Geophysical Research Abstracts,
Vol. 11, EGU2009-2762-2, 2009
EGU General Assembly 2009

General parameterization and resolution of inverse problems

L.-Y. Chiao (1,2), Y.-C. Gung (2), Y.-T. Hsu (1), Y.-H. Chang (2), and H.-Y. Yang (2)
(1) Institute of Oceanography, National Taiwan University, (2) Department of Geosciences, National Taiwan University

It is becoming a progressing consensus in the practice of resolving geophysical inverse problems that to seek for a family of related inverse models rather than just a single solution would help significantly to shed light on different perspectives of Earth's structure that a particular set of data constraints might be able to robustly resolve. Conventionally, after an a priori finite parameterization by expanding in terms of an arbitrary choice of truncated bases functions, the family of solutions is constructed along a certain tradeoff curve, for example, between data variance reduction versus model roughness or model norm; or between quantitative measures of model resolution versus model variance. It is seldom explored that cross assessment of inverse models invoking distinctive parameterizations and comparative appraisal across different regularization schemes might in fact be essential in highlighting the data's actual capability in constraining Earth's structure, as well as to differentiate whether specific features in the obtained solution might actually be artifacts arisen from the particular parameterization and the inverse algorithms invoked. Whereas most parameterizations are based on ad hoc choices of truncated bases functions, the classical Backus-Gilbert formulation of geophysical inverse theory treats Earth models as bearing inherently continuous variations. Although it is also possible to be formulated in terms of a special parameterization by adopting the data kernels as the basis functions, the original formulation yields the important information of the resolution kernel that relates the model estimates to the true Earth's structure. It is emphasized here that the information of the resolution kernel provided in correctly interpreting the inverse models is much more insightful than the vague impression obtained from the usually popular checkerboard test. Furthermore, it is worth mentioning that there are corresponding resolution kernels for every distinctive parameterization rather than just the usually much accentuated spatial resolution. Here we show that cross domain transformations of the inverse model itself, the corresponding resolution kernel, as well as the model covariance matrix can all be achieved strictly by straightforward algebraic transformations rather than tediously repeating the implementation of the forward data rule from the scratch. By taking advantage of these transformation rules, not only does the cross domain appraisal is made easy, it is also possible to formulate the forward data rule in one basis such as a global function set and then to examine the inverse models in the other basis such as a local set and vice versa. This offers great flexibility to take advantage of the intrinsic merits of each of every distinctive basis functions. An example of waveform inversion of surface wave data for the upper mantle under the Pacific region will be presented.