Information geometric approaches to finding reduced-parameter models for geoacoustic inversion

Jay C. Spendlove
Department of Physics and Astronomy, Brigham Young University, Provo, Utah, 84602, United States
jayclark24@gmail.com

Mark K. Transtrum
Department of Physics and Astronomy, Brigham Young University, Provo, Utah, 84602, United States
mktranstrum@byu.edu

Tracianne B. Neilsen*
Department of Physics and Astronomy, Brigham Young University, Provo, Utah, 84602, United States
tbn@byu.edu

Sound propagation in the ocean depends on environmental parameters such as temperature, salinity, and ocean floor composition. Ocean floor composition is especially relevant for sound propagation in shallow ocean environments. Given a seafloor configuration, sound propagation models like the ORCA model can predict transmission loss (TL). Geoacoustic inversion, that is, using TL to infer ocean floor properties, is also of great interest. However, geoacoustic inversions are ill-posed because many different environmental parameters can be statistically consistent with the data, including potentially non-physical parameters. In other words, the ocean acoustic data does not fully constrain the model parameters. Finding reduced-parameter models that are constrained by data enables meaningful geoacoustic inversion. Information geometry tools enable us to construct reduced-parameter models that match the information contained in data. The basic approach centers around a geometric representation of the model output, known as the model manifold. The model manifold is thin in the directions corresponding to the unidentifiable parameters (or parameter combinations). The manifold boundary approximation method removes the unidentifiable parameters by projecting onto the manifold boundary. We demonstrate this approach using the Pekeris model and show that its boundary is the so-called "hard bottom" model, a horizontally stratified ocean over a rigid bottom. We discuss potential applications and further research directions utilizing information geometric tools in underwater acoustics. [Work supported by the Office of Naval Research.]

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