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Site audit report Cabauw, The Netherlands

Summary: Measurements of physical aerosol properties at the EUSAAR site Cabauw were audited by Dr. Thomas Tuch of the WWCAP on February 11th and 12th 2008. The site is located near the city of Lopik 51.971”N, 4.927”E -0.7 m a.s.l. (Fig.1). It is operated by a consortium three universities and five major research institutes. A 203 meter measurement mast provides research platforms at every 20 meters of height. Aerosol instruments are currently located in a separate container at 60 meters.

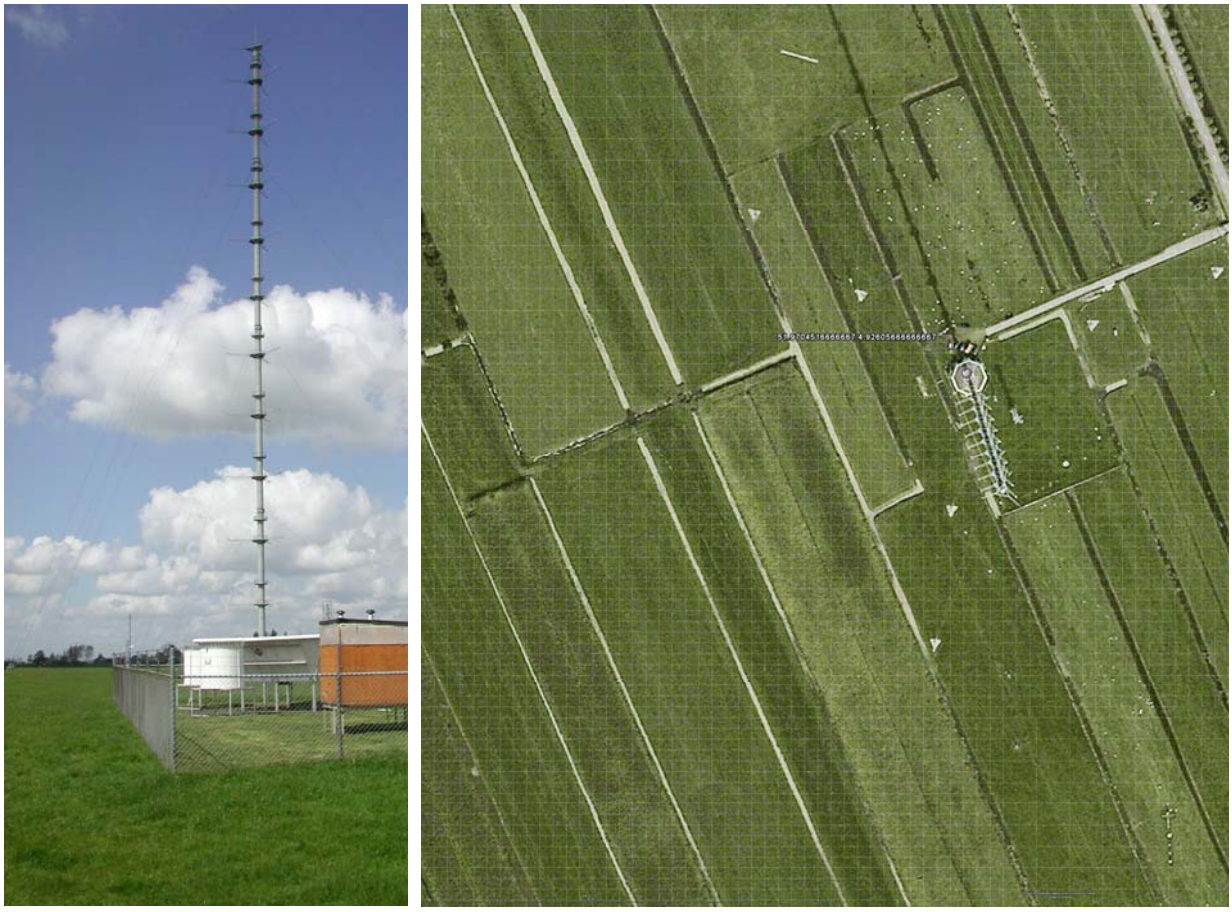

Figure 1. The 213 m meteorological tower at Cabauw, The Netherlands. Source: http://www.klimaatvoorruimte.nl/pro1/general/show_document_general.asp?documentid=1035&GUID=%7B65C1431F-1819-4347-BC05-8474DD3F6F5B%7D

Currently major changes are made at the site to improve aerosol measurements. A common aerosol inlet is build with 3 collocated PM10 inlets at a height of 60 m above the ground. Aerosol instrumentation will be relocated from the 60 meter platform to a laboratory in the basement of the tower building. Instrumentation comprises all instruments required for a EUSAAR site. A modified TSI SMPS has been installed during the audit. Although we did find some problems with the instruments at this site we expect excellent aerosol data quality from Cabauw in the future.

