ACOUSTICS2008/1603
Acoustic propagation modeling in the presence of environmental uncertainty

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Due to incomplete knowledge of ocean environments, this research incorporates environmental uncertainty into an acoustic model representing wave propagation in order to quantitatively represent the uncertainty of the acoustic field. The waveguide considered here has a spatially varying, uncertain sound speed distribution with a known correlation length. Karhunen-Loeve and polynomial chaos expansions are used to represent the uncertainty in the environment and acoustic field, respectively, in a narrow- angle parabolic wave equation. In this two-dimensional model, the water depth is 150 m and propagation is over a range of 20 km. The environmental uncertainty term in the wave equation is assumed to vary randomly in the range direction, and is characterized by an exponentially decaying correlation function. An implicit finite difference scheme is used to solve a set of coupled differential equations for the stochastic envelope function at different source frequencies in the range of a few hundred Hz. The simulated results will include probability density functions at selected spatial locations in the waveguide, first and second moments of the field, and these results will be compared with those obtained independently from Monte Carlo samplings from the same ocean environment.
Work supported by ONR.