***Site audit report Hyytiälä, Finnland***

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***Summary:***

Measurements of physical aerosol properties at the EUSAAR site SMEAR 2 in Hyytiälä have been audited by Dr. Thomas Tuch of the WWCAP May 12th through May 14th 2009.

The measurement site is located $61^0$ 50' 47"N, $24^0$ 17' 42"E 181 m above sea level (Fig.1). The largest city near the station is Tampere, ca. 60 km S-SW of the measurement site. The station is located about 200 m east of the main buildings at Hyytiälä. Two wood fired Saunas and a barbecue place are located about 600 meters to the west of the station. These building are potential sources of local pollution. Figure 2 shows views from the outside and the inside of the station. The infrastructure at Hyytiälä is excellent providing all human resources as well as necessary spare parts for the operation of the station.

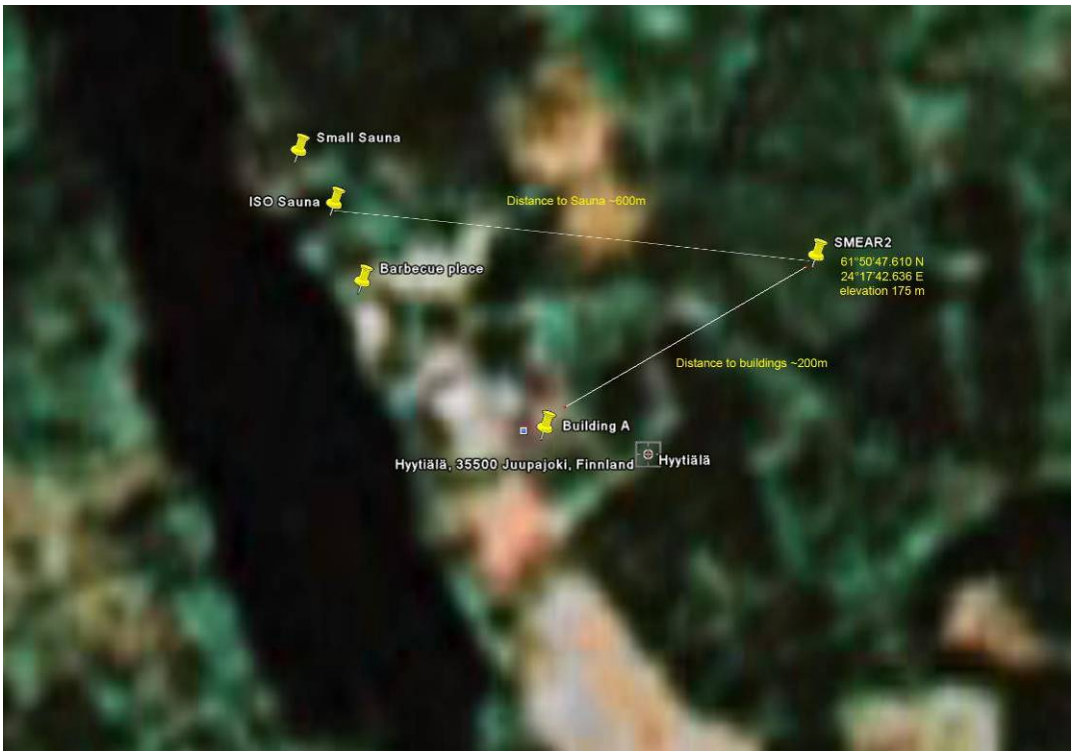


Figure 1: Google earth view of the area near SMEAR 2 station.

Figure 2: Outside and inside view of the measurements station at SMEAR 2.

***Documentation and data availability:*** All manuals have been available at the site during the audit. Instrument performance is recorded in an electronic logbook. This logbook can be accessed by Internet. Furthermore current number size distribution and integral number concentrations can be accessed via internet allowing online check of instrument performance.

http://www.atm.helsinki.fi/SMEAR/index.php?option=com_content&task=view&id=32&Itemid=68

**Data from this station are reported to the EMEP database**. Online documentations of all relevant instrument parameters meet EUSAAR quality standards.

Documentation at Hyytiälä complies with EUSAAR requirements

*Primary flow standard:*

A Gilibrator is used as primary flow standard at SMEAR 2. This Gilibrator is not available for routine flow checks. Both flow cells have been verified against the GAW reference Gilibrator during the audit. Results of this inter comparison are shown in figure 3. Note that the high flow cell of the reference is known to deviate 2% from standard.

