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Characterization of aerosol hygroscopicity, mixing state, and CCN activity at a suburban site in the central North China Plain

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This study investigates aerosol hygroscopicity, mixing state, and cloud condensation nucleation as part of the Atmosphere–Aerosol–Boundary Layer–Cloud Interaction Joint Experiment performed in the summer of 2016 at Xingtai (XT), a suburban site located in the center of the North China Plain (NCP). In general, the probability density function (PDF) of the hygroscopicity parameter (κ) for 40–200nm particles had a unimodal distribution, and mean κ-PDF patterns for different sizes were similar, suggesting that the particles were highly aged and internally mixed because of strong photochemical reactions. The κ calculated from the hygroscopic growth factor in the daytime and at night suggests that photochemical reactions largely enhanced the aerosol hygroscopicity. This effect became weaker as the particle size increased. In addition, the aerosol hygroscopicity was much larger at XT than at other sites in the NCP. This is because new particle formation takes place much more frequently in the central NCP, which is heavily polluted from industrial activities, than elsewhere in the region. The evolution of the planetary boundary layer played a dominant role in dictating aerosol mass concentration. Particle size was the most important factor influencing the ability of aerosols to activate, whereas the effect of chemical composition was secondary, especially when supersaturation was high. Using a fixed value of $\kappa = 0.31$ to calculate the cloud condensation nuclei number concentration in this region suffices.