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Variation in carbonaceous and ionic species at a rural receptor location in the eastern Indo-Gangetic Plain

Bijay Sharma[1], Anurag J. Polana[1], Jingying Mao[2], Shiguo Jia[3,4], and Sayantan Sarkar[1,5]

[1]Department of Earth Sciences, Indian Institute of Science Education and Research (IISER) Kolkata, India
[2]Institute for Environmental and Climate Research, Jinan University, Guangzhou, PR China
[3]Guangdong Province Key Laboratory for Climate Change and Natural Disaster Studies, Sun Yat-sen University, Guangzhou, PR China
[4]School of Atmospheric Sciences, Sun Yat-sen University, Guangzhou, PR China
[5]School of Engineering, Indian Institute of Technology (IIT) Mandi, Kamand, India

The Indo-Gangetic Plain (IGP) is one of the world's most populated river basins housing more than 700 million people. Apart from being a major source region of aerosols, the IGP is affected by transported aerosols from the Thar Desert, forest-fires and open burning of crop waste from central India. Studies have been carried out to understand the aerosol chemical composition and optical properties in source regions of IGP but knowledge is severely lacking for receptor locations viz. eastern IGP (eIGP). To address this, the present study reports the seasonal variability of carbonaceous and ionic species in ambient $PM_{2.5}$ from a rural receptor location (Mohanpur, West Bengal) along with insights on aerosol acidity, its neutralization and potential source regimes. A total of 88 $PM_{2.5}$ samples collected during the summer, post-monsoon and winter seasons of 2018 were analyzed for SO_4^{2-}, NO_3^-, Cl^-, Na^+, NH_4^+, K^+, Ca^{2+}, Mg^{2+}, F^-,PO_4^{3-}, water-soluble organic carbon (WSOC), organic carbon (OC) and elemental carbon (EC) fractions. Sulfate, nitrate and ammonium (SNA) were the dominating ionic species throughout the seasons (67-86% out of the total ionic species measured). Significant positive Cl^- depletion in summer (49±20%) pointed towards influx of marine air while negative depletion in post-monsoon and winter suggested a biomass burning (BB) source, which was further supported by concentration-weighted trajectory analysis. Strong acidity was found to be highest during post-monsoon (141±76 nmol m^{-3}), followed by winter (117±36 nmol m^{-3}) and summer (40±14 nmol m^{-3}) with significant differences between summer and the other seasons. Neutralization factor (N_f) and equivalent charge ratio of cation to anion ($R_{C/A}$) revealed that summertime aerosols were neutral in nature while those of post-monsoon and winter were comparatively acidic with NH_4^+ being the major neutralizing agent throughout the seasons. Correlations between WSOC and OC fractions (OC1, OC2, OC3 and OC4) suggested secondary formation of summertime WSOC (WSOC vs OC3: r=0.48, p<0.05) via photochemical oxidation of volatile organic carbons (VOCs) while that of post-monsoon (WSOC vs OC1, OC2, OC3: r=0.45-0.62, p<0.05) and winter (WSOC vs OC1, OC2, OC3: r=0.58-0.68, p<0.05), both primary and secondary pathways seem important. To elucidate the role of BB, we looked into the two components of EC i.e., char-EC (EC1-PC) and soot-EC (EC2+EC3). The percent contribution of char-EC to EC was 65±17%, 90±10% and 98±1% during summer, post-monsoon and winter, respectively.

Along with this, char-EC/soot-EC ratios of 2.3±1.8, 17.6±16.4 and 50.3±18.6 during summer, post-monsoon and winter, respectively, and significant correlations of the same with the BB-tracer K^+ (post-monsoon: r=0.78, p<0.001; winter: r=0.64, p<0.01) indicated the importance of BB emissions in constraining carbonaceous aerosol profiles during post-monsoon and winter.