Intercomparison of Mobility Particle Size Spectrometers

Project No.:	*MPSS-2017-6-6*
Principal Investigator:	Prof. Dr. Maja Remskar
Home Institution:	Institut Iosef Stefan Jamova cesta 39 1000 Ljubljana Slovenia
Participant:	Kristina Glojek
Candidate:	**SI-IJS**
Made by:	**TSI, Classifier 3080 SN: 71030281**
Counter (SN):	TSI CPC Model 3785, SN: 85101002
Software:	TSI Software V9.0
Location of the quality assurance:	TROPOS Leipzig, lab 118
Comparison period:	November 06, 2017 – November 24, 2017
Last Intercomparison (with Project No.):	

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Summary of Intercomparison:

Status:
TROPOS received the following from Slovenia: one TSI MPSS system, a water TSI CPC 3785, and a laptop with the TSI Software Version 9.0. A direct Pre-status run against the TROPOS Reference MPSS was not possible because of several problems that are discussed in the following section:

1. TSI water CPC 3785: The water CPC was not running after unpacking. The wick was removed for shipping therefore TROPOS used a new one. All water tubes inside the CPC were completely dirty and few of them are blocked (see photo below). TROPOS removed all old and dirty tubes and cleaned the whole CPC including the internal optics.

The second problem was the aerosol flow. The nominal flow for calculating the raw concentration is 1 L/min. The measured flow using a bubble flow meter (Gilibrator) was 1.12 L/min. This means the internal calculated raw concentration is 12% higher than it should be. However, this 12% deviation might not be valid for previous data. TROPOS recalibrated the flow to 1 L/min. TROPOS recommends IJS to do a zero check and measure the aerosol flow once per week. Furthermore, it is necessary to change the internal wick every 6 months depending on the ambient conditions. When using the water CPC in a heavily polluted environment, use two water bottles: one for the filling and one for wastewater. Never recirculate the water to keep the internal parts and wick clean for a longer period.

2. TSI MPSS Column 3081: TROPOS checked and cleaned the DMA TSI column 3081.

3. TSI Classifier 3080: TROPOS checked the Classifier and did a high voltage check of the negative high voltage power supply. It was not necessary to recalibrate.

4. TSI Software Version: IJS is using the Software Version 9.0 to operate the TSI MPSS System 3080. It is not possible to upgrade this model to a software version 10.0 because it is not compatible with this classifier. Therefore, when using V9.0 of the software, the user must be aware of the following issue: when using an x-ray source in a Classifier 3080, you need to have an additional tool to correct the x-ray matrix. For Krypton and Nickel sources, this version works. Otherwise, the software is running with a wrong multiple charge correction. If IJS operated the MPSS under this condition, it will be necessary to completely recalculate the previous data.

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Hence, TROPOS cannot guarantee the performance of the instrument before this workshop.

Final-Status:
For the Final-status, TROPOS changed the following: the flow ration was changed to 5:1, the water CPC was recalibrated and cleaned, the TSI software version 9.0 was updated to include the inversion for an x-ray matrix, the impact and the bypass between the DMA and CPC were removed, a homemade Nafion dryer was installed in the aerosol line. Hence, the performance of the system showed a concentration 5% lower than the TROPOS Reference Instrument No.1. The PSL check showed a correct peak at 202.33 nm. The candidate used the recalibrated TSI CPC model 3772 and its own Kr.85 source. The candidate passed the quality standards of ACTRIS and GAW.

Information about the instruments:

Date of check: November 13, 2017

List of Components	TROPOS Reference MPSS No.1	TROPOS Reference MPSS No.4	Candidate
Position	Line 1	Line 2	Line 2
Company	TROPOS	TROPOS	TSI
Software	TROPOS	TROPOS	TSI V9.0
CPC-MPSS	TSI CPC, Model 3772	TSI CPC, Model 3772	TSI CPC, Model 3785
CPC-total	TSI CPC, Model 3010	TSI CPC, Model 3010	-
flow ratio	1.0 : 5.0	1.0 : 5.0	1.0 : 5.0
source	Kr.85	Ni.63	x-ray
HV power supply	Positive	Positive	negative
DMA	Hauke medium	Hauke medium	TSI 3081
aerosol dryer	✓	✓	-
aerosol RH- sensor	✓	✓	-
aerosol T-sensor	✓	✓	-
sheath RH-sensor	✓	✓	-
sheath T-sensor	✓	✓	-
Sheath dryer	✓	✓	-
pressure sensor	✓	✓	-
info			

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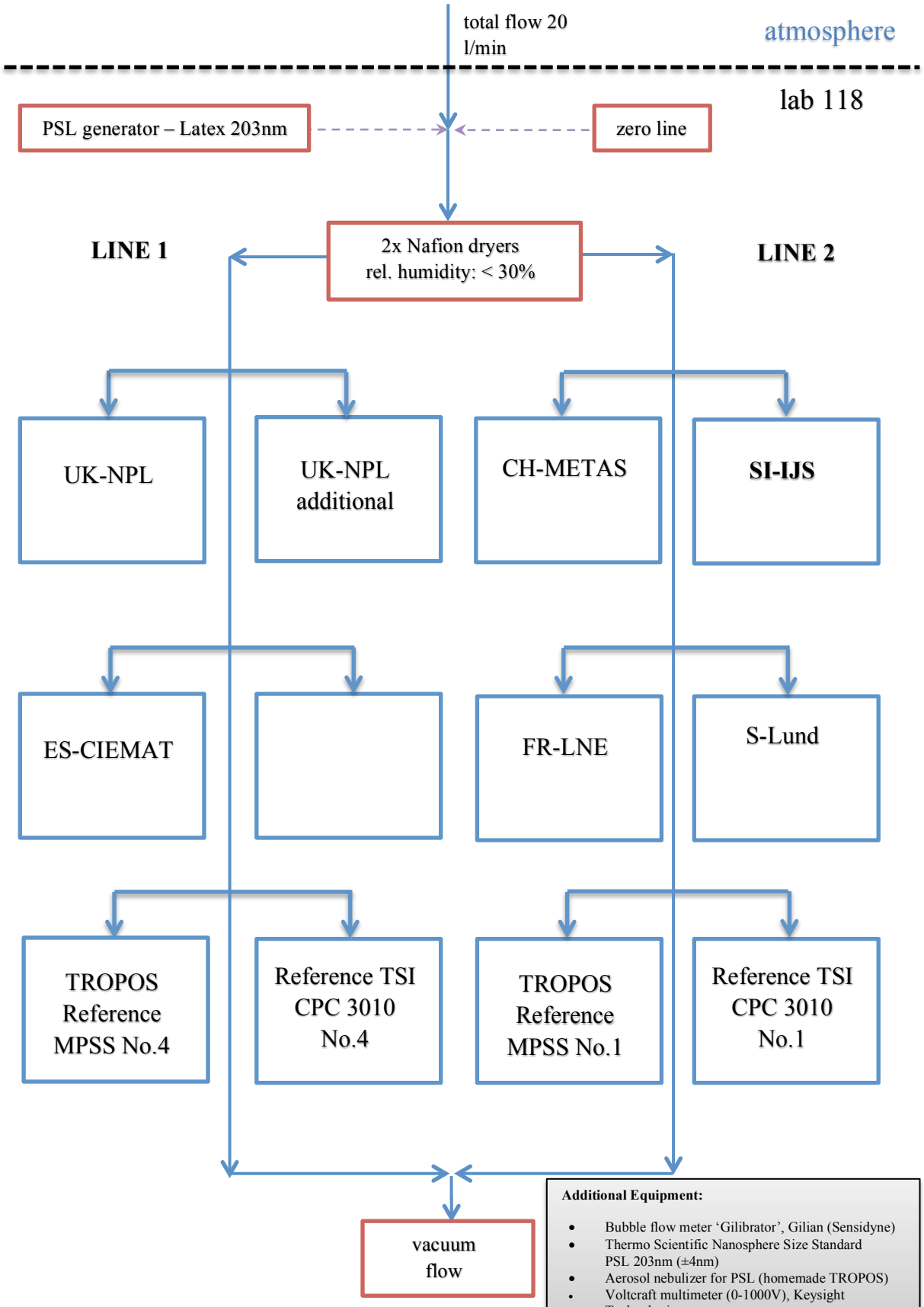
Laboratory setup:



