Impacts of Ammonia on Gas-Particle Partition and AWC during the 2016 APHH-Beijing Campaign: Inducing Effects of Nitrate Ammonium

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Atmospheric NH_3 plays a vital role not only in the environmental ecosystem but also in atmosphere chemistry. To further understand the effects of NH_3 on the formation of haze pollution in Beijing, ambient NH_3 and related species were measured and simulated at high resolutions during the wintertime Air Pollution and Human Health-Beijing (APHH-Beijing) campaign in 2016. We found that the total NHx (gaseous NH_3+particle NH_4^+) was mostly in excess of the SO_4^{2-}-NO_3^--NH_3-water equilibrium system during our campaign. This NHx excess made medium aerosol acidity, with the median pH value being 3.6 and 4.5 for polluted and non-polluted conditions, respectively, and enhanced the formation of particle phase nitrate. Our analysis suggests that NH_4NO_3 is the most important factor driving the increasing of aerosol water content (AWC) with NO_3^- controlling the prior pollution stage and NH_4^+ the most polluted stage. Increased formation of NH_4NO_3 under excess NH^x, especially during the nighttime, may trigger the decreasing of aerosol deliquescence relative humidity (DRH) and hence lead to hygroscopic growth even under lower RH conditions and the wet aerosol particles become better medium for rapid heterogeneous reactions. A further increase of RH promotes the positive feedback "AWC-heterogeneous reactions" and ultimately leads to the formation of severe haze. Both our observational and modelling results suggest that the control of NH_3 emission may be one of the most effective measures in reducing $PM_{2.5}$ under current emissions conditions in the North China Plain (NCP).