PCASP-derived Extinctions in Wildfire Smoke during BBFLUX

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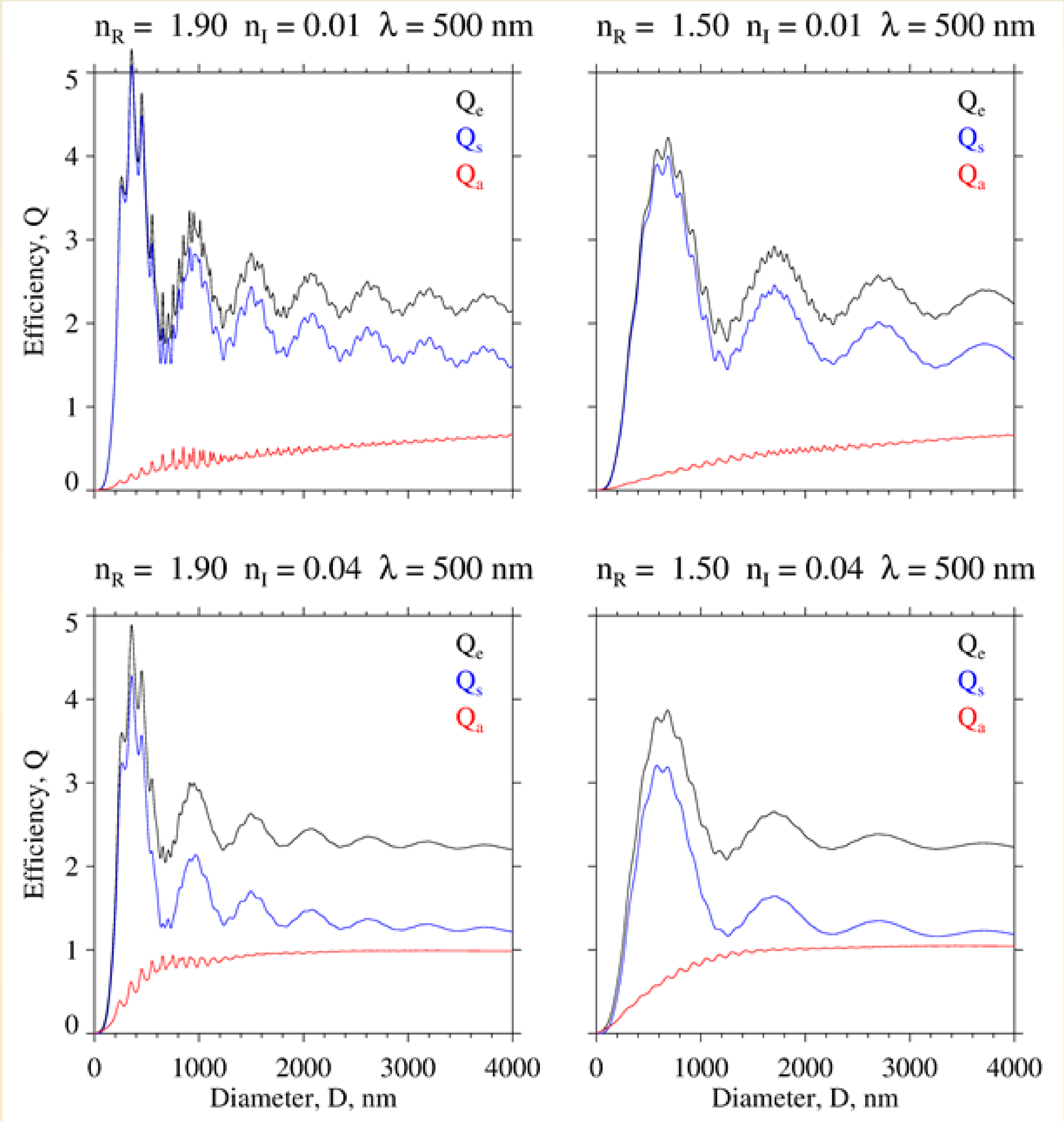
SUMMARY

During BBFLUX, the PCASP flown on the King Air was returned to Laramie to address a hardware failure. The failure was corrected, the PCASP's optical and aerosol flow systems were recalibrated, and ground-based sampling of wildfire smoke was conducted. Mie theory, and four formulations of the aerosol refractive index (Saleh et al. 2014), were applied. Measurements were analyzed in two steps: 1) Particle sizing at the wavelength of the PCASP's laser (λ = 633 nm) was adjusted using the four index formulations and the PCASP's response function (Pinnick et al., 2000), and 2) the four formulations were used to evaluate aerosol extinction coefficients at λ = 500 nm. Relative differences between extinctions based on the default PCASP sizing and those based on the four formulations range between -22 to +62 %. Because the size-integrated PCASP concentration was ~ 700 cm^{-3}, the derived extinctions are relatively unaffected by the particle coincidence error that compromised some of the BBFLUX flight data. Hence, the relative differences presented here (for extinction) can be interpreted as the sensitivity of PCASP-derived extinctions to variability in the smoke aerosol's refractive index.

