On the relation between codas in seismic reflection and transmission responses

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Abstract:

Relations between reflection and transmission responses of horizontally layered media have been formulated by Claerbout (Geophysics, 1968) and many others. In this paper we derive similar relations for 3-D inhomogeneous media. As the starting point for these derivations we make use of one-way reciprocity theorems of the convolution type and of the correlation type. We obtain amongst others relations between reflection and transmission responses, including their codas due to internal multiple scattering. These relations can be used for deriving the transmission coda from the reflection measurements (which is useful for seismic imaging schemes that account for internal multiple scattering; Herman, Inverse Problems, 1992; Wapenaar and Herrmann, SEG, 1993) as well as for deriving the reflection response from transmission measurements (which is useful for seismic imaging of the subsurface, using passive recordings of noise sources in the subsurface). Furthermore, following the same approach, we obtain mutual relations between reflection responses with and without free surface multiples. The convolution type relations are similar to those used by Berkhout and others for surface related multiple elimination whereas the correlation type relations resemble Schuster's relations for seismic interferometry. Last, but not least, we obtain expressions for the reflection response at a boundary below an inhomogeneous medium, which may be useful for imaging the medium `from below'.