Site audit report Ispra, Italy

Regional fixed station in WMO RA VI

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Site description:

Measurements of physical aerosol properties at the GAW/EUSAAR/EMEP site Ispra have been audited by Dr. Thomas Tuch of the WCCAP on March 22nd through March 24th 2010.

The station is located in a semi-rural region inside Joint Research Centre, Ispra. The main emission sources in the region are the city of Varese, about 20 km to the east, the city of Milano, about 60 km to the south-east, the city of Novara about 40 km to the south and the various industrial locations in the Po valley. A Google earth view of the station with the prevalent wind directions (2000) taken from the official site description is shown in figure 1.

Figure 1: Google Earth view of the Ispra measurement site.

The JRC-Ispra research station is operated by the Climate Change Unit of the Institute for Environment and Sustainability (IES). All core measurements recommended by the scientific advisory group in are performed at this site. During our audit most instruments where in perfect working condition (Table 1).

Continuous Measurement	Instrument	Status	Remarks
Multiwavelength optical depth	Cimel CE-318		On site but not operated by IES
Mass in two size fractions	2 TEOM FDMS		1 µm and 10 µm
Major chemical components in two size fractions	Multiple filters		
Light absorption coefficient	2 Aethalometers 1 MAAP		Note: MAAP filter holder not closing properly.
Light scattering coefficient at various wavelengths	TSI 3563		
Hemispheric backscattering coefficient at various wavelengths	TSI 3563		
Aerosol number concentration	DMPS + TSI3010		
Cloud condensation nuclei at 0.5% supersaturation		n/a	

Table 1: Measurement status at Ispra.

Data handling, documentation and data submission:

Data from all Instruments are routinely plotted against other instruments to allow early discovery of possible instrument malfunction.

Final data from Ispra have been submitted to the EBAS in time according to EUSAAR requirements. An artifact had been discovered in the DMPS data sets submitted to the database (See DMPS/APS section of this audit report). This artifact was due to a problem with the scripts translating the DMPS data to NARSTO format. The problem was solved during the audit.

Data handling documentation and data submission at Ispra comply with EUSAAR standards.

Primary flow standard:

Mini Buck primary flow standards are availailable at Jungfraujoch. The instrument with the S/N verified against WCCAP reference instruments during the audit. Results of this inter-comparison are shown in figure 2. Both tested measurements cells agreed well with the reference flowmeters.

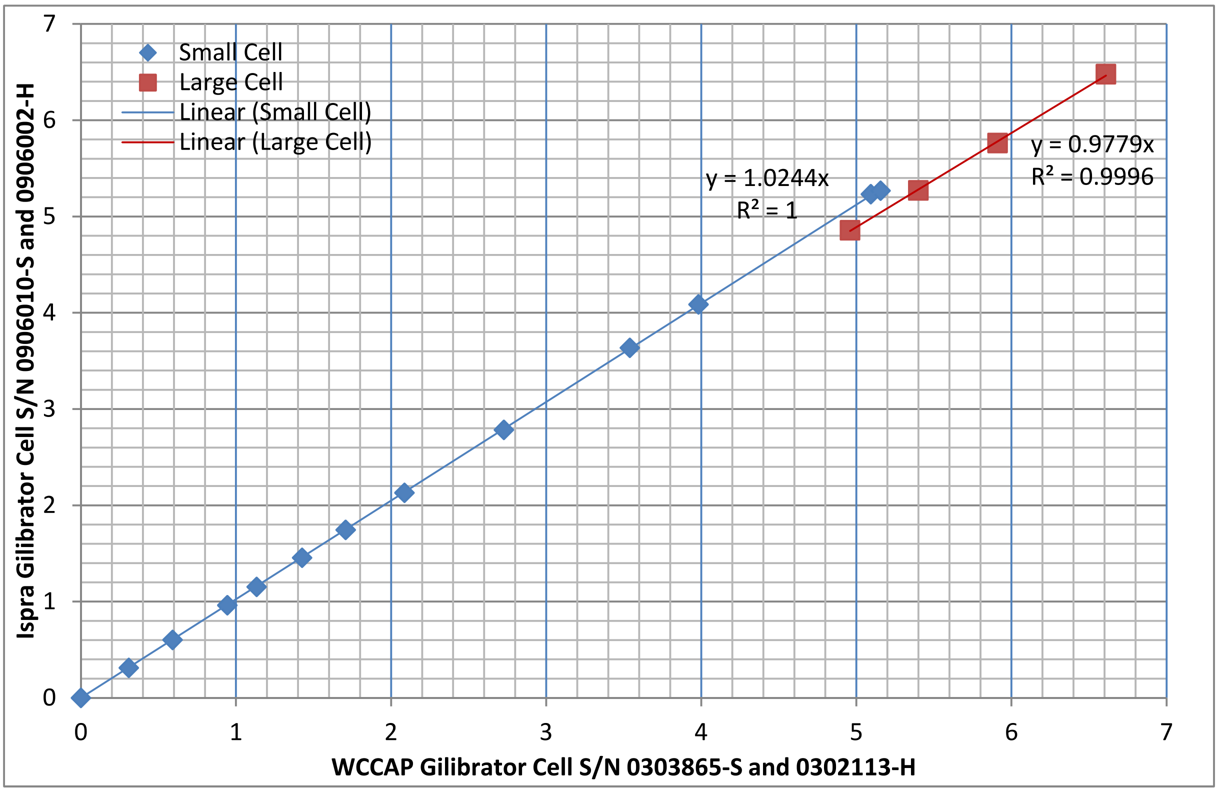


Figure 2: Comparison of primary flow standard at Ispra with WCC reference.

The primary flow standard at Ispra complies with EUSAAR standards.

Aerosol inlet:

Most aerosol instruments at Ispra are connected to a custom made aerosol inlet consisting of a Digitel sample inlet operated at a flow rate of 220 l/min mounted 2 m above the roof of the aerosol container (figure 3). Separate inlets are used for the MAAP and the TEOMs.

Figure 3: New aerosol container with inlets, the PM_{10} TEOM is located in container 2.

The aerosol is distributed through a aluminum tube inside the container. The APS samples from vertical part of tube. DMPS,CPC 3010, Aethalometer 1, Aethalometer 2 and Nephelometer sample isokinetically from center of main aerosol duct (figure 4).

Figure 4: Main aerosol duct in container 4.

All inner aerosol parts stainless steel outer parts partially TSI black tubing, Nafion driers are available for the DMPS, Aethalometers and the Nephelometer. The separate inlet of the MAAP is currently not humidity conditioned. A schematic drawing of the aerosol inlet inside the container is shown in figure 5.

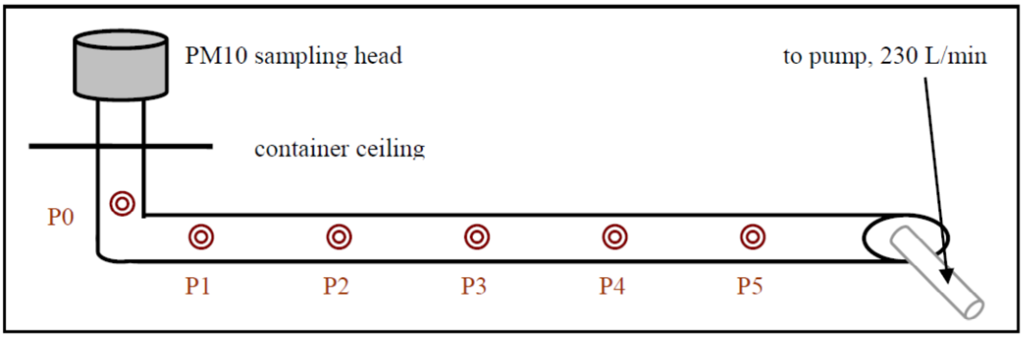


Figure 5: Schematic drawing of main aerosol inlet in container 4 with sampling port location.

