

Site audit of IZO, GAW Global station, Izaña, Tenerife

Dr. Thomas M. Tuch
Dr. Andreas Nowak
World Calibration Center for Aerosol Physics

This site audit was done in the frame of the **GAW** program from November 27th to 28th, 2006.



Fig.1: Aerosol laboratory at IZO

General remarks:

The Izaña Observatory IZO is located at 28°18'N, 16°29'W on a mountain plateau 2367 m asl. Continuous meteorological observations at this site started 1909. The station has been reconstructed during the last three years. Today it provides the infrastructure necessary for excellent science and reliable long-term observations. IZO is managed by the Instituto Nacional de Meteorología. A regular staff of 22 persons is responsible for day to day and scientific operation of the site.

Aerosol measurements in the GAW framework are scheduled to start after this first audit of the station by the WCCAP. Up to now data have been checked monthly which is not sufficient to detect instrument failures rapidly.

During standard operation aerosol measurements will be supervised by scientists from Santa Cruz on a weekly basis. Technicians will check proper operation of the instruments twice per day. Online access to aerosol data from Santa Cruz will be established in the year 2007. It is planned to grant public access to data from IZO after an initial test phase.

Scientific personnel and technicians were present during the audit. Manuals for all instruments operated in the aerosol lab were on site. Lab books were available for all instruments. Information found in these lab books was very detailed. In addition to these books checklists for technicians are available for routine checks twice per day.

The scientific advisory group on aerosol has summarized a list of comprehensive with a subset of core measurements in the WMO/GAS Aerosol measurement procedures guidelines and recommendations. Table 1 summarizes the current status of the aerosol measurements at IZO. Note that missing aerosol instrumentation will be acquired in 2007 and that the current Hi-Volume samplers used for mass concentration measurements and chemical analysis will be replaced in the same year. After installation of these new instruments all core measurements and many additional measurements will be available from IZO.

	Instrument	Status	Remarks
<i>Continuous Measurement</i>			
Multiwavelength optical depth	Cimel, Brewer	Fully operational	Not audited by WCCAP
Mass in two size fractions	MCV	Not available	PM 10 and PM2.5 are currently measured and analysed, not audited by WCCAP
Major chemical components in two size fractions	MCV	Not available	by external group, IZO measurements will start 2007
Light absorption coefficient	MAAP	Fully operational	
Light scattering coefficient at various wavelengths	n/a	Not available	TSI 3 wavelength nephelometer will be acquired 2007
Hemispheric backscattering coefficient at various wavelengths	n/a	Not available	
Aerosol number concentration	TSI 3025	Fully operational	
Cloud condensation nuclei at 0.5% supersaturation	n/a	Not available	
<i>Intermittent Measurement</i>			
Aerosol size distribution	TSI 3071	Available, needs modification, data questionable	Present TSI 3071 needs major modification
Detailed size fractionated chemical composition	n/a	Not available	Not audited by WCCAP
Dependence on relative humidity	n/a	Not available	
CCN spectra (various supersaturations)	n/a	Not available	
Vertical distribution of aerosol properties	Micro Pulse	Fully operational	Not audited by WCCAP




	Fully operational
	Available, needs modification, data questionable
	Not available

Table 1: List of comprehensive aerosol measurements with a subset of core variables (identified in bold) that are recommended by the GAW Scientific Advisory Group on Aerosols for long-term measurements in the global network. Available instruments and current status at IZO November 2006.

