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# Do aerosols matter in the context of deep convective clouds?

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The simple answer to whether aerosols matter in the context of deep convection is ‘yes’, namely in their ability to serve as cloud condensation and ice nuclei, providing the necessary seeds to form liquid and ice under normal atmospheric conditions. However, beyond their basic role as seeds for cloud formation, do they really matter in deep convective clouds? Do changes in their abundance play a major factor in the characteristics of deep convective clouds and mesoscale dynamics?

To address these questions, I begin with an overview of viable physical mechanisms by which changes in aerosol loading can indirectly affect deep convection, focusing primarily on updraft strength and precipitation using 3D cloud-resolving simulations of both supercells and squall lines. The two main methods are “invigoration”, which is related to increased latent heating and subsequent increases in buoyancy and updraft strength, and cold pool changes, which are caused by changes in the rain drop size distribution and the generation of negative buoyancy via evaporation. The simulations suggest a larger influence on convective storm dynamics due to the indirect effects on cold pools. Regardless of the dominant mechanism, the responses in updraft velocity are found to be quite small and vary as a function of the environmental conditions, e.g., low-level wind shear, humidity, and convective available potential energy, which begs the question, can these aerosol-induced effects be observed in deep convective clouds?

To address this follow up question, I present findings from a highly idealized but accurate numerical approach to examine changes in updraft velocities in deep convective updrafts due to differences in updraft slope, updraft width, and aerosol-induced warming, i.e. invigoration. Because updraft width and slope are tightly coupled to the ambient environmental conditions, this approach provides a rigorous way to examine potential indirect impacts of changes in aerosol loading on updraft velocities relative to those expected from changes in environmental conditions, which vary both spatially and temporally. The results of the idealized modeling indicate that it is highly unlikely that invigoration was observed because miniscule changes in updraft width and slope are found to overwhelm the impact of aerosol-induced warming aloft.