



## Intercomparison of absorption photometer Project No.: AP-2019-1-16

### Basic informations:

Location of the quality assurance: TROPOS, Lab 121

Date: 21 January - 25 January 2019

Principal Investigator	Home Institution	Participant	Instrument
H. Servomaa	FMI	H. Servomaa	S07-00729

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## 1 Intercomparison summary

### Status on arrival

No issues due to transportation or other damages.

### Flow calibration

The flow meter of the instrument is set to report flow for conditions of 21.11 °C and 1013.25 hPa. The flow was 1.2 % too low compared to reference flow meter (TSI 4100). Corrections for the flow deviation and the temperature and pressure (STP correction) were considered in the data evaluation.

### Noise

The noise level of the instrument is out of the normal range. The average noise ( $1\sigma$ ) for the all wavelengths was less equal  $60 \text{ ng m}^{-3}$  for one minute averaging time. The background level was acceptable with deviations of less equal  $13 \text{ ng m}^{-3}$  for all wavelengths.

## **Inspection**

The instrument was clean without any contamination.

## **Comparison to reference MAAP**

BC concentrations at 880 nm (BC6) of AE33 are 46.3 % higher than BC concentrations from a reference MAAP.

## **Comparison to reference AE33**

The deviations of BC concentrations relative to the reference AE33 are in the range of –1.3 to 3.4 %.

## **Comparison to reference absorption**

The deviations of the absorption coefficients derived from AE33 relative to the absorption coefficients from the multi-wavelength absorption reference setup are in the range of –3.8 to 4.0 %.

## **Recommendations**

No recommendations.

## **Overall assessment**

The instrument meets the requirements.

## 2 Details

### Configuration parameters

```

<?xml version="1.0"?>
<data>
  <name>Aethalometer</name>
  <manufacturer>Magee Scientific </manufacturer>
  <!-- Instrument serial number -->
  <SerialNumber>AE33-S07-00729</SerialNumber>
  <!-- Model number -->
  <ModelNo>AE33</ModelNo>
  <!-- Language used for all text in AE software! -->
  <language>EN</language>
  <!-- Number of channels 7 wavelenghts (from IR to UV) -->
  <NoOfChannels>7</NoOfChannels>
  <About>0</About>
  <SetupStartTime>2019/01/03 12:24:31 </SetupStartTime>
  <SetupEndTime>
  </SetupEndTime>
  <DateFormat>1</DateFormat>
  <MeasureTimeStamp>1</MeasureTimeStamp>
  <!-- Preset value for pump-->
  <PumpPresetValue>585</PumpPresetValue>
  <!-- Set Flow in mlpm; 2000, 3000, 4000, 5000 -->
  <FlowSet>5000</FlowSet>
  <!-- TimeBase interval; can be 1, 60 seconds -->
  <TimeBase>60</TimeBase>
  <!-- sigma value for channel 1-->
  <SG1>18.47</SG1>
  <!-- sigma value for channel 2-->
  <SG2>14.54</SG2>
  <!-- sigma value for channel 3-->
  <SG3>13.14</SG3>
  <!-- sigma value for channel 4-->
  <SG4>11.58</SG4>
  <!-- sigma value for channel 5-->
  <SG5>10.35</SG5>
  <!-- sigma value for channel 6-->
  <SG6>7.77</SG6>
  <!-- sigma value for channel 7-->
  <SG7>7.19</SG7>
  <!-- Spot size in cm2-->
  <Area>0.785</Area>
  <!-- Maximum attenuation before tape advance-->
  <AtnMAX>120</AtnMAX>
  <!-- Condition when Tape Advance starts; 1 - ATNmax, 2 - time interval (every n-hours), 3 -
      certain time of day -->
  <TAtype>1</TAtype>
  <!-- TapeAdvanceInterval is unit in hours between 2 tape advance -->
  <TapeAdvanceInterval>12</TapeAdvanceInterval>
  <!-- TapeAdvanceTime is time of next tape advance occurence! -->
  <TapeAdvanceTime>1/1/2003 12:02:47 AM</TapeAdvanceTime>
  <!-- TapeAdvanceCount is overall number of TA counts! -->
  <TapeAdvanceCount>149</TapeAdvanceCount>
  <!-- WarmUpInterval is time (in minutes) after TA of Clean Air flow-->
  <WarmUpInterval>3</WarmUpInterval>
  <!-- Flow calculation parameters -->
  <FlowFormulaA0>-2269.15551757812</FlowFormulaA0>
  <FlowFormulaA1>-2895.5966796875</FlowFormulaA1>
  <FlowFormulaA2>-3000</FlowFormulaA2>
  <FlowFormulaB0>12.5816478729248</FlowFormulaB0>
  <FlowFormulaB1>14.1727256774902</FlowFormulaB1>
  <FlowFormulaB2>16</FlowFormulaB2>
  <FlowFormulaC0>-0.000219647045014426</FlowFormulaC0>
  <FlowFormulaC1>-0.00132240261882544</FlowFormulaC1>
  <FlowFormulaC2>-0.003</FlowFormulaC2>
  <FlowFormulaD>184.929916381836</FlowFormulaD>
  <FlowFormulaE>0.0799792781472206</FlowFormulaE>
  <FlowFormulaF>1.15205075701397E-07</FlowFormulaF>
  <!-- Tape offset -->
  <!-- TapeOffset 0-not set yet! 1-set tapeleft and right offset are valid -->
  <TapeOffsetValid>0</TapeOffsetValid>
  <TapeRightFormulaK>1.14521455764771</TapeRightFormulaK>
  <TapeRightFormulaN>-68.7326812744141</TapeRightFormulaN>
  <TapeLeftFormulaK>1.19063544273376</TapeLeftFormulaK>
  <TapeLeftFormulaN>-80.8294296264648</TapeLeftFormulaN>
  <!-- Compensation algorithm-->
  <Zeta>0.01</Zeta>
  <C>1.39</C>
  <ATNf1>10</ATNf1>
  <ATNf2>30</ATNf2>

