Updated report of the in-situ aerosol program at Izaña, and feedback to the WCCAP report of the November 2006 audit

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P.I. of the in-situ aerosol program of Izaña GAW observatory

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The 27-28 of November 2006, the World Calibration Centre for Aerosol Physics (WCCAP) audited the in-situ aerosol program that was being implemented at Izaña Observatory as part of the Global Atmospheric Watch (GAW) program. As result, the WCCAP prepared the report entitled 'Site audit of IZO, GAW Global station, Izaña, Tenerife'.

This document has been prepared by request of the Scientific Advisory Group (SAG) of the GAW aerosols program. It includes updated information about the evolution of the in-situ aerosol program of Izaña GAW Observatory after the audit.

1. Overview

In-situ aerosol measurements within the frame of the Global Atmospheric Watch (GAW) program started at Izaña observatory at the end of November 2006. Previous measurements had been carried out within the frame of specific research projects (**AEROCE**: Prospero et al., 1995, Chiapello et al., 1999; ACE 2: Raes et al., 1997, Putaud et al., 2000; **I2A2**: Alastuey et al., 2005 or **MINATROC** EU funded project). These data are available in the data bases of the research groups that conducted the measurements (Izaña Atmospheric Research Centre, University of Miami, Joint Research Centre of the European Commission and the CSIC, among others).

In November 2006, the WCCAP carried out an audit of the new measurement program that was just starting. The audit was performed on 27-28 Nov 2006. The report was sent to us, Izaña's group, in Dec 2007. The audit was very helpful for us. We are very grateful to auditors for their very useful advices that allowed us to do adjustments and corrections just at the beginning of the regular activities within GAW. We are also very thanks to the World Calibration Centre for Aerosol Physics (WCCAP) for the assistance that have paid us in several times since the beginning of our activities, which have included help for repairing some instruments, support for participating in inter-comparisons at the Institute for Tropospheric Research (IfT) in Leipzig and advice for improvements.

Since the audit was carried out, the in-situ aerosol program of Izaña has experienced a significant development (Table 1). Izaña is already providing data, to the World Data Centre for Aerosols (WDCA), of total number concentration, size distribution of ultrafine and fine particles, absorption and scattering coefficient (Table 1). New measurements have been implemented within the specific research projects conducted with funds obtained by the Izaña's aerosol group, which includes light attenuation (aethalometer), absorption in the PM_1 fraction and chemical composition in the TSP and PM_1 fractions in the summer dust season when Izaña is into the Saharan Air Layer. The intention is that new instruments remain also working permanently at Izaña for long term purpose. Currently, all chemical composition data collected in Izaña (which goes back to 1987) are being revised and analysed within the frame of POLLINDUST.

The next sections provide a description of how the in-situ aerosol measurements program has evolved after the audit.

Table 1. Parameters that are currently been measured at Izaña observatory.

parameter	**Start date**	**Context of the measurements**	**Regular sent of data to WDCA ?**
Total number concentration	Jan 2007	GAW	YES
Absorption coefficient in PM_{10} fraction	Jan 2007	GAW	YES
Size distribution coarse particles	Jan 2007	GAW	NO. They will be sent after project POLLINDUST

After the audit

Size distribution fine and ultrafine	June 2008	GAW	YES
Scattering and back scattering coefficient in PM_{10} fraction	April 2008	GAW	YES
Chemical composition PM_{10} and $PM_{2.5}$	Jun 2007	GAW	NO. They will be sent after project POLLINDUST
Chemical composition TSP and PM_1 in the summer dust season.	August 2008	specific research project	NO. They will be sent after project POLLINDUST
Absorption coefficient in PM_1 fraction	August 2010	specific research project	NO. They will be sent after project POLLINDUST
Attenuation – aethalometer in the PM_{10} fraction	July 2012	specific research project	NO. They will be sent after project POLLINDUST

2. Update and response to specific sections of the audit report

In order to facilitate the traceability, this report has an identical structure that the 'Site audit of IZO, GAW Global station, Izaña, Tenerife' report prepared by WCCAP.

2.1 General remarks

As described in the WCCAP audit report, the in-situ aerosol measurements at Izaña within the GAW program started after the audit. In fact, this first WCCAP audit was conceived as an audit aimed at guiding the Izaña GAW aerosol program's start from previous measurement programs undertaken by various international projects.

Reply to specific comments and recommendations included in the WCCAP audit report:

- after the audit, routinely checks have been performed as follow:

  Twice per day: status of the instruments, leds and data acquisition software.

  Weekly: airflow with an external flow meter.

  Every 6 months: ZERO with an absolute filter.

- we have online access to control acquisition software and to access aerosol data since 2007.
- the new aerosol instruments were acquired as scheduled. This is an update to the Table 1 of the WCCAP audits report:
  - New automatic samplers for PM_{10} and $PM_{2.5}$ were acquired in 2007. Details are provided in section 2.6.
  - Chemical composition for PM_{10} and $PM_{2.5}$ is determined since 2007 within GAW.
  - Light absorption in the PM_{10} fraction. MAAP. Operative since Nov 2006. Already working during the audit.
  - Light scattering in the PM_{10} fraction with a TSI 3 wavelengths integrating nephelometer since 2008.
  - Size distribution 10 nm to 400 nm with a new TSI SMPS since 2008.
  - Total number concentration. CPCs 3025A and 30130 models (TSI) were already operative during the audit. Moreover, new CPC 3776 and 3772 units were installed in December 2012 for measuring in parallel to the new SMPS.