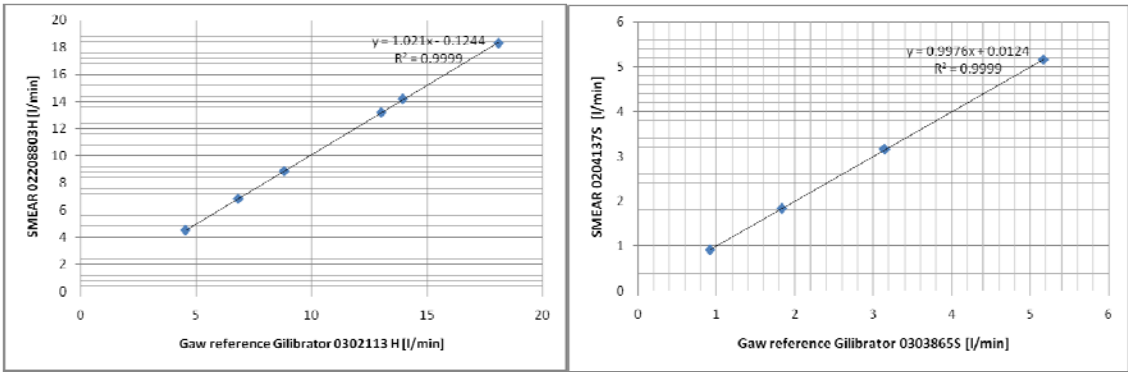


Figure 3: Comparison of SMEAR flow cells with GAW reference flow cells.

**The flow standard at SMEAR 2 complies with EUSAAR requirements**

Inlets:

Several individual inlets are used for aerosol sampling at SMEAR 2 (Figure 4).

Figure 4: Aerosol inlets at SMEAR 2

Digitel PM10 inlets mounted about 1.5 m above the roof of the station are used for Nephelometer and Aethalometer. These inlets are currently not humidity conditioned. Vertical stainless steel lines are used. A TSP inlet at the same height above the roof is used for stainless steel sampling tube with an inner diameter of 100 mm. TDMPS, CPCs, HTDMA and CCNC draw their samples from the centre of this tube.

There is no indicator for the sample flow in this common sample tube. We suggest installation of a simple flow indicator (e.g. a Rotameter) to allow for a quick check of sampling conditions in this sample line. The height of all aerosol inlets is lower than

the surrounding tree tops as seen in figure 4. Although this inlet height has been chosen intentionally to investigate new particle formation events, this inlet height does not comply with EUSAAR requirements.

For instrumental measurements, sample air should be brought into the laboratory through a vertical stack with an inlet that is high enough above ground level to minimize local influences. For sites without surrounding obstructive vegetation, topography or buildings, a minimum height of 2 m above ground level is recommended. However, obstructed sites may require even higher inlets, to avoid influence by the surroundings. (No. 153 WMO/GAW AEROSOL MEASUREMENT PROCEDURES GUIDELINES AND RECOMMENDATIONS, page 4)

Aerosol dryers for humidity conditioning had already been bought but had not yet been installed at the time of the audit.

Apart from the inlet height aerosol inlets at SMEAR 2 comply with EUSAAR standards.

TDMPS:

The TMPS system at SMEAR 2 is fixed to the wall of the measurement hut (Figure 5). It has therefore never participated in previous inter-comparison workshops at the WCCAP. The travelling standard SMPS has been run in parallel to this system for a time period of one month to investigate long-term comparability of this instrument with the other particle size spectrometers used at EUSAAR sites.

the APS 3321. This inlet is heated to about $10^0$C above ambient temperature.

A common whole air inlet is mounted about 8 m above the ground. This inlet is operated at a flow velocity of 0.5 m/s. It is connected to a horizontal common