Additional Equipment:

- Bubble flow meter 'Gilibrator', Gilian (Sensidyne)
- Thermo Scientific Nanosphere Size Standard PSL 203nm (±4nm)
- Aerosol nebulizer for PSL (homemade TROPOS)
- Voltcraft multimeter (0-1000V), Keysight Technologies

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Status of the instruments:

Date of system checks:

date	13.11.2017	20.11.2017	27.11.2017		unit
total CPC flow	-	-	-		l/min
aerosol flow (DMA)	-	-	-		l/min
aerosol flow (total)	1.125	1.0	1.01		l/min
Zero MPSS	0	0	0		#/cm³
Zero total CPC	-	-	-		#/cm³
PSL 203 nm	208	204	204		nm
HV – 20 V	-	19.3	19.8		V
HV – 50 V	-	48.8	49.1		V
HV – 200 V	-	198.2	198.6		V
HV – 900 V	-	897.5	898.4		V

Special Information regarding the Candidate:

Was it necessary to:	yes/no (date)	old part (ID/SN)	new part (ID/SN)	information
clean the aerosol inlet	Yes	-	-	
change aerosol Nafion dryer	no			
change sheath Nafion dryer	no			
check source	no	-	-	Is not possible
change HV power supply	no	-	-	-
clean/change DMA	yes	-	-	Cleaned; DMA okay
change aerosol RH/T-sensor	no	-	-	-
change sheath RH/T-sensor	no	-	-	-
change pressure sensor	no	-	-	-
change inlet Nafion dryer (500)	no	-	-	-
Change Total filter	no	-	-	-

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PSL Scan and calibration: Latex 203 nm +/- 4 nm

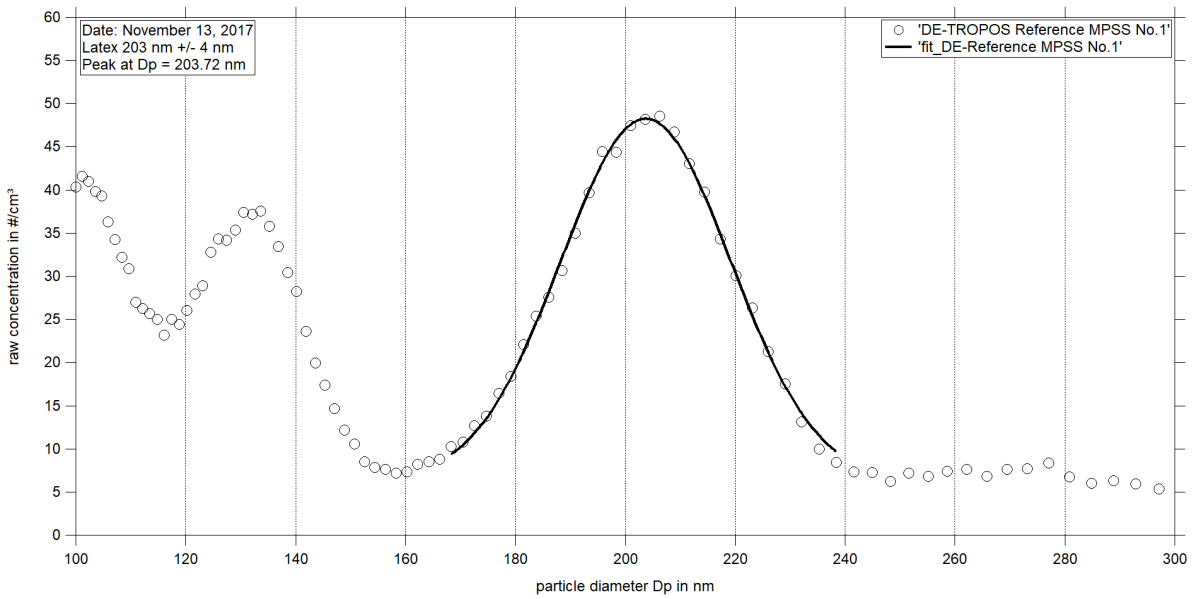

Figure 01: Measurement of latex 203 nm TROPOS Reference Instrument No.1: Particle size distribution (raw concentration) for latex 203 nm on Novmeber 13rd, 2017.