The main aerosol duct has been thouroughy tested for particle losse at different sample ports and at different distances from the center of the tube.

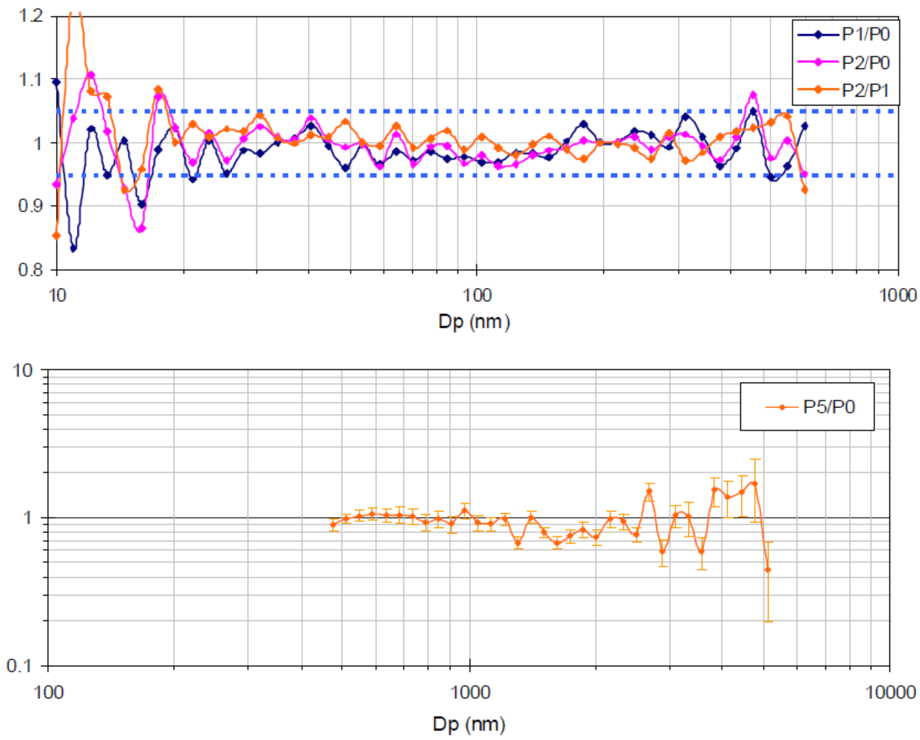


Fig. 6: Ratios of size dependent particle number concentrations measured simultaneously (top) with two DMPS systems at 2 of the 3 sampling points (P0, P1 and P2) and (bottom) as published in the 2008 report cited below.

Sampling characteristics from the mail aerosol duct have been tested in detail (figure 6.) Full information about the inlet system is available in JRC Ispra EMEP - GAW Regional Station for Atmospheric Research 2008 Report. This report can be downloaded from: http://publications.jrc.ec.europa.eu/repository/handle/111111111/538.

The aerosol inlet at Ispra complies with EUSAAR standards, humidity conditioning for the MAAP inlet should, however, be implemented.

Aerosol number size distribution:

Aerosol number size distribution at Ispra is measured using a custum made DMPS system and an APS. The DMPS has participated in an inter-comparison in Leipzig. It complies fully with EUSAAR recommendations (Wiedensohler et al., 2010, submitted to AMT). As during the inter-comparison the system slightly oversized the 200 nm particles used for the sizing check during the audit (figure 7). Sizing accuracy is ,however, well within EUSAAR specifications.

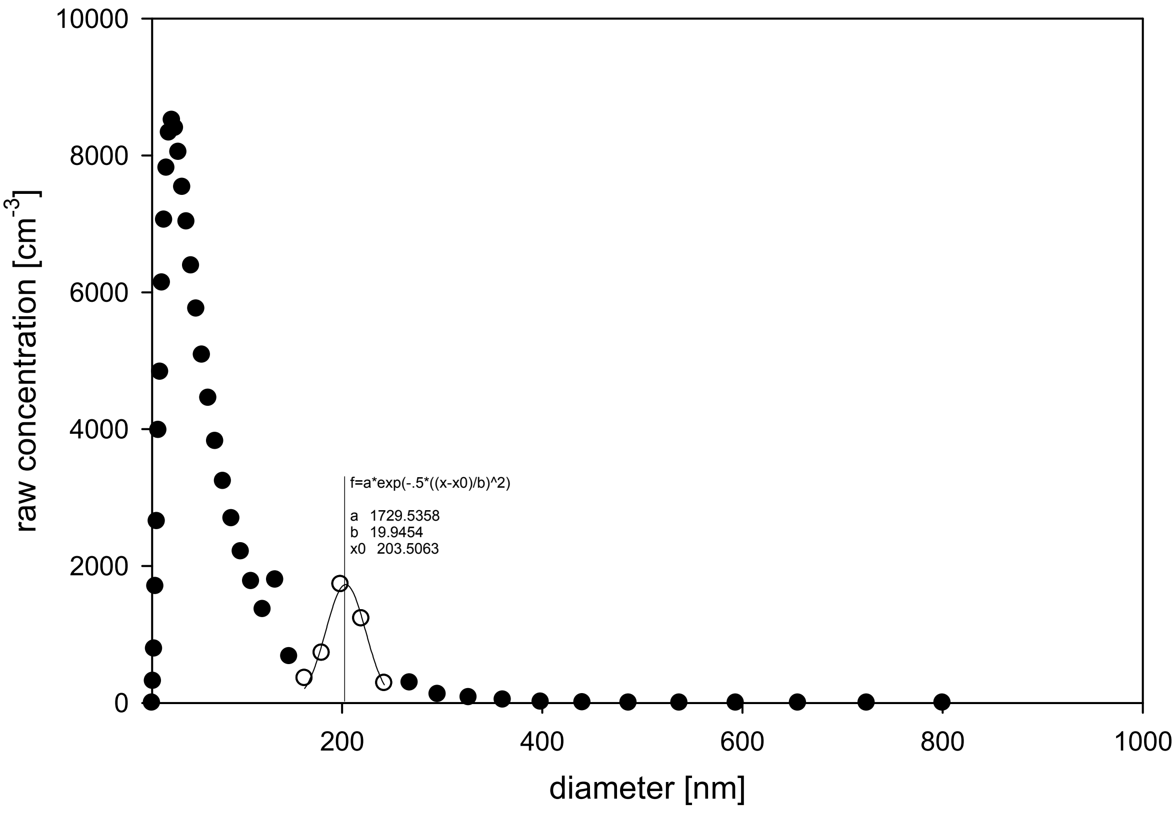


Figure 7: Sizing test with 200 nm Latex particles, 203 nm

The CPC TSI 3772 S/N 70847419 of the DMPS system was compared during the same workshop. The whole DMPS system as well as the CPC alone counted zero particles during a 10 minute test with an absolute filter.

Performance of the high voltage power supply is checked monthly up to 580 V using an automated HV calibration routine with a Fluke high precision voltmeter (8846).