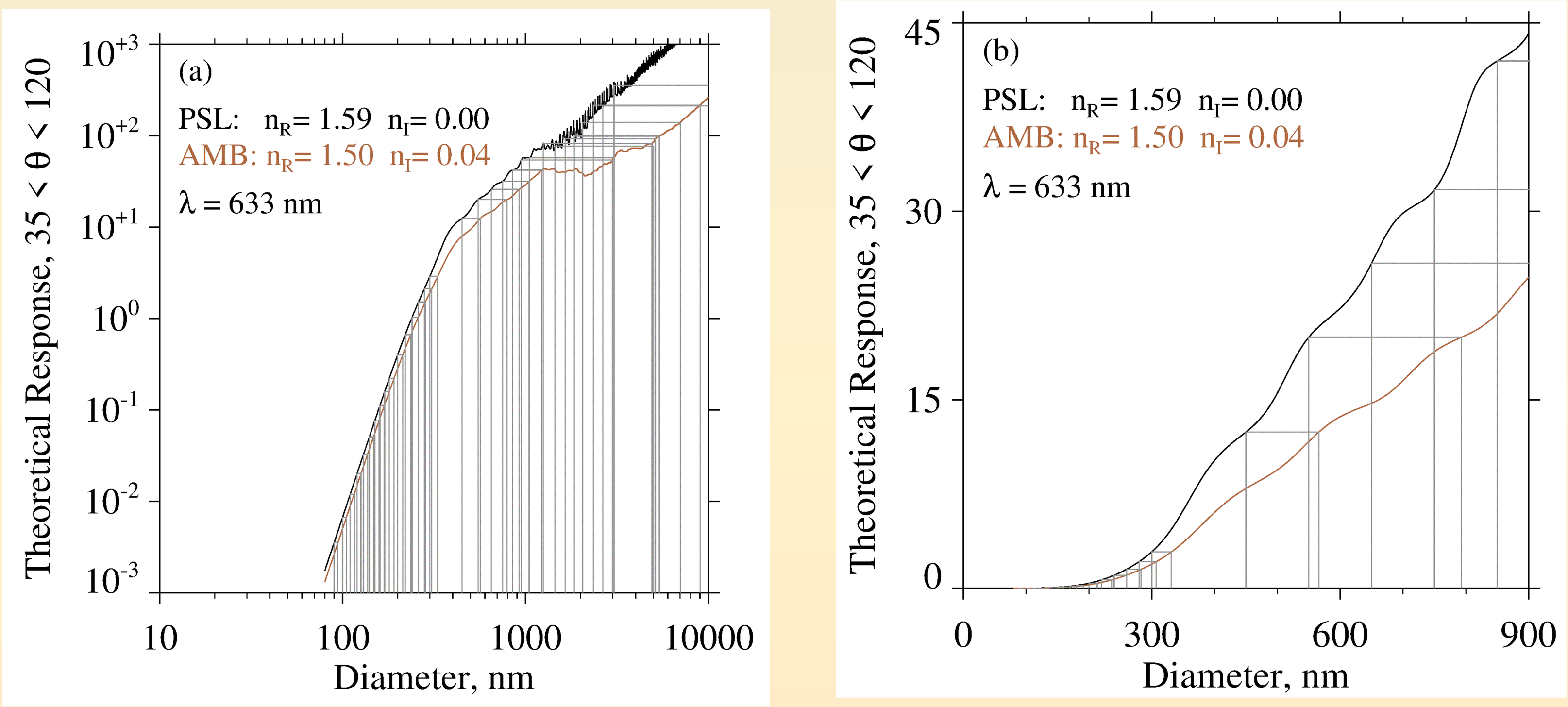
MIE CALCULATION

Mie extinction, Mie scattering, and Mie absorption efficiencies at λ = 500 nm for four formulations of the aerosol refractive index. The formulations are for wildfire smoke (Saleh et al., 2014).



