



This discussion paper is/has been under review for the journal Atmospheric Chemistry and Physics (ACP). Please refer to the corresponding final paper in ACP if available.

Chemical characterization of submicron regional background aerosols in the Western Mediterranean using an Aerosol Chemical Speciation Monitor

M. C. Minguillón¹, A. Ripoll^{1,2}, N. Pérez¹, A. S. H. Prévôt³, F. Canonaco³, X. Querol¹, and A. Alastuey¹

¹Institute of Environmental Assessment and Water Research (IDAEA-CSIC), Jordi Girona 18-26, Barcelona, 08034, Spain

²Departament d'Astronomia i Meteorologia, Universitat de Barcelona, Martí i Franquès 1, 08028, Barcelona, Spain

³Paul Scherrer Institute, Laboratory of Atmospheric Chemistry, 5232 Villigen PSI, Switzerland

Received: 8 December 2014 – Accepted: 18 December 2014 – Published: 12 January 2015

Correspondence to: M. C. Minguillón (mariacruz.minguillon@idaea.csic.es)

Published by Copernicus Publications on behalf of the European Geosciences Union.

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



Abstract

An Aerosol Chemical Speciation Monitor (ACSM, Aerodyne Research Inc.) was deployed at Montseny (MSY, 720 m a.s.l.) regional background site in the Western Mediterranean from June 2012 to July 2013 to measure real-time inorganic (nitrate, sulphate, ammonium and chloride) and organic submicron aerosol concentrations. Co-located measurements were also carried out including real-time submicron particulate matter (PM₁) and black carbon (BC) concentrations, and off-line PM₁ chemical analysis. This is one of the few studies that compare ACSM data with off-line PM₁ measurements, avoiding the tail of the coarse mode included in the PM_{2.5} fraction. The ACSM + BC concentrations agreed with the PM₁ measurements, and strong correlation was found between the concentrations of ACSM species and the off-line measurements, although some discrepancies remain unexplained. Results point to a current underestimation of the relative ionization efficiency (RIE) established for organic aerosol (OA), which should be revised in the future. The OA was the major component of submicron aerosol (53 % of PM₁), with a higher contribution in summer (58 % of PM₁) than in winter (45 % of PM₁). Source apportionment of OA was carried out by applying Positive Matrix Factorization (PMF) using the Multilinear Engine (ME-2) to the organic mass spectral data matrix. Three sources were identified in summer: hydrocarbon-like OA (HOA), low-volatile oxygenated OA (LV-OOA), and semi-volatile oxygenated OA (SV-OOA). The secondary OA (SOA, 4.7 µg m⁻³, sum of LV-OOA and SV-OOA) accounted for 85 % of the total OA and its formation during daytime (mainly SV-OOA) was estimated to be 1.1 µg m⁻³. In winter, HOA was also identified (12 % of OA), a contribution from biomass burning OA was included, and it was not possible to differentiate two different SOA factors but a single OOA factor was resolved. The OOA contribution represented the 60 % of the total OA, with a degree of oxidation higher than both OOA summer factors. An intense wildfire episode was studied obtaining a region-specific BBOA profile.

ACPD

15, 965–1000, 2015

One year ACSM at Montseny regional background site

M. C. Minguillón et al.

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



1 Introduction

Ambient aerosols have adverse effects on human health (Pope III and Dockery, 2006), and affect climate (IPCC, 2013), ecosystems, crops, and regional visibility. Fine particulate matter (PM₁, particles with an aerodynamic diameter < 1 µm) contains substantial fractions of inorganic compounds and carbonaceous aerosols, the latter reaching up to 90 % of the mass (Jimenez et al., 2009). Carbonaceous aerosols comprise organic compounds, collectively referred to as organic aerosol (OA), elemental carbon (EC), and carbonates (from mineral dust), although the latter can be considered negligible in submicron aerosols.

The Western Mediterranean Basin (WMB) has special atmospheric and geographic characteristics that imply the interest of the detailed study of the ambient aerosols in this area (Querol et al., 2009). The regional background has been investigated through long data series of measurements in previous studies available at Montseny (representative of the regional background in the WMB). Pérez et al. (2008) found average particulate matter concentrations at Montseny of 17, 13 and 11 µg m⁻³ of PM₁₀, PM_{2.5} and PM₁, respectively, in the 2002–2007 period. Cusack et al. (2012) and Querol et al. (2014) found a decreasing trend in PM_{2.5} concentrations from 2001 to 2012 of -0.39 µg m⁻³ per year. PM_{2.5} concentrations were found higher in the WMB than at other rural background sites across Spain, Portugal, Germany and Scandinavia but lower than those measured in Switzerland, Italy and Austria (Cusack et al., 2012). The prevailing daily evolution is driven by the breeze circulation (mountain and sea breezes), with lower PM_x concentrations at night owing to the nocturnal drainage flows, and higher PM_x concentrations at midday owing to the transport of atmospheric pollutants accumulated in the pre-coastal depression upwards by the breeze (Pérez et al., 2008). Maximum PM₁₀ concentrations were found in summer, February–March and November, and sporadic PM_x increases may be recorded under anticyclonic conditions (Pey et al., 2010). The chemical composition of PM_{2.5} is characterised by high concentrations of organic aerosol and sulphate, followed by crustal material, nitrate and am-

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



literature (Ng et al., 2011b; Sun et al., 2012, 2013a, b; Budisulistiorini et al., 2013; Canonaco et al., 2013, 2014; Carbone et al., 2013; Takahama et al., 2013; Bougiatioti et al., 2014; Petit et al., 2014; Ripoll et al., 2014a).

The present study aims at interpreting a one-year time series of inorganic and organic compounds in the submicron aerosol in the regional WMB, with special focus on their evolution throughout the year as a function of the concatenation of different atmospheric scenarios. The different types and origin of organic aerosol (OA) are also investigated. To this end, an ACSM was deployed for a year in the regional background site of Montseny (MSY), according to the schedule planned within the Aerosols, Clouds, and Trace gases Research InfraStructure (ACTRIS) Network project. Moreover, a validation of the ACSM data is carried out by comparison with co-located instruments both real-time and off-line.

2 Methodology

2.1 Sampling site

The MSY station (41°46'46" N, 02°21'29" E, 720 m a.s.l.) is located in the Montseny natural park, in a densely forested area, 50 km to the N–NE of the Barcelona urban area, and 25 km from the Mediterranean coast. The station is located on the upper walls of a valley extending perpendicularly from the Catalan Pre-Coastal ranges to the coast. The site is relatively far from urban and industrial areas, but it can be affected by anthropogenic emissions transported from populated and industrialised areas under specific meteorological conditions. The MSY station is in the ACTRIS Network (formerly EUSAAR, European Supersites for Atmospheric Aerosol Research), is a Global Atmosphere Watch (GAW) site, and is part of the IDAEA-CSIC and the Department of Environment of the Autonomous Government of Catalonia air quality monitoring network.

One year ACSM at Montseny regional background site

M. C. Minguillón et al.

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



**One year ACSM at
Montseny regional
background site**

M. C. Minguillón et al.

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



The prevailing atmospheric dynamics has been described elsewhere (Pérez et al., 2008; Pey et al., 2009). Briefly, in winter the location of the Azores high favours the entry of clean Atlantic air masses into the WMB which replace the existing air masses leading to a decrease of pollutants concentrations. In summer, the very weak pressure gradients result in local circulations dominating the atmospheric dynamics with the consequent accumulation of pollutants (Millán et al., 1997). The climate is typical Mediterranean with warm summers, temperate winters and irregular precipitation rates during the year.