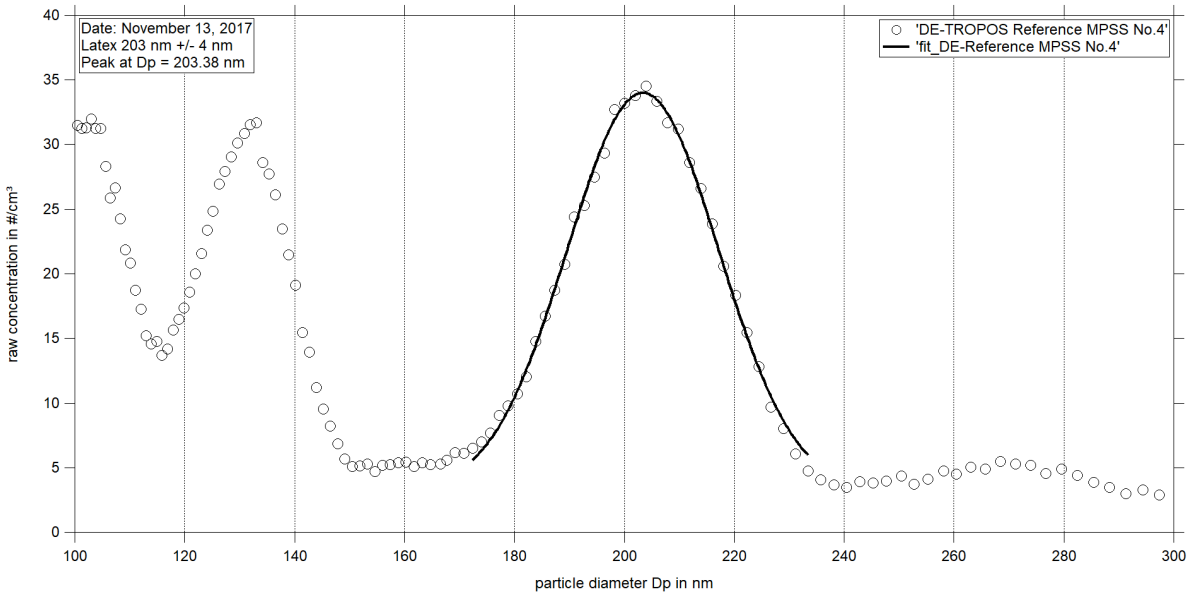

Figure 02: Measurement of latex 203 nm TROPOS Reference Instrument No.4: Particle size distribution (raw concentration) for latex 203 nm on Novmeber 13rd, 2017.

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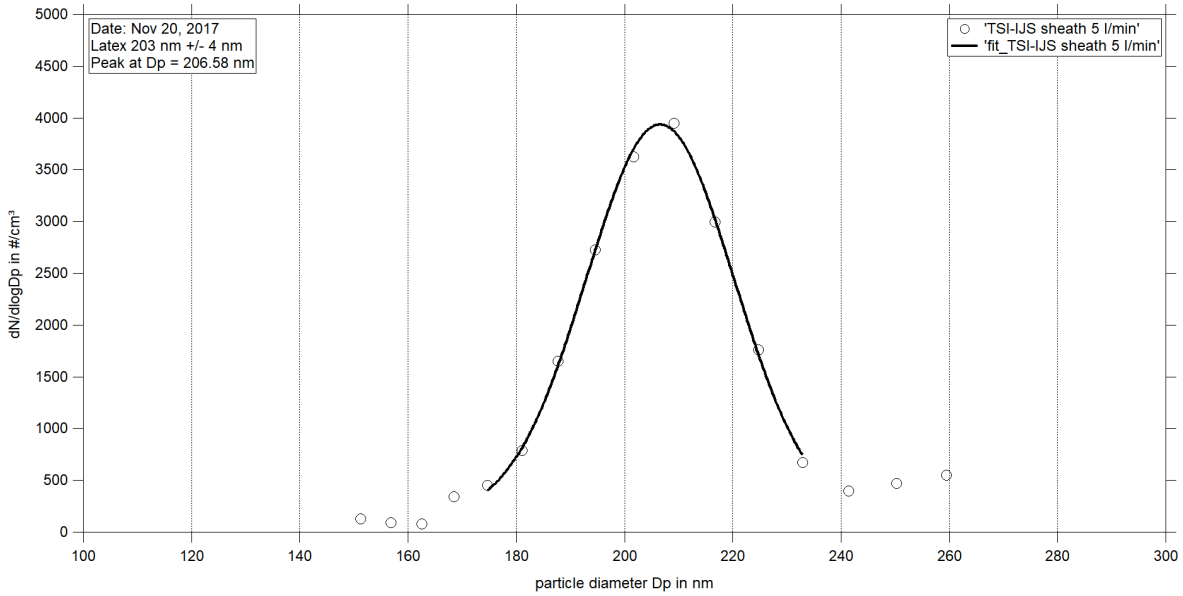

Figure 03: Measurement of latex 203 nm TSI MPSS with sheath flow 5.0 l/min: Particle size distribution (inverted data) for latex 203 nm on November 20rd, 2017.

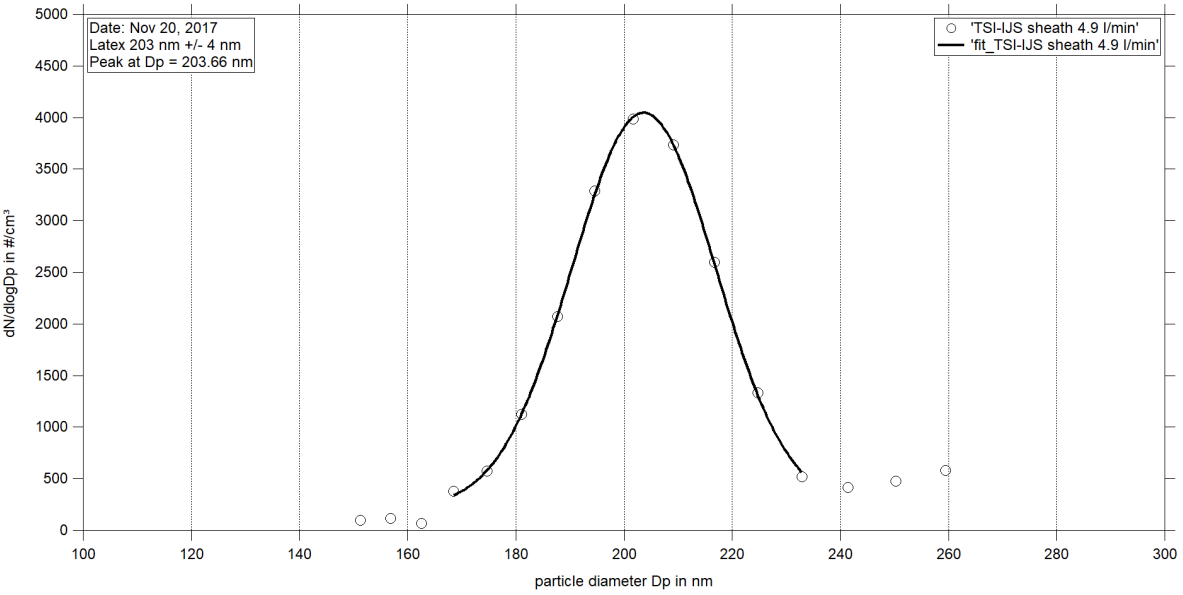

Figure 04: Measurement of latex 203 nm TSI MPSS with sheath flow 4.9 l/min: Particle size distribution (inverted data) for latex 203 nm on November 20rd, 2017.

