Geophysical Research Abstracts
Vol. 14, EGU2012-5551, 2012
EGU General Assembly 2012

Inversion with a sparsity constraint: Application to mantle tomography

J. Charléty (1), G. Nolet (1), S. Voronin (2), I. Loris (3), F.J. Simons (4), I. Daubechies (5), and K. Sigloch (6)

(1) Geosciences Azur - CNRS, Seismology, Valbonne, France (charlety@geoazur.unice.fr), (2) PACM, Princeton University, Princeton, NJ, United States., (3) Département de Mathématiques, Université Libre de Bruxelles, Bruxelles, Belgium., (4) Geosciences Department, Princeton University, Princeton, NJ, United States., (5) Mathematics Department, Duke University, Durham, North Carolina, United States, (6) Earth and Environmental Sciences - Geophysics, Ludwig-Maximilians-Universität Munich, Munich, Germany.

There is an increasing interest in using sparsity as information to find a solution of a linear problem. Usually smoothness or minimum energy model are the information chosen to select a preferred model among all possible solution.

Wavelet decomposition of models in an over-parameterized Earth and L1-norm minimization in wavelet space is a promising strategy to deal with the very heterogeneous data coverage in the Earth without sacrificing detail in the solution where this is resolved. However, L1-norm minimizations are nonlinear, and may pose problems of convergence speed when applied to large data sets.

We investigate the use of a L1 norm penalty for the model while solving the normal equation with a L2 norm. The idea originates from the image processing field and is based on FISTA (fast iterative soft thresholding algorithm). The L2 norm inversion is performed with a projected Landweber algorithm and the L1 norm constraint is dealt with a thresholding operator.

We invert 430,554 P delay times measured by cross-correlation in different frequency windows. The data are dominated by observations with US Array, leading to a major difference in the resolution beneath North America and the rest of the world. This is a subset of the data set inverted by Sigloch et al (Nature Geosci, 2008), excluding only a small number of ISC delays at short distance and all amplitude data. The model is a cubed Earth model with 3,637,248 voxels spanning mantle and crust, with a resolution everywhere better than 70 km. A total of 1912 event corrections are added as unknowns to be solved for. We will present our final results for both a synthetic model to test resolution as well as convergence, and for the real data. This new results will be compared with those obtained by LSQR with damping and smoothing terms.