The daily classification of meteorological episodes affecting MSY during the study period was made as described in Pérez et al. (2008), leading to the following types of scenario: Atlantic Advection, North African, Mediterranean, European, Regional, and Winter Anticyclonic Episodes. The frequency of each type of scenario for each of the months of the study period is shown in Fig. S1 in the Supplement.

2.2 ACSM settings, calibrations and data processing

An ACSM was deployed from June 2012 to July 2013, according to the ACTRIS schedule, to measure non-refractory submicron aerosol species (organics, nitrate, sulphate, ammonium and chloride) in real-time (Ng et al., 2011b). Briefly, the instrument uses an aerodynamic lens to sample and focus submicron particles (75–650 nm) into a narrow particle beam (Liu et al., 2007), with a flow of approximately 85 cc min^{-1} . The beam is transmitted into the final of three vacuum chambers, where particulate matter is flash-vaporized on a hot oven (600°C), ionized by hard electron impact ionization (70 eV) and subsequently detected using a commercial quadrupole mass spectrometer. The concentration of the aforementioned species is calculated based on the measured aerosol mass spectra. For a given species, its concentration is calculated based on the addition of the ion signals at each of its mass spectral fragments and its ionization efficiency (IE) (Canagaratna et al., 2007). Since calibration of IEs for all ambient species is not feasible, the relative ionization efficiency (RIE) (compared to that of nitrate) is used for different species.

**One year ACSM at
Montseny regional
background site**

M. C. Minguillón et al.

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



Thus, mass calibration of the ACSM is based on determining the instrument response factor (RF) using ammonium nitrate calibration aerosol (Ng et al., 2011b). In this study, an atomizer (TSI, Constant Output Atomizer Model 3076) was used for primary aerosol generation, followed by a silica gel diffusion dryer, an SMPS system (model TSI 3936), comprised of an electrostatic classifier (model TSI 3080) with a differential mobility analyzer (DMA, model TSI 3081) and a condensation particle counter (CPC, TSI 3772). Monodisperse 300 nm ammonium nitrate aerosol particles were generated for the calibration. The calibration comprised a range of nitrate concentrations from 0 to $15 \mu\text{g m}^{-3}$, which were achieved by diluting the generated aerosol. RIE for ammonium was directly determined from the ammonium nitrate calibration.

Several calibrations were carried out through the sampling period, and average values for nitrate IE and RIE for ammonium were used for the whole dataset. After several tests around the world, more experience has been gained regarding the performance of the ACSM. Hence, RIE for sulphate has been shown to vary from instrument to instrument and therefore the default value (1.2) (Ng et al., 2011b) cannot be directly used. Nevertheless, this information was known when our ACSM was no longer at the MSY station, and hence, sulphate RIE was determined by doing the aforementioned calibration exercise with ammonium sulphate monodisperse aerosol in Barcelona. The sulphate RIE value found was very close to the default value and hence 1.2 was used for the current dataset. The default RIE for organics (1.4) (Ng et al., 2011b) has been used, although some discussion about this can be found in Sect. 3.1.

The ACSM was connected to a general inlet equipped with a nafion drier to maintain the RH below 40 %, although technical problems resulted in some periods (about 50 % of the data points) with uncontrolled RH. The ACSM was set to measure with a time resolution of approximately 30 min, resulting from setting it to work with 24 scans (alternatively 1 sample and 1 filtered) per data point with a scan speed of 500 ms amu^{-1} . The data acquisition software provided by Aerodyne Research (version 1.4.2.5 from the beginning to 18 December 2012, and version 1.4.3.8 for the rest of the period) was used to process the measurements. The data were analyzed with the ACSM data

analysis software version 1.5.3.2 (Aerodyne Research Inc.) written in Igor Pro (Wave-Metrics, Inc., Lake Oswego, OR, USA). A correction for the instrument performance limitations was applied to the dataset based on the inlet pressure and N₂ signal. The aerosol mass concentrations were then corrected for particle collection efficiency (CE) following the Middlebrook approach (Middlebrook et al., 2012).

2.3 Additional measurements and instrumentation

Submicron particulate matter (PM₁) 24 h samples were collected on quartz fibre filters (Pallflex 2500QAT-UP) using DIGITEL (DH-80) high volume (30 m³ h⁻¹) samplers with a PM₁ impactor inlet. The sampler, and therefore the collected samples, was kept inside a container with controlled temperature (between 24 and 26 °C). Samples were collected every 4 days. Gravimetric and chemical off-line analyses were carried out. A quarter of the filter was acid digested (HNO₃ : HF : HClO₄), and the resulting solution was analysed by Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) for major elements determination, including S, from which the sulphate concentration was calculated. Another quarter of the filter was water extracted to determine the nitrate, sulphate and chloride concentrations by Ion Chromatography and the ammonium concentrations by an ion selective electrode. OC concentrations were determined by thermal-optical methods using a Sunset instrument following the EUSAAR2 thermal protocol (Cavalli et al., 2010). Blank filters were analysed together with the samples and concentrations were subtracted from those found in the samples in order to calculate the ambient concentrations.

PM₁ hourly concentrations were measured using an optical particle counter (GRIMM, model 180) and corrected with the simultaneous 24 h gravimetric measurements. Equivalent Black Carbon (BC) mass concentrations (Petzold et al., 2013) were measured with a 1 min time resolution by a multi-angle absorption photometer (MAAP, model 5012, Thermo) using a PM₁₀ inlet, and using the default mass absorption cross section (MAC) from the instrument software (6.6 m² g⁻¹).

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



Wind direction and speed, solar radiation, temperature, relative humidity and precipitation were recorded using conventional instruments and hourly data can be seen in Fig. S2.

2.4 Source apportionment of OA

- 5 The source apportionment to the organic fraction can be investigated by applying Positive Matrix Factorization (PMF) (Paatero and Tapper, 1994) using the Multilinear Engine (ME-2) (Paatero, 1999) to the organic mass spectra. Both methods describe the measurements with a bilinear factor model:

$$x_{ij} = \sum_{k=1}^p g_{ik} f_{kj} + e_{ij} \quad (1)$$

- 10 where x_{ij} is the j th species (m/z) concentration measured in the i th sample, p is the number of sources, g_{ik} is the contribution of the k th source to the i th sample, f_{kj} is the concentration of the j th species in the k th source (mass spectra) and e_{ij} is the residual associated with the j th species concentration measured in the i th sample. The values g_{ik} and f_{kj} are adjusted until a minimum for the objective function Q for a given number of factors p is found:

$$Q = \sum_{i=1}^n \sum_{j=1}^m \left(\frac{e_{ij}}{\sigma_{ij}} \right)^2 \quad (2)$$

where σ_{ij} is the user defined uncertainty for the j th species in the i th sample.

- With the ME-2, the user can introduce a priori information about sources e.g. using the so-called a value approach. Hence, the user inputs one or more factor profiles and a constraint defined by the a value, which determines the extent to which the output profile can differ from the profile fed to the model.

15 In the present study the source apportionment to OA was performed applying ME-2 using the toolkit SoFi (Source Finder) version 4.7 described in Canonaco et al. (2013).