```

```

<Kmax>0.015</Kmax>
<Kmin>-0.005</Kmin>
<!-- Aff - angstrom exponent for fossil fuel Abb - angstrom exponent for biomass burning-->
<Aff>1</Aff>
<Abb>2</Abb>
<k0>0.0001</k0>
<k1>0.0001</k1>
<k2>0.0001</k2>
<k3>0.0001</k3>
<k4>0.0001</k4>
<k5>0.0001</k5>
<k6>0.0001</k6>
<!-- Flow reporting standard-->
<FlowRepStd>0</FlowRepStd>
<!-- External Pressure -->
<P>101325</P>
<!-- External Temperature -->
<T>21.11</T>
<!-- External device on COM1-->
<Device1>5</Device1>
<!-- External device on COM2-->
<Device2>0</Device2>
<!-- External device on COM3-->
<Device3>0</Device3>
<!-- Network connection-->
<IPAddress>127.0.0.1</IPAddress>
<IPport>8001</IPport>
<AutoConnect>0</AutoConnect>
<!-- Auto test enabled 0-NO, 1-YES -->
<AutoTestEnabled>0</AutoTestEnabled>
<!-- Auto test type - weekly = 0, monthly = 1-->
<AutoTestType>0</AutoTestType>
<!-- Auto test day 1-SUN, 2-MON, 3-TUE, 4-WED, 5-THU, 6-FRI, 7-SAT-->
<AutoTestDay>1</AutoTestDay>
<!-- Auto test Time-->
<AutoTestTime>1/1/2014 12:00:00 AM</AutoTestTime>
<!-- HomeInfo 0 - UPM concentration , 1 - Display Biomass Burning(%) -->
<HomeInfo>0</HomeInfo>
<!-- Display settings - 0 - ON, 1 - Screen Saver , 2 - Auto OFF-->
<Display>1</Display>
<!-- Timezone settings , DST -->
<TimeZone>Coordinated Universal Time</TimeZone>
<DaylightSavingTime>0</DaylightSavingTime>
<ExternalID>1</ExternalID>
<BHparamID>1</BHparamID>
<TimeSync>0</TimeSync>
<TapeAdvanceAdjust>10</TapeAdvanceAdjust>
</data>

```

## Flow check

Table 1: Correction factors  $F_{flow}$  and  $F_{STP}$  for correcting eBC concentrations.  $F_{flow}$  corrects for inlet flow errors considering leakage.  $F_{STP}$  is used to adjust concentrations to STP conditions (0 °C, 1013.25 hPa).  $\zeta$  is the leakage considering the difference is due to tangential leakage through the edges of the filter tape (see manual).

System flow and reference			Measured	$F_{flow}$	$F_{STP}$	$\zeta$
$Q_{AE33}$	$T_{0,AE33}$	$p_{0,AE33}$	flow $Q$			
[slpm]	[°C]	[hPa]	[slpm]			
4.905	21.11	1013.25		4.848	1.012	1.077
						0.018

## Spot size check

Table 2: Correction factor for spot sizes  $F_{spot}$ .

