

GNSS-A data analysis to estimate the sound speed profile

*Tadashi Ishikawa¹, Yusuke Yokota², Shun-ichi Watanabe¹

1. Hydrographic and Oceanographic Department, Japan Coast Guard, 2. Institute of Industrial Science, the University of Tokyo

Seafloor geodetic observation based on GNSS - Acoustic ranging combination (GNSS-A) is a technique for estimating the absolute position consistent with International Terrestrial Reference Frame. For that reason, it may be called “seafloor GNSS” .

In this observation technique, the distance between the sea-surface ship and seafloor acoustic transponder is measured by acoustic wave. Therefore, the accuracy of sound speed affects the accuracy of position of transponder. For positioning at the centimeter level, it is necessary to have a sound speed with an accuracy of 0.1 m/s. It is not difficult for the current observation instruments to measure within this accuracy. However, it is needed the values at the place and time through which acoustic ray path passed. Because of the complex spatial and temporal variations of the sound speed, it is impossible in practice to make enough observations to cover all these variations in detail. Thus, for centimeter-level positioning, it is not sufficient to use an observed sound speed data only. On the other hand, the observed travel-time data include not only information about the range but also about the sound speed along the ray path. Taking advantage of this fact, we estimate a sound speed correction function. This idea is similar to estimating the atmospheric delay in a precise GNSS data analysis.

To improve an accuracy of positioning, it is important to improve the method to extract the information of sound speed. In this observation, the vessel is moving for about 6 to 20 hours in a region of about 2 to 5 km square. Temporal and spatial variations of sound speed are estimated from the fluctuation of spatial-temporally distributed acoustic data. In this analysis, the geometrical distribution of acoustic data greatly affects the accuracy of sound speed estimation. Therefore, it is necessary to set track line of the ship properly to accurate observation. We investigate the effect of track line on estimation of sound speed. This evaluation is expected to lead to the design of an appropriate observation system.

Keywords: GNSS-A seafloor geodesy, Sound speed profile