Pressure wavefield deghosting and its effects on amplitudes

A bootstrap deghosting approach for
horizontal and non-horizontal streamers

Abstract

The large impedance contrast between the sea-water and the air above causes an inevitable reflection event in marine seismic data known as the ghost reflection. This special kind of multiple is a well-known phenomenon in marine seismic acquisition, and has been described as far back as the early 60's. The ghost arises as the up-going signal either on the source side or receiver side reflects at the air-water interface and causing an alteration of the primary recorded signal. The interference between the ghost and primary signal is either destructive or constructive, which is seen in the frequency domain as amplification or suppression at certain frequencies. This result in inferior bandwidth compared to the original source band. The frequencies where total suppression occurs are known as notch frequencies, and information contained close to these frequencies are highly degraded.

In order to restore information close to notches, and achieving the broadest band possible, the ghost has to be removed the seismic record. The procedure of eliminating the ghost is called deghosting, and various deghosting methods have been proposed and commercialized, both on the acquisition side and processing side. One of the major objectives of broadband seismic is to enhance the low frequency content of the data. An acquisition based solution is to either increase the streamer depth to enhance the low frequency content, or vary the streamer depth with offset which desynchronizes the ghost arrival, leading to a diversity of notches within the frequency band, thus retaining information at lost frequencies over the entire source band. This thesis investigates effects which arise from pressure-only deghosting on the receiver side. Amplitude distortion effects due to deghosting and streamer configurations, which can lead to erroneous amplitude-related analysis, were also investigated.

Based on the results from this study, it is concluded that flat streamer configurations for hydrophone-only acquisition should be avoided due to the ghost wavefield non-destructive repositioning after normal moveout correction. The variable depth streamer configuration used in this thesis gives a better temporal and spectral response than the flat streamers. It is also concluded that relative amplitude distortions from deghosting is negligible and scalable if the ghost time-delay parameter is correctly estimated. In addition, no significant deviations in relative amplitudes due to streamer configurations were observed.