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Infrasonic monitoring of the eruption at a remote island volcano, Nishino-shima

Mie Ichihara (1), Junji Kikuchi (2), Kiwamu Nishida (1), Hiroko Sugioka (3), and Yozo Hamano (4)

(1) University of Tokyo, Earthquake Research Institute, Tokyo, Japan (ichihara@eri.u-tokyo.ac.jp), (2) University of Tokyo, Department of Earth and Planetary Science, Tokyo, Japan , (3) Kobe University, Department of Planetology, Kobe, Japan (hikari@pearl.kobe-u.ac.jp), (4) JAMSTEC, Yokosuka, Japan (hamano@jamstec.go.jp)

Nishino-shima volcano in some 1000 km south of Tokyo is active since November, 2013. The new island has grown to almost swallow the original Nishino-shima island. We installed infrasonic stations to Chichi-jima, which is the closest inhabited island in 130 km to the east of Nishino-shima, and have been detecting clear infrasonic signals from the direction of Nishino-shima since May 2014. We also conducted infrasonic and visual observation in the research cruise close to Nishino-shima on 26th and 27th of February, 2015. The data was compared with the infrasonic data recorded at Chichi-jima to confirm that infrasound associated with the Strombolian activity of Nishino-shima was recorded at the distance of 130 km. The detection of infrasound at such a distance obviously depends on the atmospheric structure. Here we present a simple method to evaluate the atmospheric effect, which is crucial for interpreting the infrasonic observation to the change of volcanic activity.

The method is similar to the Monte Carlo phonon method proposed by Shearer and Earle (2004) to investigate seismic scattering wave fields. A million phonon particles were transmitted from the ground to the atmosphere in random angles in 45 degrees from the horizontal direction. Ray-tracing calculation (Tahira, 1982) was performed for each particles assuming one dimensional atmospheric structure with the effect of wind advection in the plane. We counted the number of the particles that reached Chichi-jima in the area of the infrasound stations spanning about 1 km, and regarded that the number represented the infrasound energy that reached the stations. Perfect reflection was assumed on the sea surface, but the particles that were trapped in the bottom layer thinner than the scale of the infrasonic wave length were eliminated. The calculation was performed for atmospheric structures from May 2014 to December 2015, using the data from radiosonde measurements twice a day by the Japan Meteorology Agency. The method successfully distinguished the periods of absence of infrasonic signals at Chichi-jima due to declined activity of the source and due to the atmospheric propagation effect.