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The effect of aerosol-derived changes in the warm phase on the properties of deep convective clouds

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The aerosol impact on deep convective clouds starts in an increased number of cloud droplets in higher aerosol loading environment. This change drives many others, like enhanced condensational growth, delay in collision-coalescence and others. Since the warm processes serve as the initial and boundary conditions for the mixed and cold-phase processes in deep clouds, it is highly important to understand the aerosol effect on them.

The weather research and forecasting model (WRF) with spectral bin microphysics was used to study a deep convective system over the Marshall Islands, during the Kwajalein Experiment (KWAJEX). Three simulations were conducted with aerosol concentrations of 100, 500 and 2000 cm-3, to reflect clean, semipolluted, and polluted conditions. The results of the clean run agreed well with the radar profiles and rain rate observations. The more polluted simulations resulted in larger total cloud mass, larger upper level cloud fraction and rain rates. There was an increased mass both below and above the zero temperature level. It indicates of more efficient growth processes both below and above the zero level. In addition the polluted runs showed an increased upward transport (across the zero level) of liquid water due to both stronger updrafts and larger droplet mobility.

In this work we discuss the transport of cloud mass crossing the zero temperature level (in both directions) in order to gain a process level understanding of how aerosol effects on the warm processes affect the macro- and micro-properties of deep convective clouds.