Tephra transport and deposit during the climax of the Zao 1895 eruption

*Aina Nanri[1], Kae Tsunematsu[1], Masao Ban[1]

1. Yamagata University

Tephra are fragments of magma and rocks around the vent released during an explosive eruption, transported in the air, and is ultimately deposited on the slope and plain at the foot of a volcano. Consequently, tephra fallout not only damages crops and plants, but also causes lahars during and after the eruption. Therefore, it is useful to study the tephra transport and deposit process of past eruptions for each volcano in the planning of the countermeasures for future tephra hazards.
The tephra fallout of the Zao 1895 eruption spread widely across the ground, especially 20 km from the vent in the northeast direction. Miura et al. (2012) estimated the volcanic plume of this eruption was around 350 m based on the illustration of the 1895 eruption. However, the volcanic plumes from similar eruptions produced higher plumes. For example, the Ontake 2014 eruption produced a volcanic plume as high as 7000 m over the summit. Therefore, the height of the volcanic plume could have been higher than the estimated height.
We collected tephra samples for grainsize analysis and measured a thickness of layer 6 of the Zao 1895 eruption. Including the thickness data of Miura et al (2012), we redrew the isopach maps of layer 6. Then, we conducted numerical simulations using the Lagrangian-based tephra transport model of Tsunematsu (2012). As an input value of the numerical simulation, grainsize distribution of each sampling location was averaged and the total grainsize distribution was estimated based on the method of Bonadonna and Houghton (2005). According to the illustration of the eruption introduced in Kochibe (1896), the volcanic plume of this eruption seemed like a strong plume and not inclined because of the wind effect. Therefore, we calculated the plume velocity profiles with the Woods (1988) model which is a one-dimensional steady-state model for volcanic plumes assuming that the volcanic plume is a strong plume. We expanded the one-dimensional plume velocity profile to three dimensions using axial symmetry based on a cylindrical coordinate system. Tephra were transported in the velocity fileds of plume velocity, wind velocity and settling velocity which is assumed to be a terminal velocity. The wind velocity was estimated based on the wind velocity record of the Zao Togatta JMA station which is the nearest monitoring location of the JMA. In fact, the wind velocity record for the year 1895 was not available, and so we utilized the wind data from a day when the weather map was similar to the day of the 1895 eruption. As a result of the simulation, we reproduced a similar tephra distribution on the ground to the 1895 eruption introduced in Kochibe (1896) assuming the height of the volcanic plume to be 9000 m above the vent. Considering both the updated isopach map shape and the thinly spread distribution of deposits, the 1895 eruption produced a strong plume.

Keywords: tephra, Zao volcano, volcanic plume

