



AEROSOL
MAGEE SCIENTIFIC

EXPAND THE FRONTIERS OF AEROSOL SCIENCE WITH CUTTING-EDGE BLACK CARBON INSTRUMENT



AE36s
AETHALOMETER®

KEY FEATURES

- 9λ, 340 – 950 nm, characterization of light-absorbing aerosols
- Real-time Brown Carbon analyses
- Time base 1s
- DualSpot technology
- Robustness to relative humidity changes
- Real-time data visualization
- Self-cleaning procedure
- Connectivity
- Automatic data validation

KEY BENEFITS

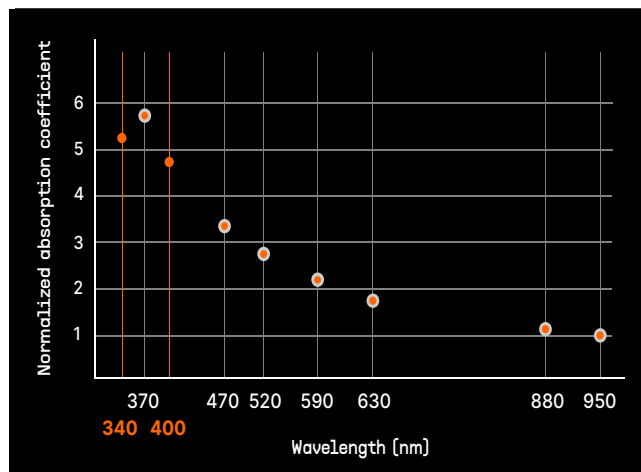
- Unique measurements
- Data you can trust
- Detailed and flexible analytical and diagnostic capabilities
- Thousands of scientific publications
- Requires minimal resources

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AE36s creates breakthrough aerosol research. Extended wavelength range offers high-quality data, and provides advanced Black Carbon source apportionment and Brown Carbon analysis. AE36s enables the broadest range of studies yet, with low resources. It is based upon decades of scientific work and experience of thousands of installations and studies globally.

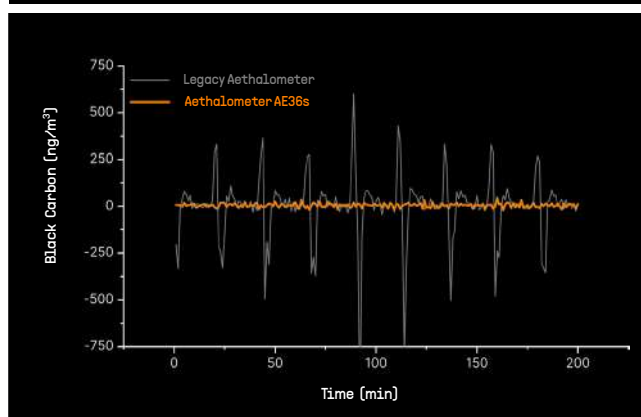
GOOD DATA. GOOD SCIENCE. GOOD POLICY.

We have extended wavelengths where it counts, in the ultraviolet (UV) range, starting from 340 nm. This offers new and unique measurements for breakthrough research of light absorbing aerosols. High-quality data, in high time resolution, enables detailed and flexible analytical capabilities, and broadest range of Black and Brown Carbon studies yet. Thanks to DualSpot, Auto validation, Self-cleaning procedure, and other valuable features AE36s requires minimal resources to get valuable and insightful data. Advanced source and component apportionment provides detailed insights into Black Carbon sources and the nature of light absorbing aerosols. This Aethalometer can shed new light on particles contributing to climate change and adverse effects on human health.



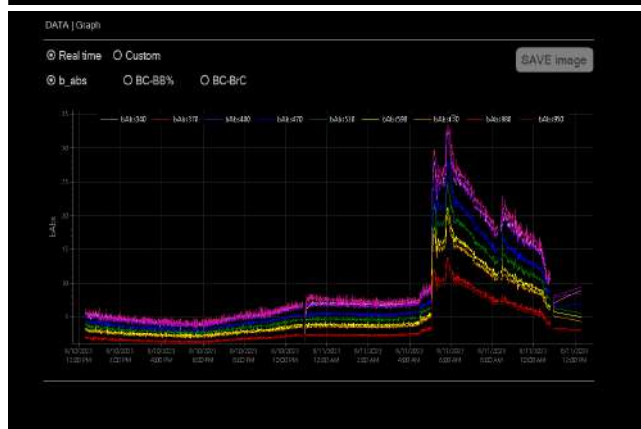
ADVANCED CHARACTERIZATION OF LIGHT ABSORBING AEROSOLS

To improve the real-time characterization of Brown Carbon absorption, two additional wavelengths are introduced in the AE36s: the 400 nm enhances the resolution of absorption spectra in the gap between 370 nm and 470 nm; the 340 nm extends the measurement range in the UV spectrum. AE36s provides new dimensions to the research of Brown Carbon, especially its optical properties, comparison to absorption properties in liquid state, and many more.