Data submitted to the EUSAAR database EBAS contained an artefact represented by the low concentration (green) sizes in the time series contourplot (figure 8). Comparison of the inversion routines during the last size spectrometer workshop at Leipzig prior to the audit did not reveal differences between the inversion routines used as EUSAAR standard and the ISPRA data inversion routine. The artifact could be attributed to two wrong data columns (pressure, temperature) in the data set. Corrected data have been submitted to EBAS short time after the audit.

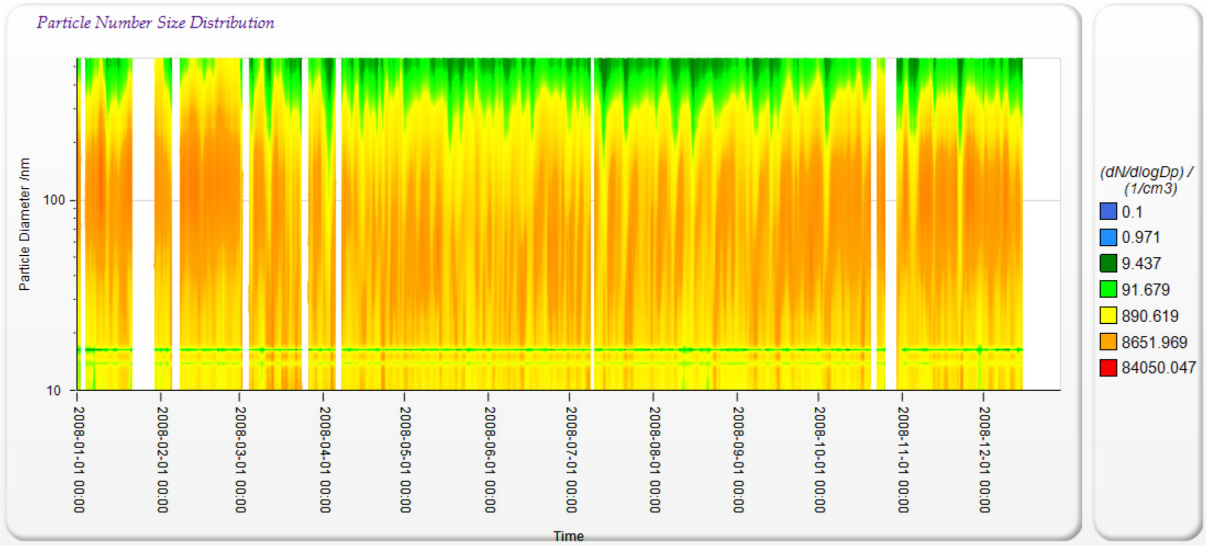


Figure 8: Contourplot of 2008 data from Ispra as retrieved from EBAS.

Setup and performance of the ISPRA DMPS fully complies with EUSAAR requirements.

Two APS 3321 are available to measure number size distribution of aerosol particles at Ispra. Only one instrument (S/N 1243) is currently used for EUSAAR/GAW measurements. Flow rates of this APS where within nominal ranges. A sizing check with 1.02 µm Latex spheres was satisfactory as seen in figure 9.

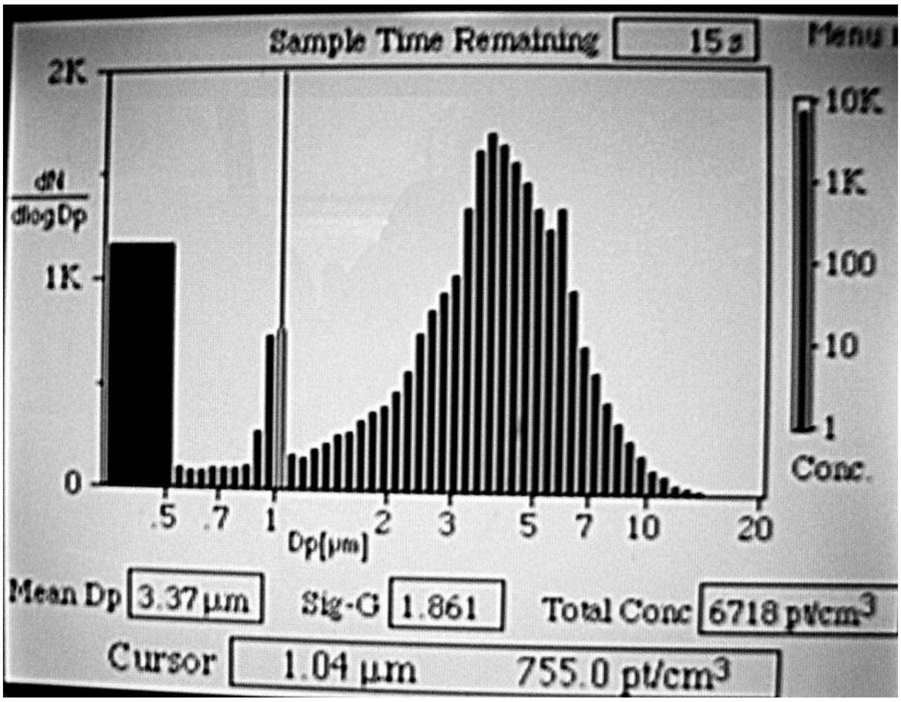


Figure 9: Sizing test of 1.02 µm Latex particles with standard APS at Ispra.

The APS at Ispra works according to manufacturer specifications.

Absorption Coefficients:

Two seven wavelength aethalometers S/N 408a1.303 (A, EUSAAR workshop 2007) and S/N 7402.609 (B) and a MAAP model 5012 (S/N 118) are used to measure aerosol absorption coefficients (as BC in case of the aethalometers) at Ispra.

The MAAP was added September 2008. This instrument is connected to a separate inlet which is not humidity conditioned. Because of the changes of the filter material with changing relative humidity a drier should be added to this inlet. MAAP inlet flows have not been checked previously. Unfortunately this instrument did have problems closing the filter holder (figure 10). Air was therefore drawn from the inside of the container to the filter. Because the aerosol flow is measured behind the filter in the MAAP there was no error indicated at the front panel of the instrument. (figure 11). The MAAP inlet will be modified to allow for automatic and manual checks of the inlet flow of this instrument.

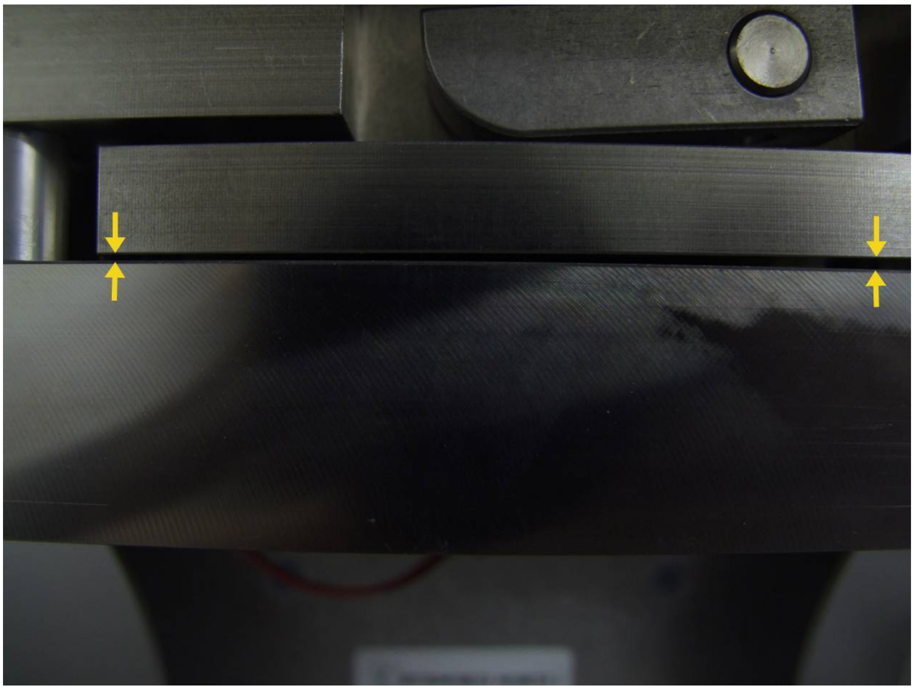


Figure 10: Filter holder of the MAAP not properly closed.