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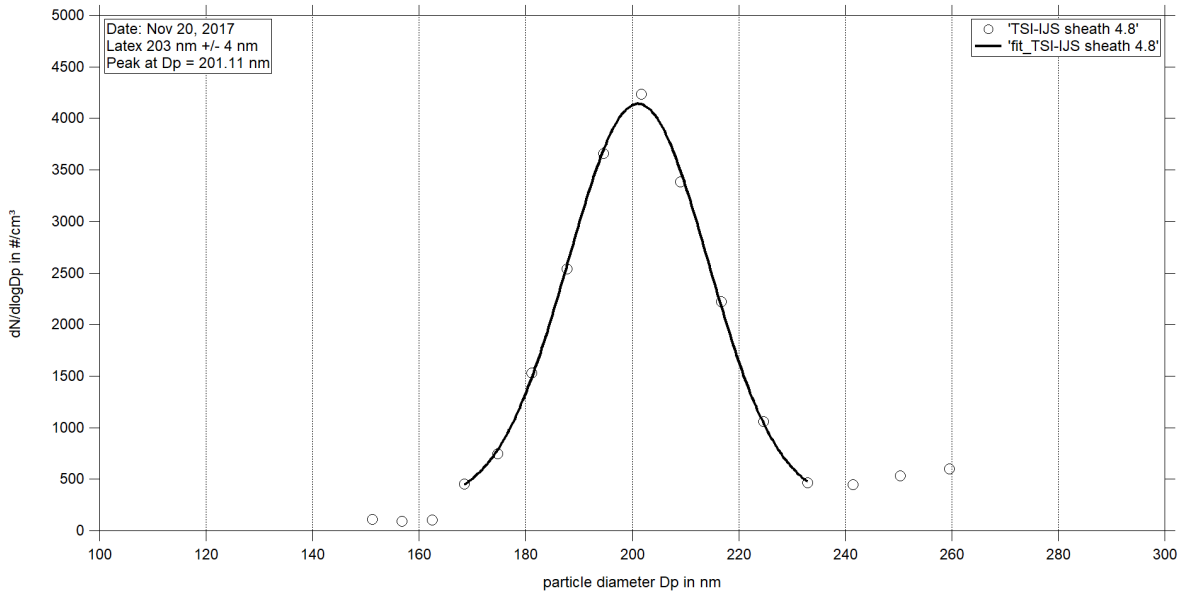

Figure 05: Measurement of latex 203 nm TSI MPSS with sheath flow 4.8 l/min: Particle size distribution (inverted data) for latex 203 nm on November 20rd, 2017.

By changing the sheath flow, you adjust the sizing of the instrument to the nominal diameter of 203 nm given by PSL. It is necessary to check the sheath flow monthly and if necessary adjust/calibrate it with PSL 203 nm.

Performance of the Candidate using varying different settings:

- **TROPOS components,**
- **TROPOS inversion software**
- **TROPOS internal correction**
- **Hardware changes**
- **TSI MPSS software settings**

The settings and setup details are mentioned in a legend directly in the plot.

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Setup 1: Status of the Candidate: Particle Number Size Distribution

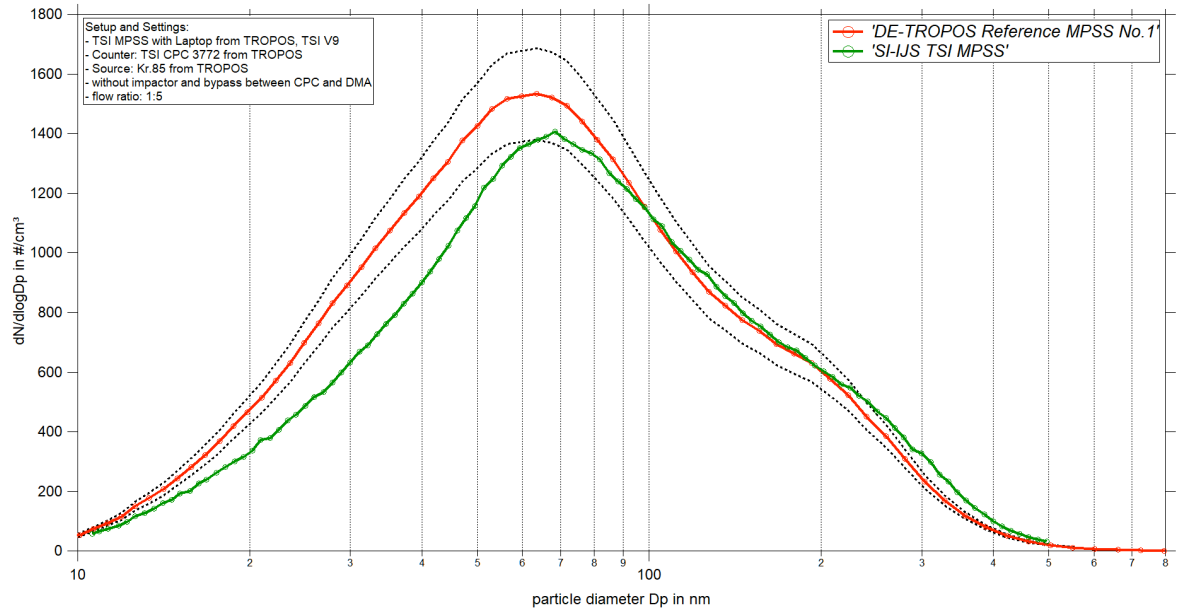

Figure 06: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against SI-IJS TSI MPSS from Nov 6, 2017 08:00 PM – Nov 7, 2017 06:00 AM. The following settings were used for the TROPOS Reference MPSS: multiple charge correction, internal diffusion losses and CPC efficiency. Setup details and settings for the candidate are mentioned in the plot.

