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Azimuthal traveltime and amplitude anomalies of infrasound from the explosive eruption of the Sakurajima volcano

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With more than 20 microbarometers (Paroscientific, Inc Model 745-16B) in a distance range from as small as 4 km to 1100 km, we observed the strongest explosive eruption since 2000 of the Sakurajima volcano, located at the southern end of the Kyushu Island in Japan. An MB2005 at 4-km away from the summit recorded one strong sharp acoustic signal with peak-to-peak amplitude 1200 Pa and duration 4 sec. This nearby microbarogram guarantees that no small eruption occurred with amplitude more than a few tens Pa within a day after this explosive eruption. At the IS30 IMS array which is 1000 km away from the volcano, we observed a dispersed pressure wave train with duration 1 min and maximum amplitude 5 Pa and dominant periods 5-10 sec. Array analysis shows a tropospheric propagating infrasound from the azimuth of Sakurajima with an apparent velocity 0.345 km/s.

All distant stations are nearly linearly aligned from Sakurajima to the IS30 array and their azimuths are 37-65 deg. Within this small azimuth range, we observed a strong azimuthal anisotropy in traveltime and amplitude. The patterns of traveltime anomaly and amplitude are similar, earlier the arrival, larger the amplitude. This implies that these traveltime and amplitude anomalies are wave propagation origin and are likely caused by the wind, not by an asymmetric radiation pattern of the explosion source. More microbarograms including two MB2005s were running in the Honshu Island during the eruption but these records show little infrasound signals with amplitude more than a few Pa. There seems a clear areal boundary where infrasound was observed or not.

Another prominent feature of waveforms is the multiple later phases reflected from the troposphere and the thermosphere. The record section of microbarograms recorded at less than 50 0 km from the volcano reveals nearly-equally time-separated later phases up to 5 bounces. The traveltime curves progressively increases the apparent velocity as the time increases and distance decreases, suggesting multiple reflections between the atmosphere and the ground. The time separation and slowness of these later phases are interpreted that these waves are reflected by an eastward wind at 10 km above aground. The microbarograms recorded at more than 500 km show later phases up to 4 bounces with a larger apparent velocity of about 0.4km/s, indicating their thermospheric origin.

More elaborated modeling of traveltimes and amplitude of these tropospheric and thermospheric acoustic waves, together with multiple phases, will reveal the wind condition above the Japanese islands, which should be compared against daily models constructed by JMA for the weather forecast.

Keywords: infrasound, volcanic explosion, pressure wave, stratosphere, thermosphere, microbarometer