Figure 11: No indication of malfunction of the MAAP on the front panel of the instrument.

The MAAP was run overnight with an absolute filter on the inlet. Summary statistics of the measured absorption coefficients (BC/6.6) are given in table 2.

	N	Minimum	Maximum	Mean	Std. Dev
Sabs	949	-.05152	.06212	.0000239	.01689588
Valid N (listwise)	949				

Table 2: Summery statistics of 1 minute measurements of the MAAP with an absolute filter (1/Mm).

Figure 12 shows the frequency distribution of MAAP zero measurements.

The observed instrument noise during these measurements is typical for a MAAP.

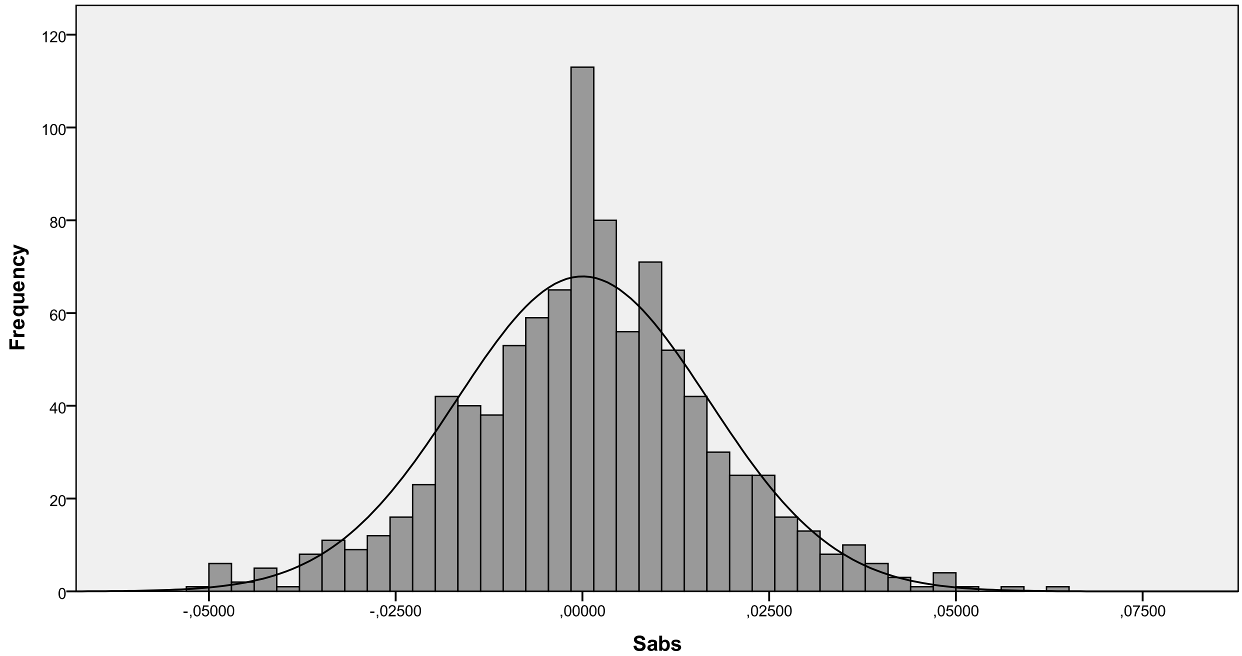


Figure 12: Frequency distribution of MAAP one minute zero measurements (1/Mm).

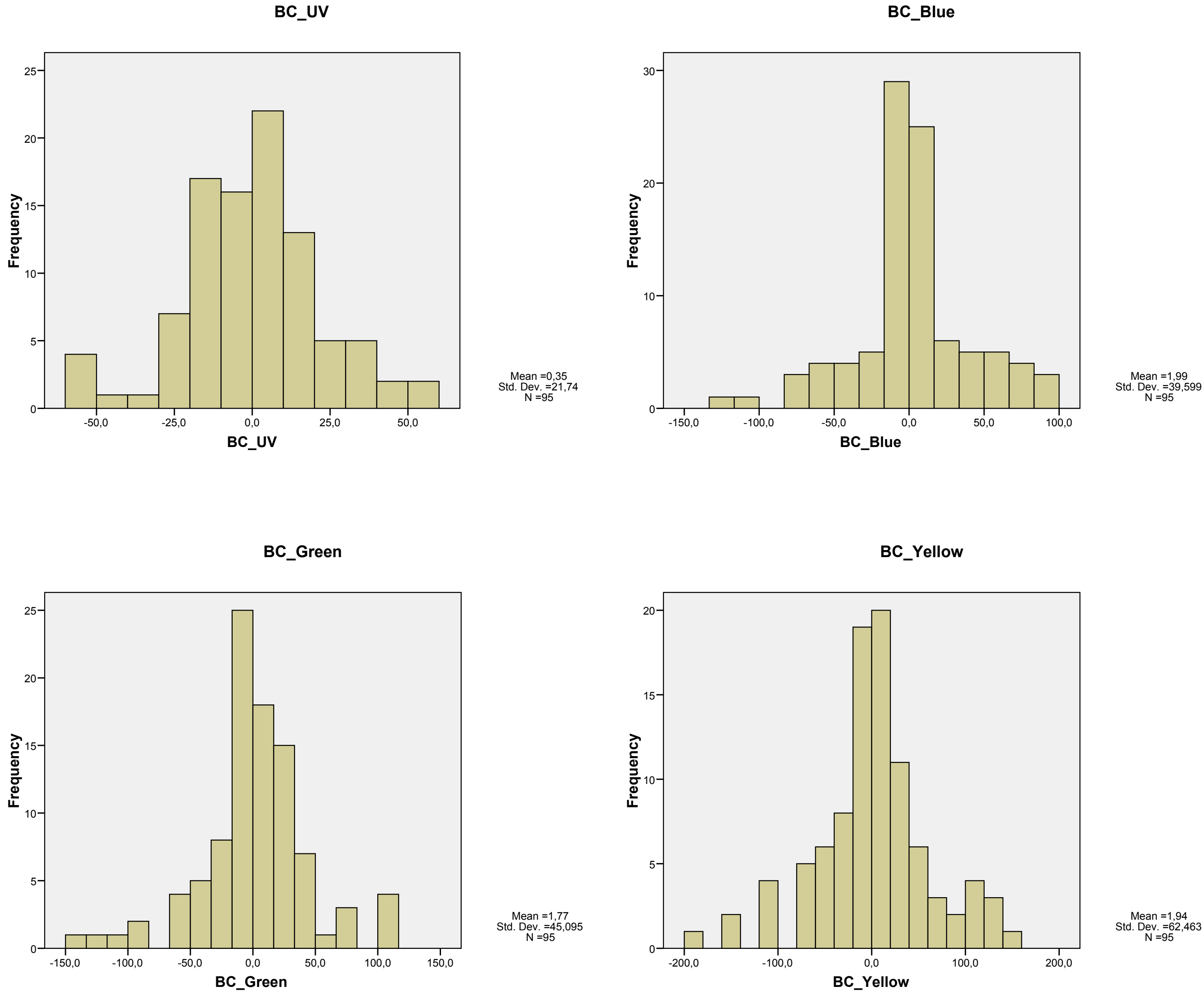
After modification of the inlet and repair of the filter holder the instrument will be in good working condition.