Documentation: All instrument manuals were available at the site during the audit. Online documentation of all relevant instrument parameters meets EUSAAR quality standards.

Documentation at Cabauw complies with EUSAAR requirements

Primary flow standard: A TSI flowmeter Model 3063 D SN 3063 0436 005 is used as a travelling standard at the site. This instrument is verified against a Gilibrator at the laboratory. Comparison of this flowmeter with the WCCAP reference Gilibrator showed reasonable agreement of both instruments.

Gilibrator Cell 0303865-S

Gilibrator	TSI
0	0.03
1.063	1.12
4.784	4.87
7.573	7.62

Note that standard conditions of the TSI flowmeter differ from NTP. TSI flowmeters define reference conditions as 1013 hPa and 21.1 deg. Celcius (=70 Fahrenheit) according to the specifications of the instrument:

For the most current information available on this instrument, go to www.tsi.com and select “Particle Instruments.”

Flow measurement
Range: 0 to 200 std. L/min (0 to 7.06 cfm) in air
*Accuracy:** 2% of reading or 0.05 std. L/min (0.0018 cfm), whichever is greater, at 21.1 °C (70 °F) and 101.3 kPa (14.7 psi)

The flow standard at Cabauw complies with EUSAAR requirements

Inlet: Currently all aerosol instruments (Nephelometer, MAAP, APS, CPC and an Aethalometer (not EUSAAR)) are installed in a separate container at 60 meters height. Commercially available PM10 inlets are used. Flow splitters are designed according to specifications supplied by the WCCAP.

Service of the instruments on the platform is difficult. A new aerosol inlet is therefore currently constructed. 3 commercially available PM10 inlets with a total inlet flow of 3 m^3/h will be collocated on the 60 meter platform. A common inlet tube leads to a laboratory in the basement of the tower building. Due to space requirements near to the tower a 3 m tube inclined 45 deg to the vertical is used to supply aerosol to the instruments.

Both the new and the old inlet systems fulfill requirements for inlets at EUSAAR sites

Nephelometer: A three wavelength TSI Nephelometer 3563 SN 1090 is available at Cabauw. This instrument has participated in the intercomparison workshop at the WCCAP in December 2007. The instrument was calibrated last time at (Fig.2) :

