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A numerical study of the heating effect of mineral aerosols on cloud and precipitation

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There have been numerous recent publications showing that mineral dust might be a good absorber for solar radiation in addition to its capability as cloud condensation nuclei (CCN) and ice forming nuclei (IFN), and could lead to reduced cloud cover and precipitation in the region it presents. This effect is investigated by using a cloud model with detailed microphysics of both warm and ice phase processes. The model is initialized using measured distributions and concentration of mineral dust particles. Our results show that when the dust layer with peak concentration appears at the cloud-base height and below 3 km, where the temperature is warmer than -5^{o}C, evaporation caused by higher temperature inhibits the development of cloud particles and precipitation, and together with early activation of larger cloud droplets on giant cloud condensation nuclei, which accelerates drizzle formation through collision coalescence process, reduces the cloud optical depth and albedo. It is also found that only when the dust layer locates at altitudes with temperature colder than -5^{o}C, mineral aerosols can act as effective ice nuclei and intensify the ice-forming processes. Under this condition, the existence of dust layer can either increase or decrease cloud optical depth and albedo, depending on the concentration and chemical composition of the absorbing components, or the time the mineral aerosols suspended in the atmosphere.