Technical development of analysis in seafloor geodetic measurement

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http://www.aob.geophys.tohoku.ac.jp/dmg/gpsa/

Improvement of accuracy in seafloor geodetic measurement is a crucial issue for reliable evaluation of occurrence of destructive large earthquakes along subduction zones as well as of general scientific interest in subducting process. Much efforts have been made on this issue by several research groups. On of the solutions is to make campaign surveys as often as possible and the other is to maximize the individual survey accuracy. For long-term semi-realtime observation, the latter approach is important. This is because it is required to detect any sign of pre-slip for a large earthquake in a short-time.

To prevail this problem, we have proposed new survey style that use 5 or more seafloor transponders to solve sound speed in ocean itself and its spatial gradient as well as horizontal position of the transponder array. In our recent analytic simulation in error propagation, mis-positioning in vertical component of kinematic GPS analysis, which is generally worse than in horizontal components, strongly devaluates the parameter estimate. In order to handle this vertical error in kinematic GPS, an additional observable is required, such as independent measurement of sound speed, or height of sea surface. The most assured way is utilize an extra transponder, which amounts to 6 in total. When the orientation of crustal deformation can be considered being confined in a certain direction, such as a relative plate motion, setting of the problem will be reduced in 1-dimensional. In this case, linearly aligned 4 seafloor transponders are the optimal configuration. We are planing to construct such a transponder array at off Miyagi along the Japan trench, to examine this proposition.

In addition to the idealization of the survey style mentioned above, careful attention must be payed in the individual component of observed data handling. For example, we have upgraded a sampling rate in the GPS gyro equipped on the buoy up to 10 Hz. For our new type of small buoy with a single GPS antenna, we are going to introduce a six-freedom rate gyro for tracking of its position and attitude. Exact traveltime detection in acoustic ranging is another issue. We found that superposition of short-length multipath in a acoustic ray strongly distort peak in correlogram even for signal of pseudo-random compression. Nature of the multipath is depend on attitude of the surface transducer relative to sea-surface and incident angle to the seafloor transponders. A careful treatment in acoustic signal with correction of exact attitude of the buoy is required.

In this study, we present our new finding in the issues listed above both in theoretical and observational approach.