Super Droplet Method for the Numerical Modeling of Clouds and Precipitations

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The formation of clouds and the development of precipitation are essentially mutiscale-multiphysics phenomena. The macro-scale processes such as the fluid motion of air associated with clouds is called 'cloud dynamics' and the micro-scale processes such as the nucleation growth, and coalescence of water droplets are called 'cloud microphysics'. These two processes mutually affect each other and we need accurate numerical simulation methods for the both processes and their interactions to understand and predict cloud-formation and precipitation phenomena.

Cloud dynamics model to describe the fluid motion of atmosphere has been well developed so far. However, it is still difficult to perform the accurate simulation of cloud microphysics, though several simulation methods, such as bulk parameterization, spectral (bin) method, and exact Monte Carlo method, have been proposed.

We newly develop a novel simulation model of cloud microphysics, called Super-Droplet Method, which enables accurate calculation for the dynamics, nucleation, and coalescence of all droplets with reasonable cost in computation. The methodology to couple between the super-droplets and the non-hydrostatic cloud dynamics is also developed. The practicality of this new cloud model is demonstrated by the regional simulations of cloud formation and precipitation. The new model could be useful for weather forecast, the optimization of artificial rain, and the accurate prediction of global warming.

The detail algorithm and the results of testing simulation for the new model will be presented.