A New Analytical Paradigm to Determine Concentration of Brown Carbon and its Sample-by-sample Mass Absorption Efficiencies

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Abstract

Brown carbon (BrC) has a substantial direct radiative effect, but current estimates of its impact on radiative balance are highly uncertain due to a lack of measurements of its light-absorbing properties, such as mass absorption efficiency (MAE). Here we present a new analytical paradigm based on a Bayesian inference (BI) model that takes multi-wavelength aethalometer measurements and total carbon data to resolve the concentrations of black carbon (BC) and BrC, and MAEs of BrC on a sample-by-sample basis. Hourly MAEs, unattainable in previous studies, can now be calculated, enabling the first-time observation of darkening-bleaching dynamics of BrC in response to photochemical transformation. We demonstrate the application of this BI-model to analyze measurements collected over one year (2021-2022) in Hong Kong. Diel variations in $MAE_{370\ nm}$ of BrC reveal a darkening-to-bleaching transition occurring between 8 and 10 o'clock when the solar irradiance ranges from 30 to 400 W m^{-2}. Furthermore, we consistently observe an increase in $MAE_{370\ nm}$ of BrC with nitrogen oxide concentrations, suggesting enhanced formation of nitrogenous organics. This BI model-based data analysis would bring forth a breakthrough in amassing observation data of BrC and its MAEs in diverse ambient environments and with high time-resolution.

Early Career Scientist

YES, I am an early career scientist.

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