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BROADBAND MATCHED-FIELD LOCALIZATION PERFORMANCE IN UNCERTAIN ENVIRONMENTS USING A SHORT ARRAY*

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Typical applications of matched-field localization use low frequency signals received on large aperture vertical-arrays. However, small aperture arrays are much more practical for real-world systems and must be considered. Additionally, any practical localization algorithm must also be robust to environmental mismatch. In this paper, we present the broadband L_∞-norm estimator for robust matched-field localization of mid-frequency signals (e.g., 800–4000 Hz) received on very short aperture vertical-arrays. Realistic simulation results are presented using broadband signals in the band of 1000–3000 Hz received on a 3 m vertical array which demonstrate the substantial performance gains in using the L_∞-norm estimator over the asymptotically-optimal maximum *a posteriori* estimator and the conventional Bartlett processor. Experimental data results in an uncertain shallow-water environment using a 2.13 m vertical array in the band of 3000–4000 Hz are also presented.

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A FREQUENCY DOMAIN INVERSION METHOD APPLIED TO OBLIQUE REFLECTED SIGNALS FROM A WATER–SEDIMENT INTERFACE*

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Due to the complexity of the seafloor as an acoustical system, it is very important to validate wave propagation models and test inversion methods first in the laboratory. A known sediment is placed in a water-filled tank, in such a way that a smooth water–sediment interface is obtained with minimal air bubbles retained in the sediment. Two broadband piston transducers are used to carry out reflection experiments at oblique incidence. The placement of the emitter and receiver is symmetrical with respect to a vertical plane perpendicular to the sediment surface. The aim of this work is to find physical parameters of the sediment from the reflected signals. A general viscoelastic model that considers losses due to absorption and dispersion along the propagation of the wave through the sediments is proposed. A rational transfer function is used to model the viscoelastic modulus of the bulk sediments and a comparison with constant Q viscoelastic modelling is performed. The estimation of the model parameters is elaborated using a Maximum Likelihood Estimator in the frequency domain.

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APPLICATION OF A THREE-DIMENSIONAL TWO-WAY PARABOLIC EQUATION MODEL FOR RECONSTRUCTING IMAGES OF UNDERWATER TARGETS*

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A three-dimensional, two-way parabolic equation model developed for solving three-dimensional backscattering problems in previous work is applied incorporating a focus-marching procedure to study the image reconstructions for underwater targets. Intensive numerical simulations are performed in this paper. Targets in the water are formed by objects with simple shapes. The "experimental data" of the return signals from targets are simulated by the backscattered sound calculated at a short distance from the source. These simulated return signals are processed by reversing their phases, and numerically propagated back to the place of the targets. It is due to the conjugating process that the target image may be reconstructed with less deformation at a distance near the target surface. This realistic study demonstrates an encouraging technique that may be utilized for studying underwater target imaging in many sonar applications.

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DETERMINATION OF A BURIED OBJECT IN A TWO-LAYERED SHALLOW OCEAN*,†

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In this paper, a method for solving the unknown object problem is presented for a two-dimensional object buried in a fluid seabed lying over a rigid basement. The algorithm makes use of a regularized Born approximation. Several examples are provided which demonstrate the utility of the algorithm.

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NEW SCHEMES OF OCEAN ACOUSTIC TOMOGRAPHY*

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Ocean acoustic tomography based on modal horizontal refraction/phase difference measurement has been developed in recent years. In this paper, potential opportunities for remotely sensing various interesting ocean dynamic structures by using the modal-horizontal-refraction tomography and modal-phase tomography are discussed, including: (1) retrieval of the 3-D structure of a mesoscale eddy, (2) monitoring of the transverse component of the current, (3) retrieval of ocean frontal parameters, and (4) acoustically diagnosing internal solitary waves (ISW) in the coastal zone.

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NUMERICAL SIMULATION OF TRANSVERSE CURRENT MONITORING IN THE FRAM STRAIT*

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The horizontal refraction method (HRM) of transverse current acoustics monitoring in the Fram Strait environment is modeled numerically. The current profile was constructed on the basis of experimental data on the West Spitsbergen Current (WSC) structure and the complex environment of the region presented by the sound speed profiles, which were derived from the experiments. The HRM is based on the measurements of the deflection of the horizontal modal rays due to the gradient of the refraction index produced by the transverse current. The signals received by the antennas in a receiving plane perpendicular to the propagation axis have a modal phase difference in proportion to the average transverse velocity, which is due to the different orientation of the acoustical path of the current. The interesting result is that even in a strong mode coupling environment the numerically obtained phase difference is quite close to its value as calculated by adiabatic approximation. The physical reason behind this is most likely that the mode coupling impact can be canceled at the sound signal propagation along the two very close paths.

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PROSPECTS FOR MEDIUM-SCALE DIFFRACTION TOMOGRAPHY ON THE SHELF*

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Acoustical tomographical reconstruction of the location and sizes of spatially localized, random perturbation in a shallow-water oceanic waveguides is developed for mid-range distances. As examples of such perturbations, clouds of bubbles arising due to breaking wind waves and shoals of fishes are discussed. The ray approximation is used for the acoustical field description. The oceanic environment is presented as a medium with a background of uniformly distributed volume and surface random inhomogeneous fluctuations. Complex acoustical repetitive pulses are used as the probing signal. The receiving system consists of an array of spatially distributed hydrophones. The signals received from all hydrophones are processed on the basis of a tomographic algorithm including matched-filter processing in the spatial and frequency domains for reconstruction of the random time-delay statistical moments (average value and dispersion), which are descriptors of the observed random spatially localized inhomogeneity. As a specific model of random perturbation, a three-dimensional Gaussian cloud of fluctuations associated with parameters of a fish shoal is investigated. A vertically distributed array of receivers and a directed source of LFM-pulses are tested as the prototype of the tomographical system in a shallow waveguide with typical hydrology. Computer simulations of the tomographical reconstructions are conducted taking into account investigation of the influence of the level of additive noise on the accuracy of the reconstructed parameters.

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