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A Numerical Study of the Effect of Different Aerosol Types on East Asian Summer Monsoon Clouds and Precipitation

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In this study, the anthropogenic aerosol impact on the summer monsoon clouds and precipitation in East Asia is investigated using the NCAR Community Atmospheric Model version 5 (CAM5), a state-of-the-art climate model considering aerosol direct, semi-direct and indirect effects. The effects of all anthropogenic aerosols, and anthropogenic black carbon (BC), sulfate, and primary organic matter (POM) are decomposed from different sensitivity simulations. Anthropogenic sulfate and POM reduce the solar flux reaching the surface directly by scattering the solar radiation, and indirectly by increasing the cloud droplet number concentration and cloud liquid water path over East China. The surface air temperature over land is reduced, and the precipitation in North China is suppressed. Unlike anthropogenic sulfate and POM, anthropogenic BC does not have a significant effect on the all-sky solar flux and the air temperature at the surface, because of the weakening of shortwave cloud forcing and the reduction of the cloud liquid water path by its semi-direct effect. The anthropogenic BC strengthens the southwesterly wind over South China and leads to stronger deep convection at the 25°N to 30°N latitudinal band, while its effect on the precipitation change is not statistically significant. The effect of all anthropogenic aerosols on air temperature, clouds, and precipitation is not a linear summation of effects from individual anthropogenic sulfate, BC and POM. It resembles the effect of anthropogenic sulfate and POM more closely than that of anthropogenic BC. Overall all anthropogenic aerosols suppress the precipitation in North China and enhance the precipitation in South China and adjacent ocean regions.