Tomography Model Using Singular Value Decomposition

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We apply a singular value decomposition (SVD) solution for the inverse problem in tomography and compares model results with a least-squares (LSQR) method which uses first difference radial and lateral smoothing parameters for regularization. Taking advantage of the increased computing power and efficient algorithms, we are now able to introduce the SVD method to solve a non-sparse matrix inversion like three-dimensional global mantle tomography. This study finds the k value for truncated SVD can serve as a unique regularization parameter and produce models with similar spectral power to the LSQR solutions.

We examine the SVD method using the same dataset as the tomographic model HSML06: long-period travel time residuals downloaded from the Incorporated Research Institutions for Seismology Data Management Center from 1976 to 2005. When employing a least-squares inversion, changing the smoothing parameters requires an entire re-calculation of inversion. However, the SVD solution provides a less computationally expensive way to regularize tomographic models by increasing or decreasing the number of singular values that contribute to the solution. Structures of small scale and fluctuations of short wavelength contribute smaller singular values and correspond to the later part of the singular matrix according to its descending property. We evaluate the SVD tomographic models to determine the necessary contribution of the smaller singular values to retain seismic structure resolved using the least-squares technique. The SVD solutions are desirable since they require negligible computation time and the resulting resolution operator provides a quantitative means for comparing tomography with geodynamics models.

Keywords: SVD, Tomography, Inverse Problem

