EGU2020-12070
https://doi.org/10.5194/egusphere-egu2020-12070
EGU General Assembly 2020

Effect of Aerosol Particles on Orographic Clouds: Sensitivity to Autoconversion Schemes

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Aerosol particles can serve as cloud condensation nuclei (CCN) to influence orographic clouds. Autoconversion, which describes the initial formation of raindrops from the collision of cloud droplets, is an important process for aerosol–cloud–precipitation systems. In this study, seven autoconversion schemes are used to investigate the impact of CCN on orographic warm-phase clouds. As the initial cloud droplet concentration is increased from 100 cm^{-3} to 1000 cm^{-3} (to represent an increase in CCN), the cloud water increases and then the rainwater is suppressed due to a decrease in the autoconversion rate, leading to a spatial shift in surface precipitation. Intercomparison of the results from the autoconversion schemes show that the sensitivity of cloud water, rainwater, and surface precipitation to a change in the concentration of CCN is different from scheme to scheme. In particular, the decrease in orographic precipitation due to increasing CCN is found to range from −87% to −10% depending on the autoconversion scheme. Moreover, the surface precipitation distribution also changes significantly by scheme or CCN concentration, and the increase in the spillover (ratio of precipitation on the leeward side to total precipitation) induced by increased CCN ranges from 10% to 55% under different autoconversion schemes. The simulations suggest that autoconversion parameterization schemes should not be ignored in the interaction of aerosol and orographic cloud.