Transmission Traveltime Tomography Based on Paraxial Liouville Equations and Level Set Formulations

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Abstract

We propose a new formulation for traveltime tomography based on paraxial Liouville equations and level set formulations. This new formulation allows us to account for multivalued traveltimes and multipathing systematically in the tomography problem. To obtain efficient implementations, we use the adjoint state technique and the method of gradient descent. Starting from some initial guess, we minimize a nonlinear energy functional by a Newton-type method. The required gradient is computed by solving one forward and one adjoint problem of paraxial Liouville equations. Then the velocity model is updated iteratively by solving a Helmholtz equation with the computed gradient as the right-hand side. Numerical examples with and without added noise demonstrate that the new formulation is effective and accurate. To our knowledge this is the first Eulerian approach to taking into account all arrivals systematically in traveltime tomography.

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