Supporting Information for
[WRF-SBM Numerical Simulation of Aerosol Effects on Stratiform Warm Clouds in Jiangxi, China]

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Supplement

1 Cloud-Rain Auto-conversion Threshold Function

The Cloud-Rain Auto-conversion Threshold Function (T) is an important parameter that measures the automatic conversion of cloud to rain. Its numerical value indirectly indicates the strength of the collision-coalescence process in the cloud (Liu et al., 2005, 2006).

$$T = \frac{P}{P_0} = \left[\frac{\int_{r_c}^{\infty} r^6 n(r) dr}{\int_0^{\infty} r^6 n(r) dr}\right]\left[\frac{\int_{r_c}^{\infty} r^3 n(r) dr}{\int_0^{\infty} r^3 n(r) dr}\right] \quad (S1)$$

$$r_c \approx 4.09 \times 10^{-4} \beta_{con}^{1/6} \frac{N_c^{1/6}}{C_{LW}^{1/3}} \quad (S2)$$

In this context, n(r) represents the cloud droplet spectrum, where r is the cloud droplet radius, rc is the critical radius of the auto-conversion function, and βcon = 1.15×10^{23}. The value of T ranges from 0 to 1, where T = 0 indicates no collision-coalescence process, and T = 1 indicates complete occurrence of the collision-coalescence process. A higher value of T indicates a higher probability of collision-coalescence occurring.

2 Calculation of cloud droplet spectrum parameters

The average cloud droplet diameter (D), cloud droplet volume-weighted radius (rv), standard deviation (σ_c) and cloud droplet spectral relative dispersion (ε) were calculated as follow:

$$D = \frac{1}{N}\sum_{i=1}^{k} r_i n_i \quad (S3)$$

$$r_v = \left(\frac{1}{N} \sum_{i=1}^{k} r_i^3 \, n_i \right)^{\frac{1}{3}} \quad (S4)$$

$$\sigma_c = \left(\frac{1}{N} \sum_{i=1}^{k} (r_i - r_m)^2 n_i \right)^{\frac{1}{2}} \quad (S5)$$

$$\varepsilon = \frac{\sigma_c}{r_m} \quad (S6)$$

ni represents the number concentration of cloud droplets in each size bin (unit: cm^{-3}), N is the total number concentration of cloud droplets (unit: cm^{-3}), ri denotes the particle radius of cloud droplets in each size bin (unit: μm), rv is the volume-weighted mean radius of cloud droplets (unit: μm), σc is the standard deviation of the cloud droplet spectrum (unit: μm), and ε represents the cloud droplet spectral relative dispersion (dimensionless).

3 Cloud Droplet Activation Intensity

Lu et al. (2020) introduced the variable FBS (First Bin Strength), which represents the Cloud Droplet Activation Intensity.

$$FBS = \frac{n_1}{n_c} \quad (S7)$$

n_1 represents the number concentration of the first bin in the cloud droplet spectrum, measured in cm^{-3}. When the value of FBS is larger, it indicates a higher probability of the peak of the cloud droplet spectrum occurring in the first bin, which means there are more small droplets in the cloud. This suggests a stronger influence of aerosol activation or small droplet deactivation.