# TNA User Report

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*eurochamp2020@lisa.u-pec.fr*

| | |
|---|---|
| Project title | Participation to the nephelometer calibration workshop, project IN-2020-1-3 |
| Name of the accessed calibration center | WCCAP (World Calibration Center for Aerosol Physics) TROPOS, Leipzig |
| Number of users in the project | 2 |
| Project objectives (max 100 words) | The objective of the participation to the calibration workshop was to verify the performances of our three wavelengths nephelometer (TSI Inc., model 3563 working at 450, 550, and 700 nm), so to test if the instrument meets the requirements for data quality within accepted uncertainty limit. We also participated to the calibration workshop with the aim of learning the best practices for operating, maintaining, and checking the performances of the instrument during field and laboratory operations. The achievement of these objectives will help us to maximize the quality of the measurements realized with the instrument under different conditions. |
| Description of work (max 100 words): | During the workshop the integrating nephelometer was first checked (zero and span gas check). Then the measured scattering and backscattering coefficients were compared to those measured by a reference nephelometer (Aurora4000, Ecotech). A maintenance (instrumental check and cleaning) was performed, followed by a new zero and span checks, and a new intercomparison against the master instrument. The intercomparison was performed on submicron laboratory generated ammonium sulphate aerosols. Several tests were performed to check the performances of the owner-provided calibration software for the TSI nepehelometer. |

| Principal Investigator's and group's information | |
|---|---|
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[1] Physics; Chemistry, Earth Sciences & Environment; Engineering & Technology; Mathematics; Information & Communication Technologies; Material Sciences; Energy; Social sciences; Humanities.
[2] UNI= University and Other Higher Education Organisation;
RES= Public Research Organisation (including international research organisations and private research organisations controlled by public authority);
SME= Small and Medium Enterprise;
PRV= Other Industrial and/or Profit Private Organisation;
OTH= Other type of organization.
[3] UND= Undergraduate; PGR= Post graduate; PDOC= Post-doctoral researcher; RES= Researcher EXP= Engineer; ACA= Academic; TEC= Technician.
[4] Reproduce the table for each user who accessed the infrastructure

# Trans-National Access (TNA) Scientific Report

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## Instructions

Please limit the report to max 5 pages, you can include tables and figures. Please make sure to address any comments made by the reviewers at the moment of the project evaluation (if applicable, in this case you were informed beforehand). Please do not alter the layout of the document and keep it in Word version. The report will be made available on the eurochamp.org website. Should any information be confidential or not be made public, please inform us accordingly (in this case it will only be accessible by the European Commission, the EUROCHAMP-2020 project partners, and the reviewers). Please include:

- Introduction and motivation
- Scientific objectives
- Reason for choosing the calibration facility
- Method and experimental set-up
- Data description
- Preliminary results and conclusions
- Outcome and future studies
- References

**Name of the PI:** Claudia Di Biagio
**Calibration center's name and location:** WCCAP, Tropos-Leipzig
**Campaign name and period:** Calibration workshop - Integrating nephelometer, 27/01/2020 – 31/01/2020

**Text:**

This report presents the activities and the results from the calibration workshop of integrating nephelometers held at the World Calibration Center for Aerosol Physics (WCCAP) at the Leibniz Institute for Tropospheric Research (TROPOS) at Leipzig, Germany between the 27$^{th}$ and the 31$^{st}$ of January 2020. The results are based on the WCCAP report, which is published in the European Center for Aerosol Calibration (ECAC) webpage (WCCAP-report-IN-2020-1-3, https://www.actris-ecac.eu/in-2020-1.html).

We participated to the workshop with a 3 wavelengths integrated nephelometer (TSI Inc., model 3563 working at 450, 550, and 700 nm, S/N 1041).

At our arrival, the nephelometer was unpacked and installed in the laboratory close to the other nephelometers participating to the calibration workshop (two other nepehelometer, an other TSI model 3563 and an Ecotech Aurora) and close to the master nephelometer, an Aurora4000 by Ecotech (S/N 14-1408) working at 450, 525 and 635 nm.