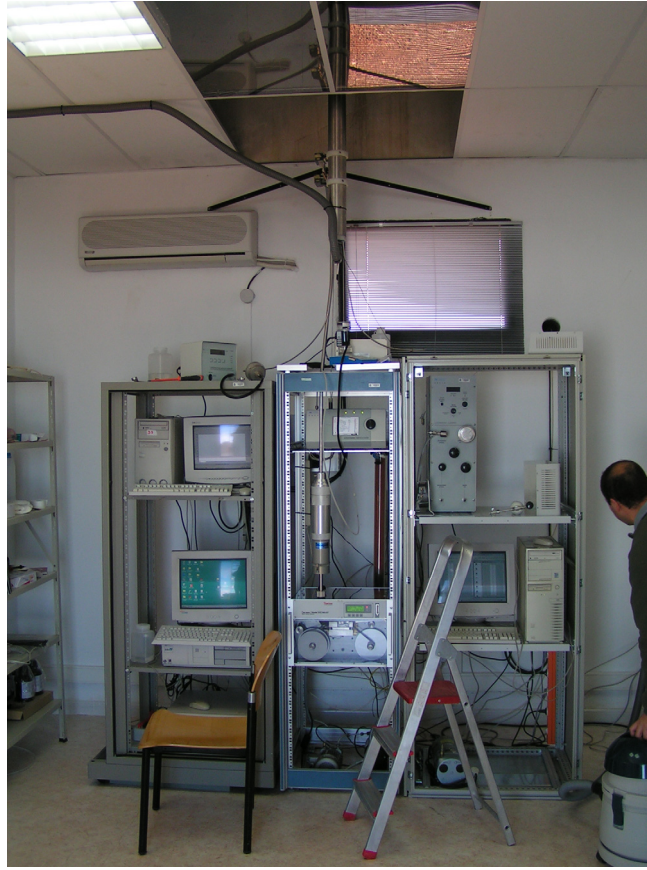


Fig. 2 Aerosol Instrumentation

Aerosol inlet:

The custom build whole air aerosol inlet (Fig.3) is mounted on the roof of the laboratory building about 2 m above the roof. It consists of an outer and an inner stainless steel tube with an inner diameter of 8 cm and a bucket type rain cover on top.



Fig. 3: Whole air inlet and sliding inner tube

The inner tube can be raised 10 cm in case of rain. This design works as an impactor removing water droplets from the airflow to prevent flooding of the system. The inner tube is automatically raised if rH exceeds 90%. Position of the inner tube is automatically logged by the control program. The original plan was to exclude data with raised inner tube from the GAW data set. We suggest, however, submission of these data with a flag indicating the modified inlet characteristics. The guiding ring of the inner tube is made of plastic. The original idea to use this material was to insulate outer from inner tube as a precaution against damage from lightning stroke. Plastic parts may, however, cause losses of ultrafine particles. If ultrafine particles are of special interest at IZO this plastic guide ring should be replaced by a ring made of metal. Air speed inside the inlet has been selected according to GAW recommendations (5.5 m³/h). The whole air duct is vertical. A flow splitter is used to provide the individual samples for the instruments. The excess air volume is checked with a gas-meter twice per day. A temperature and humidity sensor in the splitter measures aerosol temperature and relative humidity. Sample lines to the instruments are made of stainless steel. Horizontal lines have been avoided where possible. Instruments measuring coarse mode particles (e.g. Sahara dust, APS, OPC) are operated without a size selective inlet. A separate PM10 (Fig. 4) impactor in the sample line to the individual instrument is used for MAAP and will be used for the Nephelometer.



Fig 4: Flow splitter without tubing, MAAP with PM10 impactor

The whole design of the inlet system is in good agreement with recommendations by the SAG.

We suggest to build an absolute filter which fits to the aerosol inlet on the roof of the building. Such a filter would allow to check zero of the whole system more frequently.

Primary flow standard:

A Gilibrator is used as primary flow standard at IZO. We compared the flow cell SN 05110221-5 with the reference flow cell of the WCCAP (0303865-9). Both flow cells agreed within 1%. It should be noted, that the Gilibrator at IZO is transported from Santa Cruz to the

site. It would be useful to have a separate primary flow standard both at IZO and in Santa Cruz.

Measurement of the absorption coefficient:

A MAAP (SN 50) is used to measure absorption at the site. The instrument has participated in the intercomparison workshop in Leipzig 2005.

Software Version 1.28.

Flow rate is 16.64 l/min at ambient pressure and temperature. Indicated flow rate is 16.67 l/min. Last flow calibration 16th November 2006.

