Geophysical Research Abstracts,
Vol. 10, EGU2008-A-03676, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-03676
EGU General Assembly 2008

Simple kernels for long wavelength body wave tomography

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Probabilistic tomography provides a framework for the quantitative assessment of uncertainties of long wavelength tomographic model. It is based on a full model space search, the neighborhood algorithm (Sambridge et al., 1999), and allows to invert seismic observables for probability density functions (Trampert et al, 2004). So far this technique has been used to invert maps of surface wave phase velocities and normal mode splitting functions. Also including body waves will increase the depth resolution in the lowermost mantle. Because a full model space search limits the number of free parameters, this requires to find a formalism which allows an efficient parallelization of body wave travel-times, similar to phase velocity maps and normal mode splitting functions.

In a laterally homogeneous and radially layered Earth the body wave travel-time kernel depends on depth only and has a maximum near the turning point. We investigated numerically how far such a simple kernel can predict travel-time perturbations in a laterally varying Earth. Using S20RTS (Ritsema et al., 1999), we calculated travel-time perturbations using simplified kernels, ray theoretical kernels and banana-doughnut kernels (Dahlen et al., 2000; Tian et al., 2007a and 2007b). We will show for which phases, which distances and which wavelength of heterogeneity the simplified kernels are valid.

In the context of probabilistic tomography it is then possible to build travel-time residual maps as a function of ray parameter comparable to phase velocity maps as function of frequency and invert those locally as a function of depth.