Propagation of infrasound emitted by volcanic eruptions of Mount Aso and Moto-Shirane

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Infrasound is inaudible and low-frequency sound, which is lower than 20 Hz of frequency. It is emitted by an occurrence of huge-scale events such as tsunami, typhoon, lightning, volcanic eruption and so on. Because of the very low frequency, the attenuation of infrasound by viscous energy dissipation and thermal conduction is negligible. Hence, this advantage enables us to monitor distant events.

We have successfully observed infrasound signals that originate the volcanic eruptions of the Mount Aso on Oct. 6, 2016, and Moto-Shirane on Jan. 23, 2018. For example, in the case of the Mount Aso (erupted time at 1:46:37 JST), the time of arrival at Kuroshio-cho (~180 km from the crater) was 1:55:26 JST, indicating that the travel time is ~530 s. Assuming that acoustic wave propagates horizontally with the sound speed of 340 m/s, the distance from Kuroshio-cho to the crater is calculated to be ~180 km, which corresponds to the actual distance. In contrast, the time of arrival at Kochi University of Technology (~250 km from the crater) was 2:01:23 JST. If we assume horizontal propagation, the distance is calculated to be ~310 km. The difference between the calculated and actual distances, ~60 km, is large, implying that the acoustic wave did not propagate horizontally. Similar results were obtained at the CTBTO observation point, IS30, in Isumi for Mount Moto-Shirane eruption as well.

In our study, we built a 2D model to describe sound propagation in the atmosphere. For simplicity, the model ignores wind field and reflection on the ground as a first step. We consider the propagation in the troposphere (from 0 to 10 km) and the stratosphere (from 10 km to 50 km). Given the vertical temperature profiles and the dispersion relation $\omega = c_s k$, we calculate the ray paths of the sound by the Hamilton equation, where ω is the angular frequency, c_s is the sound speed, and k is the wave number. For both eruptions, we found that some of the observed sound cannot be explained by a straight horizontal ray path. In this presentation, we compare the travel time with the observations and discuss results for the two cases for Mount Aso and Moto-Shirane eruptions.

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