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IN THE SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY AT THE UNIVERSITY OF HAWAI'I AT MĀNOA

An Acoustic Ray Tracing Optimization Approach for Tomographic Assimilation

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Abstract

Acoustic ray tracing is used in oceanographic tomographic assimilation, where the goal is to infer ocean states using acoustic travel times. Acoustic ray paths are highly sensitive to fluctuations in ocean conditions, which are dynamic and challenging to predict. Achieving more accurate assimilation of experimental data into models requires iterative recalculation of ray paths to ensure modeled and observed travel times have minimal discrepancies. To accelerate the convergence of ocean state at the time of source transmission we developed a neural network that learns the mapping between perturbations in soundspeed and ray paths. A decomposition precursor was introduced to reduce the dimensionality of the training set, focusing solely on the aspects of the sound speed profile and ray paths that vary between transmissions. Sound speed profiles were decomposed as empirical orthogonal functions and principal components were used for training. The proposed neural network focuses on the variabilities in soundspeed profiles and ray paths so that a predicted decomposed ray can be obtained for small changes in the ocean state. The 2010–11 North Pacific Acoustic Laboratory (NPAL) Philippine Sea experiment dataset was used in this study to develop and validate the neural network [work funded by the Office of Naval Research].