Analytical study of volcanic eruptions by using dual polarization radar: preliminary results

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1. Introduction
The Kagoshima Local Meteorological Office is working with the Volcanic Research Department of the Meteorological Research Institute on an analytical study of volcanic plumes using dual polarization radar. The observation of volcanic plumes by the Japan Meteorological Agency (JMA) mainly relies on surveillance cameras. Therefore, when the visibility near the crater is poor, it is impossible to observe the plume. Under such circumstances, we can obtain information about the plume immediately by using meteorological radar.
In addition, the ashfall forecast provided by JMA uses the plume altitude as an initial condition, and determining the plume altitude during poor visibility can improve the forecast. However, it is difficult to distinguish between rain and ash by using single-polarization weather radar. On the other hand, dual-polarization weather radar can provide information on the particle shape of the target, which is expected to solve the problem of rain/ash discrimination. The JMA operational weather radars and the Doppler radars for airport weather (DRAW) are currently undergoing the upgrade to dual polarization. In this study, we aim to solve the problem of rain/ash discrimination by analyzing eruption cases at Sakurajima using dual polarization weather radars.

2. Methodology
The authors use the XRAIN Sakurajima radar of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and the X-band MP radar of the Meteorological Research Institute (MRI-XMP). For data analysis, we use "Draft", a radar analysis software developed by the Meteorological Research Institute (Tanaka and Suzuki (2000)). "Draft" consists of a set of commands that perform format conversion, analysis, and drawing of radar data.

3. Case study
In this study, we analyzed eruption plume echoes of Sakurajima on a clear day (June 16, 2018) and on a cloudy day (June 10, 2018). In both cases, the reflectivity was highest at the beginning of the eruption and decreased with time. Since the difference between the surrounding rain clouds and the plume disappeared as the reflectivity decreased during cloudy weather, it would be difficult to distinguish the plume from rain clouds based only on the reflectivity in such cases. It was also confirmed that the differential reflectivity (Zdr) within the plume echoes increased on average with time, when the sky was clear. This phenomenon was confirmed in previous studies, and is thought to reflect the change in the falling orientation of the particles inside the plume. On the other hand, when the sky was cloudy, the Zdr was large immediately right after the eruption, and the areas with large Zdr became less visible as time passed. It is considered that the volcanic ash may have been aggregated by the water content in the cloud, resulting in small Zdr.

4. Future works
We will continue to analyze eruption cases to clarify the difference between eruption plume/volcanic ash cloud echoes and precipitation echoes. We also aim to create an immediate plume analysis tool for

beginners in radar meteorology.

References

Tanaka Y. and Suzuki, O. (2000) Development of radar analysis software “Draft”. Proceedings of the 2000 spring meeting of Meteorological Society of Japan, **77**, 303 **(in Japanese)**

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Keywords: Volcanic eruption/cloud, weather radar, Sakurajima volcano