In addition to the new instruments listed above, measurements of the light attenuation in the PM_{10} fraction with an aethalometer and of the light absorption in the PM_1 fraction with a MAAP are being performed within the frame of a specific research project. These data will be sent to the WDCA in a future.

A picture of the aerosol laboratory taken during the audit in Nov 2006 is shown in Figure 1A. Figure 1B shows a picture of the same lab taken in September 2013. Observe the two new inlets of the PM_{10} and $PM_{2.5}$ samplers.

Figure 2 shows a picture inside the aerosol laboratory during the audit in Nov 2006 (Figure 2A) and in September 2013 (Figure 2B). Racks with new instruments are shown in Figure 2B1. New samplers are shown in Figure 2B2.

Figure 1A: aerosol laboratory (partilab) on 27 Nov 2006.

Figure 1B: particles laboratory (partilab) on 3 Sept 2013.

Figure2A. Aerosol Instrumentation in the aerosol laboratory on 27 Nov 2006.

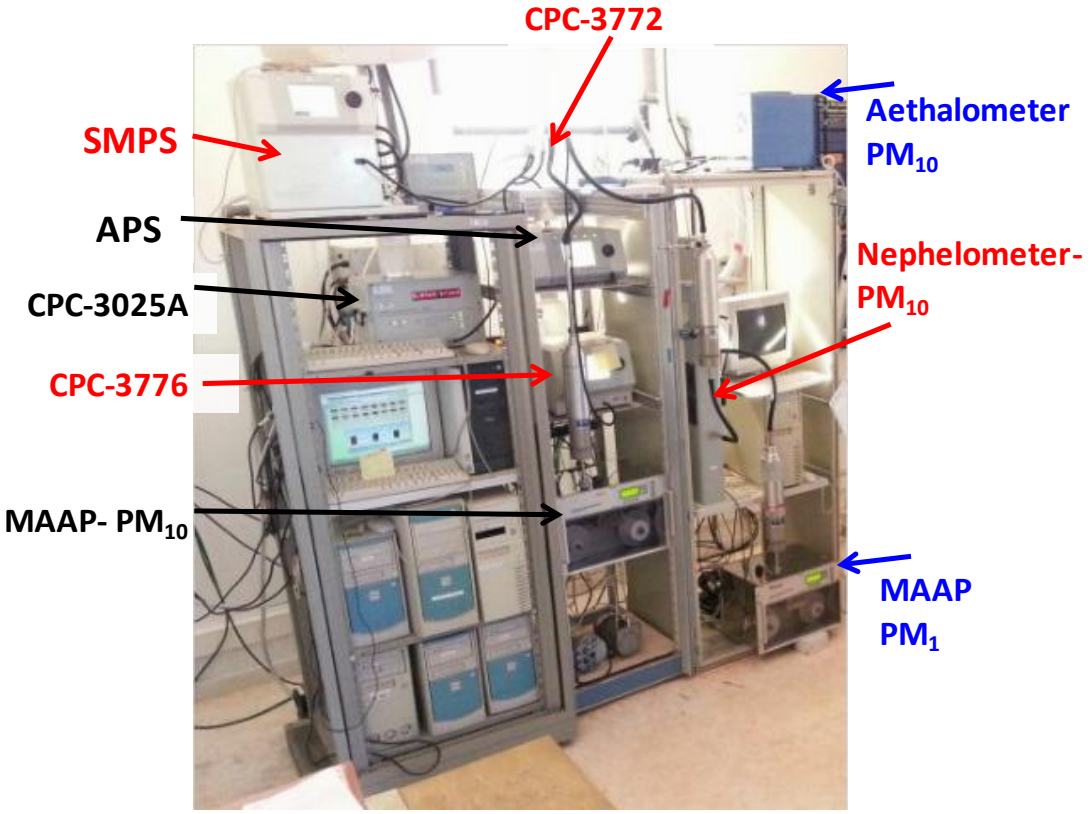

Figure2B1. Aerosol Instrumentation in the aerosols laboratory on 3 Sept 2013. **Black** letter is used for instruments that were already operative during the audit, **red** is used for instruments that were installed after the audit and that are already providing data to WDCA, and **blue** for new instruments that will provide data to the WDCA in a future.

Sampler of PM_{10} **Sampler of $PM_{2.5}$**

Figure2B2. Aerosol Instrumentation in the aerosols laboratory on 3 Sept 2013. New PM_{10} and $PM_{2.5}$ samplers (MCZ™ model HVS16), in use since 2007.

2.2 Aerosol inlet

The audit concluded that '**The whole design of the inlet system is in good agreement with recommendations by the SAG**'.

Thus, the aerosol inlet has not been modified. Following the advice of the auditors the plastic ring on the outer site of the inlet was removed. See a picture taken during the audit in Figure 3A and taken in Sept 2013 in Figure 3B.

Because of the regular low relative humidity conditions in the outdoor ambient air at Izaña (percentiles 25^{th}, 50^{th} and 75^{th} = 15%, 31% and 55%, respectively), driers are not used. Sensors of RH, T and P are installed in the aerosol inlet. The aerosol laboratory is kept to an indoor temperature of 22ºC. Because this temperature is higher than that of the outdoor ambient air during most of year, RH into the aerosol inlet is lower than in the outdoor ambient air. In July-August, outdoor temperature may reach up to 28ºC (up to 6 degrees higher than outdoor); however, because of the very dry air conditions outdoors, no significant increases in RH into the aerosol inlet are observed. Figure 3C shows, as example the 2011 data. RH in the aerosol inlet is < 40% during most of the year (Table 2). Data recorded with an internal RH into the instruments has not been submitted to EBAS. However, these will be submitted in a future reporting (flags) that internal RH was higher than 40%.

