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Bayesian geoacoustic inversion for SBCEX17 reflection, dispersion, and ship-noise data

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ABSTRACT

This paper considers a Bayesian inference approach to model selection, parameter estimation, and uncertainty quantification in seabed geoacoustic inversion, with application to three ocean acoustic data sets of different types collected as part of the 2017 Seabed Characterization Experiment (SBCEX17). The inversion approach is based on trans-dimensional (trans-D) sampling, which considers the number of seabed layers as an unknown parameter in the inversion. Trans-D sampling is carried out with the reversible jump Markov chain Monte Carlo algorithm, which constructs a Markov chain that samples from the posterior probability density (PPD) of the geoacoustic model parameters. Wide but efficient sampling of the trans-D parameter space is achieved using principal-component reparameterization and parallel tempering. The data-error model is based on the assumption of multivariate Gaussian errors with correlations represented by an autoregressive process—trans-D sampling of zeroth- and first-order autoregressive processes is applied to avoid over- or under-parameterizing the error model. The Bayesian inference approach is applied to three acoustic data sets from the New England Mud Patch during SBCEX17, including wide-angle (spherical-wave) reflection coefficients collected using a moored receiver and towed source; dispersion of water-borne acoustic modes using a single source and receiver, resolved by warping analysis; and matched-field inversion of ship-of-opportunity noise recorded at a bottom-mounted horizontal receiver array. Inversion results are presented in terms of marginal posterior probability profiles of sediment geoacoustic parameters (sound speed, density, attenuation), quantifying parameter uncertainties. Results for inversions of different data types are found to be in good agreement with each other, and with other independent measures of sediment properties, including cores and a high-resolution seismic survey. In all cases, the inversion results indicate geoacoustic properties that are approximately constant with depth over an upper mud layer, with a strong (positive) sound-speed gradient at the base of this layer, consistent with increasing sand content. Below this are higher-speed, higher-density layers, consistent with sand. Full results are presented in (1-3).

Keywords: Geoacoustic inversion, Bayesian inference, Sediment acoustics

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REFERENCES

1. Belcourt J, Holland CW, Dosso SE, Dettmer J. Goff J. Depth-dependent geoacoustic inferences with dispersion at the New England Mud Patch via reflection coefficient inversion. IEEE J Oceanic Eng. 2019:1-23.
2. Bonnel J, Dosso SE, Eleftherakis D, Chapman NR. Trans-dimensional inversion of modal dispersion data on the New England Mud Patch. IEEE J Oceanic Eng. 2019:1-15.
3. Tollefsen D, Dosso SE, Knobles DP. Ship-of-opportunity noise inversions for geoacoustic profiles of a layered mud-sand seabed. IEEE J Oceanic Eng. 2019:1-12.