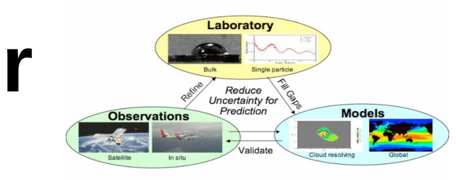

Aerosol Optical Property Measurements for ARM: The New 3-laser Photoacoustic Instrument for ISDAC and SGP

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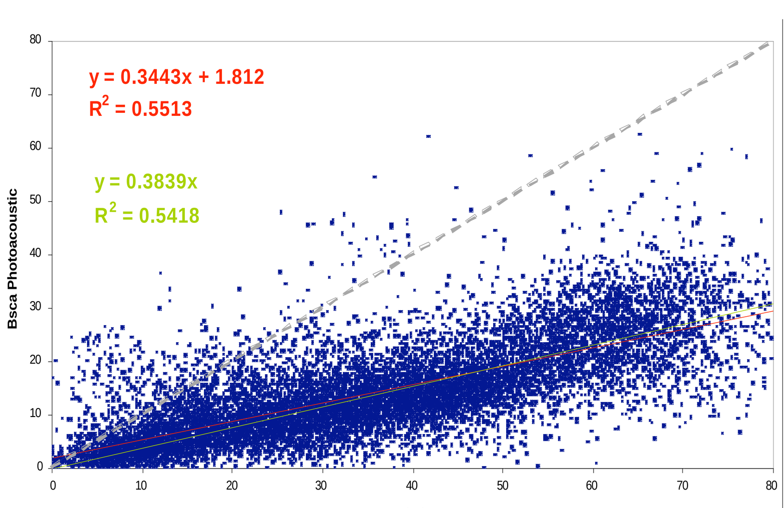
ABSTRACT:

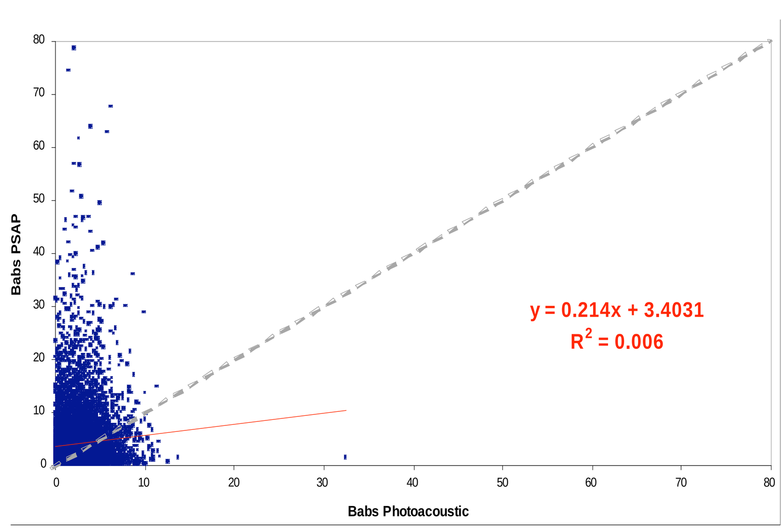
There is concern that the workhorse filter based PSAP measurements of aerosol absorption may suffer from interferences under certain conditions. We will review these issues using recent field and laboratory studies, and develop a path forward to resolve this problem. We will describe a new 3-laser photoacoustic instrument, which measures aerosol absorption, scattering and single scatter albedo in situ at 405, 532, and 780nm and does not suffer from matrix artifacts. The instrument is being deployed for the ARM-ASP ISDAC campaign in March, and another one is being ordered for the ARM-SGP site. We will report laboratory studies of black carbon, smoke, clays, serpentine, alumina, silicon nitride and hematite to illustrate the instrument capabilities. We will also describe current gaps that need to be filled such as optical property measurements as a function of relative humidity and absorption in the ultraviolet region and how our 3-laser photoacoustic can help fill these. Our goal is to work closely with the ARM user community to improve the quality and reliability of aerosol optical measurements.

