AERODYNE RESEARCH, Inc.

CAPS PM_{SSA} Monitor

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U.S. DEPARTMENT OF ENERGY

Introduction, Background, and Motivation

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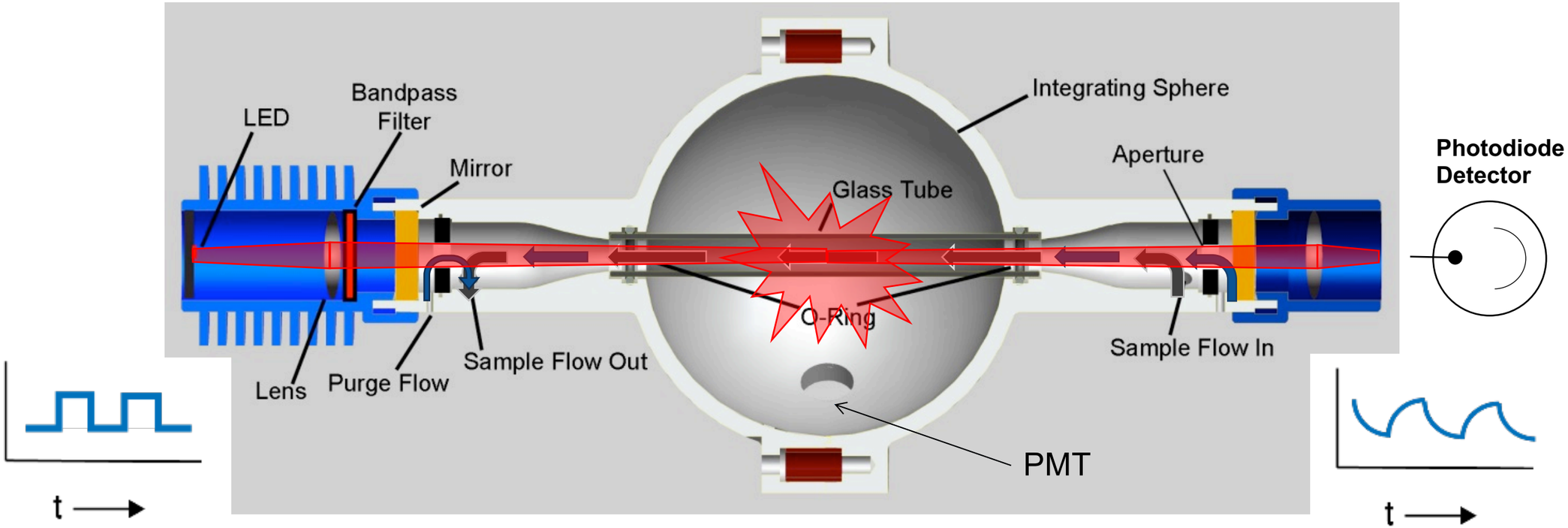
- Atmospheric particles directly affect the Earth's radiative balance through scattering and absorbing solar and terrestrial radiation.
- Robust, direct measurements of particulate extinction, scattering, and absorption are required to understand these direct effects and their climate impacts.

