

Seafloor geodetic measurements off Fukushima Prefecture using the GPS/Acoustic positioning system

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1. Background

Our group in Tohoku University has been trying to measure horizontal seafloor displacement in the subduction zone along the Japan trench using a GPS/Acoustic (GPS/A) positioning system. Because GPS observation networks on land lie far from the subduction zone, it is difficult to estimate crustal movements in the area using the data from the land-based networks. Therefore it is quite important to directly measure the crustal movements in situ for understanding the mechanism of earthquake occurrence in the subduction zone.

2. Method

The GPS/A positioning consists of kinematic GPS analysis between a reference station on land and GPS receivers at sea surface, and precise acoustic measurements between the sea surface and the seafloor. In this study, we deployed three precise acoustic transponders (PXP) to form an equilateral triangle array. A buoy towed from a vessel is used as a surface platform for the GPS/A observation. The buoy is equipped with four GPS antennas on the top and an acoustic transducer at the bottom. The towed buoy was kept near the center of the PXP array during GPS/A observation. Precise travel time is obtained from correlation analysis between the transmitted signal from the buoy and the reply signals from the PXP. The distance between the buoy and the PXP is then estimated with sound velocity data, which are calculated from XBT/XCTD observations, and corrected by using the method of Kido et al.(2004). Finally, we get position of the center of the PXP using thus obtained ranging data.

3. Summary of surveys

We started GPS/A observation in 2005 in the offshore of Fukushima Prefecture and conducted three campaign observations. In July, three PXP were newly deployed and each position was determined during the Tansei-maru cruise KT-05-13. We then carried out fixed-point observation near the center of the PXP for 2.5 days. In August, just after the earthquake occurred on August 16 ($M_j = 7.2$) at off Miyagi prefecture. Fixed-point observation was carried out again for 1.5 days. The position of the PXP array center was obtained from these observations with several centimeter precision. The results of two campaign observations agree with in the estimated errors. The third campaign observation was carried out during Hakuho-maru cruise KH-05-3 in November, when seafloor topography survey was also conducted around the observation site with a multi-narrow beam echo sounder. The GPS/A data are now under processing.