[Title Page](#)[Abstract](#)[Introduction](#)[Conclusions](#)[References](#)[Tables](#)[Figures](#)[Back](#)[Close](#)[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)

The ME-2 was applied separately for the warm and cold periods in this study, given the expected differences among them. The warm period was defined as a period with > 70 % of the days with average $T > 19^{\circ}\text{C}$, hourly max $T > 24^{\circ}\text{C}$ and hourly min $T > 15^{\circ}\text{C}$, which includes 14 June to 9 October 2012. The cold period was defined as a period with > 70 % of the days with average $T < 10^{\circ}\text{C}$, hourly max $T < 13^{\circ}\text{C}$ and hourly min $T < 8^{\circ}\text{C}$ and includes 28 October 2012 to 7 April 2013. Only $m/z \leq 100$ were used for several reasons: (a) the signals of $m/z > 100$ account for a minor fraction of the total signal (2 % on average), (b) the $m/z > 100$ have larger uncertainties, and (c) the large interference of naphthalene signals (at m/z 127, 128, and 129) is avoided. The error matrix was calculated by the aforementioned customized software, which downweights the m/z masses calculated from the m/z 44 signal. Moreover, m/z with signal to noise ratio (S/N) below 0.2 were downweighted by a factor of 10, and those with S/N between 0.2 and 1 were downweighted by a factor of 2.

3 Results and discussion

3.1 Comparison of ACSM data with other measurements

This is one of the few studies, together with Ripoll et al. (2014a), that compare ACSM data with off-line PM_1 measurements. Most of the studies found in the literature comparing ACSM data with off-line measurements are based in the $\text{PM}_{2.5}$ fraction for the off-line measurements. In this study we use PM_1 measurements, avoiding the tail of the coarse mode that the $\text{PM}_{2.5}$ fraction includes, and hence being closer to the size range measured by the ACSM (75–650 nm).

The sum of the ACSM components concentrations and the BC concentrations measured by the MAAP was compared with PM_1 concentrations determined by the optical particle counter, resulting in a strong correlation (squared Pearson correlation coefficient, $R^2 = 0.66$) and a slope very close to unity (1.005) (Fig. 1). The application of a time-dependent collection efficiency (CE) to the ACSM data based on the Middel-

**One year ACSM at
Montseny regional
background site**

M. C. Minguillón et al.

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



brook approach (Middlebrook et al., 2012) resulted in a better fit compared to the use of a constant CE = 0.5 used in several studies (which resulted in a slope of 0.913 and a $R^2 = 0.65$). Hence the time-dependent CE application is considered more suitable for the present study. Moreover, ACSM components concentrations were daily averaged and compared to off-line measurements from 24 h PM₁ samples (Fig. 2). All the species, except for chloride, showed strong correlations (R^2 of 0.68, 0.82 and 0.94 for ammonium, nitrate and sulphate, respectively). Chloride concentrations were below or close to detection limits for both ACSM and off-line analysis, which may be the cause for the discrepancies found. Such discrepancies were also found in other studies (Budisulistiorini et al., 2014). For the strongly-correlated species, the slopes (ACSM vs. off-line measurements) were different for each of them. Whereas they were relatively close to unity for sulphate and ammonium (1.15 and 1.72, respectively), the slope was much higher for nitrate (2.80). The final reasons for this discrepancy remain unexplained, although a possible cause is the volatilization of ammonium nitrate from the filters (which is also reflected in the 1.72 slope obtained for ammonium). Nevertheless, the volatilization of ammonium nitrate is expected to be low given that the samples are kept at controlled conditions (24–26 °C) as described in the methods section. Moreover, if random volatilization occurred, the correlation coefficients found between ACSM and filters would be lower.

For organic aerosol a strong correlation was found ($R^2 = 0.82$), and the high slope obtained (4.25) may be interpreted as the OM-to-OC ratio, since the ACSM measures OA and the off-line measurements determined OC. This large OM-to-OC ratio suggests photochemically well-aged organics, but it is too high even for a pure SOA (Aiken et al., 2008), which is expected to have an important contribution at MSY as will be discussed later (Sect. 3.5). This extremely large OM-to-OC ratio might be attributed to (a) underestimation of OC due to loss of semi-volatile organic compounds from the filters, and (b) overestimation of OM by the ACSM due to an underestimation of the RIE for organics. The first reason is expected to be less likely given the strong correlation found between OA and OC (which would not be so if random volatilization occurred)

and given that the samples are kept at controlled conditions, as formerly explained, hence reducing the possible volatilization. Previous studies also found higher than expected OM-to-OC ratios when comparing ACSM OA with off-line OC measurements. Budisulistiorini et al. (2014) found OM-to-OC ratios of 4.85 and 3.85 in summer and fall, respectively. Ripoll et al. (2014a) found an OM-to-OC ratio of 3.39 for a one year sampling period. This topic is currently being investigated by the ACSM manufacturer.

3.2 Time series and average composition of submicron aerosol. Seasonal variation

The average concentration (P25, P75) of the ACSM components plus BC concentrations during the study period was $7.3 \mu\text{g m}^{-3}$ (3.1, 10.2). The highest concentrations were measured during the warm periods (average $10.3 \mu\text{g m}^{-3}$), defined as the periods with most of the days with average $T > 19^\circ\text{C}$ (from 14 June to 9 October 2012 and from 13 June to 9 July 2013). The lowest concentrations were recorded during the cold period (average $5.8 \mu\text{g m}^{-3}$), which includes a period with most of the days with average $T < 10^\circ\text{C}$ (from 28 October 2012 to 7 April 2013) (Fig. 3). The average monthly concentrations, following the described variation, can be seen in Fig. 4. This is in agreement with the seasonal variations observed during a long time period (2002–2010) by Cusack et al. (2012). The summer increase is associated with the recirculation of air masses that prevent air renovation, the low precipitation (Fig. S2), and the formation of secondary aerosols enhanced by the maximum solar radiation (Fig. S2). The lower winter concentrations can be explained by the high frequency of Atlantic advections (Fig. S1) and the higher precipitation rates, although occasional high concentrations are attributed to winter anticyclonic scenarios (Pey et al., 2010). The seasonal variation of PM_{10} concentrations at MSY is also influenced by the evolution of the boundary layer height, which is lower during wintertime and increases during summertime, especially during the central hours of the day. Changes in the origin of air masses also determined the seasonal variation of PM_{10} concentrations.

[Title Page](#)[Abstract](#)[Introduction](#)[Conclusions](#)[References](#)[Tables](#)[Figures](#)[Back](#)[Close](#)[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)

the components show an increase at around 15:00 UTC, and concentrations remain high until around 22:00 UTC, when they start to decrease to reach a minimum around 9:00 UTC (Fig. 5). This simultaneous variation indicates that the pollutants are transported from the nearby polluted areas to MSY with the breeze.

