Intercomparison of Mobility Particle Size Spectrometers

Project No.:	*MPSS-2017-5-2*
Principal Investigator:	Patrik Nilsson
Home Institution:	Lund University, Nuclear Physics
Participant:	Patrik Nilsson
Candidate:	**S-LUND**
Made by:	**T-DMPS**
Counter (SN):	TSI 3025 SN: 1314 and TSI 3772, SN: 377216080
Software:	home made
Location of the quality assurance:	TROPOS Leipzig, lab 118
Comparison period:	October 09, 2017 – October 13, 2017
Last Intercomparison (with Project No.):	

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Summary of Intercomparison:

Pre-Status:
The instrument arrived with participant. The candidate from Lund is a home made TDMPS system with its own data acquisition. The candidate used a TSI UCPC Model 3025 in the UDMA part and a TSI CPC Model 3010 in the DMA part with a flow ratio of 3:20 and 1:6. It was not possible to bring their own radioactive source, hence, we used a Kr85 source from TROPOS for the whole intercomparison week. During the Pre-Status, the performance of the system showed a concentration 7% lower in the time series than the TROPOS Reference Instrument No.4. The PSL check showed a peak shifted to 212 nm. During the whole workshop, we had problems to optimize the system due to incomplete knowledge of the homemade software wherein some settings are fixed. Patrik Nilsson tried to communicate with Lund but, for example, in case of the PSL calibration, it was not possible to change the settings for a higher size resolution. In that case, it was not possible to do a correct calibration of the sizing. Furthermore, we found out that the instrument has higher diffusion losses for particles smaller than 60 nm. Only the inlet length can be changed. It was necessary to clean the CPC and DMA.

Final-Status:
During the Final-Status, the performance of the system showed a concentration 10% lower than the TROPOS Reference Instrument No.4. However, looking at the whole size range from 10 up to 800 nm the candidate fits to the TROPOS Reference Instrument No.4 implementing a correction factor of 10%. TROPOS found an orifice in the aerosol inlet and it was recommended to Patrik Nilsson to take it out because of higher diffusion losses for the size range from 10-80 nm. Lund should install a capillary to get information about the aerosol flow without disturbing the sample flow. TROPOS showed Patrik Nilsson possibilities on our TROPOS Reference instruments. For the next workshop, data acquisition and evaluation should be more transparent so we can find ways to change and improve settings for different modes of operation. The candidate passed the quality standards of ACTRIS and GAW.

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Information about the instruments:

Date of check: October 09, 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	LUND (T-DMPS)
Software	TROPOS	TROPOS	Home made
CPC-MPSS	TSI CPC, Model 3772	TSI CPC, Model 3772	TSI 3025 + 3772
CPC-total	TSI CPC, Model 3010	TSI CPC, Model 3010	
flow ratio	1.0 : 5.0	1.0 : 5.0	1:0 : 6.0; 3.0 : 20
source	Kr85	Ni63	Kr85 from TROPOS
HV power supply	Positive	Positive	Positive
DMA	Hauke medium	Hauke medium	Home made
aerosol dryer	✓	✓	✓
aerosol RH- sensor	✓	✓	✓
aerosol T-sensor	✓	✓	✓
sheath RH-sensor	✓	✓	✓
sheath T-sensor	✓	✓	✓
Sheath dryer	✓	✓	✓
pressure sensor	✓	✓	✓

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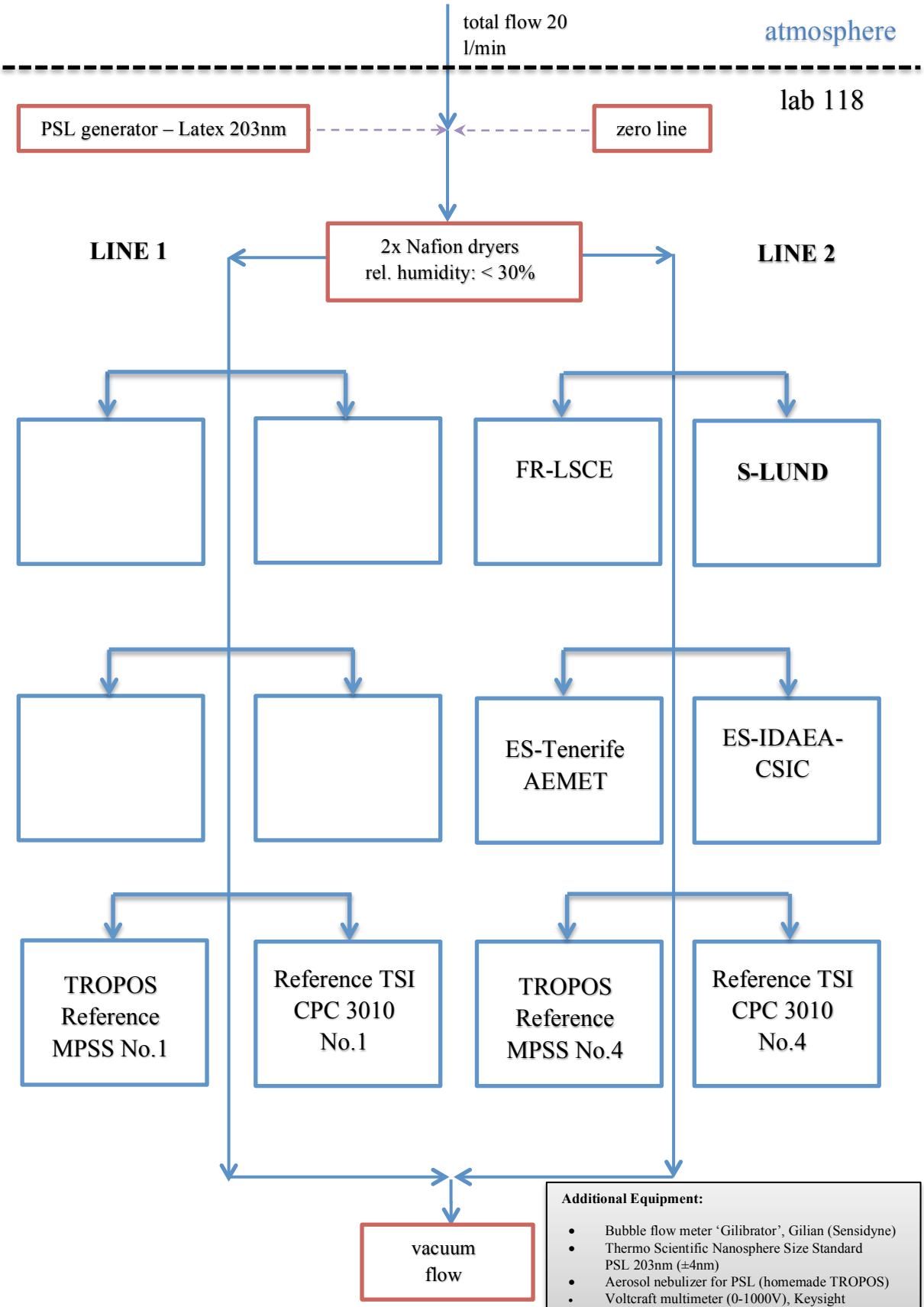
Laboratory setup:



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: more information are in the CPC Workshop Report

Date of check (Pre-Status): October 09, 2017

CPC status	MPSS (TSI 3772)		Total CPC	
power/status	LED green	-	-	-
saturator temp	39.0	°C	-	°C
condenser temp	22.0	°C	-	°C
optics temp	40.0	°C	-	°C
cabinet temp	31.9	°C	-	°C
ambient pressure	99.2	kPa	-	kPa
orifice pressure	82.5	kPa	-	kPa
nozzle pressure	2.2	kPa	-	kPa
laser current	39	mA	-	mA
liquid level	full	-	-	-

Date of check (Final-Status): October 12, 2017

CPC status	MPSS (TSI 3772)		Total CPC	
power/status	LED green	-	-	-
saturator temp	39.0	°C	-	°C
condenser temp	22.0	°C	-	°C
optics temp	40.0	°C	-	°C
cabinet temp	31.6	°C	-	°C
ambient pressure	99.5	kPa	-	kPa
orifice pressure	82.5	kPa	-	kPa
nozzle pressure	2.2	kPa	-	kPa
laser current	39	mA	-	mA
liquid level	full	-	-	-

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Date of system checks:

date	09.10.2017	10.10.2017	11.10.2017	13.10.2017	unit
total CPC flow	-	-	-	-	l/min
aerosol flow (DMA)	0.95	-	1.0	-	l/min
aerosol flow (UDMA)	3.0	-	3.0	-	l/min
aerosol flow (total)	3.8	3.9	3.95	-	l/min
Zero MPSS	0	-	0	-	#/cm³
Zero total CPC	-	-	-	-	#/cm³
PSL 203 nm		-	-	-	nm
HV – 0 V	UDMA 0.2 DMA 0	-	-	-	V
HV – 5 V	UDMA 5.0 DMA 5.2	-	-	-	V
HV – 100 V	UDMA 100.1 DMA 100.1	-	-	-	V
HV – 1000 V	UDMA 1000.1 DMA 100.2	-	-	-	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	No	-	-	-
change aerosol Nafion dryer	No	-	-	-
change sheath Nafion dryer	No	-	-	-
check source	No	-	-	TROPOS source
change HV power supply	No	-	-	-
clean/change DMA	YES	-	-	Cleaned DMA
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

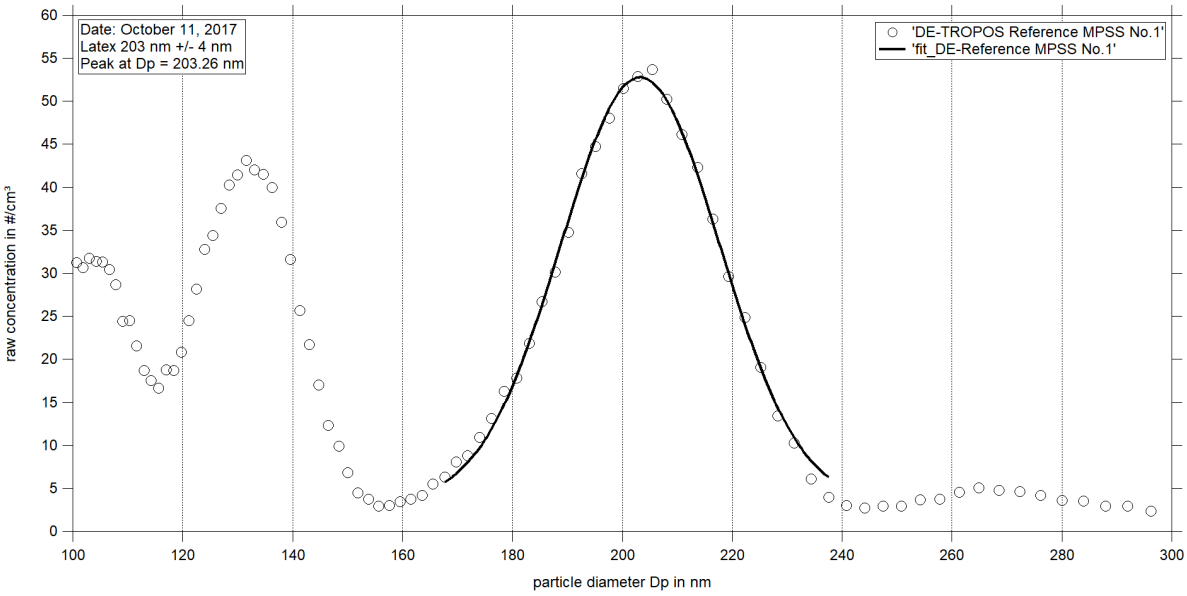

Figure 01: Measurement of latex 203 nm: Particle size distribution (raw concentration) for latex 203 nm on October 11rd, 2017.

