Carbonaceous Aerosol from Biomass Burning: Observational insights into Transformation Processes and Parameterizations

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Fresh Brown Carbon: 1.5 yr long physicochemical measurements from Boreal and Indonesian Peatland smoldering combustion as a function of Fuel Packing Density (FPD), Moisture Content (MC), and Depth of fuel collection. WashU Biomass Chamber (24 m³ stainless steel)

Spherical morphology; C:O ratio: 12:1 (XPS) 10:1 (EDX); Particle Density: 1-1.2 g/cm⁻³

- Single Scattering Albedo (mean): 0.93 (λ=375 nm) to 0.96(λ=405 nm) to 0.99 (λ=532 nm).
- Absorption Angstrom Exponents (mean): 11 (375 – 405 nm), 6(405 – 532 nm), and 1.5 (532-1047 nm)
- Complex Ref. Index (m = n+ik): n=1.5~1.7 invariant with FPD, depth and MC.
- AAE, SSA, κ are sensitive to fuel packing density (FPD), invariant with depth and MC

Closed form model: Kramers-Kronig dispersion relation of a Damped Harmonic Oscillator

\[
k = \frac{a \gamma \nu}{(\nu_0^2 - \nu^2)^2 + (\gamma \nu)^2}
\]

\[a = 10^{28} \text{ s}^{-2}
\]
\[\gamma = 2 \times 10^{12} \text{ s}^{-1}
\]
\[\nu = c/\lambda
\]
\[\lambda_0 = 300 \text{ nm.}
\]
\[375 \text{ nm} \leq \lambda \leq 532 \text{ nm}
\]

- Previously shown that at O:C ~ 0.4, fragmentation dominates the oxidation process (Kroll et al. 2009).
- Enhanced diminishment between 3.5 and 4.5 PAM-equivalent days (PED) could be a result of this mechanism.
Black Carbon mixed with Organic (coated): The 1/3 Scaling Laws for BC Mass Absorption Cross section ($\text{MAC}_{\text{BC}}$) and Enhancement of $\text{MAC}_{\text{BC}}$ ($E_{\text{MAC}_{\text{BC}}}$).

(a) $\text{MAC}_{\text{BC}} = A_\lambda \left( \frac{M_{\text{total}}}{M_{\text{BC}}} \right)^{0.35}$

(b) $E_{\text{MAC}_{\text{BC}}} = 1.00 \left( \frac{M_{\text{total}}}{M_{\text{BC}}} \right)^{0.30}$

$R^2 = 0.97$