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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The response of precipitation to aerosol through riming and melting in deep convective clouds" *by* Z. Cui et al.

Anonymous Referee #2

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The manuscript addresses a very important question within the cloud modeling community: How do aerosol perturbations affect the vigor of deep convective clouds and the resulting cumulative precipitation and precipitation intensity. Various modeling studies (e.g., *Khain et al.*, 2004; *Fan et al.*, 2009; *Khain and Lynn*, 2009), in addition to the conceptual review of *Rosenfeld et al.* (2008) have analyzed this problem in detail. Previous studies have shed light on the significance of relative humidity, vertical wind shear, and microphysical model (i.e., bin or bulk microphysics) on the aerosol-induced effect on deep convective clouds. More specifically, *Fan et al.* (2009) demonstrated that the effect of increases in the aerosol number concentration may increase precipitation in low shear environments, while the effect may be reversed, i.e., precipitation decreases with an increase in aerosol loading, in high shear environments. Since the sign of the aerosol-induced effect is strongly linked to the magnitude of the vertical

wind shear, the use of a three-dimensional (3D) dynamical core is necessary to fully resolve the dynamical effects of changes in aerosol number concentration the inherent lack of symmetry. In the absence of any horizontal winds, one can imagine that a convective cell could remain symmetric as it evolves. However, e.g., *Khain and Lynn* (2009), even if the initial thermal perturbation is symmetric, the resulting storm is not symmetric as a result of shear and dynamical feedbacks caused by phase changes in and around the cloud. These features cannot be captured with a 2D axisymmetric model. Hence, given the demonstrated importance of shear in a 3D model (*Fan et al.*, 2009) and the use of a less sophisticated, 2D axisymmetric model in the current manuscript, it is recommended that the work not be accepted for publication in ACP.

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