Multiple Scattering And Volume-Roughness Interactions In Sea Bed Acoustics

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LONG-TERM GOAL

The objective of this research is to improve understanding of bottom acoustic scattering at mid- and high-frequencies and to improve conventional algorithms for remote acoustic characterization of marine sediments.

OBJECTIVES

The primary scientific objective is to develop improved theoretical models for seabed scattering using approximations having a wider range of applicability than those presently available.

APPROACH

The seabed is treated as a multi-layered fluid medium with rough interfaces and volume inhomogeneities covering a rough inhomogeneous elastic halfspace (basement). This makes it possible to unify scattering models for a wide frequency range and for different seabed types. A general description of the scattered field is given in terms of the plane wave scattering amplitude and is based on a unified perturbation approach to volume and roughness scattering [1]. This approach can permit in principle the consideration of multiple scattering in the complex seabed medium with strong volume and roughness irregularities which in general can be correlated. As a first step, the approach gives the first-order perturbation solution in a unified form more convenient for describing both volume and roughness components of scattering. This provides direct relationships between characteristics of the scattered field and parameters of the seafloor. Average seabed parameters can be arbitrary functions of depth, and statistical properties of the seabed are described by power-law spectra of seabed roughness and the sediment volume inhomogeneity in forms consistent with available data.

WORK COMPLETED

A first-order model of seabed scattering has been developed in detail based on realistic assumptions about sediment properties, including roughness and inhomogeneity, vertical stratification (gradients and/or layering), and ability to support both compressional and shear waves [1-3]. Corresponding codes have been developed and numerical examples for various seabed types and particular models of scattering have been presented and analyzed in recent publications [4-9].

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RESULTS

The model and codes developed have made it possible to analyze the sensitivity of measurable scattering characteristics (e.g., the scattering strength and its angular-frequency dependencies) with respect to various seabed parameters and determine those parameters that can be considered as classification clues for remote acoustic characterization of marine sediments. Continued model-data comparisons using data from the CBBL experiment at Key West have confirmed the earlier conclusion that gradient effects are not responsible for slight oscillations observed in the bistatic scattering strength angular dependence. Examples of strong gradient effects on seabed volume and roughness scattering are given, e.g., in [7].

IMPACT/APPLICATION

The models of seabed scattering developed in this research will provide a better understanding of bottom acoustic interaction at mid- and high-frequencies and can be used as a basis for improved algorithms for remote acoustic inversions for seafloor properties.

TRANSITIONS

The results of this work are being adapted in practical models for seabed scattering. For example, a high-frequency bistatic scattering model funded by the ONR Torpedo Environments Program (6.2) incorporates the elastic scattering model developed as part of this work.

RELATED PROJECTS

This research is conducted jointly with the separately funded work of D.R. Jackson and comparisons with CBBL data have been carried out in collaboration with Kevin Williams. The approaches and models developed in this research are relevant to acoustic penetration and multiple scattering issues arising within the ONR Departmental Research Initiative on high-frequency sound interaction with the seafloor.

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