Title:	Enhanced secondary aerosol formation driven by excess ammonia during fog episodes in Delhi, India
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Abstract:	The Indo-Gangetic Plain (IGP) has high wintertime fine aerosol loadings that significantly modulate the widespread fog formation and sustenance. Here, we investigate the potential formation of secondary inorganic aerosol driven by excess ammonia during winter fog. Physicochemical properties of fine aerosols (PM1 and PM2.5) and trace gases (HCl, HONO, HNO3, SO2, and NH3) were simultaneously monitored at hourly resolution using Monitor for AeRosols and Gases in Ambient air (MARGA-2S) for the first time in India. Results showed that four major ions, i.e., Cl−, NO3−, SO42−, and NH4+ contributed approximately 97% of the total measured inorganic ionic mass. The atmosphere was ammonia-rich in winter and ammonium was the dominant neutralizer with aerosol neutralization ratio (ANR) close to unity. The correlation between ammonium and chloride was ≥0.8, implying the significant formation of ammonium chloride during fog in Delhi. Thermodynamical model ISORROPIA-II showed the predicted PM1 and PM2.5 pH to be 4.49 ± 0.53, and 4.58 ± 0.48 respectively which were in good agreement with measurements. The ALWC increased from non-foggy to foggy periods and a considerable fraction of fine aerosol mass existed in the supermicron size range of 1–2.5 μm. The sulfur oxidation ratio (SOR) of PM1, PM2.5 reached up to 0.60, 0.75 in dense fog and 0.74, 0.87 when ambient RH crossed a threshold of 95%, much higher than non-foggy periods (with confidence level of ≥95%) pointing to enhanced formation of secondary aerosol in fog.
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