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Uniformly Asymptotic Frequency Domain Green's Functions for the Acoustic Equation - Theory and Applications in Two and Three Dimensions

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As data collection in both seismic data acquisition and radar continues to improve, more emphasis is being placed on data pre-processing and inversion, in particular frequency domain waveform inversion in seismology [1], and, for example, time-domain waveform inversion in crosshole radar measurements [2]. Complementary to these methods are the sensitivity kernel techniques established initially in seismology [3, 4]. However, these methods have also been employed in crosshole radar tomography [5]. The sensitivity kernel technique has most recently been applied to the analysis of diffraction of waves in shallow water [6].

Central to the sensitivity kernel techniques is the use of an appropriate Green's function in either two or three dimensions and a background model is assumed for the calculation of the Green's function. In some situations, the constant velocity Green's function is used [5] but in other situations a smooth background model is used in a ray-type approximation. In the case of the smooth background model, computation of a ray-tracing type Green's function is problematic since at the source point the rays convergence, creating a singularity in the computation of the Jacobian used in the amplitude calculation. In fact the source is an axial caustic in two dimensions and a point caustic in three dimensions [7].

To obviate this problem, we will create a uniform asymptotic ansatz [8], explaining in detail how it is obtained in two dimensions. We will then show how to extend the results to three dimensions. In both cases, the Green's function will be obtained in the frequency domain for the acoustic equation with smoothly varying density and bulk modulus. The application of the new Green's function technique will provide more flexibility in the computation of sensitivities, both in seismological and radar applications.

References

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