Sensitivity study of numerical weather-model parameters for quantitatively estimating ash concentration in the atmospheric surface layer with a computational ash dispersion model, FALL3D

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An estimation of ash concentration in the atmospheric surface layer, which is the lower part of the planetary boundary layer (PBL), is of practical interest in discussion on volcanic ash impacts on critical infrastructure. For estimating ash concentration in the atmosphere, numerical simulations with an ash transport- and deposition-model have become a powerful tool (e.g. Folch 2012). However, the performance of such simulations for the surface layer has not fully understood, while that for the atmosphere and the ground deposition have been actively examined. This might due to the complicated interaction between the ass dispersion- and meteorological-processes near the ground, suggesting that the accurate description of meteorological condition must be vital for such simulations.
Thus, we have carried out sensitivity study of numerical-weather model parameters for predicting the ash concentration in the atmospheric surface layer in the present study.

We consider a test case corresponding to the eruption at Mt. Shinmoe-dake on January 2011; the eruption column height is approximately 8000m and the total mass flow rate is about 5e9 kg during 2 hr.
We have used two models to examine the interaction between dispersion- and meteorological- processes: one is the CRIEPI weather forecasting and analysis system, NuWFAS, which consist of a numerical weather model, WRF, and some pre- and post-processing tools; the other is an ash transport- and deposition-model, Fall3D. In the numerical weather simulations with NuWFAS, the horizontal- and vertical-grid spacing is varied from 2.5 km to 10km and from 100 m to 500 m, respectively, to check the grid dependency. Two PBL scheme is used to discuss the implications for the turbulence diffusion coefficient in the planetary boundary layer.

After verifying the capability of this setup through the comparison with the observations of isomap of ash deposition, we discuss the predicted ash concentration in the atmospheric surface layer in detail; the time-series of ash concentration near the ground, especially near the vent, depict complex wave forms and there values fluctuates; this is due to the change in the advection and turbulence diffusion processes of volcanic ash. The numerical-weather prediction parameters decidedly affect wind speed and directions and also turbulence diffusion coefficients in the PBL, which have important roles in the advection and diffusion processes. Thus, such parameters have also effects on quantitative estimation of ash concentrations in the surface layer.

More details will be presented in a full paper, and we believe that our study must be helpful to develop computational ash transport- and deposition-models.