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The PI is part of an interdisciplinary team, led by Allan Robinson and Phil Abbot, with expertise from the scientific to the Navy fleet application communities. The overall goals of this research were to define and characterize the variabilities and uncertainties in the components and linkages of the general physical-geo-acoustical system relevant to the support of naval operations, and transfer quantitatively the spatial-temporal environmental variabilities and uncertainties through the system, including coupled interactions, in order to determine uncertainty measures, sensitivities and feedbacks critical for operational predictions and parameters. The specific goal of this part of the project is to develop probabilistic models of transfer of uncertainties in the end-to-end system.

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Uncertainties and Interdisciplinary Transfers through the End-to-End System (UNITES)

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Final Technical Report

The PI is part of an interdisciplinary team, led by Allan Robinson and Phil Abbot, with expertise from the scientific to the Navy fleet application communities. The overall goals of this research were to define and characterize the variabilities and uncertainties in the components and linkages of the general physical-geo-acoustical system relevant to the support of naval operations, and transfer quantitatively the spatial-temporal environmental variabilities and uncertainties through the system, including coupled interactions, in order to determine uncertainty measures, sensitivities and feedbacks critical for operational predictions and parameters. The specific goal of this part of the project is to develop probabilistic models of transfer of uncertainties in the end-to-end system.

The objective of this phase of the project was to characterize the transfer of uncertainties from the acoustic environment to the sonar and its signal processing in probabilistic terms. This involved construction, calibration and evaluation of uncertainty and variability models for the system and its components and developing generic methods for efficiently and simply characterizing, parameterizing, and prioritizing variabilities in the end-to-end system (ETES) and uncertainties arising from regional scales and processes.

We applied a model ETES of modular design to investigate the combined effect of mesoscale structure and short-wavelength internal waves on acoustic transmission loss at low to moderate frequencies in the coastal environment. As a first guess, we view the internal wave field as being superimposed on the mesoscale field. Since these two fields can be expected to interact physically as well as acoustically, a proper simulation would account for exchange of energy, momentum and heat between the mesoscale field and the small-scale internal wave field. The modular design of our prototype ETES system allows us to make incremental but steady progress by increasing the complexity and level of detail represented in each component of the model.

The first version of our model ETES was implemented with the University of Miami Parabolic Equation Model (UMPE) to calculate transmission loss in the littoral environment, realizations of a random field of internal waves with the Garrett-Munk spectrum, and a variety of different realizations of the mesoscale field, the most advanced of which is the output of the Harvard Ocean Prediction System (HOPS).

In our study of uncertainty due to a random internal wave field, we found that some very small-scale features show differences of the order of 10db between the perturbed and unperturbed cases. The effect of the perturbation on the ray structure is particularly evident in shorter wavelength cases. The differences in the range-averaged transmission losses are smaller, typically a few db at 25Hz, but fields obtained by slightly different methods of range averaging can also differ by a few db.