Calibr. Label,15:57 Dec 12, 2007 MMH NEPH S/N1090 AIR/CO2. true MM & HV

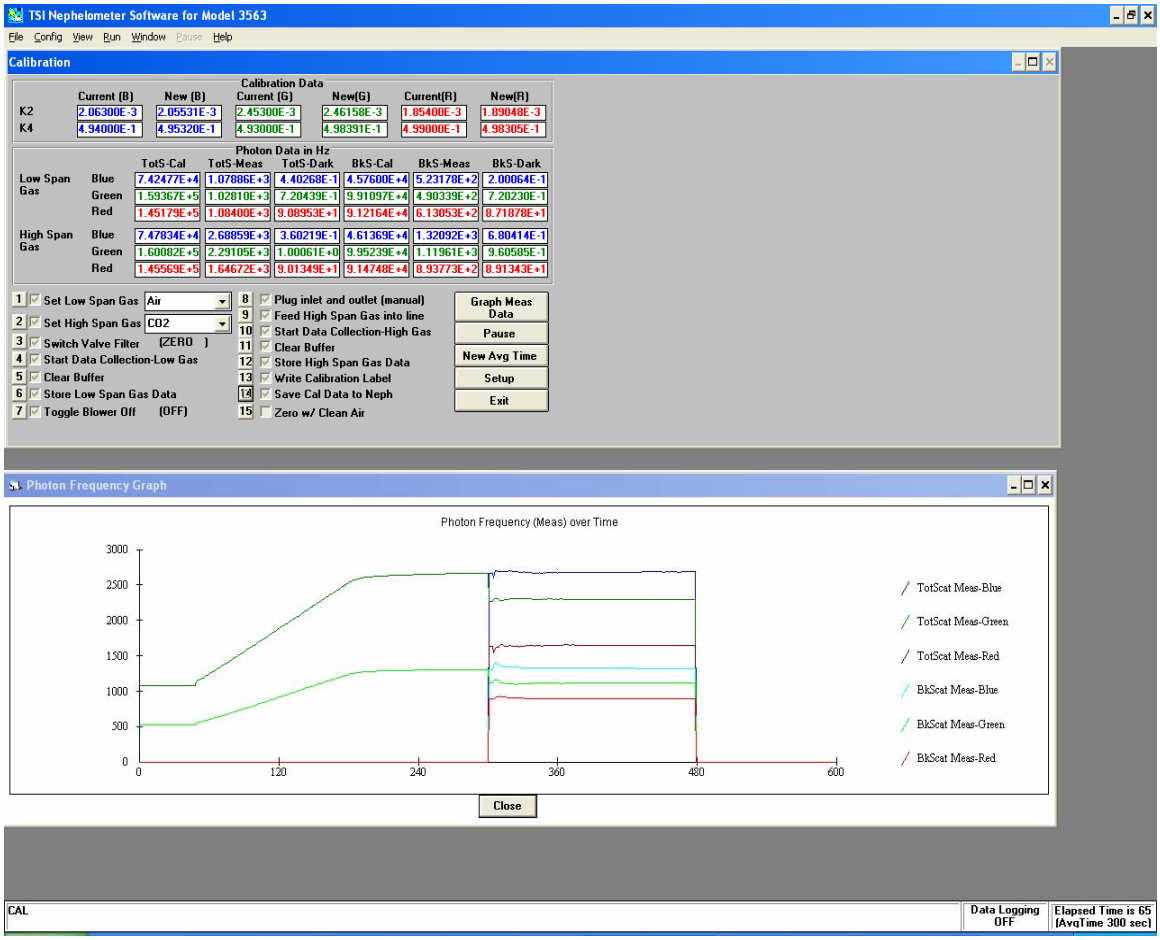

Figure 2: Last Nephelometer calibration according to logbook.

A monthly calibration of the Nephelometer is required according to EUSAAR specifications. A calibration during the audit differed by more than 5 % from the last values for the blue channel of the instrument. This difference may, however, be due to the cold CO_2 calibration gas stored outside the building (approximate temperature 5 deg. Celsius). This calibration was therefore discarded. It is planned to build a CO2 supply from the outside storage area for gas canisters to the laboratory in the basement of the tower. With this new line the CO_2 will be at room temperature.

We checked the response of the instrument with an absolute filter for a time period of 8 hours. 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. The time series of this test is shown in fig. 3, statistical parameters of the scattering coefficients are summarized in table 1.

	N	Mean	Std. Deviation
TotSCfB	91	-.00000006183	.000000345997
TotSCfG	91	-.0000000313	.00000014430
TotSCfR	91	.0000000008	.00000011763
BkSCfB	91	.0000000116	.00000018349
BkSCfG	91	.00000000206	.000000075065
BkSCfR	91	.0000000074	.00000009309
Valid N (listwise)	91		

