Geophysical Research Abstracts
Vol. 18, EGU2016-5337-3, 2016
EGU General Assembly 2016

Practical Quantification of Uncertainties in the Inversion of Airborne Electromagnetic Data Under Spatial Constraints

Juerg Hauser, James Gunning, and David Annetts
CSIRO

Airborne electromagnetic (AEM) data are often inverted with the aim of delineating near-surface geological interfaces, such as the boundaries of an aquifer or the base of regolith. Not all approaches to the inversion of AEM data are equally amenable to the recovery of such spatially coherent interfaces. If the AEM data are inverted for a 1D model on a station-by-station basis, or if a smooth resistivity distribution has been derived, qualitative interpretation of these inversion results is often required to obtain a spatially coherent interface.

Regularised deterministic inversions can take spatial correlation between 1D models into account, and be used to directly invert for a spatially coherent interface if a blocky model is sought from the data. However, inversion of AEM data is non-unique, and therefore estimating the uncertainty of an inversion result is as important as finding a single best-fitting model. Markov chain Monte Carlo (McMC) algorithms have been successful in exploring the 1D uncertainty space that arises in station-independent models. In a set of laterally independent 1D models, abrupt transverse changes in model parameters can occur, making it difficult to derive a spatially coherent interface. Full McMC sampling for laterally correlated models is computationally expensive, and independent 1D samplers are often the only feasible alternative if one wishes to explore the joint model space. Here we introduce a Bayesian parametric bootstrap approach to invert for spatially coherent layer properties, interfaces and related uncertainties. The Bayesian parametric bootstrap treats prior information on the model and its spatial correlation as implied observations, and then applies the classical parametric bootstrap.

Numerical examples demonstrate that our Bayesian parametric bootstrap will explore model space adequately for non-pathological situations, while requiring many fewer forward problem solves than a comparable McMC algorithm. Recovered uncertainties for synthetic data and field data exhibit the expected patterns. For example, we observe the well-known increase in uncertainty in interface depth with increasing depth to the interface. For a paleochannel network around the Kintyre Uranium deposit in Western Australia, we demonstrate how being able to directly invert for a spatially coherent paleosurface and related uncertainties is advantageous compared to defining the interface from a qualitative interpretation of inversion results. This is particularly important for predictive applications such as groundwater modelling. These results demonstrate that the Bayesian parametric bootstrap is an attractive compromise between efficiency and exhaustive stochastic search in the inference of spatially coherent models.