Harmonized Data Correction Procedure for Nephelometers and Filter-Based Absorption Photometers

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NEPHELOMETER

•The nephelometer measures light scattering by aerosols particles
•Ambient air passes through a chamber where particles are illuminated by a multi-wavelength light source (halogen lamp or LEDs).
•Scattered light is detected by photomultiplier tubes at blue, green, and red wavelengths.
•**Limitations include non-lambertian illumination and truncation errors**.

NEPHELOMETER limitations

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non-lambertian illumination

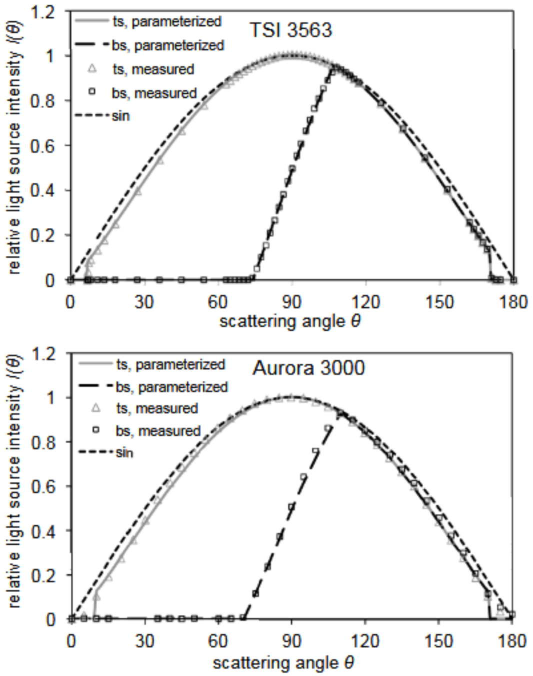
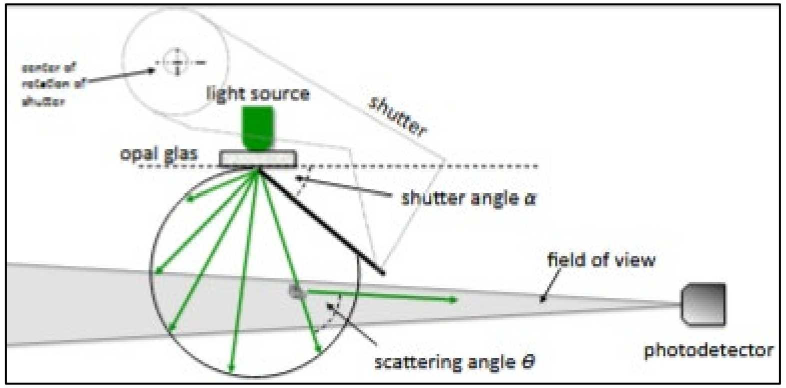


Fig. 3. Measured and parameterized angular intensity functions, $f(\theta)$, including forward and backward truncation for the TSI 3563 (upper panel, data are taken from Anderson et al., 1996) and Aurora 3000 (lower panel). For the Aurora 3000 the average of all three wavelengths is shown. For comparison purposes, the total scattering illumination function (ts) has been normalized to unity at 90° scattering angle. The backward scattering illumination function (bs) was adjusted to match the total scattering function at 110°.

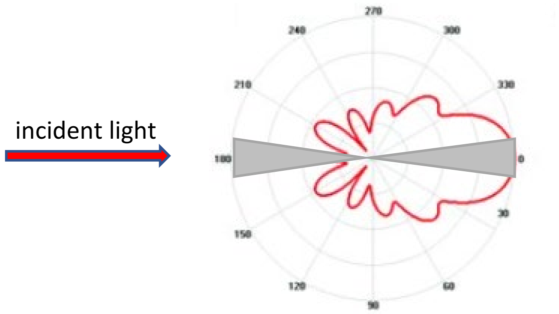
Lambertian:
- Has uniform and symmetric radiance in all directions following a cosine law

Non-Lambertian illumination
- the light source does not emit uniformly in all directions.
- particles in directions with less light scatter less

truncation



Truncation:
- The forward and backword radiation is blocked
- truncation is inevitable because the direct signal from the light source is thousands of times stronger than the particle scattering in the same direction.
- Field of view: ~ 7-170°



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Measured angles: 7-170º

TSI Integrating Nephelometer 3563

This model is discontinued.

Truncation and Angular-Scattering Corrections for Absorbing Aerosol in the TSI 3563 Nephelometer

Tami C. Bond, David S. Covert & Thomas Müller

Pages 866-871 | Received 21 Nov 2008, Accepted 28 Feb 2009, Published online: 03 Jun 2009

Cite this article https://doi.org/10.1080/02786820902998373

Measured angles: 10-171º

Ecotech Integrating Nephelometer AURORA 3000

Atmos. Meas. Tech., 4, 1291–1303, 2011
www.atmos-meas-tech.net/4/1291/2011/
doi:10.5194/amt-4-1291-2011

Atmospheric Measurement Techniques

Design and performance of a three-wavelength LED-based total scatter and backscatter integrating nephelometer

T. Müller[1], M. Laborde[2,3], G. Kassell[2], and A. Wiedensohler[1]

NEPHELOMETER correction

Forward scattering correction

Bond et al., 2009 (TSI 3563)
Müller et al., 2011 (Ecotech AURORA 3000)

(1) $$\sigma_{ts}^{corr}(\lambda) = \sigma_{ts}^{raw}(\lambda) \cdot C_{ts}(\lambda)$$

(2) $$C_{ts}(\lambda) = a + b \cdot \alpha_{ts}^{*}$$

(3) $$\alpha_{ts}^{*}(B/G) = -\frac{\log\left(\frac{\sigma_{ts}^{raw}(B)}{\sigma_{ts}^{raw}(G)}\right)}{\log\left(\frac{B}{G}\right)}$$

(4) $$\alpha_{ts}^{*}(B/R) = -\frac{\log\left(\frac{\sigma_{ts}^{raw}(B)}{\sigma_{ts}^{raw}(R)}\right)}{\log\left(\frac{B}{R}\right)}$$