Flow rates of both aethalometers where found to be according to specifications. Both instruments where run on a zero filter over night. Summery statistics for aethalometer A are given in table 3.

	N	Minimum	Maximum	Mean	Std. Deviation
BC_UV	95	-58.0	53.0	.345	21.7396
BC_Blue	95	-120.0	99.0	1.989	39.5993
BC_Green	95	-147.0	116.0	1.772	45.0950
BC_Yellow	95	-183.0	155.0	1.943	62.4631
BC_Red	95	-172.0	175.0	4.008	62.7851
BC_IR1	95	-330.0	294.0	2.712	129.3212
BC_IR2	95	-343.0	313.0	5.223	113.1822
Valid N (listwise)	95				

Table 3: Summary statistics of 10 minute average data of Aethalometer A with filter.

Note that these instruments provide only data with a time resolution of 10 minutes compared to the time resolution of 1 minute of the MAAP. Because of the longer measurement time aethalometer data appear to be less noisy. Figure 13 shows the frequency distribution of zero measurements of aethalometer A by wavelength.



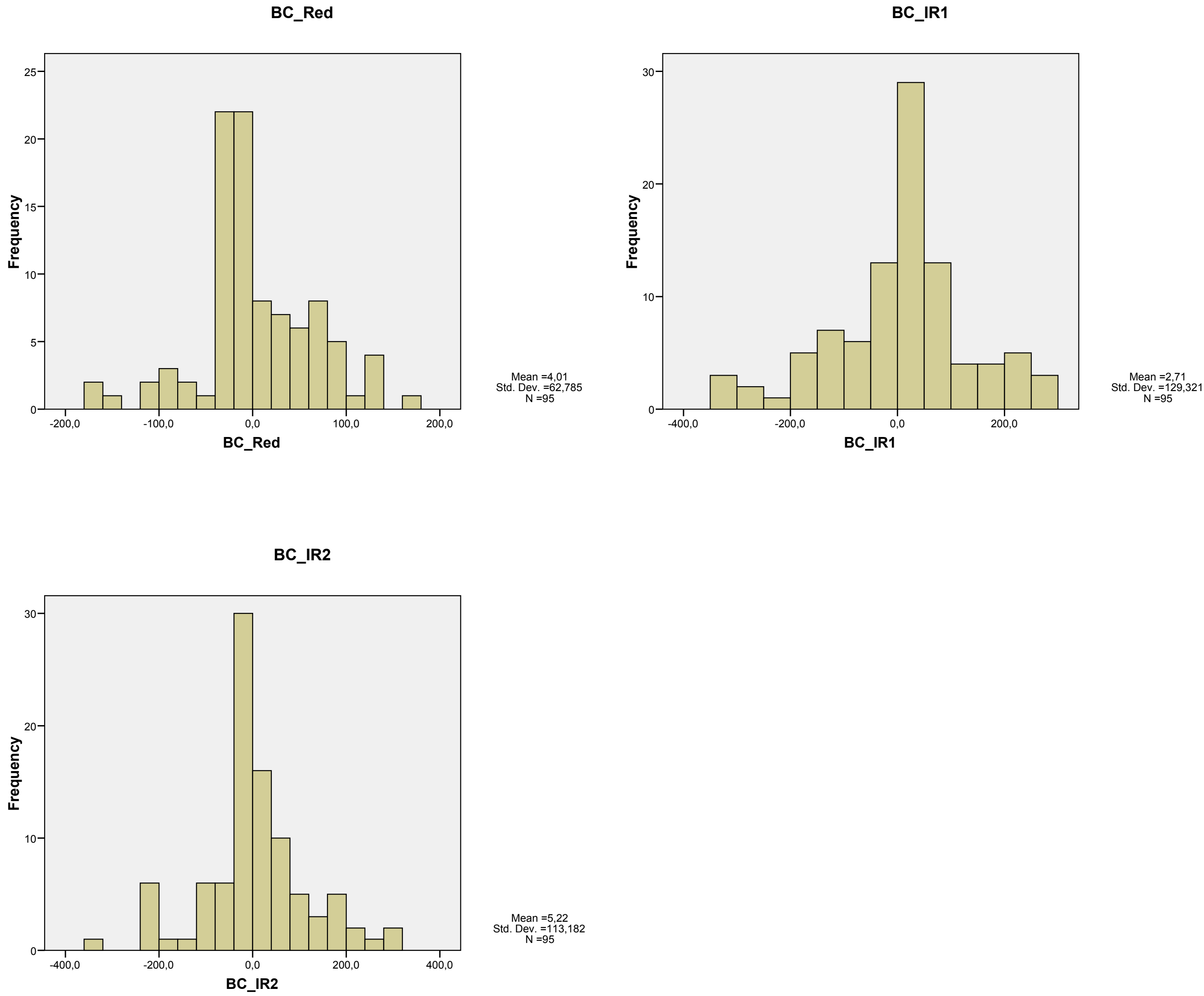
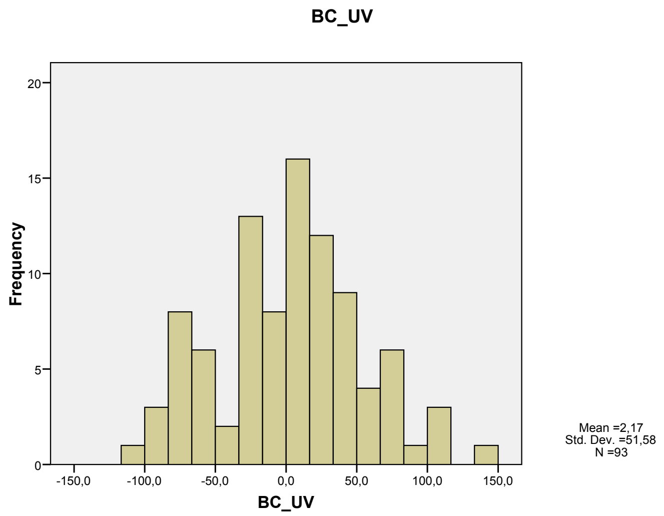


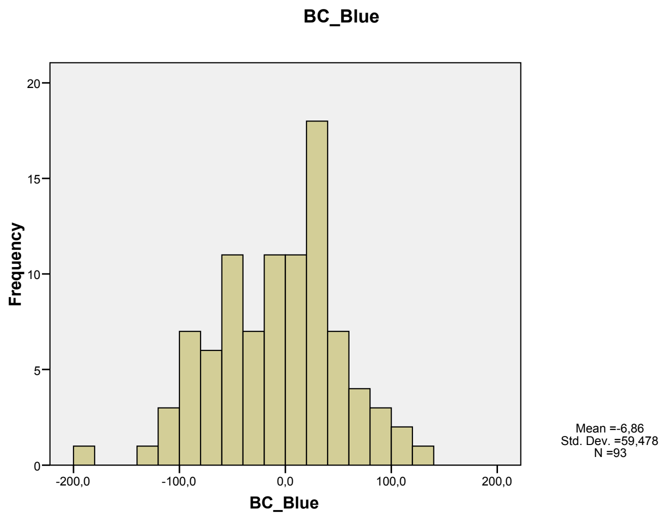
Figure 13: Frequency distribution of measured values measured by Aethalometer A during zero test at Ispra [ng/m³]

Summery statistics for aethalometer B are given in table 4. Figure 14 shows the frequency distribution of zero measurements for this instrument.

