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Brown Carbon Sources in Singapore Identified by Factor Analysis of Atmospheric Pressure Chemical Ionization Mass Spectra

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Brown carbon (BrC) is an important candidate for the direct radiative effects of aerosol particles. It has been demonstrated that positive matrix factorization (PMF) is useful in analyzing Aerosol Mass Spectrometer (AMS) data for BrC source apportionment. However, fragmentation of molecular ions in AMS has been limiting its capability to categorize BrC sources. Soft-ionization mass spectrometric techniques are known to retain molecular information of chemical species. In this study, we applied atmospheric pressure chemical ionization mass spectrometry (APCI-MS) to identify the sources of water-soluble BrC. PM_{2.5} filter samples were collected at a site in Singapore during March-May of 2019. The extracted water-soluble organic matter (WSOM) was analyzed using APCI-MS, time-of-flight aerosol chemical speciation monitor (ToF-ACSM) and ultraviolet-visible spectrophotometer (UV-Vis). Five factor components were obtained by PMF analysis of the APCI-MS data. The PMF output and UV-Vis data were subsequently used to estimate the absorption Ångstrom exponents (AAE) of WSOM in each component. The estimated values of AAE ranged from 3.95 to 8.71. When comparing the factor contributions with simultaneously monitored gas and aerosol data, we found that the factor with the lowest value of AAE was likely emitted from a methane-rich combustion source, located east of the observation site.