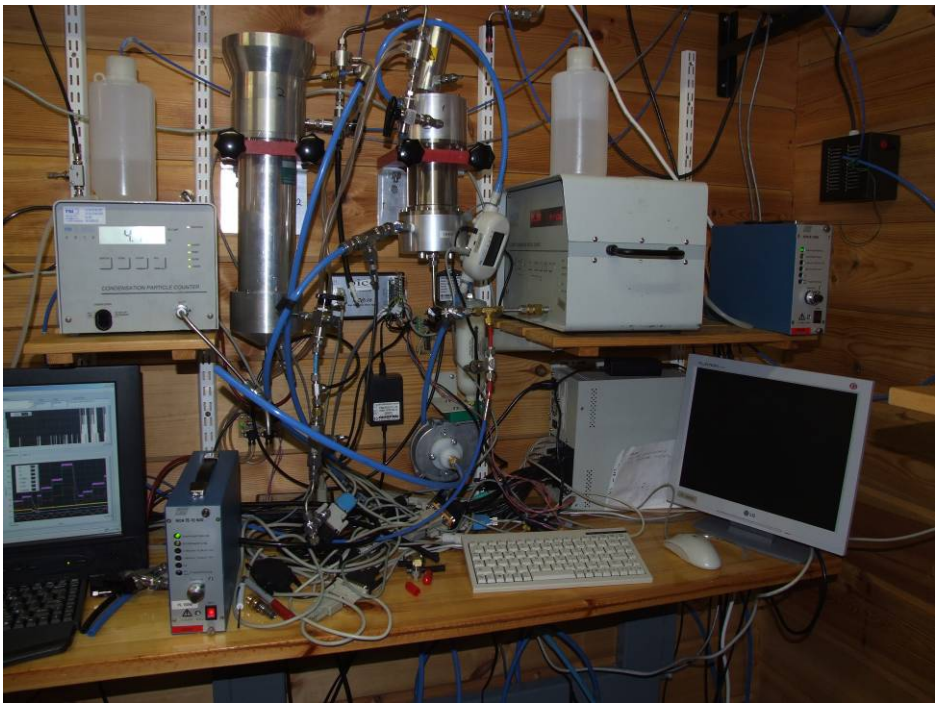

Figure 5: TDMPS system at SMEAR 2.

There are no aerosol dryers installed in the current system. Furthermore neither temperature nor humidity of both aerosol and sheath air are measured by the system. These measurements are however required for EUSAAR particle size spectrometers. The sheath air of both DMAs is dried by Silicagel dryers. Sheath air dryers are replaced on a regular basis. Sheath air flow rates are measured by TSI 3063 flow-meters.

With high voltage of the CPC S/N 2139 counted 5 particles in 10 minutes whereas the UCPC 3025A S/N 1338 counted zero particles. The CPC showed slightly elevate counts with an absolute filter installed at the inlet (37 particles in 5 minutes). This elevated count rate is probably due to the higher pressure drop of the filter and does show running the DMA at 0 V HV. This elevated count rate with a filter suggests, however, that there may be an internal leak developing in the CPC. The leak rate should be watched closely in the future to allow for timely replacement of the CPC if necessary. The sheath air flow rate of the DMA was 5.117 l/min indicated in the data as 5.11 l/min. The measured sheath air flow of the UDMA was 25.3 l/min. It was recorded by the data acquisition software as 25.2 l/min. Both recorded sheath air flow rates were in good agreement with those measured with the GAW reference Gilibrator. The Latex test aerosol with a nominal particle diameter of 200 +- 4 nm was sized correctly as shown in figure 6.

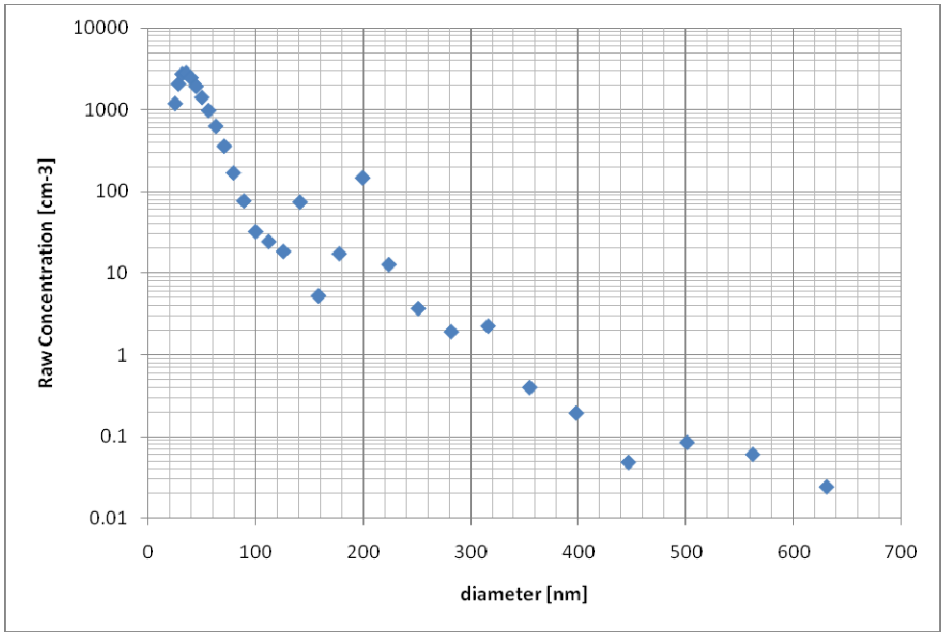


Figure 6: Sizing of 200 nm Latex monospheres with the DMA at SMEAR 2.