	N	Minimum	Maximum	Mean	Std. Deviation
BC_UV	93	-106.0	140.0	2.166	51.5802
BC_Blue	93	-197.0	121.0	-6.860	59.4783
BC_Green	93	-126.0	107.0	-13.984	52.2117
BC_Yellow	93	-233.0	165.0	-14.866	77.8525
BC_Red	93	-223.0	303.0	-6.124	87.6254
BC_IR1	93	-199.0	231.0	-12.292	98.7358
BC_IR2	93	-342.0	426.0	-3.109	157.9943
Valid N (listwise)	93				

Table 4: Summary statistics of 10 minute average data of Aethalometer B with filter.





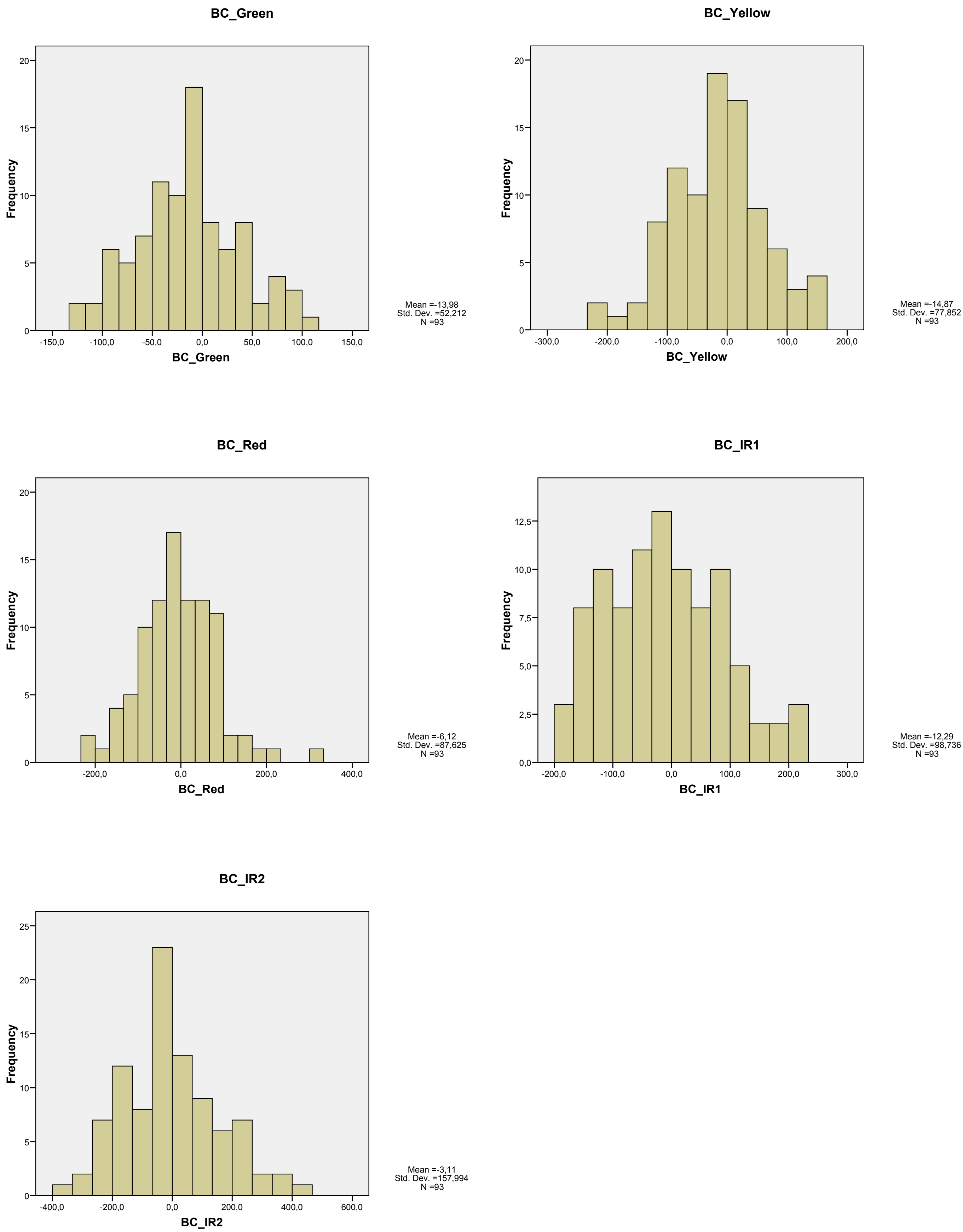


Figure 14: Frequency distribution of measured values Aethalometer B during zero [ng/m³].

Figures 15 and 16 represent data available from the EBAS database measured by the above instruments.

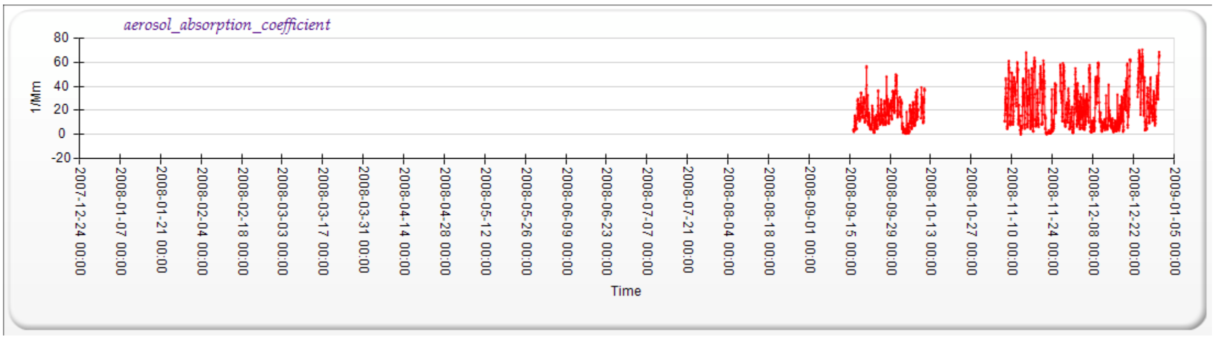


Figure 15: 2008 MAAP aerosol absorption coefficients from Ispra as retrieved from EBAS (λ=670 nm).

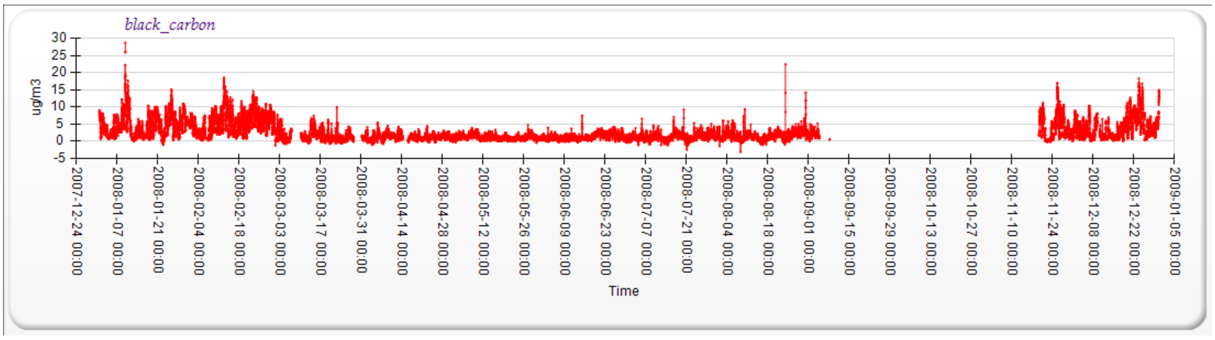


Figure 16: 2008 Aethalometer indicated black carbon (λ=660 nm) from Ispra as retrieved from EBAS.