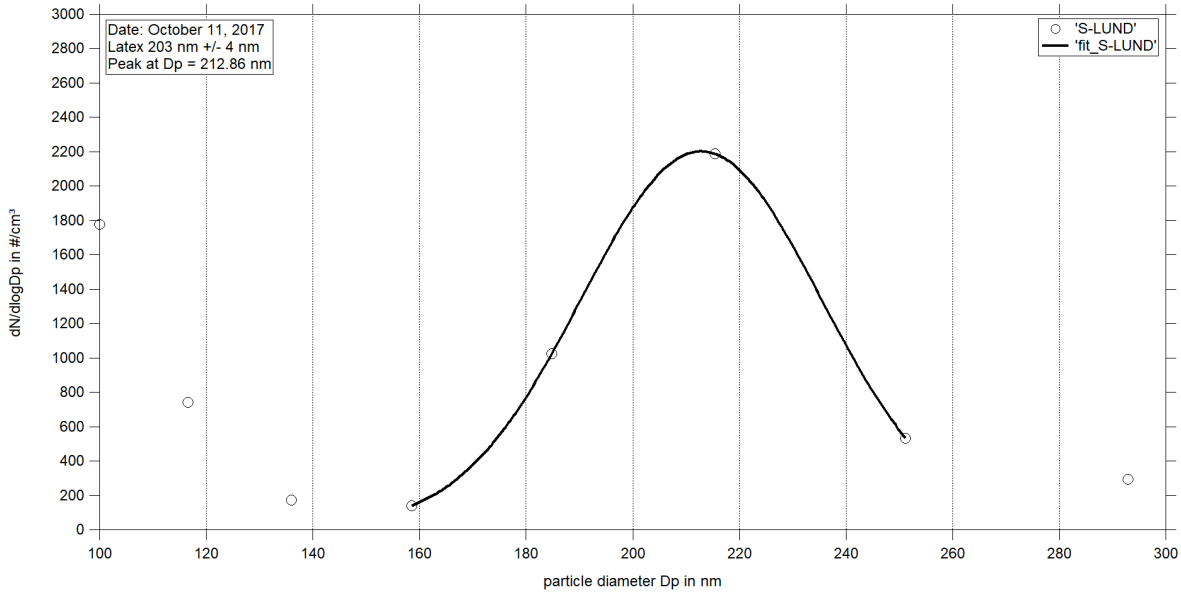

Figure 02: Measurement of latex 203 nm: Particle size distribution (raw concentration) for latex 203 nm on October 11rd, 2017.

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Status of the TROPOS Reference Instruments: Particle Number Size Distribution

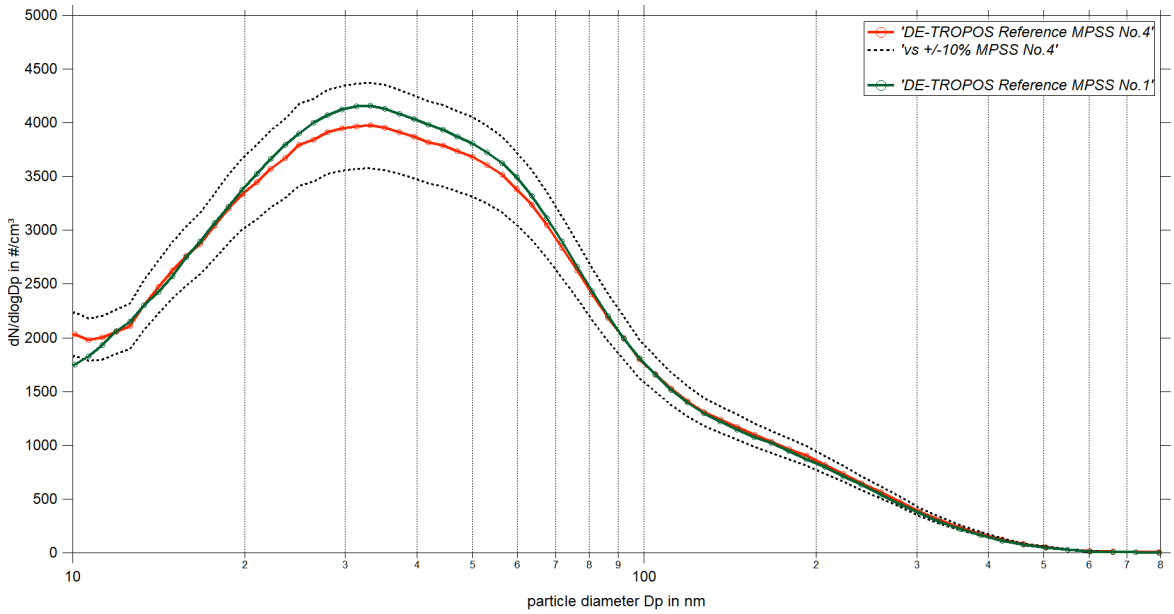

Figure 03: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against TROPOS Reference MPSS No.4 from October 09, 2017 08:00 PM – October 10, 2017 06:00 AM. Multiple charge correction, internal diffusion losses and CPC efficiency are included.

