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Bayesian model parameterization selection for seabed reflection-coefficient inversion

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This paper considers Bayesian inversion of seabed reflection-coefficient data for multi-layer geoacoustic models; in particular, the important issue of determining appropriate model parameterizations (e.g., number of layers, sound speed and density variations within layers). A poor model parameterization can lead to unreasonable inversion results. In particular, under-parameterization can introduce theory error in the inversion, causing biased results. However, more complex models always fit the data better. Therefore, parameterization quality cannot be quantified only in terms of data misfit, and Occam's razor is commonly applied to prefer simple parameterizations. In a Bayesian framework, Occam's razor is inherently included through Bayesian evidence. Bayesian inversion can be associated with two levels of inference. The first level assumes a specific model parameterization, and quantifies the data information content. This paper focuses on the second level: using Bayesian evidence to compare different model parameterizations. To this end, Gibbs sampling is applied, including full error covariance estimation, to sample the posterior probability density (PPD) for various parameterizations. Bayesian evidence is then computed from the PPD samples by numerical integration (reverse importance sampling).