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Understanding of aerosol-cloud-climate interactions using the atmospheric climate chemistry EMAC model

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We use the EMAC atmospheric chemistry-climate model to simulate clouds and climate with a prognostic cloud droplet nucleation (CDN) scheme. The CDN scheme takes account of aerosol physical and chemical properties and meteorological condition in the calculation of aerosol activation as a cloud condensation nuclei (CCN). This study presents simulated global distributions of CCN number concentration, CCN activation rates, and the effective hygroscopicity parameter kappa, which represents aerosol chemical composition effects in the calculation of CCN activation. Activated aerosols during droplet formation demonstrate the dominant size effects of large particles and the largest sensitivity of aerosol chemistry effects on small particles. The calculated shortwave cloud radiative effects at the top of the atmosphere show sensitively responding to changes in activated aerosols. The simulated cloud and climate properties generally show good agreement with observations, and improvements particularly over air pollution regions in the Northern Hemisphere compared to the simulation which is not allowed the feedback between aerosol and cloud interactions. We also found sensitive regions to aerosol-cloud-climate interactions via a sensitive test, which simulates clouds with the fixed mean hygroscopicity parameters for lands and oceans in the calculation of CCN activation.

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