3.3 Influence of the type of scenario on submicron aerosol

The total PM₁ concentrations were investigated as a function of the type of scenario, finding the lowest concentrations during Mediterranean episodes and Atlantic advections, and the highest during North African outbreaks, European episodes and Winter Anticyclonic episodes (Fig. 6). Some differences in the relative chemical composition as a function of the type of scenario were found (Fig. 6). OA and sulphate relative contributions were higher under regional and North African episodes. This may be due to the higher formation of secondary aerosols enhanced by the higher temperature and solar radiation during these episodes. See additional discussion about formation of SOA in Sect. 3.5. Moreover, the higher sulphate concentrations under regional episodes may also be due to the enhanced regional mixing, as shown by the flatter diurnal pattern for this pollutant (Fig. S3). Sulphate relative contribution was also high when Mediterranean air masses affected MSY probably owing to the impact of shipping emissions. On the other hand, nitrate relative contribution was found to be higher for Winter Anticyclonic and European episodes. For both cases the colder weather compared to the rest of the year is partly responsible for the higher nitrate concentrations. During Winter Anticyclonic episodes, the stagnant conditions favouring the accumulation of polluted air masses that are transported from the Barcelona metropolitan area towards MSY may also be responsible for the high nitrate concentrations (Pey et al., 2010). Note that this transport takes place later in the day than in warm conditions, thus reaching the maximum concentrations between 15:00 and 22:00 UTC, and that the day-night difference is much higher than for other scenarios (Fig. S3). During European episodes, the higher nitrate concentration can be attributed to the long range transport of nitrate from Europe to the study area, although this type of episodes often take place under

the a value were chosen based on several tests with different number of factors and different a values for the constrained factors, taking into account the correlations with external data, the diurnal patterns and the residuals, following the strategy described by Crippa et al. (2014) and Canonaco et al. (2013). The BBOA contribution in summer is expected to be low based on previous studies carried out in July 2009 (Minguillón et al., 2011) and on the low f_{60} registered in the present study in summer (Fig. S7), which is below the background threshold (0.003) established by Cubison et al. (2011). Hence, the BBOA factor was not identified and it was not constrained by the ME-2 in summer.

During the warmer period, the HOA accounted for 13 % ($0.7 \mu\text{g m}^{-3}$), whereas the LV-OOA and the SV-OOA accounted for 45 and 42 % of the total OA (2.4 and $2.2 \mu\text{g m}^{-3}$), respectively (Fig. 8c). As explained before, the location and meteorological conditions at MSY result in an increase of pollutants concentrations starting at mid-morning, caused by the transport from populated areas to the regional site with the breeze. This variation is clearly observed for BC (Fig. 9). BC concentrations correlate moderately with HOA (squared Pearson coefficient $R^2 = 0.51$). Nevertheless, the midday increase in the concentration of SV-OOA is larger than that of BC, and therefore it cannot be only explained by the transport of pollutants, including the SOA formed during the transport, but it is attributed to the formation of SOA during these hours in MSY. Hence, the SOA formation can be estimated as the additional increase with respect to that of BC (considered in % of the average concentration during the night hours), which results in a local SOA formation of $1.1 \mu\text{g m}^{-3}$. This SOA may result mainly from biogenic precursors, in agreement with the 70 % of non-fossil SOA found in March 2009 (Minguillón et al., 2011). The flatter diurnal pattern of LV-OOA (Fig. 9) points to a more regional and well-oxidized aerosol, which could be interpreted as the regional background SOA. This SOA formation during warm periods was also observed by Cusack et al. (2013), who studied nucleation and particle growth events, identifying both of them even under polluted conditions at MSY.

**One year ACSM at
Montseny regional
background site**

M. C. Minguillón et al.

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



One year ACSM at Montseny regional background site

M. C. Minguillón et al.

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



BBOA contribution would be lower than that determined. Nevertheless, strong correlation ($R^2 = 0.64$) was found between the BBOA contribution and the potassium concentrations determined in 24 h PM_{10} samples, which further confirms the existence of this source at MSY in winter. The relative BBOA contributions found in the present study are similar to those found in a previous study in March 2009 using a HR-ToF-AMS, where the HOA represented 7 % of the total OA, the BBOA contributed with 9 % and the rest was attributed to OOA (Minguillón et al., 2011; Crippa et al., 2014). The discrepancy in the BBOA contribution (29 vs. 9 %) may be due to the different sampling periods (the current study included November 2012-March 2013 whereas the previous study only included March 2009), to the mixture of some OOA in the BBOA factor for the present study, and/or to the possible increase of biomass burning due to the climate and energy policies in the last five years.

The average daily pattern shown by the different OA sources in winter (Fig. 9) resembles that of BC, nitrate, sulphate and ammonium (Fig. 5), with an increase of pollutants concentrations starting at around 10:00 UTC and reaching high concentrations at around 13:00 UTC. This daily increase is attributed to the transport from populated areas to the mountain site with the breeze. This variation is observed for all the components and therefore the local formation of SOA is deduced to be low in winter.

4 Conclusions

The deployment of an ACSM at the regional background site of Montseny during one year allowed for the characterization of PM_{10} composition and its variation as a function of the time of the year and atmospheric scenarios. The OA sources were also identified and studied.

Strong correlation ($R^2 = 0.66$) was found between total mass determined by ACSM components + BC and PM_{10} determined by an optical particle counter with a slope near to unity. The suitability of the application of a composition-dependent collection efficiency (CE) was confirmed.

the Generalitat de Catalunya (AGAUR 2015 SGR33 and the DGQA), and by the European Union Seventh Framework Programme (FP7/2007-2013) through ACTRIS (grant agreement no. 262254). M. C. Minguillón was partially funded by the JAE-Doc CSIC program, co-funded by the European Social Fund (ESF). A. Ripoll was partially funded by a PhD grant from the Spanish Ministry of Economy and Competitiveness through CARIATI (CGL2008-06294/CLI) project.

References

- Aiken, A. C., Decarlo, P. F., Kroll, J. H., Worsnop, D. R., Huffman, J. A., Docherty, K. S., Ulbrich, I. M., Mohr, C., Kimmel, J. R., Sueper, D., Sun, Y., Zhang, Q., Trimborn, A., Northway, M., Ziemann, P. J., Canagaratna, M. R., Onasch, T. B., Alfarra, M. R., Prevot, A. S. H., Dommen, J., Duplissy, J., Metzger, A., Baltensperger, U., and Jimenez, J. L.: O/C and OM/OC ratios of primary, secondary, and ambient organic aerosols with high-resolution time-of-flight aerosol mass spectrometry, *Environ. Sci. Technol.*, 42, 4478–4485, 2008.
- Alfarra, M. R., Prevot, A. S. H., Szidat, S., Sandradewi, J., Weimer, S., Lanz, V. A., Schreiber, D., Mohr, M., and Baltensperger, U.: Identification of the mass spectral signature of organic aerosols from wood burning emissions, *Environ. Sci. Technol.*, 41, 5770–5777, 2007.
- Alves, C., Vicente, A., Pio, C., Kiss, G., Hoffer, A., Decesari, S., Prevôt, A. S. H., Minguillón, M. C., Querol, X., Hillamo, R., Spindler, G., and Swietlicki, E.: Organic compounds in aerosols from selected European sites - Biogenic versus anthropogenic sources, *Atmos. Environ.*, 59, 243–255, 2012.
- Bougiatioti, A., Stavroulas, I., Kostenidou, E., Zarmas, P., Theodosi, C., Kouvarakis, G., Canonaco, F., Prévôt, A. S. H., Nenes, A., Pandis, S. N., and Mihalopoulos, N.: Processing of biomass-burning aerosol in the eastern Mediterranean during summertime, *Atmos. Chem. Phys.*, 14, 4793–4807, doi:10.5194/acp-14-4793-2014, 2014.
- Budisulistiorini, S. H., Canagaratna, M. R., Croteau, P. L., Marth, W. J., Baumann, K., Edgerton, E. S., Shaw, S. L., Knipping, E. M., Worsnop, D. R., Jayne, J. T., Gold, A., and Surratt, J. D.: Real-time continuous characterization of secondary organic aerosol derived from isoprene epoxydiols in downtown Atlanta, Georgia, using the aerodyne aerosol chemical speciation monitor, *Environ. Sci. Technol.*, 47, 5686–5694, 2013.

