Intercomparison of absorption photometer Project No.: AP-2020-1-1

Basic informations:

Location of the quality assurance:	TROPOS, Lab 121
Date:	27 January - 31 January 2020

Principal Investigator	Home Institution	Participant	Instrument
M. Bitter	CHMU	M. Bitter	S07-00783

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 exact 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 in the normal range. The average noise (1σ) for the all wavelengths was less eqal 31 ng m^{-3} for one minute averaging time. The background level was acceptable with deviations of less equal 7 ng m^{-3} for all wavelengths.

Inspection

The sensor head was slightly contaminated The sensor head was cleaned.

Comparison to reference MAAP

BC concentrations at 880 nm (BC6) of AE33 are 31.4 % 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 −0.4 to 7.7 %.

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 2.6 to 12.9 %.

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-S07-00783</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>2019/08/20 08:41:59</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>63</TapeAdvanceCount>
  <!-- WarmUpInterval is time (in minutes) after TA of Clean Air flow-->
  <WarmUpInterval>3</WarmUpInterval>
  <!-- Flow calculation parameters -->
  <FlowFormulaA0>-2431.06030273437</FlowFormulaA0>
  <FlowFormulaA1>-2933.2060546875</FlowFormulaA1>
  <FlowFormulaA2>-3000</FlowFormulaA2>
  <FlowFormulaB0>13.5309400558472</FlowFormulaB0>
  <FlowFormulaB1>14.4927501678467</FlowFormulaB1>
  <FlowFormulaB2>16</FlowFormulaB2>
  <FlowFormulaC0>-0.00123837834689766</FlowFormulaC0>
  <FlowFormulaC1>-0.00184198608621955</FlowFormulaC1>
  <FlowFormulaC2>-0.003</FlowFormulaC2>
  <FlowFormulaD>184.081237792969</FlowFormulaD>
  <FlowFormulaE>0.0772075280547142</FlowFormulaE>
  <FlowFormulaF>5.13795612278045E-07</FlowFormulaF>
  <!-- Tape offset -->
  <!-- TapeOffset 0-not set yet! 1-set tapeleft and right offset are valid -->
  <TapeOffsetValid>0</TapeOffsetValid>
  <TapeRightFormulaK>1.10862624645233</TapeRightFormulaK>
  <TapeRightFormulaN>-38.5143814086914</TapeRightFormulaN>
  <TapeLeftFormulaK>1.18272423744202</TapeLeftFormulaK>
  <TapeLeftFormulaN>-82.2059783935547</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 fosil 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>7</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>1</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 - UVPM 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>1</TimeSync>
  <TapeAdvanceAdjust>2</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). ζ 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}	ζ
Q_{AE33} [slpm]	$T_{0,AE33}$ [°C]	$p_{0,AE33}$ [hPa]	flow Q [slpm]			
4.976	21.11	1013.25	4.976	1	1.077	0.019

Spot size check

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

Nominal spot size [cm^2]	Measured spot size [cm^2]	F_{spot}
0.785	Well defined spot, spot size not measured	1.0

Figure 1: New spot from AE33 (S07-00783) on filter tape.

Instrumental Noise

Table 3: Noise parameters of AE33 (S07-00783) measured with filtered air.

Wavelength [nm]	Number of data points	Median [ng m^{-3}]	10th percentile [ng m^{-3}]	90th percentile [ng m^{-3}]	Mean [ng m^{-3}]	Std. dev. [ng m^{-3}]	Error of mean [ng m^{-3}]
370	116	0	-24	24	1	18	2
470	116	0	-18	30	2	19	2
520	116	1	-27	24	-1	21	2
590	116	1	-38	41	2	31	3
660	116	7	-28	35	5	26	2
880	116	6	-30	44	6	28	3
950	116	5	-32	44	5	31	3

Comparison to reference MAAP

Table 4: Correlation parameter of eBC coefficient (BC6) from AE33 (S07-00783) and reference MAAP after inspection.

Wavelength [nm]	Slope	Error	R^2
880	1.314	0.006	0.998

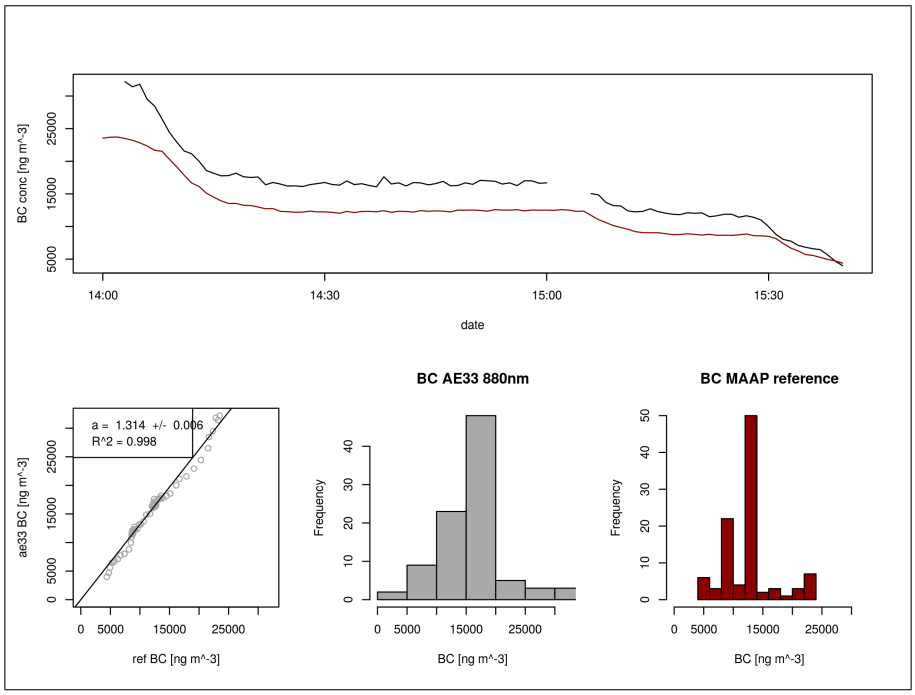

Figure 2: Correlation of eBC coefficient (BC6) from AE33 (S07-00783) and reference MAAP.

