UV-Visible Photoacoustic Spectroscopy for Aerosol Absorption

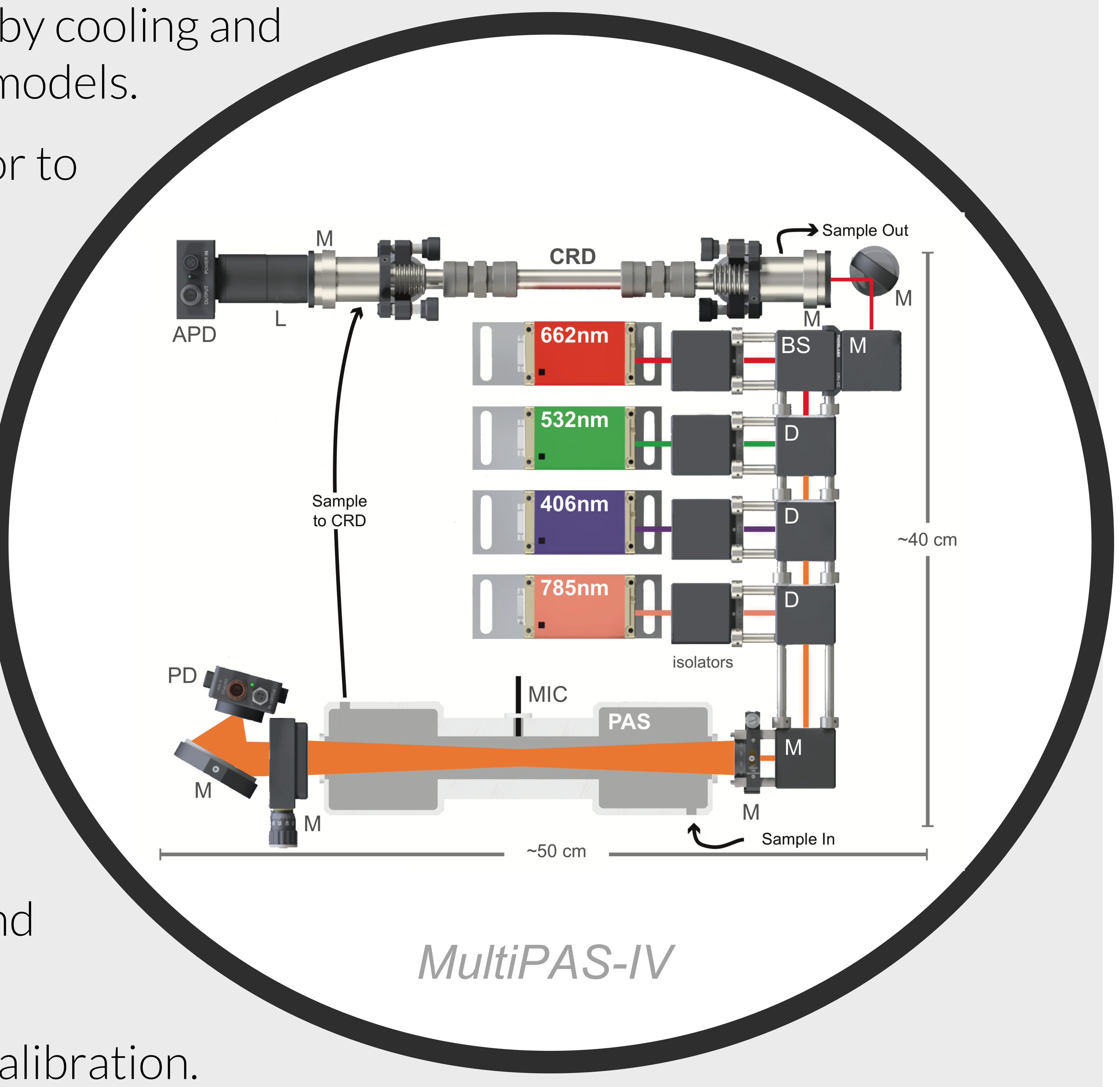
Al Fischer & Geoffrey D. Smith
Chemistry Department
University of Georgia
al@uga.edu

1 Background: Aerosols & Climate

Atmospheric aerosols both scatter and absorb incoming solar radiation, thereby cooling and warming Earth, respectively; the balance is one of the largest uncertainties in climate models.

Black carbon (BC) is a strongly absorbing aerosol, and is the second largest contributor to global warming after CO_2; brown carbon (BrC) is another absorbing aerosol, though absorbs primarily in the UV.

Although important for climate models, direct measurements of aerosol absorption remain scarce due to inherent difficulties in measuring it (weak signal, few methods).



