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Aerosol Indirect Forcing of Deep Convective Storm Dynamics

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Aerosol indirect effects can influence a number of the dynamical aspects of deep convective storms through their impacts on the thermodynamical and radiative processes of such storms. Variations in the drop and ice crystal size distributions influence evaporation and melting rates and hence the intensity and dynamics of the storm-produced cold pool. Such aerosol-induced changes to the cold pool characteristics may influence the manner in which storm outflow boundaries interact, the frequency, organization and intensity of subsequent convection, and the longevity of the parent convection, especially in regions in which multiple convective storms develop simultaneously. Variations in the melting rate of ice species such as graupel and hail can also influence other dynamical features of organized deep convection such as rear inflow jet, which in turn has implications for squall line intensity and bowing.

Variations in aerosol number concentrations can also impact the updraft strength through changes to latent heat release and condensate loading. Changes in the updraft strength are associated with changes in the convective mass flux, anvil thickness, and detrainment and subsidence rates. Such deviations in the anvil characteristics produce changes in the anvil radiative forcing with subsequent feedbacks to static stability and updraft modulation. Altering the detrainment and subsidence rates of deep convective systems may also influence the development of neighboring convective cells. It is thus apparent that enhanced aerosol concentrations may have significant effects not only on the storm of interest, but also on neighboring convective storms and secondary convective development through their influence on anvil and cold pool dynamics. The aerosol-induced cold pool and anvil feedbacks to storm intensity and longevity may vary significantly both in magnitude and sign, thus potentially offsetting one another. The results of several idealized cloud-resolving simulations designed to assess the impacts of aerosol-induced changes in cold pool and anvil forcing on storm intensity and longevity will be presented.