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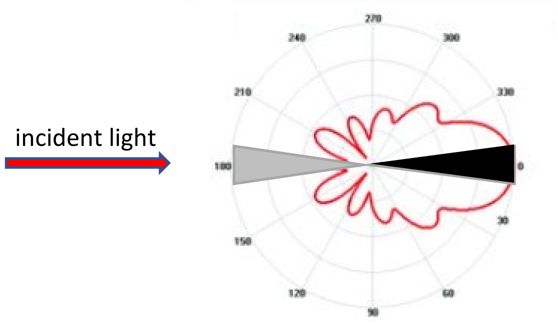
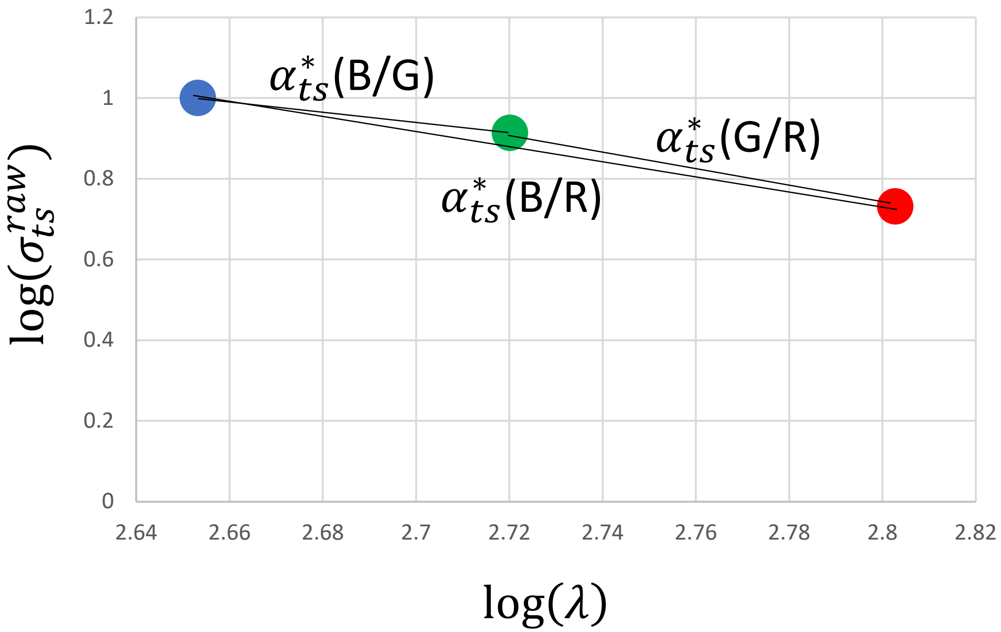


α = *scattering Ångström exponent (SAE)*



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(6) $$C_{ts}(B) = a + b \cdot \alpha_{ts}^{*}(B/G)$$

(7) $$C_{ts}(G) = a + b \cdot \alpha_{ts}^{*}(B/R)$$

(8) $$C_{ts}(R) = a + b \cdot \alpha_{ts}^{*}(G/R)$$

NEPHELOMETER correction

Forward scattering correction

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wavelength		B		G		R	
Ångström exponents		α*ts(B/G)		α*ts(B/R)		α*ts(G/R)	
parameters		a	b	a	b	a	b
TSI	no cut	1.345	-0.146	1.319	-0.129	1.279	-0.105
	sub-µm	1.148	-0.041	1.137	-0.040	1.109	-0.0033
Ecotech	no cut	1.455	-0.189	1.434	-0.176	1.403	-0.156
	sub-µm	1.213	-0.060	1.207	-0.061	1.176	-0.053

no cut = bigger particles -> stronger forward scattering

Use one of the two coefficient (no cut or sub) depending on the α calculated from raw data (α>2 = sub)

NEPHELOMETER correction

Backward scattering correction

Bond et al., 2009 (TSI 3563)
Müller et al., 2011 (Ecotech AURORA 3000)

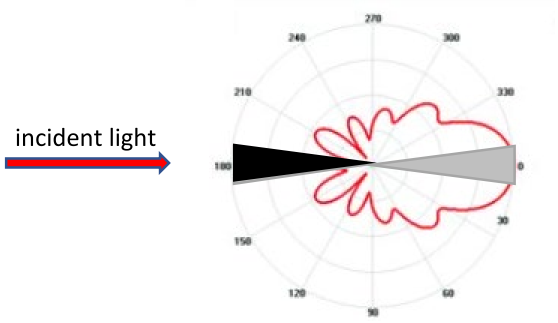

Table 3a. Nephelometer correction factors for angular nonidealities. Wavelengths for TSI 3563 are 450 nm (B), 550 nm (G), and 700 nm (R), and wavelengths for Aurora 3000 are 450 nm (B), 525 nm (G), and 635 nm (R), respectively.

(a) Midpoint ± half range of calculated correction factors for conditions with and without sub-μm cut

		total scatter			backscatter		
	wavelength	B	G	R	B	G	R
TSI 3563	no cut	1.30 ± 0.25	1.29 ± 0.24	1.26 ± 0.21	0.983 ± 0.040	0.984 ± 0.041	0.988 ± 0.043
	sub-μm	1.086 ± 0.040	1.066 ± 0.031	1.045 ± 0.021	0.950 ± 0.009	0.944 ± 0.012	0.954 ± 0.009
Aurora 3000	no cut	1.37 ± 0.29	1.38 ± 0.31	1.36 ± 0.29	0.963 ± 0.040	0.971 ± 0.047	0.968 ± 0.043
	sub-μm	1.125 ± 0.059	1.103 ± 0.046	1.078 ± 0.035	0.932 ± 0.012	0.935 ± 0.017	0.935 ± 0.014

NEPHELOMETER correction

Angular Illumination and Truncation of Three Different Integrating Nephelometers: Implications for Empirical, Size-Based Corrections

T. Müller, A. Nowak, A. Wiedensohler, P. Sheridan, M. Laborde, David S. Covert, ...show all

Pages 581-586 | Received 13 Feb 2008, Accepted 04 Feb 2009, Published online: 25 Mar 2009

