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# Size-resolved hygroscopic behaviour and mixing state of submicron aerosols in a megacity of Sichuan Basin during pollution and fireworks episodesn during pollution and fireworks episodes

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In situ measurements are performed to study the size-resolved hygroscopic behaviour of submicron aerosols during pollution and fireworks episodes in winter from late January to February 2019 in Chengdu, a megacity in Sichuan Basin, using a humidity tandem differential mobility analyser (H-TDMA). The H-TDMA is operated at a relative humidity of 90% with dry aerosol diameters between 40 and 200 nm. Three modes of aerosol particles, including nearly hydrophobic mode (NH), less hygroscopic mode (LH), and more hygroscopic mode (MH), are found in the probability distributions of the growth factor (GF-PDF) during the campaign. The GF-PDF shows that aerosol particles are usually externally mixed. The average ensemble mean hygroscopicity parameter values ($\kappa_{Mean}$) over the entire sampling period are 0.16, 0.19, 0.21, 0.23, and 0.26 for aerosols with diameters of 40, 80, 110, 150, and 200 nm, respectively. These averages are lower than those in Shanghai and Nanjing. $\kappa_{Mean}$ for aerosols larger than 110 nm, however, are higher than those in Beijing and Guangzhou during winter. Distinct diurnal patterns for all measured sizes are observed for the number fractions of the NH ($NF_{NH}$) and MH ($NF_{MH}$) modes as well as $\kappa$-PDF and $\kappa_{Mean}$. The $NF_{NH}$ values are lower, but $\kappa_{Mean}$ exhibits peak values during daytime. More aerosols are internally mixed because of photochemical ageing during daytime. The number fraction of LH ($NF_{LH}$) for the 40-nm diameter aerosols in clean periods (CPs) is larger than that in the pollution episode (PEs) because of the increasing amount of SOA formation. More aerosols of diameters larger than 80 nm are internally mixed during CPs and stage of contaminant accumulation, resulting in higher $\kappa_{Mean}$ values compared to those in PEs. The aerosol emissions of fireworks that accumulate during the Chinese New Year's Eve contribute to the slow and continuous increasing trend in $\kappa_{Mean}$ with average values of 0.19, 0.19, 0.21,0.23, and 0.27 for the 40, 80, 110, 150, and 200-nm diameter aerosols, respectively. These values are higher than those during the pre- and post-fireworks days. The hygroscopic properties of submicron aerosols in Chengdu are essential for understanding the formation and evolution of severe haze events in Sichuan Basin.