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The role of aerosol spatial inhomogeneity in mixed-phase deep convective clouds and torrential rain in urban areas

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This study examines the role played by aerosol in mixed-phase deep convective clouds and torrential rain that occurred in the Seoul area, which is a conurbation area where urbanization has been rapid in the last few decades, using cloud-system resolving model (CSRM) simulations. The model results show that the spatial variability of aerosol concentrations causes the inhomogeneity of the spatial distribution of evaporative cooling and the intensity of associated outflow around the surface. This inhomogeneity generates a strong convergence field and the associated spatial inhomogeneity of condensation, deposition and associated cloud mass, leading to the formation of torrential rain. With the increases in the variability of aerosol concentrations, the occurrence of torrential rain increases. This study finds that the effects of the increases in the variability play a much more important role in the increases in the intensity of mixed-phase clouds and torrential rain than the much-studied effects of the increases in aerosol loading. Results in this study demonstrate that for a better understanding of extreme weather events such as torrential rain in urban areas, not only changing aerosol loading but also changing aerosol spatial distribution since industrialization should be considered in aerosol-precipitation interactions.