Status of the Candidate: Time Series

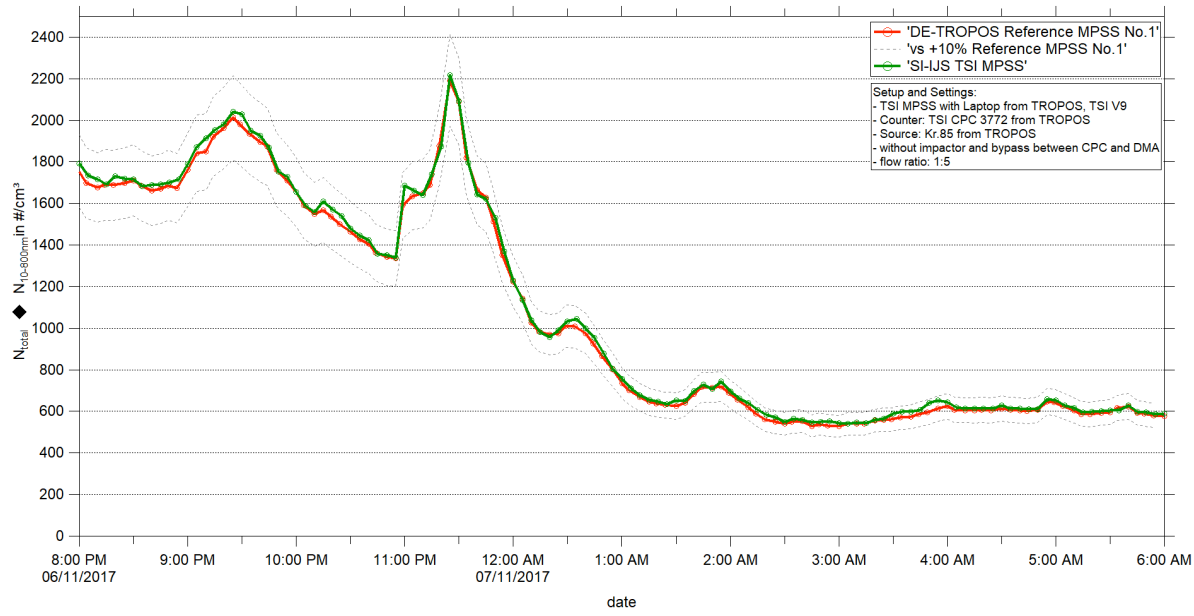

Figure 07: Time series (Nov 06, 2017 08:00 PM – Nov 07, 2017 06:00 AM) of the integrated particle number concentration ($N_{10\text{-}800nm}$) of the MPSS. The following settings were used for the TROPOS Reference MPSS: multiple charge correction, internal diffusion losses, CPC efficiency and CPC flow corrections. Setup details and settings for the candidate are mentioned in the plot.

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Setup 2: Status of the Candidate: Particle Number Size Distribution

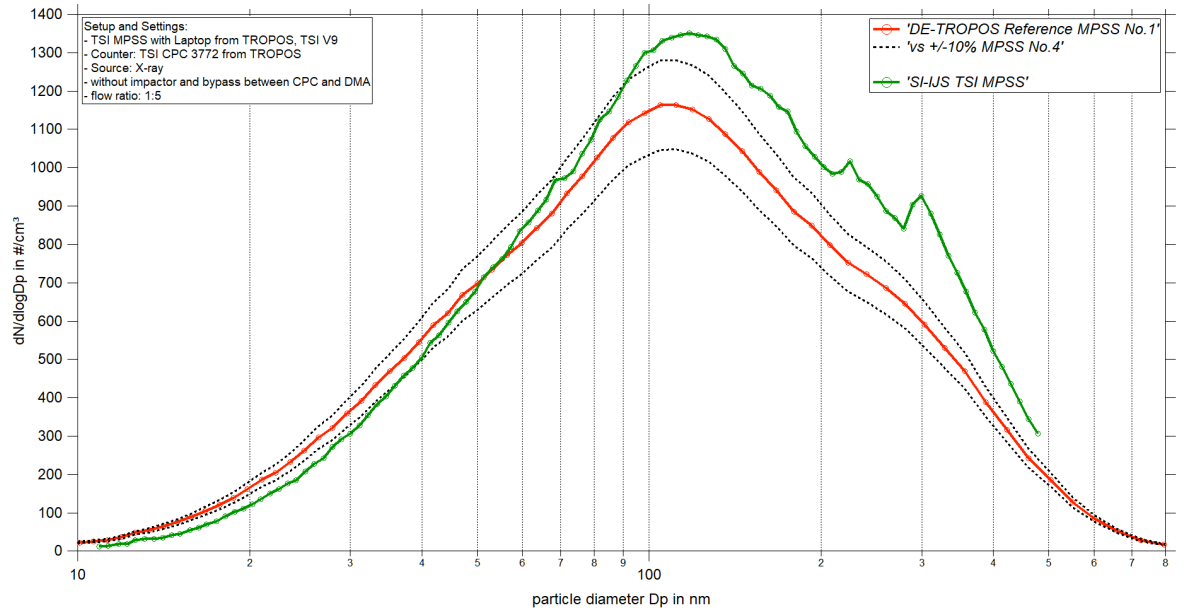

Figure 08: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against SI-IJS TSI MPSS from Nov 8, 2017 08:00 PM – Nov 9, 2017 06:00 AM. The following settings were used for the TROPOS Reference MPSS: multiple charge correction, internal diffusion losses and CPC efficiency. Setup details and settings for the candidate are mentioned in the plot.