- **CAPS PM_{SSA} monitors** measure absolute extinction and scattering

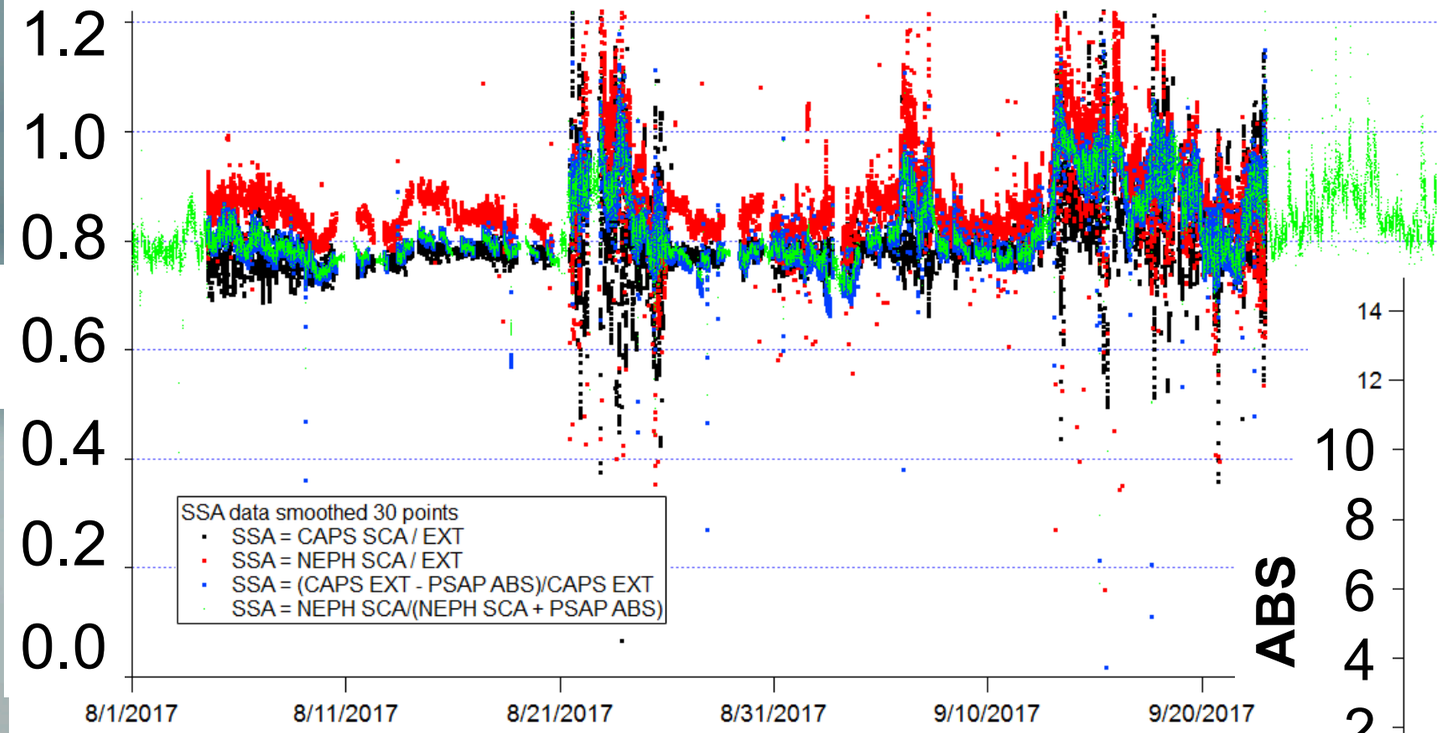
  Extinction – Cavity Attenuated Phase Shift Technique
  Scattering – Inverse Integrating Nephelometer
  Absorption = Extinction - Scattering
  SSA=Scattering/Extinction
- **Technology Readiness Level: 9**
  - **Commercially available**
  - **Field / Lab proven**

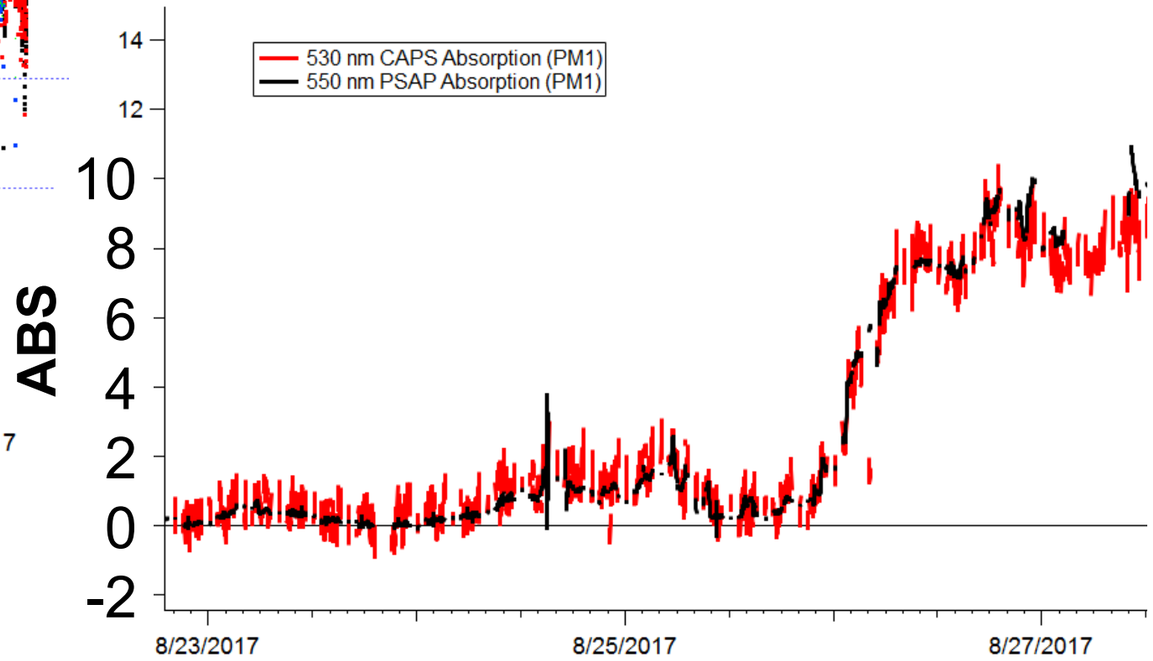
CAPS technique



- Cavity-attenuated phase-shift technology and incorporating an integrating sphere
- Simultaneously measures two of the three aerosol optical parameters from the same air sample