Figure 3A: Inlet of the aerosol laboratory. Picture made the 27 Nov 2006.

Figure 3B: Inlet of the aerosol laboratory. Picture made the 3 September 2013.

Table 2. Report of the data submitted to EBAS every year. The amount of data collected with an internal relative humidity (RH) into each instrument > 40% is reported as percentage of the 1 year period.

		Data already available in EBAS		Data not submitted to EBAS		
Abs coef MAAP	**period**	**N hourly data**	**% of 1 year period**	**N hourly data**	**% of 1 year period**	**RH (inst) > 40% % of 1 year**
2006	Nov-Dic	650	7.4	814	9.3	7.5
2007	1 year	6398	73.0	2362	27.0	8.3
2008	1 year	6218	71.0	2542	29.0	11.0
2009	1 year	6599	75.3	2161	24.7	9.7
2010	1 year	6047	69.0	2713	31.0	14.4
2011	1 year	6431	73.4	2329	26.6	10.0
2012	1 year	7417	84.7	1367	15.6	0.1

Scat coef NEPH	**period**	**N hourly data**	**% of 1 year period**	**N hourly data**	**% of 1 year period**	**RH (inst) > 40% % of 1 year**
2008	Mar-Dec	4918	56.1	3866	44.1	2.7
2009	1 year	3489	39.8	4889	55.8	0.5
2010	1 year	4441	50.7	4342	49.6	1.2
2011	1 year	5465	62.4	3295	37.6	1.5
2012	1 year	4369	49.9	4415	50.4	0.1

size distribution SMPS	**period**	**N hourly data**	**% of 1 year period**	**N hourly data**	**% of 1 year period**	**RH (inst) > 40% % of 1 year**
2008	Jul-Dec	3369	38.5	5691	65.0	5.6
2009	1 year	6236	71.2	2524	28.8	8.4
2010	1 year	4802	54.8	3958	45.2	11.9
2011	1 year	4115	47.0	4645	53.0	4.2
2012	1 year	7321	83.6	1463	16.7	0.1

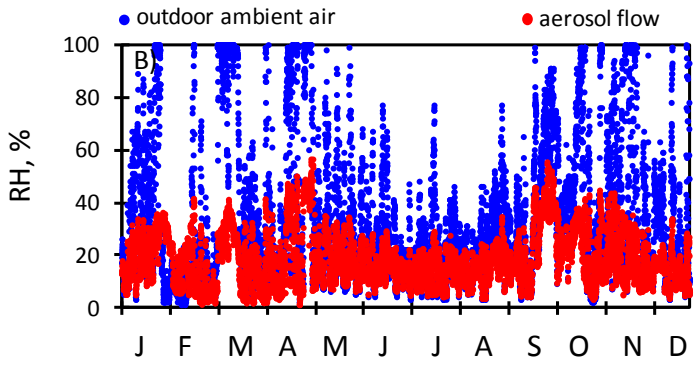

Figure 3C: Relative humidity (a) in the outdoor ambient air at Izaña and (b) in the aerosol flow of the aerosol laboratory inlet. Hourly data of 2011.

2.3 Primary flow standard

When the audit was carried out we only had 1 external flowmeter (gilibrator). Following the recommendation of the auditors, we acquired 3 more gilibrators. Since 2008, there are 4 gilibrators in the aerosol laboratory of Izaña (Figure 4):

S/N of the Izaña aersol group's gilibrators:

GIL-1, S/N: 0511065.

GIL-2, S/N: 0706007.

GIL-3, S/N: 0706006.

GIL-4, S/N: 0801017.

Figure 4. Gilibrators in the aerosol laboratory.

Moreover, 3 new external flow-meters for calibration of the new PM_{10} and $PM_{2.5}$ samplers (operated at 30 m^3/h) are available (Figure 5). These are always available in the aerosol laboratory of Izaña. Figure 5 shows a picture taken in December 2008 during a regular airflow check of the PM samplers using one of these new external flowmeters.

Figure 5. External flow-meter connected to the inlet of PM_{10} sampler. December 2008.

2.4 Measurement of the absorption coefficient

The audit concluded that '**The MAAP at IZO is in good working condition**'.

This MAAP (SN 050) has been checked and calibrated regularly (Figure 6). We have also done several intercomparisons with other MAAP units. Data are being submitted to the WDCA yearly. This MAAP unit was calibrated and intercompared at the WCCAP in 2005.

Data collected with this instrument has been used in scientific studies:

- Müller, T., Henzing, J.S., de Leeuw, G., Wiedensohler, A., Alastuey, A., Angelov, H., Bizjak, M., Collaud Coen, M., Engström, J.E., Gruening, C., Hillamo, R., Hoffer, A., Imre, K., Ivanow, P., Jennings, G., Sun, J.Y., Kalivitis, N., Karlsson, H., Komppula, M., Laj, P., Li, S.-M., Lunder, C., Marinoni, A., Martins dos Santos, S., Moerman, M., Nowak, A., Ogren, J.A., Petzold, A., Pichon, J.M., Rodriquez, S., Sharma, S., Sheridan, P.J., Teinilä, K., Tuch, T., Viana, M., Virkkula, A., Weingartner, E., Wilhelm, R., Wang, Y.Q., 2011. Characterization and intercomparison of aerosol absorption photometers: result of two intercomparison workshops. Atmos. Meas. Tech. 4, 245–268. http://www.atmos-meas-tech.net/4/245/2011/amt-4-245-2011.pdf
- Andrews, E., J.A. Ogren, P. Bonasoni, A. Marinoni, E. Cuevas, S. Rodríguez, J.Y. Sune, D.A. Jaffe, E.V. Fischer, U. Baltensperger, E. Weingartner, M. Collaud Coen, S. Sharma, A.M. Macdonald, W.R. Leaitch, N.-H. Link, P. Laj, T. Arsov, I. Kalapov, A. Jefferson, b, P. Sherida. Climatology of aerosol radiative properties in the free troposphere. Atmospheric Research 102 (2011) 365–393. http://www.sciencedirect.com/science/article/pii/S0169809511002857

