Spatiotemporal variation of infrasound propagation from Sakurajima to the infrasound network in Kirishima
- Effects of the atmospheric structure and topography -

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Introduction
Infrasound has become an important component of observation for volcanic activity. It was believed that infrasound is less modified during propagation than seismic waves, because the atmosphere is more uniform than the ground. It is certainly true, but recently, the advanced observations and numerical studies have started revealing that effects of the atmospheric structures and the topography are more significant than the thoughts.

At present, infrasound observations for volcanoes are concentrated in two distinct scales: very close to the volcano in less than 10 km, or very far in hundreds or thousands of kilometers away. The topographic effect is significant in the former case, and the atmospheric structure has a strong effect in the latter case. Studies connecting these two scales are very few.

We have a dense network of well-calibrated infrasound sensors around Kirishima volcano, about 40 km from Sakurajima volcano (Fig.1). The network measures infrasound from Sakurajima in tens of kilometers with the effect of high topography of Kirishima volcano complex. In the period from July-2011 to Jan-2012, it recorded 681 clear infrasounds of Sakurajima explosions. This dataset is used to understand infrasound propagation in the missing scale in the infrasound studies.

Observation and Numerical calculation
The variations in the amplitude and propagation time of infrasound generated by the Showa crater explosion at Sakurajima are investigated. The amplitude ratios of the individual stations at Kirishima to the reference station about 3 km from the crater show remarkable differences between the stations on the Sakurajima side and on the other side of Kirishima peaks, and between the summer season and the winter season (Fig.2). The amplitude ratios sometimes vary 2 times at a similar distance due to the topography or 5 times in one day at one station.

Taking account of the topography (10-m-mesh DEM) and the atmospheric structure, measured twice a day (0 and 12 o'clock UTC) at Kagoshima city, the variation of wave propagation is numerically investigated. A finite differential method, in 2-D with a correction of geometrical spreading is used (Lacanna et al., 2012). Excellent agreements between the observation and calculation are obtained for cases in summer, but the agreements are quite poor in winter for the individual explosion signals. Numerical results indicate just temperature variation cannot produce such a large amplification in these distances, even though it is impossible to know the detailed spatiotemporal atmospheric structure on the propagation. The other possible mechanisms (wind effects and source directivity) will be discussed.

Fig.1: The infrasound network.

Fig.2: The spatiotemporal variation of amplitude ratio at 4 stations. The top frame is the temperature structure of the atmosphere measured at Kagoshima city.