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



**One year ACSM at
Montseny regional
background site**

M. C. Minguillón et al.

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



Budisulistiorini, S. H., Canagaratna, M. R., Croteau, P. L., Baumann, K., Edgerton, E. S., Kollman, M. S., Ng, N. L., Verma, V., Shaw, S. L., Knipping, E. M., Worsnop, D. R., Jayne, J. T., Weber, R. J., and Surratt, J. D.: Intercomparison of an Aerosol Chemical Speciation Monitor (ACSM) with ambient fine aerosol measurements in downtown Atlanta, Georgia, *Atmos. Meas. Tech.*, 7, 1929–1941, doi:10.5194/amt-7-1929-2014, 2014.

Canagaratna, M. R., Jayne, J. T., Jimenez, J. L., Allan, J. D., Alfarra, M. R., Zhang, Q., Onasch, T. B., Drewnick, F., Coe, H., Middlebrook, A., Delia, A., Williams, L. R., Trimborn, A. M., Northway, M. J., DeCarlo, P. F., Kolb, C. E., Davidovits, P., and Worsnop, D. R.: Chemical and microphysical characterization of ambient aerosols with the aerodyne aerosol mass spectrometer, *Mass Spectrom. Rev.*, 26, 185–222, 2007.

Canonaco, F., Crippa, M., Slowik, J. G., Baltensperger, U., and Prévôt, A. S. H.: SoFi, an IGOR-based interface for the efficient use of the generalized multilinear engine (ME-2) for the source apportionment: ME-2 application to aerosol mass spectrometer data, *Atmos. Meas. Tech.*, 6, 3649–3661, doi:10.5194/amt-6-3649-2013, 2013.

Canonaco, F., Slowik, J. G., Baltensperger, U., and Prévôt, A. S. H.: Inverse relationship between the degree of oxidation of OOA (oxygenated organic aerosol) and the oxidant OX ($O_3 + NO_2$) due to biogenic emissions, *Atmos. Chem. Phys. Discuss.*, 14, 28079–28104, doi:10.5194/acpd-14-28079-2014, 2014.

Carbone, S., Saarikoski, S., Frey, A., Reyes, F., Reyes, P., Castillo, M., Gramsch, E., Oyola, P., Jayne, J., Worsnop, D., and Hillamo, R.: Chemical characterization of submicron Aerosol particles in Santiago de Chile, *Aerosol Air Qual. Res.*, 13, 462–473, 2013.

Cavalli, F., Viana, M., Yttri, K. E., Genberg, J., and Putaud, J.-P.: Toward a standardised thermal-optical protocol for measuring atmospheric organic and elemental carbon: the EUSAAR protocol, *Atmos. Meas. Tech.*, 3, 79–89, doi:10.5194/amt-3-79-2010, 2010.

Crippa, M., DeCarlo, P. F., Slowik, J. G., Mohr, C., Heringa, M. F., Chirico, R., Poulain, L., Freutel, F., Sciare, J., Cozic, J., Di Marco, C. F., Elsasser, M., Nicolas, J. B., Marchand, N., Abidi, E., Wiedensohler, A., Drewnick, F., Schneider, J., Borrmann, S., Nemitz, E., Zimmermann, R., Jaffrezo, J.-L., Prévôt, A. S. H., and Baltensperger, U.: Wintertime aerosol chemical composition and source apportionment of the organic fraction in the metropolitan area of Paris, *Atmos. Chem. Phys.*, 13, 961–981, doi:10.5194/acp-13-961-2013, 2013.

Crippa, M., Canonaco, F., Lanz, V. A., Äijälä, M., Allan, J. D., Carbone, S., Capes, G., Ceburnis, D., Dall'Osto, M., Day, D. A., DeCarlo, P. F., Ehn, M., Eriksson, A., Freney, E., Hildebrandt Ruiz, L., Hillamo, R., Jimenez, J. L., Junninen, H., Kiendler-Scharr, A., Kortelainen, A.-

One year ACSM at Montseny regional background site

M. C. Minguillón et al.

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



M., Kulmala, M., Laaksonen, A., Mensah, A. A., Mohr, C., Nemitz, E., O'Dowd, C., Ovadnevaite, J., Pandis, S. N., Petäjä, T., Poulain, L., Saarikoski, S., Sellegri, K., Swietlicki, E., Tiitta, P., Worsnop, D. R., Baltensperger, U., and Prévôt, A. S. H.: Organic aerosol components derived from 25 AMS data sets across Europe using a consistent ME-2 based source apportionment approach, *Atmos. Chem. Phys.*, 14, 6159–6176, doi:10.5194/acp-14-6159-2014, 2014.

Cubison, M. J., Ortega, A. M., Hayes, P. L., Farmer, D. K., Day, D., Lechner, M. J., Brune, W. H., Apel, E., Diskin, G. S., Fisher, J. A., Fuelberg, H. E., Hecobian, A., Knapp, D. J., Mikoviny, T., Riemer, D., Sachse, G. W., Sessions, W., Weber, R. J., Weinheimer, A. J., Wisthaler, A., and Jimenez, J. L.: Effects of aging on organic aerosol from open biomass burning smoke in aircraft and laboratory studies, *Atmos. Chem. Phys.*, 11, 12049–12064, doi:10.5194/acp-11-12049-2011, 2011.

Cusack, M., Alastuey, A., Pérez, N., Pey, J., and Querol, X.: Trends of particulate matter (PM_{2.5}) and chemical composition at a regional background site in the Western Mediterranean over the last nine years (2002–2010), *Atmos. Chem. Phys.*, 12, 8341–8357, doi:10.5194/acp-12-8341-2012, 2012.

Cusack, M., Pérez, N., Pey, J., Wiedensohler, A., Alastuey, A., and Querol, X.: Variability of sub-micrometer particle number size distributions and concentrations in the Western Mediterranean regional background, *Tellus, Series B: Chemical and Physical Meteorology*, 65, 2013.

Heringa, M. F., DeCarlo, P. F., Chirico, R., Tritscher, T., Dommen, J., Weingartner, E., Richter, R., Wehrle, G., Prévôt, A. S. H., and Baltensperger, U.: Investigations of primary and secondary particulate matter of different wood combustion appliances with a high-resolution time-of-flight aerosol mass spectrometer, *Atmos. Chem. Phys.*, 11, 5945–5957, doi:10.5194/acp-11-5945-2011, 2011.

IPCC: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, edited by: Stocker, T. F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S. K., Boschung, J., Nauels, A., Xia, Y., Bex, V., and Midgley, P. M., Cambridge University Press, Cambridge, UK and New York, NY, USA, 1535 pp., 2013.