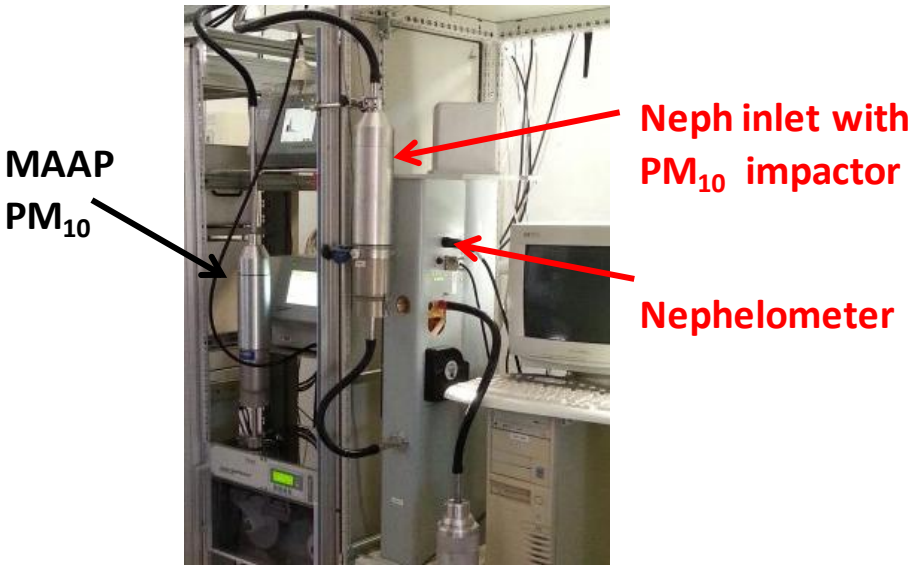

Figure 6. TSI Integrating Nephelometer installed in Izaña since 2008.

2.5 Scattering Coefficient

The Radiance Research Nephelometer that appears in the audit report (belonging to an American group) has not been used.

A new TSI Integrating Nephelometer (SN 70738230) was installed in 2008. Following the recommendation of the auditors, an adaptor to place a PM_{10} impactor similar to that we did for the MAAP was installed with the nephelometer (Figure 6). Data are being submitted to the WDCA yearly.

Data have been used in scientific studies:

Andrews, E., J.A. Ogren, P. Bonasoni, A. Marinoni, E. Cuevas, S. Rodríguez, J.Y. Sune, D.A. Jaffe, E.V. Fischer, U. Baltensperger, E. Weingartner, M. Collaud Coen, S. Sharma, A.M. Macdonald, W.R. Leaitch, N.-H. Link, P. Laj, T. Arsov, I. Kalapov, A. Jefferson, b, P. Sherida. Climatology of aerosol radiative properties in the free troposphere. Atmospheric Research 102 (2011) 365–393. http://www.sciencedirect.com/science/article/pii/S0169809511002857

2.6 Mass concentration

Prior to start GAW activities, measurements of mass concentration and chemical composition in Izaña were performed in the frame of research projects. In the period 1987 – 1999, measurements were performed in collaboration with J.M. Prospero (Univ. of Miami). In the period 2002-2006, measurements were performed in collaboration with Xavier Querol and Andres Alastuey (Research Council of Spain; CSIC). Since 2007, measurements are performed, with new automatic samplers, by the Izaña's group and the chemical analysis by the group of CSIC (Andres Alastuey and Xavier Querol). These data has never been submitted to the WDCA. Just a brief description of the sampling and methods.

2.6.1 Period 2002 – 2006

In this period, measurements of the mass concentration and chemical characterization were performed within the frame of specific research projects. In fact, these data have never been sent to the WDCA.

Sampling and chemical characterization was performed in the TSP and $PM_{2.5}$ fractions from 2002 to 2004, and in the PM_{10} and $PM_{2.5}$ fractions from 2005 to 2006. The sampling was performed with samplers MCV™ model CAV-A. Weighting of filters and chemical characterization were carried out by the group of CSIC (www.idaea.csic.es), headed by Andres Alastuey (andres.alastuey@idaea.csic.es) and Xavier Querol (xavier.querol@idaea.csic.es) in Barcelona. Those samplers were owned by this group of CSIC. Those measurements were performed within the frame of specific research projects (e.g. I2A2), in some occasions in collaboration with EU funded projects, such as MINATROC (Alastuey et al., 2005). In that period, the checking and calibration of the samplers were performed by the manufacturer (MCV™), under specific requests of the owners of the samplers (group of CSIC). Samplers were replaced at least once, and subject to airflow calibration several times by the manufacturer (MCV™). Data collected during this period were published in scientific papers:

