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# Bayesian tracking and geoacoustic inversion

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This paper describes a Bayesian approach to two related inverse problems in underwater acoustics: localizing/tracking an acoustic source when ocean environmental properties are unknown, and determining environmental properties using acoustic data from an unknown (moving) source. The goal of this work is not simply to estimate values for source and/or environmental parameters, but to determine parameter uncertainty distributions, thereby quantifying the state of knowledge and information content of the inversion. A common formulation is applied for both problems in which source parameters (location and spectrum) and environmental parameters are considered unknown random variables constrained by noisy acoustic data and by prior information on parameter values (e.g., physical limits for environmental properties) and on inter-parameter relationships (limits on horizontal and vertical source speed). Given the strong nonlinearity of the inverse problem, marginal posterior probability densities are computed numerically using efficient Markov-chain Monte Carlo importance sampling methods. Source tracking results are represented by joint marginal probability distributions over range and depth, integrated over unknown environmental parameters. The approach is illustrated with two examples representing tracking a quiet submerged source and geoacoustic inversion using noise from an unknown ship-of-opportunity. In both cases, source, seabed, and water-column parameters are unknown.