The TMDPS at SMEAR 2 was run in parallel to the travelling standard SMPS of the WCCAP. Average particle number size distributions for the whole time period are in good agreement (Figure 7). The concentration drop of the WCCAP SMPS below 15 nm is due to the CPC 3010 in this instrument.

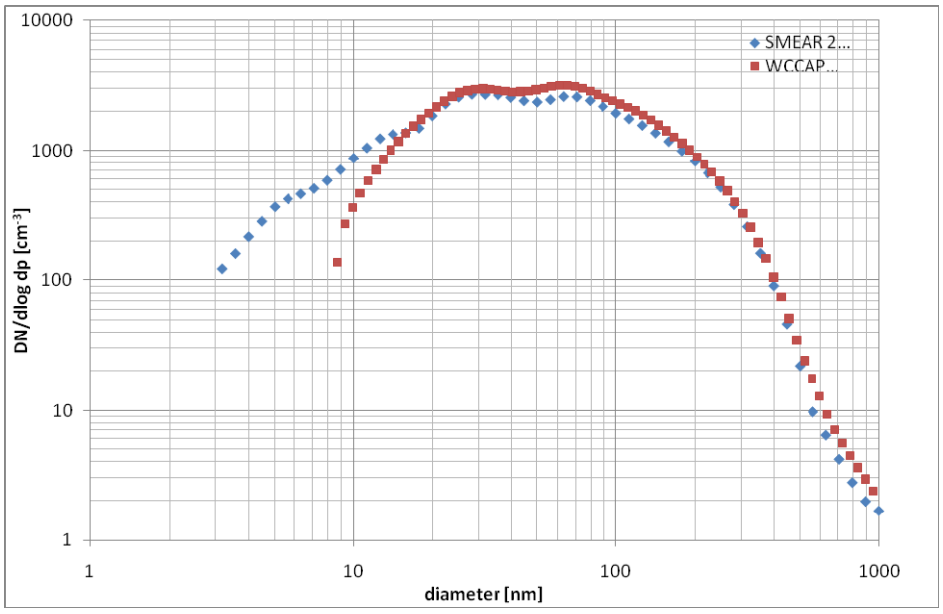


Figure 7: One months average number size distributions measured by SMEAR 2 TDMPS and WCCAP reference SMPS.

The SMPS at SMEAR 2 operates properly. In order to comply with EUSAAR specifications this instrument needs to be upgraded with temperature and humidity sensors and an aerosol dryer needs to be installed.

*Nephelometer:*

A three wavelength TSI Nephelometer 3563 SN 70539059 is available at SMEAR 2. This instrument has not participated in the inter-comparison workshop at the WCCAP in December 2007. The instrument was calibrated during the audit. Some shortcuts in the calibration procedure at the site did cause a higher calibration variability compared to the standard procedures described in the instrument manual. Namely blank times where to short and the temperature equilibration tube to the instrument was too short. With the original calibration procedure variability between consecutive calibrations improved. The instrument was run overnight with an absolute filter to investigate instrument noise. The time series of this measurement is shown in figure 8. Due to restrictions by the data acquisition only 5 minute average data are available. The amount of data is therefore not sufficient for a frequency analysis of the noise of this instrument.