ROBUSTNESS TO RAPID CHANGES OF RELATIVE HUMIDITY

AE36s maintains accuracy and stability in varying environmental conditions - 10x improvement. Relative humidity changes, e.g. due to air conditioning, are affecting the performance of all filter photometers. AE36s is robust against extreme relative humidity changes as seen on the left chart and RH compensation mechanism enables reliable and accurate performance.



FEATURE PACKED AND INTUITIVE

AE36s provides a multitude of valuable and insightful data, while requiring minimal resources. **Self-cleaning procedure** prevents buildup of dirt and other contaminants inside the inlet and instrument vital parts. Several **safety and diagnostic features** make sure the instrument is running optimally. New status control is implemented for **automatic data validation**, providing reliable and accurate data analysis and reporting. AE36 is connected using the RAS module in CAAT software.

AETHALOMETER AE36s

APPLICATIONS

The Aethalometer AE36s provides real-time monitoring, quantitation and speciation of **Black and Brown Carbon** aerosols. This data is used to study:

- Black Carbon source apportionment
- Stationary source emissions
- Public and occupational health
- Marine and air transport pollution
- Ambient air quality monitoring, supersite
- Brown Carbon measurement
- Vehicle emission factors
- Vertical profiles
- Climate change research
- Visibility research

ABOUT AE36s

THE AETHALOMETER MEASUREMENT PRINCIPLE

The Aethalometer collects and analyses aerosol particles continuously. The aerosol-laden air stream is drawn through a spot on a filter tape at a measured flow rate. Simultaneously, the tape is illuminated by light: sensitive detectors measure the intensities of light transmitted through an un-exposed portion of the tape, acting as a reference; versus the collecting spot. As optically absorbing material accumulates on the spot, the intensity of light transmitted through it gradually decreases. The decrease in light intensity from one measurement to the next is interpreted as an increase in collected material. This increased amount is divided by the known air-flow volume to calculate the concentration.

The real-time analysis is performed at 9 optical wavelengths from the ultraviolet (340 nm) to the near-infrared (950 nm), which enables source apportionment – see below – to separate traffic or diesel exhaust from biomass burning (woodsmoke, forest fires, cook stoves...), and Brown Carbon analysis.

DUALSPOT PATENTED AUTOMATIC COMPENSATION FOR FILTER LOADING EFFECT ¹

Sample collection and analysis is performed on two filter spots simultaneously at different flow rates. Mathematical combination of the data eliminates the Filter Loading Effect and provides continuously- corrected data in real time with no discontinuities at filter advances.²

The loading effect depends on the aerosol composition and properties and critically affects the optical properties and subsequently the source apportionment and BrC analysis. It must be determined in real time from the measurement data, as it cannot be predicted in advance. The parameters derived from this analysis also offer additional insights into aerosol composition and aging.

ADVANCED REAL-TIME SOURCE APPORTIONMENT

The Aethalometer analyzes the sample at 9 optical wavelengths from UV (340 nm) to IR (950 nm). Optical absorption by different aerosol components may have different variations across the spectrum: most notably, the differences between diesel exhaust and emissions from biomass burning. The 9-wavelength data allows for a separation of these components, providing a real-time speciation of the aerosol sources with advanced brown carbon analysis and determination of their origins.³ The Aethalometer source apportionment algorithm uses filter loading compensated data (DualSpot) considering different loading effect across the spectrum, resulting in true and accurate real-time source apportionment.

TIME BASE 1s

Sampling, analysis, and all calculations are performed at a fundamental rate of 1 Hz. Standard reporting time base of 1 second or 1 minute permit the identification of temporal patterns and the study of direct emission sources such as engines, stoves, etc. Data may be aggregated into averages of 1 hour, or other intervals, for air-quality reporting. All data and internal diagnostics are stored internally with an instrument capacity of many years.