Nominal spot size [cm <sup>2</sup> ]	Measured spot size [cm <sup>2</sup> ]	$F_{spot}$
0.785	Well defined spot, spot size not measured	1.0



Figure 1: New spot from AE33 (S07-00729) on filter tape.

## Instrumental Noise

Table 3: Noise parameters of AE33 (S07-00729) measured with filtered air.

Wavelength [nm]	Number of data points	Median [ng m <sup>-3</sup> ]	10th percentile [ng m <sup>-3</sup> ]	90th percentile [ng m <sup>-3</sup> ]	Mean [ng m <sup>-3</sup> ]	Std. dev. [ng m <sup>-3</sup> ]	Error of mean [ng m <sup>-3</sup> ]
370	281	12	-30	57	13	33	2
470	281	13	-50	72	13	47	3
520	281	6	-52	74	8	48	3
590	281	10	-73	87	8	60	4
660	281	-2	-70	57	-5	50	3
880	281	10	-30	45	8	30	2
950	281	10	-23	49	11	28	2

## Comparison to reference MAAP

Table 4: Correlation parameter of eBC coefficient (BC6) from AE33 (S07-00729) and reference MAAP after inspection.

Wavelength [nm]	Slope	Error	$R^2$
880	1.463	0.009	0.994

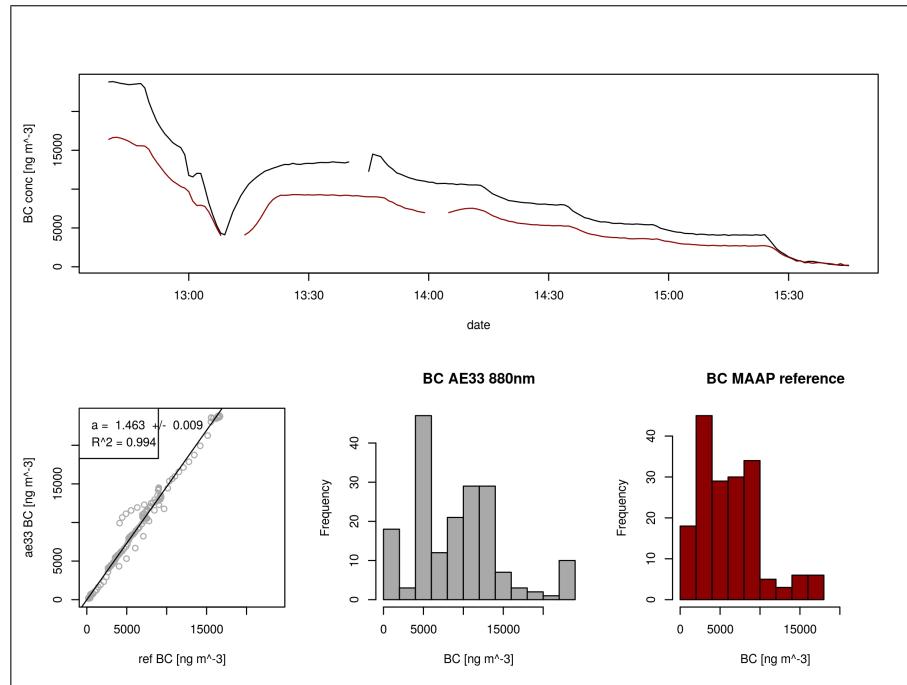


Figure 2: Correlation of eBC coefficient (BC6) from AE33 (S07-00729) and reference MAAP.

## Comparison to reference AE33

Table 5: Correlation parameter of eBC coefficients from AE33 (S07-00729) and reference AE33 after inspection.

