新たな海底地殻変動観測手法のためのGNSSブイからの連続音響測距
Continuous acoustic ranging from a GNSS buoy for the new method of seafloor crustal deformation measurements

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Our research group has been testing a measurement system for the continuous seafloor crustal deformation at a moored buoysite operated by Kochi prefecture, located 32 km off Cape Ashizuri, Japan.An acoustic transducer was fixed at about 1.7 m beneath the sea surface with a pole mounted on the buoy body.Three ocean bottom acoustic transponders had been installed around the moored point of the buoy. The acoustic signals are sequentially transmitted to these three transponders every three minutes. The recorded data on the buoy are planned to transmitted to a ground base station through a commercial communication satellite operated by Thuraya Telecommunications Company.
We performed a test for the continuous acoustic ranging between the buoy and the ocean bottom transponders from March 28 to 31 and from June 2 to July 12 (1st period), and from November 16to December 17 (2nd period) in 2018. The acoustic ranging was continuously possible throughout the above periods when power was supplied whereas it was unexpectedly terminated because of power failure during the winter season. The acoustic signals were transmitted 27,856 times in total, and the buoy-mounted acoustic ranging unit received 23,342 signals from the ocean bottom transponders. However, the acoustic data sent to the ground base station was only 12 % because of some trouble of the satellite communication modem.
The reflected signals from the buoy body and/or the seafloor sometimes contaminated the received acoustic signals; also multiple reflections inside of an anti-reflection cover attached to the buoy-mounted transducer, whose purpose is to cut off the reflection from the sea surface, were remarkable during the 1st period. The multiple reflections caused the misidentification of the direct wave from the sea-bottom units. We, therefore, removed the anti-reflection cover during the 2nd period, which remarkably reduced the confused reflections.
We coded a program for detecting the arrival time of direct acoustic wave automatically on the basis of thresholds of cross-correlation coefficient and energy ratio (the ratio of the squared amplitudes preceding and following a test point) to reduce the capacity of data transferred via satellite communication using the acoustic waveform recorded during the 1st period. The program successfully picked the correct direct wave onset for more than 99 % of the waveforms recorded during the 2nd period.

