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Conditional Impact of Aerosol on Cloud and Precipitation Revealed from Observations

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Aerosol particles can affect cloud and precipitation via various mechanisms by altering both the thermodynamic state of the atmosphere and cloud micro- and macro-physics. Apparently, different mechanisms lead to different types of impact that may suppress or foster cloud processes and precipitation. Aerosol reduces the amount of solar radiation reaching ground, reducing sensible and latent heat fluxes. For absorbing aerosol, it warms up the atmosphere. Together, they inhibits convection and convective clouds and precipitation. By serving CCN, it reduces cloud droplet size and suppress drizzle but may enhance heavy precipitation due to the invigoration effect. While it is unclear if aerosol changes total rainfall amount, but it surely change the distribution of precipitation. It is an essential but a challenging task to sort out the various effects. To tackle the problem and unravel various complex relations, data from both long-term routine measurements and intensive field experiments have been analyzed, together with some modeling studies. In this talk, I will summarize major findings drawn from several analyses using long-term acquired in US (ARM) and operational meteorological data in US, experiments in China and global satellite data from CloudSat, CALIPSO and MODIS. The key finding is that absorbing aerosol suppresses both light and heavy rains, whereas scattering aerosol of strong hygroscopicity inhibits light rain but enhance heavy rain.