



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

Project No.: ACSM-2018-1-2

Basic information

Location of the quality assurance: SIRT/ACMCC, LSCE, Lab. 705

Delivery date: Before November 13th, 2018

Setup in the laboratory: November 15th 2018

Workshop period: November 19th to November 23th, 2018


Principal investigator	Institute	Participant	Instrument
Chris Lunder Wenche Aas	NILU	Chris Lunder Wenche Aas	ToF-ACSM equipped with PM2.5 lens and  vaporizer

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Summary

This report summarizes results obtained for the NILU PM2.5 Time-of-Flight Aerosol Chemical Speciation Monitor (ToF-ACSM) during the 2018 ACMCC ACTRIS-2 workshop when compared with other ACSM systems. It is divided into three main sections. The first section describes the instrumental set-up and data treatment methodologies used for the workshop. The second section presents results obtained during the initial intercomparison, where instruments were operated as delivered by participants. The third section describes calibrations and maintenance (if any) performed during the workshop.

Performance evaluation includes:

- 1) The instrument performance is within the acceptable limits evaluated using a Z-score analysis, as described by ISO 5725-2.
- 2) The instrument is in overall good agreement - i.e., within $\pm 30\%$ - with a reference dataset, the latter corresponding to a reference instrument

The reference dataset is that measured by the SIRTa instrument. This instrument successfully participated in the previous ACSM intercomparisons and didn't travel prior to the workshop (unlike other instruments). It is regularly maintained and calibrated by the ACMCC staff. The robust median refers to the median value of all participating PM1 QACSM and excludes the PM2.5 QACSM instruments.

The NILU instrument agreed very well with the median values but had SO₄ concentrations slightly lower than the median, which was confirmed by comparison with the reference SIRTa instrument. .

1. Overview of the instrumental set-up and data treatment methodologies

Instruments were asked to be delivered at ACMCC no later than the 13th of November. They 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 ToF-ACSM, data analysis was performed using the Igor Pro (Wavemetrics, v6.3.7) procedure Tofware (v2.5.13). For the PM2.5 inlet ACSM fitted with a Capture Vapourizer (CV), a collection efficiency of 1 was applied. Instruments were compared with the SIRTa reference instrument and also with the robust median of all instruments through Z-score analysis. For comparison to the reference datasets, it is expected that good instrument performance is met when the participant's results fall within a well characterized uncertainty for aerosol mass spectrometers, taken here as $\pm 30\%$ (Bahreini et al., 2009, Middlebrook et al., 2012; Crenn et al., 2015).

The Z-score analysis was applied following the standards defined by the international standard organization (ISO). This method has been evaluated according to ISO 5725-2 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:

$$Z_i = \frac{X_I - X^*}{\sigma_*} \quad (\text{Eq. 1})$$

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 PM₁ ACSM only (i.e., for consistency, the few PM_{2.5} ACSMs were not considered for this target value calculation). According to this test, instrument performance is considered acceptable when values fall between 2 and -2 (indicated by the green lines in Figures 2.1).

2. Results from initial intercomparison campaign

Once installed by ACMCC personnel, instruments were turned on with tunings indicated by participants, and sampled ambient air at the station from the 16th to the 19th of November 2018 for intercomparison. Fifteen instruments were compared all together during a limited period of 18th Nov 18hrs to 19th Nov 08 hrs. The Z-score test illustrates the instrument performances during this period, (Figure 2.1) where each instrument was compared to the robust median of the participating instruments.

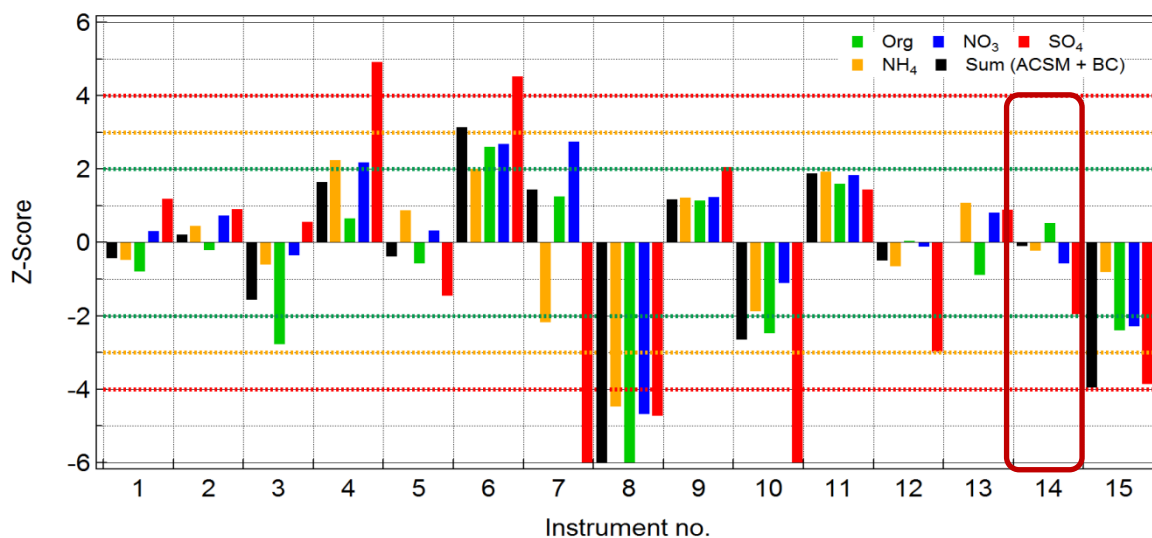


Figure 2.1. Z-score calculation for each species measured by the ACSM for each instrument that participated in the initial intercomparison campaign (18th Nov 18hrs to 19th Nov 08 hrs). The red rectangle highlights the NILU instrument.