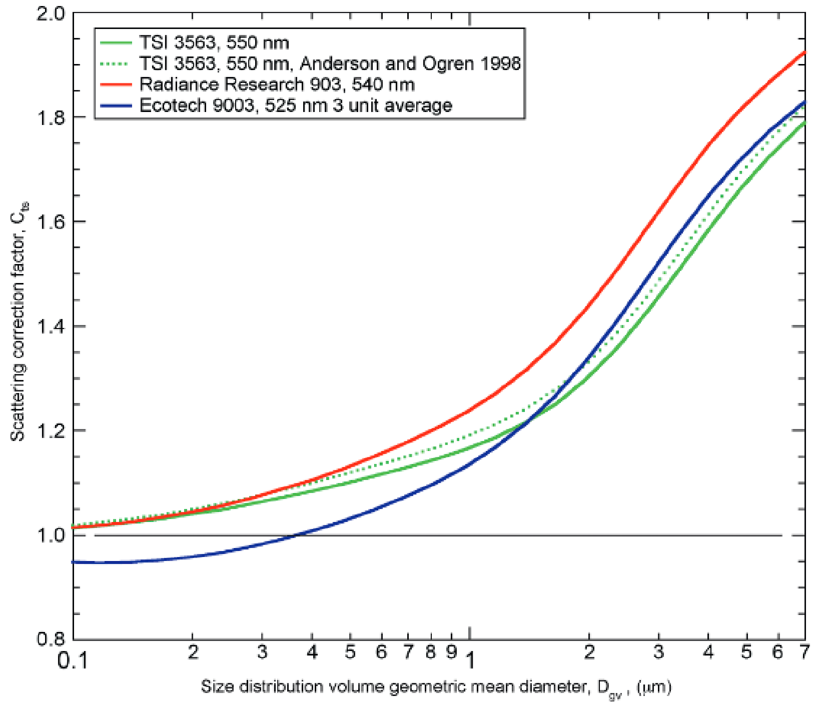

FIG. 3. Calculated generic correction factor, C_{ts}, vs. D_{gv} for three models of nephelometers accounting for truncation and angular illumination function of the light sources. The result of Anderson and Ogren (1998) from the previous illumination function for the same aerosol parameters is shown for comparison.

Manufacturer	Model	Number of units	Light source	Wave-length	Bandwidth FWHM	Angular integration range
TSI St. Paul, MN USA	3563	15 3/15 for illumination	Incandescent quartz-halogen, opal glass diffuser	450, 550, 700 nm	40 nm	7° to 170°
Radiance Research Seattle, WA USA	M903	2	Xenon flash lamp, opal glass diffuser	540 nm*	40 nm	10° to 170°
Ecotech Knoxfield, VIC Australia	9003	3	7 LED tuned array, ground glass diffuser	525 nm	60 nm	12° to 165°

NEPHELOMETER correction

10-170º

Ecotech Polar Nephelometer AURORA 4000

wavelength		B		G		R	
Ångström exponents		α*ts(B/G)		α*ts(B/R)		α*ts(G/R)	
parameters		a	b	a	b	a	b
TSI	no cut	1.345	-0.146	1.319	-0.129	1.279	-0.105
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Müller et al., 2011 (Ecotech AURORA 3000)

Scattering Coefficients and Asymmetry Parameters derived from the Polar Nephelometer Aurora4000, 2012

T. Müller, M. Paixão, Sascha Pfeifer, and A. Wiedensohler

Leibniz-Institute for Tropospheric Research, Leipzig, Germany

TROPOS

Truncation and illumination errors were simulated using the synthetic test data and correction factors for compensating the truncation and illumination errors were calculated by two methods:

•The *AO98* correction[2] for correcting the truncation and illumination error of multi wavelength nephelometers is based on the scattering Angström, which is defined by defined by

$$\alpha = -\ln\left(\sigma_{sca}^{\lambda_1} / \sigma_{sca}^{\lambda_2}\right) / \ln\left(\lambda_1 / \lambda_2\right)$$

Correction factors for instruments of types Aurora3000 and Aurora4000 are[3]

$$C_{AO98} = \begin{cases} 1.207 - 0.061 \cdot \alpha & \alpha > 2 \\ 1.434 - 0.176 \cdot \alpha & \alpha \le 2 \end{cases}$$

•A new *polar correction* based on the angular measurements of the Aurora4000 was developed. A simple function for compensating the truncation was found by

$$C_{polar} = 0.8781 + 0.955 \cdot \frac{\sigma_{sca}^{10^\circ} - \sigma_{sca}^{20^\circ}}{\sigma_{sca}^{10^\circ}}$$

Acoem, owner of Ecotech

The Aurora NE-300 (scattering **7 - 173°**; backscatter **90 - 173°**)

In the absence of an experimental characterization of these nephelometers, the corrections presented for the AURORA 3000/4000 can be applied.

NEPHELOMETER data reporting (Level 2)

After all corrections have been applied, the particle light scattering and backscattering coefficients are **converted to standard temperature and pressure conditions** to ensure comparability across measurements and monitoring sites.

$$\sigma_{ts}^{corr,ref} = \sigma_{ts}^{corr,(P,T)} \cdot \left(\frac{P_{ref}}{P}\right) \cdot \left(\frac{T}{T_{ref}}\right)$$

T_{ref} = 0 ºC
P_{ref} = 1013.25 hPa

Hourly averages

Templates for Integrating-Nephelometer-Data on different levels

Please note, you can validate your **level 0** and **level 1** data using the EBAS submission tool. If you experience problems with uploading your data, please contact us at ebas@nilu.no.

Levels

Level 0

Level 1

Level 2

Data Level	Description		Used For
0	• Annotated raw data • Format instrument specific • Contains all parameters provided by instrument as provided • Contains all parameters / info needed for processing to final value. • "Native" time resolution		• Advanced data reporting • Near-Real-Time (NRT) data reporting
1	• Data processed to final parameter • Invalid data & calibration episodes removed • "Native" time resolution • Format property specific • Correction to standard temperature & pressure cond. (273.15 K, 1013.25 hPa) if necessary		• Advanced data reporting • Intercomparisons
1.5	• Data aggregated to hourly averages • Atmospheric variability quantified by standard deviation or percentiles • Format property specific	auto-processed	Near-Real-Time (NRT) data processing
2		manual quality assurance	Regular, annual data reporting

NEPHELOMETER maintenance

After all corrections have been applied, the particle light scattering and backscattering coefficients are **converted to standard temperature and pressure conditions** to ensure comparability across measurements and monitoring sites.

