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Acoustic monitoring of an island volcano using Wave Glider: A test operation at Nishinoshima, Japan

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Nishinoshima is a volcanic island located about 900 km from the main land of Japan. The volcano started eruptive activity in November, 2013. The activity has been monitored by satellites, periodic airborne observations, and infrasound recording at the closest habited island, Chichi-jima, 130 km to the east of the volcano. This study presents a new possibility for continuous and closer monitoring of a remote island volcano.

Wave Glider is an unmanned ocean vehicle that uses only wave energy for propulsion. We mounted a pair of infrasound microphones and a hydrophone on the Wave Glider. The signals were recorded by a data logger (Hakusan, LS8800) at 200 samples per second. A customized linux-based system (Scimolex, ScWgsSys) extracted data from the logger, reformatted the data to a smaller size, and sent them to the server on land through a satellite phone (Thuraya XT) every 10 minutes. In addition, four off-line cameras were mounted to take pictures every 10 second.

The Wave Glider was released near Chichi-jima on December 1, 2017. It reached the circular orbit set around the volcano with a radius of 5 km early on December 4. After 5 rounds, it left the orbit at noon on the 8th, and returned the near sea of Chichi-jima on the 10th to be collected by a boat on December 13. The monitoring system was continuously operated from 11:27 on December 1 until it was remotely turned off at 21:30 on the 10th because of power shortage. The 89 percent of data were successfully sent to the server during the operating time.

The microphones recorded pressure change associated with up-down motion on the sea wave. The signals were frequently disturbed by strong pulses which were considered to be generated by waves swallowing the microphones. Nevertheless, cross-correlation analyses revealed infrasound signals between 14:00 and 19:45 on December 4, when steam emission was recognized on camera images. Hydrophone recorded no clear signals related to the activity. Its amplitude variation was in correlation with those of the microphone data, which supported that the strong pulses in microphone data were due to large waves.

If an eruption occurs, infrasound signals stronger than those recorded with the steam emission are expected. Therefore, the result of this study suggests that our system is useful for monitoring eruptive activity of a remote island volcano.