- Rodríguez, S., A. Alastuey, S. Alonso-Pérez, X. Querol, E. Cuevas, J. Abreu-Afonso, M. Viana, M. Pandolfi, and J. de la Rosa. Transport of desert dust mixed with North African industrial pollutants in the subtropical Saharan Air Layer. Atmospheric Chemistry and Physics, 11, 6663 – 6685, 2011.
- X. Querol, A. Alastuey, M. Viana, T. Moreno, C. Reche, M. C. Minguillón, A. Ripoll, M. Pandolfi, F. Amato, A. Karanasiou, N. Pérez, J. Pey, M. Cusack, R. V´azquez, F. Plana, M. Dall'Osto, J. de la Rosa, A. Sánchez de la Campa, R. Fernández-Camacho, S. Rodríguez, C. Pio, L. Alados-Arboledas, G. Titos, B. Artíñano, P. Salvador, S. García Dos Santos, and R. Fernández Patier. Variability of carbonaceous aerosols in remote, rural, urban and industrial environments in Spain: implications for air quality policy. Atmospheric Chemistry and Physics, 13, 6185–6206, 2013.
- Alastuey, A., Querol, X., Castillo, S., Escudero, M., Avila, A., Cuevas, E., Torres, C., P.M. Romero, Exposito, F., García, O., Díaz, J.P., Van Dingenen, R., Putaud, J.P.: Characterisation of TSP and PM2.5 at Izaña and Santa Cruz de Tenerife (Canary Islands, Spain) during a Saharan Dust Episode (July 2002). Atmospheric Environment 39, 4715–4728, 2005.

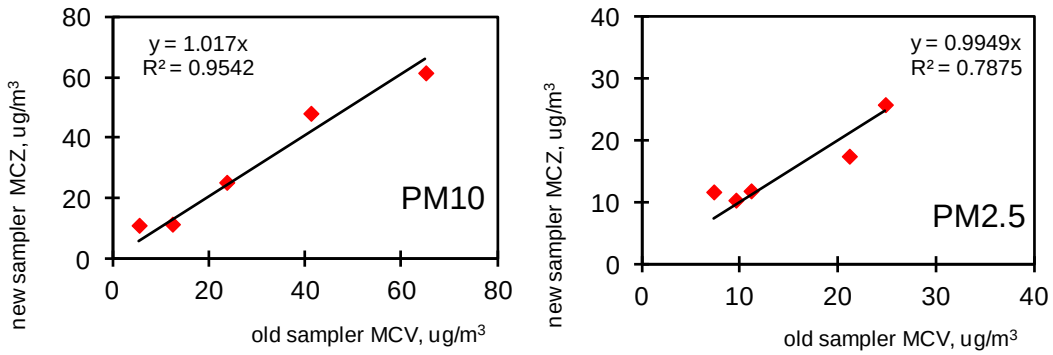

Figure 8. Intercomparison between PM_{10} and $PM_{2.5}$ concentrations determined by sampling with new sampler (MCZ™) and old samplers (MCV™). This intercomparison was carried out from 30 July to 14 August 2007 at Izaña observatory.

2.6.2 Period 2007 to present time

Since 2007, measurements of mass concentration and chemical composition at Izaña are performed in the following PM_x size fractions:

- PM_{10} and $PM_{2.5}$ through the year with new automatic samplers,
- TSP only in the summer dust season (August) when Izaña is within the Saharan Air Layer,
- PM_1 only in the summer dust season (August) when Izaña is within the Saharan Air Layer,

Sampling of PM_x is being performed with new samplers, MCZ™ model HVS16. See these samplers in Figure 2B2 and the inlets in Figure 1B. As part of the QA/QC activities, in summer 2007 we did an inter-comparison between the old MCV™ samplers and the new MCZ™ sampler. Results showed that the discrepancy between PM_x concentrations collected with the new and old samplers were sampler than < 2% (Figure 8).

Chemical analysis is carried out by the group headed by Andres Alastuey and Xavier Querol, CSIC in Barcelona, as in the 2002-2006 period. The sampling and analysis protocol includes collection and analysis of blank filed filters.

Novel issues since 2007 include:

1. .The airflow of the new samplers is checked once per week with an external airflow-meter. The new external flow-meters use the sample principle of measurement than the internal flow-meters of the samplers (pressure drop across orifice plate). The Izaña's group has 3 of these flow-meters (Figure 5).
2. An intercomparisons between samplers are performed as part of the QA/QC activities in summer (i.e. TSP vs TSP, PM_{10} vs PM_{10}, $PM_{2.5}$ vs $PM_{2.5}$; Figure 9).
3. The weighting of filters is being performed by the Izaña group in a weighting room located in Santa Cruz de Tenerife (Figure 10). The Standard Operation Procedure for the conditioning and weighting of filters is similar to that described by the EN-14907, except for RH which is maintained within the range 30-35% (our laboratory is not certificated to EN-ISO 14907, we just use the process described there). RH in the ambient air of Izaña is usually lower than the 50% (percentiles 25^{th}, 50^{th} and 75^{th} for hourly values of RH = 15%, 31% and 55%, respectively). This is the reason to condition the filters to a RH within the range 30-35%, i.e. lower than the 50% value that appears in the EN-ISO 14907. The conditioning of the filters to a RH within the range 30-35% has another advantage; these RH values are within the range of the RH at which the measurements of size distribution, of scattering and of absorption are performed (only data measured with a RH in the aerosol sampling line < 40% are sent to WDCA). This contributes to the consistency of the all aerosol measurements in Izaña. Some pictures of the weighing room with some dust filters collected at Izaña are shown in Figure 10. Some details about the weighing room: the whole room is conditioned to 20ºC and a RH 30-35%. A drier is used for reducing RH into the ambient air into the room (condensed water is stored in a close container). Filters and balance are placed into a box of methacrylate. T and RH are measured inside and outside of the methacrylate box on a continuous basis. Air from the room is conducted through a filter and through silica gel (with a pump) into the methacrylate box (regularly they are similar). Checking blank filters are always kept into the methacrylate box as the EN 14907 requests.

