Numerical simulations of blast waves induced by volcanic eruptions

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Propagation of blast waves induced by explosive-type volcanic eruption is studied at the Shock Wave Research Center, Institute of Fluid Science, Tohoku University. One of the main objectives of the study is to produce hazard maps for disasters caused by the flow and the pressure behind the blast wave. In this study, an imaginary eruption of Mt. Fuji is numerically simulated and hazard maps are produced.

In this study, the viscosity and the heat conduction are neglected. Therefore, the basic equations are the three dimensional (3D) Euler equation, together with the conservation equations of mass and energy. The equation of state for an ideal gas is used to close the system of the equations. The numerical integration is done by using the finite volume method (FVM) and the Weighted Averaged Flux (WAF) scheme developed by Toro is employed for evaluating the inter-cell numerical fluxes.

Blast waves reflect at the complex terrain and change its strength. It is, therefore, important to take the real ground shape as accurately as possible in the numerical simulations. The digital elevation maps for the area around Mt. Fuji are used to construct the ground surface mesh. The final 3D volume meshes cover the area of 5km by 5km and the altitude of up to 10 km. The number of grid points used is 800,000 (100 x 100 x 80).

Several eruption models describing how the energy is released during the eruption are proposed. The high-pressure-container model, in which an imaginary container located at the eruption site is filled with high pressure gas and it suddenly releases the gas simulating the volcanic eruption, is the simplest one. This eruption model is mainly used in the present study after some comparisons with others.

Taniguchi studied the correlation between the maximum overpressure observed behind the blast wave and the types and degree of volcanic disasters. The method is used to produce hazard maps in this study.