Table 1: Statistical parameters of zero measurement with the Nephelometer

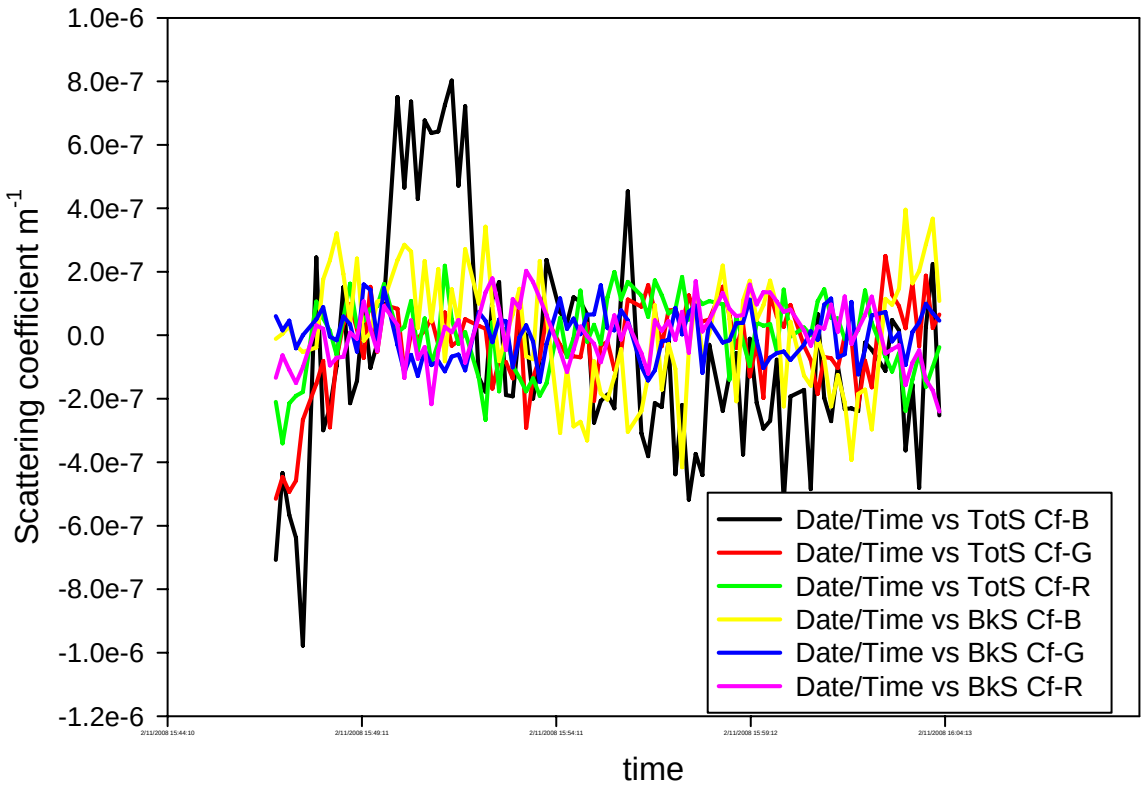

Figure 3: Time series plot of 5 minute average Nephelometer data with absolute filter.

The instrument response during this test was reasonable. Note, however, that the blue forward scattering channel seems to fluctuate more than the other channels of the instrument. It would be desirable to repeat the time series measurement with an absolute filter to investigate possible problems with the blue channel.

With more frequent calibrations the Nephelometer will comply with EUSAAR requirements

MAAP: The flow rate indicated flow rate of the MAAP was 9 l/min. We measured however a flow rate of 9.75 l/min. The flow sensor of this instrument needs to be calibrated to comply with EUSAAR requirements. The last zero check including the inlet was performed February 7th 2008 (fig.4)

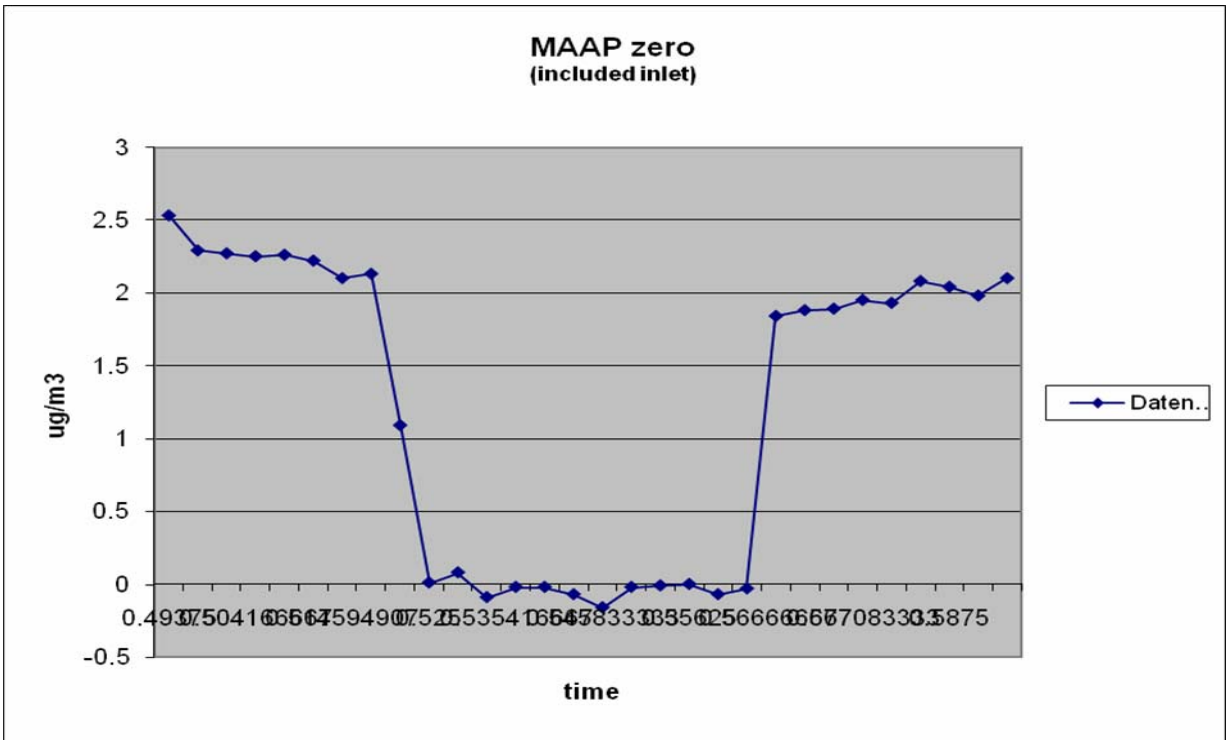

Figure 4: Zero check of the MAAP including inlet prior to the audit.