We verified that the TSI nephelometer had not undergone issues due to transportation or other damages.

The first test was the zero check that consisted in checking the instrument signal when measuring pure aerosol-free air, therefore permitting to retrieve the instrument noise. The second test was the span check, consisting in testing the nephelometer response for $CO_2$, a specie for which scattering and backscattering coefficient are well known.

The results of the zero check are reported in Table 1. They show that the background level was acceptable with deviations of less equal 0.47 $Mm^{-1}$ for full scattering and 0.41 $Mm^{-1}$ for backscattering. The standard deviation was less than 0.55 $Mm^{-1}$ for full scattering and less than 0.37 $Mm^{-1}$ for backscattering.

| Wavelength (nm) | Total scattering [$Mm^{-1}$] | | Backscattering [$Mm^{-1}$] | |
|---|---|---|---|---|
| | Mean | 1σ standard deviation | Mean | 1σ standard deviation |
| 450 | -0.12 | 0.55 | 0.41 | 0.37 |
| 550 | 0.47 | 0.26 | 0.02 | 0.16 |
| 700 | 0.06 | 0.31 | 0.27 | 0.23 |

***Table 1**. Average and standard deviation values obtained at the three nephelometer wavelengths for measurements with aerosol-free air.*

The results of the span check (Table 2) showed that the percent deviation from theoretical values for $CO_2$ was between 3.9% and 7.6% for total scattering and between 0 and 13.1% for the backscattering signal. This indicated that the nephelometer performances were quite good but only at certain wavelengths.

| Wavelength (nm) | Total scattering deviation [%] | Backscattering deviation [%] |
|---|---|---|
| 450 | 4.5 | 0 |
| 550 | 7.6 | -2.7 |
| 700 | 3.9 | -13.1 |

***Table 2**. Percentage deviation of measured scattering and backscattering coefficients from TSI nephelometer to the theoretical values for CO2 at 450, 550, and 700 nm.*

The nephelometer was compared to the master instrument by using ammonium sulfate aerosols as test specie. The submicronic ammonium sulfate aerosols were generated by atomizing a solution of 50 mg of ammonium sulfate dissolved in 80 ml of pure water. Results are shown in Figure 1 and Table 3 interpolated at the three Aurora wavelengths (450, 525, and 635 nm). The results from the intercomparison were acceptable with deviations in the range of 3.2% to 7.6% for the total scattering and −1.8% to 8.6% for the backscattering.

| Wavelength (nm) | Total scattering | | Backscattering | |
|---|---|---|---|---|
| | Slope | Correlation coefficient ($R^2$) | Slope | Correlation coefficient ($R^2$) |
| 450 | 1.04 | 1 | 0.982 | 0.997 |
| 525 | 1.076 | 1 | 1.041 | 0.998 |
| 635 | 1.032 | 0.999 | 1.086 | 0.997 |

***Table 3**. Average and standard deviation values obtained from the intercomparison of TSI nephelometer to the master instrument before inspection and cleaning. The test aerosol is submicron ammonium sulfate.*

