

Simulation and visualization of a pyroclastic surge

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Pyroclastic surges are flows of a gas-particle mixture that spread over the ground's surface during some volcanic eruptions. Pyroclastic surges rush down the mountainside at speeds of up to a few hundreds meter per second and reach the towns that lie at the foot of the volcano while they are still very hot. Over the years, pyroclastic surges have caused a number of tragedies. For example, a pyroclastic surge occurred at Mont Pelee, on Martinique Island, in 1902, killing about 28000 people. More recently, forty-three people lost their lives when a pyroclastic surge swept them away at Unzen Volcano, in 1991. These facts clearly show that it is important, for disaster mitigation, to understand the dynamics of pyroclastic surges and improve our ability to predict their behavior.

The National Research Institute for Earth Science and Disaster Prevention (NIED) is currently developing a numerical model to simulate and visualize a pyroclastic surge. This work is being conducted as part of a project entitled, 'Study on the prediction of volcanic eruptions'. One of this project's main aims is to provide useful information for disaster mitigation in Japan. An important aspect of this project is the creation of an informative movie using simulation data, which will allow people who have seldom, or never, experienced a volcanic eruption to better grasp volcanic phenomena and the consequent disasters.

Our numerical model solves three-dimensional Navier-Stokes equations with a realistic topographic data at Unzen Volcano. We adopt neither the Boussinesq approximation nor hydrostatic approximation. The effect of subgrid-scale turbulence is evaluated by the Smagorinsky model. Solid particles in a pyroclastic surge are assumed to be so fine that the gas-particle mixture can be regarded as a homogeneous single-phase fluid.

We visualize simulation data by making snapshots with POV-Ray and connecting them to produce a movie file with AVI Maker. POV-Ray, which stands for Persistence of Vision Ray Tracer, is a freely distributed software program for computer graphics with a ray-tracing function. POV-Ray allows us to easily make a realistic figure from simulation data.

By combining these visualized data with other computational techniques, we hope to provide the public with a very useful tool to distribute helpful information for disaster mitigation.