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Aerosol- and updraft-sensitive regimes of convective mixed-phase cloud formation: case studies and process analysis

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Clouds have great influence on the vertical redistribution of energy and moisture, and consequently have impacts on weather and climate change from regional to global scales. Biomass burning is an important factor that could affect deep convection in clouds, and within this work, we used the ATHAM (Active Tracer High Resolution Atmospheric Model) model to study the properties of pyro-convective clouds and precipitation in 2- and 3-dimensional simulations. The two-moment microphysical scheme of Seifert (2002), including the hydrometeor categories cloud water, rain water, cloud ice, snow, graupel and hail, was utilized to investigate the interaction between atmospheric aerosols and cloud microphysics. The Chisholm fire that occurred in Alberta, Canada, in May 2001 was used as a base case. By assuming typical aerosol concentration conditions, we calculated the cloud droplet number concentrations under different fire intensity conditions and evaluated the effects of aerosol concentration and fire intensity on the formation of precipitation. The simulation results showed different control regimes for cloud and precipitation formation, including an aerosol-limited regime, a fire intensity-limited regime and a transitional regime, which are consistent with the results from a recent parcel model study (Reutter et al 2009).