Status of the Candidate: Time Series

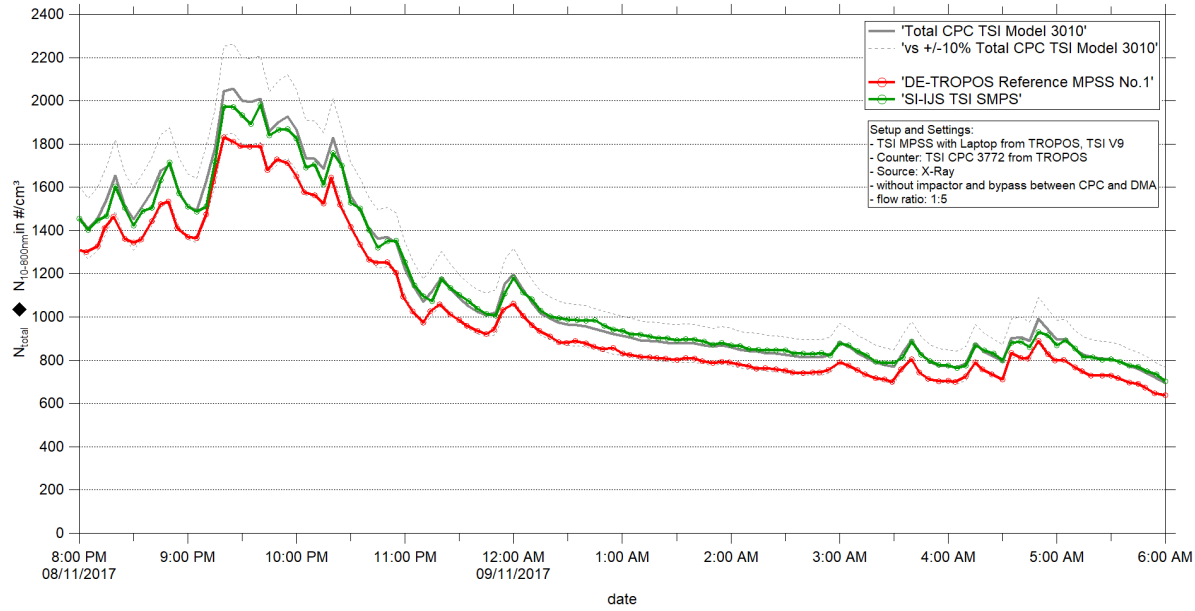

Figure 09: Time series (Nov 08, 2017 08:00 PM – Nov 09, 2017 06:00 AM) of the integrated particle number concentration ($N_{10\text{-}800nm}$) of the MPSS. The following settings were used for the TROPOS Reference MPSS: multiple charge correction, internal diffusion losses, CPC efficiency and CPC flow corrections. Setup details and settings for the candidate are mentioned in the plot.

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Setup 3: Status of the Candidate: Particle Number Size Distribution

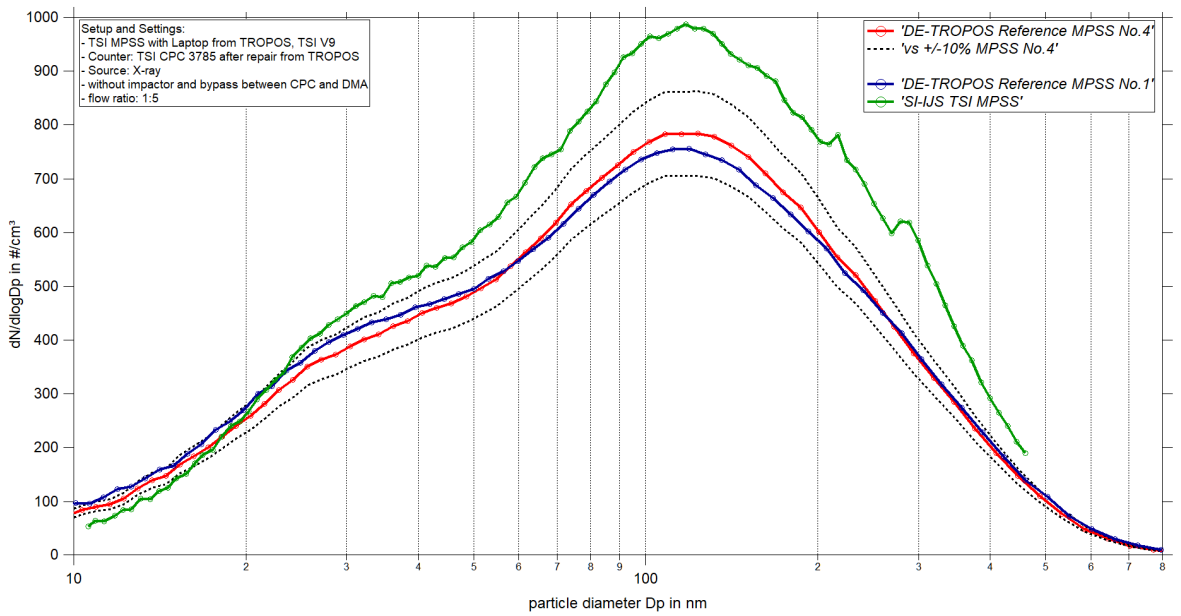

Figure 10: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1+4 against SI-IJS TSI MPSS from Nov 9, 2017 08:00 PM – Nov 10, 2017 06:00 AM. The following settings were used for the TROPOS Reference MPSS: multiple charge correction, internal diffusion losses and CPC efficiency. Setup details and settings for the candidate are mentioned in the plot.

Status of the Candidate: Time Series

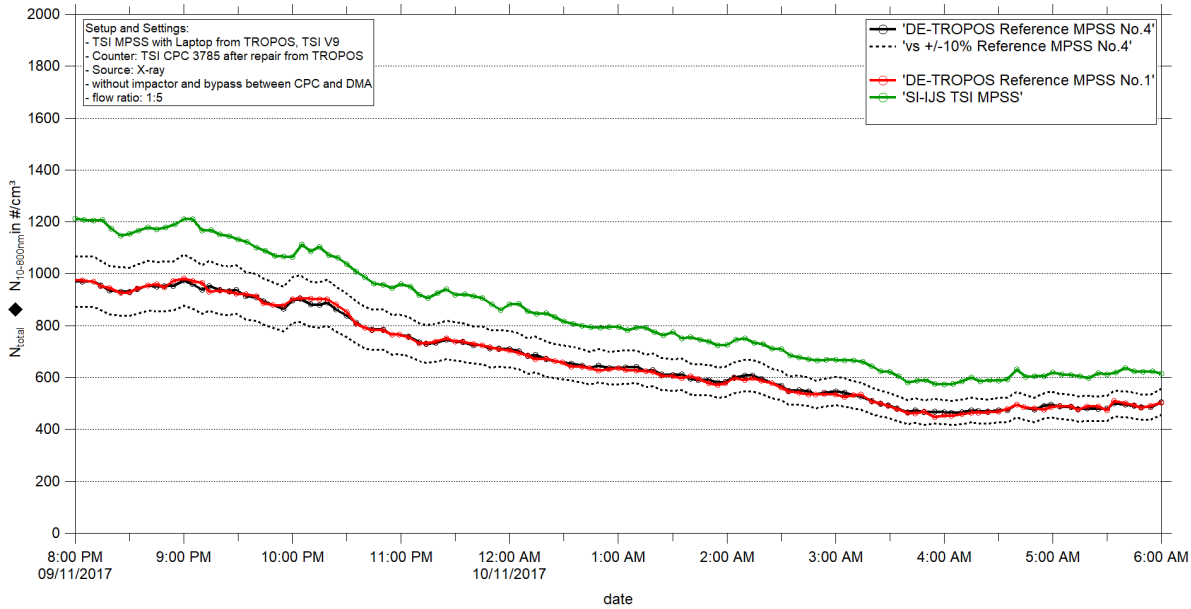

Figure 11: Time series (Nov 09, 2017 08:00 PM – Nov 10, 2017 06:00 AM) of the integrated particle number concentration ($N_{10\text{-}800nm}$) of the MPSS. The following settings were used for the TROPOS Reference MPSS: multiple charge correction, internal diffusion losses, CPC efficiency and CPC flow corrections. Setup details and settings for the candidate are mentioned in the plot.