The NILU instrument agreed well with the median values but had SO₄ concentrations slightly lower than the median. Given the large variability in instrument performance prior to calibration, the median value is not considered to be representative for comparison, and therefore a second comparison is also made using the SIRTa instrument. This is illustrated in Figure 2.2 below where the median NR-PM₁ + BC mass concentration is compared with the NR-PM₁ mass concentration measured from the Fine Dust Aerosol Spectrometer (FIDAS, Palas ®) and the Tapering Elemental Oscillating Microbalance with Filter Dynamics Measurement System (TEOM-FDMS) instruments, giving a slope of 0.72 and 0.37 respectively. In comparison the NR-PM₁ + BC mass concentration measured from the SIRTa instrument compares better with slope values of 1.08 and 0.56 respectively for the FIDAS and TEOM-FDMS instruments (Figure 2.2b).

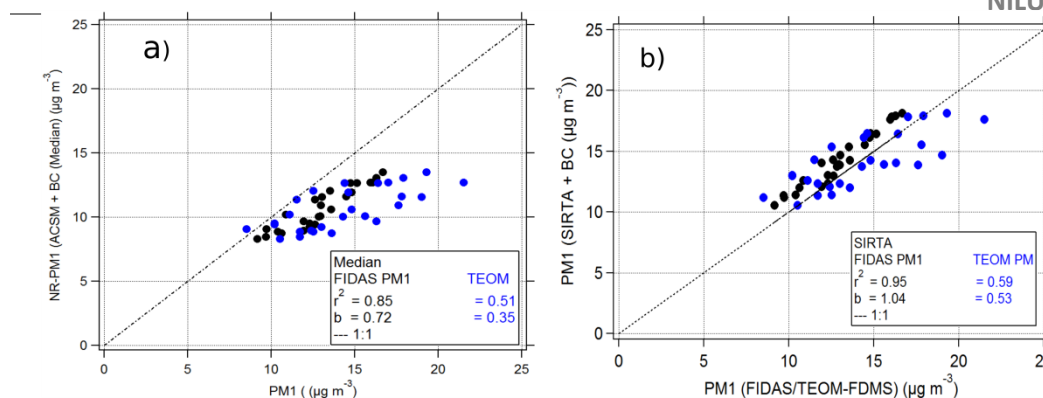


Figure 2.2. Comparison of a) Robust Median NR-PM1 + BC and b) SIRTAs NR-PM1 + BC mass concentrations with those of the FIDAS and TEOM PM1 mass concentration.

For this reason, comparison with the SIRTA instrument seems to be more representative of the NR-PM1 than the robust median of ACSM instruments. Similar to the observations from the z-score calculation, the NILU measured mass concentrations were slightly lower than those from both SIRTA and the FIDAS instrument, with slope values of 0.66 and 0.96 respectively.

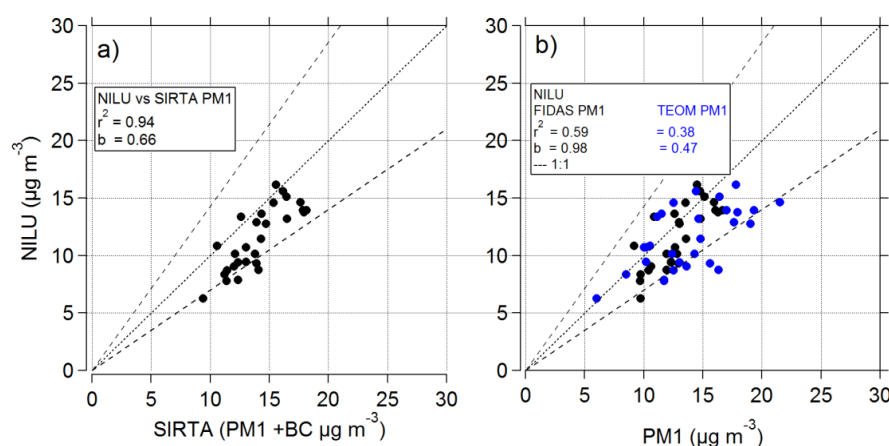


Figure 2.3. Comparison of NILU NR-PM1 + BC with the a) SIRTAs NR-PM1 + BC mass concentrations and b) with PM1 mass concentration from FIDAS and TEOM PM1 mass concentration.

3. Maintenance, tuning and calibration

Following this intercomparison, the participant along with ADDAIR (the French distributor for ACSM systems) and then Aerodyne personnel attempted to finely tune the instrument. Unfortunately, this led to unexpected technical issues, preventing the NILU instrument to efficiently participate in the second intercomparison campaign conducted during the workshop. Finally, the instrument was apparently being able to operate properly (as stated by the manufacturer) just before leaving the ACMCC on Nov. 29th.

4 Conclusion

The NILU ACSM system showed satisfactory results by comparison with other instruments during the initial intercomparison. QA/QC checks and calibrations will however be needed before the instrument is re-installed at the monitoring station.

5 References

Bahreini, R., Ervens, B., Middlebrook, A. M., Warneke, C., de Gouw, J. A., DeCarlo, P. F., et al. (2009). *J. Geophys. Res.* 114:D00F16, doi:10.1029/2008JD011493.

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.