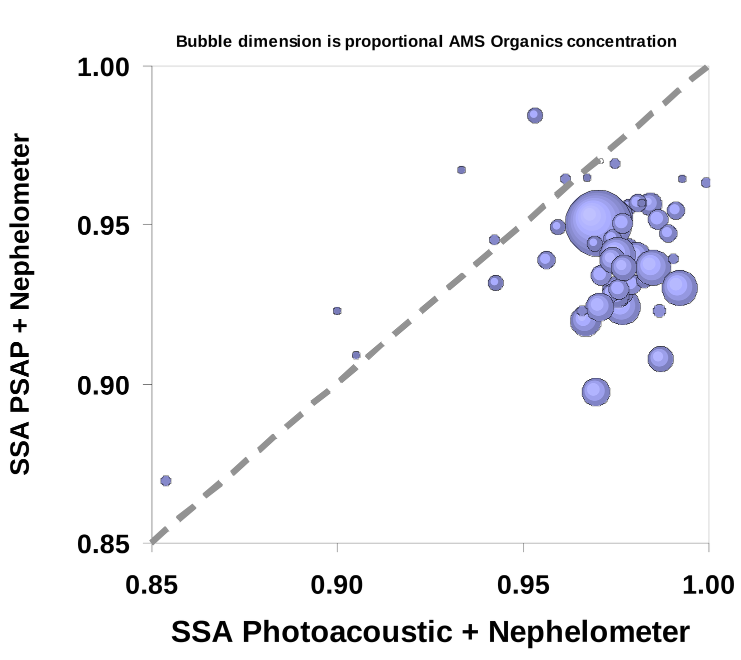
Photoacoustic (781nm) vs. PSAP and Nephelometer (660nm) during CHAPS (Oklahoma, June 2007)

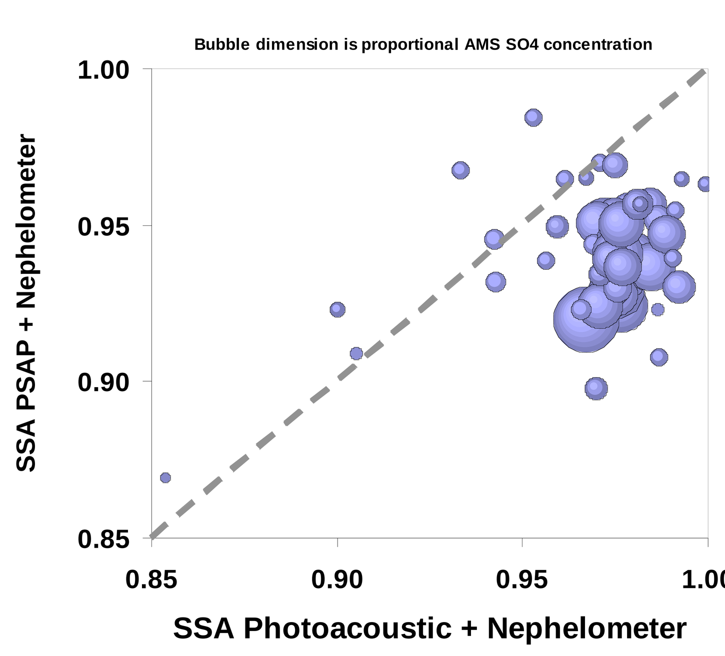
Scattering Photoacoustic vs. Nephelometer