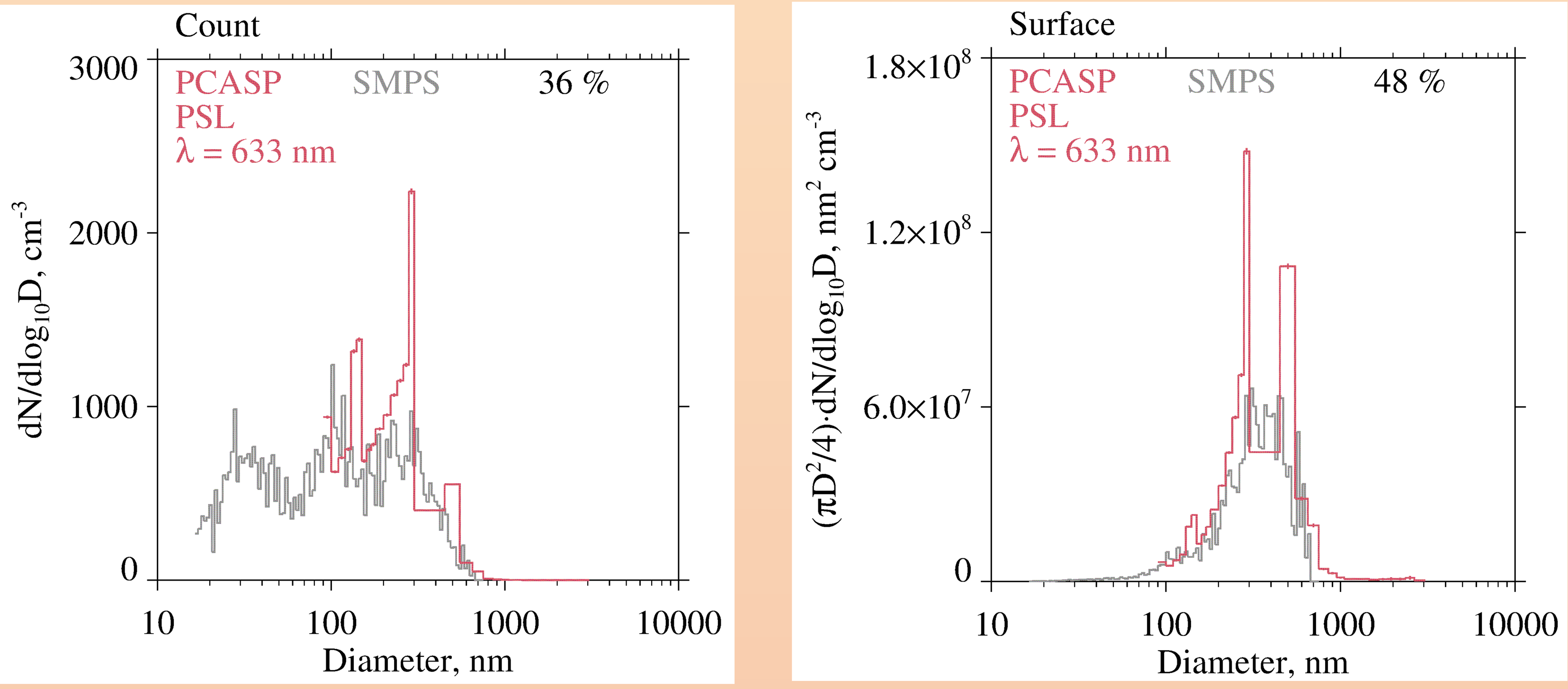
PCASP RESIZING

PCASP response functions (Pinnick et al., 2000), at the wavelength of the PCASP's laser (λ = 633 nm). Adjusted PCASP sizing is apparent at the intersections of the horizontal grey lines and the brown curve. One of four wildfire smoke refractive indices (AMB) is applied here. The material used to lab-calibrate the PCASP is polystyrene latex (PSL).



