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モンテカルロ・フォノン法による西之島から父島への空振到達可能性の評価
Atmospheric effect on infrasound detectablity at Chichi-jima from Nishino-shima assessed by a Monte Carlo phonon method

市原 美恵 [1] ; 菊地 淳仁 [2*] ; ラカンナ ジョルジオ [3] ; 菅野 洋 [1] ; 西田 究 [1]
ICHIHARA, Mie[1] ; KIKUCHI, Junji[2*] ; LACANNA, Giorgio[3] ; KANNO, Yo[1] ; NISHIDA, Kiwamu[1]

[1] 東京大学地震研究所, [2] 東京大学大学院理学系研究科, [3] フィレンツェ大学
[1]ERI, University of Tokyo, [2]Dept. Earth and Planetary Science, University of Tokyo, [3]University of Florence

Nishino-shima volcano in some 1000 km south of Tokyo is active since November, 2013. The new island keeps growing and is almost swallowing 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 Nishino-shima since May 2014. 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 directions between zero and 90 degrees in the vertical plane cutting from Nishino-shima to Chichi-jima. 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 to December 2014, using the data from radiosonde measurements twice a day by the Japan Meteorology Agency.

The calculated infrasonic energy arrivals were compared with the power of the signal from Nishino-shima detected by the infrasonic array at Chichi-jima. The calculation and the observation showed similar tendencies in general confirming that detection/non-detection of infrasound at Chichi-jima was controlled by atmospheric conditions. However, discrepancies were found in the beginning of May and in the end of June. The calculation shows infrasound was detectable, but it was not detected by the observation. These were the periods with low growth rates of the new island according to the satellite image analysis (Maeno et al., 2014). We conclude that in these periods the non-detection was due to the lack of the infrasonic source at Nishino-shima and not due to the propagation effect.

Although information for the atmospheric structure is limited, this simple method provides a first-order evaluation for the atmospheric effects and improves the interpretation of the infrasonic data at Chichi-jima for Nishino-shima activity.

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