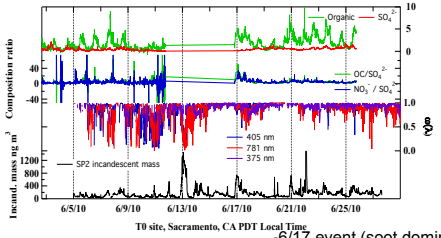
Wavelength-dependent optical properties, mass absorption coefficients, and closure studies for carbonaceous aerosol at the 2010 CARES Campaign, Sacramento, CA

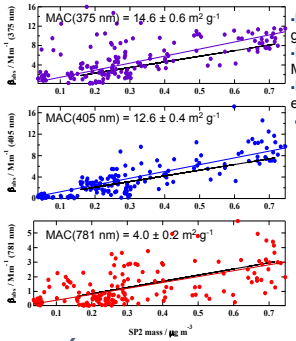
B. A. Flowers[1], A. Aiken[1], M. K. Dubey[1], M. Gyawali2, P. Arnott[2], K. Gorkowski[3], C. Mazzoleni[3], R. Subramanian[4], A. Sedlacek[5], G. Senum[5], S. Springston[5], A. Setyan[6], Y. Sun[6],Q. Zhang[6], C. Song[7], J. Shilling[7], J. Berank[7], A. Zelenyuk[7], and R. Zaveri[7]:

[1]Los Alamos National Laboratory, [2] UN-Reno, [3]Michigian Tech. Univ., [4]Brookhaven National Laboratory, [5]DMT, [6]UC-Davis, [7]Pacific Northwest National Laboratory

Aerosol absorption and scattering coefficients measured at ground sites and the DOE-G1 aircraft during the Carbonaceous Aerosol and Radiative Effects Campaign (CARES) of summer 2010 are analyzed. We report wavelength dependent single scatter albedo ($\sigma_{sca}/\sigma_{ext}$) from simultaneous measurements of aerosol absorption and scattering at 9 wavelengths between 1047 – 355 nm by 8 separate integrated photoacoustic/nephelometer (IPN) instruments. The 9-λ absorption coefficients are combined with black carbon mass measurements from single particle soot photometers (SP2) to derive wavelength-dependent mass absorption coefficients, including new results at UV wavelengths. The absorption and scattering data are combined with concurrent particle size distributions to estimate complex refractive indices (n-*ik*). The imaginary part of the complex refractive index (*ik*) is sensitive to enhanced absorption by organic coatings on soot cores and/or directly emitted primary and secondary organic particles. Closure studies will compare the estimated top-down refractive indices with bottom-up calculations using the observed chemical composition from aerosol mass spectrometers [*e.g.* Flowers, et al. ACP 2010]. The wavelength dependence of optical properties and MACs for fresh and aged urban and rural emissions, including biomass burning, will be presented to help models accurately estimate net radiative effects for carbonaceous aerosol.

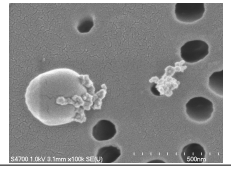
Wavelength Dependent Mass Absorption Coefficient: MAC (λ) [T0 site]





- 6/17 event (soot dominated)
- Black lines show slope for purely BC MAC for given SP2 mass
- Fit is to PASS-3, UV Babs vs SP2 mass for MAC(λ) or coated BC aerosol
- Ratio of slopes represents the coating enhancement
- MAC(λ) coating enhancement 6/17 plume
  - 375 nm (.25)
  - 405 nm (.19)
  - 781 nm (~0)
- MAC(λ) for Black carbon (BC)

MAC(375 nm) = 11.6 ± 0.6 m^2 g^{-1}
MAC(405 nm) = 10.6 ± 0.6 m^2 g^{-1}
MAC(532 nm) = 7.32 ± 0.5 m^2 g^{-1}
MAC(781 nm) = 4.24 ± 0.2 m^2 g^{-1}