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Final-Status of the Candidate: Particle Number Size Distribution

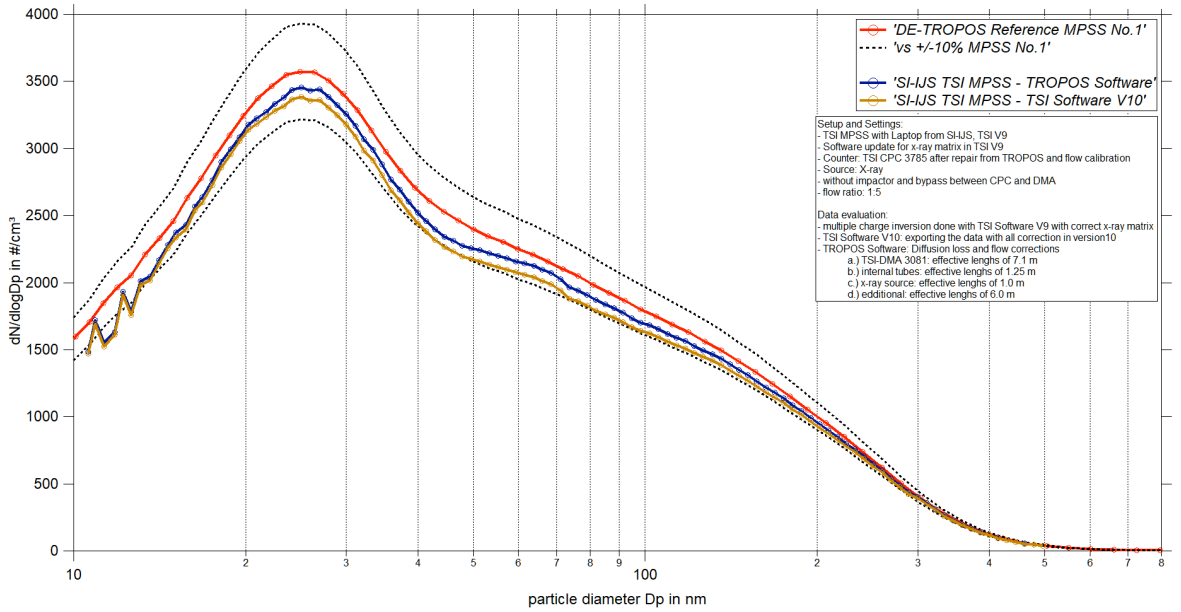

Figure 12: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against SI-IJS TSI MPSS from Nov 21, 2017 09:00 PM – Nov 23, 2017 06:00 AM. The following settings were used for the TROPOS Reference MPSS: multiple charge correction, internal diffusion losses and CPC efficiency. Setup details and settings for the candidate are mentioned in the plot.

Final-Status of the Candidate: Time Series

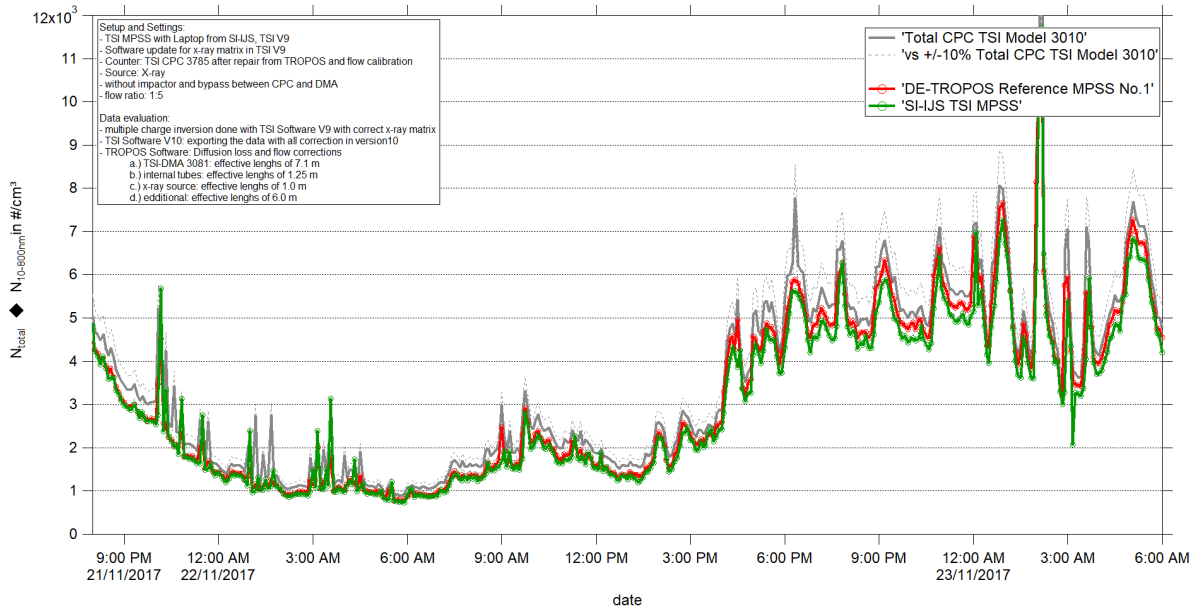

Figure 13: Time series (Nov 21, 2017 09:00 PM – Nov 23, 2017 06:00 AM) of the integrated particle number concentration ($N_{10\text{-}800nm}$) of the MPSS. The following settings were used for the TROPOS Reference MPSS: multiple charge correction, internal diffusion losses, CPC efficiency and CPC flow corrections. Setup details and settings for the candidate are mentioned in the plot.

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Final-Status of the Candidate: Correlation

