## MMM SEMINAR SERIES

## 20th anniversary of the super-droplet method

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The super-droplet method (SDM) is a Lagrangian particle-based numerical algorithm designed to model cloud microphysics and its coupling with cloud dynamics. It was 2005 when I joined Dr. Kanya Kusano's group at the Earth Simulator Center, JAMSTEC, Japan. With an eye on the future of supercomputers, we worked on creating novel numerical algorithms for multiscale-multiphysics phenomena. SDM was one of the significant outcomes of our efforts.

In Shima et al. (2009), we discussed the general framework of SDM and key algorithms required for its numerical implementation. Instead of applying Eulerian mixing ratios for various predefined cloud condensate and precipitation categories (cloud water, rain, cloud ice,

snow, graupel, hail), SDM applies point particles, referred to as super-droplets or super-particles, to represent the enormous number of aerosol, cloud, and precipitation particles present inside the simulated domain of a cloud model. The super-particles are traced in

physical space using the model-predicted flow field, and they grow or shrink as they move with the flow. The treatment of particle collision-coalescence was challenging, so we constructed an efficient Monte Carlo algorithm to address it. In SDM, the fundamental process rate equations are directly solved, allowing us to seamlessly simulate various cloud related phenomena from the aerosol scale to convective scale.

SDM offers significant advantages over Eulerian approaches typically used in cloud models, but it took a long time for the idea to gain acceptance within the atmospheric science community. Today, Lagrangian particle-based cloud models are being used widely for various

applications, and SDM has become synonymous with them. In this talk, I will present an overview of recent advances and applications of the Lagrangian particle-based cloud models. Those include applications to warm-rain development studies, inclusion of habit prediction and

proper representation of various ice growth mechanisms, and refinement of the numerical algorithms.

## Thursday, 20 March 2025, 2:00PM

Refreshments 1:45PM

Please also join colleagues for refreshments and informal discussion after the seminar until 3:30pm

NCAR-Foothills Laboratory, 3450 Mitchell Lane

FL2-1022, Large Seminar

Seminar will also be live webcast

https://sundog.ucar.edu/public/page/MMM

Participants may ask questions during the seminar via Slido.

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