Check	**Frequency**
Perform basic checks (flow rate, etc.)	During setup
Perform a zero calibration using particle-free (filtered) air	daily (at remote stations more often up to hourly)
Conduct a high-span calibration/check using CO_2. Deviations should be less than 5%.	bi-monthly
Check the noise level (mean and standard deviation) while measuring filtered air	annually
Check sample flow rate (according to observatory or network-defined protocols	annually
Cleaning of internal components such as the light trap and baffles etc	annually

FILTER BASED ABSORPTION PHOTOMETERS

Photo-detectors in the filter photometer **MEASURE the intensity of diffuse light transmitted through the sample spots** on the filter (I_s), and a second photo-diode measures the intensity of light through an unsampled area of the filter (I_r). The **attenuation, *ATN***, is calculated from the ratio of the two intensities:

The **attenuation coefficient** ($\sigma_{ATN}(t)$) is then defined as

$$\sigma_{ATN}(t) = \frac{Q}{A}\frac{\Delta ATN(t)}{\mathrm{d}t}$$

where ***ΔATN*** is the change in filter attenuation during the time interval $\Delta t = t_2 - t_1$, in seconds, ***Q*** [m^3/s)] is the sample flow rate through the filter, and ***A*** [m^2] is the area of the exposed spot on the filter.

FILTER BASED ABSORPTION PHOTOMETERS: AETHALOMETERS (AE33, AE43, AE36, AE36s)

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$$\sigma_{abs,raw}(\lambda) = \frac{\sigma_{ATN}(\lambda)}{C}$$

$$eBC_{raw}(\lambda) = \frac{\sigma_{abs,raw}(\lambda)}{MAC_n(\lambda)}$$

$MAC_n(\lambda)$ [m²/g]	**C = 1.39 (M8060)**
18.47 (370 nm)	**C = 1.57 (M8050/M8020)**
15.54 (470 nm)	
13.14 (520 nm)	
11.58 (590 nm)	
10.35 (660 nm)	
7.77 (880 nm)	*7.83 (Savadkoohi et al., 2024)*
7.19 (950 nm)	

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$$C = \frac{\sigma_{ATN}^{AE}(\lambda)}{\sigma_{abs}^{MAAP}(\lambda)} = \mathbf{2.44}\ \textbf{(M8060)}$$

$$H^* = \frac{2.44}{1.39} = 1.76\ \text{(M8060)}$$

$$H^* = 2.21\ \text{(M8020/M8050)}$$

ACTRIS Harmonization factor H*

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$$H^* = \frac{2.44}{1.39} = 1.76\ \text{(M8060)}$$

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$$\sigma_{abs,harm}(\lambda) = \frac{eBC_{raw}(\lambda)\cdot MAC_n(\lambda)}{1.76}$$

$$eBC_{harm}\left[\frac{\mu g}{m^3}\right] = \frac{BC6_{\mathrm{raw}}(880nm)}{1.76}$$

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$$MAC_{local}(\lambda) = \frac{\sigma_{abs,harm}(\lambda)}{EC}$$

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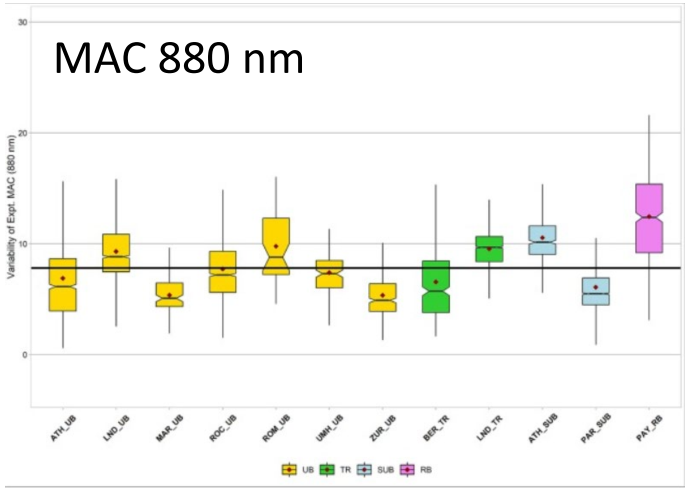

Savadkoohi et al., 2024

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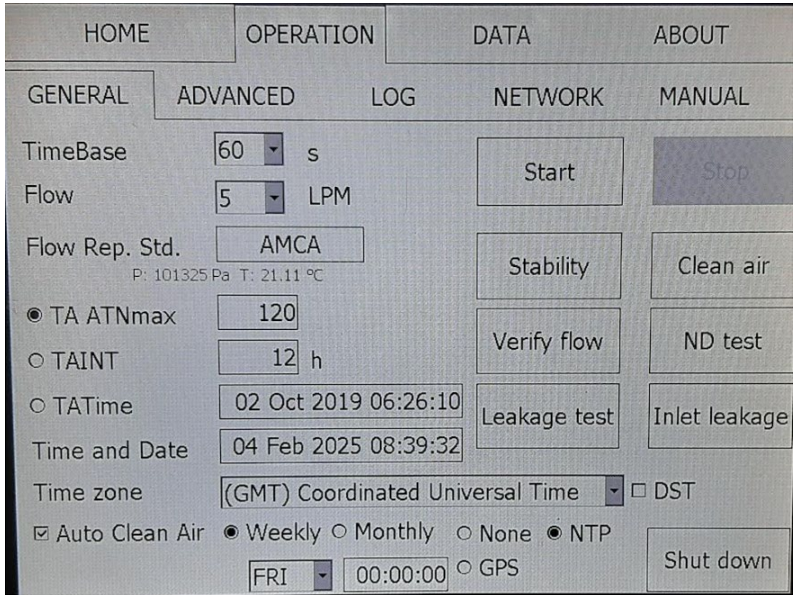
FILTER BASED ABSORPTION PHOTOMETERS: AETHALOMETERS (AE33, AE43, AE36, AE36s)

