Travel time tomography of the western US upper mantle – A Bayesian approach

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Tomographic inversion using full 3D finite-frequency sensitivity kernels and least-square formulation for the parameter estimation of the Earth have been a great success in recent years. The large amount of travel time data provided by the dense seismic station network USArray has resulted in extensive studies of the structure of the western US upper mantle. (see Sigloch, McQuarrie and Nolet, 2008, *Nature Geoscience*; Tian, Sigloch, and Nolet, 2009, *GJI*, **178(3)**:1384-1402). However, uncertainty of the optimization solutions has not been well quantified. Using classical Markov chain Monte Carlo sampling methods such as Metropolis Hastings and Gibbs samplers we estimate the P-wave velocity based on 3D finite-frequency sensitivity kernels on irregular grids generated for the western US upper mantle. A non-intrinsic prior for the neighborhood information of the gird points is applied. (see Pettitt, Weir and Hart, 2002, *Statistics and Computing*, **12**:353-367; Rue and Held, 2005) With efficient algorithms we provide a way to sample the posterior distributions for large-scale linear inverse problems, i.e. over 11000 parameters and hence allow for a precise uncertainty quantification in terms of parameter distributions and credible intervals given the data for the western US upper mantle structure.

Keywords: Travel time tomography; Bayesian linear model; Markov chain Monte carlo; spatial prior.