

STUDY OF OCEAN BOTTOM INTERACTIONS WITH ACOUSTIC WAVES BY A NEW ELASTIC WAVE PROPAGATION ALGORITHM AND AN ENERGY FLOW ANALYSIS TECHNIQUE

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Propagation (theory, modeling and computation)

LONG-TERM GOALS

Develop a new method and the code to simulate 3D acoustic/elastic wave propagation and interaction with the ocean water and ocean bottom environment. The method will be applied to numerical simulations to study the wave/sea-bottom interaction, energy partitioning, scattering mechanism and other problems that are crucial for many ocean bottom-surveying techniques. Our understanding on shallow water acoustic wave propagation and its interaction with sediments can be improved.

SCIENTIFIC OBJECTIVES

Improve and develop the ECS (Elastic Complex-Screen), a new one-way elastic wave propagation method, and apply it to the ocean bottom environment to study the elasto-acoustic wave propagation in complex laterally heterogeneous media, including rough surface and random volume heterogeneity.

APPROACH

The basic approach is connecting the acoustic phase screen algorithm and elastic complex screen algorithm with a boundary condition, which may permit certain types of roughness. With this method, the acoustic signal can propagate all the way through seawater and solid bottom. Reflections from both water and sub-bottom structures can also be calculated and propagated upward to the surface. A free surface condition can be added at either the source side or receiver side.

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WORK COMPLETED

In the year of 1997, we further tested the elastic one-way code for 3D heterogeneous model. The results have been compared with 3D finite-difference results generated on a parallel computer. Based on the plane wave decomposition, we also developed a free surface and source condition for elastic one-way wave equation method. We finished the code. The boundary condition has been connected to the existed one-way elastic code. Numerical examples have been tested and checked.

RESULTS

Unlike the full wave method, the one-way method is usually derived for a source free situation. With our boundary condition and source term combined, the elastic complex screen one-return algorithm can handle forward propagation and primary reflection, as well as buried source and free surface related wave phenomena.

IMPACT/APPLICATION

The phase screen method and elastic complex screen method are highly efficient methods for calculating wave propagation and reflection in sea water and sea bottom environments. The newly developed boundary condition and source term can be applied at either the source side or the receiver side. With this boundary condition, many of the free surface effects, e.g., reflected P and S-waves, secondary surface waves, etc., can be generated. Since this method is based on the plane wave decomposition, it is especially useful for one-way methods based on the wavenumber domain Fourier transforms.

TRANSITIONS

None

RELATED PROJECTS

The ONR supported project is part of researches conducted under a general title of Modeling and Imaging Project (MIP) at University of California, Santa Cruz. The MIP is co-sponsored by AFOSR, DOE, DOD, ONR, GRI, NSF and some industrial companies. The MIP is aiming at developing new theories, methods and algorithms for modeling and imaging in 3D complex environments. This project emphasizes on the fast one-way propagation methods, and also searches for the application of newly developed technologies, such as the wavelet transform, in the wave propagation theory.

REFERENCES

Web page for MIP (Modeling and Imaging Project) at UCSC
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