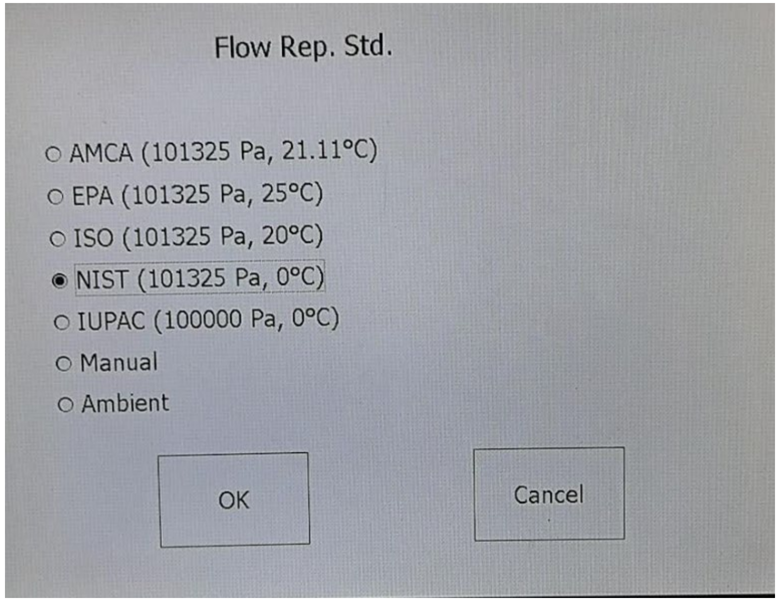
MAINTENANCE

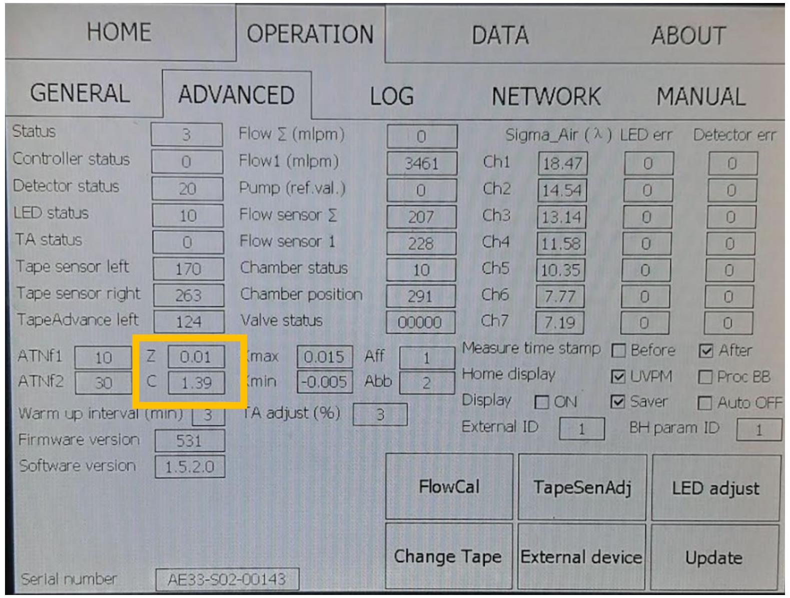
- Aethalometers are stable instruments and do not require frequent maintenance
- The most frequent routine maintenances are the filter change, check the inlet flow or inspect the sample line tubing
- It does not require a specialized technician or researcher. A little training is sufficient
- It is important to check, for example weekly, the screen to see if error messages have appeared
- The graphical interface of the Aethalometers allows to know if any maintenance is needed and what type of maintenance
- Aethalometer manuals are provided by the manufacturer
- https://www.youtube.com/watch?v=ZoUzaqMi2EQ (Aethalometers operation and maintenance)
- A number of technical guidance documents and reports about Aethalometers (and other FAPs) are available from Global Atmosphere Watch (GAW; https://www.gaw-wdca.org/Publications/) and ACTRIS (https://www.actris-ecac.eu/particle-light-absorption.html) that provide comprehensive recommendations and guidelines including operating procedures, aerosol inlets and conditioning, data management among other. The service tools from RI-URBANS project (https://riurbans.eu/project/#service-tools) to assess air quality in accordance with RI-URBANS' advanced air quality monitoring recommendations and with the ACTRIS/GAW protocols for measuring advanced air quality parameters

FILTER BASED ABSORPTION PHOTOMETERS: AETHALOMETERS (AE33, AE43, AE36, AE36s)

SETTINGS







- 60 s time resolution
- 5 LPM
- Flow Rep. Std.
- ATN max 370 nm (120)
- Weekly Auto Clean Air Test
- Z=0.01 (tangential leakage through the edges of the filter tape)
- C=1.39 (optical enhancement factor; M8060)

FILTER BASED ABSORPTION PHOTOMETERS: AETHALOMETERS (AE31)

Photo-detectors in the filter photometer **MEASURE the intensity of diffuse light transmitted through the sample spots** on the filter (I_s), and a second photo-diode measures the intensity of light through an unsampled area of the filter (I_r). The **attenuation, *ATN***, is calculated from the ratio of the two intensities:
The **attenuation coefficient** ($\sigma_{ATN}(t)$) is then defined as

$$\sigma_{ATN}(t) = \frac{Q}{A}\frac{\Delta ATN(t)}{\mathrm{d}t}$$

where ***ΔATN*** is the change in filter attenuation during the time interval $\Delta t = t_2 - t_1$, in seconds, ***Q*** [m³/s)] is the sample flow rate through the filter, and ***A*** [m²] is the area of the exposed spot on the filter.

$$\sigma_{abs} \approx \frac{\sigma_{ATN}}{3.5}$$

$$eBC(880) = \frac{\sigma_{abs}}{7.77}$$

FILTER BASED ABSORPTION PHOTOMETERS: MAAP

Photo-detectors in the filter photometer **MEASURE the intensity of diffuse light transmitted through the sample spots** on the filter (I_s), and a second photo-diode measures the intensity of light through an unsampled area of the filter (I_r). The **attenuation, *ATN***, is calculated from the ratio of the two intensities:
The **attenuation coefficient** ($\sigma_{ATN}(t)$) is then defined as

$$\sigma_{ATN}(t) = \frac{Q}{A}\frac{\Delta ATN(t)}{dt}$$

where ***ΔATN*** is the change in filter attenuation during the time interval $\Delta t = t_2 - t_1$, in seconds, ***Q*** [m^3/s)] is the sample flow rate through the filter, and ***A*** [m^2] is the area of the exposed spot on the filter.

