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Observational Research on Fog Physicochemical Properties in Nanjing, China

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A comprehensive fog in situ observation was carried out at Pancheng in Nanjing area of China during December 2006 and December 2007, including the measurement of fog droplet spectra, surface meteorological elements, boundary layer structure and visibility as well as the collection of fog water. Some new microphysical features and the reasons why low visibility (less than 50 m) lasts for around 40 h in an unusual fog event (12/24/2006-12/27/2006) are examined. The 5-min-average maximum value of liquid water content (LWC) is found extraordinarily higher than 0.5 g m-3. But it is reasonable partly because of high fog top, long-wave radiative cooling, and partly because of the significant positive correlations of number concentration (N) vs. average radius (ra) and droplet spectra standard deviation (SD) vs. ra. The possible causes for the positive correlation of N vs. ra are studied. In general, the development of collision and coalescence can consume small droplets, causing decrease of N and increase of ra. However, due to warm and moist air and sufficient cloud condensation nuclei in this site, small droplets are reproduced through nucleation and condensation. As a result, N is proportional to ra. Furthermore, the correlation between liquid water content (LWC) and N is also positive. Prolonged low visibility is directly caused by the synchronous high LWC and N, and essentially by stable boundary layer structure under the influence of warm advection, sufficient water vapor provided by moisture advection and substantial cloud condensation nuclei (CCN) in the observation site. In addition, with the 37 fog water samples in 9 fog events, fog chemistry is analyzed. Total ionic concentration (TIC), electrical conductivity (EC) in fog samples and local emissions of pollutants are one or two orders of magnitude higher than those found in Europe or South America for instance. Scavenging of NH3 and coarse particles by fog droplets are the main causes for high mean pH value, 5.9 S/LWC (S: the surface area of fog droplets per unit volume of air) is supposed to be a better index to describe the relationship between TIC and microphysics with respect to LWC. A formula between TIC and S/LWC is derived and the related parameters are discussed. Depositions of chemical species by fog events are estimated and result shows that deposition is sufficient.