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GPS/Acoustic seafloor positioning in northeastern Japan

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Large earthquakes occurred around northeastern Japan associated with subduction of oceanic plates such as the Pacific plate. Spatial distribution of the seismic coupling into the subduction zone of the Japan Trench has been estimated based on GPS observation (e.g., Suwa et al., 2006). However, the lack of data in sea area limits the resolution and repeatability of back slip estimation on the undersea plate boundary. Therefore it is important to extend the geodetic observation into the seafloor. GPS/Acoustic (GPS/A) observation can be the most probable method for monitoring seafloor crustal movement. GPS/A seafloor positioning can be the most probable method for monitoring seafloor crustal movement in the subduction zone (Spiess et al., 1998). The positioning is a combination of kinematic GPS positioning on the sea surface and precise underwater acoustic positioning. Repeated campaign observations can detect a horizontal seafloor crustal movement. We have observed the crustal movement at three sites around Northeastern Japan. The campaign observations were repeated from 2003 to 2010. In this presentation we discuss this result and the estimated slip vector with GPS/A observation.
Since 2003, we have carried out the observation to monitor the seafloor crustal movement on northeastern Japan. The measurements were conducted at three sites on this area. Two sites (GJT 3, GJT4) were located at off Miyagi on a depth of 3,000 m and 1,500 m. Another site (GFK) were located at off Fukushima on a depth of 2,000 m. We have started the observation at GJT4 since August 2003 and at GJT3 since August 2005, at GFK since 2005 July. We had little time during the cruise to precisely locate the center of the PXP array. Throughout the observation epochs, shore stations at AOB were maintained as the GPS reference stations.
We estimate the slip vector associated with the plate motion to be about 5.7cm/yr NW between August 2004 and June 2005 at GJT4, and to be about 3 cm/yr WSW between August 2005 and November 2008 at GJT3. Mizukami et al., (2007) at GFK estimated the linear trend, which it gives a rate of 7cm/yr WNW. We compare the estimated slip vector and the displacement calculated from back-slip distribution (Suwa et al., 2006). Although the error of the estimated slip vector on our results is large, our resultant slip vectors at GJT3 and GJT4 are roughly same level of the crustal movement on land. But the magnitude of their displacement velocity at GFK seems to exceed a possible maximum although its direction is also consistent. The result suggests that the plate coupling is strong off Miyagi. Although we discuss about the estimated slip vector, the error of the estimated slip vector on our results is large. Therefore we need to reduce the errors in GPS/A to detect such a temporal variation of sound speed structure (e.g., Kido et al., 2008).
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