Light-absorbing properties, chromophore composition and sources of brown carbon aerosol in Xi’ an, Northwest China

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The impact of brown carbon aerosol (BrC) on the Earth’ s radiative forcing balance has been widely recognized but remains uncertain, mainly because the relationships among BrC sources, chromophores, and optical properties of aerosol are poorly understood. In this work, the light absorption properties and chromophore composition of BrC were investigated for samples collected in Xi’ an. The mass absorption efficiency show distinct seasonal differences, which could be attributed to the differences in sources and chromophore composition of BrC. Three groups of light-absorbing organics were found to be important BrC chromophores, including those show multiple absorption peaks at wavelength > 350 nm (12 polycyclic aromatic hydrocarbons and their derivatives) and those show single absorption peak at wavelength < 350 nm (10 nitrophenols and nitrosalicylic acids and 3 methoxyphenols). These measured BrC chromophores show distinct seasonal differences and contribute on average about 1.1% and 3.3% of light absorption of methanol-soluble BrC at 365 nm in summer and winter, respectively, about 7 and 5 times higher than the corresponding mass fractions in total organic carbon. The sources of BrC were resolved by positive matrix factorization (PMF) using these chromophores instead of commonly used non-light absorbing organic markers as model inputs. Our results show that in spring vehicular emissions and secondary formation are major sources of BrC (~70%), in fall coal combustion and vehicular emissions are major sources (~70%), in winter biomass burning and coal combustion become major sources (~80%), while in summer secondary BrC dominates (~60%).

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