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Effects of the critical supersaturation algorithm on the CCN activation in the aerosol-cloud-chemistry-climate model EMAC

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Aerosol can influence the cloud properties and cloud radiation budgets as CCN and IN in the cloud formation process and therefore indirectly affect the climate system. To estimate the aerosol indirect effects on clouds and climate, many studies have used regional and global climate modeling as well as laboratory and field measurements. Nonetheless, there is still a lack of the understanding of the aerosol-cloud interaction because of the difficulty in defining their behavior in the cloud formation. The aerosol size has been discussed as a dominant effect on the nucleation process in previous studies, but the effect of aerosol chemical composition has not been thoroughly considered. This study uses the comprehensive aerosol composition and investigates the effect of two different methods to calculate critical supersaturation with the osmotic coefficient (STN) and the κ-method (HYB) on the aerosol activity patterns and cloud properties. The results show that not only physical size, but also chemistry of aerosol is very important in the CCN activation process. Both STN and HYB simulations demonstrate higher activity in larger particles than smaller particles and also show a strong sensitivity to the treatment of the chemistry by differences in the estimated aerosol activities. The activated large particles in coarse mode are nucleated about 32.6% (in HYB) and 60.6% (in STN), while the small particles in Aitken are activated about 8.8% (in HYB) and 18.7% (in STN).