Comparison to reference AE33

Table 5: Correlation parameter of eBC coefficients from AE33 (S07-00783) and reference AE33 after inspection.

Wavelength [nm]	Slope	Error	R^2
370	1.06	0.004	0.999
470	1.061	0.003	0.999
520	1.062	0.003	0.999
590	1.063	0.003	0.999
660	1.022	0.003	0.999
880	1.077	0.003	0.999
950	0.996	0.047	0.816

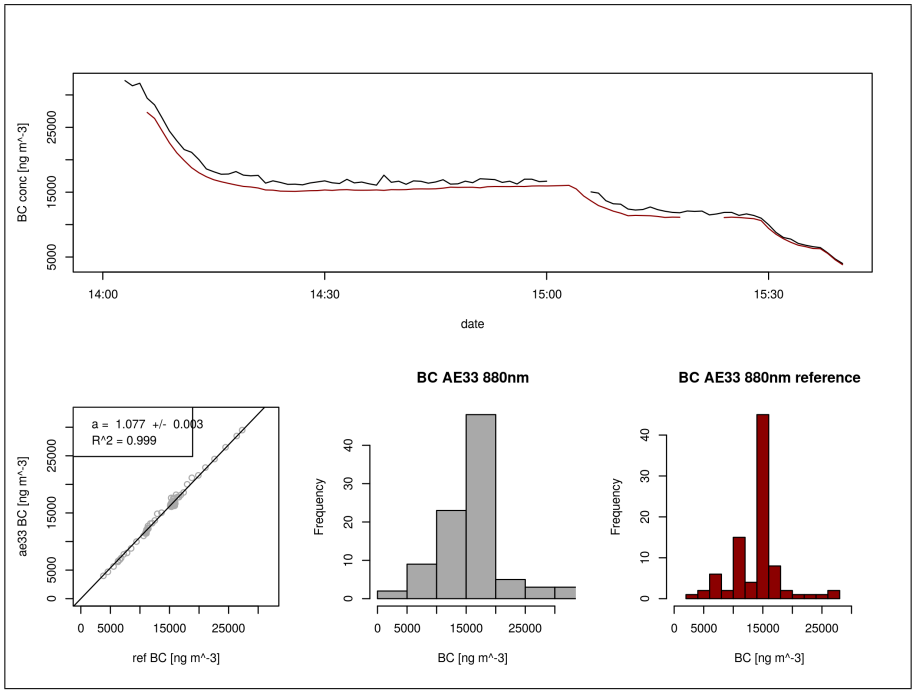

Figure 3: Correlation of eBC coefficient (BC6) from AE33 (S07-00783) and reference AE33.

Comparison to multi-wavelength absorption

Table 6: Correlation parameter of absorption from AE33 (S07-00783) ($C_0 = 2.7$) and the multi-wavelength absorption reference after inspection.

Wavelength [nm]	Slope	Error	R^2
470	1.129	0.006	0.999
520	1.119	0.006	0.999
660	1.026	0.006	0.999

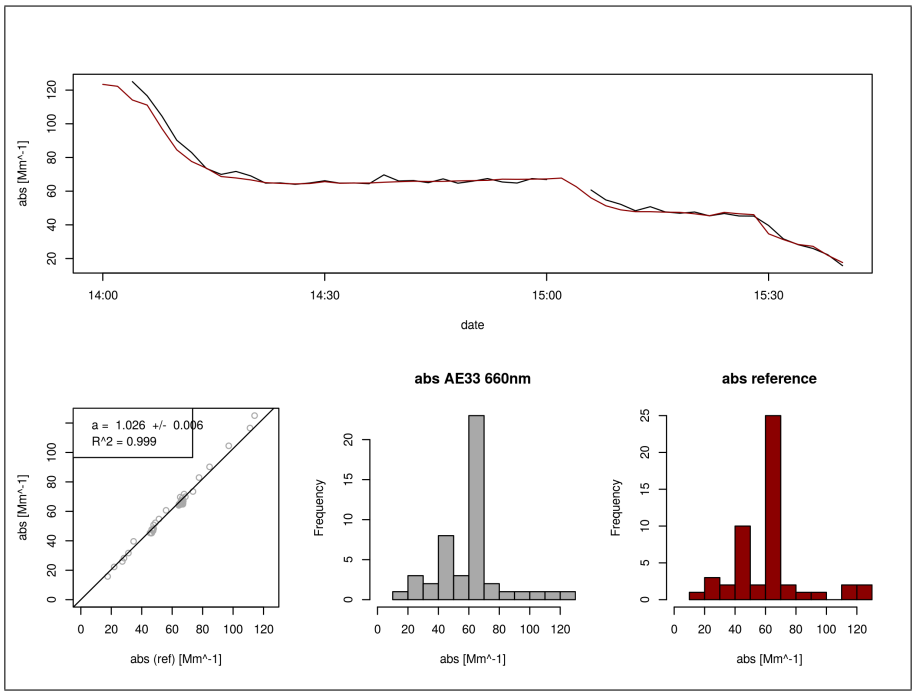

Figure 4: Correlation of absorption from AE33 (S07-00783) and the multi-wavelength absorption reference at 660 nm.