceanogr. Inst., Woods Hole, MA 02543)

It is well established that the normal mode solution for sound propagation in shallow water is a function of the local waveguide properties. Much work has been done on the inverse problem where the local modes are measured and used as input data for geoacoustic inversion methods. In the range-dependent case, short sliding-window transform methods based on the Hankel transform have been implemented to extract the corresponding range-varying wave number spectra. A major objective of this work is to extend the range-dependent work to fully three-dimensionally varying environments. Recently, experiments were conducted using cw sources operating in the frequency range 20–475 Hz. The acoustic field was measured on an array of freely drifting hydrophone buoys equipped with GPS navigation. Using the complex pressure measured on these synthetic aperture horizontal arrays, local mode information is extracted as a function of range and azimuth from the source. Emphasis is placed on modal variability for tracks both along and across bathymetric contours at several frequencies. [Work supported by ONR.]

1:45

3pAO4. Complete acoustic recording of water column scatters and sea bed characteristics. Hans Petter Knudsen, Melle Webjrn, Misund Ole Arve, Ona Egil (Inst. of Marine Res., P.O. Box 1870, N-5024 Bergen, Norway), Aksnes Dag, and Sejrup Hans Petter (Univ. of Bergen, N-5020 Bergen, Norway)

A new vessel for marine science in Norway has been commissioned for delivery in 2003. The 78-m long, 16.5-m wide, 6000-kW powered vessel is designed for multifunctional operation. Facilities for sampling the physical and chemical characteristics of the water column, recording and sampling plankton and fish stocks, mapping the sea bottom topography, and marine geological and geophysical research constitute the scientific framework of the vessel. To eliminate fish avoidance, the vessel will be silent according to the recommendation given in ICES CRR 209, and at night the ship can be darkened. The acoustic instruments for plankton and fish recordings, sea bottom mapping and characterization are described.