Array processing with acoustic measurements at a single point in the ocean.

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Schmidt *et al.*, J. Acoust. Soc. Am. **88**, 1851–1862 (1990)]. In this work, the effects of sound-speed mismatch in the lower water column (3000–5000 m) are investigated. Such mismatch can arise from differences in climatology data or inaccuracies in the sound-speed equation. Low-frequency sources are simulated at shot depths in a range-independent deep-water Pacific environment and are processed with a mismatched replica field on a long vertical receiving array. Source range is varied from 50 to 500 km. For a sound-speed mismatch of 0.6 m/s at 5000 m, the effects on the mainlobe peak level are strongly and cyclically range dependent, varying by as much as 1 dB. A closed form analysis of this phenomenon is presented and the effects of source depth and of array placement in the water column is considered.

1:30

3UW3. Limitation of reflecting irregular bathymetry on matched-field processing. O. Diachok and J. F. Smith (Naval Res. Lab., Washington, DC 20375)

Simulations of the potential of matched-field tomography for inverting ocean sound-speed structure (Tolstoy and Diachok, 1991) have to date neglected effects of bottom interacting modes. At very low frequencies these modes are significant over: thickly sedimented bottoms and thinly sedimented bottoms where V_ s > V_ w. In thinly sedimented regions of the mid-pacific, V_ s is approximately 1570 m/s (Diachok, 1991). Results of a study to determine the effect of experimentally obtained bathymetry in the thinly sedimented Pacific on matched-field processing follow. The bathymetry exhibits an irregular variation in depth as a function of range and is assumed to have a constant sound speed. The range- and depth-dependent sound speed in the water column was obtained from tomography data. The acoustic field used as synthetic data "measured" at the array was calculated by the parabolic equation program FEPE (Collins, 1991). The program was shown to be highly accurate (0.15 dB at 1000 km at 15 Hz) in matched-field studies against "exact" results produced by the normal modes program KRAKENC in a range-independent environment. Simulation of the loss in signal gain was conducted at a frequency of 14 Hz at various ranges and constant bottom sound speeds of 1530, 1540, 1550, 1560, and 1570 m/s. The effects of irregular bathymetry and shifts in critical angle were to increase signal array degradation and reduce the accuracy of source localization. Effects of interaction with far and near sides of seamounts (relative to array position), and the overall trend of signal loss with range due to multiple interactions with the bottom will be discussed.

1:45

3UW4. Holographic array processing in a range-dependent ocean. Azmi A. Al-Kurd, Robert P. Porter, and Pierre D. Mourad (Appl. Phys. Lab., Univ. of Washington, 1013 NE 40th St., Seattle, WA 98105)

Imperfect knowledge of the salient characteristics of the propagation medium limits the performance of acoustic array processors at long ranges in the ocean. Holographic and phase conjugation techniques can be used to diminish the range-integrated effect of the medium and reconstruct the wave front in the vicinity of a scatterer or other signal source. Then, using a back-propagation technique that focuses sound at the position of the unknown source, the location of the source can be determine. In this paper, the WKB approximation is implemented for a range-dependent ocean with both N^2 bilinear and exponential stratification of the sound-speed profile. The results of the analysis and simulation show the possibility of localizing a source at large distance with great accuracy.

2:00

3UW5. Array processing with acoustic measurements at a single point in the ocean. G. L. D'Spain and W. S. Hodgkiss (Marine Phys. Lab., Scripps Inst. of Oceanogr., San Diego, CA 92152-6400)

In order to obtain information on the spatial dependence of the underwater acoustic pressure field, the traditional approach has been to deploy a spatially distributed set of hydrophones. However, by use of a Taylor series expansion, the spatial dependence of the sound field can also be obtained from measurements at a single point in space. The purpose of this presentation is to discuss the adaptation of high-resolution array processing algorithms to such single-point measurements. Simulation results will be presented to illustrate the application of Capon's minimum variance method, the linear prediction method, and the multiple signal classification scheme to measurements in a Taylor series expansion to first order and in an expansion to second order of the pressure field. In addition, a comparison will be made of the high-resolution methods to standard processing (equivalent to the Bartlett method) using actual ocean acoustic data from geophones and hydrophones. Extensions of these techniques to data collected by a receiving system that combines the use of spatially distributed elements with the Taylor series expansion approach will be discussed. [Work supported by ONR and ONT.]

2:15

3UW6. Matched-field inversion of geoacoustic parameters of elastic bottoms. John W. Wolf and Orest I. Diachok (Naval Res. Lab., Washington, DC 20375)

The potential of matched-field inversion of ocean bottom parameters is demonstrated through simulation of signals transmitted by one ship and received on a 1.5-km-long horizontal ship-towed array in end-fire mode. The simulations use an ocean model that is representative of a thinly sedimented (36-m) basalt bottom. The output of a matched-field processor (Capon correlator) at a known source position is maximized by searching through bottom parameter differences from a geoacoustic profile. In particular, the shear velocities, C_s, in a model of the upper crust and an overlying thin sediment layer are varied about the true values. Relatively small differences (15% of true) in basement shear velocity produce a 4-dB degradation in processor output. Shear speed mismatch in the sediment produces thin film effects that appear in the processor output function as resonance peaks at several values of ΔC_s. The values of ΔC_s for most peaks vary strongly with source frequency except the peak at $\Delta C_s = 0$. The results illustrate the potential of broadband matched-field processing to invert elastic bottom parameters, particularly shear speeds in thin sediments and upper crust, which to date have generally proven inaccessible with existing methods.

2:30

3UW7. Matched-field inversion of geoacoustic model parameters using unguided simulated annealing. Colin Lindsay and N. R. Chapman (Defence Res. Establishment Pacific, FMO Victoria, BC V0S 1B0, Canada)

A method has been developed for the estimation of geoacoustic model parameters by inversion of acoustic field data using a nonlinear optimization procedure based on simulated annealing. The cost function used by the algorithm is the Bartlett matched-field processor which relates the measured acoustic field with replica fields calculated by the SAFARI program. Model parameters are perturbed randomly over a specified range, and the algorithm searches the multidimensional parameter space of ocean bottom models to determine the parameter set corresponding to the best replica field. Convergence is driven by adaptively restricting the search space to regions with above-average values of the matched-field correlation. This approach removes the need for a predetermined annealing schedule. The performance of the method is demonstrated for a vertical line array in a shallow-water environment where the bottom consists of homogeneous elastic solid layers. Simulated data were used to study the effects of noise contamination, undersampling of the pressure field and uncertainty of the experimental geometry on parameter estimation. Results are presented for the inversion of data obtained in an experiment off the West Coast of Vancouver Island.