Title : Relationship between black/brown carbons and airborne particulate matter's chemical composition during smoke haze and non-smoke haze periods in Northern Thailand

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ABSTRACT

The application of the DRI Model 2015 multi-wavelength thermal/optical carbon analyzer allows for the optical separation of carbonaceous aerosols into Black Carbon (BC) and Brown Carbon (BrC). This study utilized this technique to $PM_{2.5}$ collected in Chiang Mai, Thailand, during smoke haze (March - April) and non-smoke haze (May - June) periods in 2025. Although BrC is typically attributed to biomass burning emissions, the optical analysis during intense smoke haze period unexpectedly indicated a dominance of BC, characterized by an Absorption Ångström Exponent (AAE) near 1.0. Spearman's rank correlation analysis (n=57) revealed that during smoke haze, the BC attenuation coefficient (b_{ATN_BC}) strongly correlated (r=0.70–0.90) with $PM_{2.5}$, water-soluble inorganic ions, sugars, and carbonaceous fractions due to stagnant burning, whereas the BrC attenuation coefficient (b_{ATN_BrC}) paradoxically exhibited negative correlations attributable to the "shadowing effect" of dense soot. In the non-smoke period, source decoupling was evident as the galactose-b_{ATN_BC} correlation dropped significantly (0.60 to 0.08) and the chloride-b_{ATN_BC} relationship inverted. Concurrently, nitrate, magnesium, and levoglucosan shifted to positive associations with b_{ATN_BrC}. It is hypothesized that when $PM_{2.5}$ concentrations exceed 40 $\mu g/m^3$, filter saturation and shadowing effects occur, rendering Brown Carbon (BrC) undetectable. This is likely due to the dense soot layer masking the optical absorption of BrC at 405 nm.

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Conversely, significant BrC fractions were successfully resolved during the lower-loading non-smoke period. While the multi-wavelength method is effective under moderate conditions, 24-hour sampling on quartz filters may fail to accurate BrC quantification during severe smoke haze due to signal saturation. Sampling in highly-polluted environments should consider reduced sampling durations or loading correction to reduce optical artifacts.

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