Relationship between oxidation level and optical properties of secondary organic aerosol

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Introduction and Methods

- Brown carbon (BrC), which may include secondary organic aerosol (SOA), can be a significant climate-forcing agent via its optical absorption properties. However, the overall contribution of SOA to BrC remains poorly understood.
- Here, correlations between oxidation level and optical properties of SOA are examined. SOA was generated in a Potential Aerosol Mass (PAM) flow reactor in the absence of NO_x by OH oxidation of gas-phase precursors used as surrogates for anthropogenic (naphthalene, tricyclo[5.2.1.0^{2,6}]decane [JP-10]), biomass burning (guaiacol), and biogenic (α-pinene) emissions.
- SOA was produced by OH exposures ranging from 2.2×10^{11} to 1.5×10^{12} molec cm^{-3} s, approximately equivalent to 1.5 to 12 days of atmospheric exposure. SOA optical properties were calculated from real-time cavity ring-down photoacoustic spectrometry (CRD-PAS) measurements and from UV-Vis measurements of methanol extracts of filter-collected particles.

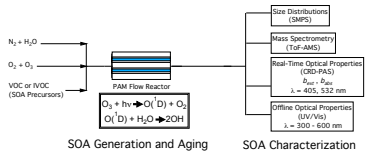

Figure 1. Experimental setup.

SOA Chemistry

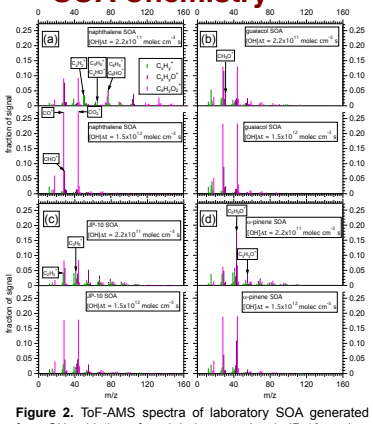

Figure 2. ToF-AMS spectra of laboratory SOA generated from OH oxidation of naphthalene, guaiacol, JP-10, and α-pinene at low and high OH exposures.

SOA Aging

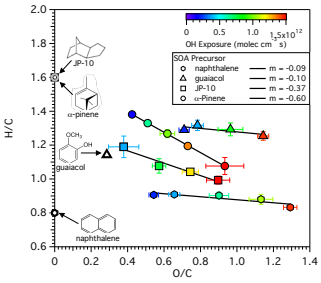

Figure 3. Van Krevelen diagram of laboratory SOA.

SOA Optical Properties

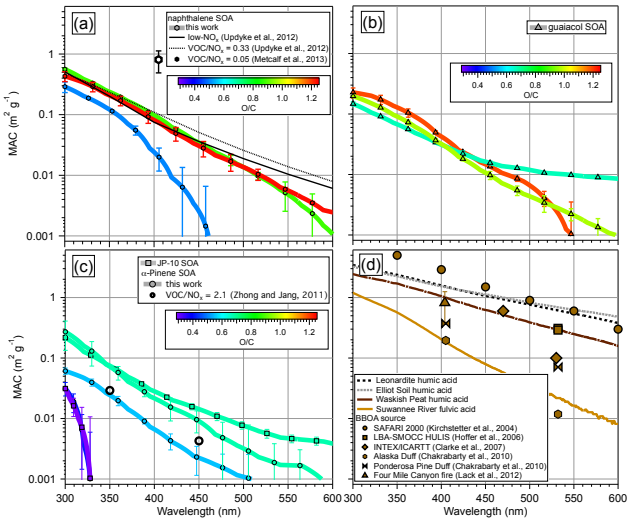

Figure 4. MAC of SOA, humic acids and fulvic acids as a function of wavelength.

Sample	O/C	AAE
naphthalene SOA	0.50	6.6
naphthalene SOA	0.88	5.5
naphthalene SOA	1.23	5.2
guaiacol SOA	0.67	5.7
guaiacol SOA	0.96	5.6
guaiacol SOA	1.19	6.0
JP-10 SOA	0.68	7.4
α-pinene SOA	0.56	7.2
α-pinene SOA	0.68	8.8
Suwannee River fulvic acid	0.62	5.4
Leonardite humic acid	0.37	2.2
Elliot Soil humic acid	0.44	2.5
Waskish Peat humic acid	0.53	1.9

Table 1. Absorption Ångstrom exponent (AAE) values calculated from UV-Vis measurments (λ = 300 - 500 nm).

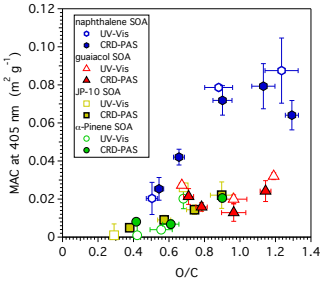

Figure 5. MAC at 405 nm of SOA produced from the OH oxidation of naphthalene, guaiacol, JP-10, and α-pinene as a function of O/C ratio.

Sample	O/C	SSA
naphthalene SOA	0.54	0.99
naphthalene SOA	0.66	0.99
naphthalene SOA	0.90	0.97
naphthalene SOA	1.13	0.96
naphthalene SOA	1.29	0.96
guaiacol SOA	0.71	0.99
guaiacol SOA	0.78	0.99
guaiacol SOA	0.96	0.99
guaiacol SOA	1.14	0.99
JP-10 SOA	0.57	1.0
JP-10 SOA	0.74	0.99
JP-10 SOA	0.90	0.98
α-pinene SOA	0.42	1.0
α-pinene SOA	0.61	1.0
α-pinene SOA	0.90	0.99

Table 2. SOA single scattering albedo (SSA) values calculated from CRD-PAS measurments of b_{ext} and b_{abs} at 405 nm.

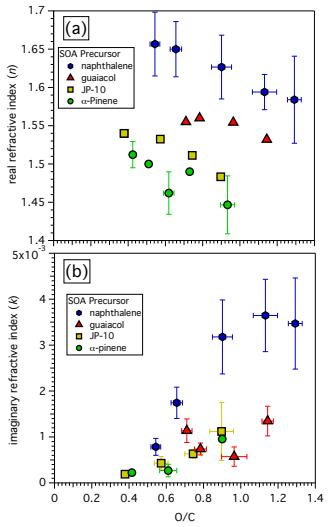

Figure 6. (a) Real and (b) imaginary refractive indices of laboratory SOA at 405 nm.

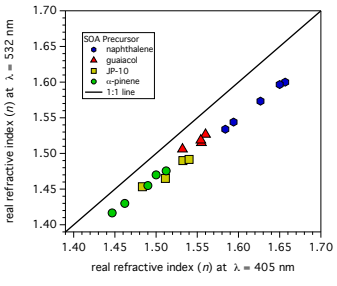

Figure 7. Comparison of real refractive indices of laboratory SOA at 405 nm and 532 nm.

Acknowledgements: DoE ASR #DE-SC0006980, #DE-FG02-05ER63995; NSF Atmospheric Chemistry Program #AGS-0904292, #ATM-0854916, #ATM-0837913, #AGS-0855135.

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