Multi-scattering pertubations

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The scattering of waves is an inherent feature of wave propagation in inhomogeneous media. The Born series offers the opportunity to build the wavefield response to such scattering through perturbation theory, requiring only the background model. In fact, the first term of this series, referred to as the Born approximation, usually holds the majority of the recorded scattering energy, and thus, is used as a valid approximation for imaging and a gradient for full waveform inversion (FWI). The additional terms of the scattering series are important to multiple attenuation problems and multiple imaging, as well as enhancing the performance of FWI. In fact, Weglein et al. (1981), Ikelle et al. (2002), and many others attempted to use the Born series to invert for the multiple information, as well as potentially the velocity. In fact, the perturbation aspect of the Born series can be extremely helpful in time lapse applications as the base model can be treated as the background model. In this case, multiple scattering might provide the majority of the energy required to evaluate the changes. Zhang and Duan (2012) formulated an approach for efficient multi scattered energy modeling using the Born series concept. Specifically, we can model double scattering as well as any level scattering by considering the single scattered image as a secondary source. This is an approximate solution as the true double scattering wavefield requires an exact reflectivity as a secondary source. An inverse problem can be formulated to find the image that provides the double scattering in the data. Since it is hard to isolate the double scattering in the data, I invert for the image responsible for single, double and multiple scattering. Such an inversion can be formulated in a least square optimization problem, where the gradient is given by the adjoint state method. I also use the second order adjoint method to help speed up the convergence of this quasi-linear problem. In Figure 1(a), I show the true velocity model, and Figure 1(b) the model inverted from single scattering, and in Figure 1(c) the model inverted from double scattering. I also touch upon the double scattering wavefield corresponding to anisotropy parameter perturbations, and look into the opportunity of inverting for these perturbations.

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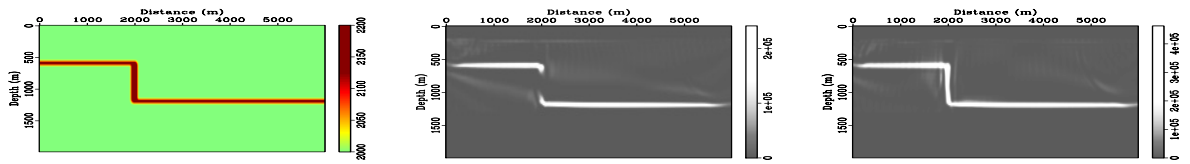

(a) (b) (c)

Figure 1: a) The actual velocity model. b) The perturbation model for single scattering obtained using the Born approximation. c) The perturbation model corresponding to using double scattering, as well.