First operation of the remote-island volcano monitoring system around Nishinoshima

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We develop a remote island volcano monitoring system by using the Wave Glider (WG), which monitor the volcanic activity of remote islands while autonomously navigating around the island far from the land, and transmit the information to the land station by satellite communication. During the KS-16-16 cruise of R/V Shinsei-maru in October, 2016, we deployed the newly developed system into the Nishinoshima sea area, and the short-term operation was performed. The monitoring system is equipped with 1) the 4 time-lapse cameras for taking pictures of volcanoes, 2) the 2 microphones for infrasound observation, 3) the hydrophone installed at 6 m below sea surface for earthquake observation, and 4) the wave meter utilizing GPS Doppler velocity measurement for detecting tsunami generation by the land slides of the volcanic body. Sound wave signals by the microphones and hydrophone, and the wave meter records are transmitted by the satellite communications to the land station. For the navigation and control of the WG, other satellite system is employed, and the navigation data set (location, speed, current speed and direction), and the weather data set (temperature, pressure, wind speed and direction) are transmitted independently to the land.

The system is launched about 1km west to the Nishinoshima at 0935 on October 20, 2016. After the launch, the system start navigation autonomously along the track of circling the island with a radius of about 5 km. After one circle of the track, the system was recovered on board at the north-west to the island at 1345 on October 21, 2016.The average amplitude of the observed sea waves was about 50 cm, and the period was around 10 sec. The water speed of WG was in the range of 1.2 - 0.9 knots. On the other hand, the ground speed observed by the GPS Doppler measurement had the mean speed of 0.5 knots, and it took more than 30 hours for travelling the distance of 30 km along the circular track.

The wave meter measures and records the heave and the three components of speed with 10 Hz sampling rate. In normal mode, data communications via satellite to the land station transmit 1 Hz sampling data sets (about 600 byte) in every minute. In emergency mode, 10 Hz sampling data sets (about 4900 bytes) are transmitted in every minute. In the present experiment, the normal mode transmission of the date sets were performed without an error, and the switch between two modes was successful. Heave and speed measurements of the wave meter are performed with the precisions cited in the specification (5 cm in heave, and 0.05 m/s in speed). The frequency spectrum of the heave seems closely resemble that of the wind generated waves in typical coastal area with a central frequency of 0.1 Hz.

Sound waves observed by the microphones and hydrophone were recorded by the data logger at sampling speed of 200Hz. Examination of the data sets indicates that the waveform of the microphones are highly correlated with that of the waves, suggesting that the microphone records the pressure change by the up-down movement of the float of WG. Since the Nishinoshima volcano did not erupt at that time, the high frequency signals more than 2Hz corresponding to the infrasound waves were not observed in the microphones. On the other hand, many line spectra are seen in the higher frequency side (>10 Hz) of the hydrophone spectram. During KR-15-17 cruise of R/V Kairei in Feburuary 2015, we made hydrophone measurement by lowering the hydrophone from the ship to the water depth of 10m, while the Nishinoshima volcano was highly active and continuous eruptions occur. The spectrum of the hydrophone records show many line spectra higher than 10Hz, which corresponds to BH-type earthquakes. Considering the observation in 2015, it seems that the activity of the deep part of the

Nishinoshima volcano does exist even now.

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