- The MAAP uses a different optical configuration than the aethalometer, with measurements of the filter reflectivity at two different angles in addition to the filter transmission measurement,
- The two reflectivity measurements allow correction for multiple scattering processes involving the deposited particles and the filter matrix.
- The MAAP nominally operates at a wavelength of 670 nm, but laboratory tests revealed that the actual wavelength is 637 nm; as a consequence, particle light absorption coefficients and equivalent black carbon mass concentrations from the MAAP should be multiplied by a factor of **1.05**

$$\sigma_{abs-MAAP} = eBC_{raw-MAAP} \cdot MAC_n \cdot 1.05$$

$$MAC_n\,(670\,nm) = 6.6\,\frac{m^2}{g}$$

✗ $670\,nm$ ✓ $637\,nm \rightarrow 1.05$

$$MAC_H = \frac{\sigma_{abs-MAAP}}{EC} = 10\,\frac{m^2}{g}$$

Zanatta et al., 2016
Savadkoohi et al., 2024

$$eBC_{corr-MAAP} = \frac{\sigma_{abs-MAAP}}{10}$$

$$eBC_{corr-MAAP} = \frac{eBC_{raw-MAAP} \cdot 6.6 * 1.05}{10}$$

FILTER BASED ABSORPTION PHOTOMETERS: PSAP

Photo-detectors in the filter photometer **MEASURE the intensity of diffuse light transmitted through the sample spots** on the filter (I_s), and a second photo-diode measures the intensity of light through an unsampled area of the filter (I_r). The **attenuation, *ATN***, is calculated from the ratio of the two intensities:
The **attenuation coefficient** ($\sigma_{ATN}(t)$) is then defined as

$$\sigma_{ATN}(t) = \frac{Q}{A}\frac{\Delta ATN(t)}{\mathrm{d}t}$$

where ***ΔATN*** is the change in filter attenuation during the time interval $\Delta t = t_2 - t_1$, in seconds, ***Q*** [m^3/s)] is the sample flow rate through the filter, and ***A*** [m^2] is the area of the exposed spot on the filter.

- The PSAP (Particle Soot Absorption Photometer) measures aerosol light absorption by collecting particles on a filter and monitoring the change in light transmission. However, the raw attenuation signal must be corrected because filter-based methods introduce artifacts.
- The particle light absorption coefficient measured by the PSAP was described in **Bond et al. (1999)**, who derived a correction equation for calculating the absorption coefficient from the attenuation coefficient.

$$\sigma_{abs} = \frac{\sigma_{ATN}}{1.317 \cdot \tau + 0.886} - 0.016 \cdot \sigma_{sca}$$

Ogren, 2010
Virkkula et al., 2005
Müller et al., 2011

The total scattering coefficient is measured by a collocated nephelometer (or estimated from size distribution measurements) at the measurement wavelength (Bond et al., 1999)

FILTER BASED ABSORPTION PHOTOMETERS: CLAP

Photo-detectors in the filter photometer **MEASURE the intensity of diffuse light transmitted through the sample spots** on the filter (I_s), and a second photo-diode measures the intensity of light through an unsampled area of the filter (I_r). The **attenuation, *ATN***, is calculated from the ratio of the two intensities:
The **attenuation coefficient** ($\sigma_{ATN}(t)$) is then defined as

$$\sigma_{ATN}(t) = \frac{Q}{A}\frac{\Delta ATN(t)}{\mathrm{d}t}$$

where ***ΔATN*** is the change in filter attenuation during the time interval $\Delta t = t_2 - t_1$, in seconds, ***Q*** [m^3/s)] is the sample flow rate through the filter, and ***A*** [m^2] is the area of the exposed spot on the filter.

- The CLAP (*Ogren et al., 2017*) was designed to be optically identical to the PSAP. The Bond et al. (1999) scheme was further refined by *Ogren (2010)*

$$\sigma_{abs} = 0.85\frac{f(\tau)\cdot\sigma_{ATN}}{K_2} - \frac{K_1\cdot\sigma_{sca}}{K_2}$$

with

$$f(\tau) = (1.0796\cdot\tau + 0.71)^{-1}$$

and

$$K_1 = 0.02 \pm 0.02$$
$$K_2 = 1.22 \pm 0.20$$

Long-term comparisons of **CLAPs and PSAPs** operated in parallel at 17 field stations revealed that measurements of the attenuation coefficient with the CLAP and PSAP are equal within the **10% uncertainty of the measurements** (*Ogren et al. 2017*). As a consequence, the PSAP correction equations in the preceding section are recommended for the CLAP as well. More information about the CLAP is provided in *Ogren et al. (2017)* including uncertainty in the absorption measurement as a function of aerosol single scattering albedo.

FILTER BASED ABSORPTION PHOTOMETERS

ACOEM/MetONE

BC 1054 BLACK CARBON ANALYZER

The BC 1054 Multi-spectrum Black Carbon Analyzer from Met One Instruments Powered by Acoem continuously measures the transmittance of light across filter media onto which particulate matter is accumulating and in real-time calculates the black-carbon "BC" concentrations at 10 different...

VIEW →

BC 1060 & BC 1065 PORTABLE BLACK CARBON MONITOR

The BC 1060 and BC 1065 2-Channel Black Carbon Monitors from Met One Instruments Powered by Acoem measure and report aerosol brown and black carbon concentrations, with user-selectable time resolution down to one minute, at both UV (370 nm) and...