Status of the TROPOS Reference Instruments: Time Series

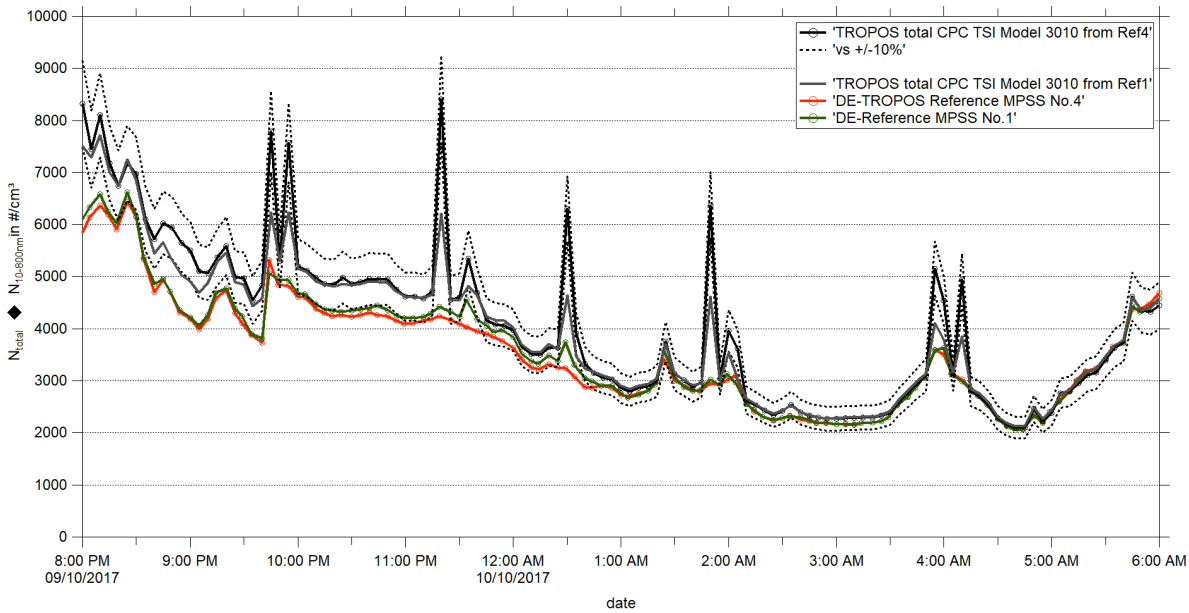

Figure 04: Time series (October 09, 2017 08:00 PM – October 10, 2017 06:00 AM) of the integrated particle number concentration ($N_{10\text{-}800nm}$) of the MPSS and total number concentration (N_{total}) of the Reference TSI-CPC Model 3010. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

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Status of the TROPOS Reference Instruments Correlation

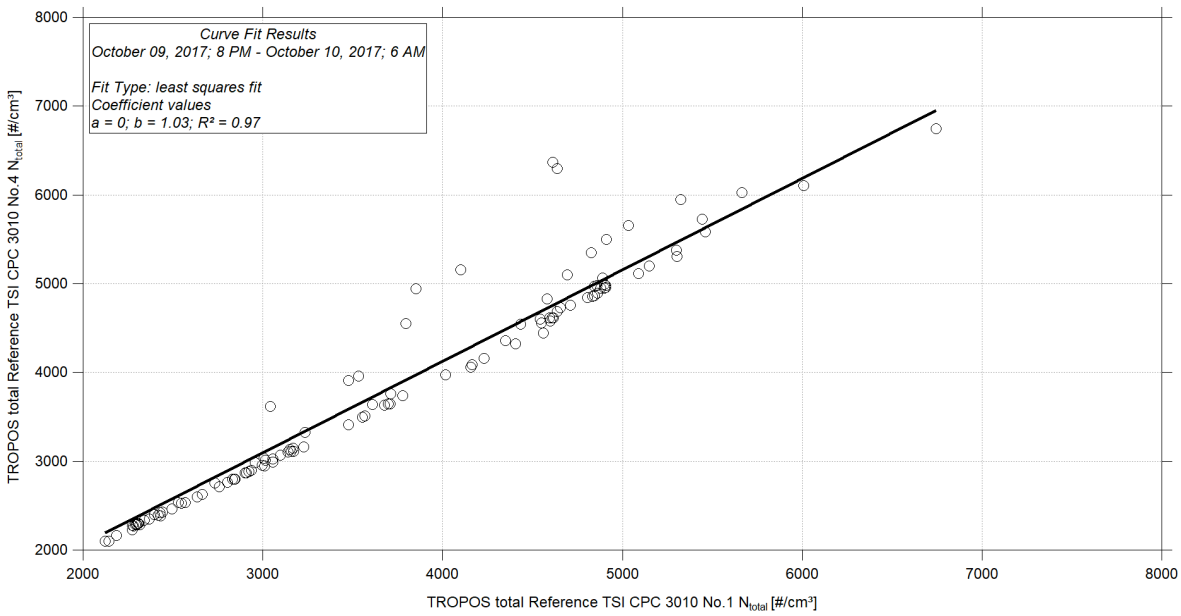

Figure 05: Linear regression between the number concentrations of the TROPOS total Reference TSI CPC Model 3010 No.1 and TROPOS total Reference TSI CPC Model 3010 No.4. Coincidence corrections and CPC flow corrections are included.

