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New buoy observation system for tsunami and crustal deformation for strong ocean current

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The off Tohoku earthquake did severe tsunami damage to coastal residents around the Tohoku region. In particular, Japan surrounded by subduction zones has high risk of the tsunami. The tsunami early warning system using a buoy has developed by many countries, which are US, German, Indonesia and Malaysia. These are similar system of the buoys named by DART system, which was developed by NOAA, and it is working in several seas. However, it is not useful under a condition of the strong ocean current. There are many ocean currents around Japan, and the most famous one is the Kuroshio with the maximum speed of over 5 knots. To realize the earliest report of tsunami, we have to observe them near trench axis with deep sea water and the strong ocean current. The most convenient tool is ocean bottom cables with pressure sensors like dense ocean floor network system for earthquake and tsunami (DONET). However, the cost is very expensive and it takes long time to complete the installation. Therefore, we developed new buoy system for the tsunami observation and detection of crustal deformation under the strong ocean current and adopted the TRITON buoy system developed by Japan Agency for Marine-Earth Science and Technology (JAMSTEC) using slack mooring. Pressure data collected on the seafloor is sent to the buoy using acoustic transmission. Tuning of directivity and sound pressure level of transponders used for the transmission is needed for the observation point due to the slack mooring. In addition, we decided to use time difference of the double pulses to express the observed pressure value to save battery, and the transducer to hear the acoustic signals from the seafloor was set on the end of 1000 m-wire rope to minimize error of the data transmission brought by strong heterogeneity of the shallow water structure. We observe water pressure with a sampling interval of 15 seconds and the collected data is sent to the buoy with an interval of one minute in normal mode or 15 seconds in tsunami mode. At the seafloor, not only pressure sensor but six transponders to detect crustal deformation were deployed. We installed four antennas on the buoy to determine attitude of the buoy precisely and estimates the position of transducer on the buoy to communicate with seafloor transponders. The distance between the buoy and six transponders is measured with an interval of one week. The collected data of tsunami and distance between buoy and the transponders are transmitted to our land station via iridium satellite transmission. And a test satellite 'KIKU No.8' is also used for the data transmission to it in realtime to keep the redundancy. In addition, we have a plan to observe of sea surface height in realtime using a quasi-zenith satellite 'Michibiki'. The observation using a technique of a precise point positioning (PPP) estimates the position with an accuracy of approximately 10 cm. Now we are in a stage of sea trial in the rupture area of the Tonankai earthquake with a magnitude of 8. Because we selected a location near the trough axis with a depth of approximately 3000 m and it is expected future large crustal deformation. We introduce the specification of the new buoy system, report a preliminary result of the sea trial and future issues to be fixed and resolved.

Keywords: tsunami, crustal deformation, observation buoy, realtime data transmission