Absorption PSAP vs. PAS

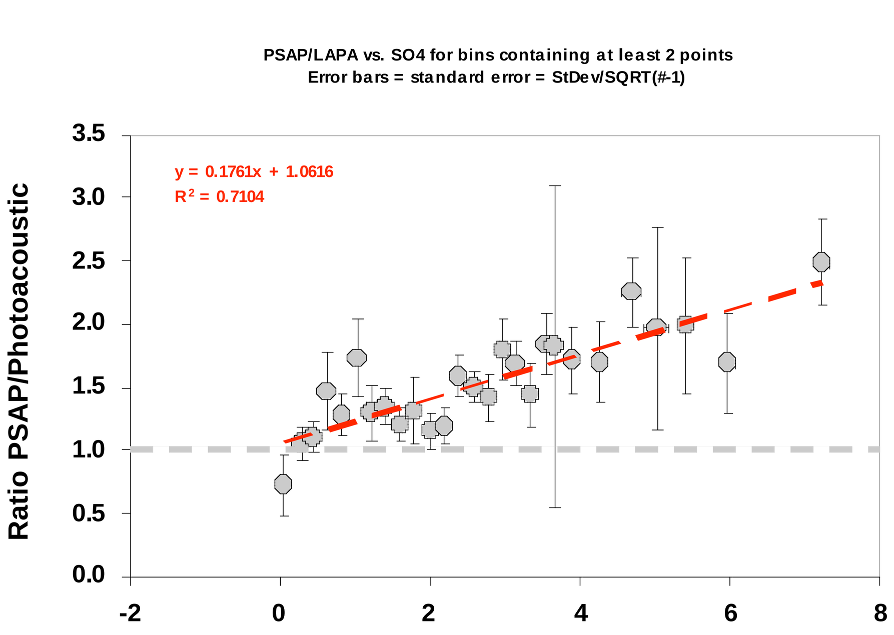




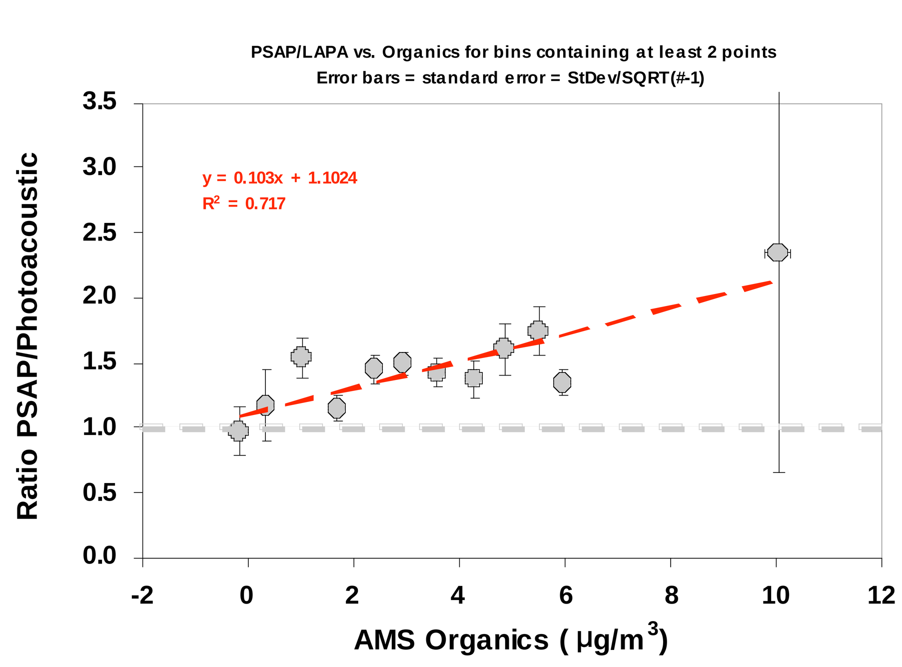


The SSA discrepancy between PSAP and Photoacoustic seems to increase with higher organics and/or SO_4 concentrations, as measured by and Aerodyne Mass Spectrometer (AMS). Averaging all the absorption and scattering data together and then calculating SSA and Co-albedo:

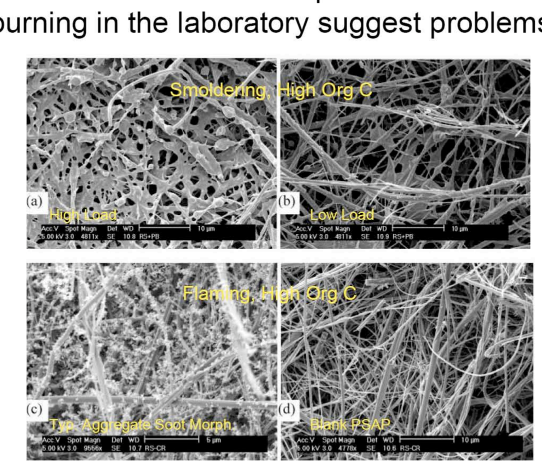
SSA From LAPA + Neph = 0.976	**Co-albedo From LAPA + Neph = 0.024**
SSA From PSAP + Neph = 0.941	**Co-albedo From PSAP + Neph = 0.059**
SSA Rel. Diff. = 3.5%	**Co-albedo Rel. Diff. = -141%**



For increasing loadings of organics and/or SO_4 the ratio of the absorption signal measured by PSAP to that measured by photoacoustic increases significantly above unity. The ratio reaches values above 200% for SO_4 concentrations of ~7 μg/m³ and Organics concentrations of ~ 10 μg/m³



SEM of PSAP filter samples of rice-straw burning in the laboratory suggest problems



Subramanian et al, Yellow Beads and Missing Particles: Trouble Ahead for Filter Based Absorption Measurements, Aer. Sci. & Tech. (2007), 41: 630-637