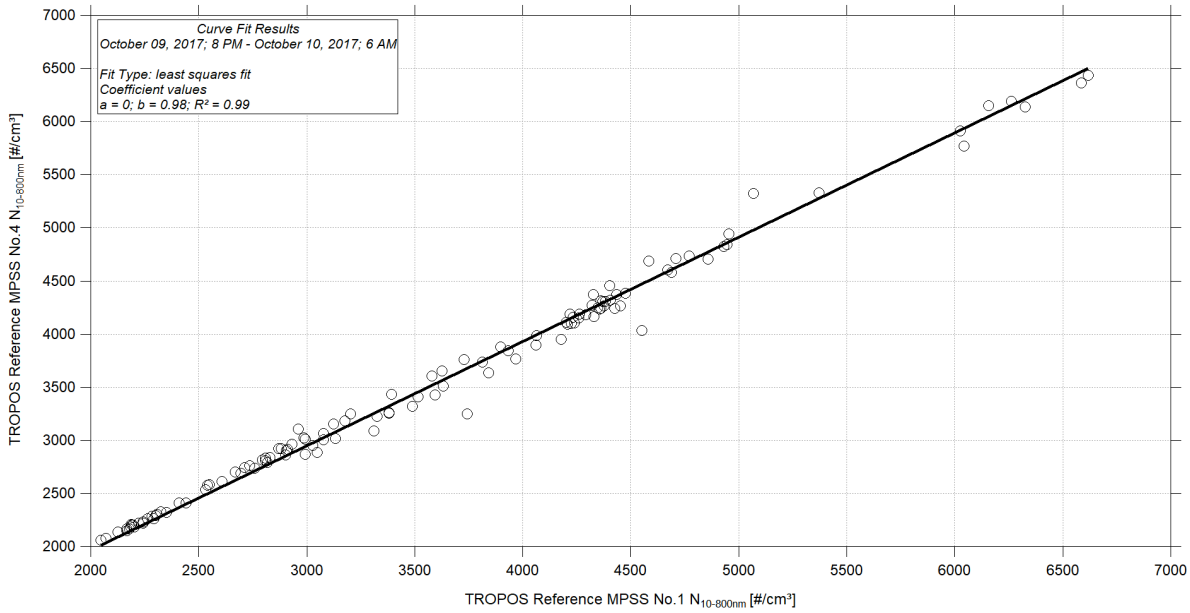

Figure 06: Linear regression between the number concentrations of the TROPOS Reference MPSS No.1 and TROPOS Reference MPSS No.4. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

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Pre-Status of the Candidate: Particle Number Size Distribution

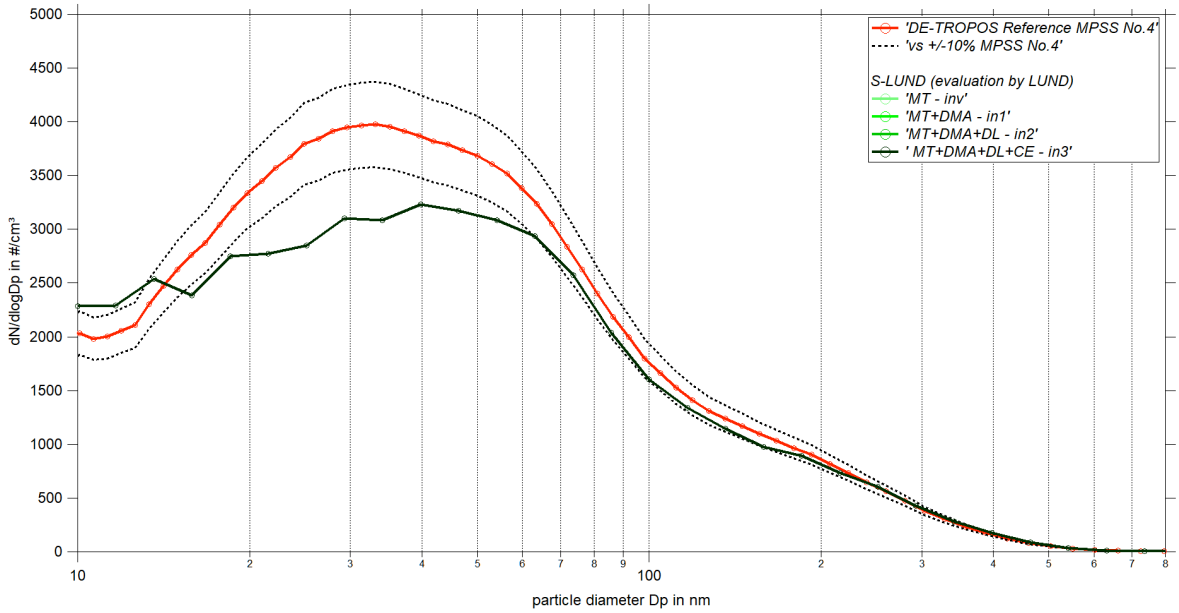

Figure 07: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.4 against FR-LSCE from October 09, 2017 08:00 PM – October 10, 2017 06:00 AM. Multiple charge correction, internal diffusion losses and CPC efficiency are included by using the LUND software.

