Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SVC46-P17 Room:Convention Hall Time:May 25 18:15-19:30

The Tephra Fall Simulations of the Ignimbrite Eruption of Aso Volcano

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For aviation safety, Tokyo Volcanic Ash Advisory Center (Tokyo VAAC) of Japan Meteorological Agency (JMA) operates the tephra prediction system using the Global Atmospheric Transport Model (JMA-GATM) in which JMA Global Forecast or JMA Global Analysis (JMA, 2013) is applied to the atmospheric conditions. JMA-GATM calculates the time evolution of tephra dispersal due to the advection by wind, the diffusion, the gravitational settling, and the wet/dry deposition. Using this model, we have performed the tephra fall simulations for possible ignimbrite eruption (Tatsumi et al, 2014) at Aso volcano in Japan.

The ignimbrite eruptions had been occurred 4 times at the Aso volcano in the past 300,000 years. The Aso-4 ignimbrite eruption (90ka) is considered to be largest among these four eruptions. The tephra particles from this eruption were distributed widely in Japan (Aso-4 tephra); the tephra fall deposits in Hokkaido (1700km far from the volcano) have thickness of about 15cm. In this study, we performed the numerical simulations of tephra fall for the ignimbrite eruption whose intensity is comparable with the Aso-4. In these simulations, it is assumed that the constant emission of the tephra continues for 20 hours, and the total amount of tephra is $7.2*10^{14}$kg.

In JMA operation, an initial distribution of tephra particles for JMA-GATM is given from the estimation using the eruption column model (Suzuki, 1983) or the satellite observation. In the present study, we carried out a numerical simulation of eruption cloud using three-dimensional fluid-dynamics model (Suzuki et al, 2005) in order to estimate an accurate initial distribution of tephra particles. The tracer distribution at 3.5 hours from the initiation of eruption which are obtained from the 3D simulation is used as an initial setting for JMA-GATM. Because JMA-GATM calculates the time evolution of the tephra particles which are advected by wind, the particles with a large velocity difference from the wind are eliminated from initial setting. Using JMA-Global forecast at 12UTC 3 April 2014 as meteorological field, the 3 days tephra forecast starting at 3.5 hours from the initiation of eruption is computed by JMA-GATM. Under this condition, the tephra particles are transported by the mid-tropospheric southwest wind and widely deposited in Japan. The simulation results show the tephra fall deposits of 10 cm in Hokkaido, which is consistent with the geological survey of Aso-4 tephra. In addition, we performed a parametric study of meteorological field with the same initial distribution of tephra. The simulation results indicate that the depositional pattern of fallout largely depends on the meteorological field. In some cases, the most of the tephra particles are settled not on the land in Japan but on the Pacific Ocean.

Keywords: Atmospheric Transport Model, ignimbrite eruption, tephra, tephra fall, numerical simulation