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A New Characterization of Sticking Efficiencies for Graupel-Ice and Snow-Ice Collisions: Derivation and Implementation in a Cloud Model with Hybrid Bin/Bulk Microphysics.

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The collision-adhesion process of ice crystals to form snowflakes and graupel pellets is one of the important processes in the growth of precipitation particles in clouds. The collision-rebound of ice particles in presence of supercooled droplets affects deeply the charge separation processes in the convective clouds.

An empirical parametrization of the sticking efficiency for graupel–ice and snow–ice collisions processes is presented. The parametrization infers the sticking efficiency as function of the temperature, collision kinetic energy and surface area. It has been derived from experimental measurements of aggregation efficiency using a 0D simple bin model to interpret the data. We compared our parametrization of sticking efficiency with experimental results to check the robustness of the scheme.

The sticking efficiency scheme has been implemented in a cloud model with hybrid bin/bulk microphysics and an electrification scheme. A simulation of a thunderstorm over the US High Plains has been validated against aircraft, ground-based and electrical observations (e.g. lightning flash rate). We then performed several sensitivity tests on the effects from inclusion of realistic sticking efficiencies on the simulated electrical activity. Moreoever, the role of sticking efficiencies in modifying the response of simulated lightning activity to extra aerosols has been investigated with more sensitivity tests.