An estimation of undersea sound speed structure: a more accurate strategy of GPS-A seafloor geodesy

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The Hydrographic and Oceanographic Department of Japan Coast Guard has been developing a system for precise seafloor geodetic positioning with the GPS-Acoustic combination technique and deploying seafloor observation sites on the landward slope of the major trenches around Japan, such as the Japan Trench and the Nankai Trough.

The primary purpose of this observation is to detect and monitor the crustal deformation caused by the subduction of the oceanic plate near the plate boundary.

For the precise GPS-Acoustic seafloor positioning, we are developing analysis software, which combines a GPS positioning result and undersea acoustic travel times to get a precise position of an array of seafloor stations.

In this analysis, undersea sound speed structure must be given to convert travel times of acoustic wave into travel ranges. In order to estimate the seafloor positions accurately, it is necessary to have a sufficiently accurate sound speed structure. However the sound speed varies with time and space. Therefore it is practically impossible to cover all these variations in detail.

For positioning at the centimeter level, we are trying to estimate the sound speed variation from the travel time residuals in the positioning analysis. The travel time residuals include the information of the temporal variation, spatial variation and systematic difference of sound speed. By taking a proper strategy, the correction of sound speed based on this estimation improves the final positioning result significantly.

We investigate the behavior of the travel time residuals using spectrum analysis to extract the various frequency of sound speed variation. Based on the result, we will examine a more accurate analysis strategy.

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