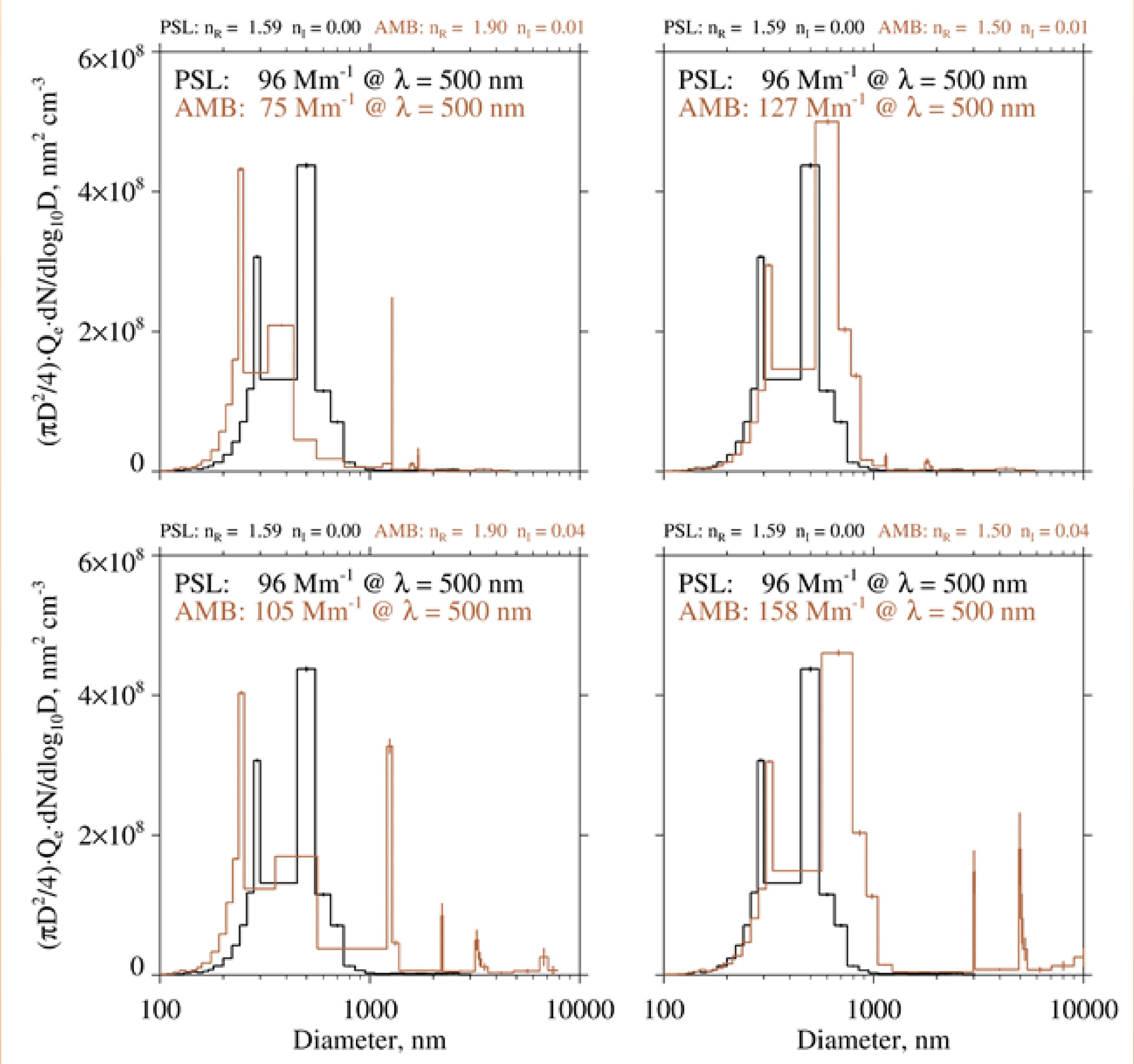
GROUND-BASED MEASUREMENTS

A ground-based aerosol size distribution measurements made downwind of a wildfire, using both a PCASP and an SMPS. PCASP sizing is based on lab calibration with PSL spheres. SMPS sizing is based on particle mobility in an electric field. Percent differences between the PCASP- and SMPS-derived size-integrated count and surface distributions indicated in the upper right.



CALCULATED EXTINCTION COEFFICIENTS

Size-distributed extinctions calculated at λ = 500 nm. Repeated in each panel is the extinction distribution based on the lab-calibrated PCASP. Also, each panel has the extinction distribution based on PCASP sizing adjusted with the four wildfire smoke refractive indices (AMB). Figure legends have the size-integrated extinctions.



Example (15:59 to 16:04 MDT) of Ground-based Sampling in Wildfire Smoke on 20180827

Refractive Index	β_e at 500 nm, Aerosol Extinction Coefficient, Mm^{-1}	$\Delta\beta_e$, Mm^{-1}	$100\cdot\Delta\beta_e/\beta_e$, %
n_R=1.59, n_I=0.00 (PSL)	96		
n_R=1.90, n_I=0.01 (AMB)	75	-21	-22
n_R=1.90, n_I=0.04 (AMB)	105	+9	+9
n_R=1.50, n_I=0.01 (AMB)	127	+31	+32
n_R=1.50, n_I=0.04 (AMB)	158	+62	+65