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The interaction between volcanic eruption clouds and the phase change of water: a numerical study

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Moist process strongly affects volcanic eruption clouds into the atmosphere. Eruption clouds rise by thermal energy which is supplied from both magma in underground and water vapor in a moist atmosphere. A two-dimensional numerical model which includs cloud microphysics and physical processes of volcanic material is developed to study how moist process affects development of eruption clouds and pyroclastic surges.

Numerical simulation clearly shows that the latent heat of condensation is important to raise eruption clouds higher. That water vapor in the low level atmosphere which is entrained into eruption clouds mainly causes condensation. The clouds can rise twice as high as that of no condensation. The results of sensitivity tests are summarized as follows. The experiments with profiles of various seasons indicated that the clouds height considerably varies with seasons (higher in summer and lower in winter). The clouds rise higher because the clouds obtain more water vapor in the summer than in the winter. Eruption clouds with generating a lapilli ascend higher than that without the lapilli. This is because generated lapilli fell quickly, and eruption clouds obtain positive buoyancy.

In addition, the evaporation of rain water is identified as a new physical process that induce a cold wet pyroclastic surge. The behavior of this type of surges, which we name ``moist ash flow'', resembles that of the surge of cold air under active thunder clouds.