Geophysical Research Abstracts
Vol. 19, EGU2017-4837, 2017
EGU General Assembly 2017

Chemical and Microphysical Properties of Three-stage Fog Water and Aerosols with Various Sizes in Nanjing

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In the time period of December 7-9, 2013, two deep dense fog events occurred in Nanjing. By using the observational data acquired from a field experiment conducted during this time period, we were able to investigate the contributions from different suspended aerosols with various sizes to the formation of fog droplets as well as the impacts of the ions in condensation nucleus on the chemical properties of the fog water. The field experiment is funded by the National Natural Science Foundation of China in the project namely 'Research on the relationship between chemical compositions of three-stage fog water chemistry and microphysical of fog'. The observational data adopted in the present study consists of the concentrations of the water-soluble ions in three-stage fog droplets and also the particle-size aerosols, number distributions of the aerosol particles, distributions of the fog drop, liquid water content(LWC), visibility, vertical structure of the boundary layer and so on. The micro-physicochemical properties of the three-stages fog water (4-16μm for stage 3, 16-22μm for stage 2, larger than 22μm for stage 1) as well as the particle-size aerosols (Aitken mode, Accumulation mode, Coarse mode) are compared and discussed. The result demonstrates that under the condition of the deep dense fog (visibility$\approx$50m), due to the weakening of the radiation, a stable temperature inversion layer tends to form. As a result, the contaminated aerosols would accumulate and transit to fog droplets. Moreover, it is found that the aerosols in Accumulation mode contribute the most to the increase of the number of the fog droplets in stage-3. In addition, among the fog droplets in these three stages, both of the anions and cations possess the highest concentrations in the droplets in stage-3. In contrast to that, the difference of the anion and cation concentrations between stage-1 and stage-2 is negligible. The results also show that the anion and cation in drop-size fog water mostly originate from the suspended aerosols and the chemical reactions. We also find that the concentration of NO_3- is the highest among all the anions which is followed by SO42-.For the cations, NH4+ has the highest concentration and Ca2+ is the second. At last, it is observed that the fog is acidic (pH=2.7-6.9), and the fog drops with smaller size have relatively stronger acidity.