MultiPAS-IV

2 The "MultiPAS" Instruments

We have created a modular, multi-wavlength, single-cell photoacoustic system using diode lasers and a multipass cell. The design is adaptable, compact, and portable. We have created three versions:

[1] **MultiPAS-IV (4 λ):** 406, 532, 662 (+CRD), and 785 nm;
[2] **MultiPAS-UV (3 λ, with 2 UV):** 320 (in progress), 375, and 445 (+CRD) nm; and
[3] **MultiPAS-III (4 λ):** 422, 532, and 782 nm (built for R. Saleh, UGA CoE).

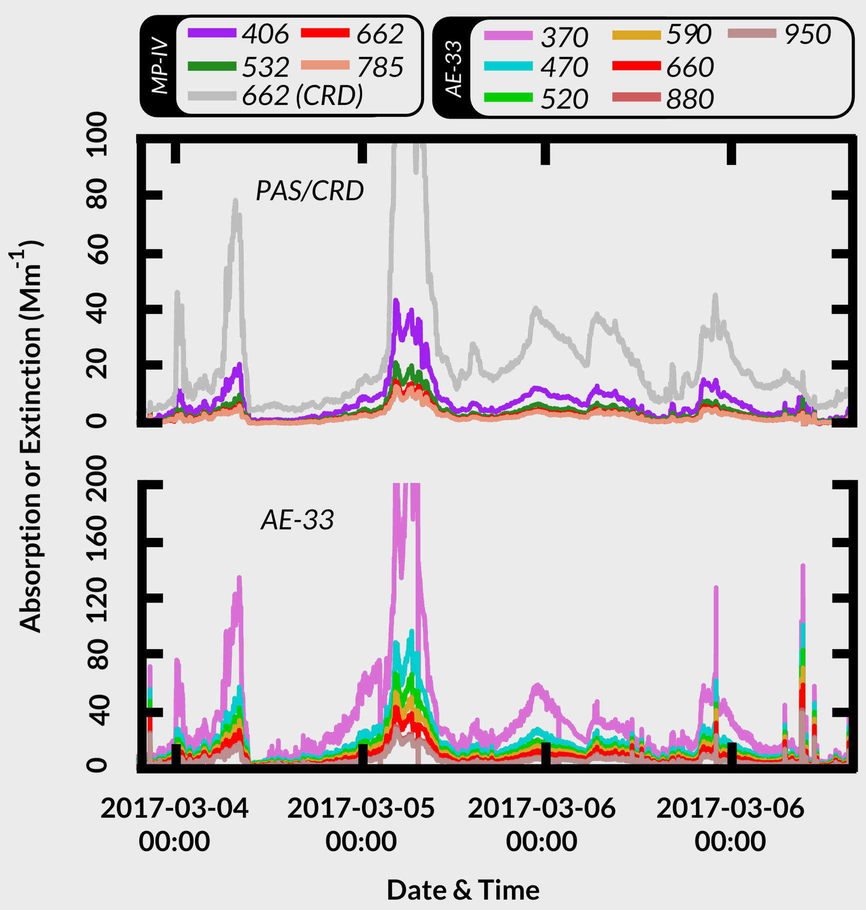
MP-IV & MP-UV contain a 1-λ cavity ringdown cell for extinction measurements and calibration.

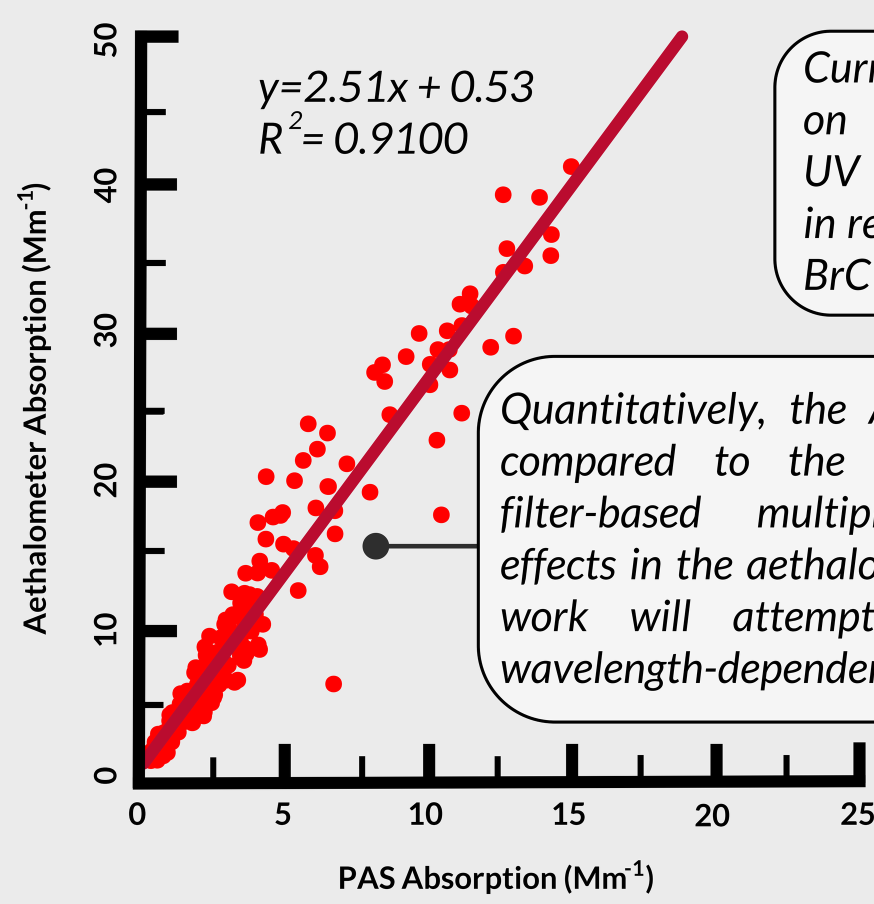
Illuminate around 1400Hz → **Heats & Cools around 1400Hz** → **Pressure Waves around 1400Hz** → **Acquire Acoustic Signal** → **Digitize & Perform FFT**