Measurements of absorption coefficients at ISPRA exceed EUSAAR requirements.

Scattering coefficients:

A TSI Nephelometer model 3563 S/N 1081 is available at Ispra to measure aerosol scattering and backscattering coeficients. This instrument is calibrated on a regular basis with particle free air and CO_2. The manual procedure follows the routine used by TSI software.

Instrument noise was checked by an overnight run with a zero filter. Frequency distributions of 1 minute measured values for scatter and backscatter coefficients are shown in figure 17.

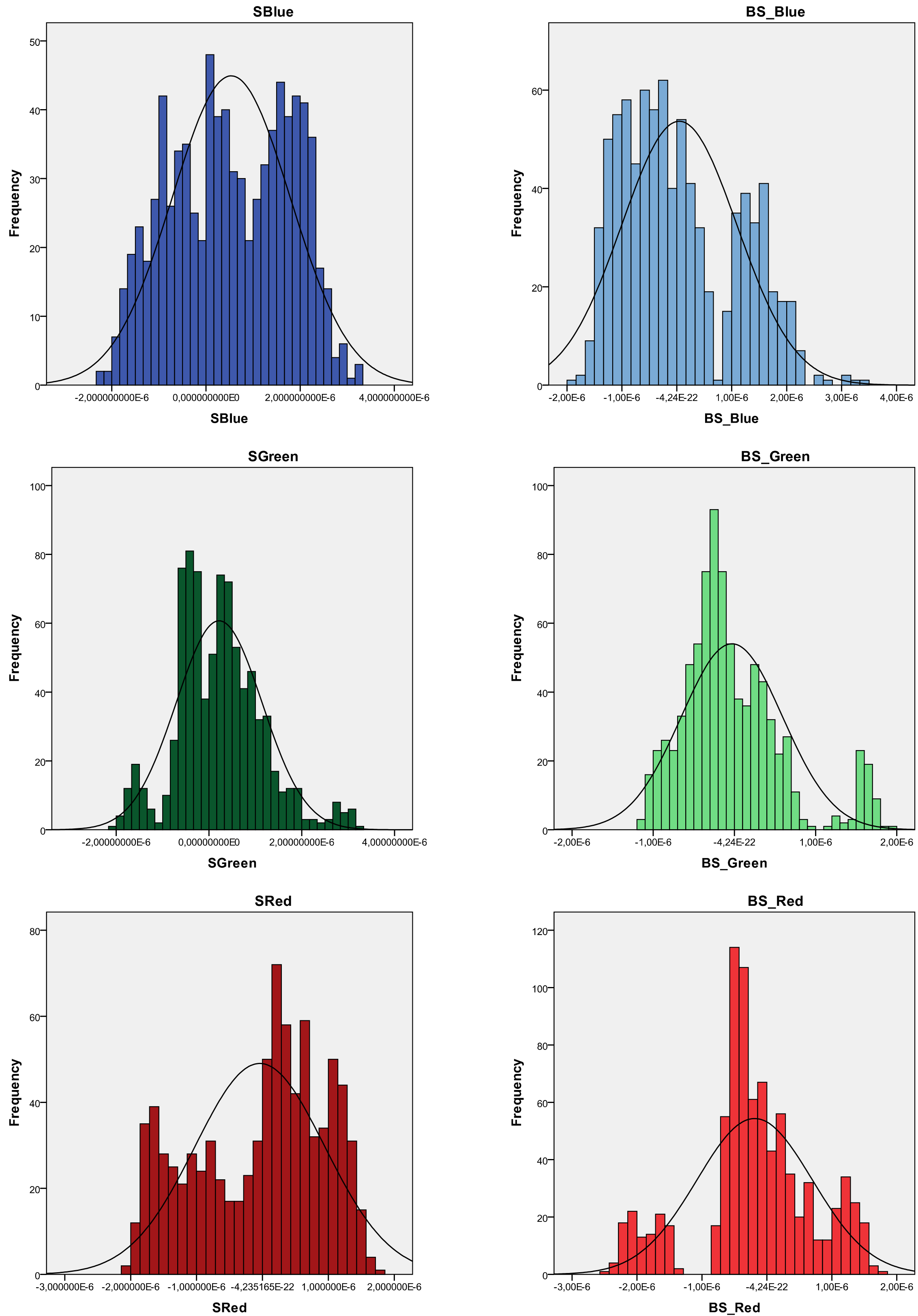


Figure 17: Frequency distribution of 1 minute scatter and backscatter coefficients of the ISPRA Nephelometer with an absolute filter.

Summery statistics for this zero measurement are shown in table 5.

Deskriptive Statistik

	N	Minimum	Maximum	Mean	Std. Dev.
SBlue	847	-.000002180	.000003292	.00000053563	.000001253683
SGreen	847	-.00000203	.00000320	.0000002183	.00000092753
SRed	847	-.0000021180	.0000018240	-.000000039931	.0000009845204
BS_Blue	847	-.000001842	.000003387	.00000004488	.000001049508
BS_Green	847	-.0000011790	.0000019110	-.000000030782	.0000006254169
BS_Red	847	-,000002454	,000001744	-,00000018887	,000000888249
Valid N (listwise)	847				

Table 5: Summary statistics of 1 minute scattering coefficients of the Nephelomter at Ispra (1/Mm).

Scattering and backsattering coefficients available from EBAS database for the year 2008 are plotted in figures 18 and 19.

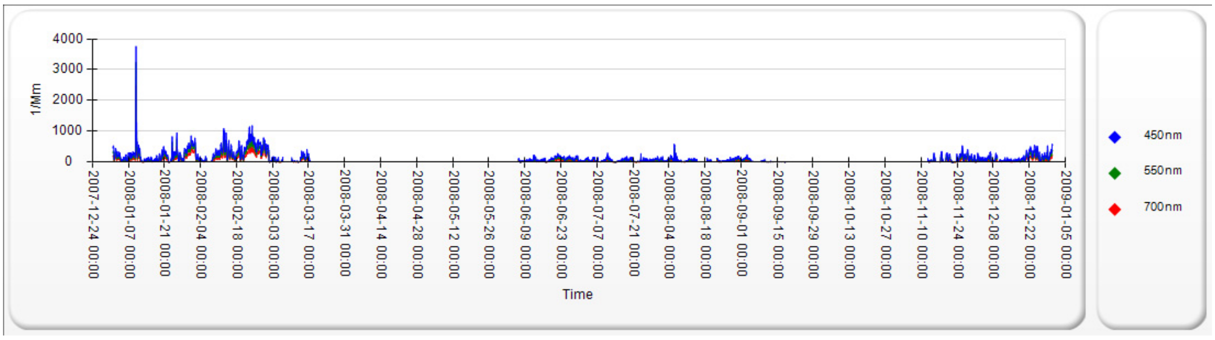


Figure 18: Time series of 2008 light scattering coefficients from Ispra as retrieved from EBAS.

