Relationship between radar reflectivity factors and amplitudes of infrasound pulses during the 2021 eruption activity of Suwanosejima volcano, Japan

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Using the relationship between radar reflection factor and volcanic ash-fall amount, distribution and amount of volcanic ash-fall are estimated from meteorological radar observation (e.g., Maki et al., 2021). On the other hand, emission volumes of eruptions have been estimated from infrasound observation (e.g., Yamada et al., 2017). While the radar observes the reflection of the radio wave by pyroclastic material in volcanic plume, the infrasound reflects the instantaneous air movement in crater during the eruption.
X-band MP radars were installed near volcanoes in southern Kyushu in August, 2017. In Suwanosejima, the radar conducts sector RHI scanning which scans the specific direction range in the elevation angle direction and generates three-dimensional data since September, 2020. An infrasound sensor was installed at the horizontal distance of 0.6 km from the crater in March, 2021.
In Suwanosejima, eruptions have frequently occurred since autumn, 2020, and the number of eruptions per day exceeded 10 in most days, and exceeded 40 in some days from August to September, 2021. Therefore, it is possible to compare the radar observation with the infrasound observation for many eruptions. We investigate the relationship between radar reflectivity factors and amplitudes of infrasound pulses from June to September, 2021. Radar reflectivity factors are extracted at 200 m intervals between 900 m and 6100 m above sea level in the coordinate of the Otake crater. we compared the integrated radar reflectivity factors for 1 hour and the maximum amplitudes of the maximum amplitudes of the infrasound pulses (FIgure).
In the periods when the maximum infrasound amplitude is large, the integrated radar reflectivity factor is small, and in the period when the integrated radar reflectivity factor is large, the maximum infrasound amplitude tends to be small. The maximum value (591 Pa) of the maximum infrasound amplitude in this period was the infrasound pulse at 0:10 on July 7, and the integrated radar reflectivity factor from 0:00 to 1:00 on July 7 was 48 mm^6/m^3. On the other hand, the maximum value of integrated radar reflective factor (6.8×10^7 mm^6/m^3) was reached between 15:00 and 16:00 on July 13, and the maximum amplitude of the infrasound pulse in this period was 29Pa. The periods when the integrated radar reflectivity factor was less than 100 mm^6/m^3 and the maximum infrasound amplitude was less than 100Pa were from 19:00 to 21:00 on July 31, 2021, from 2:00 to 5:00 on August 23, from 14:00 to 15:00 on August 28, and from 1:00 to 6:00 on September 27. The integrated radar reflection factor is small (less than 10^5 mm^6/m^3) in the period (the maximum value 300Pa or more) in which the infrasound amplitude is large, and the volcanic smoke height is less than 2000 m. On the other hand, in the periods with small infrasound amplitude (maximum value of 200Pa or less), there were the periods with large integrated radar reflectivity factors (over 10^6 mm^6/m^3), and there was an eruption with a volcanic smoke height exceeding 3000 m.
From these results, the volcanic ash emission is small and the volcanic smoke height is low in the eruption with the large infrasound amplitude. On the other hand, it can be said that the volcanic ash emission is large and the volcanic smoke height is high in the eruption with small amplitude of the infrasound pulse. In the period when the radar reflectivity factor is small, the eruption in which volcanic ash amount is small and volcanic gas emission is large is predominant, that is, the eruption by fresh magma is predominant. On the other hand, in the periods in which the radar reflectivity factor is large, the eruption in which the

volcanic ash emission is large and the volcanic gas emission is small is predominant, that is, the eruption by the magma in which the degassing progresses seems to be predominant.

Keywords: X-band MP radar, Radar reflectivity factor, Infrasound pulse, Suwanosejima