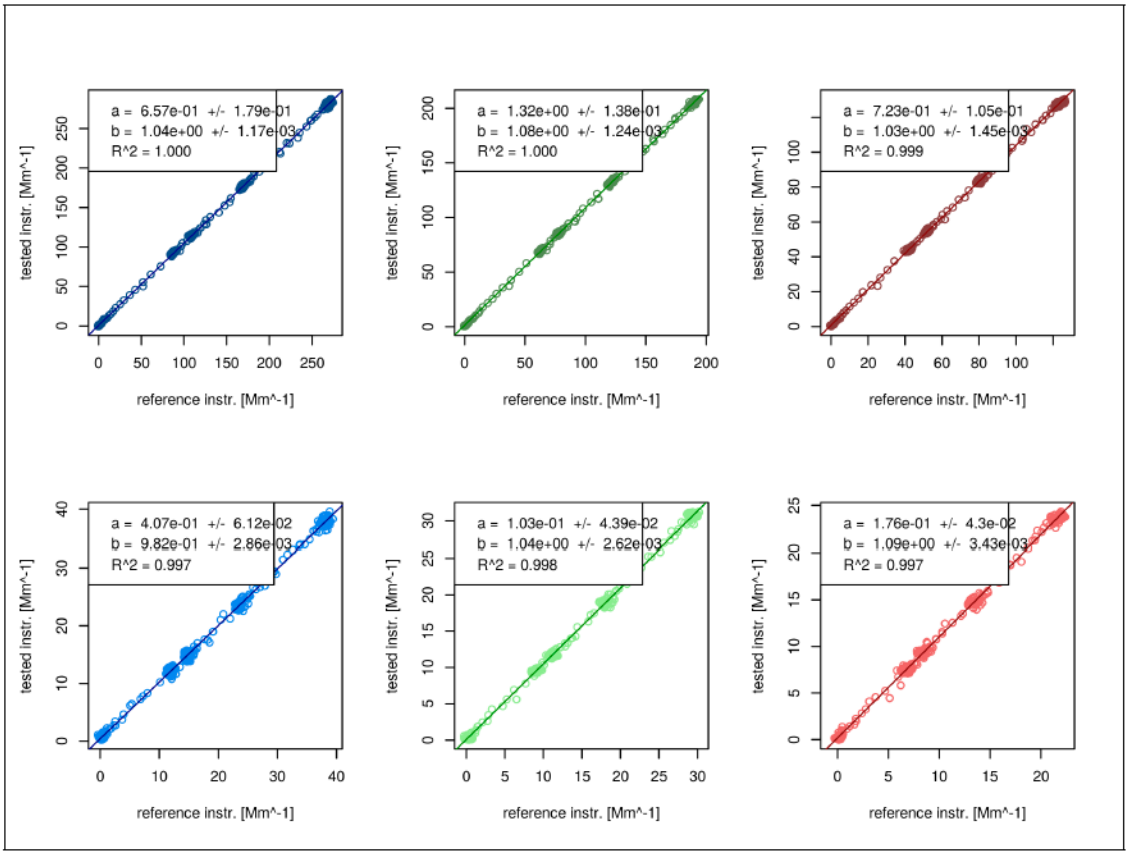


***Figure 1.** Correlation of scattering coefficients from TSI nephelometer and the master nephelometer Aurora4000 before inspection and cleaning. The test aerosol is submicron ammonium sulfate.*

After the intercomparison, the nephelometer was opened and inspected. The measuring cell and the light trap were contaminated with dust aerosols. The measuring cell and the light trap were completely cleaned. We also revised the full procedure for instrument inspection, checking and cleaning.

After that operation, the intercomparison with the master nephelometer was repeated. Results are reported in Table 4 and Figure 2. They showed that the intercomparison improved after the cleaning of the instrument, with deviations in the range of 1.5 to 5.6% for the total scattering and –3.7% to 5.6 % for the backscattering compared to the master Aurora nephelometer.

| Wavelength (nm) | Total scattering | | Backscattering | |
|---|---|---|---|---|
| | Slope | Correlation coefficient ($R^2$) | Slope | Correlation coefficient ($R^2$) |
| 450 | 1.02 | 0.999 | 0.963 | 0.996 |
| 525 | 1.056 | 0.999 | 1.024 | 0.997 |
| 635 | 1.015 | 0.999 | 1.056 | 0.994 |

***Table 4**. Average and standard deviation values obtained from the intercomparison of TSI nephelometer to the master instrument after inspection and cleaning. The test aerosol is submicron ammonium sulfate.*

