Relationship between infrasound pressure and possible flight distance of volcanic bomb

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We propose a method to estimate flight distances of volcanic bomb by using infrasound records. Ballistic bombs ejected from a volcano crater cause damage to the resident area instantly. It is important to detect the flight-bombs distance from the crater. Volcanoes are often hidden by clouds, so it is necessary to get the detecting method by not using visual observations.

At many active volcanoes in Japan, air-shock observation has been carried on for several decades in order to detect eruptions. Especially at Sakurajima volcano, having been repeated Vulcanian eruptions, many sensors are installed. Pressure changes caused by eruptions have been recorded for more than half a century by the microbarometer installed by Kyoto University at Harutayama, 2.7 km northwest from Minamidake crater. In addition, the five sensors of the infrasound microphone are located by the Japan Meteorological Agency (JMA). We investigated the relationship between flight distance of ballistic bomb and infrasound pressure recorded by microphones. 148 Vulcanian eruptions, occurred at the Showa crater from 2011 to 2012 with flight-bomb distances of over 0.7 km, were analyzed.

Most commonly, amplitude of infrasound pressure recorded at every site are not to be same, even if they are considered the distance attenuation. Therefore we need to estimate site correction factors of infrasound pressure caused by explosions, using pressure changes recorded at JMA's microphone sites in reference to pressure changes measured by the microbarometer at Harutayama. By using these correlation factors, we calculated the pressure changes normalized to a 1 km distance from the Showa crater. Then an empirical relationship between the possible maximum flight distances of ejection bomb and corrected normalized pressure changes is obtained as below,

$D_{max} = 9\ P_n$

where D_{max} is the maximum possible flight distance of bomb, in meter, and P_n is the corrected normalized pressure change, in Pascal. This relationship can be applied to Vulcanian eruptions at other volcanoes, for example of Asamayama and Shinmoedake volcanoes, in Japan.