1 Minute data (scientific data format 12) are recorded by the DAQ computer. Average concentrations for GAW are calculated from the 1 minute data.

Zero air (with an absolute filter) was measured for a time period 18 hours. Figure 5 shows the variability of 1 minute data with the absolute filter and figure 6 the respective plot for hourly average data. The variability of $\pm 100 \text{ ng/m}^3$ for 1 minute data and the variability of $\pm 5 \text{ ng/m}^3$ for hourly average data are in good agreement with the specifications by the manufacturer.

The MAAP at IZO is in good working condition.

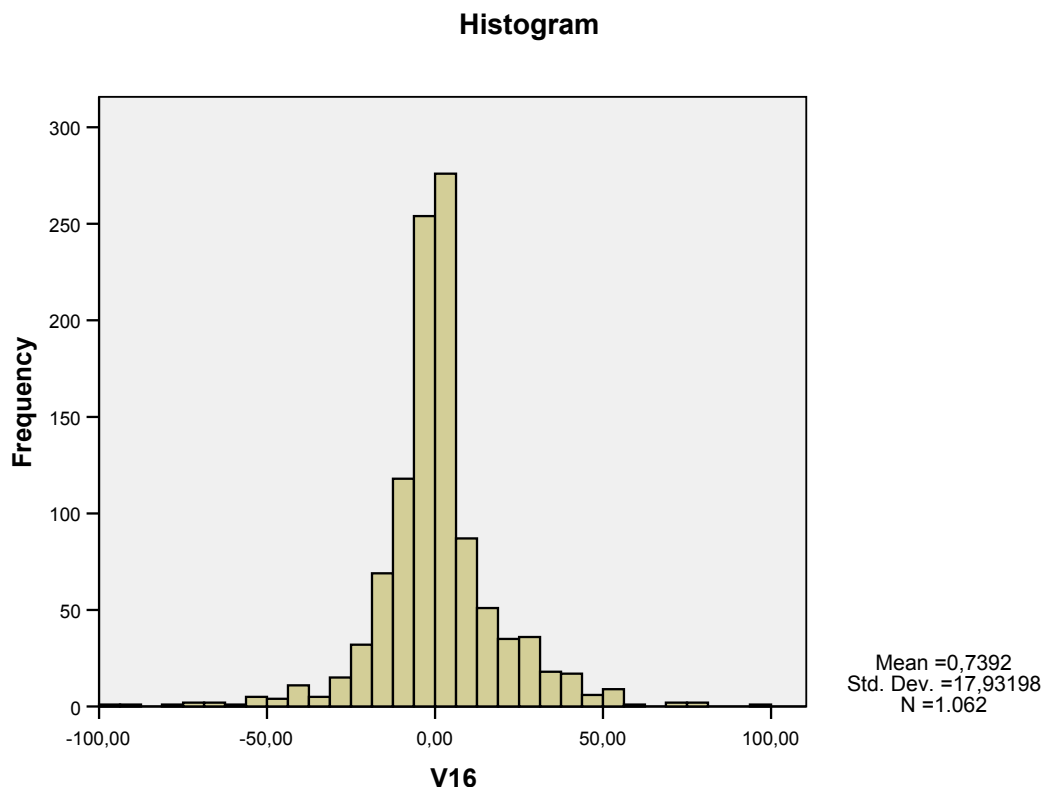


Fig. 5: Distribution of MAAP one minute data with absolute filter

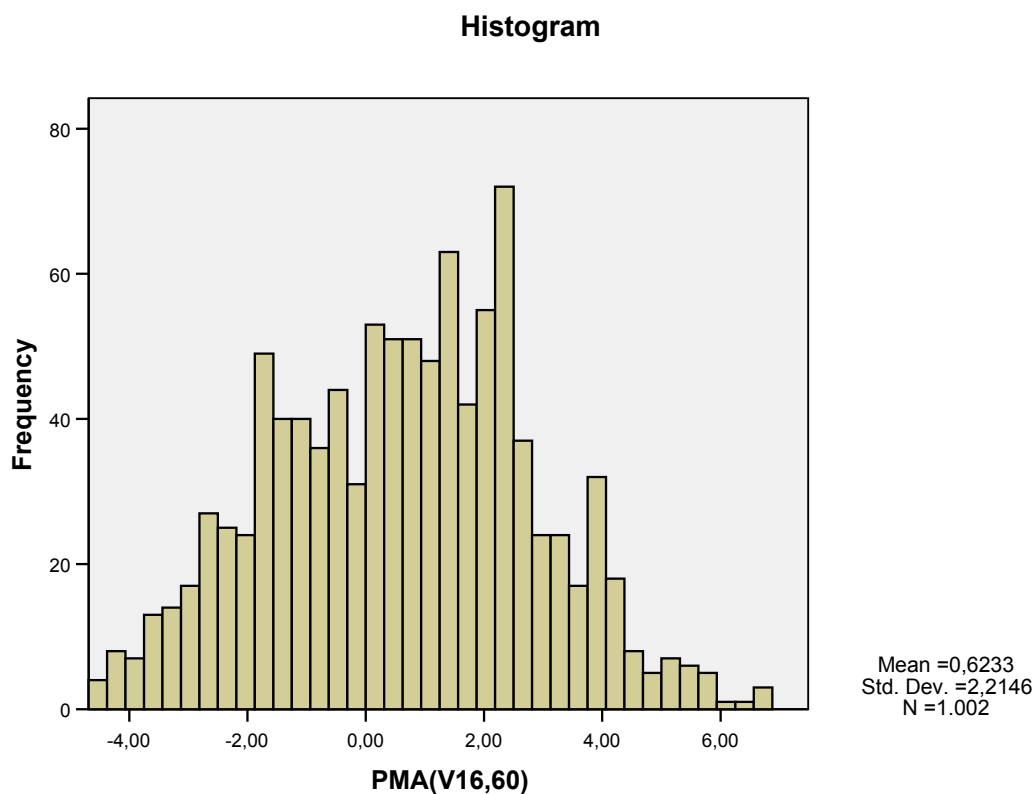


Fig 6: Distribution of hourly running average data with absolute filter.

Scattering Coefficient:

Scattering coefficients are currently not measured at IZO. A Radiance Research Nephelometer from an American group is available at the site. This instrument has, however, been modified in a way that does not allow to use it for GAW measurements.

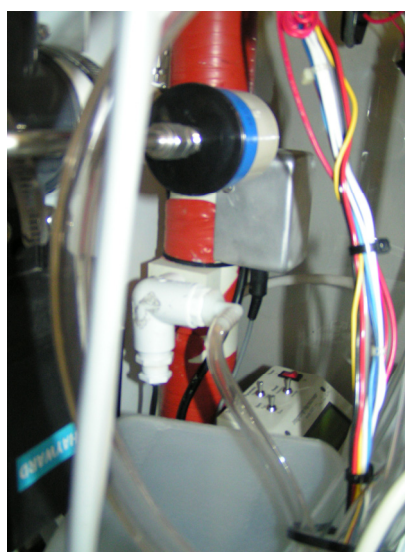


Fig. 7: Modified Radiance Research Nephelometer at IZO

Measurements of scattering coefficients are core requirements for GAW global stations. It is therefore planned to buy a 3 wavelength TSI Nephelometer in the year 2007.

Aerosol number concentration

Aerosol number concentration is measured by a TSI 3025 SN: 1267. This UCPC has not yet been calibrated at the WCCAP (INM 3025 SN 1160 was calibrated 2002).

Condenser flow of the instrument was high (0.53-0.54 cm³/s). The maximum flow rate in high flow mode was 1.38 l/min. The instrument did not count particles during a 15 minute test with an absolute filter.

The relatively low flow in high flow mode does not cause measurement artefacts. It needs, however, to be noted that the lifetime of the aerosol pump of the UCPC is reduced by this problem. The critical orifices of the UCP are corroded. The additional friction may be the cause for the reduced flow. Critical orifices have been cleaned and all filters of the UCPC have been replaced. After service a maximum high-flow flowrate of 1.43 l/min was observed. We suggest ordering new critical orifices from TSI to replace the old ones as soon as possible.