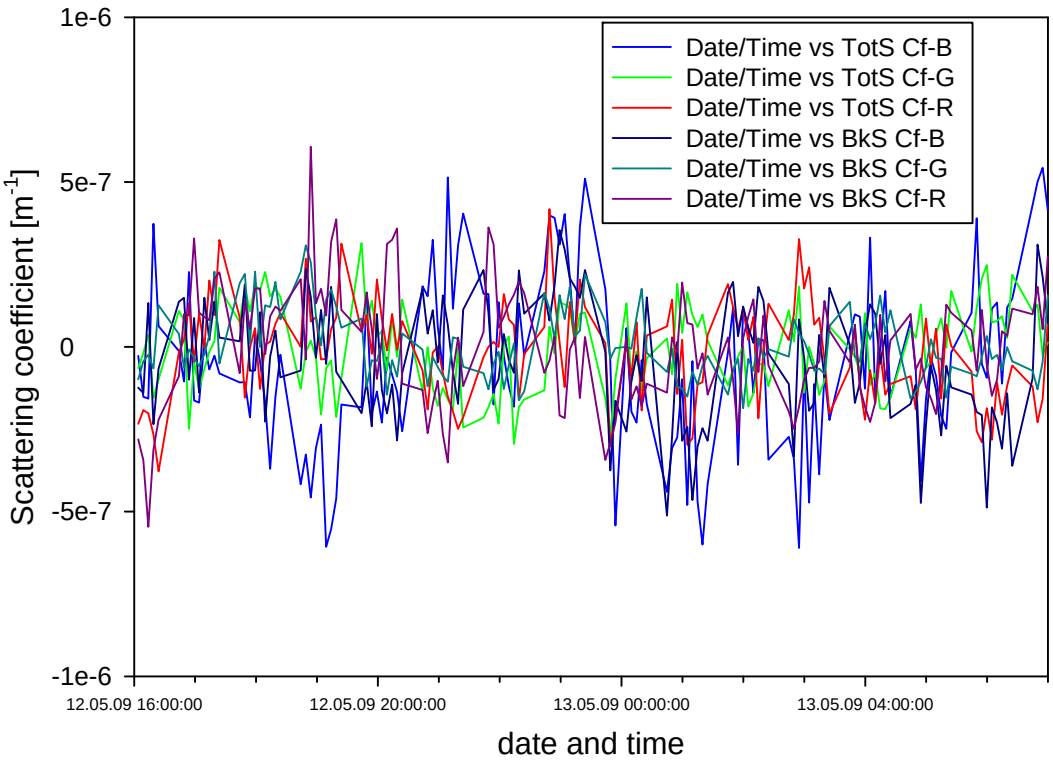


Figure 8: Time series plot of 5 minute average Nephelometer data with absolute filter.

Statistical parameters of the scattering coefficients are summarized in table 1.

| | N | Minimum | Maximum | Mean | | Std. Deviation |
|---|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic |
| TotSCfB | 134 | -0.000001 | 0.000001 | -0.00000005 | 0.000000022 | 0.000000257 |
| TotSCfG | 134 | 0.000000 | 0.000000 | -0.00000001 | 0.000000011 | 0.000000127 |
| TotSCfR | 134 | 0.000000 | 0.000000 | -0.00000002 | 0.000000013 | 0.000000147 |
| BkSCfB | 134 | -0.000001 | 0.000000 | -0.00000004 | 0.000000015 | 0.000000179 |
| BkSCfG | 134 | 0.000000 | 0.000000 | 0.00000000 | 0.000000009 | 0.000000103 |
| BkSCfR | 134 | -0.000001 | 0.000001 | 0.00000000 | 0.000000015 | 0.000000177 |
| Valid N (listwise) | 134 | | | | | |

Table 1: Statistical parameters for zero measurements with the Nephelometer.

**The Nephelometer at SMEAR 2 operates according to EUSAAR specifications.**

Aethalometer:

A seven wavelength Aethalometer Model AE31, S/N 496:0405 is used to measure absorption at SMEAR 2. The indicated aerosol flow of 4.9 l/min was in good agreement with the 4.95 l/min of the Gilibrator. The instrument was run for 18 hours with an absolute filter. While average parameters yield reasonable results for this zero measurements (Table 2) the series of the 5 minute data (Figure 9) reveals a serious problem of the instrument. Oscillations of the zero were probably due to temperature fluctuations caused by the air conditioning system. This problem has been addressed after the audit. Zero is now stable as shown in figure 9a. Descriptive statistics parameters are summarized in Table 3.

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | | Std. Deviation |
|---|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic |
| UV370nm | 221 | -65.0 | 95.0 | .213 | 1.4966 | 22.2481 |
| Blue470nm | 221 | -111.0 | 153.0 | -.382 | 3.4646 | 51.5057 |
| Green520nm | 221 | -79.0 | 103.0 | -.753 | 2.0234 | 30.0796 |
| Yellow590nm | 221 | -78.0 | 115.0 | -.538 | 1.5730 | 23.3850 |
| Red660nm | 221 | -149.0 | 131.0 | -.275 | 3.7981 | 56.4635 |
| IR1880nm | 221 | -228.0 | 206.0 | -.789 | 5.6814 | 84.4603 |
| IR2950nm | 221 | -116.0 | 227.0 | -.216 | 3.6439 | 54.1711 |
| Valid N (listwise) | 221 | | | | | |

Table 2: Descriptive statistics of the Aethalometer zero during the audit.