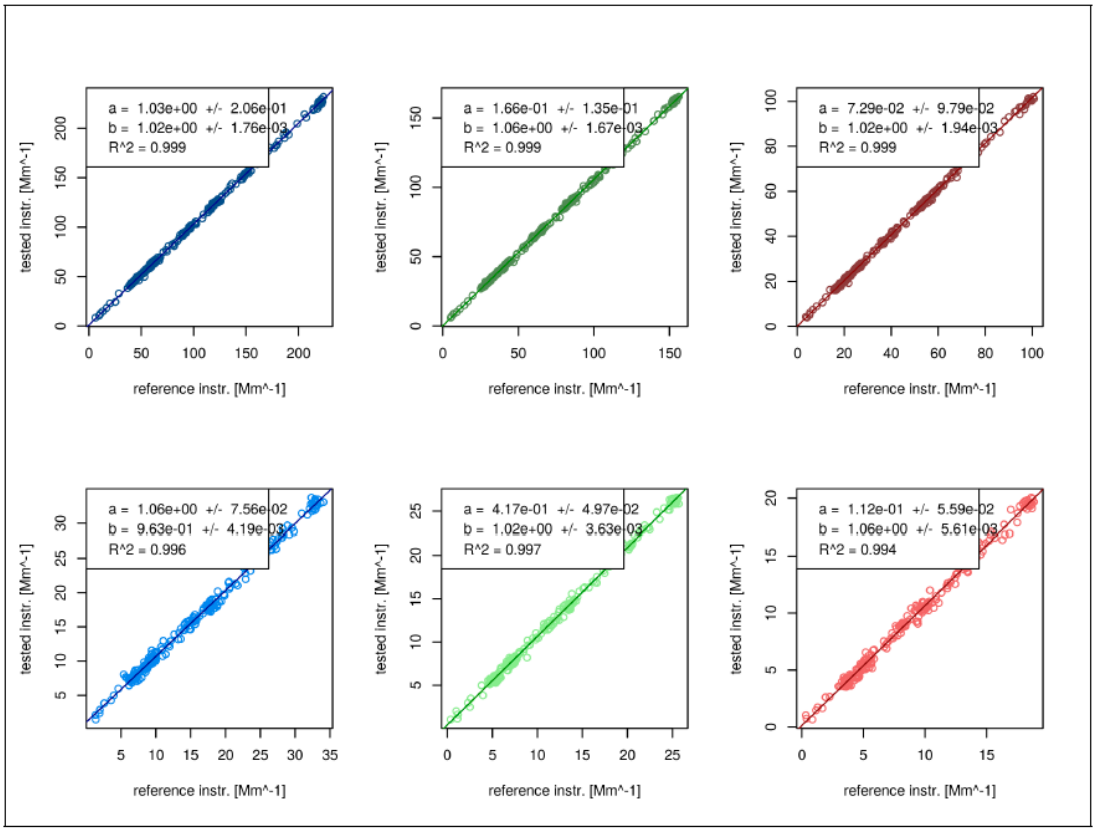


***Figure 2.** Correlation of scattering coefficients from TSI nephelometer and the master nephelometer Aurora4000 after inspection and cleaning. The test aerosol is submicron ammonium sulfate.*

Because of the good results of the intercomparison after inspection and cleaning, the recalibration was not performed.
Nonetheless, we tested the calibration software of the nephelometer provided by TSI. In fact, during tests performed in our laboratory before the calibration workshop, we noticed that it was not possible to update the nephelometer calibration based on the use of the owner-provided software. We tested the TSI software different times during the calibration workshop and we identified the problem, that seems to be an incorrect reading of the raw signals, but we were not able to fix it and to make the TSI software to correctly work for the calibration procedure. Nonetheless, we discussed possible alternative ways of performing calibration based on the standard acquisition program and applying manually the calibration calculation as explained in the manual.

In conclusion of the calibration workshop, we did not received any specific recommendation for our instrument that has been verified to meet the requirements for assuring data quality.
Revising the full procedure for instrument inspection and cleaning, as done during the workshop, has been very helpful and will help us to improve the performances of the nephelometer for its future use

**References**

WCCAP-report- IN-2020-1-3 (2020): Calibration workshop – Integrating Nephelometer Project No.: IN-2020-1-3, published in https://www.actris-ecac.eu/in-2020-1.html.