A second CPC type 3010 SN 70431239 is available at IZO. This CPC will be used in an SMPS in the future. Initial measurements with an absolute filter revealed a relatively high count rate with an absolute filter (195 particles in 10 minutes) at a flow rate of 1.00 l/min.

Note that 0.00 particle/cc indicated on the frontpanel of the CPC may be sufficient for a total counter but it is not sufficient for an instrument attached to a DMA. Use absolute counts per 10 minutes for leak-checks. The leak was found at the connector to the Butanol fill bottle. Disconnecting the fill bottle did yield a zero count rate of 2 counts in 10 minutes.

Both CPC have been run parallel prior to the audit. During night time in absence of new particle formation events both instruments yield identical particle number concentrations.

The CPCs at Izaña are in good working condition

Number size distribution

Number size distribution of particles larger than 0.3 µm in diameter is currently measured at IZO by OPC and APS. Both instruments are operated without an impactor. This allows the observation of Sahra dust events at Izaña.

Optical particle counter and APS:

A Grimm OPC model 1.108 SN# 8F008 is used to classify particles in the size range from 0.3 to 20 µm. Nominal flow of the instrument is 1.2 l/min, measured flow 1.207 l/min. We found elevated counts with an absolute filter (Fig. 8)

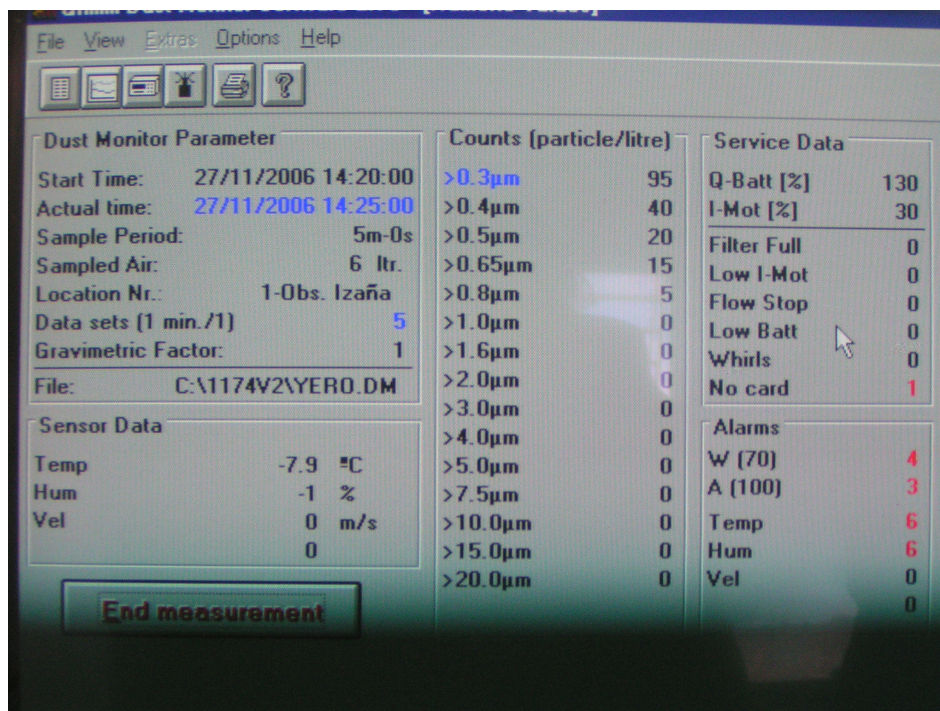


Fig.8: Particles per liter, Grimm OPC with absolute filter.

The fitting at the inlet of the instruments seems to leak. This fitting will be replaced by IZO staff as soon as possible.