VIEW →

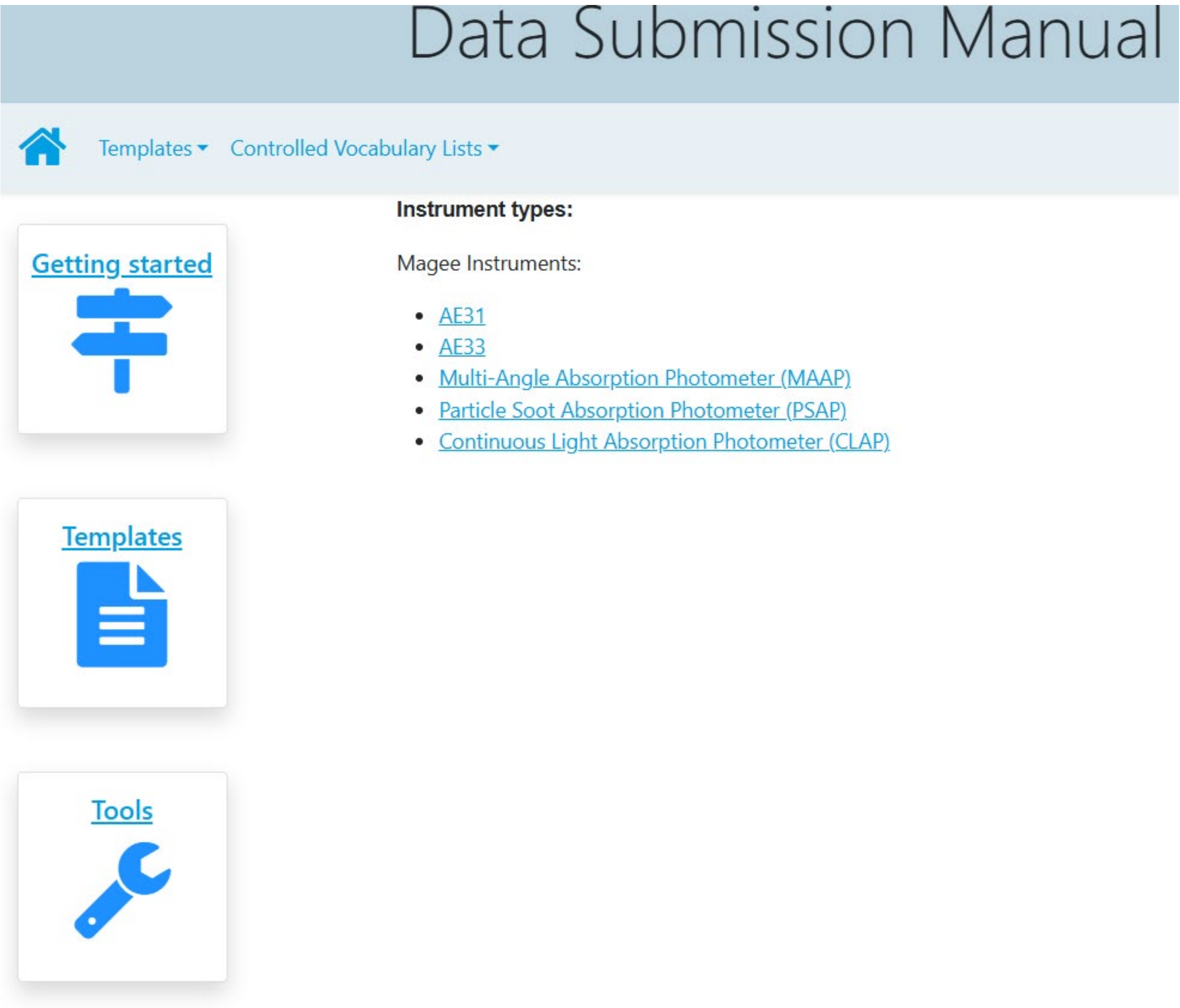
C-12 PORTABLE BLACK CARBON MONITOR

EXPERIENCE HIGHLY GRANULAR BLACK CARBON MONITORING WITH UNMATCHED AFFORDABILITY Introducing the groundbreaking C-12, our portable and weatherproof dual wavelength carbon monitor, which allows for highly granular measurement of black and brown carbon at an unbeatable total cost of ownership, making...

VIEW →

FILTER BASED ABSORPTION PHOTOMETERS: FLAGS

https://ebas-submit.nilu.no/templates/Filter-Absorption-Photometer/lev0



FILTER BASED ABSORPTION PHOTOMETERS: FLAGS

https://ebas-submit.nilu.no/templates/Filter-Absorption-Photometer/lev2

For data harmonization across the network, the following **short list of the flags** should be used with this template. It is possible to use several flags at the same time to give detailed information about the data.

Group 0: Valid data		
Flag	**Validity**	**Description**
000	V	Valid measurement
Group 1: Exception flags for accepted, irregular data		
Flag	**Validity**	**Description**
111	V	Irregular data checked and accepted by data originator. Valid measurement
Group 3: Flags for aggregated datasets		
Flag	**Validity**	**Description**
390	V	Data completeness less than 50%
392	V	Data completeness less than 75%
394	V	Data completeness less than 90%
Group 5: Chemical problem		
Flag	**Validity**	**Description**
559	V	Unspecified contamination or local influence, but considered valid
Group 6: Mechanical or instrumental problem		
Flag	**Validity**	**Description**
640	V	Instrument internal relative humidity above 40%
Group 9: Missing flags		
Flag	**Validity**	**Description**
999	M	Missing measurement, unspecified reason

ACTRIS

CAIS-ECAC
Center for Aerosol In-Situ - European Center for Aerosol Calibration and Characterization

MANY THANKS!

Marco Pandolfi, IDAEA-CSIC
marco.pandolfi@idaea.csic.es

WCCAP
World Calibration Centre for Aerosol Physics

OGTAC-CC

European Reference Laboratory for Air Pollution

ACMCC
Aerosol Chemical Monitor Calibration Center

EMC2
Elemental Mass Calibration Centre

CCC
Cluster Calibration Center

ACTRIS

CAIS-ECAC

Center for Aerosol In-Situ - European Center for Aerosol Calibration and Characterization

WCCAP World Calibration Centre for Aerosol Physics

OGTAC-CC

European Reference Laboratory for Air Pollution

ACMCC Aerosol Chemical Monitor Calibration Center

EMC2 Elemental Mass Calibration Centre

CCC Cluster Calibration Center

13.1 Startup screen checks

OPERATION AND MAINTENANCE: Aethalometers

Check	Description	Error	Solution
Communication	communication PC to optical chamber controller	hardware problem	check cables
Instrument data	Obtain data (serial number) from the optical chamber controller	hardware problem	check cables
Storage	CF card operation	CF card error	get new CF card and SW
Configuration settings	read setting from the setup file	Setup file error	restore setup file from one of the older setup files
Valves	operation of the ball valve	ball valve not moving	check cables
Chamber	optical chamber movement test	locked chamber	unlock chamber
		hardware error	service needed
Pump & Flow	test if pump is working	pump	service needed
		tube connections	reconnect tubes
Device monitoring	Win CE operating system test	faulty application file	get new CF card and SW

