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Numerical simulation of GPS-Acoustic seafloor geodetic observation for accuracy evaluation

YOKOTA, Yusuke[1*] ; ISHIKAWA, Tadashi[1] ; WATANABE, Shun-ichi[1]

[1]Hydrographic and Oceanographic Department, Japan Coast Guard

Hydrographic and Oceanographic Department of Japan, Japan Coast Guard (JHOD), has been preforming a seafloor geodetic observation with the GPS-Acoustic combination technique. In this observation, we first measure the absolute position of the acoustic transducer set at the bottom of the vessel using the GPS measurement. In addition, we measure the relative position of the seafloor acoustic transponder from the on-board transducer using the acoustic ranging and finally determine the absolute seafloor position. In the present system, the movements of the seafloor positions are measured with 2 - 3 centimeters precision (1-σ). We have determined the seafloor positions from seafloor geodetic observations 3 times a year for 4 - 5 years.

However, we should estimate the seafloor position with a high precision using a short-term data for determining a variable crustal movement due to the postseismic effect after the 2011 Tohoku-oki earthquake and the slow event along the Nankai Trough. This observation is also expected to be broadened to the Kuril Trench and Ryukyu subduction zones. Therefore, the improvement of observation and analytical approaches is required through the quantitative accuracy evaluation.

JHOD has discussed and estimated the accuracy of this technique by means of empirical approach using the practical data [e.g., Sato et al., 2013]. Because the final solution involves the effects from all error causes, we cannot discuss individual error causes quantitatively. This constitutes a barrier to develop for accuracy improvements. The past simulation studies from other research groups [e.g., Yamada et al., 2002] were not used for our system due to difference observation setting.

In this presentation, we numerically simulated the GPS-acoustic seafloor geodetic observation and evaluated the error causes in the observation and analytical processes. First, the error effects from the GPS positioning and the graded sound speed structure were derived in and investigated. The error effect from the GPS positioning was estimated smaller than the graded sound speed structure. The graded structure emerges the distortion of the array positioning of seafloor transponders and can be estimated on some level. We have plan to evaluate the error effects from the number of data, the coverage of observation lines, and time changes of sound speed structure, and so on, and compare with the practical observation data.

Keywords: seafloor geodetic observation, GPS-Acoustic combination technique, numerical simulation