Acknowledgments

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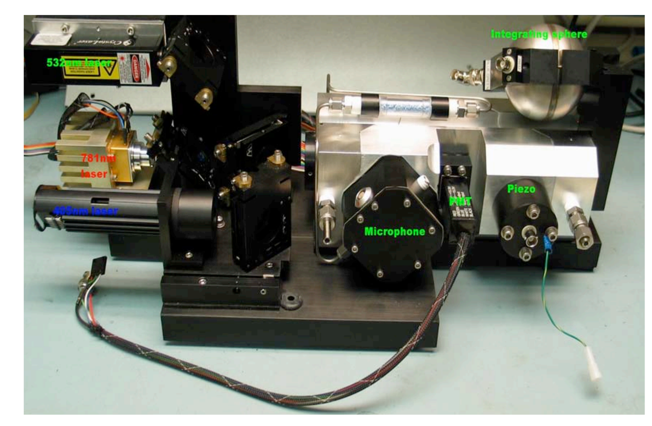
The New 3 Wavelengths Instrument

The 3-PAS (DMT Inc.)

Inside



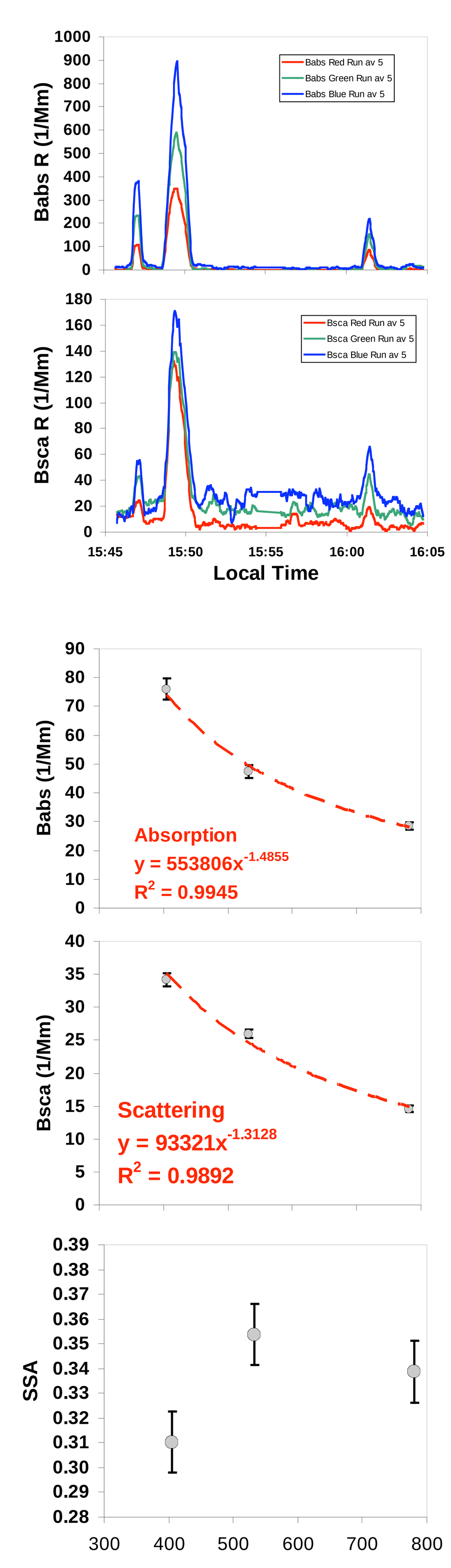
Noise (Mm^{-1}, 0.5 Hz)

(HEPA filtered air)