Jimenez, J. L., Canagaratna, M. R., Donahue, N. M., Prevot, A. S. H., Zhang, Q., Kroll, J. H., DeCarlo, P. F., Allan, J. D., Coe, H., Ng, N. L., Aiken, A. C., Docherty, K. S., Ulbrich, I. M., Grieshop, A. P., Robinson, A. L., Duplissy, J., Smith, J. D., Wilson, K. R., Lanz, V. A., Hueglin, C., Sun, Y. L., Tian, J., Laaksonen, A., Raatikainen, T., Rautiainen, J., Vaatto-

**One year ACSM at
Montseny regional
background site**

M. C. Minguillón et al.

[Title Page](#)[Abstract](#)[Introduction](#)[Conclusions](#)[References](#)[Tables](#)[Figures](#)[Back](#)[Close](#)[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)

vaara, P., Ehn, M., Kulmala, M., Tomlinson, J. M., Collins, D. R., Cubison, M. J., Dunlea, E. J., Huffman, J. A., Onasch, T. B., Alfarra, M. R., Williams, P. I., Bower, K., Kondo, Y., Schneider, J., Drewnick, F., Borrmann, S., Weimer, S., Demerjian, K., Salcedo, D., Cottrell, L., Griffin, R., Takami, A., Miyoshi, T., Hatakeyama, S., Shimono, A., Sun, J. Y., Zhang, Y. M., Dzepina, K., Kimmel, J. R., Sueper, D., Jayne, J. T., Herndon, S. C., Trimborn, A. M., Williams, L. R., Wood, E. C., Middlebrook, A. M., Kolb, C. E., Baltensperger, U., and Worsnop, D. R.: Evolution of organic aerosols in the atmosphere, *Science*, 326, 1525–1529, 2009.

Liu, P. S. K., Deng, R., Smith, K. A., Williams, L. R., Jayne, J. T., Canagaratna, M. R., Moore, K., Onasch, T. B., Worsnop, D. R., and Deshler, T.: Transmission efficiency of an aerodynamic focusing lens system: comparison of model calculations and laboratory measurements for the aerodyne aerosol mass spectrometer, *Aerosol Sci. Tech.*, 41, 721–733, 2007.

Middlebrook, A. M., Bahreini, R., Jimenez, J. L., and Canagaratna, M. R.: Evaluation of composition-dependent collection efficiencies for the Aerodyne aerosol mass spectrometer using field data, *Aerosol Sci. Tech.*, 46, 258–271, 2012.

Millán, M. M., Salvador, R., Mantilla, E., and Kallos, G.: Photooxidant dynamics in the Mediterranean basin in summer: results from European research projects, *J. Geophys. Res.*, 102, 8811–8823, 1997.

Minguillón, M. C., Perron, N., Querol, X., Szidat, S., Fahrni, S. M., Alastuey, A., Jimenez, J. L., Mohr, C., Ortega, A. M., Day, D. A., Lanz, V. A., Wacker, L., Reche, C., Cusack, M., Amato, F., Kiss, G., Hoffer, A., Decesari, S., Moretti, F., Hillamo, R., Teinilä, K., Seco, R., Peñuelas, J., Metzger, A., Schallhart, S., Müller, M., Hansel, A., Burkhardt, J. F., Baltensperger, U., and Prévôt, A. S. H.: Fossil versus contemporary sources of fine elemental and organic carbonaceous particulate matter during the DAURE campaign in Northeast Spain, *Atmos. Chem. Phys.*, 11, 12067–12084, doi:10.5194/acp-11-12067-2011, 2011.

Ng, N. L., Canagaratna, M. R., Zhang, Q., Jimenez, J. L., Tian, J., Ulbrich, I. M., Kroll, J. H., Docherty, K. S., Chhabra, P. S., Bahreini, R., Murphy, S. M., Seinfeld, J. H., Hildebrandt, L., Donahue, N. M., DeCarlo, P. F., Lanz, V. A., Prévôt, A. S. H., Dinar, E., Rudich, Y., and Worsnop, D. R.: Organic aerosol components observed in Northern Hemispheric datasets from Aerosol Mass Spectrometry, *Atmos. Chem. Phys.*, 10, 4625–4641, doi:10.5194/acp-10-4625-2010, 2010.

**One year ACSM at
Montseny regional
background site**

M. C. Minguillón et al.

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



Ng, N. L., Canagaratna, M. R., Jimenez, J. L., Zhang, Q., Ulbrich, I. M., and Worsnop, D. R.: Real-time methods for estimating organic component mass concentrations from aerosol mass spectrometer data, *Environ. Sci. Technol.*, 45, 910–916, 2011a.

Ng, N. L., Herndon, S. C., Trimborn, A., Canagaratna, M. R., Croteau, P. L., Onasch, T. B., Sueper, D., Worsnop, D. R., Zhang, Q., Sun, Y. L., and Jayne, J. T.: An Aerosol Chemical Speciation Monitor (ACSM) for routine monitoring of the composition and mass concentrations of ambient aerosol, *Aerosol Sci. Tech.*, 45, 770–784, 2011b.

Paatero, P.: The multilinear engine – a table-driven, least squares program for solving multilinear problems, including the n-way parallel factor analysis model, *J. Comput. Graph. Stat.*, 8, 854–888, 1999.

Paatero, P. and Tapper, U.: Positive matrix factorization: a non-negative factor model with optimal utilization of error estimates of data values, *Environmetrics*, 5, 111–126, 1994.

Pérez, N., Pey, J., Castillo, S., Viana, M., Alastuey, A., and Querol, X.: Interpretation of the variability of levels of regional background aerosols in the Western Mediterranean, *Sci. Total Environ.*, 407, 527–540, 2008.

Petit, J.-E., Favez, O., Sciare, J., Crenn, V., Sarda-Estève, R., Bonnaire, N., Močnik, G., Dupont, J.-C., Haefelin, M., and Leoz-Garziandia, E.: Two years of near real-time chemical composition of submicron aerosols in the region of Paris using an Aerosol Chemical Speciation Monitor (ACSM) and a multi-wavelength Aethalometer, *Atmos. Chem. Phys. Discuss.*, 14, 24221–24271, doi:10.5194/acpd-14-24221-2014, 2014.

Petzold, A., Ogren, J. A., Fiebig, M., Laj, P., Li, S.-M., Baltensperger, U., Holzer-Popp, T., Kinne, S., Pappalardo, G., Sugimoto, N., Wehrl, C., Wiedensohler, A., and Zhang, X.-Y.: Recommendations for reporting “black carbon” measurements, *Atmos. Chem. Phys.*, 13, 8365–8379, doi:10.5194/acp-13-8365-2013, 2013.

Pey, J., Pérez, N., Castillo, S., Viana, M., Moreno, T., Pandolfi, M., López-Sebastián, J. M., Alastuey, A., and Querol, X.: Geochemistry of regional background aerosols in the Western Mediterranean, *Atmos. Res.*, 94, 422–435, 2009.

Pey, J., Pérez, N., Querol, X., Alastuey, A., Cusack, M., and Reche, C.: Intense winter atmospheric pollution episodes affecting the Western Mediterranean, *Sci. Total Environ.*, 408, 1951–1959, 2010.

Pope III, C. A. and Dockery, D. W.: Health effects of fine particulate air pollution: lines that connect, *J. Air Waste Manage.*, 56, 709–742, 2006.

