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Development of a new method for GPS/Acoustic seafloor positioning using multi-buoy system

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We are developing a new method for GPS/Acoustic seafloor positioning using multi-buoy system. In this system, we combined GPS positioning and acoustic ranging to locate seafloor benchmarks. We usually use a vessel for this observation. In the single vessel measurement, we need to assume that seawater sound speed structure is horizontally layered and changes only in time because the measurement geometry by single vessel has a resolution for sound speed variation in space or time, not both. However, this assumption causes systematic error in the locations of seafloor benchmarks when sound speed structure has some lateral heterogeneity. Using the multi-buoy system, we can estimate both the spatial and temporal variation of sound speed structure because the system can obtain travel times for cross-passing ray paths at each moment. In November 2013, we conducted multi-buoy observation in Suruga Bay. In the analysis, we introduced an obliquely layered sound speed structure model (Ikuta et al., 2010). In this model, sound speed changes depending on positions of buoys and seafloor benchmarks as S(t,X,x) = S(t)+dS(X+ax), in which X and x are position of the buoys and benchmarks, respectively, S(t) and dSX are the temporally- and spatially-varying slowness, respectively, and dSx is contribution of the sloping structure. The coefficient (a) is implicated as the thickness of the laterally changing layer relative to the total depth, which is usually limited in the uppermost part of the seawater. Although the measurement time of about 2 hours was very short comparing to usual measurement time c.a. 10 hours, the benchmark was located within 19 cm from the expected position by previous study. The solution was improved 14 cm comparing to the same time-length single vessel measurement.

Keywords: Oceanbottom geodesy, GPS/Acoustic seafloor measurement, Buoy, Sound speed structure, Suruga Bay