Wavelength [nm]	Slope	Error	$R^2$
370	1.014	0.002	0.999
470	1.011	0.002	0.999
520	1.021	0.002	0.999
590	1.03	0.002	1
660	0.987	0.002	0.999
880	1.034	0.002	0.999
950	0.987	0.02	0.93

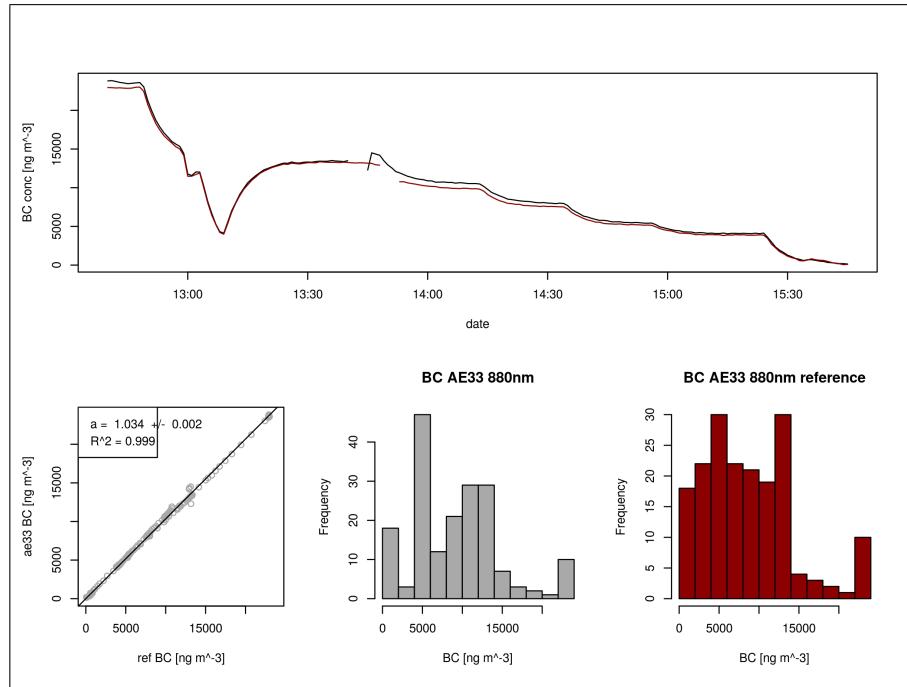


Figure 3: Correlation of eBC coefficient (BC6) from AE33 (S07-00729) and reference AE33.

## Comparison to multi-wavelength absorption

Table 6: Correlation parameter of absorption from AE33 (S07-00729) ( $C_0 = 3.5$ ) and the multi-wavelength absorption reference after inspection.

Wavelength [nm]	Slope	Error	$R^2$
470	1.009	0.007	0.992
520	1.04	0.003	0.999
660	0.962	0.003	0.999

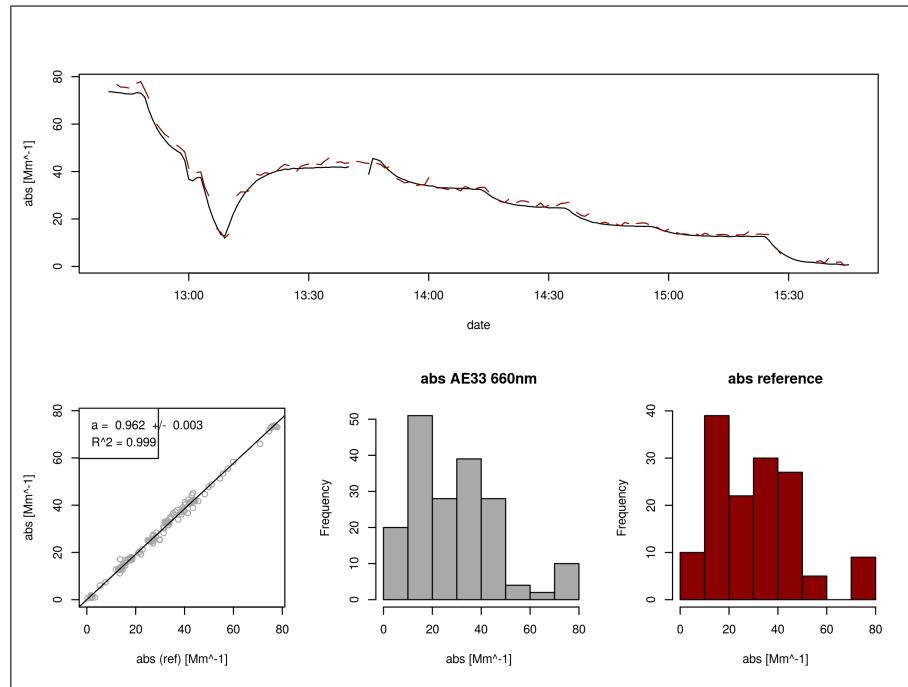


Figure 4: Correlation of absorption from AE33 (S07-00729) and the multi-wavelength absorption reference at 660 nm.