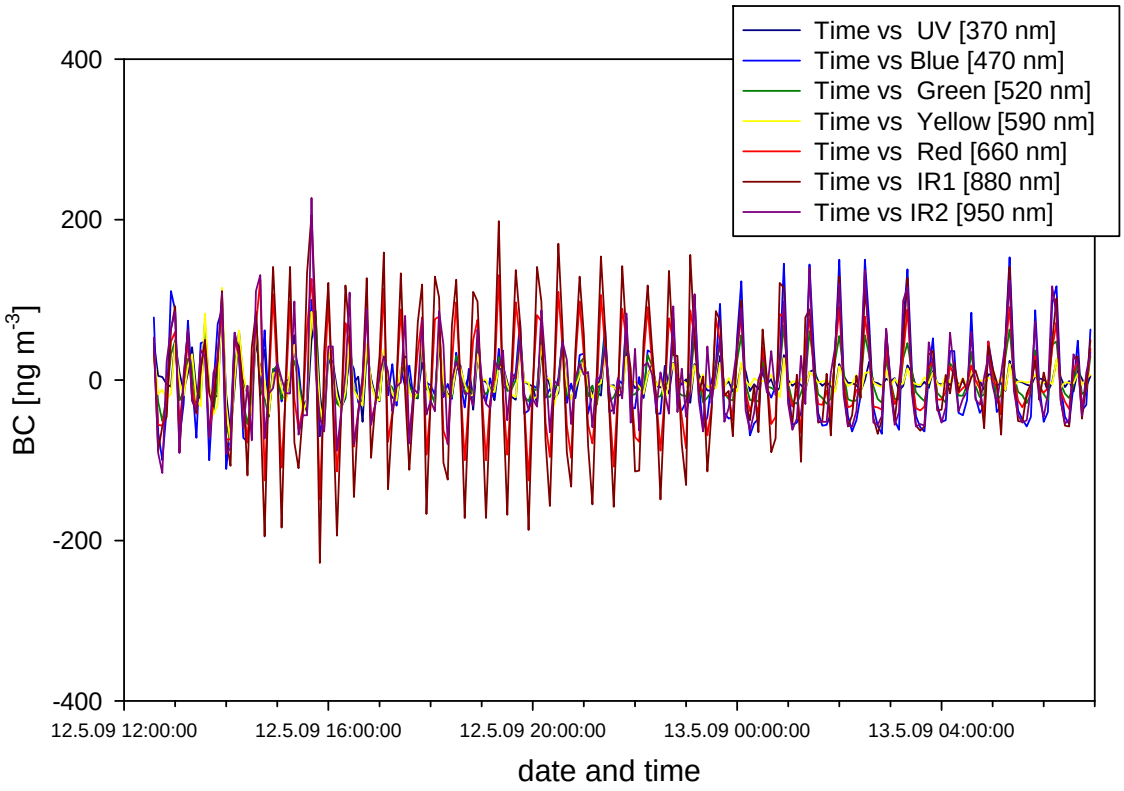


Figure 9: Time series of 5 minute data from the Aethalometer at SMEAR 2, periodic noise suggests a serious instrument problem.