Figure 9. Pictures taken during in August 2013. Red colour indicates the location of the samplers used throughout the year. Black colour indicates additional samplers that are only operative in summer dust season.

Figure 10. Weighing room of the Izaña group. Santa Cruz de Tenerife.

2.6.3 Additional information on the chemical composition measurements

Within the frame of the research project POLLINDUST (CGL2011-26259; funded by Minister of Economy and Competitiveness of Spain) all data of chemical composition collected at Izaña since 1987 are being analysed for studying how dust exportation at subtropical latitudes have evolved during the last two and a half decades. Several data sets have been joined to obtain the time series of dust from 1987 to present time at Izaña:

- 1987-1999: chemical composition (dust, Al and ions) of TSP, sampling by staff of Izaña and chemical analysis by J.M. Prospero (Univ. of Miami). Sampler provided by J.M. Prospero.
- 2002-2004: chemical composition (elemental composition, ions, total carbon) of TSP and $PM_{2.5}$. Samplers MCV™.
- 2005-2006: chemical composition (elemental composition, ions, total carbon) of PM_{10} and $PM_{2.5}$. Samplers MCV™
- 2007: chemical composition (elemental composition, ions, total carbon, OC and EC) of PM_{10} and $PM_{2.5}$. Samplers MCZ™.
- 2008-up to date: chemical composition (elemental composition, ions, OC and EC) of PM_{10} and $PM_{2.5}$ throughout the year and of TSP and PM_1 in summer (when Izaña is within the Saharan Air Layer). Samplers MCZ™.

All the data set has allowed obtaining dust records at Izaña from 1987 to 2012. The time series is shown in Figure 11. We recently did a review of the programs that are conducting long term records of in-situ aerosol dust concentrations (Figure 12; Rodríguez et al., 2012; A review of methods for long term in situ characterization of aerosol dust; *Aeolian Research* 6, 55–74). The review showed that only four remote sites have been recording in-situ dust (based on chemical composition) downwind of a dust source region during the last two and a half decades. Moreover, in-situ dust observations at Izaña have several features:

1. Izaña has the fourth longest record of aerosol dust (since 1987), after Barbados (since 1965), Miami (since 1978) and American Samoa (1983).
2. These observations constitute the longest in-situ dust records in the free troposphere downwind of Sahara.
3. Nowadays, in-situ dust observations at Izaña provide more than a decade (since 2002) record of elemental composition and dust concentrations in several size fractions.

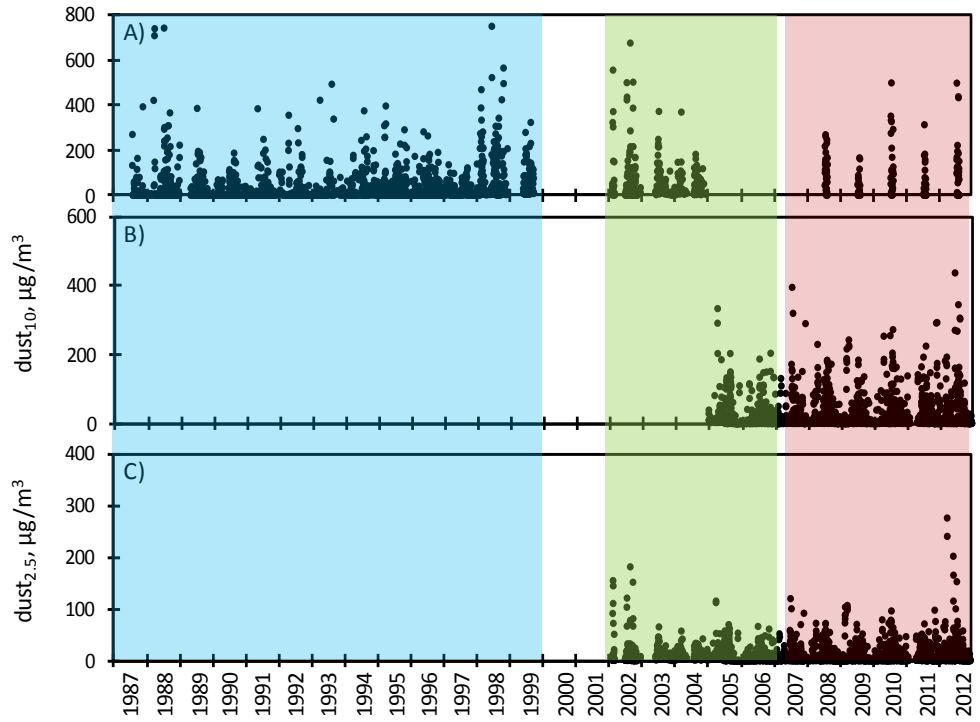

Figure 11. Time series of total dust ($dust_T$) and of dust in the PM_{10} ($dust_{10}$) and in the $PM_{2.5}$ ($dust_{2.5}$) fractions at Izaña. Background colours indicate use of different samplers: Univ. Of Miami (blue), MCV™(green) and MCZ™(red).

