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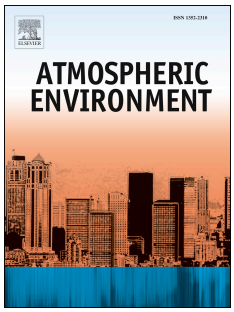

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Sources of chemical species in rainwater during monsoon and non-monsoonal periods over two mega cities in India and dominant source region of secondary aerosols

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Abstract

Samples of rainwater (RW) were collected to characterize the chemistry and sources in two representative megacities at Pune (Southwest) and Delhi (Northern) India from 2011 to 2014 across two seasons: monsoon (MN) and non-monsoon (NMN). Collected RW samples were analyzed for major chemical constituents (F^-, Cl^-, SO_4^{2-}, NO_3^-, NH_4^+, Na^+, K^+, Ca^{2+}, and Mg^{2+}), pH and conductivity. In addition, bicarbonate (HCO_3^-) was also estimated. The mean pH values of the RW were > 6 at Pune and < 6 at Delhi and 4% and 26% were acidic, respectively. The mean sum of all measured ionic species in Pune and Delhi was 304.7 and 536.4 µeq/l, respectively, indicating that significant atmospheric pollution effects in these Indian mega cities. Both the Ca^{2+} and SO_4^{2-} were the dominant ions, accounting for 43% (Pune) and 54% (Delhi) of the total ions. The sum of measured ions during the NMN period was greater than the NM period by a factor of 1.5 for Pune (278.4: NM and 412.1: NMN µeq/l) and a factor of about 2.5 for Delhi (406 and 1037.7 µeq/l). The contributions of SO_4^{2-} and NO_3^- to the RW acidity were ~40% and 60%, respectively, at Pune and correspondingly, 36% and 64% at Delhi. The concentrations of secondary aerosols ($SO_4^{2-}$and NO_3^-) were higher by a factor of two and three when the air masses were transported to Pune from the continental side. At Delhi, the concentrations of SO_4^{2-}, NO_3^-, Ca^{2+}, and Mg^{2+} were significantly higher when the air masses arrive from Punjab, Haryana, and Pakistan indicating the greater atmospheric pollution over the Indo-Gangetic Plain. Positive matrix factorization was applied to the source apportionment of the deposition fluxes of these ions. Three factors were obtained for Pune and four for Delhi. The sources at Pune were secondary aerosols from