# DECONVOLUTION WITH SPATIAL CONSTRAINTS

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Surface-consistent methods have proven to be useful processing tools for improving the quality of seismic reflection data. In these methods, data corrections are tied to the surface locations of the seismic sources and receivers used in the original reflection survey. By constraining the number of free parameters in a physically meaningful way, these methods reduce statistical uncertainty and improve signal to noise. In this thesis I tackle two difficulties that arise in surface-consistent applications of deconvolution, one algorithmic and one conceptual.

The algorithmic problem is that published methods for surface-consistent deconvolution are simple to understand and easy to use, but yield at best uncertain data quality. The basic idea of spatial averaging is sound, it is the implementation that has gone wrong.

The conceptual problem is that the surface-consistent model lumps together filtering effects due to surface conditions such as recording filters with those due to near-surface conditions such as reverberation between the free surface and the water table. For marine data these independent effects separate both temporally and spatially as the seafloor depth increases or the seafloor topography roughens.

In Chapter 2, I tackle the algorithmic problem. I return to first principles and formulate surface-consistent deconvolution as a problem in optimization, to which I apply methods for nonlinear least-squares. My deconvolution filters are computed as approximate solutions to a large, sparse, least-squares system. Useful solutions are obtained in a few iterations, with each iteration equivalent in cost to performing a single-trace deconvolution of the data.

In Chapter 3, I concentrate on removing ringing effects resulting from multiple seafloor reflections and formulate a model for marine multiple suppression that is seafloor-consistent. In this model, the seafloor is seen as a spatially-varying reflection filter. I adapt the nonlinear least-squares techniques earlier applied to surface-consistent prediction-error filtering to estimate these seafloor-consistent filters for a marine line from the Barents Sea. This results in a marked improvement in pegleg multiple suppression compared to both surface-consistent processing and conventional techniques for multiple removal.

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