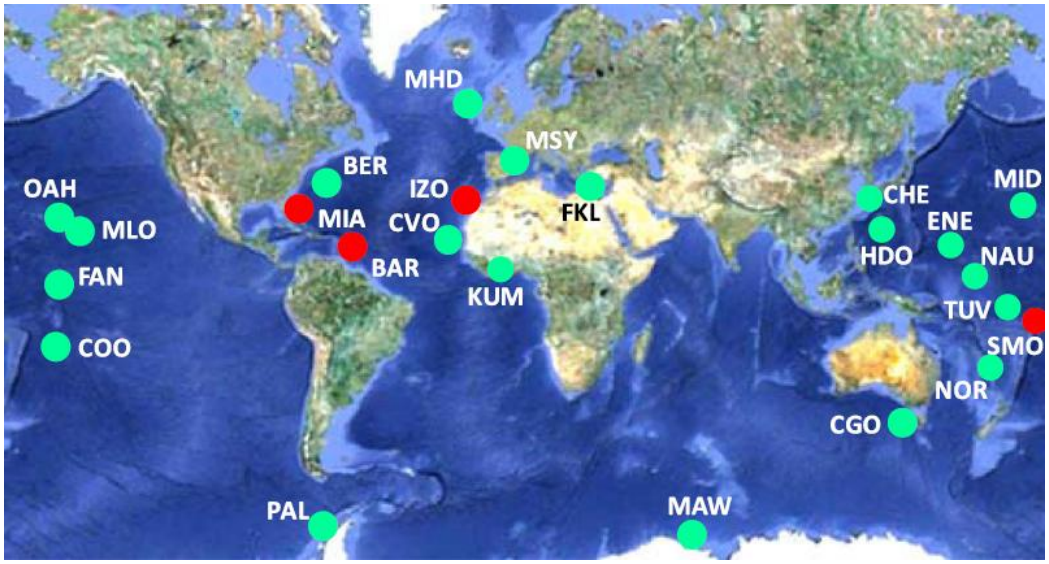

Figure 12. Green circle: location of the atmospheric remote/background observatories where long term in situ measurements of aerosol dust have been performed during at least 4 years. Red circle: sites active during at least the last two decades. Source: Rodríguez et al. (2012).

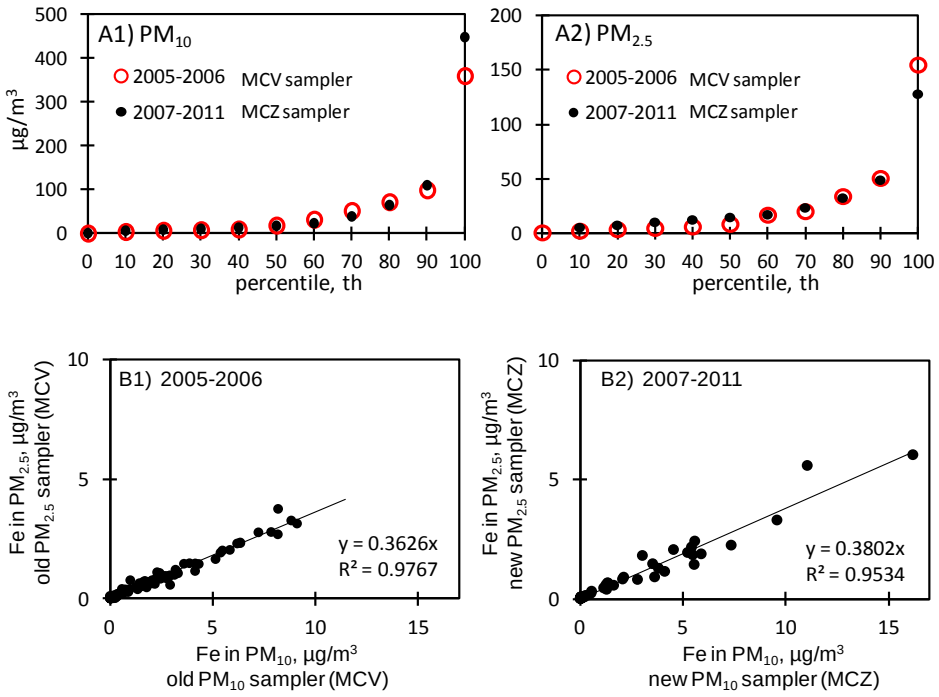

Figure 13. A) Percentile distribution of PM_{10} and $PM_{2.5}$ at Izaña in the periods 2005-2006 and 2007-2011 when different sampler were used. B) Scatter plot of iron in $PM_{2.5}$ versus PM_{10} at Izaña in the periods 2005-2006 and 2007-2011 when different sampler were used

Because different samplers have been used along time, some consistency analysis has been performed in the resulting data set (1987 to present). For example:

1. Figure 13A shows the percentiles distribution of PM_{10} and $PM_{2.5}$ concentrations in periods when different sampler were used: 2005-2006 with MCV™ sampler (Figure 13A1) and 2007-2011 with MCZ™ sampler (Figure 13A1).

2. Figure 13B shows the scatter plot of iron in the $PM_{2.5}$ versus iron in the PM_{10} fraction in samples collected with different sampler. No significant differences are observed in the slope.

2.7 Aerosol number concentration

When the audit was carried out, the Izaña's group owned only two CPCs: a CPC 3010 (SN: 70431239) and a CPC 3025A unit (SN: 1160). The audit concluded that '**The CPCs at Izaña are in good working condition**'.

Correction to the SN that appears in the audit report. In the audit reports it appears that the serial number (SN) of our CPC 3025A as 1267. I confirm that Izaña has not any CPC with such SN; most probably the SN that appears in the audit report was mixed was mixed up with that from other GAW observatory. The Izaña's CPC 3025A is SN1160. This unit was calibrated at the WCCAP in 2002 (SN 1160), as can be confirmed in the inter-comparison report.

