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Simulating cloud drop collision in an ABC-flow

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Due to the global atmospheric electric circuit, electrical charge can be present even in fair weather clouds. Even though, this charge is small compared to thunderstorm clouds, it can still have a significant effect on the interaction of cloud drops. Two charged drops with a small separation distance experience an attractive force due to the electrical charge, increasing the probability of them to collide. Therefore, the production of larger drops is accelerated which eventually could affect the rain production process.

In our project we are developing a numerical model for the interaction of charged cloud drops which calculates the position of individual drops based on the electrical force between them and the aerodynamical force due to the wind field. In order to provide realistic turbulence conditions, the code will be coupled with a Direct Numerical Simulation of a turbulent flow. This will enable us to study the effect of electrically charged cloud drops on the size spectrum and rain drop production under several different cloud conditions in a turbulent environment.

In a first step we have developed a Lagrangian particle code which explicitly simulates the collisions of cloud drops of different sizes without considering electrical charge. In this model drops experience Stokes drag due to an ABC-flow. Two drops merge when their surfaces touch and new drops are randomly introduced at a constant condensation rate following a log-normal size distribution. Large drops are removed from the volume as rain drops. The domain size is of the order of several centimeters in each direction with periodic boundaries. This simple setup already delivers interesting insights into the collision behaviour of cloud drops in a turbulence-like flow. First results presented here will be collision efficiencies for pairs of drops with different sizes and the effect of boundary conditions (e.g. initial size distribution, drop density, condensation rate) on the size spectrum. We propose that ABC-flows can provide a useful and extremely low-cost test bed for Lagrangian advection experiments in turbulent flows.