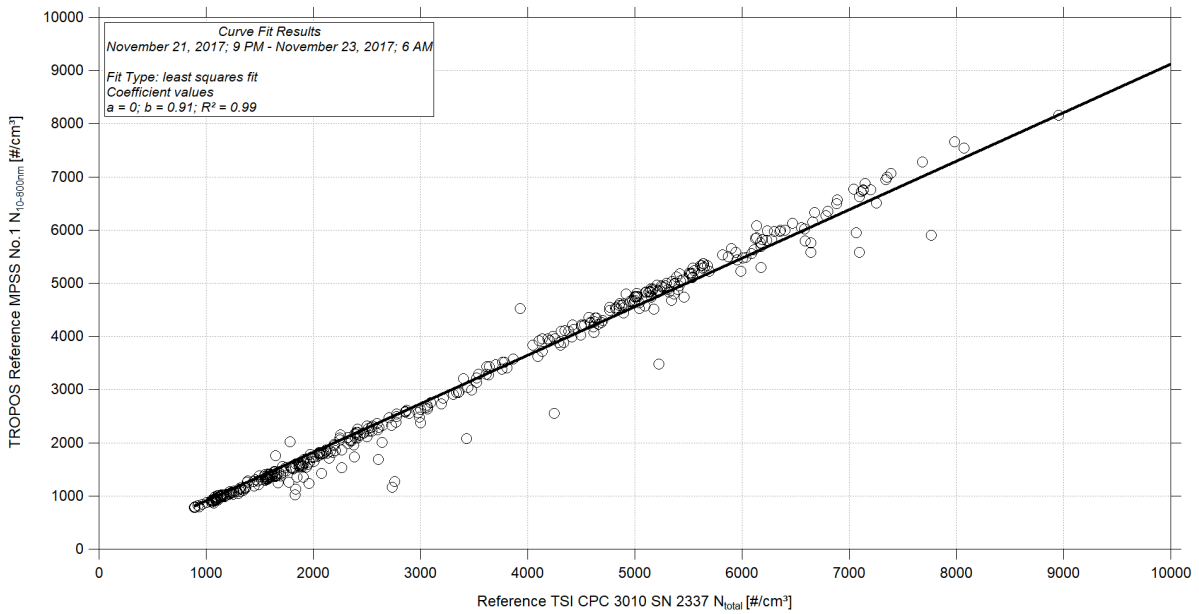

Figure 14: Linear regression between the number concentrations of the TROPOS Reference TSI CPC Model 3010 SN: 2337 and TROPOS Reference MPSS No.1 (Nov 21, 2017 09:00 PM – Nov 23, 2017 06:00 AM). Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

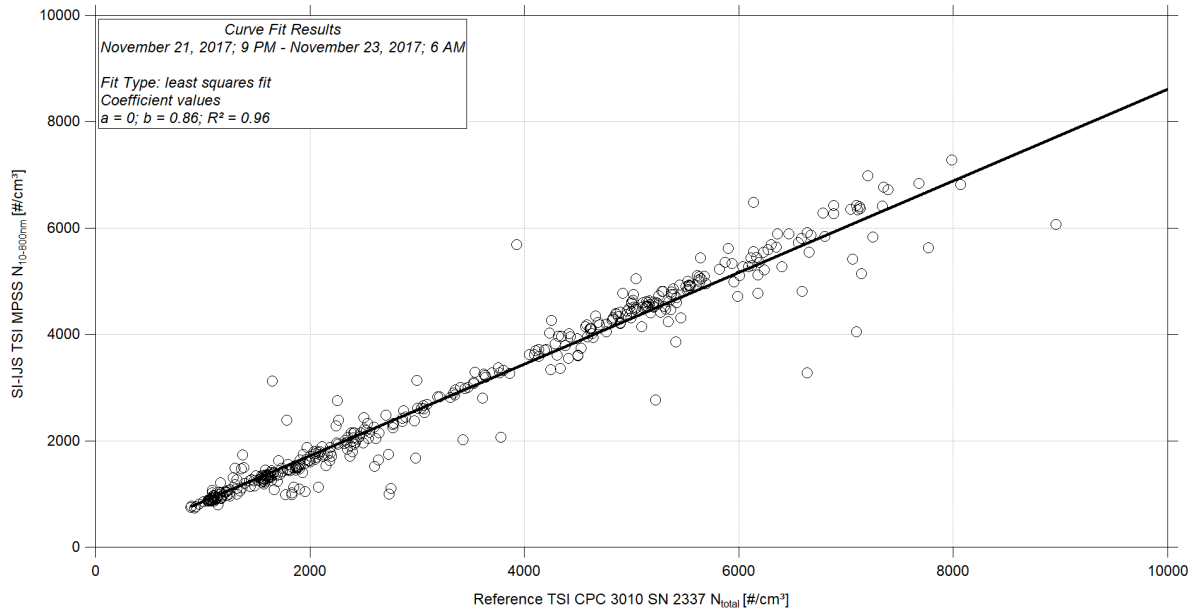

Figure 15: Linear regression between the number concentrations of the TROPOS Reference TSI CPC Model 3010 SN: 2337 and SI-IJS TSI MPSS (Nov 21, 2017 09:00 PM – Nov 23, 2017 06:00 AM). Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

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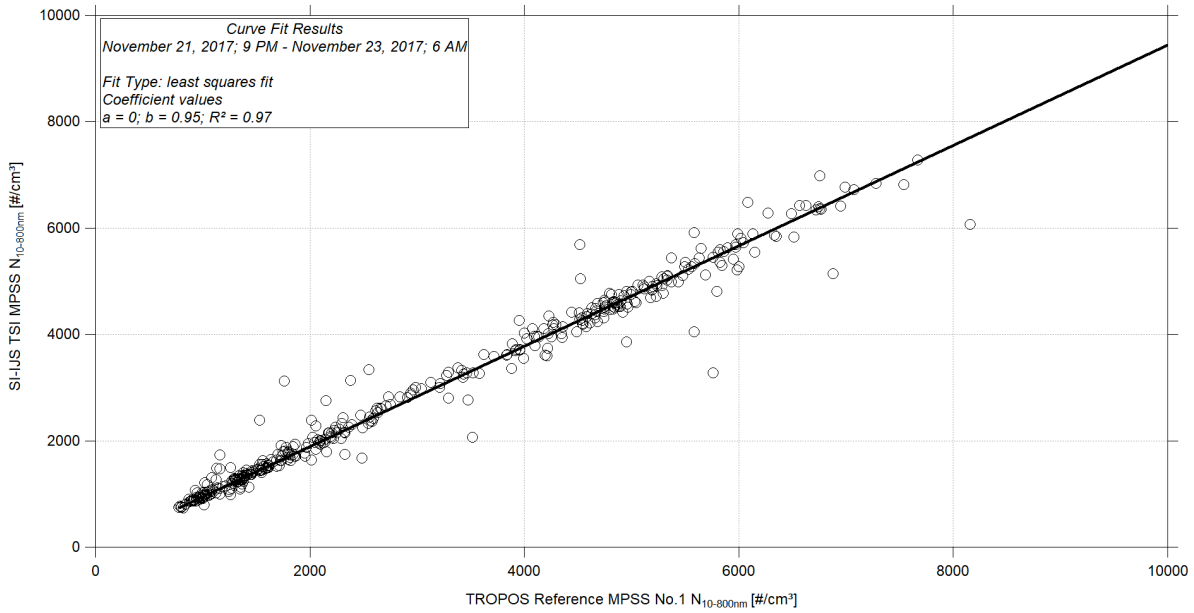

Figure 16: Linear regression between the number concentrations of the TROPOS Reference MPSS No.1 and SI-IJS TSI MPSS (Nov 21, 2017 09:00 PM – Nov 23, 2017 06:00 AM). Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

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