OPERATION AND MAINTENANCE: Aethalometers

https://www.actris-ecac.eu/particle-light-absorption.html

- Check the instrument status. Status messages other than normal operation (0 = no error and no warning) should be checked and data flagged accordingly
- Sample pressure and temperature: AE33 does not measure ambient temperature and pressure without connecting to an external sensor.
- Sample relative humidity at inlet (sensors not built in to AE33) Sample relative humidity varies with ambient relative humidity and the temperature difference between ambient and lab. The sample should be dried so that the sample has RH < 40% already at the instrument inlet. If RH is higher, apply flag 640. Since the AE33 does not measure RH, it is valid to measure the humidity at the inlet of another device that is located at the same common aerosol inlet and under similar conditions.
- Sample flow: Sample flow through the instrument inlet should be constant. The sample flow should typically be 5 l/min and shall not vary. Flow variations directly affect the signal to noise ratio. Spikes in the flow inevitably lead to outliers in equivalent black carbon concentrations. Periods showing problems with the flow must be flagged.
- Filter type : It is mandatory to report the filter tape and respective multiple scattering correction factors (C) in level 0 header data which have actually been used while collecting the data. Also make sure to verify the correct multiple scattering correction factor in the instrument settings. The recommended filter type is M8060 with a multi-scattering correction factor 1.39. For other filter types, please check the appendix. Add scattering correction factor and leakage factor to the Nasa-ames header.

OPERATION AND MAINTENANCE: Aethalometers

t-absorption.html

Status relates to:	bit position	status flag		description
		binary	decimal	
Operation	1 and 0	00	0	Measurement
		01	1	Tape advance (tape advance, fast calibration, warm-up)
		10	2	First measurement – obtaining ATN0
		11	3	Stopped
Flow	3 and 2	00		Flow OK
		01	4	Flow low/high by more than 0.5 LPM or F1 < 0 or F2/F1 outside 0.2 – 0.75 range
		10	8	Check flow status history
		11	12	Flow low/high & check flow status history
Optical Source	5 and 4	00		LEDs OK
		01	16	Calibrating LED
		10	32	Calibration error (at least one channel OK)
		11	48	LED error (all channels calibration error, COM error)

- Check the instrument status. Statu… checked and data flagged accordingly
- Sample pressure and temperature: … to an external sensor.
- Sample relative humidity at inlet (s… humidity and the temperature difference between a… eady at the instrument inlet. If RH is higher, apply flag 640. … nlet of another device that is located at the same commo…
- Sample flow: Sample flow through … min and shall not vary. Flow variations directly affect the s… ck carbon concentrations. Periods showing p…
- Filter type : It is mandatory to repo… header data which have actually been used while colle… factor in the instrument settings. The recomme… filter types, please check the appendix. Add scattering…

https://www.actris-ecac.eu/particle-light-absorption.html

- Check the instrument … flagged accordingly
- Sample pressure and … r.
- Sample relative humi… temperature differen… nt inlet. If RH is higher, a… ce that is located at the …
- Sample flow: Sample … ry. Flow variations direct… concentrations. Perio…
- Filter type : It is mand… have actually been us… instrument settings. T… check the appendix. A…

13.2 Instrument status

Normal operation

Warning ; Instrument is still performing measurements, but there is/was an issue, that needs to be checked

Instrument stopped. Immediate response needed.

Instrument status:	3
Operation status:	3 - Stopped
Flow status:	0 - Flow OK
LED status:	0 - LEDs OK
Chamber status:	0 - Chamber OK
Filter tape status:	0 - Filter tape OK
Settings status:	0 - Settings OK
Tests status:	0 - No test
External device status:	0 - Connection OK

OPERATION AND MAINTENANCE: Aethalometers

https://www.actris-ecac.eu/particle-light-absorption.html

- Check the instrument status. Status messages other than normal operation (0 = no error and no warning) should be checked and data flagged accordingly
- Sample pressure and temperature: AE33 does not measure ambient temperature and pressure without connecting to an external sensor.
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OPERATION AND MAINTENANCE: Aethalometers

Check the sample inlet flow	Once / month
Inspect the sample line tubing	Once / month
Inspect and clean the size selective inlet (if present)	Once / month
Inspect and clean the insect screen assembly (if present)	Once / month
Verify time and date (if not set to update automatically)	Once / month
Inspect optical chamber, clean if necessary	Once / 6 months* *Site dependent, use educated judgment!
Flow check (flow verification, flow calibration)	Once / 6 months
Clean Air Test	Once / 6 months
Stability Test	Once / 6 months
ND filter test	Once / year
Lubricate optical chamber sliders	Once / year
Install a new filter tape roll	As needed. The instrument issues a warning.
Change by-pass cartridge filter	As needed. Once / year

Standard maintenance procedures are shown in video clips at http://group.mageesci.com/

OPERATION AND MAINTENANCE: Aethalometers

https://www.actris-ecac.eu/aerosol-inlets-and-conditioning.html

- Drying technology: four possibilities drying the aerosol sample flow to a RH below 40%.

- Membrane dryers (Nafion): permeable membrane in which water vapor molecules are transported
- Diffusion dryers: water vapor is adsorbed by the silica gel
- Drying by dilution: This method requires the continuous provision of particle-free dry air
- Drying by heating: heating an aerosol sample leads to a reduction of RH in the sampling line

- PM10 or PM2.5 inlet

- Observational networks, such as WMO-GAW, recommend an upper cut point of 10 µm at ambient conditions (WMO-GAW report 153)
- If EC measurements are available in PM2.5, a PM2.5 inlet for AE33 can be used.
- To measure aerosol particles the air inlet must be generally between 1.5 m and 4 m above the ground (2008/50/EC). Sampling tubes should be made of a conductive, corrosion-resistant material with a low surface roughness (e.g., stainless steel).
- Aethalometers can be connected to a single dedicated inlet or to common inlet through an isokinetic splitter.

RI-URBANS SERVICE TOOLS: eBC

https://riurbans.eu/project/#service-tools

Explore all our advanced Service Tools for optimised urban air quality management:

Protocols for the measurement of novel AQ pollutants

ST1:Ultrafine (=nano)-Particle Number Size Distributions (UFP-PNSD)

ST2: Black Carbon (BC)

ST3: Offline and Online particulate matter (PM) speciation

ST4:Oxidative potential (OP) of particulate matter (PM)

ST5: Volatile Organic Compounds (VOCs)

ST6: Ammonia (NH3)

Methodologies for vertical profiles of pollutants and meteorology

Methodologies for source apportionment receptor modelling

Methodologies for urban mapping of novel AQ pollutants

Methodologies for evaluating the health effects of novel AQ pollutants

Obtaining emission inventories for novel AQ pollutants

Modelling methodologies for novel AQ pollutants

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