1D particle model for vertiacal non-uniform bubble coalescence

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Bubble coalescence deeply affects the dynamics of conduit flow during volcanic eruption.

Previously, the theory assuming nonuniform coalescence has been used.(Macini et al., 2016, etc.). However, in the outgassing process, non-uniform bubble coalescence is considered important in the radial direction and vertical direction of the conduit, the model cannot deal with the coalescence process.

In this study, we construct a simple model that describe a bubble as a particle moving on a one-dimensional line, particle coalesces when particles contact with each other, and calculates the bubble size distribution in a nonuniform coalescence process in the vertical direction.

The particles have a speed corresponding to the size (buoyancy), and the size increases with the altitude and time (expansion / growth). Note that this model is equivalent to the model by Meakin (1989) when bubble growth and advection are not considered. The particles are fed to the lower end of the system at a constant rate (foaming).

Numerical calculation was carried out by broadly controlling the time scale of foaming, rising buoyancy, expansion and growth.

As a result, there was a parameter range where foaming and coalescence are balanced, and it was found that the size distribution shows a dynamic scaling rule regardless of the fluctuation of the radius and number of particles to be supplied.

The relational expression between the expansion and growth exponential law and the vertical scaling index is derived from the conservation law under the assumption that the size distribution is self-similar.

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