Session 3aUW

Underwater Acoustics: Modeling

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Chair's Introduction—7:55

Contributed Papers

8:00

3aUW1. On the use of the sonar equation approximation when computing the response of a target in shallow water. Angie Sarkissian and Louis R. Dragonette (Naval Res. Lab., Washington, DC 20375-5350, angie@aqua.nrl.navy.mil)

The sonar equation may be used to compute the scattering response of a target in shallow water by approximating the target to be a point scatterer. The approximation significantly simplifies the interaction of the scatterer with the medium. In the more general case, since the field produced by a source arrives at the scatterer through multipaths, it is incident on the target at various directions. The response of the scatterer must be computed at all of the incident angles to obtain the correct scattered field in shallow water. Scattering results computed using the sonar equation are compared to the more correct solution for a ribbed cylindrical shell placed in shallow water for various monostatic and bistatic geometries to examine the validity of the use of the sonar equation at various frequencies and geometries. [Work supported by ONR.]

8:15

3aUW2. Sonar performance in turbid and bubbly environments. Simon D. Richards (Underwater Sensors & Oceanogr. Dept., Defence Evaluation and Res. Agency, DERA Winfrith, Dorchester, Dorset DT2 8XJ, UK) and Timothy G. Leighton (Univ. of Southampton Highfield, Southampton SO17 1BJ, UK)

The presence of both solid particles and gas bubbles in coastal waters may have a significant effect on sound propagation, particularly at high frequencies, and may therefore be partially responsible for the observed variability in high-frequency sonar performance in shallow waters. Suspended particles increase volume attenuation through the processes of thermo-viscous absorption and scattering. Microbubbles also attenuate sound through viscous and thermal dissipation and scattering. The presence of microbubbles in the water column may also modify the sound speed and result in a dispersive medium. The effects of dilute suspensions of solid particles on the sound speed may generally be neglected for practical sonar applications. Algorithms for estimating the acoustic absorption coefficient and the speed of sound in water containing suspensions of fine mineral particles and populations of microbubbles have been developed. These have been incorporated into a sonar performance prediction model based on the ray method. Results are presented from this model which show that, for populations of suspended mineral particles and microbubbles which are commonly encountered in shallow-water environments, the predicted sonar performance is significantly different from that predicted when the additional effects are not taken into account. [© British Crown copyright 2000/DERA. Published with the permission of the Defence Evaluation & Research Agency on behalf of HMSO.]

8:30

3aUW3. High-frequency propagation modeling with the parabolic equation. David M. Fromm, Michael D. Collins (Naval Res. Lab., Washington, DC 20375), and Guy V. Norton (Stennis Space Center, MS 39529)

It is generally believed that the parabolic equation method rapidly becomes impractical above a few hundred Hertz for ocean acoustics problems. Results will be presented to illustrate that the split-step Padé algorithm [J. Acoust. Soc. Am. **100**, 178–182 (1996)] is practical out to ranges of tens of kilometers for frequencies up to at least on the order of 10 kHz. The presentation will include a discussion of modifications to the parabolic equation model to handle effects that are usually neglected at lower frequencies, such as rough surfaces, internal waves, and volume attenuation in the water column. The examples will involve propagation in surface ducts and interaction with the seafloor. [Work supported by the Office of Naval Research.]

8:45

3aUW4. A wide-angle parabolic equation for advected acoustic waves. Joseph F. Lingevitch, Michael D. Collins, Dalcio K. Dacol (Naval Res. Lab., Washington, DC 20375), Joel C. W. Rogers (Polytechnic Univ., Brooklyn, NY 11201), and William L. Siegmann (Rensselaer Polytechnic Inst., Troy, NY 12180)

Parabolic equations are derived by factoring operators in elliptic equations. For acoustics problems involving an ambient flow, the elliptic equation contains two depth operators that do not commute with each other. Due to this difficulty in factoring the operator, the parabolic equations that have been derived for this problem are limited to small grazing angles (i.e., energy that propagates nearly horizontally). A wide-angle parabolic equation for advected waves will be described and examples will be presented to demonstrate its accuracy. As in previous investigations of this problem, the Mach number is assumed to be small. The derivation is based on the introduction of a new dependent variable that is related to the acoustic pressure by an amplitude operator that can be implemented using either of two approximations. A zeroth-order approximation (in Mach number) is useful in some cases since the error is local in range. Greater accuracy can be achieved using a first-order approximation, which can be expressed in terms of the derivative of an operator with respect to a parameter and implemented using a difference formula. [Work supported by the Office of Naval Research.]

9:00

3aUW5. A new stable formulation of an elastic parabolic equation. Wayne Jerzak, William L. Siegmann (Rensselaer Polytechnic Inst., Troy, NY 12180-3590), Michael D. Collins, and Joseph F. Lingevitch (Naval Res. Lab., Washington, DC 30375-5330)

The parabolic equation method can be used to model acoustic-wave propagation in elastic media. Current implementations do not accurately match the shear stress between two elastic layers, for which the expression involves a second-order depth derivative. This inaccuracy could be large