Geophysical Research Abstracts
Vol. 16, EGU2014-10145-2, 2014
EGU General Assembly 2014

3D numerical simulations of dispersion of volcanic ash using a Lagrangian model

Yujiro Suzuki and Takehiro Koyaguchi
The University of Tokyo, Earthquake Research Institute, Tokyo, Japan (yujiro@eri.u-tokyo.ac.jp)

Dispersion of volcanic ash largely depends on the atmospheric wind speed and eruption intensity. In general, when the atmospheric wind is weak and/or eruption intensity is strong (i.e., magma discharge rate is small), the volcanic plume is characterized by the formation of umbrella cloud and the particles (i.e., volcanic ashes) are transported by the gravity current of umbrella cloud. On the other hand, if the wind is strong and/or eruption intensity is weak, the volcanic plume tends to be distorted by wind and the particles are drifted mainly by the wind. Because these effects of gravity current and wind also change depending on the particle size, it is difficult to quantitatively predict the distributions of particles suspended in the atmosphere and those deposited on the ground. In this study, we are developing a 3-D numerical model which directly simulates the ash transport and deposition.

The model is designed to simulate the injection of a mixture of solid pyroclasts and volcanic gas from a circular vent above a flat surface in a stratified atmosphere, using a combination of a pseudo-gas model for fluid motion and a Lagrangian model for particle motion. During fluid dynamics calculations, we ignore the separation of solid pyroclasts from the eruption cloud, treating an eruption cloud as a single gas with a density calculated using a mixing ratio between ejected material and entrained air (Suzuki et al., 2005, JGR). In order to calculate the location and movement of ash particles, we employ Lagrangian marker particles of various sizes and densities. The marker particles are ejected from the vent with the same velocity of the eruption cloud every 2 sec. The particles are accelerated or decelerated by the drag force on the spheres and fall to the ground with their terminal velocities.

We carried out a simulation of a small-scale eruption in the strong wind fields with the magma discharge rate of 2.5 x 10^6 kg/s. The rising plume is largely distorted by wind and shows a bent-over trajectory. Subsequently, the plume stops rising and a horizontally moving cloud develops at 6-8 km asl. The simulation results of Lagrangian particles suggest three classes in terms of dispersal behavior. The coarse particles separate from the rising plume (class I); they have terminal velocity greater than the average rising velocity of the plume. On the other hand, the fine particles are transported up to the top of the cloud and suspended into the horizontal flow (class III); they have terminal velocities that are substantially smaller than the velocities of the turbulence inside the cloud. Between these two classes, class II particles are transported to the top of cloud but gradually separate from the horizontally moving cloud; their terminal velocities are smaller than the average rising velocity of the plume but greater than the velocities of the turbulence.