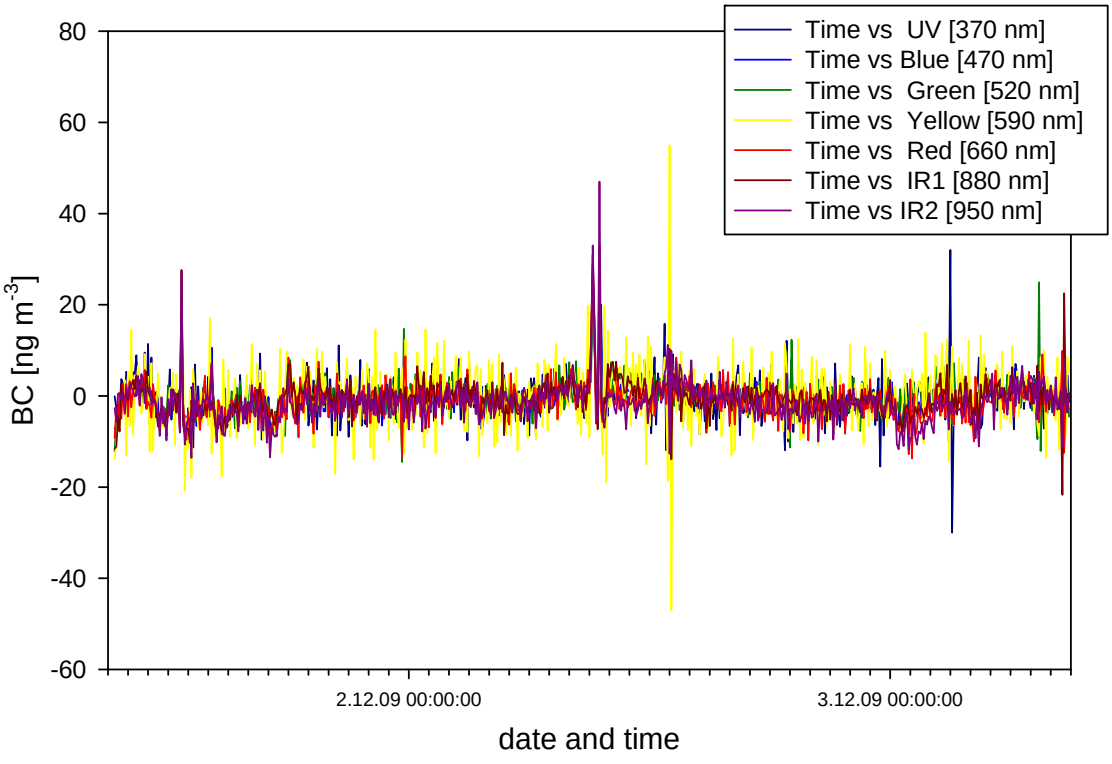


Figure 9a: December 2009 time series of the SMEAR 2 Aethalometer

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | | Std. Deviation |
|---|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic |
| UV370nm | 572 | -30.00 | 32.00 | -.5488 | .19739 | 4.72085 |
| Blue470nm | 572 | -8.10 | 24.90 | -.6325 | .12298 | 2.94125 |
| Green520nm | 572 | -14.50 | 24.90 | -.1547 | .15990 | 3.82433 |
| Yellow590nm | 572 | -47.00 | 55.00 | -.1124 | .30865 | 7.38173 |
| Red660nm | 572 | -13.70 | 33.00 | -1.0260 | .17519 | 4.18983 |
| IR1880nm | 572 | -21.70 | 31.00 | -.4325 | .16873 | 4.03539 |
| IR2950nm | 572 | -13.60 | 47.00 | -1.4733 | .19306 | 4.61737 |
| Valid N (listwise) | 572 | | | | | |

Table 3: Descriptive statistics of the Aethalometer zero in December 2009.

***The Aethalometer at SMEAR 2 suffered fluctuations of zero measurements during the audit.***

***This problem has been addressed and the Aethalometer is now working according to EUSAAR specifications.***

CPC:

A TSI CPC model 3022A is used to measure total particle number concentration. This instrument counted 8 particles in 5 minutes with an absolute filter attached. Note that without frequent calibration this instrument is only reliable in single particle count mode because the photometric signal tends to decrease with increasing pollution of the optics of the instrument.

The CPC at SMEAR 2 is suitable for measurements of the total number concentration.

APS:

A TSI APS 332100 SN 1202 is used to measure the number size distribution of particles larger than 0.53 µm. The inlet of the instrument is vertical. The inlet is heated to a temperature about 10 degrees above ambient. Note that the inlet tube

needs to be insulated because it is directly mounted in front of the air conditioner to avoid cooling of the aerosol at or close to the inlet of the instrument.

Flow rates of this instrument where nominal during the audit. We attempted to verify the sizing of this instrument with 1 µm Latex spheres. The concentration of this test aerosol was, however, too low to yield a quantitative result. The screenshot of the APS front panel (Figure 10) suggests that the sizing of the APS is ok.

