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Identifying adverse effects of wrong sensitivity kernels in tomographic inversion

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In seismic traveltime tomography, like in several other linear and linearized geoproblems, the inverse operator is derived from a linear forward mapping which often is deliberately approximated for simplicity or for computational efficiency. It is still state of the art to base applied seismic tomography on *ray curve integrals* of slowness anomaly, yet it is well known that the actual traveltime sensitivity is distributed in a more or less tube-like shape along the mathematical ray. *Does this approximation matter in practice?*

A deeper understanding of this problem is possible through analysis of *the "distortion spectrum"*, which is computed by singular value decomposition of a matrix expression derived from a combination of both the (near) exact forward mapping and the employed approximate mapping as well as optional covariance matrices of noise and model variations.

This presentation demonstrates that *the effect of the ray approximation* on the inverse estimates in seismic tomography *may range from harmless* perturbations *to more adverse distortions* of the model estimates depending not only on the measurement geometry and the average sound velocity distribution (i.e. the ray distribution), but also on the structure of the velocity anomalies.

Such distortion analysis is relevant both for the general understanding of generic problems and as a routine-companion to each specific ray-tomographic modeling.