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Sedlacek III, A. J., Kleinman, L., Shilling, J. E., Springston, S. R.,
Subramanian, R., and Zaveri, R.

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Processing of Black Carbon in the Mixed Sacramento Urban-Biogenic Environment

Arthur J. Sedlacek, III, Larry Kleinman
Atmospheric Sciences Div., Brookhaven National Laboratory

John E. Shilling
Atmospheric Sciences and Global Change Div., Pacific Northwest National Laboratory

Stephen R. Springston
Atmospheric Sciences Div., Brookhaven National Laboratory

R. Subramanian
Droplet Measurement Technologies

Rahul Zaveri
Atmospheric Sciences and Global Change Div., Pacific Northwest National Laboratory

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As part of the CARES campaign, the DOE G-1 was deployed to investigate the time evolution of aerosol in a mixed urban-biogenic environment through measurement flights conducted in the morning and afternoon. The G-1 payload included a 3-λ PSAP, a 3-λ nephelometer, CPCs, a Single Particle Soot Photometer (SP2), an Aerodyne Mass Spectrometer (AMS), and gas phase tracers for emission sources. The SP2, which generates datasets on the BC mass/number concentration, BC mass equivalent diameter (MED), and degree of BC coating can be combined with the AMS dataset to estimate the light absorbing properties of the Sacramento BC emissions.

Towards this end, the degree of BC coating was estimated by comparing the time difference between the SP2 scattering signal peak (SC; Dp = 200 300nm) and the incandescent signal peak (BC; MED = 60 - 650 nm). In the case of nascent soot, characterized by a negligible coating, the time difference, $\Delta\tau$ (= τ_{BC} - τ_{SC}), will be nominally zero since both the initial light scattering and incandescence will be from BC. In contrast, a thickly-coated particle will exhibit a non-zero because light scattering will now initially be off the coating material and before the core BC can incandesce it must first "boil" off this coating. It is this time to vaporize the coating material off the BC core that can be used to probe the mixing state of BC. For those conditions where thickly coated BC is observed, data from the AMS can be used to probe the coating composition and infer the coating volume that can, in turn, be used to estimate light absorption by the coated BC.

Two flight days will be discussed: June 15, which was characterized by the presence of a pronounced residual layer and June 28, where morning — afternoon flight comparison reveals that the nascent Sacramento BC emissions undergo a significant amount of processing, as evidenced by the measurable growth of thickly-coated BC aerosols in the afternoon flight. On the June 15th flights, the pronounced residual layer was discovered and found to be similar in composition to that observed in the foothill layer, though more highly processed. It is speculated that the detected residual layer over Sacramento is backflow from the mountains. For the latter flight, it is found that the rate of increase in thickly-coated particles between the morning and afternoon is nominally 1.5% hr^{-1}. This preliminary rate agrees reasonably well with that reported by Moteki et al. [2007] who, using an analogous approach with their SP2, found rates of 2.3% hr^{-1}

for 180 nm and 1% hr^{-1} for 250 nm in their study of the Nagoya urban plume. Consistent with the growth of thickly-coated soot, is a 40% increase in the absorption Ångstrom exponent.

References:

Moteki, N., Y. Kondo, Y. Miyazaki, N. Takegawa, Y. Komazaki, G. Kurata, T. Shirai, D. R. Blake, T. Miyakawa, and M. Koike (2007) Evolution of mixing state of black carbon particles: Aircraft measurements over the western Pacific in March 2004, *Geophys. Res. Lett.* **34** L11803, doi:10.1029/2006GL028943.

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