After the audit, the CPCs 3010 and 3025A of Izaña are being subject to regular checks and calibrations. Data are being submitted to the WDCA yearly. Moreover, data have been used in scientific studies:

- García, M. I., Rodríguez, S., González, Y., García, R. D., 2014. Climatology of new particle formation at Izaña mountain GAW observatory in the subtropical North Atlantic. Atmos. Chem. Phys. Discuss., 13, 24127–24169, 2013. http://www.atmos-chem-phys-discuss.net/13/24127/2013/acpd-13-24127-2013.pdf In press in Atmos. Chem. Phys. (already accepted).
- Rodríguez, S., González, Y., Cuevas, E., Ramos, R., Romero, P.M., Abreu-Afonso, J., Redondas, A., 2009. Atmospheric nanoparticle observations in the low free troposphere during upward orographic flows at Izaña Mountain Observatory. Atmos. Chem. Phys. 9, 6319–6335. http://www.atmos-chem-phys.net/9/6319/2009/acp-9-6319-2009.pdf
- Levels and origin of reactive gases and their relationship with aerosols in the proximity of the emission sources and in the free troposphere at Tenerife. PhD Thesis. University of La Laguna. May 2012. http://izana.aemet.es/images/stories/news/imgnews2012/TESIS-YENNY-GONZALEZ-RAMOS.pdf

In Sept 2011, the CPC3010 unit operating in Izaña participated in the CPCs intercomparison that took place in the WCCAP. Since 2008, this CP unit operates with the SMPS.

In December 2012, two new CPCs were installed in Izaña (Figure 2B1):

- a ultrafine CPC 3776 (SN 3776124301) unit that run in parallel to the ultrafine 3025A unit (SN: 1160)
- a CPC 3772 (SN 3772124204) unit that run in parallel to the new SMPS

2.8 Optical particle counter and APS

The auditors recommend us to replace the inlet of the OPC in order to avoid a leak (GRIMM, model 1.108 SN: 8F008). This replacement was done in few weeks after the audit. However this OPC has not been used for long term measurements. The audit concluded that '**After repair of the inlet fitting the OPC will be in good working condition**'. We have used this OPC just for some campaigns.

The instrument that has been used for long term measurements of size distribution of fine and coarse particles is an APS 3321 unit. (SN 70638080 September 2006). The audit concluded that '**The APS at IZO is in good working condition**'. The APS has been checked and calibrated regularly. Data are not being sent to WDCA, but will be sent together with the chemical composition data.

2.9 Number size distribution of fine and ultrafine particles

The old DMA that appears in the audit's report (TSI model 3071A) has not been used. In 2008, a new TSI SMPS was acquired (model 3080; SN 70813087). This is operated with the CPC 3010 (SN: 70431239) that was already in Izaña during the audit. The SMPS is subject to these weekly checks:

1. aerosol and sheath/excess airflows,
2. leak checks by setting zero volts in the DMA and checking that there are not absolute counts in the CPC,
3. leak checks by placing an absolute filter and making a voltage scan in the DMA,

Currently, the instrument is a transition to adapt the configuration of the SMPS to the ACTRIS recommendations (T, RH and P sensors in the inlet and the RH and T sensors are still missing, according to Wiedensohler et al., 2012). This SMPS participated in the calibration and inter-comparison activities carried out within the framework of the REDMAAS project in 2010 and 2012 (www.redmaas.com), which included calibration of the DMA measuring mono-disperse PLS (80 and 190nm) and inter-comparison with other SMPSs measuring ambient air. Details about the results of these activities are presented in:

F. J. Gómez-Moreno, E. Alonso, B. Artíñano, V. Juncal Bello, M. Piñeiro Iglesias, P. López Mahía, N. Pérez, J. Pey, A. Alastuey, B. A. de la Morena, M. I. García, S. Rodríguez, M. Sorribas,, G. Titos,, H. Lyamani, and L. Alados-Arboledas. The Spanish network on environmental DMAs: the 2012 SMPS+UFP intercomparison campaign and study on particle losses in dryers. European Aerosol Conference. Prague, 1-6 September 2013.

F. J. Gómez-Moreno, M. Sastre, B. Artíñano, V. Juncal Bello, M. Piñeiro Iglesias, P. López Mahía, J. Pey, A. Ripoll, A. Alastuey, M. Sorribas, M. Fernández, B. A. de la Morena, J. L. Trujillo de Cabo, S. Rodríguez. Main activities of the Spanish network on environmental DMAs. European Aerosol Conference 2011. Manchester, UK. 4 - 9 September 2011.

2.10 Summary and final remarks

We thanks to the auditor for the very positive comments in this section.

3. Acknowledgments

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Putaud, J.P., R.V. Dingenen, M. Mangoni, A. Virkkula, F. Raes, H. Maring, J.M. Prospero, E. Swietlicki, O.H. Berg, R. Hillamo, T. Mäkela. Chemical mass closure and assessment of the origin of the submicron aerosol in the marine boundary layer at Tenerife during ACE- 2. Tellus 52B, 141-168, 2000.

Raes, F., Van Dingenen, R., Cuevas, E., Van Velthoven, F.J.V., Prospero, J.M.: Observations of aerosols in the free troposphere and marine boundary layer of the subtropical Northeast Atlantic: discussion of processes determining their size distribution. Journal of Geophysical Research, 102, 21315-21328, 1997.

Rodríguez et al., 2012; A review of methods for long term in situ characterization of aerosol dust; Aeolian Research 6, 55–74.