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Investigating the Atmospheric Phase Distribution of Inorganic Reactive Nitrogen Species along the Urban Transect of Indo Gangetic Plains

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Abstract : As a key regulator of atmospheric oxidative capacity and secondary aerosol formations, the signatures of reactive nitrogen (Nr) emissions are becoming increasingly evident in the cascade of air pollution, acidification, and eutrophication of the ecosystem. However, their accurate estimates in N budget remains limited by the photochemical conversion processes where occurrence of differential atmospheric residence time of gaseous (NO_x, HNO_3, NH_3) and particulate (NO_3^-, NH_4^+) Nr species becomes imperative to their spatio temporal evolution on a synoptic scale. The present study attempts to quantify such interactions under tropical conditions when low anticyclonic winds become favorable to the advections from west during winters. For this purpose, a diurnal sampling was conducted using low volume sampler assembly where ambient concentrations of Nr trace gases along with their ionic fractions in the aerosol samples were determined with UV-spectrophotometer and ion chromatography respectively. The results showed a spatial gradient of the gaseous precursors with a much pronounced inter site variability ($p < 0.05$) than their particulate fractions. Such observations were confirmed for their limited photochemical conversions where less than 1 ratios of day and night measurements (D/N) for the different Nr fractions suggested an influence of boundary layer dynamics at the background site. These phase conversion processes were further corroborated with the molar ratios of NO_x/NO_y and NH_3/NH_x where incomplete titrations of NO_x and NH_3 emissions were observed irrespective of their diurnal phases along the sampling transect. Their calculations with equilibrium based approaches for an NH_3-HNO_3-NH_4NO_3 system, on the other hand, were characterized by delays in equilibrium attainment where plots of their below deliquescence K_m and K_p values with 1000/T confirmed the role of lower temperature ranges in NH_4NO_3 aerosol formation. These results would help us in not only resolving the changing atmospheric inputs of reduced (NH_3, NH_4^+) and oxidized (NO_x, HNO_3, NO_3^-) Nr estimates but also in understanding the dependence of Nr mixing ratios on their local meteorological conditions.

Keywords : diurnal ratios, gas-aerosol interactions, spatial gradient, thermodynamic equilibrium
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