Aerosol Control on Cloud Depths for Onset of Warm Rain in Convective Clouds

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Aircraft measurements of CCN (cloud condensation nuclei) aerosols and microphysical vertical profiles of convective clouds were conducted over India during CAIPEEX-I experiment (Cloud Aerosol Interaction and Precipitation Enhancement Experiment). As expected, greater CCN concentration gave rise to clouds with smaller drops at greater number concentrations. The cloud drop effective radius (r_e) increased with height above cloud depth (D). Warm rain was formed at the tops of growing convective clouds when r_e for onset of rain, r_e*, exceeded 12 to 14 μm, regardless of the CCN concentrations, Nc and D. Larger Nc incurred greater D for reaching the onset of warm rain, denoted as D*. In the extreme case, in highly polluted and moist air that formed the monsoon clouds over the flooded Indo-Gangetic plains D* exceeded 6 km, well above the 0°C isotherm level. The precipitation particles were initiated there as supercooled rain drops at temperature of -8°C. Giant CCN lowered r_e* and D*, respectively. This effect was insignificant or minor except for very large concentrations from sea salt aerosols.