MSEAS Seminar Series

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Ocean Acoustic Applications of an Autonomous Underwater Vehicle at the New England Shelfbreak

Abstract: Oceanography is an inherently interdisciplinary field, with many interconnected processes of varying spatiotemporal scales contributing to a dynamic ocean environment. Underwater acoustics is a valuable tool for studying these oceanographic processes, as environmental variability greatly influences acoustic propagation and scattering. The work in this dissertation follows an interdisciplinary approach to explore the multifaceted connections between acoustics and different branches of oceanography. An autonomous underwater vehicle (AUV) was used to study physical, biological, and geological oceanography and their joint acoustic effects as part of the New England Shelf Break Acoustics (NESBA) experiment. The AUV, a modified REMUS 600 equipped with an onboard 2.5-4.5 kHz transducer and towed hydrophone array, was deployed among a network of oceanographic and transceiver moorings. Acoustic signals transmitted and received throughout this network were used to analyze the physical links between environmental variability and acoustic propagation and scattering effects. These contributions further highlight the versatile role of AUVs in advancing ocean acoustic research. In this work, the AUV was first localized using an acoustics-based multi-channel backpropagation approach, as accurate localization of the vehicle is crucial for contextualizing the AUV data. This process involved back-propagating acoustic wavefronts between the AUV source and mooring hydrophones, as well as signals transmitted from a ship-towed source to the AUV array. Analyses on physical oceanographic uncertainty and mooring tilt were performed to further improve the localization result and understand the influence of environmental uncertainty. Next, the same AUV acoustic dataset was used to explore mid-frequency 3D bathymetric reflection and scattering at a submarine landslide. Computational acoustic modeling, including ray tracing and parabolic equation models, were used to recreate the complex seafloor-interacting acoustic arrival patterns observed in the data, with the final data-model comparison showing evidence of 3D out-of-plane acoustic reflection and scattering. Finally, mid-frequency biological attenuation of a mesopelagic deep scattering layer (DSL) was investigated. A swimbladdered-fish scattering model was used to estimate DSL biological attenuation, which was then applied to a comparison of two acoustic propagation paths traveling through and avoiding the layer, respectively. The final results emphasize the joint influence of biological scattering and physical oceanographic uncertainty on sound propagation.

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