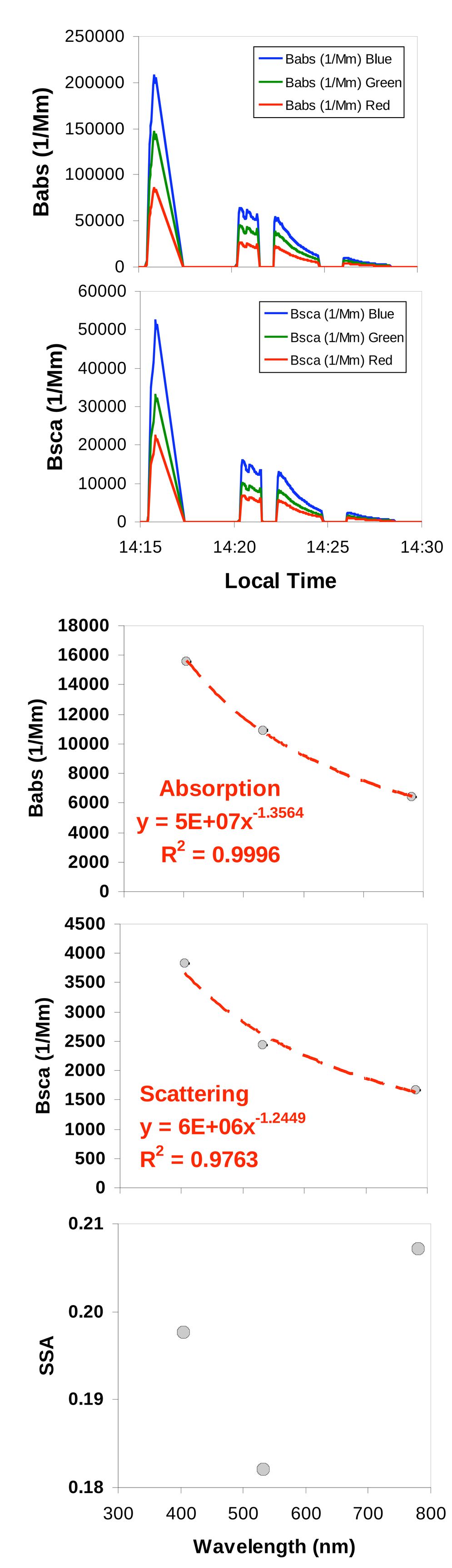
	Standard Deviation	Skewness	Kurtosis
Blue (405nm)	Babs=7.0 Bsca=10.4	Babs=-0.013 Bsca=-0.039	Babs=-0.1 Bsca=-0.0
Green (532 nm)	Babs=7.1 Bsca=6.5	Babs=-0.126 Bsca=-0.053	Babs=0.4 Bsca=-0.1
Red (781 nm)	Babs=0.5 Bsca=4.1	Babs=-0.006 Bsca=-0.002	Babs=0.2 Bsca=0.0

Analysis of Different Combustion Sources

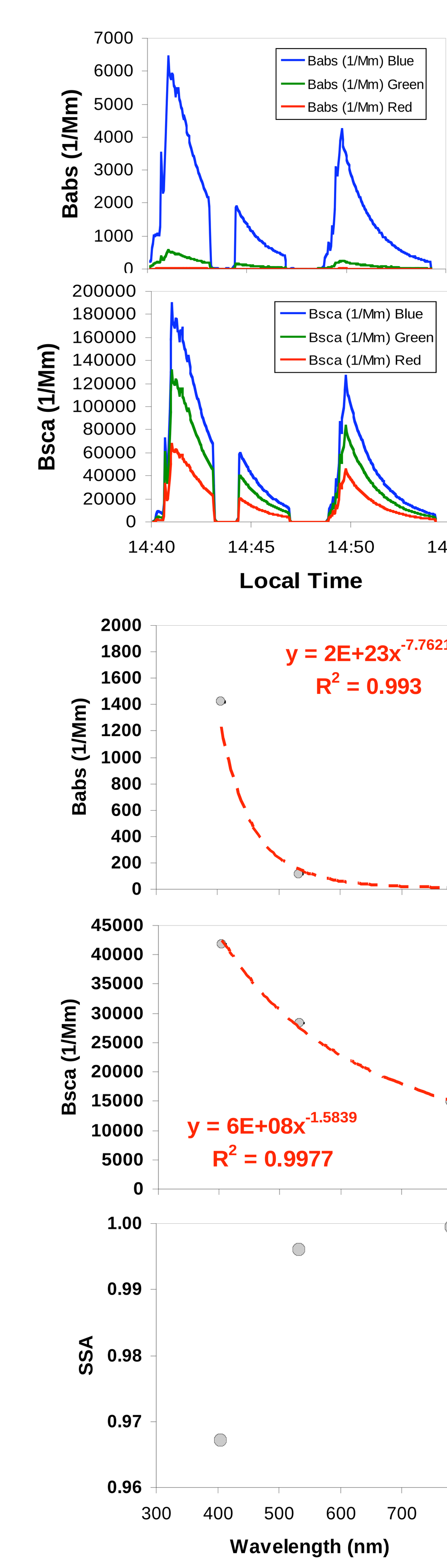
Diesel Emissions



Kerosene Lamp



Smoldering Cardboard



Analysis of Different Minerals in the laboratory

Alumina
White Al_2O_3

Silicon Nitride
Grey Si_3N_4

Serpentine
Light green $Mg_3Si_2O_5(OH)_4$

Hematite
Red-Brown Fe_2O_3

Jarosite
Yellow-gold $KFe^{3+}_3(OH)_6(SO_4)_2$

Nontronite
Yellow $Na_{0.3}Fe^{3+}_3Si_3AlO_{10}(OH)_24(H_2$