

## An offshore type of GPS tsunami meter using QZSS and ETS-VIII satellites

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A new tsunami observation system has been developed, which employs the GPS technology to detect a tsunami before it reaches the coast. The GPS antenna attached on the top of a buoy floating at the sea surface is one of the important apparatus in this system. The estimated positions of the antenna includes not only tsunami but also all kinds of sea surface changes including wind waves, tides etc. The low pass and high pass filters are used for detection of tsunami. After a series of preliminary experimental studies, the operation-oriented experiments were conducted at two offshore sites. These results showed that a GPS buoy was useful to early detection of tsunami. And the Ministry of Land, Infrastructure, Transport and Tourism has established the GPS buoy system for monitoring sea waves with fifteen GPS buoys along the Pacific coast and Japan sea coast since the year of 2008. These system succeeded to detect the tsunami of the 2011 off the Pacific coast of Tohoku Earthquake.

Currently, the GPS buoy system uses RTK (Real Time Kinematic) method which requires land base for precise positioning of the buoy. This limits the distance of the buoy from the coast at most 20km. There are two problems to be conquered, one is the precise GPS positioning and the other is the data transmission methods. The algorithm of PVD (Point precise Variance Detection) method and PPP-AR (Precise Point Positioning method with Ambiguity Resolution) method are successfully under examination in the Muroto GPS buoy. Also, the satellite communication system using QZSS (Quasi-Zenith Satellite System) and ETS-VIII (Engineering Test Satellite VIII) were introduced for this GPS tsunami observation system experimentally.

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