An additional zero check with an absolute filter was performed during the audit for a time period of 18 hours. Statistical parameters for 5 minute average data during this measurement are shown in Fig.5

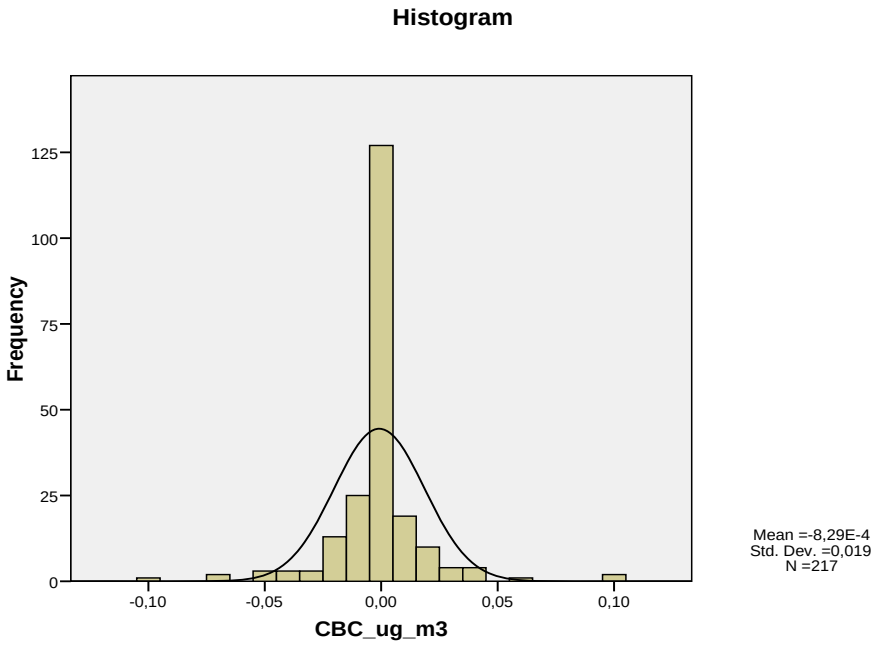

Figure 5: Frequency distribution of 5 minute average MAAP CBC data [µg/m³] with absolute filter

After flow calibration the MAAP complies with EUSAAR requirements

CPC: A TSI CPC model 3762 is used to measure total particle number concentration. With an upper concentration of 5000 cm^{-3} this instrument is not suitable for this purpose. We observed integral concentrations calculated from SMPS measurements of 20000 cm^{-3}. The CPC indicated concentration was 13000 cm^{-3}due to coincidence. The measured flow rate was 2.61 l/min (nominal = 3.1 l/min). Zero counts were slightly elevated (0.0033 cm^{-3}).

The CPC at Cabauw is not suitable for measurements of the total number concentration at Cabauw

APS: A TSI APS 332100 SN 1327 is used to measure the number size distribution of particles larger than 0.53 µm. The measured aerosol flow rate of 1.069 l/min was in good agreement with the flow rate indicated on the front panel of the instrument (1.02 l/min). A problem with the zero counts of this instrument has been identified prior to the audit. With a filter at the inlet this instrument measures sometimes zero concentration and sometimes arbitrary noise with high concentrations of supermicron particles. Cleaning of the measurement chamber did not solve this problem.

The APS has been sent to the manufacturer for factory maintenance

SMPS: A modified TSI SMPS model 3034 has been installed at the site during the audit. The data acquisition has been changed from the original TSI software to a modified version of the IfT SMPS software. A sheath-air dryer has not been installed. Relative humidity of the aerosol and the sheat-air are not measured. The instrument was installed out of the box as delivered by the IfT. It worked according to its specifications. Note that according to EUSAAR requirements both sheath-air dryer and humidity sensors need to be added to the instrument.

The SMPS at Cabauw is in good working condition

Conclusion: We did find some issues that need to be improved at the site. Part of the problems may be due to the ongoing modifications at Cabauw. We assume that the site will be in good condition by the beginning of the EUSAAR measurements. We wish to thank the station personnel for their hospitality.