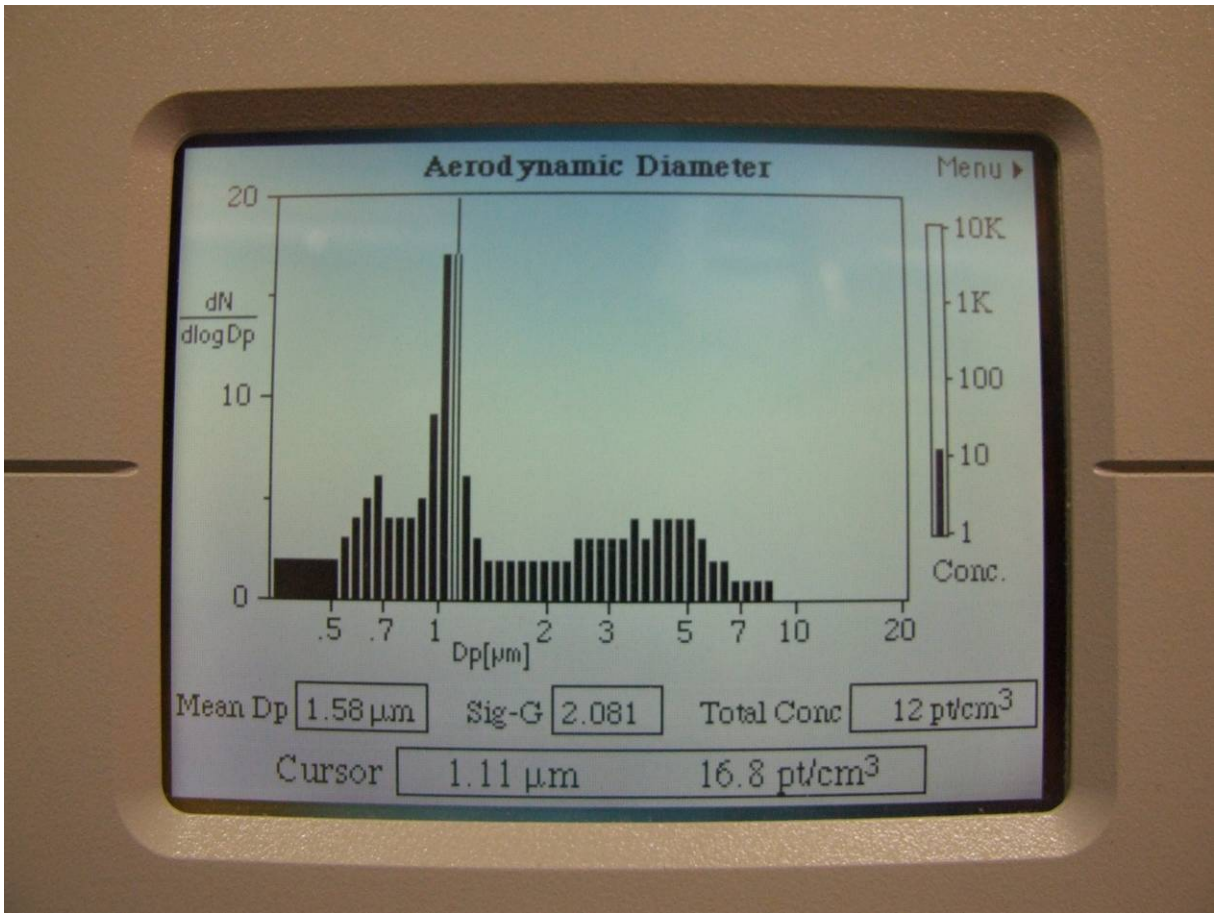


Figure 10: Sizing of 1 µm Latex particles with the SMEAR 2 APS.

**The APS at SMEAR 2 is working properly.**

HTDMA:

Humidity control of the HTDMA could not be verified during this audit. Refer to the HTDMA workshop report for more information on this instrument.

We checked the instrument with a zero filter at the inlet with a satisfactory zero count rate. A sizing check of the second DMA of this system did show an undersizing 200 nm Latex particles. The measurement of the sheath air at the test point showed an acceptable difference between the nominal flow of 6.15 l/ min and a sheath air flow of 6.05 l/min. We did however measure a CPC flow of 0.95 l/min compared to an aerosol flow at the inlet of the DMA of 0.3 l/min. This discrepancy was due to a leak in the sheath air pump.

Note that absolute concentrations measured with the second DMA are about a factor of three too low.

After repair of the sheath air pump all flows where back to nominal values and 200 nm Latex spheres where sized correctly.

After repair the HTDMA is in good working condition with respect to flow rates and sizing.

Cloud condensation Nuclei Counter:

In addition to more conventional instrumentation a DMT CCNC S/N 0508-0059 is available at SMEAR 2. This instrument is combined with a DMA selecting monomobile particles from the ambient aerosol. Currently the software controlling both the selecting DMA and the CCNC is not yet working properly. We hope these problems will be solved in the near future. The instrument was checked with a zero filter. Number concentration dropped to zero but the software of the CCNC did shut down measurements because it assumes failure of the humidifiers if the particle count rate drops to zero.

Conclusion:

Aerosol measurements at SMEAR 2 in Hyytiälä are impressive. It needs, however, to be mentioned that some deviations from EUSAAR standards have been found during the audit. While discrepancies like missing humidity sensors are likely to be addressed in the near future, change of the inlet heights is not anticipated.

We wish to thank our hosts for their hospitality.

# *Site audit report Finokalia, Greece*

Dr. Thomas Tuch, WCCAP

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Leibniz Institute for Tropospheric Research, Leipzig, Germany

***Summary:***

Measurements of physical aerosol properties at the EUSAAR site Finokalia have been audited by Dr. Thomas Tuch of the WWCAP on June 15th and 16th 2009. The station is operated by the Environmental Chemical Processes Laboratory, Department of Chemistry - University of Crete located in Heraklion about 1.5 hours drive away from the site. It serves both as a EUSAAR station and as a contributing station in WMO RA VI in the GAW framework.

The sampling station is situated at 35.3379° N 25.6696° E (Fig. 1) in the northern coast of Crete. The station is located at the top of a hilly elevation (250 m) facing the sea within a sector 270° to 90°. The nearest village with 10 inhabitants is at a distance of 3 km to the south of the station. The nearest largest urban centre is Heraklion with 150 000 inhabitants located 70 km west of Finokalia. No human activities can be found at a distance shorter than 15km within the above mentioned sector.


Figure 1. Finokalia station and Google earth view of the site.