**One year ACSM at
Montseny regional
background site**

M. C. Minguillón et al.

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



- Querol, X., Alastuey, A., Pey, J., Cusack, M., Pérez, N., Mihalopoulos, N., Theodosi, C., Gerasopoulos, E., Kubilay, N., and Koçak, M.: Variability in regional background aerosols within the Mediterranean, *Atmos. Chem. Phys.*, 9, 4575–4591, doi:10.5194/acp-9-4575-2009, 2009.
- 5 Querol, X., Alastuey, A., Viana, M., Moreno, T., Reche, C., Minguillón, M. C., Ripoll, A., Pandolfi, M., Amato, F., Karanasiou, A., Pérez, N., Pey, J., Cusack, M., Vázquez, R., Plana, F., Dall'Osto, M., de la Rosa, J., Sánchez de la Campa, A., Fernández-Camacho, R., Rodríguez, S., Pio, C., Alados-Arboledas, L., Titos, G., Artíñano, B., Salvador, P., García Dos Santos, S., and Fernández Patier, R.: Variability of carbonaceous aerosols in remote, rural, urban and industrial environments in Spain: implications for air quality policy, *Atmos. Chem. Phys.*, 13, 6185–6206, doi:10.5194/acp-13-6185-2013, 2013.
- 10 Querol, X., Alastuey, A., Pandolfi, M., Reche, C., Pérez, N., Minguillón, M. C., Moreno, T., Viana, M., Escudero, M., Orió, A., Pallarés, M., and Reina, F.: 2001–2012 trends on air quality in Spain, *Sci. Total Environ.*, 490, 957–969, 2014.
- 15 Ripoll, A., Minguillón, M. C., Pey, J., Jimenez, J. L., Day, D. A., Querol, X., and Alastuey, A.: Long-term real-time chemical characterization of submicron aerosols at Montsec (Southern Pyrenees, 1570 m a.s.l.), *Atmos. Chem. Phys. Discuss.*, 14, 28809–28844, doi:10.5194/acpd-14-28809-2014, 2014a.
- Ripoll, A., Minguillón, M. C., Pey, J., Pérez, N., Querol, X., and Alastuey, A.: Joint analysis of continental and regional background environments in the Western Mediterranean: PM₁ and PM₁₀ concentrations and composition, *Atmos. Chem. Phys. Discuss.*, 14, 16001–16041, doi:10.5194/acpd-14-16001-2014, 2014b.
- 20 Sun, Y., Wang, Z., Dong, H., Yang, T., Li, J., Pan, X., Chen, P., and Jayne, J. T.: Characterization of summer organic and inorganic aerosols in Beijing, China with an Aerosol Chemical Speciation Monitor, *Atmos. Environ.*, 51, 250–259, 2012.
- 25 Sun, Y., Wang, Z., Fu, P., Jiang, Q., Yang, T., Li, J., and Ge, X.: The impact of relative humidity on aerosol composition and evolution processes during wintertime in Beijing, China, *Atmos. Environ.*, 77, 927–934, 2013a.
- Sun, Y. L., Wang, Z. F., Fu, P. Q., Yang, T., Jiang, Q., Dong, H. B., Li, J., and Jia, J. J.: Aerosol composition, sources and processes during wintertime in Beijing, China, *Atmos. Chem. Phys.*, 13, 4577–4592, doi:10.5194/acp-13-4577-2013, 2013b.
- 30 Takahama, S., Johnson, A., Guzman Morales, J., Russell, L. M., Duran, R., Rodriguez, G., Zheng, J., Zhang, R., Toom-Sauntry, D., and Leaitch, W. R.: Submicron organic aerosol in

- Tijuana, Mexico, from local and Southern California sources during the CalMex campaign, Atmos. Environ., 70, 500–512, doi:10.1016/j.atmosenv.2012.07.057, 2013.
- 5 Van Drooge, B. L., Crusack, M., Reche, C., Mohr, C., Alastuey, A., Querol, X., Prevot, A. S. H., Day, D. A., Jimenez, J. L., and Grimalt, J. O.: Molecular marker characterization of the organic composition of submicron aerosols from Mediterranean urban and rural environments under contrasting meteorological conditions, Atmos. Environ., 61, 482–489, 2012.

**One year ACSM at
Montseny regional
background site**M. C. Minguillón et al.

[Title Page](#)[Abstract](#)[Introduction](#)[Conclusions](#)[References](#)[Tables](#)[Figures](#)[Back](#)[Close](#)[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)

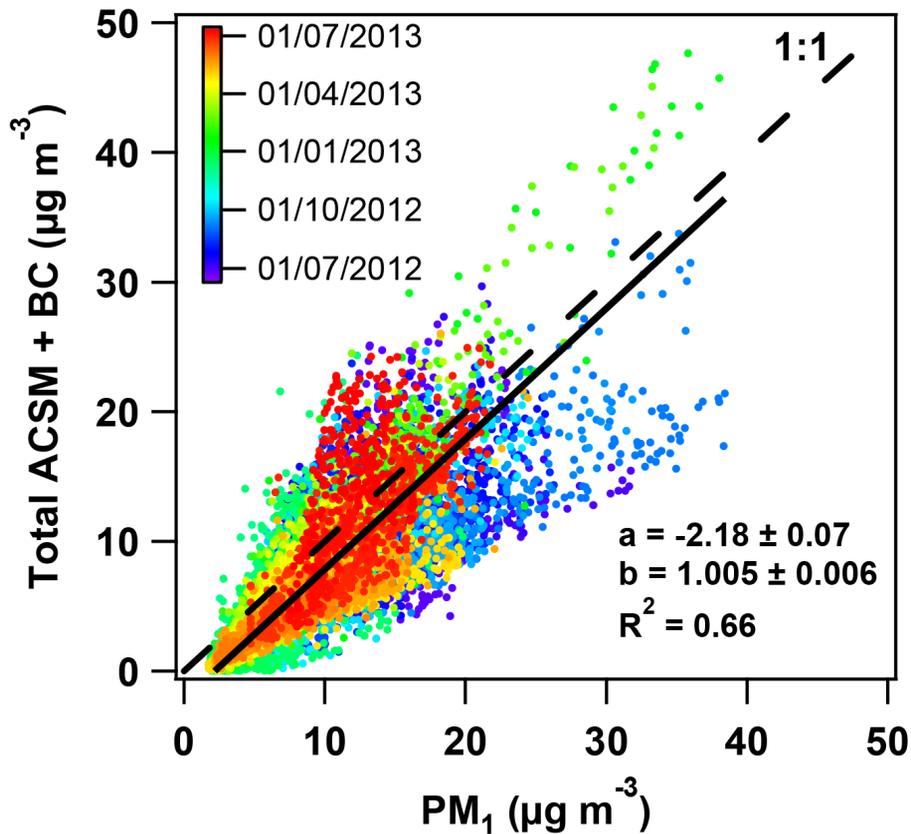


Figure 1. ACSM components + BC concentrations vs. PM₁ measured by the optical counter colored by the sampling time (dd/mm/yyyy). Line and parameters correspond to least orthogonal distance fit. The wild fire period is excluded from the plot and from the fit.

