Development of infrasound monitoring system mounted on Wave Glider

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Infrasound monitoring is an effective tool to capture eruptive and degassing activity of a volcano. When Nishinoshima volcano became active, the possible closest place to install stations was Chichi-jima, 130 km away from the volcano. Although infrasound signals associated with the volcanic activity at Nishinoshima were detected at Chichi-jima more clearly than expected, the signal detection was significantly dependent on the atmospheric structure. In order to monitor the volcanic activity regularly, it is necessary to install infrasound stations closer to the volcano. The unmanned ocean vehicle, Wave Glider, opens a possibility for infrasound monitoring close to a remote island volcano.

We conducted a test observation in a fish farm near the coast of Tarumizu facing Sakurajima volcano. Two infrasound sensors were set about 2 m apart with the data logger on a raft, while the hydrophone was set about 7 m down into the sea. Data was recorded from August 26 to 29, 2014, during which 17 explosions from Showa Crater were reported by JMA. It was confirmed that infrasound signals were distinguished from noise by the cross correlation and coherence analyses between the two infrasound sensors. By using frequency range higher than 1 Hz, coherent signals due to ocean waves and wind noise were excluded. On the other hand, no clear signal was recognized in the hydrophone data.

The first experiment (WG2016) was in October 20-21, 2016. The system was mounted on the Wave Glider, which was released on the sea about 1 km from Nishinoshima by the research vessel, Shinsei-maru. It recorded data for about 28 hours while the Wave Glider nearly completed a circle around a 5 km orbit from the volcano. There was no surface activity at the volcano and ocean waves were also very quiet. The second experiment (WG2017) was in December 1-10, 2017. The Wave Glider with the system was released by a fish boat, Shingen-maru, near the coast of Chichi-jima. It reached the circular orbit 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, when the system was remotely shutdown due to power shortage. The sea was rough almost all the time during the experiment except in the first 24 hours before approaching the volcano. When the Wave Glider was near the volcano, the time-lapse cameras mounted on it captured emission of weak white plume from the cone in the afternoon of December 04.

Correlation analyses between the pair of infrasound sensors showed weak correlation in broad frequency ranges in some periods in both experiments. In WG2017, the infrasound data were significantly spoiled by waves hitting the sensors. The correlation was observed in two periods when the noise level was relatively low. The period showing the clearer correlation corresponded to the time when the weak plume was observed. In WG2016, the noise level was low in the second day, while the correlation was observed intermittently about twice an hour in the last 7 hours. Although the amplitudes of the two sensors changed in coherent, no common waveforms were identified.

We might regard that the correlation signal in WG2017 indicates infrasound associated with the plume emission. However, it is generally difficult to detect infrasound from such weak activity even in observations on land. In addition, the correlation signal in WG2016 is certainly non-volcanic. We consider the correlation is generated by high-frequency oscillation of the Wave Glider. We have to clarify their origin in order to utilize the system for infrasound monitoring. Nevertheless, based on the magnitudes of the observed correlation and noise, we expect that the system is capable of detecting infrasound generated by a volcanic eruption if it occurs.

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