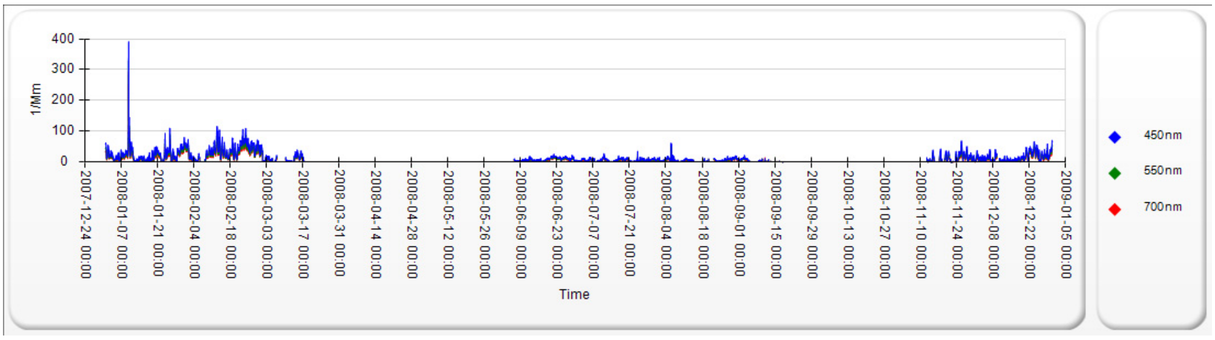


Figure 19: 2008 back scattering coefficients from Ispra as retrieved from EBAS.

The Nephelometer at Ispra works according to EUSAAR requirements.

Mass in two size fractions:

Two TEOM FDMS systems are available at ISPRA to measure PM1 and PM10 mass concentrations. The PM1 system is located in the new measurement container. It uses a PM10 inlet with a PM1 cyclon. While trying to perform flow measurements and zero checks on this system (S/N 140AB253620409) the nafion membrane of the dryer in the FDMS system broke causing a leak as seen in the subsequent zero measurements with this instrument (figure 20).

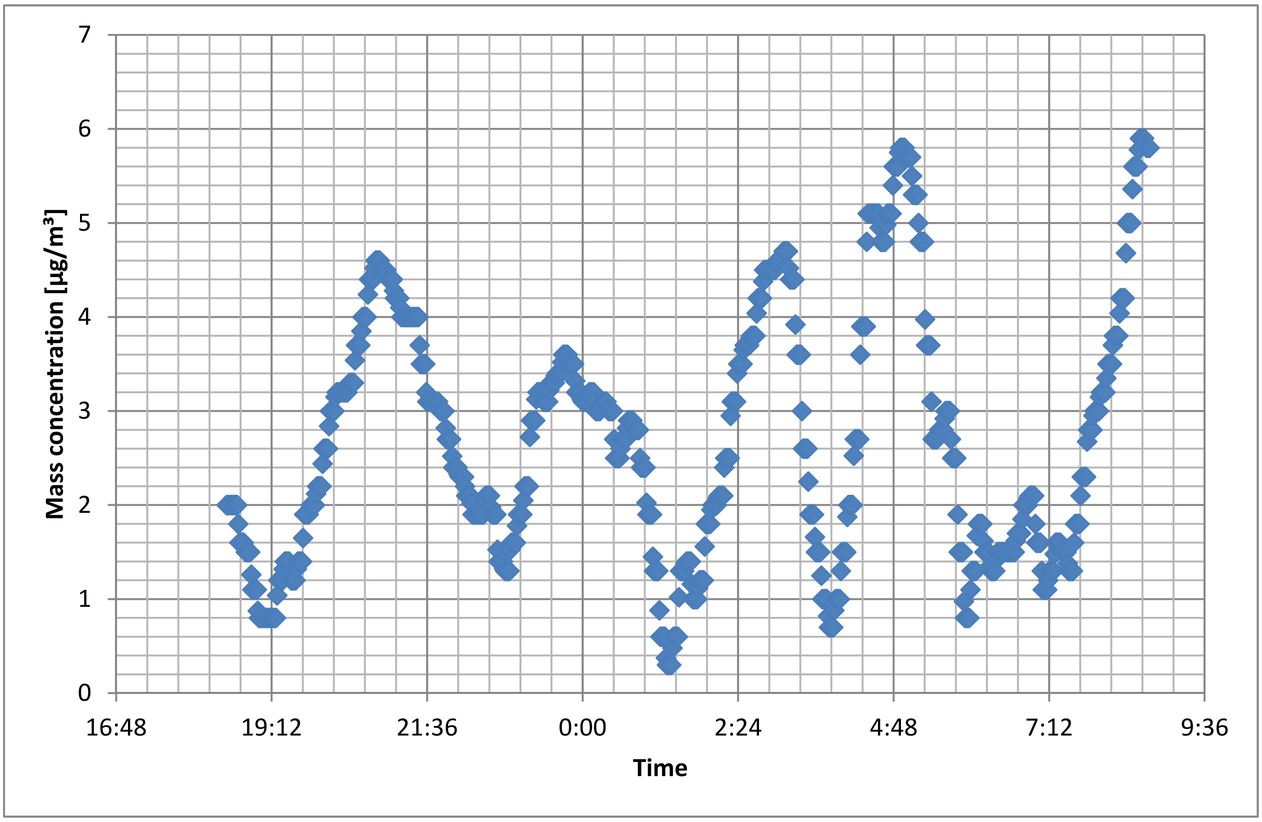


Figure 20: Time series of TEOM with broken Nafion membrane.

To avoid further damage of the remaining PM10 TEOM (S/N 140AB 233870012) further leak checks and flow checks of this instrument where skipped during this audit.

The performance of these instruments could therefore not be evaluated during this audit.

Conclusion:

Measurments of physical aerosol properties at ISPRA are state of the art. Many instruments are backed up by second units or by comparable measurements. The few smaller issues found during the audit have been corrected immediately or will be fixed in short term. Data handling and documentation at this site could serve as a good example for many other stations in the network. We wish to thank you for your hospitality.

References:

Carsten Gruening, Mariana Adam, Fabrizia Cavalli, Paolo Cavalli, Alessandro Dell'Acqua, Sebastiao Martins Dos Santos, Valerio Pagliari, David Roux, Jean-Philippe Putaud. JRC Ispra EMEP - GAW Regional Station for Atmospheric Research 2008 Report. EUR 24088EN-2009.

A. Wiedensohler, W. Birmili, A. Nowak, A. Sonntag, K. Weinhold, M. Merkel, B. Wehner, T. Tuch, S. Pfeifer, M. Fiebig, A.M. Fjäraa, E. Asmi, K. Sellegri, H. Venzac, P. Villani, P. Laj, P. Aalto, J. A. Ogren, E. Swietlicki, P. Roldin, P. Williams, P. Quincey, C. Hüglin, R. Schmidhauser-Fierz, M. Gysel, E. Weingartner, F. Riccobono, S.Santos, C. Grüning, K. Faloon, D. Beddows, C. Monahan, A. Marioni, H.-G. Horn, L. Keck, J. Jiang, J. Scheckman, P. H. McMurry, Z. Deng, C.S. Zhao, M. Moerman, G. de Leeuw (2010), Particle Mobility Size Spectrometers: Harmonization of Technical Standards and Data Structure to Facilitate High Quality Long-term Observations of Atmospheric Particle Size Distributions, submitted to AMT.