3 Current Applications: Ambient Aerosols, Black & Brown Carbon

The PAS's low detection limits (<1 Mm^{-1}) allow it to detect ambient aerosol even at very low aerosol loadings. A 2-minute rolling average is shown, right.

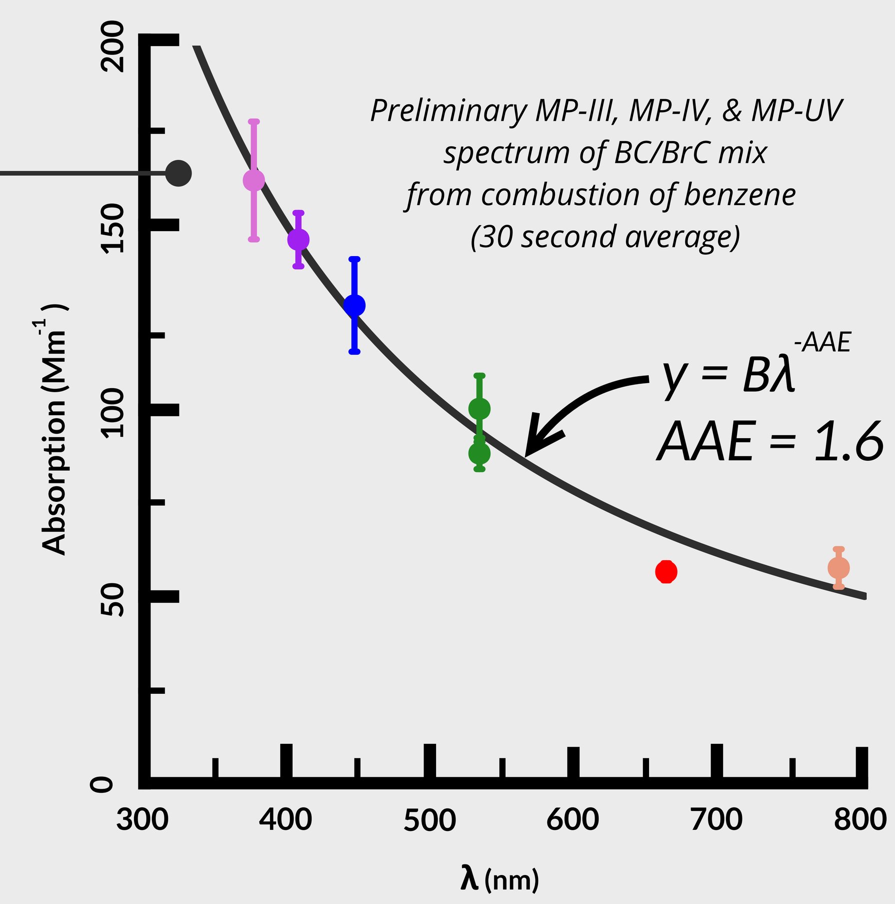
Qualitatively, the PAS compares favorably to an AE-33 7-wavelength aethalometer run simultaneously.





Quantitatively, the AE-33 is high compared to the PAS due to filter-based multiple scattering effects in the aethalometer. Future work will attempt to develop wavelength-dependent corrections.

Current work is focused on measurements at UV wavelengths to aid in retrieving the AAE of BrC and BC.



The PAS was run side-by-side with an AE-33 7-wavelength aethalometer (Magee Scientific) while sampling dried ambient air in Athens, GA during early Spring 2017, shown above left and middle. The aerosols likely represent well-aged "background" aerosols. The two instruments agree qualitatively, but the AE-33 reads ~2.6 times higher absorption than the PAS (at 660 nm), likely due to known multiple scattering effects in the filter-based aethalometer [e.g. Saturno et al. (2017), *AMT*] In-depth comparisons to the AE-33, including measurements of the absorption Ångström exponent (AAE), are ongoing with ambient aerosols and lab-made BC and BrC (above right).

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