Pre-Status of the Candidate: Time Series

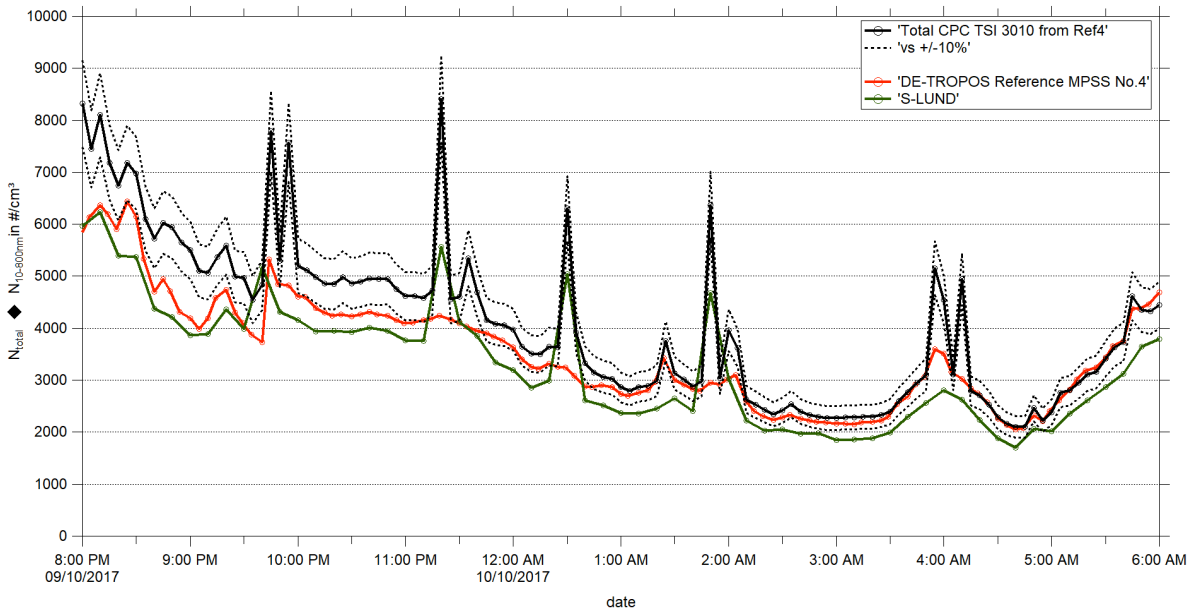

Figure 08: Time series (October 09, 2017 08:00 PM – October 10, 2017 06:00 AM) of the integrated particle number concentration ($N_{10\text{-}800nm}$) of the MPSS and total number concentration (N_{total}) of the Reference TSI-CPC Model 3010. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

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Pre-Status of the Candidate: Correlation

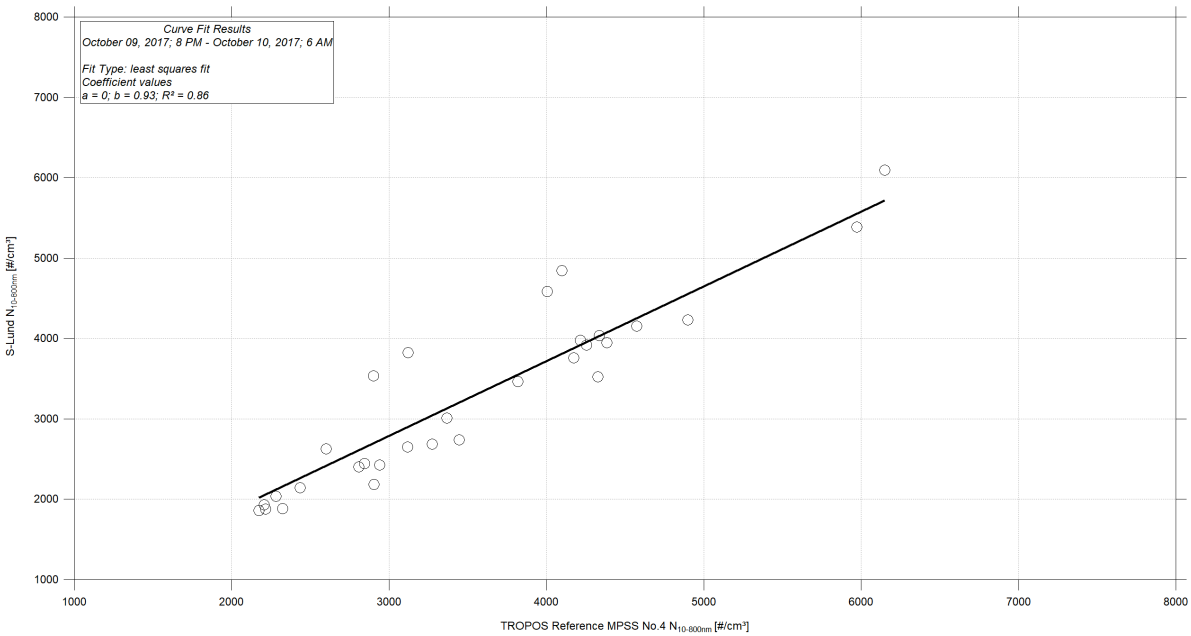

Figure 09: Linear regression between the number concentrations of the TROPOS Reference MPSS No.4 and S-Lund. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

Final-Status of the Candidate: Particle Number Size Distribution

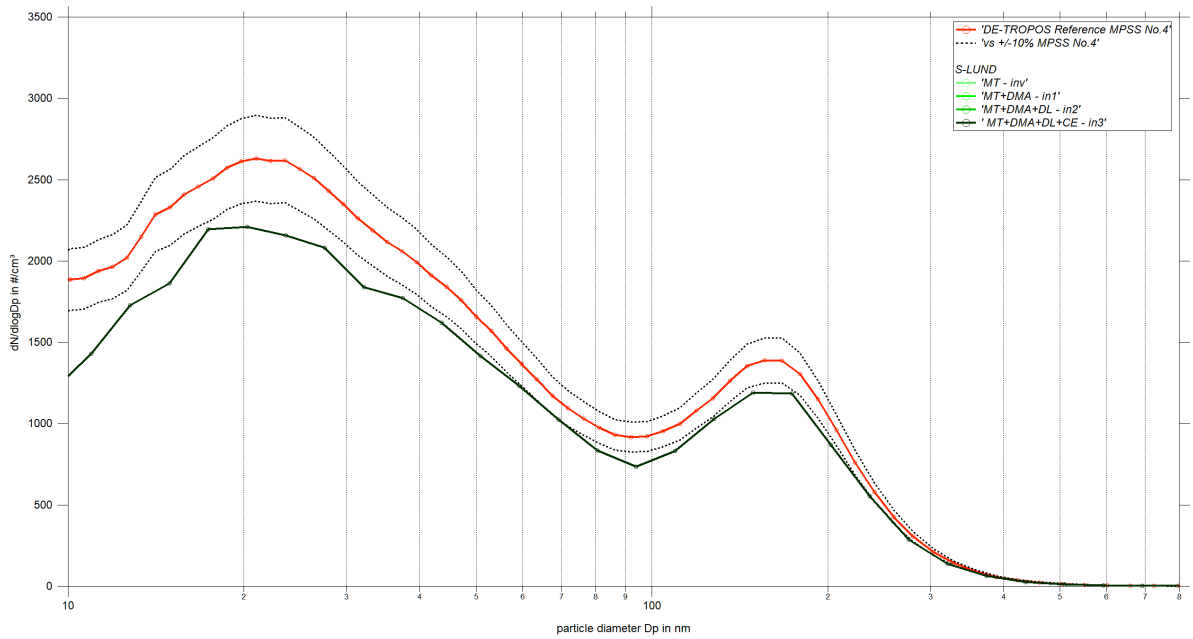

Figure 10: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.4 against S-Lund from October 11, 2017 08:00 PM – October 12, 2017 06:00 AM. Multiple charge correction, internal diffusion losses and CPC efficiency are included by using the LUND software.