LASIC deployment

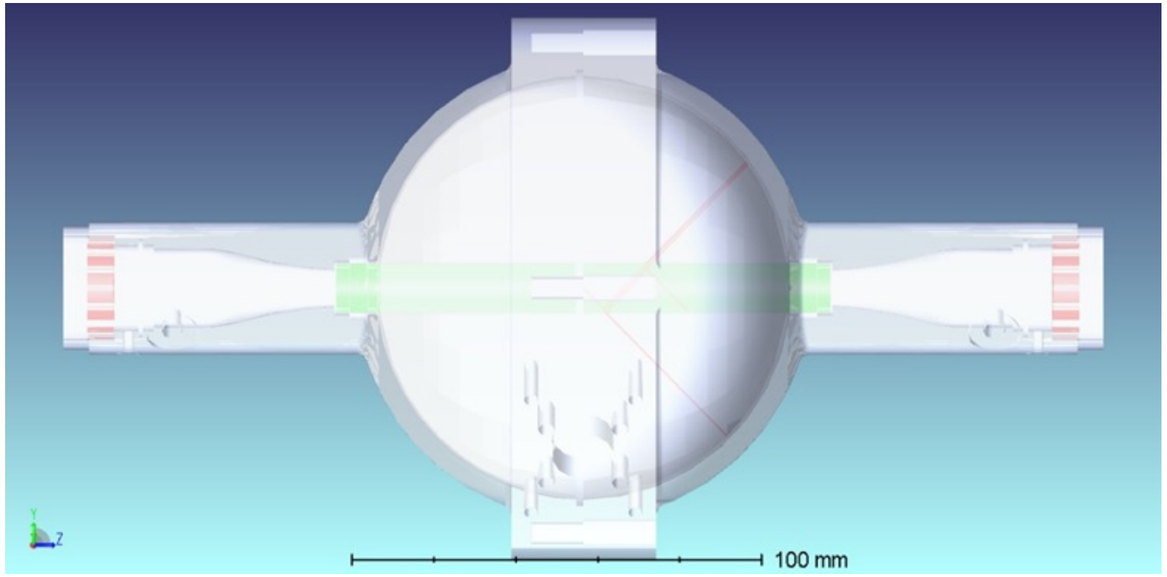




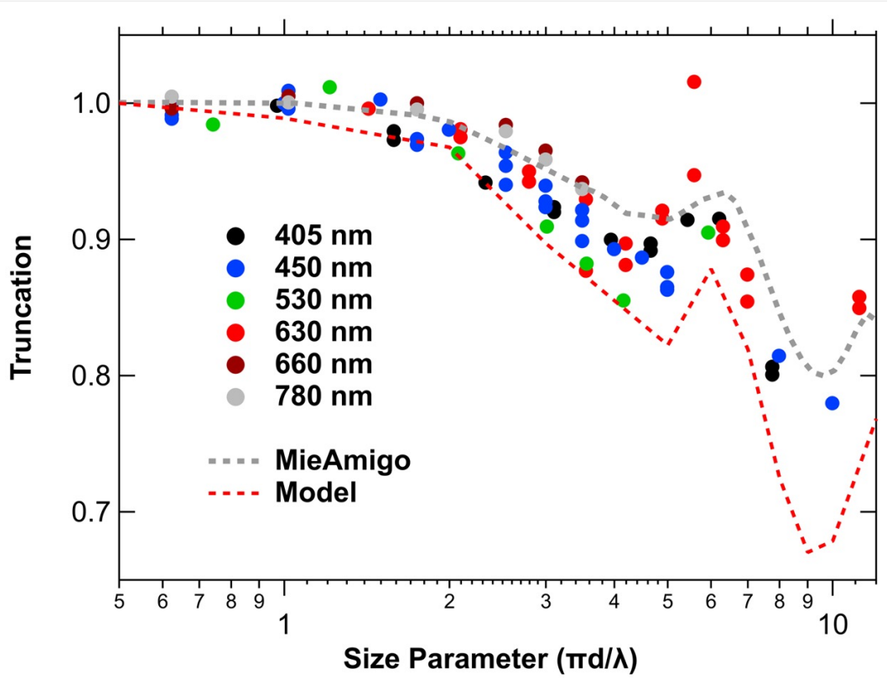
- CAPS PMssa deployed during LASIC at 530 nm wavelength
- Measured from August 4 to September 22, 2017
- Simultaneous measurements with NEPH/PSAP for SSA and PSAP for ABS

CAPS scattering truncation modeling

- Zemax OpticsStudio™ full CAD model
  - Ray tracing and Monte-Carlo
  - Multiple reflections within glass tube
  - Assumes Mie scattering



- Results
  - Zemax model matches measured truncation data
  - Glass tube reduces collection of forward scattered light at large angles of incidence
  - Extended sample volume outside of the integrating sphere offsets a fraction of the effects of the glass tube
- Scattering truncation similar to current Nephelometers



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Summary

- Aerodyne CAPS PM_{SSA} was recently developed under DOE and NASA SBIR projects
  - Successful commercial instrument
- Community Validation and Applications
  - Laboratory validation
    - *Onasch et al., 2015*
    - *Perim de Faria et al., 2021*
  - Soot source characterization
    - *Corbin et al., 2019*
  - Intensive aerosol optical properties
    - *Weber et al., 2022*
  - Absorption measurement
    - *Modini et al. 2021*
  - Humidified single scattering albedo monitor
    - *Carrico et al. 2021*

ASR Atmospheric System Research

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