After repair of the inlet fitting the OPC will be in good working condition

A TSI APS 3321 (SN 70638080 September 2006) has been recently acquired to measure number size distribution of accumulation and coarse mode particles at IZO. This instrument has only been operated for 1 week prior to the audit. The sheath air of the APS is dried by a silicagel drier.

We checked both flow rate and zero counts with an absolute filter. As expected the new APS had no zero counts with the filter and flow rates were adjusted properly (Flow 0.9857 l/min indicated flow rate 1 l/min).

The APS at IZO is in good working condition

Number size distribution of fine and ultrafine particles:

Measurements of number size distributions of fine and ultrafine particle number size distribution at IZO would be of great interest for closure studies on optical properties of the ambient aerosol. A TSI DMA type 3071A with a CPC 3010 is available at the site. Unfortunately this instrument is only usable after major modification and refitting of the instrument: The DMA SN 540 was manufactured 1996. After 10 years the aerosol neutralizer needs to be replaced. Furthermore, this type of instruments has severe design flaws (see Fig.9).

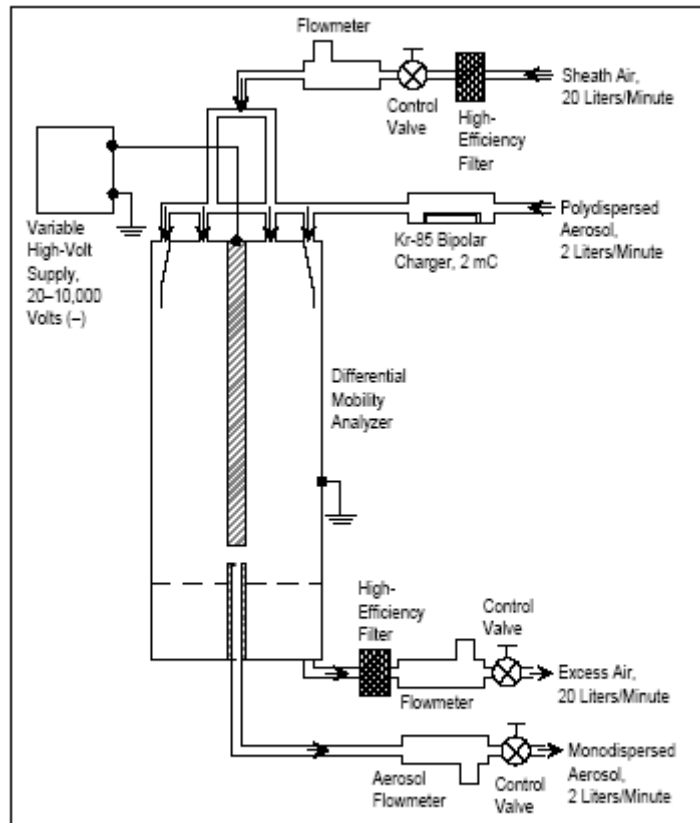


Figure 4-11
Airflow Schematic of the Classifier

Fig. 9: Schematic view of the DMA 3071A (copied from TSI 3071A manual)

- Flow design for underpressure operation makes flow control difficult.
- Hot wire anemometer in monodisperse air flow is responsible for particle losses and the sensor itself is subject to pollution by the aerosol.
- Control valve in monodisperse air flow causes particle losses.
- Relative humidity of the sheath air flow is not controlled

In order to make this DMA usable for measurements at IZO we recommend to rebuild the air flow system to a controlled closed loop system and to optimize all aerosol lines to reduce particle losses in the instrument. We suggest that the necessary modifications of the DMA should take place at the WCCAP in Leipzig. Actual modifications should be made by staff from IZO under supervision from WCCAP.

Summary and final remarks:

This audit was performed at the beginning of regular aerosol measurements for GAW at IZO. We were impressed by what has already been achieved. We are confident that with completion of the instrumentation IZO will be a very valuable station for GAW. Furthermore we expect interesting scientific results with respect to optical properties of both background aerosol and Saharan dust from this well equipped station. We wish to thank all persons involved in this audit for their hospitality and look forward to our next visit to Izaña.