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Super-droplet method as a versatile numerical approach for representing aerosol-cloud-aerosol interactions.

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Aerosol interacts with clouds by serving as cloud condensation nuclei (CCN). Its physical and chemical properties are one of the factors defining cloud droplet size distribution. On the other hand, clouds process atmospheric aerosol taking part in its wet deposition and CCN regeneration through evaporation of cloud droplets and drizzle. Physical and chemical properties of the regenerated CCN may be altered if the evaporated droplets go through collisional growth or irreversible chemical reactions.

The main challenge of representing these aerosol-cloud interactions in a numerical cloud model stems from the need to track the properties of the drop nuclei throughout the cloud lifecycle. A class of methods allowing such studies is the Lagrangian particle-based simulation technique. In a simulation of cloud, each modeled particle represents a multiplicity of particles of the same nucleus type, position and size. During the simulation particle sizes change in a continuous way from CCN-sized to rain drop particles. Tracking microphysical properties of modeled particles is an inherent feature of the particle-based frameworks, making them suitable for studying aerosol-cloud-aerosol interactions.

Super-droplet method is a Lagrangian technique introduced by Shima et al. (2009) featuring an efficient Monte-Carlo type solver for particle coalescence. In this study a new implementation of the super-droplet method, using the kappa-Koehler parametrisation of aerosol composition and an aqueous chemistry module for representing irreversible oxidation, will be presented. Components of the developed model will be discussed using a single-eddy prescribed-flow framework, focusing solely on the microphysical aspects of simulations. Example case will mimic a Stratocumulus cloud and depict cloud-aerosol interactions resolved by the model.