On Bottom Properties Estimation From Towed Array Data

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Abstract

Estimating seabottom structure from the analysis of acoustic returns of an explosive source (air-gun, sparker....) has been used for a longtime as a routine survey technique. Recent work showed the possibility of using well-suited numerical models to invert the acoustic field for estimating detailed sediment physical properties. Common implementations used long synthetic aperture arrays (up to 5 km) in order to resolve potential environmental ambiguities of the acoustic field. Others, used vertical arrays of sensors covering a significant part of the water column to identify the channel normal mode structure and thus gather information for the bottom physical relevant properties. Instead, this paper shows with simulated data, the possibility of using a moderate aperture horizontal array and a sound source simultaneously towed by a single ship for inverting the bottom structure. First, the system sensitivity to bottom parameters is investigated. In particular, it is shown that the sensitivity to sound speed variations is higher on the bottom top layers and it increases with array length. Density and attenuations (both compressional and shear) have in general small influence on the acoustic field structure and are therefore difficult to estimate. Increasing the signal frequency bandwidth by incoherent module averaging has no significant influence on sensitivity. Mismatch cases, mainly those related to array/source relative position, showed that deviations of more than $\lambda/2$ in range and $\lambda/5$ in depth may give erroneous extremum location and therefore biased final estimates. Finnaly, a modified genetic algorithm (GA) has been used for inversion of the acoustic field received at the array. Its performance has been tested for three environment types and for various parameter sets including compressional and shear velocities and attenuations. Inversion results are in agreement with the predictions obtained from the sensitivity study and their mean estimation error is within 5 to 10% of the true parameter values. Real data obtained with a 156 m long towed array on a 140 m depth water channel in the South of Sicily on March 1994, is being processed and results are expected soon.

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