Seafloor geodetic measurements at Kumano-nada and improvement in its precision

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We have been conducted repeated measurements of seafloor displacement of our seafloor transponders as a benchmark since 2004. We have reported coseismic displacement associated with the 2004 off Kii-peninsula earthquake through the survey campaigns. However seafloor displacement associated with regular convergence due to subduction and with any pre-seismic signals due to a possible large earthquake, are expected to be generally small. Therefore it is required a high precision measurement to detect such small displacement using the future seafloor cable system. In this talk, we present an example of the 2005 survey campaign, in which we obtained high quality results. Comparing this with other campaigns, we consider what factor(s) control the final precision of surveys.

Employing the pulse-compression signals in acoustic measurement, we can detect traveltimes with very high precision in theory using cross-correlation waveform between transmitted and received signals. However possible multi-path associated reflection from sea-surface, base of the buoy, and near the transducer lead us to detect a wrong peak, which results in discrete error in the seafloor positioning. If the mis-detection of the correlation peak is asymmetric feature, the final positioning result using simple time average will be biased. Actually, survey campaigns in 2004 were much affected by this problem, due to problematic sound-hood of the transducer. However this error has the discrete feature and can be corrected if errors in other factors are minimized. Most uncertainty of positioning in our past observation system was the monitoring the position of transducer at the time of signal reception. We did not tried to exclude this error because this uncertainty is completely random and never affect the final positioning by itself. However introducing a new GPS receiver, which can record 10Hz of buoy position, we have excluded this random noise which enable us to correct above mentioned discrete error easily.

Seafloor geodesy is generally based on the assumption that sound speed in seawater changes in time while keeping laterally stratified structure. Nevertheless undulation of the positioning with 15 min. to 1 hour timescale, which may due to periodic violation of the sound speed stratification associated with internal wave, is observed in our past observations. These relatively short-time oscillation can be eliminated by taking average of long period of data. On the contrary, violation of the stratification associated with variation in sea current path has not typical timescale. It is difficult to remove such effect from the data. According to our survey in 2005, which are found in good quality of data, typical oscillation period is around 30 min. in Kumano-nada region, which can be almost removed by taking an average of time series of data obtained by several hours of observation. However, uncertain timescale of undulation is also found in other survey campaigns. We need comprehensive understanding of the deviation of sound speed stratification to determine minimum survey time to remove the effect, as well as consider independent observation which can monitor the degree of the stratification.

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