ACTRIS 2 (ECAC-ACMCC) Intercomparison of Aerosol Chemical Speciation Monitors, November 2018

Project No.: ACSM-2018-1-17

Basic information

Location of the quality assurance: SIRTA/ACMCC, LSCE, Lab. 705
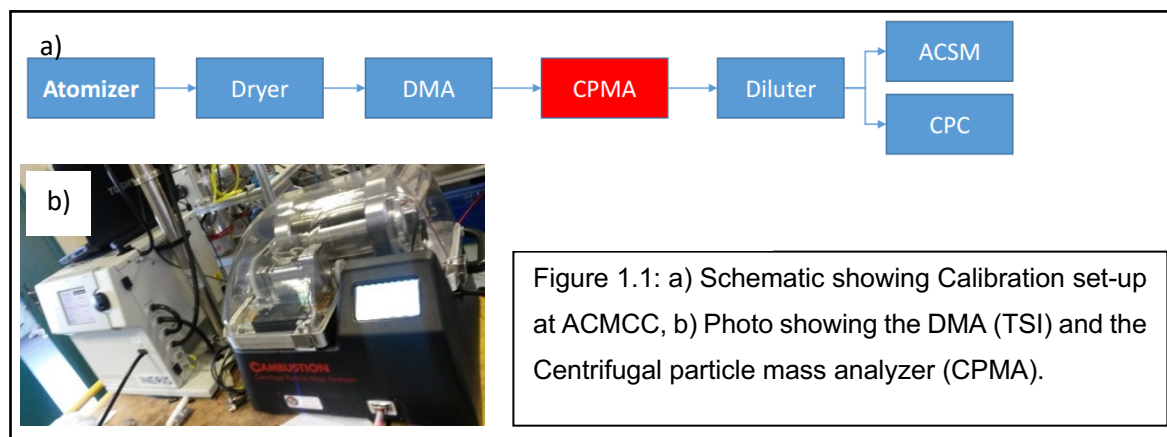
Workshop period: November 19th to November 23th, 2018

Principal investigator	Institute	Participant	Instrument
Jean-Eudes PETIT	LSCE - SIRTA	Jean-Eudes PETIT & François TRUONG	QACSM#140-113 equipped with a PM1 inlet and standard vaporizer

Summary

This report summarizes results obtained for the SIRTA PM$_1$ Quadrupole Aerosol Chemical Speciation Monitor (QACSM) during the 2018 ACMCC ACTRIS-2 workshop. This instrument successfully participated in the previous ACSM intercomparisons and didn't travel prior to the workshop (unlike other instruments). For these reasons, it has been considered as the reference instrument for the workshop. It could be compared to other participating instruments (N=16), showing good results within Z-score analysis and passing the quality standards required as part of the ACTRIS research infrastructure.

1. Overview of the instrumental set-up, data treatment methodology and calibration

The SIRTA instrument was calibrated on Nov. 15th by ACMCC staff using monodisperse (300 nm) ammonium nitrate and ammonium sulfate nebulized particles. The calibration set up is illustrated in Fig. 3.1. It included a differential mobility analyzer (DMA, TSI®) to select particles of diameter 300 nm. This DMA was calibrated prior to use, using 300 nm polystyrene latex spheres. The aerosol particles were then passed into a Centrifugal Particle Mass analyser (CPMA) that separates particles by their actual mass and removes doubly charged aerosol particles. These particles are then passed simultaneously into the ACSM and into a condensation particle counter (CPC). This CPC was calibrated prior to the workshop, based on comparison with an electrometer.

Figure 1.1: a) Schematic showing Calibration set-up at ACMCC, b) Photo showing the DMA (TSI) and the Centrifugal particle mass analyzer (CPMA).

The nitrate response factor (RF) was calculated for each instrument and applied to the raw ACSM signal to obtain quantitative information. This value is determined from a known quantity of a known chemical species that enters into the instrument. The relative ionization efficiency (RIE) is a chemical dependent value that is commonly determined experimentally for the ammonium and sulfate species.

Calibration values used for the SIRTA instrument during workshop are listed in Table 1.1.

QACSM 140-113	RF NO$_3$	RIE NH$_4$	RIE SO$_4$	Ref Airbeam
	3.81e-11	4.40	0.72	1.01e-07

Table 1.1: Calibration values used for the SIRTA instrument.

Other participating instruments (N=16) participated in this exercise were installed and switched on by ACMCC personnel during the week from the 12th to the 16th of November. There were four different tables, each containing four instruments. Each table had its own inlet, fitted with a common sampling head. All sampling lines were composed of ½ inch copper tubes and were the same length for each instrument. Each instrument sampled 3 liters from the main inlet line, this flow was controlled by external sample line flow pumps. Instruments were fitted with or without an individual dryer, as used at their usual sampling site and/or as requested by participants. For the Q-ACSM, data analysis was performed using the Igor Pro (Wavemetrics, v6.3.7) procedure acsm_local (v1.5.11.1). A composition dependent collection efficiency was applied to all data sets following the guidelines available in Middlebrook et al., (2012).