One year ACSM at Montseny regional background site

M. C. Minguillón et al.

Title Page	
Abstract	Introduction
Conclusions	References
Tables	Figures
◀	▶
◀	▶
Back	Close
Full Screen / Esc	
Printer-friendly Version	
Interactive Discussion	



One year ACSM at Montseny regional background site

M. C. Minguillón et al.

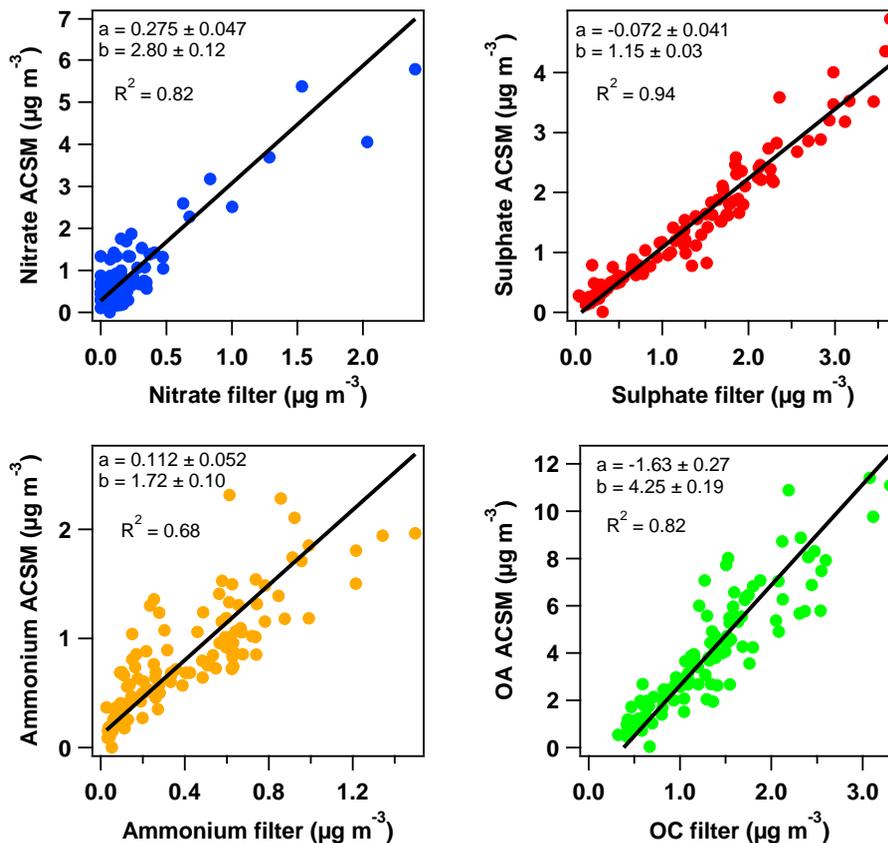


Figure 2. ACSM components concentrations vs. 24 h samples concentrations. Lines and parameters correspond to least orthogonal distance fits.

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures

◀

▶

◀

▶

Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



One year ACSM at
Montseny regional
background site

M. C. Minguillón et al.

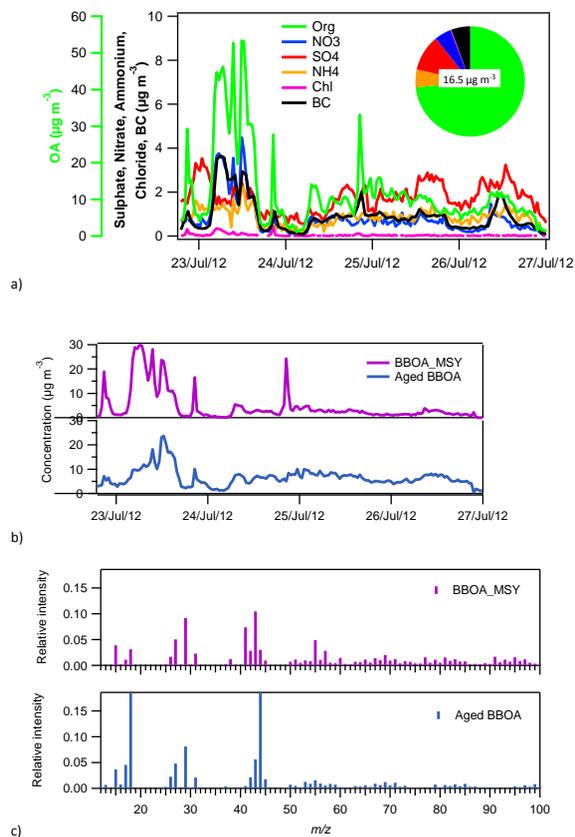


Figure 7. (a) Time series of ACSM components and BC concentrations and pie chart of the average chemical composition during the wildfire episode from 22 to 26 July 2012. (b) Time series of the contribution of the BBOA_MSY and Aged BBOA sources identified by PMF. (c) Source profile of the BBOA_MSY and Aged BBOA sources.

One year ACSM at
Montseny regional
background site

M. C. Minguillón et al.

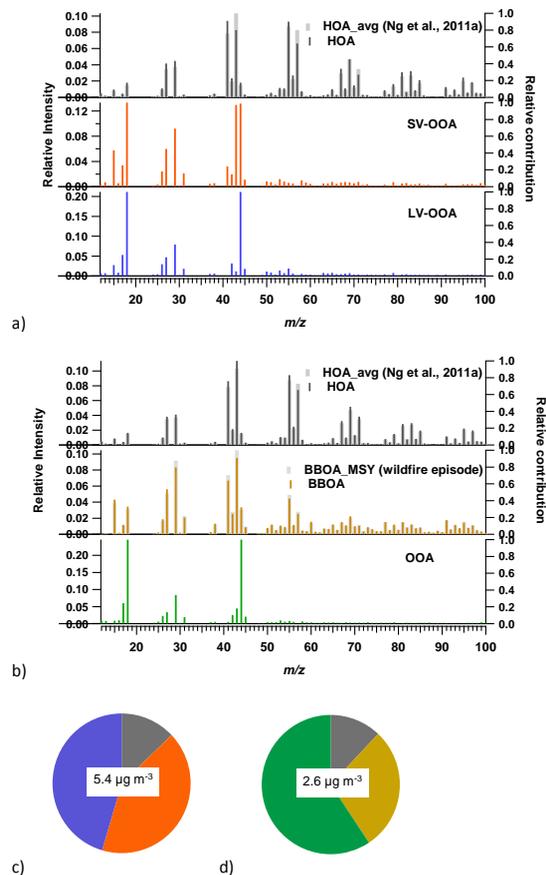


Figure 8. Mass spectral profiles of the organic sources identified for (a) summer and (b) winter. Average contribution of the organic sources to total OA for (c) summer and (d) winter.

One year ACSM at Montseny regional background site

M. C. Minguillón et al.

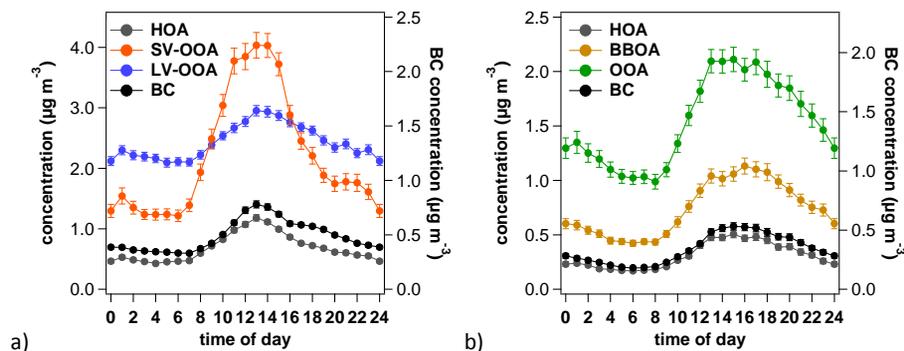


Figure 9. Average daily patterns of the organic sources contributions and BC concentrations for (a) summer and (b) winter. Error bars represent SDs.