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Final-Status of the Candidate: Time Series

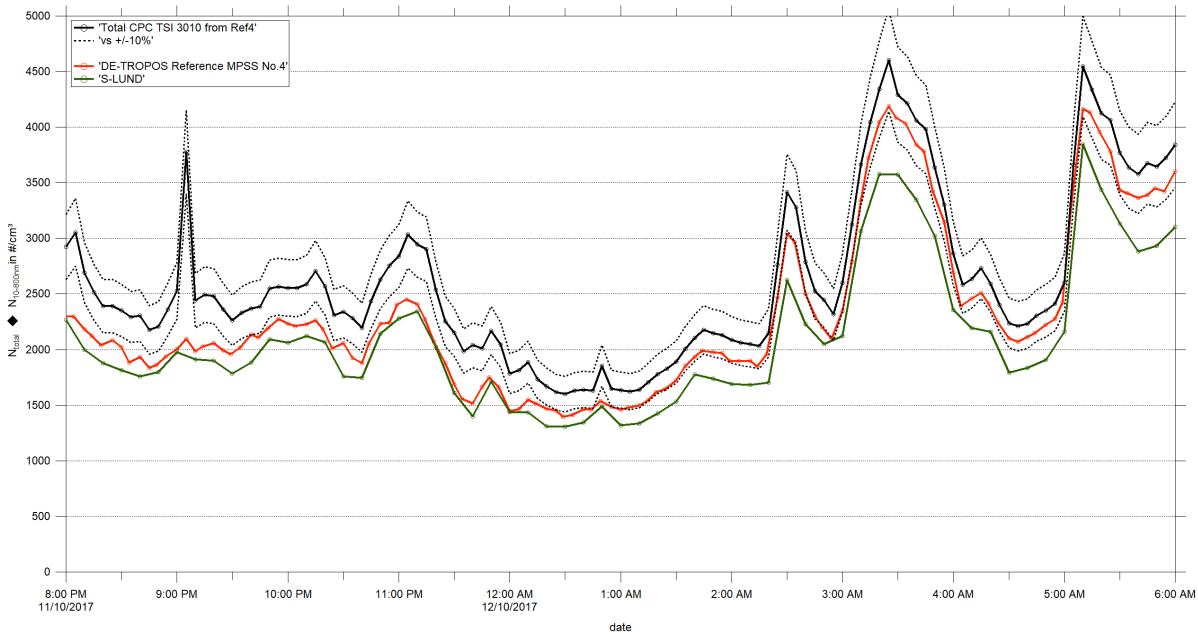

Figure 11: Time series (October 11, 2017 08:00 PM – October 12, 2017 06:00 AM) of the integrated particle number concentration ($N_{10\text{-}800nm}$) of the MPSS and total number concentration (N_{total}) of the Reference TSI-CPC Model 3010. Multiple charge correction, internal diffusion losses and CPC flow corrections are included by using Lund evaluation software.

Final-Status of the Candidate: Correlation

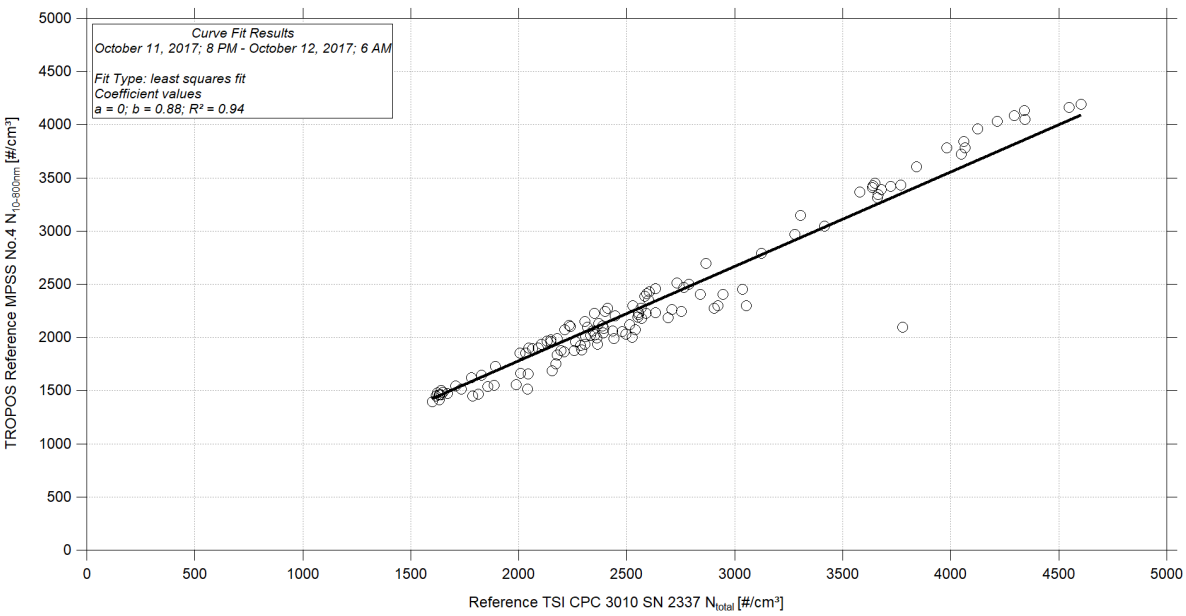

Figure 12: Linear regression between the number concentrations of the TROPOS Reference TSI CPC Model 3010 SN: 2337 and TROPOS Reference MPSS No.4 (October 11, 2017 08:00 PM – October 12, 2017 06:00 AM). Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