¹ Patents US 8411272, EP 2 151 679 A3, and other cover aspects of the proprietary technology embodied in the Aethalometer.

² Drinovec et al., Atmos. Meas. Tech., 8, 1965 1979, 2015.

³ Zotter et al., Chem Phys., 17, 4229 4249, 2017.

The Aethalometer is the instrument most-used in the world for real-time monitoring and speciation of Black Carbon. Thousands of instruments have been installed on all seven continents starting in 1986.



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PRODUCT SPECIFICATIONS

SENSITIVITY

Proportional to time-base and sample flow rate settings: $<10 \text{ ng/m}^3$ @ 1 min, 5 LPM

DETECTION

Detection limit (1 hour): $<0.001 \mu\text{g/m}^3$

Range: <0.01 to $>100 \mu\text{g/m}^3$

Black Carbon resolution: $<1 \text{ ng/m}^3$

SAMPLING

Aerosol sample collected on reinforced glass-fiber/PTFE filter tape. Tape advances automatically on aerosol loading or at predefined times or intervals. Size selective inlets (impactor, cyclone) may be attached

- Filter tape length: 10 m
- Time-base 1 s and 60 s, post-processing to any time resolution
- Flow-rate 2 to 5 LPM provided by internal pump
- Flow measured by two mass flow sensors and stabilized by closed-loop control
- Tape advances automatically on aerosol loading or at predefined times or time intervals

OPERATOR INTERFACE

Display

10.1" color touch-screen (1280 × 800 px) with status indicator LED's

Interface

- Graphical User Interface with basic data display and control, advanced screens for detailed reporting and parameter setup
- Charting of most relevant data (BC_{gr} , $\text{BB}\%$, BC_{m} , $\text{BC}_{\text{bb,r}}$, BrC) for advanced source apportionment

Remote management

Network ready for remote management and data transfer

AETHALOMETER AE36s

RH ROBUSTNESS

RH sensitivity $<1 \text{ ng BC}/(\%/ \text{min})$

SENSORS

- Inlet RH sensor
- Tape compartment RH sensor
- Door sensor

DATA OUTPUT & STORAGE

Output

- Digital data via RS-232 COM port and Ethernet
- 4x USB, 1x USB (power only), 6x RS232, 1x Ethernet

Storage

- Database: 6 GB (30 years of 1 min data)
- All data are written to internal memory once every time-base period. Stored and autovalidated data may be transferred over a network or to a manually inserted USB drive

QUALITY CONTROL AND ASSURANCE

- Stability test
- Clean air test
- ND test for optical performance verification
- Flow verification
- Filter leakage test
- Inlet leakage test
- Flow calibration
- Tape sensor calibration
- Self cleaning procedure

PHYSICAL SPECIFICATIONS

- Dimensions (H x W x D): 27 × 43 × 32 cm
- Weight: 17.5 kg
- Electrical power supply: AC: 100-230VAC, 50/60Hz (auto-switching)
- Power consumption: 30 W average
- Internal vacuum pump: dual diaphragm, brushless motor
- Modular hardware, constructed in a fully-enclosed 19" rack mount 6U chassis, hermetically sealed to be protected from external environmental conditions

RELATED PRODUCTS

- **RAS module in CAAT** for remote access and support
- **Sample Stream Dryer** including external pump
- **Upgrade with a TCA08:** AE36s can be upgraded into a CASS instrument - an online OC/EC analyzer

INSTALLATION REQUIREMENTS

- Temperature: 5°C - 55°C
- Rel. humidity: 5% - 95% (non-condensing)
- Operating altitude: up to 3000 m a.s.l.
(can be extended to 5000 m a.s.l. with an external air pump for high-altitude operation – optional accessory)

ACCESSORIES

- **Neutral density optical filter validation kit**
- **Ambient meteorological sensor**
- **Wind speed and direction sensor**
- **Sample Stream Dryer**
- **PM2.5 Inlet** (2.5 μm @ 5 LPM)
- **PM1 Inlet** (1 μm @ 5 LPM, 2.5 μm @ 2 LPM)
- **CO₂ sensor**
- **Flow calibrator ALICAT FP-25** (0.1-25 LPM)
- **Insect screen assembly with water trap**
- **Tape sensor calibration disc kit**
- **GPS module**
- **External pump for High-Altitude operation**

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Specifications are subject
to change without notice.

Keeping an Eye on the Air