Instruments were compared with the robust median of all instruments through Z-score analysis. The Z-score analysis was applied following the standards defined by the international standard organization (ISO). This method has been evaluated according to ISO 5752-2 and provides a means to evaluate instrument performance relative to other instruments participating in the intercomparison. Such a method has been applied within other European intercomparison exercises (JRC technical intercomparison reports) and was validated during the first ACTRIS1 ACSM intercomparison (Crenn et al., 2015). The Z-score tests evaluates if the variations in the different instruments from the reference value fall within a defined criterion, following Eq.1:

$$Z_i = \frac{X_I - X^*}{\sigma_*}$$

(Eq. 1)

Where X_I is the robust median of the selected instruments, X^* is the value of the instrument being compared and σ^* is the standard deviation of this latter instrument. The robust median target values were determined based on datasets obtained by PM$_1$ ACSM only (i.e., for consistency, the few PM$_{2.5}$ ACSMs were not considered for this target value calculation).

2. Results obtained for comparison with other instruments

After each participating instrument could be tuned by participants, an intercomparison campaign took place from the 23th to the 26th of November. For each instrument, chemical species concentrations were then calculated considering calibration results obtained at the ACMCC.

Evaluation was made using the Z-score comparison. Figure 2.1 shows the z-score calculated for each instrument using the robust median as a reference. The robust median was calculated as the median of all instruments but outliers and PM$_{2.5}$-inlet ACSMs (i.e., instruments # 10, 14, 15, and 16). Instrument

performance is considered acceptable when Z-score values fall between 2 and -2, which was the case for each chemical species measured by the SIRTA instrument.
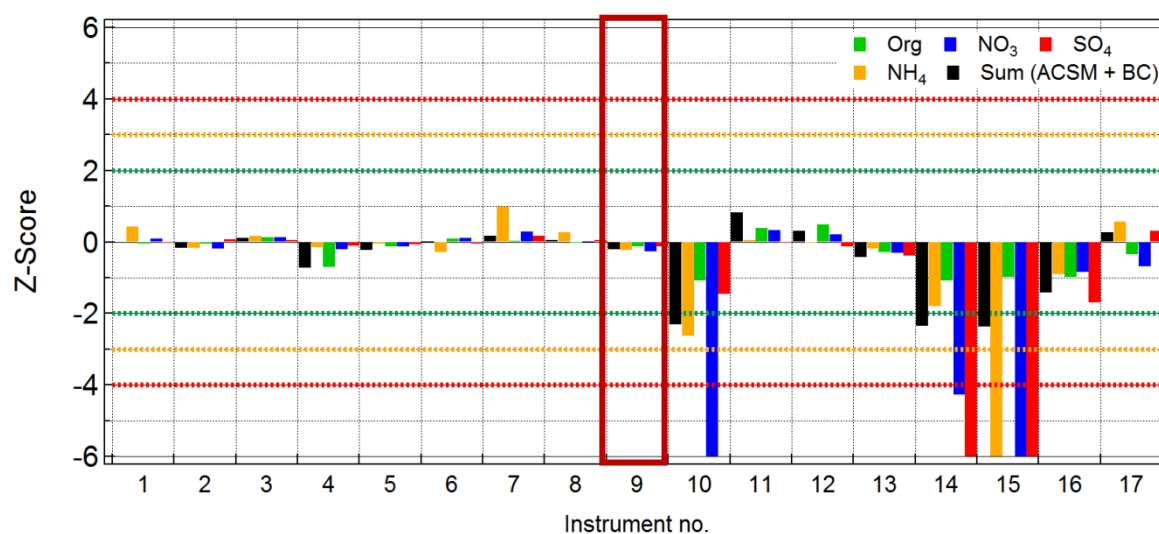

Figure 2.1. Z-score calculation for each species measured by the ACSM for each instrument that participated in the second intercomparison campaign (*period 24th Nov 00hrs to 26th Nov 00hrs)*. The red rectangle highlights the SIRTA (no.9) instrument.

3. References

Crenn, V., Sciare, J., Croteau, P. L., et al., (2015), Atmos. Meas. Tech., 8, 7239-7302, doi:10.5194/amtd-8-7239-2015.

ISO, 5725-5, 1998. Accuracy (trueness and precision) of measurement methods and results-Part 5: Alternative Methods for the Determination of the Precision of a standard measurement method. International Organization for Standardization.

Middlebrook,A.N., R. Bahreini, J. L. Jimenez and M. R. Canagaratna (2012) Aerosol Sci. Tech, 46:258–271.