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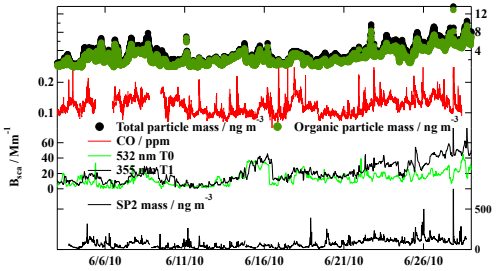
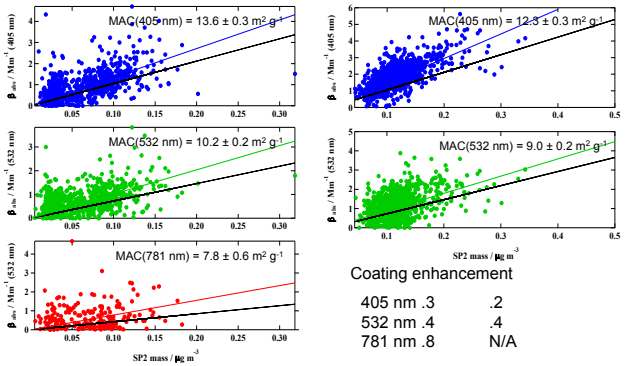
Wavelength Dependent Mass Absorption Coefficient: MAC (λ) [T1 site]



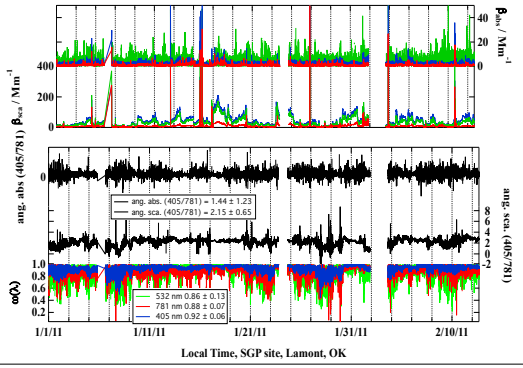
PDT



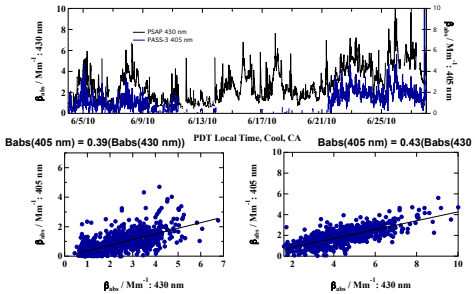
Coating enhancement

405 nm .3	.2
532 nm .4	.4
781 nm .8	N/A

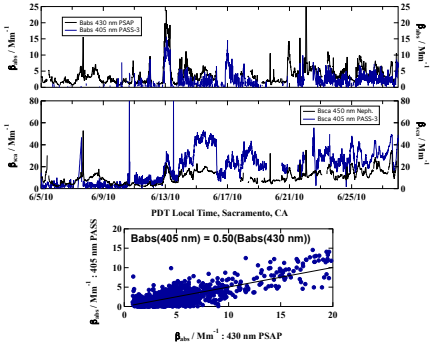
SGP PASS-3 operation – Jan - Feb 2011



Ground site PSAP vs PASS-3 intercomparison



Babs coefficient for CARES campaign at T1 site. PASS-3 (10 min data) was not operating between 6/11 and 6/21. The scatter plots are for the 6/03 - 6/11 and 6/19 -6/28 operating periods. The overestimate of Babs by the PSAP corresponds with the coating enhancement. The PSAP operated with a 1 micron size cut off, the PASS-3 nominally transmits particles smaller than 2 microns.



Babs coefficients for CARES campaign at T0 site. The PSAP operated with a 1 micron size cut off, the PASS-3 nominally transmits particles smaller than 2 microns. PSAP overestimates PASS-3 data by 50%.

Conclusions

- Coating enhancements larger for OA dominated T1 aerosol
- 6/17 MAC(λ) shows behavior for coated soot particles (no enhancement @ 781 nm)
- PASS-3/PSAP ratio closer to 1 for during second half of T1 when aerosol had more BC mass

Individual plume/event analysis on going for flight data and optical closure studies
Correlation between MAC(λ) and chemical composition

References

- Cross, et al. Aerosol Sci. Technol., 44, 592-611 (2010)
- Flowers, et al. Atmos. Chem. Phys., 10, 10387 – 10398 (2010)

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