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Light absorption and flouorescence characteristics and chemical composition of brown carbon in $PM_{2.5}$ in Tianjin, North China

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To investigate the physical and chemical characteristics of brown carbon (BrC) in North China, fine aerosols ($PM_{2.5}$) were collected at an urban (Nankai District, ND) in Tianjin, North China from July 2018 to June 2019. The UV absorption and Excitation emission matrix (EEM) fluorescence spectroscopy of BrC in different polar extracts: water and methanol, were obtained using a three-dimensional fluorescence spectrometer. Five nitroaromatic compounds of BrC were quantified using ultra-high-performance liquid chromatography-quadrupole linear ion Trap composite mass spectrometer. On average, the light absorption of water-soluble BrC ($Abs_{365,\ WSBrC}$) and water-insoluble BrC ($Abs_{365,\ WIBrC}$) was distinct from season to season. In addition, correlations between Abs_{365} and OC and WSOC were found to be low, except in autumn and spring, while they were good between Abs_{365} and K^+ and Cl^- in the autumn and spring. The seasonal average AAE of WSBrC varied slightly between 5.10 and 6.15, and the average MAE_{365} values of WSBrC and WIBrC were also showed large seasonal variations, with the highest values in winter (2.41 and 2.90 m^2 g C^{-1}, respectively), followed by spring (1.32 and 2.33 m^2 g C^{-1}), autumn (1.11 and 1.52 m^2 g C^{-1}) and summer (0.87 and 1.55 m^2 g C^{-1}). Based on the ultraviolet absorption spectrum of BrC, it can be inferred that the main source of the BrC in winter was coal combustion, while dust and biomass burning (BB) were the major sources in spring and autumn, respectively. Based on EEM, we assed that the type of chromophores in BrC were humic acid substance, including HULIS-1 and HULIS-2, and protein compounds (PLOM). The total concentration of the five nitroaromatic compounds (NACs) detected in winter was significantly higher than that in autumn, which was similar to the trend of methanol soluble BrC light absorption. Among the NACs, 4-nitrophenol (4NP) and 4-nitrocatechol (4NC) were the most abundant compounds, accounting for 41.0% and 29.8% of the NACs, respectively, in winter and 7.22% and 3.80% in autumn. The higher levels of 4NP and 4NC in winter might be attributed to the higher NO_x and organic emissions in the Tianjin region.