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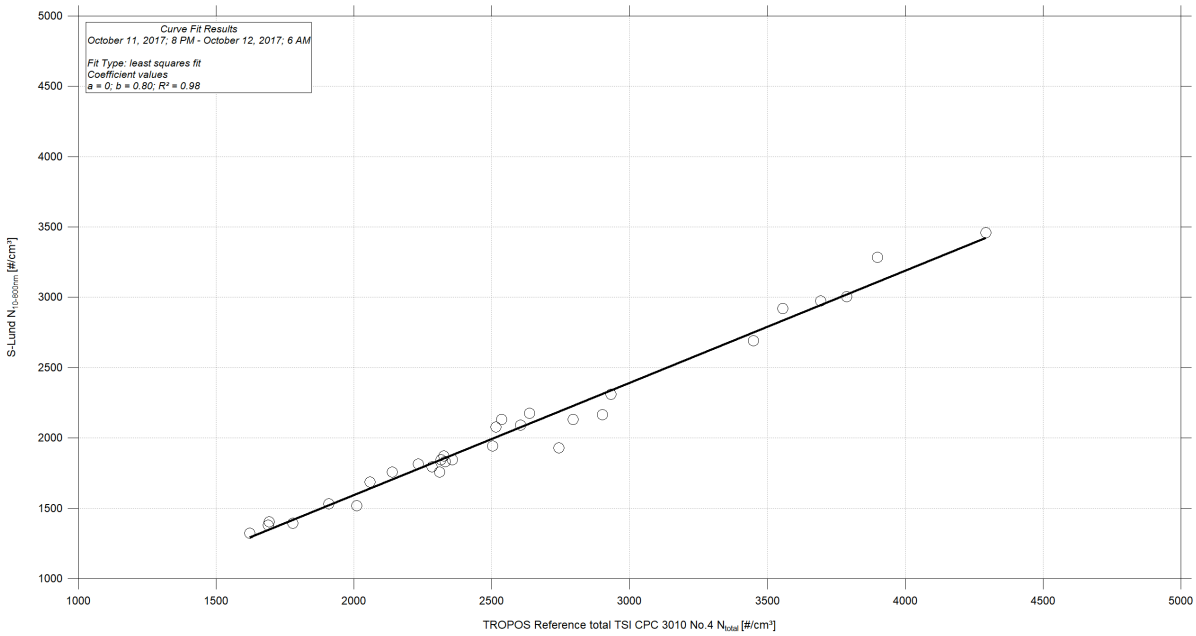

Figure 13: Linear regression between the number concentrations of the TROPOS Reference TSI CPC Model 3010 SN: 2337 and S-Lund (October 11, 2017 08:00 PM – October 12, 2017 06:00 AM).

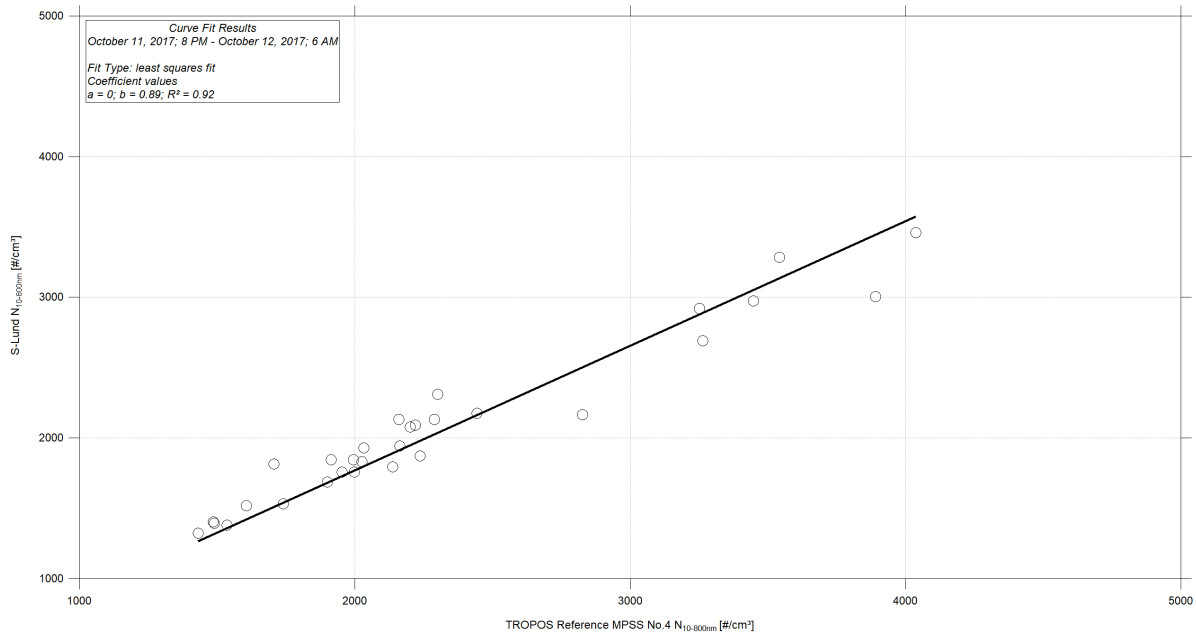

Figure 14: Linear regression between the number concentrations of the TROPOS Reference TSI CPC Model 3010 SN: 2337 and S-Lund (October 11, 2017 08:00 PM – October 12, 2017 06:00 AM). Internal diffusion losses and CPC flow corrections are included.

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