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Wave Equation Deghosting: Application to Field Data

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SUMMARY

Rigorous solutions to the well-known ghost problem (receiver or source) have been thought to require complementary elements such as multi-measurement streamers, over/under source or receiver configurations and the like. While such arrangements are sufficient, it has been shown that such efforts theoretically are not necessary (Beasley *et al.*, 2013a). So-called wave equation deghosting utilizes the causality of the wavefield as a boundary condition for the wave equation, thereby allowing for wave equation extrapolation of the (pressure) upcoming wavefield to generate the downgoing wavefield which can then be removed from the total wavefield. This is accomplished through a coupled system of partial differential equations (up- and downgoing wave equations) solved recursively in alternating time steps (Beasley *et al.*, 2013a). An important advantage of this time-space domain approach to deghosting is the ability to handle irregular cable shapes, sea surface and varying velocity (Beasley *et al.*, 2013a; Robertsson *et al.*, 2014). An important result due to the causality of the upcoming wavefield is that the so-called ghost notch response is actually not zero at the notch frequency, but it is attenuated relative to other frequencies (Beasley *et al.*, 2013b).

A natural question to investigate is the practical utility of this approach for field data, which always will have interfering noise, which is a particular concern around the notch frequencies. In this talk, we investigate the application of wave equation deghosting to field data. We find that, while noise and other issues such as cable depth and water velocity errors have an effect, practical measures such as correction for cable depth and velocity errors and simple damping of the recursion are effective. While not a substitute for the possible advantages of multi-measurement systems, particularly the enhanced spatial resolution obtainable from crossline pressure gradient measurements, we find that wave equation deghosting is competitive with other single measurement deghosting approaches particularly since it does not rely on interpolation, statistical deconvolution or other spectral estimations or assumptions. Moreover, wave equation deghosting enables a rigorous solution to the rough sea surface problem as well as inversion for cable depth, water velocity and sea surface characteristics.

References

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