Development of observation system for ocean bottom crustal deformation measurement utilizing marine GNSS buoy

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One of the problems in the GNSS-A seafloor crustal deformation measurement is improvement of time resolution. New sea-surface platforms are necessary instead of ship to solve the problem. We, then, started to development a GNSS-A observation system using a buoy under the Grant-in-Aid for Scientific Research (S) project “A challenge to develop GNSS buoy system for high-functional tsunami monitoring and continuous observation of ocean-bottom crustal movements.”
A sea-surface hardware and transducer for acoustic ranging, and a gyroscope are installed on the buoy, as well as a GNSS receiver and antenna. These data from the above equipment are transmitted to a ground station located in Niyodogawa-cho, Kochi Prefecture via satellite communication. We transmit only 60 byte ASCII data including the onset of acoustic signal, instead of 64 KB binary acoustic waveform itself to reduce the satellite communication cost. The onset of acoustic signal is recognized as the time achieving the maximum cross-correlation value with a reference waveform. Because it often happens that the maximum cross-correlation value is achieved at the arrival time of sea-surface reflected wave, we have coded a program to automatically determine the accurate arrival time of direct wave from several peaks of cross-correlation value together with signal-to-noise ratio. We have verified that the program is able to determine the accurate onset of direct wave with high rates of more than 99 % through a test using acoustic waveform recorded at a research vessel.

We are renting the Kuroshio Bokujyo No. 18 buoy of Kochi Prefecture which is moored about 40 km from Cape Ashizuri. We installed a seafloor benchmark composed of three seafloor transponders; the benchmark has a triangular shape with a span of about 1400 m. We determined the triangular configuration of the seafloor benchmark through the acoustic ranging from ships Yuge Maru and Kaiyo Maru No.3. The Kuroshio strong current near the present ocean area causes horizontal gradient of sound speed; the horizontal gradient is, however, well estimated, and the location errors of seafloor transponder is as small as 2-3 cm in the both horizontal components.

We are planning to start the continuous acoustic transmission from the buoy and to perform acoustic ranging also from an observation vessel for the accuracy evaluation of the buoy-based system after FY 2018.

